National Science Foundation

Overview of NSF's Program in

Power, Controls and Adaptive Networks

Dagmar Niebur

Program Director for Power, Controls and Adaptive Networks (PCAN)
Division of Electrical, Communications and Cyber Systems (ECCS)
National Science Foundation (NSF)
www.nsf.gov

dniebur@nsf.gov

NSF Mission and Vision

The National Science Foundation Act of 1950 (Public Law 81-507) set forth

NSF's mission and purpose:

To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense....

The Act authorized and directed NSF to initiate and support:

- basic scientific research and research fundamental to the engineering process,
- programs to strengthen scientific and engineering research potential,
- science and engineering education programs at all levels and in all the various fields of science and engineering,
- programs that provide a source of information for policy formulation,
- and other activities to promote these ends.

NSF Vision

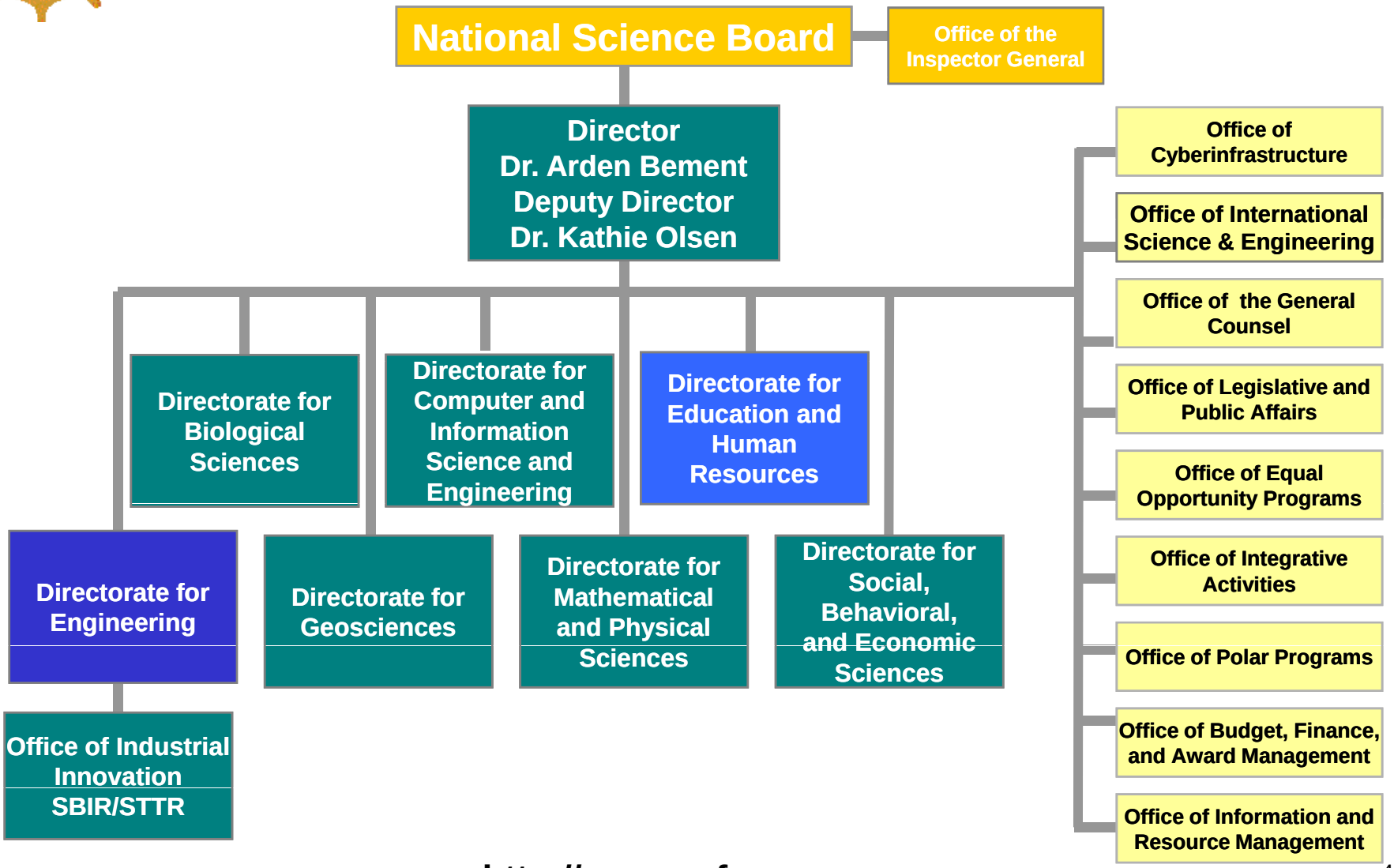
The National Science Foundation is a catalyst for progress through investment in science, mathematics, and engineering.

Guided by its longstanding commitment to the highest standards of excellence in the support of discovery and learning, NSF pledges to provide the stewardship necessary to sustain and strengthen the Nation's science, mathematics, and engineering capabilities and to promote the use of those capabilities in service to society.

