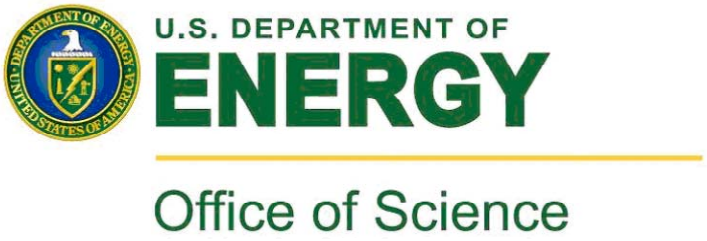

Department of Energy
Office of Nuclear Physics Report

on the

Biennial Science and Technology Review

of the

Thomas Jefferson National Accelerator Facility (TJNAF)

May 9-11, 2012

Executive Summary

The Department of Energy (DOE) Office of Nuclear Physics (NP) held a Biennial Science and Technology (S&T) Review of the Thomas Jefferson National Accelerator Facility (TJNAF or JLab) at TJNAF on May 9-11, 2012. TJNAF is a DOE facility operated under contract with the Jefferson Science Associates, LLC (JSA). The primary purpose of the review was to evaluate the quality, performance, and significance of the ongoing and planned TJNAF program, in the context of the Nuclear Science Advisory Committee (NSAC) Long Range Plan for Nuclear Science and the national Nuclear Physics Program. The review is also used to assess the activities of TJNAF as required under the JSA / TJNAF Performance-Based Contract with the DOE. The S&T review examines all supported research and development activities carried out by the Laboratory as well as the facility operations that support those activities.

The primary goal of TJNAF is to carry out a high quality research program in nuclear physics that addresses fundamental questions regarding the physics of strongly interacting particles (hadrons), as described by the theory of quarks and gluons, quantum chromodynamics (QCD). The Continuous Electron Beam Accelerator Facility (CEBAF) at TJNAF produces a high current, highly polarized, electron beam with a 100% duty factor that can be simultaneously delivered to the three existing experimental halls (Halls A,B and C), which contain extensive detector instrumentation. TJNAF has technical core competencies in superconducting radio frequency (SRF) cavities, intense polarized electron beams, energy recovery linacs (ERLs) and high power free electron lasers (FELs), polarized sources, and cryogenic facilities. Non-nuclear physics related programs include the 10 kW infrared FEL (1 kW in the ultraviolet) supported by the Department of the Navy. There is effective sharing of expertise between CEBAF and the FEL that provides clear benefits to both facilities.

The Laboratory can be credited with many significant scientific advances in the "6 GeV era" since the previous (2009) review. The CEBAF Large Acceptance Spectrometer (CLAS) collaboration (Hall B) has successfully carried out an experimental study of baryon resonance photo-production, which have led to the announcement of several new N* resonances. A few other notable results from recent 6 GeV experiments include the observation that the strange quark contributions to the proton elastic electromagnetic form factors are quite small; short range multinucleon correlations have been observed as plateaus in electron-nucleus scattering at x>1; generalized parton distributions (GPDs) and related parton distribution functions have been quantified in an initial set of experiments. The Lead Radius Experiment ("PREX") has confirmed the existence of a neutron halo in Lead-208 (^{208}Pb). The Q_{weak} experiment is expected to announce a new, accurate result for the Weinberg angle at low energy, in a search for evidence of physics "Beyond the Standard Model" (BSM).

The Laboratory has now completed data taking in the 6 GeV era, and will undergo a sixteen-month shutdown to allow a transition to running at higher beam energy in the subsequent 12 GeV era.

The lattice QCD (LQCD) theory effort has made impressive advances, crucial for the planning of aspects of the future 12 GeV upgrade experimental research program. An LQCD code "CHROMA" that was developed and maintained by the TJNAF LQCD group now has the largest user base of all codes in the LQCD community. The LQCD group has been innovative; they have developed new techniques (*e.g.* distillation) that allow the interpretation of the structure of excited hadrons, and have led the use of new computing architectures in LQCD, notably GPU based resources. The LQCD group effectively interfaces with the TJNAF experimental programs, in particular the GlueX program.

The non-LQCD component of the theory effort at TJNAF addresses a wide range of research topics, including two-photon contamination of nucleon electromagnetic form factor measurements; studies of parity-violating electron-proton scattering and the determination of the Weinberg angle at TJNAF energies; development of the theory of parton distributions functions (GPDs and TMDs); and the implementation by the Excited Baryon Analysis Center (EBAC) group of a coupled channel approach for analyzing data on meson electro- and photo-production (EBAC). In view of the extensive participation in the TJNAF science program anticipated for the Theory Group in the 12 GeV era, it was recommended that a plan be developed which identifies theoretical needs and articulates the role that the Theory Group will play in addressing those needs.

