Department of Energy
Office of Nuclear Physics Report

on the

Science and Technology Review

of the

Relativistic Heavy Ion Collider (RHIC) at BNL

June 30-July 1, 2004

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EXECUTIVE SUMMARY

On June 9, 2004, the Associate Director of the Office of Nuclear Physics (ONP) requested the NP Facility and Projects Management Division to perform an annual Science and Technology (S&T) Review of the RHIC Facility. Its primary purpose is to evaluate the quality, performance, and significance of the ongoing and planned RHIC programs and issues related to the operations the RHIC facility. The S&T review was conducted on June 30 – July 1, 2004, at Brookhaven National Laboratory (BNL).

A new exciting program of research on extremely hot, dense nuclear matter began at the RHIC in 2000 when the first collisions of counter-circulating gold nuclei were observed at beam energies of 100 A GeV, ten times higher than those available at any other facility in the world. RHIC was designed to search for the quark-gluon plasma or other new forms of matter that is believed to have filled the universe about a millionth of a second after the "Big Bang." RHIC is also the only facility in the world that provides collisions between beams of high energy polarized protons. This unique capability will provide information on the arrangement of gluons that bind quarks into a nucleon. It is the polarized proton research program, or "RHIC Spin" program that was the focus of this year's science review.

In FY2004, the RHIC facility excelled in delivering Gold beams at twice the accelerator design specification - a factor of 4 above the minimal physics goals. High statistics heavy ion data sets were acquired by all four RHIC experiments. The polarized proton beam performance has improved over previous years with ~45% spin polarization of the proton beam achieved. A new polarized hydrogen jet target was completed and made operational on schedule. Overall, Run 4 was a great success. BNL staff and the RHIC experimenters are commended for their accomplishments and productivity.

BNL management has responded to the recommendations from the June 2003 DOE review. Most notably, management has developed a 20 year planning study document in consultation with the RHIC user community and the Collider Accelerator Department (C-AD) has dramatically improved the RHIC integrated beam luminosity. The attached Action Tracking sheet (Appendix A) lists all the action items from the 2003 S&T review; these were dealt with satisfactorily.

The 200 GeV polarized spin program has well defined near-term goals whose attainment depends upon further significant improvement of the proton beam intensity and polarization. BNL should consider the benefits and feasibility of applying the technical advice provided by the reviewers in this report. The longer term 500 GeV spin program requires a research plan that articulates the science case and how the program's objectives will be accomplished taking into consideration updated projections for luminosity increases. BNL is encouraged to develop an overall RHIC spin-physics research plan which should: (1) explain what science can be done at RHIC in the context of current and future capabilities world-wide, (2) explain what accelerator and detector performances are needed to make the measurements, (3) identify the needed resources to implement the research plan and subsequent timeline with the significant technical and scientific milestones that will be achieved; and (4) explain the impact of a constant effort budget to the planned research program.

The Magnet Division is a vital resource for maintaining reliable operation of RHIC and in providing the R&D expertise to build a specialized solenoid needed for electron beam cooling. The level of resources needed for servicing RHIC should be justified. The RHIC Computing Facility is the hub of data collection and analysis for all four RHIC experiments and thus BNL should ensure its capabilities continue to meet the experimental needs.

DOE RECOMMENDATIONS:

The following recommendations address the findings of this report.

- BNL should prepare a document that articulates its research plan for the RHIC spin physics program. A copy should be submitted to DOE by January 31, 2005.

- The Magnet Division should prepare a report that identifies the level of resources and costs needed to support RHIC operations. A copy should be submitted to DOE by January 31, 2005.

