

## Relativistic Heavy Ion Collider Status and Prospects\*

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The Relativistic Heavy Ion Collider (RHIC) is the centerpiece of the nuclear physics program at Brookhaven National Laboratory. The physics program encompasses both heavy ion physics and spin physics with polarized protons. A series of three accelerators provide the ions for injection into the two counter-rotating RHIC accelerator-collider rings. A fourth machine, the proton linac, provides polarized protons to the injector chain. Figure 1 is a photograph overview of the accelerator complex and Figures 2 and 3 describe the ion and polarized proton configuration respectively.

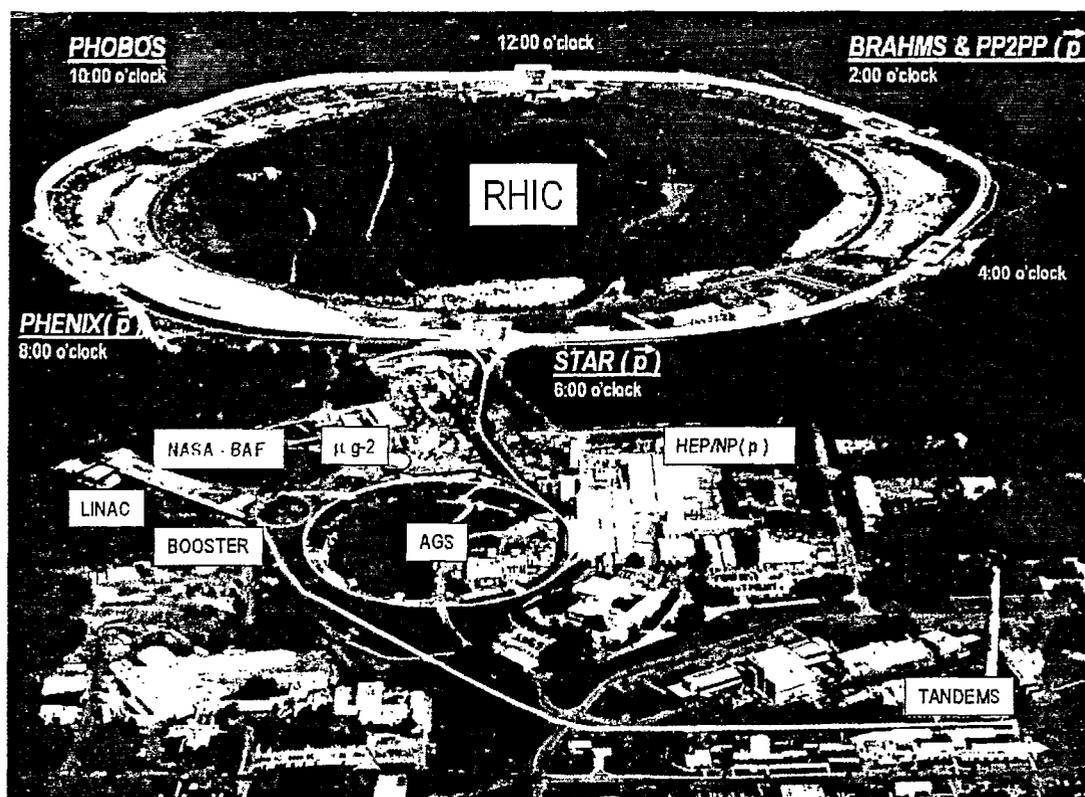


Figure 1.

RHIC has been designed to accelerate and collide all ion species from protons to uranium. We are presently limited to a mass of gold by the tandem preinjector limitations. RHIC has accelerated and stored gold ions for data taking from the injection energy of 10 GeV / nucleon to a maximum of 100 GeV / nucleon. Polarized protons have been delivered at 100 GeV for physics data taking. Most of the design parameters of RHIC have

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been achieved. The number of beam bunches, emittances, energy, bunch length and intersection region optics parameters have been achieved. Beam intensity is routinely available at 75% of design and the average luminosity is presently at 30% of design value.

