DIRECTORATE FOR ENGINEERING (ENG) **$909,780,000**
-$81,370,000 / -8.2%

ENG Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Chemical, Bioengineering, Environmental and Transport Systems (CBET)	$190.47	-	$160.29	-$30.18	-15.8%
Civil, Mechanical, and Manufacturing Innovation (CMMI)	237.91	-	200.54	-37.37	-15.7%
Electrical, Communications, and Cyber Systems (ECCS)	118.03	-	103.74	-14.29	-12.1%
Engineering Education and Centers (EEC)	102.76	-	89.49	-13.27	-12.9%
Industrial Innovation and Partnerships (IIP)	268.67	-	257.90	-10.77	-4.0%
Emerging Frontiers and Multidisciplinary Activities (EFMA)	73.30	-	97.82	24.52	33.4%
Total	**$991.15**	**-**	**$909.78**	**-$81.37**	**-8.2%**

About ENG

In FY 2021, ENG will spur engineering breakthroughs to help ensure America's security, prosperity, health, and technological leadership in the future. ENG will invest in groundbreaking fundamental engineering research including key Administration and NSF-wide research priorities. Substantial directorate investments in NSF's Big Ideas will emphasize convergence research approaches to help address grand challenges and societal impact. In addition, to advance U.S. global competitiveness, strategic ENG support will strengthen the engineering workforce and accelerate innovation created by deep-technology small businesses and industry.

ENG funding in FY 2021 will help protect Americans. ENG investments will drive advances in secure quantum communications systems and quantum computing as part of the QL Big Idea. ENG will continue its long-term support of engineering research to improve resilience to hurricanes, earthquakes, and other disasters, including the Natural Hazards Engineering Research Infrastructure (NHERI). Other ENG-funded research will investigate methods and technologies for securing the electric grid, detecting biological threats, and disrupting illicit supply networks.

Additional ENG FY 2021 investments in NSF's Big Ideas will help to build future prosperity. ENG will steward the FW-HTF Big Idea and make essential contributions to research on soft robotics, advanced manufacturing, and artificial intelligence. ENG collaboration in the HDR Big Idea will intersect with support for advanced materials, smart and autonomous systems, and disruptive technologies for energy-efficient computing and spectrum-efficient wireless communications. ENG's NNA Big Idea investments will also help ensure sustainable and reliable infrastructure systems in the Arctic through, for example, sensor systems to understand soil dynamics, complex models of food-energy-water systems, and resilient structure designs.

ENG support will help to advance health technologies and systems. ENG will invest in fundamental research to observe nanoscale cellular processes and changes, engineering biology to reverse disease and produce therapies, and synthetic biology to contribute to the URoL Big Idea. The directorate also will support neuro-technologies and imaging relevant to brain research. ENG investments will continue

advances in prosthetic and assistive technologies for veterans, senior citizens, and people with disabilities.

While fundamental engineering research fuels U.S. technological innovation and competitiveness, ENG support for workforce development and innovation speeds and strengthens the translation of discoveries. The directorate will invest in research on education, broadening participation, and inclusion in engineering, as well as in student experiences with industry. ENG will maintain its commitment to talented faculty by continuing investments in the CAREER program. ENG investments in academic partnerships with industry, entrepreneurial training through NSF Innovation Corps (I-Corps™), and startups through the Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) programs will help bring new ideas from lab to market and fortify the Nation's innovation ecosystem.

As part of the FW-HTF Big Idea, and in partnership with the other research directorates and offices, ENG will support convergence activities that transcend the traditional disciplinary boundaries of individual NSF directorates and offices. While financial stewardship for FW-HTF will be the responsibility of ENG, the convergence activities will be overseen and managed collaboratively by the multi-directorate/office FW-HTF leadership team. These activities will enable pursuit of fundamental research on advancing cognitive and physical capabilities in the context of human-technology interactions and the development of a 21st-century workforce capable of adapting to a changing employment landscape. For more information about the Big Ideas, see the narratives in the NSF-Wide Investments chapter.

ENG provides 41 percent of the federal funding for basic research at academic institutions in the engineering disciplines.