The Accelerator Operations, Research & Development Division and the Experimental Nuclear Physics Division are congratulated for the excellent accelerator operation performance and the technical support of the experimental program. The CEBAF achieved 6 GeV in beam energy operation due to the successful C50 cryomodule upgrade, and exceeded its operational target goals in terms of beam polarization and intensity, availability, and efficiency. The Laboratory's work on SRF cavities and polarized electron sources is recognized as world-class throughout the national lab complex and worldwide. The initial results for high-Q cavity development are impressive. Two out of ten new C100 cryomodules needed to achieve 12 GeV beam energy CEBAF operations have been installed and successfully operated in the accelerator, and production of the remaining cryomodules is well underway.

Laboratory management is strong with clear scientific vision. Management has done an excellent job in completing the 6 GeV program and preparing for the 12 GeV era. Careful prioritization of resources will be crucial to complete the 12 GeV CEBAF upgrade project and optimize physics output during the early scientific phase. There remain uncertainties in the implementation of experimental instrumentation for the early 12 GeV science program that need to be managed flexibly in light of constrained budgets. For the next generation of instrumentation projects, like Møller and SOLID, no funding source has yet been identified and community expectations need to be managed carefully. The user community appears generally satisfied with the decision-making process that is used by management to plan and execute the science program. The Laboratory has successfully responded to all previous recommendations.

The Laboratory's plans beyond the 12 GeV program are based on a medium-energy electron-ion collider (MEIC). The MEIC technical design is challenging and requires significant advances in design, simulation, and experimental verification of key features.

Contents

Introduction

On May 9-11, 2012, the Office of Science for Nuclear Physics performed a biennial Science and Technology (S&T) Review of the Thomas Jefferson National Accelerator Facility (TJNAF or JLab) in Newport News, Virginia. The review panel consisted of seven external peer review experts: Professor James Napolitano (Rensselaer Polytechnic Institute), Professor Bradley Filippone (Kellogg Radiation Laboratory), Dr. Jianwei Qiu (Brookhaven National Laboratory), Dr. Oliver Bruning (CERN, European Organization for Nuclear Research), Dr. Thomas Luu (Lawrence Livermore National Laboratory), Professor William Zajc (Columbia University), and Dr. James Symons (Lawrence Berkeley National Laboratory). Dr. Ted Barnes, Acting Program Manager for the Medium Energy Nuclear Physics Program chaired the review. Dr. Jehanne Gillo, Director of the Facilities and Project Management Division was responsible for the review. Dr. Timothy Hallman, Associate Director of the Office of Science for Nuclear Physics; Mr. James Hawkins, Program Manager for Major Initiatives; Dr. James Sowinski, Program Manager for Nuclear Physics Facilities; Dr. Manouchehr Farkhondeh, Program Manager for Advanced Technology Research and Development; Dr. George Fai, Program Manager for Nuclear Theory; and Dr. Helmut Marsiske, Program Manager for Nuclear Physics Instrumentation also attended the review.

The primary purpose of the review is to evaluate the quality, performance, and significance of the ongoing and planned TJNAF program, in the context of the Nuclear Science Advisory Committee (NSAC) Long Range Plan for Nuclear Science and the national nuclear physics program. In order to perform the review, each panel member was asked to evaluate and comment on any relevant aspect of the science and technology at the TJNAF, facility operations and strategic planning. Specifically, the focus of the S&T Review was on understanding:

- The quality and significance of the laboratory's scientific and technical accomplishments and the merit, feasibility, and impact of its future planned physics program;
- The effectiveness and appropriateness of facility operations and the planning for future facility upgrades in support of the research program;
- The effectiveness of management in strategic planning, developing appropriate core competencies, implementing a prioritized and optimized program, and promoting and implementing a safe work environment;
- The leadership, creativity, and productivity of the facility's scientific and technical staff in carrying out the above activities; and
- The quality and appropriateness of the laboratory's interactions with, and nurturing of, its scientific community.

In addressing these charge elements, the reviewers were also asked to assess what progress had been made towards addressing action items from the previous S&T Review and previous Facility Operations Review.

The review was based on formal presentations given by the TJNAF staff, reports from the Program Advisory Committee (PAC) and the Users' Group, and discussions with TJNAF staff and users. The first two days were devoted to presentations given by TJNAF staff. These presentations provided an overview and formal response to the charge letter. The third day included a question and answer session with staff management, and panel deliberations. The panel discussed the results of the review with Director Hugh Montgomery, TJNAF staff, and Jefferson Science Associates, LLC (JSA) representatives in a closeout briefing on Friday, May 11, 2012. The panel members were asked to submit their individual evaluations and findings in a "letter report" covering all aspects of the TJNAF program. The executive summary and the accompanying recommendations are based largely on the information contained in these letter reports. A copy of the charge letter and the agenda are included in Appendix B and Appendix C, respectively.

