U.S. DEPARTMENT OF ENERGY | Office of Science

High Energy Physics
FY 2018 Budget Request

June 2017

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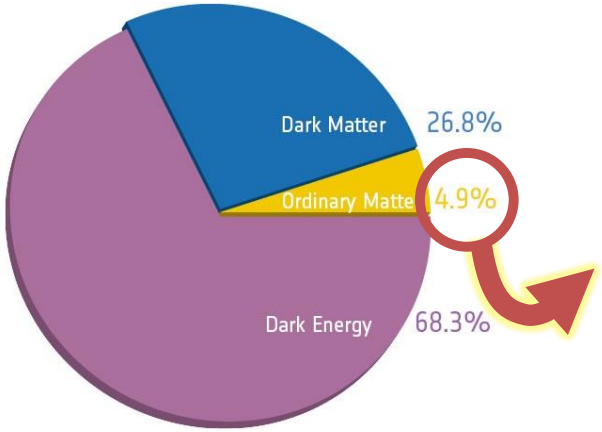
The High Energy Physics Program Mission

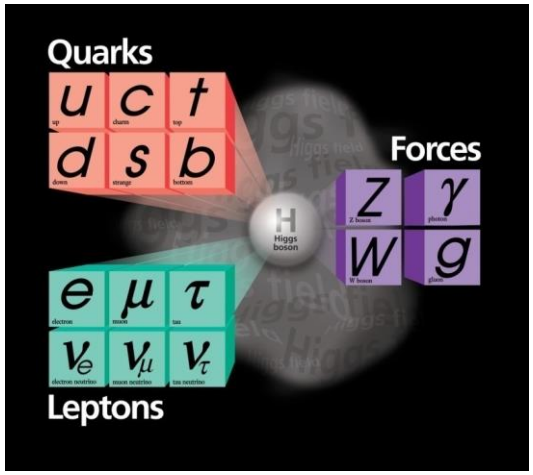
…is to understand how the universe works at its most fundamental level:

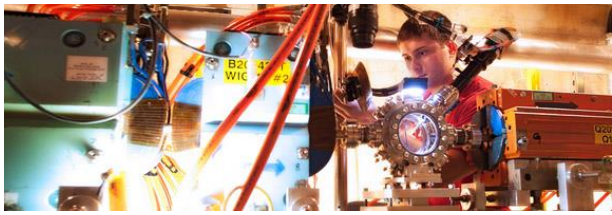
- Discover the elementary constituents of matter and energy
- Probe the interactions between them
- Explore the basic nature of space and time

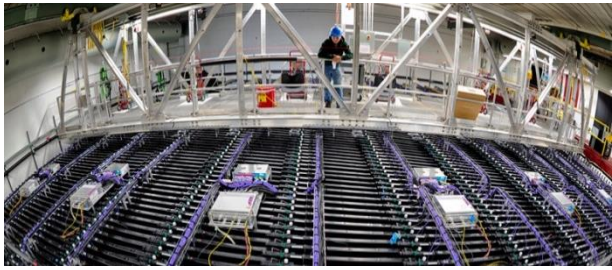
The Office of High Energy Physics fulfills its mission by:

- Building **projects** that enable discovery science
- Operating **facilities** that provide the capability to perform discovery science
- Supporting a **research** program that produces discovery science









FY 2017 Appropriation

HEP received $825M in the FY 2017 Congressional Appropriation, about $7M above the FY 2017 President's Budget Request

