U.S. Next Steps

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U.S. HEP Strategic Planning Process

The U.S. High Energy Physics program is guided by the strategic plan laid out in the 2014 P5 report

- Community Driven Strategic Process
  - "Snowmass" 2013: a year-long community-wide study of science opportunities, organized by the Division of Particles and Fields of the American Physical Society
  - Particle Physics Project Prioritization Panel (P5) 2014: High Energy Physics Advisory Panel (HEPAP) subpanel, prioritized scientific opportunities outlined in the Snowmass study within a budget framework
- Dovetailed with
  - 2010 Astronomy & Astrophysics Decadal Survey
  - 2013 European Strategy for Particle Physics

Process defines strategic plan for U.S. HEP for the decade

2013 Community Summer Study – "Snowmass"

Community driven process organized by the APS Division of Particles and Fields

- Goal: Identify compelling science opportunities over an approximately 20-yr timeframe
  - Not a prioritization, but made scientific judgements
- Year-long process
  - Several working group meetings to study individual opportunities
  - Synthesis in Minnesota with ~1000 participants
- Deliverables
  - 7 working group reports
  - ~100 subgroup reports
  - ~1000 individual contributed whitepapers
  - Set of 11 compelling scientific questions

Particle Physics Project Prioritization Panel (P5)

Scientific advisory panel (subpanel of HEPAP) tasked to develop a strategic HEP plan to be executed in 10-yr timeframe, in the context of a 20-yr global vision for the field

- Examine current, planned and proposed research capabilities and assess
  - Role & potential for scientific advancement
  - Uniqueness & scientific impact in global context
  - Time & required resources to achieve stated goals
- Provided with 3 budget scenarios to work within
  - Necessitated hard choices
- Community “Snowmass” study served as invaluable input

Signals that time was right for a new P5

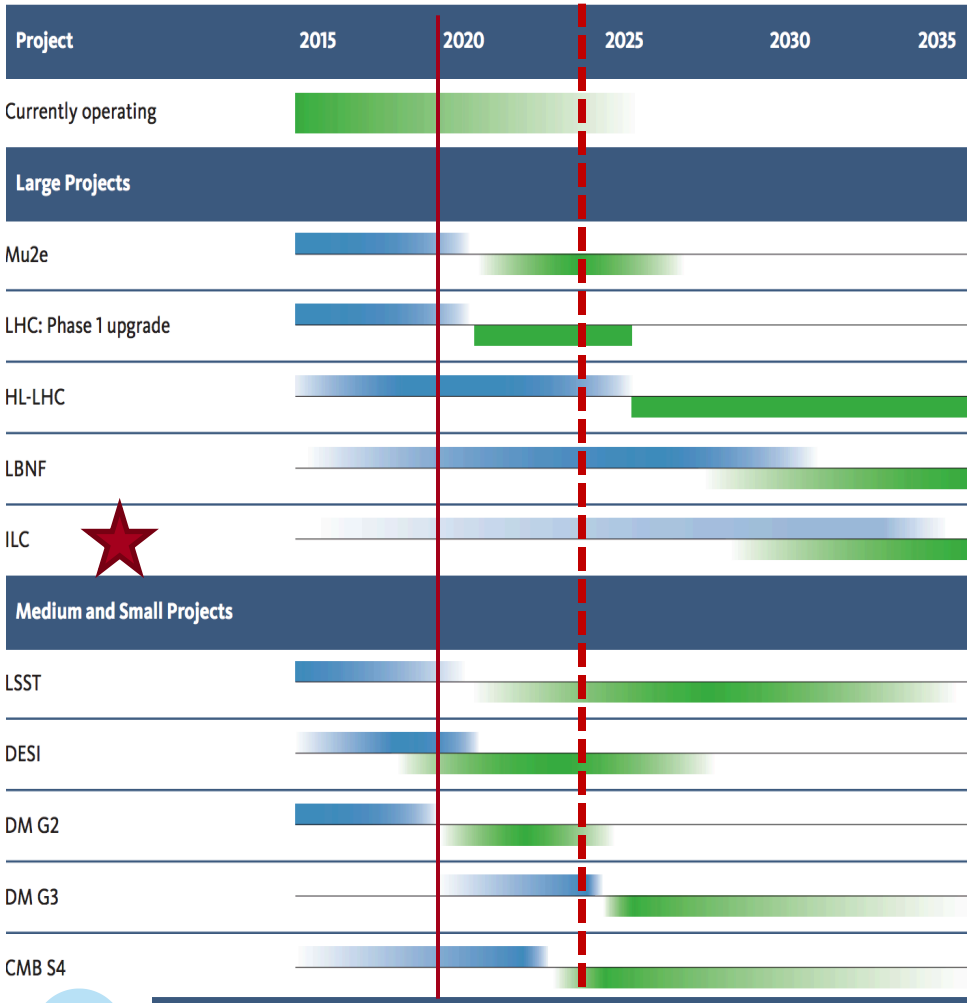
- Physics landscape changed
  - Higgs discovered at relatively low mass
  - Key neutrino mixing angle measured to be large
  - New technology & innovative approaches
  - 3 Nobel prizes: CKM, Higgs, Dark Energy
- These demonstrate importance of diversity of topics and scale
- Programmatic Changes
  - Tevatron and B-Factory ceased operations
  - Budgets more constrained than considered by last P5 (2008)
  - International considerations
- Success of 2013 “Snowmass”

