



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

# Status of the DOE High Energy Physics Program

*HEPAP Meeting  
March 13, 2017*

**Jim Siegrist**  
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Office of Science, U.S. Department of Energy

# Status of the Department of Energy

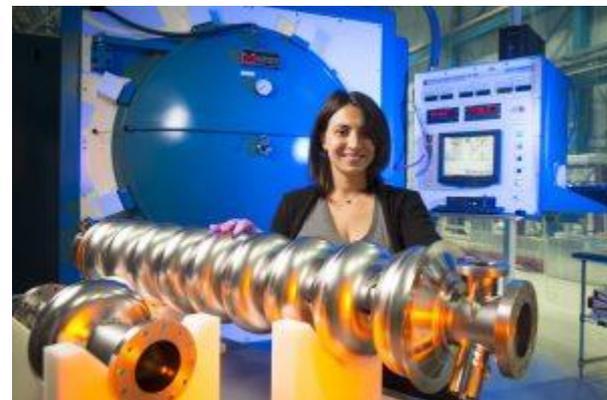
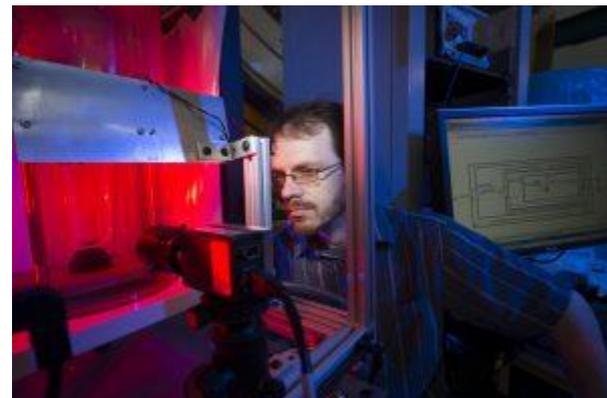
- Rick Perry was sworn in on March 2, 2017, as the 14<sup>th</sup> Secretary of the United States Department of Energy
  - From Secretary Perry’s welcome address: *“I have a long record of aggressively courting leading scientific minds to set forth innovation, solutions, and job creation strategies. Our scientists and labs are the envy of the world, and I am a major proponent of maintaining American leadership in the area of scientific inquiry.”*
- **21 DOE positions requiring Senate confirmation remain to be filled, including:**
  - Under Secretary for Science and Energy
  - Director of the Office of Science



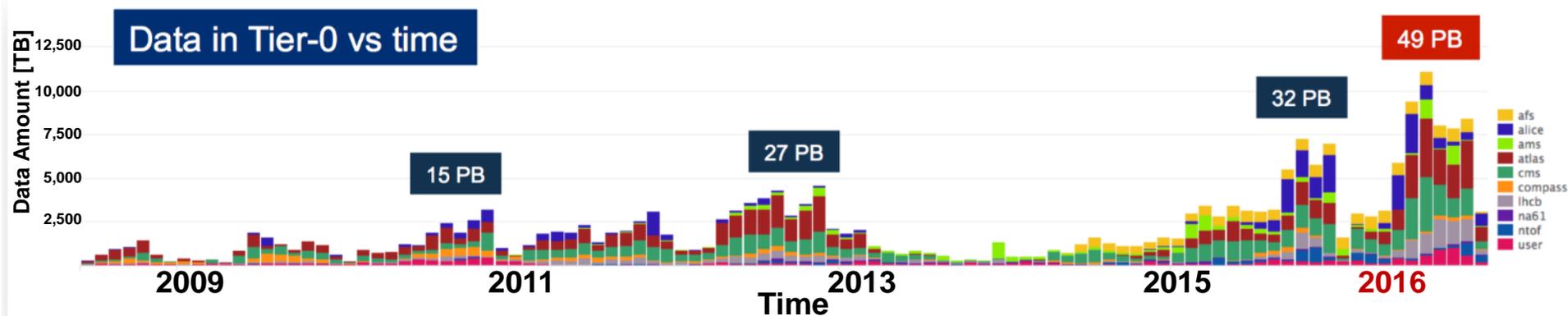
# Presidential Early Career Awards for Scientists and Engineers

