U.S. DEPARTMENT OF ENERGY | Office of Science

# High Energy Physics Program Status and Funding Opportunities


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# The 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***

# International Partnerships

***Successful partnerships key to implementing U.S. long-term strategy***

***New Bilateral U.S.-CERN Agreement – May 7, 2015***

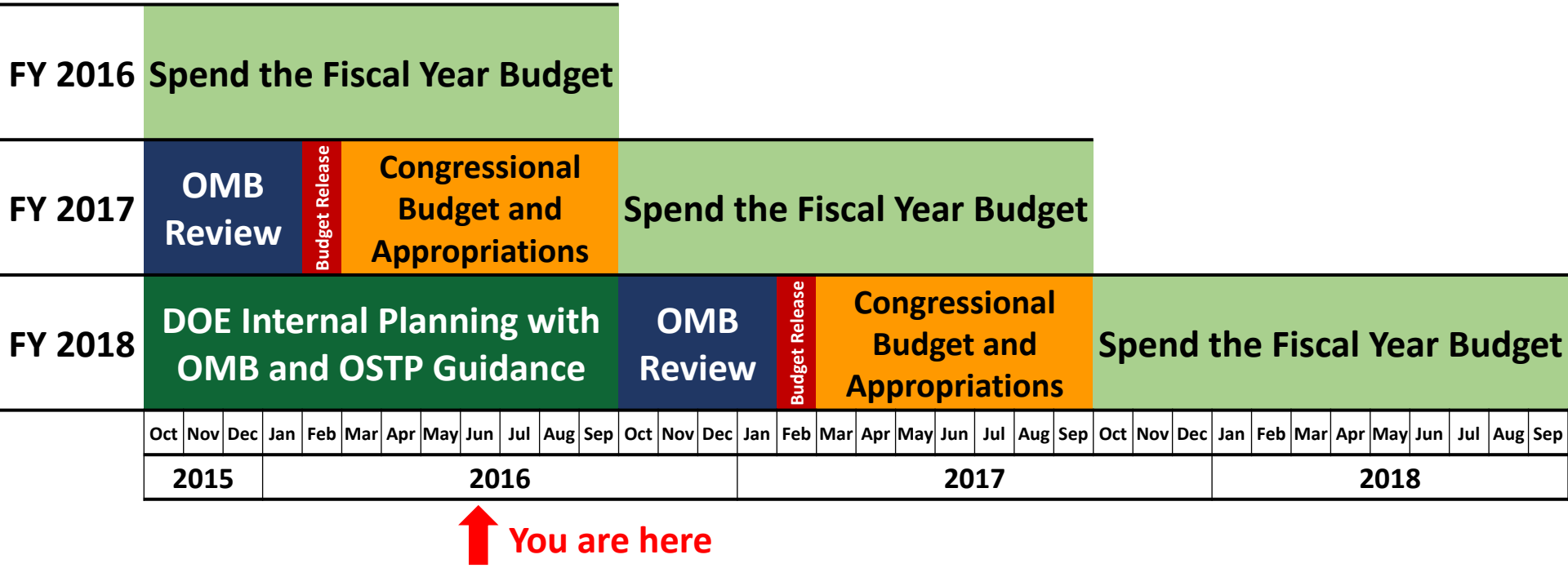
***DOE-Italy Agreement on High Energy, Astroparticle and Nuclear Physics Research – July 17, 2015***

***DOE-MEXT Project Arrangement – Oct. 6, 2015***

# HEP FY 2017 BUDGET

# The Federal Budget Cycle

- **Typically, three budgets are being worked on at any given time**
  - Executing current Fiscal Year (FY)
  - White House Office of Management and Budget (OMB) review and Congressional Appropriation for coming FY
  - Agency internal planning for the second FY from now



# Budget and Appropriations Process

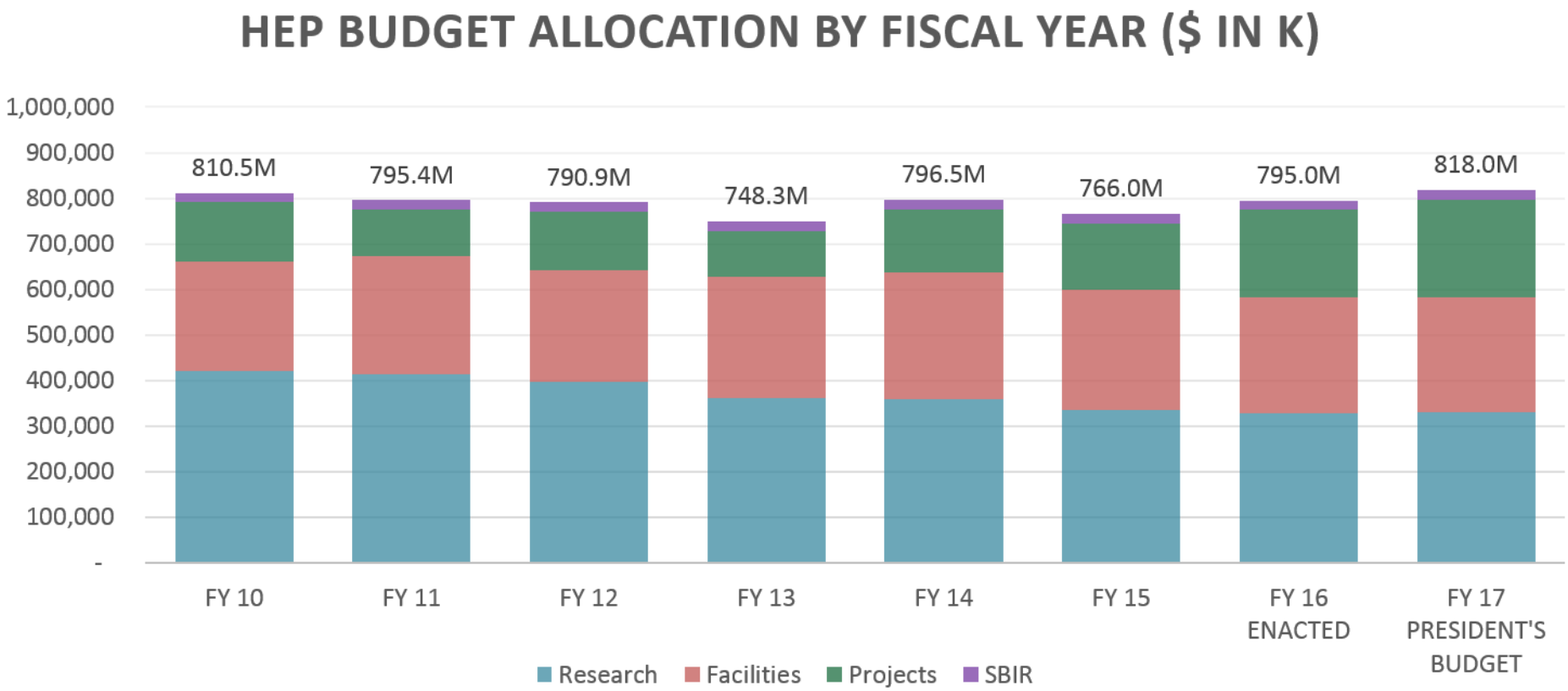
- Many factors are involved in generating the President's Budget Request
  - Bottom-up factors include:
    - Agency management and staff
    - Strategic plans
    - Advisory Panel input
    - Review committee reports
    - Community workshop reports
  - Top-down factors include
    - White House priorities/OSTP policy guidance
    - OMB directives
- President suggests, but Congress "holds the purse"
  - Congressional budget process is itself complex
    - Budget resolution, reconciliation, sequestration, authorization, appropriation…
  - Agencies usually invited to brief Congress on their budget request
  - Agencies can respond to Congressional requests for information about the impact possible funding decisions would have on a program

# Appropriators Noticed the P5 Report

- **FY 2014 House Energy and Water Development Appropriations Report:**
  - **"the Committee supports the Office of Science's challenge to the High Energy Physics community to identify an LBNE construction approach that avoids large out-year funding spikes or to identify viable alternatives with similar scientific benefits at significantly lower cost."**
- **FY 2015 House Energy and Water Development Appropriations Report:**
  - **"The Committee notes that the high energy physics research community is currently engaged in developing a ten-year plan for U.S. particle physics, which will include a ten-year report by the Particle Physics Project Prioritization Panel under various budget scenarios. The Committee applauds the Department for this undertaking . . ."**
- **FY 2016 House Energy and Water Development Appropriations Report:**
  - **"The Committee strongly supports the Department's efforts to advance the recommendations of the Particle Physics Prioritization Panel and urges the Department to maintain a careful balance among competing priorities and among small, medium, and large scale projects."**

# Overall HEP Budget Trend

- **Note significant dips in FY13 (sequestration, "restored" in FY14) and FY15 (Request developed pre-P5)**



# FY 2017 HEP Funding by Activity

| HEP Funding Category ($ in K) | FY 2015 Final | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| Research | 334,225 | 327,389 | 331,123 | Sustain support for research program |
| Facilities | 264,634 | 254,979 | 252,037 | Overall operations support reductions due to scheduled completion of projects |
| Projects | 99,373 | 107,620 | 108,516 | ***Other Project Costs (OPC) includes CDR, project-specific R&D, prototyping and testing, installation and commissioning/pre-operations before CD-4*** |
| *Energy Frontier Projects* | *15,000* | *19,000* | *18,967* | *Initial ATLAS/CMS upgrades complete in FY17; OPC* begins for HL-LHC detector upgrades* |
| *Intensity Frontier Projects* | *48,170* | *17,685* | *9,349* | *Reduction from ramp down of g-2 & end of LBNF/DUNE OPC*; SBN Program increases* |
| *Cosmic Frontier Projects* | *45,203* | *66,835* | *70,200* | *Planned ramp up supports fabrication of LSSTcam, DESI, SuperCDMS-SNOLab, LZ* |
| *Other Projects* | *1,000* | *4,100* | *10,000* | *Increase to support the FACET-II project* |
| Construction (Line Item) | 37,000 | 84,115 | 103,741 | Request engineering design, site preparation and long-lead procurement for the LBNF/DUNE; planned profile for Mu2e |
| SBIR/STTR | 20,768* | 20,897 | 22,580 | |
| **Total** | **766,000*** | **795,000** | **817,997** | ***House mark $823M; Senate mark $833M*** |

