National Science Foundation
WHERE DISCOVERIES BEGIN

Funding Trends and Opportunities in the Chemical, Bioengineering, Environmental, and Transport Systems Division of NSF

T.J. (Lakis) Mountziaris

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Program Director
Process Systems, Reaction Engineering and Molecular Thermodynamics
ENG/CBET

National Science Foundation

NATIONAL SCIENCE FOUNDATION

NSF Created by the US Congress in 1950
"to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes."

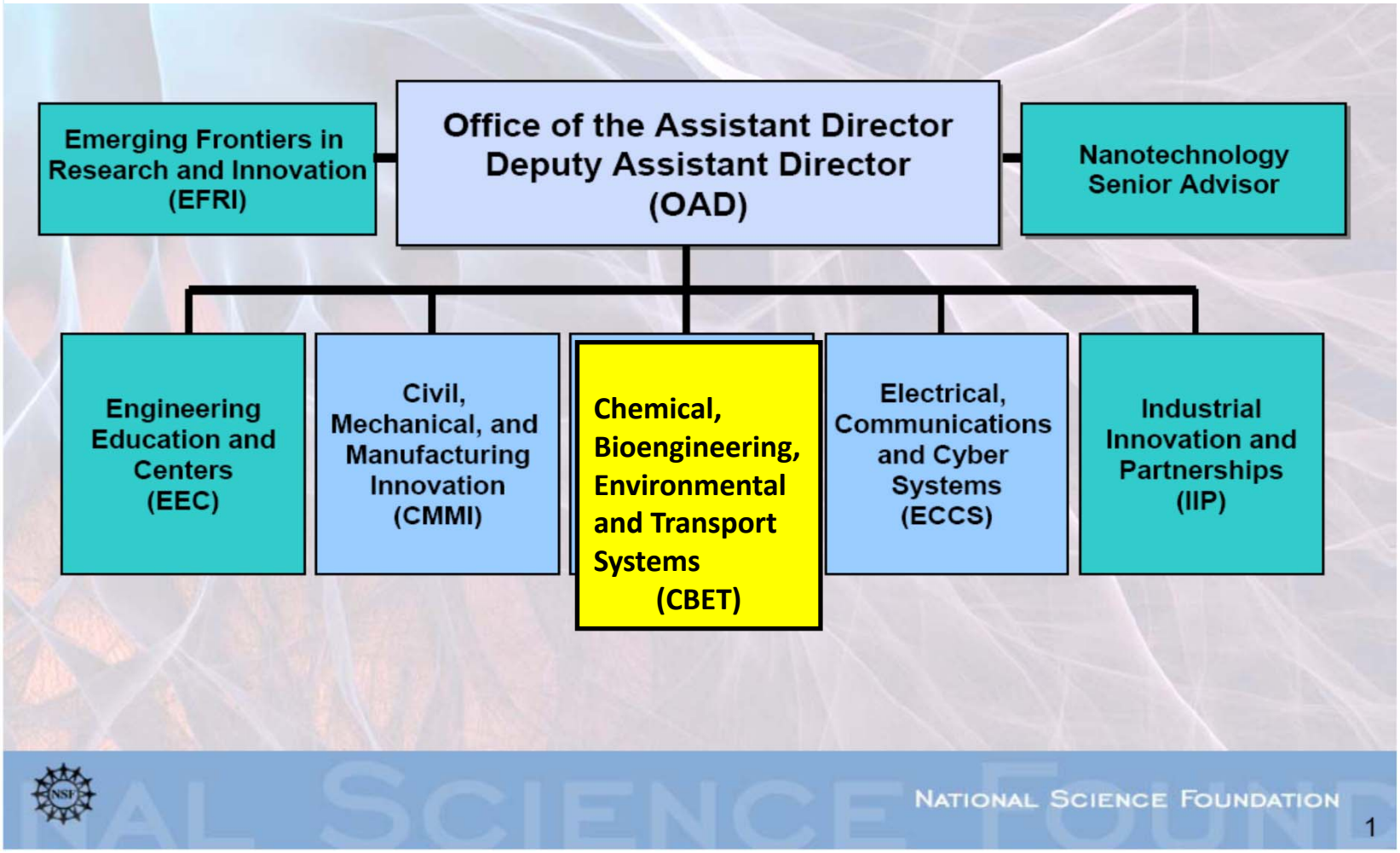
- **$7.5B budget (FY2017)**
- **24% of federally funded basic research at U.S. Universities**

- **Directorates:**
  - **Mathematical & Physical Sciences (MPS)**
  - **Engineering (ENG)**
  - **Biological Sciences (BIO)**
  - **Computer & Information Science & Engineering (CISE)**
  - **Geosciences (GEO)**
  - **Social, Behavioral and Economic Sciences (SBE)**
  - **Education & Human Resources (EHR)**

NSF Director
France A. Córdova.
Credit: *NSF/Stephen Voss*

National Science Foundation
WHERE DISCOVERIES BEGIN

Directorate for Engineering



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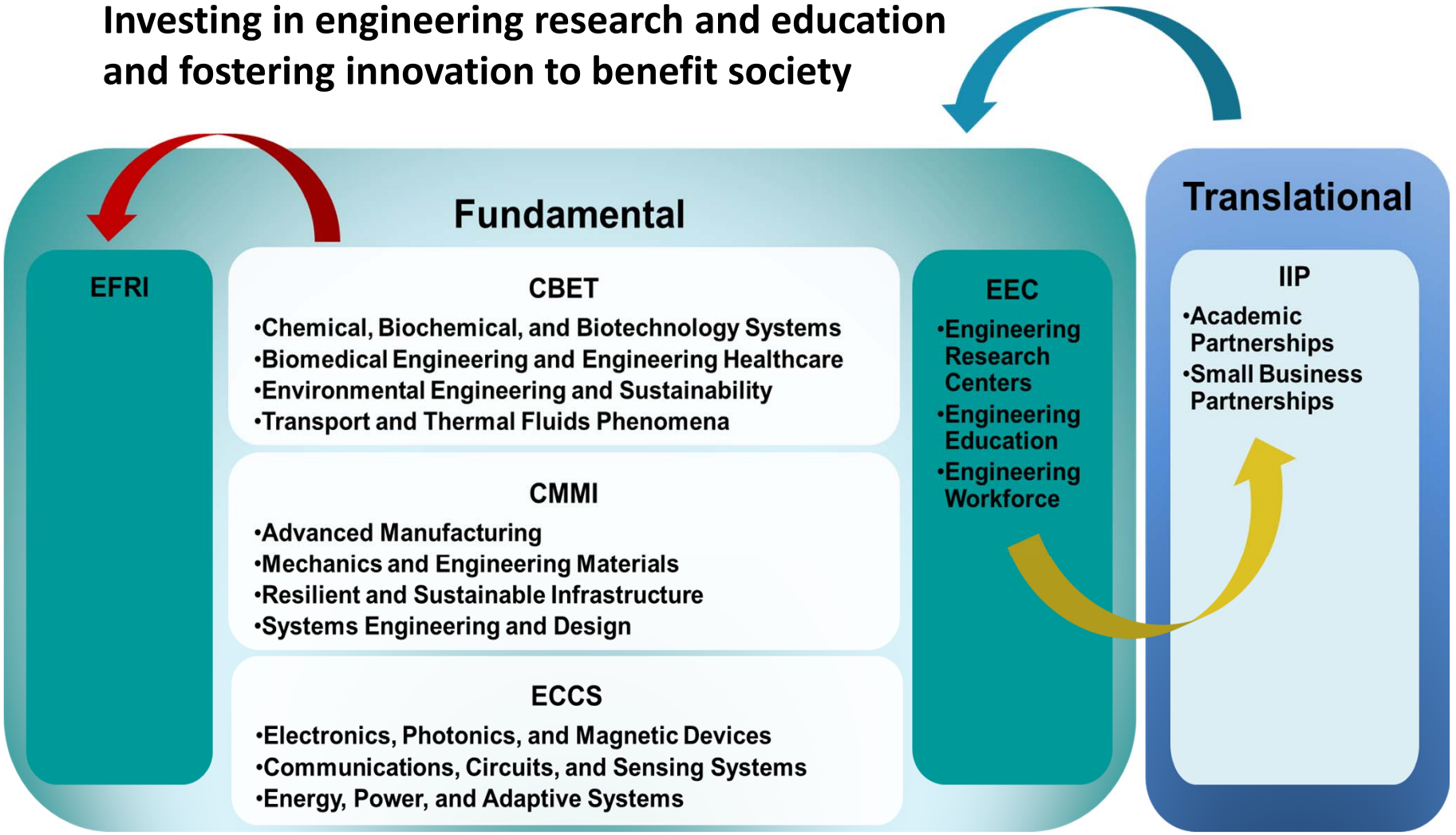
ENGINEERING

