



NSF and Engineering



**National Science Foundation
Directorate for Engineering**

Juan E. Figueroa, Program Director

**Division of Industrial Innovation and
Partnerships**

Overview

- Introduction: NSF and Engineering
 - ◆ America COMPETES
 - ◆ American Competitiveness Initiative
- NSF and Engineering Themes
- ENG Organization
- Research and Funding Opportunities: An Overview
- Spotlight On Nanotechnology
- Spotlight On Broadening Participation
- ENG Trends
- EFRI



National Science Foundation

- Created: **1950**
- Federal Agency: **Independent**
- Total Budget FY 2007: **\$5.92 B**
 - » FY 2008: **\$6.43 B (Request)**
- Director and Deputy Director: **Presidential appointees**
- Employees: **1200**
 - ◆ Intergovernmental Personnel Act (IPA): **1/3**
 - ◆ Federal service appointments: **2/3**
- Supports: **Basic research and education**
- Grant mechanism: **Merit-based review**



America COMPETES

The “America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science” Act was passed in August 2007 by Congress and signed by President Bush.

- Support and promote innovation research in the United States
 - ◆ high-risk, high-reward projects that meet fundamental scientific and technological challenges,
 - ◆ involve multidisciplinary work
 - ◆ involve a high degree of novelty
- Specific allocations for initiatives at **NASA, NIST, NOAA, DOE, and NSF**, with emphasis on education
- Calls on NSF to give priority in selecting awards that meet “critical national needs” in innovation, competitiveness, safety and security, physical and natural sciences, technology, engineering, social science, and mathematics



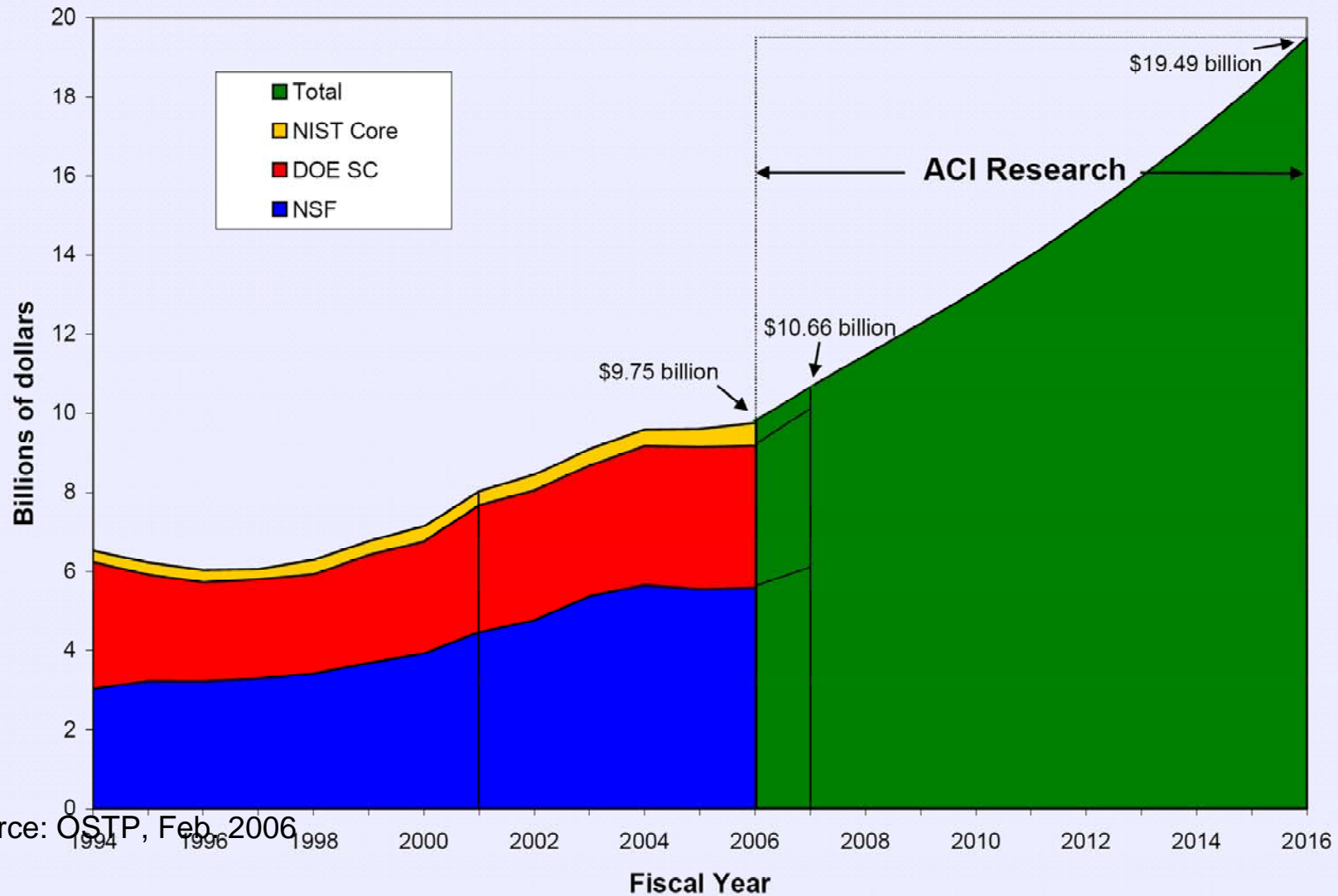
American Competitiveness Initiative

- The centerpiece of **American Competitiveness Initiative (ACI)** is to double the federal investment in key agencies that support basic research in physical sciences and engineering.
- Over the next 10 years, the Federal agencies impacted are **NSF, DOE Office of Science, and NIST**
- ACI includes three broad components:
 - ◆ Research in physical sciences and engineering (including 12 specific goals with 7 related to NSF)
 - ◆ Research and Development tax incentives
 - ◆ Education and workforce



American Competitiveness Initiative

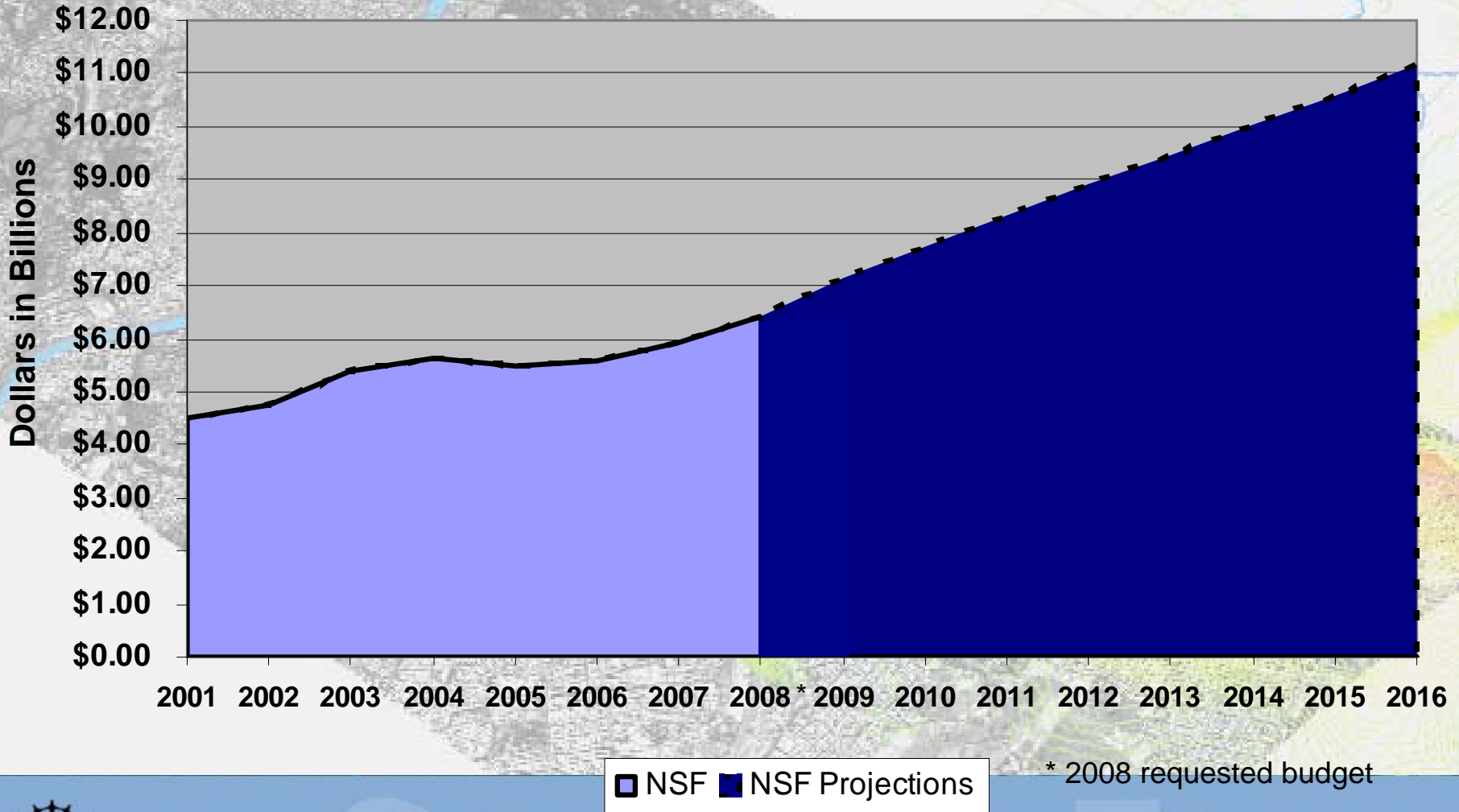
FY 2007 – FY 2016



Source: OSTP, Feb. 2006



ACI-Driven NSF Budget Projections



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



NSF Mission & Vision

→ **Mission:**

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

→ **Vision:**

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



Strategic Outcome Goals

- **Discovery:** Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.
- **Learning:** Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.
- **Research Infrastructure:** Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.
- **Stewardship:** Support excellence in science and engineering research and education through a capable and responsive organization.



