U.S. DEPARTMENT OF ENERGY | Office of Science

High Energy Physics Budget Planning and Execution

HEPAP Meeting
29 November 2018

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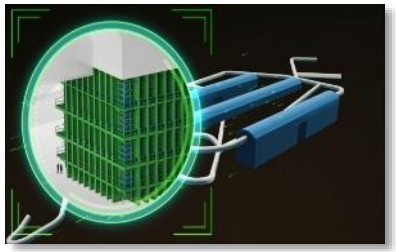
U.S. Long-Term Particle Physics Strategy

- The global vision presented in the 2014 Particle Physics Project Prioritization Panel (P5) report was the culmination of years of effort by the U.S. particle physics community
  - 2012 – 2013: Scientific community organized year-long planning exercise ("Snowmass")
  - 2013 – 2014: U.S. High Energy Physics Advisory Panel convened P5 to develop a plan to be executed over a ten-year timescale in the context of a 20-year global vision for the field

- P5 report enables discovery science with a balanced program that deeply intertwines U.S. efforts with international partners
  - **U.S. particle physics community** strongly supports strategy
  - **U.S. Administration** has supported implementing the P5 strategy through each President's Budget Request
  - **U.S. Congress** has supported implementing the P5 strategy through the language and funding levels in appropriations bills
  - **International community** recognizes strategy through global partnerships



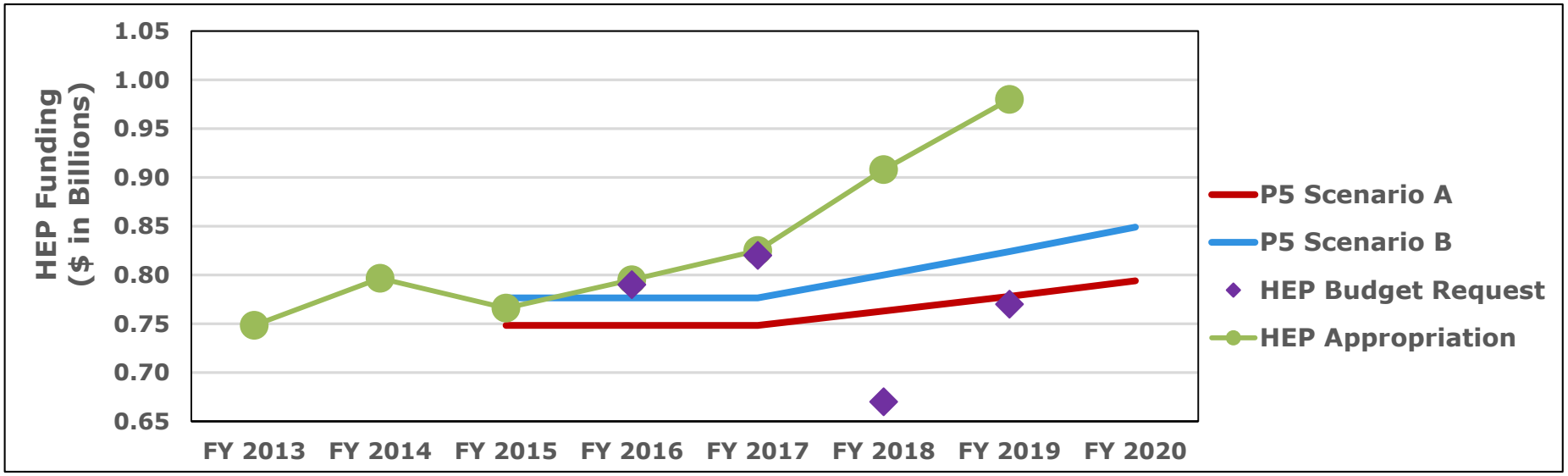
U.S. Administration Supports P5

- U.S.-CERN Agreement, signed May 6, 2015, in D.C.
  - By U.S. Secretary of Energy Ernest Moniz, CERN Director General Rolf Heuer, and U.S. National Science Foundation France Cordova
  - Aligns European and American long-range strategic plans in particle physics
- UK-U.S. Science & Technology Agreement, signed Sep 20, 2017, in D.C.
  - By UK Science Minister Jo Johnson and U.S. Acting Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs Judith Garber
  - First major project under this agreement is UK investment of £65 million ($88 million) in LBNF/DUNE
- DOE-DAE (India) Project Annex II on Neutrino Research signed April 16, 2018, in New Delhi
  - By U.S. Secretary of Energy Rick Perry and India's Atomic Energy Secretary Sekhar Basu
  - Expands accelerator science collaboration to include science for neutrinos

U.S. Congress Supports P5 Strategy

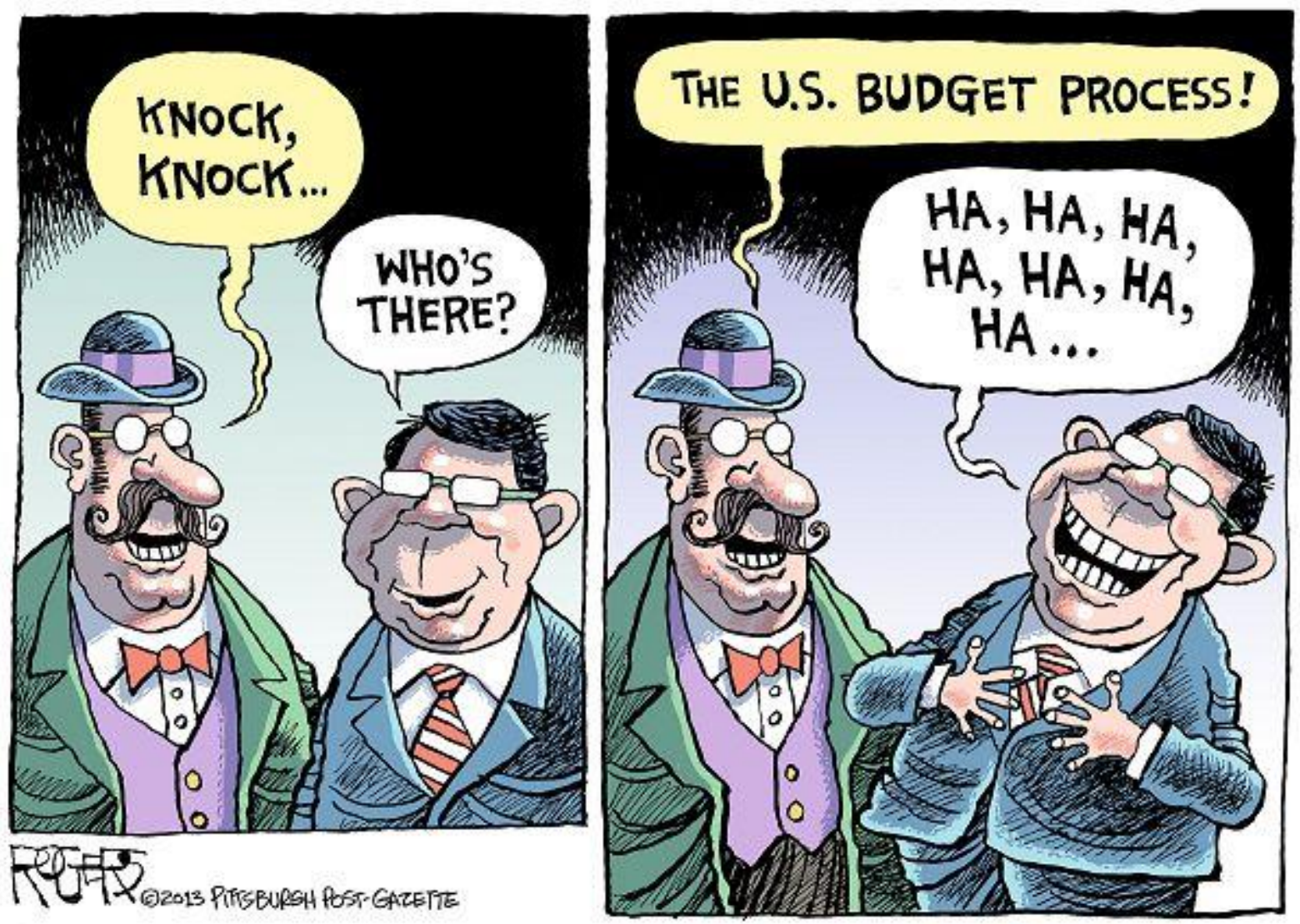
- FY 2019 Senate Energy and Water Development Appropriations Report:
  - "The Committee recommends $1,010,000,000 for High Energy Physics. **The Committee strongly supports the Department's efforts to advance the recommendations of the Particle Physics Project Prioritization Panel Report [P5],** which established clear priorities for the domestic particle physics program…"

"Four years into executing the P5, the Committee commends the Office of Science and the high energy physics community for achieving significant accomplishments and meeting the milestones and goals set forth in the strategic plan…"



Applause

Few Minutes on the U.S. Budget Process



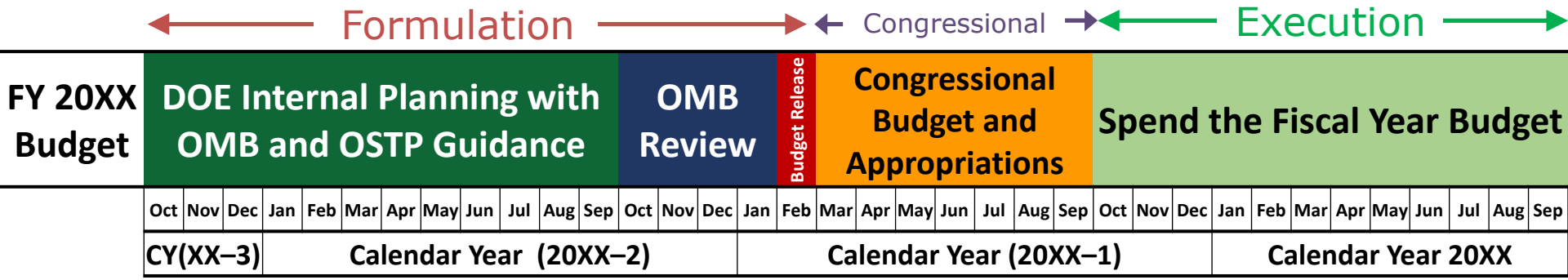
Budget and Accounting Act of 1921

- Before the Budgeting & Accounting Act of 1921, no single government entity oversaw the entire budget
  - Departments submitted budget requests directly to Congress
- After WWI, the Act was passed to provide more control over government expenditures
  - Budgeting debates hinge on powers given to Congress and President in this Act
  - Restrictions keep either branch from dominating budget decisions

- The Act requires the President to submit a budget to Congress every year
- The act created:
  - **Bureau of the Budget** (BoB), giving President control over individual departments, evaluating competing requests
  - **General Accounting Office** tells House and Senate what may be necessary to balance the budget
- **Reorganization Act of 1939** created the Executive Office of the President (**EOP**), and BoB moved from Treasury to EOP
  - In **1970**, BoB reorganized by Executive Order (Nixon) as the **Office of Management and Budget**
  - OMB is the largest agency within the EOP

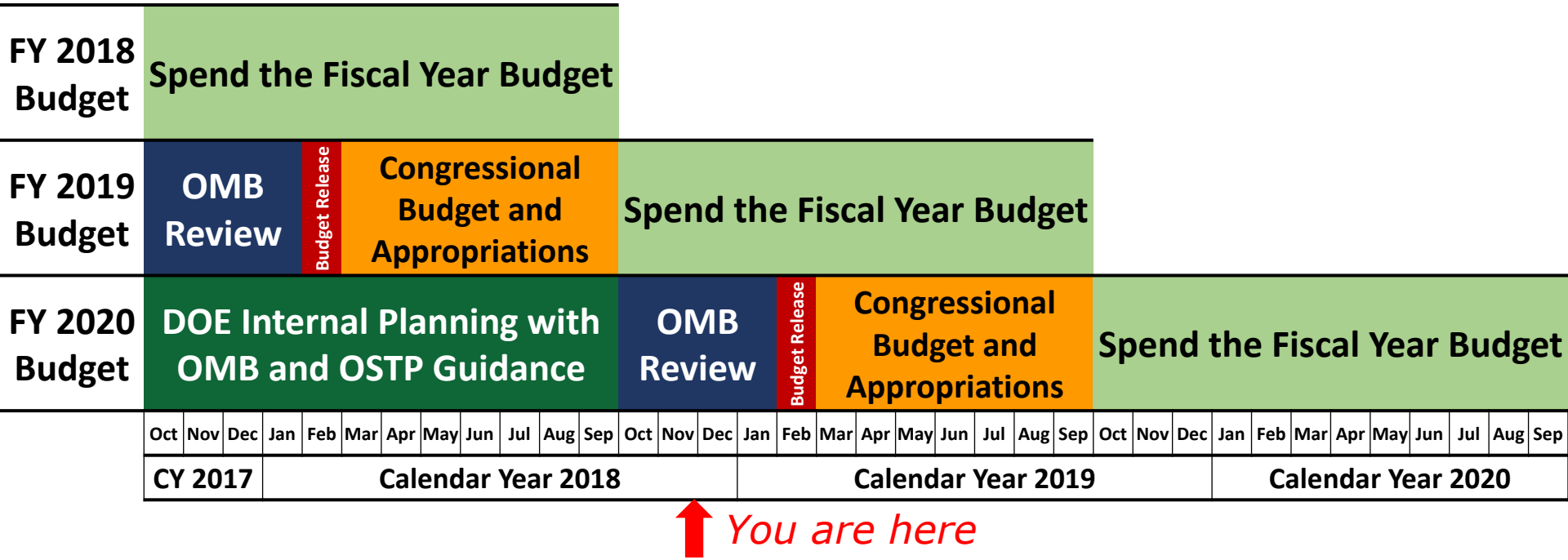
Three Phases of Budget Process

- **Formulation**: Executive branch prepares the President's Budget Request
  - White House Office of Management and Budget (OMB) controls this process, providing guidance to Executive branch agencies
- **Congressional**: Enacts laws that control spending and receipts
  - Congress considers the President's Budget proposals, passes a budget resolution, and enacts the regular appropriations acts and other 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 to carry out their programs, projects, and activities



The U.S. Federal Budget Cycle

- Typically, three budgets are being worked on at any given time
  - Executing current Fiscal Year (FY; October 1 – September 30)
  - OMB review and Congressional Appropriation for coming FY
  - Agency internal planning for the second FY from now



Creating the DOE HEP Budget Request

Top-down and bottom-up influences to the DOE HEP budget

White House

White House Priorities

OMB Directives

Advisory Panels (HEPAP, AAAC)

Community-driven Strategic Plans (P5)

