U.S. DEPARTMENT OF ENERGY | Office of Science

FY 2016 Budget Request to Congress for DOE's Office of Science

February 2015

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Acting Director, Office of Science

http://science.energy.gov/sc-2/presentations-and-testimony/

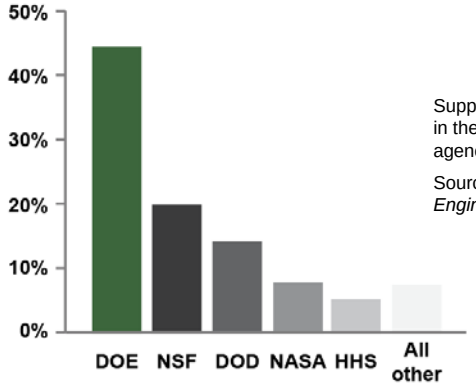
Office of Science
By the numbers

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 47% of the U.S. Federal support of basic research in the physical sciences;
- ~22,000 Ph.D. scientists, grad students, engineers, and support staff at >300 institutions, including all 17 DOE labs;
- 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 31,000 researchers each year.

Office of Science FY 2016 Budget Request to Congress

(Dollars in thousands)

	FY 2014 Enacted Approp. (prior to SBIR/STTR)	FY 2014 Current Approp.	FY 2015 Enacted Approp.	FY 2016 President's Request	FY 2016 President's Request vs. FY 2015 Enacted Appropriation	
Advanced Scientific Computing Research	478,093	463,472	541,000	620,994	+79,994	+14.8%
Basic Energy Sciences	1,711,929	1,662,702	1,733,200	1,849,300	+116,100	+6.7%
Biological and Environmental Research	609,696	593,610	592,000	612,400	+20,400	+3.4%
Fusion Energy Sciences	504,677	495,855	467,500	420,000	-47,500	-10.2%
High Energy Physics	796,521	774,920	766,000	788,000	+22,000	+2.9%
Nuclear Physics	569,138	554,802	595,500	624,600	+29,100	+4.9%
Workforce Development for Teachers and Scientists	26,500	26,500	19,500	20,500	+1,000	+5.1%
Science Laboratories Infrastructure	97,818	97,818	79,600	113,600	+34,000	+42.7%
Safeguards and Security	87,000	87,000	93,000	103,000	+10,000	+10.8%
Program Direction	185,000	185,000	183,700	187,400	+3,700	+2.0%
SBIR/STTR (SC)	.....	128,539	.....	.....	.....	.....
Subtotal, Office of Science	**5,066,372**	**5,070,218**	**5,071,000**	**5,339,794**	**+268,794**	**+5.3%**
SBIR/STTR (DOE)	.....	64,666	.....	.....	.....	.....
Subtotal, Office of Science	**5,066,372**	**5,134,884**	**5,071,000**	**5,339,794**	**+268,794**	**+5.3%**
Use of Prior Year Balances (SBIR)	.....	-3,846	.....	.....	.....	.....
Rescission of Prior Year Balances	.....	.....	-3,262	.....	+3,262	-100.0%
Total, Office of Science	**5,066,372**	**5,131,038**	**5,067,738**	**5,339,794**	**+272,056**	**+5.4%**

