PHOBOS Decadal Planning Document

The PHOBOS Collaboration

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1 Overview

In the first three years of RHIC running, PHOBOS has performed systematic studies of multiplicities [1, 2, 3, 4, 5, 6, 7, 8], particle ratios [9, 10, 11] transverse momentum spectra [12, 13] and correlations [14] for charged hadrons produced in p+p, d+Au and Au+Au collisions at RHIC. Together with data from BRAHMS, PHENIX and STAR, as well as the data from the AGS and SPS programs, these results contribute to an emerging empirical picture of the hot and dense matter produced in high energy nuclear collisions. The RHIC measurements show fascinating properties of this matter, such as the suppression of high p_T hadrons and strong elliptic flow, that are unique to collisions of heavy nuclei. At the same time, other observations, such as charged particle multiplicities and particle ratios, appear governed by surprisingly simple relationships, linking all collision system dominated by the strong interaction.

We believe that the largest conceptual advances in our understanding of the dynamical evolution of heavy-ion collisions and their connection to the QCD phase diagram will come from a comprehensive study of the energy dependence and system size dependence of the observables mentioned above. Specific PHOBOS contributions would include measurements of charged particle multiplicity and azimuthal correlations in full phase space and the study of identified particle ratios, spectra and correlations from very low to intermediate/high p_T near mid-rapidity.

A detailed description of the requested RHIC running modes and required integrated luminosities can be found in our 2003 Beam Use Proposal [15]. We believe that this survey, following the high statistics full energy Au+Au run planned for RHIC Run IV, could be completed in two or three additional running periods. This would allow PHOBOS to conclude our baseline physics program, as outlined in the original proposal, in an efficient and timely fashion.

Below we will provide a brief summary of the proposed running modes, without repeating all details from [15], and outline essential arguments for the scheduling of the energy and system size survey.

2 Run Plans and Scheduling Considerations

We foresee the following running modes for the completion of the PHOBOS baseline program:

- Au+Au at $\sqrt{s_{NN}} = 200$ GeV
- Fe+Fe (or equivalent) at $\sqrt{s_{NN}} = 200$ GeV
- p+p at $\sqrt{s_{NN}} = 200$ GeV
- Au+Au at $\sqrt{s_{NN}} = 63$ GeV
- p+p at $\sqrt{s_{NN}} = 500$ GeV
- Further energy and/or species scan

The proposed duration, integrated luminosities and number of events to tape for each of these running modes can be found in tables 1 and 2 in [15]. Based on the RHIC luminosity projections, we expect that the event rate to tape will be DAQ-limited for minimum-bias p+p running and luminosity limited for all heavy ion running, as well as p+p running using the Spectrometer Trigger.

We realize that there is a high overhead price to be paid whenever energy or species are changed, and that therefore, in any one run, the number of different conditions under which RHIC is operated must be small. To optimize the physics output under these constraints, it is essential to schedule a 200 GeV lighter ion run (Fe+Fe or Cu+Cu) and the 63 GeV Au+Au run as early in the upcoming program as possible. This will enable us to react to the findings from the initial scan and provide the basis for an optimal choice of energies and species in the subsequent runs.

3 Summary

The initial physics picture obtained from results at RHIC, as well as the AGS and SPS, provides a fascinating challenge of our understanding of the dynamical evolution of high energy heavy-ion collisions. We believe that the most valuable additional experimental information could be obtained from a comprehensive survey of the energy and system size dependence of data from RHIC. We propose that this survey is performed with high priority over the next three to four running periods, runs IV to VII, mapping out the complete RHIC landscape. This program would also allow us to conclude the PHOBOS program in a timely fashion.

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