U.S. DEPARTMENT OF ENERGY | Office of Science

High Energy Physics Budget Planning and Execution

HEPAP Meeting

21 November 2019

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Hatch Act of 1939

- The Hatch Act, officially, **An Act to Prevent Pernicious Political Activities**, is a United States federal law, enacted by Congress in 1939. The main provision **prohibits employees in the executive branch of the federal government**, except the president, vice-president, and certain designated high-level officials, **from engaging in some forms of political activity.**
- **Sen. Carl Hatch, D-N.M., introduced the act** after learning that New Deal–era government programs, specifically the Works Progress Administration, were **using federal funds overtly to support Democratic Party candidates in the 1938 elections**.
- The law was an attempt to **regulate corruption and possible intimidation of federal employees in the civil service by their elected supervisors.** The act banned the use of federal funds for electoral purposes and forbade federal officials from coercing political support with the promise of public jobs or funds.

- Federal employees are still **forbidden to use their authority to affect the results of an election.**
- In general, executive branch federal employees may not:
  - **Use official authority or influence to interfere with an election**
  - Solicit or discourage political activity of anyone with business before their agency
  - **Engage in political activity while: on duty**, in a government office, wearing an official uniform, or using a government vehicle

Federal Support of Science and Engineering

Congress shall have Power… to promote the Progress of Science and useful Arts, by securing for limited Time to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.

- **The Founders understood the importance of science and technology in the long-term future of the United States.** Without science and engineering advancement, in the face of advancement by others, the US could not compete with ideological and economic challengers.
- **Scientific and technological advancement funded by the Federal Government has a strong constitutional foundation** in the Preamble's mandated promotion of the *"common Defence and general Welfare."* Specifically, **the Congress has enumerated powers in this regard in Article I, Section 8. Implementation of those powers logically requires federal involvement in science and engineering research**, as follows:
  - Clause 5 – fixing of *"the Standard of Weights and Measures."*
  - Clause 6 – detection and prevention *"of counterfeiting."*
  - Clause 7 – establishment and implied improvement of *"post Roads"* and, by logical extension, more modern means of delivering communications.
  - **Clause 8 – evaluation of *"Discoveries"* in *"Science and the useful Arts"*** for the purpose of *"securing…exclusive rights"* for *"Inventors."*
  - Clause 12 and 13 – *"support"* of *"Armies"* and maintenance of *"a Navy"* and, by logical extension, future forces necessary to the *"common Defence."*
  - Clause 15 and 16 – support of the *"Militia"* and their use to *"repel Invasions."*
  - **Clause 18 of Section 8** further gives Congress the power ***"to make all laws necessary and proper for carrying into Execution the foregoing Powers****, and all other Powers vested by this Constitution* ***in the Government of the United States, or in any Department or Officer thereof."***

Science Policy and the Constitution

- **Under Clause 2 of Article II, Section 2**, **Presidents have the power to appoint** *"…by and with Advice and Consent of the Senate…all other Officers of the United States…whose Appointments… shall be established by Law…"* **including individuals responsible for federally supported research in science and technology**
- The President, with funding concurrence by the Congress, has **significant discretion in assigning science and technology research duties to federal Departments and Agencies** so long as Congress can constitutionally fund their implementation.
  - Federal support of science and technology research in medicine, agriculture, energy, and natural resources based on the specific applicability to national security of research projects in these arenas.
- **Since the nation's founding, federally supported or managed big science and engineering efforts have contributed to national defense or to treaty enforcement**. Examples include:
  - Canals, locks, dams, and levees beginning in the early 1800s;
  - **Agricultural research through Land Grant academic institutions (1860s and 1890s);**
  - The Transcontinental Railroad in the late 1860s;
  - Aeronautical research that began early in the 1910s;
  - **The Manhattan Project of the 1940s;**
  - Nuclear Navy and related power systems, and communication satellites in the 1950s;
  - **The Apollo Moon-landing Program of the 1960s.**

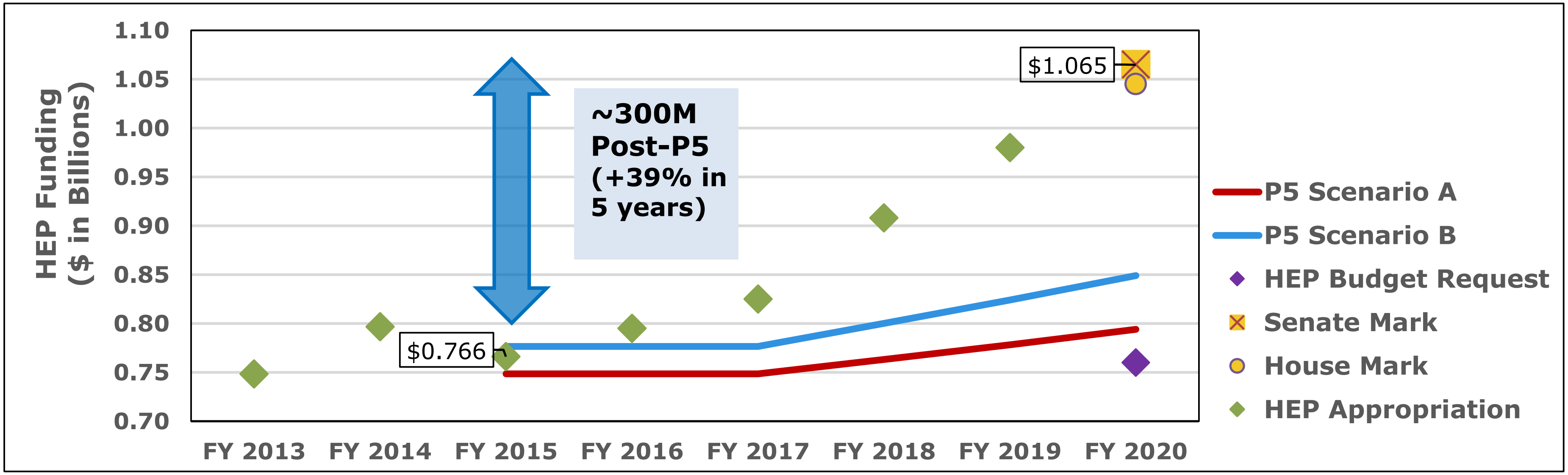
- The **constitutional rationale for selective support of pure scientific research lies primarily in the stimulation of educational initiatives that train the scientists and engineers** that serve more direct constitutional functions, particularly national security.

https://www.americasuncommonsense.com/

Let’s Talk About Budget

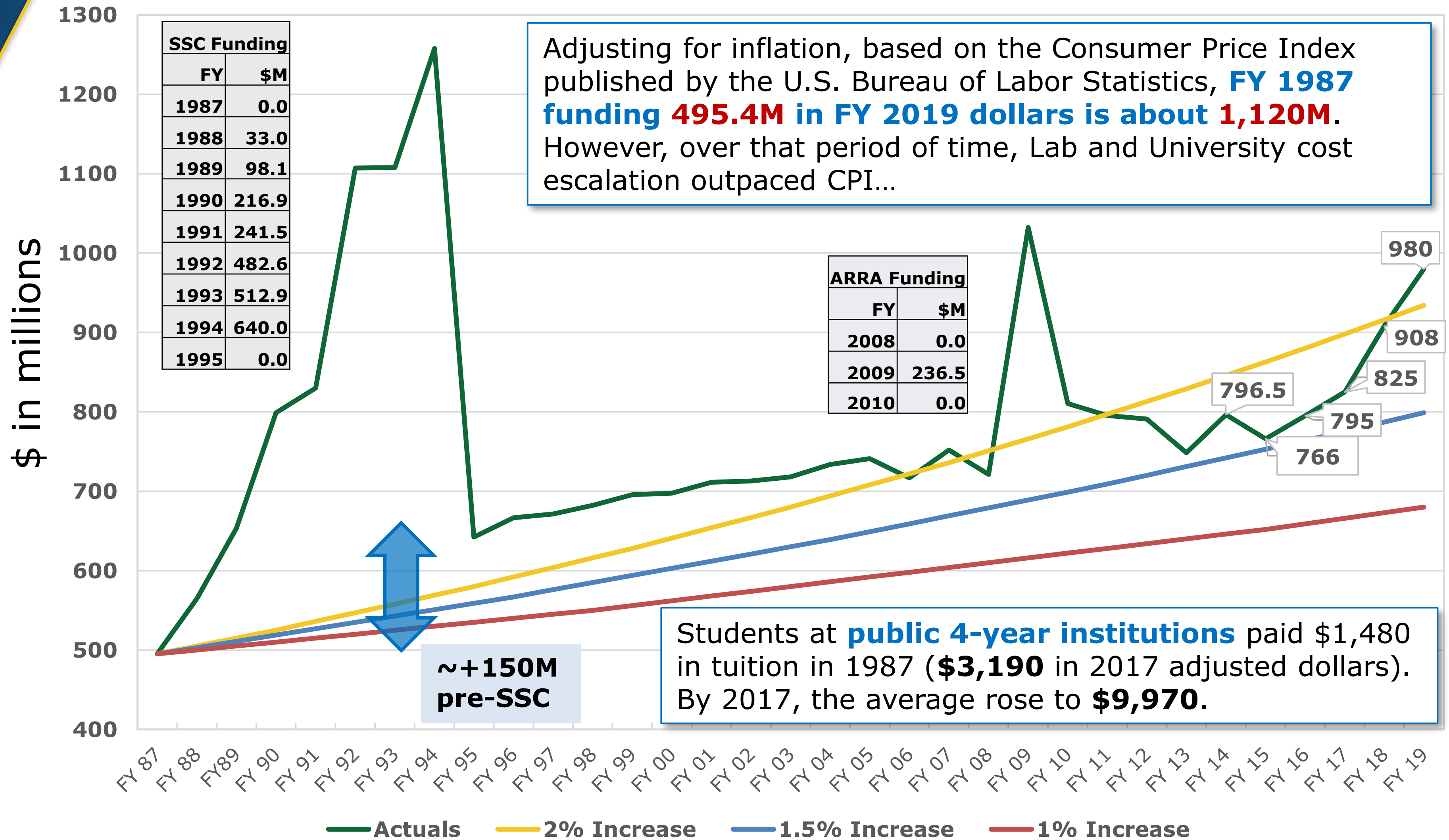
U.S. Congress Supports P5 Strategy

- U.S. Congress continues to show strong support for executing the P5 strategy, and for accelerating the pace of projects
  - FY 2020 House and Senate Marks for DOE HEP are above the President's Budget Request (PBR)



- When the P5 report was released in May 2014, the FY 2015 budget was already in Congress and the FY 2016 budget was being formulated
- Arguably the first impact (success!) of the P5 report was not seen until FY 2016, and continues today…

FY 2019 HEP Funding in Historical Context



SSC Funding

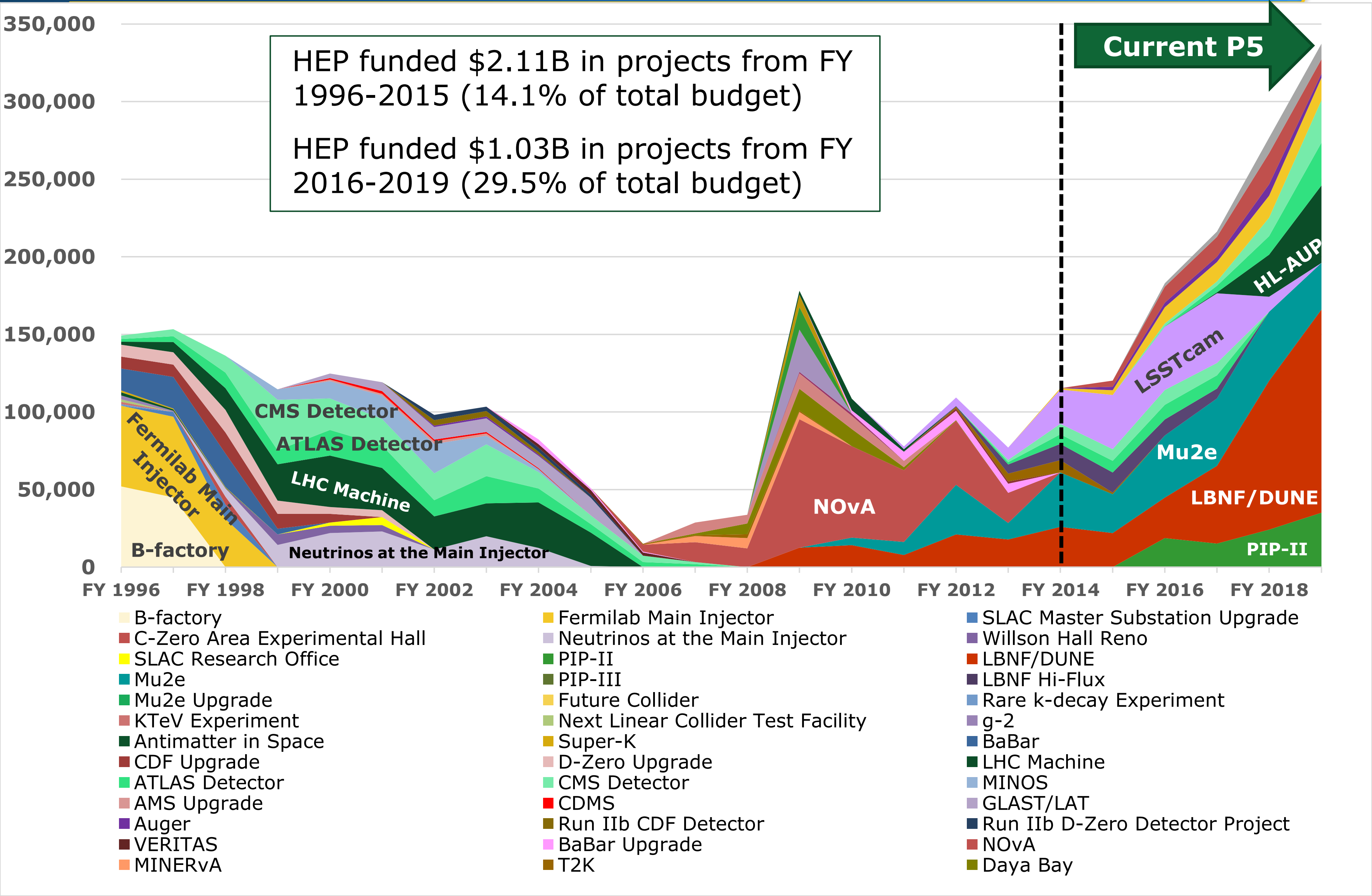
FY	$M
1987	0.0
1988	33.0
1989	98.1
1990	216.9
1991	241.5
1992	482.6
1993	512.9
1994	640.0
1995	0.0

ARRA Funding

FY	$M
2008	0.0
2009	236.5
2010	0.0

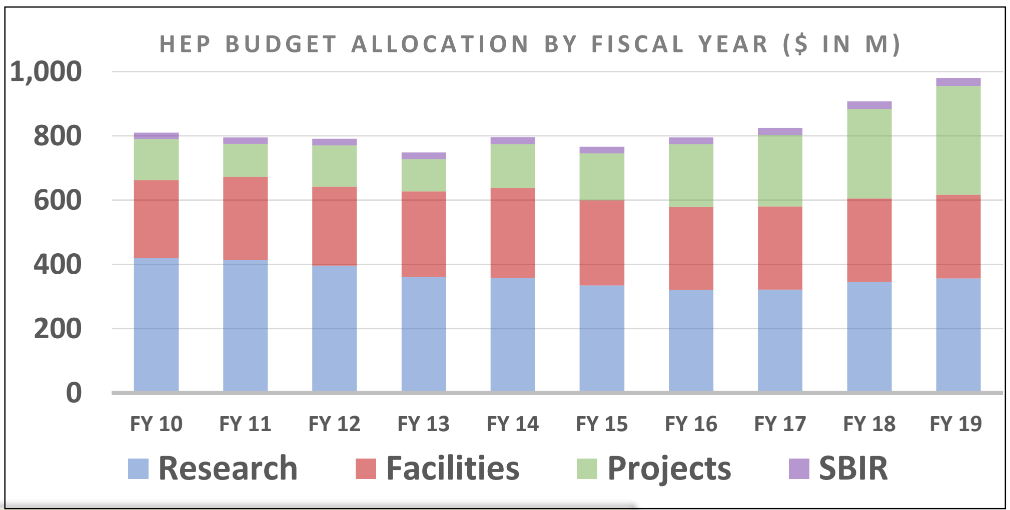
Historical Chart of HEP Projects

FY 1996 – FY 2019



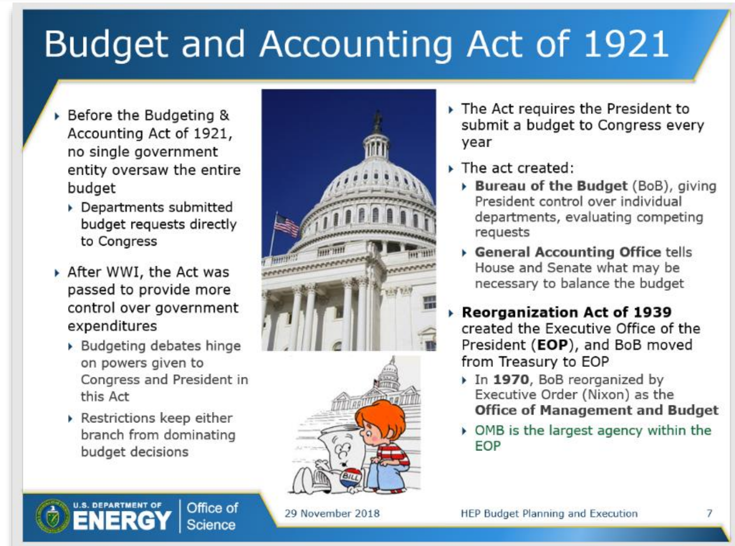
Delivery of Early Science from New Projects

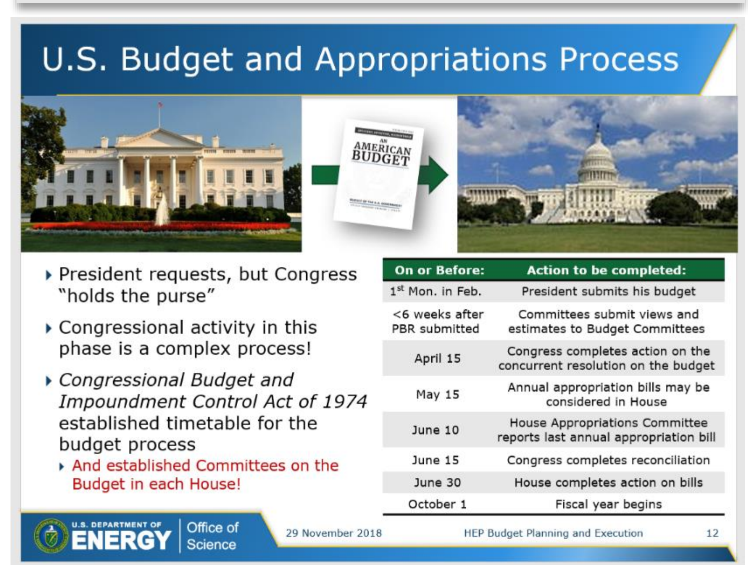
- **Eight** projects recommended by P5 have received final funding
  - Muon g-2, CMS Upgrade, ATLAS Upgrade, LSSTcam, Mu2e, LZ, SuperCDMS-SNOLAB, DESI
  - **DOE Total Project Costs ~ 650M (FY 2010-2019)**
  - Research has been reduced/constrained for a decade while building next generation of instruments 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



Few Words on U.S. Budget Process

- At November 2018 HEPAP Mtg, I discussed the U.S. Budget Process
  - Budget and Accounting Act of 1921
  - Three Phases of Budget Process
  - U.S Federal Budget Cycle
  - Budget Formulation Process
  - HEP Budget Request
  - HEP Role in Congressional Process
  - Congressional Budget and Impoundment Act of 1974
  - Authorizations and Appropriations
  - Continuing Resolutions
- For this Mtg, I will not have time to review all of this material. Slides on the above topics can be found in the back-up of this talk.





Let's Talk About FY 2019 Appropriations

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 contained a continuing resolution (CR) through December 7, 2018, for any appropriations bills not enacted before October 1, 2018…

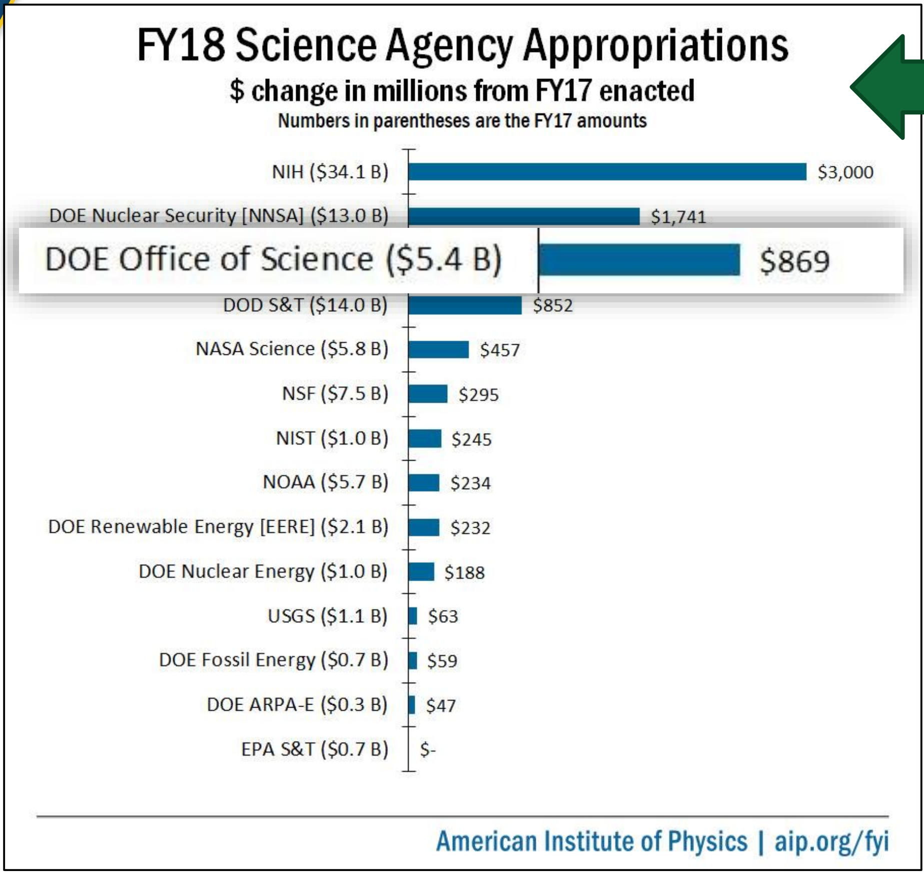
Remaining FY 2019 Spending Bills

- A 35-day shutdown ended on January 25th, after H.J. Res. 28 was amended to reopen, through February 15th
- Agencies affected by the funding lapse
  - Agriculture; Commerce, Justice, Science, and Related Agencies (NASA, NSF, NIST); Interior, Environment, and Related Agencies; Financial Services & General Government; Homeland Security; State and Foreign Operations; and Transportation, Housing and Urban Development
- On Friday, February 15, 2019, the President signed into law, H.J. Res. 31, the "Consolidated Appropriations Act, 2019"
  - Divisions A through G of the enrolled bill provide full-year funding for fiscal year 2019 through September 30, 2019, for projects and activities of all Federal Government agencies and programs not yet included in enacted appropriations bills.

