U.S. DEPARTMENT OF ENERGY | Office of Science

P5: Four Years Later

Fermilab's 51st Annual Users Meeting

Alan Stone

June 21st, 2018

Office of High Energy Physics

James Siegrist, Director

Administrative Specialist (Vacant)
Altaf Carim

HEP Budget and Planning
Erin Cruz
Michelle Bandy
Alan Stone
Michael Cooke

International Agreements Program
Altaf Carim

Accelerator Stewardship
Eric Colby

HEP Operations
Kathy Yarmas

HEP Connections
Lali Chatterjee

Research & Technology Division

Glen Crawford, Director
Janice Hannan
Christie Ashton
David Bogley
Andrea Peterson (AAAS Fellow)
Brian Morsony (AAAS Fellow)

Physics Research

Energy Frontier
Abid Patwa
Thomas LeCompte (Detailee)

Intensity Frontier
Glen Crawford (Acting)
Michael Cooke
Kevin Flood (IPA)
Laurence Littenberg (Detailee)

Cosmic Frontier
Kathy Turner
Eric Linder (IPA)
Karen Byrum (Detailee)

Theoretical Physics
William Kilgore

Research Technology

General Accelerator R&D
L.K. Len
John Boger
Eric Colby
Ken Marken

Detector R&D
Helmut Marsiske

Computational HEP & QIS
Lali Chatterjee

SBIR/STTR
Ken Marken

Facilities Division

Mike Procario, Director

Facility Operations

Fermilab Complex
John Kogut

LHC Operations
Abid Patwa

Other Operations [SLAC/Other Labs]
John Kogut

Facilities Development

LARP
Bruce Strauss

Instrumentation & Major Systems

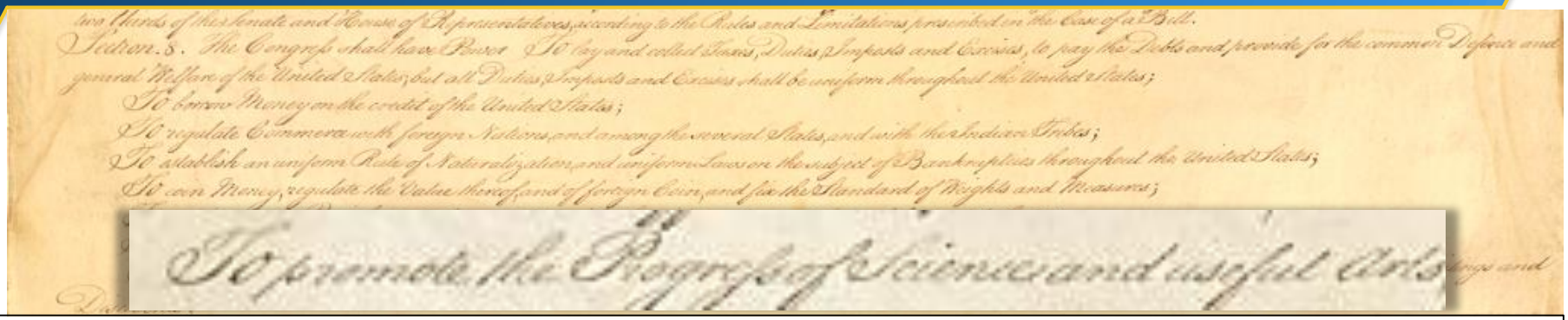
ATLAS Upgrade – Simona Rolli
CMS Upgrade – Simona Rolli
DESI – Kathy Turner
FACET-II - Ted Lavine
HL-LHC ATLAS - Simona Rolli
HL-LHC AUP - Simona Rolli
HL-LHC CMS - Simona Rolli
LBNF-DUNE -Bill Wisniewski (Detailee)
LSSTcam – Helmut Marsiske
LZ – Ted Lavine
Mu2e – Ted Lavine
PIP-II – Mike Harrison (Detailee)
SuperCDMS-SNOLAB – Simona Rolli

QUIZ

U.S. DEPARTMENT OF ENERGY | Office of Science

June 2018

Constitution and Disclaimers



U.S. Constitution. Article 1, Section 8: "The Congress shall have Power…To promote the Progress of Science and useful Arts"

- In this talk, I aim to illuminate the DOE/HEP role in the Federal budget process. This will be a high level overview.
- Along the way, I will highlight how the P5 report is having a significant impact in all phases of this process
- For additional HEP program information, I encourage everyone to view the slides from the May 2018 HEPAP meeting.

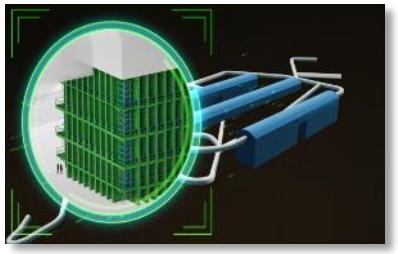
https://science.energy.gov/hep/hepap/

- **Lobbying (http://energy.gov/management/lobbying)**
  - Generally prohibited from contacting or encouraging others to contact a state or federal legislator or executive branch official in an attempt to influence the enactment or modification of legislation or other specified activities
- **Partisan Political Activity (https://osc.gov/Pages/HatchAct.aspx)**
  - 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
    - And more…

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



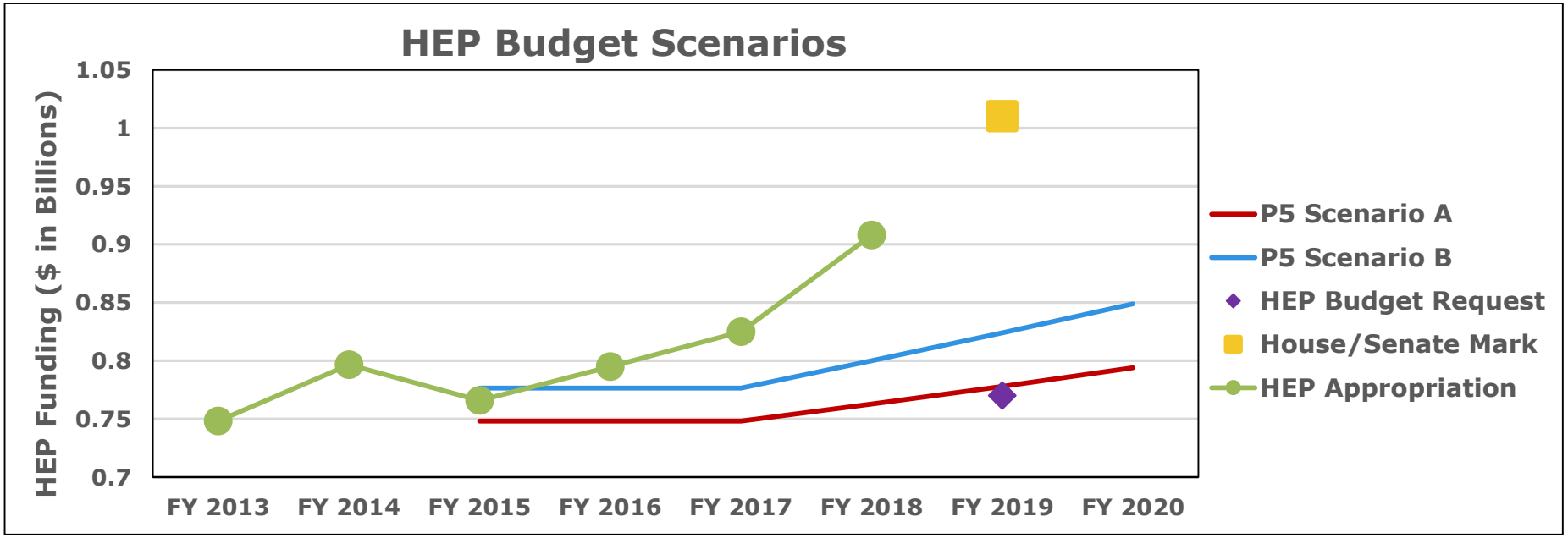
Appropriators Noticed the P5 Report

- FY 2015 House Energy and Water Development Appropriations Report:
  - "The Committee notes that the high energy physics research community is currently engaged in developing a ten-year plan for U.S. particle physics, which will include a ten-year report by the Particle Physics Project Prioritization Panel under various budget scenarios. The Committee applauds the Department for this undertaking . . ."
- FY 2017 House Energy and Water Development Appropriations Report:
  - "The Committee strongly supports the Department's efforts to advance the recommendations of the Particle Physics Prioritization Panel and urges the Department to maintain a careful balance among competing priorities and among small, medium, and large scale projects."
- FY 2018 Senate Energy and Water Development Appropriations Report:
  - "The Committee recommends $860,000,000 for High Energy Physics. The Committee strongly supports the Secretary's efforts to advance the recommendations of the Particle Physics Project Prioritization Panel Report, which established clear priorities for the domestic particle physics program."
- 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

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…"

HEP Budget vs. P5 Scenarios

- P5 considered 10-year HEP budget scenarios within a 20-year vision for the global field
  - Scenario A was the lowest constrained budget scenario
  - Scenario B was a slightly higher constrained budget scenario
- FY 2018 Appropriation ($0.91B) provides funding for all HEP Projects at their recommended profiles. Facilities and Experimental Operations are supported at their optimal levels. Research is funded above 40% of the total HEP budget.
- FY 2019 President's Budget Request ($0.77B) reflects the P5 vision
  - Preserves flexibility in situ to continue or ramp down efforts contingent on what Congress appropriates
- FY 2019 House & Senate Marks provide full funding for several projects, and accelerates funding for LBNF/DUNE, PIP-II and HL-LHC projects

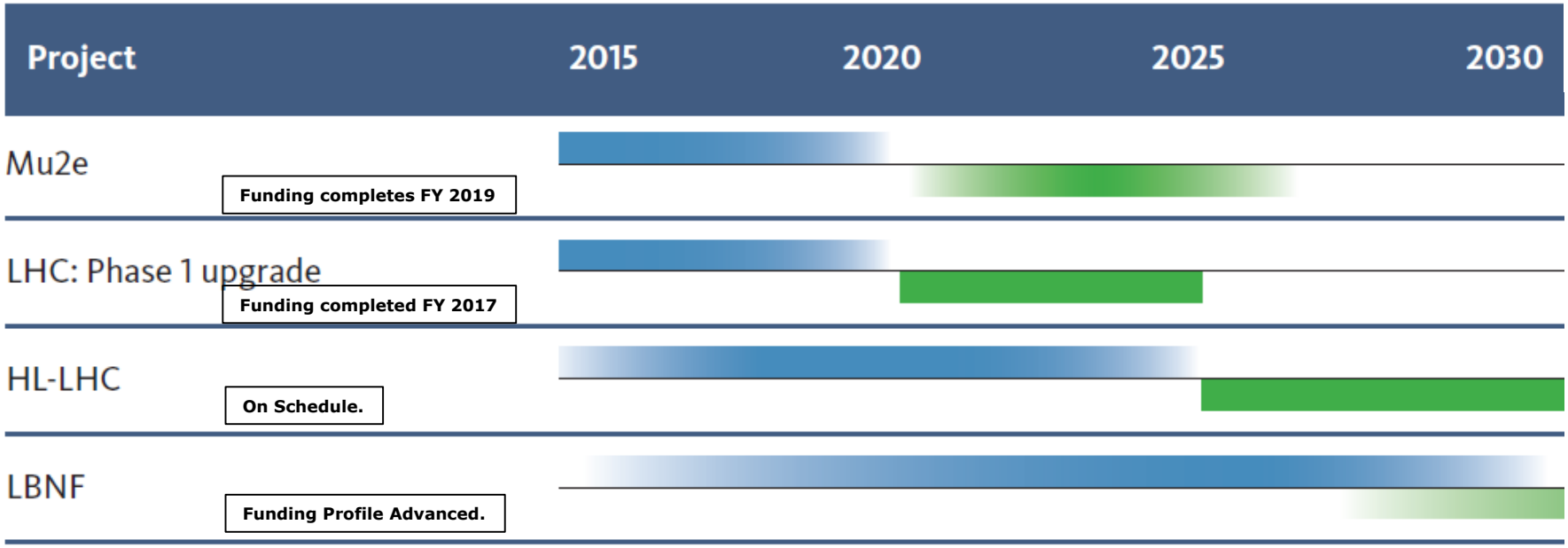


Applause

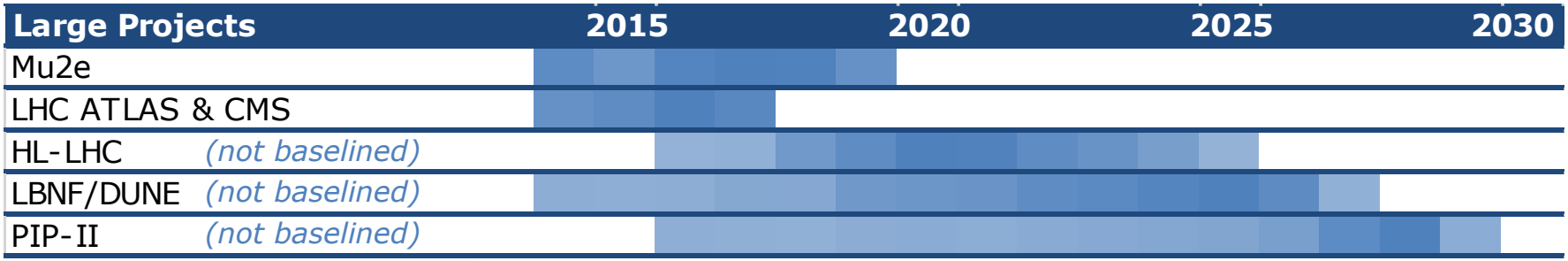
P5 Large Projects [>$200M]