Major Investments

ENG Major Investments
(Dollars in Millions)

Area of Investment[1,2]	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Advanced Manufacturing	$138.14	-	$140.00	$1.86	1.3%
Future Manufacturing	-	-	*20.00*	*20.00*	*N/A*
Advanced Wireless	21.00	-	23.00	2.00	9.5%
Artificial Intelligence	119.92	-	159.19	39.27	32.7%
Bioeconomy	95.00	-	96.00	1.00	1.1%
IUSE	0.53	-	4.43	3.90	731.3%
Microelectronics and Semiconductors	56.11	-	55.00	-1.11	-2.0%
NSF I-Corps™	17.33	-	14.63	-2.70	-15.6%
Quantum Information Science	10.19	-	27.84	17.65	173.2%
SaTC	3.25	-	3.03	-0.22	-6.8%
NSF's Big Ideas					
FW-HTF Stewardship	*29.96*	-	*45.00*	*15.04*	*50.2%*

[1] Major investments may have funding overlap and thus should not be summed.

[2] This table reflects support for selected areas of ENG's investments. In other directorate narratives, the selected areas of investment displayed may differ and thus should not be summed across narratives.

- Advanced Manufacturing: ENG research accelerates advances in manufacturing with emphasis on multidisciplinary research that fundamentally alters and transforms manufacturing capabilities, methods, and practices. The FY 2021 Request includes $20.0 million in support of Future

Manufacturing research under the advanced manufacturing umbrella. Future manufacturing is defined as fundamental research to enable manufacturing that (a) does not exist or is not possible today or (b) exists or is possible only at such small scales that it is not viable for mass production. Continued investments in advanced manufacturing include research on highly connected cyber-physical systems in smart processing and cyber manufacturing systems, and activities that develop new methods, processes, analyses, tools, or equipment for new or existing manufacturing products, supply chain components, or materials. ENG's investments will enable new functionalities that will increase the efficiency and sustainability of the production of the next generation of products and services. These developments will yield advantages such as reduced time to market, new performance attributes, improved small-batch production, cost and energy savings, and reduced environmental impact from the manufacturing of products.

- Advanced Wireless: ENG, together with other NSF directorates and offices, will invest in fundamental research, infrastructure, and education to advance knowledge gaps and innovate in areas critical to future generations of wireless technologies and networks beyond 5G to help make wireless communication faster, smarter, more responsive, and more robust. ENG funding will enable new wireless sensors, devices, circuits, protocols, networks and systems; artificial intelligence and inference on mobile devices; human-machine-network interactions; dynamic spectrum allocation and sharing; and the integration of future wireless with energy, transportation, manufacturing, and other systems involving the internet-of-things.
- AI: ENG, together with other NSF directorates and offices, will increase support for AI research and development. A key focal point will be support for AI Institutes, a center-scale activity that will span (a) foundational areas of machine learning, computer vision, natural language processing, and autonomy, along with safety, security, robustness, and explainability of AI systems; (b) translational research at the intersection of AI and various science and engineering domains supported by NSF as well as sectors such as agriculture, advanced manufacturing, transportation, and personalized medicine; (c) workforce development, including growing human capital and institutional capacity to nurture a new generation of ethical AI researchers and practitioners; and (d) advanced computing infrastructure, including access to data and computing capabilities.
- Bioeconomy: ENG, together with other NSF directorates and offices, will invest in fundamental research, infrastructure, and education to understand and harness biological processes for societal benefit. ENG investment areas related to the bioeconomy include synthetic biology, biotechnology, engineering biology, metabolic engineering, tissue engineering, biomechanics, the microbiome, and the development of new types of biomaterials, bio-based microelectronics, and biomanufacturing. ENG also supports research on the social and environmental implications of synthetic biology and other biotechnologies. ENG investments will enable future innovations in the health therapeutics, biopharmaceutical, biochemical, and biotechnology industries.
- IUSE: ENG's investment in the NSF-wide IUSE initiative, which integrates the agency's investments in undergraduate education, will continue as support for the IUSE/Professional Formation of Engineers: Revolutionizing Engineering Departments (PFE:RED) solicitation moves to a biennial cycle. PFE:RED enables research and innovations leading to and propagating interventions that improve both the quality and quantity of engineering graduates.
- Microelectronics and Semiconductors: ENG, together with other NSF directorates and offices, will support research to address fundamental science and engineering questions on the concepts, materials, devices, circuits, and platforms necessary to sustain progress in semiconductor and microelectronic technologies. Research in semiconductors and microelectronics is critical to future advances and security in information technology, communications, sensing, smart electric grid, transportation, health, advanced manufacturing, and other areas. The investment will strengthen America's capabilities and capacity for revolutionary microelectronics design, architecture, and fabrication, as well as high-performance computing. New discoveries will enable the nation to overcome crucial scientific barriers for emerging technologies such as artificial intelligence, quantum technologies, and interconnected

autonomous systems, and they will strengthen U.S. scientific leadership, economic prosperity, and national security.

