Chapter 1

Management's Discussion and Analysis

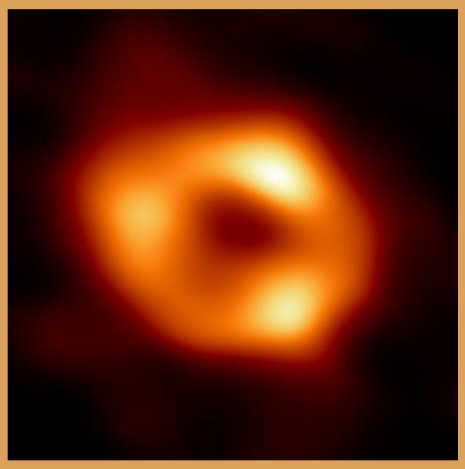
Agency Overview

Mission and Vision

The National Science Foundation (NSF) was established in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…"[1] As the only federal agency that invests in fundamental, basic research across all non-medical fields of science and engineering, this mission continues to guide the agency today.

For over seven decades, NSF has been at the forefront of discovery and innovation. NSF-funded discoveries have been instrumental in developing new ways of thinking about scientific, economic, and sociotechnical challenges facing the Nation and the world. Among the many discoveries, the agency has supported use-inspired innovations such as the manufacture of personal protective equipment and accelerating sequencing the structure of the COVID virus; laid the technological foundation for smartphones, GPS, and the Internet; invested in research to make people safer in times of natural disasters; and accelerated advances in 3D printing and nanoscience. The *CHIPS and Science Act of 2022*,[2] enacted in August 2022, emphasizes the importance of investments in NSF's mission and will further accelerate discoveries and innovations that help to overcome the challenges of today and realize the opportunities of tomorrow. The legislation strengthens investments in science, technology, engineering, and math (STEM) education and in efforts to broaden participation and build a diverse, inclusive workforce for the jobs of the future.

During fiscal year (FY) 2022, NSF marked its 72nd anniversary by unveiling the first-ever image of the black hole that lies at the center of the Milky Way. The image required the synthesis of ideas and collaborative efforts involving dozens of researchers—across nations, institutions, and disciplines—and in this way inspires and illuminates the future of the scientific enterprise.



The first image of the black hole at the center of the Milky Way. *Credit: EHT Collaboration*

The hole at the center of our galaxy, Sgr A*

In May, NSF-supported scientists released the first direct visual evidence of the supermassive black hole at the center of our Milky Way galaxy. The black hole, dubbed Sagittarius A*, or Sgr A*, was challenging to view due to its relatively small size and because it is surrounded by fast-moving gas and other objects in our galaxy passing through the viewing path. A composite image was produced by a global research team called the Event Horizon Telescope, or EHT, Collaboration, which layered observations gathered by a worldwide network of radio telescopes. Because Sgr A* is located at the center of the Milky Way, understanding how it functions is fundamental to the larger goal of understanding how our galaxy formed and continues to evolve.

[1] National Science Foundation Act of 1950 (Public Law 81–507).

[2] *The CHIPS and Science Act of 2022*, Public Law 117-167 was enacted August 8, 2022, and authorizes various new programs and activities at NSF. https://www.congress.gov/bill/117th-congress/house-bill/4346/text

This report is focused on FY 2022, a year in which NSF funded the groundbreaking research that has long been its hallmark and pursued efforts to help researchers and educators rebound from the unprecedented disruptions brought by the COVID-19 pandemic. The agency prioritized the deployment of its regular appropriations, as well as funds provided through the *American Rescue Plan* (ARP) *Act of 2021*[3] to support individuals and institutions most affected by the pandemic, with special focus on those at vulnerable transition points in their research careers.

In FY 2022, NSF's research priorities included supporting fundamental research and development, strengthening U.S. leadership in emerging technologies, improving equity in science and engineering, and advancing climate science and sustainability research. For example, as the primary non-defense federal funder of basic research on artificial intelligence (AI), NSF made critical investments in AI that will enable breakthroughs across nearly every sector of society. Other breakthroughs from NSF-supported research included materials scientists working toward the development of new, high-performance synthetic fibers; biomedical engineers creating an implantable computer–brain interface to enable precise, high-speed, multifinger movements; and pathbreaking efforts to understand the tuberculosis genome and the complex evolution of this ancient pathogen. In FY 2022, NSF also announced a new investment, in collaboration with other federal agencies and private industry, aimed at the development of intelligent, resilient, and reliable next-generation networks and computing technologies. Throughout 2022, NSF remained committed to shaping a sustainable future by building on long-standing programs for crosscutting advances in climate change research and the translation of fundamental discoveries in clean energy into technologies and systems.

Recycling CO_2 into sustainable aviation fuels

Dimensional Energy, launched with help from NSF's SBIR/STTR programs, known as America's Seed Fund, has developed a method to use sunlight to convert carbon dioxide into energy. Co-founded by two Cornell faculty members, the company gathers carbon dioxide from a sources like industrial sites (cement plants) or from direct-air capture, then adds renewable energy and hydrogen to their system of reactors, to transform it into an environmentally friendly fuel. The goal of the founders is to decarbonize the aviation industry with sustainable jet fuel and, in June 2022, United Airlines agreed to purchase at least 300 million gallons of their product over 20 years from the company.

Dimensional Energy, launched with the help of NSF's SBIR/STTR programs, produces sustainable aviation fuels.
Credit: Dimensional Energy

NSF prioritizes investments in a wide array of research infrastructure that is geographically distributed and broadly accessible to advance discovery, learning, and exploration. This infrastructure includes observatories, detectors, optical and radio telescopes as well as ships, aircraft and autonomous airborne platforms and other state-of-the-art tools that foster collaboration and provide sophisticated platforms for conducting cutting-edge research. In 2022, the upgraded NSF Natural Hazards Engineering Research Infrastructure shake table was reopened and provides researchers access to state-of-the-art facilities to

[3] https://www.congress.gov/bill/117th-congress/house-bill/1319/text

study natural hazards and the performance of civil infrastructure. Also in 2022, astronomers obtained the sharpest image to date of the universe's most massive known star using the Gemini South Telescope of the International Gemini Observatory, operated by NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab), which is the preeminent U.S. national center for ground-based, nighttime optical and infrared astronomy. The Foundation's long-term commitment to steady advancements and upgrades to research facilities enables continued ground-breaking research across scientific disciplines.

In March 2022, NSF established the Directorate for Technology, Innovation and Partnerships (TIP), which advances use-inspired and translational research, giving rise to new industries and engaging all Americans in the pursuit of new, high-wage jobs in STEM. A long-standing priority for NSF is the translation of science and engineering discoveries into innovative technologies and solutions that reach the marketplace and society. Key investments through TIP in support of this priority include Partnerships for Innovation, NSF Innovation Corps (I-Corps™), and America's Seed Fund™ (also known as the Small Business Innovation Research and Small Business Technology Transfer [SBIR/STTR] programs) powered by NSF. These programs support researchers as they pilot, prototype and otherwise demonstrate their innovations and technologies, facilitating the licensing of NSF-funded research outcomes and provide opportunities for entrepreneurial education. NSF investments through these programs have led to new startups and small businesses that have created jobs and positively benefited society by bringing significant outcomes and innovations to bear. Additionally, TIP supports programs like the NSF Convergence Accelerator and NSF Regional Innovation Engines, which foster convergent, use-inspired research, innovation, and workforce development. Ultimately, TIP will serve as a cross-cutting platform that spurs innovation across all science and engineering fields to bring new technologies to market and the benefits to society faster than ever, while investing in and nurturing the diverse talent needed for the future.

NSF programs help transform discoveries into cutting-edge solutions

NanoView Biosciences' journey shows how NSF's lab-to-market programs can help breakthrough technologies make the leap from research to commercialization. In 2011, NanoView Biosciences' cofounders received a Partnerships for Innovation grant to develop a prototype for diagnostic technology capable of rapidly detecting exosomes—messenger particles in blood, serum, and other samples that provide information about diseases. They completedNSF Innovation Corps™ training in 2013 and went on to receive a SBIR Phase I award in 2015, followed by a SBIR Phase II award in 2018. As its business grew, so did its technology, with new tools aimed at the rapidly expanding gene therapy sector. In 2022, NanoView Biosciences was acquired by Unchained Labs, a leading life sciences company. With help from three NSF programs, it was able to transform its research into cutting-edge solutions for gene therapy, biologics, and diagnostics.

NSF's investment strategy is multifaceted: it combines support for basic and translational research, which together generate a steady flow of new knowledge, with support for STEM education and workforce development at all levels. This is a central pillar of the U.S.'s standing in the global research enterprise. The sustained funding NSF provides for STEM education through its research awards keeps

the Nation's workforce competitive and readies it for future challenges. Embedded in these investments is an intentional focus on broadening participation in STEM and increasing engagements with minority-serving institutions (MSIs), community colleges, and other emerging institutions. These are critical to transformational breakthroughs shaped by capitalizing on a wide range of perspectives. One example of this is NSF's Louis Stokes Alliances for Minority Participation (LSAMP) program, which celebrated its 30th anniversary in 2022. LSAMP builds institutional alliances that assist universities and colleges in developing and retaining STEM talent from underrepresented communities so that students can more successfully transition from community colleges to four-year universities and on to graduate programs.

NSF's support for the Graduate Research Fellowship Program (GRFP) is an important component of its STEM workforce portfolio. Since 1952, NSF has funded approximately 66,000 Graduate Research Fellows, many of whom go on to become leaders in their chosen fields and make groundbreaking and important discoveries in STEM research. NSF also has funded the research of 258 individuals who have gone on to win the Nobel Prize, along with 44 individuals who have gone on to win the ACM[4] A.M. Turing Award, often referred to as the "Nobel Prize of Computing." NSF strives to provide every aspiring scientist and engineer access to the resources they need to prepare for a career in science or engineering.

Research and Mentoring for Postbaccalaureates in Biological Sciences (RaMP)

Every year, millions of American students graduate with a degree in biology, but for some, it is hard to see a path forward toward a career in biotechnology, bioengineering, or other fields that require extensive research experience. This is especially true for individuals from groups underrepresented in STEM and first-generation college students, as well as for students at institutions with limited resources for research projects. To ensure talented students everywhere have the opportunity to join the STEM workforce and research community, NSF's Biological Sciences Directorate launched the Research and Mentoring for Postbaccalaureates in Biological Sciences program, known as RaMP. Based on research that shows how inclusive training, cohort-based mentoring, and personal networks can make a big difference in future career success, RaMP is helping colleges, universities, nonprofits, and other organizations build research opportunities that expand pathways into the biosciences for more students and help recent graduates get research experience that can boost their careers.

Members of the RaMP program discuss research equipment. *Credit: Michael Reichert*

The partnerships that NSF undertakes represent another way that the agency adds value to the research enterprise. In addition to increasing access to research infrastructure and building broader communities of researchers, partnering can accelerate scientific discovery as well as the translation of research into products and services. In January 2022, NSF announced a new $100 million partnership with Intel Corporation to support research and workforce development to advance semiconductor design and manufacturing. This effort enhances U.S. competitiveness through research-based innovations that will drive future semiconductor design and manufacturing and addresses workforce shortages. Also announced this year was a $12 million partnership between NSF and the Department of Defense to

[4] ACM: Association for Computing Machinery

advance secure 5G technologies and communications for U.S. military, government, and critical infrastructure operators.

The new NSF strategic plan, *Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research*,[5] for FY 2022 – 2026 sets forth an ambitious vision, calling for the Nation to lead the world in science and engineering research and innovation, to the benefit of all, without barriers to participation. NSF staff pursue this vision by working to expand the frontiers of knowledge and integrate that knowledge into industry and education. In addition, NSF core values include diversity and inclusion, integrity, and excellence in devotion to public service, and innovation and collaboration in our support of the work of the scientific community and of each other. These values and the agency's vision are embodied in the strategic goals established in the plan: (1) EMPOWER: empower STEM talent to fully participate in science and engineering; (2) DISCOVER: create new knowledge about our universe, the world, and ourselves; (3) IMPACT: benefit society by translating knowledge into solutions; and (4) EXCEL: excel at NSF operations and management.