DOE Recommendations

- Develop a plan for the Theory Group which identifies the theoretical efforts needed to support the 12 GeV science program, articulates the role that the Theory Group will play in addressing those needs, and defines goals for how to implement the plan, within constrained budgets. The plan should include lessons-learned from the 6 GeV program. Submit to DOE by July 2013.

Scientific Program

Experimental Program

Findings:

Data taking for the 6 GeV program has been completed, with each of the scheduled experiments acquiring nearly all of their anticipated data, and significant DOE milestones having been met (*e.g*. HP3-7, HP11). Two experiments that involved major installations have been completed in Hall C: the Hypernuclear Spectroscopy Experiment E01-011 (HKS) experiment and the Q_{weak} experiment. The Q_{weak} data should provide the most precise measurement of the electroweak Weinberg angle below the mass of the Z boson.

The program to determine the strangeness content of the proton has been completed, and gives very stringent constraints on the contribution of strangeness to the charge and magnetic form factors. In addition, new results from inclusive scattering from a range of nuclei have identified intriguing evidence for short-range correlations at large values of Bjorken x and have provided indications that the nuclear European Muon Collaboration (EMC) effect may be correlated with the local nuclear density. First results were presented on the possible role of transversity in semi-inclusive scattering from a polarized neutron (via $3\overrightarrow{He}$).

Results from the Continuous Electron Beam Accelerator Facility (CEBAF) large acceptance spectrometer (CLAS) in Hall B on baryon formation in photo-production have been critical in establishing the existence of a few "missing baryons." The CLAS data, when contributed to the database used in the Bonn-Gatchina amplitude analysis, leads to at least two "three star" baryon resonances that are inconsistent with the quark-diquark model of baryon excitations. Progress has been made with CLAS towards mapping out multidimensional generalized parton distributions with polarized beams and targets.

Plans for three experimental concepts are being developed to search for new light vector bosons beyond the standard model.

The MOLLER experiment, which proposes to measure the parity-violating asymmetry in electron-electron (Møller) scattering, has passed an internal director's review and has been rated highly by the Program Advisory Committee (PAC).

Comments:

The TJNAF science program is having a significant impact on the field of Nuclear Physics. As one example, in spectroscopy the physics of confinement is being attacked, both experimentally and theoretically, through high performance computing coupled with innovations in Lattice quantum chromo dynamics (QCD). As another example, parity violation measurements at TJNAF have become reliable to the extent that they are now a critical tool for testing fundamental symmetries (*e.g.* Q_{weak}) and for contributing to related fields such as nuclear astrophysics (*e.g.* PREX).

The Laboratory did not present the Hall D physics program in detail. For a program which played such a large role in justifying the 12 GeV upgrade, only superficial evidence was given for the preparedness to begin taking data.

The CLAS experimentalists seem to work well with the Excited Baryon Analysis Center (EBAC) program in developing an analysis protocol for extracting baryon resonance parameters, albeit a very model dependent one based on an effective Lagrangian approach. However, the Bonn-Gatchina analysis has had the first successes in incorporating CLAS data to discover missing baryons.

The recently developed program to search for new light vector bosons is an exciting development for the Laboratory which may help explain the g-2 discrepancy.

The MOLLER experiment shows promise to test the standard model with a precision measurement of the weak mixing angle.

An approach that exploits the complementary technical capabilities of all the Halls for particular sub-programs, such as the semi-inclusive deep inelastic program, has the potential to optimize the physics output. The Laboratory might consider whether other programs would benefit from cross-hall optimization.

The community studying generalized parton distributions should improve its effort in elucidating the discovery potential of this field. This could include clearer demonstration of the data quality that results from at least one particular experiment, presumably using some configuration of the medium-energy electron ion collider (MEIC) concept.

Recommendations:

- None

Theoretical Program (not LQCD specific)

Findings:

The director of the Theory Center presented the Center's organization and highlighted selected research activities. The Theory Center has fourteen senior staff and joint faculty plus a number of associate faculty members, postdocs, and graduate students. The research at the Theory Center covers a broad range of topics, including parity violating electron-proton scattering, generalized parton distributions (GPDs), transverse momentum dependent parton distribution functions (TMDs), properties of excited baryons, spectra of the N* and Δ*, masses of hybrid mesons and exotics, and a coupled channel approach for analyzing data on meson electro- and photo-production. The Theory Group has made contributions to the understanding of precision parity violating electron-hadron scattering and the extraction of the value of $\sin^2\theta_W$.

