

Update to the U.S. National Input to the European Strategy Update for Particle Physics

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Abstract

In this document we update the status of U.S. community inputs for the European Strategy for Particle Physics Update (ESPPU) since April 1, 2025, and offer responses to the revised questions. Major new inputs include a long-term strategy report from the National Academies of Sciences, Engineering, and Medicine and the formal formation of a U.S. Muon Collider Collaboration.

The U.S. planning process and context

This document is an update of our previous [submission](#) [1], that reported on the outcome of the U.S. long term planning process. That process started with the [2021 Snowmass Community Planning Exercise](#) [2], organized by the Divisions of Particles and Fields and the Physics of Beams (DPF and DPB) of the American Physical Society.

That broad community process was input to a focused prioritization process in which a Particle Physics Project Prioritization Panel (P5) was charged by the National Science Foundation (NSF) and the Department of Energy (DOE) to develop a 10-year strategic plan for U.S. particle physics, in the context of a 20-year global strategy and two constrained budget scenarios. The [P5 report](#) [4] was approved by the federal High Energy Physics Advisory Panel (HEPAP), in December, 2023. 3,200 U.S. scientists signed an expression of support for the report.

For the Venice meeting, DPF [reported](#) [1, 3] on the P5 process and the first iteration of a Higgs Factory [study](#). Since then, the U.S. National Academies of Sciences, Engineering and Medicine (NASEM) has produced a report, [Elementary Particle Physics: The Higgs and Beyond](#) [5].

The National Academies Report

In parallel with the P5 process, and sharing many of the same community inputs, the National Academy of Sciences Committee on Elementary Particle Physics was tasked by the DOE and the NSF with setting a long-term vision for the field, focusing on innovation and new approaches. Their [report](#) [5] was released in June 2025. Where the [P5 report](#) focused on strategy for the next 10-20 years, the [NASEM](#) report had a 40-year outlook. The relevant NASEM recommendations are reproduced below.

Recommendation 1: The United States should host the world's highest-energy elementary particle collider around the middle of the century. This requires the immediate creation of

a national muon collider research and development program to enable the construction of a demonstrator of the key new technologies and their integration.

Recommendation 2: The United States should participate in the international Future Circular Collider Higgs factory currently under study at CERN to unravel the physics of the Higgs boson.

Recommendation 3: The United States should continue to pursue and develop new approaches to questions ranging from neutrino physics and tests of fundamental symmetries to the mysteries of dark matter, dark energy, cosmic inflation, and the excess of matter over antimatter in the universe.

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Recommendation 5: The United States should invest for the long journey ahead with sustained research and development funding in accelerator science and technology, advanced instrumentation, all aspects of computing, emerging technologies from other disciplines, and a healthy core research program.

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Recommendation 7: The United States should engage internationally through existing and new partnerships and explore new cooperative planning mechanisms.

These recommendations are similar to the P5 recommendations but further emphasize the priority of strong participation in the next collider at CERN and development of a US-based muon collider.

Additional developments since the Venice meeting

- The U.S. DOE Office of Science has repurposed the Higgs Factory Coordination Consortium (HFCC) activity as a [U.S. Higgs Factory Circular Collider](#) organization concentrating on the FCC-ee proposal. It remains charged to provide strategic direction and leadership for the U.S. community to engage, shape, and thereby advance the development of the physics, experiment, and detector (PED) and accelerator (A) programs for a potential future Higgs factory; now with greater emphasis on FCC-ee.
- The [US Muon Collider Collaboration](#) (USMCC) has been formalized in the U.S. to coordinate national muon collider activities and work closely with the [International Muon Collider Collaboration](#).
- In consultation with the [USMCC](#), the directors of eight U.S. national laboratories with accelerator programs created a short-term [National Lab Accelerator Study Group for a Muon Collider](#) to evaluate the pressing needs for muon collider R&D and assess how each laboratory's strengths can contribute to the effort. This group is charged to provide an independent assessment of the progress and future of the program, with a final report expected in mid-2026.
- The U.S. Magnet R&D community has produced a new report [The 2025 Roadmaps for the U.S. Magnet Development Program \[8\]](#).