Two HEP scientists recognized with highest honor bestowed by the United States Government on science and engineering professionals in the early stages of their independent research careers

- **Eric Dahl (Northwestern U./Fermilab)**
  - For commitment to answering fundamental science questions and a recognition that building better dark matter detectors could be transformative for discovery
- **Anna Grassellino (Fermilab)**
  - For developing particle accelerator cavities that have improved performance and are less expensive to operate
  - Anna is also recipient of the 2017 Frank Sacherer Prize for her significant, original contributions to the accelerator field



# Energy Frontier: U.S. LHC Operations Review



- **January 2017 U.S. LHC Operations Program review at UC Irvine went well for both experiments**
  - U.S. ATLAS and U.S. CMS were commended for excellent records of successfully meeting the operational needs of the international collaborations
  - Both experiments presented plans to address immediate computing resource needs as a result of the excellent LHC performance in 2016 (Run 2)
    - DOE is coordinating efforts to help address some of these needs for FY 2017
  - Reviewers further commented that the collaborations should continue coordinating with agencies to assess how the HL-LHC upgrades could impact the future requirements for operations, including software and computing
    - Aim to develop a plan that quantifies future requirements



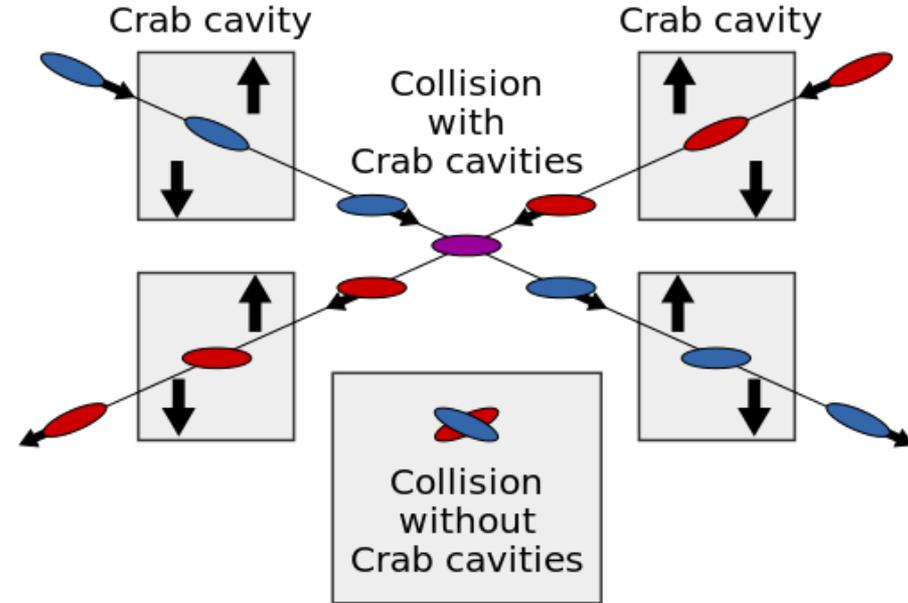
# Energy Frontier: Upgrade Projects

- **U.S. ATLAS and CMS Phase 1 upgrade projects are proceeding well**
  - U.S. CMS Phase 1 upgrade of the Forward Pixels was delivered to CERN in December 2016
  - CMS Pixel Tracker upgrade installation and commissioning proceeding well during the current year-end technical stop
- **Working on addenda to the 2015 U.S.-CERN LHC Accelerator and Experiments Protocols that will define overall scope and DOE contributions to the HL-LHC accelerator and ATLAS and CMS detector upgrades**
- **HL-LHC accelerator and detector upgrade projects working towards CD-1 in 2017**
  - Coordinating plans with NSF



