

# DOE Opening Remarks and Perspectives on US Engagement in FCC

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for High Energy Physics

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U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

[energy.gov/science](https://energy.gov/science)

# Outline

- ◆ Brief recap of the 2023 P5 process and recommendations
- ◆ Following the P5 rollout, DOE's initial response to the specific recommendations related to a future Higgs Factory
- ◆ DOE's approach to a nationally coordinated program for U.S. participation in an off-shore international Higgs Factory

# U.S. Particle Physics Strategic Planning Process



US Particle Physics:  
Scientific Opportunities  
A Strategic Plan  
for the Next Ten Years

Report of the Particle  
Physics Project  
Prioritization Panel

29 May 2008

SNOWMASS CSS 2013  
ON THE MISSISSIPPI  
JULY 29 - AUGUST 6, 2013

FERMILAB-CONF-13-448  
SLAC-PUB-13069

Planning the Future  
of U.S. Particle Physics

Report of the 2013 Community Summer Study  
of the APS Division of Particles and Fields

Study Conveners: M. Burden, W. Barletta, L. A. T. Bauerlik, R. Brock,  
D. Cronin-Hennessy, M. Donato, M. Dine, J. L. Feng, M. Glickstein, S. Gottlieb,  
J. L. Hewett, R. Lipton, H. Nicholson, M. E. Peskin, S. Ritz, I. Shipsey, H. Weerts

Division of Particles and Fields Officers in 2013: J. L. Rosner (chair), I. Shipsey  
(chair-elect), N. Hadley (vice-chair), F. Ramond (past chair)

Editorial Committee: R. H. Bernstein, N. A. Graf, F. McBride, M. E. Peskin,  
J. L. Rosner, N. Varelas, K. Yankiewicz

Building for Discovery  
Strategic Plan for U.S. Particle Physics in the Global Context

Report of the Particle Physics Project Prioritization Panel (P5)

May 2014

Community Summer Study  
SNOWMASS  
2022 July 17 - 26 Seattle

Summaries and  
Conveners' Reports

Report of the  
2021 U.S. Community Study  
on the  
Future of Particle Physics

SNOWMASS 2021

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

Edited by  
Joel N. Butler  
R. Sekhar Chivukula  
Michael E. Peskin

Exploring the  
Quantum  
Universe

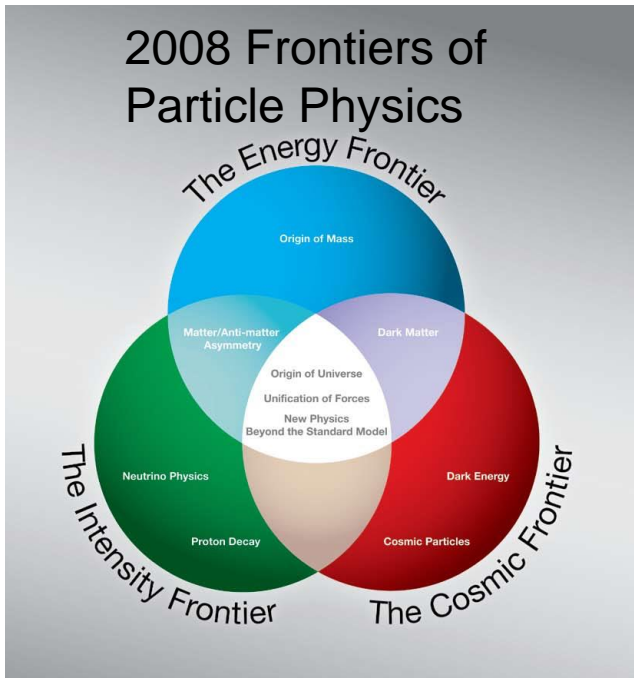
Pathways to Innovation  
and Discovery  
in Particle Physics