The Theory Center has been supporting an EBAC, which uses a coupled channel approach to determine the baryon resonance spectrum from TJNAF data on meson

electro- and photo-production. The Theory Center has plans to evolve the EBAC into a JLab Physics Analysis Center, with a fixed term postdoc to lead the effort on the study of TMDs, and a fixed term postdoc to lead the effort in QCD global analysis in spin-dependent PDFs. In addition, the Center plans to hire a new Staff member to lead the effort on Amplitude Analysis.

Comments:

The Theory Center, which is the largest nuclear theory group supported by the Office of Nuclear Physics (NP), has a broad research program. The majority of its research topics are in close connection with and in support of the experimental program at CEBAF. Important contributions have been made to the determination of nucleon electromagnetic form factors from scattering data through the identification of two-photon contributions.

The Theory Group proposes to establish a JLab Physics Analysis Center to develop tools to help interpret the vast amount of data anticipated in the 12 GeV era. Strengthening the QCD global analysis effort at JLab could provide much needed help to experimental groups in analyzing data from polarized targets in the 12 GeV program. If JLab plans to be competitive with well-established groups that have been working on the QCD global analysis of spin-dependent PDFs, then the group would likely need to focus on developing sufficient expertise within available resources.

Many newly approved experiments in the era of the 12 GeV upgrade will try to explore the landscape of the nucleon by extracting TMDs and GPDs from measurements of SIDIS or exclusive diffractive cross sections. The Theory Center could consider taking a leadership role in this new and exciting research area.

There was little discussion on how the Theory Center is positioning itself to provide the much needed phenomenological help in the analysis of experimental data to be collected by GlueX.

The EBAC is attempting to interpret the existing data on meson electro- and photo-production in terms of a coupled channel approach, and to derive the excited N* and Δ* spectrum. However, due to the large number of fitted parameters, it is difficult to assess their significance. This group might consider exploring possible connections between their coupled channel approach and the more systematic QCD effective field theory approach.

Recommendations:

- Develop a plan for the Theory Group which identifies the theoretical efforts needed to support the 12 GeV science program, articulates the role that the Theory Group will play in addressing those needs, and defines goals for how to implement the plan, within constrained budgets. The plan should include lessons-learned from the 6 GeV program. Submit to DOE by July 2013.

Lattice Quantum Chromo Dynamics (LQCD)

Findings:

The presentations which discussed the lattice theory effort highlighted their recent science results in determining the meson spectrum (including exotics), the excited baryon spectrum, meson-meson scattering phase shifts, the Sivers Distribution Function, orbital contributions to nucleon spin, and baryon-baryon systems.

The lattice theory effort presented their recent code/algorithm developments for Graphics Processing Unit (GPU)-based architectures, highlighting their multi-GPU scaling results for matrix inversion and weak-field gauge-configuration generation.

The Chroma code, developed and maintained at JLab, now has the largest user-base of all LQCD codes within the international lattice community.

The collaboration between the lattice theory group and the GlueX experimental program is highlighted in the PAC36 report, which states that the recent progress in JLab's Lattice QCD calculations serve to ". . .reaffirm the motivation and provide strong theoretical support for the (GlueX) experiment."

Comments:

The lattice theory group continues to execute sound and high impact research, as was recently acknowledged by the presentation of the Ken Wilson Lattice Prize and a DOE Early Career Award to group members.

The lattice theory group's connections with JLab's experimental programs are strong, particularly with the GlueX program. The synergistic activities and this model of collaboration between the theory group and JLab's experimental programs are commendable. The lattice theory group's contribution to the larger lattice community is significant, as is evident by Chroma's large user-base community. The lattice theory group plays integral and leadership roles within the U.S. lattice community, with members serving on the U.S. QCD executive and program committees.

The thrust on developing algorithms for hybrid technologies, such as GPU-based architectures, is the result of a strong working relationship between the high performance computing group and the lattice group at the Laboratory.

With the various emerging High Performance Computing (HPC) architectures coming on line in the near future, the demands by the lattice community for Chroma support and adoption of these architectures will grow significantly. Preparation for this enhanced demand would be prudent.

Recommendations:

- None

Facility Operations and Planning for Future Facility Upgrades

Facility Operations, Staff and SRF

Findings:

The Laboratory operates two independent Superconducting Radio Frequency (SRF) installations: CEBAF and the JLab Free-Electron Laser (FEL). The CEBAF facility has a dedicated operation team for a 24/7 operation of the facility with 3 person strong shift crews and 8-hour shifts.

The light source is a THz 4th generation light source and provides infrastructure for a novel electron beam cooling experiment, a Free-Electron Laser with an Energy Recovery Linac (ERL). The FEL facility has an independent operation crew. The operation of the FEL facility is financed by external funds and its operation is resource limited. It runs from 7 a.m. to 6 p.m. 5 days per week for 25 to 30 weeks per year.