Investing in engineering research and education and fostering innovation to benefit society



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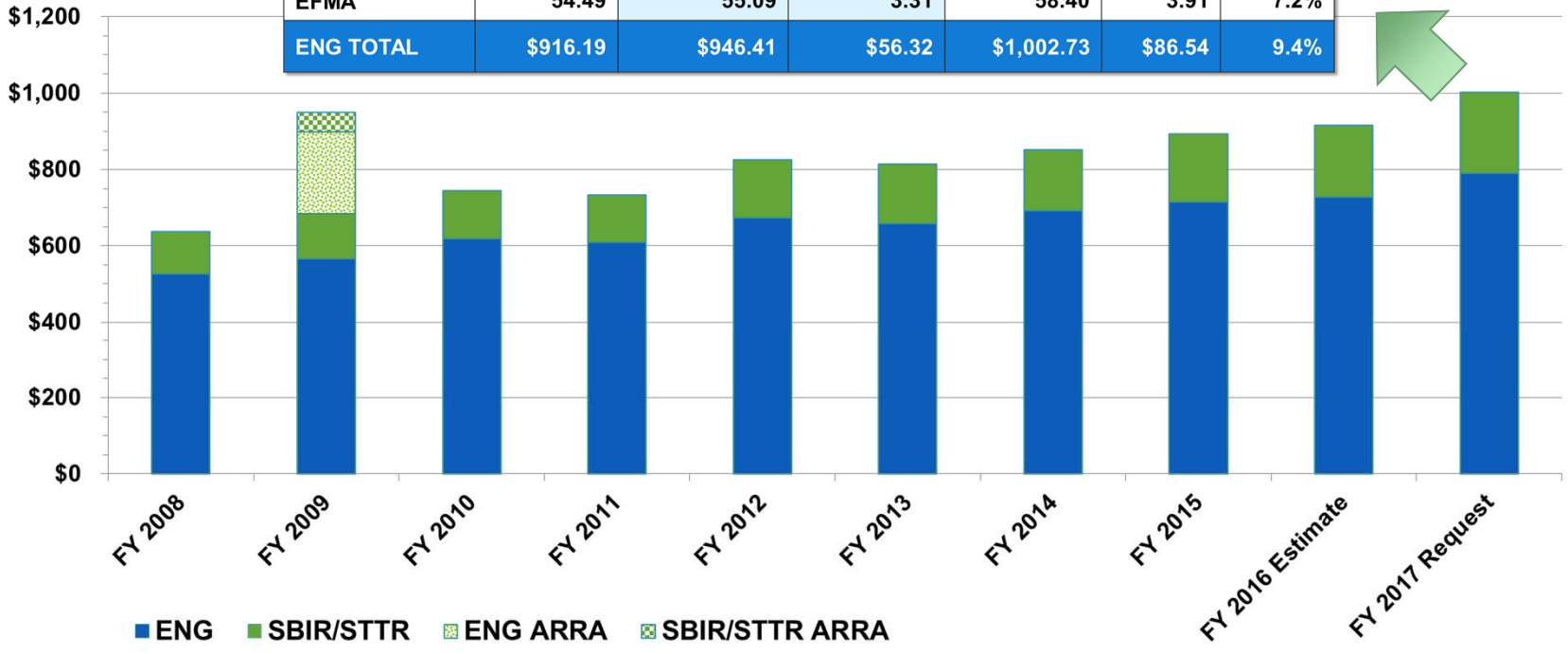
ENGINEERING BUDGET

	FY 2016 Estimate	FY 2017 Request, Discretionary	FY 2017 Request, Mandatory	FY 2017 Request, Total	FY 2017 Request Total change over FY 2016 Estimate	
					Amount	Percent
CBET	$183.82	$187.18	$11.24	$198.42	$14.60	7.9%
CMMI	216.39	220.67	13.25	233.92	17.53	8.1%
ECCS	113.95	115.80	6.97	122.77	8.82	7.7%
EEC	107.61	113.50	6.82	120.32	12.71	11.8%
IIP	239.93	254.17	14.73	268.90	28.97	12.1%
SBIR/STTR	*188.56*	*201.67*	*11.59*	*213.26*	*24.70*	*13.1%*
EFMA	54.49	55.09	3.31	58.40	3.91	7.2%
ENG TOTAL	$916.19	$946.41	$56.32	$1,002.73	$86.54	9.4%



NATIONAL SCIENCE FOUNDATION | DIRECTORATE FOR ENGINEERING

Chemical, Bioengineering, Environmental, and Transport Systems Division (CBET)

Richard Dickinson
Division Director

Timothy Patten
Deputy Division Director (Acting)

Chemical Process Systems

1401
Catalysis
Bob McCabe

1417
Separations
Angela Lueking

1403 – Process Systems, Reaction Engineering and Molecular Thermodynamics
Triantafillos (Lakis) Mountziaris

7644
Energy for Sustainability
Carol Read

Bioengineering and Engineering Healthcare

1491
Biotechnology and Biochemical Engineering
Steven Peretti

5345
Biomedical Engineering
Michele Grimm

7236
Biophotonics
Leon Esterowitz

7909
Nano-Biosensing
Chenzhong Li

5342 – General and Age-Related Disabilities Engineering
Michele Grimm

Environmental Engineering and Sustainability

1440
Environmental Engineering
Karl Rockne

1179
Biological & Enviro Interactions of Nanoscale Materials
Nora Savage

7643
Environmental Sustainability
Bruce Hamilton

022Y
INFEWS
Jim Jones

Transport, Thermal, and Fluid Phenomena

1407
Combustion and Fire Systems
Song-Charng Kong

1443
Fluid Dynamics
Ronald Joslin

1415
Particulate and Multiphase Processes
Susan Muller

1406
Thermal Transport Processes
José Lage

Biomedical Engineering
Carol Lucas
EXPERT

Multiple Programs
Geoff Prentice
EXPERT

Updated September 2017

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CBET DIVISION

Transport

Fluid Dynamics
Joslin
Particulate & Multiphase
Muller
Thermal Transport
Lage
Combustion
Kong

