NATIONAL SCIENCE FOUNDATION

FY 2012 Budget Request to Congress

February 14, 2011

About the Cover
Microbe vs., Mineral — Life and Death Struggle in the Desert
Credit: Michael P. Zach, University of Wisconsin–Stevens Point

Although the bursts of rainbow colors in this photograph are mesmerizing, microbes fight for their lives in the background. Chemist Michael P. Zach of the University of Wisconsin–Stevens Point, snapped this image of a salt sample he collected in a hot, arid valley near Death Valley National Park in California. He crushed the salt, placed it under a microscope slide and added a drop of water. Suddenly, a slew of microbes came to life as the salt crystals dissolved. Then when the water started evaporating, he took a picture. The colors come from light passing through the growing crystals, which act like prisms. This image received an Honorable Mention in the 2009 International Science and Engineering Visualization Challenge sponsored by NSF and the journal *Science.*

For more information see: www.nsf.gov/news/special_reports/scivis/winners_2009.jsp

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NSF FY 2012 Budget Request to Congress

The National Science Foundation Act of 1950 (Public Law 81-507) sets forth our mission: ***To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.***

*The National Science Foundation Strategic Plan for FY 2011 – 2016, "Empowering the Nation Through Discovery and Innovation", defines our vision: "****a nation that capitalizes on new concepts in science and engineering and provides global leadership in advancing research and education."***

For 60 years the National Science Foundation (NSF) has played a central role in innovation by catalyzing the development of fundamental ideas in science and engineering and supporting the people who generate them. As the only federal agency dedicated to the support of basic research and education across all fields of science and engineering, and in a time when economic and environmental challenges are becoming increasingly pressing, NSF is positioned to strategically stimulate innovative research that connects the science and engineering enterprise with potential economic, societal, and educational benefit. NSF's high-risk, potentially transformative investments will continue to lead the way for the important discoveries and cutting-edge technologies that will help keep our Nation globally competitive, prosperous, and secure.

NSF's FY 2012 Budget Request is $7.767 billion, an increase of $894.49 million (13 percent) over the 2010 Enacted level. In addition, NSF will receive $1.0 billion over five years for research on improving access to wireless broadband through the Wireless Innovation (WIN) Fund proposed under the Administration's Wireless Innovation and Infrastructure Initiative (WI3).

NSF Funding by Account

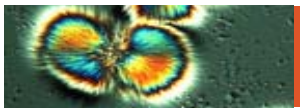
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Research & Related Activities[1]	$5,615.33	$439.17	$5,563.92	$6,253.54	$689.62	12.4%
Education & Human Resources	872.77	15.00	872.76	911.20	38.44	4.4%
Major Research Equipment & Facilities Construction	165.90	146.00	117.29	224.68	107.39	91.6%
Agency Operations & Award Management	299.85	-	300.00	357.74	57.74	19.2%
National Science Board	4.38	-	4.54	4.84	0.30	6.6%
Office of Inspector General	13.97	0.05	14.00	15.00	1.00	7.1%
Total, NSF	**$6,972.20**	**$600.22**	**$6,872.51**	**$7,767.00**	**$894.49**	**13.0%**

Totals may not add due to rounding.

[1] Funding for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, NSF is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level by account provided by the continuing resolution.



NSF: The Innovation Agency

The NSF Strategic Plan for FY 2011-FY 2016, "Empowering the Nation Through Discovery and Innovation," [1] builds on lessons learned from past accomplishments and provides a clear map for future successes by refining NSF's vision statement and strategic goals to align with both Administration and agency priorities. The plan establishes an overarching vision for NSF's role in the Nation's innovation enterprise: "a nation that capitalizes on new concepts in science and engineering and provides global leadership in advancing research and education." The plan outlines three major goals for NSF:

- **"Transform the Frontiers"** embraces NSF's unique role in supporting fundamental, interdisciplinary, high-risk, and transformative research and education, including building human capacity through educating tomorrow's science, technology, engineering, and mathematics (STEM) workforce;
- **"Innovate for Society"** focuses on linking the results of fundamental research to national and global policy areas where science and engineering play a significant role and on engaging the STEM workforce and the Nation overall in addressing pressing national challenges; and
- **"Perform as a Model Organization"** sets high standards for attaining excellence in operational activities, promotes a culture of integrity and accountability, and encourages new approaches to assessment and evaluation of NSF's investment portfolio.

NSF: The Innovation Agency. To fuel the innovations of the future, NSF continues to support fundamental research and education in all fields of science and engineering. The President's Plan for Science and Innovation aims to double the federal investment in key basic research agencies. NSF's FY 2012 Budget Request to Congress is consistent with this plan.

NSF is committed to both maintaining and growing its basic research core and enabling the emergence of transformational work, new fields, and new theoretical paradigms, particularly through multidisciplinary and agency-wide mechanisms that reflect the increasingly interdisciplinary nature of modern science and engineering. The FY 2012 Budget Request demonstrates how the innovative programs, portfolios, and initiatives created and cultivated within the Foundation align with the Administration's *Strategy for American Innovation.*

Invest in the Building Blocks of American Innovation: New interdisciplinary partnerships within NSF will produce new ways of thinking and solving problems, and educational programs to train the STEM workforce will build the human capacity necessary for tomorrow's innovations. NSF is already poised to assume leadership in orchestrating responses to problems posed in new decadal surveys and key national reports, including challenges raised in the recent President's Council of Advisors on Science and Technology (PCAST) *Prepare and Inspire* report on K-12 STEM education, and the *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5* report by the same committee that authored the seminal 2005 report. FY 2012 highlights include:

- **Growth in Research Grants** The FY 2012 Request supports approximately 2,000 additional research grants over the FY 2010 Enacted level, for a 27.8 percent increase.

[1] This plan was completed before the enactment of the GPRA Modernization Act of 2010. NSF therefore expects to have an updated plan in FY 2013 to address the requirements in the new legislation.

- **Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE)** ($12.35 million), a new effort for FY 2012, will catalyze interdisciplinary research by seamlessly integrating a suite of new activities with existing efforts and other NSF investments so as to foster and support transformative research through interdisciplinary research (IDR) proposals. INSPIRE awards will support senior and junior single investigators, as well as small groups of researchers, to enable innovative and transformative IDR breakthroughs.
- **Science and Engineering Beyond Moore's Law (SEBML)** ($96.18 million) is a multidisciplinary research investment that aims to surpass the physical and conceptual limits that will halt computer processing development within the next 10 to 20 years. SEBML supports new scientific, mathematical, engineering, and conceptual frameworks, which are needed for computer hardware and architecture advances that will address challenges such as efficient input and output, data storage and communication, and reduction of energy consumption, as well as sheer computing power. SEBML research also enhances NSF investments in both the National Nanotechnology Initiative (NNI) and in Networking and Information Technology Research and Development (NITRD).
- **Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS*)*** ($76.14 million), is a collaboration among the Directorates for Biological Sciences, Engineering, and Mathematical and Physical Sciences that aims to result in accelerated understanding of biological systems, and then apply that knowledge into fundamental understanding and new technologies, particularly clean energy.
- **Science, Technology, Engineering, and Mathematics (STEM) Education programs** promote innovative research, development, and evaluation of learning and teaching across all ages and STEM disciplines. In FY 2012, new programs include:
  - **Teacher Learning For the Future (TLF)** ($20.0 million) focuses on the potential to improve the training of pre-service, in-service, and future generations of teachers as the structure of formal education changes and the boundaries of in-school and out-of-school learning blur;
  - **Widening Implementation and Demonstration of Evidence-based Reforms (WIDER)** ($20.0 million) aims to widely transform STEM education for undergraduates by supporting research on how to achieve widespread sustainable implementation of undergraduate instructional practices leading to improved student outcomes in STEM at major universities through demonstration models; and
  - **Transforming Broadening Participation through STEM (TBPS**) ($20.0 million), a new pilot program that will be launched in FY 2012. This new program will seek innovative solutions for broadening participation in STEM at the undergraduate level in anticipation of tomorrow's changing demographics, including increased engagement with Hispanic-serving institutions.
- **The Faculty Early Career Development program (CAREER)** ($221.96 million) develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating the excitement of research with inspired teaching and enthusiastic learning. In FY 2012, NSF will support approximately 60 more CAREER awards than at the FY 2010 Enacted level, for a total of 606 new awards. The CAREER portfolio includes projects that range across all fields of science and engineering supported by the Foundation, including high priority fields such as clean energy, climate change, STEM education, and cybersecurity.
- **The Graduate Research Fellowship program (GRF)** ($198.14 million) supports the development of students and early-career researchers in order to cultivate the next generation of STEM workers. In FY 2012, 2,000 new fellowship offers will be made, maintaining the doubling of new fellowship awards achieved in FY 2010. In addition, the cost of education (COE) allowance will be increased from $10,500 to $12,000, the first increase in this level since 1998. NSF will also begin implementing a multi-year plan to address inflationary pressures on the long-stagnant GRF stipend level, including initial funding in FY 2012 for a stipend increase to $32,000 that will be fully implemented in FY 2013. Additional stipend increases are planned beyond FY 2013.

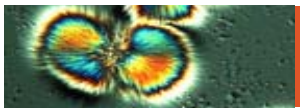
- **Community college funding** ($100.0 million) is a continued priority in FY 2012. As President Obama noted at the October 2010 White House Summit on Community Colleges, these institutions provide "a gateway to millions of Americans to good jobs and a better life." NSF plans to expand and strengthen efforts to engage community colleges through several core research and development programs, including Advanced Technological Education (ATE), Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES), the Louis Stokes Alliances for Minority Participation (LSAMP), and the Tribal Colleges and Universities Program (TCUP).

***Promote Competitive Markets that Spur Productive Entrepreneurship*:** Advances in technology, economic growth, and society depend upon the conversion of fundamental discoveries into new processes, practices, or new commercial products that are widely used. Many NSF activities incentivize scientists, engineers, and educators to undertake use-inspired research that translates and transforms basic discoveries into applications for the benefit of society and the economy. FY 2012 highlights include:

- **Advanced Manufacturing** ($190.40 million) holds tremendous potential for significant short-term and long-term economic impact by promising entirely new classes and families of products that were previously unattainable. In FY 2012, NSF's increased investment emphasizes several emerging opportunities including cyber–physical systems, advanced robotics research, scalable nanomanufacturing, sensor and model-based smart manufacturing, educational activities to support training the next generation of product designers and engineers, and industry-university cooperation.
- **The Wireless Innovation (WIN) Fund,** a component of the Administration's new Wireless Innovation and Infrastructure Initiative (WI3), will provide $1.0 billion to NSF over the next five years. WI3 proposes to reallocate a total of 500 megahertz of federal agency and commercial spectrum bands over the next ten years to increase the Nation's access to wireless broadband. NSF will support research on experimental wireless technology testbeds, more flexible and efficient use of the radio spectrum, and cyber-physical systems such as wireless sensor networks for smart buildings, roads, and bridges. WIN is to be funded through receipts generated through electromagnetic spectrum auctions. NSF's FY 2012 investments from the WIN are expected to total $150.0 million, and will be coordinated with a number of other agencies including the Defense Advanced Research Projects Agency and the National Institute of Standards and Technology.
- **Enhancing Access to the Radio Spectrum (EARS)** ($15.0 million), in addition to related research funded through the WIN, will support research into new and innovative ways to use the radio spectrum more efficiently so that more applications and services used by individuals and businesses can occupy the limited amount of available spectrum. While the first year of the EARS program will be run entirely by NSF, it is hoped that future years can involve inter-agency solicitations that draw upon additional expertise, interests, and funding from other federal agencies to insure that the program is meeting broad federal objectives, consistent with the mission of NSF.
- **Engineering Research Centers (ERCs) and Industry/University Cooperative Research Centers (I/UCRC)** ($96.15 million total) focus much of their basic research on problems with potential economic impact. By working closely with industry, these programs create enabling technologies for national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new healthcare information and telecommunications technologies. They also prepare students for innovation leadership in a globally competitive marketplace.
- **The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs** ($146.88 million total) support innovation research and build partnerships between the academic and industry sectors. They bolster the innovation economy by funding translational research at U.S. small businesses on topics that span the breadth of NSF scientific and engineering research and reflect national and societal priorities.

Catalyze Breakthroughs for National Priorities: In FY 2012, NSF will focus on key national priority areas, which require the expertise of physical, biological, and social scientists and engineers, as well as educators at all levels. NSF-catalyzed research includes investments in clean energy and the advancing fields of bio- and nanotechnology, areas that are poised for innovative breakthroughs. FY 2012 highlights include:

- **Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)** ($117.0 million), a new portfolio in FY 2012, builds on NSF's long history of providing leadership for cyberinfrastructure and computational science for the U.S. academic science and engineering community. CIF21 will develop and deploy comprehensive, integrated, sustainable, and secure cyberinfrastructure (CI) to accelerate research and education and new functional capabilities in computational and data-intensive science and engineering, thereby transforming our ability to effectively address and solve the many complex problems facing science and society.
- **The Science, Engineering, and Education for Sustainability (SEES) portfolio** ($998.19 million) consists of programs that spark innovations for tomorrow's clean energy solutions with a cross-disciplinary approach to sustainability science. SEES is designed to foster innovative insights about the environment-energy-economy nexus that will increase the effectiveness of our energy and management policies in adapting to and mitigating the impacts of climate change and improve our capabilities for rapid response to extreme events. SEES foci for FY 2012 include mechanisms for both research and education in sustainability, including research on Sustainable Energy Pathways (SEP), a formal program of Postdoctoral Fellowships in Sustainable Solutions, and targeted awards in the Partnerships for International Research and Education (PIRE) program.
- **Clean Energy investments** ($576 million) that will lead to future clean energy and energy efficiency technologies are seen throughout the NSF portfolio, in core research programs and activities such as BioMaPS and SEES. In addition, NSF participates in the Climate Change Technology Program (CCTP), an interagency activity with significant focus on clean energy research.
- **The National Nanotechnology Signature Initiatives** ($117.40 million) have the potential to both impact downstream applications that promise widespread economic benefit and improve national and homeland security. In FY 2012, NSF will participate in Nanotechnology for Solar Energy Collection and Conversion, Sustainable Nanomanufacturing – Creating the Industries of the Future, and Nanoelectronics for 2020 and Beyond. Through these, NSF also creates a significant investment in advanced manufacturing.
- **National Robotics Initiative (NRI)** ($30.0 million) is a new interagency initiative for FY 2012 that partners NSF with the National Aeronautics and Space Administration, National Institutes of Health, and the U.S. Department of Agriculture. NRI is a concerted program to provide U.S. leadership in science and engineering research and education aimed at the development of next generation robotics, conceived as robots that work beside, or cooperatively, with people in areas such as manufacturing, space and undersea exploration, healthcare and rehabilitation, military and homeland surveillance and security, education and training, and safe driving.



Interagency Activities

U.S. Global Change Research Program (USGCRP), (33.2 percent increase to $425.11 million). The USGCRP engages thirteen U.S. agencies in efforts to advance basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. FY 2012 investments are increased as part of an NSF's emphasis on clean energy and SEES. Research focuses on: improving knowledge of climate variability and change; understanding of natural and human forces of climate change; improving modeling and predicting capability for conditions and impacts; assessing the Nation's vulnerability to climate change; and providing climate information and decision support tools.

Climate Change Technology Program (CCTP), (144.5 percent increase to $62.96 million). CCTP is a multiagency effort to advance climate change research and development, demonstration, and technology adoption. As part of a FY 2012 clean energy emphasis, NSF participates in all six CCTP goals: reductions in energy end use and infrastructure emissions; reduction in energy supply emissions; carbon dioxide capture and sequestration; reduction of non-carbon dioxide gas emissions; improvements in measuring and monitoring greenhouse gases; and to bolster basic science and strategic research.

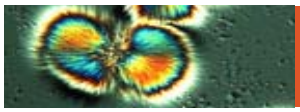
Networking and Information Technology Research and Development (NITRD), (15.3 percent increase to $1,257.67 million). NITRD coordinates the unclassified networking and information technology research and development investments across thirteen federal agencies. Funding foci for FY 2012 include human-computer interaction and information management, high-end computing infrastructure and applications, large scale networking, and cybersecurity and information assurance. Several NSF-wide investments are reflected in these foci, including CIF21, SEES, NRI, EARS, CNCI, and research on advanced manufacturing.

National Nanotechnology Initiative (NNI), (10.6 percent increase to $455.95 million). NNI is coordinated with 25 departments and agencies across the federal government. In FY 2012, NSF increases investments in Nanomanufacturing, Nanoscale Devices & Systems, and Environmental, Health and Safety, and funds the three Signature Initiatives: 1) Nanoelectronics for 2020 and Beyond, 2) Sustainable Nanomanufacturing, and 3) Nanotechnology for Solar Energy Collection and Conversion.

Homeland Security Activities, (9.2 percent increase to $425.85 million). NSF funds homeland security by funding research in two general areas: protecting critical infrastructure and key assets and defending against catastrophic threats. 73 percent of these funds are applied towards research in cybersecurity, emergency planning and response, and risk management, modeling, and simulation of resilient infrastructure.

FY 2012 Interagency Activities
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
U.S. Global Change Research Program	$319.55	-	$319.06	$425.11	$106.05	33.2%
Climate Change Technology Program	27.57	-	25.75	62.96	37.21	144.5%
Networking and Information Technology R&D	1,105.56	-	1,090.48	1,257.67	167.19	15.3%
National Nanotechnology Initiative	428.67	17.72	412.21	455.95	43.74	10.6%
Homeland Security Activities	391.19	-	390.03	425.85	35.82	9.2%



Major Research Equipment and Facilities Construction

In FY 2012, NSF will continue construction of five projects: Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO), the Advanced Technology Solar Telescope (ATST), the Atacama Large Millimeter Array (ALMA), National Ecological Observatory Network (NEON), and the Ocean Observatories Initiative (OOI).

All of the projects in the MREFC account undergo major cost and schedule reviews, as required by NSF guidelines.

- **Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO).** A planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO), AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection.
- **Advanced Technology Solar Telescope (ATST).** ATST will enable study of the Sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that affect Earth's civil life and may impact its climate.
- **Atacama Large Millimeter Array (ALMA).** ALMA, the world's most sensitive, highest resolution, millimeter wavelength telescope, will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself.
- **National Ecological Observatory Network (NEON).** NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research.
- **Ocean Observatories Initiatives (OOI).** OOI will enable continuous, interactive access to the ocean via multiple types of sensors linked by cutting-edge cyberinfrastructure, which will produce never-before-seen views of the ocean's depths.

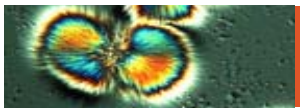
MREFC Account Funding, by Project
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO)	$46.30	-	$46.30	$20.96
Advanced Technology Solar Telescope (ATST)	20.00	146.00	13.00	10.00
Atacama Large Millimeter Array (ALMA)	42.76	-	42.76	3.00
IceCube Neutrino Observatory	2.38	-	0.95	-
National Ecological Observatory Network (NEON)	-	-	-	87.92
Ocean Observatories Initiative (OOI)	20.19	-	14.28	102.80
Other Projects[/1]	34.27	-	-	-
Total, MREFC	**$165.90**	**$146.00**	**$117.29**	**$224.68**

Totals may not add due to rounding.

[/1]Other projects with funding in FY 2010 include the Alaska Region Research Vessel (ARRV) and South Pole Station Modernization (SPSM).

A full-year 2011 appropriation for the MREFC account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level by project provided by the continuing resolution.



Model Organization

The FY 2012 Request includes $493.59 million (an increase of $63.84 million) for activities aimed at assuring that NSF will be able to effectively and efficiently manage its operations. Funds will support:

- **Staff,** 40 additional full-time equivalents (a total of 1,365 FTE). No additional IPAs are requested;
- **IT investments** ($85.77 million), such as NSF financial system modernization (iTRAK), Research.gov expansion, and improvements to the operational IT system's reliability and security;
- **Headquarters lease expiration** ($44.65 million), funding to effectively plan and prepare for a new headquarters lease; and
- **Acquisition** ($2.0 million), part of the government-wide effort to strengthen the acquisition workforce, including improving capabilities in the pre-solicitation phase of major acquisitions.

Evaluation and Performance

NSF is committed to promoting strong, independent evaluation that can inform its policy decisions, program management, and performance, and sharing publicly available findings online.

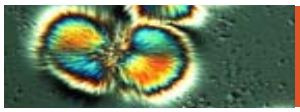
- **Priority Goal:** in FY 2012, NSF's goal to "Improve the education and training of an innovative STEM workforce through evidence-based approaches…" expands to add undergraduate programs to the existing graduate, postdoctoral, and early career level workforce programs. NSF will also work to establish additional priority goals that reflect its overall commitment to STEM workforce development and advancing interdisciplinary research.
- **FY 2011 GPRA Performance Plan:** in the Performance Information chapter, NSF presents the GPRA Performance Plan, the first plan based upon the new NSF strategic plan. The GPRA plan is characterized by its application of experimental approaches towards performance assessment.
- **STAR METRICS (Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness and Science)** is a multi-agency venture to establish a data infrastructure for analyzing federal investments in research and development to a degree not previously possible. In FY 2012, NSF funding will meet commitments to interagency activities for developing this shared infrastructure.
- **Foundation-wide planning, analysis, and evaluation activities**: In FY 2012, NSF will continue to develop a centralized agency assessment and evaluation capacity, and explore ways to more clearly distinguish between process and outcome evaluation through modifications to the agency's Committee of Visitors activity.

Model Organization by Appropriations Account

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Agency Operations and Award Management	$299.85	-	$300.00	$357.74	$57.74	19.2%
Office of Inspector General	13.97	0.05	14.00	15.00	1.00	7.1%
National Science Board	4.38	-	4.54	4.84	0.30	6.6%
Research & Related Activities	97.45	-	96.47	100.62	4.15	4.3%
Education and Human Resources	14.83	-	14.74	15.39	0.65	4.4%
Total	**$430.48**	**$0.05**	**$429.75**	**$493.59**	**$63.84**	**14.9%**

Totals may not add due to rounding.



Terminations/Reductions

NSF continually undergoes a portfolio assessment process, in order to ensure that investments are closely aligned with agency priorities and to keep at the cutting edge of innovative science and engineering research. In FY 2012, within the context of evolving programmatic directions, NSF proposes six programs for permanent termination or reduction.

Deep Underground Science and Engineering Laboratory (DUSEL): NSF eliminates funding for DUSEL, which had been pursued in conjunction with the U.S. Department of Energy's (DOE) Office of Science. This termination is based on National Science Board reviews that concluded the cost and scope of DUSEL were inconsistent with the agency's role in advancing fundamental research and education across many fields and disciplines. NSF will continue to solicit proposals for future particle physics research. No funding is required in FY 2012 for DUSEL.

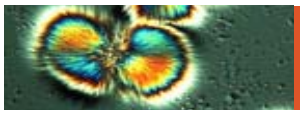
Graduate STEM Fellows in K-12 Education: NSF eliminates the agency-wide Graduate STEM Fellows in K-12 Education (GK-12) program. While the program has been effective in meeting its overall goals, recent evaluation findings indicate that the effects of this program's fellowship experience in improving research skills is mixed, and program design limits the ability of participants to gain in-depth experience in K-12 teaching. NSF plans to build on the experiences gained during the ten years of GK-12 funding to widen the breadth of graduate traineeship experiences through other programs.

National STEM Distributed Learning Program (NSDL): NSF eliminates funding for the NSDL program (formerly the National STEM Digital Library). While NSDL has been successful in meeting its original goals, an October 2010 preliminary evaluation by the RAND Corporation, *Steps Toward a Formative Evaluation of NSDL: Phase* 2, noted the challenges of sustaining the collection in the face of changing technology, and raised concerns about the currency of the collections, peer review of collections, collaboration across pathways, and lack of standardization. NSF plans to build from the substantial NSDL experience to address key areas in cyberlearning through other programs and activities, such as Cyberlearning Transforming Education (CTE). No funding is required in FY 2012 for NSDL.

Research Initiation Grants to Broaden Participation in Biology: NSF eliminates funding for the Research Initiation Grants to Broaden Participation in Biology program (RIG) because it did not achieve the goal of broadening participation in biology; the number of proposals from underrepresented groups did not increase. RIG concludes in FY 2011.

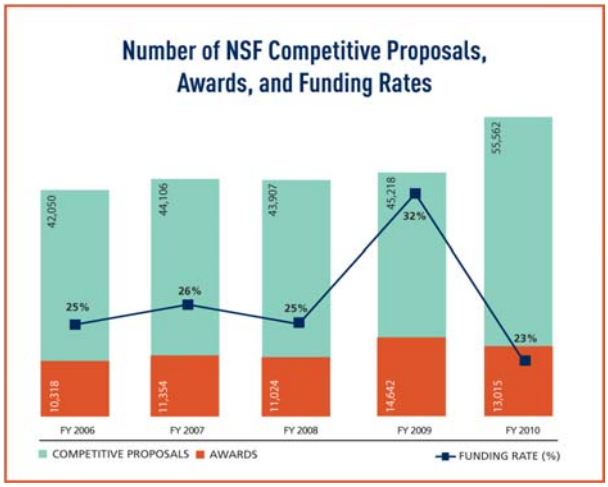
Science of Learning Centers (SLC): NSF proposes to reduce funding for the SLC program, which currently supports six large-scale, long-term centers that conduct science of learning research. The on-going center review process and reviews from an external May 2010 Advisory Committee both recommended that NSF phase the program down as funding for individual centers concludes and shift resources wherever possible to enhance support for the science of learning using non-center mechanisms. NSF expects there may be additional reductions to this program in FY 2013 and beyond, as funding for individual centers comes to a close.

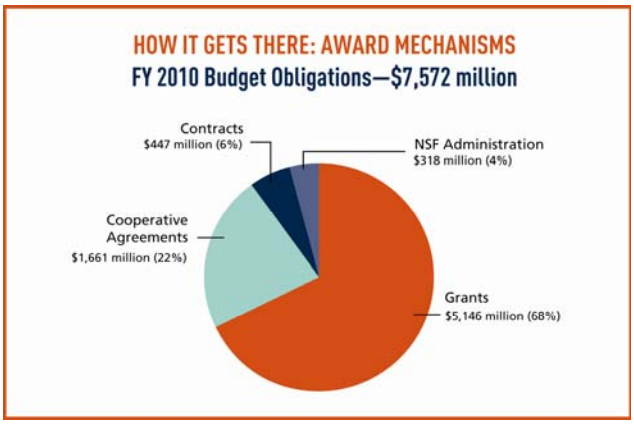
Synchrotron Radiation Center (SRC): NSF eliminates funding for the Synchrotron Radiation Center facility at the University of Wisconsin. The SRC is 30 years old, and more powerful and capable facilities have come on-line since 1980.



NSF by the Numbers

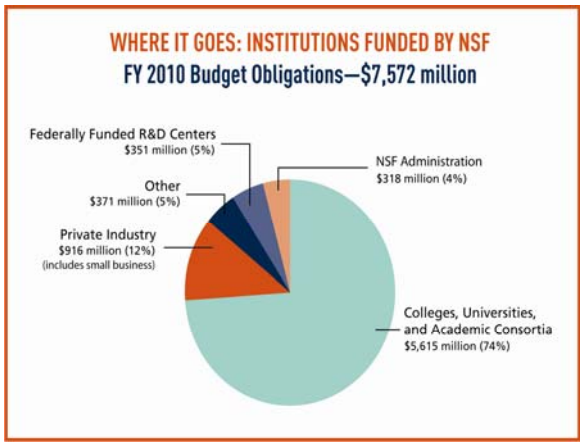
NSF by The Numbers: In FY 2010 NSF evaluated 55,600 proposals through a competitive merit process and made approximately 13,000 new awards. Nearly 287,000 proposal reviews were conducted, and nearly 46,000 members of the science and engineering community participated as panelists and proposal reviewers. NSF awards were made to 2,100 colleges, universities, and other public and private institutions in 50 states, the District of Columbia, and Puerto Rico. NSF supports approximately 294,000 researchers, postdoctoral fellows, trainees, teachers, and students.





Ninety percent of NSF's FY 2010 projects were funded using grants or cooperative agreements. Grants can be funded either as standard awards, in which funding for the full duration of the project is provided in a single fiscal year, or as continuing awards, in which funding for a multi-year project is provided in increments. Cooperative agreements are used when the project requires substantial agency involvement during the project performance period (e.g., research centers, multi-user facilities, etc.). Contracts are used to acquire products, services, and studies (e.g., program evaluations) required primarily for NSF or other government use.

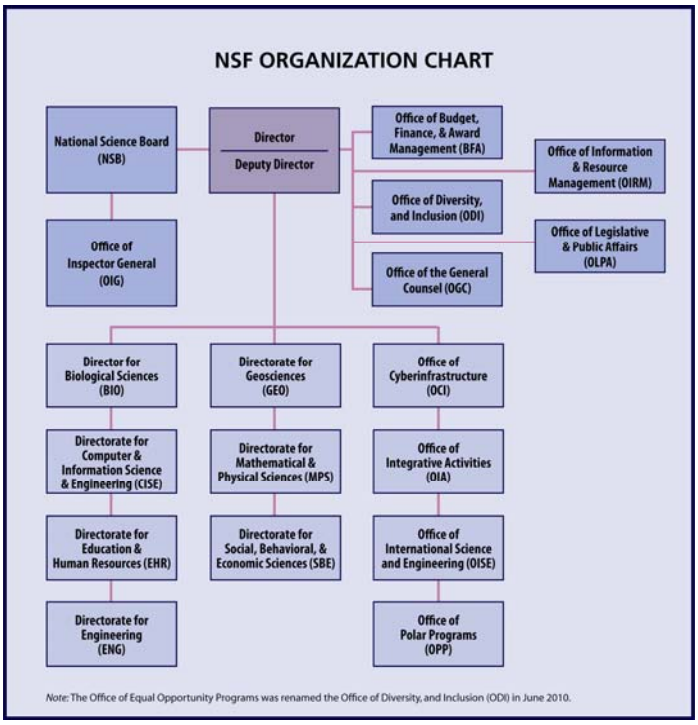
Most NSF awards are to academic institutions. Nonprofit organizations include state and local governments and international organizations. For-profit businesses include private and small businesses. Federal agencies and laboratories include funding for Federally Funded R&D Centers.



Note: NSF Administration includes three appropriation accounts—AOAM, OIG, and NSB—that support salaries, general operating expenses, and the activities of the OIG and NSB. NSF also funds other operational activities—totaling $112 million in FY 2010—through the R&RA and EHR appropriations. These are principally associated with staff working at NSF under the Intergovernmental Personnel Act and certain NSF-wide activities, including information technology investments that are directly related to programmatic investments. This larger portfolio is captured by the NSF Stewardship goal, which for FY 2010 was $431 million, or 6 percent of NSF's total obligations.

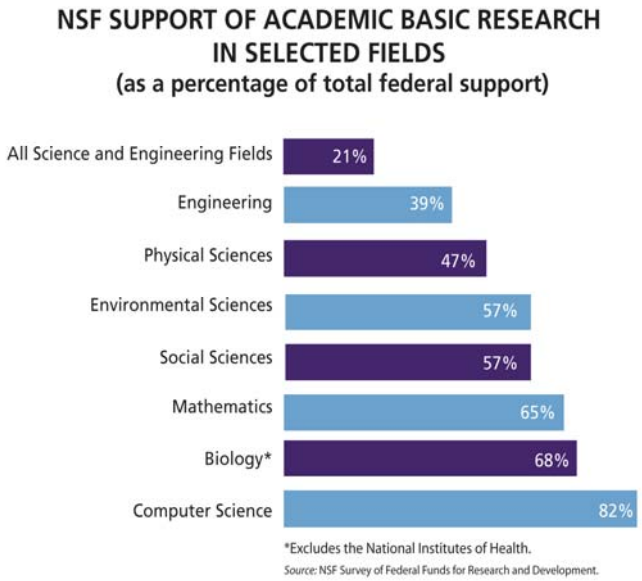
Organization and Role in the Federal Research Enterprise

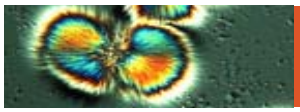
NSF's comprehensive and flexible support of meritorious projects with broad societal impacts enables the Foundation to identify and foster both fundamental and transformative discoveries within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes — and even transforms — the very frontiers of knowledge. In these ways, NSF's discoveries inspire the American public— and the world.



NSF's organization represents the major science and engineering fields, including: biological sciences; computer and information science and engineering; engineering; geosciences; mathematical and physical sciences; and social, behavioral, and economic sciences. NSF also carries out specific responsibilities for education and human resources, cyberinfrastructure, integrative activities, international science and engineering, and polar programs. The 25-member National Science Board sets the overall policies of the Foundation.

NSF's annual budget represents 21 percent of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to 61 percent when medical research supported by the National Institutes of Health is excluded. In many fields NSF is the primary source of federal academic support.

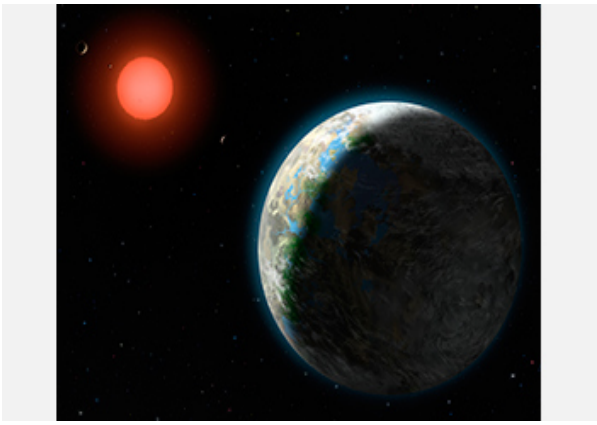




Highlights

Newly Discovered Planet May Be First Truly Habitable Exoplanet

A team of planet hunters announced the discovery of an Earth-sized planet orbiting a nearby star at a distance that places it squarely in the middle of the star's "habitable zone," where liquid water could exist on the planet's surface. The planet (about three times the mass of Earth) is one of six orbiting Gliese 581, a red dwarf star located about 20 light years from Earth. The discovery, led by astronomers at the University of California, Santa Cruz, and the Carnegie Institution of Washington, could be the most Earth-like planet yet found and the first case for a potentially habitable one.



Credit: Artwork by Lynette Cook

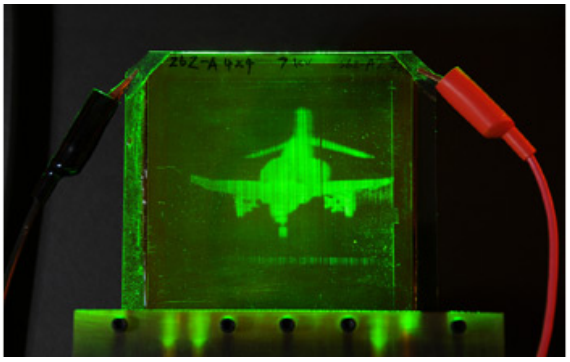
Credit: USDA ARS Image Gallery

Cyberinfrastructure for Research on Long-Term Ecological Phenomena

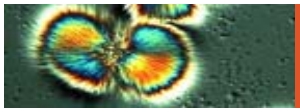
Researchers and students at the NSF CREST Cyber-ShARE Center of Excellence at the University of Texas at El Paso are developing the cyberinfrastructure required to collect environmental data and telemeter it to computer systems. This advances the research efforts at the Jornada Experimental Range, a Long-Term Ecological Research (LTER) site situated in the northern Chihuahuan Desert in southern New Mexico. The new instrumentation measures more than 200 variables including the exchange of energy, water, and carbon dioxide across the land-atmosphere boundary and facilitates linking these measurements with observations made from satellites, and employs software that is based upon algorithms first developed for managing large space missions. These measurements contribute to understanding how desert shrub lands are responding to environmental change and how these changes interact with the climate system.

The Emergence of Holographic Video

Researchers at the University of Arizona, Tucson, have developed a holographic system that can transmit a series of 3-D images in near-real-time, a precursor to holographic videoconferencing. The system can refresh holographic images and is scalable for production—coupled to a unique system for recording and transmitting 3-D images of individuals and objects via Ethernet. And the images can be viewed without special eyewear, such as 3-D glasses.



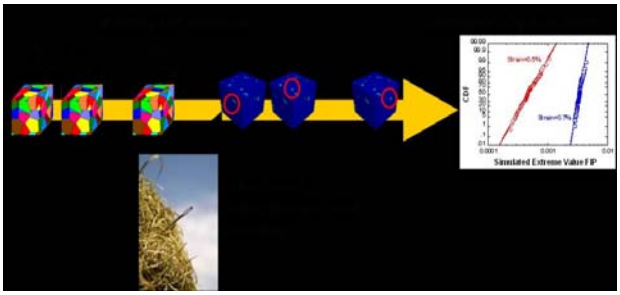
Credit: University of Arizona



Highlights

Modeling and Simulations for Designing Materials against a 'Needle in a Haystack'

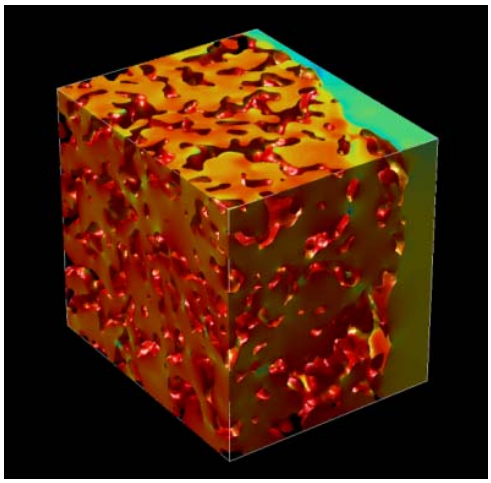
Penn State University and the Georgia Institute of Technology have collaborated under an IUCRC grant to create a model that will create digital simulation of "rare events" ranging from 500 year floods to structural fatigue cracking. The project is focused on designing fatigue resistant materials by running "virtual experiments" that are much less costly and time consuming then their physical counterparts. Their work will assist in accelerated insertion of new or improved fatigue resistant alloys in a range of fields, including aerospace, automotive, and rail applications.



Credit: C. Przybyla and D.L. McDowel

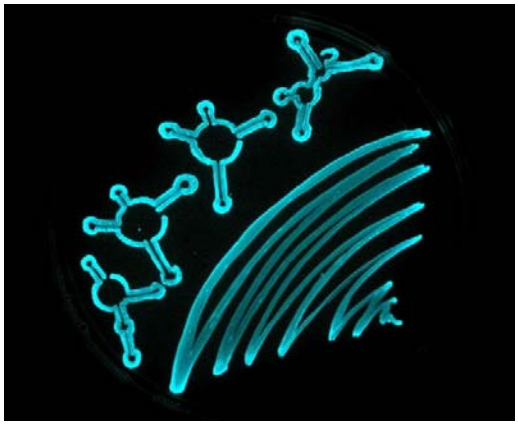
New Methods for Imaging Fuel Cells

Researchers funded by the American Recovery and Reinvestment Act are developing new methods for imaging and characterizing solid oxide fuel cells (SOFCs). SOFCs offer an important new option for converting fuels to electricity with increased efficiency, reduced pollution, and reduced greenhouse gas emissions. Better imaging can be used to determine what structures yield improved performance and hence reduced cost, find manufacturing conditions that yield the desired structure and chemistry, and examine the factors causing fuel cells to degrade over time. The improved structural and chemical information will be disseminated to the fuel cell research and development community where it will help enable critical connections between researchers and developers.



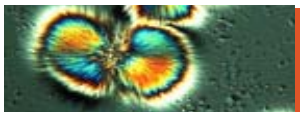
Credit: Katsuyo Thornton, University of Michigan

Scientists Eavesdrop on Bacteria Conversation



Credit: Dr. Jennifer Henke, Princeton University

Bonnie Bassler, a researcher at Princeton University, listens to bacteria talk to one another. It turns out bacteria communicate using a chemical language, and what they are saying amounts to a roll call, or quorum sensing. The tiny organisms form a social network and communicate to count how many of their own kind are present before they try to mount an attack on their host organism. As Bassler explains, bacteria "are too small to have an impact on the environment if they simply act as individuals." Bassler's work in bacterial communication may one day lead to new types of antibiotics.



Highlights

Credit: Patrick O'Connor, Worcester Polytechnic Institute

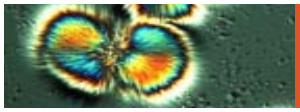
Meet Melvin, the Collaborative Robot

Melvin is a specially constructed humanoid robot that Professor Charles Rich and his students at Worcester Polytechnic Institute are using to investigate human-robot interaction. Melvin has a moveable head, arms and an expressive face, and is mounted on a two-wheeled mobile base. A speaker, microphone array, and stereo camera let it talk, hear, and see. Melvin is connected to several computers that run various kinds of artificial intelligence software, including programs for computer vision, natural language and speech understanding and generation, and planning and dialogue modeling. Together, these programs support autonomous interaction with humans. During the past year, the project has produced the first in a series of reusable open-source software modules, which are being made available to other robotics researchers and developers, so that the human-robot interaction rules discovered in this research can easily be applied to other robots. The first module embodies a set of rules called "engagement recognition," which have to do with noticing appropriate instances of looking and pointing at shared objects and making eye contact during an interaction.

Globally Sustainable Fisheries Possible With Co-Management

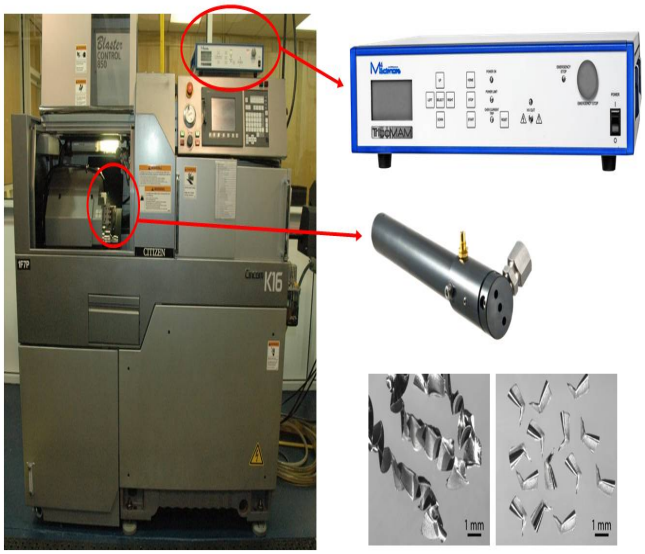
The bulk of the world's fisheries — including the kind of small-scale, often non-industrialized fisheries that millions of people depend on for food — could be sustained using community-based co-management. Under such a management system, responsibility for resources is shared between the government and users. "Our findings show that many community-based co-managed fisheries around the world are well managed under limited central government structure, provided communities of fishers are proactively engaged," says Nicolas Gutiérrez, a University of Washington fisheries scientist and lead author of the report, published in *Nature*. This new work used data on 130 fisheries in 44 developed and developing nations, and included marine and freshwater ecosystems as well as diverse fishing gears and targeted species. Statistical analysis showed that co-management typically fails without prominent community leadership, social cohesion, clear incentives, and protected areas.

Credit: Sebastian Jimenez/DINARA.



Highlights

Transformative Machining Technology for Mechanical Drilling of Meso-scale Holes

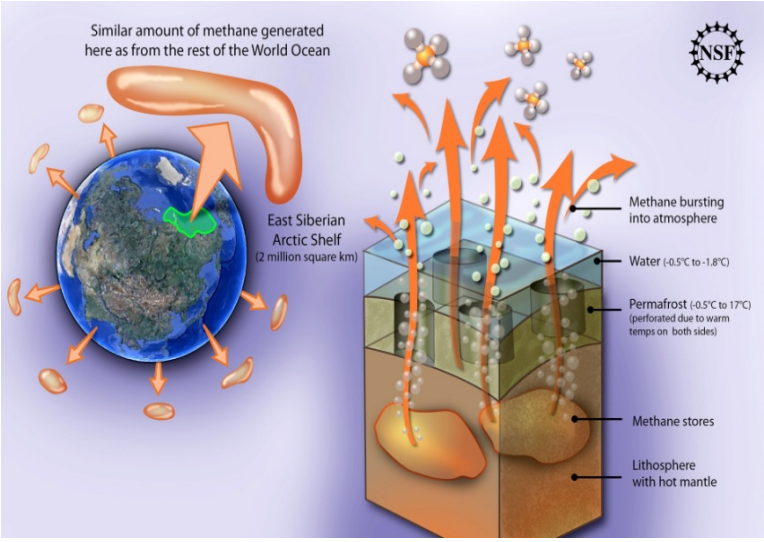


Credit: M4 Sciences LLC

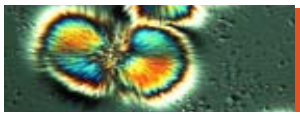
Through an STTR grant, M4 Sciences has created a new manufacturing tool for mechanical drilling of meso-scale holes. The new technique helps fill the demand for creation of smaller parts and features with enhanced performance capabilities. These are useful in a range of fields: in biomedical applications, medical devices must be small so as to be 'minimally invasive'; in electronics, the size of the components dictate the overall system size; and in automotive and aerospace sectors, efficiencies associated with increased strength-to-weight ratios are key drivers. Many products in these sectors incorporate small, complex features including meso-scale holes with length-to-diameter (L/D) aspect ratios typically greater than 10.

Methane Releases From Arctic Shelf May Be Much Larger and Faster Than Anticipated

A section of the Arctic Ocean seafloor that holds vast stores of frozen methane is showing signs of instability and widespread venting of the powerful greenhouse gas, according to the findings of an international research team led by University of Alaska Fairbanks scientists Natalia Shakhova and Igor Semiletov. The research results, published in the journal *Science*, show that the permafrost under the East Siberian Arctic Shelf, long thought to be an impermeable barrier sealing in methane, is perforated and is starting to leak large amounts of methane into the atmosphere.



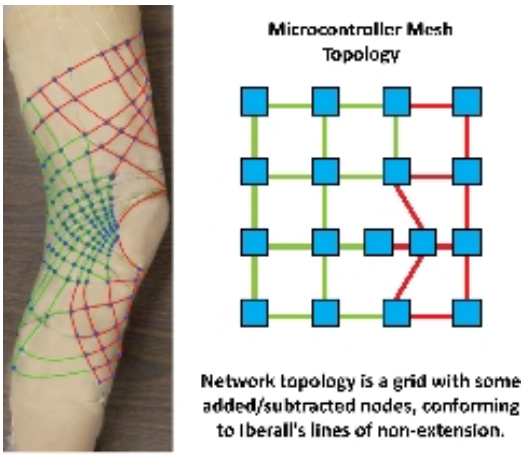
Credit: Zina Deretsky, National Science Foundation



Highlights

Could Clothing Teach Babies With Brain Injury How to Move?

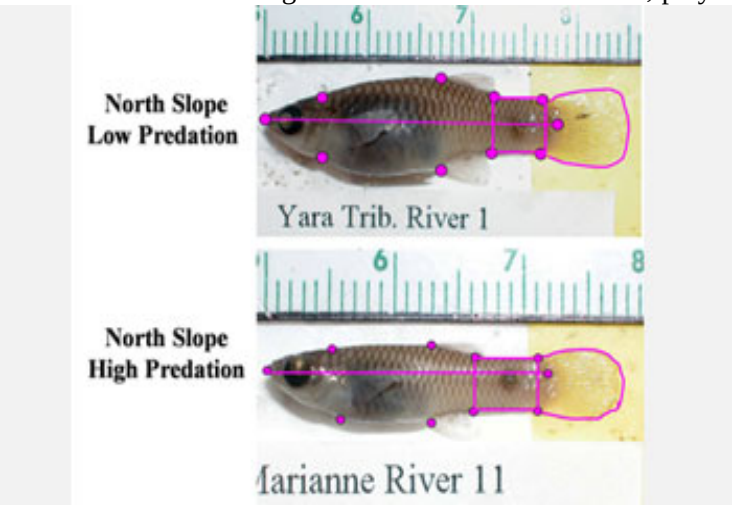
Psychologist Eugene Goldfield of the Center for Behavioral Science at Children's Hospital Boston, along with a team of engineers and scientists at the Wyss Institute, is in the early stages of a project that could help babies with cerebral palsy. Goldfield calls it the "second skin" — smart clothing whose fabric, studded with tiny sensors, would pick up attempts at motion.



Credit: Eugene Goldfield

Evolution Impacts Environment, Study Finds

Biologists have long known that ecology, the interaction between organisms and their environment, plays a significant role in forming new species and in modifying living ones. The traditional view is that ecology shapes evolution. But recently, biologists studying the impacts on artificial streams of guppies from two different stream communities presented evidence that ecology and evolution are reciprocally interacting processes, a fundamental shift in scientists' understanding of the relationship between evolution and ecology. The study documented how rapid, adaptive evolution within single species can cause substantial changes in ecosystem structure and function.



Credit: David Reznick

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National Science Foundation
Summary Table
FY 2012 Request to Congress

(Dollars in Millions)

NSF by Account	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2012 Request over: FY 2010 Omnibus Actual		FY 2012 Request over: FY 2010 Enacted	
					Amount	Percent	Amount	Percent
BIO	$714.77	$0.35	$714.54	$794.49	$79.72	11.2%	$79.95	11.2%
CISE	618.71	-	618.83	728.42	109.71	17.7%	109.59	17.7%
ENG	775.92	-	743.93	908.30	132.38	17.1%	164.37	22.1%
ENG Programs	*619.09*	-	*618.16*	*761.42*	*142.33*	*23.0%*	*143.26*	*23.2%*
SBIR/STTR	*156.84*	-	*125.77*	*146.88*	*-9.96*	*-6.3%*	*21.11*	*16.8%*
GEO	891.87	0.40	889.64	979.16	87.29	9.8%	89.52	10.1%
MPS	1,367.95	15.70	1,351.84	1,432.73	64.78	4.7%	80.89	6.0%
SBE	255.31	0.25	255.25	301.13	45.82	17.9%	45.88	18.0%
OCI	214.72	-	214.28	236.02	21.30	9.9%	21.74	10.1%
OISE	47.84	0.10	47.83	58.03	10.19	21.3%	10.20	21.3%
OPP[2]	451.77	2.23	451.16	477.41	25.64	5.7%	26.25	5.8%
IA	274.89	420.15	275.04	336.25	61.36	22.3%	61.21	22.3%
U.S. Arctic Research Commission	1.58	-	1.58	1.60	0.02	1.3%	0.02	1.3%
Research & Related Activities	**$5,615.33**	**$439.17**	**$5,563.92**	**$6,253.54**	**$638.21**	**11.4%**	**$689.62**	**12.4%**
Education & Human Resources	**$872.77**	**$15.00**	**$872.76**	**$911.20**	**$38.43**	**4.4%**	**$38.44**	**4.4%**
Major Research Equipment & Facilities Construction	**$165.90**	**$146.00**	**$117.29**	**$224.68**	**$58.78**	**35.4%**	**$107.39**	**91.6%**
Agency Operations & Award Management	**$299.85**	-	**$300.00**	**$357.74**	**$57.89**	**19.3%**	**$57.74**	**19.2%**
National Science Board	**$4.38**	-	**$4.54**	**$4.84**	**$0.46**	**10.4%**	**$0.30**	**6.6%**
Office of Inspector General	**$13.97**	**$0.05**	**$14.00**	**$15.00**	**$1.03**	**7.4%**	**$1.00**	**7.1%**
Total, NSF	**$6,972.20**	**$600.22**	**$6,872.51**	**$7,767.00**	**$794.80**	**11.4%**	**$894.49**	**13.0%**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation for these accounts was not enacted at the time the budget was prepared; therefore, these accounts are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

[2] Funding for OPP for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

National Science Foundation
Research Infrastructure (RI) Funding, by Account, Activity and Subactivity
FY 2012 Request to Congress
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Omnibus Actual RI Funding	**FY 2010 ARRA Actual**	FY 2010 ARRA Actual RI Funding	**FY 2010 Enacted/ Annualized FY 2011 CR[1]**	FY 2010 Enacted/ Annualized FY 2011 CR RI Funding[1]	**FY 2012 Request**	FY 2012 Request RI Funding	FY 2012 Request RI Change over FY 2010 Enacted RI	
									Amount	Percent
BIO	**$714.77**	$127.57	**$0.35**	-	**$714.54**	$135.45	**$794.49**	$132.93	-$2.52	-1.9%
CISE	**618.71**	28.11	-	-	**618.83**	30.60	**728.42**	30.60	-	-
ENG	**775.92**	34.40	-	-	**743.93**	32.83	**908.30**	31.33	-1.50	-4.6%
GEO	**891.87**	393.53	**0.40**	-	**889.64**	367.79	**979.16**	364.96	-2.83	-0.8%
MPS	**1,367.95**	369.43	**15.70**	15.00	**1,351.84**	353.73	**1,432.73**	305.51	-48.22	-13.6%
SBE	**255.31**	42.48	**0.25**	-	**255.25**	43.56	**301.13**	58.04	14.48	33.2%
OCI	**214.72**	160.40	-	-	**214.28**	150.38	**236.02**	148.06	-2.32	-1.5%
OISE	**47.84**	0.10	**0.10**	-	**47.83**	0.10	**58.03**	0.10	-	-
OPP[2]	**451.77**	316.17	**2.23**	-	**451.16**	321.43	**477.41**	338.02	16.59	5.2%
IA	**274.89**	92.77	**420.15**	400.15	**275.04**	93.04	**336.25**	93.14	0.10	0.1%
U.S. Arctic Research Commission	**1.58**	-	-	-	**1.58**	-	**1.60**	-	-	N/A
Research & Related Activities	**$5,615.33**	$1,564.97	**$439.17**	$415.15	**$5,563.92**	$1,528.91	**$6,253.54**	$1,502.69	-$26.22	-1.7%
Education & Human Resources	**$872.77**	$15.80	**$15.00**	-	**$872.76**	$15.98	**$911.20**	-	-$15.98	-100.0%
Major Research Equipment & Facilities Construction	**$165.90**	$165.90	**$146.00**	$146.00	**$117.29**	$117.29	**$224.68**	$224.68	$107.39	91.6%
Agency Operations & Award Management	**$299.85**	-	-	-	**$300.00**	-	**$357.74**	-	-	N/A
National Science Board	**$4.38**	-	-	-	**$4.54**	-	**$4.84**	-	-	N/A
Office of Inspector General	**$13.97**	-	**$0.05**	-	**$14.00**	-	**$15.00**	-	-	N/A
Total, National Science Foundation	**$6,972.20**	**$1,746.67**	**$600.22**	**$561.15**	**$6,872.51**	**$1,662.18**	**$7,767.00**	**$1,727.37**	**$65.19**	**3.9%**

Totals may not add due to rounding.

[1] A full-year appropriation for these accounts was not enacted at the time the budget was prepared; therefore, these accounts are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

[2] In FY 2010, the Office of Polar Programs (OPP) excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

National Science Foundation
Research Infrastructure Summary
FY 2012 Request to Congress

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2012 Request change over: FY 2010 Omnibus Actual		FY 2012 Request change over: FY 2010 Enacted	
					Amount	Percent	Amount	Percent
Facilities	**$954.21**	**$361.00**	**$880.46**	**$982.41**	**$28.20**	**3.0%**	**$101.95**	**11.6%**
Academic Research Fleet	$78.04	-	$80.00	$69.35	-$8.69	-11.1%	-$10.65	-13.3%
Regional Class Research Vessels	-	-	*2.00*	*2.00*	*2.00*	*N/A*	-	-
RHOV Construction (R/V Alvin Replacement)	-	-	*5.00*	-	-	*N/A*	*-5.00*	*-100.0%*
R/V Langseth Construction (R/V Ewing Replacement)	-	-	-	-	-	*N/A*	-	*N/A*
Ship Operations and Upgrades	*78.04*	-	*73.00*	*67.35*	*-10.69*	*-13.7%*	*-5.65*	*-7.7%*
Academic Research Infrastructure[2]	-	200.00	-	-	-	N/A	-	N/A
Cornell High Energy Synchrotron Source (CHESS) \ Cornell Electron Storage Ring (CESR)	9.51	-	9.00	15.47	5.96	62.7%	6.47	71.9%
EarthScope: USArray, SAFOD, PBO	25.25	-	25.05	26.00	0.75	3.0%	0.95	3.8%
Gemini Observatory	19.10	-	19.10	20.07	0.97	5.1%	0.97	5.1%
Incorporated Research Institutions for Seismology	12.36	-	12.36	12.36	-	-	-	-
Integrated Ocean Drilling Program	50.80	-	43.40	45.40	-5.40	-10.6%	2.00	4.6%
Large Hadron Collider	18.00	-	18.00	18.00	-	-	-	-
Laser Interferometer Gravitational Wave Observatory	28.50	-	28.50	30.40	1.90	6.7%	1.90	6.7%
National Astronomy & Ionosphere Center	10.75	-	10.60	8.70	-2.05	-19.1%	-1.90	-17.9%
National High Magnetic Field Laboratory	40.53	15.00	35.56	33.30	-7.23	-17.8%	-2.26	-6.4%
National Nanotechnology Infrastructure Network (NNIN)	16.71	-	16.26	15.56	-1.15	-6.9%	-0.70	-4.3%
National Solar Observatory	9.10	-	9.10	9.79	0.69	7.6%	0.69	7.6%
National Superconducting Cyclotron Laboratory	21.00	-	21.00	21.50	0.50	2.4%	0.50	2.4%
Network for Earthquake Engineering Simulation	23.46	-	22.00	20.50	-2.96	-12.6%	-1.50	-6.8%
Other Facilities[3]	6.93	-	7.02	3.90	-3.03	-43.7%	-3.12	-44.4%
Polar Facilities and Logistics[4]	307.18	-	312.27	327.30	20.12	6.6%	15.03	4.8%
Other Facilities Investments								
Major Research Equipment & Facilities Construction[5]	220.55	146.00	163.54	292.21	71.66	32.5%	128.67	78.7%
Pre-construction Planning[6,7]	56.44	-	47.70	12.60	-43.84	-77.7%	-35.10	-73.6%
Federally Funded R&D Centers	**$202.45**	**-**	**$198.63**	**$205.85**	**$3.40**	**1.7%**	**$7.22**	**3.6%**
National Center for Atmospheric Research	96.29	-	97.00	100.00	3.71	3.9%	3.00	3.1%
National Optical Astronomy Observatories[7]	35.40	-	31.50	29.17	-6.22	-17.6%	-2.33	-7.4%
National Radio Astronomy Observatories[8]	67.73	-	67.09	73.54	5.81	8.6%	6.45	9.6%
Science and Technology Policy Institute	3.04	-	3.04	3.14	0.10	3.3%	0.10	3.3%
Other Research Instrumentation and Infrastructure	**$590.66**	**$200.15**	**$583.36**	**$539.11**	**-$51.55**	**-8.7%**	**-$44.25**	**-7.6%**
Major Research Instrumentation	89.99	200.15	90.00	90.00	0.01	0.0%	-	-
National STEM Education Distributed Learning	16.19	-	16.25	-	-16.19	-100.0%	-16.25	-100.0%
Networking & Computational Resources Infrastructure & Services	160.40	-	150.38	148.06	-12.34	-7.7%	-2.32	-1.5%
Polar Environment, Health & Safety	6.84	-	7.01	7.27	0.43	6.3%	0.26	3.7%
Research Resources[9]	283.50	-	285.50	256.08	-27.42	-9.7%	-29.42	-10.3%
National Center for Science & Engineering Statistics[10]	33.74	-	34.22	37.70	3.96	11.7%	3.48	10.2%
Subtotal, Research Infrastructure Support	**$1,747.32**	**$561.15**	**$1,662.45**	**$1,727.37**	**-$19.95**	**-1.1%**	**$64.92**	**3.9%**
Research Infrastructure Stewardship Offset	**-$0.65**	**-**	**-$0.27**	**-**	**$0.65**	**-100.0%**	**$0.27**	**-100.0%**
RESEARCH INFRASTRUCTURE TOTAL	**$1,746.67**	**$561.15**	**$1,662.18**	**$1,727.37**	**-$19.30**	**-1.1%**	**$65.19**	**3.9%**

Totals may not add due to rounding.

[1] A full-year appropriation for these accounts was not enacted at the time the budget was prepared; therefore, these accounts are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

[2] Awards for the Academic Research Infrastructure program were funded through ARRA.

[3] Other Facilities includes support for other physics and materials research facilities.

[4] Polar Facilities and Logistics funding includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM are included on the MREFC Projects line. In FY 2010, Polar Facilities and Logistics excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[5] Funding levels for MREFC projects in this table include support for: a) concept and development associated with ongoing and requested MREFC projects provided through the R&RA account, specifically for NEON; b) initial support for operations and maintenance provided through the R&RA account (except for ALMA, which is included in the funding for NRAO); and c) construction implementation support provided through the MREFC account. Final MREFC support for SPSM is also included in this line.

[6] Preconstruction planning includes funding for potential next generation multi-user facilities. Not included on this line is $1.73 million in FY 2010 Actual pre-construction planning funds for the Large-Aperture Synoptic Survey Telescope included under NOAO.

[7] Funding for the National Optical Astronomy Observatories (NOAO) for FY 2010 Actual includes $1.73 million in pre-construction planning funds for the Large-Aperture Synoptic Survey Telescope .

[8] Funding for the National Radio Astronomy Observatories (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC projects line.

[9] Funding for Research Resources includes support for the operation and maintenance of minor facilities, infrastructure and instrumentation, field stations, museum collections, etc.

[10] Science Resources Statistics (SRS) has been renamed the National Center for Science and Engineering Statistics, per P.L. 111-358.

National Science Foundation
Selected Cross-Cutting Programs
FY 2012 Request to Congress

(Dollars in Millions)

Selected Cross-Cutting Programs		FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2012 Request change over: FY 2010 Omnibus Actual		FY 2012 Request change over: FY 2010 Enacted	
						Amount	Percent	Amount	Percent
ADVANCE	Research & Related Activities	19.53	-	19.49	20.07	0.54	2.8%	0.58	3.0%
	Education & Human Resources	1.48	-	1.53	1.58	0.10	6.7%	0.05	3.3%
	Total, NSF	**$21.01**	-	**$21.02**	**$21.65**	**$0.64**	**3.1%**	**$0.63**	**3.0%**
Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS)	Research & Related Activities	-	-	-	76.14	76.14	N/A	76.14	N/A
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	-	-	-	**$76.14**	**$76.14**	**N/A**	**$76.14**	**N/A**
Climate Change Education Program	Research & Related Activities	4.75	-	4.50	4.50	-0.25	-5.3%	-	-
	Education & Human Resources	5.49	-	5.50	5.50	0.01	0.2%	-	-
	Total, NSF	**$10.24**	-	**$10.00**	**$10.00**	**-$0.24**	**-2.4%**	-	-
Enhancing Access to the Radio Spectrum (EARS)	Research & Related Activities	-	-	-	15.00	15.00	N/A	15.00	N/A
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	-	-	-	**$15.00**	**$15.00**	**N/A**	**$15.00**	**N/A**
Faculty Early Career Development - CAREER	Research & Related Activities	218.49	0.16	196.39	221.96	3.47	1.6%	25.57	13.0%
	Education & Human Resources	0.00	-	-	-	-	N/A	-	N/A
	Total, NSF	**$218.49**	**$0.16**	**$196.39**	**$221.96**	**$3.47**	**1.6%**	**$25.57**	**13.0%**
Graduate Research Fellowship - GRF	Research & Related Activities	33.67	-	33.34	63.53	29.86	88.7%	30.19	90.6%
	Education & Human Resources	102.47	-	102.58	134.61	32.14	31.4%	32.03	31.2%
	Total, NSF	**$136.13**	-	**$135.92**	**$198.14**	**$62.01**	**45.5%**	**$62.22**	**45.8%**
Graduate STEM Fellows in K-12 Education - GK-12	Research & Related Activities	7.11	-	5.31	0.00	-7.11	-100.0%	-5.31	-100.0%
	Education & Human Resources	48.86	-	49.00	26.95	-21.91	-44.8%	-22.05	-45.0%
	Total, NSF	**$55.97**	-	**$54.31**	**$26.95**	**-$29.02**	**-51.8%**	**-$27.36**	**-50.4%**
Integrative Graduate Education and Research Traineeship - IGERT	Research & Related Activities	39.60	-	39.37	32.30	-7.30	-18.4%	-7.07	-18.0%
	Education & Human Resources	30.11	-	29.86	30.17	0.06	0.2%	0.31	1.0%
	Total, NSF	**$69.70**	-	**$69.23**	**$62.47**	**-$7.23**	**-10.4%**	**-$6.76**	**-9.8%**
Total, Graduate Fellowships & Traineeships	Research & Related Activities	$80.38	-	$78.02	$95.83	15.45	19.2%	17.81	22.8%
	Education & Human Resources	$181.43	-	$181.44	$191.73	10.30	5.7%	10.29	5.7%
	Total, NSF	**$261.81**	-	**$259.46**	**$287.56**	**$25.75**	**9.8%**	**$28.10**	**10.8%**
Long-Term Ecological Research Sites - LTER	Research & Related Activities	30.02	-	27.94	29.80	-0.22	-0.7%	1.86	6.7%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$30.02**	-	**$27.94**	**$29.80**	**-$0.22**	**-0.7%**	**$1.86**	**6.7%**
Research Experiences for Teachers - RET	Research & Related Activities	6.81	-	5.64	4.82	-1.99	-29.2%	-0.82	-14.5%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$6.81**	-	**$5.64**	**$4.82**	**-$1.99**	**-29.2%**	**-$0.82**	**-14.5%**
Research Experiences for Undergraduates - REU - Sites Only	Research & Related Activities	56.74	0.37	49.70	49.45	-7.29	-12.8%	-0.25	-0.5%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$56.74**	**$0.37**	**$49.70**	**$49.45**	**-$7.29**	**-12.8%**	**-$0.25**	**-0.5%**
Research Experiences for Undergraduates - REU - Supplements Only	Research & Related Activities	23.88	$0.00	16.96	16.52	-7.36	-30.8%	-0.44	-2.6%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$23.88**	$0.00	**$16.96**	**$16.52**	**-$7.36**	**-30.8%**	**-$0.44**	**-2.6%**
Total, Research Experiences for Undergraduates - REU	Research & Related Activities	80.62	0.37	66.66	65.97	-14.65	-18.2%	-0.69	-1.0%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$80.62**	**$0.37**	**$66.66**	**$65.97**	**-$14.65**	**-18.2%**	**-$0.69**	**-1.0%**
Research in Undergraduate Institutions - RUI	Research & Related Activities	45.17	-	37.32	37.45	-7.72	-17.1%	0.13	0.3%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$45.17**	-	**$37.32**	**$37.45**	**-$7.72**	**-17.1%**	**$0.13**	**0.3%**
Science and Technology Centers - STCs	Research & Related Activities	57.63	-	57.77	50.75	-6.88	-11.9%	-7.02	-12.2%
	Education & Human Resources	-	-	-	-	-	N/A	-	N/A
	Total, NSF	**$57.63**	-	**$57.77**	**$50.75**	**-$6.88**	**-11.9%**	**-$7.02**	**-12.2%**

Totals may not add due to rounding.

[1] A full-year appropriation for these programs was not enacted at the time the budget was prepared; therefore, these programs are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

NSF Funding Profile

The Funding Profile presents a high level, agency-wide estimate of proposal pressure, funding rates (or proposal "success"), and award statistics. These indicators are useful in gauging the relative efficacy of different funding levels.

Statistics for Competitive Awards: The Number of Proposals is based on several factors, including past actual activity, planned competitions, and research trends within the various disciplinary communities. External factors, such as the state of the national economy, also play a part. The Number of Awards is based on several factors, such as estimated funding and the expected proposal pool. The Funding Rate is the number of competitive awards made during a year as a percentage of total proposals competitively reviewed. This indicates the probability of receiving an award when submitting proposals to NSF.

Statistics for Research Grants: The Number of Proposals is based on several factors, including past actual activity, planned competitions, and research trends within the various disciplinary communities. External factors, such as the state of the national economy, also play a part. The Number of Awards is based on several factors, such as estimated funding and expected proposal pool. Research Grants are grants limited to research projects and exclude other award categories that fund infrastructure-type activities, which do not require multi-year support, such as equipment and conference awards. Annualized Award Size shows the annual level of research grants provided to awardees by dividing the total dollars of each award by the number of years over which it extends. Average Duration is the length of awards in years.

The Quantitative Data Tables, provided under a separate tab in this submission, are based on obligations made, including competitive awards, contracts, cooperative agreements, supplements, and amendments to existing grants and contracts.

NSF Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Request Estimate
Statistics for Competitive Awards			
Number of Proposals	55,400	48,700	60,000
Number of New Awards	12,890	11,400	13,900
Regular Appropriation	12,500	11,400	13,900
ARRA	390	-	-
Funding Rate	23%	23%	23%
Statistics for Research Grants			
Number of Research Grant Proposals	40,600	37,800	46,000
Number of Research Grant Awards	8,509	7,200	9,200
Regular Appropriation	8,500	7,200	9,200
ARRA	9	-	-
Funding Rate	21%	19%	20%
Median Annualized Award Size	$127,400	$125,700	$131,300
Average Annualized Award Size	$165,000	$159,000	$164,300
Average Duration (years)	2.9	3.0	3.0

National Science Foundation
NSTC Crosscuts Summary
FY 2012 Request to Congress

(Dollars in Millions)

	Climate Change Technology Program				U.S. Global Change Research Program			
	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
BIO	-	-	-	-	$81.00	-	$81.00	$89.00
CISE	-	-	-	-	-	-	-	-
ENG	$26.00	-	$25.75	$61.75	-	-	-	-
GEO	-	-	-	-	194.00	-	194.00	245.00
MPS	-	-	-	-	7.77	-	7.28	9.03
SBE	-	-	-	-	18.48	-	18.48	58.98
OCI	-	-	-	-	-	-	-	-
OISE	1.57	-	-	1.21	-	-	-	-
OPP	-	-	-	-	18.30	-	18.30	23.10
IA	-	-	-	-	-	-	-	-
R&RA	**$27.57**	-	**$25.75**	**$62.96**	**$319.55**	-	**$319.06**	**$425.11**
EHR	-	-	-	-	-	-	-	-
NSF Total	**$27.57**	-	**$25.75**	**$62.96**	**$319.55**	-	**$319.06**	**$425.11**

	Networking and Information Technology Research and Development				National Nanotechnology Initiative			
	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
BIO	$93.00	-	$93.00	$99.00	$56.67	-	$56.60	$63.10
CISE	618.71	-	618.83	728.42	12.95	-	11.00	31.00
ENG	23.70	-	23.70	23.70	152.50	17.72	148.00	174.37
GEO	22.98	-	22.98	22.98	0.85	-	0.85	0.85
MPS	97.24	-	85.39	91.75	199.11	-	190.59	182.36
SBE	25.71	-	22.80	46.30	1.73	-	1.67	1.67
OCI	214.72	-	214.28	236.02	0.00	-	-	-
OISE	-	-	-	-	1.36	-	-	0.10
OPP	-	-	-	-	-	-	-	-
IA	-	-	-	-	-	-	-	-
R&RA	**$1,096.06**	-	**$1,080.98**	**$1,248.17**	**$425.17**	**$17.72**	**$408.71**	**$453.45**
EHR	**$9.50**	-	**$9.50**	**$9.50**	**$3.50**	-	**$3.50**	**$2.50**
NSF Total	**$1,105.56**	-	**$1,090.48**	**$1,257.67**	**$428.67**	**$17.72**	**$412.21**	**$455.95**

Totals may not add due to rounding.

[1] A full-year appropriation for these accounts was not enacted at the time the budget was prepared; therefore, these accounts are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

National Science Foundation
Homeland Security Activities Summary
FY 2012 Request to Congress

(Dollars in Millions)

	BIO	CISE	ENG	GEO	MPS	SBE	OCI	OPP	IA	R&RA	EHR	AOAM	Total, NSF
FY 2010 Omnibus Actual	**$15.00**	**$179.80**	**$158.50**	**$0.00**	**$5.97**	**$4.50**	**$4.00**	**$2.80**	**$2.58**	**$373.15**	**$15.26**	**$2.79**	**$391.19**
Protecting Critical Infrastructure & Key Assets	-	**$179.80**	**$158.50**	**$0.00**	**$5.97**	**$4.50**	**$4.00**	**$2.80**	**$2.58**	**$358.15**	**$15.26**	**$2.79**	**$376.19**
Antarctic Physical Security	-	-	-	-	-	-	-	0.30	-	0.30	-	-	0.30
Counterterrorism	-	27.00	-	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	123.50	3.25	-	-	-	4.00	-	-	130.75	-	-	130.75
Electronic Commerce	-	4.50	3.75	-	-	-	-	-	-	8.25	-	-	8.25
Emergency Planning & Response	-	24.80	26.50	-	5.27	-	-	-	-	56.57	-	-	56.57
Energy Supply Assurance	-	-	29.00	-	-	-	-	-	-	29.00	-	-	29.00
IT Security	-	-	-	-	-	-	-	2.50	2.58	5.08	0.39	2.79	8.25
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	96.00	-	0.70	4.50	-	-	-	101.20	-	-	101.20
Scholarship for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	14.87	-	14.87
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*
FY 2010 Enacted/ Annualized FY 2011 CR[1]	**$15.00**	**$179.80**	**$160.50**	**$0.00**	**$3.80**	**$4.50**	**$4.00**	**$2.68**	-	**$370.28**	**$15.00**	**$4.75**	**$390.03**
Protecting Critical Infrastructure & Key Assets	-	**$179.80**	**$160.50**	**$0.00**	**$3.80**	**$4.50**	**$4.00**	**$2.68**	-	**$355.28**	**$15.00**	**$4.75**	**$375.03**
Antarctic Physical Security	-	-	-	-	-	-	-	0.28	-	0.28	-	-	0.28
Counterterrorism	-	27.00	-	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	123.50	3.20	-	-	-	4.00	-	-	130.70	-	-	130.70
Electronic Commerce	-	4.50	3.50	-	-	-	-	-	-	8.00	-	-	8.00
Emergency Planning & Response	-	24.80	26.30	-	3.10	-	-	-	-	54.20	-	-	54.20
Energy Supply Assurance	-	-	29.00	-	-	-	-	-	-	29.00	-	-	29.00
IT Security	-	-	-	-	-	-	-	2.40	-	2.40	-	4.75	7.15
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	98.50	-	0.70	4.50	0.00	-	-	103.70	-	-	103.70
Scholarship for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	15.00	-	15.00
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*
Delta from FY 2010 Enacted	-	**-$3.00**	**-$3.80**	-	-	**$13.00**	**$17.00**	**$1.62**	-	**$24.82**	**$10.00**	**$1.00**	**$35.82**
Protecting Critical Infrastructure & Key Assets	-	**-$3.00**	**-$3.80**	-	-	**$13.00**	**$17.00**	**$1.62**	-	**$24.82**	**$10.00**	**$1.00**	**$35.82**
Antarctic Physical Security	-	-	-	-	-	-	-	0.02	-	0.02	-	-	0.02
Counterterrorism	-	-	-	-	-	-	-	-	-	-	-	-	-
Cybersecurity	-	-3.00	-0.15	-	-	12.00	17.00	-	-	25.85	-	-	25.85
Electronic Commerce	-	-	-0.15	-	-	-	-	-	-	-0.15	-	-	-0.15
Emergency Planning & Response	-	-	-0.75	-	-	-	-	-	-	-0.75	-	-	-0.75
Energy Supply Assurance	-	-	-0.75	-	-	-	-	-	-	-0.75	-	-	-0.75
IT Security	-	-	-	-	-	-	-	1.60	-	1.60	-	1.00	2.60
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	-2.00	-	-	1.00	-	-	-	-1.00	-	-	-1.00
Scholarship for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	10.00	-	10.00
Defending Against Catastrophic Threats	-	-	-	-	-	-	-	-	-	-	-	-	-
Research to Combat Bioterrorism	-	-	-	-	-	-	-	-	-	-	-	-	-
Microbial Genomics, Analysis & Modeling	-	-	-	-	-	-	-	-	-	-	-	-	-
FY 2012 Request	**$15.00**	**$176.80**	**$156.70**	**$0.00**	**$3.80**	**$17.50**	**$21.00**	**$4.30**	-	**$395.10**	**$25.00**	**$5.75**	**$425.85**
Protecting Critical Infrastructure & Key Assets	-	**$176.80**	**$156.70**	**$0.00**	**$3.80**	**$17.50**	**$21.00**	**$4.30**	-	**$380.10**	**$25.00**	**$5.75**	**$410.85**
Antarctic Physical Security	-	-	-	-	-	-	-	0.30	-	0.30	-	-	0.30
Counterterrorism	-	27.00	-	-	-	-	-	-	-	27.00	-	-	27.00
Cybersecurity	-	120.50	3.05	-	-	12.00	21.00	-	-	156.55	-	-	156.55
Electronic Commerce	-	4.50	3.35	-	-	-	-	-	-	7.85	-	-	7.85
Emergency Planning & Response	-	24.80	25.55	-	3.10	-	-	-	-	53.45	-	-	53.45
Energy Supply Assurance	-	-	28.25	-	-	-	-	-	-	28.25	-	-	28.25
IT Security	-	-	-	-	-	-	-	4.00	-	4.00	-	5.75	9.75
Resilient Infrastructure (Risk Mgmt, Modeling, Simul)	-	-	96.50	-	0.70	5.50	-	-	-	102.70	-	-	102.70
Scholarship for Service / Cybercorps	-	-	-	-	-	-	-	-	-	-	25.00	-	25.00
Defending Against Catastrophic Threats	**$15.00**	-	-	-	-	-	-	-	-	**$15.00**	-	-	**$15.00**
Research to Combat Bioterrorism	15.00	-	-	-	-	-	-	-	-	15.00	-	-	15.00
Microbial Genomics, Analysis & Modeling	*15.00*	-	-	-	-	-	-	-	-	*15.00*	-	-	*15.00*

Totals may not add due to rounding.

[1] A full-year appropriation for these accounts was not enacted at the time the budget was prepared; therefore, these accounts are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

NSF STEM Education Programs by Level of Education
FY 2012 Request to Congress

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2012 Request change over:			
					FY 2010 Omnibus Actual		FY 2010 Enacted	
					Amount	Percent	Amount	Percent
K-12 Programs	$269.08	-	$272.42	$231.37	-$37.71	-14.0%	-$41.05	-15.1%
Undergraduate Programs	486.92	$0.37	478.74	521.05	34.13	7.0%	42.31	8.8%
Graduate & Professional Programs	334.33	15.06	336.79	379.58	45.25	13.5%	42.79	12.7%
Outreach and Informal Education Programs	76.73	-	76.89	77.58	0.85	1.1%	0.69	0.9%
TOTAL, NSF	**$1,167.06**	**$15.43**	**$1,164.84**	**$1,209.58**	**$42.52**	**3.6%**	**$44.74**	**3.8%**

[1] A full-year 2011 appropriation for these programs was not enacted at the time the budget was prepared; therefore, these programs are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

NSF STEM Education Programs by Level of Education
NSF FY 2012 Request to Congress

(Dollars in Millions)

Level of Education	Program Name	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2012 Request change over: FY 2010 Omnibus Actual Amount	FY 2012 Request change over: FY 2010 Omnibus Actual Percent	FY 2012 Request change over: FY 2010 Enacted Amount	FY 2012 Request change over: FY 2010 Enacted Percent
K -12	Discovery Research K-12	$118.38	-	$118.50	$99.23	-$19.15	-16.2%	-$19.27	-16.3%
K -12	GEO Teach	2.98	-	3.00	2.00	-0.98	-33.0%	-1.00	-33.3%
K -12	Innovative Technology Experiences for Students and Teachers (ITEST)	20.85	-	25.00	25.00	4.15	19.9%	-	-
K -12	Math and Science Partnership (MSP)	57.93	-	58.22	48.22	-9.71	-16.8%	-10.00	-17.2%
K -12	Research & Evaluation on Education in S&E (REESE)	64.16	-	63.50	54.72	-9.44	-14.7%	-8.78	-13.8%
K -12	Research Experiences for Teachers (RET) Sites - ENG	4.78	-	4.20	2.20	-2.58	-54.0%	-2.00	-47.6%
Total, K-12	**K-12 STEM Education Programs Subtotal**	**$269.08**		**$272.42**	**$231.37**	**-$37.71**	**-14.0%**	**-$41.05**	**-15.1%**
UG	Advanced Technological Education (ATE)	64.51		64.00	64.00	-0.51	-0.8%	-	-
UG	Broadening Participation in Computing (BPC)	14.00	-	14.00	-	-14.00	-100.0%	-14.00	-100.0%
UG	CISE Pathways to Revitalized Undergraduate Computing Education (C-PATH)	4.37	-	5.00	-	-4.37	-100.0%	-5.00	-100.0%
UG	Climate Change Education (CCE)	10.24	-	10.00	10.00	-0.24	-2.4%	-	-
UG	Computing Education for the 21st Century (CE21)	-	-	-	15.50	15.50	N/A	15.50	N/A
UG	Cyberinfrastructure Training, Education, Advancement & Mentoring (CI-TEAM)	4.85	-	5.00	4.00	-0.85	-17.5%	-1.00	-20.0%
UG	Engineering Education (EE)	13.74	-	11.85	11.85	-1.89	-13.7%	-	-
UG	Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM)	2.70	-	2.70	-	-2.70	-100.0%	-2.70	-100.0%
UG	International Research Experiences for Students (IRES)	3.43	-	3.15	3.15	-0.28	-8.2%	-	-
UG	Opportunities for Enhancement of Diversity in the Geosciences (OEDG)	4.18	-	4.60	3.60	-0.58	-13.9%	-1.00	-21.7%
UG	Research Experiences for Undergraduates Sites (REU Sites)	56.74	$0.37	49.70	49.45	-7.29	-12.8%	-0.25	-0.5%
UG	Robert Noyce Teacher Scholarship Program (Noyce)	54.93	-	55.00	45.00	-9.93	-18.1%	-10.00	-18.2%
UG	Scholarships in Science, Technology, Engineering and Mathematics (S-STEM)	75.96	-	75.00	75.00	-0.96	-1.3%	-	-
UG	Transforming Broadening Participation through STEM (TBPS)	-	-	-	20.00	20.00	N/A	20.00	N/A
UG	Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)	32.06	-	32.00	32.00	-0.06	-0.2%	-	-
UG	Louis Stokes Alliances for Minority Participation (LSAMP)	44.55	-	44.75	44.75	0.20	0.4%	-	-
UG	Tribal Colleges and Universities Program (TCUP)	13.35	-	13.35	14.35	1.00	7.5%	1.00	7.5%
UG	STEM Talent Expansion Program (STEP)	31.64	-	32.53	35.53	3.89	12.3%	3.00	9.2%
UG	Transforming Undergraduate Biology Education (TUBE)	5.06	-	10.90	14.90	9.84	194.5%	4.00	36.7%
UG	Transforming Undergrad Ed in STEM (TUES) [was CCLI]	41.60	-	42.21	47.97	6.37	15.3%	5.76	13.6%
UG	Undergraduate Research Mentoring in Biology (URM)	9.00	-	3.00	-	-9.00	-100.0%	-3.00	-100.0%
UG	Widening Implementation and Demonstration of Evidence-based Reforms (WIDER)	-	-	-	20.00	20.00	N/A	20.00	N/A
UG/Grad	Teacher Learning for the Future (TLF)	-	-	-	10.00	10.00	N/A	10.00	N/A
Total, UG	**Undergraduate STEM Education Programs Subtotal**	**$486.92**	**$0.37**	**$478.74**	**$521.05**	**$34.13**	**7.0%**	**$42.31**	**8.8%**
Grad	Alliances for Graduate Education and the Professoriate (AGEP)	16.73	-	16.75	16.75	0.02	0.1%	-	-
Grad	East Asia & Pacific Summer Institutes for U.S. Graduate Students (EAPSI)	1.74	-	2.40	2.40	0.66	37.6%	-	-
Grad	Enhancing the Mathematical Sciences Workforce of the 21st Century (EMSW21)	15.07	-	17.07	11.77	-3.30	-21.9%	-5.30	-31.0%
Grad	Ethics Education in Science & Engineering (EESE)	2.65	-	2.74	2.75	0.10	3.8%	0.01	0.4%
Grad	Federal Scholarship for Service / Cybercorps (SfS)	14.87	-	15.00	25.00	10.13	68.1%	10.00	66.7%
Grad	Graduate Research Fellowship (GRF)	136.13	-	135.92	198.14	62.01	45.5%	62.22	45.8%
Grad	Graduate STEM Fellowships in K-12 Education (GK-12)	55.97	-	54.31	26.95	-29.02	-51.8%	-27.36	-50.4%
Grad	Integrative Graduate Education & Research Traineeship (IGERT)	69.70	-	69.23	62.47	-7.23	-10.4%	-6.76	-9.8%
Grad	Post-doctoral Fellowship Programs (PFP)	21.45	0.06	23.37	23.35	1.90	8.8%	-0.02	-0.1%
	BIO Postdoctoral Research Fellowships in Biology	*4.74*	-	*3.80*	*3.80*	*-0.94*	*-19.8%*	-	-
	GEO Postdoctoral Fellowship Programs	*1.17*	-	*2.97*	*5.02*	*3.86*	*330.9%*	*2.05*	*69.0%*
	MPS American Competitiveness in Chemistry Fellowships	*2.40*	-	*2.00*	-	*-2.40*	*-100.0%*	*-2.00*	*-100.0%*
	MPS Astronomy and Astrophysics Postdoctoral Fellowships	*1.79*	-	*1.80*	*2.00*	*0.21*	*11.7%*	*0.20*	*11.1%*
	MPS Math Sciences Postdoctoral Research Fellowships	*5.13*	-	*4.03*	*3.93*	*-1.20*	*-23.4%*	*-0.10*	*-2.5%*
	MPS Math Sciences University-Industry Postdoctoral Fellowships	*0.08*	-	*0.10*	*0.10*	*0.02*	*19.6%*	-	-
	SBE Minority Postdoctoral Fellowships	*0.94*	-	*1.00*	*1.00*	*0.06*	*6.4%*	-	-
	OCI Fellowships for Transformative Computational Science Using CI (CI TRaCS)	-	-	*2.17*	*2.00*	*2.00*	*N/A*	*-0.17*	*-7.8%*
	OISE International Research Fellowship program	*4.27*	*0.02*	*4.50*	*4.50*	*0.23*	*5.3%*	-	-
	OPP Polar Postdoctoral Fellowships	*0.93*	*0.04*	*1.00*	*1.00*	*0.07*	*7.1%*	-	-
Grad	Science Masters Programs (SMP)	-	15.00	-	-	-	N/A	-	N/A
Grad/UG	Teacher Learning for the Future (TLF)	-	-	-	10.00	10.00	N/A	10.00	N/A
Total, Grad	**Graduate and Professional STEM Education Programs Subtotal**	**$334.33**	**$15.06**	**$336.79**	**$379.58**	**$45.25**	**13.5%**	**$42.79**	**12.7%**
OIE	Centers for Ocean Science Education Excellence (COSEE)	5.70	-	5.69	4.24	-1.46	-25.6%	-1.45	-25.5%
OIE	Excellence Awards in Science and Engineering (EASE)	5.18	-	5.20	5.20	0.02	0.4%	-	-
OIE	Informal Science Education (ISE)	65.85	-	66.00	68.14	2.29	3.5%	2.14	3.2%
Total, OIE	**Outreach & Informal Ed STEM Education Programs Subtotal**	**$76.73**	-	**$76.89**	**$77.58**	**$0.85**	**1.1%**	**$0.69**	**0.9%**
	TOTAL, STEM Education Programs	**$1,167.06**	**$15.43**	**$1,164.84**	**$1,209.58**	**42.52**	**3.6%**	**44.74**	**3.8%**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation for these programs was not enacted at the time the budget was prepared; therefore, these programs are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

NSF Programs to Broaden Participation
FY 2012 Request to Congress

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2012 Request change over: FY 2010 Omnibus Actual		FY 2012 Request change over: FY 2010 Enacted	
					Amount	Percent	Amount	Percent
ADVANCE	$21.01	-	$21.02	$21.65	$0.64	3.1%	$0.63	3.0%
ADVANCE - R&RA	*19.53*	-	*19.49*	*20.07*	*0.54*	*2.8%*	*0.58*	*3.0%*
ADVANCE - EHR	*1.48*	-	*1.53*	*1.58*	*0.10*	*6.7%*	*0.05*	*3.3%*
Advanced Technological Education (ATE)	64.51	-	64.00	64.00	-0.51	-0.8%	-	-
Alliances for Graduate Education and the Professoriate (AGEP)	16.73	-	16.75	16.75	0.02	0.1%	-	-
Broadening Participation in Computing (BPC)	14.00	-	14.00	-	-14.00	-100.0%	-14.00	-100.0%
Centers of Research Excellence in Science and Technology (CREST)	30.32	-	30.53	30.53	0.21	0.7%	-	-
Transforming Broadening Participation through STEM (TBPS)	-	-	-	20.00	20.00	N/A	20.00	N/A
Cyberinfrastructure Training, Education, Advancement and Mentoring (CI-TEAM)	4.85	-	5.00	4.00	-0.85	-17.5%	-1.00	-20.0%
Experimental Program to Stimulate Competitive Research (EPSCoR)	147.11	20.00	147.12	160.53	13.42	9.1%	13.41	9.1%
GEO LSAMP Linkages	1.00	-	1.00	1.00	0.00	0.1%	-	-
Graduate Research Diversity Supplements (GRDS) - ENG	2.06	-	1.50	1.50	-0.56	-27.0%	-	-
Graduate Research Fellowship - Women in Engineering and Computer Science	9.88	-	9.55	-	-9.88	-100.0%	-9.55	-100.0%
H-1B Nonimmigrant Petitioner Fee programs	96.81	-	100.00	100.00	3.19	3.3%	-	-
Historically-Black Colleges and Universities-Undergraduate Program (HBCU-UP)	32.06	-	32.00	32.00	-0.06	-0.2%	-	-
Informal Science Education (ISE)	65.85	-	66.00	68.14	2.29	3.5%	2.14	3.2%
Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM)	2.70	-	2.70	-	-2.70	-100.0%	-2.70	-100.0%
UBM - R&RA	*2.10*	-	*2.10*	-	*-2.10*	*-100.0%*	*-2.10*	*-100.0%*
UBM - EHR	*0.60*	-	*0.60*	-	*-0.60*	*-100.0%*	*-0.60*	*-100.0%*
Louis Stokes Alliances for Minority Participation (LSAMP)	44.55	-	44.75	44.75	0.20	0.4%	-	-
Math and Science Partnership (MSP)	57.93	-	58.22	48.22	-9.71	-16.8%	-10.00	-17.2%
Minority Post-Docs	3.76	-	3.50	3.50	-0.26	-6.9%	-	-
BIO Minority Post-Docs	*2.82*	-	*2.50*	*2.50*	*-0.32*	*-11.3%*	-	-
SBE Minority Post-Docs	*0.94*	-	*1.00*	*1.00*	*0.06*	*6.4%*	-	-
Noyce Scholarships	54.93	-	55.00	45.00	-9.93	-18.1%	-10.00	-18.2%
Ocean Sciences Postdoctoral Fellowship[2]	-	-	-	1.90	1.90	N/A	1.90	N/A
Opportunities to Enhance Diversity in the Geosciences (OEDG)	4.18	-	4.60	3.60	-0.58	-13.9%	-1.00	-21.7%
Partnerships for Innovation (PFI)	9.25	-	9.19	26.69	17.44	188.7%	17.50	190.4%
Partnerships in AST & Astrophysics Rsch Educ (PAARE)[3]	0.74	-	2.00	-	-0.74	-100.0%	-2.00	-100.0%
Partnerships for Research and Education in Materials (PREM) - MPS	5.52	-	5.53	6.00	0.48	8.7%	0.47	8.5%
Pre-Engineering Education Collaboratives (PEEC)[4]	1.00	-	1.00	1.00	-	-	-	-
Research in Disabilities Education (RDE)[5]	6.92	-	6.50	6.50	-0.42	-6.1%	-	-
Research Initiation Grants in Biology (RIG)	1.91	-	2.00	-	-1.91	-100.0%	-2.00	-100.0%
Research on Gender in Science and Engineering (GSE)[5]	11.57	-	11.50	10.50	(1.07)	(0.09)	-1.00	-8.7%
Science, Technology, Engineering and Math Talent Expansion Program (STEP)	31.64	-	32.53	35.53	3.89	12.3%	3.00	9.2%
STEP - R&RA	-	-	*1.00*	*1.00*	*1.00*	*N/A*	-	-
STEP - EHR	*31.64*	-	*31.53*	*34.53*	*2.89*	*9.1%*	*3.00*	*9.5%*
Significant Opportunities in Atmospheric Research and Science (SOARS) - GEO	0.67	-	0.60	0.60	-0.07	-10.4%	-	-
Tribal Colleges and Universities Program (TCUP)	13.35	-	13.35	14.35	1.00	7.5%	1.00	7.5%
Undergraduate Research Collaboratives (URC) - MPS	1.00	-	1.00	-	-1.00	-100.0%	-1.00	-100.0%
Undergraduate Research Mentoring in Biology (URM)	9.00	-	3.00	-	-9.00	-100.0%	-3.00	-100.0%
Subtotal, R&RA	**$237.54**	**$20.00**	**$233.18**	**$231.39**	**-$6.15**	**-2.6%**	**-$1.79**	**-0.8%**
Subtotal, EHR	**$432.45**	**-**	**$432.26**	**$436.85**	**$4.40**	**1.0%**	**$4.59**	**1.1%**
Subtotal, H-1B Nonimmigrant Petitioner Fees	**$96.81**	**-**	**$100.00**	**$100.00**	**$3.19**	**3.3%**	**-**	**-**
TOTAL, NSF	**$766.80**	**$20.00**	**$765.44**	**$768.24**	**$1.44**	**0.2%**	**$2.80**	**0.4%**

Please note that this table displays a subset of the overall Broadening Participation portfolio. This list comprises the standard set of programs that have been historically tracked as Broadening Participation for budget purposes.

[1] A full-year 2011 appropriation for these programs was not enacted at the time the budget was prepared; therefore, these programs are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

[2] The Ocean Sciences Postdoctoral Fellowship is a new program beginning in FY 2012.

[3] Partnerships in Astronomy and Astrophysics Research Education (PAARE) replaces Research Partnerships for Diversity (RPD).

[4] Pre-Engineering Education Collaboratives (PEEC) replaces Tribal College Pathways in ENG.

[5] Funding for Research in Disabilities Education (RDE) and Research on Gender in Science and Engineering (GSE) for FY 2012 is proposed to reside in the Research & Evaluation on Education in S&E (REESE) program in EHR.

Number of People Involved in NSF Activities

NSF estimates that in FY 2012 more than 302,600 people will be directly involved in NSF programs and activities, receiving salaries, stipends, or participant support. Also, NSF programs indirectly impact millions of people. These programs reach K-12 students and teachers, the general public, and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of improved curriculum and teaching methods.

FY 2012 Request
Number of People Involved in NSF Activities

PEOPLE DATA	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	53,161	1,726	44,675	54,560
Other Professionals	14,194	301	13,010	14,020
Postdoctoral Associates	6,923	58	6,755	8,510
Graduate Students	39,559	259	41,265	44,160
Undergraduate Students	33,234	300	24,775	32,730
K-12 Teachers	59,312	-	62,807	60,680
K-12 Students	85,319	-	84,758	88,030
TOTAL, PEOPLE	**291,702**	**2,644**	**278,045**	**302,690**

Senior Researchers include scientists, mathematicians, engineers, and educators receiving funding through NSF awards. These include both researchers who are principal or co-principal investigators on research and education projects, and researchers working at NSF-supported centers and facilities.

Other Professionals are individuals who may or may not hold a doctoral degree or its equivalent, are considered professionals but are not reported as senior researchers, postdoctoral associates, or students. Examples are technicians, systems experts, etc.

Postdoctoral Associates are individuals who have received Ph.D., M.D., D.Sc., or equivalent and are not faculty members of the performing institution. About 98 percent are supported through funds included in research projects, centers, or facilities awards. Others are recipients of postdoctoral fellowships.

Graduate Students include those compensated from NSF grant funds. About 13 percent receive support through programs such as NSF Graduate Research Fellowship and NSF Integrative Graduate Education and Research Traineeship. The balance assists senior researchers or postdoctoral associates in performing research and is provided through awards for research projects, centers, or facilities. NSF provides support for about 5 percent of the science and engineering graduate students in the U.S.

Undergraduate Students include students compensated from NSF grant funds who are enrolled in technical colleges or baccalaureate programs. They may be assisting senior researchers or postdoctoral

associates in performing research, or participating in NSF programs aimed at undergraduate students, such as Research Experiences for Undergraduates.

K-12 Teachers include teachers at elementary, middle, and secondary schools. These individuals actively participate in intensive professional development experiences in the sciences and mathematics.

K-12 Students are those attending elementary, middle, and secondary schools. They are supported through program components that directly engage students in science and mathematics experiences.

NSF By Account

(Actual Dollars in Millions - Current Dollars)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure[1]	Major Research Equipment & Facilities Construction	Agency Operations & Award Management	Office of Inspector General	National Science Board	NSF
1951	0.03	-	-	-	0.13	-	-	0.15
1952	1.40	1.54	-	-	0.53	-	-	3.47
1953	2.14	1.41	-	-	0.88	-	-	4.43
1954	4.52	1.89	-	-	1.55	-	-	7.96
1955	8.86	2.08	-	-	1.55	-	-	12.49
1956	10.79	3.52	-	-	1.68	-	-	15.99
1957	21.98	14.30	-	-	2.35	-	-	38.63
1958	27.37	19.21	-	-	2.93	-	-	49.51
1959	66.33	61.29	-	-	5.26	-	-	132.88
1960	88.35	63.74	-	-	6.51	-	-	158.60
1961	103.98	63.44	-	-	7.57	-	-	174.99
1962	173.26	78.58	-	-	8.98	-	-	260.82
1963	218.90	90.99	-	-	10.87	-	-	320.75
1964	239.95	102.58	-	-	12.05	-	-	354.58
1965	282.44	120.41	-	-	13.12	-	-	415.97
1966	328.63	124.31	-	-	13.09	-	-	466.02
1967	327.70	123.36	-	-	14.04	-	-	465.10
1968	350.20	134.71	-	-	15.38	-	-	500.29
1969	292.90	123.11	-	-	16.49	-	-	432.50
1970	316.41	126.41	-	-	19.68	-	-	462.49
1971	369.37	105.00	-	-	21.77	-	-	496.14
1972	482.43	93.73	-	-	24.56	-	-	600.72
1973	519.42	62.23	-	-	28.62	-	-	610.27
1974	533.29	80.71	-	-	31.66	-	-	645.65
1975	581.23	74.03	-	-	37.87	-	-	693.13
1976	619.72	62.48	-	-	42.23	-	-	724.42
1977	671.98	74.26	-	-	45.53	-	-	791.77
1978	734.69	73.86	-	-	48.70	-	-	857.25
1979	791.76	80.41	-	-	54.77	-	-	926.93
1980	836.83	80.06	-	-	58.24	-	-	975.13
1981	900.36	75.70	-	-	59.21	-	-	1,035.27
1982	909.75	26.20	-	-	63.18	-	-	999.14
1983	1,013.02	22.98	-	-	65.70	-	-	1,101.69
1984	1,177.70	62.97	-	-	66.26	-	-	1,306.92
1985	1,344.56	90.56	-	-	71.95	-	-	1,507.07
1986	1,329.64	91.69	-	-	71.84	-	-	1,493.17
1987	1,439.97	109.88	-	-	77.77	-	-	1,627.62
1988	1,481.31	156.79	-	-	84.47	-	-	1,722.57
1989	1,600.53	194.06	-	-	91.29	-	-	1,885.88
1990	1,696.56	230.41	0.41	-	96.35	2.33	-	2,026.06
1991	1,868.45	331.91	39.02	-	101.23	2.89	-	2,343.49
1992	1,940.48	459.44	33.36	-	109.99	3.86	-	2,547.13
1993	2,046.31	505.06	49.75	34.07	110.84	3.69	-	2,749.73
1994	2,168.36	569.03	105.38	17.04	123.49	3.92	-	2,987.21
1995	2,281.46	611.88	117.46	126.00	129.01	4.46	-	3,270.27
1996	2,327.80	601.16	70.89	70.00	132.50	3.98	-	3,206.33
1997	2,433.93	619.14	30.02	76.13	134.27	5.33	-	3,298.82
1998	2,572.62	633.16	-	78.21	136.95	4.80	-	3,425.73
1999	2,821.61	662.48	-	56.71	144.08	5.41	-	3,690.28
2000	2,979.90	683.58	-	105.00	149.28	5.60	-	3,923.36
2001	3,372.30	795.42	-	119.24	166.33	6.58	-	4,459.87
2002	3,615.97	866.11	-	115.35	169.93	6.70	-	4,774.06
2003	4,054.43	934.88	-	179.03	189.42	8.70	2.88	5,369.34
2004	4,293.34	944.10	-	183.96	218.92	9.47	2.22	5,652.01
2005	4,234.82	843.54	-	165.14	223.45	10.17	3.65	5,480.77
2006	4,351.03	798.48	-	233.81	247.06	11.47	3.94	5,645.79
2007	4,656.33	797.76	-	166.21	248.49	11.92	3.65	5,884.37
2008	4,853.24	766.26	-	166.85	282.04	11.83	3.82	6,084.04
2009 Omnibus Actual	5,152.39	845.52	-	160.76	294.09	11.99	4.02	6,468.76
2009 ARRA Actual	2,062.64	85.00	-	254.00	-	0.02	-	2,401.66
2010 Omnibus Actual	5,615.33	872.77	-	165.90	299.85	13.97	4.38	6,972.20
2010 ARRA Actual	439.17	15.00		146.00	-	0.05	-	600.22
2010 Enacted/ Annualized 2011 CR[2]	5,563.92	872.76	-	117.29	300.00	14.00	4.54	6,872.51
2012 Request	6,253.54	911.20	-	224.68	357.74	15.00	4.84	7,767.00

Totals may not add due to rounding.

[1] In addition to the specific appropriations for Academic Research Infrastructure (ARI) from FY 1990 to FY 1997, $200.0 million was provided for ARI in the R&RA account under ARRA.

[2] A full-year FY 2011 appropriation was not enacted at the time the budget was prepared; therefore, these accounts are operating under a continuing resolution (P.L. 111-242, as amended.) The amounts included for 2011 reflect the annualized levels provide

NSF By Account

(FY Actuals - FY 2011 Constant Dollars in Millions)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure[1]	Major Research Equipment & Facilities Construction	Agency Operations & Award Management	Office of Inspector General	National Science Board	NSF
1951	0.19	-	-	-	0.92	-	-	1.11
1952	9.93	10.90	-	-	3.76	-	-	24.59
1953	14.88	9.80	-	-	6.09	-	-	30.77
1954	31.06	12.99	-	-	10.62	-	-	54.66
1955	60.40	14.18	-	-	10.53	-	-	85.11
1956	71.69	23.39	-	-	11.16	-	-	106.24
1957	140.81	91.61	-	-	15.06	-	-	247.48
1958	170.24	119.44	-	-	18.24	-	-	307.91
1959	406.46	375.57	-	-	32.23	-	-	814.26
1960	534.70	385.76	-	-	39.39	-	-	959.85
1961	620.60	378.66	-	-	45.18	-	-	1,044.44
1962	1,022.80	463.87	-	-	53.00	-	-	1,539.67
1963	1,276.15	530.44	-	-	63.35	-	-	1,869.94
1964	1,382.43	591.00	-	-	69.44	-	-	2,042.88
1965	1,598.63	681.54	-	-	74.25	-	-	2,354.42
1966	1,821.66	689.08	-	-	72.56	-	-	2,583.29
1967	1,760.27	662.64	-	-	75.44	-	-	2,498.35
1968	1,817.08	698.97	-	-	79.79	-	-	2,595.83
1969	1,452.90	610.68	-	-	81.80	-	-	2,145.38
1970	1,489.56	595.10	-	-	92.63	-	-	2,177.29
1971	1,655.91	470.73	-	-	97.59	-	-	2,224.22
1972	2,065.07	401.22	-	-	105.14	-	-	2,571.42
1973	2,130.38	255.24	-	-	117.38	-	-	2,503.00
1974	2,041.01	308.90	-	-	121.16	-	-	2,471.06
1975	2,013.32	256.43	-	-	131.17	-	-	2,400.92
1976	2,002.66	201.91	-	-	136.46	-	-	2,341.03
1977	2,020.42	223.28	-	-	136.89	-	-	2,380.59
1978	2,069.36	208.05	-	-	137.16	-	-	2,414.57
1979	2,064.07	209.61	-	-	142.77	-	-	2,416.45
1980	2,004.52	191.77	-	-	139.51	-	-	2,335.80
1981	1,963.18	165.06	-	-	129.10	-	-	2,257.33
1982	1,856.56	53.47	-	-	128.93	-	-	2,038.96
1983	1,980.20	44.92	-	-	128.42	-	-	2,153.54
1984	2,220.12	118.70	-	-	124.90	-	-	2,463.72
1985	2,455.05	165.35	-	-	131.37	-	-	2,751.77
1986	2,372.85	163.63	-	-	128.20	-	-	2,664.68
1987	2,503.19	191.01	-	-	135.19	-	-	2,829.39
1988	2,495.03	264.09	-	-	142.27	-	-	2,901.39
1989	2,595.05	314.64	-	-	148.01	-	-	3,057.70
1990	2,653.08	360.31	0.64	-	150.67	3.64	-	3,168.35
1991	2,815.29	500.10	58.79	-	152.52	4.35	-	3,531.05
1992	2,849.56	674.68	48.98	-	161.52	5.66	-	3,740.41
1993	2,939.88	725.61	71.48	48.95	159.24	5.30	-	3,950.45
1994	3,050.69	800.58	148.26	23.98	173.74	5.51	-	4,202.75
1995	3,143.14	842.98	161.82	173.59	177.74	6.14	-	4,505.42
1996	3,146.24	812.53	95.82	94.61	179.08	5.37	-	4,333.65
1997	3,230.44	821.75	39.84	101.04	178.21	7.07	-	4,378.36
1998	3,371.65	829.81	-	102.50	179.48	6.29	-	4,489.72
1999	3,649.61	856.88	-	73.35	186.36	7.00	-	4,773.20
2000	3,779.77	867.07	-	133.18	189.35	7.10	-	4,976.48
2001	4,178.78	985.64	-	147.76	206.11	8.15	-	5,526.44
2002	4,408.05	1,055.83	-	140.62	207.15	8.17	-	5,819.82
2003	4,841.53	1,116.37	-	213.79	226.19	10.39	3.44	6,411.70
2004	4,998.70	1,099.21	-	214.18	254.89	11.03	2.58	6,580.59
2005	4,774.76	951.09	-	186.20	251.94	11.47	4.12	6,179.57
2006	4,743.56	870.51	-	254.90	269.35	12.50	4.30	6,155.12
2007	4,927.74	844.26	-	175.90	262.97	12.61	3.86	6,227.36
2008	5,021.13	792.77	-	172.62	291.80	12.23	3.96	6,294.51
2009 Omnibus Actual	5,260.63	863.28	-	164.13	300.27	12.24	4.11	6,604.66
2009 ARRA Actual	2,105.98	86.79	-	259.34	-	0.02	-	2,452.12
2010 Omnibus Actual	5,690.02	884.37	-	168.10	303.84	14.16	4.44	7,064.94
2010 ARRA Actual	445.01	15.20	-	147.94	-	0.05	-	608.20
2010 Enacted/ Annualized 2011 CR[2]	5,563.92	872.76	-	117.29	300.00	14.00	4.54	6,872.51
2012 Request	6,167.66	898.69	-	221.59	352.83	14.79	4.77	7,660.33

Totals may not add due to rounding.

[1] In addition to the specific appropriations for Academic Research Infrastructure (ARI) from FY 1990 to FY 1997, $200.0 million was provided for ARI in the R&RA account under ARRA.

[2] A full-year FY 2011 appropriation was not enacted at the time the budget was prepared; therefore, these accounts are operating under a continuing resolution (P.L. 111-242, as amended.) The amounts included for 2011 reflect the annualized levels provide

National Science Foundation Current Authorizations

LEGISLATION	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Authorization Levels FY 2010	FY 2011	FY 2012
				(Dollars in Millions)			
National Science Foundation Act of 1950 (P.L.81-507)[1]							
Scholarships and Graduate Fellowships					*within limits of funds made available for this purpose*		
General Authority					*within the limits of available appropriations*		
Administering Provisions					*to make such expenditures as may be necessary*		
International Cooperation and Coordination with Foreign Policy					*within the limit of appropriated funds*		
Contract Arrangements					*utilize appropriations available*		
America COMPETES Act (P.L.110-69)[2]	**$6,972.20**	**$600.22**			**$8,132.00**		
Account and Program Specific							
Research and Related Activities[3]	**$5,615.33**	**$439.17**			**$6,401.00**		
Experimental Program to Stimulate Competitive Research	*$147.11*	*$20.00*			*$147.80*		
Faculty Early Career Development (CAREER) Program	*$218.49*	*$0.16*			*$203.80*		
Graduate Research Fellowship Program	*$33.67*	-			*$11.10*		
Integrative Graduate Education and Research Traineeship Program	*$39.60*	-			*$58.30*		
Major Research Instrumentation	*$89.99*	*$200.15*			*$131.70*		
Professional Science Master's Degree Program[4]	-	-			*$15.00*		
Research Experiences for Undergraduates	*$80.62*	*$0.37*			*$75.90*		
Education and Human Resources	**$872.77**	**$15.00**			**$1,104.00**		
Advanced Technology Education	*$64.51*	-			*$64.00*		
Graduate Research Fellowship Program	*$102.47*	-			*$119.00*		
Integrative Graduate Education and Research Traineeship Program	*$30.11*	-			*$33.40*		
Mathematics and Science Education Partnerships	*$57.93*	-			*$123.20*		
Science, Mathematics, Engineering, and Technology Talent Expansion Program	*$31.64*	-			*$55.00*		
Robert Noyce Scholarship Program	*$54.93*	-			*$140.50*		
Major Research Equipment and Facilities Construction	**$165.90**	**$146.00**			**$280.00**		
Agency Operations and Award Management	**$299.85**	-			**$329.45**		
National Science Board	**$4.38**	-			**$4.34**		
Office of the Inspector General	**$13.97**	**$0.05**			**$13.21**		
America COMPETES Act (P.L.111-358)[5]			**$6,872.51**	**$7,767.00**		**$7,424.40**	**$7,800.00**
Account and Program Specific							
Research and Related Activities			**$5,563.92**	**$6,253.54**		**$5,974.78**	**$6,234.28**
Education and Human Resources			**$872.76**	**$911.20**		**$937.85**	**$978.96**
STEM-Training Grant Program						*$10.00*	*$10.00*
Major Research Equipment and Facilities Construction			**$117.29**	**$224.68**		**$164.74**	**$225.54**
Agency Operations and Award Management			**$300.00**	**$357.74**		**$327.50**	**$341.68**
National Science Board			**$4.54**	**$4.84**		**$4.80**	**$4.81**
Office of the Inspector General			**$14.00**	**$15.00**		**$14.72**	**$14.73**

LEGISLATION (cont.)	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Authorization Levels FY 2010	FY 2011	FY 2012
				(Dollars in Millions)			
Federal Ocean Acidification Research and Monitoring Act of 2009 (P.L.111-11)	**$15.67**	**-**	*****		**$8.00**	**$12.00**	
To provide for an additional temporary extension of programs under the Small Business Act and the Small Business Investment Act of 1958, and for other purposes. (P.L.112-1)							
Small Business Innovation Research (SBIR) Program[6]	*$134.45*	-	*$112.47*	*$131.34*	*2.5% of research funds (SBIR)*		
Small Business Technology Transfer (STTR) Program[7]	*$22.39*	-	*$13.30*	*$15.54*	*0.3% of research funds (STTR)*		

[1] Organic language establishing NSF, authorization and appropriation language may not correspond to current accounts and programs.

[2] Authorizes agency funding for FYs 2008-10; authorizes agency, account, and various program levels.

[3] FY 2010 Estimate for Research and Related Activities excludes $54.0 million transferred to the U.S. Coast Guard.

[4] Science Masters Program was authorized under the R&RA account. Funding was provided through FY 2009 ARRA under the EHR account and awards were made in FY 2010.

[5] Authorizes agency funding for FYs 2011-13; authorizes agency, account, and various program levels.

[6] SBIR is currently authorized through May 31, 2011.

[7] STTR is currently authorized through May 31, 2011.

*Actual amounts will be reported after awards are completed.

RESEARCH AND RELATED ACTIVITIES (R&RA) $6,253,540,000
+$689,620,000 / 12.4%

The FY 2012 Budget Request for the Research and Related Activities (R&RA) Appropriation is $6,253.54 million, an increase of $689.62 million, or 12.4 percent, above the FY 2010 Enacted level of $5,563.92 million. Support from the R&RA Appropriation enables U.S. leadership and progress across the frontiers of scientific and engineering research and education.

Sustained, targeted investment by NSF in fundamental science and engineering advances discovery and learning and spurs innovation. In addition to the amounts shown above, NSF would also receive $1.0 billion over five years for research on improving access to wireless broadband through the Wireless Innovation (WIN) Fund proposed under the Administration's *Wireless Innovation and Infrastructure Initiative* (WI3). Such transformational work holds great promise for meeting the myriad social, economic, and environmental challenges faced by both the Nation and the world.

In FY 2012, funding within the broad and flexible R&RA portfolio highlights the Administration's priorities for investing in the building blocks of American innovation. It also includes a push to better integrate interdisciplinary research and education and an investment in research in clean energy technology, nanotechnology, and advanced manufacturing.

R&RA Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Biological Sciences	$714.77	$0.35	$714.54	$794.49	$79.95	11.2%
Computer & Information Science & Engineering	618.71	-	618.83	728.42	109.59	17.7%
Engineering	775.92	-	743.93	908.30	164.37	22.1%
Geosciences	891.87	0.40	889.64	979.16	89.52	10.1%
Mathematical & Physical Sciences	1,367.95	15.70	1,351.84	1,432.73	80.89	6.0%
Social, Behavioral & Economic Sciences	255.31	0.25	255.25	301.13	45.88	18.0%
Office of Cyberinfrastructure	214.72	-	214.28	236.02	21.74	10.1%
Office of International Science & Engineering	47.84	0.10	47.83	58.03	10.20	21.3%
Office of Polar Programs[2]	451.77	2.23	451.16	477.41	26.25	5.8%
Integrative Activities	274.89	420.15	275.04	336.25	61.21	22.3%
U.S. Arctic Research Commission	1.58	-	1.58	1.60	0.02	1.3%
Total, R&RA	**$5,615.33**	**$439.17**	**$5,563.92**	**$6,253.54**	**$689.62**	**12.4%**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

[2] Funding for FY 2010 Enacted excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

RESEARCH AND RELATED ACTIVITIES

Appropriation Language

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; ~~$6,018,830,000~~*$6,253,540,000*, to remain available until September 30, ~~2012,~~*2013*, of which not to exceed ~~$590,000,000~~*$550,000,000* shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program~~, including up to $54,000,000 for the procurement of polar icebreaking services from the Coast Guard: *Provided*, That the National Science Foundation shall only reimburse the Coast Guard for such sums as are agreed to according to the existing memorandum of agreement~~: *Provided* ~~further~~, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.

Research and Related Activities
FY 2011 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers[1]	Expired	Total Resources	Obligations Incurred/ Est.
FY 2010 Appropriation	$5,617.92	$52.78	-$54.00		$5,616.70	$5,615.33
FY 2009 ARRA	2,500.00	-	-	-	2,500.00	2,062.64
FY 2010 ARRA	-	439.17	-	-	439.17	439.17
FY 2010 Enacted/Ann. FY 2011 CR	5,563.92	1.37	-	-	5,565.29	5,565.29
FY 2012 Request	6,253.54	-	-	-	6,253.54	6,253.54
$ Change from FY 2010 Enacted/Annualized FY 2011 CR						$688.25
% Change from FY 2010 Enacted/Annualized FY 2011 CR						12.4%

Totals may not add due to rounding.

[1] In FY 2010, $54.0 million was tranferred to the U.S. Coast Guard for ice breaking services per P.L. 111-117.

Explanation of Carryover

Within the **Research and Related Activities (R&RA)** regular appropriation, NSF carried over $1.37 million into FY 2011. The major items include awards and contracts from various programs throughout NSF that were not ready for obligation in FY 2010. Obligation is expected in the second quarter of FY 2011.

For more information on the Explanation of FY 2010 Carryover of funds into FY 2011, please see the Technical Information tab of this document.

WIRELESS INNOVATION FUND $150,000,000

In FY 2012, the Wireless Innovation Fund would provide $150.0 million, which represents the first year of a five-year investment totaling an estimated $1.0 billion.

Wireless Innovation Fund
(Dollars in Millions)

	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Wireless Innovation Fund	$150.00	$220.00	$260.00	$220.00	$150.00

The Administration's *Wireless Innovation and Infrastructure Initiative* (WI3) proposes to reallocate a total of 500 megahertz of federal agency and commercial spectrum bands over the next 10 years in order to increase Americans' access to wireless broadband.

In FY 2012, the Administration proposes to establish the Wireless Innovation (WIN) Fund to help develop the cutting edge wireless technologies required to drive future American economic growth and the competitiveness of American industry. The WIN Fund would be paid for with receipts generated through electromagnetic spectrum auctions. The total amount in the fund is expected to be $3 billion and will support three categories of R&D investments: basic research, experimental testbeds, and application development.

NSF would receive $1.0 billion of this total for work in the categories of basic research and experimental testbeds.

Basic Research: Of the total available to NSF, $500.0 million will support basic research that complements and expands ongoing NSF efforts in Enhancing Access to the Radio Spectrum (EARS) and Cyber-Physical Systems (CPS)**.** EARS will invest in basic research that transcends typical disciplinary research activities and enhances the efficiency with which the radio spectrum is used, and/or lead to improved access to wireless services for all Americans. CPS investments aim to discover the missing core of fundamental knowledge between the physical and software components of systems that: respond more quickly (e.g., autonomous collision avoidance); are more precise (e.g., robotic surgery and nano-tolerance manufacturing); work in dangerous or inaccessible environments (e.g., autonomous systems for search and rescue); provide large-scale distributed coordination (e.g., automated deployment of sensors in response to changing situations); are highly efficient (e.g., zero-net energy buildings); and augment human capabilities (assistive technologies and ubiquitous healthcare monitoring and delivery).

Wireless Testbeds: $500.0 million will also be available for research on experimental wireless technology testbeds. This work will connect a sufficient number of campuses and cities so that experiments on these wireless testbeds can scale up to a national, even international level; allow for a critical mass of people on these campuses and in these cities to explore future open mobile networks at scale; allow for a rich set of multidisciplinary network science and engineering research experiments, including the social, behavioral, and economic sciences and engineering; and allow for entrepreneurs in cities and on campuses to develop novel mobile services not possible on the current Internet.

DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO) $794,490,000
+$79,950,000 / 11.2%

BIO Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Molecular & Cellular Biosciences (MCB)	$125.90	-	$125.59	$145.72	$20.13	16.0%
Integrative Organismal Systems (IOS)	216.32	-	216.25	231.65	15.40	7.1%
Environmental Biology (DEB)	142.50	-	142.55	156.40	13.85	9.7%
Biological Infrastructure (DBI)	127.19	0.35	126.86	135.95	9.09	7.2%
Emerging Frontiers (EF)	102.85	-	103.29	124.77	21.48	20.8%
Total, BIO	**$714.77**	**$0.35**	**$714.54**	**$794.49**	**$79.95**	**11.2%**

Totals may not add due to rounding.