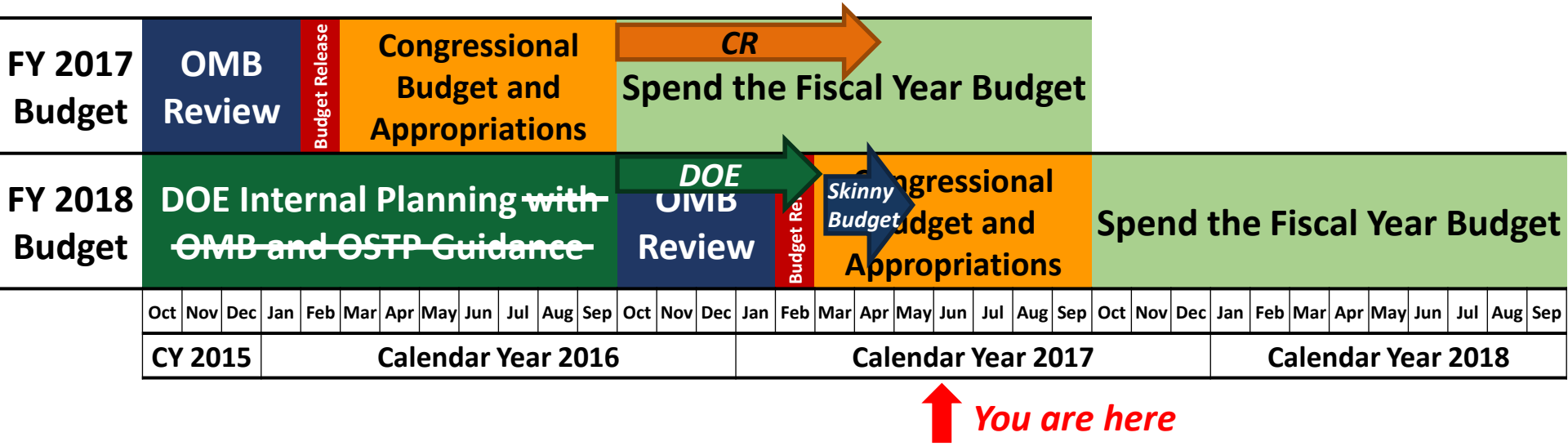
- **Congressional direction increased funding for projects**
  - Congress provided LBNF/DUNE with an increase of $4.9M over the request
  - Congress directed HEP to spend $12.5M for LZ, increase of $2M over the request
  - Congress directed HEP to spend $12M for TEC for DESI, $3M over the request
- **HEP Research Program funding was reduced as a result of Project funding increasing more than the HEP top line increase**
  - *More details on FY 2017 execution in HEP Program Status talk by Glen Crawford*

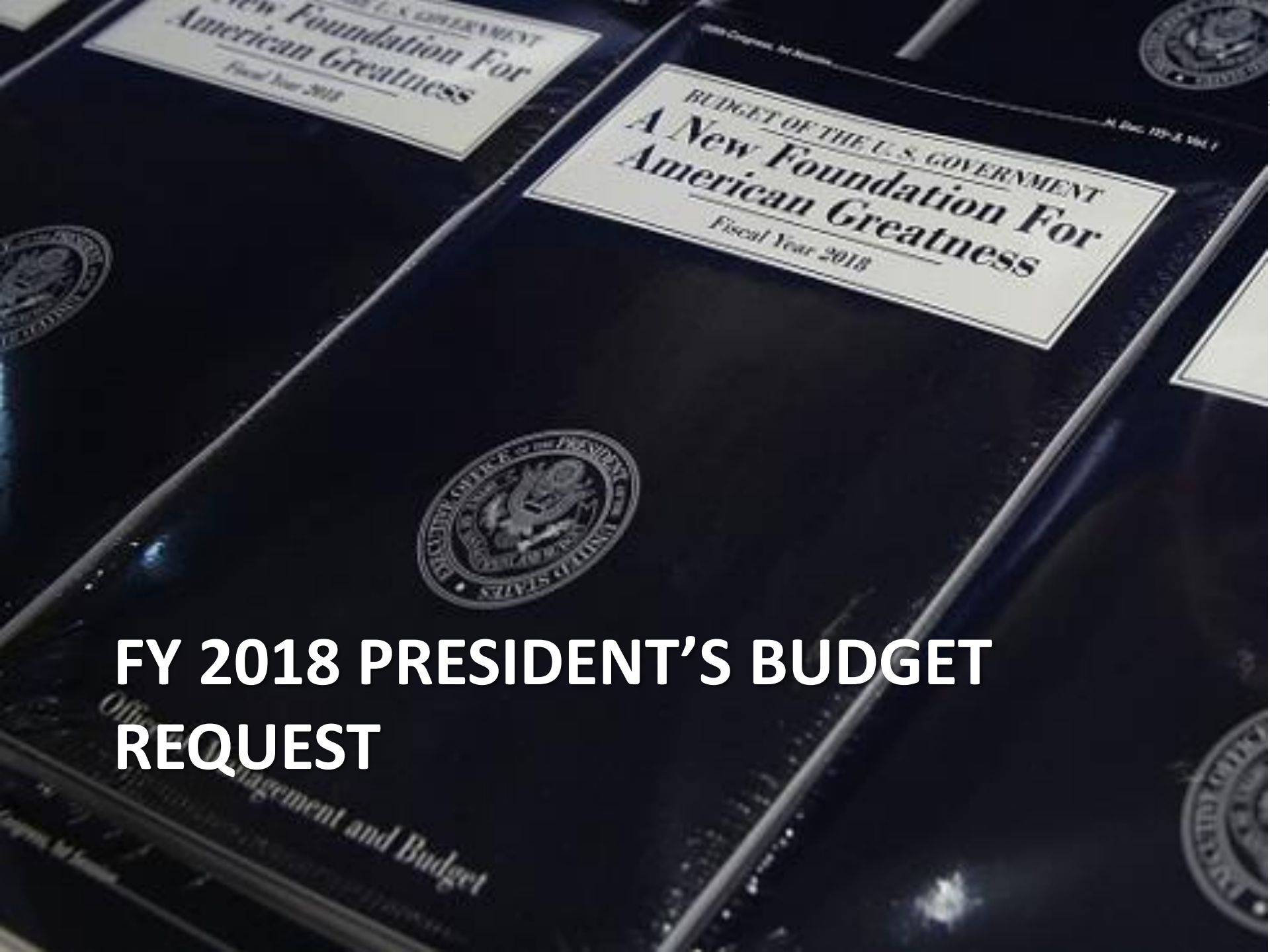
DEPARTMENT OF ENERGY
(Amounts in thousands)

