U.S. DEPARTMENT OF ENERGY

Office of Science

Department of Energy
Office of Nuclear Physics

Report

on the

Technical, Cost, Schedule and Management Review

of the

Solenoidal Tracker at RHIC (STAR)
Heavy Flavor Tracker (HFT)

November 12-13, 2009

CONTENTS

Executive Summary

On November 12-13, 2009, the Department of Energy (DOE) Office of Nuclear Physics (NP) Facilities and Project Management Division performed a Technical, Cost, Schedule and Management Review of the proposed Solenoidal Tracker At RHIC (STAR) Heavy Flavor Tracker (HFT) project located at Brookhaven National Laboratory (BNL). The review was held at BNL in Upton, New York.

The findings of the review indicate that deficiencies remain (since the Science Review) in fleshing out the science case for the HFT investment, connecting it to all three thrusts of the RHIC physics program. While the panel in general endorsed the choice of a combination of silicon pixel and strip detectors to enhance STAR's heavy flavor physics capability, they could not, in all cases, assess quantitatively how the physics requirements drive the detailed configuration and technical specifications for the instrument. In particular, there was insufficient quantitative demonstration of the degradation of final physics measurements (e.g., v_2 and R_{AA}) if key detector requirements are not met.

The panel endorsed the technology choice of the low-mass monolithic active pixel sensors (MAPS) for the HFT pixel detector (PXL), noting, though, the risk associated with the fact that it would be the first large-scale application of MAPS in a High Energy Physics (HEP)/ NP experiment. The MAPS are being developed by the Institut Pluridisciplinaire Hubert Curien (IPHC) group in Strasbourg, France. Since IPHC is not a STAR collaborator, this needs to be carefully managed and technological knowledge needs to be transferred to other PXL groups, for example, through their enhanced involvement in future in-beam system tests and irradiation tests. Uncertainty remains on the radiation tolerance of current and future versions of MAPS chips, and on its impact regarding single-hit efficiency loss and PXL replacement requirements. Furthermore, there was serious concern about the risks associated with the planned use of high-volume air-cooling and of low-mass aluminum cables. All three issues need to be addressed through tests and/or detailed simulations evaluating the cost-benefit tradeoffs.

The panel generally endorsed the concept of redundant silicon strip detectors (SSD) placed between the PXL and Time Projection Chamber (TPC) detectors, but would have liked to see a quantitative evaluation of the need for redundancy in terms of high-level physics observables. There was concern about the long-term viability of the SSD detector in light of its checkered past and somewhat uncertain future support, as well as a sparsity of detector spares. It is planned to upgrade the SSD readout electronics to be compatible with the STAR DAQ1000 system. The implementation of this should be reexamined so as to further reduce the overall SSD detector readout dead time (from the current 12% at 750 Hz). More generally, an overall cost-benefit analysis of different IST-SSD configurations is requested.

The estimated Total Project Cost (TPC) range is \$14.6 to \$17.5 million; this includes \$3.5M million of contingency and \$2.3 million of redirected labor at BNL and Lawrence Berkeley National Laboratory (LBNL). Contributed (scientific) labor, not included in the TPC, is estimated at \$2.6 million. Project completion (CD-4) is planned for 1st quarter Fiscal Year (FY) 2015. While the current cost and schedule estimates are judged adequate for seeking

CD-1 approval, at lot of project management (PM) work remains before the project can be baselined at CD-2/3. This will require additional, skilled PM effort to be made available to the project on a rather short time scale. In addition, the project team should be strengthened by adding an electronics systems engineer as soon as possible. It would be highly desirable to advance the CD-4 date such that all or at least the PXL part of the instrument could participate in Run-14 data taking. The project team should explore scenarios to enable this, even if the DOE funding profile cannot be advanced.

Prior to seeking CD-1 approval, the requisite project documentation needs to be updated and be streamlined by removing redundant information.