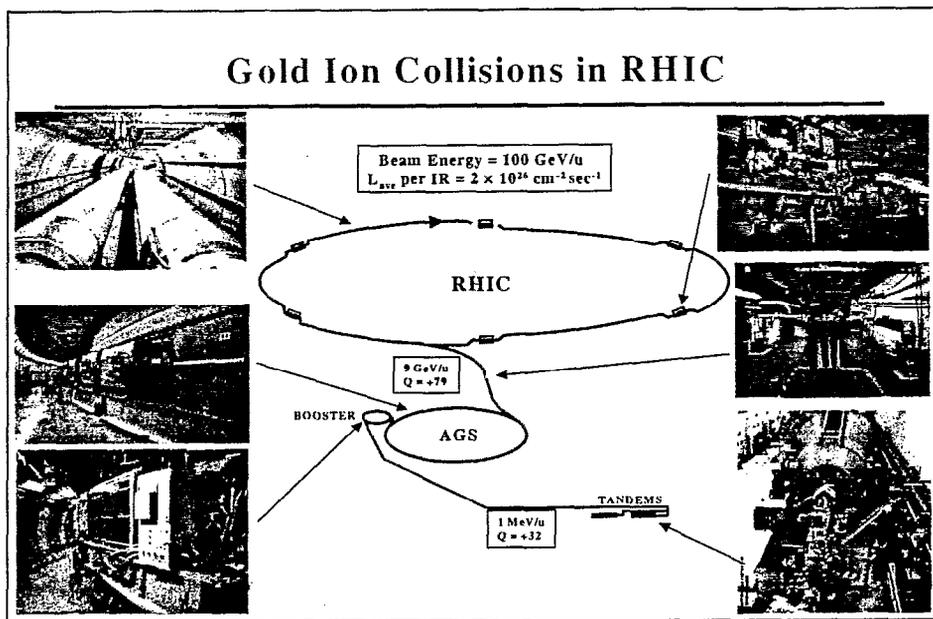


Figure 2.

During the recently completed first full year of operation a delivered luminosity of 40-80 inverse microbarns of gold-gold collisions was delivered to the four detectors, BRAHMS, PHENIX, PHOBOS AND STAR. The experimental program got off to a very rapid start. The first physics result for publication was submitted 5 weeks after the first beam collision on June 12, 2000. Data has now been taken at center-of-mass energies of 20, 56, 130 and 200 GeV. Data on antimatter production and suppression of hadron production at high transverse momentum are some of the initial striking results.

The spin program was recently commissioned and operated at a center-of-mass energy of 100 GeV. This program depends upon two critical machine components, a polarized H source and four Siberian snakes. The polarized ion source was a joint effort between KEK Japan, TRIUMF Canada, Institute of Nuclear Research Moscow and BNL. Polarization of 70-80% and intensity of  $1.5 \times 10^{12}$  were routinely achieved. One of four helical superconducting Siberian snakes is shown in Figure 4. This was a joint effort between the Budker Institute of Nuclear Physics (helical snake concept), RIKEN Japan

(funding) and BNL (design and construction). The Siberian Snake has been shown to maintain beam polarization during the acceleration, storage and collision cycle of RHIC operations. Spin rotators to provide longitudinal polarization will be installed during the summer of 2002. A fifth experiment, PP2PP, was commissioned and took proton-proton elastic scattering data at a center-of-mass energy of 200 GeV.

