U.S. DEPARTMENT OF ENERGY | Office of Science

DOE Office of Science

Update and FY 2019 Budget

Presented to the

State University System of Florida

by

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Deputy Director for Programs

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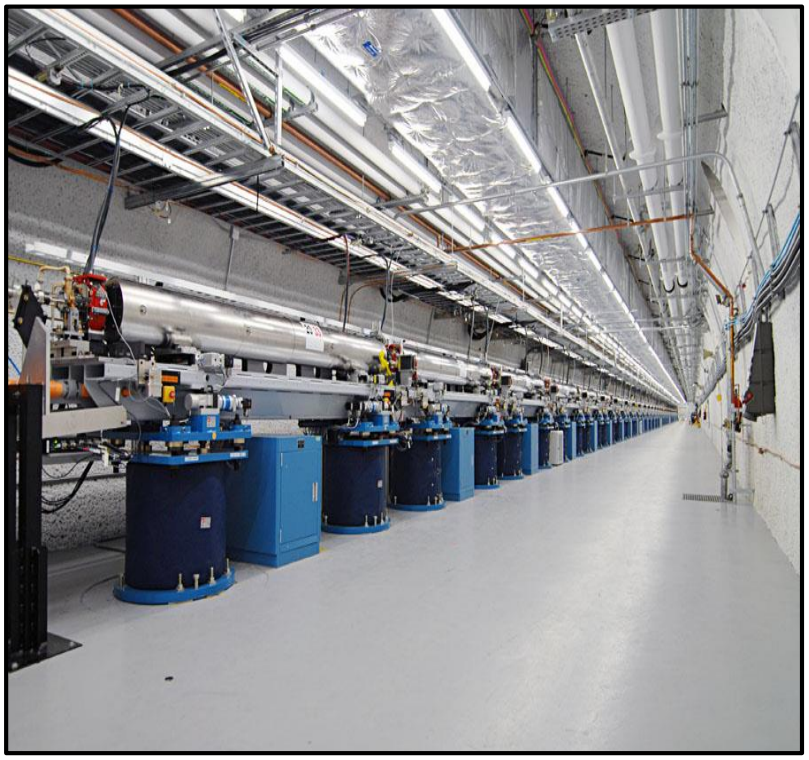
October 1, 2018

Office of Science

By the numbers

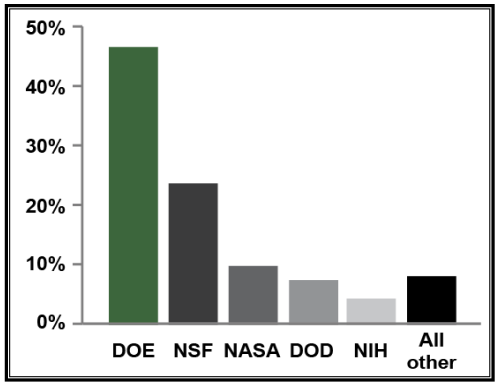


Shown is a portion of SLAC's two-mile-long linear accelerator (or linac), which provides the electron beam for the new Linac Coherent Light Source (LCLS) – the world's first hard x-ray, free-electron laser. For nearly 50 years, SLAC's linac had produced high-energy electrons for physics experiments. Now researchers use the very intense X-ray pulses (more than a billion times brighter than the most powerful existing sources) much like a high-speed camera to take stop-motion pictures of atoms and molecules in motion, examining fundamental processes on femtosecond timescales.

SC delivers scientific discoveries and tools to transform our understanding of nature and advance the energy, economic, and national security of the U.S.

Research

- Support for about half of the U.S. Federal support of basic research in the physical sciences;
- Over 22,000 Ph.D. scientists, graduate students, undergraduates, engineers, and support staff at over 300 institutions and 17 DOE national laboratories;
- U.S. and world leadership in high-performance computing and computational sciences;
- Major U.S. supporter of physics, chemistry, materials sciences, and biology for discovery and for energy sciences.



Support for basic research in the physical sciences by agency.

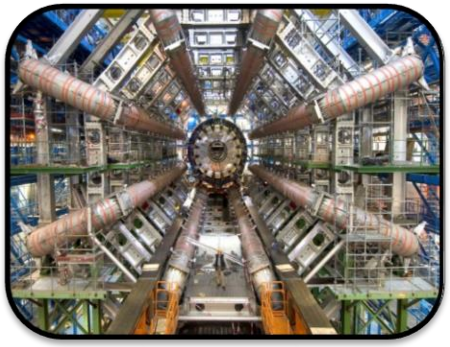
Source: *NSF Science and Engineering Indicators 2012*

Scientific User Facilities

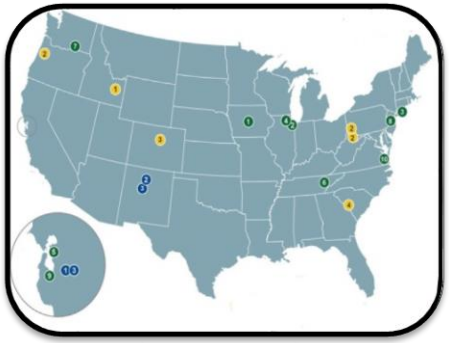
- The world's largest collection of scientific user facilities (aka research infrastructure) operated by a single organization in the world, used by nearly 32,000 researchers each year.

Office of Science at a Glance

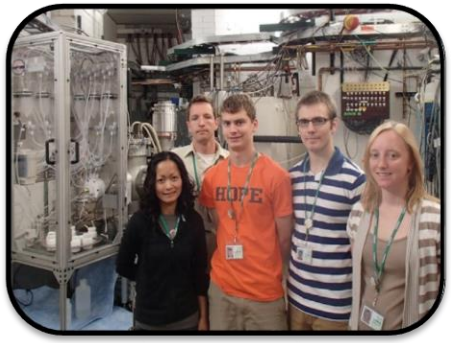
FY 2019 Request: $5.39B



Largest Supporter of Physical Sciences in the U.S.