It can take many years for the new knowledge gained through basic research to benefit society, but the benefits are undeniable. Investing in high-risk, foundational research inspires innovation, and innovation influences fundamental research. NSF supports 23 percent of all federally sponsored basic scientific research conducted by America's colleges and universities; and the share of NSF's support increases to 56 percent when medical research supported by the National Institutes of Health is excluded.[6] NSF also has well-established programs that accelerate the translation of fundamental science and engineering discoveries into new technologies that have the potential to impact society. Supporting curiosity-driven, discovery-oriented research and use-inspired innovations has transformed American lives, powered the economy, and elevated the Nation's competitiveness on the global stage.

New technology surpasses long-sought solar energy milestone

Engineers supported by NSF developed a new class of renewable solar energy technology that is as efficient as silicon-based solar cells but can be produced at lower cost and more sustainably. The new technology is based on perovskites, semiconductors that have a crystal structure compatible with solar cell technology– but that are also fragile and have a short lifespan. The team designed an accelerated aging process to improve testing and forecast long-term performance, and the perovskites can operate for nearly 30 years, a significant increase over the prior threshold of 20 years. As the technology becomes more efficient and long-lasting, competing designs will result in more durable and commercially viable technologies.

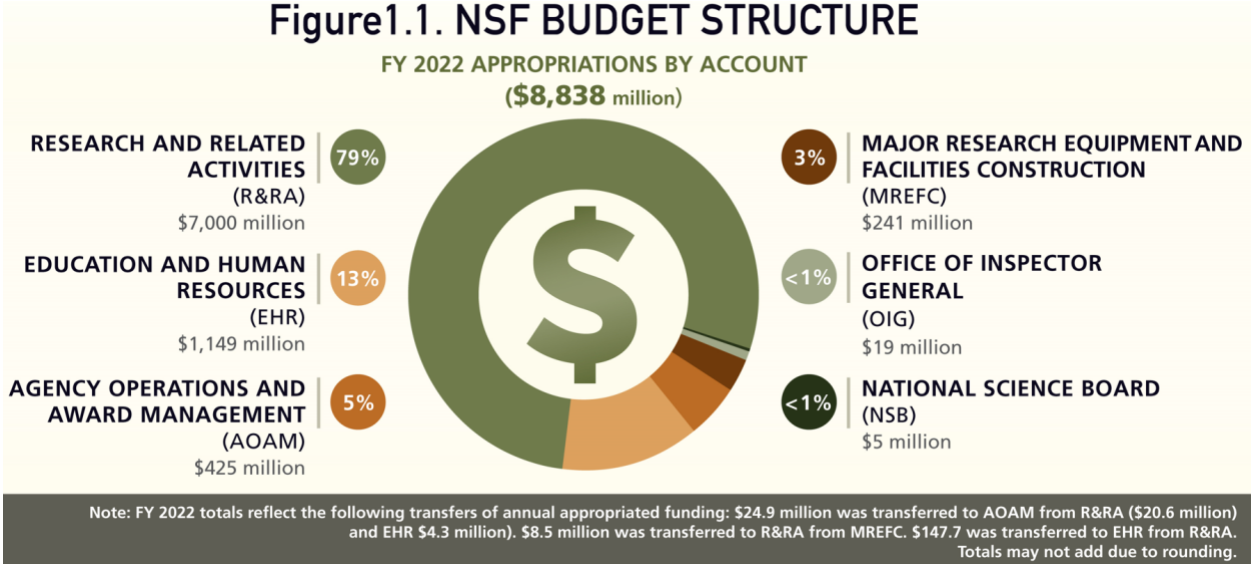
Engineers have developed an accelerated aging process to forecast long-term solar cell performance. *Credit: Bumper DeJesus*

NSF by the Numbers

NSF is funded primarily through congressional appropriations that are provided to six accounts: Research and Related Activities (R&RA), Education and Human Resources (EHR), Major Research

[5] NSF Strategic Plan FY 2022 – 2026: https://www.nsf.gov/pubs/2022/nsf22068/nsf22068.pdf
[6] National Center for Science and Engineering Statistics Survey of Federal Funds for Research and Development Fiscal Years 2020–2021: https://ncses.nsf.gov/pubs/nsf22323

Equipment and Facilities Construction (MREFC), Agency Operations and Award Management (AOAM), the National Science Board (NSB), and the Office of Inspector General (OIG). Appropriations in these six accounts in FY 2022 totaled $8,838 million.[7] When adjusted to account for the $600 million in supplemental ARP funding received in FY 2021, the FY 2022 NSF funding level was approximately $350 million, or 4 percent, higher than in FY 2021. In FY 2022, R&RA, EHR, and MREFC appropriations fund the agency's programmatic activities and accounted for 95 percent of NSF's total appropriations.



Bulleted comparisons between FY 2022 and FY 2021 appropriations exclude the one-time supplemental ARP funding in FY 2021.

- R&RA supports research and education activities in science and engineering, including high-risk and transformative research. This appropriation accounted for 79 percent of FY 2022 funding. The FY 2022 R&RA funding level of $7,000 million was approximately $120 million higher than FY 2021 of $6,880 million.
- EHR, which supports education research and activities to develop a diverse and well-prepared U.S. STEM workforce and a scientifically literate citizenry, is NSF's second largest appropriation and is over 13 percent of the agency's budget. EHR's FY 2022 funding level of $1,149 million was $181 million above the FY 2021 EHR appropriation of $968 million. In FY 2022, a transfer was made from R&RA to EHR to consolidate GRFP funding into the EHR appropriation. In FY 2021 and prior, GRFP was funded equally by the EHR and R&RA accounts.
- The MREFC appropriation supports the acquisition, construction, and commissioning of major facilities and larger mid-scale research infrastructure that provide unique capabilities at the frontiers of science and engineering. This account was 3 percent of the agency's total appropriations in FY 2022. The FY 2022 MREFC funding of $241 million was level with the FY 2021 funding.

[7] Amount shown is NSF's FY 2022 discretionary appropriations. This amount does not include Donations and H-1B Nonimmigrant Petitioner Receipts. These amounts are included in NSF's appropriations shown in the Statement of Budgetary Resources (SBR). The SBR is on page Financials-18 of this Agency Financial Report (AFR).

- FY 2022 AOAM funding of $425 million supported NSF agency operations and award management activities through which NSF's science and engineering research and education programs are administered. AOAM was 5 percent of NSF's total FY 2022 appropriations and funding increased $50 million between the two years.
- Separate appropriations support the activities of the OIG and the NSB; each accounted for less than 1 percent of NSF's total FY 2022 appropriations. The FY 2022 OIG appropriation of $19 million increased approximately $1 million over the FY 2021 appropriation. The NSB received an appropriation of $4.6 million in FY 2022; 2 percent more than the previous year's funding level.

During FY 2022, NSF evaluated over 39,000 proposals through a competitive merit review process and made approximately 11,000 new competitive awards, mostly to academic institutions. In addition to these proposals, GRFP reviewed about 13,000 applications for fellowships. Almost 32,000 members of the science and engineering community participated in the merit review process as panelists and proposal reviewers.[8] Awards were made to 1,800 institutions located in all 50 states, the District of Columbia, and three U.S. territories. These institutions employ many of America's leading scientists, engineers, and educators; and they train the leading innovators of tomorrow. In FY 2022, approximately 352,000 people were directly involved in NSF-funded programs and activities. Beyond these figures, NSF programs indirectly impact millions of people, reaching 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.

A person controls a robot to feed himself. *Credit: Cleveland State University Center for Human-Machine Systems*

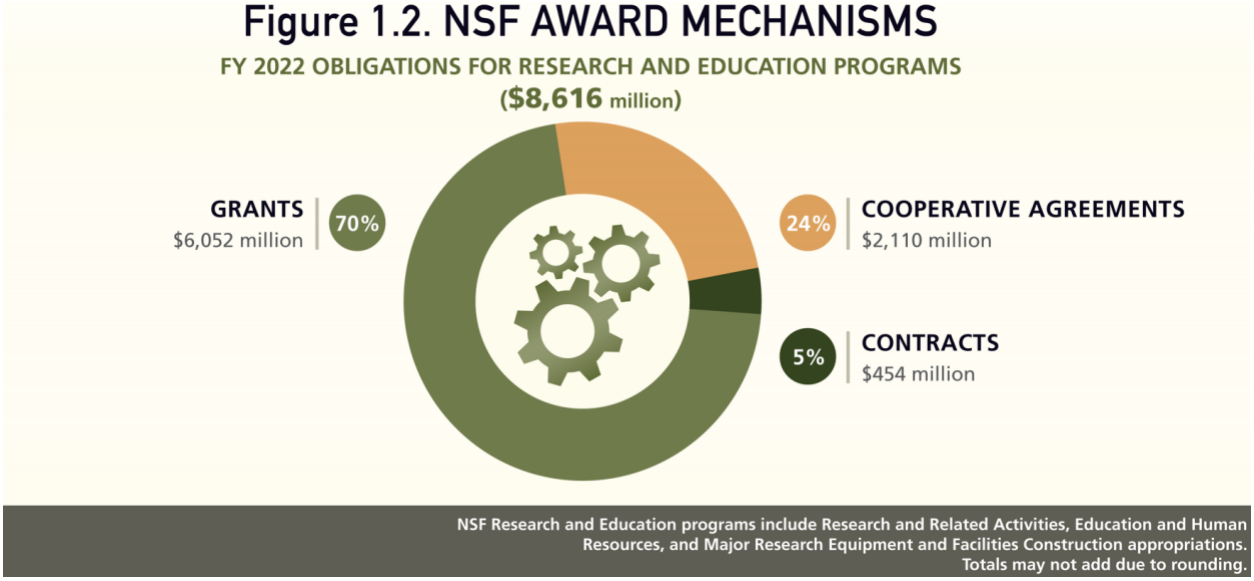
NSF Research Traineeship: Human-machine systems for physical rehabilitation

People with disabilities abandon assistive technologies at high rates, largely because their perspectives are not included in the development process. The NRT Program at Cleveland State University trains graduate students to work on transdisciplinary research teams in direct collaboration with the disability community. The goal is to ground new, accessible rehabilitation and assistive technologies in the unique perspectives and experiences of those living with disabilities. In the program, the students learn to span diverse perspectives in human-machine systems and develop human-centered approaches to research and design. This NRT program hopes to establish a new model for engineers, psychologists, and urban experts to collaborate with therapy professionals and the disability community to deliver future technologies for the most complex rehabilitation challenges.

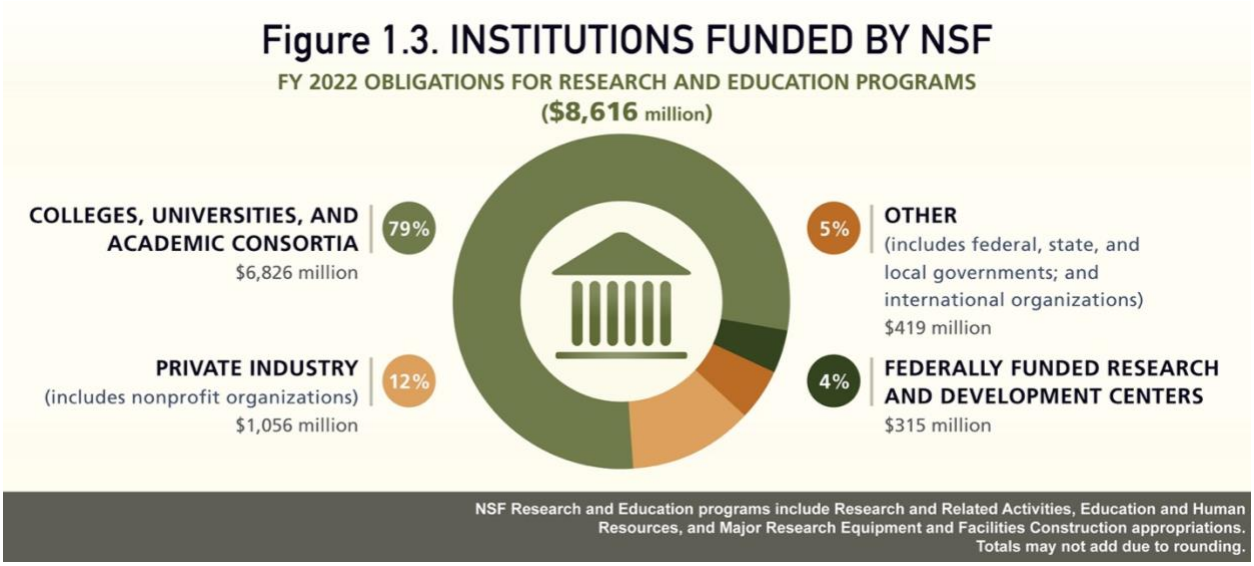
As shown in Figure 1.2 (NSF Award Mechanisms), NSF's award funding was used primarily for financial assistance to carry out a public purpose through grants and cooperative agreements. Grants can be either standard awards, in which funding for the full duration of the project is awarded in a single fiscal year, or continuing awards, in which funding for a multi-year project is awarded in increments.