- I-Corps™: ENG, in partnership with other directorates, will continue to support the NSF-wide I-Corps™ program, which connects NSF-funded science and engineering research with the technological, entrepreneurial, and business communities. It fosters a national innovation ecosystem that links scientific discovery with technology development, societal needs, and economic opportunities.
- QIS: ENG, together with other NSF directorates and offices, will increase support for quantum information science and engineering research. ENG's QIS investments strongly align with the *National Quantum Initiative Act* (P.L. 115-368) to consolidate and expand U.S.' global leadership in fundamental quantum research. QIS research will deliver proof-of-concept devices, applications, tools, or systems with a demonstrable quantum advantage over their classical counterparts. Research in QIS examines uniquely quantum phenomena that can be harnessed to advance information processing, transmission, measurement, and fundamental understanding in ways that classical approaches can only do much less efficiently, or not at all. Current and future QIS applications differ from prior applications of quantum mechanics, such as the laser, transistor, and magnetic resonance imaging, by using distinct quantum phenomena—superposition and entanglement—that do not have classical counterparts. QIS research activities will also address education and workforce development needs, broadening research collaborations, promoting innovative team- building activities, and stimulating cross-disciplinary curriculum development and training to provide a quantum-smart workforce.
- SaTC: ENG support for SaTC will focus on the engineering aspects of the NITRD Strategic Plan for the Federal Cybersecurity Research and Development Program.[1] NITRD's research thrusts cover a set of interrelated priorities for U.S. government agencies that conduct or sponsor research and development in cybersecurity.
- FW-HTF: ENG will steward the FW-HTF Big Idea. While financial stewardship for this Emerging Frontiers and Multidisciplinary Activities (EFMA) investment will be the responsibility of ENG, the convergence activities will be overseen and managed collaboratively by the multi-directorate/office FW-HTF leadership team. ENG will work closely with OIA's Convergence Accelerator (CA) for the area of FW-HTF, building on collaborative design of the CA model that draws on ENG experience in technology translation and partnerships.

ENG Funding for Centers Programs and Facilities

ENG Funding for Centers Programs

(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$71.31**	**-**	**$55.92**	**-$15.39**	**-21.6%**
Engineering Research Centers (EEC)	58.95	-	50.92	-8.03	-13.6%
STC: Emergent Behaviors for Integrated Cellular Systems (CBET)[1]	3.70	-	-	-3.70	-100.0%
STC: Engineering Mechano-Biology (CMMI)	4.96	-	5.00	0.04	0.7%
STC: Energy Efficient Electronics Systems (ECCS)[1]	3.70	-	-	-3.70	-100.0%

[1] NSF's support for 2010 class of STCs will conclude in FY 2020 as planned.

For additional information on NSF's centers programs, please see the NSF-Wide Investments chapter.

[1] www.nitrd.gov/pubs/FY2019-Cybersecurity-RD-Roadmap.pdf

ENG Funding for Major Multi-User Facilities

(Dollars in Millions)

	FY 2019 Actual[1]	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$11.57**	**-**	**$10.95**	**-$0.62**	**-5.4%**
Natural Hazards Engineering Research Infrastructure (NHERI)	11.57	-	10.95	-0.62	-5.4%

[1] Includes $8.50 million to upgrade the LHPOST facility. Excluded is $8.93 million of FY 2019 O&M costs obligated in FY 2018.

For detailed information on individual facilities, please see the Facilities and the Major Research Equipment and Facilities Construction chapters.

Funding Profile

ENG Funding Profile

	FY 2019 Actual Estimate	FY 2020 (TBD)	FY 2021 Estimate
Statistics for Competitive Awards:			
Number of Proposals	9,023	-	10,000
Number of New Awards	2,379	-	2,200
Funding Rate	26%	N/A	22%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,932	-	5,900
Number of Research Grants	1,642	-	1,500
Funding Rate	28%	N/A	25%
Median Annualized Award Size	$116,667	-	$116,000
Average Annualized Award Size	$135,094	-	$135,000
Average Award Duration, in years	2.7	-	2.7

ENG investments support fundamental engineering research, engineering education, and innovation, as well as research infrastructure such as facilities. In FY 2021, funding for centers accounts for approximately eight percent of ENG's non-SBIR/STTR Request. In FY 2021, funding for facilities is under two percent of ENG's non-SBIR/STTR Request.

Program Monitoring and Evaluation

ENG uses evidence and evaluation to build capacity for decision-making and improve program outcomes. Each year, the directorate collects evidence through workshops, surveys and other means to help identify emerging areas, learn about program results, and get other input from the community. ENG also periodically conducts reviews and evaluations to understand program effectiveness. Together, these measures help ENG make programs more strategic and impactful.

