



U.S. DEPARTMENT OF
ENERGY

Office of
Science

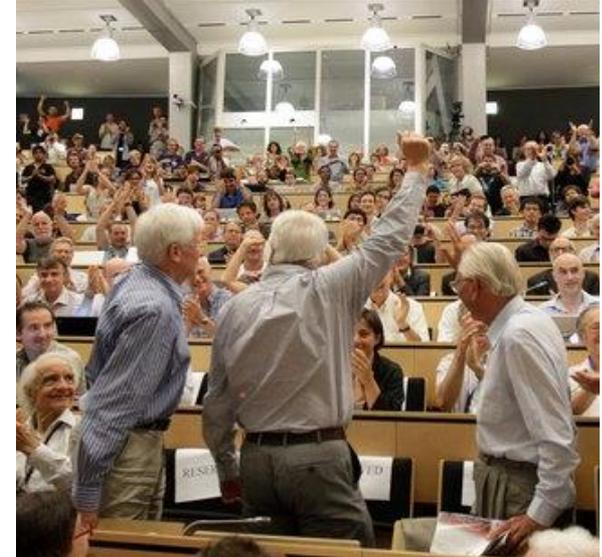
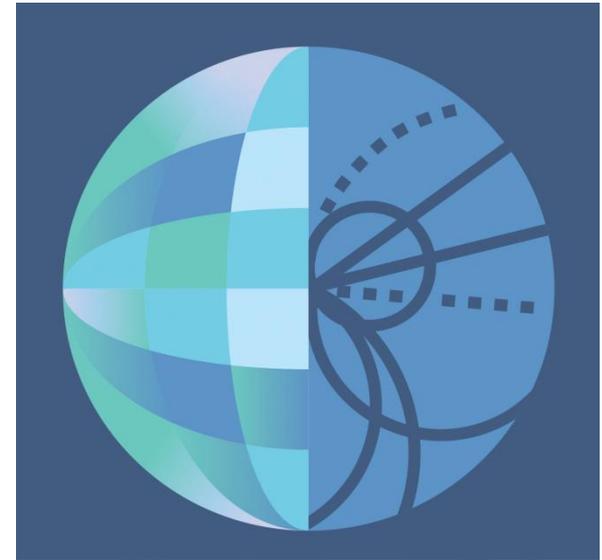
Status of the DOE High Energy Physics Program

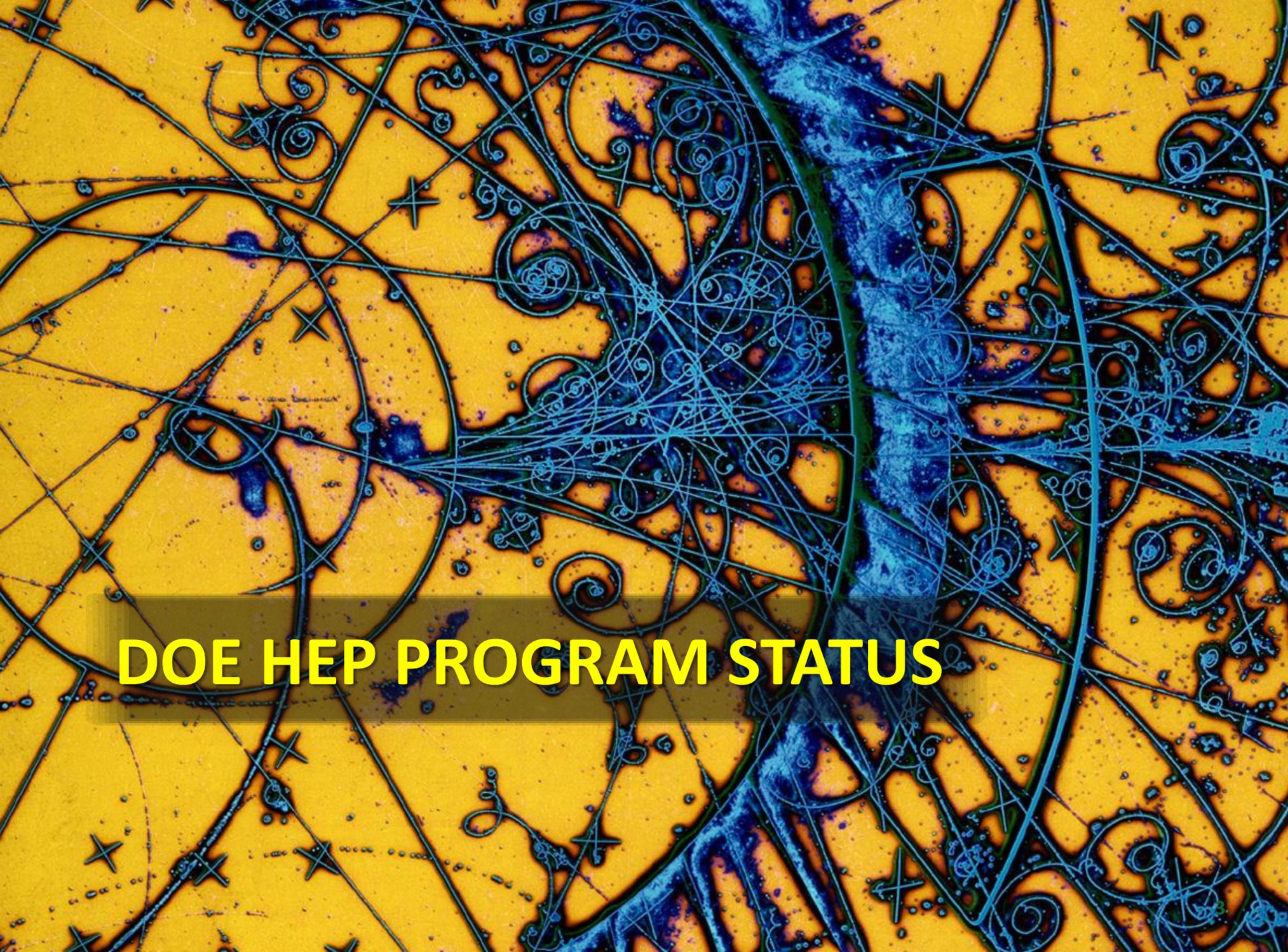
*Fermilab Users Meeting
June 11, 2015*

Glen Crawford
Research and Technology Division Director
Office of High Energy Physics
Office of Science, U.S. Department of Energy

P5 Headline: Particle Physics is Global

- The P5 report emphasized the global nature of particle physics
- U.S. HEP plan is embedded in the context of a global HEP effort
 - P5 states, “The scientific program required to address all of the most compelling questions of the field is beyond the finances and the technical expertise of any one nation or region.”
- International partnerships of growing importance in U.S. science, particle physics seen as a leader of this trend
 - U.S. involvement in LHC at CERN seen as a successful example of international collaboration





DOE HEP PROGRAM STATUS

U.S. Program Highlight:

May 7, 2015: CERN, DOE, and NSF Sign Bilateral Cooperation Agreement

- “Our research programs in the U.S. and Europe are now **deeply intertwined** by the signing of this agreement.”
 - Jim Siegrist, *DOE Associate Director for High Energy Physics*
- “a model for the kinds of international scientific collaboration that can **enable breakthrough insights and innovations.**”
 - John Holdren, *U.S. President’s Senior Science Advisor*
- “This agreement is also historic since it **formalizes CERN’s participation in U.S.-based programs** such as prospective future neutrino facilities for the first time.”
 - Rolf Heuer, *Director-General of CERN*
- “CERN acts as the facilitator and gate opener for the European particle physics community, so having them as a partner on neutrinos **merges the ambitions of U.S. and European neutrino physicists** in the best possible way.”
 - Joe Lykken, *Fermilab Deputy Director*

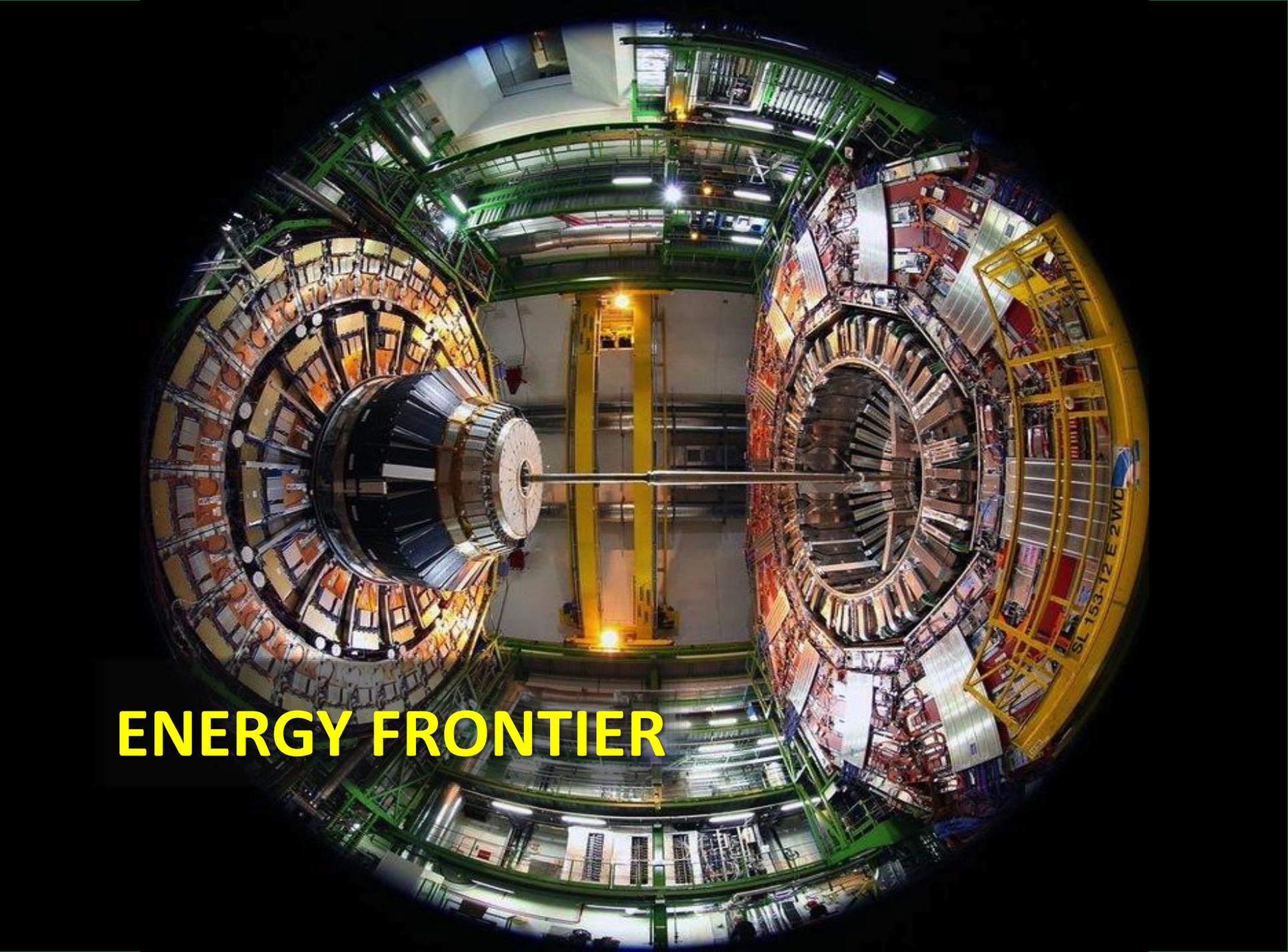


HEP Program Highlight:

Five Earn 2015 Early Career Awards in High Energy Physics

- **2015 Early Career Award recipients include:**
 - Phillip Barbeau (Duke University)
 - Coherent Neutrino-Nucleus Scattering: A Tool to Search for New Physics
 - Nathaniel Craig (UCSB)
 - Leveraging the Higgs to Discover Physics Beyond the Standard Model
 - Thomas Hartman (Cornell University)
 - Universality in Quantum Gravity
 - Tracy Slatyer (MIT)
 - Confronting Dark Matter with the Multiwavelength Sky
 - Peter Winter (Argonne National Laboratory)
 - Muon $g-2$: Precision Determination of the Magnetic Field and Enhanced Trolley Features





ENERGY FRONTIER

SL 153-12 E 2 WD

Energy Frontier Highlight:

LHC Run II Has Begun

- LHC Run II began on June 3, 2015, with collisions at 13 TeV!



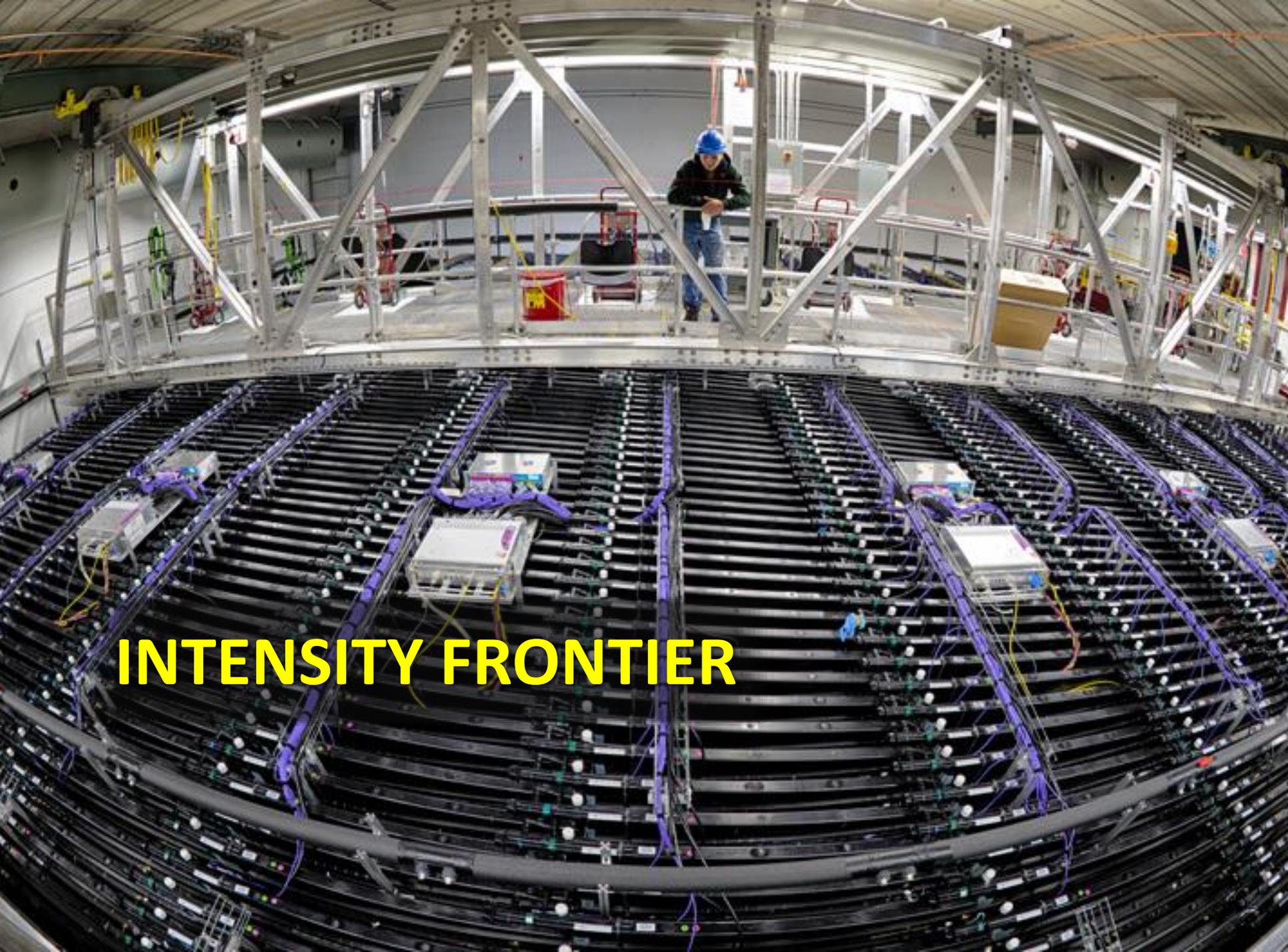
- Higher energy collisions at 13 TeV will increase the reach into search for new physics in high-impact topics:
 - SUSY, dark matter, extra dimensions, ...
 - Run II aiming for an integrated luminosity $\sim 100 \text{ fb}^{-1}$
 - Higgs boson was first observed using $\sim 10.5 \text{ fb}^{-1}$



Energy Frontier Strategy

- P5 report identified LHC upgrades as the highest priority near-term large project and specifically recommends:
 - Complete “Phase-1” (2018) upgrades of ATLAS and CMS experiments
 - Continue collaborations with the “Phase-2” (High-Luminosity LHC, 2023-25) upgrades of the accelerator and the ATLAS and CMS experiments
 - HL-LHC upgrades will increase LHC luminosity by a factor of 10 beyond its design value and significantly extend its discovery potential
 - NSF will be an important partner in realizing the continued success of the U.S. LHC program through the Phase-2 upgrades. We are actively coordinating with NSF on HL-LHC detector upgrade plans.
 - U.S. leadership in superconducting magnet technology in general, and with Nb₃Sn in particular, is widely recognized and acknowledged
 - U.S. LHC Accelerator Research Program (LARP) aims to leverage this expertise to serve needs of HEP community
 - Consists of four U.S. laboratories, BNL, FNAL, LBNL, and SLAC
 - Aims to realize the full capability of the LHC and maximize the discovery potential of U.S. investments in the LHC
- P5 noted the strong scientific importance of the ILC global project:
 - Recommended modest and appropriate levels of ILC accelerator and detector design in areas where the U.S. can contribute critical expertise
 - Report emphasized that support for these efforts would ensure a strong position for the U.S. within the ILC global project



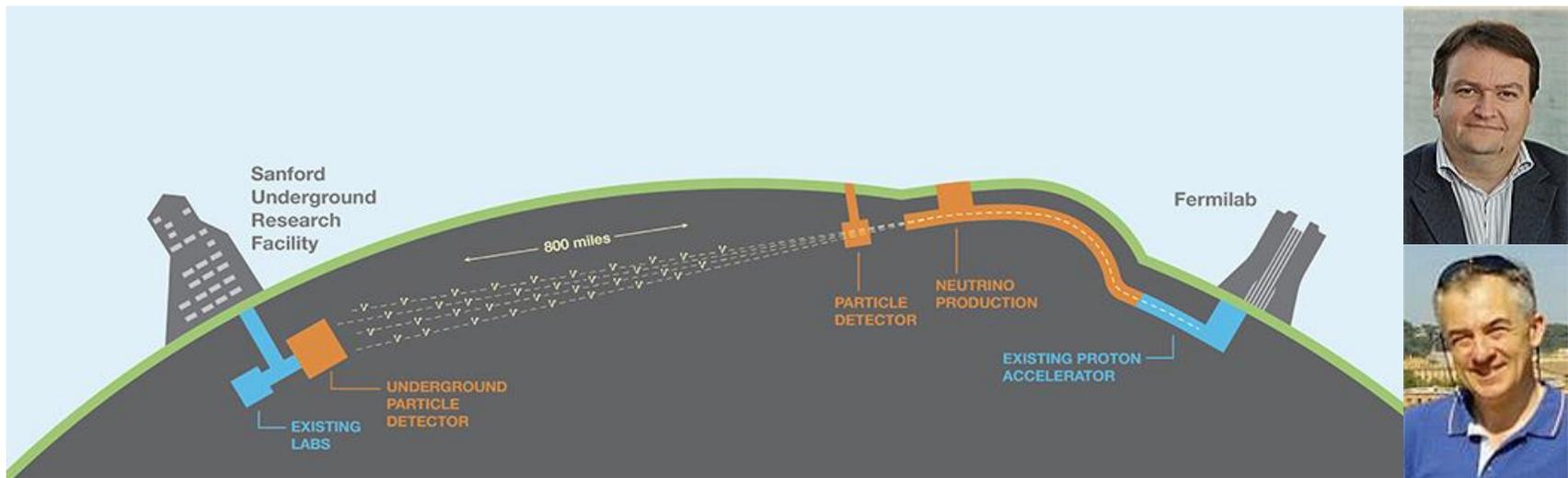


INTENSITY FRONTIER

Intensity Frontier Highlight:

International Collaboration Established for DUNE

- The long-baseline neutrino experiment has transformed into the international Deep Underground Neutrino Experiment (DUNE)
 - Major milestone in the implementation of the P5 report strategy!
- Growing collaboration includes 770 scientists from 150 institutions across 23 countries in Asia, Europe, and North and South America
 - André Rubbia (ETH Zurich) and Mark Thomson (University of Cambridge) serving as spokespersons of the international collaboration
- Fermilab and DOE continue to work with the International LBNF/DUNE programs to develop the organizational structure
 - Basing governance on successful model of LHC: IAC, RRB, Finance Board, etc.



