Division of Electrical, Communications and Cyber Systems (ECCS)

Overview

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ENG Advisory Committee
October 15, 2008

Outline

- NSF Strategic Plan
- ECCS Structure and Mission
- Funding Perspectives
- Programs and Emerging Areas
- Solicitations, Workshops, Academy Study
- Oversight Responsibilities
- Responses to 2005 COV

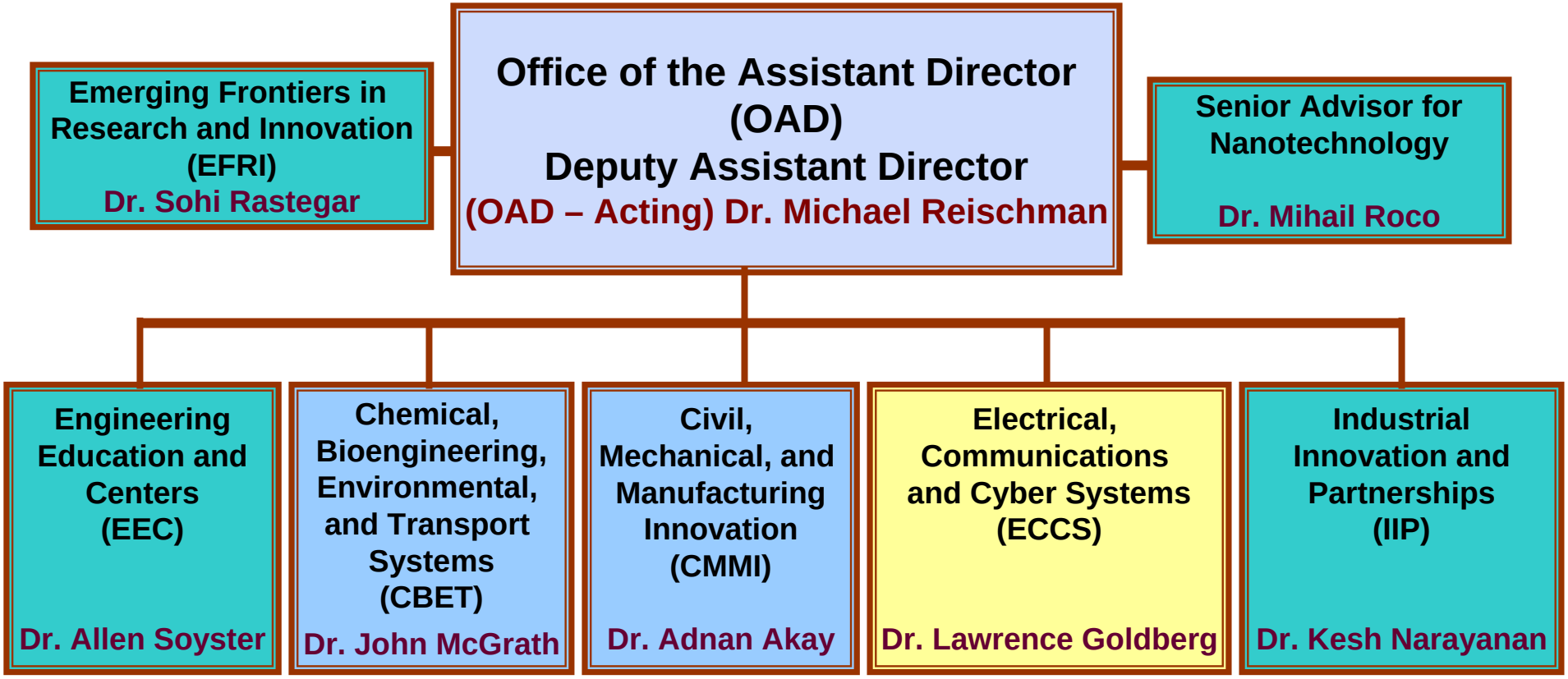
NSF Strategic Plan
Investing in America's Future

Advancing discovery, innovation and education beyond the frontiers of current knowledge, and empowering future generations in science and engineering through

- Discovery
- Learning
- Research Infrastructure
- Stewardship

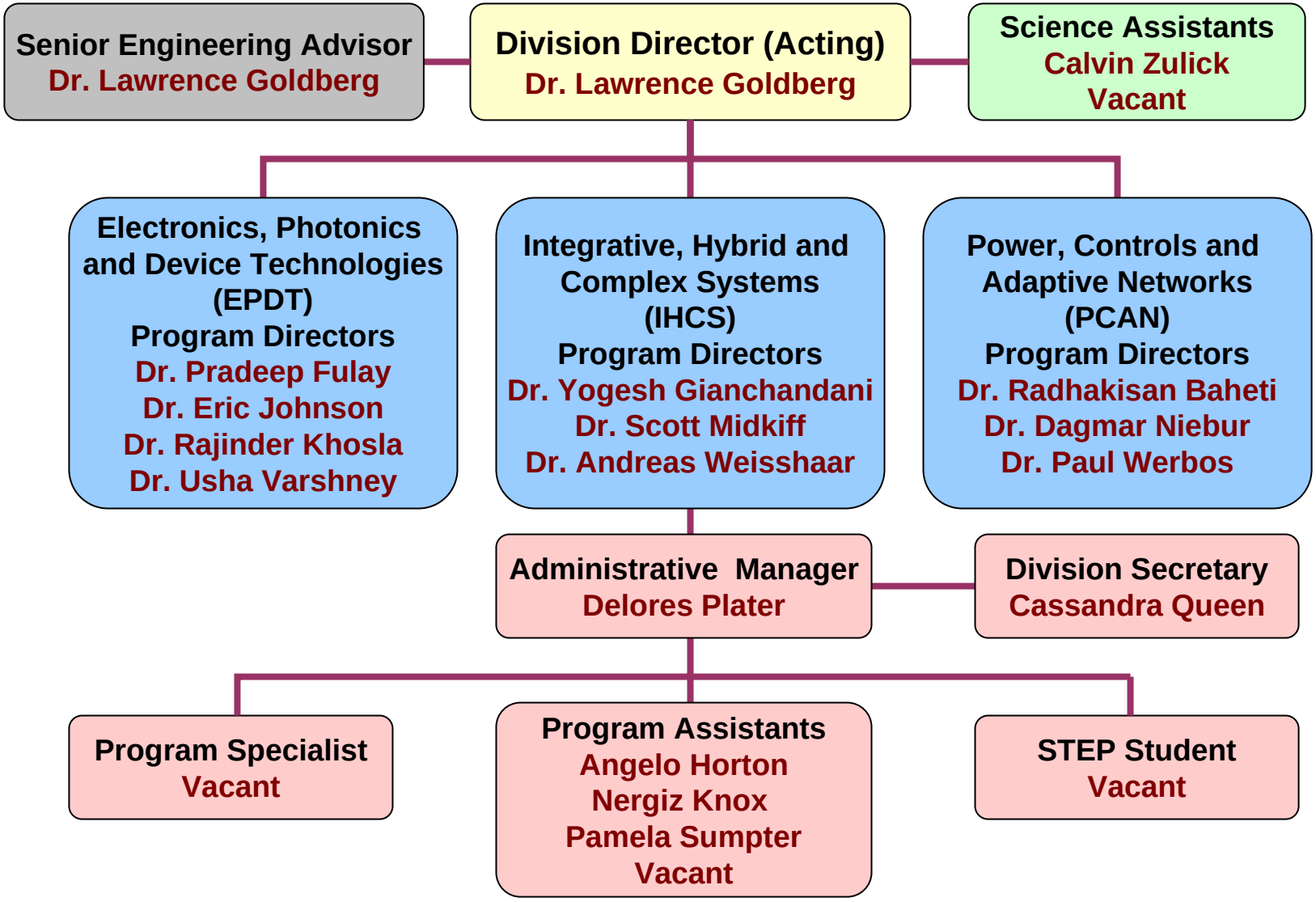
http://www.nsf.gov/pubs/2006/nsf0648/nsf0648.jsp

