Office of High Energy Physics
Report on the

Science and Technology Review of the Fermilab User Facilities

June 2008

Executive Summary

The Office of High Energy Physics conducted a Science and Technology Review of the Fermilab User Facilities on June 24-26, 2008. The facilities, the Tevatron Collider, NuMI Neutrino Beam, and the Booster neutrino beam were found to be very productive scientifically with many publications on a broad range of topics being published by the CDF and D-Zero collaborations and the MINOS and MiniBoone collaborations making important measurements.

The facilities are well run with the Tevatron producing record luminosities in the last year. It is expected that with continued reliability that the Tevatron can reach its Run II goal of integrating 8.75 fb^{-1} by the end of FY 2010. This has been done in a difficult fiscal environment that has required staff furloughs to balance the budget in FY 2008. The NuMI beam is slightly behind its goals for the year due to mechanical breakdowns that are now understood and have been addressed.

The laboratory have begun planning for the transition from running the Tevatron Collider and the neutrino program to just a neutrino program. This includes how to support the ongoing analysis of the CDF and D-Zero collaborations, the disassembly of the detectors, and eventually the disassembly of the Tevatron. This work is still in its early stages.

the Particle Physics Project Prioritization Panel (P5) has recently endorsed a long baseline neutrino program utilizing a detector at the proposed Deep Underground Science and Engineering Laboratory in Lead, South Dakota and a muon to electron conversion experiment. Both of these efforts could use the current Fermilab proton source, but would require Fermilab to build new beams. The muon beam is a significant effort but the neutrino beam would be a much larger effort even more technically challenging and expensive than the current NuMI beam. Fermilab has had just a few weeks to respond to these recommendations at the time of the review and the plan was far from mature.

The longer term future of the user facilities involve an upgrade to the proton source by replacing the Linac and Booster accelerators with an 8 GeV superconducting proton linac called Project X. This effort currently relies on other R&D programs such as the International Linear Collider and the Superconducting RF Infrastructure, and these interdependencies will need to be simplified for Project X to succeed.

Introduction

The Office of High Energy Physics conducts regular peer reviews of its scientific user facilities. The goal of these reviews is to understand the quality of the scientific research conducted at the user facilities, the efficiency of the operation of the facilities, and the planning for the future of the facilities.

Fermi National Accelerator Laboratory (Fermilab) currently operates a complex of accelerators that combine to support users with three facilities, the Tevatron Collider, the NuMI neutrino beam, and the Booster neutrino beam. These facilities were the subject of a peer review conducted at the laboratory on June 24-26, 2008. The review committee was composed of nine experts in high energy physics research, facility operations, and scientific program management drawn from universities and national laboratories. The committee heard presentations from Fermilab staff and users and had question sessions with Fermilab management.

The committee members reported their evaluations in individual peer review letters, which were used to compile this report. The report is divided into five sections, this introduction, a section on the physics research being conducted at the user facilities, a section on the efficiency of operation of the facilities, a section on the future plan for the facilities, and due to the importance of strategic planning a final section that addresses just that topic. Each section contains findings, which are statements of fact, comments where the reviewers gave their evaluations of the work, and recommendations of how to improve the program. In selected instances where special attention is needed a recommendation can be raised to the status of an action item.

Current Physics Research from the Fermilab User Facilities

FINDINGS

The two Run II experiments, CDF and D-Zero, have been very productive with about 80 papers published, 150 conference reports, and about 75 PhDs graduated over the last year. This work have spanned several major areas of the physics, including electroweak measurements, studies of top quarks, searches for the Higgs Boson, studies of B hadrons including searches for CP violation, and new physics such as supersymmetry.

D-Zero has found the first evidence for a radiation amplitude zero in W,γ production, which is a long-standing prediction of gauge theory due to an interference of amplitudes. CDF and D-Zero are aiming to soon improve the precision on the W-mass to 25 MeV using 2 fb^{-1} of data. This will require the collaborations to better understand the dominant systematic errors.