	FY 2016 Enacted	FY 2017 Request	Final Bill
High energy physics:			
Research	728,900	729,476	731,500
Construction:			
11-SC-40 Long baseline neutrino facility / deep underground neutrino experiment, FNAL	26,000	45,021	50,000
11-SC-41 Muon to electron conversion experiment, FNAL	40,100	43,500	43,500
Subtotal, Construction	66,100	88,521	93,500
Subtotal, High energy physics	795,000	817,997	825,000

The U.S. Federal Budget Cycle

- **Formulation: Executive branch prepares the President's Budget Request**
  - White House Office of Management and Budget (OMB) controls process, gives guidance
- **Congressional: Enacts laws that control spending and receipts**
  - Congress considers the Budget Request, enacts laws that control spending and receipts
- **Execution: Executive branch agencies carry out program**
  - OMB apportions funds to Executive Branch agencies, which obligate and disperse funding
- **This year's cycle is not "typical"**
  - Congress used **Continuing Resolutions (CRs)** until passing an appropriation on May 5
  - White House released the **"skinny budget"** on March 13, guiding the budget formulation
  - FY 2018 **President's Budget Request** released on May 23





FY 2018 PRESIDENT'S BUDGET REQUEST

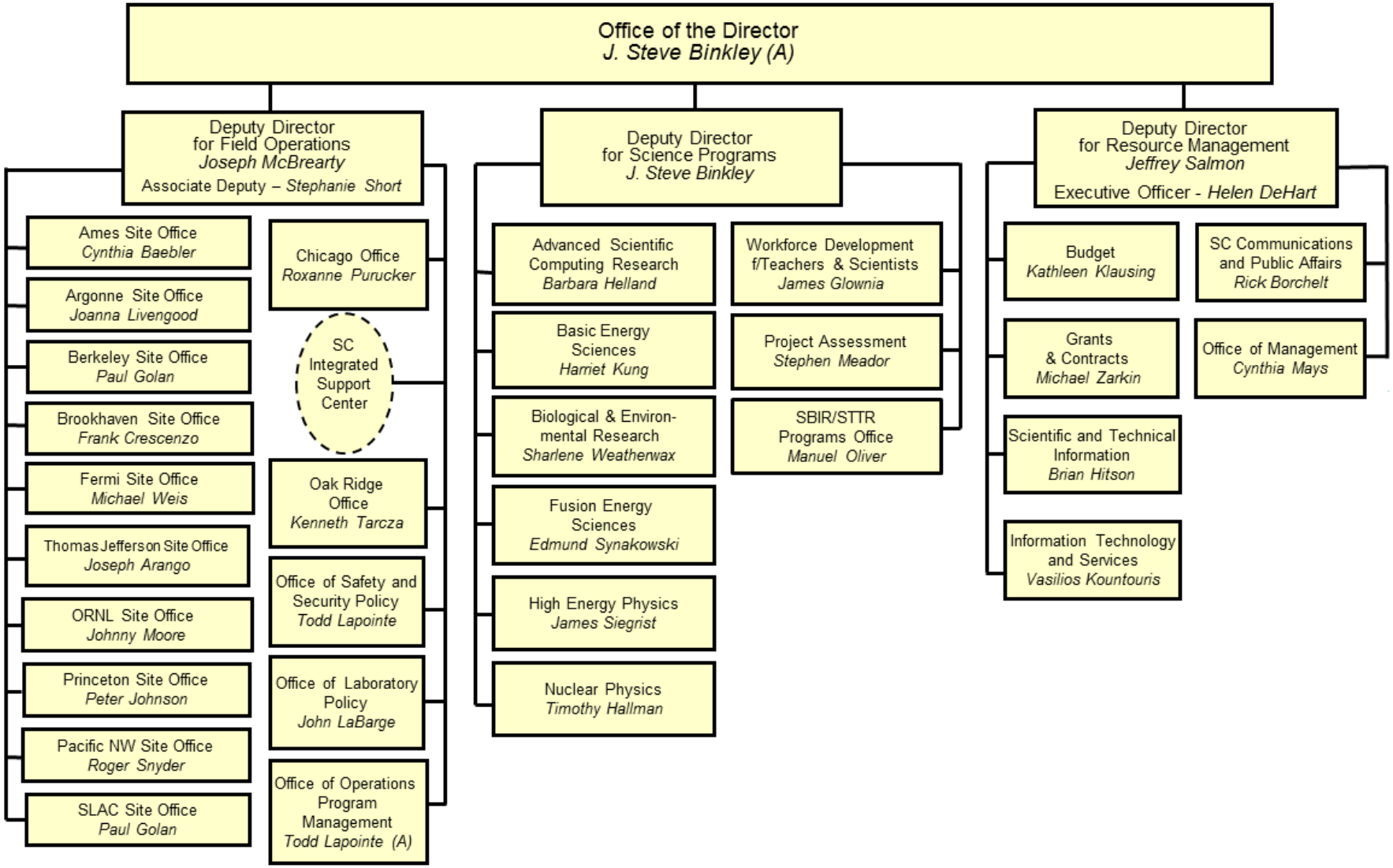
Message from Secretary Perry

- **The FY18 budget request attempts to refocus and refine our mission on several critical fronts that directly affect the safety and security of the American public.**
- **The $28 billion FY 2018 budget advances the DOE mission in key areas through significant investments to:**
  - Modernize the country's nuclear weapons arsenal
  - Achieve exascale computing
  - Advance the Nation's nuclear waste management program
  - Protect our national electric grid from cyberattacks
  - Shift the Department's focus to early-stage research and development at our national laboratories to more efficiently and cost effectively advance American dominance in scientific and energy research

Message from the DOE Office of Science

- **In support of the President's FY 2018 Budget Request, the Office of Science makes the following points:**
  - The President establishes the priorities for the Budget Request.
  - Historically, budgets have gone up and down. Our job is to deliver the best science we can with the resources we are given by the President and Congress.