FY 2016 SC Budget Request by Category

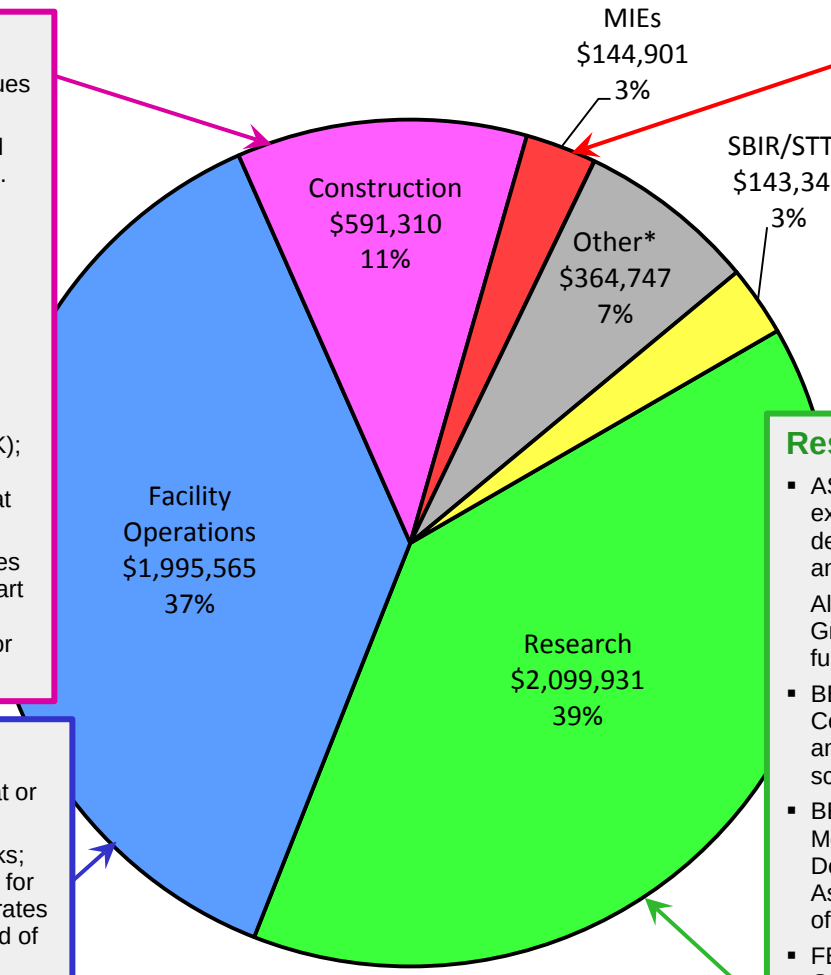
Dollars in Thousands

Construction

- BES: Linac Coherent Light Source-II continues and is in its peak funding year ($200,300K).
- FES: ITER – support for the USIPO, IO, and hardware fabrication continues ($150,000K).
- HEP: Long Baseline Neutrino Facility ($20,000K for PED); Muon to Electron Conversion ($40,100K).
- NP: FRIB continues and is at the peak of its funding profile ($100,000K); accelerator commissioning and detector construction of the CEBAF 12 GeV upgrade continue ($12,000K).
- SLI: Materials Design Lab at ANL ($23,910K); Photon Science Lab Building at SLAC ($25,000K); Integrative Genomics Building at LBNL ($20,000K).
- Also in SLI: "Infrastructure Support" increases by $31,100K for top priorities identified as part of the Campus Strategy discussions, for electrical upgrades at ANL and SLAC and for facility improvements at FNAL.

Facility Operations

- ASCR, BER, BES, HEP: Facilities operate at or near to optimal, >98%.
- FES: NSTX resumes operations for 14 weeks; DIII-D operates for 12 weeks until shutdown for installation of upgrades; Alcator C-Mod operates for 5 weeks prior to final shutdown at the end of FY 2016.
- NP: RHIC operates 22 weeks, same as in FY 2015 and has funding for capital equipment and spares; ATLAS operates 37 weeks; CEBAF is supported for continued machine development and commissioning of beam to Halls B and C.



*Other includes GPP/GPE amounts for BES, GPP for FES, Other (DOE/SC/Fermi/Lawrence) for NP, WDTS, SLI non-construction funding, S&S, and Program Direction.

Major Items of Equipment

- BES: Advanced Photon Source Upgrade (APS-U) ($20,000K) and NSLS-II Experimental Tools (NEXT) (15,500K).
- HEP: LHC Detector Upgrades (ATLAS and CMS) ($9,500K each); Large Synoptic Survey Telescope camera (LSSTcam) ($40,800K); Muon g-2 ($10,200K); LUX-ZEPLIN ($9,000K); SuperCDMS-SNOLab ($2,000K); Dark Energy Spectroscopic Instrument (DESI) ($5,300K).

Research

- ASCR: There is a significant increase for the exascale initiative to support for HPC vendors to design and develop exascale node technologies and systems. (Δ = +$86,895K).

