

Fermilab Physics Advisory Committee Fall 2026 Report

The Physics Advisory Committee:

In person: Klaus Blaum (Chair), Aida El-Khadra, Lara Faoro, Cecilia Gerber, Deborah Harris, Atsuko Ichikawa, Zach Marshall, Fulvia Pilat, Mayly Sanchez

Remote: Allen Caldwell, Joe Formaggio, Sunil Golwala, Stefania Gori, Brigitte Vachon (ex-officio, DPC Chair)

Scientific Secretary: Sergo Jindariani

Executive Summary

The Fermilab Physics Advisory Committee's Fall 2026 meeting focused on technology and its alignment with the laboratory's mission, while also reviewing progress across the accelerator complex, major experiments, and cross-cutting programs such as quantum computing, artificial intelligence / machine learning, and detector research and development. Overall, the Committee found the laboratory's programs to be strong and well aligned with its stated priorities, praised the directorate for a productive and well-organized week of presentations, and expressed particular admiration for the high technical level that became apparent during visits to the SRF and Magnet labs. At the same time, the Committee identified a number of significant near-term risks, most notably around staffing, aging infrastructure, and the sustainability of program funding, that will require sustained attention as the laboratory looks toward the period beyond 2031.

A recurring theme throughout the PAC report is the need for the laboratory to begin strategic planning now for its future beyond 2031, when two of its three core mission priorities (Beam to LBNF/DUNE and HL-LHC Upgrade) are expected to be achieved. The Committee recommended that this planning be guided by the findings of recent community studies, including Snowmass 2021, P5, and EPP 2024, so that Fermilab can maintain its position as a leader in particle physics over the long term. Closely tied to this is the question of workforce sustainability. A large fraction of the laboratory's personnel is currently engaged in DOE 413 construction projects that will conclude within the next five years, some sooner, and the Committee stressed that Fermilab needs a comprehensive ten-year staffing plan to transition scientific and technical staff from project execution into operations, ongoing science, and R&D activities. Retention challenges, particularly the loss of mid-career staff in the Accelerator Directorate, were noted across several parts of the laboratory, and the Committee suggested that preserving a degree of academic freedom for scientists and engineers, along with

support for attending one or two workshops/conferences per year, could help sustain morale and improve recruitment and retention.

On the accelerator complex, the Committee reviewed the status of operations in preparation for the 2028-2030 Long Shutdown and the goal of delivering beam to LBNF/DUNE by 2031. The FY26 Booster Neutrino Beam run concluded in June with an excellent overall uptime of 72.9%, fully meeting the needs of the low-energy neutrino program, with future runs now primarily driven by the requirements of Mu2e.

Transformer availability for the operation of the lab (and especially of the Main Injector), has improved from three to six operational units since the last PAC meeting, and a new spare transformer is expected in December for installation during the Long Shutdown. Nonetheless, the Committee flagged unmitigated risk to the FY27 run should one of the two transformers needed for full-energy operation of MI fail before then. The IOTA facility has been fully commissioned with proton beams and begins its first research run in September 2026, and the Committee highlighted its value as a low-cost platform for high-intensity beam research, as a testbed for artificial intelligence and software tools ahead of deployment in production facilities, and as a training ground for accelerator workforce development.

The Mu2e experiment has made substantial progress, with its tracker, calorimeter, cosmic ray veto, and data acquisition systems now commissioned and its analysis pipeline nearing completion. The Production and Transport Solenoids are installed and being commissioned. Given the tight schedule ahead of the Long Shutdown, the Committee continued to recommend that the laboratory undertakes every effort possible to secure a Mu2e run with beam before the shutdown, ideally with the Detector Solenoid in place, and noted the letter from the collaboration's young scientists underscoring the importance of this goal. A timely safety review will also be important in determining whether Detector Solenoid commissioning can continue during beam periods and, consequently, in enabling the strongest possible pre-shutdown run.