DOE Recommendations

- Studies should be carried through to the final physics measurement, showing the degradation of the final physics significance if key requirements are not met:
    - Give an explicit evaluation of what the loss in low-pT efficiency does regarding the fundamental physics questions relating to flow and energy loss of heavy quarks in the hot-dense medium. Evaluate this loss in terms of current theoretical models and show whether these are well tested by the measurement above ~2 GeV/c or if the loss of statistics at lower pT is a critical loss.

  Report results to DOE prior to scheduling a CD-2 Readiness Review.
- Compare the significance of planned charm and beauty measurement to be done with the HFT to similar measurements expected from the upgraded PHENIX detector. Comment on how significant an advance in theoretical understanding of energy loss and flow for the hot-dense medium the HFT would provide compared to the earlier anticipated PHENIX measurements. Report results to DOE prior to scheduling a CD-2 Readiness Review.
- Develop a plan for a ladder system test as soon as possible, using the available MIMOSA-26 chip, which has the architecture fully validated for the needs of STAR. Report draft system test plan to DOE by December 31, 2009.
- Evaluate the cost, schedule and workforce trade-offs between adding a second layer to the IST and a single-layer IST plus retaining the SSD. Report results to DOE by March 1, 2010.
- Prior to CD-2, develop a grounding and shielding plan.
- The project management team should include an electronics system engineer.
- Prior to seeking CD-2 approval, include additional milestones (at least quarterly) on the project critical path so that performance can be effectively monitored and managed.
- Provide, by institution, an annual breakdown of the project cost into capital, labor costed to the project, requested redirected labor cost, and all contributed labor. Submit to DOE by December 31, 2009.
- Prior to January 31, 2010, the Project Execution Plan (PEP) should be updated to include procedures for ascertaining, establishing agreements, and monitoring the contributed and redirected labor costs, and the strategy for handling associated cost overruns.
- Evaluate the potential risk of design changes resulting from the engineering run and apply the appropriate cost contingency.
- Evaluate areas of the project that could be identified as scope contingency.
- Prior to CD-2, develop a consistent, defensible methodology to calculate project contingency that takes in account documented project risks.
- Increase project management subject matter expert support on the HFT management team.
- Re-evaluate CD-4 deliverables to determine a reasonable list without compromising the planned research.

Introduction

On November 12-13, 2009, the Department of Energy (DOE) Office of Nuclear Physics (NP) Facilities and Project Management Division held a Technical, Cost, Schedule and Management Review of the proposed Solenoidal Tracker At RHIC (STAR) Heavy Flavor Tracker (HFT) project at the Brookhaven National Laboratory (BNL) in Upton, New York. The review committee consisted of five external consultants: Mr. Joseph May (Thomas Jefferson National Accelerator Facility), Dr. Michael Leitch (Los Alamos National Laboratory), Dr. Ronald Lipton (Fermi National Accelerator Laboratory), Dr. Simon Kwan (Fermi National Accelerator Laboratory), and Dr. Cheng-Yi Chi (Nevis Laboratories). The review was chaired by Dr. Helmut Marsiske, Program Manager for Nuclear Physics Instrumentation. Dr. Gulshan Rai, Program Manager for Heavy Ion Nuclear Physics, attended the review as well.

In order to perform the review, each panel member was asked to evaluate and comment on any relevant aspect of the proposed STAR HFT project. In particular, the following main topics were considered at the review:

- The significance and merit of the project's scientific goals;
- The status of the technical design, including the feasibility and merit of the technical approach; the completeness of the technical design and scope; and the feasibility and effectiveness of the technical performance for delivering the science;
- The feasibility and completeness of the proposed budget and schedule, including workforce availability;
- The effectiveness of the proposed management structure and the approach to ES&H; and
- Other issues relating to the STAR HFT project.

The two-day review was based on formal presentations given by the STAR HFT team and separate follow-up discussions with the reviewers. The second day included a question and answer session in which the project team responded to questions posed by the panel on the first day. The second day also included an executive session during which time the panel deliberated and prepared draft reports on their assigned areas of focus and a brief closeout with the STAR HFT project team and STAR collaborators. The panel members were asked to submit their individual evaluations and findings in a "letter report" covering all aspects of the charge. The executive summary and the accompanying recommendations are based largely on the information contained in these letters reports. A copy of the charge letter and the agenda are included in Appendices A and B, respectively.