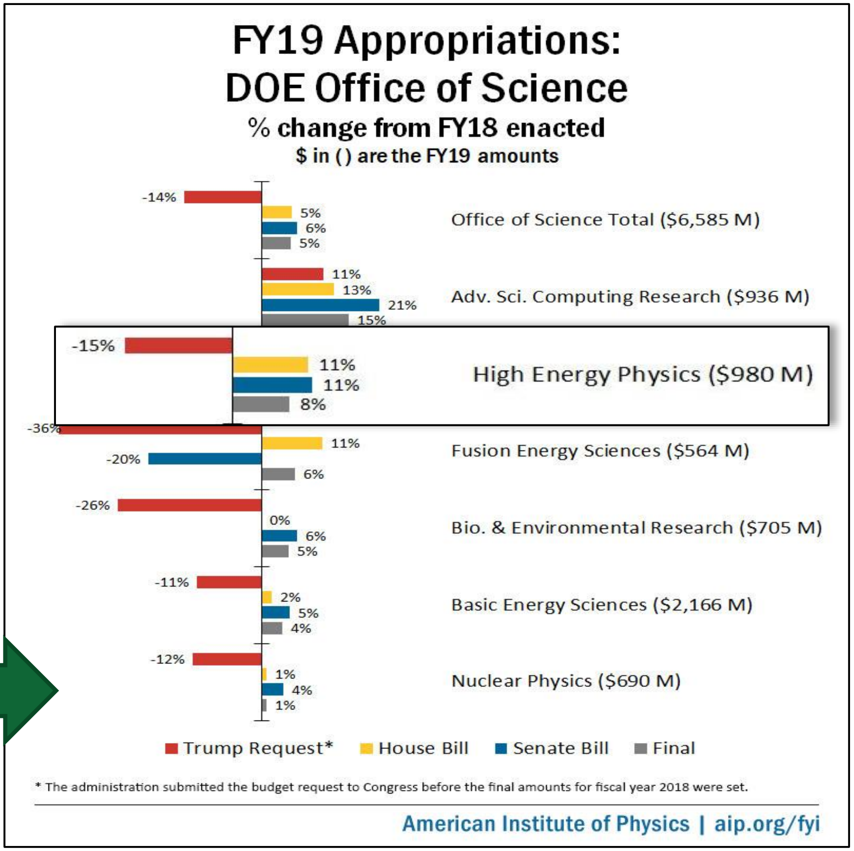
FY 2019 Final Appropriations

Appropriation Bill	FY 2018 Appropriations ($B)	FY 2019 Appropriations ($B)	$ Change, FY 2018-19	% Change, FY 2018-19
Funded During Regular Appropriations				
Military Construction/VA	92.7	98.0	5.3	6%
Energy and Water	43.2	44.6	1.4	3%
Legislative Branch	4.7	4.8	0.1	2%
Defense	654.7	674.4	19.7	3%
Labor, HHS, Education	177.1	178.1	1.0	1%
Funded Post-Shutdown				
Interior/Environment	35.3	35.6	0.3	1%
Financial Services	23.4	23.4	0.0	0%
Agriculture	23.0	23.0	0.0	0%
Transportation and HUD*	70.1	71.1	1.0	1%
Homeland Security	47.7	49.4	1.7	4%
Commerce, Justice and Science	69.9	71.5	1.6	2%
State and Foreign Operations	54.0	54.2	0.2	0%
Total	**1,295**	**1,322**	27.0	2%

FY 2018 vs FY 2019 SC 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 Independent Project Review levels. Line-Item Construction Equipment funding began for PIP-II.

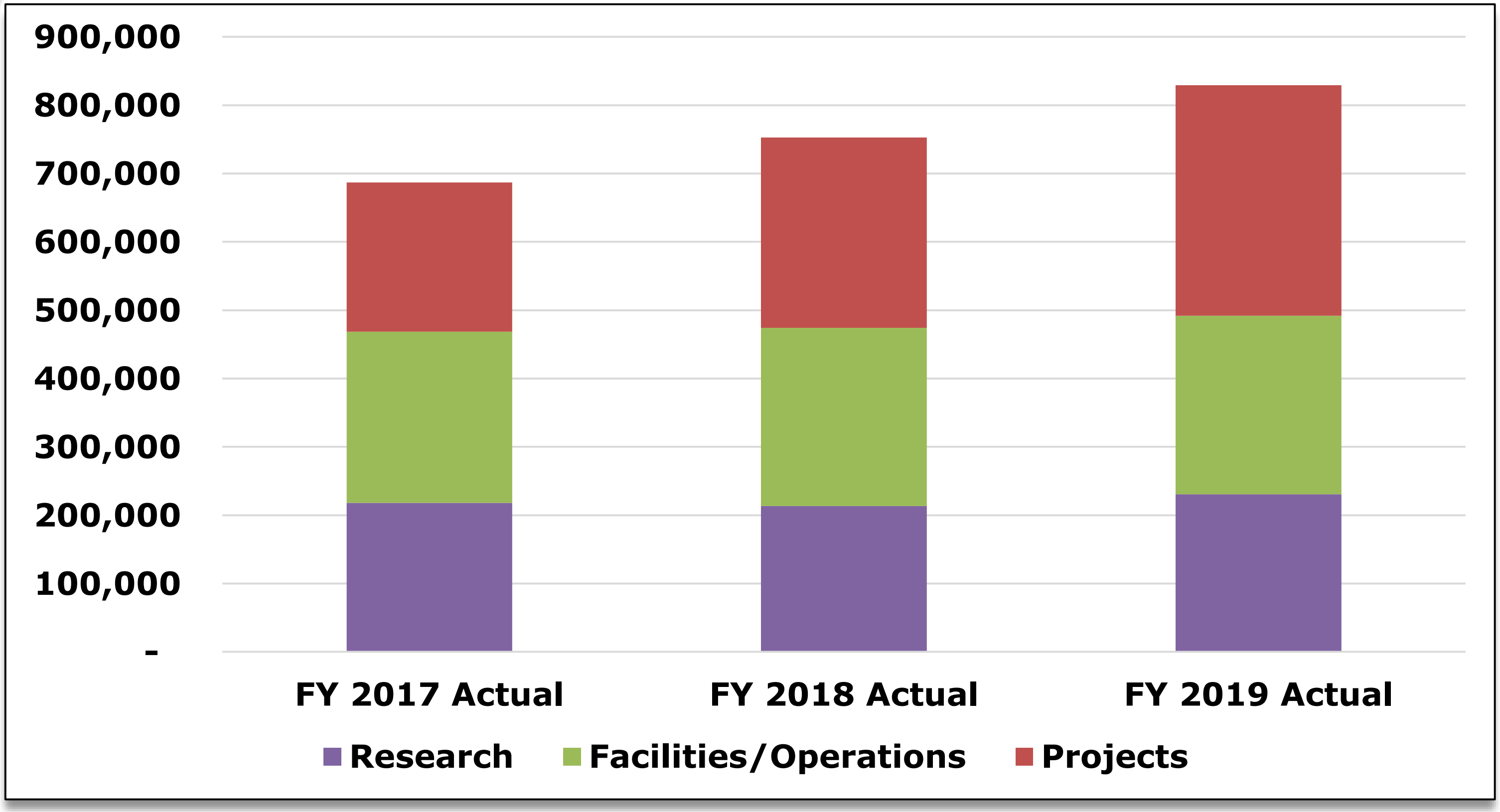


- HEP was up from 908M in FY 2018 to 980M in FY 2019, an **increase of +8%**
- All projects were addressed at their baseline and/or IPR levels. Five projects received final planned funding!

Balancing Research, Operations and Projects

- FY 2019 HEP Enacted at 980M
  - 337.4M (34.4%) for Projects fully controlled by language
    - +35M for LBNF/DUNE over FY 2018, and +17M over Request
    - Mu2e, DESI, SuperCDMS, LZ and FACET-II received final funding
  - 642.6M or 65.6% provided strong support to Research & Operations
- Accelerated Project funding:
  - Created opportunities to launch new initiatives by mid-2020s
  - Confront new risks (facility capacity, modernizing infrastructure)
  - Increased pressure to deliver on science earlier
    - Setbacks, unknown technological issues, null results, world competition

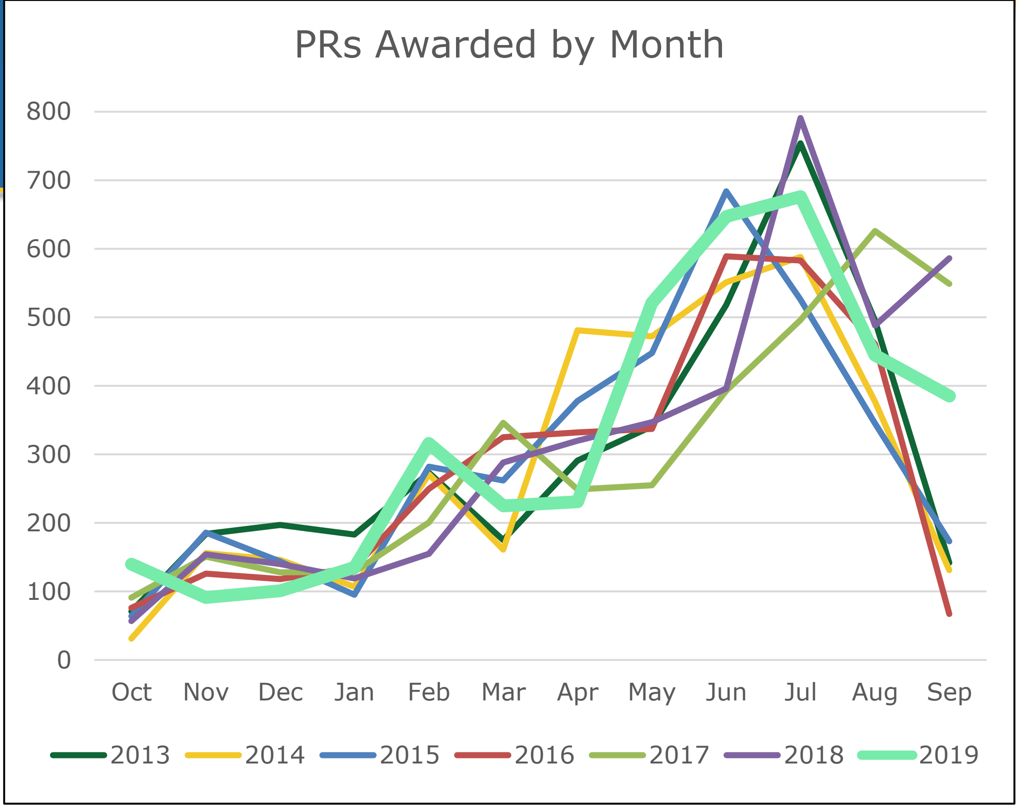
Lab Funding ($k) – FY 2017-2019



	FY 2017 Actual	FY 2018 Actual	FY 2019 Actual
Research	217,892	213,454	230,489
Facilities/Operations	250,611	260,761	261,188
Projects	218,586	278,335	337,350
Total	687,089	752,550	829,027

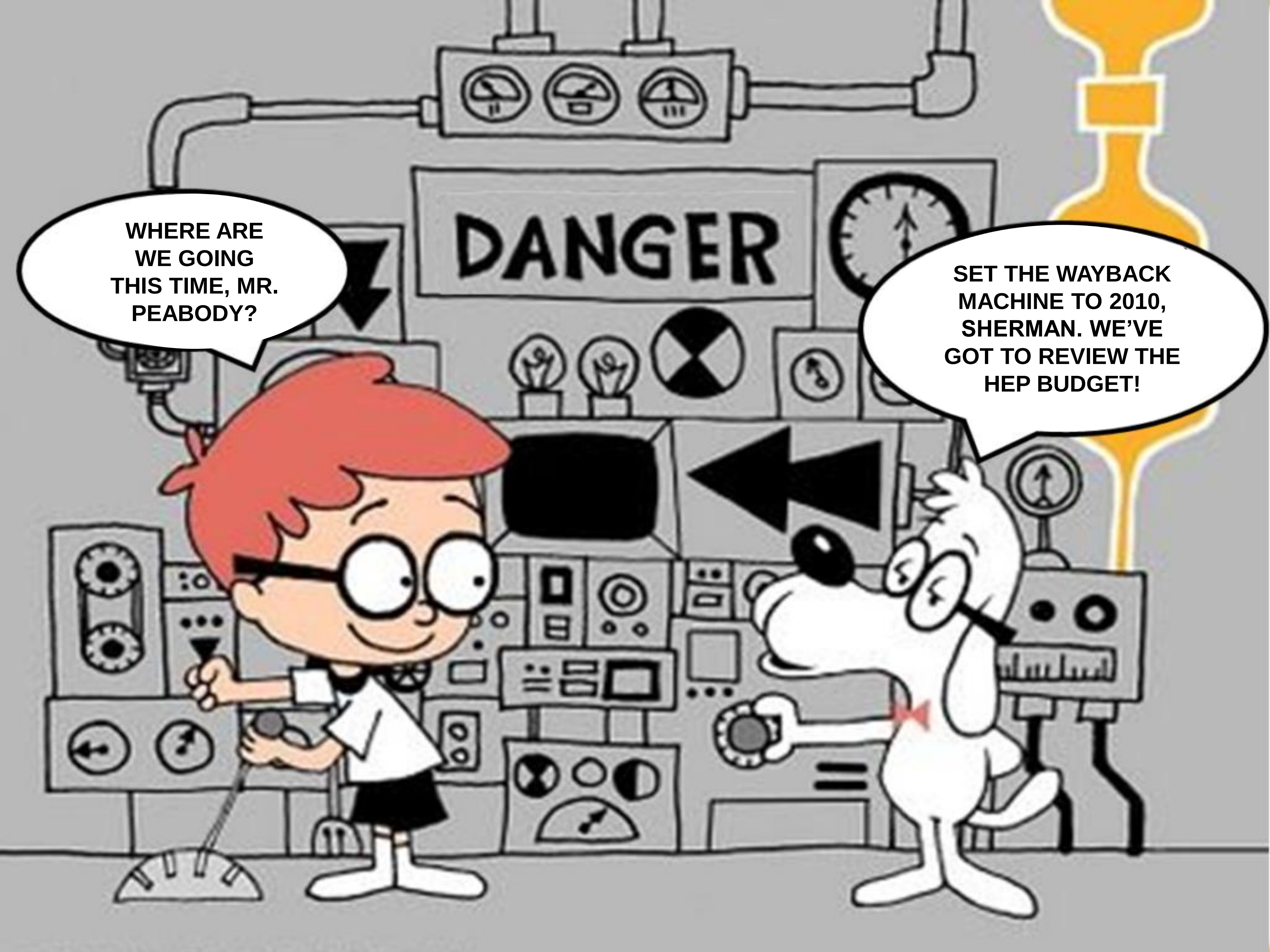
Procurement Requests (aka Grants)

- Awards are fixed once made
  - Funding cycle of 1-5 years
  - Funding adjustments (downward) are possible if circumstances change
  - Changes are also possible through submission of supplementary proposals
- FY 2020 Continuations
  - About half of HEP's PRs are continuations, providing > 50% total grand funding
  - **Progress reports can be submitted as soon as PIs get the PAMS notification in early December (two weeks!)**

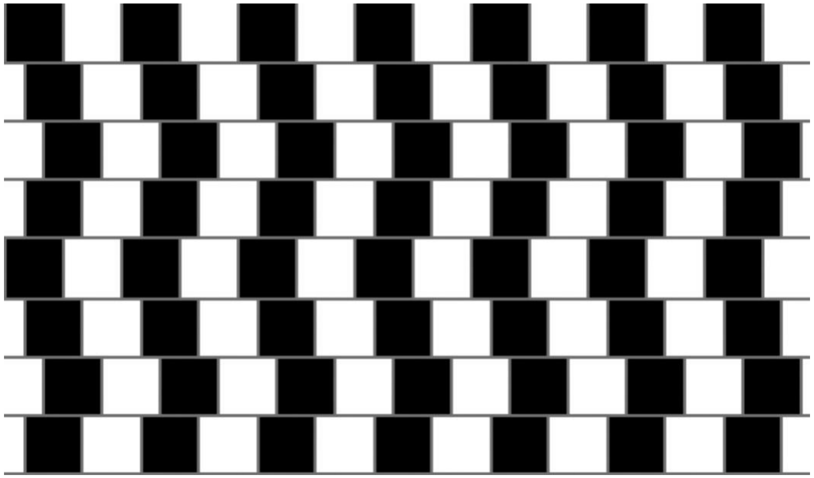


- Early submission will help ensure on-time processing by HEP and SC of continuation funding before the end of the grant budget period (March 31, 2020 or later).

Office of High Energy Physics	# of Procurement Requests		Funds Awarded	
	FY 2018	FY 2019	FY 2018	FY 2019
Total	347	364	$126,857,897.03	$121,820,365.80
Award Revision	5	8	-$116,531.97	-$200,950.29
Continuation	155	180	$72,350,000.00	$71,705,000.00
New	91	55	$26,363,429.00	$17,263,816.09
No Cost Extension	48	58	$0.00	$0.00
Renewal	36	56	$26,210,000.00	$32,635,500.00
Supplemental	12	7	$2,051,000.00	$417,000.00

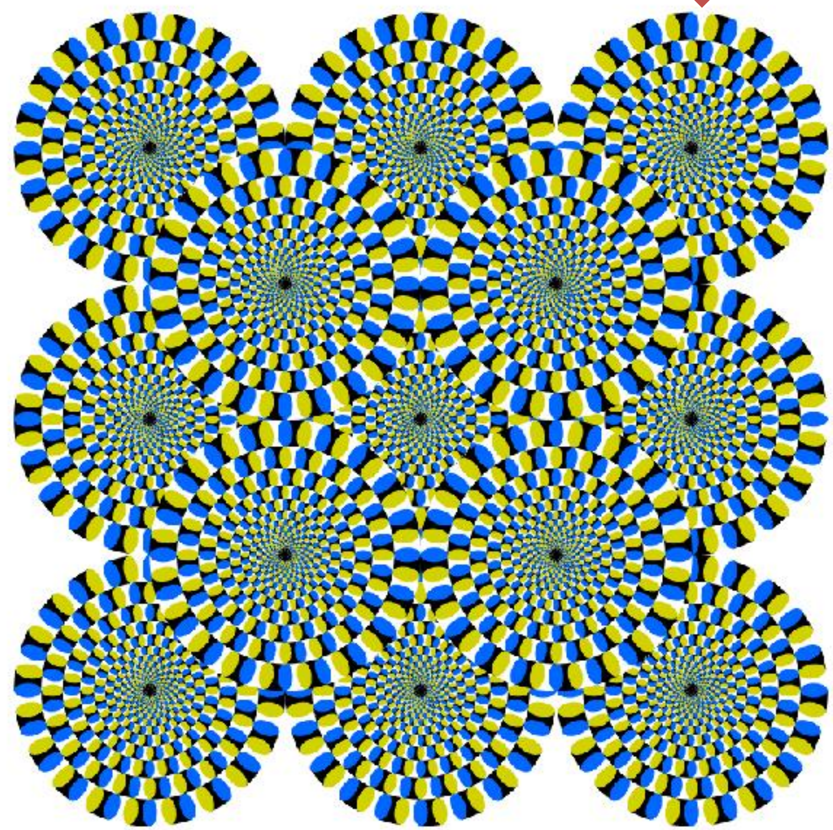

WHERE ARE WE GOING THIS TIME, MR. PEABODY?
DANGER
SET THE WAYBACK MACHINE TO 2010, SHERMAN. WE'VE GOT TO REVIEW THE HEP BUDGET!

But First – Let’s Test Your Perception

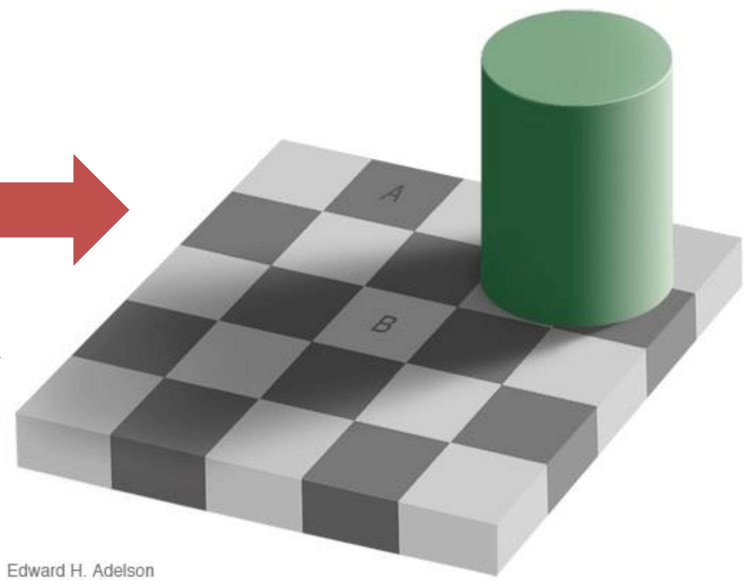


Are the horizontal lines straight or crooked?

Nothing is moving here. This is a jpeg.



