



U.S. DEPARTMENT OF
ENERGY

Office of
Science

HEP Program Status

3 December 2020

HEPAP Meeting

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Office of High Energy Physics

Office of Science, U.S. Department of Energy

Outline

- ▶ Budget Summary
- ▶ Project Status
- ▶ International progress
- ▶ Office of Accelerator R&D and Production (ARDAP)
- ▶ Glen to cover Research program + miscellaneous.





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HEP BUDGET

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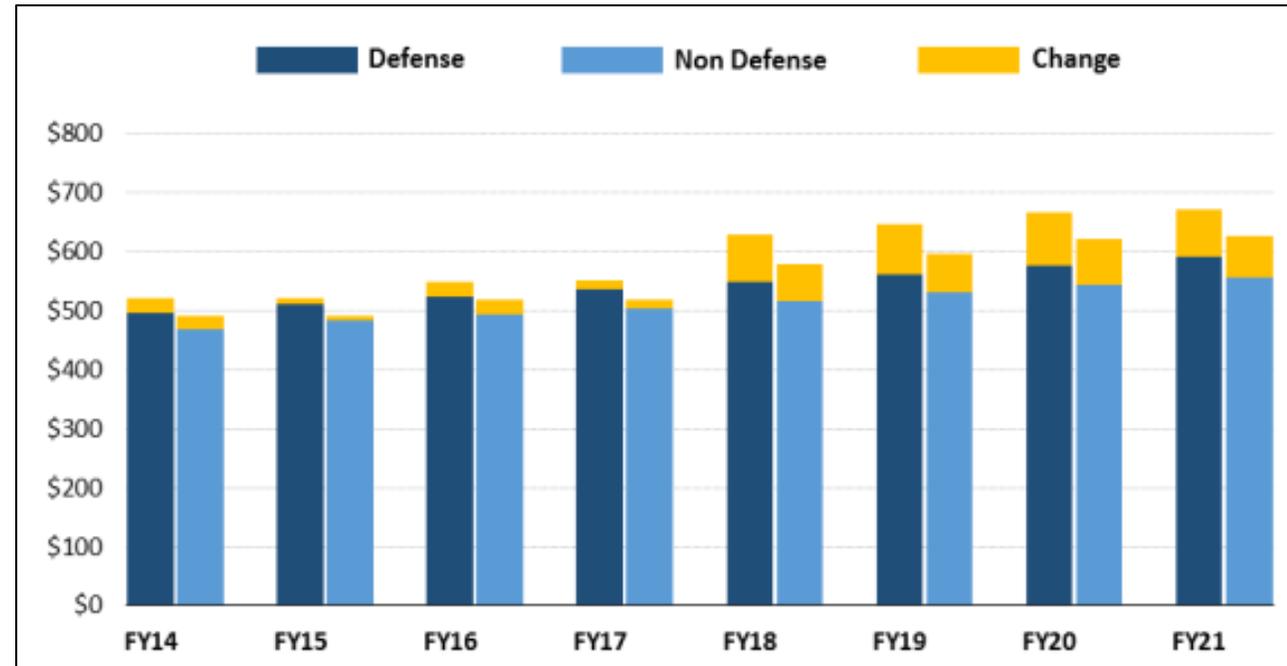
Bipartisan Budget Act of 2019 (H.R. 3877)

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



- ▶ The bill increased the caps on defense and non-defense budget authority for FY 2020 and FY 2021, the final two years for which discretionary spending caps are scheduled to be in effect under the Budget Control Act of 2011 (sequestration).
- ▶ For FY 2020, BBA 2019 raised the defense discretionary cap to \$666.5 billion (a \$90 billion increase) and the non-defense cap to \$621.5 billion (a \$78 billion increase). **The net change to non-defense discretionary spending from FY 2019 to FY 2020 was +\$24.5 billion (+4.1%).**

- ▶ For FY 2021, BBA 2019 raised the discretionary defense cap to \$671.5 billion (an \$81 billion increase) and the non-defense cap to \$626.5 billion (a \$72 billion increase). **The net change to non-defense discretionary spending from FY 2020 to FY 2021 is projected at +\$5 billion (+0.8%).**
- ▶ With this very modest increase to authorization, a fourth year of 6%+ growth to the HEP budget seems unlikely through regular appropriations. **The House and Senate Marks provide +\$5 million (0.5%) increase.**



