Snowmass 2021 Instrumentation Frontier

Kick-Off Workshop, June 19th 2020

Phil Barbeau (Duke U.)
Petra Merkel (FNAL)
Jinlong Zhang (ANL)

The Snowmass process

Long-term planning exercise for the particle-physics community.

- "Develop community long-term physics aspirations."
- "Communicate opportunities for discovery in particle-physics to broader community and to the (US) government."

(Young-Kee Kim, DPF Chair, Town-Hall Meeting, 2020 April APS meeting)

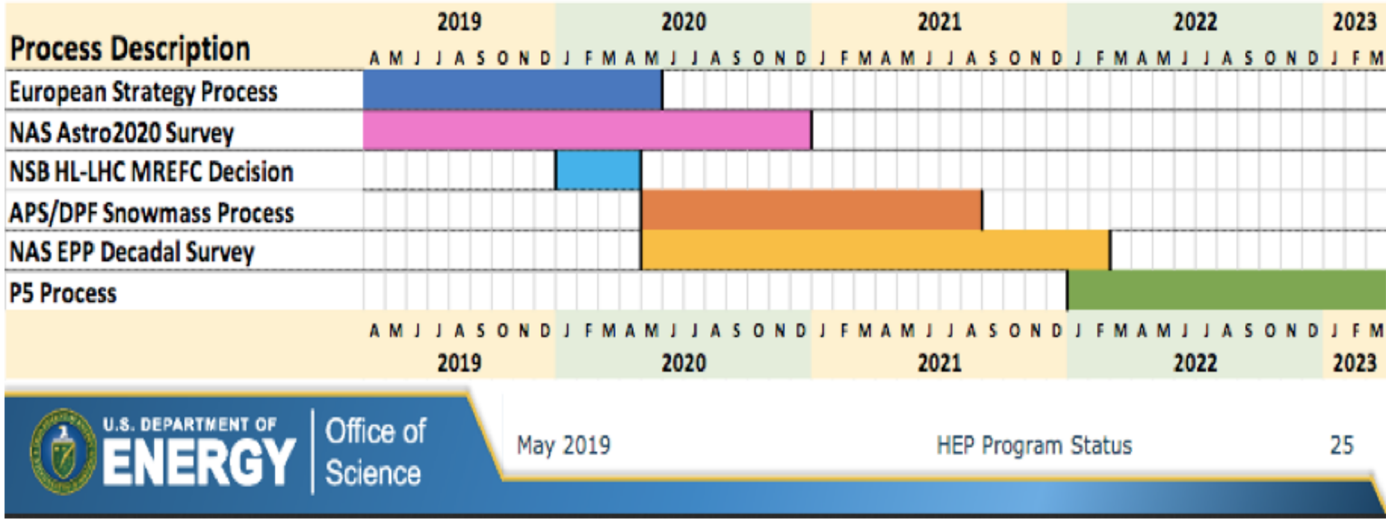
Physics-driven effort.

- Covers all areas of particle physics and facilitates cross-cutting.
- Develop overarching physics studies.

Global effort.

- Input from non-US community is essential.
- Input from recent international studies, for example HL-LHC, European Strategy Particle Physics Update (ESPPU), future colliders etc.