# Status of LARP Crab Cavities Effort for HL-LHC

- R&D is moving forward on the Crab Cavities that are part of the current plan for the High Luminosity LHC (HL-LHC) accelerator upgrade
  - Require compact SRF cavities
  - Twist proton bunches at interaction point to collide head-on
  - Level the luminosity and tune the collision pile-up density distribution
- LHC Accelerator Research Program (LARP) spearheaded the design and initial development of the concept for the HL-LHC
- First two prototypes built by LARP with Small Business Innovation Research (SBIR) support in 2014 to 2017 were recently tested
  - Exceed the current plan for HL-LHC operational requirements



*Double Quarter Wave (DQW)  
ready for final assembly at JLAB*

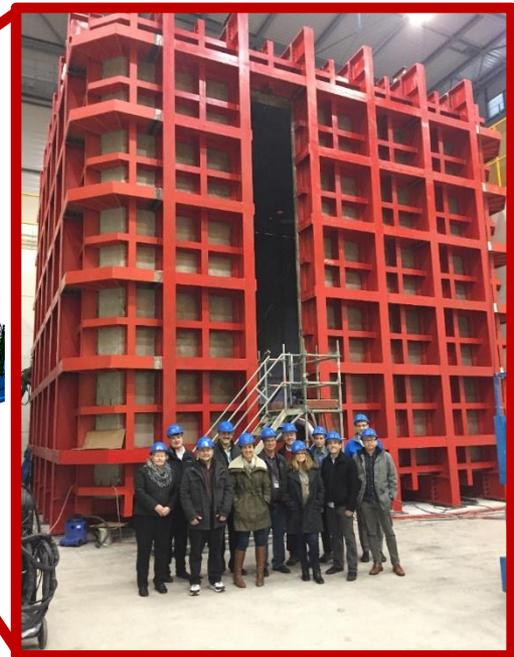
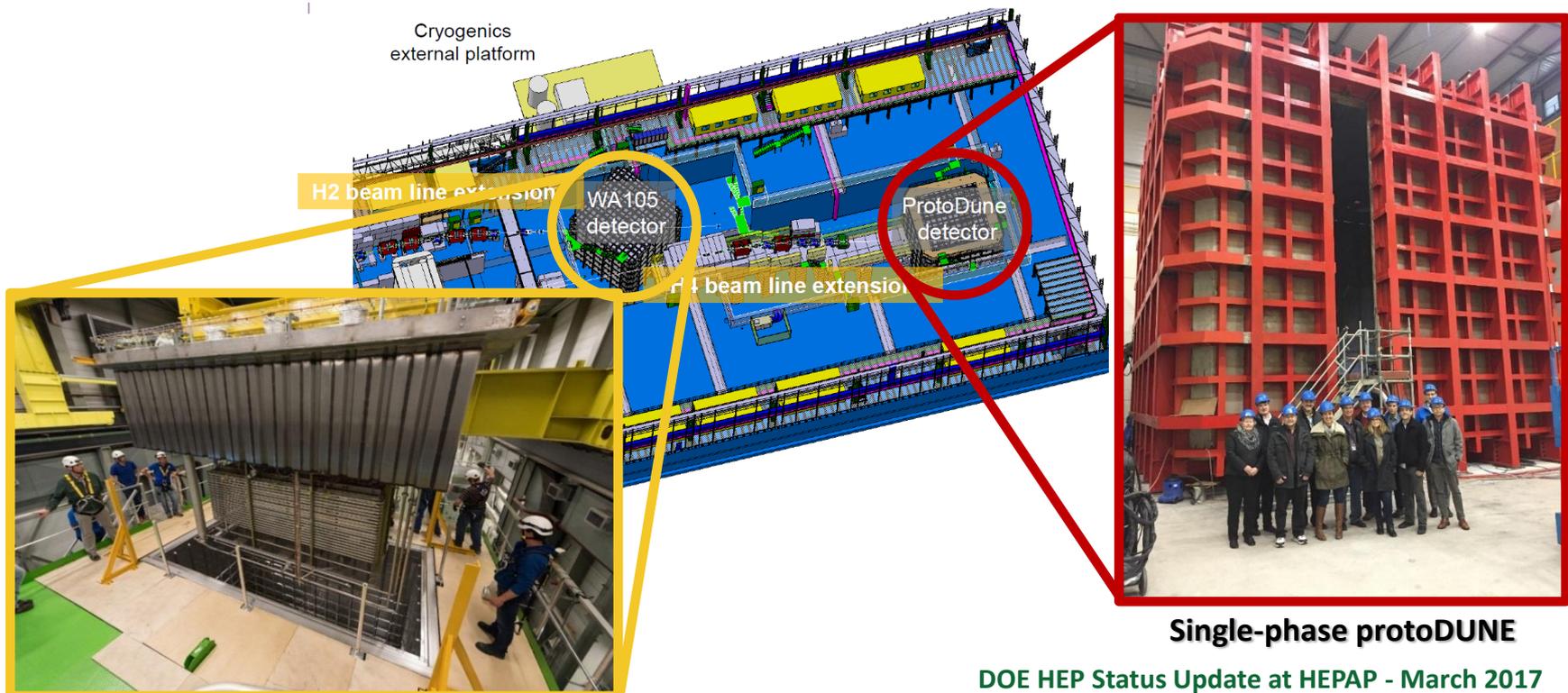