ENG Organizational Structure



http://www.nsf.gov/eng/about.jsp

ECCS Organizational Structure



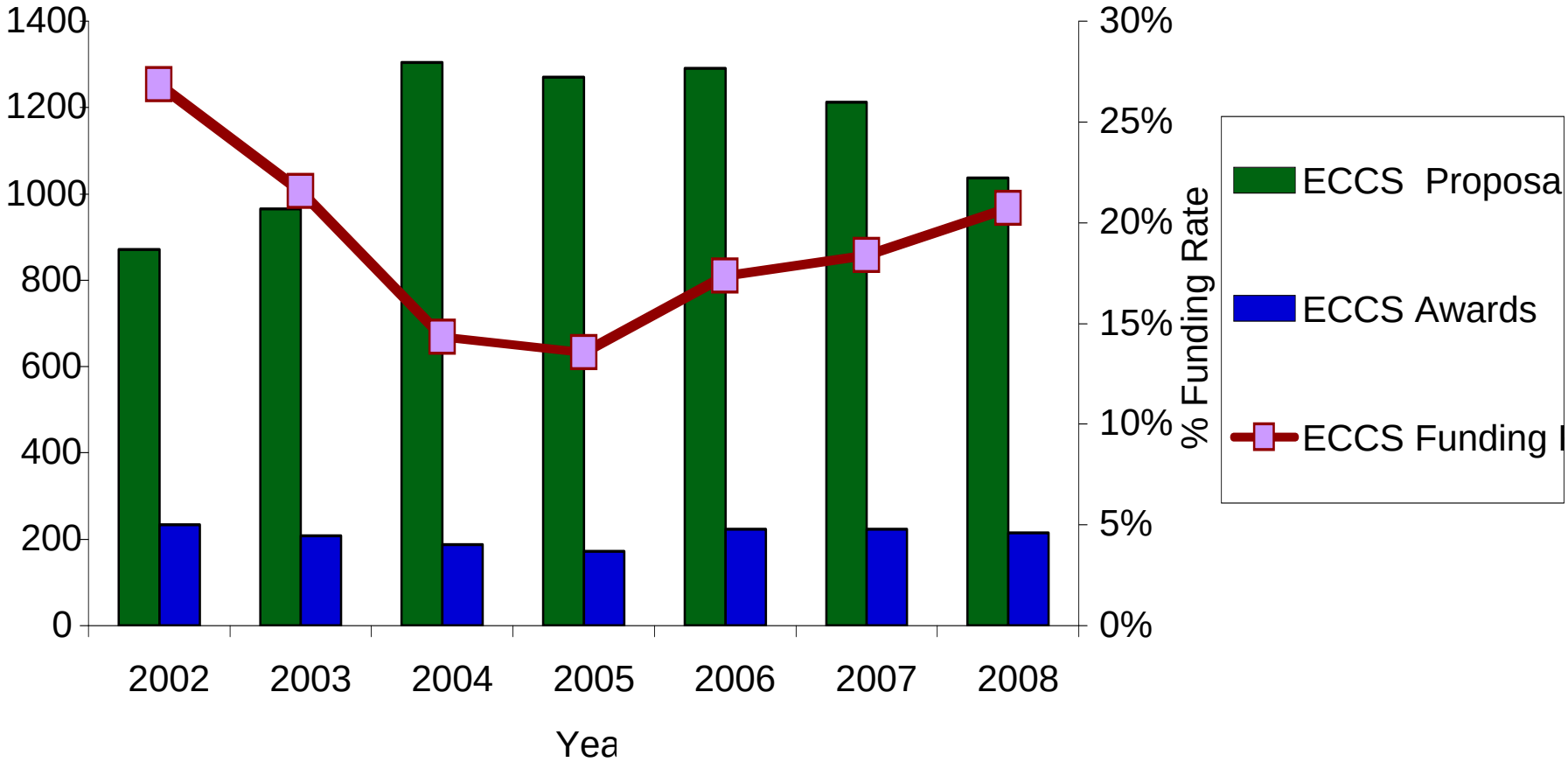
ECCS Mission

Address fundamental research issues at the nano, micro, and macro scales underlying device and component technologies, power and energy, controls, networks, communications, computation, and cyber technologies

Support integration of systems principles in intelligent engineering systems and networks for a variety of applications areas

Ensure education of a diverse workforce to meet the technological challenges of a 21st century global economy

