Fermilab All Scientist Retreat Summary

Lauren Hsu & Louise Suter on behalf of the Scientist Advisory Council

2019 July PAC Meeting, Chicago

Scientific Advisory Council

- SAC meets roughly weekly
- Representation from directorate joins when possible
- Discusses a range of topics
  - Future planning
  - Lab policy changes
  - Scientist issues

Fermilab Scientist Advisory Council (SAC) Charter

The Scientist Advisory Council is a group of approximately 15 members of the Fermilab scientific staff. The composition of the group is diverse in areas of expertise and experience. Terms are for a two-year period, with half of the group rotating out each year. At the beginning of September each year, the laboratory director solicits nominations via the "all-scientists" distribution list. The demographics being sought will be announced (i.e. number from each organizational unit). Self-nominations are accepted. Following the open nomination period, new council members are selected by the current council in consultation with the director. New terms begin October 1.

The council will meet regularly (approximately weekly) with the director. The charge to the council is to engage in open discussion on topics of interest for both short- and long-term plans for the laboratory's research program. The council will also discusses issues related to careers and professional development of the Fermilab scientific staff.

Members of the council are encouraged to share the discussion topics within their respective organizations to gather feedback and input from the broader scientific staff that the council can then share with the director. On occasion, the outcome of discussions may lead to the council initiating a sub-committee study of a theme or convening an all-scientist retreat to engage broader discussion of the topic.

Last updated August 29, 2014

From the SAC public webpage

Introduction: The Fermilab All-Scientist Retreats

By Directorate request, SAC organized three retreats to discuss the future laboratory science program

- First retreat: May 4, 2017 / Second retreat: April 26, 2018 / Third retreat: June 14th 2019
- All three retreats, well attended, with ~180 scientists attending

Each preceded by months of discussions within a set of working groups; scientists free to participate in any group of interest. Working groups organized by “Frontier” and “Technology”:

- **Physics Frontiers:**
  - Cosmic Science
  - Energy Frontier Science
  - Neutrino Science
  - Precision Science
- **Technology Groups:**
  - Quantum Science
  - Accelerator Science
  - Computational Science
  - Detectors for Science

The retreat is a half-day summary of the discussion in the working groups

Overall goal is to ensure Fermilab is ready to contribute to community planning!

2019 Retreat Goals

- With this year's retreat we sought to gain an understanding of the projects Fermilab is both most interested in pursuing and has the ability to contribute to in the post-2026 period.

- Previous retreat aimed to identify the possibilities for the post-2026 era. This year, we built on that, by probing interest in specific efforts. Working groups encouraged to categorize options based on interest level through discussions both within and across working groups.

- We also administered a poll to determine individual scientist interests. Results were incorporated into retreat presentations and data distributed to working groups for further analysis.

- There are currently multiple community planning processes in play (Snowmass, European Strategy, Fermilab Strategic Plan etc.). Additionally some working groups had internal planning efforts of their own that were ongoing or recently completed (e.g. Cosmic and Computing).
  - Goal is to support and integrate with these efforts, and not to introduce parallel efforts or hijack community planning exercises
  - This year's charge stresses that work should be ongoing and continues beyond the retreat in the form of engaging with the wider community

2019 Retreat Abbreviated Charge for Working Groups

Part 1: Determine which of the possibilities (from 2018 retreat) are of high interest for the 2026 era

A. Which experiments are most important for advancing your sub field?
B. Of these items, which efforts should Fermilab contribute to?

As Part 1 does not directly probe what individual scientists want to work on, we also conducted a poll.

Part 2: Technology and frontier physics groups work together to further understand the required capabilities

A. What required capabilities should Fermilab bring to these efforts?
B. Does the expertise exist at the lab to deliver on these items?
C. What additional expertise would be needed at the lab, and what can be done to rectify the situation ?

Part 3: Working groups engage with broader community (extending beyond timescale of Retreat)

Consider what process or metrics will be used to determine whether these are the best projects for the future and/or to decide between different high interest options. How can we enable Fermilab to take part in these efforts?

