Directorate for Engineering Advisory Committee

April 19-20, 2007

National Science Foundation
Directorate for Engineering

Assistant Director for Engineering
Richard O. Buckius

ENG Advisory Committee

Topics

- Meeting Overview and Staff Introductions
- ENG Update
- NSF and NSB Activities
- National, NSF and ENG Trends

ENG Advisory Committee

Meeting Topics

- Directorate Update
- EFRI Update
- Diversity and Broadening Participation
- ENG Division Plans
- NAE Project: Grand Challenges for Engineering
- NAE Project: Understanding and Improving K-12 Engineering Education in the United States
- Engineering PhD Education

ENG Advisory Committee

Meeting Topics

- Break out groups
  - Engineering PhD Education
  - Engineering Grand Challenges
- Update on Cyberinfrastructure Activities
- IIP COV Report
- NAE Project: Developing Effective Messages for Improving Public Understanding of Engineering
- Meet with Deputy Director

New Staff Introductions

- Office of the Assistant Director
  - Shirah Pope, Secretary to the Assistant Director
  - Beverly Baker, Secretary to the Deputy Assistant Director (on detail)
- Chemical, Bioengineering, Environmental, and Transport Systems
  - Rosemary Wesson, Program Director, Energy and Sustainability
  - William Young, Program Assistant

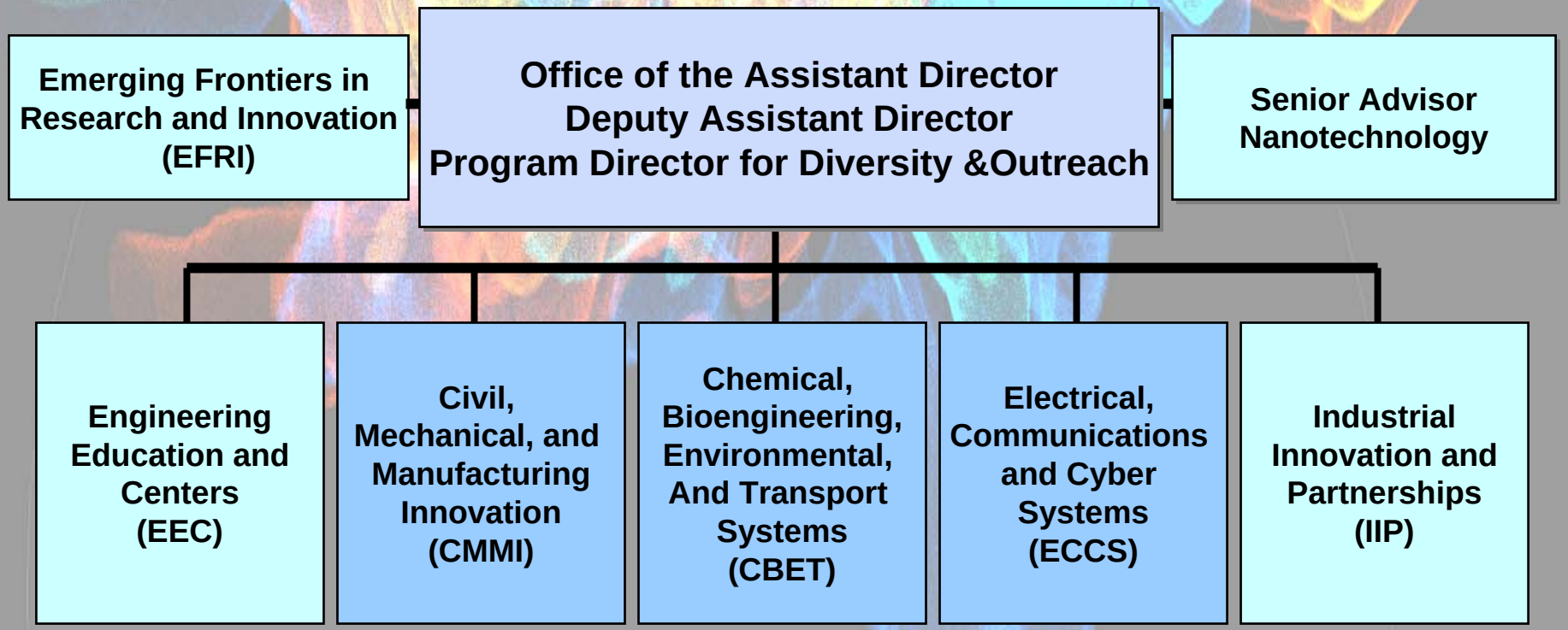
New Staff Introductions

- Electrical, Communications and Cyber Systems
  - Dagmar Niebur, Program Director, Power, Controls and Adaptive Networks, Drexel University
  - Yogesh Gianchandani, Program Director, Integrative, Hybrid and Complex Systems, University of Michigan
- Industrial Innovation and Partnerships
  - William Haines, Program Manager, Electronics, Seagate Technology, Bloomington, MN
  - Cheryl Albus, Program Director, Advanced Materials and Manufacturing
  - Patrick Ravanera, Administrative Officer

ENG Organization Update

Directorate for Engineering

FY 2007



ENG Diversity and Outreach

Goals

- Excellence and innovation through diversity
- To enable the integration and success of a diverse engineering workforce, both inside and outside NSF
- To make the demographics in engineering disciplines representative of the US census
  - The challenge is preparing for the demographics of the future
  - K-12 outreach simply cannot be separated from any research or diversity initiative

Environmental Sustainability

CBET

- Supports engineering research with the goal of promoting sustainable engineered systems that support human well-being and that also are compatible with sustaining natural (environmental) systems, which provide ecological services vital for human survival.
- Two submission windows each year – first closed on March 1, 2007 for FY07.
- 48 received and under review.
- Areas of submissions include:
  - Green Engineering (~50%)
  - Ecological Engineering (~25%)
  - Industrial Ecology (~15%)
  - Earth Systems Engineering (~5%)
  - Other

Environmental Sustainability
Cindy Lee

Energy for Sustainability

CBET

- Supports fundamental research and education in the areas of
  - Energy production, conversion, and storage, and
  - Focused on energy sources that are environmentally friendly and renewable.
- Two submission windows each year – first closed on March 1, 2007 for FY07.
- Over 200 received and under review.
- Areas of submissions include:
  - Fuel Cells (~30%)
  - Solar-related (~15%)
  - Biofuels (~15%)
  - Others – hydrogen-related, renewable energy sources, wind, etc.

Energy for Sustainability
Rose Wesson/
Trung Van Nguyen

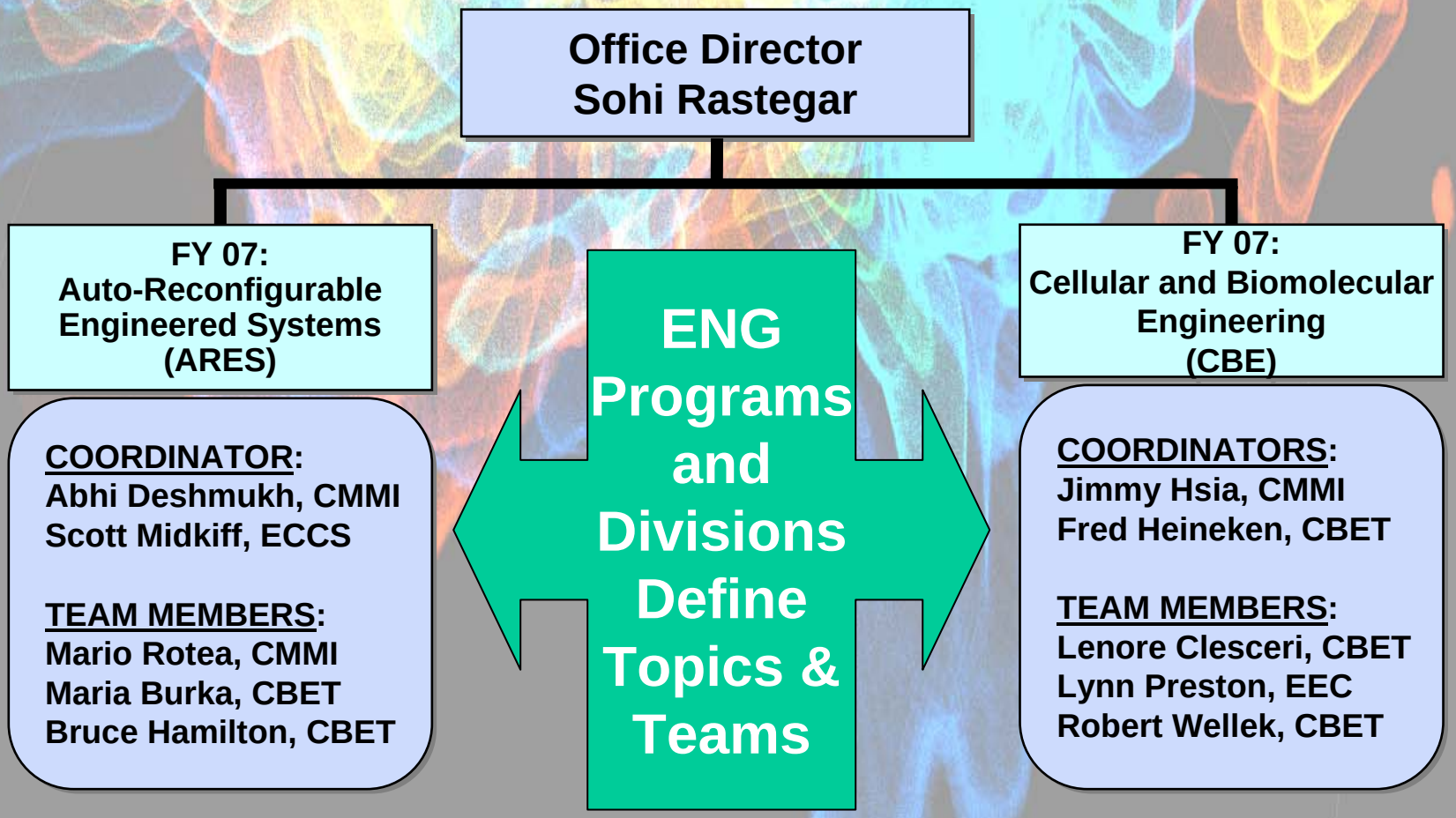
Cybersystems

ECCS

Cybersystems; Signal Processing
Scott Midkiff

- **Supports fundamental research that integrates physical devices with distributed sensing and actuation, communications, storage, computation and control of complex systems that enables visualization, analysis and reconfiguration for reliable and agile infrastructures for domain-specific applications.**
- **Two submission windows each year - September 7 through October 7 and January 7 through February 7.**
- **78 unsolicited proposals received in FY 2007.**
- **Areas of submissions include: Hybrid and integrative networks, Integrated signal processing for high-performance computing and networking, and New algorithms and architectures for secure and robust computing.**