Evidence and Surveys

- In March 2019, IIP began administering a Baseline Monitoring Survey to companies that received a SBIR/STTR Phase I award after May 2018. The survey results will be used to create a performance baseline for recent SBIR/STTR awardees. The survey data allows IIP to benchmark across Phase I

companies, understand how successful small businesses differ, and identify potential failure modes to inform future initiatives supporting current and future small businesses. As of January 2020, more than 450 Phase I awardees have completed the survey. IIP will continue administering the survey to understand the impacts of the programs on these companies over time.

- Starting in March 2019, IIP made a significant change to the SBIR/STTR proposal submission process by requiring that small businesses or entrepreneurs submit a three-page Project Pitch prior to submitting a ful+l proposal. Pitch submitters learn within three weeks if their idea aligns with program objectives and receive program guidance. The new process offers real-time assistance to startups, advances the funding process, and accelerates the development of new ventures. Between March 2019 and January 2020, more than 4,500 small businesses or entrepreneurs completed the Project Pitch process. Applicants were surveyed to inform ongoing refinements of the Project Pitch process as NSF continues to provide critical support to the technology small business and startup communities. Initial analysis indicates that most Pitch submitters found the process easy. Additionally, most SBIR/STTR applicants found the feedback provided by NSF to be helpful and were satisfied with the wait time to get feedback.

Workshops and Reports

- In March 2019, an ECCS-supported workshop on "Reconfigurable Sensor Systems Integrated with Artificial Intelligence and Data Harnessing to Enable Personalized Medicine" was held. The focus of the workshop was to determine future strategies for advancing the fundamental understanding and engineering of reconfigurable sensor systems by integrating hardware with data harnessing, real-time learning, and artificial intelligence capabilities. The workshop report,[2] published in fall 2019, will inform ECCS' plans and priorities in Reconfigurable Sensor Systems enabling Personalized Medicine.
- In March 2019, NSF's Disrupting Illicit Supply Networks program, which began in FY 2018, had two follow-up activities: (1) NSF (ENG, CISE, and SBE), led by CMMI, issued a dear colleague letter[3] for research proposals with six new awards funded in FY 2019; (2) a new workshop[4] brought together operations researchers, computer scientists, social scientists, business researchers, geographers, social service agency representatives, and federal agencies to increase understanding of both the nature, and the challenges to disruption, of illicit supply chains. NSF is currently assessing input from the workshops, PIs, other federal agencies, and NGOs for broader interagency research opportunities.
- In May 2019, an ECCS-funded workshop on the interface between machine learning (ML) and dynamics and control took place at MIT.[5] While ML has had tremendous impact in areas such as computer vision and language translation, over the next decade the explosion of real-time data (from devices that sense and control the physical world) requires a convergence of research areas such as ML, model-based dynamical systems, and control and decision theory. This activity will impact planned funding activities in priority areas such as artificial intelligence and the HDR Big Idea.
- In June 2019, NSF submitted its first report[6] to Congress about the I-Corps™ program. The report was developed in response to the *American Innovation and Competitiveness Act (AICA)* (P.L. 114-329), which requires NSF to develop program metrics and deliver a report to Congress every two years.
- In July 2019, ENG and the American Society for Engineering Education (ASEE) held a Visioning Summit to engage various engineering communities in determining mechanisms through which the fundamental engineering research community's priorities may be identified. Attendees learned about a variety of mechanisms currently used by industry and academia to identify important priorities and trends; collecting this information in one place will be useful for the engineering community and help develop an evidence base for decision making. In late 2019, ASEE published a summit report.[7]

[2] https://assistcenter.org/wp-content/uploads/2019/09/NSFWorkshop_Report-082119-v2.pdf
[3] www.nsf.gov/pubs/2019/nsf19049/nsf19049.jsp
[4] www.eventbrite.com/e/gmu-nsf-conference-on-disrupting-operations-of-illicit-supply-networks-registration-57803528911
[5] https://l4dc.mit.edu/
[6] www.nsf.gov/news/special_reports/i-corps/pdf/I-CorpsReport--6_4_19FINAL_508.pdf
[7] https://engresearchvisioning.asee.org/wp-content/uploads/2019/11/ERFVS-Workshop-Summary-lo-res.pdf