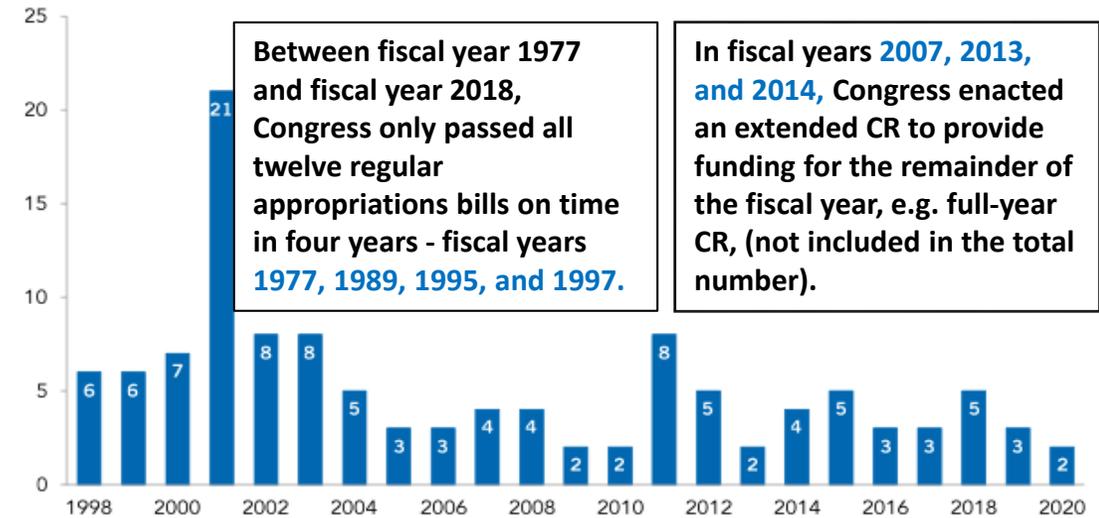
FY 2021 Continuing Resolution

- ▶ If U.S. Congress and President **have not passed and signed all appropriations bills by September 30**, a CR may be passed to avoid a U.S. Government shutdown
 - ▶ Must pass appropriations to have legal authority to spend money!
 - ▶ **CRs are now a routine** part of the federal budget process
 - ▶ **CRs prevent us from making final funding decisions**
 - ▶ **Increases our workload** as we have revisit funding decisions
- ▶ Therefore, a **CR may impede the start of new projects**
 - ▶ Projects with total cost >\$5M must be approved by Congress in an appropriations bill before funding can begin
- ▶ 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 not \geq CD-2 are likely to be impacted under CR
- ▶ Mitigation Strategies for University Grants
 - ▶ Moved start dates for University grants back in the Q3 or later in fiscal year
 - ▶ Grant funding decisions have a greater chance to be made **after the appropriation is passed**
- ▶ A **CR may also impact future-year planning...**



Lawmakers have enacted a total of 119 continuing resolutions over the past 23 fiscal years

NUMBER OF CONTINUING RESOLUTIONS ENACTED BY FISCAL YEAR



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

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

SOURCE: Congressional Research Service, Appropriations Status Table: FY2020, November 2019; and Continuing Resolutions: Overview of Components and Practices, April 2019.

NOTE: Legislation is counted as a continuing resolution if it included any appropriations that did not extend through the end of the fiscal year.

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- ▶ H.R.8337 - Continuing Appropriations Act, 2021 and Other Extensions Act
 - ▶ Passed the House on Sep. 22 on a vote of 359 to 57, and cleared the Senate on Sep. 30 on a vote of 84 to 10
- ▶ Oct 1, 2020: President Trump signed H.R.8336 providing FY 2021 appropriations to Federal agencies through Dec 11, 2020
 - ▶ **72-day continuing resolution at FY 2020 levels**