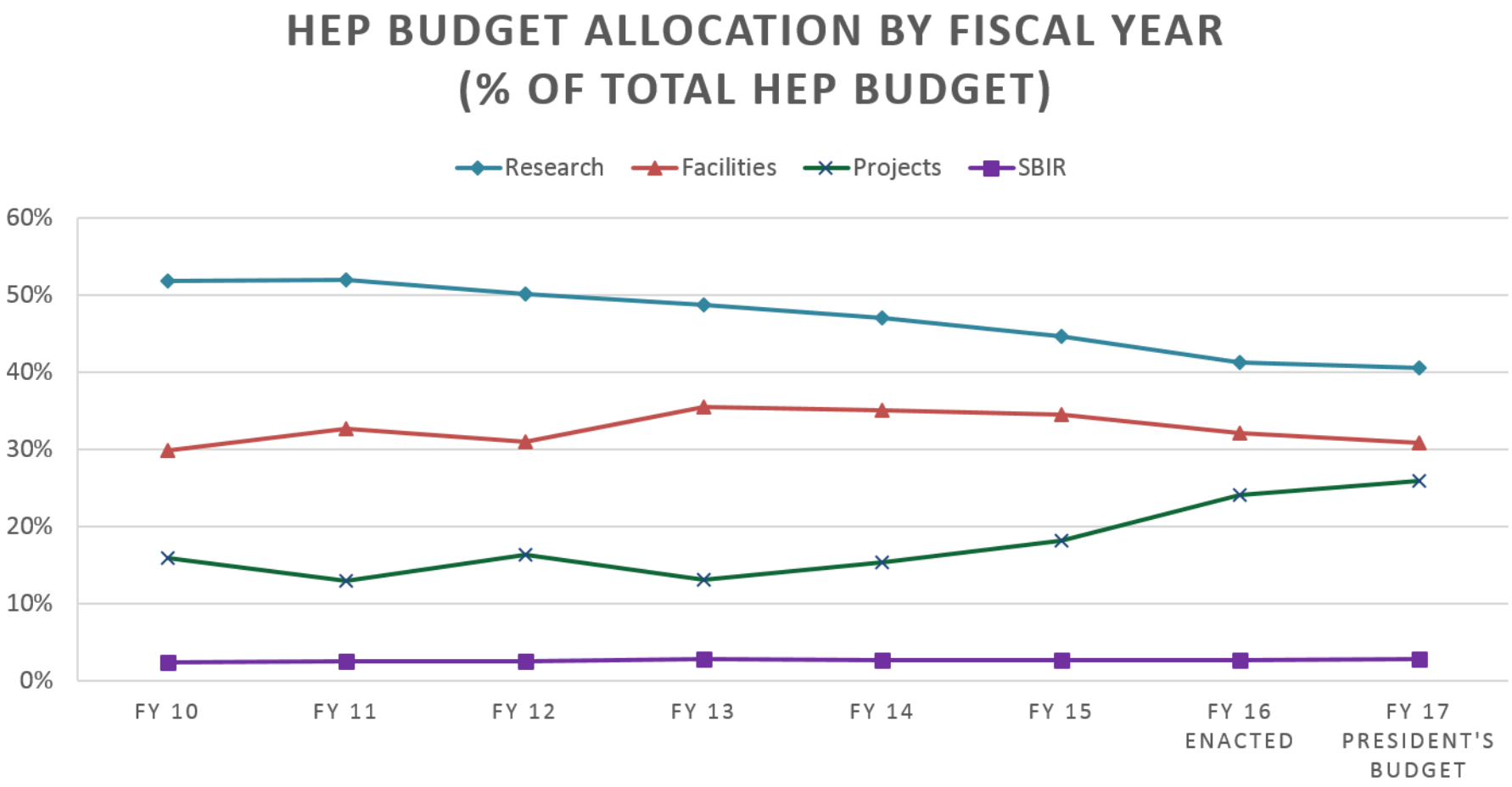
**** SBIR/STTR added to FY 2015 for comparison to FY 2016/2017***

# FY 2017 HEP Budget Strategy

- The FY 2017 HEP budget reflects the way that implementing the P5 strategy has evolved as the U.S. and international community has adopted and responded to it
  - LHC (incl. upgrades) is still the highest near-term HEP priority
  - LBNF/DUNE has been reconfigured and is gaining international support much more rapidly than anticipated in the P5 strategy
  - 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

# HEP Budget Trend by Category

- **Trading Research (R&D) for Project investments**

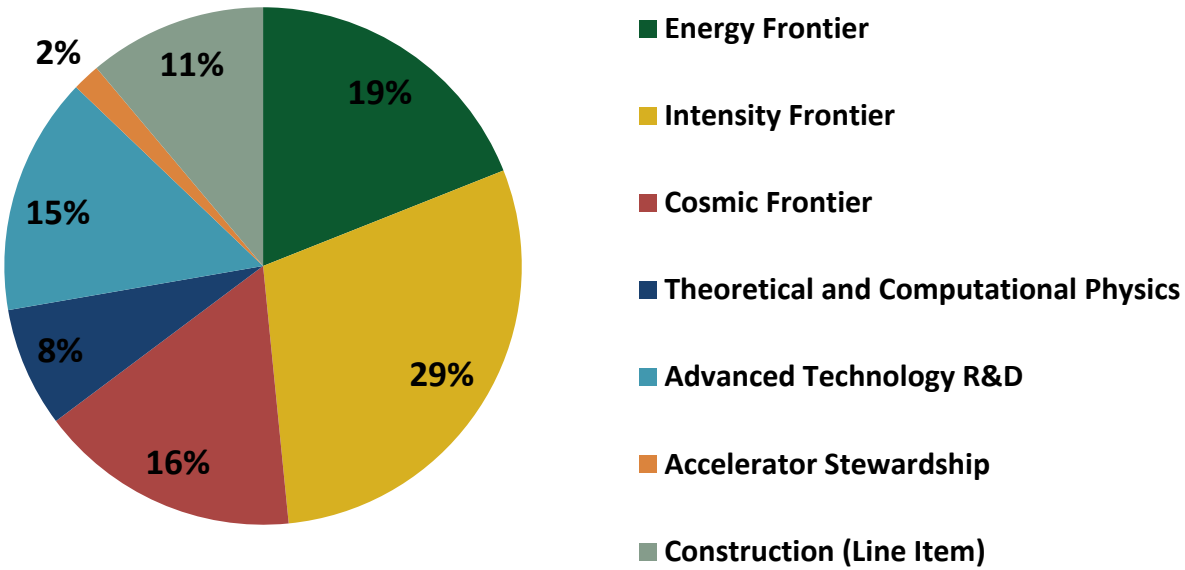


# HEP FY 2017 Budget Overview

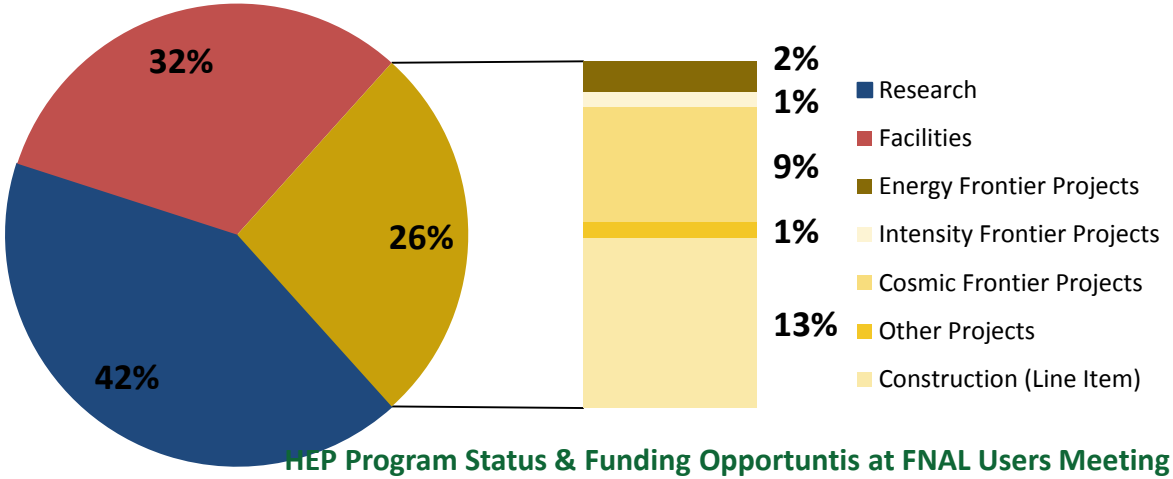
- **Energy Frontier: Continue to support leadership roles in highly successful LHC program**
  - Initial LHC detector upgrade project funding completes in FY 2017
  - Scope being determined for High Luminosity (HL)-LHC; CD-0 April 2016
  - The U.S. will continue to play a leadership role in LHC discoveries by remaining actively engaged in LHC data analysis
- **Intensity Frontier: Solidify international partnerships for U.S.-hosted LBNF/DUNE**
  - Rapid progress on LBNF/DUNE has attracted attention from interested international partners and FY 2017 investments in site preparation and cavern excavation aim to solidify international partnerships
  - Fermilab will continue improvements to accelerator complex while serving high-intensity neutrino beams to short-and long-baseline experiments, enabling full utilization of the FNAL facilities
- **Cosmic Frontier: Advance our understanding of dark matter and dark energy**
  - Fabrication funding ramp-up in FY 17 supports key P5 recommended Cosmic Frontier projects: LSSTcam, DESI, SuperCDMS-SNOLab, LZ

# FY 2017 HEP Budget Request Overview

## FY 2017 HEP Request by Subprogram



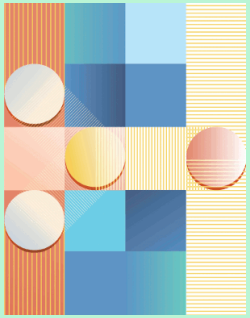

## FY 2017 HEP Request by Activity



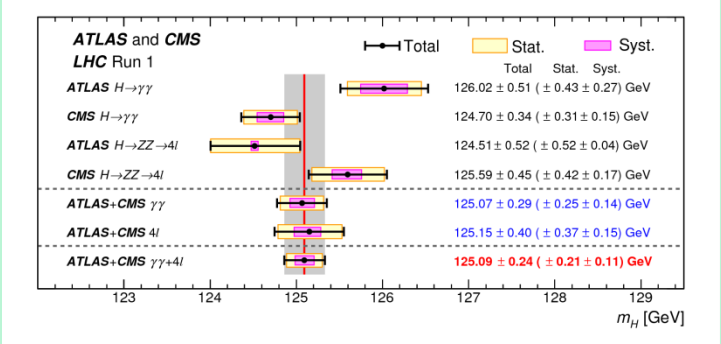
# DOE HEP PROGRAM STATUS

# Addressing Compelling Questions in HEP

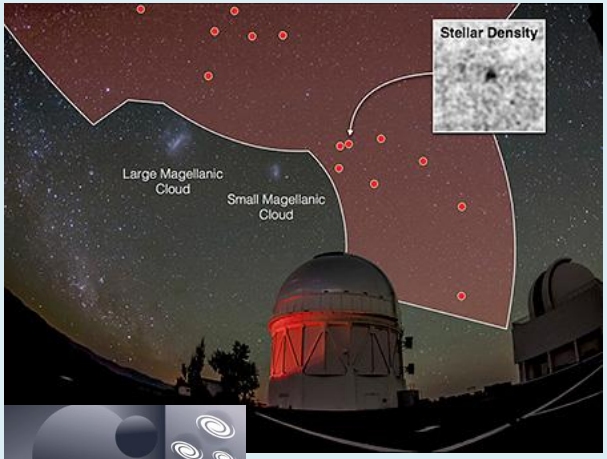
## Science Highlights from the Past Year

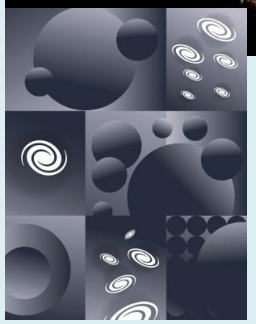


Higgs boson



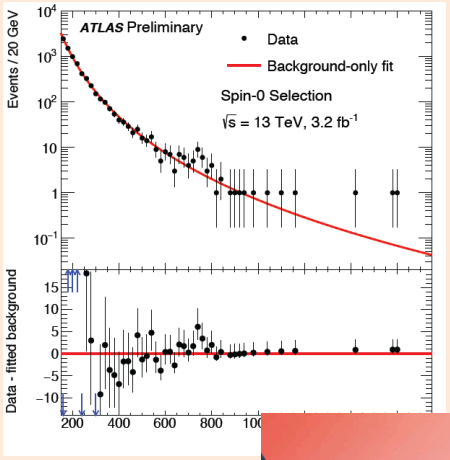

**ATLAS and CMS Higgs boson mass combination (0.19% precision!):**
**$m_H$ = 125.09 ± 0.21 (stat.) ± 0.11 (syst.) GeV**



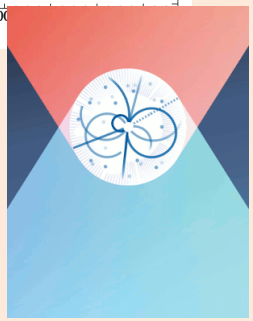



**DES discovered 17 dwarf galaxy candidates during 2015, providing excellent laboratories to study properties of dark matter**