Context important when considering next P5

Principal Conclusions of Report

- Particle Physics is Global
  - The U.S. and major players in other regions can together address the full breadth of the most urgent science questions if each hosts a unique world-class facility at home and partners in high-priority facilities hosted elsewhere
  - Reliable partnerships are essential for the success of international projects
- Urgent science questions drive the field forward
  - Vision for addressing the science drivers using a select set of prioritized experiments
- Mix of projects of all scales
- Balance Research, Operations & Projects
- 29 Recommendations in the report

The P5 plan in one glance: Building for Discovery



Blue Construction, Green Ops

Centered on 5 Science Drivers

- Higgs Boson is a tool for discovery
- Physics Associated with Neutrino Mass
- Identify the Physics of Dark Matter
- Understanding Cosmic Acceleration
- Exploring the Unknown

- Science drivers are not prioritized
- They are intertwined and dependent on each other
- Vision to address the science drivers represents the P5 plan

P5: Where are we today?

The P5 plan has endurance

- Broadly accepted by the community
- Followed by the funding agencies
- Accepted in Congress

  The FY19 DOE Congressional Budget Request states: The FY 2019 Request will focus support for HEP research on the laboratory research programs that are critical to executing the P5 recommendations, and on world-leading R&D efforts that require long-term investment.