DRAFT Report of the 2023 Particle Physics Project Prioritization Panel

A strategic plan for the High Energy Physics Advisory Panel

# Evolution of the key questions in particle physics

## 2008 Frontiers



## 2014 Science Drivers

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

## 2023 Science Drivers

Exploring the Quantum Universe

Reveal the Secrets of the Higgs Boson

Elucidate the Mysteries of Neutrinos

Determine the Nature of Dark Matter

Understand What Drives Cosmic Evolution

Search for Direct Evidence of New Particles

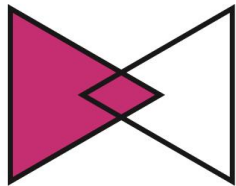
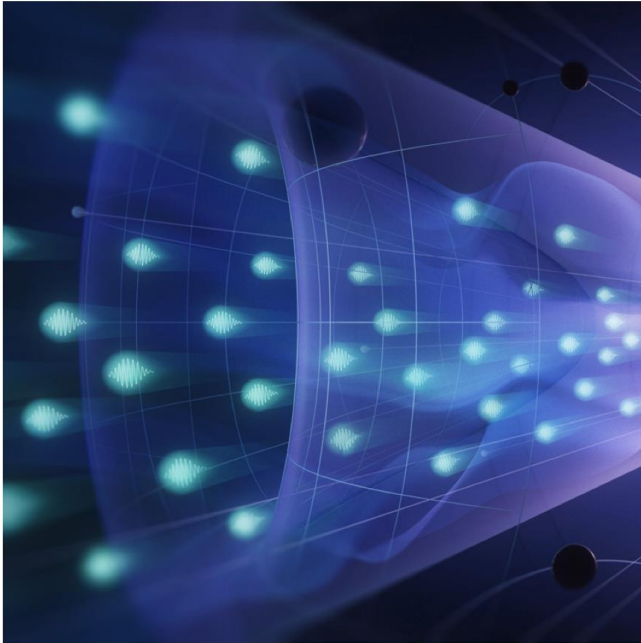
Pursue Quantum Imprints of New Phenomena

Decipher the Quantum Realm

Illuminate the Hidden Universe

Explore New Paradigms in Physics

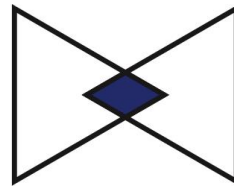
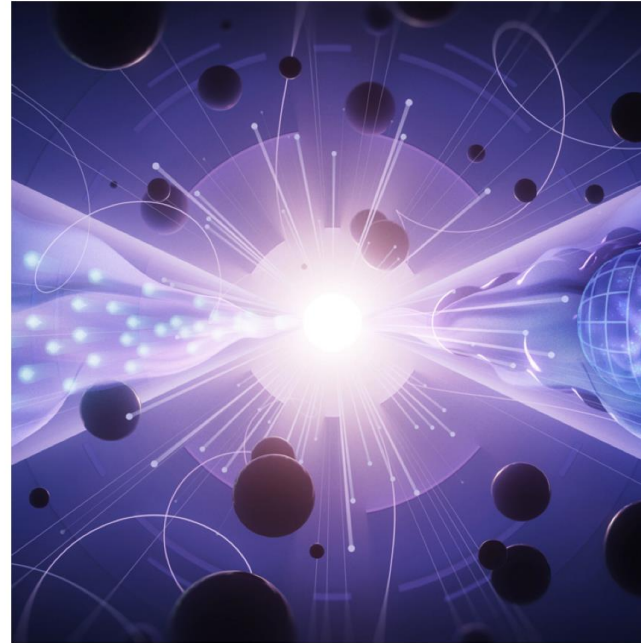
# P5 2023 Science Drivers