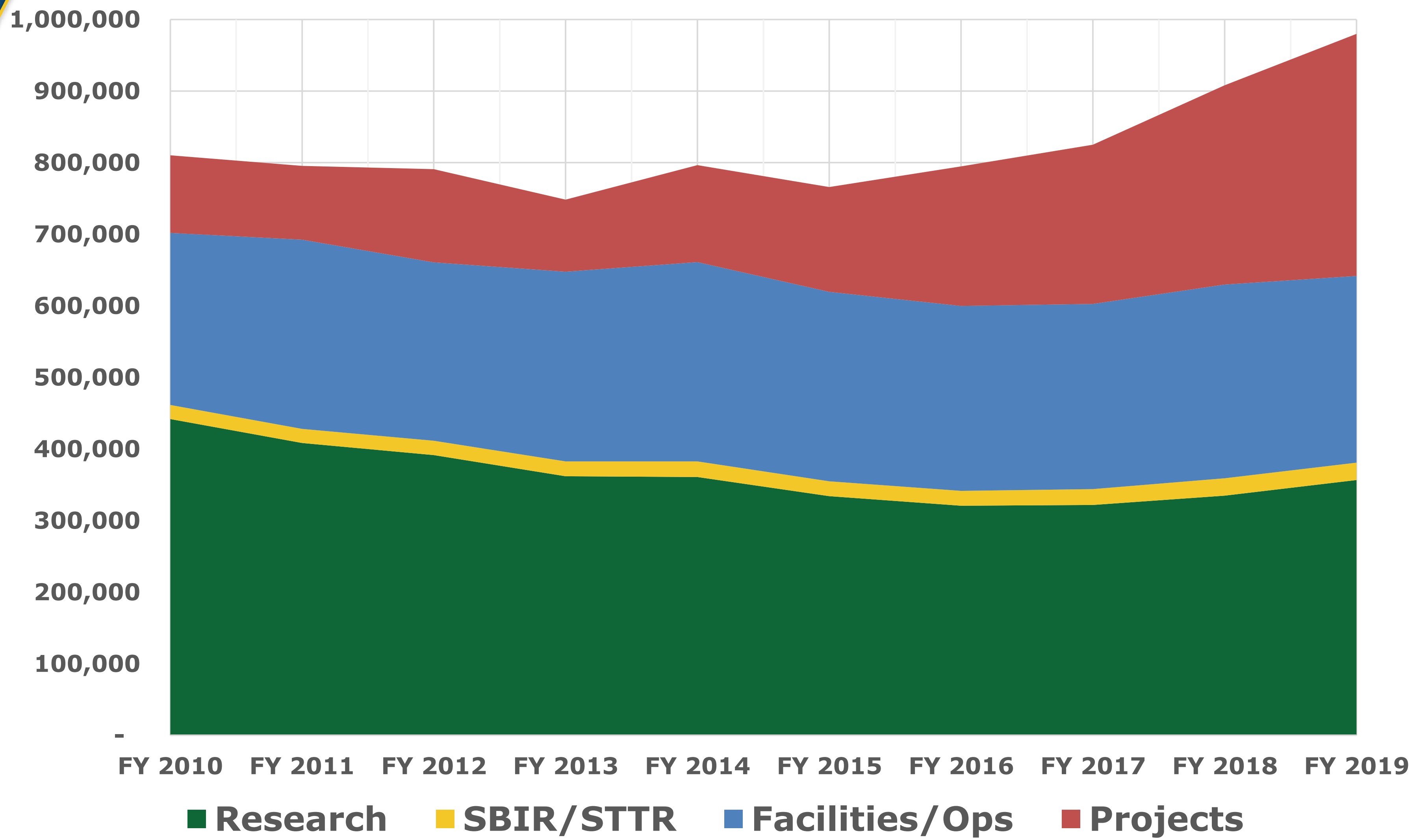
Can you convince yourself that on the checkerboard, tiles A and B are the same color?



https://www.livescience.com/33664-amazing-optical-illusions-work.html

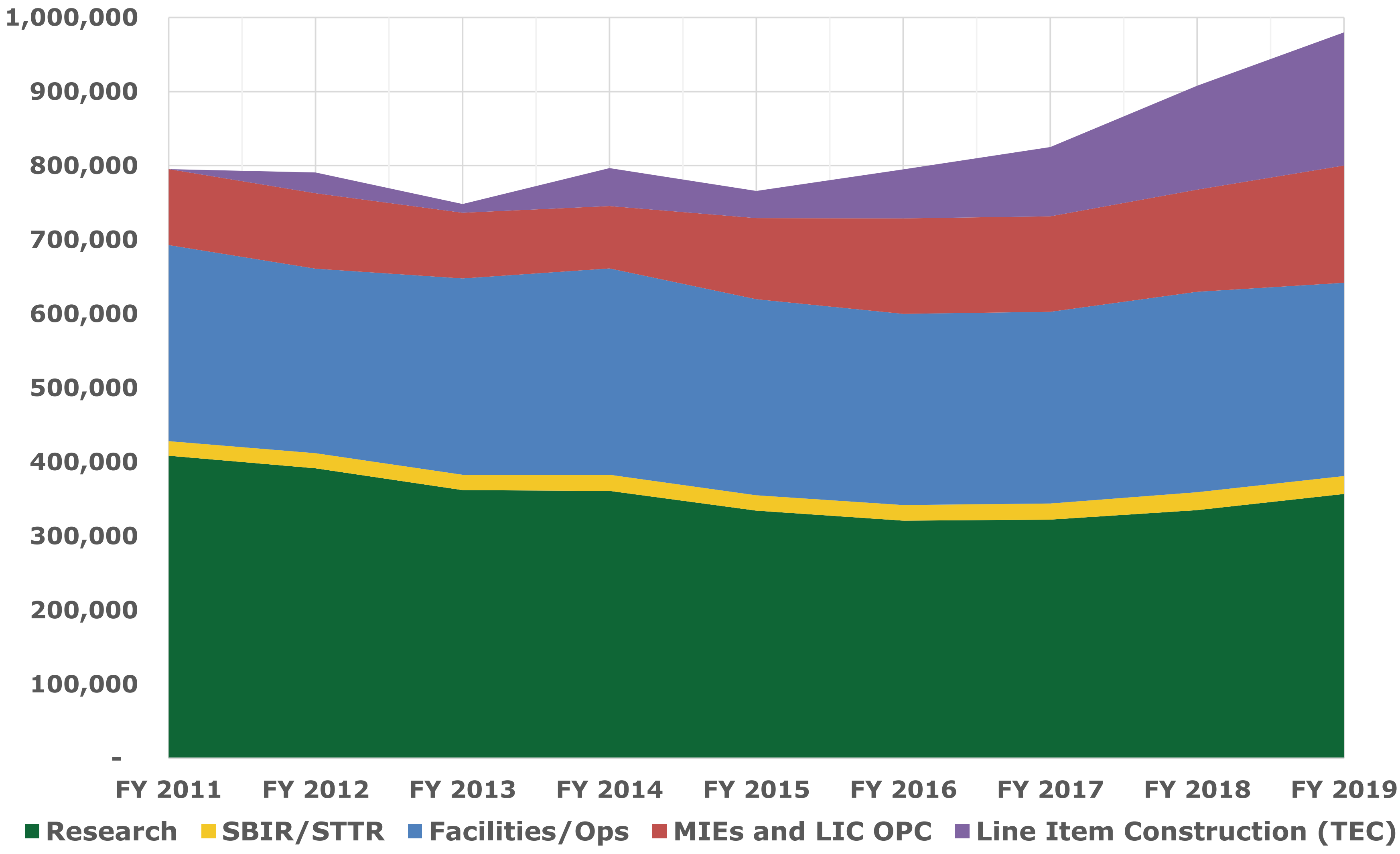
HEP Budget ($k) FY 2011-2019

Research, Operations, Projects

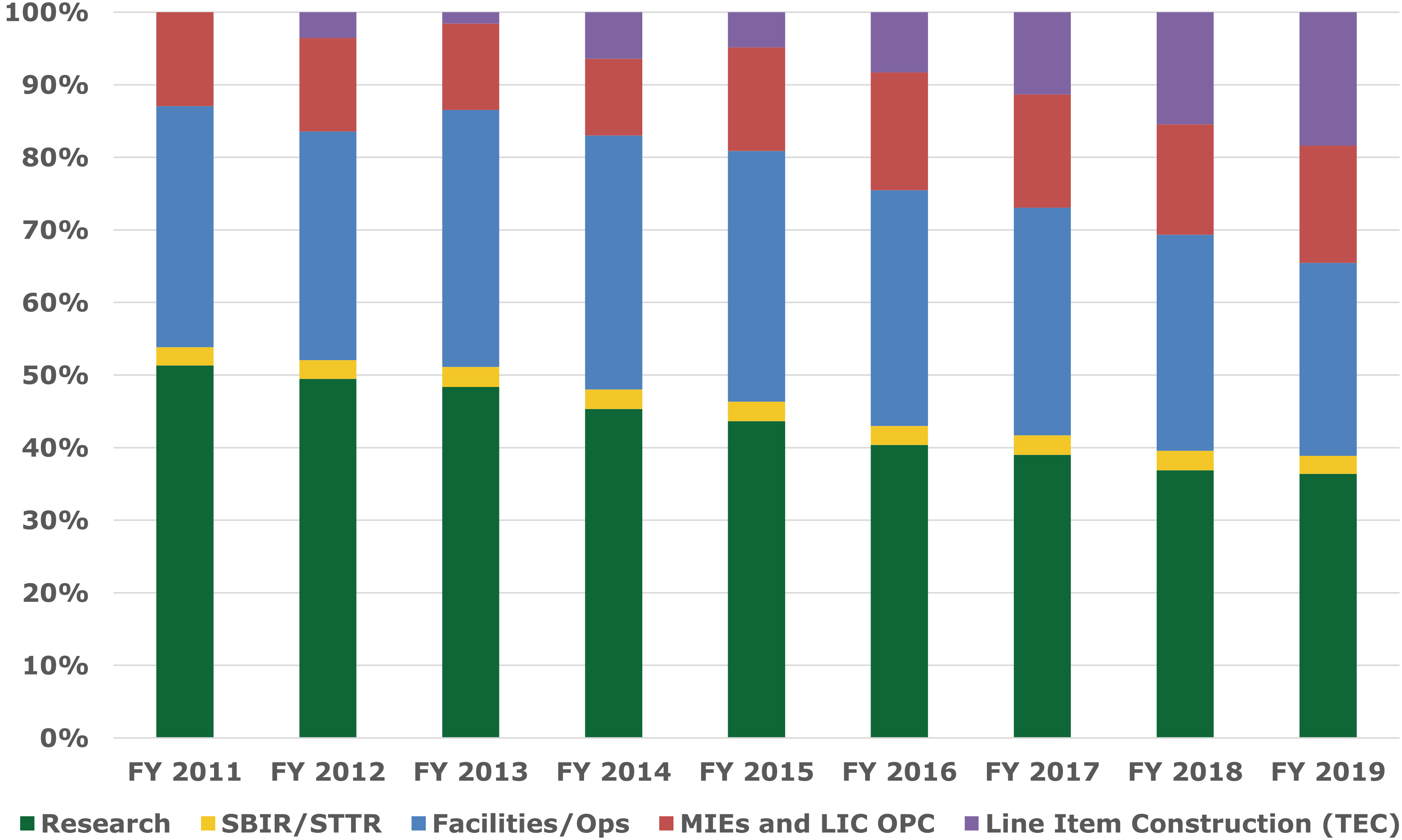


HEP Budget ($k) FY 2011-2019

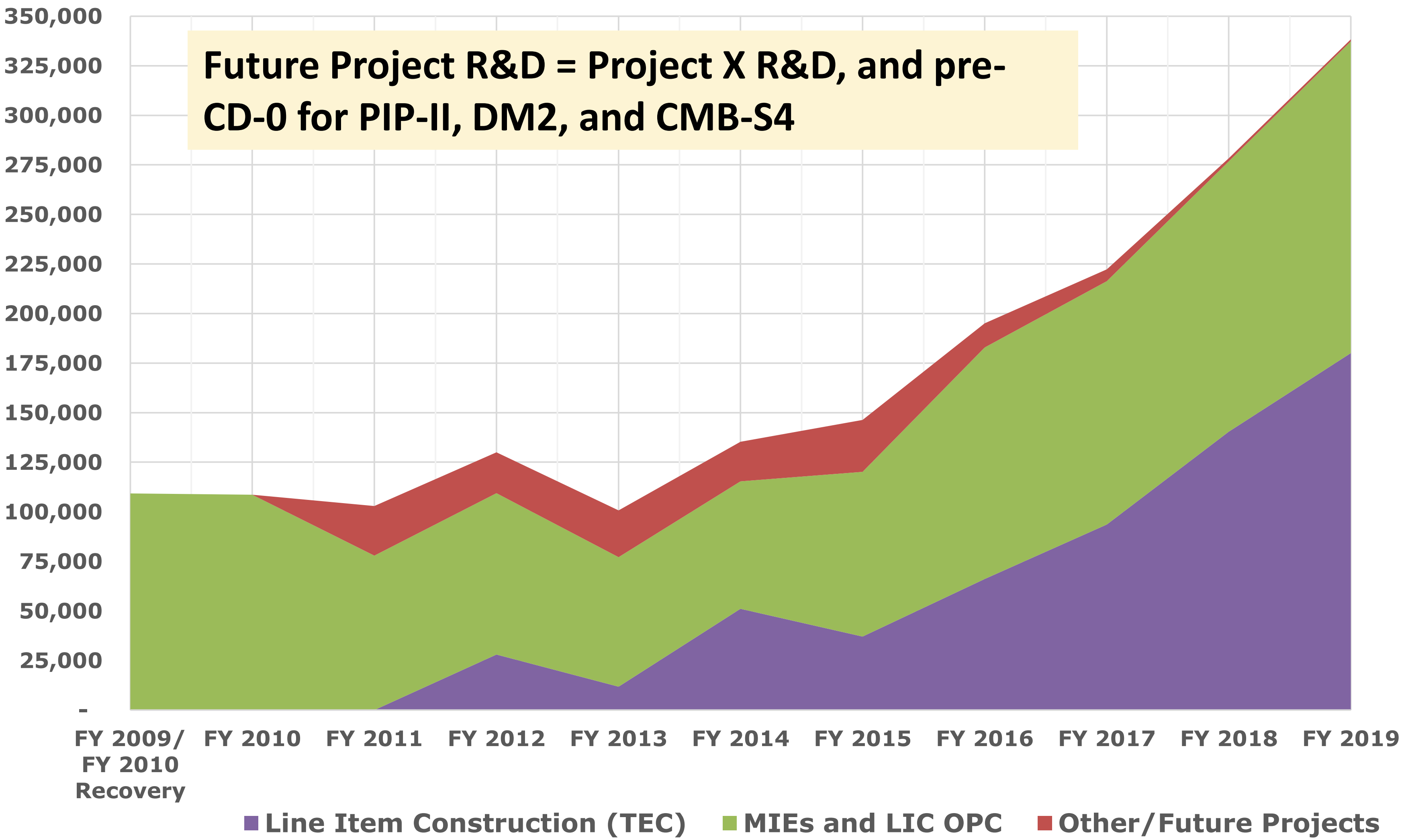
Projects: Construction and MIEs



HEP Budget (%) FY 2011-2019

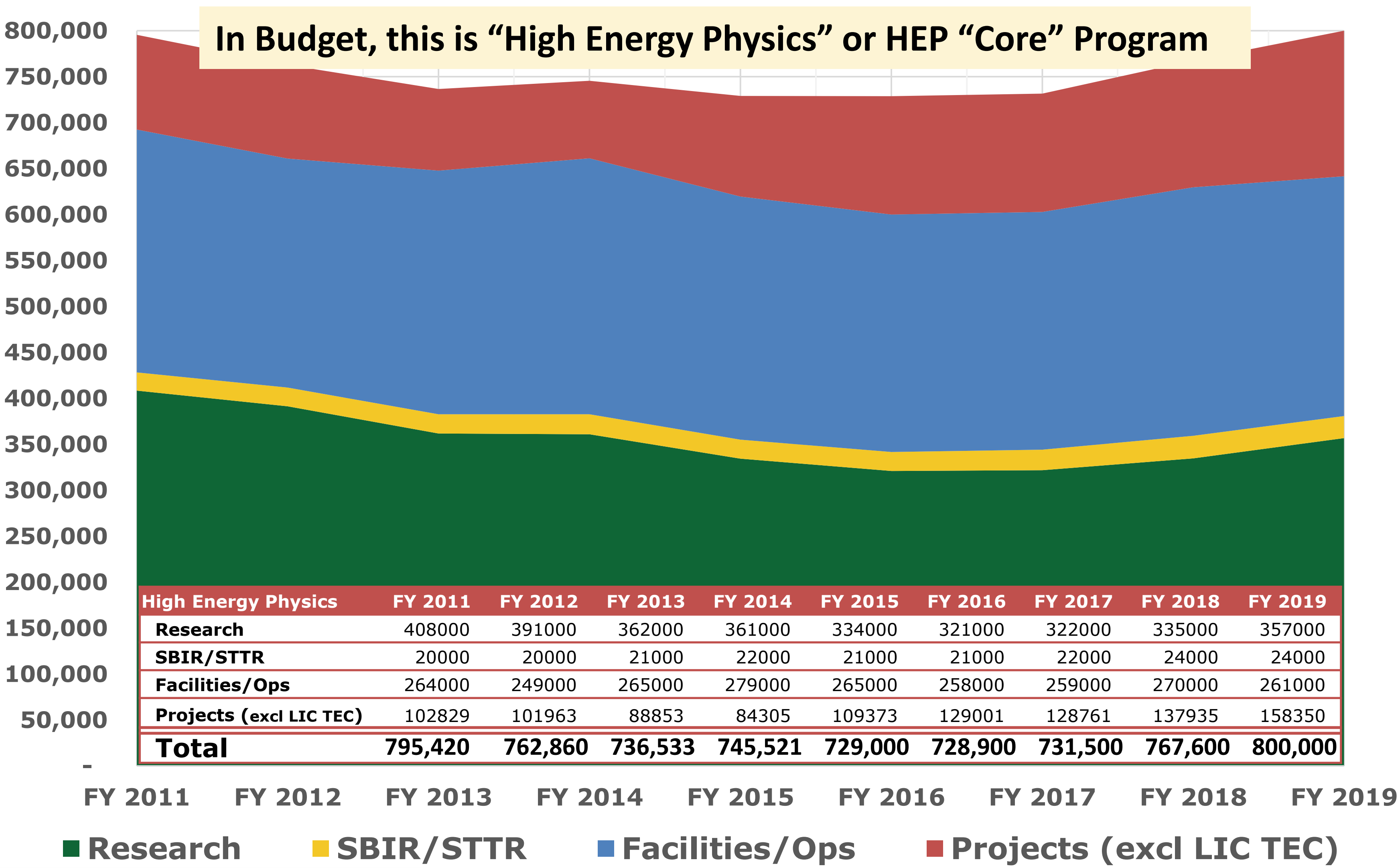


HEP Projects ($k) FY 2011-2019



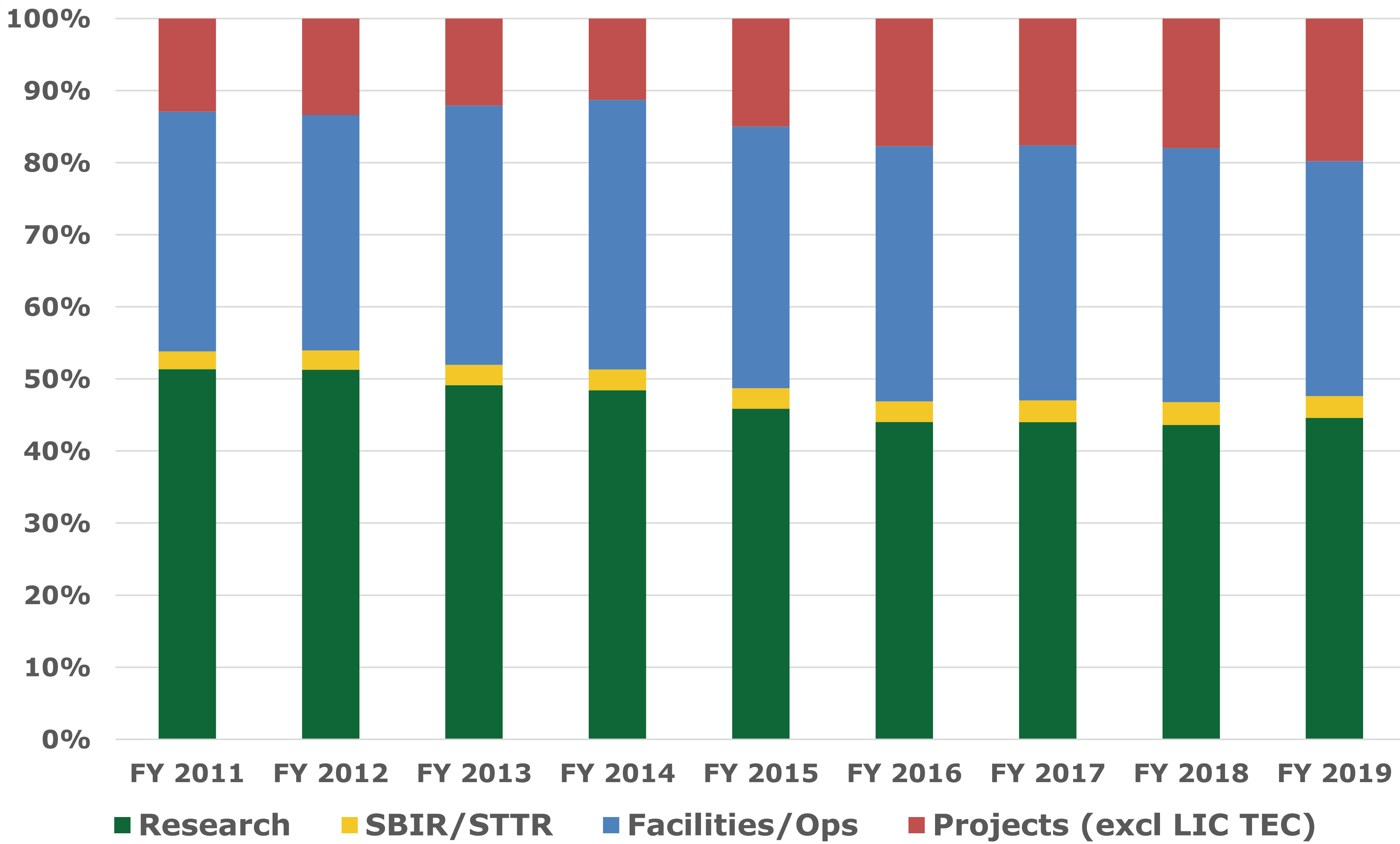
HEP Budget ($k) FY 2011-2019

(excluding Line Item Construction TEC)

