U.S. DEPARTMENT OF ENERGY | Office of Science

Intensity Frontier

DOE/HEP PI Meeting 2019

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Outline

- HEP Program Planning and Budgets
- Intensity Frontier Program Overview
- DOE/HEP Comparative Reviews
- DOE Early Career Research Program
- Closing Remarks

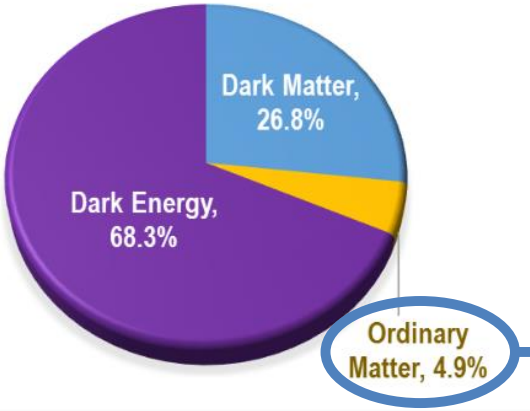
This talk will: (1) emphasize the Intensity Frontier program within the broader context of the overall HEP program;
and
(2) provide a planned-overview of the upcoming FY 2020 comparative review funding opportunity announcement. But please refer to the final announcement once issued and prior to any submission of an application.

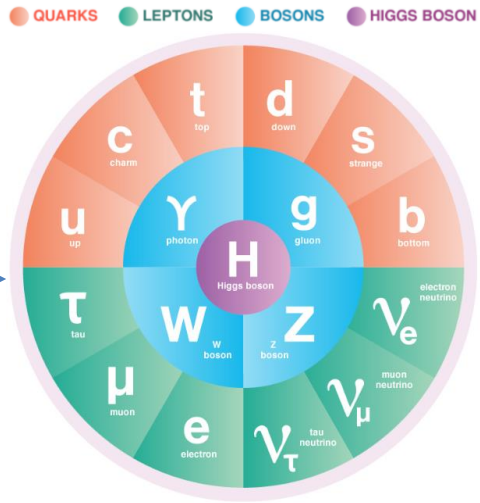
The High Energy Physics Program Mission

… is to understand how the universe works at its most fundamental level:

- Discover the elementary constituents of matter and energy
- Probe the interactions between them
- Explore the basic nature of space and time

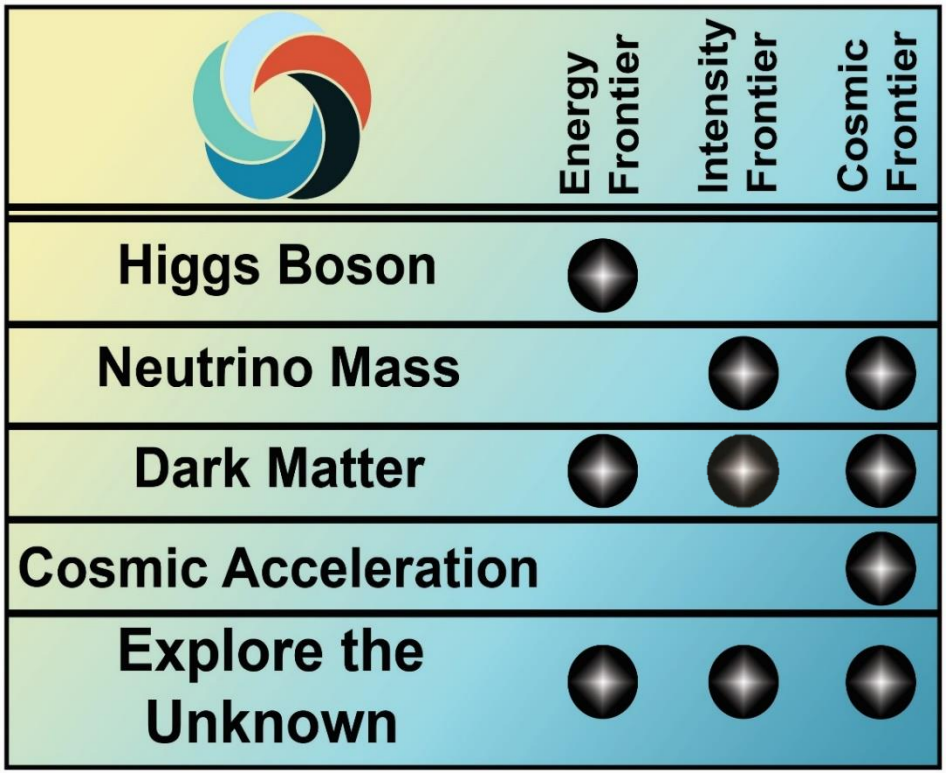
- The DOE Office of High Energy Physics fulfills its mission by:
  - Building **projects** that enable discovery science
  - Operating **facilities** that provide the capability for discoveries
  - Supporting a **research** program that produces discovery science



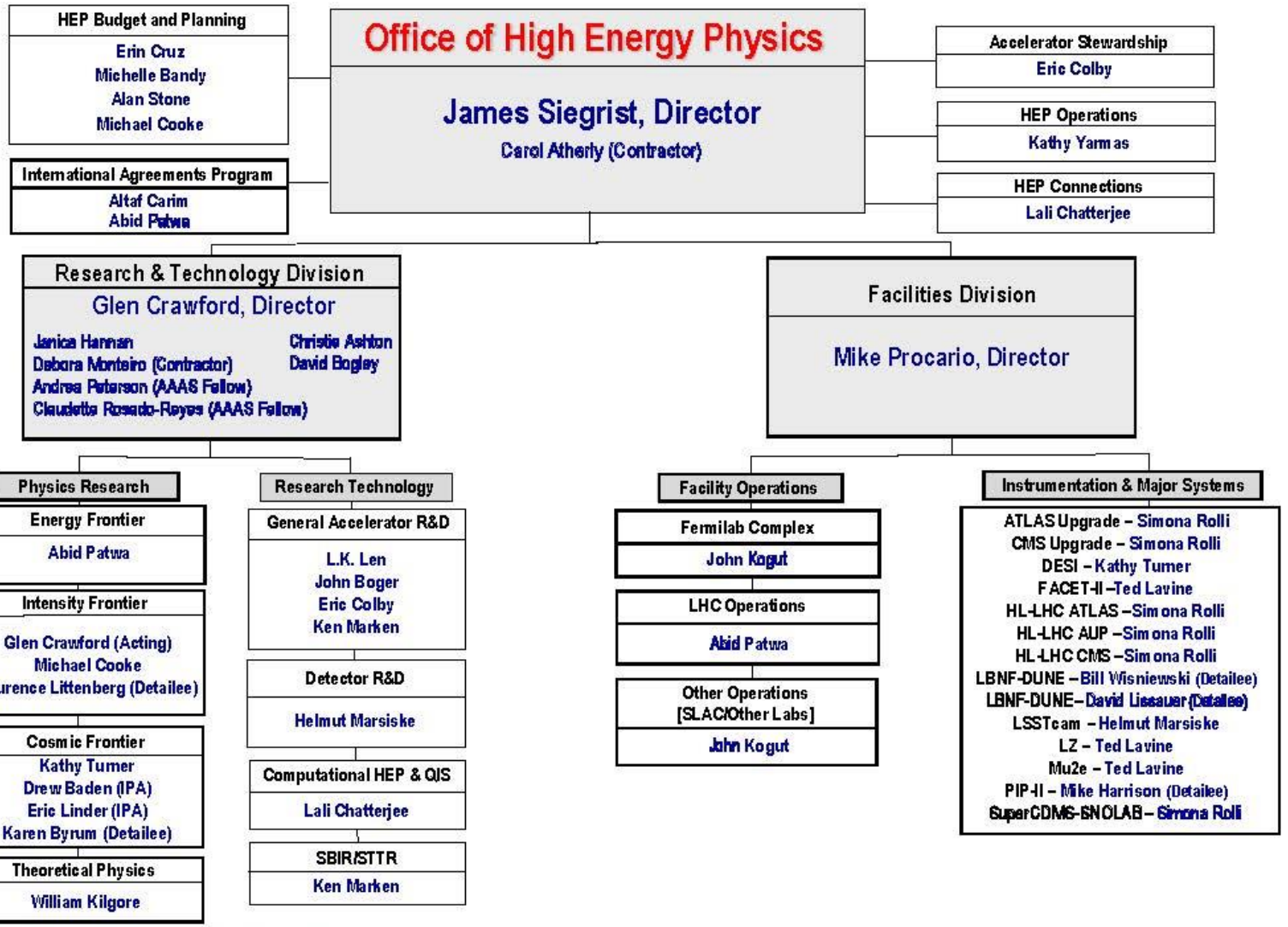


Enabling the Next Discovery

- **Science drivers** identify the scientific motivation
- **Research Frontiers** are useful categorization of experimental techniques and serve as the basis of the budget process
- Research Frontiers are complementary
  - No one Frontier addresses all science drivers
  - Each Frontier provides a different approach to address science driver
  - Enables cross-checking scientific results

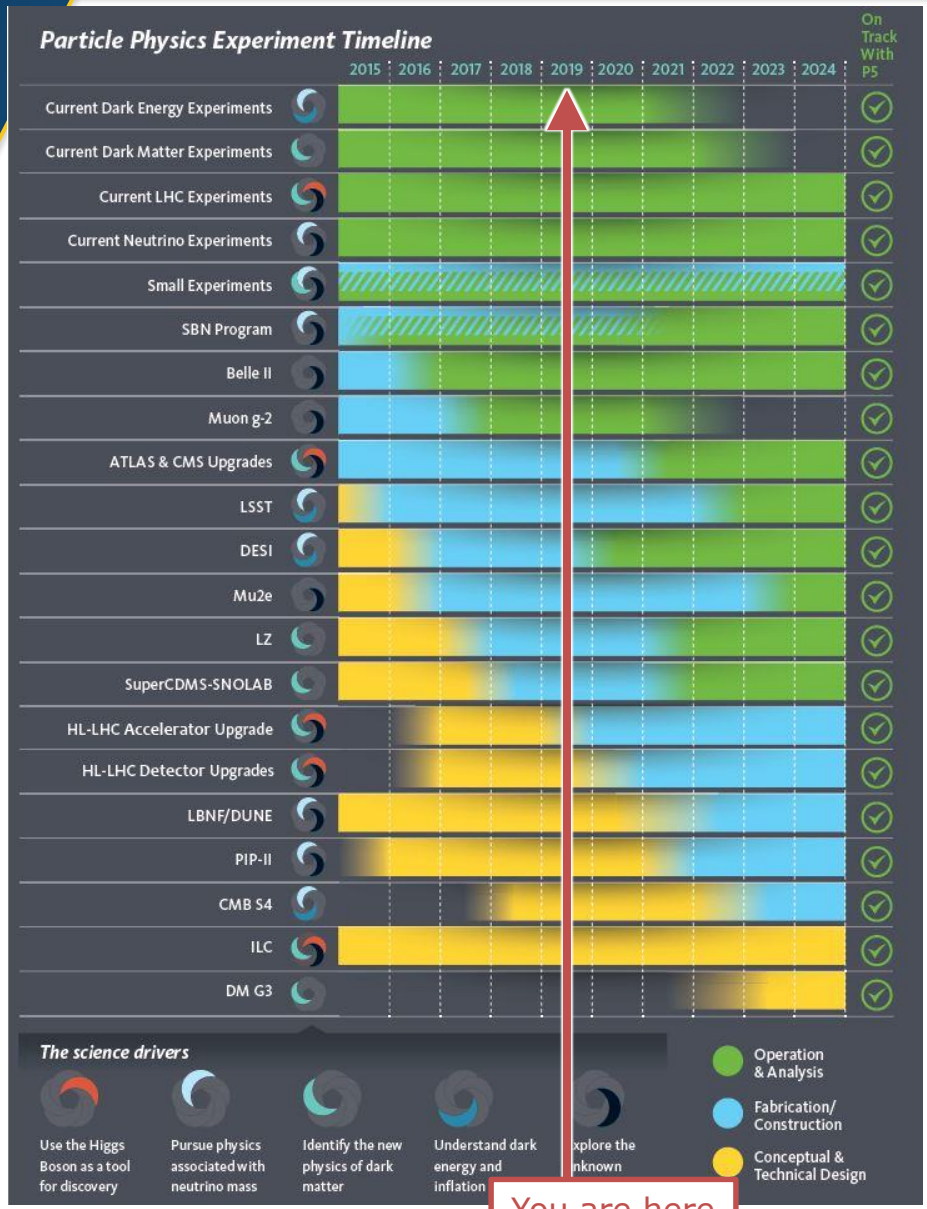


DOE Office of High Energy Physics



HEP underpins and advances the DOE missions and objectives through a balanced portfolio of scientific research, facilities' operations and projects, and by the development of key technologies and trained person-power needed to work at the cutting edge of science.