- At the end of FY 2019, CBET, together with the Department of Energy (DOE) Offices of Fossil Energy and Science and the DOE Office of Energy Efficiency and Renewable Energy, co-funded a consensus study by the National Academies of Sciences, Engineering, and Medicine. The three-year study will survey the current state of the chemical engineering discipline and its contributions to society as well as articulate a vision for the future of the field. The main objective of the study is to outline a vision and strategy for chemical engineering research, innovation, and education over the next thirty years.
- In October 2019, an ECCS-funded workshop on security in Radio Frequency (RF)/analog microelectronics and electromagnetics[8] was held to explore the needs and challenges involved in ensuring security in future analog hardware that operates over the range from direct current (DC) to terahertz (THz) frequencies. The workshop helped identify areas for future investment in ECCS core programs and special solicitations. Workshop outcomes should impact planned funding activities in semiconductor microelectronics, advanced wireless, machine-learning enhanced engineered systems, manufacturing, and other priority areas, as well as HDR Big Idea-supported programs.
- In FY 2020, IIP expects to complete the migration of the data collection and management process for the Industry-University Cooperative Research Center (IUCRC) program; the transition was delayed due to the government shutdown. One goal of this migration is to build an in-house data ecosystem for the IUCRC program that entails collecting, organizing, and managing internal and external data, including annual survey data. The combination of data sources will provide a holistic view of the program and enable customized analyses on a center level.

Evaluations and Reviews

- In FY 2016, the NSF's Evaluation and Assessment Capability office initiated a study of the I-Corps™ Teams program to assess its impacts on teams that completed the entrepreneurial training and on academic culture. The analysis used quantitative data from surveys and case studies developed from in-depth interviews and site visits. Completed in FY 2019, the evaluation advised IIP to modify the longitudinal survey questions to better capture all potential commercialization outcome metrics.
- In FY 2019, the National Nanotechnology Coordinated Infrastructure (NNCI) program went through a review of its first five years. Results provided ECCS with evidence-based data to inform future decisions regarding NNCI sites and other investments. In addition, the NNCI facility has a metrics and assessment committee with a defined common set of site and network metrics based on usage data.
- In FY 2019, the National Center for Science and Engineering Statistics (NCSES) began efforts to advance the use of its Data for Evidence-based Research and Evaluation. As part of this effort, the ENG Engineering Research Center (ERC) program will clarify its data collection requirements to make full use of NCSES data. Linkage of the dataset will allow longitudinal evaluation of the ERC program impacts on student participants.

Committees of Visitors (COV)[9]

- In FY 2019, COVs reviewed CBET and CMMI for the period of FY 2015 through FY 2018. The COVs presented their reports to the ENG Advisory Committee at its October 2019 meeting.
- In FY 2020, COVs will review EEC and IIP.
- In FY 2022, COVs will review ECCS and EFMA.

The Performance and Management chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

[8] www-mtl.mit.edu/wpmu/nsfworkshop2019/
[9] www.nsf.gov/od/oia/activities/cov/covs.jsp#eng

People Involved in ENG Activities

Number of People Involved in ENG Activities

	FY 2019 Actual Estimate	FY 2020 (TBD)	FY 2021 Estimate
Senior Researchers	9,149	-	8,400
Other Professionals	1,935	-	1,800
Postdoctoral Associates	430	-	400
Graduate Students	7,621	-	7,000
Undergraduate Students	4,298	-	4,000
Total Number of People	**23,433**	**-**	**21,600**

DIVISION OF CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS (CBET) **$160,290,000**
-$30,180,000 / -15.8%

CBET Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$190.47**	**-**	**$160.29**	**-$30.18**	**-15.8%**
Research	**185.39**	**-**	**154.95**	**-30.44**	**-16.4%**
Centers Funding (total)	3.70	-	-	-3.70	-100.0%
STC: Emergent Behaviors for Integrated Cellular Systems[1]	3.70	-	-	-3.70	-100.0%
Education	**1.40**	**-**	**1.90**	**0.50**	**35.9%**
Research Infrastructure	**3.68**	**-**	**3.44**	**-0.24**	**-6.5%**
National Nanotechnology Coordinated Infrastructure (NNCI)	3.68	-	3.44	-0.24	-6.5%

[1] NSF's support for 2010 class of STCs will conclude in FY 2020 as planned.

About CBET

CBET supports research to enhance and protect U.S. national health, energy, food, water, environment, process manufacturing, and security. Through CBET, the physical, chemical, life, and social sciences are integrated in engineering research and education, resulting in advances in the rapidly evolving fields of biotechnology, bioengineering, biomanufacturing, advanced materials, environmental engineering, and sustainable energy. CBET also invests in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET investments contribute significantly to the knowledge base and to the workforce development of major U.S. economy components, such as chemicals, pharmaceuticals, medical devices, specialty chemicals, and materials for advanced manufacturing, natural gas and petroleum production, food, textiles, utilities, and microelectronics.