Decipher  
the  
Quantum  
Realm

Elucidate the Mysteries  
of Neutrinos

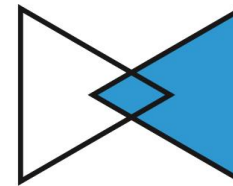
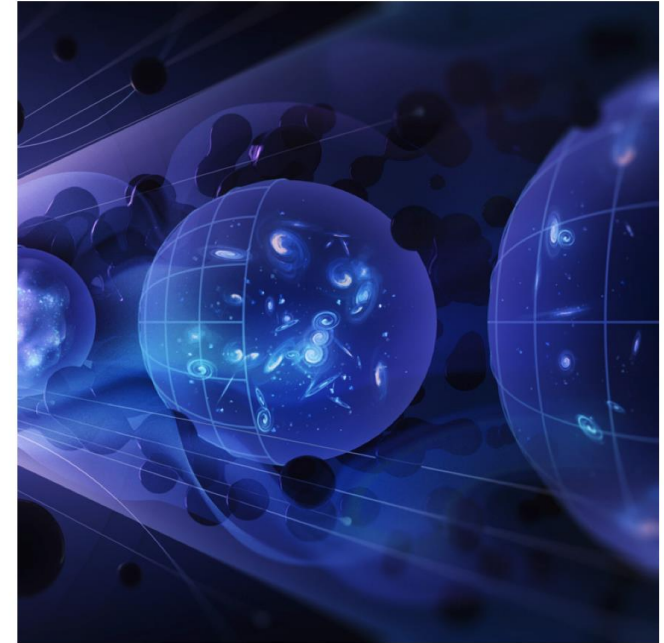
Reveal the Secrets of  
the Higgs Boson



Explore  
New  
Paradigms  
in Physics

Search for Direct Evidence  
of New Particles

Pursue Quantum Imprints  
of New Phenomena



Illuminate  
the  
Hidden  
Universe

Determine the Nature  
of Dark Matter

Understand What Drives  
Cosmic Evolution

# 2023 P5 Recommendation 1

◆ As the highest priority independent of the budget scenarios, **complete construction projects and support operations of ongoing experiments and research** to enable maximum science. We reaffirm the previous P5 recommendations on major initiatives:

- HL-LHC (including **ATLAS and CMS** detectors, as well as **Accelerator Upgrade Project**) to start addressing why the Higgs boson condensed in the universe (reveal the secrets of the Higgs boson, section 3.2), to search for direct evidence for new particles (section 5.1), to pursue quantum imprints of new phenomena (section 5.2), and to determine the nature of dark matter (section 4.1).
- The **first phase of DUNE and PIP-II** to determine the mass ordering among neutrinos, a fundamental property and a crucial input to cosmology and nuclear science (elucidate the mysteries of neutrinos, section 3.1).
- The Vera C. Rubin Observatory to carry out the **Legacy Survey of Space and Time (LSST)**, and the LSST Dark Energy Science Collaboration, to understand what drives cosmic evolution (section 4.2).
- In addition, we recommend continued support for the following ongoing experiments at the medium scale (project costs > \$50M for DOE and > \$4M for NSF), including completion of **construction, operations and research** on:
  - NOvA, SBN, and T2K (elucidate the mysteries of neutrinos, section 3.1).
  - DarkSide-20k, LZ, SuperCDMS, and XENONnT (determine the nature of dark matter, section 4.1).
  - DESI (understand what drives cosmic evolution, section 4.2).
  - Belle II, LHCb, and Mu2e (pursue quantum imprints of new phenomena, section 5.2).

# Off-shore Higgs Factory

- ◆ From P5 Recommendation 2, Priority 3 out of 5:

*An **off-shore Higgs factory**, realized in collaboration with international partners, in order to reveal the secrets of the Higgs boson. **The current designs of FCC-ee and ILC meet our scientific requirements.** The US should actively **engage in feasibility and design studies.** Once a specific project is deemed feasible and well-defined (see also P5 Recommendation 6), the US should aim for a contribution at funding levels commensurate to that of the US involvement in the LHC and HL-LHC, while maintaining a healthy US on-shore program in particle physics (section 3.2).*

