High Energy Physics Budget Planning and Execution

HEPAP Meeting
21 November 2019

Alan Stone
Office of High Energy Physics
Office of Science, U.S. Department of Energy
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

- 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.”
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 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...
Adjusting for inflation, based on the Consumer Price Index published by the U.S. Bureau of Labor Statistics, **FY 1987 funding 495.4M in FY 2019 dollars is about 1,120M.** However, over that period of time, Lab and University cost escalation outpaced CPI...

Students at **public 4-year institutions** paid $1,480 in tuition in 1987 (**$3,190** in 2017 adjusted dollars). By 2017, the average rose to **$9,970**.
Historical Chart of HEP Projects
FY 1996 – FY 2019

HEP funded $2.11B in projects from FY 1996-2015 (14.1% of total budget)
HEP funded $1.03B in projects from FY 2016-2019 (29.5% of total budget)

Current P5
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
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

AND NOW BACK TO OUR REGULARLY SCHEDULED GOVERNMENT DYSFUNCTION

Chattanooga Times Free Press

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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

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

| **Funded Post-Shutdown**         |                             |                             |                      |                      |

*Note: Figures are in billions of dollars.*
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

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

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<thead>
<tr>
<th></th>
<th>FY 2018</th>
<th>FY 2019</th>
<th>FY 2018</th>
<th>FY 2019</th>
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</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>347</td>
<td>364</td>
<td>$126,857,897.03</td>
<td>$121,820,365.80</td>
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<tr>
<td><strong>Award Revision</strong></td>
<td>5</td>
<td>8</td>
<td>-$116,531.97</td>
<td>-$200,950.29</td>
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<tr>
<td><strong>Continuation</strong></td>
<td>155</td>
<td>180</td>
<td>$72,350,000.00</td>
<td>$71,705,000.00</td>
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<tr>
<td><strong>New</strong></td>
<td>91</td>
<td>55</td>
<td>$26,363,429.00</td>
<td>$17,263,816.09</td>
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<tr>
<td><strong>No Cost Extension</strong></td>
<td>48</td>
<td>58</td>
<td>$0.00</td>
<td>$0.00</td>
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<tr>
<td><strong>Renewal</strong></td>
<td>36</td>
<td>56</td>
<td>$26,210,000.00</td>
<td>$32,635,500.00</td>
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<tr>
<td><strong>Supplemental</strong></td>
<td>12</td>
<td>7</td>
<td>$2,051,000.00</td>
<td>$417,000.00</td>
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</tbody>
</table>
WHERE ARE WE GOING THIS TIME, MR. PEABODY?

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?

HEP Budget ($k) FY 2011-2019
Research, Operations, Projects

Research
SBIR/STTR
Facilities/Ops
Projects
HEP Budget ($k) FY 2011-2019
Projects: Construction and MIEs
HEP Projects ($k) FY 2011-2019

Future Project R&D = Project X R&D, and pre-CD-0 for PIP-II, DM2, and CMB-S4
HEP Budget ($k) FY 2011-2019
(excluding Line Item Construction TEC)

In Budget, this is “High Energy Physics” or HEP “Core” Program

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</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>408000</td>
<td>391000</td>
<td>362000</td>
<td>361000</td>
<td>334000</td>
<td>321000</td>
<td>322000</td>
<td>335000</td>
<td>357000</td>
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<tr>
<td>SBIR/STTR</td>
<td>20000</td>
<td>20000</td>
<td>21000</td>
<td>22000</td>
<td>21000</td>
<td>21000</td>
<td>22000</td>
<td>24000</td>
<td>24000</td>
</tr>
<tr>
<td>Facilities/Ops</td>
<td>264000</td>
<td>249000</td>
<td>265000</td>
<td>279000</td>
<td>265000</td>
<td>258000</td>
<td>259000</td>
<td>270000</td>
<td>261000</td>
</tr>
<tr>
<td>Projects (excl LIC TEC)</td>
<td>102829</td>
<td>101963</td>
<td>88853</td>
<td>84305</td>
<td>109373</td>
<td>129001</td>
<td>128761</td>
<td>137935</td>
<td>158350</td>
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<tr>
<td><strong>Total</strong></td>
<td>795,420</td>
<td>762,860</td>
<td>736,533</td>
<td>745,521</td>
<td>729,000</td>
<td>728,900</td>
<td>731,500</td>
<td>767,600</td>
<td>800,000</td>
</tr>
</tbody>
</table>
HEP Budget (%) FY 2011-2019
(excluding Line Item Construction TEC)

