Department of Energy
Washington, DC 20585

JUN 15 2015

Dr. Nigel Lockyer
Director
Fermi National Accelerator Laboratory
P.O. Box 500
Batavia, IL 60510

Dear Dr. Lockyer:

I have enclosed the report on the Department of Energy, Office of High Energy Physics (DOE/OHEP) Institutional Review of the Fermi National Accelerator Laboratory (FNAL) held on February 10-13, 2015. It conveys our evaluation of the laboratory's entire program, focusing on five cross-cuts that span the lab's entire program in research and technology, using the findings of the review committee and our office's assessments. It also provides guidance for your future program planning and execution.

I would like to thank you and your staff for the hospitality shown the review team and for the quality of the review. The review proceeded smoothly and the presentations by the FNAL staff were generally polished, well organized and informative.

The review committee was generally very favorably impressed by the review and its associated materials. The lab is forging ahead with new plans that clearly excite the staff and engage the high energy physics community with new vigor and optimism. They did, however, point out several areas of concern and they made several suggestions that you should consider and discuss with this office in the coming months. Most importantly, they made two specific recommendations which may improve the quality of your program. The details of their findings, comments, suggestions and recommendations can be found in the attached report.

Please address the review committee's two recommendations by submitting a plan of action to this office within 45 days of the receipt of this letter.

We hope that the review report is helpful to you in planning the activities at the lab.

Congratulations on the impressive progress the lab is making.

Sincerely,

James Siegrist

James Siegrist
Associate Director of Science
for High Energy Physics

Enclosure

Office of High Energy Physics
Report on the

Fermilab
2015 Institutional Review

February 10-13, 2015

Executive Summary

The Fermi National Accelerator Laboratory (Fermilab) Institutional review was held on February 10-13, 2015 at Fermilab. This review covered the entire HEP program at the laboratory, all major research efforts as well as facilities and operations of those facilities. Since the review included all aspects of the laboratory that are normally covered in the annual Science & Technology (S&T) Review of the laboratory's facilities, this review also served as the S&T review for 2015. As part of this review, the laboratory presented its proposed performance metrics for NuMI in FY 2015 and FY 2016.

This Institutional Review was the first such review at Fermilab since the office of high energy physics began its regular comparative reviews of the national laboratories. These reviews closely examine each lab's research efforts in the various frontiers, theory and computation. In light of these separate in-depth reviews, the focus of the upcoming Institutional Review was modified to avoid duplicating those efforts and instead examined crosscuts of the laboratory's program to judge the coordination, coherence and efficiency of those efforts. For example, one crosscut was CMS where the OHEP's goal was to judge how well CMS operations and research work together with theory, computing and the university community to produce a coordinated, coherent and efficient subprogram. The primary purpose of these crosscuts was to allow the reviewers and the OHEP to assess the lab's integration of its support efforts into its physics research program, while also engaging the community of universities and the expertise of the other labs with HEP programs.

The specific crosscuts were:

1. CMS operations and research, theory, computing, university involvement
2. Cosmic frontier program, theory, computing, detector R&D, university and other lab involvement
3. Neutrino program, related accelerator programs, theory, computing, detector R&D, university and other lab involvement
4. Muon program, related accelerator programs, theory, computing, detector R&D, university and other lab involvement
5. Technology R&D as it relates to Fermilab facilities.

Within this new format, each panel member was asked to evaluate and comment on:

- The quality and significance of the laboratory's recent scientific and technical accomplishments within each of the crosscuts identified above that comprise its entire physics program; and the merit, feasibility and projected impact of its future planned physics program and its alignment with OHEP future plans as expressed in the P5 report;

- The effectiveness and efficiency of facility operations, and the planning for future facility upgrades to support the research program as organized into the crosscuts, including appropriateness of the proposed performance metrics in terms of being realistic and maximizing the scientific productivity of the facility;

- The effectiveness of current laboratory management in strategic planning, developing appropriate core competencies, implementing a prioritized and optimized program, and promoting and implementing a safe work environment;

- The effectiveness of laboratory development and oversight of projects, including the lab's efforts to integrate its project efforts with active university and other HEP labs' involvement;

- The leadership, creativity, and productivity of the facility's scientific and technical staff in carrying out the above activities;

- The quality and appropriateness of the laboratory's interactions with, and nurturing of its scientific community; and

- The laboratory's response to recommendations made in the 2013 S&T review.

The OHEP also requested that the laboratory prepare a document of up to 25 pages summarizing the current Fermilab program, recent accomplishments, near-term plans, and longer-term strategic vision for each of the crosscuts identified above. This document was available to the review team two weeks in advance of the review.

In general, the review panel was impressed by the technical and scientific strength within the Fermilab program. They found the program well aligned with the P5 report and they were impressed with the focus and enthusiasm of the Fermilab personnel. The lab has engaged in a significant reorganization to focus its program on its short and long term scientific and technical goals. This trimmed-down structure provides management clearer oversight of all of the lab's efforts in science and projects. Two of the most notable changes are the appearance of a Neutrino Division and a Chief Project Officer. Fermilab seeks to become for neutrino physics what CERN has become for Higgs physics: the premiere international laboratory in neutrino science. Fermilab is engaged in a new generation of international scientific agreements and collaborations to achieve this goal. Its Short Baseline Neutrino (SBN) program and its Long Baseline Neutrino (LBNF) programs are dependent on the success of these international collaborative efforts.

Although the review committee was impressed with the new energy and focus of the lab, they did find areas where the lab is facing challenges and could improve its performance. These areas are discussed in the body of this review. Two particularly important recommendations that the

lab should address are:

1. **Fermilab should develop a plan for effective matrix management of cryogenic resources. If possible, Fermilab should develop strong collaborative programs with regional engineering schools with a focus on developing cryogenic engineers.** This recommendation arose from several sessions at the review where Fermilab acknowledged that there is considerable stress on its cryogenic resources, those resources are essential for the success of its neutrino and muon programs and the source of these stresses should be addressed.
2. **The review committee recommends that the lab, perhaps under the auspices of the PAC, carefully review the mix of "neutrino property" versus "technology enabling" experiments as it further develops its SBN experimental suite. Realistic scientific goals and timelines for the SBN program should be developed and communicated to the science community.** There were concerns from the review panel neutrino experts that the currently planned slate of SBN experiments would not prove definitive and, in the absence of a clear set of scientific and technical timelines and goals, would damage the national and international credibility of the neutrino program at Fermilab. The review panel felt that the suite of SBN experiments must be designed so that various neutrino anomalies and hints at the existence of additional neutrinos beyond those of the standard model could be decisively addressed in the near and midterm.

The review committee also provided a number of directed comments with guidance and suggestions that the lab should consider in the near term. These comments were not called out as recommendations because the review committee felt that they were known to lab management and were under active consideration. Nonetheless, their importance is primary.

Introduction and Background

Since the shutdown of the Tevatron on September 30, 2011, Fermilab has been reinventing itself for a new era in which it will not be the international leader of research at the Energy Frontier. Great strides in that planning effort have occurred since Nigel Lockyer was appointed Fermilab Director in September, 2013, and the Particle Physics Project Prioritization Panel (P5) Report was released in May, 2014.

Following the P5 Report, Fermilab's research efforts are now much more focused than in the past. Fermilab's program now consists of five areas: 1. neutrinos, 2. Large Hadron Collider, 3. muons, 4. cosmic science, and 5. accelerator science.