U.S. Administration supports the P5 Plan

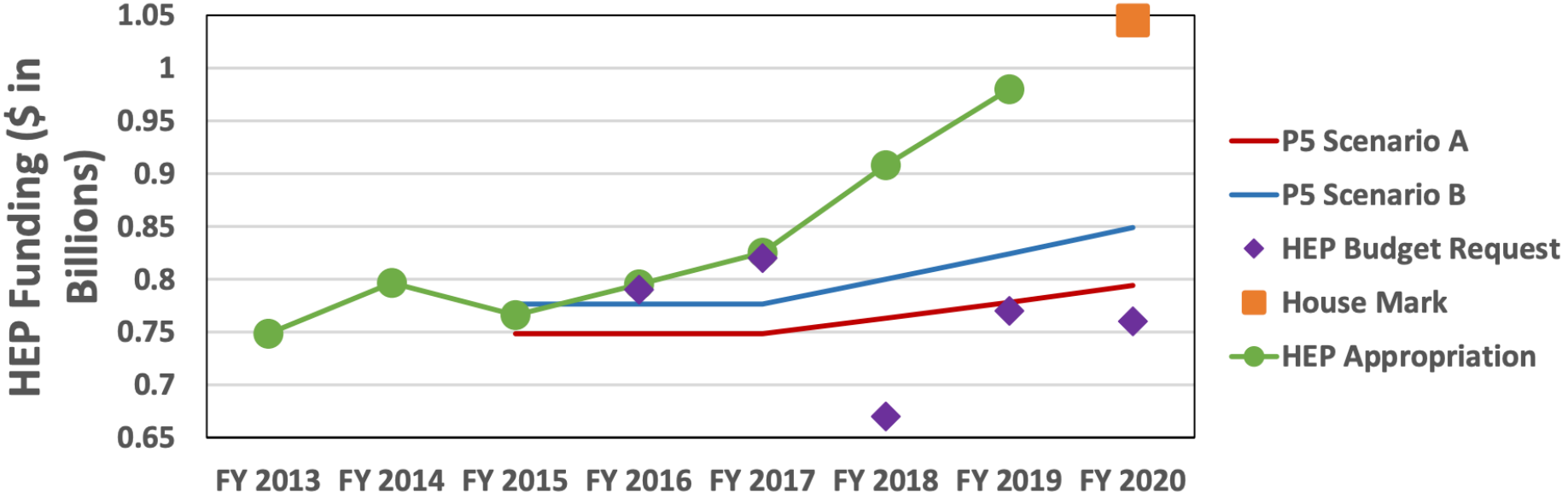
- U.S. – CERN Agreement, May 2015 in D.C
  - U.S. Secretary of Energy Ernest Moniz, CERN Director General Rolf Heuer, U.S. National Science Foundation France Cordova
  - Aligns European and American long-range strategic plans for HEP
- UK – U.S. Science & Technology Agreement, signed Sep 2017 in D.C.
  - UK Science Minister JO Johnson and U.S. Acting Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs Judith Garber
  - 1st major project under this agreement is UK investment of Lbs 65M ($88M) in LBNF/DUNE
- DOE-DAE (India) Project Annex II on Neutrino Research signed Apr 2018 in New Delhi
  - U.S. Secretary of Energy Rick Perry and India's Atomic Energy Secretary Sekhar Basu
  - Expands accelerator science collaboration to include science for neutrinos

U.S. Congress Supports P5 Plan

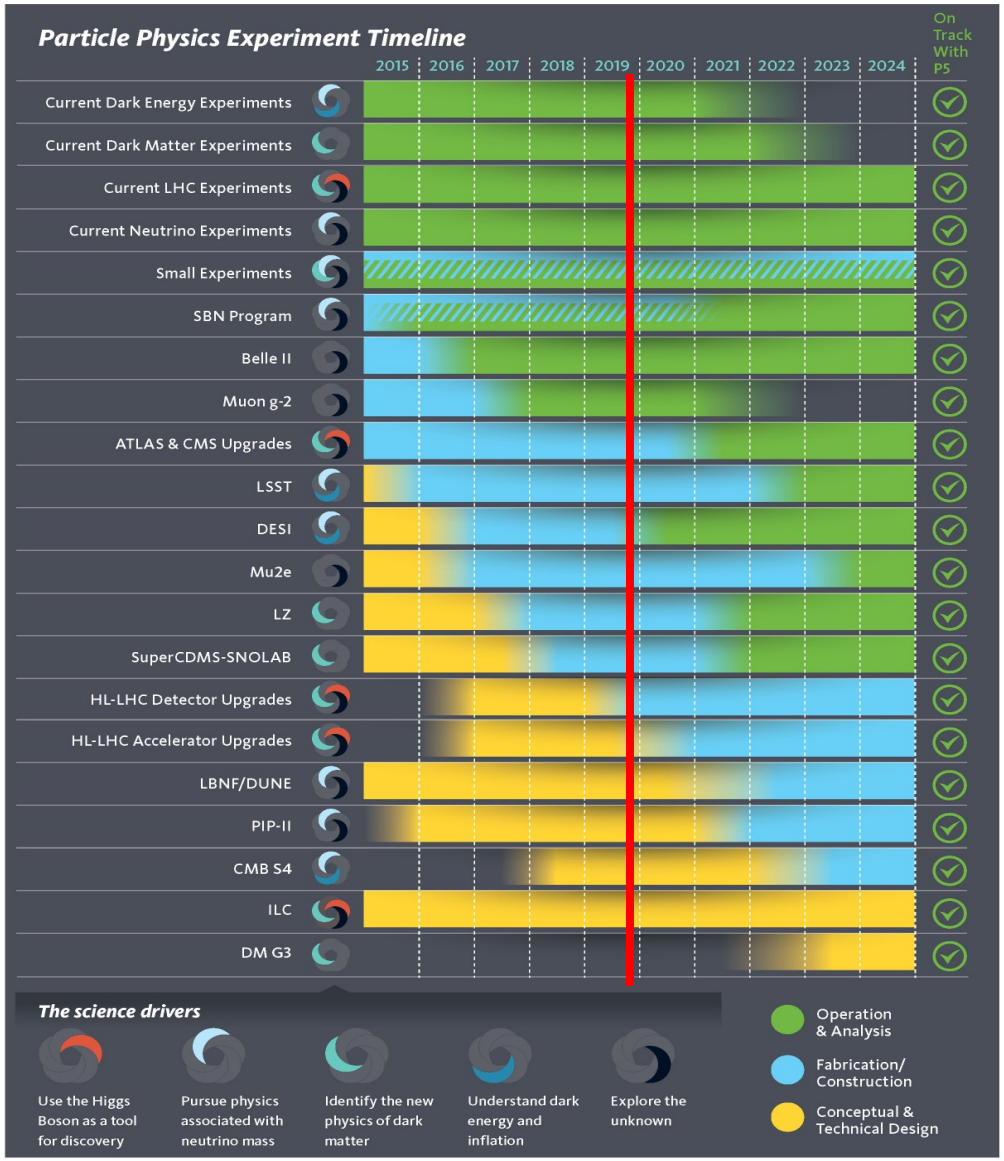
FY19 Senate Energy & Water Development Appropriations

