Transforming our World for a Better Tomorrow

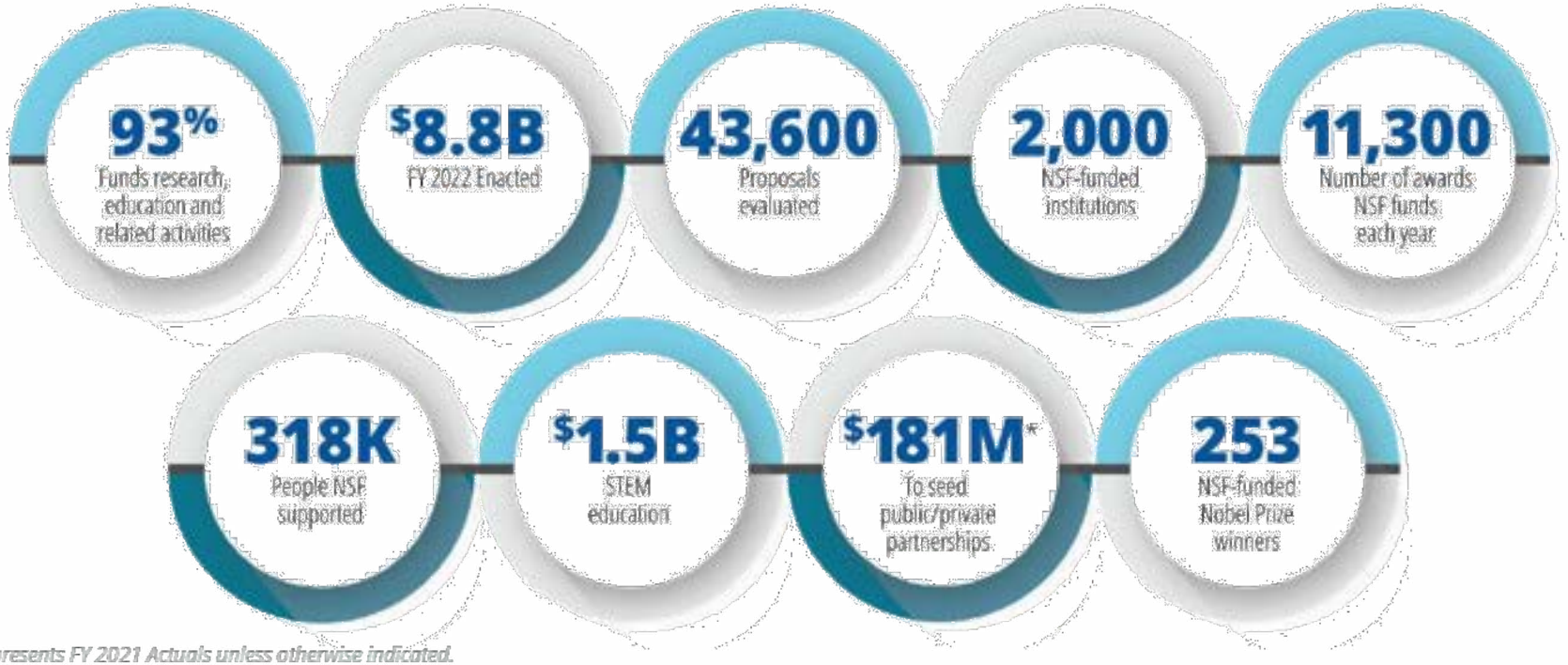
Susan Margulies, NSF Assistant Director for Engineering

May 12, 2022

NSF Mission

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

NSF By the Numbers, FY 2021



Data represents FY 2021 Actuals unless otherwise indicated.
**corresponds to NSF investments initiated in FY 2021 and spanning multiple years.*

Pennsylvania Fast Facts, FY 2021

$330,252,000

Total NSF Awards to Pennsylvania

$285,372,000

Invested in Fundamental Research in Pennsylvania

$44,880,000

Invested in STEM Education in Pennsylvania

$6,205,000

Invested in Pennsylvania startups

Top NSF-funded Academic Institutions for FY 2021

$85,506,000

Pennsylvania State University

$75,024,000

Carnegie Mellon University

$48,181,000

University of Pennslyvania

Scale: Single investigator to mid-size teams to centers and networks

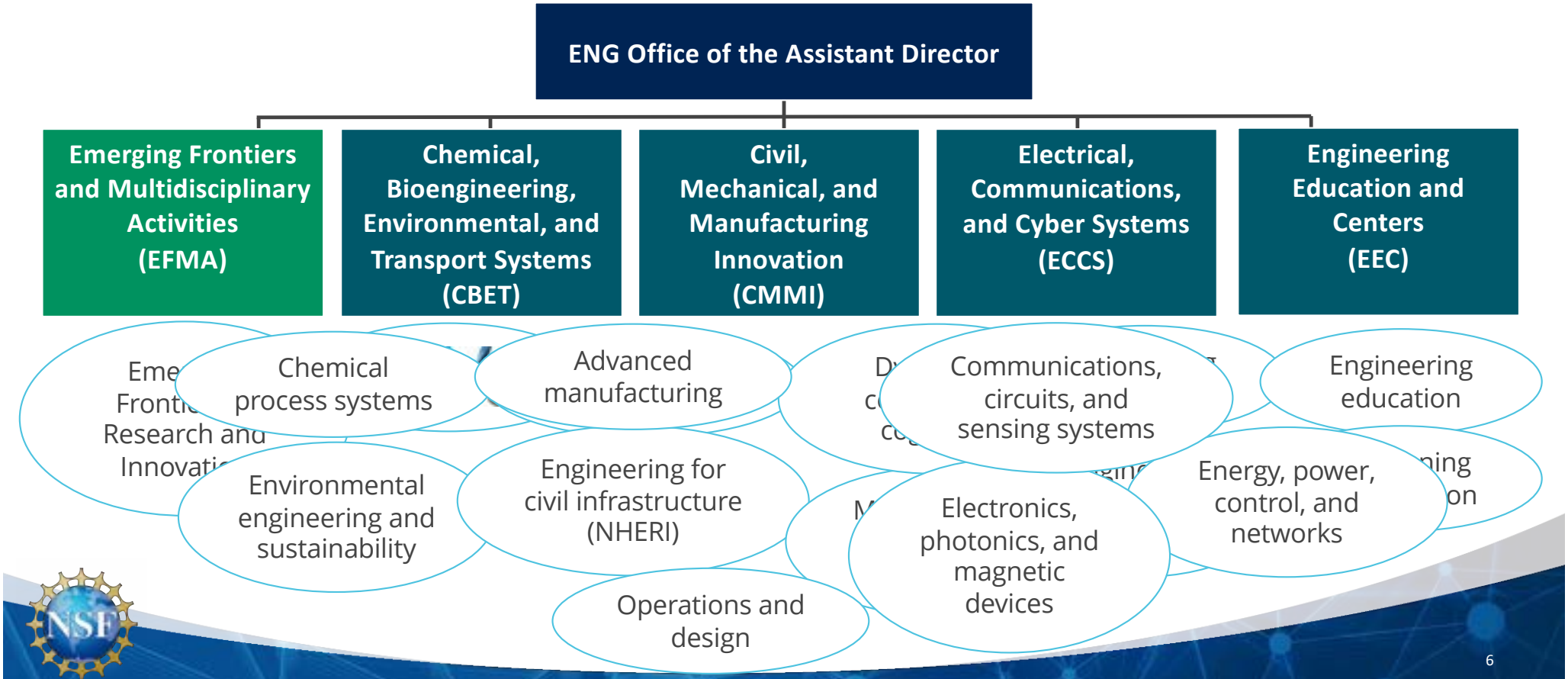
Breadth: Single discipline through convergence research