CDF is searching for CP violating effects in the $B_s \rightarrow J/\Psi\ \phi$ decay mode. Earlier CDF data provided the first evidence of mixing in the neutral B_s system. The CDF experiment has discovered several new b-hadrons. The experiments have the most precise measurements of B_c and B_s lifetimes. The measured B-meson properties will test heavy quark effective theory and lattice QCD predictions.

The combined results of the two experiments have determined the top quark mass to an accuracy of 1.5 GeV and by the end of Run II, an accuracy of about 1 GeV is expected. The D-Zero experiment has greater than 3σ evidence for single top production.

Through the implementation of new search strategies, the sensitivity of the Higgs search is improving faster than $1/\sqrt{L}$. A new Higgs search channel, $VH \rightarrow \tau^{+}\tau^{-}$ + quark-pairs, has been studied and this has improved the Higgs search sensitivity by 10% in the interesting low Higgs mass region. Particularly exciting is that the search for the $H \rightarrow W^{+}W^{-}$ decay mode has reached a limit that is just 1.1 times the SM expectation (at 95% CL).

The collaborations have placed improved lower limits on supersymmetry particle masses from jets + missing transverse energy events and trilepton events: gluino greater then 327 GeV, squark greater than 392 GeV, and chargino greater than 140 GeV.

The neutrino program is also active with MINOS and MiniBoone publishing important results, while SciBoone has had a productive run that should be competed by now.

MINOS has produced the most precise value of Δm_{32}^2 so far. They claim that by 2010 they will halve the uncertainty on the Δm_{32}^2 and increase the 90% C.L. lower limit on $\sin^2(2\theta_{32})$ from 0.87 to ~ 0.92. In addition by 2010 they expect to improve the present sensitivity to $\sin^2(2\theta_{13})$ by almost a factor of two.

MiniBooNE sees no evidence for $\nu_\mu \rightarrow \nu_e$ oscillation in the region above 475 MeV, ruling out the usual interpretation of the LSND result. However they do see an excess of electron events at lower energies. The evaluation of possible backgrounds is not yet complete. Data from NuMI beam neutrinos have been analyzed and the low energy electron events exceed the background simulation by about 1σ. However this "excess" continues to ~800 MeV. The experiment is presently embarked on collecting a sample of anti-neutrino events from 5×10^{20} POT.

COMMENTS

A high degree of cooperation between the experiments has produced new important physics results from combined data sets. This is of particular value in precision top quark and W-boson mass determinations and in the search for the Higgs boson and beyond the Standard Model physics, such as supersymmetry and extra dimensions.

The prospects for discovery of the Higgs boson at the Tevatron are still promising. This is especially the case for the mass range around 160 GeV where the WW decay mode is dominant. The reviewers found the physics case for continued Tevatron running through FY 2010 to be well justified on the basis of Higgs search and their expectation that the LHC experiments will need time to refine their Higgs analyses and calibrate their detectors.

The precision achievable on top and W-boson masses at the Tevatron may not be exceeded at the LHC because of the higher backgrounds at the higher energy. The accuracy on these masses is crucial to tests at the loop level of contributions from the Higgs boson and new physics, such as supersymmetry.

The experiments are training a large number of outstanding PhDs who are vital to the future U.S. high energy physics program. Fermilab is a very desirable place to do postdoctoral research in particle physics, as evidenced by the fact that the last 6 offers of the Wilson Fellowship have been accepted.

The improvements in Monte Carlos from fits to Tevatron data have improved the understanding of the backgrounds for Higgs and new physics searches and are an important input for LHC physics studies.

The outstanding physics accomplishments of the collaborations came in spite of the difficulties caused by the unexpected budget reductions and the necessity of staff furloughs.

Double CHOOZ and Daya Bay are likely to pass the MINOS $\sin^2(2\theta_{13})$ sensitivity before the end of 2011. Unless MINOS finds that $\sin^2(2\theta_{13})$ is large, otherwise further improvement in the other oscillation parameters that MINOS can access does not appear to be strong enough motivation to run beyond 2010.