  Also in ASCR: The Computational Science Graduate Fellowship is restored at $10,000K to fully fund a new cohort!
- BES: Increases for EFRCs (Δ = +$10,000K), Computational Materials Sciences (Δ = +$4,000K), and mid-scale instrumentation for ultrafast electron scattering (Δ = +$5,000K).
- BER: Increases for Climate and Earth System Modeling with largest increase for Climate Model Development & Validation and Integrated Assessment. (Δ = +$18,730K). Some decreases offset the increases.
- FES: Research continues in all areas. Increase for GPP for PPPL in support of NSTX-U operations. HEDLP is reduced, but the Matter in Extreme Conditions end station at LCLS remains fully funded.
- HEP: Research funding is nearly flat with FY 2015 and supports scientific results from operating experiments and R&D for future projects.
- NP: Research increases by more than 8% to support high-priority work.

FY 2016 SC Budget Request by Category

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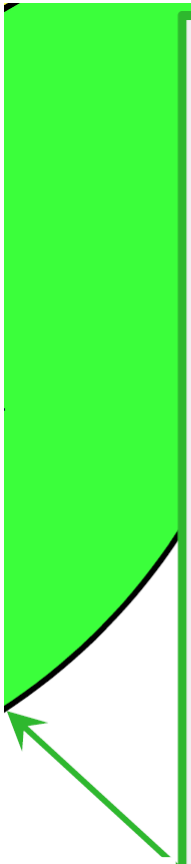

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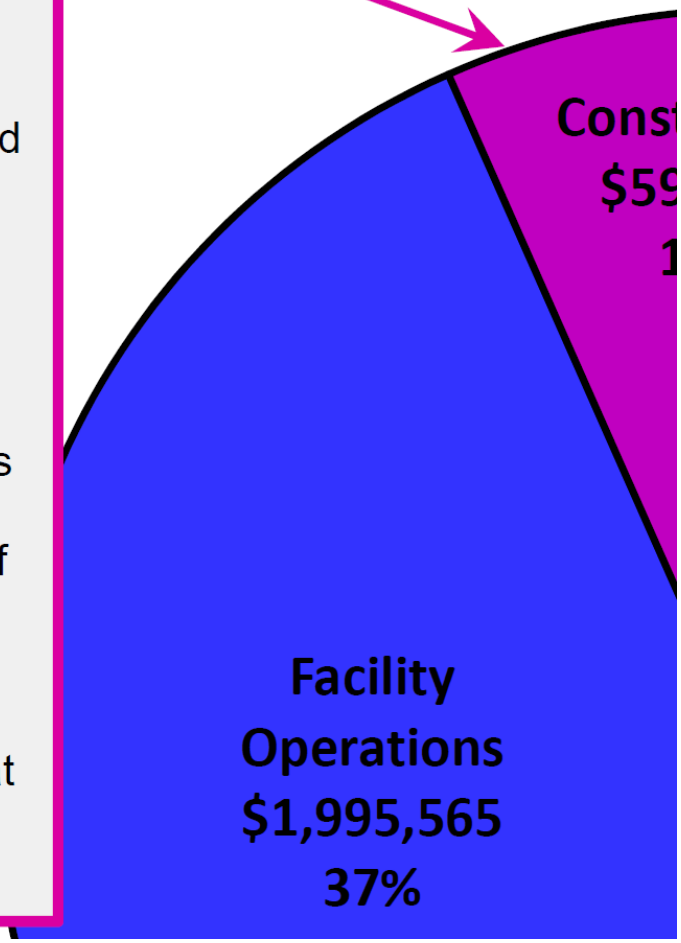