$38 M
+1 M CDSE

Microgravity

Chemical Process Systems

Catalysis
McCabe
Process & Reaction Eng
Mountziaris
Separations
Lueking
Energy for Sustainability
Read

$39 M
+3 M DMREF

Modular Manufacturing, Clean Energy

Environmental

Environmental Eng
Rockne + Prentice
Environmental Sustainability
Hamilton
NanoBio Interactions
Savage
INFEWS
Jones

$43 M
+1 M CRISP
+1 M Citizen Sci

INFEWS, Water Quality

Biotech and Biomed

Biotechnology/Biochem
Peretti
Biomedical Eng + GARDE
Grimm + Lucas
NanoBio Sensing
Li
Biophotonics
Esterowitz

$44 M
+5 M STC
+1 M NRI: Robotics

Advanced Manufacturing , Cellular Therapeutics, Engineering Biology

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CHEMICAL PROCESS SYSTEMS

Robert McCabe

Catalysis

- Heterogeneous catalysis related to sustainability and the environment
- Heterogeneous catalyst design and synthesis
- Basic understanding of catalytic reactions

Angela Lueking

Process Separations

- Methods and mechanisms for purification of gases, chemicals, or water
- Mass separation agents or processes
- Field (flow, magnetic, electrical) induced separations

T.J. (Lakis) Mountziaris

Process Systems, Reaction Eng & MolecularThermodynamics

- Chemical Reaction Engineering
- Process Design, Optimization and Control
- Reactive Polymer Processing
- Molecular Thermodynamics for Chemical Processing and Materials

Carole Read

Energy for Sustainability

- Electrochemical Energy Systems
- Organic Photovoltaics

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ENGINEERING BIOLOGY & HEALTH

Steve Peretti

Cellular & Biochemical Engineering

- Biomanufacturing: Metabolic eng, “omics”, single cell dynamics and synthetic biology
- Quantitative systems biotechnology
- Cell culture technologies
- Protein and enzyme engineering

Michele Grimm

Engineering Biomedical Systems

- Models for tissues and organ systems
- Advanced biomanufacturing of 3-D tissues and organs
- New tools to study physiological processes

Disability and Rehabilitation Engineering

- Neuroengineering
- Rehabilitation robotics

Leon Esterowitz

Biophotonics

- Macromolecule Markers
- Micro- & Nano-photonics; Low-Coherence Sensing @ Nanoscale
- Neurophotonics and Optogenetics

Chenzhong Li

Nano-biosensing

- Multi-purpose sensor platforms
- Novel transduction principles, mechanisms and sensor designs
- Nano-biosensors for biomolecular interactions
- Intracellular biosensing

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ENVIRONMENTAL ENGINEERING & SUSTAINABILITY

Karl Rockne

Environmental Engineering

- Enhancing availability of high quality water supplies
- Fate and transport of contaminants in air, water, soil, solid waste

Nora Savage

Biological & Environmental Interactions with Nanoscale Materials

- Characterization and prediction of interactions
- Transport, interaction, and impact on biological systems

Bruce Hamilton

Environmental Sustainability

- Industrial Ecology
- Green Engineering
- Ecological Engineering
- Earth Systems Engineering

Jim Jones

Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS)

- Computational modeling
- Real-time, cyber-enabled interfaces
- System and technological solutions
- FEW scientific workforce development

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TRANSPORT PHENOMENA

Ron Joslin

Fluid Dynamics

- Turbulence
- Bio-inspired fluid dynamics
- Complex Fluids
- Micro- and Nano-fluidics
- Interfacial Interactions and Instabilities
- Wind and Ocean Energy Harvesting

Susan Muller

Particulate & Multiphase Systems

- Multiphase flow
- Particle science and technology
- Multiphase transport in biological systems
- Interfacial transport

José Lago

Thermal Transport Processes

- Convection/Diffusion/Radiation
- Thermodynamics
- Bio- Heat and Mass Transport
- Nano-, Micro- and Meso-thermics