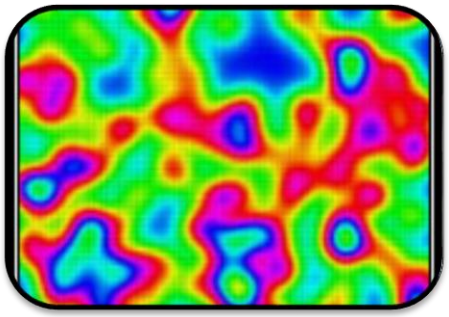
Funding at >300 Institutions including all 17 DOE Labs



Over 22,000 Scientists Supported

Nearly 32,000 Users of 26 SC Scientific Facilities

~40% of Research to Universities



Research: 40%, $2.15B

Facility Operations: 39%, $2.12B

Projects/Other: 21%, $1.12B

Seventeen DOE National Laboratories

Approximately $10 billion Research per Year in Cutting-edge Innovation

Office of Science Laboratories

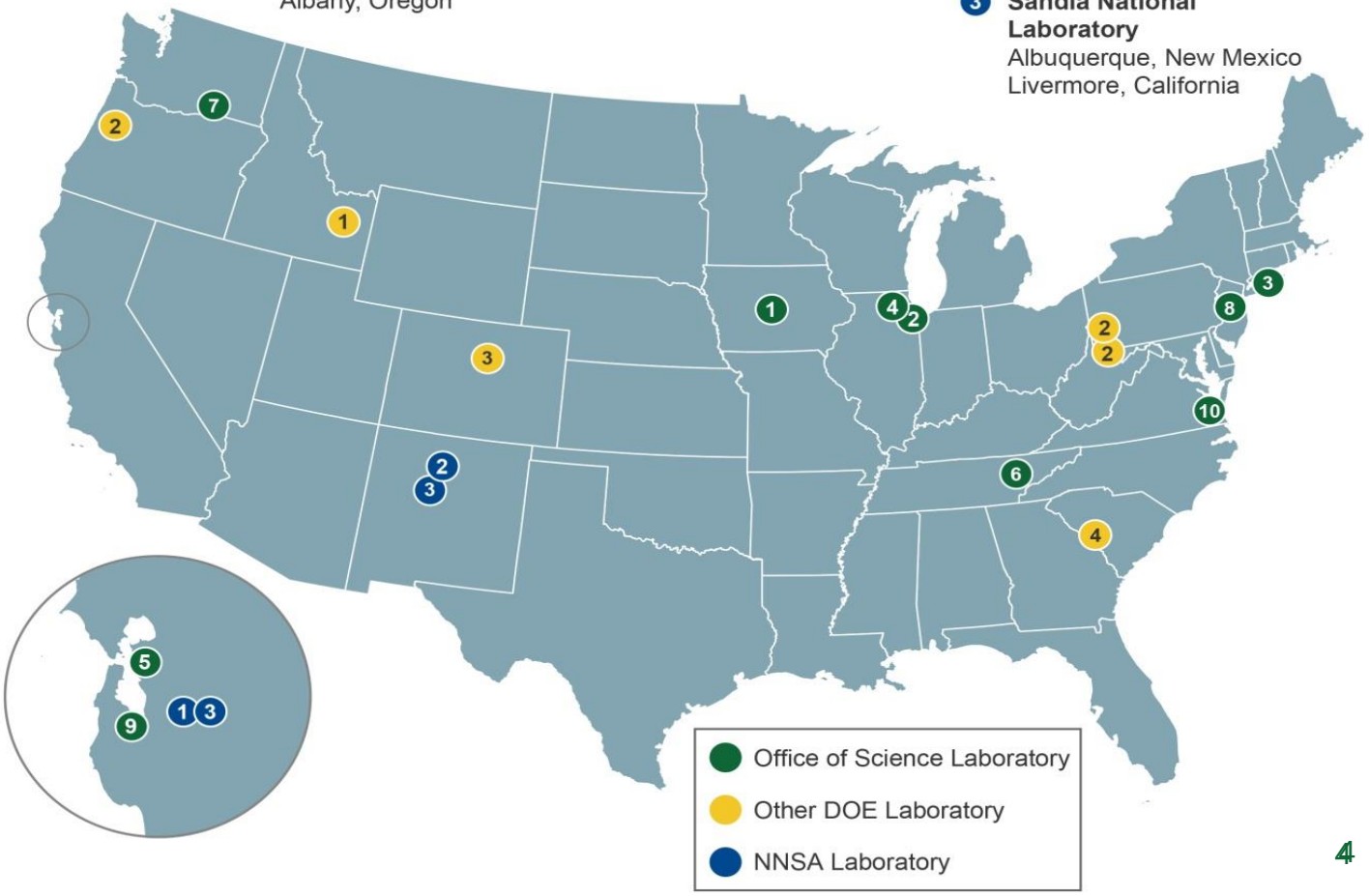
1. **Ames Laboratory**
   Ames, Iowa
2. **Argonne National Laboratory**
   Argonne, Illinois
3. **Brookhaven National Laboratory**
   Upton, New York
4. **Fermi National Accelerator Laboratory**
   Batavia, Illinois
5. **Lawrence Berkeley National Laboratory**
   Berkeley, California
6. **Oak Ridge National Laboratory**
   Oak Ridge, Tennessee
7. **Pacific Northwest National Laboratory**
   Richland, Washington
8. **Princeton Plasma Physics Laboratory**
   Princeton, New Jersey
9. **SLAC National Accelerator Laboratory**
   Menlo Park, California
10. **Thomas Jefferson National Accelerator Facility**
    Newport News, Virginia

Other DOE Laboratories

1. **Idaho National Laboratory**
   Idaho Falls, Idaho
2. **National Energy Technology Laboratory**
   Morgantown, West Virginia
   Pittsburgh, Pennsylvania
   Albany, Oregon
3. **National Renewable Energy Laboratory**
   Golden, Colorado
4. **Savannah River National Laboratory**
   Aiken, South Carolina

NNSA Laboratories

1. **Lawrence Livermore National Laboratory**
   Livermore, California
2. **Los Alamos National Laboratory**
   Los Alamos, New Mexico
3. **Sandia National Laboratory**
   Albuquerque, New Mexico
   Livermore, California



SC Labs at a Glance

THE Ames Laboratory
Creating Materials & Energy Solutions
U.S. DEPARTMENT OF ENERGY

Founded 1947 (1942)
10 acres, 13 buildings
309 FTEs, including:
- 43 post-docs
- 88 students
- 73 joint faculty

84 visiting scientists

$53 M in FY16

Argonne NATIONAL LABORATORY

Founded 1946 (1942)
1,520 acres, 157 buildings
3,300 FTEs, including:
- 315 post-docs
- 457 students
- 248 joint faculty

1,362 visiting scientists
5,525 facility users

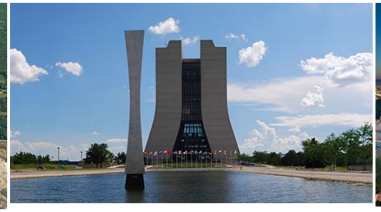
$769 M in FY16

BROOKHAVEN NATIONAL LABORATORY

Founded 1947
5,320 acres, 312 buildings
2,670 FTEs, including:
- 133 post-docs
- 405 students
- 24 joint faculty

2,147 visiting scientists
2,157 facility users

$576 M in FY16



Fermilab

Founded 1967
6,800 acres, 354 buildings
1,800 FTEs, including:
- 53 post-docs
- 9 joint faculty

19 visiting scientists
2,634 facility users
[students # N/A]

$418 M in FY16

BERKELEY LAB

Founded 1931
202 acres, 97 buildings
3,304 FTEs, including:
- 476 post-docs
- 479 students
- 245 joint faculty

1,524 visiting scientists
10,798 facility users

$802 M in FY16

OAK RIDGE National Laboratory

Founded 1943
4,470 acres, 308 buildings
4,470 FTEs, including:
- 328 post-docs
- 535 students
- 155 joint faculty