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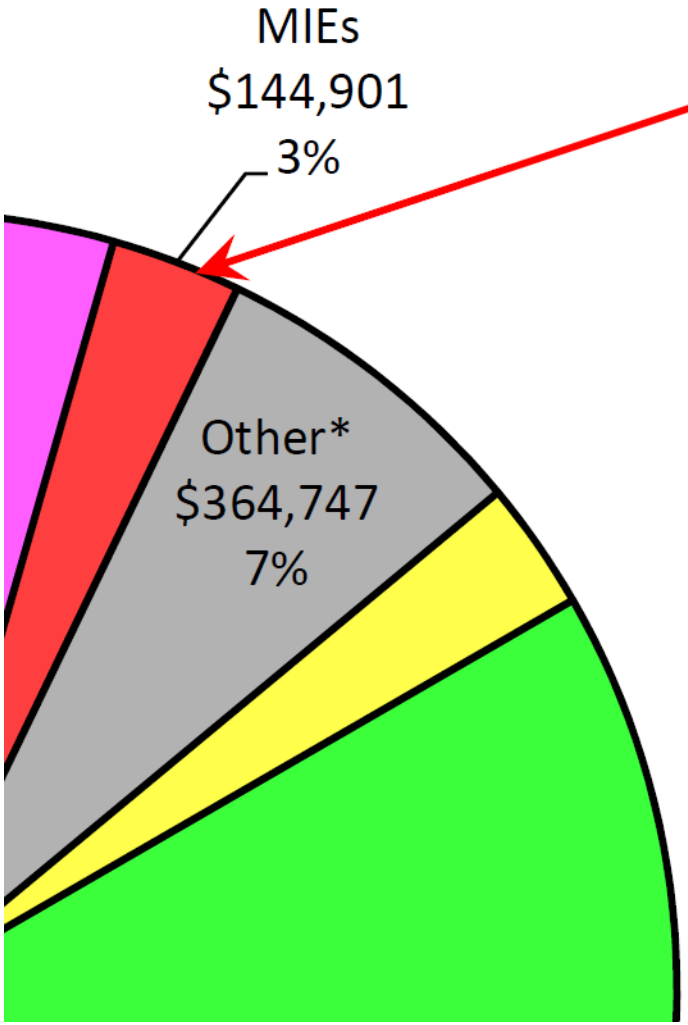

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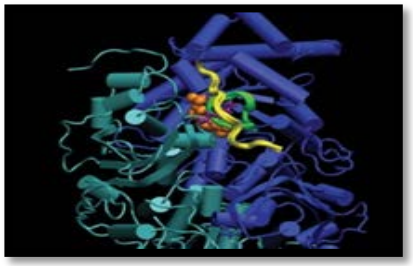
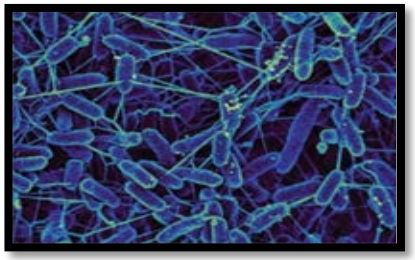
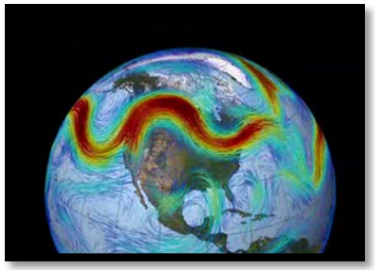
Biological and Environmental Research

Understanding complex biological, climatic, and environmental systems

- **Genomic sciences** supports the Bioenergy Research Centers and increases efforts in biosystems design for bioenergy and renewable bioproducts (Δ = +$2,145K).
- **Mesoscale-to-molecules** research supports the development of enabling technology to visualize key metabolic processes in plant and microbial cells at the subcellular and mesoscale.
- **Climate and Earth System Modeling** develops physical, chemical, and biological model components to simulate climate variability and change at regional and global scales. (Δ = +$11,763K).
- A new activity in **Climate Model Development and Validation** combines code development and numerical methods with ARM data to design an Earth system model with sub-10 km resolution for use on next generation and exascale computers. (Δ = +$18,730K).
- **Atmospheric System Research (ASR)** addresses major uncertainties in climate change models: the role of clouds and the effects of aerosols on precipitation, and the atmospheric radiation balance.
- **Environmental System Science** supports research to provide a robust, predictive understanding of terrestrial surface and subsurface ecosystems. Includes Next Generation Ecosystem Experiments targeting climatically sensitive terrestrial ecosystems not well represented in models.
- **Climate and Environmental Data Analysis and Visualization** employs server side analysis to simplify analysis of large scale observations with model-generated data. (Δ = +$2,066K).
- **User facilities operate at optimal levels: ARM** continues measurements at fixed sites, and mobile facilities deploy to the Arctic, Antarctic, and the Pacific Ocean. **JGI** provides genome sequence data, synthesis, and analysis. **EMSL** initiates work using the High Resolution and Mass Accuracy Capability.