Career stage: Undergraduate to grad to postdoc to early to middle to later career

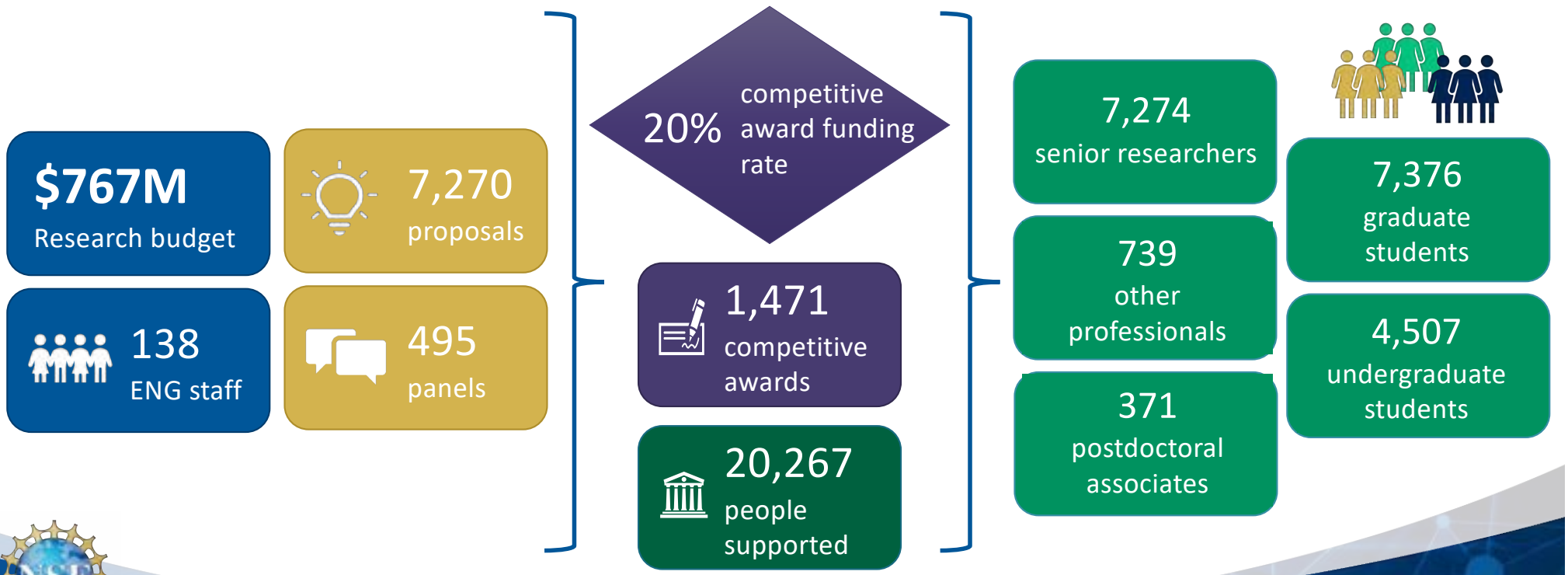
Innovation cycle: Basic research through translational research