Research
SBIR/STTR
Facilities/Ops
Projects (excl LIC TEC)
HEP Facilities/Operations ($k) FY 2011-2019

$25M shortfall in FY 2019 to optimally support Fermilab Acc Complex; procure new computing & storage for LHC; transition to experiment for Cosmic Frontier projects, etc.
HEP Research ($k) FY 2011-2019

-87M FY11 to FY16 for Research

MIEs +56M from FY11 ($103M) to FY16

LICs +66M from FY11 ($0) to FY16

+35M FY17 to FY19 QIS +27.5M

321,892

356,752

Research

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

FY16 to FY19 @3% inflation = 21M shortfall (for constant level of effort only!)
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
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.

  - 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.
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.

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.
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.

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
Fiscal Year 2020 Federal Budget

March 11, 2019: President submitted budget request

Jul 2019: Congress passed FY20/21 budget resolution

FY 2020: Congress has created continuing resolutions.

OMB estimates Federal revenue to be $3.645 trillion
- Income taxes: $1.824 trillion
- Payroll taxes: $1.295 trillion
- All Other: $0.508 trillion

OMB estimates the Federal government to spend $4.746 trillion

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

Deficit projected at $1.092 trillion

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

Source: https://thebalance.com

21 November 2019
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

  - 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 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
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

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

- 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).
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.
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 ECA funding & awards/year

- Total FY Funding
- Current FY Funding
- Total Active Awards

FY10 FY11 FY12 FY13 FY14 FY15 FY16 FY17 FY18 FY19

Total FY Funding: 18,000,000
Current FY Funding: 5,000,000
Total Active Awards: 60
### HEP Early Career FY10-19 Lab vs. Univ Awards

<table>
<thead>
<tr>
<th>Subprogram</th>
<th>FY10 (L/U)</th>
<th>FY11 (L/U)</th>
<th>FY12 (L/U)</th>
<th>FY13 (L/U)</th>
<th>FY14 (L/U)</th>
<th>FY15 (L/U)</th>
<th>FY16 (L/U)</th>
<th>FY17 (L/U)</th>
<th>FY18 (L/U)</th>
<th>FY19 (L/U)</th>
<th>Total (L/U)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong></td>
<td>3 (1/2)</td>
<td>3 (1/2)</td>
<td>1 (0/1)</td>
<td>2 (0/2)</td>
<td>2 (1/1)</td>
<td>0 (0/0)</td>
<td>2 (0/2)</td>
<td>2 (1/1)</td>
<td>3 (2/1)</td>
<td><strong>21 (8/13)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>2 (1/1)</td>
<td>1 (0/1)</td>
<td>3 (2/1)</td>
<td>1 (0/1*)</td>
<td>1 (1/0)</td>
<td>2 (1/1)</td>
<td>1 (1/0)</td>
<td>2 (2/0)</td>
<td>2 (2/0)</td>
<td><strong>16 (10/6)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cosmic</strong></td>
<td>2 (0/2)</td>
<td>3 (2/1)</td>
<td>3 (1/2)</td>
<td>2 (1/1)</td>
<td>1 (0/1)</td>
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<td>1 (0/1)</td>
<td>2 (1/1)</td>
<td>2 (0/2)</td>
<td><strong>19 (5/14)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>HEP Theory</strong></td>
<td>6 (1/5)</td>
<td>*<em>4 (0/4</em>)**</td>
<td>3 (0/3)</td>
<td>3 (1/2)</td>
<td>1 (0/1)</td>
<td>3 (0/3)</td>
<td>1 (1/0)</td>
<td>2 (0/2)</td>
<td>3 (0/3)</td>
<td><strong>29 (4/25)</strong></td>
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<tr>
<td><strong>Detector</strong></td>
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<td>0 (0/0)</td>
<td>0 (0/0)</td>
<td>0 (0/0)</td>
<td>0 (0/0)</td>
<td>0 (0/0)</td>
<td>1 (1/0)</td>
<td>2 (2/0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accelerator</strong></td>
<td>1 (1/0)</td>
<td>2 (2/0)</td>
<td>2 (1/1)</td>
<td>1 (0/1)</td>
<td>1 (1/0)</td>
<td>0 (0/0)</td>
<td>2 (2/0)</td>
<td>2 (2/0)</td>
<td>1 (0/1)</td>
<td><strong>14 (11/3)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>QIS</strong></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1 (1/0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Proposals</strong></td>
<td>154 (47/107)</td>
<td>128 (43/85)</td>
<td>89 (34/55)</td>
<td>78 (29/49)</td>
<td>77 (36/41)</td>
<td>73 (27/46)</td>
<td>84 (27/47)</td>
<td>83 (26/57)</td>
<td>92 (35/57)</td>
<td><strong>950 (332/618)</strong></td>
<td></td>
</tr>
</tbody>
</table>