INTRODUCTION

The ONP Facility and Project Management Division organized a Science and Technology Review of the Relativistic Heavy Ion Collider (RHIC) Facility on June 30 – July 1, 2004. The members of the review panel were Professor John Harris (Yale University), Professor Emlyn Hughes (California Institute of Technology), Professor Naohito Saito (RIKEN, Japan), Dr. Jean-Pierre Delahaye (CERN, Switzerland) and Dr. Desmond Barber (DESY, Germany). Dr. Gulshan Rai, Program Manager for the Heavy Ion Nuclear Physics Program chaired the review and Dr. Jehanne Simon-Gillo, Acting Director of the Facility and Project Management Division, Dr. Brad Tippens, Program Manager for the Medium Energy Nuclear Physics Program and Dr. Dennis Kovar, Associate Director of the Office of Science for Nuclear Physics also attended the review.

The primary purpose of the annual S&T review is to evaluate the quality, performance, and significance of the ongoing and planned RHIC programs, in the context of the Nuclear Science Advisory Committee (NSAC) Long Range Plan for Nuclear Science and the national nuclear physics program. However, two other reviews relevant to the optimization of the U.S. relativistic heavy ion program were either in progress or had been completed. Therefore, this fifth annual RHIC S&T review focused on the RHIC spin research program and other specific issues related to the operations and future of the RHIC facility.

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

- The quality, productivity, and significance of the laboratory's scientific and technical accomplishments, particularly in the RHIC spin physics program, and the merit, feasibility and impact of the planned spin physics program;
- The effectiveness and reliability of accelerator operations and the planning for future facility upgrades in support of the planned research program and the impact of integration issues of other facilities on RHIC operations in support of the U.S. nuclear physics program;
- The appropriateness and effectiveness of in-house core competencies needed to implement the planned future nuclear physics program;
- The effectiveness of management in implementing a balanced, prioritized and optimized program, and the implementation of a safe working environment;
- The competence, creativity, and productivity of the facility scientific and technical staff in carrying out the above activities.

In addition, the reviewers were asked to comment upon what progress was made towards addressing action items from the previous Science and Technology Review. A copy of the charge letter is included in Appendix B.

Prior to the review, BNL had provided background material to the panel reviewers, including copies of the FY 2006 Field Work Proposal, the 20 year Planning Study for RHIC at BNL, the 2004 Machine Advisory Committee Report, and the Collider Accelerator Division's beam projections for FY2004 and FY2005.

The two day review was based on formal presentations given by BNL staff and separate follow-up discussions with the reviewers. The second day included a closed session in which management responded to questions posed by the panel on the first day, an executive session during which time the panel deliberated and prepared draft reports on their assigned areas of focus and a brief closeout with BNL management. A verbal summary of the preliminary DOE findings and recommendations were provided to Dr. Tom Kirk, the BNL Associate Director for High Energy and Nuclear Physics (HENP). The panel members were asked to submit their individual evaluations and findings in a "letter report" covering all aspects of the RHIC program. The executive summary and the accompanying recommendations are based largely on the information contained in these letters reports. The agenda of the meeting is included in Appendix C.

SPIN PHYSICS PROGRAM:

Findings:

The RHIC experiments have had success in performing the initial measurements of the spin structure of the nucleon using the polarized proton beams. Experimental techniques to perform asymmetry measurements have been developed in a timely manner. Proposals for spin physics detector upgrades are at various stages of development. Some of these upgrades are required to implement the baseline program, i.e. the polarized gluon and anti-quark measurements. The STAR EEMC calorimeter was successfully installed for the 2004 run and commissioning has started.

Comments:

The short term 200 GeV program experimental goals are well defined. The reviewers felt that the resources within a constant effort schedule would seriously delay the near term spin physics goals, given the requisite luminosity and polarization development needed prior to the completion of the gluon polarization measurements. So far, a rather short beam time (~5-10 weeks per year) has been allocated for the polarized proton program.

At this time, progress is being limited by the development of the polarized proton beam capabilities and not by the readiness of the experimental hardware or availability of scientific staff. The RHIC Spin program has competition on the gluon polarization measurements and therefore the reviewers think the RHIC must provide a significant measurement by 2007-8.