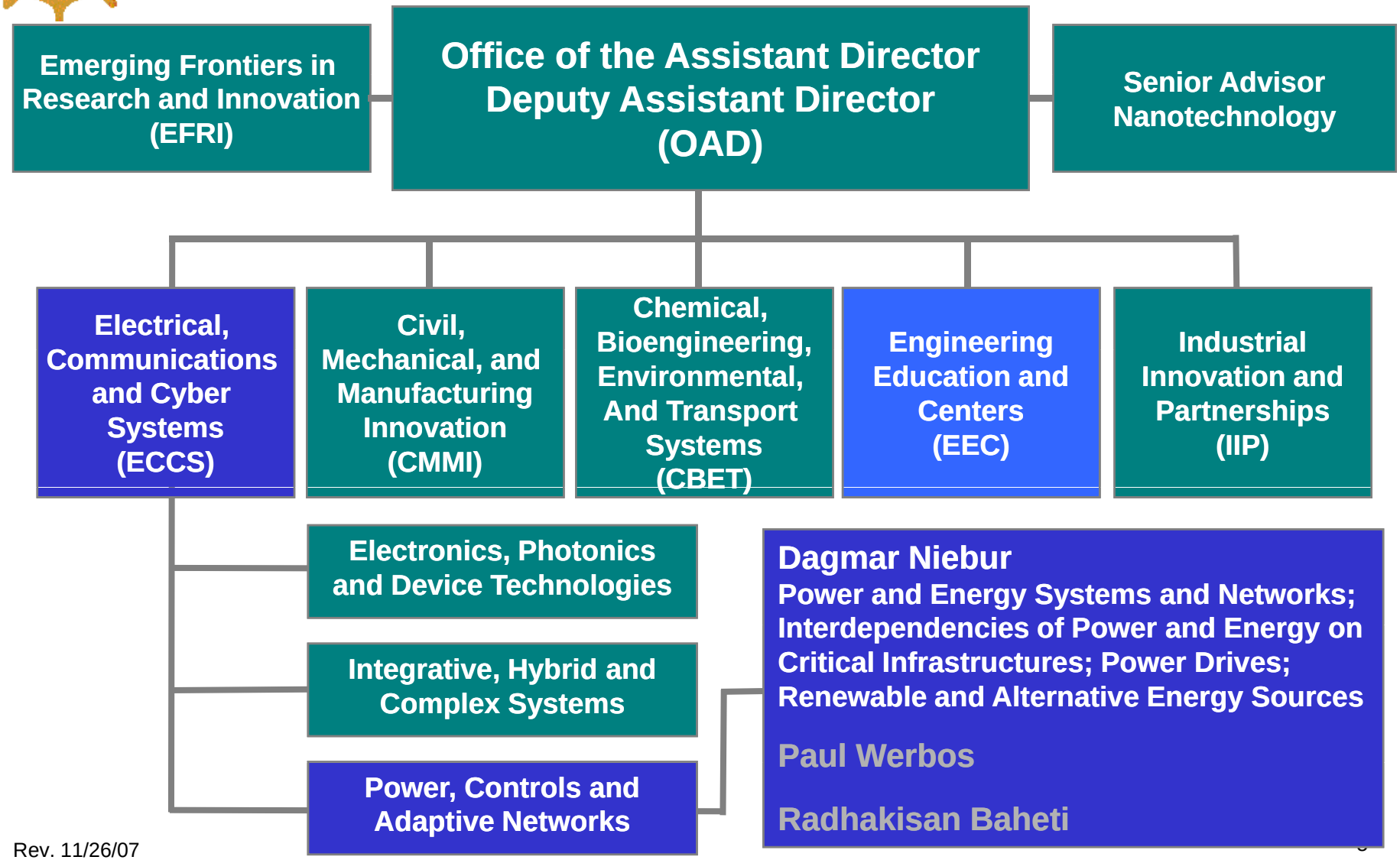
NSF in a Nutshell

- Independent USG Agency
- Funds basic research & education
- Uses peer-review in selecting proposals to fund
- Low overhead; highly automated grant management processes
- Discipline-based structure complemented by cross-disciplinary mechanisms
- Bottom-up proposal driven
- Use of Rotators/IPAs
- Overseen by National Science Board

NSF Organizational Structure



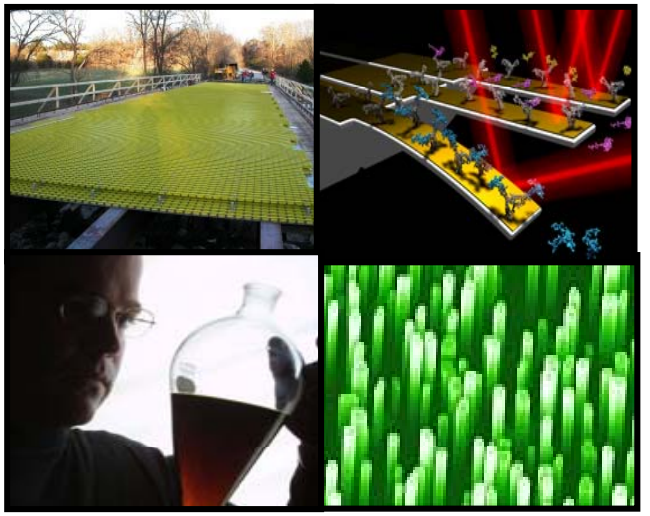
NSF Directorate for Engineering



Directorate for Engineering

Research and Education Themes FY 2007 – FY 2008

- **Rationale for themes**
  - facilitate convergence of fields, disciplines, and frontier opportunities
  - crosscut solicitations and divisions
  - provide guidance on the potential future directions of engineering research.
- **Theme designations will evolve over time, reflecting**
  - the maturation of certain fields,
  - the emergence of new fields, and
  - the shift in demand from society for significant progress on grand challenges.



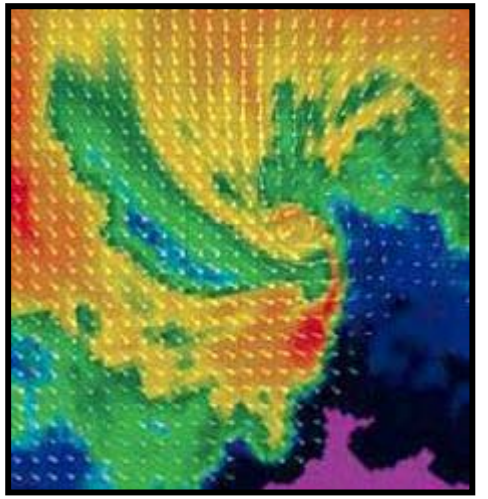
Engineering spans the frontiers – from nanotechnology to alternative energy and complex systems.

1. **Complex Engineered and Natural Systems**
2. **Energy and the Environment**
3. **Innovation**
4. **Manufacturing Frontiers**
5. **Nanotechnology**

Directorate for Engineering

R&E Theme: Complex Engineered and Natural Systems

- **Addresses unifying principles that enable modeling prediction, and control of emergent behavior in complex systems.**
- **Directly impacts a number of specific ACI research goals, including**
  - **materials for improving structural performances during natural disasters,**
  - **overcoming barriers to quantum information processing**
  - **world-leading automation and control technologies.**



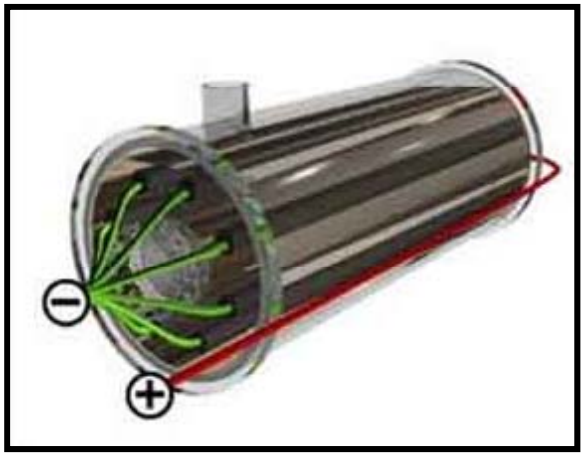
Algorithm simulates complex tornado behavior.

