



National Science Foundation

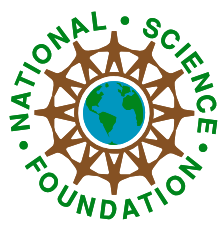
The Division of Electrical, Communications and Cyber Systems (ECCS)

2007 Divisional Plan

Advisory Committee Meeting
Directorate for Engineering

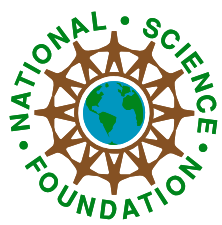
April 19, 2007

Dr. Usha Varshney
Division Director



Mission

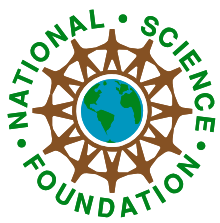
- **Address** fundamental research issues underlying component and device technologies, power, controls, computation, networks, communications and cyber technologies
- **Support** integration and networking of intelligent systems principles at the nano, micro, macro scales for a variety of application domains
- **Ensure** education of a diverse workforce prepared to continue rapid development of emerging technologies as drivers of the global economy



Vision

ECCS envisions a research community...

- that will address major technological challenges for next generation devices, systems and networks due to the **convergence of** technologies and increased emphasis on interdisciplinary research
- that will **prepare a future workforce** to meet the emerging technological challenges of the 21st Century

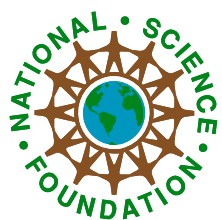


Goals

ECCS

NSF

	Discovery	Learning	Research Infrastructure	Stewardship
◆ Invest in transformative research	●	●	●	
◆ Promote innovative, high-risk, high-payoff ideas at the forefront of technologies	●	●	●	
◆ Foster cooperative activities among academia, industry and national laboratories	●	●	●	
◆ Promote outreach to universities, industries, nonprofit organizations and professional societies	●	●	●	
◆ Increase partnerships within NSF and with other Federal agencies	●	●	●	
◆ Enhance diversity within ECCS staff, researchers and reviewers	●	●	●	●
◆ Enable professional development of ECCS staff		●		●
◆ Improve organizational excellence				●
◆ Mentoring of new Program Directors				●



Programs

Electronics, Photonics and Device Technologies EPDT

- ✓ Bioelectronics
- ✓ Electromagnetics
- ✓ Flexible Electronics
- ✓ MEMS/NEMS
- ✓ Micro/Nanoelectronics
- ✓ Micro/Nanomagnetics
- ✓ Microwave Photonics
- ✓ Molecular Electronics
- ✓ Nanophotonics
- ✓ Optoelectronics
- ✓ Power Electronics
- ✓ Sensors and Actuators
- ✓ Spin Electronics

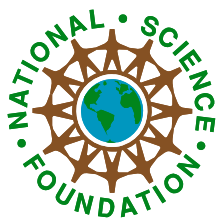
Power, Controls and Adaptive Networks PCAN

- ✓ Adaptive Dynamic Programming
- ✓ Alternate Energy Sources
- ✓ Embedded, Distributed and Adaptive Control
- ✓ Neuromorphic Engineering
- ✓ Power and Energy Systems & Networks
- ✓ Quantum and Molecular Modeling & Simulation of Devices and Systems
- ✓ Sensing and Imaging Networks
- ✓ Telerobotics