  - There will be some challenges for FY18, and it's not easy to say at this early stage exactly how the budget will impact our programs—we'll be working out the details over the next weeks and months.
  - We're going to need to be very clear about our priorities.
  - We're going to be working very hard to deliver the best science we can with the resources we have when Congress votes and the President finally signs an FY18 budget.
  - We'll do our best to keep you informed as we learn more.

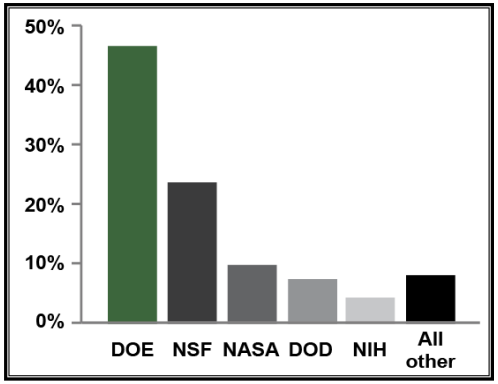
DOE Office of Science Organization



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 – 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**
  - Provides about half of the U.S. Federal support for basic research in the physical sciences;
  - Supports about 19,000 Ph.D. scientists, graduate students, engineers, and support staff at over 300 institutions and 10 DOE national laboratories;
  - Maintains U.S. and world leadership in high-performance computing and computational sciences;
  - Continues to be the 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**
  - SC maintains the world's largest collection of scientific user facilities (aka research infrastructure) operated by a single organization in the world, used by more than 27,000 researchers each year.

Office of Science Priorities for FY 2018

- **Focus on cutting edge, early stage research and development; achieve 40% funding for research**
  - The Office of Science (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—advancing a clean energy agenda through fundamental research on energy production, conversion, storage, transmission, and use, and through advancing our understanding of the earth.

- **Continue operations of the national laboratories**
  - SC oversees the operation of ten 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 management and operating contractors of its laboratories. In addition, SC funds mission-ready infrastructure and investments that foster safe and environmentally responsible operations at the labs.
  - Increase funding for Exascale Computing

- **Maintain all on-going projects and start two new construction projects**
  - 2 New Construction Projects: the Advanced Photon Source Upgrade (APS-U) at Argonne National Laboratory (ANL) in Basic Energy Sciences and the Energy Sciences Capability at Pacific Northwest National Laboratory (PNNL) in Science Laboratories Infrastructure.