1,728 visiting scientists
2,899 facility users

$1,346 M in FY16

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Founded 1965
621 acres, 99 buildings
4,061 FTEs, including:
- 244 post-docs
- 425 students
- 12 joint appointments

104 visiting scientists
1,915 facility users

$843 M in FY16

PPPL PRINCETON PLASMA PHYSICS LABORATORY

Founded 1961 (1951)
91 acres, 30 buildings
462 FTEs, including:
- 12 post-docs
- 40 students
- 5 joint faculty

350 visiting scientists

$93 M in FY16

SLAC NATIONAL ACCELERATOR LABORATORY

Founded 1962
426 acres, 151 buildings
1,452 FTEs, including:
- 119 post-docs
- 167 students
- 55 joint faculty

47 visiting scientists
2,737 facility users

$470 M in FY16

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Founded 1984
169 acres, 83 buildings
686 FTEs, including:
- 21 post-docs
- 44 students
- 24 joint faculty

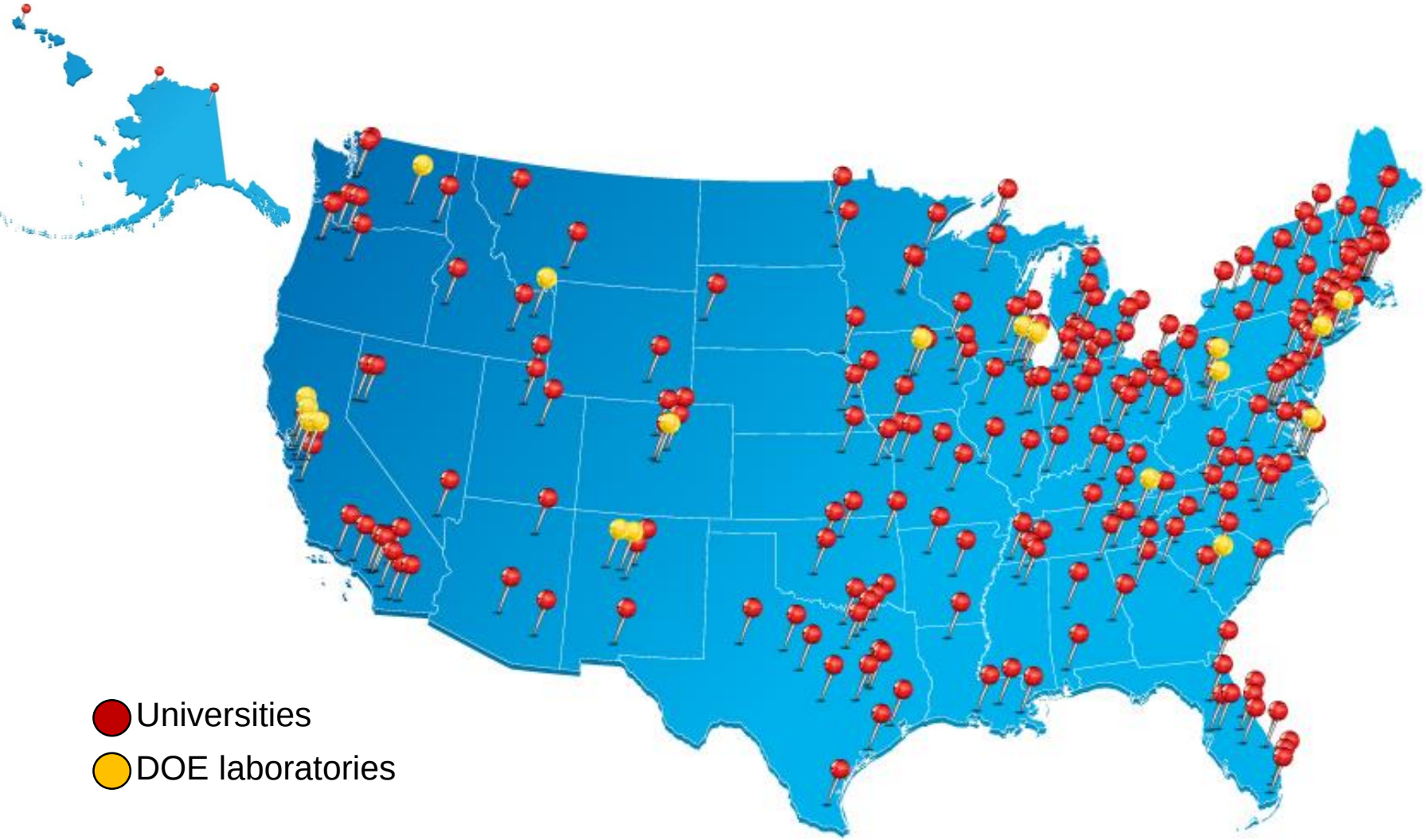
1,346 visiting scientists
1,510 facility users

$184 M in FY16

U.S. DEPARTMENT OF ENERGY | Office of Science

- FY 2016 Funding includes all DOE and non-DOE sources.
- FTE numbers represent FY 2015; FY 2016 final numbers not yet available.

Support for 300 Institutions Across the U.S.



DOE/CF-0144

Department of Energy

FY 2019 Congressional Budget Request

Budget in Brief

February 2018 Office of Chief Financial Officer

FY 2019 SC Budget Guidance

FY 2017 Enacted: $5.391B

FY 2018 Enacted: $6.260B

FY 2019 President's Request: $5.391B

House-Senate Conf.: $6.585B

Priorities:

- Continue operations of the national laboratories
- Continue exascale computing research for delivery in FY 2021
- Expand quantum computing and quantum information science efforts
- Provide sufficient funding to ensure robust cybersecurity program
- Focus on cutting edge, early stage research and development
- Maintain interagency and international partnerships

FY 2019 SC Budget (House-Senate Conference)

(Dollars in Thousands)

	FY 2017			FY 2018		FY 2019			
	President's Request	Enacted Approp.	Current Approp.	President's Request	Enacted Approp.	President's Request	House Mark	Senate Mark	Conference
ASCR	663,180	647,000	626,559	722,010	810,000	899,010	914,500	980,000	935,500
BES	1,936,730	1,871,500	1,812,113	1,554,500	2,090,000	1,850,000	2,129,233	2,193,400	2,166,000
BER	661,920	612,000	588,826	348,950	673,000	500,000	673,000	715,000	705,000
FES	398,178	380,000	368,119	309,940	532,111	340,000	590,000	425,000	564,000
HEP	817,997	825,000	802,849	672,700	908,000	770,000	1,004,510	1,010,000	980,000
NP	635,658	622,000	604,473	502,700	684,000	600,000	690,000	710,000	690,000
WDTS	20,925	19,500	19,500	14,000	19,500	19,000	19,500	24,500	22,500
SLI	130,000	130,000	130,000	76,200	257,292	126,852	290,147	302,100	232,890
S&S	103,000	103,000	103,000	103,000	103,000	106,110	106,110	106,000	106,110
PD	204,481	182,000	182,000	168,516	183,000	180,000	183,000	184,000	183,000
SBIR/STTR (SC)	...	...	154,561	...	...	...	...	...	...
Total Budget Authority and Obligations, Office of Science	5,572,069	5,392,000	5,392,000	4,472,516	6,259,903	5,390,972	6,600,000	6,650,000	6,585,000
SBIR/STTR (DOE)	...	...	90,813	...	...	...	...	...	...
Rescission of Prior Year Balances	...	-1,028	-1,028	...	...	...	...	...	...
Total, Office of Science	5,572,069	5,390,972	5,481,785	4,472,516	6,259,903	5,390,972	6,600,000	6,650,000	6,585,000