Funding Rates – Research Grants



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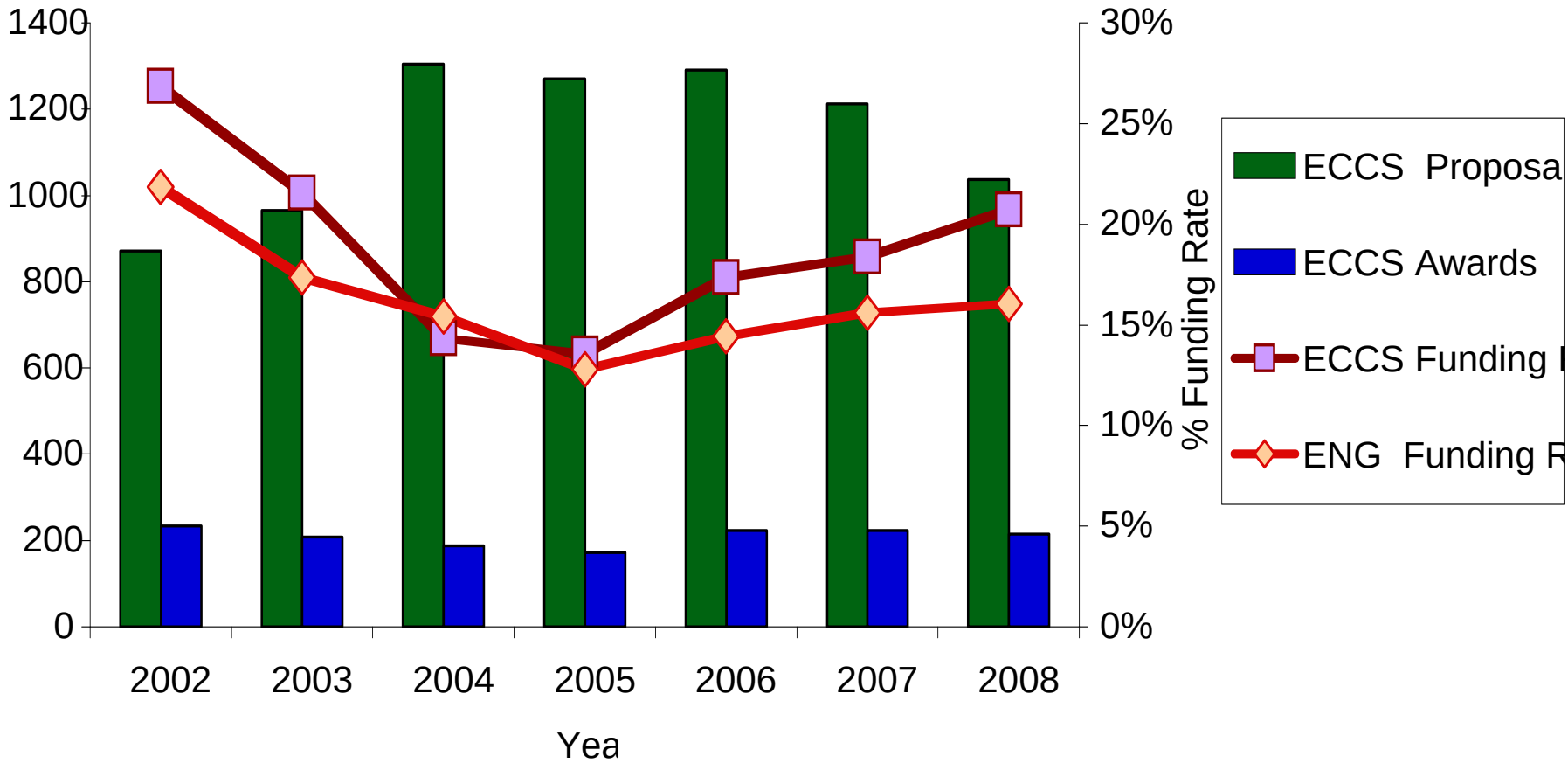