The Committee also reviewed the newly established DUNE Accelerator Readiness Coordination effort, created in response to a 2025 DOE Operations Review recommendation and led by Bob Zwaska, which brings together the various activities needed to deliver beam for DUNE by 2031. While commending the thoroughness of the scope definition, the Committee asked for a clearer statement of the coordinator's reporting lines and authority over contributing groups, given that effective coordination depends on a well-defined mandate. The Committee also noted that construction of the Near Site Facilities and Beamline lies on the critical path to achieving beam delivery to DUNE in 2031, underscoring the importance of effective coordination across the contributing projects and programs.

The PAC also had extensive discussions of quantum technologies, where Fermilab is clearly recognized as an international leader and offers very interesting potential future opportunities, and the committee is looking forward to hearing more about this in the future meetings.

Reviews of Fermilab's role in CMS found the laboratory to be the sole US host institution, responsible for delivering more detector components for the Phase-2 upgrade than any other institution, including CERN, though the Committee expressed concern that declining research funding has reduced postdoctoral support and could constrain both physics output and the delivery of AI/ML capabilities for Run 4. The Committee also expressed concern that the technical effort available for integration and installation at CERN appears limited relative to Fermilab's substantial Phase-2 responsibilities, particularly as technical personnel transition to other laboratory activities. Looking beyond completion of the HL-LHC Upgrade Project, adequate base programmatic funding will be needed to sustain the scientific personnel required for installation, commissioning, operations, and continued leadership in CMS physics.

The Neutrino Physics Center's coordination with DUNE was judged appropriate, though the Committee suggested that future data analysis schools be tailored to DUNE's near-term commissioning and calibration needs rather than modeled closely on the more mature CMS program. The Committee emphasized the broader opportunity for the NPC to strengthen Fermilab's role as an intellectual hub for the neutrino community, while improving interactions among the laboratory's neutrino experiments.

The Detector R&D program continues to be highly productive despite a constrained budget, but its strategic plan dates to 2019 and updating it has become more urgent following the global shutdown of hadron test beam facilities until 2028. The Committee was particularly impressed by the program's productivity and breadth relative to its modest resources and found its priorities well aligned with the laboratory's future scientific needs. Given its scientific and technical impact, the Committee encouraged continued efforts by the DAG, directorate, and DOE to ensure robust support for Detector R&D.

The Committee noted strong progress in AI/ML and accelerator technology R&D, including successful Nb₃Sn magnet production for HL-LHC and promising work on high-temperature superconductors, while cautioning that shrinking budgets and staffing levels in these areas pose a risk to sustaining this progress going forward. The Committee emphasized that continued programmatic AI/ML funding is essential for mission-critical activities and encouraged the directorate to communicate this need to DOE; Genesis Mission opportunities cannot substitute for programmatic support tied to experiment-specific timelines and deliverables.

The Accelerator Technology R&D program was found to be strongly aligned with Fermilab's priorities, with successful Nb₃Sn magnet production for HL-LHC and promising work on high-temperature superconductors, work expected to reduce PIP-II operating costs, improve LBNF target lifetime and reliability, and contribute important technologies to the broader national quantum effort. In light of shrinking resources, the Committee requested a future R&D plan establishing priorities consistent with realistically expected staffing and funding.

Taken together, the technology discussions reinforced the Committee's view that Fermilab's capabilities in accelerator and detector technologies, quantum science, and AI/ML constitute a major strength of the laboratory. These capabilities should be viewed not only as supporting the laboratory's current priorities, but also as strategic assets for developing the next generation of major scientific initiatives at Fermilab.

Status and Plans for Fermilab's Accelerator Complex and IOTA/FAST

Charge: We ask the PAC to review the progress of the Fermilab accelerator complex toward delivering NuMI and BNB beams to the experiments in FY27 and FY28, as well as activities in preparation for the Long Shutdown. We also ask the PAC to review the status of Fermilab's IOTA/FAST facility and its alignment with the laboratory's scientific program.