Priorities for FY 2019

- **Focus on cutting edge, early stage research and development; achieve 40% funding for research**
  - SC is the largest Federal supporter of basic research in the physical sciences in the United States. SC supports research at the frontiers of science—discovering nature's mysteries, from the study of subatomic particles, atoms, and molecules that are the building blocks of the materials of our everyday world, to the DNA, proteins, and cells that are the building blocks of entire biological systems.
  - SC also supports science for energy and the environment—mitigating the environmental impacts of energy use through fundamental research on energy production, conversion, storage, transmission, and use, and through advancing our understanding of the earth and its environment.
- **Maintain investment in Exascale Computing to achieve exascale-capable computer in 2021**
- **Continue operations of the national laboratories**
  - SC oversees the operation of 10 DOE national laboratories. SC conducts a formal laboratory strategic planning process annually with its labs to understand future directions, immediate and long-range challenges, and resource needs.
  - SC also conducts an annual evaluation of the scientific, technological, managerial, and operational performance of the M&O contractors of its laboratories.
  - In addition, SC funds mission-ready infrastructure and investments that foster safe and environmentally responsible operations at the labs.
- **Maintain all on-going projects and start new construction projects**
  - New Construction Projects: Advanced Light Source Upgrade (ALS-U) at Lawrence Berkeley National Laboratory and Linac Coherent Light Source-II High Energy (LCLS-II-HE) project at SLAC National Accelerator Laboratory in Basic Energy Sciences and Energy Sciences Capability at Pacific Northwest National Laboratory in Science Laboratories Infrastructure.

SC Research Programs

FY 2017 Enacted, FY 2018 Enacted, FY 2019 President's Request

Advanced Scientific Computing Research *(ASCR: FY 2017 $647M; FY 2018 $810M; FY 2019 $899M)*

- Advances applied mathematics, computer science, and computational research to discover, develop, and deploy computational and networking capabilities to analyze, model, simulate, and predict complex phenomena important to the U.S.
- Builds and operates some of the fastest computers in the world for open science. Leads the U.S. effort to develop the next generation of computing tools (exascale).

Basic Energy Sciences *(BES: FY 2017 $1,872M; FY 2018 $2,090M; FY 2019 $1,850M)*

- Advances fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels to provide foundations for new energy technologies. Supports a large portfolio of core research in chemical sciences, geosciences, biosciences, and materials sciences and engineering to advance DOE priorities.
- Constructs and supports scientific user facilities that enable atomic-level visualization and characterization of materials from many scientific fields, including chemistry, physics, geology, materials science, environmental science, and biology.

Biological and Environmental Research *(BER: FY 2017 $612M; FY 2018 $673M; FY 2019 $500M)*

- Advances fundamental research to achieve a predictive understanding of complex biological, earth and environmental systems for energy and infrastructure security, independence, and prosperity.
- Supports core research in genomic sciences of plants and microbes, research to understand atmospheric and earth system processes and to understand the dynamic physical, biogeochemical, microbial, and plant processes and interactions.

SC Research Programs

FY 2017 Enacted, FY 2018 Enacted, FY 2019 President's Request

Fusion Energy Sciences *(FES: FY 2017 $380M; FY 2018 $532M; FY 2019 $340M)*

- Advances the theoretical and experimental understanding of matter at high temperatures and density, including magnetic confinement science, fusion materials, and discovery plasma science.

High Energy Physics *(HEP: FY 2017 $825M; FY 2018 $908M; FY 2019 $770M)*

- Advances understanding of the basic constituents of matter, deeper symmetries in the laws of nature at high energies, and mysterious phenomena that are commonplace in the universe, such as dark energy and dark matter.

Nuclear Physics *(NP: FY 2017 $622M; FY 2018 $684M; FY 2019 $600M)*

- Advances experimental and theoretical research to discover, explore, and understand all forms of nuclear matter.
- Supports DOE's Isotopes Development and Production for Research and Applications subprogram for production of stable and radioactive research isotopes.

Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR)

(SBIR 3.20%; STTR 0.45%)

- SC manages the competitive SBIR/STTR Programs for DOE (except ARPA-E), competing the 3.65% of DOE's appropriated R&D to small businesses, in collaboration with the DOE science and technology offices.

DOE Office of Science Quantum Information Science FY 2019 Investments

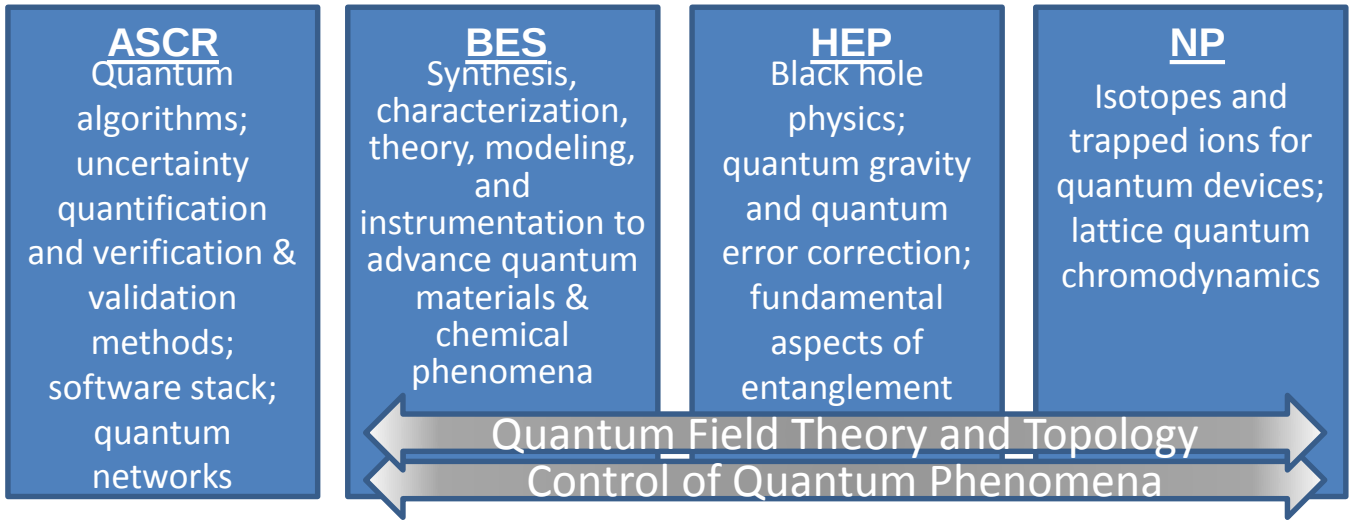
The Request also invests $105M in quantum information science to address the emerging urgency of building U.S. competency and competitiveness in the developing this area of science, including quantum computing and quantum sensor technology. This early stage, fundamental research will concentrate on accelerating progress towards application of quantum computing techniques and quantum sensing to grand challenge science questions.