Organizational Structure

National Science Board

**Office of the
Inspector General**

**Director
Dr. Arden Bement**

**Deputy Director
Dr. Kathie Olsen**

**Directorate for
Biological
Sciences**

**Directorate for
Computer and
Information
Science and
Engineering**

**Directorate for
Education and
Human
Resources**

**Directorate for
Engineering**

**Directorate for
Geosciences**

**Directorate for
Mathematical
and Physical
Sciences**

**Directorate for
Social,
Behavioral,
and Economic
Sciences**

**Office of
Cyberinfrastructure**

**Office of International
Science and Engineering**

**Office of the General
Counsel**

**Office of Legislative and
Public Affairs**

**Office of Equal
Opportunity Programs**

**Office of Integrative
Activities**

Office of Polar Programs

**Office of Budget, Finance,
and Award Management**

**Office of Information and
Resource Management**

<http://www.nsf.gov>



NSF Budget for Research & Related Activities by Directorates

Dollars in Millions

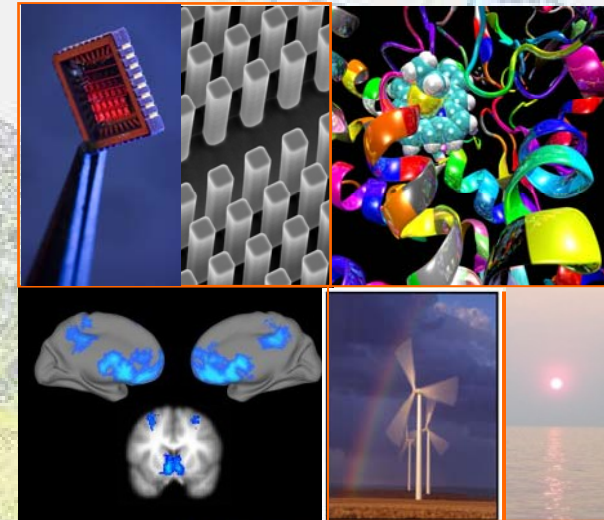
Directorate	FY 2006 Actual	FY 2007 Plan	FY 2008 Request	FY 2008 Request			
				Change over FY 2006 Actual		Change over FY 2007 Request	
				Amt	%	Amt	%
BIO	\$580.90	\$607.85	\$633.00	\$52.10	9.0%	\$25.15	4.1%
CISE	\$496.35	526.69	574.00	77.65	15.6%	47.31	9.0%
ENG (less SBIR/STTR)	\$486.01	519.67	566.89	80.50	16.6%	47.22	9.1%
SBIR/STTR	\$99.45	108.88	116.41	17.34	17.5%	7.53	6.9%
GEO	\$703.95	744.85	792.00	88.05	12.5%	47.15	6.3%
MPS	\$1,086.61	1,150.30	1,253.00	166.39	15.3%	102.70	8.9%
SBE	\$201.23	213.76	222.00	20.78	10.3%	8.24	3.9%
OCI	\$127.14	182.42	200.00	72.86	57.3%	17.58	9.6%
OISE	\$42.61	40.61	45.00	2.39	5.6%	4.39	10.8%
OPP	\$390.54	438.10	464.90	74.37	19.0%	26.80	6.1%
IA	\$233.30	231.37	263.00	29.70	12.7%	31.63	13.7%
U.S. Arctic Research Commission	\$1.17	\$1.45	\$1.49	0.32	27.4%	0.04	2.8%
Research & Related Activities	\$4,449.25	\$4,765.95	\$5,131.69	\$682.44	15.3%	\$365.74	7.7%



Directorate for Engineering

Trends

- Engineering discovery and innovation are crucial for addressing increasingly complex challenges touching every sector of society:
 - ◆ health,
 - ◆ quality of life,
 - ◆ surety, and
 - ◆ sustainability.
- Engineering makes important contributions to almost all disciplines.
- NSF Engineering discovery, innovation and education are critical elements of the national agenda (e.g., *America COMPETES Act* and the *American Competitiveness Initiative*).



Engineering contributes at all scales. Examples are nanotechnology, computational simulation, health, and alternative energy.

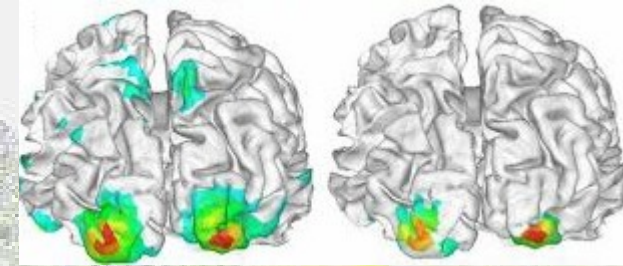


Directorate for Engineering

Research and Education Topics

Cognitive Engineering: Intersection of Engineering and Cognitive Sciences

- Supports engineering methods and systems for improving understanding of brain and nervous system.
- Enables research on how to mimic nervous system processes to engineer novel systems and machines.
- Provides a foundation for competitive innovations such as devices that augment senses and intelligent machines that analyze and adapt.



Combining EEG with functional MRI data (left image is EEG, right image shows both) enables precise mapping of brain activity. *He, 0411898.*

Directorate for Engineering

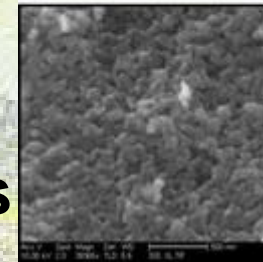
Research and Education Topics

Competitive Manufacturing and Service Enterprises

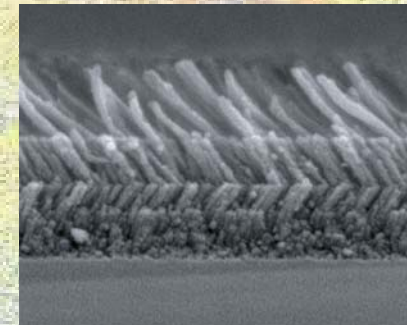
- Research that catalyzes multiscale manufacturing, from fundamental metrology through atomic-scale control of raw materials.
- In the emerging field of nanomanufacturing, opportunities include:
 - ◆ Create quality-engineered nanomaterials in necessary quantities.
 - ◆ Perfect atomic and molecular scale manufacturing.
 - ◆ Design and assemble systems that incorporate nanoscale elements and exploit functionality at the macroscale.
 - ◆ Facilitate the transfer of nanoscience discoveries to practical applications.



Nanoparticles compose a lightweight biocompatible material for bone implants (left) and reflective nanorods can be layered (bottom) to potentially increase solar cell efficiency.



Groza, 0523063.



Schubert, 0725615.

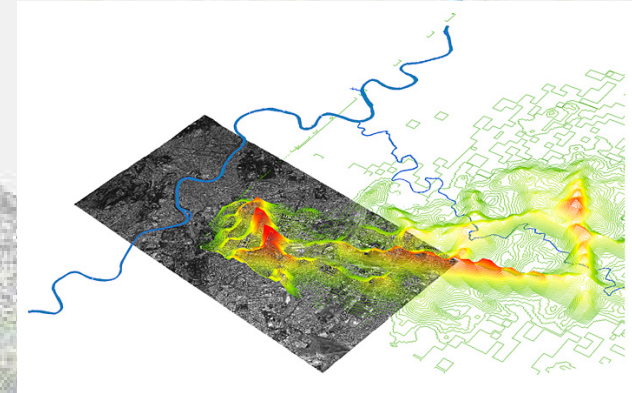


Directorate for Engineering

Research and Education Topics

Complexity in Engineered and Natural Systems

- Addresses unifying principles that enable modeling, prediction, and control of emergent behavior in complex systems.
- Impacts specific national research goals, including materials for improving structural performances during natural disasters, overcoming barriers to quantum information processing, and world-leading automation and control technologies.
- This research enhances our ability to understand natural systems, engineered systems, and interface of natural and engineered systems.



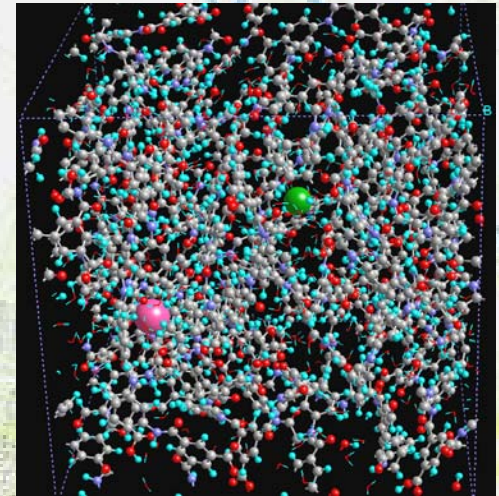
Combining maps (gray square) and density of cell-phone usage (shown as red and yellow 3-D peaks) can yield information about how a complex system responds to unplanned events. *Dahleh, 0735956*.

Directorate for Engineering

Research and Education Topics

Energy, Water and the Environment

- Enables breakthroughs essential to harness, efficiently store, and economically distribute energy from alternative sources in a sustainable and secure manner.
- This research includes:
 - ◆ 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, and
 - ◆ evaluating energy workforce needs.



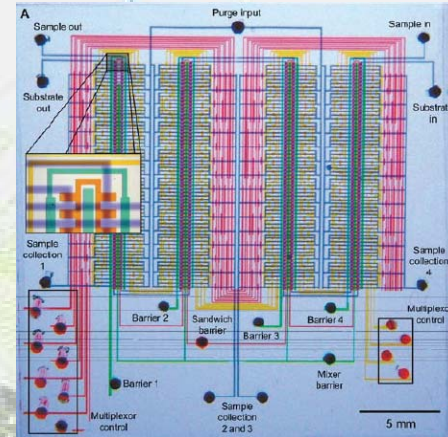
Advanced water purification and desalinization begins with a detailed understanding of how ions in water interact with purification membranes. This dynamic computer simulation shows sodium (pink) and chlorine (green) ions inside a polyamide membrane.
Shannon, 0120978.

Directorate for Engineering

Research and Education Topics

Systems Nanotechnology

- NSF, through the National Nanotechnology Initiative, drives our nation's efforts to lead the world in fundamental nanotechnology research.
- Systematic control and manufacture at the nanoscale are envisioned to evolve from passive and active nanostructures into systems of nanosystems with three-dimensional features and heterogeneous molecular nanosystems.
- Wide application: new materials, petascale computing, organ regeneration, biological sensors for health monitoring, high-specificity sensors for national security, efficient and economic use of energy.



Integrated circuits that are smaller and faster are possible with microfluidics systems built from or incorporating nanocomponents.