Office of Science FY 2018 President's Request

(Dollars in thousands)

	FY 2016 Enacted	FY 2016 Current w/SBIR-STTR[a]	FY 2017 Annualized CR[b]	FY 2017 Enacted	FY 2018 President's Request	FY 2018 Request vs. FY 2016 Current w/SBIR-STTR[a]		FY 2018 Request vs. FY 2017 Enacted	
Science									
Advanced Scientific Computing Research	621,000	621,000	619,819	647,000	722,010	+101,010	+16.3%	+75,010	+11.6%
Basic Energy Sciences	1,849,000	1,849,000	1,845,485	1,871,500	1,554,500	-294,500	-15.9%	-317,000	-16.9%
Biological and Environmental Research	609,000	609,000	607,842	612,000	348,950	-260,050	-42.7%	-263,050	-43.0%
Fusion Energy Sciences	438,000	438,000	437,167	380,000	309,940	-128,060	-29.2%	-70,060	-18.4%
High Energy Physics	795,000	795,000	793,489	825,000	672,700	-122,300	-15.4%	-152,300	-18.5%
Nuclear Physics	617,100	617,100	615,927	622,000	502,700	-114,400	-18.5%	-119,300	-19.2%
Workforce Development for Teachers and Scientists	19,500	19,500	19,463	19,500	14,000	-5,500	-28.2%	-5,500	-28.2%
Science Laboratories Infrastructure	113,600	113,600	113,384	130,000	76,200	-37,400	-32.9%	-53,800	-41.4%
Safeguards and Security	103,000	103,000	102,805	103,000	103,000	…	…	…	…
Program Direction	185,000	185,000	184,648	182,000	168,516	-16,484	-8.9%	-13,484	-7.4%
Subtotal, Science	5,350,200	5,350,200	5,340,029	5,392,000	4,472,516	-877,684	-16.4%	-919,484	-17.1%
Rescission of Prior Year Balances	-3,200	-3,200	-3,194	-239	…	+3,200	-100.0%	+239	-100.0%
Total, Science Appropriation	**5,347,000**	**5,347,000**	**5,336,835**	**5,391,761**	**4,472,516**	**-874,484**	**-16.4%**	**-919,245**	**-17.0%**

[a] The FY 2016 Enacted column printed in the FY 2018 Congressional Budget Justification (President's Request) includes SBIR/STTR funding in the program lines and reflects programmatic updates through the end of the fiscal year.

[b] This column provides the Annualized CR amount (CR through April 28, 2017; P.L. 114-254). It is calculated by reducing the FY 2016 Enacted by 0.1901%

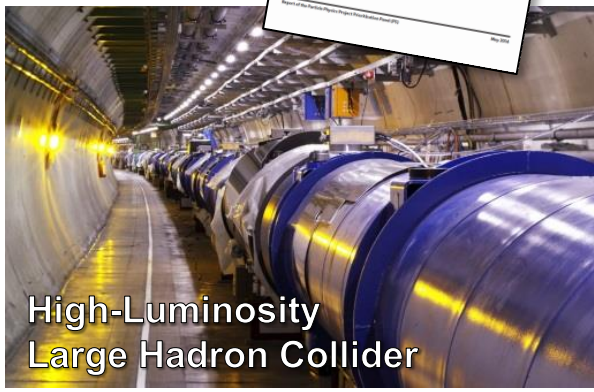
HEP FY 2018 President's Budget Request

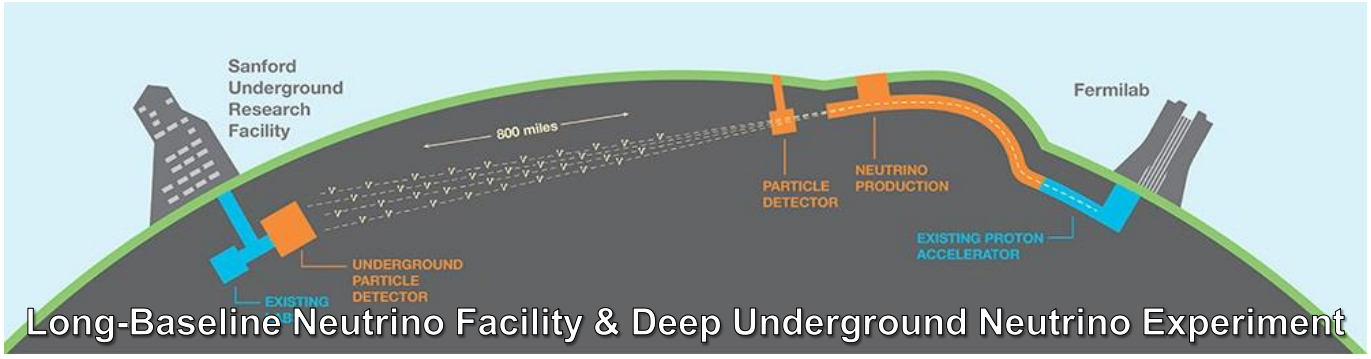
HEP Funding *($ in thousands)*	FY 2016 Enacted	FY 2017 Annualized CR	FY 2017 Enacted	FY 2018 Request	FY 2018 vs. FY 2016		FY 2018 vs. FY 2017 Enacted	
Research	341,663	352,344	347,852	272,887	-68,776	-20%	-74,965	-21%
Facility/Operations	258,236	252,084	255,162	213,813	-44,423	-17%	-41,349	-16%
Projects & Constr.	195,101	189,061	221,986	186,000	-9,101	-4%	-35,986	-16%
Total	**795,000**	**793,489**	**825,000**	**672,700**	**-122,300**	**-15%**	**-152,300**	**-18%**