[8] For more information about NSF's merit review process, see https://www.nsf.gov/bfa/dias/policy/merit_review/ and *NSF's Merit Review Process, FY 2020 Digest* (NSB-2021-45) at https://nsf.gov/nsb/publications/2021/merit_review/FY-2020/nsb202145.pdf

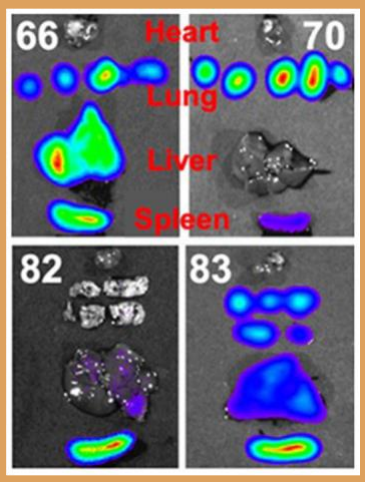
Cooperative agreements are used when the project requires substantial agency involvement (such as research centers and major facilities). Contracts are generally used for the direct benefit of the federal government (i.e., to acquire products or services), but they may be used to benefit the public in specific circumstances. NSF has had long-standing authority to use "other arrangements," and in FY 2022, NSF received "other transaction authorities" as part of the CHIPS and Science Act. These two mechanisms may support innovative approaches to fund programs managed by the TIP Directorate.



As shown in Figure 1.3 (Institutions Funded by NSF), 79 percent of support for research and education programs ($6,826 million) was provided to colleges, universities, and academic consortia. Private industry, including small businesses and nonprofit organizations, accounted for 12 percent ($1,056 million), and support to Federally Funded Research and Development Centers accounted for 4 percent ($315 million). Other recipients (federal, state, and local governments; and international organizations) accounted for 5 percent ($419 million) of support for research and education programs.



COVID-19 Activities



Representative images of mRNA delivery to different organs.
Credit: J. Am. Chem. Soc.

Targeted delivery of mRNA improves vaccine efficiency

NSF investments are about to make mRNA vaccines more effective and easier to store. Designing mRNA vaccines, like those used to protect against COVID, is a complex process. One of the key tools is macromolecules, large and complex molecular structures that play a role in countless biological processes and are critical to mRNA vaccine delivery systems. Currently, all COVID vaccines require an assembly of four different macromolecules to ensure the vaccine works. But this combination of macromolecules is unstable, and therefore the vaccine needs to be stored at extremely low temperatures to be effective—and they don't always agree on the right temperature or solubility and therefore need to be stored at extremely low temperatures. That is about to change, though, thanks to NSF-funded researchers who have found a single new macromolecule that can replace all four currently being used. In addition to increasing stability and eliminating the need for ultra-cold storage, this revolutionary approach delivers the mRNA payload more efficiently and has the new capability to target specific organs. The major vaccine producers are already working to integrate this research into future production.

As part of national efforts to recover from the COVID-19 pandemic, NSF in FY 2022 continued to fund important research, as well as recovery efforts to stabilize projects in construction and help the science, engineering, and STEM education communities rebound. Activities were funded from FY 2021 ARP funds[9] (a 2-year appropriation), NSF's FY 2022 base appropriations, and other available funds to support research related to COVID-19. NSF's FY 2022 COVID-19 activities funded over 6,000 awards to 9,000 principal investigators in 50 states, the District of Columbia, and two territories. Table 1.1 shows the FY 2022 obligations related to COVID-19 activities.[10] NSF's website provides updates on NSF's response to the pandemic.[11]

Table 1.1 FY 2022 COVID-19 Activity Awards and Obligations

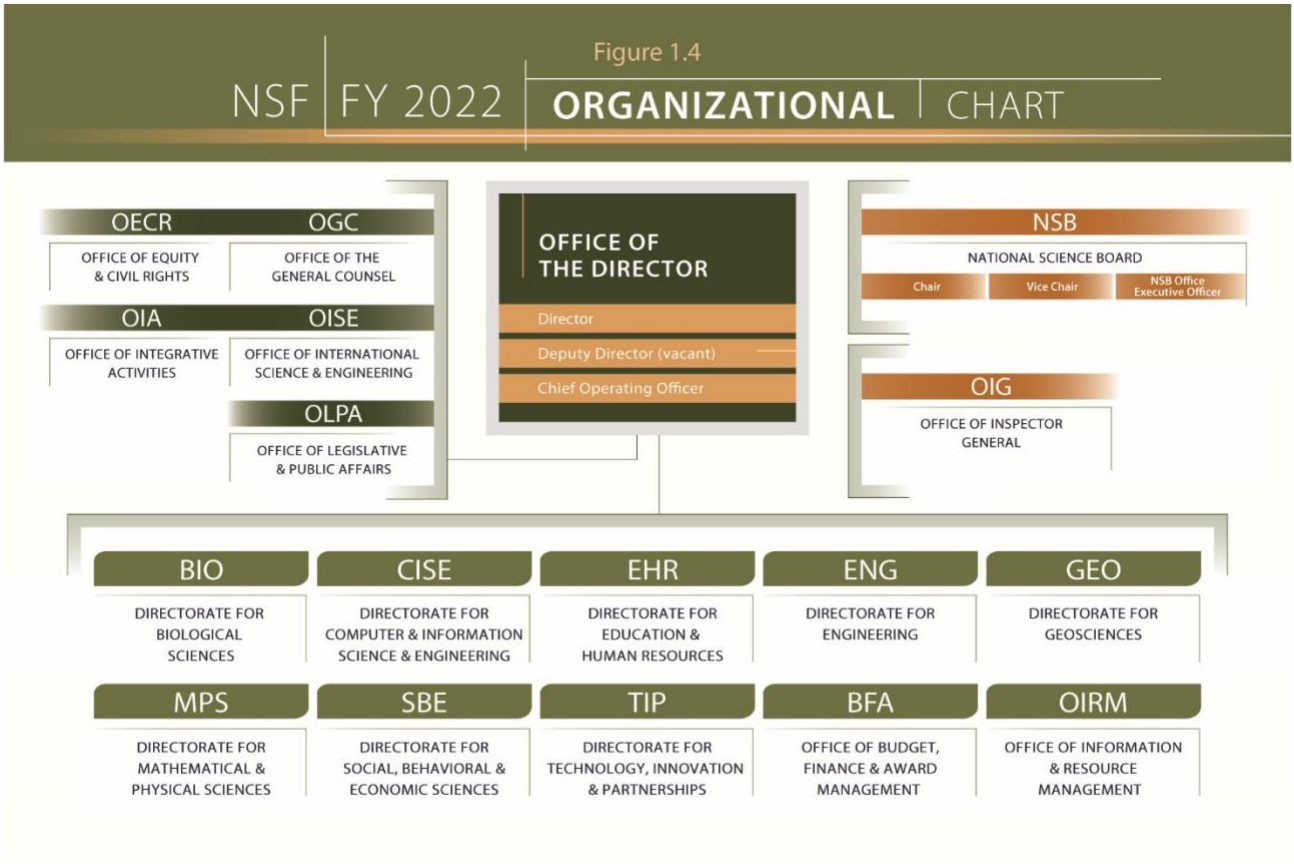
	ARP Act	All COVID-19
Number of Awards	874	6,134
FY 2022 Obligations ($ in Millions)		
Total	$361	$1,385
R&RA	*277*	*1,091*
EHR	*37*	*217*
MREFC	*47*	*47*
Other funding	*-*	*30*

Total may not add due to rounding.

[9] *American Rescue Plan Act*: https://www.congress.gov/bill/117th-congress/house-bill/1319/text
[10] Additional information on COVID-19 activities by appropriation is on page Financials-33 of this AFR.
[11] NSF Coronavirus Information page: https://www.nsf.gov/news/special_reports/coronavirus/
ARP & COVID-19 Response Updates: https://www.nsf.gov/about/congress/covidfundupdates.jsp

Organizational Structure

NSF is an independent federal agency headed by a director who is appointed by the President and confirmed by the U.S. Senate.[12] As shown in Figure 1.4, NSF's organizational structure aligns with the major fields of science and engineering.[13] In FY 2022, NSF established TIP, NSF's first new directorate in more than 30 years.



The NSF Director and the 24-member NSB jointly pursue the goals and functions of NSF, including the duty to "recommend and encourage the pursuit of national policies for the promotion of research and education in science and engineering."[14] The NSB identifies issues critical to NSF's future and helps chart the strategic direction of NSF's budget and programs. NSB members are appointed by the President and are prominent contributors to the STEM research and education community.[15] NSF's Director is a member *ex officio* of the Board. The Director and the other NSB members serve 6-year terms.

In FY 2022, NSF's workforce was comprised of approximately 1,500 federal employees and 200 scientists on temporary appointments under the Intergovernmental Personnel Act (IPA) program.[16] NSF regularly recruits scientists, engineers, and educators through the IPA program who work at NSF for up to 4 years.

[12] The Director's biography: https://www.nsf.gov/staff/staff_bio.jsp?lan=spanchan&from_org=
[13] NSF's organization chart: https://www.nsf.gov/staff/organizational_chart.pdf
[14] 42 U.S. Code 1862(d): https://www.law.cornell.edu/uscode/text/42/1862
[15] NSB members during FY 2022 are shown in Appendix 10 of this AFR
[16] The 1,516 Full-time equivalents (FTEs) in FY 2022 included the federal employee workforce for NSF, the NSB, the OIG, and U.S. Arctic Research Commission

They bring fresh perspectives from across the country and across all fields of science supported by NSF, helping explore new directions for research in science, engineering, and education, including emerging interdisciplinary fields. On returning to their home institutions from across academia, they bring knowledge of NSF programming and leading research from a national perspective.

In addition to the Foundation's headquarters in Alexandria, Virginia, NSF maintains an office in Christchurch, New Zealand, to support the United States Antarctic Program.

NSF partners with leading foundations to improve U.S. STEM education

At the core of NSF's approach to accelerating discovery, innovation, and STEM education is a commitment to building strong partnerships across an array of agencies, industries, and organizations. That is why NSF, together with the Bill & Melinda Gates Foundation, Schmidt Futures, and Walton Family Foundation, have developed a new partnership to fund unique initiatives that will improve the quality of U.S. STEM education for all students, particularly those whose talents, intelligence, and entrepreneurship have been underutilized in the nation's STEM enterprise. This historic collaboration brings together some of the largest public and private funders committed to STEM education and is one of the first of its kind involving these organizations. NSF is proud to match the money from the foundations for each funded activity and help researchers answer some of the most pressing challenges in U.S.

Credit: NSF

Management Challenges

In October 2021, the OIG identified eight areas representing challenges for NSF in FY 2022: (1) Increasing Diversity in Science & Engineering Education and Employment, (2) Overseeing the United States Antarctic Program (USAP), (3) Overseeing Grants in a Changing Environment, (4) Managing the Intergovernmental Personnel Act Program, (5) Overseeing Major Multi-User Research Facilities, (6) Mitigating Threats Posed by Foreign Government Talent Recruitment Programs, (7) Mitigating Threats Posed by the Risk of Cyberattacks, and (8) Managing Transformational Change.[17]

Management's report on the significant activities undertaken in FY 2022 to address these challenges is included in *Appendix 2B: Management Challenges – NSF's Response* of this Agency Financial Report (AFR). The report also discusses activities planned for FY 2023 and beyond. The following are highlights of the agency's significant actions and planned next steps to address the FY 2022 OIG Management Challenges.

Increasing Diversity in Science & Engineering Education and Employment

Since its founding, NSF has recognized the importance of diversity, equity, and inclusion in science and engineering education and employment. Today, these efforts warrant unprecedented urgency given the national and economic concerns, and the global science and engineering trends outlined in the NSB's *Vision 2030* report,[18] which notes "women and underrepresented minorities remain inadequately represented in science and engineering relative to their proportions in the U.S. population." NSF also recognizes the grand scale of these issues and the pressing need to recognize and embrace the full scope of challenges they bring.