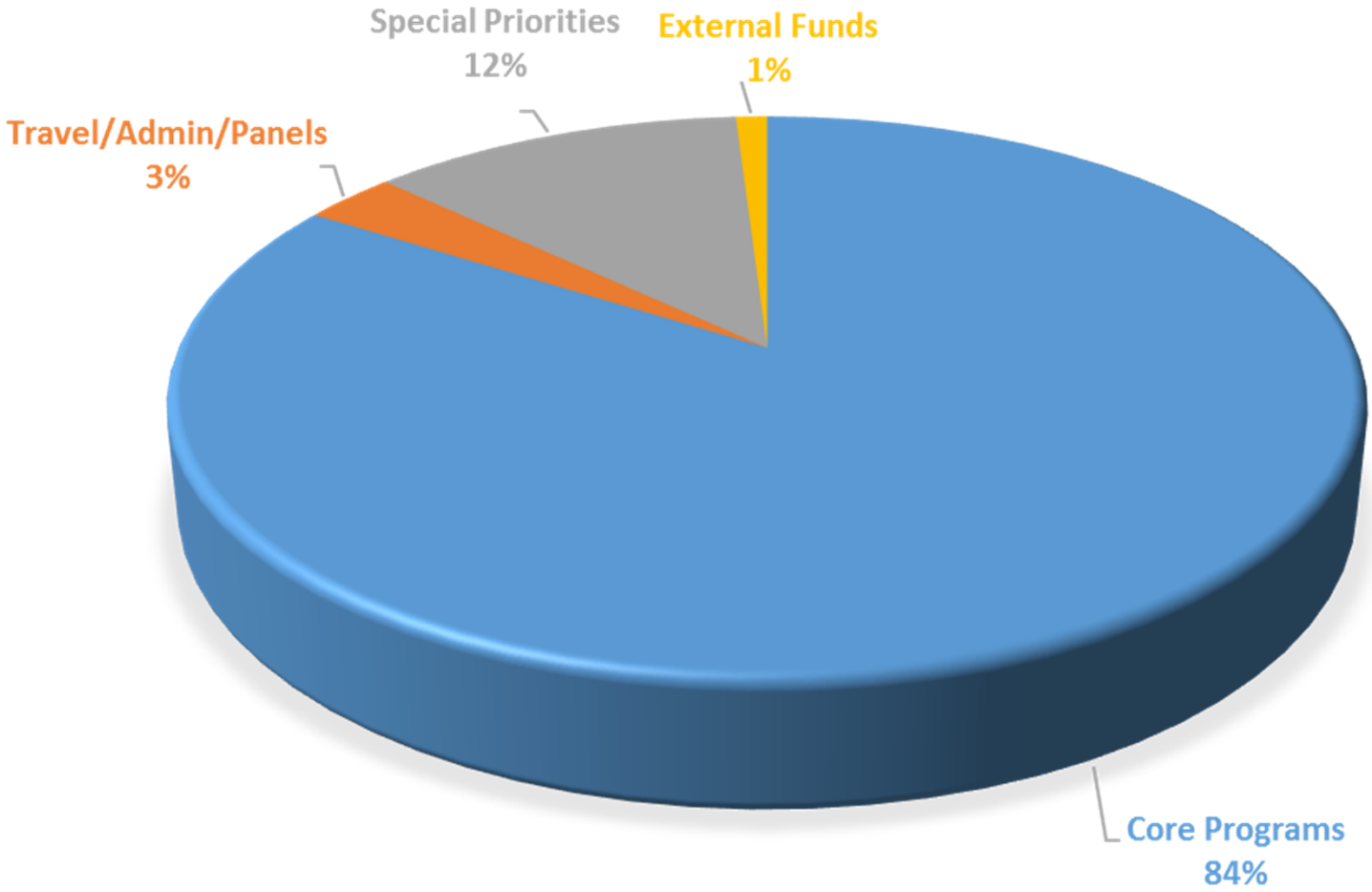
Song-Charng Kong

Combustion & Fire Systems

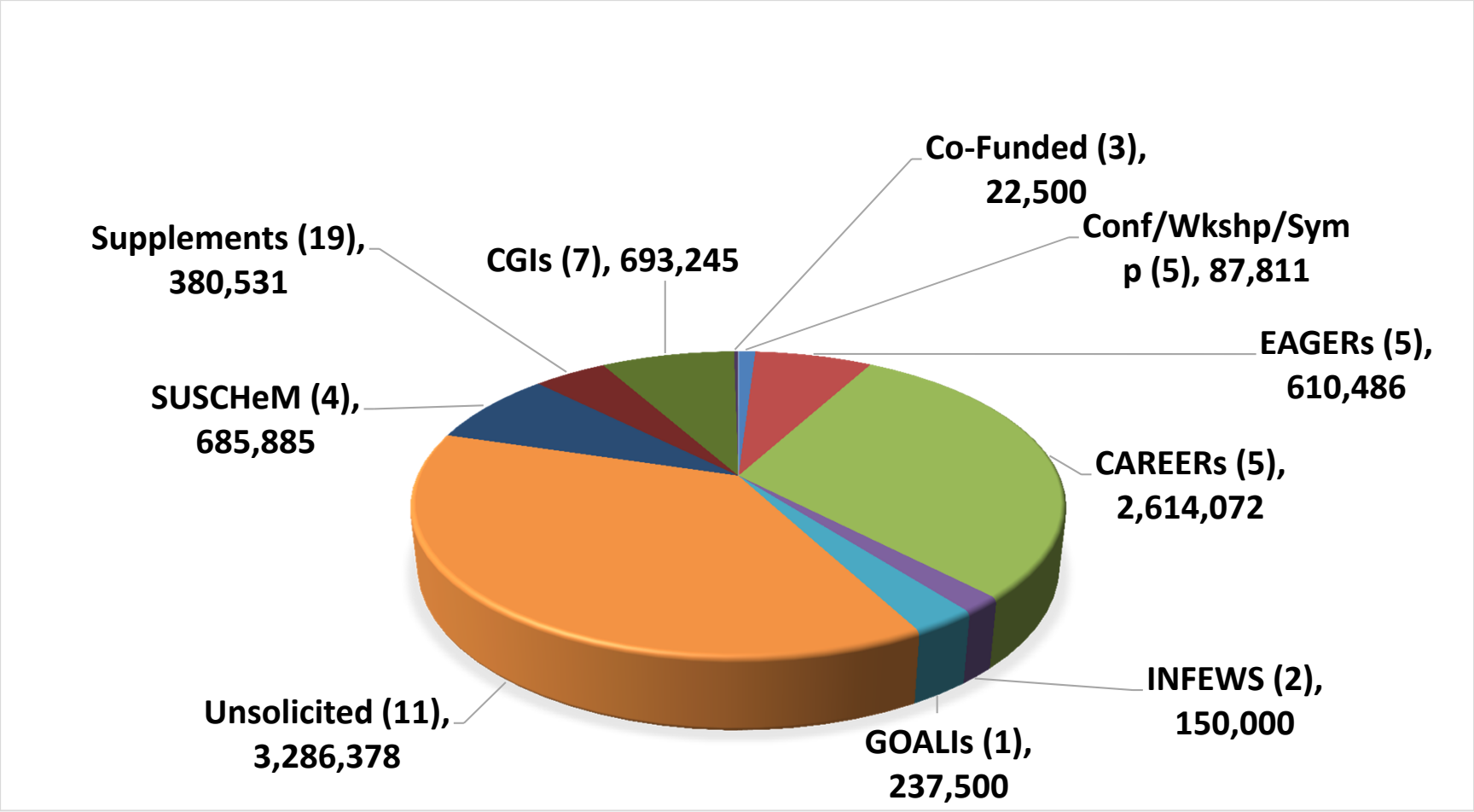
- Basic Combustion Science
- Combustion Science related to Clean Energy
- Fire Prevention