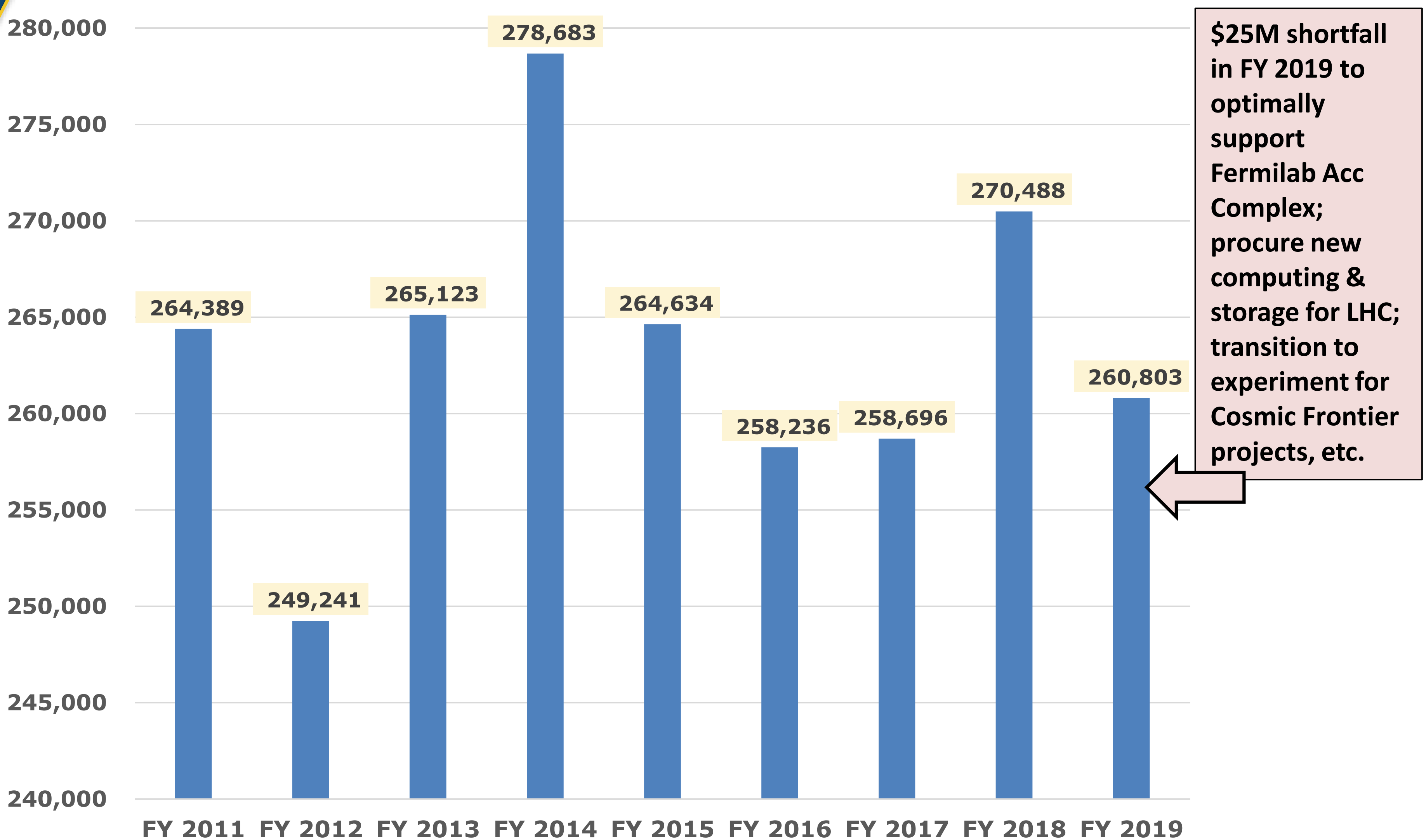


High Energy Physics	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Research	408000	391000	362000	361000	334000	321000	322000	335000	357000
SBIR/STTR	20000	20000	21000	22000	21000	21000	22000	24000	24000
Facilities/Ops	264000	249000	265000	279000	265000	258000	259000	270000	261000
Projects (excl LIC TEC)	102829	101963	88853	84305	109373	129001	128761	137935	158350
Total	**795,420**	**762,860**	**736,533**	**745,521**	**729,000**	**728,900**	**731,500**	**767,600**	**800,000**

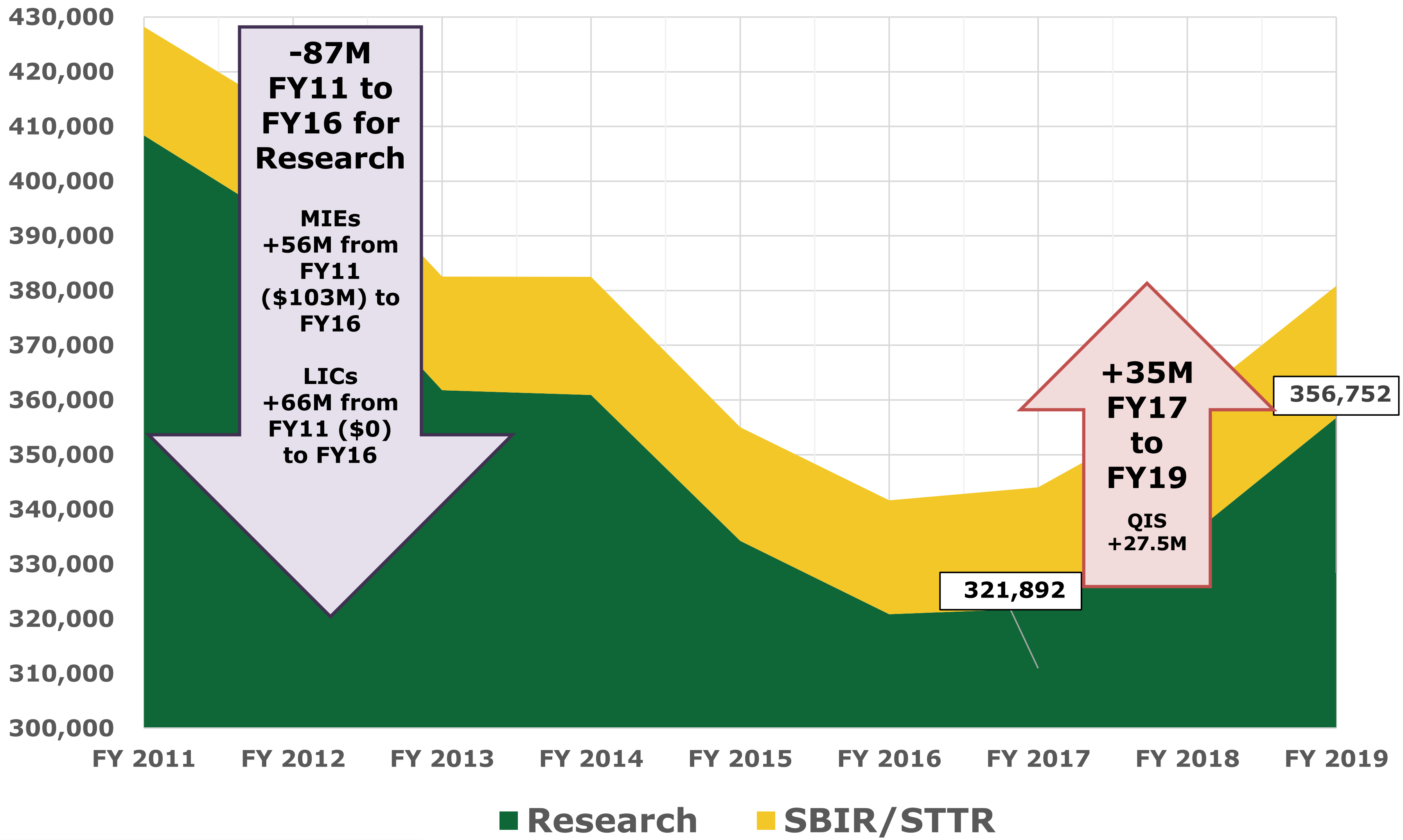
HEP Budget (%) FY 2011-2019
(excluding Line Item Construction TEC)



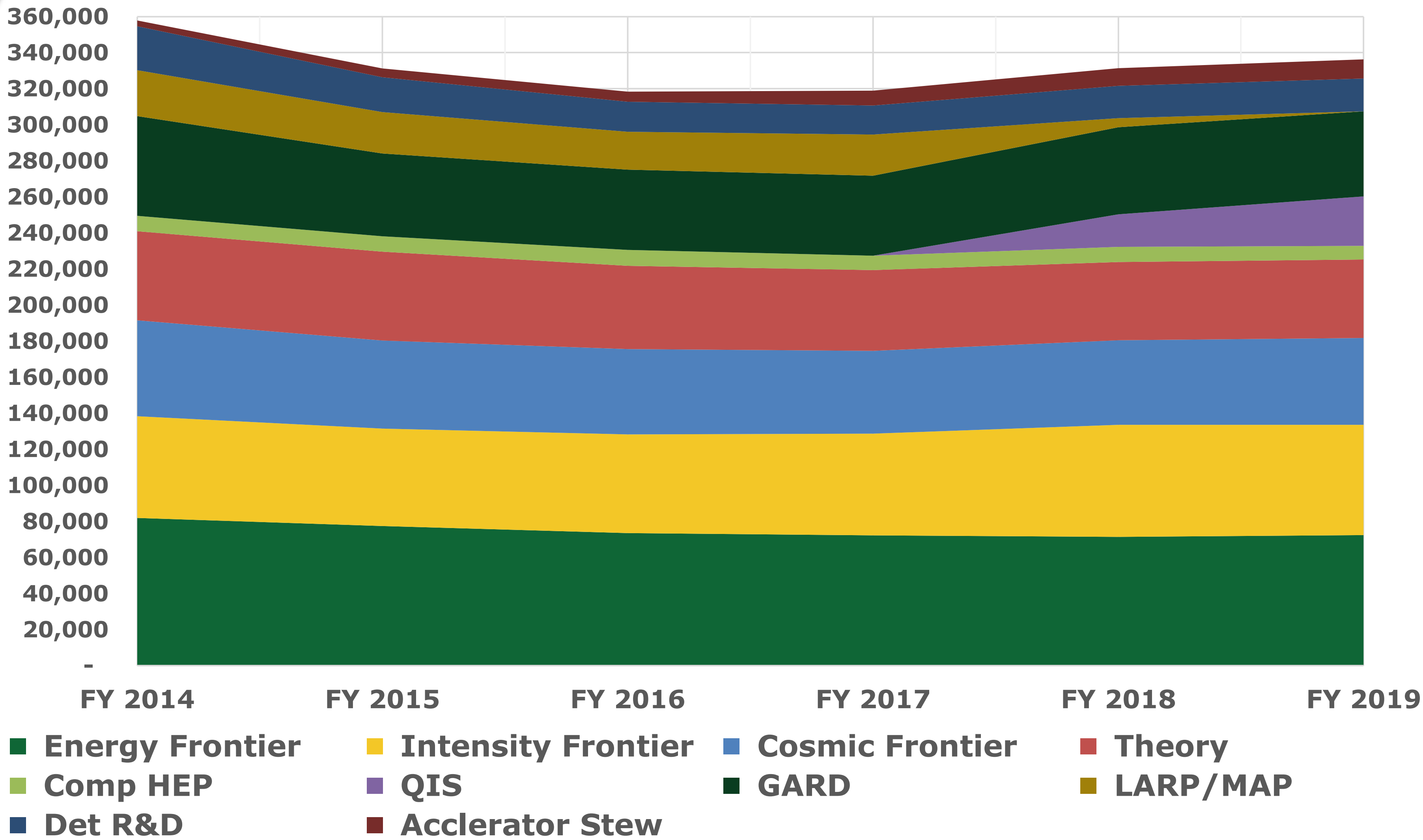
HEP Facilities/Operations ($k) FY 2011-2019



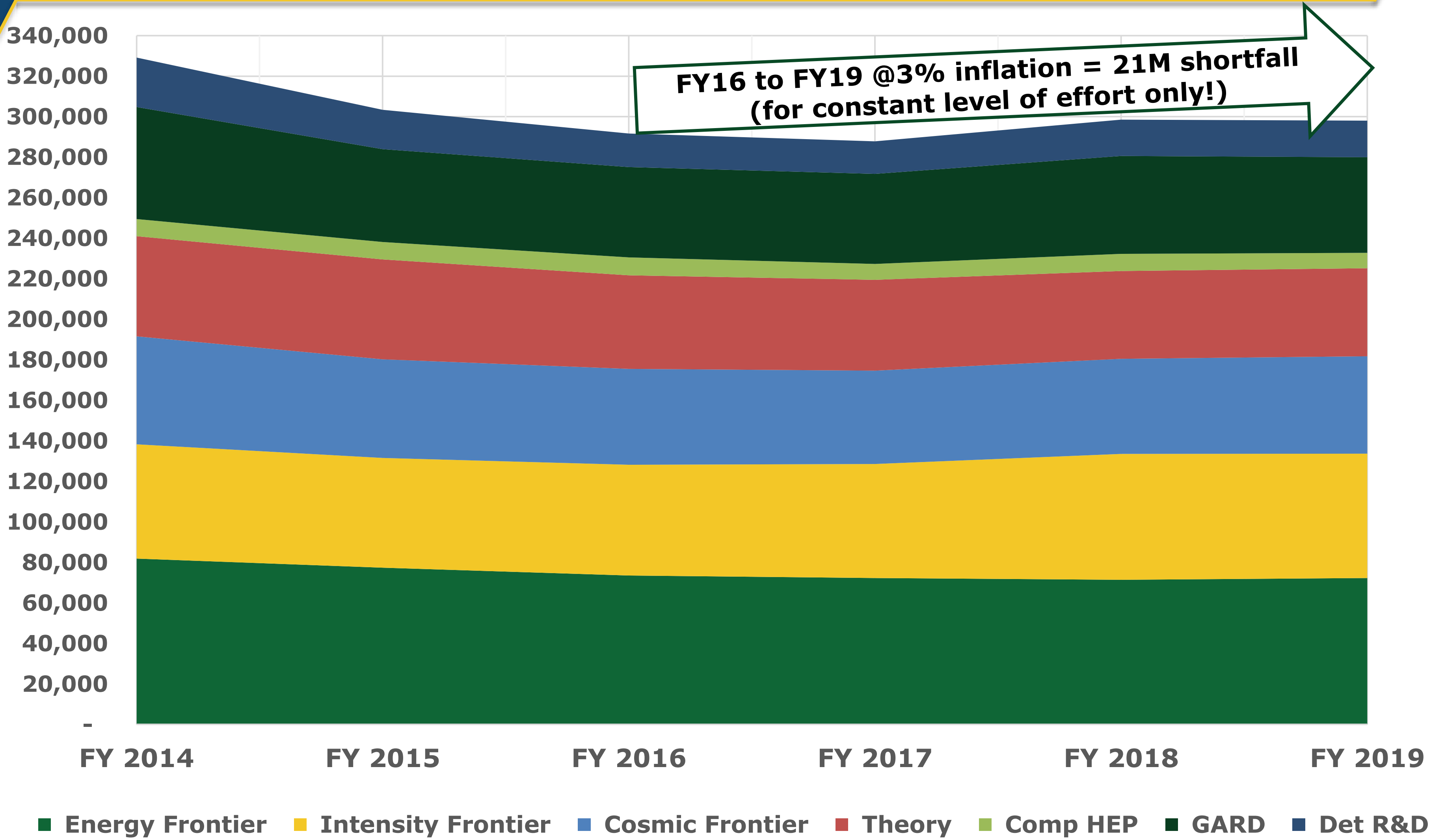
HEP Research ($k) FY 2011-2019



HEP Research ($k) FY 2014-2019
(excludes SBIR/STTR, and Program Support)

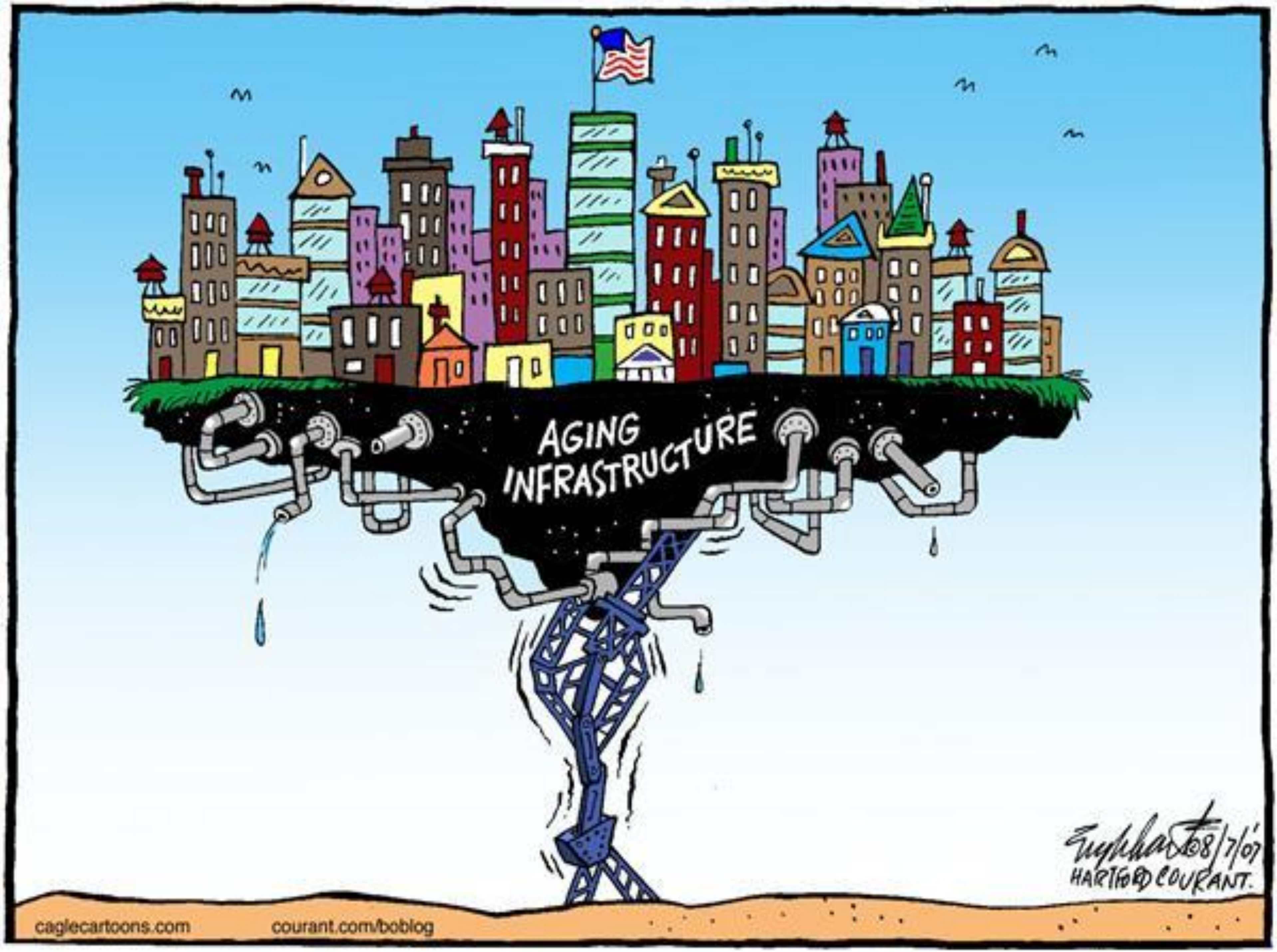


HEP Core Research ($k) FY 2014-2019



FY 2019 Budget Review Takeaways (Research Only)

- **P5 was wildly successful**, and we will need plenty of new (mid- to large-scale) ideas, **to prepare for the next long-term strategic plan**
  - Future Energy Frontier Colliders and Detectors
  - Underground HEP Science
  - Next-generation Dark Energy and Dark Matter experiments
  - PIP-II/PIP-III (non LBNF) program
  - Technology R&D demonstrators
- However… within core Research, resources for R&D will continue to be constrained for the next several years as we deliver on P5 projects, operations and research
  - **Need to leverage all available other sources (LDRD, US-Japan, QIS, non-DOE, Early Career, University Start-up, AI/ML, etc.)**
- **Basic Research Needs (BRN) Workshop** and the resulting report **may provide compelling justification for new funding**
  - Invest in Adv. Tech R&D, Theory, QIS, AI/ML, Crosscuts (SC, Private Sector, etc.)
  - Recent BRNs: Dark Matter (HEP) and Microelectronics (BES).
  - **Detector R&D next month.**
- **Continuous pipeline of new initiatives (20M+/3-5 years)** for FY 2022 and beyond. Understanding these investments will take 3-5 years for initial outcomes
  - Addresses the priorities of the Administration, DOE and Office of Science
  - Builds R&D by distinct thrusts or consortiums


AGING INFRASTRUCTURE
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HARTFORD COURANT.
caglecartoons.com
courant.com/boblog

The Science Laboratories Infrastructure (SLI) Program

Mission:

To support **scientific and technological innovation** at the Office of Science (SC) laboratories by funding and sustaining general purpose infrastructure and fostering safe, efficient, reliable and environmentally responsible operations.

Priorities:

- Improving **SC's existing physical assets (including major utility systems)**
- Funding new cutting-edge facilities that enable emerging science opportunities.
- Realized through projects that support/enable SC's current and future mission needs
  - State-of-the-art facilities that are flexible, safe, and sustainable;
  - Collaborative and interactive work environments that foster innovation;
  - **Infrastructure & utilities that are modern, available, efficient, and safe**

Primary Focus:

- Line-Item Construction Projects
- Core General Purpose Infrastructure Investments

Photos (from top to bottom): Recently completed SLI projects are (top to bottom) include Renovate Science Laboratories-Phase 2 at BNL; Seismic Modernization and Replacement of Buildings-Phase II at LBNL; the Energy Sciences Building at ANL; Infrastructure and Operational Improvements Project at PPPL; and the Photon Science Laboratory Building at SLAC.

New Strategy to Invest in Fermilab Core Campus Revitalization

- **HEP-funded projects ~15M/yr. not enough to revitalize and support P5**
  - And, each project >5M has to be signaled 18 months in advance to make it into PBR
- Fermilab indirect-supported investments are lagging the other SC labs
- **DOE Science Laboratories Investment (SLI) program is seeking strong Sponsor and Lab investments to bring lab infrastructure into the 21st century**
  - Central Utility Building, Site-wide Utility Systems
- Fermilab, with the Site Office and HEP, is preparing a Mission Need Statement (CD-0) for the purpose of replacing aged, obsolete, and severely deteriorated aspects of the laboratory's systems and facilities infrastructure, **with modern, world-class facilities for particle physics research through the current P5, and into the next.**

IERC is funded through the SLI program

- On July 16, 2019, Fermilab received authorization to start construction of the IERC.
- IERC will be Fermilab's largest purpose-built laboratory and office building since Wilson Hall was completed in 1974. The **building will integrate engineering resources** currently scattered across the laboratory **and provide state-of-the-art facilities** that will enable the design and construction of high-performance particle physics detectors.

Fermilab: IB4/MP9 Cleanroom & Facilities Consolidation

SCOPE

PROJECT SCOPE
- Removal of existing vacuum furnaces, ovens and welding glove box at MP9 to free up footprint for new cryomodule assembly cleanroom.
- Retrofit of IB4 with equipment removed from MP9
- Addition of HPR clean room in IB4 dedicated to 650 MHz PIP-II cavities
- Expand the existing MP9 cryomodule assembly cleanroom for PIP-II
- 1500kVA Transformer & Switch Acquisition

DRIVING CONSIDERATIONS
- PIP-II is in need of a new, larger and dedicated clean room for cryomodule assembly and one for vertical HPR
- Consolidate all SRF cavity processing facilities for both R&D and project & production activities at IB4, improving efficiency and reducing risk.
- Consolidation of clean rooms for cryomodule assembly in MP9, improving efficiency.

CAMPUS MASTER PLAN ALIGNMENT
Reinforces *Campus Master Plan: Guiding Principles* to support cutting-edge research and build new capabilities to support groundbreaking particle physics and accelerator science research.

RISKS / ALTERNATIVES

ASSOCIATED RISKS
- Challenge to meet PIP-II deliverables on schedule
- Risk of cost increase and schedule delays to PIP-II due to inadequate cleanroom facilities for high pressure rinse (HPR) and cleanroom assembly
- Inefficiency due to facilities spread across all campus

ALTERNATIVES CONSIDERED / RECOMMENDED
1. Utilize existing building infrastructure to execute PIP-II deliverables. Not recommended: Additional strain on existing facilities with delays to project schedule.
2. Construct separate facility. Not recommended: not cost effective.

COST

TOTAL PROJECT COST FY20
$3,400,000

FUNDING SOURCE/STATUS
HEP / Funded

PROJECT PLAN STATUS
In process

DEMOLITION INCLUDED
Demolition to retrofit interior spaces at IB4/MP9 is included.

IMPACT ON OPERATING COSTS
Consolidation of clean rooms for cryomodule assembly in MP9 and SRF cavity processing in IB4 will substantially improve operational efficiency, potential reduction of 1 technician/year.