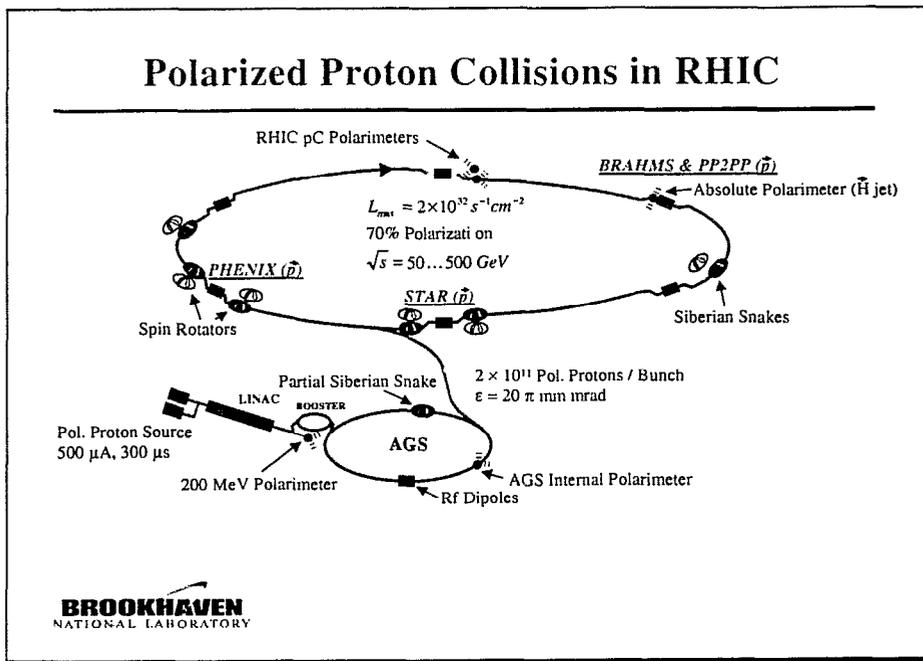


Figure 3.

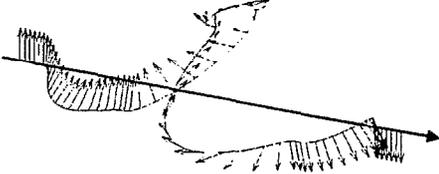
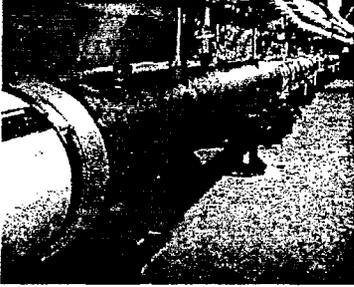
There are three future RHIC enhancement efforts that are being pursued. The first is focused towards a factor of 35 luminosity increase in the ion program ( $7 \times 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$ ) and a factor of two in the polarized proton program ( $4 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ ). This will involve beam intensity increases and the use of electron-cooling of the ion beams at storage energy (factor of 10). The electron-cooling enhancement entails the construction of a 54 MeV, 100-milliampere, energy-recirculation linac. The cooling concept is being pursued with the Budker Institute of Nuclear Physics. The second enhancement is the addition of an electron-ion and a polarized electron-polarized proton collider, eRHIC. This machine is envisioned to require the construction of an electron accelerator / storage ring. The ring would intersect one of the RHIC experimental areas. The electron ring would be injected

by a high energy electron linac. The center of mass energy for electron-ion collisions would range up to 63 GeV / nucleon and for electron-proton a range of 30-100 GeV, with polarizations of 70% per beam. The third effort is to replace the tandem accelerators with an EBIS and linac accelerator. This will provide for all ion species up to uranium and provide for polarized  $\text{He}^3$ , a polarized neutron beam for eRHIC.

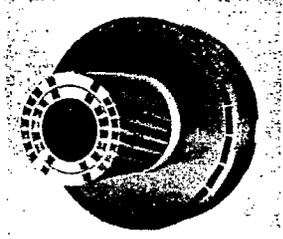
**First Siberian Snake in RHIC Tunnel**

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Siberian Snake: 4 superconducting helical dipoles, 4Tesla,  
2.4 m long with full 360° twist



Funded by RIKEN, Japan  
Designed and constructed at BNL



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Figure 4.