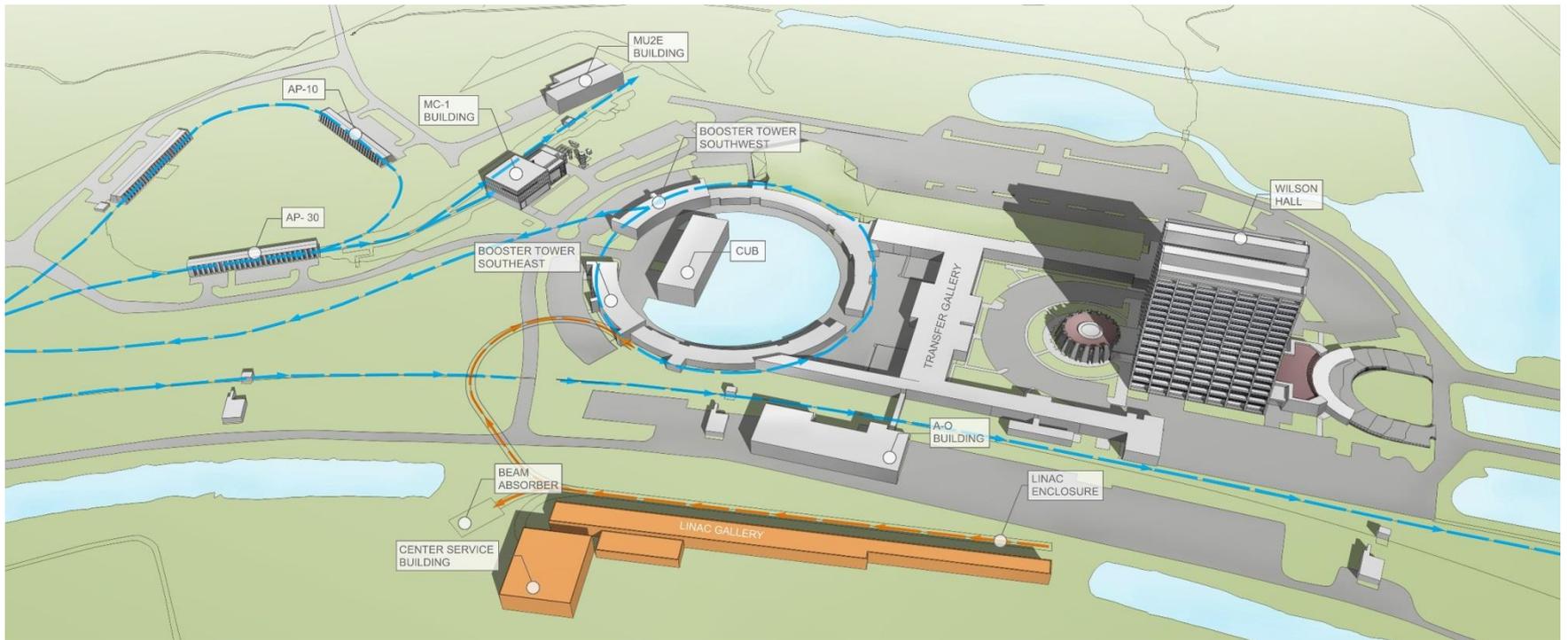
Intensity Frontier Strategy

- The P5 report recommended completing the Muon g-2 and Muon-to-electron Conversion (Mu2e) experiments at Fermilab, which provide complimentary ways of exploring the unknown for signs of new particles and interactions
- P5 recommended substantial investments in the U.S. neutrino program in order to develop, with international partners, a coherent short- and long-baseline neutrino program hosted at Fermilab
 - The swift establishment of the international Deep Underground Neutrino Experiment (DUNE) is a strong indication of the high level of interest from the neutrino community in achieving this global vision
 - The Fermilab Proton Improvement Plan II (PIP-II) program of updates to the accelerator complex will provide proton beams with power >1 MW by the time of first operation of DUNE
 - A coordinated set of short-baseline neutrino experiments will address the observed anomalies in current neutrino experiments while advancing the R&D necessary for LBNF and DUNE
- Fermilab has played a central role in coordinating the rapid community response to the significant changes in direction given in the P5 strategy
- Funding Opportunity Announcement (FOA) for the Intermediate Neutrino Program will be coming soon
 - FOA informed by February Workshop at BNL: <http://www.bnl.gov/winp/>

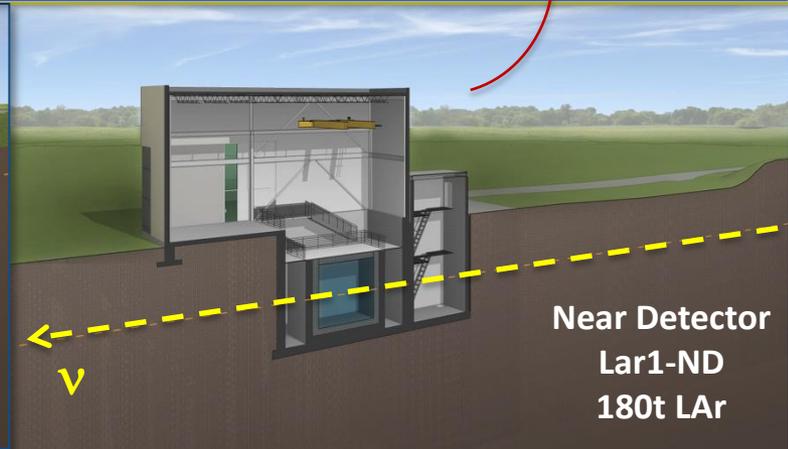
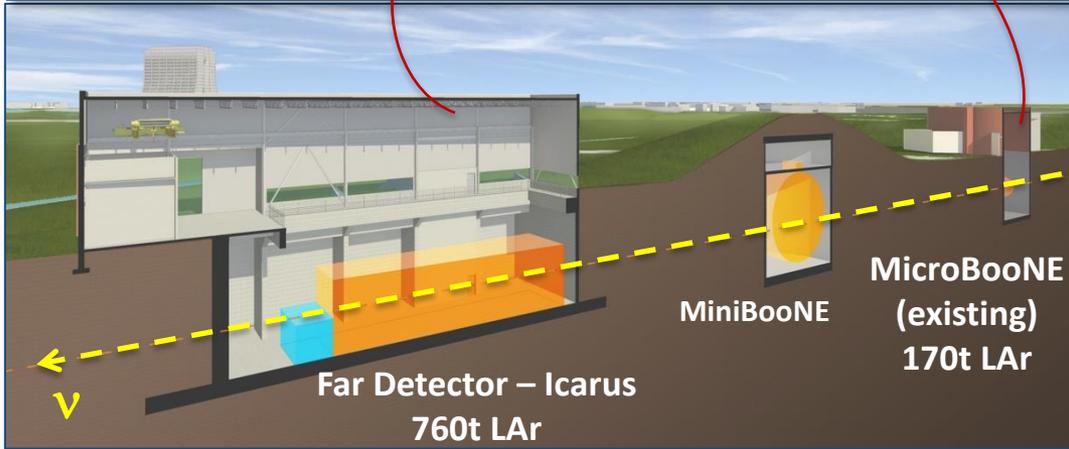
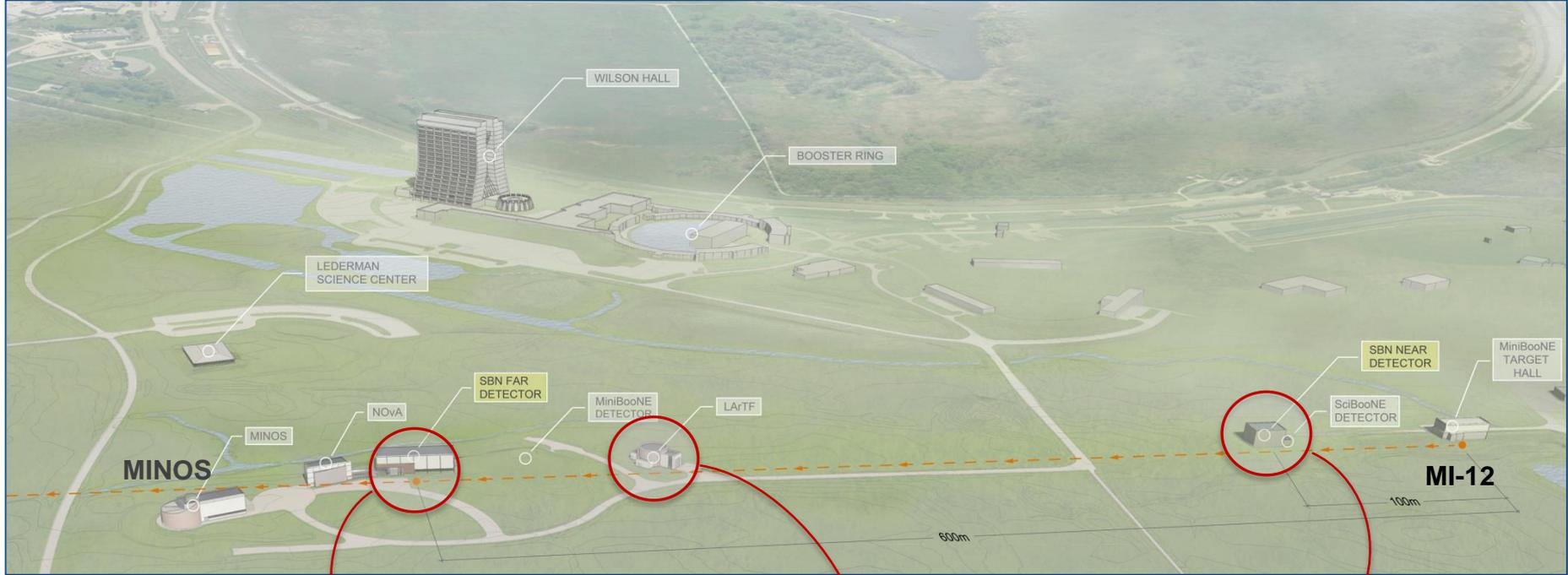