Significance and Merit

Findings:

The Solenoidal Tracker at the Relativistic Heavy Ion Collider (STAR) Collaboration proposes to fabricate a silicon-based tracking device inside the Time Projection Chamber (TPC) to enhance the STAR heavy flavor physics capability. This multi-layered Heavy Flavor Tracker (HFT) would consist of two new layers of silicon pixel detectors (PXL), a new single layer of silicon pad detectors (IST), and an existing double-sided layer of silicon strip detectors (SSD) with new readout electronics.

Unlike other measurements at RHIC, most based on the detection of leptons from semi-leptonic decays of heavy mesons where there is only an indirect connection to the actual heavy meson momentum, the exclusive $D^0 \rightarrow K\,\pi$ channel measures the meson momentum directly and the D^0 mass peak provides clear identification of the heavy meson.

A schematic strategy was given for the statistical separation of D from B mesons in their semi-leptonic decay to electrons using distance-of-closest-approach (DCA) cuts, the different DCA distributions of D and B decays, and input from exclusive hadronic decays of heavy mesons, and other measurements.

Simulations were done to show the effect of complete failure of the SSD or IST on the overall performance of the HFT. These showed around a 20% loss in single-track efficiency if one or the other of the SSD or IST was lost.

The SSD has a strip size of 20 x 750 microns, which apparently gives sufficient pointing resolution to the PXL in order to match tracks in those pixel layers.

It was stated that radiation damage to the inner layer of the PXL was substantial in Au+Au collisions, and would make it necessary to build four times as many ladders as needed to populate the (inner and outer) PXL layers, so that the radiation damaged ladders could be replaced annually. In addition, it was stated that the radiation environment in 500 GeV p+p collisions was five times worse, and in that case the inner ladders would have to be removed during any full-intensity 500 GeV p+p running.

Comments:

The measurement of the exclusive D0 $\rightarrow$ K π channel, with direct connection to the charmed-meson, is a significant contribution to heavy-quark physics at RHIC.

The panel believes that the redundancy provided by the IST is important to provide robust tracking capability in the HFT/TPC system. However, the panel was not satisfied with the level of detail in the tracking simulations to demonstrate quantitatively the need for this redundancy.

If the PXL thickness is substantially increased, e.g., copper instead of aluminum trace flex cables were used, the project showed that there was about a factor of four loss in efficiency due to poorer pointing resolution at low transverse momentum, i.e., below a pT of ~2 GeV/c.

But it was unclear to the panel for the main Au+Au physics observables, v2 and RAA, whether this loss of efficiency (or statistics) below ~2 GeV/c in pT was a significant loss of physics.

The panel found it hard to understand quantitatively the justification for many of the requirements based on the physics goals. Studies should be carried through to the final physics measurement, showing the degradation of the final physics significance if key requirements are not met.

The panel would have liked to see a demonstration of how well the statistical D and B meson separation would work, since it involves a complicated mix of inputs from different sources, involves statistical subtractions, and may have systematic uncertainties due to lack of a priori knowledge of the true pT shape for each meson.

The Collaboration showed estimates of tracking efficiencies and momentum resolution for 500 GeV p+p running. However, there was no connection made between these estimates and the spin physics program.

A major strength of the RHIC facility is the ability to explore physics with ion-ion, deuteron-nucleus, and polarized proton-proton collisions. For a project requiring a substantial investment, the panel found it unfortunate that there were not golden measurements identified in each of these three areas.

The panel stated that it would be useful to understand better the incremental cost of replacing the inner PXL layer yearly (due to radiation damage) and also whether emerging technologies for the PXL detectors could replace the first installation in later years with more radiation-hard detectors that could survive multiple years and would operate effectively in 500 GeV p+p collisions.