*RF Dipole (RFD)  
chemical processing*



# Intensity Frontier: CERN Neutrino Platform and protoDUNEs

- Continuing to advance LBNF/DUNE, working with international partners to move forward
  - International DUNE collaboration continues to grow, with over 950 collaborators from 31 countries
  - 3<sup>rd</sup> session of the International Neutrino Council, chaired by DOE, will be held March 30-31, 2017
- CERN Neutrino Platform will support the international neutrino community
  - Will include 2 test beams, 2 cryostats for testing of full-scale DUNE prototypes (protoDUNE) using single- and double-phase LAr technology
  - protoDUNE planned to be ready for test beam by autumn 2018
- Negotiating addenda to the 2015 U.S.-CERN Neutrino Protocol that will define overall scope and CERN contributions to the CERN Neutrino Platform towards the U.S.-hosted program

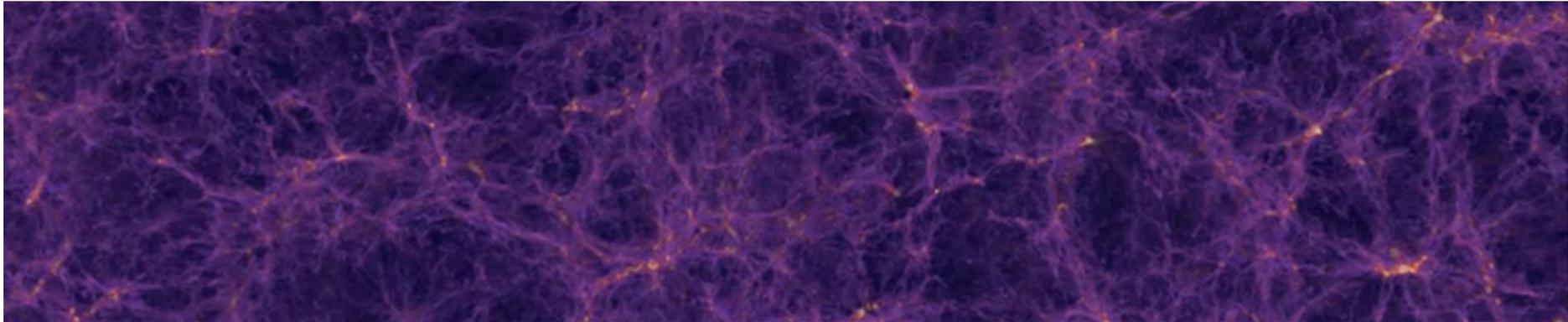


Single-phase protoDUNE

Dual-phase Demonstrator Cryostat Insertion

# Cosmic/Intensity Frontier: New Ideas in Dark Matter

- HEP is interested in identifying new, small projects for dark matter searches in areas of parameter space (*i.e.* mass ranges or types of particles) not currently being explored
  - Asking for community input to identify the most compelling science opportunities