Climate Model Development and Validation

Model capabilities today

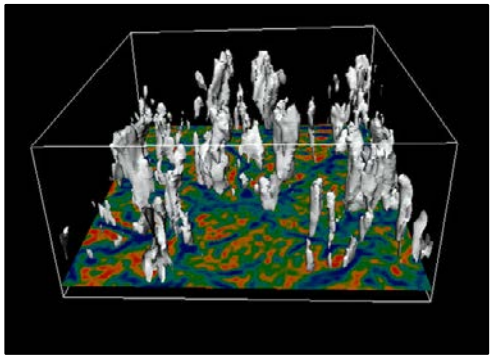
- Global and regional simulations to 50 km resolution in full integration mode; to 25 km with limited integration. *Unable to adequately represent extreme events, important to DOE and energy infrastructure*.
- No standard uncertainty quantification methodology applied to climate predictions. *Improved confidence in predictions is needed by scientists and stakeholders*.
- No common software infrastructure strategy in climate modeling community. *Current climate models will be unable to exploit DOE's next generation exascale computer architectures.*

FY 2016 Research Efforts

- Combine major upgrades in advanced software code development, downscaling methodologies, and validation against testbeds for sites in U.S. (Oklahoma, Alaska) using the Atmospheric Radiation Measurement Climate User Facility (ARM)
- Develop scale-aware physics appropriate for very high resolution phenomena extending 10 km to below 1 km.
- Integrate scale-aware physics into improved climate modeling codes for use on next generation and exascale computers.

ARM Oklahoma

Best-in-class software and hardware



First modeling of high-res extreme phenomena with Uncertainty Quantification methodologies

DOE's Role in Climate Science Research

- SC relies on unique facilities and long term observing capabilities, most hosted or managed by DOE national laboratories, to collect and analyze data to understand climate processes. These facilities are:
  - The Atmospheric Radiation Measurement (ARM) Climate Research Facility, to understand cloud-aerosol-precipitation interactions with the earth's radiant energy balance
  - Next Generation Ecosystem Experiments (NGEE), to explore ecological, biogeochemical, and soil process interactions
  - Ameriflux, to measure ecosystem carbon, water, and energy fluxes to support environmental research
  - Data from ARM, NGEE, and Ameriflux are coordinated under a DOE data informatics capability, enabling efficient use and integration by the scientific community
  - The petascale Leadership Computing Facilities at ORNL and ANL, to understand earth and environmental system process interactions based on synthesis of complex data sets

- SC grand science challenges that frame priorities include:
  - Atmospheric and terrestrial process level interactions, in particular cloud, aerosol, ecological, hydrological, and biological processes that affect the earth's energy balance at various scales
  - Understanding processes that control internal climate variability and extremes
  - Understanding uncertainty of the climate system

- DOE is a leader in climate science and has been since the 1950s, when the AEC was charged with understanding atmospheric transport for national security and, later, the impacts of CO_2. Today, DOE coordinates with other agencies through collaborative partnerships and through the U.S. Global Change Research Program.

Science Laboratories Infrastructure (SLI)

More than $600 million of line item investments on time, within budget since 2006

FY 2016 provides continued funding for:

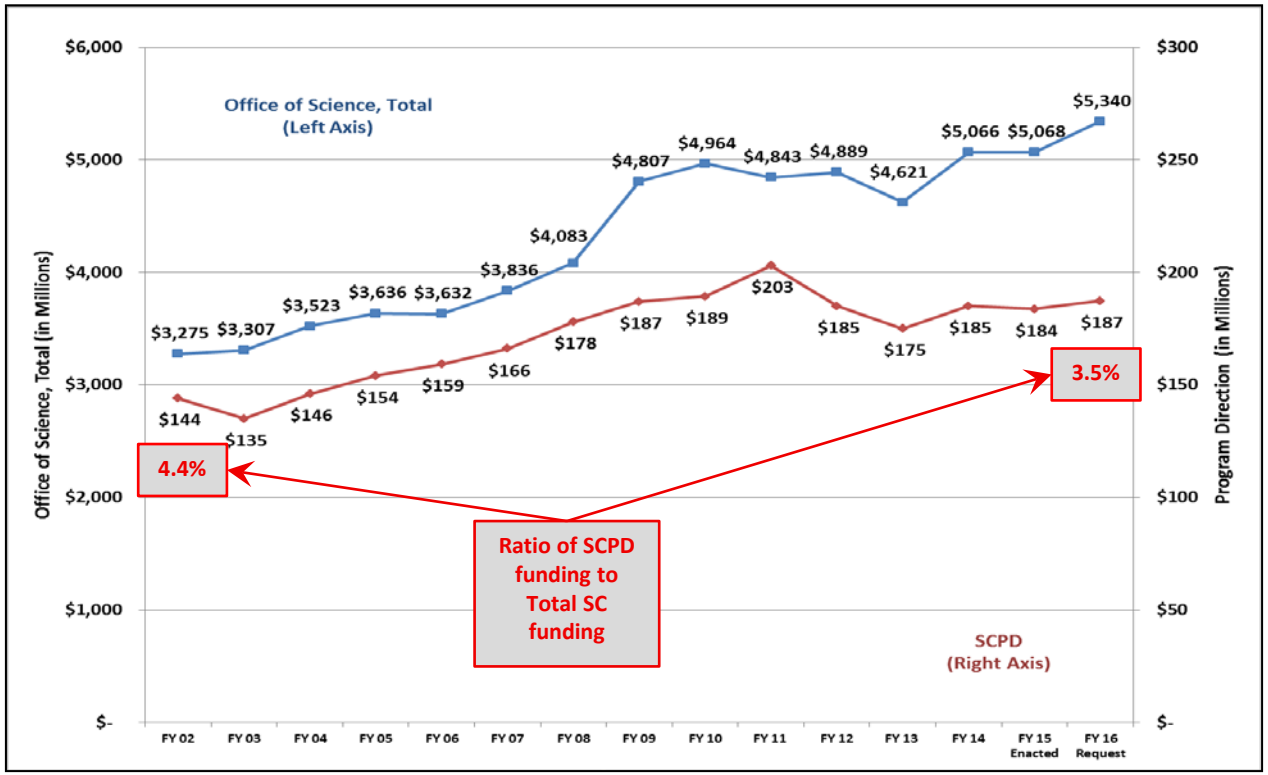
- **Materials Design Laboratory (ANL)** to house research in materials science and related disciplines.
- **Photon Science Laboratory Building (SLAC)** to provide modern lab and office space for the expansion of SLAC's photon science programs, using SSRL and LCLS-II.
- **Integrative Genomics Building (LBNL)** to begin the consolidation of a significant fraction of the biosciences research currently now located in widely distributed commercially leased space.

Funding is also provided for:

- General purpose infrastructure: electrical upgrades at SLAC and ANL and facility improvements at FNAL.
- Continued funding of the New Brunswick Laboratory for infrastructure support and for transfer and shipment of material.
- Nuclear operations support at ORNL.

Program Direction

The FY 2016 PD budget supports 945 FTEs



During the past 15 years, the ratio of the Program Direction budget to the SC appropriation has decreased from 4.4% to about 3.5% -- now the lowest ratio in DOE. This decrease has been accomplished through detailed analyses and execution of optimum staffing levels in both the SC Site Offices and the SC Headquarters program offices.

Support for:

- Management of the Office of Science programs, facilities, and projects;
- Business operations associated with portfolio management;
- Office of Science Information Technology Modernization Plan (ITMP) – the consolidation of data centers, IT support service contracts, and more efficient technologies;
- Federal travel for scientific program and laboratory operations oversight; and
- President's Council of Advisors on Science and Technology (PCAST).