U.S. DEPARTMENT OF ENERGY | Office of Science

High Energy Physics Status Report

HEPAP Meeting
November 21, 2019

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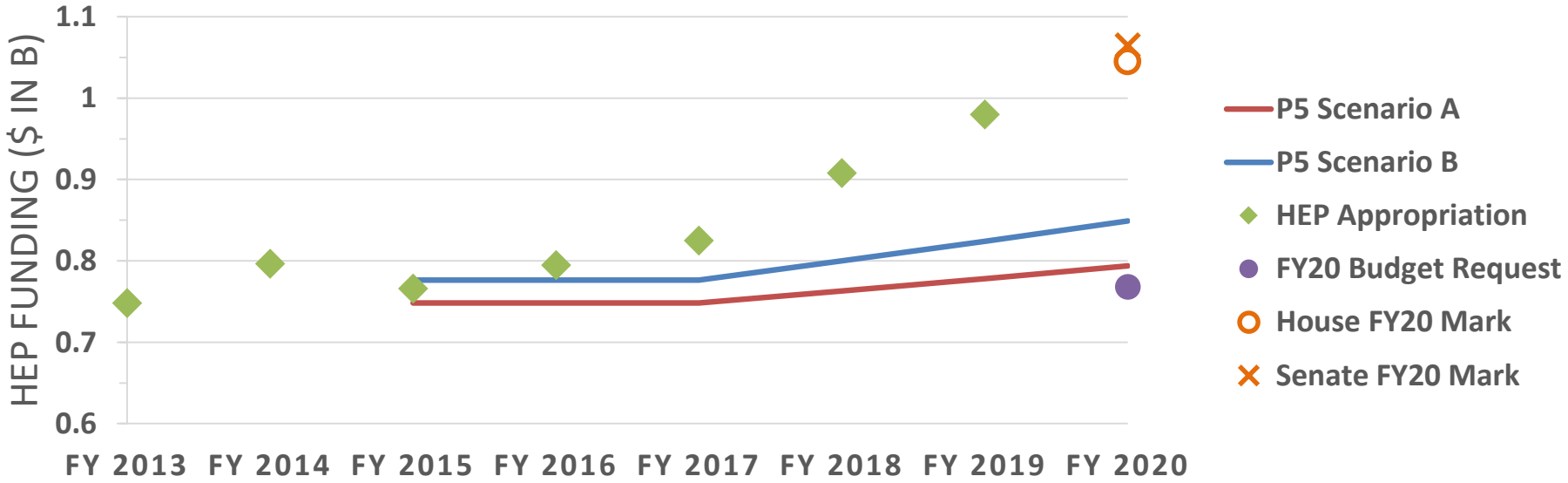
DOE Office of Science Statements on Diversity, Equity, and Inclusion

- The DOE Office of Science (SC) is fully committed to fostering safe, diverse, equitable, and inclusive work, research, and funding environments that value mutual respect and personal integrity.
  - Effective stewardship and promotion of diverse and inclusive workplaces that value and celebrate a diversity of people, ideas, cultures, and educational backgrounds is foundational to delivering on the SC mission. The scientific community engaged in SC-sponsored activities is expected to be respectful, ethical, and professional.
  - https://science.energy.gov/sc-2/research-and-conduct-policies/diversity-equity-and-inclusion/
- Office of Science Statement of Commitment
  - The DOE Office of Science (SC) is fully and unconditionally committed to fostering safe, diverse, equitable, and inclusive work, research, and funding environments that value mutual respect and personal integrity.
  - https://science.energy.gov/sc-2/research-and-conduct-policies/diversity-equity-and-inclusion/sc-statement-of-commitment/
- Office of Science Statement on Harassment
  - Harassment of any kind, including sexual and non-sexual harassment, bullying, intimidation, violence, threats of violence, retaliation, or other disruptive behavior is not tolerated in the federal workplace, including Department of Energy (DOE) site offices, or at DOE national laboratories, scientific user facilities, academic institutions, other institutions receiving Office of Science funding, or at locations where activities are funded by the DOE Office of Science.
  - https://science.energy.gov/sc-2/research-and-conduct-policies/diversity-equity-and-inclusion/harassment/
- **For latest news, see "Office of Science Diversity, Equity & Inclusion Initiatives" by Julie Carruthers at October 25, 2019, BERAC:**
  - https://science.osti.gov/ber/berac/Meetings/201910

FY 2020 Budget Status

- U.S. Congress continues to show strong support for executing the P5 strategy
  - FY 2020 House and Senate Marks for DOE HEP are above the President's Budget Request