Findings

- The present stated priorities of the Accelerator Directorate (AD) are: 1) deliver beam to LBNF/DUNE by 2031 and 2) prepare the 2028-2030 Long Shutdown (LS).
- The FY26 BNB run ended on June 12 with an overall uptime of 72.9%. It met the full request of the low energy neutrino program – so future runs are primarily motivated by Mu2e needs. The plan is for 12 weeks of operation in FY27, with a stretch goal of 20 weeks of operation, with a focus on the NuMI beam. For FY28, the plan includes 12 weeks of Booster and Recycler operation for Mu2e.
- Out of a total of 8 transformers (4 MSS and 4 Kautz) only 3 were operational at the last PAC meeting, now there are 6 transformers operational. A minimum of 2 Kautz transformers are needed to operate MI at full energy. A new spare transformer for MI will be delivered in December and will be installed during the Long Shutdown.
- Beam has already been established in Linac and Booster (Aug 26), MI will start up on September 21, stable beam is planned for October 1. The Muon Campus will also be running by September 21
- IOTA has been fully commissioned with proton beams from November 2025 to June 2026. The first operational research run starts in early September 2026. FAST/IOTA is supporting R&D towards high intensity beams and is a testbed for all AI tools before putting them in operations.
- The overall AD workforce is decreasing in the last few years, and has a staff distribution peaked at early and late career with gaps in mid career. The most acute needs are for electrical engineers and electronics technicians during the shutdown, and mechanical engineering in general. The shortage of Beam physicists will become a problem soon with the upcoming retirement of the staff hired for the MI/Recycler project execution, commissioning, and operations.

Comments

- The PAC commends the AD and FNAL for several achievements since the last PAC Meeting in April: successfully completing the FY26 BNB run, recovering sufficient transformer functionality to enable MI operations, good progress in preparing the complex for the upcoming restart of MI beam operations, and the completion of the IOTA commissioning with beams.
- There is unmitigated risk for the FY27 run, should one of the 2 transformers needed for full energy MI operations fail. The risk is understood. The risk for the FY27 run can be mitigated if needed by moving forward the installation of the new transformer arriving in December. A comprehensive risk analysis should be updated for the FY27 and FY28 runs given the strategic and scientific importance of the MI runs before the long shutdown.
- There are significant challenges in maintaining adequate AD staff levels, and the AD staff distribution is not optimal, with comparatively low levels of mid-career staff. AD leadership is recognizing the challenge and appropriate steps are being taken to mitigate the problem, focused on HR best practices.
- FNAL needs to develop a comprehensive staffing plan to address the staffing needs in the next 10 years, taking into consideration the end of many projects and needs for operational and R&D staff after project completion.
- The IOTA facility is ready for operations after a successful commissioning with beams. The facility is a small investment with potential for great return on the investment: it supports needed R&D on high intensity beams, is an ideal testbed for AI and software applications prior to deployment in the present and future user operation facilities at FNAL. Moreover it has a critical role to play in accelerator workforce recruitment, retention and training.

Recommendations

- Develop a comprehensive 10-year staffing plan for FNAL to manage the end of projects and to make sure that appropriate staffing levels are retained to execute on operations, science and R&D plans when DUNE is operational.
- Specifically for AD, work with HR and the accelerator community to insure recruitment and retention of the accelerator staff needed in the next 10 years, with focus on retention of mid career staff.
- Regularly update the AD risk analysis and mitigation for the upcoming FY27 and FY28 runs
- Fully leverage the IOTA facility potential for R&D with high intensity beams, as a testbed for AI and application software, and a training opportunity for accelerator staff.

Report from Mu2e

Charge: We ask the PAC to review the updated status of the Mu2e experiment, including any updates on the delivery and commissioning of the detector solenoid, as well as preparations for the commissioning run ahead of the Long Shutdown.

