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Can absolute polarization of the ^{3}He beams at EIC be precisely measured by HJET?

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A possibility to precisely measure absolute vertical polarization of the EIC ^{3}He beams using the polarized hydrogen gas jet target (HJET) is discussed. By concurrent measurement of a_h and a_p, the beam $h^\uparrow p$ and jet $p^\uparrow h$ spin asymmetries for the detected recoil protons, the He3 beam polarization can be approximated by $P_{\rm beam} = P_{\rm jet} \times a_h\kappa_p/a_p\kappa_h$, where $\kappa_p = 1.793$ and $\kappa_h = -1.398$ are derived from the magnetic moments μ_p and μ_h, and $P_{\rm jet} \approx 0.957$ is the jet polarization determined by a conventional Breit-Rabi polarimeter. The result does not depend on the actual parameters of hp scattering: total cross-section $\sigma_{\rm tot}$, forward real-to-imaginary ratio ρ, or Coulomb phase δ_C.

Corrections of a few percent to the value of $P_{\rm beam}$ due to the term $\sim m^2/s$ in the electromagnetic spin-flip amplitude and due to hadronic spin-flip amplitudes r_5^{hp} and r_5^{ph} are well determined. Since the ^{3}He ground state is mostly fully space-symmetric S state, the hp spin-flip amplitudes can be readily related with sufficient accuracy, $r_p^{hp} = r_5^{pp}/3$ and $r_5^{ph} = r_5^{pp}$, to the amplitude measured in elastic pp scattering. Considering the experimental uncertainty in the value of r_5^{pp} as well as the uncertainties in the measurement of a_h/a_p, we can expect $\sigma_P^{\rm syst} \leq 0.9\,\%$ accuracy for the absolute ^{3}He beam polarization at EIC.

Since only the recoil proton is detected in HJET measurements, the acquired data may be contaminated by inelastic (^{3}He break-up) events. However, since only low energy protons in the small solid angle at 90 degree are counted, the inelastic component is strongly suppressed. Analyzing Run 16 data with a deuteron beam, we found that data contamination by the break-up events should not exceed a few percent. In addition, the inelastic corrections are significantly canceled in the a_h/a_p ratio. Thus, the anticipated alteration of the measured $P_{\rm beam}$ due to ^{3}He break-up can be neglected.

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