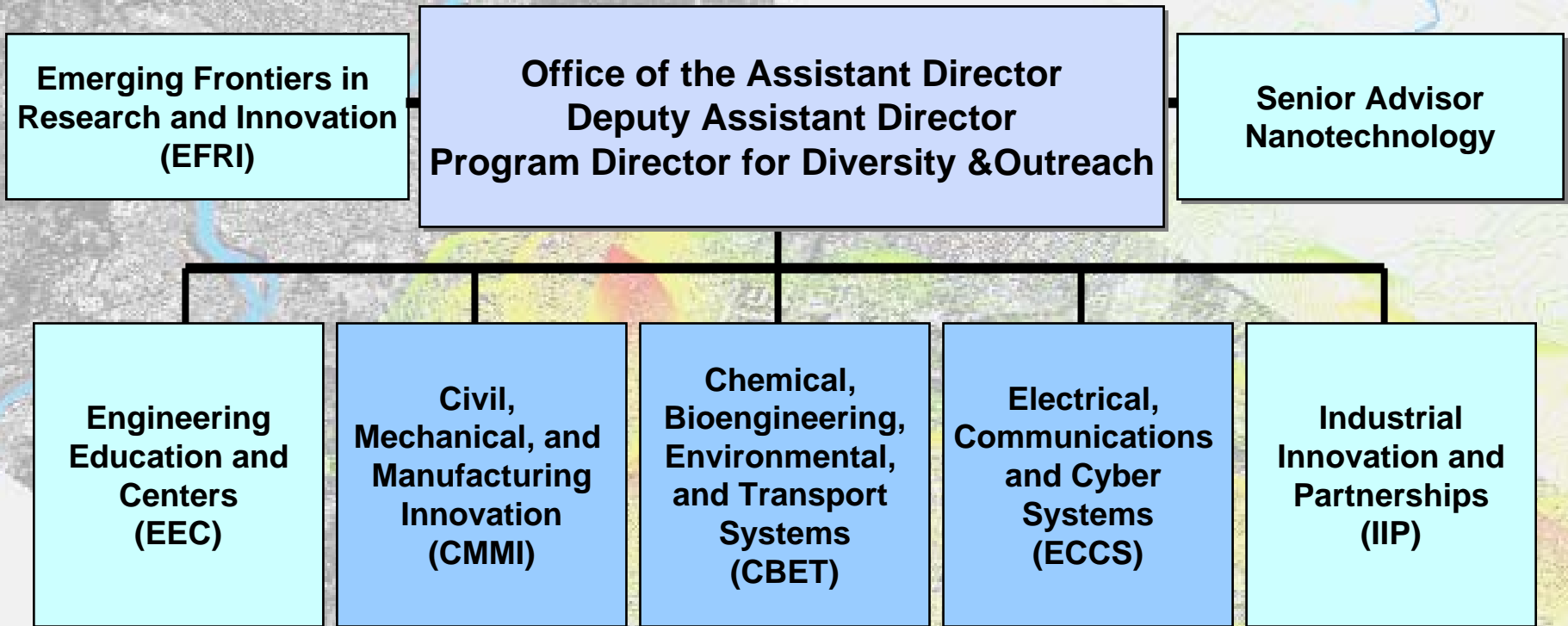
Ferreira, 0328162.

ENG Organization



Directorate for Engineering

FY 2008



Chemical, Bioengineering, Environmental, and Transport Systems

Deputy Division Director
Bob Wellek

Division Director
Judy Raper

Senior Advisor
Marshall Lih

Chemical, Biochemical, and Biotechnology Systems

Process and Reaction Engineering
Maria Burka

Catalysis and Biocatalysis
John Regalbuto

Biotechnology
Fred Heineken

Chemical and Biological Separations
Rose Wesson

Transport and Thermal Fluids

Thermal Transport Processes
Pat Phelan

Interfacial Processes and Thermodynamics
Bob Wellek

Particulate and Multiphase Processes
Marc Ingber

Fluid Dynamics
Bill Schultz

Combustion, Fire, and Plasma Systems
Phil Westmoreland

Biomedical Engineering and Engineering Healthcare

Research to Aid Persons With Disabilities
Vacant

Biomedical Engineering
Semahat Demir

Advanced Imaging and Sensing for Human Health
Leon Esterowitz

Environmental Engineering and Sustainability

Environmental Engineering
Vacant

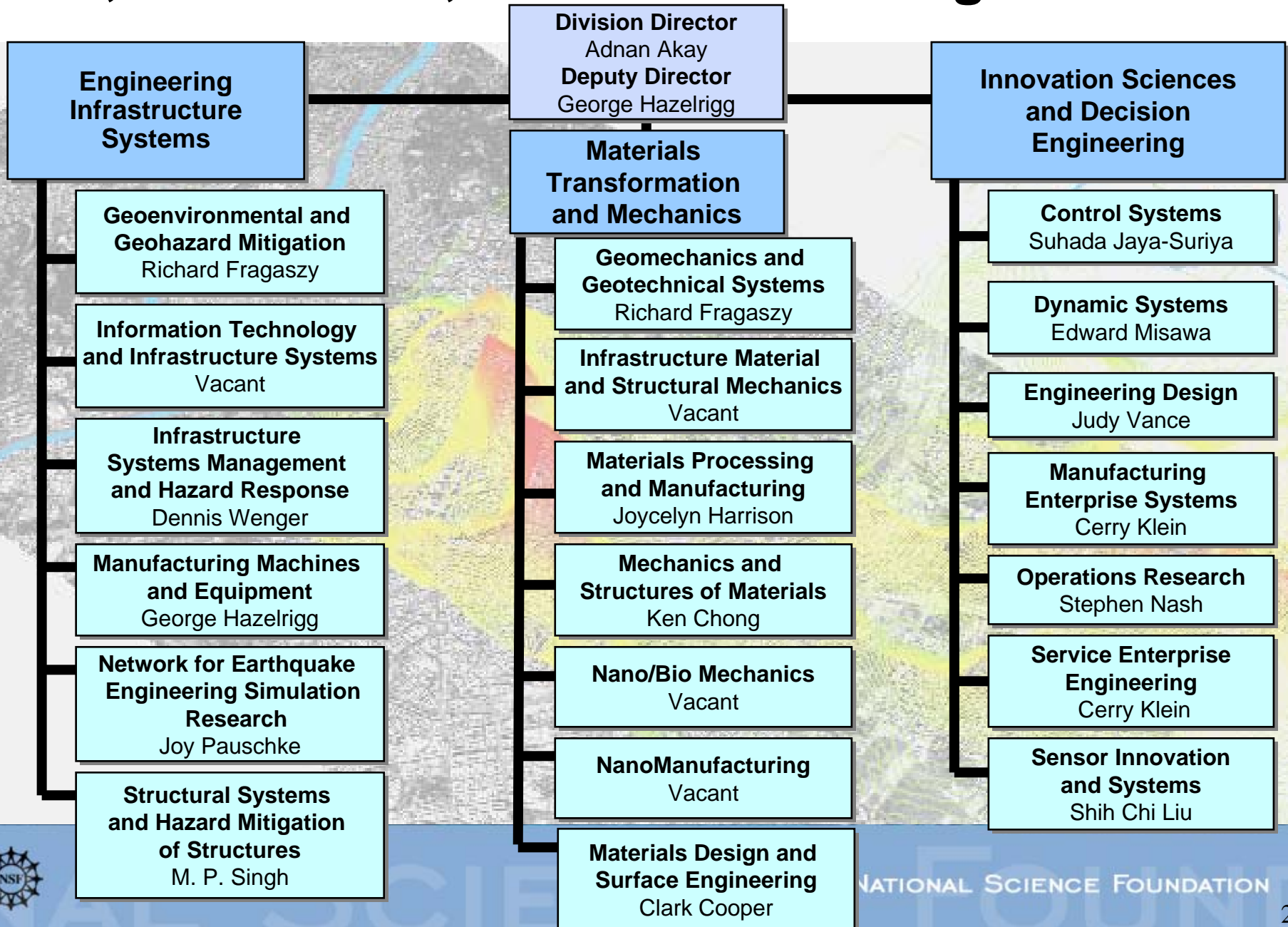
Environmental Technology
Cindy Ekstein

Energy for Sustainability
Trung Van Nguyen

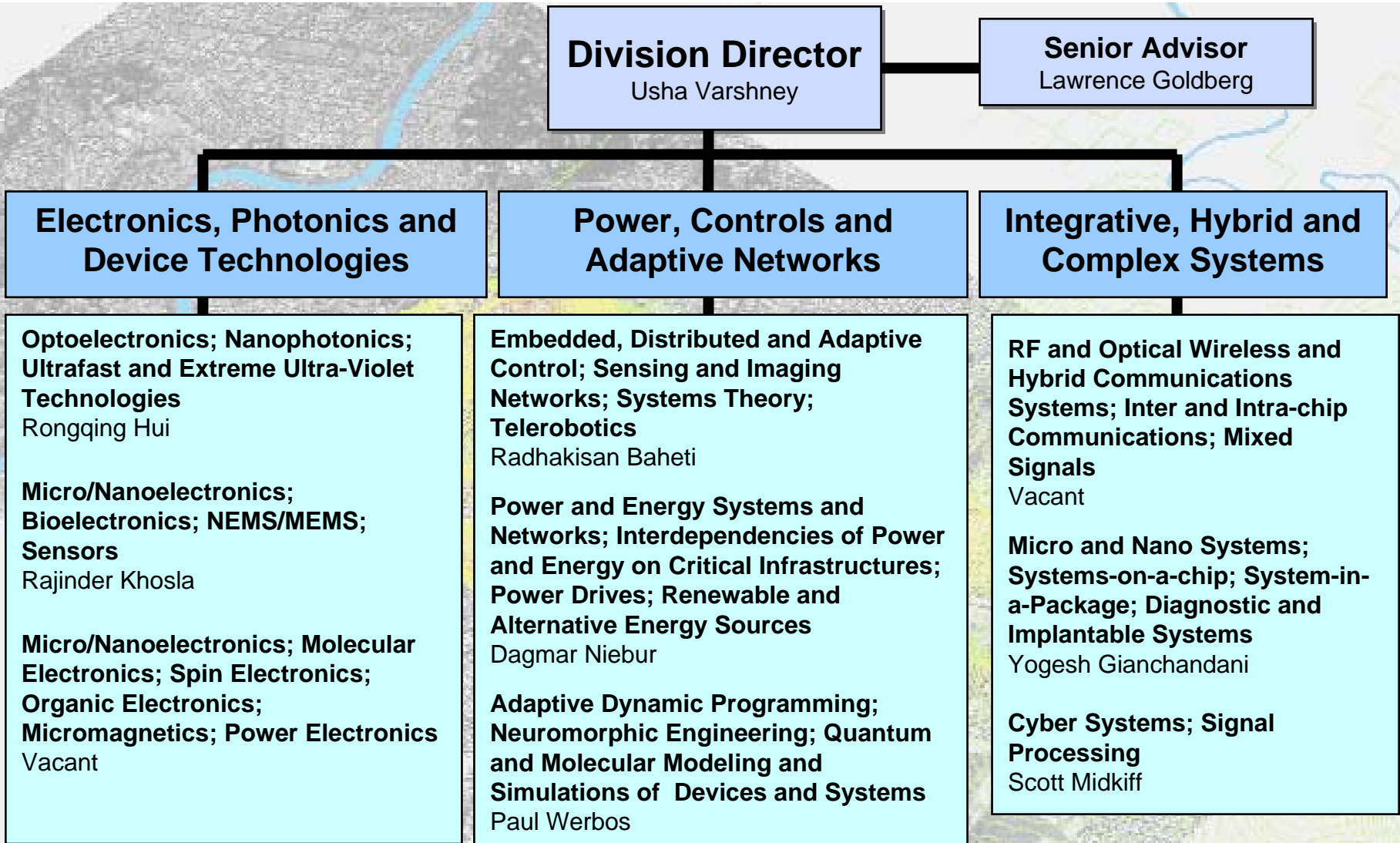
Environmental Sustainability
Bruce Hamilton