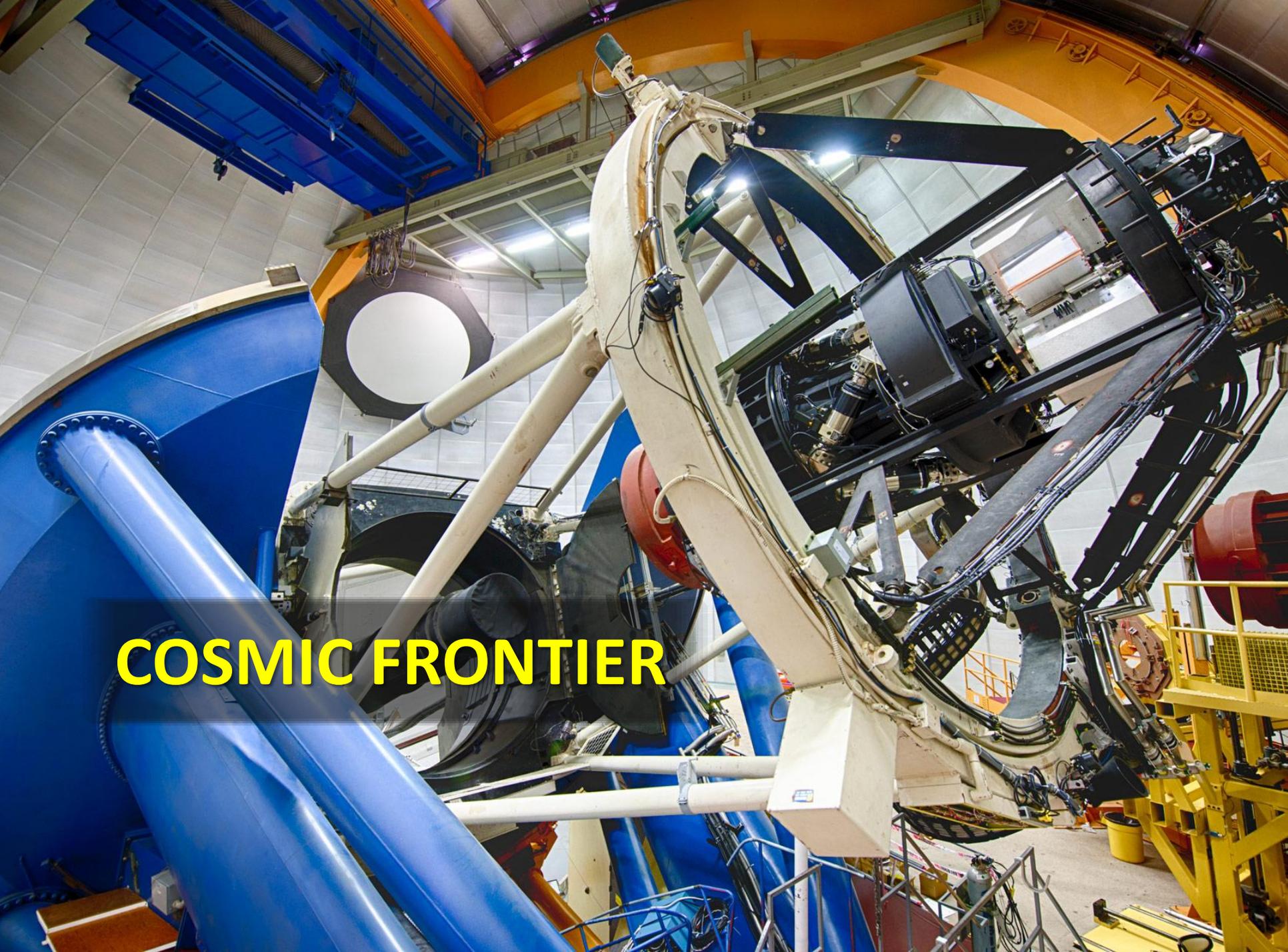
Proton Improvement Plan II (PIP-II)

- PIP-II supports longer term physics research goals by providing increased beam power to LBNF while providing a platform for the future
- Infrastructure and workforce development due to LCLS-II work at Fermilab will be leveraged in support of PIP-II, further advancing SRF capabilities



FNAL Short Baseline Neutrino Program



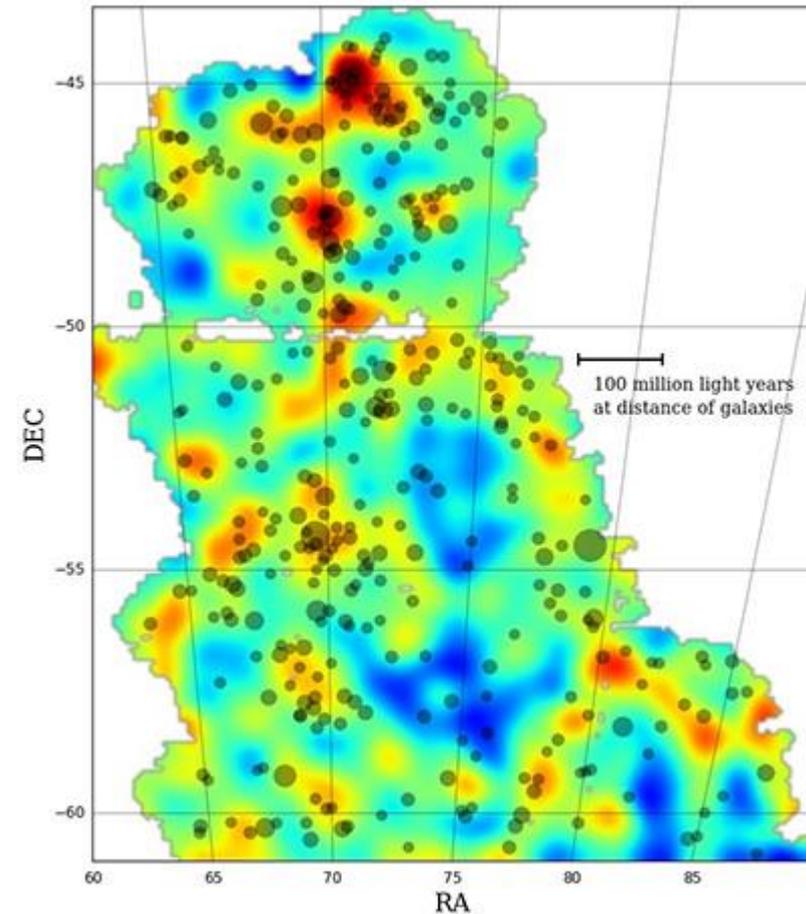


COSMIC FRONTIER

Cosmic Frontier Highlight:

DES Releases its First Map of Dark Matter

- The Dark Energy Survey and the 570-megapixel DECam continue to move science forward
 - Partnership with NSF
 - DECam mounted on the 4-meter Victor Blanco Telescope in the Chilean Andes
- Scientists on the Dark Energy Survey have released the first in a series of dark matter maps of the cosmos
 - Weak lensing mass map based on galaxy shape measurements in the 139 deg² SPT-E field from the Dark Energy Survey Science Verification data
 - Map covers only about 3% of the sky area DES will document over its five-year mission
 - Tests of analysis tools and studies of systematics performed in this analysis will benefit future DES science program



http://www.fnal.gov/pub/presspass/press_releases/2015/Mapping-The-Cosmos-20150413.html



Cosmic Frontier Strategy

- **P5 recommended proceeding immediately with a broad second-generation (G2) dark matter direct detection program and R&D towards third generation experiments**
 - Three G2 experiments jointly selected by DOE and NSF in July 2014 (ADMX-G2, LZ, and SuperCDMS-SNOlab); fabrication will begin in 2015
- **P5 supported advancing the dark energy program from current generation of experiments to the Large Synoptic Survey Telescope (LSST) and the Dark Energy Spectroscopic Instrument (DESI)**
 - LSST baseline was approved in January 2015
 - DESI is approved for fabrication start in 2015
 - Ramping up as rapidly as possible within constraints of FY 2015 funding
- **P5 recommended an advanced cosmic microwave background (CMB) experiment sensitive to the early expansion phase of the universe**
 - Community planning towards a “Phase IV” CMB experiment continues