[17] Inspector General's Management Challenges for NSF in Fiscal Year 2022 can be accessed at: https://oig.nsf.gov/reports/top-management-challenges/management-challenges-national-science-foundation-fiscal-year-2

[18] The *Vision 2030* report is available at: https://www.nsf.gov/nsb/publications/2020/nsb202015.pdf

Efforts to address these challenges span across every NSF directorate and office. Most notably in FY 2022, NSF published a new strategic plan that explicitly incorporated its commitment to ensuring accessibility and inclusivity into the agency's vision statement.[19] Selected specific actions taken in FY 2022 to increase diversity in science and engineering education and employment include the release of the development of action plans in response to diversity, equity, inclusion, and accessibility (DEIA)-related Executive Orders; the enhancement of the merit review process with exploratory pilots to strengthen the broader impacts criterion; the support of funding for resource centers and hubs to strengthen Hispanic-serving Institutions; and the implementation of listening sessions with focus groups spanning 259 individuals across 143 MSIs, two-year colleges, and primarily undergraduate universities to "design into" programming for the TIP Directorate considerations of DEIA.

Going forward, NSF will leverage its broad portfolio and sphere of influence, and act deliberately when developing and deploying all available strategies and programs. Specifically, the agency will implement, strategically monitor, and oversee an Agency Priority Goal related to improving representation in the scientific enterprise; initiate the new Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED) initiative to improve the Nation's research support and service capacity at emerging and developing research institutions that are often underserved and under-resourced compared to those more established research universities; and continue the DEIA work of the agency as well as support the NSB and Committee on Equal Opportunities in Science and Engineering.

Map of Civic Innovation Challenge awards supporting community-based solutions across the U.S. *Credit: NSF*

For a larger image: *https://beta.nsf.gov/news/civic-innovation-challenge-awards-support-community-based-solutions-mobility-and-disaster*

Community-based solutions to mobility and disaster resilience

Mitigating the effects of disasters or bridging the gap between essential resources and services and nearby populations is the driving force behind the Civic Innovation Challenge. Led by NSF in partnership with the Department of Energy and Department of Homeland Security, researchers worked with civic partners to identify and address community challenges with research-based pilot projects. The two focus areas were resilience to natural disasters, and mobility and access to jobs and services. In the first stage, teams of local, state and tribal officials as well as nonprofit and community leaders, refined the projects. In Stage 2, 11 disaster resiliency teams and six mobility teams received awards of up to $1 million to develop ready-to-implement pilot projects in a 12-month time frame. The solutions were also designed to become templates to address community-level issues across the U.S.

Overseeing the United States Antarctic Program (USAP)

NSF – through the Office of Polar Programs in the Directorate for Geosciences – funds and manages USAP which supports the United States' research and national policy goals in the Antarctic. The global pandemic associated with COVID-19 resulted in significant changes to program and construction project plans as deployed construction crews were brought home due to health and safety concerns and science deployers were significantly reduced. USAP's recovery from the drastic curtailment of activity during the pandemic is now underway along three lines of thrust – executing a temporary surge in logistics support

[19] NSF's FY 2022-2026 Strategic Plan is available at: https://www.nsf.gov/about/performance/strategic_plan.jsp

to clear the backlog of delayed science and construction work, resuming major construction projects under newly established cost and schedule baselines, and pivoting the recapitalization approach to an enduring program rather than a single major effort. To provide effective government oversight of these activities, the Antarctic Infrastructure and Logistics Section in the Office of Polar Programs continues to mature financial management, performance monitoring, and planning processes.

In addition, information security improvements continue to be implemented, using a risk-based prioritization approach that ensures effective cybersecurity in the unique environment of the USAP network. Enforcement of Personal Identity Verification, or PIV, credentialing for network access has been put into place, enhanced logging capabilities have been implemented to prepare for a future managed security service provider to automatically detect malicious network events, and the transition to screening of all permanent USAP contractor personnel through standard NSF processes is underway.

Going forward, NSF will continue monitoring and oversight of the Antarctic Infrastructure Modernization for Science project in accordance with established internal management and project execution plans, including through the Office of the Director's Watch List. Cybersecurity improvements will continue to be implemented, using a risk-based prioritization approach that ensures effective cybersecurity in the unique environment of the USAP network.

Promising anti-melanoma properties discovered in a sea squirt

Researchers identified a compound produced by bacteria living on the sea floor near Antarctica that could be used to create a naturally derived treatment for melanoma. A team of NSF grantees from the Desert Research Institute at Los Alamos National Laboratory and the University of South Florida, traced the compound, palmerolide A, to a microbe that shares a symbiotic relationship with a species of ascidian, or sea squirt, common to the waters of Antarctica's Anvers Island archipelago. To survive, ascidians and other invertebrates developed relationships with microbes that play a role in photoprotective pigments, bioluminescence, and chemical defenses. The compounds produced by these microbes may also have other applications in science, health, and industry.

Synoicum adareanum pictured with a starfish in 80 feet of water near Bonaparte Point, Antarctica. *Credit: Bill J. Baker/Department of Chemistry, USF*

Overseeing Grants in a Changing Environment

NSF's well-established advanced monitoring and Enterprise Risk Management (ERM) programs provide a strong foundation for effective oversight over the agency's grant portfolio. ERM provides a framework for NSF to objectively evaluate the need for new or enhanced controls by monitoring potential changes in portfolio composition, or other emerging risks in the research community, such as fiscal constraints and student enrollment challenges. NSF continually assesses the risk and control environment related to grants award, oversight and monitoring, and closeout processes to confirm controls are operating effectively against the evolving risk environment.

In addition, NSF has a robust payment integrity program, which was effective in assessing potential changes to improper payment risk from the COVID-19 pandemic. In the OIG's FY 2022 Performance Audit of NSF's Compliance with the *Payment Integrity Information Act*, the independent auditor determined that NSF's risk assessment conclusion that the overall low improper payment risk level for its grant and cooperative agreement programs was reasonable. The auditor also determined that NSF adequately concluded the programs have low risk of making improper payments above the statutory

threshold, with no findings and recommendations. NSF has also made significant enhancements to improve compliance on the timely submission of grant project reports across the agency. These enhancements will solidify NSF's controls around result-oriented accountability, enabling the agency to better scale its processes to integrate additional small and mid-size institutions under future, more substantial budget increases and increased emphasis on awards to groups underrepresented in STEM. Finally, NSF has recently implemented a suite of awardee self-assessment tools and fact sheets on subrecipient monitoring and participant support costs along with additional fact sheets on various topics. These tools allow awardee organizations to independently self-assess compliance in the areas of participant support and sub-recipient risk assessment and monitoring.

Going forward, NSF will continue to monitor changes to the composition of its awardee portfolio through its normal award monitoring and oversight processes. Utilizing these existing processes to monitor portfolio composition will verify whether risks noted in the management challenge have been realized. NSF's ability to successfully navigate the challenges of the pandemic demonstrates the adaptability of these processes to respond to emerging risks.

Managing the Intergovernmental Personnel Act (IPA) Program

NSF provides the opportunity for scientists, engineers, and educators to rotate into the agency on a temporary basis, bringing fresh perspectives from across all fields of science and engineering supported by the agency. NSF takes a proactive approach to the management of the IPA program to appropriately consider and mitigate inherent risks associated with its execution, including through an IPA Steering Committee that advises the senior leadership on matters that directly concern policy on the use of the IPA Program. In addition to establishing the IPA Steering Committee, significant accomplishments in recent years have included resolving and closing recommendations from the OIG report, *NSF Controls to Mitigate IPA Conflicts of Interest*,[20] and implementing a cost sharing policy requiring that institutions provide a minimum of 10 percent cost share for every full-time IPA agreement.

NSF has identified the need to better vet incoming IPA rotators via the recent OIG audit on the agency's internal processes. To address concerns and risks identified, NSF has established an IPA Vetting Working Group comprised of the agency's leaders and subject matter experts. The purpose of the IPA Vetting Working Group is to make recommendations to the Chief Operating Officer regarding the agency's approach to vetting candidates for IPA positions at NSF.

Going forward, the IPA Vetting Working Group will partner with NSF stakeholders to address issues such as (1) potential threats to national or economic security by IPA candidates with foreign affiliations or sources of funding; (2) potential risks due to other conflicts of interest and commitments; (3) confirmation of eligibility, salary, and employment history; (4) timeliness of vetting relative to employment offers and start of assignment; and (5) responsibility and overall timeline for various aspects of vetting and assessment.

Overseeing Major Multi-User Research Facilities

NSF understands the importance of its role in overseeing current award recipients' on-going management of major facilities, and of assessing prospective recipients' capabilities for managing major facilities prior to award. Since a National Academy of Public Administration report on NSF's use of cooperative agreements for major facilities was published in December 2015, NSF has greatly strengthened its oversight policies and procedures in response to that report, prior OIG audits, and

[20] The OIG report on IPA conflicts of interest is available at https://www.oversight.gov/sites/default/files/oig-reports/17-2-008_COI.pdf

General Accountability Office (GAO) reviews. Since 2017, GAO has conducted five reviews related to oversight of projects funded from the MREFC account. The reports published in 2018 and 2019 contained recommendations related to cost and schedule estimates and award recipient project management capabilities. The most recent GAO reviews (2020 through 2022) had no new recommendations, illustrating NSF's robust oversight framework for projects funded from the MREFC account.

NSF leadership continues to show its commitment to major facilities oversight through appointment of the Chief Officer for Research Facilities and through the annual Major Facilities Portfolio Risk Assessment process. Further, NSF has taken significant actions in recent years to mitigate the risks inherent in the major facilities portfolio, including the unprecedented degree of complexity and uncertainty resulting from the COVID-19 pandemic. In FY 2022, NSF finalized standard operating guidance related to the major facilities oversight reviews, and revised definitions and policies related to divestment of major facilities in response to pending recommendations from an OIG audit.

Going forward, NSF will complete implementation of the *Program Management Improvement Accountability Act* requirements, including roll-out of a new Course Curriculum Tool to support NSF staff's proficiency development based on self-assessments, and will continue to evaluate title to property (federally owned versus recipient-titled) and develop property transition plans, as necessary.

A multiplexed biomarker sensor that is quantified and read through a mobile phone for patient testing in clinical settings and even at home.
Credit:Ozcan Lab at UCLA

Low-cost, paper-based sensor conducts multiple tests simultaneously

In medicine, diagnosing disease rapidly and reliably is a crucial first step in providing effective care. However, many communities lack the centralized infrastructure and trained personnel to perform these critical and costly tests. This disparity is driving researchers at the NSF-funded Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP) Engineering Research Center (ERC) to develop easy-to-read diagnostic tests constructed from paper. The new sensors developed by the PATHS-UP ERC employ a specially designed 'sensing membrane' that can detect dozens of diseases simultaneously while using only $0.30 worth of paper materials. And with simple operating steps, these tests can be performed in under 20 minutes with minimal training, helping bring critical healthcare access to underserved communities worldwide.

Mitigating Threats Posed by Foreign Government Talent Recruitment Programs

NSF seeks to preserve the integrity of international scientific collaborations and maintain a vibrant science and engineering community for the benefit of the nation. Participation in this community relies on individuals to uphold core principles and values such as openness, transparency, reciprocity, collaboration, and integrity. However, open scientific exchange and research face a challenge from some foreign governments through the use of talent recruitment programs. Some of these programs deliberately disregard these core principles and incentivize participants to misappropriate U.S.-funded scientific research prior to its open publication. These programs target scientists, engineers, and educators of all nationalities working or educated in the U.S.

To mitigate threats posed by these programs, NSF took multiple actions in FY 2022 to continue progress on this issue. The agency (1) published a joint-agency solicitation to develop online training modules designed to promote the understanding of research security threats for research personnel whose work

is supported by the federal government; (2) continued to serve as a co-chair on the National Science and Technology Council Subcommittee on Research Security to further formulating and coordinating guidance for the research community on standardized disclosure formats, digital persistent identifiers, and research security program standards; (3) published a notice on a new system of records that will aggregate, link, and analyze information published and reported by individuals and organizations participating in NSF-supported activities; (4) convened a working group to develop recommendations regarding strategy and implementation of a prohibition of involvement in foreign government talent recruitment programs for those supported by or working for NSF; and (5) convened working groups, which reported several recommendations to establish more consistent and thorough approaches to managing security clearances and vetting IPA candidates agency-wide.

Going forward, NSF will continue to work diligently to address risks of foreign government interference in NSF-funded research. This work will include taking steps to (1) implement existing guidance and new legislation (e.g., National Security Presidential Memorandum-33 Implementation Guidance, the *CHIPS and Science Act*, etc.);[21] (2) continue coordination with the White House, other federal science funding agencies, and intelligence and law enforcement communities; and (3) begin concept development and adoption of new initiatives to address risks to research security (e.g., via the development of a Research Security Risk Assessment Center, an initial implementation of JASON's study on "Research on Research Security").