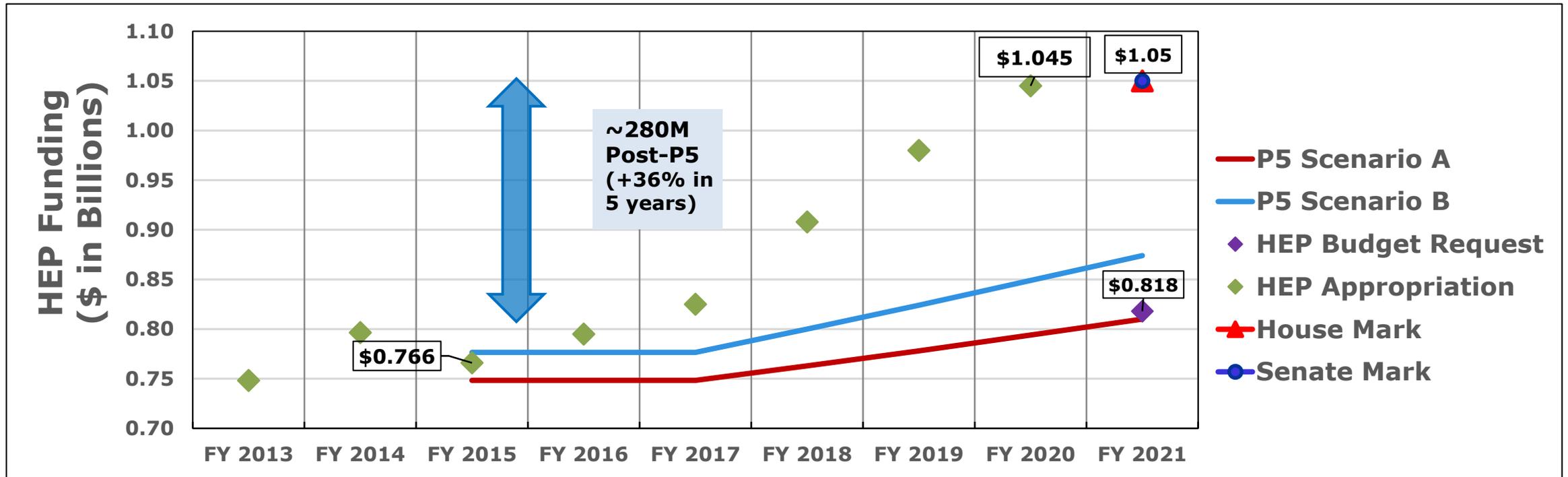


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FY 2021 Budget Execution Challenges

- ▶ HEP has developed a FY 2021 spend plan assuming a full-year CR at \$1.045 billion. If there is an appropriations at the House/Senate Mark, the additional \$5 million will likely go to planned increase of Fermilab-led Superconducting Quantum Materials and Systems Center.
- ▶ We are proceeding with a conservative plan that is likely to dissatisfy the maximum number of stakeholders. However, this plan allows us to carry out our mission, preserve lab capabilities, and minimize workforce reductions.





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HEP Project Status

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HEP Project Portfolio is based on the P5 Plan

- ▶ Five projects have been completed.
 - ▶ Muon g-2, Phase I CMS, and Phase I ATLAS
 - ▶ DESI and LZ received CD-4 this year.
- ▶ Five projects are past CD-3.
 - ▶ FACET II, HL-AUP, LSST, Mu2e, and SuperCDMS-SNOlab
 - ▶ FACET II and LSST will finish this year or early next year.
- ▶ Four projects are past CD-1.
 - ▶ HL-ATLAS (CD-3A), HL-CMS (CD-3A), LBNF/DUNE (CD-3A), PIP II
- ▶ Two projects are past CD-0.
 - ▶ CMB-S4 is the last P5 project to receive CD-0.
 - ▶ Accelerator Control Operations and Research Network (ACORN) is at Fermilab.

HEP Projects past CD-3

- ▶ FACET II is nearly complete
 - ✓ Will finish without a rebaseline
- ▶ LSSTcam project is also close to completion
 - ▶ Funding has been finished.
 - ▶ Close the project out soon and complete the initial assembly on ops.
 - ▶ Will need additional ops funding of \$5.5 million due to COVID impacts.
- ▶ Mu2e and SuperCDMS were struggling before COVID and COVID delays, and COVID pushed them over the edge.
- ▶ HL-AUP is experiencing COVID delays but has plenty of cash flow now.

HEP COVID 19 scenarios

- ▶ We do not now know how pandemic will evolve
 - ▶ We continue to monitor guidance from the public health authorities
- ▶ Fermilab has proposed a framework to analyze the risk
 - ▶ Assume different possible courses for the pandemic
 - ▶ Apply different efficiencies for work under different situations
 - ▶ Tailor the efficiencies based on experience to get the best analysis
 - ▶ The data on efficiencies is just now coming in
 - ▶ Analyze the scenarios in P6 (project schedule and cost tool)
- ▶ HEP is using this framework on all projects
- ▶ OPA has asked for three levels of impact
 - ▶ OPA did not specify that projects should use the Fermilab model

Mu2e

- ▶ Mu2e project has seen delays due to magnet procurement
 - ▶ Funding has been finished.
 - ▶ COVID-19 will clearly push the project past CD-4 and over the approved TPC.
 - ▶ There are adequate funds to wait until we know more before rebaselining.
 - ▶ The project needs to see General Atomics complete more coils before they can confidently project a CD-4 date.