Review Committee & Workshop Reports

Particle Physics Community

Project Performance

DOE/SC Management

DOE/HEP Program

Department of Energy

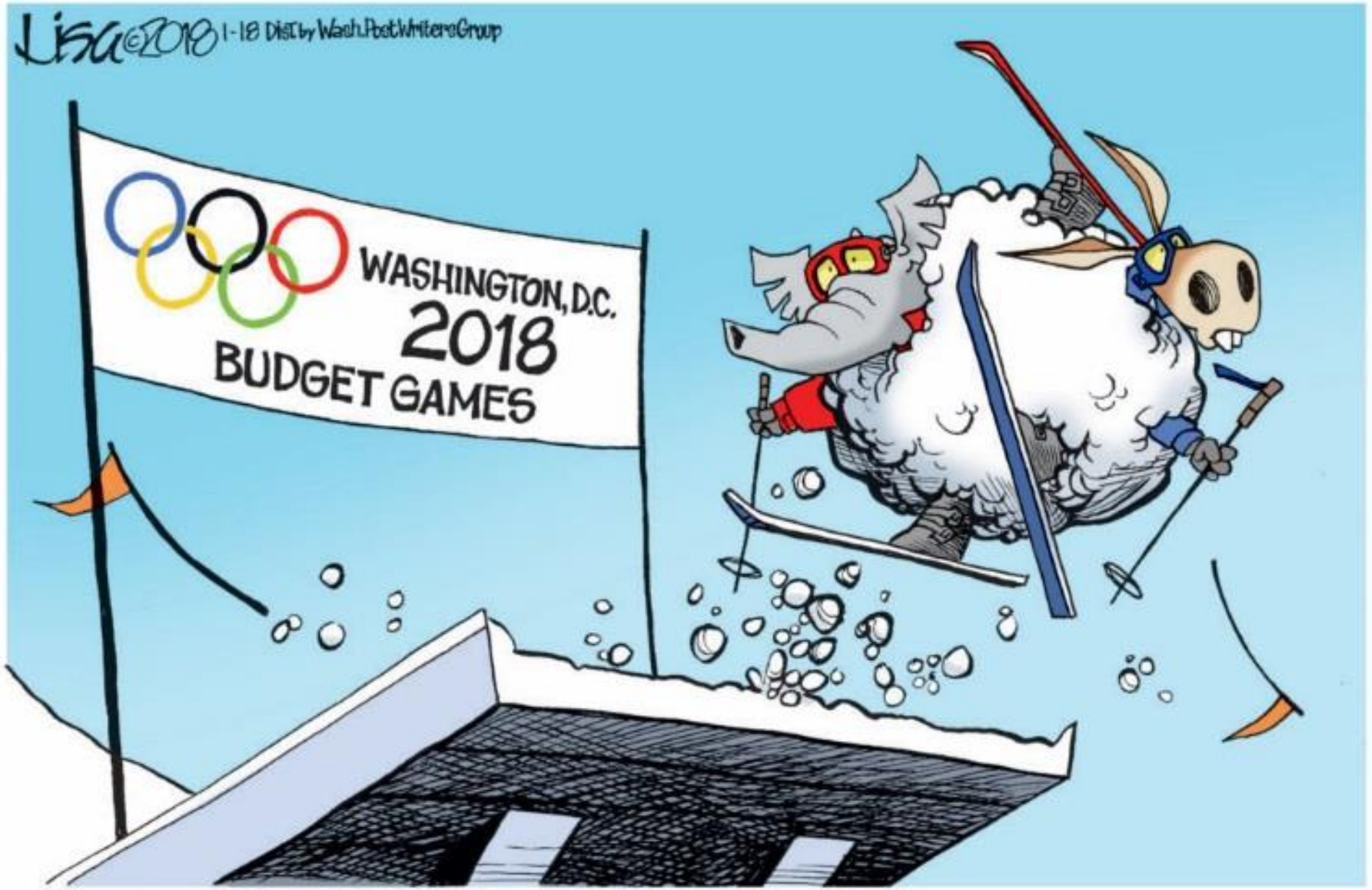
HEP Role in Congressional Process

- The budget narrative provides the justification for the level of support in the President's Budget Request
  - Narrative provides overview of the HEP program, highlights from the past year, and discussion of:
    - Line Item Construction, Major Items of Equipment, New Initiatives or New Starts, Facilities Operations, and Research program priorities
  - Detailed funding for Budget Request vs. Prior Year Request (or Enacted)
  - "Explanation of Changes"
    - **Additional scope of work (Increase) or Emphasis/Focus/Priority (Decrease)**
    - Current Administration wants focus on what can be done, with priorities
- Agencies usually invited to brief Congress on budget request
  - Opportunity to reinforce overall strategy and highlight key elements of the request
    - Congress must individually approve each DOE project >$10M
  - Informational request for additional detail
  - Respond to requests regarding impact of alternative funding decisions

U.S. Budget and Appropriations Process

- President requests, but Congress "holds the purse"
- Congressional activity in this phase is a complex process!
- *Congressional Budget and Impoundment Control Act of 1974* established timetable for the budget process
  - And established Committees on the Budget in each House!

On or Before:	Action to be completed:
1st Mon. in Feb.	President submits his budget
<6 weeks after PBR submitted	Committees submit views and estimates to Budget Committees
April 15	Congress completes action on the concurrent resolution on the budget
May 15	Annual appropriation bills may be considered in House
June 10	House Appropriations Committee reports last annual appropriation bill
June 15	Congress completes reconciliation
June 30	House completes action on bills
October 1	Fiscal year begins


Lisa ©2018 1-18 Dist by WashPostWritersGroup
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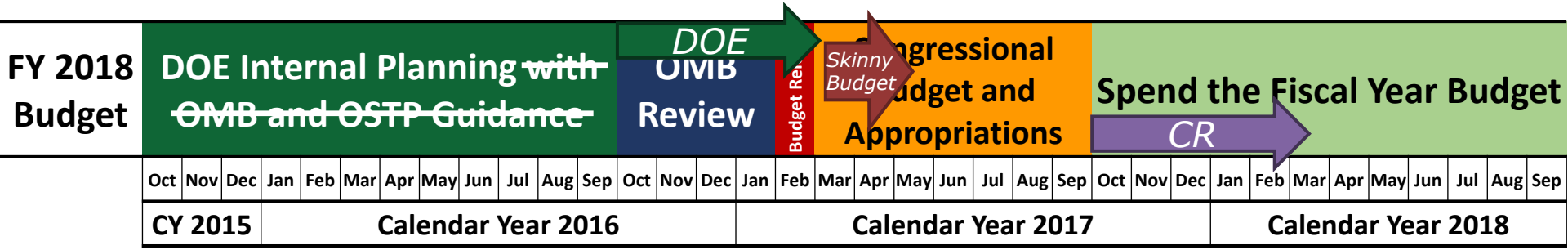
2018
BUDGET GAMES

The FY 2018 Federal Budget Cycle

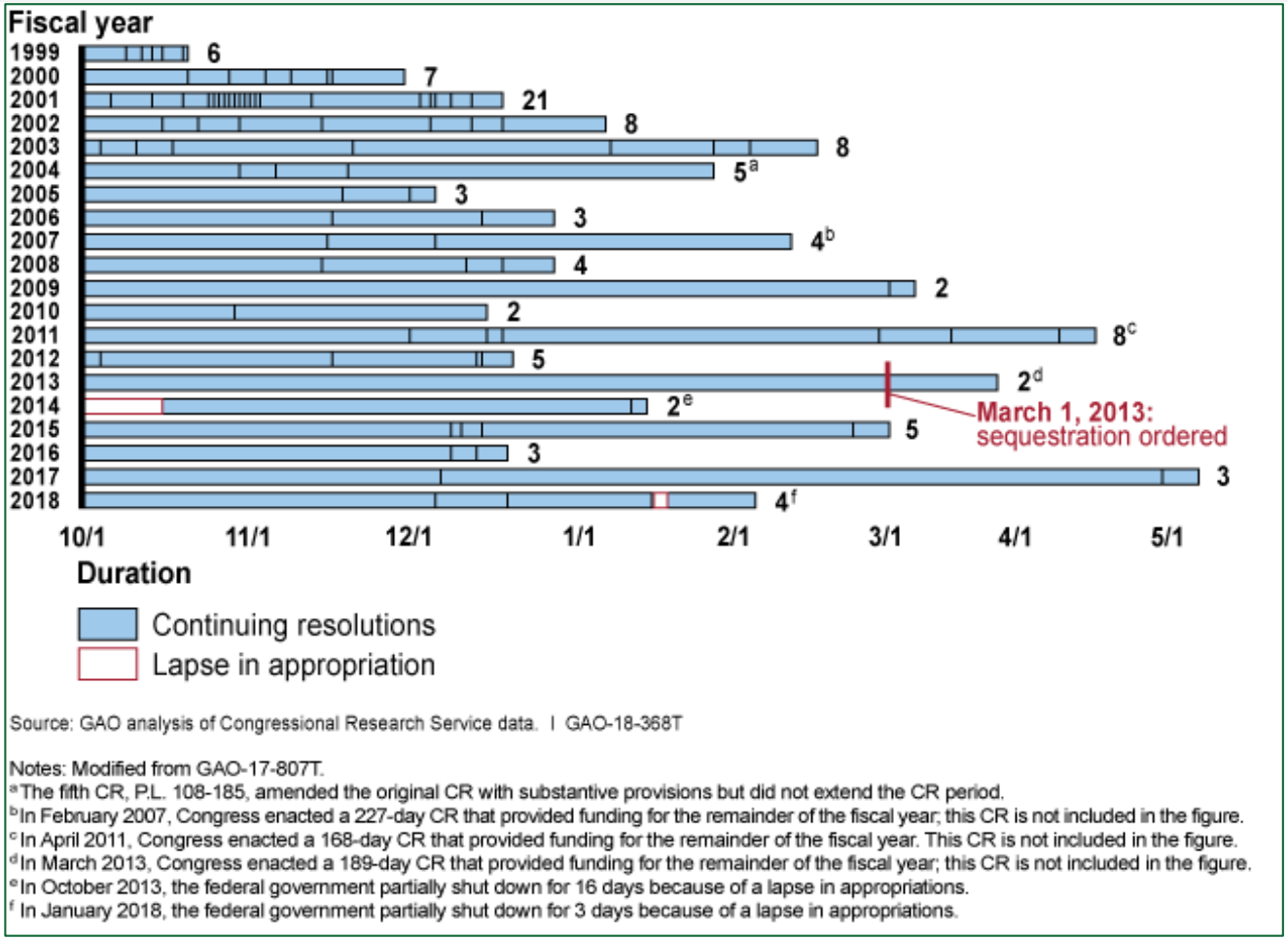
- FY 2018 process was not "typical"
  - SC internal planning began very early…No OMB review
  - White House released the **"skinny budget"** on March 13, 2017 guiding the budget formulation
  - FY 2018 **President's Budget Request** released on May 23. 2017
  - FY 2018 **Congressional Marks released** in June/July 2017
  - Congress used **Five Continuing Resolutions (CRs)** (and two very brief shutdowns) until passing an appropriation which was signed by Pres. Trump on March 23, 2018.



Impacts of a Continuing Resolution

- If the U.S. Congress and the President have not passed all appropriations bills by September 30, a Continuing Resolution (CR) may be passed to avoid a U.S. Government shutdown
  - Must pass some level of appropriations to have legal authority to spend money!
  - CRs typically extend level of funding from the previous year for a set amount of time *with no significant programmatic changes* (a.k.a. "no new starts")
- Therefore, a CR may impede the start of new projects
  - Projects with total cost >$10M must be approved by Congress in an appropriations bill before funding can begin
  - It is possible, though not typical, for CRs to include "anomalies" that would allow new starts
- A CR may also impact the ramp-up of new projects
  - DOE is committed to the successful execution of projects that have reached CD-2 and aims to provide the baseline funding profile
  - Projects that have not reached CD-2 are most likely to be impacted under a CR
- A CR may also impact future-year planning…

Duration and Number of Continuing Resolutions



Source: GAO analysis of Congressional Research Service data. | GAO-18-368T

Notes: Modified from GAO-17-807T.
[a] The fifth CR, P.L. 108-185, amended the original CR with substantive provisions but did not extend the CR period.
[b] In February 2007, Congress enacted a 227-day CR that provided funding for the remainder of the fiscal year; this CR is not included in the figure.
[c] In April 2011, Congress enacted a 168-day CR that provided funding for the remainder of the fiscal year. This CR is not included in the figure.
[d] In March 2013, Congress enacted a 189-day CR that provided funding for the remainder of the fiscal year; this CR is not included in the figure.
[e] In October 2013, the federal government partially shut down for 16 days because of a lapse in appropriations.
[f] In January 2018, the federal government partially shut down for 3 days because of a lapse in appropriations.

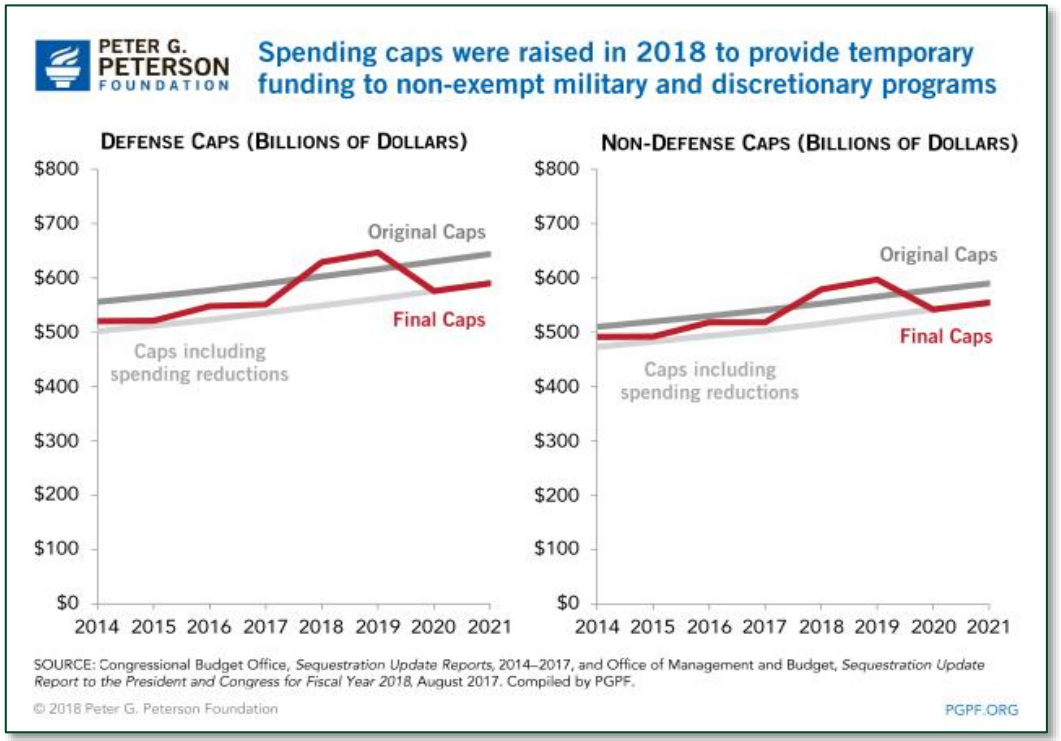
In fiscal years 2007, 2013, and 2014, Congress enacted an extended CR to provide funding for the remainder of the fiscal year, e.g. full-year CR, (not included in the figure).

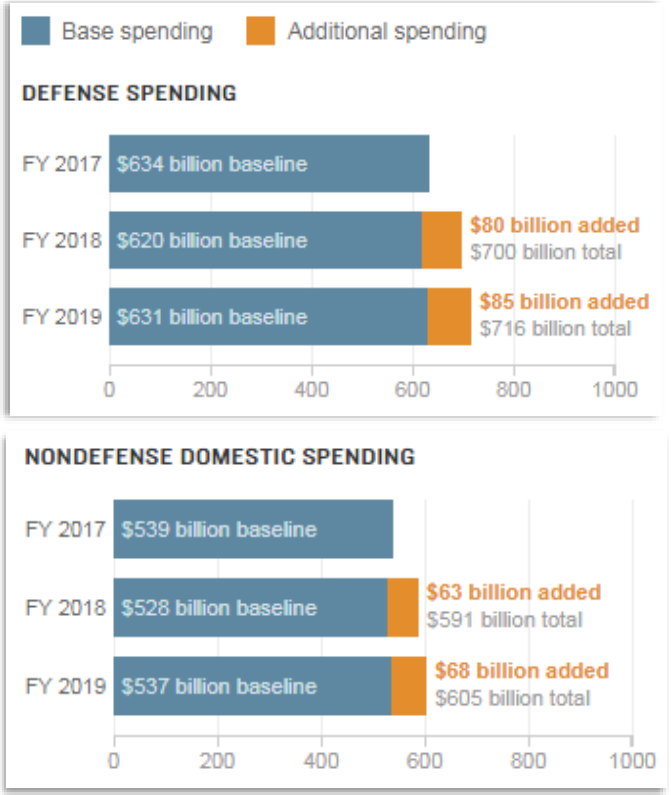
Between fiscal year 1977 and fiscal year 2018, Congress only passed all twelve regular appropriations bills on time in four years - fiscal years 1977, 1989, 1995, and 1997.

Bipartisan Budget Act of 2018 (H.R. 1892)

Passed on February 9, 2018, includes Budget Resolutions for FY 2018 and FY 2019

- With enactment of the Budget Control Act of 2011, sequestration began in FY 2013, setting across-the-board budget cuts/caps amounting to $1.2T in spending reductions on non-discretionary funding over the next 10 years
- **Bipartisan deals** in 2013 and 2015 raised the spending caps, but those adjustments expired in FY 2017
- Spending resolution for **FY 2018-2019** again set spending levels above spending caps.