P5 Implementation Status – FY 2019

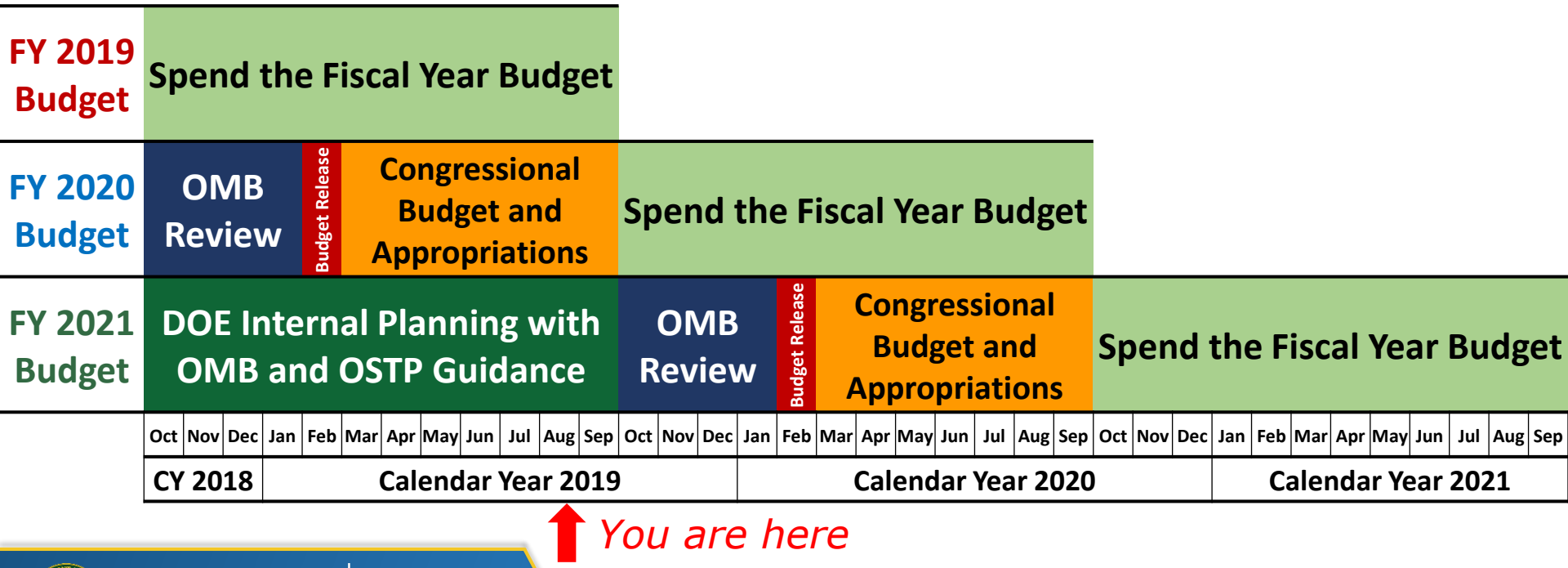


All projects on budget & schedule

- Projects fully funded as of FY19
  - Muon g-2: 1st beam 2017
  - LHC detector upgrades: on track for 2019/20 installation
  - Mu2e : 1st data in 2020
  - LSST: full science operations 2023
  - DM-G2 (superCDMS & LZ): 1st data 2020
  - DESI: 1st light on lenses, April 2019
- 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

The U.S. Federal Budget Cycle I

- 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 upcoming FY
  - Agency internal planning for the second FY from now

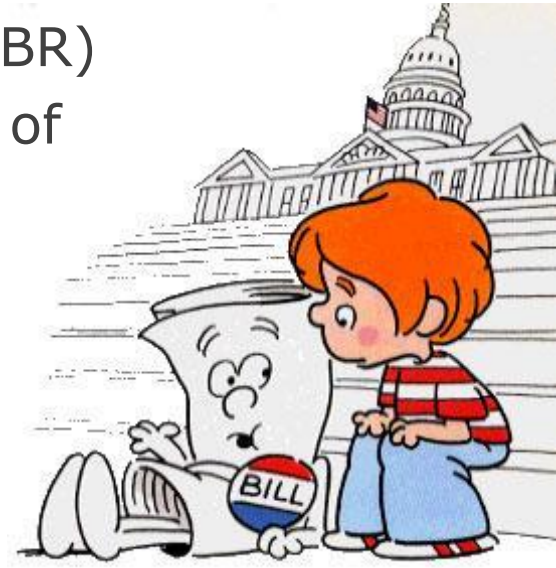


The U.S. Federal Budget Cycle II

- The President submits a Budget Request (PBR)
- Each house of Congress passes their vision of a draft budget (called a "mark")

For FY 2020, we are here

- Both houses agree on a single bill (through "reconciliation")
  - No amendments are allowed beyond this point, to ensure the process converges
- Congress passes this legislation
- The President signs it and it becomes law



Credit: "I'm Just a Bill", America Rocks, 1976. 3rd season, Schoolhouse Rock.

- If this process does not complete by the end of the fiscal year (September 30th), Congress may pass a "continuing resolution", or without any action, U.S. Government can [partially] "shutdown"

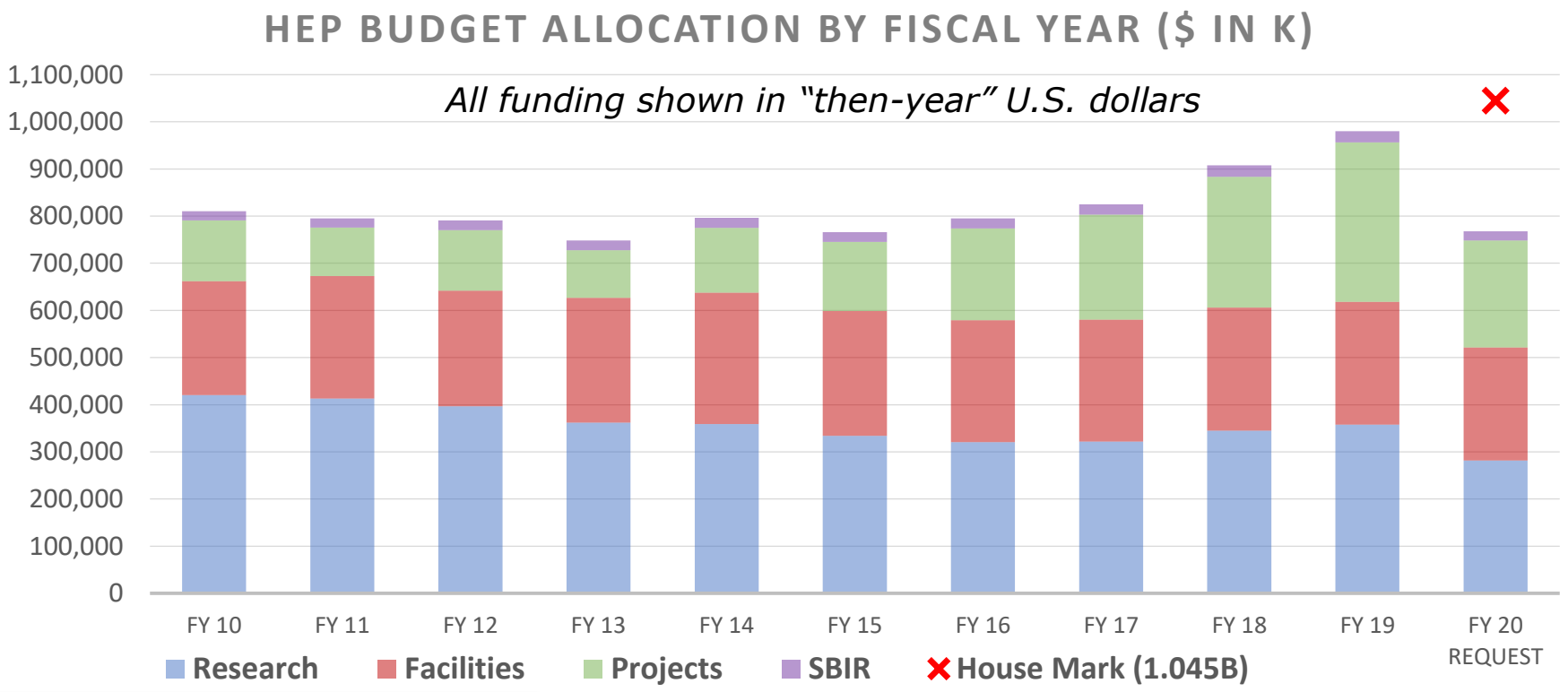
FY 2020 HEP Budget Request

HEP Funding Category ($ in K)	FY 2018 Actual	FY 2019 Enacted	FY 2020 Request	FY 2020 vs. FY 2019
Research	359,177	380,847	301,357	-79,490
Facilities/Operations	270,488	260,803	239,746	-21,057
Projects	278,335	338,350	226,935	-111,415
Total	**908,000**	**980,000**	**768,038**	**-211,962**

- FY 2020 President's Budget Request is overlay of Administration, SC, P5 priorities
  - SC: interagency partnerships, national laboratories, accelerator R&D, QIS, AI/ML
  - P5: preserve vision, modify execution
- FY 2020 HEP Budget continues support for P5-guided investments
  - Research support advances P5 science drivers and world-leading, long-term R&D in Advanced Technology, Accelerator Stewardship, and Quantum Information Science
  - "Building for Discovery" by supporting HL-LHC, LBNF/DUNE, and PIP-II
  - Operations support enables research at HEP User Facilities and science ops. of P5 experiments
- The Administration and Congress support the overall P5 strategy
  - FY20 House Mark for HEP: **$1,045,000,000** ; FY20 Senate Mark not yet released

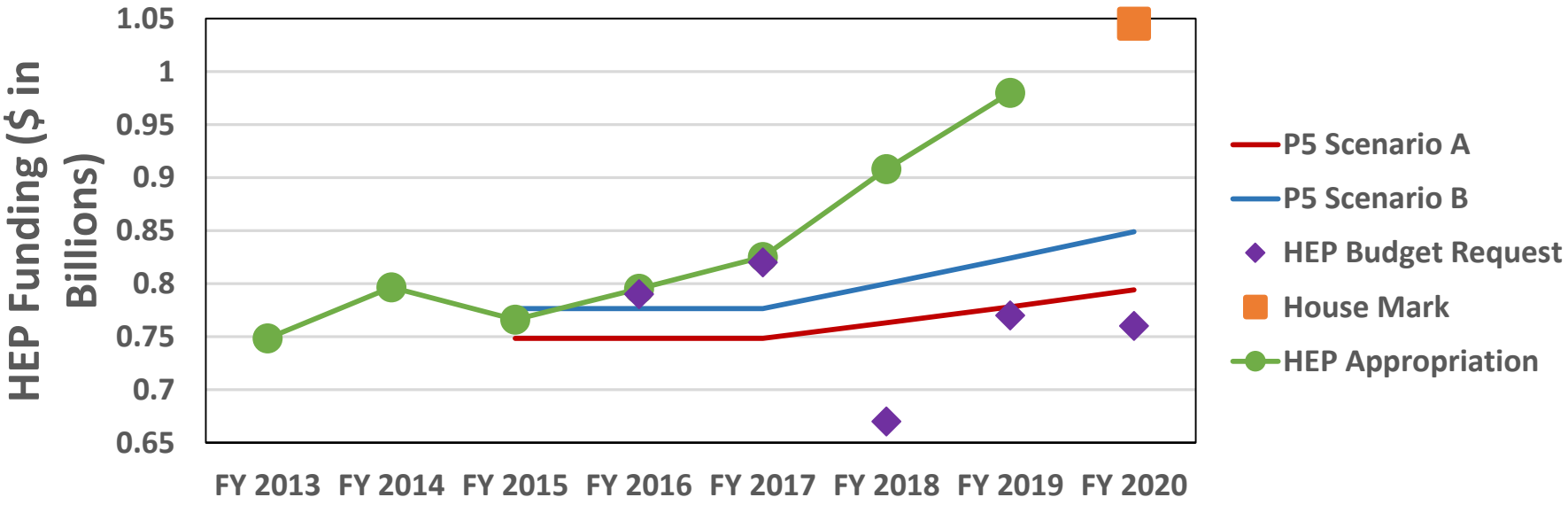
Overall HEP Budget Trend

- P5 strategy continues to define investments in future of the field
- FY 2020 House Mark increases project funding above Request
  - Profiles for high-priority projects recommended by P5 continue to ramp up
  - Importance of research and operations reflected in House Report language



U.S. Congress Supports P5 Strategy

- Recent appropriations reports include language recognizing community's efforts:
  - FY19 Senate EWD: "Four years into executing the P5, the Committee commends the Office of Science and the high energy physics community for achieving significant accomplishments and meeting the milestones and goals set forth in the strategic plan…"
- FY 2020 appropriations process is progressing
  - Senate Mark not released; still awaiting final Congressional actions for FY 2020
  - **Final language of appropriations bill/report impact how funding is directed**



The Challenges

Most of the recent HEP budget growth is in Projects, without similar increases in Operations and Research

- HEP-style Projects depend heavily on Research and Ops support for R&D, QA/QC, integration, installation, and commissioning
- Given that there is a lot of current Research and Ops effort committed to active experiments, this is not optimal for successful project execution
- Balancing Research and Ops with the needs of current and future projects will require careful prioritization

This is a complex interlocking problem with many contributing factors

- Cannot simply "trim the big projects" (or other "simple" solutions) without having impacts elsewhere
- HEP PMs work on this ~every day

Compounding Effects of Success

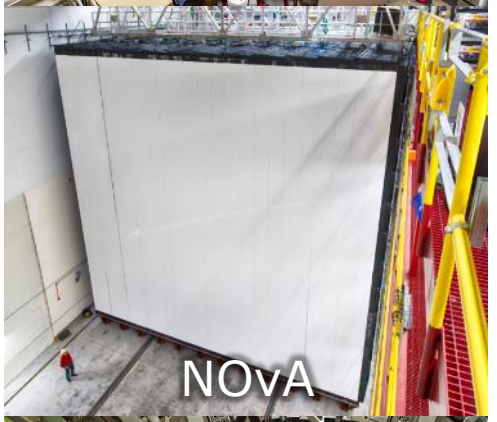
- A number of smaller issues have created a cumulative effect that impacts the Core Research program
  - Cost of doing business has increased significantly, year by year, reducing the buying power of research dollars
  - The community has grown, which adds more competitors to the pool for comparative review
  - Research efforts necessary to support large projects are increasing as the projects ramp up
  - Operations costs necessary for experiments are increasing as P5 projects are successfully completing and starting to take data
- These effects are tied to the high level of support received through appropriations based on the very successful execution of the P5 strategy so far
  - FY 2020 House Marks and Report language suggest that the message is getting through that healthy growth of the program requires Research and Operations growth in addition to Project support