Emerging Frontiers in Research and Innovation



NSF and NSB Activities

Transformative Research

NSB 07-32

- **NSB CONCERN: "Transformative research frequently does not fit comfortably within the scope of project-focused, innovative, step-by-step research or even major centers, nor does it tend to fare well wherever a review system is dominated by experts highly invested in current paradigms or during times of especially limited budgets that promote aversion to risk."**
- **NSB PROPOSED SOLUTION: "That NSF develop a distinct, Foundation-wide Transformative Research Initiative (TRI) distinguishable by its potential impact on prevailing paradigms and by the potential to create new fields of science, to develop new technologies, and to open new frontiers."**

Transformative Research

NSB

- **NSB DEFINITION: "Transformative research is defined as research driven by ideas that stand a reasonable chance of radically changing our understanding of an important existing scientific or engineering concept or leading to the creation of a new paradigm or field of science or engineering. Such research also is characterized by its challenge to current understanding or its pathway to new frontiers."**

Transformative Research

IPAMM Survey – 24,500 responses

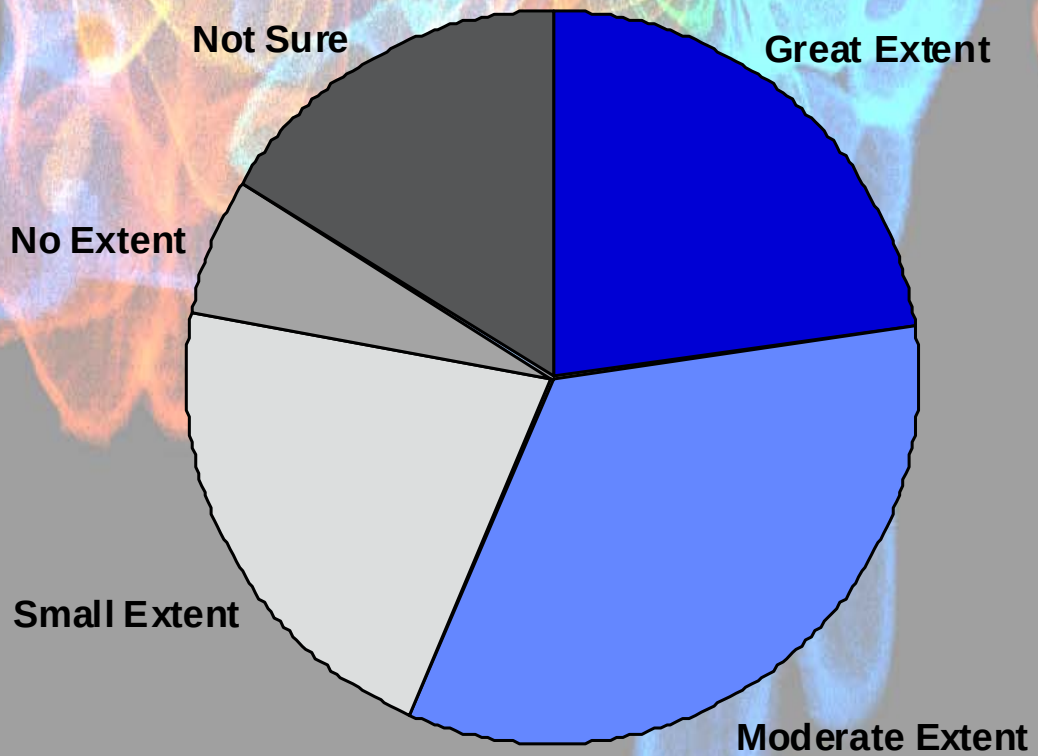
- **Where are you most likely to seek funding for a transformative research idea?**

RESPONSE	PERCENT
NSF	44.7%
Combination of Multiple Funding Sources	19.1%
Other Federal Agencies - DOD, HHS, NASA, etc.	12.6%
N/A	7.9%
Private Foundations	7.4%
My Institution	5.1%
Industry	1.7%
Other	0.9%
State or Local Government	0.5%

Transformative Research

IPAMM Survey

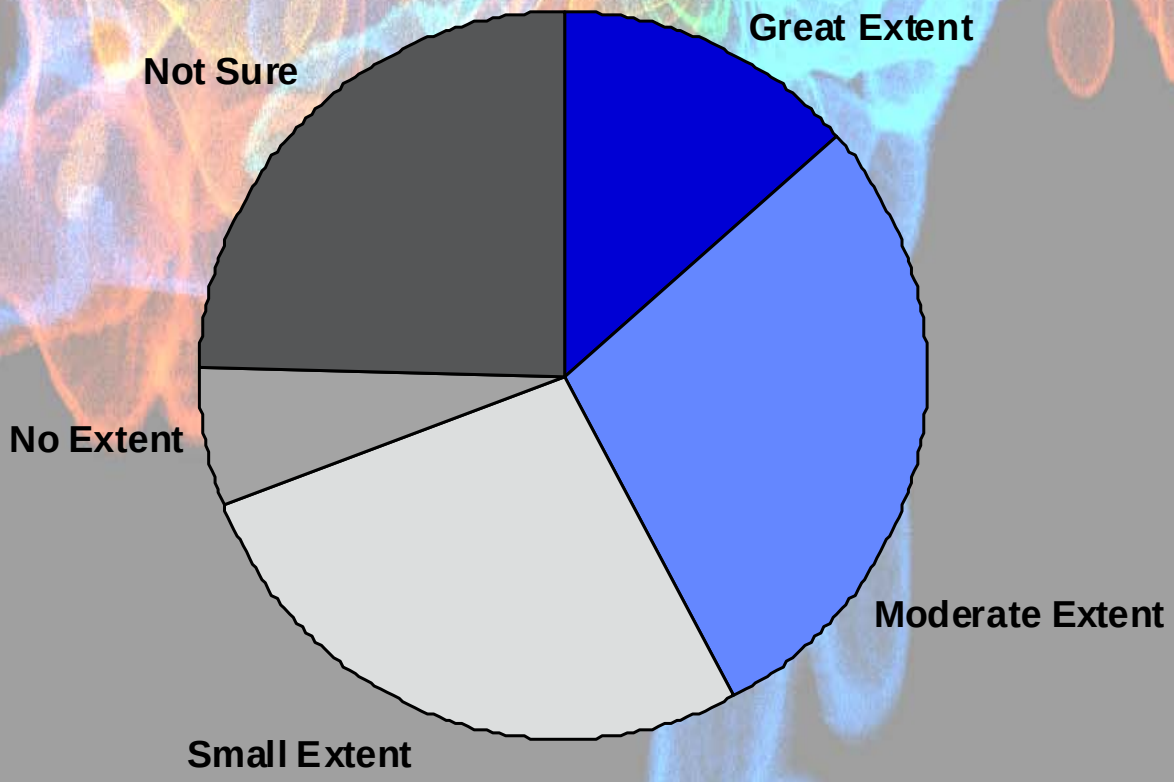
- I feel that NSF *welcomes* transformative research proposals.



Transformative Research

IPAMM Survey

- I feel that NSF *funds* transformative research proposals.



Transformative Research

NSF Examples

- Small Grant for Exploratory Research (SGER)
- Nanoscale Exploratory Research (NER)
- Accomplishment-based awards
- Directorate level offices - BIO's Emerging Frontiers (EF) Division, ENG's Office for Emerging Frontiers in Research and Innovation (EFRI) and MPS's Office of Multidisciplinary Activities (OMA)
- Directorates support of transformative research through internal reserved incentive funds - SBE Innovative Program Development Reserve (IPDR)

NSB Engineering Education

NSB Report

- NSB has sponsored two workshops at MIT and Georgia Tech focused on Engineering Education.
- NSB is currently preparing their report.
- Considered wide-ranging topics including:
  - Undergraduate retention,
  - Educational experiences, and
  - Public perceptions.
- Some items related to NSF include:
  - Existing programs: REU, RET, IGERT, GK-12, ADVANCE,
  - Encouraging interdisciplinary engineering education, and
  - Pathway issues.

NSF Strategic Planning

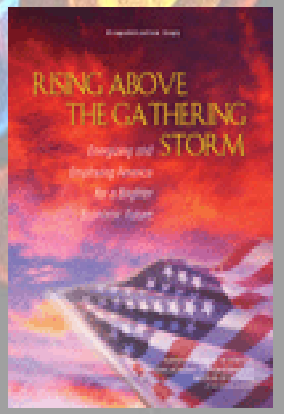
NSF Strategic Goals – 2006-2011

- **Discovery: Advancing the frontiers of knowledge**
- **Learning: Cultivate and expand and world-class, broadly inclusive engineering workforce**
- **Research Infrastructure: Fill the gaps in advanced instrumentation, facilities, and cyberinfrastructure**
- **Stewardship: Enhance the capability and responsiveness of the organization**

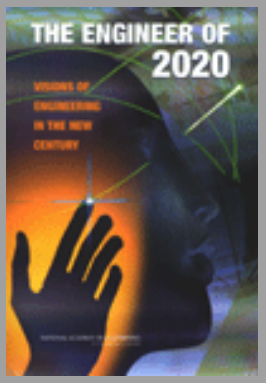
National, NSF and ENG Trends

External Reports

- The National Academies' *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* recommends enhancements in
  - K-12 education
  - Research
  - Higher Education
  - Economic policy

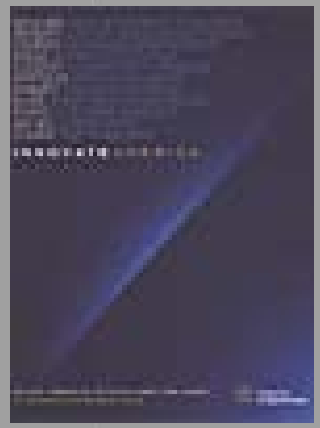


- *The Engineer of 2020* (NAE, 2004) and *Educating the Engineer of 2020* (NAE, 2005) asks "… how to enrich and broaden engineering education so that those technically grounded graduates will be better prepared to work in a constantly changing global economy."



