
Welcome to Snowmass @ LBNL

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<https://sites.google.com/lbl.gov/snowmass2021lbl>

LBL Snowmass Cross Cutting Steering Group



Snowmass

<https://snowmass21.org/start>

The Particle Physics Community Planning Exercise (a.k.a. “Snowmass”) process is an opportunity for the entire HEP community to come together to identify and document a vision for the future of particle physics in the U.S. and its international partners

- Snowmass is defined as a scientific community study [\[LINK: HOW TO SNOWMASS\]](#)
- Organized by the Division of Particles and Fields (DPF) of the American Physical Society

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The output of this process will be used as input to the P5 (Particle Physics Project Prioritization Panel) that is in charge of formulating a 10-year plan (20-year vision) for the U.S. within funding constraints

Direct impact on the particle physics program and its international participation

First Snowmass in 1982, most recent iteration completed in 2012-2013

- A similar process completed in 2020 in Europe (European Strategy [reports](#))

Snowmass 2013

Full report is [here](#).

Introduced the frontiers: Intensity, Energy, Cosmic, along with Theory, Accelerator, Underground Labs, Instrumentation, Computing, E&O

Strategic goals:

LHC, lepton collider, Higgs

Develop tech for lepton colliders

Execute prog'm to host neutrino sector

Find Dark Matter

Unravel Dark Energy

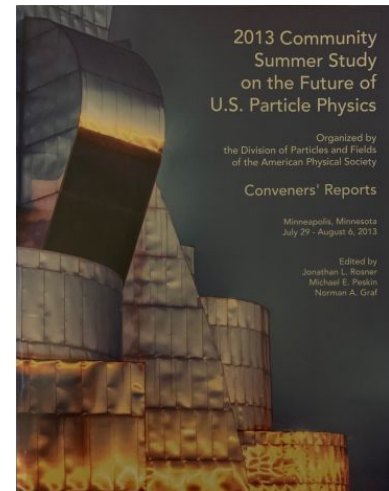
Invest in accelerator technology

Advanced computing

Carry on theory in support of expts

Invest in STEM education

Establish coordinated E&O effort



2014 P5 Report

Building for Discovery

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

Full text is [here](#).

Science Drivers:

- **Higgs Boson as a tool for discovery**
- **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**



Report of the Particle Physics Project Prioritization Panel (P5)

May 2014

More details on recommendations in backup slides

Snowmass 2021: Organization

Work divided in ten frontiers

- Each frontier has 6 to 10 working groups

A few common goals:

- Engage widely the community
- Encourage to hear ideas from everyone, especially young members
- Let's not be afraid to lay out ambitious and scientifically sound ideas!