# P5 Recommendation 6

- ◆ Convene **a targeted panel** with broad membership across particle physics later this decade that makes decisions on the US accelerator-based program at the time when major decisions concerning an off-shore Higgs factory are expected, and/or significant adjustments within the accelerator-based R&D portfolio are likely to be needed. A plan for the Fermilab accelerator complex consistent with the long-term vision in this report should also be reviewed.
  1. The panel would consider the following: The level and nature of US contribution in a specific **Higgs factory** including an evaluation of the associated schedule, budget, and risks once crucial information becomes available.
  2. The panel would consider the following: Mid- and large-scale **test and demonstrator facilities** in the accelerator and collider R&D portfolios.
  3. The panel would consider the following: A plan for the **evolution of the Fermilab accelerator complex** consistent with the long-term vision in this report, which may commence construction in the event of a more favorable budget situation.

**DOE does not envision a single panel to address this recommendation; rather we will work with NSF, the DOE national laboratories, and the community at-large to convene three separate panels that each will address one of the above topics.**



# DOE Initial Response and Actions

- ◆ Last year and earlier this year, KEK (Japan) requested that DOE support ILC development efforts through the ILC Technology Network (ITN)
  - DOE has decided that we – including our DOE national laboratories – will be observers and not officially join the ITN
- ◆ In February 2024, we presented our approach to MEXT (Japan) to be observers in the ITN while considering, at some fraction, associated R&D efforts under our existing U.S.-Japan Cooperation Program in HEP
- ◆ In March 2024, we presented DOE's view on participating in any potential FCC-ee to the CERN Council

# U.S.-CERN Statement of Intent (I)

- ◆ Through interagency coordination in the U.S., led by The White House Office of Science and Technology Policy (OSTP) and which included the U.S. Department of State, DOE, the National Science Foundation, and NASA, a Statement of Intent was signed at The White House in April 2024 between the U.S. Government and CERN
  - Among the topics, the Statement expresses an intent for the United States to collaborate on the FCC-ee should the CERN Member States determine it is likely to be CERN's next research facility following the HL-LHC
  - It also reaffirms our continued collaboration in the ongoing FCC feasibility study

# U.S.-CERN Statement of Intent (II)

## Joint Statement of Intent between The United States of America and The European Organization for Nuclear Research concerning Future Planning for Large Research Infrastructure Facilities, Advanced Scientific Computing, and Open Science