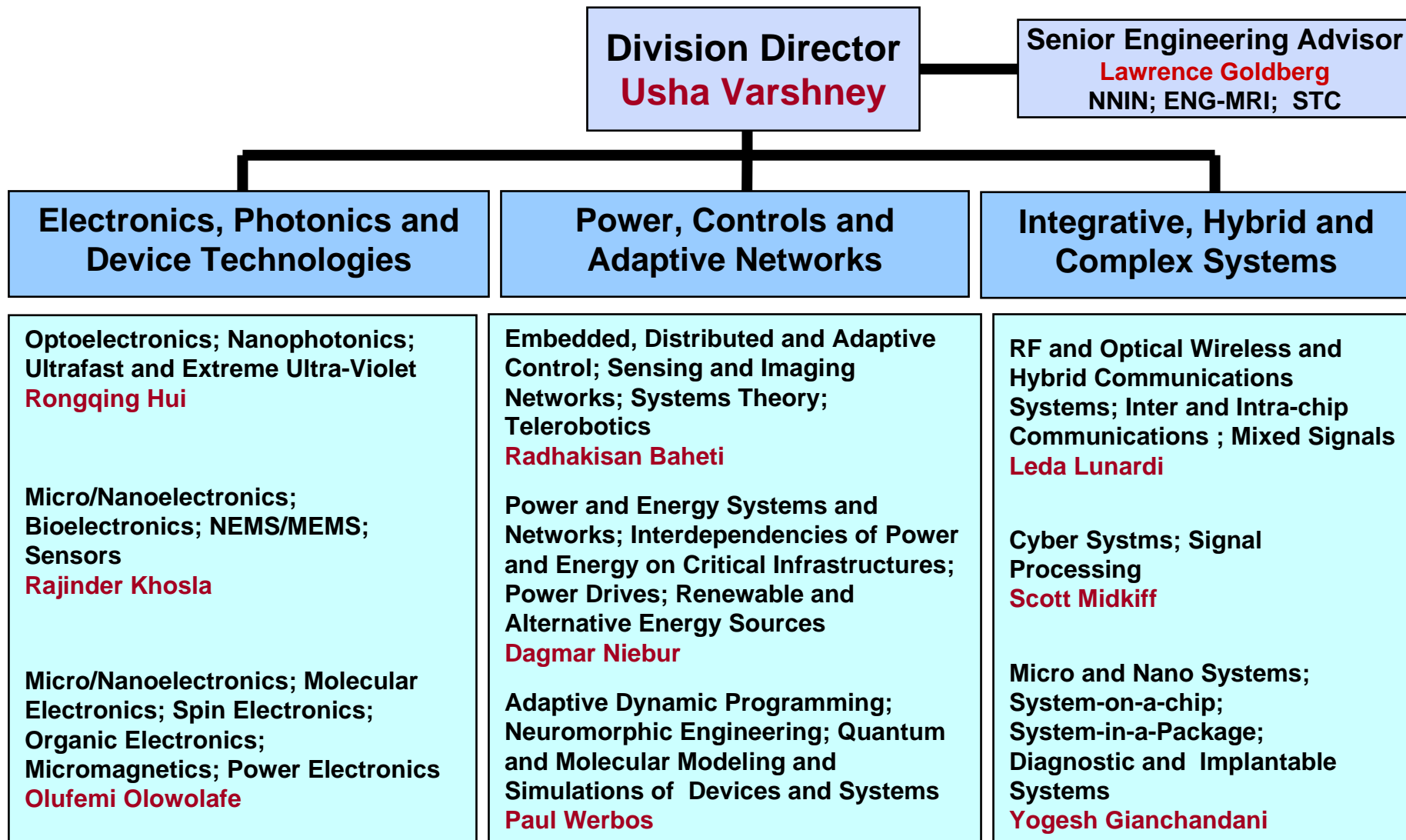
Integrative, Hybrid and Complex Systems IHCS

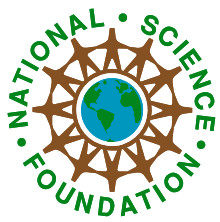
Nanosystems, Microsystems, Macrosystems

- ✓ Cyber Systems
 - Signal Processing
- ✓ Nano and Microsystems
 - System-on-a-chip
 - System-in-a-package
- ✓ RF and Optical Wireless and Hybrid Communications Systems
 - Inter and Intra-chip Communications
 - Mixed Signals



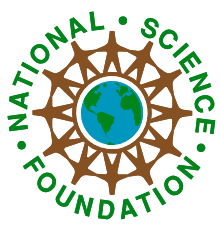
Program Directors





Program Restructuring

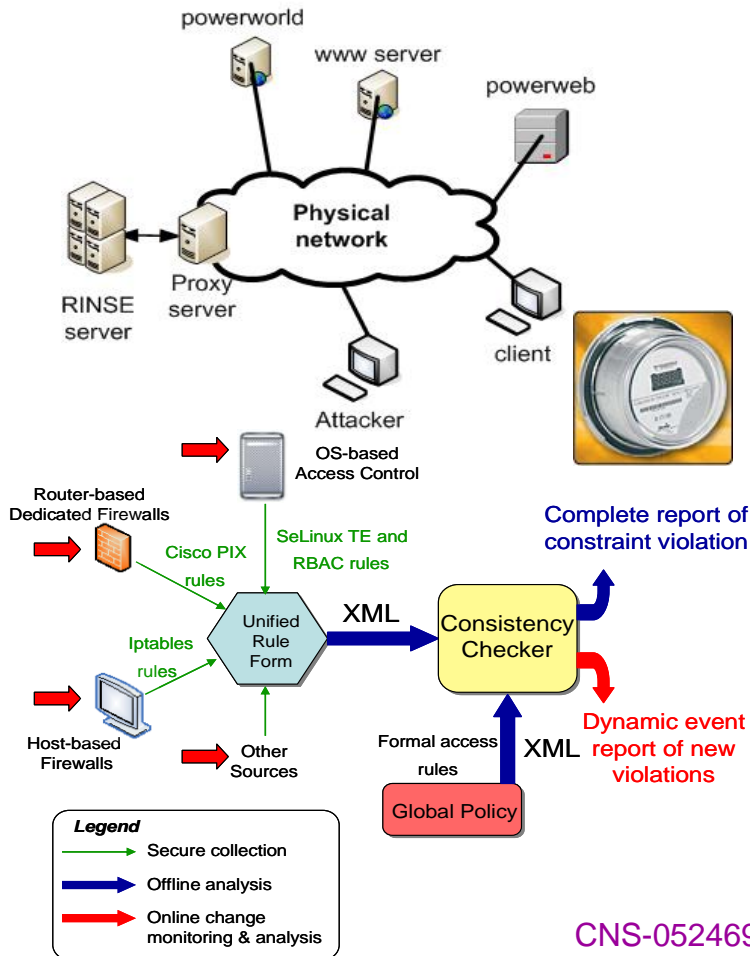
- **Integrative, Hybrid and Complex Systems (IHCS)**
 - **Micro & Nano Systems**
 - **Communications Systems**
 - **Cyber Systems**
- **Power, Controls and Adaptive Networks (PCAN)**
 - **Renaming of Program**
- **Electronics, Photonics and Device Technologies (EPDT)**
 - **Planned Program Director position**