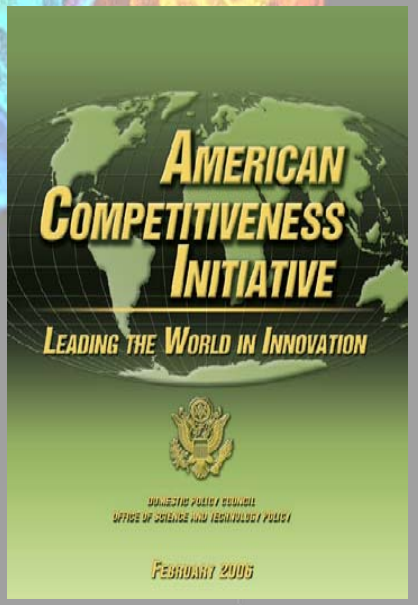
External Reports

- ***Engineering Research and America's Future*** **(NAE, 2005): Committee to Assess the Capacity of the U.S. Engineering Research Enterprise**
  - **Recommends increased research support for engineering and physical sciences**
  - **Seeks enhanced partnership, infrastructure and workforce activities**
- ***Innovate America: National Innovation Initiative*** **Final Report (Council on Competitiveness, 2005)**
  - **Recommends increased support for workforce, research investments and infrastructure**
  - **Stresses importance of frontier and interdisciplinary research**



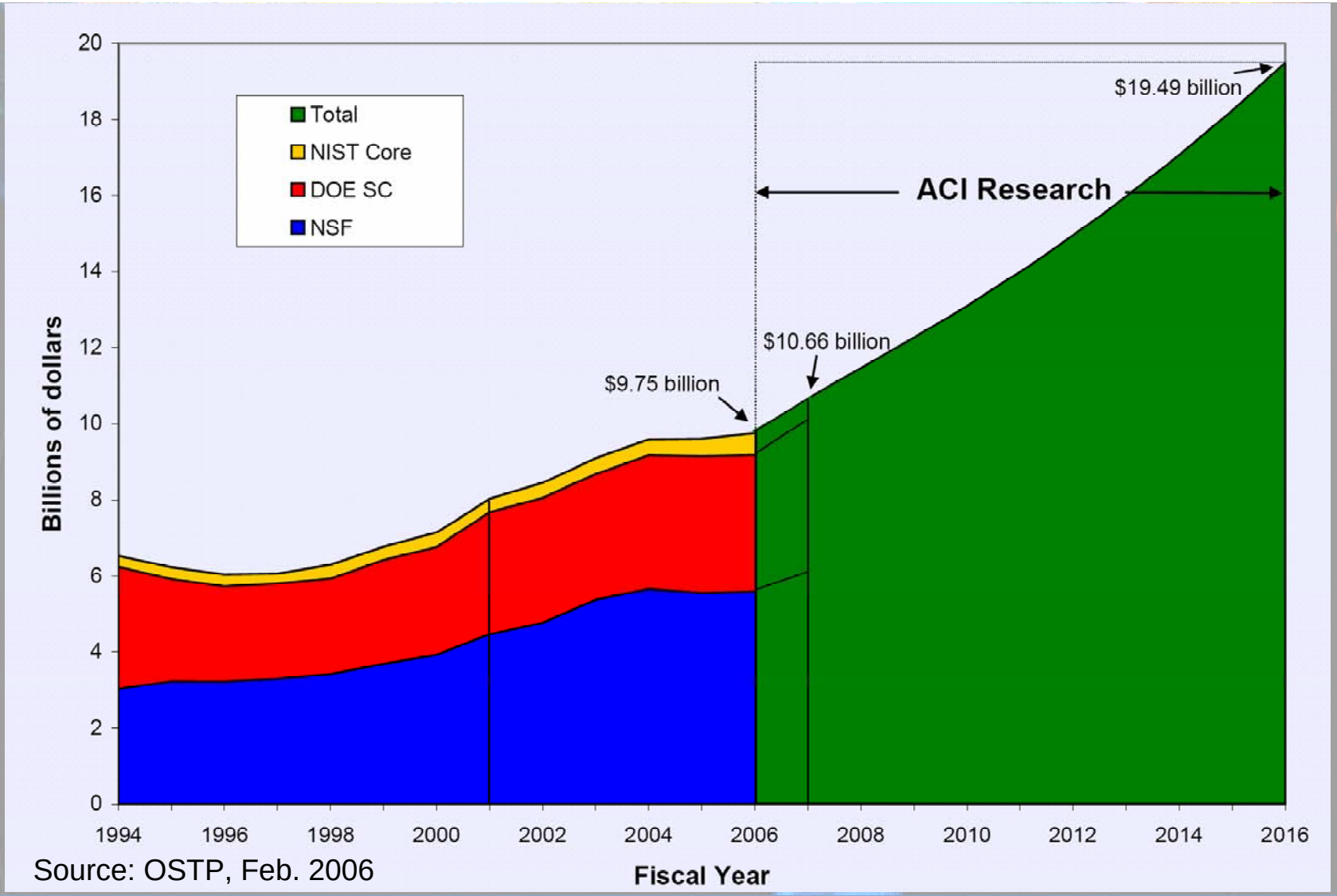
American Competitiveness Initiative

- 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 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



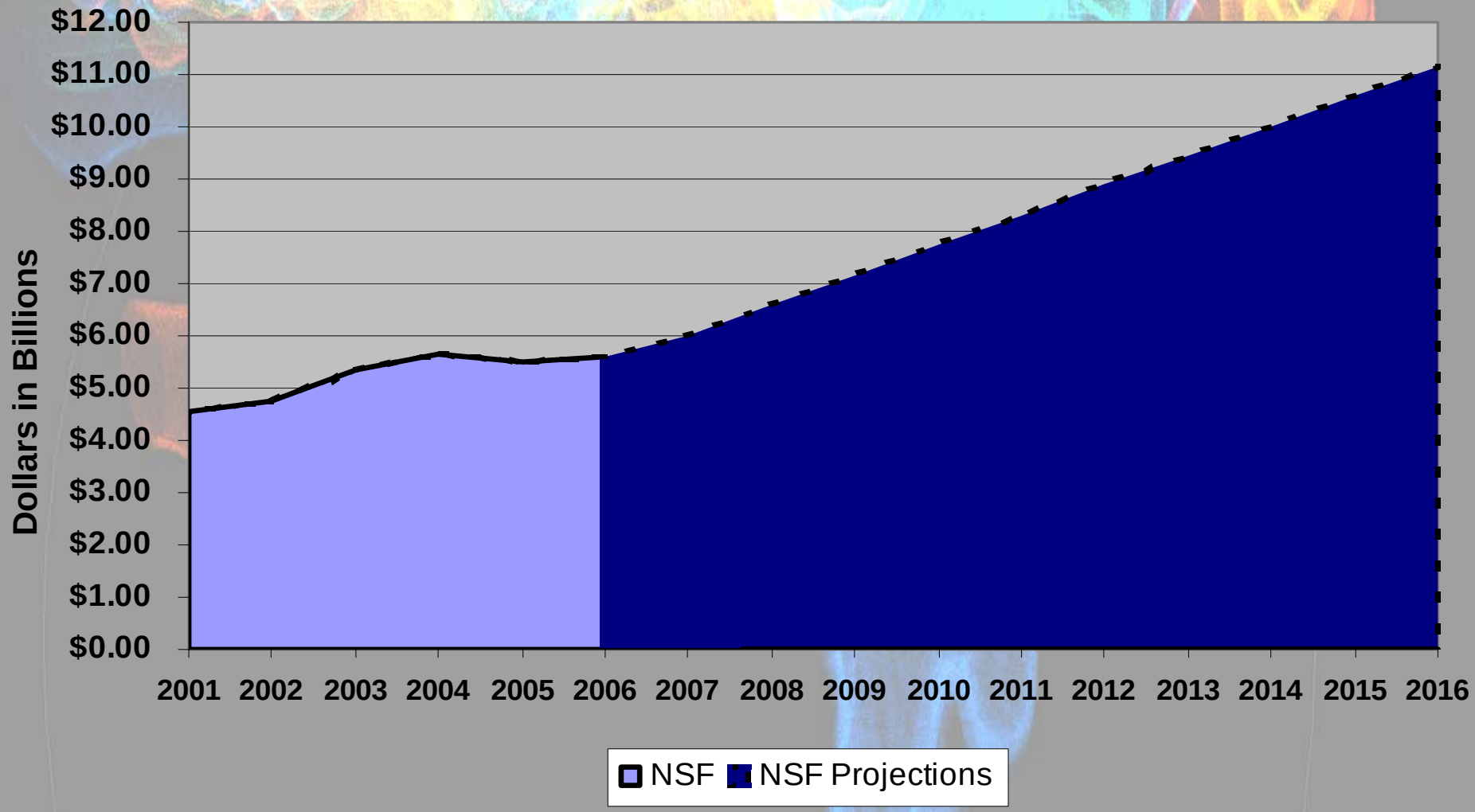
American Competitiveness Initiative

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 Budget by Research Directorate

Dollars in Millions

Directorate	FY 2006 Actual	FY 2007 Request	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%

NSF-wide Investments Totals

Dollars in Millions

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	80.03	42.58	0.00	-42.58	-100.00%
Climate Change Science Program	196.88	205.25	208.25	3.00	1.46%
Cyber-enabled Discovery & Innovation	0.00	0.00	51.98	N/A	N/A
Cyberinfrastructure	520.50	597.31	644.09	46.78	7.83%
Human and Social Dynamics	39.47	41.45	37.95	-3.50	-8.44%
Mathematical Sciences	88.81	78.45	0.00	-78.45	-100.00%
National Nanotechnology Initiative	359.71	373.18	389.90	16.72	4.48%
Networking & Information Technology R&D	811.53	903.74	993.69	89.95	9.95%

Cyber-Enabled Discovery & Innovation (CDI)

"Broaden the Nation's capability for innovation by developing a new generation of computationally based discovery concepts and tools to deal with complex, data-rich, and interacting systems."

- **ENG broadly supports research in advanced cyber-enabled engineering throughout all its divisions.**
- **CDI investments areas include:**
  - **Complex interactions**
  - **Computational experimentation**
  - **Knowledge extraction**
  - **Virtual environments**
  - **Education in computational discovery**

- **Budgets -**

2008	2009	2010	2011	2012
$51.98m	$100m	$150m	$200m	$250m

Engineering FY 2008 Budget Request

Dollars in Millions

	FY 2006 Actual	FY 2007 Plan	FY 2008 Request	Change over FY 2007 Request	
				Amt	%
CBET	$125.09	$128.29	$144.97	$16.68	13.0%
CMMI	148.82	156.86	174.08	17.22	11.0%
ECCS	77.91	83.40	93.96	10.56	12.7%
IIP	109.65	120.08	128.39	8.31	6.9%
Small Business Innovation Research (SBIR)	*99.45*	*108.88*	*116.41*	7.53	6.9%
EEC	123.99	114.92	116.90	1.98	1.7%
EFRI	-	25.00	25.00	-	-
Total, ENG	$585.46	$628.55	$683.30	$54.75	8.7%

(Totals may not add due to rounding.)