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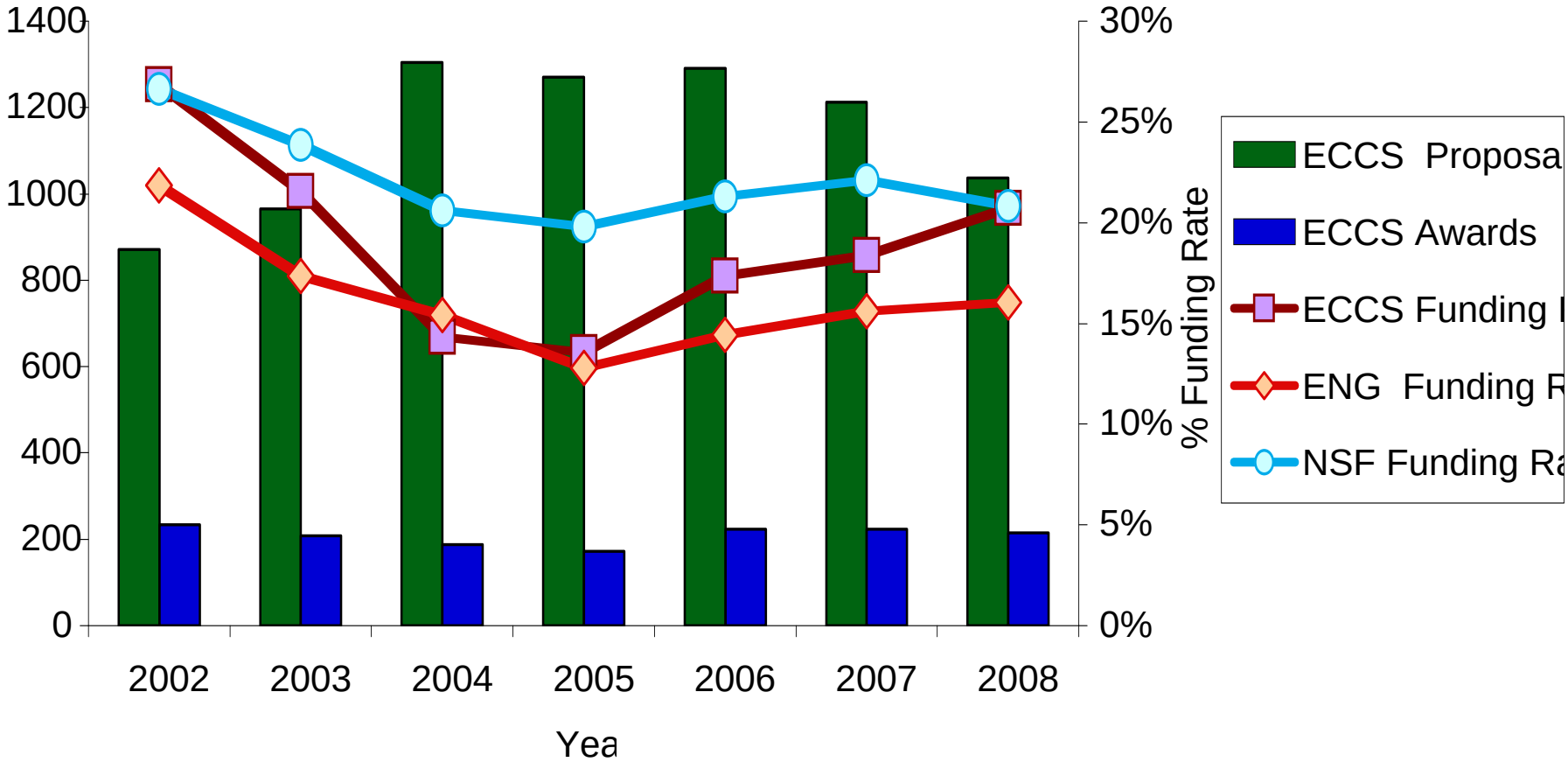
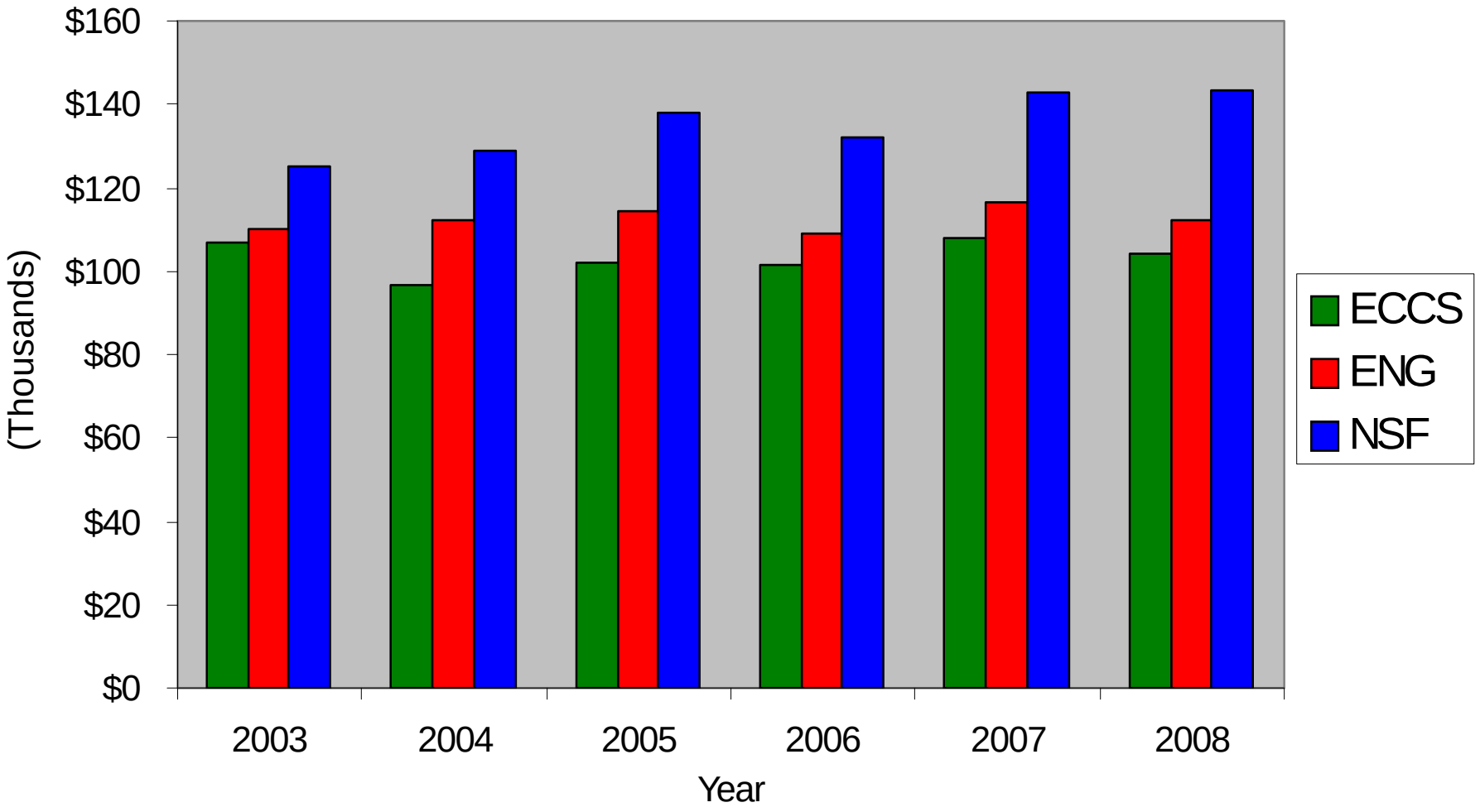
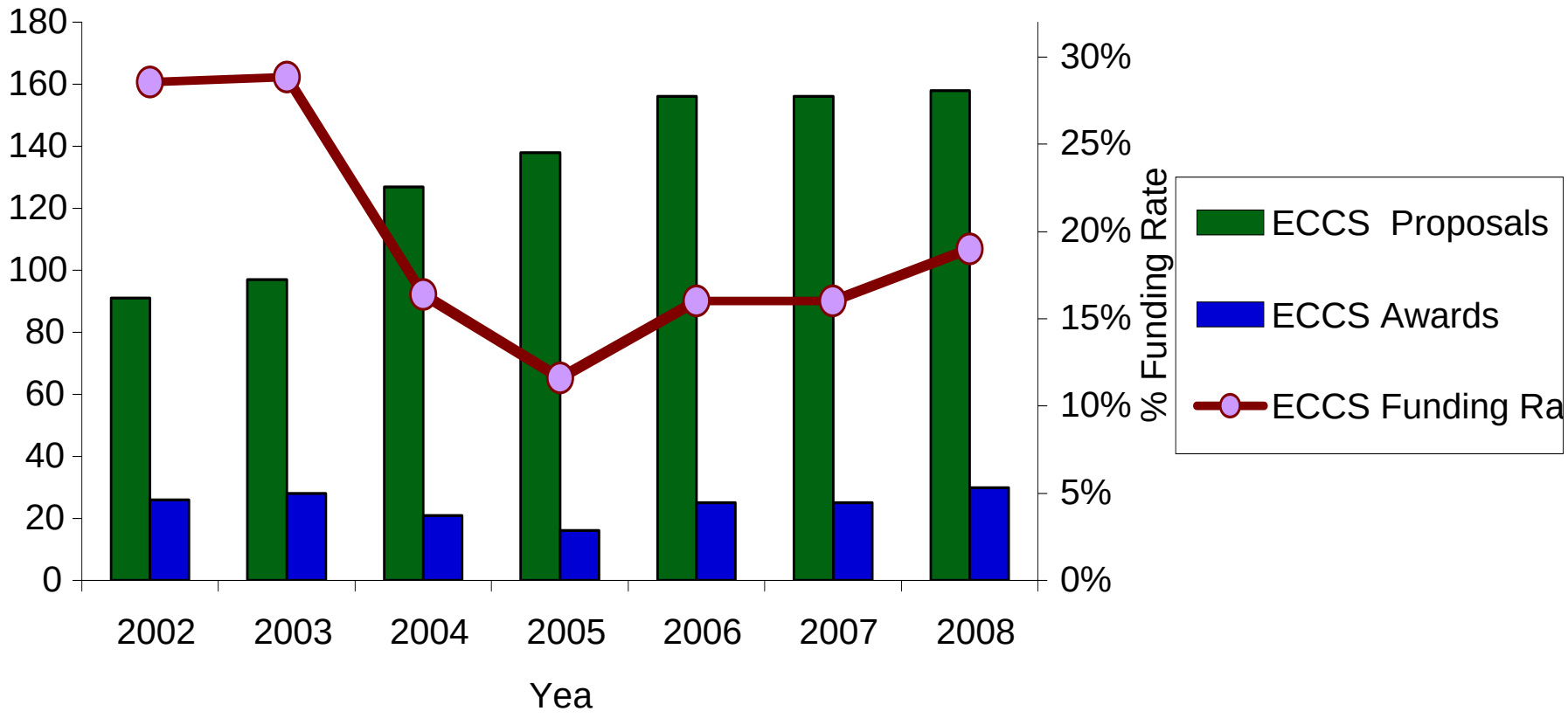