In neutrino science, Fermilab's goal is to become for accelerator-based neutrinos what CERN is for the Higgs boson. The current neutrino program includes the MINERvA, NOvA and MicroBooNE experiments. The lab is organizing its neutrino experiments into a Short Baseline Neutrino (SBN) program and a Long Baseline Neutrino (LBNF) program. The success of these programs relies on the Fermilab accelerator complex to deliver proton beams with adequate reliability and intensity. The complex is being improved through the Proton Improvement Plan (PIP), which focuses on the Linac and Booster, as well as ongoing improvements to the Recycler with the goal to run the NuMI beam at 700 kW as required by the goals of the NOvA experiment. Additional improvements to the accelerator complex are planned, including PIP II which will replace the aging Linac with a superconducting Linac of twice the energy so that the MI total beam power can be increased to 1.2 MW in order to implement the plans of the LBNF in the mid-2020's. In order to support the lab's greater emphasis on neutrino physics, a Neutrino Division has been formed out of the Particle Physics Division (PPD) under the leadership of Gina Remieka. The lab has also formed a *Neutrino Platform* that will support detector R&D, target and beamline development, software, computing, and theory. International collaborations are essential for Fermilab to reach its goals. The lab is attempting to attract the global community of neutrino physicists, and partner with CERN and other labs, to realize its vision of a new short-baseline program combined with the LBNF facility that is planned to host 40 kilotons of liquid argon detectors underground at the Sanford Underground Research Facility in South Dakota and use PIP-II to provide a megawatt-class neutrino beam.

In the Energy Frontier, Fermilab will continue to host the USCMS collaboration and engage in upgrades of the CMS detectors, and supply critical technologies and components for the LHC accelerator upgrades.

In the area of muon physics, Fermilab will host the muon g-2 and Mu2e experiments. The lab has created the Muon Campus to exploit synergies between these two experiments and to generate cost savings. Both of these experiments are sensitive to physics beyond the Standard Model at energy scales above the reach of the LHC. The muon g-2 experiment is scheduled to

begin data taking in 2017. The muon program will rely on the Accelerator Complex's Booster Neutrino Beam (BNB) which will produce the intense low energy secondary and tertiary particle beams required to create a muon beam with the required specifications.

In the Cosmic Frontier, Fermilab is the current world leader in cosmic surveys with DES, plans a project role in Dark Energy Spectroscopic Instrument (DESI) and participation in Large Synoptic Survey Telescopic (LSST). Fermilab's also plans involvement with the South Pole Telescope which will lead to a new generation of high precision studies of the cosmic microwave background (CMB).

Finally, in the realm of Accelerator Science, Fermilab plans partnerships with nearby institutions with the goal to develop the expertise and technologies to enable new, powerful accelerators for future experimental programs. A suite of test facilities is envisioned that will engage a broad user community.

In order to implement its new program, Fermilab has undergone a major reorganization that will reduce the organizational structure between management and staff. Of particular importance to this review is the creation of a Neutrino Division from the Particle Physics Division. This change should aid the lab in focusing on its major scientific thrust, neutrino physics. Another critical change is the creation of a Chief Project Officer to provide project oversight and support services, oversight of programs and projects while also attempting to address resource demands across all areas of the Lab.

The Fermilab Institutional Review took place on site from February 10 through February 13. The review consisted of one day of plenary talks, two days of breakout presentations and a half day of questions and answers with Fermilab management, closeout preparation by the review panel and closeout with lab management.

The review was organized around five cross-cuts that aimed to probe how well the lab is organized to address its science goals in an efficient and coherent manner. The cross cuts were:

1. CMS operations and research, theory, computing, university involvement
2. Cosmic frontier program, theory, computing, detector R&D, university and other lab involvement
3. Neutrino Program, related accelerator programs, theory, computing, detector R&D, university and other lab involvement
4. Muon program, related ccelerator programs, theory, computing, detector R&D, university and other lab involvement
5. Technology R&D as it relates to Fermilab facilities.

This review was designed to avoid duplication with lab comparative reviews, which focus deeply on single topic research efforts, and instead assess those special features of Fermilab which are essential for the success of its broad program in physics research and technology development.

Another unique feature of this review consisted of sessions of Q&A between the review committee and Fermilab Users. Since Fermilab must engage and serve the high energy physics community at large, an assessment of its effectiveness here is critical to its present operations and planning for its future.

The main body of this report presents the finding, comments and recommendations of the review committee on the five cross-cuts. In addition, the review committee provided an assessment of the lab's general management and oversight.

The appendices to this report provide additional detailed material relating to the review: Appendix A contains the charge letter to Fermilab management, Appendix B lists the reviewers and DOE participants, and Appendix C contains the agenda and links to the talks.

General Laboratory Management and Oversight

Findings

Fermilab, led by Nigel Lockyer, has undergone a major reorganization. The organizational structure has been flattened: ALDs and areas are being removed and replaced with seven chiefs over offices. One of these is the recently created Chief Project Officer to provide project oversight and support services, oversight of programs and projects while also addressing resource demands across all areas of the Lab.

A new Neutrino Division (ND) has been created from within the Particle Physics Division (PPD), which is central to the lab's goal of becoming the premiere international laboratory in neutrino physics.

Fermilab management has enunciated priorities for the entire laboratory and has reorganized and changed management practices in order to ensure that the priorities are addressed.

Fermilab's management oversight and resource management are strengthening.

In connection with its laboratory-wide projects/programs priority list, Fermilab has moved to a resource allocation system that is approaching a matrix configuration where centralized management work with the program and project heads determine resource allocations.

Fermilab is actively seeking international collaborators in its quest to become an international laboratory for high energy physics. These efforts are proceeding rapidly and are essential for Fermilab to reach its physics goals. The Short Baseline Neutrino Program (SBN) and the Long Baseline Neutrino Facility (LBNF) are dependent on the success of Fermilab's internationalization efforts.

Comments

Fermilab has a vibrant program and coherent strategic plan in all five cross-cutting areas (CMS operations and research, Cosmic Frontier Program, Neutrino Program, Muon Program, and Technology R&D) that were the subjects of this review.

Fermilab's strategic plans and operations are well aligned with the priorities expressed in the P5 report.

Fermilab is in its preliminary phases of moving to a matrix environment and so many of the issues that have plagued Fermilab in the past (insular programs and projects, and captive resources that may not address critical laboratory needs in a timely manner) still persist but are being addressed.

Cryogenics engineering and technical expertise is one of the resources chronically the most problematic for Fermilab by its own admission. When the Neutrino Division was organized from within the Particle Physics Division, the cryogenic expertise present in PPD was split

according to the experiments / programs they were working on, or had traditionally worked on in the past. This resulted in subdividing the cryogenic engineering effort to just a small number of engineers in each division. This occurred while the Accelerator Division and Technical Division also have cryogenic engineers. Consequently, resource allocation of this critical resource which is chronically in short supply must now be negotiated over all of the Fermilab scientific offices (with the exception of Computing). With the resource so subdivided, no one subject matter expert is likely to know the specific technical expertise and strengths of all the individual engineers or technical staff. Likewise, no specific manager is checking that the cryogenic engineers' capabilities and tools are current with the discipline's present best practice.

Fermilab should reconsider the value of a more matrixed organization rather than further subdividing expertise that is in short supply among the different groups. Fermilab would do well to combine the resources into a larger single pool of critical expertise like cryogenic engineering and technical staff that will be assigned to the different divisions based on Lab priorities.

All the major components of Fermilab acknowledge a shortage and difficulty in obtaining cryogenic engineers. While there are several active programs to attract and retain early career scientists, no correspondingly strong program for engineers exists. Fermilab should actively pursue the development of strong opportunities with engineering schools. The most successful such collaborations will likely not be achieved with major research oriented engineering schools, but rather those that focus on the formation and training of engineers for industry.

One concern raised by users is the ability for an outside user to come to the lab "and get things done". Fermilab traditionally has been highly regarded relative to other labs nationally and internationally as a place where users could come to build and run their experiments, and have access to technical resources to get things on track when they go awry. The users expressed the concern that now only those with "backdoor" friends can get help when needed. This situation raises concerns on several levels: it implies that users with real needs no longer reliably receive the assistance they need (and historically received), and it implies that "special" users get what they need, likely without regard to the relative priority of their request. Fermilab should examine their practices of support at the user level to ensure that time sensitive or small impact (on resources) needs can be met with minimal bureaucratic overhead, for new and seasoned users alike. Perhaps a system akin to trouble ticket tracking could be beneficial.