Findings

- The tracker, calorimeter, cosmic ray veto, and DAQ are now commissioned, and the development of the complete analysis pipeline involving all three major detector subsystems is close to complete.
- The Production and Transport Solenoids (PS and TS) are installed and are being commissioned. The plan is to complete commissioning of the PS before the warranty deadline (Nov. 20, 2026).
- The timeline for commissioning the DS prior to the long shutdown is now even tighter, and the collaboration is developing plans to accelerate the timeline (e.g. double shifts for certain tasks).
- A pre-Long Shutdown (LS) run is needed to measure the stopped muon rate, the proton extinction, the rate of the muon and pion radiative capture processes, and to assess the performance of the detector subsystems. One week of beam (at 3.86 kW) would enable a 10% measurement of the stopped muon rate and of the extinction (assuming to reach a 10^{-10} level). The measurements and findings improve with beam intensity.
- A plan is being developed to complete commissioning of the DS during a pre-LS run, which requires a safety review. A week (month) pre-LS run with the DS in place would improve the present best muon-to-electron conversion sensitivity by a factor of seven (thirty).
- The PAC received a copy of a letter sent to the director by the young scientists in the Mu2e collaboration, laying out the case for the experiment receiving beam before the long shutdown with or without the DS.

Comments

- The PAC commends the collaboration on completing the detector components, establishing the analysis pipeline, and developing mitigations for the leak in the solenoid and the delays in their delivery.
- The plan to measure the muon capture rate, the beam extinction, and some of the backgrounds is well prepared, and looks promising with or without the detector solenoid.
- The PAC supports the plan to have the DS magnet delivered as soon as possible to the laboratory.

- The PAC appreciates the efforts and enthusiasm of the young scientists in the Mu2e collaboration and is pleased that the laboratory and collaboration are making every effort to support them.
- The PAC expects to closely follow the commissioning progress over the next meetings with the run approaching.

Recommendations

- The PAC would like to see the outcome of a timely safety review concerning continued commissioning of the DS during beam periods.
 - The PAC continues to recommend that the lab do everything possible to ensure a Mu2e run with beam before the long shutdown, ideally with the DS.
-

DUNE Accelerator Readiness Coordination

Charge: We ask the PAC to comment on the status and plans of the DUNE Accelerator Readiness Coordination effort.

Findings

- The laboratory has established the DUNE Accelerator Readiness Coordination (DARC) effort, charged with ensuring that the beam is ready for DUNE in 2031.
- DARC brings under a single umbrella the activities needed to deliver beam on that schedule, including reliability and infrastructure work on the existing accelerator complex, PIP-II integration and LBNF operations planning.
- The DUNE Accelerator Readiness Coordinator is a position, reporting to the FNAL Lab Director, created in response to a 2025 DOE FNAL Operations Review recommendation to focus on overall coordination of all FNAL projects and programs needed to successfully enable beam for DUNE in 2031. Bob Zwaska is the DARC head.
- The DARC scope has been defined. Beam objectives for DUNE are being clarified with the DUNE collaboration including beam requirements for 2031 and minimum beam time (5 years) needed to reach the Phase 1 Physics Goals of DUNE.
- Additional commissioning needs not covered by the individual projects' commissioning plans have already been identified.

Comments

- The PAC commends the laboratory for creating a structure to coordinate the full scope of that work.
- The DARC scope identification and analysis has been thorough and complete.

- The PAC would welcome a clearer statement of how DARC reports and what authority it holds over the contributing groups, since coordination across efforts with separate management structures depends on a defined mandate to set priorities and resolve competing demands.
- The PAC looks forward to a progress report at its next meeting, including the scope DARC has taken on, its milestones, and the metrics by which readiness will be tracked.
- The start of construction of the Near Site Facilities and Beamline are on the critical path to beam delivery in 2031.

Recommendations

- The PAC recommends that DARC works closely with the DUNE collaboration so that plans for beam power ramp-up, availability, and run conditions are developed to achieve the experiment's physics objectives.

CMS Report

Charge: We ask the PAC to review the status and plans for Fermilab's contributions to the CMS Phase-2 Upgrade Project, including installation and commissioning activities during the LHC Long Shutdown. We also ask the PAC to review Fermilab's contributions to CMS computing and AI/ML and to assess how these activities enhance the experiment's physics capabilities.