Link to full text for Retreat charge:
https://docs.google.com/document/d/1tiY3XKHgYOft-NUJO7zWuCVRrBQKg8BbkfixRmbgqXo/edit?usp=sharing

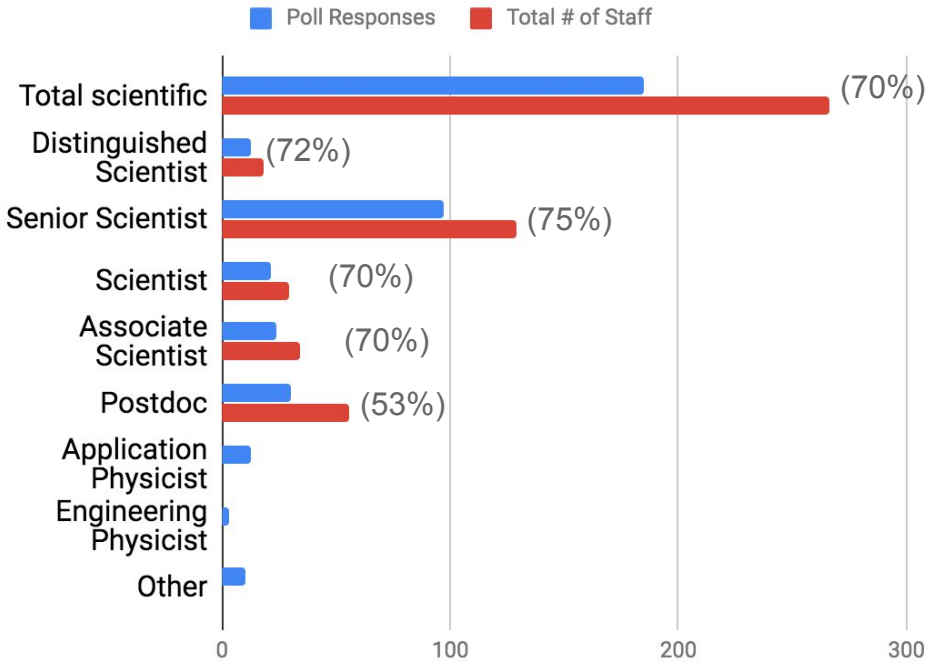
SAC Internal Planning Timeline

- **January (2019):** SAC formulates goals for Retreat and chooses date to coincide with preparation for community planning discussions at July DPF meeting
- **February:** Working Group leaders identified and Retreat charge drafted
- **March-May:** Working Groups meet on regular basis with members to address SAC charge. Working Group leaders report roughly bi-weekly to SAC on progress
- **May/June:** Scientific Interests Poll administered to staff; results distributed to working group leaders
- **June 14:** All-Scientist Retreat

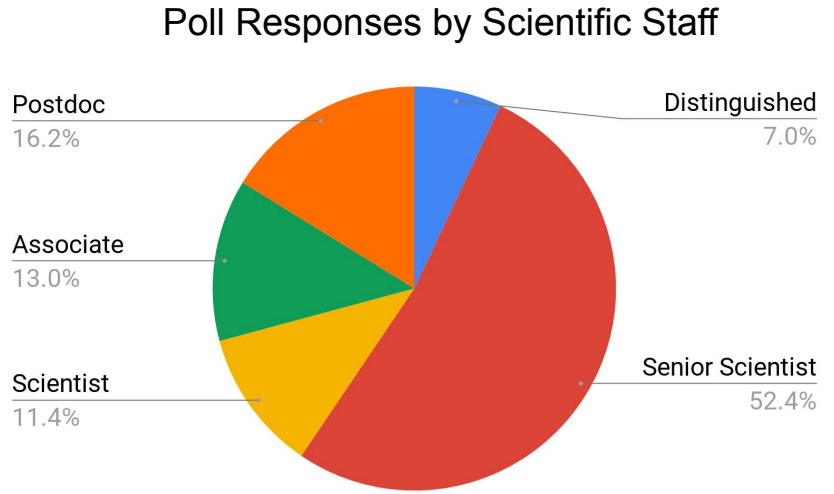
- **July:** Post-retreat follow-up includes discussions on what worked, what didn't and what should happen moving forward; Followup also includes integration with community planning efforts, discussion with Fermilab IPPM (Integrated Planning and Performance Management)
- **August:** Working Group leaders submit written summaries of Retreat findings and activities. SAC will compile into a report
- **September:** SAC membership turns over
- **October 2019-on:** New SAC will propose to organize Snowmass pre-meeting at FNAL in place of internal FNAL retreat for 2020?