Cyber-enabled Discovery and Innovation

- **Integrate physical devices with distributed sensing and actuation, communications, storage, computation and control of complex systems**
 - » **Integrated hybrid optical and electronic systems for high-performance computation and communications**
 - » **Distributed sensing and actuation for telemedicine**
- **Focus on design, integration and implementation of complex multi-scale and multi-level systems**
 - » **Ambient intelligence for homes and workplaces of the future**
- **Enable visualization, analysis and reconfiguration for reliable and agile infrastructures for domain-specific applications**
 - » **Robust electric power grids integrating power, communication and self-organizing networks**
 - » **Globally interactive environment for engineering education**

Goal: To protect the electric power grid and related cyber-infrastructure systems from the risk of cyber attacks by developing



- **Secure and Reliable Computing Base**
- **Trustworthy Communications & Control Protocols**
- **Quantitative and Qualitative Evaluation**
- **Related Educational Systems**

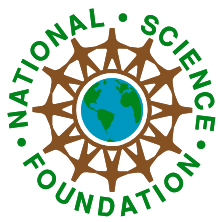
Developed simulations/physical test bed for:

- ✓ **Evaluating and validating next-generation power grid designs**
- ✓ **Representing cyber-enabled power system for power flow, and market levels**
- ✓ **Predicting impact of cyber attacks on power grid**

Developed an attested meter for:

- ✓ **Solving security problems using trusted computing and virtualization technologies**

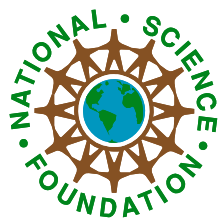
CNS-0524695, Sanders (CISE, ENG, DOE, DHS) <http://tcip.iti.uiuc.edu>



American Competitiveness Initiative

- The centerpiece of **American Competitiveness Initiative (ACI)** is the doubling of federal investment over the next 10 years (2007-2016) in key agencies that support basic research in physical sciences and engineering
- Three Federal Agencies: **NSF, DOE Office of Science, and NIST** will be impacted
- ACI includes three broad components:
 - » Research in physical sciences and engineering includes 12 specific goals, 7 of which relate to NSF
 - » Research and Development tax incentives
 - » Education and workforce





ECCS Thrust Areas Support ACI Goals

ACI GOALS

Nanofabrication and nanomanufacturing– transforming discovery into industrial applications

High-end computing coupled with networking to advance modeling and simulation at unprecedented scales

Quantum information processing for secure communications, and quantum mechanics simulations

Efficient and economic use of hydrogen, nuclear, and solar energy through basic research

Addressing gaps and needs in cyber security and information assurance to protect IT dependent economy

Sensor and detection capabilities resulting in world-leading automation and control technologies

Advances in improving structural performances during natural disasters

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- ✓ Bioelectronics
- ✓ Electromagnetics
- ✓ Organic Electronics
- ✓ MEMS/NEMS
- ✓ Micro/Nanoelectronics
- ✓ Micro/Nanomagnetics
- ✓ Microwave Photonics
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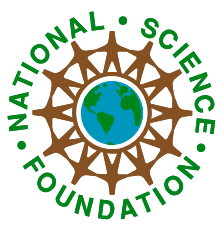
- Alternate Energy Sources in the National Grid (InterGrid)
- Flexible Electronics
- Hybrid Communications Systems
- Interdependencies of Critical Infrastructure in Power and Communications
- Neuromorphic Engineering
- Quantum and Molecular Modeling and Simulation of Devices and Systems
- Very Large-scale Photonic Integration
- Wearable and Implantable Devices and Systems