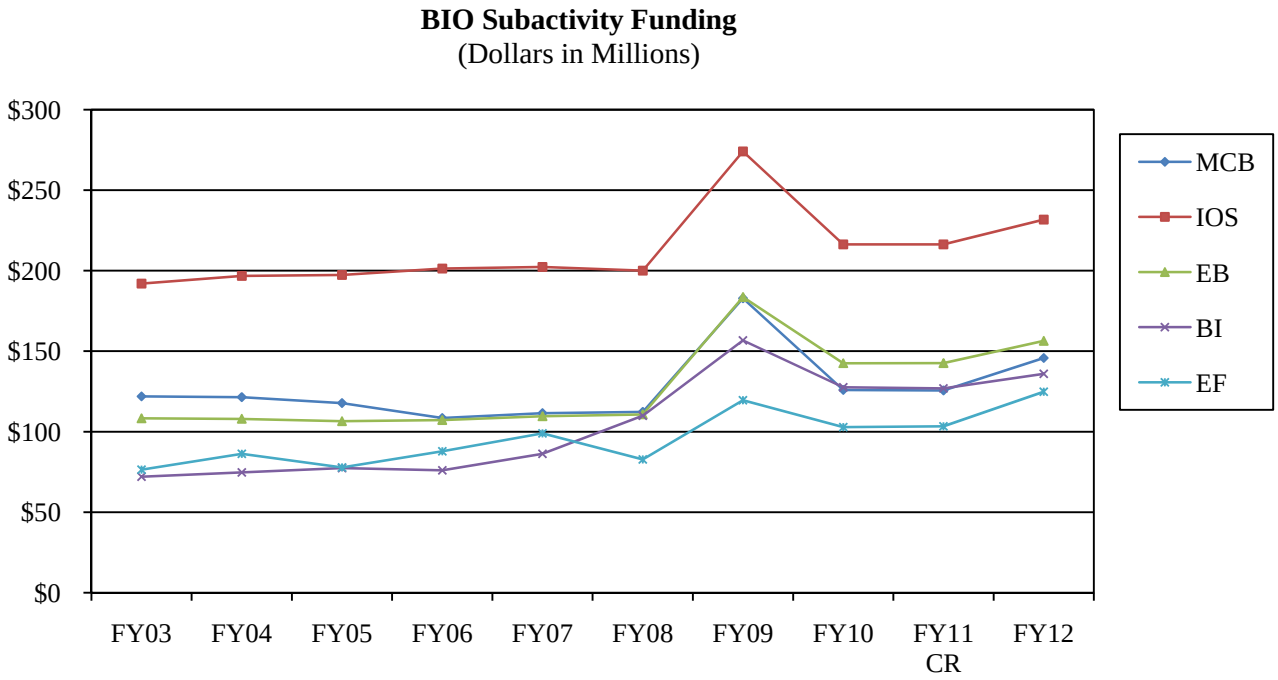
About BIO

BIO's mission is to enable discoveries for understanding life. Through investments in innovative and transformative research, BIO advances the frontiers of knowledge in the life sciences by increasing our understanding of complex living systems. BIO-supported projects also provide the theory, data, and other research resources that advance research in other science and engineering fields. These fields are adapting and employing principles and processes derived from biological systems to answer fundamental questions, develop practical applications, and solve problems.

Issues of national importance related to the environment, economy, agriculture, and human welfare require an understanding of how complex living systems function and interact with each other and with non-living systems. Research supported by BIO enhances this understanding. As the physical, computational, mathematical, and engineering fields increasingly use living systems to address their major questions, NSF's robust investment in the non-medical biological sciences becomes increasingly relevant to tackling these multidisciplinary challenges.

Biological concepts are integral to wide-ranging areas of science essential to human welfare and the bio-economy, including national priorities such as climate science, biotechnology, and bioengineering. Over the last 3.5 billion years, living organisms have evolved mechanisms for efficiently using energy, producing an endless array of novel compounds, and storing information in a highly compact, adaptable format. Fundamental biological research makes these innovations available to inform the next generation of nano-, bio-, and information technologies. For example, research funded through a BIO CAREER award recently showed that simple and efficient algorithms can be developed using insights derived from discoveries about how a nervous system develops. BIO's investment portfolio includes projects on understanding the changing dynamics of the biosphere, research on the fundamental characteristics of biological energy systems, and efforts to broaden participation and develop the next generation of biological researchers.

BIO provides about 68 percent of federal funding for non-medical, basic research at academic institutions in the life sciences, including environmental biology, a research area critical for addressing questions related to climate science.



FY 2012 Summary by Division

- Across all BIO divisions, the FY 2012 Request reflects enhanced support for Science, Engineering, and Education for Sustainability (SEES), including a priority investment in clean energy and support for the Research at The Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS) program. In addition, MCB, IOS, DEB, and DBI support the CAREER program.

- MCB's FY 2012 requested increase of $20.13 million, or 16.0 percent, reflects enhanced support for fundamental research to understand the dynamics and complexity of living systems at the biochemical, molecular, and cellular level. Within this increase, MCB will contribute to advanced manufacturing research via BioMaPS and the National Nanotechnology Initiative. MCB will also participate in the BioMaPS and SEES activities by supporting fundamental research on the components and processes that comprise and control biological systems at the nano to cellular scales. These interdisciplinary efforts will result in accelerated understanding of biological systems, leading to innovations in manufacturing in such areas as renewable fuels, bio-based materials, bio-imaging, and bio-inspired sensors.

- IOS's FY 2012 requested increase of $15.40 million, or 7.1 percent, is aimed at fundamental research on organisms as complex integrated systems, and their interactions with their social and physical environments especially as they adapt to climate variability and other environmental factors. IOS also maintains its commitment to support for fundamental plant genome research. The activities of the Plant Genome Research Program (PGRP) support genome-scale research to accelerate discoveries about basic plant biology, as well as downstream applications of societal benefit such as crop improvement, new sources of bio-based energy, and development of novel bio-based materials. IOS will also participate in BioMaPS and SEES by supporting research on novel energy capture and transduction systems.

- DEB's FY 2012 requested increase of $13.85 million, or 9.7 percent, will provide support for research on complex ecological and evolutionary dynamics to improve our ability to understand the reciprocal interactions between living systems and the environment, and inform essential considerations of environmental sustainability. The increase also reflects the Administration's focus on climate science research and support for the NSF-wide investment in SEES, including programs that enhance our understanding of the diversity of life on Earth and basic research and related activities that enhance fundamental understanding of the complex interactions within and among natural and human systems, with special emphasis placed on the coupling between human and natural systems.

- DBI's FY 2012 requested increase of $9.09 million, or 7.2 percent, empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and centers. It also reflects funding for the new NSF investment, Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21). Within this increase, DBI will contribute to clean energy research via support for the SEES Sustainability Research Networks, which link together networks of researchers exploring the intersection of environmental, energy, and economic understanding needed for long term sustainability.

- EF's FY 2012 requested increase of $21.48 million, or 20.8 percent, enhances support for developing priorities. In FY 2012, these are: focused activities within SEES; oversight and management of NEON, including the start of NEON operations; and coordination of cross-directorate innovation activities. It also reflects support for NSF's CIF21 investment. EF will also contribute to clean energy and advanced manufacturing research through support for BioMaPS.

Major Investments

BIO Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
SEES Portfolio	$121.00	$121.00	$146.00	$25.00	20.7%
Clean Energy	28.20	28.20	55.10	26.90	95.4%
CAREER	30.60	29.06	33.01	3.95	13.6%
BioMaPS	-	-	32.57	32.57	N/A
Advanced Manufacturing	-	-	10.00	10.00	N/A
CIF21	-	-	6.00	6.00	N/A

Major investments may have funding overlap, and thus should not be summed.

- BIO will participate in SEES by funding activities that will generate discoveries, advances, and capabilities in climate and energy science, engineering, and education to inform societal decisions needed for future environmental and economic sustainability and sustainable human well-being. Increased funding will be directed across all BIO divisions, reflecting a broad portfolio of support for Sustainability Research Networks, research on Sustainable Energy Pathways, Postdoctoral Fellowships in Sustainable Solutions, Dynamics of Coupled Natural Systems and the Dimensions of Biodiversity program.

- BIO will support Foundation-wide clean energy activities by funding research projects and Sustainability Research Networks that increase fundamental knowledge about how organisms capture and convert energy, which can form the basis to: imagine, invent, and deploy novel energy systems; explore alternative energy sources and technologies that can sustain a high quality of life on Earth; and investigate novel pathways for human energy futures built on a comprehensive understanding of risks and stressors related to environmental, biospheric, and societal responses associated with new energy pathways. Funding is split between MCB, IOS, EF, and DBI for this priority in FY 2012.

- BIO supports the CAREER program, an Administration priority. BIO's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

- In FY 2012, BIO will support the BioMaPS program, which seeks to integrate research at the intersections of the biological, mathematical and physical sciences, and engineering in order to discover, understand, and harness new knowledge to improve the human condition and our ability to adapt to a changing world. Research foci include discovering new physical, chemical, and mathematical principles driven by biological interactions; applying chemical and engineering principals to design and construct novel molecular and cellular systems for more efficient computational devices, complex circuits and networks, and new biomaterials; and developing novel nano-scale technologies that sense, collect, measure, and analyze information in real time. Enhanced support spans all BIO divisions.

- In FY 2012, BIO will support NSF's advanced manufacturing activities through funding in IOS, MCB, and EF. A portion of the new investment will be through BioMaPS. These interdisciplinary efforts will result in accelerated understanding of biological systems, leading to innovations in manufacturing in areas such as bio-based materials and bio-inspired sensors.

- BIO's funding for the new NSF-wide investment, Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21), will support each of the new programmatic components of CIF21: data enabled science, community research networks, new computational infrastructure, and access and connections to cyberinfrastructure facilities. FY 2012 funding will be split between EF and DBI.

Summary and Funding Profile

BIO supports investment in research and education as well as research infrastructure through support for centers and research resources such as databases and collections. BIO supports one major facility, the National Ecological Observatory Network (NEON), which begins construction in FY 2011; operations will commence late in FY 2012.

In FY 2012, the number of research grant proposals is expected to increase by approximately 20 percent compared to FY 2010 Enacted. BIO expects to award approximately 1,130 research grants in FY 2012. Average annualized award size will increase to reflect increasing costs of research, while duration will be held level with the FY 2010 Enacted.

In FY 2012, funding for Centers represents 5.3 percent of the BIO portfolio. Centers funding will increase with both the establishment in FY 2010 of a new Science and Technology Center (STC), the Bio/computational Evolution in Action Consortium, also known as the BEACON Center for the Study of Evolution, as well as increased support for a new environmental synthesis center to be established in FY 2011.

Funding for facilities, including initiating support for the maintenance and operations of NEON, represents 3.1 percent of the BIO portfolio in FY 2012.

BIO Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	8,060	7,150	8,580
Number of New Awards	1,557	1,370	1,557
Regular Appropriation	1,477	1,370	1,557
ARRA	80		
Funding Rate	19%	19%	18%
Statistics for Research Grants:			
Number of Research Grant Proposals	6,690	6,080	7,359
Number of Research Grants	1,130	930	1,130
Regular Appropriation	1,129	930	1,130
ARRA	1		
Funding Rate	17%	15%	15%
Median Annualized Award Size	$171,723	$165,500	$192,330
Average Annualized Award Size	$221,637	$206,500	$248,233
Average Award Duration, in years	3.1	3.1	3.1

BIO Funding for Centers Programs and Facilities

BIO Funding for Centers Programs
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Centers Programs	$33.63	$33.62	$41.71	$8.09	24.1%
Centers for Analysis & Synthesis	22.52	22.52	25.61	3.09	13.7%
Nano Centers	5.11	5.10	5.10	-	-
Science & Technology Centers	4.00	4.00	9.00	5.00	125.0%
Science of Learning Centers	2.00	2.00	2.00	-	-

No FY 2010 obligations for centers were made with funds provided by the ARRA.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

- Funding for the Centers for Analysis and Synthesis increases by $3.09 million over the FY 2010 Enacted level, to a total of $25.61 million. The program will support four centers in FY 2012, two of which are supported jointly with the Directorate for Mathematical and Physical Sciences (MPS). The increased support includes annual increments and a planned ramp up for the new environmental synthesis center that will be established in FY 2011.

- In addition to the Science and Technology Center for Microbial Oceanography: Research and Education (C-MORE), BIO will support the BEACON Center for the Study of Evolution in Action. BEACON is a consortium of universities led by Michigan State University, with partner institutions of North Carolina A&T State University, the University of Idaho, the University of Texas at Austin, and the University of Washington. BEACON's mission is to illuminate the power of evolution in action to advance science and technology, benefit society, and unite biologists, computer scientists, and engineers in joint study.

BIO Funding for Facilities
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Facilities	$34.71	$25.80	$23.28	-$2.52	-9.8%
Nanofabrication (NNIN)	0.35	0.35	0.35	-	-
National Ecological Observatory Network (NEON)	34.36	25.45	22.93	-$2.52	-9.9%

No FY 2010 obligations for facilities were made with funds provided by the ARRA.

For detailed information on individual facilities, please see the Facilities chapter.

Facilities

- Construction on NEON begins in FY 2011, with funding from the Major Research Equipment and Facilities (MREFC) account. In FY 2012, NEON operations will begin for the first NEON domain, the calibration and validation laboratory, and the data center.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

In FY 2010, BIO held two COVs: one for DBI, and one for the Plant Genome Research Program within IOS. In FY 2011, BIO will hold COV reviews for IOS and MCB. All BIO divisions are responding to and implementing recommendations from recent COVs. The BIO Advisory Committee (BIO AC) met twice in 2010, in April and October. The second meeting was held at NEON headquarters in Boulder, CO, and included a site review of facilities and discussions with scientific staff. FY 2012 COVs are planned for DEB and EF.

A recent workshop and two recently released reports have been of interest with respect to programmatic portfolio development. The workshop, held on January 6 and 7, 2011, "Research Frontiers in Bioinspired Energy: Molecular-level Learning from Natural Systems," was sponsored by NSF and the Department of Energy (DOE), and was jointly organized by the National Academies of Science (NAS) Boards on Life Sciences and Chemical Sciences and Technology. Its focus was to explore the molecular-level frontiers of energy processes in nature. BIO's senior management is reviewing the recommendations from the Presidential Commission for the Study of Bioethics report, *NEW DIRECTIONS: The Ethics of Synthetic Biology and Emerging Technologies*, as well as the NAS workshop report, *Implementing the New Biology: Decadal Challenges Linking Food, Energy, and the Environment*. These reports will also be evaluated at the spring 2011 BIO AC meeting for potential implementation of recommendations and incorporation into future fiscal year program planning. In addition, the 2010 NAS report, *Research at the Intersection of the Physical and Life Science*, has informed the development of the BioMaPS program in FY 2012.

In FY 2010, BIO initiated a Science and Technology Policy Institute (STPI) study to assess the scientific, technological, economic and societal impacts of NSF/BIO's investments in plant biology research. Final results from this study are expected during FY 2011.

Number of People Involved in BIO Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	5,791	452	4,547	4,530
Other Professionals	1,727	60	1,838	1,830
Postdoctorates	1,474	4	1,561	1,550
Graduate Students	2,947	9	3,123	3,330
Undergraduate Students	4,641	38	3,995	4,290
Total Number of People	**16,580**	**563**	**15,064**	**15,530**

DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB)

$145,720,000
+$20,130,000 / 16.0%

MCB Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
MCB Funding	**$125.90**	**$125.59**	**$145.72**	**20.13**	**16.0%**
Research	**124.78**	**124.89**	**145.02**	**20.13**	**16.1%**
CAREER	*14.12*	*14.06*	*15.86*	*1.80*	*12.8%*
Education	**1.12**	**0.70**	**0.70**	**-**	**-**

MCB supports fundamental research and educational activities that promote understanding of complex living systems at the molecular, subcellular, and cellular levels. Research supported by MCB typically combines integrated theoretical and experimental approaches with technologies derived from biological, physical, mathematical, computational, and engineering sciences. Projects are particularly encouraged in emerging areas such as single molecule or single cell studies, RNA biology, and synthetic biology. The MCB research portfolio also emphasizes projects aimed at understanding and predicting the molecular and cellular foundation of adaptation to environmental change. MCB continues to forge partnerships to support research that intersects biology and fields such as physical sciences and engineering, to introduce new analytical and conceptual tools for biological research, and to provide unique education and training opportunities for the next generation of researchers, scientific educators, and scientifically literate citizens.

In general, 44 percent of the MCB portfolio is available for new research grants. The remaining 56 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- Maintaining the health of its disciplinary knowledge base is one of BIO's top priorities, which is reflected in requested increases for all divisions. Increased support for basic biological research will yield insights that can be used to produce the next generation of nano-, bio-, and information technologies (+$2.87 million to a total of $144.60 million).
  - The blueprint for the form and function of an organism lies in its DNA and in the way that DNA is expressed as it interacts with its environment. MCB will support research to link the distinctive properties of organisms – from form to physiology to behavior – to the selective expression of their genetic information.
  - As with all BIO divisions, MCB will support BioMaPS in partnership with the Engineering and Mathematical and Physical Sciences Directorates (+$5.40 million to a total of $5.40 million).
- MCB will contribute $5.0 million to advanced manufacturing research via BioMaPS and the National Nanotechnology Initiative by supporting fundamental research on the components and processes that comprise and control biological systems at the nano to cellular scales.
  - Synthetic Biology employs an unconventional approach to understanding living systems by using chemical and engineering principles to design and construct (or reconstruct) functional molecular and cellular systems. MCB will encourage support of interdisciplinary research

employing Synthetic Biology approaches to advance our understanding of living systems and to enhance the quality of life on Earth.

- MCB will also contribute $5.0 million to clean energy research through the BioMaPS and SEES activities to support research on novel processes used by living organisms to capture and transduce energy.
  - MCB will prioritize research of societal importance, particularly related to energy, environment, and the diversity of life on Earth. Fundamental knowledge about how organisms capture and convert energy will help us develop sources of clean energy. For example, research funded by MCB has provided the basis for engineering of a nanoscale biocatalyst that uses light energy to generate hydrogen, a clean energy source. In addition, understanding the molecular and cellular basis for the adaptation of organisms to their environment is essential to understanding the central role of the diversity of life on Earth in adapting to or bringing about environmental change.
- MCB will increase support for CAREER (+$1.80 million to a total of $15.92 million) in accordance with Administration priorities.

Education

- All BIO divisions include support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities.

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS) $231,650,000
+$15,400,000 / 7.1%

IOS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
IOS Funding	**$216.32**	**$216.25**	**$231.65**	**$15.40**	**7.1%**
Research	**172.04**	**170.25**	**185.65**	**15.40**	**9.0%**
CAREER	*7.83*	*7.00*	*8.00*	*1.00*	*14.3%*
Education	**8.81**	**6.00**	**6.00**	**-**	**-**
Infrastructure	**35.47**	**40.00**	**40.00**	**-**	**-**

IOS supports research and education aimed at understanding the diversity of plants, animals, and microorganisms as complex systems interacting with their environments. Reaching a systems level understanding of organisms will require a new emphasis on interdisciplinary approaches and development of new tools. These approaches span computational, molecular, cellular, individual organism and population levels of inquiry. Many activities supported by IOS focus on biological processes that affect organismal development, structure, performance, and interactions under varying environmental conditions. IOS-supported research focuses on investigating organismal performance in an environmental context, which is significant for understanding reciprocal interactions between living systems and the environment.

The activities of the Plant Genome Research Program (PGRP) support genome-scale research to accelerate discoveries about basic plant biology as well as downstream applications of potential societal benefit such as crop improvement, development of new sources of bio-based energy, development of sources of novel bio-based materials, and adaptation to global climate variability.

The Basic Research to Enable Agricultural Development (BREAD) Program will continue support for basic research to test innovative, early-concept approaches and technologies for sustainable, science-based solution to problems of agriculture in developing countries. BREAD in FY 2012 is supported by NSF ($6.0 million) and the Bill & Melinda Gates Foundation ($6.0 million) through funding provided to NSF.

In general, 55 percent of the IOS portfolio is available for new research grants. The remaining 45 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- Maintaining the health of its disciplinary knowledge base is one of BIO's top priorities, which is reflected in requested increases for all divisions. In IOS (+$4.95 million to a total of $185.95 million) there is an emphasis on cross-disciplinary, integrated approaches, from the genome to the organism, to understanding complex living systems, especially as they interact with, and adapt to, a changing environment. Enabling research at the interfaces of organismal biology, environmental biology, and molecular and cellular biology, to address major questions in organismal biology and climate science, will be a priority. These studies are expected to extend the understanding of organismal structure and

function at all scales, from the individual to populations. For example, research funded by IOS has shown that tree resins collected by honey bees to fight microbes in the hive aids their immune systems. Local differences in the availability of resin producing trees and genetic behavioral differences in how much resin is collected provide insight into the interaction between these economically important pollinators and their environment at multiple scales.

  - New genomic technologies and computational tools are critical to gaining a mechanistic understanding of such diverse processes as plant development and animal development from elaboration of the nervous system to behavior processes. IOS will support development of critical tools and resources to enable a systems-level understanding of these processes.
  - IOS will continue to support basic research with the potential to yield societal benefits, in such areas as bio-inspired materials, industrial raw materials and new sources of energy. Ongoing genome-scale research within PGRP and BREAD will continue to accelerate basic discoveries with potential downstream applications.
- IOS will support BioMaPS, especially in areas relevant to bio-inspired design (+$4.39 million to a total of $4.39 million in IOS).
- IOS will contribute $5.0 million to clean energy research through BioMaPS and SEES to support research on novel energy capture and transduction systems.
- Responding to the national priority of supporting young investigators, IOS support for CAREER increases (+$1.0 million to a total of $8.00 million).

Education

- All BIO divisions include support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities.

Infrastructure

- Within infrastructure, the IOS Request includes investments in research resources essential to the plant genome research program.

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB) $156,400,000
+$13,850,000 / 9.7%

DEB Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
DEB Funding	**$142.50**	**$142.55**	**$156.40**	**$13.85**	**9.7%**
Research	**139.15**	**140.55**	**154.40**	**13.85**	**9.9%**
CAREER	*4.92*	*4.50*	*5.14*	*0.64*	*14.2%*
Education	**3.35**	**2.00**	**2.00**	**-**	**-**

DEB supports catalytic and transformative research to inventory life on earth, to discover life's origins and evolutionary history, and to understand the dynamics of ecological systems. Ecological systems, in turn, provide goods and services upon which human health and welfare depend (e.g., breathable air, potable water, food and fiber, crop pollination, disease control). Long-term DEB research is critical to understanding the feedbacks between natural and human systems. Scientific foci in DEB address the process of evolution; describe the genealogical relationships of all life; elucidate the spatial and temporal interactions of species interactions that lead functional communities; and determine the flux of energy and materials through ecosystems. This theoretical and empirical research in ecology, evolution, and the diversity of life is enhanced by dynamic interactions with the fields of genomics, computer science, and mathematics.

In general, 51 percent of the DEB portfolio is available for new research grants. The remaining 49 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- Maintaining the health of its disciplinary knowledge base is one of BIO's top priorities, which is reflected in requested increases for all divisions. Support increases in DEB (+$3.26 million to a total of $153.05 million) for fundamental research on ecological and evolutionary patterns and processes at all spatial and temporal scales in the context of climate science and other environmental factors.
- BioMaPS (+$3.39 million to a total of $3.39 million) supports interdisciplinary research at the intersection of the life and physical sciences, such as theories underlying the interactions at various levels of biological organization, from gene to population to ecosystem.
- Funding for SEES (+$5.0 million to a total of $5.0 million) supports the Dimensions of Biodiversity program and the Dynamics of Coupled Natural and Human Systems.
  - The Dimensions of Biodiversity program will use integrative, innovative approaches to transform how we describe and understand the role and scope of life on Earth. Previous research funded by DEB has demonstrated that species losses in ecosystems due to fragmentation of natural habitats can result in increases in the transmission of infectious diseases such as West Nile virus, Lyme disease, and Hantavirus. Supporting studies to elucidate the functional role of biological diversity, a major knowledge gap, is a central focus of the Dimensions program.
- Responding to the national priority of supporting young investigators, DEB support for CAREER increases (+$640,000 to a total of $5.14 million).

- DEB supports research for which long-term data are critical to address some of our most pressing environmental challenges. Increased support for the Long Term Ecological Research (LTER) program will cover planned annual increments for LTER sites (+$1.5 million to a total of $23.11 million).

Education

- All BIO divisions include support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities.

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI) $135,950,000
+$9,090,000 / 7.2%

DBI Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
DBI Funding	**$127.19**	**$0.35**	**$126.86**	**$135.95**	**$9.09**	**7.2%**
Research	**41.68**		**40.80**	**58.35**	**17.55**	**43.0%**
CAREER	*3.72*	-	*3.50*	*4.01*	*0.51*	*14.6%*
Centers Funding (total)	*33.63*	-	*33.62*	*41.71*	*8.09*	*24.1%*
Natl. Ctr for Ecol. Analysis & Synthesis	*3.70*	-			-	*N/A*
Natl. Environmental Synthesis Center		-	*3.70*	*6.00*	*2.30*	*62.2%*
Natl. Evolutionary Synthesis Center	*5.50*	-	*5.50*	*5.35*	*-0.15*	*-2.7%*
Natl. Institute for Math and Bio Synthesis	*2.35*	-	*2.35*	*2.35*	-	-
iPlant	*10.97*	-	*10.97*	*11.91*	*0.94*	*8.6%*
Cntrs. for Enviro. Implications of Nanotech.	*5.11*	-	*5.10*	*5.10*	-	-
STC: Microbial Oceanography: Res. & Ed.	*4.00*	-	*4.00*	*4.00*	-	-
STC: BEACON		-		*5.00*	*5.00*	*N/A*
SLC: Temporal Dynamics of Learning	*2.00*	-	*2.00*	*2.00*	-	-
Education	**27.77**	**0.35**	**26.06**	**17.60**	**-8.46**	**-32.5%**
Infrastructure	**57.74**	**-**	**60.00**	**60.00**	**-**	**-**
NNIN	*0.35*	-	*0.35*	*0.35*	-	-
Research Resources	*57.39*	-	*56.75*	*56.75*	-	-

DBI empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and centers. In particular, DBI supports the development of, or improvements to, research infrastructure, including instruments, software, and databases; and the improvements to biological research collections, living stock collections, and field stations and marine labs. In addition, DBI funds the development of human capital through support of undergraduate, graduate, and postdoctoral research experiences. Support of center and center-like activities creates opportunities to address targeted but deep biological questions that have major societal impact.

DBI supports research resources that include the development of research tools, acquisition of instrumentation, and infrastructure improvements; human resource activities; and centers. Approximately 45 percent of the DBI budget is available for new awards each year, with approximately 36 percent available for new research grants. Approximately 30 percent supports Centers, while the remainder is distributed through grants for various DBI and BIO priorities and continuing funds for grants made in previous years.

FY 2012 Summary

Research

- DBI will support BioMaPS (+$4.39 million to a total of $4.39 million), focusing on areas such as bio-inspired information technologies and nano-scale bio-sensors.

- BIO will be actively involved in all aspects of the new CIF21 investment, as its components are important to advancement across all of the biological sciences. Support will focus on Data-Enabled Science, but will also be directed to Community Research Networks and Access and Connections to Cyberinfrastructure Facilities (+$3.0 million to a total of $3.0 million).
- CAREER funding in DBI increases by $510,000 to a total of $4.01 million in FY 2012. This increase is consistent with DBI's emphasis on supporting early career researchers.
- The Research Improvement Grants (RIG) program will end in DBI (-$2.0 million), as the program did not receive the increased numbers of proposals from underrepresented groups, as was intended. RIG will be absorbed and supported across the other BIO divisions.
- DBI contributes $5.0 million to clean energy research through support for SEES Sustainability Research Networks to link together networks of researchers exploring the intersection of environmental-energy and economic understanding needed for long term sustainability.

Centers

- As planned, FY 2010 was the final year of funding for the National Center for Ecological Analysis and Synthesis. Support for the new environmental synthesis center that will be established in FY 2011 increases to a total of $6.0 million in FY 2012. The center will stimulate research, education, and outreach at the interface of the biological, geological, and social sciences, and foster synthetic, collaborative, cross-disciplinary efforts.
- Small adjustments are provided for the National Evolutionary Synthesis Center (-$150,000 to a total of $5.35 million) and iPlant (+$940,000 to a total of $11.91 million) as part of existing cooperative agreement annual increments.
- BIO will initiate support (+$5.0 million) for a new STC, the BEACON Center for the Study of Evolution in Action. BEACON unites biologists, computer scientists and engineers in joint study.

Education

- Support for a number of BIO programs, Undergraduate Research Mentoring (URM) and Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM) will be eliminated (-$4.10 million), and support is decreased for IGERT (-$3.25 million to a total of $3.25 million). Funding from these reductions will be used to support new biology undergraduate education activities resulting from the recommendations of the "Vision and Change: A Call to Action" conference and report: http://visionandchange.org/files/2010/03/VC_report.pdf. In addition, some new activities will be developed by partnering with the Education and Human Resources Directorate (EHR) on new pilot programs aimed at improving undergraduate STEM education.
- ADVANCE increases (+$70,000 to a total of $2.57 million) in accordance with NSF priorities.

Infrastructure

- DBI investments in infrastructure further advances in all areas of biological research as well as databases, resources, and tools for the entire biology community. For example, historically the amount of animal vocalization and associated species data has been limited, due to the enormous human effort and cost required for field collecting. DBI has funded the development of permanent and portable recording devices and accompanying software to automate species identification, which has made major contributions to the spatial and temporal coverage of animal biodiversity data. These technological advances have allowed for improved collection of biodiversity data that is aiding land managers in assessing ecosystem health and making informed conservation decisions.

DIVISION OF EMERGING FRONTIERS (EF) $124,770,000
+$21,480,000 / 20.8%

EF Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
EF Funding	**$102.85**	**$103.29**	**$124.77**	**$21.48**	**20.8%**
Research	**58.52**	**66.94**	**76.94**	**10.00**	**14.9%**
Education	**9.97**	**10.90**	**14.90**	**4.00**	**36.7%**
Infrastructure	**34.36**	**35.45**	**32.93**	**-2.52**	**-7.1%**
NEON	*34.36*	*25.45*	*22.93*	*-2.52*	*-9.9%*

EF identifies, incubates, and supports infrastructure and research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology. For example, research supported by EF found that cockroaches scrambling over rough terrain do not change the neural signals to their leg muscles; instead, control is built into the mechanics of their legs that requires no active adjustments from a brain. This ability to self-stabilize like an extraordinary passive suspension system was predicted by project mathematicians and built into a robot to improve maneuverability. Using a novel model approach, this research team "rewrote" the neural code from the spinal cord to the leg muscles in running cockroaches to tease apart the complex neural and muscular networks, information which was used to revise the mathematical models that were applied to the robot. This fundamental research to understand how animals control legged locomotion is advancing the design of the first search-and-rescue robot that has performance truly comparable to animals.

Typically, developing programs and priority areas begin in EF and then shift to other BIO divisions to become part of the disciplinary knowledge base. Examples include the Assembling the Tree of Life and Ecology of Infectious Diseases programs. Supporting biological research that crosses scales of organization and involves multiple disciplines continues to be a high priority, and is particularly relevant for research questions related to global change. EF also facilitates the development and implementation of new forms of merit review and mechanisms to support transformative research and stimulate creativity. These goals are accomplished by promoting cultural change within and across scientific disciplines to increase and strengthen multidisciplinary collaborations, encourage curiosity and exploration through novel mechanisms and investments, and facilitate support of research areas relevant to all of biology by targeted co-funding throughout the directorate.

In general, 90 percent of the EF portfolio is available for new research grants. The remaining 10 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- The Advancing Theory in Biology program (-$5.0 million) and the Life in Transition focus (-$10.0 million), after development and growth in EF, now shift to be supported as a mainstream activity across all other BIO divisions.
- The CDI program will end in BIO (-$1.0 million) as support refocuses on CIF21.
- Investment increases include:

- Active involvement in all aspects of the new CIF21 emphasis, as components are important to advancement across all of the biological sciences. Support will focus on Data-Enabled Science, but will also be directed to Community Research Networks and Access and Connections to Cyberinfrastructure Facilities (+$3.0 million to a total of $3.0 million)
- EF will support SEES (+$5.0 million to a total of $5.0 million) through sustainability research networks and the Dimensions of Biodiversity program, which is designed to provide an enhanced and integrated understanding of the key natural variation and function of life on Earth, across genetic, taxonomic, and functional dimensions.
- Continued funding ($10.0 million total) will be provided for an activity in support of digitization of scientific information associated with biological specimens held in U.S. research collections. This program was begun in FY 2009 with funding from ARRA. A strategic plan developed by the community and released in FY 2010 will guide investments in FY 2012.
- Continued support of research activities relevant to NEON, including macrosystems biology, as construction continues on NEON.
- EF contributes $5.0 million to clean energy research via BioMaPS, by supporting research on novel processes used by living organisms to capture and transduce energy.
- EF contributes $10.0 million to advanced manufacturing research via BioMaPS, by supporting research that aims to understand the components and processes that comprise and control biological systems from the nano to cellular scales.

Education

- In FY 2012, BIO is focusing on support for new biology undergraduate education activities, including selected Transforming Undergraduate Biology Education (TUBE) activities with well-developed metrics (+$4.0 million to a total of $14.90 million). This is based on the recommendations of the 2009 "Vision and Change: A Call to Action" conference and report (http://visionandchange.org/files/2010/03/VC_report.pdf). In addition, some new activities will be developed, including partnering with EHR on new pilot programs aimed at improving undergraduate STEM education.

Infrastructure

- In FY 2012, management and operations funding for NEON will commence, assuming a construction start by July 2011. The request for $22.93 million will enable operations of the first two domains constructed, including related management and technical support, seasonal biological sampling, and domain facility costs. Project planning costs conclude as the NEON project transitions into construction and operations.

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (CISE) $728,420,000 +$109,590,000 / 17.7%

CISE Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Computing and Communication Foundations (CCF)	$170.40	$170.35	$210.13	$39.78	23.4%
Computer and Network Systems (CNS)	204.33	$204.42	$235.20	30.78	15.1%
Information and Intelligent Systems (IIS)	163.21	$163.32	$197.35	34.03	20.8%
Information Technology Research (ITR)	80.78	$80.74	$85.74	5.00	6.2%
Total, CISE	**$618.71**	**$618.83**	**$728.42**	**$109.59**	**17.7%**

Totals may not add due to rounding.

About CISE

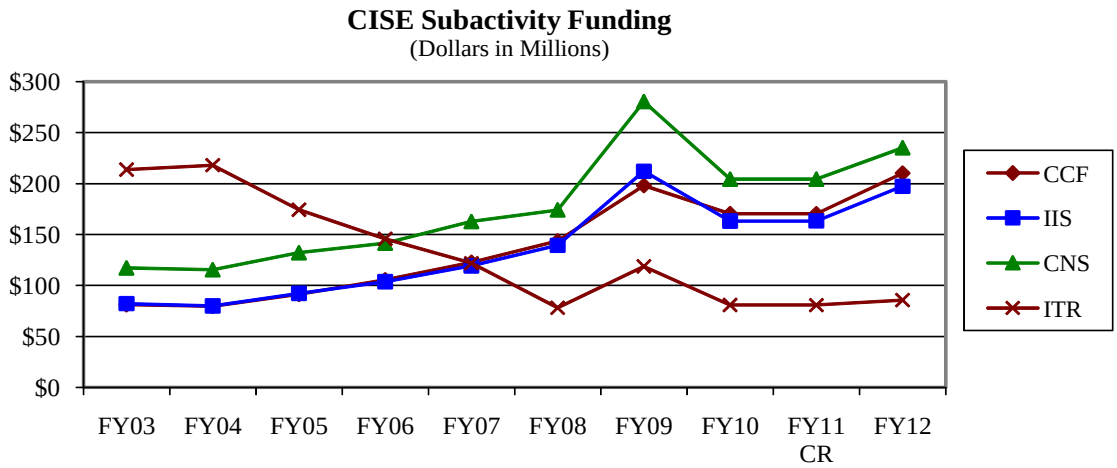
CISE's mission is to promote the progress of computer and information science and engineering research and education; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and affordable participation in an information-based society. CISE supports ambitious long-term research and research infrastructure projects within and across the many sub-fields of computing, contributes to the education and training of computing professionals and, more broadly, informs the preparation of a U.S. workforce with computing competencies essential to success in an increasingly competitive, global market.

Essentially all practical applications of Information Technology (IT) are based on ideas and concepts that emerged from investments in basic computing research. These fundamental ideas and concepts have enabled innovative products and applications that now permeate all areas of modern life. IT forms a sizeable portion of the economy and it drives discovery and innovation in many other areas, including advanced scientific research, healthcare, energy and sustainability science, national and homeland security, and public and private organizational effectiveness and efficiency. Innovation in IT will remain an essential and vital force in productivity gains and economic growth in both the manufacturing and service sectors for many years to come, positioning NSF and CISE as central and essential actors in improving the Nation's economic outlook and advancing a highly trained, technologically astute workforce.

CISE continues to play a leadership role in the multi-agency Subcommittee on Networking and Information Technology Research and Development (NITRD), which is co-chaired by the CISE Assistant Director. All research, education, and research infrastructure projects supported by CISE enrich the agency's NITRD portfolio.

NSF provides approximately 82 percent of the total federal support for basic research at academic institutions in computer science. Since 1995, networking and IT industries have accounted for 25 percent of the Nation's economic growth, although they represent only three percent of the gross domestic product.[1]

[1] *Leadership Under Challenge: IT R&D in a Competitive World*, President's Council of Advisors on Science and Technology (PCAST) 2007, page 9.



FY 2012 Summary by Division

- CCF's FY 2012 Request is focused on enhancing support for core programs and, as part of the NSF-wide Science, Engineering and Education for Sustainability (SEES) and clean energy investments, funding foundational research in energy-intelligent computing, the development of new theory, algorithms, and design principles to optimize energy-computational performance in computing and communications systems, and the scalability and sustainability of smart energy production software and hardware. CCF will also support the NSF-wide Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) investment through research on new functional capabilities in support of the entire software lifecycle and the development of new sustainable software elements. CCF will support research in advanced manufacturing through investments in the National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond (NEB). CCF will focus on research leading to innovations on novel computational paradigms that will take computation and information processing beyond Moore's Law.

- CNS's FY 2012 Request reflects its commitment to support the NSF-wide SEES investment through research to explore the use of information technology in smart sensing systems that promise to save energy and reduce greenhouse gas emissions as well as the systems trade-offs among computation, communication, and performance. CNS will support research on the networking and computing systems dimensions of clean energy through investments in the NSF-wide SEES Sustainable Energy Pathways (SEP) and Sustainability Research Networks (SRN) activities. CNS will also support the NSF-wide CIF21 investment through research in new experimental architectures and approaches to leading-edge computational infrastructure (e.g., clouds, clusters, data centers) as well as new approaches to networking and distributed computing that allow for seamless access to distributed computational resources. In partnership with the Directorate for Engineering (ENG), CNS will support the research in advanced manufacturing through increased support for forward-looking research on cyber-physical systems. CNS will continue to support the Trustworthy Computing program, which includes support for the Comprehensive National Cybersecurity Initiative (CNCI), with a focus on new computing and networking security and privacy architectures. CISE supports CNCI in collaboration with the Office of Cyberinfrastructure (OCI) and the Directorate for Social, Behavioral and Economic Sciences (SBE). CNS will partner with the Directorates for Mathematical and Physical Science (MPS), Engineering and SBE to support the Enhancing Access to Radio Spectrum (EARS) program's goal of sponsoring research that can enable more users to share a fixed amount of radio spectrum.

- IIS's FY 2012 Request will provide support for the NSF-wide SEES investment through research to optimize energy usage through intelligent decision-making for compute- and data-intensive systems. IIS will support research on the information processing dimensions of clean energy through additional investments in the NSF-wide SEES Sustainable Energy Pathways (SEP) activity. In addition, IIS will participate in the NSF-wide CIF21 investment through research in data analytics and e-science, including new approaches to data mining, machine learning and knowledge extraction and visualization. IIS will lead CISE's investment in Smart Health and Wellbeing research partnering with ENG and SBE, as well as CISE's other divisions. IIS will spearhead the multi-agency National Robotics Initiative by investing in the basic science and engineering of robotics, with accompanying industrial transfer, productization, distribution, and support.

- ITR's FY2012 Request will support the cross-directorate investment in public-private partnerships that promise to enhance IT innovation. Leveraging recent partnerships with a variety of private sector organizations, CISE will create an academic-industry research incubator that encourages and supports transformative research at the computing frontier. ITR will continue support for the Expeditions in Computing program. In planning and implementing Expeditions, researchers are encouraged to come together within or across departments or institutions to identify compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come. In collaboration with ENG and MPS, ITR will support research on advanced manufacturing through increased investments in innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research Center (I/UCRC) program. This program establishes centers that partner industry with university research efforts. ITR provides flexibility for emerging high-priority areas of potentially transformative research.

Major Investments

CISE Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
CAREER	$41.56	$50.96	$57.91	$6.95	13.6%
SEES Portfolio	15.00	17.00	46.36	29.36	172.7%
Comprehenisve National Cybersecurity Initiative (CNCI)	40.00	40.00	37.00	-3.00	-7.5%
SEBML (includes NNI: Nanoelectronics for 2020 and Beyond)	15.00	15.00	20.00	5.00	33.3%
National Robotics Initiative	-	-	17.50	17.50	N/A
Smart Health and Wellbeing	15.00	15.00	17.00	2.00	13.3%
CIF21	-	-	16.00	16.00	N/A
Science and Technology Centers	7.32	7.32	9.00	1.68	23.0%
EARS	-	-	7.00	7.00	N/A

Major investments may have funding overlap, and thus should not be summed.

Proposed activities in CISE for FY 2012 were guided by its strategic priorities: supporting the NSF wide investments in SEES and CIF21; Innovating for Society, which includes activities in robotics (such as the multi-agency National Robotics Initiative), Smart Health and Wellbeing, and Enhancing Access to the

Radio Spectrum (EARS); and enhancing core disciplinary research, including support for CAREER awards. Additional investments include support for science and technology centers, the National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond, and the Comprehensive National Cybersecurity Initiative (CNCI). CISE is also focusing on support for clean energy, via our participation in SEES; and advanced manufacturing, through activities in Cyber-Physical Systems, the National Nanotechnology Initiative, and the Industry/University Cooperative Research program.

- CAREER: CISE supports the CAREER program, an Administration priority. Contributing to the development of current and future generations of computing faculty is a priority and is reflected in the strong CISE commitment to the CAREER program.
- Science, Engineering and Education for Sustainability (SEES): In FY 2012, CISE will support the NSF-wide SEES investment and enrich the SEES portfolio with a program aimed at the challenges created as well as addressed by information and communications technologies. This effort will support research activities developing algorithmic foundations and new software and hardware for energy-efficient, energy-aware, and sustainable computing and communications.
- Through the SEES portfolio, CISE will support research on clean energy through investments in the NSF-wide SEES Sustainable Energy Pathways (SEP) and Sustainability Research Networks (SRN) activities.
- Comprehensive National Cybersecurity Initiative (CNCI): In FY 2012, CISE is focused on the development of a Science of Cybersecurity as well as three game-changing research themes – Moving Target Defense, Tailored Trustworthy Spaces, and Cyber Economic Incentives. In partnership with OCI, CISE will also actively work to transition the best of this new research into a secure research infrastructure. The Science of Cybersecurity will develop the underlying fundamental principles that allow for the adoption of a more scientific approach to building, maintaining, and using trustworthy systems. Moving Target Defense research aspires to elude attackers through diverse, shifting, and increasingly complex cyber techniques and mechanisms. The Tailored Trustworthy Spaces theme supports research into varying trustworthy space policies and services that are context specific with the aim to create flexible, distributed trust environments. The Cyber Economic Incentives theme, which both CISE and SBE support, focuses on research at the interstices of economic and computer sciences to achieve secure practices through the development of market forces that incentivize good behavior.
- Science and Engineering Beyond Moore's Law (SEBML): In partnership with other federal agencies, MPS, ENG and the Directorate for Biological Sciences (BIO), CISE will support research in advanced manufacturing, in part through investments in the National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond. CISE will support research leading to departures from traditional architectural practices of computing, including reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error prone devices at the nano-scale.
- The National Robotics Initiative (NRI) is a new inter-agency initiative that engages four U.S. agencies (NSF, NASA, NIH and USDA) in a concerted program to provide U.S. leadership in science and engineering research and education aimed at the development of next generation robotics, conceived as robots that work beside, or cooperatively, with people in areas such as manufacturing, space and undersea exploration, healthcare and rehabilitation, military and homeland surveillance and security, education and training, and safe driving. In partnership with ENG, CISE will focus on fundamental research in robotics science and engineering. This includes advanced sensing, control, and power sources; dynamical system mechanics; optimization, design, and decision algorithms; problem-solving architectures; hybrid architectures that integrate or combine methods (deductive, case-based, symbolic, etc.); safe and soft structures and mechanisms with reactive surfaces and elastic

actuators; computational models of human cognition; integration of artificial intelligence, computer vision, and assistive robotics.

- Smart Health and Wellbeing: Partnering with ENG and SBE, CISE will support Smart Health and Wellbeing in FY 2012. CISE will pursue improvements in safe, effective, efficient, equitable, and patient-centered health and wellness technology and services through innovations in computer and information science and engineering that recognize the technical feasibility of diagnosis, treatment, and care based on an individual's genetic makeup and lifestyle and acknowledge the changing demographics of an increasingly aging population. This program supports the vision laid out in the recent National Research Council report, "Computational Technology for Effective Health Care," (W. Stead and H. Lin, editors) and responds to two reports from the President's Council of Advisors on Science and Technology (PCAST) issued in FY 2011: "Report to the President, Realizing the Full Potential of Health Information Technology to Improve Healthcare for Americans: The Path Forward", and "Report to the President and Congress, Designing A Digital Future: Federally Funded Research and Development in Network and Information Technology" that advises a "national long-term multi-agency research initiative on Networking and Information Technology (NIT) that goes well beyond the current national program to adopt electronic health records."
- CIF21: In FY2012, CISE support for the new NSF-wide CIF21 investment will focus on two particular areas: new computational infrastructure and data-enabled science.
  - New computational infrastructure: CISE investments in software will catalyze and nurture the multidisciplinary processes required to support the entire software lifecycle, and result in the development of sustainable community software elements at all levels of the software stack.
  - Data-enabled science: CISE investments will lead to advances in data analytics or e-science tools and techniques – such as data mining, machine learning, and data visualization.
- Science and Technology Centers: Support for the Science and Technology Center for Embedded Networked Sensing sunsets as planned in FY 2011. In FY 2012, CISE will continue to fund the Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley. Starting in FY 2011, CISE is supporting an STC for the Science of Information at Purdue University.
- Enhancing Access to the Radio Spectrum (EARS): In partnership with MPS, ENG, and SBE, CISE will initiate support for the basic research that underpins EARS in FY 2012. The recent NSF workshop report, *Enhancing Access to the Radio Spectrum*, outlines the need for research on new and innovative ways to use the spectrum more efficiently. CISE will focus on the development of new wireless testbeds to support experiments on increasing the efficiency with which the spectrum is used. Additional information on EARS is available in the Selected Cross-Cutting Programs section of the NSF-wide Investments chapter.

Summary and Funding Profile

CISE supports investment in core and interdisciplinary research and education as well as research infrastructure, such as centers and facilities.

In FY 2012, the number of research grant proposals is expected to increase by approximately 1,630 compared to FY 2010 Enacted. CISE expects to award approximately 1,590 research grants in FY 2012. Average annualized award size and duration will be held level with the FY 2010 Enacted.

CISE Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	6,486	5,900	7,630
Number of New Awards	1,586	1,450	1,840
Regular Appropriation	1,567	1,450	1,840
ARRA	19	-	-
Funding Rate	24%	25%	24%
Statistics for Research Grants:			
Number of Research Grant Proposals	6,140	5,600	7,230
Number of Research Grants	1,350	1,220	1,590
Regular Appropriation	1,349	1,220	1,590
ARRA	1	-	-
Funding Rate	22%	22%	22%
Median Annualized Award Size	$150,000	$140,000	$140,000
Average Annualized Award Size	$199,356	$180,000	$180,000
Average Award Duration, in years	2.9	3.0	3.0

CISE Funding for Centers Programs and Facilities

CISE Funding for Centers Programs

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Centers Programs	$9.82	$9.82	$11.50	$1.68	17.1%
STC: Center for Embedded Networked Sensing (CCF)	3.32	3.32	-	-3.32	-100.0%
STC: Team for Research in Ubiquitous Secure Technology (CCF)	4.00	4.00	4.00	-	-
STC: Science of Information (CCF)	-	-	5.00	5.00	N/A
SLC: Pittsburgh Science of Learning (ITR)	2.50	2.50	2.50	-	-

No FY 2010 obligations for centers were made with funds provided by the ARRA, so that column is not included here.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

- Funding for the Center for Embedded Networked Sensing (CENS) at the University of California at Los Angeles will end as planned in FY 2011, after ten years of support.
- In FY 2012, CISE will provide the eighth year of funding for the Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley. TRUST is focused on the development of cybersecurity science and technology that will radically transform the ability of organizations to design, build, and operate trustworthy information systems for the Nation's critical infrastructure by addressing the technical, operational, legal, policy, and economic issues affecting security, privacy, and data protection as well as the challenges of developing, deploying, and using trustworthy systems.
- Starting in FY 2011, CISE is supporting the Center for the Science of Information at Purdue University. This center will develop a unifying set of principles to guide the extraction, manipulation, and exchange of information, integrating elements of space, time, structure, semantics and context. The center will bring together researchers from diverse fields (physics, life science, chemistry, computer science, economics, etc.) to develop models and methods to apply to these diverse applications.
- CISE will continue support for the Pittsburgh Science of Learning Center (SLC) for Robust Learning. The Pittsburgh SLC will leverage cognitive theory and cognitive modeling to identify the instructional conditions that cause robust student learning in order to enhance scientific understanding of robust learning in educational settings and create a research facility to support field-based experimentation, data collection, and data mining.

CISE Funding for Facilities

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Facilities	$0.60	$0.60	$0.60	-	-
National Nanotechnology Infrastructure Network (CCF)	0.60	0.60	0.60	-	-

No FY 2010 obligations for facilities were made with funds provided by the ARRA, so that column is not included here.

For detailed information on individual facilities, please see the Facilities chapter.

Facilities

- CISE will continue support in FY 2012 for the National Nanotechnology Infrastructure Network.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

During FY 2009, CISE held three Committees of Visitors (COV) reviews, which together examined and assessed the quality of the entire CISE portfolio. Other performance indicators, such as funding rates,

award size and duration, and numbers of people supported on research and education grants are reported in each division's annual report and factored into an annual performance assessment for CISE as a whole.

In FY 2012, CISE COV reviews will take place for all CISE divisions. All CISE divisions are responding to and implementing recommendations from recent COVs.
Evaluation is a vital part of CISE's STEM education programs such as Computing Education for the 21st Century (CE21) which is a partnership with EHR and OCI. Each CE21 award will provide a rigorous research and/or evaluation plan designed to guide project progress and measure its impact; the plan will also include a description of the instruments/metrics that will be used. The overall CISE education portfolio will be assessed with an appropriately rigorous evaluation process.

Number of People Involved in CISE Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	5,553	295	5,700	6,540
Other Professionals	578	30	550	680
Postdoctorates	336	7	350	400
Graduate Students	4,556	27	6,200	5,360
Undergraduate Students	1,823	25	2,350	2,150
Total Number of People	**12,846**	**384**	**15,150**	**15,130**

DIVISION OF COMPUTING AND COMMUNICATION FOUNDATIONS (CCF)

$210,130,000
+$39,780,000 / 23.4%

CCF Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
CCF Funding	**$170.40**	**$170.35**	**$210.13**	**$39.78**	**23.4%**
Research	**165.40**	**167.05**	**207.13**	**40.08**	**24.0%**
CAREER	*13.09*	*17.50*	*19.89*	*2.39*	*13.7%*
Centers Funding (total)	*7.32*	*7.32*	*9.00*	*1.68*	*23.0%*
STC: Center for Embedded Networked Sensing	*3.32*	*3.32*	*-*	*-3.32*	*-100.0%*
STC: Team for Research in Ubiquitous Secure Technology	*4.00*	*4.00*	*4.00*	*-*	*-*
STC: Science of Information	*-*	*-*	*5.00*	*5.00*	*N/A*
Education	**4.40**	**2.70**	**2.40**	**-0.30**	**-11.1%**
Infrastructure	**0.60**	**0.60**	**0.60**	**-**	**-**
National Nanotechnology Infrastructure Network	*0.60*	*0.60*	*0.60*	*-*	*-*

CCF supports research and education activities that explore the foundations and limits of computing and communication; advance algorithmic foundations and knowledge applicable to areas both within and outside computer science; and advance the science and engineering of computer hardware and software.

CCF research investments support explorations of algorithmic thinking accompanied by rigorous analysis as well as the theoretical understanding of the intrinsic difficulty of computational problems. CCF invests in transformative research that addresses the theoretical underpinnings and enabling technologies for information acquisition, transmission, and processing in communication and information networks. Investments also advance the design, verification, evaluation, and utilization of computing hardware and software to meet the future computational needs of our society. CCF invests in research that explores the impact of emerging technologies, including nanotechnology, biotechnology, and quantum physics, to create new models of computation and programmable computing substrates.

In general, 60 percent of the CCF portfolio is available each year for new research grants, with 40 percent used primarily to fund continuing grants made in prior years.

FY 2012 Summary

Research

- Support the NSF-wide SEES portfolio, including clean energy investments, by funding foundational research in energy-intelligent computing, the development of new theory, algorithms, and design principles to optimize energy-computational performance in computing and communication systems, and the scalability and sustainability of smart energy production software and hardware.
- Support the NSF-wide CIF21 investment through research on new functional capabilities in support of the entire software lifecycle and the development of new sustainable software elements.

- Continue support of Science and Engineering Beyond Moore's Law (SEBML) through research to advance computation and information processing beyond the physical and conceptual limitations of current technologies.
- Support research on advanced manufacturing, including investments in:
  - The National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond (NEB). Focus on research leading to departures from traditional architectural practices of computing, including reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error prone devices at the nano scale.
  - Cyber-Physical Systems (CPS). Focus on new computational abstractions to represent and manage data and algorithms leading to a better understanding of complex system and the interaction between computational and physical processes.
- Continue supporting interdisciplinary research, in partnership with SBE, through the Interface between Computer Science, Economics, and Social Science (ICES) program. This includes algorithmic game theory, automated mechanism design, computational tractability of basic economic problems, and the role of information, trust, and reputation in markets.
- Continue investment in CAREER awards (+$2.39 million to a total of $19.89 million).
- Continue support of the Science and Technology Center: Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley at a level of $4.0 million.
- Support the Center for the Science of Information at Purdue University, starting in FY 2011 at a level of $5.0 million. This center will develop a unifying set of principles to guide the extraction, manipulation, and exchange of information integrating elements of space, time, structure, semantics and context.
- As with all three CISE disciplinary divisions, CCF will participate in CISE cross-cutting research, education, and infrastructure programs, including Trustworthy Computing, and Smart Health and Wellbeing.

Education

- Provide support for the Computing Education for the 21st Century (CE21) program.
- Along with CNS and IIS, continue support for research experiences for undergraduates, graduates, and teachers through programs such as REU sites and supplements, and RET.

Infrastructure

- CCF co-funds the National Nanotechnology Infrastructure Network, supported primarily by ENG, at a level of $600,000.

DIVISION OF COMPUTER AND NETWORK SYSTEMS (CNS) $235,200,000
+$30,780,000 / 15.1%

CNS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
CNS Funding	**$204.33**	**$204.42**	**$235.20**	**$30.78**	**15.1%**
Research	**144.97**	**141.68**	**180.86**	**39.18**	**27.7%**
CAREER	*10.64*	*15.00*	*17.04*	*2.04*	*13.6%*
Education	**31.85**	**32.74**	**24.34**	**-8.40**	**-25.7%**
Infrastructure	**27.51**	**30.00**	**30.00**	**-**	**-**
Research Resources	*27.51*	*30.00*	*30.00*	-	-

CNS supports research and education activities that advance our understanding of the fundamental properties of computer systems and networks and their complexity; explore new ways to address the limitations of existing computer and networked systems to make better use of these technologies; and develop better paradigms, abstractions, and tools for designing, analyzing, and building next generation computer and networked systems that are robust, secure, and trustworthy. CNS investments in computer systems research focus on: distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; and parallel systems. CNS investments in fundamental network research create new insights into the dynamics of complex networks and explore new architectures for future-generation networks and services. CNS provides scientific leadership in trustworthy computing, supporting research and education activities that will ensure that society's increasingly ubiquitous and distributed computing and communication systems deliver the quality of service they are designed to achieve, without disruption, while enabling and preserving privacy, security and trust.

CNS also plays a leadership role in coordinating CISE investments in research infrastructure resources and in the development of the computing workforce of the future. Through the Computing Research Infrastructure (CRI) program, CNS supports the acquisition, enhancement, and operation of state-of-the-art infrastructures and facilities that enable high-quality computing research and education in a diverse range of institutions and projects. CNS supports the Computing Education for the 21st Century (CE21) program that seeks to increase computational competencies for *all* students, regardless of gender, race, ethnicity, disability status, or socioeconomic status, and regardless, too, of eventual career choices.

In general, about 50 percent of the CNS portfolio is available for new research grants. The remaining 50 percent is used primarily to fund continuing grants made in previous years.

FY 2012 Summary

Research

- In partnership with MPS and ENG, support the new Enhancing Access to Radio Spectrum (EARS) program's goal of sponsoring research that can enable more users to share a fixed amount of radio spectrum (+$7.0 million to a total of $7.0 million).
- Continue support for the Trustworthy Computing program, which, in collaboration with OCI and SBE includes support for the CNCI targeted research areas of Science of Cybersecurity, Moving Target Defense, Tailored Trustworthy Spaces, and Cyber Economic Incentives.

- Support the NSF-wide SEES investment through research in smart sensing systems that promise to save energy and reduce greenhouse gas emissions as well as system trade-offs among computation, communication, and performance. Support research on the networking and computing systems dimensions of clean energy through investments in the SEES SEP and SRN activities.
- Support the NSF-wide CIF21 investment through research in new experimental architectures and approaches to leading-edge computational infrastructure (e.g., clouds, clusters, data centers) as well as new approaches to networking and distributed computing that allow for seamless access to distributed computational resources.
- In partnership with ENG, support research in advanced manufacturing through increased investments in forward-looking research on cyber-physical systems motivated by grand challenge applications ranging from advanced manufacturing and transportation to healthcare and the environment.
- Continue investments in CAREER awards (+$2.04 million to a total of $17.04 million).
- As with all three CISE disciplinary divisions, CNS will participate in CISE cross-cutting research and infrastructure programs, including Smart Health and Wellbeing.

Education

- CNS will provide leadership for the cross-cutting CE21 program. This program will increase the number and diversity of K-14 students and teachers who develop and practice computational competencies in a variety of contexts, and increase the number and diversity of early postsecondary students who are engaged and have the background in computing necessary to successfully pursue degrees in computing-related and computationally-intensive fields of study.
- With CCF and IIS, continue support for research experiences for undergraduates, graduates and teachers through programs like REU sites and supplements, IGERT and RET.
- Continue support for the ADVANCE program (+$90,000 to a total of $3.04 million) to increase the participation and advancement of women in academic science and engineering careers.

Infrastructure:

- Continue to support the development of world-class computing research infrastructure through the cross-cutting CRI program at a level of $30.0 million in FY 2012.

DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS (IIS)

$197,350,000
+$34,030,000 / 20.8%

IIS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
IIS Funding	**$163.21**	**$163.32**	**$197.35**	**$34.03**	**20.8%**
Research	**157.99**	**159.92**	**194.15**	**34.23**	**21.4%**
CAREER	*17.69*	*18.46*	*20.98*	*2.52*	*13.7%*
Education	**5.22**	**3.40**	**3.20**	**-0.20**	**-5.9%**

IIS supports research and education that: develops new knowledge to support people in the design and use of information technology; enhances the capabilities of people and machines to create, discover, and reason by advancing the ability to represent, collect, store, organize, visualize, and communicate data and information; and advances knowledge about how computational systems can perform tasks autonomously, robustly, and flexibly.

IIS research investments support the exploration of novel theories and innovative technologies that advance our understanding of the complex and increasingly coupled relationships between people and computing. Investments in information integration and informatics focus on the processes and technologies involved in creating, managing, visualizing, and understanding diverse digital content as it relates to individuals, groups, organizations, and societies, and as it is hosted on engineered systems ranging from individual devices to globally-distributed systems. IIS also invests in research on artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science, and related areas leading to the computational understanding and modeling of intelligence in complex, realistic contexts.

In general, 55 percent of IIS funding is available for new research grants. The remaining 45 percent is used primarily to fund continuing grants made in previous years.

FY 2012 Summary

Research

- In partnership with other federal agencies and ENG, IIS will lead the multi-agency National Robotics Initiative. IIS will focus on fundamental research in robotics science and engineering. This includes advanced sensing, control, and power sources; dynamical system mechanics; optimization, design, and decision algorithms; problem-solving architectures; hybrid architectures that integrate or combine methods (deductive, case-based, symbolic, etc.); safe and soft structures and mechanisms with reactive surfaces and elastic actuators; computational models of human cognition; integration of artificial intelligence, computer vision, and assistive robotics.
- IIS will spearhead CISE's participation in Smart Health and Well-being research, partnering with ENG and SBE, as well as CISE's other divisions. IIS will pursue improvements in safe, effective, efficient, equitable, and patient-centered health and wellness technology and services through innovations in computer and information science and engineering. These innovations will investigate the technical feasibility of diagnosis, treatment, and care based on an individual's genetic makeup and lifestyle and acknowledge the changing demographics of an increasingly aging population.

- Support the NSF-wide SEES investment through research to optimize energy usage through intelligent decision-making for compute- and data-intensive systems. Support research on the information processing dimensions of clean energy through additional investments in SEP.
- Support the NSF-wide CIF21 investment through research in data analytics and e-science, including new approaches to data mining, machine learning and knowledge extraction and visualization.
- Continued funding for the NSF investment for the Cyberlearning Transforming Education (CTE) program through support for research on new modalities of learning. This program is conducted jointly with EHR and OCI.
- Continue investment in CAREER awards (+$2.52 million to a total of $20.98 million).
- As with all three CISE disciplinary divisions, IIS will participate in CISE cross-cutting research, education, and infrastructure programs including Trustworthy Computing.

Education

- Actively participate in the CE21 program.
- With CCF and CNS, continue support for research experiences for undergraduates, graduates, and teachers through programs such as REU sites and supplements, and RET.

DIVISION OF INFORMATION TECHNOLOGY RESEARCH (ITR) $85,740,000
+$5,000,000/ 6.2%

ITR Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
ITR Funding	**$80.78**	**$80.74**	**$85.74**	**$5.00**	**6.2%**
Research	**79.62**	**80.74**	**85.74**	**5.00**	**6.2%**
CAREER	0.14	-	-	-	N/A
SLC: Pittsburgh Science of Learning Center for Robust Learning	*2.50*	*2.50*	*2.50*	-	-
Education	**1.16**	**-**	**-**	**-**	**N/A**

The ITR subactivity provides support for transformative explorations in computer and information science and engineering research and related education activities, emphasizing the funding of high-risk, multi-investigator, often multidisciplinary projects.

In general, 70 percent of the ITR portfolio is available for new research grants. The remaining 30 percent is used primarily to fund continuing grants made in previous years.

FY 2012 Summary

Research

- Support the cross-directorate investment in public-private partnerships that promise to enhance IT innovation. Leveraging recent partnerships with a variety of private sector organizations that provided the academic computing community with access to research resources (including strategic large-scale data sets and powerful cloud computing platforms), CISE will create an academic-industry research incubator that encourages and supports transformative research at the computing frontier.
- Continue support for the Expeditions in Computing program. In planning and implementing Expeditions, researchers are encouraged to come together within or across departments or institutions to identify compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come. Funded at levels up to $10 million per award, Expeditions projects represent some of the largest single investments currently made by CISE.
- Support for research on Networked Society, partnering with SBE. This research will help to quantify, understand, and purposely design the fabric of 21st century networked society.
- In collaboration with ENG, support research on advanced manufacturing through increased investments in innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research (I/UCRC) program, which will establish centers that partner industry with university research efforts.
- Provide flexibility for support of emerging high-priority areas of potentially transformative research.
- Continue support to the Pittsburgh Science of Learning Center (SLC) for Robust Learning at a level of $2.50 million.

DIRECTORATE FOR ENGINEERING (ENG) $908,300,000
+$164,370,000 / 22.1%

ENG Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Chemical, Bioengineering, Environmental, & Transport Systems (CBET)	$157.08	-	$156.82	$194.03	$37.21	23.7%
Civil, Mechanical, & Manufacturing Innovation (CMMI)	189.40	-	188.00	226.10	38.10	20.3%
Electrical, Communications, & Cyber Systems (ECCS)	93.97	-	94.00	131.00	37.00	39.4%
Engineering Education & Centers (EEC)	125.86	-	124.11	132.40	8.29	6.7%
Industrial Innovation & Partnerships (IIP)	180.63	-	152.00	191.57	39.57	26.0%
SBIR/STTR	*156.84*	-	*125.77*	*146.88*	*21.11*	*16.8%*
Emerging Frontiers in Research & Innovation (EFRI)	28.99	-	29.00	33.20	4.20	14.5%
Total, ENG	**$775.92**	**-**	**$743.93**	**$908.30**	**$164.37**	**22.1%**

Totals may not add due to rounding.

About ENG

The Directorate for Engineering (ENG) is a global leader in identifying and catalyzing fundamental engineering research, innovation, and education. To achieve this vision, the directorate leads in frontier engineering research, cultivates an innovation ecosystem, develops the next-generation engineer, and demonstrates organizational excellence.

Since its inception, ENG has provided substantial support for frontier research and education across all fields of engineering. Directorate-funded basic and use-inspired research, combined with the creativity of well-educated engineers and the resources of state-of-the-art facilities, have fueled many important innovations that in turn have stimulated economic growth and improved the quality of life and health for all Americans.

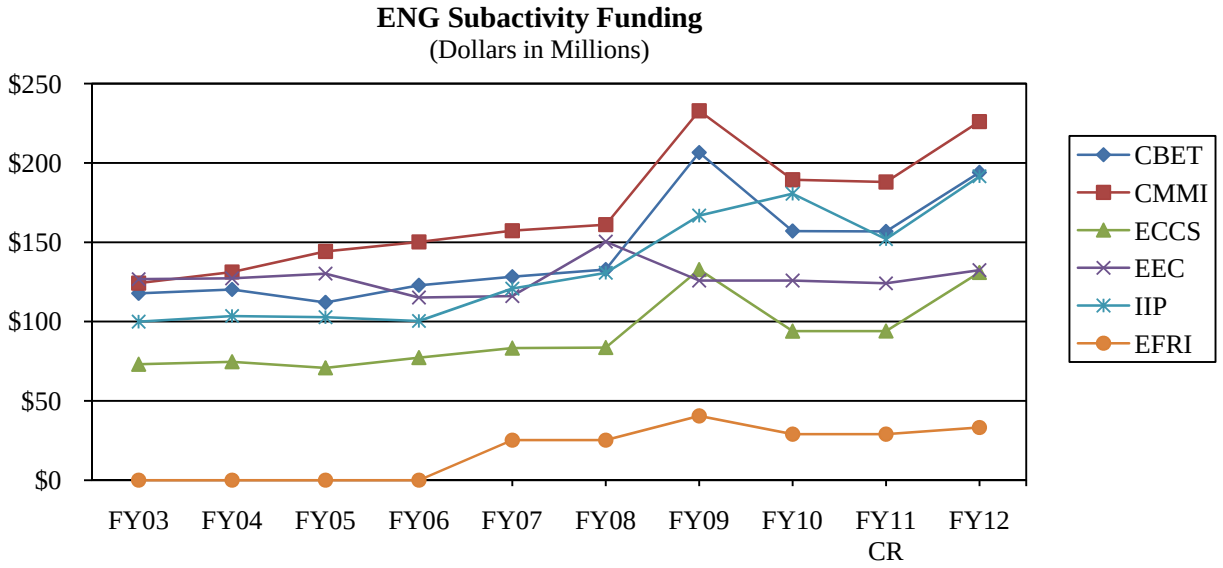
Many ENG programs and activities contribute to solutions for national priorities and grand challenges. ENG is central to major NSF investments in Science, Engineering, and Education for Sustainability (SEES), advanced manufacturing, and the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21), which are designed to create the knowledge and innovations required for these areas.

- The ENG role in SEES will grow as greater emphasis is put on Sustainable Energy Pathways (SEP). Through coordination with all other NSF directorates, especially the Directorate for Social, Behavioral and Economic Sciences (SBE), ENG will be able to tackle the human dimensions of the sustainability issue in the engineered or “built” environment.

- ENG leads the Foundation in strategic research investments focusing on innovations in manufacturing, in all its dimensions (advanced manufacturing, nanomanufacturing, and transformative technologies for traditional manufacturing).
- The ENG investment in CIF21 will build upon the directorate's support of groundbreaking work in cyber–physical systems, engineering modeling and simulation, smart networks, and sensors.

In addition, the directorate plans to fund the first class of Nanoscale Engineering Research Centers (nano ERCs) that will transition the nano-devices created at graduating Nanoscale Science and Engineering Centers (NSECs) to the systems level as modeled within the ERC program.

ENG provides about 39 percent of the federal funding for basic engineering research at academic institutions.



FY 2012 Summary by Division

- The FY 2012 Request for the **Division of Chemical, Bioengineering, Environmental, and Transport Systems** (CBET) will promote research and education for sustainability in the areas of water, climate, and especially energy, contributing to the NSF-wide SEES investment. CBET's request will bolster the National Robotics Initiative (NRI) with research to assist those with physical disabilities or cognitive impairment. CBET will also enhance support for early-career researchers and support a Science and Technology Center (STC) from the Class of 2010.

- The FY 2012 Request for the **Division of Civil, Mechanical, and Manufacturing Innovation** (CMMI) will enable contributions to the CIF21 investment by supporting research and education on computational-based approaches for engineering design, analysis, and predictive modeling, particularly under high degrees of uncertainty. CMMI's contribution to the SEES portfolio will include research for resilient and sustainable buildings and infrastructure, disaster-resilient systems, energy manufacturing, and energy-efficient materials and processes. The division's request will enable more research for advanced manufacturing technologies, and it will enhance support for early-career researchers.

- The FY 2012 Request for the **Division of Electrical, Communications, and Cyber Systems** (ECCS) will enable contributions to the CIF21 portfolio through support for research and education in advanced devices and systems directed towards computing, data storage, networking, and data management. The ECCS investment in the Enhancing Access to the Radio Spectrum (EARS) activity will support research on more efficient radio spectrum use and energy-conserving device technologies. ECCS will also enhance support for early-career researchers and support an STC.

- The FY 2012 Request for the **Division of Engineering Education and Centers** (EEC) will establish the first class of nano Engineering Research Centers (nano ERCs). This investment will transition the nano-devices created at graduating Nanoscale Science and Engineering Centers (NSECs) to the systems level and commercialization. EEC will enhance support for early-career researchers and for activities that facilitate alternative pathways to engineering careers, especially for non-traditional engineering students such as veterans.

- The FY 2012 Request for the **Division of Industrial Innovation & Partnerships (IIP)** reflects its commitment to enhancing the Nation's innovation ecosystem. Through programs for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), IIP will continue to support technological breakthroughs that benefit society. Through the Accelerating Innovation Research (AIR) activity and other programs, the division will enable academic researchers to begin translation of fundamental research discoveries, encourage academia and industry to collaborate (especially regionally), and prepare students to be entrepreneurial leaders in innovation.

- The FY 2012 Request for the **Office of Emerging Frontiers in Research & Innovation (EFRI)** will provide support for 16 interdisciplinary teams to pursue cutting-edge research with the potential for transformative impacts on national needs and/or grand challenges.

Major Investments

ENG Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
NNI	$152.50	$17.72	$148.00	$174.37	$26.37	17.8%
Clean Energy	115.20	-	115.20	172.65	57.45	49.9%
SEES Portfolio	102.00	-	108.20	162.00	53.80	49.7%
Engineering Research Centers	48.60	-	54.91	81.00	26.09	47.5%
Advanced Manufacturing	38.50	-	38.42	65.42	27.00	70.3%
CAREER	60.26	-	46.98	53.38	6.40	13.6%
BioMaPS	-	-	-	18.00	18.00	N/A
National Robotics Initiative	-	-	-	12.50	12.50	N/A
Science and Technology Centers	3.37	-	3.36	10.00	6.64	197.6%
CIF21 Portfolio	-	-	-	9.00	9.00	N/A
EARS	-	-	-	4.00	4.00	N/A

Major investments may have funding overlap, and thus should not be summed.

- The directorate will continue supporting the National Nanotechnology Initiative (NNI), with additional funding directed towards the NNI Signature Initiatives: Nanoelectronics for 2020 and Beyond; Sustainable Nanomanufacturing – Creating the Industries of the Future; and Nanotechnology for Solar Energy Collection and Conversion.

- ENG support for clean energy will enhance research and innovations in smart grid technologies, solar energy technologies, biofuels and bioenergy, wind energy generation, and renewable energy storage. The ENG clean energy investment will be strategically divided among all divisions.

- ENG will support the NSF-wide SEES investment by funding activities across the directorate that will lay the foundation for technologies to mitigate against, and adapt to, environmental change that threatens sustainability. The greatest share of funding will be directed to CBET, CMMI, and ECCS, for investments in Sustainable Energy Pathways.

- The directorate will increase investment in the EEC ERC program in order to fund the first class of nano ERCs. This investment will transition the nano-devices created at graduating NSECs to the systems level and commercialization.

- ENG will strategically invest additional funds across the directorate in advanced manufacturing to support innovations in multi-scale modeling for simulation-based design and manufacturing across the supply chain, nanomanufacturing, innovative materials and manufacturing processes, energy manufacturing, and complex engineering systems design and manufacturing. The directorate will support industry–university partnerships and anticipates that at least one of the new nano ERCs will be in the area of advanced manufacturing.

- ENG supports the CAREER program, an Administration priority. ENG's CAREER awards support young investigators who exemplify the role of teacher–scholar through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

- ENG will invest in Research at the Interface of the Biological, Mathematical, Physical Sciences, and Engineering (BioMaPS) through the Clean Energy and Advanced Manufacturing activities as well as the core programs. Funding for this activity will be directed to CBET, CMMI, and ECCS. Additional information on BioMaPS is available in the Selected Cross-Cutting Programs section of the NSF-wide Investments chapter.

- ENG support of the National Robotics Initiative (NRI) will fund research on assistive mechanisms for those with physical disabilities and cognitive impairment as well as the elderly; on systems integration that enables ubiquitous, advanced robotics to be realized; and on next-generation robotics for manufacturing, healthcare and rehabilitation, surveillance and security, education and training, and transportation. This investment will be directed to CBET, CMMI, and ECCS. NRI is a cross-agency initiative involving NSF's CISE and ENG directorates along with external partners NASA, NIH, and USDA.

- The STC for Advanced Materials for Water Purification, supported by CBET, sunsets in 2011. ENG will fund two other STCs in FY 2012: CBET will support the Center on Emergent Behaviors of Integrated Cellular Systems, and ECCS will support the Center for Energy Efficient Electronics Science.

- ENG investment in the new NSF-wide CIF21 investment will focus on three components: Data-Enabled Science, New Computational Infrastructure, and Access and Connections to Cyberinfrastructure Facilities. Funding will be directed to CBET, CMMI, and ECCS.

- ENG support for Enhancing Access to the Radio Spectrum (EARS) begins in FY 2012. The recent NSF workshop report, *Enhancing Access to the Radio Spectrum,* outlines the need for research on new and innovative ways to use the spectrum more efficiently. In partnership with Directorate for Computer and Information Science and Engineering (CISE) and the Directorate for Mathematical and Physical Sciences (MPS), ENG ECCS will initiate support for the basic research that underpins this effort. Additional information on EARS is available in the Selected Cross-Cutting Programs section of the NSF-wide Investments chapter.

Summary and Funding Profile

ENG supports investments in core research and education as well as research infrastructure such as facilities.

In FY 2012 the number of research grant proposals is expected to increase by nearly 2,000 compared to the FY 2010 Enacted. ENG expects to award approximately 1,800 research grants in FY 2012. Average annualized award size and duration are estimated to be $123,000 and three years, respectively, in FY 2012.

In FY 2012, funding for centers accounts for nearly 15 percent of ENG's non-SBIR Request. Centers funding is increasing as research in many ENG-supported disciplines has evolved to be more collaborative.

Funding for facilities accounts for 5 percent of ENG's non-SBIR FY 2012 Request. Funding is decreasing as a result of a slight reduction in support to the Network for Earthquake Engineering and Simulation equipment sites.

ENG Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	13,230	11,674	16,000
Number of New Awards	2,375	2,252	2,970
Regular Appropriation	2,321	2,252	2,970
ARRA	54	-	-
Funding Rate	18%	19%	19%
Statistics for Research Grants:			
Number of Research Grant Proposals	9,746	9,627	11,500
Number of Research Grants	1,423	1,365	1,800
Regular Appropriation	1,423	1,365	1,800
ARRA	-	-	
Funding Rate	15%	14%	16%
Median Annualized Award Size	$100,000	$101,000	101,000
Average Annualized Award Size	$122,322	$115,000	123,000
Average Award Duration, in years	2.9	3.0	3.0

ENG Funding for Centers Programs and Facilities

ENG Funding for Centers Programs

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted	
				Amount	Percent
Centers Programs	$79.78	$85.22	$107.95	$22.73	26.7%
Engineering Research Centers (EEC)	48.60	54.91	81.00	26.09	47.5%
Nano Centers Program (Multiple)	25.59	24.75	14.75	-10.00	-40.4%
Science & Technology Centers (CBET/ECCS)	3.37	3.36	10.00	6.64	197.6%
Science of Learning Centers (EEC)	2.22	2.20	2.20	-	-

Totals may not add due to rounding.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

- Support for the ERC program will increase by $26.09 million, to a total of $81.0 million. Building on the long-standing ERC program model, ENG will fund the first class of three nano ERCs. This investment will transition the nano-devices created at graduating NSECs to the systems level and commercialization.
- Support for NSECs will decrease by $10.00 million, to a total of $14.75 million, as commensurate ENG funding for the six graduated NSECs is reallocated to the ERC program for new nano ERCs.
- ENG will fund two Class of 2010 STCs for a total of $10.0 million in FY 2012. FY 2011 is the final year of support for the STC for Advanced Materials for Water Purification from the Class of 2002.

ENG Funding for Facilities

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted	
				Amount	Percent
Facilities	**$34.40**	**$32.83**	**$31.33**	**-$1.50**	**-4.6%**
NEES (CMMI)	23.46	22.00	20.50	-1.50	-6.8%
NNIN (Multiple)	10.94	10.83	10.83	-	-

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

Facilities

- ENG support for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) operations in FY 2012 will be reduced by $1.50 million, to a total of $20.50 million, in line with an overall reduction in core research supported at the network sites. The directorate will leverage investment in CIF21 to support NEES connections and foster data-enabled research within the earthquake engineering community.
- ENG continues support for the National Nanotechnology Infrastructure Network (NNIN) of user facilities at the FY 2010 Enacted level. FY 2012 represents year seven of this planned ten-year investment.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors (COVs) and directorate Advisory Committees. Please see this chapter for additional information.

In 2010, COVs reviewed EEC and IIP. The COVs presented their reports to the ENG Advisory Committee, which convened in April and October of 2010. ENG divisions are responding to and implementing recommendations from recent COVs.

In 2011, COVs will review EFRI and ECCS. In 2012, COVs will review CBET and CMMI.

ENG, along with GEO and SBE, provided funding to the National Research Council to review the Science Plan of the WATERS Network, a potential Major Research Equipment and Facilities Construction (MREFC) project. Based on the findings and recommendations in the NRC report,

published in 2010, NSF decided not to proceed on the MREFC path for the WATERS Network at this time and instead embark on the Research and Related Activities (R&RA) path, with the issuing and implementation of the Water, Sustainability, and Climate solicitation in FY 2010.

ENG funded SRI International to evaluate the outcomes of ENG-supported Research Experiences for Undergraduates (REU) awards. In October 2010, ENG received SRI's report on the longer-term impacts of the ENG REU and other undergraduate research experiences, which was based on data collected from ENG REU students from 2006. ENG has disseminated the report and is seeking community input on how to accomplish the report's recommendations.

In FY 2010–2011, the directorate is supporting two studies to assess future earthquake engineering research and research infrastructure needs. An NRC committee is preparing a workshop report on research grand challenges for networked earthquake engineering experimental facilities and cyberinfrastructure. To build on this work, the Science and Technology Policy Institute (STPI) is developing potential scenarios for the future of NSF-supported earthquake engineering facilities.

In FY 2010–2011, ENG is supporting STPI to perform a formative assessment and evaluation of the processes by which topic areas and potentially transformative projects are selected by EFRI, and to design a protocol for future outcome evaluation of EFRI research projects.

Number of People Involved in ENG Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	11,565	393	6,695	14,100
Other Professionals	1,936	20	1,205	2,360
Postdoctorates	532	4	374	650
Graduate Students	7,074	31	6,986	8,630
Undergraduate Students	3,611	17	2,263	4,500
Total Number of People	**24,718**	**465**	**17,523**	**30,240**

DIVISION OF CHEMICAL, BIOENGINEEING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS (CBET)

$194,030,000
+$37,210,000 / 23.7%

CBET Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
CBET	**$157.08**	**-**	**$156.82**	**$194.03**	**37.21**	**23.7%**
Research	**153.38**	**-**	**153.12**	**190.33**	**37.21**	**24.3%**
CAREER	*27.88*	-	*26.00*	*28.50*	*2.50*	*9.6%*
Centers Funding (total)	*9.47*	-	*9.26*	*9.86*	*0.60*	*6.5%*
Nano Centers	*6.10*	-	*5.90*	*4.86*	*-1.04*	*-17.6%*
STC for Water Purification	*3.37*	-	*3.36*	-	*-3.36*	*-100.0%*
STC on Emergent Behavior	-	-	-	*5.00*	*5.00*	*N/A*
Infrastructure	**3.70**	**-**	**3.70**	**3.70**	**-**	**-**
NNIN	*3.70*	-	*3.70*	*3.70*	-	-

Totals may not add due to rounding.

CBET supports research to enhance and protect U.S. national health, energy, environment, and security. Through CBET, the physical, life, and social sciences are merged in engineering research and education, resulting in advances in the rapidly evolving fields of bioengineering and environmental engineering, and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, forest products, metals, petroleum, food, textiles, utilities, and microelectronics.

CBET supports research in biotechnology and the chemical, environmental, biomedical, mechanical, civil, and aerospace engineering disciplines. To serve these communities and achieve its goals, CBET has been organized into four thematic clusters: Chemical, Biochemical, and Biotechnology Systems; Biomedical Engineering and Engineering Healthcare; Environmental Engineering and Sustainability; and Transport and Thermal Fluids Phenomena.

In general, 68 percent of the CBET portfolio is available for new research grants. The remaining 35 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- CAREER funding increases by $2.50 million to a total of $28.50 million in FY 2012. This increase is consistent with CBET's emphasis on supporting early-career researchers and contributes to the Administration priority of keeping support for CAREER increasing at the same rate as overall NSF funding.
- The Environmental Engineering and Sustainability Cluster investment in SEES will support the areas of water sustainability, climate engineering, and climate change mitigation and adaptation research with an emphasis in the energy area, to be supplemented by core investments in the areas of green chemistry, water, energy and the environment.

- Investments for CIF21 will contribute to developing a cyberinfrastructure of "Sustainable Computation" that allows the use of "expert algorithms" by multiple groups (including undergraduates and industrial practitioners), less experienced than experts, to perform calculations after minimal instruction. Existing resources (envelopes, clouds, open source modules, etc.) will be used to create this environment of learning and discovery.
- To bolster the ENG portfolio for Advancing American Innovation, CBET will invest in several focused research areas:
  - Science and Engineering Beyond Moore's Law (SEBML) investments will support material processing research in reaction and process engineering as well as interfacial thermodynamics and self-assembly.
  - Investments in support of the NRI will fund research on assistive mechanisms for those with physical disabilities and cognitive impairment as well as the aging population through the Bioengineering and Engineering Healthcare cluster, especially through the Biosensing program and the Research to Aid Persons with Disabilities (RAPD) program.
  - Support for BioMaPS – research at the interface/intersection of biology, the physical sciences, and engineering – will be provided primarily through the Bioengineering and Engineering Healthcare cluster, to include research on nanoscale biosensing, neuro-engineering, and cellular biomechanics, as well as metabolic engineering and engineering aspects of synthetic biology.
- CBET reduces support for the existing portfolio of NSECs by $1.04 million below the FY 2010 Enacted level of $5.90 million as ENG transitions its investment to nano ERCs.
- STC funding increases by $1.64 million in FY 2012 to fund the STC on Emergent Behavior of Integrated Cellular Systems, led by the Massachusetts Institute of Technology, and as the Center for Advanced Materials for Water Purification graduates from the program.

Infrastructure

- CBET will continue support of $3.70 million for NNIN user facilities. FY 2012 represents year seven of this planned ten-year investment.

DIVISION OF CIVIL, MECHANICAL, AND MANUFACTURING INNOVATION (CMMI)

$226,100,000
+$38,100,000 / 20.3%

CMMI Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
CMMI	**$189.40**	**-**	**$188.00**	**$226.10**	**38.10**	**20.3%**
Research	**164.02**	**-**	**164.10**	**203.70**	**39.60**	**24.1%**
CAREER	*17.30*	*-*	*11.50*	*13.75*	*2.25*	*19.6%*
Nano Centers	*5.64*	*-*	*5.45*	*4.70*	*-0.75*	*-13.8%*
Infrastructure	**25.38**	**-**	**23.90**	**22.40**	**-1.50**	**-6.3%**
NEES	*23.46*	*-*	*22.00*	*20.50*	*-1.50*	*-6.8%*
NNIN	*1.92*	*-*	*1.90*	*1.90*	*-*	*-*

CMMI funds fundamental research in support of the Foundation's strategic goals directed at advances in the disciplines of civil, mechanical, industrial, systems, and manufacturing engineering, and materials design. In addition, the division has a focus on the reduction of risks and damage resulting from earthquakes and other hazards and disasters. CMMI encourages discovery enabled by the use of cross-cutting technologies such as adaptive systems, nanotechnology, and high-performance computational modeling and simulation. The division promotes cross-disciplinary research partnerships at the intersections of traditional research disciplines to advance transformative research results that promote innovative manufacturing technology; enable the design and analysis of complex engineering systems; enhance the sustainability and resiliency of the Nation's infrastructure (for example, buildings, transportation, and communication networks); help protect the Nation from extreme events; and apply engineering principles to improve the Nation's service enterprise systems such as healthcare.

The integration of research and education is supported across all programs of the division. These investments contribute broadly to the engineering knowledge base and create the human capital needed for major components of U.S. industry to compete in a global economy. To achieve its goals, CMMI has been organized into four thematic clusters: Advanced Manufacturing, Mechanics & Engineering Materials, Resilient & Sustainable Infrastructures, and Systems Engineering & Design.

In general, 72 percent of the CMMI portfolio is available for new research grants. The remaining 22 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- CAREER funding increases by $2.25 million, to a total of $13.75 million, in FY 2012. This increase is consistent with CMMI's emphasis on supporting early-career researchers and contributes to the Administration priority of keeping support for CAREER increasing at the same rate as overall NSF funding.
- Support for CIF21 is initiated in FY 2012. CMMI will contribute to this NSF-wide investment by supporting research on computational-based approaches for engineering design, analysis, and predictive modeling particularly under high degrees of uncertainty. Further efforts will support

research in the areas of data-enabled science and engineering, with emphasis on complex systems design and analysis.

- Fundamental research in support of advanced manufacturing technology increases in FY 2012. Areas of emphasis include nanomanufacturing (including SEBML), manufacturing enterprise systems, smart manufacturing, design and manufacturing of complex engineered systems, modeling and simulation for manufacturing including integration with CIF21 initiatives, innovative materials and manufacturing processes, and BioMaPS research in such areas as clean energy systems, bio-based materials, bio-imaging, and bio-inspired sensors.
- Investments in SEES increase to support cross-disciplinary research associated with resilient and sustainable buildings and infrastructure, disaster-resilient systems, energy manufacturing, and energy-efficient materials and processes.
- Under the umbrella of Advancing American Innovation, CMMI will contribute to several focused research activities:
  - CMMI-related Smart-Health research increases to support fundamental research efforts in operations research, service enterprise systems, mechanobiology and nano-biomechanics, and design techniques and analysis methods for Smart-Health infrastructure and systems.
  - Research in support of the NRI will increase to ensure U.S. leadership in robotics research. FY 2012 priorities for CMMI include research on advanced sensing; control systems; dynamical systems mechanics; optimization, design, and decision algorithms; novel multifunctional robotic structures and mechanisms. Research may lead to the development of next-generation robotics for manufacturing, healthcare and rehabilitation, surveillance and security, education and training, and safer driving.

Infrastructure

- FY 2012 support for NEES operations will be reduced by $1.50 million, to a total of $20.50 million, in line with an overall reduction in core research supported at the network sites. CIF21 investment will also support NEES connections and foster data-enabled research within the earthquake engineering community.
- Support for NNIN will continue at the FY 2010 Enacted level.

DIVISION OF ELECTRICAL, COMMUNICATIONS, AND CYBER SYSTEMS (ECCS)

$131,000,000
+$37,000,000 / 39.4%

ECCS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
ECCS	**$93.97**	**-**	**$94.00**	**$131.00**	**37.00**	**39.4%**
Research	**88.67**	**-**	**88.77**	**125.77**	**37.00**	**41.7%**
CAREER	*15.05*	-	*9.08*	*10.33*	*1.25*	*13.8%*
Centers Funding (total)	*3.61*	-	*3.40*	*7.40*	*4.00*	*117.6%*
Nano Centers	*3.61*	-	*3.40*	*2.40*	*-1.00*	*-29.4%*
STC for Efficient Electronics	-	-	-	*5.00*	*5.00*	*N/A*
Infrastructure	**5.30**	**-**	**5.23**	**5.23**	**-**	**-**
NNIN	*5.30*	-	*5.23*	*5.23*	-	-

ECCS addresses fundamental research issues underlying electronic and photonic devices and component technologies, radio frequency circuit integration, nanoelectronics, energy, power, smart-grid, controls, computation, networking, communications, robotics, and cyber–physical technologies. The division supports fundamental research of novel electronic and photonic devices and the integration of these devices into circuit and system environments and the networking of intelligent systems at multiple scales for applications in energy, healthcare, disaster mitigation, telecommunications, environment, manufacturing, and other systems-related areas. ECCS research and education investments emphasize interdisciplinary collaboration and the convergence of technologies to take on major technological challenges for the next generation of innovative devices and systems.

In general, 69 percent of the ECCS portfolio is available for new research grants. The remaining 27 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- Because support for early-career researchers is an ECCS priority, the division funds CAREER grants at a higher rate than general unsolicited research grants. This priority is consistent with ENG objectives and contributes to the Administration goal for CAREER grant support. FY 2012 funding of $10.33 million represents an increase of $1.25 million over the FY 2010 Enacted level.
- ECCS will contribute to the CIF21 portfolio through support for research in advanced devices and systems directed towards computing, data storage, networking, and data management.
- Under the umbrella of Advancing American Innovation, ECCS will provide research support in several areas:
  - Building on its investment in SEBML, ECCS will increase support for novel electronic and optical devices, particularly nanoelectronics, which will permit improved performance and enable operation beyond current limits.
  - ECCS support for Smart Health research, at the interface of biological and electronic systems, will focus on areas such as distributed and ubiquitous computing and communications technologies to greatly expand the capability of current systems.

  - The division's investment in the NRI will support the integration of electronic, mechanical, computing, controls, and intelligent systems that enable ubiquitous, advanced robotics to be realized.
  - The ECCS investment in EARS will support research on more efficient radio spectrum use and energy-conserving device technologies.
  - In support of BioMaPS, ECCS will invest in bio-electronic devices and systems for sensing, analysis, communications, computing, and the interface of biological and electronic systems. This will result in improved systems that will significantly advance health care, environmental sensing, and climate change monitoring.
- In an ongoing collaboration with CISE, the division will maintain support for research on cyber–physical systems (CPS) at $4.0 million. The ECCS investment will be directed towards the integration of intelligent decision-making algorithms and hardware into physical systems.
- ECCS reduces support for the existing NSEC portfolio by $1.0 million below the FY 2010 Enacted level of $3.4 million as ENG transitions its investment to nano ERCs.
- ECCS funding of $5.0 million in FY 2012 funds the STC for Energy Efficient Electronics Science led by the University of California at Berkeley and awarded in FY 2010.

Infrastructure

- The division continues support of $5.23 million for NNIN user facilities. FY 2012 represents year seven of this planned ten-year investment.

DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC)

$132,400,000
+$8,290,000 / 6.7%

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
EEC	**$125.86**	**-**	**$124.11**	**$132.40**	**$8.29**	**6.7%**
Research	**77.12**		**78.60**	**98.76**	**20.16**	**25.6%**
CAREER	*0.02*	-	*0.40*	*0.80*	*0.40*	*100.0%*
Centers Funding (total)	*61.06*	-	*67.11*	*85.99*	*18.88*	*28.1%*
ERC	*48.60*	-	*54.91*	*81.00*	*26.09*	*47.5%*
Nano Centers	*10.24*	-	*10.00*	*2.79*	*-7.21*	*-72.1%*
SLC	*2.22*		*2.20*	*2.20*	-	-
Education	**48.74**	**-**	**45.51**	**33.64**	**-11.87**	**-26.1%**

EEC integrates disciplinary basic research and education, often accomplished in other divisions of ENG and across NSF, into strategic frameworks critical to addressing societal grand challenges and to promoting innovation. Research included in the EEC portfolio spans both the physical and life sciences and engineering, from nanostructured materials to new device concepts, subsystems, and systems. Applications range across a wide spectrum, including energy, medicine, telecommunications, nanoelectronics, manufacturing, civil infrastructure, the environment, computer networks, cyber security, and others. Also included are formal scholarly studies in engineering education and on how people learn.

The complex integrative role of EEC requires a comprehensive infrastructure of people, equipment, and facilities. Fresh, creative approaches to developing the engineering workforce are vital, as a lack of properly prepared engineers is a critical barrier to a healthy U.S. economy. EEC invests in faculty, graduate and undergraduate students, post doctoral scholars, and K–12 teachers. As nontraditional students comprise more than 70 percent of the general undergraduate population, EEC is defining unique alternative pathways for these students, especially veterans, to earn degrees in engineering successfully.

The programs in EEC are administratively managed within three categories: (1) Major Centers; (2) Engineering Education Research; and (3) Human Resources. The Major Centers category is comprised of the signature ERC program along with NSECs and a Science of Learning Center. They provide the framework for interdisciplinary research and education, development, and technology transfer in partnership with academia, industry, and government. The Engineering Education Research category advances new productive engineering pedagogy. The Human Resources category includes programs such as Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET).

In general, 22 percent of the EEC portfolio is available for new research grants. The remaining 78 percent funds continuing grants made in previous years. This high fraction of continuing grant commitments is a consequence primarily of the ERC funding modes which includes awards made as five year cooperative agreements.

FY 2012 Summary

Research

- Support for the ERC program increases by $26.09 million, to a total of $81.0 million. Building on the long-standing ERC program model, ENG will fund the first class of three nano ERCs. This investment will transition the nano-devices created at graduating NSECs to the systems level and commercialization. It is expected that at least one of these new nano ERCs will be in the area of advanced manufacturing. Increased support will also allow for the continuation and expansion of opportunities to encourage small business partnerships with ERCs.
- Support for NSECs decreases by $7.21 million, to a total of $2.79 million, as commensurate ENG funding for the six graduated NSECs is reallocated to the ERC program in order to fund the new nano ERCs.
- Funding of $2.20 million will provide continued support for a Science of Learning Center – the Center of Excellence for Learning in Education, Science, and Technology (CELEST) led by Boston University.
- Support for the CAREER program increases by $400,000 to a total of $800,000, allowing for the addition of one award.

Education

- Funding for the Engineering Education Program maintains prior year funding level of $11.85 million. EEC will provide support in the areas of education pedagogy, veterans in engineering programs, virtual learning and others. The division will also continue to support an Education Innovation Center jointly funded with EHR.
- Nanotechnology Undergraduate Education funding remains level at $1.0 million.
- Funding for the REU sites program is maintained at the FY 2010 Enacted level of $10.50 million.
- Funding for the RET program decreases by $2.0 million to a total of $2.20 million.
- Funding to support all educational elements of ENG's thrust areas in robotics, SEBML, SEES, and CIF21 will be increased by $1.20 million. Some portion of those funds may be used for REU/RET site programs addressing these specific, targeted thrust areas.
- ENG's FY 2010 Enacted funding of $7.0 million for the Graduate Research Fellowships (GRF) Program will be eliminated in the FY 2012 Request as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).

DIVISION OF INDUSTRIAL INNOVATION AND PARTNERSHIPS (IIP)

$191,570,000
+$39,570,000 / 26.0%

IIP Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
IIP	**$180.63**	**-**	**$152.00**	**$191.57**	**39.57**	**26.0%**
Research	**180.63**	**-**	**152.00**	**191.57**	**39.57**	**26.0%**
SBIR/STTR	*156.84*	*-*	*125.77*	*146.88*	*21.11*	*16.8%*

IIP contributes to the NSF innovation ecosystem by: (1) supporting innovation research that builds on fundamental research discoveries that exhibit potential for societal impact; (2) encouraging research partnerships between academia and industry; and (3) offering hands-on experience in the innovation process to entrepreneurs and future innovators.

IIP is home to two federal small business research programs, the Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program. These programs support innovation research that leverages academic research findings and builds partnerships between academia, small business, and large industry with the goal of achieving commercialization of new products, processes, or services. Technology topics draw upon the breadth of NSF scientific and engineering research disciplines and are aligned along national and societal priorities.

IIP also supports academic research by leveraging industrial support through three research programs: the Industry/University Cooperative Research Centers (I/UCRC) program, the Partnerships for Innovation (PFI) program, and the Grant Opportunities for Academic Liaison with Industry (GOALI) program. University grantees in these programs work closely with industry to create enabling technologies for national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new healthcare information and telecommunications technologies. Furthermore, these programs prepare students for innovation leadership in a globally competitive marketplace through opportunities to work closely with industry.

In general, 90 percent of the IIP portfolio is available for new research grants. The remaining 10 percent of funding supports continuing grants made in previous years, primarily to the long-duration I/UCRCs. All other programs are managed with standard grants.

FY 2012 Summary

Research

- The SBIR/STTR program increase of $21.11 million, to a total of $146.88 million, is in line with set-asides required by Public Law 112-1.
- Funding for Accelerating Innovation Research (AIR) in FY 2012 will total $19.50 million, and will include innovation research fellowships in small businesses and industry-defined fundamental research (IDFR). The IDFR component expands on an earlier pilot in partnership with the Industrial Research Institute (IRI). The program will bring together leaders in industrial science to identify pre-competitive fundamental research requirements that will ultimately have a direct effect on the success

of American industry. The program intends to allow participating companies to inform a scientific research agenda, in a pre-competitive space, by defining key questions and then partnering universities and companies to explore them. The increase will also allow support for the continuation and expansion of opportunities to encourage small business partnerships with ERCs.

- Investment in the Industry/University Cooperative Research Centers (I/UCRC) program increases by $1.80 million, to a total of $9.65 million. The increased support will focus on topics related to sustainable energy and cyberinfrastructure in line with NSF investments in SEES and CIF21.
- Support for the PFI program will be maintained at $9.19 million, the same as in the prior fiscal year.
- IIP Support for the GOALI program increases by $1.35 million to a total of $6.35 million. Increased support in clean energy will allow for six additional awards. ENG's total FY 2012 Request for GOALI will be $16.10 million.

EMERGING FRONTIERS IN RESEARCH AND INNOVATION (EFRI)

$33,200,000
+$4,200,000 / 14.5%

EFRI Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
EFRI	**$28.99**	**-**	**$29.00**	**$33.20**	**4.20**	**14.5%**
Research	**28.99**	**-**	**29.00**	**33.20**	**4.20**	**14.5%**

EFRI was created in FY 2007 to enable ENG to strategically pursue important emerging areas in a timely manner. Each year EFRI recommends, prioritizes, and funds interdisciplinary topics at the frontiers of engineering research and education that have the potential for transformative impacts on national needs and/or grand challenges.

Technological innovations have given rise to new industries, expanded access to quality healthcare, and fueled national prosperity even as global competition has grown. To help ensure the Nation's continued success, EFRI will provide critical, strategic support of fundamental discovery, particularly in areas that may lead to breakthrough technologies and strengthen the economy's technical underpinnings. EFRI will have the necessary flexibility to target long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

EFRI encourages the engineering community to come forward with new and paradigm-shifting proposals at the interface of disciplines and fields. Their ideas and discoveries may potentially lead to new research areas for NSF and other agencies, new industries or capabilities that result in a leadership position for the country, and/or significant progress on a recognized national need or grand challenge.

Recent EFRI topics have included areas such as sustainable energy sources; integrated systems designed to make U.S. infrastructures more resilient to disasters; and regeneration of some of the body's most complex tissues. In FY 2010, EFRI invested in Sustainable Environmental and Energy Design (SEED) to develop foundational technologies for "green" buildings of the future, and in Renewable Energy Storage (RESTOR) to overcome a major barrier to widespread adoption of renewable energy sources. FY 2010 awards are being coordinated and managed in partnership with other NSF directorates as well as with the Department of Energy and the Environmental Protection Agency. In FY 2011, EFRI will consider proposals for emerging frontier research to investigate the areas of Engineering New Technologies Based on Multicellular and Inter-kingdom Signaling (MIKS), and Mind, Machines, and Motor Control (M3C).

In general, 95 percent of the EFRI portfolio is available for new research grants. The remaining 5 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- FY 2012 funding will provide support for 2 additional interdisciplinary team projects, for a total of 16 projects, that will address national challenges such as renewable energy or advanced manufacturing.

DIRECTORATE FOR GEOSCIENCES (GEO)

$979,160,000
+$89,520,000 / 10.1%

GEO Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Atmospheric and Geospace Sciences (AGS)	$259.87	-	$259.80	$286.33	$26.53	10.2%
Earth Sciences (EAR)	183.26	-	183.00	207.27	24.27	13.3%
Ingegrative and Collaborative Education & Research (ICER)	98.87	0.40	97.92	100.92	3.00	3.1%
Ocean Sciences (OCE)	349.88	-	348.92	384.64	35.72	10.2%
Total, GEO	**$891.87**	**$0.40**	**$889.64**	**$979.16**	**$89.52**	**10.1%**

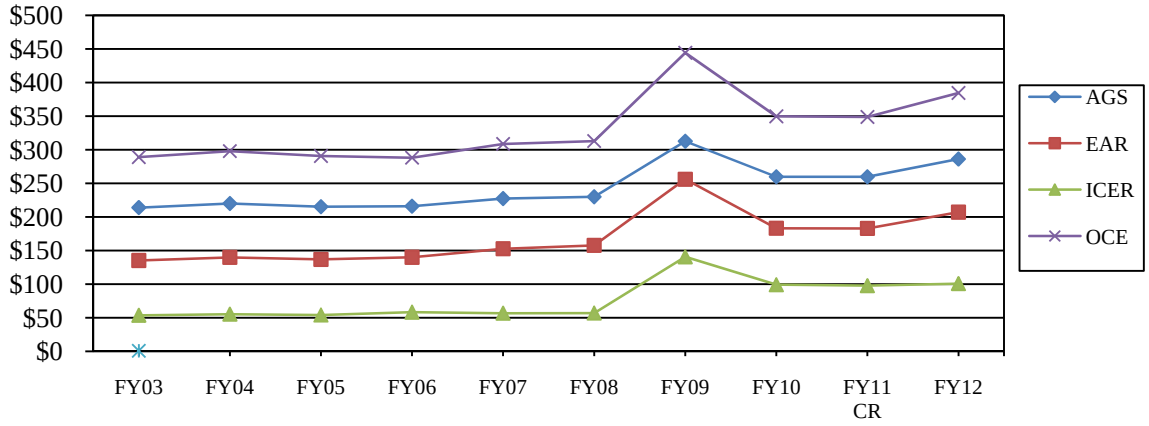
Totals may not add due to rounding.

About GEO

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that affect the global environment. These processes include the role of the atmosphere and oceans in climate, the planetary water cycle, and ocean acidification. Support is provided for interdisciplinary studies that contribute directly to national research priorities such as: understanding, adapting to, and mitigating the impacts of global change, developing and deploying integrated ocean observing capabilities to support ecosystem-based management, and understanding future availability of fresh water. Lives are saved and property is preserved through better prediction and understanding of natural environmental hazards such as earthquakes, tornados, hurricanes, tsunamis, drought, and solar storms. Basic research supported by GEO enables preparation for and subsequent mitigation of or adaptation to the effects of these and other disruptive natural events.

GEO provides about 68 percent of the federal funding for basic research at academic institutions in the geosciences.

GEO Subactivity Funding
(Dollars in Millions)



FY 2012 Summary by Division

- AGS' FY 2012 Request is focused on supporting the new NSF-wide priority area of Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) and enhancing support for the ongoing NSF-wide Science, Engineering and Education for Sustainability (SEES) investment, where emphasis will be on developing clean energy and sustainability research networks. Funding for an emerging priority area within GEO, Creating a More Disaster Resilient America (CaMRA), is also supported. AGS will continue support of the observational infrastructure required to conduct modern research, including overseeing the final year of construction of the NCAR-Wyoming supercomputer center.

- EAR's FY 2012 Request is also focused on supporting the new NSF-wide priority area of CIF21, while enhancing support for the ongoing NSF-wide SEES investment. Within SEES, EAR will lead GEO efforts on programs related to clean energy and will participate in the sustainability research networks. EAR also will provide support for CaMRA, and will modestly increase support for operation of the EarthScope facility, enabling EarthScope services to continue at levels similar to those in the past.

- ICER's FY 2012 Request is focused on enhancing support of the NSF-wide SEES investment while maintaining support for GEO-wide education and diversity activities.

- OCE's FY 2012 Request is similarly focused on supporting the new NSF-wide priority area of CIF21, while enhancing support for the ongoing NSF-wide SEES investment, where emphasis will be on developing clean energy and sustainability research networks. OCE is also providing support for CaMRA. OCE's ongoing investments in research, education, and infrastructure strongly support the recent Executive Order 13547, establishing a National Ocean Policy (NOP). OCE is continuing to invest in research infrastructure; support for Ocean Observatories Initiative (OOI) operations increases by $19.20 million and planning for possible new Regional Class Research Vessels continues.

Major Investments

GEO Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
SEES Portfolio	$195.95	-	$195.50	$282.70	$87.20	44.6%
CIF21	-	-	-	16.00	16.00	N/A
CAREER	12.59	0.05	12.60	13.80	1.20	9.5%
Science and Technology Centers	14.62	-	14.64	13.00	-1.64	-11.2%
CaMRA	-	-	-	10.00	10.00	N/A

Major investments may have funding overlap, and thus should not be summed.

- GEO will support the NSF-wide SEES investment by funding activities that will lay the foundation for technologies to mitigate against, and adapt to, environmental change that threatens sustainability.

Support for new activities will be housed in all GEO divisions, with emphasis on the emerging Sustainability Research Network activity, as well as Sustainability Energy Pathways activities to identify clean energy sources and their potential for future use and the impact of their use on the environment and society. Funding for the U.S. Global Change Research Program (USGCRP) is contained within SEES.

- Support for the new NSF-wide CIF21 investment will focus on the New Computational Infrastructure and Data Enabled Science components of the activity. In particular, geoinformatics – the tools and techniques that facilitate data-enabled geoscience – will be a priority. These investments will contribute to enhancing community research networks and the ability of geoscientists to access and connect to output of observing facilities.

- GEO supports the CAREER program, an Administration priority. GEO's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

- FY 2012 support for Science and Technology Centers reflects the planned ending of two centers in FY 2011and the initiation of one new center in FY 2010.

- In FY 2012, GEO will initiate a new $10.0 million GEO-wide program on Creating a More Disaster Resilient America (CaMRA). The overarching goal of CaMRA is to catalyze basic research efforts at NSF in hazard-related science to improve forecasting and prediction of natural and man-made hazardous events.

Summary and Funding Profile

GEO supports investment in research, centers, and education, as well as the infrastructure and facilities required to conduct cutting-edge geoscience investigations.

In FY 2012, the number of research grant proposals is expected to increase by approximately 600 compared to FY 2010 Enacted. GEO expects to award approximately 1,500 research grants in FY 2012. Average annualized award size and duration will remain level with FY 2010 Enacted.

Funding for infrastructure accounts for 37 percent of GEO's FY 2012 Request. Overall, infrastructure support is about the same as at the FY 2010 Enacted level, but significant changes within the infrastructure portfolio are occurring. Support for OOI operations and maintenance is increasing by $19.20 million, while support for construction of the NCAR-Wyoming Supercomputer Center is reduced by $25.0 million, reflecting the completion of construction support.

GEO Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	4,819	4,400	5,100
Number of New Awards	1,689	1,200	1,800
Regular Appropriation	1,645	1,200	1,800
ARRA	44	-	-
Funding Rate	35%	27%	35%
Statistics for Research Grants:			
Number of Research Grant Proposals	4,243	3,800	4,500
Number of Research Grants	1,397	900	1,500
Regular Appropriation	1,395	900	1,500
ARRA	2	-	-
Funding Rate	33%	24%	33%
Median Annualized Award Size	$123,466	$125,000	$125,000
Average Annualized Award Size	$159,210	$175,000	$175,000
Average Award Duration, in years	2.6	3.0	3.0

GEO Funding for Centers Programs and Facilities

GEO Funding for Centers Programs
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Centers Programs	**$14.87**	**$14.89**	**$13.25**	**-$1.64**	**-11.0%**
Science and Technology Centers (AGS, EAR, OCE)	14.62	14.64	13.00	-1.64	-11.2%
Nanoscale Science and Engineering Centers (ICER)	0.25	0.25	0.25	-	-

No FY 2010 obligations for centers were made with funds provided by the ARRA.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

- GEO supports three Science and Technology Centers (STC) in FY 2012, with the GEO funding for the Center for Dark Energy Biosphere Investigations (C-DEBI) beginning in FY 2011, and continued funding for two ongoing centers. Final funding in FY 2011 concludes two STCs initiated in 2002.

GEO Funding for Facilities
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Facilities	**$281.68**	**$277.11**	**$292.61**	**$15.50**	**3.9%**
National Astronomy and Ionosphere Center (AGS)	2.35	2.20	3.20	1.00	36.2%
National Center for Atmospheric Research (AGS)	96.29	97.00	100.00	3.00	3.9%
National Nanotechnology Infrastructure Network (ICER)	0.60	0.60	0.60	-	-
Academic Research Fleet (OCE)	78.04	80.00	69.35	-10.65	-11.1%
Incorporated Research Instutions for Seismology (EAR)	12.36	12.36	12.36	-	-
EarthScope (EAR)	25.25	25.05	26.00	0.95	3.0%
Integrated Ocean Drilling Program (EAR)	50.80	43.40	45.40	2.00	-10.6%
Ocean Observatories Initiative (OCE)	15.99	16.50	35.70	19.20	123.3%

For detailed information on individual facilities, please see the Facilities chapter.

Facilities

- Funding for the Academic Research Fleet decreases by $10.65 million to a total budget of $69.35 million. This reflects the completion of support for the Replacement Human Occupied Vehicle (which replaces the *ALVIN*) and the retirement of the *R/V OCEANUS*.
- Support for operation and maintenance of the OOI increases to $35.70 million as planned. The increased funds support the transition from the design phase to an active network build phase.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors (COVs) and directorate Advisory Committees (AC). Please see this chapter for additional information.

In FY 2010, GEO held three COVs – for cross-directorate education and diversity programs, the Atmosphere Section in the Division of Atmospheric and Geospace Sciences, and the Instrumentation and Facilities Program in the Division of Earth Sciences. The Directorate for Geosciences' Advisory Committee (AC/GEO) met twice in FY 2010.

In FY 2011, COV reviews are planned for research programs in EAR, the Upper Atmosphere Research Section in AGS, and the Integrative Projects Section in OCE.

In FY 2012, COV reviews will take place in the AGS' NCAR and Facilities Section, and for OCE's Marine Geosciences and Ocean Sections.

Number of People Involved in GEO Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	5,426	61	5,200	4,900
Other Professionals	2,909	32	2,800	2,000
Postdoctorates	685	5	600	1,800
Graduate Students	2,593	17	2,400	3,600
Undergraduate Students	1,942	9	1,300	2,000
Total Number of People	**13,555**	**124**	**12,300**	**14,300**

DIVISION OF ATMOSPHERIC AND GEOSPACE SCIENCES (AGS) $286,330,000
+$26,530,000 / 10.2%

AGS Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
AGS	**$259.87**	**$259.80**	**$286.33**	**$26.53**	**10.2%**
Research	**125.21**	**126.35**	**147.08**	**20.73**	**16.4%**
CAREER	6.17	5.70	6.20	0.50	8.8%
Centers Funding (total)	7.30	7.32	4.00	-3.32	-45.4%
Center for Integrated Space Weather Modeling	*3.32*	*3.32*	-	*-3.32*	*-100.0%*
Center for Multi-scale Modeling of Atmospheric Processes	*3.98*	*4.00*	*4.00*	-	-
Education	**1.34**	**2.85**	**2.85**	**-**	**-**
Infrastructure	**129.15**	**125.70**	**130.70**	**5.00**	**4.0%**
NAIC	*2.35*	*2.20*	*3.20*	*1.00*	*45.5%*
Nat'l Center for Atmospheric Research	*96.29*	*97.00*	*100.00*	*3.00*	*3.1%*
Research Resources	*30.52*	*26.50*	*27.50*	*1.00*	*3.8%*

The mission of AGS is to extend intellectual frontiers in atmospheric and geospace sciences by making responsible investments in fundamental research, technology development, and education that enable discoveries, nurture a vibrant, diverse scientific workforce, and help attain a prosperous and sustainable future. AGS supports activities to further our understanding of the physics, chemistry, and dynamics of the Earth's atmosphere, from the Earth's surface to the sun, on timescales ranging from minutes to millennia. AGS provides support for: 1) basic science projects and 2) the acquisition, maintenance, and operation of observational and cyberinfrastructure facilities and services that enable modern day atmospheric and geospace science research activities. Although the majority of AGS support is through traditional "individual investigator" merit-reviewed, multi-year grants, the division also supports small scale, limited-duration exploratory research projects; collaborative or multi-investigator group projects focusing on a particular project, subject, or activity; large center or center-like projects; and funding for the research conducted by NSF's National Center for Atmospheric Research (NCAR), which extends and enhances research at universities. More information on NCAR is available in the Facilities chapter. The division will increase support in key areas of fundamental atmospheric and geospace science including space weather, the genesis and dynamics of storms and severe weather, and biogeochemical cycling. In addition, the AGS will also support research in NSF's Science, Engineering, and Education for Sustainability (SEES) and Cyberinfrastructure Framework for the 21st Century Science and Engineering (CIF21) investments, as well as, in a GEO-wide program, Creating a More Disaster Resilient America.

Approximately 45 percent of the annual budget of AGS is used to support NCAR and other observational and computational facilities and 55 percent for individual, small group, and center-like research grants. In general, of the 55 percent of the AGS budget available for research grants, 54 percent (or 30 percent of the total AGS portfolio) is available for new research grants. The remaining 25 percent of the budget funds continuing grants made in previous years.

FY 2012 Summary

Research

- FY 2012 will see a strong emphasis on Science, Engineering and Education for Sustainability (SEES), with a particular emphasis on clean energy research. AGS will lead GEO activities in establishing a robust suite of Sustainability Research Networks and participating in Sustainable Energy Pathways to identify clean energy sources and the impact of using those sources on the environment and society. SEES support in AGS will total $24.50 million in 2012; a $12.50 million increase.
- Support for Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) is initiated in FY 2012. AGS will contribute $6.0 million in FY 2012 to this NSF-wide activity by increasing funding for research in geoinformatics and for the use of computational infrastructure. This is consistent with NSF's goal of facilitating data-enabled science.
- In FY 2012 AGS will contribute $3.0 million in a new GEO-wide program, Creating a More Disaster Resilient America (CaMRA). The overarching goal of CaMRA is to catalyze basic research in hazard-related science to support a broad spectrum of research into the prediction of atmospheric and space weather hazards.
- CAREER funding increases by $500,000 above the FY 2010 Enacted to a total of $6.20 million in FY 2012. This increase is consistent with AGS's emphasis on supporting early career researchers.
- Centers
  - As planned, support for the Center for Integrated Space Weather Modeling, an NSF Science and Technology Center will end in FY 2011.
  - Support for the Center for Multi-scale Modeling of Atmospheric Processes, an NSF Science and Technology Center focused on improving the representation of cloud processes in climate models, continues into its fifth year at the planned level of $4.0 million.

Education

- Funding for AGS education activities including Research Experiences for Undergraduates (REU) site and supplemental awards, as well as for Research Experiences for Teachers (RET), is maintained at the FY 2010 enacted level of $1.13 million. The Atmospheric and Geospace Sciences Postdoctoral Fellowship funding at $1.72 million remains consistent with the FY 2010 Enacted level.

Infrastructure

- Support for the National Astronomy and Ionosphere Center (NAIC) will increase by $1.0 million to $3.20 million. This facility is supported collaboratively by GEO and MPS.
- Support for the National Center for Atmospheric Research (NCAR) will increase by $3.0 million in FY 2012 to $100.0 million. This augmentation will support research and infrastructure activities related to SEES, CIF21, and CaMRA.

DIVISION OF EARTH SCIENCES (EAR)

$207,270,000
+$24,270,000 /13.3%

EAR Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
EAR	**$183.26**	**$183.00**	**$207.27**	**$24.27**	**13.3%**
Research	**113.80**	**113.08**	**133.29**	**20.21**	**17.9%**
CAREER	4.12	4.40	4.80	*0.40*	*9.1%*
Centers Funding (total)	3.32	3.32	-	-3.32	-100.0%
Center for Earth Surface Dynamics	*3.32*	*3.32*	-	*-3.32*	*-100.0%*
Education	**4.29**	**4.93**	**5.08**	**0.15**	**3.0%**
Infrastructure	**61.78**	**61.59**	**65.41**	**3.82**	**6.2%**
Incorporated Research Institutions for Seismology	*12.36*	*12.36*	*12.36*	-	-
EarthScope	*25.25*	*25.05*	*26.00*	*0.95*	*3.8%*
Research Resources	*24.17*	*24.18*	*27.05*	*2.87*	*11.9%*

EAR supports fundamental research into the structure, composition, and evolution of the Earth, and the life it has sustained over the four and a half billion years of Earth history. The results of this research will lead to a better understanding of Earth's changing environment (past, present, and future), the natural distribution of its mineral, water, biota, and energy resources, and provide methods for predicting and mitigating the effects of geologic hazards such as earthquakes, volcanic eruptions, floods, and landslides.

Through its Surface Earth Processes section, EAR supports research in geomorphology and land use, hydrologic science, geobiology and low temperature geochemistry, and sedimentary geology and paleobiology. The Division's Deep Earth Processes Section maintains programs in geophysics, tectonics, petrology and geochemistry, and continental dynamics. The newest program in EAR is EarthScope, a $200.0 million facility and science program focused on studying the structure and tectonics of the North American continent. In addition to these core programs, EAR has an Instrumentation and Facilities program that supports community-based, shared use facilities and the acquisition and development of instrumentation by individual investigators, and an education program that funds a number of activities to attract and support students and young investigators to the field of Earth science.