The panel would like to understand more explicitly what the assumed 500M minimum-bias events correspond to in terms of recorded and delivered luminosity, given the tight (+/-5 cm) vertex cut required and the limiting data acquisition (DAQ) bandwidth at STAR. Detail trigger strategies that could enable the accumulation of higher sampled luminosity for the main physics measurements, compared to minimum-bias triggered data.

The panel notes that some of the simulation deficiencies noted in this review were identified previously in the Science Review. The Collaboration is encouraged to continue to strengthen the science case.

Recommendations:

- Studies should be carried through to the final physics measurement, showing the degradation of the final physics significance if key requirements are not met:
    - Give an explicit evaluation of what the loss in low-pT efficiency does regarding the fundamental physics questions relating to flow and energy loss of heavy quarks in the hot-dense medium. Evaluate this loss in terms of current theoretical models

and show whether these are well tested by the measurement above ~2 GeV/c or if the loss of statistics at lower pT is a critical loss.

Report results to DOE prior to scheduling a CD-2 Readiness Review.

- Compare the significance of planned charm and beauty measurement to be done with the HFT to similar measurements expected from the upgraded PHENIX detector. Comment on how significant an advance in theoretical understanding of energy loss and flow for the hot-dense medium the HFT would provide compared to the earlier anticipated PHENIX measurements. Report results to DOE prior to scheduling a CD-2 Readiness Review.

Technical Status

Pixel Detector (PXL)

Findings:

The STAR Collaboration plans to build a two-layer pixel detector (PXL) as part of the HFT. The pixel detector uses the Monolithic Active Pixel Sensors (MAPS) developed by the IPHC group in Strasbourg, France. The group has been developing this technology for the last ten years with a very rich development programs in the future. This would be the first large-scale application of MAPS in a HEP/ NP physics experiment. The stated advantages of using such a novel technology are good intrinsic distance-of-closest-approach (DCA) resolution (~ 20 μm) and low material mass.

PXL deliverables include 40 ladders arranged in 10 sectors, a support structure, services (cable and cooling), and installation tools.

There are two new elements introduced in the base design: air-cooling and the use of aluminum cables. Air-cooling is required by the strict pixel layer mass budget. The power requirements for the pixel layers have increased to ~170 mW/cm2 from a previous estimate of ~100 mW/cm2.

The major PXL procurements add up to $820,000. The total labor costed to the project amounts to ~ 18 full time equivalents (FTEs) at a cost of just over $2 million. The total PXL cost is $4.78 million, with a contingency of $1.54 million (32%).

A prototype test will be completed in 2nd quarter fiscal year (FY) 2011 (2QFY11). Production of the MAPS will start in 1QFY13. The PXL detector will be installed in 3QFY14.

Comments:

The Collaboration considered several alternative technologies, including hybrid pixels, Charged Coupled Devices (CCDs), and DEPleted Field Effect Transistor structures (DEPFETs). The panel agrees that the MAPS technology is a suitable choice for the PXL detector.

The MAPS technology will continue to evolve in the foreseeable future. Criteria need to be defined to choose the proper chip version for the experiment. The MAPS development is driven by the IPHC group at Strasbourg which is not a STAR collaborator. There is uncertainty about the radiation tolerance of the MAPS. As presented by the chip designer, the loss in single hit efficiency following exposure to 300 kRad of x-rays is well below 1%, whereas the expected ionizing dose for the innermost layer is about 90 kRad/year. The impact of this loss in efficiency, especially on PXL replacement, needs to be clarified.

The total radiation environment at RHIC including the mix of direct hadronic production and electrons from ultra-peripheral collisions is not well known at radii relevant for PXL. Knowledge of this environment is needed to inform choices on radiation hardness of detector technologies, to assess data readout loads and to understand pattern recognition issues. A better understanding of these backgrounds could become available when a smaller beam pipe is installed in PHENIX next year.