Findings

- Fermilab plays a significant role in the CMS experiment. The Fermilab CMS group has more than 200 members including 72 scientists who have qualified as authors.
- Fermilab serves as the sole host laboratory for CMS in the US, supporting the LHC Physics Center, Remote Operations Center, and Tier 1 Computing center.
- Fermilab also acts as Operations and HL-LHC Upgrade Project program administrators for US CMS.
- The Fermilab CMS funding effort is divided between "research", "operations", and "upgrade" with roughly 40, 30, and 30 FTEs in each. Only "research" supports the salary of scientific personnel, drawing from core funds and programmatic AI/ML funds. These scientists mostly contribute as uncoded labor to the upgrade and operations project.
- The staff are well-represented in key management roles, including the current Spokesperson, 2 previous spokespeople and 1 deputy spokesperson.
- The upgrade scope is significant — Fermilab is responsible for the delivery of more detector components than any other CMS institution, including CERN.

- The FNAL group also makes significant contributions to CMS computing, including planning and R&D for HL-LHC computing.
- The AI/ML effort of the group is focused on delivering AI/ML for Run 4, through real-time AI/ML, surrogate and foundation models.

Comments

- The majority of the group's physics analysis effort is undertaken by postdocs.
- The reduction in research funding has led to a clear decline in supported postdocs which, in turn, has a direct impact on the group's physics output.
- The possible reduction of programmatic AI/ML funding presents a significant risk to the AI/ML plans of the group which cannot be recovered by Genesis Mission proposals, as these proposals have a different focus and a timeline inconsistent with the work needed to deliver AI/ML for Run 4 of CMS.
- The contribution to integration and installation, particularly the effort at CERN, seems small in view of the number of detector components for which Fermilab is responsible. Of further concern is the statement that technical personnel are expected to move to other laboratory areas and will not be available for CERN-based efforts.

Recommendations

- Adequate base programmatic funding for scientific personnel is necessary to fully participate in installation, commissioning and operations after the completion of the US-CMS HL-LHC Upgrade Project. The directorate should ensure this funding is available.
- Support of RAs needs to be maintained at a level that ensures continued leadership of the group in CMS physics analysis.

Dune and Neutrino Physics Center

Charge: We ask the PAC to comment on DUNE's vision for how the NPC can best support the experiment during its construction and operational phases in order to maximize DUNE's scientific output.

Findings

- The NPC gave 5 out of 11 NPC Fellowship positions to DUNE-related proposals.
- The DUNE Spokespeople and NPC Organizers meet monthly to discuss ways NPC can support DUNE
- The NPC encouraged and helped organize the first DUNE Data Analysis School, modeled on the CMS Data Analysis Schools
- NPC Coordinators have also met with SURF Scientists to start considering what an NPC Presence at SURF would look like.

Comments

- The current level of coordination between DUNE and NPC appears appropriate
- The current fraction of NPC Fellows that were awarded to DUNE-related projects also seems appropriate.
- The DUNE Data Analysis school had a smaller number of students than expected. In the future it might be useful to consider giving less support per student to enable more students to attend the school.
- The DUNE Data Analysis School seems like a good idea, but the agenda for the school looked more like what the CMS Data Analysis school is, which is a school for a very mature experiment. Future schools might be focused on DUNE's more immediate needs, for example commissioning and/or calibrating the far detector modules with cosmic rays, doing ProtoDUNE analyses, in addition to analyzing ND Prototype data.
- Establishing an NPC presence at SURF is challenging and demands an additional commitment from the lab.
- Fermilab would do well to establish a mechanism where DUNE-related NPC fellows could get offices closer to where the DUNE activities related to their proposal are based.
- The NPC activities seem closely modeled on the LPC model, yet the purpose of the NPC seems like it might need to be different from that of the LPC because FNAL is already the host lab for DUNE.
- There is high value to Fermilab to remain (and for SURF to become) an intellectual hub for the neutrino community, and for the NPC to improve communications and interactions between the various FNAL-based neutrino experiments.

Recommendations

- The committee encourages continued support of the NPC, including providing physical space for the NPC and for gatherings of the members of the neutrino community. A communal space modeled on the 11th floor crossover would also be good to establish for the NPC.

