NSAC Subcommittee
Review of US Heavy Ion Physics Program

Recommendation #1

A new and complex form of dense QCD matter has been discovered at RHIC. To investigate and understand the properties of this matter, we recommend full exploitation of the existing RHIC facility and investment in future research tools. The flexibility of this dedicated collider, coupled with detector and luminosity upgrades, sustains RHIC's unique discovery potential. RHIC should run for as many weeks per year as possible, compatible with the following:

- **Invest in near-term detector upgrades of the two large experiments, PHENIX and STAR, to take full advantage of the existing accelerator capabilities.**
- **Invest now in accelerator and detector R&D, in preparation for RHIC II to enable crucial measurements of this new form of dense matter using rare probes.**
- **Construct EBIS as quickly as possible to improve the reliability and increase the capabilities of the heavy-ion injection system and to realize the projected reduction in RHIC operating cost.**

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Recommendation #2

In addition to its unique role in producing dense QCD matter, RHIC is poised to become a leading hadronic physics facility through a study of the structure of the proton using high-energy polarized proton-proton collisions. Its goals go well beyond current and expected results at other facilities. In order that this program succeed we recommend that:

- **Polarized proton-proton running remain an integral part of the RHIC program;**
- **In the near term, polarized proton-proton running time be sufficient to allow measurement of the gluon polarization on a reasonable time scale;**
- **Accelerator and detector improvements proceed at a rate that allows a timely determination of the flavor dependence of the quark-antiquark sea polarization through W-asymmetry measurements.**

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Recommendation #3

The LHC offers outstanding opportunities for new discoveries in relativistic heavy-ion physics, driven by a large increase in center-of-mass energy, different initial conditions, and a larger kinematic reach for hard probes. Parallel studies at RHIC and LHC provide a synergy important for global understanding of the properties and dynamics of dense QCD matter. We recommend that:

- **Participation at the LHC should become a component of the U.S. Heavy-ion program.**
- **This participation should receive comparable investment priority with the near-term upgrades for each of the two large RHIC detectors.**

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Recommendation #4

The Committee finds that it is impossible to realize the compelling scientific opportunities identified in Recommendations #1-3 within a constant-effort budget. However, within such a budget, the long-term scientific impact of the heavy-ion program can be best maintained by a balanced program that includes elements from all three recommendations. This can only be done through painful cuts.

Specifically:

- **RHIC running will have to be reduced substantially.**
- **Compelling near-term RHIC detector upgrades will need to be stretched out or deferred.**
- **Participation in the LHC heavy-ion program can only be funded at a very limited level.**
- **PHOBOS and BRAHMS may need to be phased out earlier than envisioned in the BNL 20-year plan.**

Even within a constant-effort budget, we recommend that certain essential investments must be made. These include:

- **Construction of the STAR Time-of-Flight Barrel and the PHENIX Silicon Vertex Barrel.**
- **RHIC accelerator and detector R&D.**
- **Construction of EBIS.**
- **Participation in the LHC heavy-ion program.**
- **Support at the present level for university and national laboratory research.**

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- **Construction of the STAR Time-of-Flight Barrel and the PHENIX Silicon Vertex Barrel.**
- **RHIC accelerator and detector R&D.**
- **Construction of EBIS.**
- **Participation in the LHC heavy-ion program.**
- **Support at the present level for university and national laboratory research.**
- **RHIC running time sufficient to preserve the integrity of the heavy-ion and spin physics programs.**

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Recommendation #5

The Committee concludes that additional resources above the constant-effort level are essential to exploit outstanding opportunities in heavy-ion and spin physics that would be otherwise lost. The Committee considered two possible budget increments over constant effort:

- **An increment of up to 5% over constant effort should be devoted to increased RHIC running time. This should permit operation of the RHIC accelerator at least as many weeks per year as envisioned within the recent BNL 20-year plan.**

- **Additional funds beyond a 5% increment should be allocated in comparable amounts to:**

  - **RHIC detector upgrade investments to maximize the scientific potential of RHIC in the era prior to the luminosity upgrade.**

  - **U.S. participation within the LHC heavy-ion physics program.**

  - **Experimental and theoretical research in heavy-ion physics.**

PDB Conclusions and Comments

1. The RHIC facility and the US HI Research Program have had a very productive four years of data collection and analysis. The current RHIC luminosity is four times greater than the specifications and the current data production rate per year is at the current limit of the data analysis capability of the community.

2. The discovery potential of RHIC is manifest in the evidence for a new form of dense QCD matter.

3. The US Heavy Ion Physics Program is entering a new phase in which the characterization of this new form of matter requires exploration of the role of hard probes (production of charm and beauty), high p_T spectra, jet production, and exploitation of beams of different species and at ever increasing center of mass energies.

4. To realize the potential for new physics requires full utilization of the capabilities at both RHIC and the LHC and the interplay of their measurements.

5. The US RHIC Spin program is poised to initiate an investigation in to the role of quark and gluon spin in the nucleon with unprecedented precision and at unprecedented polarized proton beams energies.

6. The program envisioned by the US Heavy Ion and Spin physics community at RHIC and the LHC is compelling, unique, and has very high discovery potential for at least the next decade.