You are at the heart of NSF's mission

NSF Directorate for Engineering



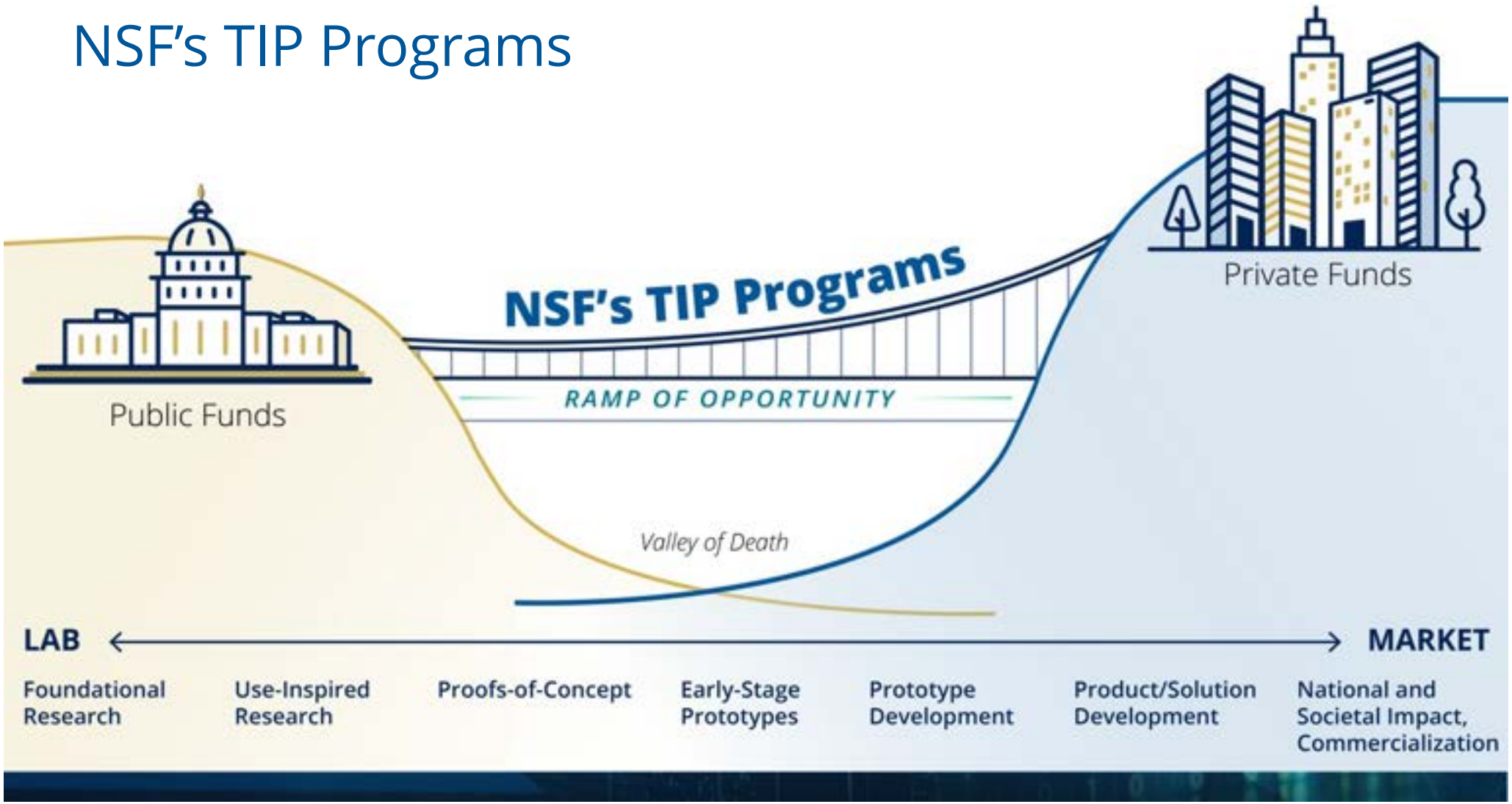
ENG by the Numbers: FY 2021



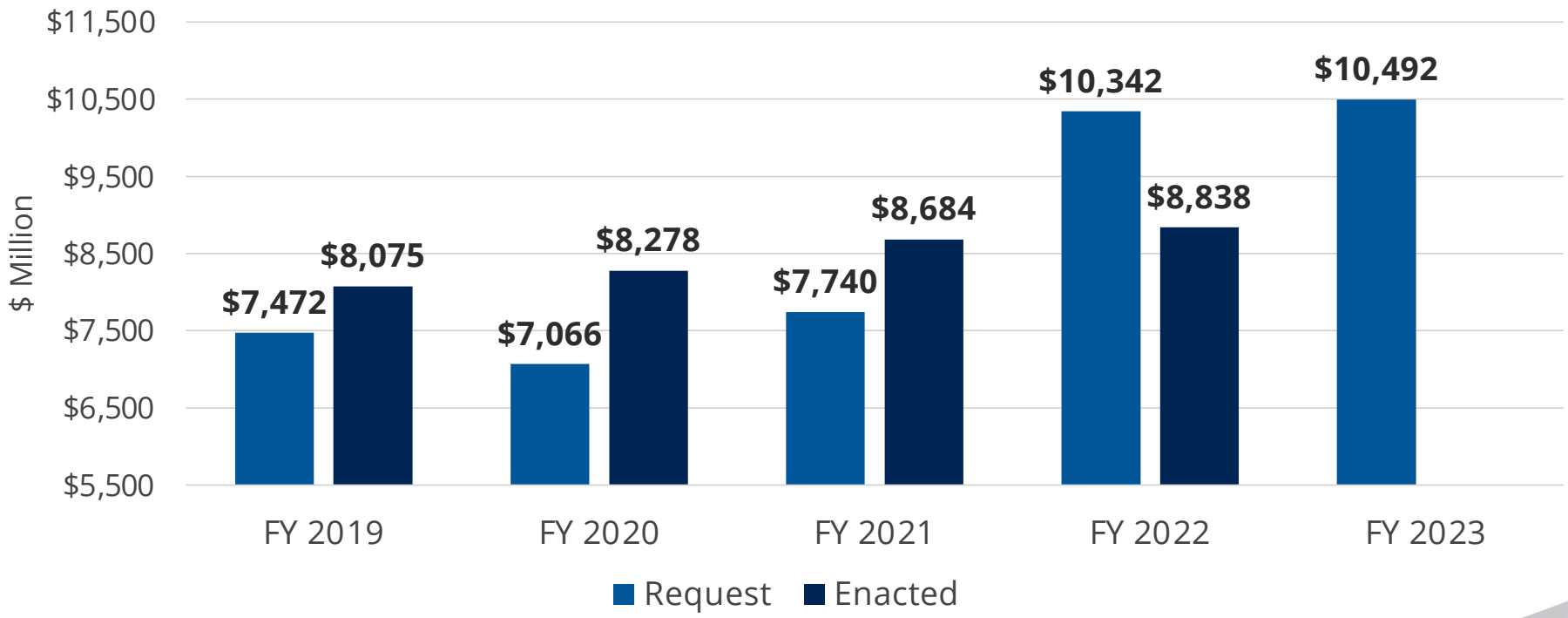
A New "Horizontal": Foster Innovation Ecosystems, Establish Translation Pathways, Partner to Engage the Nation's Talent

TIP integrates with NSF's existing directorates to rapidly bring use-inspired research and innovation to society