FY 2020 Budget Status

- FY 2020 began on October 1, 2019
  - Currently operating under a Continuing Resolution (CR) through November 21, 2019
  - House passed CR through December 20; now in Senate
- House and Senate Marks include increased support for LBNF/DUNE and PIP-II projects
- More details on HEP Budget in Alan's talk

HEP ($ in K)	FY19 Enacted	FY20 Budget Request	FY20 House Mark	FY20 Senate Mark
HEP Core Program	800,000	648,038	814,000	829,000
Line Item Construction	180,000	120,000	231,000	236,000
PIP-II	*20,000*	*20,000*	*60,000*	*65,000*
LBNF/DUNE	*130,000*	*100,000*	*171,000*	*171,000*
Mu2e	*30,000*	*……*	*……*	*……*
Total	**980,000**	**768,038**	**1,045,000**	**1,065,000**

The DOE SC QIS Initiative and Budget

- DOE SC resources devoted to QIS have ramped up rapidly in the past few years, and the President's Budget Request for next year (FY 2020) invests further:
  - QIS Identified as a priority by both Congress and the Executive Office of the President
  - Cuts across all six SC research programs (and several other DOE programs)
  - The HEP QIS budget is allocated to HEP from the overall SC QIS Budget
- FY 2020 request highlights establishment of DOE quantum centers:
  - "(ASCR, BES, and HEP will partner to) establish at least one multi-disciplinary QIS center to promote basic research and early stage development to accelerate the advancement of QIS through vertical integration between systems and theory and hardware and software."

Dollars in thousands	**FY 2018**	**FY 2019**	**FY 2020**		
Quantum Information Science	Enacted Approp.	Enacted Approp.	President's Request	Request vs. FY 2019 Enacted	
Total across Office of Science	62,379	123,483	168,492	45,009	36.4%