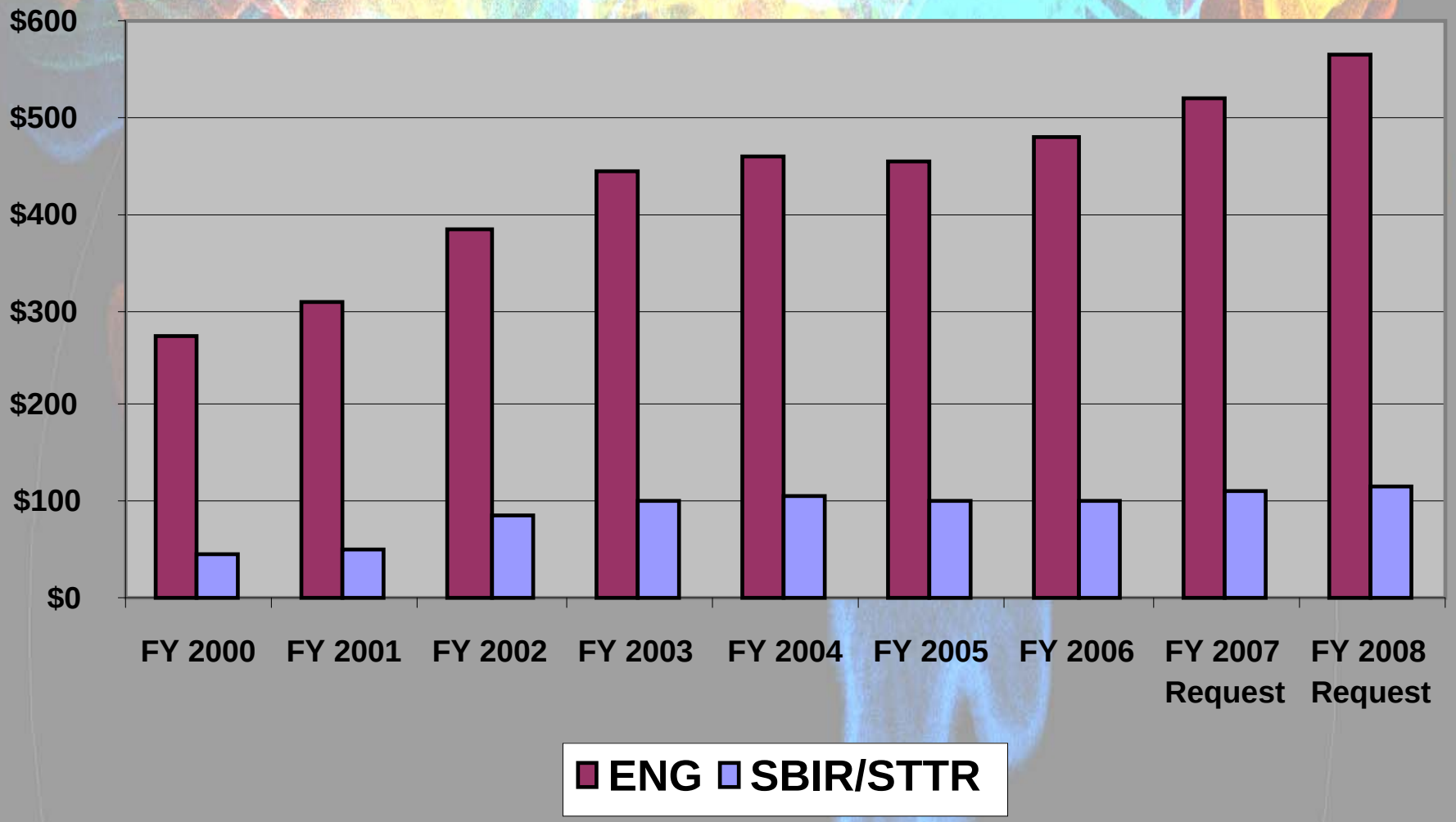
ENG NSF-wide Investments

Dollars in Millions

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Biocomplexity in the Environment	6.00	4.00	0.00	-4.00	-100.00%
Climate Change Science Program	1.00	1.00	1.00	0.00	0.00%
Cyber-enabled Discovery & Innovation	0.00	0.00	10.00	10.00	N/A
Cyberinfrastructure	52.00	54.00	58.00	4.00	7.41%
Human and Social Dynamics	2.00	2.00	1.50	-0.50	-25.00%
Mathematical Sciences	2.91	1.46	0.00	-1.46	-100.00%
National Nanotechnology Initiative	123.77	137.02	139.02	2.00	1.46%
Networking & Information Technology R&D	11.20	11.20	21.20	10.00	89.29%