NSF's TIP Programs



NSF Budget


$11,500
$10,500
$9,500
$8,500
$7,500
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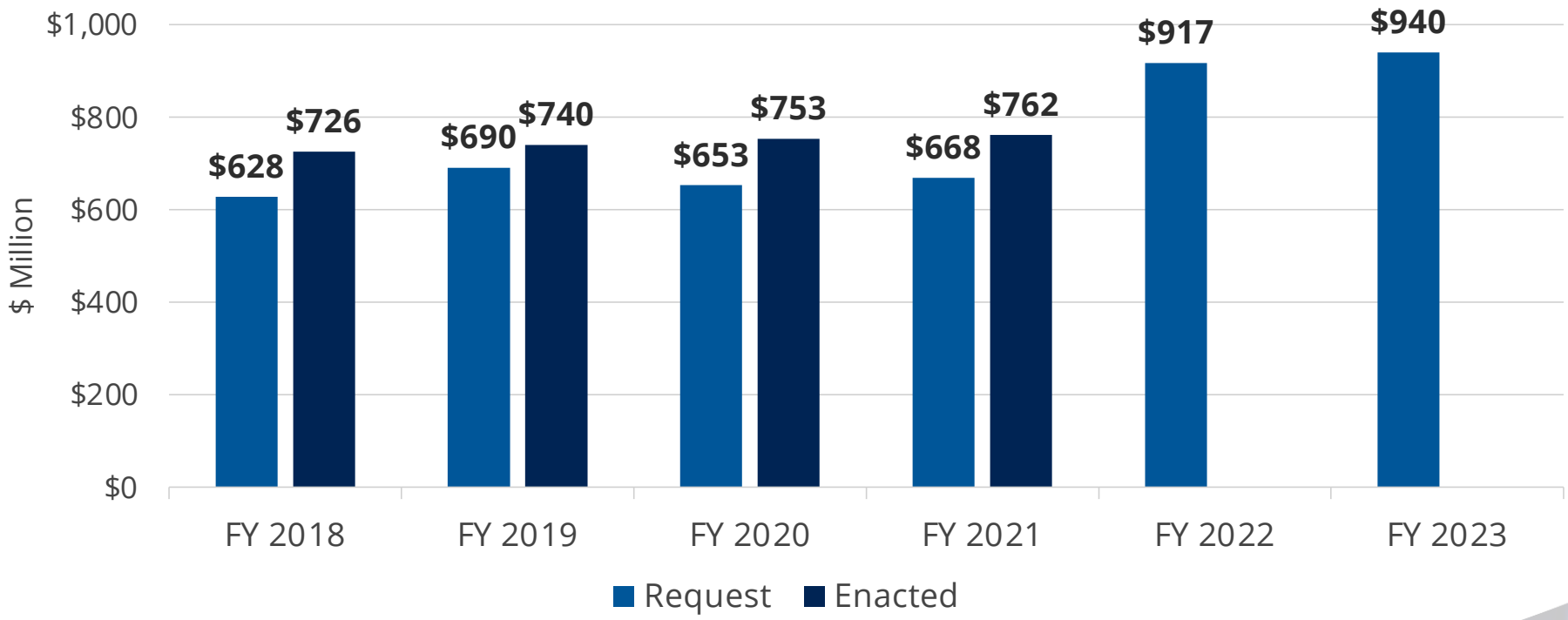
$7,472
$8,075
$7,066
$8,278
$7,740
$8,684
$10,342
$8,838
$10,492
FY 2019
FY 2020
FY 2021
FY 2022
FY 2023
Request
Enacted

ENG Budget



NOTE: Former ENG programs that moved to TIP (SBIR/STTR, Partnerships for Innovation, and I-Corps) were removed from past budget years.

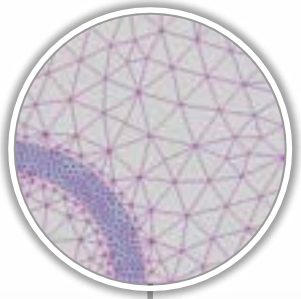
Mission

NSF MISSION: To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense; and for other purposes.

NSF ENG MISSION: **Transforming our world for a better tomorrow** *by driving discovery, inspiring innovation, enriching education, and accelerating access.*

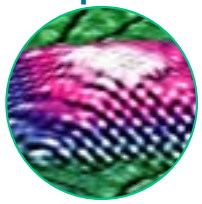
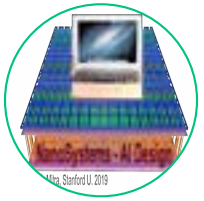
A Track Record of Leadership in Transformational Engineering Impact

Advanced Manufacturing

	1950s FINITE ELEMENT ANALYSIS	1970s GEOMETRIC SOLID MODELING	1980s LASER POWDER BED FUSION	1980s BINDER JETTING
NSF INVESTMENTS				
CURRENT IMPACTS				
	DIGITAL TWIN MODELING	COMPUTER-AIDED DESIGN (CAD)	AEROSPACE INDUSTRY MANUFACTURING	3D PRINTING PPE

Nanotechnology

National Nanotechnology Initiative

	1970-1980s:	1990s:	2000s:	2010s:	2020s:
NSF INVESTMENTS	Atomic Clusters, Supramolecules	Ceramic, Metal & Polymer Nanostructures; Nanoparticles	NSEC, NIRT, NSEE, Manufacturing, Nano-bio, Quantum, Environment, Ethics	Integration at Nano, NSF-SRC Semiconductors, Neuromorphics	Nano Foundation, New S&E Platforms for Converging Technologies
					
CURRENT IMPACTS					
	Atomic & Electron Microscopy; C60 Materials	Composite Materials, Nanotubes, Nanowire Lasers	High Memory Devices, Targeted Drugs, Nano-medicine, First Quantum Devices; Nano-ecosystems	2D Systems, Energy, Cells, Computers, Sensors, Sustainable Society, Synthetic Biology	Pervasive in All Economic Sectors

Biotechnology Revolution

synberc

GINKGO BIOWORKS

Agile BioFoundry

CMaT

CELL-MET

- Tools to manipulate DNA strings, proteins, and organoids
- Engineering proteins and scaffolds to build functional systems

Wastewater Surveillance

2000s

- Genetic tools to identify genetic fragment targets in wastewater

2010s

- Recognition of viral load in sewage
- Iteration of sensing technologies
- Detection of coronaviruses in sewage

2020s

- SARS-CoV-2 Wastewater Surveillance Research Coordination Network
- Predictive Intelligence for Pandemic Prevention: BIO, CISE, ENG, SBE
- National Sewage Surveillance Interagency Leadership Council
- White House Pandemic Innovation Task Force

NSF Engineering Strategic Plan

MISSION

To transform our world for a better tomorrow by driving discovery, inspiring innovation, enriching education, and accelerating access

VISION

NSF Engineering will be a global leader in identifying and catalyzing fundamental engineering research, innovation, and education.