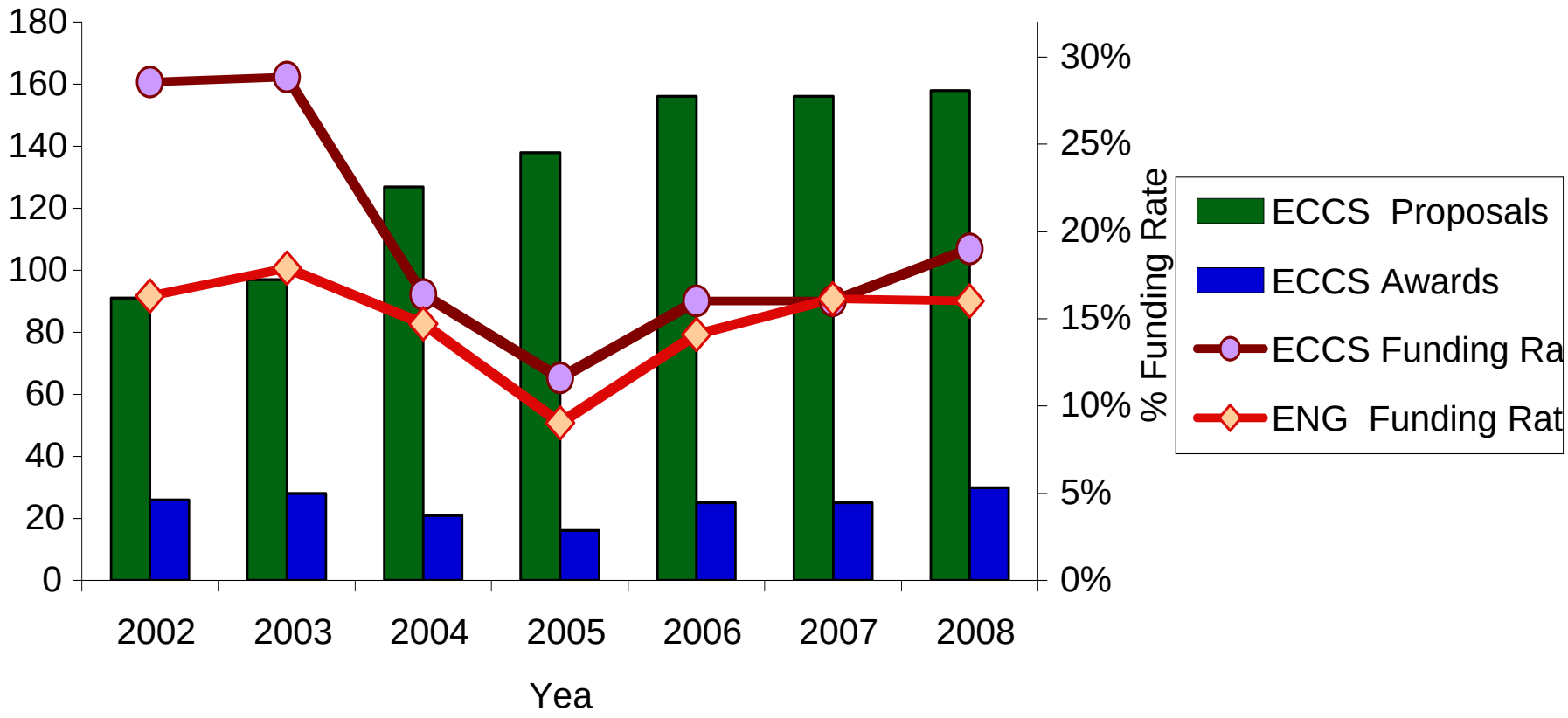
Award Size – Research Grants



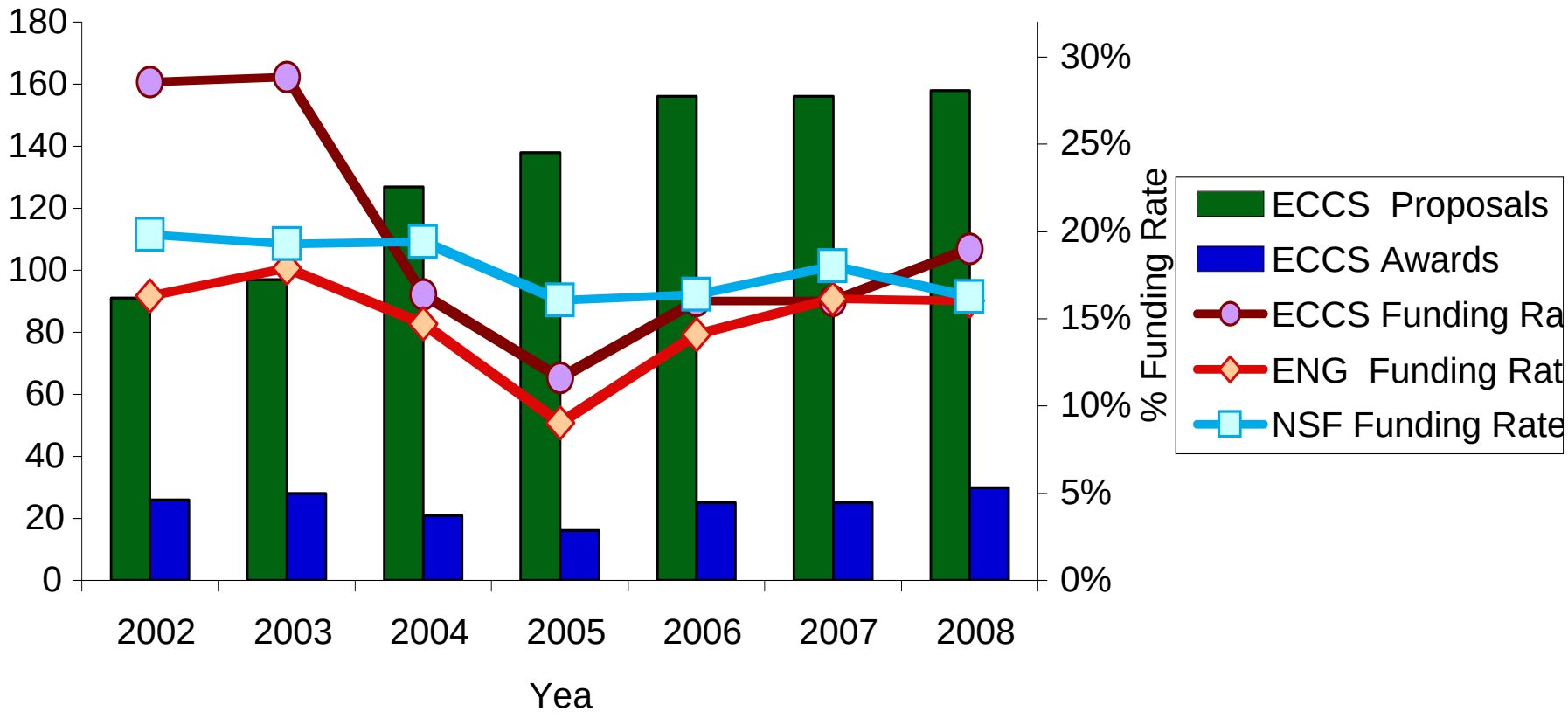
Funding Rates – CAREER Grants



Funding Rates – CAREER Grants



Funding Rates – CAREER Grants



ECCS Program Research Areas

Electronics, Photonics and Device Technologies (EPDT)