- **ENG will support research that enhances our ability to understand:**
  - **Natural Systems (e.g., ocean/atmosphere interactions, protein folding)**
  - **Engineered Systems (e.g., critical infrastructure, nanoscale self-assembly)**
  - **Interface of Natural and Engineered Systems (e.g., brain/machine interface, DNA-based computers).**

Directorate for Engineering

R&E Theme: Energy and the Environment

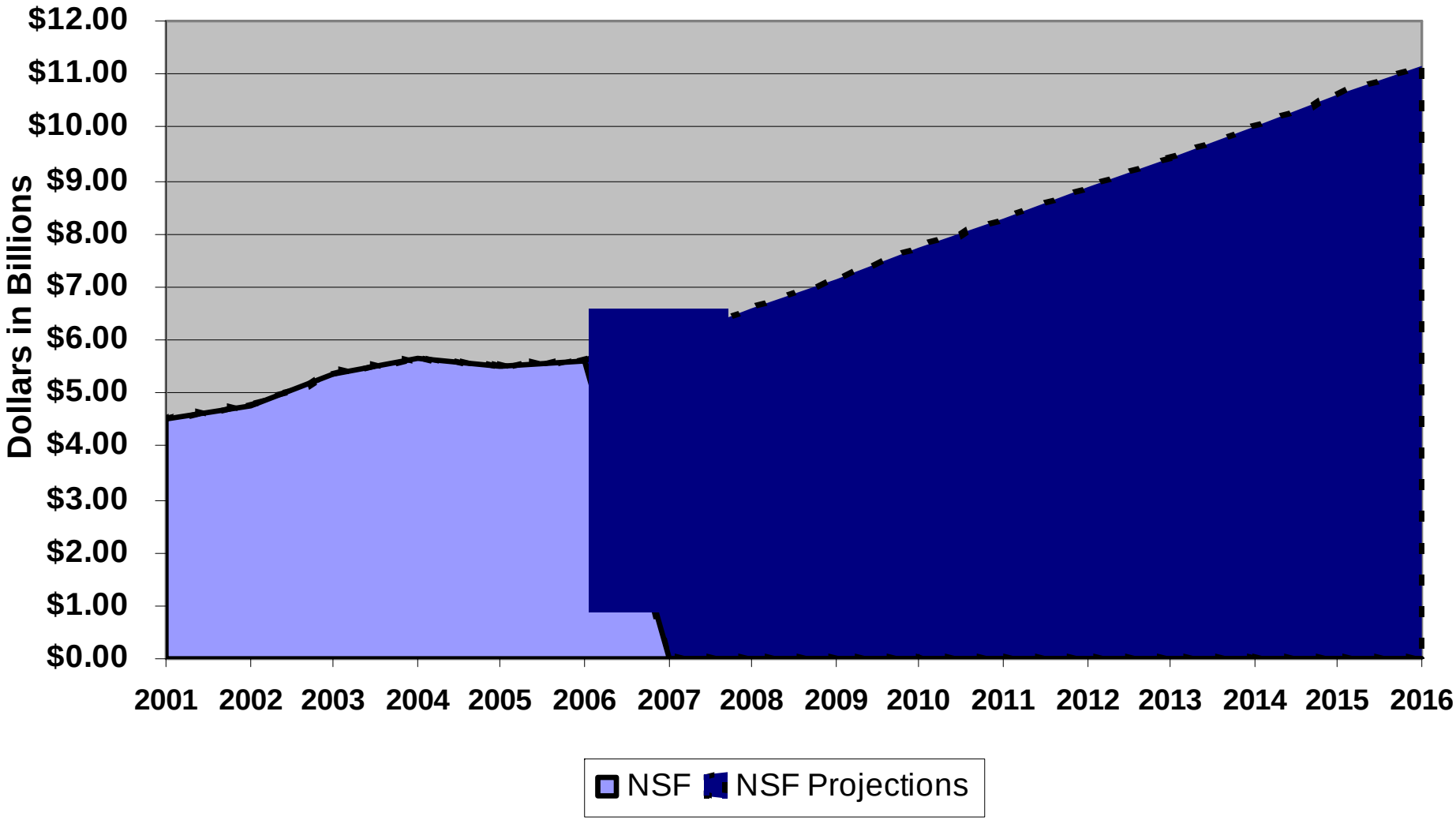
- **Frontier research to improve the cost, sustainability, and security of our nation's energy system. Topics**
  - include biofuels, hydrogen production, and solar and fuel cells.
  - closely align with the ACI goals of hydrogen and solar energy, and research critical to alternative energy.



Bacterial fuel cell that produces electricity as it cleanses wastewater.

- **ENG will support research that improves costs, sustainability, and security of global energy system, including:**
  - Performing fundamental research to discover new methods of energy conversion and distribution
  - Understanding reaction pathways for energy systems
  - Developing quantitative understanding of energy/environment interactions – including water – at the impact of these systems on society
  - Evaluating energy workforce needs, and stimulating evolution of education programs

ACI-Driven NSF Budget Projections



FY 2006 through FY 2016 budgets are estimates based on White House data.

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 scale
- 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

EPDT

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

EMERGING

- Alternate Energy Sources in the National Grid (InterGrid)
- Flexible Electronics
- Hybrid Communications Systems
- Interdependencies of Critical Infrastructure in Power and Communications
- Nanoelectronics, Nanophotonics and Nanomagnetics
- Neuromorphic Engineering
- Quantum and Molecular Modeling and Simulation of Devices and Systems
- Very Large-scale Photonic Integration
- Wearable and Implantable Devices and Systems

PCAN

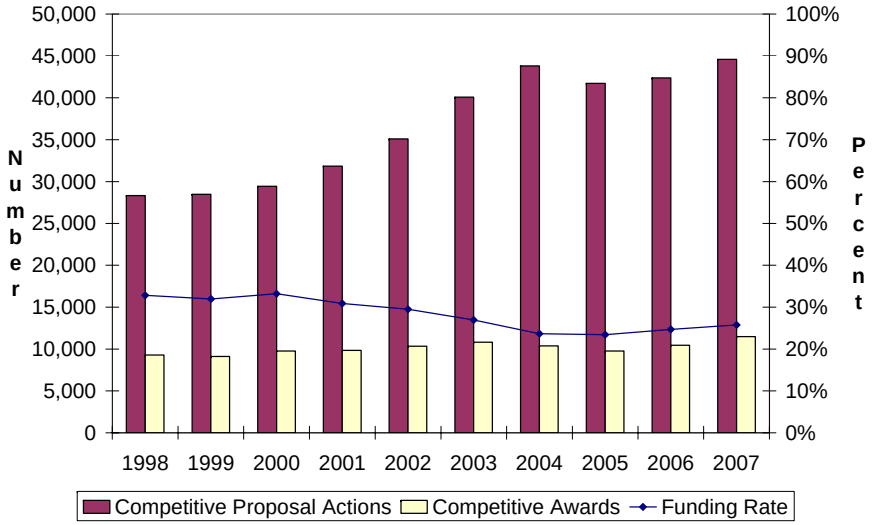
- ✓ Adaptive Dynamic Programming
- ✓ Alternate Energy Sources
- ✓ Embedded, Distributed and Adaptive Control
- ✓ Neuromorphic Engineering
- ✓ Power and Energy Systems & Networks
- ✓ Quantum and Molecular Modeling & Simulation of Devices and Systems
- ✓ Sensing and Imaging Networks
- ✓ Telerobotics