- P5 timeline vs. FY19 Budget Request project funding profiles
  - Appropriation language and DOE CD process will impact final profiles

P5 Report Timeline



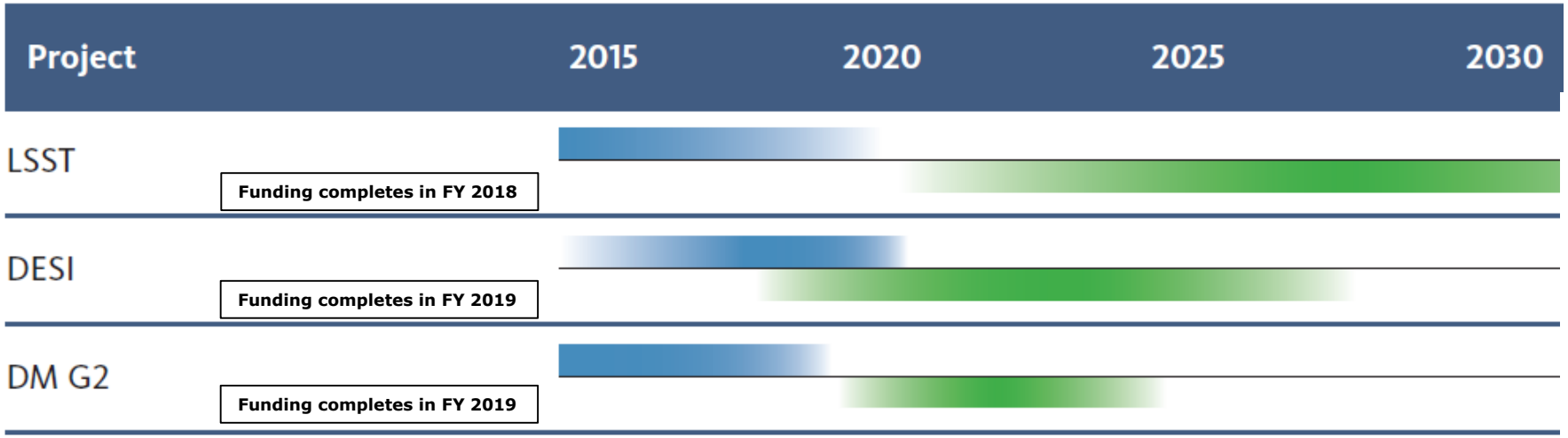
FY19 PBR



P5 Medium Projects [<$200M]

- P5 timeline vs. FY19 Budget Request project funding profiles
  - Appropriation language and DOE CD process will impact final profiles

P5 Report Timeline



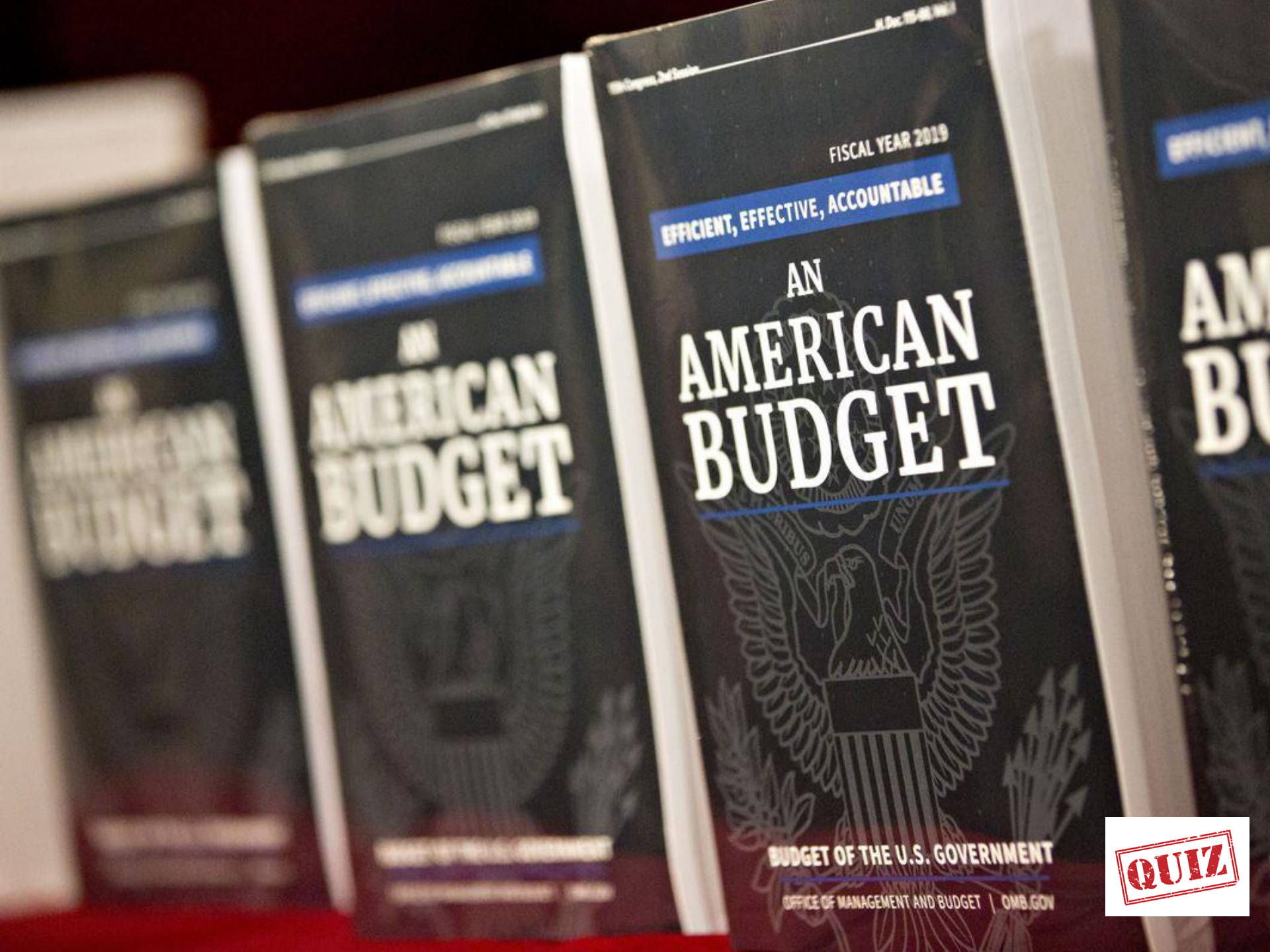
FY19 PBR

- Operations of new instruments & facilities ramps up as P5 projects complete
- As for Small Projects…

QUIZ

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, ICARUS, FAST/IOTA, LQCD, NA61/SHINE, SBND, SPT-3G
- Intermediate Neutrino Research Program workshop and 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


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

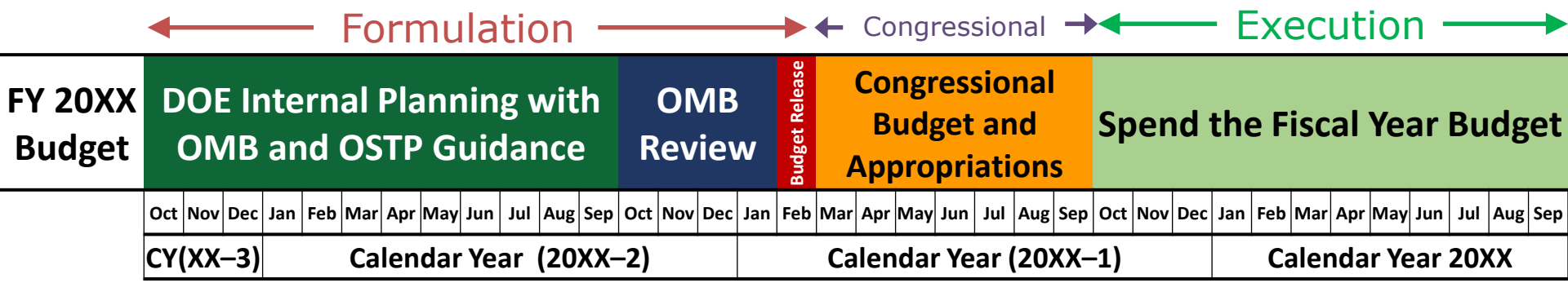
Budget and Accounting Act of 1921

- Before the Budgeting & Accounting Act of 1921, no single government entity oversaw the entire budget
  - Departments submitted budget requests to Congress
- After WWI, Act 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

- Act requires the President to submit a budget to Congress every year
- The act created:
  - **Bureau of the Budget**, 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