Snowmass Frontiers

Energy Frontier

Neutrino Physics Frontier

Rare Processes and Precision

Cosmic Frontier

Theory Frontier

Accelerator Frontier

Instrumentation Frontier

Computational Frontier

Underground Facilities

Community Engagement Frontier

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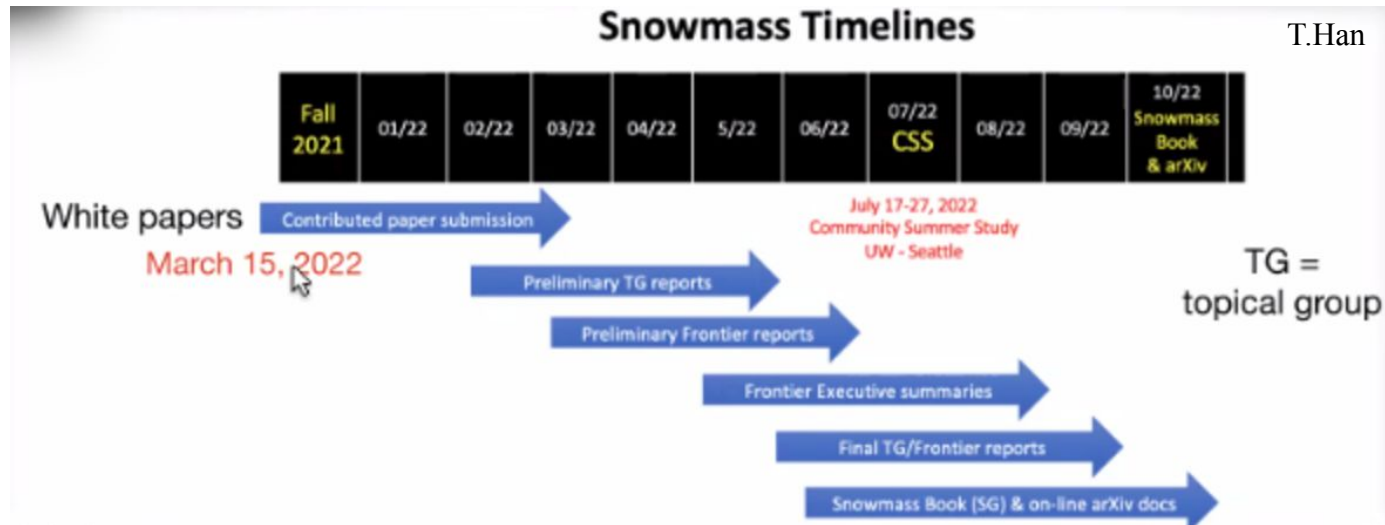
Underground Facilities

Community Engagement Frontier

LBNL is involved and often leads
efforts in all these areas!

Do you know at least one LBNL person involved in each of these areas?
- After today's meeting, you will!

Snowmass Timeline



- Snowmass effort initially started in April 2020
- Long pause from Jan 2021 to ~now
- Snowmass (Half-)Day virtual meeting: Sep 24th 2021 [<https://indico.fnal.gov/event/50538/>]
- A key date to remember: March 15th 2022
 - deadline for contributed papers submission from the community

Purpose of today's meeting

What today's meeting is for:

- Invite even more LBNL people to engage in Snowmass
- Bring very important questions at your attention, with focus on selected topics we believe LBNL can play a leading role in and are being less thoroughly explored in Snowmass

What today's meeting is NOT for:

- Giving a high-level overview of Snowmass activity
 - see instead the Snowmass Day on Sep 24th and the Snowmass twiki page
- Be comprehensive: there are other very important topics being heavily discussed in Snowmass that are not represented in the meeting today

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Today's meeting gives us the unique opportunity
to bring together a diverse set of expertise

Physics Division

Computing Research / NERSC

Nuclear Science

Accelerator Technology
and Applied Physics

and foster collaborations!

Overview of today's program

Physical Sciences ML Strategy

Exploring how AI/ML techniques developed in different areas can uniquely address the demands of our future experiments needs

Lepton collider physics opportunities and energy scales

Physics opportunities/challenges and accelerator technologies for leptons and gammas at few TeV to 15 TeV scales

Future LBNL-led small/demonstrator experiments

While LBNL is leader in many international projects, many opportunities exist for future small experiments / demonstrators potentially on the LBNL site or led by LBNL

Lunch Break

Cosmic Frontier

- What will we learn about Dark Energy in the 2020s?
- Will cosmic experiments measure neutrino masses?
- Will cosmic experiments measure inflation?
- What should the cosmo+CMB data repository look like?

Neutrinos for fundamental and applied particle and nuclear physics

- Long baseline physics at DUNE
- Double beta decay into the normal hierarchy and low-energy physics
- Neutrinos for nonproliferation

Future of large-scale DM experiments

What's ahead in the quest for direct detection of Dark Matter and what new ideas can shape how we'll build the next generation of Dark Matter detectors?

This is the one frontier that is not represented in today's meeting

- very little LBL engagement in this frontier so far.
- this is a great opportunity for LBL to shape the future climate of the field.