CBET BUDGET

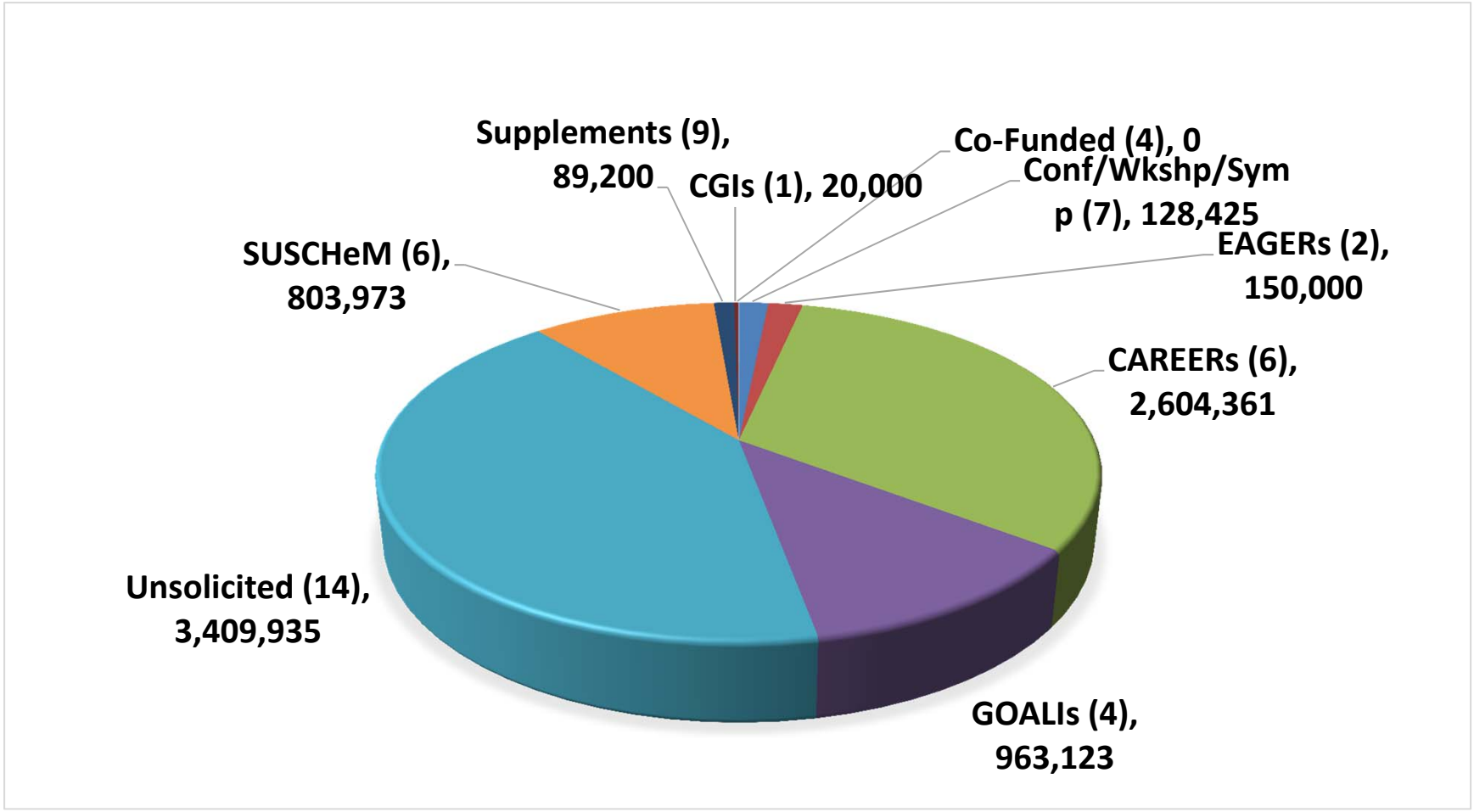
FY2017 BUDGET: $184.5M



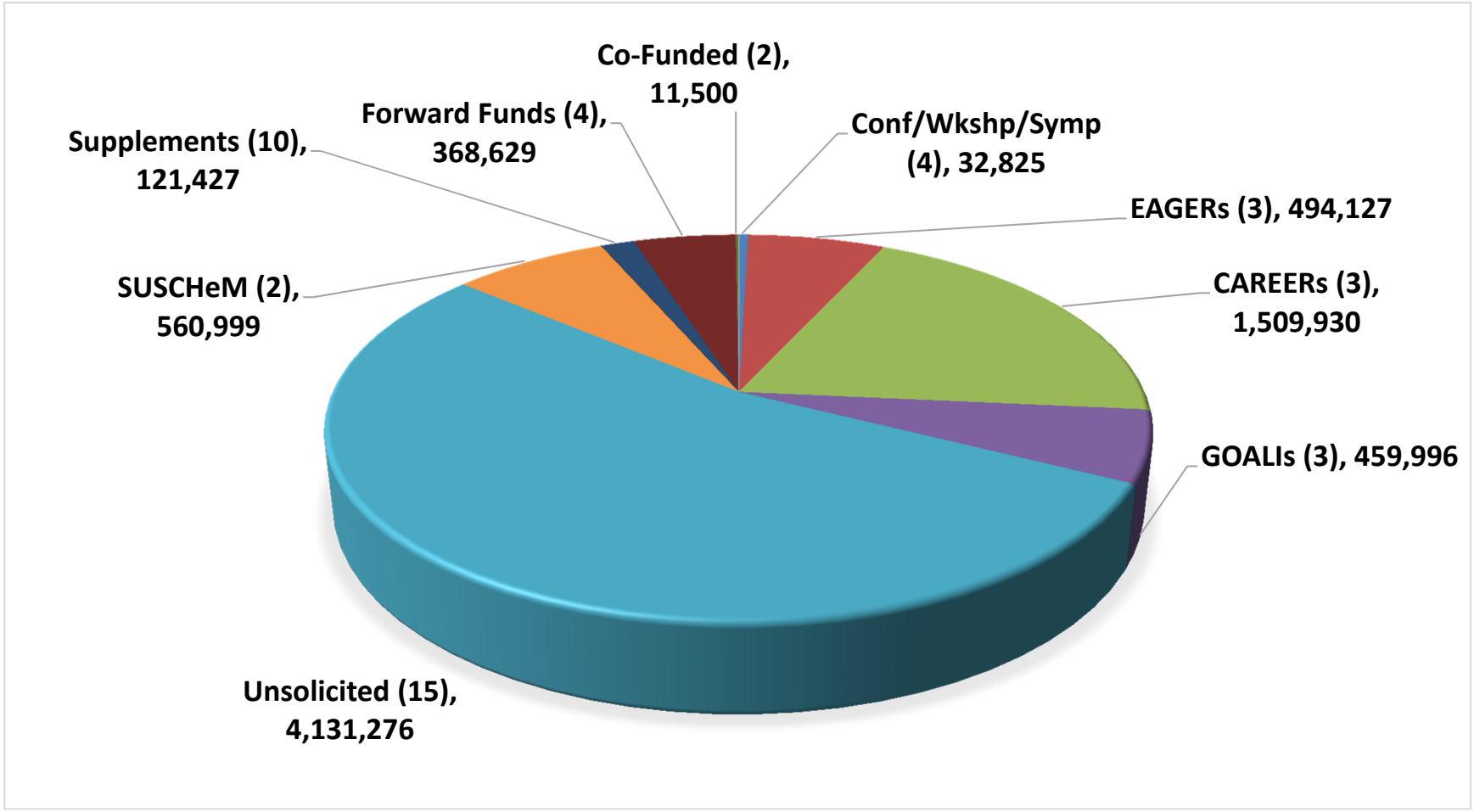
CATALYSIS FY17 ($8.7M)



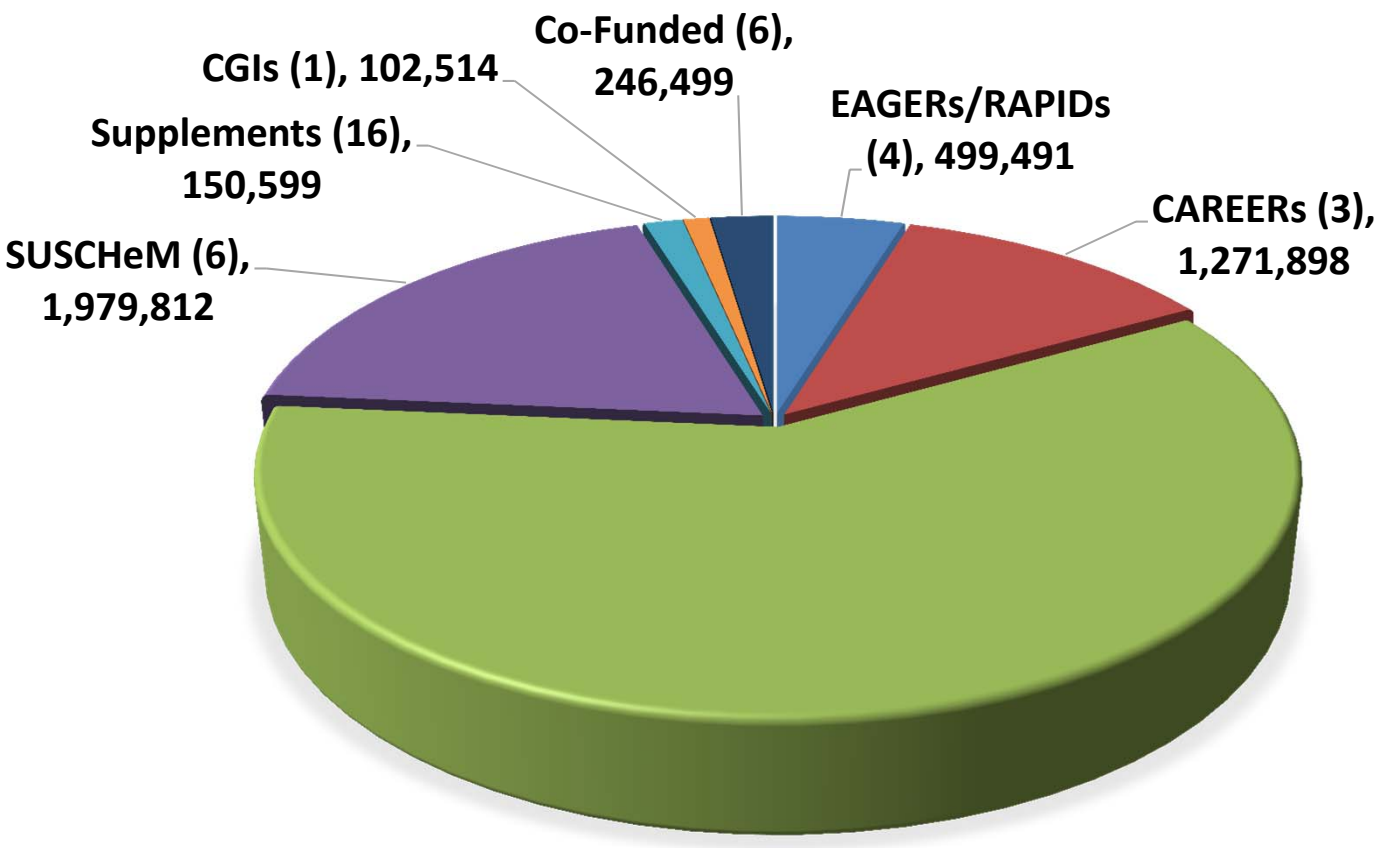
PROCESS SYSTEMS, REACTION ENGINEERING AND MOLECULAR THERMODYNAMICS FY17 ($8.2M)