Optoelectronics;
Nanophotonics;
3D: Very Large-Scale Photonic Integration;
Ultrafast and Extreme UV Technologies
Dr. Eric Johnson

Micro/Nanoelectronics;
Bioelectronics;
NEMS/MEMS; Sensors
Dr. Rajinder Khosla

Molecular, Spin, Organic, Flexible Electronics;
Micro/Nanomagnetics;
Power Electronics
Dr. Pradeep Fulay

Microwave Photonics;
Millimeter, Sub-millimeter, and Terahertz Devices
Dr. Usha Varshney

Integrative, Hybrid and Complex Systems (IHCS)

Micro/Nano Integrative Systems;
Systems-on-a-chip;
Diagnostic and Implantable Devices and Systems
Dr. Yogesh Gianchandani

Optical, Wireless, and Hybrid Communications Systems;
Inter- and Intra-chip Communications;
Mixed Signal Analog-Digital Systems
Dr. Andreas Weisshaar

Cyber Physical Systems;
Next-Generation Cyber Systems;
Signal Processing
Dr. Scott Midkiff

Power, Controls and Adaptive Networks (PCAN)

Embedded, Distributed, and Adaptive Control;
Telerobotics;
Sensing and Imaging Networks; Systems Theory
Dr. Radhakisan Baheti

Power and Energy Systems and Networks;
Interdependencies on Critical Infrastructures;
Micro Grids; Power Drives;
Renewable and Alternative Energy Sources
Dr. Dagmar Niebur

Adaptive Dynamic Programming;
Neuromorphic Engineering;
Quantum and Molecular Modeling/Simulation of Devices and Systems
Dr. Paul Werbos

ENG Research and Education Themes FY 2008-2009

Convergence of fields, disciplines, and frontier research opportunities that cut across divisions – provide guidance on potential future directions of engineering research.

- Cognitive Engineering: Intersection of Engineering and Cognitive Sciences
- Competitive Manufacturing and Service Enterprises
- Complexity in Engineered and Natural Systems
- Energy, Water and the Environment
- Systems Nanotechnology

ENG Research and Education Themes

ECCS Emerging Research Emphases

- Cognitive Engineering: Intersection of Engineering and Cognitive Sciences
  - Reverse-Engineering the Brain (PCAN)
  - Embedded, Distributed and Adaptive Control (PCAN)
- Competitive Manufacturing and Service Enterprises
  - Green Engineering of Electronics and Photonics (EPDT)
  - Telerobotics and Adaptive Dynamic Programming (PCAN)
- Complexity in Engineered and Natural Systems
  - Interdependencies of Critical Infrastructures in Power and Communications (PCAN)
  - Cyber-Physical Systems (IHCS)
- Energy, Water and the Environment
  - Alternate Energy Sources and Integration into the National Grid (PCAN)
  - Micro/Nano Sensing Systems/Networks for Water and the Environment (ICHS)
- Systems Nanotechnology
  - Beyond Moore's Law Scaling: NanoElectronics/ Photonics/ Magnetics (EPDT)
  - Implantable Systems for Diagnostics and Drug Delivery (IHCS)
  - Quantum and Molecular Modeling/Simulation of Devices and Systems (PCAN)

Emerging Frontiers in Research and Innovation (EFRI)
ECCS Program Director Co-Leads

- FY 2007
  - Auto-Reconfigurable Engineered Systems (ARES) - (IHCS–Midkiff)
  - Cellular and Biomolecular Engineering (CBE)
- FY 2008
  - Cognitive Optimization and Prediction - From Neural Systems to Neurotechnology (COPN) - (PCAN–Werbos)
  - Resilient and Sustainable Infrastructures (RESIN) - (PCAN–Niebur)
- FY 2009 – (NSF 08-599; Letter of Intent: October 14, 2008)
  - Hydrocarbons from Biomass (HyBi) - (PCAN–Niebur)
  - BioSensing and BioActuation: Interface of Living and Engineering Systems (BSBA) - (IHCS–Gianchandani)

New Solicitations, Released FY2008

- Multicore Chip Design and Architecture – NSF 08-584 (IHCS–Gianchandani)
  - » Joint with CISE, ECCS, and Semiconductor Research Corp. (SRC)
    - Architectures, computer-aided design, interconnect and packaging technologies, low-power circuit techniques for multicore design
  - » Deadline: October 17, 2008

- Cyber-Physical Systems – NSF 08-611 (IHCS–Midkiff)
  - » Joint with CISE and ECCS
    - Computation and communication, tightly coupled with engineered systems to improve robustness, performance, efficiency in dynamic environments
  - » Deadline: February 27, 2009

NSF-SIA/NRI Graduate Student and Postdoctoral Fellow Supplements to NSF Centers in Nanoelectronics, FY2006-2008

- NSF cooperation with the Semiconductor Industry Association (SIA) – through the Industry's Nanoelectronics Research Initiative (NRI)
  - Help strengthen Industry linkages with NSF Centers
  - Industry assignees work collaboratively with students and postdocs
- Explore new concepts beyond the scaling limit of CMOS technology
  - Novel non-charge based logical switch as a successor to CMOS
  - Novel architectures for efficient computation with post-CMOS devices.
- $2M funds invested each year – FY2006, FY2007, FY2008
  - $1 million NSF (ENG, MPS, CISE); $1 million NRI
  - Average award size $300-500K for a duration of 3 years
  - 18 supplement awards at 12 NSF Centers – NCN, NSECs, MRSECs
- At Dec 2007 NRI annual review, industry members expressed great benefit in their collaborations with NSF-supported university researchers

ECCS Focused Workshops, FY2007-2009

FY2007

- Wearable and Implantable Devices and Systems for Health Monitoring and Diagnostics (w/USDA, FDA, NIH/NIBIB), NSF (EPDT–Khosla)
- Future Power Engineering Workforce (w/EEC, DUE), NSF (PCAN–Niebur)
- Very Large-Scale Photonic Integration, NSF (EPDT–Hui [Johnson])
- Quantum and Molecular High Performance Modeling and Simulation of Devices and Systems, NSF (PCAN–Werbos)

FY2008

- Workshop on Advanced Power Conditioning for Alternate Energy Systems, (w/NIST, DoE, US Army), NIST, MD (PCAN–Niebur)
- Drug Discovery Approach to Breakthroughs in Batteries (w/DoE, DARPA, GM), MIT, Boston, MA (PCAN–Werbos)