It's not clear how much light further MiniBooNE running will throw on the low energy excess. If the final background evaluation supports the current size of this excess, the proposed MicroBooNE detector is likely to be much more definitive if it has the claimed performance. The committee concurs with the March evaluation of the Fermilab PAC on the quality of the physics case for MicroBooNE.

The reviewers were impressed by efficiency and effectiveness with which the SciBooNE collaboration has carried out its research program.

RECOMMENDATIONS

NONE

Current Accelerator and Detector Operations

FINDINGS

At the time of the review the Tevatron has delivered 1.1 fb^{-1} in FY 2008 and a total of 4.24 fb^{-1} in all of Run II. The best month for integrated luminosity was May 2008.

The number of protons on target (POT) delivered to NuMI is slightly below base goals for the year due primarily to technical problems, including a chronic problem with a ceramic coupler in the horn that now appears to be solved. Spares consist of 1 target and 1 horn. It is planned that another target be produced and the existing horn repaired to provide a spare for the second horn.

Fermilab has taken further actions to mitigate the potential tritium problem by improved water control and an extensive dehumidifying system.

The current proton plan to increase the number of protons on target has progressed towards its goal of achieving 3×10^{20} POT/year by implementing slip stacking, MI collimation, and improvements to the Booster.

The CDF and D-Zero collaborations are deeply embedded in the operation of their detectors taking on major responsibilities but supported by the laboratory. D-Zero recorded 954 pb^{-1} recorded of 1050 pb^{-1} delivered in 33 weeks (including startup), with efficiency consistently higher since January, and a total recorded luminosity of 3.76 fb^{-1} out of 4.24 fb^{-1} delivered. The detector has had a data taking efficiency greater than 90% since the 2007 shutdown. The CDF detector has its best data taking efficiency of approximately 85% since the 2007 shutdown, which compares well with the average Run II efficiency of 76% for Run II. CDF recorded 3.26 fb^{-1} of the total delivered luminosity of 4.24 fb^{-1}.

During the ten-week shutdown in 2007 CDF focused on repairs to the silicon cooling line and L2 trigger upgrades aimed at maintaining high live time at ever increasing luminosity, while D-Zero made many minor repairs and upgrades on the detector systems. These activities were carried out under a safety environment that includes special D-Zero safety orientation and training, using written procedures with job hazard analysis, work control and a lessons learned program, and CDF activities were carried out using written procedures for routine tasks, job hazard analyses for major tasks, periodic review of safety procedures, application of lessons learned, and safety meetings with staff.

The silicon systems of both experiments are expected to continue to perform acceptably through the entire planned run. The observed effect of radiation on the detectors has been modeled and has now been successfully tested against real data. The CDF tracker is stable. The aging effects seen in 2004 were eliminated by the introduction of oxygen into the gas mixture.

D-Zero presented a detailed analysis of the number of FTEs needed to run the detector and prepare the data, which showed the requirement is over 100. This is expected to drop to 100 in 2010. Manpower estimates from MOUs for the period 2007-2009 were 357, 272, and 184 respectively. An updated projection for 2009-2011 yields 240, 185, and 119 respectively.

CDF presented an analysis of its manpower needs and showed that the number of FTEs needed to run the detector and prepare data was 117 of the 392 available FTEs in 2007. Estimates for 2009 and 2010 are 96 of 253 and 85 of 196 respectively.

The large data processing needs of CDF and D-Zero have thus far been met by the Fermilab Computing Division combined with dedicated off-site processing and use of Grid resources, particularly in the case of D-Zero. The Fermilab base capacity of 15,000 mixed age processors provides adequate capacity for the peak needs of both experiments, as well as for CMS (large) and neutrino program needs (small).

The 2008 computing budget for the Tevatron experiments is approximately $3.8M. This covers equipment maintenance, tape purchase and slot amortization, new CPU and disk purchase, and visitor support. The detailed breakdown of CPU and disk costs varies between the Tevatron experiments. Total costs to meet the requirements generated by these experiments are approximately equal. The budgets for 2009 and 2010 are approximately $3.7M. Once data taking has completed, the budget decreases to approximately $2.8M due to lower projected needs.