The test results for air-cooling indicate that the flow needed will induce vibrations in the support structure. This represents significant risks for the pixel project in terms of degradation of resolution as well as long-term mechanical damage. Measurements in a test structure showed vibration displacements of ~20 μm. This has to be compared to the intrinsic spatial resolution of the MAPS measured in a test beam to be 4.5 μm +/- 0.2 μm. In the real pixel detector placed inside STAR, it is not clear that this cooling method would produce enough cooling and what the impact of the vibration on the DCA would be. Mechanical damage of wirebonded connections is another concern. Long-term tests with mock-up ladders and prototype detectors should be undertaken to understand and mitigate this risk.

The use of Al cable is rather new and risky. It possibly has few or only a single vendor. It is also expensive (~ $240k). The benefit of pursuing this technology as the baseline rather using a more conventional technology (Cu on kapton) has to be evaluated and understood broadly.

The detailed tradeoff between pixel layer thickness and risks of degraded performance due to vibration, thermal effects, sensor robustness, and conductor thickness requires continuing informed physics/engineering judgment. It is worthwhile both to understand radiation length effects in detail and have a mechanism to make decisions on these tradeoffs in an informed way.

A test beam measurement has been carried out by the IPHC team. The Lawrence Berkeley National Laboratory (LBNL) team should participate in the test beam and perform irradiation tests with the help of the IPHC team in the future. Incremental system integration tests by the LBNL group are encouraged.

Insufficient detail has been presented on the system test (test plan, manpower), test stand, and software needs.

The in-beam engineering run is important but it is not clear whether any provision has been made to allow for any major design changes based on the lessons learned in the engineering run.

Contingency seems to be rather low considering that there are four areas of high technical risk identified.

Recommendations:

- Develop a plan for a ladder system test as soon as possible, using the available MIMOSA-26 chip, which has the architecture fully validated for the needs of STAR. Report the draft system test plan to DOE by December 31, 2009.

Intermediate Silicon Tracker and Silicon Strip Detector

Findings:

The IST detector is intended to link tracks from the TPC to the pixel layers. The Collaboration has chosen silicon pad technology as providing the necessary pattern recognition. The Collaboration has experience with this technology and argues that alternative technologies either deliver poor pattern recognition performance (silicon strips) or higher risk and expense. The IST readout system uses the well-understood APV25-S1 chip. The APV25-S1 readout is the same as for the FGT detector. Details of the FGT readout system were not presented.

The SSD upgrade is an upgrade to the readout of an existing silicon strip array. As such it is constrained by the existing silicon sensor hardware. This hardware is being refurbished and a new readout consistent with the STAR DAQ1000 standard is being developed. The deployment of ladders has been redesigned to improve coverage and make use of a limited number of functional ladders. There is one spare ladder; no new ladders will be produced.

Comments:

The APV chip used in the IST readout has a known issue with heavily ionizing particles which causes occasional dead time. There are mitigation strategies, but the Collaboration should verify that this chip feature will not be an issue in the STAR environment.

The SSD silicon sensor hardware has been refurbished, but there is significant concern about its ultimate robustness, especially given the lack of spares.

Recommendations:

- Evaluate the cost, schedule and workforce trade-offs between adding a second layer to the IST and a single-layer IST plus retaining and refurbishing the SSD. Report results to DOE by March 1, 2010.

Electronics and DAQ

Findings:

The pixel detector has 464 million channels. The noise level is assumed to be 10^{-4}. The readout system is designed to accommodate this noise rate.

The PXL, IST and SSD detector readout systems are designed to be interfaced with the standard STAR DAQ. The upgrade of the SSD readout involves replacing the single ADC with 16 ADCs per ladder. The link speed from the ADCs to the DAQ is increased to 120 MB/sec. The SSD readout has 12% dead time for a 750 Hz rate. It is dominated by the ADC conversion rate.

The project management team includes a mechanical engineer to oversee the interfaces between the three subsystems and overall integration. The electronics is designed by many institutions. The pixel chip is designed in France and LBNL is designing the detector and readout electronics. The Massachusetts Institute of Technology (MIT) group is working on the IST readout electronics. The SSD detector readout is being designed by SUBATECH in Nantes, France and the BNL group.