Fermilab's responses to the 2013 S&T review recommendations appear adequate on the whole.

Recommendations

Fermilab should develop a plan for effective matrix management of cryogenic resources.

Fermilab should develop strong collaborative programs with regional engineering schools with a focus on developing cryogenic engineers.

CMS operations and research, Theory, Computing, University involvement

Findings

Fermilab operates a number of Energy Frontier facilities, including a CMS Remote Operations Center (ROC), a Tier-1 Computing facility, the LHC Physics Center (LPC) and the Silicon Detector Facility (SiDet).

Fermilab scientists make direct contributions to the scientific and technical accomplishments of CMS. This group's effort amounts to over 100 FTE. The list of 55 CMS authors includes 15 post-docs, making Fermilab the second largest group within CMS. Fermilab scientists are involved in a wide range of activities encompassing detector operations, software and computing, physics analysis as well as Phase-1 and Phase-2 upgrades.

The Fermilab CMS group has taken on leadership responsibilities in support of operations of the CMS experiment such as tracker operations, offline beam spot and commissioning of the HCAL readout electronics. A partial list of leadership positions includes Level-1 computing coordinator and Level-1 offline coordinator, and HCAL project manager and operations coordinator.

Fermilab scientists led SUSY searches using all-jets and γ+jets final states, SUSY searches with single and di-lepton final states, and developed the Higgs spin/parity analysis. These contributions are recognized within CMS through a number of appointments. They include ~15 analysis group and sub-group conveners as well as ~10 object group and sub-group conveners since 2008.

The Fermilab scientific and technical staff was involved in the construction of the original forward pixel detector (FPIX), and they have continued to support its operation, e.g. calibration during Run 1 and recovery of defective modules during Long Shutdown 1. In the Phase-1 upgrade, Fermilab staff has responsibility for a new cooling system and electronics. There are aspirations for extensive Phase-2 upgrade tracker engagements.

Fermilab also manages the Phase-1 upgrade project, which has three main areas of work: hadron calorimeter (HCAL), forward pixel detector (FPIX) and trigger. Fermilab is working directly on HCAL front-ends. Fermilab has a large footprint on FPIX, leveraging the SiDet facility.

The Fermilab group plays a significant role in CMS computing. It has responsibilities for the software framework, and for making it multi-threading capable. Fermilab hosts the Tier-1 computing center which has achieved excellent performance metrics.

Fermilab's Geant4 development and support team has worked on geometry implementation and physics validation for Phase-2 detectors, and it plans to eventually implement parallelism to process single Geant4 events on multiple cores.

Comments

The CMS program is very well aligned with the priorities outlined in the P5 Report.

The CMS Remote Operations Center provides an alternative to physical presence at CERN for users as well as Laboratory personnel. The infrastructure of ROC enables good real-time interaction with those working on CMS operations at CERN. While it is not a perfect replacement for physical presence, the ROC offers definite advantages. First, there are savings on travel, both in terms of time and money. Furthermore, users can take advantage of their presence at Fermilab's ROC to participate in the activities of the LPC and SiDet, depending on their interests.

The Tier-1 computing facility at Fermilab is of critical importance to CMS. It provides significantly more computing resources than the average CMS Tier-1 computing center. Its performance, as measured by monthly reports on availability and reliability, is consistently among the best.

The Fermilab group in CMS computing has made considerable progress in porting its software framework to multi-threading architectures.

The LHC Physics Center is particularly noteworthy. There were testimonials from numerous users, ranging from senior faculty members to graduate students, praising the intellectually stimulating environment, easy access to theorists and the co-location of other facilities like ROC and SiDet. Several students and post-docs highlighted the opportunity for hands-on work during their assignment at the LPC, opportunities that are unfortunately rare in many universities nowadays.

Many indirect benefits of the LPC were pointed out. For example, the Fermilab theory group now has closer ties to experimentalists, and hardware facilities such as SiDet have access to manpower that would otherwise not be available.

The Silicon Detector Facility is where some of the Phase-1 FPIX work is taking place. It is important to sustain this facility, since it may play a similar role in the Phase-2 upgrade.

Collaborating university groups are well integrated into project management and project execution structures. For example, the Phase-1 upgrade trigger task has no Fermilab participation and is the responsibility of the University of Wisconsin and the Florida State University. On the other hand, both Fermilab and university partners are well represented in the HCAL and FPIX tasks, at both the management and execution levels. There is good technical progress and effective management independent of the makeup within the tasks.

The hadron calorimeter (HCAL) is another area with sustained Fermilab contributions: the development of QIE chips, detector operations and HCAL management. The Phase-1 upgrade is centered on the deployment of SiPM photo-detectors and readout electronics. The Phase-2 calorimeter upgrade is about to make a technology choice between a Shashlik approach similar to the present calorimeter and a high granularity approach using silicon sensors. Fermilab's SiDet could be an important asset if the latter approach is chosen. However, with its expertise in electronics, Fermilab can be expected to play a significant role independent of the outcome of the decision.

The Fermilab CMS group has a post-doc mentoring program. Post-docs have latitude to pursue their physics interests and the opportunity to broaden their experience in a supportive environment. The success of the mentoring program is illustrated by the subsequent placement of these post-

docs: nine out of 18 post-docs are now in more senior long-term physics appointments such as Lab staff or assistant professorships.

Phase-2 upgrades are under consideration. USCMS and Fermilab have expressed interest in the same three areas as for Phase-1 upgrades; however, the scope of the Phase-2 work is substantially larger. For example, an entirely new tracker is envisioned with extended rapidity coverage, reduced material thickness, greater radiation tolerance and trigger capability. It is not clear that these ambitions can fit within anticipated budgets. Furthermore, Phase-2 upgrades have not yet received DOE Critical Decision (CD) approvals despite a broad consensus on its physics case. This puts Phase-2 upgrades at a disadvantageous position when competing for Fermilab resources against other projects that are farther along the CD process. It is therefore an urgent task for the newly appointed USCMS Phase-2 upgrade manager as well as the entire team to assess the realistic scope and costs, including any off-project Laboratory support, needed to realize the Phase-2 upgrade ambitions.

Fermilab is making investments in SiDet and it is making targeted hires in anticipation of CMS Phase-2 upgrades. These are welcome developments. However, the ambitious scope and the ambitious pace of the Phase-2 upgrade may be difficult to support, particularly before it is well into the DOE CD process.

Recommendations

None.

Cosmic Frontier Program, Theory, Computing, Detector R&D, University and other lab involvement

Findings

The Cosmic Frontier team at Fermilab continues to make major technical and scientific contributions in the dark sector, where there are clear signatures for new fundamental physics.

There is tight coupling between theoretical, the experimental/technical, the science collaboration, the computational, and the operations and management elements of the Cosmic Frontier program.

The group has a long term plan, including engagement in DESI, LSST, SuperCDMS, LZ and ADMX, and Stage 4 polarization maps of the CMB. This plan is well-aligned with DOE's program for dark sector physics.

Except for the holometer, the Cosmic Frontier projects collect data at remote sites. This includes the direct detection dark matter projects, the dark energy survey programs, and (eventually) microwave background polarization measurements. In most cases this entails cooperative operations with existing scientific facilities (CTIO, Sanford lab, SNOlab). Relationships with these remote facilities appear to be collegial and effective.

Fermilab provides important (but hard to quantify with performance metrics) "glue" that knits together the engineering, data collection, data analysis, and collaborative science aspects of these projects.

The recent initiation of CMB work, in anticipation of a stage 4 experiment, will provide important Cosmic Frontier effort in the physics of inflation. This is in addition to dark energy, dark matter, and neutrino physics.