Intensity Frontier Program

Intensity Frontier Program

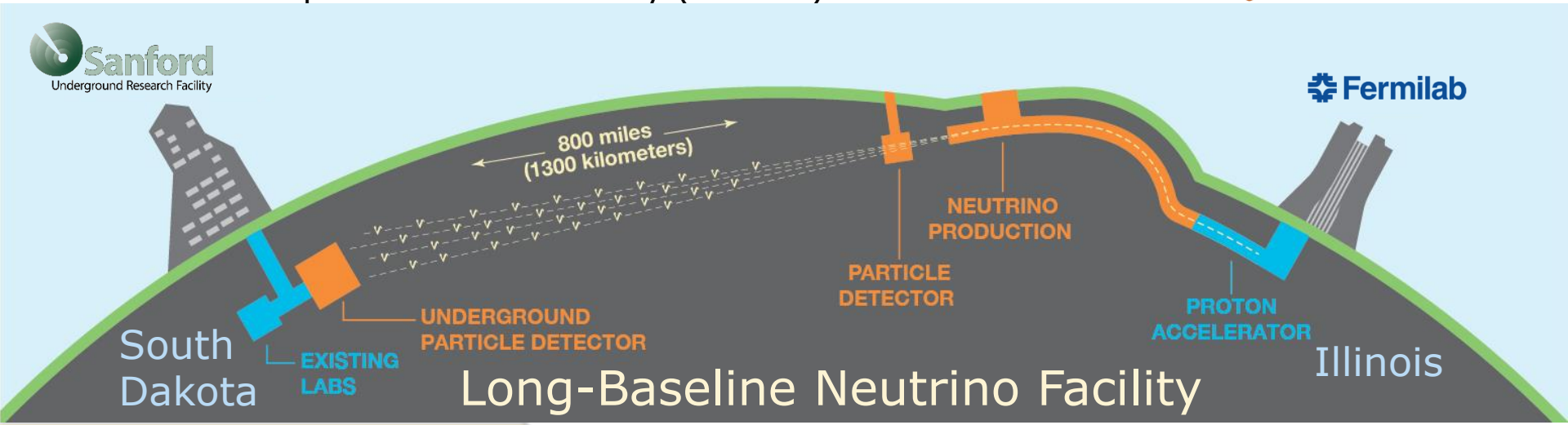
Intensity Frontier experiments address the P5 Science Drivers through intense beams and sensitive detectors

- Exploring the unknown through precision measurements:
  - Muon g-2, Muon-to-Electron Conversion Experiment (Mu2e), Belle II, K0TO
- Identify the new physics of dark matter:
  - Heavy Photon Search
- Pursuing the physics associated with neutrino mass:
  - NOvA, Daya Bay, MINERvA, Super-K, T2K ongoing
  - Ramping up Fermilab Short-Baseline Neutrino Program (MicroBooNE, SBND, ICARUS)
  - Preparing to host world-leading neutrino program with the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE)



Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment

- P5 recommended Long-Baseline Neutrino Facility (LBNF) as the centerpiece of a U.S.-hosted world-leading neutrino program
  - LBNF will produce the world's most intense neutrino beam, send it 800 miles through the earth to DUNE
  - Strong support within the U.S. Government and many interested potential global partners
- International DUNE collaboration includes:
  - Over 1,100 collaborators from 176 institutions, 31 countries
- Proton Improvement Plan II (PIP-II) will provide increased proton beam intensity (>1 MW) for LBNF



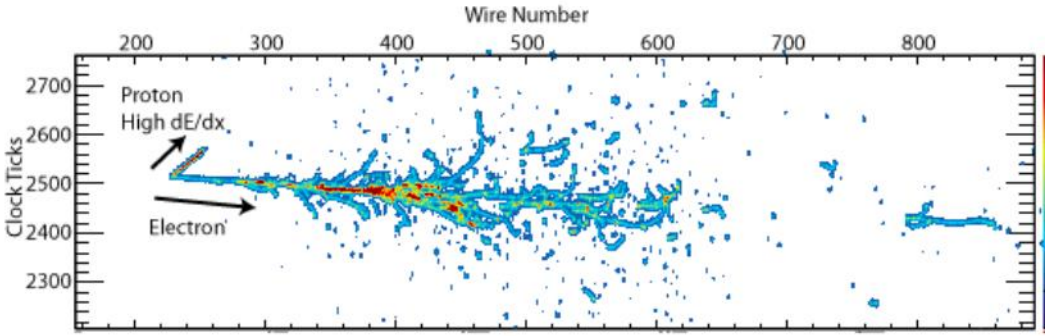
LBNF/DUNE Timeline

2019: Far Site Primary Excavation Begins

2022: First Module Installation Begins

2026: Neutrino Beam + 2 Far Detectors

- Physics data as soon as 1st module complete
- Atmospheric vs
- SNB and solar vs
- Baryon number violation
- Detector calibration



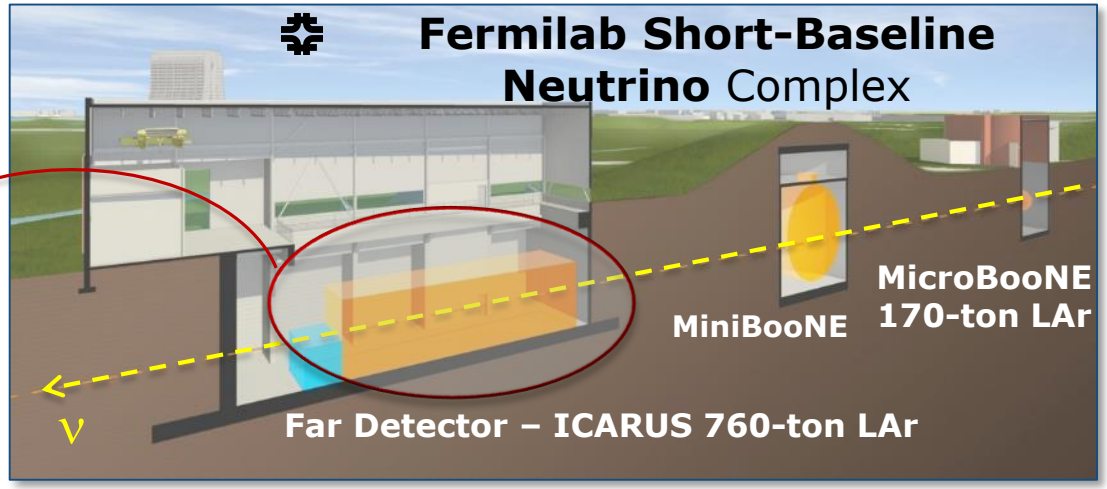
Proton Improvement Plan II (PIP-II)

- PIP-II Groundbreaking held on March 15, 2019
  - Attended by many stakeholders from U.S. and international partners contributing to PIP-II
- P5 report recommended that PIP-II proceed immediately in order to provide increased proton beam intensity (of > 1 megawatt) for LBNF
  - Replace the existing 50 year old linear accelerator with a higher power one, using superconducting radiofrequency cavities
  - Supports longer-term physics research goals by providing increased beam power and high reliability for future experiments at Fermilab, including LBNF/DUNE

From left: Senator Tammy Duckworth (IL), Senator Dick Durbin (IL), Rep. Sean Casten (IL-6), Rep. Robin Kelly (IL-2), Rep. Bill Foster (IL-11), Fermilab Director Nigel Lockyer, Rep. Lauren Underwood (IL-14), Illinois Governor JB Pritzker, DOE Under Secretary for Science Paul Dabbar, Fermilab PIP-II Project Director Lia Merminga, DOE Associate Director for High Energy Physics Jim Siegrist, University of Chicago President Robert Zimmer, Consul General of India Neeta Bhushan, British Consul General John Saville, Consul General of Italy Giuseppe Finocchiaro, Consul General of France Guillaume Lacroix, DOE Fermi Site Office Manager Mike Weis, DOE PIP-II Federal Project Director Adam Bihary and Consul General of Poland Piotr Janicki. Photo: Reidar Hahn

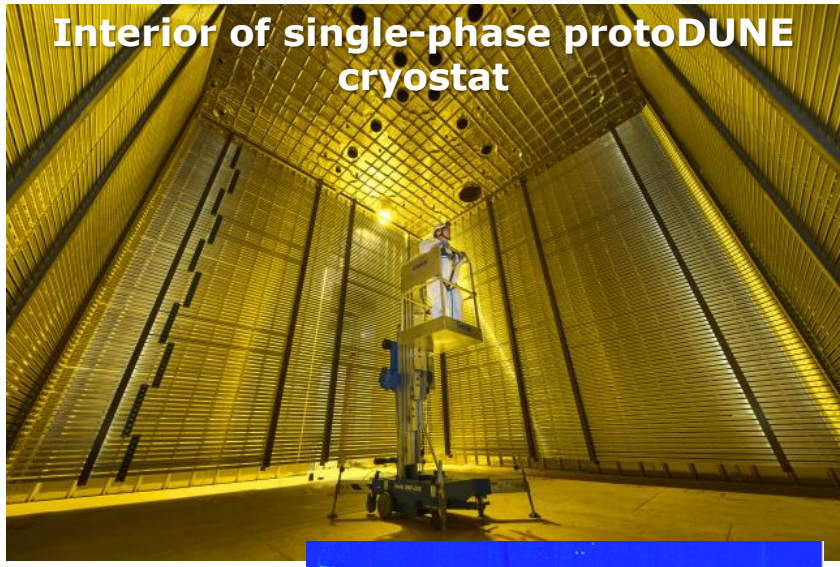
Advancing Science and Technology Towards LBNF/DUNE

- Fermilab Short-Baseline Neutrino Program
  - Resolve experimental anomalies in measured ν-spectrum, search for sterile neutrino
  - Demonstrate the detector technology for DUNE
- The largest liquid argon neutrino detector in the world, ICARUS was transported last summer from Europe to Fermilab
  - Liquid argon fill and transition to commissioning in 2019



ProtoDUNE

- ProtoDUNE is not a formal part of the DOE LBNF/DUNE project, but is a critical, internationally-supported precursor
- Testing full size components in a neutrino beam at CERN
  - ProtoDUNE uses 6 full-sized drift cells
  - A DUNE detector module has 150 cells
- Two designs:
  - Single phase liquid argon has been successfully built before
    - Will be used for first full size detector
    - ProtoDUNE-SP completed July 2018, now taking data
  - Dual phase liquid argon could be lower cost
    - Electronics are outside the liquid
    - After successful prototype, ProtoDUNE-DP now in fabrication



PROSPECT

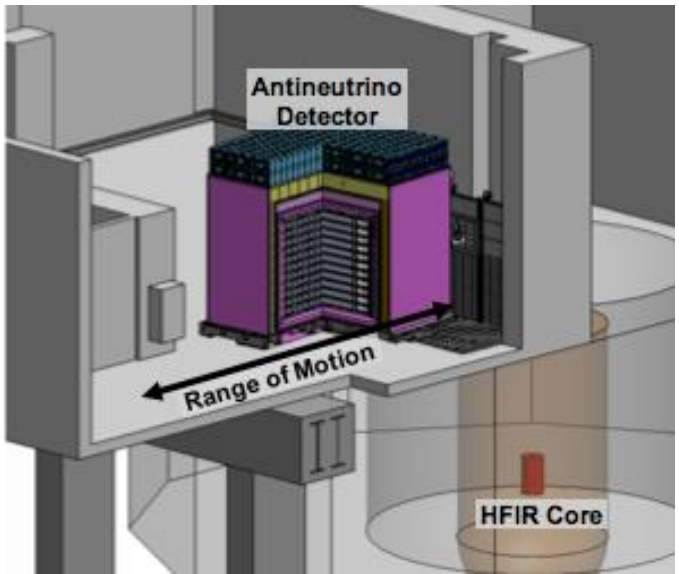
- Precision Oscillation and Spectrum Experiment
  - Segmented Detector
  - ^{6}Li-doped liquid scintillator
  - ~4 ton, 14x11 segments
  - ~4.5%/√E resolution

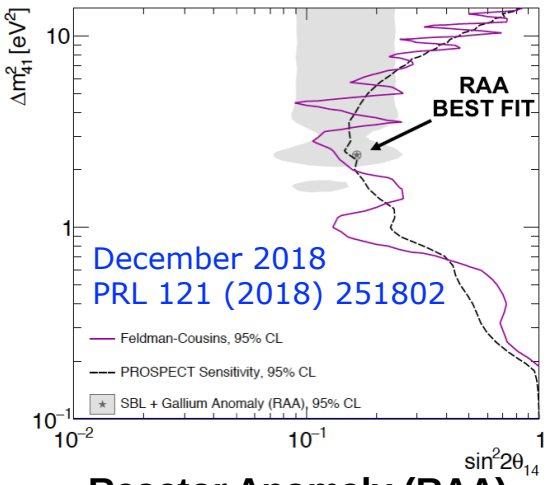
PROSPECT $\bar{\nu}$
prospect.yale.edu

HEISING-SIMONS FOUNDATION

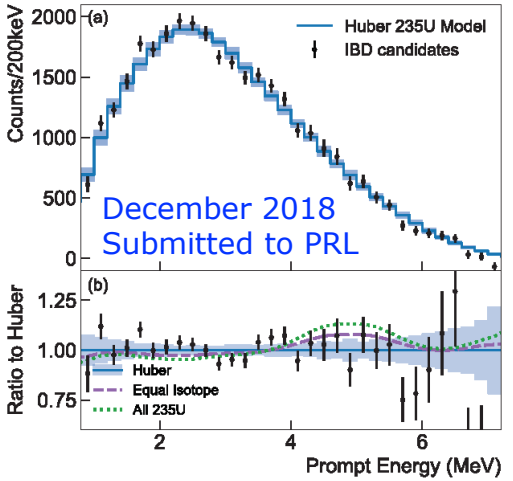
- Physics Objectives
  - Search for short-baseline oscillation at <10m
  - Precision measurement of ^{235}U reactor $\bar{\nu}_e$ spectrum

- Started data taking in March 2018
  - Best signal/background for antineutrino detection ever on-surface
  - > 5σ reactor neutrino detection in <2 hrs on Earth's surface





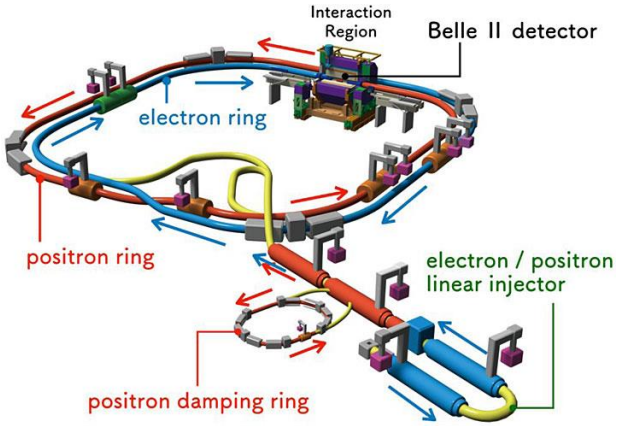
Reactor Anomaly (RAA) best-fit point disfavored at > 95% CL