Approximately 66 percent of EAR's budget is used to support individuals and small groups of researchers while about 32 percent of the budget goes to instrumentation and facilities. The two largest facilities supported by EAR are EarthScope and IRIS, a community-based seismic instrumentation facility. In general, 40 percent of EAR's portfolio is available for new research grants. The remaining 60 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- EAR will participate in Science, Engineering and Education for Sustainability (SEES) with $7.0 million for the Water, Sustainability and Climate solicitation, and ongoing support for EAR's Critical Zone Observatories. EAR will contribute funds, as part of the NSF-wide clean energy activity, to identify clean energy sources and their potential for future use, as well as the impact of that use on the environment and society ($8.0 million);
- Support for Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) is initiated in FY 2012. EAR will contribute $4.0 million in FY 2012 to this NSF-wide investment by increasing funding for research in geoinformatics and for the acquisition and use of computational infrastructure. This is consistent with NSF's goal of facilitating data-enabled science and making data acquired by NSF-funded investigators openly available to any interested user;
- In FY 2012, EAR will invest $4.0 million in a new $10.0 million per year GEO-wide program on Creating a More Disaster Resilient America (CaMRA). The overarching goal of CaMRA is to catalyze basic research efforts at NSF in hazard-related science to improve forecasting and prediction of natural and man-made hazards;
- CAREER funding will be increased by $400,000 above FY 2010 to a total of $4.80 million, reflecting EAR's continuing commitment to supporting early career researchers;
- As planned, support for The Center for Earth Surface Dynamics, an NSF Science and Technology Center, ends in FY 2011 after 10 successful years of operation.

Education

- An increase of $150,000 is proposed for EAR's Postdoctoral Fellowship program.

Infrastructure

- An increase of $2.87 million (to a total of $27.05 million) is proposed for support of multi-user research instrumentation, acquisition or upgrading of research equipment, and development of new instrumentation, analytical techniques or software;
- EarthScope operations will increase to $26.0 million, 3.8% over FY 2010, reflecting rising personnel and field costs;
- Support of Incorporated Research Institutions for Seismology (IRIS) is maintained at FY 2010 levels.

INTEGRATIVE AND COLLABORATIVE EDUCATION & RESEARCH (ICER)

$100,920,000
+$3,000,000 / 3.1%

ICER Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
ICER	**$98.87**	**$0.40**	**$97.92**	**$100.92**	**$3.00**	**3.1%**
Research	**44.90**	**0.38**	**41.40**	**72.95**	**31.55**	**76.2%**
CAREER	0.40	0.05	-	-	-	N/A
Centers Funding (total)	0.25	-	0.25	0.25	-	-
Nano Centers	*0.25*	-	*0.25*	*0.25*	-	-
Education	**21.18**	**0.02**	**26.97**	**25.67**	**-1.30**	**-4.8%**
Infrastructure	**31.60**	**-**	**27.60**	**0.60**	**-27.00**	**-97.8%**
NNIN	*0.60*	-	*0.60*	*0.60*	-	-
Academic Research Fleet	-	-	*2.00*	-	*-2.00*	*-100.0%*
Research Resources	*31.00*	-	*25.00*	-	*-25.00*	*-100.0%*

ICER supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER's principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and to join with other parts of NSF in major integrative research and education efforts. In FY 2012, the division will make strategic investments in climate research, international activities, education, diversity, and human resource development.

In general, 40 percent of the ICER portfolio is available for new research grants. The remaining 60 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- In FY 2012, ICER will support GEO's increased activities in Science, Engineering and Education for Sustainability (SEES). Supported activities will lay the foundation for technologies to mitigate against, and adapt to, environmental change that threatens sustainability, with an emphasis in 2012 on vulnerable regions in the Arctic and along coasts. Also in FY 2012, a strong emphasis will be placed on clean energy. ICER will participate in activities to establish a robust suite of Sustainability Research Networks and in a program to identify clean energy sources and the impact of using those sources on the environment and society. FY 2012 SEES activities in ICER will total $27.75 million.
- ICER supports a varied portfolio of international collaborative activities. In FY 2012 this will total $6.50 million and will emphasize collaborative research across the Americas.

Education

- ICER is home to a number of education and diversity activities, including ADVANCE, GEO Disciplinary Education, GEO Teach, and IGERT programs. This portfolio will total $25.67 million in FY 2012.

Infrastructure

- ICER supports limited infrastructure activities. The most significant change in 2012 is the completion of construction support for the NCAR-Wyoming Supercomputer Center, funded through Research Resources.
- All FY 2012 funding for the Academic Research Fleet is provided through OCE. The FY 2010 Enacted amounts shown support fleet operations.

DIVISION OF OCEAN SCIENCES (OCE) $384,640,000
+$35,720,000 / 10.2%

OCE Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
OCE	**$349.88**	**$348.92**	**$384.64**	**$35.72**	**10.2%**
Research	**164.19**	**181.32**	**201.14**	**19.82**	**10.9%**
CAREER	1.90	2.50	2.80	0.30	12.0%
Centers Funding (total)	4.00	4.00	9.00	5.00	125.0%
Coastal Margin Observation & Prediction	*4.00*	*4.00*	*4.00*	-	-
Dark Energy Biosphere Investigations	-	-	*5.00*	*5.00*	*N/A*
Education	**8.97**	**8.37**	**8.82**	**0.45**	**5.4%**
Infrastructure	**171.00**	**152.90**	**168.25**	**15.35**	**10.0%**
Academic Research Fleet	*78.04*	*78.00*	*69.35*	*-8.65*	*-11.1%*
Integrated Ocean Drilling Program	*50.80*	*43.40*	*45.40*	*2.00*	*4.6%*
Pre-Construction Planning (total)	-	*2.00*	*2.00*	-	-
Regional Class Research Vessels	-	*2.00*	*2.00*	-	-
Ocean Observatories Initiative (OOI)	*15.99*	*16.50*	*35.70*	*19.20*	*116.4%*
Research Resources	*26.17*	*15.00*	*17.80*	*2.80*	*18.7%*

Research, education, and infrastructure funded by OCE address the central role of the oceans in a changing Earth and as a national strategic resource, as recognized in the President's July 19, 2010 Executive Order 13547, establishing a National Ocean Policy (NOP) and creating a National Ocean Council (NOC) to implement the policy and its nine strategic objectives. OCE supports interdisciplinary research of the water column to better understand changing ocean circulation and temperature, the health of marine ecosystems, and changing ocean chemistry with implications for ocean acidification. OCE also supports research on the geology of the ocean margins and sub-seafloor to investigate past ocean and climate conditions, stability of methane hydrates, natural hazards associated with earthquakes and volcanic eruptions, and microbial life deep below the seafloor. Since ocean science requires access to the sea, OCE supports research vessels, deep submergence capability including submersibles and autonomous vehicles, and technologically advanced sensors and instrumentation. In FY 2012, OCE will emphasize research in support of the NOP objectives, especially those involving improved understanding through the advancement of knowledge, ecosystem-based management, coastal marine spatial planning, protection of marine biodiversity, the impact of increased atmospheric CO_2 on ocean acidification, ocean observing and the enhancement of infrastructure, and changing conditions in the Arctic.

In general, 38 percent of the OCE portfolio is available for new research grants. The remaining 62 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- OCE will participate in the SEES emphasis on clean energy and research networks at a level of $8.50 million in FY 2012. There are many crossovers between the NOP and SEES objectives as they relate to the oceans. These themes include ocean acidification, addressing the role of the oceans in climate change, the integration of marine ecosystem models with climate change models, interactions

between warming oceans and ice-sheets, integrated social and natural science models of our coasts, dimensions of biodiversity, LTERs, and others.

- Investment of $3.0 million for a new GEO program, Creating a More Disaster Resilient America (CaMRA), to support research programs and facilities involving severe storms, tsunamis, long term effects of oil spills, and biotic hazards (e.g., Harmful Algal Blooms (HABs), invasive species).
- Investment by OCE of $4.0 million in support for Cyberinfrastructure Framework for 21 Century Science and Engineering (CIF21) is initiated in FY 2012. OCE will contribute to this NSF-wide initiative by supporting research on geoinformatics and the enhancement of access and connections to facilities and scientific instruments emerging from national data- and compute-intensive facilities such as the Ocean Observatories Initiative (OOI).
- Investment of $5.0 million in the Center for Dark Energy Biosphere Investigations (C-DEBI). Initial funding for this STC began in 2010 within Integrative Activities. This center uses the highly advanced technologies of the Integrated Ocean Drilling Program (IODP) to pursue exploration of the nature and limits of life in the largest biome on earth, the sub-seafloor biosphere, and the interactions of this life with the largest hydrological system on our planet.
- OCE will also continue its partnership on the theme of Oceans and Human Health with the National Institute of Environmental Health Sciences (NIEHS), and on the theme of ecosystem-based management in the Comparative Analysis of Marine Ecosystem Organization program with the National Oceanographic and Atmospheric Administration (NOAA).
- In late CY 2010, OCE received a National Research Council report with recommendations for research on ocean acidification. The division will again partner with OPP, BIO, and other federal agencies to fulfill priority research recommendations on the biological, ecosystem, and chemical processes involved with decreasing ocean pH and impacts to important marine resources. Divisional investments will be up to $10.0 million in FY 2012.

Education

- Funding for educational activities will increase slightly and will emphasize initiatives emerging from the NOP that aim to improve public understanding of the oceans and encourage broader participation in ocean sciences.
- Funding is provided for a new program, the OCE Postdoctoral Fellowship and Research Facilitation Awards ($1.90 million). This program aims to broaden participation in the ocean sciences through fellowships and research support.
- Funding for the Centers for Ocean Science Education Excellence (CoSEE) program continues at a level of $4.24 million, representing a reduction of $1.45 million from the FY 2010 Enacted level. During FY 2011, CoSEE will complete a decadal review of its program successes along with a forward-looking strategic plan to define new opportunities and directions.

Infrastructure

- A modest increase in funds (+$2.0 million) is requested for the Integrated Ocean Drilling Program to capitalize on enhanced investment returns from the successful operation of the retro-fitted drilling vessel, *JOIDES RESOLUTION*, under the current science plan and in support of the C-DEBI STC. In FY 2011, OCE will receive the results of an NRC study evaluating the impact of scientific ocean drilling on the geosciences and assessing a new Science Plan, developed by the international community, for a possible new ocean drilling program post-FY 2013.
- Decreases in the Academic Research Fleet operations result from the retirement of the *R/V OCEANUS* and completion of the of *RHOV ALVIN* replacement in FY 2011. Investments are continued ($2.0 million) for planning and design for a possible fleet renewal effort.
- Implementation of the Ocean Observatories Initiative (OOI) continues with a planned $19.20 million increase, bringing the total for operations and maintenance to $35.70 million in FY 2012. These increased funds support the transition from the design phase to an active network build phase.

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

$1,432,730,000
+$80,890,000 / 6.0%

MPS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Division of Astronomical Sciences (AST)	$246.53	-	$245.69	$249.12	$3.43	1.4%
Division of Chemistry (CHE)	233.68	15.70	233.73	258.07	24.34	10.4%
Division of Materials Research (DMR)	302.57	-	302.67	320.79	18.12	6.0%
Division of Mathematical Sciences (DMS)	244.92	-	241.38	260.43	19.05	7.9%
Division of Physics (PHY)	301.66	-	290.04	300.91	10.87	3.7%
Office of Multidisciplinary Activities (OMA)	38.58	-	38.33	43.41	5.08	13.3%
Total, MPS	**$1,367.95**	**$15.70**	**$1,351.84**	**$1,432.73**	**$80.89**	**6.0%**

Totals may not add due to rounding.

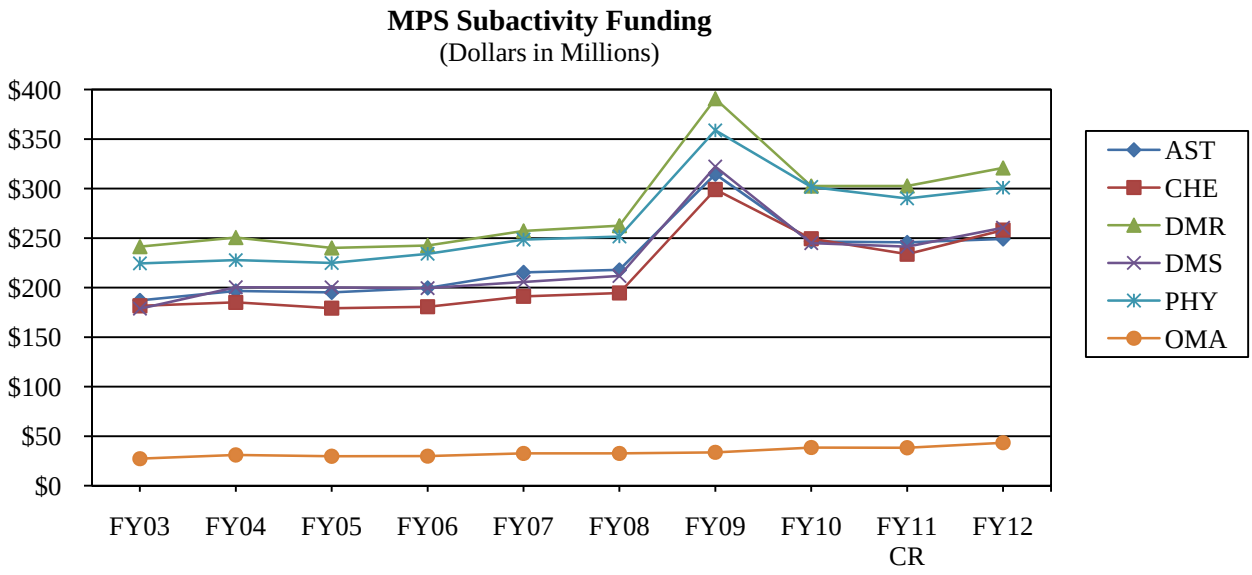
About MPS

The Directorate for Mathematical and Physical Sciences Request of $1,432.73 million is based on three key priorities: (1) strengthening innovation in basic research programs, (2) supporting essential facilities for basic science, and (3) providing significant funding for targeted basic research areas, including Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21); Science, Engineering, and Education for Sustainability (SEES); research at the interface between biological and mathematical and physical sciences (BioMaPS) and Science and Engineering Beyond Moore's Law (SEMBL).

A principal driver of the FY 2012 Request is funding for core research programs; these awards drive new discoveries in the mathematical and physical sciences, directly strengthening the building blocks of innovation. The MPS commitment to core research strengthens science, seeds longer-term innovation, and develops the foundation for translational activities in NSF as well as other agencies, industry, and society.

MPS continues to fund the operations and management of 15 major multi-user facilities, allowing thousands of scientists and students to press the bounds of scientific knowledge, and invests in potential future projects needed to remain at the cutting-edge of research, such as the Large Synoptic Survey Telescope (LSST), which will rapidly scan the sky, charting objects that change or move and tracing billions of remote galaxies, providing multiple probes of the mysterious dark matter and dark energy.

MPS provides about 50 percent of the federal funding for basic research at academic institutions in the mathematical and physical sciences.



FY 2012 Summary by Division

- AST's FY 2012 Request is focused on ramping up the Atacama Large Millimeter Array (ALMA) to full operations as its construction funding comes to an end. This ramp will occur while AST continues to maintain its core grant programs in basic research and instrumentation development. The other highest priority activity will be continuing the design and development of the Large Synoptic Survey Telescope (LSST), the first-priority large project in the National Research Council decadal survey in astronomy and astrophysics, as LSST moves toward readiness for construction. AST will initiate funding for the NSF-wide investments in Enhancing Access to the Radio Spectrum (EARS) and Sustainable Energy Pathways (SEP), an element of SEES.

- CHE's FY 2012 Request is focused on enhancing support for core programs and, as part of the NSF-wide SEES investment, funding activities that will lay the foundation for future clean energy technologies and sustainable, environmentally benign chemical manufacturing. Funding for education and infrastructure programs in CHE will be reduced to accommodate these priorities.

- DMR plans to increase its portfolio of individual investigator awards, including NSF focus areas where advances in materials science are key: SEES, SEBML, and BioMaPS. DMR also plans to support the newly restructured Materials Research Centers and Teams Program as well as key facilities and to continue efforts to strengthen education in materials science and broaden participation in the discipline.

- DMS's FY 2012 Request is focused on enhancing support for basic research; training a diverse group of researchers in mathematical and statistical sciences, with better core, computational and communication skills; investing in mathematical sciences institutes and networking opportunities; and providing support and efficient mechanisms to foster multidisciplinary research activities in, but not limited to CIF21, SEES, and BioMaPS. Some of the limited existing funds from previous priority areas will also be invested to achieve these goals and be realigned to match division goals with that of MPS and NSF.

- PHY will focus on three major areas for FY 2012: providing continued support for individual investigator awards, especially in those areas that are priorities for the division, including physics of the universe, quantum information science, and the physics-biology interface; ensuring that sufficient funding is available for investigators using the major facilities sponsored by the division; and ensuring sufficient funding to support operations and maintenance of these facilities as they transition to a new era of operations. A major factor affecting total funding for PHY is the termination of NSF support for the Deep Underground Science and Engineering Laboratory (DUSEL), a savings of $36.0 million relative to FY 2010 Enacted. This $36.0 million will be repurposed within PHY to the three priority areas described above.

- OMA will continue its tradition of providing support for interdisciplinary research. In FY 2012, OMA will increase emphasis on key NSF-wide areas of SEES, CIF21, SEBML, BioMaPS, clean energy, and advanced manufacturing.

Major Investments

MPS Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
NNI	$199.11	-	$190.59	$182.36	-$8.23	-4.3%
SEES Portfolio	151.15	-	87.00	160.00	73.00	83.9%
CAREER	62.81	0.11	47.92	53.78	5.86	12.2%
SEBML	59.12	-	18.68	42.18	23.50	125.8%
BioMaPS	-	-	-	25.57	25.57	N/A
CIF21	-	-	-	20.00	20.00	N/A
Advanced Manufacturing	-	-	-	20.00	20.00	N/A
EARS	-	-	-	3.00	3.00	N/A

Major investments may have funding overlap and thus should not be summed.

- National Nanotechnology Initiative (NNI): MPS is a strong supporter of NNI, with $182.36 million in FY 2012. Although this represents a decrease from the FY 2010 level, MPS will invest both in basic NNI-related research and in the three FY 2012 NNI Signature Initiatives: Nanoelectronics for 2020 and Beyond, Nanomanufacturing for Sustainable Development, Nanotechnology for Solar Energy Collection and Conversion.. MPS NNI investments are primarily in fundamental science and in new materials, with significant support for education through the centers programs and for major facilities such as the National High Magnetic Field Laboratory and the National Nanotechnology Infrastructure Network.

- Science, Engineering, and Education for Sustainability Portfolio (SEES): MPS will continue to support the NSF-wide SEES investment by funding activities that will lay the foundation for future clean energy technologies and sustainable, environmentally benign chemical manufacturing. In FY 2012, MPS will invest in SEP and Sustainability Research Networks (SRN) including NSF-wide solicitations and programs as well as core research programs in SEES-related areas. In FY 2012, all five MPS Divisions and OMA will contribute to SEES-related activities at a level of $160.0 million.

- CAREER: At $53.78 million, MPS strongly supports CAREER, an Administration priority, providing nearly 25 percent of the total NSF investment. CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations.

- Science and Engineering Beyond Moore's Law (SEBML): In FY 2012, MPS will continue to invest in research designed to position the U.S. at the forefront of communications and computation capability. One area for investment in FY 2012 is $20.0 million requested for nanoelectronics research; MPS will partner in nanoelectronics with the Directorate for Computer and Information Science and Engineering (CISE), the Directorate for Engineering (ENG), and the Nanoelectronics Research Initiative (NRI), a consortium of companies in the Semiconductor Industry Association (SIA). MPS invested significantly more in SEBML research than originally expected in FY 2010 due to an increase in proposals in this area from the scientific community.

- Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS): MPS will invest in the BioMaPS program at $25.57 million, continuing the formal partnership with the Directorates for Biological Sciences (BIO) that began in FY 2010. In addition, ENG will join MPS and BIO in FY 2012 to support interdisciplinary research that will contribute to the NSF-wide efforts on clean energy and advanced manufacturing. The study of biological complexity necessitates new developments in mathematical and physical sciences, leading to new theoretical and experimental approaches. These interdisciplinary efforts will result in accelerated understanding of biological systems, as well as uncovering of new mathematical and physical concepts, leading to innovations in such areas as renewable fuels, bio-based materials, bio-imaging, and bio-inspired sensors. Working together, BIO, MPS, and ENG will coordinate research over the entire spectrum from the discovery of biological, physical, and mathematical principles underlying the biological processes, to their application to the energy sector and advanced manufacturing.

- Cyber-Infrastructure Framework for the 21st Century (CIF21): MPS will heavily support the new NSF-wide CIF21 investment in FY 2012 at $20.0 million. All Divisions in MPS will contribute to computational and data-enabled science and engineering activities, focusing on the areas of Data and New Computational Infrastructure. MPS will support fields necessary to ensure that simulations are able to capture the complexity of nature, and are physically correct, reproducible, and predictive, investing in MPS computational sciences, algorithm development, and software infrastructure needed for sustained long-term research efforts. Equal attention will be given to data-enabled science, including fundamental mathematical algorithms, software, data services, and network infrastructure needed to serve scientists wherever they are located.

- Advanced Manufacturing: MPS will fund this at $20.0 million. These investments will be made in the areas of nanomanufacturing, industry/university partnerships, and BioMaPS.

- Enhancing Access to the Radio Spectrum (EARS): Support of $3.0 million for EARS is initiated in FY 2012 to promote interdisciplinary research in use of the radio spectrum, in response to the Presidential Memorandum on "Unleashing the Wireless Broadband Revolution" and to the National Broadband Plan (http://www.broadband.gov). The recent NSF workshop report, *Enhancing Access to the Radio Spectrum*, outlines the need for research on new and innovative ways to use the spectrum more efficiently. In partnership with the Directorates for Engineering, Social, Behavioral, and Economic Sciences, and Computer and Information Sciences and Engineering, MPS will initiate support for the basic research that underpins this effort.

Summary and Funding Profile

MPS supports investment in core research and education as well as research infrastructure such as centers and facilities.

In FY 2012 MPS will spend $92.77 million for Centers, accounting for 6.5 percent of the MPS budget. This total is down from FY 2010 as a number of MPS-supported centers have sunsetted. Centers are an important modality for MPS sciences as research in many MPS-supported disciplines has evolved to be more collaborative and interdisciplinary. While two Science and Technology Centers are sunsetting in FY 2011, MPS is maintaining commitments to the Centers for Chemical Innovation and increasing its investments in Materials Centers.

Operations and maintenance funding for MPS-supported user facilities comprises 19 percent of MPS's FY 2012 Request. MPS has increased operations budgets for facilities to maintain current operational capacity. Where increases were not possible, MPS has maintained operations budgets as close to constant as possible.

MPS Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	9,421	8,500	9,500
Number of New Awards	2,680	2,150	2,350
Regular Appropriation	2,539	2,150	2,350
ARRA	141	-	-
Funding Rate	28%	25%	25%
Statistics for Research Grants:			
Number of Research Grant Proposals	7,688	7,200	8,500
Number of Research Grants	2,016	1,600	1,750
Regular Appropriation	2,016	1,600	1,750
ARRA	-	-	-
Funding Rate	26%	22%	21%
Median Annualized Award Size	$115,446	$115,000	$118,000
Average Annualized Award Size	$150,051	$140,000	$144,000
Average Award Duration, in years	3.1	3.1	3.1

MPS Funding for Centers Programs and Facilities

MPS Funding for Centers Programs
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Centers Programs	$100.99	$105.06	$92.77	-$12.29	-11.7%
Nanocenters	*13.70*	*13.56*	*7.57*	*-5.99*	*-44.2%*
STCs - 2002 Class	*6.60*	*6.60*	-	*-6.60*	*-100.0%*
STCs - 2006 Class	*4.00*	*4.00*	*4.00*	-	-
Centers for Analysis & Synthesis	*0.20*	*0.20*	*0.20*	-	-
Centers for Chemical Innovation	*24.00*	*24.00*	*24.00*	-	-
Materials Centers	*52.49*	*56.70*	*57.00*	*0.30*	*0.5%*

No FY 2010 obligations for centers were made with funds provided by the ARRA.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

- Nanocenters: MPS is reducing its commitment to the Nanoscale Science and Engineering Centers (NSEC) program (-$5.99 million to a total of $7.57 million) in FY 2012. The first class of NSECs, funded in 2001, received final year funding in FY 2010 and complete their research programs associated with this support in FY 2011. In FY 2012, funding for the formal NSEC program decreases as funds are reallocated to provide support that will transition the nano-devices created at graduating NSECs to a more applied level.

- Science and Technology Centers (STCs): Two MPS-supported Science and Technology Centers are sunsetting in FY 2011, the Center for Materials and Devices for Information Technology Research and the Center for Biophotonics Science and Technology. This results in a decrease of $6.60 million to a total of zero for the STC 2002 Class. MPS is maintaining its investment in the Center for Layered Polymeric Systems, initiated in FY 2006.

- Materials Centers: The Materials Research Science and Engineering Centers (MRSEC) program has been restructured in response to the 2007 National Academy of Science report *The NSF's Materials Research Science and Engineering Program, Looking Back, Moving Forward*. The new Materials Research Centers and Teams program has two tracks: Centers of Excellence for Materials Research and Innovation (CEMRI) and Materials Interdisciplinary Research Teams (MIRT). Competitions for both programs are held triennially, the first of which is expected in late FY 2011. FY 2012 Request funding in the table above (+$300,000 to a total of $57.0 million) provides new support for the CEMRI centers and ongoing support for the existing 14 MRSEC centers, which are expected to continue through FY 2014 as the old structure is phased out. Funding for the MIRT teams, $6.0 million, is captured in core programs, as presented in the DMR section.

MPS Funding for Facilities
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Facilities	$270.05	$15.00	$259.80	$268.77	$8.97	3.5%
Advanced Technology Solar Telescope (ATST)	-	-	-	*2.00*	*2.00*	*N/A*
Atacama Large Millimeter Array (ALMA)	*18.20*	-	*17.57*	*30.65*	*13.08*	*74.4%*
Cornell High Energy Synchr. Source (CHESS)	*9.51*	-	*9.00*	*15.47*	*6.47*	*71.9%*
GEMINI Observatory	*19.10*	-	*19.10*	*20.07*	*0.97*	*5.1%*
IceCube Neutrino Observatory (IceCube)	*2.15*	-	*2.15*	*3.45*	*1.30*	*60.5%*
Large Hadron Collider (LHC)	*18.00*	-	*18.00*	*18.00*	-	-
Laser Interfer. Grav. Wave Observatory (LIGO)	*28.50*	-	*28.50*	*30.40*	*1.90*	*6.7%*
Nat'l Astronomy & Ionosphere Center (NAIC)	*8.40*	-	*8.40*	*5.50*	*-2.90*	*-34.5%*
Nat'l High Magnetic Field Laborary (NHFML)	*40.53*	*15.00*	*35.56*	*33.30*	*-2.26*	*-6.4%*
Nat'l Nanotechnology Infra. Network (NNIN)	*3.71*	-	*3.38*	*2.68*	*-0.70*	*-20.7%*
Nat'l Optical Astronomy Observatory (NOAO)	*35.40*	-	*31.50*	*29.17*	*-2.33*	*-7.4%*
Nat'l Radio Astronomy Observatory (NRAO)	*49.52*	-	*49.52*	*42.89*	*-6.63*	*-13.4%*
National Solar Observatory (NSO)	*9.10*	-	*9.10*	*9.79*	*0.69*	*7.6%*
Nat'l Superconducting Cyclotron Lab (NSCL)	*21.00*	-	*21.00*	*21.50*	*0.50*	*2.4%*
Other MPS Facilities [1]	*6.93*	-	*7.02*	*3.90*	*-3.12*	*-44.4%*

[1] Other MPS Facilities: Synchrotron Radiation Center (SRC), Center for High Resolution Neutron Scattering (CHRNS), and CheMatCARS.

For detailed information on individual facilities, please see the Facilities chapter.

Facilities

MPS has increased operations and maintenance budgets for facilities to maintain current operational capacity. Where increases were not possible, MPS has maintained budgets as close to constant as possible. Notable items include:

- ATST facility construction is presented in the MREFC chapter. $2.0 million presented above is the FY 2012 Request to support cultural mitigation activities agreed to during the permit/compliance process.
- ALMA: Support (+$13.08 million to a total of $30.65 million) is consistent with a planned ramp-up of operations as this observatory comes on line and begins early science activities.
- CHESS: Funding (+$6.47 million to a total of $15.47 million) for the synchrotron light source will allow this facility to continue operation as well as support X-ray technology research and development. The CHESS user program supports work in cancer research, new materials for electronics, aircraft, biotechnology, batteries, fuel cells, solar cells and other energy applications.
- LIGO: Support increases (+$1.90 million to a total of $30.40 million) in accordance with the agreed-upon funding profile for operations during the Advanced LIGO construction project. (See the MREFC chapter for more details on Advanced LIGO).
- NAIC: Decreased MPS funding for the Arecibo radio telescope (-$2.90 million to a total of $5.50 million) was recommended by the 2006 Senior Review of AST-supported facilities and programs. As a result of a solicitation in 2010, a new cooperative agreement with sufficient funding to preserve a

viable base facility is expected to be issued in FY 2012. (The Directorate for Geosciences also supports NAIC. See the Facilities chapter for more information).

- NHFML: Funding (-$2.26 million to a total of $33.30 million) will enable this world-leading laboratory to continue transformational research using high magnetic fields. This facility serves researchers in fields ranging from biology to materials and condensed matter physics. Note that the apparent decrease in the FY 2012 Request from the FY 2010 Actual is due to a one-time supplementary award in FY 2010 provided by the American Recovery and Reinvestment Act of 2009 for development of an instrument.
- NOAO: Support is eliminated for the Telescope System Instrumentation Program (TSIP), which funds community access to private telescopes. Future TSIP-like access may be acquired as part of other AST grants programs.
- NRAO: A decrease (-$6.63 million to a total of $42.89 million) is due to completion of the Expanded Very Large Array construction program.
- Other MPS Facilities: The major change (-$2.87 million) in this category is for NSF stewardship of the Wisconsin Synchrotron Research Center, which is being ended as planned in March 2011.

Pre-construction Planning:

- Deep Underground Science and Engineering Laboratory (DUSEL): NSF support for this proposed project is eliminated in FY 2012 (-$36.0 million), following the determination by the National Science Board that the scope and likely cost of the project were outside of NSF's core mission responsibilities. The Department of Energy will support pre-construction activities for its proposed Long Baseline Neutrino Experiment (LBNE), including an analysis of whether the LBNE far detector should be located at the Homestake site in South Dakota.
- Large Synoptic Survey Telescope (LSST): Funding for design and development activities is increased (+$1.0 million to $5.0 million) following the proposed project's first-place ranking in the National Research Council's Astronomy and Astrophysics Decadal Survey – *New Worlds, New Horizons in Astronomy and Astrophysics.*

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

Committees of Visitors (COV):

- In FY 2010, both CHE and DMS held their COV reviews. Both Divisions are responding to and implementing recommendations from their respective COV.
- In FY 2011, COV reviews will take place for AST and DMR.
- In FY 2012, a COV is planned to take place in PHY.

Reports by the National Research Council:

- A report released by the National Research Council in October 2009: *Evaluation of NSF's Program of Grants and Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE).* While the overall recommendation of the report was to continue the program, the two most recent competitions had yielded only a very small number of proposals.
- Late in FY 2010, the decadal survey in Astronomy and Astrophysics, *New Worlds, New Horizons,* was released by the National Research Council. Report recommendations are under review by AST,

and the first-ranked large project, the Large Synoptic Survey Telescope (LSST), has been given priority.

Science and Technology Policy Institute (STPI) Reports and Evaluations:

- In FY 2010, CHE supported a contract to the Science and Technology Policy Institute (STPI) to design the program evaluation for the Centers for Chemical Innovation CCI program. The design is complete for CCI Phase II and currently underway for CCI Phase I.
- In FY 2010, DMS initiated a STPI study to assess the need for and feasibility of evaluation of the mathematical sciences institutes *at the portfolio level*. If the formal evaluation is determined to be warranted and feasible, an additional objective is to recommend an evaluation approach and strategy. Final results from this study are expected during FY 2011.
- In FY 2010, MPS initiated a STPI feasibility study on MPS programs for broadening participation. The study will evaluate the appropriateness of an extensive analysis of the diverse ways in which the MPS directorate attempts to address the broadening participation of groups that have been traditionally underrepresented in the sciences. If the feasibility study shows such an analysis to be appropriate, MPS may follow up with an analysis and recommendation to contract for a thorough evaluation by a private sector contractor.

Number of People Involved in MPS Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	9,153	78	7,639	8,100
Other Professionals	2,737	24	2,363	2,500
Postdoctorates	2,484	21	2,297	2,430
Graduate Students	8,774	48	8,042	8,520
Undergraduate Students	8,422	184	5,986	6,340
Total Number of People	**31,570**	**355**	**26,327**	**27,890**

DIVISION OF ASTRONOMICAL SCIENCES (AST) $249,120,000
+$3,430,000 / 1.4%

AST Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
AST	**$246.53**	**$245.69**	**$249.12**	**$3.43**	**1.4%**
Research	**70.58**	**72.18**	**80.76**	**8.58**	**11.9%**
CAREER	*4.75*	*4.10*	*4.56*	*0.46*	*11.2%*
Education	**7.37**	**9.09**	**5.25**	**-3.84**	**-42.2%**
Infrastructure	**168.58**	**164.42**	**163.11**	**-1.31**	**-0.8%**
Gemini Observatory	*19.10*	*19.10*	*20.07*	*0.97*	*5.1%*
Atacama Large Mm Array(ALMA)	*18.20*	*17.57*	*30.65*	*13.08*	*74.4%*
Nat'l Astron. & Ion. Ctr. (NAIC)	*8.40*	*8.40*	*5.50*	*-2.90*	*-34.5%*
Nat'l Optical Astron. Obs (NOAO)	*35.40*	*31.50*	*29.17*	*-2.33*	*-7.4%*
Nat'l Radio Astron. Obs. (NRAO)	*49.52*	*49.52*	*42.89*	*-6.63*	*-13.4%*
Nat'l Solar Observatory (NSO)	*9.10*	*9.10*	*9.79*	*0.69*	*7.6%*
Pre-Construction Planning (total)	*9.06*	*12.00*	*5.00*	*-7.00*	*-58.3%*
Large Synoptic Survey Tel. (LSST)	*5.82*	*4.00*	*5.00*	*1.00*	*25.0%*
Giant Segmented Mirror Tel. (GSMT)	*0.24*	*5.00*	*-*	*-5.00*	*-100.0%*
Square Kilometer Array (SKA)	*3.00*	*3.00*	*-*	*-3.00*	*-100.0%*
Research Resources	*21.53*	*17.23*	*18.04*	*0.81*	*4.7%*

Totals may not add due to rounding.

AST is the federal steward for ground-based astronomy in the U.S., working in partnership with private institutions to enhance overall observing capacity and capability. Funding covers observational, theoretical, computational, and laboratory work to understand the origins and characteristics of planets, the Sun, other stars, our galaxy, extragalactic objects, and the structure and origin of the Universe through awards to individual investigators, small groups, and national facilities. AST supports the development of advanced technologies and instrumentation, the planning and design of future facilities, and management of the electromagnetic spectrum for scientific use. AST funds operations and maintenance for several national and international facilities. These major world-class facilities provide access to a wide range of observational resources on a competitive basis and serve thousands of users each year. (See the Facilities chapter of this document for more details). AST also funds various private facilities with varied arrangements for community access, as part of the ground-based public-private U.S. astronomy system.

In general, 18 percent of the AST portfolio is available for new research grants. The remaining 82 percent funds continuing awards made in previous years, including facility support at about 65 percent of the division's budget.

FY 2012 Summary

All funding increases/decreases represent change over the FY 2010 Enacted level.

Research

- CAREER is supported at $4.56 million (+$460,000). This level maintains AST's emphasis on supporting early career researchers and contributes to the Administration priority efforts.
- Investment of $2.0 million in Sustainable Energy Pathways in the SEES Portfolio supports the application of receptor and data-management systems for improved energy collection and efficiency.

- Support of $3.0 million for EARS is initiated in FY 2012 to promote interdisciplinary research in use of the radio spectrum, in response to the Presidential Memorandum on "Unleashing the Wireless Broadband Revolution" and to the National Broadband Plan (http://www.broadband.gov).
- Support for CIF21 is initiated in FY 2012. AST will contribute to this NSF-wide investment by supporting research into the analysis and archiving of large data sets and providing access to these large data sets to a broad cross-section of the scientific and public community. Of particular interest to AST is how data will be analyzed and served by the potential future LSST, which would have a data rate of tens of terabytes per day.

Education

The decrease in support for Education programs is chiefly due to these adjustments:

- The Astronomy and Astrophysics Postdoctoral Fellowship (AAPF) program is increased (+$200,000 to a total of $2.0 million). These fellowships require research and education components, so added funding will increase the emphasis on integrating research and education for early-career scientists.
- AST support for Integrative Graduate Education and Research Traineeship (IGERT) ends in FY 2012 (-$1.68 million) in order to reinvest in higher priority training programs within the division.
- GRF funding (-$300,000) is eliminated as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).
- The Partnerships in Astronomy and Astrophysics Research and Education (PAARE) program, aimed at increasing representation of under-represented minorities in astronomy, ends in FY 2012, (-$2.0 million). The demand for PAARE has been decreasing for several years; an evaluation will be conducted regarding future programs that may more effectively achieve similar goals.

Infrastructure

AST oversees an array of infrastructure projects and programs. For detailed information on individual AST facilities, please see the Facilities chapter.

- Gemini: FY 2012 support of $20.07 million for the Gemini Observatory reflects the agreement among the international partners for a 2.5 percent increase to account for the effects of inflation.
- ALMA: FY 2012 support (+$13.08 million to a total of $30.65 million) is consistent with a planned ramp-up of operations as this observatory comes on line and begins early science activities.
- NAIC: Funding for the Arecibo radio telescope decreases (-$2.90 million to a total of $5.50 million) as recommended by the 2006 Senior Review of AST-supported facilities and programs. As a result of a solicitation in 2010, a new cooperative agreement with sufficient funding to preserve a viable base facility is expected to be issued in FY 2012.
- NOAO: Support is eliminated for the TSIP program, which funds community access to private telescopes. Future TSIP-like access may be acquired as part of other AST grants programs.
- NRAO: A decrease (-$6.63 million to a total of $42.89 million) is due to completion of the Expanded Very Large Array construction program.
- NSO: Funding (+$690,0000 to $9.79 million total) supports continued operations and maintenance.
- LSST: Funding for design and development activities is increased (+$1.0 million to $5.0 million) following the proposed project's first-place ranking in the National Research Council's Astronomy and Astrophysics Decadal Survey – *New Worlds, New Horizons in Astronomy and Astrophysics (Astro2010).* Though still eligible for funding through AST instrumentation programs, lower ranked *Astro2010* candidates had their identified project funding reduced or eliminated.
- Research Resources: Funding growth (+$810,000 to a total of $18.04 million) due to higher programmatic demand. This includes the Advanced Technologies and Instrumentation and mid-scale experiment programs, which emphasize development of future instrumentation and use of university-scale instrumentation to address specific astrophysical questions.

DIVISION OF CHEMISTRY (CHE)

$258,070,000
+$24,340,000 / 10.4%

CHE Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2011 Estimate Amount	Change Over FY 2011 Estimate Percent
CHE	**$233.68**	**$15.70**	**$233.73**	**$258.07**	**$24.34**	**10.4%**
Research	**206.28**	**0.70**	**206.03**	**247.72**	**41.69**	**20.2%**
CAREER	*21.05*	*0.11*	*20.80*	*22.67*	*1.87*	*9.0%*
Centers Funding (total)	*26.77*	*-*	*26.85*	*25.55*	*-1.30*	*-4.8%*
Centers for Chemical Innovation	*24.00*	*-*	*24.00*	*24.00*	*-*	*-*
Nanoscale Science & Engr. Centers	*2.77*	*-*	*2.85*	*1.55*	*-1.30*	*-45.6%*
Education	**11.99**	**-**	**12.30**	**6.95**	**-5.35**	**-43.5%**
ACC Postdoctoral Fellowships	*2.00*		*2.00*	*-*	*-2.00*	*-100.0%*
Infrastructure	**15.41**	**15.00**	**15.40**	**3.40**	**-12.00**	**-77.9%**
Nat'l Nanotech. Infra. Network (NNIN)	*0.40*	*-*	*0.40*	*0.40*	*-*	*-*
Nat'l High Magnetic Field Lab (NHMFL)	*4.03*	*15.00*	*4.06*	*1.50*	*-2.56*	*-63.1%*
Research Resources	*10.58*	*-*	*10.94*	*1.10*	*-9.84*	*-89.9%*

CHE supports a large and vibrant research community engaged in fundamental research linked to key national priorities. The basic research supported by CHE will enable the discovery of new catalysts for solar energy generation and storage, increased appreciation of and insight into the chemistry of life processes, new nanostructured materials that will revolutionize electronics, and better awareness of how nanosized aerosols and particles impact our environment. CHE supports research seeking paths to sustainable molecules and materials that are essential to our economy and well-being. In addition, CHE supports curiosity-driven research that leads to increased understanding of molecules and materials.

In general, 47 percent of the CHE portfolio is available for new research grants. The remaining 53 percent funds continuing grants made in previous years.

FY 2012 Summary

All funding decreases/increases represent change over the FY 2010 Enacted level.

Research

- An increase (+$40.94 million to a total of $195.54 million) for core research programs will enable greater support of projects at the frontier of chemistry.
- CAREER investment increases (+$1.87 million to a total of $22.67 million). This program is particularly important to the development of strong academic departments and the training of the next generation of scientists and engineers.
- The Centers for Chemical Innovations program, which inspires research on strategic, transformative "Grand Challenges" in chemical research, remains at $24.0 million. CCI awards are strengthened by direct links to chemical industry and governmental laboratories, which encourage successful transitions from the lab to innovation to societal applications. CHE plans to initiate three new Phase I CCIs and fund two Phase II CCIs. The Phase II awards will be selected competitively from a pool of four Phase I awards and one Phase II CCI requesting renewal.

- New and continuing investments in the areas below will be committed as research grants, centers, and software institutes.
  - SEES funding increases (+$23.50 million for a total of $63.50 million). New understanding of the chemistry of nanosized aerosols and dusts will impact the research of climate scientists and climate modelers. Increased understanding of photovoltaic and photocatalytic materials will lead to new possibilities for chemical fuels from sunlight, fuel cells and batteries. Chemists will develop the fundamental understanding, reactions, and catalysts that will allow a new sustainable chemical industry using bio-based feedstocks and inexpensive and inexhaustible building blocks such as water, carbon dioxide, and dinitrogen. Through interdisciplinary programs such as Sustainable Research Networks and Sustainable Energy Pathways, chemists will work with others to effectively translate the fundamental chemical advances into new energy systems.
  - Investment ($4.30 million) in advanced manufacturing will include new modes of funding that support industry-university interactions.
  - A new investment of $3.50 million in CIF21 will include efforts in data-enabled science and chemometrics, Matter by Design and other aspects of computational chemistry, and a significant investment in new software development.
  - Research at the chemistry-biology interface is rapidly expanding. CHE funding in BioMaPS ($5.24 million) will strengthen research programs in advanced spectroscopic and imaging techniques for biomolecules and biosystems, metal speciation, coordination and function, chemical studies of enzyme and ribozyme catalysis, and other studies at the chemistry-biology frontier. This funding includes emphases on research at this interface aimed at clean energy ($800,000) and advanced manufacturing ($800,000).
  - SEBML investment will increase (+$7.60 million to a total of $13.68 million). Emerging areas include molecular electronics, spintronics, and molecule-based quantum computing. This includes a contribution to the new nanoelectronics area of $3.0 million.

Education

- Support will slightly increase for IGERT (+$40,000 to a total of $1.58 million) and slightly decreases for REU Sites (-$550,000 to a total of $4.50 million).
- Support is suspended for the American Competitiveness in Chemistry Fellowship Program for FY 2012 (-$2.0 million to zero). These funds will be reallocated to core research programs. Postdoctoral researchers will continue to be supported through research grants and centers, as well as the new SEES Postdoctoral Fellowship program.
- The Undergraduate Research Collaborative was terminated as planned in FY 2011 (-$1.0 million).
- GRF funding (-$1.59 million) within CHE is eliminated as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).

Infrastructure

- NNIN: Co-funding support continues at $400,000.
- NHMFL: Co-funding support continues at $1.50 million. The decrease of -$2.56 million is due to a one-time instrument development award funded in FY 2010.
- Research Resources: The Chemistry Research Instrumentation and Facilities: Departmental Multiuser Instrumentation (CRIF:MU) program will be suspended in FY 2012 (-$9.84 million to a total of $1.10 million). The funds will be reallocated to core research programs. The investigator community will be encouraged to use the Major Research Instrumentation (MRI) program for infrastructure needs in FY 2012. (See the Integrative Activities section for more information on MRI).

DIVISION OF MATERIALS RESEARCH (DMR)

$320,790,000
+$18,120,000 / 6.0%

DMR Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
DMR	**$302.57**	**$302.67**	**$320.79**	**$18.12**	**6.0%**
Research	**224.27**	**225.26**	**254.14**	**28.88**	**12.8%**
CAREER	*20.20*	*14.19*	*15.59*	*1.40*	*9.9%*
Centers Funding (total)	*67.97*	*72.33*	*65.88*	*-6.45*	*-8.9%*
Materials Research Centers	*52.49*	*56.70*	*57.00*	*0.30*	*0.5%*
Nanoscale Science & Engr. Centers	*8.16*	*8.31*	*4.88*	*-3.43*	*-41.3%*
STC 2002: Materials and Devices for Inform. Tech.	*3.32*	*3.32*	*-*	*-3.32*	*-100.0%*
STC 2006: Center for Layered Polymeric Systems	*4.00*	*4.00*	*4.00*	*-*	*-*
Education	**11.72**	**9.48**	**9.00**	**-0.48**	**-5.1%**
Infrastructure	**66.58**	**67.93**	**57.65**	-10.28	-15.1%
Nat'l Nanotech. Infra. Network (NNIN)	*2.99*	*2.65*	*2.28*	*-0.37*	*-14.0%*
Nat'l High Magn.Field Lab (NHMFL)	*36.50*	*31.50*	*31.80*	*0.30*	*1.0%*
Cornell High Energy Synchr. (CHESS)	*9.51*	*9.00*	*15.47*	*6.47*	*71.9%*
Research Resources	*6.35*	*13.06*	*-*	*-13.06*	*-100.0%*
Other MPS Facilities[1]	*6.93*	*7.02*	*3.90*	*-3.12*	*-44.4%*

[1] Other MPS Facilities: Synchrotron Radiation Center, Center for High Resolution Neutron Scattering, and CheMatCars.

Awards from DMR cover a wide spectrum of materials research and education ranging from condensed matter and materials physics, solid-state and materials chemistry, multifunctional, hybrid, electronic, photonic, metallic, superconducting, ceramic, polymeric, biomaterials, composites, and nanostructures. These awards enable the DMR community to advance our understanding of electronic, atomic, molecular mechanisms and processes that govern macroscale properties so that we can learn how to manipulate and control them, to discover new synthesis and processing strategies that lead to new materials with unique and novel properties, and to discover and to understand emerging phenomena. The discoveries and advancements transcend traditional scientific and engineering disciplines, and can result in elimination of roadblocks to enabling new technology. A key and critical enabler to these scientific advances is the investment in development and support of next generation instruments and facilities. Finally, conveying the excitement, significance and societal benefit enabled by materials research to students (K-12 and beyond), some of whom will become the next generation of materials researchers, and to the general public remain important aspects of the Division's mission.

In general, 24 percent of the DMR portfolio is available for new research grants and 76 percent funds continuing grants.

FY 2012 Summary

All funding decreases/increases represent change over the FY 2010 Enacted level.

Research

- Funding for SEES increases (+$21.0 million to a total of $61.0 million). DMR's fundamental research in energy focuses on new phenomena that may transform energy production, storage, delivery and use in a decade or more. DMR plans to continue its partnerships with the Divisions of Chemistry and Mathematical Sciences on the SOLAR project and with the Directorate for Engineering on Nanotechnology for Solar Energy Collection and Conversion Signature Initiative.
- Funding for SEBML (+$10.70 million will total $17.55 million) will support discovery of new materials, devices, and processes such as nanoelectronics, photonics, spintronics, atom condensates, entanglement and superposition, and molecular-based approaches, any of which might become the next physical basis of computing. This includes a contribution of $3.0 million to the nanoelectronics investment area, a Signature Initiative.
- DMR will foster the underlying fundamental materials science that will enable breakthroughs in advanced manufacturing technologies ($3.80 million).
- The Matter-by-Design effort (+$3.50 million) will increase understanding and development of new matter from sub-components, ranging from biological and polymeric assemblies to metallic and ceramic nanostructures and hybrids. The advantage of this approach comes from the combination of experts who know how to envision new structures, to synthesize them to a sufficient level of purity, to discover their properties and characterize them, to predict new matter based on them, and to use data to design new materials.
- Biological aspects of materials research are the most rapidly growing component of materials research and will be supported at a level of $5.24 million in FY 2012 through the BioMaPS effort. Biomaterials can have important applications in medical devices, biosensors and actuators, tissue engineering, drug and gene delivery, nanomedicine, and medical imaging, benefitting health and ecosystems. This funding includes emphases on research at this interface aimed at clean energy ($800,000) and advanced manufacturing ($800,000).
- In keeping with the administration's goal of maintaining strong support for CAREER, funding will increase by $1.40 million to a total of $15.59 million.

Centers

- DMR increases its commitment to the newly restructured Materials Research Centers and Teams program as an interdisciplinary vehicle for increasing materials research, reaching new institutions, and educating students. The restructuring created two tracks: Centers for Materials Research and Innovation (CEMRI) and new and distinct Materials Interdisciplinary Research Teams (MIRT). FY 2011 marks the competition year, which is held triennially. In FY 2012, DMR will invest $57.0 million in the CEMRI centers as well as $6.0 million in the MIRT teams, whose funding is captured in the core research program budget line. The sum of these two areas, $63.0 million, is an increase of $6.30 million in FY 2012.
- Funding for the Nanoscale Science and Engineering Centers will continue at a reduced level (-$3.43 million for a total of $4.88 million) due to the planned sunsetting of some centers.
- Funding for the STCs (-$3.32 million to a total $4.0 million) reflects the planned sunsetting of the Class of 2002 Center for Materials and Devices for Information Technology. The Center for Layered Polymeric Systems, initiated in FY 2006, will be maintained at $4.0 million.

Education

- The Education portfolio maintains a commitment to Research Experiences for Undergraduates (REU) and the Integrative Graduate Education and Research Traineeship (IGERT) programs.
- GRF funding (-$500,000) is eliminated as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).

Infrastructure

- NHFML: Funding (+$300,000 to a total of $31.80 million) will enable this world-leading laboratory to continue transformational research using high magnetic fields. This facility serves researchers in fields ranging from biology to materials and condensed matter physics.
- CHESS: Funding (+$6.47 million to a total of $15.47 million) for the synchrotron light source, CHESS/CESR, will allow continued operation as well as support X-ray technology research and development. The CHESS user program supports work in cancer research, new materials for electronics, aircraft, biotechnology, batteries, fuel cells, solar cells and other energy applications.
- Other MPS Facilities: The major change (-$2.87 million) in this category is for NSF stewardship of the Wisconsin Synchrotron Research Center, which is being ended as planned in March 2011.
- Research Resources: The Instrumentation for Materials Research-Major Instrumentation Program and the Instrumentation for Materials Research Program will not be run in FY 2012 (-$13.06 million).

DIVISION OF MATHEMATICAL SCIENCES (DMS) $260,430,000
+$19,050,000 / 7.9%

DMS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
DMS	**$244.92**	**$241.38**	**$260.43**	**$19.05**	**7.9%**
Research	**216.19**	**214.23**	**240.80**	**26.57**	**12.4%**
CAREER	*7.96*	*3.23*	*3.53*	*0.30*	*9.3%*
Centers for Analysis & Synthesis	*0.10*	*0.10*	*0.10*	-	-
Education	**28.73**	**27.15**	**19.63**	**-7.52**	**-27.7%**

NSF plays a critical role in the mathematical sciences, as it provides more than 60 percent of all federal support for basic research in the Nation's colleges and universities. In certain core areas of the mathematical sciences this percentage is much higher, since NSF supports a broader range of fundamental and multidisciplinary research topics than do other federal agencies.

DMS supports research at the frontiers of fundamental, applied, and computational mathematics and statistics and also enables discovery and innovation in other fields of science and engineering. In turn, advances in science and engineering, especially those generating massive and complex data sets or that are driven by powerful computing environments, require development of ever more sophisticated mathematical and statistical tools. DMS plays a key role in training future researchers in the mathematical and statistical sciences, and in training the Nation's scientific and engineering workforce.

DMS supports core research programs in algebra and number theory; analysis; applied mathematics; computational mathematics; geometry and topology; mathematical biology; probability, combinatorics and foundations; and various areas within statistics. In addition, DMS supports national mathematical sciences research institutes; training and mentoring of a diverse group of postdoctoral, graduate and undergraduate students; and infrastructure, such as workshops, conferences, and equipment.

In general, 59 percent of the DMS portfolio is available for new research grants. The remaining 41 percent is used primarily to fund continuing grants made in previous years. In FY 2010, DMS received 2,455 research proposals and made 715 awards.

FY 2012 Summary

All funding increases/decreases represent change over the FY 2010 Enacted level.

Research

- Support for CIF21 is initiated in FY 2012 at $6.60 million. DMS research will focus on mathematical, statistical, and computational sciences which will support theoretical and methodological developments in mathematics and statistics, the development of new models and algorithms, visualization methods and computational tools that help solve complex scientific problems involving massive and complex data, and that enable scientific discovery and innovation. This investment expands upon some existing programs supporting research in the analysis of large data sets, development of novel algorithms, and new computational methods in mathematics and

statistics. It will also support training and networking activities, and help develop new theoretical foundations in mathematics and statistics related to CIF21 goals.

- SEES increases by +$14.50 million to a total of $21.50 million. This activity will address challenges in climate, sustainability, and energy research, and education through data analysis, modeling, and simulation. Also, DMS will increase investment in the CHE-DMR-DMS Solar Energy project (SOLAR), a program supporting multi-disciplinary teams engaged in research on the efficient harvesting, conversion, and storage of solar energy. The investment in SEES will also support effective training and networking opportunities for collaborations among mathematical scientists and with domain scientists.
- Support for advanced manufacturing activity will be $2.0 million. DMS seeks to invest in innovative partnerships between university and industry scientists in mathematical and statistical sciences, and support research in Materials by Design as it relates to computational, mathematical, and statistical sciences in CIF21.
- BioMaPS support will be initiated at $5.24 million. DMS will invest in innovative research at the intersection of the mathematical and physical sciences and the biological sciences in a comprehensive new approach to acquire insight into and inspiration from the living world. This funding includes emphases on research at this interface aimed at clean energy ($800,000) and advanced manufacturing ($800,000).
- SEBML funding increases by +$1.20 million to a total of $3.95 million. In parallel with Moore's Law for hardware, SEBML continues the algorithmic "Moore's Law", i.e., the exponential increase in speed of basic computations due to innovative new algorithms, and develops new mathematical and statistical frameworks for computation.
- Support increases for mathematical sciences institutes (+$5.50 million to a total of $32.50 million). Institutes are typically funded on 10-year cycles and the current cycle for three of the Institutes ends in FY 2011. They are eligible to re-compete with other projects for funding in FY 2012. This budget growth will accommodate an increase in the number and/or size of Institute awards.
- Support will increase (+$4.0 million to a total of over $180.0 million) for individual investigator and small group awards in disciplinary research programs. This will be achieved by an effective consolidation of existing interdisciplinary partnerships.
- Consistent with the Administration's priority, funding for CAREER will increase (+$300,000 to a total of $3.53 million).
- Funding for Cyber-Enabled Discovery and Innovation (CDI) will decrease (-$10.40 million to zero). DMS will more effectively fund highly interdisciplinary research where the mathematical sciences play a fundamental role by focusing on other specific interdisciplinary programs and partnerships.

Education

- Funding for Enhancing the Mathematical Sciences Workforce for the 21st Century (EMSW21) will decrease (-$5.26 million to $11.77 million). Higher priority programs in the overall DMS workforce portfolio more closely support research and training in the disciplinary programs.
- Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM) will end (-$1.0 million) and be merged into BioMaPS.
- Funding for IGERT ends in FY 2012 in order to reinvest these funds in higher priority training programs within the division.
- GRF funding (-$500,000) is eliminated as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).

DIVISION OF PHYSICS (PHY)

$300,910,000
+$10,870,000 / 3.7%

PHY Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
PHY	**$301.66**	**$290.04**	**$300.91**	**$10.87**	**3.7%**
Research	**178.72**	**177.97**	**214.12**	**36.15**	**20.3%**
CAREER	*8.76*	*5.60*	*7.43*	*1.83*	*32.7%*
Centers Funding (total)	*5.68*	*5.68*	*1.14*	*-4.54*	*-79.9%*
STC 2002: Cntr. For Bio. Sci.&Tech.	*3.28*	*3.28*	*-*	*-3.28*	*-100.0%*
Nanoscale Sci. and Eng. Ctrs.	*2.40*	*2.40*	*1.14*	*-1.26*	*-52.5%*
Education	**8.14**	**9.42**	**8.44**	**-0.98**	**-10.4%**
Infrastructure	**114.80**	**102.65**	**78.35**	**-24.30**	**-23.7%**
Large Hadron Collider (LHC)	*18.00*	*18.00*	*18.00*	*-*	*-*
Laser Inteferomter Grav. Wave Obs. (LIGO)	*28.50*	*28.50*	*30.40*	*1.90*	*6.7%*
Nat'l Superconducting Cyclotron Lab (NSCL)	*21.00*	*21.00*	*21.50*	*0.50*	*2.4%*
IceCube	*2.15*	*2.15*	*3.45*	*1.30*	*60.5%*
Pre-Construction Planning (total)	*40.69*	*29.00*	*-*	*-29.00*	*-100.0%*
Deep Underground Sci. & Engr. Lab (DUSEL) [1]	*40.69*	*29.00*	*-*	*-29.00*	*-100.0%*
Research Resources	*4.47*	*5.00*	*5.00*	*-*	*-*

[1] DUSEL FY 2010 Actual includes $11.74 million in carryover funding from FY 2009.

The Division of Physics (PHY) supports fundamental research addressing frontier areas of physics that lead to the understanding of the make-up of the Universe, from the formation of stars and galaxies to the principles of life processes on earth. This research is spread across a range of subfields: atomic, molecular, optical and plasma physics; elementary particle physics; gravitational physics; nuclear physics; particle and nuclear astrophysics; physics of living systems; physics at the information frontier; and theoretical physics. PHY is the primary supporter of all U.S. research in gravitational physics and the leading supporter of fundamental research in atomic, molecular, and optical physics in the U.S. PHY is an important partner with the Department of Energy (DOE) in support of elementary particle physics, nuclear physics, and plasma physics. PHY also has the only U.S. program designed for the support of physics research in living systems. Development of advanced, cutting-edge computational resources, innovative technology, and new instrumentation is a key part of physics research, and tools developed by the physics community continuously have major impact in other scientific and engineering fields.

In general, 22 percent of the PHY portfolio is available for new research grants. The remaining 78 percent is used primarily to fund continuing grants made in previous years (53 percent) and to support operations and maintenance for four facilities that are a key part of the division portfolio (25 percent).

FY 2012 Summary

All funding decreases/increases represent change over the FY 2010 Enacted level.

Research

- An increase of $36.15 million to a total of $214.12 million for research grants will enable increased support of projects at the discovery frontiers of physics. Major changes include:
  - Increase programs that support Quantum Information Science as part of SEBML (+$4.0 million to a total of $7.0 million).
  - Eliminate funding for CDI (-$1.25 million).
  - Initiate funding for programs that support CIF21 ($3.0 million), in particular a focus on the development of new computational infrastructure that supports the research portfolio in PHY.
  - Initiate funding for programs that support the SEES portfolio ($6.50 million), in particular, activities that address fundamentals in the energy/climate research base portfolio ($1.0 million) and research in science, engineering, and education for sustainability ($5.50 million)
  - Fund advanced manufacturing ($2.25 million) with a major emphasis on nanomanufacturing in the quantum realm ($1.50 million) and for manufacturing related to plasma physics ($750,000).
  - Support research at the interface between the mathematical and physical sciences and the life sciences (BioMaPS) (+$5.25 million to a total of $5.25 million). This includes emphases on research at the interface aimed at clean energy ($800,000) and advanced manufacturing ($800,000).
- CAREER funding increases by $1.83 million to a total of $7.43 million in FY 2012, reflecting a continued emphasis on fostering career development of junior scientists.
- Centers:
  - As planned, support of the 2002 STC Center for Biophotonics Science and Tech ends in FY 2011.
  - As planned, support of the NSEC: Science of Nanoscale Systems and their Device Applications will end in FY 2012, reducing the total funding for nanoscale science and engineering centers by $1.26 million to $1.14 million.
- Funding (-$4.0 million) for DUSEL-related research is redirected to the above core program areas.

Education

- GRF funding (-$1.22 million) is eliminated as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).

Infrastructure

- LHC: FY 2012 support for operations of the ATLAS and CMS detectors during the first period of data-taking is estimated at the current level ($18.0 million) while review and negotiations for a new cooperative agreement to begin in FY 2012 are underway.
- LIGO: Support increases (+$1.90 million to $30.40 million total) in accord with the agreed-upon funding profile for operations during the Advanced LIGO construction project. (See the MREFC chapter for more details on Advanced LIGO)
- NSCL: Support increases (+$500,000 to $21.50 million total) during negotiations for a new cooperative agreement that will sustain NSCL while design and construction for a new DOE-funded Facility for Rare Isotope Ion Beams (FRIB) facility to be built on the NSCL platform are initiated.
- IceCube: Funding increases (+$1.30 million to $3.45 million total) as part of the NSB-approved post-construction ramp-up in operations. IceCube construction is now complete, on-time and on-budget. The main IceCube detector, a massive ice-bound telescope that fills a cubic kilometer of deep Antarctic ice, contains 5,160 optical sensors on 86 strings embedded two kilometers below the Amundsen-Scott South Pole Station.
- DUSEL: NSF support for this proposed project is eliminated in FY 2012 (-$29.0 million in PHY), following the determination by the National Science Board that the scope and likely cost of the project were outside of NSF's core mission responsibilities. The $29.0 million is reallocated to frontier research grants within PHY, including core research activities in underground physics.

OFFICE OF MULTI-DISCIPLINARY ACTIVITIES (OMA) $43,410,000
+$5,080,000 / 13.3%

OMA Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
OMA	**$38.58**	**$38.33**	**$43.41**	**$5.08**	**13.3%**
Research	**33.52**	**34.90**	**40.21**	**5.31**	**15.2%**
Centers for Analysis and Synthesis	*0.10*	*0.10*	*0.10*	-	-
Education	**1.01**	**0.10**	**0.20**	**0.10**	**100.0%**
Pan-American Advanced Studies Institute	*0.15*	*0.10*	*0.20*	*0.10*	*100.0%*
Infrastructure	**4.05**	**3.33**	**3.00**	**-0.33**	**-9.9%**
Nat'l Nantech. Infra. Network (NNIN)	*0.33*	*0.33*	-	*-0.33*	*-100.0%*
Pre-construction planning (total)	*3.72*	*3.00*	-	*-3.00*	*-100.0%*
Deep Underground Science & Engr. Lab (DUSEL)	*3.72*	*3.00*	-	*-3.00*	*-100.0%*

The Office of Multidisciplinary Activities (OMA) enables and facilitates MPS support of novel, challenging, or complex projects of varying scale, in both research and education, which are not readily accommodated by traditional organizational structures and procedures. This is done primarily in partnership with MPS disciplinary divisions and is especially directed at activities by multi-investigator, multidisciplinary teams, as well as cross-NSF and interagency activities.

FY 2012 Summary

All funding decreases/increases represent change over the FY 2010 Enacted level.

Research

- In FY 2012, OMA will focus on multidisciplinary research addressing the key NSF-wide priority areas of SEES, CIF21, SEBML, BioMaPS, clean energy, and advanced manufacturing.
- In the area of clean energy where MPS is partnering with BIO and ENG, OMA will coordinate across the MPS divisions and ensure full participation in Research Networks (+$2.0 million), Sustainable Energy Pathways including Matter by Design (+$3.50 million), and BioMaPS (+$2.3 million).
- In the area of advanced manufacturing, OMA will coordinate MPS' participation with BIO, CISE, and ENG in BioMaPS (+$2.30 million), industry/university partnerships (+$1.0 million), Nanomanufacturing (+$2.0 million), and Matter by Design (+$750,000).
- OMA will continue to support the National Institute for Mathematical and Biological Synthesis, a Center for Analysis and Synthesis primarily managed by BIO, at the level of $100,000 in FY 2012.

Education

- Funding will double for the Pan-American Advanced Studies Institutes (+$100,000 to $200,000) to increase the base award size for this program.

Facilities

- NNIN: Support is reduced by $330,000 to zero. The National Nanotechnology Infrastructure Network continues to be an important asset to its user community. The reduction of OMA support reflects the maturing status of this investment.

- DUSEL: NSF support for this proposed project is eliminated in FY 2012 (-$3.0 million in OMA), following the determination by the National Science Board that the scope and likely cost of the project were outside of NSF's core mission responsibilities.

SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES (SBE) $301,130,000
+$45,880,000 / 18.0%

SBE Funding

(Dollars in Millions)

	FY 2010 Omnibus Actuals	FY 2010 ARRA Actuals	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Behavioral and Cognitive Sciences (BCS)	$94.56	$0.21	$94.58	$105.90	$11.32	12.0%
Social and Economic Sciences (SES)	99.05	0.03	99.05	113.81	14.76	14.9%
National Center for Science and Engineering Statistics (NCSES)[1]	34.76	-	34.62	38.01	3.39	9.8%
SBE Office of Multidisciplinary Activities (SMA)	26.94	-	27.00	43.41	16.41	60.8%
Total, SBE	**$255.31**	**$0.24**	**$255.25**	**$301.13**	**$45.88**	**18.0%**

Totals may not add due to rounding.

[1] In FY 2012, the Division of Science Resources Statistics (SRS) is renamed the National Center for Science and Engineering Statistics (NCSES).

About SBE

SBE's mission is to promote the understanding of people and their lives by supporting research that reveals basic facets of human behavior; to encourage research that helps provide answers to important societal questions and problems; to work with other scientific disciplines to ensure that basic research and the solutions to problems build upon the best multidisciplinary science; and to provide mission-critical statistical information about science and engineering (S&E) in the U.S. and the world through the National Center for Science and Engineering Statistics.

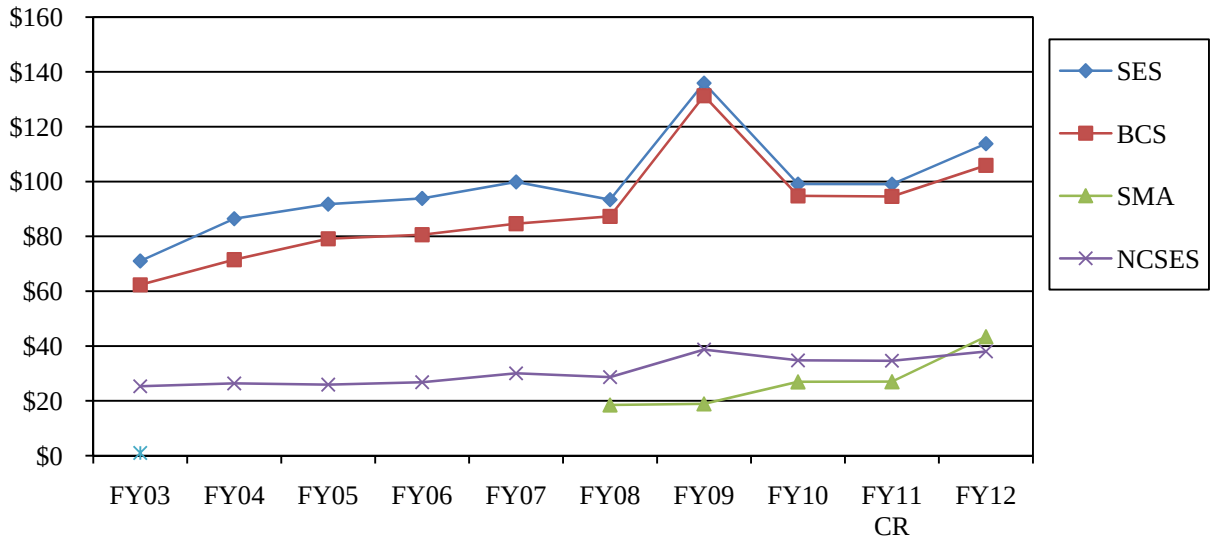
SBE supports long-term research across a diverse range of sciences that include economics, psychology, sociology, geography, neuroscience, anthropology, archaeology, statistics, linguistics, and political science. SBE combines these sciences in a dynamic and constantly-evolving suite of interdisciplinary activities that link these fields to each other and to other science and engineering fields. Thus, SBE is a significant partner in cross-directorate programs that connect the social and behavioral sciences to priority investments across NSF, such as clean energy and sustainability (via the Science, Engineering, and Education for Sustainability (SEES) portfolio), cyberinfrastructure and computer science (via Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)), and national security (via the Comprehensive National Cybersecurity Initiative (CNCI)). The SBE FY 2012 Request directly reflects this commitment to advancing interdisciplinary work in areas of national priority.

In recent decades, SBE research has resulted in new understandings of human development and social dynamics; of perception, memory, linguistic, learning, and reasoning processes; of how people behave both as individuals and as members of groups and organizations; and of key social institutions and indicators of these institutions' health. SBE contributions to knowledge of economic processes, for example through improved auctions and markets for the wireless spectrum, have produced large contributions of revenue for the U.S. government. SBE participates in inter-directorate, interagency, and international research and education activities, and supports many forms of transformative research. SBE supported research is beginning to provide a better understanding of the innovation process.

The SBE portfolio also includes major surveys that provide broad-based infrastructure for the research community, while providing policy makers with needed information. The National Center for Science and Engineering Statistics (NCSES) is the designated federal statistical entity with responsibility for statistics about the S&E enterprise, and its data collections and analyses are important for evaluating overall U.S. competitiveness in science and engineering.

SBE provides about 58 percent of the federal funding for basic research at academic institutions in the SBE sciences.

SBE Subactivity Funding
(Dollars in Millions)



FY 2012 Summary by Division

In FY 2012 BCS will be a major partner in NSF-wide interdisciplinary activities such as SEES, CIF21, and CNCI. As part of these initiatives, BCS will expand support for behavioral and cognitive research that informs our understanding of critical issues facing the nation such as terrorism, pandemics, climate change, and sustainability. Increased SEES funding in the Request will support research with SBE-specific emphases, such as investments in understanding human behavior and decision making about energy use, interactions among natural and human systems, vulnerability and resilience, and participation in Sustainable Energy Pathways and Sustainability Research Networks. In its ongoing programs, BCS will operate in an interdisciplinary context; providing additional support for research on the complex ways people interact with climate and other natural systems; and research and methodological development on learning and adaptive systems. BCS support for CNCI will enable research on cognitive and behavioral aspects of threats to cybersecurity. BCS will continue to support the Science of Learning Centers (SLC) program, and the science of broadening participation. It will also continue investments in support of integrative interdisciplinary approaches to the understanding of human cultural and biological evolution over long time scales.

SES' FY 2012 request reflects its strong contribution to the unifying themes in the FY 2012 NSF Budget Request. This includes support for SEES, through investments in understanding energy use and decision making and the Sustainably Energy Pathways and Sustainability Research Networks activities; support for CNCI through the Cyber Economic Incentives theme; and support for CIF21 through community re-

search networks and research on virtual organizations. SES will also maintain its commitment to major existing programs and continue its support for surveys that provide unique insights into U.S. social, economic, and political life, while providing support for new research that has the potential to transform the social and economic sciences and contribute to effective policy development. SES will also enhance the CAREER program, an Administration priority. SES will partner with the Directorate for Computer and Information Science and Engineering (CISE) in exploring the emerging interface between computer science and economics. As part of a broadly interdisciplinary activity that spans SBE, SES will contribute to a new activity designed to understand the implications of a changing population shaped by aging and migration, and to develop new approaches to ensuring social well-being in this emerging population.
The Division of Science Resources Statistics (SRS) was renamed the National Center for Science and Engineering Statistics (NCSES) in the America COMPETES Reauthorization Act of 2010 (P.L. 111-358). NCSES' FY 2012 request is focused on expanding activities to develop improved data on innovation activities in the U.S. NCSES requests support for development of a new Microbusiness R&D and Innovation Survey for firms with less than five employees and for an innovation module for the Business R&D and Innovation Survey (BRDIS) 2012. NCSES will pilot a project that will establish a collaboration between several federal agencies and NCSES to test the feasibility of tagging and extracting data from agencies' administrative records related to measures of research and development (R&D) activity; and partner with SMA on cyberinfrastructure for innovation as part of CIF21. Support is requested for the start of full scale implementation of a data collection system on those in postdoctorate appointments in the academic sector. NCSES will initiate a transition from its current online data systems to an alternative with improved and more flexible interfaces and will explore new methods to enhance data collection, analysis, and sharing capabilities.

SMA provides a focal point for programmatic activities that cut across NSF and SBE boundaries, and is SBE's broadest mechanism for contributing to Administration and NSF priorities. In addition, SMA assists with seeding multidisciplinary activities for the future. In FY 2012 SMA will play a critical role in the development of infrastructure to support interdisciplinary activities, most notably cyberinfrastructure for innovation, associated with CIF21; the Science of Science and Innovation Policy activity (SciSIP); the interagency STAR METRICS project; and SEES, including Sustainable Energy Pathways and Sustainability Research Networks. SMA will participate in the Enhancing Access to the Radio Spectrum (EARS) activity and CNCI, a multi-agency priority. SMA will partner with the BCS and SES divisions in supporting research on understanding population change in the 21st century, a new SBE investment with emphasis on migration and aging and their impact on job creation and human development. SMA also will continue to manage and support the agency-wide Science of Learning Centers (SLCs).

Major Investments

SBE Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
SEES Portfolio	$22.67	$20.78	$56.98	$36.20	174.2%
Science of Learning Centers (SLC)	19.85	19.10	13.67	-5.43	-28.4%
SciSIP	14.30	13.75	14.75	1.00	7.3%
CIF21	-	-	12.00	12.00	N/A
CNCI	-	-	12.00	12.00	N/A
CAREER	6.68	5.16	5.87	0.71	13.8%
CTE	-	-	1.20	1.20	N/A
EARS	-	-	1.00	1.00	N/A

Major investments may have funding overlap, and thus should not be summed.

- SBE will make a significant investment in clean energy research through the SEES portfolio (+$36.20 million, to a total of $56.98 million) by funding existing and new research across the whole range of SBE sciences, as well as cross-directorate activities. Additional funding supports the SEES Sustainability Research Networks, Sustainability Energy Pathways, and Postdoctoral Fellowships. Funding also strengthens existing climate research and energy investments, and supports both existing and new investments in understanding energy use and in decision making, coastal communities, and vulnerability and resilience. The SMA, BCS, and SES divisions support new and existing SEES activities.

- In FY 2012, the Science of Learning Centers (SLC) program will begin a gradual phasing down of the program as the centers reach their endpoints, reflecting long-term planning for the Centers and advice from site visits, the SBE Advisory Committee, and the National Science Board. In FY 2012, SBE's investment will decrease by $5.43 million to a total of $13.67 million.

- SBE support for the Science of Science and Innovation Policy (SciSIP) increases in FY 2012 (+$1.0 million, to a total of $14.75 million), to support research and data collections related to innovation and R&D spending.

- Support for the new NSF-wide CIF21 investment (+$12.0 million) will focus on three major components: Data-enabled Science, Community Research Networks, and Access and Connections to Cyberinfrastructure Facilities. SBE will simultaneously contribute to the development of new types of cyberinfrastructure and create new opportunities for SBE researchers in four important activities: Observation Data Network Pilots, Research Data on Innovation, Research on understanding and designing the 21st century networked society, and improved access to the large surveys supported by SBE. CIF21 is supported by four SBE divisions.

- SBE's support for CNCI (+$12.0 million) is initiated in FY 2012 for research on cybersecurity, economics, and society as part of NSF's commitment to research in the area of cybersecurity. Part of this effort will be in partnership with CISE. SBE's major role will be to support the Cyber Economic Incentives theme within CNCI, but SBE's broad scientific base in the behavioral, social, and decision sciences opens up a wealth of opportunities to contribute to this important national priority.

SBE supports the CAREER program, an Administration priority ($5.87 million). SBE's CAREER awards support young investigators in social and behavioral sciences who exemplify the role of teacher-scholar through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

- SBE's participation in Cyberlearning Transforming Education (CTE) is funded at $1.20 million in FY 2012 for research on the development of technologies for cyberlearning, and for studying the impact of those technologies on learning.

- EARS support is initiated in FY 2012 (+1.0 million). The recent NSF workshop report, *Enhancing Access to the Radio Spectrum*, outlines the need for research on new and innovative ways to use the spectrum more efficiently. SBE will work in partnership with the Directorates for Engineering (ENG), Mathematical and Physical Sciences (MPS), and Computer and Information Science and Engineering (CISE).

Summary and Funding Profile

SBE supports investment in core research and education as well as research infrastructure such as centers and facilities.

In FY 2012, the number of research grant proposals is expected to increase by approximately 797 compared to the FY 2010 Enacted level. SBE expects to award approximately 819 research grants in FY 2012. Average annualized award size will increase by $12,702 and duration will be held constant at the FY 2010 Enacted level.

In FY 2012, funding for Centers accounts for 4.7 percent of SBE's request. Centers funding is decreasing as funding for SLC centers is phased down as planned. The SLC program will support six centers in FY 2012. Funding for facilities will continue at the FY 2010 Enacted level.

SBE Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	5,621	5,000	6,242
Number of New Awards	1,259	1,187	1,397
Regular Appropriation	1,251	1,187	1,397
ARRA	8	-	-
Funding Rate	22%	24%	22%
Statistics for Research Grants:			
Number of Research Grant Proposals	3,961	3,600	4,397
Number of Research Grants	739	720	819
Regular Appropriation	738	720	819
ARRA	1	-	-
Funding Rate	19%	20%	19%
Median Annualized Award Size	$99,921	$104,086	$116,575
Average Annualized Award Size	$115,447	$121,873	$134,575
Average Award Duration, in years	2.4	3.0	3.0

SBE Funding for Centers Programs and Facilities

SBE Funding for Centers Programs
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Centers Programs	**$21.03**	**$19.70**	**$14.27**	**-$5.43**	**-27.6%**
Science of Learning Centers (SMA)	*13.63*	*12.90*	*8.07*	*-4.83*	*-37.4%*
Science of Learning Centers (BCS)	*6.23*	*6.20*	*5.60*	*-0.60*	*-9.7%*
Nano Centers (BCS)	*0.18*	*0.18*	*0.18*	-	-
Nano Centers (SES)	*1.00*	*0.42*	*0.42*	-	-

No FY 2010 obligations for centers were made with funds provided by the ARRA.

Centers Programs

- The Science of Learning Centers (SLC) program funding decreases by $5.43 million to a total of $13.67 million as funding for centers is phased down as planned. The program will support six centers in FY 2012.
- Funding for the Centers for Nanotechnology in Society (NSEC, CNS, CEIN) will continue at $600,000.

SBE Funding for Facilities
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Facilities	**$0.40**	**$0.40**	**$0.40**	-	-
National Nanotechnology Infrastructure Network (SES)	*0.40*	*0.40*	*0.40*	-	-

No FY 2010 obligations for facilities were made with funds provided by the ARRA.

For detailed information on individual facilities, please see the Facilities chapter.

Facilities

- Funding for the National Nanotechnology Infrastructure Network (NNIN) will continue at $400,000.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

In FY 2010, SBE held one COV in September for the Division of Social and Economic Sciences (SES). The SBE Advisory Committee (SBE AC) met three times in FY 2010: November 2009 and May and September 2010.

In FY 2011, no SBE COVs will convene. SBE is scheduled to hold two Advisory Committee (AC) meetings.

In FY 2012, COVs will be held for the BCS, SMA and NCSES divisions. All SBE divisions are responding to and implementing recommendations from recent COVs.

Number of People Involved in SBE Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	3,992	117	3,478	4,391
Other Professionals	527	9	441	580
Postdoctorates	341	9	259	375
Graduate Students	2,403	1	2,462	2,643
Undergraduate Students	936	7	1,330	1,030
Total Number of People	**8,199**	**143**	**7,970**	**9,019**

DIVISION OF BEHAVIORAL AND COGNITIVE SCIENCES (BCS) $105,900,000
+$11,320,000 / 12.0%

BCS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
BCS Funding	**$94.56**	**$0.21**	**$94.58**	**$105.90**	**$11.32**	**12.0%**
Research	**90.88**	**0.21**	**90.67**	**100.42**	**9.75**	**10.8%**
CAREER	*4.10*	-	*2.57*	*2.92*	*0.35*	*13.6%*
Centers Funding (total)	*6.91*	-	*6.58*	*5.98*	*-0.60*	*-9.1%*
Science of Learning Centers	*6.23*	-	*6.20*	*5.60*	*-0.60*	*-9.7%*
Nano Centers	*0.18*	-	*0.18*	*0.18*	-	-
LTER	*0.50*	-	*0.20*	*0.20*	-	-
Education	**3.68**	**-**	**3.91**	**3.48**	**-0.43**	**-11.0%**
Infrastructure	**-**	**-**	**-**	**2.00**	**2.00**	**N/A**
Research Resources	-	-	-	*2.00*	*2.00*	*N/A*

BCS supports research and related activities that advance fundamental understanding in the behavioral, cognitive, anthropological, and geographic sciences. Strong core programs are complemented by active involvement in competitions that support collaborative and cross-disciplinary projects. The division seeks to advance scientific knowledge and methods focusing on human cognition and behavior, including perception, thought processes, language, learning, and social behavior across neural, individual, family, and group levels. BCS also supports activities focusing on human variation at the scales of society, culture, and biology, and how these variations and related patterns develop and change across time and space. The division aims to increase basic understanding of geographic distributions and relationships as well as the capabilities to explore them, with an emphasis on interactions among human and natural systems on the Earth's surface. BCS research is helping us prepare for and mitigate the effects of natural and human-initiated disasters, predict and address how people respond to stressors, improve methods for effective learning, enhance the quality of social interaction, and respond to issues such as globalization, terrorism, and climate change. BCS investments in SEES advance our understanding of sustainability, and contribute to clean energy research.

In general, 54 percent of the BCS portfolio is available for new research grants. The remaining 46 percent of funds continuing grants made in previous years.

FY 2012 Summary

Research

- Overall, support for BCS basic research increases (+$9.75 million to a total of $100.42 million).
- CAREER funding will increase by $350,000, to a total of $2.92 million. This investment is consistent with BCS' emphasis on supporting early-career researchers and with the Administration's priority of support for CAREER awards.
- Increased funding (+$11.80 million) for SEES to support research with SBE-specific emphases, such as investments in understanding human behavior and decision making about energy use, interactions among natural and human systems, vulnerability and resilience, and to participate in Sustainable Energy Pathways and Sustainability Research Networks.

- Increased support (+$600,000) for interdisciplinary activities in learning and brain sciences.
- As planned, support for the SLC program decreases by $600,000 to a total of $5.60 million, with resources redirected to research on learning and understanding the brain. The reduction in FY 2012 will initiate a gradual phasing down of the SLC program as the centers reach their endpoints.
- Support of $1.0 million for CIF21 will create new opportunities for BCS researchers to understand human behavior and cognition in the context of the 21st century networked society.
- $1.50 million is aimed at understanding population change in the 21st century, a new SBE interdisciplinary investment, with emphasis on migration and human development as they pertain to learning, cognition, language, group dynamics, culture change, and the use of natural resources.
- Continued investment in the science of broadening participation in order to better understand the mechanisms and processes that result in the underrepresentation of women and minorities in STEM.
- Continued investment in support of integrative and interdisciplinary approaches to the understanding of human cultural and biological evolution over long time scales.
- Support of $2.0 million for CNCI in FY 2012 for research in cybersecurity and behavior as part of NSF's commitment to research in this area.

Education

- FY 2012 support for REU supplements ($1.0 million) and IGERT ($1.80 million) will remain at the FY 2010 Enacted level.
- Funding for ADVANCE increases by $20,000, to a total of $680,000.
- Funding for the Next Generation Workforce (NGW) is eliminated (-$450,000) in FY 2012 due to realignment of BCS' award portfolio. SBE and the Directorate for Education and Human Resources (EHR) are considering options for the future.

Infrastructure

- The BCS Request includes a new $2.0 million investment in SEES and CIF21:
  - $1.0 million for SEES will support Integrated Science and Engineering Research on Environmental, Economic and Energy Systems, designed to integrate SBE data and computational capabilities with those of other relevant fields.
  - Support of $1.0 million for CIF21's Access and Connections to Cyberinfrastructure Facilities through SBE's new pilot program, Observation Network Data Pilots.
- Continued investments in needed research resources, particularly shared cyberinfrastructure.

DIVISION OF SOCIAL AND ECONOMIC SCIENCES (SES) **$113,810,000**
+$14,760,000 / 14.9%

SES Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
SES Funding	**$99.05**	**$0.03**	**$99.05**	**$113.81**	**$14.76**	**14.9%**
Research	**85.79**	**0.03**	**84.99**	**97.18**	**12.19**	**14.3%**
CAREER	*2.38*	-	*2.59*	*2.95*	*0.36*	*13.9%*
Online Ethics Center for Engineering & Science	*0.40*		*0.40*	*0.40*	-	-
Centers Funding (total)	*1.00*	-	*0.42*	*0.42*	-	-
Nano Centers(NSEC,CNS,CEIN)	*1.00*	-	*0.42*	*0.42*	-	-
Education	**4.77**	**-**	**4.72**	**4.29**	**-0.43**	**-9.1%**
Infrastructure	**8.49**	**-**	**9.34**	**12.34**	**3.00**	**32.1%**
Facilities-NNIN	*0.40*	-	*0.40*	*0.40*	-	-
Research Resources	*8.10*	-	*8.94*	*11.94*	*3.00*	*33.6%*

SES supports research and related activities, conducted within the U.S. and globally, that improve our understanding of economic, political, and social institutions and how individuals and organizations behave within them. SES also supports activities investigating risk assessment and decision-making by individuals and groups; the nature and development of science and technology and their impact on society; methods and statistics applicable across the social, economic, and behavioral sciences; scholarly career development; and broadening participation in the social, behavioral, and economic sciences. Its discipline-based programs include sociology, economics, and political science, while interdisciplinary programs support fields such as decision-making and risk; methods, measurement and statistics; innovation and organizational change; law and social science; and science and technology studies. In many of its programs, SES is the major, if not only, source of federal funding for fundamental research, making important investments in the data resources and methodological advances that produce transformative research.

SES supports research and education through grants that range in size from small supplements for undergraduate collaboration with faculty to doctoral student support of dissertation research expenses to multi-million dollar survey awards such as the American National Elections Studies (ANES), the Panel Study of Income Dynamics (PSID), and the General Social Survey (GSS). These surveys, and others supported in SES, are national resources for research, teaching, and decision-making and have become models for similar undertakings in other fields.

SES also coordinates the Ethics Education in Science and Engineering Program, supporting (with other NSF directorates) the Online Ethics Center for Engineering and Science, and manages the Centers for Nanotechnology in Society. SES is also a participant in a number of Nanoscale Science and Engineering Centers and the National Nanoscale Infrastructure Networks (NNIN). In addition, SES plays a major role in managing the Decision Making Under Uncertainty collaborative projects.

In general, 63 percent of the total SES portfolio is available for new research grants. The remaining 37 percent funds continuing grants made in previous years.

FY 2012 Summary

Research

- Overall, support for basic SES research increases (+$12.19 million to a total of $97.18 million).
- CAREER funding in FY 2012 increases by $360,000, to a total of $2.95 million. This investment is consistent with SES's emphasis on supporting early career researchers and contributes to the Administration priority of increasing support for CAREER.
- SES will continue its centers investments ($820,000), with support for the Online Ethics Center for Engineering and Science, and management of the Centers for Nanotechnology in Society.
- Support for CIF21 is initiated in FY 2012. SES will contribute by supporting research on community-based networks. Of particular interest to SES is how researchers can enhance the effectiveness of virtual organizations. Support of $1.0 million will create new opportunities for SES researchers to understand the 21st century networked society.
- Increased funding ($13.50 million) for SEES will support research in expanded SEES activities through SBE-specific emphases, such as investments in understanding energy use and in decision making, coastal communities, and vulnerability and resilience, through the enhancement of existing programs and new solicitations; funding will also support Sustainable Energy Pathways and Sustainability Research Networks.
- $1.50 million supports research on understanding population change in the 21st century, a new SBE interdisciplinary investment with emphasis on migration and aging and their impact on job creation.
- SES support of $6.0 million for CNCI is initiated in FY 2012 for research on cybersecurity, economics and society, as part of NSF's commitment to research in the area of cybersecurity.

Education

- FY 2012 support for REU supplements ($1.0 million) and IGERT ($2.5 million) will remain at the FY 2010 Enacted level.
- Funding for the ADVANCE program increases by $20,000 to a total of $790,000.
- Funding for the Next Generation Workforce (NGW) is eliminated (-$450,000) in FY 2012 due to realignment of SES' award portfolio. SBE and the Directorate for Education and Human Resources (EHR) are considering options for the future.

Infrastructure

- FY 2012 support for NNIN ($400,000) will remain at the FY 2010 Enacted level.
- Increased funding (+$2.0 million) in CIF21, Access and Connections to Cyberinfrastructure Facilities:
  - $1.0 million will support SBE's new pilot program, Observation Network Data Pilots.
  - $1.0 million will improve mechanisms to provide access to data generated from SBE's large social and economic surveys.
- Increased funding of $1.0 million for SEES will support Integrated Science and Engineering Research on Environmental, Economic and Energy Systems, designed to integrate SBE data and computational capabilities with those of other relevant fields.

NATIONAL CENTER FOR SCIENCE AND ENGINEERING STATISTICS (NCSES) — $38,010,000 / +3,390,000 / 9.8%

NCSES Funding
(Dollars in Millions)

	FY 2010 Omnibus Actuals	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
NCSES Funding[1]	**$34.76**	**-**	**$34.62**	**$38.01**	**$3.39**	**9.8%**
Research	**$0.68**		**$0.30**	**$0.31**		
Education	**0.10**	**-**	**0.10**	**-**	**-0.10**	**-100.0%**
Infrastructure	**33.98**	**-**	**34.22**	**37.70**	**3.48**	**10.2%**

[1] In FY 2012, the Division of Science Resources Statistics (SRS) is renamed the National Center for Science and Engineering Statistics (NCSES).

In the America COMPETES Reauthorization Act of 2010 (P.L. 111-358), the Division of Science Resources Statistics (SRS) was designated the National Center for Science and Engineering Statistics (NCSES) with the legislative mission to "…serve as a central Federal clearinghouse for the collection, interpretation, analysis, and dissemination of objective data on science, engineering, technology, and research and development." The legislative mandate for NCSES, as stated in the National Science Foundation Act of 1950, includes "to provide a source of information for policy formulation by other agencies of the Federal Government…."

To meet this mandate, NCSES, in its role as the federal statistical agency with responsibility for statistics about the S&E enterprise, provides policymakers, researchers, and other decision makers with high quality data and analysis on R&D, innovation, the education of scientists and engineers, and the S&E workforce. The work of NCSES involves survey development, methodological and quality improvement efforts, data collection, analysis, information compilation, dissemination, web access, and customer service to meet the statistical and analytical needs of a diverse user community. It also prepares two congressionally mandated biennial reports — *Science and Engineering Indicators (SEI)* and *Women, Minorities, and Persons with Disabilities in Science and Engineering*. The data collected by NCSES also serve as important tools for researchers in SBE's Science of Science and Innovation Policy (SciSIP) program and as the major component of the content of *SEI.*

The funding portfolio for NCSES includes ongoing, cyclical surveys; reports and other products; and projects accomplished primarily through contracts and also a few standard grants.

FY 2012 Summary

Education

- Funding for the Next Generation Workforce (NGW) is eliminated (-$100,000) in FY 2012 due to realignment of NCSES' award portfolio. SBE and the Directorate for Education and Human Resources (EHR) are considering options for the future.

Infrastructure

- NCSES will increase support for the National Survey of College Graduates (NSCG) by $1.19 million to implement the final stage of a new sample design based upon the Field of Degree question on the American Community Survey. The new sample design will enable the NSCG to provide more accurate

estimates of the size and characteristics of the total science and engineering (S&E) workforce, including immigrant scientists and engineers.

- Increased support in the amount of $400,000 will be devoted to exploring new methods to enhance data collection, analysis, and sharing capabilities so that NCSES can better serve its role of providing information on the science and engineering enterprise.
- NCSES will provide $300,000 for a pilot project establishing a collaboration between several federal agencies and NCSES to test the feasibility of tagging and extracting agencies' administrative records to measure R&D activity and improve the quality and timeliness of data collected and disseminated by NCSES in its federal R&D surveys.
- NCSES will invest in cyberinfrastructure for innovation as part of CIF21 (+$1.50 million); NCSES will begin development of new transformational data sets that link R&D data traditionally collected by NCSES with outcomes data in order to better measure innovation.

SBE OFFICE OF MULTIDISCIPLINARY ACTIVITIES (SMA) $43,410,000
+$16,410,000 / 60.8%

SMA Funding
(Dollars in Millions)

	FY 2010 Omnibus Actuals	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
SMA Funding	**$26.94**	**-**	**$27.00**	**$43.41**	**$16.41**	**60.8%**
Research	**23.16**	**-**	**23.53**	**34.04**	**10.51**	**44.7%**
CAREER	*0.20*	-	-	-	-	*N/A*
Centers Funding (total)	*13.63*	-	*12.90*	*8.07*	*-4.83*	*-37.4%*
Science of Learning Centers	*13.63*	-	*12.90*	*8.07*	*-4.83*	*-37.4%*
Education	**3.78**	**-**	**3.47**	**3.37**	***-0.10***	***-2.9%***
Infrastructure	**-**	**-**	**-**	**6.00**	**6.00**	**N/A**
Research Resources	-	-	-	*6.00*	*6.00*	*N/A*

SMA provides a focal point for programmatic activities that cut across SBE disciplinary boundaries, including the agency-wide Science of Learning Centers (SLCs). SMA also funds Science of Science and Innovation Policy (SciSIP), Research Experiences for Undergraduates (REU) Sites programs, and Minority Postdoctoral Research Fellowships (MPRF). In FY 2012, 36 percent of the SBE increase will be assigned to SMA, giving the directorate enhanced flexibility with which to support interdisciplinary science aimed at Administration and NSF strategic priorities. SMA will play a critical role in the development of infrastructure to support interdisciplinary activities, most notably cyberinfrastructure for innovation, associated with CIF21; SciSIP; the interagency STAR METRICS project; and SEES. In addition, SMA will fund Enhancing Access to the Radio Spectrum (EARS) and the Comprehensive National Cybersecurity Initiative (CNCI), a multi-agency initiative. Co-funding with other divisions in SBE and with other directorates is typical for SMA, as is participation in interagency activities. While all SBE divisions pursue interdisciplinary work, SMA assists with seeding multidisciplinary activities for the future. All areas of SBE sciences are represented in the SMA portfolio.

In general, 70 percent of the SMA portfolio is available for new research grants. The remaining 30 percent funds continuing awards made in previous years, including all funding for the SLCs.

FY 2012 Summary

Research

- Overall, support increases for basic research activities (+$10.51 million above the FY 2010 Enacted level to a total of $34.04 million).
- Funding for the SLC program (six active centers) in SMA decreases by $4.83 million, to a total of $8.07 million. The overall SLC program decreases by $5.43 million in SBE (to a total of $13.67 million) to initiate a gradual phasing down of the program as the centers reach their endpoints.
- $1.0 million supports research on understanding population change in the 21st century, a new interdisciplinary SBE investment with emphasis on migration and aging and their impact on job creation and human development as they pertain to learning, cognition, language, group dynamics, culture change, and the use of natural resources.

- SEES increases (+$7.40 million above the FY 2010 Enacted level) for Sustainability Research Networks, Sustainable Energy Pathways, and support for cross-directorate and cross-divisional research.
- Support of $1.0 million for Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) is initiated in FY 2012. SMA will contribute by supporting research on Community Research Networks. Of particular interest to SMA are new opportunities for SBE researchers to understand the 21st century networked society.
- Support of $1.0 million is initiated in FY 2012 for the EARS program.
- Support of $4.0 million for CNCI in FY 2012, will enable a partnership with CISE's Cyber Economic Incentives theme to support research at the interstices of the economic and computer sciences to achieve secure practices through the development of market forces that incentivize good behavior.

Education

- FY 2012 support for REU Sites ($2.37 million) and the Minority Postdoctoral Research Fellowships (MPRF) ($1.0 million) programs will remain at the FY 2010 Enacted level.
- Support for the GK-12 program will end in FY 2011 (-$100,000), as part of the NSF-wide termination of the program.

Infrastructure

The SMA Request includes new investments (+$6.0 million to a total of $6.0 million) in SEES and CIF21:

- SMA will take the lead SBE role, working with BCS and SES, to integrate SBE data and computational capabilities with those of other relevant fields as part of SEES, Integrated Science and Engineering Research on Environmental, Economic and Energy Systems ($1.50 million).
- With a $2.0 million investment, SMA will lead a new pilot program, in collaboration with BCS and SES, titled Observation Network Data Pilots. This program will create a network of social and behavioral observation stations that will enhance research infrastructure and promote data access as part of CIF21's Access and Connections to Cyberinfrastructure Facilities.
- As part of CIF21, $2.50 million will support activities in Data-Enabled Science.

OFFICE OF CYBERINFRASTRUCTURE (OCI) $236,020,000
+$21,740,000 / 10.1%

OCI Funding
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Research	**$45.51**	**$53.13**	**$79.36**	**$26.23**	**49.4%**
Software	22.71	12.50	30.00	17.50	140.0%
Data	3.70	12.27	26.00	13.73	111.9%
Other Disciplinary and Interdisciplinary Research	19.10	28.36	23.36	-5.00	-17.6%
Education	**8.81**	**10.77**	**8.60**	**-2.17**	**-20.1%**
Infrastructure	**160.40**	**150.38**	**148.06**	**-2.32**	**-1.5%**
High Performance Computing (HPC)	128.10	$113.00	$94.00	-19.00	-16.8%
Other Networking and Computational Programs	32.30	$37.38	$54.06	16.68	44.6%
Total, OCI	**$214.72**	**$214.28**	**$236.02**	**$21.74**	**10.1%**

Totals may not add due to rounding.

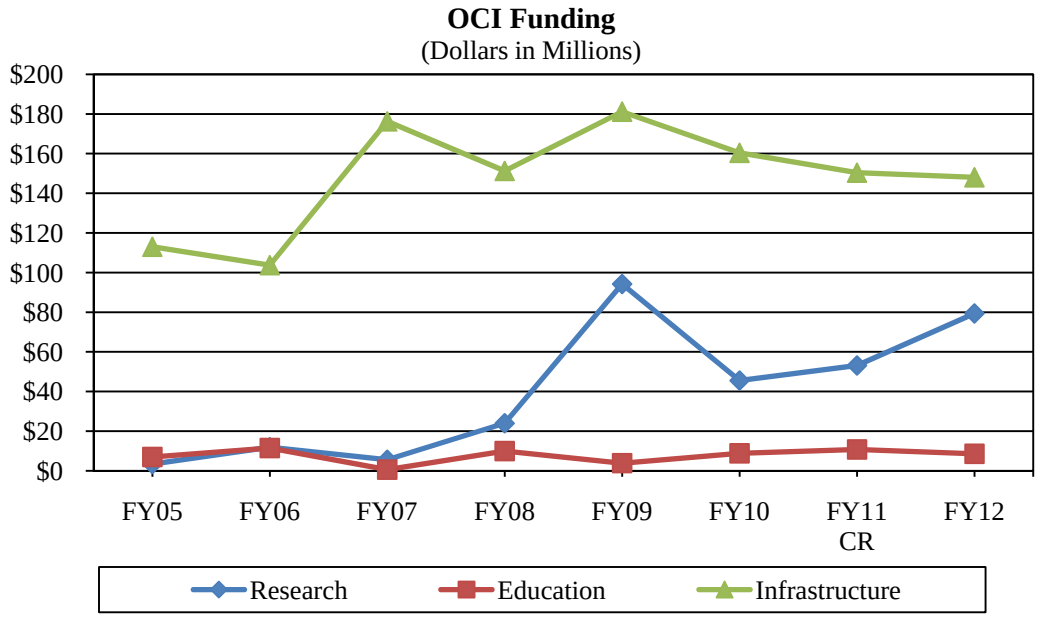
About OCI

OCI supports research, development, acquisition, and operation of advanced shared and connecting cyberinfrastructure (CI) that enables otherwise unrealizable advances in 21st century science and engineering research and education. Every discipline of science and engineering is undergoing a revolution, transformed by the widespread use and deployment of cyberinfrastructure. Data volumes, computing power, software, and network capacities are all on exponential growth paths, and research collaborations are expanding dramatically. Data are everywhere: produced by all scientific and education endeavors, and generated by surveys, mobile and embedded systems, sensors, observing systems, scientific instruments, publications, experiments, simulations, evaluations, and analyses. Scientists and citizens alike communicate by sharing data, software, papers, and visualizations.

OCI supports the development and use of advanced CI to address frontier science problems through the growing discipline of computational science and engineering, as well as the computational scientists who develop and use it. OCI capitalizes on a broad range of fundamental scientific and engineering research and education to create and expand the next generation of CI. CI is used to convert data to knowledge, thereby understanding complexity through simulation and prediction, and creating more systematic knowledge about the social and technical issues of large-scale, multidisciplinary, collaborative communities, known as virtual organizations. CI is needed to address the complex problems and grand challenges facing science and society. It does this by ensuring broad and useful access to scientific instruments, facilities, and data. CI also enables end-users to access remote resources at-speed to support transformative research.

OCI's FY 2012 Request is influenced by three key priorities: (1) ongoing support for the High Performance Computing (HPC) portfolio; (2) expanding support for core research and development in

software, data, and networking; and (3) providing support and funding for the two NSF-wide investment portfolios: Science, Engineering, and Education for Sustainability (SEES) and Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21). In addition, OCI is making a focused effort to provide healthy funding and support for education and broadening participation efforts to develop the next generation of cyberinfrastructure professionals.



All funding increases/decreases represent change over the FY 2010 Enacted level.

Research

There is a growing need for increased software and data capabilities. Consequently, OCI has reprioritized funding towards research based on feedback from the other offices and directorates within NSF, as well as recommendations from the NSF Advisory Committee for Cyberinfrastructure (ACCI).

- Software funding increases by $17.50 million to a total of $30.0 million in FY 2012. This increase will support a focus on sustainability and extensibility of software, tools, algorithms, and efforts that ensure robustness and security while also providing opportunities for upgrades and new capabilities.
  - This includes a $2.50 million increase for CIF21 New Computational Infrastructure, and a $14.0 million increase for Software Institutes. There is also a $1.0 million increase for CI Reuse, which supports sustainable software.
- Data support increases by $13.73 million to a total of $26.0 million for data-enabled science, including long-term data support and infrastructure, a data life-cycle program focus (access, curation, mining, security, management), data tools, data interoperability, data repositories, and a multi-disciplinary focus on data services, data science, and data-intensive science.
  - This includes a $10.0 million increase for CIF21 Data Enabled Science and a $3.73 million increase for the DataNet and data interoperability networks programs.
- Other disciplinary and interdisciplinary research funding decreases by $5.0 million to a total of $23.36 million. This includes:
  - An increase of $2.0 million for CIF21 Community Research Networks activities and programs linking organizations, people, buildings, computers, and vehicles. It will also support the development of collaboration tools, virtual organizations, shared tools (e.g., visualization, crowd-

sourcing), and cybersecurity tools research to create a secure environment that facilitates and supports transformative research.

- A decrease of $4.0 million for CDI since the objectives of CDI have been included in the broader objectives of CIF21.

Education

- Support for education decreases by $2.17 million to a total of $8.60 million. Funding decreases slightly for educational activities overall. However, support for students will also be provided through research awards that are part of the CIF21 portfolio.
  - GRF funding is eliminated (-$1.0 million) as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).
  - It also reflects small decreases in support for CI-TEAM (-$1.0 million to a total of $4.0 million), IGERT (-$400,000 to a total of $1.0 million) and CI-TRaCS (-$170,000 to a total of $2.0 million).
  - OCI support of $500,000 for EHR's TUES program ends.
  - Support for REU Sites increases by $400,000 to a total of $1.0 million.
  - OCI will provide $500,000 of support for the CISE-led Computing Education for the 21st Century program.

Infrastructure

Reflecting the growing need for software and data capabilities, OCI has shifted funding away from infrastructure to fund research. This is based on the feedback from the other offices and directorates within NSF, as well as recommendations from the ACCI.

- Support for High Performance Computing decreases by $19.0 million to a total of $94.0 million.
  - The Blue Waters (Track One) program is reduced by $58.0 million as this program will be transitioning from acquisition to operations and maintenance.
  - Funding for Track 2D awards is reduced by $10.0 million as the funding for the program ramps down as planned.
  - Innovative HPC funding increases by $20.0 million to a total of $30.0 million. This increase will fund operations and maintenance for the Innovative HPC acquisition that is scheduled to occur in FY 2011.
  - Funding for eXtreme Digital is increased by $29.0 million to meet outstanding commitments as the program ramps up.
- Support for other networking and computational programs increases by $16.68 million to $54.06 million.
  - An increase of $17.0 million for the Comprehensive National Cybersecurity Initiative (CNCI) (+$16.0 million to a total of $16.0 million) and other cybersecurity efforts (+$1.0 million to a total of $5.0 million) including early deployment and testing of game-changing cybersecurity prototypes, and experimental approaches and development of cybersecurity in advanced compute environments and leading-edge IT services.
  - An increase of $2.50 million will support activities and programs for the development of CIF21 New Computational Infrastructure including new computational resources (HPC, Clouds, Data Centers), sustainable software, new architectures and algorithms, and end-to-end access to resources.
  - An increase of $6.0 million for CIF21 Access and Connections to Cyberinfrastructure Facilities to support activities and programs in high-speed connections to emerging national data- and compute-intensive facilities, such as NEON, OOI, NEES, iPlant, and other major MREFC projects, and supporting the use of networks of remote instruments (e.g., Arctic Observing Network and Polenet) and access to large databases by remote users are essential and require research and development for user-control and interactive remote steering.

- A decrease of $3.40 million for seed grants in networking and computation, as these efforts will be integrated into the FY 2012 CIF21 New Computational Infrastructure and Access and Connections to Cyberinfrastructure Facilities program areas.
- And a decrease of $5.42 million to broadband, as these efforts will be integrated into CIF21 Access and Connections to Cyberinfrastructure Facilities.

Major Investments

OCI Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
High Performance Computing	$128.10	$113.00	$94.00	-$19.00	-16.8%
CIF21	-	-	23.00	23.00	N/A
CNCI	-	-	16.00	16.00	N/A
SEES Portfolio	2.60	5.50	5.00	-0.50	-9.1%
CAREER	3.77	3.71	4.21	0.50	13.5%

Major investments may have funding overlap, and thus should not be summed.

- OCI continues to invest in high performance computing (HPC). However, efforts will transition from acquisition to operations and maintenance for Track 1, while Track 2 funding is eliminated as these resources transition into the TeraGrid. Consistent with recent recommendations from the President's Council of Advisor's on Science and Technology, OCI's overall HPC investments will shift to the innovative HPC and extreme Digital programs.

- Support for the new NSF-wide CIF21 investment will focus on the Data Enabled Science component of CIF21. Data Enabled Science funding will be used to facilitate the collection, analysis, and retention of data critical to OCI-related research domains. CIF21 also includes support for Community Research Networks, which link organizations, people, buildings, computers, and vehicles to form the effective and efficient distributed, coordinated, interdisciplinary collaborations that are increasingly central to science and engineering. CIF21 also includes New Computational Infrastructure, which encompasses HPC, clouds, clusters, data centers and focused special-purpose resources. It incorporates sustained software at all levels, all protected and embedded in a rich and robust cybersecure environment. Lastly, CIF21 includes Access and Connections to Cyberinfrastructure facilities, which will create improved access and connections to facilities and scientific instruments and resources that will enable computational communities built around emerging national data- and compute-intensive facilities, such as the National Ecological Observatory Network (NEON), Ocean Observatories Initiative (OOI), EarthScope, Network for Earthquake Engineering Simulation (NEES), and iPlant.

- OCI will support the NSF-wide Comprehensive National Cybersecurity Initiative (CNCI), which includes early deployment and testing of game-changing cybersecurity prototypes, and experimental approaches and development of cybersecurity in advanced compute environments and leading-edge IT services.

- OCI will support the NSF-wide SEES investment by funding CI activities that support research efforts in energy, environment, and society.

- OCI supports the CAREER program, an Administration priority. OCI's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

Summary and Funding Profile

OCI supports investment in core research and education as well as research infrastructure such as high performance computing resources, software, data, and networking infrastructure. In FY 2012 the number of research grant proposals is expected to increase by 190 compared to FY 2010 Enacted. OCI expects to award approximately 120 research grants in FY 2012. Average annualized award size and duration will be slightly above FY 2010 Enacted.

OCI Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	826	510	700
Number of New Awards	169	103	125
Regular Appropriation	156	103	125
ARRA	13	-	-
Funding Rate	20%	20%	18%
Statistics for Research Grants:			
Number of Research Grant Proposals	739	490	680
Number of Research Grants	112	97	120
Regular Appropriation	112	97	120
Funding Rate	15%	20%	18%
Median Annualized Award Size	$204,617	$225,000	$230,000
Average Annualized Award Size	$318,813	$395,550	$400,000
Average Award Duration, in years	2.7	2.4	2.5

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

The most recent OCI Committee of Visitors met in FY 2008. The COV focused on two performance dimensions in the context of OCI's four focus areas of High Performance Computing, Data, Virtual

Organizations, and Learning and Workforce Development: 1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and 2) comments on how the outputs and outcomes generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals. The COV made a number of recommendations that OCI has since addressed.

OCI will be holding its next COV meeting in April 2011. This COV will focus on the same two performance dimensions described above in the context of OCI's six focus areas: Software, Data and Visualization, Networking, Virtual Organizations, Learning and Workforce Development, and High Performance Computing.

The Office of Cyberinfrastructure is working with NSF's Advisory Committee for Cyberinfrastructure (ACCI) to gather input from the researchers and educators who use computing and the technologists who develop high-performance computing on future requirements and opportunities for the national CI. The NSF-wide ACCI has established six task forces and has asked them to address long-term cyberinfrastructure issues and provide recommendations for the future. The task forces are:

- Campus Bridging;
- Data;
- Grand Challenge Communities;
- High Performance Computing;
- Software and Tools; and
- Learning and Work Force Development.

These task forces are composed of a set of distinguished members from the external science and engineering community, with NSF program officers from the research directorates and offices acting as liaisons. The task forces reported their findings and recommendations at the December 2010 ACCI meeting and are in the process of completing their final reports by third quarter of FY 2011.

Number of People Involved in OCI Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	778	91	455	775
Other Professionals	319	21	205	320
Postdoctorates	98	-	50	100
Graduate Students	340	-	200	340
Undergraduate Students	158	-	75	155
Total Number of People	**1,693**	**112**	**985**	**1,690**

Office of Cyberinfrastructure High Performance Computing Portfolio

OCI High Performance Computing Funding

(Dollars in Millions)

	Prior Years[1]	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
TeraGrid[2]	$133.91	$6.70	-	-
Track 1	98.38	90.50	90.00	32.00
Track 2	144.22	15.40	10.00	-
Innovative HPC Program	-	11.90	10.00	30.00
Teragrid - Phase III (XD)	20.22	3.60	3.00	32.00
Total	**$396.73**	**$128.10**	**$113.00**	**$94.00**

Totals may not add due to rounding.

[1] Prior Years includes $17.0 million of ARRA funding in FY 2009.

[2] Transition from TeraGrid to eXtreme Digital (XD) in FY 2010 - refer to section on XD for more information.

Track 1 – Blue Waters

Description

The National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign will provide the capability for researchers to tackle much larger and more complex research challenges than previously possible, across a wide spectrum of domains. NCSA will acquire, deploy, and operate a petascale sustainable, architecturally coherent, innovative, leadership-class, high-performance computational resource, to be known as Blue Waters, for the science and engineering research community. This investment complements the Department of Energy (DoE) Office of Science program on compute hardware, which focuses on peak petascale performance, while Blue Waters will provide sustained petascale performance. Also, while the DoE microprocessors are commodity processors, the microprocessors in Blue Waters were altered to address the specific needs of the HPC community. This system will be sited at University of Illinois at Urbana-Champaign (UIUC) where it will be operated by NCSA and its partners in the Great Lakes Consortium for Petascale Computing (GLC).

The Blue Waters project also includes education and outreach programs that will target pre-college, undergraduate, graduate, and post-graduate levels. A Virtual School of Computational Science and Engineering has been established to create courses that focus on petascale computing and petascale-enabled science and engineering. The Virtual School is exploring new instructional technologies and creating courses, curricula, and certificate programs tailored to science and engineering students. It has also sponsored workshops, conferences, summer schools, and seminars.

The project includes an annual series of workshops targeted at the developers of simulation packages and aspiring application developers. In addition, the project includes two industrial partnership activities: the Industry Partners in Petascale Engagement (IPIPE) program will provide industrial partners with a first look at the technological and scientific developments that flow from the petascale program. The Independent Software Vendor Application Scalability Forum will promote collaborations among consortium members, independent software vendors, and the industrial end-user community.

The broader impacts of this award include: provisioning of unique infrastructure for research and

education; extensive efforts accelerating education and training in the use of high-performance computation in science; training in petascale computing techniques; promoting an exchange of information between academia and industry about the applications of petascale computing; and broadening participation in computational science through NCSA's Girls Engaged in Mathematics and Science (GEMS) program. GEMS is designed to encourage middle-school girls to consider mathematics-oriented and science-oriented careers.

Science and engineering research and education activities enabled by Blue Waters

This award permits investigators across the country to conduct innovative research demanding petascale capabilities. Allocations have been requested for research on: complex biological behavior in fluctuating environments, the electronic properties of strongly correlated systems, the properties of hydrogen and hydrogen-helium mixtures in astrophysically relevant conditions, the electronic and magnetic structures of transition metal compounds, the molecular dynamics responsible for the properties of liquid water, and the propagation of seismic energy through a detailed structural model of Southern California together with the predicting of ground motion and the modeling of the response of buildings and other structures. Other allocations address testing hypotheses about the role of cloud processes and ocean mesoscale eddy mixing in the dynamics of climate and improving climate models, the formation of the first galaxies, turbulent stellar hydrodynamics, binary black hole and neutron star systems as sources of gamma ray bursts, and other intense radiation phenomena, contagion, and particle physics.

Management and Oversight

NSF Structure: The project is managed and overseen by OCI program staff and a grants officer from the Division of Grants and Agreements (DGA). These NSF staff members receive strategic advice from NSF's CIF21 working group, which includes representatives from the various directorates and offices and is currently jointly led by OCI and the Directorate for Mathematical and Physical Sciences (MPS). Advice from the Office of General Counsel (OGC) is sought as necessary.

The contract between UIUC and IBM, the principal sub-awardee, includes milestones at which IBM's progress is assessed through a series of deliverables, including software packages and demonstrations, tests of preliminary hardware, simulators, technical specifications, and programmer guides.

External Structure: During the development and acquisition phase of this project, UIUC oversees work by a number of sub-awardees, conducts software development, and assists competitively selected research groups to prepare to use the Blue Waters system. The primary sub-awardee, IBM, is responsible for implementation of the hardware, system software, and main program development tools. Other sub-awardees will work on performance modeling, the evaluation of an astrophysical modeling framework, the engagement of applications groups, scalable performance tools, undergraduate training, and broadening the participation of underrepresented groups in high-performance computing. Following system testing and acceptance in mid-2012, the Blue Waters project will enter a five-year operations phase. A proposal from UIUC for operations is anticipated in FY 2012. The project team is advised by a Petascale Executive Advisory Committee composed of senior personnel with technical and management expertise in high-performance scientific computing, the management of acquisition contracts for leading-edge computing systems, and the operation of large computing centers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The extensive review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The Track 1 award required that risks be identified, analyzed, and a mitigation plan created and followed. One of the activities of the periodic NSF external reviews, by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may

be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register. Discussion of risks is part of the weekly discussions between UIUC and NSF. Periodic closed session updates to the NSB identify any major changes in risk assessment.

Reviews: The project was selected through a competitive review in 2007. An external panel of experts, selected by NSF, reviews the progress of the project including project management, risk management, hardware and software development, and the provision of advanced user support to research groups receiving provisional resource allocations on the Blue Waters system. One of the important roles of this external review panel is to analyze the awardee's assessments of the deliverables from its sub-awardees, together with the awardee's and sub-awardees' plans for remedial action when necessary, and to provide NSF with advice on whether these assessments and plans are reasonable. At the time of writing, these external reviews had been conducted in February 2008, April 2008, October 2008, April 2009, July 2009, December 2009, April 2010, and September 2010, with further reviews planned for February 2011 and at four to six month intervals thereafter until project completion. In addition, NSF conducts site visits. The most recent review, held in September 2010, focused on project deliverables, project risks and risk management. In addition, current milestone deliverables were reviewed for acceptance. Specific topics included IBM deliverables, IBM schedule, IBM technical plans for hardware and system software, early testing results, I/O and storage plans, and science and engineering team support. The review panel provided feedback and recommendations on all items, concurring with proposed revisions to project schedule and overall project plans.

Current Status: In late FY 2010 UIUC was notified by IBM that FY 2011 sub-award milestones would be delayed. UIUC submitted a request to NSF to extend the project end date by approximately nine months. The external review panel recommended approval of the extension in December 2010 and NSF approved the change to schedule in January 2011. Acquisition is expected to be completed in FY 2012. Mitigation includes installation of a large partial system for early science users in FY 2011. The project is currently within budget and the project scope remains unchanged.

Track 2

The Track 1 system is targeted to provide sustained petascale performance, while the Track 2 systems provide, at most, petascale peak performance. The Track 1 system is expected to support on the order of a dozen projects, each capable of producing break-through results as a direct result of having access to such a facility. Each Track 2 system is capable of supporting hundreds of researchers (over the course of a year) doing leading-edge science and engineering. In previous years, funding was provided for Track 2A and 2B awards that have transitioned into production TeraGrid resources. The Track 2C competition did not result in an award. The three Track 2D awards are in the initial phases and will transition to production resources in 2011 and 2012. Operations and maintenance funding for the Track 2Da and Track 2Dc awards was provided in FY 2010 as they will begin to support early TeraGrid science users in FY 2011 Track 2Db installed an initial system in FY 2010 and operations and maintenance will be provided in FY 2011.

There is a direct relationship between the Track 2 awards and the TeraGrid activity. Track 2A and 2B provide the acquisition process for new systems that will become part of TeraGrid. Track 2 awards are made to an institution following an extensive external review process. Track 2A and B proposals submitted consisted of two parts: a) an acquisition component and associated funding, and b) an operations and maintenance component and associated funding. Track 2D proposals did not separate these components due to the experimental nature of the systems. When an award is made, the funding goes to the institution which issues sub-awards to vendors as necessary. Once the system has passed the acceptance process, any vendors receive final payment for the system. Once the system has been fully

tested, it becomes a TeraGrid/eXtreme Digital (XD) resource and the institution becomes a TeraGrid/XD resource provider and has access to the operations and maintenance funding component of the award. Immediately below is information that is common to the Track 2D program and hence is applicable to all Track 2D awards. Any differences or project-specific information are discussed in that award's section.

Science and engineering research and education activities enabled by Track 2D

- The complete spectrum of scientific research is supported, including: climate and weather modeling, cosmology and astrophysics, geosciences, physics, chemistry, biology and medicine, earthquake engineering, and mechanical engineering.

- TeraGrid is required to provide evidence of outreach activities that include various education and training opportunities being made available. These are evaluated as part of the annual review process.

- In addition, part of the Track 2D acquisition review process includes an assessment of education and outreach activities being considered.

Management and Oversight for Track 2D

NSF Structure:

- NSF oversight is provided by OCI program officers who provide direct oversight during both the acquisition and operations phase and the system integration into the TeraGrid and the follow-on eXtreme Digital (XD) activity.