The model contains about 20% headroom to accommodate special processing needs (reprocessing). CDF has not done major data set reprocessing. D-Zero has reprocessed the data set in the past, taking advantage of grid resources for added capacity. Neither experiment currently has plans for a last pass reprocessing of the data at the end of data taking. Resource contention may occur in the future, as CMS ramps up. This can be resolved in the worst case by falling back to limiting use to the resources procured for the individual experiments.

It is expected that as the experiments shrink, key computing expertise may no longer be available within the collaborations. Fermilab computing management recognizes that some tasks may need to be taken on by the professional computing staff. Computing management is planning for a five-year analysis period, followed by a period of five years of legacy access to the data.

The Fermilab neutrino program is currently comprised of three experiments using two beam lines.

MINOS, long baseline neutrino oscillation experiment using the Main Injector beam with a near detector at Fermilab and a far detector at Soudan mine, has 140 members. The postdoc and student base is expected to be stable through 2009, with losses likely to other experiments thereafter. 4.86×10^{20} protons have been delivered on target since start of operations in 2005.

The 2007 shutdown was used to fill the decay pipe with He to reduce window stress and to install a dehumidification system in the target area to reduce tritium production.

Shifts are covered at Fermilab with 4 single person shifts per day under a single run coordinator. At the far detector, underground shifts are manned for the day shift on weekdays, on call on weekends. The use of underground crew is limited, but the loss of beam time has only been an acceptable 1%.

MINOS far detector has had no recordable safety incidents in the last year. NuMI had one. Great attention is paid to minimizing exposure to radiation in dealing with repairs of beamline elements (horns, targets). Access control and good housekeeping limit hazards in the Fermilab near detector hall. Joint stakeholder inspections of the Soudan mine site found staff knowledgeable and the site safe.

MiniBooNE, a collaboration of 80 physicists, operates a detector in the Booster neutrino beam, and used 1.1×10^{21} POT since 2003, with expectation of another 2×10^{20} protons before the 2009 shutdown. Second horn is functioning well; third horn available as a spare for the balance of the run.

SciBooNE, a collaboration of 60 physicists, operates a detector in the Booster neutrino beam and has used 1.05×10^{20} POT in neutrino mode, as well as 0.86×10^{20} POT in antineutrino mode. The goal by the mid-August shutdown of SciBoone is 1×10^{20} POT in antineutrino mode. The detector has operated with an efficiency of 95%. The detector will be disassembled in August at the end of its run.

COMMENTS

The increase in Tevatron integrated luminosity can be attributed to several factors: the successful upgrades to the Tevatron Complex that have been implemented over the past years, a strong operations team that features excellent cooperation between the run coordinators, the division office, theoretical support and the shot data analysis group, and a focus on improving Tevatron reliability.

The reviewers expressed the opinion that the goal of integrating 8.75 fb^{-1} through FY 2010 can be met with the present performance of the Tevatron, if reliability can be maintained. This will be challenging, so Fermilab will need to be vigilant in pursuing reliability over the next two years.

The present proton plan has been effectively implemented. Recently weekly rates of approximately 7×10^{18} protons on target indicate that the design goals can be met. Fermilab is to be commended for taking a proactive approach to tritium mitigation. The reviewers were impressed with the success in minimizing radiation dose to personnel working on the NuMI horn repair.

The D-Zero collaboration supplies 20 FTE/year to man shifts. This may be a burden in the last running years, though reductions in shift-taker per shift may increase data losses due to lack of recent experience by shifters.

D-Zero has been successful in retaining greater commitment to the program than expected. Manpower is expected to be adequate for operations through the running period, though the individual burden will almost double in the final year of data-taking. Manpower tracking by individual associated with each service task, not currently implemented, might be a useful tool in insuring coverage of all necessary tasks for the balance of Run II.

The CDF experiment is to be commended for its effort to reduce the shift load on collaborators. This shift burden is likely to be tolerable through the completion of Run II.