Report: "The committee strongly supports the Department's efforts to advance the recommendations of the Particle Physics Project Prioritization Panel Report [P5], which established clear priorities for the domestic particle physics program…."

"...Four years into executing the P5, the Committee commends the Office of Science and the high energy physics community for acheiving significant accomplishments and meeting the milestones and goals set forth in the strategic plan..."



P5 Plan in 2019



All projects on budget & schedule

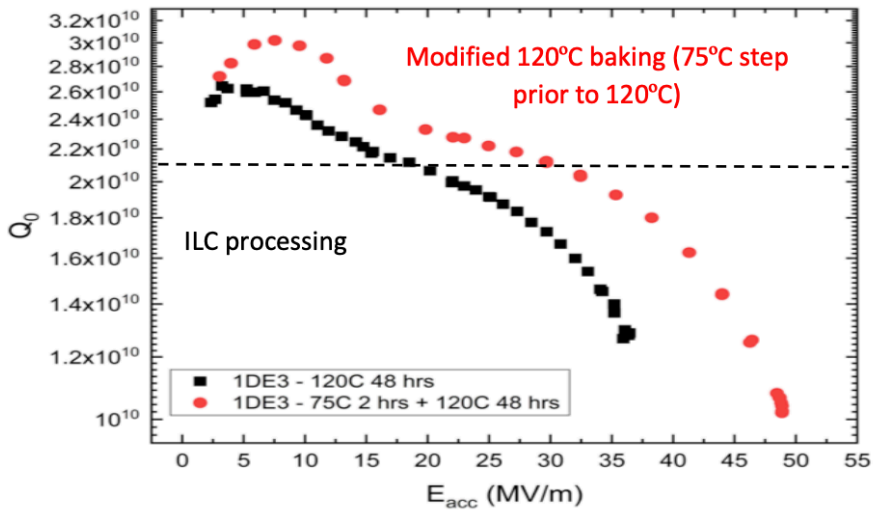
- Projects fully funded as of FY19
  - Muon g-2: 1st beam 2017
  - LHC detector upgrades: on track for 2020 installation
  - Mu2e : 1st data in 2020
  - LSST: full science operations 2023
  - DM-G2 (superCDMS & LZ): 1st data 2020
  - DESI: 1st light on lenses 2019
- HL-LHC accelerator and detector upgrades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