IHCS

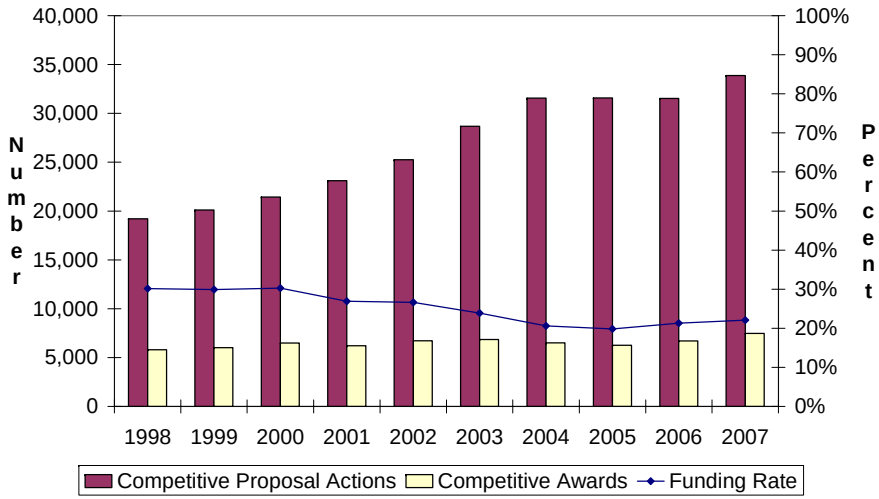
- ✓ Cyber Systems
- ✓ Signal Processing
- ✓ Nano and Microsystems
- ✓ Communications Systems