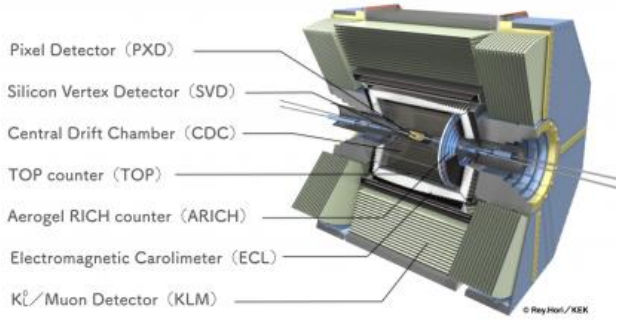


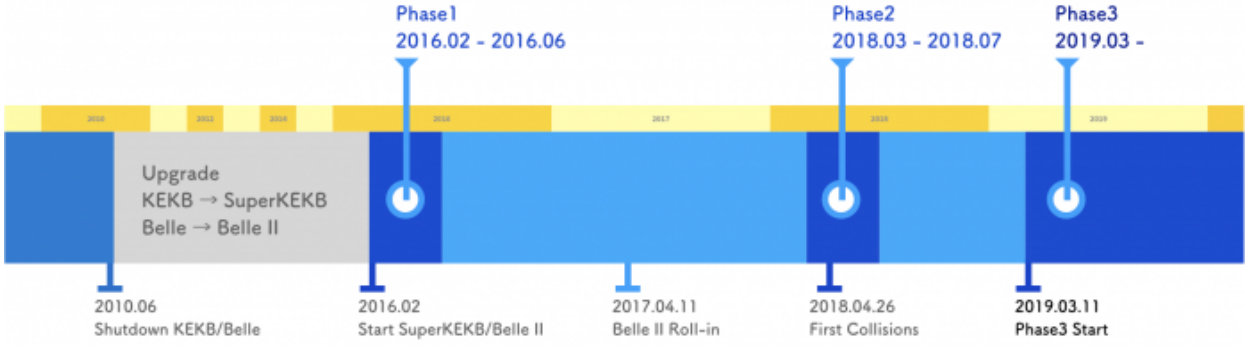
High-statistics ^{235}U spectrum measurement

SuperKEKB Phase 3 Operations

- SuperKEKB began Phase 3 operations successfully on March 11, 2019
  - This will begin the physics run for the Belle II experiment, which will start taking data with a fully instrumented detector
- SuperKEKB aims to provide 40 times the luminosity of KEKB to enable Belle II to search for new physics in rare particle decays







Intensity Frontier Science

Experiment	Location	Science Goals
ANNIE	Fermilab, Batavia, IL, USA	Study neutrino-nucleus interactions in a Water Cherenkov detector using new photodetector technology
Belle II	KEK, Tsukuba, Japan	Physics of the bottom and charm quarks and the tau lepton; CP asymmetries; new states of matter
COHERENT	Spallation Neutron Source, ORNL, Oak Ridge, TN, USA	Detect coherent elastic neutrino-nucleus scattering
Daya Bay	Dapeng Penisula, China	Measure $\sin^2 2\theta_{13}$ within 3%; precise measurement of atmospheric mass splitting
EXO-200	Waste Isolation Pilot Plant, Eddy County, NM, USA	Search for neutrinoless double beta decay. (Note; nEXO will be supported by DOE Office of Nuclear Physics)
Heavy Photon Search	Jefferson Lab, Newport News, VA, USA	Search for massive vector gauge bosons which may be evidence of dark matter or explain g-2 anomaly
ICARUS	Fermilab, Batavia, IL, USA	Search for sterile neutrinos in LArTPC
K0TO	J-PARC, Tokai , Japan	Discover and measure $K_L \rightarrow \pi^0 \nu\nu$ to search for CP violation
LArIAT	Fermilab, Batavia, IL, USA	Characterize LArTPC performance with a test beam at energies relevant to short- and long-baseline neutrino expts.
LBNF/DUNE	Fermilab, Batavia, IL & Homestake Mine, SD, USA	Discover and characterize CP violation in the neutrino sector; comprehensive program to measure neutrino oscillations, proton decay, and supernova neutrinos
MicroBooNE	Fermilab, Batavia, IL, USA	Address MiniBooNE low energy excess; measure neutrino cross sections in LArTPC
MINERvA	Fermilab, Batavia, IL, USA	Precise measurements of neutrino-nuclear effects and cross sections at 2-20 GeV
Mu2e	Fermilab, Batavia, IL, USA	Charged lepton flavor violation search for $\mu N \rightarrow eN$
Muon g-2	Fermilab, Batavia, IL, USA	Definitively measure muon anomalous magnetic moment
US-NA61	CERN, Geneva, Switzerland	Measure hadron production cross sections crucial for neutrino beam flux estimations
NOvA	Fermilab, Batavia, IL & Ash River, MN, USA	Measure ν_μ-ν_e and ν_μ-ν_μ oscillations; resolve the neutrino mass hierarchy; explore δ_{cp} (with T2K)
PROSPECT	High Flux Isotope Reactor, ORNL, Oak Ridge, TN, USA	Search for sterile electron antineutrino oscillation at very short baseline
SBND	Fermilab, Batavia, IL, USA	Precision neutrino-LAr interaction measurements
Super-K	Mozumi Mine, Gifu, Japan	Nucleon decay, supernova neutrinos, atmospheric neutrinos
T2K	J-PARC, Tokai & Mozumi Mine, Gifu, Japan	Measure ν_μ-ν_e and ν_μ-ν_μ oscillations; resolve the neutrino mass hierarchy; explore δ_{cp} (with NOvA)
WATCHMAN	Boulby Underground Lab. UK	Develop technology, data analysis techniques to demonstrate v-based monitoring of nuclear reactors

HEP Small Project Portfolio

"Small" (approx. 100 collab. Or less) projects currently HEP-supported (incl. new since P5):

Intensity Frontier:

- **ANNIE**
- **CAPTAIN**
- **COHERENT**
- **EXO-200**
- **Heavy Photon Search (HPS)**
- **KOTO**
- **LArIAT**
- **NA61**
- **PROSPECT**
- **SBND**
- **WATCHMAN**

Cosmic Frontier:

- **ADMX-G2**
- **eBOSS**
- **HAWC**
- **SuperCDMS-SNOLab**
- **SPT-3G**

Recently retired:

- **BES-III**
- **DarkLight**
- **LUX**
- **MINOS+**
- **SuperCDMS-Soudan**
- **VERITAS**

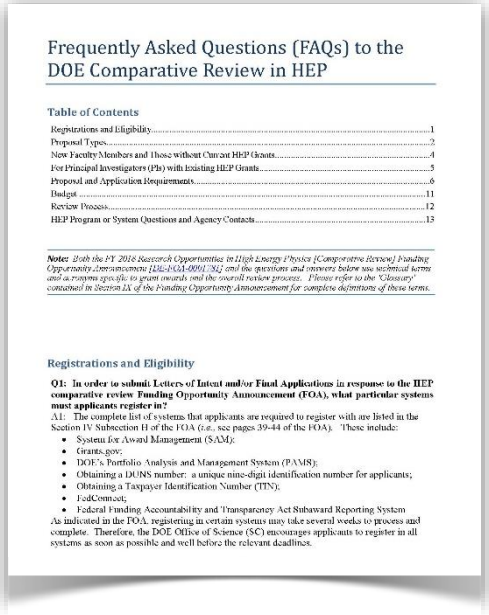

HEP Funding
Opportunities

FY20 HEP Comparative Review FOA & FAQ

- **DE-FOA-000xxxx** issued **TBD**
- Six HEP research subprograms
  - Energy, Intensity, and Cosmic Frontiers, HEP Theory, Accelerator Science and Tech. R&D, and Detector R&D
- Letter of Intent (strongly encouraged) due: **TBD**
- Final Proposal deadline: **TBD**

Please read the FOA carefully to comply with all requirements prior to submitting a proposal.

- In addition to the FOA, a FAQ is available and addresses topics on:
  - Registration and eligibility requirements
  - Proposal types and requirements;
  - Guidance for new faculty and those without current HEP grants
  - Guidance for PIs with existing HEP grants
  - Budget information and guidance on scope of request(s)
  - Letter of Intent
  - Information on overall scientific merit review process
  - Contacts for program- or system-related questions



Frequently Asked Questions (FAQs) to the DOE Comparative Review in HEP

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Note: Both the FY 2018 Research Opportunities in High Energy Physics [Comparative Review] Funding Opportunity Announcement [DE-FOA-0001782] and the questions and answers below use technical terms and acronyms specific to grant awards and the overall review process. Please refer to the 'Glossary' contained in Section IX of the Funding Opportunity Announcement for complete definitions of these terms.

Registrations and Eligibility

Q1: In order to submit Letters of Intent and/or Final Applications in response to the HEP comparative review Funding Opportunity Announcement (FOA), what particular systems must applicants register in?

A1: The complete list of systems that applicants are required to register with are listed in the Section IV Subsection H of the FOA (i.e., see pages 39-44 of the FOA). These include:

- System for Award Management (SAM);
- Grants.gov;
- DOE's Portfolio Analysis and Management System (PAMS);
- Obtaining a DUNS number: a unique nine-digit identification number for applicants;
- Obtaining a Taxpayer Identification Number (TIN);
- FedConnect;
- Federal Funding Accountability and Transparency Act Subaward Reporting System

As indicated in the FOA, registering in certain systems may take several weeks to process and complete. Therefore, the DOE Office of Science (SC) encourages applicants to register in all systems as soon as possible and well before the relevant deadlines.

Both the FOA and FAQ are planned to be available at:
http://science.osti.gov/hep/funding-opportunities/

Recent FOA Changes

- All *Research* proposals to DOE/SC must have a Data Management Plan (DMP)
  - Includes HEP comparative review and Early Career, but not conferences, workshops, operations, projects
  - Any research thrust in a proposal without a DMP will be **declined without review**
- All *Renewal* proposals must submit "proposal products" (publications, etc.) after the application is submitted
  - PIs will be notified by PAMS and have 5 days to respond
  - We **cannot review** incoming proposals until this step is completed
  - These will eventually be captured with your annual Progress Report, but must be entered by hand during the transition phase
- Recurring Submissions of Research Applications (*since FY 2018*):
  - "A previously declined application may be resubmitted to this FOA, but **only after it has undergone substantial revision**. An application submitted to this FOA that has not clearly taken into account the major concerns from prior DOE reviews may be **declined without review and will not be considered for funding**."
- All FOAs have different eligibility, technical requirements, page limits, etc.
  - ***Read the instructions carefully!***

DOE HEP Research Priorities: Snapshot

- Energy Frontier
  - Analysis of LHC Run 2 data
  - Contribute to operational responsibilities and complete "Phase I" upgrades
  - Scientific support for HL-LHC program
- Intensity Frontier
  - Neutrino Program
    - Support ProtoDUNE, LBNF/DUNE, and PIP-II
    - Implement Fermilab Short-Baseline Neutrino Program and Intermediate Neutrino Program
    - NOvA, T2K/SK, Minerva, MicroBooNE data analysis
  - Muon Program: Complete Mu2e, take data with Muon g-2
  - Heavy Flavor Program: take and analyze data with Belle-II
- Cosmic Frontier
  - Dark Matter: Scientific support for G2 experiments (in fabrication)
  - Dark Energy: DES analysis; scientific support for LSST and DESI (in fabrication)
  - Continue science planning for CMB-S4
- Accelerator R&D
  - Focus on outcomes and capabilities that will dramatically improve cost effectiveness for mid-term and far-term accelerators
  - Hosting workshops to develop and implement R&D plan following P5 and GARD panels
- Detector R&D
  - Developing process to identify highest priority R&D activities for current phase of implementing P5
  - Long-term "high-risk" R&D with potential for wide applicability and/or high-impact
  - "Blue-Sky" scientific research on innovative technologies not already in contention for implementation in future DOE HEP projects
- HEP Theory
  - Maintain an overall "thriving" program as per P5

Key Items to Keep in Mind

- Proposed research will review best if closely aligned with the DOE/HEP mission, its program, and the P5 strategy
  - Investigators in experimental HEP research frontiers (Energy, Intensity, Cosmic) will review best if they are closely integrated into HEP experiment collaborations and have key roles and responsibilities on those experiments
  - "Generic" research that is not to be carried out as part of a specific HEP experimental collaboration should be directed to the HEP Theory or Detector R&D programs, as appropriate.