Mu2e Impacts	Low	Medium	High
Cost Impact	\$3.6M	\$4.7M	\$6.6M
Schedule Impact	3.5 mo.	7.5 mo.	12 mo.
Delay to CD-4	1.5 mo.	5.5 mo.	10 mo.

Mu2e Superconducting Transport Solenoid (TS)

- ▶ TS cold mass is being assembled at Fermilab
- ▶ All 14 units have been delivered from ASG in Italy
- ▶ Acceptance testing is progressing well; on the 11th unit
- ▶ Assembly of upstream half of the TS is shown here



SuperCDMS at SNOLAB

- ▶ SuperCDMS project has seen delays due to cryostat procurement
 - ▶ Funding has been finished
 - ▶ COVID-19 has also pushed the project over the TPC
 - ▶ The project has enough funds to last into Q2FY21 before rebaselining
 - ▶ HEP is discussing with NSF how to complete this project
 - ▶ We are waiting to see costs for the redesigned cryostat before rebaselining

Cost impacts (k\$)			Schedule impact	TPC limit hit
NSF	DOE	Total	CD-4 forecast	
\$ 601	\$ 1,589	\$ 2,190	Dec-21	Mar-21

**Well within CD-1 cost range;
Pre-COVID CD-4 forecast was Mar-21**

LZ Experiment at SURF completed

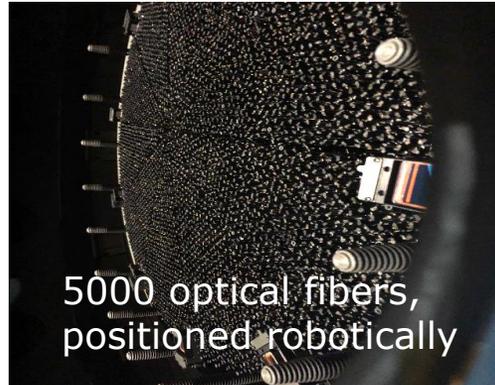
Side Acrylic Tanks are installed around the Outer Cryostat Vessel, in the Davis Cavern



P5 Science Driver Cosmic Acceleration Dark Energy Spectroscopic Instrument (DESI) Project → Operations