- Formal reporting consists of quarterly and annual reports. These are reviewed by the program officer. There are also bi-weekly teleconferences with NSF program officers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The Track 2D award process requires that risks be identified, analyzed, and a mitigation plan created and followed. One of the activities of the periodic NSF external reviews, by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register.

Reviews:

- Annual reviews are performed as part of the TeraGrid annual review.

- Semi-annual reviews are performed as part of the acquisition phase. The reviews are arranged by the NSF program officer. The reviewers' backgrounds include scientific research, project management, and large scale systems acquisitions and operations, and include familiarity with projects funded by NSF as well as other federal agencies. To the extent possible, continuity through the series of reviews is provided by using the same set of reviewers.

External Structure:

- Each Track 2D award will be managed under a cooperative agreement. Each Track 2D awardee will be responsible for the satisfactory completion of milestones in order for the spending authorization to be raised. Progress will be determined by the review process and the NSF program officer.

- Each project has a detailed management plan in place. Each cooperative agreement includes the management structure, milestones, spending authorization levels, and review schedule.

Current Status:

- The Track 2D cooperative agreement awards were made in FY 2009 and are proceeding appropriately with early TeraGrid science users beginning to test the Track2Da and Track2Dc systems. The Track2Db system was delayed to late FY 2010 to take advantage of a newer, improved technology, which has since been implemented.

Track 2Da - Gordon Data Intensive Computing at San Diego Supercomputer Center (SDSC)

Description

- The University of California at San Diego (UCSD) will provide a ground-breaking new computing facility, Gordon, which will be made available to the research community together with advanced user support for researchers with data intensive problems that may not parallelize well or will require access to very large amounts of memory.

- The distinguishing features are the integration of solid state disks (SSDs) and very large shared memory. This system will be optimized to support research with very large data-sets or very large input-output requirements. It will provide a step-up in capability for data-intensive applications that scale poorly on current large-scale architectures, providing a resource that will enable transformative research in many research domains.

- The system will become part of the NSF TeraGrid and the follow-on eXtreme Digital cyberinfrastructure in FY 2011.

Track 2Db – Keeneland Experimental High Performance Computing at Georgia Institute of Technology

Description

- The Georgia Tech Research Corporation (GTRC) will provide a new experimental high performance computing facility with unconventional architectures, Keeneland, to scientific and engineering researchers so they can evaluate the merit of these architectures.

- The distinguishing feature of Keeneland is the inclusion of General-Purpose computation on Graphics Processing Units (GPGPU) processors as general purpose compute accelerators in a sufficiently large system to address computational problems that are challenging to more conventional supercomputing architectures. Productivity is of particular interest in using Open Computing Language (OpenCL) as a mechanism to program the GPGPUs.

- Applications will require additional development and testing to be appropriately prepared to effectively use this new type of architecture.

- An initial system has been installed, has passed acceptance testing and is in use for software development and applications testing. This allows researchers lead time in order to prepare their applications for the full scale system to be installed two years later.

- The system will become part of the NSF eXtreme Digital cyberinfrastructure in FY 2012.

Track 2Dc - FutureGrid Experimental High Performance Grid Testbed at Indiana University (IU)

Description

- The project team, led by Indiana University, will provide a significant new experimental computing grid and cloud test-bed, named FutureGrid, to the research community, together with user support for third-party researchers conducting experiments on FutureGrid. This will enable them to tackle complex research challenges in computer science related to the use and security of grids and clouds.
- The test-bed includes a geographically distributed set of heterogeneous computing systems, a data management system that will hold both metadata and a growing library of software images, and a dedicated network allowing isolatable, secure experiments.

- The test-bed will support virtual machine-based environments as well as native operating systems for experiments aimed at minimizing overhead and maximizing performance.

- The project partners will integrate existing open-source software packages to create an easy-to-use software environment that supports the instantiation, execution, and recording of grid and cloud computing experiments.

- The FutureGrid project team has been directed to prepare a written interaction plan and to present this to NSF after the award for XD has been made. The plan should include the mechanism by which XD may leverage FutureGrid.

Innovative HPC Program

Description

Using lessons learned during the execution of the HPC Track 2 program and informed by the NSF ACCI's High Performance Computing task force, the HPC Track 2 program has been renamed in 2011 with incremental changes in the FY 2011 solicitation. This program provides production ready HPC systems and services as well as opportunities for investigating innovative high-risk/high-payoff approaches to providing the necessary computational resources required by the science and engineering community. The newly named program is aligned with the eXtreme Digital activity, TeraGrid Phase III (XD). XD serves as the consistent foundation for the services and resources within the Innovative HPC Program. XD contributes to achieving the NSF Vision for Cyberinfrastructure for 21st Century Science and Engineering.

Beginning in FY 2011, based on feedback from the scientific and engineering community, a more sustained approach to core HPC services will be initiated. This will allow a longer time horizon for funding of HPC providers in recognition of the value and time required for building and retaining staff skilled in interdisciplinary computational science. Thus, an eight to ten year horizon is envisioned for a core HPC provider, with at least two awards plus accompanying O&M awards over the same time period for each provider. At least one acquisition award of up to $30.0 million is planned in FY 2011.

Science and Engineering Activities Enabled by Innovative HPC

- Innovative HPC will enable world leading transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering by underrepresented groups, by providing researchers and educators with usable access to computational resources, beyond those typically available on most campuses, together with the interfaces, consulting support, and training necessary to facilitate their use.

- Through the unifying XD framework and services, Innovative HPC will enable researchers to

manipulate extremely large amounts of digital information from simulation, sensors, and experiments, and add needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.

- Outreach and training critical to reducing the barriers to the use of HPC systems by the research and education community will be provided. Innovative HPC will incorporate new computational technologies and new approaches to software and data management, together with the expertise to enable researchers and students to complement theory and experiment with an equal emphasis in computation.

Management and Oversight

NSF Structure: OCI program officers provide direct oversight during both the acquisition and operations phase. Formal reporting consists of quarterly and annual reports, which are reviewed by the program officer. There are also bi-weekly teleconferences with NSF program officers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The experimental awards, by nature, will encompass high-risk, high-reward scenarios. The award process requires that risks be identified, analyzed, and a mitigation plan created and followed. One of the activities of the periodic NSF external reviews, conducted by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register.

Reviews:
Annual reviews will be performed as part of the XD review. Semi-annual reviews will be performed as part of the acquisition phase. The reviews are arranged by the NSF program officer. The reviewers' backgrounds include scientific research, project management, and large scale systems acquisitions and operations, and include familiarity with projects funded by NSF as well as other federal agencies. To the extent possible, continuity through the series of reviews will be provided by using the same set of reviewers.

External Structure:
Each Innovative HPC award will be managed under a cooperative agreement. Each awardee will be responsible for the satisfactory completion of milestones in order for the spending authorization to be raised. Progress will be determined by the review process and the NSF program officer. Each cooperative agreement will include the management structure, milestones, spending authorization levels, and review schedule.

Current Status: The solicitation was released in December 2010 with proposals due in March 2011. One award is expected in late FY 2011.

TeraGrid Phase III: eXtreme Digital (XD)

Description:
- The TeraGrid (TG), predecessor to XD, is an advanced, nationally distributed, open cyberinfrastructure comprised of supercomputing, storage, analysis, and visualization systems, data

services, and science gateways, connected by high-bandwidth networks, integrated by coordinated policies and operations, and supported by computing and technology experts.

- It enables and supports leading-edge scientific discovery and promotes science and technology education.
- XD takes a significant step forward by encouraging innovation in the design and implementation of an effective, efficient, increasingly virtualized approach to the provision of high-end digital services – extreme digital services – while ensuring that the infrastructure continues to deliver high-quality access for the many researchers and educators that use it in their work.

Science and engineering research and education activities enabled by XD

- XD will enable transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering by under-represented groups, by providing researchers and educators with usable access to extreme-scale digital resources beyond those typically available on most campuses, together with the interfaces, consulting support, and training necessary to facilitate their use.

- XD will provide high-performance computing services, enable researchers to manipulate extremely large amounts of digital information from simulations, sensors, and experiments, and add needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.

- Outreach and training critical to reducing the barriers to the use of advanced digital systems by the research and education community will be provided. XD will incorporate new ideas and technologies to enable researchers and students to move transparently between local and national resources, substantially lowering the barriers to effective use of cyberinfrastructure and promoting enhanced productivity.

Management and Oversight

NSF Structure:

- XD will consist of several inter-related parts: a High-Performance Remote Visualization Service (HPRVS), a Coordination and Management Service (CMS), a Technology Audit and Insertion Service (TAIS), an Advanced User Support Service (AUSS), and a Training, Education and Outreach Service (TEOS).

- These elements are designed and implemented in a way that is consistent with sound system engineering principles, clearly tied to the user requirements of the science and engineering research community using a flexible methodology that permits the architecture to evolve in response to changing user needs and presents the individual user with a common user environment regardless of where the resources or user are located.

- The HPRVS was reviewed in FY 2009 and two awards were made, one to the University of Texas ($7.0 million) and one to the University of Tennessee ($10.0 million).

- The TAIS component of XD was reviewed in FY 2010 and two awards were made; one to the University of Buffalo for the Technical Audit Service and one to the University of Illinois for the Technical Insertion Service. These two awards will facilitate the TeraGrid to XD transition.

- The final phase of XD, involving the other three services, is scheduled to come online in FY 2011. The total anticipated funding for XD in FY 2012 is $32.0 million.

- Similar to TG, XD will be managed by OCI, informed by the ACCI and its task forces, with ongoing strategic guidance from the NSF cross-directorate CIF21 working group. An external Science Advisory Board, similar to the TG Science Advisory Board, will provide ongoing community input to the XD project.

- OCI will hold weekly teleconferences with XD senior personnel.

External Structure:

- The final configuration of XD will consist of seven sites, each containing a range of high performance computing platforms, large disk storage devices, computational platforms specifically tailored for remote visualization, high-bandwidth networks, a broad set of user services and an education, outreach, and training component designed to fulfill the needs of current users of high-performance computing as well as to broaden participation to new communities and under-represented groups in science and engineering.

Current Status:

- Phase I – Two planning grants, one to UCSD ($1.60 million) and one to UIUC ($1.62 million), were made in FY 2009 to obtain community input and engagement in order to develop the ideas and expanded horizons that will be required to deploy the advanced infrastructure required for XD. The planning grants were reviewed in February 2010, and the two teams submitted their full proposals in July 2010.

- Phase II – The full proposals were reviewed by an external panel of experts in the fourth quarter of FY 2010 and a recommendation will be made in the second quarter of FY 2011. NSF expects to make an award in FY 2011.

- NSF expects to have all components of XD in production between FY 2011 and FY 2013.

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING (OISE)

$58,030,000
+$10,200,000 / 21.3%

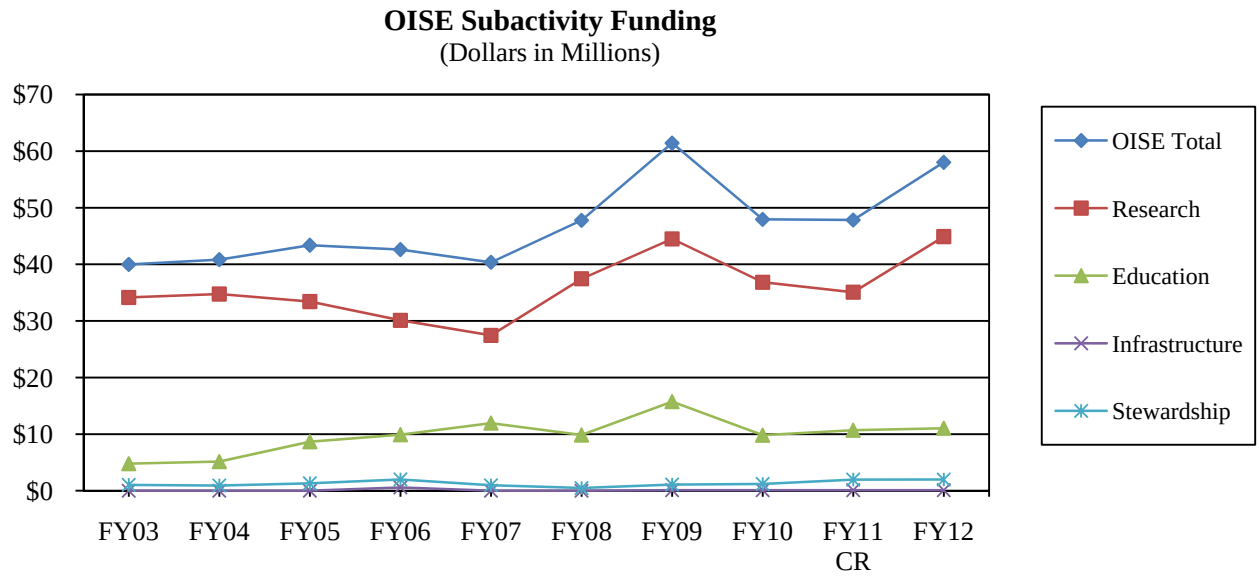
OISE Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Total, OISE	**$47.84**	**$0.10**	**$47.83**	**$58.03**	**$10.20**	**21.3%**

The Office of International Science and Engineering (OISE) serves as the focal point, both inside and outside of NSF, for international science and engineering activities. OISE promotes the development of an integrated, Foundation-wide international strategy and manages international programs that are innovative, catalytic, and responsive to a broad range of NSF and national interests. OISE supports U.S. scientists and engineers engaged in international research and education activities in all NSF-supported disciplines involving any region of the world. As such, OISE enables high-impact international collaborations and partnerships that help achieve U.S. foreign policy objectives.

OISE programs and activities are designed to complement and enhance the Foundation's broad research and education portfolio and to overcome barriers to international collaboration. America's next generation of scientists and engineers must be able to work effectively in the global arena and marketplace. OISE supports programs that enable students and researchers to engage in international research and educational activities across such areas as cyberinfrastructure, complex biological systems, natural hazards prediction and mitigation, nanotechnology, water resources, climate, and energy sustainability. OISE carries out its functions by working closely with the other NSF directorates and offices as well as through its own programs. In addition, OISE manages NSF's offices in Beijing, Paris, and Tokyo that report on and analyze in-country and regional science and technology developments and policies, promote greater collaboration between U.S. and foreign researchers, liaise with foreign counterpart agencies and research institutes, and facilitate coordination and implementation of NSF research and education programs.

OISE coordinates much of NSF's engagement with international organizations across diverse disciplines and initiatives. OISE also coordinates NSF efforts to strengthen collaborations with developing countries, which are increasingly important partners in addressing critical global issues, but can present special challenges related to infrastructure and resources. NSF's efforts related to the Administration's call for increased U.S. engagement with Muslim-majority countries are also coordinated by OISE.



Major Investments

OISE Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Partnerships for International Research and Education (PIRE)	$18.20	-	$18.00	$25.20	$7.20	40.0%
Sustainability Research Networks	-	-	-	2.00	2.00	N/A
International programs for students and early career researchers	9.57	0.02	10.70	11.05	0.35	3.3%
Catalyzing New International Collaborations (CNIC)	2.32	-	2.00	2.50	0.50	25.0%
U.S. Participation in International Organizations	8.15	-	8.47	8.50	0.03	0.4%

- Partnerships for International Research and Education (PIRE) is a major NSF funding priority in FY 2012. The PIRE program makes multi-million dollar awards to U.S. institutions that build strong international research and education partnerships. Each PIRE award supports U.S. faculty to lead projects designed to achieve research excellence through the added-value gained by international collaboration including, access to essential expertise, facilities, and/or phenomena outside the U.S. Each PIRE award prepares a globally engaged U.S. workforce by funding U.S. undergraduate and graduate students and/or junior researchers to participate in international research experiences, and fosters the internationalization of U.S. institutions in science and engineering fields.

  In FY 2012, OISE plans to invest $15.0 million for the first-year funding of a new 2012-2016 cohort, $9.74 million for the existing 2010-2014 PIRE cohort, and $460,000 to initiate a PIRE program evaluation. The FY 2012 PIRE competition will focus on the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio and apply PIRE's successful model of international

collaboration to sustainability research challenges in the global context. This will enable U.S. researchers, students, and institutions to engage effectively with foreign partners in leading-edge discovery and innovation in sustainability disciplines. The increase in funding for the PIRE program is a response to a growing demand for international engagement from the U.S. STEM community and NSF's recognition of the importance of addressing international challenges of sustainability research. In particular, the increase will allow NSF to fund a broader range of PIRE awards for international partnerships related to SEES research areas, including clean energy, an area identified as a critical national need.

- OISE will contribute $2.0 million to support Sustainability Research Networks (SRN) that will engage and build collaborations among U.S. and foreign researchers and educators within the SEES portfolio.

- OISE manages four programs that support students and early career researchers in international activities:
  - International Research Experiences for Students (IRES) supports groups of U.S. undergraduate or graduate students conducting research in collaboration with foreign investigators at an international site. In FY 2012, IRES funding will be $3.15 million, which is unchanged from the FY 2010 Enacted level.

  - East Asia and Pacific Summer Institutes (EAPSI) introduces U.S. graduate students to science and engineering research in the East Asia and Pacific region, and initiates scientific relationships that will enable future collaboration with foreign counterparts. Seven locations currently partner with NSF in the program: Australia, China, Japan, Korea, New Zealand, Singapore, and Taiwan. In FY 2012, EAPSI funding will be $2.40 million, which is unchanged from the FY 2010 Enacted level.

  - International Research Fellowship Program (IRFP) supports U.S. postdoctoral-level scientists and engineers for international collaborative research, with the objective of furthering their research capacity and global perspective, and forging long-term relationships with researchers abroad. In FY 2012, IRFP funding will be $4.50 million, which is unchanged from the FY 2010 Enacted level.

  - Advanced Studies Institutes (ASI) (formerly Pan American Advanced Studies Institutes) will build on years of successful implementation in the Americas, and recent pilot institutes in Africa and Asia, to provide opportunities for U.S. students and early-career researchers to connect with foreign counterparts around the globe. ASIs are short courses of up to four weeks in duration, aimed at disseminating advanced scientific knowledge and stimulating training and cooperation. The courses involve distinguished U.S. and foreign lecturers and active researchers in a scientific field. OISE manages the ASI program with most of the funding contributed from other NSF directorates and the Department of Energy. The FY 2012, ASI budget for OISE will be $1.0 million.

- Catalyzing New International Collaborations (CNIC) is an OISE effort that offers support for the initial phases of U.S. participation in mutually beneficial international collaborations in all regions of the world. Many types of activities intended to catalyze new international collaborations may be proposed and supported, including: planning visits, small workshops, initial data-gathering activities, and the development of research coordination networks. If the initial OISE-supported collaboration phase achieves positive results, the next phase is expected to involve submission of a follow-on

proposal to the appropriate NSF program for continued and/or expanded funding of the collaborative research. In FY 2012, OISE plans to allocate $2.50 million to CNIC activities.

- In FY 2012, OISE will continue to provide approximately $8.5 million per year in support of U.S. participation in international organizations such as the Civilian Research and Development Foundation, the Global Science Forum, and the Human Frontier Science Program.

OISE Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
OISE Funding	**$47.84**	**$0.10**	**$47.83**	**$58.03**	**$10.20**	**21.3%**
Research	38.03	0.08	37.03	46.88	9.85	26.6%
Education	9.71	0.02	10.70	11.05	0.35	3.3%
Infrastructure	0.10	-	0.10	0.10	-	-

FY 2012 Summary

Research

- The FY 2012 OISE research request of $46.88 million includes $15.0 million for new SEES-related PIRE awards, and $2.0 million for SRNs.
- OISE works closely with the other NSF directorates and offices to leverage international opportunities for U.S. researchers and educators. The OISE FY 2012 request will in part co-fund international disciplinary and interdisciplinary activities with other NSF organizational units. OISE's existing funding mechanisms, together with the potential for involving new funding partners, will enable more and stronger research and education collaborations with Muslim-majority and developing countries. A NSF-U.S. Agency for International Development (USAID) Memorandum of Understanding provides a framework for OISE to support U.S. participants and USAID to support developing country partners. OISE will apply approximately $10.0 million of the FY 2012 request towards co-funding with other NSF directorates, and developing country and Muslim-majority country activities.
- Approximately $2.50 million will be allocated to CNIC activities in FY 2012, with the expectation that successful interactions will result in competitive proposals to relevant NSF directorates.

Education

- OISE supports international research and education activities for U.S. undergraduate and graduate students and post-doctoral fellows via the IRES, EAPSI, IRFP, and ASI programs. The total FY 2012 budget for these programs will be $11.05 million.

Infrastructure

- OISE will continue to provide $100,000 in support of the National Nanotechnology Infrastructure Network (NNIN) to leverage connections and collaborations with foreign institutions. For information about NNIN, please refer to the Facilities chapter.

Summary and Funding Profile
OISE supports investment in core research and education as well as research infrastructure.

In FY 2012 the number of research grant proposals is expected to increase by over 200 compared to the FY 2010 Enacted primarily attributable to the PIRE competition. OISE expects to award approximately 95 research grants in FY 2012. Average annualized award size and duration are estimated to increase in FY 2012 due to the 2012 PIRE competition.

OISE Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	1,043	820	1,050
Number of New Awards	396	365	410
Regular Appropriation	396	365	410
ARRA	-	-	-
Funding Rate	38%	45%	39%
Statistics for Research Grants:			
Number of Research Grant Proposals	600	375	600
Number of Research Grants	85	70	95
Regular Appropriation	85	70	95
ARRA	-	-	
Funding Rate	14%	19%	16%
Median Annualized Award Size	$49,880	$50,000	$70,000
Average Annualized Award Size	$197,985	$180,000	$270,000
Average Award Duration, in years	2.4	2.0	2.4

OISE Funding for Centers Programs and Facilities

OISE Funding for Facilities
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Facilities	$0.10	$0.10	$0.10	-	-
National Nanotechnology Infrastructure Network (NNIN)	*0.10*	*0.10*	*0.10*	-	-

No FY 2010 obligations for facilities were made with funds provided by the ARRA.

Facilities

- In FY 2012, OISE will continue to provide $100,000 in support of the NNIN to leverage connections and collaborations with foreign institutions.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of NSF programs and portfolios of programs by external Committees of Visitors (COVs) and directorate/office Advisory Committees. Please see that chapter for additional information. All OISE-managed programs and activities will be reviewed by a COV in FY 2011.

External evaluations of IRFP and the EAPSI program will be completed in FY 2012. OISE has a contract with Abt Associates to conduct the evaluations. These evaluations will focus on four tasks: (1) a study of the IRFP and EAPSI fellows' experiences in applying for and participating in the programs; (2) a comparative data analysis of professional outcomes (educational and occupational) for IRFP and EAPSI awardees and other applicants; (3) an analysis of the impact IRFP and EAPSI have on U.S. academic institutions and on the foreign institutions that host IRFP and EAPSI fellows; and (4) the bringing together of an advisory group to ensure the quality of the evaluation process. Funding for the evaluation was provided in FY 2010 and FY 2011. The FY 2012 PIRE competition will be the fourth PIRE competition and an evaluation and assessment is timely and appropriate. A proposed amount of $460,000 will initiate, but not fully fund the evaluation, in FY 2012.

Number of People Involved in OISE Activities

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	1,077	1,250	1,340
Other Professionals	65	50	50
Postdoctorates	472	600	640
Graduate Students	1,809	2,260	2,410
Undergraduate Students	1,071	1,350	1,440
Total Number of People	**4,494**	**5,510**	**5,880**

OFFICE OF POLAR PROGRAMS (OPP) $477,410,000
+$26,250,000 / 5.8%

OPP Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Arctic Sciences	$105.11	$0.18	$106.31	$112.94	$6.63	6.2%
Antarctic Sciences	74.57	2.05	71.08	76.65	5.57	7.8%
Antarctic Infrastructure & Logistics	265.26	-	266.76	280.55	13.79	5.2%
U.S. Antarctic Logistical Support	[67.52]	-	[67.52]	[67.52]	-	-
Polar Environment, Health & Safety	6.84	-	7.01	7.27	0.26	3.7%
U.S. Coast Guard Polar Icebreaking[1]	[54.00]	-	-	-	-	N/A
Total, OPP	**$451.77**	**$2.23**	**$451.16**	**$477.41**	**$26.25**	**5.8%**

Totals may not add due to rounding.

[1] Funding for U.S. Coast Guard Polar Icebreaking for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

About OPP

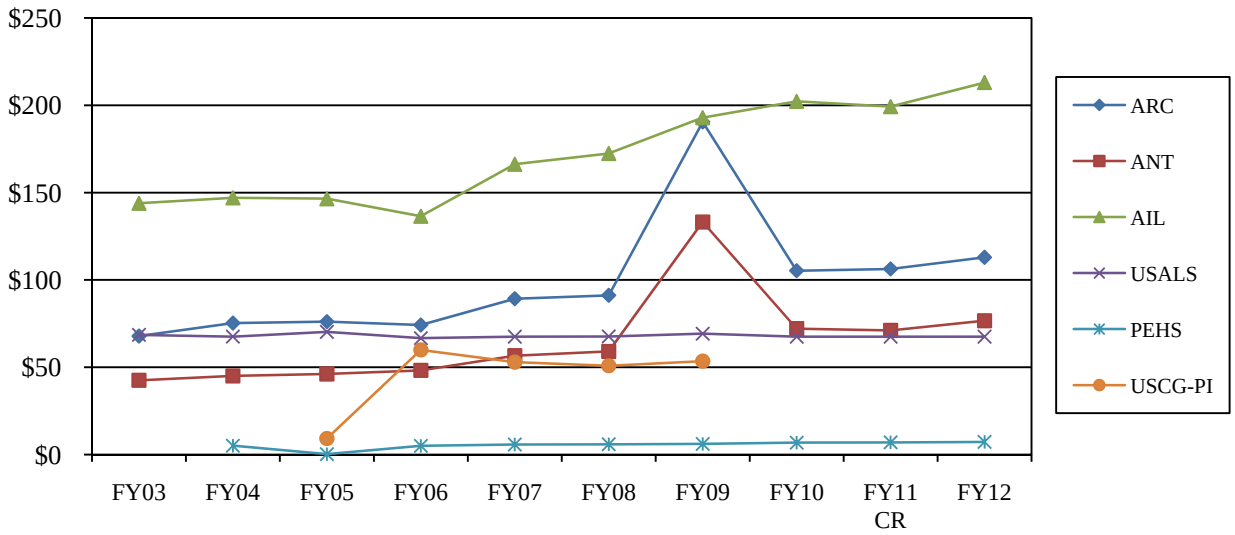
Polar research provides insights into ice sheets, the atmosphere, oceans, and solid earth, without which the behavior of and changes in the global system cannot be understood. For example, the study of polar ice sheets reveals how the Earth's climate has changed in the past and provides information essential to predicting future global sea level change. Polar regions also offer important opportunities for environmental research. The extreme sensitivity of polar ecosystems to changes in climate enables study of the linkages between the physical and living components of the coupled earth systems. A key goal of these studies is to improve our understanding of the factors that govern regional climate as well as the potential impacts of change. In addition, the Arctic and Antarctic are premier natural laboratories whose extreme environments and geographically unique settings enable research on phenomena and processes not feasible elsewhere. For example, the cold, dry environment and high altitude at the South Pole make it the world's best location for key astrophysics measurements, and research in polar regions reveals how organisms have adapted to the extreme polar environment at a genetic level.

The Office of Polar Programs (OPP) is the primary U.S. supporter of fundamental research in polar regions. In addition, NSF provides interagency leadership for U.S. activities in polar regions. In the Arctic, NSF helps coordinate research planning as directed by the Arctic Research Policy Act of 1984. The NSF Director chairs the Interagency Arctic Research Policy Committee created for this purpose, which is now directly overseen by the President's National Science and Technology Council. In the Antarctic, per Presidential Memorandum 6646, NSF manages all U.S. activities as a single, integrated program, making research possible in Antarctica by scientists supported by NSF and by other U.S. agencies. The latter include the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Smithsonian Institution, and the Department of Energy. The U.S. Antarctic Program supports the U.S. governance role through the Antarctic Treaty.

Environmental change in parts of the Arctic and Antarctic is occurring faster than anywhere else in the world, and has a wide variety of regional and global impacts. These impacts include coastal erosion, economically significant changes in terrestrial and marine ecosystems, sea ice changes with effects on planetary albedo, ecosystems and shipping activities, thawing permafrost that compromises civil infrastructure and has the potential to increase releases of methane, a potent greenhouse gas, and contributions to global sea level rise by melting land ice. The human response to these changes also have local to global implications.

The thrust of research supported by OPP is determined via community-driven indications of high priority areas, followed by external merit review of proposals. To address the evolving frontier, in FY 2012, OPP will continue and further develop its emphasis on climate change research and education, a topic of clear interest and importance to researchers and policy-makers.

OPP Subactivity Funding
(Dollars in Millions)



FY 2012 Summary by Division

- The Division of Arctic Sciences investments include: the new Discovery and Understanding in Polar Oceans, focusing on ocean circulation and including as a key component studies related to ocean acidification; the NSF-wide Science, Engineering and Education for Sustainability (SEES), creating new networks to link research teams who are exploring the human-environment nexus in a region that is experiencing rapid environmental change and on networks studying the role of clean energy in sustainability; and the NSF-wide Cyber-Infrastucture Framework for the 21st Century (CIF21), creating data management approaches that support access and archive requirements and interoperability among different databases. Also included are investments to enhance the efficiency, safety, and environmental footprint of activities at Summit Station in Greenland.

- The Division of Antarctic Sciences investments include: the new Discovery and Understanding in Polar Oceans, focusing on developing predictive models of sea level rise and understanding ocean acidification processes in order to better understand the effects of increasing global carbon dioxide on the Southern Ocean ecosystem; the NSF-wide SEES, focusing on system science research and modeling, as well as on networks studying the role of clean energy in sustainability; and the NSF-wide CIF21, advancing interoperability between disparate observational data sets so that new

knowledge can be gained from integrated data and model analysis as well as to enhance the capability to acquire observations from remote and far-flung observational networks.

- The Division of Antarctic Infrastructure & Logistics investments include providing logistical support in Antarctica and on the Southern Ocean for new research foci in SEES, CIF21, and Discovery and Understanding in Polar Oceans. Improvements will be made to Palmer Pier to stabilize it for another 30 years; the pier is critical to continued resupply of Palmer Station, the research enabled by the Station, and NSF's ability to meet its responsibilities for implementing the national objectives of Presidential Memorandum 6646 which requires the U.S. to operate a year-round station in the Antarctic Peninsula. The division will also introduce new data systems that will integrate with contractor-provided systems and increase the transparency, supportability, and security of existing information systems. Funding also supports several strategic investments to enhance the efficiency, safety, and environmental footprint of U.S. Antarctic Program.

- The Office of Polar Environment, Health & Safety continues its emphasis on environmental stewardship of the Arctic and the Antarctic, and on protecting the health and safety of grantees and others conducting and supporting research in the polar regions. A priority for the office is the establishment of an electronic medical records system, using information technology to lower health care costs and improve delivery of health care services.

Major Investments

OPP Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Research Infrastructure	$316.17	-	$321.43	$338.02	$16.59	5.2%
SEES Portfolio	65.26	-	65.26	83.65	18.39	28.2%
Discovery and Understanding in Polar Oceans	11.00	-	11.00	16.00	5.00	45.5%
Center for Remote Sensing of Ice Sheets	4.45	-	4.45	4.45	-	-
CIF21	-	-	-	4.00	4.00	N/A

Major investments may have funding overlap, and thus should not be summed.

- Research and logistics support is maintained for ongoing research projects and new initiatives in SEES, CIF21, and Discovery and Understanding in Polar Oceans. Support to other new deep field activities in the Antarctic is reduced and progress on investments to enhance the efficiency, safety, and environmental footprint of activities at Summit Station in Greenland and U.S. Antarctic Program operations is slowed. Funds will be applied to improving the pier at Palmer Station – critical to continued resupply of the station, research enabled by the station, and NSF's ability to meet its responsibilities for implementing the national objectives of Presidential Memorandum 6646, which requires the U.S. to operate a year-round station in the Antarctic Peninsula – and new data systems that will increase the transparency, supportability, and security of existing systems.

- Increased funding for SEES will be used to build on previously supported research in this area, focusing on regional climate modeling and creating new networks linking research teams exploring regions that are experiencing rapid environmental change. These networks are expected to strengthen system science elements including modeling, observations and synthesis, as well as, research to examine social understanding and responses in the Arctic, and the physical and ecosystem components of the Antarctic. OPP participation in the SEES clean energy activity will emphasize networks studying the role of clean energy in sustainability, by linking engineers, social scientists, community leaders, and community members in studies of energy usage and changing energy usage toward cleaner, more sustainable patterns.

- Funding for Discovery and Understanding in Polar Oceans increases, addressing areas that comprise about 10 percent of the global ocean surface and that are key components of the global climate system. Studies on ocean circulation and ice-ocean-atmosphere interactions, including interaction with global circulation, and ocean acidification will inform U.S. Government stewardship, particularly of the Arctic Ocean. In the Southern Ocean, these factors are key to developing predictive models of sea level rise and predicting the effects of increasing global carbon dioxide on the Southern Ocean ecosystem.

- Support for the Science and Technology Center for Remote Sensing of Ice Sheets continues.

- Funding requested for CIF21 will be used to emphasize creation of robust data management approaches that support accessibility and archiving requirements, and interoperability among different databases, an activity previously supported under the Cyber-enabled Discovery and Innovation program.

- The emphases to support the Discovery and Understanding in Polar Oceans, SEES, and CIF21 priority areas represents a redistribution of approximately 10 percent of the funds that are typically available for new research award starts each year. This focusing of support will be accompanied by efforts to maintain a balance between established and early career investigators.

Summary and Funding Profile

OPP invests in core research and education as well as research infrastructure such as centers and facilities.

In FY 2012 the number of research grant proposals is expected to increase by approximately 174 compared to the FY 2010 Enacted funding level. OPP expects to award approximately 352 research grants in FY 2012. Average annualized award size and duration increases slightly above the FY 2010 Enacted level.

The FY 2012 funding for the Center for Remote Sensing of Ice Sheets accounts for one percent of OPP's Request.

Funding for facilities accounts for 69 percent of OPP's FY 2012 Request.

OPP Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	798	1,071	1,242
Number of New Awards	284	310	376
Regular Appropriation	275	310	376
ARRA	9	-	-
Funding Rate	36%	29%	30%
Statistics for Research Grants:			
Number of Research Grant Proposals	757	1,033	1,207
Number of Research Grants	251	279	352
Regular Appropriation	247	279	352
ARRA	4	-	-
Funding Rate	33%	27%	29%
Median Annualized Award Size	$150,422	$154,342	$161,885
Average Annualized Award Size	$187,047	$189,400	$199,780
Average Award Duration, in years	2.6	2.8	2.9

OPP Funding for Centers Programs and Facilities

OPP Funding for Centers Programs

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Centers Programs	$4.45	$4.45	$4.45	-	-
Center for Remote Sensing of Ice Sheets	4.45	4.45	4.45	-	-

No FY 2010 obligations for centers were made with funds provided by the ARRA.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

- The Center for Remote Sensing of Ice Sheets' (CReSIS) research and education program is aimed at determining ice sheet thickness and the nature of the lithosphere/ice sheet interface that are critical to developing the models of ice sheet behavior that will result in improved understanding of the contribution of ice sheets to sea level rise. CReSIS has been credited internationally for development of ice penetrating radar analysis methods that improve existing data sets by removing clutter and other confounding effects. Funding for CReSIS remains unchanged in FY 2012.

OPP Funding for Facilities
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Facilities	$309.33	$314.42	$330.75	$16.33	5.2%
Arctic Research Support & Logistics	44.50	45.51	46.75	1.24	2.7%
IceCube Neutrino Observatory	2.15	2.15	3.45	1.30	60.5%
U.S. Antarctic Facilities & Logistics	195.16	199.24	213.03	13.79	6.9%
U.S. Antarctic Logistical Support	67.52	67.52	67.52	-	-
U.S. Coast Guard Polar Icebreaking [1]	[54.00]	-	-	-	N/A

No FY 2010 obligations for facilities were made with funds provided by the ARRA.

[1]Funding for USCG Polar Icebreaking for FY 2010 excludes a one-time appropriation transfer of $54.0 million to USCG per P.L. 111-117.

For detailed information on individual facilities, please see the Facilities chapter.

Facilities

- Arctic Research Support & Logistics and U.S. Antarctic Facilities & Logistics maintain research and logistics support for ongoing research projects and new initiatives in SEES, CIF21, and Discovery and Understanding in Polar Oceans. Progress on investments to enhance the efficiency, safety, and environmental footprint of activities at Summit Station in Greenland (Arctic Research Support and Logistics) and U.S. Antarctic Program operations (U.S. Antarctic Facilities & Logistics) will continue.
- Funding increases for operation and maintenance of the IceCube Neutrino Observatory now that it will be in full operation.
- U.S. Antarctic Facilities & Logistics will invest in improvements to the pier at Palmer Station and new data systems that will increase the transparency, supportability, and security of existing systems.
- Funds requested for U.S. Antarctic Logistics Support are used to reimburse the Department of Defense for support to the U.S. Antarctic Program.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors (COVs) and directorate Advisory Committees. Please see this chapter for additional information.

OPP held three COVs in FY 2009 – one each for the Arctic and Antarctic Sciences divisions, and one addressing support provided by the Division of Antarctic Infrastructure & Logistics and the Office of Polar Environment, Health & Safety. The OPP Advisory Committee met twice in FY 2010 – November and May.

For FY 2012 OPP will conduct COVs for the Arctic and Antarctic Sciences divisions, and one addressing support provided by the Division of Antarctic Infrastructure & Logistics and the Office of Polar Environment, Health & Safety.

Aspects of the Office of Polar Environment, Health & Safety requiring medical input are reviewed annually by a medical panel. Specialized reviews, such as that of the scientific diving program, are conducted periodically.

Indicators such as funding rates, award size and duration, and numbers of people supported on research and education grants also factor in to OPP's program evaluation and performance improvement processes.

In FY 2010, NSF—which manages the U.S. Antarctic Program on behalf of the U.S. Government—began an independent review of the program that will continue through FY 2012. The review will be conducted in two phases: the first involves a National Research Council committee that will examine and identify scientific drivers over the next two decades; the second, a Blue Ribbon Panel established by NSF, will analyze and report on the associated logistics and infrastructure needed to implement the science of the future. The first phase of this review will be completed in summer 2011.

Number of People Involved in OPP Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	1,292	78	1,048	1,160
Other Professionals	615	34	742	830
Postdoctorates	114	8	114	140
Graduate Students	398	18	378	440
Undergraduate Students	276	12	272	320
Total Number of People	**2,695**	**150**	**2,554**	**2,890**

DIVISION OF ARCTIC SCIENCES (ARC)

$112,940,000
+$6,630,000 / 6.2%

ARC Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
ARC	**$105.11**	**$0.18**	**$106.31**	**$112.94**	**$6.63**	**6.2%**
Research	59.26	0.14	58.80	64.94	6.14	10.4%
Education	1.35	0.04	2.00	1.25	-0.75	-37.5%
Infrastructure	44.50	-	45.51	46.75	1.24	2.7%
Arctic Research Support & Logistics	44.50	-	45.51	46.75	1.24	2.7%

Arctic Sciences is organized into several programs that support research in social science, earth system science, and a broad range of natural science. Educational projects are also supported. The Research Support & Logistics program assists researchers with access to the Arctic, improves safety and environmental stewardship, and increases the ability of researchers to share plans and results with local Arctic communities. The Arctic is at the forefront of global climate change. Observations have revealed an estimated 14 percent per decade reduction in sea ice extent in the Arctic over the past 30 years, and significant summer melting of the Greenland Ice Sheet. These and many other phenomena are forcing change and uncertainty in traditional Arctic populations, present challenges and opportunities for industry and commerce, and have the potential to affect the global population through changes in sea level and changed weather patterns. Arctic Sciences funds a broad range of activities to provide an integrated understanding of environmental change in the Arctic, including study of significant, system-scale environmental change and its human dimension.

The Research Support & Logistics program is driven by and responds to research and education funded by the division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic support and logistics. Emphasis will be placed on improving access to and the energy security of the remote facilities used by Arctic researchers and educators.

In general, 50 percent of the division's portfolio is available for new research grants. The remaining 50 percent funds continuing grants made in previous years, and research support and logistics.

FY 2012 Summary

Research

- Increased investments for Discovery and Understanding in Polar Oceans will focus on ocean circulation, including interaction with global circulation, the potential role of enhanced upper-ocean mixing resulting from reduced sea-ice cover, and ecological response of the shelf seas. This focus builds on Bering Sea ecosystem studies currently underway, but is broadened to include the Chukchi and Beaufort Seas. Studies related to ocean acidification will be a key component of this work. This suite of activities is expected to inform U.S. Government stewardship of the Arctic Ocean with an increase of $1.7 million for a total of $6.70 million.
- Additional funding for SEES will be used to support the creation of new networks linking research teams who are exploring the human-environment nexus in a region that is experiencing rapid

environmental change. The networks are expected to strengthen system science foci including modeling, observations and synthesis, including research to examine social understanding and responses to a total of $3.0 million. Under the SEES clean energy networks activity, social scientists, community leaders, and community members could be linked in studies of energy usage and changing energy usage toward cleaner, more sustainable patterns with an increase of $1.56 million to a total of $43.01 million.

- Underpinning a robust system science approach linking observations with modeling and synthesis is under the CIF21 umbrella for creation of data management approaches that support accessibility and archiving requirements, and interoperability among different databases to a total of $2.5 million.

Education

- Arctic Sciences participates in the multidisciplinary, multi-faceted Climate Change Education Program, engaging the full spectrum of its research and education communities for a total of $750,000. The investment in the Polar Postdoctoral Program, designed to broaden the community of polar researchers, continues at a total of $500,000.

Infrastructure

- Arctic Sciences will continue to make strategic investments to enhance the efficiency, safety, and environmental footprint of activities at Summit, Greenland for a total of $2.0 million. Funds are requested to continue implementation of renewable power generation at the station to reduce fuel usage and emissions, thereby improving atmospheric observations at the station. The use of elevated and modular, more energy efficient buildings will reduce the need for snow management and reduce energy consumption. Energy savings of up to 30 percent are anticipated once the multi-year investment is completed.
- Funds are provided for logistics support to new research programs, including Discovery and Understanding in Polar Oceans and SEES to a total of $1.60 million.
- ARC has refocused support within the infrastructure portfolio to the above referenced priorities by adjusting logistics support.

DIVISION OF ANTARCTIC SCIENCES (ANT) $76,650,000
+$5,570,000 / 7.8%

ANT Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
ANT	**$74.57**	**$2.05**	**$71.08**	**$76.65**	**$5.57**	**7.8%**
Research	71.19	2.05	66.58	71.95	5.37	8.1%
Centers Funding (total)	4.45	-	4.45	4.45	-	-
Center for Remote Sensing of Ice Sheets	4.45	-	4.45	4.45	-	-
Education	1.23	-	2.00	1.25	-0.75	-37.5%
Infrastructure	2.15	-	2.50	3.45	0.95	38.0%
IceCube Neutrino Observatory	2.15	-	2.50	3.45	0.95	38.0%

Antarctic Sciences funds research in all areas of science that can only be done, or is best done, in Antarctica. Antarctic Sciences enables research on Earth's physical, biological, geological, glaciological, oceanographic, and atmospheric processes in Antarctica, as well as on interactions between the ice sheets, the underlying continent, the surrounding ocean, and the overlying atmosphere, toward a comprehensive understanding of Antarctica's role in the evolution of Earth and life on Earth, and the Antarctic environment's role in the whole Earth system. In particular, a new programmatic emphasis fosters linkages across the disciplines in order to better advance understanding of the Antarctic climate as a system. Antarctic Sciences also enables research in astronomy and astrophysics to advance understanding about high-energy phenomena such as supernovae and events associated with black holes, the nature of dark energy and dark matter (which is now known to be a major component of the universe), as well as advancing general understanding about the origin and evolution of the universe.

In general, 40 percent of the Antarctic Sciences portfolio is available for new research grants. The remaining 60 percent is used primarily to fund continuing grants made in previous years.

FY 2012 Summary

Research

- Increased emphasis is placed on investments for Discovery and Understanding in Polar Oceans. Because of strong coupling with the world's oceans through major currents, the Southern Ocean is a key element of heat and mass transfer for the global ocean system. Understanding the heat it carries to the margins of the Antarctic ice sheet is a key factor that must be known in order to develop predictive models of sea level rise, and understanding processes of ocean acidification must be known in order to better understand the effects of increasing global carbon dioxide on the Southern Ocean ecosystem. Consequently, improved understanding of the Southern Ocean is important for advancing models of global climate change and informing U.S. Government stewardship, which will be assisted by an increase of $1.70 million for a total of $7.70 million.
- Additional funding for SEES will be used to support research in existing programs in this area and to enhance system science research on modeling, particularly with a regional focus. New knowledge about ocean processes, for instance, is critical to advance modeling that encompasses interactions among the physical and ecosystem components of the Antarctic system to a total of $3.0 million. Under the SEES clean energy networks activity, social scientists, community leaders, and community

members could be linked in studies of energy usage and changing energy usage toward cleaner, more sustainable patterns with increased support of $1.83 million for a total of $35.64 million.

- Funding for CIF21 will be used to emphasize creation of robust data management approaches that support accessibility and archiving requirements, and interoperability among different databases. For instance, incorporation of ocean and atmospheric observations into Geographic Information Systems that also integrate physical changes to the ice sheets are crucial if results of global earth system models are to be rigorously validated. Investments will be made to advance interoperability between disparate observational data sets so that new knowledge can be gained from integrated data and model analysis; and to enhance capability to acquire observations from remote and far-flung observational networks for a total of $1.50 million.

Center for Remote Sensing of Ice Sheets (CReSIS)

- Funding continues to support research and education programs at CReSIS, a Science and Technology Center devoted to developing innovative radars for determining ice sheet thickness and the nature of the lithosphere/ice sheet interface that are critical to developing models of ice sheet behavior, and to link expertise developed there to that of other key projects.

Education

- Antarctic Sciences participates in the multidisciplinary, multi-faceted Climate Change Education Program, engaging the full spectrum of its research and education communities ($750,000). The investment for the Polar Postdoctoral Program, designed to broaden the community of polar researchers, continues ($500,000).

Infrastructure

- Funds support operation and maintenance of IceCube, the world's only neutrino observatory designed to discover astrophysical sources of neutrinos. IceCube is expected to make discoveries about fundamental physical processes that occur in high-energy astrophysical phenomena such as supernovae or gamma-ray bursters. The increase in funding to a total of $3.45 million is necessary as IceCube ramps up to full operations.

DIVISION OF ANTARCTIC INFRASTRUCTURE & LOGISTICS (AIL)

$280,550,000
+$13,790,000 / 5.2%

AIL Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
AIL	**$265.26**	**-**	**$266.76**	**$280.55**	**$13.79**	**5.2%**
Infrastructure	265.26	-	266.76	280.55	13.79	5.2%
U.S. Antarctic Facilities & Logistics	195.16	-	199.24	213.03	13.79	6.9%
U.S. Antarctic Logistical Support	67.52	-	67.52	67.52	-	-

Antarctic Infrastructure & Logistics supports research through a network of stations, labs, equipment, and logistics that enables research activities in Antarctica. This includes operation of a year-round inland research station at the South Pole; two year-round coastal research stations (McMurdo and Palmer) with extensive laboratory, transportation, housing, communication, and computing capabilities; summer camps as required for research; icebreaking research ships—the *Laurence M. Gould* and the *Nathaniel B. Palmer*; small fixed-wing aircraft and helicopters; and icebreakers for channel breaking and ship escort at McMurdo Station. The division uses a mix of government and civilian contract service providers for research support activities in Antarctica.

The U.S. Antarctic Logistical Support budget line funds support provided by the U.S. Department of Defense (DoD). DoD operates as a logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations and maintenance support through the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York, and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the resupply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

FY 2012 Summary

Infrastructure

- New focused research initiatives in SEES, CIF21, and Discovery and Understanding in Polar Oceans will require associated logistical support in Antarctica and on the Southern Ocean ($3.0 million).
- AIL will continue to enhance the efficiency, safety, and environmental footprint of U.S. Antarctic Program operations by deploying additional renewable energy technology, reducing dependence on fossil fuels, and curtailing greenhouse gas emissions, albeit at a slower pace for a total of $5.75 million. Once fully implemented, these enhancements will have a cascading effect through the entire Antarctic resupply chain by driving down the amount of fossil fuel transported to Antarctica. At McMurdo, AIL invests in research into alternative and renewable energy production and smart grid technologies with an anticipated savings of 10 percent of current consumption. At South Pole Station, AIL continues testing and development of alternative power solutions such as wind and solar panels.
- Funds are requested to begin to stabilize Palmer Pier for another 30 years for a total of $3.0 million. The pier is critical to continued resupply of Palmer Station, the research enabled by the station, and

NSF's ability to meet its responsibilities for implementing the national objectives of Presidential Memorandum 6646, which requires the U.S. to operate a year-round station in the Antarctic Peninsula.

- Funds are requested to make progress on the investments required to introduce new data systems that will integrate with contractor-provided systems and increase the transparency, supportability, and security of existing systems for a total of $3.35 million.
- Adjustments are made to accommodate the above priorities, including reducing airlift support for new deep field research activities by approximately 15 percent, in order to maintain progress on consolidating aviation operations at a single location at the Pegasus runway site ($3.0 million).

OFFICE OF POLAR ENVIRONMENT, HEALTH & SAFETY (PEHS)

$7,270,000
+$260,000 / 3.7%

PEHS Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2011 Enacted Amount	Change Over FY 2011 Enacted Percent
PEHS	**$6.84**	**-**	**$7.01**	**$7.27**	**$0.26**	**3.7%**
Infrastructure	6.84	-	7.01	7.27	0.26	3.7%
Polar Environment, Health & Safety	*6.84*	-	*7.01*	*7.27*	*0.26*	*3.7%*

The Office of Polar Environment, Health & Safety within OPP manages and oversees the environmental, health and safety aspects of research and operations conducted in polar regions. It ensures compliance with environmental, safety, and health related regulatory, statutory, and international treaty requirements. The office has overall responsibility for guiding the implementation of both environmental protection and environmental stewardship to minimize the environmental impact of OPP-supported activities in polar regions. The office also develops and oversees programs to ensure the safety and health of all participants.

FY 2012 Summary

Infrastructure

- During FY 2012, there will be continued emphasis on environmental stewardship of the Arctic and the Antarctic, and for measures to protect the health and safety of grantees and others conducting and supporting research in the polar regions.
- A priority for the office is establishment of an electronic medical records system, using information technology to lower health care costs and improve delivery of health care services for a total of $260,000.

INTEGRATIVE ACTIVITIES (IA)

$336,250,000
+$61,210,000 / 22.3%

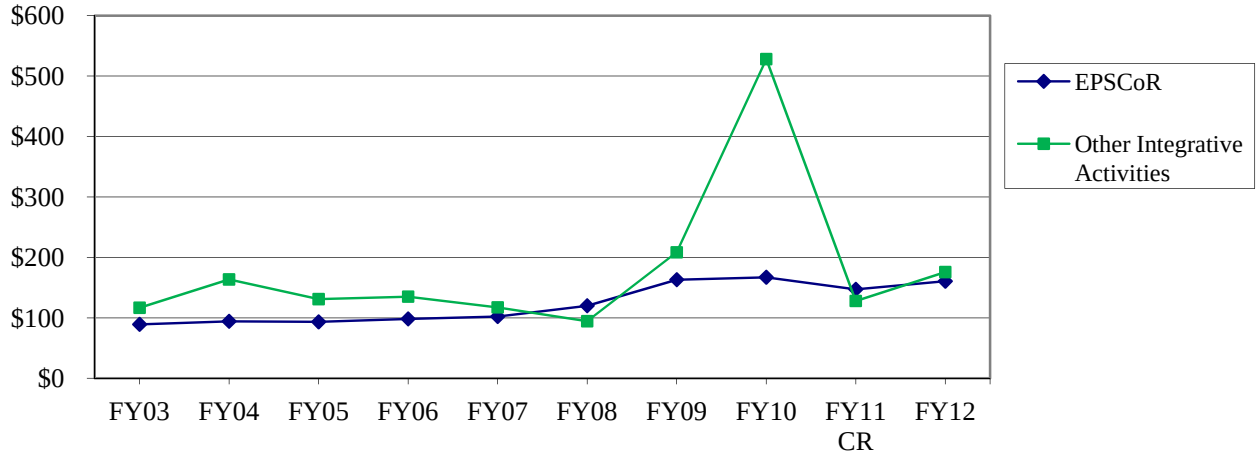
IA Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Academic Research Infrastructure	-	$200.00	-	-	-	N/A
Communicating Science Broadly	4.00	-	4.00	4.00	-	-
EPSCoR	147.11	20.00	147.12	160.53	13.41	9.1%
Graduate Research Fellowships	17.48	-	17.48	63.53	46.05	263.4%
INSPIRE	-	-	-	12.35	12.35	N/A
Major Research Instrumentation	89.99	200.15	90.00	90.00	-	-
Science and Technology Centers	13.27	-	13.40	1.30	-12.10	-90.3%
Science and Technology Policy Institute	3.04	-	3.04	3.14	0.10	3.3%
STAR METRICS	-	-	-	1.40	1.40	N/A
Total, IA	**$274.89**	**$420.15**	**$275.04**	**$336.25**	**$61.21**	**22.3%**

Totals may not add due to rounding.

Integrative Activities (IA) supports emerging, cross-disciplinary, and potentially transformative research and education activities that span the traditional boundaries of other NSF directorates and offices. IA invests in a number of integrative research and education programs that foster the development of the next generation of scientific and engineering leaders, a diverse, technically trained STEM workforce, and a scientifically literate general public. IA is a source of federal funding for the acquisition and development of research instrumentation at U.S. academic institutions and for strengthening the research and educational infrastructure throughout the Nation.

IA Subactivity Funding
(Dollars in Millions)



FY 2012 Summary/Major Investments

- In today's technological culture, opportunities for learning abound in both community and personal settings. Communicating Science Broadly (CSB) creates products and processes through traditional and social media platforms that make learning and understanding science, technology, engineering, and mathematics part of everyday life. In FY 2012, CSB will focus on informing students and other young people of the value of science in their lives with the aim to increase the long term diversity among the Nation's future scientists, engineers, and researchers. The FY 2012 Request of $4.0 million is unchanged from the FY 2010 Enacted level.

- The Experimental Program to Stimulate Competitive Research (EPSCoR) assists the Foundation in its mandate to promote scientific progress nationwide. EPSCoR effects lasting improvements in the research capacity of institutions in participating states to prompt broader engagement at the frontiers of discovery and innovation in science and engineering. EPSCoR's FY 2012 Request of $160.53 million, an increase of $13.41 million over the FY 2010 Enacted budget, is focused on these strategic investment tools: Research Infrastructure Improvement (RII) awards, Co-Funding, and Outreach. RII is further differentiated into **RII Track-1** awards, which support development of physical, human, and cyber-based research infrastructure in EPSCoR jurisdictions; **RII Track-2** awards, which support cyberinfrastructure development in a consortium of EPSCoR jurisdictions, and **RII C2** awards, which support intercampus and intracampus cyber connectivity within EPSCoR jurisdictions.

- The Graduate Research Fellowships (GRF) program builds the critical human capital base required for future STEM investigation and innovation. Research and Related Activities (R&RA) investments in GRF will increase $46.05 million above the FY 2010 Enacted level to a total of $63.53 million. In FY 2012, total NSF investments in GRF will support an estimated total of 2,000 new graduate research fellows.

- In FY 2012, IA will invest $12.35 million in a new activity to catalyze interdisciplinary research (IDR). Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) consists of a suite of activities that will foster and support interdisciplinary research, both in the form of funding potentially transformative research through a new INSPIRE awards program as well as identifying and lowering barriers to interdisciplinary research within NSF and in the research community — such as augmenting staff and reviewer training to convey the importance and value of IDR; ensuring that NSF's e-business systems and processes allow for the complexity of IDR; fostering the exchange of best practices; and undertaking outreach to the research community. Additionally, to facility the study of IDR outcomes, the program will establish an integrated evaluation system that supports longitudinal data collection of INSPIRE's impact on the advancement of science as well as on the career pathways of awardees over time.

- Advanced research instrumentation is essential for breakthrough discoveries and state-of-the-art research instrumentation motivates researchers at all career levels. In FY 2012, the Major Research Instrumentation (MRI) program investments will continue to support research instrumentation capacity and a modern research infrastructure. FY 2012 funding of $90.0 million is unchanged from the FY 2010 Enacted level.

- The Science and Technology Policy Institute (STPI), a Federally Funded Research and Development Center sponsored by the NSF on behalf of the White House Office of Science and Technology Policy (OSTP), provides analysis on significant domestic and international science and technology policies and developments for OSTP and other federal agencies. STPI funding increases $100,000 above the FY 2010 Enacted to a total of $3.14 million to support additional analytical studies for OSTP.

- Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness, and Science (STAR METRICS) represents an innovative approach to developing information on how NSF and other federal research and development investments affect the innovation ecosystem. The FY 2012 Request of $1.40 million will enable NSF participation in interagency partnerships, which will contribute to the development of a data infrastructure that will be shared by major R&D agencies, such as NSF, NIH, DOE and EPA, and used by them and by OSTP. Funding will support piloting the integration of elements of STAR METRICS into a developing assessment and evaluation information system linked to NSF management information systems and developing assessment and evaluation plans for NSF programs using STAR METRICS tools. This investment is critical to the new NSF assessment and evaluation framework that is currently under development.

IA Support to NSF-wide Initiatives SEES and CIF21

IA Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
SEES	$21.00	-	$26.50	$26.50	-	-
CIF21	-	-	-	11.00	11.00	N/A

IA will support SEES and CIF21 by investing in research, education activities, and/or infrastructure. IA will support SEES by funding energy and climate-related research, education, and/or infrastructure activities in EPSCoR jurisdictions. IA will invest $11.0 million in CIF21 by funding new computational infrastructure including computing clusters and advanced computing architectures.

IA Funding for Centers Programs

IA Funding for Centers Programs

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Centers Programs	$13.27	$13.40	$1.30	-$12.10	-90.3%
Science and Technology Centers	*13.27*	*13.40*	*1.30*	*-12.10*	*-90.3%*

No FY 2010 obligations for centers were made with funds provided by the ARRA.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

NSF's investments in Science and Technology Centers (STCs) create platforms to support interdisciplinary exchange and discovery. The STC Integrative Partnerships program — which will fund 11 centers nationwide in FY 2012 — supports innovative, potentially transformative and complex research and education projects that require large-scale, long-term efforts. STCs engage the Nation's intellectual talent through partnerships between academia and other sectors including industry, national laboratories, and government. These collaborations create synergies that enhance innovation and the timely transfer of knowledge and technology from the laboratory to industry and policymakers; they support the training of the next generation of scientists, engineers and educators; and they foster the launch of spin-off companies and the creation of job opportunities.

In FY 2012, NSF-wide funding for STCs decreases by $7.02 million due to the planned sunset of six centers from the Class of FY 2002 cohort. Within IA, $1.30 million will support administrative costs associated with the next STC competition and post-award management for the existing 11 centers. A decrease of $12.10 million in the IA budget line reflects the transfer of funding to the Directorates for Biology (BIO), Computer and Information Science and Engineering (CISE), Geosciences (GEO), and Engineering (ENG) for management of individual STCs from the Class of 2010 cohort.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

A number of program reviews and performance improvement activities are underway or planned for FY 2011-2012.

- Activities to evaluate the STC program will continue. A review, initiated in FY 2009 and organized by the American Association for the Advancement of Science, is nearing completion and a final report is expected in early 2011. The review examined the performance, accomplishments, and effectiveness of 17 STCs (from the 2000, 2002, and 2005/6 cohorts) as well as envisioned the future of the STC program.
- In FY 2011, the Office of Integrative Activities (OIA) plans to initiate an assessment of the accumulative impact of MRI investments on science and engineering across the full range of NSF-supported disciplines. OIA also plans to conduct site visits to selected institutions as part of post-award management of awards funded through the American Recovery and Reinvestment Act (ARRA).
- Oversight and reviews of awards for the Academic Research Infrastructure competition (a one-time initiative called for in ARRA) will be undertaken in FY 2011 to ensure that NSF and ARRA-specific post-award requirements are met.
- EPSCoR will identify and charge an independent, external organization with conducting an evaluation of the NSF EPSCoR program. The focus will be on progress in research competitiveness, infrastructure development, broadened participation in science and engineering, and STEM workforce development within EPSCoR jurisdictions. The estimated completion of this evaluation is by December 2013.
- Eligibility criteria for participation in NSF EPSCoR programs will be examined to identify changes that would enhance the effectiveness of the NSF EPSCoR investment toward strengthening research and education in science and engineering throughout the United States.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)

$160,530,000
+$13,410,000 / 9.1%

EPSCoR Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
EPSCoR	**$147.11**	**$20.00**	**$147.12**	**$160.53**	**$13.41**	**9.1%**
Research Infrastructure Improvement (RII)	100.21	20.00	114.44	116.13	1.69	1.5%
Co-Funding	45.42	-	31.18	42.75	11.57	37.1%
Outreach	1.47	-	1.50	1.65	0.15	10.0%

Totals may not add due to rounding.

The FY 2012 increase to RII, Co-funding, and Outreach and Workshop activities is $13.41 million or 9.1 percent over FY 2010 funding. The FY 2012 Request of $160.53 million is consistent with the NSF growth trend for the Research and Related Activities (R&RA) account for FY 2009 through FY 2012. EPSCoR uses three major investment strategies to achieve its goal of improving the research and development competitiveness of researchers and institutions within EPSCoR jurisdictions. These strategies are:

- **Research Infrastructure Improvement (RII)**
  RII Track-1 awards provide up to $4.0 million per year for up to five years. They are designed to improve the research competitiveness of jurisdictions by strengthening their academic research infrastructure in areas of science and engineering supported by NSF and critical to the particular jurisdiction's science and technology initiative or plan. These areas are identified by the jurisdiction's EPSCoR governing committee as having the best potential to improve the jurisdiction's future R&D competitiveness.

  RII Track-2 awards provide up to $2.0 million per year for up to three years as collaborative awards to consortia of EPSCoR jurisdictions to support innovation-enabling cyberinfrastructure of regional, thematic, or technological importance. These awards facilitate the enhancement of discovery, learning, and economic development of EPSCoR jurisdictions through the use of cyberinfrastructure and other technologies.

  RII Inter-Campus and Intra-Campus Cyber Connectivity (RII C2) awards provide up to $1.0 million for up to two years to support the enhancement of inter-campus and intra-campus cyber connectivity within an EPSCoR jurisdiction. RII C2 awards are intended to enhance broadband access for academic research, and to broaden individual and institutional participation in science, technology, engineering, and mathematics (STEM) research and education activities within and among jurisdictions. RII C2 awards enhance broadband access for academic research and the use of cyberinfrastructure consistent with the jurisdiction's science and technology plan.

- **Co-Funding of Disciplinary and Multidisciplinary Research**
  EPSCoR co-invests with NSF directorates and offices meritorious proposals from individual investigators, groups, and centers in EPSCoR jurisdictions that are submitted to the Foundation's research and education programs, and crosscutting initiatives. These proposals are merit reviewed in

NSF disciplinary programs and recommended for award but cannot be funded without the combined, leveraged support of EPSCoR.

- **Outreach and Workshops**
  The EPSCoR Office solicits requests for support of workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other capacity-building areas of importance to EPSCoR jurisdictions.

In general, about 24 percent of the EPSCoR portfolio is available for new research awards. The remaining 76 percent funds continuing awards made in prior years.

Number of People Involved in EPSCoR Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	625	13	533	682
Other Professionals	219	31	246	268
Postdoctorates	66	-	80	87
Graduate Students	523	8	569	620
Undergraduate Students	547	8	489	533
Total Number of People	**1,980**	**60**	**1,917**	**2,190**

UNITED STATES ARCTIC RESEARCH COMMISSION (USARC)

$1,600,000
+$20,000 / 1.3%

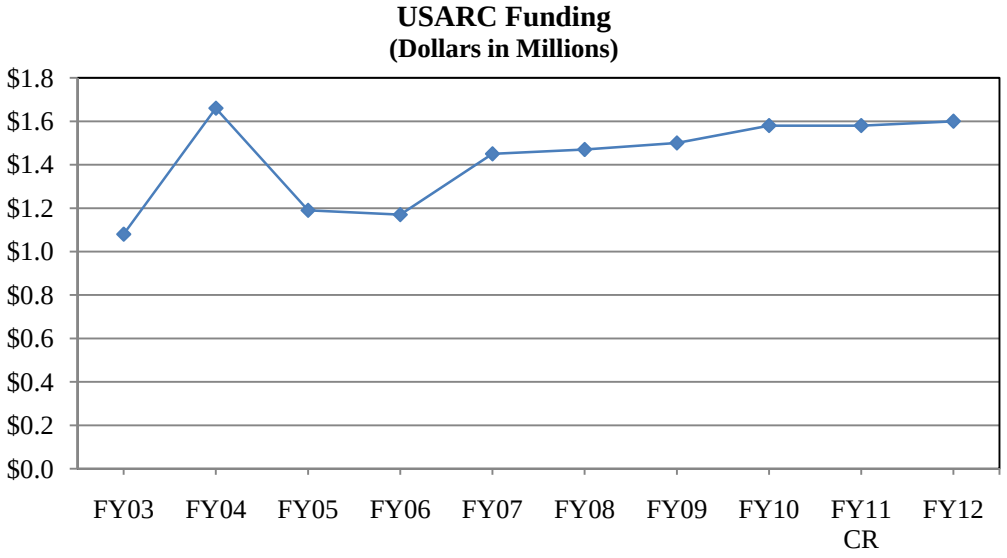
USARC Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Total, USARC	**$1.58**	**$1.58**	**$1.60**	**$0.02**	**1.3%**

About USARC

USARC was created by the Arctic Research and Policy Act of 1984, (as amended, P. L. 101-609), to establish the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied scientific research with respect to the Arctic, including natural resources and materials, physical, biological and health sciences, and social and behavioral sciences. This request provides funds to promote Arctic research, to recommend Arctic research policy, and to communicate research and policy recommendations to the rest of the Administration and the Congress, as well as supporting close collaboration with the National Science Foundation (NSF) as the lead agency responsible for implementing Arctic research policy and supporting cooperation and collaboration throughout the Federal Government. In addition, USARC gives guidance to the Interagency Arctic Research Policy Committee (IARPC) to develop national Arctic research projects and a five-year plan to implement those projects. USARC also supports interaction with Arctic residents, international Arctic research programs and organizations, and local institutions, including regional governments, in order to obtain the broadest possible view of Arctic research needs. USARC is an independent federal agency, funded through NSF's appropriations, specifically as an activity in the Research and Related Activities account.

The USARC is requesting an increase of $20,000 above the FY 2010 Enacted amount. Currently, there are three FTE funded at the USARC, with two additional IPAs. A total of seven compensated personnel are authorized in P.L. 101-609.



Note: The increase in FY 2004 reflects a one-time recovery of $370,000.

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES (EHR)

$911,200,000
+$38,440,000 / 4.4%

EHR Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Division of Research on Learning in Formal and Informal Settings (DRL)	$260.49	-	$260.00	$264.09	$4.09	1.6%
Division of Human Resource Development (HRD)[2]	138.49	-	138.91	159.96	21.05	15.2%
Division of Graduate Education (DGE)[3]	181.43	15.00	181.44	191.73	10.29	5.7%
Division of Undergraduate Education (DUE)	292.35	-	292.41	295.42	3.01	1.0%
Total, EHR	**$872.77**	**$15.00**	**$872.76**	**$911.20**	**$38.44**	**4.4%**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

[2] In FY 2012, Research in Disabilities Education and Research on Gender in Science and Engineering program funding responsibilities are transferred from HRD to DRL. Funding for all years is shown in the FY 2012 structure for comparability.

[3] Funds appropriated through ARRA in FY 2009, totaling $15.0 million, were obligated by DGE in FY 2010 for the Science Masters Program.

About EHR

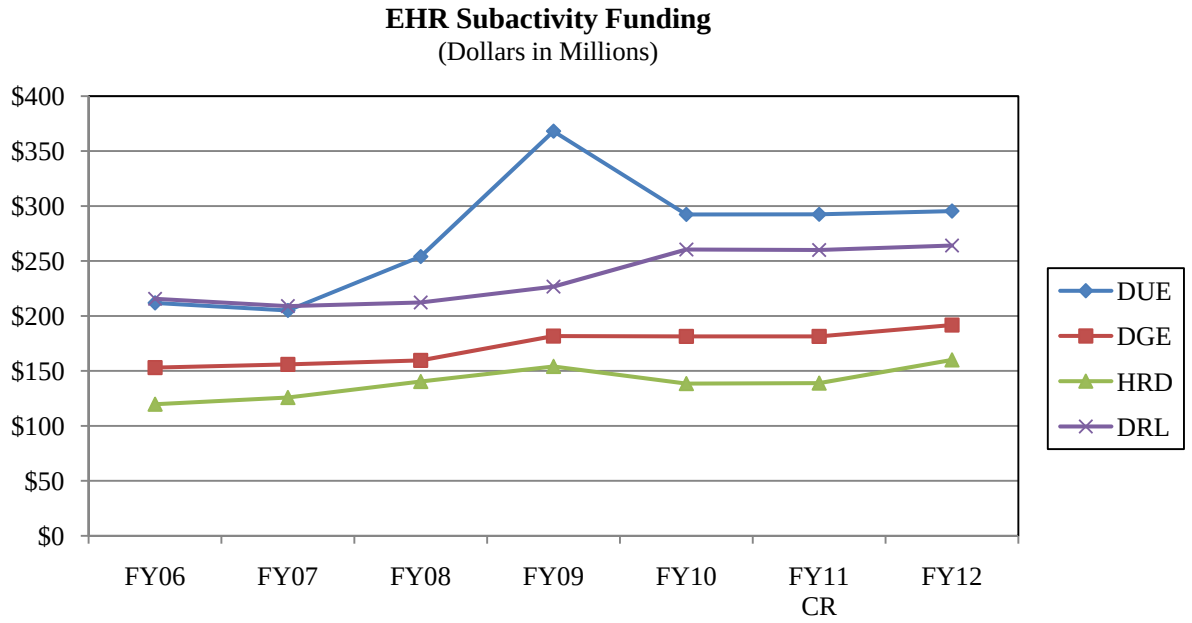
NSF's strategic goals of transforming the frontiers of science and innovating for society require a scientifically literate populace and a scientific workforce prepared for innovation. With this budget request EHR continues its national leadership role in advancing an innovation agenda for science, technology, engineering, and mathematics (STEM) education that provides foundational building blocks, stimulates use-inspired research and translation, and addresses national priorities. In an exciting and shifting landscape for learning, new technologies allow STEM learning to occur anywhere, anytime, and by anyone. The lines between formal education and outside-of-school learning are blurred; and today's preparation of the workforce must ensure the diversity, creativity, and experience needed for tomorrow's scientific innovations. EHR programs support the research and development activities that enable the U.S. to respond positively to the challenges posed by such innovations.

Three broad national priorities drive the EHR FY 2012 Request:

- Improving K-12 STEM student and teacher learning, with more dramatic results in student outcomes ;
- Building a diverse and highly qualified STEM workforce, at a more rapid pace in areas of national need; and
- Advancing evaluation methods, designs, and approaches to ensure strategic investment.

NSF/EHR is the lead federal agency providing funding for research and development (R&D) in STEM education. For FY 2012, EHR proposes a realigned portfolio of programmatic investments intended to catalyze the design and implementation of the most promising education models, and to stimulate cutting-edge research and evaluation to better understand STEM learning programs, models, and resources. A second priority for EHR, the development of tomorrow's STEM workforce, is also an essential building block of the Administration's *Strategy for American Innovation.* In FY 2012, EHR proposes new directions for workforce development at all educational levels in order to ensure the diversity and

experience needed for tomorrow's scientific innovations and to continue to build capacity in educational institutions, particularly minority serving institutions and community colleges. Finally, EHR is committed to a strong focus on evaluation, to both learn from evaluation of its programs and to support research that will build evaluation knowledge, theory, and instruments. In addition, these efforts will be coordinated with planning for the NSF-wide assessment and evaluation.



The Administration has made education reform a top priority: "… countries that out-educate us today will out-compete us tomorrow. And so we want every citizen to have the skills and training they need in a global economy – from the day that you're born through whatever career you may choose." (President Obama, Carnegie Mellon University, June 2, 2010). This request is responsive to the President's goals and to recent key reports with strong recommendations about how to improve STEM education, such as *Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Mathematics Education* (President's Council of Advisors on Science and Technology, 2010). EHR will play a fundamental role in support of the President's goal of preparing 100,000 STEM teachers by expanding the research evidence about quality education for effective STEM teaching along with increasing the quantity. In FY 2012, EHR will explore across NSF – in conjunction with the field and other key agencies – the best structures and emphases for NSF's education and learning portfolio going forward. This is likely to result in further realignment within EHR and other education programs supported by NSF to enable more integrated, coherent, and impactful STEM learning and education investments.

Appropriation Language

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel, and rental of conference rooms in the District of Columbia, ~~$892,000,000~~*$911,200,000*, to remain available until September 30, ~~2012~~*2013*.

Education and Human Resources
FY 2012 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Expired	Total Resources	Obligations Incurred/Est.
FY 2010 Appropriation	$872.76	$0.05		$872.81	$872.77
FY 2009 ARRA	100.00			100.00	85.00
FY 2010 ARRA	-	15.00		15.00	15.00
FY 2010 Enacted/Annualized FY 2011 CR	872.76	0.04		872.80	872.80
FY 2012 Request	911.20			911.20	911.20
$ Change from FY 2010 Enacted/Annualized FY 2011 CR					$38.40
% Change from FY 2010 Enacted/Annualized FY 2011 CR					4.4%

Totals may not add due to rounding.

Explanation of Carryover

Within the **Education and Human Resources (EHR)** appropriation, $44,070 was carried over into FY 2011 for projects that were not ready for obligation in FY 2010. Obligation of these funds is expected by the second quarter of FY 2011.

FY 2012 Summary by Division

- As EHR's primary R&D division, the Division of Research on Learning in Formal and Informal Settings (DRL) has a mission that includes promoting innovative research, development, and evaluation of learning and teaching across all ages and STEM disciplines by advancing cutting-edge knowledge and practices in both formal and informal learning settings. DRL's role in the larger context of Federal support for education research and evaluation is to be a catalyst for change, and to ensure that tomorrow's innovations are being developed today. DRL programs advance theory, method, measurement, development, and application in STEM education. DRL's FY 2012 Request will continue to support: the development of innovative resources, models, and tools for K-12 STEM education; fundamental research on learning; engaging experiences that support lifelong STEM learning; cyberlearning; teacher learning; research on national STEM education priorities; and evaluation studies and activities aimed at strategic STEM education investments. Specifically, a $10.0 million increase in Program and Project Evaluation (PPE) will fund enhanced EHR-wide activities to strengthen evaluation and improvement of STEM education programs.

  The new Teacher Learning for the Future (TLF) program will provide R&D awards to further understanding of the preparation and continuing education of STEM teachers, as the structure of formal education changes, as new technologies are developed, and as new science emerge. TLF will be housed in DRL and co-managed with DUE. As a crucial component of the Administration's innovation strategy, the 2012 Budget proposes an investment of $100 million through the Department of Education and the National Science Foundation to prepare effective STEM teachers for the classroom. The TLF program will coordinate closely with the Department of Education's Teacher Pathways program, which has $80 million specifically set aside to scale programs that recruit the nation's top undergraduates into STEM teaching. TLF will improve our understanding of what

makes a great STEM teacher, and how to best train, support, and retain highly effective STEM teachers.

The Research and Evaluation on Education in Science and Engineering (REESE) program will incorporate the substantive focus of two programs currently in the Division of Human Resource Development – Research in Disabilities Education (RDE) and Research on Gender in Science and Engineering (GSE) – in order to bring more coherence to the directorate's research programs (see crosswalk table at the end of this section).

- The Division of Human Resource Development (HRD) serves as a focal point for NSF's agency-wide commitment to promoting excellence in STEM education and research through broadening participation of underrepresented minorities and minority-serving institutions, women, and persons with disabilities. In FY 2012, EHR proposes to realign HRD into two main areas: Broadening Participation at the Core (BPAC) and Research and Education Infrastructure (REI). BPAC will further efforts toward synergy with an overarching, comprehensive framework that will amplify and expand targeted investments in minority-serving institutions. In FY 2012, HRD will maintain the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), Louis Stokes Alliances for Minority Participation (LSAMP), and Tribal Colleges and Universities Program (TCUP) separately within this comprehensive framework. Additionally, a new pilot program, Transforming Broadening Participation through STEM (TBPS), will be launched under BPAC to engage the field in new approaches to broadening participation that can reach particular populations such as Hispanic-serving institutions.

  ADVANCE, the Alliances for Graduate Education and the Professoriate (AGEP), and Centers of Research Excellence in Science and Technology (CREST) form the Research and Education Infrastructure (REI) area. Research on Gender in Science and Engineering (GSE) and Research in Disabilities Education (RDE) move to DRL as components of the REESE program and will be jointly managed by HRD and DRL, so that the substantive focus on gender and persons with disabilities remains core within HRD (see crosswalk table at the end of this section).

- The Division of Graduate Education (DGE) leads NSF's efforts to attract the most talented U.S. students into graduate studies and to promote excellence in graduate education to prepare the Nation's leading scientists and engineers of the future. DGE's FY 2012 Request reflects its commitment to supporting U.S. graduate students and innovative graduate traineeship programs that prepare tomorrow's leaders in STEM. The Graduate Research Fellowship program will award 2,000 new fellowships, maintaining the doubling of the number of new awards as achieved in FY 2010. In FY 2012 NSF will increase the cost of education (COE) allowance from $10,500 to $12,000 and integrate international opportunities into the fellows' graduate education to support their development as global leaders of tomorrow. FY 2012 funding for the Integrative Graduate Education and Research Traineeship (IGERT) program will provide continued support for training programs that integrate innovation into the development of graduate students.

  The GK-12 program is being eliminated and will not hold a new competition in FY 2012 or subsequent years. FY 2011 funds, from both R&RA and EHR, will be used to cover FY 2011 and part of FY 2012 out-year commitments. The remaining out-year commitments will be funded by EHR. Other programs, such as IGERT and Math and Science Partnership (MSP) will consider introducing the promising practices identified through evaluation of the GK-12 program into their solicitations. See the division narrative for more detail.

- DUE's FY 2012 Request will support the division's mission to be the NSF focal point for transforming undergraduate STEM education to meet the needs of the 21st century. DUE will

continue to meet its objectives to strengthen the science and engineering workforce and prepare all undergraduate students for an increasingly technological global society. DUE will make additional investments in increasing and developing the scientific and technical workforce via the STEM Talent Expansion Program (STEP) and the Federal Cyber Service: Scholarship for Service/Cybercorps (SfS) programs. DUE will increase its efforts to engage the community college sector.

A new program, Widening Implementation and Demonstration of Evidence-based Reforms (WIDER), will be housed in DUE and co-managed with DRL. WIDER will fund research on how to achieve widespread sustainable implementation of evidence–based undergraduate instructional practices to improve student outcomes, based in part on demonstration models of such practices.

The National STEM Education Distributed Learning (NSDL) program will be eliminated in FY 2012. Its core agenda, to assure the availability and utility of electronic resources for education, will be subsumed as part of the larger agenda of Cyberlearning Transforming Education (CTE).

Division of Human Resource Development (HRD) Realignment

(Dollars in Millions)

Proposed FY 2012 Structure			FY 2011 Structure											Total, FY 2012 Structure
			HRD										DRL	
			Undergraduate/Graduate Student Support					Opportunitites for Women and Persons with Disabilities			Research and Education Infrastructure			
			Total	*HBCU-UP*	*LSAMP*	*TCUP*	*Pilot for Comprehensive Broadening Participation of Undergraduates in STEM (CBP-US)*	ADVANCE	*GSE*	*RDE*	AGEP	CREST	REESE	
HRD	Broadening Participation at the Core (BPAC)	Science & Engineering Workforce for Tomorrow	$111.10											**$111.10**
		Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)		*32.00*										***$32.00***
		Louis Stokes Alliances for Minority Participation (LSAMP)			*44.75*									***$44.75***
		Tribal Colleges and Universities Program (TCUP)				*14.35*								***$14.35***
		Transforming Broadening Participation through STEM (TBPS)					*20.00*							***$20.00***
	Research and Education Infrastructure	ADVANCE						1.58						**$1.58**
		Alliances for Graduate Education and the Professoriate (AGEP)									16.75			**$16.75**
		Centers for Research Excellence in Science and Technology (CREST)										30.53		**$30.53**
													Total, FY 2012 Structure for HRD	**$159.96**
DRL		Research and Evaluation on Education in Science and Engineering (REESE)											54.72	**$54.72**
		Research in Disabilities Education (RDE)							*6.50*					***$6.50***
		Research on Gender in Science and Engineering (GSE)								*10.50*				***$10.50***
													Total, FY 2012 Structure for DRL - REESE	**$54.72**

Major Investments

EHR Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Widening Implementation and Demonstration of Evidence-based Reforms (WIDER)	-	-	-	$20.00	$20.00	N/A
Teacher Learning for the Future (TLF)	-	-	-	20.00	20.00	N/A
Community Colleges and Two-Year Institutions	65.00	-	75.00	100.00	25.00	33.3%
Project and Program Evaluation (PPE)	12.10	-	12.00	22.00	10.00	83.3%

- Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) is a new program proposed for FY 2012, with a goal of moving improved undergraduate STEM education practices to scale. This program will support research on how to achieve widespread sustainable implementation of improved undergraduate instructional practices and student outcomes at major universities, as well as demonstration models. Competitive proposals will target the teaching of a majority of undergraduate courses and the instructional practices of faculty in a department, for STEM departments at an institution. This program will also support activities to address improvements in the student educational experience not tied to specific courses. Data to be collected will include, but not necessarily be limited to, impacts on student learning and completion rates, faculty teaching practices, impacts on institutional evaluation, and incentive practices for faculty. Data will be collected on organizational policies and structures that either encourage or inhibit the desired changes. DUE will serve as the lead division for this new program, which will be co-managed by DRL. There is strong interest in engagement from across NSF.

- Teacher Learning for the Future (TLF) is a new research program proposed for FY 2012 that will focus on the potential to improve the training of pre-service, in-service, and future generations of teachers as the structure of formal education changes, as technologies enable teaching practices not yet envisioned, as new science is developed, and as boundaries between in-school and out-of-school learning blur. TLF will re-establish the centrality of NSF in discovering, studying, and promoting pathways for STEM teacher learning through research. Complementing the support of new tools for cyberlearning, the TLF program will focus on the needs of the next generation of STEM teachers. The program will be housed in DRL and co-managed with DUE. In this effort, the TLF program will coordinate closely with the Department of Education's Teacher Pathways program, which has $80 million specifically set aside to replicate and then scale programs that recruit the nation's top undergraduates into STEM teaching.

- Funding for community colleges will be a priority across EHR in FY 2012, building on EHR's long history in this area. As President Obama has stated about community colleges, "They may not get the credit they deserve, they may not get the same resources as other schools, but they provide a gateway to millions of Americans to good jobs and a better life….These are places where young people can continue their education without taking on a lot of debt. These are places where workers can gain new skills to move up in their careers." (White House Summit on Community Colleges, October 5, 2010). In addition to a continued focus on community colleges through DUE's Advanced

Technological Education (ATE) program, in FY 2012, the Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) program in DUE and undergraduate programs in HRD (namely, LSAMP and TCUP), will provide support to this important segment of the higher education spectrum. Other EHR programs that will contribute to this effort include SfS, STEP, TLF, MSP, and Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

- The Project and Program Evaluation (PPE) program, an EHR-wide initiative housed in DRL, will fund evaluation, synthesis, and comparison studies designed to increase knowledge of effective practices in STEM learning and education, and program evaluation. EHR will continue to evaluate its programs on a regular basis, working through a newly-formed directorate-wide coordination group in consultation with experts both inside and outside of NSF, including research methodologists, evaluators, NSF's Division of Science Resources Statistics (SRS), and other agencies. Solicitations calling for research and development in evaluation theory, methods, and tools will be expanded in FY 2012. Under this EHR-wide arrangement, the directorate will build coherent directorate-level systems for program and thematic evaluation, including engaging with the U.S. Department of Education on issues of mutual interest.

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

EHR programs require project-level evaluations that are used for both formative and summative input to the projects and also for informing NSF programs and divisions about important findings. In addition, program evaluations are ongoing to assess program quality and impact, and the results of these formative and summative evaluation activities are essential to the continued shaping of program and portfolio directions and emphases. In FY 2012, program evaluation and planning activities are scheduled for the Advanced Technological Education (ATE), Cyberlearning Transforming Education (CTE), Math and Science Partnership (MSP), Promoting Research and Innovation in Methodologies for Evaluation (PRIME), STEM Talent Expansion Program (STEP) and Transforming Undergraduate Education in STEM (TUES) programs. See the Performance Information section for additional information.

To ensure the quality of EHR's processes for handling proposals and recommending proposals for awards, EHR convenes Committee of Visitors (COV) comprised of expert external evaluators to review all programs on a three-year rotating basis. In FY 2012, COV reviews are scheduled for REESE and DR-K12 in DRL; ATE, TUES, STEP, and NSDL in DUE; GRF in DGE; and RDE and GSE in HRD.

Number of People Involved in EHR Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	7,909	148	8,130	8,040
Other Professionals	2,562	40	2,570	2,600
Postdocs	321	-	470	330
Grad Students	8,142	100	8,645	8,270
Undergrads	9,807	-	5,365	9,970
K-12 Teachers	59,136	-	62,150	60,100
K-12 Students	84,844	-	82,470	86,230
Total, Number of People	172,721	288	169,800	175,540

DIVISION OF RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS (DRL)

$264,090,000
+$4,090,000 / 1.6%

DRL Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
DRL	**$260.49**	**$260.00**	**$264.09**	**$4.09**	**1.6%**
Knowledge Building					
Research and Evaluation on Education in Science & Engineering (REESE)[1]	64.16	63.50	54.72	-8.78	-13.8%
Research in Disabilities Education (RDE)	*[6.92]*	*[6.50]*	*[6.50]*	-	-
Research on Gender in Science and Engineering (GSE)	*[11.57]*	*[11.50]*	*[10.50]*	*[-1.00]*	*[-8.7%]*
Project and Program Evaluation (PPE)	12.10	12.00	22.00	10.00	83.3%
Lifelong Learning					
Informal Science Education (ISE)	65.85	66.00	68.14	2.14	3.2%
Resources, Models, and Tools					
Discovery Research K-12 (DR-K12)	118.38	118.50	99.23	-19.27	-16.3%
Teacher Learning for the Future (TLF)	-	-	20.00	20.00	N/A

Totals may not add due to rounding.

[1] In FY 2012, Research in Disabilities Education and Research on Gender in Science and Engineering program funding responsibilities are transferred from HRD to DRL. Funding for all years is shown in the FY 2012 structure for comparability.

DRL invests in research, evaluation, and development to improve the learning and teaching of STEM by all citizens. The division's programs build the knowledge base on STEM learning by learners of all ages and in all learning settings, including formal schooling, out-of-school programs, and the full range of everyday or designed learning environments, such as museum exhibits. The division is organized in three areas: Knowledge Building; Lifelong Learning; and Resources, Models, and Tools. These groupings provide intellectual direction and operational coordination for the division's programs and activities. The division's investment priorities are shaped by such ongoing educational challenges as reaching *all* learners with substantive opportunities to engage in STEM anywhere and anytime and bringing effective STEM learning innovations to scale. In addition, DRL is committed to developing and studying cutting-edge learning technologies, blurring the boundaries between formal and informal learning settings, and creating methodological tools for assessing learning impacts in a variety of forms.

STEM program evaluation design, research, and implementation is a high priority for the Division in FY 2012. Divisional plans will expand programmatic activity to enrich the tools, methods, and designs available for innovation in the evaluation of STEM learning and workforce programs and projects. In addition, DRL will assume a key role within EHR for building capacity and expertise in STEM education program evaluation and will be deeply engaged in collaborations with the U.S. Department of Education and other agencies in the planning and implementation of cross-agency evaluation efforts in STEM teacher professional development.

Knowledge Building

- Research and Evaluation on Education in Science and Engineering (REESE).
  In FY 2012 the REESE program ($54.72 million) will realign funding priorities to incorporate emphases in research in disabilities education and gender in science and engineering. This results from the proposed move of the RDE and GSE programs out of the Division of Human Resource Development (HRD) and into DRL to group all of the EHR basic research activities together in a single cluster (see page EHR – 6 for a diagram of the realignment). REESE will collaborate with HRD in FY 2012 on a solicitation to include RDE and GSE activities. The expanded REESE program will be managed jointly by DRL and HRD to strengthen and capitalize on the synergies among these complementary areas, and to ensure a continued focus on using research on broadening participation in HRD investments.
- Project and Program Evaluation (PPE).
  PPE increases by $10.0 million to a total of $22.0 million in FY 2012. PPE will fund research, evaluation, synthesis, and comparison studies designed to improve evaluation of STEM education and workforce programs, as well as STEM education program evaluation. Solicitations calling for research and development in evaluation theory, methods, and tools will be expanded in FY 2012. Program and portfolio evaluation activities will be subsumed within new, coherent EHR-wide program evaluation frameworks and structures. Planning for the joint NSF-Institute of Education Sciences evaluation of mathematics professional development has been underway and the study will move to implementation in FY 2012. NSF's investment will include PPE resources.

Lifelong Learning

- Informal Science Education (ISE).
  ISE receives a total investment of $68.14 million in FY 2012. This includes a $3.74 million investment to support Connecting Researchers and Public Audiences (CRPA), which increases opportunities for NSF-funded researchers to engage the public using cutting-edge evidence-based communication techniques. This will utilize platforms that support the Communicating Science Broadly activity funded through Integrative Activities (IA). In addition, ISE will place emphasis on projects that strengthen connections between the research and practice communities and between the formal and informal learning communities. Evaluation plans will be developed to assess impact of CRPA, in conjunction with experts in communication and public understanding.

Resources, Models, and Tools

- Discovery Research K-12 (DR-K12).
  DR-K12 will be supported at $99.23 million. High priorities for the program continue to be creating and studying new generations of cyber-enabled learning materials, providing anywhere and anytime learning resources for teachers and students, advancing assessment of student STEM knowledge and skills, and understanding the issues and requirements for effective scale-up of successful approaches. With DRL assuming lead responsibility for TLF, the DRK-12 program can be re-focused to emphasize resources, models, and tools for K-12 students. Aspects of DRK-12 that have focused on recruitment and development of teacher learning will be addressed in TLF.
- Teacher Learning for the Future (TLF).
  TLF is a new $20.0 million research program proposed for FY 2012. It will catalyze new lines of research and development needed for rapid improvement of the preparation and continued professional learning of the STEM teachers of tomorrow. TLF will support concept development and prototype proposals, to encourage research about new modes of teacher learning. It will also fund implementation and evidence-building proposals, where demonstration projects will be designed, implemented, and studied. Finally, TLF will competitively fund research synthesis and evaluation networks to help knowledge accumulate and be ready for use to improve teacher education. TLF will provide the needed research base to support efforts across government to help ensure quality in

implementing the President's goal of preparing 100,000 STEM teachers in the next ten years. EHR will use the implementation of TLF, together with the proposed Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) program, as an opportunity to design a set of linked evaluation studies of EHR programs. Common instruments will be used for periodic data-gathering across several programs aimed at reforming undergraduate STEM education. In addition, the TLF program will coordinate closely with the Department of Education's Teacher Pathways program, which has $80 million specifically set aside to scale programs that recruit the nation's top undergraduates into STEM teaching. Research undertaken in the TLF program will improve our understanding of what makes a great STEM teacher.

DIVISION OF HUMAN RESOURCE DEVELOPMENT (HRD) $159,960,000
+$21,050,000 / 15.2%

HRD Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
HRD[1]	**$138.49**	**$138.91**	**$159.96**	**$21.05**	**15.2%**
Broadening Participation at the Core	**89.96**	**90.10**	**111.10**	21.00	23.3%
Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)	32.06	32.00	32.00	-	-
Louis Stokes Alliances for Minority Participation (LSAMP)	44.55	44.75	44.75	-	-
Tribal Colleges and Universities Program (TCUP)	13.35	13.35	14.35	1.00	7.5%
Transforming Broadening Participation through STEM (TBPS)	-	-	20.00	20.00	N/A
Research and Education Infrastructure	**48.53**	**48.81**	**48.86**	**0.05**	**0.1%**
Alliances for Graduate Education and the Professoriate (AGEP)	16.73	16.75	16.75	-	-
Centers of Research Excellence in Science and Technology (CREST)	30.32	30.53	30.53	-	-
ADVANCE	1.48	1.53	1.58	0.05	3.3%

Totals may not add due to rounding.

[1]In FY 2012, Research in Disabilities Education and Research on Gender in Science and Engineering ~~P~~program funding responsibilities are transferred from HRD to DRL. Funding for all years is shown in the FY 2012 structure for comparability.

In FY 2012, EHR proposes to realign HRD into two main themes (see page EHR – 6 for a diagram of the realignment): Broadening Participation at the Core (BPAC) and Research and Education Infrastructure (REI).

Broadening Participation at the Core (BPAC)

- In FY 2012, HRD will build on existing portfolio activities and launch Broadening Participation at the Core (BPAC), an overarching, comprehensive framework that will amplify and expand targeted investments in HBCUs, TCUs, other minority-serving institutions, and institutions with strong missions to support broadening participation, in coordination with other EHR programs such as ATE and STEP. BPAC will highlight emerging and exciting new directions in disciplinary and interdisciplinary science as key resources for attracting and retaining students from groups traditionally underrepresented in STEM. It will take into account the lessons learned and evidence base from previous investments and will recognize the emerging contexts and cultures of particular groups, institutions, and disciplines. The BPAC goal is to transform education practice and learning opportunities at the undergraduate level to broaden participation and to engage undergraduate students with frontier research in emerging fields to retain them in STEM majors. Within this activity HRD will expand its efforts to involve community colleges. An additional $20.0 million is requested in BPAC in FY 2012 for a pilot program, Transforming Broadening Participation through STEM (TBPS). This new program will seek innovative solutions for broadening participation in STEM at the undergraduate level in anticipation of tomorrow's changing demographics, including increased engagement with Hispanic-serving institutions.

The Research and Education Infrastructure (REI)

- The REI cluster will include ADVANCE, the Alliances for Graduate Education and the Professoriate (AGEP), and the Centers of Research Excellence in Science and Technology (CREST). Requesting $48.86 million in FY 2012, these programs will support the transformation of institutional academic and research infrastructures to expand opportunities for underrepresented groups in STEM disciplines at the graduate, post-doctorate, and professoriate levels.

DIVISION OF GRADUATE EDUCATION (DGE) $191,730,000
+$10,290,000 / 5.7%

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
DGE	**$181.43**	**$15.00**	**$181.44**	**$191.73**	**$10.29**	**5.7%**
Graduate Research Fellowship (GRF)	102.47	-	102.58	134.61	32.03	31.2%
Graduate STEM Fellows in K-12 Education (GK-12)	48.86	-	49.00	26.95	-22.05	-45.0%
Integrative Graduate Education and Research Traineeship Program (IGERT)	30.11	-	29.86	30.17	0.31	1.0%
Science Masters Program (SMP)	-	15.00	-	-	-	N/A

Totals may not add due to rounding.

DGE supports U.S. graduate students and innovative graduate programs to prepare tomorrow's leaders in science, technology, engineering and mathematics. DGE meets this objective through a portfolio of three graduate education programs that vary in their designs and in the options and opportunities provided to graduate students.

- Graduate Research Fellowship (GRF).
  The FY 2012 Request, $134.61 million, supports 2,000 new GRF fellows and maintains the doubling of new awards achieved in FY 2010. Within this budget, a planned international activity ($2.0 million), jointly led by DGE and the Office of International Science and Engineering (OISE), will allow fellows to integrate international opportunities into their graduate education for development as global leaders of tomorrow. To maintain the competitiveness and fiscal integrity of the GRF program, the cost of education (COE) level will be increased in FY 2012 from $10,500 to $12,000. The new COE level is consistent with the America COMPETES Reauthorization Act of 2010. NSF will also begin implementing a multi-year plan to address inflationary pressures on the long-stagnant GRF stipend level, including initial funding in FY 2012 for a stipend increase to $32,000 that will be fully implemented in FY 2013. Additional stipend increases are planned beyond FY 2013.
- Graduate STEM Fellows in K-12 Education (GK-12).
  Graduate STEM Fellows in K-12 Education (GK-12) was initiated in 1999, and during the subsequent years more than 300 projects have been funded throughout the Nation. NSF is terminating the GK-12 program in FY 2012 because the program has achieved its goal of providing models for potential adopters; recent evaluation findings suggest that the effects of this program's fellowship experience in improving the trainees' research skills are mixed and the program design limits the ability of participants to gain enough in-depth experience in K-12 teaching to impact pupil learning. Remaining out-year commitments will be funded by EHR. DGE will use the experience gained from ten years of funding the GK-12 program to call for innovation in graduate traineeship experiences through other programs.
- Integrative Graduate Education and Research Traineeship (IGERT).
  FY 2012 funding for IGERT ($30.17 million) will provide continued support for training programs that integrate preparation for research and innovation into the development of graduate students. Special emphasis in FY 2012 will be placed on how such areas as preparation for innovation, institutional integration, advanced manufacturing education, and communicating with students, teachers, and the public can be infused within the IGERT program.

DIVISION OF UNDERGRADUATE EDUCATION (DUE)

$295,420,000
+$3,010,000 / 1.0 %

DUE Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
DUE	**$292.35**	**$292.41**	**$295.42**	**$3.01**	**1.0%**
Curriculum, Laboratory and Instructional Development	**63.29**	**63.46**	**73.47**	**10.01**	**15.8%**
Transforming Undergrad Ed in STEM (TUES) [was CCLI]	41.60	41.71	47.97	6.26	15.0%
National STEM Education Distributed Learning (NSDL)	16.19	16.25	-	-16.25	-100.0%
Climate Change Education (CCE)	5.49	5.50	5.50	-	-
Widening Implementation and Demonstration of Evidence-based Reforms (WIDER)	-	-	20.00	20.00	N/A
Workforce Development	**116.20**	**115.73**	**128.73**	**13.00**	**11.2%**
Advanced Technological Education (ATE)	64.51	64.00	64.00	-	-
Excellence Awards in Science and Engineering (EASE)	5.18	5.20	5.20	-	-
Federal Cyber Service: Scholarship for Service/Cybercorps (SFS)	14.87	15.00	25.00	10.00	66.7%
STEM Talent Expansion Program (STEP)	31.64	31.53	34.53	3.00	9.5%
Teacher Education	**112.86**	**113.22**	**93.22**	**-20.00**	**-17.7%**
Robert Noyce Scholarship Program (NOYCE)	54.93	55.00	45.00	-10.00	-18.2%
Math and Science Partnership (MSP)	57.93	58.22	48.22	-10.00	-17.2%

Totals may not add due to rounding.

DUE is the NSF focal point for transforming undergraduate STEM education to meet the needs of the 21st century. DUE's objectives are to strengthen the science and engineering workforce and prepare all undergraduate students for an increasingly technological global society. DUE programs emphasize innovation and ongoing improvement in curricula, teaching procedures, and laboratories, so that the next generation is continuously learning with the tools and methods of inquiry used by working professionals. Collaborations are encouraged among institutions and across sectors (higher education, industry, and K-12). So that best practices penetrate deeply into the undergraduate education community, DUE provides support for faculty development, new instructional materials, reform of courses, laboratories, and curricula, and assessment of outcomes. DUE also requires that projects build on available evidence about teaching and learning and that projects generate findings to enrich the knowledge base. This emphasis on transforming undergraduate education will be expanded through the Widening Implementation and Demonstration of Evidence-based Reforms program, proposed for FY 2012.

In addition to its core activity of improvement in undergraduate curriculum and teaching practice, DUE contributes directly to the development of the scientific and technical workforce via the Advanced Technological Education (ATE) and the Federal Cyber Service: Scholarship for Service (SfS) programs. The STEM Talent Expansion Program (STEP) further supports the Nation's technical workforce by increasing the number of students completing STEM degrees. DUE also has a significant investment in STEM teacher education through the MSP and NOYCE programs. To complement these programmatic activities, a new teacher education program, Teacher Learning for the Future (TLF), is proposed for FY 2012, to be based in DRL and co-led by DUE.

In FY 2011 DUE will collaborate with HRD to increase outreach to community colleges and in FY 2012, EHR will implement a systematic means to track community college investments. A combination of

programs (ATE, STEP, SfS, TLF, MSP, S-STEM, and BPAC in HRD) will invest $100.0 million in community colleges in FY 2012.

Curriculum, Laboratory, and Instructional Development

- Transforming Undergraduate Education in STEM (TUES).
  TUES increases by $6.26 million. The additional resources will be utilized to enhance efforts to engage community colleges.
- National STEM Education Distributed Learning (NSDL).
  In FY 2012, the NSDL program will be eliminated based in part upon recent evaluation findings that point to the challenges of sustaining such a program in the face of changing technology and the ways educators now find and use classroom materials. The key research and development elements of its agenda – to assure the availability and utility of digital objects for learning – will be subsumed as part of the agenda of other programs, mainly the multi-directorate Cyberlearning Transforming Education (CTE) effort.

  In 2009, a working group convened jointly by the Advisory Committees for EHR and the Office of Cyberinfrastructure advised the NSF to make investments that would launch cyberlearning as a field of study in a way analogous to its investment in nanotechnology. Several core program solicitations in EHR now call attention to the centrality of cyberlearning (e.g., DRK-12, TUES, and ITEST); and others will move in this direction (e.g., MSP). In FY 2012, preparing the next generation of teachers to be confident of a cyberlearning environment will have its own visible support as part of the TLF initiative. These core programs within EHR will fund studies of the impact of cyberlearning approaches on teacher behavior and student learning, and will also support the ongoing work of engaging teachers with cyberlearning.

- Widening Implementation and Demonstration of Evidence-based Reforms (WIDER).
  WIDER is a new program proposed for FY 2012 to bring evidence-based undergraduate STEM education practices and curricular innovations to scale. This program will support research on how to achieve widespread sustainable implementation of undergraduate instructional practices leading to improved student outcomes in STEM at major universities through demonstration models. Competitive proposals will target the teaching of a majority of undergraduate STEM courses and the teaching practices of a majority of the faculty in a department for many STEM departments at the institution. Proposals also may include improvements in students' education experiences not tied to specific courses, such as effective advising, mentoring, and use of cohorts. Data will be collected on student learning outcomes and completion rates, description of faculty teaching practices, institutional evaluation, incentive practices and policies for faculty, and documentation of organizational policies and structures. Baseline data-gathering about the state of instruction and curriculum at awardees' institutions will be required. WIDER will be housed in DUE and co-managed by DRL. There is strong commitment from across NSF for engagement with all directorates and offices in WIDER so that particular disciplinary emphases, priorities, and opportunities can be reflected.

Workforce Development

- DUE will make increased investments in developing the scientific and technical workforce through both the STEM Talent Expansion Program (+$3.0 million to a total of $34.53 million) and the Federal Cyber Service Scholarship for Service (SfS) program (+$10.0 million to a total of $25.0 million). The increased resources for the STEP program will support additional STEP Centers, and the increased resources for the SfS program will support progress toward the program's target number of scholars.

Teacher Education

- Robert Noyce Scholarship Program (NOYCE)
  In FY 2012, $10.0 million from NOYCE will be reallocated to establish the new Teacher Learning for the Future (TLF) program housed in DRL. This reduction will result in fewer NOYCE awards; however, complementary, innovative projects will be supported by TLF. In this way NSF can continue to support research and innovation in teacher preparation programming in tandem with efforts to increase the STEM teacher workforce for tomorrow. The $45.0 million requested for NOYCE will continue to encourage talented STEM undergraduate and graduate students and professional to become K-12 mathematics and science teachers through scholarship and stipends.
- Math and Science Partnership (MSP).
  In FY 2012, $10.0 million from MSP will also be reallocated to establish the new TLF program. This reduction will result in fewer MSP awards but similar to NOYCE, complementary, innovative projects will be supported by TLF. The requested $48.22 million for MSP will support robust continuation of MSP's current focus on establishing partnerships from which NSF continually learns about effective practices for enhancement of STEM teacher preparation. In FY 2012, MSP will enhance efforts to engage community colleges.

H-1B NONIMMIGRANT PETITIONER FEES **$100,000,000**

+$0 / 0%

In FY 2012, H-1B Nonimmigrant Petitioner Fees are projected to be $100.0 million, equal to the FY 2011 projection.

H-1B Nonimmigrant Petitioner Fees Funding

(Dollars in Millions)

	FY 2010 Actual	FY 2011 Estimate	FY 2012 Estimate	Change over FY 2011 Estimate Amount	Percent
H-1B Nonimmigrant Petitioner Fees Funding	$96.81	$100.00	$100.00	-	-

In FY 2005, Public Law 108-447 reauthorized H-1B funding. NSF was provided with 40 percent of the total H-1B receipts collected. Thirty percent of H-1B receipts (75 percent of the receipts that NSF receives) are to be used for the Low-income Scholarship Program, which has now been renamed Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM). Ten percent of receipts (25 percent of the receipts that NSF receives) are designated for support of the Grants for Mathematics, Science, or Engineering Enrichment Courses, through ITEST.

- **Low-income Scholarship Program: S-STEM.** Eligibility for the scholarships was expanded in 2006 from the original fields of computer science, engineering, and mathematics to include "other technology and science programs designated by the Director." The maximum annual scholarship award amount was raised from $3,125 to $10,000. NSF may use up to 50 percent of funds "for undergraduate programs for curriculum development, professional and workforce development, and to advance technological education." Because of the changes, the program was renamed in 2006 from CSEMS to Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM).

  Since its inception the low-income scholarship program has received approximately 3,281 proposals from all types of colleges and universities and has made awards for 1,104 projects. Approximately 58,000 students have received scholarships ranging from one to four years, and many new grants have yet to award all their scholarships. In addition to scholarships, projects include student support activities featuring close involvement of faculty, student mentoring, academic support, curriculum development, and recognition of the students. Such activities are important in recruiting and retaining students in high-technology fields through graduation and into employment. S-STEM projects report much higher retention and graduation rates among scholarship students than among other STEM majors. Approximately 90 awards are anticipated in FY 2012, with an emphasis on increasing involvement of community colleges.

- **Mathematics, Science, or Engineering Enrichment Courses: ITEST**. The ITEST program invests in K-12 activities that address the current concern about shortages of STEM professionals and information technology workers in the U.S. and seeks solutions to help ensure the breadth and depth of the STEM workforce. ITEST funds education programs for students and teachers that emphasize mathematics, science, and engineering careers. The program supports the development, implementation, testing, and scale-up of models, STEM robotic projects, and research studies to improve the STEM workforce and build student's capacity to participate in the STEM workforce. The solicitation places emphasis on capturing and establishing a reliable knowledge base about the dispositions toward and knowledge about STEM workforce skills in U.S. students.

Since its inception, the ITEST program has received 1,541 proposals and funded over 200 projects that allow students and teachers to work closely with scientists and engineers on extended research projects, ranging from biotechnology to environmental resource management to programming and problem-solving. Projects draw on a wide mix of local resources, including universities, industry, museums, science and technology centers, and school districts in order to identify the characteristics that engage a wide range of young people in STEM, especially those not successful in traditional school settings. Through a projected $191 million federal investment, ITEST impacts an estimated 216,000 students (grades K-12), 7,700 educators, and 2,300 parents and caregivers. In FY 2010, ITEST received 396 full proposals and funded 14 awards.

H-1B Financial Activities from FY 2000 - FY 2010

(Dollars in Millions)

	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Receipts	**$48.61**	**$88.34**	**$61.04**	**$65.34**	**$0.57**	**$83.68**	**$105.32**	**$107.36**	**$104.43**	**$88.66**	**$91.22**
Unobligated Balance start of year	**$26.35**	**$49.89**	**$59.72**	**$63.45**	**$83.90**	**$29.10**	**$89.58**	**$98.19**	**$63.37**	**$50.83**	**$52.62**
Obligations incurred:											
Computer Science, Engineering, and Mathematics Scholarships	23.16	68.37	34.69	25.30	33.91	0.54	80.95	100.04	92.40	61.22	75.96
Grants for Mathematics, Engineering or Science Enrichment Courses	0.20	4.22	5.83	16.27	-	-	-	-	-	-	
Systemic Reform Activities	1.70	3.70	3.97	5.00	2.50	2.72	-	-	-	-	
Private-Public Partnership in K-12[1/]	-	2.22	12.82	-	20.87	22.69	18.45	45.90	28.72	27.86	20.85
Total Obligations	**$25.06**	**$78.51**	**$57.31**	**$46.57**	**$57.28**	**$25.95**	**$99.40**	**$145.94**	**$121.12**	**$89.08**	**$96.81**
Unallocated Recoveries										2.20	3.12
Unobligated Balance end of year	**$49.89**	**$59.72**	**$63.45**	**$83.90**	**$29.10**	**$89.58**	**$98.19**	**$63.37**	**$50.83**	**$52.62**	**$50.15**

Totals may not add due to rounding.

[1/] P.L 106-313 directs that 15 percent of the H-1B Petitioner funds go toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, math and science teacher professional development, etc.

Beginning in FY 1999, Title IV of the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) established an H-1B Nonimmigrant Petitioner Account in the general fund of the U.S. Treasury for fees collected for each petition for alien nonimmigrant status. That law required that a prescribed percentage of funds in the account be made available to NSF for the following activities:

- **Computer Science, Engineering, and Mathematics Scholarships (CSEMS)**. The program supported grants for scholarships to academically-talented, financially needy students pursuing associate, baccalaureate, or graduate degrees in computer science, computer technology, engineering, engineering technology, or mathematics. Grantee institutions awarded scholarships of up to $2,500 per year for two years to eligible students.

- **Grants for Mathematics, Engineering, or Science Enrichment Courses.** These funds provided opportunities to students for enrollment in year-round academic enrichment courses in mathematics, engineering, or science.
- **Systemic Reform Activities.** These funds supplemented the rural systemic reform efforts administered under the former EHR Division of Educational System Reform (ESR).

In FY 2001, Public Law 106-311 increased the funds available by increasing the petitioner fees. Also, the American Competitiveness in the 21st Century Act (P.L. 106-313) amended P.L. 105-277 and changed the way petitioner fees were to be expended.

- The CSEMS activity continued under P.L. 106-313 with a prescribed percentage of H-1B receipts. The maximum scholarship duration was four years and the annual stipend was $3,125. Funds for this scholarship program totaled 59.5 percent of the total H-1B funding for NSF.
- Private-Public Partnerships in K-12: P.L. 106-313 directed the remaining 40.5 percent of receipts toward K-12 activities involving private-public partnerships in a range of areas such as materials development, student externships, and mathematics and science teacher professional development.
- The Information Technology Experiences for Students and Teachers (ITEST) program was developed as a partnership activity in K-12 to increase opportunities for students and teachers to learn about, experience, and use information technologies within the context of STEM, including information technology (IT) courses.

Explanation of Carryover

An amount totaling $50.15 million was carried over into FY 2011. NSF's carryover for H-1B funded programs consists of $40.63 million in S-STEM and $9.52 million in ITEST. All carryover funds are expected to be obligated during the second quarter of FY 2011.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

$224,680,000
+$107,390,000 / 91.6%

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Major Research Equipment and Facilities Construction	$165.90	$146.00	$117.29	$224.68	$107.39	91.6%

The Major Research Equipment and Facilities Construction (MREFC) account supports the acquisition, construction, and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and post-construction operations and maintenance of the facilities are funded through the Research and Related Activities (R&RA) account.

MREFC Account Funding, by Project
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate
AdvLIGO	$46.30	-	$46.30	$20.96	$15.17	$14.92	-	-	-
ALMA	42.76	-	42.76	3.00	-	-	-		
ARRV	33.23	-	-	-	-	-	-	-	-
ATST	20.00	146.00	13.00	10.00	30.00	20.00	20.00	20.00	14.93
IceCube	2.38	-	0.95	-	-	-	-	-	-
NEON	-	-	-	87.92	101.07	103.43	86.23	32.07	-
OOI	20.19	-	14.28	102.80	46.80	20.00	-	-	-
SPSM	1.03	-	-	-	-	-	-	-	-
MREFC Total	**$165.90**	**$146.00**	**$117.29**	**$224.68**	**$193.04**	**$158.35**	**$106.23**	**$52.07**	**$14.93**

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution. See the FY 2012 Summary Statement on the next page for a full accounting of the FY 2010 Enacted amounts in the MREFC account. Upon enactment of a full-year appropriation for FY 2011, the FY 2011 funding amounts for each project will be determined.

Modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering (S&E). The future success of entire fields of research depends upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

To be considered for MREFC funding, NSF requires that a project represent an exceptional opportunity to enable research and education. In addition, the project should be transformative in nature in that it should have the potential to shift the paradigm in scientific understanding. The projects included in this budget request meet these criteria based on NSF and National Science Board (NSB) review.

All of the projects in the MREFC account have undergone major cost and schedule reviews as required by NSF guidelines. Most recently, the projects that received funding through the American Recovery and Reinvestment Act of 2009 (ARRA), the Alaska Region Research Vessel (ARRV), the Ocean Observatories Initiative (OOI), and the Advanced Technology Solar Telescope (ATST), have initiated construction.

In FY 2012, NSF requests funding to continue construction of five projects: Advanced LIGO (AdvLIGO), the Atacama Large Millimeter Array (ALMA), ATST, OOI, and the National Ecological Observatory Network (NEON).

NSF maintains a "no cost overrun" policy which requires that each MREFC project be completed within the total risk-adjusted cost estimate established when the project is approved for implementation. Consequently any cost increases encountered during implementation that exceed the approved total project cost must be accommodated by reductions in scope. NSF senior management has instituted agency-wide procedures to assure that the cost tracking and management processes are robust and that the project management oversight has sufficient authority to meet this objective.

Appropriation Language

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, ~~$165,190,000,~~*$224,680,000*, to remain available until expended.

Major Research Equipment and Facilities Construction
FY 2012 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers	Total Resources	Obligations Incurred/Est.
FY 2010 Appropriation	$117.29	$57.78		$175.07	$165.90
FY 2009 ARRA	400.00			400.00	254.00
FY 2010 ARRA	-	146.00		146.00	146.00
FY 2010 Enacted/Ann. FY 2011	117.29	9.17		126.46	126.46
FY 2012 Request	224.68			224.68	224.68
$ Change from FY 2010 Enacted/Annualized FY 2011 CR					$98.22
% Change from FY 2010 Enacted/Annualized FY 2011 CR					77.7%

Totals may not add due to rounding.

Explanation of Carryover:
Within the MREFC appropriation, a total of $9.17 million was carried over into FY 2011. This includes:

- $5.98 million for IceCube Neutrino Observatory (IceCube): Funding to the Air National Guard and other support functions is expected to be obligated by the fourth quarter of FY 2011.

- $3.0 million for National Ecological Observatory Network (NEON): Funding for continuing costs associated with this multi-year construction project are expected to be obligated and expended over the remaining period of construction.

- $190,944 for South Pole Station Modernization (SPSM): Costs related to completion of the fuel system and hoist are expected to be obligated in the third quarter of FY 2011.

American Recovery and Reinvestment Act of 2009 (ARRA)

Within the **Major Research Equipment and Facilities Construction** appropriation, a total of $146.0 million of ARRA funds was carried over into FY 2010 for the Advanced Technology Solar Telescope (ATST), and obligated in January 2010.

The MREFC Account in FY 2012

The following pages contain information on NSF's ongoing projects in FY 2012, grouped by sponsoring organization. These are:

Advanced LIGO (MPS) ..... MREFC – 4
Advanced Technology Solar Telescope (MPS) ..... MREFC – 8
Alaska Region Research Vessel (GEO) ..... MREFC – 13
Atacama Large Millimeter Array (MPS) ..... MREFC – 18
IceCube (OPP/MPS) ..... MREFC – 23
National Ecological Observatory Network (BIO) ..... MREFC – 28
Ocean Observatories Initiative (GEO) ..... MREFC – 35

Advanced Laser Interferometer Gravitational-Wave Observatory $20,960,000

The FY 2012 Budget Request for the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) is $20.96 million, which represents the fifth year of a seven-year project totaling an estimated $205.12 million.

Appropriated and Requested MREFC Funds for the Advanced Laser Interferometer Gravitational-Wave Observatory

(Dollars in Millions)

FY 2008	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	Total Project Cost[1]
$32.75	$51.43	$46.30	$46.30	$20.96	$15.17	$14.92	$205.12

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $23.58 million. Any FY 2011 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

Baseline History

NSF first requested FY 2008 construction funds for AdvLIGO through the MREFC account in the FY 2006 Budget Request to Congress. The original proposal, received in 2003, estimated a total construction cost of $184.35 million. A baseline review in June 2006 established the project cost at $205.12 million, based upon known budget inflators at the time and a presumed start date of January 1, 2008. A second baseline review, held in June 2007, confirmed this cost, subject to changes in budget inflators. Final Design Review in November 2007 recommended that construction begin in FY 2008. The National Science Board approved the project at a cost of $205.12 million in March 2008, and the project began in April 2008.

AdvLIGO is the planned upgrade of the Laser Interferometer Gravitational-Wave Observatory (LIGO) that will allow LIGO to approach the ground-based limit of gravitational-wave detection. LIGO consists of the world's most sophisticated optical interferometers, operating at two sites 3,000 km apart: Hanford, WA and Livingston, LA. These interferometers measure minute changes in arm lengths resulting from the passing of wave-like distortions of spacetime called gravitational waves, caused by cataclysmic processes in the universe such as the coalescence of two black holes or neutron stars. LIGO is sensitive to changes as small as one one-thousandth the diameter of a proton over the 4-km arm length; AdvLIGO is expected to be at least 10 times more sensitive. The LIGO program has stimulated strong interest in gravitational-wave research around the world, producing vigorous programs in other countries that provide strong competition as well as highly beneficial collaborations. LIGO has pioneered and led the field of gravitational-wave detection, and a timely upgrade is necessary to sustain progress in this area.

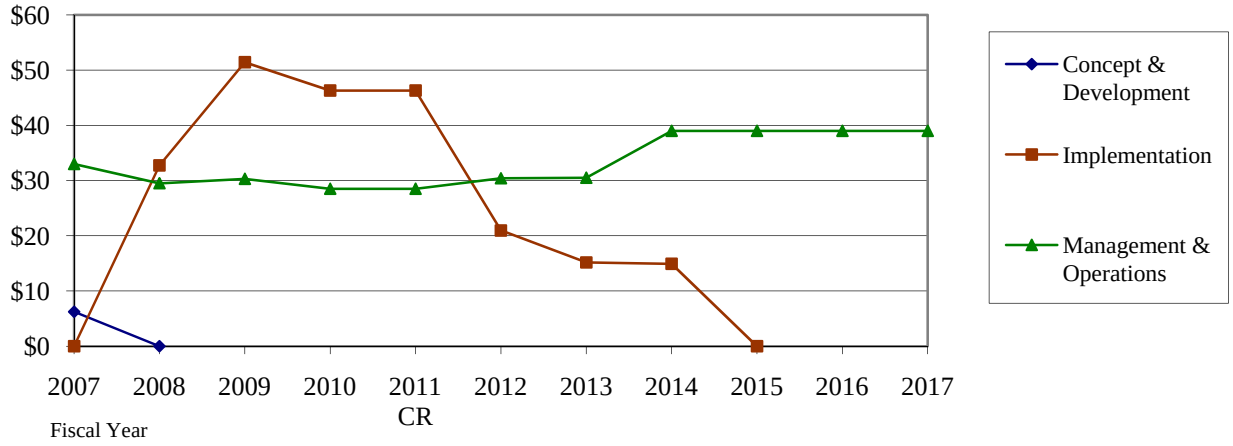
Total Obligations for AdvLIGO
(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$40.74	-	-	-	-	-	-	-	-
Management & Operations	30.30	28.50	28.50	30.40	30.50	39.00	39.00	39.00	39.00
Subtotal, R&RA Obligations	$71.04	$28.50	$28.50	$30.40	$30.50	$39.00	$39.00	$39.00	$39.00
MREFC Obligations:									
Implementation	84.18	46.30	46.30	20.96	15.17	14.92	-	-	-
Subtotal, MREFC Obligations	$84.18	$46.30	$46.30	$20.96	$15.17	$14.92	-	-	-
TOTAL Obligations	**$155.22**	**$74.80**	**$74.80**	**$51.36**	**$45.67**	**$53.92**	**$39.00**	**$39.00**	**$39.00**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $53.88 million: $23.58 million for MREFC and $30.30 million for R&RA. Any FY 2011 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

AdvLIGO Funding, by Stage
(Dollars in Millions)



Note: Management & Operations refers to the continued operations of LIGO during the construction phase and the onset of operations for the newly constructed AdvLIGO planned for FY 2015.