International Timeline

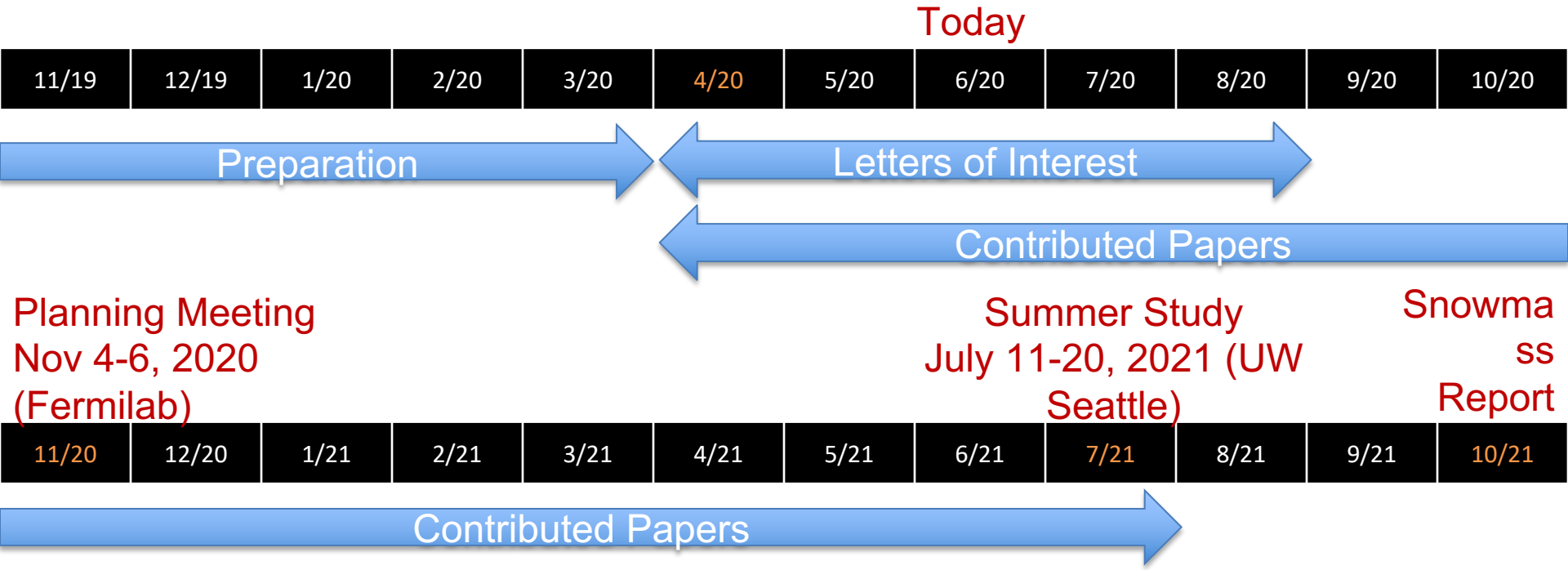


Snowmass Final Report: Fall 2021

Snowmass 2021 results will be used as input to the next P5 (2022)

Snowmass 2021 Timeline

We are ahead of the curve compared to Snowmass 2013



Past Snowmass and P5

- **Snowmass 2013**: **new successful model**
  - Energy Frontier
  - Intensity Frontier
  - Cosmic Frontier
  - Cross-cutting groups: Facilities, Instrumentation, Computing, Theory, Communication.

  Report: https://www.slac.stanford.edu/econf/C1307292/

- **P5 (2014)**: identified **five science drivers**
  - Use the Higgs boson as a new tool for discovery.
  - Pursue the physics associated with neutrino masses.
  - Identify the new physics of dark matter.
  - Understand cosmic acceleration: dark energy and inflation.
  - Explore the unknown: new particles, interaction, and physical principles.

  Report: https://www.usparticlephysics.org

Previous P5 Recommendations (*Detectors*)