NSF Funding Rates

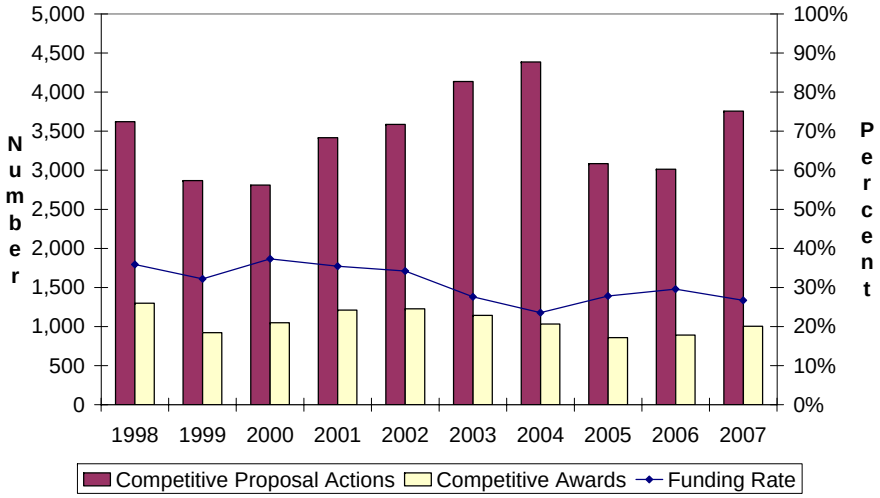
NSF Funding Rate for Competitive Awards



NSF Funding Rate for Competitive Awards - Competitive Research Grants

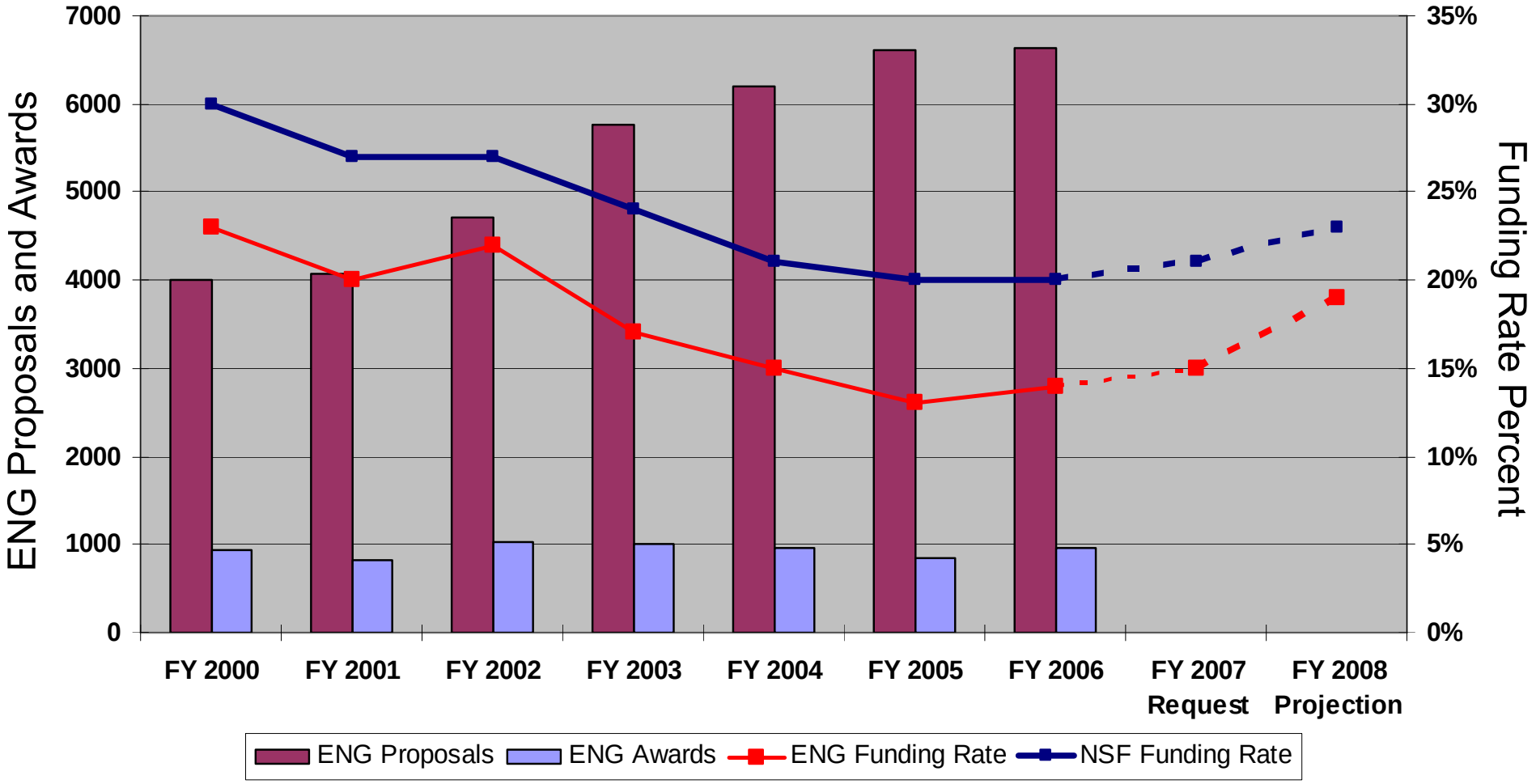


NSF Funding Rate for Competitive Awards -Edu + Training



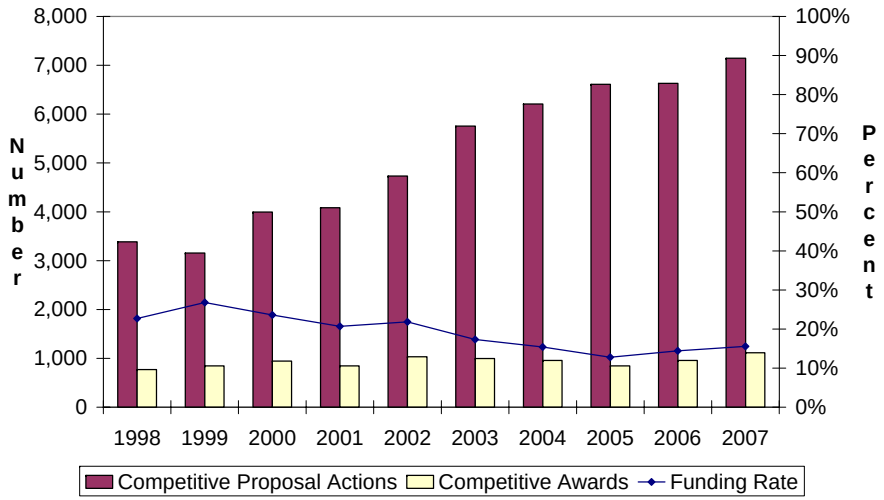
ENG and NSF Funding Rates

Research Grants

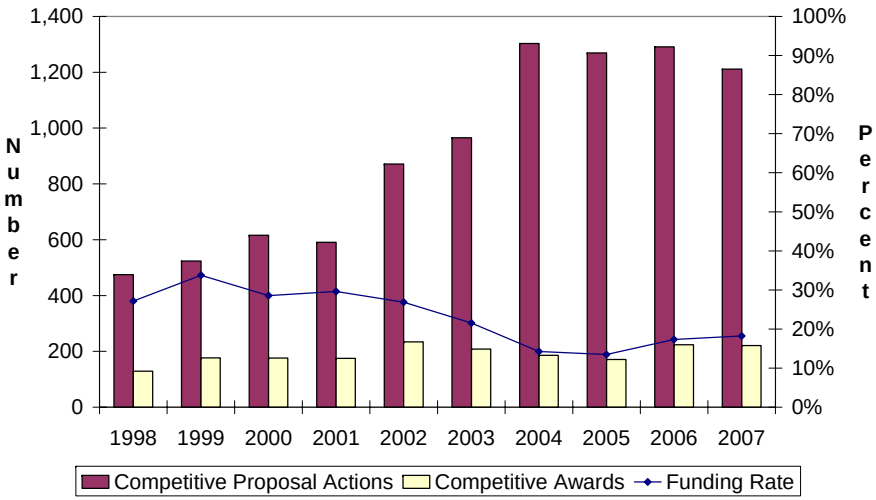


ENG and ECCS Funding Rate

Funding Rate for Competitive Awards - Competitive Research Grants in 07 ENG

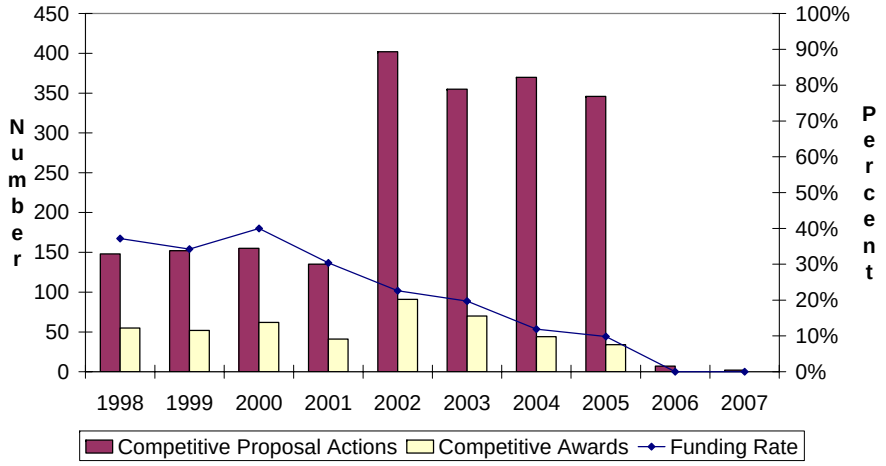


Funding Rate for Competitive Awards - Competitive Research Grants in 07 ENG in 0701 ECCS