- **Read the FOA carefully** and follow the requirements on content, length, etc.
  - **Several requirements in the FOA are set from outside the DOE/HEP office**, and there is little to no flexibility to modify.
    - **Non-compliant proposals submitted to the FOA will not be reviewed.**
  - **In recent years, 5-10% of incoming proposals are declined without review.** Requirements most often missed or overlooked include:
    - Data management plans, page limits, separate budget sheets (if needed) for each research subprogram or thrust, and inclusion of Personally Identifiable Information (PII)

Particular Considerations for DUNE

- Compelling research proposal for next ~3 years
  - ✓ Demonstrable impact on DUNE R&D/fabrication plan or performance
  - ✓ Supports current timeline for DOE CD's or other milestones
  - ✘ Outside of DUNE plan, not timely, or no clear leadership role
  - ✘ Project activities
- Significant recent contributions in last 3–4 years
  - Should be able to show science impact/leadership in neutrino physics and/or detector development
- Alignment with programmatic priorities
  - Highest priority HEP project in its time frame
- Balanced program of R&D/design, support of construction or operations (ProtoDUNE), data analysis
  - DUNE research program will be focused on first item in next ~2–3 years
  - PIs should look to other experiments for additional operations or analysis elements during this period

Proposal Project Narrative

- Project Narrative comprises the **research plan** for the project
  - Should contain enough background material in the introduction to demonstrate sufficient knowledge of the research
  - Devote main portion to a description and justification of the proposed project, include details of the methods to be used and any relevant results
  - Indicate which project personnel will be responsible for which activities
  - Include timeline for the major activities of the proposed project
- Must not exceed 9 pages per senior investigator when printed on standard 8 ½" x 11" paper with 1-inch margins (all sides). Font must not be smaller than 11 point.
  - Senior investigator ≡ active tenured or tenure-track faculty member at sponsoring institution
  - Non-tenure track faculty (*e.g.*, research scientists) and staff with term appointments are not included in the 9-page limit per investigator unless they are the lead PI on the application
  - Faculty members at collaborating institutions listed on the proposal (if any) are not included
- Refer to Section IV of the planned FOA for useful information to prepare narratives
  - What to address for the Background/Introduction
  - Multiple Investigators and/or Multiple Research Subprograms or Thrusts
  - Common narrative with overview of each group's activities in different research areas
  - Discussion of any synergies and connections between areas
  - Proposed Project Objectives, Research Methods, Resources
  - Timetable and Level of Effort of different activities, …

HEP Research Activities Supported

✓What DOE supports

- Efforts that are in direct support of our programs
  - Support depends on merit review process, programmatic factors, and available funds
- Research efforts (mainly scientists) on R&D, experiment design, fabrication, data-taking, analysis-related activities
- Some engineering support may be provided in the Detector R&D subprogram
- Theory, simulations, phenomenology, computational studies

- **Faculty support**
  - Based on merit reviews and/or optimizing the number of research personnel supported by financial assistance awards, support of up to 2-months faculty summer salary
  - Summer support should be adjusted according to % time the faculty is on research effort

- **Research Scientists**
  - Support may be provided, but due to long-term expectations, need to consider case-by-case on merits: whether the roles and responsibilities are well-matched with individual capabilities and cannot be fulfilled by a term position
  - Efforts are related towards research; not long-term operations and/or project activities

✗What's not supported by 'Research' grants

- Any significant HEP operations and/or project-related activities:
  - Engineering, major items of equipment, consumables for prototyping or production
- Non-HEP related efforts (*e.g.* gravitational waves (LIGO), heavy-ion (RHIC/LHC), AMO Science)

Research Scientists (RS)

Panel will evaluate RS efforts where support is requested in a proposal.

- Guidance to PIs given in Q&A of FAQ
  - Requests to support RS dedicated full-time (and long-term) to operational and/or project activities for an experiment will not be supported by respective frontier research areas
  - If RS conducting physics research-related activities, requests [scaled to % of time on such efforts] can be included
    - Any final support will be **based on the merit review** process
- Common [past] reviewer comments that result in unfavorable merit reviews:
  - "RS conducting scope of work typically commensurate at the postdoctoral-level…"
  - "RS involved in long-term ops/project activities with minimum physics research efforts…"
    - May review well in the operation/project program but **not in a review of the experimental research program**
- What are "physics research-related activities?"
  - Object reconstruction/algorithm development, performance studies, data taking and analysis, and mentorship of students & postdocs in these areas
  - Scientific activities in support of detector/hardware design and development
- From the research program, cases become an issue when operations/projects become the dominant activity in the long-term
  - A well-balanced portfolio that includes physics research-related activities is encouraged
  - **Important to narrate complete plans** in 2-page "appendix narrative" + provide 1-page bio

Crosscut, Multi-thrust, or Transitional Proposals

- Applications where a PI is proposing to conduct research across multiple HEP research subprograms during the project period are planned to be considered
- PIs are encouraged to submit only one application, describing:
  - Overall research activity, including fractional time planned in each subprogram
  - **Continue into the planned FY20 FOA:** in proposal's Budget Justification material (Appendix 7), include level of effort table for any transition of effort during project period, as appropriate
- As part of their overview of the subprogram and review process, DOE PMs will provide the panel with details regarding such research plans across multiple HEP thrusts
- Reviewers with appropriate topical expertise in the research area(s) will assess the full scope, relevance, and impact of the proposed research in the merit review process — *e.g.*, merit review questions consider:
  - Are the plans for such cross-cutting efforts reasonably developed and balanced; will the proposed activities have impact?
  - Does the scope of the full proposed program provide synergy or additional benefits to the HEP mission beyond the individual thrusts?
  - Will PI's overall efforts across multiple thrusts add value to HEP program goals and mission?

Programmatic Considerations

- Generally very useful to have head-to-head reviews of PIs working in similar areas, particularly for large grants
  - Discussion of relative strengths and weaknesses of individual proposals and PIs
- Many factors weigh into final funding decisions
  - ***Compelling research proposal*** for next ~3-4 years
    - ✓ **Interesting? Novel? Significant? Plausibly achievable?**
    - ✘ **Incremental? Implausibly ambitious? Poorly presented?**
  - ***Significant recent contributions*** in last 3-4 years
    - Synergy and collaboration within group (as appropriate)
    - Contributions to the research infrastructure of experiments
  - ***Alignment with HEP*** programmatic priorities
  - ***Balanced program*** of R&D/design, support of construction or operations, data analysis
    - This may span multiple experiments over a 3+ year proposal
- Supportive of excellent research, including excellent research by *new* people, even when times are tough!
  - Corollary: Some proposals, including some from senior personnel, ranked below average may not be funded

Comparative Merit Review Criteria

Sub-questions to be provided in Section V of FOA

1. **Scientific and/or Technical Merit of the Proposed Research**
   e.g., What is the scientific scope and impact of the proposed effort? **How might the results of the proposed work impact the direction, progress, and thinking in relevant scientific fields of research?** What is the likelihood of achieving valuable results? How does the merit of the proposed research, both in terms of scientific and/or technical merit and originality, compare with other efforts within the same research area for a) applications submitted to this FOA and b) those in the overall HEP field? Is the Data Management Plan suitable for the proposed research and to what extent does it support the validation of research results? **Please comment individually on each senior investigator.**

2. **Appropriateness of the Proposed Method or Approach**
   e.g., **How logical and feasible are the approaches? Does the proposed research employ innovative concepts or methods?** Are the conceptual framework, methods, and analyses well justified, adequately developed, and likely to lead to scientifically valid conclusions? Does the applicant recognize significant potential problems and consider alternative strategies?

3. **Competency of Applicant's Personnel and Adequacy of Available Resources**
   e.g., **How well qualified is each senior investigator and their team, and what is the likelihood of success in carrying out the proposed work?** Does the proposed work take advantage of unique facilities and capabilities? What is the past scientific performance of the team, including the dissemination of results? Are any proposed plans for recruiting any additional scientific and/or technical personnel including new senior staff, students and postdocs reasonable, justified, and appropriate? Are the environment and facilities adequate for performing the proposed effort, including any synergistic opportunities, institutional support, and/or infrastructure? Are the senior investigator(s) or any members of the research group that are being reviewed leaders within the proposed effort(s) and/or potential future leaders in the field? For senior investigator(s) proposing to work across multiple research thrusts, are the plans for such cross-cutting efforts reasonably developed and will the proposed activities have impact?

4. **Reasonableness and Appropriateness of the Proposed Budget**
   e.g., Are the proposed budget and staffing levels adequate to carry out the proposed work? If multiple research thrusts are proposed, is the balance of proposed efforts reasonable and well-matched to the proposed research goals? Are all travel, student costs, and other ancillary expenses adequately estimated and justified? **Is the budget reasonable, appropriate for the scope?**

5. **Relevance of the Proposed Research to the HEP Program Mission and Priorities**
   e.g., **How does the proposed research of each senior investigator contribute to the mission, science goals, and programmatic priorities of the subprogram in which the application is being evaluated? Is the proposed research consistent with HEP's overall priorities and strategic plan?** For multi-thrust proposals, does the scope of the full proposed program provide synergy or additional benefits to the HEP mission beyond the individual thrusts? **How likely is the research to impact the direction of the overall HEP program?** For senior investigator(s) proposing to work and/or transition across multiple research thrusts during the project period, will their overall efforts add value in the broader context of HEP program goals?

Comparative Merit Review Criteria Use

For Reviewers/Panelists

- The merit review criteria and corresponding questions are given to all reviewers to input their reviews in DOE's Portfolio Analysis and Management System (PAMS)
  - Serves as a guide for reviewers to address each review criteria for written reviews
- They are highlighted by DOE Program Managers at the beginning of panel deliberations
- These are presented and discussed by individual panelists for each proposal
- Other Program Policy Factors are also discussed with panelists.
  - For e.g., program alignment with respect to the P5 strategic plan, fostering development of diverse cadre of supported researchers, and opportunity for early-stage investigators and/or junior scientific personnel.

For Principal Investigators

- The merit review criteria and corresponding questions are given in Section V of the FOA
- Program Policy Factors are also given in Section V of the FOA
- Serves as an additional guide for PIs to address in their proposal's project narratives
  - Do not just write an explicit paragraph answering each question-by-question, but instead, PIs should integrate and adapt these (as appropriate) when narrating the group's activities and research plans

Office of Science Data Management Plan

- Focus of the SC Digital Data Management is the sharing and preservation of digital research data
  - Data management involves all stages of the digital data life cycle including capture, analysis, sharing, and preservation
  - See Dr. Laura Biven's presentation on SC Digital Data Management, Sept. 2014 HEPAP meeting: http://science.osti.gov/hep/hepap/meetings/201409/
  - FOAs issued by HEP require Data Management Plan (DMP) compliance with the SC Statement
    - SC statement on DMPs: http://science.osti.gov/funding-opportunities/digital-data-management/
    - See Section IV, the subsection on Appendix 8 of the FOA, for requirements pertaining to DMPs that must be included in your application
- Most experiments have developed DMPs for their collaborations
  - When applying for financial assistance (universities) or submitting FWPs (labs), PIs can cite the DMPs for their experiments with the appropriate links
    - If DMP cited, PIs must briefly describe how proposed research relates to the experiment
  - Theorists need DMPs: explain how theoretical/simulated data can be accessed/validated
  - If there is no data of any sort generated by the proposed research, the DMP must state this. **A DMP that is blank or states "not applicable" is not acceptable**

Each research thrust in a proposal requesting DOE research support, including the FY 2020 Comparative Review FOA, require addressing the DMP requirements for it to be reviewed, and hence, to be considered for funding

Renewal Proposal Products

- 'Renewal' proposals plan to be accepted
  - Such proposals are appropriate where funds are requested for an award first awarded in 2012 or later with no change in
    - Recipient/applicant institution; research thrust(s) and research scope(s); and award's lead-PI
  - See also, when available, FAQ Q&As for additional guidance
- Renewal Proposal Products
  - Since Feb 2015, PI must complete and submit 'Renewal Proposal Products' section in PAMS by entering each product created during the course of the previous project period
    - Details with step-by-step instructions available in PAMS User Guide, Section 9.2: https://pamspublic.science.energy.gov/WebPAMSEPSExternal/CustomInterface/Common/ExternalUserGuide.pdf
  - Types of products include:
    - Publications (for collaborators on large experiments, list those where you were primary)
    - Intellectual property, technologies or techniques
    - Databases or software (made public)
- Renewal Proposal Products are to be submitted ***after*** the application submission
  - DOE will assign the renewal proposal to a Program Manager, resulting in an automated email from PAMS to the PI with instructions ← ***watch for this email in your inbox***
  - Navigate in PAMS to 'Tasks' and enter all products within 5-days after the proposal submission
  - Application will not be considered complete and therefore cannot be reviewed until the product list has been submitted

Guidance Checklist for FY20 Comp Rev

- Non-compliant applications will not be reviewed, and therefore, will not be considered for funding. As a convenience and courtesy, DOE/HEP plans to provide a checklist in the FY20 FOA.
  - **The list, on the opening pages of the FOA, is <u>not</u> intended to be complete; applicants should review the FOA in-detail and follow all instructions**

FY 2018 Comparative Review FOA – GUIDELINE FOR APPLICATION REQUIREMENTS	COMPLETED
Is the proposed research scope aligned with programmatic priorities of DOE-HEP?	☑
Personally Identifiable Information (PII): Do not supply any information, such as birth date or place, citizenship, home address, personal phone nos., etc., that should not enter into the merit review.	☑
A Data Management Plan is required for each research thrust (*e.g.,* ATLAS, LSST, lattice gauge theory, etc.). It must appear in Appendix 8 of the application and comply with page-limit requirements specified in the FOA.	☑
Project Summary/Abstract Page: contains the name(s) of the applicant, the project director/principal investigator(s) and the PD/PI's institutional affiliation, and any Co-Investigators and their affiliations.	☑
DOE Cover Page: list each HEP research subprogram (*e.g.,* Energy Frontier, HEP Theory) for which funding is requested. If there is more than one, be sure to attach the Cover Page Supplement.	☑
Page limits for each section comply with the FOA requirements (as defined in Section IV of the FOA).	☑
Biographical sketches carefully follow the FOA instructions and avoid PII.	☑
Current and Pending Support information completed, including an abstract of the scope of work.	☑
In addition to the budget information for the full proposal: separate budget and budget justification narratives for each HEP research subprogram in the proposal for each year in which funding is being requested and for the cumulative funding period has been provided in Appendix 7.	☑
Level of Effort Tables completed in Budget Justifications in Appendix 7: for each person for whom funding is requested in a research thrust, on the scope of activities during proposed project period.	☑
Post-submission of a 'renewal' application, timely submitted the Renewal Proposal Products (RPP) in PAMS.	☑

Other Funding Opportunities

- Workforce Development (WDTS) programs: https://science.osti.gov/wdts/
  - **Office of Science Graduate Student Research fellowships (SCSGR)**
    - Supports grad student research at a DOE lab, 3 to 12 months
    - Two calls per year, usually Feb/Aug.
    - Applications typically due May/Nov for following Fall or Summer start
  - **Science Undergraduate Laboratory Internships (SULI)**
    - Supports undergraduate research at a DOE lab, 10 to 16 weeks
    - Three calls per year, for following Spring/Summer/Fall terms
    - *Now accepting applications for Spring 2020!*
  - **Visiting Faculty Program**
    - Summer research support for faculty/students from historically underrepresented institutions
    - One call per year, usually in Oct. Applications due in Jan.