$1.3T FY 2018 Omnibus Budget Bill

- Commerce, Justice, Science, and Related Agencies
  - **National Aeronautics and Space Administration**
  - **National Science Foundation**
- Energy and Water Development
  - **Department of Energy**
- Interior, Environment, and Related Agencies
  - Specific portions of Department of Health and Human Services
- Labor, Health and Human Services, Education, and Related Agencies
  - Department of Health and Human Services (with above exceptions)

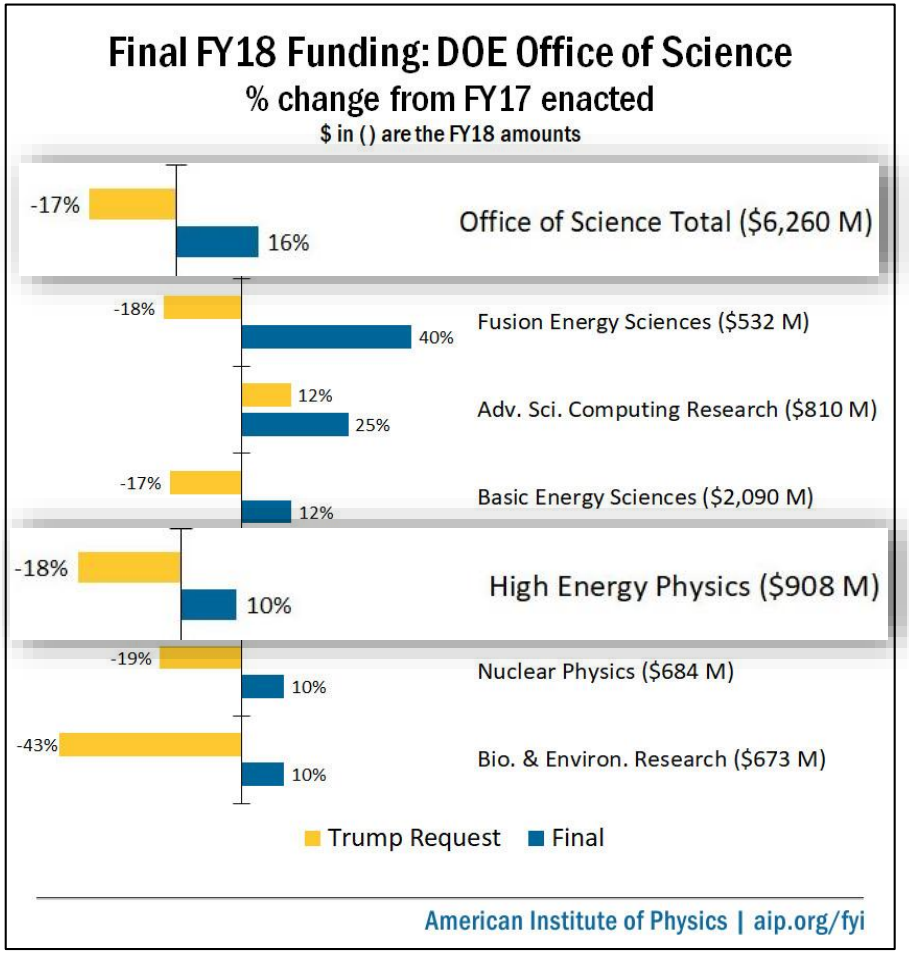
- Omnibus Spending Bill rolled all 12 Appropriations into one

Consolidated Appropriations Act of 2018 (FY 2018 Omnibus)

Appropriations Bill	Budget ($B) FY 2017 (Enacted)	FY 2018	% Δ
Agriculture	21.2	23.3	9.9%
Commerce, Justice, Science	56.6	59.6	5.3%
Defense	598.4	659.5	10.2%
Energy and Water	37.8	43.2	14.3%
Financial Services	21.4	23.4	9.3%
Homeland Security	42.4	47.7	12.5%
Interior/Environment	32.2	35.2	9.3%
Labor, HHS, Education	161.1	177.1	9.9%
Legislative Branch	4.4	4.7	5.9%
Military Construction and Veterans Affairs	82.4	92.0	11.7%
State and Foreign Operations	57.4	54.0	-5.9%
Transportation, Housing and Urban Development	57.7	70.3	21.8%

FY 2018 DOE Office of Science Enacted

- **$6,260M for the Office of Science**
  - $868M (16%) increase was largest single-year influx since 2009, when $1.6B stimulus provided through American Recovery Reinvestment Act
- Facility construction projects and upgrades received appropriations well above the administration's request
  - New starts for construction of two light sources upgrades and a neutron source upgrade (BES)
- Funding for line-item construction: LBNF/DUNE increased to $95M ($40M more than requested), and $1M provided for PIP-II
- Senate report says the committee continues to "strongly support" U.S. participation in the Large Hadron Collider
- Two experiments, which will search for dark energy and matter, received funding above the administration's request
  - $17.5M for DESI, $7.4M SuperCDMS-SNOLAB
- Requested level of funding was provided for LZ, Mu2e, and LSSTcam projects



"Dude, Where's My Grant?" The Sequel

Budget Execution

- Start from the general plan laid out in budget formulation, modified by the actual appropriation, taking into account:
  - Strategic plan for program
  - Available funding vehicles
  - Stewardship of DOE National Labs
  - Support for projects
  - Coordination with partners

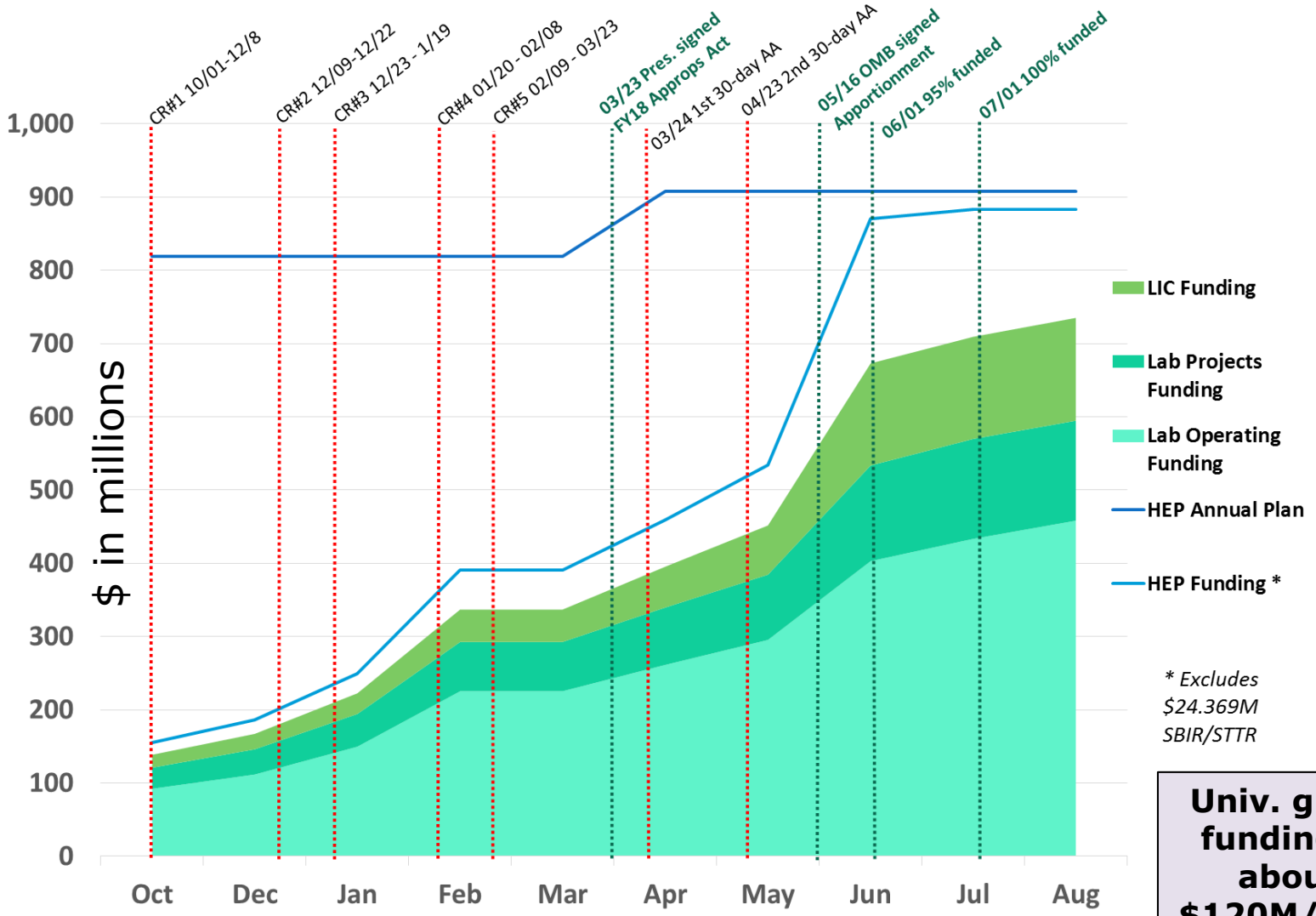
- Note that it typically takes some time to translate Congressional Appropriation into detailed agency-level budgets
- Agency CFOs have to resolve budget language, CR spending, and get agreement with OMB before issuing current FY "allotments" of budget authority

Available funding, e.g. cash flow for financial assistance agreements in FY 2018 was constrained by:

- Five Continuing Resolutions and Stop-gap Funding at Prior Year levels
- Five projects at CD-2/3
- Two 30-day allotments by OMB.

Let's unpack…in the next slide…

HEP FY 2018 Budget Execution

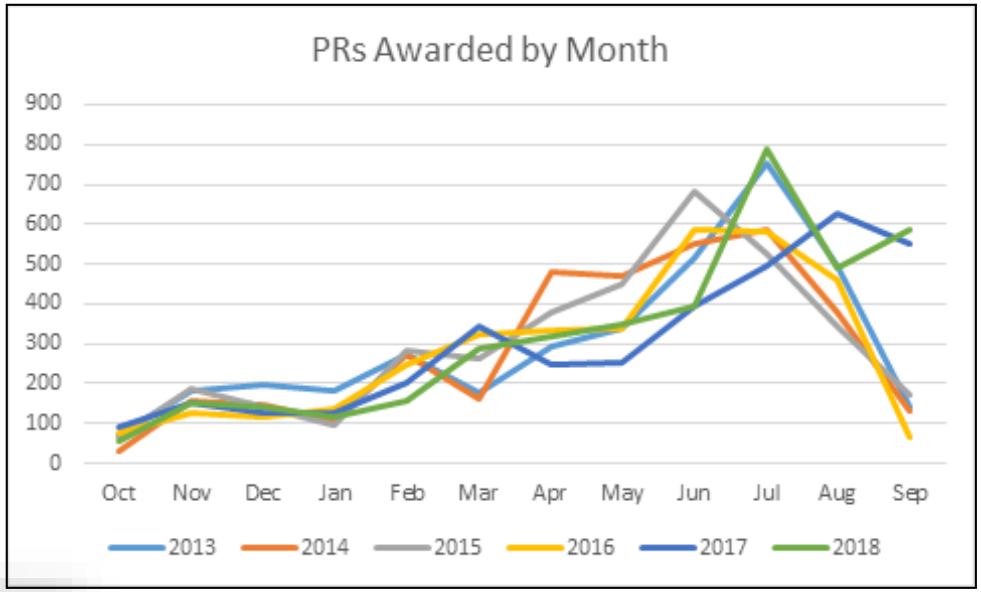


** Excludes $24.369M SBIR/STTR*

Univ. grant funding is about $120M/year

Procurement Requests

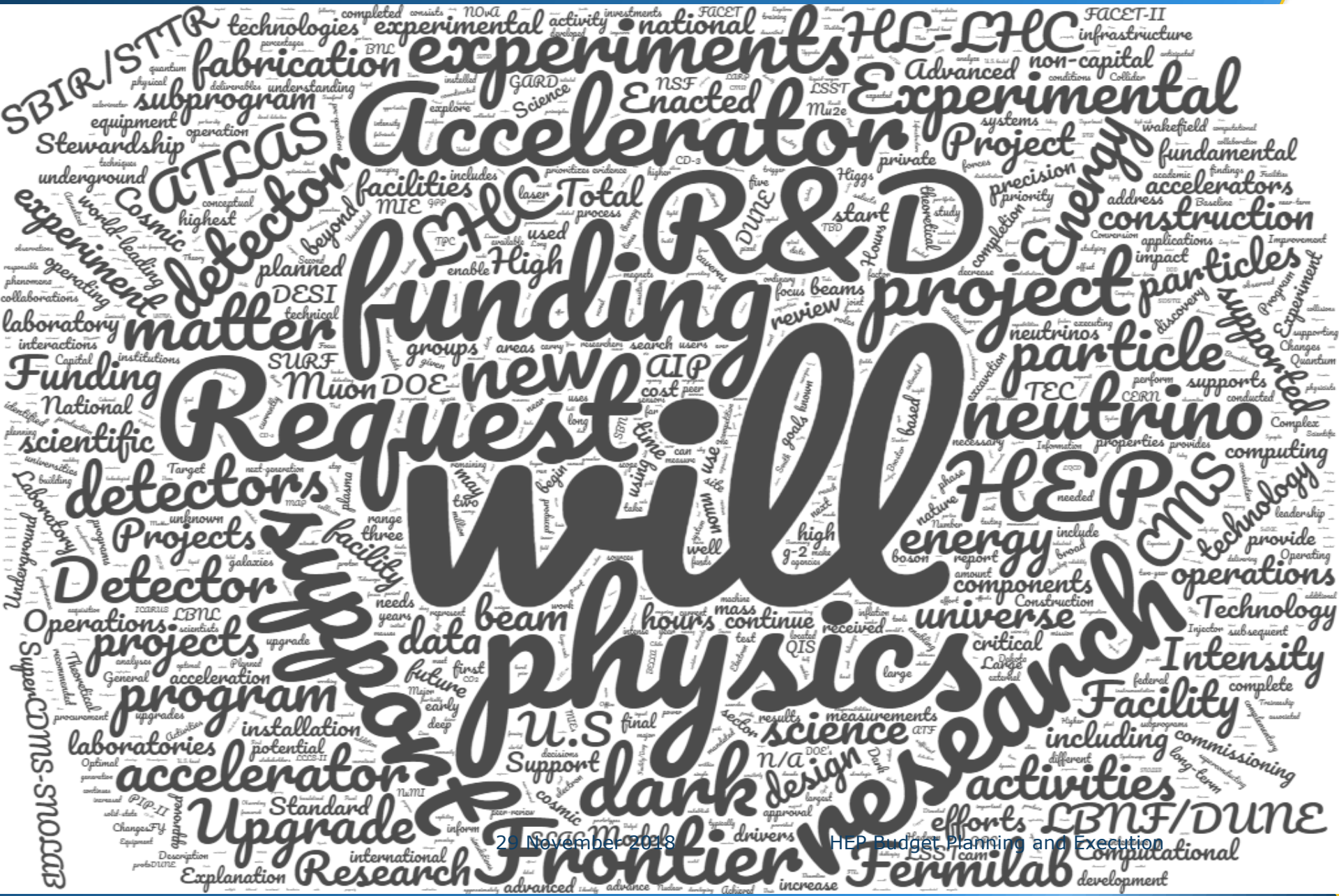
- **Grant proposals are submitted in response to a Funding Opportunity Announcement (FOA)**
  - Independent peer review informs the selection of awards
- Award is ~fixed once made, with funding cycle of 1-5 years
  - Funding adjustments (downward) are possible if circumstances change
  - Changes are also possible through submission of supplementary proposals



Office of High Energy Physics (FY 2018)	Number of PRs	Funds Awarded
Total	347	$126,857,897.03
Award Revision	5	-$116,531.97
Continuation	155	$72,350,000.00
New	91	$26,363,429.00
No Cost Extension	48	$0.00
Renewal	36	$26,210,000.00
Supplemental	12	$2,051,000.00

- A Note on FY 2019 Continuations
  - About half of HEP's PRs are continuations, providing more than 50% total grand funding
  - Progress reports can be submitted as soon as PIs get the PAMS notification in early December (next week!)
  - Early submission will help ensure on-time processing by HEP and SC of continuation funding before the end of the grant budget period (March 31, 2019).

FY 2019 HEP Budget



FY 2019 Appropriations (and C.R.)

- **On September 21**, President Trump signed into law a bipartisan minibus (Senate 92-5, House 377-20) spending package consisting of three FY 2019 spending bills: Energy and Water, Military Construction and Veterans Affairs, and Legislative Branch.
- **On September 28**, President Trump signed into law the "Department of Defense and Labor, Health and Human Services Appropriations Act, 2019 and Continuing Appropriations Act, 2019," the second of three Fiscal Year 2019 minibus appropriations packages, which includes funding bills for the Defense; and Labor, Health and Human Services, and Education, and Related Agencies subcommittees.
- The bill also contains a continuing resolution (CR) through December 7, 2018, for any appropriations bills not enacted before October 1, 2018.