*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
Few Minutes on the U.S. Budget Process

Knock, Knock...
Who's There?
The U.S. Budget Process!
Ha, Ha, Ha, Ha, Ha, Ha...

©2013 Pittsburgh Post-Gazette
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

<table>
<thead>
<tr>
<th>FY 2020 Budget</th>
<th>Spend the Fiscal Year Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2021 Budget</td>
<td>OMB Review</td>
</tr>
<tr>
<td>FY 2022 Budget</td>
<td>DOE Internal Planning with OMB and OSTP Guidance</td>
</tr>
</tbody>
</table>

You are here
Overview of Budget Formulation Process

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

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

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

→ Agencies submit budgets to **OMB**

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

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

→ December: Agencies may appeal to **OMB** and President

→ 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 Priorities

OMB Directives

"Thread the needle"

Advisory Panels (HEPAP, AAAC)
Community-driven Strategic Plans (P5)
Review Committee & Workshop Reports

Particle Physics Community

Department of Energy

Project Performance
DOE/SC Management
DOE/HEP Program

21 November 2019
HEP Budget Planning and Execution
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
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.

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

21 November 2019
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...
FY 2019 Budget
Fiscal Year 2019 Federal Budget

- **FY 2019 deficit projected at $1.092 trillion**
- **OMB estimated Federal revenue to be $3.438 trillion**
  - Income taxes: $1.698 trillion
  - Payroll taxes: $1.242 trillion
  - All Other: $0.496 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 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
- **OMB estimated interest payments on National debt to be $393 billion in FY 2019**
- **Congress approved $1.359 trillion discretionary spending for FY 2019**

FY 2019 deficit projected at $1.092 trillion

Source: [https://thebalance.com](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 **over the next 10 years**

- **Bipartisan deals** in 2013 and 2015 raised the spending caps, but those adjustments expired in FY 2017

- Spending resolution for **FY 2018-2019** again set spending levels above spending caps.

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

- 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

- 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

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

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

- 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**

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

- **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.

