

## THE RHIC POLARIZED SOURCE UPGRADE

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**Abstract.** A novel polarization technique had been successfully implemented in the RHIC polarized H<sup>-</sup> ion source upgrade to higher intensity and polarization for use in the RHIC polarization physics program at enhanced luminosity RHIC operation. In this technique a primary proton beam inside the high magnetic field solenoid is produced by charge-exchange ionization of the atomic hydrogen beam in the He-gas ionizer cell. Further proton polarization is produced in the process of polarized electron capture from the optically-pumped Rb vapor. The atomic beam of a 6-8 keV energy and total (equivalent) current up to 3.5 A is produced by neutralization of proton beam in pulsed hydrogen gas target. Formation of the proton beam (from the surface of the plasma emitter with a low transverse ion temperature ~0.2 eV) is produced by four-electrode spherical multi-aperture ion-optical system with geometrical focusing. Polarized beam intensity produced in the source exceeds 4.0 mA. A strong space-charge effects cause significant beam losses in the LEBT (Low Energy Beam Transport, 35.0 keV beam energy) line. The LEBT was modified to reduce losses and 1.4 mA polarized beam was transported to the RFQ and maximum so far 0.7 mA was accelerated in linac to 200 MeV. Maximum polarization of 84% was measured at 0.3 mA beam intensity and 80% at 0.5 mA in 200 MeV polarimeter. This high beam intensity allowed reduction of the longitudinal and transverse beam emittances at injection to AGS to reduce polarization losses in AGS. The source reliably delivered beam for 2013 polarized run in RHIC at  $\sqrt{s}=510$  GeV. This was a major contribution to the RHIC polarization increase to over 60 % for colliding beams. The high intensity polarized beam is also required for a planned RHIC luminosity upgrade by using the electron beam lens to compensate the beam-beam interaction at collision points.