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Measurement of the Proton-Nuclear Transverse Analyzing Power with the RHIC Polarized Hydrogen Gas Jet Target

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In the RHIC spin program, the Atomic Polarized Hydrogen Gas Jet Target (HJET) was constructed to measure the absolute polarization of proton beams. Recoil protons from the vertically polarized proton beam CNI (Coulomb Nuclear Interference) scattering off the vertically polarized proton jet target were detected using left-right symmetric Si detectors. Since the jet polarization is well known, $P_{\text{jet}} \approx 96 \pm 0.1\%$, concurrent measurements of the beam and target spin-correlated recoil proton asymmetries enabled the determination of the beam polarization with low systematic uncertainty, σ_P^{syst}/P
$lesssim 0.5\%$.
Additionally, single $A_{\text{N}}(t)$ and double $A_{\text{NN}}(t)$ spin analyzing powers were precisely measured at $|t| < 0.02$ GeV^2 for two beam energies, 100 and 255 GeV, allowing for reliable isolation of the corresponding hadronic spin-flip amplitudes. Since HJET also performed well with nuclear beams, $p^{\uparrow}A$ analyzing powers were routinely studied during heavy ion runs at RHIC without disrupting RHIC operations. For 100\,GeV/nucleon beams, $A_{\text{N}}^{pA}(t)$ was measured for $^{2}\text{H}^{+}$ (d), $^{16}\text{O}^{8+}$, $^{27}\text{Al}^{12+}$, $^{96}\text{Zr}^{40+}$, $^{96}\text{Ru}^{44+}$, and $^{197}\text{Au}^{79+}$, providing a detailed test of spin effects within the Glauber model. The energy dependence of $A_{\text{N}}^{pA}(t)$ was also studied for Au (3.8–100 GeV) and d (10–100 GeV).
These measurements have the potential to determine pp spin-flip amplitudes across a wide range of beam energies, thereby improving the reliability of Regge fits for spin-flip measurements. Preliminary results from the HJET $p^{\uparrow}A$ data analysis will be discussed.

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