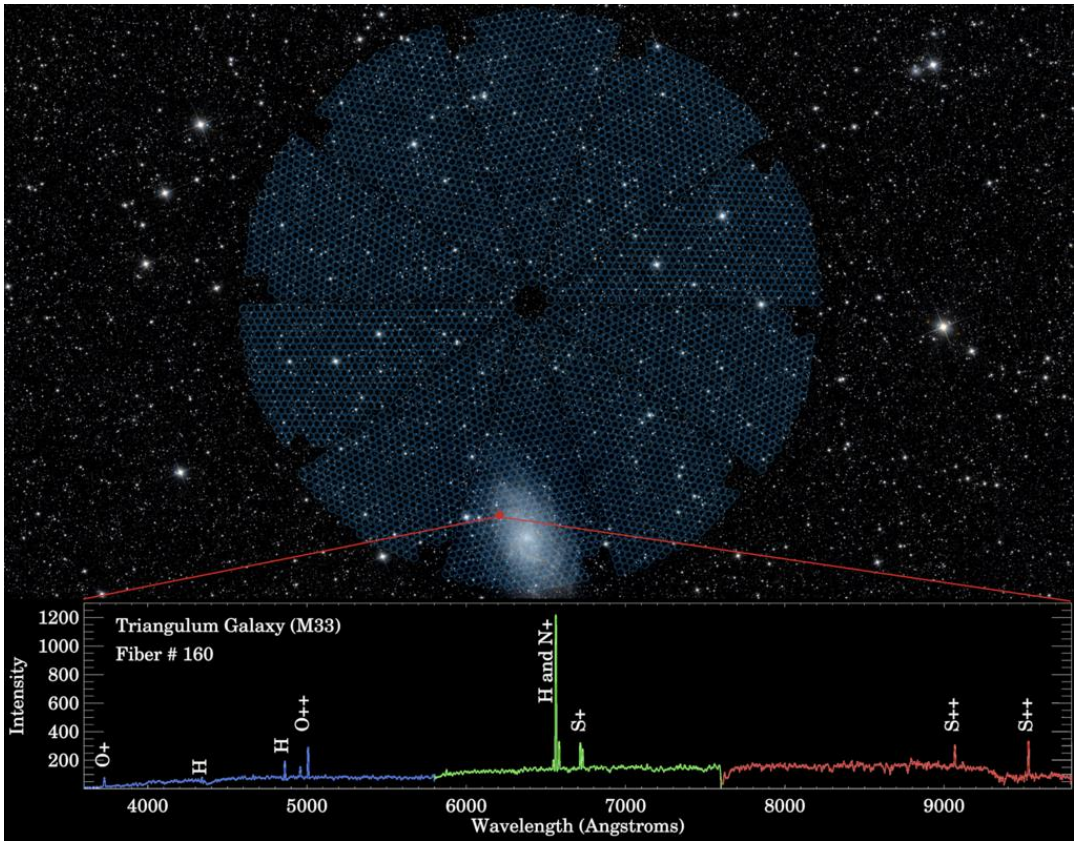
LHC and Future Colliders

- ATLAS and CMS (Phase-1) Detector Upgrade projects have been completed and both received CD-4 in the summer
  - CMS completed all the installation within the projects, in some cases before LS2
  - Following a baseline change in August 2018, ATLAS New Small Wheel activities are being carried out in the Operations program
- Consolidation and detector installation activities in LS2 (2019-2020) continue
  - DOE working with experiments on remaining plans for installation and commissioning of Phase-1 upgrades (e.g. ATLAS Muon New Small Wheel)
- High-Luminosity LHC Upgrade Projects continue to make progress:
  - HL-LHC AUP received CD2/3b approval in February 2019
  - HL-LHC ATLAS received CD3a approval in October 2019
  - HL-LHC CMS is scheduled for CD-1 in December 2019
- Future Colliders
  - Coordinating with U.S. State Department and The White House OSTP on discussions in support of proposed CERN Future Circular Collider & Japan International Linear Collider
  - DOE recently partnered with CERN on a "FCC Innovation Study" proposal submitted to EU Horizon 2020 $\Longrightarrow$ enable DOE labs to engage into the FCC network

DESI First Light

First Light achieved on October 22, 2019, on the first day of commissioning

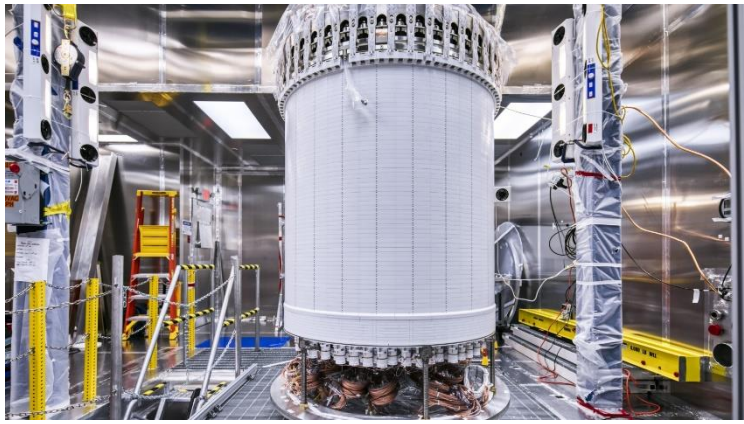
- Blue circles represent the sky footprint of the 5000 fiber positioners on the focal plane
  - Spectrum shown collected by one fiber from a section of the Triangulum Galaxy
- Commissioning expected to last 5 mo., ending Mar. 2020
  - Measured performance surpasses requirements and expectations!
- 70+ institutions, 500 scientists, including 140 graduate students!
  - U.S. DESI is: LBL (lead), FNAL, SLAC, ANL, BNL, LLNL, and 21 U.S. Universities



LUX-ZEPLIN (LZ) Dark Matter Experiment

- Major milestone for the LZ Project achieved October 2019
  - LZ TPC loaded into cryostat and moved underground
- Early finish of the LZ Project is currently scheduled for July 2020
  - Science operations to begin Fall 2020

LZ Time Projection Chamber prior to insertion into Inner Cryostat Vessel



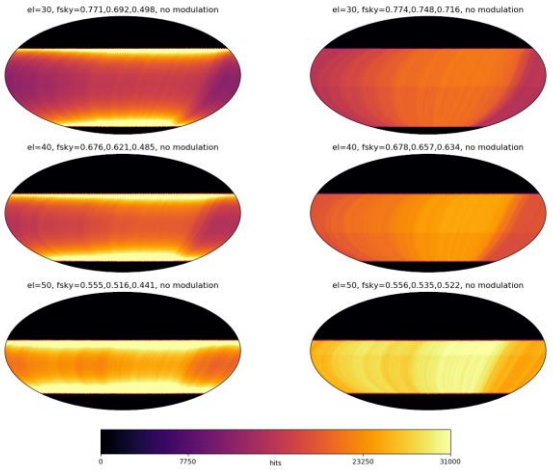
LZ TPC inside ICV after transport underground at SURF on Oct 21, 2019

CMB-S4 Progress

Science:

New scanning strategy simultaneously meets wide-area survey requirements for light relics, galaxy clusters, and mm-wave transients:

- Large sky area
- Uniform coverage
- Daily cadence



Project Development:

07/19: DOE Critical Decision 0
08/19: DOE detector fabrication review
10/19: NSF Mid-Scale RI-1 funding & PEP
10/19: 10th biannual collaboration meeting
11/19: 2nd annual project review
11/19: Astro2020 RFI/TRACE response

AMS Upgrade

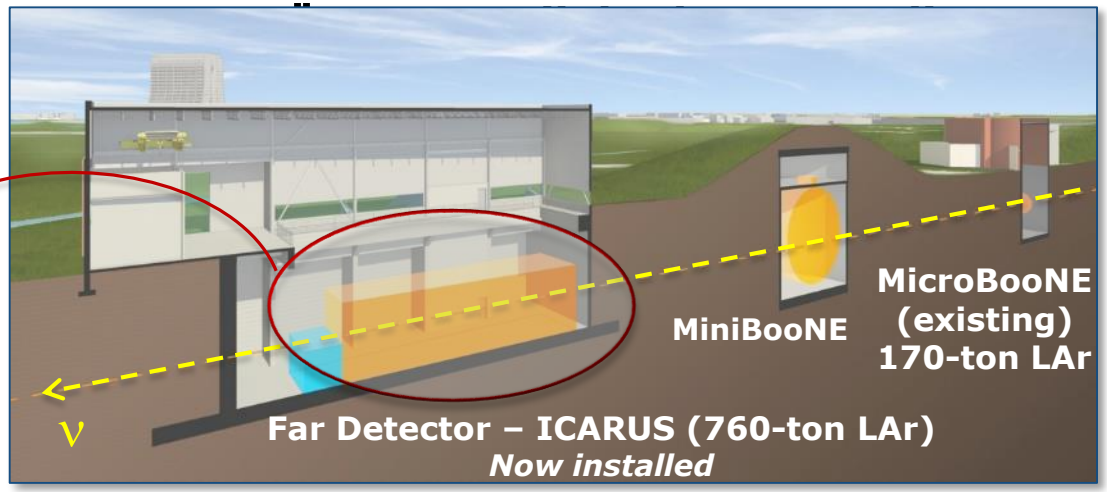
- AMS is a joint effort between DOE and NASA, led by Samuel Ting
  - Collaboration includes 600 physicists from 56 institutions in 16 countries
- Successful November 2, 2019, launch of the Cygnus spacecraft, NG-12, carried new pumps for AMS to the International Space Station
  - Over coming months, a series of spacewalks will service AMS to connect the new pumps to the cooling system

DOE Science ✓
@doescience

Happy to be at @NASA_Wallops for the launch of equipment to upgrade the @Space_Station's Alpha Magnetic Spectrometer! AMS has gathered cosmic radiation data since 2011 to search for #darkmatter & more. Extension will further expand our understanding of the universe -Dr Chris Fall

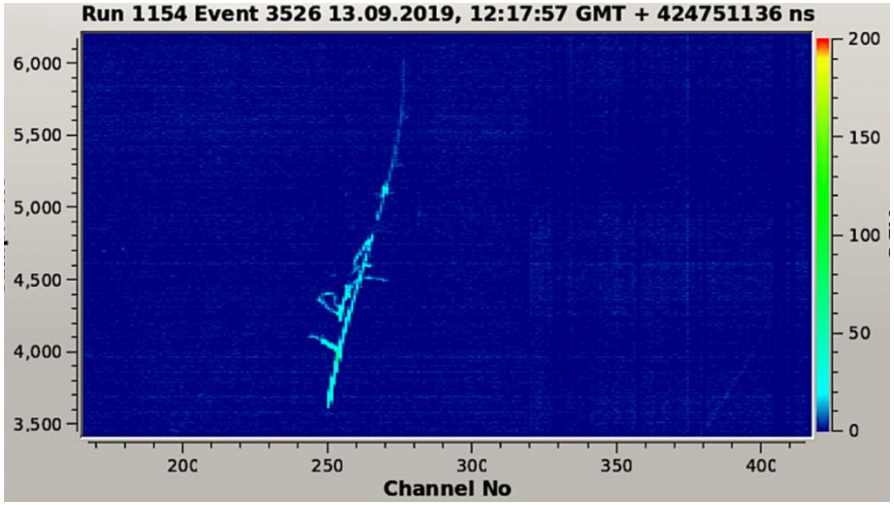
Advancing Technology Towards LBNF/DUNE

- Fermilab Short-Baseline Neutrino Program
  - Resolve experimental anomalies in measured ν-spectrum, including search for sterile neutrino
  - Demonstrate the detector technology for DUNE
- The largest liquid argon neutrino detector in the world, ICARUS, was transported last summer from Europe to Fermilab
  - Now preparing for the **liquid argon fill** to begin in the coming weeks!