10 state of the art spectrographs



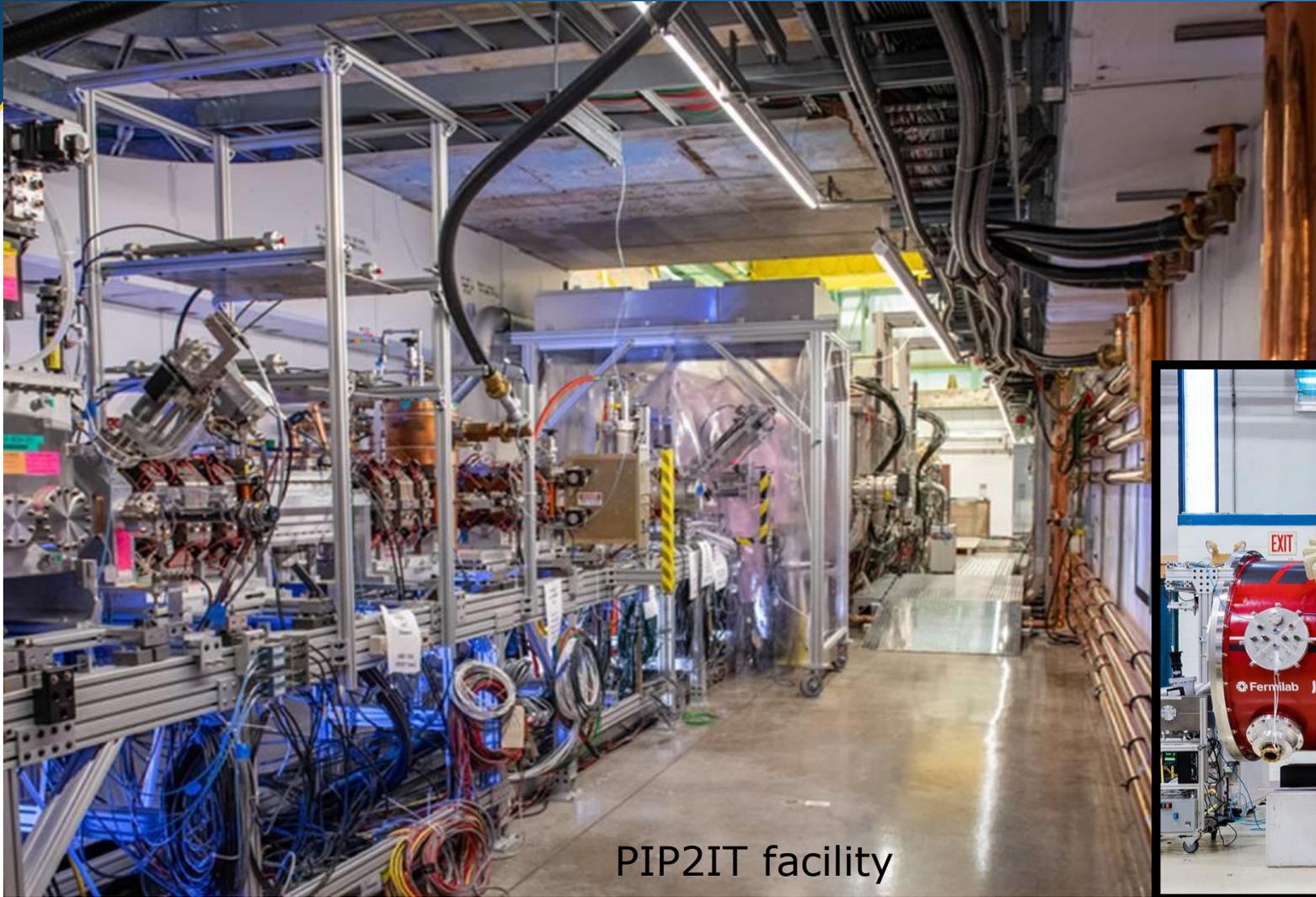
DOE "leases"
NSF's Mayall
Telescope at Kitt
Peak National
Observatory



DESI construction complete, moving to operations
after COVID delays this year

See <https://vimeo.com/422889846>

PIP II Technical Progress



PIP2IT facility

- PIP2IT has delivered beam through two prototype cryomodules.
- India has ordered the cryoplant.
- The construction for the building for the cryoplant is started.



SSR1 prototype cryomodule

PIP II Reviews

- ▶ CD-2 Review in January 2020 went well.
 - ▶ Four issues had to be resolved.
 - ▶ Funding profile, French funding, Indirect rates, RLS clean-up
 - ▶ COVID added a fifth issue.
 - ▶ RLS clean up was done & reviewed by the cost and schedule subcommittee.
 - ▶ Indirect rates were lowered but not by as much as hoped.
 - ▶ French funding was confirmed but lower than hoped.
 - ▶ Funding profile was updated, but it increases more slowly.
 - ▶ COVID impact analysis completed.
- ▶ CD-2 update review was held in October 2020 and went well.
- ▶ A CD-2 ESAAB was held on December 1, 2020.
- ▶ Details in Mossey's talk later this meeting

LBNF/DUNE

- ▶ The size and complexity of LBNF/DUNE has been challenging.
- ▶ COVID 19 shutdown work at SURF for 8 weeks.
- ▶ The excavation has been more expensive than early cost estimates predicted.
 - ▶ Newer cost estimates have been reliable.
 - ▶ The excavation contract was just reviewed, and the review went well.
 - ▶ The CD-3A authorization has been revised to be consistent with the contract.
 - ▶ Main excavation contract has now been awarded; *a major milestone!*
- ▶ Installation and integration must be on the project.
 - ▶ It costs too much to be supported by operations funding.
- ▶ International contributions to the facility has been smaller than planned.
- ▶ The current TPC is close to \$2.6 billion. CD-2 is planned for FY 21.
- ▶ Details in Mossey's talk this meeting