Some routine maintenance tasks for CDF are being transferred to lab support organizations. This is a reasonable approach to reducing the service task burden. Manpower tracking by individual associated with each service task, not currently implemented, might be a useful tool in insuring coverage of all necessary tasks for the balance of Run II.

The computing budgets planned are consistent with other experiments with large data sets. The detailed breakdown into budget components appears to be reasonable. The planned roll off of funding, in light of the current reprocessing plans of the experiments, is also reasonable. Resource contention has been adequately dealt with. It is not unlikely that the Tevatron experiments and CMS will have spikes in need at different times, allowing significant resource sharing and headroom for peak needs.

Computing Division management is wise to be prepared to support the shrinkage of the experiments' computing expertise base with declining membership. It would be useful to understand in more detail the magnitude of exposure of the computing professional staff.

Computing Division management has been ahead of the curve in recognizing, and dealing with, power and cooling issues. Continued vigilance and planning on the infrastructure needs of computing is required. By careful planning, computing management has thus far avoided issues, which have affected other labs.

MiniBooNE shift coverage may prove problematic now that operations will not be shared with SciBooNE.

RECOMMENDATIONS

- Lab management is urged to keep a sharp focus on maintaining the cooling and power infrastructure of the computing facilities.

Planning for the Future of the Fermilab User Facility

FINDINGS

According to current planning, Fermilab will move from having both hadron collider and neutrino user facilities to just neutrino facilities, NOvA and MINERvA. After the shutdown of the Tevatron collider at the end of FY 2009 or 2010, it will be necessary to support the continued analysis of the data taken. In addition, there is the possibility that other uses will be found for the complex of accelerators that make up Fermilab's proton source beyond neutrinos and the upgrade of the proton source complex to support a world class program in intensity frontier physics.

The laboratory expects to save $60 million per year after three years by not operating the Tevatron. The current plan to decommission the Tevatron considered five options for the Tevatron magnets: liquid nitrogen cooling, purging with dry nitrogen gas, purging with dry air, turn off the lights, and bulldozing. Preliminary cost estimates for liquid nitrogen cooling and dry air purging were presented. The detailed labor estimate for removing all the mechanical systems from the tunnel has been completed. The storage or disposal cost of those systems and the electrical system removal estimates will follow in about six months. A partial Tevatron tunnel parts count was presented.

Fermilab prefers to implement the liquid nitrogen cooling option for two years (thru FY 2012); this is the operating mode that is used during the summer shutdown. It will best preserve the equipment for any use identified in the future. After two years, this will be reviewed on how to proceed.

There plan for decommissioning the CDF and D-Zero detectors is based on an immediate decommissioning after the shutdown to where the detectors are safe and stable, followed by a 5-year period when reusable components can be harvested.

The computing plan for Run II support envisions flat effort through FY 2010 which falls slightly in subsequent two years. While computing using the shared resources (i.e. Grid) will be exploited for the Tevatron experiments, it is envisioned that the Tevatron experiments will have specific supported resources for approximately five years after data taking. Archived data are envisioned to be supported for more than ten years.

The experiments are currently producing results at an impressive rate; the projected manpower outlook through FY 2010 appears to be good. Planning of analysis beyond FY 2010 is sketchier, but core analyses are expected to finish within six months with some precision measurements taking up to two years.

The NOvA and MINERvA projects are underway to build two new experiments to run in the NuMI beam at Fermilab.

The NOvA project is scientifically sound and has received approval from the Fermilab PAC, NuSAG and P5, the latter with the proviso that there is sufficient funding in the FY 2009 budget. The experiment has been on hold during FY 2008. A $2M dollar FY07 carryover permits progress to CD-3 in the current year.

Improvements in reconstruction have made significant improvement in ν_e detection efficiency, corresponding to an equivalent 50% increase in detector mass.

MINERvA is a relatively small neutrino experiment designed to make improvements in the precision of many neutrino-nucleus cross sections that are required for the interpretation of next generation neutrino oscillation experiments.