Instrumentation R&D

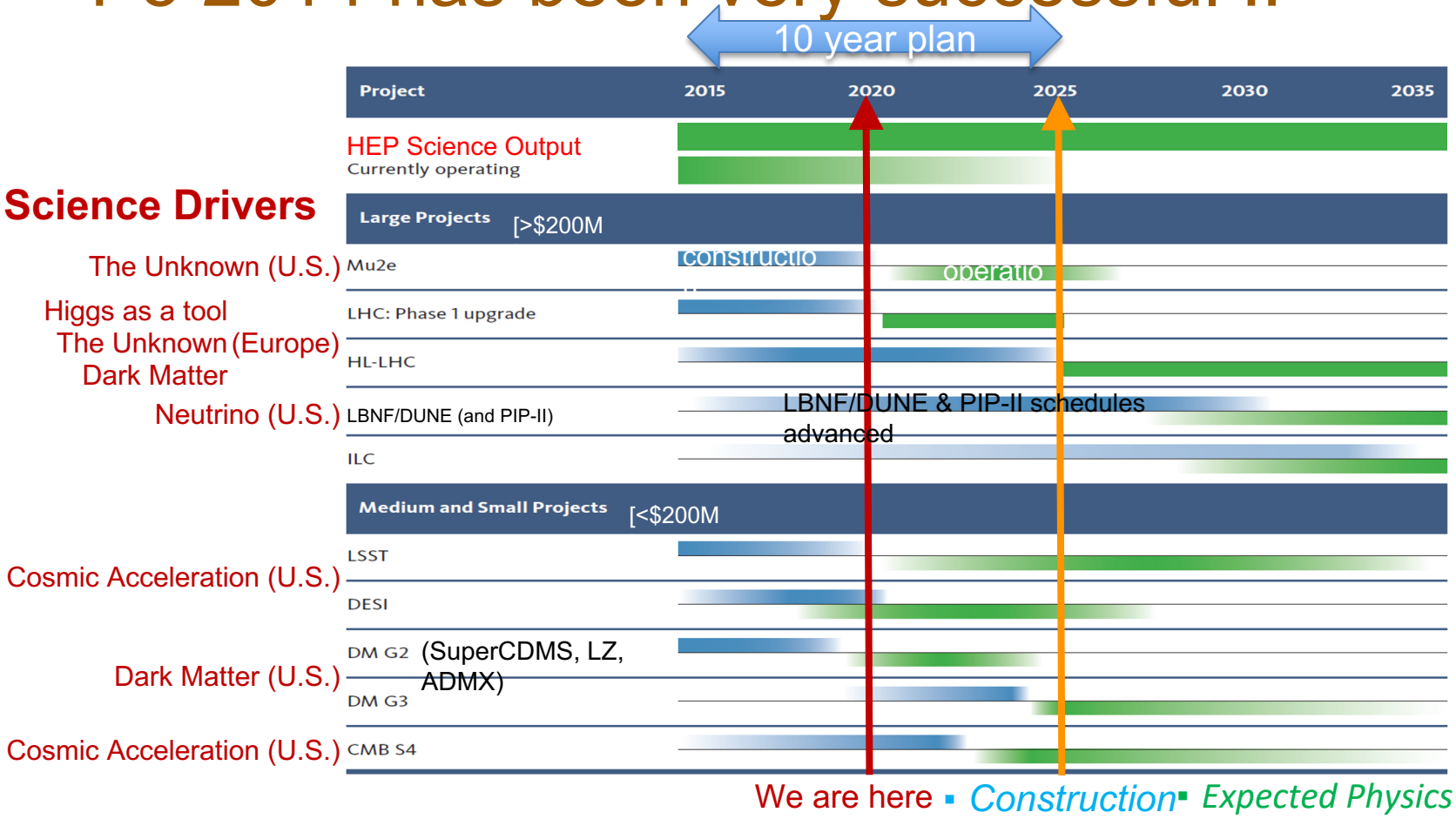
The particle physics detector community has historically been an important contributor to broadly applicable innovation in instrumentation. A recent example is the key role of ultra-sensitive transition edge bolometers in CMB experiments. A rich spectrum of challenging physics experiments is planned that requires advances in instrumentation. The challenges include ever-greater requirements for sensitivity and performance. It is only through investments in the development of advanced, cost-effective new technologies that the science goals can be met. With the recommended increase in new project construction (Recommendation 5), detector R&D activity will shift toward addressing the relatively near-term requirements of the LHC detectors and the neutrino program. This shift will enable these projects to realize their physics program in a cost-constrained environment. For the longer term, a portfolio balanced between incremental and transformational R&D is required.

Recommendation 27: Focus resources toward directed instrumentation R&D in the near-term for high-priority projects. As the technical challenges of current high-priority projects are met, restore to the extent possible a balanced mix of short-term and long-term R&D.

To alleviate the serious shortage of physicists with a background in instrumentation, workforce training at the graduate or post-doctoral level and promising career opportunities are necessary to accomplish and sustain research. University infrastructure to support teaching of instrumentation has decreased over the last decade, which has adversely affected the ability of universities to train students.

Recommendation 28: Strengthen university-national laboratory partnerships in instrumentation R&D through investment in instrumentation at universities. Encourage graduate programs with a focus on instrumentation education at HEP supported universities and laboratories, and fully exploit the unique capabilities and facilities offered at each.