SEPARATIONS FY17 ($7.6M)



ENERGY FOR SUSTAINABILITY FY17 ($10.5M)



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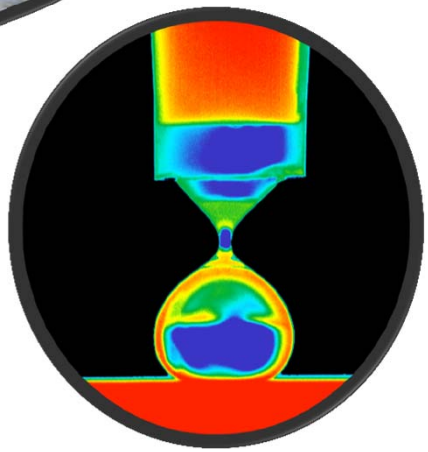
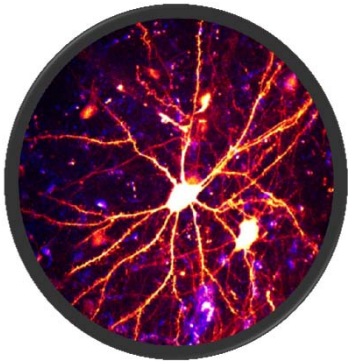
CBET COMMUNITY

Civil/Environmental Engineering, 12%

Chemical Engineering, 22%



Mechanical Engineering, 23%



Bioengineering/Biomed Engineering, 16%

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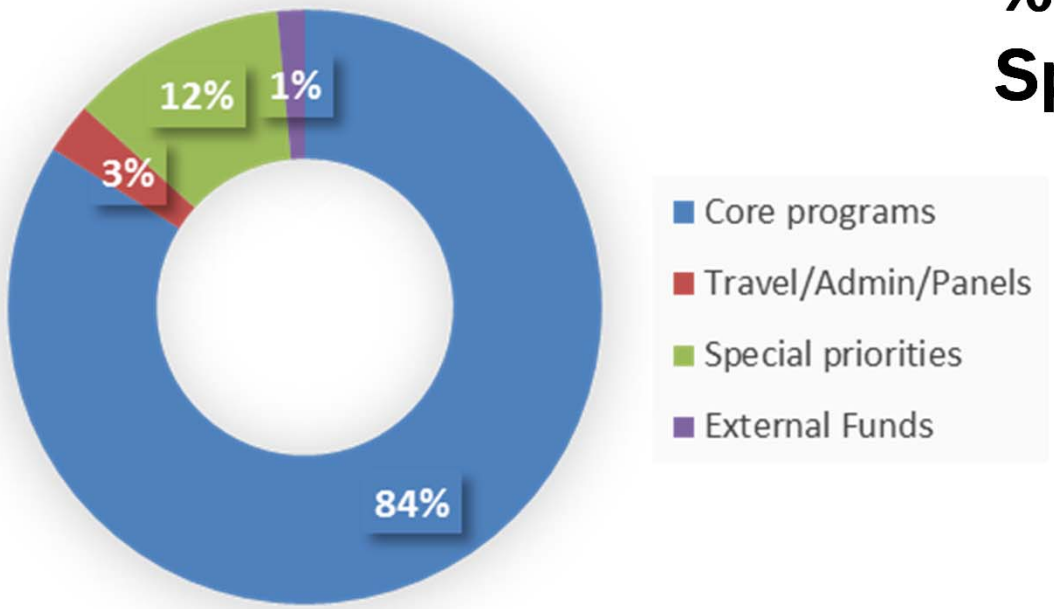
FY2016 INVESTMENT CATEGORIES

CBET Total: $184.5 M



% of Total Budget to Special Programs:

- **CAREER ~24%**
- **EAGER/RAPID ~ 5%**
- **GOALI ~ 2.5%**
- **Workshops/ Conferences/ Supplements ~ 3%**

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PRIORITY AREAS

- Innovations at the Nexus of Food, Energy, and Water Systems
- Risk and Resilience
- Clean Energy Technologies
- Cyber-Enabled Materials, Manufacturing, and Smart Systems
  - Advanced Manufacturing
  - Modular Manufacturing
- Smart and Connected Communities
- National Nanotechnology Initiative
- Understanding the Brain
  - BRAIN Initiative
- Broadening Participation
  - NSF INCLUDES: Inclusion across the Nation of Communities of Learners that have been Underrepresented for Diversity in Engineering and Science
- National Strategic Computing Initiative
- Innovation Corps

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COLLABORATION WITH OTHER AGENCIES

MODULAR CHEMICAL MANUFACTURING (NSF-DOE)

- National Academies Workshop: *The Changing landscape of Feedstocks for Chemical Production – Implications for Catalysis (2016)*
- NSF-DOE Workshop in January 2017

LOW-TEMPERATURE PLASMAS (NSF-DOE)

CLEAN WATER (NSF-WRF-EPRI-WE&RF)