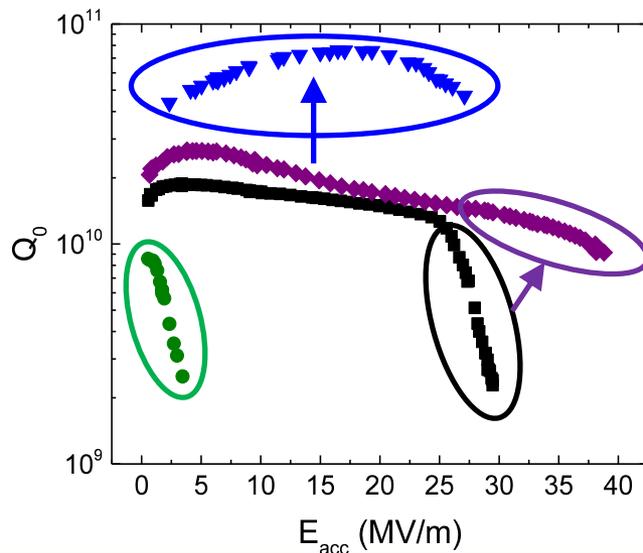
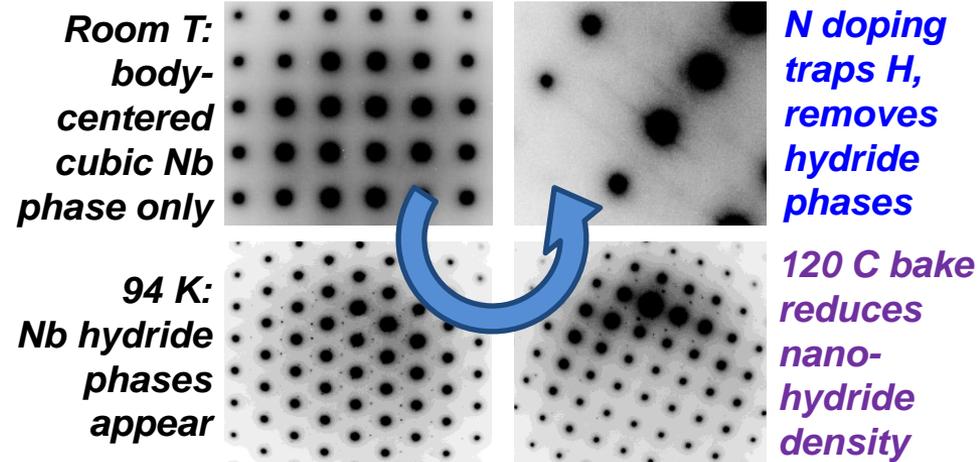


ADVANCED TECHNOLOGY R&D

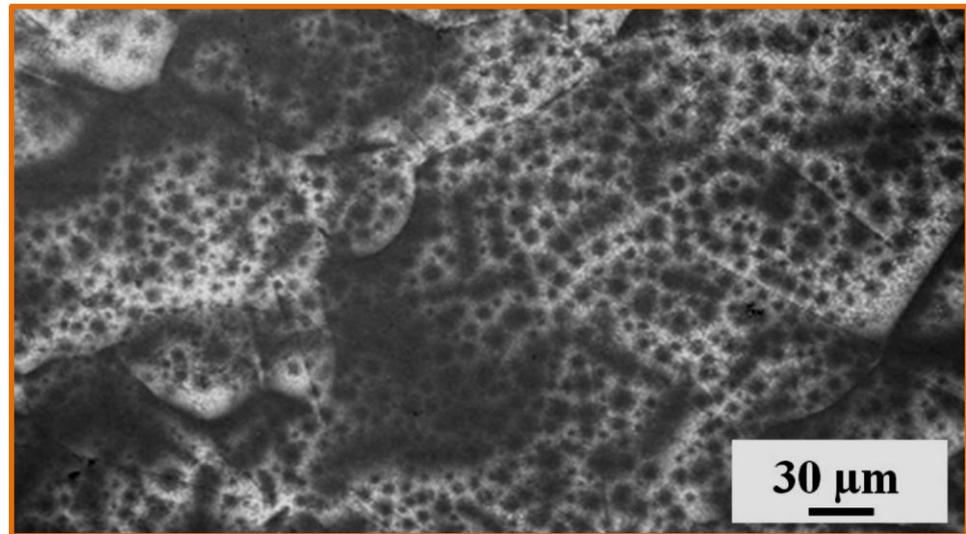
Advanced Technology R&D Highlight:

Advances in SRF Performance

- Recent SRF advancements have been driven by fundamental understanding of the underlying physics of the cavity surface
 - Microscopic mechanism of “Q-disease”
 - Origin of the “high field Q slope”
 - Mechanism of the “120 C baking”
 - Nitrogen doping to increase Q
 - Effect of cooling dynamics on Q



Trapped magnetic vortices imaged via Bitter Decoration





ACCELERATOR STEWARDSHIP

Accelerator R&D Stewardship Program

The mission of the HEP long-term accelerator R&D stewardship program is to support fundamental accelerator science and technology development of relevance to many fields and to disseminate accelerator knowledge and training to the broad community of accelerator users and providers.

- **Strategies:**
 - **Improve access to national laboratory accelerator facilities** and resources for industrial and for other U.S. government agency users and developers of accelerators and related technology
 - Work with accelerator user communities and industrial accelerator providers to **develop innovative solutions to critical problems**, to the mutual benefit of our customers and the DOE discovery science community
 - Serve as a catalyst to **broaden and strengthen the community** of accelerator users and providers
- **Engages the entire U.S. accelerator R&D ecosystem in a coordinated manner to solve high-impact challenges at a scale well beyond the reach of the DOE Small Business Innovation Research (SBIR) program**



Current and Upcoming Stewardship Activities

- **The Accelerator Stewardship Test Facility Pilot Program is launching after a delay due to appropriations**
 - The seven participating SC labs are conducting public outreach events through April–June and will propose collaborative R&D with industry to HEP for funding in FY 2015
 - The ANL/FNAL outreach event alone drew 95 registered participants
- **An Energy & Environmental Applications of Accelerator Basic Research Needs workshop is being planned for June 23-26 at ANL**
 - The goal is to identify accelerator technology R&D opportunities that, if developed, could enable high-impact solutions for current E&E challenges. Three working groups will address:
 - **WG-1: High power, low-energy e-beam systems for treating potable and waste water, removing pollutants from stack gases;**
 - **WG-2: High power, medium-energy e-beam systems for sterilization of sludges and solid wastes; mobile e-beam systems for environmental remediation;**
 - **WG-3: Superconducting magnet technologies for wind generators, enhanced magnetic separation of material streams, and other industrial processes.**
 - For more information contact Eric Colby (eric.colby@science.doe.gov)





FY 2016 HEP BUDGET REQUEST

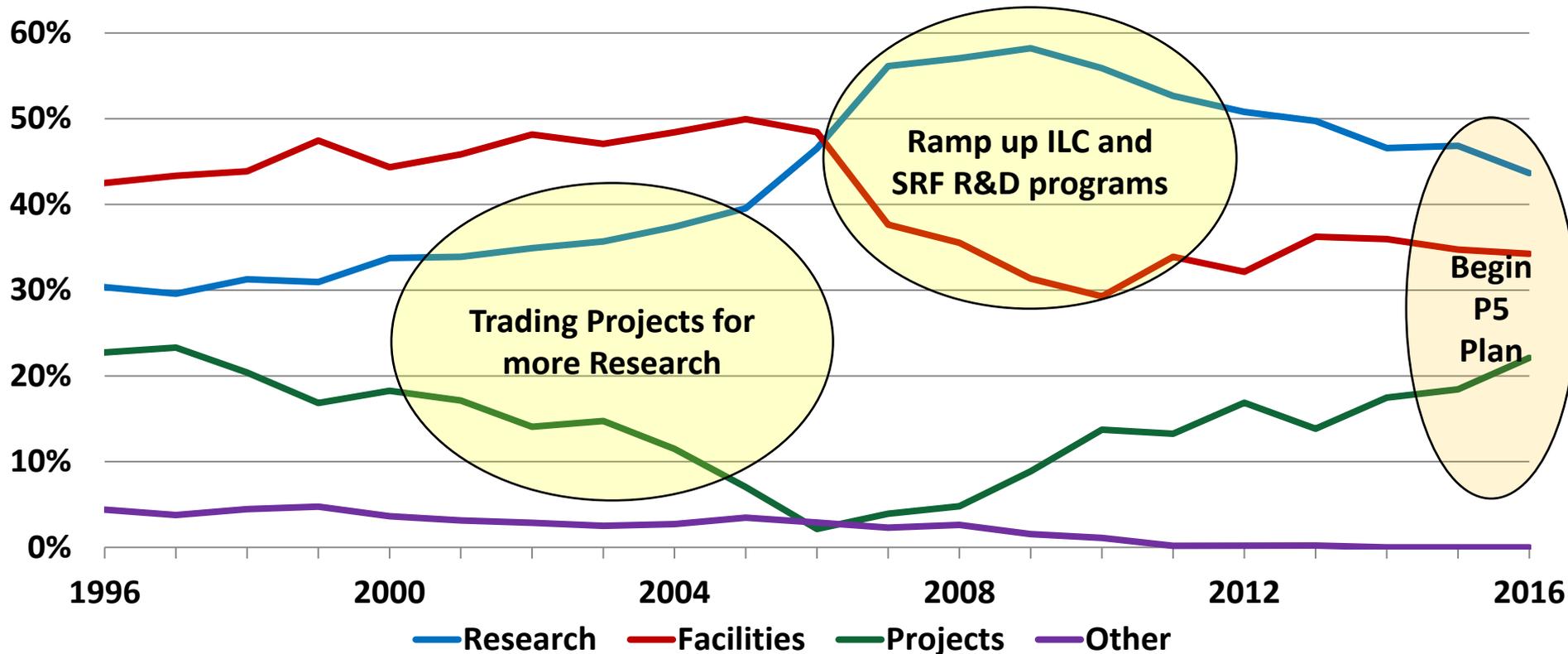
The FY 2016 HEP Budget Request

- **HEP is implementing the strategy detailed in the May 2014 report of the Particle Physics Project Prioritization Panel (P5), formulated in the context of a global vision for the field**
 - HEP Addresses the five compelling science drivers with research in three frontiers and related efforts in theory, computing and advanced technology R&D
 - Increasing emphasis on international partnerships (such as LHC) to achieve critical physics goals
- **Energy Frontier: Continue LHC program with higher collision energy (13+ TeV)**
 - The U.S. will continue to play a leadership role in LHC discoveries by remaining actively engaged in LHC data analysis and the initial upgrades to the ATLAS and CMS detectors
- **Intensity Frontier: Develop a world-class U.S.-hosted Long Baseline Neutrino Facility**
 - Continue the design process for an internationalized LBNF and development of a short baseline neutrino program that will support the science and R&D required to ensure LBNF success
 - Fermilab will continue to send world's highest intensity neutrino beam to NOvA, 500 miles away to Ash River, MN
- **Cosmic Frontier: Advance our understanding of dark matter and dark energy**
 - Immediate development of new capabilities continue in dark matter detection with baselining of 2nd-generation experiments; and in dark energy exploration with baselining of DESI and fabrication of LSST camera.