OTHER RELEASE

BUREAU OF OCEANS AND INTERNATIONAL ENVIRONMENTAL AND SCIENTIFIC AFFAIRS

APRIL 26, 2024

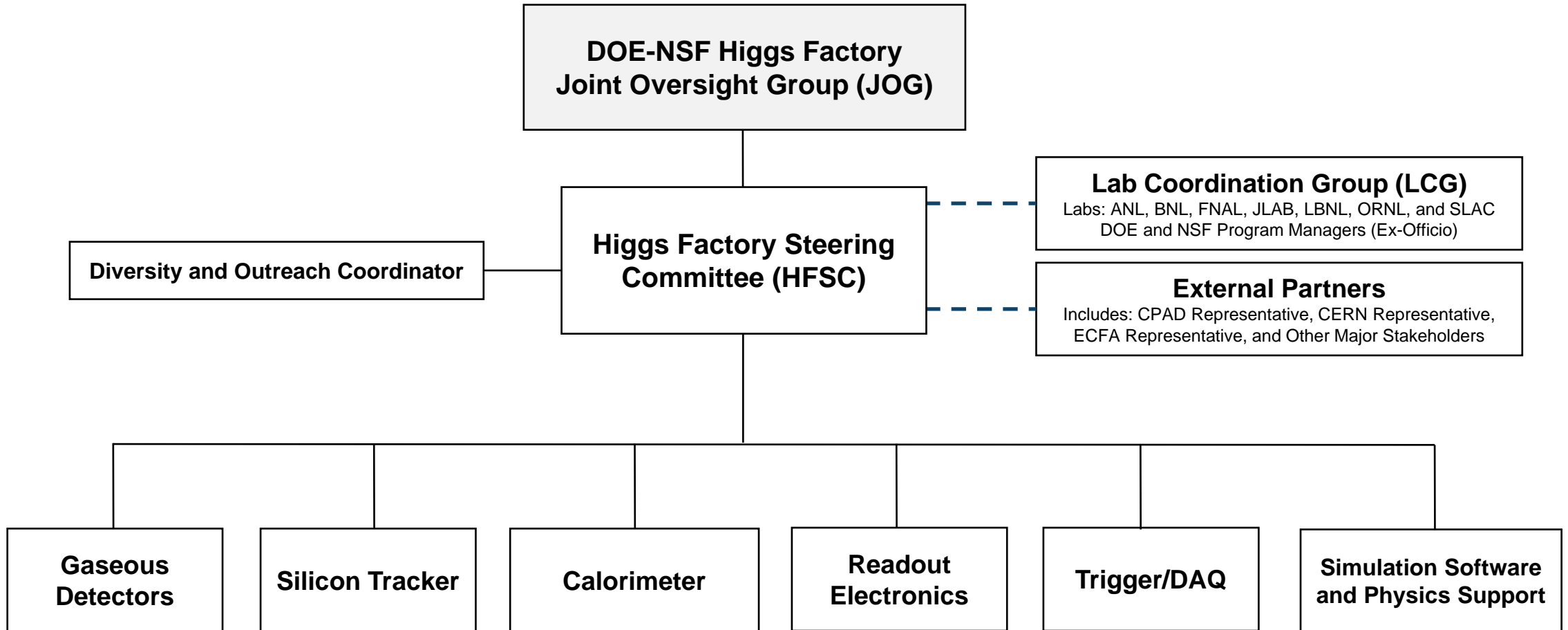


The text of the following statement was released by the Government of the United States of America and the European Organization for Nuclear Research (CERN), an Intergovernmental Organization having its seat at Geneva, Switzerland. White House Office of Science and Technology Policy Principal Deputy U.S. Chief Technology Officer Deirdre Mulligan signed for the United States while Director-General Fabiola Gianotti signed for CERN.

- ◆ Text available at: [U.S. Department of State Remarks & Releases](#) site
- ◆ Among the topics in the Statement,
  - Expresses intentions by the U.S. and CERN to continue collaborating in the FCC Higgs Factory feasibility study
  - Subject to appropriate processes, the intention for the U.S. to collaborate on the FCC-ee, should the CERN Member States determine the FCC-ee is likely to be CERN's next research facility following the HL-LHC
- ◆ Statement aligned with P5: should FCC-ee receive a "green-light" following the next update of the European Strategy, U.S. intends to collaborate; and nature of the contributions to be discussed by the panel prescribed in 6.1.

# U.S. Organization for Higgs Factory Development – PED

- ◆ DOE and NSF have jointly issued a charge that forms a ***nationally coordinated U.S. Higgs Factory Coordination Consortium (HFCC)*** for developing the **physics, experiments, and detectors (PED) program**.