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects, with some partnerships leading to the development of new products. Areas of involvement include novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product introduced), high-power active optical components (new products), the development of new ultra-fine optics polishing techniques, and the development of new optical inspection equipment (new product).

LIGO has extensive international ties. The LIGO Scientific Collaboration, which sets the scientific agenda for LIGO, is an open collaboration that has established formal ties with at least 61 institutions in

13 countries. Close collaboration is maintained with two other gravitational-wave observatories: GEO, a UK-German collaboration, and Virgo, a French-Italian collaboration. LIGO has signed an agreement with Virgo under which all data will be shared and analyzed cooperatively and all discoveries will be jointly credited. New technologies critical to AdvLIGO are being contributed by foreign institutions: the pre-stabilized laser source, funded and developed by the Max Planck Gesellschaft; the mirror/test mass suspension systems, funded and developed by the GEO collaboration; and auxiliary optical components, developed by the Australian National University and Adelaide University.

Project Report

Management and Oversight

- NSF Structure: NSF oversight is coordinated internally by a dedicated LIGO program director in the Division of Physics (PHY) in the Directorate for Mathematics and Physical Sciences (MPS), who also participates in the LIGO Advisory Team (LIGO PAT). The LIGO PAT includes staff from the Offices of Budget, Finance, and Award Management (BFA), General Counsel (OGC), and Legislative and Public Affairs (OLPA). Formal reporting consists of submitted quarterly and annual reports and brief monthly status reports to the LIGO program officer, who in turn reviews, edits, comments, and submits the reports to the Deputy Director for Large Facility Projects.

- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement with NSF. An Executive Director has overall responsibility for the LIGO Laboratory. A Deputy Director is responsible for executing the LIGO program and for organizing and directing the Laboratory team. A LIGO Scientific Collaboration (LSC) Spokesperson is responsible for assuring that the efforts of the LSC and LIGO Laboratory are well aligned. (The LSC carries out the LIGO research and development program, the analysis of data, the publication of scientific results, and it enables participation by collaborating groups in appropriate LIGO activities). The Advanced LIGO construction project has its own management structure, which reports directly to the LIGO Executive Directorate. Advanced LIGO management consists of a Project Leader, who is responsible for the overall management of the project, a Project Manager, who oversees construction activities, and the System Engineer, who is responsible for all engineering for the project.

- Reviews:
  - Technical Reviews: NSF conducts annual scientific and technical reviews involving external reviewers, participates in meetings of the LIGO Scientific Collaboration (LSC), and conducts site visits to the Hanford, WA and Livingston, LA interferometers.
  - Management, Cost, and Schedule Reviews: (1) AdvLIGO construction proposal review in 2003; (2) first baseline review in June 2006; (2) second baseline review in June 2007; (3) final readiness review in November 2007.
  - The first AdvLIGO review of the active project was held in November 2008.
  - AdvLIGO's first annual review was held in April 2009, and an interim review was conducted in December 2009; the second annual review was held in April 2010, with an interim review in December 2010; and the third annual review is scheduled for April 2011.
  - Continuing annual reviews will be conducted by external panels throughout construction; these reviews will be supplemented by smaller interim reviews held concurrently with the LIGO facility annual reviews, which are held in the October to December timeframe each year.

Current Project Status

The National Science Board approved funding for AdvLIGO in March 2008, and the project began in April 2008. Major initial activities included the placing of long lead-time orders, the preparation of the sites for the upgrade, and the assembly of the new components. On October 20, 2010, the final LIGO

science run ended and the facility was turned over to the AdvLIGO project for the installation of the advanced components. The project has met its milestone dates so far, including ordering major items such as core optics blanks and their polishing and coating, and ordering components for the seismic isolation systems. Assembly of large subsystem components is continuing, and the removal of initial LIGO components has begun. The current performance is consistent with ending on time and on budget. Total project contingency usage as of November 2010 is $4.40 million of an initial $39.10 million, or 11 percent of contingency for 38 percent of the project completed.

Cost and Schedule

The projected length of the project is seven years, with an 11-month schedule contingency. The risk-adjusted cost of $205.12 million included a contingency budget of 23.7 percent (at the time of the award).

Risks

The AdvLIGO project underwent a comprehensive external annual review in April 2010 and an interim review in December 2010. The annual review panel reported: "Overall the project is on-track, and we commend and congratulate the AdvLIGO Project Team for another very successful year. The first class management team is working well together…. We are impressed by the quality, energy and commitment of the entire Advanced LIGO Project Team. Technical progress over the past year has been outstanding; important changes have been made and the go-forward technical plans are sound." The panel also found that "the management team is appropriately assessing and managing risks and allocating contingency judiciously." The interim review panel also found that "The project management is doing an excellent job of managing and conducting the project." NSF program staff are confident that risk is being managed effectively but are monitoring progress, maintaining frequent communications with the project managers, and conducting frequent reviews.

Technical risks include uncertainties about such topics as eliminating parametric instabilities in the optical cavities, the minimization of thermal noise in the mirror optical coatings, and the mitigation of possible electrical charges on optical elements. The LIGO Laboratory has been conducting research to minimize these and other risks, and an internal risk management team oversees these efforts. Risk management and its results are topics of internal and biannual external reviews.

Management risks include the planned decommissioning and installation procedures as well as risks involving adherence to the project timelines and budget. NSF staff conduct weekly meetings with the project management to oversee the progress of the project; monthly, quarterly, and annual reports, as well as annual reviews (supplemented by interim reviews), are also important project monitoring instruments. The project status is tracked with earned value management parameters.

Environmental risk is being effectively mitigated. The freely-suspended optical elements at the core of the observatory are carefully protected from earthquakes. Anthropogenic noise at the Livingston site due to logging and oil exploration has been mitigated by communication with local industry and by the early adoption of AdvLIGO seismic noise isolation technology.

Safety is maintained by adherence to institutional guidelines and to published LIGO Laboratory safety practices, overseen by dedicated safety officers at both sites. Hazard analysis is conducted before work is begun and mitigation is performed. External reviews have found safety procedures to be satisfactory.

Future Operations Costs

Future operations and maintenance costs will be approximately $39.0 million per year funded through NSF's Division of Physics in the Directorate for Mathematical and Physical Sciences.

Advanced Technology Solar Telescope $10,000,000

The FY 2012 Budget Request for the Advanced Technology Solar Telescope (ATST) is $10.0 million. The total project cost to NSF, $297.93 million, was finalized after a Final Design Review (FDR) in May 2009. The National Science Board approved an award for this amount at the NSF Director's discretion, contingent upon completion of compliance with relevant environmental and cultural/historic statutes. The environmental compliance requirements were completed on November 20, 2009, and the Record of Decision authorizing the construction was signed by the NSF Director on December 3, 2009. The Board on Land and Natural Resources approved the project's application for a Conservation District Use Permit (CDUP) on December 1, 2010.

Appropriated and Requested MREFC Funds for the Advanced Technology Solar Telescope
(Dollars in Millions)

	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	FY 2017 Estimate	Total Project Cost[1]
Regular Approps	$7.00	$13.00	$13.00	$10.00	$30.00	$20.00	$20.00	$20.00	$14.93	$151.93
ARRA	146.00	-	-		-	-	-	-	-	146.00
Total, ATST	**$153.00**	**$13.00**	**$13.00**	**$10.00**	**$30.00**	**$20.00**	**$20.00**	**$20.00**	**$14.93**	**$297.93**

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $17.0 million. Any FY 2011 funding shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

Baseline History

Beginning in 2001, NSF provided funds to the National Solar Observatory (NSO) for an eight-year design and development program for ATST and its initial complement of instruments through the Division of Astronomical Sciences (AST) and the Division of Atmospheric and Geospace Sciences (AGS, formerly ATM). The current design, cost, schedule, and risk were scrutinized in an NSF-conducted Preliminary Design Review (PDR) in October-November 2006. The FDR held in May 2009 determined that the project was fully-prepared to begin construction. Specific panel recommendations on contracting, contingency, and other items were subsequently included in the project execution plan.

In FY 2009, $6.67 million was provided in the Research and Related Activities (R&RA) account to support design activities to complete a construction-ready design. Of these funds, $3.10 million was appropriated through the American Recovery and Reinvestment Act of 2009 (ARRA) for risk reduction, prototyping, and design feasibility and for cost analyses in areas identified at preliminary and systems design reviews. The funds also supported several new positions to complete preparation for the start of construction. Also in FY 2009, $153.0 million was provided through the Major Research Equipment and Facilities Construction (MREFC) account to initiate construction. Of these MREFC funds, $146.0 million was appropriated through ARRA. Given the timing of the receipt of budget authority and the complexity of project contracting, the entire $153.0 million was carried over from FY 2009 to FY 2010. In FY 2010, an additional $13.0 million was appropriated in the MREFC account. The primary mirror blank was purchased and contracts for detailed designs of the ATST subsystems and instruments have been let. Site preparation awaits the approval of a Habitat Conservation Plan (HCP) that is designed to protect and rehabilitate habitats of the endangered Hawaiian petrel and Hawaiian goose that could potentially be affected by the construction of the ATST. The approval of the HCP and completion of formal consultation with the U.S. Fish and Wildlife Service (USF&WS) are expected to be completed early in calendar year 2011.

Total Obligations for ATST

(Dollars in Millions)

	Prior Years	FY 2010 Actual[1]	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$20.41	-	-	-	-	-	-	-	-
Management & Operations[3]	-	-	-	2.00	2.00	7.00	11.00	13.00	16.00
ARRA	3.10	-	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$23.51	-	-	$2.00	$2.00	$7.00	$11.00	$13.00	$16.00
MREFC Obligations:									
Implementation	-	20.00	13.00	10.00	30.00	20.00	20.00	20.00	14.93
ARRA	-	146.00	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	-	$166.00	$13.00	$10.00	$30.00	$20.00	$20.00	$20.00	$14.93
TOTAL Obligations	**$23.51**	**$166.00**	**$13.00**	**$12.00**	**$32.00**	**$27.00**	**$31.00**	**$33.00**	**$30.93**

Totals may not add due to rounding.

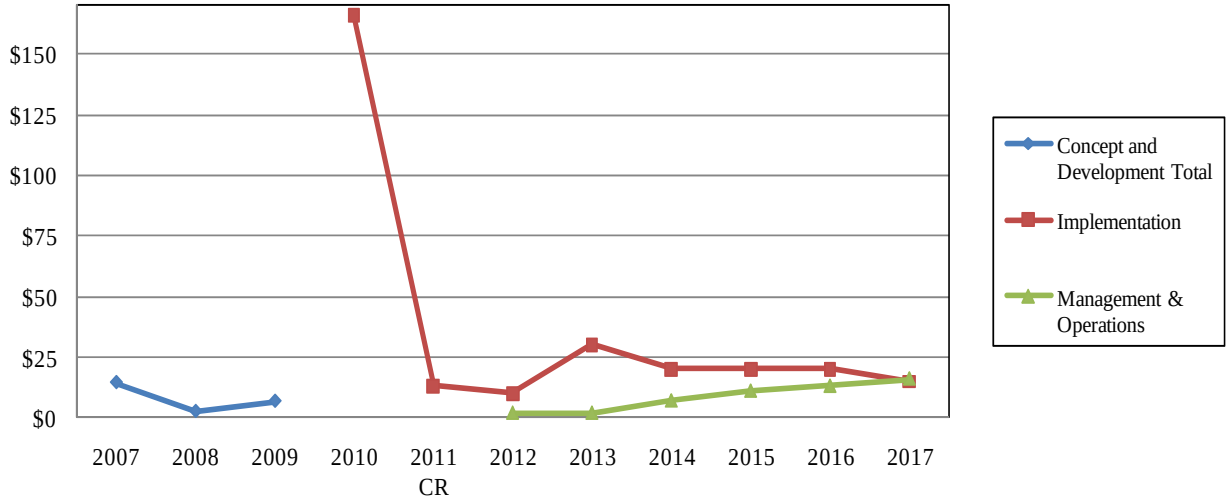
[1] FY 2010 Actual includes $146.0 million in ARRA MREFC funds and $7.0 million in regular MREFC funds carried over from FY 2009.

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $19.0 million: $17.0 million for MREFC and $2.0 million for R&RA. Any FY 2011 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

[3] $2.0 million per year for FY 2011 through FY 2020 is for cultural mitigation activities agreed to during the compliance process.

ATST Funding, by Stage

(Dollars in Millions)



ATST will enable the study of magneto-hydrodynamic phenomena in the solar photosphere, chromosphere, and corona. Determining the role of magnetic fields in the outer regions of the Sun is crucial to understanding the solar dynamo, solar variability, and solar activity, including flares and coronal mass ejections, which can affect civil life on Earth through the phenomena generally described as "space weather" and may have impact on the terrestrial climate.

The project is a collaboration of scientists and engineers at more than 20 U.S. and international organizations. Other potential partners include the Air Force Office of Scientific Research and international groups in Germany, the United Kingdom, and Italy. Now that there is firm funding for construction, details of these partnerships are being discussed. These include the following activities:

- The US Air Force has replaced the aluminizing chamber at the AEOS telescope on Maui and sized it to accommodate the ATST mirror. This obviates the need to build a chamber for the ATST primary.
- Kiepenheuer-Institut fuer Sonnenphysik (Freiburg, Germany) will contribute a narrow-band visible tunable filter, a first-light instrument. This partnership has been formalized in a memorandum of understanding with NSO.
- Queens University Belfast is considering contributing high speed cameras for ATST instrumentation.
- Arcetri Observatory (Italy) is considering the design and construction of an adaptive secondary (an upgrade to the current plans), as well as an infrared tunable filter.

Discussions of other possible contributions for second-generation instruments are continuing. Partner share of observing time on the facility will be calculated according to the value of their contributions.

Project Report

Management and Oversight

- NSF Structure: Oversight from NSF is handled by a program manager in the MPS AST Division working with staff from the Offices of Budget, Finance and Award Management (BFA), General Counsel, Legislative and Public Affairs, and Atmospheric and Geospace Sciences in the GEO Directorate. The Deputy Director for Large Facilities in BFA also provides advice and assistance.
- External Structure: The project is managed by NSO. NSF funds NSO operation and maintenance and ATST design and development via a cooperative agreement with the Association of Universities for Research in Astronomy, Inc. (AURA). The NSO Director is director of the ATST project; a senior NSO scientist is the project scientist; and an experienced project manager coordinates project activities. Several councils and working groups provide input from the solar and space physics communities.
- Reviews:
  - Technical Reviews: Reviews have been conducted throughout the design and development phase. The preliminary design was found to be robust in the NSF-conducted Conceptual Design Review in March 2005 and Preliminary Design Review in October-November 2006. The project has completed a comprehensive set of system-level design reviews for all major sub-systems.
  - Management, Cost, and Schedule Reviews: The ATST cost, schedule, and risk were scrutinized and validated at the Preliminary Design and Final Design Reviews.
  - The Final Design Review: The FDR was held on May 18-21, 2009 in Tucson, Arizona. The unanimous finding of the review panel was that the ATST project was fully prepared to begin construction. A number of specific panel recommendations on contracting strategy, contingency estimating, and other items, were subsequently included in the project execution plan.
  - Upcoming Reviews: A baseline review will be conducted in early CY 2012, after final approval to begin construction is received from the State of Hawaii.

Current Project Status

Current activities include finalizing the detailed designs for all ATST subsystems and instruments, completing permitting, and preparing for site preparation and construction. Haleakala High Altitude Observatory on the island of Maui was chosen as the ATST site. The Final Environmental Impact Statement was submitted to the Environmental Protection Agency on July 24, 2009. Consultation with Native Hawaiian stakeholders has resulted in a fully-executed programmatic agreement that details steps to minimize impacts on the traditional cultural assets on Haleakala, thereby completing compliance with the National Historic Preservation Act. The record of decision authorizing the commencement of construction in FY 2010 was signed by the NSF Director and published in the Federal Register on December 9, 2009. All federal environmental compliance requirements are now complete. Application for the final construction permit (CDUP) required for the ATST site was completed in June 2010 and the issuance of the CDUP was approved by the State of Hawaii's Board on Land and Natural Resources in December 2010. The issuance of the CDUP has been challenged by a Native Hawaiian group via two lawsuits, the status of which is unclear at the time of this writing. Assuming these challenges are favorably resolved, it is anticipated that the CDUP will be issued in the spring of 2011, thereby allowing groundbreaking at the site and the subsequent commencement of construction. The project is working with the Haleakala National Park to obtain Special Use Permits required for construction traffic to traverse the park road to access the site. The project has established an office in Pukalani, Maui. Local support staff hiring as well as augmentation of the project staff is ongoing.

Costs and Schedule

The baseline not-to-exceed cost was established following the FDR. Funding is derived from ARRA ($146.0 million) and annual appropriations in the MREFC account ($151.93 million). Because it is necessary to clearly separate funds from the two sources, the project developed two separate statements of work, dividing their resource-loaded Work Breakdown Structure (WBS) between large contracts to be funded early in the project by ARRA, and smaller procurements and project costs such as labor and rent, to be funded by future annual MREFC appropriations. In January 2010, the project submitted a revised budget for the construction proposal for use of MREFC funds, along with a revised statement of work and budget justification for funds from the ARRA. Initial awards of $146.0 million and $20.0 million of ARRA and MREFC funds, respectively, were made via separate Cooperative Support Agreements under NSO Management and Operations Cooperative Agreement. Extreme front-loading of funding resulting from the large ARRA award as well as judicious choice of the WBS elements expected to be funded by future MREFC appropriations, allow for a constant funding ramp in the outyears while maintaining a reasonable spend-and-commit profile for both cost and contingency. Full operation is set for FY 2018, assuming a construction start in CY 2011.

Risks

Cost and contingency have been validated and essentially all technical risks have been retired. The design is mature and construction contracts are being let pending site permit approval. Project management control, interface control, and change control, are all in place. The ATST can be built and commissioned on schedule for a risk-adjusted not-to-exceed cost of $297.93 million.

Technical: The remaining technical risk is very low as a result of the long design and development phase. Risk reduction undertaken post-FDR using $3.10 million of ARRA funds includes the prototyping of a cooled deformable mirror, development of high-speed cameras, and completion of the foundation design.

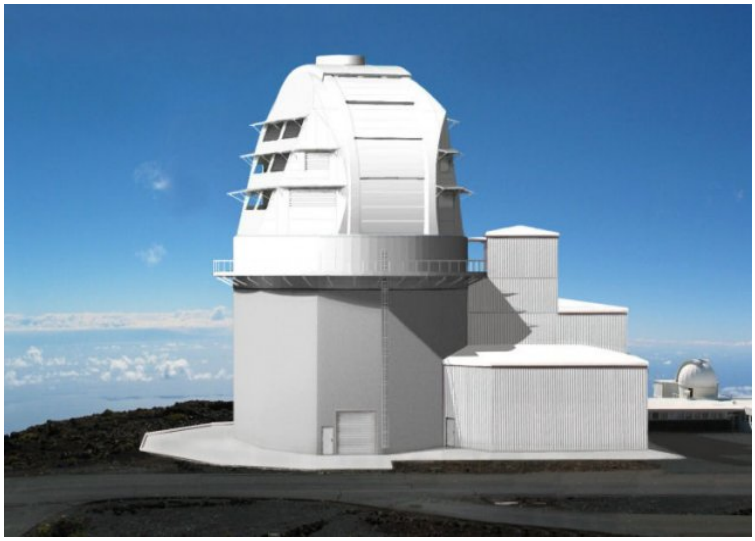
Environmental and Cultural Compliance: Given the recent history of telescope construction on mountains sacred to Native American and Native Hawaiian people, there is risk of delay in obtaining permission to begin construction. The Division of Astronomical Sciences, NSF's Office of the General Counsel, and the ATST project have worked carefully through the processes of the applicable statutes

such that a protracted delay is not expected. At issue at this time is the resolution of legal challenges to the CDUP. It was previously assumed that heavy construction could not be carried out during the brooding season of the Hawaiian petrels that nest in the cliffs adjacent to the site; however acceptance of the HCP and an expected positive outcome of formal consultation with USF&WS will enable year-round construction activity.

Environmental Health and Safety: NSO has a well-developed safety program engendered in the ATST project. However, it is imperative that a culture of safety be imposed on site contractors. The ATST project has developed a site safety plan and will conduct a construction readiness review in early 2011.

Future Operations Costs

Estimates for annual operations are $12.0 to $14.0 million, in addition to $2.0 million annually that has been committed for cultural mitigation. A revised plan was presented at FDR. Since ATST will become the flagship solar telescope of NSO and will render some telescopes obsolete, about $5.0 to $7.0 million per year of NSO costs will be recovered from the closure or divestment of redundant facilities. NSO has a preliminary transition plan that will be revised and externally reviewed after approval of construction funds. As noted above, future costs include investments from 2011 through 2020 for cultural mitigation activities required through the environmental and cultural compliance process. Pursuant to the terms of the ATST environmental and cultural compliance as described in the final environmental impact study and the subsequent Record of Decision, $2.0 million of R&RA funding will be provided annually for programs on Maui supporting STEM (Science, Technology, Engineering, and Mathematics) education and workforce development with an emphasis towards Native Hawaiian students.



Artist's rendition of the ATST facility, looking south. *Credit: NSO/AURA*.

Alaska Region Research Vessel (R/V *Sikuliaq*) $0.00

No MREFC funds are requested for the Alaska Region Research Vessel (ARRV). The remaining project balance was provided through the American Recovery and Reinvestment Act of 2009 (ARRA) as shown in the table below. The estimated total project cost is $199.50 million.

Appropriated and Requested MREFC Funds for the Alaska Region Research Vessel
(Dollars in Millions)

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Total Project Cost[1]
Regular Approps	$9.43	$42.00	-	-	-	-	$51.43
ARRA	-	-	148.07	-	-	-	148.07
Total, ARRV	**$9.43**	**$42.00**	**$148.07**	**-**	**-**	**-**	**$199.50**

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $0.0.

Baseline History

NSF first requested construction funding for the ARRV through the MREFC account in FY 2007. The project received an initial appropriation of $9.43 million in that year followed by an additional appropriation of $42.0 million in FY 2008. In FY 2009, NSF delayed acquisition of the ARRV to incorporate updated pricing information into the construction plan. Rapid inflation in the shipbuilding industry made it difficult to accurately project the final construction cost for the ARRV. A revised project estimate was provided during the Final Design Review (FDR) held in October 2008. The new baseline, which was presented to and approved by the National Science Board in March 2009, incorporates an updated technical scope for the ship in order to meet current regulatory requirements, proper administrative support by the awardee, a realistic construction schedule, and an independent, risk-adjusted cost estimate for construction.

The project is being led by the awardee, the University of Alaska, Fairbanks (UAF), with the contract-level design package and engineering support provided by UAF's naval architect, The Glosten Associates, Inc. The final construction baseline against which progress is being monitored was developed by UAF immediately following execution of the shipyard contract with Marinette Marine Corporation (MMC).

Total Obligations for the ARRV
(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$2.24	-	-	-	-	-	-	-	-
Management and Operations	-	-	-	-	-	4.17	8.34	8.50	8.50
Subtotal, R&RA Obligations	$2.24	-	-	-	-	$4.17	$8.34	$8.50	$8.50
MREFC Obligations:									
Implementation	18.19	33.23	-	-	-	-	-	-	-
ARRA	148.07	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$166.26	$33.23	-	-	-	-	-	-	-
TOTAL Obligations	**$168.50**	**$33.23**	**-**	**-**	**-**	**$4.17**	**$8.34**	**$8.50**	**$8.50**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $0.0.

The ARRV will replace the R/V *Alpha Helix*, which, at 40 years of age prior to its decommissioning, was the oldest ship in the national Academic Research Fleet. Science activities in the Arctic have been limited by the capabilities of the *Alpha Helix*, which was too small to operate in ice or in severe winter weather in the open seas. An ice-strengthened hull will allow the ARRV to operate in seasonal ice up to 3.9 feet in both the Arctic and Antarctic. An anti-roll tank hull will also allow the vessel to operate more effectively in the open waters of the Bering Sea, Gulf of Alaska and North Atlantic. Satellite observations have shown that the perennial ice in the Arctic is thinning at a rate of 9 percent per decade, which is beginning to have major regional and global consequences. Research is urgently needed on topics ranging from climate change, ocean circulation, ecosystem studies, and fisheries research to natural hazards and cultural anthropology. Furthermore, the ARRV will provide a sophisticated and significantly larger platform for scientists, graduate, and undergraduate students to participate in complex multidisciplinary research activities and will enable the training of the next generation of scientists with the latest equipment and technology. Broadband satellite communications capable of relaying data, including high definition video from tools such as remotely operated vehicles that explore under the ice and the ocean depths, will bring research into the K-12 classroom and to the general public.

It is anticipated that the ARRV will greatly expand research capabilities in the region, going from a maximum of 160 ship operating days with the R/V *Alpha Helix*, up to 270-300 days with the ARRV. The vastly increased capability of the ARRV, both with regard to its ability to accommodate much larger interdisciplinary research teams and greatly enlarged geographical and seasonal ranges, will dramatically increase the number of proposals addressed to NSF for its utilization. Individual projects vary greatly in cost, as do the number of projects supported onboard at any given time. Assuming two simultaneous projects onboard for 3-4 weeks at a time and the average grant size in the Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO), over $17.0 million in

This image is an artist's rendition of the ARRV.

research would be supported annually. Due to its size and projected operating area, the ARRV will operate as a Global Class vessel within the U.S. academic research vessel fleet. In early 2010, the ARRV was officially named the R/V *Sikuliaq* which means "First year ice able to be walked on" in a native Inuit dialect.

Project Report

Management and Oversight

- NSF Structure: NSF oversight is described in the Program's Internal Management Plan (IMP). The NSF Program Officer for Ship Acquisition and Upgrades has primary responsibility for oversight of the project and resides within the Integrative Programs Section (IPS) of the Division of Ocean Sciences (OCE), Directorate for Geosciences (GEO). Periodic oversight is provided by a Project Advisory Team (PAT) which includes staff from GEO and OPP, the Division of Acquisition and Cooperative Support (DACS), the Large Facilities Office (LFO), the Office of the General Counsel (OGC), and the Office of Legislative Public Affairs (OLPA). Additional staff from IPS, the LFO, and DACS, as well as external consultants, help provide the program officer with routine project management and technical assistance.

- External Structure: UAF has established a project management office in Fairbanks, AK, a component of which will eventually include an on-site team that will remain in the shipyard throughout the construction process. The *Sikuliaq* Oversight Committee (SOC), which includes community experts in research vessel design, construction, and operations, has been commissioned and convenes monthly to review project status and provide technical and science support advice to both UAF and NSF.
- Reviews:
  1. Final Design Review (FDR): FDR was completed in October 2008. The panel advised that both the design and Project Execution Plan were "sound" and ready to proceed with construction. UAF presented a risk-adjusted project baseline that was considered realistic based on market conditions just prior to FDR. NSF used panel recommendations to increase confidence levels and account for recent global market volatilities to arrive at the final estimated project cost of $199.50 million.
  2. Acquisition Strategy Review: NSF conducted a final review of UAF's vessel and propulsion acquisition strategies in January 2009 based on panel comments from FDR. Final NSF guidance was given to UAF and revised documents have been received and approved by NSF.
  3. Consent Reviews: NSF has conducted two internal reviews during Phase II to evaluate UAF's shipyard and thruster (Z-drive) selection processes. A third consent review was conducted following receipt of cost proposals and UAF's "best value" determination in November 2009.
  4. Contract Management Review: NSF conducted an annual project review in July 2010 that focused primarily on project and contract management. The panel of experts chosen was highly experienced with ship construction and Earned Value Management (EVM).
  5. Upcoming Reviews: With a firm construction schedule now laid out, NSF will conduct annual project reviews as follows: 2011: Construction Review; 2012: Construction and Trials Review; 2013: Trials and Operations Review.

Current Project Status

Fabrication was originally set to begin in late October 2010. During Design Verification and Transfer (DVT) the preliminary weight estimate from the shipyard came in approximately 10 percent higher than the contract estimate once actual equipment and steel weights were known. In order for the ship to meet operational requirements for draft, science payload, and stability, six additional feet had to be added to the hull and the superstructure changed to aluminum. Start of fabrication was delayed in order to properly

develop and incorporate the required design changes, but began in early January 2011 with only a slight delay in delivery from the shipyard anticipated. There appears to be adequate schedule float in Phase IV (Transition to Operations) to complete science trials and still begin science operations in early 2014 as originally planned. Once the contract modifications associated with the weight are executed in early 2011 and DVT is complete, a significant level of project risk will be retired. Detailed design of the propulsion drives and ice-strengthened, low-cavitation propellers is well underway with delivery to the shipyard scheduled for December 2011 as originally planned.

Cost and Schedule

The total project cost approved by NSF and NSB following FDR is $199.50 million. The majority of this total, an estimated $134.0 million (67 percent), is the fixed price contract with the shipyard to-date including the changes associated with vessel weight. UAF management, including purchase of propulsion units as Owner-Furnished Equipment, is $34.70 million (17 percent). Final outfitting, science trials, and delivery are $11.20 million (6 percent). Uncommitted construction contingency for the shipyard contract is approximately $20.0 million (10 percent).

Delivery of the *Sikuliaq* to UAF is scheduled for early to mid 2013. This will be followed by a period of science and ice trials, final outfit, and transit to Alaska. Science operations are projected to begin in early 2014.

To ensure effective management and oversight, monthly and annual reports provided by the project office are closely monitored by the ARRV Program Manager for deviations from established baselines using Earned Value Management.

Risks

A formal risk assessment and management plan was developed by UAF in accordance with NSF guidelines and presented at FDR. Since FDR, the Risk Management Plan and Risk Register is formally updated monthly by UAF and reviewed by NSF on a routine basis. Significant risks at this stage of the project include:

- Technical Risk: Any component of the vessel not meeting technical requirements of the specifications resulting in loss of capability or increased costs to correct after installation or delivery.
- Change Risk: Shipyard cost claim potential associated with design development due to changing regulatory body requirements, Buy American and owner initiated design changes during design and/or construction (Change Orders). The weight issue discovered during DVT falls under this broad category.
- Schedule Risk: Extension of the construction and delivery schedule which would result in project cost increases due to inflation, shipyard liquidated damages, and UAF standing army costs.

Technical and Change risks will see substantial reductions following negotiation of the Change Orders associated with the weight issue in early 2011.

Mitigation strategies have been employed by UAF, and the risk analysis reviewed by the panel in July 2010 indicates that sufficient contingency is currently in place to handle these project risks. The panel also believed that proper change and contingency management control processes are in place to facilitate the project coming on time and within budget. UAF's revised risk analysis in October 2010 incorporated resolution of the weight issue and retirement of other risk elements indicates that adequate contingency still remains to cover future risks.

Future Operations Costs

Vessel operations will be governed by the terms of a separate cooperative agreement with UAF through the Ship Operations Program within IPS. Daily rate estimates for both the ship and technical services were provided by UAF at FDR. It is anticipated that OCE will pay for approximately 65 percent of the annual vessel operating costs ($8.50 million per year) based on historical data from other global ships within the academic research vessel fleet. The remaining 35 percent of the funding support for the *Sikuliaq* is expected to come from the Office of Polar Programs (OPP) and other federal agencies. In short, the *Sikuliaq* will fold into an already well-established framework for operating the academic research vessel fleet.

Atacama Large Millimeter Array $3,000,000

The FY 2012 Budget Request for the Atacama Large Millimeter Array (ALMA) is $3.0 million, which represents the last year of an eleven-year project totaling an estimated $499.26 million.

Appropriated and Requested MREFC Funds for the Atacama Large Millimeter Array

(Dollars in Millions)

FY 2007 & Earlier[1]	FY 2008	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	Total Project Cost[2]
$255.27	$102.07	$82.25	$42.76	$42.76	$3.00	$499.26

[1]An additional $31.99 million was appropriated through the MREFC account prior to FY 2005 for concept and development.

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $13.91 million.

The global ALMA project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 to 0.4 mm. ALMA will be the world's most sensitive, highest resolution, millimeter-wavelength telescope, combining sub-arcsecond angular resolution with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The interferometer is under construction at 5,000 meters altitude near San Pedro de Atacama in the Antofagasta (II) Region of Chile, the ALMA host country.

Baseline History

A $26.0 million, three-year design and development phase was originally planned for a U.S.-only project, the Millimeter Array. NSF first requested funding for design and development of this project in FY 1998. In June 1999, the U.S. entered into a partnership via a Memorandum of Understanding (MOU) with the European Southern Observatory (ESO), a consortium of European funding agencies and institutions. The MOU committed the partners to construct a 64 element array of 12-meter antennas. NSF received $26.0 million in appropriations between FY 1998 and FY 2000. Because of the expanded managerial and technical complexity of the joint U.S./ESO project, now called ALMA, an additional year of design and development was provided by Congress in FY 2001 at a level of $5.99 million. In FY 2002, $12.50 million was appropriated to initiate construction of ALMA; the U.S. share of the cost was estimated to be $344.0 million. The National Research Council (NRC) of Canada joined ALMA as a partner in 2003. In 2004, Japan entered under the provisions of a MOU between NSF, ESO, and the National Institute of Natural Sciences of Japan.

The ALMA Board initiated rebaselining in the fall of 2004 under the direction and oversight of the Joint ALMA Office (JAO) Project Manager. The project was at that point sufficiently mature that the baseline budget and schedule established in 2002, prior to the formation of the partnership, could be refined based on experience. The rebaselining process took approximately one year, scrutinizing cost and schedule throughout the project, assessing technical and managerial risk, and ultimately revising the assumptions on the scope of the project. The new baseline plan developed by the JAO assumed a 50-antenna array as

opposed to the original number of 64, extended the project schedule by 24 months, and established a new U.S. total project cost of $499.26 million. The FY 2009 Request was increased by $7.50 million relative to the rebaselined profile in order to allow more strategic use of project contingency to buy down near-term risk, as recommended by the 2007 annual external review. The increase in FY 2009 was offset by a matching decrease in the FY 2011 Budget Request.

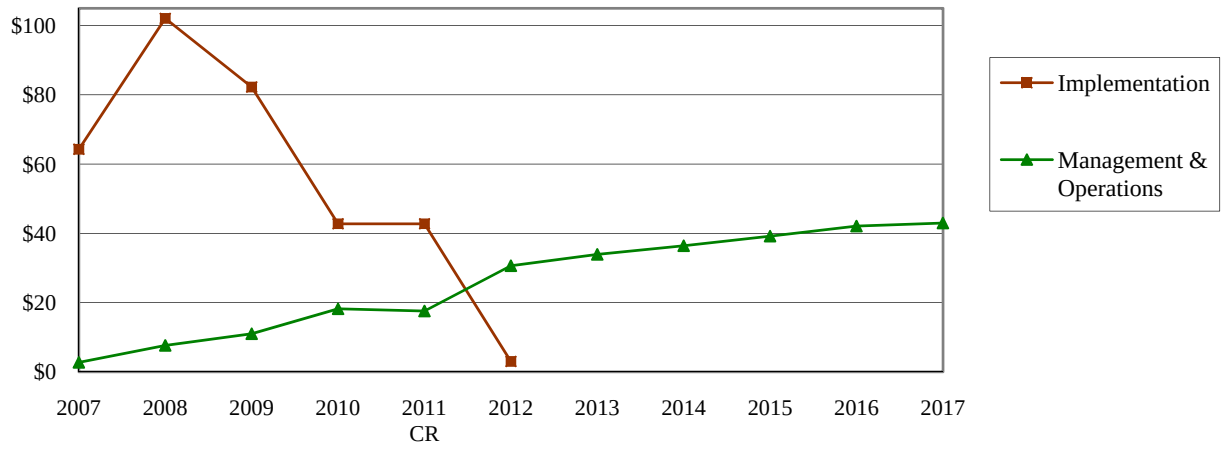
Total Obligations for ALMA
(Dollars in Millions)

	Prior Years	FY 2010 Actual	Enacted/ Annualized FY 2011 CR FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$6.50	-	-	-	-	-	-	-	-
Management & Operations	11.00	18.20	17.57	30.65	33.92	36.41	39.17	42.10	42.98
Subtotal, R&RA Obligations	$17.50	$18.20	$17.57	$30.65	$33.92	$36.41	$39.17	$42.10	$42.98
MREFC Obligations:									
Concept & Development	31.99	-	-	-	-	-	-	-	-
Implementation	439.59	42.76	42.76	3.00	-	-	-	-	-
Subtotal, MREFC Obligations	$471.58	$42.76	$42.76	$3.00	-	-	-	-	-
TOTAL Obligations	**$489.08**	**$60.96**	**$60.33**	**$33.65**	**$33.92**	**$36.41**	**$39.17**	**$42.10**	**$42.98**

Totals may not add due to rounding.

[1]A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $37.41 million: $13.91 million for MREFC and $23.50 million for R&RA.

ALMA Funding, by Stage
(Dollars in Millions)



Once completed, ALMA will be the most capable imaging radio telescope ever built and will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1 millimeter wavelength with the same 0.1 arcsecond resolution achieved by the Hubble Space Telescope at visible wavelengths, and will form a critical complement to the leading-edge optical, infrared, ultraviolet, and x-ray astronomical instruments of the 21st century.

ALMA will help educate and train U.S. astronomy and engineering students; at least 15 percent of ALMA's approximately 1,000 yearly users are expected to be students. There is already substantial involvement by graduate students in applied physics and engineering at universities participating in the ALMA Design and Development program, providing an opportunity to broaden participation in science and engineering by members of underrepresented groups.

Extensive public and student ALMA outreach programs will be implemented in North America, Europe, and Chile as ALMA approaches operational status. ALMA education and public outreach (EPO) programs are funded regionally, through the Associated Universities Incorporated/National Radio Astronomy Observatory (AUI/NRAO), ESO, and the National Astronomical Observatory of Japan (NAOJ), and jointly by the ALMA partnership in Chile. AUI/NRAO's request for NSF funding (including partnership activities) was critically evaluated as a component of a proposal review in mid-2010 and assessment will continue as part of the annual external reviews. NRAO's EPO activities are included in their annual program plan and the status, performance, and issues are assessed by program staff through regular quarterly reports. ESO and NAOJ will follow their own processes for review of their contributions. These reviews include consideration of plans for educational evaluation and measurement of all programs. A visitors' center will be constructed at the 2,800 meter-altitude Operations Support Facility gateway to the ALMA site near San Pedro de Atacama in northern Chile. The project also supports a fund for the Antofagasta (II) Region of Chile that is used for economic, scientific, technical, social, and cultural development, particularly within the nearby towns of San Pedro de Atacama and Toconao.

North America and Europe are equal partners in the core ALMA instrument. Japan joined ALMA as a third major partner in 2004, and will deliver a number of enhancements to the baseline instrument. The North American side of the project, consisting of the U.S., Canada, and Taiwan, is led by AUI/NRAO. Funding and execution of the project in Europe is carried out through the ESO. Funding of the project in Japan is carried out through the National Institutes of Natural Sciences of Japan and project execution is the responsibility of the NAOJ.

From an industrial perspective, ALMA instrumentation will push gallium arsenide and indium phosphide transistor amplifier technology to high frequencies, will challenge production of high-density, high-speed integrated circuits for computational uses, and is expected to stimulate commercial device and communication technologies development.

Peer-review telescope allocation committees will provide merit-based telescope time but no financial support. NSF will not provide awards targeted specifically for use of ALMA. Most U.S. users will be supported through NSF or National Aeronautics and Space Administration (NASA) grants to pursue research programs that require use of ALMA.

Construction progress continues in FY 2011, both at the site in Chile and within the ALMA partner countries. In FY 2010, delivery of North American production antennas continued at the planned rate of one every two months, and a total of fifteen antennas were accepted or assembled and tested in Chile. The first antennas were transported to the final, high-altitude site and science commissioning has begun. Early science operations are planned to commence in late FY 2011 and completion of the construction project and the start of full science operations are forecast to occur in FY 2013.

Project Report

Management and Oversight

- NSF Structure: Programmatic management is the responsibility of the ALMA program manager in

the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS). An NSF advisory group consisting of representatives from the Office of General Counsel, the Office of Budget, Finance, and Award Management, the Office of International Science and Engineering, and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team (PAT). The NSF Deputy Director for Large Facility Projects (DDLFP) is a member of the PAT and provides advice and assistance.

- External Structure: An international ALMA Management Advisory Committee (AMAC) advises AST and the ALMA Board. Management of the NRAO effort on ALMA is carried out under a cooperative agreement with AUI. Oversight of the full international project is vested in the ALMA Board, whose membership includes an NSF member; coordination and management of the merged international efforts is the responsibility of the Joint ALMA Office (JAO), whose staff includes the ALMA Director, project manager, and systems engineer.
- Reviews:
  - Technical reviews: The JAO holds frequent technical and schedule reviews at appropriate design and fabrication milestones. For example, a series of reviews to assess the schedule, risks and cost to complete was held in October 2009 and March 2010. A review of the science operations implementation plan was held in September 2009 and further science readiness reviews were held in October and November 2010. A function of the AMAC is to conduct project-wide annual external reviews on behalf of the ALMA Board.
  - Management, Cost, and Schedule reviews: NSF, through the ALMA Board, holds external reviews of the broad project and in targeted areas. A review of the operations plan was conducted in July 2010. Project-wide annual reviews, last held in November 2009 and October 2010, assessed management, cost, and schedule performance, status, issues, and risks. A follow-up assessment of implementation of the 2009 review recommendations was held in June 2010. A performance review of the labor management and practices at the Chilean sites was held in September 2010.
  - Upcoming reviews: The annual external review will occur in October 2011.

Current Project Status

- Major project milestones attained in FY 2010 included:
  - Continued delivery of North American antennas at a rate of one every two months
  - Acceptance of the fourth through ninth North American antennas and the second Japanese 12-meter antenna
  - Transport of eight accepted antennas to the high-altitude site in Chile
  - Installation and acceptance of the central local oscillator (serves the first 16 antennas for early science)
  - Start of commissioning
- Major milestones for FY 2011 are expected to include
  - Continued delivery of North American antennas at a rate of one every two months
  - Acceptance of the first European antennas
  - Acceptance of the remaining Japanese 12-meter and first 7-meter antennas
  - Installation and acceptance of third and fourth quadrants of the correlator
  - Installation and acceptance of the remainder of the central local oscillator (serves all ALMA antennas)
  - Call for proposals for early science
  - Start of early science operations (late FY 2011)

- Major milestones for FY 2012 are expected to include:
  - All North American deliverables made, including final North American antennas and receiver systems
  - Acceptance of the remaining Japanese 7-meter antennas
  - Continued delivery of European antennas at a rate of one every four to six weeks
  - Continued commissioning of accepted antenna and integration into the science array

Cost and Schedule

The current schedule performance is slightly behind plan due to equipment delivery delays, in particular delivery of the receivers and the first European antennas. Consequently, the major milestones of early-science and full-science are forecast to be delayed by six to nine months. Cost performance is very good at this stage in the project — cost variance is +2 percent and schedule variance is –5 percent relative to the reference baseline — with about 20 percent contingency remaining in the uncommitted budget. Significant expenditure of budgeted contingency is foreseen during the remainder of the project.

Risks

- The receiver systems and European antennas are the pacing items for the medium- and long-term schedule, respectively. Fabrication of North American antennas is at the planned rate and testing and handover are catching up with delivery.
- Fabrication of individual receiver components is approaching the production rate and implementation of parallel integration and testing lines is intended to ensure that the receivers stay ahead of antenna delivery in the longer term.
- Timely handover of the first European antennas and production of the remaining units will be required to hold the forecast schedule for completion. Integration of the final antennas and receivers into the science array is projected to continue into 2013.
- The schedule for the start of initial scientific observations in 2011 depends upon successful commissioning of the growing complement of antennas at the final high-altitude site during early 2011. Initial commissioning has been impacted by adverse weather and reliability of the temporary power supply and first, pre-production, units.

Future Operations Costs

Operations and maintenance funds phase-in as initial site construction is completed and antennas are delivered. Funds will be used to manage and support site and instrument maintenance, array operations in Chile, early-science (FY 2011) and eventually full-science operations, and in support of ALMA observations by the U.S. science community. Full ALMA science operations are forecast to begin in 2013. An operations plan and a proposal for North American operations were externally reviewed in FY 2007 and again in July 2010. A funding profile through FY 2011 was authorized by the National Science Board in December 2007 and a renewal through FY 2015 is being prepared for authorization by the National Science Board in FY 2011. The process of a competition for the management and operation of NRAO for a subsequent award in 2016 is expected to begin in FY 2012 provided that ALMA construction is completed as forecast and operations in Chile continue on their path to become sustainable. The operations estimates for FY 2012 and beyond are based on current cost projections. The anticipated operational lifespan of this project is at least 30 years.

Five antennas undergoing science commissioning at the ALMA high altitude site in Chile. *Credit: ALMA/ESO/ NRAO/NAOJ.*

IceCube Neutrino Observatory **$0.00**

No MREFC funds are requested for the IceCube Neutrino Observatory in the FY 2012 Budget Request. The FY 2010 Budget Request to Congress requested $950,000, which represented the final amount necessary to complete funding for the ten-year project, totaling an estimated $279.47 million. $242.07 million of the total project cost has been funded through NSF's MREFC account, and the balance of $37.40 million has been provided by foreign partners in the project. Operations funding is provided through the Research and Related Activities account and is augmented by contributions from foreign partners.

Appropriated and Requested MREFC Funds for the IceCube Neutrino Observatory
(Dollars in Millions)

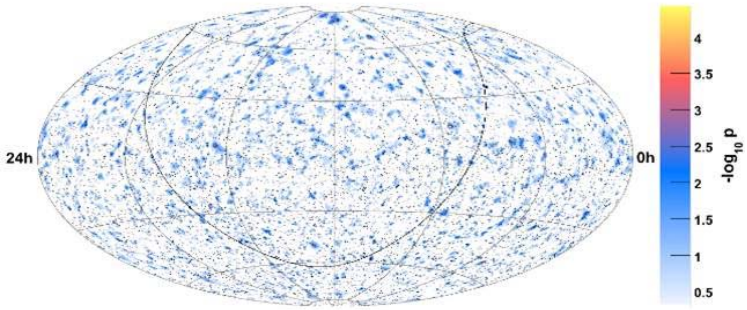
FY 2004 & Earlier	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2010 Enacted Annualized FY 2011 CR[1]	FY 2012 Request	Total Project Cost[1]
$81.29	$47.62	$49.85	$28.65	$22.38	$11.33	$0.95	$0.95	-	$242.07

Total may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized levels provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $0.0 million, as FY 2010 was the final year of MREFC funding.

Baseline History

Congress provided initial appropriations for IceCube of $15.0 million in FY 2002 and $24.54 in FY 2003 for "Start-up Activities", including development of an enhanced hot water drill. NSF requested construction funding for IceCube in the FY 2004 Budget Request, and the total cost of the project (including start-up activities) was estimated to be $271.77 million at that time ($242.07 from NSF and the balance from the international partners). NSF carried out a comprehensive external baseline review of the entire project, including cost, schedule, technical, and management review, in February 2004; this rebaselining effort confirmed the U.S. total project cost of $242.07 million.



This skymap of muon events represents six months of data taken with the 40-string IceCube array from July 2008 through December 2008. The color shading indicates the significance of the data and the curved black line is the galactic plane. This all-sky neutrino map is the first to unify the search of up-going neutrinos from the Northern Hemisphere of TeV energies with a search of down-going neutrinos from the Southern Hemisphere at higher (PeV) energies. While no point source has been identified yet, the sensitivity of the skymap will continue to increase rapidly as IceCube construction continues on schedule. *Credit: IceCube Collaboratory.*

Foreign partners provided an additional $7.70 million in FY 2009 for additional sensor strings that will add to the capability of instrument. This increase in non-U.S. contributions brings the total project cost to $279.47 million. NSF's cost, however, remains constant at $242.07 million.

IceCube is the world's first high-energy neutrino observatory, located deep within the ice cap under the South Pole in Antarctica. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. Approximately one cubic kilometer of ice is being instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. An array of Digital Optical Modules (DOMs), each containing a PM and associated electronics, will be distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. When completed, IceCube will record the energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV (10^{11} electron Volts [eV]) to 10 PeV (10^{16} eV).

The project includes a Deep Core Array (DCA), situated within the geometry of the larger observatory. The DCA will be composed of eight strings with the DOMs concentrated in the lower-middle part of the array. The tighter spacing of the DOMs will allow the observatory to detect lower energy neutrinos (down to about 10 GeV), thus opening the door to studies of neutrino oscillation measurements and studies of Weakly Interacting Massive Particles (WIMPs) below 250 GeV. In essence, this change closes the energy gap between the IceCube Neutrino Observatory and the SuperKamiokande detector in Japan. This positioning will also allow effective observations of high energy neutrinos entering from the sky of the southern hemisphere.

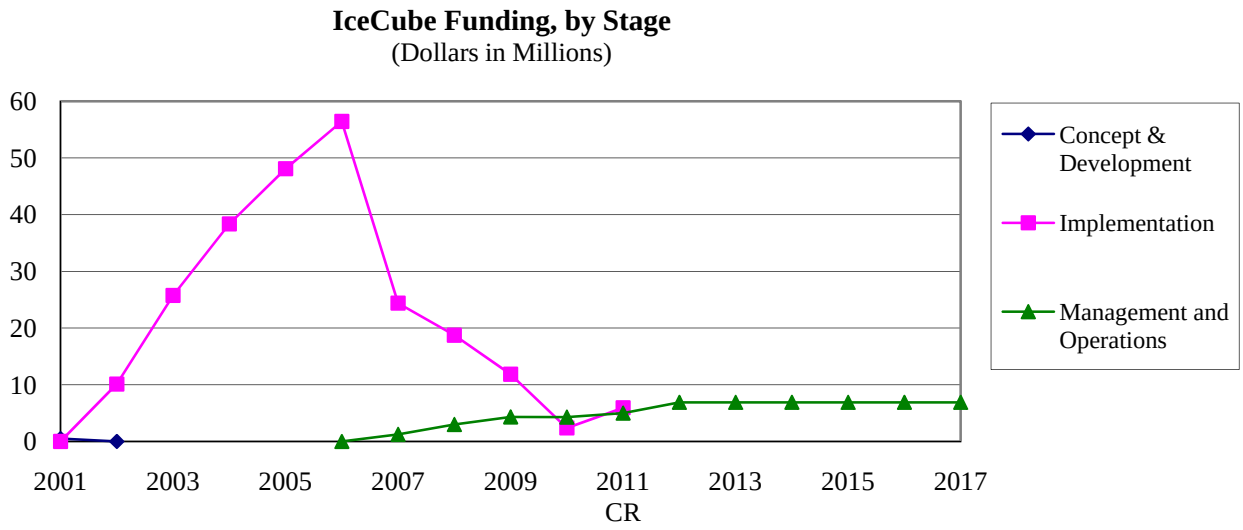
Total Obligations for IceCube

(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$0.50	-	-	-	-	-	-	-	-
Operations & Maintenance (OPP)	3.66	2.15	2.15	3.45	3.45	3.45	3.45	3.45	3.45
Operations & Maintenance (PHY)	3.66	2.15	2.15	3.45	3.45	3.45	3.45	3.45	3.45
Subtotal, R&RA Obligations	$7.82	$4.30	$4.30	$6.90	$6.90	$6.90	$6.90	$6.90	$6.90
MREFC Obligations:									
Implementation	233.75	2.38	0.95	-	-	-	-	-	-
Subtotal, MREFC Obligations	$233.75	$2.38	$0.95	-	-	-	-	-	-
TOTAL Obligations	**$241.57**	**$6.68**	**$5.25**	**$6.90**	**$6.90**	**$6.90**	**$6.90**	**$6.90**	**$6.90**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized levels provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $10.98 million: $5.98 million for MREFC from prior appropriations, and $5.0 million for R&RA.



The principal tasks in the IceCube project are: production of the needed DOMs and associated electronics and cables; production of an enhanced hot water drill and a DOM deployment system capable of drilling holes for and deploying DOM strings in the ice at the Pole; refurbishment and outfitting of the IceCube Laboratory (ICL) at the South Pole; the actual drilling of the deep-ice holes, deployment of the needed DOMs, and their commissioning and verification; installation of a surface array of air shower detectors ('IceTop') to both calibrate and eliminate background events from the IceCube DOM array; construction of data acquisition, handling, archiving, and analysis systems; and associated personnel and logistics support.

IceCube construction is being carried out by the IceCube Collaboration, led by the University of Wisconsin (UW). The IceCube Collaboration consists of 12 U.S. institutions and institutions in three other countries: Belgium, Germany, and Sweden. NSF's foreign partners are contributing approximately $37.40 million to the project, as well as a pro rata share of IceCube operations and maintenance costs based on the number of PhD-level researchers involved. NSF's share of the operations and maintenance costs is $6.90 million in FY 2012.

NSF will support activities at U.S. institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades through ongoing research programs. The annual support for these research activities at U.S. institutions will be provided through the R&RA account in response to merit-reviewed proposals.

IceCube provides a vehicle for helping to achieve national and NSF education and outreach goals. Specific outcomes include the education and training of next-generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials and using the South Pole environment to convey the excitement of astrophysics, and science generally, to K-12 students; increased opportunity for involvement of students in international collaborations; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits (such as the Adler Planetarium) based on IceCube science and the South Pole environment. Education and outreach activities so far have been supported principally by participating institutions, leveraged by the IceCube construction and research activities. NSF expects to support evaluation and measurement-based education and outreach programs under

separate R&RA grants to universities and other organizations that are selected following standard NSF merit review.

Project Report

Each summer the IceCube project sponsors a "boot camp" on the collaboration's simulation, reconstruction, and analysis software and the modular software framework, IceTray. Intended primarily for summer students, new graduate students, and postdocs, anyone in the collaboration may attend. *Credit: IceCube Collaboratory.*

Management and Oversight

- NSF Structure: Oversight responsibility for IceCube construction is the responsibility of the Office of Polar Programs (OPP). Support for operations and maintenance, research, education and outreach will be shared by OPP and the Directorate for Mathematical and Physical Sciences (MPS), as well as other organizations and international partners. Besides annual progress reviews and other specialized reviews (e.g., a safety review), the project provides monthly progress reports and quarterly reports. NSF conducts site visits, weekly teleconferences with the project managers, and internal NSF project oversight and management meetings.
- External Structure: The UW management structure for the IceCube project includes leadership by a project director and a project manager. At lower levels, project management includes international participation as well as participation by staff at collaborating U.S. institutions. This framework was put in place during the start-up phase of IceCube and provided a sound basis for initiation of full construction with FY 2004 funding as soon as the project was baselined. UW has in place an external Scientific Advisory Committee, an external Project Advisory Panel, and a high-level Board of Directors (including the UW Chancellor) providing awardee-level oversight of the project.
- Reviews: NSF carried out a comprehensive external baseline review of the entire project (including cost, schedule, technical, and management) in February 2004. There was a follow-up external cost review in fall 2004. Comprehensive external reviews are held each spring following the annual deployment season; such reviews were held annually from 2005 through 2010.

Current Project Status

- IceCube construction was successfully completed at the South Pole on December 18, 2010, New Zealand Time. The Observatory consists of 5,160 optical sensors installed at a depth between 1.5 and 2.5 kilometers on 86 cables, and 324 optical sensors placed in 162 surface tanks. All cables are routed into the IceCube laboratory located in the center of the surface array.

Cost and Schedule

- IceCube is 97.5 percent complete (as of December) in terms of earned value measures, well within the originally proposed budget and on schedule.

Risks

- Based on the above achievements, the project has retired all risks.

Future Operations Costs

Operations and maintenance in support of scientific research began in FY 2007 and cost approximately $5 million per year. Full science operations begin in FY 2011 following completion of drilling and DOM deployment in that year. The associated costs are and will continue to be shared by the partner funding agencies – U.S. (NSF) and non-U.S. – proportional to the number of PhD researchers involved (currently about 55:45). Starting in FY 2012, the U.S. share of full science operations and maintenance is $6.90 million annually.

The annual cost of the data analysis that will be carried out by the collaborating U.S. and foreign institutions in FY 2010 is estimated at $9.0 million, of which $5.0 million will come from NSF for support of the U.S. analytical groups, and which is separate from support for operations and maintenance (e.g., the data acquisition and data handling systems, data quality monitoring, information technology (IT) upgrades). In FY 2012, the U.S. share of data analysis and modeling costs is estimated at $5.50 million.

The general operations of South Pole Station, reported in a separate section, also contribute to supporting IceCube. The cost of IceCube operations shown in the table herein includes only those that are project-specific and incremental to general South Pole Station operations. Progress in IceCube operations will be reviewed annually. The expected operational lifespan of this project is 25 years beginning in FY 2011.

The National Ecological Observatory Network $87,920,000

The FY 2012 Budget Request for the National Ecological Observatory Network (NEON) is $87.92 million, which represents the second year of a 5-year project that spans six fiscal years and totals an estimated $433.72 million.

Appropriated and Requested Funding for the National Ecological Observatory
(Dollars in Millions)

Prior Years[1]	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	FY 2016 Estimate	Total Project Cost[2]
$3.00	-	-	$87.92	$101.07	$103.43	$86.23	$32.07	$433.72

[1] Per P.L. 110-161, $4.0 million was rescinded from prior year unobligated balances.

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $20.0 million. Any FY 2011 funding shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

Baseline History

In 2004 the National Research Council (NRC) evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated a total of $7.0 million through the MREFC account for NEON in FY 2007 and FY 2008, $4.0 million of which was rescinded in FY 2008. A Preliminary Design Review (PDR) was completed in June 2009 and a Final Design Review (FDR) was completed in November 2009. Project planning continues through the first three quarters of FY 2011 until construction start in the fourth quarter of FY 2011. A formal construction baseline review and cost review occurred as part of the FDR, and an additional baseline review will be conducted in April 2011 prior to initiation of construction, to ensure there are no significant changes to cost and the estimated schedule baselines.

Total Obligations for NEON

(Dollars in Millions)

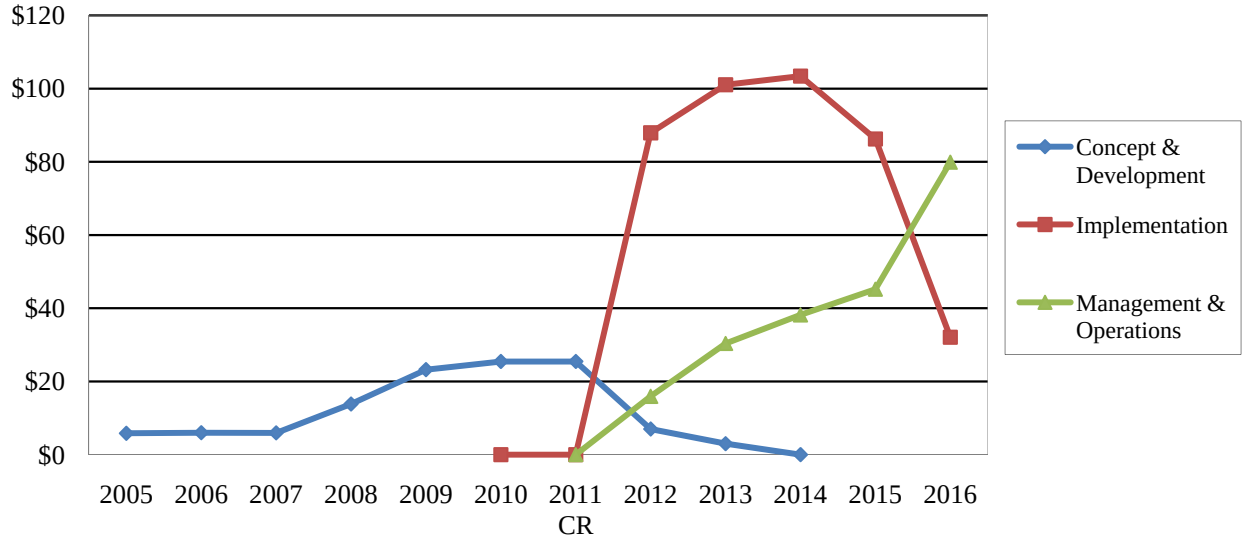
	Prior Years	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:								
Concept & Development	$44.84	$25.45	$7.00	$3.00	-	-	-	-
Management and Operations	-	-	15.93	30.39	38.18	45.51	79.91	83.10
ARRA	9.96	-	-	-	-	-	-	-
Subtotal, R&RA Obligations	$54.80	$25.45	$22.93	$33.39	$38.18	$45.51	$79.91	$83.10
MREFC Obligations:								
Implementation	-	-	87.92	101.07	103.43	86.23	32.07	-
Subtotal, MREFC Obligations	-	-	$87.92	$101.07	$103.43	$86.23	$32.07	-
TOTAL Obligations	**$54.80**	**$25.45**	**$110.85**	**$134.46**	**$141.61**	**$131.74**	**$111.98**	**$83.10**

Totals may not add due to rounding.

[1]A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The total funding presented in the FY 2011 Request is $38.0 million. This includes $23.0 million for construction implementation and $15 million for concept and development. Of the $23.0 million, $20.0 is requested in FY 2011 and $3.0 is available from prior year appropriations. Any FY 2011 funding shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

NEON Funding, by Stage

(Dollars in Millions)

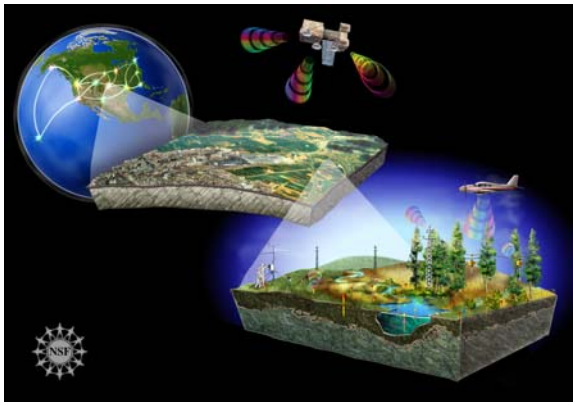


Since NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, advances in the field of ecology and the infrastructure to enable those advances depend largely on support from NSF. Current research infrastructure does not enable studies to address the

complex phenomena driving ecological change in real time and at the scales appropriate for studying many grand challenge questions in ecology. NEON will build upon previous NSF investments through the Long Term Ecological Research (LTER) program, an ecosystem-based research program. NEON is a research facility that will enable research at regional to continental scales. NEON infrastructure will be co-located at eleven LTER sites. When operational, NEON will allow LTER researchers to expand the scale of their research to understand larger scale dynamics affecting their ecosystems. As a continent-wide research instrument, NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will use NEON infrastructure in their research and educational programs. A NEON cyberinfrastructure gateway will provide resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. Data from standard measurements made using NEON will be available in "near real time". The basic NEON datastreams will be open-access via web portals and available as soon as possible, once basic quality assurance and quality control procedures have been applied.

Recent United States Global Change Research Program (USGCRP) assessments indicate that U.S. ecosystems will experience abrupt and unpredictable changes from a suite of human-driven processes in the near future. The Administration has identified these environmental issues as among the most important, demanding, and urgent global problems of our time, and scientific discovery and science-based decision making are critical to selecting mitigation and adaptation policies and strategies. NEON is the ideal platform to provide the scientific foundation needed to address these environmental challenges, and the urgency of these issues to our national resources, economic vitality, health, quality of life, and national security justified beginning to build NEON in FY 2011. NEON will provide an unprecedented opportunity to detect environmental signals as early as FY 2013.

NEON will enable research on the impacts of climate and land use change, water use, and invasive species on the Nation's living ecosystems at temporal and spatial scales that are relevant to human well-being. NEON will be the first research platform and the only national experimental facility specifically designed to enable basic research in these areas. All prior basic research infrastructure was designed and deployed on an *ad hoc*, question-, mission-, or site basis. NEON is unique. Its statistically-determined, continental-scale design, with data products, data management, and standardization will support research on the dynamics of complex coupled systems needed for modeling and understanding rates of change on regional and continental scales. No other standalone system – federal or private – can provide the scientifically validated suite of data measurements that NEON anticipates providing. For example, federal operational agencies, such as the Environmental Protection Agency (EPA), provide comprehensive, sustained, and dependable observations in real time on a broad geographic basis, similar to the observations supporting the forecasts of the National Weather Service; these observations support information needs and forecasts for resource management. In contrast, NEON will provide infrastructure to enable hypothesis-driven basic biological and ecological research, with data and high-level data products available in close to real-time. NEON scientists will develop and use the latest technologies and sensors to push the envelope of knowledge. Just as NEON researchers will benefit from access to data from Federal Agency networks that provide spatial and temporal coverage of the U.S., so will federal agencies benefit as the techniques, sensors and knowledge gained through NEON-enabled



NEON will be a collaborative research platform of geographically distributed infrastructure connected via the latest information technology. By combining in-situ sensing with remote sensing observations, NEON will address pressing environmental questions on regional to continental scales. *Credit: NSF.*

activities migrate from research to societal applications and inform management decisions.

NSF and NEON, Inc. coordinate with other federal agencies through the NEON Federal Agency Coordinating Committee, Memoranda of Understanding (MOU), Memoranda of Agreements, and Cooperating Agency Agreements. Areas of coordination include planning, design, construction, deployment, environmental assessment, data management, geospatial data exchange, cyberinfrastructure, research, and modeling. In addition, NSF will continue to seek opportunities for new interagency and international partnerships. Examples of current partnerships include:

- Design: The Jet Propulsion Laboratory (JPL) at the National Aeronautics and Space Agency (NASA) designed and is building the hyperspectral sensor for the NEON airborne observation platform
- NEON infrastructure deployment sites: U.S. Department of Agriculture Forest Service, USDA Agricultural Research Service, Bureau of Land Management, Department of Energy (DOE), and National Park Service
- Sharing of geospatial data, in-situ verification, and archival of NEON aerial remote sensing data with the U.S. Geological Survey (USGS)
- Partners in research, modeling, data exchange, standards, and protocols: NASA, the National Oceanic and Atmospheric Administration (NOAA), USGS, and EPA
- International: Discussions have begun between NEON, Inc. and Mexican and Canadian scientists to broaden linkages with NEON and expand the research capability to the North American continent

Private organizations including the Heinz Center, Nature Serve, and the Science and Engineering Alliance, participated in NEON design and development activities. The Science and Engineering Alliance and the Ecological Society of America are assisting NEON, Inc. with education and inclusion of minority serving institutions in NEON science and education. Building enhanced accessibility for all institutions into the design will broaden the impact of NEON science and education to the next generation of scientists and educators. While the bulk of NEON's infrastructure and instrumentation will be "commercial off-the-shelf", NEON's scientific and networking design required certain technological innovations. Consequently, the Directorate for Biological Sciences (BIO) has provided Research and Related Activities (R&RA) funds for advanced research and development (R&D) activities in the areas of sensors and cyberinfrastructure.

Project Report

Management and Oversight

NSF Structure: The NEON program is managed in the BIO Office of the Assistant Director (OAD/BIO) as part of Emerging Frontiers. OAD/BIO provides overall policy guidance and oversight, and the location of the NEON program in the Emerging Frontiers Division (EF) within BIO fosters its interdisciplinary science connections. The NEON program is managed by a dedicated program officer, and an NSF/NEON project manager was added in FY 2011 to oversee construction and participate in planning, development and oversight of management and operations. A business oversight team chaired by the NEON program officer advises and assists with the business framework of the project. A BIO-NEON committee, which includes the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) and a cross-NSF Program Advisory Team (PAT), formulates program planning for NEON. The NEON program officer served as the contracting officer's technical representative (COTR) for the NEON environmental assessment completed in FY 2010. A NEON Environmental Assessment Team (EA) provides ongoing technical advice on the National Environmental Policy Act (NEPA) compliance and NSF environmental policy.

External Structure: The NEON project is funded through cooperative agreements with NEON, Inc., a non-profit, membership-governed consortium, established to oversee the design, construction, management and operation of NEON for the scientific community. Within that organization, the CEO provides overall leadership and management; the project manager oversees all aspects of the project design, review, construction, and deployment; and the director of computing is responsible for oversight of the cyberinfrastructure and embedded sensor development. A Board of Directors, a Science, Technology, and Education Advisory Committee (STEAC) and a Program Advisory Committee (PAC), composed of members of the NEON user community, each provide oversight and guidance to the project and help ensure that NEON will enable frontier research and education.

Reviews:

- Technical reviews: The NEON Observatory Design Review (including site selection and deployment design) was successfully completed in February 2009.
- Management, Cost, and Schedule reviews:
  - The Conceptual Design Review was held in November 2006.
  - A combined PDR/FDR of the airborne observation platform was successfully completed in February 2009.
  - A PDR for the entire project was successfully completed in June 2009.
  - An FDR was successfully completed in November 2009, including construction and cost reviews.
  - National Science Board (NSB) Review: The Board reviewed and authorized NEON construction subject to final appropriation of funds in May 2010.
  - An additional baseline review, to ascertain readiness to begin construction, is scheduled for April 2011 prior to construction.
  - An operations review of the project's operating plan and anticipated budget is scheduled for August 2011.

Current Project Status

In November 2009, the final design, scope, schedule, and risk-adjusted costs were reviewed and the project's baseline scope, budget, and schedule were found to be credible. The review panel endorsed the remaining pre-construction planning activities slated for 2011 that will enable the project to commence construction in FY 2011. Contingency was increased to cover known risks, per panel recommendations. The NEON, Inc. Project Office has completed the final design, NEON project execution plan (PEP), and maintenance and operations plan. The site selection and associated deployment plan is complete and was merit reviewed during the preliminary design review. The NEPA environmental assessment was completed in November 2009 and a "Finding of No Significant Impact" was signed by NSF in December 2009. The U.S. Fish and Wildlife Service has concurred with the "Finding of No Significant Impact" and NSF's compliance with the Endangered Species Act. This compliance action will allow construction to commence in July 2011. A NEON-led operations review was completed in April 2010; NSF staff participated as observers. The first NSF-led operations review, covering the operating plan and associated budget, is scheduled for August 2011.

Support was provided through the R&RA account for final NEON Project planning. Funds came specifically through Emerging Frontiers (EF) in FY 2011. R&RA funds were used to retire risk, complete detailed construction-ready design documents, and scale up final project activities, including: establishment of the NEON Calibration/Validation Laboratory for sensors and instrumentation; advanced design for the first six NEON domains and all NEON core sites; and biological assessment and permitting for the first six domains.

Cost and Schedule

The projected length of the project is five years, covering six fiscal years, with a six-month schedule contingency. The risk-adjusted cost of $433.72 million includes a contingency budget of 19 percent.

In 2011, NEON requested $20.0 million in MREFC funds to initiate construction. These funds will: establish the NEON Data Center and two domain offices, initiate construction of two domains, procure instruments for the two domains, support the engineering technical facility, and provide for contracts and procurements for long-lead instruments, communications, and field equipment.

In FY 2012, $87.92 million is requested for construction. These funds will support: civil and facilities construction in 9 domains; instrument procurement and calibration for 11 domains, with deployment in 6 domains; biological site characterization in 6 domains; and aquatic site characterization in all domains. Construction activities include production engineering and ongoing equipment procurement for the associated calibration/validation and instrument integration laboratories. These funds also include support for the Data Center infrastructure and will initiate the data products application implementation. Construction will begin on the NEON Airborne Observatory, including spectrometer and LIDAR procurements.

In FY 2012, management and operations funding will commence, with an initial request for $15.93 million. The funds will enable operations of the first two domains constructed, including related management and technical support, seasonal biological sampling, and domain facility costs.

Risks

Technical: Dependence on commercial off-the-shelf technology will be mitigated by long-lead purchase orders and alternative vendors. Production quality, embedded and system-level cyberinfrastructure will be addressed by a combination of "in-house" design, commercial, contracts, and targeted research (e.g., cyber-dashboard).

Deployment: Environmental assessment and permitting may impact schedule and costs. These risks have been and continue to be addressed through multiple means, including: the direct contracting of the environmental assessment by NSF; the hiring of two national firms by NEON, Inc. for engineering and permitting; the identification of alternative sites if the primary sites are determined to have significant risk; and the allocation of two full-time equivalents (FTE) by the U.S. Forest Service to assist with environmental compliance issues on Forest Service lands.

Geospatial Data Acquisition: A potential risk is the long-term availability of satellite (e.g., LANDSAT and MODIS) borne sensors. This risk is mitigated through a partnership with the USGS EROS Data Center, which has the federal responsibility for curation and management of LANDSAT and MODIS images and having alternative satellite sensor sources to purchase images (e.g., SPOT - France, AWIFS – India, Terra and Aqua - US). The proposed NEON airborne observatory platform (AOP) sensor system design and aircraft availability are also sources of technical and implementation risk. To minimize this risk, the AOP is being developed by JPL; similar instrument packages are being prototyped by NASA and Carnegie Institution at Stanford University. The sensor system fits multiple aircraft, including commercial aircraft. Experienced flight design engineers were contracted by NEON, Inc. to provide the baseline operations plans, aircraft analysis, and assessment of commercial companies that could potentially support NEON flight operations, and experienced research aircraft pilots serve on the design team.

Future Operations Costs

Operations costs will ramp up to $83.10 million in FY 2017. Preliminary management and operations costs were reviewed at the NEON FDR in November 2009. A NEON-led operations review, with NSF as observer, was held in April 2010. An NSF-led operations cost review is scheduled for August 2011 and cost reviews will be conducted throughout the operations phase to assess the project and inform future budget requests. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle, so operations costs include scheduled replacement and refreshing of sensor, instrumentation, and cyberinfrastructure technology. NEON operations also include significant labor costs due to the labor-intensive processes required as part of the Fundamental Sentinel Unit (FSU), which is a major component of each domain.

Ocean Observatories Initiative **$102,800,000**

The FY 2012 Budget Request for the Ocean Observatories Initiative (OOI) is $102.80 million, which represents the fourth year of a six-year construction project totaling $386.42 million.

Appropriated and Requested MREFC Funds for the Ocean Observatories Initiative
(Dollars in Millions)

	Prior Years[1]	FY 2009	FY 2010	FY 2010 Enacted/ Annualized FY 2011 CR[2]	FY 2012 Request	FY 2013 Estimate	FY 2014 Estimate	Total Project Cost[1]
Regular Approps	$5.91	-	$14.28	$14.28	$102.80	$46.80	$20.00	$280.49
ARRA	-	105.93	-	-	-	-	-	105.93
Total, OOI	**$5.91**	**$105.93**	**$14.28**	**$14.28**	**$102.80**	**$46.80**	**$20.00**	**$386.42**

[1] Per P.L. 110-161, $5.12 million was rescinded from prior year unobligated balances.

[2] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's funding profile is $90.70 million. Any FY 2011 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

The OOI will consist of an integrated observatory network that will provide the oceanographic research and education communities with continuous, interactive access to the ocean. The OOI will have three elements: 1) deep-sea buoys with designs capable of deployment in harsh environments such as the Southern Ocean; 2) regional cabled nodes on the seafloor spanning several geological and oceanographic features and processes; and 3) an expanded network of coastal observatories. A cutting edge, user-enabling cyberinfrastructure will link the three components of the OOI and facilitate experimentation using assets from the entire OOI network. Data from the network will be made publicly available via the internet.

Baseline History

NSF first requested construction funding for OOI through the MREFC account in FY 2007 and received an initial appropriation of $5.12 million in that year. The OOI has undergone a series of technical reviews, with the Final Design Review (FDR) conducted on November 6-7 and 12-14, 2008. The FDR panel determined that OOI was ready to move to construction, assuming some adjustments to the baseline with respect to schedule and overall project contingency. Following the FDR, in an effort to focus OOI more specifically on high priority science issues related to climate change, ocean acidification, carbon cycling, and ecosystem health, NSF initiated a rapid turn-around process to develop a modified network design in January 2009, referred to as the Variant Design. An additional Science Review Panel and Cost/Schedule Review Panel convened by NSF in March 2009 supported proceeding with the Variant Design and the project was approved at the May 2009 National Science Board meeting.

Total Obligations for OOI

(Dollars in Millions)

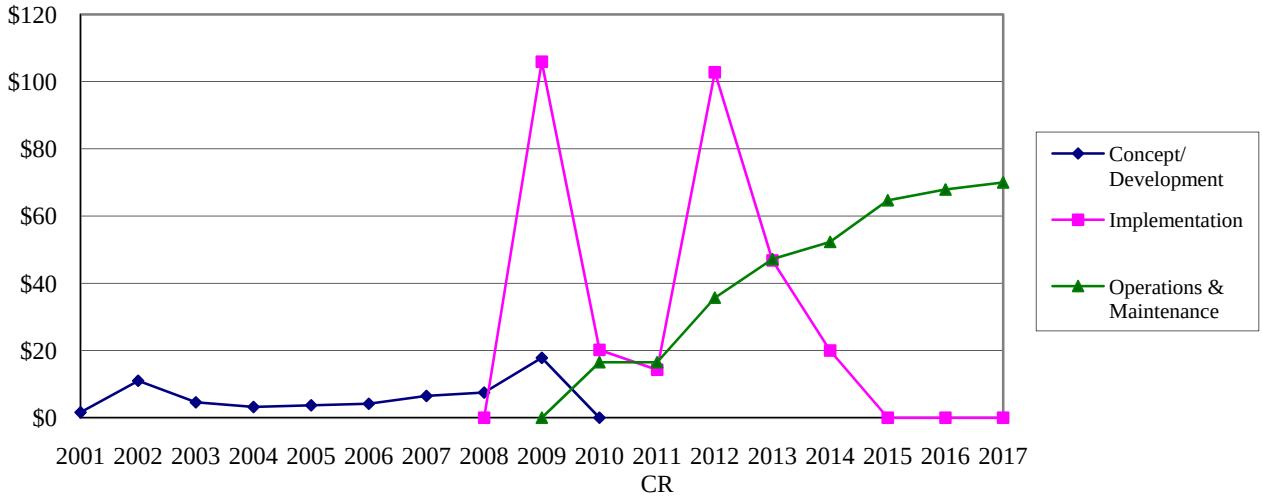
	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations:									
Concept & Development	$74.90	-	-	-	-	-	-	-	-
Management and Operations	-	15.99	16.50	35.70	47.20	52.81	64.70	67.90	70.00
Subtotal, R&RA Obligations	$74.90	$15.99	$16.50	$35.70	$47.20	$52.81	$64.70	$67.90	$70.00
MREFC Obligations:									
Implementation	-	20.19	14.28	102.80	46.80	20.00	-	-	-
ARRA	105.93	-	-	-	-	-	-	-	-
Subtotal, MREFC Obligations	$105.93	$20.19	$14.28	$102.80	$46.80	$20.00	-	-	-
TOTAL Obligations	**$180.83**	**$36.18**	**$30.78**	**$138.50**	**$94.00**	**$72.81**	**$64.70**	**$67.90**	**$70.00**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized level provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $118.20 million: $90.70 million for MREFC, and $27.50 million for R&RA. Any FY 2011 shortfall might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

OOI Funding, by Stage

(Dollars in Millions)



NOTE: FY 2009 implementation funding includes $105.93 million provided through the American Recovery and Reinvestment Act.

Deployed in critical parts of the global and U.S. coastal ocean, OOI's 24/7 telepresence will capture climate, carbon, ecosystem, and geodynamic changes on the time scales at which they occur, rather than when research vessels are able to be in the area. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea. Science themes for OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of

climate variability and ocean circulation, coastal ocean dynamics and ecosystem response, and the interplay of tectonically-driven fluid flow on the carbon cycle, deep ocean ecosystems, and earthquakes.

The education and public engagement infrastructure of OOI will complement and leverage existing ocean education efforts, and build off of the cyberinfrastructure to provide an interactive digital presence to educators and the public alike. Educational links will be made with the Division of Ocean Sciences' (OCE) Centers for Ocean Science Education Excellence (COSEE). In addition, with the establishment of the National Integrated Ocean Observing System (IOOS), there will be an unprecedented need for a STEM workforce and oceanographers skilled in the use and manipulation of large, oceanographic, time-series datasets. The facilities comprising OOI will provide the ideal platforms to train this new generation of oceanographers. These activities will include rigorous evaluation and measurement.

OOI is the NSF contribution to the Integrated Ocean Observing System (IOOS) Program and will supplement operational mission objectives of agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Navy, the National Aeronautics and Space Administration (NASA), and the U.S. Coast Guard.

Science proposals using the OOI network will be solicited as part of the normal competition for funds in OCE. The research envisioned for OOI encompasses a broad range of disciplines. Proposals will be reviewed and competed with other research proposals submitted to OCE.

Project Report

Management and Oversight

- NSF Structure: The project is managed and overseen by a program director in OCE in the Directorate for Geosciences (GEO). The program director receives advice and oversight support from an NSF Project Advisory Team (PAT) that includes representatives from GEO, the Directorates for Biological Sciences (BIO) and Engineering (ENG); the Office of Budget, Finance and Award Management (BFA); the Office of International Science and Engineering (OISE); the Office of General Counsel (OGC); and the Office of Legislative and Public Affairs (OLPA). The Deputy Director for Large Facility Projects (DDLFP) in BFA is also a member of the PAT and provides advice and assistance. NSF has established an Ocean Observing Science Committee (OOSC) via the University National Oceanographic Laboratory System (UNOLS). The committee will be made up of ocean science community representatives. The OOSC is charged with providing guidance on decisions and plans from the science perspective related to all NSF observing systems. The OOSC will be an essential element in the process of communicating the science use perspective to NSF and project teams involved in deploying and operating ocean observatories.
- External Structure: NSF established a cooperative agreement with the Consortium for Ocean Leadership (Ocean Leadership) for the construction and initial operation of the OOI in September 2009. The program director at Ocean Leadership is responsible for designing, building, deploying, testing, commissioning, and conducting initial operations and maintenance for the OOI. The Ocean Leadership program director is accountable to NSF, the Ocean Leadership Board of Trustees, and an external scientific and technical advisory committee. The OOI Project Advisory Committee membership is drawn from individuals with expertise in ocean observing science and engineering. Subawards have been issued by Ocean Leadership to establish three Implementing Organizations (IOs). These IOs will deliver the regional cabled observatory (led by the University of Washington), cyberinfrastructure (led by the University of California-San Diego), and coastal/global observatories (led by Woods Hole Oceanographic Institution). These IOs report directly to Ocean Leadership, which ensures integration, cooperation, and coordination between the IOs.

- Reviews:

  Preconstruction Phase Reviews of OOI

  - Technical reviews: NSF organized a series of external science reviews for OOI, including the Blue Ribbon Review in July 2006, which assessed whether the ocean observing network proposed in the OOI Conceptual Network Design (CND) would provide the capabilities for the ocean researchers to answer high priority science questions that require *in situ*, real-time measurements across the three scales of OOI. A second Blue Ribbon Review in October 2007 assessed whether the OOI Preliminary Network Design provided the experimental capabilities needed to address the scientific scope outlined for OOI. These science reviews provided a general endorsement of OOI, supplemented by a series of recommendations for improvement. These reviews also served as input to the paired design reviews (Conceptual and Preliminary). NSF convened a Blue Ribbon Review in March 2009 to assess a modified OOI network design and its ability to provide transformative research capabilities for the ocean science community. This OOI Variant Design is a modification to the existing network design that more closely focuses OOI infrastructure on climate processes, carbon cycling, ocean acidification, and ecosystem health. The Blue Ribbon Review panel noted that the OOI, as described by the Variant Network Design, remains a worthy investment, providing a transformative capability for the ocean science community.

  Management, Cost, and Schedule reviews

  - The OOI Conceptual Design Review (CDR), held August 2006, reviewed the scope and system level implementation plans for OOI, including management plans and budgeting. It discussed whether all major risks with this project have been identified and whether appropriate initial system development specifications (performance requirements, major system components, and interfaces) have been established for each sub-element of OOI.
  - The Preliminary Design Review (PDR) in December 2007 assessed the robustness of the technical design and completeness of the budget and construction planning for the OOI. The PDR panel also reviewed progress made by the OOI Project Team on the findings of the CDR.
  - The FDR in November 2008 assessed whether OOI's project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.
  - A Cost-Schedule Review Panel in March 2009 assessed whether the OOI Variant Design project plans were fully ready for construction and determined that there was a high degree of confidence that the scope, as proposed, could be delivered within the parameters defined in the project baseline.

  Construction Phase and Initial Operations Reviews of OOI

  - Construction Reviews: NSF conducted the first construction review of the OOI in June 2010, month nine of the sixty-six month construction effort. The panel assessed the construction progress to date and the future prospects for the project. The panel determined that the project achieved major progress in the implementation of project management tracking and reporting systems, award of the major subcontract for the regional primary cable, design and systems engineering requirements management. The panel reported that schedule delays due to staffing ramp-up need to be addressed by active schedule management focused on recovery. The panel determined that despite being behind schedule and underspent at this early stage, the project is on track in month nine of a sixty-six month effort.
  - NSF conducted the first Operations and Maintenance (O&M) review of OOI on August 17-18, 2010, using an external panel of experts. The panel recommended that the project have tighter linkages between the construction schedule and O&M ramp up plans. Work to further mature the O&M plan and schedule is continuing through FY 2011.
  - A second, combined Construction and O&M review is planned for May 2011.

Current Project Status

The project is in year two of the construction and O&M ramp-up effort. Major construction activities include design and production engineering as well as continued prototyping of key coastal and global components (moorings, buoys, and sensors), permitting and environmental compliance, oversight and management of the primary cable contract, entry into leases for a shore station and backhaul services, design activities for the second spiral of cyberinfrastructure, and procurement of components. Delays in project staffing and lagging procurements caused the project to be behind schedule and underspent. A corrective action plan was enacted November 30, 2010 to recover from these delays. Significant staff were brought on board in FY 2011 in order to accelerate design and planning activities. Active schedule management that will link O&M ramp up to construction activities is currently being undertaken and will be fully reviewed in May 2011. In FY 2012, the project will transition from the design phase to an active network build phase. The project requests $102.80 million to support these efforts.

In FY 2010, Ocean Leadership was funded $15.99 million for operations and maintenance. This funded the initial spare parts purchases for the network, initial hiring of operations personnel and production of a more mature O&M plan. The request for O&M funding for FY 2012 is $35.70 million. The OOI will gradually transition to operations throughout the construction phase. Full operations and maintenance is planned for FY 2015.

Cost and Schedule

Test and acceptance of procured assets and transition to component builds will be a major activity during FY 2012. The procured assets include items such as gliders, sensors, and electronic components. Testing activities at the subsystem level will occur both in the laboratory, off shore, and on-site when applicable. Testing will involve use of the UNOLS fleet ships. Woods Hole will manage a major build of marine assets in FY 2012 upon successful completion of a Production Readiness Review in 2011. The University of San Diego will build the second spiral of cyberinfrastructure which will provide a managed instrument network, adding end-to-end control of how data are collected and supporting more advanced processes of instrument providers with managed instrument control. The University of Washington will test and install the primary nodes for the regional network. This is a key milestone for cabled observatory and will allow for the buildout of the secondary infrastructure that includes the sensors and scientific instrumentation. During FY 2013 to FY 2015, major deployments of coastal/global marine assets, regional scale secondary marine assets and completion of all spirals of cyberinfrastructure are planned.

To ensure effective management and oversight, monthly and annual reports provided by the Project Office and IOs are closely monitored by the OOI Program Manager for deviations from established baselines using Earned Value Management. Contingency is tightly managed via change control and specific guidelines in the Cooperative Agreement. Total project contingency is $88.10 million, about 22 percent of the project cost.

Risks

- Oversight risk: The complexity of the OOI and the need for the Project Office and Implementing Organizations to coordinate and integrate construction activities and network implementation under the schedule, cost, and scope constraints of the project presents a project risk. OOI relies heavily on open lines of communication and effective cooperation between the managing entities (Project Office and IOs) and NSF. The June 2010 panel was complementary about the processes and procedures used to track the OOI project. Site visits and reviews will be used to gain a more detailed understanding of the integrative nature of the project teams. In addition, weekly teleconferences with the program staff from both the Project Office and IOs help ensure that all groups are up to date with current activities. NSF will conduct programmatic reviews on an annual or semi-annual basis, as needed, in addition to assessments by an external scientific oversight committee. Lastly, NSF's OOI

Program Director will attend the Project Office's own internal reviews to ensure that OOI implementation is proceeding according to established principles as outlined in the cooperative agreement.

- Scope contingency: The Project Team has provided an appropriate level of contingency for OOI as dictated by a comprehensive (top-down and bottom-up) risk analysis. Should this contingency be exhausted, reductions in the scope of the OOI network plan will be required. These potential reductions, or scope contingency, must be implemented based on clearly articulated scientific priorities. Any changes to scope (as well as cost or schedule) will follow the OOI Change Control Process, which has a tiered evaluation process for evaluating and determining any change to the project. Any reduction in scope will be reported to the Director of the National Science Foundation via the Monthly Large Facilities report. There have been no reductions in scope to date for the project.
- Risks Related to the OOI Cyberinfrastructure (CI): The OOI CI will not only provide the network integration needed to achieve the scientific goals of OOI, but a robust, user-friendly CI will be essential to develop a vigorous OOI user community. Ensuring the "usability" of the CI was a key topic of discussion at the preliminary and final design reviews. Addressing recommendations from the FDR, the CI Implementing Organization was required by NSF to incorporate continued engagement of the user community during development and testing of the cyberinfrastructure. Additionally, continued involvement of Office of Cyberinfrastructure (OCI) Program Managers, via the PAT, and participation in reviews of the OOI network, will help mitigate risks associated with development and construction of the OOI CI.

Future Operations Costs

The FY 2010 to FY 2015 estimates for initial operations and maintenance are $243.90 million. Initial operations and maintenance include post commissioning activities such as network sensing, data acquisition, and data delivery to the scientific community.

Full operations costs in FY 2015 are estimated at $64.70 million. The expected operational lifespan of this project is 25 years. Operations cost reviews will be conducted prior to and throughout the operations phase to assess the project and inform future budget requests.

PERFORM AS A MODEL ORGANIZATION

The NSF Strategic Plan for Fiscal Years (FY) 2011-2016 establishes Perform as a Model Organization as one of three strategic goals for NSF. It emphasizes that NSF expects to attain excellence in all operational aspects. Excellence in NSF's performance as a model organization is essential to achieving and carrying out the Foundation's mission and accomplishing its other strategic goals: Transform the Frontiers and Innovate for Society.

The activities that advance NSF's Perform as a Model Organization goal are funded through five appropriations accounts. Additional details on each account are provided in the respective chapters.

Agency Operations and Award Management (AOAM) increases by $57.74 million, or 19.2 percent, to $357.74 million in FY 2012. These resources include funding for personnel compensation and benefits, information technology (IT) that supports administrative activities, staff travel, training, rent, and other operating expenses necessary for effective management of NSF's research and education activities. Approximately $44 million of this increase is associated with the expiration of NSF's headquarters lease.

Office of Inspector General (OIG) increases by $1.0 million, or 7.1 percent, to $15.0 million in FY 2012. These resources include funding for personnel compensation and benefits, contract audits, training and operational travel, office supplies, materials, and equipment.

National Science Board (NSB) increases by $300,000, or 6.6 percent, to $4.84 million in FY 2012. These resources include funding for personnel compensation and benefits, employment of external experts and consultants, contracts, training and operational travel, office supplies, materials, and equipment.

Program Accounts - Research and Related Activities (R&RA) and **Education and Human Resources** (EHR) – Model Organization funding from program accounts increases by $4.80 million, or 4.3 percent, to $116.01 million in FY 2012. Program funded Model Organization activities include Intergovernmental Personnel Act (IPA) agreements and certain Foundation-wide activities such as major studies, evaluations, outreach efforts, information technology investments that are directly related to the mission of the Foundation, and NSF contributions to interagency e-Government activities.

Model Organization by Appropriations Account

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Agency Operations and Award Management	$299.85	-	$300.00	$357.74	$57.74	19.2%
Office of Inspector General	13.97	0.05	14.00	15.00	1.00	7.1%
National Science Board	4.38	-	4.54	4.84	0.30	6.6%
Program Support						
Research & Related Activities	*97.45*	-	*96.47*	*100.62*	*4.15*	*4.3%*
Education and Human Resources	*14.83*	-	*14.74*	*15.39*	*0.65*	*4.4%*
Subtotal, Program Support	112.28	-	111.21	116.01	4.80	4.3%
Total	**$430.48**	**$0.05**	**$429.75**	**$493.59**	**$63.84**	**14.9%**

Totals may not add due to rounding.

NSF Workforce

NSF Workforce
Full-Time Equivalents (FTE)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
AOAM FTE Allocation					
Regular	*1,310*	*1,310*	*1,325*	*15*	*1.1%*
Student	*40*	*40*	*40*	-	-
Subtotal, AOAM FTE Allocation	*1,350*	*1,350*	*1,365*	*15*	*1.1%*
AOAM FTE Usage (Actual/Projected)					
NSF Regular	1,285	1,285	1,325	40	3.1%
NSF Student	44	40	40	-	-
Subtotal, AOAM FTE[1]	1,329	1,325	1,365	40	3.0%
Office of the Inspector General[2]	76	73	84	11	15.1%
Regular	*70*	*67*	*76*	*9*	*13.4%*
Student	*6*	*6*	*8*	*2*	*33.3%*
National Science Board[3]	19	17	18	1	5.9%
Arctic Research Commission[4]	3	4	3	-1	-25.0%
Total, Federal Employees	1,427	1,419	1,470	51	3.6%
IPAs	165	195	195	-	-
Detailees to NSF	2	6	6	-	-
Contractors (est.)	494	449	494	45	10.0%
Total, Workforce (usage)	**2,088**	**2,069**	**2,165**	**96**	**4.6%**

[1] Additional information regarding FTEs funded through AOAM appropriation are available in the AOAM chapter.

[2] The Office of Inspector General is described in a separate chapter and is funded through a separate appropriation.

[3] The National Science Board is described in a separate chapter and is funded through a separate appropriation.

[4] The U.S. Arctic Commission is described in a separate chapter and is funded through the R&RA appropriation.

In FY 2012, NSF's total federal workforce will increase by 51 FTE over the FY 2010 Enacted. The staffing profile in the table above shows that a small but significant percentage of the NSF workforce included in the FY 2012 Request – 195 people or approximately 9 percent – consists of temporary employees hired through the authority provided by the Intergovernmental Personnel Act (IPA). IPAs do not count as federal FTE. A smaller number of visiting staff – roughly 40 people annually – are employed through NSF's own Visiting Scientist, Engineer, and Educator Program (VSEE). VSEEs count as federal FTE and are included in the Federal Employees total (see table above). The use of IPAs and VSEEs, commonly referred to as rotators, has been a defining characteristic of NSF since its inception in 1950, as it gives NSF a direct connection to the researchers and educators working at the frontiers of science and engineering.

Program Funded Model Organization

R&RA and EHR Program Support funds account for about a quarter of the total Model Organization portfolio. There are two activities that comprise Program-Funded Model Organization – Intergovernmental Personnel Act (IPA) costs and Program Related Administration.

Summary of Program Funded Model Organization
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
IPA Costs	$42.28	$47.12	$49.92	$2.80	5.9%
Program Related Administration	69.99	64.09	66.09	2.00	3.1%
Program Related Technology	*56.00*	*56.00*	*58.00*	*2.00*	*3.6%*
Other Program Related Administration	*13.99*	*8.09*	*8.09*	-	-
Total, Program Funded Model Organization	**$112.27**	**$111.21**	**$116.01**	**$4.80**	**4.3%**

Totals may not add due to rounding.

IPA Costs

IPA Costs by Appropriation
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
R&RA					
IPA Compensation	$31.15	$33.63	$36.49	$2.86	8.5%
IPA Lost Consultant & Per Diem	3.19	4.07	3.73	-0.34	-8.4%
IPA Travel	2.35	2.86	2.75	-0.11	-3.8%
Subtotal, R&RA Costs	36.69	40.56	42.97	2.41	5.9%
EHR					
IPA Compensation	4.63	5.39	5.75	0.36	6.7%
IPA Lost Consultant & Per Diem	0.69	0.86	0.86	-	-
IPA Travel	0.27	0.31	0.34	0.03	9.7%
Subtotal, EHR Costs	5.60	6.56	6.95	0.39	5.9%
Total, IPA Costs	**$42.28**	**$47.12**	**$49.92**	**$2.80**	**5.9%**

Totals may not add due to rounding.

IPAs remain employees of their home institution while serving alongside NSF employees during their temporary appointment. They are not paid directly by NSF and are not subject to federal pay benefits and limitations. NSF reimburses the home institution using the traditional grant mechanism. IPAs are eligible to receive per diem, relocation expenses, and reimbursement for income foregone because of their

assignment at NSF (i.e., lost consulting fees). IPAs function in a manner virtually identical to NSF permanent staff – leading the merit review process and overseeing awards.

Total IPA costs increase by $2.80 million, or 5.9 percent, to $49.92 million due to an increase in the estimated total number of IPAs on board.

Program Related Administration

Program Related Administration (PRA) includes funding for certain Foundation-wide activities such as major studies, evaluations, outreach efforts, NSF contributions to interagency e-Government activities, and grants management applications that benefit the research community, such as a reviewer management system to more effectively plan for and find the thousands of scientific experts required to support the merit review process.

Program Related Administration

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Program Related Technology	$56.00	$56.00	$58.00	$2.00	3.6%
Other Program Related Admin	13.99	8.09	8.09	-	-
Total, PRA	**$69.99**	**$64.09**	**$66.09**	**$2.00**	**3.1%**

Totals may not add due to rounding.

Program Related Technology (PRT) (+$2.00 million, to a total of $58.00 million)

PRT investments support NSF program staff as they formulate and announce program opportunities; accept proposals; conduct the merit review process; make awards to fund proposals that have been judged the most promising by the merit-review process; monitor program performance and results; and disseminate results of NSF funded research. Major IT systems funded through PRT include iTRAK, Research.gov, eJacket, and FastLane.

The PRT budget includes:

Mission-Support Applications Services (+$2.0 million, to a total of $41.13 million)

- iTRAK (+$2.30 million, to a total of $3.90 million) This will fund the first year of acquisition and implementation for NSF's financial management system modernization. iTRAK is the Foundation-wide strategic initiative to transition NSF from its disparate, aging financial and property management systems to a fully integrated financial management and property solution. iTRAK is proportionately funded out of PRT (70 percent) and AOAM (30 percent) accounts based on the respective share of program-related and administrative financial transactions. iTRAK will:
  - Facilitate standardization and increase automation of NSF financial transactions, business processes, and operating procedures;
  - Provide NSF managers with financial and business analysis capabilities to support informed decision-making in administering and managing NSF grants; and
  - Enable NSF to comply with federal regulations and standards, which cannot be fully supported by NSF's current financial management environment.

  The total iTRAK budget, including $1.67 million funded by the AOAM account, will be $5.57 million in FY 2012.

- Other mission-related applications (-$300,000 to a total of $22.23 million) This decrease will reduce funding for operations and maintenance for NSF's suite of legacy applications that provide comprehensive services for NSF staff, applicants, and awardees to manage the grants life cycle. NSF processes approximately 44,000 proposals annually. Every proposal is acted on: withdrawn, declined, or awarded. These legacy capabilities are essential to carrying out NSF's mission in an efficient manner and include FastLane, eJacket, and the Awards system.

- Research.gov (no change, to a total of $15.0 million) Funding will provide NSF staff and its extended research community with capabilities to plan and manage programs, proposals, and awards; information to further promote scientific innovations and discoveries; and to support broadening participation by enabling a more diverse set of institutions, investigators, and reviewers greater access to NSF funding opportunities. Research.gov is NSF's critical investment to meet the high priority needs of NSF staff and the research community, consistent with new government-wide standards, and in partnership with the broader research community. Research.gov will:
  - Provide NSF staff new services and tools via an intuitive, easy to use desktop portal;
  - Provide services and access to information for institutions and researchers as they conduct business with NSF throughout the grants lifecycle; and
  - Implement new and emerging government-wide standards for research agencies, such as the new Research Performance Progress Report standard.

Associated IT Operations and Infrastructure (no change, to a total of $13.91 million)
Investments in this category provide basic maintenance and operations levels for ongoing operations, which includes NSF's data center, hosting, phone, email, remote access services, and help desk services. FY 2012 funding will provide associated IT infrastructure support and services, including technical refresh projects, system redundancy, and network connections to the offsite commercial data facility housing NSF critical systems.

Related Security and Privacy Services (no change, to a total of $2.96 million)
These investments will secure mission-related applications and protect information by providing proactive protection from viruses, spyware, and other threats. This includes network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services.

Other Program Related Administration (no change, to a total of $8.09 million)
Other Program Related Administration includes funding for Foundation-wide activities such as major studies, evaluations, and NSF's costs associated with interagency e-Government activities. These activities include verification and validation of performance information; surveys of scientists, engineers, and educators who submit proposals for NSF awards; the Waterman Award which recognizes an outstanding young researcher in any field of science or engineering supported by NSF; AAAS fellowship program and internships; and external evaluations of cross-foundational programs.

Information Technology Investments

Information Technology (IT) Investments by Appropriation and Activity
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Agency Operations and Award Management (AOAM)					
Applications Services and Support	$12.81	$11.81	$13.48	$1.67	14.1%
Associated IT Operations and Infrastructure	13.80	11.50	11.50	-	-
Security and Privacy Services and Support	2.79	2.79	2.79	-	-
Subtotal, AOAM	$29.40	$26.10	$27.77	$1.67	6.4%
Program Related Technology					
Mission-Support Applications Services	39.13	39.13	41.13	2.00	5.1%
Associated IT Operations and Infrastructure	13.91	13.91	13.91	-	-
Related Security and Privacy Services	2.96	2.96	2.96	-	-
Subtotal, Program Related Technology	$56.00	$56.00	$58.00	$2.00	3.6%
Total, Information Technology Investments	**$85.40**	**$82.10**	**$85.77**	**$3.67**	**4.5%**

Totals may not add due to rounding.

Information Technology (IT) Investments by Appropriation
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Agency Operations and Award Management	$29.40	$26.10	$27.77	$1.67	6.4%
Program Related Technology	56.00	56.00	58.00	2.00	3.6%
R&RA	*48.72*	*48.72*	*50.46*	*1.74*	*3.6%*
EHR	*7.28*	*7.28*	*7.54*	*0.26*	*3.6%*
Total	**$85.40**	**$82.10**	**$85.77**	**$3.67**	**4.5%**

Totals may not add due to rounding.

Total funding for NSF's Information Technology (IT) investments in FY 2012 is $85.77 million, an increase of $3.67 million over the FY 2010 Enacted. This increase will fund first year acquisition and implementation of NSF's financial system modernization (iTRAK).

- $58.0 million is for Program Related Technology (PRT) activities that relate directly to NSF's programmatic investments and associated services and support, such as iTRAK, Research.gov, eJacket, and FastLane. PRT is funded with direct program resources from the R&RA and EHR accounts. Further information on PRT-funded IT investments can be found on page 4 of this chapter.
- $27.77 million is funded with AOAM resources and will support routine administrative activities, such as human resources, financial statement preparation, procurement, etc. Further information on AOAM-funded IT investments can be found in the AOAM chapter of this Request.

E-Government Activities

NSF is providing funding to these E-Government Activities:

NSF FY 2010 Enacted/ FY 2011 Annualized CR Funding for E-Government Initiatives

Initiative	FY 2010 Agency Contributions	FY 2010 Agency Svc. Fees	NSF Total	Appropriations Account		
				AOAM	R&RA	EHR
Grants.gov	$475,294	-	**$475,294**	-	$413,506	$61,788
Grants Management LoB	174,360	-	**174,360**	-	151,693	22,667
E-Travel	-	150,038	**150,038**	150,038	-	-
Geospatial LoB	15,000	-	**15,000**	-	13,050	1,950
E-Training	-	370,000	**370,000**	370,000	-	-
E-Rulemaking	-	5,100	**5,100**	5,100	-	-
Recruitment One-Stop (USA Jobs)	-	4,871	**4,871**	4,871	-	-
E-HRI	-	48,724	**48,724**	48,724	-	-
Integrated Acquisition Environment (IAE)	-	18,866	**18,866**	18,866	-	-
Human Resources Management LoB	65,217	-	**65,217**	-	56,739	8,478
Financial Management LoB	44,444	-	**44,444**	-	38,666	5,778
Budget Formulation/Execution LoB	95,000	-	**95,000**	-	82,650	12,350
E-Payroll (incl. Shared Services)	-	304,704	**304,704**	304,704	-	-
Total	**$869,315**	**$902,303**	**$1,771,618**	**$902,303**	**$756,304**	**$113,011**

Totals may not add due to rounding.

NSF FY 2012 Funding for E-Government Initiatives

Initiative	FY 2012 Agency Contributions	FY 2012 Agency Svc. Fees	NSF Total	Appropriations Account		
				AOAM	R&RA	EHR
Grants.gov	-	$481,957	**$481,957**	-	$419,303	$62,654
Grants Management LoB	106,426	-	**106,426**	-	92,591	13,835
E-Travel	-	215,163	**215,163**	215,163	-	-
Geospatial LoB	-	-	**-**	-	-	-
E-Training	-	370,000	**370,000**	370,000	-	-
E-Rulemaking	-	10,500	**10,500**	10,500	-	-
Recruitment One-Stop (USA Jobs)	-	7,522	**7,522**	7,522	-	-
E-HRI	-	26,237	**26,237**	26,237	-	-
Integrated Acquisition Environment (IAE)	-	18,511	**18,511**	18,511	-	-
IAE - Loans and Grants		89,973	**89,973**	89,973	-	-
Human Resources Management LoB	65,217	-	**65,217**	-	56,739	8,478
Financial Management LoB	44,444	-	**44,444**	-	38,666	5,778
Budget Formulation/Execution LoB	105,000	-	**105,000**	-	91,350	13,650
E-Payroll (incl. Shared Services)	-	314,640	**314,640**	314,640	-	-
Total	**$321,087**	**$1,534,503**	**$1,855,590**	**$1,052,546**	**$698,649**	**$104,395**

Totals may not add due to rounding.

Benefits realized through the use of these activities are:

- *Grants Management Line of Business (GMLoB)*
  NSF anticipates the key benefit of Grants Management LoB (GMLoB) will be having a common place for grantees to track the status of applications, find award information, and submit grant progress and financial reports. Automated business processes available through Consortia will decrease agency reliance on manual and paper-based processing. GMLoB will lead to a reduction in the number of record systems for grants data across NSF and the government and will foster the development of common reporting standards, improving NSF's ability to provide agency and government wide reports on grant activities and results.

  As a GMLoB Consortium lead, NSF has developed Research.gov in partnership with NASA, the Defense Research Agencies, and USDA National Institute of Food and Agriculture. Research.gov is a web portal containing government-wide resources and tools for research institutions to conduct grants business with Federal research agencies. Research.gov aims to ease the grants administrative burden on applicants and awardees by providing a menu of services focused on the needs of research institutions. Research.gov provides:
  - Research Spending and Results Service enabling the general public to search for detailed research grant award information including Principal Investigator, Award Abstract, and Publication Citations.
  - Research Headlines and Events highlighting research activities from NSF and partner agencies;

- Policy library providing access to federal and agency-specific policies, guidelines, and procedures;
- Grants Application Status Service enabling principal investigators and sponsored project office staff to check the status of grant applications submitted to participating agencies;
- Federal Financial Report Service enabling grant recipients to complete and submit grant financial reports using the new government-wide federal financial report standard; and,
- Institutions and User Management Service allowing institution administrators to add users and manage their profiles.

By leading the GMLoB Consortium, NSF will receive the following benefits:

- Avoiding costs related to developing and implementing online grants management services;
- Supporting federal agencies' efforts to promote their common research mission;
- Fulfilling federal mandates (Public Law 106-107, President's Management Agenda, E-Government Act, and the Federal Funding Accountability and Transparency Act); and
- Organizing information into a single access point throughout the grants management business process.

  Service to constituents will be improved through the standardization and streamlining of government-wide grants business processes. The public will receive time savings as a result of quicker notification and faster payments due to an automated system for grants processing. Furthermore, GMLoB will minimize complex and varying agency-specific requirements and increase grantee ease of use on federal grants management systems. Constituents will benefit from having fewer unique agency systems and processes to learn; grantees' will benefit from ease in learning how to use the system and reduced need to rely on call center technical support.

- *Geospatial Line of Business*
  NSF supports basic research at the frontiers of discovery across all fields of science through competitive proposals that are evaluated using merit-based peer review. To advance its mission, NSF actively participated in activities that shape and enhance the scientific enterprise. Although NSF is not currently a provider of geospatial data, it does consider proposals for support of fundamental research that utilizes or enhances the value of geospatial information. NSF recognized the importance of the Geospatial LoB in establishing a more collaborative and performance-oriented culture within the federal geospatial arena that optimizes investments in data and technology and yield many long-term benefits to the Nation.
- *Human Resources Line of Business (HRLoB)*
  NSF benefits through its use of best-in-class Human Resources (HR) services and systems provided by one of the approved service providers, the Department of Interior's National Business Center. Through its adoption of an approved service provider, NSF achieves the benefits of "best-in-class" HR solutions and offers employees across the agency improved HR services without the costs of developing and maintaining their own HR systems. Participation in the Human Resources Management LoB (HR LoB) allows NSF to participate in the implementation of modern HR solutions and benefit from best practices and government-wide strategic HR management.
- *Financial Management LoB (FMLoB)*
  NSF will realize the following benefits through participation in the Financial Management LoB (FM LoB) and usage of a common solution:
  - Cost Savings: Customer agencies will reduce the cost of their financial operations when adopting the centralized transaction processing solutions.

- Reduced administrative burden: Customers of a common shared solution can rely on authoritative data sources for certain financial reporting thereby reducing or eliminating the need to capture and send data for reporting.
- Cost Avoidance: Agencies implementing common solutions will eliminate the capital expenses associated with building and maintaining server and system infrastructures.
- Minimizing Risk: Customer agencies will minimize risk by implementing solutions for their transactions processing that are already operating with standard data and standard data exchanges.

- *Budget Formulation and Execution Line of Business (BFELoB)*
  The Budget Formulation and Execution LoB (BFELoB) chartered a workgroup with the intent of reducing the need for duplicate data entry by agencies into the MAX A-11 system by improving the quality of data and data exchange. NSF has participated in the process of developing standards formats for data submission and rules validation, and worked to coordinate their agency's efforts to build or update their agency's budget system to interface with MAX A-11 directly. NSF has also provided input into the development and validity testing of the Budgeting Capabilities Self Assessment Tool (BCSAT) and has already begun using it to assess organizational practices and develop strategic plans to address areas of need. The National Science Foundation (NSF) currently has approximately 250 users registered for the MAX Federal Community.

AGENCY OPERATIONS AND AWARD MANAGEMENT $357,740,000
+$57,740,000 / 19.2%

Summary of Agency Operations and Award Management
Major Categories
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Human Capital					
Personnel Compensation & Benefits	$199.85	$203.66	$211.90	$8.24	4.0%
Management of Human Capital	10.27	8.92	12.52	3.60	40.4%
Operating Expenses	12.67	14.11	14.11	-	-
Travel	6.65	9.00	9.00	-	-
Subtotal, Human Capital	229.44	235.69	247.53	11.84	5.0%
Technology and Tools					
Information Technology	29.40	26.10	27.77	1.67	6.4%
Space Rental	25.76	26.00	26.39	0.39	1.5%
Other Infrastructure	14.46	11.40	11.40	-	-
Subtotal, Technology and Tools	69.61	63.50	65.56	2.06	3.2%
Future NSF HQ[2]	0.80	0.81	44.65	43.84	*
Total, AOAM	**$299.85**	**$300.00**	**$357.74**	**$57.74**	**19.2%**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

[2] The FY 2012 percent change for the Future NSF HQ category is not applicable as this is a one-time project.

AOAM in Context

Investments in the Agency Operations and Award Management (AOAM) account, contained within the Foundation's *Perform as a Model Organization Strategic Goal*, continue to be an NSF priority. This activity provides the fundamental framework through which the Foundation's science and engineering, research, and education programs are administered. AOAM funding covers NSF's scientific, professional, and administrative workforce, the physical and technological infrastructure necessary for a productive, safe and secure work environment, and the essential business operations critical to managing NSF's administrative processes and providing high-quality customer service to the public.

NSF's Perform as a Model Organization Strategic Goal defines three performance goals that frame the overall priorities for AOAM.

- Achieving management excellence through leadership, accountability, and personal responsibility;
- Infusing learning as an essential element of the NSF culture with emphasis on professional development and personal growth; and
- Encouraging and sustaining a culture of creativity and innovation across the agency to ensure efficiency and effectiveness in achieving high levels of customer service.

FY 2012 Request by Major Category

HUMAN CAPITAL ($247.53 million)

Human Capital Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Personnel Compensation & Benefits	$199.85	$203.66	$211.90	$8.24	4.0%
Management of Human Capital	10.27	8.92	12.52	3.60	40.4%
Operating Expenses	12.67	14.11	14.11	-	-
Travel	6.65	9.00	9.00	-	-
Total, Human Capital	**$229.44**	**$235.69**	**$247.53**	**$11.84**	**5.0%**

Totals may not add due to rounding.

AOAM NSF Workforce
(Full-Time Equivalent (FTE) and Other Staff)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
NSF AOAM -- Regular	*1,310*	*1,310*	*1,325*	*15*	*1.1%*
NSF AOAM -- Student	*40*	*40*	*40*	*-*	*-*
Subtotal, FTE Allocation	*1,350*	*1,350*	*1,365*	*15*	*1.1%*
NSF AOAM -- Regular	1,285	1,285	1,325	40	3.1%
NSF AOAM -- Student	44	40	40	-	-
Subtotal, FTE Usage	1,329	1,325	1,365	40	3.0%
Detailees to NSF	2	6	6	-	-
Total, Workforce (Usage)	**1,331**	**1,331**	**1,371**	**40**	**3.0%**

Totals may not add due to rounding.

NSF funding for Human Capital covers four general areas:

- Personnel Compensation and Benefits funds the salaries of NSF's federal employees and students, as well as the costs related to their employee benefits;
- Management of Human Capital encompasses a broad array of personnel-related services including recruiting, classification and staffing, workforce planning, policy development and execution, competency modeling, succession planning, learning and development activities, and talent management. Resources devoted to this strategic investment ensure that the agency has highly qualified, motivated, and trained staff to facilitate the grant making process and assure that the best science, engineering, and education research is funded;
- Operating Expenses includes funding for supplies and equipment, as well as contracts for post-award monitoring and financial services consulting; and
- Travel includes outreach activities, post-award oversight and monitoring, and site visits.

Personnel Compensation and Benefits (+$8.24 million, to a total of $211.90 million)

Personnel Compensation & Benefits
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Regular FTE Allocation	1,310	1,310	1,325	15	1.1%
Regular FTE Usage (actual/projected)	*1,285*	*1,285*	*1,325*	*40*	*3.1%*
Student FTE	*44*	*40*	*40*	*-*	*-*
Total, FTE Usage	*1,329*	*1,325*	*1,365*	*40*	*3.0%*
Regular Salary					
Base Salary[1]	$151.51	$149.14	$155.29	$6.15	4.1%
Salary Cost of Additional FTE	-	2.20	5.29	3.09	140.5%
COLA & Locality Pay Adjustments	-	2.71	-	-2.71	-100.0%
Subtotal, Regular FTE Salary	151.51	154.05	160.58	6.53	4.2%
Student Salary	1.41	1.49	1.43	-0.06	-4.0%
Subtotal, FTE Pay	152.92	155.54	162.01	6.47	4.2%
Benefits and Other Compensation[2]	46.93	48.12	49.89	1.77	3.7%
Total, PC&B	**$199.85**	**$203.66**	**$211.90**	**$8.24**	**4.0%**

Totals may not add due to rounding.

[1]The increase in the FY 2012 base salary reflects the full annual cost of employees hired throughout FY 2011.

[2]This category includes employee benefits, detailees to NSF, terminal leave, awards, and other benefits.

The FY 2012 Request of $211.90 million for PC&B represents an increase of $8.24 million, or 4.0 percent over NSF's FY 2010 Enacted level of $203.66 million. The FY 2012 Request for PC&B is based on estimated salaries and benefits for 1,325 regular FTE, includes zero pay raise, and holds general workforce performance awards and SES bonuses level with FY 2010.

The 1,325 FTE level represents an increased utilization level of 40 FTE over the FY 2010 Enacted. The additional positions include staffing for the government-wide effort, presented in FY 2011, to strengthen the acquisition workforce; the FTE to support NSF's financial system modernization effort (iTRAK); and the additional personnel required based on a workforce and staffing forecast that is commensurate with the anticipated workload associated with the total NSF portfolio in FY 2012.

The FY 2012 PC&B estimate contains the costs associated with 11 FTE assigned to the Division of Acquisition and Cooperative Support to continue the augmentation of NSF's acquisition activities by improving the capacity, capabilities, and effectiveness of the acquisition workforce. A key priority for NSF is improving capabilities in the pre-solicitation phase of major acquisitions. In addition, the FY 2012 PC&B request includes the five additional FTE that will support iTRAK.

NSF also uses a workforce and staffing forecast model to provide a data-driven rationale for NSF's annual staffing request. The analysis incorporates the relationship between NSF's budget and workload and takes into consideration the directorate workload, including: the volume and dollar threshold of awards; the

number of declinations; the number of post award activities; the number of pre-proposals; and the historical ratio between support and program staff. The analysis is based primarily on the workload demands of activities related to merit review and the funding of awards on a transaction basis and does not include the additional and increasing responsibilities related to program planning and evaluation and the added demands of increased levels of reporting and accountability. The FY 2012 PC&B increase includes $7.06 million for salaries and benefits to fund the 40 additional FTE over the FY 2010 Enacted.

Management of Human Capital (+$3.60 million, to a total of $12.52 million)

Funding for the Management of Human Capital includes:

- Services in support of effective recruitment, marketing and outreach, employment and retention of staff; and payments to shared service providers, such as the Department of the Interior's National Business Center, which provides central personnel and payroll services;
- Health and employee assistance services, benefits and retirement counseling;
- Workforce and succession planning and implementation;
- Organizational development;
- Performance management system implementation; and
- Training and talent management services to create and provide in-house, on-line, and external learning opportunities for NSF staff.

The additional $3.60 million is being requested for:

- Contract support for the processing of personnel actions, position classification, employee benefits, and related activities, including support for e-recruiting systems and payments to the Department of Interior for centralized payroll support increase (+ $1.04 million, to a total of $4.59 million);
- On-going and nascent programs of learning and development in support of NSF's Strategic Plan and its Human Capital Strategic and Management Plans. High priorities include: on-boarding processes for all staff with an emphasis on a program of offerings on management responsibilities for new executives, managers, and supervisors in response to concerns of NSF staff as expressed in the Employee Viewpoint Survey, OIG Management Challenges for NSF, and OPM mandates for such training; offerings on diversity management and conflict resolution, important to achieving NSF's goal to become a model Equal Employment Opportunity (EEO) agency; and offerings that are geared to enhancing effectiveness of employee and agency performance, with particular attention to filling gaps identified through a broad needs analysis (+ $710,000, to a total of $2.91 million);
- NSF wellness activities, including the NSF health center and services related to Office of Polar Programs deployment. These funds will enhance on-going activities and support development of additional activities in line with the Administration's Employee Wellness Initiative (+ $150,000, to a total of $1.13 million); and
- Contractor support for strategic management of human capital including support for the Chief Human Capital Officer in the development and implementation of human capital management planning, implementation and accountability; workforce planning and succession planning activities; implementation of actions to enhance employee satisfaction; and implementation of the Hiring Reform Action Plan (+ $1.70 million, to a total of $3.89 million).