What's new since P5?: SRF R&D

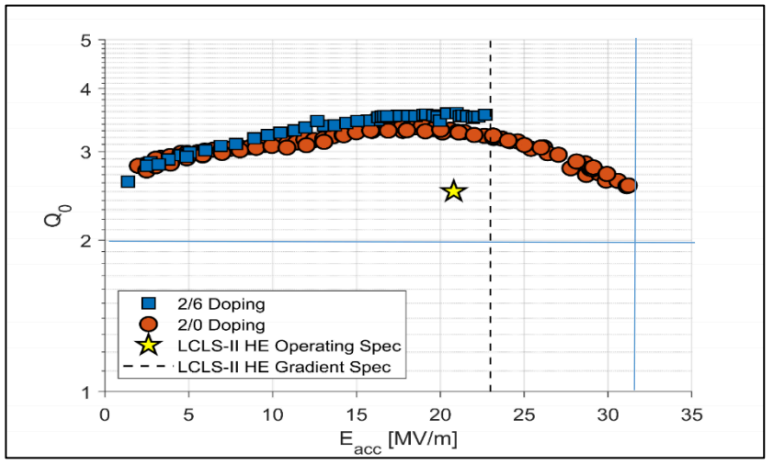
SRF R&D @FNAL/Jlab allows for ILC luminosity upgrade to 8.1×10^{34}

- Factor of 6 above design
- Achieved by higher Q performance at high gradients
- Allows double number of bunches per RF pulse length
- R&D performed for LCLS-HE yet applicable to ILC upgrade

Nitrogen Infusion



2-step baking – 9 cell cavity



Details in https://arxiv.org/abs/1910.01276

Lumi Upgrade R&D Beam Characteristics

	TDR Baseline	6× Luminosity upgrade, with $Q = 1\times10^{10}$	6× Luminosity upgrade, with $Q = 2\times10^{10}$
Energy [GeV]	250	250	250
Luminosity [$\times10^{34}$]	1.35	8.1	8.1
Total capital cost (no labor) [B ILCU]	5.5	8.0	7.73
Total AC power [MW]	132	286	267
Cyomodules (including cavities) [B ILCU]	1.93	1.93	1.93
Conventional Facilities, CF (all) [B ILCU]	1.43	1.63	1.63
Refrigeration system [B ILCU]	0.5	1.3	1.0
High power RF (linac only) [B ILCU]	0.6	1.2	1.2
Damping ring [B ILCU]	0.33	0.66	0.66
Positron source [B ILCU]	0.23	0.69	0.69
Beam Dumps [B ILCU]	0.07	0.21	0.21
Other systems (not including CF) [B ILCU]	0.41	0.41	0.41
Tunnel length [km]	20	20	20
Gradient [MV/m]	31.5	31.5	31.5
Q	1×10^{10}	1×10^{10}	2×10^{10}
Repetition rate [Hz]	5	15	15
Number of bunches	1,312	2,624	2,624
Beam power [MW]	5.3	31.5	31.5
Total RF pulse length [ms]	1.618	2.35	2.35

HEP Strategic Planning Process – Next Round for U.S.

Astronomy & Astrophysics Decadal Survey – 2020

- NCR & NAS
- Chaired by Fiona Harrison & Robert Kennicutt

Community Study ("Snowmass") – ~2020/2021

- Ideas for facilities & experiments bubble up from community
- Feasibility studies & physics reach evaluations

National Academies of the Sciences Study – TBD

Particle Physics Project Prioritization Panel (P5) – ~2021/22

- HEPAP subpanel, prioritizes science within a budget framework

Timing fits with European strategy and ILC decision

Next HEP Community Planning Exercise "Snowmass"

Organized by the Division of Particles and Fields of the American Physical Society

- Steering cmtte formed
- Final large meeting date set for July 11-20, 2021
- DPF soliciting nominations for working group conveners
  - Due Nov 15, 2019!
- Kick-off at 2020 April APS meeting
  - April 18-21, 2020 Washington DC https://www.aps.org/meetings/april/
- Several working group meetings between 2020-2021

Watch DPF webpage for more details https://www.aps.org/units/dpf/

U.S. involvement in next collider will be a focus topic
Folks interested in ILC, please participate!