FY 2019 Appropriations Status

Agencies with Full Year Appropriations:

- Energy and Water Development
  - **Department of Energy**
- Labor, Health and Human Services, Education, and Related Agencies
- Defense
- Legislative Branch
- Military Construction and Veteran Affairs

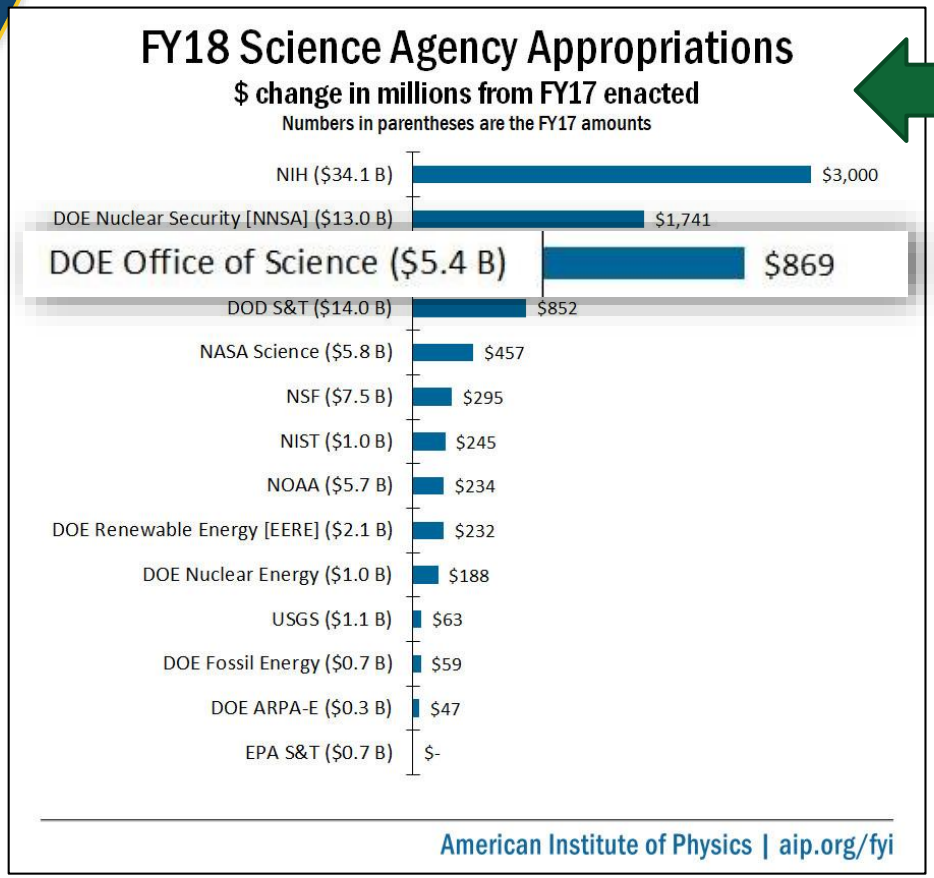
Agencies under a C.R. until Dec 7th:

- Commerce, Justice, Science, and Related Agencies
  - **National Aeronautics and Space Administration**
  - **National Science Foundation**
- Interior, Environment, and Related Agencies
- Agriculture
- Financial Services
- Homeland Security
- State and Foreign Operations
- Transportation, Housing and Urban Development

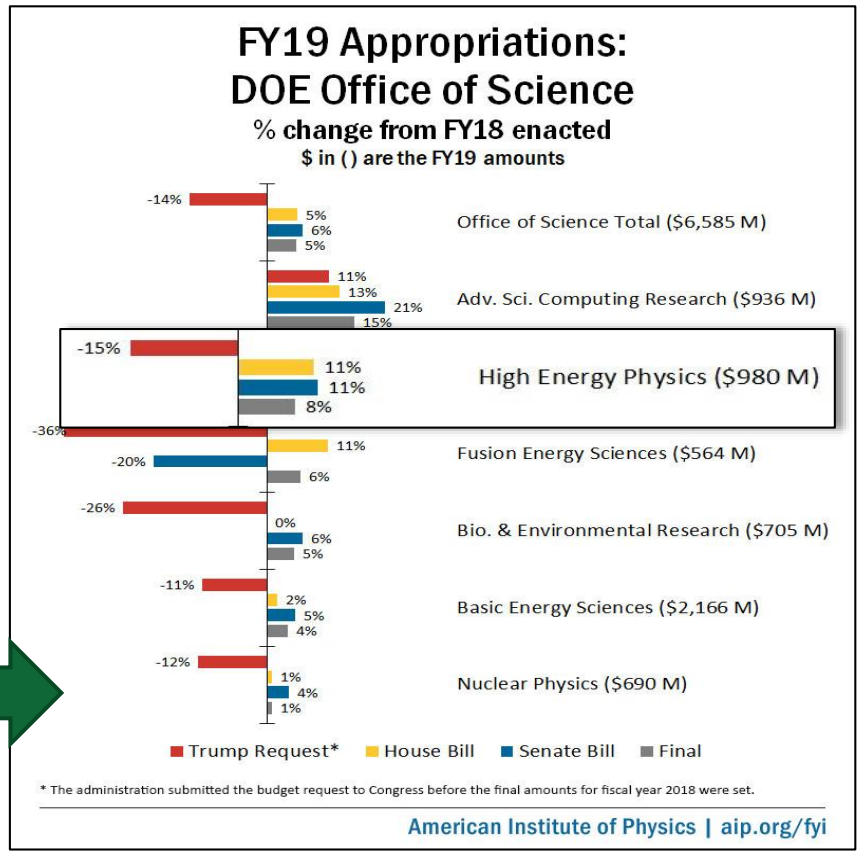
Status of FY 2019 Appropriations

Appropriations Bill	Budget FY 2017	FY 2018	FY 2019	FY19 +/-18 % Δ
Agriculture	21.2	23.3	23.2	0%
Commerce, Justice, Science	56.6	59.6	62.5	4.9%
Defense	598.4	659.5	674.6	2.3%
Energy and Water	**37.8**	**43.2**	**44.7**	**3.5%**
Financial Services	21.4	23.4	23.4	0.0%
Homeland Security	42.4	47.7	58.1	21.8%
Interior/Environment	32.2	35.2	35.3	0.3%
Labor, HHS, Education	161.1	177.1	179	1.1%
Legislative Branch	4.4	4.7	4.9	4.3%
Military Construction and Veterans Affairs	82.4	92.0	98.1	6.6%
State and Foreign Operations	57.4	54.0	54	0.0%
Transportation, Housing and Urban Development	57.7	70.0	71.8	2.6%

FY 2018 vs FY 2019 Appropriations



- HEP was up from 825M in FY 2017 to 908M in FY 2018, an **increase of +10.1%**
- All projects were addressed at their baseline and/or IPR levels. Line-item construction funding began for PIP-II.



- HEP is up from 908M in FY 2018 to 980M in FY 2019, an **increase of +8%**
- All projects are addressed at their baseline and/or IPR levels. Five projects receive final planned funding!

FY 2019 HEP Enacted Budget

HEP Funding Category ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 2019 vs. FY 2018
Research	344,043	359,177	380,847	+21,670
Facilities/Operations	258,696	270,488	260,803	-9,685
Projects	222,261	278,335	338,350	+60,015
Total	**825,000**	**908,000**	**980,000**	**+72,000**

- FY 2019 Appropriations supports the SC and P5 priorities
  - SC: interagency partnerships, national laboratories, accelerator R&D, QIS
  - P5: preserve vision, modify execution
- FY 2019 HEP Budget continues support for P5-guided investments in mid- and long-term program
  - "Building for Discovery" by supporting highest priority P5 projects to enable 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

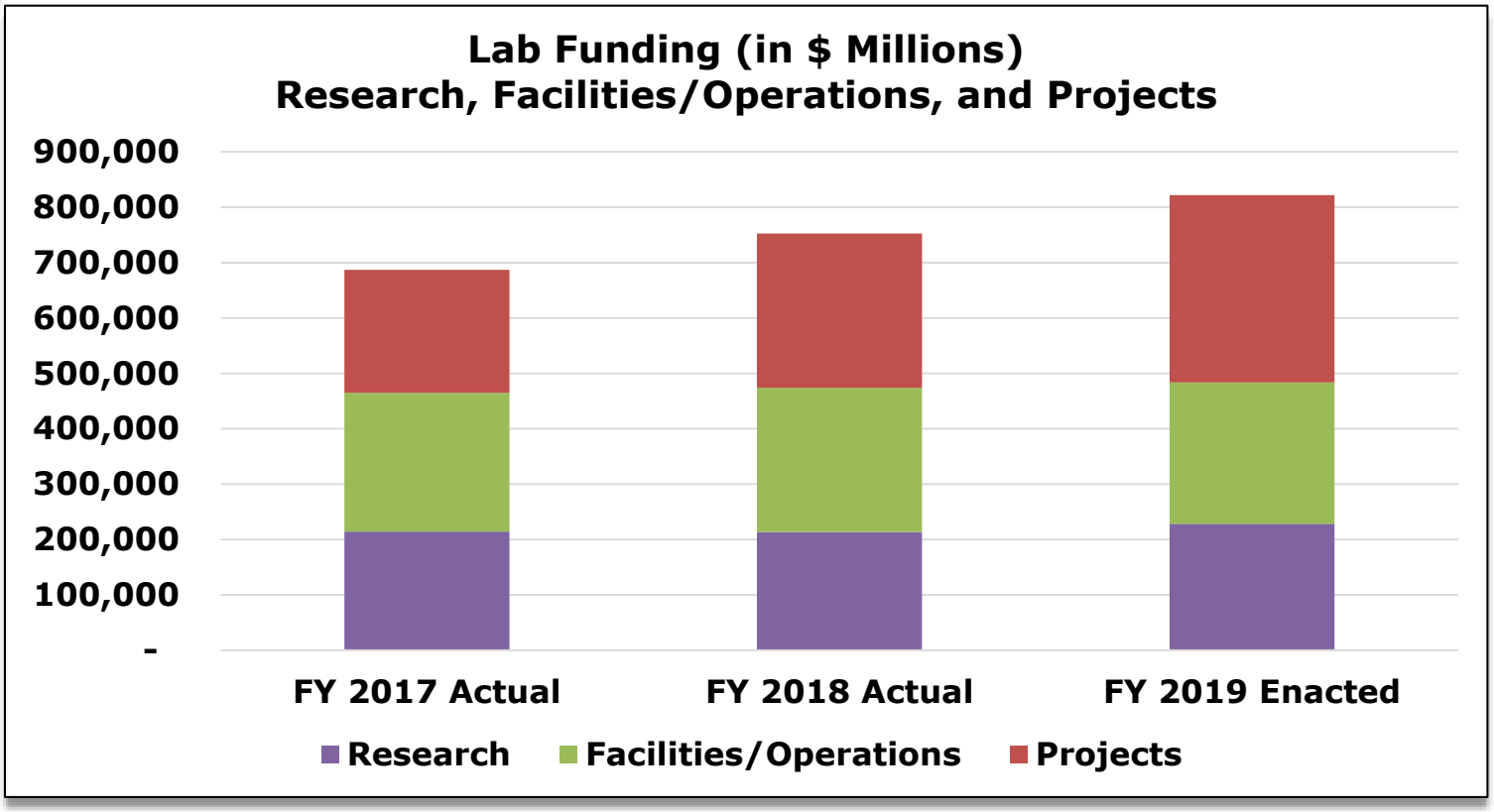
Balancing Research, Operations and Projects

- FY 2019 HEP Enacted at 980M
  - 338.4M (34.5%) for projects fully controlled by language
    - +35M for LBNF/DUNE over FY 2018, and +17M over Request
    - Mu2e, DESI, SuperCDMS, LZ and FACET-II to receive final funding
  - 641.6M or 65.5% provides strong support to Research & Operations
- Accelerates Project funding:
  - Creates opportunities to launch new initiatives by mid-2020s
  - Confronts new risks (facility capacity, modernizing infrastructure)
  - Increases pressure to deliver on science earlier
    - Setbacks, unknown technological issues, null results, world competition

HEP MIE Project Status

Subprogram	TPC ($M)	CD Status	CD Date
INTENSITY FRONTIER			
Long Baseline Neutrino Facility / Deep Underground Neutrino Experiment (LBNF/DUNE)	1,300 – 1,900	CD-3A	September 1, 2016
Proton Improvement Project (PIP-II)	653 - 928	CD-1	July 23, 2018
Muon g-2 FY 2017	46.4	CD-4	January 16, 2018
Muon-to-Electron Conversion Experiment (Mu2e) FY 2019	273.677	CD-3	July 14, 2016
ENERGY FRONTIER			
LHC ATLAS Detector Upgrade FY 2017	33	CD-3	November 12, 2014
LHC CMS Detector Upgrade FY 2017	33	CD-4A	September 19, 2017
High-Luminosity LHC (HL-LHC) Accelerator Upgrade	208 - 252	CD-1/3A	October 13, 2017
High-Luminosity LHC (HL-LHC) ATLAS Detector Upgrade	149-181	CD-1	September 21, 2018
High-Luminosity LHC (HL-LHC) CMS Detector Upgrade	125-155	CD-0	April 13, 2016
COSMIC FRONTIER			
LUX-ZEPLIN (LZ) FY 2019 FY 2019	55.5	CD-3	February 9, 2017
Super Cryogenic Dark Matter Search - SNOLAB (SuperCDMS-SNOLAB)	18.6	CD-2/3	May 2, 2018
Dark Energy Spectroscopic Instrument (DESI) FY 2019	56.328	CD-3	June 22, 2016
Large Synoptic Survey Telescope Camera (LSSTcam) FY 2018	168	CD-3	August 27, 2015
ADVANCED TECHNOLOGY R&D			
Facility for Advanced Accelerator Experimental Tests II (FACET-II) FY 2019	25.6	CD-2/3	June 8, 2018