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- ✓ Adaptive Dynamic Programming
- ✓ Alternate Energy Sources
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- ✓ Telerobotics

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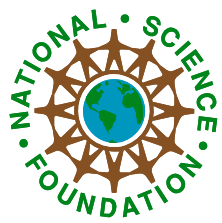
- ✓ Cyber Systems
- ✓ Signal Processing
- ✓ Nano and Microsystems
- ✓ Communications Systems



ENG Research and Education Themes 2007-2008

- **Complex Engineered and Natural Systems**
 - » Cyber Systems
 - » Hybrid Communications Systems
 - » Interdependencies of Critical Infrastructure in Power and Communications
- **Energy and the Environment**
 - » Alternate Energy Sources and Integration in the National Grid (InterGrid)
 - » Power & Energy Devices, Components, Systems and Networks
 - » Sensors and Sensor Networks
- **Innovation**
 - » Core Programs: EPDT, IHCS, PCAN
- **Manufacturing Frontiers**
 - » Adaptive Dynamic Programming
 - » Embedded, Distributed and Adaptive Control
 - » Signal Processing
 - » Telerobotics
- **Nanotechnology**
 - » Nanoelectronics, Nanophotonics and Nanomagnetism Devices and Systems; Beyond CMOS; Nanomanufacturing; Environmental, Health and Safety
 - » Quantum and Molecular Modeling & Simulation of Devices and Systems

With emphasis on integration of research and education for the development of future workforce



ECCS Investments

NSF Priority Areas

- Nanoscale Science and Engineering
- Biocomplexity in the Environment
- Human and Social Dynamics
- Mathematical Sciences
- Sensors and Related Research

ENG Initiatives & Collaborative Programs

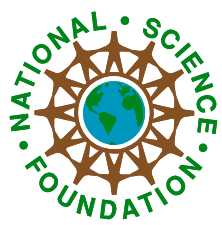
- CLEANER/WATERS
- Cyberinfrastructure
- Emerging Frontiers in Research and Innovation (EFRI)
- Active Nanostructures and Nanosystems (ANN)

NSF Programs

- CAREER: Faculty Early Career Development
- PECASE: Presidential Early Career Award
- SGER: Small Grants for Exploratory Research
- RET: Research Experiences for Teachers Supplements
- REU: Research Experiences for Undergraduates Supplements
- ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers
- MRI: Major Research Instrumentation
- GOALI: Grant Opportunities for Academic Liaison with Industry

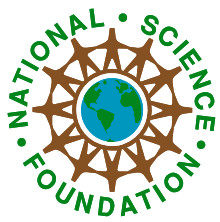
ECCS Core & Collaborative Programs and Initiatives

- Leveraging Technological Innovations for Cyber Systems
- Wearable and Implantable Devices and Systems
- Alternate Energy Sources and Integration in the National Grid



Workshops

- **ECCS/ENG and CNN/CISE Cyber-Physical Systems Workshop, NSF, VA, September 21, 2006**
- **Wearable and Implantable Devices and Systems for Health Monitoring & Diagnostics (USDA, FDA, NIBIB/NIH), NSF, VA, November 13, 2006**
- **NSF/IEEE Workshop for Middle and High School Students and Teachers in Cross-Boundary Nature of Decision & Controls, San Diego, CA, December 13, 2006**
- **Large-Scale Photonic Integration, NSF, VA, March 19-20, 2007**
- **Quantum, Molecular and High Performance Modeling and Simulation for Systems and Devices, NSF, VA, April 16-17, 2007**
- **2007 ECCS Grantees Workshop to Broaden Participation, U. of Nevada, Reno, April 30- May 2, 2007**
- **Engineering of Cyber- Physical Systems Roundtable, NSF, VA, May 17, 2007**
- **Adaptable Multi-scale Engineered Systems for Biomedical Applications, NSF, VA, July 19-20, 2007**
- **Challenges of Spin Electronics Integrated Systems, NSF, VA, August 9-10, 2007**
- **World Technology Center Study in Flexible Electronics, 2007- 2009**



Graduate Research Supplements

- **NSF- SIA Supplements to NSF Centers in Nanoelectronics for Graduate Students and Postdoctoral Fellows**

- » Explore new concepts beyond the scaling limit of CMOS technology
- » Enhance industry linkages with active NSF centers involved in long-term nanoelectronics research
- » Develop future cadres of industry and faculty researchers to help drive the field
 - Average award size \$300-500K for a duration of 3 years
 - FY 2006, Six awards to NCN, NSECs, MRSECs at: Purdue U., U. Virginia, Columbia U., UCSB, Harvard U., U. Oklahoma
 - FY 2007, Six awards (in process)