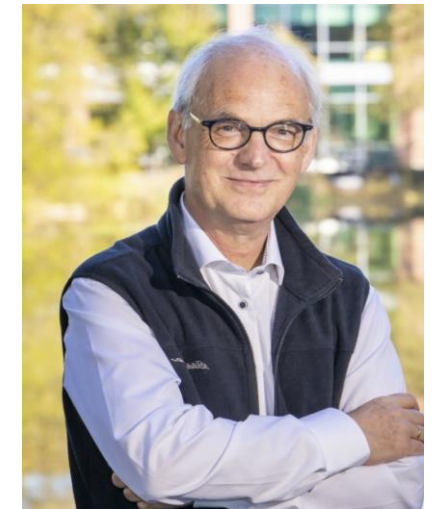


# U.S. Higgs Factory Development – PED

- ◆ The U.S. HFCC includes:
  - 1) Higgs Factory Steering Committee (HFSC)
  - 2) Lab Coordination Group (LCG), which is integral to the U.S. Higgs factory coordination
  - 3) Detector systems that report to the HFSC and naturally map onto CERN's DRD structure
- ◆ The Consortium is to ensure that collaborations by the U.S. with our international partners are cost-effectively carried out for the Higgs factory initiatives
- ◆ The LCG will include representatives from each of our DOE labs:
  - ANL, BNL, FNAL, JLAB, LBNL, ORNL, and SLAC
  - A representative from each lab is to be selected by the respective lab's management
- ◆ Representatives in this Consortium also include external partners such as those from the APS/DPF's Coordinating Panel for Advanced Detectors (CPAD) in the U.S. and the CERN-hosted Detector R&D (DRD) initiative

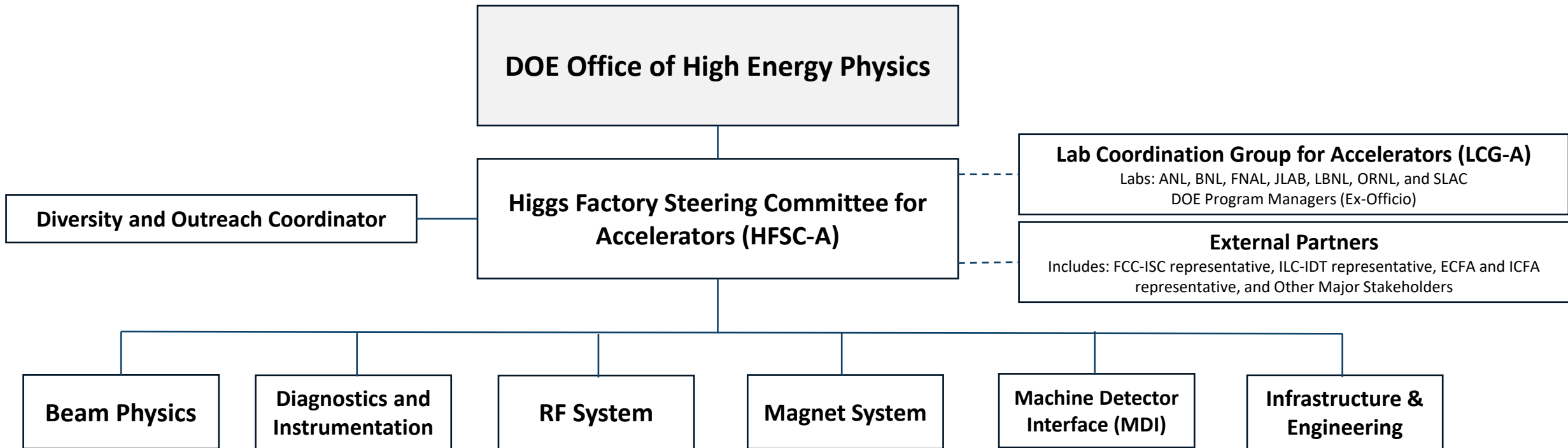
# Higgs Factory Steering Committee – PED

- ◆ Goals and tasks of the U.S. HFCC include:
  - Coordinate efforts of the U.S. community, bringing together both the linear and circular collider communities
  - To be done during the phase which precedes the development of a specific future project
- ◆ DOE and NSF selected members of the Higgs Factory Steering Committee from the leadership of the community-driven FCC-ee P5 input group and the Americas' Linear Collider Committee
  - Srini Rajagopalan (*Chair*), Sarah Eno
  - Ritchie Patterson (*Deputy Chair*), Marcel Demarteau
- ◆ No lead DOE laboratory is designated for this Consortium
  - Each lab collaborating in Higgs factory efforts is represented through the Lab Coordination Group



# U.S. Organization for Higgs Factory Development – Accelerators

- ◆ DOE is separately preparing a charge that forms a ***nationally coordinated U.S. Higgs Factory Coordination Consortium (HFCC)*** for developing the **accelerators program**; the charge to-be-released soon.
- ◆ In general, similar structure as the U.S. HFCC for PED; includes appropriate partners and accelerator systems
- ◆ Membership in the Higgs Factory Steering Committee for Accelerators (HFSC-A) is under discussion, and the Committee’s leaders are to be identified soon.