Comments:

The final system noise is often higher than that of an individual readout element. The readout system should be designed to maintain reasonable flexibility to deal with a possible higher system noise rate while maintaining the overall readout rate.

Carbon fiber is a good conductor at moderate frequencies and could act as a "floating capacitor" injecting noise into the detectors. Good grounding has been achieved by co-curing carbon fiber with copper-clad kapton mesh. This technology may be useful for the PXL and IST detectors.

One should understand the existing SSD detector analog readout speed to minimize the overall SSD detector readout dead time.

Few commercial regulators are radiation hard. Radiation levels at power distribution points for all three detectors should be understood.

It is important to track progress of the electronics for the three silicon detectors. The ancillary electronics, grounding, shielding, etc. need to be coordinated among the silicon systems. Electrical isolation between the three different silicon detectors needs to be carefully addressed.

Recommendations:

- Prior to CD-2, develop a grounding and shielding plan.
- The project management team should include an electronics system engineer.

Integration

Findings:

The mechanical support structures (East Support Cone, or ESC and Inner Detector Support, or ISD) are necessary for prototype ladder testing in STAR. The funding profile for that work has been advanced relative to other systems to enable prototype testing.

Comments:

A rather mature integration design was presented which includes a set of carbon fiber cylinders which will support all of the inner trackers. These supports are similar in concept to existing designs at STAR and ATLAS. There appears to be modest technical risk associated with this work. Schedule risk is associated with the funding profile.

Recommendations:

- None

Budget and Schedule

Findings:

Bottom-up cost estimates of labor, material and contributed labor by work breakdown structure (WBS) element were developed by subsystem experts.

Total Project Cost (TPC) Range is $14.6 million to $17.5 million. Overall project contingency is $3.5 million. The overall TPC range provided at the WBS Level 2 uses the same cost estimating formula for each WBS element: the low-range base cost uses cost plus 0.5 times contingency; and the high-range cost uses base cost plus 1.35 times contingency.

Contributed labor is estimated at $2.6 million. No contingency is applied to contributed labor.

Planned redirects from BNL and LBNL are estimated at ~$2.3 million and are spread over five years of the project.

The project has requested a change in the funding profile, shifting $1.3 million additional funds into FY 2011, which would shift CD-4 completion from 1QFY15 to 1QFY14.

The project critical path has only five milestones over a five-year period.

Comments:

Bottom-up cost and schedule estimating by sub-system is at variable stages of completeness and may not appropriately take into account contributed and redirected labor/materials.

The WBS 1.6 contribution to the project (i.e., software) needs to more completely folded into the project planning (e.g., TPC, integrated schedule, Project Execution Plan, or PEP).

The methodology used for determining contingency is varied by subsystem.

The Collaboration should develop a scenario which enables a descoped HFT to take data already in Run 14 in case advanced FY 2011 funding is not available.

Because the project is not using earned value management, only five milestones are not adequate to effectively manage and monitor the critical path.

Recommendations:

- Prior to seeking CD-2 approval, include additional milestones (at least quarterly) on the project critical path so that performance can be effectively monitored and managed.
- Provide, by institution, an annual breakdown of the project cost into capital, labor costed to the project, requested redirected labor cost, and all contributed labor. Submit to DOE by December 31, 2009.
- Prior to January 31, 2010, the PEP should be updated to include procedures for ascertaining, establishing agreements, and monitoring the contributed and redirected labor costs, and the strategy for handling associated cost overruns.

- Evaluate the potential risk of design changes resulting from the engineering run and apply the appropriate cost contingency.
- Evaluate areas of the project that could be identified as scope contingency.
- Prior to CD-2, develop a consistent, defensible methodology to calculate project contingency that takes in account documented project risks.

Management, ES&H, QA and Documentation

Findings:

The HFT project utilizes an Integrated Project Management process. An Integrated Project Team (IPT) has been formed, including a DOE Federal Project Director (FPD). The IPT meets as necessary to provide leadership to the project.