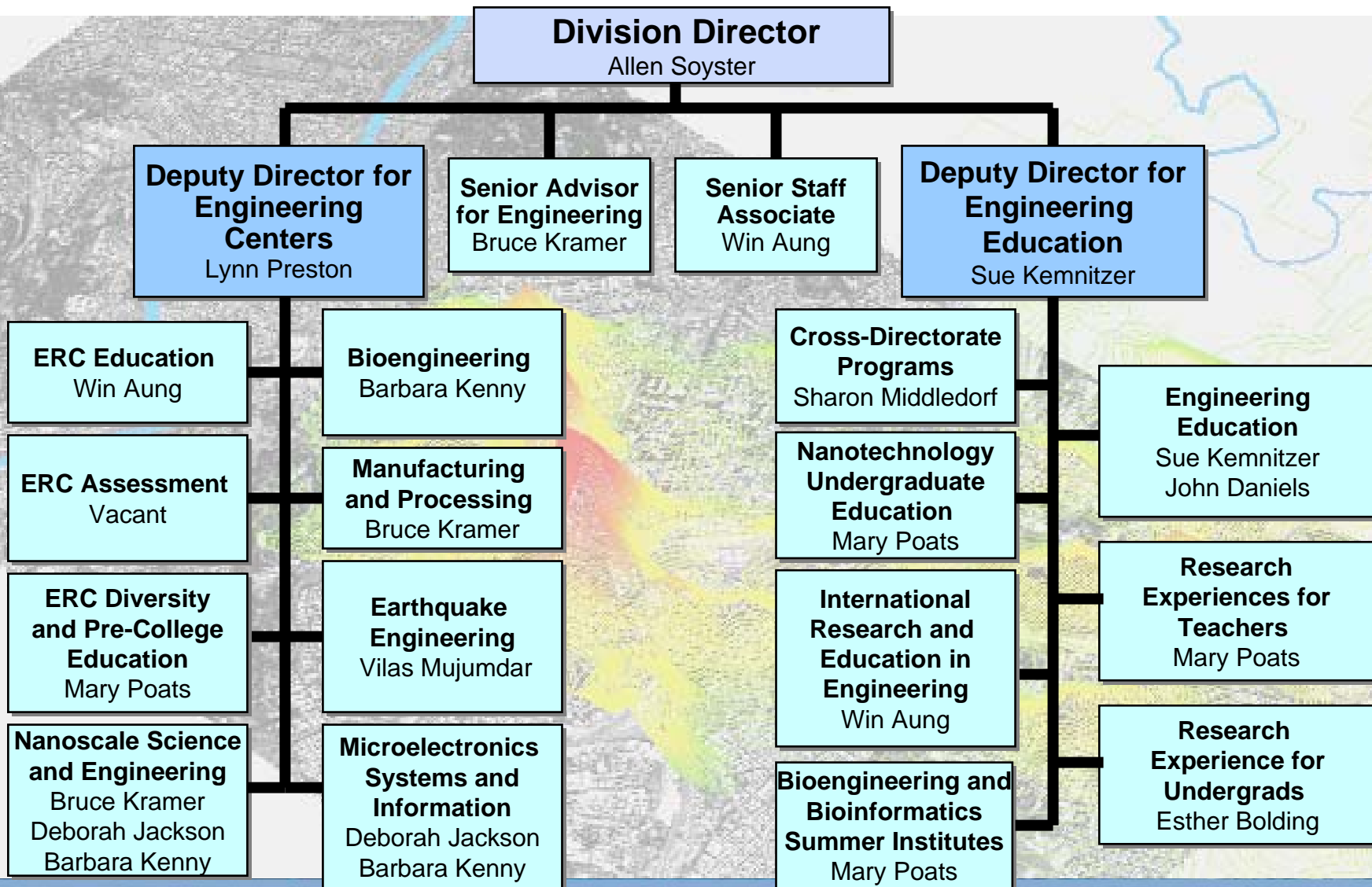
Civil, Mechanical, and Manufacturing Innovation



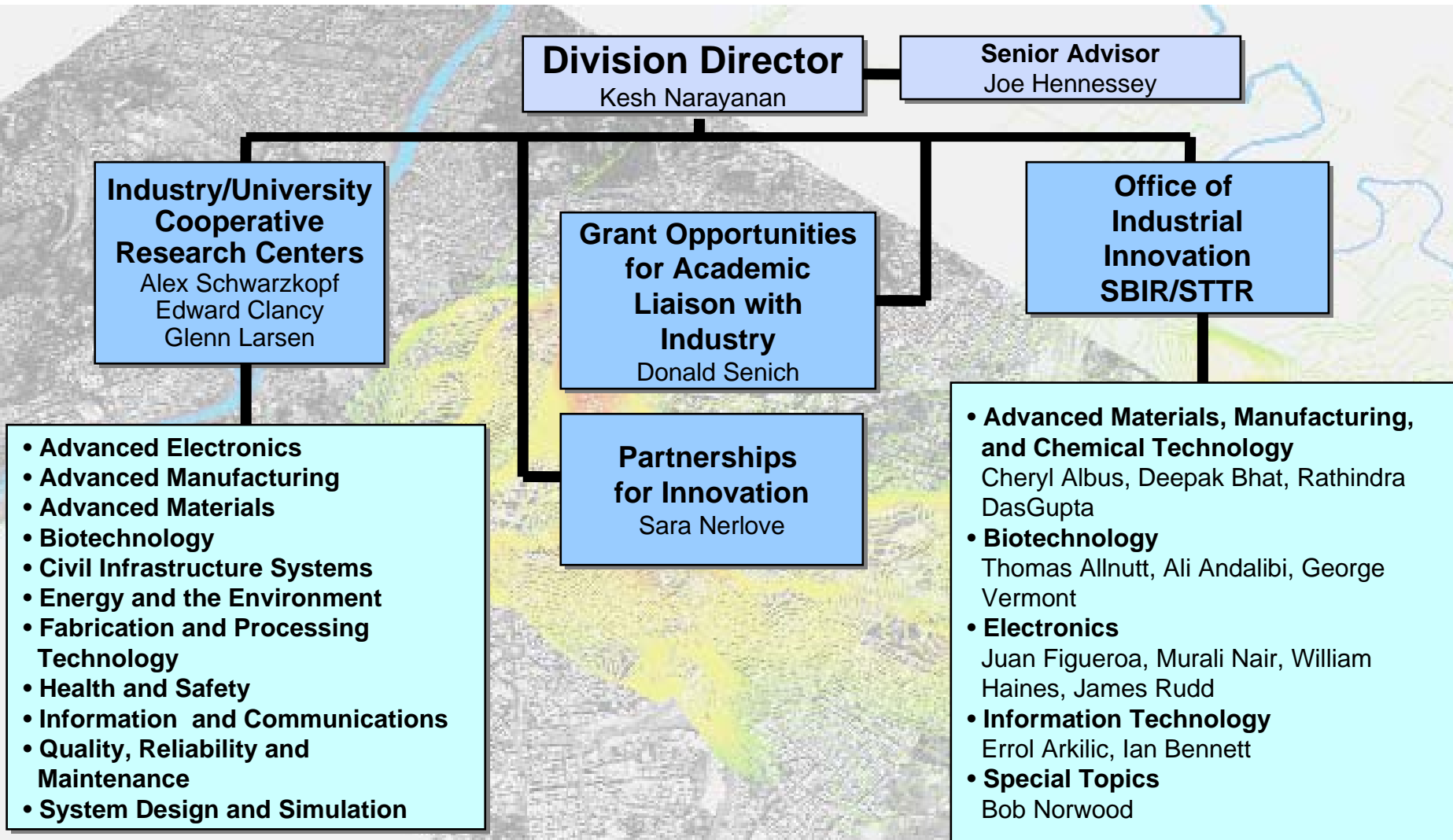
Electrical, Communications and Cyber Systems



