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Status and Outlook for the RHIC Luminosity Upgrade

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As the world highest energy heavy ion collider, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory has been the center for exploring the universe at its infant stage. The operations of RHIC over the past decade has produced many results. A new state of matter, the quark-gluon plasma which is believed to only have existed right after the birth of the universe, was first observed at RHIC during the collisions of Au ions. The experimental data also revealed that this new state of matter behaves like a perfect fluid. In addition to the heavy ion program, RHIC is also capable to accelerate polarized proton beams to high energy, which allows one to explore the spin structure of polarized protons. Both the heavy ion program and spin physics program require high luminosities at RHIC. Various efforts aimed at increasing the RHIC luminosity of heavy ion and polarized proton collisions, such as NEG coating beam pipes to reduce electron clouds, using intrabeam scattering lattice for heavy ion operations as well as longitudinal stochastic cooling. The average store luminosity of Au collisions at a beam energy of 100 GeV/u has reached 1027cm^{-2}s^{-1}. The average store luminosity of RHIC polarized proton collisions at a beam energy of 100 GeV reached 28x1030cm^{-2}s^{-1} and 55x1030 cm^{-2}s^{-1} for the polarized proton collisions at a beam energy 250 GeV. Currently, the luminosity is limited by beam-beam effects for polarized proton collisions and intrabeam scattering for heavy ion collisions. Novel techniques are explored and under development to address these issues. The addition of transverse stochastic cooling will minimize the beam size growth due to intrabeam scattering and increase the heavy ion luminosity lifetime. The technique of using 9MHz cavity to accelerate polarized protons minimizes the electron cloud effect, which can cause emittance blowup. It also helps to preserve the longitudinal emittance and yields shorter bunches. The technique of employing an electron lens to compensate the beam-beam effect is also currently explored at RHIC. This presentation will report the current performance of RHIC as well as the plans for RHIC luminosity upgrades.