Rock Conveyer Nearing Completion at SURF

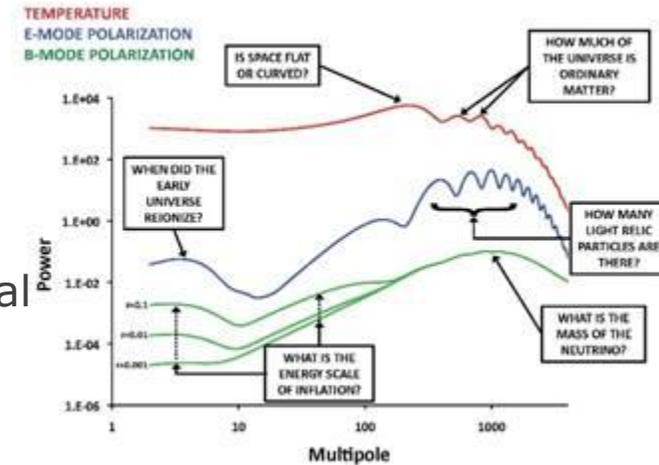


High Luminosity LHC projects

- ▶ The CERN shutdown due to COVID 19 has slower progress on all of the projects.
- ▶ The Accelerator Upgrade Project (AUP) was already building magnets when COVID shut the labs, so the impacts on it were larger.
 - ▶ AUP will need to be rebaselined, but it is not a pressing issue.
- ▶ CMS and ATLAS are looking at CD-2 next year. They are still waiting for decisions from the international collaborations.

CMB-S4

- ▶ Project received CD-0 in August of 2019.
 - ▶ Envisioned as a joint DOE-NSF project with 3 NSF divisions:
 - ▶ MPS/Physics, MPS/Astronomy, GEO/Polar programs
 - ▶ Microwave telescopes, South Pole and Chile.
 - ▶ High sensitivity measurement of CMB power spectrum, huge discovery potential
 - ▶ The DOE cost estimate range is \$320-395 million.



- ▶ Lead lab

- ▶ Many labs were interested in leading the project, HEP invited ANL, LBNL, and SLAC to propose to lead.
- ▶ Evaluation committee (7 DOE plus 1 from NSF), recommendation made to Siegrist
- ▶ LBNL chosen, approved by Office of Science leadership (Fall)

- ▶ Short term challenge: R&D funding towards CD-1 due to COVID impact

- ▶ Longer term challenge: Synchronizing the NSF and DOE parts

- ▶ Experience with NSF for LSST and HL-LHC will prove useful here



ACORN

- ▶ The accelerator control network at Fermilab is very old and inadequate for the future program.
 - ▶ It is a custom system developed by Fermilab.
 - ▶ The hardware is becoming outdated and hard to replace.
 - ▶ The software uses old languages and libraries that are obsolete.
- ▶ Not a P5 project, it falls under HEP's stewardship of the lab.
- ▶ CD-0 was approved August of 2020 with a cost range of \$100-142 million.
- ▶ Funding will also be limited due to COVID impacts elsewhere.

Smaller Projects

- ▶ There are a number of smaller projects (<\$10M) mostly lab led that are also moving through the system
- ▶ This in response to P5 recommendations to maintain a broad portfolio of projects also in project size
- ▶ These projects don't have the same oversight as those over \$10M in terms of Office of Project Assessment reviews, Earned Value Management tracking, etc. etc. so have less management overhead than the larger ones
- ▶ These are mostly going OK with some COVID impacts



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HEP International Agreements

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DOE-CERN Future Circular Collider Cooperation

- **DOE coordinating with CERN to update the 2015 DOE-CERN FCC agreement to continue future R&D topics**

- Framework to advance the next stage of FCC feasibility studies as emphasized in the 2020 update of the European Strategy for Particle Physics

- **Cooperative activities include**

- Overall FCC concept optimization, including civil engineering and technical infrastructure designs
- Beam physics studies
- Accelerator R&D and key technology developments in view of either the FCC-ee and FCC-hh collider
- Longer-term activities towards the development of concepts of time- and cost-effective FCC tunneling techniques

- **Framework continues to allow DOE national labs to undertake topic-specific activities with CERN that are to be identified through subsequent MOUs**

- For additional guidance, interested DOE labs may contact Abid Patwa and L.K. Len at abid.patwa@science.doe.gov and lk.len@science.doe.gov

- **DOE and CERN aiming to sign the new FCC agreement by end of calendar year 2020**

2020: Proposed DOE-CERN FCC Agreement

Addendum III to Accelerator Protocol III for Participation by the U.S. Department of Energy in the Future Circular Collider Feasibility Study

The European Organization for Nuclear Research ("CERN"), an Intergovernmental Organization having its seat at Geneva, Switzerland,

and

The Department of Energy of the United States of America ("DOE"),

(hereafter collectively referred to as "the Parties");