- **The 2018 President's Budget Request for HEP is an overlay of:**
  - Administration priorities
  - SC priorities (interagency partnerships, national laboratories, accelerator R&D, FACET-II, Quantum Information Science as a new SC initiative)
  - P5 priorities (preserve vision, modify execution)
- **FY18 Budget Request reduces near-term science for P5-guided investments in mid- and long-term program**
  - All projects continue, some with delays
  - Research maintained at 40% of the program budget
  - Operations support for ongoing experiments reduced to make this possible
- **The new administration supports the overall P5 strategy**

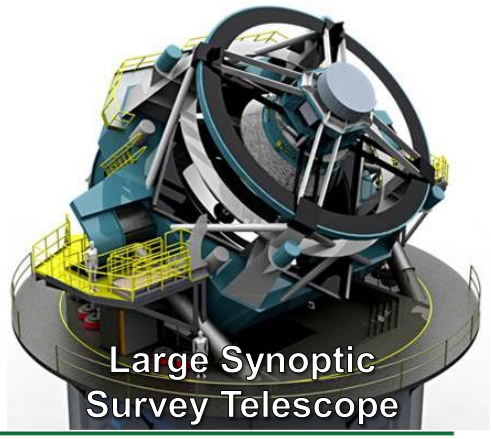
HEP FY18 President's Budget Request Strategy

- **FY 2018 Request for HEP guided by priorities of Administration, Office of Science, and P5 report strategy**
  - Currently in the midst of "Building for Discovery" to support the future program
  - Highest priority P5 projects supported with least adjustment possible to scope and schedule
  - Other efforts across Research, Facility Operations, and Projects have scope reduced or schedules delayed, based on factors including the P5 report strategy and project maturity


High-Luminosity Large Hadron Collider

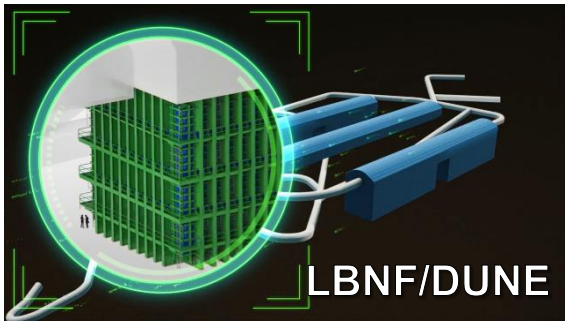


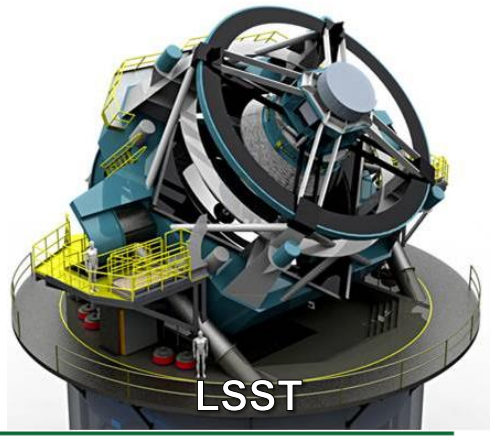
Long-Baseline Neutrino Facility & Deep Underground Neutrino Experiment