The reviewers are also concerned over the feasibility of attaining the long term goals of the 500 GeV polarized proton program. Under the proposed constant effort budget, the reviewers believe the 500 GeV proton program will be significantly delayed (or jeopardized) and furthermore its success is dependent upon the completion of the 200 GeV baseline program within the three future runs planned after 2005. International partners in the RHIC spin program have made considerable investments and their commitments hinge on a well conceived strategic plan. One of the reviewers mentioned that the 500 GeV proton program, described in the original RHIC Spin proposal in the early 1990s, has not been updated in light of the recent progress made in the scientific field and the experimental and technical performances achieved at RHIC.

BNL is encouraged to develop a research plan that articulates the science case and how the spin program's objectives will be accomplished taking into consideration updated projections for luminosity increases. The plan should: (1) explain what science can be done at RHIC in the context of current and future capabilities world-wide (i.e. what will be the important measurements, what will be their significance and impact and will some of these be made elsewhere prior to RHIC, etc.), (2) explain what accelerator and detector performances are needed to make the measurements (i.e. what beam energies, intensities and polarizations, what detector capabilities, etc.), (3) identify the needed resources to implement the research plan and subsequent timeline with the significant technical and scientific milestones that will be achieved (assuming projected improvements in

luminosity and polarizations, estimated time for developing the 500 GeV proton beam, estimated times to implement needed detector upgrades, what funding will be needed, etc.), and (4) explain the impact of a constant effort budget to the planned research program.

Recommendation:

- BNL should prepare a document that articulates its research plan for the RHIC spin physics program. A copy should be submitted to DOE by January 31, 2005.

HEAVY ION EXPERIMENTAL PROGRAM:

Findings:

RHIC has completed its fourth experimental run. The delivered heavy ion Gold (Au) beam and luminosity has exceeded expectations, resulting in all four RHIC experiments accomplishing their desired run goals. Also a short, low energy 63 GeV Au beam run was successfully completed. The RHIC Computing Facility (RCF) has operated seamlessly to meet the data acquisition and storage demands of all the experiments. About 70 scientific papers have been published to date. The scientific community has worked with BNL laboratory management to create a 20 year plan for heavy ion physics at RHIC. Recently, at the behest of the NSAC Heavy Ion subcommittee, BNL has carried out an exercise to optimize its research plans assuming a "constant effort budget". These plans were shared with the S&T review committee.

Comments:

The productivity of the heavy ion research program is tremendous and the scientific results are impressive. The present debate among theorists and experimentalists about the "discoveries" at RHIC is healthy and timely for the field.

The power cost for running RHIC is expected to increase significantly in FY2006. Consequently, in a constant effort budget scenario full utilization of RHIC is not possible. Investments in near-term detector upgrades are necessary to sustain a strong research program in order to accomplish the scientific objectives of the DOE nuclear physics program. BNL has presented a plan to the NSAC subcommittee which called for a nearly 30-week back-to-back running schedule over two fiscal years with modest upgrades funded from the reduced operating costs. It was mentioned that forfeiting the detector upgrades would not, in a significant way, restore RHIC operations to 32 weeks. This plan is contingent upon the negotiated power contract, an issue on which the BNL Director expressed his commitment to secure the most favorable power rates. The reviewers recognized the difficult circumstances and they were concerned with the inevitable option to reduce operating weeks; but they did not disapprove of the forward-looking priorities. They felt that the resources available within a constant effort schedule will delay the short-term heavy ion physics goals and it will dilute the intermediate term physics program (2009 – 2012) without having additional upgrades to

STAR and PHENIX. Additional resources may be required to prepare the RHIC facility to operate through the summer period necessitated by the conjoint schedule. Thus, BNL should carefully assess the reliability of the accelerator operations and its needs.

To ensure that the RHIC continues to produce quality data and significant scientific results, it is essential that the RHIC Computing Facility (RCF) maintains the capability to accumulate and analyze RHIC data in a timely manner, particularly as the beam luminosity increases and the detectors improve their data acquisition rates. The Constant Effort budget plan to reduce RCF funds in FY2005 should be carefully analyzed for its physics impact.