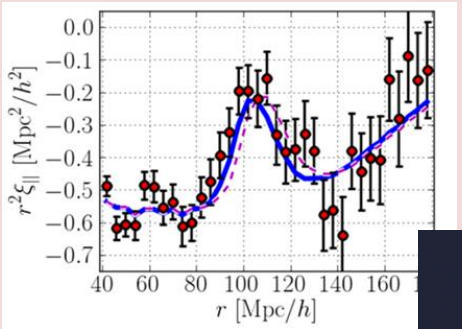
Dark matter



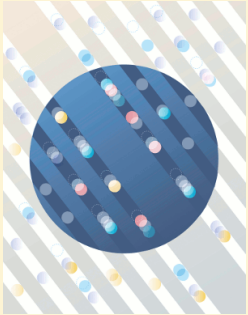

**ATLAS and CMS beyond the Standard Model searches show a slight excess at 750 GeV in two photon events**



Explore the Unknown



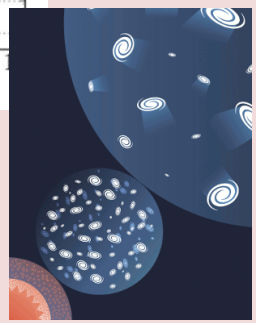

**NOvA results using the first 7.6% of the total planned neutrino beam exposure slightly favor the Normal Mass Hierarchy**



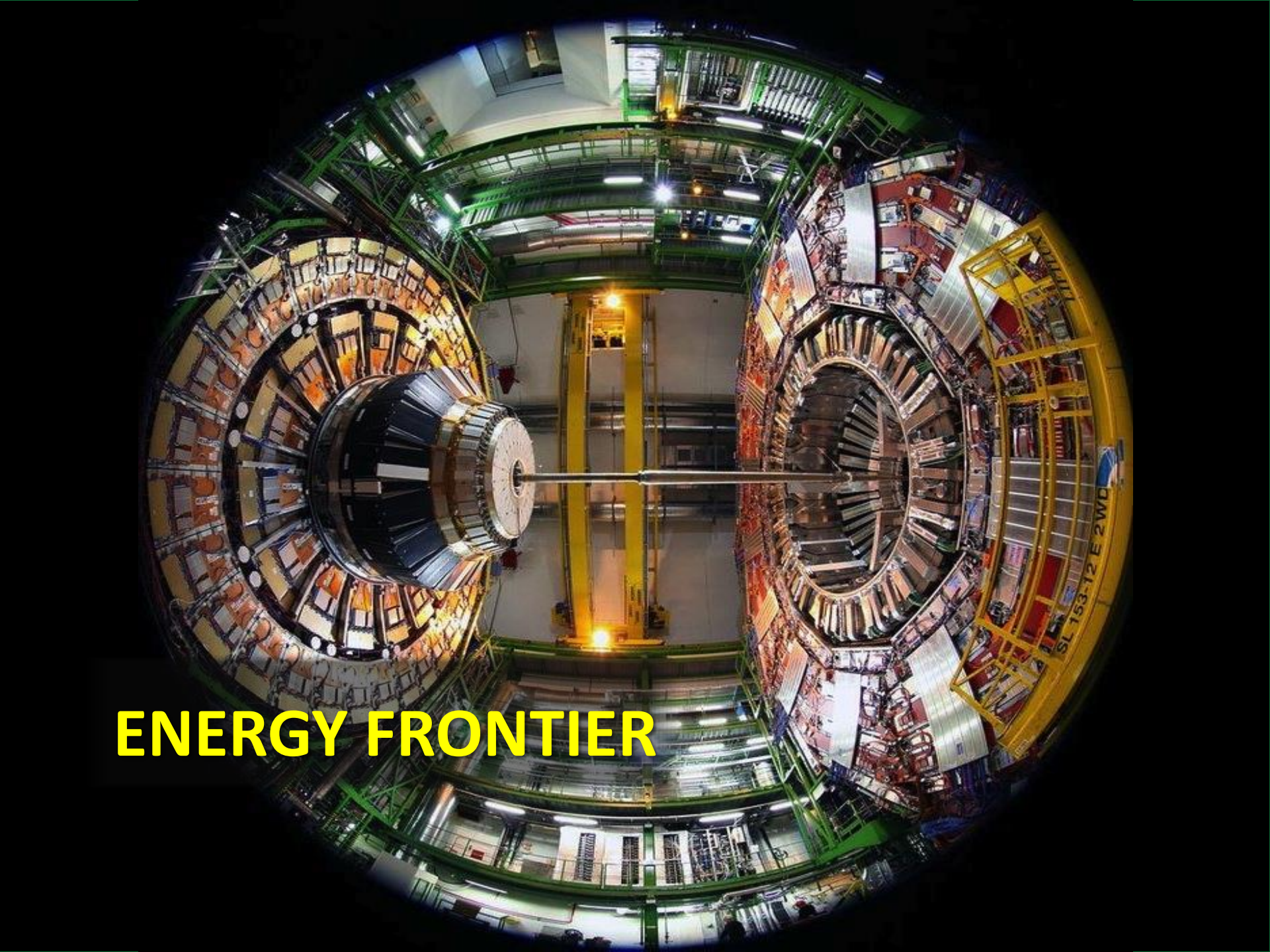
Neutrino Mass




**BOSS measured the expansion rate in the young Universe with an unprecedented 2% precision**



Cosmic acceleration




# ENERGY FRONTIER

# Energy Frontier Status

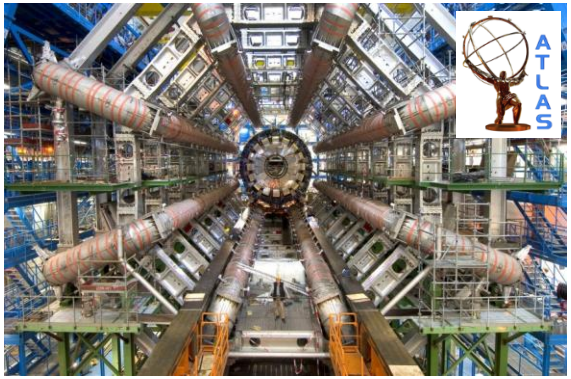
**Current program**

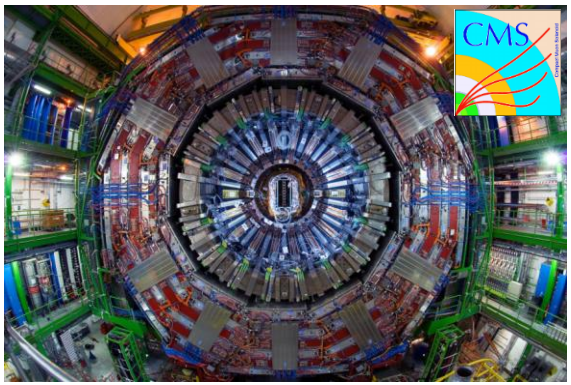
- 500+ LHC Run 1+2 papers submitted by *each* of the ATLAS and CMS Collaborations
- The U.S. will continue to play a leadership role in LHC discoveries and is actively executing the initial upgrades (Phase-1) to the LHC detectors

**Planned program**

- P5 report identified LHC upgrades as the highest priority near-term large project
- High-luminosity LHC accelerator and detector upgrades in 2024-2026 will extend the discovery reach
  - Increase luminosity by 10 times LHC design value to explore new physics at TeV energies
  - DOE/HEP actively working with US-CMS and US-ATLAS to finalize scope and determine U.S. contributions
  - NSF will be an important partner in realizing the continued success of the U.S. LHC program through the HL-LHC upgrades
- Very modest investments in R&D for future options
  - Lepton colliders and very high energy hadron colliders

**FY17: Initial LHC detector upgrade funding ends & HL-LHC upgrade efforts begin**



# Global Coordination of Future Energy Frontier Machine Planning

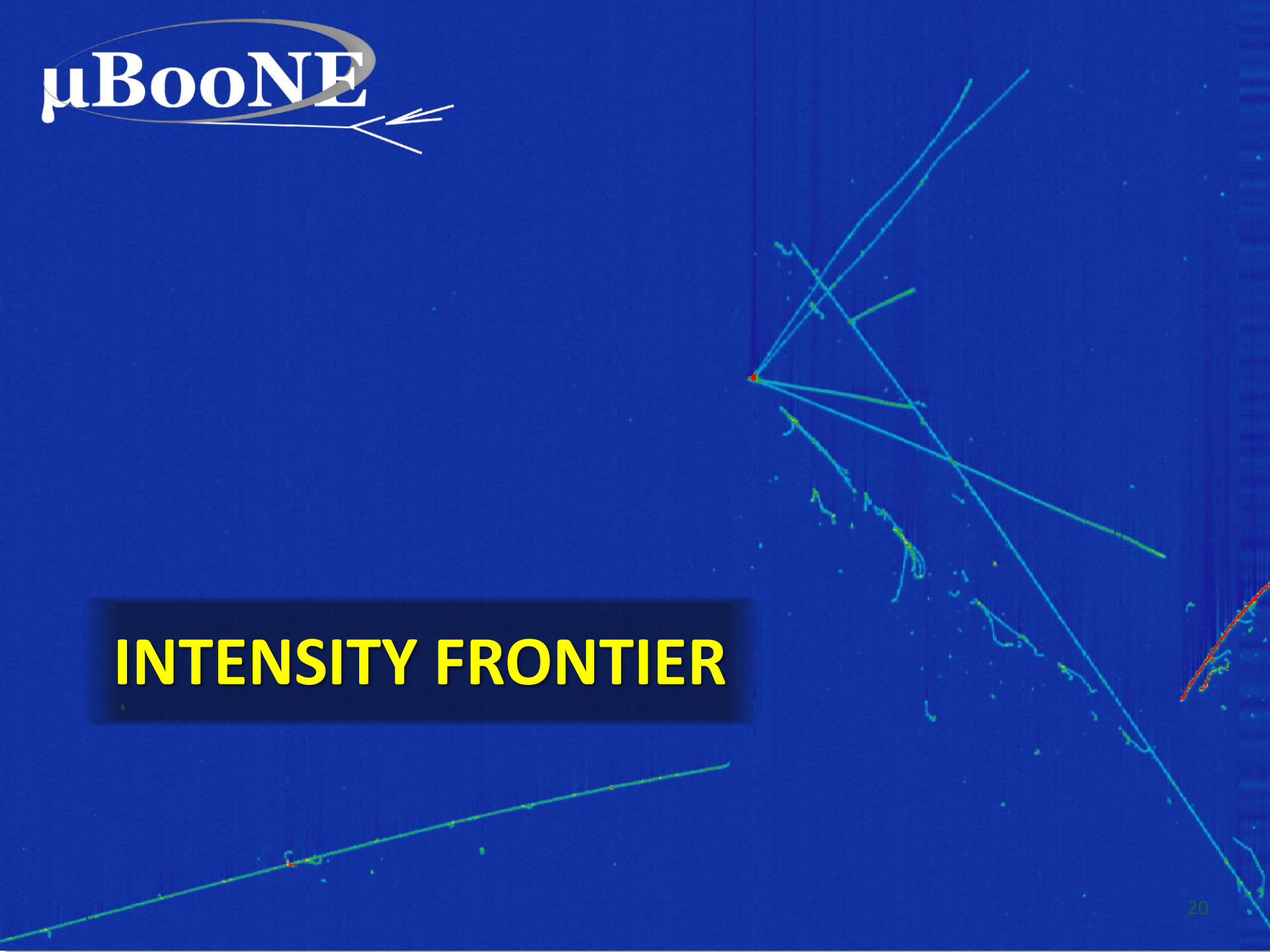
- P5 reported that particle physics is a global field for discovery and why
  - "The United States and major players in other regions can together address the full breadth of the field's most urgent scientific questions if each hosts a world-class facility at home and partners in high-priority facilities hosted elsewhere."
    - "Hosting world-class facilities and joining partnerships in facilities hosted elsewhere are both essential components of a global vision."
- China & Europe are studying and initiating R&D for future circular colliders
  - P5 said that U.S. should be counted among the potential host nations
- There is a pressing need for a global discussion among regions regarding the Energy Frontier program to follow the HL-LHC
  - Regional and national planning needs global coherence
  - Labs and agencies need a coordinated discussion in order that the formal planning process does not slow the scientific community
  - Funding Agencies for Large Colliders (FALC), coordinated with major partner institutions, may become a forum for this discussion among agencies
- Current priority in the General Accelerator R&D portfolio is investment in the enabling technologies for future machines