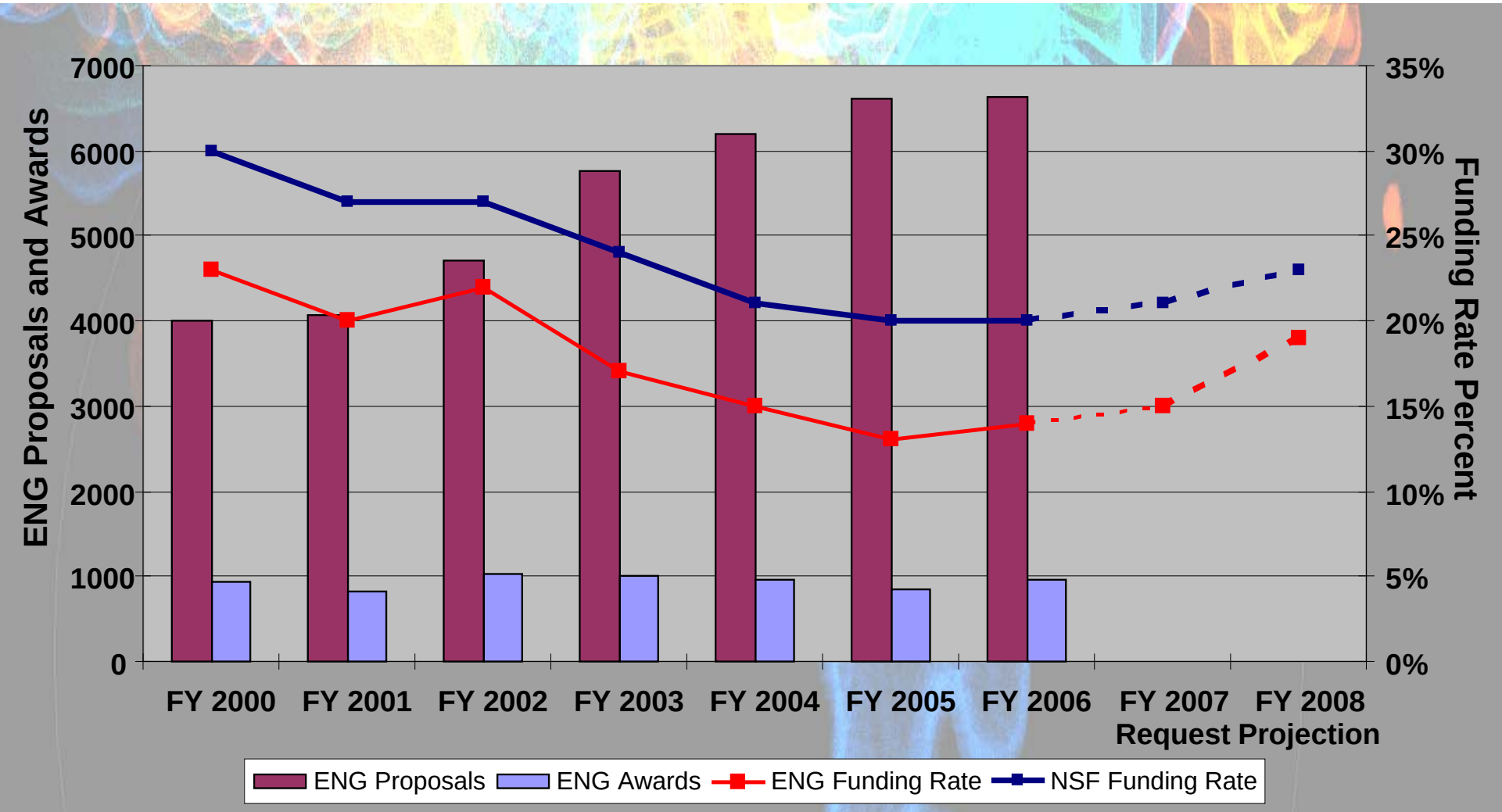
ENG and SBIR/STTR Budget History

Dollars in Millions

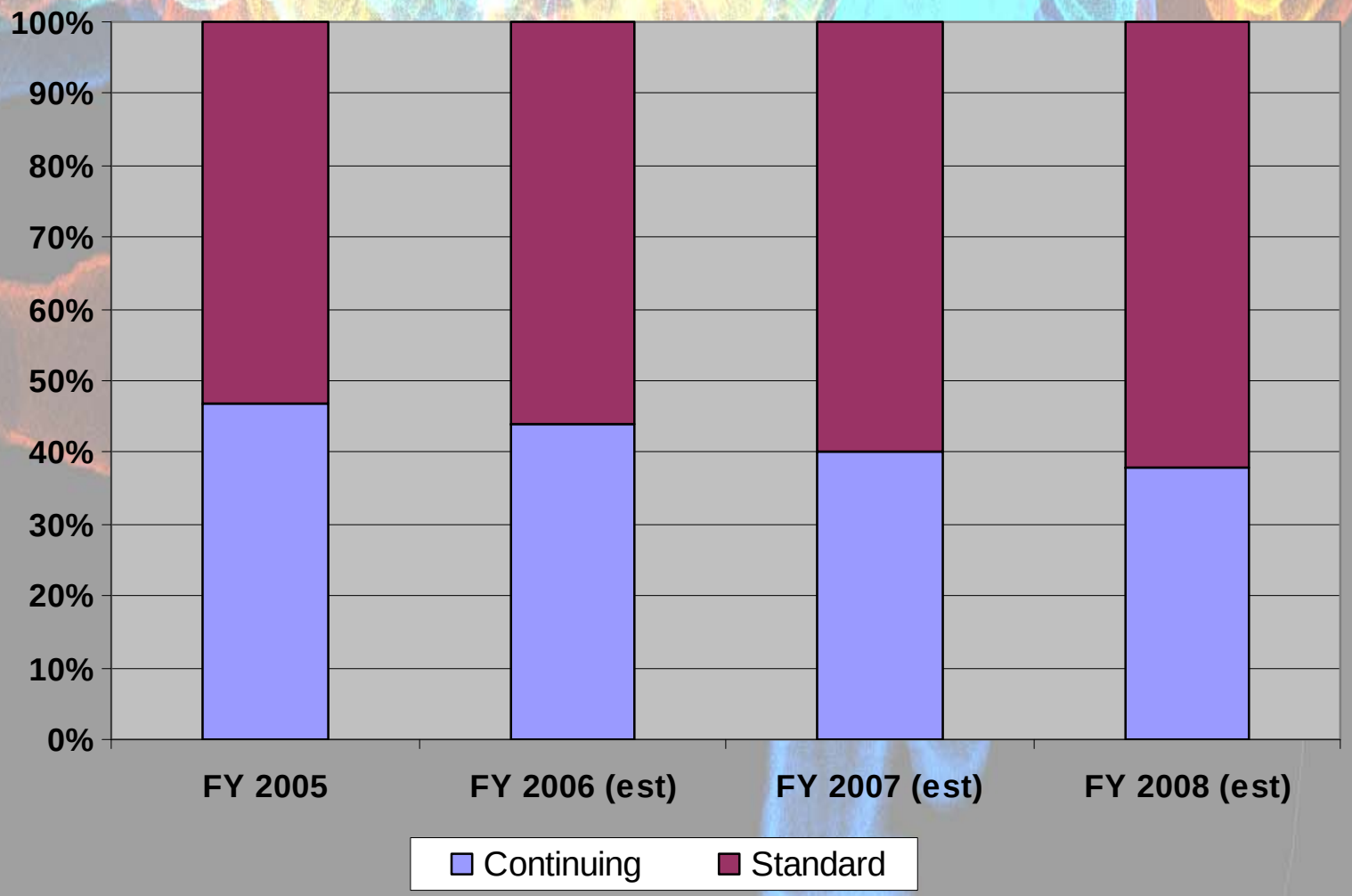


ENG and NSF Funding Rates

Research Grants

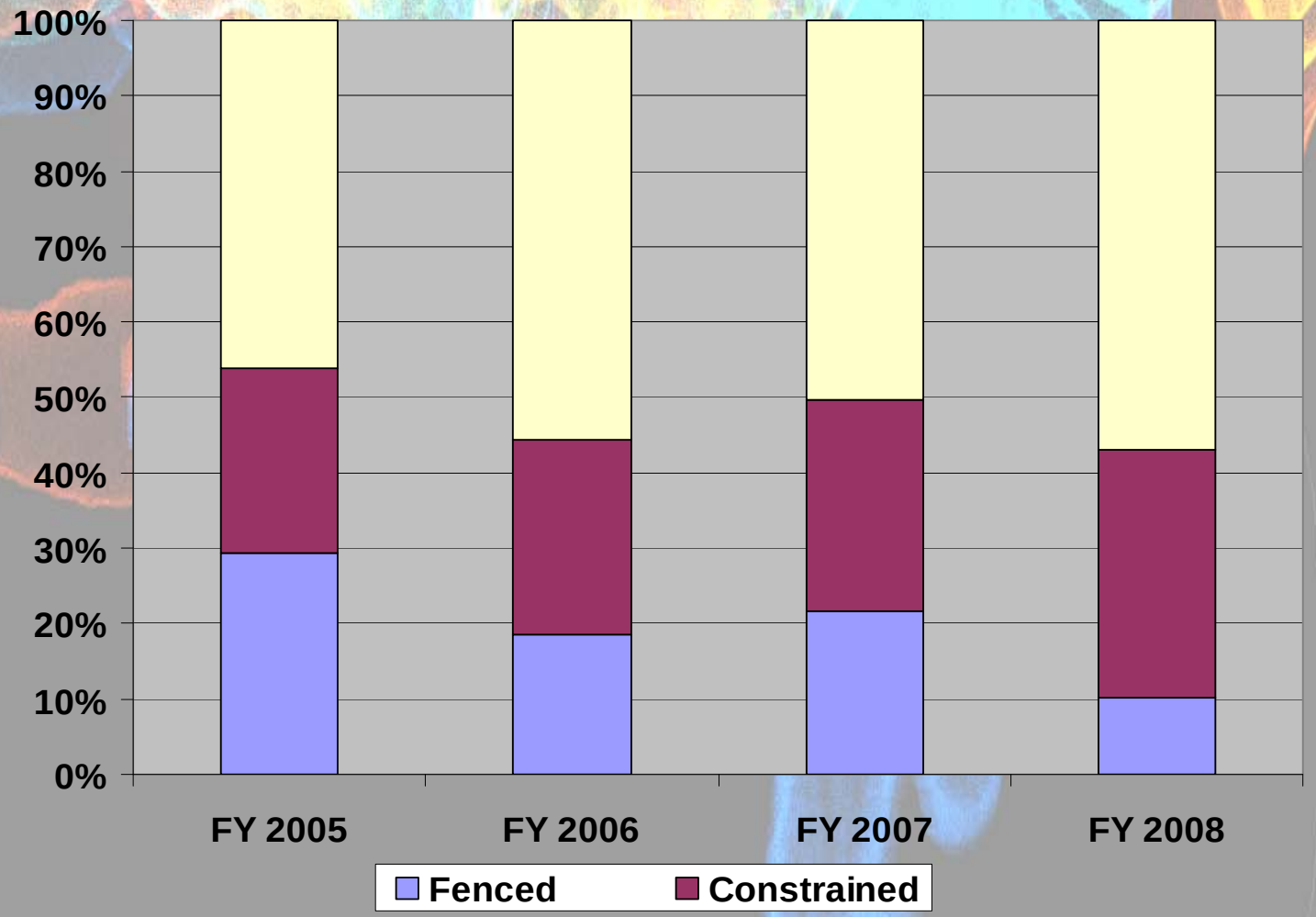


ENG Standard vs. Continuing Grants



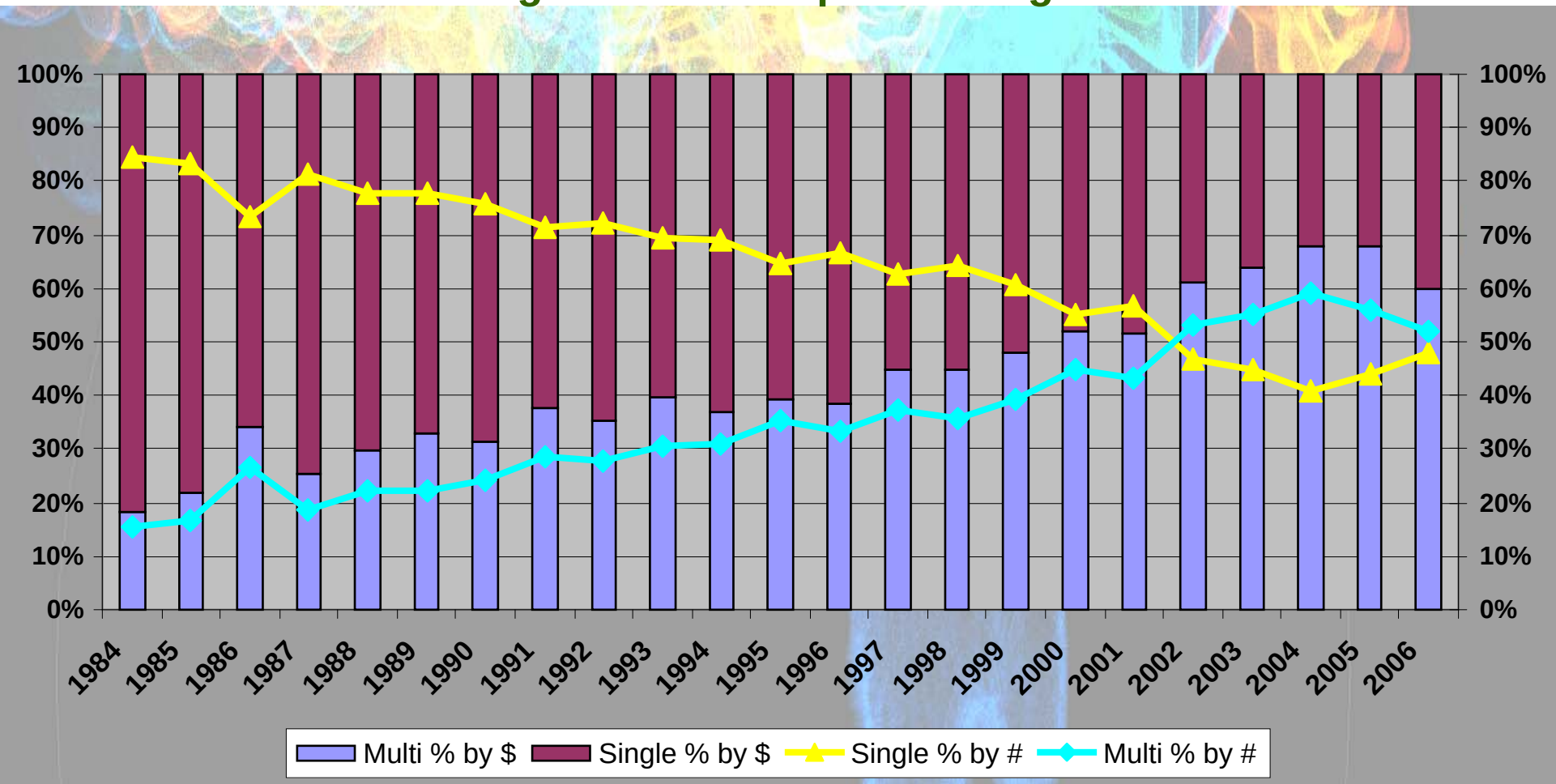
ENG Funding Analysis

Fenced vs. Constrained vs. Unfenced



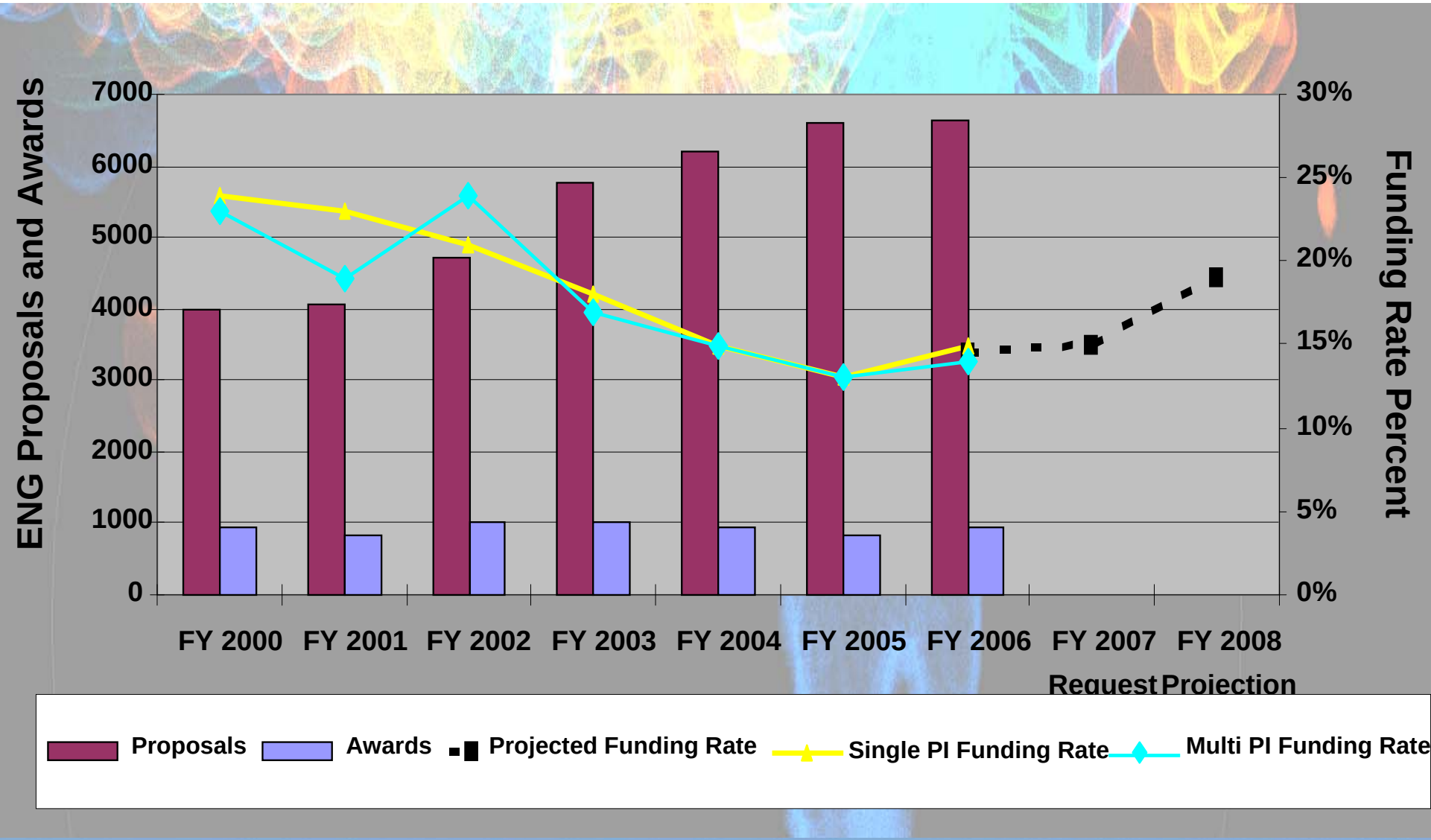
Research Collaborations

Percent of Single PI vs. Multiple Investigator Awards



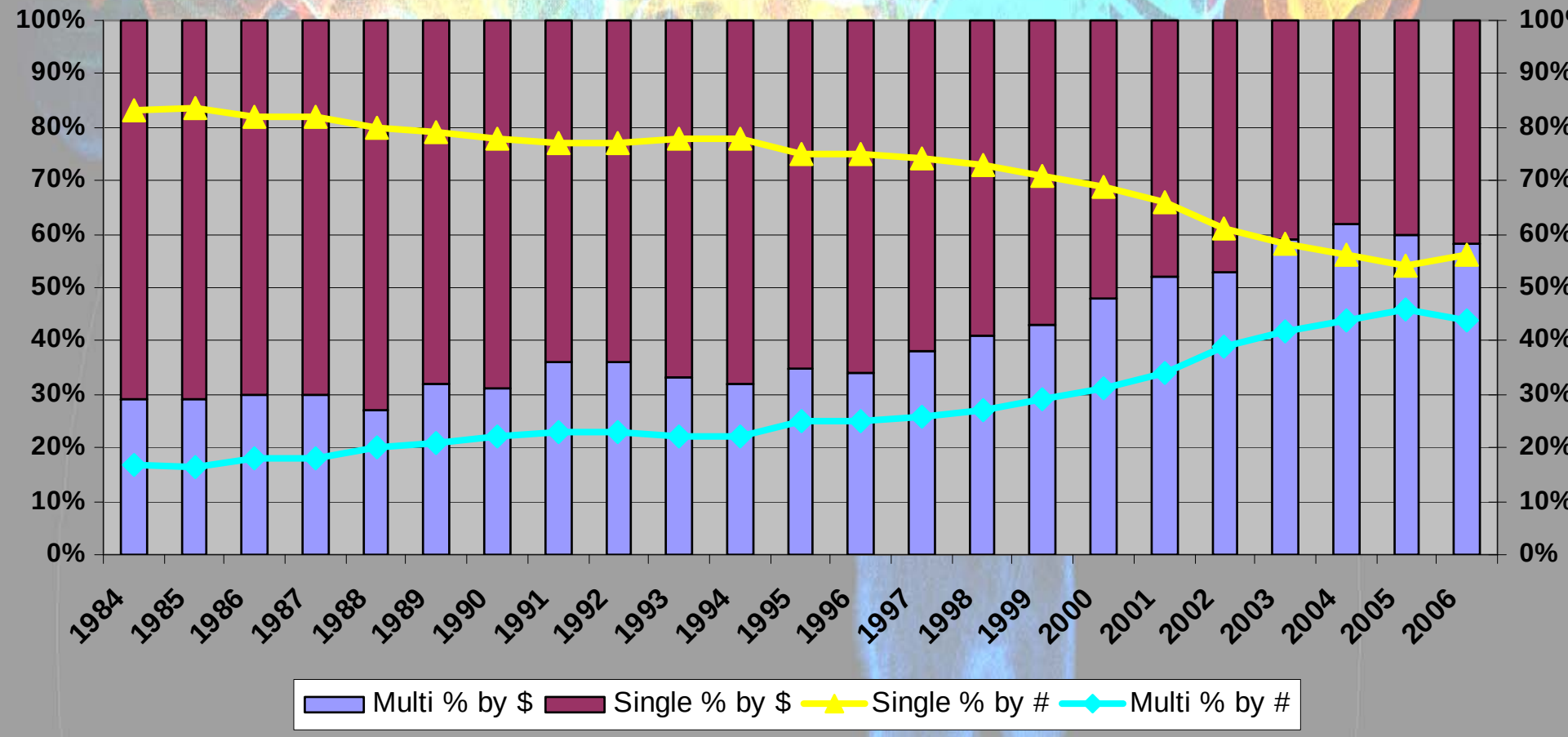
ENG Funding Rates

Research Grants



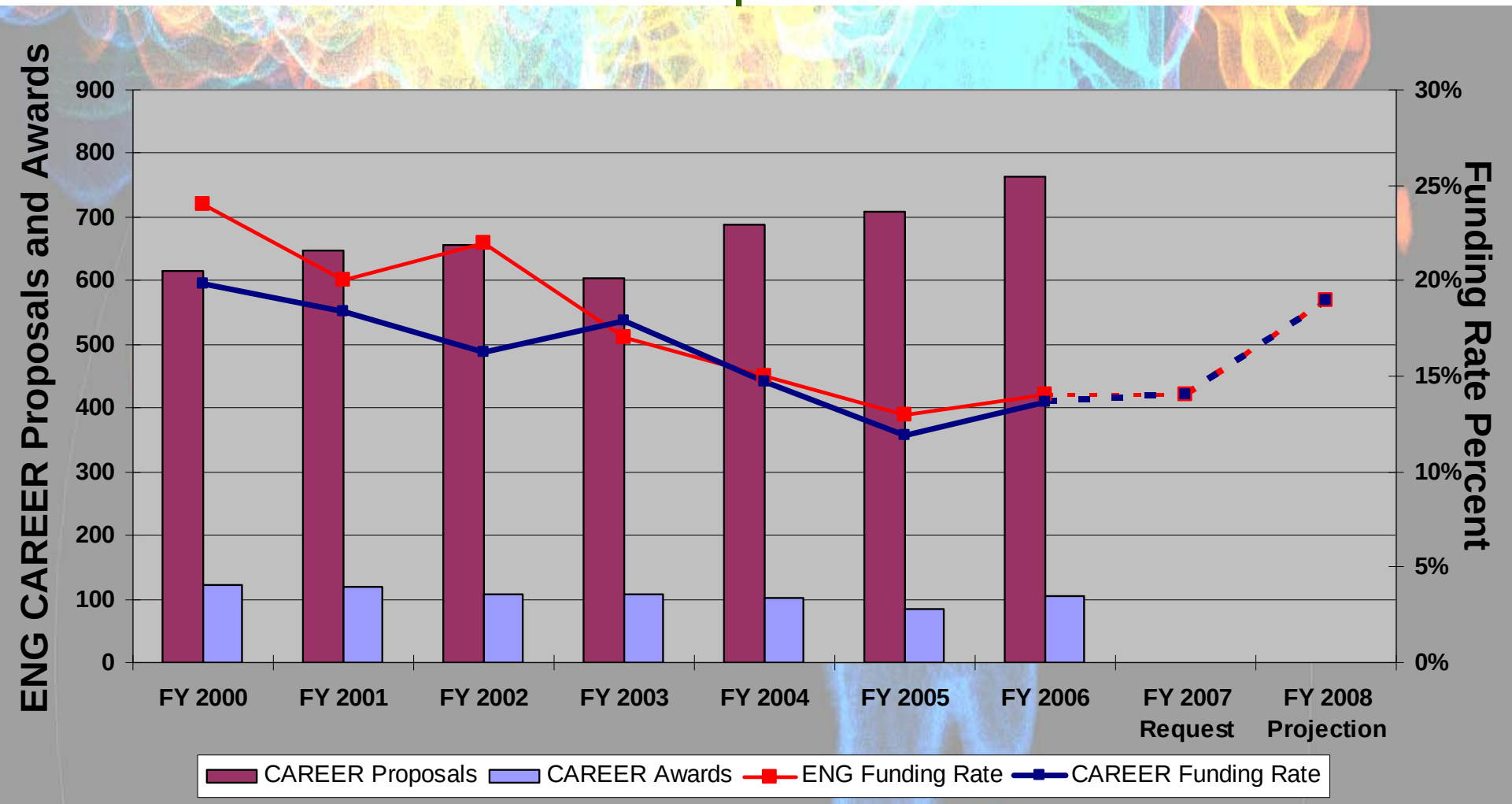
NSF Research Collaborations

Percent of Single PI vs. Multiple Investigator Awards



CAREER Funding Rates

