Contribution ID: **8** Type: **not specified**

Precision small scattering angle measurements of proton-proton and proton-nucleus analyzing powers at the RHIC hydrogen jet polarimeter

Thursday, 29 September 2022 08:50 (20 minutes)

The Polarized Atomic Hydrogen Gas Jet Target polarimeter (HJET) is used to precisely, $\sigma_P^{\rm syst}/P \sim 0.5\%$, measure the absolute (vertical) polarization of the proton beams at the Relativistic Heavy Ion Collider (RHIC). At HJET, the recoil protons from the beam Coulomb-nuclear interference scattering ($0.0013 < -t < 0.018\,{\rm GeV}^2$) off the jet target are detected in the vertically oriented Si strips. Measuring time of flight, kinetic energy, and z-coordinate (discriminated by the Si strips) for each detected proton allows us to reliably isolate elastic pp scattering events. Since both beam a_b and target (the jet) a_j spin correlated asymmetries are measured concurrently (i.e., using the same events), the beam polarization can be related $P_{\rm beam} = P_{\rm jet} \times a_b/a_j$ to the jet one, $P_{\rm jet} \sim 0.96 \pm 0.001$, monitored by the Breit-Rabi polarimeter.

Low and well controllable background in the measurements allowed us to precisely determine, for 100 and 255 GeV proton beams, the single $A_{\rm N}(t) \sim 0.04$ and double $A_{\rm NN}(t) \sim 0.002$ spin analyzing powers with the experimental uncertainties of about $|\delta A_{\rm N,NN}(t)| \sim 2 \times 10^{-4}$. The hadronic spin-flip amplitude parameters r_5 and r_2 were reliably isolated. The Regge fit of the spin-flip amplitudes indicated that Pomeron single and double spin-flip couplings were well determined and found to be significantly different from zero.

For the proton-proton scattering at HJET, the inelastic events, $p + p_{\rm jet} \to \pi + X + p_{\rm jet}$ can be isolated at the momentum transfer range of about $0.004 < -t < 0.009\,{\rm GeV}^2$ and at the missing mass $M_{\pi X} > m_p + m_\pi$ range limited by the detector acceptance (and, thus, depending on the beam energy). It was found that the inelastic jet spin analyzing power $A_{\rm N}^j$ is significantly smaller compared to the elastic $A_{\rm N}$ while the beam spin $A_{\rm N}^b$ is significantly larger. The measured inelastic $A_{\rm N}^{b,j}$ grows if the missing mass $M_{\pi X}$ is decreased. For the beam spin asymmetry, large values of up to $A_{\rm N}^b(t, M_{\pi X}) \sim 35\%$ were found in the data analysis.

It was found that the HJET recoil spectrometer performance in the RHIC heavy ion beams is about the same as in the proton ones. This allowed us to measure $p^\uparrow A$ analyzing power at 100 GeV for the following ions $^2{\rm H}^+$ (d), $^{16}O^{8+}$, $^{27}{\rm Al}^{12+}$, $^{96}{\rm Zr}^{40+}$, $^{96}{\rm Ru}^{44+}$, $^{197}{\rm Au}^{79+}$. Also, the beam energy scan was done for d (9.9, 19.6, 31.3, and 100\,GeV) and Au (3.85, 4.59, 5.76, 9.8, 13.2, 19.5, 27.2, 31.2, and 100 GeV). No evidence of the quasi-elastic (breakup) events, the fraction $< 1\%$, was found in the Au elastic data. For the deuteron beam, the breakup fraction was evaluated to be about 5\% (for $t \sim -0.007\,{\rm GeV}^2$).

The considered possibility to precisely measure, using HJET, ^{3}He beam polarization at the Electron-Ion Collider will also be discussed.

Presenters: POBLAGUEV, Andrei (Brookhaven National Laboratory); POBLAGUEV, Andrei (Brookhaven National Laboratory (US))

Session Classification: Soft and low-mass diffraction

Track Classification: Soft and low-mass diffraction