# International Linear Collider Strategy

- **DOE is maintaining modest investments in ILC R&D efforts during the Japanese decision making process**
  - **An interim report of the ILC Advisory Panel to the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) recommends monitoring LHC Run II results closely for potential impact on the science achievable with the ILC**
    - **This establishes a time scale for a decision on ILC by Japan**

- **DOE and MEXT have agreed to establish a discussion group to exchange views on the ILC**
  - **Membership will include senior members of DOE Office of Science and MEXT**
  - **Initial discussion will focus on possibilities of collaborative research for cost reduction**
  - **DOE and MEXT shared the views that solid and broad consensus among science community is indispensable for successful implementation of such a large scale project as the ILC**
  - **Next round of discussion group meetings will be held this summer**

# INTENSITY FRONTIER



# Intensity Frontier Status

**Explore the unknown through precision measurements**

- Development of muon-beam based program at Fermilab continues with Mu2e and Muon g-2
- Collaborating with Japan on *K* meson, *c/b* quark, and *τ* lepton precision studies with Belle II and KOTO

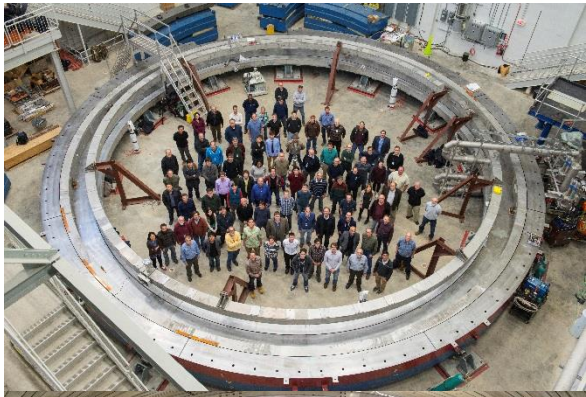
**Identify the physics of dark matter**

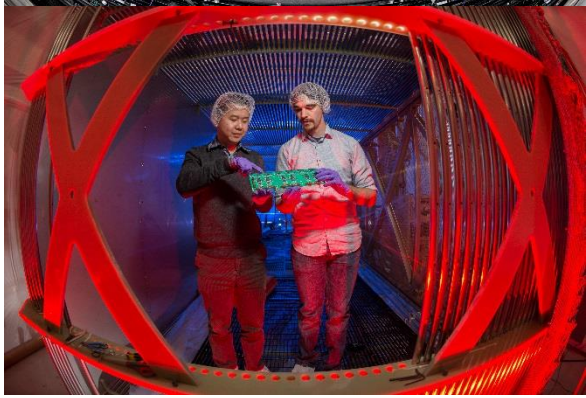
- APEX and Heavy Photon Search performing particle beam based searches for DM

**Pursue the physics associated with neutrino mass**

- Mass hierarchy & *ν* properties studied at Fermilab, Japan, China, and underground:
  - Daya Bay, MicroBooNE, MINERvA, MINOS+, NOvA, Super-K, T2K
- Sterile neutrino search and neutrino CP violation program continues to evolve:
  - Fermilab Short-Baseline Neutrino (SBN) program: MicroBooNE (taking data), ICARUS (2017), SBND (2018)
  - Intermediate Neutrino Research Program awards will complement Fermilab-based program soon
  - LBNF/DUNE identified by P5 as the highest priority large project in its time frame; International DUNE collaboration continues to grow

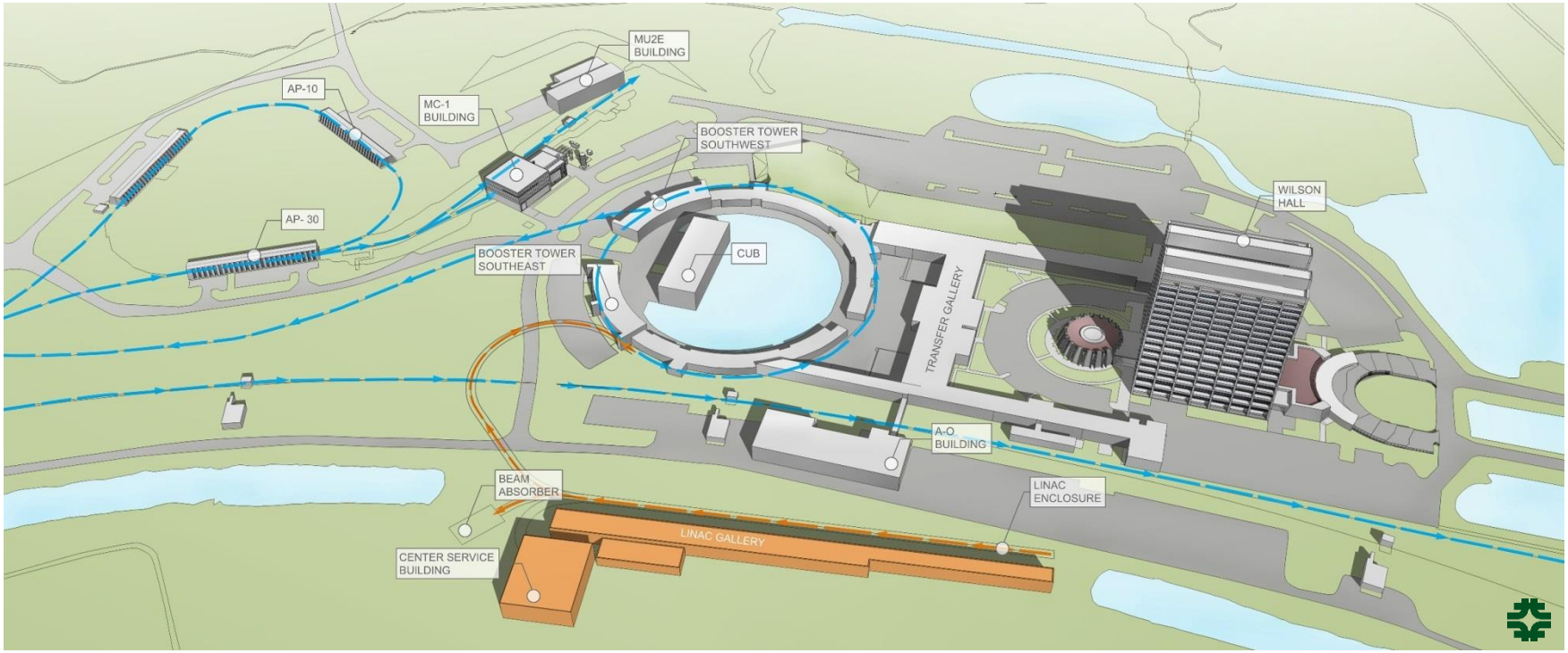
**FY17: Aim to solidify international partnerships for LBNF/DUNE with investments in site preparation and excavation of caverns**



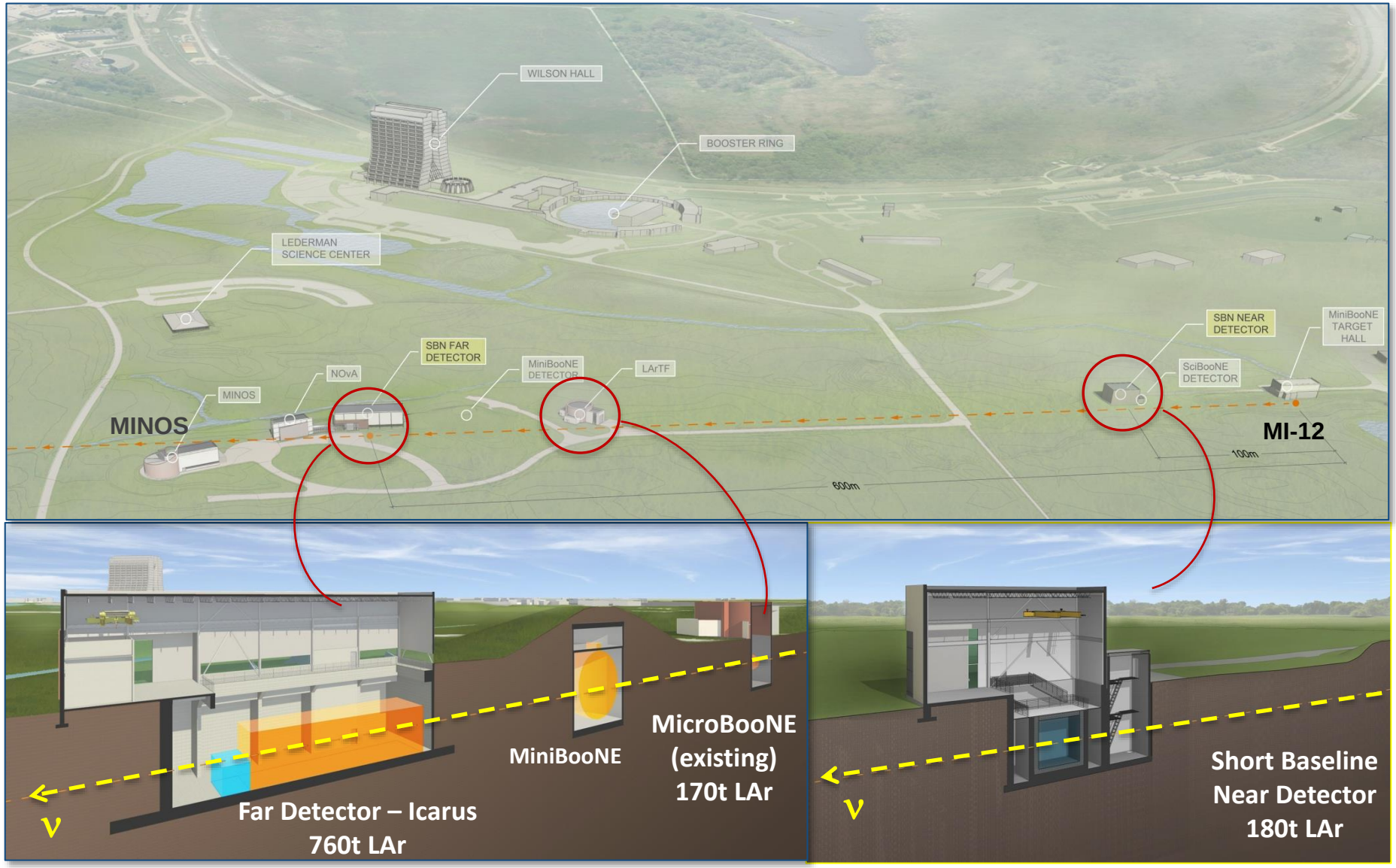


# Proton Improvement Plan II (PIP-II)

- **PIP-II supports longer term physics research and technology goals by providing increased beam power to LBNF while providing a platform for the future**
  - **Forms an integral part of the LBNF/DUNE scientific program**
- **Infrastructure and workforce development due to LCLS-II work at Fermilab will be leveraged in support of PIP-II, further advancing superconducting radiofrequency (SRF) accelerator capabilities**