CBET supports the chemical, environmental, biomedical, mechanical (transport), and civil (environmental) engineering disciplines. To serve these communities and achieve its goals, CBET is organized into four thematic clusters: Chemical Process Systems; Engineering Biology and Health; Environmental Engineering and Sustainability; and Transport Phenomena.

In general, 82 percent of the CBET portfolio is available to support new research grants. The remaining 18 percent supports research grants made in prior years.

DIVISION OF CIVIL, MECHANICAL, AND MANUFACTURING INNOVATION (CMMI) **$200,540,000**
-$37,370,000 / -15.7%

CMMI Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$237.91**	**-**	**$200.54**	**-$37.37**	**-15.7%**
Research	**220.85**	**-**	**184.74**	**-36.11**	**-16.4%**
Centers Funding (total)	4.96	-	5.00	0.04	0.7%
STC: Engineering Mechano-Biology	4.96	-	5.00	0.04	0.7%
Education	**2.79**	**-**	**2.33**	**-0.46**	**-16.4%**
Facilities	**11.57**	**-**	**10.95**	**-0.62**	**-5.4%**
Natural Hazards Engineering Research Infrastructure (NHERI)[1]	11.57	-	10.95	-0.62	-5.4%
Other Research Infrastructure	**2.70**	**-**	**2.52**	**-0.18**	**-6.7%**
Center for High Energy X-ray Science (CHEXS)	0.80	-	0.75	-0.05	-6.3%
National Nanotechnology Coordinated Infrastructure (NNCI)	1.90	-	1.77	-0.13	-6.8%

[1] FY 2019 includes $8.50 million to upgrade the LHPOST facility. Excluded is $8.93 million of FY 2019 O&M costs obligated in FY 2018.

About CMMI

CMMI funds fundamental research in support of the Foundation's strategic goals directed at advances in civil, mechanical, industrial, systems, manufacturing, and materials engineering. In addition, the division has a focus on the reduction of risks and damage resulting from earthquakes, wind, and other hazards. CMMI encourages discoveries enabled by cross-cutting technologies such as adaptive systems, artificial intelligence, nanotechnology, and high-performance computational modeling and simulation.

The division supports cross-disciplinary research partnerships at the intersections of traditional research disciplines to achieve transformative research results. CMMI investments create innovative manufacturing technology that does not exist today (such as future manufacturing); enable the design and analysis of complex engineered systems; enhance the sustainability and resilience of U.S. infrastructure (for example, buildings, transportation, and communication networks); help protect the Nation from extreme natural and human-induced events; and apply engineering principles to improve the Nation's service and manufacturing enterprise systems, such as healthcare.

CMMI also provides funding and management of NHERI and contributes to the directorate's annual operations support of the CHEXS facility.

In general, 82 percent of the CMMI portfolio is comprised of new research grants and 18 percent supports continuing grants.

DIVISION OF ELECTRICAL, COMMUNICATIONS, AND CYBER SYSTEMS (ECCS) **$103,740,000**
-$14,290,000 / -12.1%

ECCS Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$118.03**	**-**	**$103.74**	**-$14.29**	**-12.1%**
Research	**111.92**	**-**	**97.20**	**-14.72**	**-13.2%**
Centers Funding (total)	3.70	-	-	-3.70	-100.0%
STC: Energy Efficient Electronics Systems[1]	3.70	-	-	-3.70	-100.0%
Education	**0.67**	**-**	**1.57**	**0.90**	**134.5%**
Research Infrastructure	**5.44**	**-**	**4.97**	**-0.47**	**-8.6%**
Center for High Energy X-ray Science (CHEXS)	0.10	-	0.09	-0.01	-10.0%
National Nanotechnology Coordinated Infrastructure (NNCI)	5.34	-	4.88	-0.46	-8.6%

[1] NSF's support for 2010 class of STCs will conclude in FY 2020 as planned.

About ECCS

ECCS supports enabling and transformative research at the nano, micro, and macro scales that fuels progress in engineering system applications with high societal impacts. The division's programs encompass novel electronic, photonic, quantum, and magnetic devices (such as semiconductors integrated with biological structures), and the integration of these devices into circuit and system environments, intelligent systems, control, and networks.

ECCS investments in artificial intelligence research for real-time learning and decision-making will help enable safe, reliable, and efficient data-enabled engineering systems. Breakthroughs in devices and systems advance applications spanning cyber and communications technologies (such as 5G networks and spectrum efficiency and security), energy and power, healthcare, transportation, robotics, advanced manufacturing, and other systems-related areas.