Large Synoptic Survey Telescope

HEP FY18 President's Budget Highlights

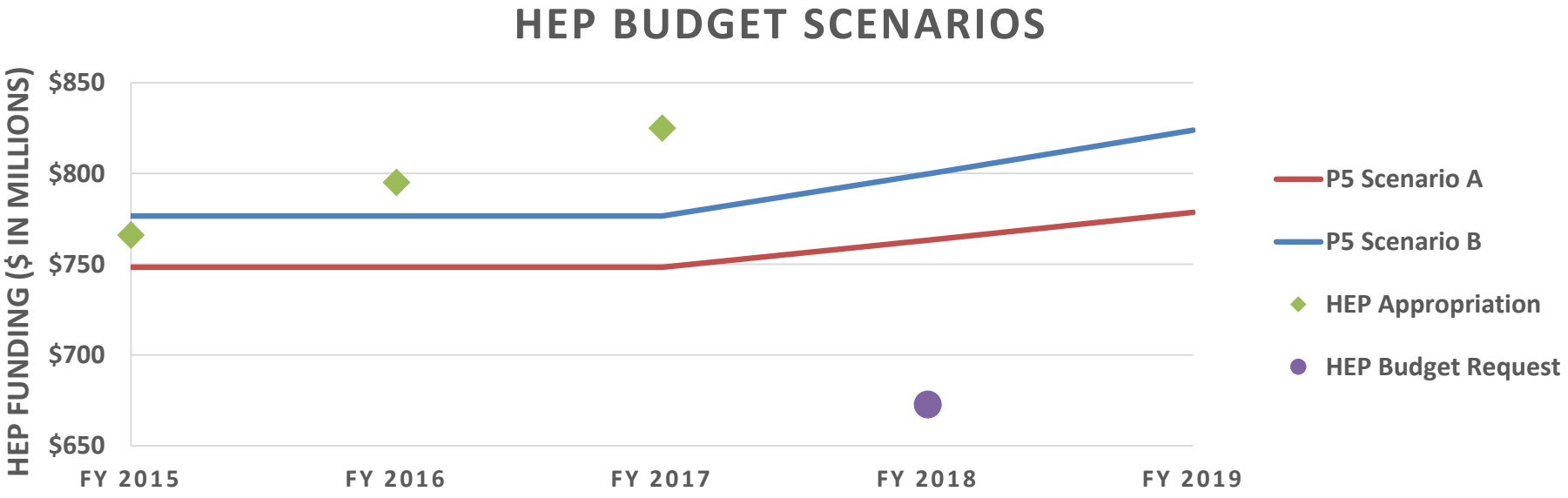
- **Energy Frontier: Actively engage in successful LHC program and High-Luminosity LHC (HL-LHC) upgrades**
  - P5's highest priority near-term large projects are the High-Luminosity Large Hadron Collider (HL-LHC) Accelerator Upgrade (new MIE start) and HL-LHC ATLAS & CMS detector upgrades
- **Intensity Frontier: Support establishing a U.S.-hosted world-leading neutrino program**
  - LBNF/DUNE is the highest P5 priority in its time frame and FY 2018 investments in initial far-site construction are crucial to enable scheduled delivery of contributions from international partners
- **Cosmic Frontier: Advance understanding of dark matter and dark energy**
  - P5 recommended a complementary suite of projects to study dark matter and dark energy and to support CMB experiments as part of core program





HEP Budget vs. P5 Funding Scenarios

- **P5 was charged to consider three 10-year budget scenarios for HEP within the context of a 20-year vision for the global field**
  - Scenario A was the lowest constrained budget scenario
  - Scenario B was a slightly higher constrained budget scenario
  - Scenario C was "unconstrained," but not considered unlimited
- **FY 2018 President's Budget Request was generated under tight time constraints as a formulation plan that reflects the P5 vision**
  - More time is necessary to reformulate the long-term execution plan for P5 at this funding level



FY18 Request: Projects and New Initiatives

- **P5 strategy balances small & large projects, provides continuous science output. Adjustments based on factors including P5 strategy, project maturity:**
  - Projects **fully supported** in FY 2018 according to planned funding profile: ***Muon to Electron Conversion (Mu2e)***, ***LSST camera***, and ***LZ*** direct-detection dark matter
  - Projects **adjusted** in FY 2018 with respect to profiles in latest DOE Critical Decision reviews (will coordinate with other SC offices, agencies, international partners):
    - ***LBNF/DUNE*** investment growth slowed; investments made are necessary to enable international contributions
    - ***Proton Improvement Plan II (PIP-II)*** for Fermilab Accelerator Complex is slowed
    - ***High-Luminosity LHC (HL-LHC) Accelerator Upgrade Project*** and ***HL-LHC ATLAS*** and ***CMS*** detector upgrade projects are minimally adjusted
    - ***SuperCDMS-SNOLAB*** will be delayed as it transitions from design to fabrication
    - ***DESI*** project will be rebaselined
    - ***FACET-II*** accelerator project will be delayed, requiring coordination with the BES *LCLS-II* project to plan a new schedule for installation
- **New initiatives**
  - ***HL-LHC Accelerator Upgrade Project*** is a new start Major Item of Equipment (MIE) in FY 2018
  - **Quantum Information Science (QIS)** is a new area of HEP emphasis in the SC and national program, and includes quantum computing and foundational QIS, quantum sensor technology, and small experiments exploiting entanglement.