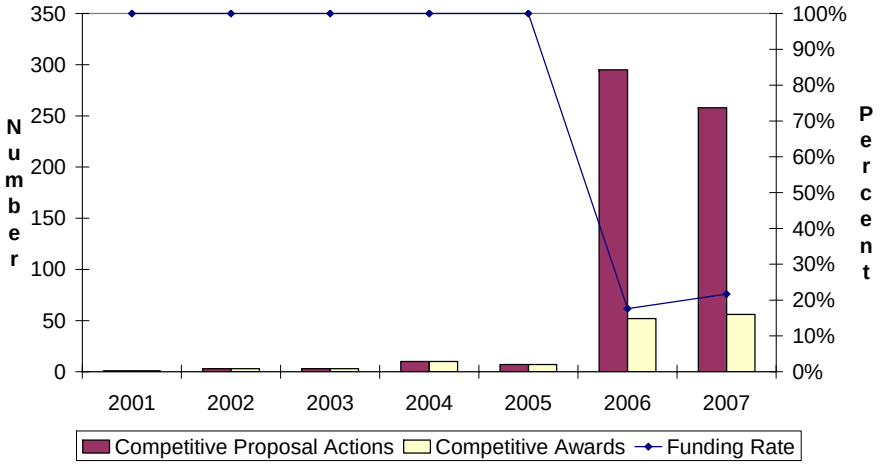


Funding Rates for 1518 and 7607

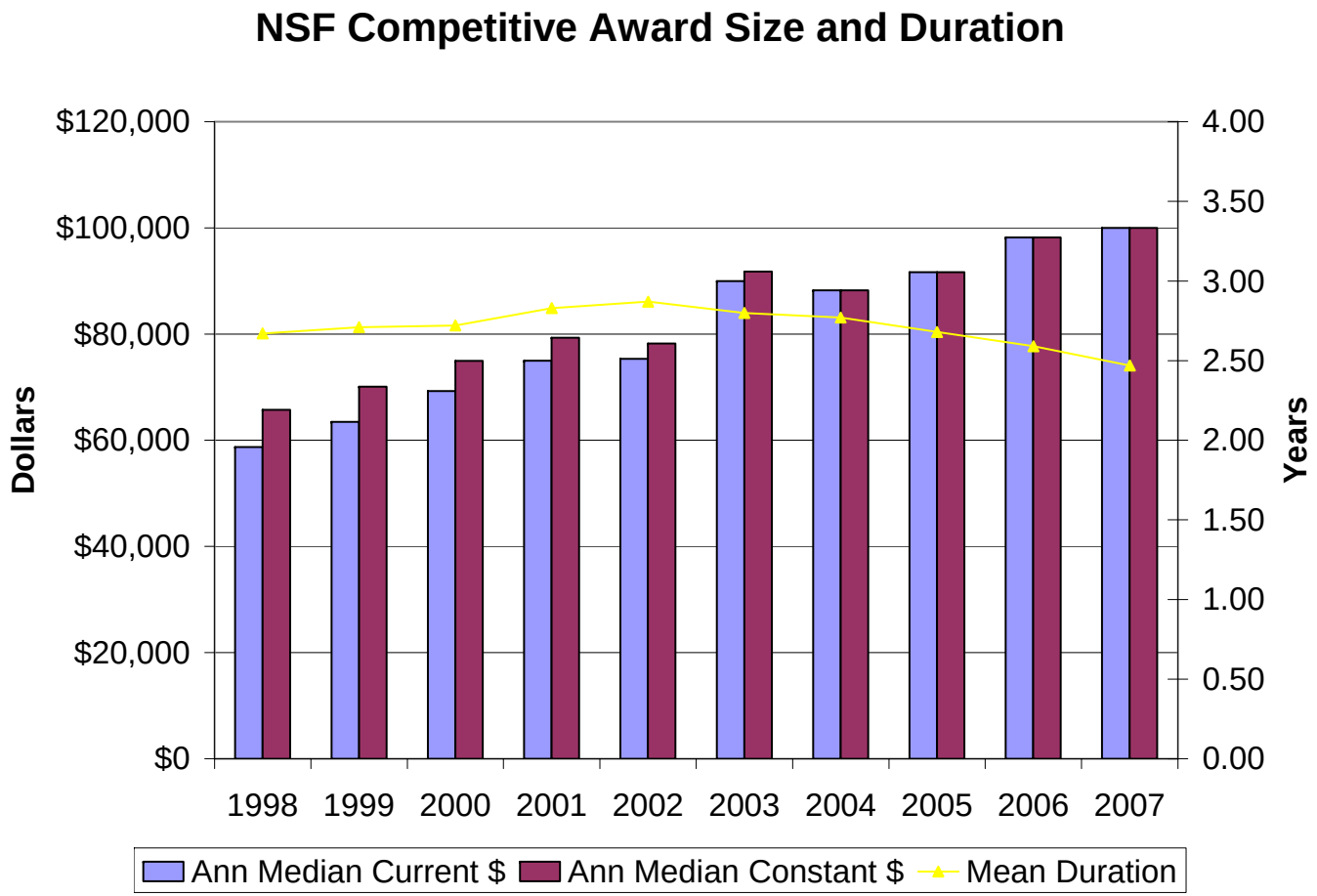
Funding Rate for Competitive Awards - Competitive Research Grants in 07 ENG in 0701 ECCS in 1518 CONTROL, NETWORKS, & COMP INTE



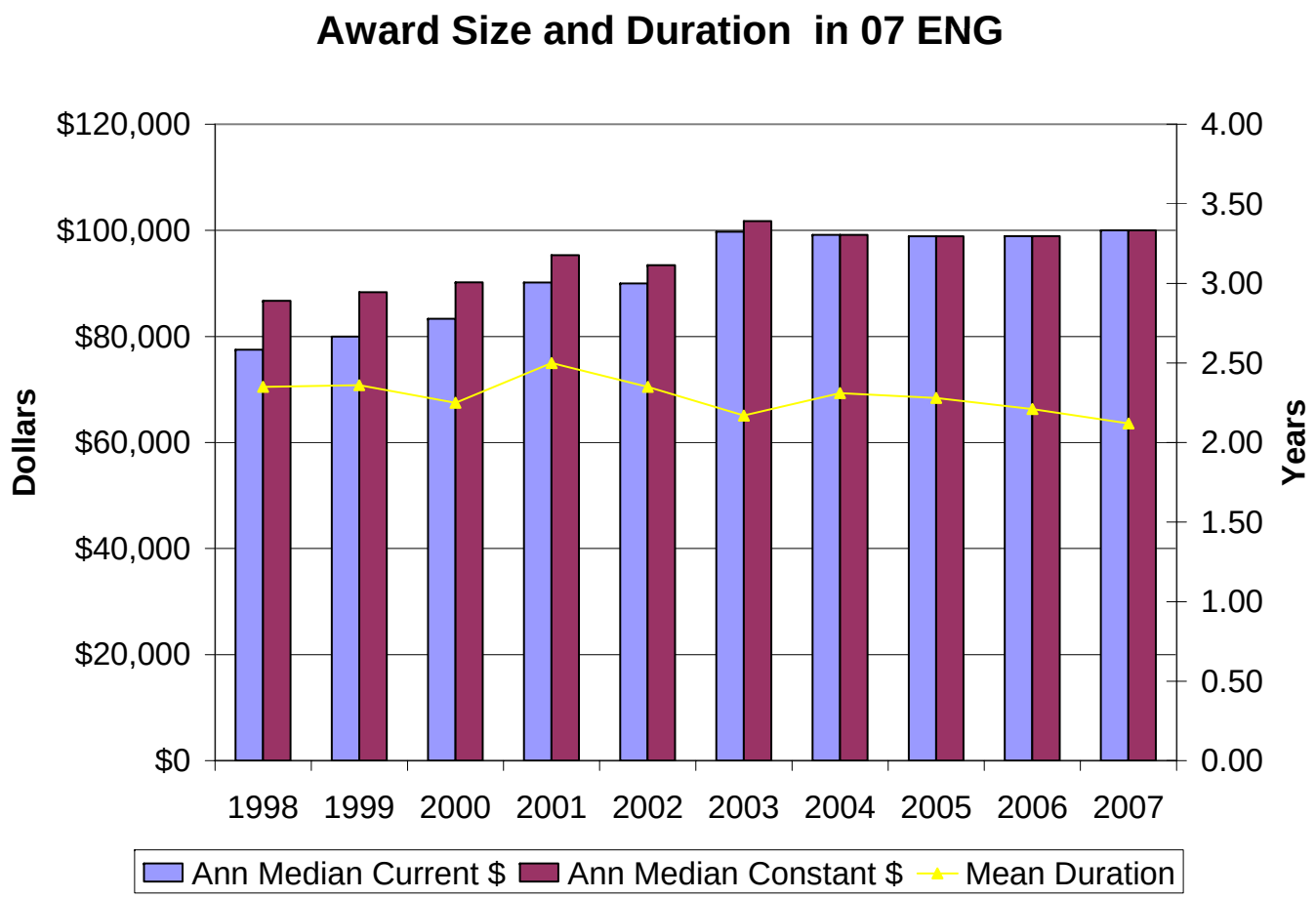
Funding Rate for Competitive Awards - Competitive Research Grants in 07 ENG in 0701 ECCS in 7607 POWER, CONTROLS & ADAPTIVE NET



