US participation in FCC PED after Snowmass

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University of Maryland

2/7/2022

US and FCC

US physicists are actively participating in FCC PED work

- Up to 25% of the research time of physicists funded by the US DOE can be used for work on experiments for future colliders.
- US DOE and CERN signed bilateral agreement in December 2020 for DOE labs to participate in FCC feasibility study.
- Several US institutions have FCC MOUs October 2022 (note e.g. Maryland does not have one, so this is an undercount of US activity)
- We are having US workshop April 24-26 at Brookhaven National Lab.
- There are US physicists that are FCC physics group conveners

Larger scale participation depends on a positive outcome from the process within the US that sets funding priorities in particle physics (broadly): “P5” (Particle Physics Project Prioritization Panel), which has just started, and will take place over the course of this year with a report for HEPAP approval in October 2023.

P5: particle physics project prioritization panel

- P5 is organized by the US DOE and NSFas a subpanel of the agencies' advisory panel, HEPAP.
- The US Congress is strongly supportive of the P5 prioritization process, and NSF and DOE use it to guide funding

http://seattlesnowmass2021.net/

The P5 process

- Takes as one of its inputs the report(s) of the “bottoms-up” Snowmass process, in 2021
- While Snowmass was originally scheduled for a one year duration, was extended until summer 2022 due to COVID
- Culminated in the Snowmass workshop in Seattle and the Snowmass report https://arxiv.org/abs/2301.06581
- (some slides on what is in this report later in the talk)

Energy Frontier
Neutrino Physics Frontier
Rare Processes and Precisior
Cosmic Frontier
Theory Frontier
Accelerator Frontier
Instrumentation Frontier
Computational Frontier
Underground Facilities
Community Engagement

FERMILAB-CONF-23-008
SLAC-PUB-17717
January 2023

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

Summary Chapter

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Snowmass 2021 Frontier Conveners:

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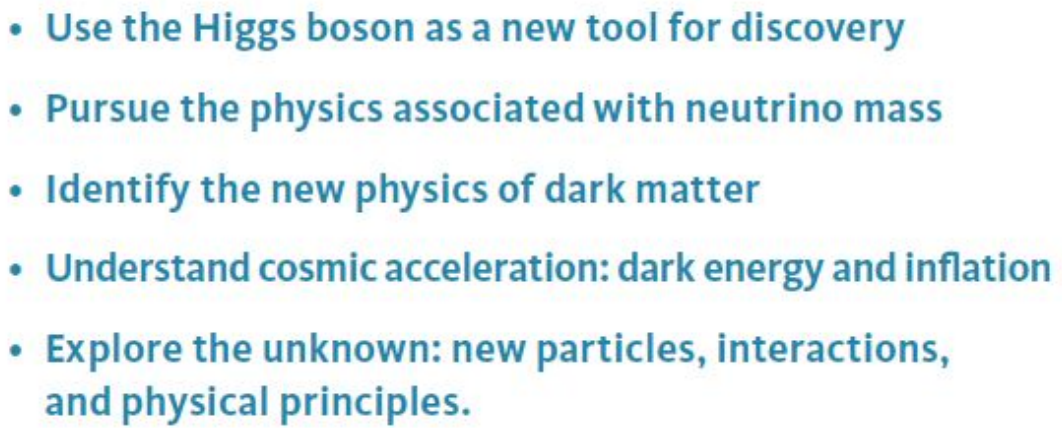
Editor: Michael E. Peskin[11]

Abstract

The 2021-22 High-Energy Physics Community Planning Exercise (a.k.a. “Snowmass 2021”) was organized by the Division of Particles and Fields of the American Physical Society. Snowmass 2021 was a scientific study that provided an opportunity for the entire U.S. particle physics community, along with its international partners, to identify the most important scientific questions in High Energy Physics for the following decade, with an eye to the decade after that, and the experiments, facilities, infrastructure, and R&D needed to pursue them. This Snowmass summary report synthesizes the lessons learned and the main conclusions of the Community Planning Exercise as a whole and presents a community-informed synopsis of U.S. particle physics at the beginning of 2023. This document, along with the Snowmass reports from the various subfields, will provide input to the 2023 Particle Physics Project Prioritization Panel (P5) subpanel of the U.S. High-Energy Physics Advisory Panel (HEPAP), and will help to guide and inform the activity of the U.S. particle physics community during the next decade and beyond.