FY2009

- Self-Organizing Wireless Networks Based on Cross-Layer Interactions (w/OISE, Australian Research Council), Sydney, Australia (IHCS–Midkiff)
- Flexible Electronics, WTEC study in Europe, Asia (w/CMMI, MPS/DMR, AFOSR, NIST, ARL), Planned (EPDT–Fulay, Varshney)
- Challenges of Integrated Spin Electronics Systems, NSF, Planned (EPDT–Varshney, Fulay)
- Cyber-Physical Systems for Power and Energy (w/CISE/CNS), NSF, Planned (IHCS/PCAN–Midkiff, Niebur)
- Challenges in Science and Engineering Beyond Moore's Law (w/MPS/DMR, SRC), NSF (EPDT–Varshney, Khosla, Goldberg)

ECCS Workshop – "Drug Discovery Approach to Breakthroughs in Batteries", Sep 2008 at MIT

- Focus: Cross-disciplinary research to maximize the probability of breakthrough battery designs, suitable at low cost for plug-in hybrid cars.
- Motivation: IEEE white paper argues that fuel-flexible plug-in cars offer best near-term hope for reducing dependence on oil imports, but the high cost of batteries for new cars like the GM Volt is the main obstacle.
- Sponsors: ECCS; Participation from DOE, DARPA, GM; strong encouragement from OSTP. (PCAN–Werbos, Niebur)
- Key findings:
  - The "design space" is very large, and poorly explored.
  - Systematic exploration using computational approaches now used in the pharmaceutical industry show great promise (quantum modeling, learning from data, stochastic search).
  - New lifetime analysis, catastrophic safety analysis, and open-source models for battery management systems are also needed.

Proposed Study by National Academy of Sciences: **Photonics for 21st Century Competitiveness**

- In 1998, NAS-NRC released landmark report, *Harnessing Light: Optical Science and Engineering for the 21st Century*, supported by NSF (ENG, PHY), DARPA, NIST
  - Report guided *Photonics 21* activities overseas – Germany, UK, Korea
- Identify new technological opportunities and recent advances in the field
  - Telecommunications, solar energy and lighting, environmental sensing, biophotonics, imaging and microscopies, national security, ...
- Assess trends in public and private research, market needs
  - Role of university–industry interactions
  - Innovation and competitiveness, including small businesses
  - Manufacturing infrastructure, affect on the national economy, ...
- Identify near-term and long-range goals to improve economic and scientific competitiveness in photonics science and technology
  - Define research Grand Challenges to fill technological gaps
- Agencies // Organizations: NSF (ENG Lead), DARPA, DOE, DHS, NIH // OSA, SPIE, IEEE-LEOS, OIDA, SRC

ECCS Lead Oversight for NSF Networks, Centers, Partnerships

- NNIN: National Nanotechnology Infrastructure Network, Cornell (Goldberg)
- NCN: Network for Computational Nanotechnology, Purdue U. (Khosla)

- STC: Nanobiotechnology Center, Cornell U. (Goldberg)
- ERC: Center for Integrated Access Networks, U. Arizona (Goldberg)
- ERC: Wireless Integrated Microsystems, U. Michigan (Weisshaar)
- NSEC: Center for Nanoscale Systems, Cornell U. (Varshney)
- SLC: Center of Excellence for Learning in Education, Science and Technology, Boston U. (Baheti)
- I/UCRC: Center for Radio Frequency Systems, Ohio State U. (Weisshaar)
- I/UCRC: Telecommunications Systems, U. of Hawaii (Weisshaar)

- PTAP: Photonics Technology Access Program, NSF, DARPA (Goldberg)

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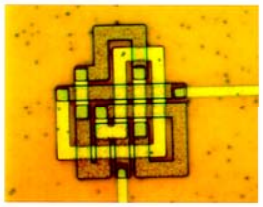
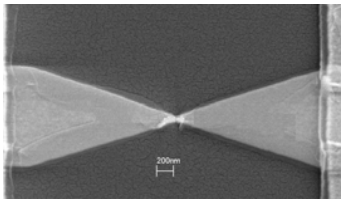
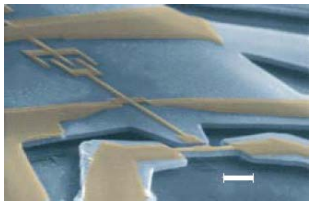
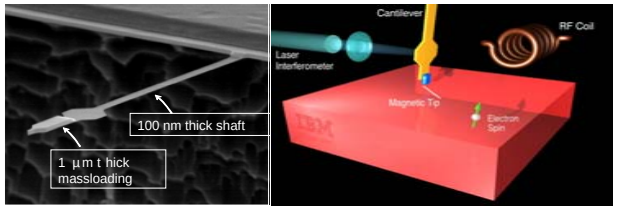
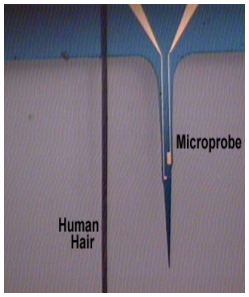
National Nanotechnology Infrastructure Network (NNIN)