The longer term future of the user facility will rely on the proposed superconducting 8 GeV proton linac, known as Project X. This will provide adequate proton beam power to allow 2 MW or greater beam for neutrino physics as well as a program to study rare processes using the 8 GeV beam.

The R&D for Project X requires the activities of three orthogonal (no personnel or funding overlap), but related programs: High Intensity Neutrino Source (HINS), Superconducting RF Infrastructure (SRF), and the International Linear Collider (ILC).

HINS will address Project X's front end structure with new technologies, which will allow beam power increase to 2 MW at 8 GeV by increasing peak current, pulse length and repetition rate. Its deliverable is a prototype 66 MeV H^- linac at 325 MHz with 1 ms pulse length and 27 mA peak current. HINS will demonstrate acceleration above 10 MeV with spoke cavities, single-klystron multi-cavity RF distribution and control with vector modulators (first time for $\beta<1$), and high speed (ns) chopping at 2.5 MeV.

The current status of HINS is that the MW, 3.5 ms klystron and vector modulator have been successfully operated. The first SC spoke cavity is being tested. RFQ fabrication is complete and is being shipped.

The FY 2008 budget situation has severely impacted the SRF effort. Only the 3.9 GHz cavity studies are currently being pursued.

Project X R&D has the goals of provide the needed support for CD1 in 2010, CD2/3a in 2011, design and develop technical components using as much as possible of the ILC design. The laboratory is putting together a multi institutional collaboration. Project X currently assumes the ILC-like cavity and cryomodule development and procurement is developed outside of Project X.

The future neutrino physics program features θ_{13}, θ_{23} measurements, the study of CPV, and the mass hierarchy. It could begin with a 700 kW beam to DUSEL and could benefit from the 2.3 MW beam available after Project X is built.

There are two competing technologies for the large neutrino detector at DUSEL. A liquid argon TPC of approximately 100 kilotons would have high efficiency and excellent background rejection. It is not yet understood how to build such a large device. A water Cerenkov detector would need to be even larger (300-400 kilotons) due to its lower detection efficiency and poorer background rejection. The technology for this option is well understood.

Several flavor physics initiatives have been mentioned as possible future Fermilab experiments: a search for $\mu^- \rightarrow e^-$ conversion in the field of a nucleus ("mu2e"), a high-precision measurement of the anomalous magnetic moment of the muon ("g-2"), and studies of charged and neutral versions of the decay $K \rightarrow \pi\nu\nu$.

The mu2e experiment was particularly highly rated by P5. It is largely based on the MECO experiment originally conceived to run at the Brookhaven AGS. The g-2 experiment also originated at BNL and much of the apparatus would be physically transferred to Fermilab. The object of the Fermilab experiment would be an improvement in the precision of the measurement made at BNL by about a factor of three.

The charged kaon experiment would be a stopping experiment like BNL E787/949, but placed on a lower energy beam and upgraded in many respects. The neutral kaon experiment would be similar in technique to the KOPIO proposal, but would exploit the superior intensity of Project-X in a number of ways to improve on the former's sensitivity.

To support work on future experiments, Fermilab operates a well-instrumented test beam facility with beams down 500 MeV. It runs 12 hours per day and is available to the international community.

COMMENTS

The reviewers found the prioritization of Tevatron Magnet mothballing approach to be sensible. Liquid nitrogen cooling will assure that the magnets will be ready for restart with no corrosion or other adverse effects. Dry nitrogen purge was considered to be a distant second choice, the reviewers expressed serious concerns about the dry air option, due to the potential for dryer failure as well as the oxidization issues. The process of developing a detailed D&D plan for the Tevatron is off to a good start.

The decommissioning plan for the experiments is still very preliminary. The reviewers raised questions about whether there will be adequate technical expertise available for decommissioning and if new engineering efforts will be needed. There is the possibility that some costs can be defrayed by scrapping material from the detector.

The experiments are aware of the issues involved in decreasing manpower beyond FY 2010. Both experiments are making efforts to streamline and standardize analyses procedures to decrease the reliance on experts. The long term planning, however, has not been very quantitative so far.

