

Development of absolute polarimeter for the low energy ${}^3\text{He}^{++}$ ion beam

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For the Electron-Ion Collider, a polarized ${}^3\text{He}^{++}$ ion source is being constructed at the Electron Beam Ionization Source (EBIS) of the Brookhaven National Laboratory. For precision determination of the ${}^3\text{He}$ polarization, the ${}^3\text{He}$ beam, after acceleration to 6 MeV at EBIS, will be elastically scattered off a gas ${}^4\text{He}$ target. For such a scattering, the analyzing power $A_N(E_{\text{beam}}, \theta_{\text{CM}})$ can reach absolute, 100%, maximum at some points in the beam energy / center of mass scattering angle plane [1]. Several such points were found in Refs. [2, 3] including ($E_{\text{beam}} = 5.3 \text{ MeV}, \theta_{\text{CM}} = 91^\circ$).

The vertically polarized 6 MeV ${}^3\text{He}^{++}$ ion beam will enter, through a thin window (to minimize the energy loss of the beam), to the scattering chamber filled with ${}^4\text{He}$ gas at a pressure of ~ 5 Torr. Two left-right symmetric Si strip detectors (with vertically oriented strips) will be used to detect both scattered ${}^3\text{He}$ and recoil ${}^4\text{He}$ particles in every event. Good energy and time resolution of the detectors will allow us to recognize ${}^3\text{He}$ and ${}^4\text{He}$ signals and to eliminate background events. A spin rotator will provide the beam spin-flip to suppress the acceptance and intensity related systematic errors.

For the polarimeter calibration, we plan to scan the ${}^3\text{He}$ energy (by variation the entrance window thickness) and to measure the spin-correlated asymmetry dependence on scattering angle θ_{CM} . Analyzing power $A_N = 100\%$ can be attributed to the absolute maximum found in these measurements.

[1] G. Plattner et al., “Absolute calibration of spin – 1/2 polarization”, Phys. Lett. B **36**, 211 (1971)

[2] D.M. Hardy et al., “Polarization in ${}^3\text{He} + {}^4\text{He}$ elastic scattering”, Phys. Lett. B **31**, 355 (1970)

[3] W.R. Boykin, S.D. Baker, D.M. Hardy, “Scattering of ${}^3\text{He}$ and ${}^4\text{He}$ from polarized ${}^3\text{He}$ between 4 and 10 MeV”, Nucl. Phys. A **195**, 241 (1972)

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