Status and plans of Detector R&D

Charge: We ask the PAC to review the current status of Fermilab's detector R&D program and the developing plans for future activities, in alignment with the laboratory's present and long-term scientific priorities.

Findings

- The Detector Advisory Group (DAG) oversees a broad Detector R&D program with two major areas of work, Microelectronics and Advanced Technology, but without a hard boundary between the two (some work under Microelectronics might be considered Advanced Technology).
- The program funds a total of 10.9 FTEs out of a yearly \$4.5M budget. Of these, only 1.2 FTE are scientific personnel; the remainder are engineer/technical support spread out over SiDet, Microelectronics, and Advanced Detector R&D. The scientists participating in Detector R&D are supported by their base programs. About 30 persons (primarily early career) undertake extended visits every year, typically for 1-3 months via SCGRF, VURP, summer internships, etc.
- The DAG is responsible for managing and operating a broad set of facilities useful for both internal work and the user community. SiDet is supported and maintained by the Detector R&D budget while the other facilities (Lab 6, Noble Liquid Test Facility) are supported by Infrastructure Services.
- The Detector R&D program maintains numerous collaborations with other laboratories, university groups, and industry.
- The Detector R&D program provides unique hands-on training opportunities for early-career scientists.
- The DAG runs a blue sky research New Initiatives program that supports interesting new ideas at a seed-funding level. Recent awards are largely to early career scientists.
- HEERC has offered the opportunity to set up a number of new labs (Precision Timing, Quantum Sensing) in close proximity to Wilson Hall.
- The last Detector R&D strategic plan was prepared in 2019. It is recognized by the DAG that it is time to update the strategic plan.
- The DAG has also contributed to the now-completing Facilities Strategic Plan, which has provided an opportunity to advocate for future support for facilities under Detector R&D management.
- Many activities critically rely on test beam: detector R&D and measurement programs for neutrino experiments including DUNE (example: EMPHATIC and ArCS, respectively ECA and LDRD not directly supported by KA25), and EM and HAD calorimeters.
- There will be no hadron test beam facility available in the world until late 2028.

Comments

- The PAC continues to be impressed with the excellent and productive technical program that the DAG stewards, especially on a tight budget.
- The productivity as measured by quantitative metrics, such as publications, conference presentations, patents, PhD dissertations, and facility users, is high given the budget.

- The program priorities appear to be well-aligned with major future needs. The DAG has made hard choices about what work can and cannot be supported given the budget environment and is well aware of work that is deserving but is not currently supported.
- The yearly budgeting and prioritization process is systematic, engages the appropriate stakeholders, and endeavors to align with the most recent strategic plan and current lab and DOE priorities.
- It was not clear how external collaborations are established and prioritized, in particular how open the process is to the initiation of new collaborations.
- It was not clear how open the Detector R&D facilities are to external users and to what extent those capabilities are known to the broader community. It is recognized that the Detector R&D program has a public web page with some of this information, but it was not highlighted in the presentation and the information there on outside user use is limited.
- The PAC encourages greater outreach to the community about facility availability and capability, collaboration development, etc. on a regular basis. Advertisement via the DPF newsletter and DPF meetings could be possible options.
- The shutdown of the Fermilab test beam is likely to cause significant delays and negatively affect the overall Detector R&D program.

Recommendations

- The PAC agrees that it is timely and, in fact, urgent to update the strategic plan, especially given the shutdown of the test beam program. A presentation on the strategic plan is requested at a future PAC meeting. This process can serve as a way to address a number of the comments and, in concert with the now-completing Facilities Strategic Plan, will clarify future support for and maintenance of Detector R&D facilities under DAG purview.
- The PAC encourages the DAG to work with the directorate and the DOE program manager to continue to advocate for robust support for the Detector R&D program.