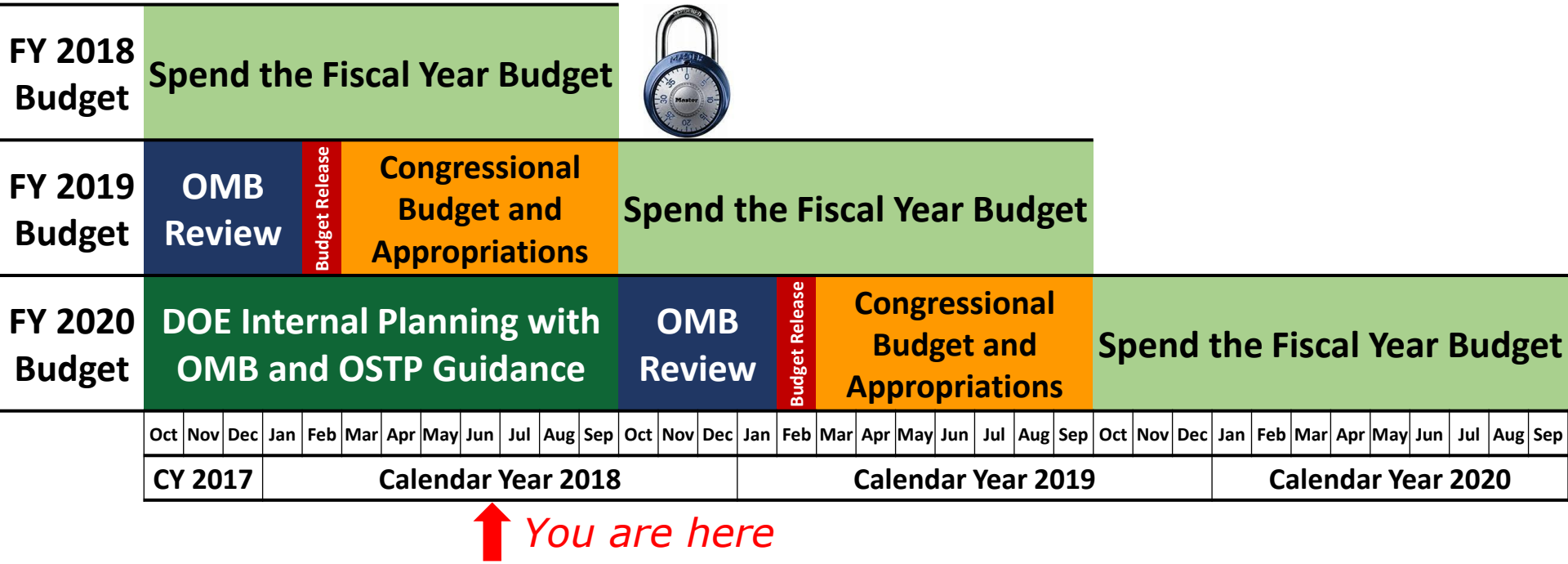
Three Phases of Budget Process

- **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



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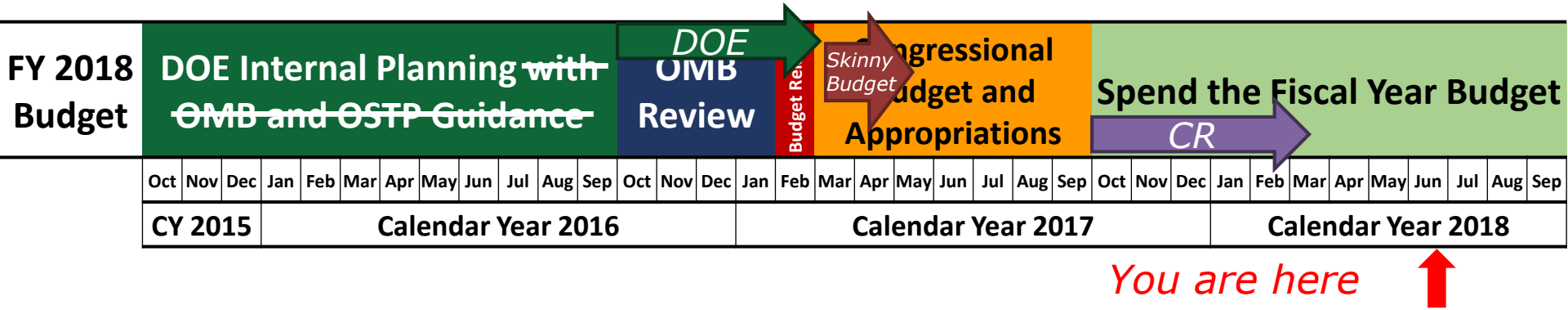
U.S. Budget Process

The FY 2018 Federal Budget Cycle

- FY 2018 process was not "typical"
  - 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.



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

Fall

→ OMB reviews budget proposals
- Considers Presidential priorities, program performance, budget constraints

Late Nov.

→ OMB provides recommended budget proposal to President and provides passback to agencies

Dec.

→ December: Agencies may appeal to OMB and the President

Jan.

→ January: Agencies prepare and OMB reviews final congressional budget justification materials

→ 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

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 plans
  - Tables with detailed breakdown of funding for past year vs. current year vs. budget request
  - Explanation of changes for each line of budget table
    - Current Administration wants focus on what can be done, with priorities
- Agencies usually invited to brief Congress on their budget request
  - Opportunity to reinforce overall strategy and highlight key elements of the request
    - Recall that 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!

QUIZ

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

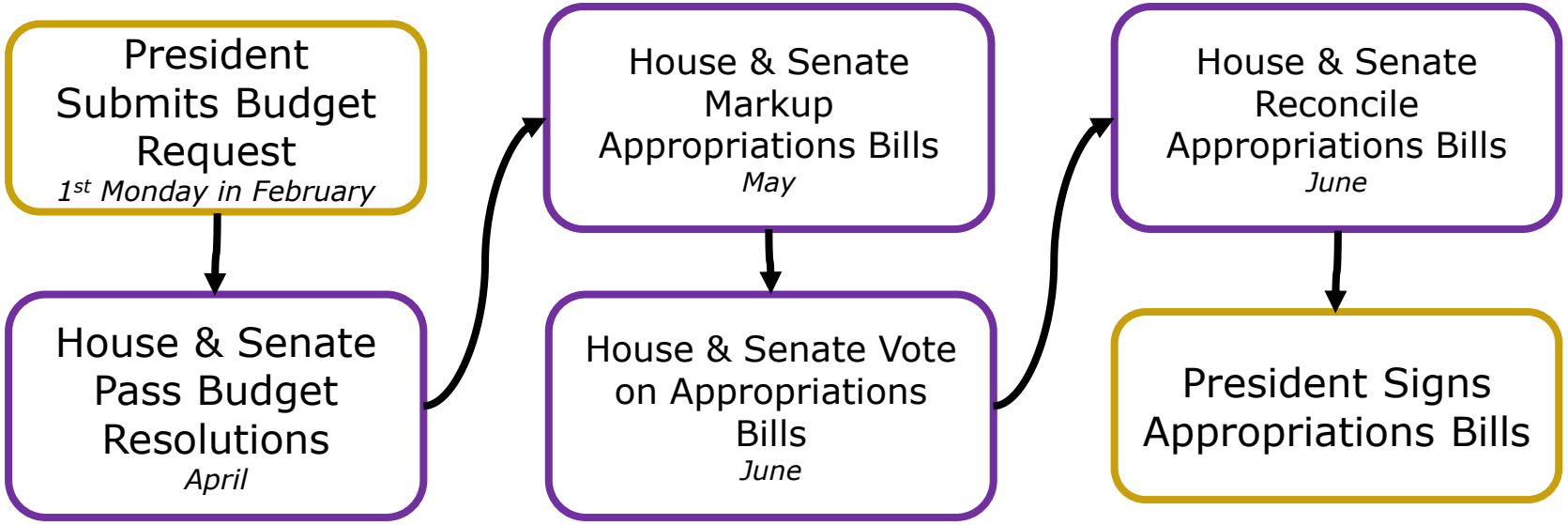
- **Discretionary spending** determined by appropriations process, includes National defense, food safety, education, and science research
- Provided in **12 appropriation acts**, is less than 1/3 of current federal expenditures

Renewing Authorizations

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

Congressional Budget Process

- Budget Resolution
  - Overall appropriation committee sets each subcommittee's allocation of spending authority for the next fiscal year and aggregate spending and revenue levels for 5 years
- Authorization legislation
  - May create or continue agencies, programs, or activities as well as authorize and recommend funding levels for the subsequent enactment of appropriations
- Appropriation bills (must originate in House)
  - 12 bills define discretionary spending and provide the funding for authorized agencies, programs, or activities

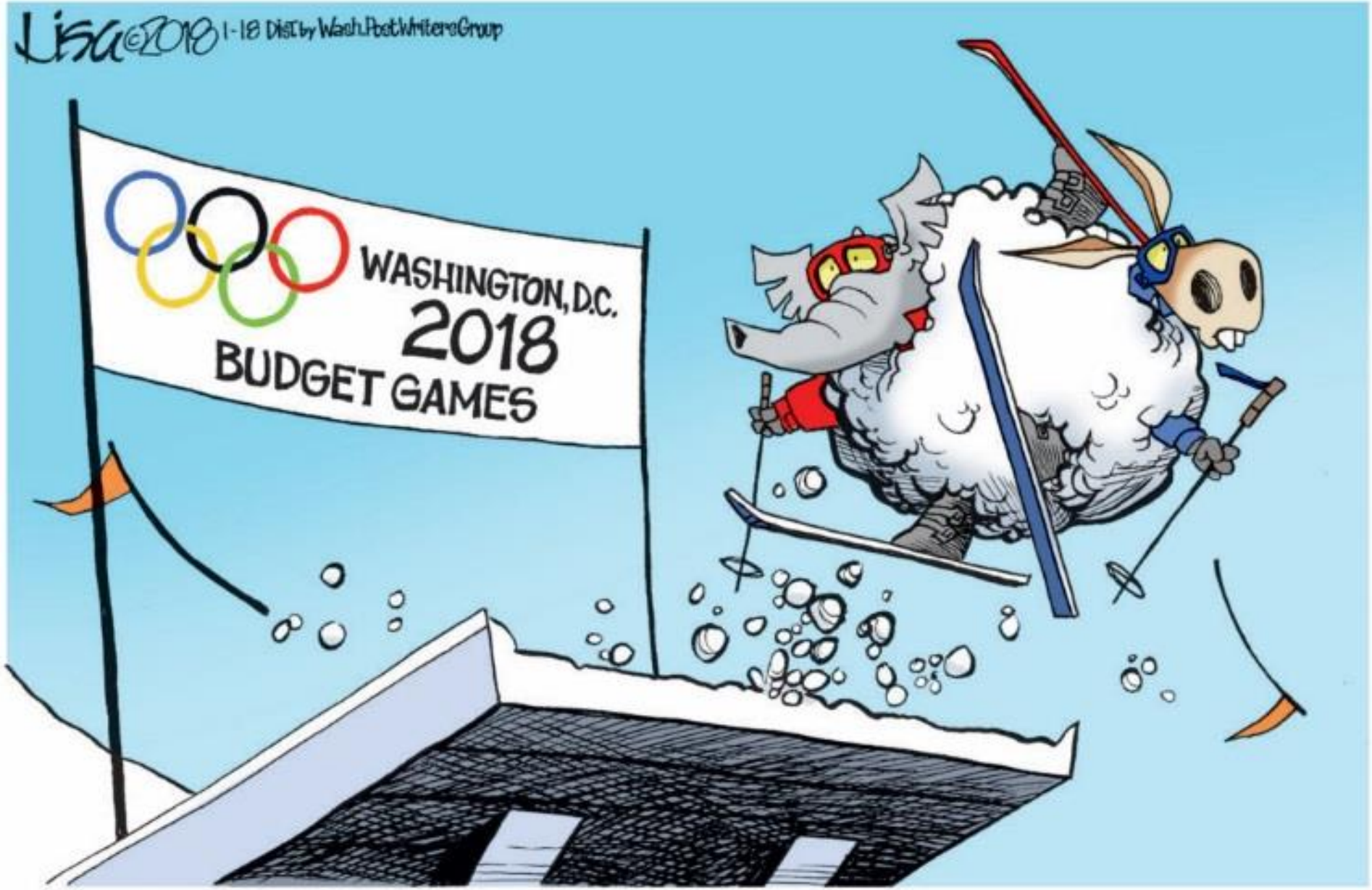


Report Language Matters!