P5 2014 has been very successful !!



European Strategy for Particle Physics Update

- Detector R&D identified among high priority activities

4c) The success of particle physics experiments relies on innovative instrumentation and state of the art infrastructures. To prepare and realise future experimental research programmes, the community must maintain a strong focus on instrumentation. *Detector R&D programmes and associated infrastructures should be supported at CERN, national institutes, laboratories and universities. Synergies between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase opportunities for more technology transfer benefiting society at large. Collaborative platforms and consortia must be adequately supported to provide coherence in these R&D activities. The community should define a global detector R&D roadmap that should be used to support proposals at the European and national levels.*

Summary of recommendations: Strategy recommendations
Full report: Deliberation document

Snowmass 2021: leading to the next P5

Ten Frontiers (with Liaisons in between).

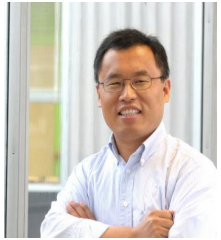
- Energy Frontier
- Frontiers in Neutrino Physics
- Rare Processes & Precision Measurements
- Cosmic Frontier
- Theory Frontier
- Underground Facilities
- Accelerator Frontier
- Instrumentation Frontier
- Computational Frontier
- Community Engagement Frontier

Wiki: https://snowmass21.org/start

Instrumentation Frontier


Phil


Petra


Jinlong

Wiki: https://snowmass21.org/instrumentation/start

The Instrumentation Frontier is geared to discuss **detector technologies and R&D needs for future experiments in collider physics, neutrino physics, intensity physics and at the cosmic frontier**. It is divided into diagonal topical groups with some overlap among a few of them. Synergies between the different topical groups, as well as with other Frontier groups and research areas outside of HEP will be paid close attention to.

Instrumentation Frontier – Topical Groups

Topical Group	Co-Conveners			
Quantum Sensors	Thomas Cecil (ANL)	Kent Irwin (SLAC)	Reina Maruyama (Yale)	Matt Pyle (Berkeley)
Photon Detectors	Juan Estrada (FNAL)	Mayly Sanchez (ISU)	Abigail Vieregg (Chicago)	
Solid State Detectors and Tracking	Tony Affolder (UCSC)	Artur Apresyan (FNAL)	Lucie Linssen (CERN)	
Trigger and DAQ	Darin Acosta (Florida)	Wes Ketchum (FNAL)	Stephanie Majewski (Oregon)	
Micro Pattern Gas Detectors	Bernd Surrow (Temple)	Maxim Titov (SACLAY)	Sven Vahsen (Hawaii)	
Calorimetry	Andy White (UTA)	Minfang Yeh (BNL)	Rachel Yohay (FSU)	
Electronics/ASICS	Gabriella Carini (BNL)	Mitch Newcomer (Penn)	John Parsons (Columbia)	
Noble Elements	Eric Dahl (Northwestern)	Roxanne Guenette (Harvard)	Jen Raaf (FNAL)	
Cross Cutting and System Integration	Jim Fast (PNNL)	Maurice Garcia-Sciveres (LBL)	Ian Shipsey (Oxford)	

Topical Group Activities

All IF Topical Groups (TG) have:

- wiki pages and Indico sites for their meetings
- **mailing lists** (subscribe!) and **Slack channels**.

Everybody's contribution and participation are vital to the Snowmass process!

How to engage:

- Contact the TG conveners and join the TG activities (join meetings, discussion).
- Bring existing studies and/or new ideas and projects to investigate.
- Write a Letter of Interest (LOI): 2 pages, briefly what you want to work on (the IF conveners and TG conveners will facilitate the process).
  - This can be done as individuals, user groups or collaborations
  - We invite collaborations & initiatives to submit (one or multiple) LOIs with a set of open questions and how to get new users involved in the studies.