Last P5

- The last P5 report was in 2013-2014. Charge: “Updated strategic plan for U.S. high energy physics that can be executed over a 10-year timescale, in the context of a 20-year global vision of the field.”
- The report identified five key scientific drivers:



2013-2014 P5 report: collider recommendations

Recognized the strength of collider physics as a tool for particle physics, and the importance of doing this physics in an international context. Strong support for HL-LHC, ILC, and a future proton collider.

Recommendation 1: Pursue the most important opportunities wherever they are, and host unique, world-class facilities that engage the global scientific community.

Recommendation 10: Complete the LHC phase-1 upgrades and continue the strong collaboration in the LHC with the phase-2 (HL-LHC) upgrades of the accelerator and both general-purpose experiments (ATLAS and CMS). The LHC upgrades constitute our highest-priority near-term large project.

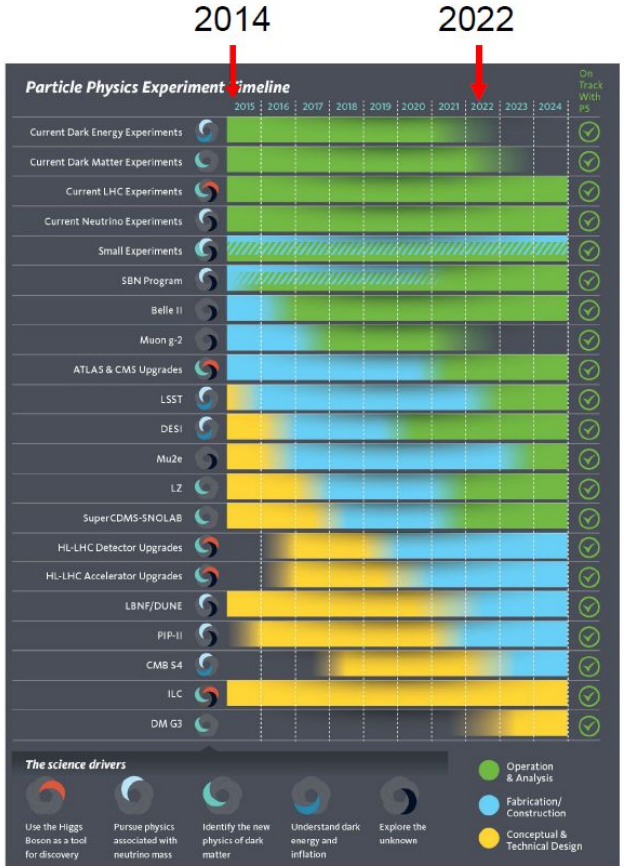
Recommendation 24: Participate in global conceptual design studies and critical path R&D for future very high-energy proton-proton colliders. Continue to play a leadership role in superconducting magnet technology focused on the dual goals of increasing performance and decreasing costs.

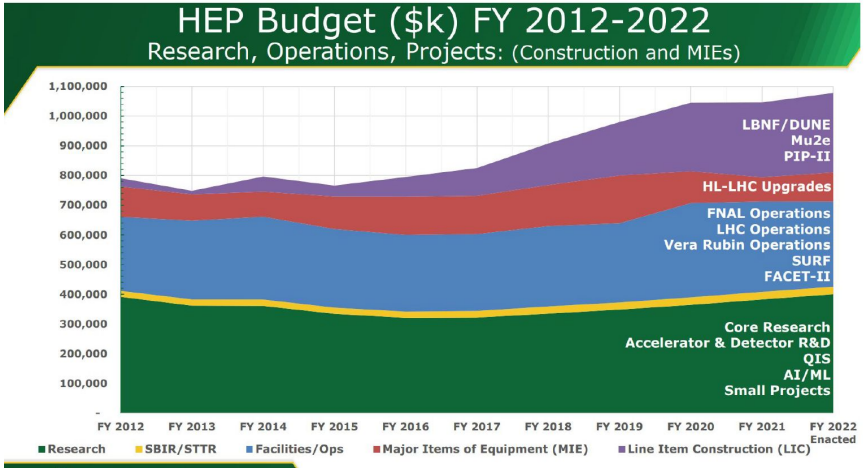
- The interest expressed in Japan in hosting the International Linear Collider (ILC) is an exciting development. Participation by the U.S. in project construction depends on a number of important factors, some of which are beyond the scope of P5 and some of which depend on budget Scenarios. As the physics case is extremely strong, all Scenarios include ILC support at some level through a decision point within the next 5 years.