The Review Committee heard positive comments from external users about the healthy climate for junior scientists engaged in Cosmic Frontier activities.

The Cosmic Frontier work is compliant with DOE standards for a safe workplace.

Comments

The Cosmic Frontier work at Fermilab is well-aligned with the priorities set forth in the P5 report.

The operations aspect of the Cosmic Frontier program is both effective and efficient. Data collection for the Dark Energy survey is an example of recent success in this regard.

The planning for the evolution of Cosmic Frontier facilities is sound and realistic, for both the detector development facilities at Fermilab and for cosmic frontier experiments operating at remote sites.

The long-term scientific strategic planning for the laboratory is a work in progress. The Cosmic Frontier team's scientific priorities are reflected in their planned evolution of staged participation in dark sector science projects, and are appropriate for a DOE science lab.

The Fermilab Cosmic Frontier team has assembled and is successfully curating an excellent, and well-integrated, blend of skills across the engineering, computational, scientific, and managerial elements of the program.

The Fermilab Cosmic Frontier scientific staff is among the world leaders in this domain. Recent appointments follow in this tradition.

The technical, scientific management and computational staff have been essential to the lab's success in executing international projects at remote sites that integrate diverse teams into doing dark sector physics.

The Fermilab Cosmic Frontier team is fully integrated into the broader community, and is seen as a partner in executing these projects.

Fermilab has an unrivaled opportunity to embark on an integrated neutrino physics program that fully exploits both accelerator and cosmological observations of neutrinos. Fermilab should incorporate the cosmological measurements, both existing and planned, into its anticipated accelerator results and plans.

Along these lines, the review committee encourages the laboratory to adopt a fully integrated approach to increasing our understanding of neutrino sector physics. This might include a targeted hire that bridges the theory/cosmic/accelerator aspects of neutrino physics, or more cross-pollination between Divisions (seminar committees, visitor selections, etc).

The dark matter direct detection efforts at Fermilab are currently distributed across multiple experiments. We encourage the lab to continue its planning for the transition from G1 to G2 direct detection projects, and to bring its unique skills to bear on the challenges posed by G2 experiments.

The current Cosmic Frontier program at Fermilab appears spread very thin. While P5 has recommended that Fermilab support the Cosmic Frontier experimental program, it should develop a more focused and coherent long-term strategic plan. The plan should reflect not only the interests of individual investigators at the lab, but also define criteria that help decide whether or not Fermilab will become involved in experiments that request Fermilab's participation. **The P5 mandate should not necessarily be construed to mean that Fermilab must support every Cosmic Frontier experiment that asks.**

Recommendations

None.

Neutrino Program, related Accelerator Programs, Theory, Computing, Detector R&D, University and other lab involvement

Findings

Fermilab is hosting a rich program of neutrino physics including short baseline neutrino oscillations, neutrino interactions and long baseline neutrino oscillations. There are three running experiments, with another to turn on soon. Proton Improvement Plan (PIP) upgrades to the accelerator complex have made good progress and when successfully completed will position the Lab for further outstanding intensity frontier science. There will continue to be tremendous demands on protons in the Fermilab complex now and into the future.

The booster RF cavity refurbishment program under PIP, critical to achieving 15 Hz booster rep rate, is nearing completion, with refurbishment of 17 cavities expected before the 2015 summer shutdown to allow 15 Hz demonstration before the shutdown.

Fermilab has been taking significant steps towards internationalization of the long baseline neutrino program and securing the necessary additional resources vital to the success of this critical program.

Fermilab is in the process of reorganizing itself, consistent with P5. Reorganization into a Neutrino Division has made good progress although much remains to be accomplished. Additional staff is clearly needed and planned for. Immediate needs are to ramp up technical staff – particularly cryogenic engineering. Scientific staff growth is also needed, especially with expertise in the physics of neutrino properties (oscillation physics) and in the support of neutrino detector projects.

The Neutrino Division has introduced the concept of a Neutrino Platform (following CERN's example). This includes short baseline experiments, test stands, long baseline experiments, operations, theory, R&D, test beams and software development that span several organizational boundaries. This is a work in progress.

The lab has a long history of hosting international visitors to its own experimental program and is working its way to becoming the host of large internationalized experiments. Although management is committed to this transition, improvements in services, access to resources and technical support and communication are needed for thelLab to fully support an international experiment in which the U.S. is a participant. Current users complain that the assignment of housing is not transparent and users feel they are treated with lower standards. For instance, there is no assistance provided to users in finding offsite housing that is provided for Fermilab supported students. There is a dire need for office space, especially for users of experiments which are about to go online. The helpdesk is not adequately serving users. The wireless connection in the village is not adequate (the recent improvements are acknowledged). New users often do not know how to navigate the system when there is need for a resource or

technical support. Experienced Users rely on their own network of Fermilab contacts (i.e. they know whom to ask informally for help). While this system may have worked in the past, it is not scalable in view of a growing and more diverse user community.

The user community has noted the necessity of having members of the Scientific Computing Division (SCD) and Accelerator Division (AD) as collaborating scientists, actively involved on the experiments in order for the experiments to make effective use of lab resources. This is thought to be a better model than the liaison model or the "godparent" model. The current liaison model in SCD typically only allocated 10-15% of a person to this role which appears to be frequently insufficient for the liaison to truly understand the experimental requirements. Users often do not know how to communicate their technical resource or computing needs without the technical expertise from SCD or AD.

The theory group has demonstrated diverse expertise in neutrino physics that has been beneficial to the planning for and interpretation of neutrino experiments. The group has developed a plan to continue to support the lab neutrino program by hiring a broad neutrino physicist who can foster interactions with the experimental community.

The Scientific Computing Division is evolving towards a model supporting the full suite of internationalized experiments hosted at Fermilab. There is some recognition of the need for distributed hardware and software resources throughout the world along the lines of the LHC experiments, although there is some resistance to this new paradigm. An expanded SCD effort towards engagement and support of the community outside of Fermilab is a necessary part of the Lab realignment towards an internationalized program. SCD anticipates a need to increase FTEs supporting the neutrino program. This includes scientists with software and physics expertise to develop the needed software, such as LArSoft, and of technical staff to increase operations support as a number of new experiments turn on over the next few years. The Review Committee was told of a need to grow LArSoft with ~3 scientist hires in the next several years. They were told of an expected need to increase SCD operations for neutrinos from 4 people to 8 by 2018. SCD is engaged in international collaboration on projects such as GEANT V, which the committee sees as an important outward looking approach. SCD is also taking on valuable roles in GENIE such as release validation (currently with 1 junior scientist and a total of 1.5 FTE with an expected need increasing to 2 scientists and 2 postdocs)

Comments

The future neutrino physics program looks promising.

The development of the SBN program is clearly aligned with P5 priorities for Fermilab.

Fermilab should work hard to assure that Booster RF replacements are completed on schedule for testing 15 Hz operation this summer, which is crucial to the combined success of the muon and neutrino programs.

The various experimental run planning meetings from yearly planning, to bi-weekly updates,

appear to offer good communication from the accelerator operations to the experiments.

Fermilab should make every effort to ensure that the experimental programs continue to be consulted regularly in its scientific computing planning.

Given the tremendous demands on protons in the Fermilab complex now and into the future, attention should be paid to efficient use of protons, including being able to run parts of the accelerator complex independently while other parts are down to make sure the overall program is maximized. For example, gates and a dump would enable Booster operations while the main injector is under personnel access.

The Short Baseline Neutrino program (SBN) has made some incremental progress in defining a coherent short baseline program. A proposal has been written and has been supported by the PAC. This program is important for international collaboration building and for development of LArTPC detectors.