- U.S. Cosmic Visions: New Ideas in Dark Matter Workshop
  - Will be held at U. Maryland, College Park, March 23-25, 2017
- Depending on outcomes, DOE will consider possibilities for small dark matter experiments in unexplored parameter space



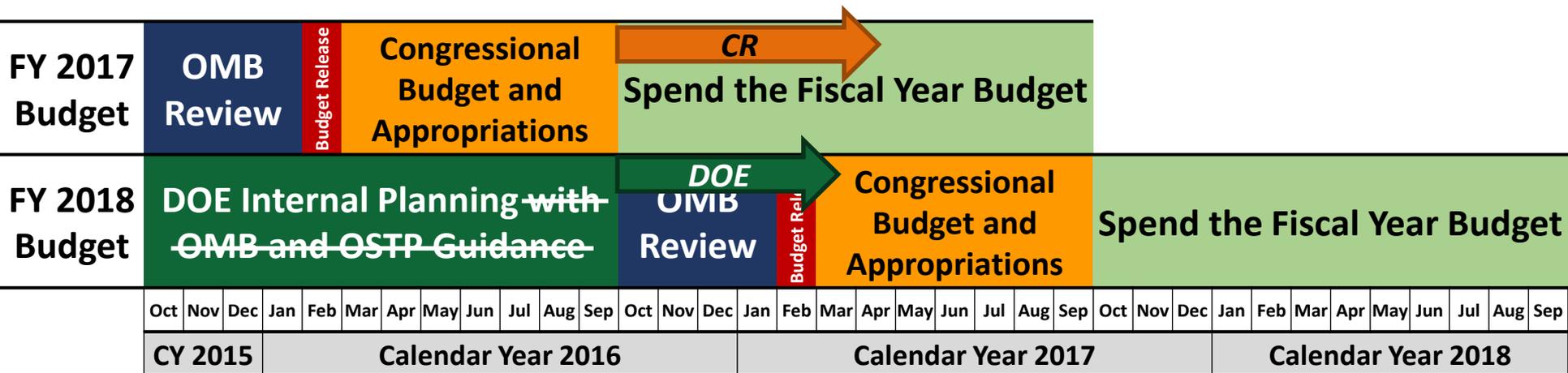
# Adv. Tech. R&D: RF Research Roadmap Workshop

- Following the release of the HEPAP Accelerator R&D Subpanel Report in April 2015, the General Accelerator R&D (GARD) Program has engaged its research community to address the Subpanel recommendations to develop research roadmaps for:
  - Superconducting High Field Magnet Thrust
  - Advanced Accelerator Concepts Thrust
- 2017 GARD RF Research Roadmap Workshop was held March 8-9, 2017
  - Goal to develop a 10-year comprehensive research roadmap with appropriate milestones and metrics for the medium- and long-term GARD RF Acceleration Technology Thrust, unifying the following research technology development areas:
    - Superconducting RF
    - Normal Conducting RF
    - RF Sources
  - Roadmap should include:
    - Pressing challenges to be addressed to move the field forward, toward more affordable collider and other applications
    - Prioritized milestones aligned to the most compelling research