A very high-energy proton-proton collider is the most powerful future tool for direct discovery of new particles and interactions under any scenario of physics results that can be acquired in the P5 time window. Colliders of energy up to 100 TeV, with a circumference of about 100 km with an option of e^+e^-, are presently under study at CERN, in China, and in the U.S. Extensive

R&D is required to make such a collider feasible at a reasonable cost. The U.S. is the world leader in R&D on high-field superconducting magnet technology, which will be a critical enabling technology for such a collider. Future R&D follows naturally from the directed R&D now conducted by the LARP program for the HL-LHC.

P5 sets priorities for many parts of fundamental science





- Generally believed adherence to the report has had a good impact on funding
- Most of the projects recommended in the last P5 are in operations and analysis (green). A few, including HL-LHC, are still in fabrication/construction (blue). ILC and DM G3 are still in conceptual/technical design.

New P5 charge at December 2022 HEPAP meeting

For complete text, see DOE HEP Associate Director talk at https://science.osti.gov/hep/hepap/Meetings/202212.

I extract some text I found particularly relevant to FCC.

long-range planning guidance to the DOE and NSF. To that end, we ask that you constitute a new P5 panel to develop an updated strategic plan for U.S. high-energy physics that can be executed over a 10-year timeframe in the context of a 20-year, globally aware strategy for the field.

Again, a 10-year strategic plan with a 20-year vision for the field

P5 charge

- A core tenet of the 2014 P5 Report is that particle physics is fundamentally a global enterprise. Thus far, the U.S. program has achieved high impact through U.S. researchers participating in the programs at world-class facilities outside the U.S. and international researchers working at world-class U.S. facilities. The recommendations developed for this report should carefully consider the current and future international landscape for particle physics. The panel's report should include an explicit discussion of the choices made in this context, including the extent to which it is necessary to construct, maintain, and/or upgrade leading U.S.hosted high-energy physics facilities so that our leadership position in the global scientific arena continues, while at the same time preserving the essential roles of, and contributions by, the National Laboratories and universities to global collaboration on large-scale initiatives.

Balance between US-hosted projects and programs with those hosted abroad

P5 panel

Name		Institution	expertise
Tulika	Bose	Wisconsin	CMS
Kyle	Cranmer	Wisconsin	ATLAS
Francis-Yan	Cyr-Racine	New Mexico	theory
Sarah	Demers	Yale	ATLAS, mu2e
Cameron	Geddes	LBNL	laser-plasma accelerators
Patrick	Huber	Virginia Tech	theory
Kendall	Mahn	Michigan State	T2K
Rachel	Mandelbaum	Carnegie Mellon	LSST
Jelena	Maricic	Hawaii	DUNE
Petra	Merkel	FNAL	CMS
Christpher	Monahan	William and Mary	lattice qcd
Peter	Onyisi	Texas Austin	ATLAS
Mark	Palmer	BNL	accelerator
Tor	Raubenheimer	SLAC	accelerator
Mayly	Sanchez	Iowa State	NOVA
Richard	Schnee	South Dakota	supercdms
Jesse	Thaler	MIT	theory
Abigail	Vieregg	Chicago	anita
Amanda	Weinstein	Iowa State	annie and dune
Lindley	Winslow	MIT	neutrinoless double-beta, axions
Tien-Tien	Yu	Oregon	dark matter, sensei, silicon ccd
Bob	Zwaska	FNAL	accelerator
Beate	Heinemann	DESY	ATLAS
Christos	Touamanis	Liverpool	t2k, dune
Shoji	Asai	Tokyo	ATLAS
Karsten	Heeger	Yale	cupid neutrino experiment
JoAnne	Hewett	SLAC	theory
Hitoshi	Murayama	Berkeley/LBNL	theory

The members of the P5 panel are chosen for their expertise in fundamental physics. CERN-based collider physics is well represented.

Chair is Hitoshi Murayama, Deputy is Karsten Heeger. Joanne Hewitt is chair of HEPAP.

Should produce a report on the time scale of a year. Report will be reviewed by HEPAP and they will send to NSF/DOE their recommendation regarding its acceptance.