# FNAL Short Baseline Neutrino Program



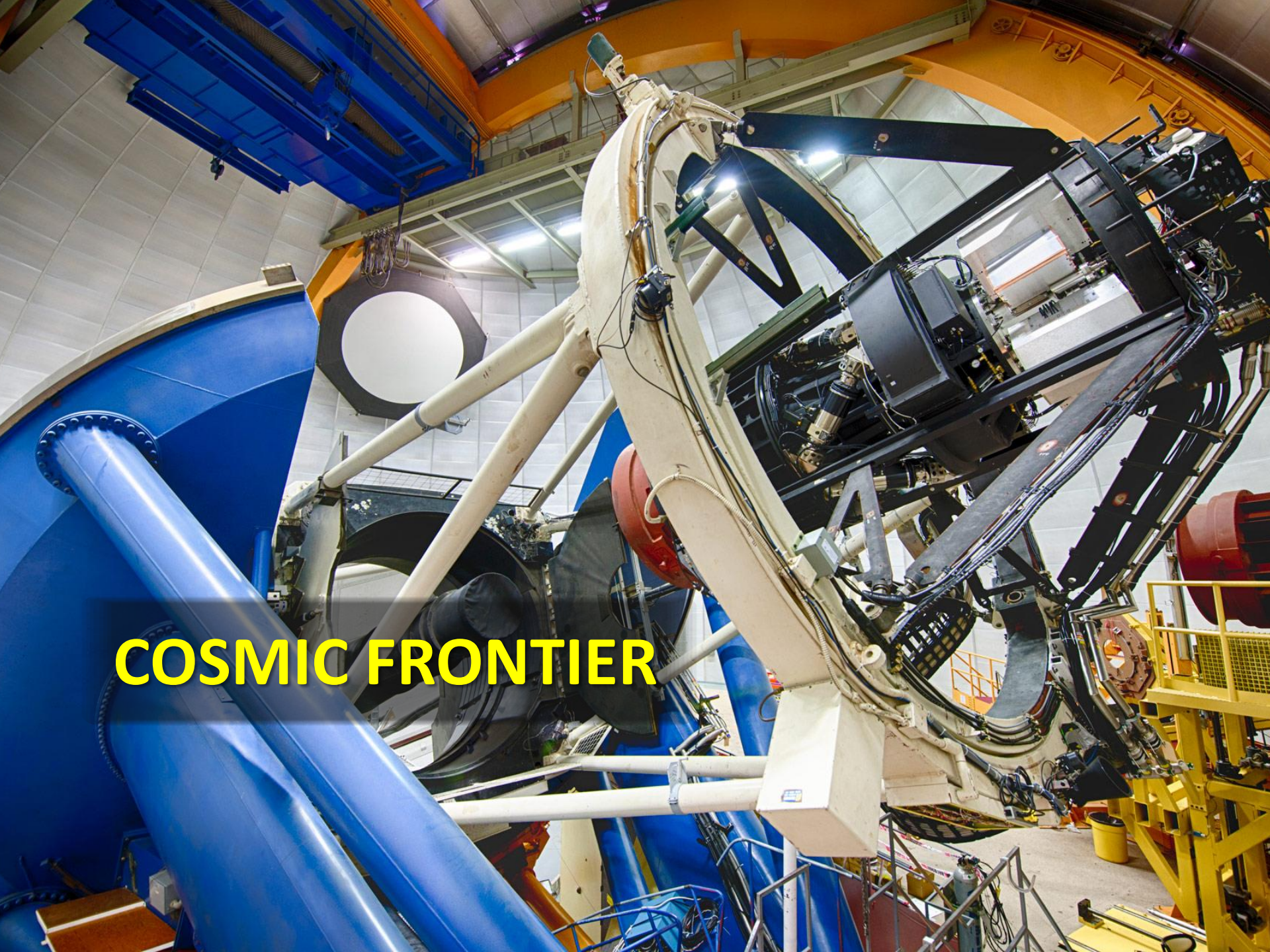
# Progress on Developing LBNF/DUNE

- The international effort on LBNF/DUNE made impressive progress
  - An international collaboration of over 850 physicists from 29 countries has formed
  - The experimental design has been enhanced to deliver more physics on a faster time scale
  - DOE has an signed agreement with CERN to cooperate on LBNF/DUNE, and CERN has allocated significant support in their 2015 financial plan
  - First international science "megaproject" hosted in the U.S.
- The new design was evaluated by an independent project review and was found to meet mission need
  - CD-1 for this new design was approved by DOE in November 2015
  - The DOE LBNF/DUNE cost range at CD-1 is $1,260 to $1,860 million with international in-kind contributions adding another ~30%
    - If successful, this may become one of the largest projects ever undertaken by SC
    - Continued support from community, Administration, and Congress needed to succeed
- Preparation of the site has begun to allow excavation to start in late FY 17
  - Another independent project review evaluated the readiness of the project to begin excavating detector halls at the Homestake Mine in South Dakota
  - The review panel found the project ready to proceed with underground excavation
- Aim is to optimize construction schedule for LBNF/DUNE to enable first data from DUNE in late 2024 and first neutrino beam data in late 2026

# Science Laboratories Infrastructure (SLI)

*"In 10 years, Fermilab with international and national partners will have successfully built a new billion-dollar class neutrino facility and will have a modern, centralized campus catering to a large international user community."* *– Nigel Lockyer, Fermilab Director*

**The Integrated Engineering Research Center at Fermilab will consolidate engineering functions from across the laboratory into the core campus near Wilson Hall**



# COSMIC FRONTIER

# Cosmic Frontier Status

**Dark Energy: Staged program of complementary suite of imaging and spectroscopic surveys**

- Extended Baryon Oscillation Spectroscopic Survey (eBOSS) and Dark Energy Survey continue operations
- Large Synoptic Survey Telescope (LSST) and Dark Energy Spectroscopic Instrument (DESI) projects are proceeding

**Dark Matter (direct detection): Staged program of current and next-generation experiments with multiple technologies**

- Completing operations on current DM-G1 experiments in FY 2016
- Progress continues on DM-G2 experiments: ADMX-G2, LZ, SuperCDMS-SNOLab

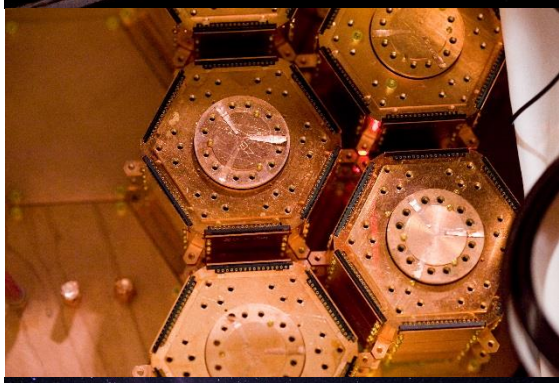
**Cosmic-ray, Gamma-ray**

- Fermi/GLAST, AMS, and HAWC continue operations
- DOE operations efforts will complete in FY 2016 for VERITAS and Auger

**Cosmic Microwave Background (CMB)**

- South Pole Telescope polarization (SPTpol) continues operations
- SPT-3G begins operations in December 2016
- Community planning proceeding for CMB-S4 experiment

**FY17: Fabrication funding ramp up supports key P5 recommended Cosmic Frontier projects: LSSTcam, DESI, SuperCDMS-SNOLab, and LZ**



# ADVANCED TECHNOLOGY R&D

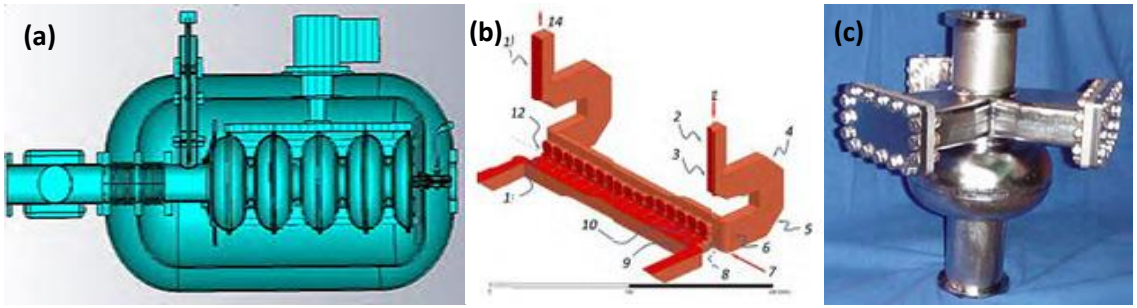
# Advanced Technology R&D Strategy

- **P5 report recommended moving forward with a focused Advanced Technology R&D strategy:**
  - Play a leadership role in superconducting magnet technology focused on the dual goals of increasing performance and decreasing costs
  - Pursue accelerator R&D with a focus on outcomes and capabilities that will dramatically improve cost effectiveness for mid-term and far-term accelerators
  - Focus resources toward directed instrumentation R&D in the near-term for high-priority projects
- **Following P5, the Accelerator R&D Subpanel (ARDS) was charged to identify the most promising accelerator research areas to support the advancement of HEP**
  - ARDS report provided prioritization in an R&D roadmap towards the Next Steps and Further Future accelerators
- **Follow-on workshops will provide roadmaps to guide General Accelerator R&D (GARD)**
  - HEP-GARD Magnet Workshop held July 2015
  - Advanced Accelerator Concepts Roadmap Workshop held February 2016
  - GARD RF Acceleration Technology Workshop planned for late FY 2016

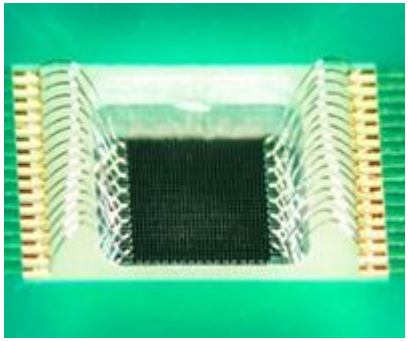
# ACCELERATOR STEWARDSHIP

# Acc. Stewardship Awards

- **Nine FY 2016 awards seek to improve accelerator technologies across a wide range of applications, including:**
  - **Accelerator-based research (particle physics, materials science, etc.)**
  - **Uses of accelerators for industry and defense**
  - **Medical applications for advanced cancer therapies**