- Congress will usually specify top-line budget for a program and sometimes direct specific project or subprogram budget levels
  - It is up to program management to make things work "within available funds"
- Example: HEP received $825M in the FY 2017 Congressional Appropriation, about $7M above the FY 2017 President's Budget Request
  - Congressional direction increased funding for specific MIEs/projects by $9.9M
  - **Difference ($9.9M - $7M = $2.9M) has to come out of the rest of the program**

DEPARTMENT OF ENERGY
(Amounts in thousands)

	FY 2016 Enacted	FY 2017 Request	Final Bill
High energy physics:			
Research	728,900	729,476	731,500
Construction:			
11-SC-40 Long baseline neutrino facility / deep underground neutrino experiment, FNAL	26,000	45,021	50,000
11-SC-41 Muon to electron conversion experiment, FNAL	40,100	43,500	43,500
Subtotal, Construction	66,100	88,521	93,500
Subtotal, High energy physics	795,000	817,997	825,000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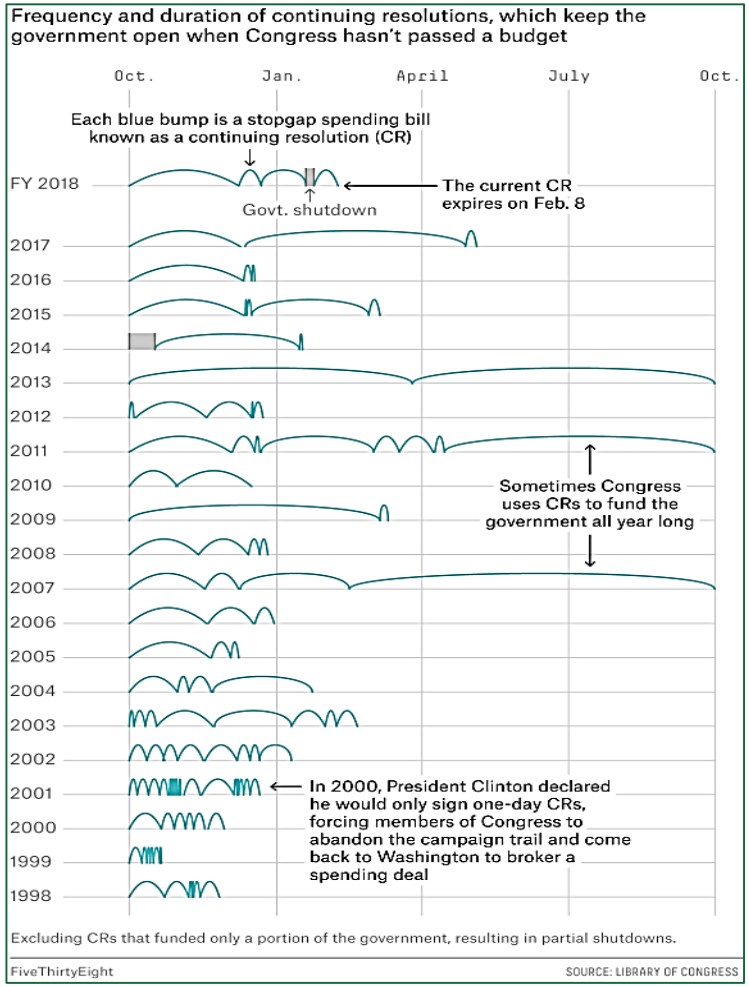
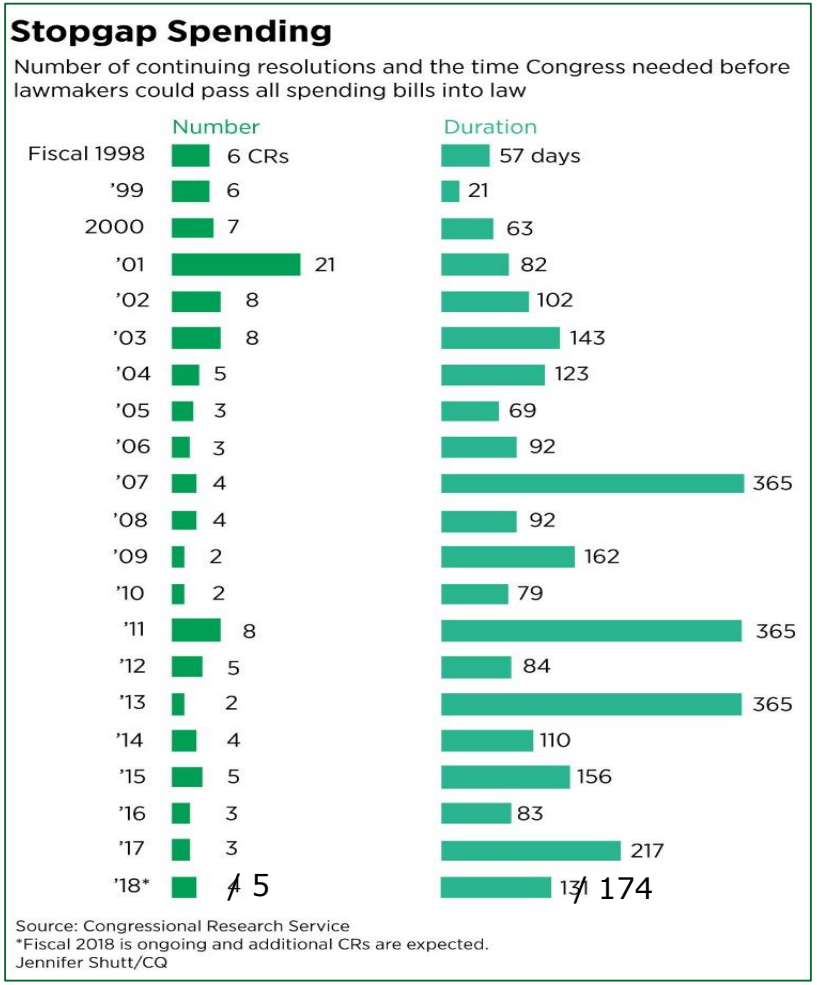
2018
BUDGET GAMES

Breaking the Cycle: 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…

Frequency and Duration of Continuing Resolutions





Between fiscal year 1977 and fiscal year 2015, Congress only passed all twelve regular appropriations bills on time in four years - fiscal years 1977, 1989, 1995, and 1997.

Fiscal Year 2018 Federal Budget

FY 2018 deficit is projected at $833 billion, almost double the $440 billion budgeted in President's Request

OMB estimates that Federal revenue will be $3.340 trillion

OMB estimates the Federal government will spend $4.173 trillion in FY 2018

May 2017: President submitted Budget Request

Jan 2018: Congress passed FY18/19 budget resolution

March 2018: Congress passed omnibus appropriations bill

OMB estimates interest payments on National debt will be $310 billion in FY 2018

OMB estimates mandated benefits will cost $2.593 trillion

Social Security: $987 billion
Medicare: $582 billion
All Other: $624 billion

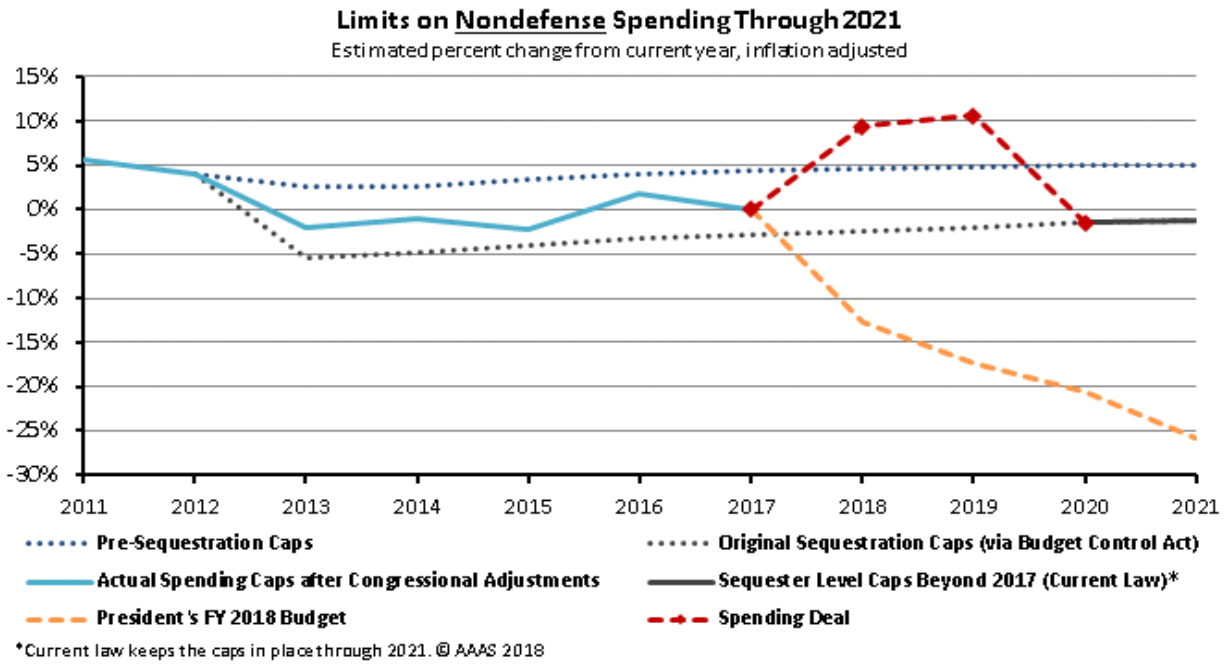
Congress approved $1.2 trillion discretionary spending for FY 2018

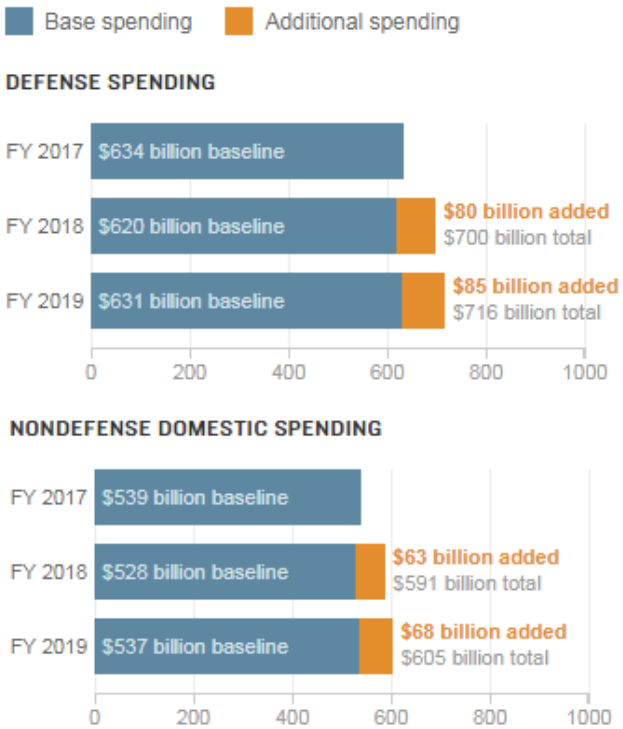
Source: https://thebalance.com

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

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

- 2013 sequestration set across-the-board budget cuts/caps amounting to $1.2 trillion in spending reductions on non-discretionary funding over the next 10 years
- **Bipartisan deals** raised the budget caps, but those adjustments expired in FY 2017
- Spending resolution for **FY 2018/19** again set spending level above sequestration





$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)

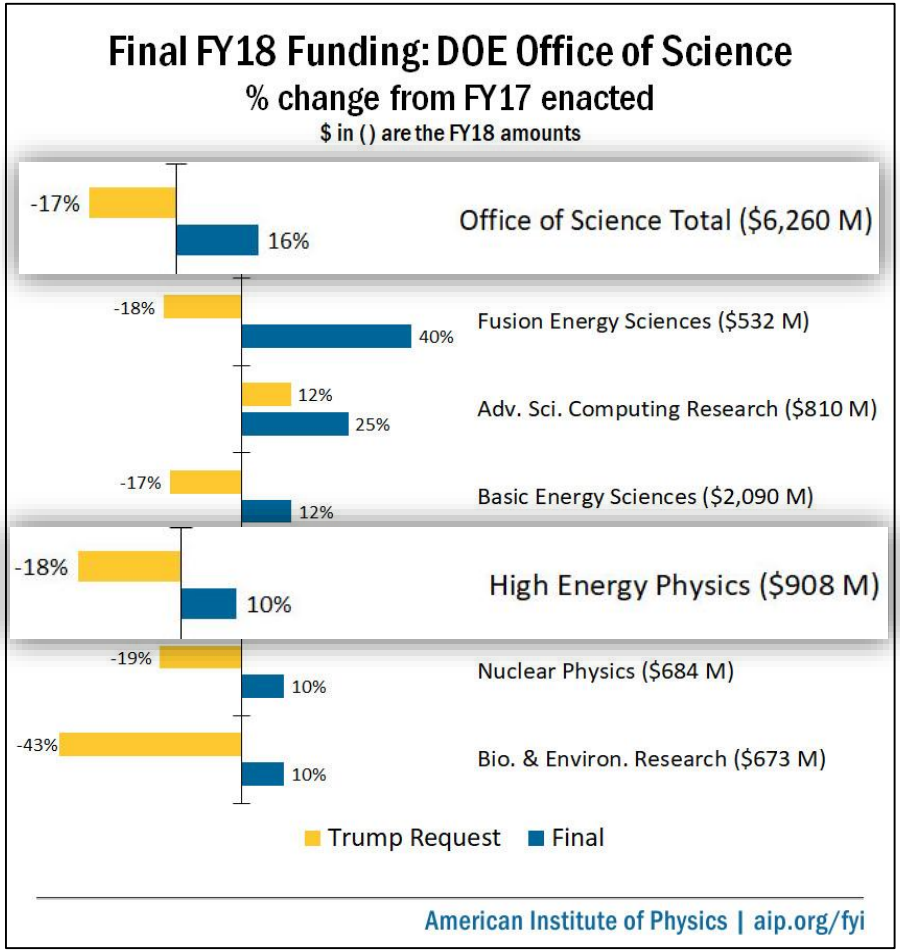
Consolidated Appropriations Act of 2018 (FY 2018 Omnibus)