The current budget for particle physics in the U.S. is unfortunately below the level of the less optimistic P5 funding scenario. NSF funding, which supports detectors, computing and individual investigators, is particularly impacted.

Response to ECFA questions

1. What is your preferred large-scale post-LHC accelerator for CERN?

Both the P5 and NASEM reports agree that the preferred next collider should be a Higgs factory. P5 concluded that such a facility could not be hosted by the U.S. within the budget guidelines from the agencies. P5 identified both FCC-ee and a linear collider as projects that could meet the scientific requirements without specifying their locations. The NASEM report more explicitly recommends ([recommendation 2](#)) U.S. participation in the international Future Circular Collider Higgs factory currently under study at CERN.

The U.S. [Higgs Factory Coordination Consortium](#) submitted their [input](#) to the European Strategy in March.

"The U.S. is enthusiastic for a Higgs Factory as the next major collider and strongly supports FCC-ee, intending to collaborate on its construction and physics exploitation if it is chosen as the next major research infrastructure project at CERN. ... The U.S. would also support an LC if the CERN Council approves such a project in a timely manner. The U.S. eagerly awaits a CERN Council decision and looks forward to partnering with CERN on the next future collider project." [6]

The DOE has since supported focusing U.S. studies on FCC-ee detector and machine development.

2. What is your preferred alternative, if the preferred option would not be feasible?

The U.S. community is enthusiastic about participation in CERN's next collider. As noted above, there is now an official U.S. Higgs Factory Circular Collider working group directed towards the FCC-ee option. If the FCC-ee is not feasible, there are substantial communities exploring a Linear Collider Facility [9], as well as alternate paths to high-energy colliders [7, 10, 11, 12, 13, 14]. The specific choice would depend on the reasons why the preferred option is not feasible and the timescale to physics of the alternatives. A more definitive answer awaits further input from the U.S. community and the ESPPU.

3. What is your preferred alternative, if the preferred option would not be competitive?

Answering this question requires a better understanding of global plans for large projects than we currently have. P5 recommended that the U.S. should revisit this question, in light of international developments, later in this decade.

Beyond the next collider

The USMCC has engaged a vibrant and growing community that is focused on critical R&D and a Muon Collider Demonstrator to support eventual construction of a Muon Collider. The new NASEM report ([recommendation 1](#)) states "The United States should host the world's highest-energy elementary particle collider around the middle of the century. This requires the immediate creation of a national muon collider research and development program to enable the construction of a demonstrator of the key new technologies and their integration."

From the USMCC [submission](#) to the [European Strategy for Particle Physics Update](#):

"Assuming expanded funding and successful technological developments, we anticipate achieving technical design readiness for the collider within approximately 20 years, which could pave the way for the start of a construction project in the mid-2040s and operations commencing soon thereafter." [7]

The broader U.S. research program

The next collider is not the only priority for the U.S. program. Both the [P5](#) and [NASEM](#) reports emphasized the need for a broader program; both to exploit existing construction projects such as the HL-LHC and DUNE (P5 recommendation 1) [4] and “to pursue and develop new approaches to questions ranging from neutrino physics and tests of fundamental symmetries to the mysteries of dark matter, dark energy, cosmic inflation, and the excess of matter over antimatter in the universe.” ([NASEM recommendation 3](#)). These efforts, wherever they are located, rely on mutual international collaboration, including essential contributions from CERN and European institutions.

In parallel, we must build further upon our global R&D collaborations spanning computation, theory, and technology development that will provide the foundation for the future of the field.

Conclusion

In this document, we have summarized recent updates in the U.S. community prioritization process. The [P5](#) and [NASEM](#) reports are the result of broad community input followed by a rigorous prioritization process, only retaining the most compelling projects that are consistent with known budget and time constraints. The P5 priorities have been explicitly endorsed by a majority of the U.S. particle physics community and reinforced by the [NASEM](#) report.

US and European particle physics efforts have benefited tremendously from mutual engagement. The U.S. community and funding agencies continue to pursue collaboration towards the FCC-ee at CERN and a Muon Collider, potentially hosted by the U.S. While CERN priorities remain a predominantly European decision, our mutual goal must be worldwide optimization of resources for high-impact science.

References

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