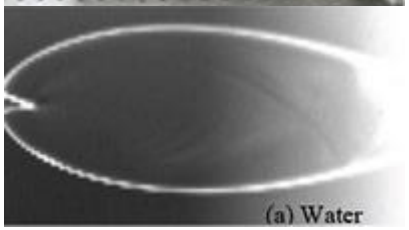

**Concept Studies of Accelerators for Energy & Environmental Applications**
*(a) FNAL, Colorado State U., NIU, Calabazas Creek Research, Euclid TechLabs, Advanced Energy Systems, and the Metropolitan Water Reclamation District of Greater Chicago; (b) SLAC, General Atomics, and Texas A&M; (c)TJNAF, Advanced Energy Systems, and General Atomics*



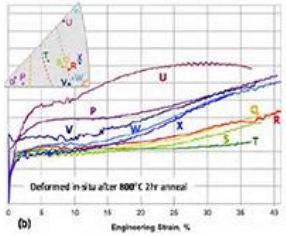
**High Precision Beam Detectors for Cancer Therapy**
*Stony Brook U., BNL, Best Medical International*

**High-Efficiency High Power Ultrafast Lasers**

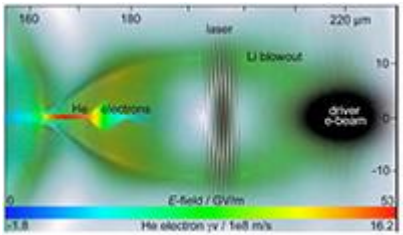
← *Colorado State U., LLNL, U. of Maryland*



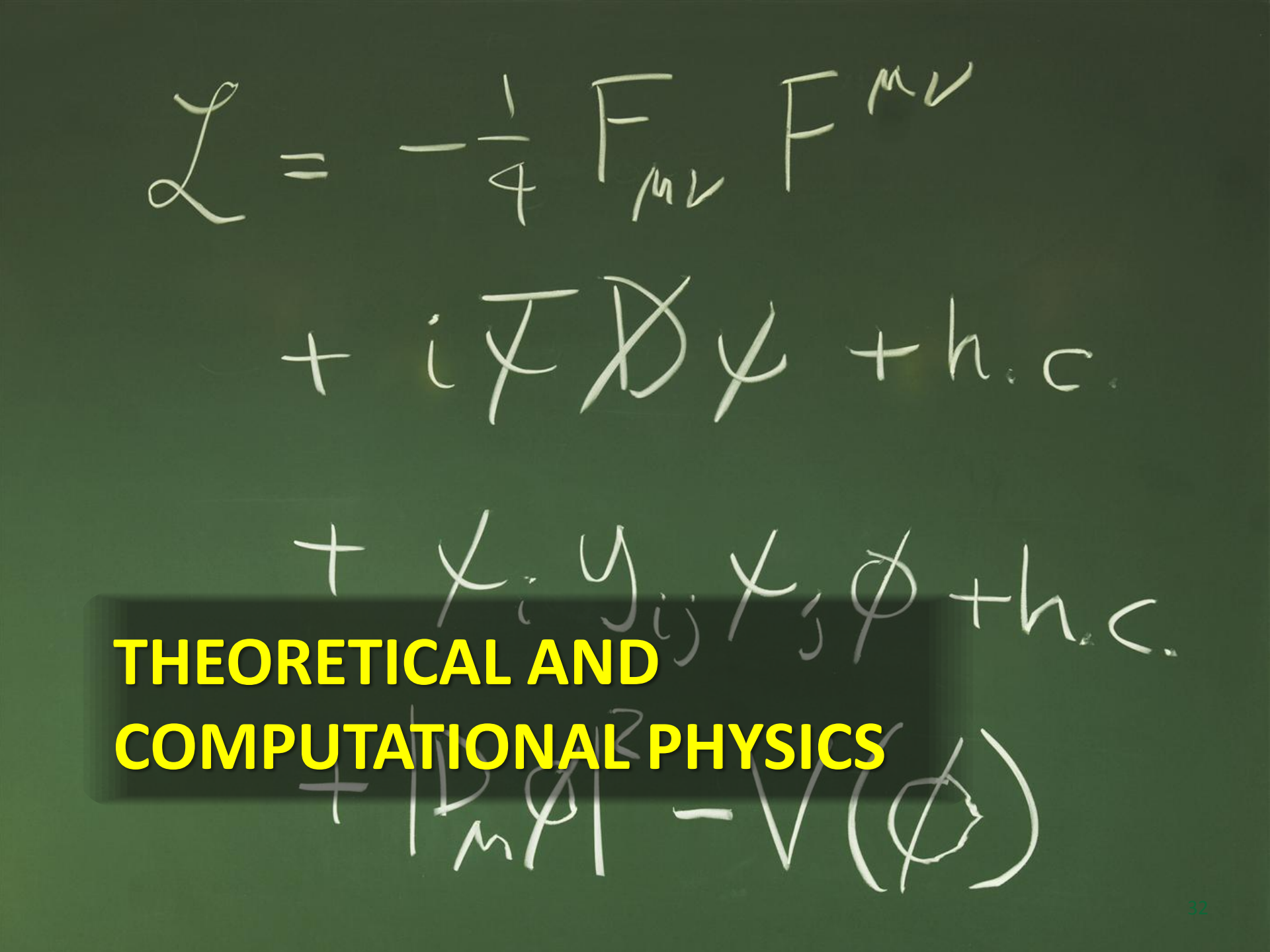

← *Michigan State U.*




**Fundamental Studies of Superconductors**
*Michigan State U., Florida State U., Ohio State U., Arizona State U., the National High Magnetic Field Laboratory, and TJNAF*




**New Sources of Particles and Radiation**
*UCLA*




# THEORETICAL AND COMPUTATIONAL PHYSICS

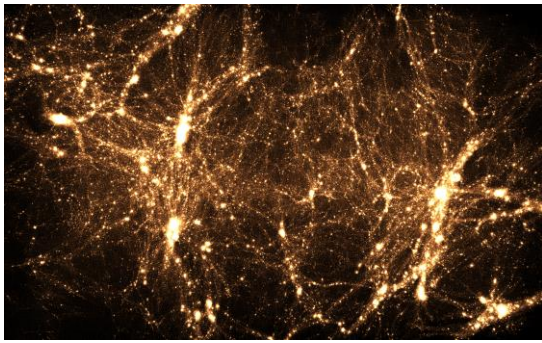
# Theoretical and Computational Physics

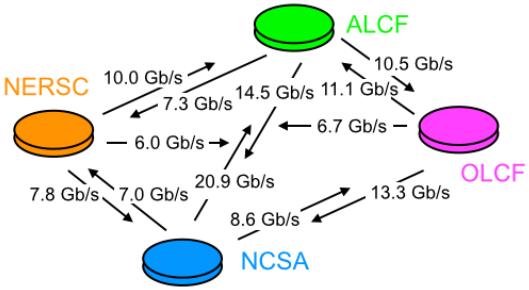
- Provides the mathematical, phenomenological, and computational framework to understand and extend our knowledge of the dynamics of particles and forces, and the nature of space and time
  - Theoretical research essential for proper interpretation and understanding of the experimental research activities in other HEP subprograms
  - Advanced computing tools necessary for designing, operating, and interpreting experiments and scientific simulations that enable experimental discovery research
- The P5 report recognized the importance of theory and computing:
  - "The U.S. has leadership in diverse areas of theoretical research in particle physics. A thriving theory program is essential for both identifying new directions for the field and supporting the current experimental program."
- DOE/HEP considering limited, targeted initiatives for theoretical studies that can directly address priorities in the experimental program (a la LQCD)
  - E.g., Neutrino-nucleus interactions

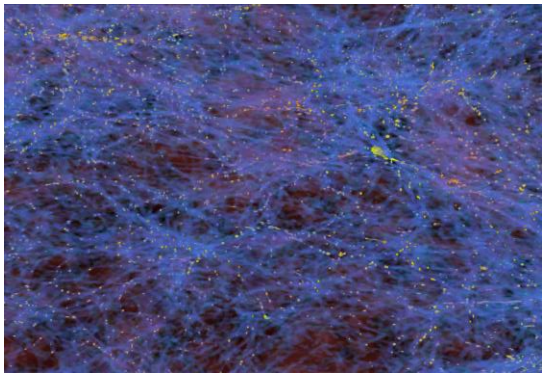
# Computational Physics Strategy

**Leverage partnerships to address computing challenges identified by P5**

- **HEP is strengthening and expanding its computing partnerships with ASCR through Computational HEP**
- **Along with the SciDAC Program, HEP partners with the ASCR Research Division and with Facilities through:**
  - **The HEP FCE -> HEP Center for Computational Excellence**
    - **Data Movement and Mini App projects**
  - **Extreme Analysis Systems (EASy)**
    - **Data sharing and movement**
  - **SENSE: SDN for End-to-End Networks for Extreme-Scale Science**
  - **Potential new international pilot projects and**
- **HEP-ASCR Exascale Requirements Review Report will be available soon**
- **HEP will partner with ASCR on the post-Moore algorithms, technologies, and QIS test beds**





# HEP FUNDING OPPORTUNITIES

# Purpose of DOE/HEP-based Solicitations

*"Annual Solicitation for the Office of Science"* is for:

- Conferences and Workshops
- Experimental operations support at non-DOE facilities, with no DOE lab involvement (e.g., T2K)
- Supplemental awards and other invited or special-purpose applications

***NOTE: SC Annual Solicitation generally has lower programmatic priority in HEP***

*"FY 20XX Research Opportunities in High Energy Physics"* is for:

- HEP Research and Technology R&D grants
  (HEP experimental frontiers, HEP Theory, Accelerator R&D, Detector R&D)

***Supports Research in highest programmatic priority areas***

*"Early Career Research Program"* is for:

- Outstanding junior investigators from labs or universities
  - Establish new research programs with potential for high impact and future leadership in HEP
  - All junior faculty/lab staff are encouraged to apply

*"Research Opportunities in Accelerator Stewardship"* is for:

- Specifically for accelerator R&D which predominantly impacts non-HEP applications
  - Specific technical topics TBA
  - Collaborative teams strongly encouraged

# Schedule of DOE/HEP-based Solicitations

*"FY 2016 Continuation of Solicitation for the Office of Science Financial Assistance Program"*
**[DE-FOA-0001414]**

- **Also known as the "general *or* open annual DOE/SC solicitation"**
  - **SC-wide FOA that invites applications in support of work in any of six SC offices, incl. HEP research**
- **Published annually, typically at beginning of FY (October), remains open until successive issuance**

*Upcoming: "FY 2017 Research Opportunities in High Energy Physics"*

- **Issued for *new* or *renewing* grant applications, evaluated through comparative review (CR) process**
  - **Anticipate (optional but encouraged) Letter of Intent (LOI) will be due mid-August**
  - **Anticipate final applications due mid-September**

*Upcoming: "Early Career Research Program"*

- **SC-wide invitation for junior investigators (within 10-years post PhD) from labs or universities**
  - **Early career development of outstanding scientist's research programs in areas supported by DOE/SC**
  - **Anticipate that required pre-application will be due mid-September, final applications mid-November**

*Upcoming: "Research Opportunities in Accelerator Stewardship"*

- **Specifically for accelerator R&D which predominantly impacts non-HEP applications**
  - **LOI will be required, resulting in encourage/discourage response**
  - **Eligibility will include academia, national labs, and industry**