	Budget ($B)		
Appropriations Bill	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%

QUIZ

FY 2018 DOE Office of Science Enacted

- **$6,260M for the Office of Science**
  - $868M (16%) increase is largest single-year influx since 2009, when $1.6B stimulus provided through American Recovery and Reinvestment Act
- Facility construction projects and upgrades receiving appropriations well above the administration's request
  - New starts for construction of two light sources upgrades and a neutron source upgrade (BES)
- Funding for construction of LBNF increases to $95M
  - $40M more than requested, also provides $24.1M for PIP-II
- Senate report says the committee continues to "strongly support" U.S. participation in the Large Hadron Collider
- Two experiments that are searching for dark energy and matter received funding above the administration's request
  - $17.5M for DESI, $7.4M SuperCDMS-SnoLab
- Requested level of funding is provided for LZ, Mu2e, and LSSTcam



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:
  - Appropriations bills are long and detailed
  - If in a CR, have to resolve current spending level versus final Appropriation
  - Often there are "rescissions" and/or recovery of prior year balances
  - Occasionally there are internal contradictions or errors
  - Agency CFOs have to resolve all this and get agreement with OMB before issuing current FY "allotments" of budget authority

Funding Vehicles

- DOE National Laboratories
  - Most are Government Owned/Contractor Operated (GOCO) Federally Funded Research and Development Centers (FFRDCs) and operate under Management and Operating (M&O) contracts
  - Laboratory research is mission driven and funded through Field Work Proposals (FWPs)
    - Comparative reviews of the Lab Research programs held every 3-4 years
  - **Laboratories propose yearly financial plans based on DOE guidance**
    - Mechanisms exist to tune funding each month
- Universities
  - **Submit grant proposals in response to a Funding Opportunity Announcement (FOA)**
    - Independent peer review informs the selection of awards
  - Award is ~fixed once made, with typical funding cycle of 3 years
    - Funding adjustments (downward) are possible if circumstances change
    - Changes are also possible through submission of supplementary proposals

Typical FOAs & New Initiatives

- In recent years, there is one "continual" FOA (DOE/SC Open Solicitation) and these annual FOAs:
  - Research Opportunities in HEP (a.k.a. Comparative Review FOA)
  - Early Career Research Program
  - Research Opportunities in Accelerator Stewardship
  - Quantum Information Science
  - Traineeship in Accelerator Science & Technology
  - U.S.-Japan Science and Technology Cooperation Program
- FOAs that launch new initiatives are informed through:
  - Strategic plans
  - Whitepapers
  - Roundtables
  - Workshops or working groups

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.

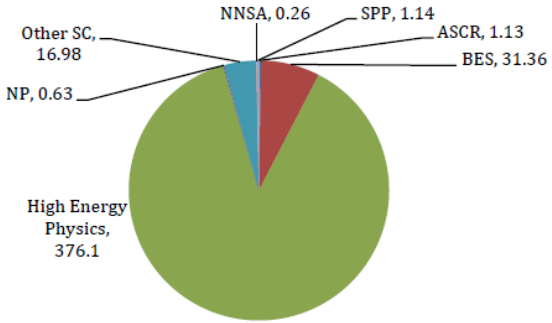
- Stewardship of Fermilab is an important part of the HEP mission

Fermilab

Physical Assets:
- 6,800 acres and 366 buildings
- 2.4 million GSF in buildings
- Replacement Plant Value: $2.15B
- 18,849 GSF in 9 Excess Facilities
- 19,771 GSF in Leased Facilities

Human Capital:
- 1,783 Full Time Equivalent Employees (FTEs)
- 13 Joint faculty
- 88 Postdoctoral Researchers
- 65 Undergraduate Students
- 29 Graduate Students
- 3,472 Facility Users
- 9 Visiting Scientists

FY 2017 Costs by Funding Source: *(Cost Data in $M):*



Lab Operating Costs: $427.59M
DOE Costs: $426.45M
SPP (Non-DOE/Non-DHS) Costs: $1.14M

QUIZ

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

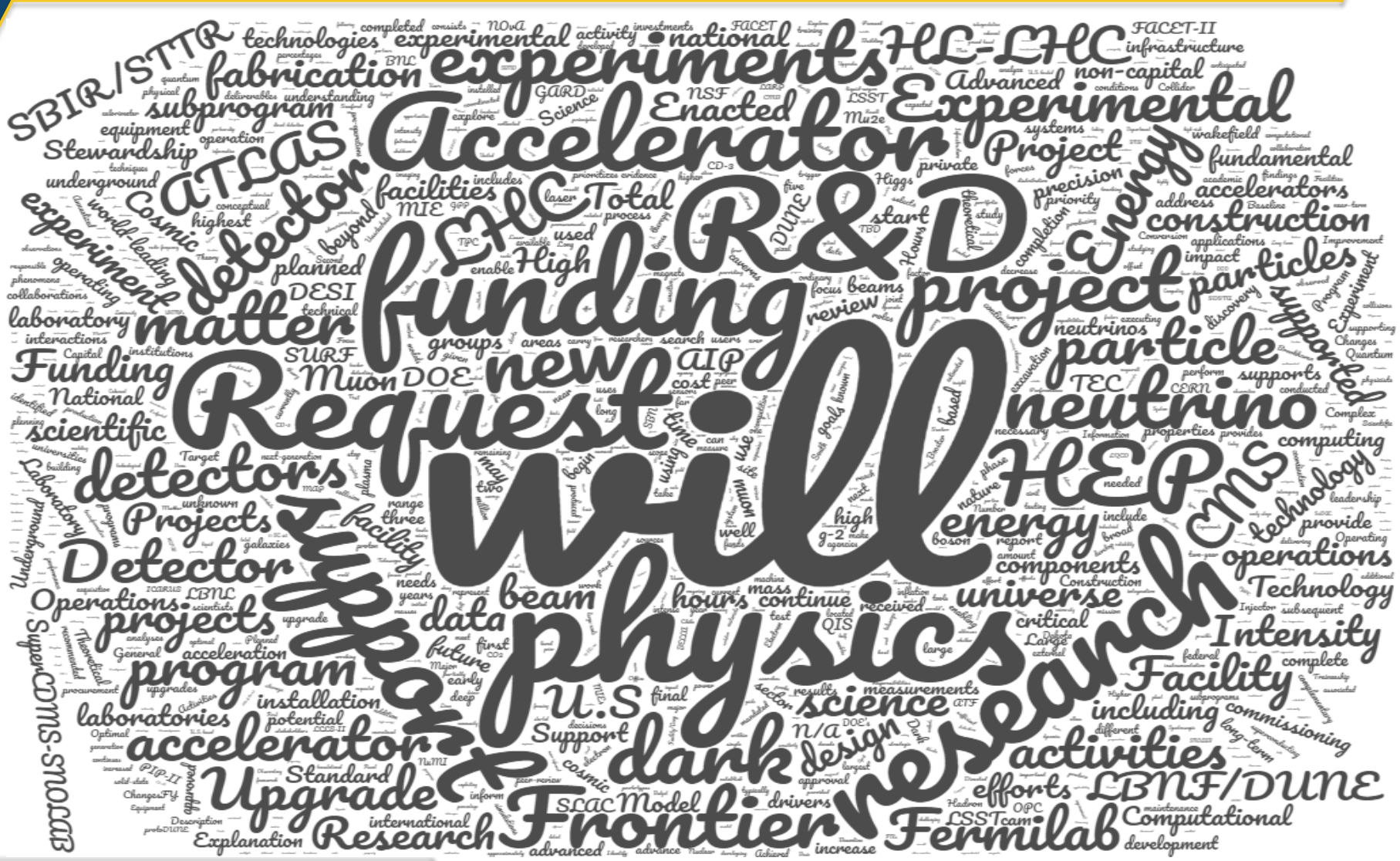
Project Support

- Successful delivery of construction projects and facilities for science is a central part of the DOE science mission
  - In particular, Office of Science practice (critical decision [CD] process and Office of Project Assessment reviews) considered gold-standard in DOE
    - "Failure is not an option"
  - SC has earned the authority to manage projects flexibly
    - This authority is only protected by unblemished project execution and is recognized as essential to SC success
- DOE is committed to the successful execution of projects that have reached CD-2 and aims to provide the baseline funding profile
  - Approval of CD-2 establishes the Performance Baseline against which the project success or failure will be measured
  - CD-2 also allows project to request construction/fabrication funds
- In difficult budget situation, projects that have not yet reached CD-2 are much more likely to have their profiles adjusted

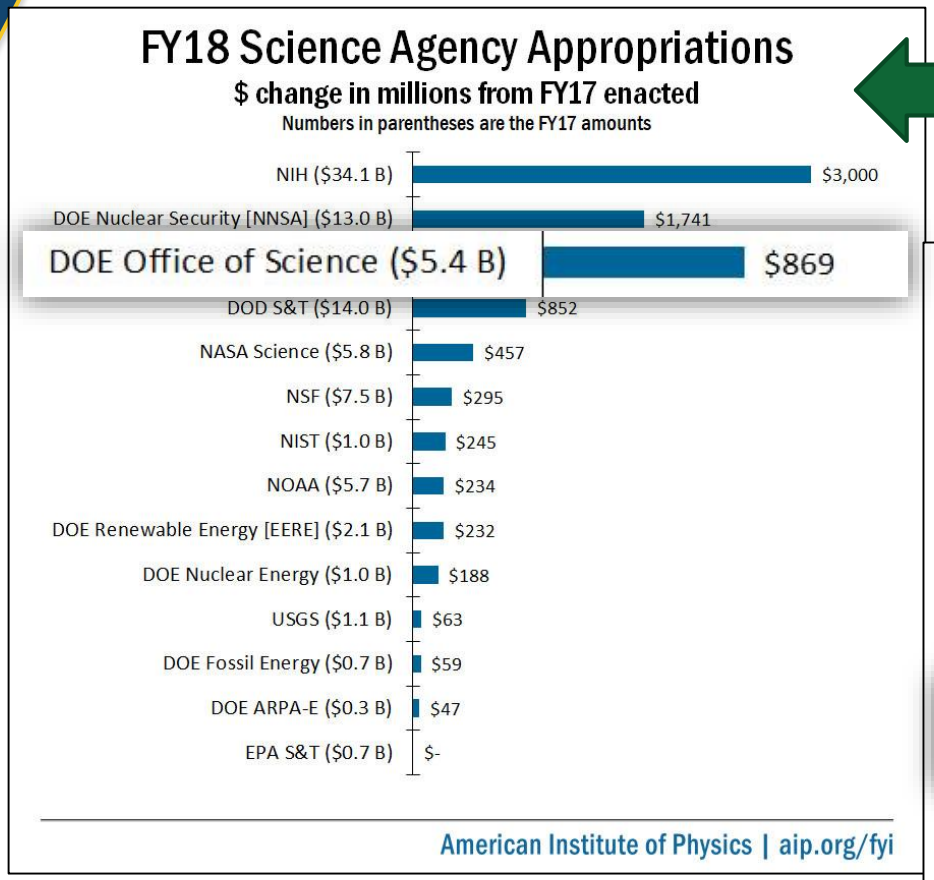
Coordination with Partners

- Many HEP efforts are collaborative and mechanisms exist to make sure that this process goes smoothly and obligations are met
  - Contributions between partners are typically in-kind
- The White House Office of Science and Technology Policy (OSTP) ensures that the scientific and technical work of the Executive Branch is properly coordinated
  - With oversight from OSTP, DOE/HEP coordinates closely with partner agencies, including NASA and NSF, through:
    - Memoranda of Understanding (MOU), Joint Oversight Groups (JOGs), and Advisory panels
- The U.S. State Department can authorize DOE to establish the framework necessary to work with international partners through:
  - **Science and Technology Agreements (S&TA):** nation-to-nation agreements that acts as legal umbrellas for subsidiary agreements
  - **Implementing Arrangements (IAs):** agency-to-agency agreements for cooperation in broad areas of S&T
  - **Project Annexes (PAs):** Annexes to IAs are agreements that cover project- or subfield-specific cooperative activities
- 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