Quantum Information Science (non-SBIR/STTR)

($ in millions)

	FY 2017	FY 2018		FY 2019
	Enacted	President's Request	Enacted	President's Request
ASCR	5.801	20.801	20.609	33.507
BES	-	7.708	19.270	31.561
BER	-	2.000	4.500	4.500
HEP	-	14.453	18.000	27.500
NP	-	-	-	8.300
Total	**5.801**	**44.962**	**62.379**	**105.368**

Fundamental Science That Advances QIS



SC Unique Strengths

- **Intellectual capital accumulated for more than a half-century**
- **Successful track record of forming interdisciplinary yet focused science teams for large-scale and long-term investments**
- **Demonstrated leadership in launching internationally-recognized SC-wide collaborative programs**

QIS Awards Announcement

News Media Contact: (202) 586-4940
For Immediate Release: September 24, 2018

Department of Energy Announces $218 Million for Quantum Information Science

Field Will Shape Future of Information Processing

WASHINGTON, D.C. – Today, the U.S. Department of Energy (DOE) announced $218 million in funding for 85 research awards in the important emerging field of Quantum Information Science (QIS). A wide-ranging multidisciplinary area of research, QIS is expected to lay the foundation for the next generation of computing and information processing, as well as an array of other innovative technologies.

"QIS represents the next frontier in the Information Age," said U.S. Secretary of Energy Rick Perry. "At a time of fierce international competition, these investments will ensure sustained American leadership in a field likely to shape the long-term future of information processing and yield multiple new technologies that benefit our economy and society."

The awards are led by scientists at 28 institutions of higher learning across the nation and nine DOE national laboratories and cover a range of topics from developing hardware and software for a new generation of quantum computers, to the synthesis and characterization of new materials with special quantum properties, to probing the ways in which quantum computing and information processing provide insights into such cosmic phenomena as Dark Matter and black holes.

Research is expected to bear fruit over the long run in many potential new applications. It is known that quantum computers—once fully mature systems are developed and deployed—will be capable of solving certain large, extremely complex problems that lie entirely beyond the capacity of even today's most powerful supercomputers.

In addition, among other applications, quantum systems hold out promise as potentially exquisitely sensitive sensors, with a variety of possible medical, national security, and scientific applications down the road.

QIS Awards Announcement

Quantum computing is also almost certainly destined to revolutionize the field of encryption, a critical capability in an era when cybersecurity remains an overarching concern.

Three major program offices within the Department's Office of Science—Advanced Scientific Computing Research (ASCR), Basic Energy Sciences (BES) , and High Energy Physics (HEP)—participated in the initiative and are separately administering the awards, which were made on the basis of competitive peer review.

ASCR awards were made under a Funding Opportunity Announcement and three Laboratory Announcements to be found here, here, and here; a list of ASCR awards can be found here.

BES awards were made under a Funding Opportunity Announcement and a Laboratory Announcement; a lists of BES awards can be found here.

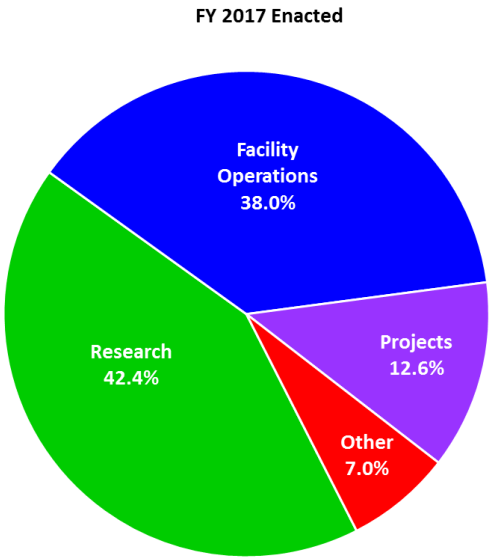
HEP awards were also made under Funding Opportunity Announcement and a Laboratory Announcement; a list of HEP awards can be found here.

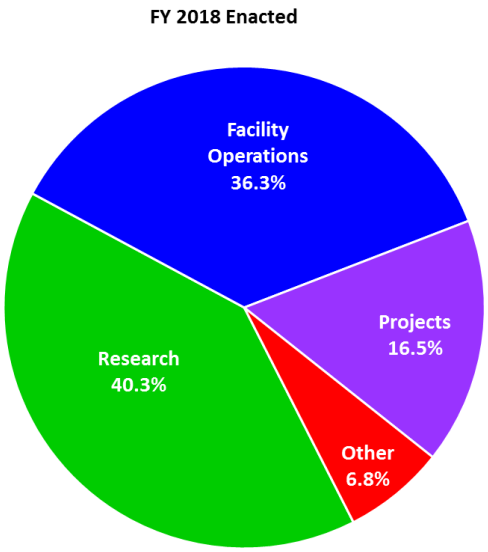
Depending on the topic and program, awards range in duration from two to five years. Total funding for Fiscal Year 2018 will be $73 million, with outyear funding contingent on congressional appropriations.

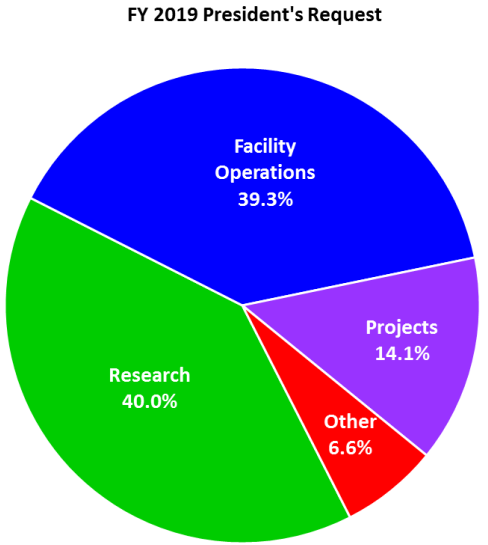
FY 2019 SC Budget Request by Budget Element

	FY 2017		FY 2018		FY 2019			
	Enacted	% of Total	Enacted	% of Total	President's Request	% of Total	vs. FY18 $ Change	vs. FY18 % Change
Research	2,286,552	42.4%	2,525,663	40.3%	2,154,311	40.0%	-371,352	-14.7%
Facility Operations	2,047,930	38.0%	2,272,148	36.3%	2,118,949	39.3%	-153,199	-6.7%
Projects	677,213	12.6%	1,034,150	16.5%	759,631	14.1%	-274,519	-26.5%
Other	379,277	7.0%	427,942	6.8%	358,081	6.6%	-69,861	-16.3%
Total	**5,390,972**	**100.0%**	**6,259,903**	**100.0%**	**5,390,972**	**100.0%**	**-868,931**	**-13.9%**

*Other includes all Rescissions, GPP/GPE, WDTS, S&S, and PD.