- Office of Science programs:
  - **Early Career Research**: https://science.osti.gov/early-career/
  - **SC "Open Call" [**DE-FOA-0001968]
    - HEP uses this primarily for supplemental proposals, experimental operations support and conferences
  - Can also participate in Research Consortia in other FOAs/Lab Calls such as QuantISED and US-Japan Program

Research Consortia

- Research consortia are a possible mechanism for funding where a single proposal is created by multiple institutions
  - One member of the consortium serves as the prime recipient/consortium representative (lead organization).
  - Consortia must provide a collaboration agreement which sets out the rights and responsibilities of each consortium member, including:
    - Management structure
    - Method of making payments to consortium members
    - Means of ensuring and overseeing members' efforts on the project
    - Provisions for members' cost sharing contributions
    - Provisions for ownership and rights in intellectual property developed previously or under the agreement
  - Note that a consortium is applied for in one application and results in one award with subawards to consortia members
- This mechanism could allow research efforts with specific timelines and goals to provide the "big picture" for consideration, rather than "puzzle pieces" from separate individual institution proposals
  - A consortium approach may benefit specific topics in future FOAs
  - This has already been "piloted" in the QuantISED and Stewardship FOAs

Early Career Research Program

Preparing an Early Career Proposal I

- Plan to issue a FY 2020 funding opportunity announcement for the next round of Early Career applicants
  - Stay tuned to https://science.osti.gov/early-career/ for further updates…
- In addition to the merit review criteria found in the FOA, the following guidance should be applied while preparing the proposal narrative:
  - What **challenges/problems** are you trying to solve? Communicate this!
  - Is **someone else** doing it already?
    - Alternatively, aren't those research activities already being funded elsewhere?
    - If you carry-out these efforts, why are they unique and require 'you'?
  - How does this research exploit/engage **unique capabilities** of your institution?
  - What **resources** are needed to complete the project?
  - Does your proposal outline a **5-year timeline**, with key **deliverables and personnel profiled** during this project period?
  - If funded, what will be the **outcome after 5-years**?
  - Have you **led the activities** that you are proposing?
  - **Why are you a future leader in HEP?**
    - Identify your leadership activities in Collaboration, HEP, or broader scientific community

Preparing an Early Career Proposal II

- General observations of strong proposals
  - Provide **unique** capabilities and impact. What doesn't get done, if not funded?
    - Proposal should address "why is it critical that **I** carry-out this research?"
    - How does your work **impact** efforts within the collaboration or international community?
    - Include figures/plots that address your study; show any simulation results, efficiency studies, or quantitative projections **you have completed** on your research activity
    - Identify, where appropriate, **innovative approaches** to analysis method
  - **Balanced** program with a strong physics effort and a hardware project where PI takes a lead
  - For searches, discuss the **discovery** reach and do not just state: "in the absence of a signal, a 95% C.L. limit will be set."
- Prior to submission, applicants may want to seek guidance from appropriate senior faculty and/or staff while preparing proposals (including the narrative and budget material)
  - **Applicants are also encouraged to draw guidance from any members within the international collaboration**

Take Away Messages

- HEP is maintaining the core of the DOE science mission
  - We are delivering exciting discoveries, important scientific knowledge, and technological advances
  - We must stay focused and continue to deliver outcomes for the nation
  - Science results from the collaborations have impact in Washington, DC
- HEP is executing the P5 plan and delivering science
  - FY 2019 funding actions are moving forward
  - FY20 funding opportunities are anticipated to be advertised in the fall
- FY 2020 Congressional Marks are 'budget indicators'
  - Senate Marks are next major step, but fiscal budget is only known when Congress passes an appropriation and the President signs the bill
  - Though post-P5 growth has favored Projects, message is getting through that healthy growth of the program requires Research and Operations growth in addition to Project support

Intensity Frontier Conclusion

- It is an exciting time to be doing Intensity Frontier science!
  - Portfolio of experiments exploring three of the Science Drivers in pursuit of discovery:
    - Neutrino mass, dark matter, exploring the unknown
  - Opportunities for contributing to experiments at all stages of lifecycle
- There is plenty of work to do!
  - Scientists from all backgrounds are welcome to apply their skill sets to the Intensity Frontier

U.S. DEPARTMENT OF
ENERGY

Office of
Science

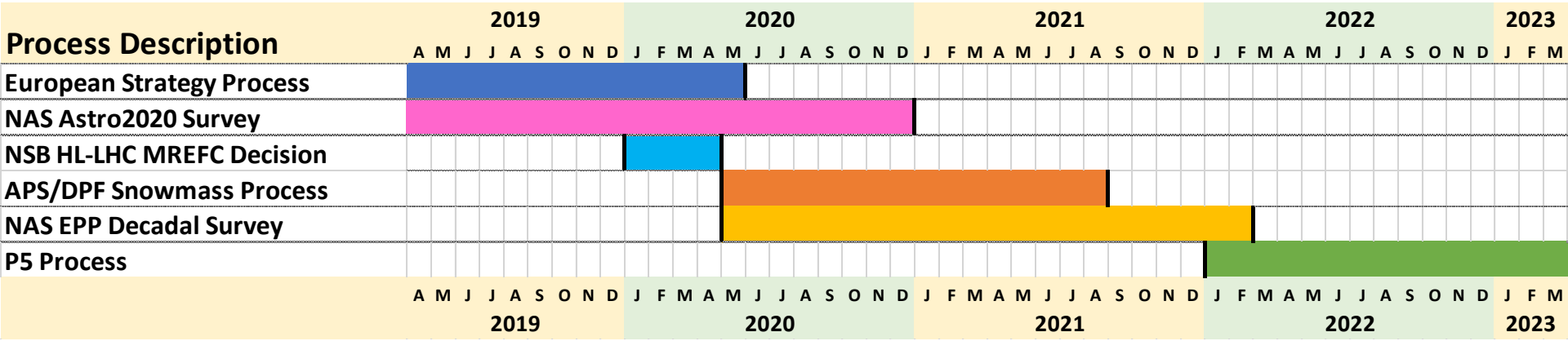
Strategic Planning

Timeline for Updating the U.S. Strategy

- **The May 2014 P5 report was successful because it was well informed by the science community**, including information from:
  - 2010 New Worlds, New Horizons in Astronomy and Astrophysics
  - 2012 Report of the Subcommittee on Future Projects of High Energy Physics (Japan)
  - 2013 European Strategy for Particle Physics Report
  - 2013 U.S. Particle Physics Community-driven "Snowmass" process
- The timeline of processes that impact the next strategic plan:
  - 2018-20: New NAS Astronomy and Astrophysics Decadal Survey
  - 2018-20: European Strategy for Particle Physics Process
  - 2019/20: Anticipated Japanese decision on ILC
  - 2020: Earliest opportunity for National Science Board to approve obligating HL-LHC MREFC
- **From a DOE perspective, the earliest that new APS/DPF Snowmass, NAS Elementary Particle Physics Decadal Survey, and P5 processes could begin is 2020**
  - **Relative timing of Snowmass, P5, and NAS EPP Decadal Survey to be determined**
  - **Enables receiving next P5 recommendations by March 2023, in time to inform FY 2025 budget formulation**

Possible Strategic Planning Timeline

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



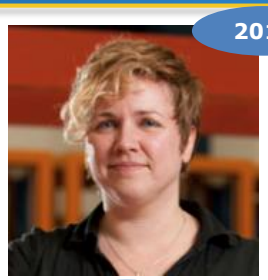
Community Participation

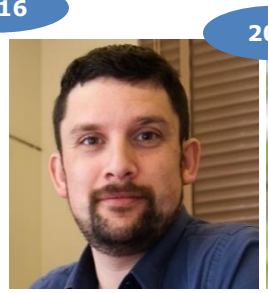
- Broad community participation in the U.S. particle physics strategic planning process is essential
  - The 2014 P5 report was successful because it built upon a solid foundation of community effort
- PIs are encouraged to be active in all phases of the process:
  - Submit whitepapers to the NAS Astro2020 and possible EPP decadal surveys
  - Actively participate in the DPF-led Snowmass process
  - Develop new concepts for future projects
- PIs on HEP research grants may contribute to planning processes as aligned with scope of work
  - Discuss any questions with your Program Manager!

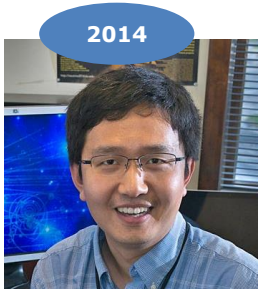
IF Early Career Awards 2010-2016

2016: Jennifer Raaf (Fermilab)
- "Coming in from the Cold: A High-Pressure Gaseous Argon Time Projection Chamber as an Option for the DUNE Near Detector"

- 2015: Phillip Barbeau (Duke University)
  - "Coherent Neutrino-Nucleus Scattering: A Tool to Search for New Physics"
- 2015: Peter Winter (ANL)
  - "Muon g-2: Precision Determination of the Magnetic Field and Enhanced Trolley Features"
- 2014: Xin Qian (BNL)
  - "Detector Development towards Precision Measurements of Neutrino Mixing"
- 2013: Jelena Maricic (University of Hawaii)
  - "Resolving Reactor Antineutrino Anomaly with Strong Antineutrino Source"
- 2012: Geralyn (Sam) Zeller (Fermilab)
  - "Understanding Liquid Argon Neutrino Detectors: Moving from Art to Science"
- 2012: Brendan Casey (Fermilab)
  - "Early Career: Tracking for the New Muon g-2 Experiment"
- 2012: Lisa Whitehead (University of Houston)
  - "Precision Measurement of Electron Antineutrino Disappearance in the Daya Bay Experiment"
- 2011: Ryan Patterson (California Institute of Technology)
  - "Developing novel techniques for readout, calibration and event selection in the NOvA long-baseline neutrino experiment"
- 2010: Alysia Marino (University of Colorado)
  - "Probing Neutrino Properties with Long-Baseline Neutrino Beams"
- 2010: Christopher Mauger (LANL)
  - "Design of the near detectors and optimization of water and ice targets for fine-grained tracking detectors for the Fermilab Long-Baseline Neutrino Experiment"
- 2010: Patrick Huber (Virginia Polytechnic Institute & State University)
  - "Neutrinos in the Universe"



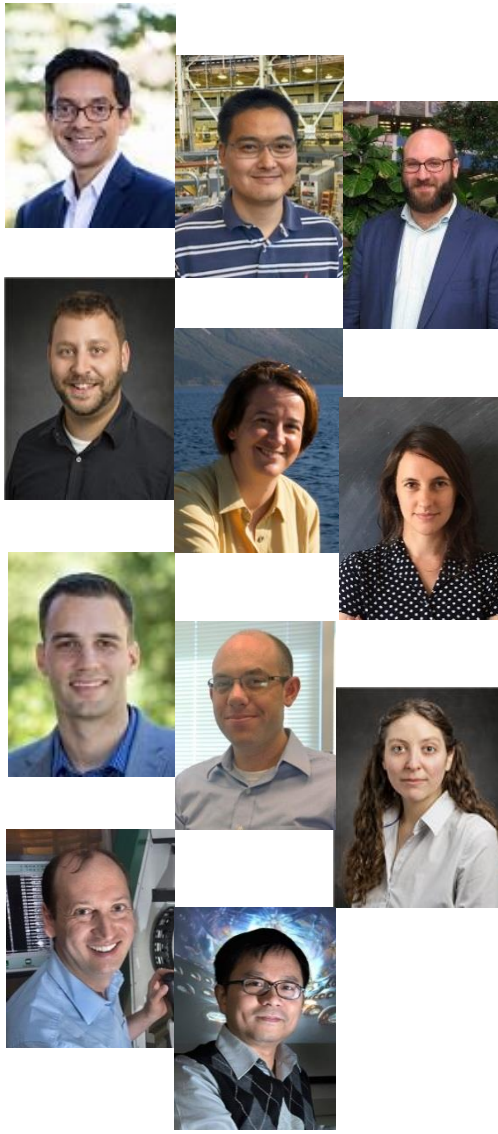




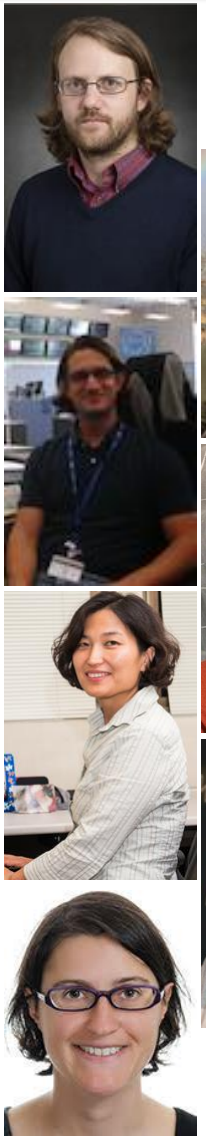

FY 2017 Early Career Awards

- **Zeeshan Ahmed (Detector, SLAC)** Development of High-density Microwave-multiplexed Transition Edge Sensor Bolometers for next-generation CMB Cameras
- **Qiang Du (Accelerator, LBNL)** Scalable Control of Multidimensional Coherent Pulse Addition for High Average Power Ultrafast Lasers
- **Alexander Himmel (Intensity, FNAL)** Seeing Neutrinos: The Physics Potential of Photon Signals in DUNE
- **Ben Hooberman (Energy, UIUC)** Probing Naturalness with Searches for Supersymmetric Higgs Partners at the LHC
- **Anja von der Linden (Cosmic, SUNY SB)** Towards Precision Cluster Cosmology with LSST
- **Marilena Loverde (Theory, SUNY SB)** Discovering dark energy, dark matter and neutrino properties with cosmic structure
- **Emilio Nanni (Accelerator, SLAC)** High-Gradient Accelerators at THz Frequencies
- **Michael Schneider (Cosmic, LLNL)** Dark Energy Constraints from Weak Gravitational Lensing in the Large Synoptic Survey Telescope (LSST)
- **Jessie Shelton (Theory, UIUC)** Hidden sectors from cosmos to colliders
- **Alessandro Tricoli (Energy, BNL)** Unveiling the electroweak symmetry breaking mechanism at ATLAS and at future experiments with novel silicon detectors
- **Chao Zhang (Intensity, BNL)** Optimization of Liquid Argon TPCs for Nucleon Decay and Neutrino Physics



FY 2018 Early Career Awards: Univ.