Mitigating Threats Posed by the Risk of Cyberattacks

NSF's Information Technology (IT) Security Program is committed to ensuring that NSF infrastructure and assets are appropriately protected while maintaining effective interfaces with the community to support an open and collaborative environment for scientific research and discovery. NSF recognizes the importance of moving to a modern data-centric model of cybersecurity as government networks evolve and adopt more resilient architectures. The concept of Zero Trust Architecture (ZTA) provides the framework for implementing controls and providing scalability as NSF extends mission critical applications into diverse cloud environments. NSF's ZTA plan describes the approach to address the five pillars of the Zero Trust Maturity Model. NSF is employing a multipronged approach to the implementation of the ZTA model; this is a long-term effort that will require coordinated efforts across many pillars of cybersecurity.

NSF continues to implement actions in support of ZTA principles. For example, NSF is leveraging the Department of Homeland Security's (DHS) Continuous Diagnostics and Monitoring program to expand asset inventory and information sharing; is maturing endpoint detection and response capabilities through upgraded detection-on-demand capabilities; maintains a Vulnerability Disclosure Policy and rapidly responds to researcher reports; and implements techniques where components are replaced rather than changed in the cloud environment. As NSF continues to move agency systems and services to the cloud, the agency will use the principles of ZTA in cloud planning and deployment efforts and all agency modernization strategies.

Going forward, NSF's near-term zero trust efforts are focused on establishing new capabilities to reduce risk and protect sensitive agency data from compromise. NSF intends to deploy an architectural approach that will converge networking and security services into a cloud service. Planned improvements such as network environment isolation, automation for component build, and secure

[21] Guidance for Implementing National Security Presidential Memorandum 33 (NSPM-33) on National Security Strategy for United States Government-Supported Research and Development is available at https://www.whitehouse.gov/wp-content/uploads/2022/01/010422-NSPM-33-Implementation-Guidance.pdf

application deployment are in progress. Password management technologies are being evaluated for enterprise-facing and public-facing systems. NSF will continue to refine its long-term ZTA migration plan in alignment with DHS's zero trust maturity model and as federal guidance clarifies requirements around emerging zero trust requirements.

Managing Transformational Change

Fiscal year 2022 was one of notable change for NSF. In Spring 2022, the agency announced the establishment of TIP, received its largest increase in annual appropriations in over a decade, and began transitioning staff back to working in the NSF headquarters building after two years of operating under a maximum telework posture. NSF has established processes to identify, anticipate, and manage the risk to accomplishment of these organizational changes, including a strong history of financial controls, robust pre- and post-award monitoring, and an ERM process that leverages tools such as data analytics to identify risk areas. In addition to expanding and improving processes, NSF recognizes it must develop new capacity and centralize certain functions to ensure smooth transitions across growth and change.

In FY 2022, NSF initiated work to establish an enterprise-wide knowledge management framework to position the agency to be more strategic and agile in delivering the mission. Establishment of the TIP directorate required development of novel approaches to funding innovative science in addition to integrating TIP's operations into existing processes. NSF will use the experience of establishing TIP to update, confirm, and validate the process for realignments and reorganizations. Finally, NSF also prepared for the transition to a hybrid workforce by initiating a robust change management strategy that engaged all levels of the workforce, and established new telework and remote work policies, which will take effect in early FY 2023.

NSF will continue to monitor and develop technologies to improve the agency's hybrid work capabilities.

NSF-supported scientists are honing long-range forecasts of U.S. tornadoes and hail. *Credit: Victor Gensini, Northern Illinois University*

Magnetic reconnection breakthrough could help predict space weather

NSF-supported scientists are improving extended-range weather forecasting in the U.S. by studying atmospheric phenomena halfway around the globe. The researchers found 100 instances of significant weather fluctuations from 1979 through 2019 in the Madden-Julian Oscillation – a major disturbance of wind, rain, and pressure that circles the globe every 30 to 60 days. As these disturbances moved over the Maritime Continent, which includes Indonesia and the Philippines, they found 53 of these storms gained strength, creating ripples in the atmosphere, and eventually changing circulation patterns over North America. The researchers identified three categories of storms, and all have heightened the potential to increase U.S. tornado and hail events. This information can be used to create extended-range forecasts and provide more time to raise awareness of severe weather.

Climate-related Financial Risk

As noted in NSF's Sustainability Report and Implementation Plan to the Council for Environmental Quality, in FY 2022 NSF proactively put in place measures to begin evaluating major facilities' resilience to natural hazards created by climate change (fires, flooding, extreme wind, etc.) on a regular cadence as part of major facility external reviews. Although reviews are typically conducted annually, reviewing facility condition will now take place once every 5 years. The assessments will generally be conducted by

the award recipient, and the resulting report will be provided to NSF. External panel recommendations will help inform agency decisions around future investments in the supporting infrastructure to reduce risk to the agency and the scientific community. NSF-owned assets in the Arctic and Antarctic are constructed to withstand the harshest environments on Earth, and their conditions are routinely assessed as part of ongoing operations due to the inherent risks. Over time, NSF will consolidate recapitalization needs for the full suite of research infrastructure into a unified plan.

Performance

In March 2022, NSF released its Strategic Plan for FYs 2022–2026: *Leading the World in Discovery and Innovation, STEM Talent Development, and the Delivery of Benefits from Research*.[22] The four strategic goals in this plan are built upon four themes—Empower, Discover, Impact, and Excel—that form the core of the plan. These themes focus on expanding frontiers, engaging people, and delivering solutions. Under each goal are two strategic objectives, which together encompass all areas of agency activity. This goal structure enables NSF to link its investments to longer-term outcomes.

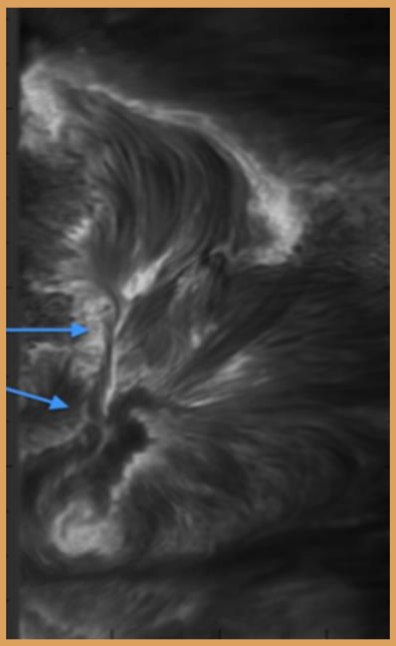
Strategic Goals and Objectives

Strategic Goals	Strategic Objectives
1. Empower: Empower STEM talent to fully participate in science and engineering	**1.1 Ensure accessibility and inclusivity –** Increase the involvement of communities underrepresented in STEM and enhance capacity throughout the nation.
	1.2 Unleash STEM talent for America – Grow a diverse STEM workforce to advance the progress of science and technology.
2. Discover: Create new knowledge about our universe, our world, and ourselves	**2.1 Advance the frontiers of research –** Accelerate discovery through strategic investments in ideas, people, and infrastructure.
	2.2 Enhance research capacity – Advance the state of the art in research practice.
3. Impact: Benefit society by translating knowledge into solutions	**3.1 Deliver benefits from research –** Advance research and accelerate innovation that addresses societal challenges.
	3.2 Lead globally – Cultivate a global science and engineering community based on shared values and strategic cooperation.
4. Excel: Excel at NSF operations and management	**4.1 Strengthen at speed and scale –** Pursue innovative strategies to strengthen and expand the agency's capacity and capabilities.
	4.2 Invest in people – Attract, empower, and retain a talented and diverse NSF workforce.

In support of Strategic Objective 1.1, Increase the involvement of communities underrepresented in STEM and enhance capacity throughout the nation, NSF established an Agency Priority Goal for FY 2022-2023 to "Improve representation in the scientific enterprise." The goal focuses on making changes to NSF practices, processes, and policies that will lead to an increase in proposal submissions from members of groups underrepresented in STEM and underserved institutions. NSF is implementing its approach to this goal through workgroups focused on needed changes in policy, data collection and analysis, engagement with external stakeholders, and internal engagement with NSF staff. Through these efforts, NSF hopes to increase the number and percentage of proposals from groups underrepresented in STEM and underserved institutions by 10 percent.[23]

[22] NSF's Strategic Plan is available at https://www.nsf.gov/about/performance/strategic_plan.jsp

[23] More information on NSF's Agency Priority Goal to "Improve representation in the scientific enterprise," as well as quarterly updates are available at https://www.performance.gov/agencies/NSF/apg/goal-1/



The arrows point to a twisted filament, or magnetic flux rope, before magnetic reconnection occurs. *Credit: K. Reardon, NSF's National Solar Observatory and L. Kleint, University of Bern*

Magnetic reconnection breakthrough could help predict space weather

Space storms can wreak havoc on satellites and power grids, and magnetic reconnection plays a major role in the plasma eruptions on the sun's surface that spark space storms. NSF grantees at West Virginia University learned new information about magnetic reconnection and the physics of space-like plasmas by experimenting with lab-developed plasma. The research, part of the PHAse Space Mapping, or PHASMA, experiment, probed the plasma and light scattered from individual electrons in the plasma to assess how fast the particles were moving. PHASMA can accurately measure the motion and velocity of the ions and electrons on a very small scale, allowing the team to measure the actual speeds of individual electrons. The research will impact how space weather and solar storms are predicted and improve understanding of the universe's mechanics and dynamics.

Progress Toward Achievement of Performance Goals

Each year, NSF issues three reports to provide financial management and program performance information to demonstrate accountability to our stakeholders, including the American public. In addition to the AFR, NSF produces a Performance and Financial Highlights summary report, and the Annual Performance Report.[24] NSF's FY 2022 Annual Performance Report will appear in the *FY 2024 Budget Request to Congress* along with the Annual Performance Plan for FY 2024. This report will provide a complete discussion of NSF's performance measures, including descriptions of the metrics, methodologies, results, and trends. The topic areas of these goals and their FY 2022 targets are listed in the following table. Annual results will be provided in the FY 2022 Annual Performance Report along with information about NSF's verification and validation review of performance data, as required by the *Government Performance and Results Modernization Act of 2010*.

[24] All three reports are made available on NSF's website as they are completed at: https://www.nsf.gov/about/performance/annual.jsp

FY 2022 Performance Goals

Strategic Objective	Annual Goal Statements	FY 2022 Target
Empower 1.1	Two-year Agency Priority Goal: Improve representation in the scientific enterprise.	2023 target: Increase the number and proportion of proposals received from underrepresented and underserved 1) investigators and 2) institutions.
Discover 2.1	Major Facility Infrastructure Investments: Ensure program integrity and responsible stewardship of major research facilities and infrastructure.	100% of facilities with negative cost and schedule variance at or below 10%.
Discover 2.2	Mid-Scale Infrastructure Investments: Ensure program integrity and responsible stewardship of mid-scale research infrastructure.	Track cost and schedule for all defined projects.
Impact 3.1	Grow Partnerships: Increase opportunities for public and private partnerships that will address major scientific and technological goals while ensuring broad societal benefits.	Establish baseline (new goal in 2022).
Excel 4.1	Robust and reliable IT services: Ensure availability of IT resources for NSF staff and the broader research community.	IT systems are available 99.6% of the time.
Excel 4.2	Human Capital Operating Plan (HCOP): Track progress against NSF's HCOP.	Submit draft FY 2022-2025 HCOP to OPM.
	Culture of Inclusion: Foster a culture of inclusion through change management efforts resulting in change leadership and accountability.	Increase agency-wide engagement in Special Emphasis Program observances and Diversity and Inclusion-related activities by 10% from 2021.
Cross-cutting	Make Timely Proposal Decisions: Inform applicants whether their proposals have been declined or recommended for funding within 182 days, or six months, of deadline, target, or receipt date, whichever is later.	75% of proposals have a funding decision communicated to the principal investigator for the proposal within 6 months of receipt.
	Key Program Investments are on Track: American Rescue Plan Ensure key FY 2022 NSF-wide program investments are implemented and on track.	NSF will obligate 100% of designated targets for American Rescue Plan funding.