Have heard P5 considering to add more members to its panel.

Other P5 inputs

P5 considers input from meetings with proponents that they will organize and “town hall” meetings open to all. They also consider the documentation that was produced during the community-driven Snowmass process, which took place over 2021 and 2022, and was organized by the Division of Particles and Fields (DPF) of the American Physical Society (APS). The US community interested in FCC provided input to several of the “Frontiers”, that produced reports based on white papers submitted by proponents within the community (on order 500 submitted).

From the US, Dmitri Denisov, Andy Lankford, and I will work with the international FCC team to organize input. We will also work with the US accelerator and international accelerator community.

Straw-person schedule

- 4 town halls: LBNL, Brookhaven, SLAC, Fermilab from January to April
- Virtual town halls, especially early career scientists
- 4 in person closed meetings from May to July
  - Make sure to build consensus
- Preliminary version in August
- Final report in October
- Probably need a sub-subpanel for cost and risk evaluations
- Followup with outreach to congress, other fields, public

Muryama’s talk at HEPAP

Energy Frontier report

Joel Butler (DPF chair), HEPAP

Energy Frontier

It is essential to

- Complete the LHC and HL-LHC program,
- Start now a targeted program for detector R&D for Higgs Factories
  - **Support a fast start of the construction of a Higgs factory**
- Ensure the long-term viability of the field by developing **a multi-TeV energy frontier facility such as a muon or hadron collider.**
- The US EF community has a renewed interest and ambition to bring back energy-frontier collider physics to US soil while maintaining its international collaborative partnerships and obligations, e.g. with CERN.
  - A US-sited linear e+e- collider (ILC/CCC) **(Cold Copper Collider)**
    - Exploring other e+e- collider options to fully utilize the Fermilab site
    - I sense that elements of the community at Snowmass are frustrated by a timeline which now appears to produce the next new collider about 25 years from now
  - Hosting a 10-TeV range Muon Collider
- Instrumenting uncovered parts of phase space in ATLAS and CMS (e.g. Faser, Mathusla) provides a "mid-scale" addition to the program and new opportunities for innovation and leadership

Accelerator Frontier

Joel Butler (DPF chair), HEPAP

Accelerator Frontier

- To enable the near-to medium-term future, AF needs
  1. An integrated **National Future Collider R&D Program** in OHEP to engage in the design and to coordinate development of the next generation collider projects such as: ILC, CLIC, FCC-ee, CCC/HELEN, a multi-TeV Muon Collider, or hadron collider.
- To enable medium- and long-term future, we an active R&D program in labs and universities aimed at general accelerator R&D that is critical in developing technologies and options for future HEP accelerators (but does not develop accelerator proposals), e.g.
  1. General Accelerator R&D (GARD)
  2. Accelerator and Test facilities

Other panels giving input to DOE/NSF

National Academies: Elementary Particle Physics 2024, Professors Maria Spiropulu (CalTech) and Michael Turner (Chicago) co-chairs. More information at https://science.osti.gov/hep/hepap/Meetings/202212. A few screen grabs from that talk.

- **EPP2024** will provide a vision and the approaches needed to achieve it over a much longer timescale (decade and beyond). Report to be released June 2024

- Identify the fundamental questions in particle physics that could motivate research in the next decade and beyond, irrespective of the tools and techniques to address them.
- Distinguish which of these questions could be addressed with available experimental and theoretical tools in the coming decade and which could require new techniques or approaches.
- Suggest technical research areas that could provide particle physics with new tools needed to enable new techniques and approaches.
- Suggest different ways of thinking and alternative approaches from other areas of science that could be incorporated into and benefit the overall particle physics enterprise.

July 2022: Seattle, WA
- Organize, meet with sponsors, attend SM21

November 2022: Irvine, CA
- Meet with P5, new DOE AD/HEP
- Information gathering

February 2023: CERN visit

March 2023: Fermilab visit

April 2023: NAS DC
- Information gathering

June 2023: Irvine, CA *
- Formulate findings, conclusions

September 2023: NAS DC *
- Formulate recommendations and make writing assignments

December 2023 (TBD): Irvine, CA *
- Review and consider the P5 report

Early 2024: Report sent to National Academy review *

June 2024: Report released

Additional activities
- Events (EC Town Hall, Academic Leadership Panels)
- Participation in the public activities of P5
- Monthly Committee Zoom meetings *
- Working Groups on special topics *

Other panels giving input to DOE/NSF

International benchmarking panel, Bonnie Fleming, Patricia McBride, co-chairs. More information at: https://science.osti.gov/hep/hepap/Meetings/202212. A few screen grabs.