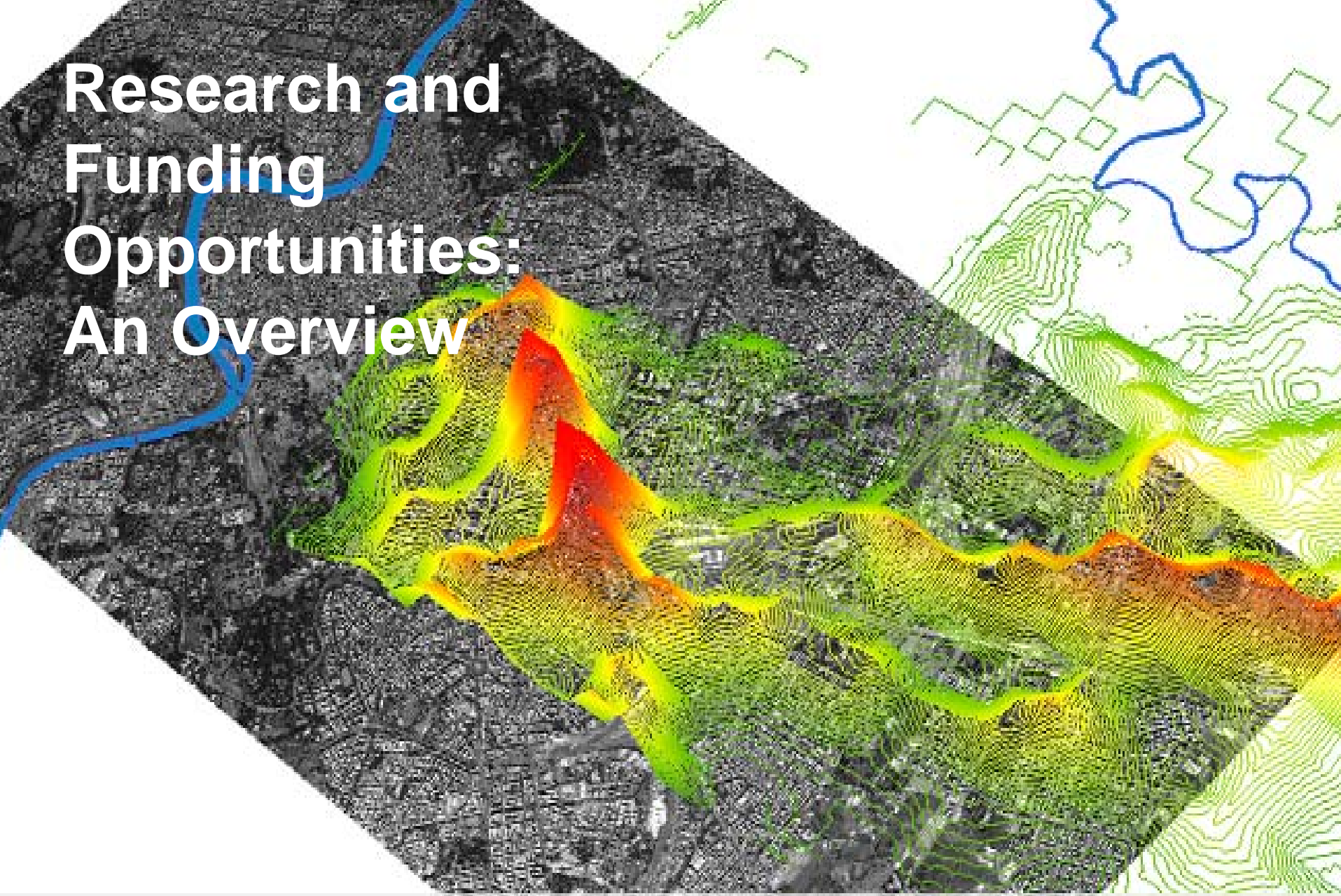
Engineering Education and Centers



Industrial Innovation and Partnerships



Research and Funding Opportunities: An Overview



Research Opportunities in ENG Divisions

→ **Disciplinary Research Programs**

- ◆ Investigator Initiated Unsolicited Proposals
- ◆ Faculty Early Career Development (CAREER) program
- ◆ Small Grant for Exploratory Research (SGER)
- ◆ Supplements (REU, RET, Instruments, GRS, IREE)
- ◆ Major Research Instrumentation (MRI)
- ◆ Workshops & Conferences

→ **Engineering Education and Centers (EEC)**

- ◆ Engineering Research Centers (ERC)
- ◆ Research Experiences for Undergraduates (REU) Sites
- ◆ Research Experiences for Teachers (RET) Sites
- ◆ Unsolicited Education Proposals

→ **Industrial Innovation and Partnerships (IIP)**

- ◆ Partnership for Innovation (PFI)
- ◆ Industry/University Cooperative Research Centers (I/UCRC)
- ◆ Small Business Innovation Research (SBIR)
Small Business Technology Transfer (STTR) Programs
- ◆ Grant Opportunities for Academic Liaison with Industry (GOALI)



Faculty Early Career Development (CAREER / PECASE) Program

<http://www.nsf.gov/pubs/2005/nsf05579/nsf05579.pdf>

Foundation-wide activity that offers NSF's most prestigious awards for junior faculty members within context of their early career development activities.

- Enhances and emphasizes the importance of balanced academic careers that include both research and education
- Requires:
 - ✓ Career Development Plan
 - ✓ Research Plan and Integrated Educational Activities
 - ✓ Departmental Endorsement
- Collaborative activities are strongly encouraged
- Awards are for 5 years at \$80K per year

Most meritorious new CAREER awardees, showing exceptional potential for leadership at the frontiers of knowledge, are eligible for Presidential Early Career Awards for Scientists and Engineers (PECASE)

Proposal Submission Deadlines: July 17/18/19, 2008

Program Solicitation: NSF 05-579 NATIONAL SCIENCE FOUNDATION



Small Grants for Exploratory Research (SGER)

http://www.nsf.gov/pubs/gpg/nsf04_23/2.jsp

High-risk research in the fields of science, engineering and education

- Preliminary work on **untested and novel ideas**
- Ventures into **emerging and potentially transformative research ideas**
- Application of **new expertise or new approaches** to research topics
- Quick-response research on **unanticipated events**
- **Efforts to catalyze** rapid and innovative advances
 - ◆ **Submit to individual programs**
 - ◆ **Strongly encouraged to discuss with Program Directors before submitting the proposal for appropriateness**
 - ◆ **Project description no more than two-to-five pages**
 - ◆ **Maximum award amount not to exceed \$200K for 2 years**
 - Normally the award size is \$50-75k for 1 year
 - Number of awards is limited



Grant Opportunities for Academic Liaison with Industry (GOALI)

- **Effective mechanism for transfer of knowledge between academe and industry**
 - **New research topics, intellectual contributions from industry, student education, culture change**
- **Aims to synergize university- industry partnerships by enabling eclectic linkages:**
 - **Faculty, postdoctoral fellows, graduate and undergraduate students to conduct research and gain experience in an industrial setting**
 - **Industrial scientists and engineers to bring industry's perspective and integrative skills to academe**
 - **Collaborative university - industry teams to conduct research projects**
- **Supported by all NSF Directorates**

Program Solicitation: NSF 07-522

<http://www.nsf.gov/pubs/2007/nsf07522/nsf07522.htm>

NATIONAL SCIENCE FOUNDATION



Major Research Instrumentation Program (MRI)

Program designed to increase access to scientific and engineering equipment for research and research training in our Nation's organizations of higher education, research museums, and non-profit research organizations

- Provides support for acquisition (up to 3 Yrs) or development (up to 5 Yrs) proposals of major state-of-the-art research instrumentation
- Awards for single instruments, large systems of instruments or multiple instruments that share a common or specific research focus
- Awards range from \$100K to \$4M
- Less than \$100K for non-PhD granting organizations, disciplines of mathematical science or social, behavioral, and economic science at any eligible organization
- Mandatory 30% cost-sharing has been reintroduced



Research Experiences

Research Experiences for Undergraduates (REU):

Supports active research participation by undergraduate students in on-going research programs

→ Sites

- ◆ Requires an independent proposal
- ◆ International dimensions are encouraged
- ◆ Average award size \$300K for a duration of 3 years

→ Supplements

- ◆ To active NSF awards
- ◆ Maximum 2 undergraduate students per grant

Program Solicitation: NSF 07-569, June 6, 2008

Research Experiences for Teachers (RET): Supports K-12 teachers and community college faculty in on-going engineering research programs

→ Sites

- ◆ Requires an independent proposal
- ◆ Award size \$450K maximum for a duration up to 3 years

→ Supplements

- ◆ To active ENG awards including SBIR/STTR
- ◆ Award size \$10K for a duration up to 1 year and 2 teachers per grant



Graduate Research Supplements

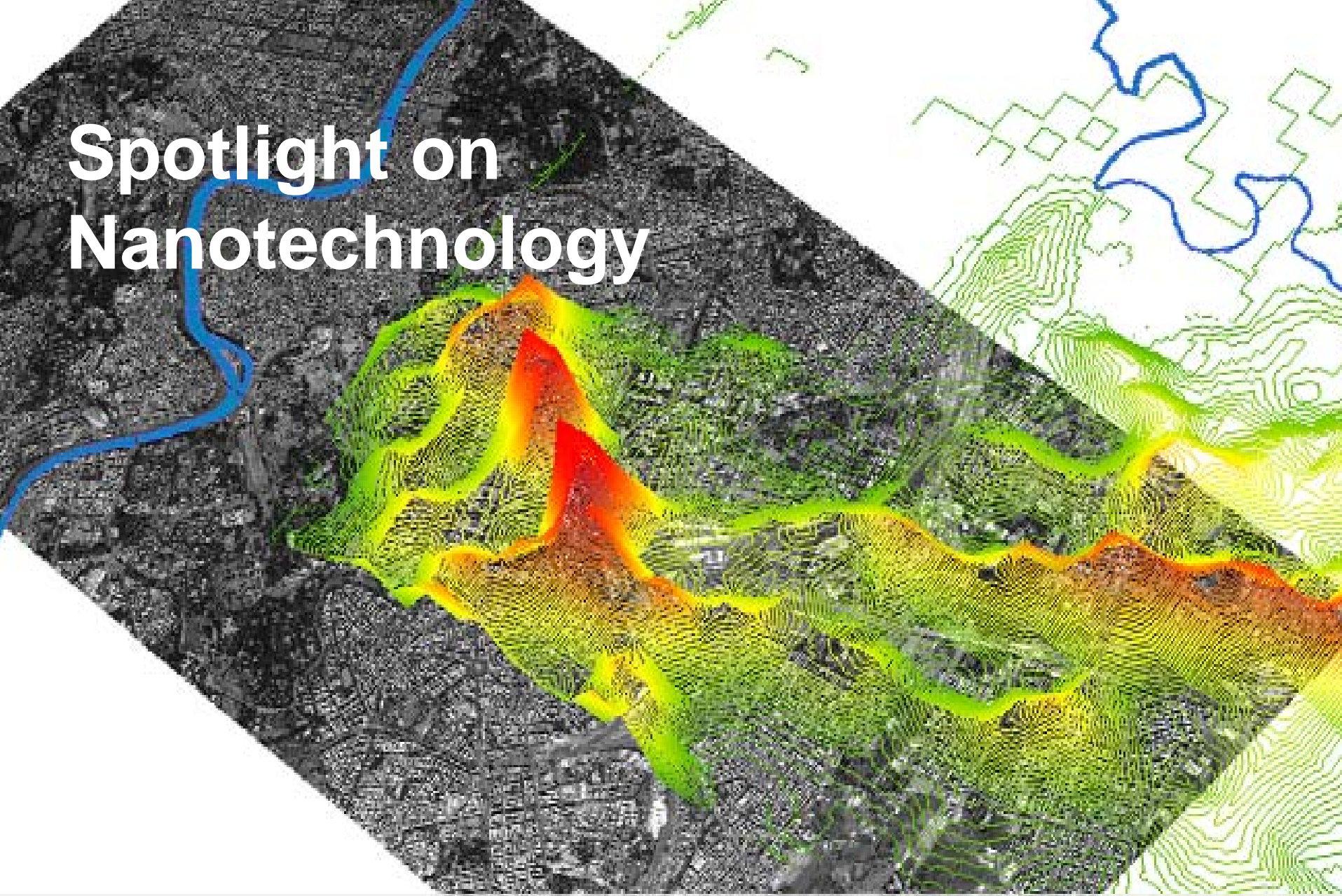
Graduate Research Supplements (GRS) to Current ENG Awards to Broaden Participation