Supplement Submission Deadline: November 15, 2006 (NSF 06-051)

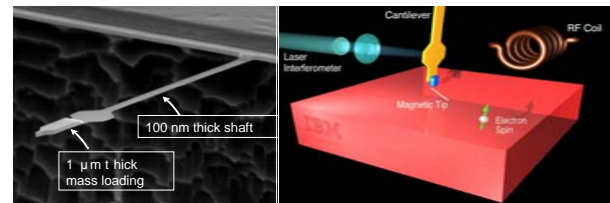
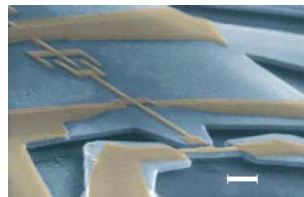
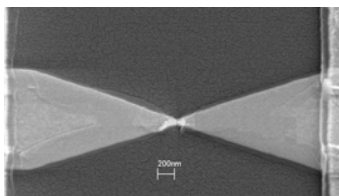
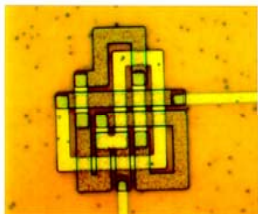
- **Graduate Research Supplements (GRS) to Current ENG Awards to Broaden Participation**

- » To increase numbers in academic/professional careers
- » Supplements to existing ENG grants
- » Ph.D. Students Majoring in Engineering Disciplines
 - Graduate student stipend and tuition consistent with university practices
 - 25% Administrative Cost
 - 12 months, renewable for two additional years during the grant period
 - Nontransferable
 - US Citizens or Nationals or Permanent Residents
 - FY 2005 – 5 Supplements - 4 females (1 African American female) and 1 Hispanic male
 - FY 2006 – 13 Supplements - 8 females, 3 African American males, 2 Hispanic males and 1 Hispanic female

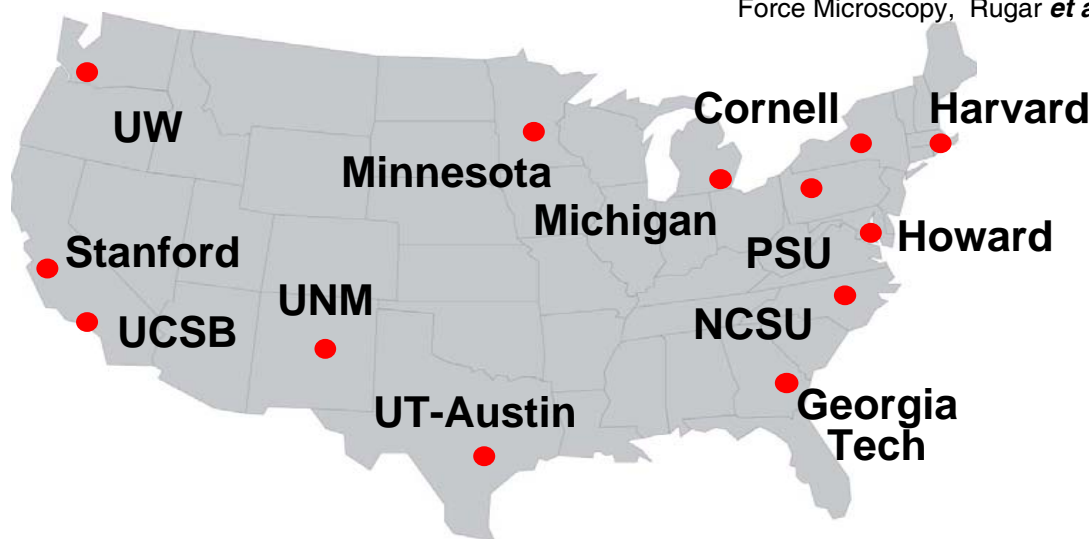
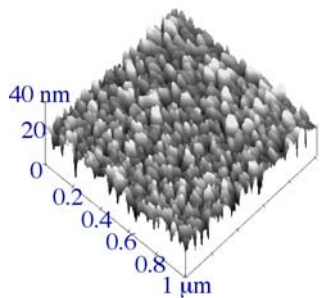
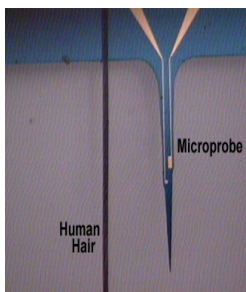
Supplement Submission Deadline: May 15, 2007 (NSF 07-023)



National Nanotechnology Infrastructure Network (NNIN)

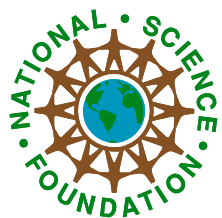


Single Electron Spin Detection using Magnetic Resonance Force Microscopy, Rugar *et al.*, *Nature* 430, July (2004)