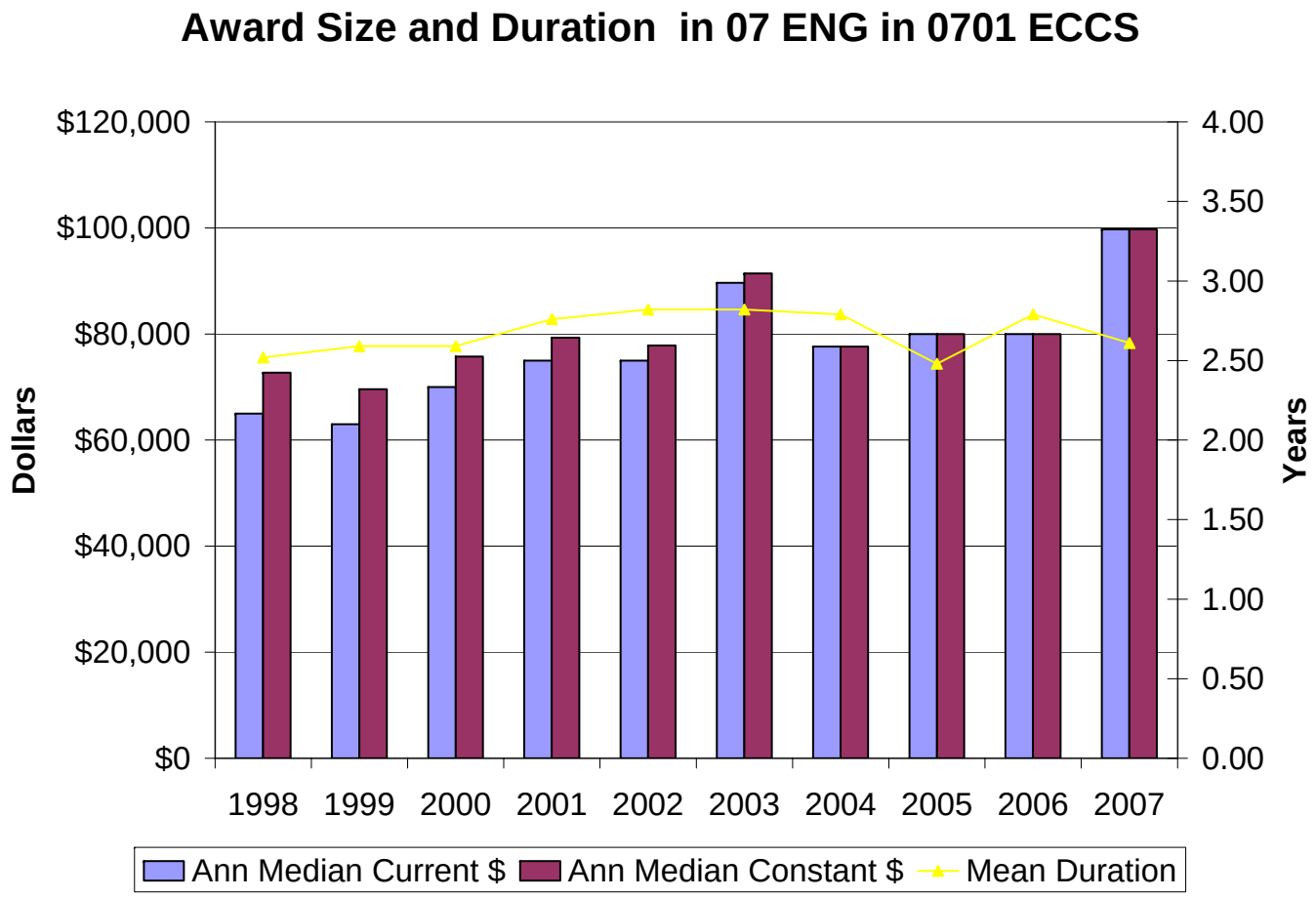
NSF Competitive Award Size and Duration



Award Size and Duration in 07 ENG

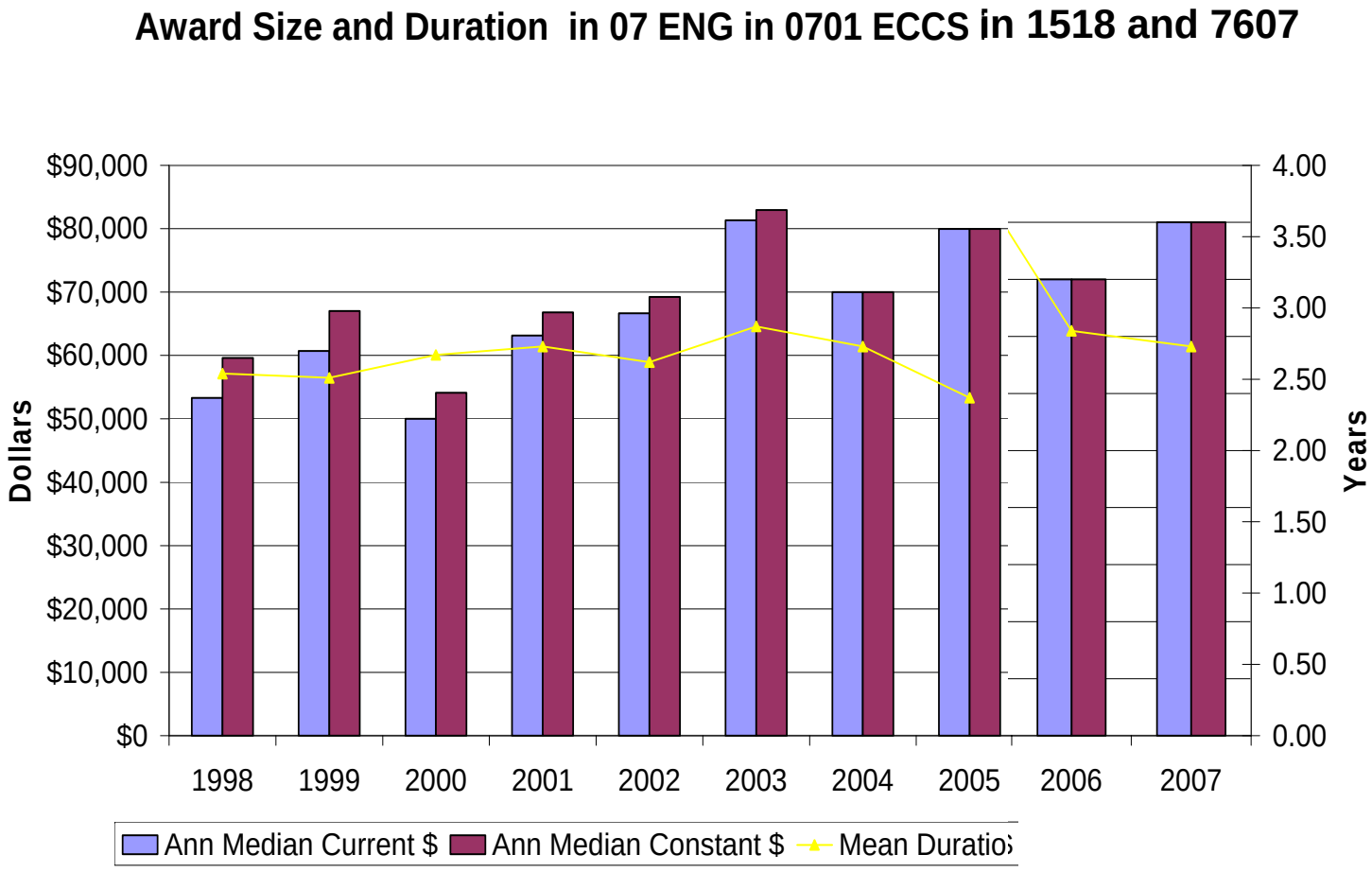


Award Size and Duration in ENG/ECCS 0701



Award Size and Duration in ENG/ECCS (0701) for Areas 1518 and 7607

Merged Thrust Areas:
Control, Networks and Computational Intelligence (1518, 99-05) &
Power Controls and Adaptive Networks (7607, 06-07)



Some Programs Supporting Power Engineering

- ENG/ECCS/PCAN — Fundamental Science and Engineering Research ~$100k/y
- ENG/EEC — Engineering Education and Centers ~$2M/y
- ENG/IIP — Industry/University Cooperative Research Centers Program (I/UCRC) ~$300K/y
  Grants Opportunities for Academic Liaison with Industry ~$100K/y

  Small Business Innovation Research (SBIR)
  Small Technology Transfer Research (STTR)
  $25K/5-$500K/y
- ENG — Major Research Instrumentation $200K/y
- DUE — Course, Curriculum, and Laboratory Improvement, up to $200K/y
- DGE — Integrative Graduate Education and Research Traineeship Program ~$600K
- Other Initiatives — Cybertrust (CISE), EFRI (ENG)

NSF Funding 2006-2008

NSF Funding by Account

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Research and Related Activities[1/]	$4,449.25	$4,765.95	$5,131.69	$365.74	7.7%
Education and Human Resources	700.26	716.22	750.60	34.38	4.8%
Major Research Equipment and Facilities Construction	233.81	240.45	244.74	4.29	1.8%
Agency Operations and Award Management	247.06	281.82	285.59	3.77	1.3%
National Science Board	3.94	3.91	4.03	0.12	3.1%
Office of Inspector General	11.47	11.86	12.35	0.49	4.1%
Total, NSF	$5,645.79	$6,020.21	$6,429.00	$408.79	6.8%

Totals may not add due to rounding.

[1/] In FY 2008, funding for EPSCoR is requested within the Research and Related Activities appropriation. Prior to FY 2008, EPSCoR was funded within the Education and Human Resources appropriation. EPSCoR is included here in Research and Related Activities for all years for comparability.

NSF/ENG Funding 2006-2008

Engineering Funding5