ProtoDUNE

- ProtoDUNE is not a formal part of the DOE LBNF/DUNE project, but is testing full size components in a neutrino beam at CERN
  - ProtoDUNE will use 6 full-sized drift cells; a DUNE detector module has 150 cells
- Two designs:
  - Single phase liquid argon has been successfully built before
  - Dual phase liquid argon could be lower cost
- Dual-phase ProtoDUNE began operations in August 2019:



Two ProtoDUNE detectors at the CERN Neutrino Platform

LBNF Near-Site Groundbreaking

- Nov. 14, 2019: Groundbreaking celebration for start of the site preparation for Illinois portion of LBNF
  - Near-site will include a new beamline for its accelerator complex to direct those neutrino particles to South Dakota, and an underground cavern on the Fermilab site to house a multi-component particle detection system

From left: Fermilab Deputy Director for LBNF Chris Mossey, Warrenville City Council Member Leah Goodman, Batavia Mayor Jeff Schielke, West Chicago Mayor Ruben Pineda, DOE Associate Director of Science for High Energy Physics Jim Siegrist, CERN Experimental Physics Department Head Manfred Krammer, Fermilab Director Nigel Lockyer, STFC Executive Director Mark Thomson, DOE Fermi Site Office Manager Mike Weis, Sanford Underground Research Facility Communications Director Connie Walter, INFN Professor Sergio Bertolucci, Special Advisor to FAPESP Roberto César, IN2P3-CNRS Deputy Director Patrice Verdier, DOE Federal LBNF/DUNE Project Director Pepin Carolan, Kenny Construction Project Manager Michael Zika, Wroclaw University of Science and Technology Professor Maciej Chorowski. Photo: Reidar Hahn

DOE Status Review of LBNF/DUNE

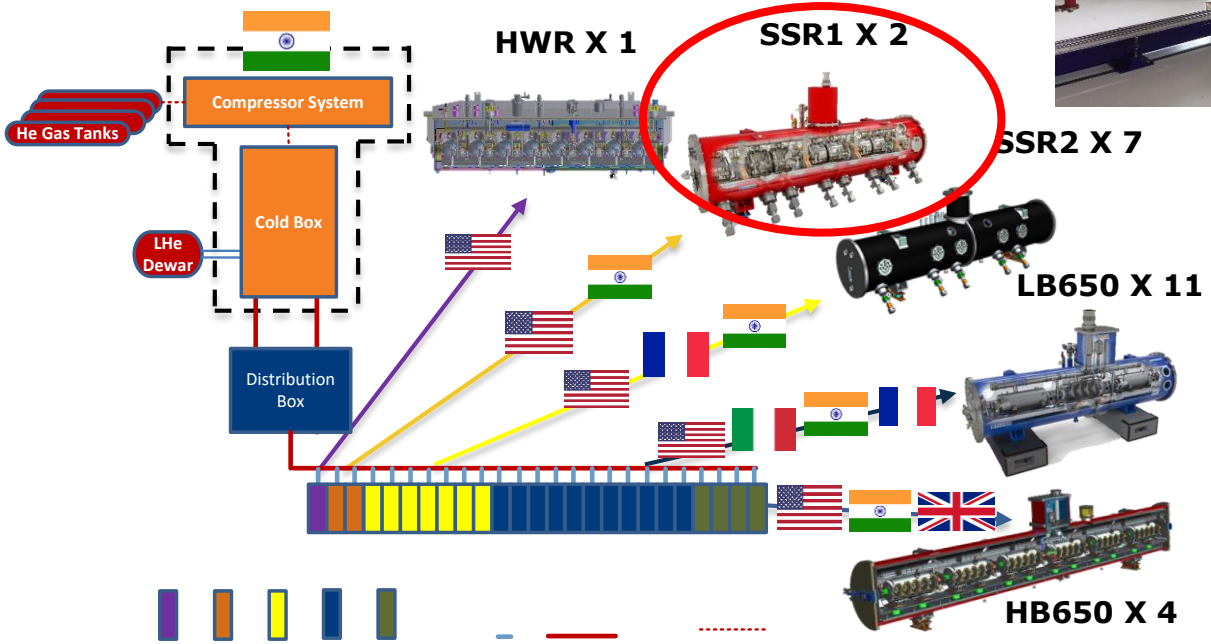
A DOE Office of Science Status Review for LBNF/DUNE was held October 29 to November 1, 2019, at Fermilab