The C50 upgrade of the 10 lowest performing cavities provided 6 GeV running for the first time.

Comments:

Accelerator performance and beam delivery are world class at TJNAF. Leadership is clear, and the organization for operations, maintenance, and upgrades is well thought out and strives for continual improvement.

The CEBAF facility reached the impressive completion of its 18 year CEBAF program. The initial program was based on 4 GeV beam operation, but the final performance was pushed to 6 GeV beam energies thanks to the high performance of the SRF system. The operational achievements of the initial CEBAF run are impressive (85% polarization, up to 90% availability and 80% efficiency) and exceed the target goals for the CEBAF operation.

The simultaneous delivery of a controlled 23 pA to Hall B while delivering 180 μA to Hall C is a significant technical achievement.

The SRF expertise is a core competency of the Laboratory that has very effectively supported the mission both of JLab and other national laboratories.

The results for high Q_0 cavity development are impressive and encouraging. Increasing the Q_0 value of SRF cavities by a factor four due to changes in the treatment procedure (high temperature bake out) can significantly increase the operational efficiency of future projects (reduced cryo power). Thoroughly understanding the underlying processes for these performance achievements may merit a high priority in future SRF studies.
The inverted source design with a load lock system and the utilization of Nb cathodes for polarized electron sources allows for a source with high voltage cathodes and improved cathode lifetimes and beam quality.

The FEL team demonstrated an impressive understanding of beam dynamic issues in FELs with re-circulating linacs (CSR and Space Charge -> kW photons in THz regime).

Recommendations:

- None

Future Facility and Instrumentation Upgrades

Findings:

The CEBAF facility is undergoing an upgrade from 6 GeV beam operation to 12 GeV operations by the installation of 10 additional new, high gradient SRF cryo modules, one arc, and the addition of a new experimental hall. Two of the ten new C100 cryo modules have been installed during the six month long shutdown between FY 2011 and FY 2012. The new C100 cryo modules were commissioned and tested during the FY 2012 operation and performed up to specifications while producing parity quality beam parameters during a half day test April 29, 2012. Most of the C100 SRF modules performed above 25MV/m (CW). Some of the cavities went up to 35MV/m with a record performance of 46MV/m.

JLab is pursuing several R&D studies for potential future projects (e.g. MEIC, high energy electron cooling, Large Dynamic Range beam instrumentation [beam profile measurements], polarized electron sources, polarized positron sources.)

A polarized target magnet which was contributed by outside collaborators failed in Hall-A, and required a concerted effort by the technical group to substitute an in-house target from Hall-B. It should be noted that this is a near-repeat of a Finding from the 2009 Review.

The R&D effort on radiation hardness of Silicon Photomultipliers (SiPM's) has produced a good understanding of the effects and expected lifetimes. This work is relevant both to GlueX and to electron ion collider (EIC) detector design.

The JLab PAC has approved various experiments for the 12 GeV program with beam time allocations in excess of 3000 "PAC days." Even allowing for fully parallel operation of the experiments, this represents a decade of approved experiments, with more anticipated.

There remain some uncertainties in the implementation of needed instrumentation for the early 12 GeV science program. Operational funds are needed for Hall A instrumentation, and capital equipment funds for the completion of SBS. Hall C instrumentation requires modest capital equipment funds for the polarized He-3 target; Hall B instrumentation relies on support from foreign institutions and funding has not yet been identified for all desired equipment.

The Laboratory has been developing a strategy for instrumentation for Hall A and has been given approval to start the fabrication of the SuperBigBite Spectrometer. In the longer term, the Laboratory proposes the Moller Experiment as well as the SoLID experiment.

Comments:

Beginning the 12 GeV era with a 10-year backlog on the books will require deft scientific management to develop a sequence of experiments for Years 1-3 that optimizes physics output within available resources.

It will be important to manage community expectations for ambitious projects such as SoLID and MOLLER that are approved by the PAC, but not the funding agency. It would be useful to consider what steps could be taken to optimize the physics reach of such large acceptance devices as SoLID across a broad variety of physics topics.

The Laboratory seems to have a good understanding of where the uncertainties remain in the implementation of the early science instrumentation, and are engaged with the experimental hall groups in the realization of the equipment. It will be important for the Laboratory to remain flexible in these goals as budget constraints will likely influence these instrumentation plans.

The installation and commissioning of two of the C100 cryo modules during a six month long shutdown in FY 2011-FY 2012 provided an excellent test bed for the installation and commissioning procedures. The experience gained from this first upgrade step provides confidence in the accelerator upgrade.