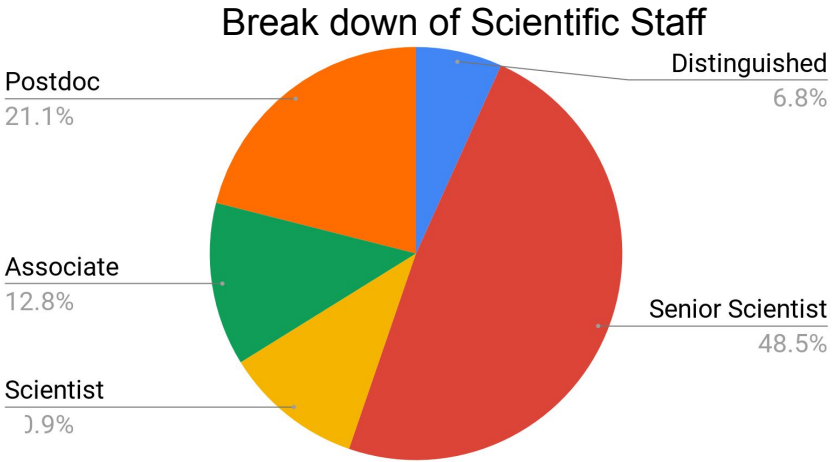
Fermilab Scientific Interests Poll

The SAC administered a poll to the Fermilab scientific community and received 211 responses (~70% of scientific staff).



Numbers not available for application/engineering physicists



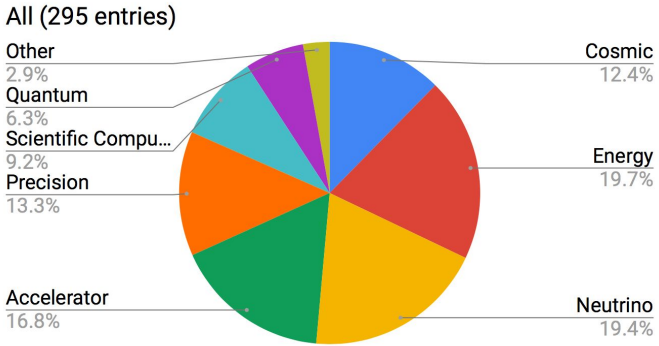


Scientific Interests: Poll Questions

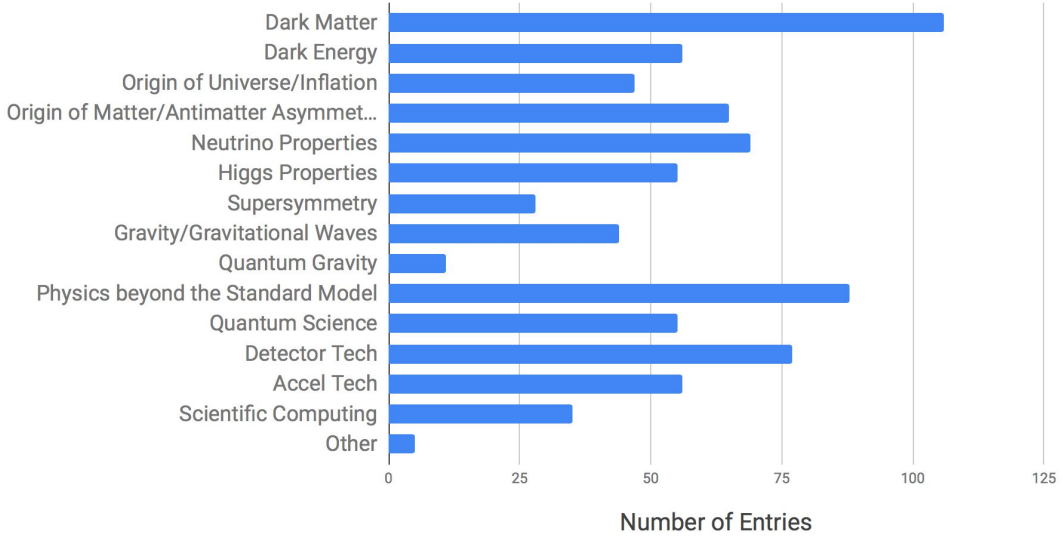
- Poll gathered information on:
  - Current position at the lab and areas scientists are working in
  - Personal interest level in specific future efforts at the lab:
    - choose from list of small and midscale efforts
    - rate interest in future Fermilab based accelerator-based efforts
    - rate future interest in categories of relevance to the lab (*Cosmic, Energy Frontier Precision, Neutrinos, Quantum, Detector R&D, Accelerator Science, Computing)*
  - Queried personal interest and understanding in variety of detector R&D and computing topics
  - Gauged sentiments on challenges for launching a future flagship effort at Fermilab
  - Poll-takers could choose to participate in 5 additional sub-polls based on specific interests in Cosmic, Energy-Frontier, Neutrinos, Precision Measurements, and Quantum Information Science.
  - Links to supporting documentation were provided, although in some cases it was clear that scientist were still learning

Example Poll Results

What do you work on?