The review committee feels that it is important to understand and communicate accurately the technical goals and the scientific reach of the SBN program. The committee was not satisfied with the openness of the SBN personnel when these issues were discussed. The absence of realistic scientific goals and a sharp timeline for those goals could hurt the Fermilab neutrino program at a time when it is confidence building at the national and international levels and its future is being mapped out and secured. In particular, the committee suggests the lab may want to further assess the SBN's decisiveness in addressing the MiniBooNE anomaly in neutrino mode.

The creation of the new Neutrino Division offers potential for better coherence of the entire neutrino program, but it is too early to evaluate how it will function in practice. Care will continue to be needed to balance matrixed resources. Initial development of the Neutrino Division and of the Fermilab Neutrino Platform is generally positive. Fermilab should continue work to grow the Neutrino Division and to implement the Fermilab Neutrino Platform, focusing on making resources readily available to the community and experiments. The Review Committee saw potential for the Neutrino Platform concept as a useful management and organization tool to focus lab resources on this high priority program. The R&D program in support of the intensity frontier effort has been exceptional. The creation of the Target Systems Department is seen as a valuable step forward. The creation of ROC West offers a very attractive addition to keep the entire neutrino program visible in the center of the lab. The proposal to establish a Neutrino Physics Center similar to the LHC Physics Center seems an excellent way to provide better cross-fertilization among the various neutrino efforts.

Given a drop in support for technical resources at universities, it is important for Fermilab to work with DOE to consider how to facilitate engagement from universities in project construction that may bring cost effective value to projects as well as providing important training. The lab must remain vigilant to represent and support all of U.S. high-energy physics, including universities, other labs and all international partners.

Fermilab should continue to work towards the new paradigm of an internationalized program centered on SBN/LBN, including:

- Improved logistical support for users (housing, offices)
- Prepare for possible increase in needs associated with visas to the U.S.
- Support of experiments
- Communication and transparency
- Software and computing support for distributed users

We encourage computing division efforts to support distributed software and computing for the international community of neutrino physicists running experiments at Fermilab. The computing division is encouraged to expand the effort towards engagement and support of the community outside of Fermilab.

The review committee supports the theory group's plans for hiring a neutrino physicist.

Laboratory management should continue to pay careful attention to assuring the U.S. neutrino community a stake in the new LBN detectors. Attention should be paid to assuring that the importance of internationalization is internalized throughout the lab organization. The plan for the next 5–10 years should be articulated and publicized. Substantial effort will be required to manage expectations among all stakeholders (community, agency and governmental) in the US and abroad.

Recommendations

There were concerns from the review panel neutrino experts that the currently planned slate of SBN experiments would not prove sufficiently definitive in scientific and technical goals to continue to attract national and international support. The review committee recommends that the lab, perhaps under the auspices of the PAC, carefully review the mix of "neutrino property" versus "technology enabling" experiments as it further develops its SBN experimental suite. Realistic scientific goals for the SBN program should be developed and communicated and, if necessary, the SBN program should be redesigned to garner the requisite national and international support.

Muon Program, related Accelerator Programs, Theory, Computing, Detector R&D, University and other lab involvement

Findings

The Muon Campus exemplifies the synergies between the different Fermilab divisions:

- the muon program capitalizes on groundwork laid by Nova, including the booster to recycler beam delivery capability on the accelerator side, to the ART framework and FIFE more generally on the computing side;
- AD and PPD worked together to conceive the muon campus concept which resolved the Mu2e cost overrun, resolved incompatibilities between Mu2e and g-2 needs, and provided a $100M cost savings over the original individual schemes. It led to identification of common accelerator needs that led to a coherent suite of AIPs and GPPs that capitalized on the existing antiproton infrastructure (~same total cost as g-2 project);
- the muon campus led to further cost-savings through co-location of the cryoplants in MC-1 with independent control of the two systems.

University groups are significantly integrated into the muon projects, especially in the area of detector development, with almost all detector construction at universities. The test beam facilities at Fermilab are proving to be important in their research and development phases.

The muon project managers and the collaboration representatives from Fermilab reported that they found the current management structure, and the PMG/EMG meetings in particular, effective in providing their resources on average, yet still able to bring additional resources to bear when crises arise. The muon program users felt that through the technical and executive boards, the project decision processes were sufficiently transparent.

Comments

The Muon Campus should become a leading muon facility that can support a new muon program.

In addition to the Muon Campus concept, there exists a strong resonance between the Fermilab theory group and the two muon experiments that has resulted in efforts that will benefit the particle physics community overall, as well as help to ensure the success of the experiments themselves. For example, Beyond Standard Model implications fit naturally into theory group's interests, and the group has already done work that evaluate implications of the goals of both the Mu2e and Muon g-2 experiments. Because the experimental program now exists, the local Lattice QCD group has moved effort into calculations that will significantly improve the Standard Model muon g-2 prediction. That improvement, in turn, will be critical for the community to take full advantage of the expected improved measurement. For Mu2e, the theory group's fellowship program has been crucial to bringing in outside community members (like A. Czarnecki) to provide calculations critical to the success of the experiment itself.

The management related to the muon projects has been effective on multiple levels, with the Muon project managers satisfied with the overall management and resource allocation processes at the laboratory, and the university collaborators satisfied overall with the management of their individual projects.

The Muon g-2 project has remained on or ahead of schedule in meeting the project milestones. The project management and Fermilab should be commended on working together to find ways to proceed with low-risk yet critical path work while awaiting the full magnet test required for final CD-2/3 approval. The Mu2e project has been moving smoothly through the CD process once the Muon Campus concept fell into place, and moved through its CD-2/3b review in a timely manner.

While the projects have proceeded smoothly with adequate resources flowing to them through the lab, there were some concerns raised by both the project managers and the users. In particular, with the lab focused (for good reason) on its transition to *the* international home for neutrino physics and on its role as the central U.S. CMS site, the muon experiments feared being sidelined – they are perceived as a small program; they fear that their resource needs (people and protons) might get overlooked when conflicts arise. The fears appear valid: the impending transition of the muon projects to (partial) operations appears to have caught Fermilab management somewhat off guard. For example, there is a fixed operations budget with no other programs turning off while the Muon programs ramp up. For the Muon g-2 experiment, once the storage ring magnet is cooled and initially powered, its maintenance shifts to operations; for Mu2e, once they are granted beneficial occupancy of their building. Both occur on the year or less timescale. The recent incorporation of the muon experiments into the Experimental Management Group meetings has improved planning and coordination on this front. To help streamline the cost of operations and incorporate these experiments, Fermilab should continue to identify resources that can be made common to operational experiments. Overall, Fermilab management should maintain extra vigilance to ensure that the needs of the muon program continue to be met as the transition from partial to full operations occurs.

The second symptom was lack of user space on site. This area registered by far the greatest frustration level from the muon program users who participated in this review. Their discontent had reached the extent that some felt that they no longer considered Fermilab a welcoming environment in which to work. While the lab has long term goals for improved user space in Wilson Hall, and an initial plan for improved space for the muon users on the ninth floor of Wilson Hall, it took some work to dig that information out at the review, and the muon users clearly felt there was no clear communication regarding the plans. The ninth floor plans will be greeted positively by the muon user community, who feel strongly that the user space should be near to the Muon Campus. During the breakout sessions, the review panel strongly emphasized that the immediate crisis be at least partially addressed on the timescale of this summer to accommodate those experiments that will be transitioning to operations.

The muon users expressed great frustration with the lack of assistance that the Fermilab Housing

office currently provides for locating offsite housing. This problem is particularly acute during the summer housing crunch, when rates are exorbitant. The users wished to urge Fermilab to expand the mandate of the Housing Office, perhaps even to organize rentals of a number of offsite apartments for university users as they do for summer students. They also found the allocation process for offsite housing opaque, particularly with respect to how groups that have had on-site space for many years were reviewed in terms of need and priority. They were enthusiastic about the prospect of an on-site hostel, though noted that access to meals on-site in the evenings would be crucial for complete success of the hostel.