Overall aim of the CommF: deliver best practices for the community, implementation plans, as well as advice for leadership and funding agencies. There are currently 3 project areas being considered, encompassing the LOIs submitted:

Creating climate from the top down

Policies, how they work, how they are measured, how they are supported.

Measuring and accounting for the existing climate

Mechanisms to measure issues within the existing climate, their biases and implementation.

Equitably interacting with the broader scientific community

How scientists interact with populations in the broader scientific community, what works and how to improve.

- If you are interested in contributing to this frontier let me know - we can include a discussion in the next LBL workshop.

Looking forward...

This is the first step in what we hope will be a continuous collaboration across divisions on Snowmass (and beyond)

We plan to follow up with another meeting – initially planned in-person

- more time will be allocated for in-depth discussions on specific topics
- encourage - especially younger - people to show their research
- show results that follow up from questions/ideas that will arise today!

Reminder:

We aim for this event to be engaging for as many of you as possible and we invite everyone to actively participate in all the discussion sessions! The main focus is to raise questions that can be explored, rather than providing answers.

Let's get started !!!

BACKUP

Program-wide Recommendations



- 1) Pursue the most important opportunities wherever they are, and host unique, world-class facilities that engage the global science community.
- 2) Pursue a program to address the five science drivers.
- 3) Develop a mechanism to reassess the project priority at critical decision stages if costs and/or capabilities change substantially.
- 4) Maintain a program of projects of all scales, from largest international project to mid- and small-scale projects.
- 5) Increase the budget fraction invested in construction of projects to 20- 25% range.
- 6) In addition to reaping timely science from projects, the research program should provide the flexibility to support new ideas and developments.
- 7) Any further reduction in LOE for research should be planned with care...
- 8) As with research program, and construction projects, facility and lab operations budgets should be evaluated to ensure alignment with P5
- 9) Funding for participation of US particle physicists in experiments hosted by other agencies and other countries is appropriate and important, but should be evaluated in the context of Drivers and P5 Criteria and should not compromise the success of prioritized and approved particle physics experiments

Project Specific Recommendations



10) Complete LHC phase-1 upgrades and continue strong collaboration in the LHC with phase-2 upgrades of the accelerator and both general purpose expts. The LHC upgrades constitute our highest-priority near-term large project.

11) Motivated by the strong scientific importance of the ILC and the recent initiative in Japan to host it, the US should engage in modest and appropriate levels of ILC accelerator and detector design in areas where US can contribute critical expertise. Consider higher levels of collaboration if ILC proceeds.

12) In collaboration with international partners, develop a coherent short- and long-baseline neutrino program hosted at Fermilab.

13) Form a new international collaboration to design and execute a highly capable LBNF hosted by the US. To proceed, a project plan and identified resources must exist to meet the minimum requirements in the text. LBNF is the highest-priority large project in its time frame.

Project Specific Recommendations



- 14) Upgrade the FNAL proton accelerator complex to produce higher intensity beams. R&D for PIP-II should proceed immediately, followed by construction, to provide p-beams of $> 1\text{MW}$ by the time of first operation of the new LBNF.
- 15) Select and perform in the short term a set of small-scale short-baseline expts that can conclusively address hints of physics beyond 3-neutrino paradigm. Some of these expts should use LAr to advance the technology and build the international community for LBNF.
- 16) Build DESI as a major step forward in dark energy science, if funding permits.
- 17) Complete LSST as planned.

Project Specific Recommendations



- 18) Support CMB experiments as part of core particle physics program. The multidisciplinary nature of science warrants continued multiagency support.
- 19) Proceed immediately with a broad G2 DM direct detection program with capabilities described in the text. Invest in this program at a level significantly above that called for in the 2012 joint agency announcement of opportunity.
- 20) Support one or more G3 DM direct detection experiments guided by the preceding searches. Seek a global complementary program and increased international partnership in G3 experiments.
- 21) Invest in CTA as part of the small project portfolio if the critical NSF Astronomy funding can be obtained.
- 22) Complete Mu2e and muon g-2 projects.