SLAC: Sector 30 Transfer Line (S30XL)

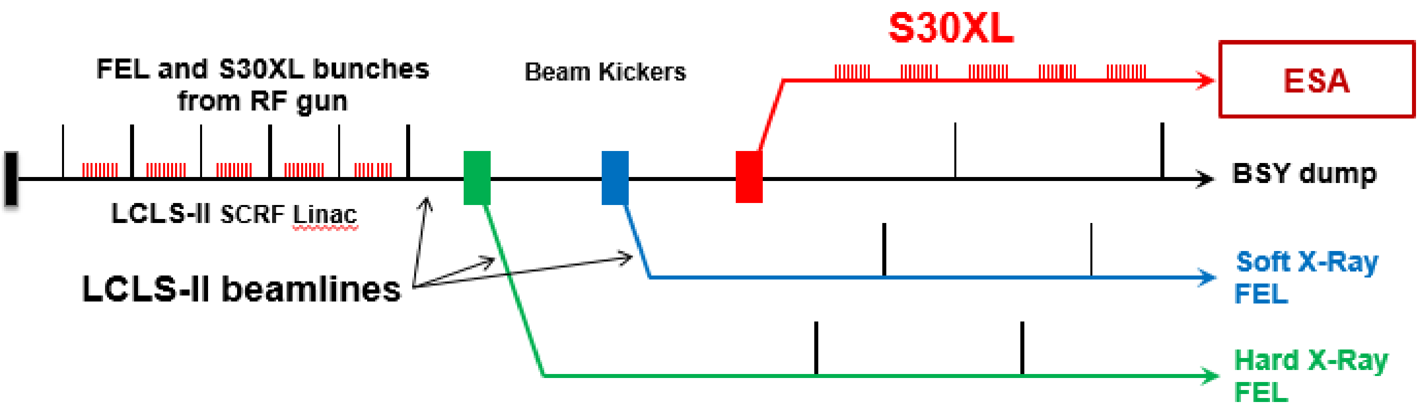
SCOPE

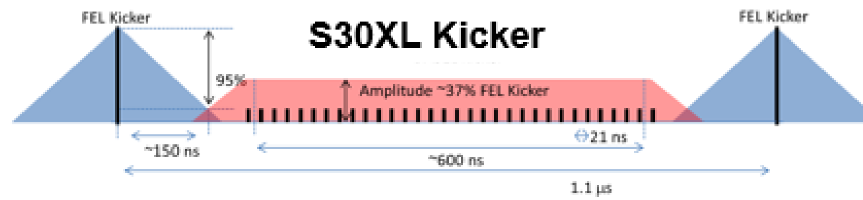
PROJECT SCOPE

- Construct an 80 meter beam line that connects to Linac Coherent Light Source (LCLS)-II SRF in order to extract dark current for science and test beam studies parasitic to the LCLS-II FEL DOE BES program

DRIVING CONSIDERATIONS

- Beamline will be first stage of a connection between the Continuous Wave LCLS-II SRF linac and End Station A in support of HEP experiments.
- Beamline will transport 4 to 8 GeV electrons with average currents up to 1 mA and a 50% duty cycle.
- Beamline operation ***must*** remain parasitic to LCLS-II Free Electron Laser operation and is expected to be available ~5,000 hours/year.





COST

TOTAL PROJECT COST FY20
$3,563,000 construction + $400,000 design + $1,262,000 Contingency

FUNDING SOURCE/STATUS
HEP AIP ($4,655,000) / SLAC PSF ($300,000)

PROJECT PLAN STATUS
In design

DEMOLITION INCLUDED
None

IMPACT ON OPERATING COSTS
$200,000/FY – general maintenance and operations for Stage A

RISKS / ALTERNATIVES

ASSOCIATED RISKS

1) Interference with LCLS-II operations
2) Extraction kicker limited in pulse length or repetition rate

RISK MITIGATION STRATEGY

1) Review design and interference mitigation with LCLS-II management and operation teams
2) Continued R&D with improved power transistors to meet high power design goals; reduce effective duty until goals are achieved.

ALTERNATIVES CONSIDERED / RECOMMENDED

1. Do nothing, utilize other GeV-class low current beams from other laboratories. Not recommended: only other CW e-source is JLab and it is heavily oversubscribed.
2. Construct separate facility to generate GeV-class low current beams. Not recommended: not cost effective.

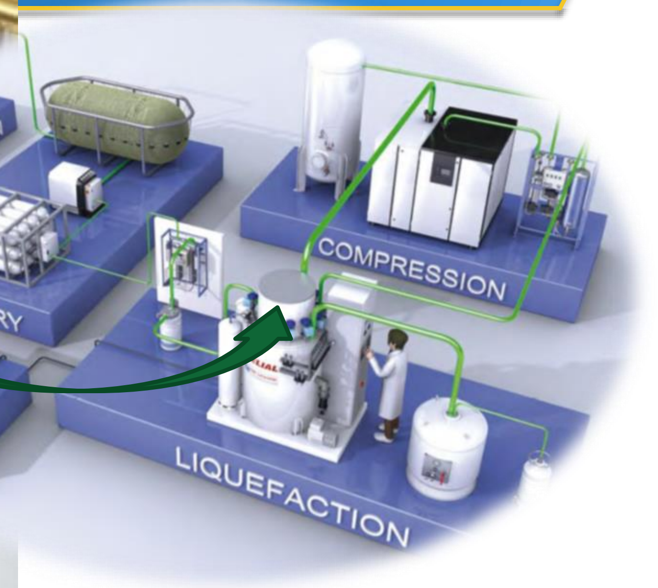
LBNL: Berkeley Center for Magnet Technology Helium Liquefier

SCOPE

PROJECT SCOPE
- Procurement of a new liquefier and associated plumbing and electrical connections. Removal of >40-year-old liquefier, preparation of site for new liquefier, installation of new liquefier and connection to existing Helium storage and recovery lines. Commissioning of new liquefier and associated systems.

DRIVING CONSIDERATIONS
- Improved performance of helium liquefier (higher efficiency, higher capacity, reduced maintenance & operational support), enabling faster, more cost-effective, and a higher number of magnet tests. Smaller per-test operating cost due to reduced maintenance and technical oversight costs.

CAMPUS MASTER PLAN ALIGNMENT
- LBNL long-term goal of a sustainable approach to helium stewardship, via broad and efficient helium gas recapture, purification, storage, & liquefaction.



COST

TOTAL PROJECT COST FY20
$3,940,000 (includes 35% contingency)

FUNDING SOURCE/STATUS
HEP - Partially funded

PROJECT PLAN STATUS
In process

DEMOLITION INCLUDED
Removal of existing old liquefier, site prep for new liquefier.

IMPACT ON OPERATING COSTS
Increased Liquefier usage due to enhanced performance and ease of use, offset by reduction in maintenance costs.

RISKS / ALTERNATIVES

ASSOCIATED RISKS
- Risk of failure of existing liquefier and resulting inability to perform large magnet tests;
- Risk of significant dark time between removal of old, and installation of new, liquefier, jeopardizing critical magnet tests for HEP programs

RISK MITIGATION STRATEGY (if not funded)
- Increase maintenance efforts on existing liquefier, refurbishment of helium transfer lines to reduce losses

ALTERNATIVES CONSIDERED / RECOMMENDED
- Outsource all magnet tests to other laboratories. Not recommended due to breadth of tests impacted, and potential loss of core competencies.

Infrastructure Takeaway

- **Additional investments are necessary to increase capacity and efficiency** due to
  - Increased demands on Fermilab to deliver on large-scale projects much greater size, complexity and cost than done before (LCLS-II, LBNF, PIP-II, Mu2e)
  - **Provide higher beam intensity**
  - **Manage increasing data processing and storage**
  - **Support a growing user population**
- Infrastructure support at other SC labs and institutions being assessed for impact, capability, ROI, etc.

- Funding for infrastructure needs to be factored into the next community planning process
  - HEP, SLI, Other SC, Public/Private
  - Small, Medium, Large Projects; Costs/Schedules
  - Investments made by Other Projects, Facilities, or Indirect-Support

FY 2020 Budget

Fiscal Year 2020 Federal Budget

OMB estimates Federal revenue to be $3.645 trillion

Income taxes: $1.824 trillion
Payroll taxes: $1.295 trillion
All Other: $0.508 trillion

Deficit projected at $1.092 trillion

OMB estimates the Federal government to spend $4.746 trillion

March 11, 2019: President submitted budget request

Jul 2019: Congress passed FY20/21 budget resolution

FY 2020: Congress has created continuing resolutions.

OMB estimates interest payments on National debt to be $479 billion

President requests $1.426 trillion discretionary spending

OMB estimates mandated benefits to cost $2.841 trillion

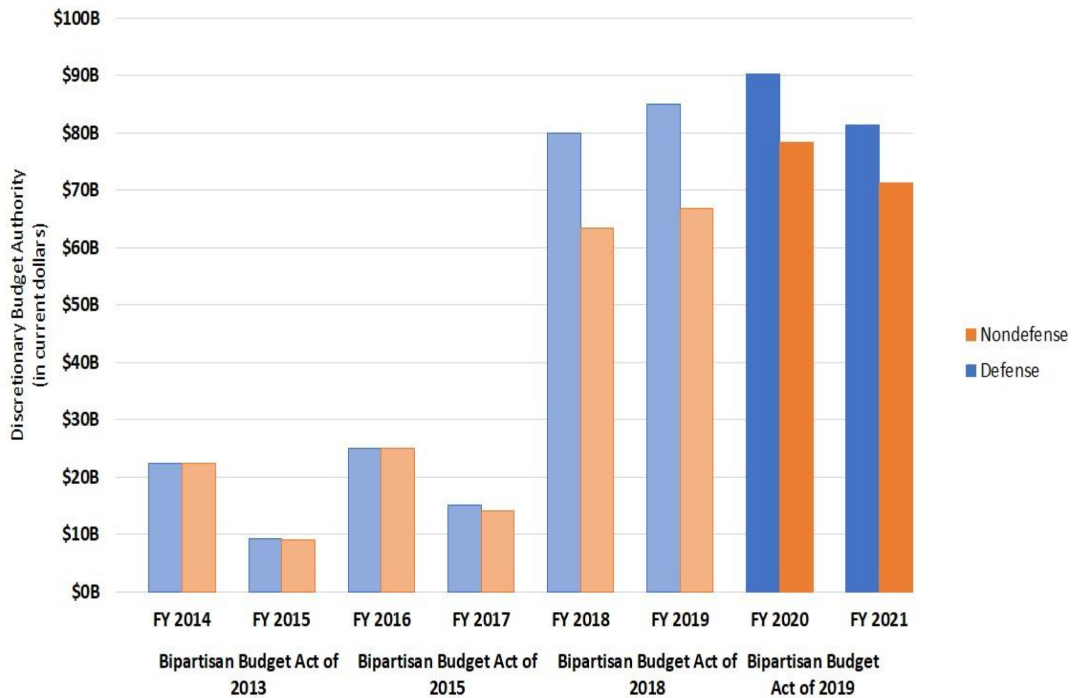
Social Security: $1.102 trillion
Medicare: $0.679 trillion
Medicaid: $0.418 trillion
All Other: $0.642 trillion

Source: https://thebalance.com

Bipartisan Budget Act of 2019 (H.R. 3877)

Signed on August 2, 2019, includes Budget Resolutions for FY 2020 and FY 2021

- The bill raises the 2011 Budget Control Act (BCA) budget caps for both defense and nondefense for FY 2020 and FY 2021, the final 2 years of the discretionary caps.

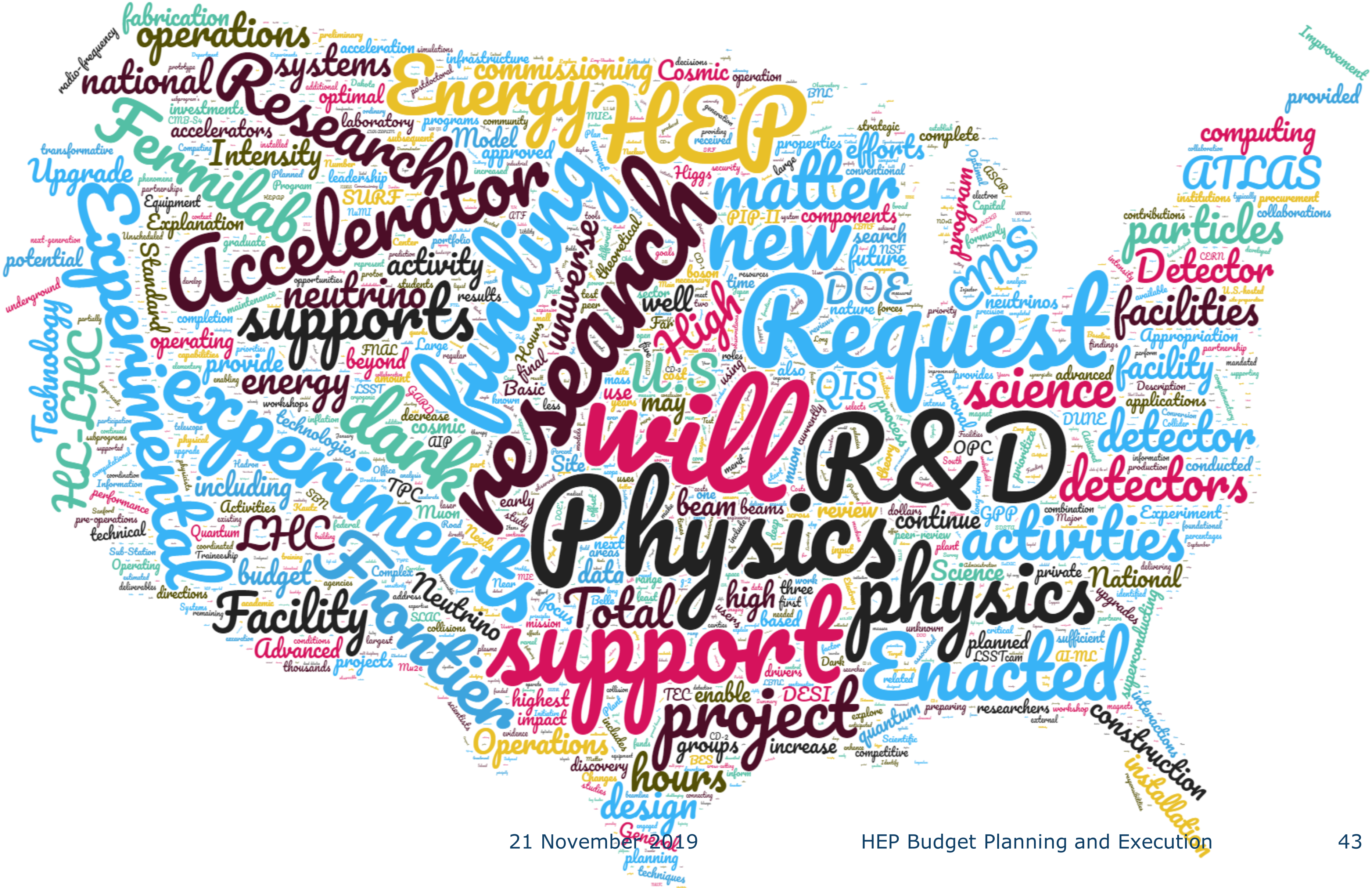


- The bill also suspends the debt ceiling through July 31, 2021 and extends cuts on certain mandatory programs from FY 2027 to FY 2029.

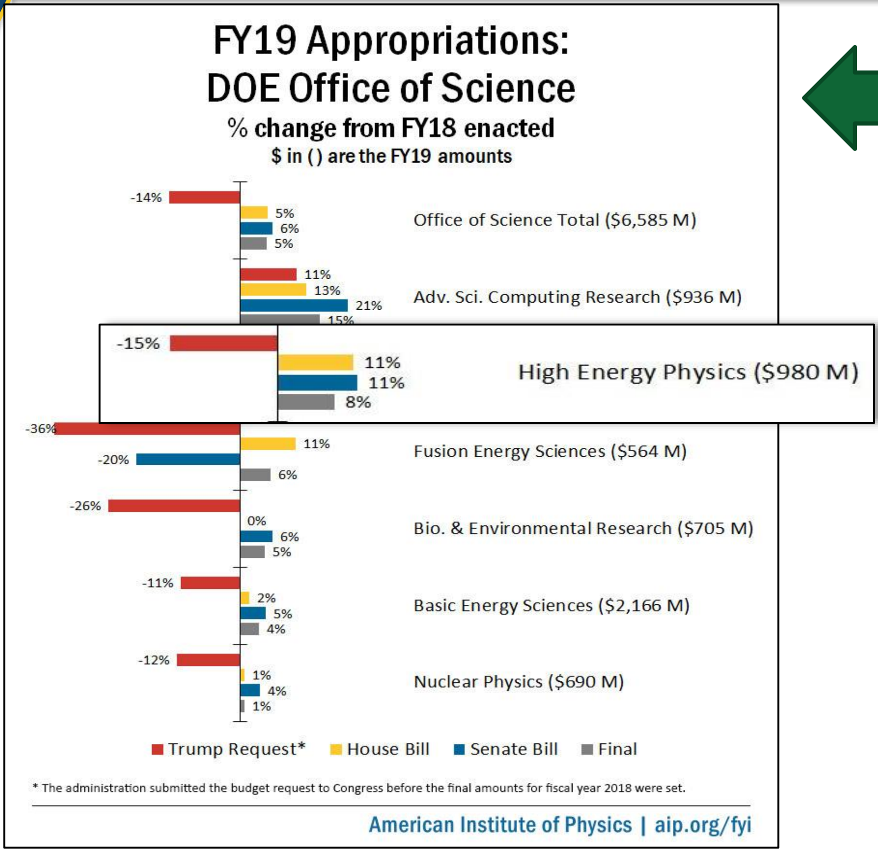
FY 2020 Continuing Resolution

- H.R. 4378: Continuing Appropriations Act, 2020, and Health Extenders Act of 2019
  - Sep 27, 2019: **President Trump signed a 7-week continuing resolution into law, delaying the possibility of another government shutdown**
  - Senate passed the CR a day earlier with 82-15 vote, and House on Sep 19 with a 301-123 vote.
  - **CR #1 funds agencies at 2019 levels through Nov. 21**, buying lawmakers more time to negotiate over several full-year appropriations bills.
- **House Democrats unveiled a new continuing resolution on Monday (Nov 18th)** aimed at keeping government running after current stopgap funding measure runs out Nov 21, 2019.
  - **CR #2 would last until Dec. 20**, giving lawmakers more time to set spending levels and pass the 12 appropriations bills. Legislation maintains FY 2019 funding levels, but does allow for 3.1% military pay raise
  - The House passed the measure on Tuesday, and it is with the Senate. The White House has indicated President Trump would sign it

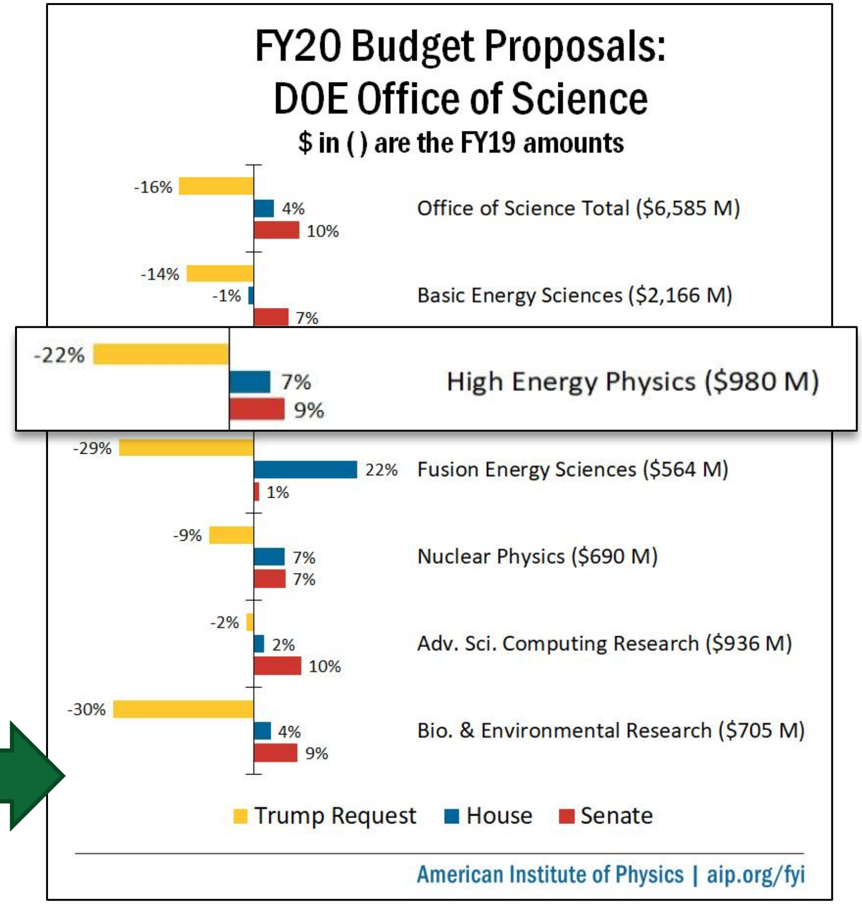
FY 2020 HEP Budget



FY 2019 vs FY 2020 Office of Science



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



Congressional Marks Indicate:

- Strong support in QIS and Artificial intelligence Research
- Increased construction funding for LBNF/DUNE and PIP-II. Strong support for HL-LHC projects.
- Increased support for Sanford Underground Research Facility

FY 2020 HEP Budget Status

	FY 2019 Enacted	FY 2020 Request	FY 2020 House	FY 2020 Senate	CR Annual Level based on FY 2019
High Energy Physics	800,000	648,038	814,000	829,000	800,000
Construction					
LBNF/DUNE	130,000	100,000	171,000	171,000	130,000
PIP-II	20,000	20,000	60,000	65,000	20,000
Mu2e	30,000*	-	-	-	-
HEP Total	980,000	672,700	1,045,000	1,065,000	950,000

- Four MIE projects received final funding in FY 2019: LZ, DESI, SuperCDMS-SNOLAB, and FACET-II. These four projects need a significant ramp up in Facilities/Operations in FY 2020.
- PIP-II received $15M of the total $35M in FY 2019 funding as Other Project Costs (OPC). Both House and Senate have indicated strong support for FY 2020, $60M and $65M respectively, which will be provided as Total Equipment Costs (TEC), if appropriated. PIP-II will only need about $2M OPC in FY 2020.
- OPC for LBNF/DUNE increases from $1M in FY 2019 to $4M in FY 2020, as planned.
- $30M from Mu2e (funding for LIC completed in FY 2019) is restricted during FY 2020 CR

Projects Transition to Operations & Research

	Project	FY 2019 Enacted	FY 2020 House Mark	FY 2020 Senate Mark	FY 2020 Full Year CR	FY 2020 CR - FY 2019 Enacted
Major Item of Equipment (MIE) and Line Item Construction Other Project Costs (LIC OPC)	LBNF/DUNE OPC	1,000	4,000	4,000	4,000	3,000
	PIP-II OPC	15,000	0	0	2,100	-12,900
	HL-LHC ATLAS	27,500	24,500	25,000	24,500	-3,000
	HL-LHC CMS	27,500	23,475	25,000	23,475	-4,025
	HL-LHC AUP	50,000	50,000	50,000	50,000	0
	LZ	14,450	0	0	0	-14,450
	SuperCDMS-SNOLAB	2,550	0	0	0	-2,550
	DESI	9,350	0	0	0	-9,350
	FACET II	10,000	0	0	0	-10,000
	CMB-S4 (OPC)	0	2,000	2,000	2,000	2,000
	Accelerator Controls (OPC)	0	1,000	1,000	0	0
	Other Projects	1,000	0	2,700	1,000	0
LIC Total Equipment Cost (TEC)	LBNF/DUNE	130,000	171,000	171,000	130,000	0
	PIP-II	20,000	60,000	65,000	20,000	0
	Mu2e	30,000	0	0	0	-30,000
	Project Subtotal	338,350	335,975	345,700	257,075	-81,275
	Total	980,000	1,045,000	1,065,000	950,000	-30,000

- Net reduction from FY 2019 to FY 2020 for MIEs (and LIC OPC) is more than $50M. For FY 2020, about two-thirds of the $50M is being redirected to Facilities/Operations (Cosmic Frontier, Fermilab Accelerator Complex, FACET-II, SURF, and Test Facilities). About one-sixth is being redirected to core Research. HEP will retain at headquarters the remaining fraction as contingency (operations and research).