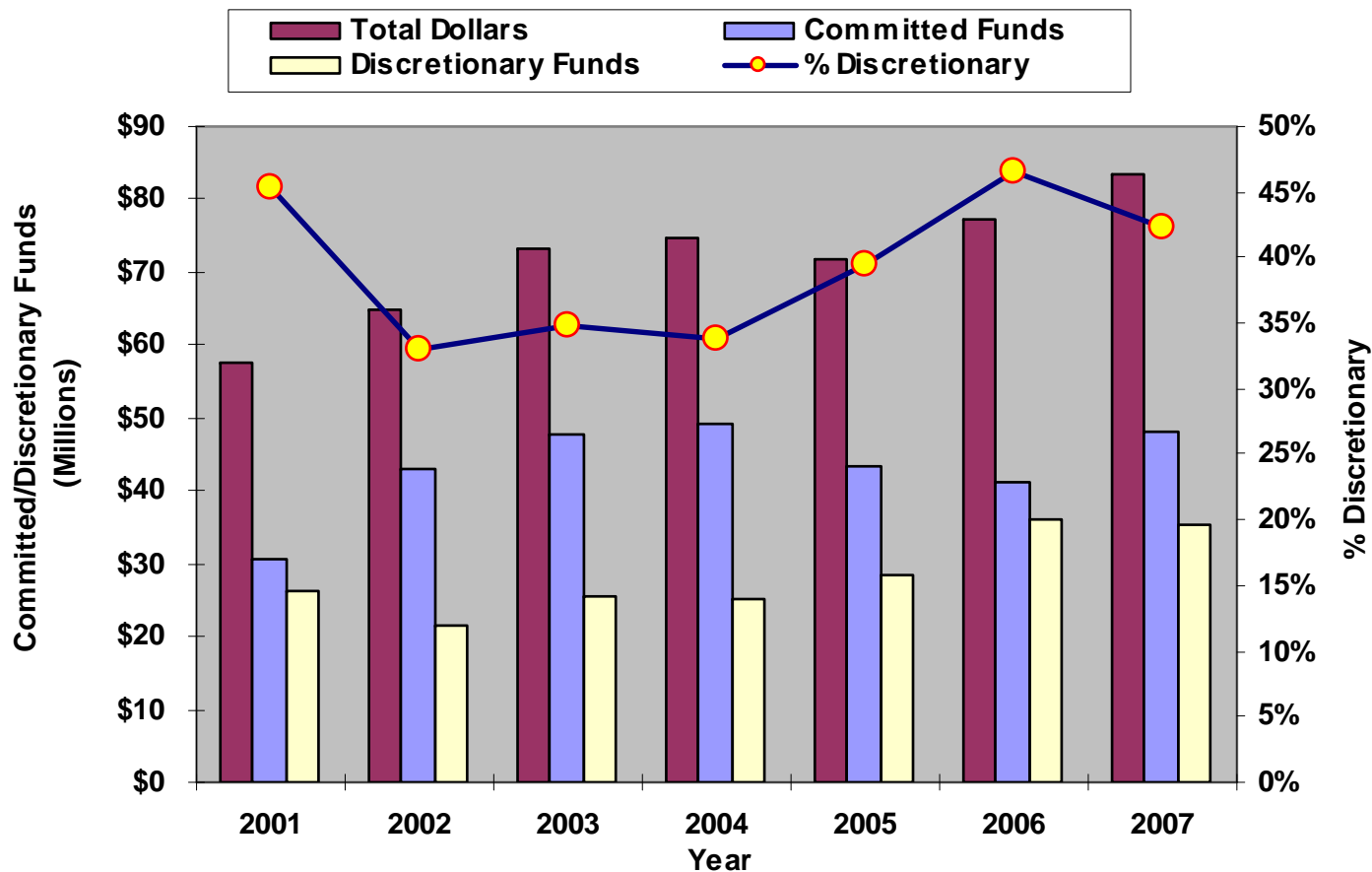


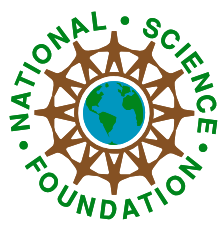
- Cornell U.*
- Stanford U.*
- U. of Michigan*
- Georgia Institute of Technology*
- U. of Washington*
- Pennsylvania State U.*
- U. of California-Santa Barbara*
- U. of Minnesota*
- U. of New Mexico*
- U. of Texas –Austin*
- Harvard U.*
- Howard U.*
- North Carolina State U.*

An integrated national network of user facilities providing researchers open access to resources, instrumentation and expertise in all domains of nanoscale science, engineering and technology