# U.S. Higgs Factory Development – PED and Accelerators

- ◆ PED efforts to be coordinated by the U.S. Higgs Factory Coordination Consortium include:
  - Physics and technical feasibility studies, including any associated design and R&D efforts, to advance various experimental detector concepts at a future Higgs factory
  - Prioritization and stewardship of national R&D efforts (under any available funding)
  - Pre-project R&D prior to DOE and/or NSF initiating any detector project at a future  $e^+e^-$  collider
  - Conceptualization of software and computing framework to advance the physics and R&D
- ◆ Similarly, accelerator efforts to be coordinated by the respective Consortium include:
  - Physics and technical feasibility studies, including any associated design and R&D efforts, to advance the accelerator designs for a future  $e^+e^-$  collider
  - Prioritization and stewardship of national R&D efforts (under any available funding)
  - Pre-project R&D prior to DOE initiating an accelerator project at a future  $e^+e^-$  collider
  - Conceptualization of appropriate accelerator controls software and computing framework



# Summary Remarks (I): U.S.-CERN Partnership

- ◆ The U.S. collaborative partnership with CERN is long standing and very strong
- ◆ We appreciate the willingness of the CERN management and the Member States to accept our collaboration on the projects that are addressing the most fundamental questions in particle physics
  - The plan is to complete the construction of the High-Luminosity LHC, and we are committed to supporting the subsequent operations and exploitation of the data that it will bring
- ◆ We greatly appreciate the investment and collaboration that CERN is making in the neutrino program hosted in the United States
- ◆ We look forward to carrying this partnership far into the future
- ◆ We also look forward to continuing our discussions with CERN to advance the development and realization of the future Higgs factory

# Summary Remarks (II)

## The 2023 P5 Report

- ◆ Provides a strategic vision of an exciting path into the future for high energy particle physics
- ◆ Reaffirms the projects and programs that are undertaken in the global collaborative context
- ◆ Provides us with actionable recommendations that will keep us on that path
- ◆ The vision is long-term and will take long-term planning

DOE appreciates all your work & welcomes you to FCC Week in San Francisco (to the United States)

- ◆ I hope you have a pleasant and productive week ahead!





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# Prescriptive P5 Area Recommendations

P5 Recommendation	Funding/year (\$M)
ASTAE Initiative	35
Detector R&D	20
HEP Theory	15
General Accelerator R&D	10
Energy Frontier Detectors	20
Energy Frontier Accelerator	35
<b>TOTAL</b>	<b>135</b>

DOE Office of High Energy Physics	
FY 2024 Enacted Budget (\$M)	1,200
FY 2025 President's Budget Request (\$M)	1,230
<b>Initiative Fraction</b>	<b>11%</b>

- The 2023 P5 Area Recommendations for budgets is >10% of the current DOE-HEP budget. At this moment, 10% increases in the budget look very unlikely.
- Our analysis shows the ASTAE (Advancing Science and Technology through Agile Experiments) funding can support a steady stream of one new project starting per year, so it looks quite appropriate.
- The other recommendations have not yet been fully studied.
- In order, to prevent strain on the core HEP research budget and facility operations, we will need to build up to these levels as current projects ramp down.
- We need to emphasize that funding priorities will be towards the execution of P5's Recommendation #1.

# Budget Scenarios Considered by 2023 P5 Panel