---

LBNF/DUNE: Far Site Primary Excavation Begins  
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)

<table>
<thead>
<tr>
<th></th>
<th>FY 2017 Actual</th>
<th>FY 2018 Actual</th>
<th>FY 2019 Enacted</th>
<th>FY 19 vs. FY 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>8,270</td>
<td>9,783</td>
<td>9,083</td>
<td>-700</td>
</tr>
<tr>
<td>Facilities/Operations</td>
<td>4,868</td>
<td>5,517</td>
<td>6,067</td>
<td>+550</td>
</tr>
<tr>
<td>SBIR/STTR</td>
<td>478</td>
<td>585</td>
<td>574</td>
<td>-11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13,616</strong></td>
<td><strong>15,885</strong></td>
<td><strong>15,724</strong></td>
<td><strong>-161</strong></td>
</tr>
</tbody>
</table>

- **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

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

- **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

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

- **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 competitiveness.

21 November 2019
## Cosmic Frontier FY 2019 Program

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

- **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)

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

- **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

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

- **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

<table>
<thead>
<tr>
<th>Subprogram Awards</th>
<th>FY10 (M/F)</th>
<th>FY11 (M/F)</th>
<th>FY12 (M/F)</th>
<th>FY13 (M/F)</th>
<th>FY14 (M/F)</th>
<th>FY15 (M/F)</th>
<th>FY16 (M/F)</th>
<th>FY17 (M/F)</th>
<th>FY18 (M/F)</th>
<th>FY19 (M/F)</th>
<th>Total (M/F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>3 (2/1)</td>
<td>3 (2/1)</td>
<td>1 (1/0)</td>
<td>2 (1/1)</td>
<td>2 (1/1)</td>
<td>0 (0/0)</td>
<td>2 (2/0)</td>
<td>2 (2/0)</td>
<td>3 (2/1)</td>
<td>3 (1/2)</td>
<td>21 (14/7)</td>
</tr>
<tr>
<td>Intensity</td>
<td>2 (1/1)</td>
<td>1 (1/0)</td>
<td>3 (1/2)</td>
<td>1 (0/1*)</td>
<td>1 (1/0)</td>
<td>2 (2/0)</td>
<td>1 (0/1)</td>
<td>2 (2/0)</td>
<td>2 (2/0)</td>
<td>1 (0/1)</td>
<td>16 (10/6)</td>
</tr>
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<td>HEP Theory</td>
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<td>11 (8/3)</td>
<td>14 (11/3)</td>
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<tr>
<td>Proposals</td>
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<td>128 (110/18)</td>
<td>89 (75/14)</td>
<td>78 (64/14)</td>
<td>77 (62/15)</td>
<td>73 (57/16)</td>
<td>84 (65/19)</td>
<td>83 (59/24)</td>
<td>92 (72/20)</td>
<td>92 (67/25)</td>
<td>950 (762/188)</td>
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</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th>Subprogram Proposals</th>
<th>FY10 (L/U)</th>
<th>FY11 (L/U)</th>
<th>FY12 (L/U)</th>
<th>FY13 (L/U)</th>
<th>FY14 (L/U)</th>
<th>FY15 (L/U)</th>
<th>FY16 (L/U)</th>
<th>FY17 (L/U)</th>
<th>FY18 (L/U)</th>
<th>FY19 (L/U)</th>
<th>Total (L/U)</th>
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<td>21 (10/11)</td>
<td>17 (9/8)</td>
<td>7 (4/3)</td>
<td>14 (9/5)</td>
<td>15 (8/7)</td>
<td>19 (7/12)</td>
<td>14 (7/7)</td>
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<tr>
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<td>12 (5/7)</td>
<td>17 (5/12)</td>
<td>22 (9/13)</td>
<td>13 (7/6)</td>
<td>14 (6/8)</td>
<td>14 (6/8)</td>
<td>13 (5/8)</td>
<td>16 (5/12)</td>
<td>16 (4/12)</td>
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<tr>
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<td>Detector</td>
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<td>8 (7/1)</td>
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<td>35 (25/10)</td>
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<tr>
<td>Total Proposals</td>
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<td>128 (43/85)</td>
<td>89 (34/55)</td>
<td>78 (29/49)</td>
<td>77 (36/41)</td>
<td>73 (27/46)</td>
<td>84 (27/57)</td>
<td>83 (26/57)</td>
<td>92 (35/57)</td>
<td>92 (35/57)</td>
<td>950 (332/618)</td>
</tr>
</tbody>
</table>
**Central Campus Revitalization Project (CCRP)**