GOALS

Propel
U.S. leadership in transformational engineering approaches to problems with societal impact

Expand
opportunities for people

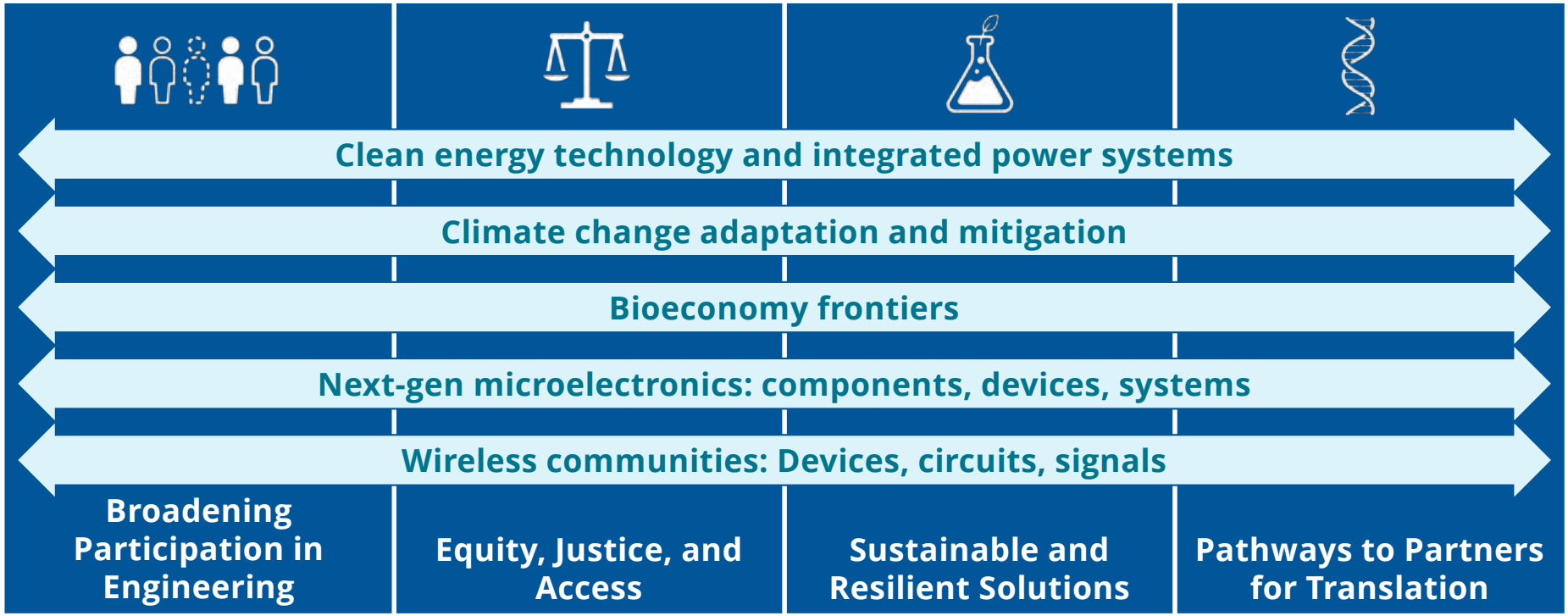
Catalyze
purposeful partnerships

Goal 1: Propel US Leadership in Transformational Engineering Approaches to Problems with Societal Impact

NSF Priorities for FY 2022

- **Enhance fundamental research and development**
- **Strengthen U.S. leadership in emerging technologies**
- **Advance equity in science and engineering**
- **Advance climate science and sustainability research**
- **Continue construction of forefront infrastructure**

Investing in Cross-ENG Strategic Priorities



Coordinate — Collaborate — Co-fund

Predictive Intelligence for Pandemic Prevention (PIPP)

Fundamental research and capabilities needed to tackle grand challenges in infectious disease pandemics via

- Prediction
- Monitoring
- Mitigation
- Prevention

FY 2022: Development grants (Phase I) ***Proposals under review***

- Articulation of a grand challenge
- Novel conceptual research
- Multidisciplinary team formation

FY 2023: Anticipated Phase II center grants solicitation

Jointly supported by BIO, CISE, ENG, and SBE

Critical Aspects of Sustainability (CAS): Innovative Solutions to Climate Change

CAS supports basic research aimed at improving the sustainability of resources for future generations to offer technologically-advanced, economically competitive, environmentally-benign and useful materials.

NSF Dear Colleague Letter (NSF 21-124) encourages proposals on:

- Reducing Greenhouse Gas (GHG) emissions and energy use
- Energy innovations relevant to climate change mitigation
- Enhancing GHG sequestration
- Accelerating strategies for climate change adaptation
- Synergistic topics

CAS-Climate: Crowd-Sourced Just-in-Time Inlet Maintenance as an Urban Strategy for Climate Resilience, #2141192 led by Drexel Univ.

FY 2022: ***Rolling submission***

- Already, ENG has awarded 16 grants: 3 research grants, 2 EAGER awards, 2 Engineering Research Initiation awards, 8 CAREER awards, 1 workshop

NSF's Engineering Research Infrastructure

Mid-Scale Research Infrastructure provides experimental research capabilities in the range between the Major Research Instrumentation ($6M) and Major Facilities ($100M) thresholds.