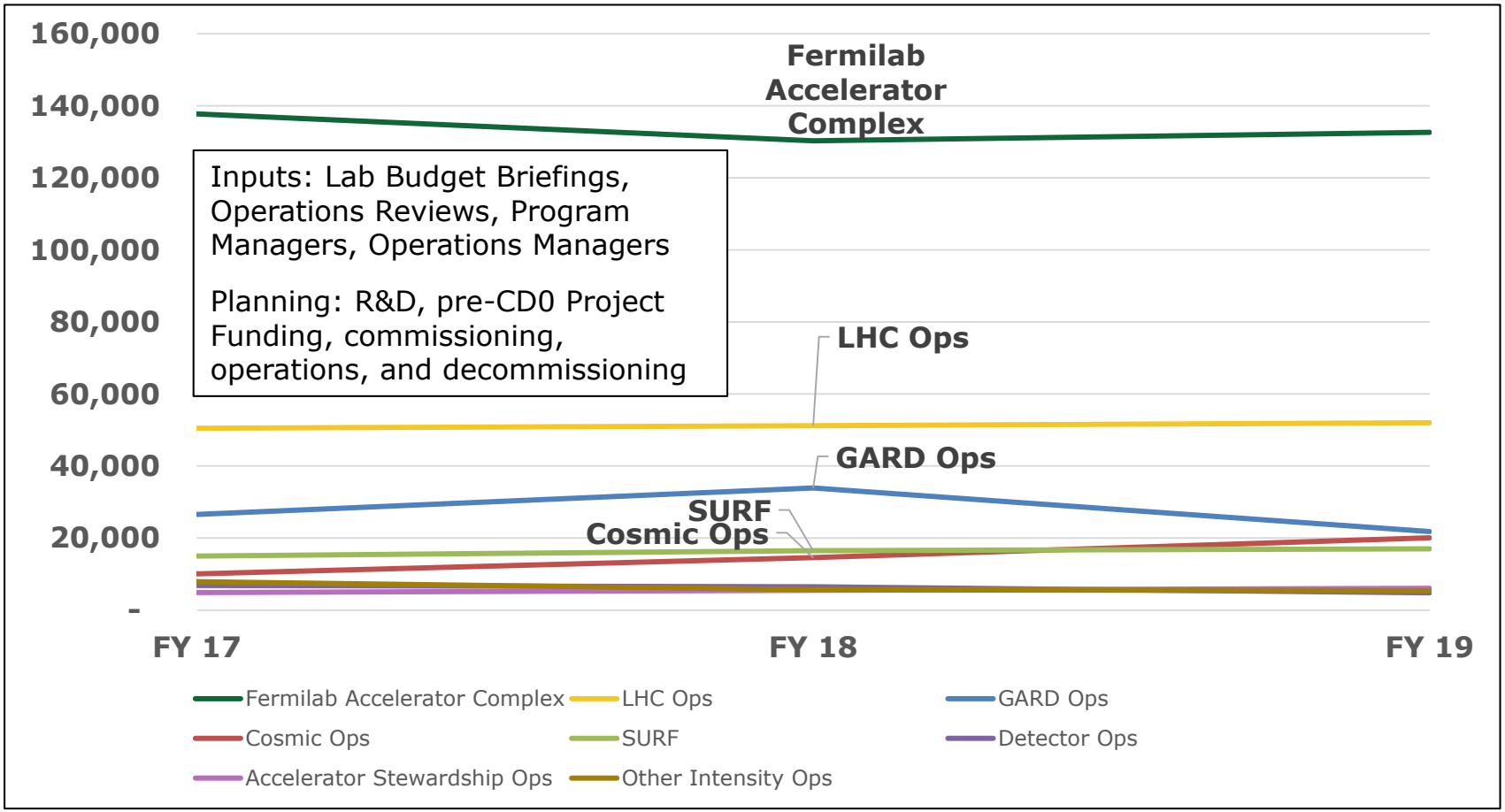
Lab Funding – FY 2017-2019



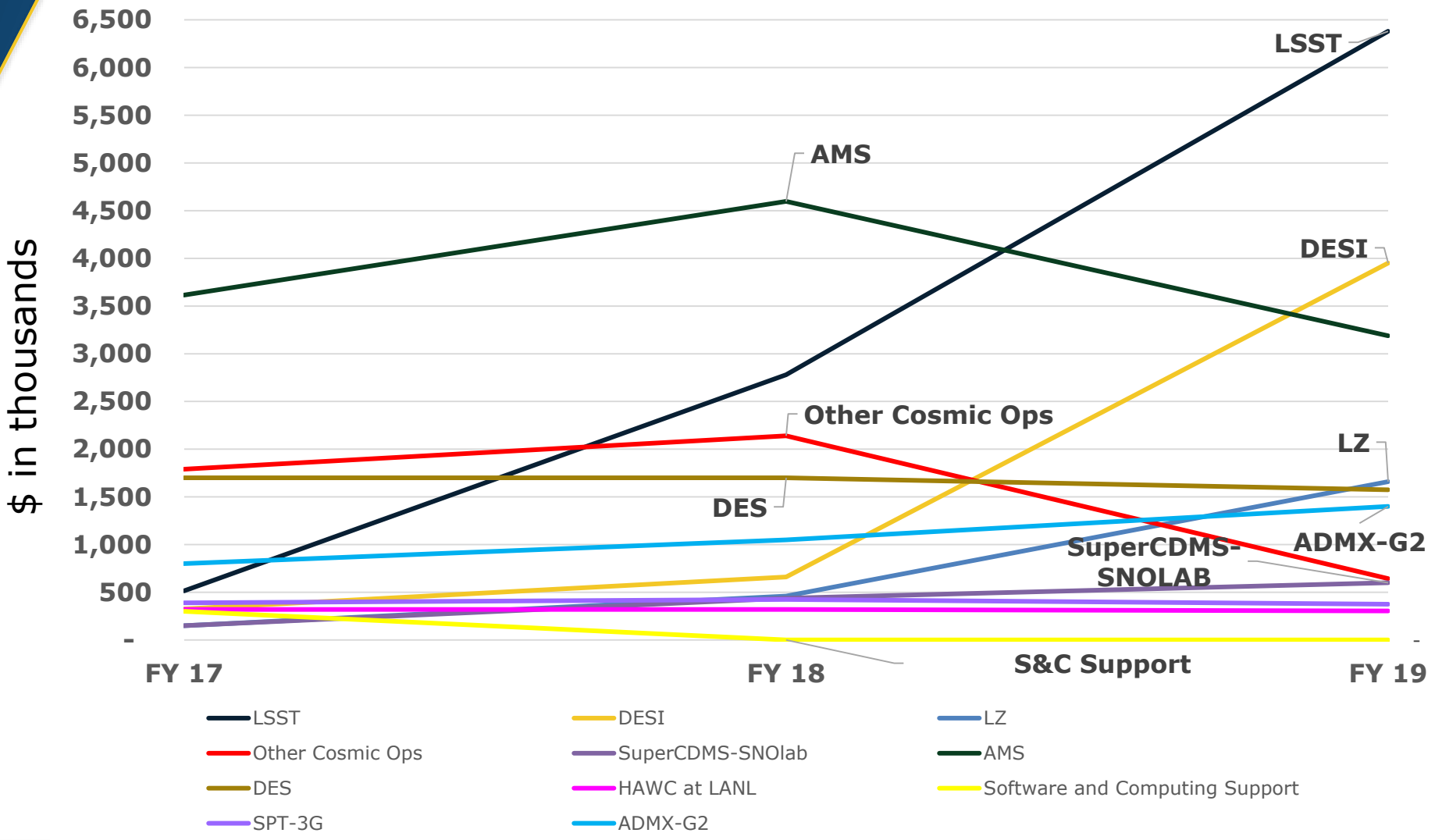
	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted
Research	214,217	213,454	228,203
Facilities/Operations	250,611	260,761	255,342
Projects	222,261	278,335	338,350
Total	687,089	752,550	821,895

Facilities/Operations funding for FY 2017-2019

Within Fermilab Accelerator Complex, we have detailed planning for the Accelerator & Technical Divisions, GPPs, AIPs, Detector & Computing by experimental thrust, etc.



Cosmic Frontier Facilities/Operations funding for FY 2017-2019



FY 2019 Funding by Subprogram

HEP Funding Category ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
Energy Frontier	154,274	183,219	238,920	+55,701
Intensity Frontier	242,924	247,048	240,980	-6,068
Cosmic Frontier	135,988	119,630	101,036	-18,594
Theoretical, Computational, and Interdisciplinary Physics	60,251	76,176	89,834	+13,658
Advanced Technology R&D	124,447	125,643	113,506	-12,137
Accelerator Stewardship	13,616	15,885	15,724	-11
Construction (Line Item)	93,500	140,400	180,000	+39,600
Total	**825,000**	**908,000**	**980,000**	**+72,000**

- Energy: +54M HL-LHC Projects
- Intensity: -8.1M PIP-II OPC
- Cosmic: -25M LSSTcam, DESI, SuperCDMS-SNOLAB projects; Operations ramps up
- Theory, Computational, and Interdisciplinary: +9.5M QIS
- Advanced Technology: -9M Accelerator Improvement Projects at LBNL and SLAC

Line-Item Construction FY 2019 Program

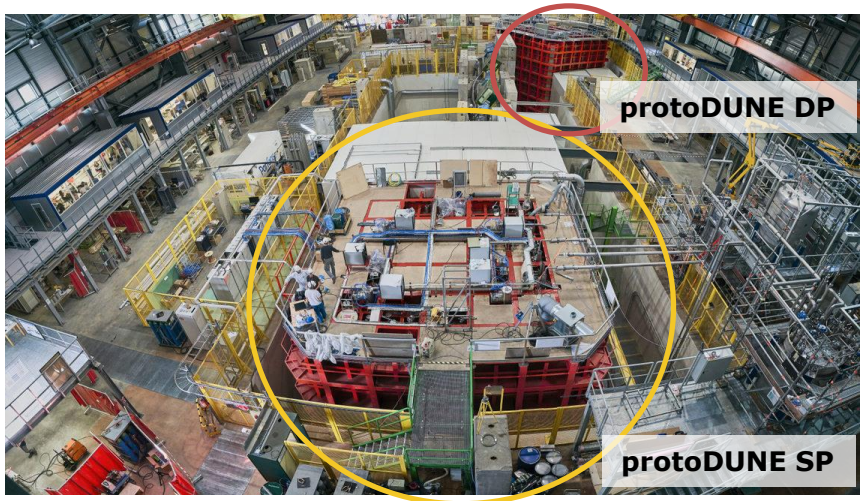
Construction (Line Item) ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
LBNF/DUNE	50,000	95,000	130,000	+35,000
Mu2e	43,500	44,400	30,000	-14,400
PIP-II	-	1,000	20,000	+19,000
Total	**93,500**	**140,400**	**180,000**	**+39,600**

- **LBNF/DUNE:** Far Site civil construction for the excavation of the underground equipment caverns and connecting drifts (tunnels). In addition, the project will continue to do design work for the Near Site, cryogenic systems, and the DUNE detectors.
- **Mu2e:** Completion of the procurements and the beginning of equipment installation. FY 2019 will be last year of funding for the project
- **PIP II**: Project engineering and design funding ramps up.

2019: Far Site Primary Excavation Begins

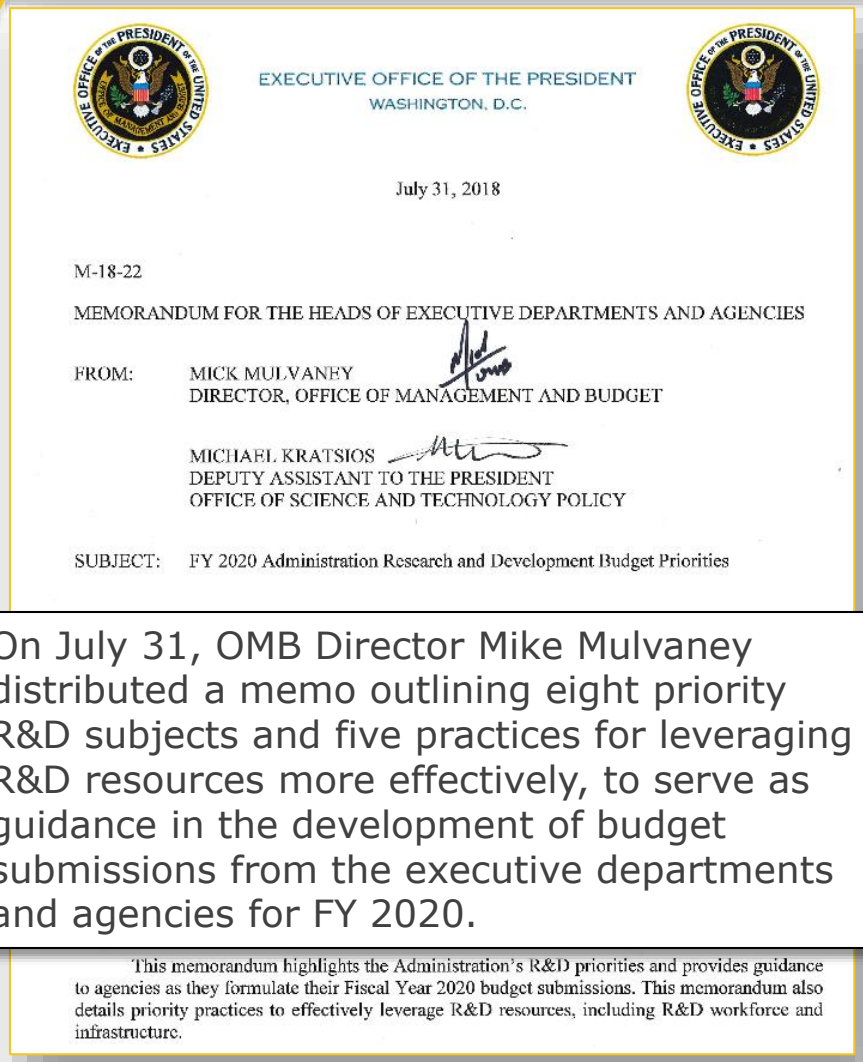
2022: First Module Installation Begins

2026: Neutrino Beam + 2 Far Detectors




OPPORTUNITY
AHEAD

White House FY 2020 R&D Priorities



EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C.

July 31, 2018

M-18-22

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: MICK MULVANEY
DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

MICHAEL KRATSIOS
DEPUTY ASSISTANT TO THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

SUBJECT: FY 2020 Administration Research and Development Budget Priorities

This memorandum highlights the Administration's R&D priorities and provides guidance to agencies as they formulate their Fiscal Year 2020 budget submissions. This memorandum also details priority practices to effectively leverage R&D resources, including R&D workforce and infrastructure.

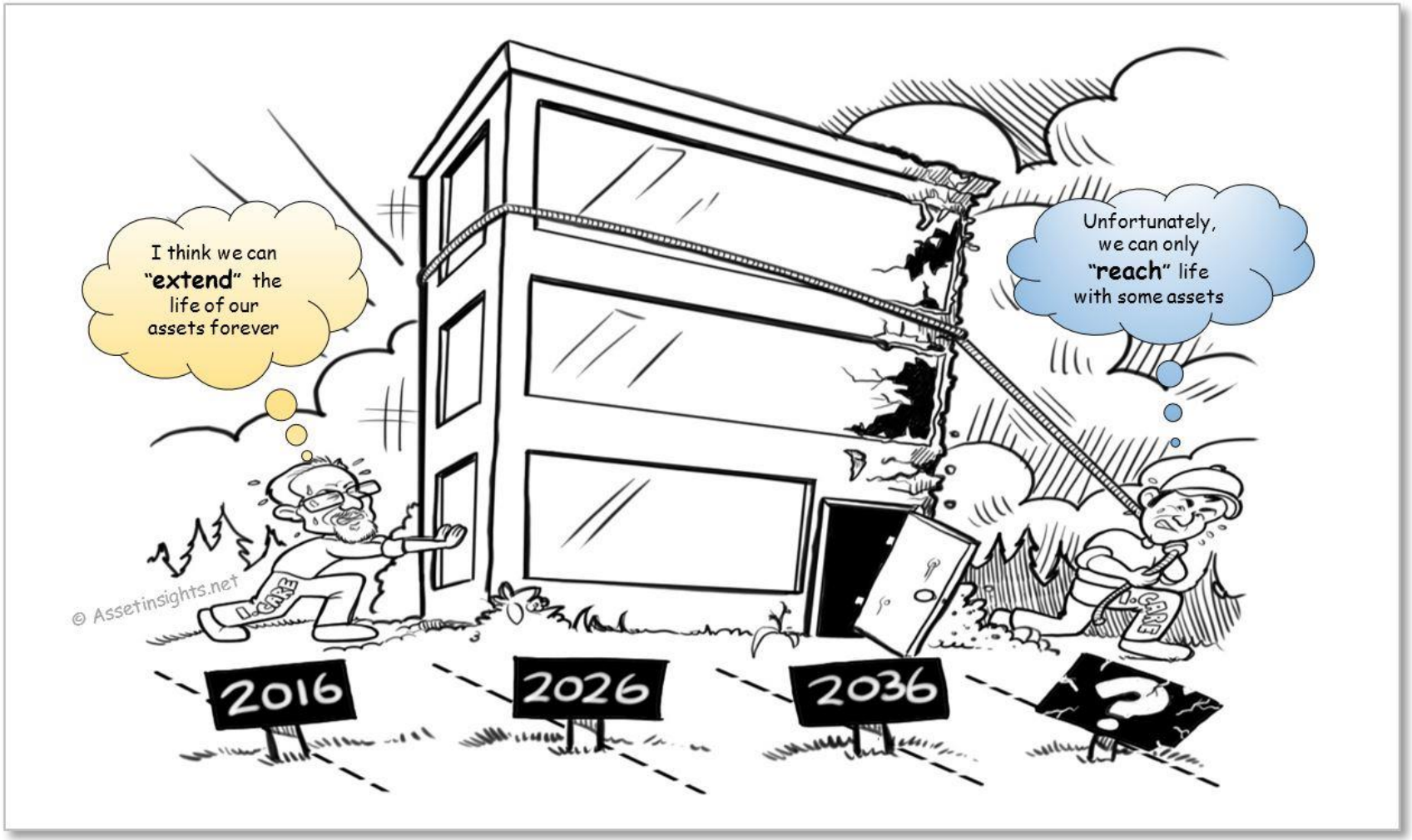
On July 31, OMB Director Mike Mulvaney distributed a memo outlining eight priority R&D subjects and five practices for leveraging R&D resources more effectively, to serve as guidance in the development of budget submissions from the executive departments and agencies for FY 2020.