- The project has accomplished a great deal and made good progress in many areas over the last 10 months
  - Updated cost estimate was shown of $2.5 billion
- There considerable strength in the management of the project and throughout the project team, but …
  - Top-level management restructuring and strengthening is required
  - Strategic experienced capabilities are needed to further strengthen the team
  - Streamlining must be pursued
  - Open clear, concise, and candid communication must be nurtured
- The excavation should not be delayed, but …
  - The project must focus on establishing a credible not-to-exceed CD-2 project baseline
- LBNF/DUNE is encouraged to continue accelerating the progress and momentum it has established

This is an exciting and important project that will become the centerpiece of a U.S.-hosted world-leading neutrino program

PIP II Status

- PIP-II moving towards CD-2 review in January 2020
  - Updated cost estimate $890 million
- Nov. 11, 2019: Insertion of proto SSR1 cold mass into vacuum vessel successfully completed
  - Congratulations SRF team!



International Cooperation Agreements (I)

- Activities on several fronts by DOE/HEP on advancing international cooperation with global partners for collaboration in particle physics program
- Working to finalize the international contributions to support the baseline design of LBNF/DUNE
  - Good progress being made in completing international agreements and/or other written instruments towards LBNF/DUNE Project Baselining (DOE Critical Decision 2)
- International agreements in support of PIP-II accelerator project are in good shape
  - Baseline review is planned for January 2020; multiple project planning documents have been drafted and are being reviewed at DOE (dedicated Working Group) and by global partners

International Cooperation Agreements (II)

- Status of written instruments:
  - bilateral legally- (LB) and non-legally binding (NLB) agreements concluded thus far related to DOE-hosted international neutrino program [SBN, LBNF/DUNE, PIP-II]

#	Parties	Country	Agreement/Arrangement	In-force (mm/dd/yy)	Type	Scope
1	DOE-CERN	CERN	Neutrino Protocol I to Co-operation Agreement	12-18-2015	LB	LBNF, DUNE, SBN
2	DOE-CERN	CERN	Addendum I to Neutrino Protocol I	05-02-2017	LB	LBNF, DUNE, SBN
3	DOE-DAE	India	Project Annex I to Implementing Agreement	01-20-2015	LB	PIP-II
4	DOE-DAE	India	Project Annex II to Implementing Agreement	04-16-2018	LB	DUNE, LBNF
5	DOE-MIUR	Italy	Addendum I to 2015 Project Annex on Neutrinos	06-28-2018	LB	SBN
6	DOE-MIUR	Italy	Project Annex to Implementing Arrangement	12-4-2018	LB	PIP-II
7	DOE-CEA/CNRS	France	Statement of Interest (MOU): DOE-CNRS & DOE-CEA	12-11-2018	NLB	PIP-II, DUNE, LBNF
8	DOE-BEIS	UK	Implementing Arrangement (IA)	04-12-2019	NLB	SC Program Wide (incl. HEP)
9	DOE-Czech	Czech Republic	IA: Pending signatures with Czech Academy of Science	End of 2019	LB	SC Program Wide (incl. HEP)

NLB = Non-Legally Binding; LB = Legally-Binding

International Cooperation Agreements (III)

- Bilateral instruments currently under negotiations

#	Parties	Country	Agreement/Arrangement	Anticipate Signatures	Type	Scope
1	DOE-BEIS	UK	Project Annex to IA: Pending signatures with UK	January 2020	LB	LBNF, DUNE, PIP-II
2	FNAL-UNICAMP	Brazil	I-CRADA: Fermilab – UNICAMP (Brazil)	End of 2019	LB	LBNF, DUNE
3	DOE - CONCYTEC	Peru	Statement of Interest (MOU) on Neutrino Collaboration	Early 2020	NLB	DUNE
4	DOE - CONICYT	Chile	Statement of Interest (MOU) on Neutrino Collaboration	Early 2020	NLB	DUNE

- Other written instruments for U.S.-hosted international neutrino program planned during calendar year 2020 include those between DOE and Ministries in Italy, France, Poland, and Spain
- Separately, MOUs for Short-Baseline Neutrino Program and DUNE; and Project Planning Documents (PPD) for LBNF and PIP-II currently being prepared and coordinated between 'DOE MOU Working Group' [HEP, SC, GC, FSO], Fermilab, and international partners