Questions?

Backup Slides

FY 2019 Program Summaries

The Office of Science

The DOE Office of Science (SC) has as its mission the delivery of scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States.

- **SC is the largest Federal supporter of basic research in the physical sciences in the United States. SC supports research at the frontiers of science—discovering nature's mysteries, from the study of subatomic particles, atoms, and molecules that are the building blocks of the materials of our everyday world, to the DNA, proteins, and cells that are the building blocks of entire biological systems.**
- **SC also supports science for energy and the environment—advancing a clean energy agenda through fundamental research on energy production, conversion, storage, transmission, and use, and through advancing our understanding of the earth and its environment.**

The scale and complexity of the SC research portfolio provide a competitive advantage to the nation as multidisciplinary teams of scientists, using some of the most advanced scientific instruments in the world, are able to respond quickly to national priorities and evolving opportunities at the frontiers of science.

DOE's Office of Science: World Leading Science

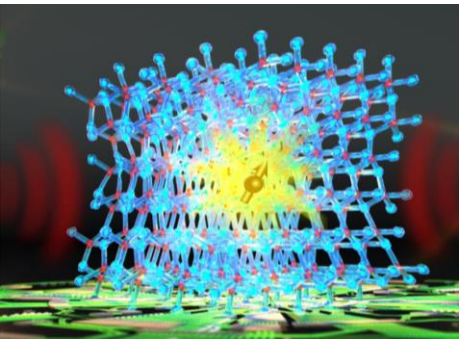
To Meet the Nation's Challenges Today and into the 21st Century

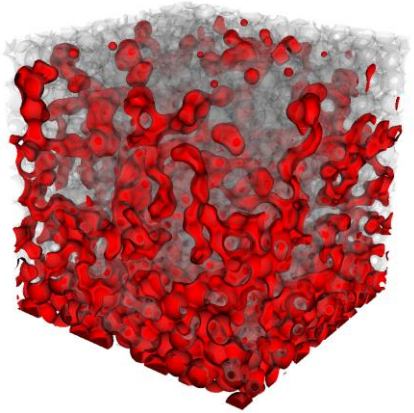
- **Advancing the frontiers of science**
  - Providing over 45% of Federal support in the physical sciences
  - Supporting over 22,000 Ph.D.s, graduate students, undergraduates, engineers, and support staff at more than 300 universities and at all 17 DOE laboratories
- **Advancing DOE missions**
  - Supporting specialized centers for energy and environmental research including 36 Energy Frontier Research Centers and 4 Bioenergy Research Centers for the study of cellulosic biofuels
- **Serving the Nation's scientists**
  - Providing world-leading scientific user facilities to nearly 32,000 users per year

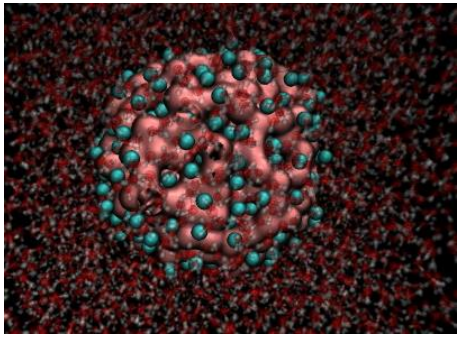
Advanced Scientific Computing Research

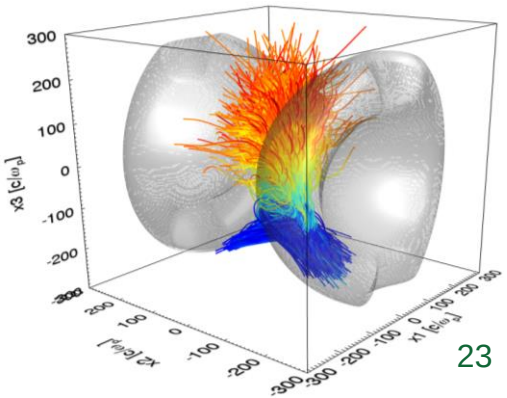
Computational and networking capabilities to extend the frontiers of science and technology

- Exascale Computing Initiative (ECI) and Exascale Computing Project (ECP). The ECI activity is a joint ASCR/NNSA partnership to undertake, through ECP, the application, software and hardware R&D necessary to develop an exascale ecosystem and through the facilities, deploy at least one exascale-capable computer (10^{18} operations per second) in 2021.
- Facilities operate optimally and with >90% availability; deployment of 200 petaflop upgrade at OLCF, continue operations and maintenance while supporting upgrades at NERSC and Esnet, and through ECI, continue site preparations and non recurring engineering investments at ALCF and OLCF for deployment of a second exascale system in the 2021-2022 timeframe.
- SciDAC partnerships and institutes, selected in FY 2017, continue activities that span basic science priorities.
- Applied Mathematics research addresses challenges of increasing complexity and improving the rigor and reliability of machine learning techniques; Computer Science research and Research and Evaluation Partnerships explore future computing technologies, including quantum testbeds and networks.
- Maintain support for the Computational Sciences Graduate Fellowship.





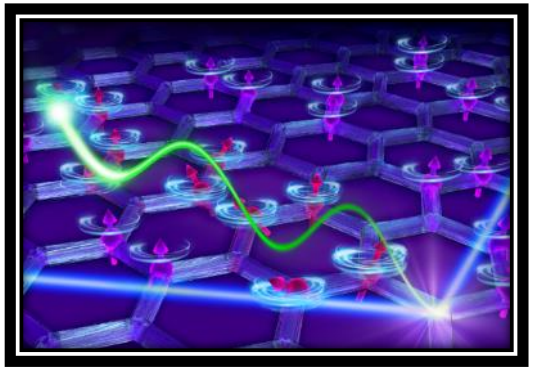
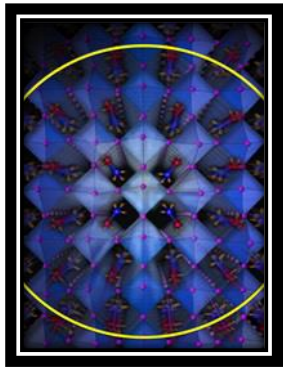
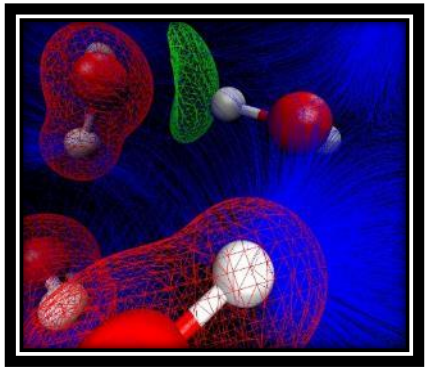
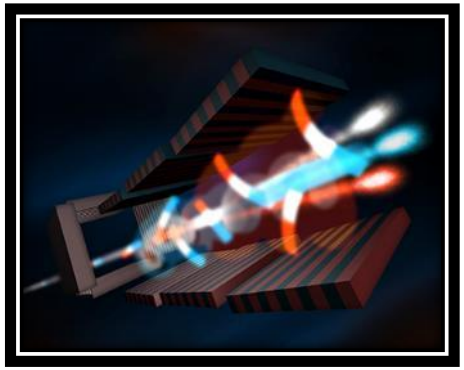