# Recent FOA Changes

- Data Management Plans (DMPs)
  - All *Research* proposals to DOE/SC must have a data management plan
    - Includes HEP comparative review, Early Career
    - *Does not include* conferences, workshops, operations, projects
  - Please make sure applicants know that the requirement for a data management plan will be strictly enforced. Any research thrust in a proposal without a DMP will be declined without review.
- All *Renewal* proposals will need to also submit "proposal products" (essentially recent publications and other records of science outcomes from DOE-supported research) 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
  - In the future, these will be captured with your annual Progress Report, but during the transition phase, you will need to enter them by-hand
- 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
  - Prepare for leading roles and determine scope of U.S. contributions to HL-LHC upgrades
- **Intensity Frontier**
  - Neutrino Program
    - NOvA, T2K/SK, Minerva, MINOS+ data analysis
    - Implement Fermilab Short Baseline Neutrino Program and Intermediate Neutrino Program
    - Prepare to host LBNF/DUNE and PIP-II
  - Muon Program: Complete Mu2e and Muon g-2 and take data
  - Heavy Flavor Program: Complete Belle-II and take data
- **Cosmic Frontier**
  - Dark Matter: Complete G1 analysis, construct G2 experiments, modest R&D
  - Dark Energy: Complete BOSS, DES analysis; construct LSST and DESI
  - Continue 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**
  - In process of seeking community input to identify highest priority R&D activities in wake of 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

# Opportunities to meet with DOE PMs

- **Many DOE/HEP program managers (PMs) will be at the ICHEP Conference Aug. 3-10 in Chicago:**
  - **Presentations for each Frontier and special topics:**
    - https://www.ichep2016.org/satellite_meetings/doe_pi.php

| Subprogram Session/Presentation | Lead PM | Tentative Date | Week 1 or Week 2 of ICHEP | Duration (incl. Q&A) |
|---|---|---|---|---|
| Energy Frontier | A. Patwa | Thu, Aug. 4 | Week 1 Evening (8-9:30pm) | 1.5 hours |
| Cosmic Frontier | K. Turner | Thu, Aug. 4 | Week 1 Evening (8-9:30pm) | 1.5 hours |
| Intensity Frontier | P. Rapidis | Fri, Aug. 5 | Week 1 Evening (8-9:30pm) | 1.5 hours |
| HEP Theory | S. Rolli | Fri, Aug. 5 | Week 1 Evening (8-9:30pm) | 1.5 hours |
| Detector R&D | H. Marsiske | Sat, Aug. 6 | Weekend Lunch (TBD) | 1 hour |
| DOE/HEP General Presentation (FOA, budgets, etc.) | G. Crawford | Wed, Aug. 10 | Week 2 Lunch | 1 hour |
| DOE/HEP Civics Presentation | M. Cooke | Fri, Aug. 5 | Week 1 Lunch | 1 hour |

  - **Opportunities for one-on-one (for individual or lead-PIs) or few-on-few meetings (for larger groups): contact your PM(s) directly**

# OFFICE NEWS AND MISCELLANY

# HEP Program Personnel Updates

- **Comings and Goings**
  - Petros Rapidis began as Program Manager for Intensity Frontier in January 2016
  - Our new budget team is Erin Cruz (began September 2015, focus on formulation) and Michelle Bandy (began February 2016, focus on execution)
- **New Assignments and Opportunities**
  - New permanent position for Theory PM (vice Simona) closed, interviewing candidates now.
  - New IPAs (Intensity, Stewardship) starting late summer/early fall
  - Interested in new IPA/detailee for Energy Frontier starting Fall 2016
  - *Interested parties should contact HEP management!*

# HEP Laboratory Sustainability

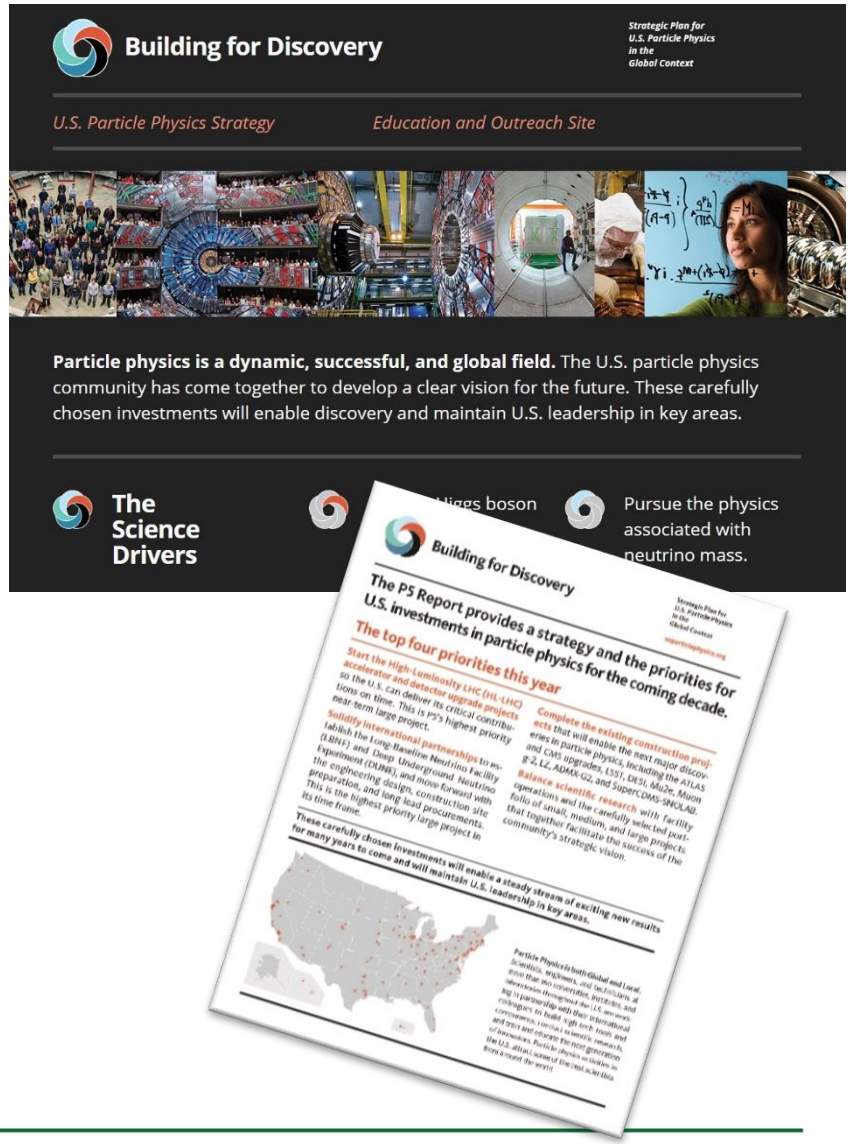
- **HEP is working with the laboratories to improve the long-term sustainability of the HEP program**
  - **Exercise looks ahead 7 years, attempting to account for:**
    - **Expected modest growth of Research funding**
    - **Expected costs of Operations**
    - **Expected participation in Projects**
- **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**

# Best Practices in Media Communication

- A "Best Practices in Media Communication" meeting was held for spokespersons of HEP experiments on January 19, 2016
  - Talks by Jim Siegrist, Steve Ritz, Lynn Cominsky, and Katie Yurkewicz
  - Aimed to:
    - Inspire renewed focus on best practices in media communications within each collaboration
    - Start a conversation that will continue within the community as you work to implement your media plans
- Will follow up with spokespersons soon for feedback, including:
  - Outcome of collaboration's review of their media plan
  - Request to provide DOE PM and Michael Cooke with contact information for collaboration's media coordinator
  - Encourage community to host & attend communications training talks
- HEP further requests that collaborations give advanced notice before big announcements via two paths:
  - Media coordinators, to help plan appropriate collaboration press rollout
  - DOE via PM and Michael Cooke, to help ensure that the agency has an opportunity to coordinate with the collaboration's announcement

# Community Materials

- Steve Ritz has lead a community effort to produce materials to help maintain the visibility of the P5 report
  - Initial materials are available at: http://www.usparticlephysics.org/
  - Steve plans to continue working with the community to update the material as needed
- Users' Groups report that Steve's material was helpful during their March visit to Washington, DC
- Spokespersons should consider using Steve's messages as part of their media interaction strategy
- HEPAP working group also looking at means for more effective community interactions with public



# Fulfilling the HEP Mission: Enabling Discovery

**The P5 plan enables discovery in particle physics**

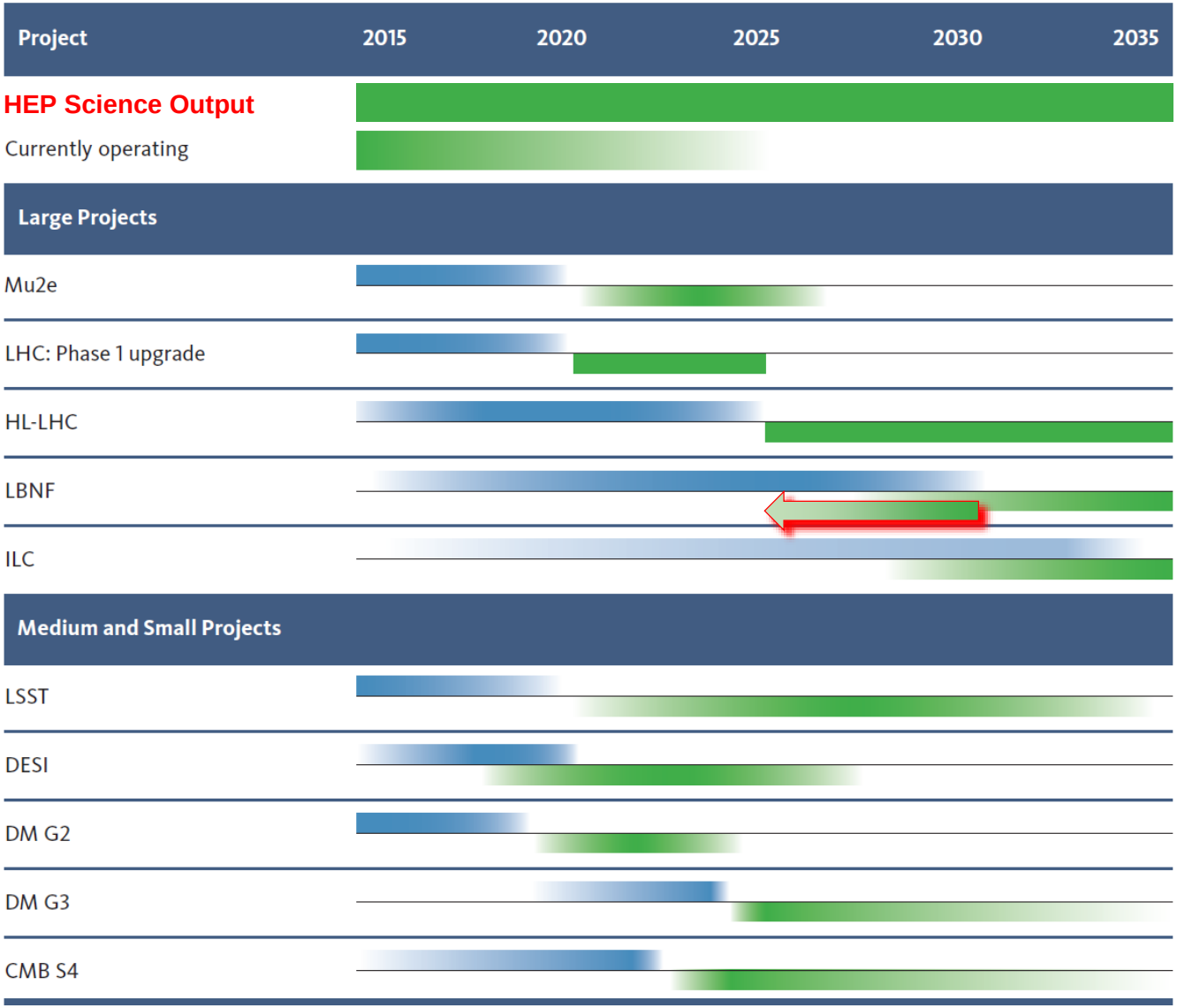
- Pursues the most important science opportunities wherever they are: on- and off-shore
- Coordinates time-phased project execution
- Incorporates projects of different scales
- Balances across experimental Frontiers

**"Scenario B+" aims to advance the LBNF/DUNE timeline**

- First DUNE data late 2024, first beam data late 2026

**P5 strategy produces continuous physics output**

- Any science driver across the Frontiers could lead to discovery
- Historic opportunities await us!