The division also provides funding, in partnership with other NSF directorates, and management of the National Nanotechnology Coordinated Infrastructure (NNCI).

In general, 82 percent of the ECCS portfolio is comprised of new research grants and 18 percent supports continuing grants.

DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC) **$89,490,000**
-$13,270,000 / -12.9%

EEC Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$102.76**	**-**	**$89.49**	**-$13.27**	**-12.9%**
Research	**79.27**	**-**	**74.27**	**-5.00**	**-6.3%**
Centers Funding (total)	58.95	-	50.92	-8.03	-13.6%
Engineering Research Centers	58.95	-	50.92	-8.03	-13.6%
Education	**23.49**	**-**	**15.22**	**-8.27**	**-35.2%**

About EEC

EEC integrates disciplinary basic research and education conducted in other ENG divisions and across NSF into strategic frameworks that address societal grand challenges and promote innovation. Research included in the EEC portfolio spans both the physical/life sciences and engineering, from nanostructured materials to new device concepts, subsystems, and systems. Applications range across a wide spectrum, such as energy, medicine, telecommunications, nanoelectronics, manufacturing, civil infrastructure, the environment, computer networks, cybersecurity, and others. Also included are formal scholarly studies in the professional formation of engineers, which can lead to innovations in engineering education and career development.

The complex, integrative role of EEC requires a comprehensive infrastructure of people, equipment, and centers. Creative and effective approaches to developing the engineering workforce are vital, as a lack of properly prepared engineers is a critical barrier to a healthy U.S. economy. EEC invests in faculty, graduate and undergraduate students, post-doctoral scholars, and K–12 teachers. As nontraditional students—such as part-time, delayed enrollment, veteran, and others—comprise more than 70 percent of the general undergraduate population, EEC is also defining alternative pathways for these students, especially veterans, to successfully earn degrees in engineering.

The programs in EEC are administratively managed within four categories: (1) Centers and Networks; (2) Engineering Education Research; (3) Engineering Workforce Development; and (4) Broadening Participation in Engineering. The Centers and Networks category is comprised of the signature Engineering Research Centers (ERC) program.

The ERC program provides the framework for interdisciplinary research and education, development, and technology transfer in partnership with academia, industry, and government. The FY 2021 funding level supports 13 centers. The total includes funding for three 4th-generation (Gen-4), Class of 2020, ERCs that will advance convergence engineering research to tackle high-impact challenges that have the potential to benefit U.S. security, prosperity, health, and society. The 2020 ERCs will implement strategies for effective team formation, diversity and inclusion, and engagement with stakeholder communities to maximize their impacts. To build capacity for a new generation of convergent engineering research centers, ENG funded planning grants for engineering research collaborations designed to create societal benefits, providing 61 awards in FY 2018 and 41 awards in FY 2019.

Engineering Education programs advance new productive engineering pedagogy and learning strategies in traditional and non-traditional environments. This category also includes EEC's participation in the NSF-

wide activity, IUSE, which integrates the agency's investments in undergraduate education. Engineering Workforce Development includes programs such as Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET). Broadening Participation in Engineering supports research and activities that enhance opportunities for underrepresented groups by addressing structural inequalities and biases within educational and workforce systems. This category also includes EEC's engagement with the NSF INCLUDES Big Idea, which integrates the agency's investments to build on and scale up what works in broadening participation programs.

In general, 22 percent of the EEC portfolio is comprised of new research grants. The remaining 78 percent funds continuing grants and cooperative agreements made in previous years. This high fraction of multi-year commitments is primarily a consequence of centers funding, which includes awards made as five-year cooperative agreements.

DIVISION OF INDUSTRIAL INNOVATION AND PARTNERSHIPS (IIP) **$257,900,000**
-$10,770,000 / -4.0%

IIP Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$268.67**	**-**	**$257.90**	**-$10.77**	**-4.0%**
Research	**268.67**	**-**	**257.54**	**-11.13**	**-4.1%**
SBIR/STTR, including Operations	211.66	-	209.25	-2.41	-1.1%
SBIR	181.87	-	179.06	-2.81	-1.5%
STTR	24.78	-	25.19	0.41	1.6%
SBIR/STTR Operations	5.00	-	5.00	-	-
Education	**-**	**-**	**0.36**	**0.36**	**N/A**

About IIP

IIP contributes to the NSF innovation ecosystem by: (1) supporting technical innovation research that builds on fundamental research discoveries that exhibit potential for societal and economic impact; (2) encouraging research partnerships between academia and industry; and (3) offering hands-on experience in the innovation process to current and future hi-tech entrepreneurs and innovators.