ENG CAREER Proposals and Awards



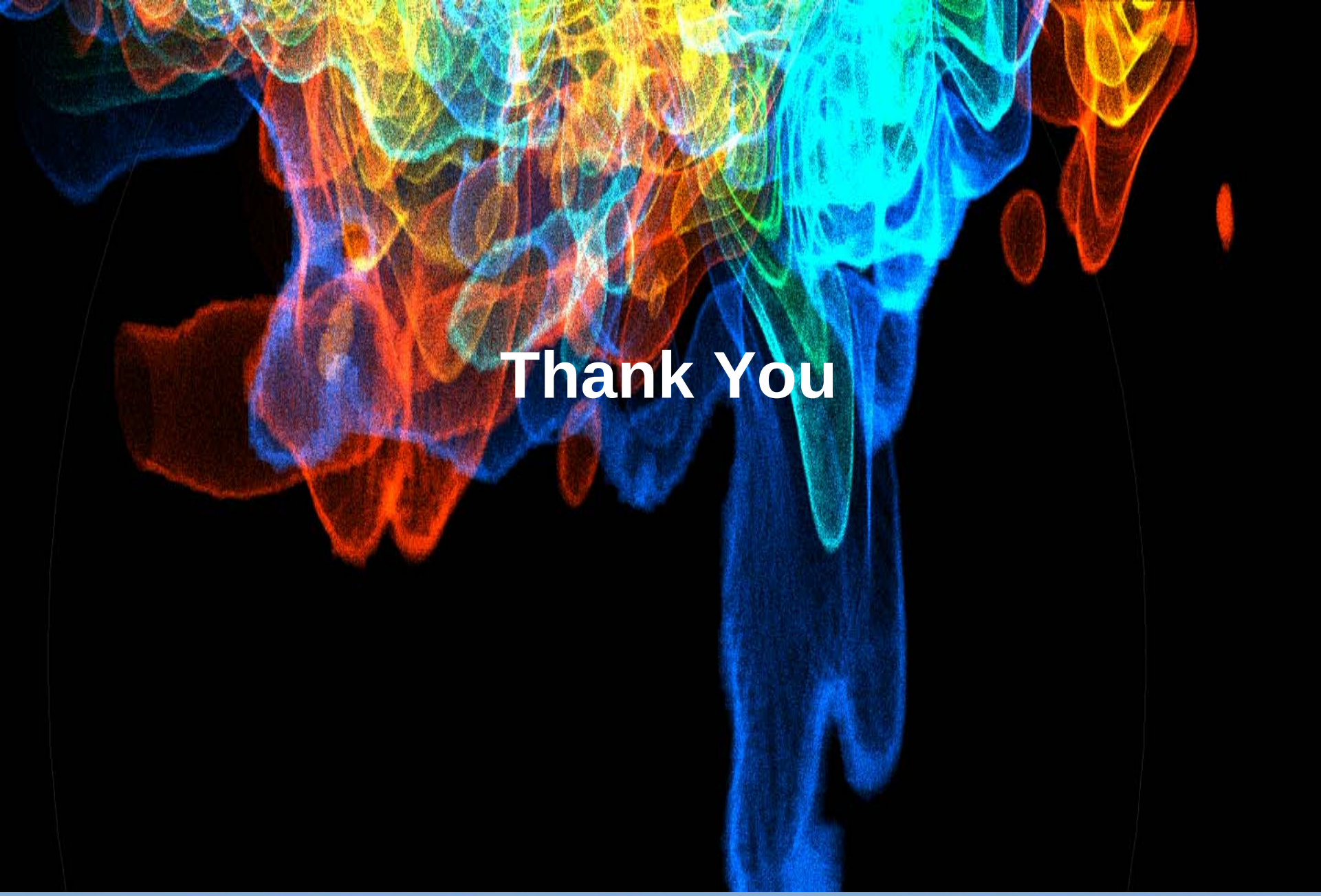
Recent Solicitations

- Active Nanostructures and Nanosystems – NSF 06-595, August 6, 2006
- Major Research Instrumentation Program – NSF 07-510, October 26, 2006
- Engineering Research Centers – NSF 07-521, November 13, 2006
- Grant Opportunities for Academic Liaison with Industry – NSF 07-522, November 13, 2006
- Explosives and Related Threats: Frontiers in Prediction and Detection – NSF 07-528, November 30, 2006
- Nanotechnology UG Education – NSF 07-554, March 13, 2007
- RET in Engineering – NSF 07-557, April 3, 2007
- Engineering Virtual Organizations – NSF 07-558, April 4, 2007

Summary and Discussion

Topics

- Directorate update