The users clearly felt that the Intensity Frontier and URA fellowship programs were critical to the successful involvement of the university groups in the on-site experiments. They did feel that it can be difficult to take full advantage of those programs across all stages of a project. Since projects play an increasingly important role at Fermilab, the lab should review its award policies in that context.

Recommendations

None.

Technology R&D as it relates to Fermilab facilities.

Specific Technology R&D Cross-cuts – Superconducting RF

Findings

The SRF program is central to Fermilab's success.

Fermilab's recent accomplishments in SRF have had direct impacts on its effectiveness and productivity across multiple scientific communities. In particular, the recent world-record setting improvements in Q_0 (through the development of nitrogen doping and flux expulsion) and increased average gradient (>31.5 MV/m) were noted. Plans to incorporate these advances into LCLS-II and PIP-II are underway.

Fermilab has made effective and efficient use of its SRF related facilities and operations. Part of this effectiveness and efficiency is in taking on development and production of 50% of the LCLS-II SRF cavities and cryomodules. The SRF R&D program has yielded a significant cost reduction for LCLS-II and has potentially larger impacts on future colliders.

Comments

The investments made by OHEP and Fermilab in SRF have been very productive.

The SRF program is well managed and works well in the national and international context.

SRF is a key technology for Fermilab's high intensity program, eventual US contribution to ILC and to OHEP's stewardship of accelerator physics and technology.

The SRF activities at Fermilab have a broad and well-balanced mix of expertise: fundamental surface science, technology development, engineering and production preparation.

Recommendations

None.

Specific Technology R&D Cross-cuts – Superconducting Magnets

Findings

Fermilab's major superconducting magnets foci are Nb_3Sn magnet development for LHC, luminosity upgrades, R&D on high field magnets, R&D on conductor and cable development, and Mu2e and other Muon Campus magnet development needs.

Fermilab has developed a strong set of capabilities and facilities such as the Vertical Measurement Test Facility, which is the only 1.9°K magnet test stand in the United States. Fermilab is a lead for the LHC Accelerator Research Program (LARP).

The emphasis within high-field strength magnets has principally been on high-field quadrupoles. They have also worked on dipole magnets as part of LARP until CERN took that scope back.

Fermilab is also a strong collaborator in the superconducting conductor development program which has demonstrated an improved J_E exceeding 700 A/mm^2 for commercial powder-in tube Ag-sheathed Bi-2212 round wire to the values of 20 T at 4.2 °K. Fermilab also has demonstrated robust design approaches with the solenoids for Mu2e.

The high-field magnet program is critical to HiLumi-LHC and future colliders.

Comments

Fermilab would strengthen its own position as leader of the accelerator technology within the U.S. by being more proactive in tapping the expertise that exists in other national laboratories and liberally acknowledging such collaborations, contributions, and leadership of other institutions. Such behavior will encourage greater collaboration and cooperation and provide further opportunities for Fermilab leadership. The upper management of Fermilab understands this, but this cultural and perspective shift must permeate to all levels of Fermilab.

Recommendations

None.

Specific Technology R&D Cross-cuts – Accelerator R&D

Findings

The accelerator program and accelerator R&D are well established and developed at Fermilab.

Fermilab's accelerator R&D planning displays effectiveness, leadership, creativity and productivity.

The Fermilab program is focused and aligned well with P5. This alignment extends across the major technology areas: accelerator, superconducting magnets and superconducting RF.

The accelerator group has begun exploratory R&D towards multi-MW beam facilities.

The Fermilab facility related Accelerator R&D has a major focus on increasing the intensity of high-intensity proton beams: theoretical and experimental studies of many instabilities mechanisms, s*lip-stacking* and other techniques to directly increase beam intensity, integrable non-linear focusing techniques, space-charge compensation techniques, high-power target development, and the development of high-current, long-pulse, low emittance sources.

The accelerator group has produced many publications over the last 4 years, including an effort to document what was accomplished at the Tevatron both in a special issue of JINST and in the book "Accelerator Physics at the Tevatron Collider." The number of peer-reviewed publications on Fermilab accelerator research has increased over the last 5 years with a ~45 maximum in 2011.

Comments

The IOTA project is progressing well with > 40% of components in hand and operations expected to begin in FY15-FY17. The growing IOTA collaboration includes universities, labs and international partners.

The cultivation and nurturing of greater opportunities for universities is commendable. The Accelerator group has joint PhD programs with 10 Universities across the US. Fermilab recently has emphasized boosting Illinois accelerator research with a NIU (S. Chattopadhyay) led consortium that includes University of Chicago and IIT.

Recommendations

None.

APPENDIX A

Charge Letter to Fermilab Management

Dr. Nigel Lockyer

Director, Fermi National Accelerator Laboratory

Fermi National Accelerator Laboratory

PO Box 500: 105 (WH 2E)

Batavia, Illinois 60510-5011

Dear Dr. Lockyer:

The Office of High Energy Physics (OHEP) of the Department of Energy (DOE) has scheduled the Institutional Review of the Fermi National Accelerator Laboratory (Fermilab) for February 10-13, 2015.The office conducts Institutional reviews of each national laboratory with a high energy physics program every three or four years. This review will cover the entire HEP program at the laboratory, all major research efforts as well as facilities and operations of those facilities. The review will include all aspects of the laboratory that are normally covered in the annual Science & Technology (S&T) Review of the laboratory's facilities, so this review will also serve as the S&T review for 2015. As part of this review, the laboratory should present its proposed performance metrics for NuMI in FY 2015 and FY 2016.

This Institutional Review is the first such review at Fermilab since the Office of High Energy Physics began its regular Comparative Reviews of the National Laboratories. These reviews closely examine each lab's research efforts in the various frontiers, theory and computation. In light of these separate in-depth reviews, the focus of the upcoming Institutional Review will be modified to avoid duplicating those efforts and will instead examine crosscuts of the laboratory's program to judge the coordination, coherence and efficiency of those efforts. For example, one crosscut will be CMS where we will want to judge how well CMS operations and research work together with Theory, Computing and the university community to produce a coordinated, coherent and efficient subprogram. The primary purpose of these crosscuts is to allow the reviewers and the OHEP to assess the lab's integration of its support efforts into its physics research program, while also engaging our community of universities and the expertise of the other labs with HEP programs.

The specific crosscuts we would like you to address are:

1. CMS operations and research, Theory, Computing, University involvement
2. Cosmic Frontier Program, Theory, Computing, Detector R&D, University and other lab involvement
3. Neutrino Program, related Accelerator Programs, Theory, Computing, Detector R&D, University and other lab involvement
4. Muon Program, related Accelerator Programs, Theory, Computing, Detector R&D, University and other lab involvement
5. Technology R&D as it relates to Fermilab facilities.

In order to plan and organize this review, please work with the OHEP to devise a coordinated agenda for the review. Our goal is to judge the Fermilab Program and its synergies that make it more than the "sum of its parts". As always the review will assess the merit, effectiveness and impact of both the program at Fermilab and the laboratory's contributions to the national program. We expect that the reviewers will be given adequate material to evaluate the current performance of the facility, the science resulting from the experiments that are served by the facility, and plans for future improvements to the facility, where the facility is the Accelerator Complex which consists of the Main Injector, Booster and Linac, the NuMI beam, and all other beams provided to experiments.

