Fermilab

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Response to Recommendations and Comments from the 2013 Science and Technology Review

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Institutional Review of Fermilab

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The 2013 S&T charge

- The Office of High Energy Physics will conduct a Science & Technology (S&T) Review of the laboratory's scientific user facilities. The review will be held at the laboratory, November 5–7, 2013. The goal of the review is to assess 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. For this review the panel will also be asked to include its assessment of the facilities that Fermilab provides to support the needs of the US CMS user community. As part of this review, the laboratory should present its proposed performance metrics for NuMI in FY 2013 and FY 2014.

Three recommendations from S&T 2013

- In general, the review panel found areas of technical and scientific strength within the Fermilab program. However, the review panel also raised several concerns and presented three recommendations to management.

  1 The review panel recommended that the lab formulate a coherent plan for its small and mid-scale neutrino experiments, which should include a timeline for physics and technical milestones. The reviewers did not find the suite of neutrino experiments to be adequately coordinated into a program that had decisive physics goals that lend support to the lab's flagship experiment, the Long Baseline Neutrino Experiment (LBNE).

  2.The review panel recommended that the lab should develop a systematic comparison of the two or more linac upgrade options to reach the MW power goal. The plan should address what R&D is needed and when, the cost, the role of international contributions, any necessary infrastructure additions or upgrades, and the upgrade potential of the design. They should determine the implications for the ongoing PXIE and SRF work.

  3. The reviewers requested the Scientific Computing Division to develop a plan for supporting software and computing needs for the neutrino experiments which will fully engage and leverage other DOE national labs' expertise and resources. The plan must enable distributed simulations, data management, and analysis and should include a set of metrics to gauge the success of the plan based on user experiences, both on and off site. The plan should call out any re-prioritization and re-allocation of resources in the Scientific Computing Division needed to align the computing support manpower with Fermilab priorities, as is being done in the accelerator, detector, and research areas.

Recomendation 1: SBN Program Development

See: Rameika, Wilson

- The Fermilab SBN program is built on the well developed Booster Neutrino Beam with a goal of definitively addressing the short-baseline anomalies observed by LSND and MiniBooNE.
  - At January 2014 PAC proposals from ICARUS (P-1052) and LAr1-ND (P-1053) collaborations.
  - Initiated coordinated effort to create a coherent plan combining the ICARUS, MicroBooNE and LAr1-ND detectors and collaborations to address short-baseline anomalies and development needs for ELBNF.
  - Combined SBN LOI was presented to January 2015 PAC and given full endorsement by the committee.
  - Stage 1 approval for program granted by the director on February 5, 2015
- Detailed analysis of the SBN program sensitivity described in the LOI suggests that the LSND anomalies can be strongly addressed.
- SBN program includes development of a new detector (LAr1-ND) with direct technology link to the ELBNF single-phase design.
- Preliminary schedule has the LAr1-ND and ICARUS-T600 detectors ready for beam (joining MicroBooNE) in Spring 2018

SBN Program Coherence with ELNBF

- The SBN program is a crucial intermediate term part of a coherent neutrino program leading to ELBNF.
- A definitive statement on the LSND and MiniBooNE anomalies and the potential for discovery of a sterile neutrino are an important component of testing the 3 neutrino paradigm that ELBNF is designed to test.
- ELBNF will rely on improved models of ν-nucleon interactions to achieve the necessary level of systematic uncertainty. The SBN program will provide valuable measurements of ν-Ar interactions based on high statistics data samples.
- The large data sets in the three SBN LAr-TPCs will be a testing ground for reconstruction algorithms and automation of reconstruction that will be essential for ELBNF.
- The LAr1-ND detector is being developed by many of the same people who have been developing the ELBNF single-phase design. This will help ensure that lessons learned are shared between the two programs.