Consequences of FY 2020 Full-Year CR

- **Core Research**
  - FY 2020 planned funding at the Annualized CR **level is a modest 2% above the FY 2019 final funding**. This plan will be executed conservatively while we await a full-year appropriations
  - HEP has also communicated that **funding is insufficient to reap the full scientific/technology benefits of the P5 project investments**, to develop new research and technology concepts in preparation for the next HEP long-range strategic planning beginning in 2022, **to address critical workforce needs**, and **to maintain a leading position in key accelerator technologies**.
- **Facilities and Experimental Operations**
  - FY 2020 planned funding at the Annualized CR level is **17% above the FY 2019 final funding**
  - But the **planned funding does not meet the Critical Needs** of the HEP program
    - **Fermilab Accelerator Complex at 7 months (1 month less than optimal).** Will address maintenance risks, commissioning for Mu2e, and computing needs.
    - **FACET-II at 3 months (3 months less than optimal).** First year of running, a one-time delayed start may be acceptable
    - **LSST Installation & Commissioning, Facility, and DESC Operations are not fully supported**

- **LBNF/DUNE and PIP-II LIC are held at FY 2019 levels**
  - Working with Fermilab, Project, SC Management on options to prevent the projects from slowing down
- No new starts
  - Typically applies to >5M projects that do not request funding before FY 2020 PBR
- Targeted Initiatives
  - Assumption is made that increased or new funding for Quantum Information Science (including **QIS Centers**) and Artificial Intelligence will be provided in the FY 2020 appropriations.
- The FY2020 budget request includes funds in HEP, BES, and ASCR for at least one jointly-supported and multidisciplinary **QIS Center**, as per the National Quantum Initiative Act signed into law in Dec 2018
  - DOE published a “Notice of Intent” and “Request for Information” in the Federal Register on May 20th. Comments closed on July 5th

FY 2021 Budget

- The Bipartisan Budget Act of 2019 has already set authorization levels for FY 2021.
- DOE has submitted the FY 2021 budget request to OMB. A briefing by HEP to the new OMB examiner was given on Sep 13th. The pass-back from OMB is typically in late November or early December.
- Independent of the details of the FY 2021 President's Request, there are looming issues for FY 2021 including
  - Possible year-long Continuing Resolution
  - Election year
  - …

Budget R&D Priorities

1. American Security
2. American Leadership in Industries of the Future
3. American Energy and Environmental Leadership
4. American Health & Bioeconomic Innovation
5. American Space Exploration and Commercialization

Crosscutting Action Priorities

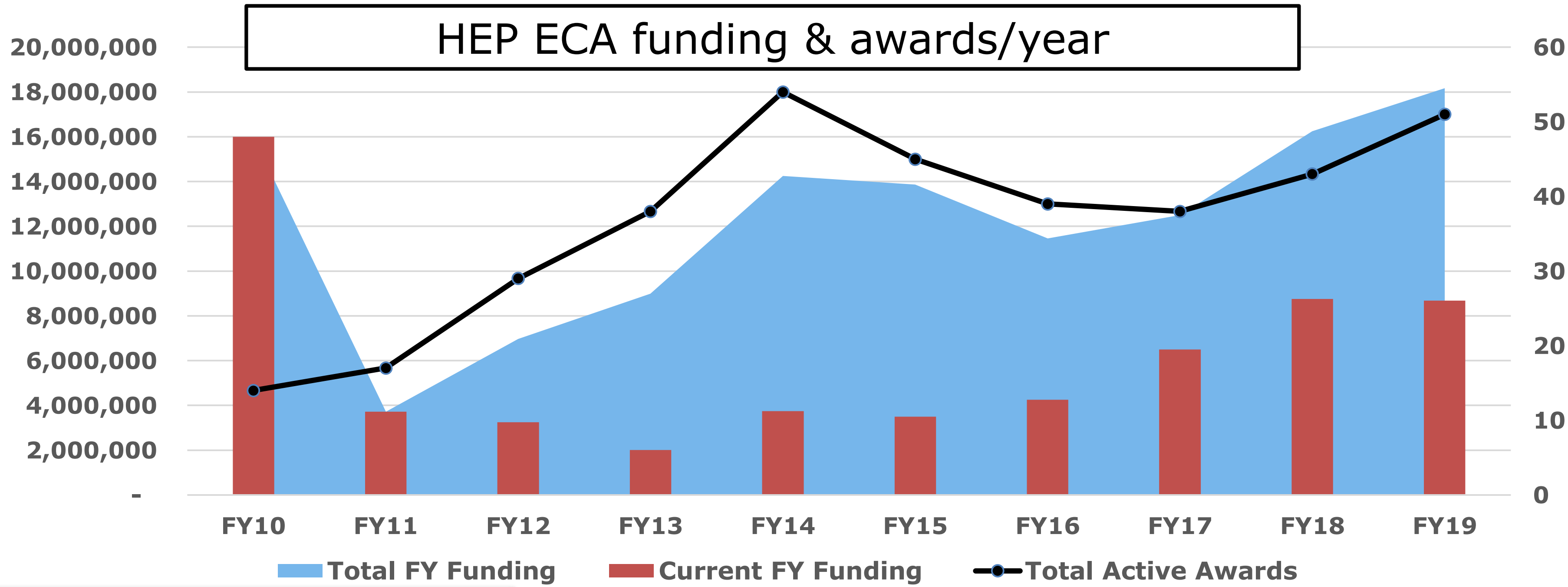
1. Build and Leverage a Diverse, Highly Skilled American Workforce
2. Create and Support Research Environments that Reflect American Values
3. Support Transformative Research of High Risk and Potentially High Reward
4. Leverage the Power of Data
5. Build, Strengthen, and Expand Strategic Multisector Partnerships

HEP Overlap with White House FY 2021 R&D Priority Areas and Practices

- **Semiconductors: Working in collaboration with industry and academic partners, where appropriate**
  - Prioritize investments that will enable whole of government access to trusted and assured **microelectronics for future computing and storage paradigms**
- **Artificial Intelligence, Quantum Information Science, and Computing:**
  - Prioritize basic and applied research investments that are consistent with 2019 Executive Order on **Maintaining American Leadership in Artificial Intelligence** and the 8 strategies detailed in 2019 update of the National Artificial Intelligence Research and Development Strategic Plan
  - **Prioritize R&D advancing fundamental QIS**, building and strengthening the workforce, engaging industry, and providing infrastructure supporting QIS while **coordinating relevant activities to ensure intelligence, defense, and civilian efforts grow synergistically**
  - Explore new applications in and **support R&D for high performance future computing paradigms, fabrication, devices, and architectures** alongside sustainable and interoperable software; data maintenance and curation; and appropriate security.
- **Build and Leverage a Diverse, Highly Skilled American Workforce**
  - **Prioritize efforts to build strong foundations for STEM literacy**, to **increase diversity, equity, and inclusion**, and to prepare the STEM workforce, including college-educated STEM workers and those working in **skilled trades that do not require a four-year degree**
  - Build R&D capacity at institutions that **serve high proportions of underrepresented or underserved groups**
- **Support Transformative Research of High Risk and Potentially High Reward**
  - Support risk taking in their R&D investments and within the communities they support, and they should ensure that review processes fully consider the possible rewards, risks, and **benefits of failure for potentially transformative research.**
- **Build, Strengthen, and Expand Strategic Multisector Partnerships**
  - Partnerships with academic institutions, established and startup businesses nonprofit institutions, and others involved in the U.S. S&T enterprise are instrumental to building and leveraging our Nation's innovation capacity and lie at the core of success for the Second Bold Era of S&T.
  - Prioritize investments and policies that facilitate or strengthen multisector partnerships, including partnerships that **engage institutions seeking to build S&T capacity**

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)
- 105 total awards to date: 61 University and 45 National Labs



HEP Early Career FY10-19 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)	FY17 (L/U)	FY18 (L/U	FY19 (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 (1/1)	3 (2/1	3 (2/1)	21 (8/13)
Intensity	2 (1/1)	1 (0/1)	3 (2/1)	1 (0/1*)	1 (1/0)	2 (1/1)	1 (1/0)	2 (2/0)	2 (2/0	1 (0/1)	16 (10/6)
Cosmic	2 (0/2)	3 (2/1)	3 (1/2)	2 (1/1)	1 (0/1)	0 (0/0)	1 (0/1)	2 (1/1)	2 (0/2	3 (0/3)	19 (5/14)
HEP Theory	6 (1/5)	4 (0/4*)	3 (0/3)	3 (1/2)	1 (0/1)	3 (0/3)	1 (1/0)	2 (0/2)	3 (0/3	3 (1/2)	29 (4/25)
Detector	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	1 (1/0)	2 (2/0	2 (2/0)	5 (5/0)
Accelerator	1 (1/0)	2 (2/0)	2 (1/1)	1 (0/1)	1 (1/0)	0 (0/0)	2 (2/0)	2 (2/0)	1 (0/1	2 (2/0)	14 (11/3)
QIS	NA	NA	NA	NA	NA	NA	NA	NA	1 (1/0	0 (0/0)	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 (7/4)	14 (7/7)	14 (7/7)	105 (44/61)
Proposals	154 (47/107)	128 (43/85)	89 (34/55)	78 (29/49)	77 (36/41)	73 (27/46)	84 (27/47)	83 (26/57)	92 (35/57	92 (28/64)	950 (332/618)

* 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).

Closing Remarks on Budget

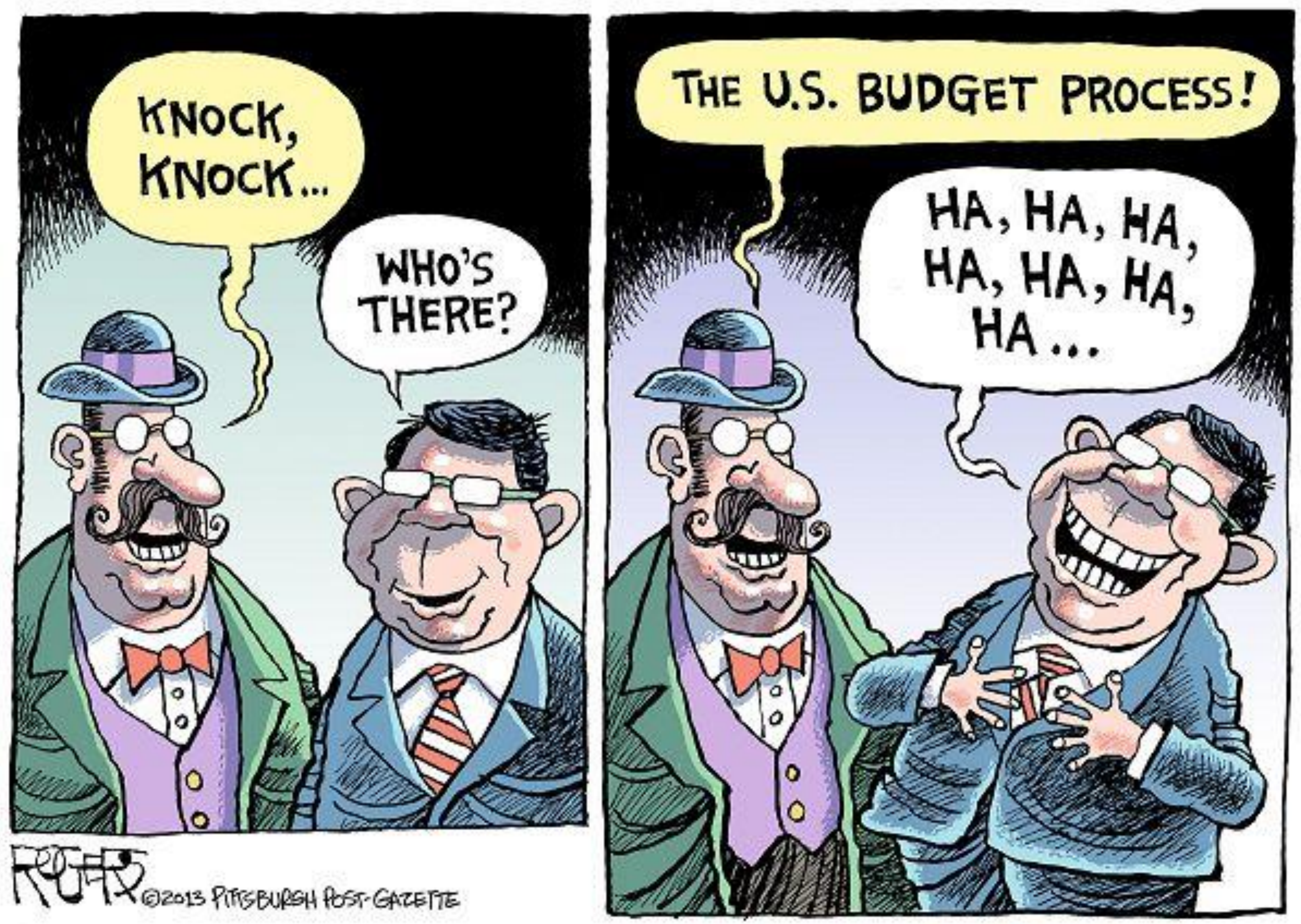
- The annual Federal budget process is long and complex
  - Excursions from “standard order” are possible
  - The community-driven P5 strategy plays an important role in all phases of the process
- Broad support is enabling us to implement the P5 strategic plan and achieve its vision!
  - Many thanks to the DOE Management, the Administration, and Congress for their support
  - SC programs in QIS, Computing, and Science Laboratories Infrastructure (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

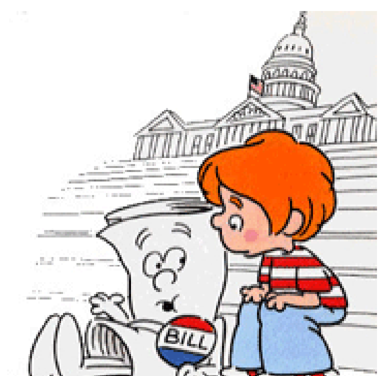
Office of
Science

Few Minutes on the U.S. Budget Process



Budget and Accounting Act of 1921

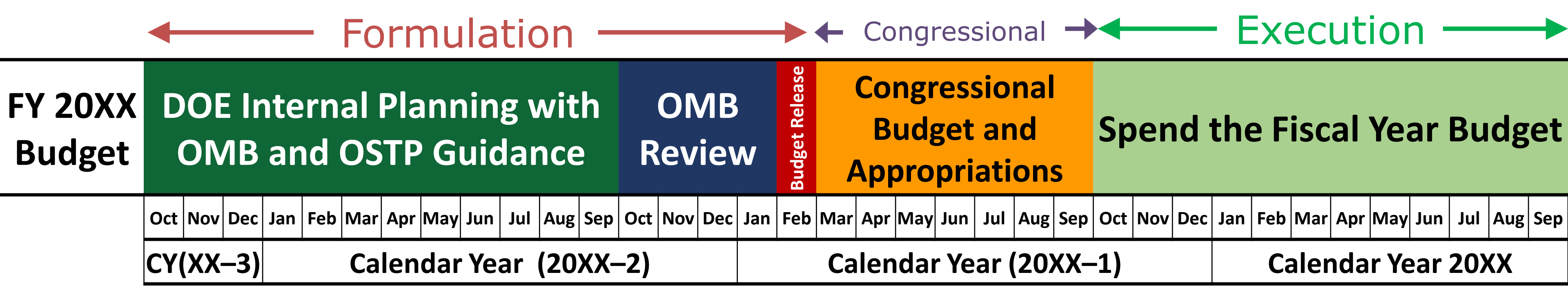
- Before the Budgeting & Accounting Act of 1921, no single government entity oversaw the entire budget
  - Departments submitted budget requests directly to Congress
- After WWI, the Act was passed to provide more control over government expenditures
  - Budgeting debates hinge on powers given to Congress 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

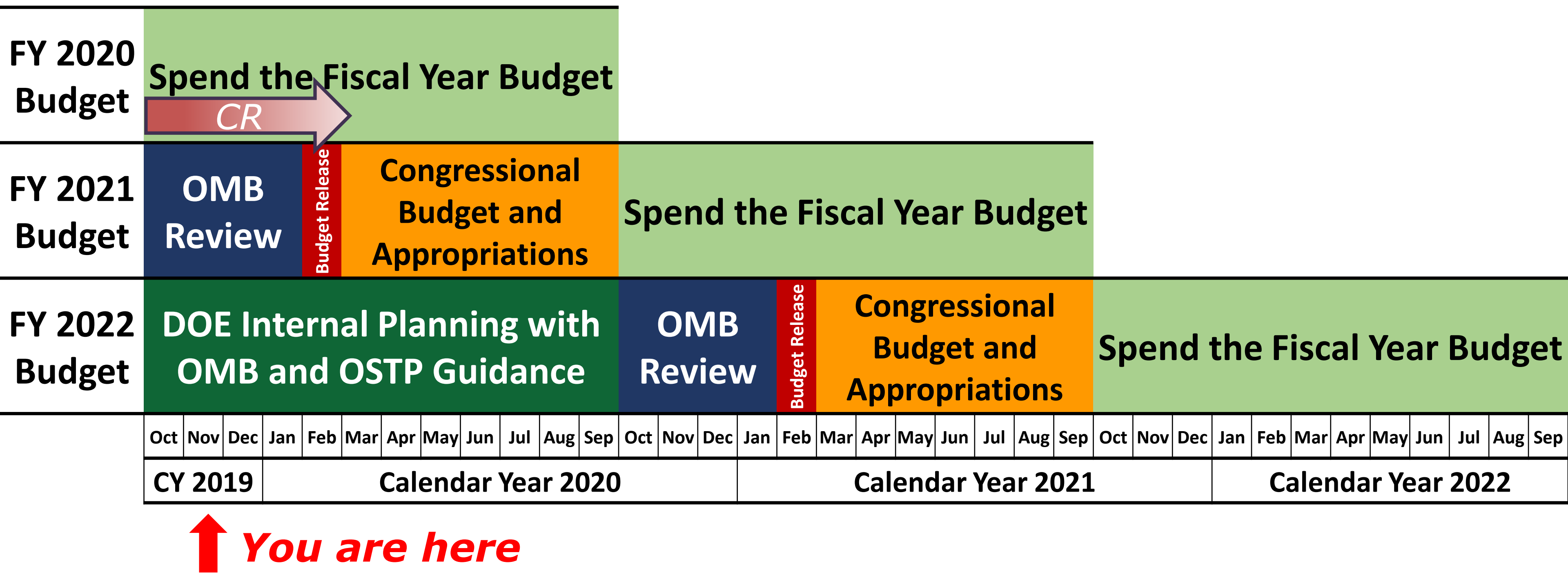
Three Phases of Budget Process

- **Formulation**: Executive branch prepares the President's Budget Request (PBR)
  - 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



Overview of Budget Formulation Process

Spring
- → **OMB** provides policy guidance for Executive branch agency budget requests
  - Absent more specific guidance, agencies start with out-year estimates from previous budget

Spring & Summer
- → **OMB** works with agencies
  - Identify major issues, develop plans for fall review, plan analysis of issues that will require decisions

June
- → **OMB** provides detailed instructions for submitting budget material

Sept.
- → Agencies submit budgets to **OMB**
- → **OMB** reviews budget proposals
  - Considers Presidential priorities, program performance, budget constraints

Fall
- → **OMB** provides recommended budget proposal to President and provides pass back to agencies

Late Nov.
- → December: Agencies may appeal to **OMB** and President

Dec.
- → January: Agencies prepare and **OMB** reviews final congressional budget justification materials

Jan.
- → February: President transmits budget to Congress

Creating the DOE HEP Budget Request

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

White House

White House Priorities

OMB Directives


FISCAL YEAR 2019
EFFICIENT, EFFECTIVE, ACCOUNTABLE
AN AMERICAN BUDGET
BUDGET OF THE U.S. GOVERNMENT
OFFICE OF MANAGEMENT AND BUDGET | OMB.GOV

"Thread the needle"

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 (PBR)
  - 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
  - Informational request for additional details
  - Respond to requests regarding impact of alternative funding decisions

Congressional Budget and Impoundment Control Act of 1974 [aka CBA]

- Prior to 1974, Congress had no formal process for establishing a federal budget. The Act was passed in response to feelings in Congress that President Nixon was **abusing his power of impoundment** by withholding funding of programs he opposed.
- CBA **created the Congressional Budget Office** (CBO), which gained more control of the budget, limiting the power of the OMB.
- Established **timetable for the budget process**, and **Committees on the Budget** in the House and Senate
- The Act passed easily while the administration was embroiled in the Watergate scandal and was unwilling to provoke Congress.