- Mid-scale RI-1: National Full-Scale Testing Infrastructure for Community Hardening in Extreme Wind, Surge, and Wave Events (NICHE), design project led by Florida International University
- Mid-scale RI-2 ***Proposals under review***
- Dear Colleague Letter: Mid-scale Research Infrastructure — Engineering Conferences ***New NSF 22-075***

National Nanotechnology Coordinated Infrastructure

- Mid-Atlantic Nanotechnology Hub (MANTH), led by University of Pennsylvania with Community College of Philadelphia

Natural Hazards Engineering Research Infrastructure

Advanced Wireless

NSF's Spectrum Innovation Initiative will advance areas critical to making future wireless technologies and networks faster, smarter, and more responsive and robust

FY 2021

- SpectrumX, an NSF Spectrum Innovation Center
- Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT)

FY 2022

- SWIFT: ***NSF 22-571 deadline May 11, 2022***
  - Spectrum utilization; on-demand spectrum access and resilient coexistence; challenges to passive observations from space-borne transmitters
- National Radio Dynamic Zones ***NSF 22-579 deadline June 21, 2022***
- Resilient & Intelligent NextG Systems (RINGS) – Virtual Organization ***NSF 22-590 deadline August 1, 2022***

Artificial Intelligence

Expands the AI frontiers to create transformational technologies and breakthroughs benefiting both science and society

FY 2021

- 11 new National AI Research Institutes

FY 2022

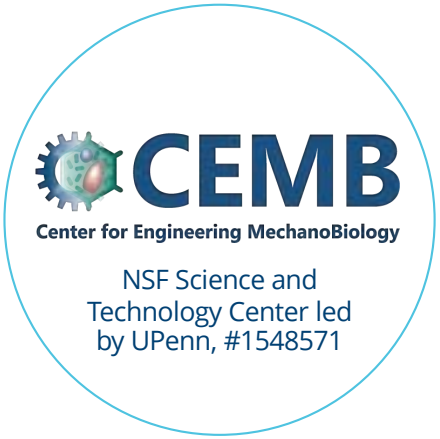
- AI Research Institutes ***NSF 22-502 deadline May 13, 2022***
- NSF-NIH Smart Health and Biomedical Research in the Era of Artificial Intelligence and Advanced Data Science ***NSF 21-530 deadline November 10, 2022***

Biotechnology

To understand and harness biological processes, enabling future innovations in the therapeutics, biopharmaceutical, biochemical, and biotechnology industries

FY 2022

- Reproducible Cells and Organoids via Directed-Differentiation Encoding (RECODE) ***NSF 21-608 deadline March 31, 2022***
- Accelerating Innovations in Biomanufacturing Approaches through Collaboration Between NSF and the DOE Bioenergy Technologies Office funded Agile BioFoundry ***NSF 22-549 deadline April 4, 2022***
- Dear Colleague Letter: Sentinel Systems that Detect, Recognize, Actuate, and Mitigate Emergent Biological Threats (DREAM Sentinels) ***NEW NSF 22-077***



Future Manufacturing

- For manufacturing that either does not exist today or exists only at such small scales that it is not viable
- **FY 2021:** $31.5 million in 22 new research and seed projects
- **FY 2022:** ***NSF 22-568 deadline May 10, 2022***
  - Biomanufacturing
  - Cyber-manufacturing
  - Eco-manufacturing

FMRG: Cyber: A Cyber Nanomanufacturing Platform for Large-scale Production of High-quality MXenes and Other Two-dimensional Nanomaterials, #2134607 Drexel Univ.

FMRG: Eco: Sustainable Route to 3D Solid-State Sodium-ion Battery by Direct Ink Writing and Capillary Rise Infiltration, #2134715 UPenn

Quantum Science and Engineering

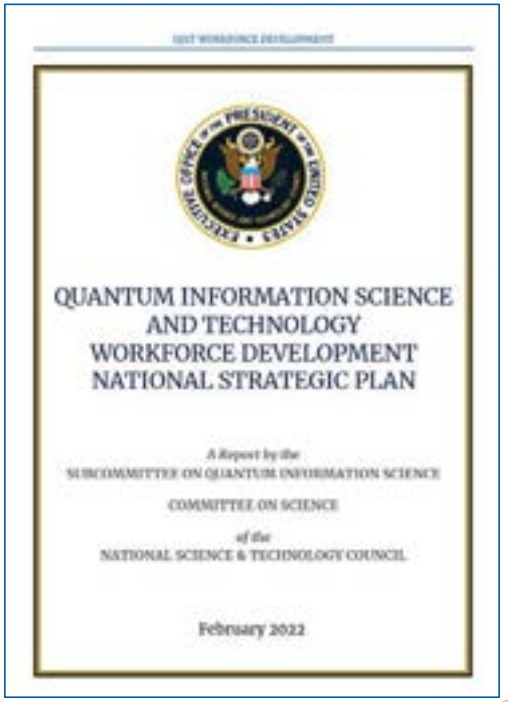
To design devices, applications, tools, or systems with a quantum-based advantage over classical counterparts

FY 2021

- 2 new NSF Quantum Leap Challenge Institutes
- EPSCoR Research Infrastructure: Emergent Quantum Materials and Technologies (EQUATE)
- Quantum Interconnect Challenges for Transformational Advances in Quantum Systems (QuIC-TAQS)

FY 2022

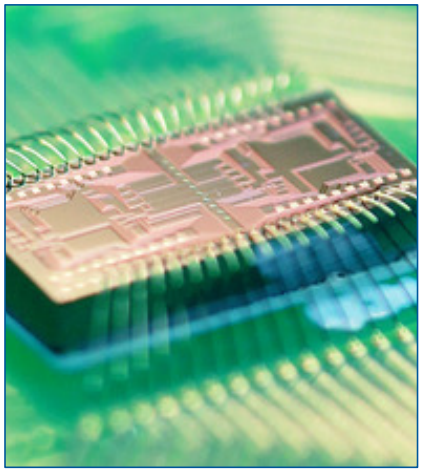
- Expanding Capacity in Quantum Information Science and Engineering ***NSF 22-561 Track 2 (large team) proposals due May 6, Track 1 (small team) proposals due June 3***
- Dear Colleague Letter: Quantum Manufacturing ***NSF 22-074 EAGER research concepts due June 1***