Funding Trends by Fiscal Year

(FY 2016 shows President's Request)

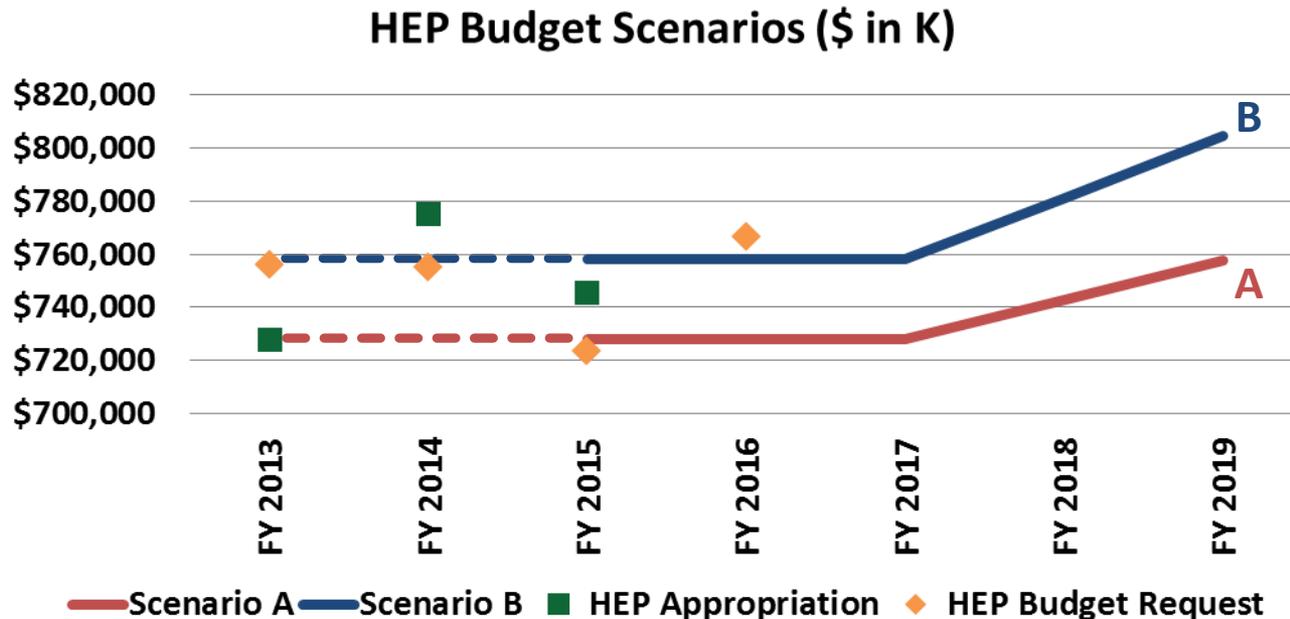


- P5 report recommendation suggests increasing the project budget fraction to 20%–25%
 - “Addressing the [science] Drivers in the coming and subsequent decades requires renewed investment in projects.”
- P5 report strategy has informed the HEP request in the FY 2016 DOE budget



Context: P5 HEP Budget Scenarios

- 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

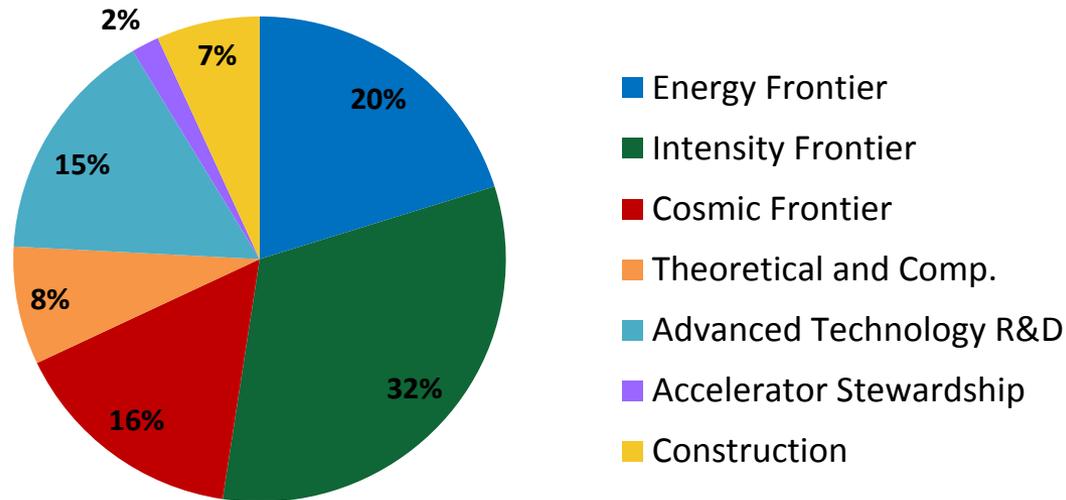


**Budget Request and Appropriations do not include SBIR/STTR*

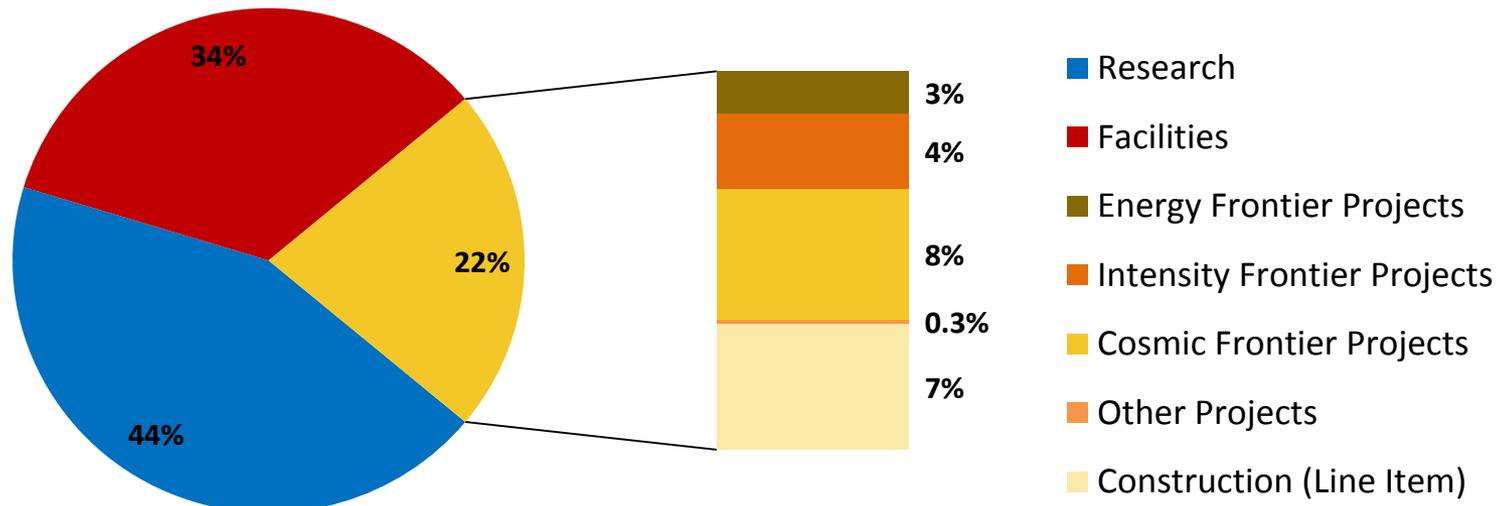


FY 2016 HEP Budget Request Overview

HEP FY 2016 Request Funding by Subprogram



HEP FY 2016 Request Funding by Activity



FY 2016 HEP Funding by Activity

HEP Funding Category (\$ in K)	FY 2014 Current	FY 2015 Enacted	FY 2016 Request	Explanation of Changes (FY16 vs. FY15)
Research	373,932	337,383	334,703	<i>Research reductions support project investments</i>
Facilities	278,683	265,125	262,658	<i>Maintain efficient operations of facilities and ongoing experiments</i>
Projects	71,305	105,698	113,401	
<i>Energy Frontier Projects</i>	<i>0</i>	<i>15,000</i>	<i>19,000</i>	<i>Ramp up in LHC detector upgrades fabrication</i>
<i>Intensity Frontier Projects</i>	<i>37,400</i>	<i>43,970</i>	<i>33,700</i>	<i>Continue g-2 and FNAL acc. upgrade profiles; some LBNE efforts move to construction</i>
<i>Cosmic Frontier Projects</i>	<i>30,705</i>	<i>45,728</i>	<i>58,701</i>	<i>Increase supports LSSTcam, DESI and second generation dark matter experiments</i>
<i>Other Projects</i>	<i>3,200</i>	<i>1,000</i>	<i>2,000</i>	<i>Planned Lattice QCD hardware acquisition</i>
Construction (Line Item)	51,000	37,000	56,100	<i>Planned profile for Mu2e; engineering and design for LBNE</i>
SBIR/STTR	21,601*	20,794	21,138	
Total	796,521*	766,000	788,000	House mark: \$776 M; Senate mark: \$788.1 M



FY 2016 HEP Budget: House Mark

- The FY 2016 [President's] Request for HEP was \$788 M, about a 2.9% increase compared to FY 2015
- The House released its FY 2016 Markup of the Energy and Water Appropriation at \$776 M, which overall is slightly below the FY 2016 Request, but above FY 2015 (by ~1.3%)
 - The mark is aligned with Scenario B of the P5 strategic report and notes:
“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.”
 - Construction Line-item is increased by \$2 M for the Long-Baseline Neutrino Facility
 - Accelerator Stewardship is marked at “not less than \$5 M” compared to \$14 M in the Request
 - Energy Frontier is marked at the FY 2016 requested level and includes LHC Experimental Research, Operations, and ATLAS and CMS [Phase-1] Detector Upgrades
- The Senate released its FY 2016 Markup of the Energy and Water Appropriation at \$788.1 M, which overall is at the level of the FY 2016 Request
- Actual allocation to research groups will continue to be based on funding availability, programmatic factors and priorities, and the results of merit reviews
- The House and Senate marks are “budget indicators” but not the final word on FY 2016
 - When an appropriation for the full-year is determined by Congress, there could be either an increase or a decrease in HEP research funding