CONSIDERING:

That the Parties collaborated to their mutual benefit under the International Co-Operation Agreement Concerning Scientific and Technical Co-Operation on Large Hadron Collider (LHC) Activities signed December 8, 1997;

That the Parties successfully participated in the original construction activities of the LHC accelerator and in the exploitation of the LHC under an Accelerator Protocol I signed December 19, 1997, and continued their collaboration on LHC commissioning and consolidation activities under an Accelerator Protocol II signed July 11, 2014;

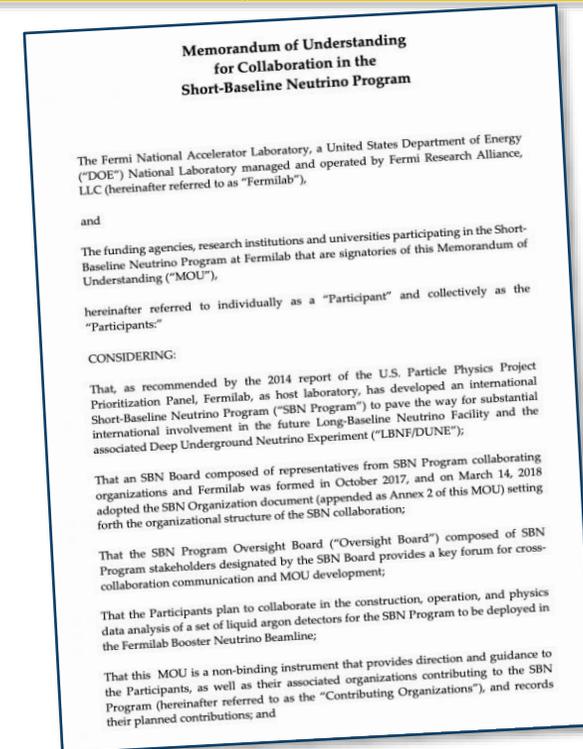
That the Parties renewed their collaboration under the Co-Operation Agreement Concerning Scientific and Technical Co-Operation in Nuclear and Particle Physics signed May 7, 2015 (hereinafter the "2015 Co-Operation Agreement"), and under Accelerator Protocol III, signed December 18, 2015 (hereinafter "Accelerator Protocol III") on the LHC accelerator consolidation plan and the LHC accelerator upgrade program;

That the Parties established a common understanding of their collaboration in the design study for a Future Circular Collider ("FCC") under Addendum I to Accelerator Protocol III signed December 18, 2015;

Short-Baseline Neutrino Program Multi-Institutional MOU

2020: SBN Program Multi-Institutional MOU

- **MOU for collaboration by international partners on the Fermilab-hosted SBN program now being processed for signatures by all parties**
 - Preparation and coordination of the MOU by a DOE-based MOU Working Group, including those from DOE/HEP, Office of Science, Office of General Counsel, and Fermi Site Office
 - Being signed by Fermilab, Brazil (University of Campinas), CERN, INFN-Italy, Los Alamos National Lab, UKRI-STFC, and Switzerland (University of Bern)
- **SBN MOU memorializes**
 - Organizational, managerial, financial structure, and participants' responsibilities to the international SBN program
 - Environmental, safety, and radiological control regulations of Fermilab as the host facility
 - Matrix structure of recorded contributions by all international funding agencies
- **Blazes an important trail for a future multi-institutional DUNE MOU**
- **Separately, a [MOU-type] project planning document for the PIP-II accelerator being finalized with Fermilab and international partners**
 - Details roles and international contributions to PIP-II by France, Italy, India, Poland, and the UK