- **Priority R&D Areas**
  - "Security for the American people" — emphasizing military superiority, cyber security, border surveillance and weather prediction;
  - **Artificial intelligence, quantum information sciences and strategic computing;**
  - Communications connectivity and autonomy of driving and unmanned vehicles;
  - **Next generation manufacturing, including digital manufacturing, robotics, industrial Internet of Things, machine learning and AI;**
  - Space exploration, including research into long-duration spaceflight, in-space manufacturing, cryogenic fuel storage, space-related power and propulsion;
  - "American Energy Dominance";
  - Medical innovation — personalized medicine, disease prevention, health promotion and translation, veteran health care and aging populations; and,
  - Agriculture, including precision agriculture, aquatic technologies and input minimization and yield maximization.
- **Priority R&D Practices:**
  - **Support educating & training workforce in STEM fields**
  - **Managing and modernizing the R&D infrastructure**
  - Improve interagency coordination and cross-disciplinary collaboration
  - Increase technology transfer
  - **Facilitate industry-academia partnerships.**

HEP Overlap with White House FY 2020 R&D Priority Areas and Practices

- **American Leadership in Artificial Intelligence, Quantum Information Sciences, and Strategic Computing**
  - Agencies should invest in fundamental and applied AI research, including machine learning, autonomous systems, and applications at the human-technology frontier.
  - **Agencies should prioritize QIS R&D**, which will build the technical and scientific base necessary to explore the next generation of QIS theory, devices, and applications.
  - Agencies should prioritize investment in research and infrastructure to maintain U.S. leadership in strategic computing…
- **American Manufacturing**
  - In order for the United States **to maintain leadership in semiconductor design and fabrication**, including assured access to advanced microelectronics, agencies should work in collaboration, and, when appropriate, in partnership, with industry to develop new design tools, materials, devices, interconnect solutions, and **architectures needed for future computing and storage paradigms**.
- **Educating and Training a Workforce for the 21st Century Economy**
  - Agencies should prioritize initiatives that reskill Americans for the jobs of today and the future. **Education in science, technology, engineering, and mathematics (STEM), including computer science…**
  - Agencies should work to ensure the STEM workforce includes all Americans, including those from urban and rural areas as well as underrepresented groups.
- **Managing & Modernizing R&D Infrastructure**
  - Agencies should prioritize infrastructure investments that enable shared resources and improve capabilities across a range of disciplines.
  - Long-term stewardship of scientific infrastructure also **necessitates that agencies decommission or divest out-of-date or obsolete facilities** quickly and efficiently.
- **Partnering with Industry and Academia**
  - **Innovative partnership models involving other agencies, state and local governments, the private sector, academia, and international parties can help maximize utilization of Federal facilities and lead to sharing the costs of new R&D facilities.**
  - Agencies should seek to rapidly field innovative technologies from the private sector, where possible, that are easily adaptable to Federal needs, rather than reinventing solutions in parallel.

Modernization



Kautz Road Substation Radial Feed (HEP-GPP)

Kautz Road Substation (KRSS) Radial Feed provides a portion of the electrical services to the Main Ring area. The other portion of the electrical work is the Main Substation (MSS) Radial Feed that it is proposed in a future year.

The combination of KRSS and MSS provide redundancy therefore increased reliability of current and future accelerator operations and is considered part of the general purpose infrastructure supporting laboratory operations

Purpose:
To replace/upgrade existing electrical feeders that serve the Main Ring area of the site to improve reliability, increase the capacity of the site wide electrical system and bring the service up to modern standards.

Scope:
New below grade electrical duct bank that meets current design and access standards, new medium voltage electrical circuit breakers, medium voltage electrical switches and related work.

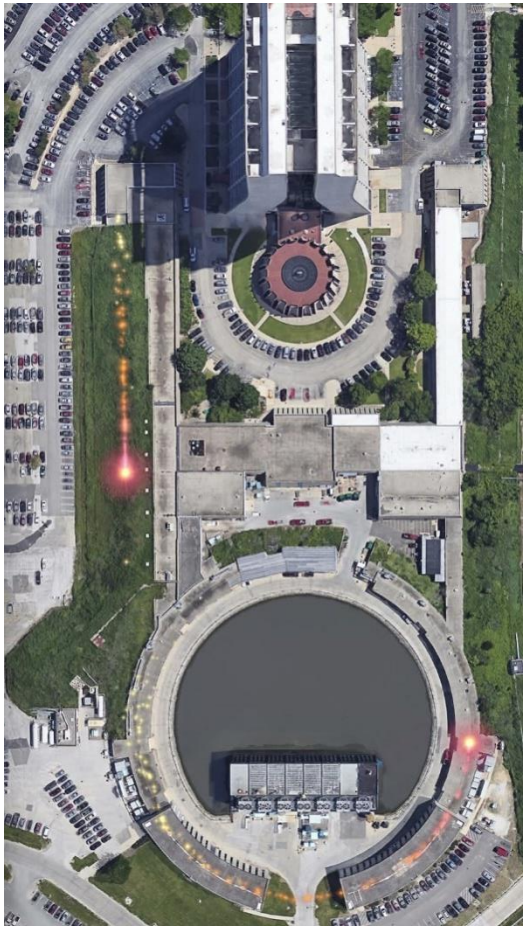
Additional Priority Items (HEP- or SLI-GPP)

Domestic Water Upgrades
Project Cost Estimate – $2M

The aging underground domestic water infrastructure requires replacement to ensure reliable and safe potable water supply. This project estimated at $2M starts the next increment on replacement.

Sanitary Sewer Upgrades
Project Cost Estimate – $3.5M

This project eliminates storm water infiltration into the existing legacy sanitary system in the Fermilab Village area and the effluent sent to the City of Warrenville. The project will repair broken pipe and redirect storm water migration away from the sanitary sewer system in the Fermilab Village area reducing the volume of wastewater sent to the City of Warrenville and reduce the cost of the Fermilab sanitary service.



Core Campus Parking - West
Project Cost Estimate – $2M

The parking complex supporting the Fermilab core campus west area is aging and presents hazards from storm water inundation and lack of separation of multimodal transportation elements (pedestrians, bicycles, vehicles). Leveraging operating funds, Fermilab will reconstruct the parking facilities for its core campus which will mitigate storm water hazards, create safe travel patterns for multimodal transportation, and realign existing parking patterns to maximize capacity.

Wilson Hall Modernization
Project Cost Estimate – $6M

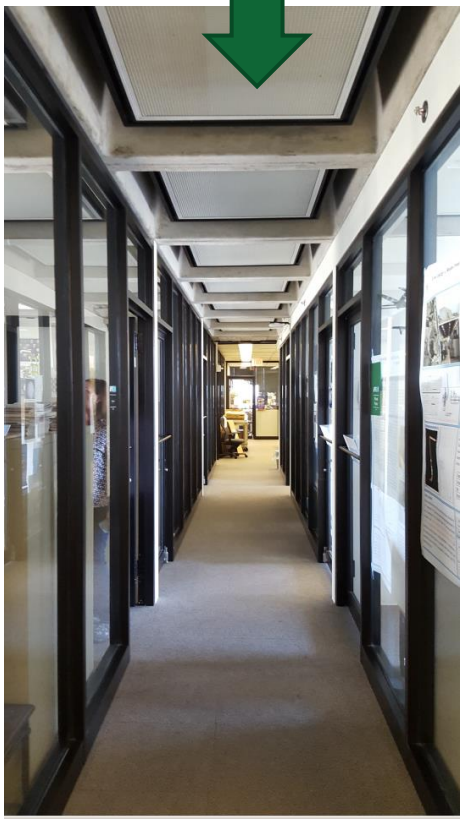
This project continues the modernization of Wilson Hall floor by floor at $6M per floor to eliminate deferred maintenance on the plumbing system and increase the density of each floor through a more open office environment and modular systems furniture.
WH 14 is the next candidate (electronics)

See WH13 modernization…next slide!

Wilson Hall 13th Floor Modernization

Before and After

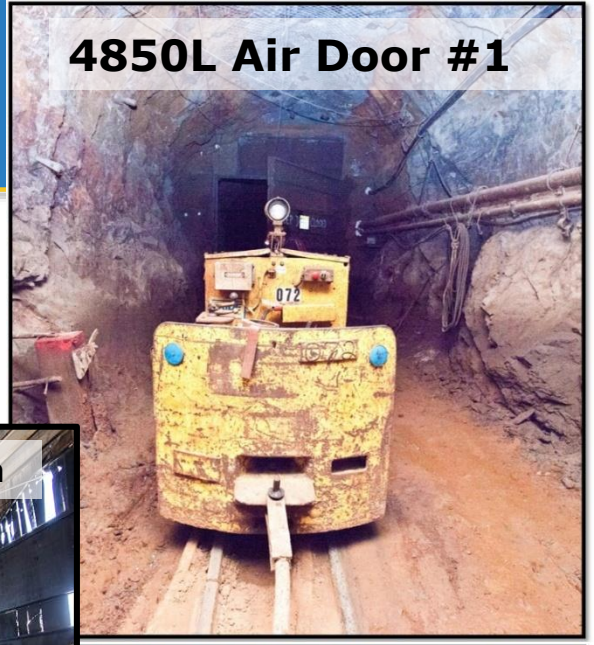
August 2016

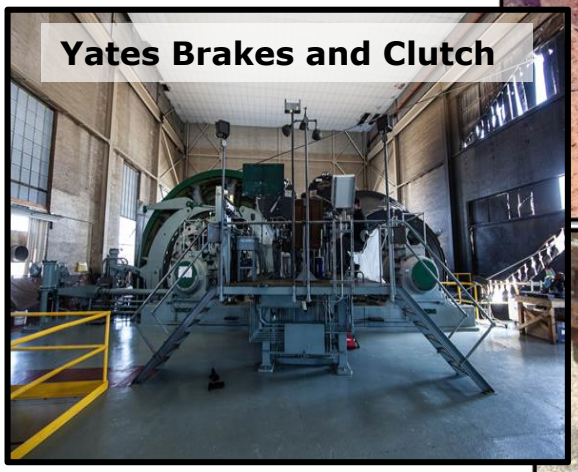


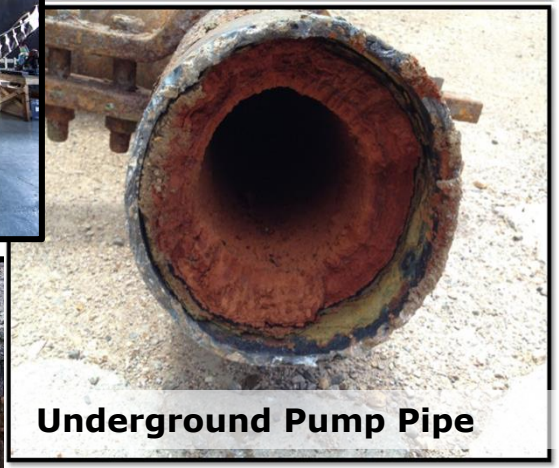
May 2018

SURF Infrastructure

- **Fire Safety Controls; Refuge Chambers and Air Doors**
  - Replace deteriorated air door in the 4850L West Access Drift to provide critical control of air flow through the drifts. Current air door is a safety hazard for personnel passage and limits ventilation control.
- **Yates Cage Hoist Brakes and Clutch**
  - The existing cage brake and clutch system is 1930's technology. Project will replace the existing gravity set, low pressure, high volume braking system with PLC controls and install a new positive engagement clutch
- **1250L and 3650L Pump room System Rehabilitation**
  - Existing dewatering system is antiquated and parts availability for pumps is a challenge. Replace pump and piping, and stabilize ground conditions.
- **Water Inflow Monitoring System**
  - No monitoring system presently exists for upper level inflows. Flow monitoring systems will be installed primarily on the 1100L and 1850L to allow for the facility to accurately track inflows during heavy rain/inflow events.



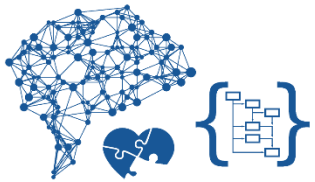


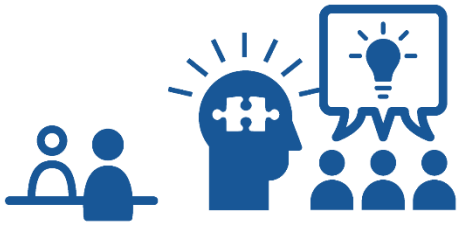


Workforce in the 21st Century

Top 10 skills

in 2020	in 2015
1. Complex Problem Solving	1. Complex Problem Solving
2. Critical Thinking	2. Coordinating with Others
3. Creativity	3. People Management
4. People Management	4. Critical Thinking
5. Coordinating with Others	5. Negotiation
6. Emotional Intelligence	6. Quality Control
7. Judgment and Decision Making	7. Service Orientation
8. Service Orientation	8. Judgment and Decision Making
9. Negotiation	9. Active Listening
10. Cognitive Flexibility	10. Creativity

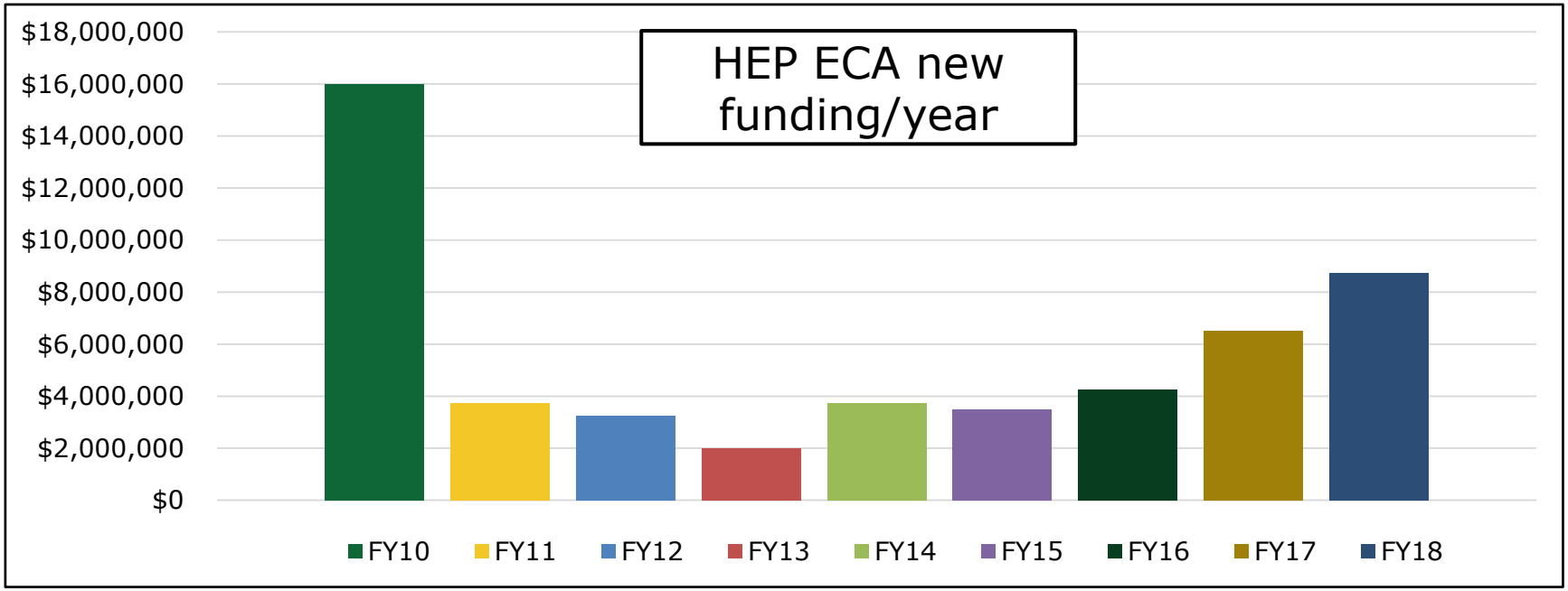




Source: Future of Jobs Report, World Economic Forum

Increasing Investments to Early Career Research Program

- Launched in FY 2010 with ARRA funding
- Established Program to Stimulate Competitive Research (EPSCoR) supported 1 Theory ECA in FY 2011 and 1 Intensity ECA in FY 2013
- Funding nadir was FY 2013, the first year impacted by sequestration
- Full-funding requirement took affect in FY 2014 (awards < $1M)
- 92 total awards to date: 57 University and 35 National Labs



HEP Early Career FY10-18 Lab vs. Univ Awards

L = National Laboratory Proposal
U = University Proposal

Subprogram Awards	FY10 (L/U)	FY11 (L/U)	FY12 (L/U)	FY13 (L/U)	FY14 (L/U)	FY15 (L/U)	FY16 (L/U)	FY1 (L/	FY18 (L/U)	Total (L/U)
Energy	3 (1/2)	3 (1/2)	1 (0/1)	2 (0/2)	2 (1/1)	0 (0/0)	2 (0/2)	2 (1	3 (2/1)	18 (6/12)
Intensity	2 (1/1)	1 (0/1)	3 (2/1)	1 (0/1*)	1 (1/0)	2 (1/1)	1 (1/0)	2 (2	2 (2/0)	15 (10/5)
Cosmic	2 (0/2)	3 (2/1)	3 (1/2)	2 (1/1)	1 (0/1)	0 (0/0)	1 (0/1)	2 (1	2 (0/2)	16 (5/11)
HEP Theory	6 (1/5)	4 (0/4*)	3 (0/3)	3 (1/2)	1 (0/1)	3 (0/3)	1 (1/0)	2 (0	3 (0/3)	26 (3/23)
Detector	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	1 (1	2 (2/0)	3 (3/0)
Accelerator	1 (1/0)	2 (2/0)	2 (1/1)	1 (0/1)	1 (1/0)	0 (0/0)	2 (2/0)	2 (2	1 (0/1)	12 (9/3)
QIS	NA	NA	NA	NA	NA	NA	NA	NA	1 (1/0)	1 (1/0)
HEP Awards	14 (4/10)	13 (5/8)	12 (4/8)	9 (2/7)	6 (3/3)	5 (1/4)	7 (4/3)	11 (7/	14 (7/7)	91 (37/54)
Proposals	154 (47/107)	128 (43/85)	89 (34/55)	78 (29/49)	77 (36/41)	73 (27/46)	84 (27/47)	83 (26/	**92 (35/57)**	**858 (304/554)**