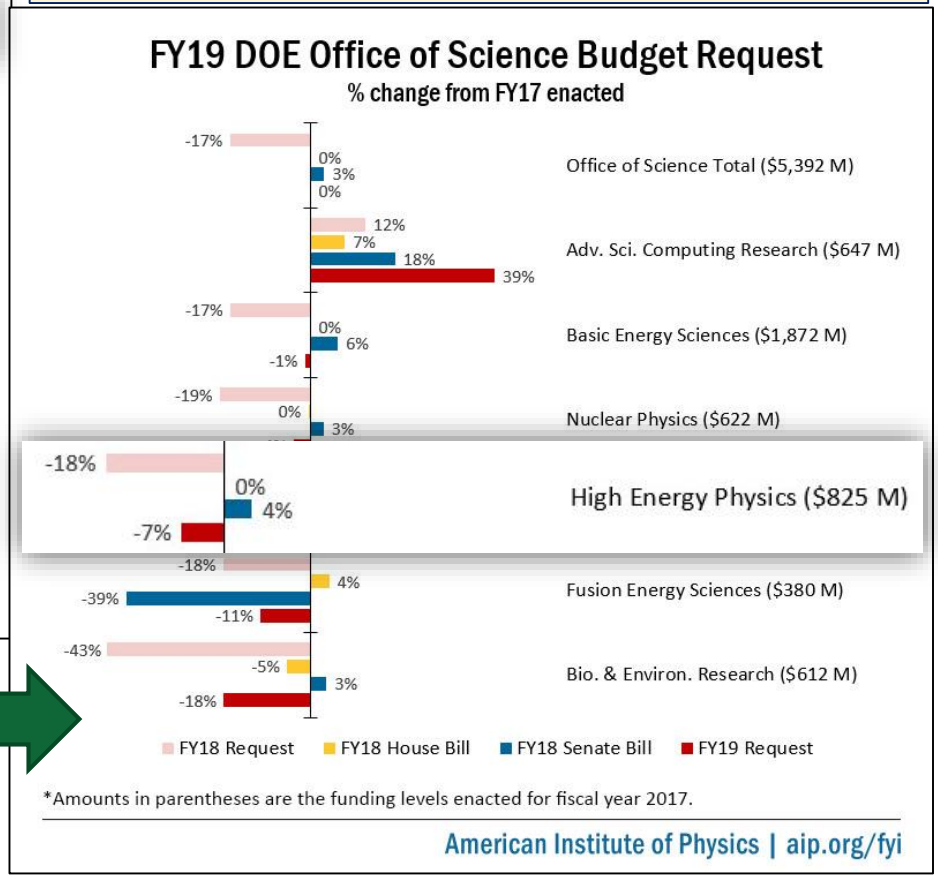
FY 2019 HEP Budget Request



Dichotomy of Budget Formulation and Budget Execution



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



- HEP is down from 908M in FY 2018 to 770M in FY 2019 PBR, a **decrease of -15.1%**
- All projects (except FACET-II) are addressed at their baseline and/or IPR levels. Research falls to 36.5%.

FY 2019 DOE Office of Science Request

SCIENCE

The FY 2019 Budget Request includes $5.4B for the Office of Science, the same as FY 2017 Enacted, to focus on its core mission of conducting cutting edge, early-stage research. Highlights of the Request include:

- $2.2B for discovery at the frontiers of science, maintaining 40% of its budget for research, including $578M to achieve exascale and quantum computing.
- $2.1B to operate national labs and world-class scientific instruments for over 30,000 researchers.
- $760M to construct the next generation of scientific facilities and tools, including the new Advanced Light Source Upgrade (ALS-U) at Lawrence Berkeley National Laboratory and the Linac Coherent Light Source-II High Energy project at SLAC; continuation of construction of the Long Baseline Neutrino Facility at Fermi, the Facility for Rare Isotope Beams at Michigan State University, two significant upgrades to the Large Hadron Collider, and $75M for the ITER project.

SCIENCE

Science Programs	FY19 ($M)
• Advanced Scientific Computing Research	899
• Basic Energy Sciences	1,850
• Biological and Environmental Research	500
• Fusion Energy Sciences	340
• High Energy Physics	770
• Nuclear Physics	600
• Science Laboratory Infrastructure	127
• Security and Administration	286
• Workforce Development for Teachers and Scientists	19
Science Total	**5,391**

FY 2019 President's Budget Request

HEP Funding Category ($ in K)	FY 2017 Actual	FY 2018 Enacted	FY 2019 Request	FY 19 vs. FY 18
Research	344,043	369,565	280,130	-89,435
Facilities/Operations	258,696	260,535	211,020	-49,515
Projects	222,261	277,900	278,850	+950
Total	**825,000**	**908,000**	**770,000**	**-138,000**

- The 2019 President's Budget Request for HEP is an overlay of:
  - Administration priorities
  - SC priorities (interagency partnerships, national laboratories, accelerator R&D, QIS)
  - P5 priorities (preserve vision, modify execution)
- FY19 Budget Request reduces near-term science 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
- The Administration and Congress support the overall P5 strategy
  - FY19 House Mark for HEP: **$1,004,510,000** ; FY19 Senate Mark for HEP: **$1,010,000,000**

Balancing Research, Operations and Projects

- FY 2019 House Mark is 1004.5M
  - 388.3M (38.3%) for projects is fully controlled by language
    - +80M for LBNF/DUNE over FY 2018, and +62M over Request
    - Mu2e, DESI, SuperCDMS, LZ and FACET-II receive final funding
  - 620M or 61.7% remains to support all of Research & Operations
- FY 2019 Senate Mark is 1010M
  - 357.4M (35.4%) for projects is fully controlled by language
    - +50M for LBNF/DUNE over FY 2018, and +32M over Request
    - Mu2e, DESI, SuperCDMS, LZ and FACET-II receive final funding
  - 652.6M or 64.6% provides strong support to Research & Operations
- Either House or Senate Mark - Accelerates Project funding:
  - Creates 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

Timeline for Updating the U.S. Strategy

- **The May 2014 P5 report was successful because it was well informed by the science community**, including information from:
  - 2010 New Worlds, New Horizons in Astronomy and Astrophysics
  - 2012 Report of the Subcommittee on Future Projects of High Energy Physics (Japan)
  - 2013 European Strategy for Particle Physics Report
  - 2013 U.S. Particle Physics Community-driven "Snowmass" process
- The timeline of processes that impact strategic planning is:
  - 2018: Anticipated Japanese decision on ILC
  - 2018-20: New NAS Astronomy and Astrophysics Decadal Survey
  - 2019: Start of European Strategy for Particle Physics process
  - 2020: Release of updated European Strategy for Particle Physics
  - 2020: Earliest opportunity for National Science Board to approve obligating MREFC for HL-LHC
- From a DOE perspective, the earliest that new "Snowmass," NAS Elementary Particle Physics Decadal Survey, and P5 processes could begin is 2020
  - Relative timing of Snowmass, P5, and NAS EPP Decadal survey to be determined
  - Enables receiving new P5 recommendations in time to inform the FY 2024/25 budget
- **U.S. community encouraged to work with international collaborators in developing other regional plans with a global vision for particle physics**

Communications

- Community groups and Steve Ritz updated content on usparticlephysics.org
  - Coordinated effort of DPF Executive Committee, **Fermilab UEC**, SLUO, and USLUA
    - With help from AAAS S&T Policy Fellow Andrea Peterson
  - New material includes brochure on STEM connections of particle physics
- DOE provides opportunities to highlight results or amplify articles
  - University Research stream on Office of Science Webpage
  - Science Highlights articles
    - Contact: Michael.Cooke@science.doe.gov

2018 HEP PI Mtg

- To brief and guide the HEP community on future FOAs and to provide a status and overview of the DOE-supported HEP program, **we invite you to the next HEP Principal Investigator (PI) Meeting on August 22-24, 2018 in the Washington, D.C. area at:**
  - **Hilton Rockville/ Washington DC Hotel & Executive Meeting Center (1750 Rockville Pike, Rockville, MD)**
- Invitation is also extended to co-PIs on existing DOE grants, those PIs interested in applying to future DOE FOAs, and interested national laboratory staff.
- The format for the meeting will include the following:
  - General presentations during a plenary session covering the overall DOE-HEP program, budgetary issues, and different HEP FOAs at DOE to which PIs may apply
  - Parallel sessions led by individual DOE-HEP Program Managers (PMs) within the following subprograms: Energy, Intensity, and Cosmic Frontiers, Theoretical HEP, and Detector R&D, to provide detailed guidance on preparing comparative review applications for the merit review process, and the programmatic priorities and budgetary factors for the respective subprogram.
  - Opportunities for separate one-on-one sessions.
- We believe the above meetings will benefit investigators and their research groups, and provide an opportunity for all researchers to better understand the DOE-HEP program. To take advantage of this opportunity, we encourage you to visit the PI Meeting website at:
  - **https://www.orau.gov/heppi2018/**
- This link contains details for PIs to make their individual hotel room reservations (*on their own*) as well as registration (*no fee*), and additional information on the agenda for different PI Meeting sessions, as they become available. Please check back periodically for any updates.
  - For questions, please contact Abid Patwa (abid.patwa@science.doe.gov) and Christie Ashton (christie.ashton@science.doe.gov).

Summary: Implementing the P5 Vision

- 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

- Process is continuous, but the response time to stimulus can be long
  - 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
  - Arguable the full impact (success!) of the P5 report was not fully seen until FY 2016, but continues today

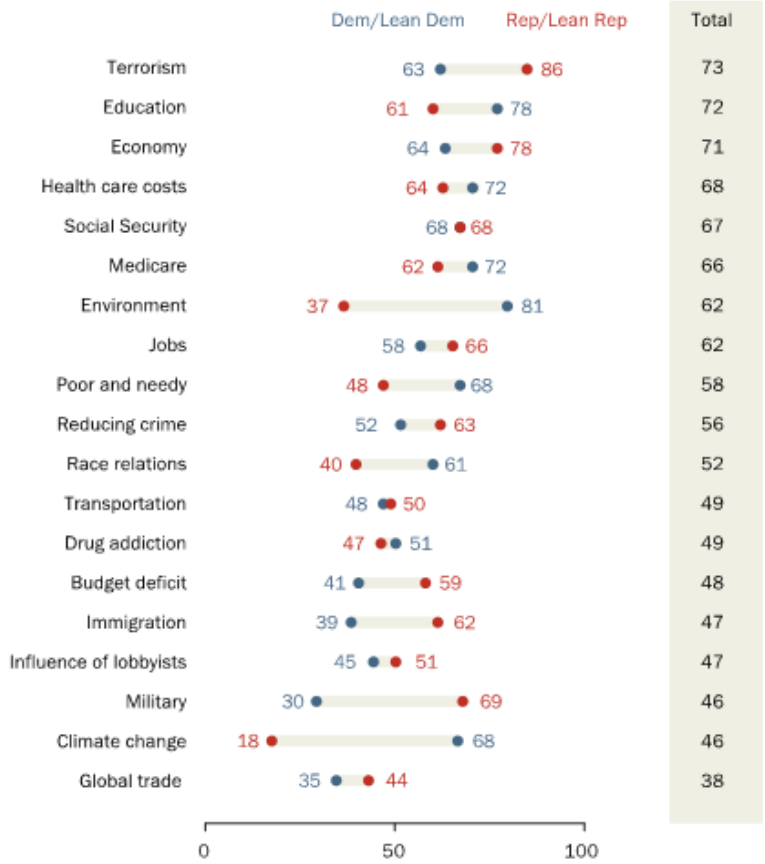
- **Community continues to play an important role**
  - Coordinated efforts have been successful in sharing P5 vision
  - A long-term view is necessary to provide feedback in a context that is most helpful

U.S. DEPARTMENT OF ENERGY | Office of Science

Public Policy Priorities

Partisans agree on some policy priorities, differ on many others – especially climate change, environment

% who say ____ is a top priority for Trump and Congress



Source: Survey of U.S. adults conducted Jan. 10-15, 2018

PEW RESEARCH CENTER

Public's policy priorities: 2010-2018

% who say ____ is a top priority for the president and Congress

	8 years ago Jan 2010 %	4 years ago Jan 2014 %	1 year ago Jan 2017 %	Now Jan 2018 %	8-year chg '10-'18	1-year chg '17-'18
Defending against terrorism	80	73	76	73	-7	-3
Improving education	65	69	69	72	+7	+3
Strengthening nation's economy	83	80	73	71	-12	-2
Reducing health care costs	57	59	66	68	+11	+2
Securing Social Security	66	66	60	67	+1	+7
Securing Medicare	63	61	59	66	+3	+7
Protecting environment	44	49	55	62	+18	+7
Improving job situation	81	74	68	62	-19	-6
Problems of poor and needy	53	49	56	58	+5	+2
Reducing crime	49	55	56	56	+7	0
Addressing race relations	–	–	56	52	–	-4
Improving transportation	–	39	36	49	–	+13
Dealing with drug addiction	–	–	36	49	–	+13
Reducing budget deficit	60	63	52	48	-12	-4
Dealing with immigration	40	40	43	47	+7	+4
Reducing lobbyist influence	36	42	43	47	+11	+4
Strengthening the military	49	43	45	46	-3	+1
Dealing with climate change	28	29	38	46	+18	+8
Dealing with global trade	32	28	40	38	+6	-2

Notes: In 2013 and earlier, the item "dealing with the issue of immigration" asked about "illegal immigration." In 2015 and earlier, the item "Dealing with global climate change" asked about "global warming." Significant changes in **bold**.
Source: Survey of U.S. adults conducted Jan. 10-15, 2018.