Green: Physics Blue: Approximate Construction

# Advancing the P5 Vision

- **The FY 2017 budget continues the implementation of the 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 Administration and Congress
- **Our strategy is to implement P5's plan for Scenario B while pursuing an opportunity to accelerate the establishment of the first U.S.-hosted international science facility, LBNF/DUNE**
  - HL-LHC accelerator and detector upgrades are the foundation of our implementation and we will support all other projects in P5's Scenario B
  - Additional funding supports accelerating the implementation of LBNF/DUNE, which has received strong support from the Administration, Congress, and interested international partners
  - Our implementation maintains balance between Research, Operations, and Projects
  - Fermilab and its research community have critical roles in all these areas

# BACKUP

# HEP MIE Project Status

| Subprogram | TPC ($M) | CD Status | CD Date |
|---|---|---|---|
| INTENSITY FRONTIER | | | |
| Long Baseline Neutrino Facility (LBNF) / Deep Underground Neutrino Experiment (DUNE) | 1,260 - 1,860 | CD-1(R) | November 5, 2015 |
| Muon g-2 | 46 | CD-2/3 | August 20, 2015 |
| Mu2e | 273 | CD-2/3 | March 4, 2015 |
| Next Generation B-Factory Detector Systems (BELLE-II) | 15 | CD-2/3 | April 23, 2014 |
| ENERGY FRONTIER | | | |
| LHC ATLAS Detector (Phase-1) Upgrade | 33 | CD-2/3 | November 12, 2014 |
| LHC CMS Detector (Phase-1) Upgrade | 33 | CD-2/3 | November 12, 2014 |
| HL-LHC ATLAS Detector (Phase-2) Upgrade | 150 | CD-0 | April 13, 2016 |
| HL-LHC CMS Detector (Phase-2) Upgrade | 150 | CD-0 | April 13, 2016 |
| COSMIC FRONTIER | | | |
| LZ | 46-59 | CD-1/3A | April 28, 2015 |
| SuperCDMS-SNOlab | 16-21 | CD-1 | December 21, 2015 |
| Dark Energy Spectroscopic Instrument (DESI) | 56 | CD-2 | September 17, 2015 |
| 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) | TBD | CD-1 | December 21, 2015 |
| Proton Improvement Project (PIP-II) | TBD | CD-0 | November 12, 2015 |
| HL-LHC Accelerator Upgrade | 200 | CD-0 | April 13, 2016 |

# FY 2017 HEP Funding by Subprogram

| HEP Funding Category ($ in K) | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| Energy Frontier | 146,040 | 150,723 | 150,998 | LHC initial detector upgrades complete; HL-LHC detector upgrade activities begin; research slightly reduced to support projects |
| Intensity Frontier | 259,750 | 243,121 | 234,144 | LBNF/DUNE OPC ramps down; SBN, NuMI ops, and accelerator refurb. supported at Fermilab; research increases; SRF R&D/ops activities move to ATR&D |
| Cosmic Frontier | 106,507 | 130,582 | 130,069 | MIE projects (LSSTcam, DESI, LZ, SuperCDMS-SNOLab) ramp up according to profile |
| Theoretical and Computational Physics | 61,848 | 59,083 | 59,656 | Research slightly reduced; Lattice QCD project held constant as in planned profile |
| Advanced Technology R&D | 124,087 | 115,494 | 118,285 | LARP increases to complete prototype magnets LHC upgrade; FY17 is last funding year for MAP as MICE deliverables complete |
| Accelerator Stewardship | 10,000 | 9,000 | 13,744 | Research increases; BNL ATF upgrade continues |
| Construction (Line Item) | 37,000 | 66,100 | 88,521 | Request engineering design, site preparation and long-lead procurement for the LBNF/DUNE; planned profile for Mu2e |
| SBIR/STTR | 20,768* | 20,897 | 22,580 | |
| **Total** | **766,000*** | **795,000** | **817,997** | |

**** SBIR/STTR added to FY 2015 for comparison to FY 2016/2017***

# Energy Frontier

| Energy Frontier Experimental Physics | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| Research | 77,370 | 77,270 | 76,811 | Reduced to support current and future experimental capabilities; some research staff redirected to complete LHC detector upgrade projects and begin leading HL-LHC upgrade projects |
| Facility Operations and Experimental Support | 53,670 | 54,453 | 55,220 | Some detector maintenance personnel redirected to complete LHC detector upgrade projects and begin leading HL-LHC upgrade projects |
| Projects | 15,000 | 19,000 | 18,967 | Initial ATLAS/CMS upgrades complete in FY17; OPC begins for HL-LHC detector upgrades |
| **Total** | **146,040** | **150,723** | **150,998** | |

- **LHC continues Run II operations at 13+ TeV**
- **Phase-1 LHC Detector upgrade projects receive final funding in FY 2017, are on track to reach CD-4 in 2019**
- **As part of international process, HL-LHC detector upgrade efforts begin in FY 2017**

# Intensity Frontier

| Intensity Frontier Experimental Physics | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| Research | 54,122 | 56,104 | 56,509 | Increase supports current and future experimental capabilities; some research staff redirected to lead the internationalization of LBNF/DUNE or development of SBN Program |
| Facility Operations and Experimental Support | 158,658 | 151,317 | 153,066 | Reduction primarily from completion of four AIP projects in Fermilab MC complex in FY 16 |
| Projects | 46,970 | 35,700 | 24,569 | Reduction from ramp down of g-2 & end of LBNF/DUNE OPC; SBN Program increases |
| **Total** | **259,750** | **243,121** | **234,144** | |

- **Active research program will take advantage of new data from:**
  - **NOvA, MicroBooNE, Belle II**
- **Site preparation and excavation of caverns begins at SURF for LBNF/DUNE**
- **R&D will continue on SBND and ICARUS for the Short-Baseline Neutrino (SBN) Program**
- **Fabrication continues on Muon g-2, Mu2e**

# Cosmic Frontier

| Cosmic Frontier Experimental Physics | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| Research | 48,777 | 49,910 | 49,934 | Research slightly increases to support: planning for calibration, simulation, and operation of new projects; data analyses for operating or recently completed experiments |
| Facility Operations and Experimental Support | 11,327 | 13,837 | 9,935 | Facilities activities decrease for Working Capital Fund costs; increased support for early operations planning activities for future experiments, particularly LSST |
| Projects | 46,403 | 66,835 | 70,200 | Planned ramp up supports fabrication of LSSTcam, DESI, SuperCDMS-SNOLab, LZ |
| **Total** | **106,507** | **130,582** | **130,069** | |

- **Research activities continue for ongoing experiments:**
  - **AMS-2, HAWC, FGST, DES, eBOSS, SPT**
- **Ramp up in project support for fabrication efforts on:**
  - **2nd generation dark matter experiments LZ and SuperCDMS-SNOLab**
  - **Dark energy experiments DESI and LSSTcam**

# Advanced Technology R&D

| Advanced Technology R&D | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| Research | 88,217 | 83,644 | 83,360 | |
| *General Accelerator R&D* | *45,903* | *46,722* | *44,510* | *Focus on high priority areas in SC magnets, SRF, and high–power beam targets; $1M of funding to initiate traineeship activity* |
| *Directed Accelerator R&D* | *23,000* | *20,640* | *21,500* | *Reductions from MAP ramp down offset by increase in LARP SC magnet effort to meet schedule for delivery of magnet prototypes* |
| *Detector R&D* | *19,314* | *16,282* | *17,350* | *Modest detector R&D support while focus remains on high priority R&D identified by P5* |
| Facility Operations and Experimental Support | 35,870 | 29,750 | 26,925 | Reduction dominated by end of operations funding for FACET |
| Projects | 0 | 2,100 | 8,000 | Increase to support the FACET-II project |
| **Total** | **124,087** | **115,494** | **118,285** | |

- **Advanced Technology Traineeship Activity will revitalize education and innovation in the physics of particle accelerators for the benefit of HEP and other SC programs that rely on these enabling technologies**

# Accelerator Stewardship

| Accelerator Stewardship | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | |
|---|---|---|---|---|
| Research | 4,891 | 3,378 | 6,853 | Research increased to handle full breadth of translational R&D challenges in the laser, medical, and energy & environmental application areas |
| Facility Operations and Experimental Support | 5,109 | 5,622 | 6,891 | Increases as the BNL-ATF relocation to a larger building reaches a peak year of activity; Accelerator Stewardship Test Facility Pilot Program is expanded |
| **Total** | **10,000** | **9,000** | **13,744** | |

- **Continue support for research activities at laboratories, universities, and in industry for technology R&D areas such as laser, ion-beam therapy, and accelerator technology for energy and environmental applications**
- **Support ATF relocation and user facility operations and the expansion of the Accelerator Stewardship Test Facility Pilot Program**

# Theoretical and Computational Physics

| Theoretical and Computational Physics | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| Research | 60,848 | 57,083 | 57,656 | |
| *Theory Research* | *52,323* | *48,465* | *49,620* | *Slight increase to maintain a thriving theory program as recommended in the P5 report* |
| *Computational Research* | *8,525* | *8,618* | *8,036* | *HEP expanding cooperation with ASCR on multiple computational projects and will rely less on the SciDAC program* |
| Projects | 1,000 | 2,000 | 2,000 | LQCD funded according to planned profile |
| **Total** | **61,848** | **59,083** | **59,656** | |

- **SciDAC will be re-competed in FY 2017 in partnership with ASCR**
  - **New partnership with ASCR results in a lower level of funding necessary for SciDAC**
- **LQCD plan includes acquisition of new hardware as well as continued operations**

# Construction

| Accelerator Stewardship | FY 2015 Current | FY 2016 Enacted | FY 2017 Request | Explanation of Changes (FY17 vs. FY16) |
|---|---|---|---|---|
| 11-SC-40, LBNF/DUNE | 12,000 | 26,000 | 45,021 | TEC funding increased to continue site preparation and start excavation of caverns for the neutrino detectors and cryogenic infrastructure |
| 11-SC-41, Mu2e Experiment | 25,000 | 40,100 | 43,500 | Funding increases according to planned funding profile as construction continues |
| **Total** | **37,000** | **66,100** | **88,521** | |

- **LBNF/DUNE:**
  - **TEC funding is requested to continue technical design of the facility and the experiment**
  - **The design of cryogenic infrastructure is the next part of the facility design that needs to be completed**
  - **Funding is also needed to continue site preparation and start excavation of the large caverns for the neutrino detectors, as long-lead procurement**
- **Mu2e:**
  - **Construction funds are requested to finish civil construction and continue fabrication of technical components (solenoid magnets and particle detectors)**