Within this new format, each panel member will be asked to evaluate and comment on:

- The quality and significance of the laboratory's recent scientific and technical accomplishments within each of the crosscuts identified above that comprise its entire physics program; and the merit, feasibility and projected impact of its future planned physics program and its alignment with OHEP future plans as expressed in the P5 report;

- The effectiveness and efficiency of facility operations, and the planning for future facility upgrades to support the research program as organized into the crosscuts, including appropriateness of the proposed performance metrics in terms of being realistic and maximizing the scientific productivity of the facility;

- The effectiveness of current laboratory management in strategic planning, developing appropriate core competencies, implementing a prioritized and optimized program,

will be asked to evaluate and comment on:

and promoting and implementing a safe work environment;

- The effectiveness of laboratory development and oversight of projects, including the lab's efforts to integrate its project efforts with active university and other HEP labs' involvement;

- The leadership, creativity, and productivity of the facility's scientific and technical staff in carrying out the above activities;

- The quality and appropriateness of the laboratory's interactions with, and nurturing of its scientific community; and

- The laboratory's response to recommendations made in the 2013 S&T review.

The first, second and third day of the review will consist of presentations by the laboratory and executive sessions. Breakout sessions in addition to the traditional plenary talks are encouraged. The fourth day will be used for an executive session and preliminary report writing; a brief close-out will take place in the late morning. Preliminary findings, comments and recommendation will be presented at the close-out.

Dr. John Kogut will chair the review and serve as our contact on all aspects of the review. He can be reached at (301) 903-1298 or John.Kogut@science.doe.gov . Please work with him and other members of the OHEP to develop the agenda for the review. In addition, materials for the review committee should be posted on a review website at least two weeks before the review. These materials should include review reports from recent comparative reviews as well as project and other related reviews.

Given the breadth of the program at Fermilab and the new organization of this review, we are also requesting that the laboratory prepare a document of up to 25 pages summarizing the current Fermilab program, recent accomplishments, near-term plans, and longer-term strategic vision for each of the crosscuts identified above. All requested materials for the review committee should be uploaded to the review website no later than Tuesday, January 27, 2015.

Each panel member is being asked to review all aspects of the HEP program at Fermilab. In

addition, each panel member will be asked to evaluate in greater detail those parts of the program in which they have specialized expertise. They will be asked to write individual letters on their findings. The Chairman will accumulate these letters, and compose a DOE report based on the information in the letters.

I greatly appreciate your efforts in preparing to present your laboratory's activities before this Institutional Review. It is an important process that allows our office to understand the accomplishments, quality, needs, and plans of Fermilab. I look forward to a very informative and stimulating visit.

Sincerely,

James Siegrist

Associate Director of Science for High Energy Physics

Enclosure

cc: Michael Procario, SC-25.2
Glen Crawford, SC-25.1
Michael Weiss, FSO

APPENDIX B

Cross-cut Reviewers for Fermilab 2015 Institutional Review

1. CMS operations and research
    a. **Bing Zhou (Michigan) bzhou@umich.edu**
    b. **Charlie Young (SLAC) young@slac.stanford.edu**

2. Cosmic Frontier Progra
    a. **Chris Stubbs (Harvard) stubbs@physics.harvard.edu**

3. Neutrino Program
    a. **Steve Kettell (BNL) kettell@bnl.gov**
    b. **Janet Conrad, (MIT) conrad@mit.edu**

4. Muon Program
    a. **Lawrence Gibbons (Cornell) lawrence.gibbons@cornell.edu , lawrence.gibbons@cern.ch**

5. Technology R&D in support of Fermilab Facilities
    a. **David Lissauer (BNL) lissauer@bnl.gov**
    b. **Kem Robinson (LBNL) KERobinson@lbl.gov**

A. Theory
    a. **Doreen Wackeroth (Buffalo) dow@ubpheno.physics.buffalo.edu**
    b. **Frank Petriello (Northwestern) f-petriello@northwestern.edu**

B. Computing
    a. **Paul Messina (ANL) messina@alcf.anl.gov or messina@anl.gov**

C. Detector R&D
    a. **David Nygren (Texas Arlington, LBNL) drnygren@lbl.gov nygren@uta.edu**

D. Accelerator Program
    a. **Fulvia Pilat (JLAB) pilat@jlab.org**

b. Nan Phinney (SLAC) nan@SLAC.Stanford.EDU

DOE HEP Representatives

1. Jim Siegrist Jim.Siegrist@science.doe.gov
2. Michael Procario Michael.Procario@science.doe.gov
3. Glen Crawford Glen.Crawford@science.doe.gov
4. Simona Rolli Simona.Rolli@science.doe.gov
5. LK Len LK.Len@science.doe.gov
6. Kathy Turner Kathy.Turner@science.doe.gov
7. Abid Patwa Abid.Patwa@science.doe.gov
8. Helmut Marsiske Helmut.Marsiske@science.doe.gov
9. John Kogut John.Kogut@science.doe.gov

APPENDIX C

Fermilab Institutional Review --- February 10---13, 2015

Chaired by John Kogut (DOE)

Tuesday, February 10, 2015

Time	Topic	Speaker		Location
8:30 am	Executive Session		30'	Comitium
9:00 – 10:50	Plenary Session I			One West
9:00	Fermilab Strategic Plan, alignment with P5	Nigel Lockyer	40' + 10'	
9:50	Fermilab management of technical resources	Mike Lindgren	20' + 10'	
10:20	Response to 2013 S&T Review Comments	Greg Bock	20' + 10'	
10:50	Coffee Break			Atrium
11:20 – 12:40	Plenary Session II			One West
11:20	CMS program	Kevin Burkett	30' + 10'	
12:00	Cosmic program	Craig Hogan	30' + 10'	
12:40 – 1:45	Lunch			2nd Floor
1:45 – 3:45	Plenary Session III			One West
1:45	Neutrino program	Gina Rameika	30' + 10'	
2:25	Muon program	Adam Lyon	30' + 10'	
3:05	Technology R&D program	Hasan Padamsee	30' + 10'	
3:45	Coffee Break			Atrium
4:15 – 5:45	Plenary Session IV			One West

4:15	Theory	John Campbell	20' + 10'	
4:45	Computing	Panagiotis	20' + 10'	
5:15	Detector R&D	Erik Ramberg	20' + 10'	
5:45	Accelerator program	Sergei Nagaitsev	20' + 10'	
6:15	Executive Session with Fermilab management		30'	Comitium
6:45	Executive Session		30'	Comitium
7:30 – 8:00	Refreshments			Chez Leon
8:00	Dinner			Chez Leon

Wednesday Morning, first session, February 11, 2015

Time	Topic	Speaker		Location
8:30 am	Executive Session		30'	Comitium
9:00 – 10:40	Breakout 1A: (Zhou, Young, Lissauer, Messina) Chair: Burkett			One East
9:00	Coherence of CMS research, operations, upgrades Research, operations --- Lothar (20+30) Upgrades --- Steve Nahn (20+30)	Lothar Bauerdick (20') Steve Nahn (20')	40' + 60'	
9:00 – 10:40	Breakout 1B: (Stubbs, Nygren, Petriello, Wackeroth) Chairs: Hogan,			Black
9:00	Cosmic research and theory: Dan and Scott summarize the many cross cuts of the astro theory group, with some more detailed examples Also present for discussion: Elise Jennings, Ilias Cholis, Nick Gnedin, Josh Frieman, Albert Stebbins	Dan Hooper (5') Scott Dodelson (5')	10' + 20'	

9:30	Coherence of cosmic research and operations Josh: overview of DES science and operations, with special emphasis on cross cuts (especially computing) Dan: overview of CDMS operations	Josh Frieman (20') Dan Bauer (10')	30' + 40'	
9:00 – 10:40	Breakout 1C: (Kettell, Conrad, Phinney)	Chairs: Rameika, Brice		Comitium
9:00	Coherence of current neutrino research and operations	Sam Zeller	30' + 70'	
9:00 – 10:40	Breakout 1D: (Gibbons, Pilat, Robinson)	Chairs: Casey, Glenzinski		Chief's Conf.
9:00	Coherence of muon program and muon campus 20+10 Muon Campus, Mary Convery	Mary Convery(20) Chris Polly (20) Ron Ray (20)	60' + 40'	
10:40	Coffee Break			2nd Floor