# Status of the Budget Process

- An FY 2017 Continuing Resolution (CR) in effect through April 28, 2017
  - Equivalent to \$793M level of funding for HEP, if extrapolated to a full FY
- A “skinny budget” for FY 2018 is expected in the near future
  - First look, in broad strokes, at Administration’s priorities for FY 2018
  - Full budget request anticipated later in spring
- The final FY 2017 budget may be adjusted to reflect the priorities in the President’s FY 2018 budget request



↑ You are here



# Status of HEP Comparative Review Process

- **The Situation:**
  - Since we are in a CR through April 28, 2017, we have about half of the FY 2017 HEP budget available
  - DOE procurement requires that we have funding allocated before awards (grants) can be made final
  - We do not have sufficient funds to award many HEP grants by their nominal April 1, 2017, starting date
- **Impact on Continuing grants (going into  $\geq$  Year 2 of award):**
  - Progress reports were due in early January 2017
  - If progress was satisfactory, award will be continued at or near planned funding level, but may come later than April 1, 2017
    - Almost all Continuation actions have been sent to Chicago for award
    - Over 30 have been awarded already
- **Impact on New/Renewing grants:**
  - An initial round of recommendations for awards has gone out...
    - Some PIs were contacted to submit revised budgets based on these recommendations
    - Some PIs were contacted regarding declinations, based on merit reviews and programmatic priorities
  - ...but PIs for remaining proposals (~20) may not be contacted regarding recommendation or declination until we have further guidance on FY17 budget
    - Mitigations may be possible (e.g., no cost extension) in case of difficulties



# HEP Laboratory Optimization

- **HEP is working with the laboratories to improve the long-term sustainability and optimization of the HEP program**
  - Exercise looks ahead 7 years, attempting to account for:
    - Expected modest growth of Research funding
    - Expected costs of Operations
    - Expected participation in Projects
- **Process is ongoing and has not yet reached an outcome, but progress is being made**
  - Some marginal or low priority efforts have been curtailed
  - Laboratory leadership are discussing the HEP program across laboratory boundaries, exploring:
    - Unique capabilities brought by each laboratory to HEP mission
    - Best way to leverage unique capabilities in future program
    - Prioritization of where to invest resources to maintain a healthy, sustainable program in the long term
  - Laboratories have now provided lists of their capabilities, which have been rated through self-evaluation, by stakeholders, and by HEP
    - This information will inform the next steps of the process



# The Future of U.S. Particle Physics

- **DOE HEP continues the implementation of the 2014 P5 global vision for particle physics**
  - Strong community support has been crucial to the successful implementation of the P5 strategy so far
  - Continued community support is necessary to maintain our momentum with the U.S. Administration and Congress
- **At an appropriate point, the strategy for U.S. particle physics will need to be reevaluated and updated**
  - Discoveries and results from upcoming experiments will impact the strategy for future investments
    - Next strategy should be informed by results from the 13-14 TeV run of the LHC, second generation dark matter experiments, precision muon experiments, and short- and long-baseline neutrino experiments
  - Further advance current R&D and planning activities conducted towards future projects (*e.g.*, high-field magnets, SRF cavities, CMB-Stage IV, and third generation dark matter)
  - Updated strategy for the future of particle physics should be available in time to guide next round of major investments
    - Guidance should be available as the current round of projects are being completed and the field seeks to make new investments
    - Updated strategy should incorporate results from current, ongoing studies of future collider initiatives by the international community