FY18 Request: Research & Facilities Operations

- **In the midst of "Building for Discovery" for the future, must keep P5 projects moving forward**
  - Research and Facilities Operations are adjusted in order to maintain project support
- **FY 2018 Request will reduce Research activities at the National Laboratories and Universities, with higher priority given to:**
  - Laboratory research programs that are critical to executing the P5 recommendations
  - R&D that requires long-term investments (i.e., "seeding the future") including Accelerator Stewardship, Detector R&D, and Quantum Information Science (QIS)
- **FY 2018 Request provides reduced funding for the Fermilab Accelerator Complex to operate and support the neutrino and muon experiments**
  - FY 2018 experiment operations will include NOvA, MicroBooNE, ICARUS, and Muon g-2
  - Proposal to run 1,800 hours of Fermilab Accelerator Complex operations (37.5% of optimal 4,800) will require further discussion with Fermilab regarding program impacts

Quantum Information Science (QIS)

- **QIS identified as a national (interagency) and Office of Science priority**
- **HEP QIS emphasis (both near-term and long-term) is on:**
  - P5 science drivers – exploiting entanglement and QIS technology
  - New computational and foundational techniques via QIS
  - Advancing the national QIS enterprise
- **Approach: Interdisciplinary partnerships via connections with other SC programs and/or other federal agencies**
- **Areas of focus for HEP research via coordinated partnerships:**
  - Quantum Computing and Foundational QIS
    - Simulations, entanglement, algorithms, machine learning, data analysis on qubit systems
  - Quantum Sensor Technology
    - Sensors developed in alignment with qubit technology that expand the measurement ranges for experiments
  - Experiments Exploiting Quantum Entanglement
    - New windows on research utilizing QIS foundations, tools, and techniques
- **Reports available at:**
  - http://science.energy.gov/hep/community-resources/reports/
- **Program Manager: Lali Chatterjee**

Closing Remarks

- **In the immediate future:**
  - Keep "Building for Discovery!"
    - The FY 2018 Budget Request supports all P5 projects, with some on a delayed schedule
  - Keep producing great science!
  - Communicate your concerns with us

- **In the coming months:**
  - Keep producing great science!
  - It is unknown what the final appropriation will be, but we must be ready to execute come October 1, 2017
    - HEP will work with laboratory management to prepare to execute the FY 2018 President's Budget Request
    - HEP will work with Project Managers to examine multiple scenarios so we are prepared to execute the eventual appropriation

U.S. DEPARTMENT OF
ENERGY

Office of
Science

HEP FY18 President's Budget Request by Activity

HEP Funding Category ($ in K)	FY 2016 Enacted	FY 2017 Enacted	FY 2018 Request	Explanation of Changes (FY18 vs. FY16)
Research	341,663	347,852	272,887	Higher priority for lab efforts critical to P5 and R&D requiring long-term investments (Acc. Stewardship, Det. R&D, QIS)
SBIR/STTR	*20,847*	*22,279*	*18,680*	*In FY 2018, SBIR/STTR funding will be assumed to be 3.65% of non-capital funding*
Facilities	258,236	255,162	213,813	Reduced to support critical P5 projects
Projects	129,001	128,486	86,700	
Energy Frontier Projects	*21,085*	*24,017*	*39,000*	*HL-LHC AUP (FY18 MIE start) and HL-LHC ATLAS and CMS detector upgrades*
Intensity Frontier Projects	*29,001*	*21,569*	*14,100*	*PIP-II OPC and LBNF OPC*
Cosmic Frontier Projects	*64,600*	*73,700*	*31,600*	*Planned profile for LSSTCam and LZ. Delay SuperCDMS-SNOLAB, rebaseline DESI.*
Other Projects	*2,100*	*3,500*	*2,000*	*Delayed schedule for FACET-II*
Construction (Line Item)	66,100	93,500	99,300	Planned profile for Mu2e. Slight LBNF/DUNE increase, but delay vs. CD-3A schedule.
Total	**795,000***	**825,000**	**672,700**	

**** SBIR/STTR added to FY 2016 for comparison to FY 2017/2018***