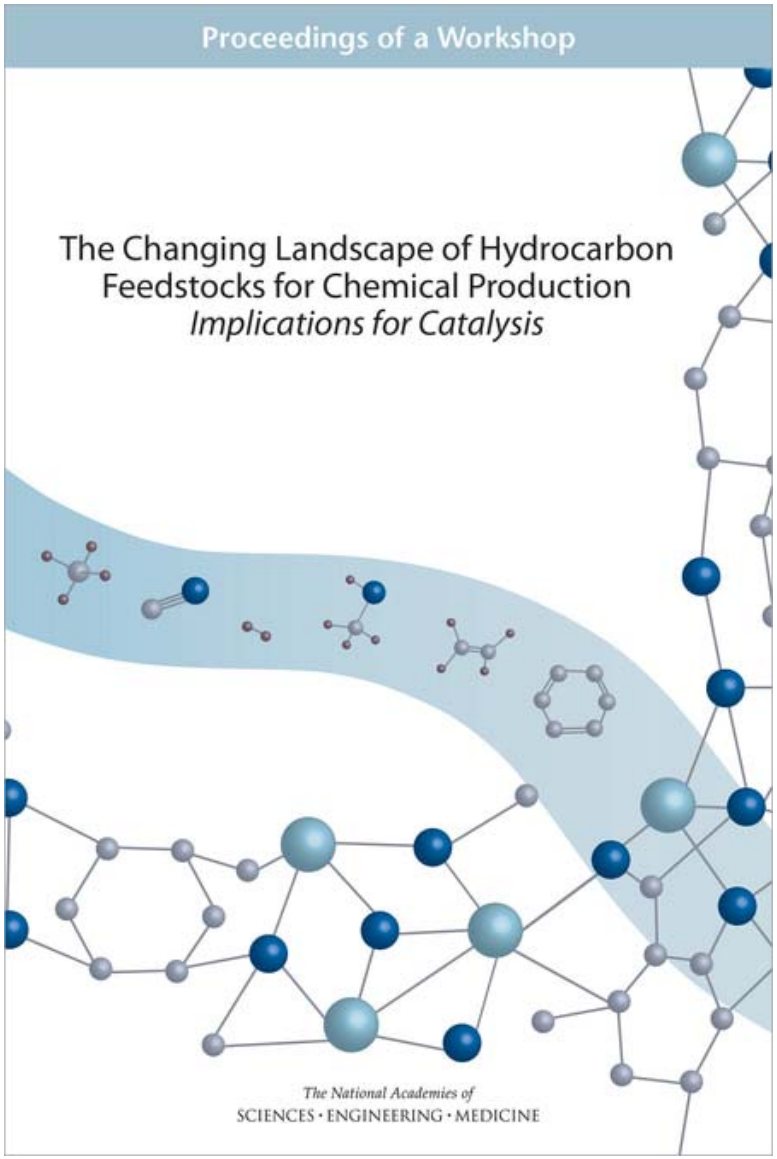
CBET - Engineering and Physical Sciences Research Council (UK)

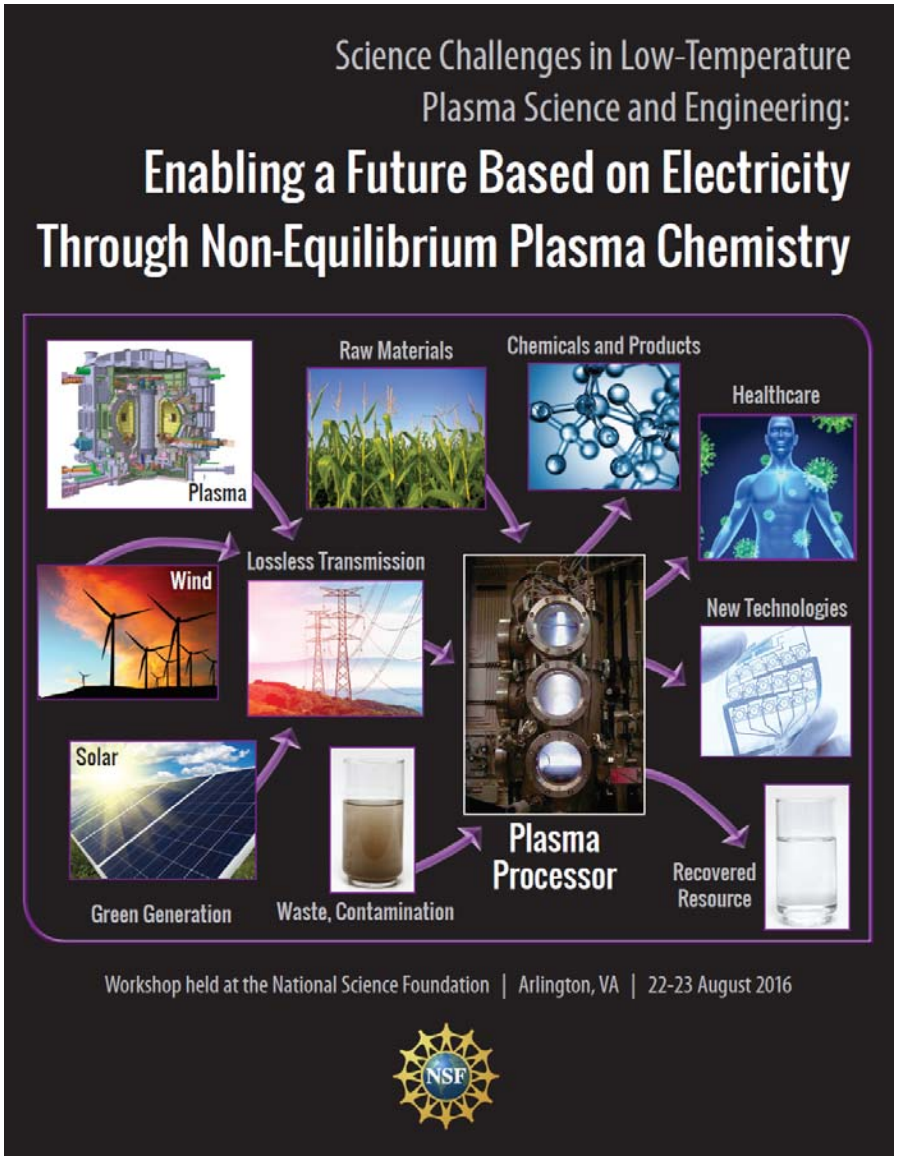
NSF-CASIS - Combustion and Thermal Transport Processes

Research on the International Space Station

National Science Foundation

WORKSHOPS





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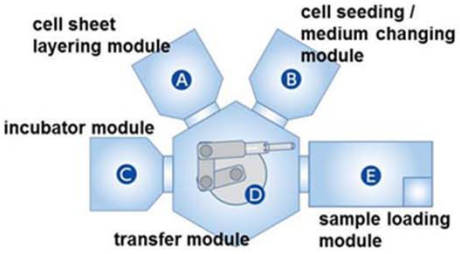
ADVANCED BIOMANUFACTURING

Biomanufacturing for Cell-Based Therapies :

- Increase efficiency of differentiation
- Rapid, non destructive cell phenotyping
- Bioreactors for reproducible cell expansion/differentiations
- Separation technologies
- Stable cell lines
- Computational models of stochastic cell variability
- Scale up and scale out

FY16 Budget: ~$3.7M



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INNOVATION AT THE NEXUS OF FOOD ENERGY AND WATER SYSTEMS (INFEWS)

Goals

- Understand the FEW system through integrated systems modeling;
- Create methodologies for effective data integration/ cyber elements;
- Research innovative solutions and technologies; and,
- Support education, workforce, and community development.