FACET-II Operations Review

- The FACET-II Preliminary Operations Plan review held January 23-24, 2019, at SLAC
  - Review preliminary plans to begin operating a National User Facility in FY 2020
  - Review committee was requested to perform a general assessment of the preliminary operations plan as well as addressing specific questions
- In general, the review panel was impressed with the ops planning for FACET-II
  - Plans followed closely those that led to success with the FACET National User Facility
  - In several cases, bottoms up analyses led to cost estimates which were more mature than required at a preliminary operations review
- There was a recommendation from the committee concerning the two large ($10M each) AIPs FACET-II is anticipating in order to implement its critical plans to study positron wakefield acceleration
  - Committee recommends that FACET-II management develop a detailed and realistic plan for the two AIPs, including cost and schedule, to deliver the positron complex for FACET-II in FY2021 and 2022
  - The execution plan should take into consideration the constraints posed by the operation of LCLS and LCLS II

HEP Small Project Portfolio

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

Intensity Frontier:

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

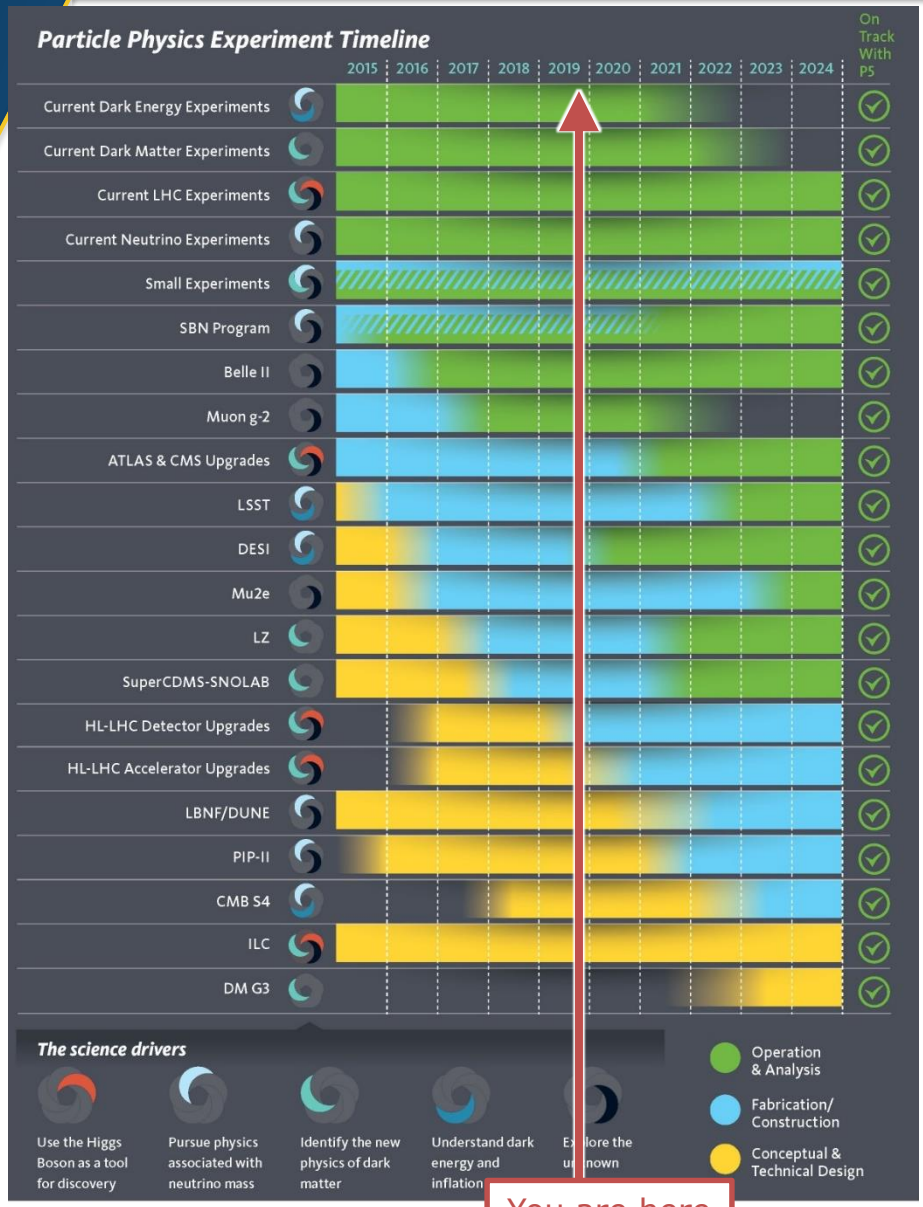
Cosmic Frontier:

- **ADMX-G2**
- **eBOSS**
- **HAWC**
- **SuperCDMS-SNOLab**
- **SPT-3G**
- **Dark Matter New Initiatives**

Recently retired:

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

P5 Implementation Status – FY 2019



All projects on budget & schedule

- Projects fully funded as of FY19
  - Muon g-2: 1st beam 2017
  - LHC detector upgrades: ATLAS and CMS Phase-1 achieved CD-4
  - Mu2e : 1st data in 2023
  - LSST: full science operations 2023
  - DM-G2 (superCDMS & LZ): 1st data 2020
  - **DESI: first light on October 22, 2019!**
- HL-LHC accelerator and detector upgrades started on schedule
- LBNF/DUNE & PIP-II schedules advanced due to strong support by Administration & Congress
- CMB S4: developing technically-driven schedule to inform agencies, NAS Astro 2020 Decadal Survey
- DM-G3: R&D limited while fabricating G2
- ILC: cost reduction R&D while waiting for decision from Japan
- Broad portfolio of small projects running

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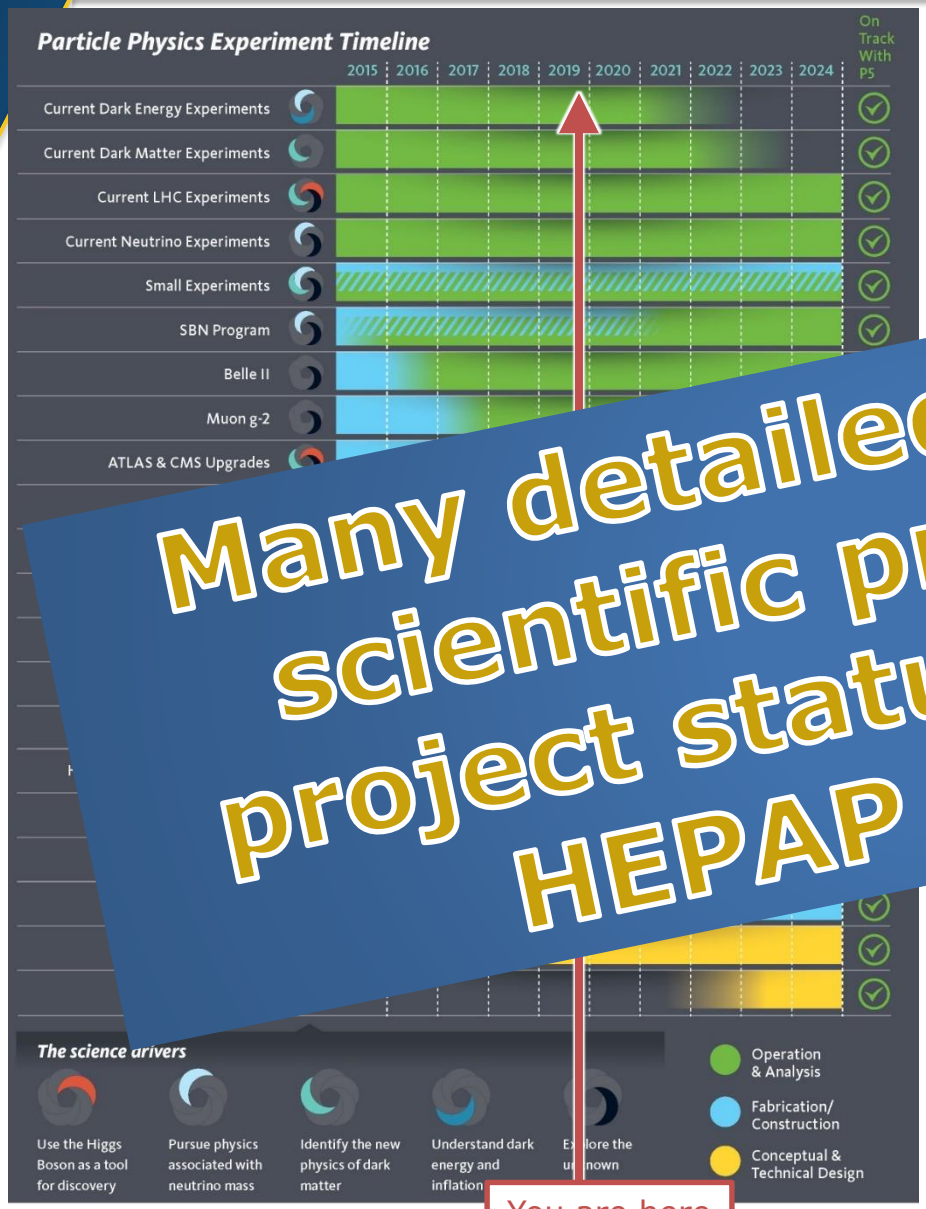

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Many detailed updates on scientific progress and project status during this HEPAP meeting!

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