**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.

**CURRENT FUNDING GUIDANCE (in M$)**

<table>
<thead>
<tr>
<th>FY20</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
<th>FY25</th>
<th>FY26</th>
<th>FY27</th>
<th>FY28</th>
<th>FY29</th>
<th>Total</th>
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<tr>
<td>5</td>
<td>28</td>
<td>35</td>
<td>45</td>
<td>50</td>
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<td>50</td>
<td>45</td>
<td>35</td>
<td>7</td>
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**PLANNED CD’s (in FY)**

<table>
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<tr>
<th>CD-0</th>
<th>CD-1</th>
<th>CD-2</th>
<th>CD-3</th>
<th>CD-4</th>
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<tr>
<td>10/19</td>
<td>FY20</td>
<td>FY21</td>
<td>FY22</td>
<td>FY30</td>
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</table>

**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

**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.
**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
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.
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
28 scientific user facilities
# DOE Office of Science Research Programs

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

[https://www.energy.gov/science/office-science](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**
- 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 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

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

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

- 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
- Strong connections Theoretical Physics
- Modest ties Technology R&D

Space-based experiments

21 November 2019
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.
# HEP Project Status

## Subprogram

<table>
<thead>
<tr>
<th>Subprogram</th>
<th>TPC ($M)</th>
<th>CD Status</th>
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<td><strong>INTENSITY FRONTIER</strong></td>
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<tr>
<td>Long Baseline Neutrino Facility / Deep Underground Neutrino Experiment</td>
<td>1,300 – 1,900</td>
<td>CD-3A</td>
<td>September 1, 2016</td>
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<td>(LBNF/DUNE)</td>
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<tr>
<td>Proton Improvement Project (PIP-II)</td>
<td>653 - 928</td>
<td>CD-1</td>
<td>July 23, 2018</td>
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<td>Muon g-2 FY 2017</td>
<td>46.4</td>
<td>CD-4</td>
<td>January 16, 2018</td>
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<td>Muon-to-Electron Conversion Experiment (Mu2e)</td>
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<td>CD-3</td>
<td>July 14, 2016</td>
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<td><strong>ENERGY FRONTIER</strong></td>
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<td>LHC ATLAS Detector Upgrade FY 2017</td>
<td>33</td>
<td>CD-3</td>
<td>November 12, 2014</td>
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<td>LHC CMS Detector Upgrade FY 2017</td>
<td>33</td>
<td>CD-4A</td>
<td>September 19, 2017</td>
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<td>High-Luminosity LHC (HL-LHC) Accelerator Upgrade FY 2017</td>
<td>208 - 252</td>
<td>CD-1/3A</td>
<td>October 13, 2017</td>
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<td>High-Luminosity LHC (HL-LHC) ATLAS Detector Upgrade FY 2017</td>
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<td>High-Luminosity LHC (HL-LHC) CMS Detector Upgrade FY 2017</td>
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<td><strong>COSMIC FRONTIER</strong></td>
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<td>LUX-ZEPLIN (LZ) FY 2019</td>
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<td>Super Cryogenic Dark Matter Search - SNOLAB (SuperCDMS-SNOLAB) FY 2019</td>
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<td>Large Synoptic Survey Telescope Camera (LSSTcam) FY 2018</td>
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<td>CD-3</td>
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<td><strong>ADVANCED TECHNOLOGY R&amp;D</strong></td>
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<td>Facility for Advanced Accelerator Experimental Tests II (FACET-II) FY 2019</td>
<td>25.6</td>
<td>CD-2/3</td>
<td>June 8, 2018</td>
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</table>
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+
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.