Renewing NSF

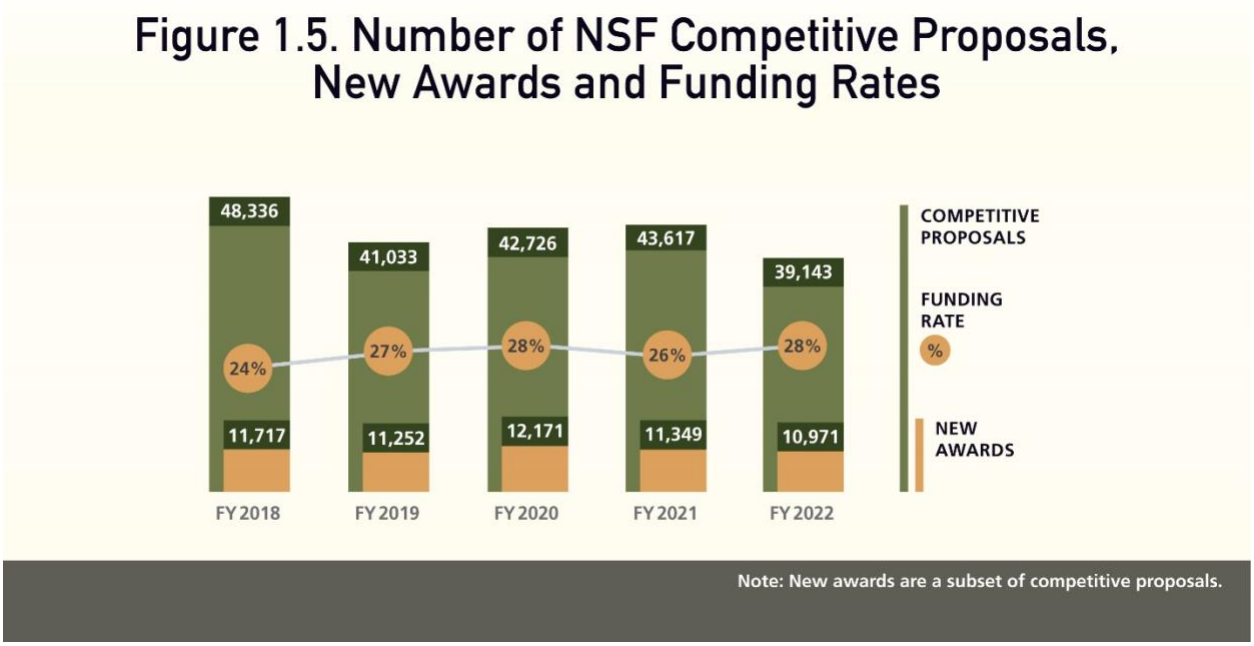
The NSF 2022-2026 Strategic Plan emphasized the agency's continued efforts to excel at operations and management to enhance performance of NSF's mission and thereby maintain U.S. leadership in research and education across all areas of STEM. In FY 2022, the enterprise-scale reform and process improvement efforts, collectively called "Renewing NSF," continued to implement innovative strategies

to strengthen and expand operational capacity and capabilities. Primary outcomes in FY 2022 included: the formation of a new internal group to champion reform projects and explore and prioritize updated priorities; rapid development, piloting, and deployment of the Program Suitability and Proposal Concept Tool to support streamlined intake and handling of project concept outlines; ongoing support of partnerships resources including the eventual transition of these to the TIP Directorate; and, a successful multi-program pilot of a streamlined post-merit review workflow. At the same time, given the success and visibility of Renewing NSF, the agency also transitioned the leadership of this activity into the Office of the Director, formally establishing a program manager position and ensuring a long-term capability to foster continuous organizational adaptation. The focus areas of Renewing NSF remain: (1) making information technology work even better for all; (2) adapting the workforce and the work; (3) streamlining, standardizing, and simplifying processes and practices; and (4) expanding and deepening public and private partnerships.

Proposal Workload and Management Trends

NSF continuously monitors key portfolio, proposal workload, and financial measures to understand short- and long-term trends and to help inform management decisions. For an analysis of the long-term trends in competitive proposals, awards, funding rate, and other portfolio metrics, see the *National Science Foundation's Merit Review Process, Fiscal Year 2020 Digest*.[25]

Figure 1.5 identifies three key portfolio measures: competitive proposals acted upon, new awards, and funding rates.



[25] *NSF's Merit Review Process, FY 2020 Digest (NSB-2021-45)*: https://www.nsf.gov/nsb/publications/2021/merit_review/FY-2020/nsb202145.pdf

Table 1.2 provides proposal workload and management trends over 5 years. Highlights of these indicators are as follows:

- Between FY 2021 and FY 2022, the number of competitive proposal actions decreased by 10 percent; from 43,617 to 39,143.
- There were 10,971 new awards in FY 2022, a decrease of 3 percent from FY 2021.
- The overall funding rate in FY 2022 was 28 percent, an increase of 2 percentage points. Funding rates differ by directorate and are presented in the agency's annual budget request to Congress.
- The average annual award size of competitive awards was $220,680, approximately $11,000 lower than in FY 2021.
- The number of employees (full-time equivalent [FTEs]) increased between FY 2021 and FY 2022, 1,456 FTE and 1,516 FTE, respectively.
- The number of active awards increased almost 4 percent in FY 2022, from 56,427 in FY 2021 to 58,384 in FY 2022. The 5-year average number of active awards is almost 56,000.

Table 1.2 Proposal Workload and Management Trends

Measure		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Percent Change (FY 2022-FY 2021)	Average (FY 2018-FY 2022)
Portfolio	Competitive proposal actions	48,336	41,033	42,726	43,617	39,143	–10.3%	42,971
	Competitive award actions	11,717	11,252	12,171	11,349	10,971	–3.3%	11,492
	Average annual award size (competitive awards)	$189,418	$197,530	$213,280	$231,202	$220,680	–4.6%	$210,422
	Funding rate	24%	27%	28%	26%	28%	+2 percentage points	27%
Proposal Workload	Number of employees FTE, usage[1]	1,417	1,415	1,421	1,456	1,516	4.1%	1,445
	Number of active awards[2]	54,386	54,093	55,239	56,427	58,384	3.5%	55,706
	Proposal reviews conducted	223,781	192,033	199,526	211,903	187,318	–11.6%	202,912
Financial	Number of grant payments	21,727	20,935	22,169	23,794	27,065	13.7%	23,138
	Award expenses incurred but not reported at 9/30 ($ in millions)[3]	$393	$425	$390	$461	$462	<1%	$426

Notes:

[1] FTEs shown include the federal employee workforce for NSF, NSB, OIG, and U.S. Arctic Research Commission.

[2] Active awards include all active awards regardless of whether funds were received during the fiscal year.
[3] FY 2022 number reflects an accrual, and all other years reflect the validated estimate for the fiscal year. This metric does not include accruals for SBIR awards.

- All NSF awardee institutions are required to submit payment requests at the award level to the NSF Award Cash Management Service (ACM$). Award expenses are posted to the NSF financial system at the time of the payment request. Reliance on ACM$ reduces the burden of manual invoicing and potential for errors or missed payments.
- Since its introduction in FY 2013, ACM$ has significantly improved the timeliness of grant financial data. The amount of incurred but not yet reported award expenses have averaged $426 million for the last 5 years.

Fire refugia—islands of living trees that remain following forest fires—help forests regenerate. This photo of a forest hit by the 2012 Shadow Lake Fire in Oregon shows a fire refugium (patch of tall trees) and post-fire regeneration (small tree seedlings) in the burn area. *Credit: Sebastian Busby*

'Green islands' help forest regenerate after fire

NSF grantees from Portland State University are helping forest managers determine when they should intervene to help forests recover from fires and when the landscapes should be left to recover naturally. High-elevation forests in the Pacific Northwest are burning more frequently than in the past due to climate change. These forests primarily regenerate from the dispersal of seeds from refugia - areas of live trees that survived fires. If there are only a few live trees, it may be hard for the forest to regenerate naturally, but too much human-aided replanting can be expensive and may result in overstocked forests with high tree density, reduced habitat quality and even greater risk of fires in the future.

Financial Discussion and Analysis

The Foundation recognizes the importance of maintaining sound financial stewardship while improving its systems to ensure proper accountability and alignment with the agency's vision, mission, and strategic goals. For example, in FY 2022, NSF staff across the agency analyzed the new CHIPS and Science Act to understand the full impact of the Act on NSF's funding and operations and develop comprehensive planning scenarios. In addition, the agency put in place the appropriate administrative and financial controls to ensure accountability for the newest NSF directorate, TIP. Following are several important FY 2022 financial management activities that highlight NSF's commitment to fiscal stewardship:

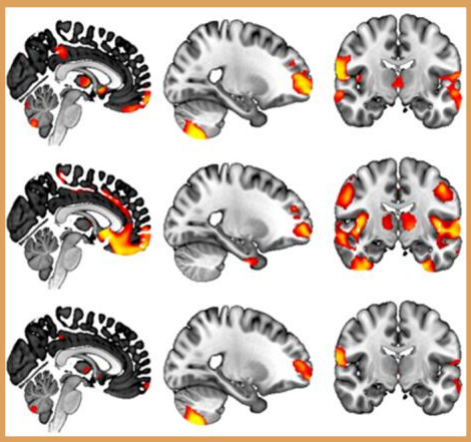
- *Government-wide Initiative on Unique Entity Identification (UEI):* In February, ahead of the Office of Management and Budget (OMB) April deadline, NSF released changes to all production grant management systems to support the UEI. The newly created UEI is assigned and maintained by the System for Award Management (SAM). This transition streamlined the entity identification and validation process, making it easier and less burdensome for entities to do business with the federal government. To comply with the governmentwide mandate, NSF successfully implemented its planned enhancements to the financial system and certain NSF business applications. In addition, NSF reviewed institution data to validate the accuracy of the transition to the new UEI, as well as ensure the consistent usage of SAM data across its externally facing systems.
- *Reporting Innovations:* NSF developed policy and reporting tools to promote proper stewardship of all NSF financial resources.
  - The NSF Open Obligation Monitoring Policy was issued in May to standardize the review of open obligations across the agency and support accurate annual financial reporting and compliance with laws and regulations. It also leverages existing practices and procedures while allowing for future innovation.
  - The agency enhanced its Enterprise Reporting application with self-service reports that facilitate the review and analysis of obligations. The data for these reports is near real-time and users can customize the output to display necessary and relevant data for their analysis.
  - The FOOD (Financial Open Obligation Detective) for Thought is an enhanced analytical tool to help identify invalid open obligations. FOOD represents an advancement from prior approaches to open obligation identification in that it can isolate specific awards with parameters derived from statistical analysis.
  - Using business and visual analytic tools, NSF partnered with agency stakeholders to develop easy to understand dashboards, graphical displays, and ad hoc reporting that facilitate analysis and decision-making.
  - NSF upgraded iTRAK and Research.gov to automate the receipt and processing of banking information for individuals, fellows, and IPAs. This enhancement (1) streamlined and automated a paper-driven process, thereby reducing the administrative burden on agency staff and (2) provides a more-secure payment processing system.
- *G-Invoicing:* NSF implemented G-Invoicing for General Terms and Conditions in FY 2022 and will begin using G-Invoicing for Orders in early FY 2023. Treasury's new G-Invoicing system will serve as the front-end application for users to originate and manage interagency agreements (IAAs) and will store transactional data generated over the full lifecycle of the agreements. NSF will use G-Invoicing and iTRAK to record and interface IAA data between the two applications to address

challenges with accounting, reporting, and monitoring IAAs by providing a common platform between federal partners.

- *Enterprise Risk Management (ERM):* ERM supports NSF's mission by promoting and facilitating a risk-aware culture across NSF and enabling risk-informed decision-making and resource prioritization. The release of NSF's 2022-2026 Strategic Plan provided an opportunity to reflect on the linkage between strategy and risk, and to revisit the risk appetite statements that guide the agency when considering whether to mitigate, transfer, or accept risks. The Chief Operating Officer, with the input of the ERM Risk Captains, developed agency-level risk appetite statements that align with the new Strategic Plan and will help guide risk-based decision-making across the agency.

In accordance with the *Chief Financial Officers Act* and the *Government Management Reform Act of 1994*, NSF prepares financial statements using generally accepted accounting principles (GAAP) for federal entities. The financial statements present NSF's detailed financial information relative to its mission and the stewardship of resources entrusted to the agency. They also provide readers with an understanding of the resources that NSF has available, the cost of its programs, and the status of resources at the end of the fiscal year. NSF's financial statements have undergone an independent audit to ensure they are free from material misstatement and can be used to assess NSF's financial status and related financial activities for the year ending September 30, 2022.