Recommendations:

There are no recommendations.

ACCELERATOR OPERATIONS:

Findings:

The Accelerator Division (C-AD) is commended for the superior operations of RHIC that delivered a record breaking quantity of Au beams during Run 4. The integrated Au luminosity exceeded by a factor of four the beam use request of the physics program and by a factor of two above the accelerator design. The C-AD has successfully responded to last year's action item to increase the "up time". Start-up time has been reduced from 5 to 4 weeks, while 22.5 days were saved during the physics run due to better reliability, better operational tools and more efficient operational procedures. Consequently, time "in store" has been increased to 53% close to the goal of 60%. The luminosity at the start of the Au run appears to be close to the maximum, thus allowing a more efficient integration of luminosity.

Comments:

There are opportunities for further improvements of the up-time with better automation, diagnostics and reproducible tuning procedures. About 47% of the accelerator time is not available for physics research. Research data is accumulated during "beam store" which lasts approximately 4 hours accompanied by a 1.5 - 2 hour elapsed time used for tuning the beam between stores. One reviewer believes that the estimated time for a typical tune could be 20 to 30 minutes when there are no problems. The C-AD should continue to improve the RHIC up-time to a value closer to 30 minutes by reducing the time elapsed for tuning between stores.

The peak luminosity is largely limited by the instabilities of the vacuum in the RHIC accelerator rings. The C-AD is in the process of installing NEG coated pipes in the warm sections of the RHIC ring that would suppress the formation of electron clouds that contribute to vacuum instability. The beam lifetime is limited by intra-beam scattering, but it could be improved with the application of electron and/or stochastic cooling. Accordingly, the C-AD is carrying out ground-breaking R&D to establish the feasibility of cooling bunched ion beams.

The C-AD has addressed the vulnerability of linac power amplifier tubes to the extent that the current inventory is sufficient for 1 year of RHIC operations and 2 years with additional stock.

Adequate performance of a half scale EBIS prototype has been demonstrated in the Test-Facility but DOE construction funds are still uncertain. NASA is considering investing 25 % of the funds. In concordance with last year's S&T review, the justification for the replacement of the aging and high maintenance tandem accelerators with a reliable and versatile EBIS injection system is re-affirmed by the present review. The Accelerator Division should continue to seek funding and resources for the completion and installation of EBIS as soon as possible to replace the aging and high maintenance Tandem accelerators.

Recommendations:

There are no recommendations.

POLARIZED PROTON ACCELERATOR PROGRAM:

Findings:

The C-AD is commended for making substantial progress on developing the polarized proton beam capabilities. A new machine operating point was established that preserves both the beam lifetime and polarization. With the AGS helical warm snake installed, an average polarization of 40-45% was accomplished for an average luminosity of $4x10^{30}cm^{-2}s^{-1}$. The total beam intensity or number of beam bunches is limited by increased vacuum pressure caused by multipacting electrons. A potentially effective scheme for avoiding all polarization loss in the AGS has been proposed using two partial snakes, but almost no spin-orbit simulations were presented. The RHIC absolute polarimeter using a Hydrogen Jet Target operated successfully achieving ~96% polarization. Initial measurements of the absolute beam polarization have been made with ~10% accuracy. The C-AD responded to last year's recommendation by presenting to the review its plans for increasing the luminosity and polarization.

Comments:

The recent polarimetry effort is remarkably successful and it has helped in the commissioning of the accelerator to attain a higher beam polarization, as well as provide data for the publication of the first spin asymmetry results from the experiments. However, risks are still evident over the next four years to achieve the spin physics goals for this program due to the need for both substantial beam intensity and sizeable polarization improvements. Similar to last year's comments, the reviewers believe that much work remains to be done before final physics production runs can start. They have offered a number of technical suggestions for improving beam quality (e.g. a "scrubbing" technique) and BNL is encouraged to examine these options; though it appears that some of these options are currently being pursued (e.g. NEG coating). The development of a new superconducting

solenoid for the polarized proton source is expected to double the beam intensity and its development should be pursued.