  - New ENG programs
  - NSB transformative research
  - NSF and ENG trends
- Additional Advisory Committee items
  - EFRI
  - Diversity and broadening participation
  - NSF strategic planning - ENG division plans
  - Understanding and improving U.S. K-12 engineering education
  - Break out groups
    - Engineering PhD education
    - Engineering grand challenges
  - NSF and ENG cyberinfrastructure activities
  - Messages for improving public understanding of engineering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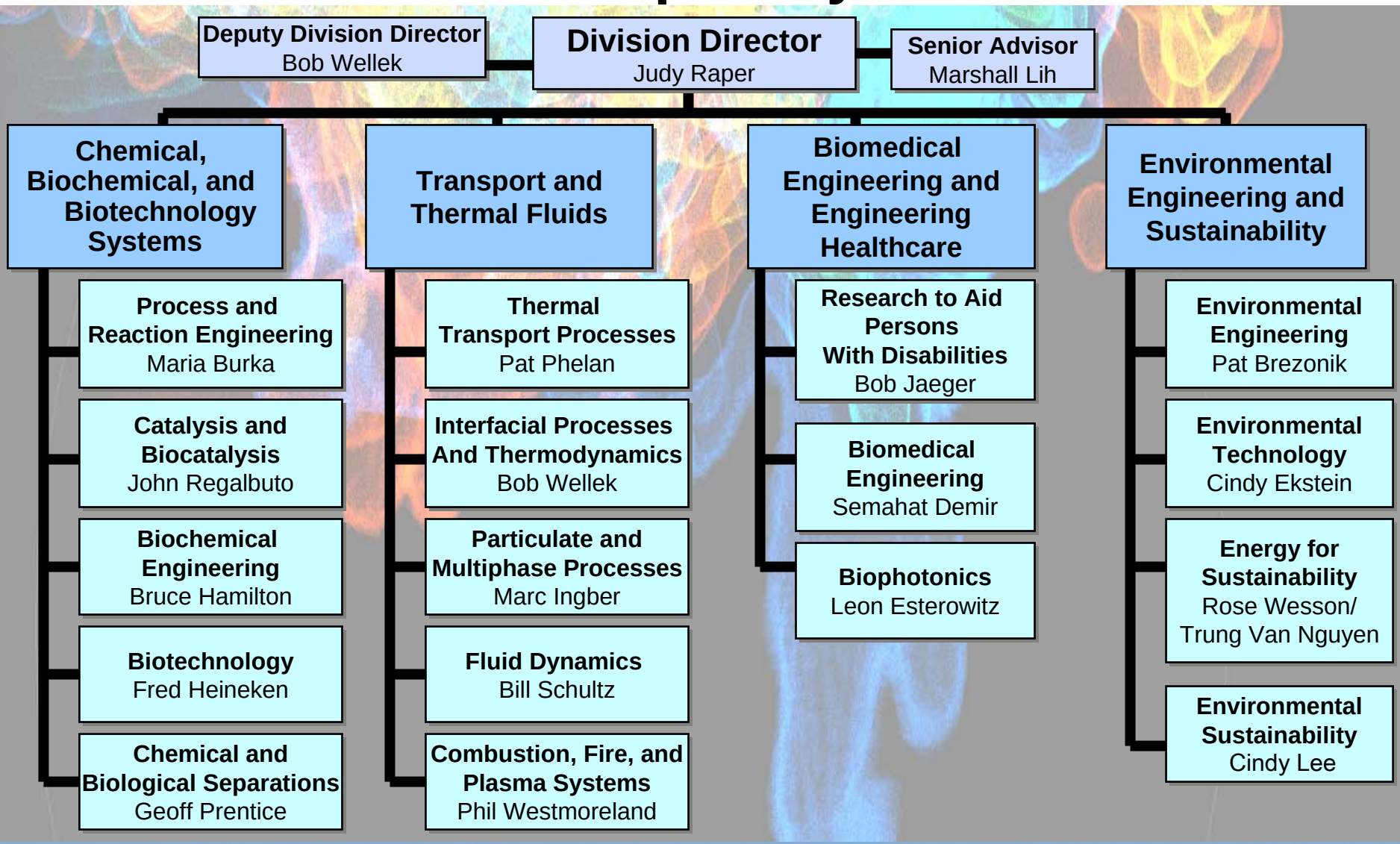
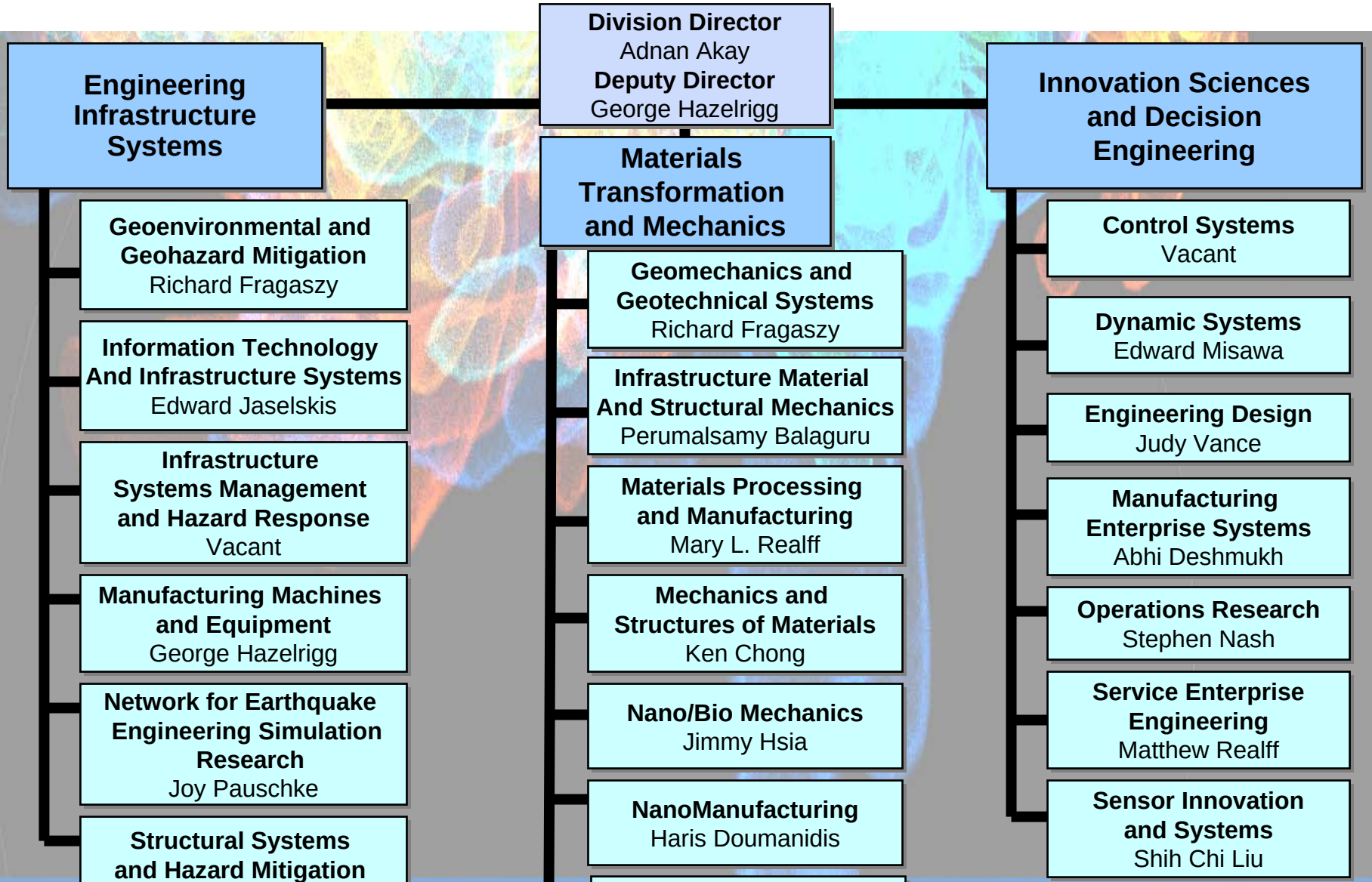
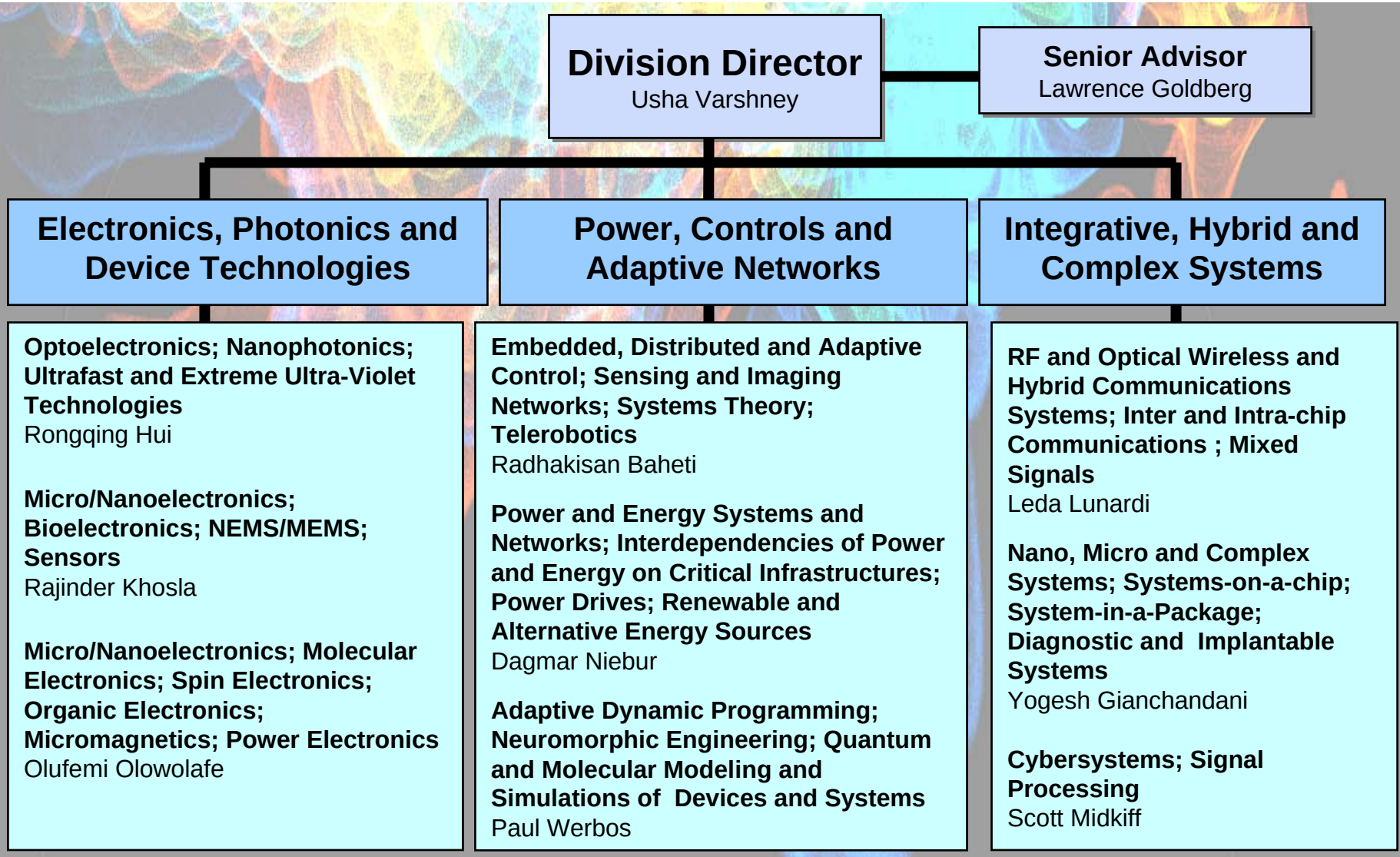
Chemical, Bioengineering, Environmental, and Transport Systems