Wednesday Morning, second session, February 11, 2015

Time	Topic	Speaker		Location
11:00 – 12:10	Breakout 2A: (Zhou, Young, Lissauer, Messina, Petriello, Wackeroth) Chair: Burkett			
11:00	LPC and CMS users	Meenakshi Narain	30' + 40'	One East
11:00 – 12:10	Breakout 2B: (Stubbs, Nygren) Chairs: Hogan, Bauer			Black

11:00	Cosmic program and users Brenna and Klaus: DES collaboration (Brenna will float ideas for fellowship program here) Lauren and Prisca: CDMS collaboration	Brenna Flaugher and Klaus Honscheid (20') Lauren Hsu and Prisca Cushman (10')	30' + 40'	
11:50	Breakout 2C: (Kettell, Conrad, Gibbons, Pilat, Phinney, Robinson) Chairs: Rameika, Casey			Comitium
	Resource allocation among Fermilab accelerator---based experiments (technical + computing)	Rob Roser (15) Eric James (15)	30' + 40'	
12:10 – 1:00	Lunch			2nd Floor

Wednesday Afternoon, first session, February 11, 2015

Time	Topic	Speaker		Location
1:00 – 2:15	3A: Discussion with Users: CMS (Zhou, Young, Messina) Users: Cecilia Gerber,(Chair), Maria Spiropulu, Chris Hill, Jane			Comitium
1:00 – 2:15	3B Discussion with Users: Cosmic (Stubbs, Nygren, Wackeroth) Users: Priscilla Cushman (Chair), John Carlstrom, Klaus Honscheid, Steve			One East
1:00 – 2:15	3C: Discussion with Users: Neutrino (Kettell, Conrad)			Black
1:00 – 2:15	3D: Discussion with Users: Muon (Gibbons, Petriello) Users: Lee Roberts (Chair), David Hitlin, Craig Dukes, Kevin Pitts			Chief's Conf. Room
1:00 – 2:15	3E: SRF, PIP---II (Lissauer, Robinson, Pilat, Phinney) Chairs: Padamsee, Holmes			One West

2:15	Breakout 4A: (Zhou, Young, Stubbs, Nygren, Lissauer, Messina) Chair: Ramberg			One East
	Coherence of Detector R&D for CMS and Cosmic Ron Lipton (15 + 15) Juan Estrada (15 + 15)	Ron Lipton (15') Juan Estrada (15')	30' + 30'	
2:15	Breakout 4B: (Kettell, Conrad, Gibbons, Pilat, Phinney, Robinson) Chairs: Rameika, Casey			Black Hole
	Proton economics 20+10: Protons available between now and PIP---II, Paul Derwent	Paul Derwent (20') Steve Geer (20')	40' + 20'	
2:15	Breakout Session 4C: (Petriello, Wackeroth) Chairs: Van De Water and			Comitium
	Theory	Stephen Parke	20' + 40'	
3:15 pm	Coffee Break			2nd Floor

Wednesday Afternoon, second session February 11, 2015

Time	Topic	Speaker		Location
3:45	Breakout Session 5A: (Kettell, Conrad, Lissauer, Robinson, Nygren, Wackeroth) Chairs: Rameika, Brice			One East
	Coherence of SBN and LBNF	Peter Wilson	30' + 45'	
3:45	Breakout Session 5B: (Pilat, Phinney) Chair: Shiltsev			Comitium

	Accelerator program RR studies, HPT, Modeling/Theory	Vladimir Shiltsev	30' + 45'	
3:45	Breakout Session 5C: (Messina, Zhou, Young, Gibbons, Petriello) Chairs: Roser, Spentzouris			Black Hole
	Computing "Facilities and operations", Oliver Gutsche (20 + 10), "Simulation", Gabe Perdue with Daniel Elvira* (15 + 7), "HPC infrastructure and applications", Jim Amundson (15+7).	Oliver Gutsche Gabe Perdue Daniel Elvira Jim Amundson	50' + 25'	
3:45	Breakout Session 5D: (Stubbs) Chairs: Hogan, Bauer			Chief's Conf.
	Fermilab Cosmic and national program Craig: brief overview of DM and DE John: plans for CMB S3 and S4 Aaron Chou , Hugh Lippincott, Eric Dahl, Dan Bauer should also attend this session for discussion on DM plans; Josh Frieman, Brenna Flaugher and Scott Dodelson for	Craig Hogan (10') John Carlstrom (20')	30' + 45'	
5:00	Executive Session		90'	Comitium
6:30	Distribution of Reviewer Questions			

Thursday morning, first session, February 12, 2015

Time	Topic	Speaker		Location
8:30 am	Executive Session		45'	Comitium

9:15 – 10:35	Breakout Session 6A (Lissauer, Pilat, Phinney, Robinson) Chair: Shiltsev			One East
9:15	LARP	Giorgio Apollinari	20'+20'	
9:55	IOTA	Alex Valishev	20'+20'	
9:15 – 10:35	Breakout Session 6B (Gibbons, Petriello, Wackeroth) Chairs: Casey,			Black
9:15	Muon program 30+10 g---2 highlights, Brendan Kiburg 30+10 Mu2e highlights, Kyle	Brendan Kiburg (30') Kyle Knoepfel (30')	60' + 20'	
9:15 – 10:35	Breakout Session 6C (Kettell, Conrad, Nygren, Stubbs) Chairs: Rameika, Brice			One West
9:15	Neutrino platform	Steve Brice	30' + 50'	
9:15 – 10:35	Breakout Session 6D (Young, Zhou, Messina) Chair: Burkett			Chief's Conf.
9:15	Coherence of CMS Upgrades for High Luminosity	Vivian O'Dell	30' + 50'	
10:35 am	Coffee Break			Atrium

Thursday morning, second session, February 12, 2015

Time	Topic	Speaker		Location
11:00 – 12:30	Breakout Session 7A			One East

	As requested by reviewers			
11:00 – 12:30	Breakout Session 7B			Black
	As requested by reviewers			
11:00 – 12:30	Breakout Session 7C			Comitium
	As requested by reviewers			
11:00 – 12:30	Breakout Session 7D			Chief's Conf.
	As requested by reviewers			
12:30 – 1:30	Lunch			2nd Floor

Time	Topic	Speaker		Location
1:30 – 3:30	Breakout Session 8A (Young, Zhou, Stubbs, Nygren, Messina, Petriello)			One East
1:30	CMS recap	TBA	20' + 40'	
2:30	Cosmic recap	Craig Hogan	20' + 40'	
1:30 – 3:30	Breakout Session 8B (Kettell, Conrad, Gibbons, Wackeroth)			Black Hole
1:30	Neutrino recap	Gina Rameika, Steve Brice	20' + 40'	
2:30	Muon recap	Brendan Casey, Doug Glenzinski	20' + 40'	
1:30 – 3:30	Breakout Session 8C (Lissauer, Robinson, Pilat, Phinney)			Comitium
1:30	Technology R&D recap	Hasan Padamsee	20' + 40'	
2:30	Accelerator recap	Sergei Nagaitsev	20' + 40'	
3:30 pm	Coffee Break			Atrium

Thursday afternoon, first session, February 12, 2015

4:30 – 5:30	Plenary Session V			One West
4:30	Summary	Joe Lykken	45' + 15'	
5:30	Executive Session with Fermilab management		30'	Comitium
6:00	Executive Session		60'	Comitium
7:00	Distribution of Reviewer Questions			

Friday, February 13, 2015

Time	Topic	Speaker		Location
8:30 am	Executive Session		60'	Comitium
9:30	Executive Session with answers to questions		60'	Comitium
10:30	Coffee Break			2nd Floor
10:30	Executive Session		90'	Comitium
12:00 – 12:30	Boxed Lunch for Reviewers			Small Dining
12:30 – 2:00	Closeout		90'	One West
2:00	Adjournment			