The reviewers believe that the preservation of polarization up to 250 GeV beam energy could be considerably more difficult than up to 100 GeV and that large scale simulations should be attempted to understand the spin-orbit motions in RHIC. It was suggested that the C-AD strengthen its collaboration with university groups who could provide graduate students to work on accelerator simulations.

Recommendations:

There are no recommendations.

ACCELERATOR FUTURE PLANS AND R&D:

Findings:

Efforts aimed at dedicated R&D are either planned or in progress. These include R&D on EBIS, electron beam cooling, enhanced luminosity, and eRHIC. Support for these efforts (~$2 million in FY2004) is largely provided from the base accelerator operating funds with supplemental contributions made by the laboratory and external sources.

Comments:

This accelerator R&D is essential for the future of RHIC. In the near-term, the goal is a 40-fold increase in the luminosity. The first factor of four is believed by BNL to be attainable without significant new hardware and has been partially achieved (~ factor of 2) in Run 4. The additional factor of 10 is the goal of RHIC II; to achieve this, electron cooling of ion beams has been identified as a critical and challenging technology that must be developed and tested. The reviewers could not discern from the presentations whether sufficient manpower with the relevant expertise was available to undertake this ambitious program. However, the reviewers believe the C-AD should continue to pursue the R&D as planned, but they also suggested the division prepare a breakdown of the manpower needed so that the feasibility of the R&D projects can be evaluated and gaps identified. BNL has a recently established Machine Advisory Committee (MAC) which could address the manpower issue at its next meeting.

The future of the RHIC science program is tied to further improvements of the RHIC accelerator performance. At present various major R&D projects are at different stages of development that follow individual plans. BNL is encouraged to develop a comprehensive R&D plan that identifies the major elements of the accelerator R&D that are required to realize the pre-conceptual design of the proposed RHIC II project.

Recommendation:

There are no recommendations.

ACCELERATOR INTEGRATION ISSUES:

Findings:

A broad program with dedicated users outside of the nuclear physics community also exists at RHIC. This program includes commercial users at the Tandem, Isotope production at the Linac, NASA research at the Booster, and Radiobiology research at the AGS. A possible expansion into other non-nuclear physics programs may be forthcoming (RSVP, g-2, rare K+ decay, NASA second beamline studies). The C-AD operations overview presentation reported the findings and recommendations of the DOE review (January 2004) of the future RSVP project and discussed the impacts on the AGS operations of the NASA Space Radiation Laboratory.

Comments:

The reviewers did not believe that the support for these efforts presently interfered with operations of the NP RHIC program. It was not clear to the reviewers that RHIC can absorb a future major expansion of its non-nuclear physics program (i.e. NSF particle, NASA, DOE HEP) without impacting the existing research programs.

Recommendations:

There are no recommendations.

CORE COMPETENCIES:

Findings:

The Superconducting Magnet Division (SMD) provides support services for RHIC operations typically associated with inventory, maintenance, repair, fabrication, testing, cryogenics and field mapping of magnets. The RHIC budget supports approximately 29 FTE's (~2/3 technician and ~1/3 professional/engineers) representing ~ 40% of the division's total activity in FY2004. There is synergy between components of the SMD operations, the international community (RIKEN) involved at RHIC and the Nuclear Physics program. These include the development of the Warm Partial Siberian Snake and a new cold Siberian Snake for the AGS, and R&D on electron beam cooling, the Rare Isotope Accelerator (RIA) and the Large Hadron Collider (LHC). No major magnet production tasks are anticipated in the near future. Activities related to nuclear physics R&D (electron cooling) are a small portion (~5%) of the Magnet Division's RHIC operations budget (~$5,600k).