"it is timely to consider more closely the **unique international context of particle physics,** and how we can best position the U.S. program and its researchers for success in this evolving landscape"

"ensure that the U.S. **continues to be a leader in particle physics internationally** and remains one of the best places to conduct research, as well as **preserving its ability to collaborate effectively at leading facilities hosted elsewhere**. We want to be the best partner we can be for the international scientific community"

"**develop and maintain world-leading capabilities** in key technologies, especially particle accelerators and detectors, as well as high performance computing; and also provide compelling, inclusive, and equitable opportunities for all those who want to explore the secrets of the universe at their most fundamental level"

Panel Activities

Data collection → bringing report together

- The subcommittees are completing a "data collection" phase, seeking input across all areas
  - Interviewing many members of the community
  - Collecting demographics
  - Community and Snowmass takeaways

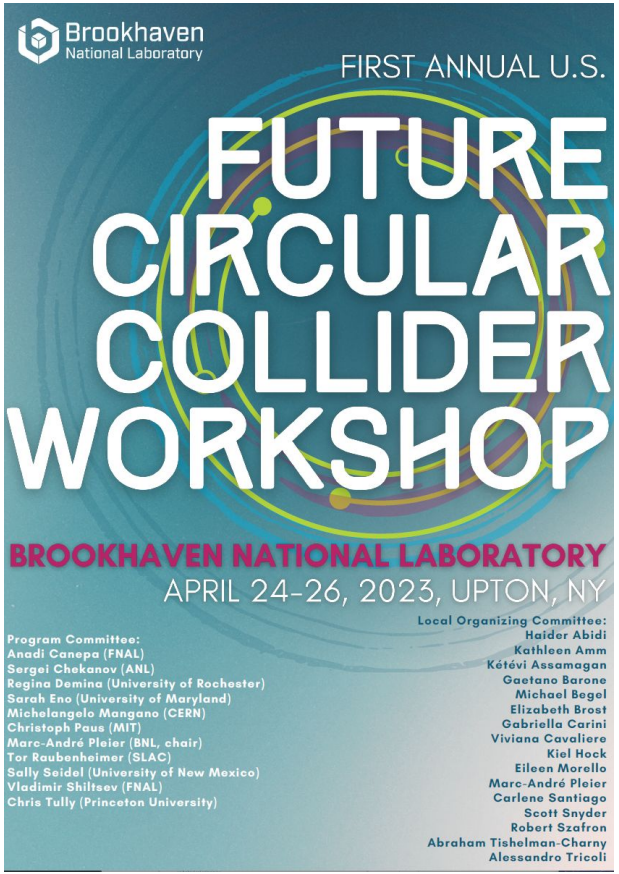
We have a place to submit feedback through our website.

- Launch of Panel → Mid June 2022, several remote meetings
- Regular subcommittee meetings and cross subcommittee meetings
- Town Hall at Snowmass July 23rd
- In person Subcommittee Chairs meeting → November 4-6

Final In Person Workshop: January 13-16

Summary

- The NSF and DOE have a process for prioritizing funding that is based on a long-range strategic plan, P5.
- A new cycle has begun. Report expected by late 2023 and topical Town Hall meetings are being planned by the P5 panel.
- In the meantime, the number of US-based physicists actively involved in FCC continues to grow.



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P5 charge

- A number of the projects recommended by the 2014 P5 report are still being built, and the agencies take their commitments to complete them very seriously. Understanding the continued strength of the science case for these projects is quite valuable, and the panel should provide its assessment of these projects in this context.

P5 charge

The recommended projects and initiatives should be implementable under reasonable assumptions and be based on generally accepted estimates of science reach and capability Estimated costs for future projects and facility operations should be given particular scrutiny and may be adjusted if the panel finds it prudent to do so. Given the long timescales for realizing these initiatives, we expect the funding required to enable the priorities the panel identifies may extend well past the 10-year budget profile, but any recommendation should be technically and fiscally plausible to execute in a 20-year timeframe.