QUANTUM INFORMATION SCIENCE AND TECHNOLOGY WORKFORCE DEVELOPMENT NATIONAL STRATEGIC PLAN

A Report by the SUBCOMMITTEE ON QUANTUM INFORMATION SCIENCE COMMITTEE ON SCIENCE of the NATIONAL SCIENCE & TECHNOLOGY COUNCIL

February 2022

Future of Semiconductors



- ENG workshops in early 2021 identified challenges in semiconductor innovation and manufacturing ecosystems
  - New materials and devices with added/integrated functionality
  - Infrastructure in short to long terms
  - Support for the next-generation workforce
- **NSF and SRC partner to support Research Experiences for Undergraduates sites on semiconductor topics later in 2022**
- Semiconductor Synthetic Biology Circuits and Communications for Information Storage (SemiSynBio-III) ***NSF 22-557 deadline April 25, 2022***
- Future of Semiconductors - Teaming for Co-Design Research Capacity (FUSE) ***NSF 22-589 deadline July 18, 2022***

Goal 2: Expand Opportunities for People

Revolutionizing Engineering Departments

The goal is to catalyze revolutionary changes to the education of the next generation of engineers while expanding the reach of changes that have proven effective. ***NSF 22-587 deadline July 18***

- RED Innovation
- RED Adaptation and Implementation
- RED Two-Year ***NEW TRACK***
  - For radically new approaches among two-year institutions to expand pathways to engineering and engineering technology education

Image courtesy University of San Diego

Broadening Participation in Engineering

- Planning and Conference Grants
- Research in Broadening Participation in Engineering
- Inclusive Mentoring Hubs ***NSF 22-514 target date November 16, 2022***
  - Connect and dynamically build networks for racial and ethnic groups not sufficiently represented
  - Could engage students, faculty, academic leaders, postdoctoral and career transitioning researchers, small businesses and industry professionals, K-12 educators, or others
- Centers for Equity in Engineering ***NSF 22-514 target date November 16, 2022***
  - Catalyze culture change in engineering colleges to create equitable and inclusive practices that recruit and retain a diverse community of students

Early Career Support

- Engineering Postdoctoral Fellowship Program
  - ***Accepting applications for fall 2022 cohort May 1 – June 30***
  - **efellows.asee.org**
- Engineering Research Initiation ***NSF 22-595 deadline October 11***
  - Supports new investigators as they initiate their research programs
  - Limited to those not affiliated with “very high research activity” R1 institutions
- Faculty Early Career Development Program (CAREER)
  - ***NSF 22-586 deadline July 27***
  - Program webinars on May 10 and 16
  - Proposal submission logistics webinar on May 26

Goal 3: Catalyze Purposeful Partnerships

Industry–University Cooperative Research Centers

IUCRCs advance pre-competitive research, drive technology innovation, and develop a diverse, highly skilled S&E workforce by enabling close and sustained engagement between academia, government, and industry.

Current IUCRCs

42 unique jurisdictions, including Washington, DC
16 EPSCoR jurisdictions
14 minority-serving institutions

84 IUCRCs in FY 2021

110+ Universities
700+ Students

750+ Industry Members

20+ Federal Members

12 IUCRC Sites collaborated with 2-year institutions via START
24 Faculty + 62 Students

Center for High Pressure Plasma, Energy, Agriculture, and Biomedical Technologies (PEAB), Drexel University

Water and Environmental Technology (WET) Center, Temple University

Engineering Research Centers

The ERC program supports broad, multidisciplinary high-impact and high-risk/high-payoff engineering research.

Gen-4 ERCs have added emphases on integrating convergent research, engineering workforce development, a culture of diversity and inclusion, and innovation for societal impact.

Current ERCs

22 unique jurisdictions, including Puerto Rico and Washington, DC, with 4 EPSCoR jurisdictions

8 minority-serving institutions

IoT4Ag

The Internet of Things for Precision Agriculture
an NSF Engineering Research Center

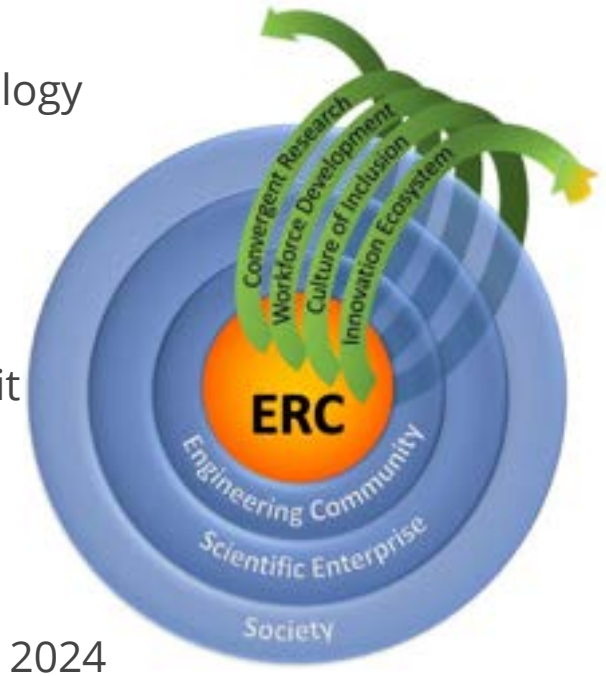
14 ERCs involving 44 unique institutions and 520 industrial participants in FY 2021

1985 through 2021	
75	ERCs
240	Spinoffs
1,380	Licenses
2,560	Invention disclosures
900	Patents
190	Textbooks
14,400	Students

Gen-4 Engineering Research Centers

Advance engineering knowledge and engineered systems technology while exposing students to the integrative aspects of engineered systems and industrial practice

- convergent research that will lead to strong societal impact
- engineering workforce development at all participant stages
- a culture of diversity and inclusion where all participants benefit
- value creation within an innovation ecosystem