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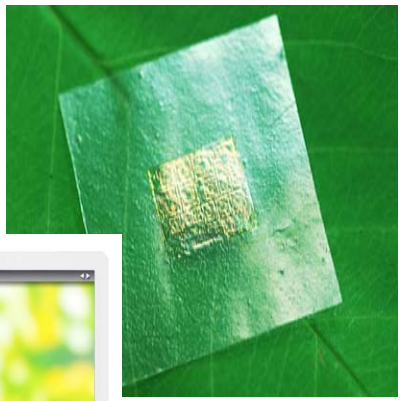
CLEAN ENERGY

- Investments in fundamental research including:
  - solar energy, wind energy, energy harvesting, and other forms of sustainable energy generation
  - biofuels and bioenergy
  - energy storage and smart grid
  - smart buildings and energy efficiency
  - systems engineering and optimization for energy
  - energy materials and manufacturing
- Focused topic areas in clean energy technology in NSF SBIR/STTR programs

NNI Vision

A future in which the ability to understand and control matter at the nanoscale leads to *a revolution in technology and industry that benefits society.*



Nano.gov
U.S. National Nanotechnology Initiative

National Nanotechnology Initiative

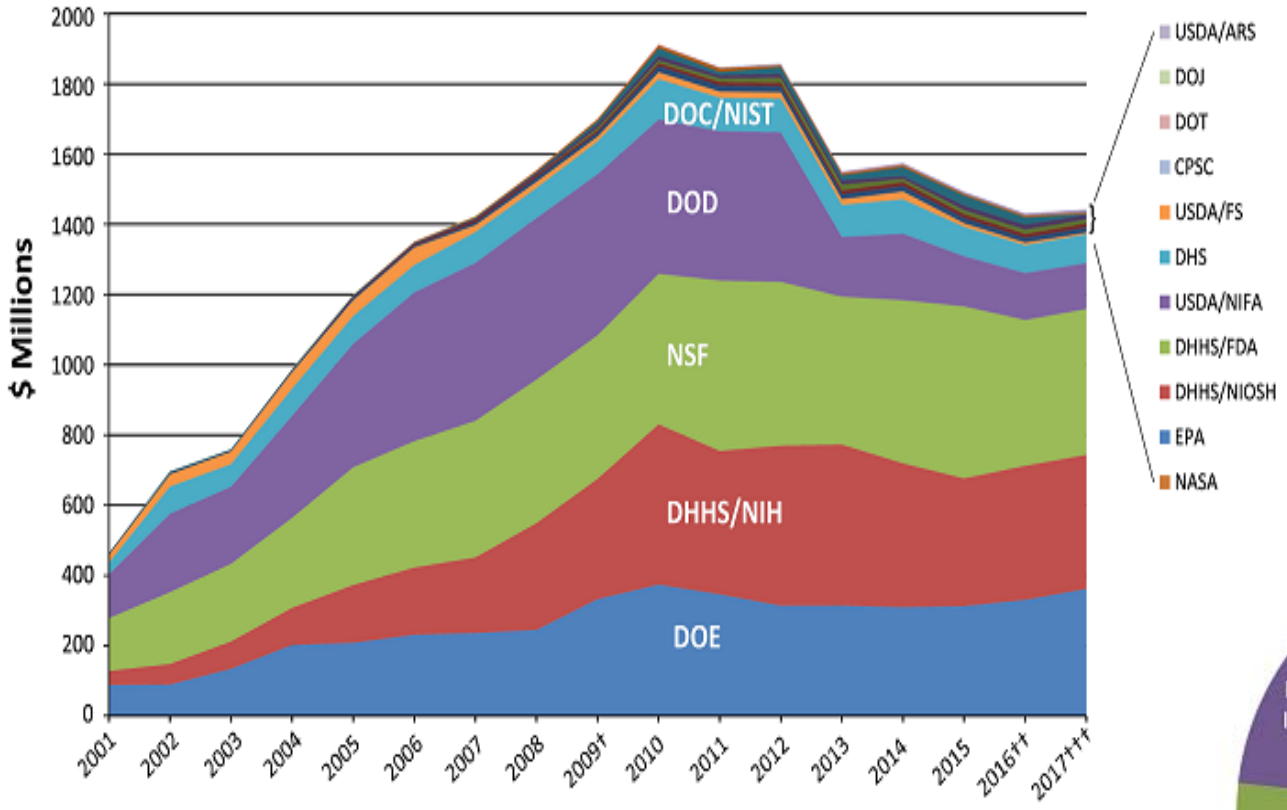
Collaborative research and development that will advance understanding and control of matter at nanoscale for:

- **National economic benefit**
- **National security**
- **Improved quality of life**

DOE
HHS/NIH
OST
OM
NS
DOD
HHS/FDA
DOC/NIST
NASA
HHS/CDC/NIOSH
USDA/NIFA
USDA/ARS
USDA/FS
DOS
EPA
DOTr
NRC
DOT
DOC/USPTO
IC/DNI
DOI/USGS
DOJ
DOC/EDA
DOC/BIS
DHS
CPSC
ITC
DOEd
DOL

Nano.gov
U.S. National Nanotechnology Initiative

Funding by NNI Agency, 2001-2017



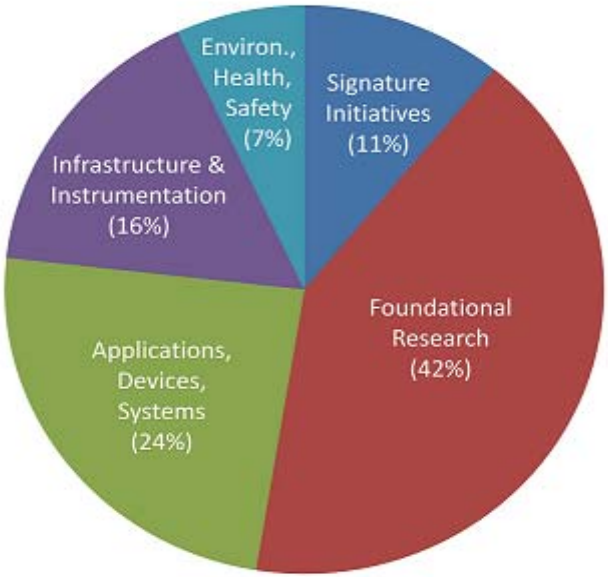
Fiscal Year

NNI Funding by Agency, 2001-2017

† 2009 figures do not include American Recovery and Reinvestment Act funds for DOE ($293 million), NSF ($101 million), NIH ($73 million), and NIST ($43 million)

†† 2016 estimated funding is based on 2016 enacted levels and may shift as operating plans are finalized.

††† 2017 Budget.



2017 NNI Investments by PCA

Looking Ahead: Ten Big Ideas

Navigating the New Arctic

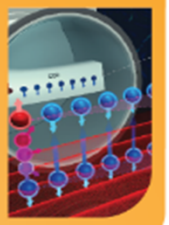
Harnessing Data for 21st Century Science and Engineering

Work at the Human-Technology Frontier: Shaping the Future

RESEARCH IDEAS

Understanding the Rules of Life: Predicting Phenotype

The Quantum Leap: Leading the Next Quantum Revolution



Windows on the Universe: The Era of Multi-messenger Astrophysics

PROCESS IDEAS

Growing Convergent Research at NSF

NSF-INCLUDES: Enhancing Science and Engineering through Diversity

Mid-scale Research Infrastructure

NSF 2050: Seeding Innovation