Comments:

The reviewers believe that the core competencies contained in the magnet division are vital to sustain the reliable operation of the RHIC facility. The division's research portfolio is world-leading and innovative. However, based on the information provided, the reviewers were unable to assess what the appropriate size of the magnet division should be.

Recommendation:

- **The Magnet Division should prepare a report that identifies the level of resources and costs needed to support RHIC operations.**

SCIENTIFIC AND TECHNICAL STAFF:

Findings:

The BNL Scientific and Technical Staff are highly experienced, competent, innovative and well integrated. The local scientific groups continue to have essential roles both in the detector operation and in significant physics analysis. Scientific productivity is outstanding as noted by the numerous peer reviewed publications, invited presentations - particularly at the QM2004 conference which had caught the attention of the general public. The C-AD staff has excelled during Run4 to improve RHIC operations for Au beams beyond the accelerator design and beam use expectations. The motivation and ingenuity of the C-AD was evident during the polarized proton run with the establishment of a new operating point that preserves polarization and the beam intensity. C-AD staff members have published 12 papers in peer reviewed journals in 2004, while individual efforts were recognized: 2 staff members were inducted as APS fellows, 3 BNL awards received and two Ion Source prizes.

Comments:

The accelerator physicists involved with spin dynamics were encouraged by the reviewers to document their work in refereed journals.

Recommendations:

There are no recommendations.

MANAGEMENT:

Findings:

The RHIC management has been responsive to the recommendations from the June 2003 DOE review. Most notably, management has developed a 20 year planning study document in consultation with the RHIC user community. The reviewers found discrepancies existed

between the various schedules presented at the review by management, accelerator operations and experimenters.

Comments:

BNL management is commended for delivering a very successful run last year and the 20-year planning study report. Management is engaged in optimizing its resources and priorities to meet the minimal experimental goals set out in its 20-year plan. The 20-year plan is an evolving document. Many of the minimal goals will have been attained upon the successful completion of Run 5 next year; hence the 20-year plan should be updated assuming the best estimate for the new power costs in FY2006. The updated plan should integrate the results of the 500 GeV polarized proton plan which are attuned to the updated accelerator luminosity development R&D milestones.

All of the presentations at the S&T Review were clear, concise and informative. Management is encouraged to co-ordinate the presentations of the various plans and schedules so that a consistent set is shown at the next S&T review.

Recommendations:

There are no recommendations.

ENVIRONMENTAL HEALTH AND SAFETY:

Findings:

The BNL has taken safety and health issues seriously starting with line management responsibility (20% of the Associate Director's salary is dependent on safety performance). The Department Chair has set the goal of zero injuries. The HENP department has established preventative procedures, including enhanced work planning, individual training, awareness sessions, and regular discussions. Safety "occurrences" are tracked and analyzed for cause and mitigation. The RHIC-AGS facility users receive appropriate training for their level of responsibility.

Comments:

Enabling BNL staff to perform their work safely and in an environmentally sound manner is an on-going priority for the DOE. The laboratory's approach to enhance awareness among its staff and users through regular meetings and group forums is well appreciated and encouraged. During the review, further data in the form of historical performance indicators, and incident and injury reportable rates were presented. The reviewers noted that safety at the laboratory had improved dramatically over the past years as evidenced by the large reduction in the "Collective Dose" exposure, OSHA type deficiencies, number of reportable occurrences and the Lost Work Case Rate. In the first quarter of CY2004, C-AD had critiqued five events, two of which were deemed DOE reportable occurrences. The

reviewers could not comment on whether the present safety performance levels conformed to the DOE assessment criteria; this task was beyond the panel's charge and expertise.

Recommendations:

There are no recommendations.

