



## **Fermilab Scientific Program Planning: Snowmass and P5**

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## Overall lab strategy/philosophy moving toward Snowmass

- Lab scientists given freedom to work on whatever Snowmass topics they found interesting. Scientist Advisory Council (SAC) provided a forum to share ideas and thoughts.
- **Based upon Snowmass the Lab needs to provide input to the P5 process.**
  - Goal **is not** to tell P5 what to decide.
  - Goal **is** to provide insight, expertise, input on opportunities for Fermilab to P5. In many places, Fermilab uniquely positioned to do this (e.g., accelerator configurations.)



**Background: “Snowmass stage”**

# SAC Scientific Working Groups

Good alignment with the  
Snowmass Frontiers

SAC Scientific Working groups established in 2019 prior to the first All-Scientist Retreat (June 14, 2019)

First retreat focused on: Assessing the Scientific Interest Level / Resource Identification

Overall goal was to ensure Fermilab is ready to contribute to Snowmass community planning effort!

## **Accelerator Frontier:** [contact conveners](#)

Conveners: Maria Baldini, Mattia Checchin, **Frederique Pellemoine**, Arun Saini, **Vladimir Shiltsev**

## **Computing Frontier:** [sac-comp-wg@fnal.gov](mailto:sac-comp-wg@fnal.gov)

Conveners: Kyle Knoepfel, Adam Lyon\*

## **Cosmic Frontier:** [fcpa\\_general@fnal.gov](mailto:fcpa_general@fnal.gov)

Conveners: Brad Benson\*, Gordan Krnjaic, Albert Stebbins, **Alex Drlica-Wagner**

## **Detector Frontier:** [detectors@fnal.gov](mailto:detectors@fnal.gov)

Conveners: **Juan Estrada**, Angela Fava, Zoltan Gecse\*, Vadim Rusu

## **Energy Frontier:** [fermilab\\_ef@fnal.gov](mailto:fermilab_ef@fnal.gov), [future-colliders-fermilab@fnal.gov](mailto:future-colliders-fermilab@fnal.gov)

Conveners: Pushpa Bhat, Anadi Canepa\*, **Paddy Fox**, Sergo Jindariani\*, Sergei Nagaitsev

## **Neutrino Frontier:** [sac\\_neutrinos@fnal.gov](mailto:sac_neutrinos@fnal.gov)

Conveners: Minerba Betancourt\*, Zarko Pavlovic, Joseph Zennamo, Peter Shanahan

## **Precision Frontier:** [precision-science@fnal.gov](mailto:precision-science@fnal.gov)

Conveners: Chris Polly, Ron Ray

## **Quantum Frontier:** [contact conveners](#)

Conveners: David Van Zanten, Bianca Giaccone

Names in red also hold  
roles within the  
Snowmass organization

\*current or former  
Fermilab Strategic  
Planning Group Leader

# Organization and Meetings Timeline

- Creation of the SAC Scientific Working Groups (2019)
- **All-Scientist Retreat 2019** (June 14, 2019)
- Dedicated All-Scientist meeting focusing on Snowmass LOI Planning (Aug 21, 2020)
- Effort has been integrated into the Snowmass organization
- Snowmass Community Planning Meeting (Oct 5-8, 2020)

## PAUSE

- All-Scientist Quarterly meetings with Snowmass focus (Dec 4, 2020, Apr 2, 2021, Aug 4, 2021)  
<https://indico.fnal.gov/category/905/>
- **All-Scientist Retreat 2021** (Sep 9-10, 2021)

## RESUME

- Snowmass Day (Sept 24, 2021)
- All-Scientist Quarterly Meeting (Dec 3, 2021)

Goal of the All-Scientist Retreats was to make sure the interests of the lab scientists are included in the Snowmass report (white papers) and to discuss post-Snowmass strategy (P5)

Followup discussions during the all-scientist quarterly meetings

*Many opportunities for all scientists to provide input and to engage in the discussions...*

# All-Scientist Retreat Summary

The all-scientist retreat summary is **53 pages**

Executive summaries at the beginning of the document provide a summary of the detailed discussion found later in the document

Available on sharepoint

<https://fermipoint.fnal.gov/org/ood/sac/Shared%20Documents/2022%20Files/SAC-All-Sci-Retreat-2021.pdf>

Includes a summary of Snowmass white papers for each Working Group

*The document is not a complete plan* – it is intended to help focus the discussions that will take place within the context of the Science Strategic Planning Workshops

Ensure that the interests of the Fermilab Scientists are included in the Snowmass report and reflected in the P5 report



2021 All-Scientist Retreat

2021

## All-Scientist Retreat Summary

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Science Advisory Council 2

# Transition: Fermilab Science Strategic Planning Workshops I and II

## First workshop: February 15

- Focus primarily on timelines for projects/activities in progress
  - Accelerator R&D
  - Accelerator Run Plan
  - Collider Science
  - Cosmic Science
  - LBNF/DUNE
  - Mu2e, NOvA, SBN
  - PIP-II