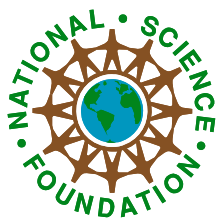
Budget Profile



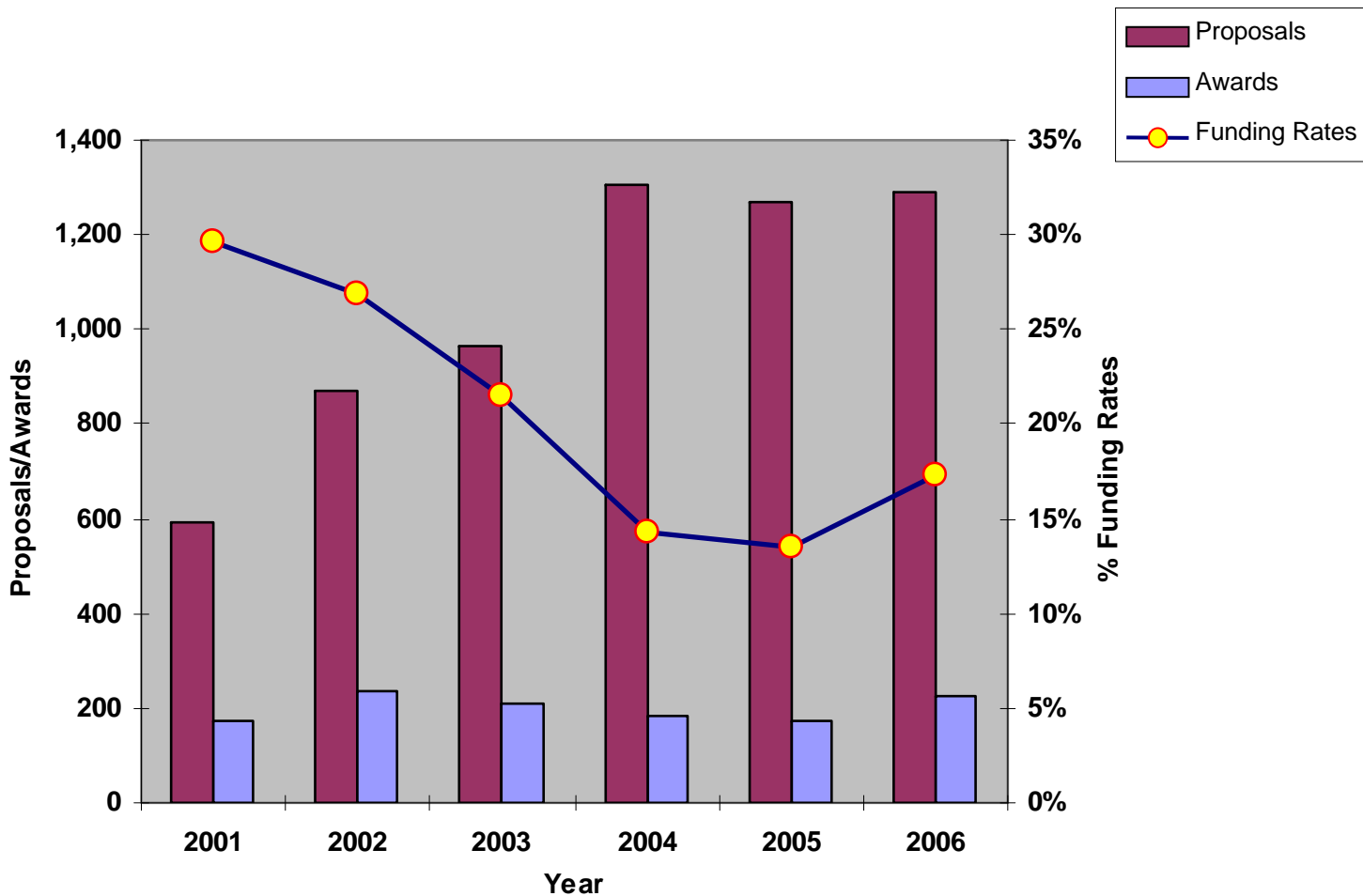


Unsolicited Proposals

- **Submission Windows**
 - » September 7 - October 7
 - » January 7 - February 7
- **Award Size**
 - » \$270-300K for three years
 - » Limited number of group proposals
- **Reviewers**
 - » Encourages reviewers from university, industry and government