Operating Expenses (no change, to a total of $14.11 million)

Operating Expenses includes funding for supplies and equipment, as well as contracts for post-award monitoring and financial services consulting.

The FY 2012 Request of $14.11 million for Operating Expenses represents no change from the FY 2010 Enacted. The FY 2012 Request includes funding for contracts for post-award monitoring, the e-

procurement system, the Budget Internet Information System, Contracting Officer's Technical Representative (COTR) training, A-123 Internal Controls Monitoring, financial services consulting, and the continued expansion of NSF's acquisition capabilities. Operating expenses also include other general expenses such as the costs of supplies, equipment, training for individual staff members, and other operating expenses necessary for the management of NSF's award processing.

Travel (no change, to a total of $9.0 million)

NSF travel includes outreach activities, post-award oversight and monitoring, and site visits.

The FY 2012 Request of $9.0 million for Travel represents no change from the FY 2010 Enacted level. Travel resources are essential to meet programmatic needs and to carry out the necessary level of site reviews, post-award monitoring and oversight, and outreach activities.

TECHNOLOGY AND TOOLS ($65.56 million)

Technology and Tools Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Information Technology	$29.40	$26.10	$27.77	$1.67	6.4%
Space Rental	25.76	26.00	26.39	0.39	1.5%
Other Infrastructure	14.46	11.40	11.40	-	-
Total, Technology and Tools	**$69.61**	**$63.50**	**$65.56**	**$2.06**	**3.2%**

Totals may not add due to rounding.

The Technology and Tools activities encompass the information and physical infrastructure for NSF's working environment.

Information Technology for Agency Operations (+$1.67 million, to a total of $27.77 million)

NSF's Information Technology (IT) investments are funded through three accounts; Agency Operations and Award Management (AOAM), Research and Related Activities (R&RA), and Education and Human Resources (EHR). The FY 2012 Request includes $27.77 million for IT investments funded with AOAM resources and will support routine administrative activities, such as human resources, financial statement preparation, and procurement. The FY 2012 increase of $1.67 million over the FY 2010 Enacted is to fund the AOAM portion of the first year acquisition and implementation of iTRAK – NSF's financial system modernization.

IT investments funded from the R&RA and EHR accounts is for Program Related Technology (PRT) activities that relate directly to NSF's programmatic investments and associated services. Further information on PRT-funded IT investments can be found in the Model Organization chapter of this request.

Summary of Agency Operations Information Technology (IT)
(Dollars in Millions)

Agency Operations Information Technology	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Applications Services and Support	$12.81	$11.81	$13.48	$1.67	14.1%
Associated IT Operations and Infrastructure	13.80	11.50	11.50	-	-
Security and Privacy Services and Support	2.79	2.79	2.79	-	-
Total, Information Technology	**$29.40**	**$26.10**	**$27.77**	**$1.67**	**6.4%**

Totals may not add due to rounding.

Applications Services and Support (+$1.67 million, to a total of $13.48 million)
This increase will fund the first year of acquisition and implementation for NSF's financial management system modernization. iTRAK is the Foundation-wide strategic investment to transition NSF from its disparate, aging financial and property management systems to a fully integrated financial management and property solution. iTRAK is proportionately funded out of PRT (70 percent) and AOAM (30 percent) accounts based on the respective share of program-related and administrative financial transactions.

iTRAK will:

- Enable NSF to comply with federal regulations and standards, which cannot be fully supported by NSF's current financial management environment.
- Facilitate standardization and increase automation of NSF financial transactions, business processes, and operating procedures.
- Provide NSF managers with financial and business analysis capabilities to support informed decision-making in administering and managing NSF grants.

Applications Services and Support also funds information technology solutions supporting administrative activities that cut across the Foundation including:

- Human resource information systems supporting workforce/succession planning, performance management, and benefits/retirement management;
- Legacy financial accounting system and interfaces to payroll, travel, and training systems; and
- Conference space management, visitor registration, and productivity/collaborative applications and related tools supporting all NSF staff.

Associated IT Operations and Infrastructure (no change, to a total of $11.50 million)
Investments in this category provide basic maintenance and operations levels for ongoing operations, which includes NSF's data center, hosting, telephone, email, remote access services, and help desk services. FY 2012 funding will provide associated IT infrastructure support and services, including technical refresh projects, system redundancy and network connections to the offsite commercial data facility housing NSF critical systems.

Security and Privacy Services and Support (no change, to a total of $2.79 million)
These investments will secure applications and protect sensitive information by providing proactive protection from viruses, spyware, and other threats. This includes network security, application security, security control testing and tools, automated vulnerability assessment tools, and remediation and intrusion detection services.

Summary of Space Rental and Other Infrastructure by Function
(Dollars in Millions)

Space Rental & Other Infrastructure	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Space Rental	$25.76	$26.00	$26.39	$0.39	1.5%
Other Infrastructure	14.46	11.40	11.40	-	-
- Administrative Contracts	*9.11*	*6.00*	*6.00*	-	-
- Government Goods and Services	*1.35*	*1.35*	*1.35*	-	-
- Administrative Services Equipment & Supplies	*4.00*	*4.05*	*4.05*	-	-
Total, Space Rental & Other Infrastructure	**$40.22**	**$37.40**	**$37.79**	**$0.39**	**1.0%**

Totals may not add due to rounding.

Space Rental (+$0.39, million, to a total of $26.39 million)
Space Rental includes General Services Administration (GSA) rent, utilities, taxes and security.

The FY 2012 request for Space Rental is $26.39 million, an increase of $390,000, or 1.5 percent, over the FY 2010 Enacted level. NSF currently occupies 650,000 square feet of space, primarily in two adjoining, leased office buildings located in Arlington, Virginia. The additional $390,000 is required to cover increased GSA rental costs, real estate taxes, and utility costs.

Other Infrastructure (no change, to a total of $11.40 million)
Other Infrastructure funding supports the following major sets of activities:

Administrative Contracts – Investments in this category provide basic activities such as the physical security of the NSF workplace; conference room, meeting and travel management support; infrastructure maintenance and building services; records management; the intranet; and the employee transit subsidy program.

Government Goods and Services – Investments in this category provide basic activities such as the security guards for NSF's leased office locations, infrastructure maintenance and building services, building improvements, and office space reconfiguration and realignment.

Administrative Services Equipment and Supplies – Investments in this category fund a full range of office machine and office furniture purchases, upgrades and installations; subscriptions to scientific and engineering databases and periodicals that support NSF programs; and support for video conferencing and other virtual technologies.

FUTURE NSF HQ ($44.65 million)

Future NSF HQ
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Future NSF HQ	**$0.80**	**$0.81**	**$44.65**	**$43.84**	*****

The FY 2012 percent change for the Future NSF HQ category is not applicable as this is a one-time proj

Future NSF HQ (+$43.84 million, to a total of $44.65 million)

NSF headquarters has been housed in Stafford Place in Arlington VA since 1993. As NSF's mission, operations, and staff have grown over the past 18 years, NSF expanded into the adjacent Stafford II facility. Both leases expire by the end of 2013.

To effectively plan and prepare for a new lease, in FY 2009 NSF initiated a strategic housing study, engaging all levels of the organization in defining the vision, guiding principles and major characteristics and criteria for a future NSF working and operating environment. In FY 2010, NSF worked collaboratively with the GSA to develop a comprehensive Program of Requirements to further define the space and functional elements that would be procured for NSF's future space. The resulting NSF Housing Plan provides a guideline by which NSF's future headquarters space will support a measurably improved, efficient, and adaptable and technologically advanced working and operating environment through which NSF's grant making process will be enhanced.

The new facility will include modular walls and floors, energy efficient power, and other related features. These investments respond to recent Administration mandates to improve economic performance through reductions in space utilization and future space reconfiguration costs, through the increased use of virtual technologies to reduce travel costs and in lowering energy consumption.

In December 2010, GSA submitted a prospectus to Congress requesting authorization to enter into a new 15-year operating lease for the Foundation. GSA anticipates that the procurement of a new lease, the design, renovation and/or construction of a new headquarters, and the relocation and occupancy of NSF's employees will be completed by May 2015.

Explanation of Change: The Future NSF HQ project is part of the GSA FY 2011 prospectus program before Congress. The procurement process requires that NSF fund certain costs, such as customization for tenant improvements, when GSA signs the lease in FY 2012. Other project and program management activities such as NSF's technology infrastructure planning and design will play an essential role in successfully meeting project schedule milestones for FY 2012. Future funding will be required to continue the purchase of contracts for design; equipment and installation of all technology, security and related equipment; office furniture and equipment; and relocation costs.

As part of the FY 2012 budget, NSF requests that funds remain available until expended within the AOAM appropriation for Future NSF HQ funding activities. This will enable NSF sufficient flexibility for a project of this size to plan and execute the most cost effective acquisition strategies that represent the best value to the government.
The following table provides the estimated cost for Future NSF, including out-year requirements:

Future NSF HQ Funding
by Activity
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
Customization Costs	-	-	$34.71
Technology Costs	-	-	8.07
Program Management Costs	0.80	0.81	1.71
Move Costs	-	-	0.16
Furniture & Equipment Costs	-	-	-
Total, Future NSF	**$0.80**	**$0.81**	**$44.65**

Totals may not add due to rounding.

Explanation of the Major Cost Components in FY 2012:

Customization Costs ($34.71 million) – When the new lease is awarded in FY 2012, NSF will be responsible for providing GSA a lump sum payment for "customizing the building shell" with tenant improvements that are necessary to functionally outfit the space to meet the agency's mission. The requested funding level was validated through an analysis and independent government estimate of NSF's comprehensive Program of Requirements. These funds will allow NSF to:

- Design and construct a flexible and adaptable work environment that will minimize subsequent major space alterations and additional lease costs in future years;
- Support technology for the increasing use of virtual panels and advisory committee meetings in NSF;
- Design and construct adequately sized and supported services spaces (e.g., library, health center, food service) for NSF staff and visitors; and
- Provide for the appropriate energy efficient electrical power infrastructure and integrated building control systems to support NSF's mission and accountability reporting requirements (e.g. computer and communications rooms, integrated security system, secure rooms, etc.) in accordance with Executive Order 13514.

Technology Costs ($8.07 million) – In accordance with the GSA project schedule, in FY 2012 the engineering and design for technology service routes and infrastructure between NSF IT service sites and the future NSF lease location will be completed. These efforts will also include detailed migration planning and design, construction equipment specifications, developing integrated services and installation requirements for NSF-based networks including IT systems, and voice, video, wireless, radio and satellite systems. Designing an integrated physical security and access control system as well as completing the specifications for an integrated audio/visual system will be essential to successfully meet NSF's program requirements for its future headquarters.

Program Management Costs ($1.71 million) – These costs fund the ongoing contract for NSF technical expertise and services support required for the project.

Agency Operations and Award Management by Object Class

The following table shows the planned distribution of general operating expenses by object class. A brief explanation of each general operating expenses category follows.

AOAM Expenses by Object Class
(Dollars in Thousands)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Personnel Compensation	$161,664	$165,107	$171,236	$6,129	3.7%
Personnel Benefits	38,183	38,553	40,664	2,111	5.5%
Travel and Transportation of Persons	6,650	9,000	9,000	-	-
Transportation of Things	378	441	545	104	23.6%
Rental Payments to GSA	25,067	26,000	26,390	390	1.5%
Rental Payments to Others	869	797	984	187	23.5%
Communications, Utilities and Misc. Charges	1,627	1,638	2,023	385	23.5%
Printing and Reproduction	128	205	253	48	23.4%
Advisory and Assistance Services	44,144	37,474	46,271	8,797	23.5%
Other Services	7,702	7,338	9,061	1,723	23.5%
Purchases of Goods & Srvcs from Gov't. Accts	6,930	6,157	7,602	1,445	23.5%
Operation and Maintenance of Equipment	118	53	65	12	22.6%
Supplies and Materials	4,170	3,815	4,711	896	23.5%
Equipment	2,223	3,422	4,225	803	23.5%
Land and Structures	-	-	34,710	-	N/A
Total, AOAM	**$299,852**	**$300,000**	**$357,740**	**$57,740**	**19.2%**

Totals may not add due to rounding.

A description of categories:

Personnel Compensation and Benefits: Personnel compensation funds pay, awards/bonuses, reimbursable details to NSF, overtime, and terminal leave. Benefits include the Government's contribution towards retirement systems, health and life insurance, thrift saving plans, special overseas allowances, and unemployment insurance.

Travel and Transportation of Persons: These resources fund travel required for planning, outreach, and increased oversight of existing awards as recommended by the agency's Inspector General.

Transportation of Things: This category consists of household moves associated with bringing new staff to NSF.

Rental Payments to GSA: This category includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and additional floors in an adjacent building.

Rental Payments to Others: This category includes rent paid to Payments to a non-Federal source for rental of space, land, and structures.

Communications, Utilities, and Miscellaneous Charges: This category includes all costs for telephone lines and services, both local and long distance, and postage.

Printing and Reproduction: This category includes contract costs of composition and printing of NSF's publications, announcements, and forms, as well as printing of stationery and specialty items.

Advisory and Assistance Services: This category includes development, learning, and career enhancement opportunities offered through the NSF Academy, contracts for human capital operational activities, work life initiatives, outreach, and related services, assistance in award oversight and monitoring, A-123 review.

Other Services: This category includes warehousing and supply services, mail handling, proposal processing, equipment repair and maintenance, building-related costs, furniture repair, contract support for conference room services, security investigations, and miscellaneous administrative contracts.

Purchases of Goods and Services from Government Accounts: This category includes reimbursable services purchased from GSA. These costs include security guard services, some electrical upgrades, and modest renovation services.

Operation and Maintenance of Equipment: This category includes management and operation of the central computer facility 24x7 year-round; operation of the customer service center and FastLane help desk; maintenance of database server hardware and related peripherals; software licensing fees; data communications infrastructure and network systems support; electronic mail support; and remote access (e.g., internet and World Wide Web).

Supplies and Materials: This category includes office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies.

Equipment: This category includes new and replacement computing equipment, desktop computers, data communications equipment, video-teleconferencing equipment, office furniture, file cabinets, and support equipment such as audio-visual equipment.

Land and Structures: This category includes the purchase and improvement (additions, alterations, and modifications) of land and structures and is specific to Future NSF HQ.

Appropriation Language

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $9,000 for official reception and representation expenses; uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; ~~$327,190,000~~*$357,740,000: Provided*, That contracts may be entered into under this heading in fiscal year ~~2011~~*2012* for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year*: Provided further, That of the amounts made available under this heading, not less than $1,960,000 is for strengthening the agency's acquisition workforce capacity and capabilities: Provided further, That such funds shall be available for training, recruitment, retention, and hiring members of the acquisition workforce as defined by the Office of Federal Procurement Policy Act, as amended (41 U.S.C. 401 et seq.): Provided further, That such funds shall be available for information technology in support of acquisition workforce effectiveness or for management solutions to improve acquisition management: Provided further, That of the funds made available under this heading, $44,650,000 shall remain available until expended for costs associated with the acquisition of headquarters space, including design, alteration, tenant improvement, and relocation.*

Agency Operations and Award Management
FY 2012 Summary Statement
(Dollars in Millions)

	Enacted/ Request	Carryover/ Recoveries	Transfers	Expired	Total Resources	Obligations Incurred/Est.
FY 2010 Appropriations	$300.00			-0.15	$299.85	$299.85
FY 2010 Enacted/Ann. FY 2011 CR	300.00				300.00	300.00
FY 2012 Request	357.74				357.74	357.74
$ Change from FY 2010 Enacted/Annualized FY 2011 CR						$57.74
% Change from FY 2010 Enacted/Annualized FY 2011 CR						19.2%

Totals may not add due to rounding.

NATIONAL SCIENCE BOARD (NSB) $4,840,000
+300,000 / 6.6%

The FY 2012 Request for the National Science Board is $4.84 million, an increase of $300,000, or 6.6 percent, over the FY 2010 Enacted of $4.54 million. The FY 2012 Budget Request will enable the Board to fulfill its policy-making responsibilities for NSF. This funding will allow the Board to continue its responsibilities related to the American Recovery and Reinvestment Act of 2009 (ARRA) and the America COMPETES Reauthorization Act of 2010, activities in the review of major research facilities projects, and to complete studies on the Foundation's merit review criteria, data policies, mid-scale research, and mid-scale instrumentation.

NSB Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Personnel Compensation and Benefits	$2.91	$2.86	$3.18	$0.32	11.2%
Other Operating Expenses	1.47	1.68	1.66	-0.02	-1.2%
Total, NSB	**$4.38**	**$4.54**	**$4.84**	**$0.30**	**6.6%**
Full-Time Equivalent Employment	19	17	18	1	5.9%

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

Appropriation Language

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $4,840,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

National Science Board
FY 2012 Summary Statement

(Dollars in Millions)

	Enacted/ Request	Rescission	Expired	Total Resources	Obligations Incurred/Est.
FY 2010 Appropriation	$4.54		-$0.16	$4.38	$4.38
FY 2010 Enacted/Ann. FY 2011 CR	4.54			4.54	4.54
FY 2012 Request	4.84			4.84	4.84
$ Change from FY 2010 Enacted/Annualized FY 2011 CR					$0.30
% Change from FY 2010 Enacted/Annualized FY 2011 CR					6.6%

Totals may not add due to rounding.

National Science Board in Context

The Board, established by the NSF Act of 1950, has dual responsibilities to: a) provide national science policy advice to the President and Congress; and b) establish policies for NSF. The Board is composed of 25 presidentially appointed, Senate-confirmed members, including the NSF Director, representing the broad U.S. science and engineering community. Board Members, who serve 6-year terms on staggered appointments, are drawn from industry, academe, non-profit organizations and professional scientific societies, and represent the breadth of S&E disciplines supported by NSF. They are selected for their eminence in research, education, or public service.

The Board currently meets five to six times a year to review and approve major NSF awards and new programs, oversee and provide policy direction to NSF, and address significant science and engineering related national policy issues. It initiates and conducts studies and reports on a range of policy topics and reviews NSF's priorities both to ensure progress and consistency along the strategic direction set for NSF and to ensure balance among new investments and core programs.

Policy Responsibilities

Issues of importance to the science, engineering, and education communities in general and to the NSF in particular are often examined by the Board. Topics for exploration are determined through consultation with the science community and NSF management. Recent reports have examined topics such as cost sharing, science and engineering education, and the globalization of science and engineering research.

Currently, the Board is conducting studies critical to the functioning of the agency. These include a task force to examine the agency’s merit review process with a focus on the two merit review criteria, Intellectual Merit and Broader Impacts. The Board is also developing a report on data policies to determine best practices for data collected through NSF-sponsored research so that they remain available to the broad science, engineering, and education communities. Another area of interest is the support structure for potentially transformative and interdisciplinary mid-scale research. A final report, mandated by the America COMPETES reauthorization, requires the Board to report on mid-scale instrumentation needs of the community. Much of the costs associated with these efforts are for workshops and roundtables to facilitate expert analysis of all aspects of the issues.

In addition to those special studies, the Board has several standing committees to assist with its responsibilities. The Committee on Audit and Oversight provides general supervision for the NSF Inspector General; oversight of major agency administrative processes and principal administrative systems; and review of the agency's GPRA requirements. The Committee on Strategy and Budget (CSB) focuses on strategic planning and new investments for NSF; analyzes the Foundation's budget to ensure progress and consistency against strategic direction for the Foundation; and identifies strategic, typically long term, issues that are critical to NSF's future. The Board recently established within CSB the Subcommittee on Facilities (SCF) to provide increased guidance and review of the NSF-funded research equipment and facilities portfolio, including both Major Research Equipment and Facilities Construction (MREFC) account-funded and Research and Related Activities (R&RA)-funded facilities.

The Committee on Education and Human Resources (CEH) provides guidance and advice on major policy issues related to the NSF education, informal science, and training portfolio; and reviews proposals representing a significant expenditure of National Science Foundation resources. It also provides advice on major national policy issues in science, technology, engineering and mathematics (STEM) education, human resource needs and employment, and human resource development. The Committee on Science and Engineering Indicators (SEI) offers guidance on content, organization, and presentation of data in the

Board's biennial report, *Science and Engineering Indicators*, and other related products; and keeps the Board informed on trends and other data with significant policy implications identified during the production of *Indicators*.

The Board is responsible for direct review and approval of the Foundation's largest awards, and is responsible for the review and approval of MREFC projects at all stages of development, including budget planning, review of proposals and management effectiveness, and approval of awards. The Committee on Programs and Plans (CPP) provides guidance and advice on major policy issues related to the NSF research and related activities portfolio, reviews proposals representing a significant expenditure of agency resources, and makes informal recommendations, as appropriate, to the Board for its full consideration and action. The Subcommittee on Polar Issues (SOPI), reporting to CPP, provides oversight, guidance, and advice on major policy and operational issues related to the NSF polar research portfolio.

The Board's Executive Committee (EC) is required by the National Science Foundation Act of 1950, as amended (42 U.S.C. Section 1865). It consists of the NSF Director, who chairs the Committee, and four other elected members from the Board. Per 42 U.S.C. Section 1863(b), the Board may delegate to the Executive Committee or to the Director or both such of the powers and functions granted to the Board by the NSF Act as it deems appropriate.

The Board expects to continue to be significantly engaged with assisting the agency in its responsibilities stemming from the American Recovery and Reinvestment Act of 2009 and the America COMPETES Reauthorization Act of 2010.

On-going activities of the Board include reviews of the following:

- NSF's Office of Inspector General (OIG) Semi-annual Reports to Congress and NSF management responses;
- The NSF Budget Submission for transmittal to the Office of Management and Budget (OMB);
- NSF's research infrastructure portfolio;
- NSF's annual Merit Review Report; and
- Large awards, MREFC projects, or proposal funding requests and other proposals as needed.

Staffing

Most of the Board's FY 2012 Budget Request supports a small core of full-time policy, administrative, legal, and operations staff. Over 67 percent of the 2012 request is for Board member and staff salaries and benefits. The Board Office staff provides both the independent resources and capabilities for coordinating and implementing S&E policy analyses and development, and the operational support that is essential for the Board to fulfill its mission. For FY 2012, NSB requests an additional FTE to support policy activities. It is essential that the Board office have the professional personnel available to fully support its efforts. Currently, the seven-member policy staff supports three Task Forces, two Subcommittees, and six full Committees. In addition to the request for an additional policy staff person, the 11 percent increase will also accommodate the return to NSBO of an administrative employee currently on military leave. Finally, the Board Office must also plan for the retirement of two staff members in FY 2012, and our personnel budget must account for the mandated benefits for these employees.

Science and Engineering Indicators

The Board's publication, *Science and Engineering Indicators (SEI)*, is a statutory responsibility. SEI is a biennial publication of the major, high quality quantitative data on the status of U.S. science and engineering. Over the past several years, the Board has heightened its efforts to expand the audience for *Indicators*, implementing enhancements such as the on-line Digest of Key Science and Engineering Indicators that encourage audiences outside the normal community of users to become familiar with the data resources in *Indicators* and to facilitate the use of *Indicators* data in policy decisions and analyses. Release of the 2012 edition of *SEI* to Congress is scheduled for January, 2012.

Electronic Records and Open Government

One of the major functions of the Board Office is to keep the records of Board decisions and policy pronouncements. The records of these decisions, and policy statements and reports on national science and engineering policy issues prepared for the President and Congress, are currently housed in various formats and media. Electronic and paper documents were not easily accessible because they were maintained in inconsistent systems of records. This situation created substantial barriers to requests by interested members of the public, science historians, and NSF staff who wished or needed to understand the underlying process for particular decisions or to obtain original documents relevant to a policy position.

The Board Office is developing an electronic architecture to search, identify, and retrieve relevant documents, in a common format, for use by stakeholders. This electronic records center will house substantive Board materials, such as discussions, decisions, and minutes, and will reduce the administrative cost and effort associated with information retrieval.

Other Costs

Other costs associated with Board activities include website maintenance; transcription services; report printing and dissemination; and logistical support for Board meetings and events. The Board's logistical support provides limited services including: travel planning assistance for invited speakers and participants; mailing of announcements and invitations; local transportation planning, printing, audio-visual and other services for off-site events; and additional meeting support.

National Science Board

Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Personnel Compensation and Benefits	$2,913	$2,860	$3,183	$323	11.3%
Staff Development & Training	31	47	52	5	10.6%
Advisory & Assistance Services	819	980	902	-78	-8.0%
Travel & Transportation of Persons	353	330	360	30	9.1%
Communications, Supplies and Equipment	265	320	340	20	6.3%
Representation Costs	3	3	3	-	N/A
Total, NSB	**$4,384**	**$4,540**	**$4,840**	**$300**	**6.6%**
Full-Time Equivalent	19	17	18	1	5.9%

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL (OIG) $15,000,000
+1,000,000 / 7.1%

The Appropriations Act that funds the National Science Foundation provides for a separate appropriation for NSF's Office of Inspector General (OIG). Accordingly, the FY 2012 Request level identifies the resources needed to support OIG, including amounts for personnel compensation and benefits, contract services, training, travel, supplies, materials, and equipment.

The FY 2012 Budget Request for OIG is $15.0 million, which represents an increase of $1.0 million or 7.1 percent, over the FY 2010 Enacted level of $14.0 million.

OIG Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Personnel Compensation and Benefits	$10.95		$11.02	$12.14	$1.12	10.2%
Other Operating Expenses	3.02	0.05	2.98	2.86	-0.12	-4.0%
Total, OIG	**$13.97**	**$0.05**	**$14.00**	**$15.00**	**$1.00**	**7.1%**
Full-Time Equivalent Employment	76		73	84	11	15.1%

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

Appropriation Language

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, ~~$14,350,000,~~*$15,000,000*, to remain available until September 30, ~~2012~~*2013*.

Office of Inspector General
FY 2012 Summary Statement

(Dollars in Millions)

	Enacted/ Request	Rescission	Carryover/ Recoveries	Expired	Total Resources	Obligations Incurred/Est.	Carryover/ Recoveries
FY 2010 Appropriations	$14.00	-		-$0.03	$13.97	$13.97	
FY 2010 ARRA[1]	-	-	1.98	-	1.98	0.05	1.93
FY 2010 Enacted/Ann. FY 2011 CR	14.00	-		-	14.00	14.00	
FY 2012 Request	15.00	-		-	15.00	15.00	
$ Change from FY 2010 Enacted/Annualized FY 2011 CR						$1.00	
% Change from FY 2010 Enacted/Annualized FY 2011 CR						7.1%	

Totals may not add due to rounding.

[1]$1.98 million in unobligated FY 2009 ARRA funds were carried over into FY 2010. The remaining unobligated balance was subsequently carried over into FY 2011.

Explanation of Carryover

American Recovery and Reinvestment Act of 2009 (ARRA)
Within the **Office of Inspector General** appropriation, $1.93 million was carried over.

- Reason for Carryover: Five year funds intended explicitly for ARRA use.
- Expected Obligation: Will be obligated over the period of availability, which is until September 30, 2013.

OIG Responsibilities

In February 1989, the National Science Board established OIG pursuant to the Inspector General Act Amendments of 1988. The statute confers on OIG the responsibility and authority to:

- Conduct and supervise audits of NSF programs and operations, including organizations that receive NSF funding;
- Conduct investigations concerning NSF programs and operations, including organizations that receive NSF funding;
- Evaluate allegations of research misconduct, such as fabrication, falsification, or plagiarism, involving individuals who participate in NSF-funded activities;
- Provide leadership, coordination, and policy recommendations for:
  - Promoting economy, efficiency, and effectiveness in the administration of NSF programs and operations, and
  - Preventing and detecting fraud and abuse in NSF programs and operations;
- Issue semiannual reports to the National Science Board and Congress to keep them informed about problems, recommended corrective actions, and progress being made in improving the management and conduct of NSF programs.

As set forth in the OIG Strategic Plan, the primary functions of the office are to perform audits, reviews, and investigations. Because diverse skills, training, and experience are necessary to oversee NSF's varied programs, the OIG staff includes scientists, attorneys, certified public accountants, investigators, evaluators, and information technology specialists. The subjects of investigations, audits, and other reviews are varied, and may include: an individual grant recipient or institution; a broad program or functional area of NSF; or a project involving multiple disciplines or entities. In FY 2012, the office will continue to be significantly involved in audits and investigations of NSF programs, grants, contracts, and other activities associated with funding provided by the American Recovery and Reinvestment Act of 2009 (ARRA).

OIG performs audits of grants, contracts, and cooperative agreements funded by NSF's programs. The office also conducts audits and reviews of both internal agency programs and external organizations that receive NSF funding to ensure that financial, administrative, and programmatic activities are conducted economically, effectively, and in compliance with agency and federal requirements. OIG is also responsible for overseeing the audit of NSF's annual financial statements, which are required for all NSF accounts and activities by the Government Management Reform Act of 1994. The office contracts with a public accounting firm to conduct the financial statements audit. Since FY 2006, funds to cover the complete cost of the financial audit have been requested in this appropriation. OIG also audits financial, budgetary, and data processing systems used by NSF to develop the financial statements. In addition, the office performs multi-disciplinary reviews – involving auditors, attorneys, management analysts, investigators, and others as needed – of financial, management, and program operations to identify broader problems and highlight best practices.

OIG investigates possible wrongdoing by organizations and individuals who seek or receive NSF funds such as those who submit proposals to, receive awards from, conduct business with, or work for NSF.

Allegations of research misconduct are also investigated. OIG assesses the validity and seriousness of all the allegations it receives and recommends proportionate action. When appropriate, the office refers the results of these investigations to the Department of Justice or other authorities for criminal prosecution, civil litigation, or resolution via settlement agreements and institutional compliance plans. OIG refers other cases to NSF for administrative resolution and when needed will recommend modifications to agency policies and procedures to ensure the integrity of NSF's business systems. The office works closely with institutions on the conduct of their internal investigations and performs outreach activities aimed at preventing and detecting fraud, waste, and abuse; and at raising the awareness of funded researchers, institutional administrators, and agency employees about OIG's role and NSF's rules and expectations.

Office of Inspector General
Personnel Compensation and Benefits and General Operating Expenses

(Dollars in Thousands)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Personnel Compensation and Benefits	$10,955		$11,020	$12,140	$1,120	10.2%
Travel & Transportation of Persons	275	54	230	375	145	63.0%
Advisory & Assistance Services[1]	2,479		2,471	2,125	-346	-14.0%
Communications, Supplies and Equipment, and Other Services[2]	263		279	360	81	29.0%
Training	168		110	160	50	*45.5%*
Council of Inspectors General for Integrity and Efficiency Assessment	14		-	-	-	*N/A*
Other	81		169	200	31	*18.3%*
Total, OIG	**$13,972**	**$54**	**$14,000**	**$15,000**	**$1,000**	**7.1%**
Full-Time Equivalent	76		73	84	11	15.1%

Totals may not add due to rounding.

[1] Includes the costs of the annual financial statements audit and the outsourcing of contracting services.

[2] The amounts spent on Training and CIGIE Assessment are presented separately as required by the IG Reform Act of 2008, and also in the total for Communications, Supplies and Equipment, and Other Services.

The increase of 7.1 percent and 11 FTEs requested in the FY 2012 budget will enable OIG to improve the quality and lower the cost of audits by performing more audits using OIG staff and fewer with contractors, resulting in an increase of 8 auditor FTEs funded by a commensurate reduction in the contracting services account. The 3 remaining FTEs would be assigned to investigations to handle an overall caseload that over the past decade is increasing at an average annual rate of 14 percent. The requested funds will also allow us to continue outreach and other proactive efforts, particularly with regard to research misconduct and financial fraud; and make modest systems and equipment upgrades including the acquisition of investigative case management software.

OIG's operational expenditures continued to increase during the past year driven by higher contracting costs, employee health insurance and benefit expenses, and the increasing cost of travel necessary to conduct nationwide audits and investigations. In FY 2012 we expect that travel and training expenses will grow as new staff are hired, receive in-service training, and are assigned to audit awardees around the

country. In the coming year, OIG will also need additional funds to procure new office space in Denver to house staff responsible for audit coverage of NSF's awards in the western U.S. An arrangement to share office space in Denver with the Commerce Department OIG was recently terminated by the host agency.

Audits. Due to the declining quality and economy of contractor-performed audits, OIG is planning to conduct more contract and grant audits with its own staff and fewer that utilize contractors. The average cost of a contracted audit has risen from approximately $100,000 in FY 2004 to about $130,000 in FY 2009, while the need for staff oversight of contractors and the rework associated with their audits further adds to their cost. OIG plans to redirect funds from its Advisory and Assistance Services category in order to hire 8 additional auditors at no net cost to the government, and to add an in-house information technology audit capability that was formerly lacking. This change should enable us to achieve greater control over the audit process, resulting in better quality audits at a lower price. OIG also expects to gain greater institutional knowledge and familiarity by sending its staff out into the field to personally observe and report on awardee financial issues, resulting in better program oversight and integrity.

The funds requested will allow OIG to perform additional critically needed contract and financial assistance audits and thereby keep pace with NSF's increased financial exposure in awarding billions of dollars in grants and contracts each year. In the last two years, the agency has obligated $3.0 billion in ARRA funds in addition to its regular annual appropriation of approximately $7 billion. Though NSF OIG received a $2 million appropriation to oversee ARRA, much of our past and current Recovery Act work is being funded from our regular appropriation. The bulk of our ARRA funds are being marshaled in expectation of a heightened need for audits and investigations as more ARRA funds are expended. As the agency's funding grows, so does this risk – and the concomitant need for increased OIG oversight. The additional audit and contract resources will enable OIG to strengthen its oversight of NSF awards categorized as high-risk, and to actively monitor NSF's regular portfolio of projects including ARRA.

The requested funding level would also support additional performance and information technology audits that reflect important federal and OIG priorities, including reviews of: 1) NSF's management of its rotating program officer workforce (i.e. temporary employees who typically return to their home institution after a few years), 2) NSF's handling of conflicts of interest involving its grantee institutions and principal investigators, 3) the effectiveness of NSF's acquisition program and its ability to meet existing and newly implemented federal requirements, and 4) oversight of NSF's workforce to meet its increasing programmatic and financial accountability and oversight responsibilities. Funds will also be used to complete an audit of the adequacy of NSF's cooperative agreements to manage and oversee its large facility awards, and improve our oversight of IT security at NSF. Additional funds will also allow the OIG to provide oversight of NSF's planning and relocation of its headquarters to ensure there is no interruption of its critical mission. Finally, funds are needed to perform audits that are mandated by law, including the annual Financial Statement Audit, the related Federal Information Security Management Act independent evaluation report, and the triennial audit of the National Science Board's compliance with the Government in the Sunshine Act.

Investigations. The requested funds will enable OIG to hire 3 additional staff to keep pace with an expanding investigative workload driven by: NSF's increase in number of awards and ARRA expenditures, a vigorous proactive review and investigative program, the increasing complexity of the fraud and internal cases being investigated, and significant concerns about Small Business Innovation Research (SBIR) program fraud.

Over a 10 year period, OIG's total caseload has increased by approximately 280 percent, resulting in five times the number of significant outcomes (convictions, suspensions, etc.) as before. Our investigations unit has achieved these results with a minimal increase in staff. It has increased productivity by refining investigative skills, initiating targeted proactive reviews to identify potential new cases, and utilizing

student interns to assist on investigations. However, in recent years OIG's output has begun to plateau and further increases in productivity will be difficult to attain without changes to the number and composition of current staff. OIG requests 3 new FTEs in order to provide enhanced oversight of research funding and respond to the calls for zero tolerance of fraud. Additional staff combined with the knowledge acquired over the years will enable OIG to vigorously pursue new fraud and research misconduct investigations, and develop targeted proactive initiatives that have been critical to developing new cases.

Our civil and criminal cases frequently produce both financial settlements for institutional fraud and compliance agreements for correcting the underlying systemic problems, thus providing greater protection for future federal funding. Monitoring institutions' efforts to meet the terms of their five-year compliance plans is vital to preventing fraud from recurring, but also very time consuming. The systemic problems that have allowed fraud to occur take time to correct, and ongoing oversight is required to ensure that the flaws in the systems are not further exploited. Our investigative workload is growing rapidly in other areas as well. Over the past few years, there has been an increase in serious data fabrication and falsification cases, and in the incidence of fraud in international collaborations. Increasing concerns about research integrity led NSF to recently implement a responsible conduct of research requirement for NSF awards. OIG will oversee the plans to ensure that they effectively address risk while respecting the many sensitive issues that arise within international collaborations, a new and challenging effort. Addressing research integrity and misconduct issues requires highly-skilled staff with resources to determine their scope and complexity, to perform more intricate investigations, and to develop meaningful recommendations.

The requested level of funding will make it possible to maintain and expand on the gains we have made by acquiring needed electronic case management software to increase productivity and streamline the process of preparing for prosecutions and public information requests. It will enable OIG to continue to perform proactive reviews including an analysis of fraud and duplicative funding within the SBIR program, and oversight of research integrity programs. It would also permit us to: expand our use of commercial investigative software and research tools; further develop our forensic accounting program, which has proven to be effective in helping to solve complex financial fraud cases; and fund case-related travel necessary to support investigations that occur nationwide.

OIG has a vigorous outreach program consistent with our mission to prevent fraud, waste, and abuse. OIG's outreach program draws on its extensive experience in dealing with occurrences of grant fraud and research misconduct to play a key role within the federal and research communities to educate colleagues from other OIGs as well as NSF awardees about these issues. OIG's proactive efforts are consistent with the emphasis on transparency and accountability mandated by the administration and Congress, and helps to assure the scientific integrity of federally funded research, and the oversight of ARRA funds.

From an investigative perspective, the requested funds will enable OIG to address: 1) growing concerns regarding the erosion of research integrity as evidenced by a threefold increase in allegations in the past decade and studies indicating that 25 to 30 percent of scientists engage in questionable research practices; 2) the issues underlying the increasing number of egregious allegations that we are investigating, many of which are related to the employment of scientists from other countries; 3) lack of transparency by grantees receiving ARRA funds; and 4) SBIR program fraud. Universities continue to request our attendance at conferences and other events to help educate faculty, students, and principal investigators regarding compliance plans, oversight, responsible conduct of research, and financial fraud. OIG's audit staff is also involved in outreach activities aimed at informing NSF and its awardee community of the recurring issues we are finding in our audit work. However, our ability to accommodate these requests and accomplish our outreach mission is limited and must depend on whether our staffing and travel budget is sufficient to support our urgent investigative and audit priorities.

In accordance with the Inspector General Act of 1978, as amended (5 U.S.C. App.), the Inspector General of the National Science Foundation has presented its FY 2012 Congressional Budget Request for $15.0 million, $430,000 less than the $15.43 million initially submitted to, and approved by, the National Science Board (NSB). Since OMB specified that costs for operating the Council of the Inspectors General on Integrity and Efficiency (CIGIE) assessment will be paid entirely by the OIGs for the 15 cabinet level agencies, this item has been removed from the FY 2012 Budget Request. Finally, in response to the Administration's proposal to freeze pay for civilian personnel in FY 2011 and FY 2012, the amount for personnel costs and benefits has been reduced accordingly.

MAJOR MULTI-USER RESEARCH FACILITIES $1,185,120,000
+$109,070,000 / +10.1%

Major Multi-User Research Facilities Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Facilities	$954.21	$361.00	$880.46	$982.41	$101.95	11.6%
Federally Funded R&D Centers	199.41	-	195.59	202.71	7.12	3.6%
Total, Major Multi-User Research Facilities	**$1,153.62**	**$361.00**	**$1,076.05**	**$1,185.12**	**$109.07**	**10.1%**

NSF investments provide state-of-the-art tools for research and education, such as multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in internet-based and distributed user facilities are increasing as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, agencies, and countries to ensure complementarity and integration. Planning, and operations and maintenance of multi-user facilities are funded through the Research and Related Activities (R&RA) account, and most major construction projects are funded through the Major Research Equipment and Facilities Construction (MREFC) account.

This chapter provides descriptions of each major multi-user research facility supported through the R&RA account and provides funding information by life cycle phase for each facility. The information presented for each facility follows the overall framework established by NSF for large facility projects. Information on the construction projects funded through NSF's MREFC account is provided in the MREFC chapter.

Major Multi-User Research Facilities Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Engineering						
National Nanotechnology Infrastructure Network (NNIN)	$16.71	-	$16.26	$15.56	-$0.70	-4.3%
Network for Earthquake Engineering Simulation	23.46	-	22.00	20.50	-1.50	-6.8%
Geosciences						
Academic Research Fleet	78.04	-	80.00	69.35	-10.65	-13.3%
EarthScope: USArray, SAFOD, PBO	25.25	-	25.05	26.00	0.95	3.8%
Incorporated Research Institutions for Seismology	12.36	-	12.36	12.36	-	-
Integrated Ocean Drilling Program	50.80	-	43.40	45.40	2.00	4.6%
Mathematical and Physical Sciences						
Cornell High Energy Synchrotron Source (CHESS) / Cornell Electron Storage Ring (CESR)	9.51	-	9.00	15.47	6.47	71.9%
Gemini Observatory	19.10	-	19.10	20.07	0.97	5.1%
Large Hadron Collider	18.00	-	18.00	18.00	-	-
Laser Interferometer Gravitational Wave Observatory	28.50	-	28.50	30.40	1.90	6.7%
National Astronomy & Ionosphere Center[1]	10.75	-	10.60	8.70	-1.90	-17.9%
National High Magnetic Field Laboratory	40.53	15.00	35.56	33.30	-2.26	-6.4%
National Solar Observatory	9.10	-	9.10	9.79	0.69	7.6%
National Superconducting Cyclotron Laboratory	21.00	-	21.00	21.50	0.50	2.4%
Polar Programs						
Polar Facilities and Logistics[2]	307.18	-	312.27	327.30	15.03	4.8%
Other						
MREFC Projects[3]	220.55	146.00	163.54	292.21	128.67	78.7%
Other Facilities[4]	6.93	200.00	7.02	3.90	-3.12	-44.4%
Pre-construction Planning[5,7]	56.44	-	47.70	12.60	-35.10	-73.6%
Federally Funded Research and Development Centers[6]						
Geosciences						
National Center for Atmospheric Research	96.29	-	97.00	100.00	3.00	3.1%
Mathematical and Physical Sciences						
National Optical Astronomy Observatories[7]	35.40	-	31.50	29.17	-2.33	-7.4%
National Radio Astronomy Observatories[8]	67.73	-	67.09	73.54	6.45	9.6%
Total	**$1,153.62**	**$361.00**	**$1,076.05**	**$1,185.12**	**$109.07**	**10.1%**

Totals may not add due to rounding.

[1] NSF will decertify NAIC as an FFRDC upon award of the next cooperative agreement for its management and operation in FY 2011.

[2] Polar Facilities and Logistics funding includes support for the operations and maintenance of the South Pole Station Modernization (SPSM) project. Funds provided through the MREFC account for SPSM are included on the MREFC Projects line. In FY 2010, Polar Facilities and Logistics excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[3] Funding levels for MREFC projects in this table include support for: a) concept and development associated with ongoing and requested MREFC projects provided through the R&RA account, specifically for NEON; b) initial support for operations and maintenance provided through the R&RA account (except for ALMA, which is included in the funding for NRAO); and c) construction implementation support provided through the MREFC account. Final MREFC support for SPSM is also included in this line.

[4] Other Facilities includes support for other physics and materials research facilities, and Academic Research Infrastructure funded through ARRA.

[5] Pre-construction planning includes funding for potential next-generation major multi-user facilities. Not included on this line is $1.73 million in FY 2010 Actual pre-construction planning funds for the Large-Aperture Synoptic Survey Telescope included under NOAO.

[6] Federally Funded R&D Centers does not include support for the Science and Technology Policy Institute, which is an FFRDC but not a research platform.

[7] Funding for the National Optical Astronomy Observatories (NOAO) includes $1.73 million in pre-construction planning funds for the Large-Aperture Synoptic Survey Telescope .

[8] Funding for the National Radio Astronomy Observatories (NRAO) includes operation and maintenance support for the Atacama Large Millimeter Array (ALMA). Construction funding for ALMA is included in the MREFC projects line.

NSF's Facilities Investments in FY 2012:

The following pages contain information on NSF's ongoing facilities in FY 2012. These are:

Facilities
- Academic Research Fleet ..... Facilities – 4
- Cornell Electron Storage Ring/Cornell High Energy Synchrotron Source ..... Facilities – 8
- EarthScope ..... Facilities – 11
- Gemini Observatory ..... Facilities – 14
- Incorporated Research Institutions for Seismology ..... Facilities – 17
- Integrated Ocean Drilling Program ..... Facilities – 20
- Large Hadron Collider ..... Facilities – 24
- Laser Interferometer Gravitational Wave Observatory ..... Facilities – 27
- National Astronomy and Ionosphere Center ..... Facilities – 30
- National High Magnetic Field Laboratory ..... Facilities – 35
- National Nanotechnology Infrastructure Network ..... Facilities – 38
- National Solar Observatory ..... Facilities – 41
- National Superconducting Cyclotron Laboratory ..... Facilities – 44
- Network for Earthquake Engineering Simulation ..... Facilities – 47
- Polar Facilities and Logistics and the South Pole Station Modernization Project ..... Facilities – 51

Federally Funded R&D Centers
- National Center for Atmospheric Research ..... Facilities – 58
- National Optical Astronomy Observatory ..... Facilities – 62
- National Radio Astronomy Observatory ..... Facilities – 65

Other Facilities
- Major Research Equipment and Facilities Construction Account ..... Facilities – 68
- Preconstruction Planning ..... Facilities – 68

Academic Research Fleet

$69,350,000
-$10.65 / -13.3%

Academic Research Fleet
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Academic Research Fleet	$78.04	$80.00	$69.35	-$10.65	-13.3%

The Academic Research Fleet consists of 21 vessels in the University-National Oceanographic Laboratory System (UNOLS). These vessels range in size, endurance, and capabilities, enabling NSF and other federally-funded scientists with the means to conduct ocean science research with a diverse fleet capable of operating in coastal and open ocean waters. Funding for the Academic Research Fleet includes investments in ship operations; shipboard scientific support equipment; oceanographic instrumentation and technical services; and submersible support. Funding levels reported here reflect investments in the Directorate of Geosciences (GEO) by the Division of Ocean Sciences (OCE) and the Division of Innovative and Collaborative Education and Research (ICER). In addition to operations, OCE has undertaken selected construction projects based on an inter-agency fleet renewal status plan.

Total Obligations for the Academic Research Fleet
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$78.04	$73.00	$67.35	$70.00	$72.50	$75.00	$78.00	$81.00
Fleet Renewal:								
Human Occupied Vehicle		5.00	-					
Regional Class Research Vessel		2.00	2.00					
Total, Academic Research Fleet	**$78.04**	**$80.00**	**$69.35**	**$70.00**	**$72.50**	**$75.00**	**$78.00**	**$81.00**

Totals may not add due to rounding.
[1] Outyear funding estimates are for planning purposes only.

The Academic Research Fleet serves as the main platform for the collection of data and testing of hypotheses about the structure and dynamics of the oceans. Scientists contribute to advances in areas such as climate variability, marine ecosystems, fisheries, and ocean-related natural hazards such as tsunamis through use of these facilities. Vessels in the Academic Research Fleet provide about 62,000 scientist days at sea and permit shipboard training of future oceanographers, with students forming about 25 percent of the sea-going science parties. Participating graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Increasingly, technological innovations allow research conducted at sea to be transmitted via satellite back to the classroom, broadening the educational impact of the vessels to a wider audience, including K-12 students.

The Academic Research Fleet is supported through an interagency partnership, principally with the National Oceanic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR) via a Memorandum of Understanding (MOU). The operating costs for the Fleet are divided proportionally among the vessel users based on usage; NSF supports approximately 70 percent of the total. NSF also coordinates with ship-operating and ship-user academic institutions through UNOLS.

Support for scientists using the Fleet is provided by both NSF and other state and federal agencies. Within NSF, science is supported via competitive peer-reviewed proposals, most typically funded within OCE and through selected programs in the Division of Earth Sciences (EAR) and the Division of Atmospheric and Geospace Sciences (AGS), and also through the Office of Polar Programs (OPP) and the Directorate for Biological Sciences (BIO). Approximately 30 percent of the GEO proposals request ship time; GEO-funded shipboard science has ranged from about $35.0 million to $45.0 million per year over the last five years. Not reflected in this number is the science that utilizes samples or data collected on prior cruises, scientists piggy-backing on scheduled cruises to accomplish additional science, international scientists sailing with the U.S. Academic Research Fleet, and science funded by other agencies.

The reduction in ship operation and upgrade costs in FY 2012 is the result of the retirement of the *R/V OCEANUS*. The FY 2012 Request of $67.23 million will support approximately 2,300 ship operating days.

Project Report

Fleet Operations

- Oversight: NSF provides oversight to the Academic Research Fleet through cooperative agreements with each ship-operating institution and through a separate cooperative agreement with the UNOLS Office. In addition, NSF oversees the Fleet through site visits, ship inspections, and participation at UNOLS Council and Subcommittee meetings by NSF program directors. Several program directors within OCE at NSF, at NOAA, and at ONR are involved in the activities and overall oversight of the Academic Research Fleet. A Business Systems Review (BSR) was conducted in April 2010; none are scheduled for 2011 or 2012.

- Management: Management of an operating institution's ship-operating facilities varies with the scale of the operation, but the core responsibility typically resides with the Director of the Institution, the Marine Superintendent (for all aspects of the facility), and the Ship's Captain (for at-sea operations). For larger multi-ship-operating institutions, a Chief of Marine Technicians, schedulers, and finance administrators may also be involved in facility management.

- Reviews: Based on projected science requirements identified in recent reports and workshops, a fleet of vessels supporting ocean science research will be needed far into the future. The most recent documents supporting this need include the *National Ocean Policy* and the *Final Recommendations of the Interagency Ocean Policy Task Force* of July 19, 2010, as well as the October 2009 report by the National Research Council (NRC), *Science at Sea: Meeting Future Oceanographic Goals with a Robust Academic Research Fleet*. In coordination with the other federal agencies with ocean research investments and UNOLS, the Interagency Working Group for Facilities (IWG-F) published a *Federal Oceanographic Fleet Status Report* in December 2007 reviewing the status and describing plans for renewal of the federal and academic oceanographic research and survey fleet. Ship operations and technical services activities are reviewed internally on the basis of detailed annual reports provided by the operating institutions. Ship operations proposals are exempt from external review by peers, and

budgets are negotiated yearly since they are dependent on the number of days the ships will be at sea in support of NSF-funded research programs. Technical services awards are reviewed every three years and negotiated annually.

Fleet Renewal

- Oversight: The NSF coordinator for fleet renewal activities is the Program Director for Ship Acquisitions and Upgrades, within the Integrative Programs Section (IPS) in OCE, with additional IPS staff providing project management assistance as required.

- Regional Class Research Vessel (RCRV): NSF is continuing planning and development activities for potential new Regional Class Research Vessels. A panel of experts, in October 2009, conducted a technical evaluation of two alternative designs and made a recommendation to NSF using a rigorous down-select process. NSF worked with UNOLS in FY 2010 to identify areas in the ship design that will need additional inputs. In FY 2011, NSF is soliciting proposals using a phased approach beginning with the conceptual design phase of preconstruction development. Decisions on proceeding to further development stages will be based upon NSF, National Science Board, and interagency reviews. A major purpose of these reviews will be to integrate this potential investment with other needs across the government for research vessel support, including consideration of several acquisition models.

- Research Vessel *SIKULIAQ* (formerly known as the Alaska Region Research Vessel (ARRV)): This project represents NSF's first major contribution to fleet renewal in over twenty years. Construction of the *SIKULIAQ* was funded completely through the MREFC account and American Reinvestment and Recovery Act (ARRA) funds, and is described separately in the MREFC chapter. Shipyard construction will begin in CY 2011 and science operations are anticipated to begin in mid-calendar year 2014 at which time operational funding will be supported by OCE.

Other Ongoing Activities

- Development and construction of a deep submergence capability to replace the submersible human occupied vehicle *(HOV) ALVIN* continues in FY 2012. This project, begun in FY 2004 to design and build an all-new submersible, experienced significant cost over-runs in 2008 and was subsequently re-scoped and placed on a revised review path, which included a Preliminary Design Review (PDR) in December 2009, and a Final Design Review (FDR) in September 2010. The FDR Panel recommended the project continue and felt the budget was adequately defined. The Panel also recommended NSF partner with the Navy, specifically Naval Sea Systems Command (NAVSEA), to certify the operational capability and safety of *ALVIN*. NSF subsequently entered into an interagency agreement with NAVSEA to do so, and the WHOI team is supporting this effort.

  The re-scoped *ALVIN* Upgrade Project would be accomplished in two phases. Phase I is integration of a new titanium 6,500 meter-capable personnel sphere with existing *ALVIN* vehicle components. Initial Phase I operations are anticipated in 2012 with a depth capability of 4,500 meters, the limit of the current *ALVIN* components to be retained during Phase I. A potential Phase II would provide upgrades to permit operations to a depth of 6,500 meters could follow in three to five years, pending availability of funds and science priority evaluations. The cost increase over previous estimates was due to delays in schedule, increases in labor costs and levels of effort, and a rise in titanium prices.

Renewal/Recompetition/Termination:

Ships supported by NSF are operated by academic institutions, each having a cooperative agreement with NSF. These awards are reviewed using the NSB-approved criteria and awardees are subject to additional oversight measures, including Business System reviews conducted by NSF.

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring

$15,470,000
+$6,470,000 / 71.9%

Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Cornell High Energy Synchrotron Source and Cornell Electron Storage Ring[1]	$9.51	$9.00	$15.47	$6.47	71.9%

Totals may not add due to rounding.
[1] The combined reporting of CHESS and CESR began in FY 2009.

The Cornell High Energy Synchrotron Source (CHESS) is a high-intensity, high-energy X-ray facility supported by NSF with partial interagency support from the National Institutes of Health (NIH). It uses synchrotron light given off by charged particles, both electrons and positrons, as they circulate at nearly the speed of light around the Cornell Electron Storage Ring (CESR). CHESS provides state-of-the-art capabilities for X-ray research in physics, chemistry, biology, materials, and environmental sciences. Areas of emphasis include soft matter and thin film studies, solution scattering, nanomaterials, high-pressure science, structural biology, time-resolved studies of materials, and X-ray studies of items of art and archaeology. The mission of CHESS also includes X-ray technology development. Support and oversight of CHESS is provided through the NSF Division of Materials Research (DMR) within the Directorate for Mathematical and Physical Sciences (MPS).

The significant increase in FY 2012 reflects one-time action in FY 2010: Forwarding funding of some CHESS activities in late FY 2009 using dollars provided by the American Recovery and Reinvestment Act of 2009 (ARRA). The FY 2012 Request supports operations of CHESS/CESR as a user facility and is consistent with funding levels in previous years. Funding will allow continued operation of the facilities in support of synchrotron light users. A separate award will support a program of X-ray technology development.

Total Obligations for CHESS/CESR
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$9.51	$9.00	$15.47	$21.43	$21.43	$21.43	$21.43	$21.43

Totals may not add due to rounding.

[1] Outyear funding is shown through the end of the current cooperative agreement in March, 2014. Years beyond FY 2013 are shown for planning purposes only. NSF support for future light sources will be within the framework of a developing MPS/DMR strategic plan for instrumentation for materials research.

The CHESS user program supports work in cancer research, new materials for electronics, aircraft and biotechnology, batteries, fuel cells, solar cells and other energy applications. X-ray detectors developed at CHESS are now in use at 3rd and 4th Generation X-ray sources around the world, including the world's

first hard X-ray laser, the Department of Energy (DOE) Linac Coherent Light Source. Accelerator research and development conducted at CHESS is helping to create the world's most advanced future storage rings and accelerators. For more information on coherent light sources, please see the narrative for the Division of Materials Research in the Directorate for Mathematical and Physical Sciences chapter.

CHESS/CESR staff assists in transferring Superconducting Radio Frequency technology to industry. Several CHESS/CESR users are from industry, including pharmaceutical corporations (such as Rib-x Pharmaceuticals) and the research arms of Eastman Kodak, Xerox, and General Motors. Some medical institutions also make use of CHESS/CESR (Dana Farber Cancer Institute, Boston Biomedical Research Institute, and Memorial Sloan-Kettering Institute). CHESS/CESR also has partnerships with DOE-supported synchrotron facilities such as the Advanced Photon Source and National Synchrotron Light Source.

CHESS/CESR supports and enhances Ph.D. level graduate education, postdoctoral research, and research experiences for undergraduates and for K-12 science teachers. Each year about 100 Ph.D. thesis projects result in more than 25 degrees granted. More than 60 undergraduates participate in research at the facility during the academic year; about 16 undergraduates and 10 pre-college teachers participate during the summer. In this educational role, CHESS plays a key role as a training ground for X-ray science and accelerator physics with many CHESS students and postdoctorates going to staff or lead other X-ray facilities in the U.S. and around the world.

Project Report

Management and Oversight

- NSF Structure: CHESS is supported by DMR and by the National Institutes of Health (NIH). CHESS also hosts MacCHESS, a NIH-funded macromolecular crystallography program at Cornell. NSF and NIH provide oversight of CHESS through regular site visits by external reviewers.

- External structure: Both CESR and CHESS are administered by the Cornell Laboratory of Accelerator-based Sciences and Education (CLASSE), which reports to Cornell's Vice-Provost for Research. CHESS/CESR is operated by Cornell University in accordance with cooperative agreements with NSF that set goals and objectives for the facility.

- CHESS is a national user facility accessed on the basis of competitive proposal review. The primary function of the CHESS staff is to maintain and operate the facility and to assist users. A policy and advisory board, appointed by the Cornell Vice President for Research, provides advice to the director of CHESS on policies related to the use and development of CHESS facilities and equipment for user experiments. A users committee appointed by the users of CHESS advises the director on matters of facilities operations and priorities for the users. An annual users meeting and several workshops help disseminate results from the facility.

- Reviews:
  - Site visit review of CHESS operations, November 2010.
  - Business Systems Review by NSF Large Facilities Office, FY 2010 – FY 2011.
  - Next operations review, planned for fall 2011.

Renewal/Recompetition/Termination

In FY 2009, NSF completed the review of a proposal for the continued operation of CHESS/CESR in

support of X-ray photon science. In December 2009, the National Science Board authorized NSF to make a four-year award. The cooperative agreement between NSF and Cornell University funds operations from April 2010 until March 2014.

EarthScope **$26,000,000**
+$950,000 / 3.8%

EarthScope
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
EarthScope	$25.25	$25.05	$26.00	$0.95	3.8%

The EarthScope facility is a distributed, multi-purpose geophysical instrument array that is making major advances in our knowledge and understanding of the structure and dynamics of the North American continent. EarthScope instrumentation is expected to be located in nearly every county within the U.S. over the 15-year life span of the program. Construction of EarthScope was completed September 30, 2008. FY 2009 was the first year of operation of the full EarthScope facility.

Total Obligations for EarthScope
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations & Maintance	$25.25	$25.05	$26.00	$27.25	$42.68	$43.49	$44.34	$45.20

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, there is a significant increase in EarthScope support beyond 2013.

EarthScope seeks to enhance our understanding of the structure and evolution of the North American continent, including earthquakes and seismic hazards, magmatic systems and volcanic hazards, lithospheric dynamics, regional tectonics, continental structure and evolution, fluids in the crust, and associated educational aspects. Science and non-science students will be engaged in geosciences discovery through the use of technology in real-time or retrospectively with the aim of integrating research and education.

The U.S. Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the International Continental Scientific Drilling Program are partners with NSF in EarthScope. Project partners also include state and local governments, geological and engineering firms, and Canadian and Mexican agencies. Over 3,000 Earth scientists and students are expected to use the facility annually. Geotechnical and engineering firms directly use data and models that are enabled by EarthScope. Instrumentation firms are collaborating on development for state-of-the-art seismic systems, down-hole instrumentation, and high-precision GPS antenna designs.

The USArray component of EarthScope is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales. USArray consists of four major components: (1) a Reference Network of permanent seismic stations, (2) a Transportable Array of ~400 seismic stations, (3) a Flexible Array pool of seismic instruments for use in experiments proposed by individual scientists, and (4) a Magnetotelluric

Array with permanent and transportable instruments. The Plate Boundary Observatory (PBO) component of EarthScope is a geodetic observatory designed to study the three-dimensional strain field resulting from deformation across the active boundary zone between the Pacific and North American plates in the western United States. PBO includes 1,200 geodetic and 79 strain meter/seismic stations. The San Andreas Fault Observatory at Depth (SAFOD) is a 3-kilometer deep hole drilled directly into the San Andreas Fault midway between San Francisco and Los Angeles, near Parkfield, CA. Located in an area that has ruptured six times since 1857, the hole is providing the first opportunity to observe directly the conditions under which earthquakes occur and to collect rocks and fluids from the fault zone for laboratory study. SAFOD also includes a long-term observatory intended to continuously monitor the physical condition within an active earthquake nucleation zone. Along with direct operations and maintenance support for EarthScope, NSF will support research performed utilizing the facility through ongoing research and education programs. The annual support for such activities is approximately $6.50 million.

Facility Report

Management and Oversight

- NSF Structure: The EarthScope Program Director, located in the Division of Earth Sciences (EAR) in the Directorate for Geosciences (GEO), provides NSF oversight. The Deep Earth Processes Section Head and division director in EAR provide other internal oversight.

- External Structure: The external management structure includes the community-based EarthScope National Office, currently located at Oregon State University; an independent steering committee consisting of scientists from the EarthScope community including two subcommittees, one devoted to education and outreach and one devoted to cyberinfrastructure; and external management oversight committees for each of the EarthScope facility components.

- Reviews: Each year, NSF convenes a panel of external experts to review project management, cost, schedule, and technical status of the EarthScope facilities and to provide advice for the EarthScope managers and NSF.

Current Project Status

The SAFOD observatory ceased operating in late 2008 and is currently undergoing examination by an independent panel of experts to understand how the instruments ceased operating and what appropriate restoration methods may be. The EarthScope seismic and geodetic instruments consistently exceed 90 percent uptime, and have provided over 67 terabytes of data for the scientific community. EarthScope's open access data policy is having an impact on how experiments are planned and carried out, and is resulting in more scientists making data available to the community in real-time. As just one example, following the March 2010 magnitude 8.8 Chile earthquake, scientists from the United States, Chile, France, Germany, and elsewhere worked together to record critical data using EarthScope and other equipment, and in an unprecedented international partnership, all agreed to share all data collected through the IRIS Data Management Center, which hosts EarthScope data.

Although it became fully operational only during FY 2009, EarthScope has already led to a number of important scientific advances. EarthScope is aiding in the development of predictive models for earthquakes by unraveling the dynamic processes along faults, from stress build-up to catastrophic rock failure. Analysis of the unique SAFOD core from the San Andreas Fault is well underway. At the 2010

American Geophysical Union (AGU) Fall Meeting, more than 35 papers presented results from studies of SAFOD core, including insights into the roles of different minerals and fault fluids in earthquake and faulting processes. The combined use of PBO geodetic and strain data, and USArray seismic data, has documented a wide range of seismic and aseismic signals associated with different modes of fault slip along the Cascadia subduction zone and San Andreas Fault and provided unique new insight into spatial and temporal relationships between earthquakes (large and small), tremor, and slow slip. These exciting new results may have important implications for assessing seismic risk along a plate boundary that is capable of a magnitude 9+ earthquake similar to the great Sumatra earthquake and tsunami of December 2004. PBO's regional scale geodetic network has also provided surprising new information on the Pacific-North American plate boundary, showing for example that extension in the Basin and Range province is not uniform as was once widely believed, but instead focused near its western and eastern edges.

New advances are also being made in joint modeling of EarthScope seismic and strain data with other data types such as those used in geochemistry and structural geology. EarthScope data have been used to develop a revolutionary new tomographic technique for imaging crust and upper mantle structure in western North America that utilizes seismic signals previously considered to be noise. Finally, EarthScope data are being used for unexpected discoveries with potentially transformative impact. Among these are use of EarthScope GPS measurements to understand the distribution of soil moisture and snow depth, key inputs to climate models across the western U.S., and vegetation greenness, a measure of the health of the environment and response to drought. Another example is the incorporation of atmospheric pressure sensors at the USArray Transportable Array stations, which is providing improved understanding of atmospheric structure and enhanced coverage of severe storms, along with better recordings of the seismic data that are the main focus of USArray. These new results have been incorporated in an updated science plan for EarthScope that was developed through an extensive community process and released in February 2010.

EarthScope has engaged a broad and steadily growing community of scientists. More than 120 unique investigators have received NSF funding through the EarthScope science program, including eleven early career scientists in just FY 2009 through FY 2010; at the same time, success rate has remained fairly steady at about 30 percent. About 300 scientists came together for the May 2009 EarthScope National Meeting in Boise, ID, and during the 2009 and 2010 AGU meetings, there were more than 50 special sessions relevant to EarthScope science, covering thirteen different areas of AGU, and including two Union sessions focused on EarthScope. Scientific results utilizing data collected by the EarthScope facility have already been presented at numerous national meetings and in professional publications.

Operations costs

Annual operations costs for EarthScope are anticipated to remain approximately steady, with annual adjustments for inflation.

Renewals/Recompetition/Terminations

In FY 2013, NSF will begin the phased integration of IRIS and UNAVCO core facilities with the EarthScope facilities operated by these organizations under two awards, one to IRIS and one to UNAVCO. Budget estimates shown for FY 2014 and beyond reflect the combined EarthScope, IRIS and UNAVCO facility budgets.

Gemini Observatory

$20,070,000
+$970,000 / 5.1%

Gemini Observatory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Gemini Observatory	$19.10	$19.10	$20.07	$0.97	5.1%

The Gemini Observatory consists of two infrared-optimized 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope, Gemini North, is situated on Mauna Kea at an altitude of 4,200 meters, while the Chilean telescope, Gemini South, is located at the outstanding photometric site of Cerro Pachon, at an altitude of 2,700 meters. This siting of the two telescopes assures complete coverage of the sky and complements the observations from space-based observatories. They provide access to the center of our own Galaxy as well as the Magellanic Clouds, our nearest galactic neighbors. Both telescopes are designed to produce superb image quality and both use sophisticated adaptive optics technology to compensate for the blurring effects of the Earth's atmosphere.

Total Obligations for the Gemini Observatory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$19.10	$19.10	$20.07	$20.07	$20.07	$20.07	$20.07	$20.07

[1] Outyear funding estimates are for planning purposes only.

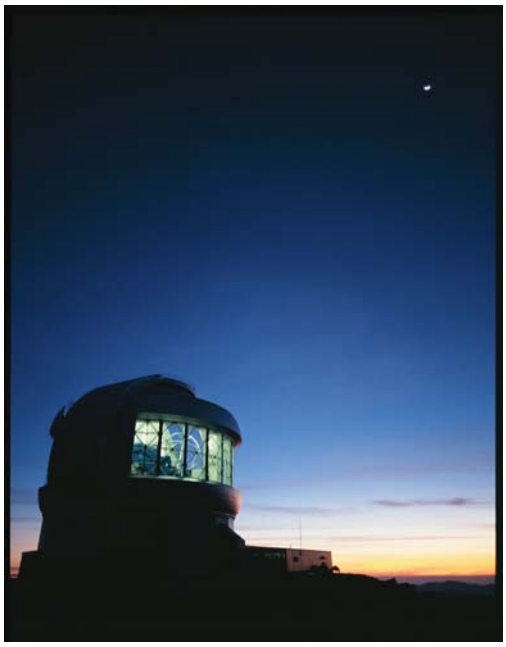
Astronomers are working to resolve important questions about the age and rate of expansion of the universe, its overall topology, the amount and nature of non-luminous matter, the epoch of galaxy formation, the evolution of galaxies, including our own once they are formed, and the formation of stars and planetary systems. The current generation of optical/infrared telescopes with large aperture (8-meter diameter and above) provides unsurpassed sensitivity and spectral and spatial resolution. Technological advances in a number of key areas of telescope construction and design optimize the telescopes' imaging capabilities and infrared performance, as well as the ability to rapidly reconfigure the attached instrumentation in response to changing atmospheric conditions.

The Gemini telescopes help educate and train U.S. astronomy and engineering students. An estimated 10 percent of the roughly 500 U.S. users per year are students. Gemini is also providing a focus for public outreach and high school student training in all the partner countries, including "sister city" arrangements between Hilo, Hawaii and La Serena, Chile, involving students and teachers at high school and elementary school levels. Gemini staff members also provide guidance and support to the Imiloa Science Center, a public astronomy and cultural center in Hilo.

Gemini is an international partnership with the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil. Construction of the telescopes and their instrumentation has involved a large number of industrial

entities in several partner and non-partner countries. These industrial entities have involved firms specializing in large and/or complex optical systems, aerospace, electronics, and engineering, etc. Continued involvement of such industries is part of the instrumentation and facilities renewal activities included in the operating budget of the Gemini Observatory.

Peer-review telescope allocation committees provide merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of Gemini. Many U.S. users are supported through separate NSF or NASA grants to pursue scientific programs that require use of Gemini.



The Gemini South telescope on Cerro Pachon in Chile prepares for the beginning of observation. The telescope is visible through the three-storey-high vents on the rotating dome, which allow a strong air flow across the telescope to provide good image quality. *Credit: Gemini Observatory/Association of Universities for Research in Astronomy.*

Laser guide star systems, which greatly improve the telescopes' ability to correct for atmospheric blurring, are available for both telescopes, with the laser on Gemini North in routine use. Late 2010 saw the installation and beginning of commissioning of an advanced "multi-conjugate" adaptive optics system, which will yield crisp images over a substantially larger field of view than previous laser systems. Several new instruments are in various states of development. A high-performance infrared spectrometer is now available for science observations; and the Gemini Planet Imager, an advanced camera for the southern telescope designed to directly detect planets around nearby stars, is undergoing subsystem acceptance testing.

Budget projections for FY 2013 and beyond represent a level of effort adopted by the Gemini Board and NSF for planning purposes.

Facility Report

Management and Oversight

- NSF Structure: NSF has one seat on the Gemini Board and an additional NSF staff member serves as the executive secretary to the board. Programmatic management is the responsibility of an assigned NSF program manager for Gemini in the Division of Astronomical Sciences in the Directorate for Mathematical and Physical Sciences. The program manager approves funding actions, reports, and contracts, and conducts reviews on behalf of the Gemini partnership.

- External Structure: The Observatory is governed by the Gemini Board, established by the International Gemini Agreement signed by the participating agencies. NSF serves as the executive agency for the seven-nation partnership, carrying out the project on their behalf. An independent visiting committee, established by the Gemini Board, advises on the operation of the Observatory and meets bi-annually. Gemini is managed by Associated Universities for Research in Astronomy (AURA), Inc., on behalf of the partnership through a cooperative agreement with NSF. AURA conducts its own management reviews through standing oversight committees.

- Reviews: In addition to a review held mid-way through the cooperative agreement, NSF conducts periodic reviews of AURA management and Observatory programs as requested by the Gemini

Board. The mid-term management review was held in Hilo on September 23-26, 2008. In addition, NSF conducted a Business System Review of the Observatory in March 2009.

Renewal/Recompetition/Termination

The current International Gemini Agreement will expire at the end of calendar year 2012. The Gemini Board is developing the process and schedule for renegotiation of the agreement. At the November 2009 meeting of the Gemini Board, all partners with the exception of the United Kingdom expressed their intention to remain in the partnership in 2013 and beyond. In late December 2009, the United Kingdom officially announced its intention to withdraw from the partnership post-2012, guaranteeing that there will be changes in the partner shares and attendant budgetary impact in the years following 2012. The Board is now considering contingency plans proposed by the Observatory for reduced operations scope in response to a potential budget reduction of 20 percent. Negotiations for the international agreement and the Gemini management scheme may require a number of years to complete, thus requiring extensions of the current agreements.

The current NSF cooperative agreement covered calendar years 2006-2010. On the basis of the mid-term management review of AURA's performance as the Gemini managing organization in November 2008, the Gemini Board recommended not to compete the management of the Observatory when the current cooperative agreement expired. Furthermore, due to uncertainties in the international financial climate that make it difficult for some of the Gemini partners to commit to long-term funding, the current cooperative agreement has been extended through mid-calendar year 2012 in order to provide a stable operations and management environment throughout the negotiations with the Gemini partners on their future involvement in the partnership. A proposal from AURA for a new cooperative agreement covering the mid-2012-2015 timeframe is expected in January 2011, with review scheduled for March 2011. A key recommendation of the National Research Council-commissioned Astro2010 Decadal Survey suggests that the Gemini Observatory and National Optical Astronomy Observatories (NOAO), which operates smaller aperture telescopes in both hemispheres and is also managed by AURA, be considered for some type of consolidation under a single operational structure, for the purposes of cost-effectiveness and better response to scientific needs. That recommendation is being actively explored.

Incorporated Research Institutions for Seismology

$12,360,000
+$0.00 / 0.0%

Incorporated Research Institutions for Seismology
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Incorporated Research Institutes for Seismology	$12.36	$12.36	$12.36	-	-

The Incorporated Research Institutes for Seismology (IRIS) operates a distributed, multi-user, national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research and education in the Earth sciences, in earthquake research, global real-time earthquake monitoring, and in nuclear test ban verification. It is managed via a consortium of 114 U.S. universities and non-profit institutions with research and teaching programs in seismology, 22 educational affiliates, and 108 foreign affiliates. IRIS led the construction of the USArray component of the EarthScope project and it is now operating USArray as part of the EarthScope Facility.

Total Obligations for IRIS
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$12.36	$12.36	$12.36	$12.36	-	-	-	-

[1]Outyear funding estimates are for planning purposes only. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, separate budget estimates for IRIS are not made beyond FY 2013.

The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design, and the acquisition, transmission, and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the interior. To serve the research needs of the broad national and international seismology community, IRIS is organized in four major core program elements:

- The Global Seismographic Network (GSN), which currently consists of a global deployment of over 150 permanently-installed broadband digital seismic stations, most of which have real-time data access;
- The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL), which manages a pool of portable seismometers that are made available to the seismology research community for scheduled regional and local scale studies;
- The IRIS Data Management System (DMS), which provides the national and international seismic research community with timely access to data from the GSN and PASSCAL (130 terabyte archive);
- The IRIS Education and Outreach (E&O) Program, which enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher

workshops, student internships, lectureships, museum exhibits, educational materials, school seismographs, and programs for under-resourced schools.

In addition, IRIS operates the USArray component of EarthScope. The USArray is a continental-scale seismic and magnetotelluric observatory designed to provide a foundation for integrated studies of continental lithosphere and deep Earth structure over a wide range of scales.

Besides its role in providing the observational data essential for basic research in geophysics and earthquake dynamics, IRIS also plays a significant role providing real-time seismic data to the U.S. Geological Survey and the National Oceanic and Atmospheric Administration for global earthquake and tsunami monitoring, in seismic monitoring of the Comprehensive Test Ban Treaty, and in bringing seismology to students and the public through the activities of its education and outreach program.

IRIS is heavily involved in partnership activities, many international in nature. Installation and operation of the GSN has put IRIS in contact with scientists as well as government and non-government organizations from around the world. Many international IRIS GSN stations are designated as the official stations for nuclear test-ban monitoring in their host countries. The IRIS facilities also are multi-use resources for other government agencies that have responsibilities for development of a nuclear test-ban monitoring capability and for monitoring global seismicity. For these purposes, agencies in partnership with NSF have provided substantial support to IRIS for accelerated development of the GSN (Department of Defense), shared operation and maintenance of the GSN (U.S. Geological Survey), and accelerated development of the PASSCAL instrument pool (Department of Energy).

Polar engineer Guy Tytgat installing a seismographic station in Antarctica's Gamburtsev Province. *Credit: IRIS.*

The use of IRIS PASSCAL instruments for investigations of the shallow crust provides opportunities for collaboration with the petroleum exploration industry. Many students involved in these experiments receive training in techniques that prepare them for careers in the exploration industry. In a broader sense, IRIS continues to collaborate closely with industry in development of seismic instrumentation and software.

The Geophysics, Tectonics, and Continental Dynamics Programs in the Division of Earth Sciences (EAR); the Marine Geology and Geophysics Program in the Division of Ocean Sciences (OCE); and the Geology and Geophysics, and Glaciology Programs in the Antarctic Research Section of the Office of Polar Programs (OPP) provide most of the funds, totaling approximately $15.0 million per year, for NSF-sponsored research making use of the IRIS facilities. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major Earth science problems.

Facility Report

Management and Oversight

- NSF Structure: EAR, through its Instrumentation & Facilities Program (IF), provides IRIS with general oversight to help assure effective performance and administration. The program also facilitates coordination of IRIS programs and projects with other NSF-supported facilities and projects and with other federal agencies and evaluates and reviews the operational and administrative performance of IRIS.

- External Structure: IRIS is incorporated as a non-profit consortium representing 114 U.S. university and non-profit organizations with research and teaching programs in seismology. Each voting Member Institution of the Consortium appoints a Member Representative. However, all IRIS program and budget decisions are made by a nine-member Board of Directors, elected to three-year terms by the Member Representatives. These decisions are made after consultation with the IRIS advisory committees (four standing committees for each of the four IRIS programs and additional ad hoc working groups appointed for special tasks). The Board of Directors appoints a president of IRIS to a renewable two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.

- Reviews: All major ongoing geoscience facilities routinely undergo mid-award reviews of their management in addition to peer review of proposals for new or continued support. A management review of IRIS took place in April 2009. Although a number of specific recommendations were made by the review committee, overall the committee found that IRIS is a well-managed and effective organization that has, through its commitment to the collection and open dissemination of the highest quality seismological data, transformed the discipline of seismology. A review of the IRIS Education and Outreach (E&O) Program also took place during 2009. The review panel found the E&O Program to be healthy but made a number of recommendations that are being considered by the seismological community as it prepares a new Strategic Plan for this program.

Renewal/Recompetition/Termination

A five-year cooperative agreement with the IRIS Consortium for the continued management of the IRIS core facilities (2006-2011) was approved by the NSB in May 2006 and finalized in September 2006. A proposal from IRIS for a 27-month renewal of support was submitted in August 2010; if awarded, this would synchronize the IRIS award with the complementary EarthScope activity. In FY 2013, NSF will begin the phased integration of IRIS and IRIS-operated EarthScope facilities under a single award. For this reason, separate budget estimates for IRIS are not made beyond FY 2013.

The Integrated Ocean Drilling Program and the Scientific Ocean Drilling Vessel

$45,400,000
+$2,000,000 / 4.6%

The Integrated Ocean Drilling Program

(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Integrated Ocean Drilling Program	$50.80	$43.40	$45.40	$2.00	4.6%

The Integrated Ocean Drilling Program (IODP), which began in FY 2004, is an expanded successor program to the Ocean Drilling Program (ODP) and represents an international partnership of the scientists, research institutions, and funding organizations of 24 nations to explore the evolution and structure of Earth as recorded in the ocean basins. The IODP is co-led by NSF and the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan. IODP platforms provide sediment and rock samples (cores), in-situ monitoring, sampling, and measurement from borehole observatories, shipboard and shorebased descriptive and analytical facilities, downhole geophysical and geochemical measurements (logging), and opportunities to conduct experiments to determine in-situ conditions beneath the sea floor.

SODV Underway for Initial Science Expedition, March 10, 2009. *Credit: NSF*

Total Obligations for IODP

(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$50.80	$43.40	$45.40	$46.40	$46.40	$46.40	$46.40	$46.40

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only. Funding for FY 2014, FY 2015, FY 2016, and FY 2017 is estimated assuming renewal of the program.

Annual operations and maintenance support for IODP includes the costs of operating the platform itself and is based on NSF experience in management of the ODP and the contract with the SODV operator. Maintaining databases, preparing scientific publications emerging from IODP expeditions, and management of the international program are additional IODP science integration costs, made minimal to NSF because of international contributions to the IODP program. In addition, NSF provides support for U.S. scientists to sail on IODP drilling platforms and to participate in the IODP Science Advisory

Structure through an associated grants program. The annual costs for the associated science integration and science support (not included in the table above) are estimated to be about $12.0 million.
The IODP Scientific program includes emphasis on the following research themes:

- Deep Biosphere and the Sub-seafloor Ocean;
- Processes and Effects of Environmental Change; and
- Solid Earth Cycles and Geodynamics, including study of tsunami-producing seismogenic zones and other geohazards.

Undergraduate and graduate students participate in drilling expeditions, working with leading scientists to help become future leaders themselves. Other students and the public are engaged in geoscience discovery through distance learning initiatives (including remote broadcasts from the drillship), classroom teaching modules on IODP research initiatives, outreach displays for museums and educational/teaching institutions, and lecture programs. During each fiscal year, an estimated 180,000 K-12, 10,000 undergraduate and 10,500 graduate students, and 35,000 teachers are engaged in or supported by IODP education and outreach efforts.

MEXT and NSF are equal partners in IODP and contribute approximately equally to program operation costs. The European Consortium for Ocean Research Drilling (ECORD; representing 16 European countries and Canada), the People's Republic of China, Korea, India, Australia, and New Zealand have also officially joined IODP and provide financial contributions. IODP partners, including NSF, support IODP integrative activities including science planning, review, data management, drilling science-related engineering development, core and sample archiving, publishing, and international outreach.

Over 2,300 scientists from 40 nations have participated on ODP and IODP expeditions since 1985, including approximately 1,050 U.S. scientists from over 150 universities, government agencies, and industrial research laboratories. Samples and data have been distributed to more than 800 additional U.S. scientists.

NSF is contracting the services of a light drillship (see the Scientific Ocean Drilling Vessel discussion below) from a leading offshore drilling contractor. A commercial contractor provides downhole-logging services. In addition, scientists from industrial research laboratories propose and participate in IODP cruises, are members of the program's scientific and technical advisory committees, and supply data for planning expeditions and interpretation of drilling results.

Facility Report

<u>Management and Oversight</u>

- NSF Structure: The Division of Ocean Sciences (OCE) in the Directorate for Geosciences (GEO) manages the SODV and the IODP under the NSF Ocean Drilling Program. NSF's Ocean Drilling Program is located within the Marine Geosciences Section, with several program officers dedicated to its oversight. One of the program officers serves as the contracting officer's technical representative for the Central Management Office (CMO) contract and the System Integration Contractor (SIC) contract.

- External Structure: NSF and MEXT have signed a Memorandum of Cooperation, which identifies procedures for joint management of a contract to an IODP CMO. A non-profit corporation of U.S., Japanese, and other international institutions (IODP Management International, Inc.) has been

contracted by NSF for the CMO activity. The CMO coordinates and supports scientific planning, drilling platform activity, data and sample distribution, and publication and outreach activities through its management of commingled international science funds, collected and provided by NSF. Drillship providers are responsible for platform operational management and costs. NSF provides a light drillship through a contract with the U.S. SIC, an alliance formed by the Consortium for Ocean Leadership, Inc. (COL) together with subcontractors at Texas A&M University and Lamont-Doherty Earth Observatory, Columbia University. MEXT manages its drillship through the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), while the British Geological Survey manages ECORD drilling contributions.

Scientific advice and guidance for IODP is provided through the science advisory structure (SAS). The SAS consists of a Science Advisory Structure Executive Committee (SASEC) and a series of committees, panels, and groups headed by the Science Planning Committee (SPC). The CMO is responsible for coordinating the SAS committees, panels, and groups; and for integrating the advice from the SAS into drilling and operational guidance for IODP. Representation in the SAS is proportional to IODP member's financial contribution.

- Reviews: Both the CMO and SIC contracts call for management reviews every three years by independent, external panels. Both the SIC and CMO contracts underwent external review in FY 2010, and are available at http://www.iodp-usio.org/Publications/IODP_OA_2010.pdf and http://www.iodp.org/triennium-review/. Reviews for each expedition are carried out on a regular basis to evaluate operational and scientific performance, with review of scientific progress in broader thematic areas conducted by an independent panel every several years.

Renewal/Recompetition/Termination

The current IODP program officially ends in 2013, with IODP international agreements and contracts covering activities through FY 2013. NSF activities regarding a possible IODP renewal, including overall program review, are expected to commence in FY 2011. IODP scientific community planning efforts for a possible post-FY 2013 science program commenced in FY 2009.

Scientific Ocean Drilling Vessel (SODV)

The SODV project was funded through the Major Research Equipment and Facilities Construction (MREFC) account and supported the contracting, conversion, outfitting, and acceptance trials of a deep-sea drilling vessel for long-term use in the IODP. The total NSF cost of the project was $115.0 million appropriated through the MREFC account over three years, with FY 2007 representing the final year of appropriations. The ship owner and operator, Overseas Drilling Limited (ODL), covered an additional $15.0 million in construction costs in exchange for a higher day rate charge during operations. Construction activities have been completed and the ship commenced international scientific operations on March 5, 2009. It has since proved highly reliable, with a facility efficiency rating approximating 100 percent. As well, the drillship and crew have broken numerous scientific coring depth records, with recovered core being of extremely high quality. The outfitted drillship is capable of operating in nearly all ocean environments (subject to limitations regarding minimum water depth and surface ice coverage), and accommodates a scientific and technical staff of up to 60 persons.

Assessment of the SODV science facilities, with emphasis on its data management systems, was conducted during summer 2010 by an independent, international group of ocean drilling geoscientists. The ship has completed nine IODP expeditions with exceptional reliability and demonstrably superior

coring capability (both the single bit rotary coring and global piston coring depth records have been broken).

Notably, in Spring, 2010 the ship completed a pole-to-pole investigation of Earth's past climate history. It was discovered that in the Pliocene Epoch (the last warm period before the Pleistocene "Ice Ages"), the Bering Sea was ice-free year-round and at least 5 degrees C warmer than it is presently, where sea ice is absent only during summer months. Additionally, a 10,000 year-long marine climate record of unprecedented annual resolution was cored offshore of Wilkesland, Antarctica, showing apparent seasonal variations within each 1cm-thick annual deposition. This sediment core allows precise study of Antarctic climate since the last Ice Age glaciation, tying in the marine sedimentary record to the annual climate record shown in Antarctic ice cores.

Large Hadron Collider

$18,000,000
+$0.00 / 0.0%

Large Hadron Collider
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Large Hadron Collider	$18.00	$18.00	$18.00	$0.00	0.0%

The Large Hadron Collider (LHC), an international project at the CERN laboratory in Geneva, Switzerland, is the premier facility in the world for research in elementary particle physics. The facility consists of a superconducting particle accelerator providing two counter-rotating beams of protons, approximately 16.5 miles in circumference, with each beam to have an energy up to 7 TeV (1TeV=10^{12} electron volts). It can also provide colliding beams of heavy ions, such as lead. Because of start-up difficulties encountered with the accelerator in 2008, data-taking with colliding proton beams was delayed until the Spring 2010, beginning at a lower beam energy of 3.5 TeV. To be prudent, it was decided that the beam energy would be slowly increased in stages. Since the accelerator and the detectors performed very well in the 2010 run, the decision has been made that the run will be extended through 2012 before a shut-down for planned accelerator upgrade work is implemented.

The U.S. is involved in the maintenance and operation of two particle detectors, a Toroidal LHC Apparatus (ATLAS) and the Compact Muon Solenoid (CMS). These have been built to characterize the different reaction products produced in the very high-energy proton-proton collisions that will occur in intersection regions where the two beams are brought together. They are also being used to study the reaction products from heavy ion beam collisions. A total of 43 international funding agencies participate in the ATLAS detector project and 41 in the CMS detector project. NSF and the Department of Energy (DOE) are providing U.S. support. CERN is responsible for meeting the goals of the international LHC project. The ATLAS and CMS detectors are expected to take data approximately 200 days per year. The remaining time is to be used for maintenance and testing.

The U.S. LHC collaboration continues to be a leader in the development of grid-based computing. The grid is enabling the enhanced participation of U.S. universities, and thus the training of students, in both state of the art science and computational techniques, in a project that is centered overseas. The grid is expected to have broad application throughout the scientific and engineering communities.

Total Obligations for LHC
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00

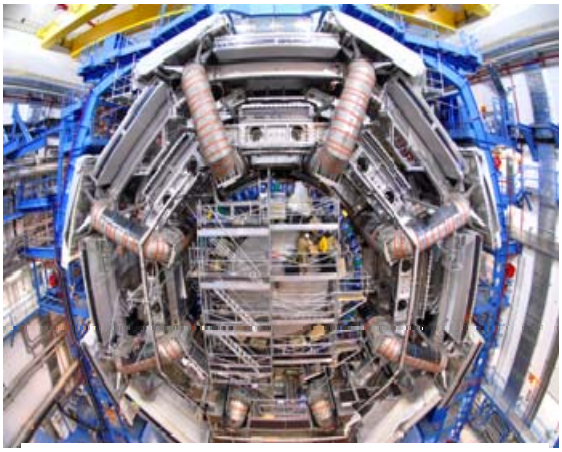
[1] The current cooperative agreement ends in FY 2011. FY 2012 funding is the subject of current negotiations. Outyear funding estimates are for planning purposes only.

The LHC is enabling a search for the Higgs particle, the existence and properties of which will provide a

deeper understanding of the origin of mass of known elementary particles. The LHC program also includes searches for particles predicted by a powerful theoretical framework known as supersymmetry, which may provide clues as to how the four known forces evolved from different aspects of the same "unified" force in the early universe, and can investigate the possibility that there are extra dimensions in the structure of the universe. Through the participation of young investigators, graduate students, undergraduates, and minority institutions in this international project, LHC serves the goal of helping to produce a diverse, globally-oriented workforce of scientists and engineers. Further, innovative education and outreach activities, such as the QuarkNet project, allow high school teachers and students to participate in this project (see http://quarknet.fnal.gov).

Major procurements of components of both warm and superconducting magnets, as well as high-speed electronics, are performed through U.S. industries. Major developments in grid computing are also valuable outcomes. In the construction phase, approximately $45.0 million was devoted to materials procurements from industry. In FY 2012 the estimate for material procurements is approximately $5.0 million, which is included within the $18.0 million operating costs.

Because of the delay in the start-up schedule of the accelerator due to failure in September 2008 of a high current line that caused arcing and destructive failure of a liquid helium cryogenic system, the U.S. LHC collaboration did extensive commissioning of the detectors and the data analysis systems using cosmic rays while the accelerator was being repaired. As a result, with the advent of colliding beams in the Spring of 2010, the detectors began immediately taking data at very near design performance levels, which was unprecedented for the start-up of such complex instruments. Since then, the collaborations have been actively engaged in keeping the detectors operating smoothly and adapting quickly to the significant increases in beam intensities, which will be an ongoing challenge.



The ATLAS detector in February 2007. *Credit: CERN.*

Facility Report

Management and Oversight

- NSF Structure: A program director in the Division of Physics (PHY) is responsible for day-to-day project oversight. The NSF program director participates in an internal Project Advisory Team, including staff from the NSF Offices of Budget, Finance, and Award Management, General Counsel, Legislative and Public Affairs, and International Science and Engineering, as well as the Office of the Assistant Director for the Directorate of Mathematical and Physical Sciences (MPS).

- External Structure: U.S. LHC program management is performed through a Joint Oversight Group (JOG), created by the NSF and DOE. The JOG has the responsibility to see that the U.S. LHC program is effectively managed and executed to meet commitments made under the LHC international agreement and its protocols.

- Reviews: There is one major management/technical review each year with a panel of external, international experts, as well as bi-weekly telephone reviews by NSF/DOE program directors to

monitor progress. The next major management/technical review is scheduled for March 2011. Two JOG review meetings per year monitor overall program management.

Renewal/Recompetition/Termination

The LHC project is expected to continue at least through the end of the next decade. As the present award ends at the close of calendar year 2011, a new cooperative agreement will be negotiated with the ATLAS and CMS collaborations to extend funding for an additional five years to support their role in the international collaboration of which they are members. This process comes at a critical time due to the fact that the detectors are only just beginning to collect data. All participating scientists want to maximize use of the first phase of the machine operation, which has been extended to compensate for the downtime induced by a mechanical accident shortly after start-up. Therefore, NSF will review proposals from the U.S. ATLAS and U.S. CMS collaborations for an additional five years of funding to cover this critical period.

Laser Interferometer Gravitational-Wave Observatory

$30,400,000
+$190,000 / 6.7%

Laser Interferometer Gravitational-Wave Observatory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
Laser Interferometer Gravitational-Wave Obs.	$28.50	$28.50	$30.40	$1.90	6.7%

Einstein's theory of general relativity predicts that cataclysmic processes involving extremely dense objects in the universe, such as the collision and merger of two neutron stars or black holes, will produce gravitational radiation. Detection of these gravitational waves is of great importance for both fundamental physics and astrophysics. The Laser Interferometer Gravitational-Wave Observatory (LIGO), the most sensitive gravitational-wave detector ever built, comprises two main facilities, one in Livingston Parish, LA and one in Hanford, WA. At each facility, a large vacuum chamber with two 4-km arms joined at right angles houses one or more optical interferometers; the Hanford chamber contains a second 2-km interferometer. The interferometers are used to measure minute changes in the distances between test masses at the ends of the arms caused by a passing gravitational wave. The predicted distortion of space caused by a gravitational wave from a likely source is on the order of one part in 10^{21}, meaning that the expected change in the apparent 4-km length is only on the order of 4×10^{-18}, or about 1/1000th the diameter of a proton. The 4-km length for LIGO, the largest for any optical interferometer, was chosen to make the expected signal as large as possible within terrestrial constraints. Looking for coincident signals in all the interferometers simultaneously increases the likelihood for gravitational wave detection.

In April 2008 construction began on the Advanced LIGO project (AdvLIGO), which is designed to increase the sensitivity of LIGO tenfold. AdvLIGO is being built within the existing LIGO laboratory. LIGO's current and projected operations and maintenance expenses are designed to sustain operation of the LIGO laboratory during the time that the construction is underway. These include support for the basic infrastructure costs not directly related to the AdvLIGO construction project, support for data analysis for the S5 and S6 science runs, maintenance of computational resources for data storage and analysis, support for R&D for any pre-design costs and risk reduction related to AdvLIGO that are outside the scope of the AdvLIGO project, and support for the education and outreach projects associated with the laboratory.

Total Obligations for LIGO
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$28.50	$28.50	$30.40	$30.50	$30.50	$30.50	$30.50	$30.50

[1] Outyear funding estimates are for planning purposes only.

LIGO has been a significant source of highly trained Ph.D. graduates for the country's workforce. The number of graduate students has grown from the beginning of LIGO's science runs in FY 2002 and will continue to do so. In addition, active outreach programs have been developed at both the Hanford and

Livingston sites. Teams at both sites have provided visual displays, hands-on science exhibits, and fun activities for visiting students and members of the public. In the last three years an average of over 2,000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experiences for Teachers (RET) program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Summer Undergraduates Research Fellowships/Research Experiences for Undergraduates (SURF/REU) programs for college students. Both sites have developed web-based resources for teachers that include information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. The LIGO Science Education Center at the Livingston site contains many exhibits from the Exploratorium® Museum of Science in San Francisco and is the focal point for augmenting teacher education at Southern University and other student-teacher activities state-wide through the Louisiana Systematic Initiative Program. The LIGO Science Education Center's programs include funding for an external evaluation firm that provides both assistance in aligning future activities with proposed goals and evaluating outcomes. In FY 2010, each site has made more than 10,000 on- or off-site outreach contacts. The LIGO Scientific Collaboration has developed a traveling exhibit, which has appeared at the New York City World Science Festival, the Science and Engineering Expo in Washington, DC, and at several science centers across the country.

An aerial view of the Hanford, WA observatory. *Credit: LIGO Laboratory.*

Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in LIGO projects with some leading to new products. Interactions with industry include exploring novel techniques for fabrication of LIGO's vacuum system, seismic isolation techniques, ultrastable laser development (new product), new ultra-fine optics polishing techniques, and optical inspection equipment (new product).

In 1997 LIGO founded the LIGO Scientific Collaboration (LSC), an open collaboration that organizes the major international groups doing research supportive of LIGO. The LSC now has more than 61 collaborating institutions in 13 countries with more than 830 participating scientists, and LSC membership is growing at a rate of approximately 10 percent per year. A Memorandum of Understanding between the LIGO Laboratory and each institution determines the role and membership responsibilities of each participating institution. The LSC plays a major role in many aspects of the LIGO effort, including R&D for detector improvements, R&D for AdvLIGO, data analysis and validation of scientific results, and setting priorities for instrumental

A view of the high-vacuum vertex chambers at the Livingston, LA site (bottom). *Credit: LIGO Laboratory.*

improvements at the LIGO facilities. Annual NSF support for science and engineering research directly related to LIGO activities through ongoing research and education programs is about $5.50 million, provided through the disciplinary programs.

LIGO concluded its mission-defining scientific run (S5), in which a year's accumulation of data was taken at its design sensitivity with all three interferometers operating in coincidence, in October 2007. These data were taken at a detector sensitivity in excess of the defined goal sensitivity outlined in the design specifications. The S6 science run, which, in addition to the acquisition of science data, also tested technologies that will become part of AdvLIGO, began in July 2009 and ended in October 2010. The detector sensitivity was higher than that during the previous S5 run, making the S6 science run a valuable testbed for AdvLIGO.

For more information on AdvLIGO, see the MREFC chapter.

Facility Report

Management and Oversight

- NSF Structure: NSF oversight is coordinated internally by the LIGO Program Director in the Division of Physics (PHY), who also participates in the PHY AdvLIGO Project Advisory Team, comprising staff from the NSF Offices of General Counsel, Legislative and Public Affairs, International Science and Engineering , as well as the the Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management .

- External Structure: LIGO is managed by the California Institute of Technology under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LIGO Scientific Collaboration (LSC), and collaboration with the other major gravitational-wave detector activities in Asia, Europe, and Australia. External peer-review committees organized by NSF help provide oversight through an annual review.

- Reviews:
  - AdvLIGO Baseline Review, May-June 2006
  - LIGO Annual Review, November 2006
  - AdvLIGO Baseline Update Review, June 2007
  - LIGO Annual Review and LIGO FY 2009-2013 Operations Proposal Review, November 2007
  - LIGO Annual Review, November 2008
  - AdvLIGO Annual Review, April 2009
  - LIGO Annual Review and AdvLIGO Interim Review, December 2009
  - AdvLIGO Annual Review, April 2010
  - LIGO Annual Review and AdvLIGO Interim Review, December 2010
  - AdvLIGO Annual Review, April 2011
  - LIGO Annual Review and AdvLIGO Interim Review, October 2011

Renewal/Recompetition/Termination

LIGO began operating under a new five-year cooperative agreement at the beginning of FY 2009. As a condition of approval of this award (and a possible future award), the National Science Board stipulated that the operation of LIGO be recompeted no later than 2018. The projected lifetime of the LIGO facility is 20 years.

National Astronomy and Ionosphere Center

$8,700,000
-$1,900,000/ -17.9%

National Astronomy and Ionosphere Center
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Astronomy and Ionosphere Center	$10.75	$10.60	$8.70	-$1.90	-17.9%

The National Astronomy and Ionosphere Center (NAIC) is a national center for multidisciplinary research and education, as enabled by the world-class observational facilities of the Arecibo Observatory. The center's principal observing facility is the world's largest single-dish radio/radar telescope, a 305-meter diameter reflector located near the town of Arecibo in western Puerto Rico on 120 acres of U.S. Government-owned land. Currently operated and managed by Cornell University under a cooperative agreement with NSF, NAIC serves over 300 users annually with a wide range of research and observing instrumentation in passive radio astronomy, solar system radar astronomy, and space and atmospheric sciences.

Including the Angel Ramos Foundation Visitor Center, NAIC has a staff of about 120 full-time-equivalent positions, of which approximately 90 are supported by NSF funds. A permanent staff of 17 scientists and 34 engineers, technicians and operators are available to help visiting investigators with observing programs. The remainder includes 26 management, administrative and clerical positions, 37 maintenance staff, and several postdoctoral scholars and students.

Total Obligations for NAIC
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$10.75	$10.60	$8.70	$8.30	$8.00	$8.00	$8.00	$8.00
Astronomical Sciences (MPS)	*8.40*	*8.40*	*5.50*	*5.00*	*4.50*	*4.00*	*4.00*	*4.00*
Atmospheric & Geospace Sciences (GEO)	*2.35*	*2.20*	*3.20*	*3.30*	*3.50*	*4.00*	*4.00*	*4.00*
Total, NAIC	**$10.75**	**$10.60**	**$8.70**	**$8.30**	**$8.00**	**$8.00**	**$8.00**	**$8.00**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

NAIC is jointly supported by the Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences (MPS) and the Division of Atmospheric and Geospace Sciences (AGS) in the Directorate for Geosciences (GEO). In 2006 the AST Senior Review recommended a reduction in AST support for NAIC to $8 million (FY 2006 dollars) by 2010. In response, the managing organization reduced the NAIC staff by 30 FTEs, modified the operating mode for astronomy observations, and limited the observing time for astronomy and planetary radar projects.

AST support for NAIC in FY 2008–2010 reflected a planned ramp down in response to the Senior Review recommendations. The AST Senior Review also recommended that sufficient external financial or personnel contributions be found to operate NAIC with competitive scientific productivity after 2011

with an AST contribution not to exceed half of the expected operational costs, estimated in FY 2006 at $8.0 million. AST support for FY 2011–2017 is based upon the Senior Review recommendations, guidance from a third-party cost review of AST facilities, and a third-party estimate of NAIC's non-scientific costs.

As AST has ramped down support for NAIC, AGS has significantly increased support and, in FY 2011 and beyond, will contribute substantively to general facility operations. In the past, AGS funding has primarily supported a research staff in the space and atmospheric sciences program and contributed only incrementally for basic operations costs. Outyear estimates for AGS support of NAIC ramp up to parity with AST support by FY 2015.

Partnerships and Other Funding Sources: NAIC leverages NSF support with funding from other federal and non-federal sources. In FY 2010, the NASA Near Earth Object Observation Program committed $2.0 million to NAIC in support of the Arecibo planetary radar program. NASA support is expected to continue at this level, subject to availability of appropriated funds. In FY 2010, Cornell finalized an assistance agreement with the Puerto Rico Infrastructure Financing Authority to receive $3.0 million for major infrastructure improvements at Arecibo Observatory. In FY 2009 Cornell contracted with the Puerto Rico Department of Education for up to $2.35 million to provide student enhancement and teacher professional development programs at Arecibo through the site's Angel Ramos Foundation Visitor Center and Learning Center. Recent sources of external funding also include $942,000 from the Defense University Research Instrumentation program at the Air Force Office of Scientific Research (AFOSR/DURIP) and the Office of Naval Research (ONR), and approximately $500,000 from other non-federal and private sources.

An aerial image of the Arecibo Radio Telescope in Puerto Rico. The platform suspension structure, including the Gregorian dome that houses the main suite of research instruments, is visible over the 305-meter primary reflector dish below. *Credit: Arecibo Observatory/NSF.*

A peer-review telescope allocation committee provides merit-based telescope time to users but no financial support. NSF does not provide awards targeted specifically for use of Arecibo Observatory, although many users are supported through NSF or NASA grants to pursue scientific programs that require use of NAIC.

Education and Public Outreach: A primary education goal for NAIC is to support and enhance the experiences of student researchers. Arecibo hosts a Research Experiences for Undergraduates (REU) site, and Ph.D. students receive training through use of the facility. In collaboration with the National Radio Astronomy Observatory, NAIC holds a summer school on single-dish radio astronomy techniques. NAIC also sponsors a major outreach program in Puerto Rico via the modern Angel Ramos Foundation Visitor Center and Learning Center, as well as summer workshops for K-12 teachers. This center attracts roughly 100,000 visitors each year; over 1.3 million people have visited since its opening in 1997. With funds from the Puerto Rico Department of Education, NAIC recently hosted 25,000 K–12 school children

through the *Inspiration for Science* program that provided transportation to the Observatory and science enrichment activities at no cost to participants.

Operations and Maintenance, $8.70 million: NAIC administers observing time to the astronomy and aeronomy communities via competitive observing proposals and conducts educational and public outreach programs at all levels. Observing hours among science programs are based on the quality of observing proposals; the current average oversubscription rate of the telescope is approximately 3.5. This metric accounts for the number of current astronomical surveys requesting time for a given area of sky, plus the time request in the program year for small radio astronomy projects, solar system observations, and atmospheric sciences programs. About 80 percent of astronomy users conduct their observing remotely via networked control software, while radar observations typically employ on-site users.

- Division of Astronomical Sciences, $5.50 million: AST funds basic operations costs and science programs in passive radio astronomy and solar system radar astronomy. Funding for the Astronomy program continues to decrease in FY 2012, in response to recommendations of the AST Senior Review. Operational scope changes are anticipated in response to decreased AST funding, pending merit review of proposals received in response to an open competition for the next five-year award for NAIC management and operations. Beginning in program year 2011, support for planetary radar astronomy will shift to NASA (see below).

  Radio astronomers use the Arecibo facility to study diverse areas such as interstellar gas, galactic structure formation and evolution, pulsars and fundamental physics; topics in solar system astronomy include the physical properties of asteroids, planetary surfaces and moons, and the post-discovery characterization and orbital refinement of near-Earth asteroids. Approximately 50 to 60 percent of the astronomy observing time is dedicated to ongoing survey programs, most of which use the Arecibo L-band Feed Array (ALFA) receiver that was commissioned in 2005–2006. The installation and commissioning of wide-band spectrometers in FY 2008 allows up to three survey programs to be conducted simultaneously on each sky pointing.

- Division of Atmospheric and Geospace Sciences, $3.20 million: AGS supports a research staff in the space and atmospheric sciences program and has historically contributed only incrementally for basic operations costs. As stated above, in FY 2011 and beyond, AGS funding will contribute substantively to general operations. The incoherent scatter radar at Arecibo is part of an NSF-supported network of radars strategically distributed to observe the transport of radiative energy and charged particles, from their origins at the sun to their deposition in Earth's upper atmosphere. The unique sensitivity of the Arecibo incoherent scatter radar system allows it to measure the density, temperature, and motion of plasma in Earth's ionosphere with unrivaled time and spatial resolution. Arecibo is also the only aeronomy observatory located at tropical mid-latitudes where many important ionospheric processes take place. An ionospheric high-frequency heating facility is currently under construction at Arecibo with completion anticipated in FY 2011.

Facility Report

Management and Oversight

- NSF Structure: Ongoing oversight is provided by an assigned NSF program director in AST, in close cooperation with AGS and in consultation with community representatives. The program director makes use of detailed annual program plans, long range plans, quarterly technical and financial reports, and annual reports submitted to NSF by Cornell, as well as attending Cornell governance

committee meetings as appropriate. To address issues as they arise, AST program managers work closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office. The NSF program director and AGS program manager conduct periodic site visits.

- External Structure: Management is via a cooperative agreement with Cornell University. Cornell provides management and oversight through its own advisory and visiting committees. The NAIC Director is resident at Cornell and reports to the Vice Provost for Research in Physical Sciences and Engineering. The Arecibo Observatory Site Director reports to the NAIC Director.

- Reviews: Management reviews by external review panels are held midway into each 5-year cooperative agreement. The last management review was held in March 2007; a follow up assessment of Cornell's response to the AST Senior Review recommendations was completed in March 2008. NAIC underwent an NSF Business Systems Review in FY 2005. AST and AGS jointly conduct annual external reviews of NAIC program plans; the most recent review was held in December 2010. Future annual reviews will continue after review and recommendation of proposals received in response to the competition for NAIC management and operations (see below).

Renewal/Competition/Termination

The current cooperative agreement with Cornell for the management of NAIC is in effect through September 30, 2011. Consistent with National Science Board policy, NSF has solicited proposals through a competitive process for a new, five-year cooperative agreement for NAIC management and operations. The program solicitation (NSF 10-562) was published in April 2010 with a proposal submission deadline of October 1, 2010. Proposals are currently under review. Following recommendation and negotiation of an award and, if applicable, an appropriate transition plan, the new cooperative agreement is planned for award in early FY 2012.

The program solicitation for the management and operation of NAIC provided five-year budget guidance at a level significantly reduced relative to current operations, as reflected in out-year estimates for NSF support. To sustain NAIC as a competitive scientific and educational facility that is responsive to its stakeholders in the scientific community and in the Commonwealth of Puerto Rico, proposing organizations were encouraged to consider novel models of operations and governance, revisions to programmatic scope, and/or sources of additional funding. Within available resources and as consistent with the expectations and criteria identified in the program solicitation, the successful proposal is expected to present a compelling, sustainable vision for NAIC that supports an optimal suite of user-driven research and education activities through effective structures for management and operations.

In FY 2010, NASA established support of $2.0 million to NAIC expressly for planetary radar capabilities and in support of the agency's Congressional mandate to identify potentially hazardous near-earth objects. NASA has communicated the intent to continue this level of support, increased at inflation rates and subject to availability of appropriated funds, and that any institution awarded the cooperative agreement for NAIC management and operations may propose to NASA for this planetary radar supplement under the Near Earth Object Observation Program. In association with the next cooperative agreement for NAIC management and operation, NSF will negotiate a memorandum of understanding with NASA to establish appropriate oversight procedures for multi-agency support of NAIC.

NSF will decertify NAIC as a Federally Funded Research and Development Center (FFRDC) upon award of the next cooperative agreement for its management and operation. The decision to remove NAIC from the list of FFRDCs was made after careful consideration of the advantages and disadvantages this

designation carries with it. Without restrictions imposed by the FFRDC designation, the NAIC managing organization will have greater freedom to establish partnerships beyond those permitted by government regulations applicable to FFRDCs.

National High Magnetic Field Laboratory

$33, 300,000
-$2, 260,000 / -6.4%

National High Magnetic Field Laboratory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Change over FY 2010 Enacted Percent
National High Magnetic Field Lab	$40.53	$15.00	$35.56	$33.30	-$2.26	-6.4%

The National High Magnetic Field Laboratory (NHMFL) is operated by Florida State University (FSU), the University of Florida (UF), and Los Alamos National Laboratory (LANL). NHMFL develops and operates high magnetic field facilities that scientists and engineers use for research in physics, biology, bioengineering, chemistry, geochemistry, biochemistry, materials science, medicine, and engineering. It is the world's premier high magnetic field laboratory with a comprehensive assortment of high-performing magnet systems. The principal scientific goals of NHMFL are to provide the highest magnetic fields, state-of-the-art instrumentation, and support services for scientific research. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process.

In addition, the lab is an internationally recognized leader in magnet design, development, and construction. Many of the unique magnet systems were designed, developed, and built by the Magnet Science and Technology (MS&T) Division of NHMFL. MS&T has broad responsibility to develop high field magnets as well as conducting and superconducting materials for future generation magnet components in response to national needs. MS&T works with industry and other international magnet laboratories on a variety of technology projects. These include analysis, design, component development and testing, coil fabrication, cryogenics, system integration, and testing.

Two FY 2010 actions -- a $15.0 million award funded by the American Recovery and Reinvestment Act of 2009 (ARRA) and a $2.56 million award funded by regular appropriated dollars -- are supporting design and development of a 21 Tesla magnet and world-record-holding advanced mass spectrometer. This equipment will be capable of analyzing chemical samples of unprecedented complexity, such as biological fluids and biofuels, and with unprecedented speed. This new capability will have high impact in several areas including chemistry, molecular biology, and heavy petroleum analysis. The FY 2012 Request will allow the facility to continue operations, focus on magnet development, and strengthen education, training, user support, and in-house research.

Total Obligations for NHMFL
(Dollars in Millions)

	FY 2010[1] Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	ESTIMATES[2] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$40.53	$35.56	$33.30	$33.30	$33.30	$33.30	$33.30	$33.30
ARRA[3]	15.00	15.00	-	-	-	-	-	-
Total, NHMFL	**$55.53**	**$50.56**	**$33.30**	**$33.30**	**$33.30**	**$33.30**	**$33.30**	**$33.30**

Totals may not add due to rounding.

[1] FY 2010 funding reflects one-time support for the design and development of the 21 Tesla magnet.

[2] Outyear funding estimates are for planning purposes only.

[3] $15.0 million in ARRA funding was carried over from FY 2009 and obligated in FY 2010.

Current magnet development at NHMFL focuses on new energy-saving, high-field magnet technologies, including the design and construction of all-superconducting magnets based on high-temperature superconductor technology. The goal is to develop high-field magnets for the NHMFL user program that double current energy-efficiency. NHMFL collaborates with more than 60 private sector companies, including Cryomagnetics, Pfizer, and Oxford Superconductor Technologies, and national laboratories and federal centers, including those supported by the Department of Energy (DOE) such as the Spallation Neutron Source and the Advanced Photon Source at Argonne National Laboratory. International collaboration includes magnet development with the Helmholtz-Zentrum Berlin (HZB) (previously known as the Hahn-Meitner-Institute Berlin), the International Thermonuclear Experimental Reactor (ITER) in France, and national magnet labs in France, the Netherlands, Germany, and China.

NHMFL provides a unique interdisciplinary learning environment. Its annual K-12 outreach engages more than 9,000 students from Florida and Georgia in hands-on activities in their classrooms and tours of the lab. In addition, NHMFL conducts a College Outreach-Workforce Initiative program to increase diversity in lab programs. This has included outreach to approximately 200 undergraduates at historically-black colleges and universities. Summer researchers include 13 high school teachers, 21 undergraduates, and 7 high school and 14 middle school students. Thirty-two middle school girls attend the SciGirls summer camp per year. The annual one-day open house features 80 science demonstrations and hosts more than 5600 visitors, aged 3 to 83.

Facility Report

Management and Oversight

- NSF Structure: NHMFL is supported by the Division of Materials Research (DMR) and the Division of Chemistry (CHE) in the Directorate for Mathematical and Physical Sciences (MPS). Primary responsibility for NSF oversight is with the national facilities program director in DMR, with guidance from an *ad hoc* working group with members from CHE and the NSF Directorates for Engineering and Biological Sciences. Site visit reviews are conducted annually. In addition to a panel of experts from the community, representatives from other federal agencies such as DOE and the National Institutes of Health (NIH) attend these site visits.

- External Structure: A consortium of the three institutions (FSU, UF, and LANL) operates NHMFL under a cooperative agreement. FSU, as the signatory of the agreement, has the responsibility for

appropriate administrative and financial oversight and for ensuring that operations of the laboratory are of high quality and consistent with the objectives of the cooperative agreement. The principal investigator serves as the NHMFL director. Four senior faculty members are co-principal investigators. The NHMFL director receives guidance and recommendations from an external advisory committee, the NHMFL executive committee, the NHMFL science council, the NHMFL diversity committee, participating institutions, and the users' executive committee.

- Reviews: NSF conducts annual external reviews, which assess user programs, in-house research, long-term plans to contribute significant research developments both nationally and internationally, and operations, maintenance, and new facility development. Annual reviews also assess the status of education training and outreach, operations and management efficiency, and diversity plans. Recent and upcoming reviews include:
  - Annual Review by external panel of site visitors, November 2010.
  - National Research Council study on the future of high field magnetic science, to be started in FY 2011.

Renewal/Recompetition/Termination

A comprehensive renewal review was conducted in FY 2007. On August 8, 2007 the National Science Board approved a five-year renewal award not to exceed $162.0 million for FY 2008-2012. A proposal will be reviewed in summer 2011 for a potential renewal beginning in FY 2013. In FY 2011, NSF will seek broad-based community input through the National Research Council to plan for the Nation's long-term investment in high magnetic field research.

National Nanotechnology Infrastructure Network

$15,560,000
-$700,000 / -4.3%

National Nanotechnology Infrastructure Network
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Nanotechnology Infrastructure Network	$16.71	$16.26	$15.56	-$0.70	-4.3%

The National Nanotechnology Infrastructure Network (NNIN) is in the second and final five-year funding period from FY 2009-2013. NNIN comprises 14 university sites that form an integrated national network of user facilities supporting research and education in nanoscale science, engineering, and technology. The NNIN provides users across the Nation with access, both on-site and remotely, to leading-edge tools, instrumentation, and capabilities for fabrication, synthesis, characterization, design, simulation, and integration. The broad scope of NNIN coverage includes areas of physics, chemistry, materials, mechanical systems, geosciences, biology, life sciences, electronics, optics, molecular synthesis, and molecular scale devices, among others.

Total Obligations for NNIN
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$16.71	$16.26	$15.56	$17.10	$17.10	$17.10	$17.10	$17.10

[1] Outyear funding estimates are for planning purposes only. The current award receives final funding in FY 2013.

NNIN's broad-based national user facilities enable the Nation's researchers from academia, small and large industry, and government to pursue transformative research, to seek new discoveries and applications in a broad range of domains of nanoscale science and engineering, and to stimulate technological innovation. The network also develops the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology, including issues of environment, health, and safety.

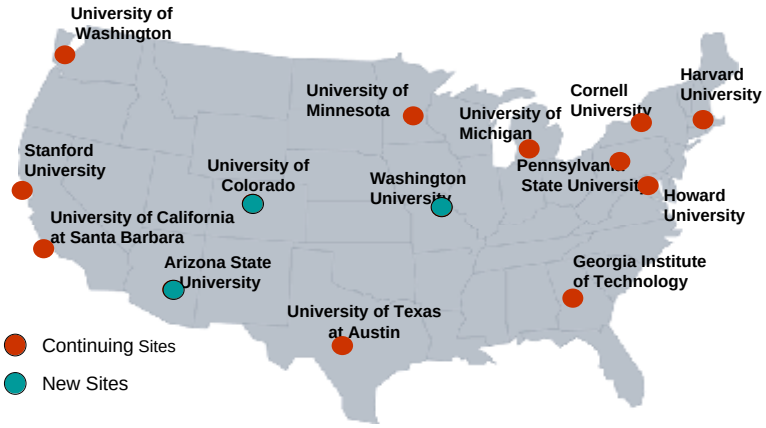
NNIN undertakes, on a national scale, a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach to the science, engineering, and technological communities. Special emphasis is placed on education and training of a diverse science and engineering workforce that involves non-traditional users and under-represented groups, including women and minorities.

NNIN seeks to leverage its capabilities through connections and collaborations with national and industrial laboratories and with foreign institutions. Through such partnerships, joint meetings, and workshops, the network shares expertise and perspectives, provides specialized training opportunities, coordinates access to unique instrumentation, and transfers newly developed technologies.

NNIN leverages research strengths of the university to bring them to the external community. The institutions comprising the NNIN have strong underlying internal research programs that provide the knowledge base for developing new processes, methodologies, and instrumentation, as well as much of the capital infrastructure. NSF and other agencies independently award research grants to principal investigators who use the NNIN facilities to carry out some aspects of their research projects.

Three institutions joined the network in the renewal period, each bringing new capabilities: the University of Colorado, which focuses on research in energy-related problems and in precision sciences that include measurements, standards, and systems; Arizona State University, which focuses on organic/inorganic interfaces in electronics, biodesign, implantable devices, flexible electronics, sensors., and outreach to underrepresented communities in the Southwest; and Washington University in St. Louis, whose research focuses on nanomaterials and nanosciences for environment, health, and safety. NNIN, through lead efforts at the University of Washington and University of Michigan, is also serving as a technology source to facilitate collaboration between the ocean sensing infrastructure geoscienses community and the nanotechnology sensor community.

In its seventh year of operation for the 10 month period encompassing March 2010 through December 2010, NNIN served 5,352 unique users (an increase of 10 percent over the previous year 10 month period) who performed a significant part of their experimental work at NNIN facilities. Of these, 4,446 were academic users, most of whom were graduate students, 818 industrial users (653 from small companies), 57 from U.S., state, and federal laboratories, and 31 from foreign institutions. Nearly 2,500 publications, several of them the significant scientific and engineering highlights of the year, resulted from the work of the user community. A major task of staff of NNIN is in training of this user community, particularly graduate students, from across United States, where there is a continuous and significant turnover. During the 10 month period, 1,883 new (first time) users were trained across the network's vast instrument set. The results of NNIN enabled research are presented in over 3,100 attributed publications in high quality journals and at conferences worldwide. The NNIN user facilities promote interdisciplinary research by bridging the gap between materials, mechanics, electronics, photonics, biology and diverse fields, and enabling longitudinal pathways from fundamental studies to devices and systems.