What are you excited to investigate post-2026?



- Poll represents a “snapshot” of the staff when administered. Retreat itself generated enough discussion that likely some results would change if administered again today. Results reflect current knowledge of scientific staff and highlight importance of making sure people are well informed.
- Poll very helpful in generating discussions both in and across working group boundaries and has helped to focus discussion on topics of highest interest.

Fermilab

Cosmic Frontier Summary

- FNAL Cosmic program recently underwent *internal strategic planning exercise for DOE HEP:*
  - Plan stretching to ~2030 in Dark Matter Searches, CMB and Cosmic Surveys (see Josh Frieman's talk for details)
  - Retreat served as a forum to present the strategic plan and get feedback
- **Poll participants included a much broader group than those engaged in the internal planning. Despite this, results indicated strong support for the main elements of the strategic plan.** This was reassuring to see. Poll also indicated strong interest in Cosmic Frontier science.
- Retreat feedback indicates that many felt Cosmic Frontier has a well-motivated program to present for next Snowmass.
- Moving forward, WG leaders will work within DOE HEP cosmic visions groups and Snowmass community planning to ensure case is argued

Energy Frontier Summary

- EF group held over one dozen meetings and sub-meetings; strong participation by junior scientists
- Concluded the following are critical for future of the field:
  - A “Higgs factory” - a lepton collider with center of mass energy at 240 GeV and above to make precision measurements of the Higgs sector
  - A p-p collider - at or above ~2xLHC energy, for direct searches for physics beyond the SM
- **FNAL will strongly support world-wide future collider efforts. Additionally, discussions and poll indicated strong interest, across divisions, in a future energy frontier collider at Fermilab, possibly in a compact 16 km ring (Fermilab site-filler) at a modest cost, after the PIP-II/LBNF/DUNE projects at the Lab (pp or e+e-)**:
  - Propose to form a small group to perform feasibility studies and develop conceptual designs along with a technology task force to define R&D priorities
  - Strong support for SRF R&D and aggressive high-field magnet R&D to develop 20-25 T magnets; Novel and innovative designs for accelerator magnets and lattice design necessary
- Will continue regular EF monthly meetings to stay up-to-date with technology developments and develop further feasibility studies; Will fully engage in DPF Snowmass process to develop options for U.S. Energy Frontier program in collaboration with broader community

Neutrino Science Summary

- For pre-retreat meetings, neutrino working group divided into “advocacy groups” for deeper discussions on specific topics.
- **Poll and retreat discussions identified efforts of notable interest:**
  - **Stopped pion beam program for PIP-II (dark matter, sterile neutrino searches, coherent neutrino scattering studies, “and more”)**
  - **Next-generation neutrinoless double beta decay**
  - **ν_τ appearance with upgraded LBNF and DUNE**
- In certain cases, the richness of some programs was not evident to those completing the poll; once additional context was provided at the retreat, it increased overall interest
- Will continue working within advocacy groups, expanding membership and effort to better define technological needs for each topic and lay foundation for white-papers in future Snowmass process
- Overall, retreat discussions generated a lot of excitement in the future neutrino program !

Precision Measurements Summary

- Pre-retreat discussions identified following areas of experimental interest:
  - REDTOP (eta factory)
  - Mu2e - II
  - Fixed target dark matter search
  - Future precision muon physics using FNAL beams (CLFV or lepton universality)
  - Storage ring electric dipole moment experiments (proton, deuteron, or muon)
- **Retreat discussions and poll indicated:**
  - **Strongest interest in Mu2e-II and CLFV/lepton universality tests**
  - **Higher interest in fixed target dark matter from people not currently doing precision physics**
  - **In all cases ~20 or more scientists expressed some interest in all 5 topics above**
- Moving forward:
  - REDTOP will present case at upcoming DPF meeting and is engaged in European Strategy
  - Mu2eII continue to schedule workshops, push R&D and engage with Snowmass
  - LDMX pursing BRN proposal for “new dark matter initiatives”, DarkQuest moving forward
  - CLFV/lepton universality will form proto-collaborations to explore capabilities at FNAL
  - Storage ring EDM’s - no champions at FNAL, collaboration pursuing effort at COSY/Juelich