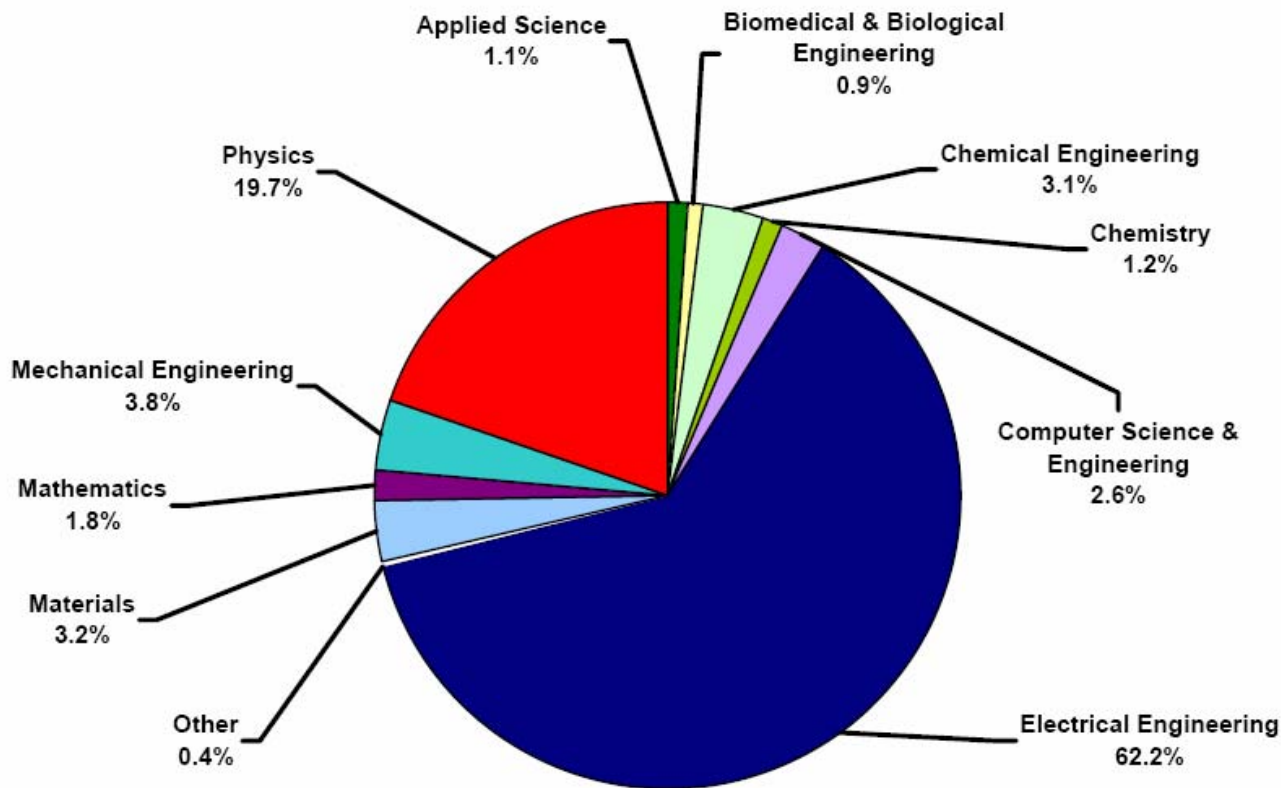


Funding Rates for Research Grants

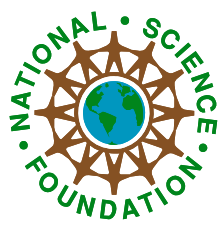




ECCS Investment by Academic Department

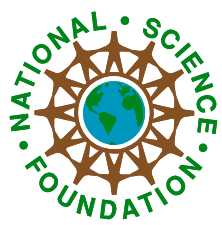


*** Percentage of ECCS FY 2006 investment in Research Grants by Academic Department of Principal Investigator**



Emerging Technologies

- ✓ **Cyber Systems**
- ✓ **Alternate Energy Sources and Integration in the National Grid (InterGrid)**
- ✓ **Diagnostic, Wearable and Implantable Devices and Systems**
- ✓ **Flexible Electronics**
- ✓ **Neuromorphic Engineering**
- ✓ **Interdependencies of Critical Infrastructures in Power and Communications**
- ✓ **Quantum and Molecular Modeling and Simulation of Devices and Systems**
- ✓ **Very Large-scale Photonic Integration**



Challenges

- **Redress the imbalance** between committed and discretionary funds
- **Maintain the overall productivity and efficiency** of the Division by continued improvement in protocols for streamlining Division operations
- **Improve evaluation, acquisition and dissemination of quality Division Highlights** through organization of Grantees Workshops
- **Provide visibility to focused research areas** within the research community, consistent with research priorities of ENG, NSF and ACI
- **Strategize future funding** for small group proposals in the Division



Thank you

**Division of
Electrical, Communications and Cyber Systems (ECCS)
Directorate for Engineering**

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4201 Wilson Boulevard
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<http://www.nsf.gov/eng/ecs/about.jsp>**