BNL is responsible for the overall design, procurement, fabrication, assembly and integration of the project. Several institutions (e.g., Lawrence Berkeley National Laboratory (LBNL), Massachusetts Institute of Technology (MIT), BNL, Kent State University (KSU)) are responsible for development of the sub-systems (e.g., pixel, IST, SSD, software).

CD-2 Project documentation has been developed, including:

- preliminary Project Execution Plan (PPEP);
- preliminary Acquisition Strategy;
- preliminary Risk Management Plan and risk matrix;
- preliminary Hazard Analysis;
- WBS by sub-system and detailed WBS dictionary (down to Level 5).

A Quality Assurance (QA) Board has been established for the project. A Technical Committee has been also established, which includes the Contractor Project Management (CPM), Deputy CPM (DCPM), sub-systems managers, and other sub-system subject matter experts.

DOE Project Assessment and Reporting System (PARS) monthly project status input is provided by the DOE FPD. The CPM provides monthly and quarterly project reporting to DOE.

A draft preliminary Hazard Analysis (pHA) has been developed and it addresses the primary hazards associated with the project (e.g., electrical, mechanical, radioactivity, work practices). The pHA includes summary level hazard analysis by Level 2 WBS with Hazard Ratings that range between 2 (moderate initial risk) to 3 (high initial risk). WBS 1.2, HFT-PIXEL, WBS 1.3, HFT-IST and WBS 1.4, HFT-SSD are determined to have moderate initial risk; while WBS 1.5, HFT-Integration has high initial risk.

All HFT project activities shall comply with BNL safety requirements.

The HFT project utilizes the BNL Standards Based Management System (SBMS) process. The Collider Accelerator Division (C-AD) Experimental Safety and Review Committee (ESRC) reviews project work activities and equipment design, testing and installation to ensure compliance with SBMS.

A dedicated Safety Coordinator has been assigned to the project.

The BNL Security Manager has issued a letter stating that the HFT has been appropriately incorporated into the BNL security program.

Comments:

There are numerous DOE O 413.3A requirements that necessitate more support in DOE project management than is currently available to the HFT project management team.

The HFT project will be utilizing standard BNL environment, safety and health (ES&H) and QA programs. It is a good practice to have a dedicated safety coordinator. It is not clear from reviewing the project documentation what mitigation actions are being undertaken to address project hazards. The HFT project should consider just following the BNL QA programs and not create a supplemental QA program. The project should simply create an approved QA document that declares it will follow the BNL QA program in its entirety.

There are inconsistencies between the information in the PEP versus the Acquisition Strategy (e.g., NEPA requirements). In order to facilitate the use of identical information it would be advisable to use the "graded approach" in redundant information. Using the grade approach for a project of this size, some of the documentation (e.g., Acquisition Strategy, Quality Assurance Plan) could be reduced similar to what was done for the Security Vulnerability Assessment Report.

Consider evaluating programmatic risks (e.g., extended continuing resolution).

Recommendations:

- Increase project management subject matter expert support on the HFT management team.
- Re-evaluate CD-4 deliverables to determine a reasonable list without compromising the planned research.

Appendix A: Charge Letter

The Department of Energy (DOE) Office of Nuclear Physics Facilities and Project Management Division, with input by the DOE Office of Project Assessment, is organizing a Technical, Cost, Schedule, and Management Review of the Solenoidal Tracker at the Relativistic (STAR) Heavy Ion Collider (RHIC) Heavy Flavor Tracker (HFT) project. As you are aware, this review will take place on November 12-13, 2009 at Brookhaven National Laboratory (BNL) in Upton, New York. A list of the members of the review panel and anticipated DOE participants is enclosed.

The purpose of this review is to assess all aspects of the project's conceptual design and associated plans—scientific, technical, cost, schedule, management, and environment, safety and health (ES&H). The following main topics will be considered at the review:

1. The significance and merit of the project's scientific goals;
2. The status of the technical design, including the feasibility and merit of the technical approach; the completeness of the technical design and scope; and the feasibility and effectiveness of the technical performance for delivering the science;
3. The feasibility and completeness of the proposed budget and schedule, including workforce availability;
4. The effectiveness of the proposed management structure and the approach to ES&H; and
5. Other issues relating to the STAR HFT project.