- ◆ To increase numbers in academic/professional careers
- ◆ Supplements to existing ENG grants
- ◆ New 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

<http://www.nsf.gov/pubs/2007/nsf07023/nsf07023.jsp>



Spotlight on Nanotechnology



National Nanotechnology Initiative

Funding Opportunities at NSF

NSF support in Nanoscale Science and Engineering is through:

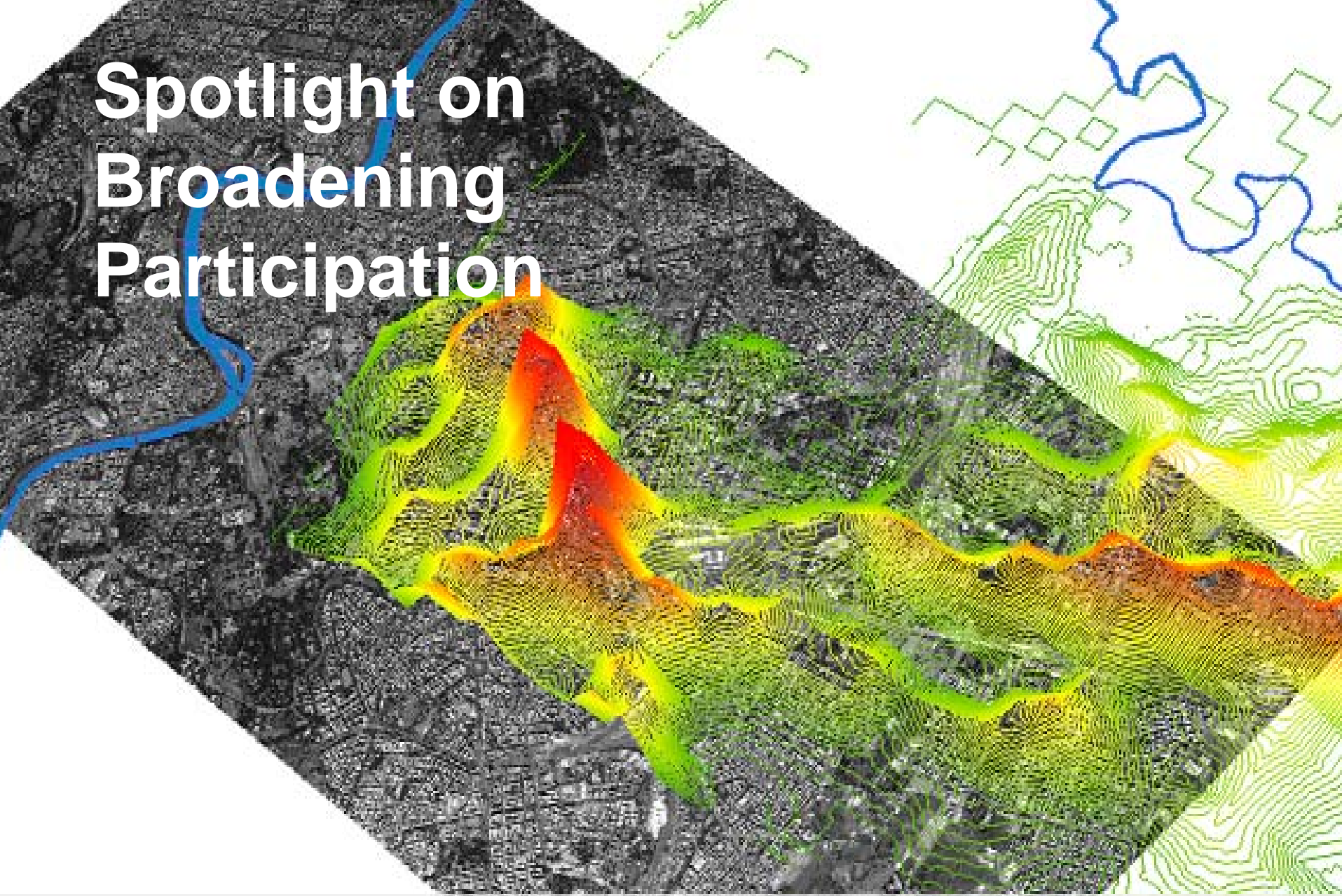
- Competitive awards in existing **Core Programs**, including **Interdisciplinary Team** and **Small Group** research proposals
- **“Center for the Environmental Implications of Nanotechnology (CEIN),” NSF 07-590**
- **“NSF-SIA/NRI Graduate Student and Postdoctoral Fellow Supplements to NSF Centers in Nanoelectronics,” NSF 07-051**
- **“EPA-NSF-DOE Research Solicitation: Nanotechnology Research Grants Investigating Fate, Transport, Transformation, and Exposure of Engineered Nanomaterials”**

<http://www.nsf.gov/nano>



NATIONAL SCIENCE FOUNDATION

Spotlight on Broadening Participation



ENG Broadening Participation

BRIGE

- **Broadening Participation Research Initiation Grants in Engineering (BRIGE)**
 - ◆ **Research initiation grant funding opportunity intended to increase the diversity of researchers through research program support early in their careers, including under-represented groups, engineers at minority serving institutions, and persons with disabilities.**
 - ◆ **Up to \$175,000 over two years.**
 - ◆ **Early career faculty (fewer than three years).**
 - ◆ **Announced in September 2007 with a submission date of February 8, 2008.**
 - ◆ **NSF 07-58 at <http://www.nsf.gov/pubs/2007/nsf07589/nsf07589.htm>**



ENG Broadening Participation

ADVANCE:

**Increasing the Participation and Advancement of Women
in Academic Science and Engineering Careers**

Goal: to develop systemic approaches to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce.

- **Institutional Transformation (IT)**

Awards support academic institutional transformation to promote the increased participation and advancement of women scientists and engineers in academe

- **Institutional Transformation Planning Grants (IT-Start)**

Awards support basic data collection and analysis functions necessary to understand the status of women faculty in academic science and engineering at institutions seeking institutional transformation

- **Partnerships for Adaptation, Implementation and Dissemination (PAID)**

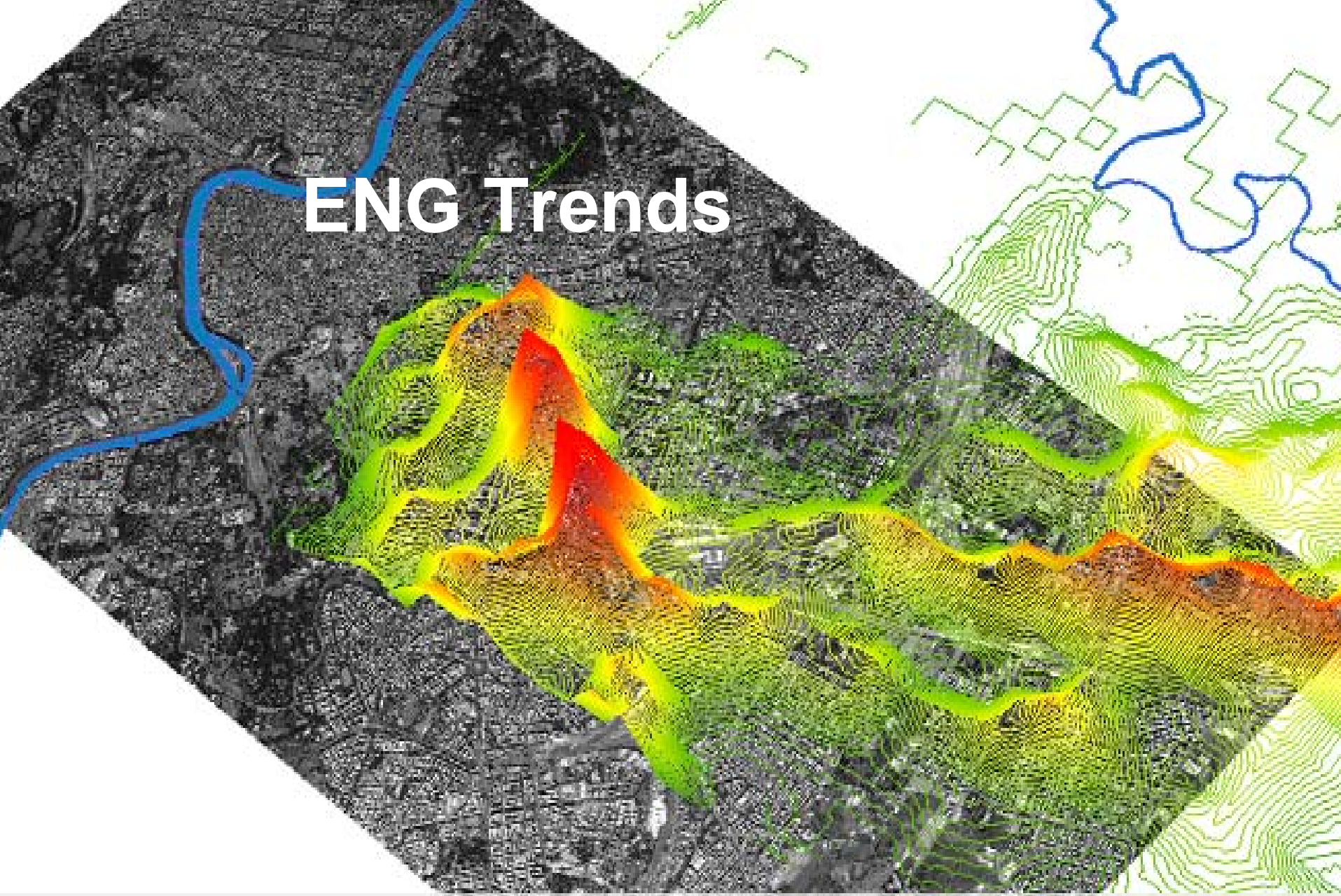
Awards support analysis, adaptation, dissemination and use of existing innovative materials and practices that have been demonstrated to be effective in increasing representation and participation of women in academic science and engineering careers