APPENDIX A: Action Tracking from the 2003 S&T Review

Item	Recommendation/Action	**Response** by Dr. T. Kirk BNL Associate Laboratory Director, High Energy and Nuclear Physics	DOE Comment
1	BNL should develop a prioritized 5-year and a long-term 10-year strategic plan that optimally exploits the RHIC accelerator and detectors, especially during the next 5-years before the heavy ion program begins at the LHC, paying particular attention to the integration of the beam schedule, the scientific program, risks and the available resources. The plan should include milestones, timelines and the provision to monitor progress. A copy should be submitted to DOE by December 31, 2003.	BNL submitted "Twenty Year Planning Study for the RHIC Facility" to DOE Office of NP on December 31, 2003.	This review has commended BNL management for the development of a "complete, ambitious, staged and well documented" plan. The BNL plan has established minimal running requirements over 2004-2008 that would allow progress on realizing the Office of Nuclear Physics milestones.
2	In order to guarantee continued physics output, RHIC management should set a minimum performance goal that will be achieved with high priority. Furthermore, an effort should be made to improve the "up time" beam fraction from 20% to a value that is more comparable to other collider accelerators.	BNL collaborated with DOE Office of NP on Performance Measures for the FY04 Run and exceeded all three performance measures; the measures included an availability of 80.4% of scheduled physics collision time.	In Run 4 (FY2004), RHIC has operated with superior performance. The delivered Gold beam integrated luminosity has exceeded the planned physics data goal by factor of 4 (~double the RHIC design goal).
3	The replacement of the tandems by an EBIS source has merit and DOE and BNL are encouraged to implement this.	BNL has submitted a request to DOE Office of Nuclear Physics for approval of the EBIS Project; DOE is now preparing a CD0.	Based upon on the advice provided in prior reviews, NP has obtained a CD0 for the EBIS project.
4a	Construction and installation of a strong Siberian snake in the AGS should proceed expeditiously to improve the proton polarization.	BNL is constructing a cold snake for the AGS; installation December 2004.	BNL has proceeded to construct the AGS cold snake. The review noted that the commissioning of this device is expected to be completed in FY2005 and fully operational in FY2006.
4b	A long-term schedule with realistic goals and milestones		Additional progress needs to be

	for the polarized proton program needs to be developed		made which is addressed by Recommendation 1 of this review.
5	Given its importance for future operations and future projects, R&D of electron cooling should be pursued	BNL R&D is in progress on electron cooling.	Current R&D activities and a timeline for future work were presented at this review. The panel re-affirmed their continued support for this activity.
6	BNL should explore the feasibility of mounting a joint effort with other national laboratories to ensure the availability of new and remanufactured linac power amplifier tubes.	BNL has ordered and expects to receive new/reconditioned 7835 power tubes from Burle Industries this year.	BNL plans to receive a 2-year supply of spare tubes.
7	Staffing levels for the local support groups should be at least maintained at present strength, or preferably strengthened to ensure an optimal operation of the RHIC.	BNL has not maintained staff because DOE research funding levels are below inflation on Long Island.	
8a	The RHIC/AGS UEC is encouraged to continue its effort to ensure that the composition of RHIC/AGS Users Executive Committee reflect the interests of foreign users.	The RHIC-AGS Users Executive Committee has taken positive steps to increase the representation of non-U.S. users on the UEC.	Representation changes on the UEC will become apparent over the long-term cycle of elections. It will be monitored periodically.
8b	The DOE should assist in any way it can to promote the case for having reasonable visa and security regulations for non-US laboratory users.		Not a specific action item for BNL.

Appendix B: Charge Memorandum

On June 9, 2004, the Associate Director of the Office of Science for Nuclear Physics (NP) requested the NP Facility and Project Management Division to perform an annual Science and Technology Review of the Relativistic Heavy Ion Collider (RHIC). Thank you for agreeing to participate as a panel member for this review which will take place at Brookhaven National Laboratory, on June 30-July 1, 2004.

The RHIC facility plays an essential role in two major scientific thrusts of the U.S nuclear physics program, the national heavy-ion program and spin physics program. As the primary sponsor of U.S. nuclear physics research and the operations of RHIC, it is important for the Office of Nuclear Physics to understand the progress and future potential of these two research programs, the effectiveness of RHIC operations and whether resources and planning are being directed optimally to achieve the scientific goals of the nation's nuclear physics program. Over the past six months, various reviews have been and are being conducted that are relevant to the optimization of the U.S. heavy-ion program. This annual RHIC Science and Technology review will therefore focus on the RHIC Spin Program and other specific issues related to the operations and future of the RHIC facility.