PEW RESEARCH CENTER

STAKEHOLDER MAP – Particle Physics in Pres. Trump's Administration

Executive Offices | Specialized Media Groups | Federal Agencies | Advisory Groups | Special Interest Groups | International Partnerships | Private Sector Organizations | 115th US Congress

Office of Management and Budget
Dir. Mick Mulvaney
PR Budget, Policies

Office of Science and Technology Policy
Dir. (TBD)
Science Advisor

Department of Energy
Sec. Rick Perry
Under Sec. for Science
Paul Dabbar
Office of Science
Dir. Steve Binkley (Acting)
Build projects, operate facilities, support discovery science

National Science Foundation
Dir. France Cordova
Supporting Education and Research

National Aeronautics and Space Administration
Dir. Jim Bridenstine
Space Science

CERN

Italy/ INFN

UK/ STFC

Japan /MEXT

Google, Simons Foundation, Moore Foundation, Battelle, Bechtel, Lockheed Martin

NYT, Washington Post, Fox News, MSNBC, CNN, TheHill, AIP FYI, Politico, Facebook, Twitter, Buzzfeed

American Physical Society

University Research Associates

DOE National Laboratories

FOCUS ISSUE AREAS

Particle Physics Priorities:

- Large Hadron Collider
- Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment
- Large Synoptic Survey Telescope
- Advanced Technology R&D

Senate Commerce Subcommittee on Space, Science and Competitveness
Ted Cruz, TX, Chair (Rep)
Ed Markey, MA, Rnk. Mem. (Dem)

Senate Energy Subcommittee on Energy
Cory Gardner CO, Chair (Rep)
Joe Manchin WV, Rnk. Mem. (Dem)

National Academy of Sciences

High Energy Physics Advisory Panel
Dr. JoAnne Hewitt (Chair)

Astronomy and Astrophysics Advisory Committee
Dr. Buell Januzzi (Chair)

Senate Appropriations Subcommittee on Energy and Water Development
Lamar Alexander, TN, Chair (Rep)
Diane Feinstein, CA, Rnk. Mem. (Dem)

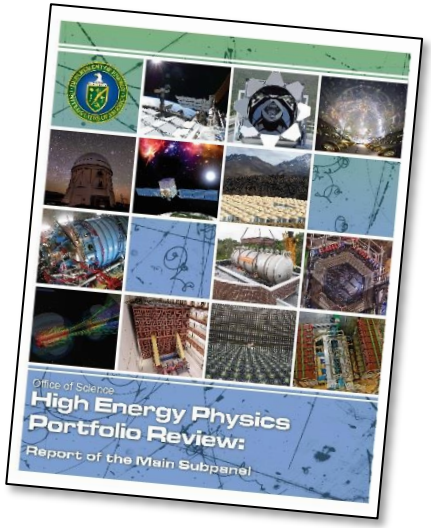
House Science Subcommittee on Energy
Randy Weber, TX, Chair (Rep.)
Marc Veasey, TX, Rnk. Mem. (Dem.)

House Energy Subcommittee on Energy and Power
Fred Upton, MI, Chair (Rep.)
Bobby Rush, IL, Rnk. Mem. (Dem.)

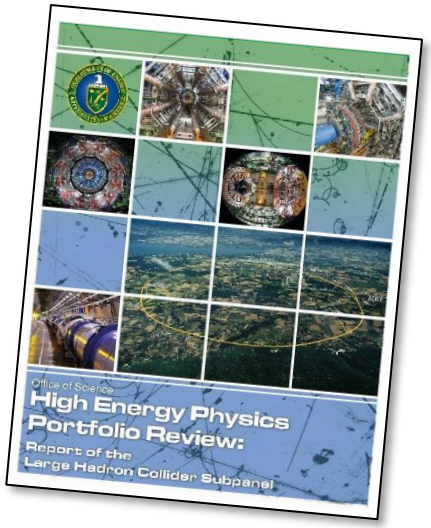
House Appropriations Subcommittee on Energy and Water Development
Mike Simpson, ID, Chair (Rep.)
Marcy Kaptur, OH, Rnk. Mem. (Dem)

HEP Portfolio Review

- Following HEPAP and COV recommendations, HEP has undertaken several steps recently to help further optimize program plans and budgets:
  - HEP Lab Optimization
    - Ongoing rebalancing of Research and Facilities capabilities
  - **Portfolio Reviews (reports issued→)**
  - Basic Research Needs workshops (Dark Matter, Compact Accelerators upcoming)
  - Accelerator Technology Roadmaps



- **Portfolio Review** assessed 13 currently operating HEP-supported experiments and prioritized their impact on P5 science drivers:
  - 4 Tiers, from absolutely essential to "less effective"
  - HEP will prioritize ongoing support for top-Tier(s)
  - Lower Tier(s) to be ramped down over a few years depending on budgets, partnerships, external factors
  - US contributions to LHC experiments also examined, with generally high praise and a few comments



Mission

The mission of the Energy Department is to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions.

The mission of the Office of Science is the delivery of scientific discoveries and major scientific tools to transform our understanding of nature and to advance the energy, economic, and national security of the United States.

The mission of the High Energy Physics (HEP) program is to understand how our universe works at its most fundamental level.

DOE Particle Physics Agency Partnerships

NSF

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

DOE

- 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

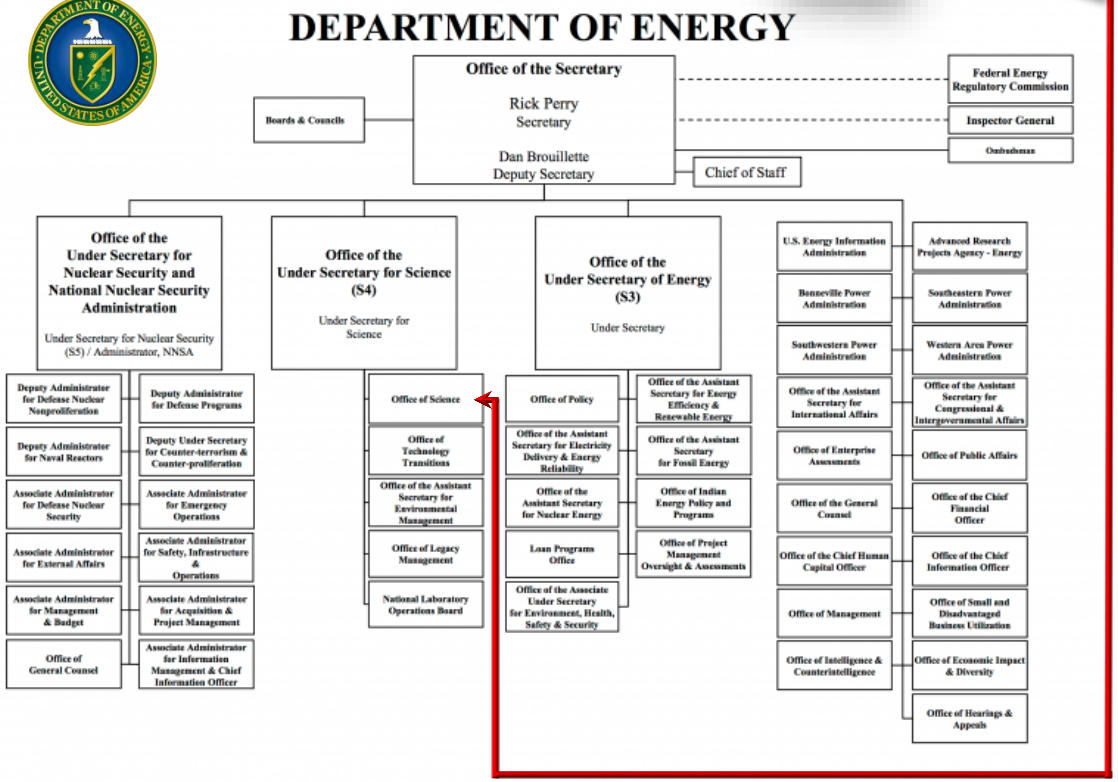
HEPAP Coordination

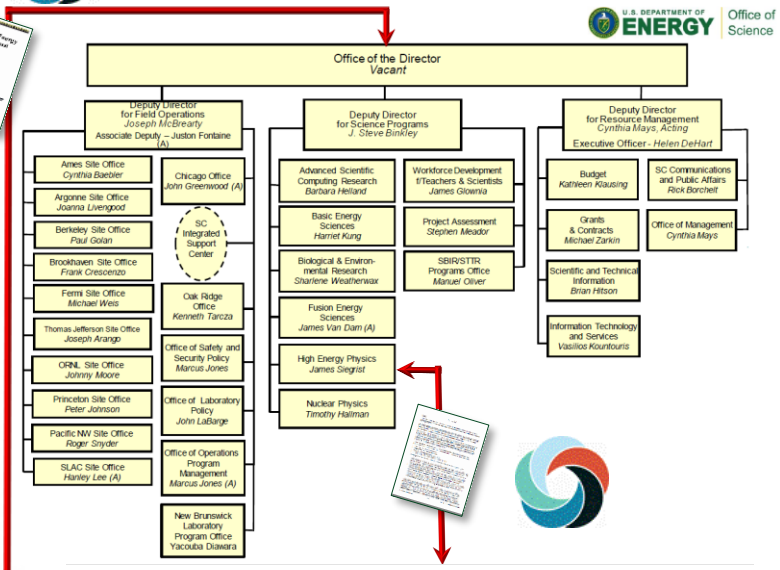
AAAC Coordination

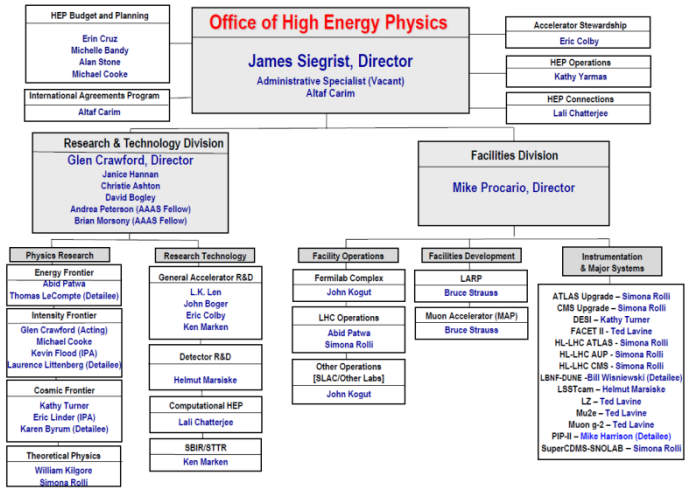
Strong connections	Energy Frontier	
Modest ties	Intensity Frontier	
Strong connections	Cosmic Frontier	*Space-based experiments*
Strong connections	Theoretical Physics	
Modest ties	Technology R&D	

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

Path to the President's Budget Request







Program Advice and Coordination

- Formal advice (Federal Advisory Committee Act)
  - High Energy Physics Advisory Panel (HEPAP)
    - Jointly serves DOE and National Science Foundation (NSF)
    - 2014: P5 long-term strategy report
    - 2015: Accelerator R&D Subpanel report
  - Astronomy and Astrophysics Advisory Committee (AAAC)
    - Advises DOE, NSF, and NASA on selected issues of mutual interest within the fields of astronomy and astrophysics (*e.g. CMB-S4 Conceptual Design Team*)

- Community input
  - National Academies of Science: Astronomy and Astrophysics Decadal Survey (*New Worlds, New Horizons*)
  - DOE Workshop reports, including Quantum Sensors, Accelerator R&D Roadmaps, Technology Connections, Basic Research Needs, etc.