# Considerations for Updating U.S. Strategy

- **P5 report is making a significant impact in budget formulation & appropriation**
  - Some large, high-priority projects have not yet reached important milestones in the DOE Critical Decision or appropriations process
  - Current plan saturates DOE HEP project funding until ~FY 2024
  - FY17 House (\$823M) and Senate (\$833M) marks above President's Request (\$818M)
  - P5 called out in House bill "DOE Research and Innovation Act" (Jan 24, 2017; *next slide...*)
- **DOE is coordinating plans for the HL-LHC accelerator and ATLAS and CMS detector upgrades with our partners, including NSF for the detector upgrades**
  - DOE baseline (CD-2) anticipated for HL-LHC projects within 2018-2019
  - Request of construction start anticipated in FY 2020 at the earliest
- **Global vision of current P5 report is central to ongoing discussion with international partners**
  - Core part of building upon new bilateral U.S.-CERN agreement
  - International partnerships are still growing for LBNF/DUNE
- **Transition to new administration adds uncertainty to timeline**
  - Must share P5 vision with new elements of management before plan can continue to move forward
  - Launching too early an update of the P5 strategy would confound decision makers
- **Beginning the next planning process too early would risk undermining ongoing efforts to implement the strategy of the P5 report**
  - **Must avoid "decisional paralysis" until after the HL-LHC projects and LBNF/DUNE are baselined, resulting in strategy studies taking place in the 2020-2021 time frame**

# Department of Energy Research and Innovation Act

- Passed by the U.S. House of Representatives under unanimous consent (voice vote) on **January 24, 2017**
- **SEC. 305. HIGH-ENERGY PHYSICS.**
  - (a) **Sense Of Congress.**—It is the sense of Congress that—
    - (1) the Director should incorporate the findings and recommendations of the report of the **Particle Physics Project Prioritization Panel entitled “Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context”** into the planning process of the Department; and
    - (2) the **nations that lead in particle physics** by hosting international teams dedicated to a common scientific goal attract the world’s best talent and inspire future generations of physicists and technologists.
  - (b) **International Collaboration.**—The Director, as practicable and in coordination with other appropriate Federal agencies as necessary, shall ensure the access of United States researchers to the most advanced accelerator facilities and research capabilities in the world, including the **Large Hadron Collider**.
  - (c) **Neutrino Research.**—The Director shall carry out research activities on rare decay processes and the nature of the neutrino, which may include collaborations with the National Science Foundation or international collaborations.
  - (d) **Dark Energy And Dark Matter Research.**—The Director shall carry out research activities on the nature of dark energy and dark matter, which may include collaborations with the National Aeronautics and Space Administration or the National Science Foundation; or international collaborations.



# 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
- From a DOE perspective, the appropriate timeline is:
  - 2018: Anticipated Japanese decision on ILC
  - 2018-20: New NAS Astronomy and Astrophysics Decadal Survey
  - 2019: Start of European Strategy for Particle Physics process
  - 2020: Release of updated European Strategy for Particle Physics
  - 2020: Begin process to update the 2013 “Snowmass” report
  - 2022: Release new P5 strategy report in time to inform FY 2024 budget
- U.S. community encouraged to work with international collaborators in developing other regional plans with a global vision for particle physics



# P5 Construction and Physics Timeline



- Legend:**
- *Approximate Construction* (Blue)
  - *Expected Physics* (Green)
  - *LBNF/DUNE physics under "Scenario B+"* (Red)

**New P5 Report Release (2022)**

**Budget Impact of new P5 Report (FY 2024)**

# DOE Perspective on P5 Strategy Update

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- **Most important factors to DOE in timing of P5 strategy update:**
  - **Main audience in the U.S. for the strategy report**
    - DOE Management
    - White House Office of Management and Budget
    - U.S. Congress
    - Particle Physics Community
  - **Must baseline major projects of current report before update**
    - Avoids “decisional paralysis” of main audience
  - **Funding window for new projects opens in FY 2024**
    - Set by planning for successful implementation of current strategy
- **Although coordination with other global efforts is important, above factors create major planning and execution concerns**
  - U.S. community is welcome to participate in other global planning efforts

# Community Material

- Community groups, including Users Organizations and the APS DPF, developed new material to help U.S. particle physicists explain their research to new audiences
  - **“Particle Physics is Discovery Science”** provides a starting point: the “big questions,” some of the benefits, and introduces the P5 science drivers
  - **“Particle Physics Makes a Difference in Your Life”** describes the broad benefits of particle physics, including its connections to other sciences and industry and its impact on daily life
- Steve Ritz worked with the community groups to update the **“Recent Advances and Top Priorities”** document that aims to maintain the visibility of the P5 report and present the status of the implementation of its strategy
- New material will be available soon at:  
<http://www.usparticlephysics.org/>
  - U.S. particle physicists should make use of these community materials as part of their public interactions