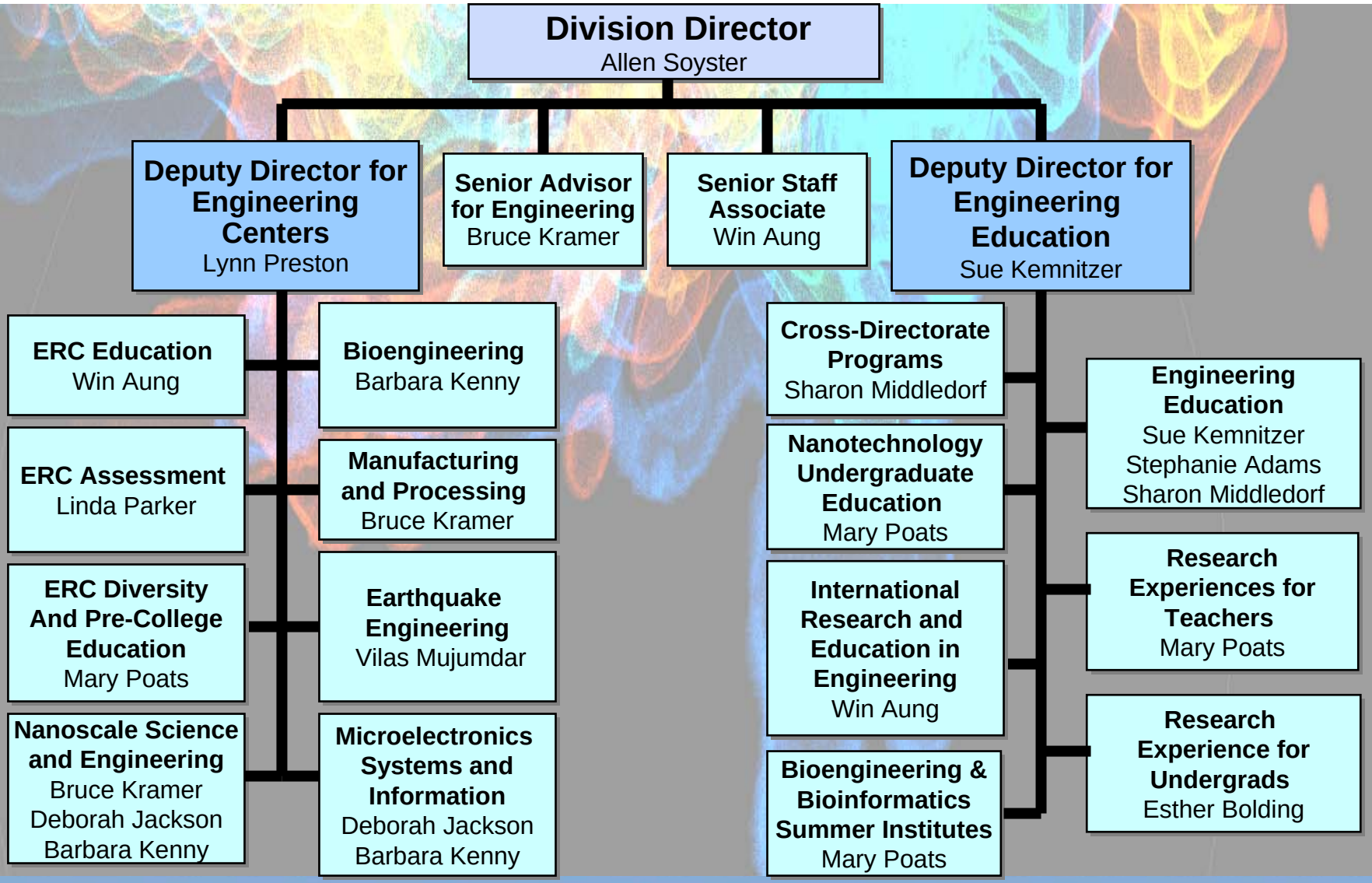
Civil, Mechanical, and Manufacturing Innovation



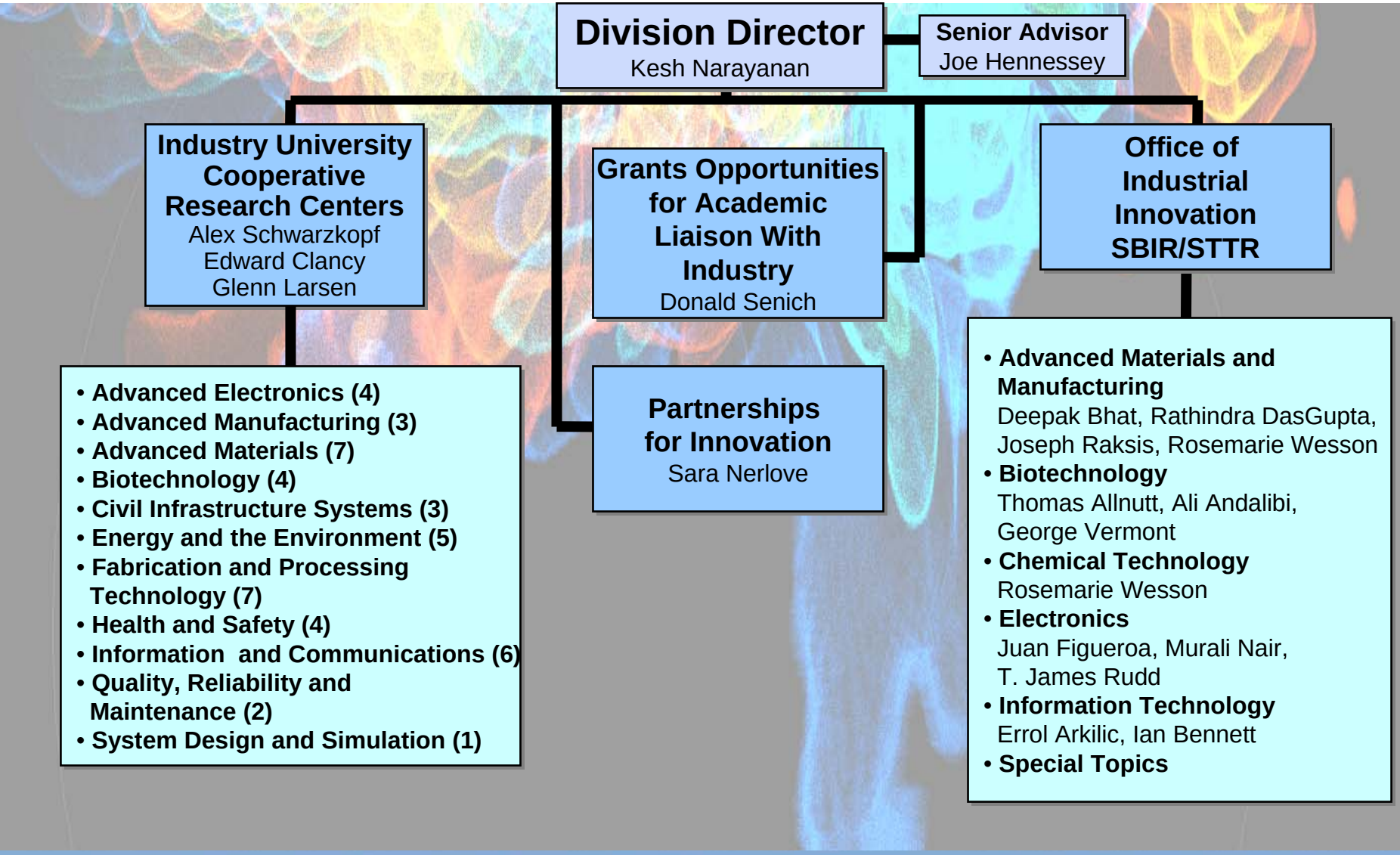
Electrical, Communications and Cyber Systems



Engineering Education and Centers



Industrial Innovation and Partnerships



EFRI Timeline