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

Authorizations and Appropriations

Basic Purposes of Authorization

- **Establish/continue/modify** federal programs
- Provide Congress **budget authority and guidance** for appropriations

Direct or Mandatory Spending

- **Mandatory spending** is done automatically based on eligibility or formula, includes entitlement programs like Medicare and Social Security
- **Authorization must change** to reduce funding; not part of annual appropriation process

Annual Appropriations

- **Discretionary spending** determined by appropriations process, includes National defense, food safety, education, and science research
- Provided in **12 appropriation acts**, it is less than 1/3 of current federal expenditures

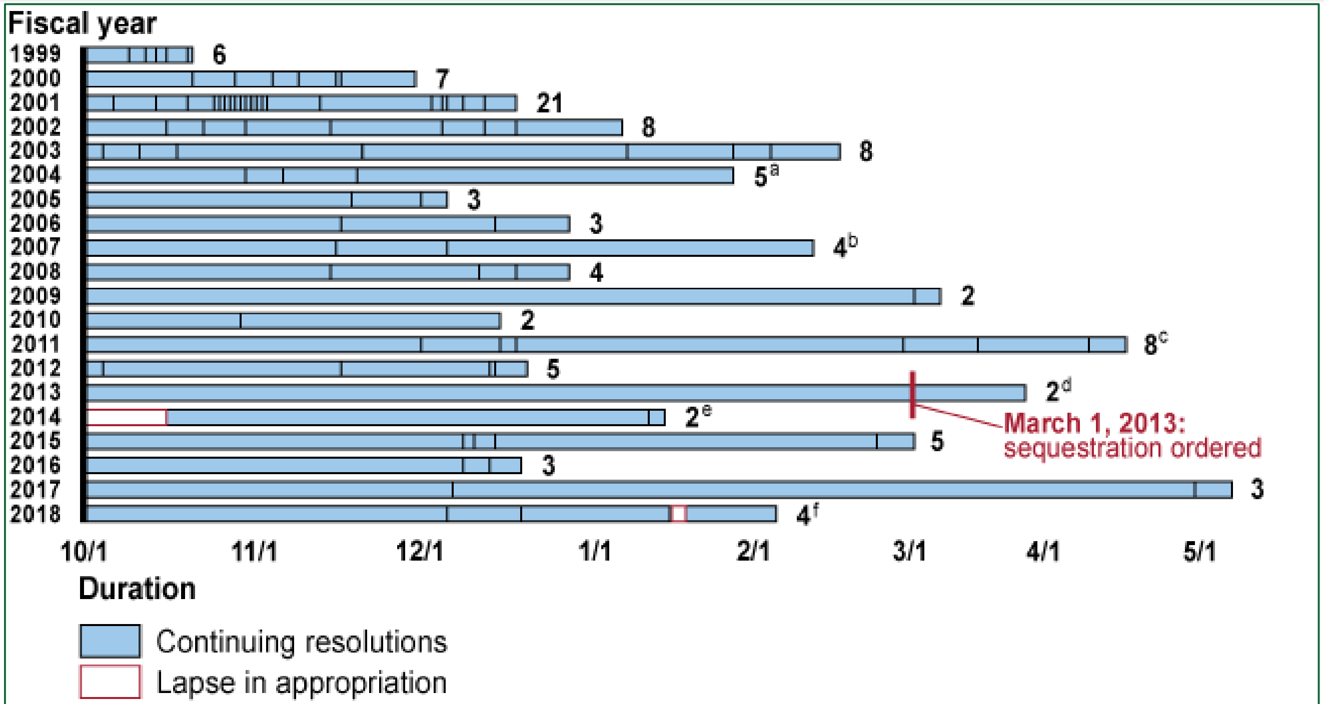
Renewing Authorizations

- **Reauthorization** can extend a program
- Unless prohibited, **new appropriations** may also extend a program

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: FY 1999 – FY 2018



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).

I will discuss FY 2019 & 2020 in later slides…

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.

FY 2019 Budget

Fiscal Year 2019 Federal Budget

OMB estimated Federal revenue to be $3.438 trillion

Income taxes: $1.698 trillion
Payroll taxes: $1.242 trillion
All Other: $0.496 trillion

FY 2019 deficit projected at $1.092 trillion

Jan 2018: Congress passed FY18/19 budget resolution

Feb 2018: President submitted budget request

Sep 2018/Feb 2019: Congress passed appropriations bills

OMB estimated the Federal government to spend $4.529 trillion in FY 2019

OMB estimated interest payments on National debt to be $393 billion in FY 2019

OMB estimated mandated benefits to cost $2.777 trillion

Social Security: $1.041 trillion
Medicare: $0.645 trillion
Medicaid: $0.419 trillion
All Other: $0.672 trillion

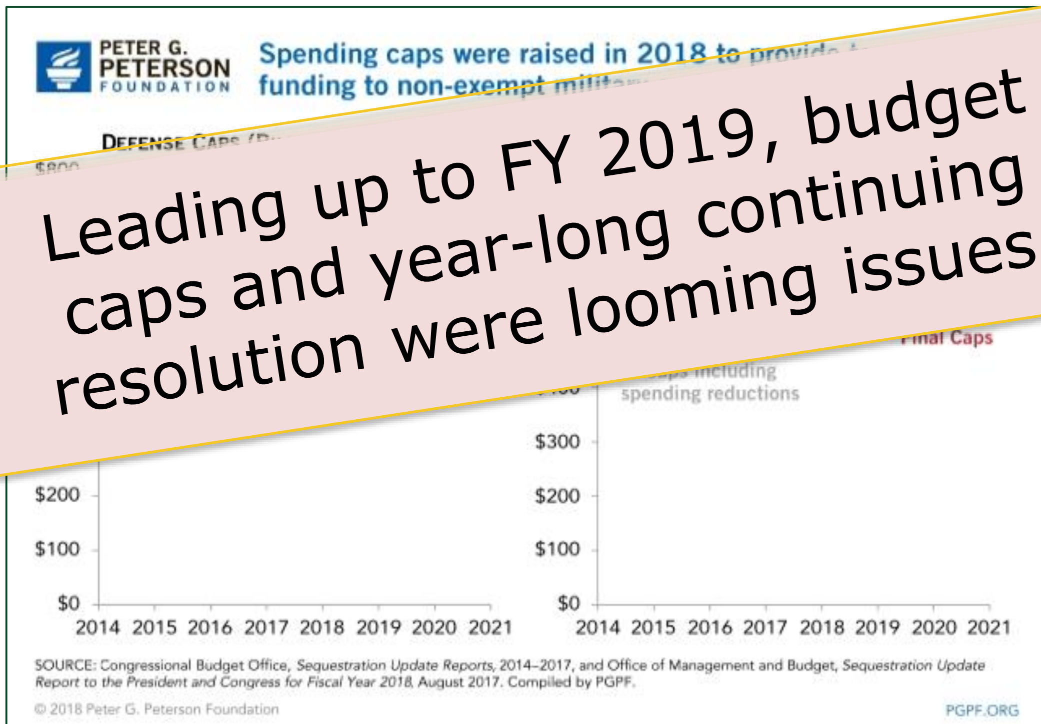
Congress approved $1.359 trillion discretionary spending for FY 2019

Source: https://thebalance.com

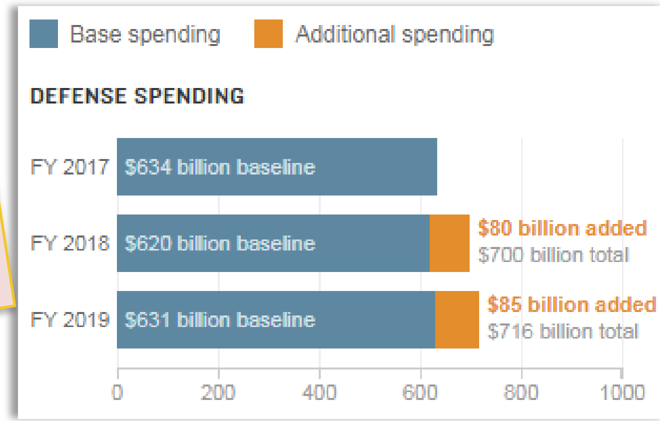
Bipartisan Budget Act of 2018 (H.R. 1892)

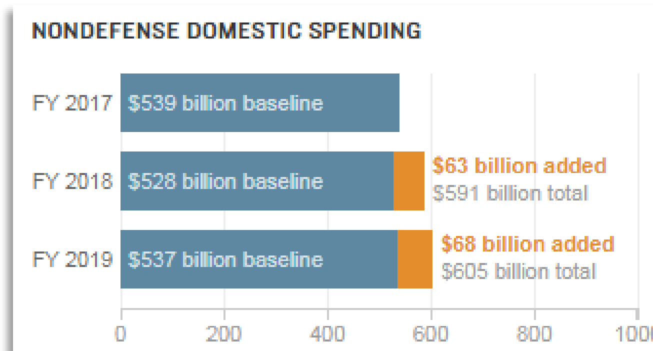
Passed on February 9, 2018, includes Budget Resolutions for FY 2018 and FY 2019

- 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 <u>over the next 10 years</u>**
- **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.



Leading up to FY 2019, budget caps and year-long continuing resolution were looming issues.





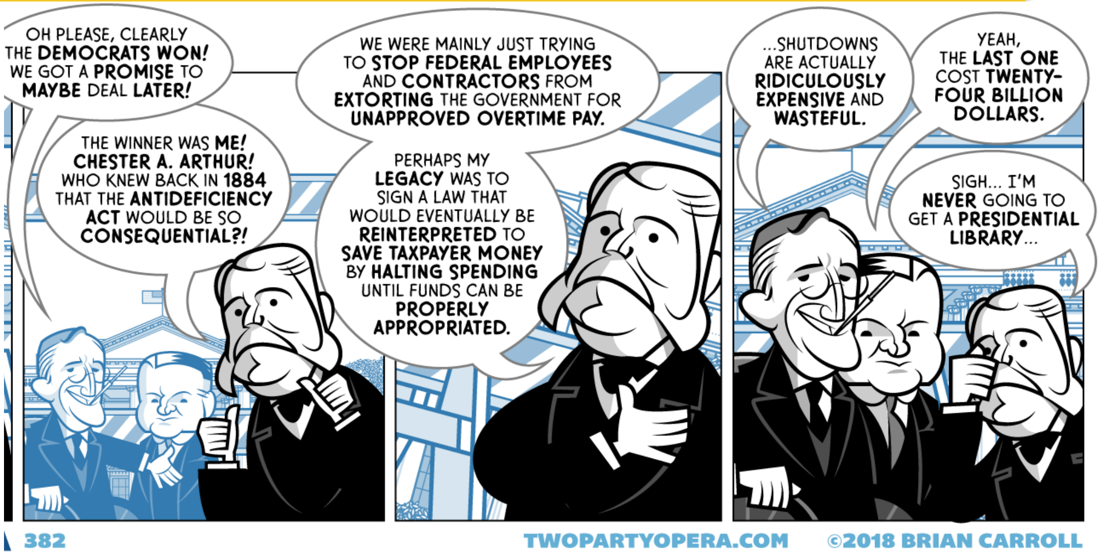

NATIONAL ARCHIVES
CLOSED
We're sorry. Due to the shutdown of the Federal Government, the Washington, DC, facility is closed.
Please check www.archives.gov for updated information.
NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

Antideficiency Act (ADA) of 1884

Current version enacted on September 12, 1982

- **It shall not be lawful for any department of the government to expend in any one fiscal year any sum in excess of appropriations made by Congress for that fiscal year**, or **to involve the government in any contract for the future payment of money in excess of such appropriations**

- ADA has its roots in post-Civil War.
  - Many agencies, particularly the military, would **intentionally run out of money**, obligating Congress to provide additional funds to avoid breaching contracts.
  - Some agencies went so far as to **spend their entire budget in the first few months of the fiscal year**, funding the rest of the year after the fact with additional appropriations from Congress.



- To some extent, but not entirely, it implements the provisions of Article One of the United States Constitution, Section 9, Clause 7 (the "power of the purse"): **"No money shall be drawn from the treasury, but in consequence of appropriations made by law."**
- The Government Accountability Office, inspectors general, and individual agencies investigate potential violations of the ADA every year. The act has ramifications for agencies and individual employees alike.
  - Although **no one has ever been convicted or indicted for ADA violation**, **punitive administrative actions are routinely taken against government employees.**
- The **ADA is cited as the reason for a government shutdown** when Congress misses a deadline for passing an interim or full-year appropriations bill.

Government Shutdown

- **Until 1980, there was no such thing as a "government shutdown."** When presidents didn't have cash, they spent on credit. If Congress failed to pass a budget on time, federal agencies just carried on with work until appropriated funding was authorized retroactively.
- **Benjamin Civiletti, Pres. Carter's attorney general**, was asked for a legal opinion on what exactly the federal bureaucracy is supposed to do when Congress doesn't pass a budget by deadline, as they did every fiscal year of Pres. Carter's presidency.
- On April 25, 1980, he wrote to Pres. Carter "**My Dear Mr. President; It is my opinion that, during periods of 'lapsed appropriations,' no funds may be expended except as necessary to bring about the orderly termination of an agency's functions."**
  - Expenditure of additional funds without congressional approval would violate the Antideficiency Act
- The law's language was "plain and unambiguous," and that it **barred agencies** from "**incurring pay obligations once its authority to expend appropriations lapses**." The only legitimate use for funds once a budget deadline has passed is **to facilitate an "orderly termination"**, the reason federal employees get to go into work for a few hours to batten down the proverbial hatches on the first day of a shutdown.
- In a second legal opinion on the matter, Civiletti carved out exemptions to his austere, "either exists or it does not" rule. **The Executive has the constitutional "leeway to perform essential functions and make the government 'workable'"**—this is the reason "essential" air traffic controllers still go to work while most of "nonessential" NASA stays home.

How Many Times Has the Government Shutdown?

- Since the passage of the Congressional Budget and Impoundment Act of 1974, there have been 22 gaps in budget funding
- Before 1980, the government did not shut down but rather continued normal operations through six funding gaps.
- Since 1981, ten funding gaps of three days or less have occurred, mostly over a weekend when government operations were only minimally affected.
- There have been 4 “true” shutdowns where operations were affected for **more than one business day**.
- The first two happened in the winter of 1995-1996, when President Bill Clinton and the Republican Congress were unable to agree on spending levels and shut down the government twice, for a total of 26 days.
- The third was in 2013 when the House and Senate standoff on funding the Affordable Care Act resulted in a 16-day shutdown.

Government shutdowns, 1976–2018

YEAR	DAYS OF SHUTDOWN	PRES.	SEN.	HOUSE	FURLOUGHED?
1976	12	Ford	D.	D.	No
1977	14	Carter	D.	D.	No
1977	10	Carter	D.	D.	No
1977	10	Carter	D.	D.	No
1978	19	Carter	D.	D.	No
1979	13	Carter	D.	D.	No
1980	1	Carter	D.	D.	Yes
1981	3	Reagan	R.	D.	Yes
1982	3	Reagan	R.	D.	No
1982	5	Reagan	R.	D.	No
1983	4	Reagan	R.	D.	No
1984	4	Reagan	R.	D.	No
1984	3	Reagan	R.	D.	Yes
1986	3	Reagan	R.	D.	Yes
1987	3	Reagan	D.	D.	No
1990	5	Bush	D.	D.	Yes
1995	7	Clinton	R.	R.	Yes
1995–96	21	Clinton	R.	R.	Yes
2013	17	Obama	D.	R.	Yes
2018	3	Trump	R.	R.	Yes
2018	1	Trump	R.	R.	No
2018–19	35	Trump	R.	D.	Yes

- The fourth (partial) shutdown, starting Dec 22, 2018 and lasted 35 days, centered on a dispute over border wall 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

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**

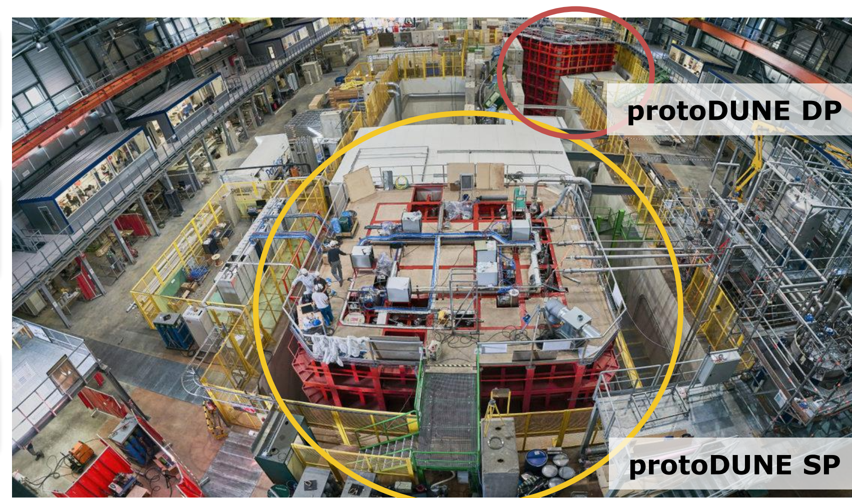
- **LBNF/DUNE:** Far Site civil construction for the excavation of the underground equipment caverns and connecting drifts (tunnels). In addition, the project will continue to do design work for the Near Site, cryogenic systems, and the DUNE detectors.
- **Mu2e:** Completion of the procurements and the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

Anode Plane ASM (Wisconsin, PSL)

2019: Far Site Primary Excavation Begins

2022: First Module Installation Begins

2026: Neutrino Beam + 2 Far Detectors



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.

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**

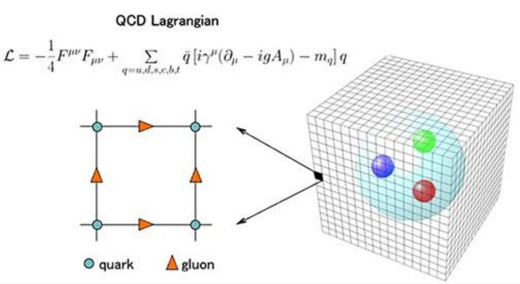
- **GARD:** World-leading research activities in the areas of accelerator and beam physics, advanced acceleration concepts, particle sources and targetry, radio-frequency acceleration technology and superconducting magnet and materials. The Traineeship Program for Accelerator Science and Technology will 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.

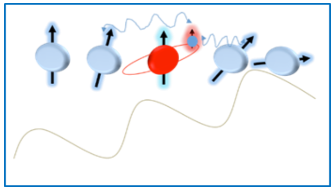
Theoretical, Computational, and Interdisciplinary Physics FY 2019 Program

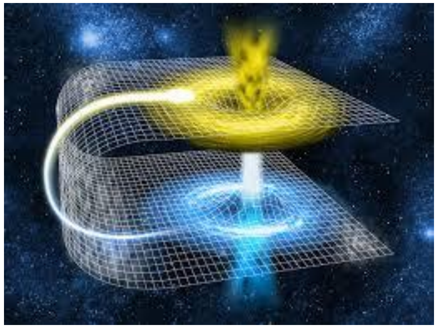
Theoretical, Computational, and Interdisciplinary Physics ($ in K)	**FY 2017 Actual**	**FY 2018 Actual**	**FY 2019 Enacted**	**FY 19 vs. FY 18**
Research	55,713	73,164	86,611	+13,447
Theoretical Physics	*44,848*	*46,664*	*45,760*	*-904*
Computational HEP	*7,924*	*8,500*	*13,351*	*+4,851*
Quantum Information 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.







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.

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.

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.

HEP Early Career FY10-19 Demographics

M= Male F= Female

Subprogram Awards	FY10 (M/F)	FY11 (M/F)	FY12 (M/F)	FY13 (M/F)	FY14 (M/F)	FY15 (M/F)	FY16 (M/F)	FY17 (M/F)	FY18 (M/F)	FY19 (M/F)	Total (M/F)
Energy	3 (2/1)	3 (2/1)	1 (1/0)	2 (1/1)	2 (1/1)	0 (0/0)	2 (2/0)	2 (2/0)	3 (2/1)	3 (1/2)	21 (14/7)
Intensity	2 (1/1)	1 (1/0)	3 (1/2)	1 (0/1*)	1 (1/0)	2 (2/0)	1 (0/1)	2 (2/0)	2 (2/0)	1 (0/1)	16 (10/6)
Cosmic	2 (2/0)	3 (3/0)	3 (2/1)	2 (2/0)	1 (1/0)	0 (0/0)	1 (1/0)	2 (1/1)	2 (0/2)	3 (2/1)	19 (14/5)
HEP Theory	6 (6/0)	4 (3/1*)	3 (3/0)	3 (3/0)	1 (1/0)	3 (2/1)	1 (1/0)	2 (0/2)	3 (3/0)	3 (2/1)	29 (24/5)
Detector	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	0 (0/0)	1 (1/0)	2 (2/0)	2 (2/0)	5 (5/0)
Accelerator	1 (0/1)	2 (2/0)	2 (2/0)	1 (1/0)	1 (0/1)	0 (0/0)	2 (2/0)	2 (2/0)	1 (1/0)	1 (1/1)	12 (9/3)
QIS	NA	NA	NA	NA	NA	NA	NA	NA	1 (1/0)	0 (0/0)	1 (1/0)
HEP Awards	14 (11/3)	13 (11/2)	12 (9/3)	9 (7/2)	6 (4/2)	5 (4/1)	7 (6/1)	11 (8/3)	14 (11/3)	14 (8/6)	105 (79/26)
Proposals	154 (131/23)	128 (110/18)	89 (75/14)	78 (64/14)	77 (62/15)	73 (57/16)	84 (65/19)	83 (59/24)	92 (72/20)	92 (67/25)	950 (762/188)

* 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).

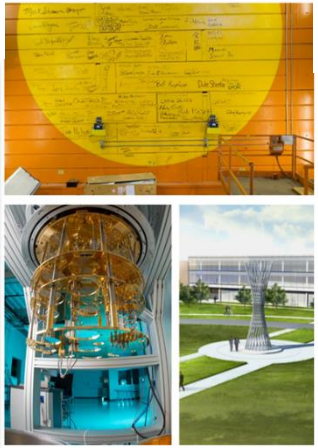
HEP Early Career FY10-19 Demographics (I)

L = National Laboratory Proposal
U = University Proposal

Subprogram Proposals	FY10 (L/U)	FY11 (L/U)	FY12 (L/U)	FY13 (L/U)	FY14 (L/U)	FY15 (L/U)	FY16 (L/U)	FY17 (L/U)	FY1 (L/	FY19 (L/U)	Total (L/U)
Energy	47 (7/40)	32 (5/27)	18 (2/16)	15 (4/11)	14 (4/10)	10 (3/7)	18 (4/14)	15 (3/12)	16 (8/8)	23 (6/17)	208 (46/162)
Intensity	16 (6/10)	21 (10/11)	17 (9/8)	7 (4/3)	14 (9/5)	15 (8/7)	19 (7/12)	14 (7/7)	15 (8/7)	10 (3/7)	148 (71/77)
Cosmic	20 (8/12)	12 (5/7)	17 (5/12)	22 (9/13)	13 (7/6)	14 (6/8)	14 (6/8)	13 (5/8)	16 (5/1	16 (4/12)	157 (60/97)
HEP Theory	49 (6/43)	45 (7/38)	23 (5/18)	20 (3/17)	23 (3/20)	25 (3/22)	21 (1/20)	29 (2/27)	31 (3/2	29 (2/27)	295 (35/260)
Accelerator	19 (18/1)	18 (16/2)	10 (9/1)	8 (6/2)	11 (11/0)	7 (6/1)	10 (9/1)	8 (6/2)	6 (4/2)	10 (10/0)	107 (95/12)
Detector	3 (2/1)	0 (0/0)	4 (4/0)	6 (3/3)	2 (2/0)	2 (1/1)	2 (0/2)	4 (3/1)	8 (7/1)	4 (3/1)	35 (25/10)
Total Proposals	154 (47/107)	128 (43/85)	89 (34/55)	78 (29/49)	77 (36/41)	73 (27/46)	84 (27/57)	83 (26/57)	92 (35/5	92 (35/57)	950 (332/618)

Central Campus Revitalization Project (CCRP)

Wilson Hall Restoration



Technology Campus Modernization

Accelerator Controls Modernization

PROGRAM, MISSION & SCOPE

MISSION NEED

SC/HEP is moving forward with new experiments, international engagements, and research programs at Fermilab that support the P5 science drivers. Aged, obsolete, and severely deteriorated aspects of the laboratory's systems and facilities infrastructure must be replaced and modernized to meet the needs of these high priority world-leading research initiatives and ensure appropriate stewardship of SC's infrastructure.