Accelerator Working Group Summary

- This working group split into 5 mini-groups reflecting these focus areas at Fermilab:
  - Superconducting magnets
  - Superconducting RF
  - High power targets
  - Accelerator and beam physics
  - Accelerator ancillaries
- Discussions reflected broad expertise at FNAL and confirmed that current R&D efforts are directed at enabling future accelerator-based science at FNAL
- **Nearly half of poll respondents favored an increased investment in accelerator science and technology (R&D);** Frontier topics hitting a Science/$$ limit; general feeling that investment in accelerator R&D pays back many times over
- Accelerator Science R&D is funding-limited and not ideas-limited
- WG will use outcome from retreat as input to Annual Lab Strategic Planning exercise to produce comprehensive summary document for guiding future discussion within HEP

Computing Working Group Summary

- Retreat exercise combined with internal FNAL Scientific Computing Division strategy realignment.

- Similar to Cosmic frontier, **poll indicated that FNAL community supports the planned strategies of CD** *(see Elizabeth Sexton-Kennedy's talk for details)*:
  - Lead in data management & storage
  - Lead in access to heterogeneous computing
  - Be the center of core software development, and scientific software R&D
  - Lead in HEP artificial intelligence/machine learning R&D, and in DAQ integration
  - Provide home for physics analysis

- FNAL already working within larger HEP computing community:
  - HEP Software Foundation (HSF), IRIS-HEP, DOE OHEP/ASCR/ECP/CCE, ICAC

- Scientists and Scientific Computing Division are looking to meet challenges of the future:
  - Meeting needs of the experiments
  - Address demands of changed and changing computing landscape
  - Support physicists use of new computing ideas and techniques
  - Further collaborations with DOE and world-wide community

Detector R&D WG summary

- Each of the detector R&D working group leaders is a member/representative of a “Frontier” working group, with all Frontier groups represented.

- **Detectors Working Group identified future technical challenges for each frontier group and mapped specific detector R&D projects to those challenges.** Some topics overlap across frontiers, but generally detector R&D was rather specific to future experimental effort.

- Polling on specific detector R&D tasks yielded significant number of people indicating no opinion on many detector R&D topics:
  - Motivations for that choice are varied, but general conclusion is that we could benefit from more education and advocacy on R&D needed for future experiments.

- The discussions, especially in view of the next Snowmass and P5 processes, will continue through dedicated meetings taking place at regular intervals in the period leading up to Snowmass

- The detector R&D leaders will remain engaged in the discussion in the corresponding physics frontier working group.

Quantum WG Summary

- Goal of “Quantum Information Science” at Fermilab is to exploit quantum properties (coherence, superposition, entanglement, squeezing, ...) for acquiring, communicating, and processing information beyond classical capabilities
- The QIS program at Fermilab is emergent. A group that is planning the near-term future of the Fermilab program was already in existence at the start of our retreat. In order not to interfere, we asked Quantum WG leaders simply to report on activities at Retreat
- **Components of Fermilab Program (see talks from January PAC meeting):**
  - **Applications of Quantum Sensors**:
  - **Superconducting Quantum Systems**:
  - **Applications of Quantum Computing**:
  - **Develop quantum simulations:**

- *Poll results indicated significant interest in Quantum Information Science at Fermilab*

Integrating Annual Laboratory Strategic Planning Exercises

- In January, the PAC recommended to better integrate the grass roots SAC exercise with Annual Lab Strategic Planning process (organized by IPPM)

- About the Annual Lab Strategic Planning Process:
  - Defines 10-year lab goals and objectives with the purpose of communicating the plan to the DOE, employees and community
  - Serves as a starting point for discussion between laboratory and DOE about laboratory's future directions
  - Organized into strategic themes, aligned with SAC Working Groups several years ago; It remains in alignment
  - Some theme leaders and SAC working group leaders are the same people but there is not 100% overlap
  - Organized by Office of Integrated Planning and Performance Management (IPPM).