Beam halo is one of the limiting factors for high current CW Linear Accelerators (LINACs). Pushing the performance of CW LINACS requires large dynamic range (LDR) imaging. The R&D studies for LDR imaging therefore offer a vital investment for future high current CW LINACs.

The development of a Crab cavity system that is compatible with the operation in a hadron storage ring (low noise requirements) offers synergies with similar other projects (e.g. Large Hadron Collider, or LHC) where collaborations with other laboratories (LARP) could be explored.

The proposed studies for a Polarized Electron beam based Polarized Positron source seem interesting; however, the applicability to the existing and planned JLab accelerator complex was unclear.

The MEIC proposal seems to be maturing, and should include a detailed magnet design and consideration for the re-use of existing superconducting magnets. The design of a Figure-8 ring layout is based on the expected intrinsic compensation of the spin procession (vanishing total bending angle along the machine). A verification of these expectations with simulation studies that include realistic magnet and optics errors and acceleration are essential requirements for further project development.

Electron beam cooling is a vital ingredient for the MEIC proposal. The proposed demonstration experiment in the JLab FEL facility requires a demanding bunch deflection system. Related studies might benefit from collaboration with other projects that have similar requirements (e.g. Compact Linear Collider Test Facility (CTF3) combiner ring).

An essential and critical component in establishing the scientific case for the MEIC will be sensitivity analyses in which the high profile physics signals are extracted from simulated data incorporating appropriate detector resolution effects.

Recommendations:

- None

Scientific and Technical Staff

Comments:

The impressive list of awards garnered by the researchers associated with the Laboratory indicates their leadership and visibility in the nuclear physics community. The JLab staff seems to be very well integrated into the international community as illustrated by the broad range of collaborations and international projects it is involved in, both technical and scientific.

The JLab experimental staff plays lead roles in the development, implementation, and data analysis of both the 6 GeV and 12 GeV programs. The panel was impressed with the presentations from the junior staff. The impressive operational track record for the 6 GeV operation period reflects an efficient and productive operation setup. The existing operation team represents therefore a key ingredient for a fast commissioning and efficient operation of the new 12 GeV project phase.

The SRF developments, FEL, ERL, and source studies illustrate the scientific creativity and productivity of the JLab staff.

The ability to attract recognized leaders from other institutions indicates that the Laboratory provides an attractive work environment combined with excellent scientific opportunities.

The theory and HPC staff continue to carry out a strong research program in QCD and hadron physics, and has been active in organizing influential International Workshops locally at JLab as well as elsewhere. The efforts to organize or bring major international workshops to JLab are commendable.

Recommendations:

- None

Scientific Community

Findings:

User interactions are coordinated by a formal user group under the auspices of JSA. The organization advocates for user interests with regular input to management and representation on the PAC. JLab management works closely with the PAC to optimize the scientific program.

The Users Group is active and has organized users meetings, evaluated proposals, participated in a science exhibition on Capitol Hill, and selected a winner of the 2012 Postdoc Prize.

Comments:

The User Group seemed generally pleased with their interactions with the Laboratory. Management interactions with the user organization seem effective. The User Group noted a number of user concerns of which they are addressing with the Laboratory, such as data transfer, user space, and health insurance. The topic of computing and data exchange was identified as an area which required additional management attention.

JSA support of the User Group has a positive impact on their productivity.

The CEBAF operation team is responsive to the user community.

Recommendations:

- None

Management

Findings:

JLab prepares a formal 10 Year Laboratory Plan annually and submits it to the DOE Office of Science. In addition, management organizes many internal planning exercises, in close cooperation with the user community.

JLab has developed core competencies in superconducting RF and many other key technologies needed for medium energy electron scattering experiments, especially polarized targets and ion sources.

JLab is working closely with Brookhaven National Laboratory and the user community to develop the scientific case for an Electron Ion Collider.

Integrated Safety Management is the basis for an effective and rigorous safety program. Some increases in accident rates have occurred during the 12 GeV construction project.

Comments:

Recommendations from the 2009 S&T review have been addressed in full.

Management of the Laboratory is strong with clear scientific vision. The Directorate is deeply engaged in all aspects of the Laboratory activities including strategic planning, accelerator operations, project management, scientific direction, and safe operations. Since the last S&T review, the Director has strengthened the leadership team including a number of very strong hires from outside the Laboratory.

Laboratory leadership has enabled the staff to effectively carry out the 6 GeV program, utilize the Six Month Shutdown, and prepare for the Long Shutdown and subsequent 12 GeV program. Extraordinary efforts have been made to maximize the scientific output of the 6 GeV program by careful optimization of the schedule of the 12 GeV project. It is reassuring to see that an organizational structure has been put in place for the management of the Long Shutdown for the 12 GeV CEBAF upgrade.