NSF received an unmodified audit opinion on its financial statements, and no material weaknesses or significant deficiencies were identified in the internal control program for financial reporting. The Independent Auditor's Report begins on the first page of Chapter 2, *Financials*. Management's response follows the audit report.



Scientists analyzed the impact of environment, genetics and socioeconomic status on the human brain. *Credit: Farah, Koellinger, et al. Science Advances*

Genetic, environmental factors contribute to how socioeconomic status impacts the brain

An international team of NSF-funded researchers is shedding light on how genetic and environmental factors, including socioeconomic status, interact to affect human brain development. By analyzing brain scans and genetic information of nearly 24,000 individuals, the researchers discovered that while nature and nurture both play a role, only about half of the measured features in the brain were the result of genetic factors. While researchers have known for a long time that environmental factors like water and air quality can affect brain development, this research takes an important step forward in identifying how socio-economic factors such as income, education, and occupation affect the brain and can help inform efforts to mitigate factors that negatively affect brain development.

Understanding the Financial Statements

The following discussion of NSF's financial condition and results of operations should be read together with the FY 2022 financial statements and accompanying notes, found in Chapter 2, Financials, of this AFR.

In accordance with guidance in OMB Circular No. A-136, *Financial Reporting Requirements,* NSF's FY 2022 financial statements and notes are presented in a comparative format to facilitate analysis of FYs 2022 and 2021. Table 1.3 summarizes the changes in NSF's financial position in FY 2022 relative to FY 2021.

Table 1.3 – Changes in NSF's Financial Position in FY 2022

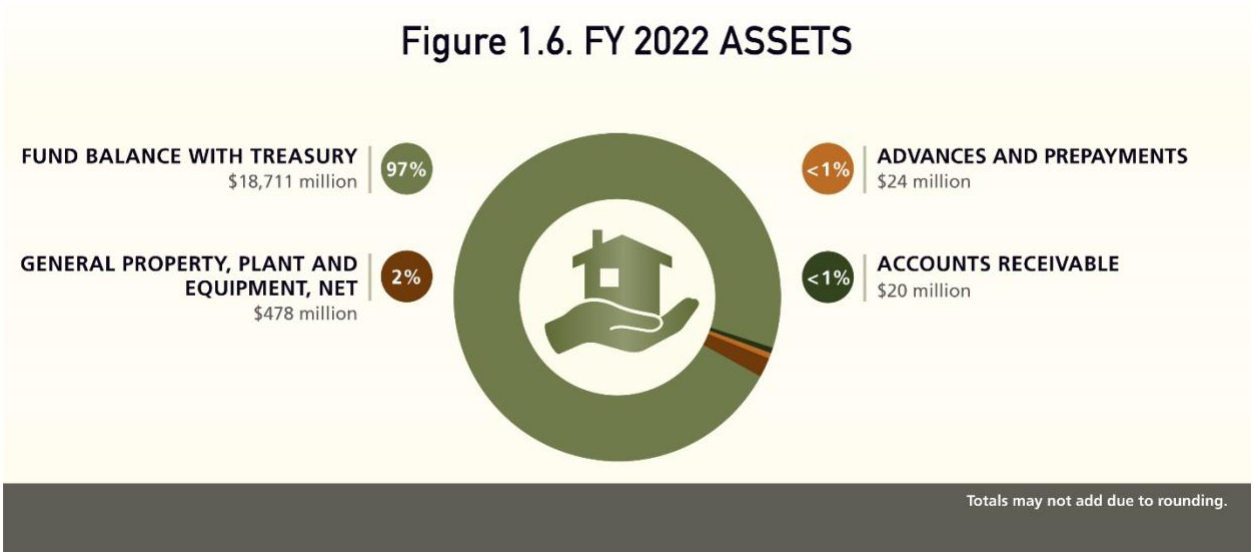
(Dollars in Millions)

Net Financial Condition	FY 2022	FY 2021	$ Change	% Change
Assets	$19,233	$18,349	$884	5%
Liabilities	$796	$665	$131	20%
Net Position	$18,438	$17,684	$754	4%
Net Cost	$8,190	$7,376	$814	11%

Balance Sheet

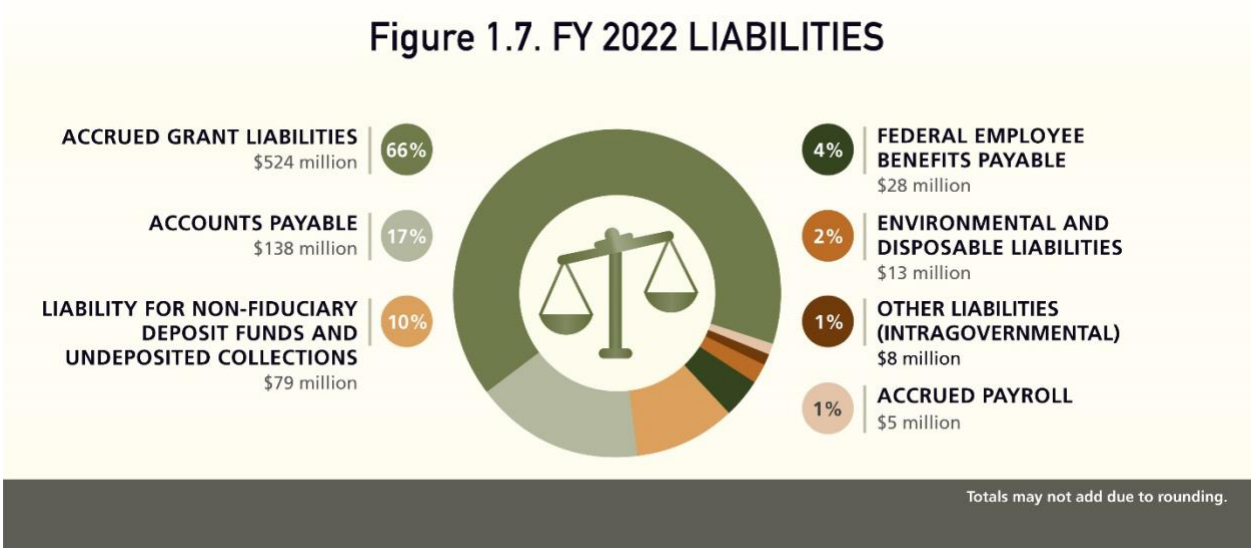
The Balance Sheet presents the total amounts available for use by NSF (assets) against the amounts owed (liabilities) and amounts that comprise the difference (net position). NSF's total assets are largely composed of *Fund Balance with Treasury*.

In FY 2022, *Assets* (Figure 1.6) increased 5 percent from FY 2021. The majority of the change occurred in the *Fund Balance with Treasury* account, which increased by $855 million in FY 2022. NSF is authorized to use *Fund Balance with Treasury* to make expenditures and pay amounts due through the disbursement authority of Treasury. The *Fund Balance with Treasury* is increased through appropriations and collections and decreased by expenditures and rescissions.



In FY 2022, *Liabilities* (Figure 1.7) increased by 20 percent as compared to FY 2021. Driving this change was a $79 million increase in the *Liability for Non-Fiduciary Deposit Funds and Undeposited Collections*, a $41 million increase in *Accounts Payable, and* a $17 million increase in *Accrued Grant Liabilities*.

The increase in *Liability for Non-Fiduciary Deposit Funds and Undeposited Collections* is primarily attributed to the implementation of an FY 2022 change in accounting principle to account for foreign contributions received by NSF in a deposit fund account, which is a liability to NSF. *Accounts Payable (Other than Intragovernmental)* is estimated annually by utilizing historical data based on the actual expenses incurred but not reported, as a percentage of current fiscal year expenses. NSF determines *Accounts Payable (Intragovernmental)* by performing outreach to its federal trading partners and recording offsetting payables for any reported trading partner *Accounts Receivable*. In FY 2022, *Accounts Payable (Intragovernmental)* increased by $30 million due to an increased federal accounts payable accrual. This was the primary driver of the $41 million increase in NSF's total *Accounts Payable,* mentioned earlier. The accrual for standard grants and cooperative agreements are estimated annually by utilizing a linear regression model based on the correlation of NSF grantee's historical unliquidated obligations and expenses incurred but not reported. The accrual for SBIR/STTR grants uses a methodology that is based on their unique terms and conditions. In FY 2022, the unliquidated obligations balance for grantees increased, resulting in a higher *Accrued Grant Liabilities* as compared to FY 2021.

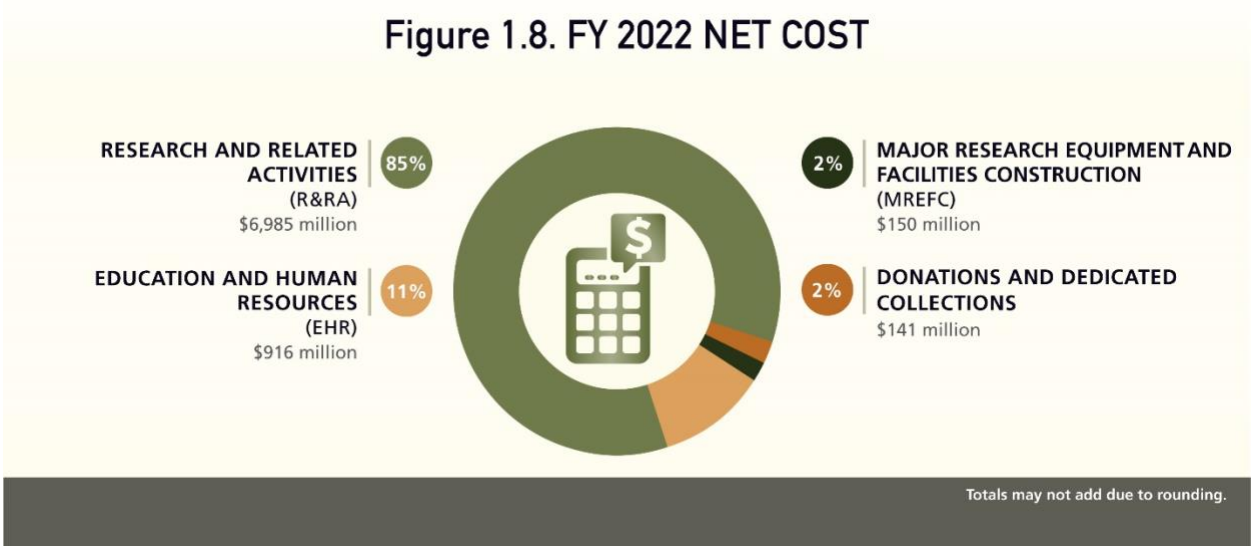


NSF's assets and liabilities were impacted by appropriated funds received in prior fiscal years related to the *Coronavirus Aid, Relief, and Economic Security (CARES) Act* (2020) and *ARP Act* (2021) funding primarily in support of R&RA for COVID-19. As of September 30, 2022, NSF had $498 million in assets and $15 million in liabilities for COVID-19 related activities.

Statement of Net Cost

The Statement of Net Cost presents the annual cost of operating NSF programs. The net cost of operations of each NSF program equals the program's gross cost less any offsetting revenue. Intragovernmental earned revenues are recognized when related program or administrative expenses are incurred. Earned revenue is deducted from the full cost of the programs to arrive at the *Net Cost of Operations*.

Approximately 95 percent of FY 2022 *Net Cost* (Figure 1.8) was related to the direct support of R&RA, EHR, MREFC, and Donations and Dedicated Collections. Additional costs were incurred for indirect general operation activities (e.g., salaries, training, and activities related to the advancement of NSF information systems technology) and activities of the NSB and the OIG. These indirect costs were allocated to R&RA, EHR, MREFC, and Donations and Dedicated Collections and account for approximately 5 percent of FY 2022 *Net Cost*. These administrative and management activities support the agency's program goals. In FY 2022, net costs related to CARES and ARP for R&RA, EHR, MREFC, and AOAM were $89 million, $7 million, $5 million, and $3 million, respectively.



