



FCC in America and the Snowmass Process

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USA high energy physics priorities



- Are set by “P5” (particle physics project prioritization) panel, ganized by DOE and NSF
- The last P5 report [1] 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 objectives:

- Use the Higgs boson as a new tool for discovery
- Pursue the physics associated with neutrino mass
- Identify the new physics of dark matter
- Understand cosmic acceleration: dark energy and inflation
- Explore the unknown: new particles, interactions, and physical principles.

The US Congress is strongly supportive of the P5 prioritization process, and NSF and DOE use it to guide its funding plans.

[1] https://www.usparticlephysics.org/wp-content/uploads/2018/03/FINAL_P5_Report_053014.pdf



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.

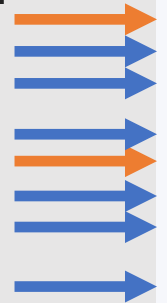


Snowmass



The P5 committee develops an updated strategic plan for US particle physics funding using input from documentation produced in the “Snowmass” process. The US is in the midst of the Snowmass phase of the Snowmass-P5 process.

Several “frontiers” relevant to FCC



The screenshot shows the Snowmass 2021 website. The main content area is titled "Snowmass Steering Group" and "DPF Chairline". It lists the following members:

- Chair: Tao Han, University of Pittsburgh
- Chair-Elect: Joel Butler, Fermilab
- Vice Chair: Sekhar Chivukula, University of California - San Diego
- Past Chair: Young-Kee Kim, University of Chicago
- Ex Officio: Priscilla Cushman, University of Minnesota

Below this, it lists "Representatives from other Divisions":

- DPB: Sergei Nagaitsev, Fermilab
- DNP: Yury Kolomensky, University of California, Berkeley
- DAP: Glennys Farrar, New York University
- DGRAV: Nicolas Yunes, University of Illinois - Urbana-Champaign

The left sidebar contains a navigation menu with categories like "Organization", "Snowmass Frontiers", and "Community Contributions". The "Snowmass Frontiers" section includes: Energy Frontier, Neutrino Physics Frontier, Rare Processes and Precision, Cosmic Frontier, Theory Frontier, Accelerator Frontier, Instrumentation Frontier, Computational Frontier, Underground Facilities, Community Engagement, and Snowmass Liaisons. The "Community Contributions" section includes "Letters of Interest" and "Contributed (White) papers".



Accelerator Frontier



Frontier Conveners

Name	Institution	email
Steve Gourlay	Lawrence Berkeley National Laboratory	sagourlay[at]lbl.gov
Tor Raubenheimer	SLAC National Accelerator Laboratory	tor[at]slac.stanford.edu
Vladimir Shiltsev	Fermi National Accelerator Laboratory	shiltsev[at]fnal.gov

Whitepapers submitted to Snowmass, supplemented by presentations in a series of ongoing meetings, are digested by the frontier conveners and their subgroups and are used to produce the Snowmass report which goes to P5.

Topical Group		Co-Conveners			
AF1	Beam Physics & Acc. Education	Mei Bai (SLAC)	Zhirong Huang (SLAC)	Steve Lund (MSU)	
AF2	Accelerators for Neutrinos	John Galambos (ORNL)	Bob Zwaska (FNAL)	Gianluigi Arduini (CERN)	
AF3	Accelerators for EW/Higgs	Goerg Hoffstaetter (Cornell)	Qing Qin (IHEP)	Frank Zimmermann (CERN)	Angeles Faus-Golfe (IN2P3)
AF4	Multi-TeV Colliders	Mark Palmer (BNL)	Nadia Pastrone (INFN)	Jingyu Tang (IHEP)	Alexander Valishev (FNAL)
AF5	Accelerators for PBC & Rare Processes	Mike Lamont (CERN)	Richard Milner (MIT)	Eric Prebys (UC Davis)	
AF6	Advanced Acc. Concepts	Ralph Assmann (DESY)	Cameron Geddes (LBNL)	Mark Hogan (SLAC)	Pietro Musumeci (UCLA)
AF7	Accelerator Technology				
	RF	Emilio Nanni (SLAC)	Sergey Belomestnykh (FNAL)	Hans Weise (DESY)	
	Magnets	Susana Bermudez (CERN)	Gianluca Sabbi (LBNL)	Sasha Zlobin (FNAL)	
	Targets/Sources	Charlotte Barbier (ORNL)	Frederique Pellemoine (FNAL)	Yin-E Sun (ANL)	
ITF	Implementation Task Force	Thomas Roser (BNL)			



Schedule



- Snowmass began in early 2020
- Was paused in January 2021 due to COVID
- Resumed Sept 2021
- White papers due March 15, 2022
- Energy frontier meeting [1] at Brown University, Rhode Island 28 March - 1 April
- Workshop in Seattle Washington 17-27 July [2]. where much of report will be produced.
- Early-fall of 2022: DOE and NSF plan to charge US High Energy Physics Advisory Panel (HEPAP) to convene a P5 subpanel of HEPAP to begin the US P5 process
- May 2023: P5 report delivered to HEPAP for approval

[1] <https://indico.fnal.gov/event/52465/>

[2] <https://indico.fnal.gov/event/22303/>



USA, FCC, and Snowmass



- DOE have indicated that researchers supported by current agency grants may spend up to 25% of their time towards studies and R&D for future initiatives.
- Quite a few presentations in frontier subgroup meetings have been made
- Much US interest, especially in the theory community.
- We got a late start on our whitepaper, beginning in December 2021
- Nevertheless, a strong group of US physicists have stepped up to help produce the paper, with assistance of our colleagues in Europe.