Facility Report

<u>Management and oversight</u>

- NSF structure: NSF provides oversight of the NNIN under a cooperative agreement with Cornell University, the lead institution. The program officer for the NNIN activity resides in the Division of

Electrical, Communications and Cyber Systems (ECCS) in the Directorate for Engineering (ENG). The program officer coordinates NNIN oversight with the NNIN working group comprised of representatives from all NSF research and education directorates. NNIN is reviewed annually through site reviews held at one of the network sites. These reviews involve an external team of experts selected by NSF staff. In addition to the annual site reviews, semi-annual briefings of NSF staff are held at the NSF attended by the NNIN network director, site directors, and area coordinators.

- External structure: NNIN is managed as a cohesive and flexible network partnership through a Network Executive Committee derived from the individual site directors, and the Education/Outreach and Society/Ethics coordinators. The network director, is from the lead institution, Cornell University, and provides intellectual leadership for the network, is responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network, and serves as the principal contact on behalf of the network with the NSF. An external Network Advisory Board meets at least annually and provides independent advice and guidance to the network director and Executive Committee concerning the network's programs, activities, vision, funding allocations, and new directions. The Advisory Board shares its major recommendations with the NSF. The site directors are responsible for local management functions of the individual user facilities, for interfacing with other facilities and with the management team for the overall network, and for connections with the outside communities.

- Reviews:
  - The first comprehensive annual review of the NNIN was held following an initial 9 months of operation at the Georgia Institute of Technology site in December 2004. The second annual review was held at the University of Texas-Austin site in February 2006. The third annual review was held at the University of Michigan site in May 2007. The fourth annual review was held at Stanford University in May 2008. This review also served to evaluate the NNIN renewal proposal for the five-year period FY 2009-2013. A mid-year informational review was held at NSF in October 2009. The sixth annual review was held at the University of Washington site in May 2010.
  - Upcoming reviews: The seventh annual review will be held at the University of Colorado in Boulder in May 2011.

NNIN was awarded $10 million in ARRA funds in FY 2009 to acquire advanced nanofabrication and characterization instrumentation and tools at each of its network sites to enable users to accomplish state-of-the-art research projects. Availability of these funds helped address challenges the network has faced in maintaining its capital equipment base through acquisition of new instrumentation and replacement of old or high-demand equipment.

Renewal/Recompetition/Termination

The National Science Board approved NSF's review-based recommendation in December 2008 and authorized renewal of the NNIN award for a final five-year period from FY 2009-2013. In FY 2011, the third year of this final award period, NSF plans to convene a panel of recognized national experts to evaluate the needs of, and appropriate future investments in, the national infrastructure for nanotechnology.

National Solar Observatory

$9,790,000
+$690,000 / 7.6%

National Solar Observatory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Solar Observatory	$9.10	$9.10	$9.79	$0.69	7.6%

The National Solar Observatory (NSO) operates facilities in New Mexico and Arizona as well as a coordinated worldwide network of six telescopes specifically designed to study solar oscillations. NSO leads the community in design and development of the Advanced Technology Solar Telescope (ATST). (More information on this project may be found in the Major Research Equipment and Facilities Construction chapter). NSO makes available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona. NSO also provides routine and detailed, synoptic solar data used by many researchers and other agencies through its online archive and data delivery system.

NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. In 2010, 68 unique observing programs from 12 U.S. and 13 foreign institutions were carried out using NSO facilities. Thirty three per cent of these programs were carried out by students, and they included 11 Ph.D. thesis programs. Nearly six terabytes of NSO synoptic data were downloaded from the NSO digital archives.

Total Obligations for NSO
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
NSO-Operations	$7.25	$7.25	$7.81	$8.02	$8.26	$7.80	$5.74	$2.69
NSO-Development	1.50	1.50	1.61	1.67	1.72	1.75	1.80	0.84
NSO-Research & Education	0.35	0.35	0.37	0.40	0.41	0.45	0.46	0.47
Total, NSO	**$9.10**	**$9.10**	**$9.79**	**$10.09**	**$10.39**	**$10.00**	**$8.00**	**$4.00**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Partnerships and Other Funding Sources: Thirty-seven U.S. member institutions and seven international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NSO. Other partners include the U.S. Air Force Office of Scientific Research, U.S. Air Force Weather Agency, NASA, and industrial entities. Many universities and institutes collaborate with NSO on solar instrumentation development and on the design and development of ATST. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with industry through subawards to aerospace, optical fabrication, and information technology companies. Observing time on NSO telescopes is assigned on the basis of merit-based review. No financial support accompanies telescope time allocation.

Education and Public Outreach: NSO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. NSO introduces undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate students (REU) program. NSO has diverse education programs, including teacher training and curriculum development, visitor centers, and a web-based information portal at www.nso.edu.

NSO-Operations, $7.81 million: NSO Operations include facility operations at Sacramento Peak Observatory (SPO) in New Mexico, the world-wide Global Oscillations Network Group (GONG), and solar facilities based on Kitt Peak, Arizona. The ATST will replace several of the NSO telescopes at SPO and on Kitt Peak. These will be divested or removed as ATST approaches full operation. The reductions in operations costs in the 2015-2017 timeframe reflect the savings from the decommissioning of these redundant facilities. Increasing support through FY 2012 is intended to offset the impact of reduced FY 2009 funding, including deferred merit pay.

NSO-Development, $1.61 million: NSO reporting now includes only work apart from ATST, notably for the SOLIS telescope. Small increases in FY 2012 and beyond will help maintain the scientific productivity of existing facilities as ATST enters construction and moves toward operations.

NSO-Research & Education, $370,000: NSO supports public education in solar physics through its education and public outreach office at SPO. This office provides science community outreach, a visitors' center, news and public information, and the activities on Maui in collaboration with University of Hawaii Maui Campus.

ATST infrastructure, $0.00 million in this narrative ($2.0 million in the ATST narrative): In its Record of Decision authorizing ATST construction, NSF agreed to mitigation activities of $2.0 million per year for ten years expected to begin in FY 2011. This support is provided through the ATST budget in the Research and Related Activities account, not the MREFC construction project account. Please see the ATST narrative in the MREFC chapter for more information.

Facility Report

Management and Oversight

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program director makes use of detailed annual program plans, annual long-range plans, quarterly technical and financial reports, and annual reports submitted by NSO as well as attending AURA Solar Observatory Council meetings. The latter committee is formed from the national solar physics community and provides a window into community priorities and concerns. The AST program manager works closely with other offices at NSF, particularly the Division of Acquisition and Cooperative Support, the Office of General Counsel, and the Large Facilities Project Office in the Office of Budget, Finance, and Award Management.

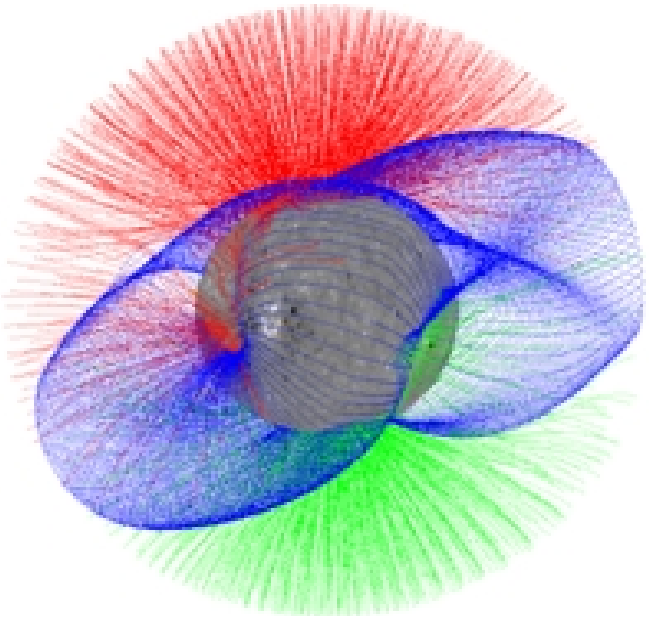
- External Structure: AURA is the managing organization for NSO. The NSO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from its Solar Observatory Council, composed of members of its scientific and management communities. NSO employs visiting and users' committees for the purposes of self-evaluation and prioritization. The visiting committee, composed of nationally

prominent individuals in science, management, and broadening participation, reviews for AURA all aspects of the management and operations of NSO. The users' committee, composed of scientists with considerable experience with the observatory, reviews for the Director all aspects of NSO that affect user experiences at the observatory.

- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc reviews of AURA management, as needed, by external committees. The last extensive review for NSO was in FY 2008 which led to the award of a new cooperative agreement at the beginning of FY 2010. The last review of major NSO activities was conducted during the final design review of the ATST project in May 2009. Annual reviews are anticipated for both NSO program plans and the ATST project, beginning in spring 2011.

Renewal/Recompetition/Termination

A management review of AURA's performance was carried out in August 2006. In response to the favorable review, the National Science Board extended the current cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized a new cooperative agreement with AURA for management and operation of NSO for the period October 1, 2009, through March 31, 2014. Since NSO is the home for the ATST project, which will begin operation in 2018, it is anticipated that the current cooperative agreement will be renewed without competition upon its expiration in 2014.



The magnetic field in the corona of the sun derived from GONG data. Magnetic field lines that are closed on the Sun are shown in blue, those that are open to interplanetary space are shown in red (negative inward pointing field polarity) and green (positive polarity). *Credit: NSO/AURA.*

National Superconducting Cyclotron Laboratory

$21,500,000
+$500,000 / 2.4%

National Superconducting Cyclotron Laboratory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Superconducting Cyclotron Laboratory	$21.00	$21.00	$21.50	$0.50	2.4%

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is a university-based national user facility. With two linked superconducting cyclotrons, K500 and K1200, it is the leading rare isotope research facility in the U.S. and is among the world leaders in heavy ion nuclear physics and nuclear physics with radioactive beams. Funding for NSCL also supports the MSU faculty and staff research program.

Total Obligations for NSCL
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$21.00	$21.00	$21.50	$21.50	$21.50	$21.50	$21.50	-

[1] Outyear funding estimates are for planning purposes only.

NSCL scientists employ a range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Applications of the research conducted at the NSCL benefit society in numerous areas, including new tools for radiation treatments of cancer patients and the assessment of health risks to astronauts. The K500 was the first cyclotron to use superconducting magnets, and the K1200 is the highest-energy continuous beam accelerator in the world. Through the Coupled Cyclotron Facility (CCF), heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities.

Scientists at NSCL work at the forefront of rare isotope research. They make and study atomic nuclei that cannot be found on Earth and perform experimental research using beams of unstable isotopes to extend our knowledge of new types of nuclei, many of which are important to an understanding of stellar processes. Research activities include a broad program in nuclear astrophysics studies, the studies of nuclei far from stability using radioactive ion beams, and studies of the nuclear equation of state. In addition, research is carried out in accelerator physics.

NSCL supports and enhances doctorate graduate education and post-doctoral research experiences. About 10 percent of all doctorates granted in nuclear physics in the U.S. are based on research at NSCL. The lab also provides research experiences for undergraduate students, K-12 students, and K-12 teachers.

NSCL occasionally enters into license agreements for cyclotron technology or nuclear electronics. An agreement with Accel Corporation exists for compact cyclotrons based on superconducting technology.
The coupled cyclotron facility supports a broad experimental program. The mix of experiments is

determined by beam use proposals. An external program advisory committee selects the best proposals at a typical success rate of about 50 percent. The science output of NSCL is driven by these experiments – many per year, with most running one to three days. The FY 2012 funding level is the first of an overall five-year plan developed in response to recommendations from an external operations review committee in 2011. The committee recommended providing support such that NSCL runs at close to optimal operation, which includes new capabilities that have been provided by MSU, with "optimal" defined as the maximum amount of added beam time per extra dollar spent.

Facility Report

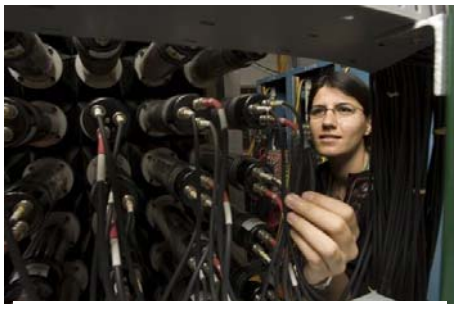
Management and Oversight

- NSF Structure: MSU operates NSCL under a cooperative agreement with NSF. The lab director is the key officer, who has the authority to appoint associate directors and designate responsibilities, notifying NSF of changes. NSF oversight is provided through annual site visits by the cognizant program officer of the Division of Physics and other staff, accompanied by external experts.

- External Structure: NSCL is managed by the laboratory director and four associate directors for research, education, operations, and new initiatives. NSCL's research program is guided by a program advisory committee of external experts as well as an in-house expert, and includes the chairperson of the full NSCL user group. The procedure for users includes writing and submitting proposals to the NSCL director and oral presentations. There are two proposal submission opportunities each year. About 5,000 beam hours are provided for experiments annually, with a backlog of at least a year.

- Reviews:
  - Latest Review: A 5-year review in FY 2011 covered results and achievements related to intellectual merit and broader impacts for the past five year period (FY 2007 – FY 2011), and future funding for the next five year period (FY 2012 – FY 2016)
  - Next Review: An annual review is planned for February 2012. Review topics include science, operations, and future funding.

Renewal/Recompetition/Termination



An NSCL research associate adjusts a cabling on a detector. *Credit: NSCL.*

In December 2008 the Department of Energy (DOE) announced that it had selected Michigan State University as the site for a new world-class rare isotope Facility for Rare Isotope Beams (FRIB). FRIB will be built on the site of the present NSCL and will make use of much of the NSCL beamlines and general infrastructure. Michigan State University will be the performing institution under a cooperative agreement with DOE for the future FRIB, which is now in the preliminary design stage. A recent National Science Board (NSB) resolution allows a new 5-year renewal of the present Cooperative Agreement, which expires at the close of FY 2011. New funding will permit NSCL to continue to operate as a user facility up to and through the initial phases of FRIB construction activities and will facilitate the transfer of operations to DOE when construction is complete. The FRIB cooperative agreement between DOE and MSU was signed in 2009 and start of FRIB operations is expected to occur in 2019. To facilitate NSCL termination and interagency planning, and to allow for a

smooth transition from NSF-funded NSCL user operations to DOE-funded FRIB user operations, a Joint Oversight Group (JOG) of DOE and NSF personnel has been formed and has begun to meet regularly.

Network for Earthquake Engineering Simulation

$20,500,000
-$1,500,000 / -6.8%

Network for Earthquake Engineering Simulation
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Network for Earthquake Engineering Simulation	$23.46	$22.00	$20.50	-$1.50	-6.8%

The Network for Earthquake Engineering Simulation (NEES) is a national, networked simulation resource of 14 advanced, geographically distributed, multi user earthquake engineering research experimental facilities with telepresence capabilities. NEES provides a national infrastructure to advance earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, databases, and model-based simulation to improve the seismic design and performance of U.S. civil infrastructure systems. Experimental facilities include shake tables, geotechnical centrifuges, a tsunami wave basin, large-scale laboratory experimentation systems, and mobile and permanently installed field equipment. NEES facilities are located at academic institutions (or at off-campus field sites) throughout the United States, networked together through a high performance Internet2 cyberinfrastructure system (NEEShub). NEES completed construction on September 30, 2004, and opened for user research and education projects on October 1, 2004. NEES was operated during FY 2005-FY 2009 by NEES Consortium, Inc., located in Davis, CA. During FY 2008 and FY 2009, NSF recompeted NEES operations using program solicitation NSF 08-574 George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. The outcome of that competition was an award to Purdue University to operate NEES from FY 2010-FY 2014. Through a five-year cooperative agreement with NSF (FY 2010-FY 2014), Purdue University operates the NEES experimental facilities and cyberinfrastructure; coordinates education, outreach, and training; and develops national and international partnerships.

Total Obligations for NEES
(Dollars in Millions)

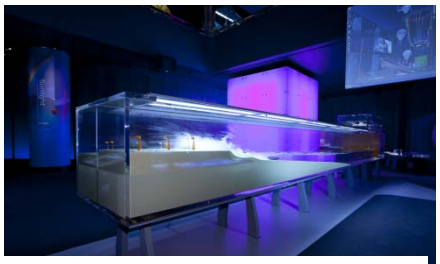
	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$23.46	$22.00	$20.50	$23.00	$23.00	$23.00	$23.00	$23.00

[1] Outyear funding estimates are for planning purposes only. The current award receives final funding in FY 2014.

NEES' broad-based national research facilities and cyberinfrastructure enables new discovery and knowledge through capabilities to test more comprehensive, complete, and accurate models of how civil infrastructure systems respond to earthquake loading and tsunamis. This enables the design of new methodologies, modeling techniques, and technologies for earthquake and tsunami hazard mitigation. NEES engages students in earthquake engineering discovery through on-site use of experimental facilities, telepresence technology, archival experimental and analytical data, and computational resources with the aim of integrating research and education. Purdue University operates NEES under a strategic plan and develops a broad spectrum of education and human resource development activities with special

emphasis on non-traditional users and underrepresented groups through its Research Experiences for Undergraduates (REU) program. Purdue also organizes an Annual Meeting for NEES users/researchers and facility operators.

Through the National Earthquake Hazards Reduction Program (NEHRP), the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), and NSF, NEES supports research and outreach related to earthquake hazard mitigation. Connections to industry include private engineering consultants and engineering firms engaging in NEES research or using data and models developed through NEES. NEES leverages and complements its capabilities through connections and collaborations with large testing facilities at foreign earthquake-related centers, laboratories, and institutions. NSF has developed a partnership to utilize the NEES infrastructure with the 3-D Full-Scale Earthquake Testing Shake Table Facility (E-Defense), located in Miki City, Japan, built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED), and operational in 2005. To facilitate NEES/E-Defense collaboration, in September 2005, NSF and the Japanese Ministry of Education, Culture, Sports, Science, and Technology signed a Memorandum Concerning Cooperation in the Area of Disaster Prevention Research. The annual planning meeting was held at the E-Defense facility in September 2010 to develop research topics and experiments for continuing NEES/E-Defense collaboration. Two NSF-supported research projects conducted tests at the E-Defense facility during FY 2009 to investigate new seismic design methodologies for mid-rise wood frame buildings and steel frame structures, and collaborative testing on reinforced concrete structures was conducted during December 2010.



As an outreach and education component of a NEES research (NEESR) project, Researcher and Project Investigator Dan Cox, Oregon State University, helped the Museum of Science and Industry, Chicago develop content for "Science Storms", which includes this 30-foot tsunami wave tank exhibit and a large-scale video presentation that relates the basic concepts demonstrated in the wave tank to the research that is being conducted to make coastlines safer. *Courtesy of J.B. Spector, Museum of Science and Industry, Chicago, IL*

As a part of the NEES education and outreach program, the NEES tsunami facility at Oregon State University developed the 30-Foot Science Storms Tsunami Wave Tank exhibit at the Museum of Science and Industry in Chicago, Illinois.

Along with direct operations and maintenance support for NEES, NSF separately provides support for research to be conducted at the NEES experimental facilities through ongoing research and education programs. The NEEShub also provides a platform for the earthquake engineering and tsunami communities, as well as other communities, to develop new tools for shared cyberinfrastructure. The annual support for such activities, funded through annual NEES research program solicitations, is estimated to be up to $12.0 million in FY 2012, a reduction of $500,000 from the FY 2010 Enacted level. These awards support basic research in multi-hazard engineering involving experimental and computational simulations at the NEES facilities, addressing important challenges in earthquake and tsunami engineering research. ENG support for NEES Operations in FY 2012 will be reduced by $1.50 million to a total of $20.50 million in line with an overall reduction in core research supported at the network sites.

Facility Report

Management and Oversight

- NSF structure: NSF provides oversight to NEES operations through a cooperative agreement with Purdue University during FY 2010-FY 2014. NEES operations are reviewed through annual site visits and through periodic site visits to the individual NEES facilities. The annual site reviews are held at either the headquarters or at one of the network facilities. All reviews involve an external team of experts selected by NSF staff. The NSF Program Manager for NEES is located in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) in the Directorate for Engineering (ENG). The Deputy Director for Large Facility Projects in the Office of Budget, Finance and Award Management (BFA) provides advice and assistance.

- External structure: Purdue University provides the headquarters and staffing to coordinate network-wide operation of the NEES experimental facilities, cyberinfrastructure, and education, outreach, and training activities, and to develop national and international partnerships. Day-to-day operations of the network are overseen by the headquarters staff led by a director. A governance board meets several times a year and provides independent advice and guidance to the director concerning the network's programs, activities, vision, funding allocations, and new directions. The governance board shares its major recommendations with the NSF. Each of the 14 experimental facilities has an on-site director responsible for local day-to-day equipment management, operations, and interface with Purdue, other NEES facilities, users, and the NEEShub for network coordination. The NEEShub provides telepresence, the NEES Project Warehouse data repository, and collaborative, simulation, and other related services for the entire NEES network.

- Reviews:
  - Management reviews: NSF BFA Business Systems Review: May 2006
  - Mid-award operations reviews: NSF Annual Merit Reviews: June 2005, April 2006, July 2007
  - Experimental facility reviews: NSF Periodic Merit Reviews: FY 2006-FY 2008
  - Transition review: April 2010
  - Management reviews: NSF BFA Business Systems Review: FY 2011
  - Mid-award operations reviews: NSF Annual Merit Reviews: FY 2010-FY 2013
  - Experimental facility reviews: Up to three annually: FY 2010-FY 2013

Renewal/Recompetition/Termination

In FY 2008, NSF recompeted NEES operations for a second five-year period from FY 2010-FY 2014. The competition was announced in program solicitation NSF 08-574, George E. Brown, Jr. Network for Earthquake Engineering Simulation Operations (NEES Ops) FY 2010-FY 2014. As an outcome of that competition, the National Science Board, at its August 5-6, 2009 meeting, approved NSF's recommendation for a five-year cooperative agreement (FY 2010-FY 2014) to Purdue University. Annual funding to Purdue University for NEES operations is based upon satisfactory progress and availability of funding. During FY 2010, the prior NEES operations awardee, NEES Consortium, Inc., was supported by NSF to provide continuity of operations and to help transition software, documents, and other inventory to Purdue University. During FY 2010, NEES Consortium, Inc., also closed out its support for NEES operations. In FY 2010, NSF supported two studies for the assessment of the need for earthquake engineering experimental and cyberinfrastructure facilities beyond 2014, as described in the Dear Colleague Letter NSF 10-071 (http://128.150.4.107/pubs/2010/nsf10071/nsf10071.jsp). These two

studies are to be completed in FY 2012 and will form the basis for determination by NSF for support for future earthquake engineering research infrastructure beyond 2014.

Polar Facilities And Logistics **$327,030,000**
and the South Pole Station Modernization Project **$15,030,000 / 4.8%**

Polar Facilities and Logistics
(Dollars in Millions)

	FY 2010 Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
Polar Facilities[1]	$195.16	-	$199.24	$213.03	$13.79	6.9%
Transfer to U.S. Coast Guard per P.L. 111-117	[54.00]	-	-	-	-	N/A
Polar Logistics	112.02	-	113.03	114.27	1.24	1.1%
Total, Polar Facilities and Logistics	**$307.18**	**-**	**$312.27**	**$327.30**	**$15.03**	**4.8%**

Totals may not add due to rounding.

[1]Funding for Polar Facilities for FY 2010 excludes a one-time appropriation transfer to U.S. Coast Guard per P.L.111-117.

Polar Facilities

The Office of Polar Programs (OPP) within NSF provides the infrastructure needed to support U.S. research conducted in Antarctica, including that funded by U.S. mission agencies, for year-round work at three U.S. stations, two research ships, and a variety of remote field camps. Examples of support to other agencies include mission essential satellite communications support at McMurdo Station for the National Polar-Orbiting Operational and Environmental Satellite System (NPOESS) and NASA's Ground Networks for the relay of data. In addition, OPP enables important climate monitoring activities for NOAA at the Clean Air Facility at South Pole Station, one of only five such sites around the globe, and OPP provides support for NASA's Long Duration Balloon program that enables research in fields ranging from astrophysics to cosmic radiation to solar astronomy.

All life support is provided by OPP, including transportation, facilities, communications, utilities (water and power), health and safety infrastructure, and environmental stewardship. The U.S. Antarctic Program (USAP) maintains the U.S. presence in Antarctica in accordance with U.S. policy, and supports Antarctic Treaty administration under State Department leadership.

Total Obligations for Polar Facilities

(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Antarctic Infrastructure & Logistics	$195.16	$199.24	$213.03	$213.03	$213.03	$213.03	$213.03	$213.03
South Pole Station Modernization Project	*15.93*	*16.15*	*16.33*	*16.33*	*16.33*	*16.33*	*16.33*	*16.33*
U.S. Coast Guard Icebreaker Support	-	54.00	-	-	-	-	-	-
Total, Polar Facilities	**$195.16**	**$199.24**	**$213.03**	**$213.03**	**$213.03**	**$213.03**	**$213.03**	**$213.03**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

NOTE: Funding for the South Pole Station Modernization (SPSM) Project in this table is for the operation of the South Pole Station and is included in the amounts shown for Antarctic Infrastructure and Logistics. FY 2010 funding for U.S. Coast Guard Icebreaker Support excludes a one-time appropriation transfer of $54.0 million to USCG per P.L. 111-117.

OPP contracts with a prime contractor for science support, operations, the leasing of research vessels, and the maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile. The contractor is selected through a competitive bidding process. Rotary- and fixed-wing aircraft used in support of research are also provided through competitively awarded contracts. Other agencies and contractors provide technical support in areas of expertise such as engineering, construction, and communications.

Facility Report

Management and Oversight

- NSF Structure: OPP has overall responsibility for funding and managing Polar Facilities. This includes planning all activities, and overseeing contractors.

- External Structure: The current Antarctic support contract was recompeted and awarded to Raytheon Polar Services Company (RPSC) in FY 2000. There are many separate subcontractors for supplies and technical services.

- Reviews: OPP evaluates the performance of RPSC every year via a Performance Evaluation Committee and an Award Fee Board that includes representatives from OPP and the Office of Budget, Finance, and Award Management (BFA). In addition, OPP's performance is reviewed externally by Committees of Visitors and the OPP Advisory Committee.

Helicopters provide support to field parties in the McMurdo Dry Valleys in southern Victoria Land and at remote field camps. *Credit: Kristan Hutchison, RPSC.*

Current Status

- All facilities (stations, research vessels, and field camps) are currently operating normally.

Evolution

- U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. The research emphases at the three stations change as the scientific forefronts addressed there evolve with time, as does the infrastructure needed to support it.

Recompetition

- NSF is currently engaged in an effort to recompete the Antarctic support contract. The most recent Antarctic support contract was recompeted and awarded to Raytheon Polar Services Company (RPSC) in FY 2000. After a five-month phase-in period, RPSC assumed responsibility for operations in March 2000. The contract's ten-year performance period is segregated into a five-year initial period and a five-year option period. NSF exercised its option to extend the performance period through March 31, 2010, and extended the contract through March 2011. NSF is in the process of extending the contract for a second year, through March 2012. An award for the new support contract is expected to be made in Fall 2011.

Polar Logistics

Polar Logistics consists of two activities: the U.S. Antarctic Logistical Support program within the Division of Antarctic Infrastructure and Logistics, and the Research Support and Logistics program within the Arctic Sciences Division.

Total Obligations for Polar Logistics
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
U.S. Antarctic Logistical Support	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52	$67.52
Research Support and Logistics	44.50	45.51	46.75	46.75	46.75	46.75	46.75	46.75
Total, Polar Logistics	**$112.02**	**$113.03**	**$114.27**	**$114.27**	**$114.27**	**$114.27**	**$114.27**	**$114.27**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

The U.S. Antarctic Logistical Support program funds support provided by the U.S. Department of Defense (DoD). The DoD operates as a logistical support provider on a cost-reimbursable basis. Major funding elements of DoD support include: military personnel, LC-130 flight operations and maintenance support through the 109th Airlift Wing (AW) of the New York Air National Guard in Scotia, New York, and Antarctica; transportation and training of military personnel supporting the U.S. Antarctic Program; support for air traffic control, weather forecasting, and ground electronic equipment maintenance; the charter of Air Mobility Command airlift and Military Sealift Command ships for the re-

supply of McMurdo Station; bulk fuel purchased from the Defense Logistics Agency; and reimbursement for use of DoD satellites for communications.

The Research Support and Logistics program in the Arctic Sciences Division is driven by and responds to science supported by the division. Funding is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. A contractor provides research support and logistics services for NSF-sponsored activities in the Arctic. Additional major support components include: access to U.S. Coast Guard and other icebreakers, University-National Oceanographic Laboratory (UNOLS) vessels and coastal boats; access to fixed- and rotary-wing airlift support; upgrades at Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; safety training for field researchers and funding for field safety experts; global satellite telephones for emergency response and improved logistics coordination; and development of a network of strategically placed U.S. Long-Term Ecological Research observatories linked to similar efforts in Europe and Canada.

Facility Report

Management and Oversight

- NSF Structure: OPP has overall responsibility for U.S. Antarctic Logistical Support and Arctic Research Support & Logistics. DoD operates as a logistical support provider on a cost-reimbursable basis. The agencies cooperate under a Memorandum of Agreement that includes guidance for planning and scheduling and sets forth the terms and conditions for reimbursement to DoD by NSF.

- External Structure: The current Arctic support contract was recompeted and awarded to CH2M Hill (previously, VECO USA) in January 2005. There are many separate subcontractors for supplies and technical services.

- Reviews: OPP's performance is externally reviewed by Committees of Visitors and the OPP Advisory Committee.

Current Status

- All facilities (stations, research vessels, and field camps) are currently operating as normal.

Renewal/Recompetition/Termination

- U.S. policy directs NSF to maintain an active and influential presence in Antarctica, including year-round occupation of South Pole Station and two coastal stations. As discussed above, the research emphases at the three stations and at Arctic research sites change as the scientific forefronts addressed there evolve with time, as does the logistics support for these activities. NSF is currently engaged in an effort to recompete the Arctic support contract. The most recent Arctic support contract was recompeted and awarded to CH2M Hill in January 2005. The contract has an initial term of four years and the possibility of three one-year extensions exercised on the basis of performance. All options have been exercised for this contract. An award for the new support contract is expected to be made in October 2011, with the phase-out completed in May 2012.

South Pole Station Modernization (SPSM)

The SPSM project was funded through NSF's Major Research Equipment and Facilities Construction (MREFC) account, and supported procurement, construction, and commissioning. SPSM provides a new station to replace the previous U.S. station at the South Pole, built 30 years ago and inadequate in terms of capacity, efficiency, and safety. The new station is an elevated complex with two connected buildings, supporting 150 people in the summer and 50 people in the winter. The completed South Pole Station will provide a platform for the conduct of science at the South Pole and fulfills NSF's mandate to maintain a continuous U.S. presence at the South Pole in accordance with U.S. policy. FY 2008 represented the final year of MREFC appropriations for SPSM. Construction continues through the 2010/2011 operating season.

The prime contractor for the U.S. Antarctic Program is responsible for constructing the South Pole Station. In addition, there are many separate subcontractors for supplies and technical services.

NSF also supports education associated with the research projects at the South Pole. Along with direct operations and maintenance support for South Pole Station, NSF supports science and engineering research through ongoing programs. The annual support for such activities is currently estimated to be approximately $9.50 million.

Total Obligations for SPSM
(Dollars in Millions)

	Prior Years	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
R&RA Obligations									
Concept & Development	$16.40								
Management & Operations		15.93	16.15	16.33	16.33	16.33	16.33	16.33	16.33
Subtotal, R&RA Obligations	16.40	15.93	16.15	16.33	16.33	16.33	16.33	16.33	16.33
MREFC Obligations									
Implementation	148.09	1.03	0.17	-					
Subtotal, MREFC Obligations	148.09	1.03	0.17	-	-	-	-	-	-
Total, SPSM Obligations	**$164.49**	**$16.96**	**$16.32**	**$16.33**	**$16.33**	**$16.33**	**$16.33**	**$16.33**	**$16.33**

Totals may not add due to rounding.

[1] A full-year 2011 appropriation was not enacted at the time the budget was prepared; therefore, this project is operating under a continuing resolution (P.L. 111-242, as amended). The amounts shown above for 2011 reflect the annualized levels provided by the continuing resolution. The FY 2011 Request based on the project's planned funding is $16.15 million; $0.0 million for MREFC, and $16.15 million for R&RA. Any FY 2011 funding shortfal might need to be addressed in future budgets and could impact the total project cost and schedule baseline.

[2] Outyear funding estimates are for planning purposes only.

NOTE: Funding for the operation of South Pole Station is provided through Antarctic Infrastructure and Logistics.

Project Report

Management and Oversight

- NSF Structure: OPP has overall responsibility for SPSM, including development of the basic requirements, design, procurement, and construction. The project status, including cost expenditures and cost projections, is monitored closely by the OPP Facilities Engineer and other OPP staff, and on a periodic basis by the project's Project Advisory Team, a group of experts drawn from all relevant NSF directorates and offices.

- External Structure: NSF contracted for procurement and construction management for all phases of the project, including design reviews of all drawings and specifications; conformance of the designs and procurements with established standardization criteria; assistance in establishing functional interfaces; transition from the existing to the new facilities; and systems integration. Naval Facilities Engineering Command, Pacific Division (PACDIV) selects, monitors, and manages architectural and engineering firms for design, construction inspection for the project, and post-construction services.

The newly completed South Pole Station, January 2010. *Credit: Vladimir Papitashvili, NSF*

- Reviews: Design, development, planning, and closely related activities in support of this project included preparation of more than 40 engineering studies and reports. The documents ranged widely in subject matter including subjects such as snowdrift minimization modeling, detailed analysis of power and heating requirements, preparation of a draft Environmental Impact Statement, energy conservation measures, efficiency and maintainability of diesel generators, fuel storage support system evaluation, design code criteria matrix, concept for signal/communication systems, gray-water system evaluation, minimization of ventilation requirements, control of diesel engine exhaust emissions, and jacking plan and concept.

  The OPP Facilities Engineer, other OPP and NSF staff, and subject matter experts attend quarterly reviews at the contractor's facility for the purpose of reviewing all aspects of the project including cost, schedule, and plans. In September 2006, an external panel of experts reviewed the scope, cost, schedule, and effectiveness of management processes to complete the final 10 percent of the project. As a result, the project's baseline was increased to $149.29 million. A subsequent review of the cost and schedule for the final year of the project was completed early in FY 2010; this review confirmed the project would complete on schedule and on budget.

Current Project Status

- The project is on schedule to complete all tasking by the end of the 2010/2011 operating season.

Cost and Schedule

- SPSM scope is approximately 99.9 percent complete and within budget. All science facilities are in full use.

Risks

Project performance could be affected by equipment failure, damaged materials, unforeseen downtime from power failures, inclement weather, and widespread illness – all of which have occurred to varying degrees. Risk management is ongoing and has produced multiple sets of back-up strategies to employ in the face of identified concerns.

Future Operations Costs

Operational costs of the modernized station are expected to be higher than those of the previous station due to increased station size and increases in science support and information systems. The FY 2012 level ($16.0 million) for operational costs of the modernized station is anticipated to represent the steady state for future years (before inflation). The expected lifetime of the modernized station is 25 years, through FY 2031.

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

National Center For Atmospheric Research

$100,000,000
$3,000,000 / 3.1%

National Center for Atmospheric Research
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Center for Atmospheric Research	$96.29	$97.00	$100.00	$3.00	3.1%

The National Center for Atmospheric Research (NCAR) is a Federally Funded Research and Development Center (FFRDC) serving a broad research community, including atmospheric scientists and researchers in complementary areas of the environmental and geosciences. NCAR is managed under a cooperative agreement with NSF by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprising 75 Ph.D. granting academic institutions.

As of November 2010, NCAR employed a total of 833 FTEs, of which 392 are funded under the NSF primary award to UCAR.

The Mesa Laboratory, designed by architect I.M. Pei, in Boulder, CO. *Credit: NCAR.*

Number of FTEs Supported at NCAR

FTEs	Primary Award[1]	All Funding
Career Scientists	98	134
Scientific Support[2]	249	572
Other Staff[3]	15	127
Total	**362**	**833**

[1]The primary award supports substantial facility infrastructure that does not include staff costs.

[2]Scientific Support includes Associate Scientists, Project Scientists, Post Docs, Software Engineers, Engineers, System Support and Technicians.

[3]Other Staff includes Administrative positions, Managers, Paid Visitors, Pilots and Mechanics.

NCAR provides facilities, including world-class supercomputing services, research aircraft, airborne and portable ground-based radar systems, atmospheric sounding, and other surface sensing systems for atmospheric research, to university, NCAR, and other atmospheric researchers. In addition, NCAR operates several facilities dedicated to the study of the Sun, solar phenomena, space weather, and the responses of the upper atmosphere to the sun's output. As an NSF sponsored facility, NCAR is committed to the dissemination of newly discovered knowledge in all the above areas.

Total Obligations for NCAR
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Aircraft Support	$9.93	$9.93	$9.93	$10.43	$10.95	$11.50	$12.07	$12.67
Computational Infrastructure	22.00	22.00	26.00	$27.30	$28.67	$30.10	$31.60	$33.18
Other Facility Support	23.42	23.42	23.42	$24.59	$25.82	$27.11	$28.47	$29.89
Research & Education Support	41.65	41.65	40.65	$43.21	$45.37	$47.64	$50.02	$52.52
Total, NCAR	**$97.00**	**$97.00**	**$100.00**	**$105.53**	**$110.80**	**$116.34**	**$122.16**	**$128.27**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

Partnerships and Other Funding Sources: NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In FY 2010, NCAR received approximately $48.0 million in support from other federal agencies such as the National Oceanographic and Atmospheric Administration (NOAA) and the Federal Aviation Administration, and $28.0 million from non-federal sources.

Major Investments in FY 2012: In FY 2012, investments at NCAR will focus on issues of societal importance in the areas of atmospheric chemistry, climate, including climate models, cloud physics, severe storms weather models, weather hazards to aviation, and interactions between the Sun and Earth. In all of these areas, NCAR scientists will work with their university colleagues to look closely at the role of humans in both creating climate change, responding to severe weather occurrences and to better understand the characteristics of the Sun and Sun-Earth connections. Example investments are an increased emphasis on preparing input for the next Intergovernmental Panel on Climate Change (IPCC) assessment and research into significantly enhancing our ability to understand and predict changes in hurricane intensity.

Aircraft Support: NCAR operates a C-130 and a Gulfstream-V (G-V, also known as the High Altitude Instrumented Airborne Platform for Experimental Research, or HIAPER), both of which are highly modified to enable the support of research activities designed to understand complex environmental processes. The two aircraft will support several community-originated projects deemed by peer review to be of exceptional scientific merit.

Computational Infrastructure: NCAR's computational facility supports high end modeling and simulation of climate, weather and other Earth Systems processes. Additionally, this facility supports the development and application Interagency USGCRP Community Climate System Model (CCSM) which uses mathematical formulas to simulate and better understand the chemical and physical processes that drive Earth's climate system. The CCSM results are to be used as a major US contribution to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report scheduled for release in 2013.

In FY 2012, NCAR will oversee the completion of construction and transition to operations of a new computational facility near Cheyenne, Wyoming. This new facility is a joint effort between NCAR and the University of Wyoming and other Wyoming partners. The NCAR/ Wyoming Supercomputing Center will provide physical infrastructure needed to expand NCAR's computational capability to better meet the high end computational needs of the atmospheric and related sciences and to allow the development of

supercomputing research and educational activities of specific interest to the University of Wyoming and the state.

Other Facility Support: In addition to the C-130 and G-V, NCAR also provides support for a number of other atmospheric observing platforms through its Earth Observing Laboratory (EOL), including transportable Doppler radars, upper atmosphere observing capabilities, and other experimental systems. As well as the operation of a coronagraph as a community resource, NCAR also supports community models and other infrastructure facilities. These facilities are used by both NCAR and community researchers to undertake cutting edge research projects.

Research and Education Support: Funding for research and education support at NCAR totals $40.65 million in FY 2012. NCAR operates scientific research programs that include the following areas:

- studies of large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change;
- global and regional atmospheric chemistry, including atmospheric connections to geochemical and biogeochemical cycles;
- the variable nature of the sun and the physics of the corona and their interaction with the Earth's magnetic field;
- the physics of clouds, thunderstorms, precipitation formation, and their interactions and effects on local and regional weather; and
- the examination of human society's impact on and response to global environmental change.

Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and serve as a focus and meeting point for the broader atmospheric and related sciences community. Further, NCAR works to develop new collaborations and partnerships with the private sector through directed research and technology transfer. These activities span improved capabilities for detecting, warning, and forecasting mesoscale weather phenomena of economic and social importance to the private and public sectors to longer term economic consideration of climate change issues.

Educational activities at NCAR are noteworthy, in particular the SOARS (Significant Opportunities in Atmospheric Research and Science) program is an undergraduate-to-graduate bridge program designed to broaden participation in the atmospheric and related sciences, which integrates research, education, and mentoring into an effective program.

In addition, NCAR further supports the scientific community by providing fellowships, internships, workshops, and colloquia for students and visiting scientists, and disseminates knowledge of the geosciences to the general public, K-12 schools, teachers and students, undergraduate and graduate institutions, postdoctoral and career scientists and researchers, as well as to policy and decision makers. Professional training courses, innovative and award-winning science education websites, as well as the directed activities of NCAR's Office of Education and Outreach are further examples of how NSF's goal of integrating research and education is attained through NCAR activities. Total support for education and outreach is $3.34 million.

Management and Oversight

- NSF Structure: NSF's Division of Atmospheric and Geospace Sciences (AGS), along with the Division of Acquisitions and Cooperative Support (DACS), provide oversight of NCAR and the cooperative agreement with the University Corporation for Atmospheric Research (UCAR) for

NCAR's management. The cooperative agreement between UCAR and NSF encourages interactions between NCAR scientists and AGS staff and ensures close coordination between AGS and NCAR management. The agreement contains requirements necessary for AGS's oversight of the NCAR program and UCAR management activities that affect NCAR. These include a provision that UCAR submit an annual program plan for AGS approval that provides details on how resources will be used in that fiscal year. In addition, NCAR summarizes its past year's accomplishments in an annual scientific report. Annual strategic planning sessions between AGS, UCAR, and NCAR are held to ensure that scientific and facility priorities remain consistent with those of NSF. Previous Committee of Visitors (COV) reports offered positive and constructive comments on NSF's oversight of UCAR/NCAR. The most recent COV found that AGS's management of the NCAR program was "good to excellent."[1]

- External Structure: UCAR works in partnership with NSF and the university community to ensure the effective implementation of the strategic mission of NCAR to the benefit of the research community. In addition, other research sponsors such as the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Department of Energy (DOE), the Department of Defense (DOD), the Environmental Protection Agency (EPA), and the Federal Aviation Administration (FAA) support research collaboration wherever it enhances NCAR's basic NSF-supported research goals or facilities missions.

- Reviews:
  - Approximately mid-way through the current award (in FY 2012), AGS will conduct comprehensive reviews of science, facilities, and management. The results of these reviews will inform future decisions regarding recompetition of the facility.

Renewal/Recompetition/Termination:

In May 2008, UCAR competed successfully for the management and operation of NCAR. The term of the award is for a period of 60 months, extensible for an additional 60 months subject to appropriate and successful review.

[1] www.nsf.gov/geo/adgeo/advcomm/fy2009_cov/atm_ulafos_cov_report_2009.pdf

National Optical Astronomy Observatory

$29,170,000
-$2,330,000 / -7.4%

National Optical Astronomy Observatory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Optical Astronomy Observatory	$35.40	$31.50	$29.17	-$2.33	-7.4%

Totals may not add due to rounding.

The National Optical Astronomy Observatory (NOAO) was established in 1982 by uniting operations of the Kitt Peak National Observatory (KPNO) in Arizona and the Cerro Tololo Inter-American Observatory (CTIO) in Chile. NOAO is a Federally Funded Research and Development Center (FFRDC) for research in ground-based, nighttime, optical, and infrared (OIR) astronomy. NOAO also is the gateway for the U.S. astronomical community to the International Gemini Observatory and to the "System" of federally-funded and non-federally-funded OIR telescopes through the Telescope System Instrumentation Program (TSIP) and the Renewing Small Telescopes for Astronomical Research (ReSTAR) program. For all NOAO and "System" telescopes, peer-review telescope allocation committees provide merit-based telescope time but no financial support. NOAO manages national community involvement in the development of potential future infrastructure projects such as the Giant Segmented Mirror Telescope (GSMT) and is closely involved in the design, development, and potential construction of the Large Synoptic Survey Telescope (LSST). Both of these projects are high ranking recommendations of the 2010 Decadal Survey (*Astro2010*) conducted by the National Research Council's Astronomy and Astrophysics Survey Committee.

NOAO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals. They serve nearly 1,000 scientists annually. In FY 2010, 95 thesis students and an additional 81 non-thesis graduate students from U.S. institutions used NOAO telescopes for their research. In FY 2010 NOAO employed nearly 360 personnel in Arizona and Chile, including 46 support scientists and 11 postdoctoral fellows.

Partnerships and Other Funding Sources: Thirty-seven U.S. member institutions and seven international affiliate members comprise the Association of Universities for Research in Astronomy, Inc. (AURA), the management organization for NOAO. Other partners include NASA and industrial entities. A large number of U.S. universities support their own astronomical facilities at KPNO and CTIO with reimbursed services provided by NOAO. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with universities and with industry through subawards to aerospace, optical fabrication, and information technology companies. NOAO leverages NSF support with funding from other federal agencies and non-federal sources. In FY 2010, NOAO received $12.49 million for reimbursed services from partnerships and tenant observatory support, and from the Kitt Peak Visitors' Center, grants from other federal agencies, and NSF supplemental funding for the Research Experiences for Undergraduates (REU) program, GSMT, and LSST.

Education and Public Outreach: NOAO supports U.S. education goals by promoting public understanding and support of science and by providing education and training at all levels. Typically, a quarter of all doctorates awarded annually in astronomy in the U.S. involve use of NOAO facilities. The

observatories introduce undergraduate students to scientific research by providing stimulating environments for basic astronomical research and related technologies through NSF's Research Experiences for Undergraduate Students (REU) program. NOAO has a diverse education program, visitor centers, and a web-based information portal at www.noao.edu.

Total Obligations for NOAO

(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
NOAO-Operations	$20.00	$20.00	$20.84	$21.36	$21.89	$21.89	$21.89	$21.89
NOAO-Development	10.90	7.00	7.78	8.12	8.47	8.47	8.47	8.47
NOAO-Research & Education	0.50	0.50	0.55	0.57	0.59	0.59	0.59	0.59
TSIP[2]	4.00	4.00	-	-	-	-	-	-
Total, NOAO	**$35.40**	**$31.50**	**$29.17**	**$30.05**	**$30.95**	**$30.95**	**$30.95**	**$30.95**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

[2] TSIP is the Telescope System Instrumentation Program.

NOAO-Operations: $20.84 million: NOAO-Operations cover the operation of facilities at KPNO, CTIO, and the headquarters, offices, laboratories, and workshops in Tucson, Arizona and La Serena, Chile. The majority of these funds will be used for the retention of key personnel.

NOAO-Development: $7.78 million: Development support includes $1.50 million for the share of LSST design and development funded from NOAO's base budget, as well as the development of new instrumentation for telescopes at KPNO and CTIO. The Senior Review recommended that the instrumentation at KPNO and CTIO urgently be modernized. In FY 2010 NOAO began a multi-year effort to introduce new capabilities to the U.S. community. This investment in new instrumentation at KPNO, CTIO, and, possibly Gemini will continue with modest increases in this component. In FY 2010, $3.90 million in supplemental funding was awarded to NOAO as the second award in response to an unsolicited 3-yr proposal for "Renewing Small Telescopes for Astronomical Research (ReSTAR)"; this supplemental funding is included in the NOAO Development line. The goal of ReSTAR awards is to improve the instrument capabilities and increase the availability to the community of telescope time on "small" NOAO and non-federally-funded telescopes. In this context, "small" telescopes are from two to five meters in aperture. There are no current commitments to ReSTAR awards in FY 2011 and beyond.

NOAO-Research and Education: $550,000: NOAO links the research conducted at its facilities to education of the public through its education and public outreach office in Tucson. Although this has historically been supported at a higher level, some programs are ending as planned, and other priorities currently preclude full exploitation of NOAO's many opportunities in education and public outreach.

Telescope System Instrumentation Program (TSIP): $0.0 million: The TSIP program has been used to enhance instrumentation at non-federal observatories in exchange for open-access time for the U.S. community at those observatories; the TSIP competition and this open-access time has been administered by NOAO and has resulted in U.S. community access to unique assets such as the Keck and Magellan telescopes. While TSIP has been somewhat successful in achieving its original goals, the budget request proposes to eliminate it as a standalone program and reallocate funding to a broader, more competitive activity outside the NOAO budget: the Mid-Scale Innovations Program, which was a top recommendation of the *Astro2010* decadal survey in astronomy. Proposals for TSIP-like activities will

still be entertained within the Disciplinary and Interdisciplinary Research portfolio of the Division of Astronomical Sciences.

Facility Report

Management and Oversight

- NSF Structure: An NSF program director in the Division of Astronomical Sciences (AST) provides continuing oversight, including consultation with an annual NSF program review panel. The program director reviews detailed annual program plans, annual long range plans, quarterly technical and financial reports, and annual reports submitted by NOAO, and attends AURA governance committee meetings. Governance committees are formed from the national astronomical community and provide additional windows into community priorities and concerns. The AST program manager works closely with other offices at NSF, particularly the Office of General Counsel and the Division of Acquisition and Cooperative Support and the Large Facilities Project Office in the Office of Budget, Finance, and Award Management.

- External Structure: AURA is the managing organization for NOAO. The NOAO director reports to the president of AURA, who is the principal investigator on the FY 2010 NSF cooperative agreement. AURA receives management advice from an observatory council composed of members of its scientific and management communities. NOAO employs separate visiting and users committees for the purposes of self-evaluation and prioritization. The visiting committees, composed of nationally prominent individuals in science, management, and broadening participation, review for AURA all aspects of the management and operations of the observatories. The user committees, composed of scientists with considerable experience with the observatories, review for the NOAO Director all aspects of user experiences at the observatory.

- Reviews: In addition to reviews held mid-way through all cooperative agreements, NSF conducts both periodic and ad hoc external reviews of AURA management. A Business Systems Review is scheduled for FY 2012.

Renewal/Recompetition/Termination

A management review of AURA's performance was carried out in August 2006. In response to the review, the National Science Board extended the previous cooperative agreement with AURA for eighteen months, through September 30, 2009. A proposal for renewal of the cooperative agreement was received from AURA in December 2007 and underwent review in 2008. The National Science Board authorized a new cooperative agreement with AURA for the management and operation of NOAO for the period October 1, 2009, through March 31, 2014. When this current cooperative agreement nears expiration, a solicitation will be promulgated for the management of NOAO under a new cooperative agreement to begin April 1, 2014. As recommended by the *Astro2010* decadal survey, consolidation of the management of NOAO and Gemini as part of this solicitation is under consideration.

The Cerro Tololo Inter-American Observatory 4-meter telescope dome. *Credit: M. Urzua Zuniga/Gemini Observatory.*

National Radio Astronomy Observatory

$73,540,000
+$6,450,000 / 9.6%

National Radio Astronomy Observatory
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted Amount	Percent
National Radio Astronomy Observatory	$67.72	$67.09	$73.54	$6.45	9.6%

Totals may not add due to rounding.

The National Radio Astronomy Observatory (NRAO) provides state-of-the-art radio telescope facilities for scientific users. NRAO conceives, designs, builds, operates, and maintains radio telescopes used by scientists from around the world to study virtually all types of astronomical objects known, from planets and comets in our own Solar System to quasars and galaxies billions of light-years away.

As a Federally Funded Research and Development Center (FFRDC), NRAO operates major radio telescopes in Green Bank, West Virginia, near Socorro, New Mexico, and at ten telescope array sites spanning the U.S. from the Virgin Islands to Hawaii. Headquartered in Charlottesville, Virginia, NRAO is the North American implementing organization for the international Atacama Large Millimeter Array (ALMA) project. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation or nationality, on the basis of scientific peer-reviewed proposals, and annually serve over 1,500 users worldwide. The Observatory allocates telescope time on the basis of merit but provides no financial support. NSF does not provide individual investigator awards targeted specifically for use of NRAO facilities. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of the facilities.

In 2010 the Very Large Array (VLA) telescope, located about 80 km west of Socorro, NM, transformed into the Expanded Very Large Array (EVLA). Like the VLA the EVLA is composed of 27 individual antennas arranged in a "Y" pattern. In their closest configuration (about 1 km wide), the EVLA is able to image large portions of the sky. In its largest configuration (about 36 km wide) the EVLA is able to home in on the fine details of astronomical objects. *Credit: Andrew Clegg, National Science Foundation.*

NRAO staff includes 432 FTEs in the operations and maintenance component of the Observatory: 35 in Observatory Management, 344 in Observatory Operations, 33 in Science & Academic Affairs and Education and Public Outreach (EPO), and 20 in the Central Development Laboratory.

Total Obligations for NRAO

(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	ESTIMATES[1] FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Operations and Maintenance	$43.14	$43.14	$42.89	$44.33	$46.95	$49.25	$49.25	$49.25
Observatory Management	*6.03*	*6.03*	*7.10*	*7.25*	*7.30*	*7.40*	*7.40*	*7.40*
Observatory Operations	*31.77*	*31.77*	*30.64*	*31.33*	*33.15*	*35.00*	*35.00*	*35.00*
Science, Academic Affairs, EPO	*3.62*	*3.62*	*3.65*	*4.00*	*4.50*	*4.60*	*4.60*	*4.60*
Central Development Lab	*1.72*	*1.72*	*1.50*	*1.75*	*2.00*	*2.25*	*2.25*	*2.25*
Implementation of EVLA	6.38	1.13	-	-	-	-	-	-
ALMA Operations	18.20	22.82	30.65	33.92	36.41	39.17	39.17	39.17
Total, NRAO	**$67.72**	**$67.09**	**$73.54**	**$78.25**	**$83.36**	**$88.42**	**$88.42**	**$88.42**

Totals may not add due to rounding.

[1] Outyear funding estimates are for planning purposes only.

The major area of increased funding in FY 2012 is in ALMA operations. Base funding for NRAO operations decreases in FY 2012 as part of the budget realignment plan to support increases in ALMA operations. Funding for the implementation of the Expanded Very Large Array (EVLA) is scheduled to conclude in FY 2011.

Partnerships and Other Funding Sources: NRAO supplements Division of Astronomical Sciences (AST) support with funding provided by other NSF sources, other federal agencies, and non-federal sources. In FY 2010, NRAO received approximately $300,000 from non-AST sources at NSF, $400,000 from other federal agencies, and about $500,000 from U.S. universities, foreign scientific and technical institutes, and other non-federal and industrial sources. The development of new telescopes, instrumentation, and sensor techniques is completed in partnership with relevant industries through competitive subawards to various large and small aerospace companies, radio antenna manufacturing firms, and specialized electronics and computer hardware and software companies.

Education and Public Outreach: NRAO supports a comprehensive outreach program that makes information about radio astronomy available to the public (see www.nrao.edu/index.php/learn). NRAO facilities are also used by graduate students carrying out dissertation research and work experience programs and by undergraduate students participating in the Research Experiences for Undergraduates (REU) program, with over 150 students involved per year. NRAO sites also support visitor and education centers and conduct active educational and public outreach programs. The Green Bank Science Center and the visitor center at the Very Large Array (VLA) together attract about 68,000 public visitors each year.

Observatory Management, $7.10 million: Observatory Management includes the director's office, administrative services, the end-to-end data management initiative, and the New Initiatives Office.

Observatory Operations, $30.64 million: The Observatory Operations programmatic area includes support for operating facilities at Green Bank, West Virginia and in New Mexico, and the computer and information services that support the facilities.

Science & Academic Affairs and EPO, $3.65 million: This area includes staff research, science training and education, science centers, the library, science community outreach, and news and public information.

Central Development Laboratory (CDL), $1.50 million: The CDL is developing next generation electronics and detectors for radio astronomy, making fundamental contributions to materials science, the physics of quantum detectors, electromagnetics, photonics, and radio propagation.

Implementation of EVLA, $0.00: FY 2011 is scheduled to be the last year of support for the construction phase of EVLA, so there is no funding in FY 2012.

ALMA Operations, $30.65 million: NRAO is engaged in construction of the international ALMA, which in FY 2012 will be entering the eleventh year of its eleven year construction phase, funded through the Major Research Equipment and Facilities Construction (MREFC) account. Early operations funding for ALMA began in FY 2005 and ramps up sharply from FY 2008 to FY 2015. A funding profile through FY 2011 was authorized by the National Science Board in December 2007. The operations funding plan for FY 2012 through FY 2015 is the subject of National Science Board action in 2011. Please see the MREFC chapter for additional information on the ALMA project.

In 2006 NRAO created the North American ALMA Science Center (NAASC) to support the broad user community in fully realizing the scientific capabilities of ALMA. The NAASC is increasing its activity in conjunction with the ramp up in ALMA operations. The NAASC serves two key functions: (1) supporting basic ALMA operations as an ALMA Regional Center (ARC), providing day-to-day support for ALMA operations carried out in Chile, and (2) providing easy access and strong support to the broad astronomical community that will be using ALMA. The NAASC organizes summer schools, workshops, and courses in the techniques of millimeter and submillimeter astronomy.

Facility Report

Management and Oversight

- NSF Structure: Continuing oversight and assessment is carried out in AST and in consultation with community representatives making use of detailed annual program plans, long-range plans, quarterly technical and financial reports, and annual reports submitted to NSF by NRAO, as well as by attendance at governance committee meetings of the managing organization, Associated Universities, Inc., (AUI). AST works closely with other NSF offices, such as the Office of General Counsel and the Division of Acquisition and Cooperative Support and the Large Facilities Office in the Office of Budget, Finance, and Award Management, to address issues as they arise.
- External Structure: Management is through a cooperative agreement with AUI. AUI manages the observatory through its own community-based oversight and users' committees. The NRAO director reports to the president of AUI.
- Reviews: NSF conducts annual reviews of the NRAO Program Operating Plan, the Long Range Plan, and the AUI Management Report.

Renewal/Recompetition/Termination

The current cooperative agreement is in place for the years FY 2010 through FY 2015. When this current cooperative agreement nears expiration, a solicitation will be promulgated for the management of NRAO under a new cooperative agreement to begin September 30, 2015.

OTHER FACILITIES FUNDING

Major Research Equipment and Facilities Construction Account Projects

The MREFC account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) accounts.

For information on projects funded through this account, refer to the MREFC chapter of this Budget Request.

Preconstruction Planning

Within the R&RA account, funds are provided for preconstruction planning activities for prospective large facility projects. This funding generally supports such activities as design, cost estimations, and other activities that prepare potential projects for oversight review, agency decision milestones, and potential implementation.

NSF-WIDE INVESTMENTS

NSTC Activities

National Nanotechnology Initiative……..... NSF-Wide Investments – 3

Networking and Information Technology R&D……..... NSF-Wide Investments – 9

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Science and Engineering Beyond Moore's Law……..... NSF-Wide Investments – 35

Science, Engineering, and Education for Sustainability…..... NSF-Wide Investments – 37

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NATIONAL NANOTECHNOLOGY INITIATIVE (NNI)

NSF's contribution to the multiagency National Nanotechnology Initiative (NNI) encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. Novel materials, devices, and systems – with their building blocks designed on the scale of nanometers – open up new directions in science, engineering, and technology with potentially profound implications for society. With the capacity to control and manipulate matter at this scale, science, engineering, and technology are realizing revolutionary advances in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry, order-of-magnitude faster computer chips, and sustainable development for water and energy resources utilization.

NNI by Program Component Area

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
1. Fundamental Nanoscale Phenomena & Processes	$168.10	-	$152.57	$151.63
2. Nanomaterials	74.87	-	78.67	76.30
3. Nanoscale Devices & Systems	55.55	-	43.74	59.17
4. Instr. Research, Metrology, & Standards for Nanotech	17.88	-	18.34	16.58
5. Nanomanufacturing	21.41	-	22.43	57.20
6. Major Research Facilities & Instrumentation Acquisition	29.32	17.72	37.83	31.53
7. Environmental Health & Safety	27.05	-	24.34	34.51
8a. Education	28.64	-	28.44	23.75
8b. Societal Dimensions (ELSI)	5.85	-	5.85	5.28
Total, National Nanotechnology Initiative	**$428.67**	**$17.72**	**$412.21**	**$455.95**

Totals may not add due to rounding.

FY 2012 NNI Funding

NSF supports nanoscale science and engineering throughout all the research and education directorates as a means to advance discovery and innovation and integrate various fields of research. NNI enables increased interdisciplinarity at atomic and molecular levels for about 5,000 active awards, representing approximately 10 percent of NSF's portfolio. About 10,000 students and teachers will be educated and trained in nanoscale science and engineering in FY 2012. NSF contributes to the goals and eight program component areas (PCAs) outlined in the NNI Strategic Plan (www.nano.gov).

A portion of NSF's FY 2012 NNI funding is for the NNI Signature Initiatives. FY 2012 funding for the Nanoelectronics for 2020 and Beyond signature initiative is $50.0 million which is distributed in the Fundamental Nanoscale Phenomena and Processes, Nanomaterials, and Nanoscale Devices PCAs. These three PCAs also include FY 2012 funding of $32.0 million for the Nanotechnology for Solar Energy Collection and Conversion signature initiative. In addition, FY 2012 funding of $35.40 million for Sustainable Nanomanufacturing is contained within the Nanomanufacturing PCA.

In FY 2012, funds are transferred from several PCAs to increase funding for the Environmental, Health and Safety (EHS) PCA to reach a total FY 2012 funding level of $34.51 million. This shift reflects the prioritization of EHS within the overall NNI portfolio. Requests for research are primarily directed at environmental, health, and safety implications and methods for reducing the respective risks of

nanotechnology development. The support for EHS represents over 7.5 percent of total NNI funding at NSF. Overall NNI funding in the FY 2012 Request will increase by $43.74 million as compared to the FY 2010 Enacted primarily due to additional monies for the NNI Signature Initiatives.

NSF sponsored an international study on long-term research entitled "Nanotechnology Research Directions for Societal Needs in 2020" (NSF/WTEC 2010, Springer, available on www.nsf.gov/nano and www.wtec.org/nano2/. It provides assessment of nanotechnology development in the last ten years (2000-2010) and a long-term vision of the field in the next decade (2010-2020). This study evaluates the outcomes as recommended by the first report "Nanotechnology Research Directions: A vision for the next decade" (1999), adopted as an official document of the National Science and Technology Council (NSTC).

Fundamental Nanoscale Phenomena and Processes

The FY 2012 Request includes $151.63 million, which represents a decrease of $940,000 compared to the FY 2010 Enacted, for fundamental research and education. A part of those funds have transitioned to other PCAs, as part of the competitive planning process in each directorate. Special emphasis will be on:

- *Novel phenomena, quantum control, selfassembling, and basic engineering processes at the nanoscale*. – to discover and understand phenomena and design processes specific at the nanoscale, including new phenomena in materials, mechanics, chemistry, biology, electronics, and optics. Potential applications include quantum information systems, novel products by multiscale self assembling, and new devices and sensors for industry and environmental monitoring. A new focus will be on understanding complex and emerging behavior of nanosystems, and creating nanomaterials and nanosystems by computational design.
- *Biosystems at the nanoscale* – to support study of biologically based or inspired systems that exhibit novel properties and potential applications. Potential applications include improved drug delivery, biocompatible nanostructured materials for implantation, exploiting of functions of cellular organelles, devices for research in genomics, proteomics, and cell biology, food and plant systems, and nanoscale sensory systems, such as miniature sensors for early detection of cancer. A focus will be on the understanding of structure and function and simulation of cells, tissues, and nervous systems.
- *Converging science and engineering at the nanoscale* – to support the convergence of nanotechnology with information technology, modern biology, and social sciences – potentially reinvigorating discoveries and innovation in almost all areas of the economy. Examples are the nano-biology interface, the nano-information interface, and nano-neurosciences.
- *Multi-scale, multi-phenomena theory, modeling, and simulation at the nanoscale* – to support theory, modeling, large-scale computer simulation and new design tools, and infrastructure in order to understand, control, and accelerate development in new nanoscale regimes and systems. A special focus will be on simulations with atomic precision, time resolution of chemical reactions, and for domains of engineering and biological relevance.
- *NNI Signature Initiatives* -- to support the NNI Signature Initiatives, as well as planning for Nanotechnology for Regenerating the Human Body and Nanostructured Catalysts for Green Manufacturing.
- *Advanced Manufacturing Technologies* -- to support research in the Directorate for Computer and Information Science and Engineering (CISE) on advanced manufacturing technologies. A portion of this funding supports CISE's participation in the Nanoelectronics for 2020 and Beyond signature initiative.

Nanomaterials
The FY 2012 Request includes $76.30 million, a decrease of $2.37 million from the FY 2010 Enacted, for discovery of novel nanoscale and nanostructured materials, and improving the comprehensive understanding of the properties of nanomaterials (ranging across length scales and including interface interactions). A special focus will be design and synthesis, in a controlled manner, of nanostructured materials with targeted properties. Research on the discovery, understanding, and control of materials at the nanoscale will be critical to the development and success of innovative technologies, including advances in electronics in Science and Engineering Beyond Moore's Law (SEBML), catalysts, energy, healthcare, and manufacturing.

Nanoscale Devices and Systems
The FY 2012 Request includes $59.17 million, an increase of $15.43 million from the FY 2010 Enacted, for R&D that applies the principles of nanoscale science and engineering to create novel, or to improve existing, devices and systems. The bulk of the increase over the FY 2010 Enacted – $15.0 million – is for advanced manufacturing technologies research in CISE, a portion of which will support CISE's participation in the Nanoelectronics for 2020 and Beyond signature initiative. A special focus will be on the architecture and emerging behavior of nanosystems, and on nanomanufacturing of active nanostructures and nanosystems. Nanoelectronics beyond silicon nanotechnology and complementary metal-oxide superconductors (CMOS) research will explore the ultimate limits to scaling of features and alternative physical principles for devices employed in sensing, storage, communication, and computation. The research activity in this area will help develop innovative technologies, including replacing electron charge as information carrier, bottom-up device assembly technologies at the atomic and molecular levels, and new system architectures using nanoscale components. Another focus will be on building bio-systems and to regenerate the human body. An additional area of emphasis will be nano-informatics for better communication and nanosystem design.

Instrumentation Research, Metrology, and Standards for Nanotechnology
The FY 2012 Request includes $16.58 million for R&D, a decrease of $1.76 million from the FY 2010 Enacted, to create new tools needed to advance nanotechnology research and commercialization. Special challenges are developing tools for measuring and restructuring matter with atomic precision, for time resolution of chemical reactions, and for domains of biological and engineering relevance. Another focus is on developing on-line process instrumentation for nanoscale characteristics.

Nanomanufacturing
The FY 2012 Request includes an increase of $34.77 million above the FY 2010 Enacted, to $57.20 million, to support new concepts for high rate synthesis and processing of nanostructures, nanostructured catalysts, nanobiotechnology methods, fabrication methods for devices, and assembling them into nanosystems and then into larger scale structures of relevance in industry and in the medical field. R&D is aimed at enabling scaled-up, reliable, cost effective manufacturing of nanoscale materials, structures, devices, and systems. Advanced semiconductor and optical device design, fabrication and processing, for application in biomedical, alternative energy, communications, computing and sensing systems, will be pursued both through support of the centers and the core programs. The National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond, will be supported for work on novel paradigms representing departures from traditional architectural practices of computing, including reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error-prone devices at the nanoscale. The Foundation will strengthen the support for four NSECs (Nanoscale Science and Engineering Centers) that focus on manufacturing at the nanoscale. Those centers and the National Nanotechnology Infrastructure Network (NNIN) have strong partnerships with industry, national

laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies. The NSECs with a focus on nanomanufacturing are: the Center for Hierarchical Manufacturing (CHM); the Center for Scalable and Integrated Nanomanufacturing (SINAM); (c) the Center for High-rate Nanomanufacturing (CHN); and the Center for Nano-Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS). NSF also supports the National Nanomanufacturing Network (NNN), which includes the NSF NSECs and non-NSF centers in collaboration with the Department of Defense (DOD), National Institute of Standards and Technology (NIST), and industry partners in an alliance to advance nanomanufacturing strength in the U.S. The FY 2012 Request increase is primarily associated with $35.40 million in additional funding for the signature initiative on Sustainable Nanomanufacturing.

Major Research Facilities and Instrumentation Acquisition

The FY 2012 Request includes $31.53 million, a decrease of $6.30 million from FY 2010 Enacted, for user facilities, acquisition of major instrumentation, and other activities that develop, support, or enhance the scientific infrastructure required for the conduct of nanoscale science, engineering, and technology research and development. It also supports ongoing operations of the National Nanotechnology Infrastructure Network (NNIN), the Network for Computational Nanotechnology (NCN), the National Network for Nanomanufacturing (NNN), and the National High Magnetic Field Laboratory (NHMFL). The networks are planned to have over 110,000 users in FY 2011. The investment will support facilities for 17 ongoing Nanoscale Science and Engineering Centers (NSEC). The FY 2012 funding decrease is due to the first class of six NSECs, initiated in 2001, receiving their final year of support in FY 2010 and other adjustments in the major research facilities. In addition, the FY 2012 Request will support the first class of three new Nanoscale Engineering Research Centers (Nanoscale ERCs).

Environmental, Health and Safety

The FY 2012 Request includes $34.51 million, an increase of $10.17 million over the FY 2010 Enacted, for research primarily directed at environmental, health, and safety (EHS) implications and methods for reducing the prospective risks of nanotechnology development. NSF, the Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), and the European Union (EU) will continue collaboration on development of a joint solicitation for nanotechnology EHS. A focus will be on implications of the next generation of nanotechnology products and productive processes, as well as public participation in nanotechnology related activities. Research on both implications and applications of nanotechnology will address the sources of nanoparticles and nanostructured materials in the environment (in air, water, soil, biosystems, and working environments), as well as the non-clinical biological implications. Research on the safety of manufacturing nanoparticles is included in seven NSECs and NNIN. Environmental implications of nanotechnology, including development of new measurement methods for nanoparticle characterization and toxicity of nanomaterials will be investigated in two dedicated multidisciplinary centers (Centers for Environmental Implications of Nanotechnology at UCLA and Duke University). These centers aim to conduct fundamental research on the interactions between nano-particles and materials and the living world at all scales. An essential element of this will be research on methods and instrumentation for nano-particle detection, characterization, and monitoring, including interactions of nano-materials with cellular constituents, metabolic networks and living tissues, bioaccumulation and its effects on living systems, and the impacts of nanostructures dispersed in the environment.

Education and Societal Dimensions

The FY 2012 Request includes $29.03 million for research and other activities that address the broad implications of nanotechnology for society, including education and social aspects, including:

- Education-related activities, such as development of materials for schools, curriculum development for nanoscience and engineering, development of new teaching tools, undergraduate programs, technical training, and public outreach ($23.75 million). Two networks for nanotechnology education with national outreach will be supported.
- Research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, workforce, educational, ethical, and legal implications ($5.28 million). The application of nanoscale technologies will stimulate far-reaching changes in the design, production, and use of many goods and services. NSF also supports a project to embed humanists and social scientists in nanoscience around the world, providing a model for future integration of ethicists and social scientists into nanotechnology R & D laboratories.

Coordination with Other Agencies

The NSF program is coordinated with 25 departments and agencies through the National Science and Technology Council's subcommittee on Nanoscale Science, Engineering and Technology (NSET). Examples of specific coordination efforts are: Nanomanufacturing (DOD/NIST); Environmental issues (EPA/ National Institute of Environmental Health Sciences (NIEHS)/USDA); NSECs, NNIN and NCN centers and networks (DOD/ National Aeronautics and Space Administration (NASA)/ Department of Energy (DOE)/ National Institutes of Health (NIH)); nanoelectronics (NIST, DOD), simulations in nanoelectronics (DOD/NASA); and research and training activities (DOD/NIH).

NNI Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual[1]	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
Biological Sciences	$56.67	-	$56.60	$63.10
Computer and Information Science and Engineering	12.95	-	11.00	31.00
Engineering	152.50	17.72	148.00	174.37
Geosciences	0.85	-	0.85	0.85
Mathematical and Physical Sciences	199.11	-	190.59	182.36
Social, Behavioral and Economic Sciences	1.73	-	1.67	1.67
Office of International Science and Engineering	1.36	-	-	0.10
Subtotal, Research and Related Activities	$425.17	$17.72	$408.71	$453.45
Education and Human Resources	3.50	-	3.50	2.50
Total, National Nanotechnology Initiative	**$428.67**	**$17.72**	**$412.21**	**$455.95**

Totals may not add due to rounding.

[1] FY 2010 ARRA funding represents Major Research Instrumentation awards funded by Integrative Activities but managed by Engineering.

NETWORKING AND INFORMATION TECHNOLOGY R&D

The National Science Foundation is a primary federal agency supporting the Networking and Information Technology Research and Development (NITRD) program. NSF's NITRD portfolio includes all funding in the Directorate for Computer and Information Science and Engineering (CISE) and the Office of Cyberinfrastructure (OCI), and contributions from all of the agency's other directorates. NSF makes research, education, or research infrastructure investments in every NITRD Program Component Area (PCA). NSF's Assistant Director for CISE is co-chair of the NITRD Subcommittee of the National Science and Technology Council's Committee on Technology and OCI provides NSF representation to the subcommittee. In addition, NSF works in close collaboration with other NITRD agencies and participates at the co-chair level in five of the seven PCA Coordinating Groups.

NSF's FY 2012 Request continues strong support for NITRD at a level of $1.258 billion, a 15.3 percent increase over the FY 2010 Enacted level. NITRD activities represent approximately 16 percent of NSF's FY 2012 budget. CISE and OCI's combined support comprises 77 percent of NSF's NITRD activities.

Several NSF-wide investments, both new and continuing, are reflected in various NITRD PCAs:

- Cyberinfrastructure Framework for the 21st Century (CIF21), designed to develop and deploy comprehensive, integrated, sustainable, and secure cyberinfrastructure to accelerate research and new functional capabilities in computational and data-intensive science and engineering, primarily supports investments in five program component areas: Large Scale Networking; High End Computing Research and Development (R&D); High End Computing Infrastructure and Applications; Human-Computer Interaction and Information Management; and Social/Economic/Workforce Implications of IT and IT Workforce Development.

- The Science, Engineering, and Education for Sustainability (SEES) cross-Foundation investment supports activities in Large Scale Networking as well as in Software Design and Productivity and Social/Economic/Workforce Implications of IT and IT Workforce Development.

- The National Robotics Initiative (NRI), a new cross-agency initiative engaging four U.S. agencies (NSF, NASA, NIH and USDA) in a concerted program to provide U.S. leadership in science and engineering research and education aimed at the development of next generation robotics, supports activities in Human-Computer Interaction and Information Management, High Confidence Software and Systems, and Social/Economic/Workforce Implications of IT and IT Workforce Development.

- Advanced Manufacturing investments encompass research in nanotechnology and cyber-physical systems, as well as expanded industry/university cooperation. Activities are supported in High End Computing R&D, High End Computing Infrastructure and Applications, and High Confidence Software and Systems.

- Enhancing Access to the Radio Spectrum (EARS), which supports basic research on new and innovative ways to use the spectrum more efficiently, supports activities in Large Scale Networking.

- The Comprehensive National Cybersecurity Initiative (CNCI) supports activities in Cybersecurity and Information Assurance.

Networking and Information Technology Research and Development Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
Biological Sciences	$93.00	$93.00	$99.00
Computer and Information Science and Engineering	618.71	618.83	728.42
Engineering	23.70	23.70	23.70
Geosciences	22.98	22.98	22.98
Mathematical and Physical Sciences	97.24	85.39	91.75
Social, Behavioral, and Economic Sciences	25.71	22.80	46.30
Office of Cyberinfrastructure	214.72	214.28	236.02
Subtotal, Research and Related Activities	$1,096.06	$1,080.98	$1,248.17
Education and Human Resources	9.50	9.50	9.50
Total, NITRD	**$1,105.56**	**$1,090.48**	**$1,257.67**

Totals may not add due to rounding.

FY 2012 NSF Investments by Program Component Area
The following information focuses on FY 2012 NSF-wide investments, both new and continuing, by PCA.

Large Scale Networking ($132.56 million) CISE will support the basic research that underpins Enhancing Access to the Radio Spectrum (EARS). The recent NSF workshop report, *Enhancing Access to the Radio Spectrum*, outlines the need for research on new and innovative ways to use the spectrum more efficiently. A portion of NSF's new investment in CIF21 will address broadband applications and research on end-to-end performance from the desktop to major scientific and computational facilities.

Cybersecurity and Information Assurance ($94.72 million) Support for the Comprehensive National Cybersecurity Initiative (CNCI) is increased by $10.0 million above the FY 2010 Enacted level to a total of $65.0 million for CNCI activities. A realignment of the funding allocation within CNCI provides $37.0 million for CISE to focus on the development of a Science of Cybersecurity as well as three research themes – Moving Target Defense, Tailored Trustworthy Spaces, and Cyber Economic Incentives. OCI will provide $16.0 million to (1) early deployment and testing of cybersecurity prototypes, and experimental approaches, (2) development of cybersecurity in advanced compute environments and leading-edge IT services, and (3) support research on virtual organization and coordination. SBE will provide $12.0 million, working in partnership with CISE, to support research at the interstices of the economic and computer sciences to achieve secure practices through the development of market forces that incentivize good behavior.

High-End Computing R&D ($123.82 million) Additional support is provided for CISE's nanotechnology research, including participation in the National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond. NSF supports this effort in partnership with other federal agencies. NSF's investment in Science, Engineering, and Education for Sustainability (SEES) is increased and a portion of NSF's investment in CIF21 is included here.

High-End Computing Infrastructure and Applications ($308.11 million) NSF's investment in CIF21 is reflected here as well as increased investments in innovative partnerships and collaborations between

universities and industries, including the Industry/University Cooperative Research Centers program (I/UCRC). OCI's Track 1 and Track 2 high performance computing activities are reduced. MPS will continue to invest in new computational methods, algorithms, robust software and other computational tools to support researchers in the mathematical and physical sciences.

High Confidence Software and Systems ($91.76 million) CISE will support the National Robotics Initiative and continue investments in smart health and wellbeing. As development of the next generation of robotics proceeds, complete confidence in the systems supporting robots that work beside, or cooperatively with, people in areas such as manufacturing, space and undersea exploration must be assured. High confidence surgical robots and medical devices are central to high quality healthcare and building trust in robotic aids. CISE and ENG will support advanced manufacturing technologies research in cyber-physical systems such as smart infrastructure that will blend traditional concrete-and-steel physical infrastructure systems with cyber-infrastructure systems such as computers, networks, and sensors.

Human Computer Interaction and Information Management ($329.95 million) CISE support for the National Robotics Initiative is included here as well as support for smart health and wellbeing. As part of the next generation of robotics, co-robot systems will be characterized by their flexibility and resourcefulness. They will use of a variety of modeling or reasoning approaches, and use real-world data in real time, demonstrating a level of intelligence and adaptability seen in humans and animals. Research in smart health and wellbeing will focus on human-centered intelligent information systems and tools that collect, mine, synthesize, protect and share appropriate data and knowledge with healthcare organizations, practitioners, caregivers and individuals to enable effective, safe and well-informed decision-making by all stakeholders. NSF investments in CIF21 also are reflected. BIO will continue investments to facilitate discovery through tools that integrate the published literature with the expanding universe of digital data collections, expand capacity for understanding through virtual environments, and make it practical for scientists to search vast collections of biological images simply and quickly.

Software Design and Productivity ($78.79 million) Software centers are added to the Software Infrastructure for Sustained Innovation program (OCI). NSF investments in CIF21 and SEES also are included.

Social, Economic and Workforce (SEW) Implications of IT and IT Workforce Development ($97.96 million) CISE support for the National Robotics Initiative is reflected here. SEW research will focus on human robot interaction, a critical component in achieving effective human robot partnerships in manufacturing, education, space exploration, etc. In addition, CISE's continued emphasis on smart health and wellbeing focuses on, for example, assistive technologies and quality of life aids. EHR will continue to study the impact of information and communication technology on educational practice, new approaches to using technology in education, application and adaptation of technologies to promote learning in a variety of fields and settings, the effects of technology of learning, and efforts that advance teaching and learning opportunities utilizing cyberinfrastructure. These efforts also will support science, technology, engineering and mathematics education for the cyber-workforce through workforce programs and research and development in learning sciences. In FY 2012, EHR will fund research that highlights the educational use of information tools that operate seamlessly across formal and informal learning environments and across traditional computers, mobile devices, and newly emerging information and communications.

NITRD by Program Component Area
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
Large Scale Networking	$120.96	$107.18	$132.56
Cybersecurity and Information Assurance	72.74	71.36	94.72
High End Computing R&D	89.06	98.54	123.82
High End Computing Infrastructure and Applications	325.24	310.87	308.11
High Confidence Software and Systems	74.25	73.08	91.76
Human-Computer Interaction and Info Management	269.81	280.70	329.95
Software Design and Productivity	54.35	57.58	78.79
Social/Economic/Workforce	99.15	91.17	97.96
Total, NITRD	**$1,105.56**	**$1,090.48**	**$1,257.67**

Totals may not add due to rounding.

U.S. GLOBAL CHANGE RESEARCH PROGRAM (USGCRP)

Climate and global change have pervasive effects on the U.S. through their impacts on the environment, natural resources, and the economy. Global change encompasses a wide range of planetary-scale changes in the Earth's natural and human systems. These changes involve atmospheric and ocean circulation and composition, the water cycle, biogeochemical cycles, land and sea ice, biological diversity, marine and terrestrial ecosystem health, resource and land use, urbanization, economic development, and more. The U.S. Global Change Research Program (USGCRP) provides the Nation and the world with the scientific knowledge necessary for understanding and predicting climate change and environmental responses, managing risk, and anticipating opportunities that may result from changes in climate and climate variability. Research conducted through the USGCRP (www.globalchange.gov) builds on the scientific advances of recent decades and deepens our understanding of how the interplay between human and natural systems affects the climate system, and of the impacts of a changing climate on those systems. The USGCRP involves thirteen U.S. agencies in a concerted interagency program of basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. NSF provides support for a broad range of fundamental research activities that provide a sound scientific basis for climate-related policy and decisions.

The Earth's climate is determined by highly complex interactions between and among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere – all significantly influenced by human activities. NSF programs address these components by investing in: fundamental discovery that utilizes the full range of intellectual resources of the scientific community; research infrastructure that provides advanced capabilities; and innovative educational activities. NSF strongly encourages interdisciplinary approaches, and focuses particularly on fundamental Earth system processes and the consequences of change. High priorities for the agency include: data acquisition and information management activities necessary for global change research; the enhancement of models designed to improve our understanding of Earth system processes and of feedbacks between ecosystems and the physical climate; the development of new, innovative Earth observing instruments and networks; the development of advanced analytic research methods; and preparation of a scientific workforce equipped to deal with the complexities of global change. NSF also supports fundamental research on the processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to varying environmental conditions. NSF-supported research on the science of impacts, vulnerability and resilience as well as the enhancement and development of a range of climate and process models will be key contributions to the National Climate Assessment. NSF is leading the development of a new strategic plan for the USGCRP, which is expected to be completed by the end of 2011.

U.S. Global Change Research Program Funding

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
Biological Sciences	$81.00	$81.00	$89.00
Geosciences	194.00	194.00	245.00
Mathematical and Physical Sciences	7.77	7.28	9.03
Social, Behavioral and Economic Sciences	18.48	18.48	58.98
Office of Polar Programs	18.30	18.30	23.10
Total, U.S. Global Change Research Program	**$319.55**	**$319.06**	**$425.11**

Totals may not add due to rounding.

FY 2012 Areas of Emphasis

NSF's FY 2012 investment in USGCRP increases by $106.05 million, or 33 percent, over the FY 2010 Enacted level. NSF's USGCRP investments reflect two major integrated NSF initiatives, the Science, Engineering, and Education for Sustainability (SEES) and the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21). The major USGCRP foci in FY 2012 include:

Improving our knowledge of Earth's past and present climate variability and change – NSF investments include activities to document and understand long-term climate cycles across the globe, as well as to better understand the natural variability of climate and the processes responsible for climate changes using a range of paleoclimate and instrumental data and modeling approaches. NSF also supports activities to improve our understanding of the frequency and intensity of extreme climate events in the past and how those may be manifested in the future. Upgrading and expanding critical environmental observing systems and ensuring data quality and access are integral parts of NSF's investments that will be supported under the CIF21 Data and Access to Cyberinfrastructure components

Improving our understanding of natural and human forces of climate change – NSF activities in this area span a broad range of disciplines and topics that seek to better understand the physical, geological, chemical, biological, and human components of the Earth system and their interactions. Examples of major foci include fundamental research on all aspects of the carbon cycle, the water cycle, atmospheric composition and greenhouse gas processes, marine and terrestrial ecosystems, and ocean and atmospheric circulations that both drive and respond to climate and global change. Human drivers of change include urbanization, population growth, and economic development. NSF has a strong commitment to fostering new interdisciplinary research approaches that allow exploration of the interdependencies across these areas. Such efforts will be enhanced with the sustainability focus under the SEES Integrated Science and Engineering thrust.

Improving our capability to model and predict future conditions and impacts – NSF-supported research will examine major feedback processes between the climate and natural and human systems and will incorporate these into the next generation Community Earth System Model (CESM). High priority will be given to developing more complete representations of coupled interactive atmospheric chemistry, terrestrial and marine ecosystems, biogeochemical cycling, and middle atmospheric processes. NSF will continue to devote significant resources to advancing climate modeling capabilities from global and centennial to regional and decadal scales. In addition, NSF is encouraging the development of ecosystem and water models at regional scales, as well as models that integrate human system components such as risk, vulnerability, and decision-making. These efforts will depend on new computational resources and tools that will be developed through the CIF21 efforts in computational infrastructure.

Assessing the Nation's vulnerability to current and anticipated impacts of climate change – A key focus of the USGCRP is developing better means of assessing the impacts of climate change and the vulnerability and resilience of both human and natural systems to those changes. NSF supports the basic research that underpins the National Climate Assessment, including developing models that can be used for these assessments. For example, NSF-supported researchers are developing integrated river-basin models to address often competing water management issues that affect stream flow, such as protecting endangered species, meeting agricultural needs, and honoring transboundary water rights agreements. NSF will support fundamental research regarding the science of adaptation, from developing the theoretical framework for evaluating adaptation options (and avoiding unintended consequences of adaptation choices) to risk assessment and decision making. Under the SEES Integrated Science and Engineering Research on Environmental, Economic, and Engineering systems, NSF will continue interdisciplinary research (including human factors) in water sustainability, biodiversity, and ocean

acidification and initiate new efforts in particularly vulnerable areas such as the Arctic and coastal regions.

Providing climate information and decision support tools – NSF supports basic research on how humans impact climate and other natural systems, how people respond to changing natural conditions, and how human and natural systems engage in complex interactions across multiple spatial, temporal, and organizational scales. Support will continue for basic research on decision making under uncertainty associated with climate change, as well as for developing and testing decision-support tools that can be used by stakeholders to improve their decision making processes.

ADVANCED MANUFACTURING

Few areas of research hold as much potential for significant short-term and long-term economic impact as research in advanced manufacturing. Rather than a "refinement" of traditional manufacturing processes, advanced manufacturing involves new methodologies, new systems, new processes, and entirely new paradigms for translating fundamental raw materials into finished products. In many cases, advanced manufacturing promises entirely new classes and families of products having previously unattainable properties and functionalities.

Summary

NSF supports a diverse research portfolio providing basic research discoveries that benefit advanced manufacturing. In recent years, significant investments have been made in areas of importance to advanced manufacturing, and for FY 2012, additional investment in these as well as new areas is a principal focus for NSF.

Within the Foundation, major areas of emphasis include:

- Manufacturing enterprise systems, manufacturing and construction machines, and materials processing and manufacturing;
- Advanced semiconductor and optical device design, fabrication and processing, for application in biomedical, alternative energy, communications, computing and sensing systems, pursued both through support of the National Nanotechnology Infrastructure Network (NNIN) and other ongoing programs;
- The National Nanotechnology Initiative (NNI) Signature Initiative: Nanoelectronics for 2020 and Beyond, supporting innovations on novel paradigms representing departures from traditional architectural practices of computing, including reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error-prone devices at the nanoscale;
- Capabilities for the 21st century, specifically those associated with complex engineering systems design and manufacturing, such as materials and surface engineering, sensors and sensing systems, engineering design and innovation, control systems, and dynamical systems;
- Cyber–physical systems and advanced robotics research; and
- A variety of activities aimed at bolstering industry/university interactions, such as forums and networks that connect fundamental research developments with regional and national innovation ecosystems, and related activities through the Industry/University Cooperative Research Centers (I/UCRC) program.

Ongoing Investments: Advanced Manufacturing

National Nanotechnology Initiative (NNI): Investments include nanoscale processing and materials science, as well as reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error prone devices at the nanoscale. Support for nanomanufacturing research is aimed at the manufacture of materials devices and systems through manipulation and assembly of materials at the atomic and molecular levels. In addition, NSF's participation in the NNI Signature Initiative on Sustainable Nanomanufacturing includes cutting-edge research aimed at overcoming key roadblocks to the scale-up of nanotechnology to the commercial level.

NSF also supports centers, interdisciplinary projects, and investigator-initiated research projects related to manufacturing processes and manufacturing enterprises, as well as education and workforce development.

Center-scale Activities: The Foundation supported four NSECs (Nanoscale Science and Engineering Centers), with a budget of about $12.7 million for FY 2010, that focus on manufacturing at the nanoscale. These centers have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies. The NSECs with a focus on nanomanufacturing are:

- The Center for Hierarchical Manufacturing at the University of Massachusetts Amherst;
- The Center for Scalable and Integrated Nanomanufacturing (SINAM) at the University of California, Berkeley (formerly at UCLA);
- The Center for High-rate Nanomanufacturing (CHN) at Northeastern University; and
- The Center for Nano-Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS) at the University of Illinois at Urbana-Champaign.

NSF also supports the National Nanomanufacturing Network (NNN), which includes the NSF NSECs and non-NSF centers in collaboration with the Department of Defense (DoD), National Institute of Standards and Technology (NIST), and industry partners in an alliance to advance nanomanufacturing strength in the U.S.

Through the Engineering Research Centers Program (ERC), NSF supports the ERC for Compact and Efficient Fluid Power (CCEFP) at the University of Minnesota. The Foundation has also supported workshops for manufacturing innovation such as "Re-Shaping U.S. Manufacturing for Global Competitiveness" held in May 2010 and "Extreme Manufacturing" held at NIST in January 2011.

Core Research in Science and Engineering: Support for manufacturing enterprise systems includes research into the dynamic behavior of manufacturing and supply chain operations for more efficient and responsive production and distribution, for the design and operation of manufacturing and distribution facilities, and effective use of sensor data for improved product and process reliability. Support for operations research focuses on mathematical models that can be used to improve the efficiency of factory operations, connect manufacturing management more closely to dynamically changing customer needs, provide more effective collaboration with suppliers, and management strategies to deal with supply chain disruptions.

Education Activities: Investments are also made (through the CAREER, Research Experiences for Undergraduates (REU), and Research Experiences for Teachers (RET) programs as well as manufacturing engineering education) in the people who will educate, lead, manage, operate and create the new wealth-generating manufacturing enterprises for the 21st century. NSF also supports training of the next generation of product designers and product engineers on the ethical production of products through awards in its Ethics Education for Science & Engineering program.

Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR): NSF's SBIR/STTR investments strongly reflect the 2004 Executive Order on *Encouraging Innovation in Manufacturing* (Executive Order 13329).

- In FY 2010, of roughly 450 SBIR/STTR Phase I awards, 140 had a major manufacturing innovation component.
- Of the current active SBIR/STTR Phase II awards, about 30 percent have a significant manufacturing research component.
- For FY 2011, it is anticipated that more than 80 SBIR/STTR Phase I awards will support manufacturing innovation.

Advanced Manufacturing in FY 2012

While many of the activities described above will continue, NSF's increased investment in FY 2012 will emphasize several emerging opportunities in advanced manufacturing research. FY 2012 resources for advanced manufacturing will be utilized to pursue revolutionary research advances in cyber-physical systems including advanced robotics, sensor and model-based smart manufacturing, multi-scale modeling for simulation-based design and manufacturing across the supply chain, scalable nanomanufacturing and nano-bio manufacturing, energy manufacturing, and complex engineering systems design and manufacturing.

A feature of these efforts will be integrated research and educational initiatives focused on making cyber-based access to design, prototyping, fabrication and manufacturing computational tools and physical resources widely available to innovative small and medium-sized businesses and the U.S. citizenry at large. The aim of these efforts is to unleash the creative energy of the U.S. populace, which may provide a major competitive edge in global competition.

A portion of the new NSF-wide investment in research at the intersections of biological, mathematical, and physical sciences and engineering (BioMaPS) will be invested in advanced manufacturing areas. These interdisciplinary efforts will result in accelerated understanding of biological systems, as well as uncovering of new mathematical and physical principles, leading to innovations in manufacturing in such areas as clean energy systems, bio-based materials, bio-imaging, and bio-inspired sensors.

Building on current efforts, additional resources will be allocated to promoting unique collaborations and alliances between academic researchers and industrial partners to accelerate the translation of basic research discoveries to useful manufacturing processes and methods. Investments will be focused on people who will educate, lead, manage, operate, and create the new wealth generating manufacturing enterprises for the 21st century. NSF will also continue to provide training support for the next generation of product designers and product engineers on the ethical production of products through awards in its Ethics Education for Science & Engineering program.

Advanced Manufacturing Funding

(Dollars in Millions)

	2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
Biological Sciences	-	-	$10.00
Computer and Information Science and Engineering	15.71	17.15	65.90
Engineering	38.50	38.42	74.50
Mathematical and Physical Sciences	20.00	20.00	40.00
Total, Advanced Manufacturing	**$74.21**	**$75.57**	**$190.40**

Totals may not add due to rounding.

NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are a principal means by which NSF fosters interdisciplinary research.

NSF Centers Funding

(Dollars in Millions)

	Program initiation	Numbers Centers in FY 2010	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2012 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Centers for Analysis & Synthesis	1995	4	$22.72	$22.72	$25.81	$3.09	13.6%
Centers for Chemical Innovation	1998	14	24.00	24.00	24.00	-	-
Engineering Research Centers	1985	15	48.60	54.91	81.00	26.09	47.5%
Materials Centers	1994	27	52.49	56.70	57.00	0.30	0.5%
Nanoscale Science & Engineering Centers	2001	19	47.99	46.26	30.27	-15.99	-34.6%
Science & Technology Centers	1987	17	57.63	57.77	50.75	-7.02	-12.2%
Science of Learning Centers	2003	6	26.58	25.80	20.37	-5.43	-21.0%
Totals		**102**	**$279.99**	**$288.16**	**$289.20**	**$1.04**	**0.4%**

Totals may not add due to rounding.

DESCRIPTION OF MAJOR CHANGES

Centers for Analysis and Synthesis (BIO)

The Centers for Analysis and Synthesis are designed to continue development of new tools and standards for management of biological information and meta-information, support data analysis capabilities with broad utility across the biological sciences, host workshops that bring together scientists from a variety of disciplines, and begin to host and curate databases. The Centers have a critical role in organizing and synthesizing biological knowledge that is useful to researchers, policy makers, government agencies, educators, and society. In FY 2012, four centers are expected to be funded.

The National Center for Environmental Synthesis will use synthetic approaches to advance the frontiers of scientific understanding of environmental complexity in order to anticipate and manage environmental challenges. This center will allow scientists from diverse disciplines to frame questions, identify resource needs to advance synthesis, reorganize how researchers carry out their research, and thus transform approaches to environmental synthesis. Workshops sponsored by this center will engage philosophers, sociologists, political scientists, psychologists, anthropologists, and environmental biologists (together with policy makers) to integrate broad disciplines from the outset and to set precedence for all subsequent activities.

The National Evolutionary Synthesis Center (NESCent) is a collaborative effort by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill to foster a greater conceptual synthesis in biological evolution by bringing together researchers and educators, extant data, and information technology resources. NESCent will fund graduate students engaged in center activities, support activities to expand the conceptual reach of the center into targeted areas, and initiate a

formalized, three-tiered assessment of the center that includes milestones for reporting on the impact of those activities. No major changes are planned for NESCent in FY 2012

The National Institute for Mathematical and Biological Synthesis (NIMBioS), located at the University of Tennessee-Knoxville, fosters cross-disciplinary approaches in mathematics and biology to address fundamental and applied biological questions, including national needs research in modeling of infectious diseases of plants and animals. The center will design education programs aimed at the mathematics/biology interface, thereby building the capacity of mathematically competent, biologically knowledgeable, and computationally adept researchers needed to address the vast array of challenging questions in this century of biology. Although predominantly supported by the Directorate for Biological Sciences, the Directorate for Mathematical and Physical Sciences and the Department of Homeland Security also contribute. No major changes are planned for NIMBioS in FY 2012.

iPlant (formerly Plant Science Cyberinfrastructure Collaborative), led by the University of Arizona, uses new computer and information science, and cyberinfrastructure solutions to address an evolving array of grand challenges in the plant sciences. This center is a community-driven effort, involving plant biologists, computer and information scientists and engineers as well as experts from other disciplines, all working in integrated teams. No major changes are planned for iPlant in FY 2012.

Centers for Chemical Innovation (MPS)

The Centers for Chemical Innovation (CCI) are designed to support research on strategic, transformative "big questions" in basic chemical research. The program is stimulating the chemical sciences community to perform work that is high-risk and of potential high scientific and societal impact. CCIs promote the integration of research and education through the extensive involvement of students and postdoctoral fellows in all phases of the work. CCIs are expected to be agile, responding to scientific opportunities as they arise, and to creatively engage the public. Grand challenges include emulating and even surpassing the efficiency of the natural process of photosynthesis to capture the sun's energy; activating strong bonds as a means to store and use chemical energy and to lower energy costs in chemical processing; and designing self-assembling, complex structures, such as molecular computers, with emergent and useful functions not yet known or foreseen.

The program is designed as a staged competition. Several Phase I centers are supported, which then compete for larger Phase II awards. At FY 2012 Request, a total of 15 CCIs will be supported. These are:

- Six Phase II awards: Four continuing awards, as well as two new and/or renewal awards. The Center for Enabling New Transformations through Catalysis will be seeking renewal of its Phase II award and four Phase I awards are eligible to compete for Phase II support.
- Nine Phase I awards: Three new awards and six continuing awards (three initiated in FY 2010 and three initiated in FY 2011).
- Four Phase I awards initiated in FY 2009 will conclude in FY 2012.

The CCI program evaluation design is scheduled for completion in FY 2011, allowing the initiation of a resource center and data gathering in FY 2012. A Leadership Network to support the CCI program will also be implemented in FY 2012.

Engineering Research Centers (ENG)

NSF Engineering Research Centers (ERCs) enable innovation through partnerships, bridging the intellectual curiosity of discovery-focused university research and the engineered systems and technology opportunities of industry research. The centers also educate a technology-enabled workforce with hands-on, real-world experience. These characteristics catalyze the development of marketable technologies to

generate wealth and address grand challenges. ERCs are investigating intelligent electric power grid systems to provide electricity from renewable sources, devising healthcare innovations through tissue engineering and microelectronics research, creating sensing systems that improve the prediction of tornados, and demonstrating intelligent robotic systems to assist people who are elderly or disabled in daily tasks.

ERCs face two renewal reviews, one in year three to determine if they are structured effectively to deliver on ERC program goals, and another in year six to determine if they are making an impact, delivering on goals, and positioning themselves for more challenging tasks to warrant further support. The ERC program periodically commissions program-level evaluations by external evaluators such as SRI International; the Science and Technology Policy Institute (STPI); and ABT Associates to determine the effectiveness of ERC graduates in industry and the benefits of ERC membership to industry and others. A recent survey of the 33 ERCs that have graduated from NSF support after 10 years finds that 27 (83 percent) are self-sustaining with strong financial support and most ERC features in place.

In FY 2012, funding for ERCs increases by $26.09 million over FY 2010 Enacted to a total of $81.0 million. This will support the first class of three new Nanoscale Engineering Research Centers (Nanoscale ERCs), bringing the number of traditional ERCs and Nanoscale ERCs to a total of 21. Funding for the three new Nanoscale ERCs comes from a reallocation of support from the Nanoscale Science and Engineering Centers (NSECs) that graduate in 2011. The reallocated funds will enable the transition of nano-devices created at graduating NSECs to the level of nano-enabled systems created at Nanoscale ERCs.

Materials Centers (MPS)

The Materials Research Centers and Teams (MRCT) program is an interdisciplinary vehicle for increasing materials research and educating students including global research experiences. Thus, the next class of centers will be called Centers of Excellence in Materials Research and Innovation (CEMRI), while the teams will be known as Materials Interdisciplinary Research Teams (MIRT). A restructuring of the Materials Research Science and Engineering Centers (MRSEC) program was implemented with the FY 2011 competition. This new approach eliminates small centers in favor of a new team program. This change is in response to the 2007 National Academies report *The NSF's Materials Research Science and Engineering Program, Looking Back, Moving Forward*.

FY 2011 marks a competition year, which is held triennially. Eight to 10 CEMRI and 10 to 12 MIRT awards are expected in 2011, depending on funds availability.

At FY 2012 Request, funding for all Materials Centers awards, CEMRIs and ongoing MRSECS, is $57.0 million (+$300,000 over FY 2010 Enacted). Support for 14 MRSEC awards is expected through FY 2014 as the old structure is phased out. The FY 2012 Request also includes an additional $6.0 million for MIRT team awards, which will be tracked within the core programs budget line, separate from the Materials Centers line. In total, 21 to 23 centers and 10 to 12 team awards will be supported in FY 2012, compared to the roughly 27 MRSEC-only awards that have been previously funded. Funding increases will allow the newly structured program to broaden participation to institutions not previously supported and to expand participants' international collaborations, thus strengthening U.S. materials research performance and workforce.

Nanoscale Science and Engineering Centers (multi-directorate)

Nanotechnology, which addresses the smallest of scales, is projected to be one of the largest drivers of technological innovation for the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale through NSF-funded Nanoscale Science and Engineering Centers (NSECs) aims to advance the

development of the ultra-small technology that will transform electronics, materials, medicine, environmental science, and many other fields. Each center has an extended vision for research. Together they provide coherence and a long-term outlook to U.S. nanotechnology research and education and also address the social and ethical implications of such research. NSEC funding supports education and outreach programs from K-12 to the graduate level, which is designed to develop a highly skilled workforce, advance pre-college training, and further public understanding of nanoscale science and engineering. These centers have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies.

The FY 2012 Request level of $30.27 million will support 13 continuing NSECs. The first class of six NSECs, initiated in 2001, received their final year of support in FY 2010 and will complete their associated research programs in FY 2011. The decrease of $15.99 million from the FY 2010 Enacted level is principally due to redirection of funds from the NSECs to Nano Engineering Research Centers (ERCs) in FY 2012. As noted in the ERC section above, these reallocated funds will support the first class of Nanoscale ERCs.

Science and Technology Centers: Integrative Partnerships (multi-directorate)

The Science and Technology Centers: Integrative Partnerships (STC) program advances interdisciplinary discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and the development of a diverse workforce. The STC portfolio reflects NSF-supported disciplines. Examples of investment include: engineering of biological systems; energy-efficient electronics; global and regional environmental systems -- sustainability and change; new ways of handling the extraction, manipulation, and exchange of information; cyber security; and new materials for optical and electronic applications. STCs engage the Nation's intellectual talent and collaborate with partners in academia, industry, national labs, and government. STCs strengthen the caliber of the Nation's science, technology, engineering, and mathematics (STEM) workforce through intellectually challenging research experiences for students, postdoctoral fellows, researchers, and educators and advance public scientific understanding through partnerships with K-12 and informal education communities.

A review of the STC program, initiated in FY 2009 and organized by the American Association for the Advancement of Science, is nearing completion. A final report is expected in February 2011. The review examined the performance, accomplishments, and effectiveness of 17 STCs (from the 2000, 2002, and 2005/6 cohorts) as well as envisioned the future of the STC program. As one of the general conclusions in the preliminary draft report states, "STC concept has been very effective in catalyzing and nurturing interdisciplinary and transformational science and technology."

At FY 2012 Request, $50.75 million supports eleven STCs, five from the 2010 cohort and six from the 2005-2006 cohort. This decrease of $7.02 million from FY 2010 Enacted is due to the planned sunset of six centers from the FY 2002 cohort in FY 2011.

Science of Learning Centers (multi-directorate)

The Science of Learning Centers (SLC) program supports six large-scale, long-term centers that create the intellectual, organizational, and physical infrastructure needed for the advancement of Science of Learning research. It supports research that harnesses and integrates knowledge across multiple disciplines to create a common groundwork of conceptualization, experimentation, and explanation that anchor new lines of thinking and inquiry towards a deeper understanding of learning. The SLC program goal is to advance the frontiers of all the sciences of learning through integrated research; to connect the research to specific scientific, technological, educational, and workforce challenges; to enable research communities to capitalize on new opportunities and discoveries; and to respond to new challenges. The

SLC portfolio represents synergistic, exciting research efforts that address many different dimensions of learning.

Each SLC award includes funding for an external evaluation of the center. Annual meetings of the SLC evaluators contribute to consistency across these evaluations and its usefulness for program managers. A Committee of Visitors (COV) review for the SLCs was held in 2009, and the SLCs will be part of a COV for the Directorate for Social, Behavioral, and Economic Sciences Office of Multidisciplinary Activities (SBE/OMA) in late 2011. An external evaluation of the SLC program is being planned for FY 2012.

Four awards for the first cohort of SLCs were made in FY 2004. One center was decommissioned in its second year due to its failure to develop cohesively as a center. Three awards for a second cohort were made in FY 2006. The remaining three centers in the first cohort have been approved for renewal through FY 2014, with some ramp down in funding beginning in FY 2012. In February 2011, the National Science Board will consider renewal actions for up to five years (through FY 2016) for two of the three second cohort centers. The third center in the second cohort will be extended at a reduced level of funding for four years, through FY 2015.

In FY 2012, $20.37 million (-$5.43 million from FY 2010 Enacted) will fund six SLCs. SBE/OMA will continue to oversee management of all six centers, with co-funding from the NSF Directorates for Biological Sciences, Computer and Information Science and Engineering, and Engineering.

SBE initiated external discussion on the future of the SLC program and the science it supports at its May 2010 Advisory Committee meeting. The consensus was that NSF should phase down the program as funding for individual centers comes to a close, shifting resources wherever possible to enhance support for the science of learning through non-center mechanisms. NSF will begin ramping down SLC funding in FY 2012, and as possible, redeploy some funds to activities in science of learning and brain sciences.

Estimates of Centers Participation in 2010

(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total FY 2010 NSF Support	Total Est. Leveraged Support	Number of Participants
Centers for Analysis & Synthesis	617	116	$23	$8	2,337
Centers for Chemical Innovation	71	57	$24	$3	490
Engineering Research Centers	369	263	$49	$85	3,583
Materials Centers	365	278	$52	$50	4,500
Nanoscale Science & Engineering Centers	522	550	$48	$46	3,900
Science & Technology Centers	131	108	$58	$59	3,127
Science of Learning Centers	44	73	$27	$8	981

No. of Participating Institutions: all academic institutions participating in activities at the centers.

No. of Partners: the total number of non-academic participants, including industry, states, and other federal agencies at the centers.

Total Leveraged Support: funding for centers from sources other than NSF.

No. of Participants: the total number of people who use center facilities, not just persons directly support by NSF.

Centers Supported by NSF in FY 2010

Center	Institution	State
Centers for Analysis and Synthesis		
National Center for Ecological Analysis and Synthesis	U of California-Santa Barbara	CA
National Evolutionary Synthesis Center	Duke, NC State U, U of N. Carolina	NC
National Institute for Mathematical & Biological Synthesis	U of Tennessee- Knoxville	TN
Plant Science Cyberinfrastructure Collaborative	U of Arizona	AZ
Centers for Chemical Innovation		
Center for Chemical Evolution (phase II)	Georgia Institute of Technology	GA
Center for Enabling New Technologies through Catalysis (phase II)	U of Washington	WA
Chemistry at the Space-Time Limit (phase II)	U of California-Irvine	CA
Powering the Planet (phase II)	California Institute of Tech	CA
Center for Chemistry Effects on Climate (phase I)	U of California San Diego	CA
Center for the Chemistry of the Universe (phase I)	U of Virginia	VA
Center for Energetic Non-Equilibrium Chem. at Interfaces (phase I)	U of Chicago	IL
Center for Green Materials Chemistry (phase I)	Oregon State U	OR
Center for Molecular Interfacing (phase I)	Cornell	NY
Center for Molecular Spintronics (phase I)	North Carolina State U	NC
Center for Molecular Tools for Conjugated Polymer Analy (phase I)	U of Texas Austin	TX
Center for Nanostructured Electronic Materials (phase I)	University of Florida	FL
Center for Quantum Info & Chemistry (phase I)	Purdue U	IN
Center for Stereoselective C-H Functionalization (phase I)	Emory U	GA
Engineering Research Centers		
Biomimetic Microelectronic Systems	U of Southern California	CA
Biorenewable Chemicals	Iowa State U	IA
Collaborative Adaptive Sensing of the Atmosphere	U of Mass-Amherst	MA
Compact and Efficient Fluid Power	U of Minnesota	MN
Extreme Ultraviolet Science and Technology	Colorado State	CO
Future Renewable Electric Energy Delivery & Mgmt. Systems	North Carolina State U	NC
Integrated Access Networks	U of Arizona	AZ
Mid-IR Tech for Health and the Environment	Princeton	NJ
Quality of Life Technology	Carnegie Mellon/U of Pittsburgh	PA
Revolutionizing Metallic Biomaterials	North Carolina A&T U	NC
Smart Lighting	Rensselaer Polytechnic Institute	NY
Structured Organic Composites	Rutgers	NJ
Subsurface Sensing and Imaging Systems	Northeastern	MA
Synthetic Biology	U of California-Berkeley	CA
Wireless Integrated MicroSystems	U of Michigan	MI
Materials Centers		
Brandeis Materials Research Science and Engineering Center	Brandeis U	MA
Center for Complex Materials	Princeton	NJ
Center for Emergent Materials	Ohio State U	OH
Center for Materials Research	Cornell	NY
Center for Materials Science and Engineering	Massachusetts Institute of Tech	MA
Center for Micro- and Nanomechanics of Materials	Brown	RI
Center for Multifunctional Nanoscale Materials Structures	Northwestern	IL
Center for Nanomagnetic Structures	U of Nebraska	NE
Center for Nanoscale Science	Pennsylvania State	PA
Center for Nanostructured Interfaces	U of Wisconsin	WI
Center for Research on Interface Structures and Phenomena	Yale	CT
Center for Science and Engineering of Materials	California Institute of Tech	CA
Center for Semiconductor Physics in Nanostructures	U of Oklahoma, U of Arkansas	OK, AR
Ferroelectric Liquid Crystals Materials Research Center	U of Colorado-Boulder	CO
Genetically Engineered Materials Science and Engineering Center	U of Washington	WA

Laboratory for Research on the Structure of Matter	U of Pennsylvania	PA
Materials Research Center	U of Chicago	IL
Materials Research Science and Engineering Center	Carnegie Mellon	PA
Materials Research Science and Engineering Center	Johns Hopkins	MD
Materials Research Science and Engineering Center	Harvard	MA
Materials Research Science and Engineering Center	Georgia Institute of Tech	GA
Materials Research Science and Engineering Center	New York U	NY
Materials Research Science and Engineering Center	U of California-Santa Barbara	CA
Materials Research Science and Engineering Center	U of Maryland	MD
Materials Research Science and Engineering Center	U of Minnesota	MN
Materials Research Science and Engineering Center on Polymers	U of Massachusetts	MA
Renewable Energy Materials Science and Engineering Center	Colorado School of Mines	CO
Nanoscale Science and Engineering Centers		
Affordable Nanoengineering of Polymer Biomedical Devices	Ohio State	OH
Center for Environmental Implications of Nanotechnology (CEIN)	Duke	NC
Center for Integrated and Scalable Nanomanufacturing	U of California-Los Angeles	CA
Directed Assembly of Nanostructures	Rensselaer Polytechnic Institute	NY
Electronic Transport in Molecular Nanostructures	Columbia	NY
High Rate Nanomanufacturing	Northeastern, U of New Hampshire, U of Mass-Lowell	MA, NH
Integrated Nanomechanical Systems	U of California-Berkeley, Cal Tech, Stanford, U of California-Merced	CA
Integrated Nanopatterning and Detection Technologies	Northwestern	IL
Molecular Function at the Nano/Bio Interface	U of Pennsylvania	PA
Nanotechnology in Society Network: Center at ASU	Arizona State U	AZ
Nanotechnology in Society Network: Center at UCSB	U of California-Berkeley	CA
Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Urbana Champaign	IL
Nanoscale Systems in Information Technologies	Cornell	NY
Nanoscience in Biological and Environmental Engineering	Rice	TX
National Nanomanufacturing Network: Center for Hierarchical Manufacturing	U of Massachusetts-Amherst	MA
Predictive Toxicology Assessment & Safe Implementation of Nanotechnology in the Environment (CEIN)	U of California-Los Angeles	CA
Probing the Nanoscale	Stanford, IBM	CA
Science of Nanoscale Systems and their Device Applications	Harvard	MA
Templated Synthesis and Assembly at the Nanoscale	U of Wisconsin-Madison	WI
Science and Technology Centers		
An NSF Center for the Study of Evolution in Action	Michigan State U	MI
Center of Adv. Materials for the Purification of H2O wth Systems	U of Illinois-Urbana Champaign	IL
Center for Biophotonics Science and Technology	U of California-Davis	CA
Center for Coastal Margin Observation and Prediction	Oregon Health and Science U	OR
Center for Dark Energy Biosphere Investigations	U of Southern California	CA
Center for Energy Efficient Electronics Science	U of California-Berkeley	CA
Center for Embedded Networked Sensing	U of California-Los Angeles	CA
Center for Integrated Space Weather Modeling	Boston U	MA
Center for Layered Polymeric Systems	Case Western Reserve U	OH
Center for Microbial Oceanography: Research and Education	U of Hawaii-Manoa	HI
Center for Multi-Scale Modeling of Atmospheric Processes	Colorado State U	CO
Center for Remote Sensing of Ice Sheets	U of Kansas	KS
Emergent Behaviors of Integrated Cellular Systems	MIT	MA
Emerging Frontiers of Science Information	Purdue U	IN
National Center for Earth Surface Dynamics	U of Minnesota-Twin Cities	MN
Center on Materials and Devices for Info. Technology Research	U of Washington	WA
Team for Research in Ubiquitous Secure Technology	U of California-Berkeley	CA

Science of Learning Centers

Center for Excellence for Learning in Education, Science, & Tech.	Boston U	MA
Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms	Carnegie Mellon	PA
LIFE Center - Learning in Formal and Informal Environments	U of Washington	WA
Spatial Intelligence and Learning Center	Temple	PA
The Temporal Dynamics of Learning Center	U of California-San Diego	CA
Visual Language and Visual Learning	Gallaudet	DC

CYBERINFRASTRUCTURE FRAMEWORK FOR 21st CENTURY SCIENCE AND ENGINEERING (CIF21)

Goal

Develop and deploy comprehensive, integrated, sustainable, and secure cyberinfrastructure (CI) to accelerate research and education and new functional capabilities in computational and data-intensive science and engineering, thereby transforming our ability to effectively address and solve the many complex problems facing science and society.

Description and Rationale

Widespread use of a comprehensive CI framework has the potential to revolutionize every science and engineering discipline as well as education. Computing power, data volumes, software, and network capacities are all on exponential growth paths. Highly diverse, multidisciplinary collaborations and partnerships are growing dramatically, greatly enabled by new and emerging technologies, spanning multiple agencies and international domains to address complex grand challenge problems. Scientific discovery is being advanced by linking computational facilities and instruments to build highly-capable simulation models, sophisticated algorithms, software, and other tools and services. CIF21 will enable new approaches to research and education – supporting new modalities such as distributed collaborative networks, allowing researchers to more easily adapt to changes in the research and education process, and providing an integrated framework for people, instruments, and tools to address complex problems and conduct multidisciplinary research. CIF21 will consist of secure, geographically distributed, and connected CI: advanced computing facilities, scientific instruments, software environments, advanced networks, data storage capabilities, and the critically important human capital and expertise.

NSF has a long history of providing leadership for CI and computational science for the U.S. academic science and engineering community, including high performance computing (HPC) systems and the networks and tools to provide access to such capabilities and systems. *Revolutionizing Science and Engineering through Cyberinfrastructure* (2003) set the stage for aggressive efforts led by NSF to build transformative CI. The creation of the Office of Cyberinfrastructure (OCI) provided a focal point for enhancing CI and moving into other important areas such as data interoperability and virtual organizations. The NSF Cyber-enabled Discovery and Innovation (CDI) investments developed new approaches to research and education across the NSF disciplines and in numerous interdisciplinary areas.

NSF has now determined that, in order to realize the potential of CI and computational science to accelerate the progress of science and engineering, it must elevate its coordination and leadership in these areas. The NSF Advisory Committee for Cyberinfrastructure (ACCI) established six task forces in FY 2010 to address critical emerging needs and opportunities, and initiated detailed planning for the development of a framework for expanding the influence of CI. Simultaneously, NSF established an NSF-wide working group to discuss, plan, and coordinate CI programs and activities. These parallel activities led to the development of CIF21, which is designed to leverage previous CI and ongoing CI investments for transformative results across science and engineering. The portfolio has four interconnected components that underpin efforts to realize the potential of computational and data-enabled science:

- Data-Enabled Science
- Community Research Networks
- New Computational Infrastructure
- Access and Connections to Cyberinfrastructure Facilities

In addition to specific activities in each of these four areas, NSF's CIF21 investments will benefit two key domains of high priority for the Nation:

- Matter by Design, which will build on existing strengths in nanotechnology, nanomanufacturing, materials science, mathematical and statistical science, chemistry, engineering, software applications, and investments in programs such as PetaApps and CDI; and
- Research activities in energy, environment, and society, as presented in NSF's Science, Engineering, and Education for Sustainability (SEES) portfolio.

NSF is developing and supporting a systematic and purposeful approach to the creation, development, deployment, and maintenance of cyberinfrastructure. NSF has adopted a "spiral" development approach (for data, software, hardware, etc) that utilizes 3-5-year periods (spirals) leading to new and successively more sophisticated generations of comprehensive cyberinfrastructure to explore and support science and engineering. Establishing effective cyberinfrastructure to handle the volume and range of data in today's world, coupled with the need for more advanced computational expertise and capabilities, requires focus, planning, and long-term coordination. CIF21 will consolidate, coordinate, and leverage a set of CI programs and efforts across NSF to create and establish meaningful infrastructure and develop a level of integration and interoperability of data and tools that is unprecedented. A roadmap for this spiral development path is in process of being finalized and will be shared with stakeholders.

Complex problems in areas of national importance will benefit from creating research and education communities that coalesce around computational and data-enabled challenges and make use of CI and CI-connected infrastructure of all types. CIF21 will establish a broad foundation in computational and data-enabled science and engineering (CDS&E) that supports both disciplinary and interdisciplinary research environments.

Details on each of the four CIF21 components are provided below.

Data-Enabled Science

Data are being generated at prodigious rates across science and engineering, leading to new insights, innovation and discovery. They are already radically transforming science and society. Data-enabled science refers to any science that depends on data; data-intensive science is a subset of data-enabled science and refers to science that uses computational methods to analyze and manipulate data. Because generation, use, curation, and reuse of data are critical components of all science and engineering, CIF21 emphasizes immediate and long-term data support and infrastructure and the development of data-intensive computational algorithms and mathematical and statistical methods including data analytic tools, interoperability, and repositories. CIF21 efforts to facilitate and advance data-intensive scientific and engineering research will be highly responsive to the differing needs of specific research communities, in the context of the overall goal of facilitating the collection, analysis, and retention of data critical to NSF-related research domains. Data acquired or created through simulations, modeling, and analytics provide a basic resource for future research and the opportunity to increase the understanding and involvement of students and the general public in science and engineering.