Progress on Integration

- Key differences between SAC Retreat and Annual Lab Strategic Planning:
  - SAC Retreat organized for the benefit of scientists, to understand long-term possibilities for science. Results of SAC Retreat serve as input to next Snowmass and P5
  - Annual Lab Strategic Planning is shorter term and focused on carrying out previous P5 recommendations. IPPM tailors information on what scientists are currently doing for audiences such as DOE, and manages PEMP feedback and notables outcomes from DOE.
- **SAC and IPPM have met multiple times and discussed the details of both planning processes so that we both have better awareness and understanding of each other's efforts. Additionally, we have brainstormed and begun discussing ways to integrate better.**
  - Discussion favored keeping groups separate, with some, but not all, leaders overlapping. This is because tasks required for SAC working group leaders and IPPM planning are distinct from each other.
  - It was felt that better communication between SAC working group leaders and IPPM leaders would facilitate natural integration between the efforts. Steps taken so far to increase awareness of each process have already greatly improved communication between groups.
  - SAC and IPPM will continue to discuss how to better enable each other's efforts moving forward.

Many thanks to everyone who has enabled the retreat and planning process to be a success

Working group leaders

B. Benson, A. Drlica-Wagner, G. Krnjaic, A. Stebbins, A. Canepa, S. Jindariani, P. Bhat, P. Fox, S. Nagaitsev, Z. Pavlovic, J. Zennamo, P. Shanahan,, M. Betancourt, C. Polly, Ron Ray, P. Spentzouris, R. Harnik, J. Jarvis,, N. Solyak, A. Valishev, S. Posen, T. Spina, A. Lyon, C. Jones, J. Estrada, A. Fava, P. Merkel, V. Rusu, Patrick Hurh

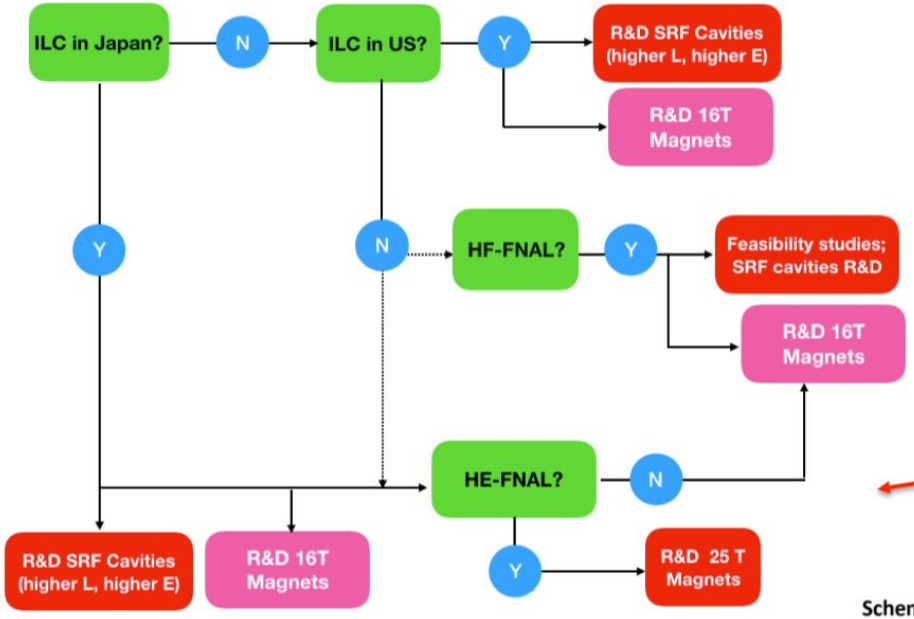
SAC members

K. Badgley, D. Elvira, Z. Gecse, B. Kiburg, P. Merkel, D. Stratakis, M. Toups, E. Gianfelice-Wendt, N. Gnedin, R. Harnik, M. Martinello, G. Perdue, A. Pla-Dalmau, C. Thangaraj

Chairs: L. Suter, L. Hsu, P. Adamson

Backup

Scenarios for Colliders & R&D



ILC in Japan or US, if CERN decides on HE-LHC or FCC-hh after HL-LHC

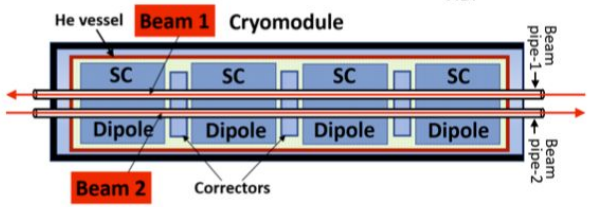
16 T magnet R&D needed for HE-LHC/FCC-hh at CERN

If CepC goes ahead, decision on US participation needs to be made

In case of no HE-LHC, and CERN proceeds with plans for FCC-ee and then FCC-hh

It is critical to start working now on reducing the timescale and costs of the future colliders!

Schematic of 25-Tesla SC Magnet Assembly - P.B.



Fermilab

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