Issues of long-term archiving of the data are not being actively pursued by the experiments. This effort should be started relatively soon while the manpower situation is still relatively good. It will become more and more difficult as manpower falls after data taking.

The reviewers recognized the difficulty of maintaining an active program for Project X in view of the uncertain funding for ILC and SRF and acknowledged the efforts made by FNAL personnel to compensate for the uncertainties in funding.

Project X as presented would provide important technical demonstrations for the ILC. However, Project X should be optimized and managed to meet the requirements of the Fermilab neutrino program and not be compromised by other considerations. The 2 MW 8 GeV option for Project X is highly desirable, and the reviewers were pleased to see that the upgrade potential is being maintained. Well-planned multi-institution collaborations and industry involvement for Project X are desirable to distribute the workload without increasing the FNAL workforce.

The most important issue for a large neutrino detector at DUSEL is to understand the limitations on cavern size. The lab presented a LAr TPC R&D plan that showed several stages, ~100 ton and 5000 ton detectors, before the full size detector would be built, but the committee was not presented with a detailed timeline and resources needs. The reviewers understood the function of a 5000 ton detector in the R&D plan, but they were not sure that the scientific return from the 5000 ton LAr detector was adequate in light of the expense of the detector.

The plan presented for mu2e seems to include completely reevaluating all of the elements of MECO. This seems most sensible for the aspects of the accelerators and beamlines that are intrinsically different from the situation at the AGS. The mu2e collaboration should move expeditiously to strengthen collaboration with both domestic and international collaborators.

The g-2 experiment could broaden the Fermilab program in the period after the 2012 shutdown. The reviewers expressed concern that dismantling, re-assembling and bringing up the experiment will be a challenge, and a careful estimate of the time and resources needed to bring the g-2 experiment to Fermilab should be undertaken.

The kaon experiments are seen as possibilities for the Project-X era, but it should be noted that worthwhile progress could be made on these before Project-X is ready. It should also be noted that it will be very difficult to attract a collaboration for these far-future experiments if there is no intermediate experiment of this type. It should also be noted that initiatives to do these measurements in Europe and Japan are not yet quite launched.

The test beam is extremely valuable to the HEP community.

RECOMMENDATIONS

- Complete the detailed Tevatron accelerator D&D estimate by the next S&T review.
- It is recommended that the lab assign responsibility to one person to work with the experiments to flesh out the decommissioning skeleton plan that has been presented.
- It is recommended that the experiments make an estimate of available analysis manpower

- Project X depends on R&D and developments outside the project. Contingency plans should be developed to deal with possible reduction in funds for these other programs (HINS/ILC/SRF), so that the Project can proceed.
- Technical differences between ILC and Project X cryomodules should be investigated early to benefit from the relaxed conditions (HOM filters, gradients), but also to determine if the modified modules and cavities may have some pathological behavior (e.g. multipacting, coupler/cavity electron coupling, field emission coupling, dynamic Lorentz force detuning etc.). This should appear in the Planning for the Accelerator RD&D.
- Develop detailed plans for the R&D timelines and resource needs for mu2e, the large neutrino detector and any of the other experiments discussed if the lab is serious about pursuing them.

ACTION ITEM

The lab management will work with the experiments and computing division to develop a plan for archiving the data. The plan should be presented at the next S&T review.

Effectiveness of Management in Strategic Planning

FINDINGS

Over the last six months Fermilab has had to deal with a major shortfall in the FY 2008 funding and the possibility that FY 2009 will be a continuation of the same. Fermilab management quickly determined that a reduction in staffing that was required to balance the budget. A furlough system was quickly established. The plan for a Reduction In Force has been more difficult to implement. Approximately 65 FTE's have signed up for a voluntary separation, and this may be followed up by a non-voluntary one by end of the fiscal year.