“Letters of Interest” and “Contributed Papers”

- **Letters of Interest (LOI)**

  (submission period: April 1, 2020 – August 31, 2020)

“They allow Snowmass conveners to see what proposals to expect and to encourage the community to begin studying them. They will help conveners to prepare the Snowmass Planning Meeting that will take place on November 4 - 6, 2020 at Fermilab. Letters should give brief descriptions of the proposal and cite the relevant papers to study. Instructions for submitting letters are available at https://snowmass21.org/loi.

Authors of the letters are encouraged to submit a full write-up for their work as a contributed paper.”

- ➔ Very brief (two pages).
- ➔ Uploaded by Authors through Snowmass 2021 Wiki.
- ➔ Index of submitted LOI available on the Snowmass 2021 Wiki.
- ➔ Could represent existing work (cite) or new ideas.
- ➔ Will help the IF conveners plan the work of the Frontier (including liaisons with other Frontiers: avoid duplication/build synergy).
- ➔ If further developed in the context of the Snowmass 2021 exercise could lead to a Contributed Paper.

“Letters of Interest” and “Contributed Papers”

- **Contributed Papers**

(submission period: April 1, 2020 – July 31, 2021)

“Contributed papers will be part of the Snowmass proceedings. They may include white papers on specific scientific areas, technical articles presenting new results on relevant physics topics, and reasoned expressions of physics priorities, including those related to community involvement. These papers and discussions throughout the Snowmass process will help shape the long-term strategy of particle physics in the U.S. Contributed papers will remain part of the permanent record of Snowmass 2021. Instructions for submitting contributed papers are available at https://snowmass21.org/submissions/”

- ➔ More extensive studies.
- ➔ May include white papers, scientific/technical articles, etc.
- ➔ Can but do not have to be related to a given LOI.
- ➔ Submitted by Authors following instructions given on Snowmass 2021 Wiki page (submit to arXiv, send email to M. Peskin with subject “Contribution to Snowmass 2021”, etc.)
- ➔ Will be part of the official Snowmass 2021 records.

Liaisons among Frontiers

- They will provide high-level and bi-directional communication b/w Frontiers.
- They will be people with interests in both communities.
- **Official IF Liaisons:**
  - Energy Frontier: Caterina Vernieri (SLAC), Maksym Titov (CEA Saclay)
  - Neutrino Physics Frontier: Mayly Sanchez (ISU), NF10
  - Rare Processes and Precision: Marina Artuso (Syracuse)
  - Cosmic Frontier: Kent Irwin (SLAC), Hugh Lippincott (UCSB)
  - Accelerator Frontier: Andy White (UTA)
  - Computational Frontier: Darin Acosta (Florida)
  - Underground Facilities: Eric Dahl (Northwestern), Maurice Garcia-Sciveres (LBNL)
  - Community Engagement: Farah Fahim (FNAL)

Today's Meeting and Community Workshop

- **Kick-off Meeting**: Today (full day)
  - Review of existing studies, and plans to engage communities.
    - *Goal is to lay out our plans, strategy, activities, discuss the organization of the IF group and TGs, how to communicate within the community.*
    - *Summaries of studies that can be considered as stepping stones for TG activities (e.g. surveys of previous or international studies, e.g. ESG results, Yellow Reports etc.) as well as overviews of ideas for studies that can be carried out for Snowmass 2021.*
    - *Present plans for and use of letters of intents and contributed papers within the IF group.*
- **Community Workshop**: November 4-6
  - Originally planned as in-person workshop at Fermilab
  - Now leaning towards all-virtual workshop
    - *Facilitate get-together of entire community*
    - *Facilitate communication within frontiers and topical groups*
    - *Facilitate cross-frontier communication*

CPAD Workshops

- **Last Snowmass:**
  - CPAD was the Instrumentation Frontier group
- **Since then**:
  - Vibrant, annual instrumentation workshops
  - Cross-cutting Quantum Sensing workshop
  - Workshop reports
  - Instrumentation Awards, Instrumentation Studentships, SBIR process, …

- **Next CPAD Workshop**: early 2021 @ Stony Brook University
  - Hopefully in-person
  - Serve as Snowmass Instrumentation Frontier workshop
  - Facilitate cross-fertilization with NP/EIC community

We hope you will enjoy today's kick-off meeting

and

join the work of the
Snowmass 2021 Instrumentation Frontier!