FY 2022

- ***NSF 22-580 Letters of Intent deadline September 2, 2022***
- Investment of up to $156 million for up to 6 awards in summer 2024

Civic Innovation Challenge

CIVIC INNOVATION CHALLENGE

POWERING SMART & CONNECTED COMMUNITIES

- Continuing partnership between NSF, Department of Energy, and Department of Homeland Security
- CIVIC is a research-and-action competition designed to build a more cohesive research-to-innovation pipeline and foster collaboration for smart and connected communities.
- Goal: find community-based solutions through collaboration with local communities and make them sustainable, scalable and transferrable to other communities.
- **FY 2021: 52 team planning grants, 17 team awards for 12-month pilots**
  - Communities and mobility (NSF and DOE)
  - Resilience to natural disasters (NSF and DHS)
- **FY 2022: *NSF 22-565 deadline May 5, 2022***
  - Living in a changing climate: pre-disaster action around adaptation, resilience, and mitigation
  - Bridging the gap between essential resources and services & community needs.

Improving the Post-Flood Financial Resiliency of Low- and Moderate-Income Households, #2133256 led by UPenn

Disaster Resilience Research Grants

Modeling Intergovernmental Fiscal Impacts of Coastal Hazards, #2053637 Rutgers University–New Brunswick

- NSF and NIST coordinate and collaborate on research and translation related to natural disasters
  - National Earthquake Hazards Reduction Program (NEHRP)
  - National Windstorm Impacts Reduction Program (NWIRP)
- NSF–NIST joint call for research proposals to advance fundamental understanding of disaster resilience
  - FY 2022: $7.6 million in 20 new research projects
  - ***NSF 22-593 Letters of intent due June 20, proposals due August 19***

Current Partnerships

New Partnerships

Research

- Memorandum of Understanding with NIH National Institute of Biomedical Imaging and Bioengineering
- Memorandum of Understanding with DOE Office of Energy Efficiency and Renewable Energy
- Memorandum of Agreement with NOAA
- Partnership with DOE Bioenergy Technologies Office's Agile BioFoundry to scale biomanufacturing
- Discussions on expanding partnerships with Air Force and NIH

Experiential Training and Workforce Development

- Collaboration with VentureWell and the Lemelson Foundation for a roadmap to transform the engineering curriculum for environmental sustainability
- Partnership with SRC on Research Experiences for Undergraduates in semiconductors
- Partnership with DOE Bioenergy Technologies Office's Agile BioFoundry to scale biomanufacturing

International opportunities

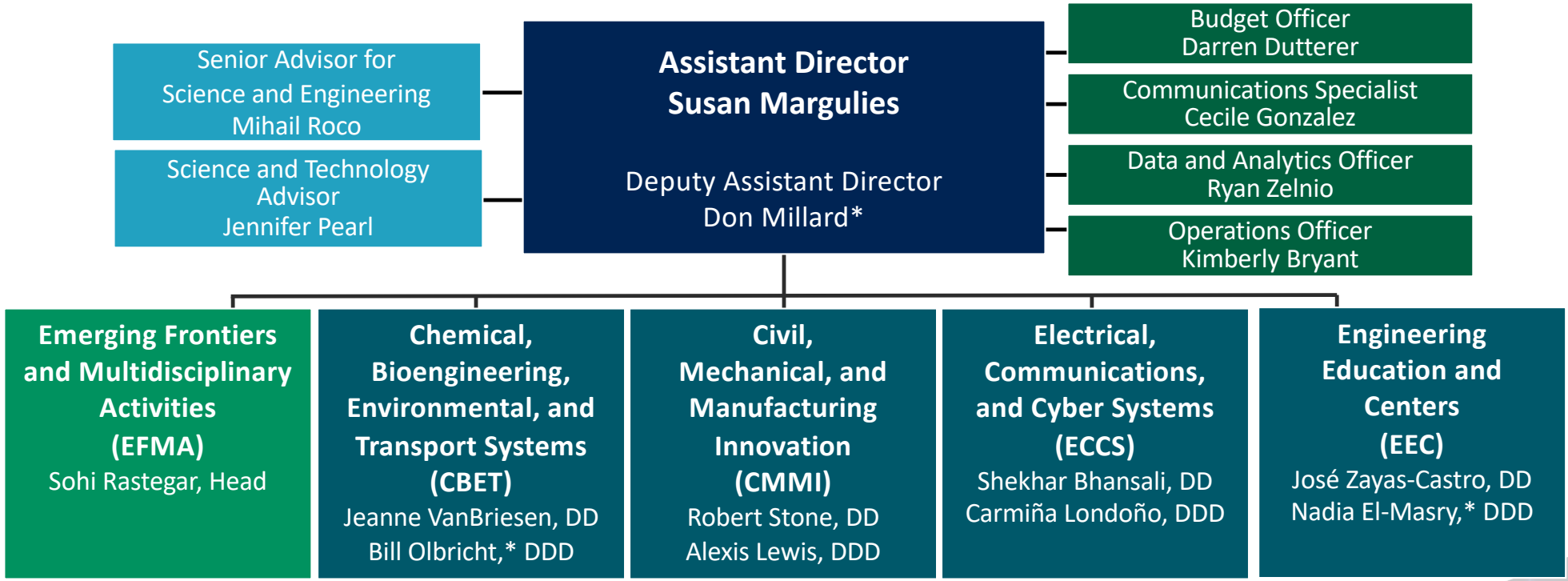
- Discussions with Australia, Brazil, Republic of Ireland, Sweden, UK

Opportunities to Engage

- Workshops, information sessions, ERVA
- NSF Website – Funding Opportunities
- Continuous submission and application deadlines
- RFI, Metaprograms, DCL, Solicitations
- Contact PDs directly

SIGN UP FOR UPDATES ›

NSF Directorate for Engineering



DD = Division Director; DDD = Deputy Division Director; *Acting

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- Propel transformational engineering impact
- Expand opportunities for people
- Catalyze purposeful partnerships

Transforming our World for a Better Tomorrow

Susan Margulies, NSF Assistant Director for Engineering

April 20, 2022