The P5 report was issued May 29, 2008, and Fermilab has accepted this as guidance. However, the laboratory has not had time to put together a detailed R&D plan carry out the recommendations of the report. The graphs and table of resources presented at the review did not explicitly address the those needed to develop the DUSEL beam line, DUSEL detector, and mu2e experiment, but had "available" resource place holders. The funding table had available funds in FY 2011 & FY 2012, while the major manpower was not available until FY 2012. The P5 report assumed DUSEL could start operations in 2017.

The Machine-Experiment Interface Study Group has been constituted to determine the requirements of the various experiments and how they can operate in conjunction with each other.

COMMENTS

The viewers were impressed with how well Fermilab management had dealt with the FY 2008 funding shortfall. The lab continued to function and the Tevatron ran well, despite the impact of the furloughs.

Fermilab management stated that they have accepted the elements of the P5 plan, but there remain significant scope and timing integration issues that the lab will need to address.

Some reviewers found the onsite experimental program after the end of the Tevatron run to be quite narrow. It is dominated by NOvA and mu2e, which are both practically single measurement experiments. It would be wise to look for opportunities to broaden the program within the known budget constraints.

RECOMMENDATIONS

NONE

ACTION ITEM

Put together a detailed FY 2009–FY 2019 Fermilab plan consistent with DOE guidance, and highlight the differences with the P5 report by December 2008.

APPENDIX A

Department of Energy
Office of Science
Washington, DC 20585

MAY 0 1 2008

MEMORANDUM FOR MICHAEL PROCARIO
ACTING DIRECTOR
FACILITIES DIVISION
OFFICE OF HIGH ENERGY PHYSICS

FROM: DENNIS KOVAR
ACTING ASSOCIATE DIRECTOR OF SCIENCE
FOR HIGH ENERGY PHYSICS

SUBJECT: Fermi National Accelerator Laboratory (FNAL) Annual Science and Technology Review

This memorandum is to request that you organize and conduct a Science and Technology Review of Fermi National Accelerator Laboratory (FNAL). This review should appropriately involve the input and participation of the science and technology programs in the Office of High Energy Physics responsible for activities at FNAL.

The research program at the Tevatron Complex, encompassing the Tevatron Collider, the NuMI beam, and all other beams provided to experiments at FNAL, plays a major role in the nation's high energy physics program. As the primary sponsor of U.S. high energy physics research and the user accelerator operations at FNAL, it is important for the Office of High Energy Physics to understand the progress and future potential of the research program, the effectiveness of its operations and whether resources and planning are being directed optimally to achieve the scientific goals of the nation's high energy physics program.

It is requested that your review evaluate:

- The quality and significance of the laboratory's user facility scientific and technical accomplishments, and the merit, feasibility and impact of its planned research program;
- The effectiveness and efficiency of accelerator operations and the planning for future facility upgrades in support of the planned research program;
- The effectiveness of management in strategic planning, developing appropriate core competencies, implementing a prioritized and optimized program, and implementing a safe working environment;
- The leadership, creativity, and productivity of the facility 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.

In the context of these general review criteria there are special circumstances that the laboratory is facing where additional information at this time would be helpful for this office in its planning. In particular, what is the proposed accelerator-based program at the laboratory after the termination of Tevatron operations, what is the timeline and the resources and staffing needed to mount this program, what are the scientific and technical risks associated with the proposed program, and are the available resources for accelerator and detector R&D (General Accelerator Development, SRF and Detector R&D) being optimally used to achieve the planned program.

The review should also comment upon what progress has been made towards addressing action items, if any, from previous Science and Technology Reviews.

I would appreciate receiving the review reports, suitable for transmission to the laboratories, within 45 days after the review.

APPENDIX B

List of Reviewers

Name	Institution
Vernon Barger	University of Wisconsin-Madison
Eugene Beier	University of Pennsylvania
Isadoro Campisi	Oak Ridge National Laboratory
Rod Gerig	Argonne National Laboratory
Laurence Littenberg	Brookhaven National Laboratory
Claus Rode	Thomas Jefferson National Accelerator Facility
Michael Tuts	Columbia University
Bill Wisniewski	Stanford Linear Accelerator Center
Rik Yoshida	Argonne National Laboratory