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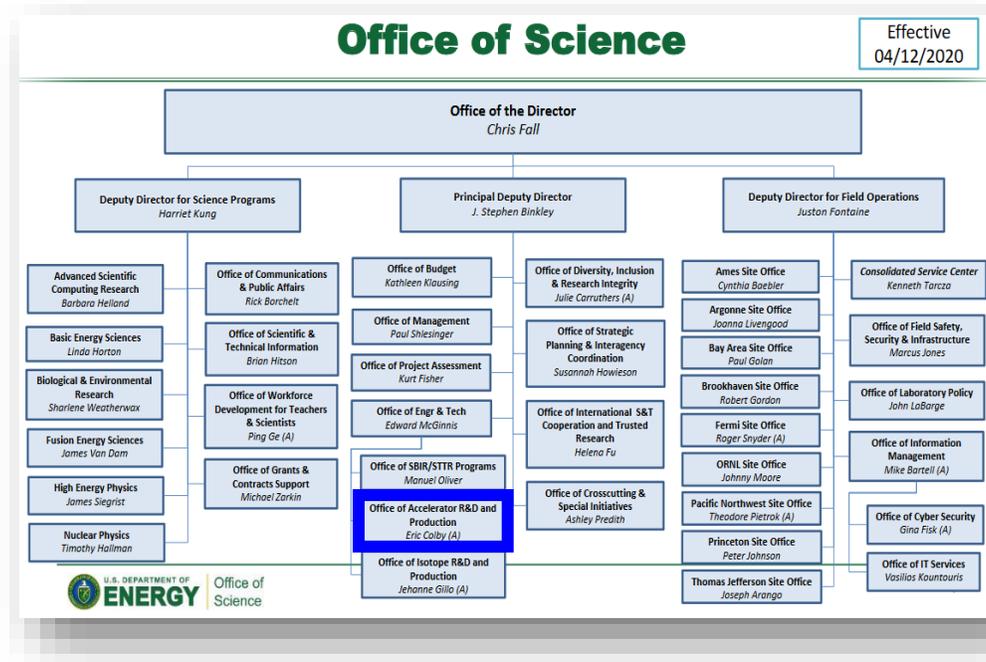
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Reorganization

Office of Accelerator R&D and Production (ARDAP)

- ARDAP (SC-24.2) was established April 12, 2020 in recognition of the central importance of accelerators and related technologies to the current and future scientific capabilities stewarded by SC programs.



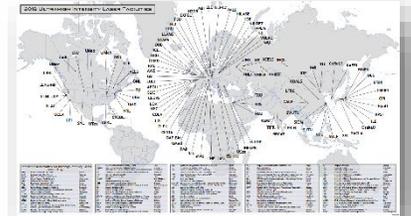
- ARDAP activities will be tightly integrated with those in BES, FES, HEP, and NP, and will help coordinate accelerator R&D across SC, including the Strategic Accelerator Technology Initiative
 - Accelerator Stewardship will move from HEP to ARDAP with the FY 2021 Appropriation.

ARDAP Mission

...is to coordinate and make accelerator R&D and production investments that are aimed at addressing Accelerator Science & technology (AS&T) gaps to help ensure that future U.S. accelerator-based physical science R&D priorities will be met.

- ARDAP will fulfill its mission by:
 - Maintaining a strategic picture of AS&T needs and worldwide competition;
 - Facilitating coordination of Programmatic AS&T R&D investments across SC;
 - Investing in selected cross-cutting AS&T areas;
 - Providing a system engineering perspective for SC facility projects;
 - Supporting workforce development, when needed;
 - Maturing key AS&T technologies and developing capable U.S. vendors;
 - Transitioning accelerator technology to broader uses.

Objective: Ensure a robust pipeline of next-generation AS&T to support physical sciences research while providing technology advances and industrial strength that position the U.S. to lead the world for decades to come.

A table with multiple columns and rows, likely containing data related to accelerator R&D and production investments. The table is partially obscured by a redacted area.

ARDAP's first task is to develop an SC-wide AS&T Strategy

A substantive input process has started that will result in an AS&T investment strategy for the next 10-20 years:

- **Identifying high-level goals**
 - Plans for DOE's major facilities and future facility construction
 - Plans for other USG facilities
- **Analyzing domestic capability and plans**
 - Near- and long-term AS&T advances and actions needed
 - Virtual site visits to key institutions
 - Data calls, roundtables, RFIs, workshops (virtual)
 - Workforce and development pipelines
- **Analyzing international capabilities and plans**
 - Capabilities and plans for scientific facilities, AS&T R&D, and industrialization
- **Studying technology transfer examples through case studies**
 - Examples of public-private-partnerships, organizations, ecosystems, ...



Conclusion

- ▶ Good program progress in face of COVID pandemic
- ▶ We have avoided general carnage from COVID on the project front, but it appears we will suffer delay (12mo?) in the project portfolio completion
- ▶ International discussions proceeding in virtual meeting mode with important progress on most fronts
- ▶ Community support remains strong
- ▶ Uncertainties larger than normal due to COVID, Congressional budget uncertainty, transition to new administration – all this makes for a difficult budget year
- ▶ Your patience in the face of this uncertainty is appreciated