## Second workshop: April 25

- Focus on key areas that we didn't cover in February
  - Accelerator Technology (Magnets, SRF)
  - AI/ML
  - Detector R&D
  - High-power Targetry
  - Microelectronics
  - Quantum Program
  - Quantum Internet
  - Sustainability Initiatives


# Summarizing what we have going forward

- **Near term: next 5 years (2022-2027)**

- Run accelerator: beam to NOvA, SBND, ICARUS, ANNIE, Muon g-2, Mu2e, SpinQuest, test beam, ITA
- LHC Run 3 in progress
- Projects: HL-LHC AUP/CMS, PIP-II, LBNF/DUNE, CMB-S4
- Cosmic: SPT-3G, DESI, Rubin, SuperCDMS, Sensei, ADMX
- Cross-cutting: lots (SRF, quantum, AI/ML, detector R&D,...)

- **Long shutdown: 2027-2028**

- Accelerator: not running, connect PIP-II
- Projects: HL-LHC AUP/CMS installation, LBNF/DUNE, CMB-S4
- Cosmic: Rubin, SuperCDMS, OSCURA, ADMX
- Cross-cutting: lots (SRF, quantum, AI/ML, detector R&D,...)



Disclaimer: these lists  
are incomplete...for  
illustration only




# Summarizing what we have going forward

## • End of decade: 2029-2030

- Accelerator restart – commission PIP-II  $\Rightarrow$  Booster, run Mu2e
- DUNE far detectors operational
- HL-LHC run (run 4) begins
- Projects: HL-LHC AUP/CMS installation, LBNF/DUNE, CMB-S4
- Cosmic: Rubin, SuperCDMS, OSCURA, ADMX
- Cross-cutting: lots (SRF, quantum, AI/ML, detector R&D,...)

## • Early next decade: 2031-2033

- Running accelerator for Mu2e, LBNF/DUNE
- Complete LBNF beamline, DUNE Near detector
- Projects: LBNF/DUNE winding down
- LHC Run 4 in progress
- CMB-S4 operational
- Cosmic: Rubin, CMB-S4, OSCURA, ADMX
- Cross-cutting: lots (SRF, quantum, AI/ML, detector R&D,...)



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**Moving forward after Snowmass: “P5 stage”**

## Moving forward post-Snowmass: Working Groups

- Director Lia Merminga has formed two working groups to help prepare input to P5
- Groups forming now, but main work will proceed after Snowmass

# Science Priorities Working Group

- The recommendations for the U.S. particle physics program should be prioritized, emphasizing Fermilab's role over the next decade, and align with the broader community's scientific aspirations, set in a global context, e.g., in coordination with the European strategy.
- Take into account the community's outputs from Snowmass, along with the health and capabilities of the Fermilab program.
- Identify the scientific opportunities that can and cannot be pursued as well as the approximate overall level of support needed in the HEP core research and advanced technology R&D programs to achieve these opportunities in various scenarios.
- Identify and prioritize an experimental/theoretical/computational program at Fermilab that delivers continuous science results while LBNF/DUNE construction is ongoing.
- Identify and prioritize physics opportunities with the new PIP-II accelerator, the Booster Replacement and 2.4MW Upgrade of the accelerator complex. You should use as a resource the Fermilab report "Physics Opportunities for the Fermilab Booster Replacement."

# Fermilab Proton Intensity Upgrade Central Design Group

We are asking that you chair the Central Design Group (CDG) for the Fermilab Proton Intensity Upgrade, the upgrade of the accelerator complex and LBNF to multi-MW capability. The 2014 P5 Report noted PIP-II will establish a platform for “subsequent upgrades to multi-MW capability.” This is an essential upgrade to the Fermilab Accelerator Complex in order to achieve 2.4 MW of beam power for LBNF/DUNE, reduce the time for LBNF/DUNE to achieve first results, and sustain high-reliability operation of the Fermilab Accelerator Complex, and potentially enable other science possibilities.

The Proton Intensity Upgrade should include the extension to the PIP-II linac to higher energy, the Booster Replacement (BR), upgrades to the Recycler Ring and Main Injector for multi-MW capability, and high-power target R&D.

The primary outputs from this group will be project plans for the multi-MW upgrade of the accelerator complex that will be an important input to the next P5 process.

# Summary

- **Snowmass is a community effort, Lab scientists participating fully**
- **Based upon Snowmass and in preparation for P5, Fermilab working groups aimed at providing relevant input:**
  1. **Science priorities/opportunities**
    - Aligned with existing projects, plans
    - Identifying potential opportunities for future Fermilab program
  2. **Accelerator options for high intensity (2.4MW to DUNE) upgrade**
    - Different technology options
    - What physics can be enabled?