Basic Energy Sciences

Understanding, predicting, and controlling matter and energy at the electronic, atomic, and molecular levels

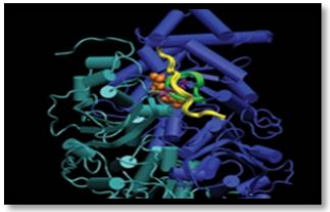
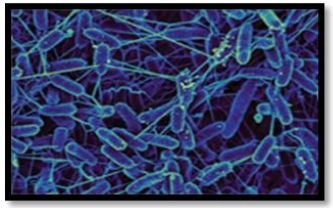
- The BES FY 2019 Request of $1,850M focuses resources toward the highest priorities in fundamental research, in operation and maintenance of scientific user facilities, and in facility upgrades.
- The highest priorities in core research are quantum information science (QIS), ultrafast science, and computational materials and chemical sciences as part of the Exascale Computing Initiative (ECI), as well as materials and chemistry for future nuclear energy. Other research priorities include catalysis science, synthesis, instrumentation science, materials and chemical research related to interdependent energy-water issues, and next-generation electrical energy storage.
- Funding is requested for continued support of the Energy Frontier Research Centers, two BES-supported Energy Innovation Hubs (Batteries and Energy Storage and Fuels from Sunlight), and the DOE Established Program to Stimulate Competitive Research.
- The BES user facilities continue operations at 95% of optimum: five x-ray light sources, two neutron scattering sources, and five research centers for nanoscale science.
- No funding is requested for Long Term Surveillance and Maintenance or for the disposition of unused equipment for the Lujan Neutron Scattering Center.
- To maintain international competitiveness of our facilities, the Linac Coherent Light Source-II (LCLS-II) project is fully funded for its last year and the Advanced Photon Source Upgrade (APS-U) project continues. The Request also includes funds to initiate the Advanced Light Source Upgrade (ALS-U) project at Lawrence Berkeley National Laboratory and the Linac Coherent Light Source-II High Energy (LCLS-II-HE) project at SLAC National Accelerator Laboratory.

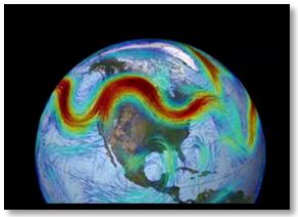





Biological and Environmental Research

Understanding complex biological and environmental systems

- **Genomic sciences** supports the third year of full performance for the four Bioenergy Research Centers (BRCs), environmental genomics and microbiomes, and efforts in secure biosystems design for bioenergy and renewable bioproducts.
- **Biomolecular Characterization and Imaging Science** research supports the development of enabling technology to visualize key structural biomolecules and metabolic processes in plant and microbial cells, including new efforts to characterize quantum information science (QIS) materials in environmental sensors.
- **Atmospheric System Research** supports research to advance the understanding of cloud-aerosol-precipitation interactions, and their influence on the earth's energy balance.
- **Earth and Environmental Systems Modeling** supports quantifying and reducing uncertainties in Earth System models based on more advanced process representations of Earth system observations and modeling components. The Energy Exascale Earth System Model will prioritize incorporation of studies of the water cycle.
- **Environmental System Science** supports research to provide a robust, predictive understanding of terrestrial surface, terrestrial-aquatic interface, and the biogeochemistry of subsurface ecosystems not well represented in earth system models.
- **User facilities:** Atmospheric Radiation Measurement (ARM) prioritizes measurements at two fixed sites: North Slope, Alaska and Southern Great Plains, Oklahoma; funds support full deployment of one mobile facility to Norway and one mobile facility seasonal deployment at Oliktok, Alaska. Joint Genome Institute (JGI) provides genome sequence data, synthesis, and analysis. Environmental Molecular Sciences Laboratory (EMSL) focuses on molecular scale analysis for biological and environmental samples.

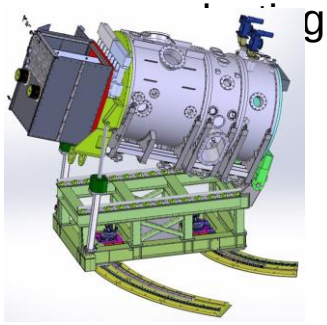


Fusion Energy Sciences

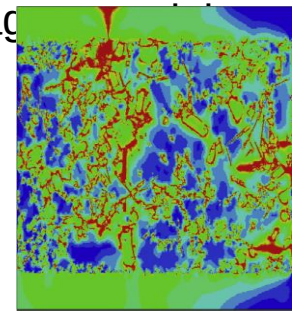
Matter at very high temperatures and densities and the scientific foundations for fusion

- DIII-D emphasizes completion of facility improvements begun in FY 2018, followed by 12 weeks of research operation on high-priority topics identified by community research needs workshops.
- NSTX-U focuses on high-priority activities to implement repairs and corrective actions required to obtain robust, reliable research operations.
- Scientific Discovery through Advanced Computing research continues to emphasize whole-device modeling.
- Support maintained for U.S. research involvement on international facilities with unique capabilities, such as EAST (China), KSTAR (Korea), W7-X (Germany), and JET (U.K.).
- Materials and Fusion Nuclear Science research focuses on high-priority research, including the Materials Plasma Exposure eXperiment (MPEX) MIE project.
- HEDLP research is focused on the MEC instrument at LCLS.
- General Plasma Science activities focus on the intermediate-scale plasma science collaborative user facilities, including the partnership with NSF.
- The U.S. Contribution to the ITER project focuses on the highest-priority First Plasma hardware components, including the continued fabrication of the central solenoid

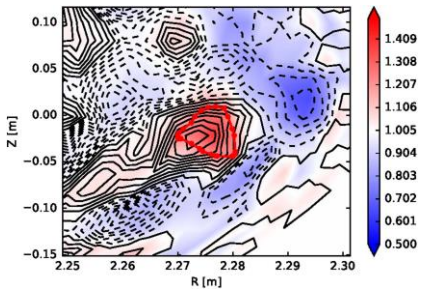
g mag



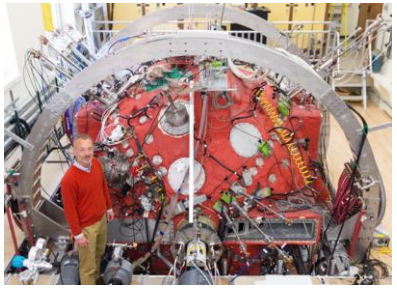
Modified bi-directional off-axis neutral beam for heating and current drive in DIII-D