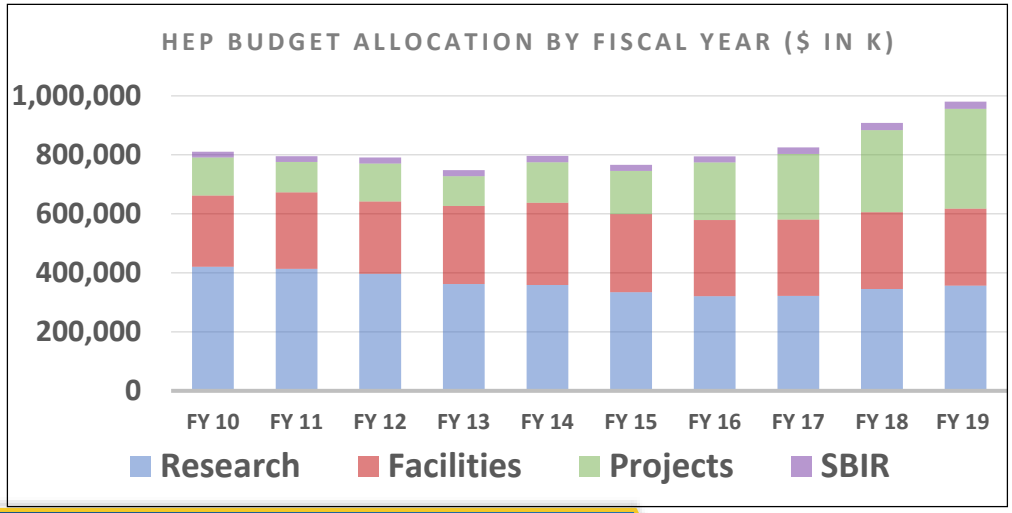
*** Two awards funded by DOE Office of Basic Energy Sciences (BES) as an EPSCoR [Experimental Program to Stimulate Competitive Research] award with grant monitored by DOE Office of High Energy Physics (HEP).**

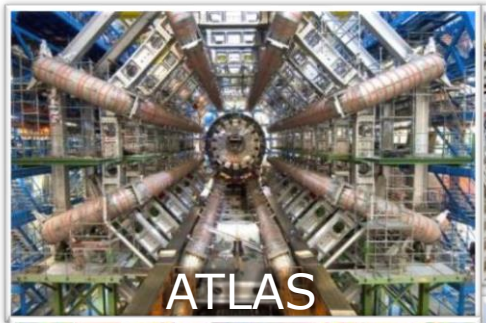
Where Have All the Ph.Ds. Gone?

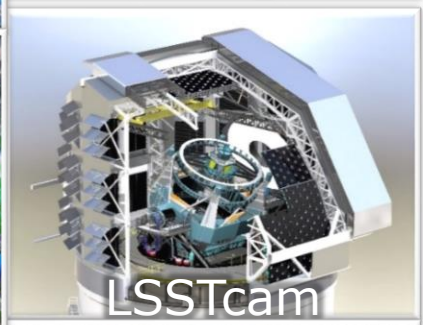
- Initiative to identify all Ph.Ds. supported by HEP
  - Goal: **Quantify and qualify workforce post-Ph.D. to now.**
- Began with queries from INSPIRE, Fermilab, and CERN databases
  - Major thanks to Heath O'Connell at Fermilab!
  - Rolling out to Labs and Universities requests to review data; update and add information
    - **Responses have been very positive!**
- Information available:
  - Author; Degree type; Year; Institution; Thesis Title; Research Program; Advisor(s); Key Words
  - Support (all that apply): HEP Grant, DOE Lab (specify), SC User Facility (specify), Other (specify); Post-Ph.D. Position; Current (or Final) Position; Status: Active, Retired, Deceased;
  - Awards and Distinctions*
- Current Dataset >10,500 Ph.Ds.
  - M. Stanley Livingston Ph.D. 1931 (Advisor: Ernest Lawrence) *Co-inventor of cyclotron.*
  - Maya Wospakrik (Advisor: Heather Ray) *First female Indonesia student to graduate with a Physics Ph.D from U Florida. She also became the first Indonesia postdoc hired by Fermilab.*
- Near-term focus will be on the 1980-Present.
- Preliminary discussions with ORISE about maintaining this database.
- If sufficient interest, data can be presented at the next HEPAP.
  - Community assistance will be appreciated.

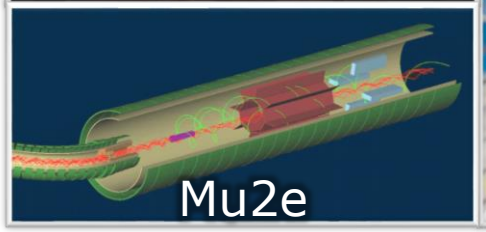
Delivery of Early Science from New Projects

- By FY 2020, **eight** projects recommended by P5 will have received final funding
  - Muon g-2, CMS Upgrade, ATLAS Upgrade, LSSTcam, Mu2e, LZ, SuperCDMS-SNOLAB, DESI
  - **DOE Total Project Costs ~ 650M (FY 2010-2019)**
  - Research has been reduced/constrained for a decade while building next generation of instruments for HEP
- Recognize urgency to increase support to Research to **ensure efficient, reliable, and high quality physics data taking**, and to augment efforts towards early & visible science.
  - Boost the number of graduate students & post-docs









New R&D Initiatives for FY 2021+

- FY 2020 Budget Cycle is too advanced to insert a new initiative
- Going forward, promote new initiatives (15M+) that:
  - Addresses the priorities of the Administration, DOE and Office of Science
  - Builds R&D by a distinct thrusts, not general "Increase Research" to obtain support
  - Does NOT only serve the needs of the HEP community
- Model would be to host a Basic Research Needs (BRN) Workshop and use the resulting report to justify an Over Target Request for funding.
  - Invest in R&D, Theory, Computing, Advanced Technology, Cross-cutting (SC, Federal Agencies, Private Sector)
  - Recent BRNs: Dark Matter (HEP) and Microelectronics (BES)
- Your input on FY 2021 will be crucial. We also need a continuous pipeline of new initiatives for FY2022 and beyond, understanding these investments will typically take 3-5 years for initial outcomes

Closing Remarks

- The annual Federal budget process is long and complex
  - Excursions from "standard order" are possible
  - The community-driven P5 strategy plays an important role in all phases of the process
- Broad support is enabling us to implement the P5 strategic plan and achieve its vision!
  - Many thanks to the DOE Management, the Administration, and Congress for their support
  - SC programs in QIS, Computing, and SLI provide additional support to enable P5 goals
- The particle physics community continues to perform well on delivering projects, a foundation of the long-term strategy
- **Community continues to be unified in support of P5 strategy**
  - Communications are effectively supporting the community's goals
  - A long-term view is necessary to provide feedback in a context that is most helpful

Your Moment of Zen

U.S. DEPARTMENT OF
ENERGY

Office of
Science

Energy Frontier FY 2019 Program

Energy Frontier ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
Research	72,268	71,400	76,530	+5,130
Facilities/Operations	52,771	54,808	52,000	-2,808
Projects	24,017	51,000	105,000	+54,000
LHC ATLAS Upgrade	*8,500*	*-*	*-*	*---*
LHC CMS Upgrade	*7,967*	*-*	*-*	*---*
HL-LHC Accelerator Upgrade	*500*	*27,000*	*50,000*	*+23,000*
HL-LHC ATLAS Upgrade	*4,300*	*12,000*	*27,500*	*+15,500*
HL-LHC CMS Upgrade	*2,750*	*12,000*	*27,500*	*+15,500*
SBIR/STTR	5,218	6,001	5,390	-611
Total	**154,274**	**183,219**	**238,920**	**+55,701**

- **Research:** U.S. leadership roles in all aspects of the ATLAS and CMS experiments.
- **Operations:** ATLAS and CMS detector maintenance activities, including those related to commissioning of U.S.-built detector components during the two-year long technical stop of the LHC, which will start in 2019.
- **Projects:** The procurement of solid-state detecting components for the HL-LHC ATLAS and HL-LHC CMS Detector Upgrade Projects (new MIE starts), and the production of focusing magnets for the HL-LHC Accelerator Upgrade Project.

Intensity Frontier FY 2019 Program

Intensity Frontier ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
Research	56,317	62,085	61,646	-439
Facilities/Operations	154,301	152,449	155,035	+2,586
Projects	24,569	24,100	16,000	-8,100
LBNF/DUNE OPC	*-*	*1,000*	*1,000*	*---*
PIP-II OPC	*15,220*	*23,100*	*15,000*	*-8,100*
Muon g-2	*6,349*	*-*	*-*	*---*
SBIR/STTR	7,737	8,414	8,299	-115
Total	**242,924**	**247,048**	**240,980**	**-6,068**

- **Research:** U.S. leadership on all aspects of the neutrino and muon experiments including NOvA, ICARUS and Muon g-2, and the future projects including LBNF/DUNE and Mu2e. The first physics data results from Belle II will be anticipated.
- **Operations:** Operation of the Fermilab Accelerator Complex and the neutrino and muon experiments, while the running time of the Main Injector and Booster accelerators will be shortened to 75% of optimal. SURF operations will continue to support the LBNF/DUNE construction and the commissioning of the LZ experiment. Fermilab NuMI Target System and Booster Intensity AIPs will begin.
- **Projects:** OPC for the preliminary design and prototyping of the most technologically advanced accelerator components for the PIP-II project, and the OPC for plant support costs at SURF during LBNF/DUNE construction.

Cosmic Frontier FY 2019 Program

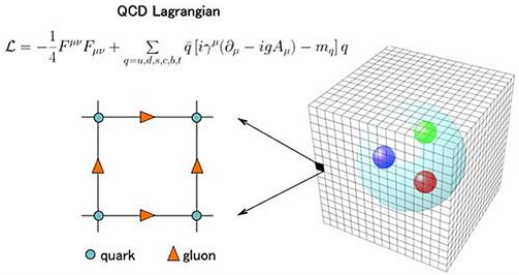
Cosmic Frontier ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
Research	45,990	47,008	50,741	+3,733
Facilities/Operations	13,353	17,300	20,076	+2,776
Projects	74,375	52,835	27,350	-25,485
LSSTcam	*45,000*	*9,800*	*-*	*-9,800*
DESI	*12,800*	*20,000*	*9,350*	*-10,650*
LZ	*12,500*	*14,100*	*14,450*	*+350*
SuperCDMS	*3,400*	*7,400*	*2,550*	*-4,850*
SBIR/STTR	2,270	2,487	2,869	+382
Total	**135,988**	**119,630**	**101,036**	**-18,594**

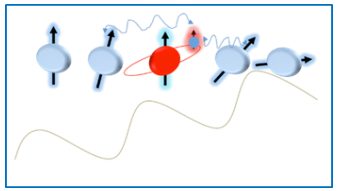
- **Research:** World-leading research efforts in support of design and optimization on dark matter and dark energy experiments in their fabrication and commissioning phases, as well as on planning for future experiments, including CMB-S4.
- **Operations:** Start of installation and commissioning activities for the LSSTcam, as well as early planning for LSST facility and science operations. Planning, commissioning, and pre-operations activities will begin for DESI, LZ, and SuperCDMS-SNOLAB. Support for the currently operating experiments will continue.
- **Projects:** Completion of fabrication and installation of the LZ dark matter project, and will support the fabrication of the DESI dark energy project and the SuperCDMS-SNOLAB dark matter project.

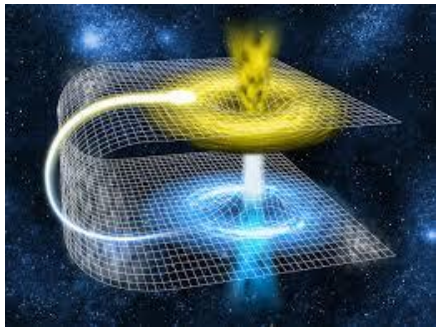
Theoretical, Computational, and Interdisciplinary Physics FY 2019 Program

Theoretical, Computational, and Interdisciplinary Physics ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
Research	55,713	73,164	86,611	+13,447
Theoretical Physics	*44,848*	*46,664*	*45,760*	*-904*
Computational HEP	*7,924*	*8,500*	*13,351*	*+4,851*
Quantum Information Science	*-*	*18,000*	*27,500*	*+9,500*
Projects (Lattice QCD)	2,300	-	-	---
SBIR/STTR	2,238	3,012	3,223	+211
Total	**60,251**	**76,176**	**89,834**	**+13,658**

- **Theory:** World-leading theoretical research program at universities and national labs.
- **Computational Physics:** Transformative computational science and SciDAC 4 activities.
  Quantum Information Systems: New foundational QIS research and supporting technology. HEP will employ the latest developments in QIS from the private sector, contribute to the national effort, and promote American competiveness.







Advanced Technology R&D FY 2019 Program

Advanced Technology R&D ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
Research	83,334	71,300	72,141	+841
GARD	*44,357*	*48,330*	*48,447*	*+117*
LARP	*21,800*	*5,000*	*-*	*-5,000*
MAP	*1,000*	*-*	*-*	*-*
Detector R&D	*16,177*	*17,970*	*23,694*	*+5,724*
Facilities/Operations	33,403	40,415	27,625	-12,790
Projects *(FACET-II)*	3,500	10,000	10,000	-
SBIR/STTR	4,210	3,928	3,740	-188
Total	**124,447**	**125,643**	**113,506**	**-12,137**

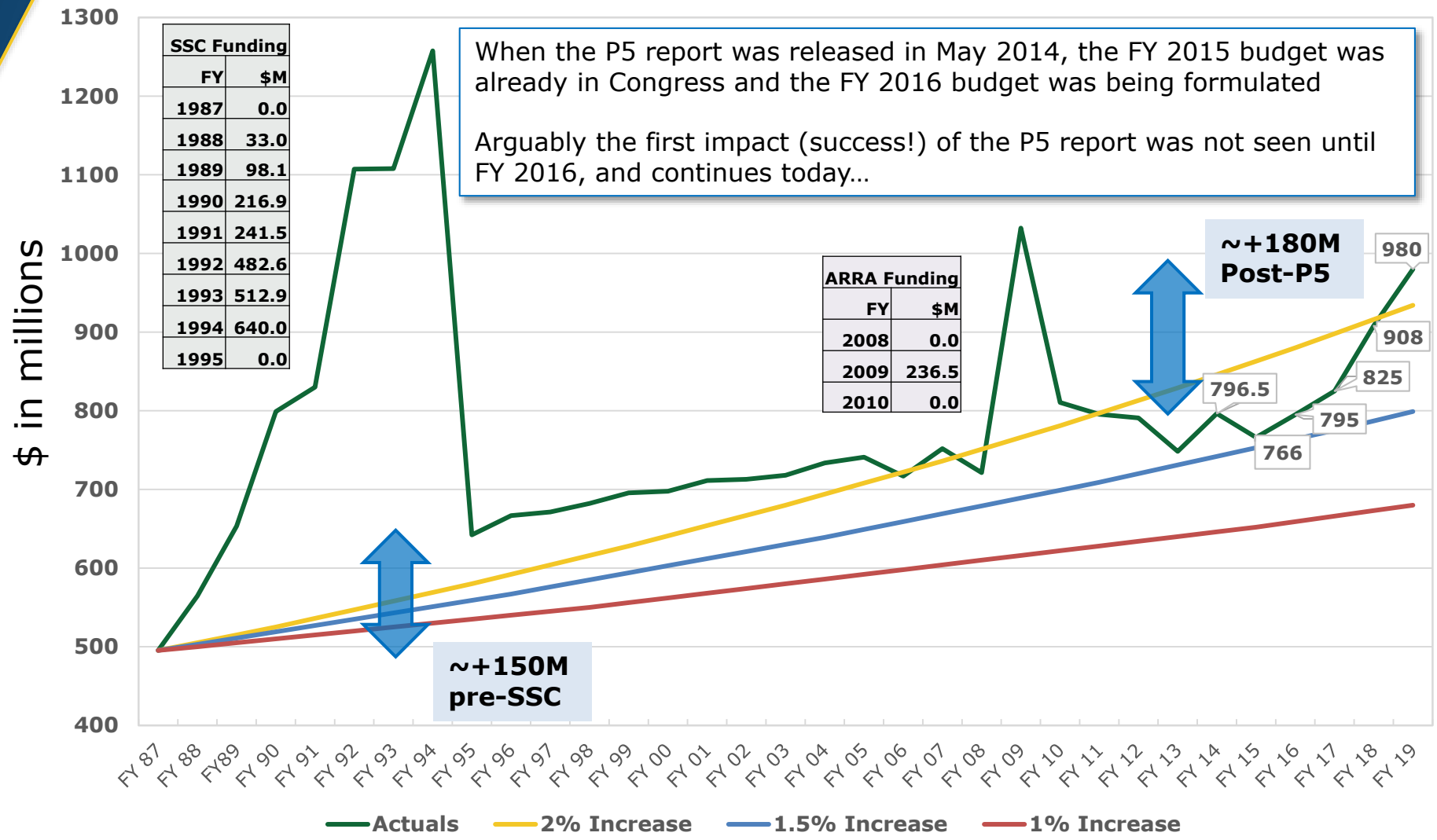
- **GARD:** World-leading research activities in the areas of accelerator and beam physics, advanced acceleration concepts, particle sources and targetry, radio-frequency acceleration technology and superconducting magnet and materials. The Traineeship Program for Accelerator Science and Technology will be supported.
- **Detector R&D:** Vigorous, cutting-edge Detector R&D activities at universities and national laboratories, targeted at the most promising, high-impact directions led by U.S. efforts.
- **Operations:** Operation of accelerator, test beam and detector facilities at Fermilab, LBNL and SLAC.
- **Projects:** Continued fabrication for FACET-II.