OFFICE NEWS AND MISCELLANY

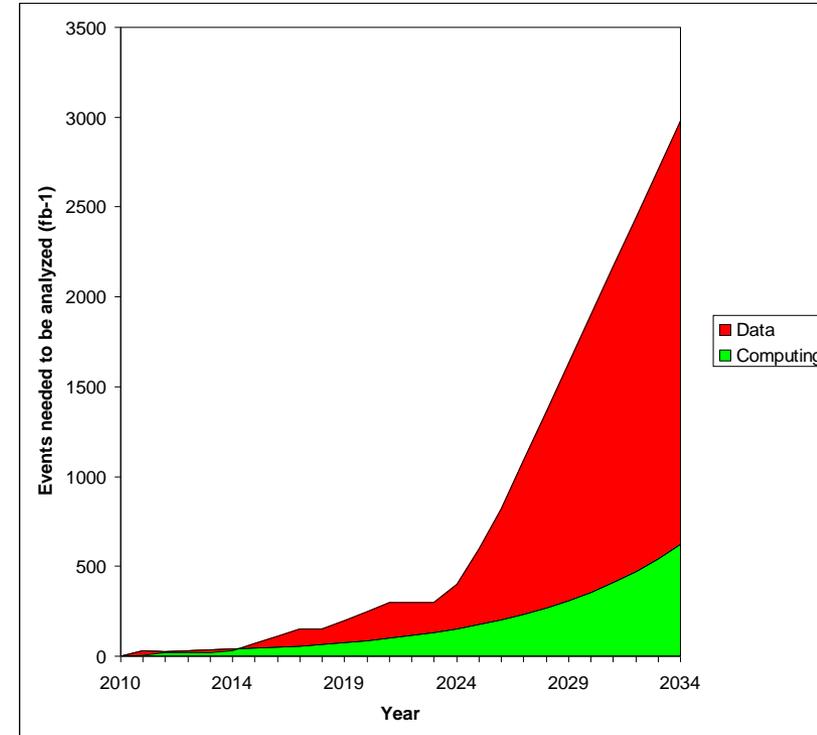
Request for Information (RFI)

- HEP posted a Request for Information on May 14, 2015, on “Strengthening U.S. Academic Programs in Accelerator Science”
 - Intent is to assess whether modest changes in funding practice may strengthen accelerator science programs in the universities and thereby support more robust accelerator workforce development
 - Full RFI is available online here:
 - <https://www.federalregister.gov/articles/2015/05/14/2015-11664/strengthening-us-academic-programs-in-accelerator-science>
 - Written comments and information are requested on or before June 18, 2015



HEP & Advanced Scientific Computing Research

- **HEP partnership with ASCR, including through the Forum for Computational Excellence, will help address issues facing HEP computing needs**
 - Many successful HEP-ASCR partnerships are already in place, such as SciDAC
 - Specific HEP groups have successfully used ASCR leadership-class facilities, but interest from HEP & number of HEP users continues to grow
- **HEP computational needs are continually growing**
 - Traditional solution of larger farms of commodity PCs is not a sustainable solution
 - Industry is trending towards more and smaller cores with less memory per core
 - High Performance Computers (HPCs) are ahead of the curve on these trends
- **HEP computing must adapt to the trends in HPCs as we move into the Exascale computing era**
- **DOE ASCR is holding a series of Office of Science Exascale Requirements Reviews**
 - Reviews begin with HEP-ASCR on June 10–13, 2015



Estimated ATLAS Computing Requirements

The green assumes 15% growth per year from Run 1, and that Run 1 had exactly enough capacity.

HEP Program Status Updates

- **(Lots of) Comings and Goings**

- Dave Boehnlein (Energy Frontier IPA, FNAL) departed Jan 2015
- Keith Dienes (Theory IPA, Arizona/NSF) departed Jan 2015
- Peter Kim (Detector R&D Detailee, SLAC) departed Feb 2015
- Larry Price (Computing Detailee, ANL) departed Mar 2015
- Tina Kaarsberg (Detailee, DOE EERE) arrived Nov 2014 → SBIR, Stewardship, infrastructure
- Eric Linder (Cosmic IPA, LBNL) arrived Jan 2015 → Operations, data management
- Steve Peggs (Detailee, BNL) arrived Mar 2015 → PIP-II
- Bill Wisniewski (Detailee, SLAC) arrived April 2015 → LBNF
- ~~Intensity Frontier Detailee TBA coming June 2015~~

- **New Assignments and Opportunities**

- Helmut Marsiske now assisting >half-time with Detector R&D program
- Michael Salamon ~full-time on International agreements
- Abid Patwa managing LHC Ops and Phase-2 detector upgrades
- Alan Stone taking on budgets and strategic planning
- Approval for **4 new Fed staff positions**
 - Physicist (Program planning, strategic communications) closed; *reviewing candidates*
 - Science Advisor (Accelerator R&D) closed; *reviewing candidates*
 - **Intensity Frontier program manager position will post soon**
 - Interested parties should contact HEP management



Secretary of Energy Ernest Moniz on U.S. Megascience

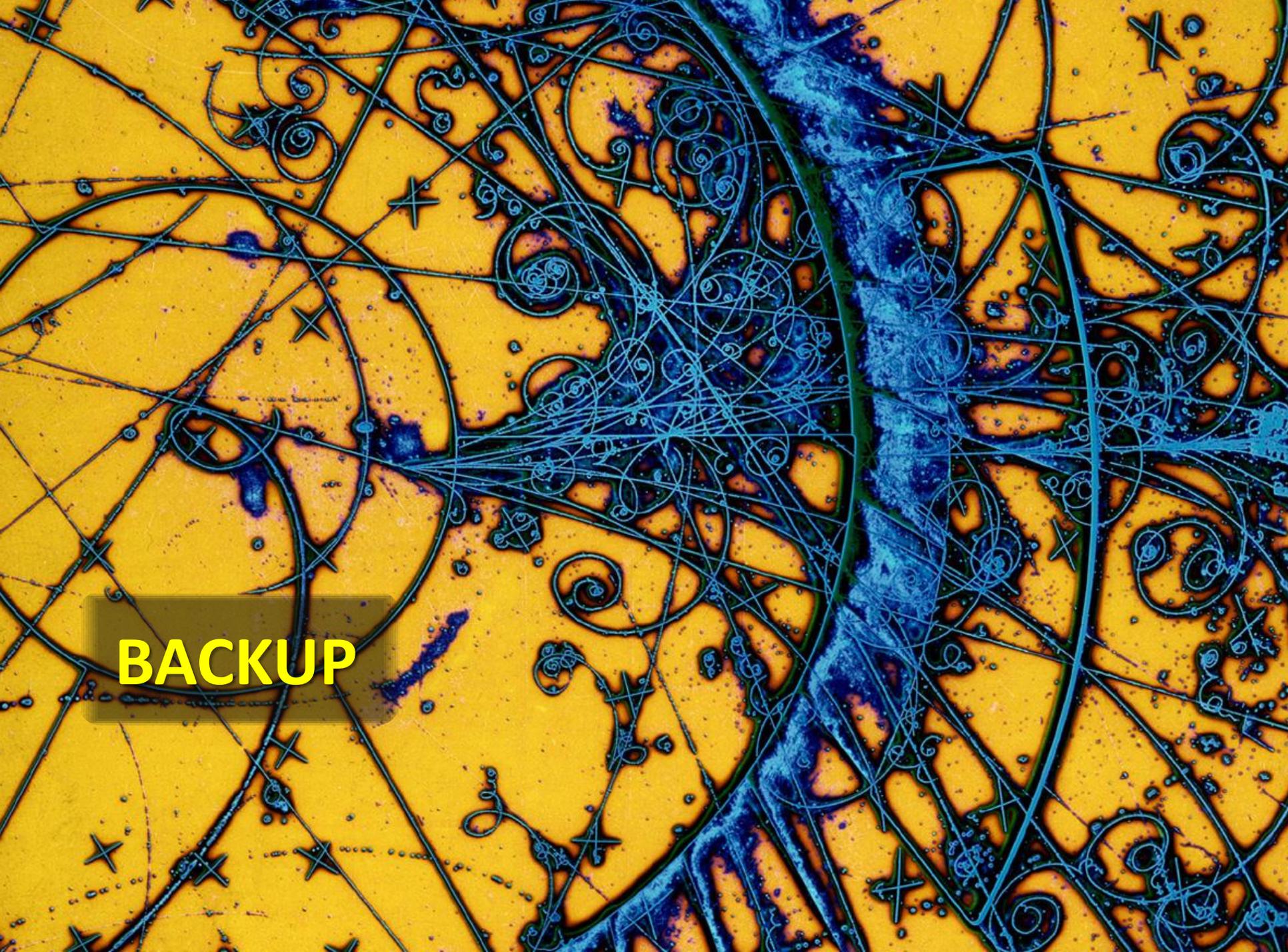


- The Secretary views “how to send a positive signal” to international partners that the U.S. is considering hosting an international megascience project (LBNF/DUNE) as a “policy issue”
 - Therefore, this issue is of importance to the White House Office of Science and Technology Policy (OSTP)

Future

- **Particle physics has a long history of leading successful efforts to “internationalize” science**
- **Science will likely only increase reliance on internationalization**
 - A host will need to assemble experts (and other resources) from around the globe to achieve ambitious science goals and enable future discoveries
- **LBNF/DUNE gives the U.S. the opportunity to set a strong example in hosting its first international “megascience” facility**
 - Builds on the foundation of highly successful international cooperative efforts in particle physics
 - May lead to future opportunities for megascience in the U.S.