Status and Plans for AI/ML Efforts

Charge: We ask the PAC to review updates on the status of the laboratory's AI/ML program (including recent news from the Genesis Mission), as well as progress in addressing recommendations from previous reviews:

- The laboratory should complete a strategic vision for its AI/ML strengths and unique capabilities. This vision should leverage both funded projects and promising unfunded Genesis Mission projects to position the laboratory for future funding opportunities.

Findings

- FNAL has significantly reorganized their AI/ML program to ensure connections across the laboratory while still supporting both scientific and enterprise applications. Area leads have been appointed to support these connections.
- FNAL leads one funded Phase I Genesis Mission project and partners on eight others. Six of these are HEP projects. Four Phase II proposals have been submitted, including one led by FNAL.
- The PAC was presented with a high-level strategic vision for AI/ML strengths and how to build the program on the unique capabilities of the laboratory. The three key areas of strength presented were surrogate models, foundation models, and edge AI.
- Several interesting AI/ML projects were presented that have already returned some scientific fruit, including agentic AI projects.
- The laboratory is engaging with community planning efforts and with the experiments to ensure that the laboratory vision is aligned with their needs and interests.

Comments

- FNAL has a great opportunity with the Fermi Data Platform to provide a valuable service for the community, if restrictions on accessing the data on the platform can be overcome.
- Regular meetings of the area leads with users helps ensure the success of the program.
- AI/ML applications appeared in several other sessions during the week, emphasizing the pervasiveness of AI/ML work across the lab programs.
- FNAL is beginning planning towards the next Genesis Mission proposal call, with a focus on Phase II proposals that offer longer-term support.
- Some of the ideas stemming from the Genesis Mission call have been supported through LDRD, which offers better positioning for the next call.

Recommendations

- The PAC encourages the laboratory directorate to emphasize the importance of programmatic AI/ML funding to the DOE in supporting mission-critical AI/ML efforts.

Status and plans of Accelerator Technology R&D

Charge: We ask the PAC to review the current status of Fermilab's Accelerator Technology R&D program and the developing plans for future activities, in alignment with the laboratory's present and long-term scientific priorities.

Findings

- The funding for the R&D activities is coming primarily through the General Accelerator R&D (GARD) program.
- A report was presented on three of the GARD thrusts: superconducting RF technology, superconducting magnet technology, and targetry.
- The focus of the R&D activities is on topics that will have targeted impact for the FNAL program. These are broken down according to the three priority areas for the laboratory.
- For priority area 1 — DUNE/LBNF: the effort is focused on reducing operating costs for PIP-II via improved performance of SRF cavities and improved target lifetimes. AI techniques are used e.g. in resonance tuning of the SRF cavities.
- For priority area 2 — HL-LHC: the R&D effort resulted in the successful production of Nb₃Sn magnets for HL-LHC. The focus is now shifting to magnets for next generation accelerators and fusion test facilities.
- For priority area 3 — Novel Technologies: several projects were described. These include the shift from Nb₃Sn to ReBCO high T_c superconductors which can have applications such as FCC-hh.
- The successful surface treatment of SRF cavities had direct implications for the Quantum Computing program as they can be directly adapted to shield, interconnect, and extend the coherence times of superconducting qubits.
- The FTE numbers decreased by 26% between FY18 and FY24. Due to reductions in the GARD program, the numbers decreased further in the last two FYs.

Comments

- The Accelerator Technology R&D effort is well aligned with the priorities of the laboratory.
- The PAC commends the FNAL teams for their very impressive achievements.
- The R&D effort is on track to generate significant operating cost decreases for the operation of PIP-II. The material studies should also importantly improve the lifetime and reliability of the LBNF target.
- The successful surface treatment of the SRF cavities are impressive and important for the National Quantum Initiatives both for the efforts at FNAL and also for the broader community.
- The focus on ReBCO as the technology for high T_c superconductors is in line with other activities internationally in this area. However effects such as delamination have surfaced. It is encouraged to investigate whether R&D with alternative HTS materials should also be pursued.
- The budget and personnel is shrinking yet this is very important and impactful work.

Recommendations

- A plan for future R&D efforts in line with expected available FTEs and other resources should be presented at a future PAC meeting.