White paper



Goals:

- about 50 pages, currently about 54 pages
- Contains only the plots/tables that are most frequently needed. Something that summarizes, with extensive references to the papers that contain the detailed work
- Concentrate on FCC-ee as this is a necessary precursor to FCC-hh, but includes and summarizes this important upgrade path as well.

Strong involvement of the US community in producing the text, building a US community interested in this physics

Transcendental Preprint
February 4, 2022

The Future Circular Collider: (a Summary for the US 2022 Snowmass Process)

ABSTRACT

In this white paper for the 2022 Snowmass process, we give a description the proposed Future Circular Collider project and its physics program. The paper summarizes and updates the discussion submitted to the European Strategy. The physics and accelerator programs are complementary. After construction of an ≈ 90 km tunnel, an electron-positron collider allows world-record instantaneous luminosities at center-of-mass energies from the Z resonance through the ZH and WW and $t\bar{t}$ thresholds, enabling a diverse set of physics measurements that will allow measurement of the Higgs couplings at the loop level, precision tests of the weak and strong forces, and searches for new particles, including dark matter, both directly and via virtual corrections to high rate processes. The tunnel could then be reused as a proton-proton collider, establishing record center-of-mass collision energy, allowing unprecedented reach for direct searches for new particles, and a diverse program of measurements of the standard model and Higgs boson, including a precision measurement of the di-Higgs coupling. The program builds on the stable funding provided by the CERN member states and the existing, long-standing world-wide partnerships built via the LHC, but requires substantial contributions both intellectual and financial from the US and other non-CERN-member to become a reality.

N.B. final paper should be about 50 pages. Each chapter roughly 5 pages

Submitted to the Proceedings of the US Community Study
on the Future of Particle Physics (Snowmass 2021)

1 Introduction

main editor: S. Eno, D. Denisov (US), consulting editors: Janot, Blondel (Europe)

A brief description of the motivation and outline of the white paper

In 2005 the LEP Electroweak Working Group*, using results from experiments at the LEP collider at CERN and from SLC at SLAC, showed that (within the context of the Standard Model) the Higgs mass must be less than 285 GeV at the 95% confidence level [1]. In 2012, data from a new accelerator built in the LEP tunnel, the Large Hadron Collider (LHC), confirmed that prediction, observing a new particle with properties consistent with those of the Higgs Boson and a mass near 125 GeV [2, 3]. All of these results came from collaborations with strong participation from the United States. While many say that the Higgs discovery was the ultimate confirmation of the standard model, this is very far from the truth. We still do not know what dark matter (DM) is, and if it has

*<http://lepewwg.web.cern.ch/LEPEWWG/>



White paper

Current team



Section	US Primary authors	Secondary input
Introduction	Eno, Denisov	Janot, Blondel
Accelerator	Raubenheimer	Zimmerman
Higgs	Brost, Paus	Klute, Grojean, Bernardi, Janot, d'Enterria
Precision EWK	Hildreth, Freitas, Zhu	Blondel, Gluza, Alcaraz, de Blas
Top	Demina, Skinnari	Simon, Azzi, Vos
BSM	Willocq, Thomson	Gonzalez Suarez, Heinemeyer, Antusch
QCD	Eno	D'Enterria
flavor	Novotny, Altmannshofer, Landsberg	Dam, Isidori, Pich, Hill
FCC-hh	Harris, Barberis, Wang	Mangano, Selvaggi
Detectors	Seidel, Qian	Bedeschi, Giacomelli, Aleksa, Perez
Summary	Eno, Denisov	Janot, Blondel
Additional readers	Heintz	

Additional input / authors/ readers always welcome!!
Please contact me.

Call for additional signers will occur in early March

My sincere thanks to all team members for their hard work on this short timescale!



USA, Snowmass, and FCC



The Snowmass process covers over all areas of fundamental physics. A future plan that includes a collider option beyond HL-LHC is not a given. The USA has a strong commitment to neutrino physics, the cosmic frontier, quantum computing, and other probes of fundamental physics.

There is already strong interest in the US in a variety of future collider options, including ILC, CCC, muon collider, AF06 and others. The “Agora” workshops are generating more interest. The Agora on circular colliders, featuring Alain Blondel and Frank Zimmerman from FCC, was enthusiastically attended.

Only strong enthusiasm for a future Higgs factory, and participation in the Snowmass week, can yield US funding for a future collider option.

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Conferences, Workshops, and Events

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Some events in the list below have been hidden.

There are 3 events in the future. [Show](#)

February 2022

- Feb 16 [Snowmass Agora on Future Colliders: Muon Colliders](#) **NEW**

January 2022

- Jan 19 [Snowmass Agora on Future Colliders: Circular e+e- Colliders](#)

December 2021

- Dec 15 [Snowmass Agora on Future Colliders: Linear e+e- Colliders](#)



Conclusions



- The US is in the process of deciding its priorities for the next decade via the snowmass and P5 processes
- There will be a submission for the FCC
- However, for a positive outcome, more involvement is probably needed.
- Even if your time is very limited, we can find a task that fits.
Please contact us!
- Many many thanks to those who are making this white paper a reality