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

- The quality, productivity, and significance of the laboratory's scientific and technical accomplishments, particularly in the RHIC spin physics program, and the merit, feasibility and impact of the planned spin physics program;
- The effectiveness and reliability of accelerator operations and the planning for future facility upgrades in support of the planned research program and the impact of integration issues of other facilities on RHIC operations in support of the U.S. nuclear physics program;
- The appropriateness and effectiveness of in-house core competencies needed to implement the planned future nuclear physics program;
- The effectiveness of management in implementing a balanced, prioritized and optimized program, and the implementation of a safe working environment;
- The competence, creativity, and productivity of the facility scientific and technical staff in carrying out the above activities.

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

The first day will consist of presentations by the laboratory and executive sessions. The second day will be used for an executive session and preliminary report writing; a brief close-out will take place in the late afternoon. Preliminary findings, comments and recommendations will be presented at the close-out. The review will be chaired by Dr. Gulshan Rai, Program Manager for Heavy Ion Energy Nuclear Physics.

You will be asked to write individual "letter reports" on your findings. Your "letter report" will be held in strictest confidence, so please be candid in your written remarks. The Chairman will accumulate your "letter reports", and compose a summary report based on the information in the letters. The "letter reports" will be due at DOE two weeks after the conclusion of the review.

Enclosed you will find a Facility S&T package containing relevant information and guidance of the nuclear physics S&T review process. A draft agenda and background material as well as

travel and housing information will be sent to you directly from RHIC. The laboratory will make word processing and secretarial assistance available during the review. If you have any questions about the review, please contact Dr. Gulshan Rai at (301) 903-4702, or E-mail: Gulshan.Rai@science.doe.gov. For logistics questions, contact Elaine Zukowski at RHIC at (631)-344-3830 or E-mail: zukowski@bnl.gov.

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 RHIC. I look forward to a very informative and stimulating visit.

Sincerely,

Jehanne Simon-Gillo
Acting Division Director
Facility and Project Management Division
Office of Nuclear Physics

APPENDIX C: Agenda

http://www.bnl.gov/henp/rhic0604.asp

Wednesday, June 30, 2004 Location Berkner Room B

[talk+questions]

8:00 am DOE Executive Session

8:45 am Welcome.....P. Chaudhari/G. Rai

9:00 am Overview Director's Perspective.....T. Kirk [30 +10]

9:40 am RHIC Experiments: Physics Department Perspective.....T. Ludlam [25+10]

10:15 am Coffee Break

10:30 am C-AD Operations Overview.....D. Lowenstein [35+10]

11:15 am RHIC Polarized Protons, Operations and Plans.....M. Bai [35+10]

12:00 am RHIC Gas Jet Target & Polarimeters.....A. Bravar [20+10]

12:30 pm DOE Working Lunch

1:30 pm Reliability of RHIC Operations.....W. Fisher [25+10]

2:05 pm PHENIX Spin Program..... G. Bunce [25+10]

2:40 pm STAR Spin Program.....L. Bland [25+10]

3:105pm Coffee Break

3:30 pm RHIC R&D, including e-Cooling.....T. Roser [35+15]

4:20 pm DOE Executive Session

6:00 pm Questions for BNL Presenters

6:25 pm Adjourn

Thursday, July 1, 2004 Berkner Room B

8:00 am DOE Executive Session

9:00 am Questions and Answers with Laboratory Management

9:45 am Superconducting Magnet Program..... M. Harrison [30+10]

10:25 am Coffee Break

10:40 am Committee Discussion and Report Drafting

12:00 pm DOE Executive Session

12:30 pm Working Lunch

4:00 pm Close-out with BNL

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