**U.S. Particle Physics: Building for Discovery**

U.S. Particle Physics Strategy      Education and Outreach Site

Particle physics is a dynamic, successful, and global field. The U.S. particle physics community has come together to develop a clear vision for the future. These carefully chosen investments will enable discovery and maintain U.S. leadership in key areas.

**The Science Drivers**

Five intertwined Science Drivers provide compelling lines of inquiry that show great promise for discovery.



**Building for Discovery**

The P5 Report provides the strategy and priorities for investments in particle physics for the coming decade.

**The top four priorities in 2017**

Advance the High Luminosity LHC (HL-LHC) upgrade and increase the number of collisions per bunch crossing. Upgrade the LHC injection chain and the LHC main ring. Upgrade the LHC main ring to 13 TeV. Upgrade the LHC main ring to 14 TeV.

Support the existing and planned neutrino experiments. Upgrade the neutrino detector infrastructure. Upgrade the neutrino detector infrastructure. Upgrade the neutrino detector infrastructure.

Advance the Long-Baseline Neutrino Facility (LBNF) and Deep Underground Neutrino Experiment (DUNE) program. Upgrade the LBNF infrastructure. Upgrade the DUNE infrastructure. Upgrade the LBNF and DUNE infrastructure.

Support the existing and planned particle physics experiments. Upgrade the particle physics detector infrastructure. Upgrade the particle physics detector infrastructure. Upgrade the particle physics detector infrastructure.

Advance the Compact Linear Collider (CLIC) program. Upgrade the CLIC infrastructure. Upgrade the CLIC infrastructure. Upgrade the CLIC infrastructure.

These candidate science investments will ensure a steady stream of discovery for many years to come and will maintain U.S. leadership in the field.

**Particle Physics Makes a Difference in Your Life**

Global science, local impact. Particle physics research has led to the development of the World Wide Web, the medical imaging techniques of PET and MRI, and the development of the microchip. Particle physics research has also led to the development of the Global Positioning System (GPS) and the development of the Large Hadron Collider (LHC).

**Particle Physics is Discovery Science**

Exploring the Universe. Particle physics is the study of the smallest building blocks of matter and the forces that govern their interactions. It is the study of the fundamental laws of nature and the search for a unified theory of physics.





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# FY 2017 HEP Budget Strategy

- The FY 2017 HEP budget request reflects the way that implementing the P5 strategy has evolved as the U.S. and international community has adopted and responded to it
  - LHC (including the initial Phase 1 and HL-LHC upgrades) remains the highest-priority large project in the near-term
  - LBNF/DUNE, the highest-priority large project in its time frame, has been reconfigured and is gaining international support much more rapidly than anticipated in the P5 strategy
  - U.S. Administration and Congress strongly support establishing LBNF/DUNE as the first U.S.-hosted international science facility
- This presents an opportunity to advance the P5 strategy on a shorter time scale through additional funding: “Scenario B+”
  - HL-LHC accelerator and detector upgrades per CERN schedule
  - Support all other projects in P5’s Scenario B
  - Maintain balance between Research, Operations, and Projects
  - Additional funding *beyond* the above priorities would support accelerating the implementation of LBNF/DUNE



# 2014 P5 Formulation: U.S. HEP Budget Scenarios

- 2014 P5 was charged to consider three 10-year budget scenarios for HEP within the context of a 20-year vision for the global field
  - Scenario A was the lowest constrained budget scenario
  - Scenario B was a slightly higher constrained budget scenario
  - Scenario C was “unconstrained,” but not considered unlimited