NSF 07-582 , 30 to 28 awards, \$13 M
<http://www.nsf.gov/advance>

NATIONAL SCIENCE FOUNDATION

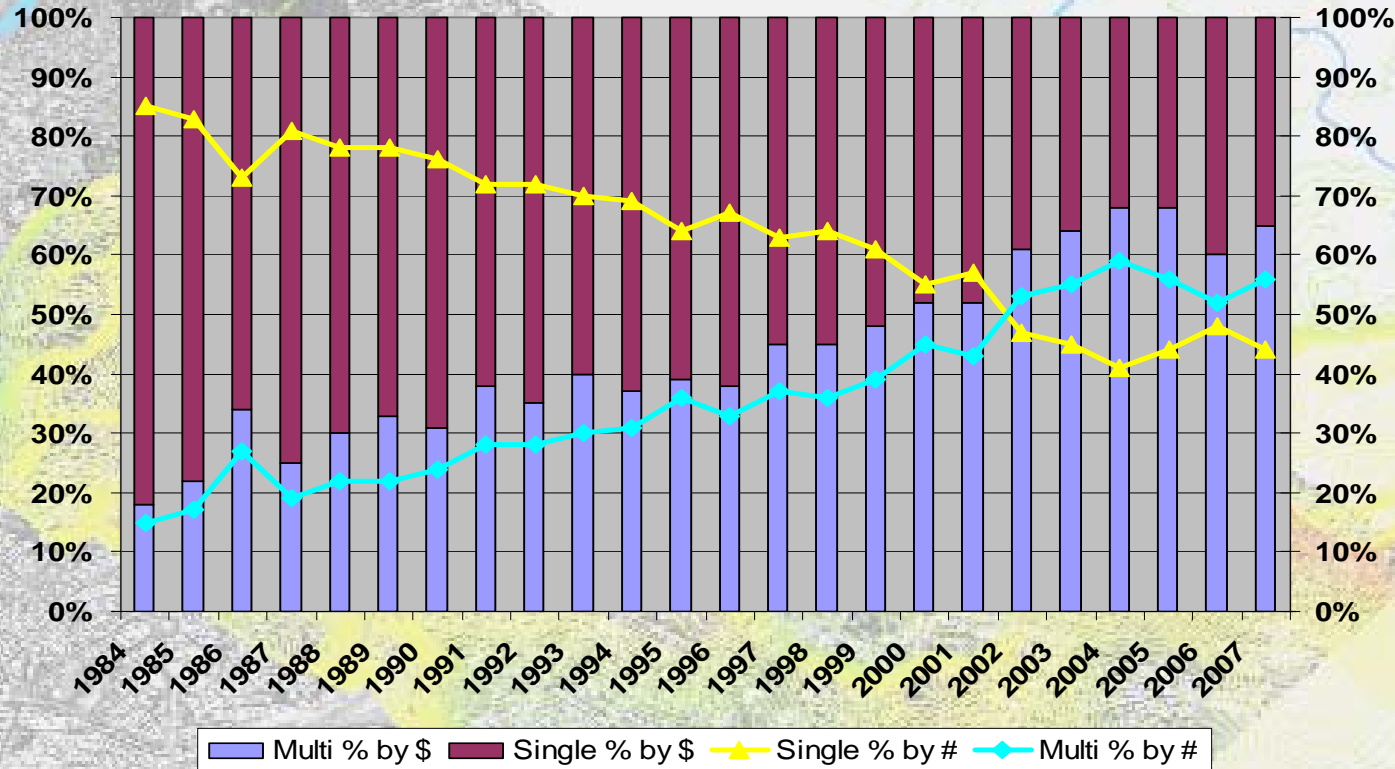
ENG Trends



Research Collaborations

Percent of Single PI vs. Multiple Investigator Awards

- A majority of ENG awards are provided to multiple-investigator projects.
- For the past decade, ENG is typically 10-15% above the rest of NSF in such awards.



NSF Budget by Research Directorate

Dollars in Millions

Directorate	FY 2007 Actual	FY 2008 Estimate
BIO	\$608.54	\$612.02
CISE	\$526.68	534.53
ENG (<i>less SBIR/STTR</i>)	\$521.33	527.50
SBIR/STTR	\$108.67	109.37
GEO	\$745.85	752.66
MPS	\$1,150.73	1,167.31
SBE	\$214.54	215.13
OCI	\$182.42	185.33
OISE	\$40.36	41.34
OPP	\$438.43	442.54
IA	\$219.45	232.27
U.S. Arctic Research Commission	\$1.45	\$1.47
Research & Related Activities	\$4,758.44	\$4,821.47



Engineering FY 2009 Budget Request by Division

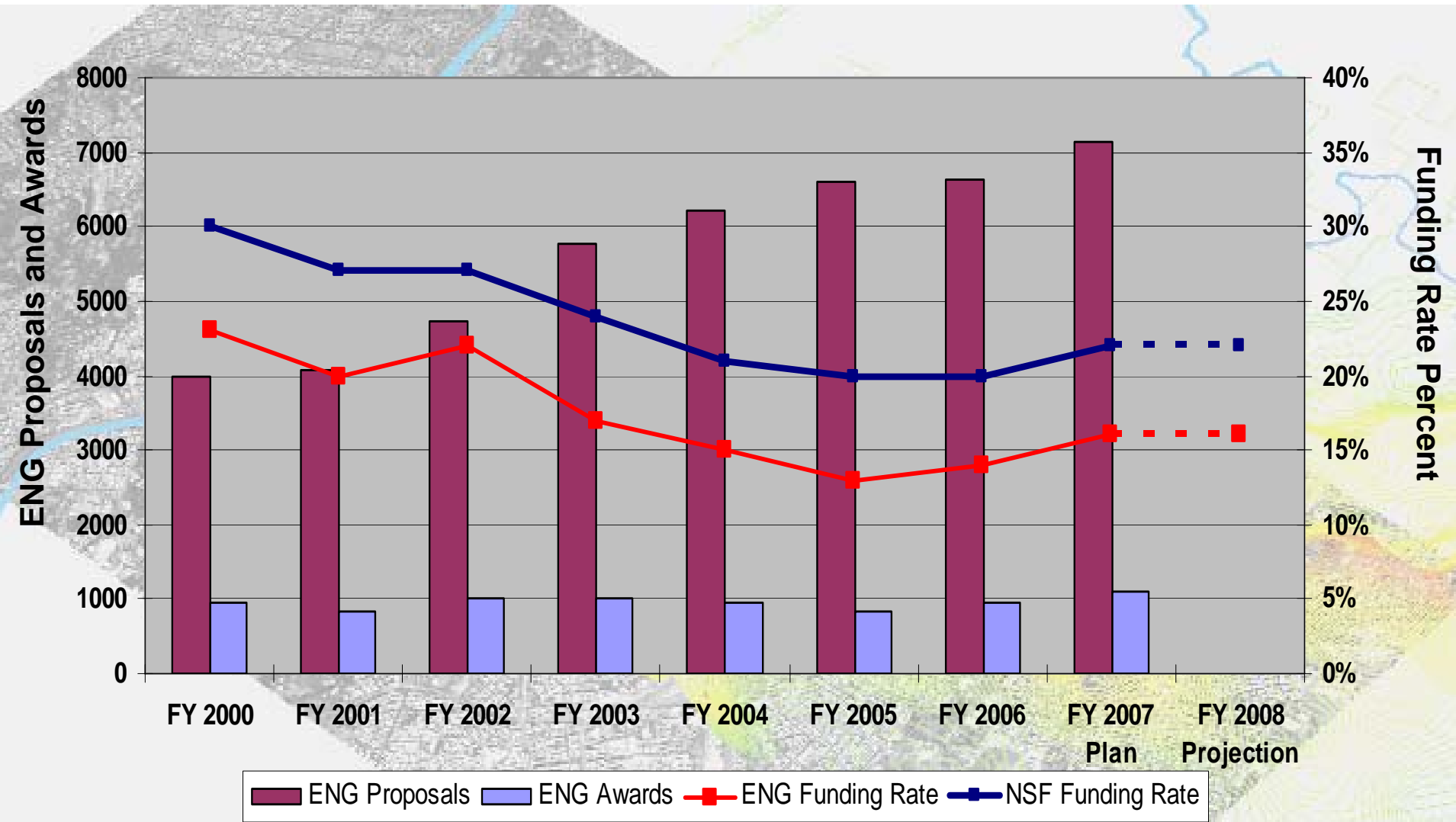
Dollars in Millions

	FY 2007 Actual	FY 2008 Estimate
CBET	\$128.27	\$131.00
CMMI	157.30	159.81
ECCS	83.24	83.50
IIP	120.78	121.67
<i>Small Business Innovation Research (SBIR)</i>	108.67	109.37
EEC	115.16	115.89
EFRI	25.00	25.00
Total, ENG	\$630.00	\$636.87