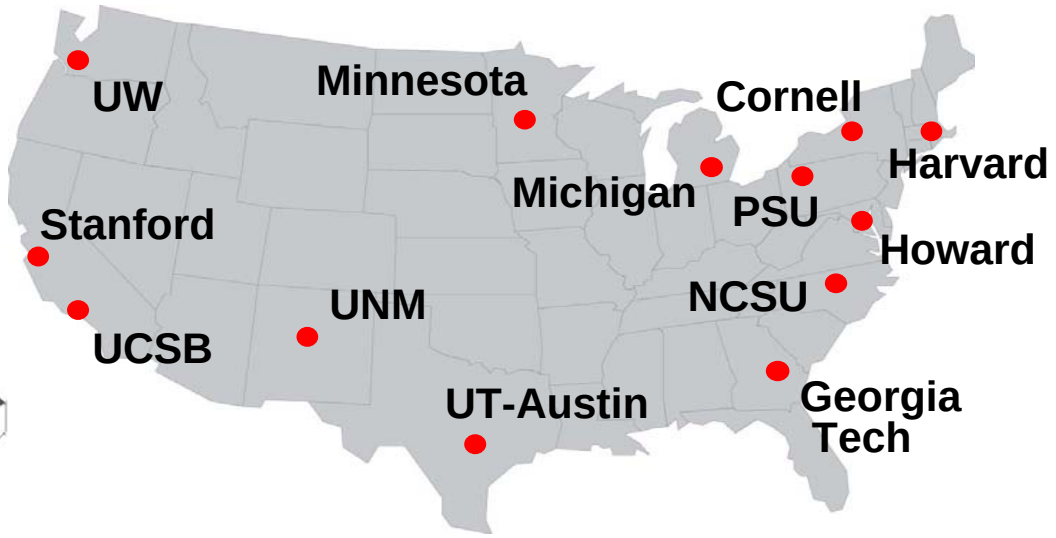


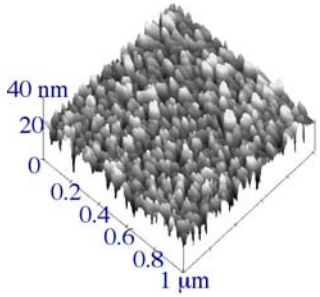












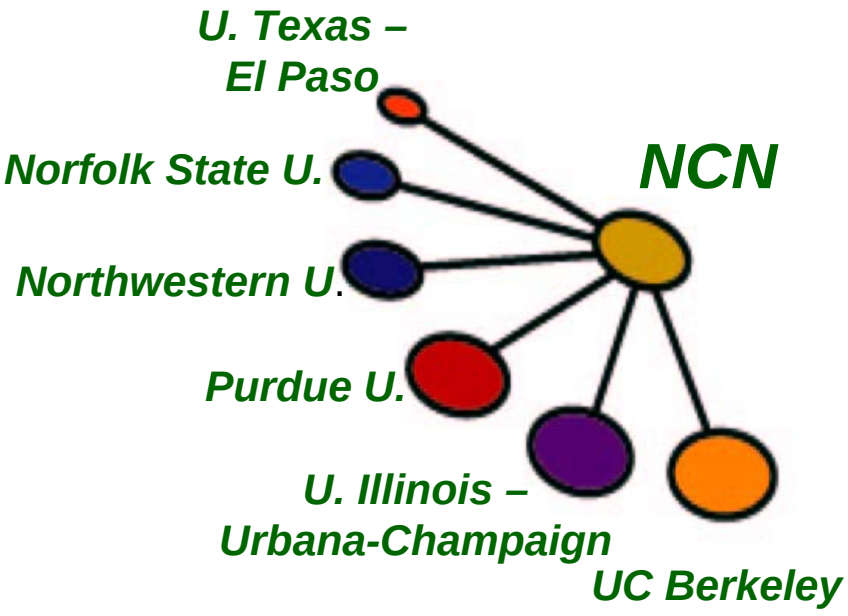
Cornell U. (Lead)
Stanford U.
U. of Michigan
Georgia Institute of Technology
U. of Washington
Pennsylvania State U.
U. of California – Santa Barbara
U. of Minnesota
U. of New Mexico
U. of Texas – Austin
Harvard U.
Howard U.
North Carolina State U.

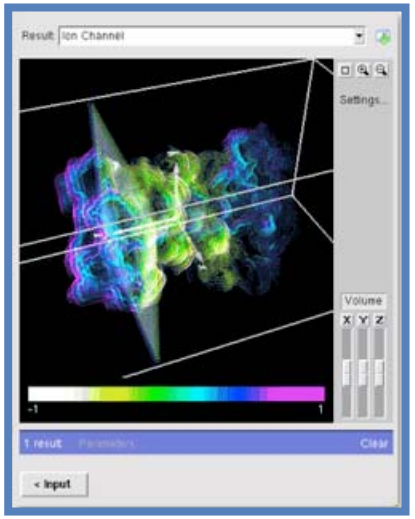
An integrated national network of user facilities providing researchers open access to resources, instrumentation and expertise in all domains of nanoscale science, engineering and technology

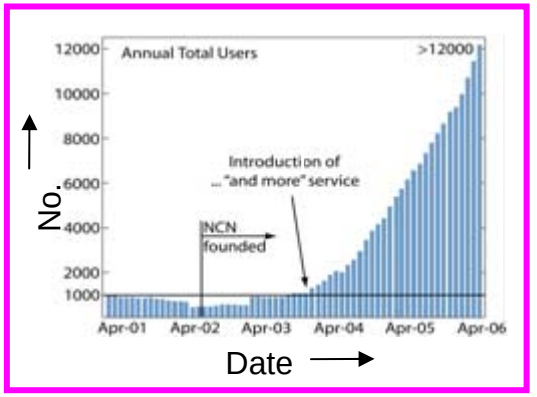
http://www.NNIN.org

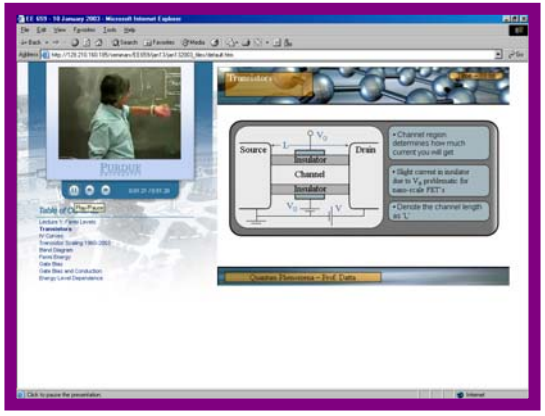
Network for Computational Nanotechnology (NCN)

A National resource to accelerate the transformation of nanoscience to nanotechnology through theory, modeling and simulation, and collaboration enabled by cyberinfrastructure









NSF Infrastructure and Research Network

www.nanoHUB.org

Division Responses to 2005 COV Report

- Discretionary award size is decreasing over time in both absolute and inflation-adjusted dollars
  - ECCS increased average three-year grant size of unsolicited proposals by 10% annually from $210,000 in FY 2004 … to $270,000 in FY 2006 to $300,000 in FY 2007, and we expect to increase the grant size to $330,000 in FY 2008.
  - ECCS funded a limited number of unsolicited group proposals up to $450,000 to promote interdisciplinarity. Division Director discretionary funds were used as incentives.
- CAREER award funding rate has declined from 29% in 2002 to only 16% in 2004 and is continuing to decline
  - CAREER proposal-funding rate was increased from 11.6% in FY 2005 to 16% in FY 2006 and FY 2007, and 19% in FY 2008.
- COV encouraged the Division, ENG Directorate and the Foundation to enhance mechanisms for the support of innovative projects
  - ECCS increased investments in SGER by 65% in FY 2005, 96% in FY 2006, and 92% in FY 2007 over FY 2004. Division Director's discretionary funds were used as incentives.

Division Responses to 2005 COV Report

- COV suggested emphasis on bioelectrical devices, subsystems, and systems biology
  - ECCS made a significant increase in investments in bioelectronics devices and systems through the EPDT and IHCS programs.
- COV suggested emphasis on signal processing and systems theory
  - ECCS placed emphasis on signal processing algorithms and systems theory through the IHCS and PCAN programs.
- GOALI awards in the portfolio have excellent industrial interaction, but low level of follow-up.
  - ECCS organized its first 2006 Grantees' Workshop, which was very successful in evaluating accomplishments and assessing the current status of GOALI collaborations with industrial partners.
- COV encouraged the Division to increase diversity of the panels (gender, ethnicity, racial, geographical, institutional)
  - Division Director encouraged ECCS PDs to increase diversity in panel composition.
  - ECCS has tracked panel statistics by having PDs observe and record the aggregate composition of each review panel.