Substantial investments have been made in LQCD and the GlueX experiment in Hall D. This is a great opportunity for discovery at JLAB, which has been recognized by many scientific panels and will require continued management attention.

JLab's leadership in SRF technology, polarized sources, polarized targets, and instrumentation has resulted from long-term management attention to these core competencies.

Management has used Scientific Laboratory Infrastructure (SLI) support and other funds very effectively to solidify its core competence and world leadership in SRF technology.

The JLab safety program regularly ranks in the top two or three Office of Science Laboratories according to established metrics. The Safety Officer has full and proactive support of the Directorate.

The implementation plans of the 12 GeV early science program assume growth in the workforce, as well as investment in infrastructure, operations, and instrumentation. In a time of budget austerity for the DOE Office of Science, careful optimization and prioritization of the experimental program within available funds will be essential as the Laboratory completes the upgrade and begins the 12 GeV era.

In order to make a compelling science case for the EIC, the community will need to elucidate the scientific opportunities in the next Long Range Plan, in the context of specific facility designs.

Recommendations:

- None

Appendix A: Action Tracking

2009 S&T Review

Item	Recommendation/Action	Response by Thomas Jefferson National Accelerator Facility	DOE Comment
1	Formulate a plan to mitigate the risks associated with not having produced and tested a full 12 GeV cryomodule, in the context of recent cryomodule performance, and present it at the upcoming Lehman Review of the 12 GeV project.	The response to this recommendation was presented at the September 2009 DOE OPA Independent Project Review (IPR) of 12 GeV.	Action is closed.
2	Prepare a laboratory staffing plan for all activities extending into the 12 GeV era that also includes the past staffing history since FY 2004. This plan should be submitted to Department of Energy (DOE) Office of Nuclear Physics by October 13, 2009.	The staffing plan was presented to DOE on November 9, 2009.	Action is closed.

2010 Facility Operations Review

Item	Recommendation/Action	Response by Thomas Jefferson National Accelerator Facility	DOE Comment
1	Provide a plan to DOE that describes the implementation plan and proposed NP funding support of the TEDF by May 1, 2011.	Response provided April 13, 2011.	Action is closed.
2	Develop a plan for Hall A physics that articulates the scope, goals, schedule and resources needed to implement a physics program for Hall A in the 12 GeV era. Submit to DOE by May 1, 2011.	Response provided April 13, 2011.	Action is closed.

3	Work on the Super Big Bite spectrometer may not proceed with base funding until a path forward for supporting these activities has been identified and agreed upon with NP.	Proposal submitted to NP in February 2011.	Action is closed. Subsequent to a DOE project review, approval has been given to TJNAF to commence the experiment.
4	Prepare a document which identifies and justifies the needed resources and changes of those resources comparing FY 2016 to FY 2004 for all of the B&R accounts covered by this review. A template will be provided by the Office of Nuclear Physics. This should be submitted to Department of Energy (DOE) Office of Nuclear Physics by May 1, 2011.	Response submitted to NP April 13, 2011.	Action is closed. This presentation and subsequent interactions led to an understanding and agreement of staffing transition and planned. NP supports an ultimate ramp up to 400 FTEs after 12 GeV project completion under current budget environments.
5	Identify increments for additional funding above constant effort and prioritize them. Identify increments for staffing above FY 2004 levels and prioritize them. Submit to DOE by May 1, 2011.	Response submitted to NP April 13, 2011.	Action is closed.

Appendix B: Charge Memorandum

Thank you for agreeing to participate as a panel member for the biennial Science and Technology (S&T) Review of the Thomas Jefferson National Accelerator Facility (TJNAF) that will take place at TJNAF on May 9-11, 2012. A list of the members of the review panel and anticipated Department of Energy (DOE) participants is enclosed.

The TJNAF research program, based around the Continuous Electron Beam Accelerator Facility (CEBAF), plays a major role in the Nation's nuclear physics program. As the primary sponsor of U.S. nuclear physics research and the operations of TJNAF, it is important for the Office of Nuclear 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 nuclear physics program.

In carrying out this charge, each panel member is asked to evaluate and comment on:

- The quality and significance of the laboratory's scientific and technical accomplishments and the merit, feasibility, and impact of its future planned physics program;
- The effectiveness and appropriateness of facility operations and the planning for future facility upgrades in support of the research program;
- The effectiveness of management in strategic planning, developing appropriate core competencies, implementing a prioritized and optimized program, and promoting and implementing a safe work environment;
- The leadership, creativity, and productivity of the facility's scientific and technical staff in carrying out the above activities; and
- The quality and appropriateness of the laboratory's interactions with, and nurturing of, its scientific community.

The review should also comment on what progress has been made towards addressing action items from the previous Science and Technology Review and Facility Operations Review.