- International coordination
  - CERN Council (LHC)
    - Governs CERN by defining its strategic programs, setting and following up its annual goals, and approving its budget
  - International Neutrino Council (LBNF/PIP-II)
    - International consulting body for DOE that facilitates high-level global coordination across the LBNF/PIP-II enterprise
  - Resources Review Board (DUNE)
    - Facilitates Fermilab's coordination of resource-related matters for DUNE

DOE Roles and Responsibilities

- Certain functions are considered "inherently governmental" and reserved for Federal staff, including:
  - Determination of agency policy, such as determining the content and application of regulations, among other things
  - Determination of Federal program priorities for budget requests
  - Determination of budget policy, guidance, and strategy
  - Approving, awarding and administering government prime contracts
    - Including determining what supplies or services are to be acquired with government funds
- Moreover, since Federal staff are normally hired following civil service laws, there is a strong precept that contractors must not act as Federal staff and vice versa, e.g.:
  - Government employees do not directly supervise contractors
  - Federal staff are generally not involved in contractor personnel decisions
- For all intents and purposes, DOE labs are *prime contractors* and lab employees are *contractor employees*

DOE Lab Roles and Responsibilities

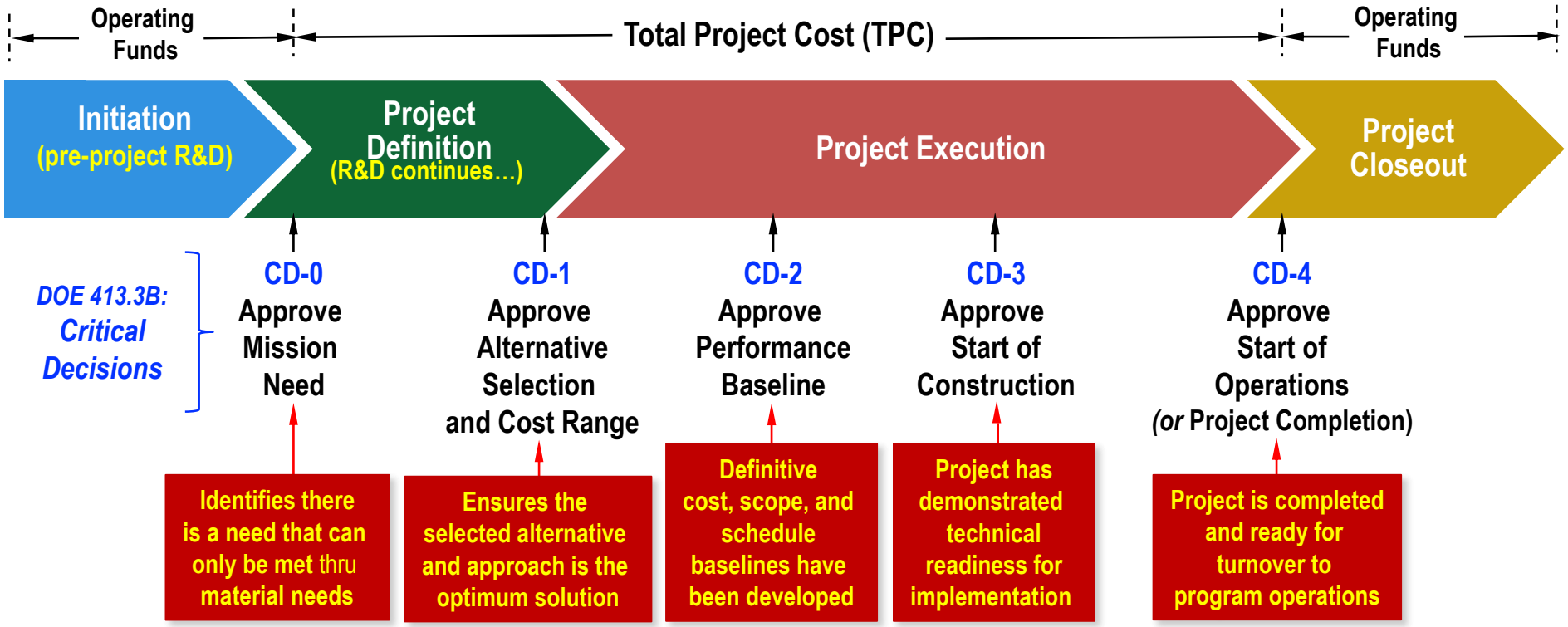
- Facility Operations and Construction
  - Performance judged against specified metrics (e.g. pb^{-1} ; EVMS)
  - Includes maintenance, upgrades, planning for new facilities
  - User support
- HEP Research and Technology R&D
  - Nurture and support HEP research collaborations to enable discovery science
  - Participation in all phases – from design, construction, operations & analysis
  - Particular emphasis on:
    - Management, design, construction and operation of HEP experiments
    - Integration of cross-cutting activities, *e.g.*: computation, simulation and theoretical research, in support of HEP program
    - Exploiting lab infrastructure and resources to develop next-generation particle accelerator and detector technologies for the advancement of HEP and science more broadly

University Roles and Responsibilities (DOE Perspective)

- HEP Research and Technology R&D
  - Contribute significantly to HEP research collaborations to enable discovery science
  - Participation in all phases – from design, construction, operations & analysis
  - Particular emphasis on:
    - Advanced training of students and postdocs
    - Data analysis and comparison with theoretical models
    - Vision and theoretical framework for understanding the Standard Model and beyond
    - Novel and innovative concepts and approaches
    - Design of future HEP experiments

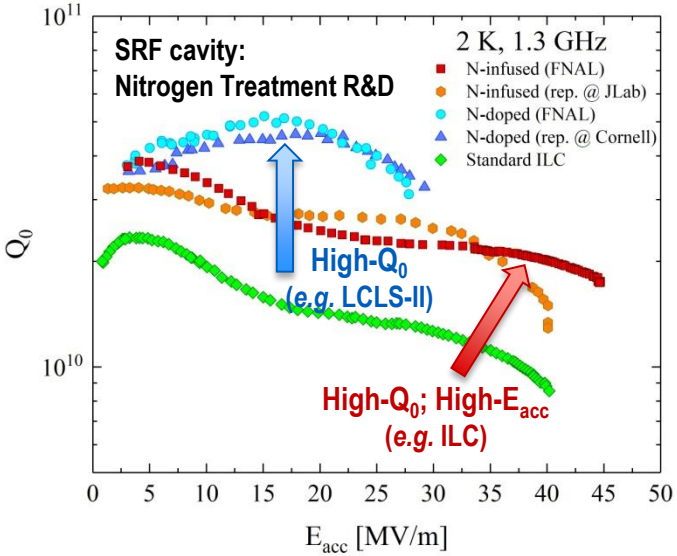
DOE Project Management

- Construction projects and fabrication of large pieces of experimental equipment costing over $10M are managed through a series of "Critical Decision" milestones
- The CD process ensures successful project execution and scientific return on agency investments, but funding must still be appropriated
  - Linked to – *but independent of* – the budget process!



Future Colliders

- DOE coordinating with international community towards development of the next collider program
  - U.S. looks forward to a decision this year by Japan to host the ILC as an international project
  - Global strategy for circular collider awaits 2020 European Strategy Update for Particle Physics
- Interest from HEP community to pursue R&D studies for future collider options
  - Circular collider: DOE efforts focused on high-field magnet technology to enable higher energy
  - ILC: DOE efforts focused on cost reduction R&D, *e.g.*, nitrogen treatment in SRF cavities has potential for up to 10% cost reductions in 3-5 years, up to 15% in 5-10 years
- Under any fiscal constraints in the Energy Frontier program, near-term priorities will aim to support the LHC program as well as R&D for the HL-LHC upgrades



Fundamental Science That Advances QIS

ASCR
Quantum algorithms; uncertainty quantification and verification & validation methods; software stack; quantum networks

BES
Synthesis, characterization, theory, modeling, and instrumentation to advance quantum materials & chemical phenomena

HEP
Black hole physics; quantum gravity and quantum error correction; fundamental aspects of entanglement

NP
Isotopes and trapped ions for quantum devices; lattice quantum chromodynamics

Quantum Field Theory and Topology

Control of Quantum Phenomena

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

Overall HEP Goals for QIS Activities

- Focused efforts in order to:
  - Advance the science drivers identified by P5 using QIS
  - Advance QIS itself through capabilities, expertise, and fundamental knowledge of the HEP community – in foundations, analogue simulation, controls, qubit technology, and more
  - Develop the appropriate and necessary interdisciplinary collaborations to advance high energy physics in particular and science more broadly
- As QIS is an SC cross-cutting initiative, partnerships with other SC programs, other agencies, and/or industry are expected where relevant

Computing Strategy Development

- OHEP initiated a **consultative process** with the HEP community to:
  - More accurately capture the largest expected computing needs
  - Look for opportunities where economies of scale and optimal use of resources can close the gap

- **Inventory of HEP Computing Needs Roundtable Meeting** – *May 2018*
  - Focused on hardware, software, and personnel needs for the next decade
  - Identification of next steps
- **Commonalities Roundtable Meeting** – *later this year*
  - Focused on identifying common elements in software and workflows, HPC applicability, and integration with Exascale, HSF, S2I2, and other computing initiatives

What We've Learned So Far

- HPC architectures will continue to evolve, but moving to vectorized, multithreaded codes tailored to I/O-bound systems will result in higher efficiency codes
  - Engaging HPC experts to analyze code has helped identify algorithm alternatives and data flow bottlenecks, in some cases resulting in spectacular speedups (e.g. 600x). Continued engagement is therefore essential!
  - Need to identify which codes could benefit the most
- Using Exascale machines badly (e.g. by ignoring the GPU/accelerator) will result in a factor-of-40 penalty in performance that will not be tolerated. HEP will lose its allocations if it does this.
  - Engaging Exascale Computing Project (ECP) experts early and often will result in faster adoption of best practices for exascale machines, and influence ECP design choices to HEP's benefit. HEP needs a coordinated interface to both ECP & the Leadership Computing Facilities.
  - Need to identify which codes could benefit the most
- LQCD regularly rewrites its code, has reaped significant speedup benefits every time
- Reinforced that multiyear NERSC allocations & better metrics for pledges are needed
- End-to-end network data flow models are needed to support tradeoff analysis of storage vs. CPU vs. network bandwidth on a system-wide and program-wide basis
  - Greater sharing of the underlying data management software layer may also be beneficial

Next Steps

- OHEP exploring a process to enable multiyear allocations at NERSC
- Studies of selected HEP codes
  - In-depth analysis of 1-2 critical codes to identifying resource bottlenecks and opportunities for speedup (both general and GPU-accelerated), drawing on expertise at NERSC, the LCFs, and the ECP
  - Discussions with the broader community to assess the potential for vectorization and efficient CPU/GPU utilization of the most resource-intensive codes in use; "dissect-a-thons" to triage codes
  - Identification of recurrent kernels and themes in HEP software
- Identification of common areas where efficiencies of scale can be jointly explored
  - Data processing and storage models optimized for current and anticipated CPU/storage/network costs
  - Shared best programming practices

Community input is important — please work with your experiment's computing leads to provide input