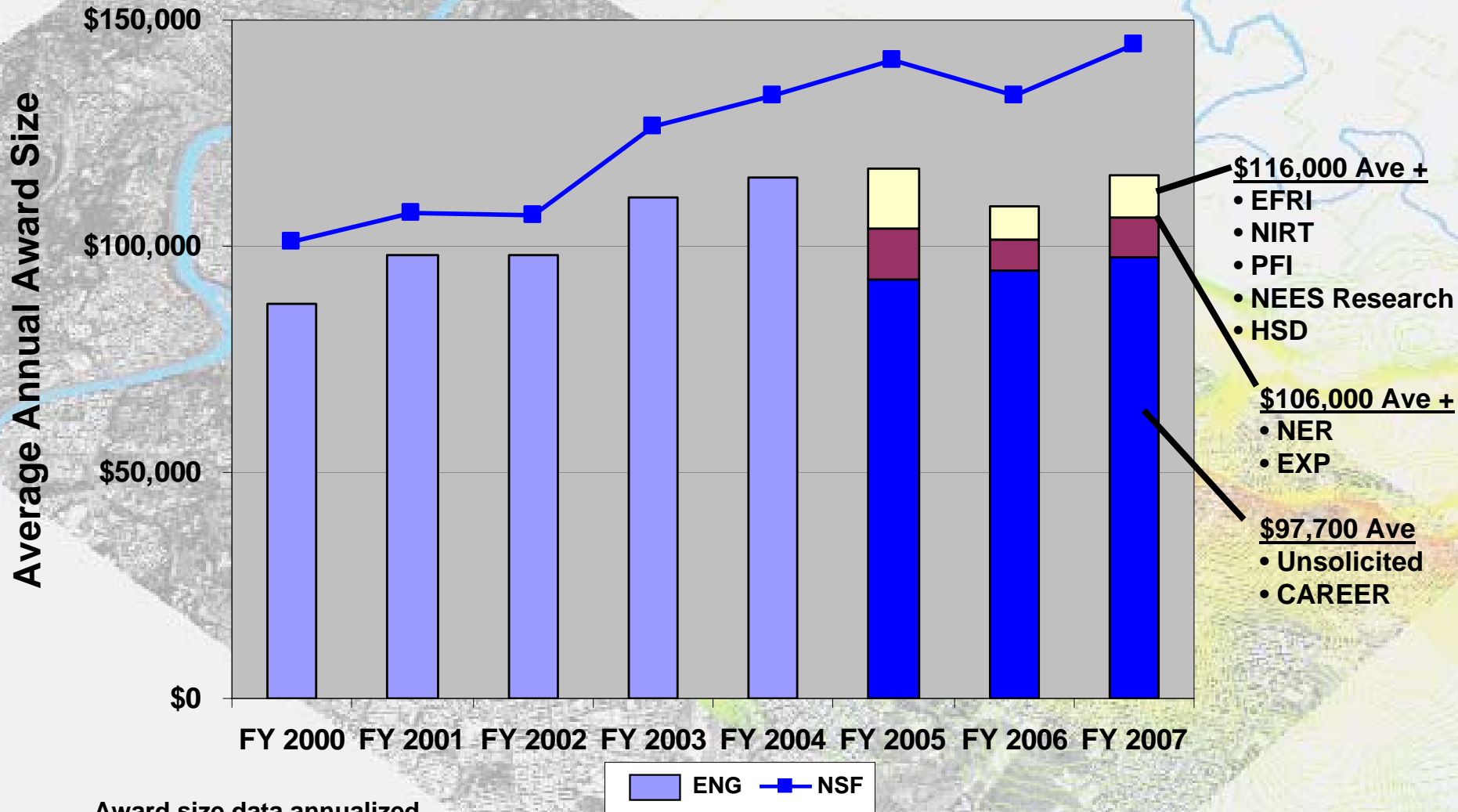
ENG and NSF Funding Rates

Research Grants



Annual Award Size

Averages for ENG Research Grants

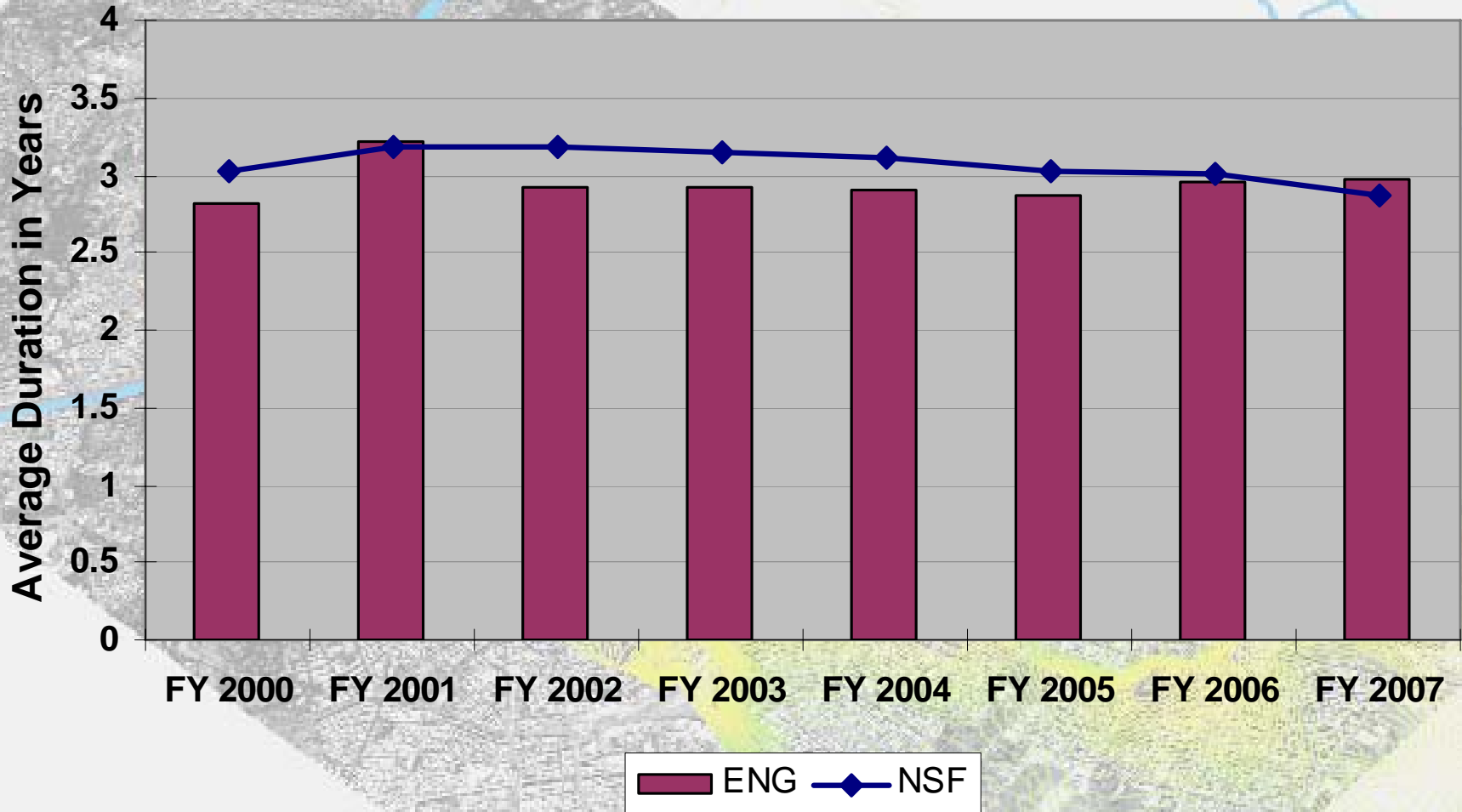


Award size data annualized.

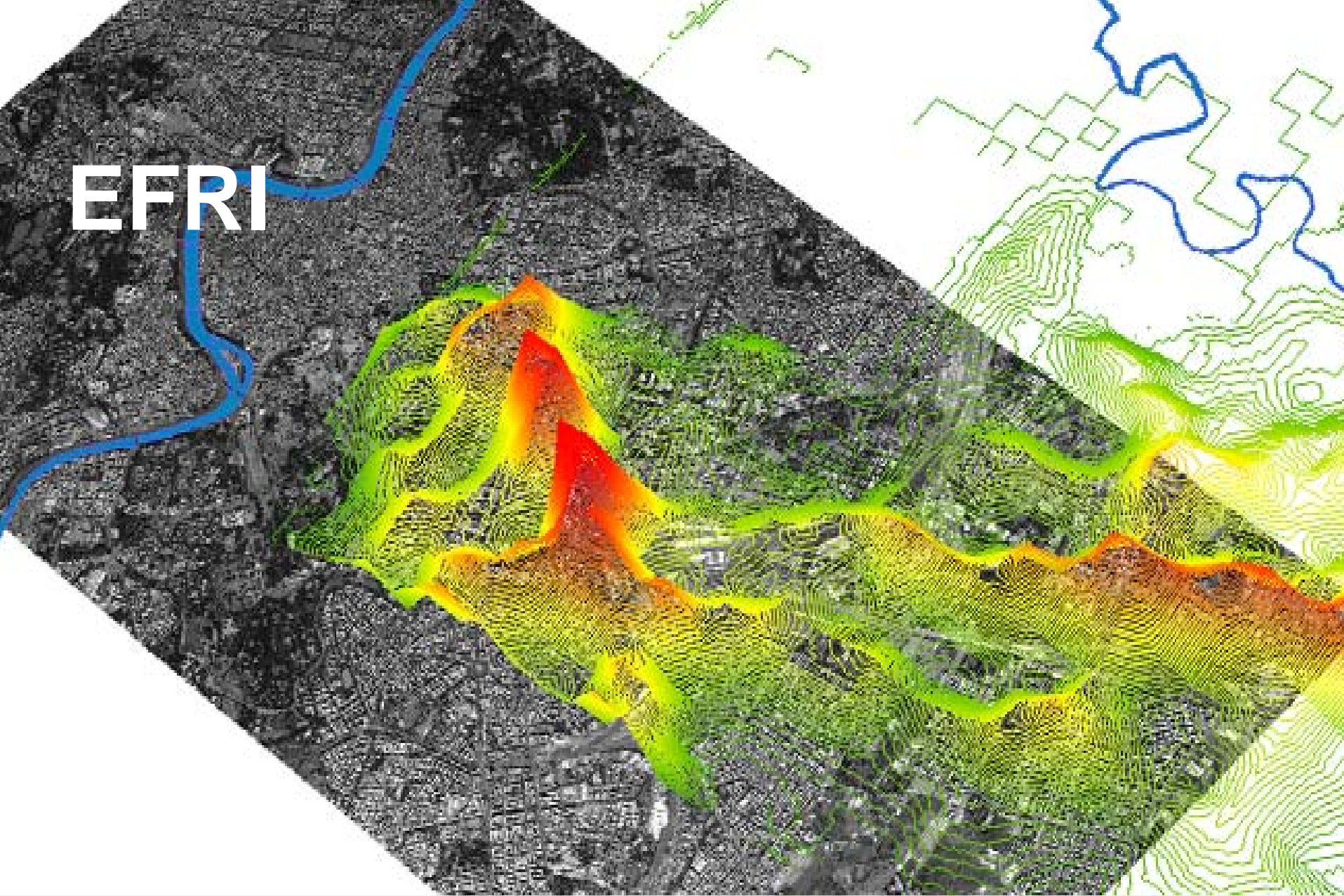


Average Award Duration in Years

ENG Research Grants in Comparison to NSF



EFRI



EFRI Office

- EFRI will support higher risk, higher payoff opportunities leading to:
 - ◆ new research areas for NSF, ENG, and other agencies
 - ◆ new industries/capabilities resulting in a leadership position
 - ◆ significant progress on advancing a “grand challenge”
- Successful topics would likely require:
 - ◆ small- to medium-sized interdisciplinary teams
 - ◆ the necessary time to demonstrate substantial progress and evidence for follow-on funding through other established mechanisms
- The current investment for EFRI totals \$25 million for 4-year awards at \$500k per year.



EFRI Timeline

Community Input
(Continuous)

- Workshops
- Meetings
- Panels
- AdCom
- Societies
- Academies
- Proposals
- Publications
- COV