PROJECT SCOPE

- Replacing/upgrading the complex's accelerator controls system
- Consolidate and modernize technology campus facilities used for SRF, superconducting magnets, detectors, computing & quantum
- Comprehensively refurbish and modernize Wilson Hall

STATUS & ACTIONS

PROJECT STATUS

Mission Validation Independent Review was completed in August, 2019 and CD-0 is in preparation. Once the project is staffed, the Lab will begin more detailed analysis of scope and alternatives (including alternate ways to fund the capability gaps).

CURRENT CHALLENGES/ISSUES

1. Fermilab Research Alliance is evaluating how best to staff and execute this project which is dependent upon funding assumptions. Significant progress in the early project planning will be challenging until funding is more clearly understood.
2. Fermilab Site Office is evaluating how to properly support CCRP and other future potential projects.

CCRP's TOP 3 TAKE-AWAYS

CCRP Primes the Campus for SC's Flagship Projects

Office of Science is investing in the future of particle physics and pioneering new levels of international collaboration at Fermilab through the flagship LBNF/DUNE and PIP-II projects; this project refreshes and aligns the facilities and processes in the core campus:

CCRP is a Long-Term Strategic Investment

The capabilities gaps to be addressed by CCRP support all of SC's top mission objectives at Fermilab and the four Core Capabilities:

- Accelerator Science & Technology
- Advanced Computer Science, Visualization and Data
- Particle Physics
- Large-Scale User Facilities

This Project's Requirements Are Distinct

The requirements for CCRP are being carefully coordinated with other Lab efforts and proposed projects to ensure no overlap in requirements/scope and efficient use of appropriated funds.

CURRENT FUNDING GUIDANCE (in M$)

FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	Total
5	28	35	45	50	50	50	45	35	7	350

PLANNED CD's (in FY)

CD-0	CD-1	CD-2	CD-3	CD-4
10/19	FY20	FY21	FY22	FY30

Fermilab: Master Substation Radial-Feed Project

SCOPE

PROJECT SCOPE
Includes connection to existing MSS feeders with new medium-voltage underground feeders in concrete duct bank system and routing to electrical switches in accelerator campus Utility Corridor.

DRIVING CONSIDERATIONS
MSS provides electrical service to the Fermilab footprint area, the Main Ring area and north half of the site. It contains new, modern, arc-resistant switchgear and control systems that provide increased operator safety, reliability, and flexibility. This is the preferred power source for the Accelerator Campus.

CAMPUS MASTER PLAN ALIGNMENT
Several projects are planned for the central campus area including the IERC & ASTC buildings as well as the PIP-II, Mu2e, and LBNF projects. MSS will serve either as the primary or secondary electrical substation to the above listed projects.

COST

TOTAL PROJECT COST FY20
$7,500,000

FUNDING SOURCE / STATUS
HEP / Funded

PROJECT PLAN STATUS
In process

DEMOLITION INCLUDED
Demolition of existing switchgear and abandon underground cable systems

IMPACT ON OPERATING COSTS
$10K/FY. Planned (does not include emergency repair costs) in annual dollars

RISKS / ALTERNATIVES

ASSOCIATED RISKS
- Kautz Road Substation Failure
- Failure of a major project – Utility Corridor

ALTERNATIVES CONSIDERED / RECOMMENDED
The alternatives include increased capacity feeders from Master Substation (MSS). This alternative is not recommended due to single source failure risk.

Seventeen DOE National Laboratories

Office of Science Laboratories

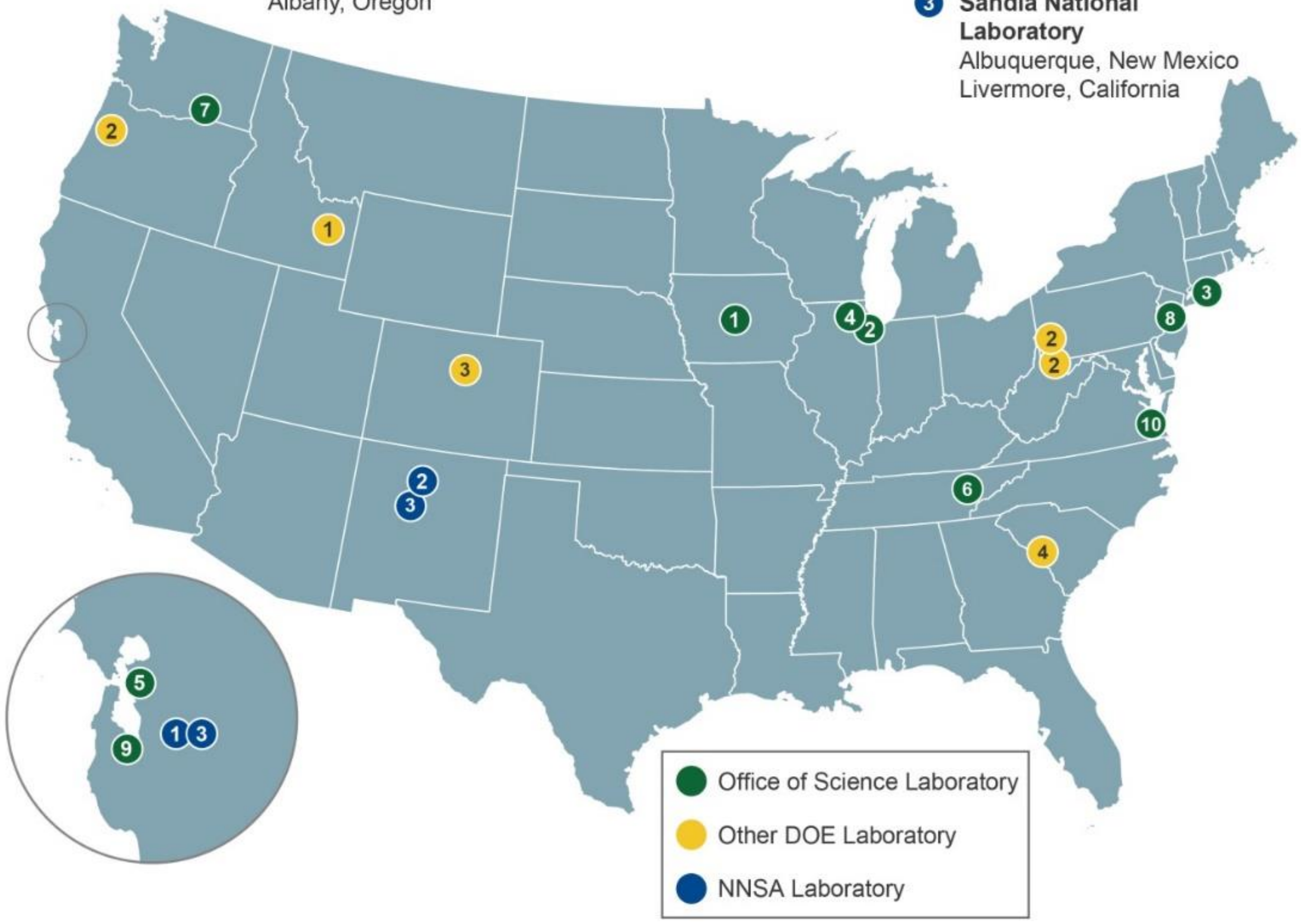
1. **Ames Laboratory**
   Ames, Iowa
2. **Argonne National Laboratory**
   Argonne, Illinois
3. **Brookhaven National Laboratory**
   Upton, New York
4. **Fermi National Accelerator Laboratory**
   Batavia, Illinois
5. **Lawrence Berkeley National Laboratory**
   Berkeley, California
6. **Oak Ridge National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

Other DOE Laboratories

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

NNSA Laboratories

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



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.

DOE Office of Science

A research funding agency and a steward of national research infrastructure.

The undulator hall at the Linac Coherent Light Source, SLAC National Accelerator Laboratory

- The mission of DOE's Office of Science is to deliver scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States.
- The U.S. largest federal supporter of basic research in the physical sciences
  - 25,000 Ph.D. scientists, graduate students, undergraduates, engineers, and technical staff supported through competitive awards
  - 27 scientific user facilities serving more than 36,000 users each year

DOE Support for SC National Laboratories

Berkeley Lab

$858M in FY 2018

- Founded 1931
- 202 acres, 96 buildings
- 3,302 FTEs, including: 486 post-docs, 411 students, and 232 joint faculty
- 2,241 visiting scientists
- 11,403 facility users

Pacific Northwest National Laboratory

$887M in FY 2018

- Founded 1965
- 781 acres, 71 buildings
- 4,238 FTEs, including: 256 post-docs, 745 students, and 64 joint faculty
- 302 visiting scientists
- 1,742 facility users

The Ames Laboratory

$56M in FY 2018

- Founded 1947 (1942)
- 10 acres, 13 buildings
- 307 FTEs, including: 46 post-docs, 174 students, and 43 joint faculty
- 321 visiting scientists

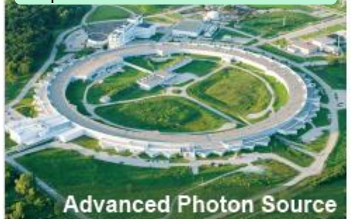
Fermilab

$414M in FY 2018

- Founded 1967
- 6,800 acres, 366 buildings
- 1,783 FTEs, including: 88 post-docs, 94 students, and 13 joint faculty
- 9 visiting scientists
- 3,472 facility users

Argonne National Laboratory

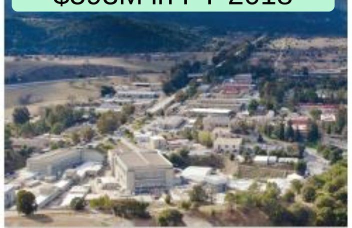
$782M in FY 2018



- Founded 1946 (1942)
- 1,517 acres, 154 buildings
- 3,225 FTEs, including: 273 post-docs, 569 students, and 274 joint faculty
- 1,107 visiting scientists
- 8,305 facility users

SLAC National Accelerator Laboratory

$593M in FY 2018



- Founded 1962
- 426 acres, 149 buildings
- 1,531 FTEs, including: 152 post-docs, 299 students, and 36 joint faculty
- 19 visiting scientists
- 2,692 facility users

Oak Ridge National Laboratory

$1,570M in FY 2018

- Founded 1943
- 4,421 acres, 271 buildings
- 4,957 FTEs, including: 320 post-docs, 633 students, and 214 joint faculty
- 1,888 visiting scientists
- 3,248 facility users

Jefferson Lab

$172M in FY 2018

- Founded 1962
- 169 acres, 69 buildings
- 1678 FTEs, including: 34 post-docs, 53 students, and 27 joint faculty
- 1,438 visiting scientists
- 1,597 facility users

PPPL – Princeton Plasma Physics Laboratory

$100M in FY 2018

- Founded 1961 (1951)
- 91 acres, 30 buildings
- 495 FTEs, including: 21 post-docs, 48 students, and 6 joint faculty
- 50 visiting scientists
- 292 facility users

Brookhaven National Laboratory

$546M in FY 2018

- Founded 1947
- 5,322 acres, 315 buildings
- 2,527 FTEs, including: 116 post-docs, 395 students, and 123 joint faculty
- 2,313 visiting scientists
- 2,923 facility users

28 scientific user facilities

U.S. DEPARTMENT OF
ENERGY
Office of Science

DOE Office of Science Research Programs

Basic Energy Sciences (BES)	• **Understanding, predicting, and ultimately controlling matter and energy flow at the electronic, atomic, and molecular levels**
Advanced Scientific Computing Research (ASCR)	• **Delivering world leading computational and networking capabilities to extend the frontiers of science and technology**
Biological and Environmental Research (BER)	• **Understanding complex biological, climatic, and environmental systems**
Fusion Energy Sciences (FES)	• **Building the scientific foundations for a fusion energy source**
High Energy Physics (HEP)	• **Understanding how the universe works at its most fundamental level through research, projects, and facilities**
Nuclear Physics (NP)	• **Discovering, exploring, and understanding all forms of nuclear matter**

https://www.energy.gov/science/office-science

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, PIP-II, 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

NSF

- Proposal driven program
- Funds facilities and equipment, such as telescopes, through cooperative agreements with research consortia

Department of Energy

- Mission driven program
- National Laboratory enterprise and National User Facilities provide important capabilities & expertise

NASA

- Mission driven program
- Expertise in human spaceflight, aeronautics, space science, and space applications
- Partnership enables unique science opportunities

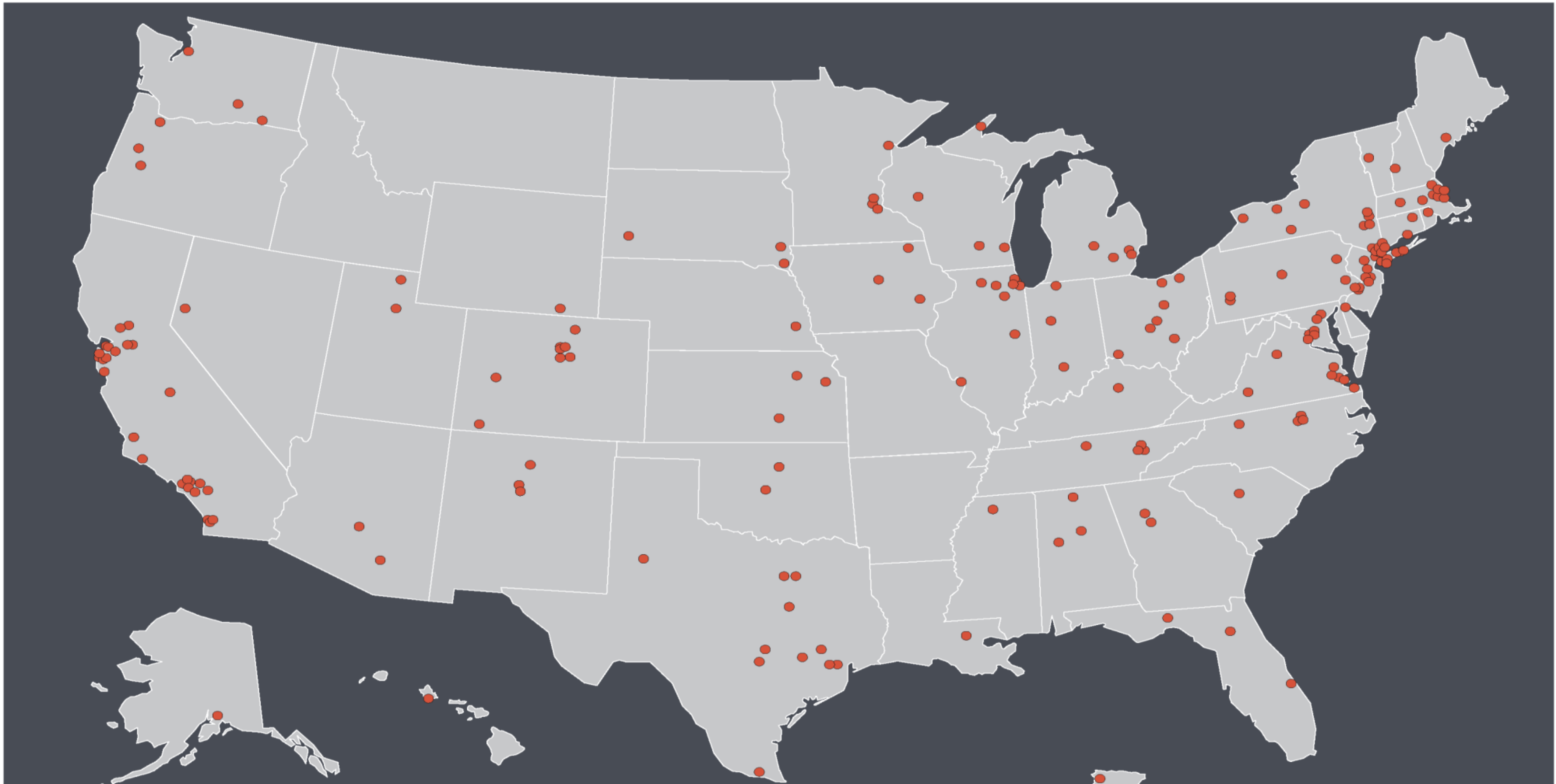
HEPAP Coordination

AAAC Coordination

NSF	DOE	NASA
Strong connections	Energy Frontier	
Modest ties	Intensity Frontier	
Strong connections	Cosmic Frontier	*Space-based experiments*
Strong connections	Theoretical Physics	
Modest ties	Technology R&D	Department of Defense, NIST (National Institute of Standards and Technology, U.S. Department of Commerce), U.S. Department of Homeland Security, NIH (National Institutes of Health)

Particle Physics in the United States

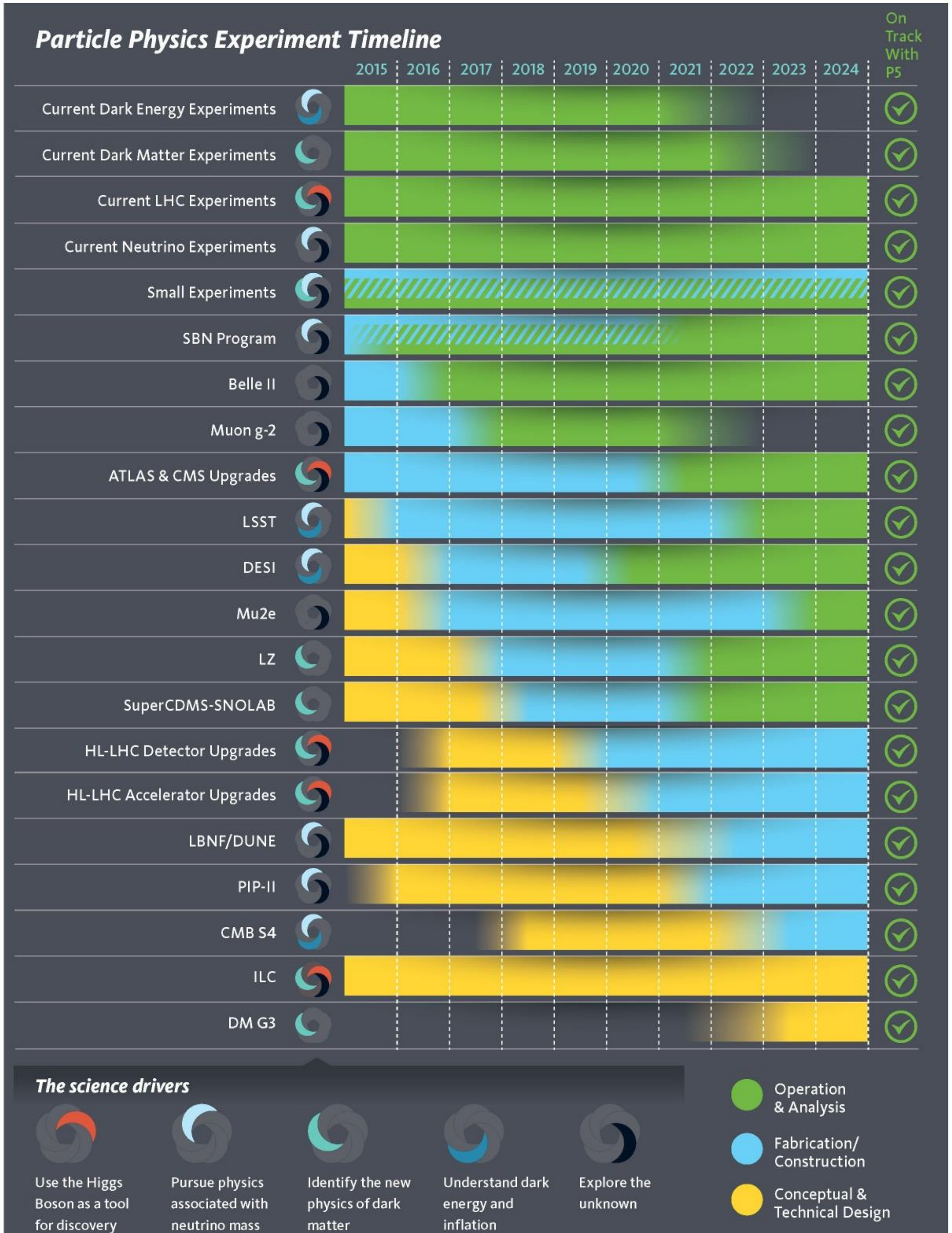
Scientists, engineers, and technicians at more than 180 universities, institutes, and laboratories throughout the U.S. are working in partnership with their international colleagues to build high-tech tools and components, conduct scientific research, and train and educate the next generation of innovators. Particle physics activities in the U.S. attract some of the best scientists from around the world.



Dots represent Laboratories and Universities receiving funding in 2019 for particle physics from DOE or NSF

HEP 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	55.5	CD-3	February 9, 2017
FY 2019 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



All Projects on budget & schedule

- Projects fully funded as of FY19
  - Muon g-2: 1st beam 2017
  - LHC detector upgrades: on track for 2019/20 installation
  - DESI: 1st light 2019
  - DM-G2 (superCDMS & LZ): 1st data 2020
  - Mu2e : 1st data in 2023
  - LSST: full science operations 2023
- HL-LHC accelerator and detector upgrades started on schedule
- LBNF/DUNE & PIP-II schedules advanced due to strong support by Administration & Congress
- CMB S4: developing technically-driven schedule to inform agencies, NAS Astro 2020 Decadal Survey
- DM-G3: R&D limited while fabricating G2
- ILC: cost reduction R&D while waiting for decision from Japan
- Broad portfolio of small projects running

Small Projects Portfolio

- HEP supports a number of "small projects" and will continue to pursue timely physics opportunities with new experimental techniques. For example:
  - ADMX-G2, Belle-II, COHERENT, eBOSS, FACET-II, HAWC, HPS, FAST/IOTA, LQCD, NA61/SHINE, SBN Program, SPT-3G, BELLA Second Beamline
- Intermediate Neutrino Research Program workshop and FY 2015 FOA enabled: PROSPECT, ANNIE
- Basic Research Needs workshops will help define and prioritize additional opportunities for small project investments
  - Topic areas include: Accelerator applications (compact accelerators), Light dark matter, Detector R&D, Neutrinos

When Do We Need an Updated P5?

- Funding for HL-LHC projects complete in FY 2024/2025
- Funding for Line-Item Construction Projects LBNF/DUNE and PIP-II peak in FY 2025, and completes by FY 2027/2028
- Only CMB-S4 project remains in the list of P5 recommendations
  - Future Collider project has dependency on strategic planning in Europe and Asia
- Continuous new ideas and new input to budget formulation is critically important to continue the pursuit of funded Discovery Science (new Projects)
- Submit new Mission Needs (CD-0) at the rate of one/year from FY 2019 through FY 2035+

Possible Strategic Planning Timeline

- To provide timely input to the FY25 budget formulation, the next P5 report will be required by March 2023
- U.S. Community considering Snowmass process with major meeting occurring in summer 2021
- Potential timeline for the next NAS EPP Decadal Survey could be mid-2020 through early-2022
  - Overlap with Snowmass could enable synergy with Snowmass processes and delivery of report as P5 process begins