BACKUP

A Long-term Strategy to Enable Discovery

- *How do we address the science drivers and enable the next discovery in particle physics?*
- **The Particle Physics Project Prioritization Panel (P5) report is the culmination of years of effort by the U.S. particle physics community**
 - 2012 – 2013: American Physical Society’s Division of Particles and Fields organized a year-long community planning exercise (“Snowmass”)
 - 2013 – 2014: DOE and NSF charged the High Energy Physics Advisory Panel (HEPAP) to convene P5 to develop an updated strategic plan
 - **Plan to be executed over a ten year timescale in the context of a 20-year global vision for the field**
 - In May, 2014, HEPAP unanimously approved a P5 report that presents a strategy that enables discovery and maintains the U.S. position as a global leader in particle physics
- **U.S. particle physics community enthusiastically supports the new plan**
 - 2,331 community members signed a letter of support to DOE and NSF



Enabling the Next Discovery

Science drivers identify the scientific motivation while the Research Frontiers provide a useful categorization of experimental techniques



	Energy Frontier	Intensity Frontier	Cosmic Frontier
Higgs Boson	●		
Neutrino Mass		●	●
Dark Matter	●	●	●
Cosmic Acceleration			●
Explore the Unknown	●	●	●

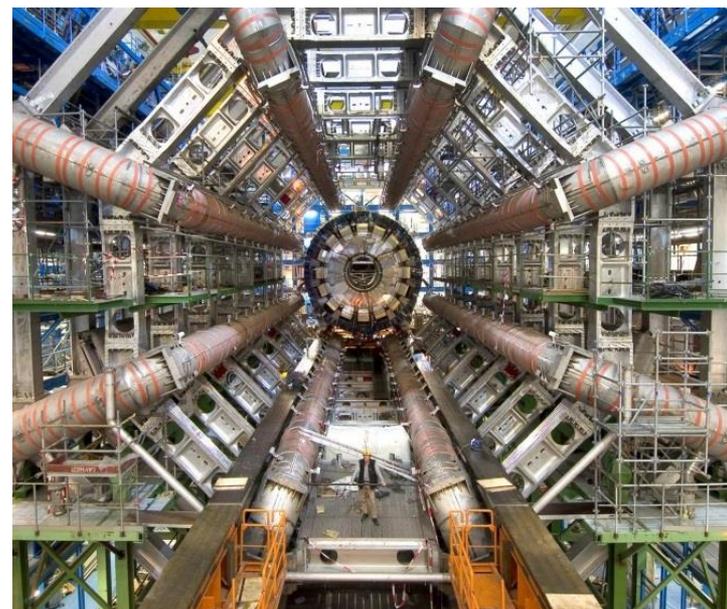
Energy Frontier Status Update

Current program

- 400+ LHC Run I 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
 - Phase-1 U.S. CMS/ATLAS upgrades received CD-3 approval on November 12, 2014

Planned program

- Considering high-luminosity LHC upgrade around 2023 to extend discovery reach
 - Increase luminosity by 10 times LHC design value to explore new physics at TeV energies
 - DOE/HEP actively working with US-CMS/ATLAS to begin mounting HL-LHC Detector Upgrade Project
- The new bilateral U.S.-CERN Cooperation Agreement was signed on May 7, 2015
 - DOE has initiated drafting of the 3 Annexes (\equiv Protocols) to the umbrella agreement
- Modest investments in R&D for future options:
 - Lepton colliders
 - Very high energy hadron colliders



Intensity Frontier Status Update

Exploring the unknown through precision measurements

- **Development of muon-beam based program at Fermilab continues:**
 - *Muon g-2*: Cryogenic test of the SC magnet system will be completed before baselining
 - *Mu2e*: Reached CD-3 on March 4, 2015
- **Collaborating with Japan on *K* meson, *c/b* quark, and τ lepton precision studies:**
 - *Belle II*: reached CD-3 on April 23, 2014
 - *KOTO*

Identify the physics of dark matter

- ***APEX* and *Heavy Photon Search* performing particle beam based searches for DM**
 - *Heavy Photon Search (HPS)*

Pursuing 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 will complement *MicroBooNE* with *ICARUS* arrival anticipated in 2017, LAr1-ND installation planned for 2018
 - Funding Opportunity Announcement (FOA) for the Intermediate Neutrino Program will be coming soon
 - *DUNE* established as international long-baseline neutrino experiment



Cosmic Frontier Status Update

Dark Energy

- *BOSS* and *DES* released new results at the APS April meeting
- *Large Synoptic Survey Telescope (LSST)* received CD-3a in June 2014, CD-2 on Jan. 7, 2015
 - CD-3 review scheduled for August
- *Dark Energy Spectroscopic Instrument (DESI)* received CD-1 in March 2015
 - CD-2 review scheduled for July; fabrication start approved in FY 2015
 - Finalizing MOA with NSF to transition Mayall telescope operations costs to DOE in FY2016 – FY2019

Dark Matter (direct detection)

- Progress continues on DM-G2 experiments: *ADMX-G2*, *LZ*, *SuperCDMS-SNOlab*
 - *LZ* & *SuperCDMS-SNOlab* MIE projects are approved for fabrication starts in FY 2015
 - *LZ* received CD-1/3a on April 28, 2015; *SuperCDMS-SNOlab* will have CD-1 review in summer 2015

Cosmic-ray, Gamma-ray

- *Fermi/GLAST*, *AMS*, and *HAWC* continue operations
 - *HAWC* gamma-ray observatory began taking data in late November 2014
- DOE operations efforts will complete in FY 2016 for *VERITAS* and *Auger*

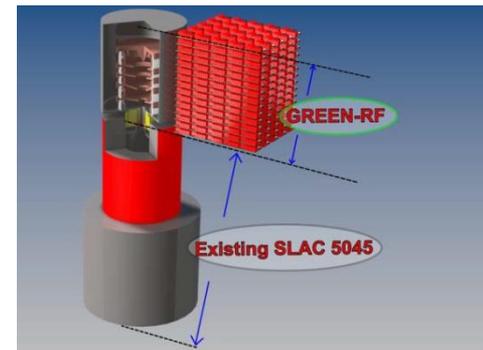
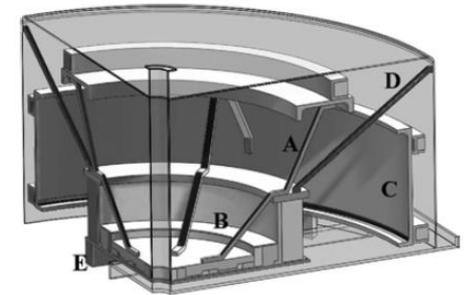
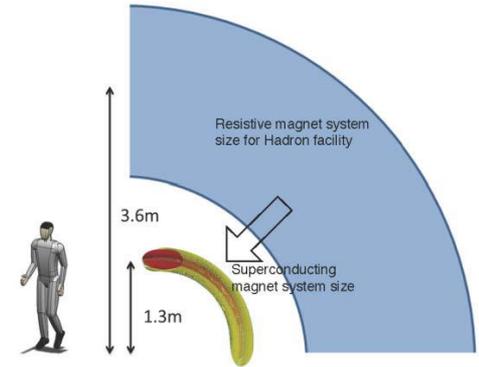
Cosmic Microwave Background (CMB)

- *South Pole Telescope polarization (SPTpol)* continues operations
- *SPT-3G* had successful review of DOE roles/responsibilities in September 2014
 - Fabrication funding approved for FY 2015 – 16
- Community planning continues for a CMB Stage IV experiment



Accelerator R&D Stewardship Program Awards

- Two awards coordinated with the National Cancer Institute of the National Institutes of Health, targeting particle-beam-based cancer therapies:
 - LBNL, Paul Scherrer Institute, and Varian Particle Therapy, Inc.
 - Light-weight SC magnets to reduce the size and weight of particle beam delivery systems by nearly a factor of 10
 - MIT and ProNova Solutions, LLC
 - Innovative design for an ironless superconducting cyclotron capable of providing particle beams for cancer therapy
- Four grants coordinated with BES, NP, DOD and NSF focus on broad, promising new areas for improving general accelerator performance:
 - LBNL, LLNL and University of Michigan
 - Test technologies that promise to increase the speed of laser-based science by a factor of 1,000
 - SLAC and Communications & Power Industries, LLC
 - Energy recapture technology that could be applied to LCLS and other klystron-powered linacs
 - Cornell University
 - Advanced optimization techniques to automate the control of complex accelerators
 - Texas A&M
 - Beam dynamics in cyclotrons to increase beam power
- We welcome input on maximizing the appeal of this program to industry partners



Optimally Implementing the HEP Program

- DOE HEP has created internal working groups aimed at identifying ways to better move forward with the P5 vision
 - HEP Cross-cuts within the Office of Science
 - Leveraging connections between HEP and other program offices
 - HEP Office Operations
 - Optimizing internal operations to more efficiently implement our program
 - HEP Research Initiatives
 - Identifying opportunities for near-term high-priority directed investments (e.g. WINP-based FOA)
- Talks at the April HEPAP meeting discussed other aspects of the DOE program:
 - Accelerator Stewardship
 - University Accelerator R&D
 - FY 2015 Annual University Comparative Review

Computing in HEP

- **HEP Computing and Data Challenges continue to grow for all Frontiers**
 - Data production exceeded 10 PB last year!
- **HEP Computational program is looking into addressing P5 Recommendation 29 on computing**
 - We need to draw in all available resources and expertise
- **Talks at the April HEPAP meeting discussed ways to move computing efforts forward:**
 - Dr. Steve Binkley, Associate Director for Advanced Scientific Computing Research (ASCR), discussed DOE facilities and the partnerships available for HEP to use
 - The HEP Forum for Computational Excellence (FCE) discussed their plans to respond to P5 Recommendation

HEP Science & Technology Connections Updates

- **Joint HEP-ASCR Study Group**

- “Grand Challenges at the Intersections of QIS (Quantum Information Science), Particle Physics, and Computing” was held on December 11, 2014

- Report presents a set of Grand Challenge questions along with potential paths forward for advancement of associated technology and fundamental science insight

- <http://science.energy.gov/hep/news-and-resources/reports/>

- Will be discussed in talks by J. Preskill and S. Binkley

- **HEP-BES Round Table**

- “Common Problems in Condensed Matter Physics and Particle Physics” was held February 2, 2015

- Report in progress

- Also see “Materials-by-design & implications for HEP” by Mike Norman (Argonne) at the December 2014 HEPAP Meeting