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Chemical, Bioengineering, Environmental and Transport Systems (CBET)	$125.09	$124.44	$144.97	$20.53	16.5%
Civil, Mechanical and Manufacturing Innovation (CMMI)	148.82	152.16	174.08	21.92	14.4%
Electrical, Communications and Cyber Systems (ECCS)	77.91	80.90	93.96	13.06	16.1%
Industrial Innovation and Partnerships (IIP)	109.65	120.08	128.39	8.31	6.9%
SBIR/STTR	*99.07*	*108.88*	*116.41*	*7.53*	*6.9%*
Engineering Education and Centers (EEC)	123.99	125.97	116.90	-9.07	-7.2%
Emerging Frontiers in Research and Innovation (EFRI)	-	25.00	25.00	-	-
Total, ENG	$585.46	$628.55	$683.30	$54.75	8.7%

Totals may not add due to rounding.

NSF/ENG/ECCS Funding

Electrical, Communications and Cyber Systems Funding

(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Change over FY 2007 Request Percent
Electrical, Communications and Cyber Systems	**$77.91**	**$80.90**	**$93.96**	**$13.06**	**16.1%**
Major Components:					
Research and Education Grants	65.91	69.19	81.91	12.72	18.4%
Nanoscale Science and Engineering Centers (NSEC)	3.13	3.16	3.50	0.34	10.8%
National Nanoscale Infrastructure Network (NNIN)	4.77	4.55	4.55	-	-
Science and Technology Center (STC)	4.10	4.00	4.00	-	-

Some Alarming Numbers

- CAREER Proposals in Power: Close to single digits

  => <~ 5 new power engineering assistant professors hired each year who are interested in pursuing research

- Unsolicited Proposals
  - <~ 10% of all proposals submitted to NSF/ENG/ECCS focus on power engineering

- Since NSF/ENG/ECCS budget is proportional to submission => relatively small budget (currently <4M$/y)

Note: Goal is not to inflate number of proposals,
but critical mass and mentoring at universities
is vital for creative research and up-to-date education programs.

Acknowledgement

The following NSF Divisions support the workshop

ENG/EEC – S. Kemnitzer
HER/DUE – R. Pimmel
ENG/ECCS – D. Niebur

Thanks for your attention!

Questions?

Suddenly, knowing a lot about the U.S. power grid became sexy at cocktail parties.