Within the Data-Enabled Science component of CIF21, three efforts will be initiated in FY 2012. These are data services, data analysis, and data-intensive science.

The data services program will focus on establishing data services, including providing reliable digital preservation, access, integration, and curation capabilities for science and engineering data over a decades-long timeline and serving as component elements of an interoperable data preservation and access network. The program will build on and leverage prior investments in high-end computing, networking, software, algorithms, digital libraries, and domain-specific data systems. Efforts will include

community engagement to develop standards, open access policies, meta-data systems, and ontologies; education and training of a knowledgeable workforce in data; new institutional paradigms for archiving and curation on a national grid; and new global data partnerships able to catalyze and deploy advances quickly. This program will enable transparent access, control, analysis, and synthesis of data and information, while maintaining data integrity and ensuring appropriate security and privacy.

The data analysis program will focus on data analysis efforts and tools that support data mining, manipulation, modeling, simulation, visualization and decision-support systems and will also continuously anticipate and adapt to changes in technologies and in user needs and expectations.

The data-intensive sciences program will support data-intensive scientific and engineering that requires intensive disciplinary efforts and fosters wide ranging, broad programs that build from multiple data domains and areas of expertise to cross disciplinary boundaries and create new algorithms and policies for areas such as data sharing and open access.

Community Research Networks

New cyberinfrastructure tools and changes in the research process have enabled community research networks to address complex, multi-disciplinary problems of societal concern such as competitiveness, security, economic development, and well-being. Community research networks enable people and organizations to perform everyday research functions more effectively by building on and integrating diverse resources, knowledge, and abilities. NSF has a long history of investing in community research networks such as the iPlant collaborative, the Southern California Earthquake Center, the SRS Data Enclave, and the nanoHUB. Cyberinfrastructure links these combinations of people, organizations, instrumentation, physical facilities, computers, data, and software, but few scientists know how to select and assemble these components into a functioning community research network. Focused investments in sociotechnical analyses advance understanding of how to develop virtual organizations, and under what conditions they can foster innovation in science, engineering and education. Such investments are necessary to harness the full potential and promise offered by virtual organizations.

Two efforts are planned for FY 2012 within the Community Research Networks component of CIF21.

The first program will support the establishment of new multidisciplinary research communities to exploit existing and developing computational and data-enabled capabilities to attack scientific challenges that require groups or communities of researchers. To better support and optimize research community networks, appropriate resources must be created for each of three kinds of collaborations: small, mid-level, and large. Small research community networks include two or three researchers working in one or at most two organizations. Mid-level research community networks involve four to seven researchers across three to five organizations. Large research community networks involve eight or more researchers across more than five organizations. Mid and large-scale networks will connect already functioning research groups, potentially including centers.

The second program will focus on advanced research on community research networks. Although the terms “community research networks,” “social networks,” “collaboration,” “virtual organizations,” and “multi-disciplinary research” are used frequently, the underlying processes and optimal structures are not systematically well researched. Relatively little is known about how they unfold, their various structures and forms of leadership, how to provide them with conducive environments, their role in promoting the advancement of science and in addressing societal concerns, and, finally, the role of cyberinfrastructure in supporting and fostering them.

The community research networks that are envisioned as part of the Research Coordination Networks and SEES investments, where highly interdisciplinary, global interactions are essential, will provide a unique

arena for research on scientific networks. Other research efforts include a portfolio of research community networks, approaches to address complex, multidisciplinary distributed grand challenge problems, and offering new ways to collaborate and support transformative research. Advances in this area will allow scientists to collaborate more broadly, more rapidly, and across more dimensions than ever before.

New Computational Infrastructure

A new vision for computational resources and services, from HPC, clouds, clusters, and data centers to focused special-purpose resources and incorporation of sustained software at all levels, all protected and embedded in a rich and robust cybersecure environment, will provide the foundation for supporting innovation and discovery in computational and data-enabled science and engineering. Discipline-specific, as well as cross-discipline software institutes, novel computing platforms, multi-disciplinary data centers, and major computational resources will be expanded to address and support long-term research requirements. Realizing this vision requires attention to the sustainability and extensibility of software, data, and algorithms as well as efforts that ensure robustness while also providing opportunities for upgrades and for introduction of new capabilities.

Two efforts are planned for FY 2012 within the New Computational Infrastructure component of CIF21.

The first program will focus on establishing new, innovative computational and data-enabled resources that will leverage and expand the existing HPC sustainable program. This includes innovative computing environments (e.g., GPGPU, clouds) as well as innovative data sharing and archiving systems and approaches such as shared distributed file systems and services. Other resources needed to advance science and engineering will be developed including a focus on leveraging existing and planned computational capabilities with a plan toward interoperability. And once the computational or data resource becomes operational, it will be linked and integrated with other CI resources (such as eXtreme Digital (XD)) to significantly expand the national and global cyberinfrastructure ecosystem. These activities will also provide an important step towards more deeply integrating campus and national CI (including projects funded through NSF's Major Research Equipment and Facilities Construction (MREFC) account), making it easier to address scaling problems as well providing deeper connectivity between researchers at different sites and in different communities.

The second effort will leverage and expand the activities of the existing Software Infrastructure for Sustained Innovation (SI2) program. This effort will focus on the development of new software tools and services across multiple science disciplines. It also will focus on software as a service; application interfaces, workflows, middleware, testing, evaluation, deployment models and sustainability. It should be noted that a significant efforts in education will required, from undergraduates to postdocs to faculty as CDS&E is essentially new ground for the academic community. While such activities will benefit individual research groups, emphasis will be placed on discipline-specific activities that impact communities, providing services that also may integrate with the national CI investments such as MREFCs, XD, and SI2.

Access and Connections to Cyberinfrastructure Facilities

Many NSF research communities are already organized for conducting research around major pieces of infrastructure. The Global Environment for Network Innovations (GENI) is exploring network architectures and models to support next generation science and research; these new models will inform the development and deployment of leading edge network connections and access. Improved access and connections to facilities and scientific instruments and resources will enable computational communities built around emerging national data- and compute-intensive facilities, such as the National Ecological Observatory Network (NEON), Ocean Observatories Initiative (OOI), EarthScope, Network for Earthquake Engineering Simulation (NEES), and iPlant. Effective use of networks of remote instruments

(e.g., Arctic Observing Network and Polenet) and access to large databases by remote users are essential and require research and development for user-control and interactive remote steering. Research in this topical area also includes work on connectivity to widely distributed sensors, diverse data collections, and geographically remote instruments, where the challenge is not simply one of adequate bandwidth, but of providing at-speed secure connectivity to campuses and labs for researchers and students.

Within the Access and Connections to Cyberinfrastructure Facilities component of CIF21, two programs are planned for FY 2012.

The first program in this CIF21 component is a network connections and engineering program that combines both new and upgraded network connectivity with advancements in deployed networking technology drawn from academic research, commercial development, and engineering. This program has three elements: access to facilities and instruments, networking for the campus and researcher, and integration.

Access to facilities and instruments will address capacity requirements for existing and new facilities and instruments that are being driven by a non-linear increase in scientists' ability to capture data, (for example, through the Large Synoptic Survey Telescope).

Networking for the campus and researcher will focus on investments in the "last mile" connections and building upgrades (including end-to-end activities) to ensure researchers and students have adequate access from their office desktops and not just from centrally-located campus facilities.

Integration will support end-to-end networked cyberinfrastructure through integration activities, including transitioning successful research to development, deployment, and broad scale use.

The second program will expand the efforts in cybersecurity (including identity management) and will leverage the considerable research efforts NSF already supports. The program will focus on moving cybersecurity from innovation to practice and early deployment as part of NSF's support for CNCI.

Management, Assessment, and Funding

Activities in FY 2012 will include enhancing ongoing programs, integrating programs, and issuing new solicitations for CIF21. The portfolio of investments will continue to be led by a senior NSF leadership team and coordinated by an implementation group of senior managers. Advancing the CIF21 vision is a Foundation-wide priority that is reflected not only by the participation of the different units identified in the table below, but also by a management strategy that coordinates these diverse investments in a way that supports science by leveraging the benefits of centralized and scalable cyber-resources. This will be achieved by enlisting the participation of program officers across the Foundation who are members of the CIF21 Working Group (CIF21 WG) to help manage CIF21 solicitations and provide direct linkages to each directorate and office. The CIF21 WG and the senior NSF leadership team are developing performance metrics for each major component of CIF21 and a process to assess and evaluate the programs and efforts of CIF21; these will be finalized in FY11 and put into place before FY12 execution. The NSF Advisory Committee for Cyberinfrastructure (ACCI) will review the CIF21 program and provide external oversight.

Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) Funding

(Dollars in Millions)

	BIO	CISE	ENG	GEO	MPS	SBE	OCI	OPP	IA	Total, NSF
Data-Enabled Science	$3.00	$7.00	$5.00	$7.00	$10.90	$4.00	$10.00	$3.00	-	$49.90
Community Research Networks	1.00	-	-	2.00	-	3.00	2.00	1.00	-	9.00
New Computational Infrastructure	1.00	9.00	3.00	5.00	9.10	-	5.00	-	11.00	43.10
Access and Connections to Cyberinfrastructure Facilities	1.00	-	1.00	2.00	-	5.00	6.00	-	-	15.00
Total, CIF21	**$6.00**	**$16.00**	**$9.00**	**$16.00**	**$20.00**	**$12.00**	**$23.00**	**$4.00**	**$11.00**	**$117.00**

SCIENCE AND ENGINEERING BEYOND MOORE'S LAW (SEBML)

Goal: Position the U.S. at the forefront of communications and computation capability beyond the physical and conceptual limitations of current technologies.

Description and Rationale: The transistor was demonstrated in 1947, and once multiple devices were simultaneously fabricated, the packing density of devices on a chip began to increase. Moore's Law is the empirical observation, made in 1965, by the co-founder of Intel, Gordon E. Moore, that semiconductor device density, and therefore computer processing power, doubles about every 18 months. Currently, many innovations are being pursued to prolong the scalability of computer processing power, but with silicon technology the fundamental physical and conceptual limits of Moore's Law are likely to be reached in 10 to 20 years.

To take computation *beyond* Moore's Law requires new scientific, mathematical, engineering, and conceptual frameworks. Long term basic research across many disciplines will lead to the new hardware and architectures needed to address challenges such as efficient input and output, data storage and communication, and reduction of energy consumption, as well as sheer computing power. Further, there are also great potential increases in speed of basic computations due to innovative new algorithms and software, and new mathematical frameworks for computation. In the near term, massively parallel machines require a fundamental shift from the traditional sequential model of computation in order to utilize distributed paradigms such as grid and cloud computing. In the longer term, a completely new physical and conceptual foundation of computing will likely be needed.

SEBML is a multidisciplinary research investment with strong ties to future economic competitiveness and potential for long term transformation. Tied to nanotechnology, computer science, chemistry, mathematics, materials science, and physics, it builds on past NSF investments and energizes them with new directions and challenges. Connections to the communications and computer industries ensure that SEBML will directly address economic benefits to the Nation. This research will also enhance NSF investments in both the National Nanotechnology Initiative (NNI) and Networking and Information Technology Research and Development (NITRD).

Potential for Impact, Urgency, and Readiness: The U.S. has fundamental strengths in computers and information systems. In today's globalized enterprise, however, many other countries dominate parts of the hardware and software markets. The areas where the U.S. currently excels are in innovative state-of-the-art components, which require a continual investment in research and development. The reward of this approach has been continual leadership in the areas of the largest economic return. To continue U.S. leadership, a paradigm shift is required in the physical foundations of computing. For more details, see: www.er.doe.gov/bes/reports/files/GC_rpt.pdf, www.itrs.net/Links/2009ITRS/Home2009.htm, and www.calyptus.caltech.edu/qis2009/documents/FederalVisionQIS.pdf

Fundamental research will focus on a number of areas, including:

- *New materials, devices, and processes* that exploit the capability to create and manipulate specific quantum states. Some possible candidates include optical and photonic systems, spin-based or single electron transistors, atom condensates, ions, non-equilibrium devices, and molecular-based approaches including biologically inspired systems.
- *New architectures*, particularly multi-core processors, with new control principles, massive parallelism, and designed asynchronicity and indeterminacy. Advances may be applicable to other communication, distribution, and computing systems, leading to truly transformational outcomes.
- *New algorithms* that exploit hardware and architecture characteristics to optimize computing power, including those that exploit quantum behavior. The consideration of biological and social systems may lead to new approaches.

- *New software* that allows the effective use of new devices. New programming models will be needed, along with languages and compilers to support them. Tools for analyzing, monitoring, debugging, and documenting software on these parallel and distributed systems will be essential.
- *New paradigms* that take us from bits (binary logic) to quantum bits or qubits (non-binary logic). These programming models are shifts in thinking that change the conceptual base of computing.
- *New awareness* of power and energy considerations throughout the "computation stack" from physical devices to architectures to software and applications.

Integration of Research and Education: SEBML has the potential to take computing and communications to new levels of capability, making the development of a workforce trained in these new areas particularly important. All activities will seek creative ways to engage students and, as appropriate, take new ideas into formal and informal learning environments.

Leveraging Collaborations: NSF has proven partnerships among its directorates, connections with other communities (notably other governmental funding organizations and industry), and collaborations with international partners. Strong potential exists for interagency partnering with organizations such as the Department of Defense, Department of Energy, National Aeronautics and Space Administration (NASA), National Institutes of Science and Technology and the intelligence community. NSF, in particular the Directorate for Mathematical and Physical Sciences (MPS), Engineering (ENG), and Computer and Information Science and Engineering (CISE), and the Office of Cyberinfrastructure (OCI) has the broad responsibility for support of fundamental research needed to have a significant technological impact.

In FY 2010, MPS invested more than expected in SEBML ($59.12 million actual versus $18.68 million estimated) due to an increase in proposals in this area from the scientific community. In FY 2012, MPS will partner with ENG, CISE, and the Nanoelectronics Research Initiative — a consortium of companies in the Semiconductor Industry Association — to fund $20.0 million in nanoelectronics.

Evaluation and Management: While it may be 10 to 20 years before the full impact of the investment is known, indicators of success will be developed and monitored along the way. Indicators of a growing capability to conduct research in SEBML include: increased numbers of students involved in SEBML projects and related data on breadth/diversity of participation, degree completion, opportunities to participate in interdisciplinary teaming, and progression to higher levels of education or first professional jobs; increased numbers of researchers involved in SEBML projects; numbers of collaborative projects that span disciplines or institutions; increased partnerships with national labs and private sector organizations; and the development of curricular materials or informal education activities that convey aspects of SEBML research. Indicators of research progress include highlights demonstrating progress from NSF awards; publications and patents resulting from NSF awards; and public or private sector adoption of ideas from NSF awards in developing new technologies that stimulate innovation. External review panels and new Science of Science and Innovation Policy tools will be involved in evaluating progress on SEBML research and education.

SEBML Funding
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
CISE	$15.00	$15.00	$20.00
ENG	10.00	10.00	31.00
MPS	59.12	18.68	42.18
OCI	-	3.00	3.00
Total, SEBML	**$84.12**	**$46.68**	**$96.18**

SCIENCE, ENGINEERING AND EDUCATION FOR SUSTAINABILITY (SEES)

Goal
Advance climate and energy science, engineering, and education to inform the societal actions needed for environmental and economic sustainability and sustainable human well-being.

Description and Rationale
SEES is designed to foster insights about the environment-energy-society nexus that will increase the effectiveness of our energy and management policies in adapting to, and mitigating the impacts of, environmental and climate change. SEES research will improve our capabilities for rapid response to extreme events, such as power grid disruption, floods, or extreme weather.

In response to numerous major community reports, including the National Science Board's *Building a Sustainable Energy Future* (2009), NSF developed the Science, Engineering, and Education for Sustainability (SEES) portfolio in FY 2010, by drawing the programs that address sustainability into a common framework to optimize investments and outcomes. The shape of the portfolio was influenced by reports from many disciplines, such as *The Mathematics of Climate Change: A New Discipline for an Uncertain Century* (Mathematical Sciences Research Institute, 2007), and various assessments such as the United States Climate Change Science Program report, the *Effects of Climate Change on Energy Production and Use in the United States* (2008). Initial efforts focused on coordinating a suite of research and education programs at the intersection of climate and environment, with specific attention to human behavior. NSF released solicitations that aligned with and expanded key aspects of the existing SEES portfolio. In FY 2010, these solicitations (Water Sustainability and Climate; Dimensions of Biodiversity; Ocean Acidification; Regional and Decadal Earth System Modeling; and the Climate Change Education Program) resulted in 70 awards totaling approximately $66.0 million.

Beginning in FY 2012, NSF will expand the SEES portfolio (+$337.45 million, to a total of $998.19 million) through significant investments that 1) continue the integration, responsiveness, and effectiveness of ongoing programs; 2) emphasize research and education on Sustainable Energy Pathways (SEP); 3) institute a formal program of Postdoctoral Fellowships in Sustainable Solutions; 4) initiate a program of interdisciplinary Sustainability Research Networks (SRNs) linking existing and new nodes; and 5) include international connections through targeted awards in the Partnerships for International Research and Education (PIRE) program. These SEES plans align with key national and NSF priorities to stimulate the discovery and innovation needed to address the challenges of creating sustainable energy solutions and building human capacities to imagine, design, and implement them.

SEES themes will also be reflected in other major FY 2012 investments. These include: 1) the new $20.0 million Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) program in the Directorate for Education and Human Resources, which aims to advance large-scale improvements to undergraduate STEM educational practices; and 2) the new $12.3 million Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) program under the Office of Integrative Activities, which has the dual objectives of fostering research in multiple disciplines and lowering the disciplinary barriers that exist within NSF and in the research community.

Integrated Science and Engineering Research on Environmental, Economic and Energy Systems (+$47.75 million in FY 2012): NSF has broad and long-standing investments in environment, energy, climate, social and behavioral sciences, education and workforce development, mathematics, and many other areas of fundamental research and education that provide a foundation for the development of innovative solutions to pressing problems in sustainability. Research in such areas as complex environmental and climate-system responses and pathways will continue to be supported and emphasized across NSF and will be matched by increased emphasis on activities focused on sustainable and clean

energy technologies. These solutions must simultaneously take into account social, environmental, and economic sustainability, through deep understanding of how these systems interact with one another.

NSF's unique mandate to support all areas of science, engineering, and science education allows it, through SEES, to address research aimed at tackling the full range of complex system level problems. SEES research will include investigation of the fundamental role of social, economic, and political systems as well as the conceptual, theoretical, empirical, and computational challenges needed to further develop the basic science, engineering, education, and policy knowledge base required for planning at both individual and systems levels.

The NSB report outlined a range of needed research investments in the area of sustainable energy, including: novel energy storage schemas; ecosystem impacts of energy technologies; improving the efficiency and yield of established and emerging energy systems; and the development of clean energy sources, such as biofuels and ocean/kinetic power. In response, SEES will investigate energy-intelligent computational performance in computer and network systems, as well as use of information technology in smart sensing systems that have the potential to save energy. Energy efficiency and renewable alternatives to fossil fuels and raw materials in manufacturing processes will be stressed, as will research on economical alternatives to traditional chemical products and practices.

SEES research will address some key scientific uncertainties identified in the Intergovernmental Panel on Climate Change (IPCC) report. These include: interactions among the climate, human, and natural systems; feedbacks in the climate, particularly carbon cycles; impacts of ice sheets dynamics on climate change and sea level rise; regional climate change and causes; the difference between low probability/high impact events and high probability/low impact events on risk-based approaches to decision making; interactions between socio-economic factors and the evolution and utilization of adaptive and mitigating strategies; barriers, limits and costs of adaptation; and effects of lifestyle and behavioral changes on energy consumption and climate.

SEES will have an enhanced focus on the dramatic stresses faced by the linked coasts and oceans and the Arctic region. Productive and fragile, these ecosystems and coastal communities continue to feel the sharp impact of occasional disasters, such as oil spills, superimposed on the gradual but inexorable pressures of human use, warming temperature, and rising sea level. Data on climate, energy, and the environment will also be integrated with information on human demographics and other trends.

In addition to advances in research, the FY 2012 awards will include activities that help prepare an informed, solutions-oriented citizenry and future workforce to address the complex problems and decisions associated with sustainability. Experiences for undergraduate, doctoral, and postdoctoral students will complement experiences currently supported by the Climate Change Education program, which includes projects on public engagement with science.

Sustainable Energy Pathways (SEP) (+$178.20 million in FY 2012): The creation of a secure and prosperous future depends on progress toward reliable energy resources that will not degrade essential ecosystems and environmental services, nor lead to unacceptable social or economic consequences. One of NSF's strengths is the ability to mobilize the social, behavioral, and economic science research community to work in close collaboration with natural scientists and engineers to provide a comprehensive and integrated approach to solving questions of sustainability.

Potential areas that may benefit from this integrated approach include: technological and societal hurdles and options for a hydrogen economy; development and acceptance of new materials for higher-efficiency/lower-cost energy production, novel battery components, and energy transmission technologies; optimization of energy usage through new algorithms and intelligent decision-making for

computational and data-intensive systems; controls and limits on primary productivity and land use; access and optimization challenges for renewable energy sources, such as solar, wind, tidal, geothermal, and biomass; energy storage technologies to overcome the intermittency of energy generation from certain sources and capacitors; and the human dimensions of decision-making with respect to a low carbon energy future, and associated assessments of economic and environmental risks and impacts for each technology solution.

Specific SEP goals are to:

- Create the fundamental knowledge base necessary to characterize and understand existing energy systems and their limitations, and to imagine, invent, and deploy clean and renewable energy systems, as appropriate and in partnership with the Department of Energy (DOE) and other agencies;
- Explore innovative and sustainable alternative energy sources and technologies;
- Investigate novel pathways for human energy futures based on a comprehensive understanding of risks and stressors associated with new energy approaches and their environmental responses, including biological, hydrological, and societal aspects;
- Develop human capital to address the interdisciplinary challenge of building a sustainable energy future; and
- Foster public engagement with issues of energy sustainability science and engineering.

Postdoctoral Fellowships in Sustainable Solutions (+$11.50 million in FY 2012): A postdoctoral fellowships program will continue in FY 2012. The program's emphasis is on gaining experiences that build bridges between academic inquiry, economic growth, and societal needs. These may range from research expertise in energy technology development to investigation of how to facilitate the public's adaptation of those technologies. Sustainability issues require inherently interdisciplinary research and education efforts–often at the intersection of the environmental sciences, engineering, and the social and behavioral sciences—and these efforts often do not fit neatly into traditional academic structures. Because near term capacity needs are critical, it is necessary to reduce institutional barriers in order to enable existing faculty members, as well as those who are just entering the postgraduate workforce, to effectively contribute to solving complex sustainability-related problems. While eligibility for these fellowships is open to recent and early doctoral scientists and mid-career faculty, applicants are required to gain expertise in a discipline different from the one in which they have been educated or working. The fellow is also expected to develop a partnership activity that would broaden the impact and/or scope of sustainability efforts, such as a connection with: an SRN or industry; a national laboratory; an NSF-supported center or facility; a professional society; a state, regional, or local resource management agency; an education project that focuses on public engagement and broadening participation; or another appropriate entity.

Sustainability Research Networks (SRN) (+$85.0 million in FY 2012): A primary way NSF will address the SEES goals is through Sustainability Research Networks (SRNs), which cross the boundaries of all scientific disciplines. Through the existing Research Coordination Networks program and other NSF programs encouraging collaborations, investigators have begun to build teams and explore fundamental theoretical issues and empirical questions, such as how our nation can move toward improved predictions, technologies, policies and practices to achieve sustainability and how we can harness clean and renewable sources of energy to build healthy environments and conserve biodiversity on Earth, while ultimately enhancing economic vigor and human well-being.

In FY 2012, best practices from existing NSF activities will guide expansion of each network's reach and integrate the major themes of energy, environment, and the economy. All SRNs will be required to design educational and information exchange systems to engage the general public and policymakers in understanding sustainability issues and to help scientists understand societal needs. These networks will

tap highly talented individuals from both the U.S. and other countries who represent a spectrum of disciplines, perspectives, and research methods. These scientists, unconstrained by institutional boundaries, will work together to develop and deploy cyberinfrastructure to convey and meld disparate sources of data. These networks will connect with existing centers of research excellence, such as relevant Science and Technology Centers (STCs) and Engineering Research Centers (ERCs), which investigate sustainability science and engineering topics such as predictive modeling and decision-making under uncertainty. A fully-developed network would include network-level research, cyberinfrastructure for data management and modeling, student support, workforce training, community engagement in the network's thematic areas, and evaluation and assessment activities. It is important to note that not all activities in the SRN networks will be supported solely by NSF; for example, DOE Innovation Hubs, focused on solar energy and energy storage, which are basic research topics of interest to both agencies, might be associated with SRN networks.

Partnerships for International Research and Education (PIRE) (+$15.0 million in FY 2012): Many of the intellectual and practical SEES challenges are global in scope and require a comparative understanding of geographic, ecological or cultural variability. International activities in sustainability will seed new paradigms for the cross-fertilization of ideas based on region-specific resources, and will provide access to international expertise, facilities, and data. The PIRE competition will focus on sustainability research—integrating topics such as clean and renewable energy, environmental resilience, and regional economies—with other countries by facilitating the exchange of ideas, materials, instrumentation, researchers, and students. Many of these teams will be linked with SRNs to enhance their global impact.

Other Partnerships: A hallmark of SEES has been, and will continue to be, formation of partnerships with other agencies and appropriate entities. The United States Department of Agriculture (USDA) and DOE have participated in SEES programs. Discussions with USDA, DOE, the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), and the United States Geological Survey (USGS) indicate considerable interest in building joint programs and sharing infrastructure. Industrial partnerships will help define and discover the basic science needed to build a sustainable industrial base. Included in these efforts will be activities aimed at bolstering industry/university interactions, such as forums and networks that connect fundamental research developments with regional and national innovation ecosystems, and related activities through the Engineering Research Centers (ERCs), Science and Technology Centers (STCs), Industry/University Cooperative Research Centers (I/UCRC) program. Research funding agencies from a number of other countries, including the European Union, have expressed considerable interest in offering parallel solicitations on sustainability topics.

Management, Assessment, and Funding

Activities in FY 2012 and beyond will include enhancing ongoing programs, deepening integration among programs, and issuing new SEES solicitations. A roadmap of detailed plans has been developed to guide program development, management, and evaluation. The portfolio of investments will continue to be led by a senior NSF leadership team and coordinated by an implementation group of senior managers. Working groups of program officers will manage specific solicitations. The overall program will be reviewed by several NSF Committees of Visitors, with particular attention paid by the Advisory Committee for Environmental Research and Education. The impact of the networks' research results and their dissemination will be measured by program review methods appropriate to each program. Evaluation tools will include bibliometric analysis of research publications, STAR Metrics to assess human capital development, and wiki crowd sourcing to monitor biodiversity milestones. Evaluation of the postdoctoral fellowship program, for example, will assess the extent to which interdisciplinary experiences and direct connections with practitioners help meet the goal of identifying research needs and disseminating solutions. By 2015, the impact of the SEES program will be measured against its goals to:

increase the knowledge base available to scientists and decision-makers; accelerate identification and deployment of technologies to address sustainability issues; and create a robust cadre of early career sustainability scientists and engineers.

SEES Portfolio Funding

(Dollars in Millions)

	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request Level
Biological Sciences	$121.00	$146.00
Computer and Information Science and Engineering	17.00	46.36
Engineering	108.20	162.00
Geosciences	195.50	282.70
Mathematical and Physical Sciences	87.00	160.00
Social, Behavioral and Economic Sciences	20.78	56.98
Office of Cyberinfrastructure	5.50	5.00
Office of International Science and Engineering	2.50	17.00
Office of Polar Programs	65.26	83.65
Office of Integrative Activities	26.50	26.50
Subtotal, Research and Releated Activities	$649.24	$986.19
Education and Human Resources	11.50	12.00
Total, SEES	**$660.74**	**$998.19**

Totals may not add due to rounding.

SELECTED CROSSCUTTING PROGRAMS

NSF crosscutting programs include interdisciplinary programs and programs that are supported by multiple directorates. Examples of major crosscutting activities include the following:

ADVANCE

A budget of $21.65 million for ADVANCE in FY 2012, an increase of $630,000 above the FY 2010 Enacted level of $21.02 million, will fund transformative efforts to address the systemic barriers to women's full participation in academic science, technology, engineering, and mathematics (STEM). ADVANCE will broaden the spectrum of institutions participating in the program. Predominantly undergraduate institutions, teaching intensive colleges, community colleges, minority-serving institutions, and women's colleges will be reached through the IT-Catalyst program component, which provides support to institutions to undertake institutional self-assessment activities. The funding will also support new awards under the Institutional Transformation (IT) program component as well as an overall program evaluation and data collection to capture the impact of prior ADVANCE awards.

ADVANCE has begun the planning process for an evaluation of its program, focusing primarily on awards that have completed their funding cycles. The evaluation examines such questions as:

- What is the impact of ADVANCE on institutional transformation?
- What is the impact of ADVANCE on individuals in ADVANCE programs?
- What is the impact of ADVANCE beyond institutions (e.g., publications, new collaborations)?
- How and why have successful programs worked in specific institutional contexts?

Current plans for the evaluation design include a quasi experimental design using comparison data from the Survey of Doctorate Recipients, together with a case study approach that involves site visits and in-depth interviews with faculty and administrators, along with analysis of project documents. It is anticipated that the evaluation will begin in FY 2012.

Climate Change Education Program

The FY 2012 Request provides $10.0 million for the Climate Change Education (CCE) program, equal to the FY 2010 Enacted allocation. The Directorates for Education and Human Resources, Geosciences, Biological Sciences, and the Office of Polar Programs will support this Administration priority program. CCE is a multi-disciplinary, multi-faceted climate change education program that is enabling a variety of partnerships within formal and informal settings, including partnerships among K-12 education, higher education, the private sector, related non-profit organizations, and relevant education and/or climate-related policymakers. It will support individual investigators and multidisciplinary teams of STEM researchers and educators in a range of activities, including those with a local, regional, and/or global scope.

NSF has made an award to the National Research Council to implement an 18-month roundtable process that is examining key issues and needs inherent to climate change education. The roundtable is bringing together federal and state policymakers, educators, communications and media experts, and members from the business and scientific community. Insights gained through the roundtable are providing NSF with important foundational knowledge related to key aspects of CCE. These aspects include learning, the nature and scope of existing efforts, achievable and measurable goals, challenges and opportunities inherent in developing a national level CCE initiative, and areas where investments in FY 2012 may provide the greatest leverage. In addition, NSF is collaborating with NASA and NOAA to support annual tri-agency principal investigator meetings for climate change education-related awards and development of methods for evaluation of federal climate change education programs.

Enhancing Access to the Radio Spectrum
NSF's FY 2012 Request provides $15.0 million for Enhancing Access to the Radio Spectrum (EARS), a cross-cutting program whose purpose is to fund interdisciplinary research that can enhance the efficiency with which radio spectrum is used, and/or lead to improved access to wireless services for all Americans. EARS is a collaboration among the Directorates for Computer and Information Science and Engineering (CISE), Engineering (ENG), Mathematical and Physical Sciences (MPS), and Social, Behavioral, and Economic Sciences (SBE). It will fund innovative collaborative research that transcends the traditional boundaries of existing disciplinary programs.

Faculty Early Career Development (CAREER)
The FY 2012 Request provides $221.96 million for the CAREER program, which is a continuing Administration priority program. This is an increase of $25.57 million over the FY 2010 Enacted level of $196.39 million. This will result in approximately 60 more CAREER awards than in FY 2011. CAREER awards support exceptionally promising college and university junior faculty who are committed to the integration of research and education and who are most likely to become the leaders in their fields.

Graduate Fellowships and Traineeships
The FY 2012 Request provides $288.16 million for NSF's flagship graduate fellowship and traineeship programs. This funding will enable NSF to support an estimated 6,450 graduate students.

- $198.14 million for the Graduate Research Fellowship (GRF) program, an increase of $62.22 million over the FY 2010 Enacted of $135.92 million, will provide up to 3 years of support over a 5-year period to graduate students in all STEM fields. In FY 2012, 2,000 new fellows will be supported maintaining the doubling of new fellowships awarded as achieved in FY 2010. In order to maintain the competitiveness and fiscal integrity of the GRF program, NSF will increase the cost of education (COE) allowance in FY 2012 from $10,500 to $12,000. The new COE level is consistent with the America COMPETES Reauthorization Act of 2010. NSF will also begin implementing a multi-year plan to address inflationary pressures on the long-stagnant GRF stipend level, including initial funding in FY 2012 for a stipend increase to $32,000 that will be fully implemented in FY 2013. Additional stipend increases are planned beyond FY 2013.

NSF Graduate Research Fellowship Program

	Total Number of Fellows	Number of New Fellows	Projected Fellows on Tenure[1]
FY 2010 Enacted/Annualized	6,700	2,000	3,400
FY 2011 CR Estimate			
FY 2012 Estimate	7,800	2,000	4,200

[1]Fellowship tenure status is the period of time during which fellows actively utilize the fellowship award to pursue an advanced degree in the science, technology, engineering, or mathematics fields supported by the National Science Foundation.

- $62.47 million for the Integrative Graduate Education and Research Traineeship (IGERT) program, a decrease of $6.76 million from the FY 2010 Enacted of $69.23 million. This decrease reflects reduced support provided through the Research and Related Activities account. Determining the appropriate framework for R&RA contributions to IGERT will be a focus of upcoming efforts associated with NSF's implementation of the IGERT-related provisions of the recently-enacted

America COMPETES Reauthorization Act of 2010. IGERT will support comprehensive Ph.D. programs that are innovative models for interdisciplinary education and research and that prepare students for academic and non-academic careers. Funding will support an estimated 1,450 IGERT trainees. In 2009 Abt Associates, Inc. completed a survey of over 800 IGERT graduates in order to investigate the short-term professional outcomes of IGERT graduates and assess whether the IGERT program has prepared funded graduate students for successful STEM-related careers and developed their capacity for research, teaching, and leadership.

- $26.95 million for the NSF Graduate STEM Fellows in K-12 Education (GK-12) program, a decrease of $27.36 million from the FY 2010 Enacted of $54.31 million. The GK-12 program was initiated in 1999, and during the subsequent years more than 300 projects have been funded throughout the Nation. The GK-12 program is not holding a new competition in FY 2011 and will terminate in FY 2012; because (1) the program has achieved its goal of providing models for potential adopters to consider, along with evaluation data, in developing their efforts; and (2) the program design limits the ability of participants to gain in-depth experience in K-12 teaching to impact pupil learning. The FY 2011 Request amounts for both R&RA and EHR will be used to cover FY 2011 out-year commitments for grants made in prior years. Funding to cover remaining out-year commitments will be funded by EHR. FY 2012 funding will support an estimated 800 GK-12 graduate fellows.

Long-Term Ecological Research (LTER)

The FY 2012 Request provides $29.80 million, an increase of $1.86 million above the FY 2010 Enacted level of $27.94 million. LTER supports fundamental ecological research that requires long time periods and large spatial scales. This program supports a coordinated network of more than two dozen field sites that focus on: 1) understanding ecological phenomena that occur over long temporal and broad spatial scales; 2) creating a legacy of well-designed and documented ecological experiments; 3) conducting major syntheses and theoretical efforts; and 4) providing information necessary for the identification and solution of environmental problems. LTER field sites represent a diversity of habitats in continental North America, the Caribbean, Pacific Ocean, and the Antarctic, including coral reefs, deserts, estuaries, lakes, prairies, various forests, alpine and Arctic tundra, urban areas, and production agriculture. The National Ecological Observatory Network (NEON) will begin construction in FY 2011, the first year of a six-year construction project. NEON infrastructure will be co-located at eleven LTER sites. This co-location will permit the integration of the historic long-term LTER research into NEON and allow scientists to scale the site based research to regional and continental scales. Increased support in FY 2012 covers planned periodic increases to cover higher costs as sites are renewed.

Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS)

The FY 2012 Request provides $76.14 million for the BioMaPS program, an interdisciplinary partnership between the Directorates for Biological Sciences, Mathematical and Physical Sciences, and Engineering. BioMaPS seeks to discover fundamental new knowledge at the intersections of the biological, mathematical and physical sciences and engineering in order to enable innovation in national priorities such as clean energy, climate science, and advanced manufacturing that are essential to the Nation's prosperity, economic competitiveness, and quality of life.

Research Experiences for Teachers (RET)

The FY 2012 Request for NSF's RET program totals $4.82 million, a decrease of $820,000 below the FY 2010 Enacted level of $5.64 million. Funding will provide pre-service and in-service K-12 teachers with discovery-based learning experiences.

Research Experiences for Undergraduates (REU)
The FY 2012 Request for NSF's REU program totals $65.97 million, a decrease of $690,000 from the FY 2010 Enacted of $66.66 million. The request for FY 2012 reflects the importance of undergraduate research experiences to building students' interest and competence in STEM disciplines, and it is consistent with the external evaluation of REU by SRI International, which found that undergraduate students who participate in hands-on research are more likely to pursue advanced degrees and careers in STEM. REU supplements support active research participation by undergraduate students in any area of research funded by NSF by providing supplements to research grants. REU sites involve students in research who might not otherwise have the opportunity, particularly those from institutions where research programs are limited. A significant fraction of the student participants come from outside the host institutions. REU grants involve students at all stages of undergraduate education, including the freshman and sophomore levels, which enhances retention and graduation rates in STEM. The program encourages partnerships between community colleges and baccalaureate degree-granting institutions to provide research opportunities for community college STEM students and faculty. This emphasis will continue in FY 2012 as a means of broadening participation in STEM and fostering educational pathways and transfer opportunities for students in STEM programs.

Research in Undergraduate Institutions (RUI)
The FY 2012 Request for NSF's RUI program totals $37.45 million, an increase of $130,000 million above the FY 2010 Enacted level of $37.32 million. The RUI activity supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions.

Science and Technology Centers (STCs)
The FY 2012 Request for the Science and Technology Centers program totals $50.75 million, a decrease of $7.02 million below the FY 2010 Enacted level of $57.77 million. For additional information, see the NSF Centers Programs section of this chapter.

PERFORMANCE INFORMATION

NSF Performance Assessment Framework…….. Performance Information – 3

FY 2011 Annual Performance Plan…….……..……..…….…… Performance Information – 7

FY 2010 Annual Performance Report..…….….....Performance Information – 13

American Recovery and Reinvestment Act Performance Report.....Performance Information – 23

Additional Performance Information…….……..…… http://nsf.gov/about/budget/fy2012

NSF PERFORMANCE ASSESSMENT FRAMEWORK

As was noted in the NSF FY 2011 Budget Request, NSF is reviewing its performance assessment framework, in keeping with the Administration's commitment to establishing an evaluation infrastructure that complements and integrates efforts to strengthen performance measurement and management. This overall effort has been a specific focus of the recent update of the NSF Strategic Plan, which places special emphasis on testing and refining new approaches to assessment and evaluation. The FY 2011 GPRA Performance Plan – presented later in this chapter – is the first such plan based upon the new Strategic Plan.

A number of related efforts are also underway. These include:

- Continued progress toward NSF's STEM Workforce Priority Goal.
- Sustained NSF support for the multi-agency data infrastructure for monitoring and analyzing investments in science and engineering research and education (see STAR METRICS below).
- The establishment of an NSF-wide capability for assessment and evaluation planning for an expanded NSF-wide assessment and evaluation capacity.
- Systematic efforts to improve evaluation and monitoring activities in STEM education and workforce programs.

This chapter presents key aspects of NSF's performance assessment framework, including the FY 2010 GPRA Performance Report, the FY 2011 GPRA Performance Plan, and an update on the STEM Workforce Priority Goal. Additional performance information related to the development of metrics for STEM education program is available at www.nsf.gov/about/budget/fy2012/toc.jsp. This opening section also includes a summary of the new Strategic Plan and brief updates on key related efforts.

NSF's FY 2011-FY 2016 Strategic Plan

As noted above, NSF has recently developed an update of its Strategic Plan.[1] This plan – *Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2011-2016* fundamentally reframes the Foundation's strategic goals. The goals—Transform the Frontiers, Innovate for Society, and Perform as a Model Organization—lay out a path towards both longer-term outcomes and the more immediate impacts NSF's investments can generate. To bridge the gap between NSF's new strategic goals and measurable, performance-relevant outputs, the plan establishes a set of performance goals for each strategic goal.

Strategic Goal	Performance Goal
Transform the Frontiers (T) emphasizes the seamless integration of research and education as well as the close coupling of research infrastructure and discovery.	T-1: Make investments that lead to emerging new fields of science and engineering and shifts in existing fields. T-2: Prepare and engage a diverse STEM workforce motivated to participate at the frontiers. T-3: Focus international partnerships on transforming the frontiers. T-4: Enhance research infrastructure and promote data access to enable transformation at the frontiers.

[1] This plan was completed before the enactment of the GPRA Modernization Act of 2010. NSF therefore expects to have an updated plan in FY 2013 to address the requirements in the new legislation.

Innovate for Society (I) points to the tight linkage between NSF programs and societal needs, and it highlights the role that new knowledge and creativity play in economic prosperity and society's general welfare.	I-1: Make investments that lead to results and resources that are useful to society. I-2: Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering. I-3: Catalyze the development of innovative learning systems.
Perform as a Model Organization (M) emphasizes the importance to NSF of attaining excellence and inclusion in all operational aspects.	M-1: Achieve management excellence through leadership, accountability, and personal responsibility. M-2: Infuse learning as an essential element of the NSF culture with emphasis on professional development and personal growth. M-3: Encourage and sustain a culture of creativity and innovation across the agency to ensure efficiency and effectiveness in achieving high levels of customer service.

In this chapter NSF presents its first annual GPRA Performance Plan based upon the new Strategic Plan. This Performance Plan is characterized by its application of experimental approaches towards performance assessment. Some measures have been used in previous years at NSF, but baselines are also being taken and new measures are being explored. This approach is strongly informed by a principal recommendation from the FY 2009 report of the Advisory Committee for GPRA Performance Assessment: "Consider an assessment framework that uses multiple measures and methods, applied over various time scales." NSF delays finalization of its Performance Plan for FY 2012 due to the early stages of implementation of the new Strategic Plan.

Interagency Initiatives and NSF Performance Goals

STAR METRICS (Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness and Science)

NSF participates in the STAR METRICS activity. This multi-agency venture may eventually help the federal government document the impact of its investments in research and development to a degree not previously possible. In FY 2012, NSF funding will meet commitments to the interagency partnership. NSF is aiming to integrate elements of STAR METRICS into management information systems as well as assessment and evaluation activities. In the long run, NSF envisions that the STAR METRICS capability could be applied to the assessment of performance goals that relate to documenting the impact of research investments (such as T-1 and I-1, for example).

Priority Goal: Science, Technology, Engineering, and Mathematics (STEM) Workforce

NSF's Priority Goal is to "Improve the education and training of an innovative Science, Technology, Engineering, and Mathematics (STEM) workforce through evidence-based approaches that include collection and analysis of performance data, program evaluation, and other research." By the end of 2011, at least six major NSF STEM workforce development programs at the graduate, postdoctoral, or early career level will have evaluation and assessment systems in place. In FY 2012, the set of workforce

programs will grow to include undergraduate programs. This activity is included under Performance Goal T-2, "Prepare and engage a diverse STEM workforce motivated to participate at the frontiers."

Activities in support of the Priority Goal are generating strategic design, improvement, and planning for the evaluation and monitoring of the agency's STEM workforce development portfolio. A coordinated approach is in place that involves:

- Convening program representatives from across the agency to establish composite baseline information about workforce development programs, their goals, and their approaches;
- Collaborating across the agency in sharing metrics and implementing and refining performance management systems that may have common core elements; and
- Accumulating data and evidence and using for program improvement and redesign.

NSF framework for making progress on the Priority Goal uses a continuum model. Programs progress along the continuum with the support of the collaborations and collective expertise being built in the Priority Goal processes. The first stages of this continuum are to assist programs in: establishing workforce development assumptions and needs; creating and sharing explicit program logic models and theories of action; and refining program measurement outcomes and metrics. Building on this base, in the later stages of the continuum, programs establish and improve program performance management systems, and then accumulate and use data for program improvement.

Efforts in this initiative are leading to new collaborations and informal working groups across NSF addressing such issues as postdoctoral programs, longitudinal tracking of fellowship recipients, discussion of NSF's overall investment portfolio in graduate and early career scientists, and innovation in evaluation of STEM education programs. This will all serve as important foundational activity as plans for the centralized NSF-wide evaluation capacity are developed.

Fostering NSF-wide Perspectives on Assessment and Evaluation

NSF directorates and offices develop and implement assessment and evaluation capacities tailored to their particular programmatic needs, and NSF is starting to broaden and deepen its capacity to perform similar functions and analyses of activities around and across the agency.

- NSF activities in the area of STEM education and learning are in a multi-year process of developing performance metrics. The FY 2011 Budget Request published an initial set of metrics in an online supplement (www.nsf.gov/about.budget/fy2011). Metrics development continued in FY 2010 and an updated and expanded inventory can be found on NSF's website as a supplement to this chapter (www.nsf.gov/about/budget/fy2012). Collecting these data agency-wide is already enabling NSF staff to identify opportunities for program harmonization and to begin conversations about practices and approaches.
- In FY 2012, NSF will continue to develop a centralized NSF-wide assessment and evaluation capacity. In FY 2010 and FY 2011, NSF explored the issues around scope, organizational placement, necessary resources, and initial activities of an expanded capacity.
- In FY 2012, NSF will explore ways to more clearly distinguish between process and outcome evaluation through modifications to the agency's Committee of Visitors activity.

FY 2011 ANNUAL PERFORMANCE PLAN

NSF's new Strategic Plan establishes three Strategic Goals for NSF, and progress toward each goal will be monitored against the set of Performance Goals established in the draft plan. For more information, see page 3 of this chapter.

Performance Monitoring Framework

A number of Performance Goals in the new Strategic Plan continue and build on ongoing NSF activities. Some Performance Goals, however, represent priorities of the Foundation that have not previously been addressed in a performance context. For Performance Goals with no precedents in earlier years, the focus of FY 2011 activities is on initiating a longer-term process that will establish baselines and test different indicators of progress. This will position NSF to pursue a more comprehensive approach to monitoring and assessment in FY 2012 and beyond.

Transform the Frontiers

Transform the Frontiers emphasizes the seamless integration of research and education as well as the close coupling of research infrastructure and discovery.

NSF creates opportunities to expand and shape the frontiers of human knowledge. The Foundation embraces our unique role in supporting the fundamental, interdisciplinary, high-risk, and potentially transformative research and education that are central to the discovery of emergent properties and structures in physical, living, human, and engineered systems. NSF enables research at the frontiers by providing state-of-the-art infrastructure, by educating and preparing a diverse, world-class STEM workforce, and by partnering with others nationally and internationally. By transforming the frontiers, NSF can best promote the progress of science, engineering, and education. This research agenda encourages high-risk/high-reward activities and pursues potentially transformative ideas, in keeping with recent mandates from the science and engineering community[1], the National Science Board[2], Congress[3], and the Administration[4].

Performance Goal T-1: Make investments that lead to emerging new fields of science and engineering and shifts in existing fields.

- FY 2011 Goal Statement: Produce an analysis of NSF's FY 2010 investments in activities undertaken to foster potentially transformative research.
- Lead Organization: Office of the Director.
- Goal Target: One analysis.
- Target Explanation: This Goal builds upon NSF's FY 2010 performance goal, which is described in the FY 2010 Annual Performance Report elsewhere in this chapter. In FY 2011, NSF is conducting a portfolio analysis of the way these FY 2010 funds were used to investigate which methods, techniques, and approaches could foster PTR. NSF is collecting information from each directorate and office regarding the nature of the work funded and the underlying decision-making processes that were used.

[1] "Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5." The National Academies Press, 2010.
[2] National Science Board. "Enhancing Support of Transformative Research at the National Science Foundation." NSB-07-32: May 7, 2007. (http://www.nsf.gov/pubs/2007/nsb0732/nsb0732.pdf)
[3] America COMPETES Reauthorization Act of 2010 (Public Law 111-358).
[4] United States, OMB/OSTP. "Science and Technology Priorities for the FY 2012 Budget." M-10-30: July 21, 2010.

Performance Goal T-2: Prepare and engage a diverse STEM workforce motivated to participate at the frontiers.

- FY 2011 Goal Statement: NSF science, technology, engineering, and mathematics (STEM) workforce development programs at the graduate, professional, or early career level participate in evaluation and assessment systems.
- Lead Organization: Directorate for Education and Human Resources.
- Goal Target: Six programs.
- Target Explanation: In FY 2010, Federal agencies identified a limited set of Priority Goals to be achieved by the end of FY 2011. This Goal overlaps with NSF's Priority Goal, described in the first section of this chapter. Achieving this Goal should be equivalent to achieving the Priority Goal.

Performance Goal T-3: Focus international partnerships on transforming the frontiers.

- FY 2011 Goal Statement: Identify number of new NSF program solicitations, announcements, and Dear Colleague Letters with international implications.
- Lead Organization: Office of International Science and Engineering (OISE).
- Goal Target: Establish baseline.
- Target Explanation: NSF has a system for program officers to indicate which solicitations, announcements, and Dear Colleague Letters have international implications in the internal clearance stages. OISE will conduct a baseline count of such materials and will also examine non-indicated materials for potential international implications.

Performance Goal T-4: Enhance research infrastructure and promote data access to enable transformation at the frontiers.

- FY 2011 Goal Statement: For all MREFC facilities under construction, keep negative cost and schedule variance at or below 10 percent.
- Lead Organization: Large Facilities Office.
- Goal Target: 100 percent of construction projects that are over 10 percent complete.
- Target Explanation: This is an existing NSF Performance Goal. Overall context, past trends, and current results can be found in the FY 2010 Performance Report. This goal provides a monitoring component for the "no cost overrun" policy that NSF has established, as discussed on page 2 of the MREFC chapter.

- FY 2011 Goal Statement: Determine current data management practices at NSF-funded facilities.
- Lead Organization: Directorate for Mathematics and Physical Sciences.
- Goal Target: Current data management practices documented for 100 percent of NSF-funded facilities.
- Target Explanation: NSF will contact its large facilities and document existing procedures. This is expected to aid future development of Foundational data management policies.

Innovate for Society

Innovate for Society points to the tight linkage between NSF programs and societal needs, and it highlights the role that new knowledge and creativity play in economic prosperity and society's general welfare.

By forging links between fundamental research and society's needs, NSF helps articulate important new areas of science and engineering, improves quality of life, creates a scientifically literate populace, and empowers future generations. NSF is committed to creating connections between research produced through our investments and the needs of society. This goal requires close interaction with NSF

stakeholders, a clear recognition of the Foundation's role in the nation's innovation enterprise, and an appreciation of the dynamic global context. Through this strategic goal, NSF advances the welfare and prosperity of the nation.

Performance Goal I-1: Make investments that lead to results and resources that are useful to society.

- FY 2011 Goal Statement: Industrial & Innovation Partnerships (IIP): Identify the number and types of grantee's partnerships.
- Lead Organization: Directorate for Engineering (ENG).
- Goal Target: Establish baseline.
- Target Explanation: Using ENG's IIP division as the model to start the process of collecting data on diverse types of partnerships is intended as the beginning of a process to identify how the links between science, industry, and innovation mediate the long term impacts of NSF investments.

Performance Goal I-2: Build the capacity of the nation's citizenry for addressing societal challenges through science and engineering.

- FY 2011 Goal Statement: Identify number of programs that fund activities that address public understanding and communication of science and engineering.
- Lead Organization: Division of Research on Learning in Formal and Informal Settings (DRL), EHR.
- Goal Target: Establish baseline.
- Target Explanation: Certain DRL programs explicitly aim to address public understanding and communication of science and engineering, but other NSF activities may also work towards this aim. This Goal's intent is to identify all such activities across the Foundation. With such an inventory, targets for subsequent years can be designed that take into account the totality of activities across NSF, not just those within DRL.

- FY 2011 Goal Statement: Identify number of programs that fund activities with K-12 components.
- Lead Organization: Directorate for Education and Human Resources.
- Goal Target: Establish baseline.
- Target Explanation: Certain EHR programs explicitly aim to support K-12 education activities, but other NSF activities may also work towards this aim. This Goal's intent is to identify all such activities across the Foundation. With such an inventory, targets for subsequent years can be designed that take into account the totality of activities across NSF, not just those within programs known to impact K-12 education.

Performance Goal I-3: Catalyze the development of innovative learning systems.

- FY 2011 Goal Statement: Identify number of programs that fund the development of research-based innovative learning systems.
- Lead Organization: Directorate for Education and Human Resources.
- Goal Target: Establish baseline.
- Target Explanation: This Goal's intent is to identify activities across the Foundation that contribute to development of innovative learning systems. Such activities are not funded by any one program within NSF. After determining NSF's baseline for this area of research, targets for subsequent years can be designed.

- FY 2011 Goal Statement: Identify number of programs that fund activities that promote partnerships that support development of learning technologies.
- Lead Organization: Directorate for Education and Human Resources.
- Goal Target: Establish baseline.

- Target Explanation: Interdisciplinary partnerships that support development of learning technologies are funded by organizational units across the Foundation. This Goal's intent is to identify all such activities so an NSF-wide baseline can be determined. Only then can targets for subsequent years be designed.

Perform as a Model Organization

Perform as a Model Organization emphasizes the importance to NSF of attaining excellence and inclusion in all operational aspects.

NSF sets high standards for performance and integrity in support of our mission and in enabling our workforce to carry out activities efficiently, effectively, and sustainably. The Foundation promotes a culture of excellence that encourages diversity, creativity, and initiative. NSF is committed to broadening participation. This is reflected in our recruitment and selection of reviewers and panelists as well as the selection and empowerment of staff. We implement first-rate administrative, financial, information technology, and infrastructure systems that support individual staff members and provide high-quality customer service to the public. NSF aspires to be a learning organization that aims for continual improvement in our processes and continual development of our people. NSF is committed to the principles underlying open government including transparency, participation, and collaboration, and to translating this commitment into action. NSF serves as a model for other organizations that fund research and education and takes a leadership role in cross-agency activities.

Performance Goal M-1: Achieve management excellence through leadership, accountability, and personal responsibility.

- FY 2011 Goal Statement: Include temporary staff appointed under the Intergovernmental Personnel Act (IPAs) under NSF's performance management system.
- Lead Organization: Division of Human Resources Management.
- Goal Target: 80 percent of all IPAs and 90 percent of IPAs in executive-level positions have performance plans as of July 1, 2011.

- FY 2011 Goal Statement: Pilot use of OPM's 360 degree evaluation instrument to provide feedback to NSF leaders and managers on skills and abilities.
- Lead Organization: Division of Human Resources Management.
- Goal Target: By July 1, 2011, at least 20 NSF managers use OPM's 360 instrument. By September 30, 2011, at least 20 NSF managers who used OPM's 360 instrument establish a plan for improving performance.

- FY 2011 Goal Statement: Attain essential elements of a model Equal Employment Opportunity (EEO) program, as defined in Equal Employment Opportunity Commission (EEOC) requirements.
- Lead Organization: Office of Diversity and Inclusion.
- Goal Target: Three elements.
- Target Explanation: For NSF to become a model EEO agency, it needs to meet each of the six criteria established by the EEOC. The target of three is based on the progress reported for last year (one) as compared to resource-responsive expectations for this fiscal year. EEOC refers to these criteria as the "Essential Elements" of a Model Agency, which are:
  - Demonstrated commitment from agency leadership;
  - Integration of EEO into the agency's strategic mission;
  - Management and program accountability;
  - Proactive prevention of unlawful discrimination;

- Efficiency; and
- Responsiveness and legal compliance.

Performance Goal M-2: Infuse learning as an essential element of the NSF culture with emphasis on professional development and personal growth.

- FY 2011 Goal Statement: Pilot process for assessing developmental needs and addressing them.
- Lead Organization: Division of Human Resources Management.
- Goal Target: By March 31, 2011 commence survey of administrative support staff. By September 20, 2011, obtain contract support for assessment of non-administrative-support staff.
- Target Explanation: NSF stresses personal learning and development to enhance performance, further our knowledge base on all aspects of NSF activity, and continue to build for the future. This directly reflects the specific action identified in the Strategic Plan: "review current NSF learning opportunities and develop a plan for addressing gaps."

Performance Goal M-3: Encourage and sustain a culture of creativity and innovation across the agency to ensure efficiency and effectiveness in achieving high levels of customer service.

- FY 2011 Goal Statement: Gather functional requirements for changes in current system processes that will accommodate the transition to a grant by grant payment method.
- Lead Organization: Division of Financial Management.
- Goal Target: Documentation of functional requirements.
- Target Explanation: NSF is committed to transition its financial processing of grants from a pooled system (quarterly reporting of expenditures by institution) to grant-by-grant (real-time reporting of expenditures by award) by FY 2013. This change will have many advantages for both NSF and its grantees, such as better and more timely financial data and stronger recipient monitoring programs. This is an essential aspect of establishing the capability to monitor expenditures at the award level as part of NSF's financial system modernization.

- FY 2011 Goal Statement: Inform applicants whether their proposals have been declined or recommended for funding within six months of deadline, target date, or receipt date, whichever is later.
- Lead Organization: Office of the Director.
- Goal Target: 70 percent.
- Target Explanation: This is an existing NSF Performance Goal. Overall context, past trends, and current results can be found in the FY 2010 Performance Report.

FY 2010 ANNUAL PERFORMANCE REPORT

NSF Funding by FY 2006-FY 2011 Strategic Outcome Goal

(Dollars in Millions)

	FY 2010 Total Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change over FY 2010 Enacted	
				Amount	Percent
Discovery	$3,860.69	$3,826.68	$4,514.70	$688.02	18.0%
Learning	973.38	953.90	1,031.34	77.44	8.1%
Research Infrastructure[1]	2,307.82	1,662.18	1,727.37	65.19	3.9%
Stewardship	430.54	429.75	493.59	63.84	14.9%
Total, NSF	**$7,572.43**	**$6,872.51**	**$7,767.00**	**$894.49**	**13.0%**

Totals may not add due to rounding.

Funding for all years is shown in the FY 2010 structure for compatibility.

[1] Funding for Research Infrastructure for FY 2010 excludes a one-time appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

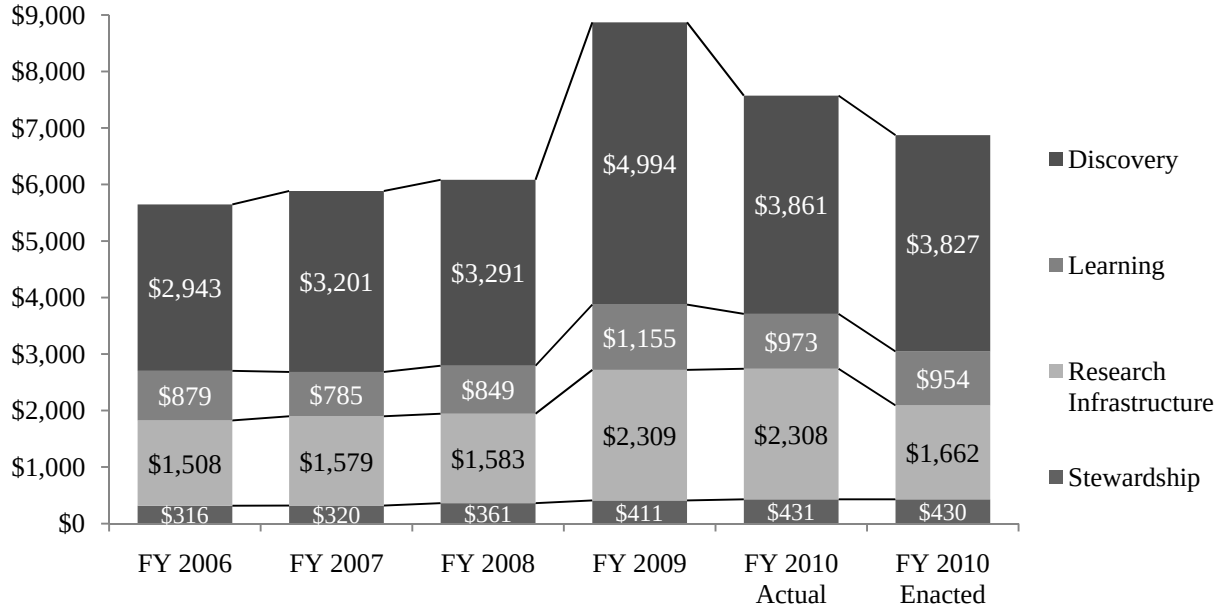
NSF's Strategic Plan for FY 2006–2011 established four long-term strategic outcome goals for the agency's activities and performance: Discovery, Learning, Research Infrastructure, and Stewardship. The first three goals focus on NSF's long-term investments in science and engineering research and education. The fourth goal emphasizes improving effectiveness and efficiency in agency management.

- **Discovery:** Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit, and establishing the nation as a global leader in fundamental and transformational science and engineering.
- **Learning:** Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.
- **Research Infrastructure:** Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.
- **Stewardship:** Support excellence in science and engineering research and education through a capable and responsive organization.

At a Glance: FY 2010 GPRA Performance Goals and Results

Strategic Goal	Performance Goal		Target	Result	Status
Discovery	Time to decision		70%	75%	✓
	Potentially transformative research		$94.0 million	$138.4 million	✓
Learning	Portfolio metrics		100%	100%	✓
Research Infrastructure	Major Research Equipment and Facilities Construction		100%	3 of 5 (60%)	✗
	Operational facilities		100%	100%	✓
Stewardship	Business Systems Reviews of large facilities		3	4	✓
	Merit review	Context statements	95%	93%	✗
		COV report analysis	One report	One report	✓
	Post-award monitoring	Site visits	95%	80%	✗
		Desk reviews	95%	146%	✓
		Transaction testing	95%	100%	✓
		ARRA recipient reporting rate	98%	99.5%-99.8%	✓
		ARRA significant error rate	< 1%	0%-0.0004%	✓

Funding Trends by Strategic Goal, FY 2006-FY 2010
(Dollars in Millions)

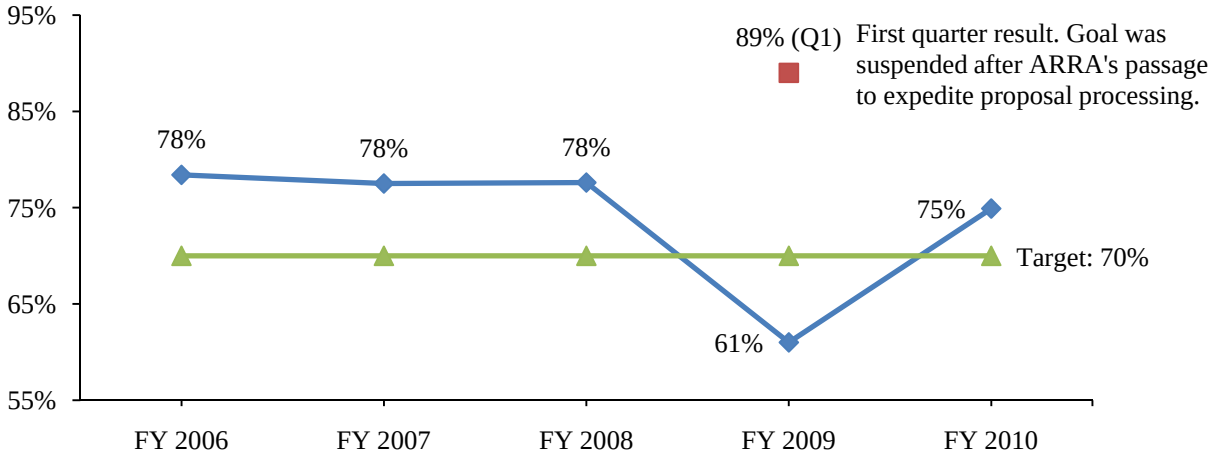


Goal 1 – Discovery/Time to Decision

Inform applicants whether their proposals have been declined or recommended for funding within six months of deadline, target date, or receipt date, whichever is later.

Result: Goal achieved.

Time to decision performance trends, FY 2006-FY 2010



Motivation behind goal
One of the most significant issues raised in customer satisfaction surveys is the time it takes NSF to process proposals. This goal seeks to improve that time for proposals while balancing the need for a credible and efficient merit review system.

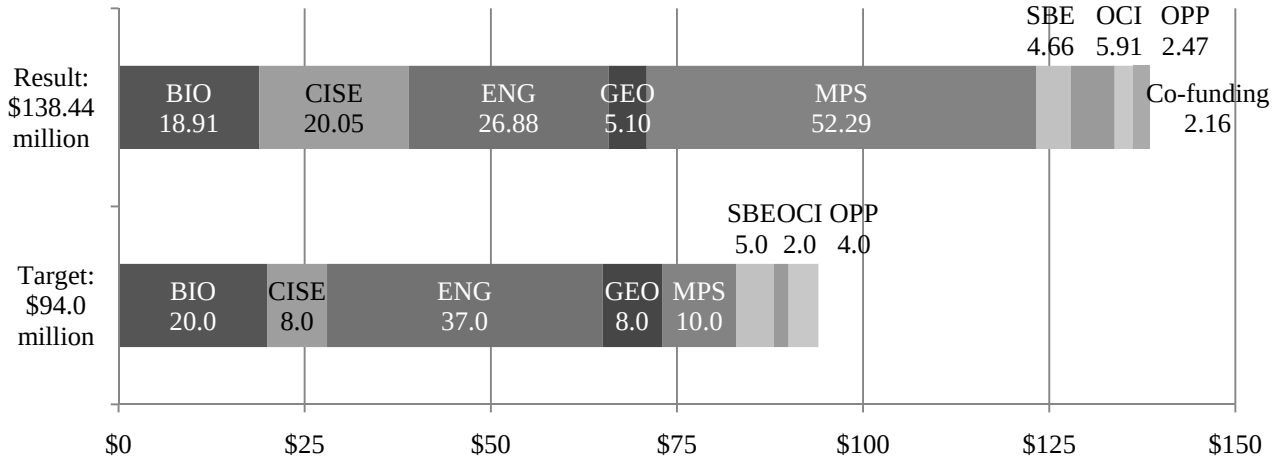
Discussion of result
NSF exceeded this goal in FY 2010 despite a significant increase in workload. The number of competitive proposal actions increased 23 percent in FY 2010, while the workforce increased only 3 percent.

Goal 2 – Discovery/Potentially Transformative Research (PTR)[1]

Each directorate in the Research and Related Activities account will invest a minimum of $2.0 million per research division to leverage and facilitate activities that foster PTR.

Result: Goal achieved.

FY 2010 funding for PTR, by directorate/office
(Dollars in Millions)



Motivation behind goal
NSF identifies PTR as work that may lead to

- Dramatically new ways of conceptualizing or addressing major scientific and technological challenges.
- New methods or analytical techniques that could put a discipline on a new scientific pathway, provide tools that allow unprecedented insights, or radically increase the rate of data collection.

In FY 2010, each R&RA directorate allocated a minimum of $2.0 million per research division ($94.0 million Foundation-wide) to explore methodologies that help support PTR.

Discussion of result
Collectively, R&RA directorates obligated a total of $138.44 million towards explorations of methodologies that help support potentially transformative research (PTR). This exceeded the collective target of $94.0 million by over 47 percent.

Following this FY 2010 investment, NSF will engage in activities to compare the different approaches used across directorates and offices. NSF expects that this process will help to determine the most effective approaches to employ in future years to support PTR. Specific FY 2011 activities are indicated in the section presenting the FY 2011 Annual Performance Plan.

[1] This report of NSF's PTR activities is provided also per Section 1008 of the 2007 America COMPETES Act.

Goal 3 – Learning: Portfolio Metrics

Develop goals and metrics for NSF's programmatic investments in its FY 2010 Learning portfolio.

Result: Goal achieved.

Motivation behind goal
NSF's Learning portfolio includes activities funded by the Education and Human Resources (EHR) and Research and Related Activities (R&RA) accounts. In FY 2009, an EHR Directorate working group developed metrics for all EHR programs. In FY 2010, EHR expanded and refined these goals and metrics, and goals and metrics were developed for R&RA-funded activities in the Learning portfolio. Programs also submitted evaluation plans.

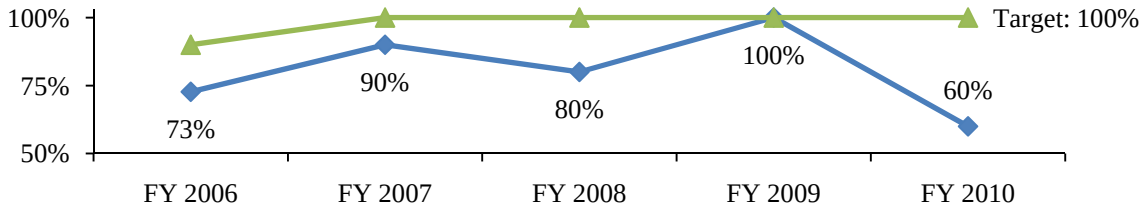
Discussion of result
All Learning programs that received funds in FY 2010 have established goals and metrics. Current metrics, goals, and evaluation plans for the following FY 2010 Learning portfolio programs can be found at NSF's website under "Additional Performance Information" (http://nsf.gov/about/budget/fy2012).

Goal 4 – Research Infrastructure: Major Research Equipment and Facilities Construction

For all MREFC facilities under construction, keep negative cost and schedule variance at or below 10 percent.

Result: Goal not achieved.

Major Research Equipment and Facilities Construction performance trends, FY 2006-FY 2010



Motivation behind goal

NSF uses the Earned Value Management (EVM) system to track its construction projects. EVM is an integrated management control system for assessing, understanding, and quantifying what a contractor or field activity is achieving with program dollars. It is a standard measure of performance for construction projects.

Projects that are under ten percent complete are not considered eligible for this goal because EVM data is less meaningful statistically in the very early stages of a project. Early in a project, the actual costs of the work, and the total values of the work scheduled and performed, are small compared to the total project cost and schedule. Consequently, their ratios - the reported cost and schedule variances - can change by large amounts even though the real values of their differences are small.

Discussion of result

At the end of FY 2010, two projects were behind schedule out of a total of five active projects. OOI and AdvLIGO are suffering lagging procurements and delays in staffing at the implementing organizations. Active schedule management is underway to recover from these delays.

One MREFC project, South Pole Station modernization, is not included in the denominator for the FY 2010 result (60 percent) on the chart above. SPSM concluded on time and within cost in FY 2010.

MREFC Project		**Goal Status, September 2010**
ARRV	Alaska Regional Research Vessel	Achieved
IceCube	IceCube Neutrino Observatory	Achieved
ALMA	Atacama Large Millimeter Array	Achieved
OOI	Ocean Observatories Initiative	Not achieved (behind schedule)
AdvLIGO	Advanced Laser-Interferometer Gravity-wave Observatory	Not achieved (behind schedule)
SPSM	South Pole Station (modernization)	Achieved, but not included in goal calculation
ATST	Advanced Technology Solar Telescope	Not included in goal—project under 10 percent complete

Goal 5 – Research Infrastructure: Operational Facilities

For facilities in the operational phase, keep scheduled operating time lost to less than 10 percent for 90 percent of those facilities.

Result: Goal achieved.

Operational facilities performance trends, FY 2006-FY 2010

Motivation behind goal
To qualify as a facility in the operational phase, the project must be funded by an award or collection of awards that 1) Operates infrastructure, instrumentation, equipment, and/or software that is intended to enable a broad segment of researchers and/or educators to conduct research and/or education activities and 2) Has an Operations and Maintenance portion of the expenditure plan that is at least $8.0 million annually.

Discussion of result
All NSF facilities met this goal. See the Facilities chapter for more information about the facilities covered under this goal.

Goal 6 – Stewardship: Management of Large Facilities

Conduct a Business System Review (BSR) once per 5-year award cycle for all institutions hosting NSF-supported large facilities. FY 2010 target: three BSRs.

Result: Goal achieved.

Motivation behind goal
A BSR is conducted in order to provide a reasonable assurance that the business systems employed to support a facility are capable of supporting activities conducted by the large facility. They verify that administrative business policies and procedures are written and determine whether these policies and procedures conform to OMB requirements, NSF expectations, and other applicable federal regulations.

Discussion of result
NSF exceeded this goal. BSRs were performed on the following facilities:

- EarthScope
- National Center for Atmospheric Research
- Alaska Regional Research Vessel
- Academic Research Fleet

Goal 7 – Stewardship: Merit Review, Context Statement

Provide a written context statement to the Principal Investigator (PI) whose proposal is awarded or declined that describes the process by which the proposal was reviewed and the context of the decision (such as the number of proposals and awards, information about budget availability, and considerations in portfolio balancing). FY 2010 target: 95 percent.

Result: Goal not achieved

Motivation behind goal
Context statements provide a level of transparency to the investigator. Examples of broader contexts which might affect a funding decision include: portfolio shaping (targeting support for potentially transformative advances in a field, building capacity in a particular research area; achievement of special program objectives and initiatives); fostering of novel approaches to significant research questions; assessment of potential impact on the development of human resources and infrastructure; support of NSF core strategies, such as the integration of research and education and/or broadening participation; availability of other funding sources; and geographic distribution.

Discussion of result
Statements were provided for 93.3 percent of eligible proposals.

Goal 8 – Stewardship: Merit Review, Committees of Visitors report

Analyze Committees of Visitors (COV) reports in order to identify issues of quality and the transparency of the merit review process

Result: Goal achieved.

Motivation behind goal
A Committee of Visitors is a panel of external experts that meet at regular intervals of approximately three years to review the work conducted by programs and offices that recommend or award grants, cooperative agreements, and/or contracts and whose main focus is the conduct or support of NSF research and education in science and engineering. COV reports perform two functions: 1) they list process issues identified by reviewers that could affect agency operations, and 2) they provide reviewers' determinations of the potential outcomes of NSF investments.

Discussion of result
In FY 2008 and FY 2009, NSF defined, tested, and implemented a process for assessing COV reports on an annual basis. In FY 2010, NSF produced its second annual assessment related to issues of quality and the transparency of the merit review process. One report was completed and delivered to the Office of the Director.

Goals 9, 10, and 11 – Stewardship: Post-award Monitoring

Appropriately apply NSF's risk assessment strategy to ensure adequate post-award financial and administrative monitoring of NSF's riskiest awards.

Results: Two of three goals achieved.

Measure	Target	Result
Site monitoring visits (30 projected)	95 percent	Goal not achieved. 80 percent (24 visits)
Desk reviews (73 projected)	95 percent	Goal achieved. 146 percent (107 reviews)
FFR transaction testing	Completion of testing	Goal achieved. Completed Q3. Error rate 0.087 percent

Motivation behind goals
Post-award monitoring activities manage risk, provide broad oversight coverage of its award portfolio, and ensure that awardee institutions administer grants and cooperative agreements in compliance with federal regulations and NSF policies.

Discussion of results

- The purpose of a site visit is to assess awardees' capability, performance, and compliance against the applicable elements that make up each award. NSF did not achieve its goal of conducting 95 percent of planned site visits to NSF awardee institutions. In FY 2010, NSF award monitoring personnel were temporarily redeployed to support a high-priority, high-dollar procurement. NSF readjusted its award monitoring plan by deferring site visits to the six institutions with the lowest risk (as determined using NSF's risk assessment methodology). The six institutions received advanced monitoring through increased application of the desk review process and have been assigned site visit priority as part of the FY 2011 risk assessment.

- Desk reviews collect and analyze information to assess recipients' capacity to manage federal awards. Desk reviews include a review of an institution's policies and general management practices. This goal was achieved.

- The Federal Financial Report (FFR) Transaction Testing process is an assessment of the adequacy of the institution's accounting and financial systems, and reconciliation between amounts included in an FFR submitted to NSF and corresponding amounts tracked by the awardee for the previous fiscal year's transactions. This goal was achieved.

Goals 12 and 13 – Stewardship: Post-award Monitoring, American Recovery and Reinvestment Act

Appropriately apply NSF's risk assessment strategy to ensure adequate post-award financial and administrative monitoring of NSF's riskiest awards.

Results: Both goals were achieved.

Measure	Quarterly Target	Result
Recipient reporting rate	98 percent	Goal achieved. Q1: 99.7 percent Q2: 99.5 percent Q3: 99.8 percent Q4: 99.6 percent
Uncorrected significant error rate	Under 1 percent	Goal achieved. Q1: 0.0003 percent (1 in 4535) Q2: 0 percent Q3: 0.0004 percent (2 in 4703) Q4: 0 percent

Motivation behind goals
Each quarter, American Recovery and Reinvestment Act (ARRA) award recipients report financial and programmatic information. Two Stewardship performance goals in FY 2010 involved monitoring ARRA awardee performance. NSF implemented a quarterly, multi-phase recipient reporting review process that aided compliance with requirements for quarterly recipient reporting, improved the quality of data reported by those award recipients, and increased awardee communication, outreach, and oversight to ensure the timely expenditure of award funds. A coordinated communications plan reminded awardees of their reporting obligations at defined stages during the reporting cycle and notified them of data quality issues and reporting errors. These measures enabled NSF to quickly recognize and address potential problems.

Discussion of results
NSF achieved excellent results in its data quality program and is a government leader with a high degree of compliance among NSF awardees and a low error rate.

- ARRA award recipients are required to submit a report for their previous quarter's ARRA funded activities. NSF identifies, documents, and alerts recipients who have failed to submit a report thirty days following the end of the previous quarter.
- The uncorrected significant error rate (reported to OMB) on ARRA award recipients on Day 30 after federal review and continuous correction period was maintained well below the target.

AMERICAN RECOVERY AND REINVESTMENT ACT PERFORMANCE REPORT

In February 2009, NSF received $3.0 billion dollars through the American Recovery and Reinvestment Act of 2010 (ARRA). Eighty percent – $2.4 billion – of NSF's ARRA funds were obligated in FY 2009, and the remaining $600 million in FY 2010. At the end of 2010, outlays of the agency's total ARRA funds were $598 million.

NSF's FY 2009 APR reported on ARRA measures, and this report on FY 2010 performance includes those FY 2009 data for context and coherence. When NSF set its performance goals for its ARRA investments, it anticipated reporting on activity over varying timeframes as appropriate to each investment:

- Research and Related Activities-funded performance was measured with award characteristics metrics (number of awards made, number of investigators supported) and were therefore measurable immediately once the award was made.
- The Education and Human Resources account made awards to institutions in the first year, and the performance of the awards is also being measured over time (number of participants supported over the award duration).
- Projects funded through the Major Research Equipment and Facilities Construction account will generate performance metrics throughout the construction period.

When appropriate, NSF will continue to report on the performance of its ARRA-funded investments in future years.

NSF American Recovery and Reinvestment Act Funding by Account

(Dollars in Millions)

	FY 2009 Actual	FY 2010 Actual	Adjustment to Prior Year Accounts	Total
Research and Related Activities	**$2,062.64**	**$439.17**	**-$1.81**	**$2,500.00**
Academic Research Infrastructure (ARI)	-	*200.00*	-	*200.00*
MRI Instrumentation	*99.85*	*200.15*	-	*300.00*
Education and Human Resources	-	-	-	**100.00**
Robert Noyce Teacher Scholarship Programs	60.00	-	-	60.00
Math and Science Partnership Program	25.00	-	-	25.00
Science Masters Program	-	15.00	-	15.00
Major Research Equipment and Facilities Construction	-	-	-	**400.00**
Alaska Regional Research Vessel (ARRV)	148.07	-	-	148.07
Ocean Observatories Initiative (OOI)	105.93	-	-	105.93
Advanced Technology Solar Telescope (ATST)	-	146.00	-	146.00
Office of Inspector General	**0.02**	-	-	**0.02**
Total, NSF	**$2,401.66**	**$600.17**	**-$1.81**	**$3,000.02**

Totals may not add due to rounding.

At A Glance: ARRA Performance Highlights

Program/Subprogram		Measure	2009 Target	2009 Result	2010 Target	2010 Result	Status
Research and Related Activities	Competitive Awards	Number of awards*	4,000	4,599	-	5,027	✓
		Number of ARI-R2 and MRI-R2 awards	-	-	500	398	✗
	Principal Investigators (PIs)	Total number of Primary Investigators*	6,400	6,762	-	8,030	✓
		Number of new Primary Investigators*	2,400	2,352	-	2,839	✓
Education and Human Resources	Robert Noyce Teacher Scholarship Program	Number of new awards	67	67	-	-	✓
		New pre-service teachers and teacher participants	30	124	370	420	✓
		New teachers teaching in high-need districts	0	0	28	75	✓
	Math and Science Partnership (MSP) Program	Number of new awards	9	9	-	-	✓
		Number of MSP teacher leader/master teacher participants	15	24	133	180	✓
		Number of post-baccalaureate credentials or master's degree recipients	13	15	119	110	✗
	Science Masters Program	Number of new awards	New program in FY 2010		21	21	✓
		Number of students supported			80	100	✓
		Number of students earning science master's degrees			-	-	-
Major Research Equipment and Facilities Construction	Alaska Region Research Vessel (ARRV)	Variance from target cost and schedule: <10% behind schedule <10% above cost	> -10%	ns	>-10%	Achieved	✓
	Advanced Technology Solar Telescope (ATST)		> -10%	ns	>-10%	ns	-
	Ocean Observatories Initiative (OOI)		> -10%	ns	>-10%	Not Achieved	✗

** FY 2010 results are cumulative. All other targets and results in the table are annual values.*
ns*: Variance data from projects less than 10 percent complete are not considered significant.*
ARI-R^2: Academic Research Infrastructure-Recovery and Reinvestment solicitation
MRI-R^2: Major Research Instrumentation-Recovery and Reinvestment solicitation

Research and Related Activities Account

"Research and related activities" include investigator-initiated research projects, postdoctoral fellowships, instrumentation awards, workshop and planning grants, and cooperative agreements for facilities. For existing programs, NSF set targets for R&RA-related variables of interest for FY 2009 only, in expectation that all ARRA funds would be expended in FY 2009. Targets were set for FY 2010 only for new programs and solicitations. Only 80 percent of ARRA funds were obligated in FY 2009. No targets were set for these measures for FY 2010.

R&RA ARRA Performance Measures, FY 2009-FY 2010

Fiscal Year	Number of competitive awards		Number of ARI-R2 and MRI-R2 awards		Total number of Primary Investigators		Number of new Primary Investigators	
	Target	Result	Target	Result	Target	Result	Target	Result
FY 2009	4,000	4,599	*(New solicitations in FY 2010)*		6,400	6,762	2,400	2,352
FY 2010	*No target*	428	500	398	*No target*	1,268	*No target*	487
Cumulative	4,000	5,027	500	398	6,400	8,030	2,400	2,839

FY 2009 Goals: Core Research, Facilities, and Infrastructure

Number of competitive awards made with ARRA funds: This target was based on a formula taking into account the amount of funding and the average award size and duration. It assumed a $155,000 average annual award size and a three-year duration.

Number of investigators supported: The target for the number of investigators was based on a ratio of 1.6 principal investigators per award, according to FY 2008 figures.

Number of new investigators supported: New investigators were defined as those who have not served as the principal investigator or co-principal investigator on any award from NSF, with the exception of doctoral dissertation awards; graduate or postdoctoral fellowships; research planning grants; or conference, symposia, and workshop awards. NSF's target in FY 2009 took into account the emphasis on supporting first-time investigators with ARRA funds, and the target ratio of new investigators (0.6) was adjusted upward from the ratio from FY 2008 (0.5). While the target was not met in FY 2009, the result of 2,352 new investigators corresponds to a ratio of 0.59 new investigators per award. The FY 2009 target was exceeded in FY 2010.

FY 2010 Goals: Major Research Instrumentation and Academic Research Infrastructure

The Major Research Instrumentation (MRI) Program provides funds to purchase shared scientific and engineering instruments for research and training in institutions of higher education, museums and science centers, and non-profit organizations. The Academic Research Infrastructure Program provides funds to purchase equipment or services to repair, renovate, improve, or replace research facilities and cyberinfrastructure. NSF did not achieve its goal to make 500 awards under the new Major Research Instrumentation Recovery and Reinvestment (MRI-R2) and Academic Research Infrastructure Recovery and Reinvestment (ARI-R2) solicitations. The goal was based on an extrapolation of FY 2008 MRI program data on requested and awarded amounts. The average request and award under the MRI-R2 competition were over 50 percent higher than projected, so fewer awards could be made.

Education and Human Resources Account

The EHR Program promotes excellence in STEM education through the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians, and educators; a well-informed citizenry; and access to the ideas and tools of science and engineering for all. ARRA awarded EHR resources totaling $100.0 million to:

- Expand the Robert Noyce Teacher Scholarship Program, which produces STEM K-12 teachers who commit to teaching in high need school districts.
- Expand the Math and Science Partnership (MSP) Program, which focuses on the development of STEM K-12 master teachers and school-based instructional leaders in mathematics and science education.
- Establish the Science Master's (SM) Program, which will further broaden graduate training and talent for industry, the national laboratories, and non-governmental agencies. This new ARRA program made its awards early in FY 2010.

The programs are managed by the Divisions of Undergraduate Education and Graduate Education.

Robert Noyce Teacher Scholarship Program

The Robert Noyce Teacher Scholarship Program seeks to encourage talented science, technology, engineering, and mathematics majors and professionals to become K-12 mathematics and science teachers. The ARRA funds support Phase I projects from institutions that have not previously been funded or are requesting funding for a department or academic unit that has not participated in a previous Noyce award. These funds also support Phase II projects from institutions that have previously been funded and whose award expiration date occurs on or before December 31, 2009, enabling these institutions to support additional cohorts of prospective teachers while conducting longitudinal studies of previous cohorts. In addition, ARRA funds will support proposals submitted under the Noyce Program's NSF Teaching Fellowships and Master Teacher Fellowships track.

Subgoal 1: Number of new awards to lead institutions of higher education. The target for FY 2009 (67) was met. Only one round of competitions was held so there are no targets in subsequent years.

Subgoal 2: Number of new pre-service teachers and teacher participants. This measure represents the total number of teachers and teacher participants supported over the five-year duration of awards. Cumulative target for FY 2013: 1,530 participants.

Subgoal 3: Number of new teachers teaching in high need districts. This measure represents the total number of people moving into teaching in high need districts over the five-year duration of awards. Cumulative target for FY 2013: 1,440 teachers.

Robert Noyce Teacher Scholarship Program: Annual Targets and Results through FY 2010

Fiscal Year	Number of new awards to institutions		Number of New Pre-service and Teacher Participants		Number of New Teachers Teaching in High Need School Districts	
	Target	Result	Target	Result	Target	Result
FY 2009	67	67	30	124	0	0
FY 2010	*No targets*		370	420	28	75
FY 2011			415	-	270	-
FY 2012			415	-	475	-
FY 2013			300	-	667	-
Cumulative	67	67	1530	544	1440	75

Math and Science Partnership Program

The Math and Science Partnerships Program supports innovative partnerships to improve K-12 student achievement in math and science. MSP projects are expected to raise the achievement levels of all students and significantly reduce achievement gaps in the math and science performance of diverse student populations. The ARRA funds support three categories of projects: (1) Institute Partnerships – Teacher Institutes for the 21st Century, which focus on meeting national needs for teacher leaders/master teachers who have deep knowledge of disciplinary content for teaching and are fully prepared to be school- or district-based leaders in math or the sciences; (2) Phase II Partnerships for prior MSP Partnerships awardees who focus on specific innovative areas of their work where evidence of the potential for significant positive impact is clearly documented; and (3) MSP-Start Partnerships for awardees new to the MSP Program, especially from minority-serving institutions, community colleges, and primarily undergraduate institutions, to support the necessary data analysis, project design, evaluation, and team building activities needed to develop a full MSP Targeted or Institute Partnership.

Subgoal 1: Number of new awards to lead institutions of higher education. The target for FY 2009 (9) was met. Only one round of competitions was held so there are no targets in subsequent years.

Subgoal 2: Number of MSP teacher leader/master teacher participants. This measure represents the total number of people supported over the five-year duration of awards. Cumulative target for FY 2013: 369 participants.

Subgoal 3: Number of Post-baccalaureate credential or master's degree recipients. This measure represents the total number of people receiving master's degrees or other credential over the five-year duration of awards. Cumulative target for FY 2013: 331 recipients.

Math and Science Partnership: Annual Targets and Results through FY 2010

Fiscal Year	Number of new awards to institutions		Number of Leader/Master Teacher Participants		Number of Participants Receiving Graduate Credit/Degree or Other Credential	
	Target	Result	Target	Result	Target	Result
FY 2009	9	9	15	24	13	15
FY 2010	*No targets*		133	180	119	110
FY 2011			73	-	67	-
FY 2012			74	-	66	-
FY 2013			74	-	66	-
Cumulative	9	9	369	204	331	125

Science Master's Program

The Science Master's program is a new program in FY 2010. From Program Solicitation 09-607 (http://www.nsf.gov/pubs/2009/nsf09607/nsf09607.htm): "The Science Master's Program prepares graduate students for careers in business, industry, nonprofit organizations, and government agencies by providing them not only with a strong foundation in science, technology, engineering and mathematics (STEM) disciplines, but also with research experiences, internship experiences, and the skills to succeed in those careers. The program is intended to catalyze the creation of institution-based efforts that can be sustained without additional federal funding. This program is also intended to encourage diversity in student participation so as to contribute to a broadly inclusive, well-trained science and engineering workforce."

Subgoal 1: Number of new awards to lead institutions. The target for FY 2010 (21) was met. Only one round of competitions was held so there are no targets in subsequent years.

Subgoal 2: Number of new students supported. This measure represents the total number of people to be supported over the three-year duration of awards. Cumulative target for FY 2012: 220.

Subgoal 3: Number of students earning science master's degrees. This measure represents the total number of degree recipients over the three-year duration of awards. Cumulative target for FY 2012: 200.

Science Masters Program: Annual Targets and Results through FY 2010

Fiscal Year	Number of new awards to institutions		Number of New Students Supported		Number of Students Earning Science Master's Degrees	
	Target	Result	Target	Result	Target	Result
FY 2010	21	21	80	100	0	0
FY 2011	*No targets*		140	-	80	-
FY 2012			0	-	120	-
Cumulative	21	21	220	100	200	0

Major Research Equipment and Facilities Construction Account

ARRA funds supported the following Major Research Equipment and Facilities Construction (MREFC) projects:

- the Advanced Technology Solar Telescope (ATST), which will enable the study of solar activity in unprecedented detail,
- the Alaska Region Research Vessel (ARRV), a new multipurpose research ship to operate in seasonal sea ice and open ocean waters in the Bering Sea and the Gulf of Alaska, and
- the Ocean Observatories Initiative (OOI), an integrated observatory network to study the complex, interlinked physical, chemical, biological, and geological processes operating throughout the global ocean.

NSF uses the Earned Value Management (EVM) system to track its construction projects. EVM is an integrated management control system for assessing, understanding, and quantifying what a contractor or field activity is achieving with program dollars. It is a standard measure of performance for construction projects.

In FY 2009, all projects were under 10 percent complete. Projects that are under ten percent complete are not considered eligible for this goal because EVM data is less meaningful statistically in the very early stages of a project. Early in a project, the actual costs of the work, and the total values of the work scheduled and performed, are small compared to the total project cost and schedule. Consequently, their ratios - the reported cost and schedule variances - can change by large amounts even though the real values of their differences are small.

Two projects crossed the ten percent threshold in FY 2010. Of those, one (OOI) was off schedule at the end of the fiscal year. OOI is suffering lagging procurements and delays in staffing at the implementing organizations. Active schedule management is underway to recover from these delays.

MREFC Project	**Target**	**FY 2009**	**FY 2010**
Advanced Technology Solar Telescope (ATST)	< -10%	*Results not significant--projects under 10 percent complete*	*Results not significant--project under 10 percent complete*
Alaska Region Research Vessel (ARRV)			Achieved (schedule: 0%, cost: 58%)
Ocean Observatories Initiative (OOI)			Not achieved (schedule: -29%, cost: 12%)

TECHNICAL INFORMATION

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National Science Foundation

RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of aircraft; and authorized travel; $6,253,540,000, to remain available until September 30, 2013, of which not to exceed $550,000,000 shall remain available until expended for polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program: *Provided*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.

EDUCATION AND HUMAN RESOURCES

For necessary expenses in carrying out science, mathematics and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, authorized travel, and rental of conference rooms in the District of Columbia, $911,200,000, to remain available until September 30, 2013.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including authorized travel, $224,680,000, to remain available until expended.

AGENCY OPERATIONS AND AWARD MANAGEMENT

For agency operations and award management necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $9,000 for official reception and representation expenses; uniforms or allowances therefore, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the Department of Homeland Security for security guard services; $357,740,000: *Provided*, That contracts may be entered into under this heading in fiscal year 2012 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year: *Provided further, That of the amounts made available under this heading not less than $1,960,000 is for strengthening the agency's acquisition workforce capacity and capabilities: Provided further, That such funds shall be available for training, recruitment, retention, and hiring members of the acquisition workforce as defined by the Office of Federal Procurement Policy Act, as amended (41 U.S.C. 401 et seq.): Provided further, That such funds shall be available for information technology in support of acquisition workforce effectiveness or for management solutions to improve acquisition management: Provided further, That of the funds made available under this heading, $44,650,000 shall remain*

available until expended for costs associated with the acquisition of headquarters space, including design, alteration, tenant improvement, and relocation.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended, $15,000,000, to remain available until September 30, 2013.

OFFICE OF THE NATIONAL SCIENCE BOARD

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the National Science Foundation Act of 1950, as amended (42 U.S.C 1863) and Public Law 86-209 (42 U.S.C. 1880 et seq.), $4,840,000: *Provided*, That not to exceed $2,500 shall be available for official reception and representation expenses.

SUMMARY OF FY 2012 BUDGETARY RESOURCES BY APPROPRIATION

(DOLLARS IN MILLIONS)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
RESEARCH AND RELATED ACTIVITIES						
Appropriation	$5,617.92	$0.00	$5,617.92	$6,253.54	$635.62	11.3%
Unobligated Balance Available Start of Year	44.59	437.36	$1.37			
Unobligated Balance Available End of Year	-1.37	-0.24				
Adjustments to Prior Year Accounts[2]	8.20	2.05				
Subtotal, R&RA	5,669.34	439.17	5,619.29	$6,253.54	$634.25	11.3%
Transferred to/from other funds[3]	-54.00		-54.00	-		
Total Budgetary Resources	$5,615.34	$439.17	$5,565.29	$6,253.54	$688.25	12.4%
EDUCATION AND HUMAN RESOURCES						
Appropriation	$872.76	$0.00	$872.76	$911.20	$38.44	4.4%
Unobligated Balance Available Start of Year	0.02	15.00	0.04			
Unobligated Balance Available End of Year	-0.04					
Adjustments to Prior Year Accounts[2]	0.03	-				
Total Budgetary Resources	$872.77	$15.00	$872.80	$911.20	$38.40	4.4%
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION						
Appropriation	$117.29	$0.00	$117.29	$224.68	$107.39	91.6%
Unobligated Balance Available Start of Year	57.73	146.00	9.17			
Unobligated Balance Available End of Year	-9.17	0.00				
Adjustments to Prior Year Accounts[2]	0.05	-				
Total Budgetary Resources	$165.90	$146.00	$126.46	$224.68	$98.22	77.7%
AGENCY OPERATIONS AND AWARD MANAGEMENT						
Appropriation	$300.00	-	$300.00	$357.74	$57.74	19.2%
Unobligated Balance Available Start of Year	-	-	-			
Unobligated Balance Available End of Year	-0.15	-				
Adjustments to Prior Year Accounts[2]	-	-				
Subtotal, AOAM	299.85					
	-					
Total Budgetary Resources	$299.85	-	$300.00	$357.74	$57.74	19.2%

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

[2]Adjustments include upward and downward adjustments to prior year obligations.

[3]Funding for FY 2010 excludes an appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

SUMMARY OF FY 2012 BUDGETARY RESOURCES BY APPROPRIATION

(DOLLARS IN MILLIONS)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
NATIONAL SCIENCE BOARD						
Appropriation	$4.54	-	$4.54	$4.84	$0.30	6.6%
Unobligated Balance Available Start of Year	-	-				
Unobligated Balance Available End of Year	-0.16	-				
Adjustments to Prior Year Accounts[2]	-	-				
Total Budgetary Resources	$4.38	-	$4.54	$4.84	$0.30	6.6%
OFFICE OF INSPECTOR GENERAL						
Appropriation	$14.00	$0.00	$14.00	$15.00	$1.00	7.1%
Unobligated Balance Available Start of Year	-	1.98				
Unobligated Balance Available End of Year	-0.03	-1.93				
Adjustments to Prior Year Accounts[2]	-	-				
Total Budgetary Resources	$13.97	$0.05	$14.00	$15.00	$1.00	7.1%
TOTAL DISCRETIONARY, NATIONAL SCIENCE FOUNDATION	$6,972.20	$600.22	$6,883.09	$7,767.00	$883.91	12.8%
EDUCATION AND HUMAN RESOURCES, H-1B						
Appropriation, Mandatory	$91.22	-	$100.00	$100.00	$100.00	100.0%
Unobligated Balance Available Start of Year	52.62	-	50.15			
Unobligated Balance Available End of Year	-50.15	-				
Adjustments to Prior Year Accounts[2]	3.12	-				
Total Budgetary Resources	$96.81	-	$150.15	$100.00	-$50.15	-33.4%
TOTAL, NATIONAL SCIENCE FOUNDATION	$7,069.01	$600.21	$7,033.24	$7,867.00	$833.76	11.9%

Totals may not add due to rounding.

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[2]Adjustments include upward and downward adjustments to prior year obligations.

NSF FY 2012 FUNDING BY PROGRAM
(Dollars in Millions)

PROGRAM	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Total Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
BIOLOGICAL SCIENCES							
MOLECULAR AND CELLULAR BIOSCIENCES	$125.90	-	$125.90	$125.59	$145.72	$20.13	16.0%
INTEGRATIVE ORGANISMAL SYSTEMS	216.32	-	216.32	216.25	231.65	15.40	7.1%
ENVIRONMENTAL BIOLOGY	142.50	-	142.50	142.55	156.40	13.85	9.7%
BIOLOGICAL INFRASTRUCTURE	127.19	0.35	127.54	126.86	135.95	9.09	7.2%
EMERGING FRONTIERS	102.85	-	102.85	103.29	124.77	21.48	20.8%
Total, BIO	$714.77	$0.35	$715.12	$714.54	$794.49	$79.95	11.2%
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING							
COMPUTING & COMMUNICATION FOUNDATIONS	$170.40	-	$170.40	$170.35	$210.13	$39.78	23.4%
COMPUTER & NETWORK SYSTEMS	204.33	-	204.33	204.42	235.20	30.78	15.1%
INFORMATION & INTELLIGENT SYSTEMS	163.21	-	163.21	163.32	197.35	34.03	20.8%
INFORMATION TECHNOLOGY RESEARCH	80.78	-	80.78	80.74	85.74	$5.00	N/A
Total, CISE	$618.71	-	$618.71	$618.83	$728.42	$109.59	17.7%
ENGINEERING							
CHEMICAL, BIOENGINEERING, ENVIRONMENTAL & TRANSPORT SYSTEMS	$157.08	-	$157.08	$156.82	$194.03	$37.21	23.73%
CIVIL, MECHANICAL & MANUFACTURING INNOVATION	189.40	-	189.40	188.00	$226.10	38.10	20.27%
ELECTRICAL, COMMUNICATIONS & CYBER SYSTEMS	93.97	-	93.97	94.00	$131.00	37.00	39.36%
INDUSTRIAL INNOVATION & PARTNERSHIPS	180.63	-	180.63	152.00	$191.57	39.57	26.03%
SBIR/STTR	[156.84]	-	[156.84]	[125.77]	[146.88]	[21.11]	[16.78%]
ENGINEERING EDUCATION & CENTERS	125.86	-	125.86	124.11	$132.40	8.29	6.68%
EMERGING FRONTIERS IN RESEARCH & INNOVATION	28.99	-	28.99	29.00	$33.20	4.20	14.48%
Total, ENG	$775.92	-	$775.92	$743.93	$908.30	$164.37	22.09%

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[2]Formerly known as Division of Science Resources Statistics

[3]Funding for FY 2010 excludes an appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[4]Awards for the Academic Research Infrastructure program, funded through ARRA, were made in FY 2010.

[5]Awards for the Science Masters Program, funded through ARRA, were made in FY 2010.

[6]Excludes $96.81 million in obligations in FY 2010 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2011 and FY 2012.

[7]In FY 2012, Research in Disabilities Education and Research on Gender in Science and Engineering program funding responsibilities are transferred from HRD to DRL. Funding for all years is shown in the FY 2012 structure for comparability.

NSF FY 2012 FUNDING BY PROGRAM
(Dollars in Millions)

PROGRAM	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Total Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
GEOSCIENCES							
ATMOSPHERIC & GEOSPACE SCIENCES	$259.87	-	$259.87	$259.80	$286.33	$26.53	10.2%
EARTH SCIENCES	183.26	-	183.26	183.00	$207.27	24.27	13.3%
INTEGRATIVE & COLLABORATIVE EDUCATION AND RESEARCH	98.87	0.40	99.27	97.92		3.00	3.1%
OCEAN SCIENCES	349.88	-	349.88	348.92	$100.92 $384.64	35.72	10.2%
Total, GEO	$891.87	$0.40	$892.27	$889.64	$979.16	$89.52	10.1%
MATHEMATICAL AND PHYSICAL SCIENCES							
ASTRONOMICAL SCIENCES	$246.53	-	$246.53	$245.69	$249.12	$3.43	1.4%
CHEMISTRY	233.68	15.70	249.38	233.73	258.07	24.34	10.4%
MATERIALS RESEARCH	302.57	-	302.57	302.67	320.79	18.12	6.0%
MATHEMATICAL SCIENCES	244.92	-	244.92	241.38	260.43	19.05	7.9%
PHYSICS	301.66	-	301.66	290.04	300.91	10.87	3.7%
MULTIDISCIPLINARY ACTIVITIES	38.58	-	38.58	38.33	43.41	5.08	13.3%
Total, MPS	$1,367.95	$15.70	$1,383.65	$1,351.84	$1,432.73	$80.89	6.0%
SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES							
SOCIAL AND ECONOMIC SCIENCES	$99.05	$0.03	$99.08	$99.05	$113.81	$14.76	14.9%
BEHAVIORAL AND COGNITIVE SCIENCES	94.56	0.21	94.77	94.58	105.90	11.32	12.0%
NATIONAL CENTER FOR SCIENCE AND ENGINEERING STATISTICS[2]	34.76	-	34.76	34.62	38.01	3.39	9.8%
OFFICE OF MULTIDISCIPLINARY ACTIVITIES	26.94	-	26.94	27.00	43.41	16.41	60.8%
Total, SBE	$255.31	$0.25	$255.56	$255.25	$301.13	$45.88	18.0%

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[2]Formerly known as Division of Science Resources Statistics
[3]Funding for FY 2010 excludes an appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.
[4]Awards for the Academic Research Infrastructure program, funded through ARRA, were made in FY 2010.
[5]Awards for the Science Masters Program, funded through ARRA, were made in FY 2010.
[6]Excludes $96.81 million in obligations in FY 2010 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2011 and FY 2012.
[7]In FY 2012, Research in Disabilities Education and Research on Gender in Science and Engineering program funding responsibilities are transferred from HRD to DRL. Funding for all years is shown in the FY 2012 structure for comparability.

NSF FY 2012 FUNDING BY PROGRAM
(Dollars in Millions)

PROGRAM	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Total Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING	$47.84	$0.10	$47.94	$47.83	$58.03	$10.20	21.3%
OFFICE OF CYBERINFRASTRUCTURE	$214.72	-	$214.72	$214.28	$236.02	$21.74	10.1%
OFFICE OF POLAR PROGRAMS							
ARCTIC SCIENCES	$105.11	$0.18	$105.29	$106.31	$112.94	$6.63	6.2%
ANTARCTIC SCIENCES	74.57	2.05	76.62	71.08	76.65	5.57	7.8%
ANTARCTIC INFRASTRUCTURE & LOGISTICS	265.26	0.00	265.26	266.76	280.55	13.79	5.2%
U.S. Antarctic Logistical Support Activities	[67.52]	[0.00]	[67.52]	[67.52]	[67.52]	-	-
POLAR ENVIROMENT, HEALTH & SAFETY	6.84	-	6.84	7.01	7.27	0.26	3.7%
USCG POLAR ICEBREAKING[3]	0.00	-	0.00	0.00	0.00	0.00	N/A
Total, OPP	$451.77	$2.23	$454.00	$451.16	$477.41	$26.25	5.8%
INTEGRATIVE ACTIVITIES							
EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)	[147.11]	[20.00]	[167.11]	[147.12]	[160.53]	[7.24]	[4.9%]
MAJOR RESEARCH INSTRUMENTATION (MRI)	[89.99]	[200.15]	[290.13]	[90.00]	[90.00]	-	-
ACADEMIC RESEARCH INFRASTRUCTURE (ARI)[4]	[0.00]	[200.00]	[200.00]	[0.00]	[0.00]	-	-
Total, IA	$274.89	$420.15	$695.04	$275.04	$336.25	$61.21	22.3%
U.S. ARCTIC RESEARCH COMMISSION	$1.58	-	$1.58	$1.58	$1.60	$0.02	1.3%
Total, RESEARCH AND RELATED ACTIVITIES2	$5,615.33	$439.17	$6,054.50	$5,563.92	$6,253.54	$689.62	12.4%
EDUCATION AND HUMAN RESOURCES							
RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS	$260.49	-	$260.49	$260.00	$264.09	$4.09	1.6%
UNDERGRADUATE EDUCATION	292.35	-	292.35	292.41	295.42	3.01	1.0%
GRADUATE EDUCATION[5]	181.43	15.00	196.43	181.44	191.73	10.29	5.7%
HUMAN RESOURCE DEVELOPMENT	138.49	-	138.49	138.91	159.96	21.05	15.2%
Total, EHR[6,7]	$872.77	$15.00	$887.77	$872.76	$911.20	$38.44	4.4%

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[3]Funding for FY 2010 excludes an appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[4]Awards for the Academic Research Infrastructure program, funded through ARRA, were made in FY 2010.

[5]Awards for the Science Masters Program, funded through ARRA, were made in FY 2010.

[6]Excludes $96.81 million in obligations in FY 2010 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2011 and FY 2012.

[7]In FY 2012, Research in Disabilities Education and Research on Gender in Science and Engineering program funding responsibilities are transferred from HRD to DRL. Funding for all years is shown in the FY 2012 structure for comparability.

NSF FY 2012 FUNDING BY PROGRAM
(Dollars in Millions)

PROGRAM	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Total Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION	$165.90	$146.00	$311.90	$117.29	$224.68	$107.39	91.6%
AGENCY OPERATIONS AND AWARD MANAGEMENT	$299.85	-	$299.85	$300.00	$357.74	$57.74	19.2%
NATIONAL SCIENCE BOARD	$4.38	-	$4.38	$4.54	$4.84	$0.30	6.6%
OFFICE OF INSPECTOR GENERAL	$13.97	$0.05	$14.02	$14.00	$15.00	$1.00	7.1%
NATIONAL SCIENCE FOUNDATION	$6,972.20	$600.22	$7,572.42	$6,872.51	$7,767.00	$894.49	13.0%

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

[2]Formerly known as Division of Science Resources Statistics

[3]Funding for FY 2010 excludes an appropriation transfer of $54.0 million to U.S. Coast Guard per P.L. 111-117.

[4]Awards for the Academic Research Infrastructure program, funded through ARRA, were made in FY 2010.

[5]Awards for the Science Masters Program, funded through ARRA, were made in FY 2010.

[6]Excludes $96.81 million in obligations in FY 2010 and an estimated $100.0 million in receipts from H-1B Nonimmigrant Petitioner Fees in FY 2011 and FY 2012.

[7]In FY 2012, Research in Disabilities Education and Research on Gender in Science and Engineering program funding responsibilities are transferred from HRD to DRL. Funding for all years is shown in the FY 2012 structure for comparability.

OBJECT CLASSIFICATION
NSF Consolidated Obligations
(Dollars in Millions)

Object Class Code	Standard Title	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	FY 2012 Legislative Proposal
11.1	Full-time permanent	$151	$155	$159	-
11.3	Other than fulltime permanent	14	13	14	-
11.5	Other personnel compensation	7	8	7	-
11.8	Special personal service payment	1	2	2	-
	Total personnel compensation	173	178	182	-
12.1	Civilian personnel benefits	41	40	44	-
21.0	Travel and transportation of persons	33	31	34	-
23.1	Rental payments to GSA	26	26	26	-
23.3	Communications, utilities, and miscellaneous charges	2	2	2	-
25.1	Advisory and assistance services	175	166	173	-
25.2	Other services	19	19	20	-
25.3	Purchases of goods and services from Government accounts	36	29	31	-
25.4	Operation and maintenance of facilities	368	444	444	-
25.5	Research and development contracts	12	19	19	-
26.0	Supplies and materials	6	6	6	-
31.0	Equipment	3	5	6	-
32	Land and Structures	-	-	35	-
41.0	Grants, subsidies, and contributions	6,822	6,141	6,871	150
	Total, Direct obligations [1]	$7,716	$7,106	$7,893	$150

Totals may not add due to rounding.

[1]Includes mandatory obligations, but excludes obligations for reimbursable accounts.

REIMBURSABLE ACTIVITY

Reimbursements for the Research and Related Activities Appropriation and the Education and Human Resources Appropriation are realized from other federal agencies that have entered into interagency agreements with the Foundation. NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. These activities can include jointly funded projects and programs, support of research operations and logistics, and access to NSF supported research facilities.

(Dollars in Millions)

DEPARTMENT/AGENCY	FY 2010 Actual
DEFENSE	
Air Force	$10.3
Army	$7.1
Other DOD (DARPA, NSA & Intelligence)	$14.6
Subtotal, DOD	$32.0
Agriculture	$3.6
Commerce (Including Census, NOAA, & NIST)	$8.8
Education	$0.6
Energy	$4.6
Environmental Protection Agency	$1.3
Health & Human Services	$16.5
Homeland Security	$5.9
Interior	$0.5
NASA	$11.6
National Archives	$1.9
State	$1.6
Transportation	$11.2
OTHER (less than $500,000)	$1.9
TOTAL REIMBURSEMENTS	**$102.0**

Consistent with applicable legislation and GAO decisions, agreements include reimbursement for costs that are incurred in the management and administration of these awards.

In FY 2010, the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense (31.4 percent), the Department of Health and Human Services (16.2 percent), National Aeronautics and Space Administration (11.4 percent), the Department of Transportation (11.0 percent), Department of Commerce (including Census, NOAA, & NIST) (8.6 percent), the Department of Homeland Security (5.8 percent), and the Department of Energy (4.5 percent). Reimbursable activities with the Department of Defense were primarily for the management of the National Center for Atmospheric Research (NCAR). Reimbursable activities with the Department of Health and Human Services are for non-medical biological research such as the Human Frontiers Science Program and the Macromolecular Structure Database (MSD) program.

NSF Personnel Summary of Permanent Appointments

Statutory Pay Systems	FY 2010 Actual Appointments
ES	74
AD	342
GS/GM-15	95
GS/GM-14	135
GS/GM-13	128
GS-12	112
GS-11	90
GS-10	14
GS-9	71
GS-8	31
GS-7	86
GS-6	9
GS-5	2
Subtotal, GS/GM	773
Total, Permanent Appointments	1,189
Average Salary	$115,849

All data are for permanent appointments.

EXPLANATION OF FY 2010 CARRYOVER INTO FY 2011 BY ACCOUNT

The National Science Foundation's (NSF) total unobligated balance of $62.66 million from the FY 2010 Regular Discretionary and Mandatory appropriations, and the American Recovery and Reinvestment Act of FY 2009 (ARRA) appropriation consist of amounts described below.

REGULAR DISCRETIONARY

Within the **Research and Related Activities (R&RA)** regular appropriation, NSF carried over $1.37 million into FY 2011. The major items include awards and contracts from various programs throughout NSF that were not ready for obligation in FY 2010. Obligation is expected in the second quarter of FY 2011.

Within the **Educational and Human Resources (EHR)** appropriation, $44,070 was carried over into FY 2011 for projects that were not ready for obligation in FY 2010. Obligation of these funds is expected by the second quarter of FY 2011.

Within the **Major Research Equipment and Facilities Construction (MREFC)** appropriation, a total of $9.17 million was carried over into FY 2011. This includes:

$5.98 million for IceCube Neutrino Observatory (IceCube): Funding to the Air National Guard and other support functions is expected to be obligated by the fourth quarter of FY 2011.

$3.0 million for National Ecological Observatory Network (NEON): Funding for continuing costs associated with multi-year construction project are expected to be obligated and expended over the remaining period of construction.

$190,944 for South Pole Station Modernization (SPSM): Costs related to completion of the fuel system and hoist are expected to be obligated in the third quarter of FY 2011.

MANDATORY

Within the **H-1B Nonimmigrant Petitioner** account (Mandatory), $50.15 million was carried over into FY 2011. NSF's carryover for H-1B funded programs consisted of $9.52 million in ITEST, $40.63 million in S-STEM. These amounts include $31.75 million in fourth quarter receipts.

- Reason for Carryover: NSF receives the largest amount of H-1B visa fees in the fourth quarter, leaving insufficient time to commit all receipts to awards before the end of the fiscal year.
- Expected Obligation: Second quarter of FY 2011.

AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009 (ARRA)

Within the **Office of Inspector General** appropriation, $1.93 million was carried over.

- Reason for Carryover: Five year funds intended explicitly for ARRA oversight.
- Expected Obligation: Will be obligated over the period of availability, which is until September 30, 2013.

Regular Discretionary, Mandatory, and ARRA Appropriations
Distribution of FY 2010 Carryover into FY 2011
(Dollars in Millions)

	FY 2011 Carryover from FY 2010	ARRA FY 2011 Carryover from FY 2010	Total FY 2011 Carryover
Research and Related Activities	$1.37	-	$1.37
Education and Human Resources	0.04	-	0.04
Major Research Equipment and Facilities Construction	9.17	-	9.17
Office of Inspector General	-	1.93	1.93
Subtotal	**10.58**	**1.93**	**12.51**
H-1B Nonimmigrant Petitioner **(Mandatory)**	50.15	-	50.15
Total	**$60.73**	**$1.93**	**$62.66**

Totals may not add due to rounding.

QUANTITATIVE DATA TABLE

NATIONAL SCIENCE FOUNDATION

Research and Development Special Analysis

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA	FY 2010 Total	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
Support of R&D					
Conduct of Research and Development					
Basic Research[2]	$4,629.01	$38.20	$4,667.21	$4,581.19	$5,095.87
Applied Research	348.48	0.01	348.49	343.16	566.74
Subtotal, Conduct of R&D	4,977.49	38.21	5,015.70	4,924.35	5,662.61
R&D Facilities					
Land, Building and Fixed Equipment	84.89	200.00	284.89	48.61	31.47
Major Equipment	425.85	346.95	772.80	400.31	403.00
Subtotal, R&D Facilities & Major Equipment	510.74	546.95	1,057.69	448.92	434.47
Total, Support of R&D	5,488.23	585.16	6,073.39	5,373.27	6,097.08
Non-Investment Activities[2]	583.58	0.05	583.63	552.97	652.57
Education and Training	900.39	15.01	915.40	946.27	1,017.35
TOTAL	$6,972.20	$600.22	$7,572.42	$6,872.51	$7,767.00

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

[2]Basic Research and Non-Investment Activities were redefined to report ship operations and Polar Logistics as basic research instead of non-investment activities. This designation was changed in order to identify these areas with the underlying activity.

QUANTITATIVE DATA TABLE

RESEARCH AND RELATED ACTIVITIES

Research and Development Special Analysis

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA	FY 2010 Total	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
Support of R&D					
Conduct of Research and Development					
Basic Research[2]	$4,555.56	$38.20	4,593.76	$4,509.97	$5,030.87
Applied Research	302.93	0.01	302.94	338.71	539.74
Subtotal, Conduct of R&D	4,858.49	38.21	4,896.70	4,848.68	5,570.61
R&D Facilities					
Land, Building and Fixed Equipment	84.89	200.00	284.89	48.61	31.47
Major Equipment	259.18	200.95	460.13	283.02	178.32
Subtotal, R&D Facilities & Major Equipment	344.07	400.95	745.02	331.63	209.79
Total, Support of R&D	5,202.56	439.16	5,641.72	5,180.31	5,780.40
Non-Investment Activities[2]	223.21	-	223.21	197.89	231.99
Education and Training	189.56	0.01	189.57	185.72	241.15
TOTAL	$5,615.33	$439.17	$6,054.50	$5,563.92	$6,253.54

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

[2]Basic Research and Non-Investment Activities were redefined to report ship operations and Polar Logistics as basic research instead of non-investment activities. This designation was changed in order to identify these areas with the underlying activity.

QUANTITATIVE DATA TABLE

EDUCATION AND HUMAN RESOURCES

Research and Development Special Analysis

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA	FY 2010 Total	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	$73.45	-	$73.45	$71.22	$65.00
Applied Research	45.55	-	45.55	4.45	27.00
Subtotal, Conduct of R&D	119.00	-	119.00	75.67	92.00
R&D Facilities					
Land, Building and Fixed Equipment	-	-	-	-	-
Major Equipment	0.77	-	0.77	-	-
Subtotal, R&D Facilities & Major Equipment	0.77	-	0.77	-	-
Total, Support of R&D	119.77	-	119.77	75.67	92.00
Non-Investment Activities	42.17	-	42.17	36.54	43.00
Education and Training	710.83	15.00	725.83	760.55	776.20
TOTAL	$872.77	$15.00	$887.77	$872.76	$911.20

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

QUANTITATIVE DATA TABLE

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

Research and Development Special Analysis

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA	FY 2010 Total	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	-	-	-	-	-
Applied Research	-	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment	-	-	-	-	-
Major Equipment	$165.90	$146.00	311.90	$117.29	$224.68
Subtotal, R&D Facilities & Major Equipment	165.90	146.00	311.90	117.29	224.68
Total, Support of R&D	165.90	146.00	311.90	117.29	224.68
Non-Investment Activities	-	-	-	-	-
Education and Training	-	-	-	-	-
TOTAL	$165.90	$146.00	$311.90	$117.29	$224.68

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

QUANTITATIVE DATA TABLE

AGENCY OPERATIONS AND AWARD MANAGEMENT

Research and Development Special Analysis

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA	FY 2010 Total	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	-	-	-	-	-
Applied Research	-	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment	-	-	-	-	-
Major Equipment	-	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-	-
Total, Support of R&D	-	-	-	-	-
Non-Investment Activities	$299.85	-	$299.85	$300.00	$357.74
Education and Training	-	-	-	-	-
TOTAL	$299.85	-	$299.85	$300.00	$357.74

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

QUANTITATIVE DATA TABLE

OFFICE OF INSPECTOR GENERAL

Research and Development Special Analysis

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA	FY 2010 Total	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	-	-	-	-	-
Applied Research	-	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment	-	-	-	-	-
Major Equipment	-	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-	-
Total, Support of R&D	-	-	-	-	-
Non-Investment Activities	$13.97	$0.05	$14.02	$14.00	$15.00
Education and Training	-	-	-	-	-
TOTAL	$13.97	$0.05	$14.02	$14.00	$15.00

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.

QUANTITATIVE DATA TABLE

NATIONAL SCIENCE BOARD

Research and Development Special Analysis

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA	FY 2010 Total	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
Support of R&D					
Conduct of Research and Development					
Basic Research	-	-	-	-	-
Applied Research	-	-	-	-	-
Subtotal, Conduct of R&D	-	-	-	-	-
R&D Facilities					
Land, Building and Fixed Equipment	-	-	-	-	-
Major Equipment	-	-	-	-	-
Subtotal, R&D Facilities & Major Equipment	-	-	-	-	-
Total, Support of R&D	-	-	-	-	-
Non-Investment Activities	$4.38	-	$4.38	$4.54	$4.84
Education and Training	-	-	-	-	-
TOTAL	$4.38	-	$4.38	$4.54	$4.84

Totals may not add due to rounding.

[1]A full-year 2011 appropriation for this account was not enacted at the time the budget was prepared; therefore, this account is operating under a continuing resolution (P.L. 111–242, as amended). The amounts included for 2011 reflect the annualized level provided by the continuing resolution.