In addition to the above, the panel will be asked to evaluate drafts of project documentation that will be considered for Critical Decision-1 (CD-1, *Approve Alternative Selection and Cost Range*), e.g., Conceptual Design Report, Preliminary Project Execution Plan, Preliminary Acquisition Strategy, Preliminary Hazard Analysis Report, Preliminary Risk Management Plan and Risk Registry, and Work Breakdown Structure dictionary and basis of cost.

The review will be chaired by Dr. Helmut Marsiske, Program Manager for Nuclear Physics Instrumentation for the Office of Nuclear Physics. Dr. Marsiske can be contacted at 301-903-0028, or E-mail: Helmut.Marsiske@science.doe.gov. The first day of the review will consist of presentations by the project team and executive sessions. The second day will include presentations, break-out sessions and preliminary report writing. A brief close-out will occur around 4 p.m.; preliminary findings, comments and recommendations will be presented at the close-out. The panel members have been instructed to contact Elizabeth Mogavero at BNL at 631-344-3940 or E-mail: Mogavero@bnl.gov regarding any logistics questions. Word processing, internet connection, and administrative assistance should be made available during the review.

I greatly appreciate your efforts in preparing for this review. It is an important process that allows our office to understand the project plans, and serves as a readiness assessment for seeking CD-1 approval. I look forward to a very informative and stimulating review at BNL.

Sincerely,

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

Enclosure

cc: Nand Narain, BNL Site Office
James Symons, LBNL

Appendix B: Agenda

Department of Energy Pre-CD-1 Review
of the
STAR Heavy Flavor Tracker (HFT)
Brookhaven National Laboratory
November 12-13, 2009
AGENDA

Thursday, November 12

8:00 – 8:45	Executive Session	
8:45	Welcome………………………………….…………..…	S. Vigdor, BNL
8:45 – 9:30	Project Overview ……………………………...…...	F. Videbaek, BNL
9:30 – 10:15	Physics of HFT in STAR …………………………	N. Xu, LBNL
10:15 – 10:30	BREAK	
10:30 – 11:00	Pixel – Overview and Mechanical ………………	H. Wieman, LBNL
11:00 – 11:25	Pixel – Sensors and Readout ………………….…...	L. Greiner, LBNL
11:25 – 11:45	Pixel -- Sensor Development ……………………	M. Winter, IPHC
11:45 – 12:30	IST – Sensor, Readout and Mechanics ……….…	B. Surrow, MIT
12:30 – 13:45	LUNCH	
13:45 – 14:30	SSD – Electronics Upgrade and Integration …….	M. J. LeVine, BNL
14:30 – 15:15	Cone Mechanical - Integration ………...….………..	E. Anderssen, LBNL
15:15 – 16:00	Management, Cost & Schedule, Contingency, Risk, ES&H …………….………..………...	F. Videbaek, BNL
16:00 – 16:10	Summary …………………...….….…….………	H. G. Ritter, LBNL
16:15 – 18:45	Executive session	

Friday, November 13

8:00 – 9:00	Questions and answers
9:00 – 11:00	Breakout sessions*
11:00 – 11:15	Break
11:15 – 16:00	Executive session and lunch
16:00	Closeout

Breakout sessions*

Project Management, Cost & Schedule, Workforce, Risk, ES&H	F. Videbaek, K. Mirabella, H G Ritter, R. Ernst
Mechanics, Controls, Integration	E. Anderssen, J. Kelsey, D. Beavis
Pixel Sensors, Electronics, Radiation	H. Wieman, L. Greiner, G. Visser
IST and SSD Sensors, Electronics	M. J. LeVine, B. Surrow, G.Visser, G.v. Nieuwenheuzen, H.Matis
Physics, Software, Simulation	N. Xu, S. Margetis, B. Surrow