- Thomas Faulkner, University of Illinois
  - New perspectives on QFT and gravity from quantum entanglement
- Alexie Leauthaud-Harnett, University of California, Santa Cruz
  - Exploiting Synergies Between Lensing and BAO Surveys for Improved Cosmological Constraints
- Themis Mastoridis, California Polytechnic State University
  - Optimal Design of Radio Frequency Algorithms and Models for Next Generation Accelerators
- Benjamin Safdi, University of Michigan
  - Particle Dark Matter Across Scales
- Hee-Jong Seo, Ohio University
  - Optimal and robust reconstruction of BAO, redshift-space distortions and the Alcock-Paczynski effect
- David Simmons-Duffin, Caltech
  - Precision Computations in Strongly Coupled Conformal Field Theories
- Rachel P. Yohay, Florida State University
  - Probing New Physics with Tau Leptons using the CMS Detector



FY 2018 Early Career Awards: Labs

- Artur Apresyan, FNAL
  - Exploring the Lifetime Frontier with New Detectors and New Searches
- Daniel Bowring, FNAL
  - Microwave Single-Photon Sensors for Dark Matter Searches and Precision Neutrino Measurements
- Daniel A. Dwyer, LBNL
  - Improving Neutrino Detection in DUNE with Pixel Sensors
- Michael Kagan, SLAC
  - Exploring the Higgs Sector at the Energy Frontier with Bottom Quarks, Machine Learning, and the Upgraded ATLAS Pixel Detector
- Aritoki Suzuki, LBNL
  - Development of high throughput techniques for SC microfabrication, assembly and deployment for future high energy physics experiments
- Kazuhiro Terao, SLAC
  - GPU/FPGA Accelerated Deep Learning Technique Development for Discovering Physics in Liquid Argon Time Projection Chambers
- Javier Tiffenberg, FNAL
  - Towards table-top neutrino detectors: A 10 kg Skipper-CCD experiment

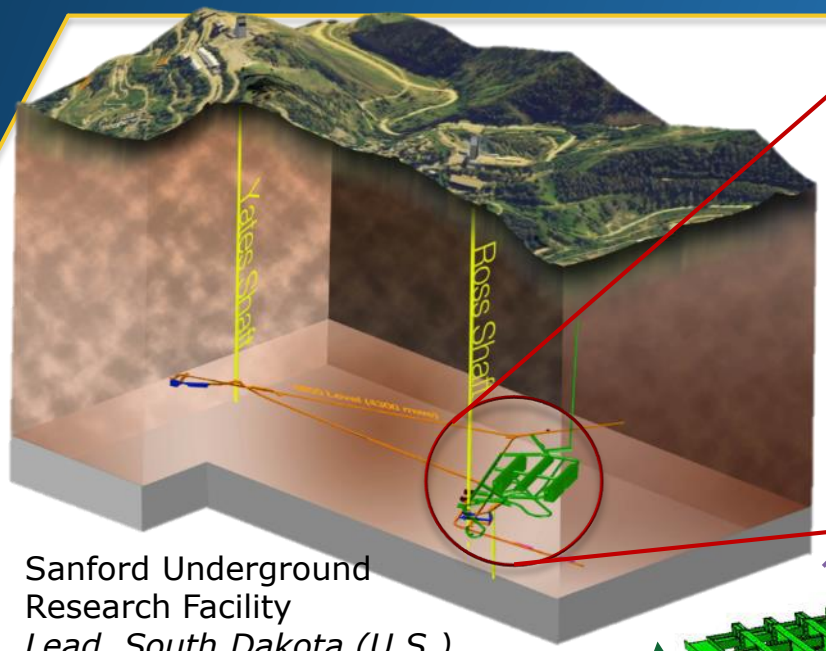
Science Drivers of Particle Physics

The P5 report identified five **intertwined science drivers**, compelling lines of inquiry that show great promise for discovery:

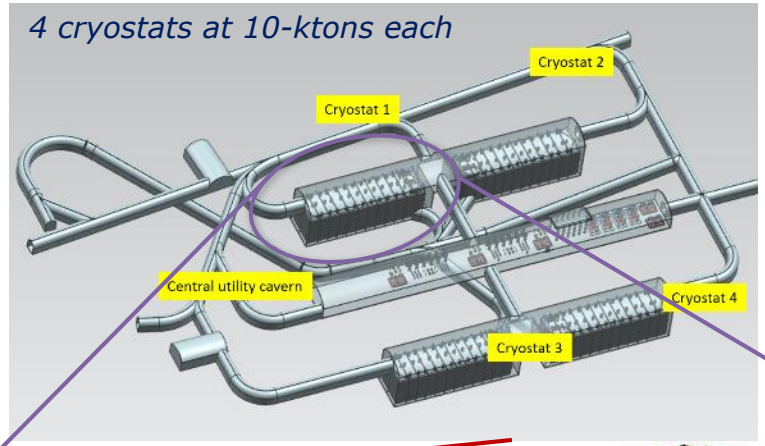
- Use the **Higgs boson** as a new tool for discovery *2013
- Pursue the physics associated with **neutrino mass** *2015
- Identify the new physics of **dark matter**
- Understand **cosmic acceleration**: dark energy and inflation *2011
- **Explore the unknown**: new particles, interactions, and physical principles

** Since 2011, three of the five science drivers have been lines of inquiry recognized with Nobel Prizes*

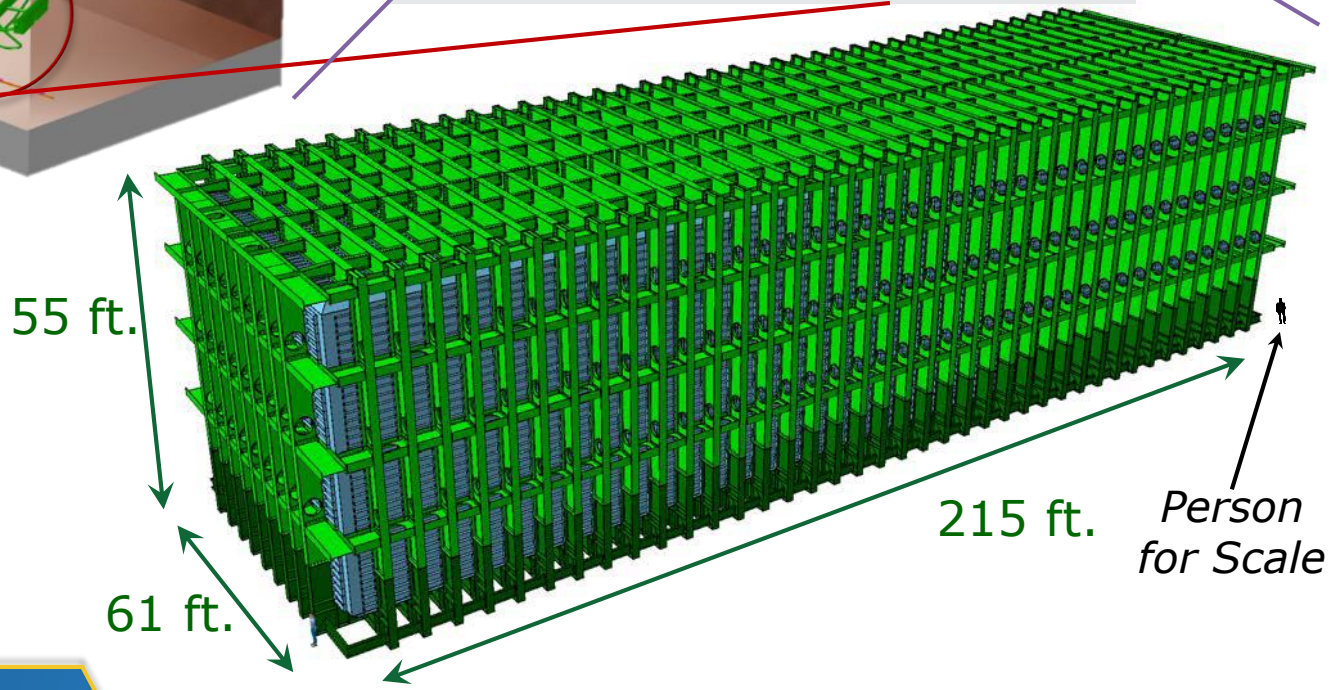
LBNF/DUNE in South Dakota



Sanford Underground Research Facility
Lead, South Dakota (U.S.)



Large-scale cryogenic vessel will house state-of-the-art neutrino detector one mile underground



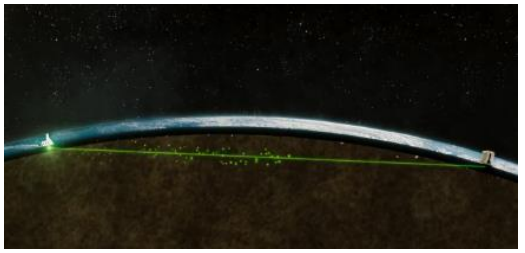
LBNF/DUNE Project Groundbreaking

From Left: Fermilab Director N. Lockyer; Exec. Director of Programs G. Blair, STFC U.K.; Prof. S. Bertolucci, INFN Italy; Director for International Relations C. Warakaulle, CERN; Rep. R. Hultgren, Illinois; Rep. K. Noem, South Dakota; Senator M. Rounds, South Dakota; Senator J. Thune, South Dakota; Assoc. Director for HEP J. Siegrist, U.S. DOE; Deputy Assistant to the President and Deputy U.S. CTO M. Kratsios; South Dakota Governor D. Daugaard; Project Manager S. Lundgren, Kiewit/Alberici; Exec. Director M. Headley, SURF; and Chair of the Board C. Peterson, South Dakota Science and Technology Authority. *Photo Courtesy: Reidar Hahn, Fermilab.*

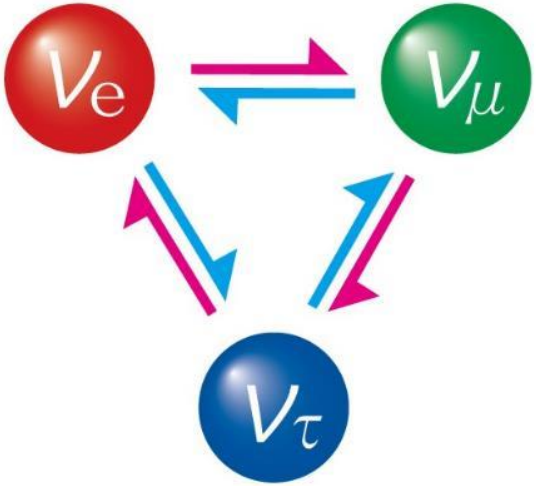
- "Today's groundbreaking … serves as a model for what the future of mega-science research looks like: an intensely collaborative effort between state, local and federal governments, international partners, and enterprising corporate and philanthropic pioneers whose combined efforts will significantly increase our understanding of the universe." – *Deputy Assistant to the President and Deputy U.S. CTO Michael Kratsios, OSTP*

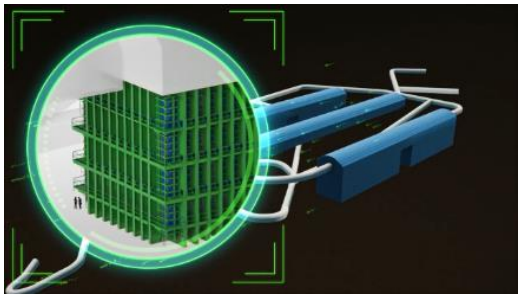
Transformative Discoveries in Neutrinos

- Using the world's most intense neutrino beam and large, sensitive underground detectors, DUNE aims to make discoveries that will transform our understanding of the universe



- **What is the mass ordering of neutrinos?**
  - The relative mass ordering of the three known neutrinos is not yet known, but DUNE would be capable of definitively determining it.
- **Why is there an imbalance of matter and antimatter in the universe?**
  - If neutrinos exhibit matter-antimatter asymmetries, they may have played a key role in creating our matter-dominated universe.
- **What happens inside a supernova?**
  - Observing thousands of neutrinos from a core-collapse supernova in the Milky Way would enable unpresented insight into the process of stellar collapse and the creation of neutron stars and black holes.
- **Do protons decay?**
  - With the world's largest cryogenic particle detector deep underground, DUNE will be able to observe proton decay, if it should occur, and seek a relation between the stability of matter and the Grand Unification of forces.





Program Advice and Coordination

- Formal advice (Federal Advisory Committee Act)
  - High Energy Physics Advisory Panel (HEPAP)
    - Jointly serves DOE and National Science Foundation (NSF)
    - 2014: P5 long-term strategy report
    - 2015: Accelerator R&D Subpanel report
  - Astronomy and Astrophysics Advisory Committee (AAAC)
    - Advises DOE, NSF, and NASA on selected issues of mutual interest within the fields of astronomy and astrophysics (*e.g. CMB-S4 Conceptual Design Team*)
- Community input
  - National Academies of Science: Astronomy and Astrophysics Decadal Survey (*New Worlds, New Horizons*)
  - DOE Workshop reports, including Quantum Sensors, Accelerator R&D Roadmaps, Technology Connections, Basic Research Needs, etc.
- International coordination
  - CERN Council (LHC)
    - Governs CERN by defining its strategic programs, setting and following up its annual goals, and approving its budget
  - International Neutrino Council (LBNF/PIP-II)
    - International consulting body for DOE that facilitates high-level global coordination across the LBNF/PIP-II enterprise
  - Resources Review Board (DUNE)
    - Facilitates Fermilab's coordination of resource-related matters for DUNE

Comparative Review Process

University HEP Comparative Reviews

- Since FY 2012, DOE/HEP uses a process of comparative grant reviews for university research grants – those scheduled for renewal and any new proposals
  - The FY 2019 FOA will mark the 8th round in the process
  - Each HEP subprogram at the DOE national laboratories is also reviewed every 3-4 years
- Process was recommended by several DOE advisory committees, including the 2010, 2013, and 2016 HEP Committee of Visitors (COV):
  - 2010 COV: *"In several of the cases that the panel read, proposal reviewers expressed negative views of the grant, but only outside of their formal responses. Coupled with the trend in the data towards very little changes in the funding levels over time, this suggests that grants are being evaluated based on the historical strength of the group rather than the current strength or productivity of the group. This is of particular concern when considering whether new investigators, new science, or high-risk projects can be competitive. Comparative reviews can be a powerful tool for addressing these issues and keeping the program in peak form."*
    - use **comparative review panels** on a regular basis
  - **2013 COV**: **Continue comparative reviews**. Augment with independent mail-in reviews;
  - ***and* 2016 COV**: **Continue comparative reviews**;
    - and continue **communicating** with PIs about program priorities at DOE PI-meetings held at a major conference/workshop

Goal: improve overall quality and efficacy of the HEP research program by identifying the best proposals with highest scientific impact and potential

Subprogram Review Panels

- The Comparative Review process is very competitive and hard choices have to be made based on the reviews, as well as to fit into our limited funding availability
  - The process implies that certain proposals and PIs will be ranked at the top, middle, and bottom
- It is understood that the vast majority of people applying are working hard and their efforts are in support of the HEP program
  - Due to constrained budgets, some people whose research activities and level of effort are ranked lower in terms of priority and impact relative to others in the field will not be funded on the grant
  - This does not necessarily mean the person cannot continue working on the experiments; they are not being funded by the grant to do it
    - It could be that the person has a critical role in the program, but this did not come out in the proposal or review process
  - This is why it is imperative to respond to the FOA solicitation and detail each person's efforts
- Members of subprogram review panels see all of the proposals and each member provides input and ranks proposals relative to the others
  - When a panel member is faced with comparing efforts, impacts and limited budgets, rather than rank the whole proposal low, they may provide guidance regarding details of the proposals
    - *e.g.*, current group size works well, therefore do not add additional postdoc on this effort

Why Perform Panel Reviews?