Predicted material damage and fracture development in dual-phase Ti3SiC2/SiC joints



Simulation of density and potential fluctuation "bubbles" at the edge of magnetically confined plasmas

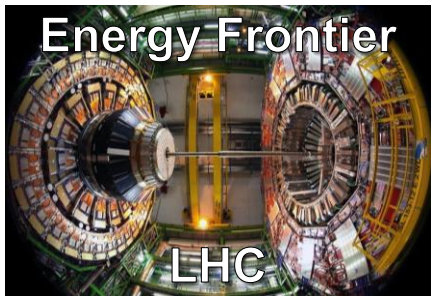


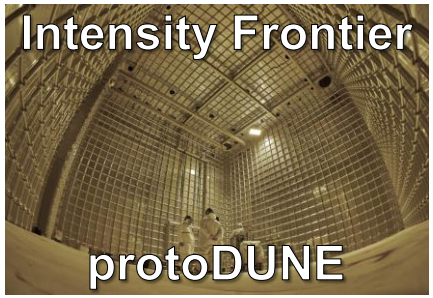
New WiPPL intermediate-scale experimental facility for general plasma science

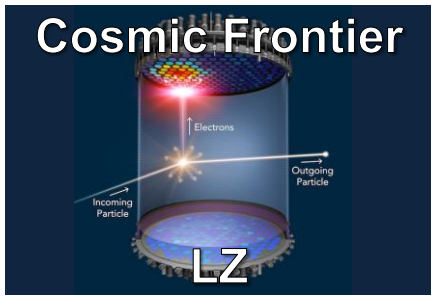
High Energy Physics

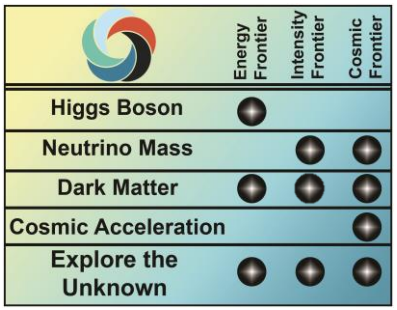
Understanding how the universe works at its most fundamental level

- FY 2019 Request is guided by priorities of Administration, SC, and P5 report
  - "Building for Discovery" by supporting the highest priority P5 projects to enable the future program
  - Research support advances P5 science drivers and world-leading, long-term R&D in Advanced Technology, Accelerator Stewardship, and Quantum Information Science
  - Operations support enables world-class research at HEP User Facilities
- Energy Frontier: Actively engage in successful LHC program and HL-LHC upgrades
  - The High-Luminosity Large Hadron Collider (HL-LHC) ATLAS & CMS detector upgrades (new MIE starts) and the HL-LHC Accelerator Upgrade Project are together considered one of P5's highest priority large projects
  - The U.S. will continue to play a leadership role in LHC discoveries by remaining actively engaged in analysis of world's highest energy particle collider data
- Intensity Frontier: Support establishing a U.S.-hosted world-leading neutrino program
  - LBNF/DUNE is P5's highest priority U.S.-hosted large project and FY 2019 investments in far-site civil construction are crucial to enable scheduled delivery of contributions from international partners
  - Support Short-Baseline Neutrino (SBN) program at Fermilab, DUNE prototype R&D efforts at CERN, and continued funding for PIP-II project to upgrade the Fermilab Accelerator Complex
- Cosmic Frontier: Advance our understanding of dark matter and dark energy
  - P5 recommended complementary suite of projects to search for dark matter candidates and study dark energy; request supports full planned profile for LZ, SuperCDMS-SNOLAB, and DESI





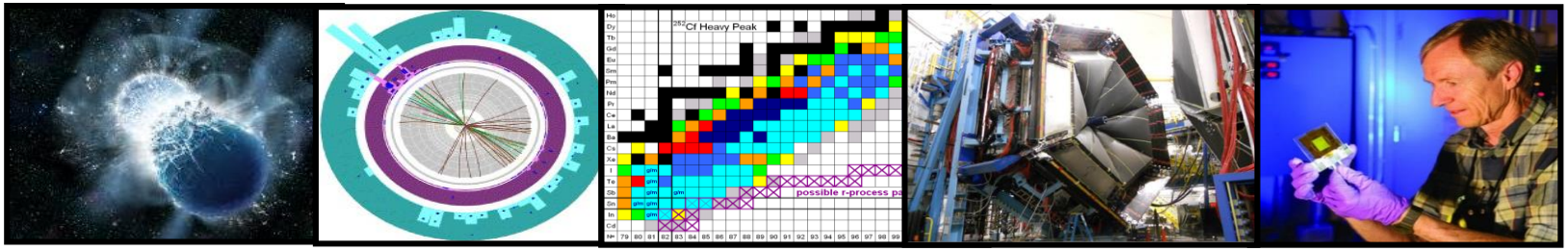




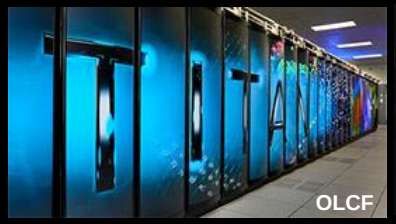
Nuclear Physics

Discovering, exploring, and understanding all forms of nuclear matter

- Funding for research focuses resources on the highest priority nuclear science research in relativistic nuclear collisions, hadron physics, nuclear structure and nuclear astrophysics, and fundamental symmetries.
- Operations at RHIC are supported for 19 weeks in FY 2019 to search for a critical point in the phase diagram of nuclear matter. The sPHENIX MIE is initiated within current RHIC funding levels for precision, high rate particle jets studies.
- The 12 GeV CEBAF Upgrade, completed in FY 2017, continues its scientific program with a 19 week run in FY 2019 promising new discoveries and an improved understanding of quark confinement.
- Funding for ATLAS supports 34 weeks of operations, to provide high-quality beams of all the stable elements up to uranium, as well as selected beams of short-lived nuclei for nuclear structure and astrophysics experiments.
- Construction continues on the Facility for Rare Isotope Beams. The Gamma-Ray Energy Tracking Array (GRETA) MIE is continued to exploit the scientific potential of FRIB.
- A Nuclear Physics Quantum Information Science (QIS) effort is initiated to support NP experiments and modeling, as well as the production of critical isotopes for quantum computing.
- Increased funding for the Isotope Program supports the Stable Isotope Production Facility (SIPF) MIE to produce kilogram quantities of enriched stable isotopes, mission readiness of radioisotope production facilities, and the initiation of a university production network for short-lived isotopes and QIS.



FY 2019 President's Request
User Facilities



Number of User Facilities
26