IIP is home to two cross-agency small business research programs, the SBIR and STTR programs. These programs seek to transform scientific discovery into societal and economic benefit by catalyzing private sector commercialization of deep technological innovations. SBIR/STTR programs provide the opportunity for startups and small businesses to undertake cutting-edge, high-quality scientific research and development to determine the scientific and technical feasibility of a new concept or innovation that could be developed into new products, processes, or services for profound societal impact. SBIR/STTR technology topics draw upon the breadth of NSF scientific and engineering research disciplines and are aligned with national and societal priorities.

IIP also supports academic research through three industry-university research programs: Industry-University Cooperative Research Centers (IUCRC), Partnerships for Innovation (PFI), and Grant Opportunities for Academic Liaison with Industry (GOALI)/Non-Academic Research Internships for Graduate Students (INTERN). These programs aim to stimulate academia–industry partnerships, leverage industrial support, accelerate technology commercialization, and empower future generations in science and engineering. University grantees in these programs collaborate with industry to create enabling technologies that meet national needs, such as managing the electrical power system, enhancing advanced manufacturing, improving biological and biomedical processing, and supporting new information and communications technologies.

IIP also leads the I-Corps™ program that connects NSF-funded science and engineering research with the technological, entrepreneurial, and business communities, and fosters a national innovation ecosystem that links scientific discovery with technology development, societal needs, and economic opportunities.

In general, 97 percent of the IIP portfolio is comprised of new research grants and 3 percent supports continuing grants.

OFFICE OF EMERGING FRONTIERS AND MULTIDISCIPLINARY ACTIVITIES (EFMA) **$97,820,000**
+$24,520,000 / 33.4%

EFMA Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$73.30**	**-**	**$97.82**	**$24.52**	**33.4%**
Research	**69.17**	**-**	**97.64**	**28.47**	**41.2%**
Education	**4.03**	**-**	**0.09**	**-3.94**	**-97.8%**
Research Infrastructure	**0.10**	**-**	**0.09**	**-0.01**	**-10.0%**
Center for High Energy X-ray Science (CHEXS)	0.10	-	0.09	-0.01	-10.0%

About EFMA

EFMA strategically pursues and supports projects in important emerging areas. The office also provides support to high impact multidisciplinary education and learning platform programs such as Germination of Research Ideas for Large Opportunities and Critical Societal Needs (GERMINATION), Research Experience and Mentoring (REM) and REU supplements; contributes to the directorate's annual operations support of NSF facilities such as CHEXS; and supports special studies such as the Visioning Framework for Engineering Research.

Funding for the FW-HTF Big Idea ($45.0 million) will support convergence activities that transcend the traditional disciplinary boundaries of individual NSF directorates and offices. While financial stewardship for this NSF investment will be the responsibility of ENG, the convergence activities will be overseen and managed collaboratively by the multi-directorate/office FW-HTF leadership team. These activities will enable pursuit of fundamental research on advancing cognitive and physical capabilities in the context of human-technology interactions, and the development of a 21st-century workforce capable of adapting to a changing employment landscape.

A major activity in EFMA is the Emerging Frontiers in Research and Innovation (EFRI) program. Each year EFRI funds interdisciplinary projects at the frontiers of engineering with potential for major impacts on national needs and/or grand challenges, particularly in areas that may lead to breakthrough technologies and strengthen the economy's technical underpinnings. EFRI is intended to have the necessary flexibility to target long-term challenges, while retaining the ability and agility to adapt as new challenges demand.

- In FY 2018 and FY 2019, EFRI invested in two topics: Chromatin and Epigenetic Engineering to advance the engineering of biology at the molecular and cellular levels; and Continuum, Compliant, and Configurable Soft Robotics Engineering (C3 SoRo) to create robots that are safer, more adaptable, and more compatible with human collaborators than are today's rigid ones.
- Two new topics are debuting in FY 2020 and will continue in FY 2021.
  - Distributed Chemical Manufacturing will enable the development of modular process plants able to take advantage of distributed feedstocks and product delivery needs, or to address environmental remediation problems at the source.
  - Engineering the Elimination of End-of-Life Plastics (E3P) will create a scientific foundation for viable solutions to the capture, management, and elimination of end-of-use plastics.

In general, 91 percent of the EFMA portfolio is comprised of new research grants, and about 9 percent supports continuing increments for grants made in previous years.