- The Intensity Frontier program comprises a number of highly complex experiments and projects and new opportunities arise and evolve for research and development
  - Discussion of proposals provides a richer context to the full Intensity Frontier HEP program compared to the 5-6 proposals each panelist reviews
- Reviewer numeric score calibration varies and initial evaluations may be incomplete
  - We can provide a context for calibrating scores by discussing the highest- and lowest-ranked proposals determined by the initial evaluations
  - During and following panel discussions, panelists can revise and update their reviews, scores, and rankings based on additional factual information
- Discussion within a panel can help clarify the understanding of elements within a proposal, and thus sharpen the review narrative
  - Most panel members collaborate on many of the experimental efforts under review, and will be able to participate in the discussion
  - Note: Proposal assignments are anti-correlated with current research efforts

HEP Proposal Review and Award Process

Pre-Review

- **August: Letter of Intent (LOI) received from PI. Program and review planning at DOE/HEP.**
- **September: Proposal received. FOA compliance checks at DOE: PI qualifications, scope, page limits, budget pages, DMP, etc.**

Merit Review

- **Sept-October: Proposals assigned to *at least* three merit reviewers via DOE's Portfolio Analysis and Management System (PAMS);**
- **October-November: Reviewers' input their written evaluations in PAMS.**
- **November: Panel deliberations of proposals and senior investigators. Add any additional reviews and make comparative reviews & evaluations.**

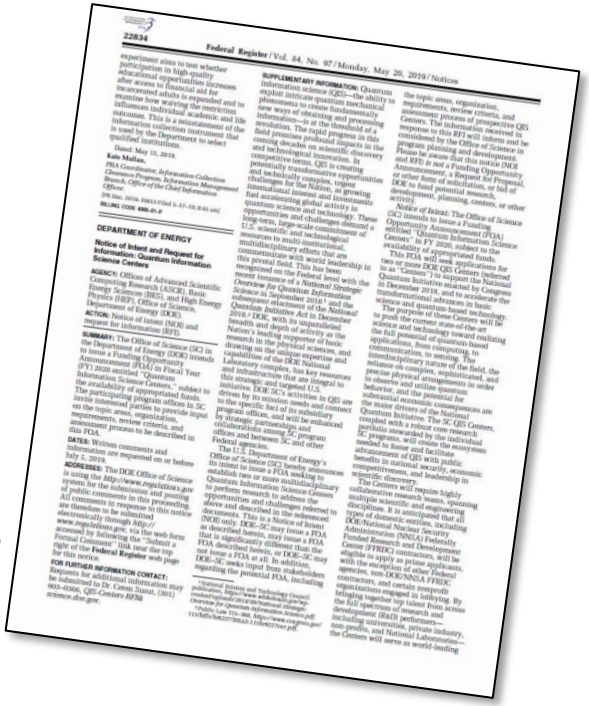
Post-Review and Award

- **December: Assessment of each proposal and each PI by DOE/HEP using merit review, grant monitor input, programmatic priorities, budget constraints.**
- **Early-to-mid January: Prioritized budget guidance sent to PIs and requests for revised budgets and budget justifications using proper DOE forms.**
- **During the Spring: Route proposal's procurement packages through DOE/SC and DOE Chicago Operations Office for approval. Awards processed by the DOE Chicago Operations Office.**

HEP FY 2020 Budget Detail

Quantum Information Science Centers

- 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 December 2018
- May 20, 2019, DOE published a notice in the Federal Register (FR) with two components:
  - A Notice of Intent (NOI) indicating that DOE-SC is considering issuing a Funding Opportunity Announcement in FY2020 for Quantum Information Science Centers
  - A Request For Information (RFI) seeking stakeholder input on the topic areas, organization, requirements, review criteria, and assessment process for prospective QIS Centers
- Comments were due by July 5, 2019
  - Information will inform next steps in considering QIS Centers


22834 Federal Register / Vol. 84, No. 97 / Monday, May 20, 2019 / Notices

DEPARTMENT OF ENERGY

Notice of Intent and Request for Information: Quantum Information Science Centers

AGENCY: Office of Advanced Scientific Computing Research (ASCR), Basic Energy Sciences (BES), and High Energy Physics (HEP), Office of Science, Department of Energy (DOE).

ACTION: Notice of intent (NOI) and request for information (RFI).

SUMMARY: The Office of Science (SC) is the Department of Energy (DOE) intends to issue a Funding Opportunity Announcement (FOA) in Fiscal Year (FY) 2020 entitled "Quantum Information Science Centers," subject to the availability of appropriated funds. The participating program offices in SC invite interested parties to provide input on the topic areas, organization, requirements, review criteria, and assessment process to be described in this FOA.

DATES: Written comments and information are requested on or before July 5, 2019.

ADDRESSES: The DOE Office of Science is using the http://www.regulations.gov system for the submission and posting of public comments in this proceeding. All comments in response to this notice are therefore to be submitted electronically through http://www.regulations.gov via the web form accessed by following the "Submit a Formal Comment" link near the top right of the Federal Register web page for this notice.

FOR FURTHER INFORMATION CONTACT: Requests for additional information may be submitted to Dr. Lenny Susnit, (301) 903-0266, QIS-Centers-RFI@science.doe.gov.

SUPPLEMENTARY INFORMATION: Quantum information science (QIS)—the ability to exploit intrinsic quantum mechanical phenomena to create fundamentally new ways of obtaining and processing information—is at the threshold of a revolution. The rapid progress in this exciting decades-in-the-making area of science and technological innovation, is potentially transformative opportunities and challenges for the Nation, of growing international interest and investments and accelerating global activity in quantum science and technology. These opportunities and challenges demand a U.S. scientific and technological response to multi-institutional, multidisciplinary efforts that are commensurate with world leadership in this pivotal field. This has been recognized on the Federal level with the announcement of a National Strategic Overview for Quantum Information Science in September 2018[1] and the subsequent enactment of the National Quantum Initiative Act in December 2018.[2] DOE, with its unparalleled breadth and depth of activity as the Nation's leading supporter of basic research in the physical sciences, and capabilities of the DOE National Laboratory complex, has key resources and infrastructure that are integral to this strategic and urgent U.S. initiative. DOE SC's activities in QIS are driven by its mission needs and connect to the specific foci of its subsidiary program offices, and will be enhanced by strategic partnerships and collaborations among SC program offices and between SC and other Federal agencies.

The U.S. Department of Energy's Office of Science (SC) hereby announces its intent to issue a FOA and/or to establish two or more multidisciplinary Quantum Information Science Centers to perform research to address the opportunities and challenges referred to above and described in the referenced documents. This is a Notice of Intent (NOI) only. DOE–SC may issue a FOA as described herein, may issue a FOA that is significantly different than the FOA described herein, or DOE–SC may not issue a FOA at all. In addition, DOE–SC seeks input from stakeholders regarding the potential FOA, including the topic areas, organization, requirements, review criteria, and assessment process of prospective QIS Centers. The information received in response to this RFI will inform and be considered by the Office of Science in program planning and development. Please be aware that this notice (NOI and RFI) is not a Funding Opportunity Announcement, a Request for Proposal, or other form of solicitation, or bid of DOE to fund potential research, development, planning, centers, or other activity.

Notice of Intent: The Office of Science (SC) intends to issue a Funding Opportunity Announcement (FOA) entitled "Quantum Information Science Centers" in FY 2020, subject to the availability of appropriated funds.

This FOA will invite applications for two or more DOE QIS Centers (referred to as "Centers") to support the National Quantum Initiative enacted by Congress in December 2018, and to accelerate the transformational advances in basic science and quantum-based technology. The purpose of these Centers will be to push the current state-of-the-art science and technology toward realizing the full potential of quantum-based applications, from computing to communication, to sensing. The interdisciplinary nature of the field, the promise of novel arrangements in order to observe and utilize quantum behavior, and the potential for substantial economic consequences are the major drivers of the National Quantum Initiative. The SC QIS Centers, coupled with a robust core research portfolio supported by the individual SC programs, will create the ecosystem needed to foster and facilitate advancements of QIS with public benefits in national security, economic competitiveness, and leadership in scientific discovery.

The Centers will require highly collaborative research teams, spanning multiple scientific and engineering disciplines. It is anticipated that all types of domestic entities, including DOE/National Nuclear Security Administration (NNSA) Federally Funded Research and Development Center (FFRDC) contractors, will be eligible to apply as prime applicants with the exception of other Federal agencies, non-DOE/NNSA FFRDC contractors, and certain nonprofit organizations engaged in lobbying. By bringing together the talent from across the full spectrum of research and development (R&D) performers—including universities, private industry, non-profits, and National Laboratories—the Centers will serve as world-leading

FY 2020 Funding by Subprogram

- Each subprogram has a different balance of investments in research, operations, and projects

HEP Funding Category ($ in K)	FY 2018 Enacted	FY 2019 Enacted	FY 2020 Request	FY 20 vs. FY 19
Energy Frontier	190,938	238,920	197,599	-41,321
Intensity Frontier	246,768	240,980	193,682	-47,298
Cosmic Frontier	121,246	101,036	57,468	-43,568
Theoretical, Computational and Interdisciplinary Physics	78,156	89,834	94,705	+4,871
Advanced Technology R&D	114,962	113,506	91,707	-21,799
Accelerator Stewardship	15,530	15,724	12,877	-2,847
Construction (Line Item)	140,400	180,000	120,000	-60,000
Total	**908,000**	**980,000**	**768,038**	**-211,962**

FY 2020 House Marks

- DOE Office of Science: **$6.87B**
  - $285M above FY19 enacted and $1.32B above FY20 request
    - Supports Artificial Intelligence (AI)
- High Energy Physics: **$1.045B**
  - [*HEP Core Program*]—Within available funds, the recommendation provides $25,000,000 for the Sanford Underground Research Facility, not less than $50,000,000 for Accelerator R&D, and $97,975,000 for the HL–LHC Upgrade Projects.

    The Committee strongly urges the Department to **maintain a balanced portfolio** of small, medium, and large scale experiments, and to **ensure adequate funding for research** performed at universities and the national laboratories. The Committee encourages the Department to fund facility operations at levels for **optimal operations**.

HEP ($ in K)	FY19 Enacted	FY20 Request	FY20 House Mark	HM vs Request		HM vs FY19 Enacted	
HEP Core Program	800,000	648,038	814,000	165,962	25.6%	14,000	1.8%
Line Item Construction	180,000	120,000	231,000	111,000	92.5%	51,000	28.3%
PIP-II	*20,000*	*20,000*	*60,000*	*40,000*	*200%*	*40,000*	*200%*
LBNF/DUNE	*130,000*	*100,000*	*171,000*	*71,000*	*71.0%*	*41,000*	*31.5%*
Mu2e	*30,000*	*……*	*……*	*……*	*……*	*-30,000*	*-100.0%*
Total	**980,000**	**768,038**	**1,045,000**	**276,962**	**36.1%**	**65,000**	**6.6%**

HEP MIE Project Status

Subprogram	TPC ($M)	CD Status	CD Date
INTENSITY FRONTIER			
Long Baseline Neutrino Facility / Deep Underground Neutrino Experiment (LBNF/DUNE)	1,300 – 1,900	CD-3A	September 1, 2016
Proton Improvement Project (PIP-II)	653 – 928	CD-1	July 23, 2018
Muon g-2	46.4	CD-4	January 16, 2018
Muon-to-Electron Conversion Experiment (Mu2e)	273.7	CD-3	July 14, 2016
ENERGY FRONTIER			
LHC ATLAS Detector Upgrade	33	CD-3	November 12, 2014
LHC CMS Detector Upgrade	33	CD-4A	September 19, 2017
High-Luminosity LHC (HL-LHC) Accelerator Upgrade	208 – 252	CD-1/3A	October 13, 2017
High-Luminosity LHC (HL-LHC) ATLAS Detector Upgrade	125-155	CD-0	April 13, 2016
High-Luminosity LHC (HL-LHC) CMS Detector Upgrade	125-155	CD-0	April 13, 2016
COSMIC FRONTIER			
LUX-ZEPLIN (LZ)	55.5	CD-3	February 9, 2017
Super Cryogenic Dark Matter Search - SNOLAB (SuperCDMS-SNOLAB)	18.6	CD-2/3	May 2, 2018
Dark Energy Spectroscopic Instrument (DESI)	56.3	CD-3	June 22, 2016
Large Synoptic Survey Telescope Camera (LSSTcam)	168	CD-3	August 27, 2015
ADVANCED TECHNOLOGY R&D			
Facility for Advanced Accelerator Experimental Tests II (FACET-II)	25.6	CD-2/3	June 8, 2018