The first two days will consist of presentations by the laboratory, and executive sessions. The third morning will be used for an executive session and preliminary report writing; a brief close-out will take place in the early afternoon. Preliminary findings, comments, and recommendations will be presented at the close-out.

Each panel member is asked to review these aspects of TJNAF and write an individual "letter report" on his/her findings. These "letter reports" will be due at DOE two weeks after conclusion of the review. The review will be chaired by Dr. Ted Barnes, Acting Program Manager for Medium Energy Nuclear Physics, Office of Nuclear Physics. As Chair, he will collate the comments and recommendations from these "letter reports" and compose a final summary report based on the information in the letters. We take care to keep the identity of the reviewers confidential in the summary report. It would be

convenient if you would prepare your response in a form suitable for transmittal to the proponents devoid of potentially identifying information. The cover letter may include other remarks you wish to add.

An agenda and background material, as well as travel and housing information, will be sent to you directly from TJNAF. The Laboratory will make word processing and secretarial assistance available during the review. If you have any questions about the review, please contact me at (301) 903-1455, or E-mail: Jehanne.Gillo@science.doe.gov or Dr. Ted Barnes at (301) 903-3212, or E-mail: Ted.Barnes@science.doe.gov. For logistics questions, contact Ms. Pat Stroop at TJNAF at (757) 269-7553 or E-mail: stroop@jlab.org.

I greatly appreciate your willingness to assist us in this review. This is a very important process, and it helps to insure the highest quality scientific program at TJNAF. I look forward to a very informative and stimulating visit.

Sincerely,

Jehanne Gillo
Director
Facilities and Project Management Division
Office of Nuclear Physics

Enclosure

Appendix C: Agenda

Science & Technology Review
Thomas Jefferson National Accelerator Facility
May 9th–11th, 2012
Agenda

Wednesday May 9th (F113)

8:00	Executive Session/Continental Breakfast	
9:00	DOE Introduction	T. Hallman/J. Gillo
9:05	JSA Welcome	J. Draayer
9:15	Laboratory Overview	H. Montgomery
9:30	Scientific Overview	R. McKeown
10:15	Experimental Nuclear Physics	R. Ent
11:00	Break	
11:30	Accelerator Overview	A. Hutton
12:15	Theoretical Physics	M. Pennington
1:00	Lunch (B207)/ Executive Session (F113)	
2:30	The 12 GeV Project – Status and Schedule	C. Rode
2:55	FEL Status and Plans	G. Neil
3:20	Medium-energy Electron Ion Collider (MEIC) Physics	P. Nadel-Turonski
3:45	Medium-energy Electron Ion Collider (MEIC) Machine	Y. Zhang
4:10	Modernization, Sustainability and Cost Improvements to Enhance Scientific Productivity	M. Dallas
4:30	Break	
4:40	Users Group Report	Z. Meziani
5:00	PAC Report	N. Makins
5:20	Executive Session	
6:30	Reception followed by Dinner, CEBAF Center	

Thursday, May 10th (F113)

8:00	Report on Experimental Facilities and Operations Metrics	J. Gomez
8:45	Accelerator Operations	A. Freyberger
9:30	Long Shutdown Plan	F. Pilat
9:45	Break	

Breakout Session Ia: Accelerator S&T (L102/104)

10:00	SRF Program (R&D, production, include TEDF)	R. Rimmer

10:45	Studies of Niobium Material Properties	G. Myneni
11:10	World Record Q_0 for Ingot Niobium Cavity	G. Ciovati
11:30	MEIC Electron Cooling Demonstration at the FEL	E. Nissen

Breakout Session IIa: Nuclear Physics Research (F113)

10:00	New Results on DVCS and GPDs	F.X. Girod
10:45	Transversity	K. Allada
11:10	New Results on x>1 and EMC	P. Solvignon
11:35	Parity Violation Experiments	R. Michaels
12:00	Lunch (B207)/Executive Session (F113)	

Breakout Session Ib: Accelerator S&T (L102/104)

1:30	Beam Diagnostics R&D	P. Evtushenko
2:00	Polarized Electron Beams at CEBAF	M. Poelker
2:30	The PEPPo Experiment	J. Grames

Breakout Session IIb: Nuclear Physics Research (F113)

1:30	Enabling Lattice QCD Calculations using Graphics Processors	B. Joo
1:50	Hall D Spectroscopy	E. Chudakov
2:10	Silicon Photomultipliers	Y. Qiang
2:30	Detector Technology and Applications	D. Weisenberger
3:00	Tour	
4:30	Executive Session	

Friday May 11th (F113)

8:00	Executive Session
9:00	Discussion with Management, if required
12:30	Lunch
2:00	Closeout