Statement of Changes in Net Position

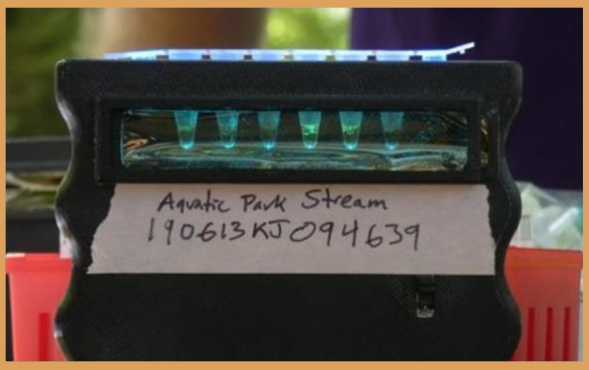
The Statement of Changes in Net Position presents the agency's cumulative results of operations and unexpended appropriations for the fiscal year. In FY 2022, NSF's *Unexpended appropriations* increased by $688 million from FY 2021 and NSF's *Cumulative Results of Operations* increased by $66 million, for a total increase in *Net Position* of $754 million.

In FY 2022, NSF implemented a change in accounting principle that resulted in a $48 million adjustment to the beginning balance of the agency's *Cumulative Results of Operations* as seen on the *Statement of Changes in Net Position.* Further information related to the change in accounting principle implemented by NSF can be found in this AFR's Chapter 2, Financials, Note 1C, *Summary of Significant Accounting Policies* and Note 2, *Fund Balance with Treasury.*

Appropriations received from CARES and ARP resulted in *Unexpended Appropriations* of $4 million and $479 million in FY 2022, respectively. As NSF continues to provide support for COVID-19 related research, costs will increase, which will lead to a decrease in net position.

New DNA computer assesses water quality

Synthetic biologists at Northwestern University have developed a low-cost, easy-to-use hand-held device that can let users know if their water is safe to drink. Rather than complex nanotechnology, quantum sensors, or other exotic, expensive electronics, the researchers turned to bacteria that have specific protein structures that act as "tastebuds" for detecting pollutants like lead, copper, cobalt, and chromium. These "tastebuds" are isolated and combined with custom-engineered strands of DNA to create a solution that glows green when the pollutant-sensitive proteins are activated. While most water testing methods are slow, expensive, and require lab access, the researchers' device is simple and fast, consisting of eight small test tubes that can alert users to 17 different contaminants. Simply add water and within minutes contaminated samples will glow green—a quick and easy way to for people anywhere to monitor water quality and protect their health.



Testing water from an area affected by wildfires in California.
Credit: Northwestern University

Statement of Budgetary Resources

The Statement of Budgetary Resources provides information on how budgetary resources were made available to NSF for the year and the status of those budgetary resources at year end. For FY 2022, *Total Budgetary Resources* increased $242 million from the FY 2021 level. *Budgetary Resources—Appropriations* in FY 2022 for the R&RA, EHR, and MREFC accounts were $6,999 million, $1,149 million, and $266 million, respectively. The combined *Budgetary Resources—Appropriations* in FY 2022 for the NSB, the OIG, and AOAM accounts totaled $449 million. NSF also received $188 million of funding via warrant from the Nonimmigrant Petitioner Account (H-1B); and $20 million of donations from private companies, academic institutions, nonprofit foundations, and individuals.

As part of ARP, NSF received $600 million "to fund or extend new and existing research grants, cooperative agreements, scholarships, fellowships, and apprenticeships, and related administrative expenses to prevent, prepare for, and respond to coronavirus." Further information related to the status of budgetary resources of COVID-19 funding can be found in Chapter 2, Financials, Note 11. *COVID-19 Activity* of this AFR.

Limitations of the Financial Statements

The financial statements are prepared to report the financial position, financial condition, and results of operations, pursuant to the requirements of 31 U.S.C. § 3515(b). The statements are prepared from NSF records in accordance with Federal GAAP and the formats prescribed by OMB. Reports used to monitor and control budgetary resources are prepared from the same records. Users of the statements are advised that the statements are for NSF, a component of the U.S. Government.

Other Financial Reporting Information

Debt Collection Improvement Act of 1996

Net Accounts Receivable totaled $20 million on September 30, 2022. Of that amount, $18 million was due from other federal agencies. The remaining $2 million was due from the public. In accordance with the *Debt Collection Improvement Act, as amended by the Digital Accountability and Transparency Act of 2014*, NSF fully participates in Treasury's Cross-Servicing Program. This program requires NSF to refer

debts due from the public that are delinquent more than 120 days to Treasury for appropriate collection action. In accordance with OMB Circular No. A-129, *Policies for Federal Credit Programs and Non-Tax Receivables*, NSF writes off delinquent debt due from the public that is more than 2 years old. Additionally, NSF seeks Department of Justice concurrence for the write-off of debts greater than $100,000.

Cash Management Improvement Act of 1990

In FY 2022, NSF had no awards covered under *Cash Management Improvement Act* Treasury-State Agreements. The timeliness of NSF's payments to grantees through its payment systems makes the issue of timeliness of payment under the *Act* essentially not applicable to the agency. No interest payments were made in FY 2022.

Analysis of Systems, Controls, and Legal Compliance

Management Assurances

The *Federal Managers' Financial Integrity Act of 1982* (FMFIA)[26] and the OMB Circular A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control*[27] require NSF to evaluate annually the effectiveness of agency internal controls and provide reasonable assurance to the President and the Congress on control system adequacy.

NSF assures its internal control system supports a mature, agile, and sustainable control environment. The approach is proactive and supports effective governance and oversight informed by internal and external risk. A strong risk-based framework ensures focus on the most consequential management issues and confidence that operations are functioning as intended. The risk-based approach also supports a maturing ERM program.

National Science Foundation

FY 2022 Statement of Assurance

The National Science Foundation (NSF) management is responsible for managing risks and maintaining effective internal control to meet the objectives of Sections 2 and 4 of the *Federal Managers' Financial Integrity Act* (FMFIA).

NSF conducted its assessment of risk and internal control processes in accordance with OMB Circular No. A-123, *Management's Responsibility for Enterprise Risk Management and Internal Control*. Based on the results of the assessment, NSF can provide reasonable assurance that internal control over operations, reporting, and compliance was operating effectively as of September 30, 2022.

/s/
Sethuraman Panchanathan
Director

November 14, 2022

The FY 2022 unmodified Statement of Assurance, with no material weaknesses, provides reasonable assurance as to the overall adequacy and effectiveness of internal controls based upon information that the system of internal control is operating efficiently and effectively.

NSF's internal control assessment provides reasonable assurance that the objectives of FMFIA and the *Federal Financial Management Improvement Act of 1996* (FFMIA) were achieved and that the internal control process over financial reporting is effective.

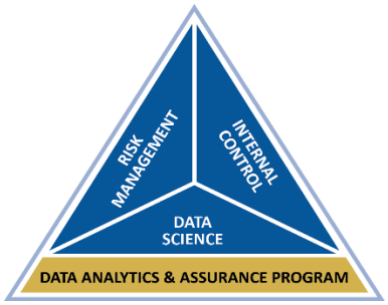
[26] FMFIA: https://www.congress.gov/bill/97th-congress/house-bill/1526/text

[27] *OMB Circular A-123*: https://obamawhitehouse.archives.gov/sites/default/files/omb/memoranda/2016/m-16-17.pdf

Highlights from NSF's FY 2022 Data Analytics and Assurance Program

NSF's Data Analytics & Assurance Program (DAAP) adapts knowledge sharing for ERM and internal control risks leveraged by data science and innovative technology to continuously improve the effectiveness of risk monitoring. The DAAP supports the NSF mission by:

- Dealing with the proliferation of data.
- Leveraging artificial intelligence and automation.
- Targeting and reducing the cost of compliance efforts.
- Strengthening management decision-making.



The DAAP's areas of focus for FY 2022 were as follows:

ERM – NSF continued to mature its ERM program in alignment with risk management standards issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) ERM Integrated Framework. Efforts included the strengthening of ERM governance, increasing the maturity of analytic and risk management tools, supporting the OIG-identified FY 2022 management challenge on grants oversight, aligning ERM entity-level controls to validate internal control practices, and the introduction of GAO's Artificial Intelligence Accountability Framework.

Internal Control – Oversight of NSF's internal controls over financial reporting was conducted to evaluate program integrity in accordance with OMB Circular A-123, the Green Book, and COSO's Internal Control Integrated Framework and Internal Control Over Financial Reporting Compendium of Approaches and Examples through the following key activities:

- Assessed internal control entity level controls.
- Conducted Biannual Risk and Control Checkpoints related to key risk areas.
- Conducted internal control over financial reporting risk assessment through testing and modernizing the control environment.
- Conducted the triennial improper payments risk assessment, including quantitative (grants payments testing) and qualitative assessments.
- Provided support for the validation of the grant accrual.
- Completed IT General Controls assessment.
- Supported the Statement of Standards for Attestation Engagements (SSAE 18) review cycle.

In addition, the DAAP monitors internal controls over compliance, including: the *Anti-Deficiency Act; Digital Accountability and Transparency Act; Government Charge Card Abuse Prevention Act; Federal Information Security Modernization Act Management Act; Federal Financial Management Improvement Act; Single Audit Act,* and other requirements applicable to internal control.

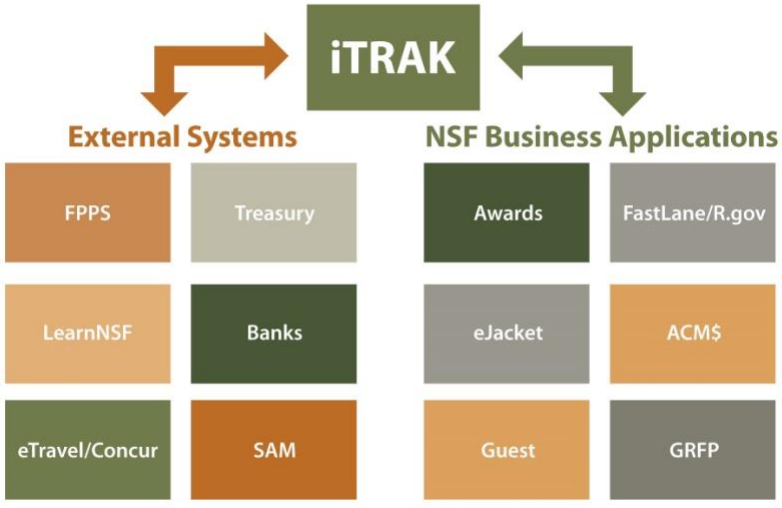
Financial Management Systems

iTRAK is NSF's Oracle-based, commercial-off-the-shelf financial system, hosted off-premises in the cloud. In May 2022, NSF was among the first Federal agencies to transition its financial system's infrastructure to the cloud. This transition significantly strengthened iTRAK's system security, reliability, and performance. The financial system provides automated business processes, funds control management, and reporting capabilities for NSF's external and internal customers, including grantees, financial and administrative staff, and program managers. iTRAK, also performs system edit checks and provides an audit trail for financial transactions, thereby strengthening internal controls. iTRAK aligns with NSF's *Strategic Objective 4.1 – Strengthen at speed and scale: Pursue innovative strategies to strengthen and expand the agency's capacity and capabilities* by enabling efficient, effective execution of financial activities and business operations. NSF has begun planning for the next generation of iTRAK, a cloud-based solution that offers a consumer-like user experience, provides financial analytics, and utilizes artificial intelligence and machine learning.

iTRAK also supports the agency in its stewardship role by providing managers and staff with financial data and reports to aid in data analysis so they can make informed decisions about the programs they manage and support. iTRAK interfaces with NSF's awards, grants management, and business process systems including:

- Award Cash Management Service (ACM$).
- MyNSF Awards (Awards) — NSF's award and award amendment processing, approval, and notification system.
- eJacket — NSF's internal proposal processing system, post-award request tracking and approval system, and document repository.
- Research.gov — Website for the research community that provides quick access to research information and grants management services. Research.gov will replace FastLane.
- Graduate Research Fellowship Program (GRFP) System.
- Guest Travel and Reimbursement System (Guest).

Figure 1.9—NSF Financial Management System Framework



iTRAK also interfaces with external systems operated by Treasury; Citibank and LearnNSF, the Foundation's training system; and with other federal systems such as the Federal Personnel Payroll System (FPPS), eTravel/Concur, and the General Services Administration's SAM.

iTRAK's service provider provides NSF assurance for its financial system through service provider audits (more technically referred to SSAE No. 18) at the application, platform, and infrastructure levels. Application and infrastructure audit opinions were unmodified (i.e., clean), while the platform audit opinion was qualified. NSF's service provider took immediate action to resolve the audit qualification and NSF's complementary controls mitigated any risks to NSF's data, financial reporting or iTRAK application.