

Run06 Polarization in Proton-Proton Operation at RHIC Using the Hydrogen Jet Polarimeter

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A necessary ingredient in the RHIC spin program is high polarization that is precisely measured. A polarized Hydrogen jet polarimeter¹⁾ is used to make an absolute measurement of the beam polarization, which is needed to normalize the results from the proton-Carbon polarimeters.²⁾ In the 2006 RHIC run (Run06), the RHIC spin goal of less than 5% total relative uncertainty in the polarization of a single beam was achieved at beam energy of 100 GeV.

The Hydrogen jet is designed to study protons elastically scattered at low recoil energy (T_R) nearly perpendicular to the beam direction. In this low recoil energy region of a few MeV, the asymmetry due to the Coulomb nuclear interference effect is expected to be maximal. In a polarized hydrogen target, two different asymmetries can be measured: ε_T , the target asymmetry where the target is taken as polarized and the beam unpolarized, and ε_B , the beam asymmetry where the beam is taken as polarized and the target unpolarized. The analyzing power, which is a physics quantity, is the same in both cases, and so we can relate target and beam polarization as

$$P_B = \frac{\varepsilon_B}{\varepsilon_T} P_T \quad (1)$$

where P_T (P_B) is the target (beam) polarization. P_T is monitored by a Breit-Rabi polarimeter and was maintained at $92.4 \pm 1.8\%$ throughout Run05 and Run06.

Figure 1 shows the measured asymmetry for the target and beam from Run06 for $1 \text{ MeV} < T_R < 4 \text{ MeV}$. The target asymmetry is flat across the whole Run06, which is expected as the target polarization is constant. Nonstatistical fluctuations can be seen in the beam asymmetry indicating changes in the beam polarization from fill to fill, with higher beam polarization later in Run06.

The left side of Fig. 2 compares the Run05 and Run06 measured target and beam asymmetries as a function of the struck proton's recoil energy for the two beams (called "Blue" and "Yellow"). The target asymmetry is consistent between the two years, whereas the difference in beam asymmetry indicates the increased polarization in Run06.

Polarization was also measured during a short 31 GeV run. The right side of Fig. 2 shows the target and beam asymmetries measured with the "Blue" beam. Large backgrounds in the "Yellow" running period prevented asymmetry measurements.

References

- 1) H. Okada *et al.*, Phys. Lett. B **638**, 450 (2006).
- 2) O. Jinnouchi *et al.*, RHIC/CAD Accelerator Physics Note 171, 2004.

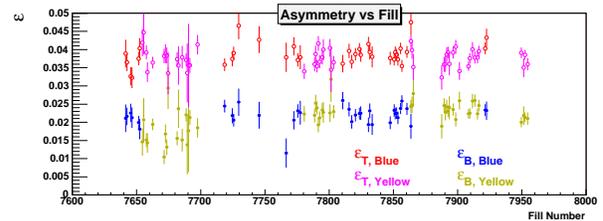


Fig. 1. Target (open circles) and beam (filled circles) asymmetry vs. fill number at RHIC. The different colors signify which beam was centered on the Hydrogen Jet.

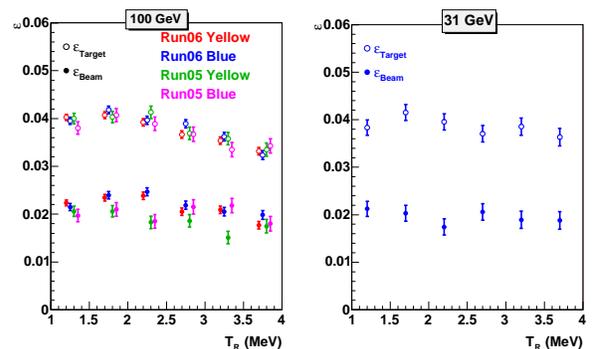


Fig. 2. Target (open circles) and beam (filled circles) asymmetry vs. recoil energy at 100 GeV from Run05 and Run06 (left) and at 31 GeV (right).

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