Accelerator Stewardship FY 2019 Program

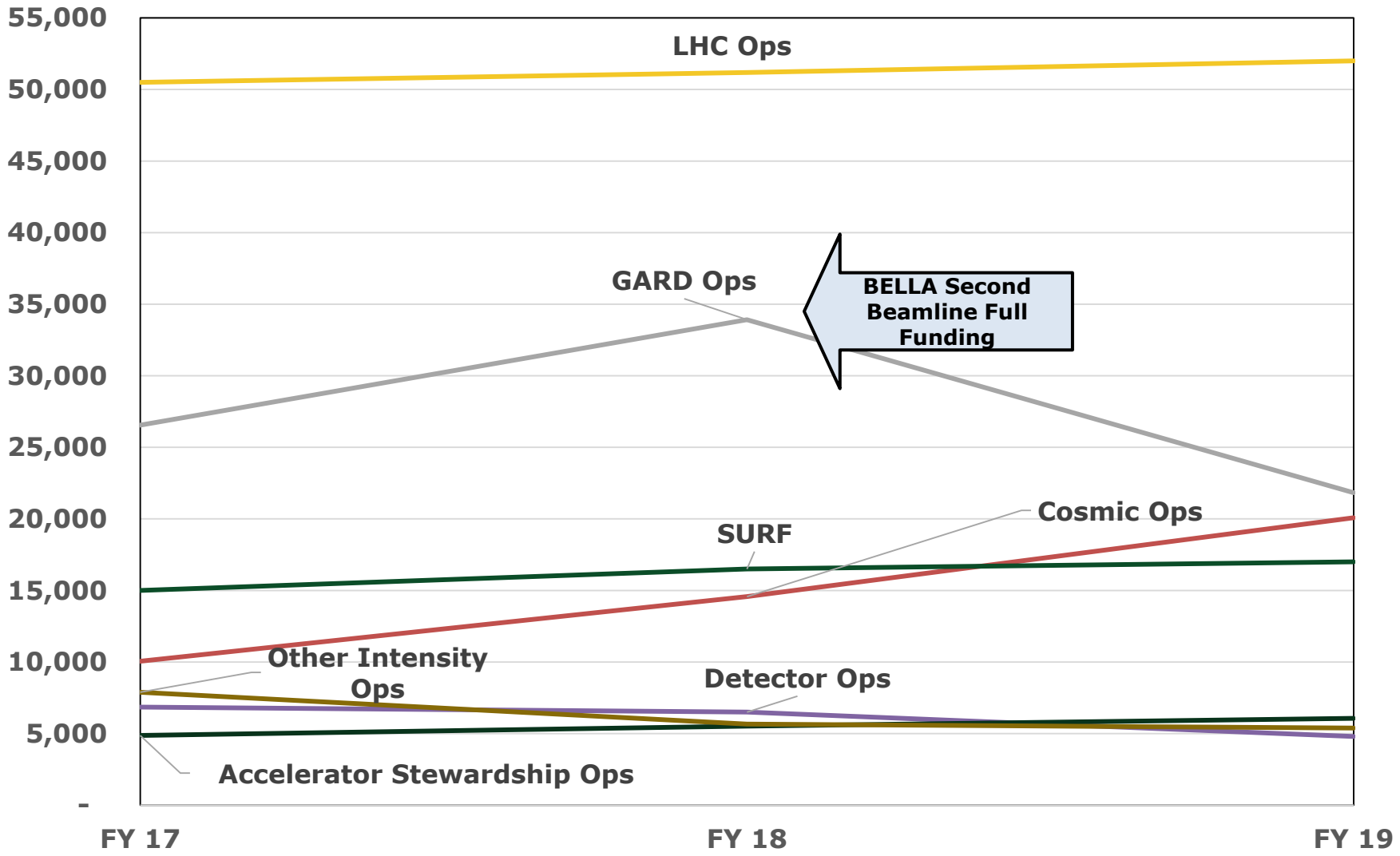
Accelerator Stewardship ($ in K)	FY 2017 Actual	FY 2018 Actual	FY 2019 Enacted	FY 19 vs. FY 18
Research	8,270	9,783	9,083	-700
Facilities/Operations	4,868	5,517	6,067	+550
SBIR/STTR	478	585	574	-11
Total	**13,616**	**15,885**	**15,724**	**-161**

- **Research:** New research activities at laboratories, universities, and in the private sector for technology R&D areas such as accelerator technology for industrial and security uses, laser, and ion-beam therapy.
- **Operations:** BNL Accelerator Test Facility. Extend operations at Building 820.

FY 2019 HEP Funding in Historical Context



Facilities/Operations (in $ Millions) for FY 2017-2019
(Excluding Fermilab Accelerator Complex)



Stewardship of DOE National Laboratories

- Together, the 17 DOE laboratories comprise a preeminent federal research system, providing the Nation with strategic scientific and technological capabilities. The laboratories:
  - **Execute long-term government scientific and technological missions**, often with complex security, safety, project management, or other operational challenges;
  - **Develop unique, often multidisciplinary, scientific capabilities** beyond the scope of academic and industrial institutions, to benefit the Nation's researchers and national strategic priorities; and
  - **Develop and sustain critical scientific and technical capabilities** to which the government requires assured access.

HEP Major Laboratory Investments

Argonne NATIONAL LABORATORY

- Cross-disciplinary R&D with material science and advanced computing, including instrumentation
- Dielectric accelerator R&D with the Argonne Wakefield Accelerator
- Computational Cosmology
- High performance computing applications in HEP, leveraging Argonne Leadership Computing Facility (ALCF)

BERKELEY LAB
Lawrence Berkeley National Laboratory

- Laser-driven plasma wakefield accelerator technology (BELLA)
- Silicon detectors for LHC, dark matter, and dark energy experiments
- Leveraging NERSC for high-throughput computing & large-scale simulations and Energy Sciences Network (ESnet) for big data transfer, including LHC
- Host Lab for LZ experiment and Dark Energy Spectroscopic Instrument (DESI)

BROOKHAVEN NATIONAL LABORATORY

- Brookhaven Accelerator Test Facility
- Detector R&D and readout development, leveraging Instrumentation Division
- Host Lab for U.S. ATLAS, hosting ATLAS Tier-1 computing center

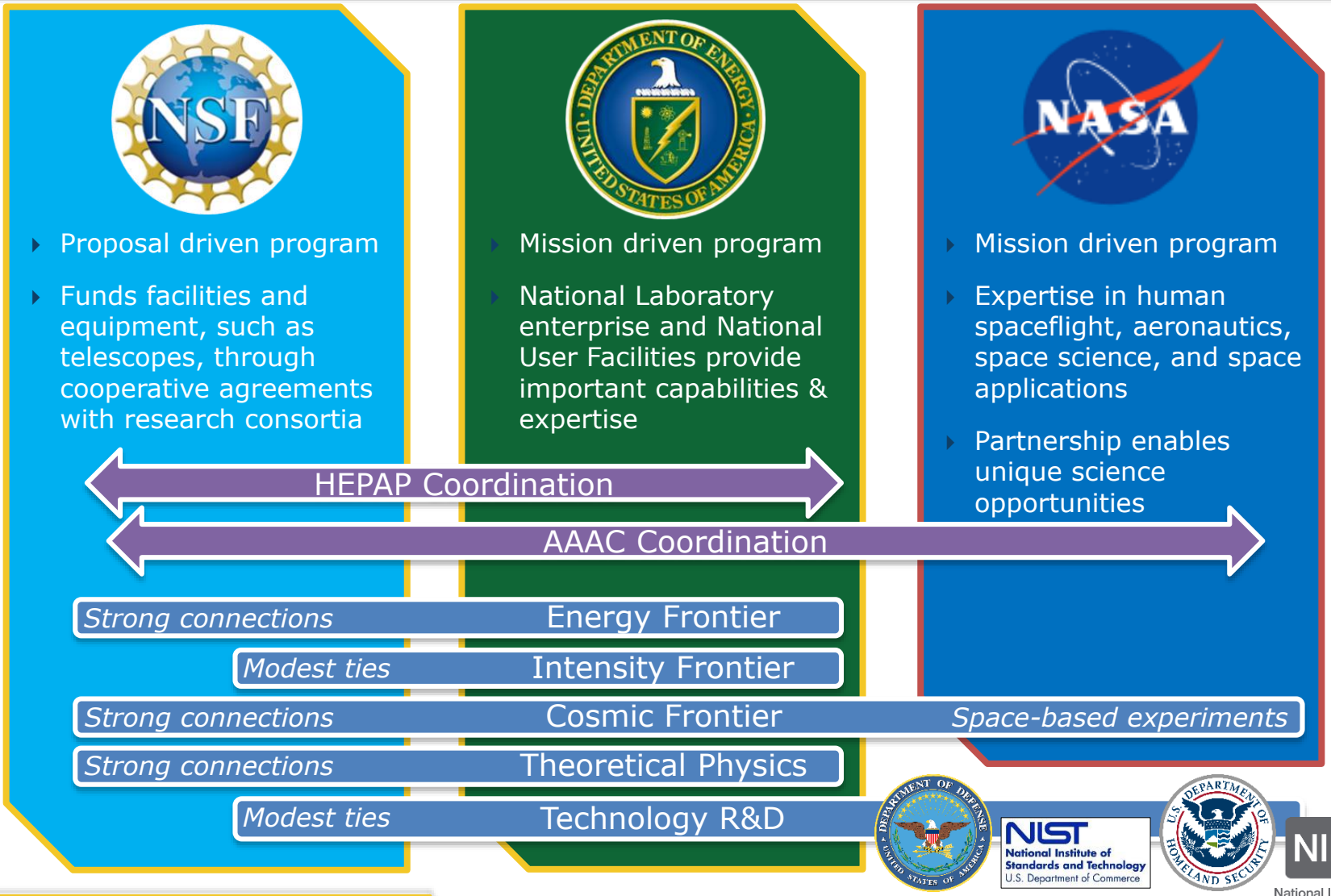
Fermilab

- Fermilab Accelerator Complex User Facility supports beam-driven neutrino science and precision science experiments
- Superconducting RF accelerator technology, high-intensity particle beams and high-power targets
- Extensive infrastructure for accelerator and detector R&D, including specialized facilities for design, fabrication and testing
- Host Lab for LBNF/DUNE and U.S. CMS, hosting CMS Tier-1 computing center

SLAC NATIONAL ACCELERATOR LABORATORY

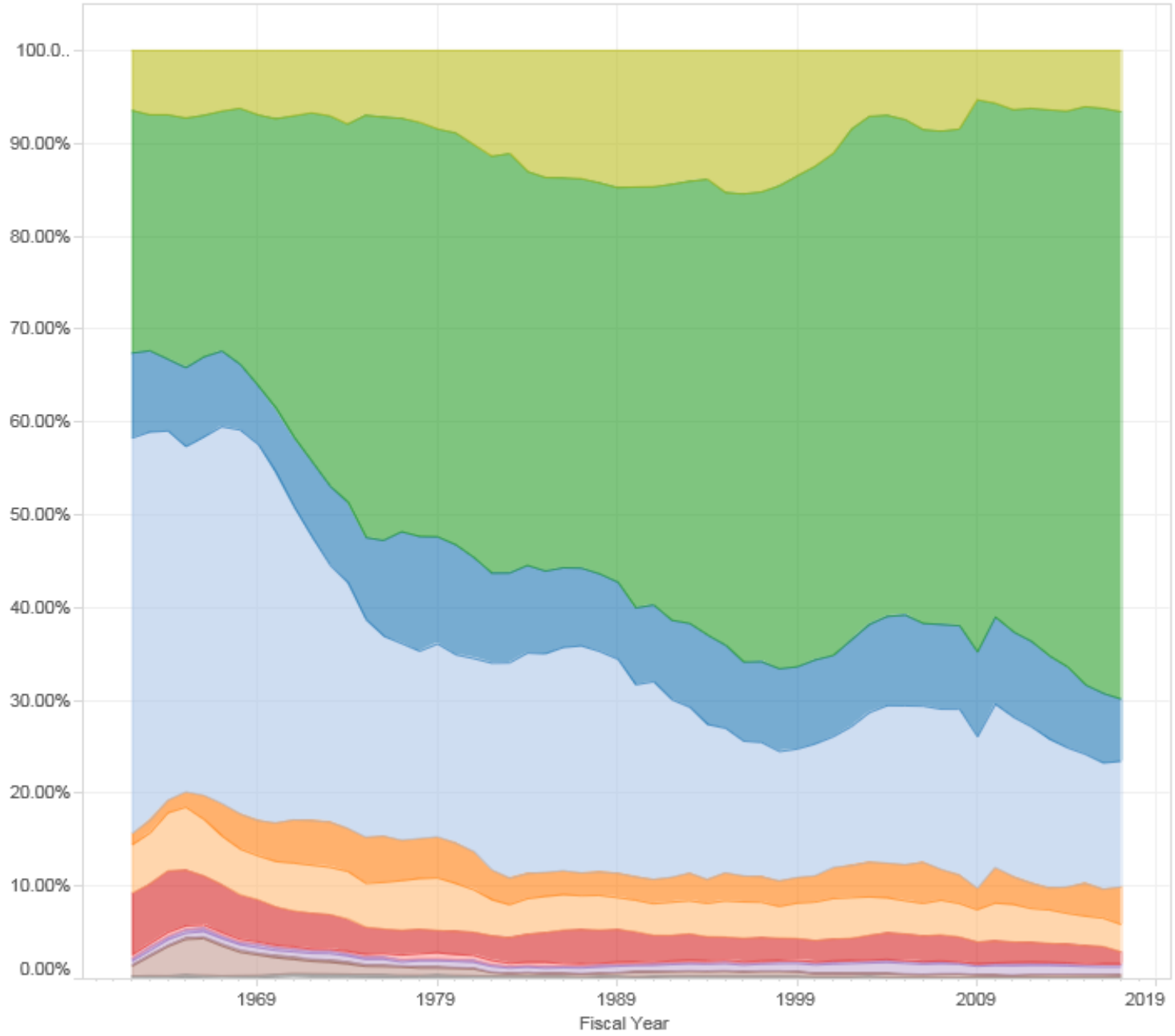
- Beam-driven plasma wakefield accelerator technology (FACET)
- Kavli Institute for Particle Astrophysics and Cosmology
- Host Lab for SuperCDMS-SNOLAB dark matter experiment and Large Synoptic Survey Telescope

DOE Particle Physics Agency Partnerships



Composition of the Federal Budget

(outlays)



Fiscal Years

1962 — 2017

Metric

Share of Federal Budget

Spending Categories

- Net Interest
- Mandatory Outlays
- All Other Outlays
- Defense Outlays (non-R&D)
- Education and Training
- Infrastructure (Nondefense)
- R&D: Defense Function
- R&D: Energy Function
- R&D: General Science
- R&D: Health Function
- R&D: Other Functions
- R&D: Space Function
- R&D: Ag and Environment
- R&D: Transportation

Spending Categories

(All)

"Mandatory outlays" are mostly composed of Medicare, Medicaid, and Social Security. "Defense Outlays (non-R&D)" include non-R&D activities of the Defense Department, the National Nuclear Security Administration, and other programs. Based on OMB historical data tables from the FY 2019 request. Last updated May 2018.