Recommendation 2: PIP-II Options

See: Nagaitsev, Holmes

- Plan A - Superconducting Linac
  - 800 MeV pulsed SC linac
  - Constructed from CW-capable accelerating modules
  - Operated initially at low duty factor
  - Sited in close proximity to Booster and to significant existing infrastructure
- Plan B - Afterburner
  - 400 MeV pulsed linac appended to existing 400 MeV linac
  - 805 MHz accelerating modules
  - Requires physical relocation of existing linac upstream ~50 m
  - ~1 year interruption to operations
  - Less expensive than Plan A

Pluses and Minuses

	Plan A: PIP-II	Plan B
Beam power to LBNE	1.2 MW	1.2 MW
Cost to DOE (FY2020 $M)	~$400	~$250
R&D aligned with efforts to date	**Y**	**N**
Upgradable to 2 MW to LBNE	Y	Y
High Duty Factor Capable	**Y**	**N**
Proton Driver for Muon Facility	Y	N
Upgrade paths utilize 1.3 GHz infrastructure & capabilities	Y	N
Retires significant reliability risks	**Y**	**N**
Interruption to operations	**~2 months**	**>12 months**
International contribution & collaboration	**Significant**	**Minimal**
Reutilization of existing infrastructure	Significant	Modest
Status of technical development/understanding	Advanced conceptual	Pre-conceptual

See: Spentzouris

Recommendation 3: Scientific Computing Tactical Approach

- Supporting the current program and preparing for the future requires leveraging resources and expertise.
  - Work **across lab organizations** to support the entirety of the program
  - Build stronger ties and **collaborations with other institutions** to advance computing infrastructure and transform major HEP toolkits
- Provide state of the art, reliable facilities and computing services
  - Leverage expertise and tools from our successful CMS program and integrate tools and services to develop a common approach for Fermilab experiments
  - Rely on the Scientific Project Portfolio Management Process, IT Infrastructure Library (ITIL) best practices for Service Management, and the SCD Liaisons
    - continuous feedback both for planning and operations
- Maintain competencies and infrastructure capabilities through R&D to enable and support next-generation experiments, upgrades, and our future scientific program.

Tools, Services, and Training

- Framework for the running experiments
  - Application software shared among experiments
  - LArSoft is a common simulation, reconstruction and analysis toolkit for experiments using LAr TPCs.
  - Common services and interfaces needed to turn a physics task into results, seamlessly utilize onsite and offsite resources.
- Support and training for members of the community are a priority
  - 'art' framework for intensity frontier experiments: excellent workbook that is praised by the community for its usefulness and conducts Regular training sessions for users are conducted
  - Recently started user training; conduct yearly workshops to interact with the community and foster information exchange and re-started offering a C++ course
  - Specialized training to help users and experts to stay informed about latest technologies and techniques

Computing Collaborations to meet Intensity Frontier challenges

- Shared Analysis Code for LArTPC based Neutrino Experiments (**LArSoft**)
  - FNAL, BNL, SLAC, LBNL, LANL; Cambridge, MIT, Yale, Columbia…
- Accelerator Modeling across multi-scale accelerator technologies (**ComPASS**)
  - FNAL, ANL, LBNL, SLAC; UCLA, UTA; Tech-X
- Worldwide HEP and other sciences modern detector simulation project (**Geant4**)
  - CERN, Japan, … + In US: ANL, FNAL, SLAC, …
- Neutrino Physics Event Generator (**GENIE**)
  - Rutherford Lab, U. of Liverpool, U. of Pittsburgh, Tufts U., FNAL

Comments from the 2013 S&T review (further details this week)

- Neutrino program synergy, technology, organization, coherence, and motivation
  - Major accomplisments during the year
- Concern about ramp up time to 700KW for the NuMI program
  - Remained on schedule over the last year
  - Recent reviews by OHEP and the PAC
- Increase attention to the Test Beam program
  - Now reviewed by a standing external committee and a report has been recently issued
- Monitor conflicts with LCLSII work and SRF staff
- Defined LPC Metrics in response to a comment
- Produce and update a Fermilab road map.
  - Director launched a strategic planning effort
- Interest in LDRD program

Summary

- We have responded to the recommendations from the 2013 S&T Review and have been mindful of the reviewers' comments as we reorganized the laboratory, made progress on construction projects, while supporting the operating experiments and science programs.
- More details will follow in the subsequent presentations and discussions during the week.