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OPTICALLY-PUMPED POLARIZED 3HE++ ION SOURCE AND ABSOLUTE POLARIMETER DEVELOPMENT AT RHIC

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The proposed polarized 3He++ acceleration in RHIC and future Electron- Ion Collider (EIC) will require on the order of 2·1011 ions per source pulse. A new technique had been proposed for production of high intensity polarized 3He++ ion beam. It is based on ionization and accumulation of the 3He gas (polarized by optical-pumping and metastability-exchange technique in the high magnetic 5.0 T field) in the Electron Beam Ion Source (EBIS). A novel 3He cryogenic purification and storage technique was developed to provide required gas purity. A system for gas refill and polarized 3He gas injection to the EBIS gas cell drift tube was developed to ensure polarization preservation. The EBIS gas cell is a differentially pumped and operated at the required drift tube voltage. The 3He polarization 80-85% (and sufficiently long ~30 min relaxation time) was obtained in the "open"cell configuration with refilling valve tube inlet and extraction-injection to the drift tube outlet. It is planned, that the Extended EBIS upgrade project will be completed by the end of 2022. The development of the spin-rotator and 3He -4He absolute nuclear polarimeter at 6 MeV 3He++ beam energy is a part of this upgrade. In this talk we will focus on polarimeter development. There is a unique opportunity for precision measurements of the absolute 3He++ polarization at beam energies 5.0-6.0 MeV after the EBIS LINAC. It was shown [1], that the analyzing power for the elastic scattering of spin-1/2 particles -3He on spin-0 particles -4He can reach the maximum theoretical value |P| = 1 at some point (Ebeam, θCM). Using the experimental data [2], several such points were established for 3He + 4He elastic scattering including the P= +1 at beam E ≈ 5.3 MeV and θ (center of mass) ≈ 91°. Therefore, the main effort of this R@D will be development of precision absolute polarimeter for the measurements of the 3He++ beam polarization produced in the EBIS as a reference for the further polarization measurements (and possible polarization losses along accelerator chain. The polarimeter vacuum system is integrated in the spin-rotator transport line. The 3He++ ion beam will enter the scattering chamber through the thin window to minimize beam energy losses. The scattering chamber is filled with 4He gas at ~ 5 Torr pressure. The silicon strip detectors will be used for energy and TOF measurements of the scattered 3He and recoil 4He nuclei (in coincidence) for the identification of the scattering kinematics with analyzing power AN ~ 1. Two sets of detectors will measure both nuclei and left-right asymmetry at the spin–flip. The status of polarimeter development (vacuum system, scattering chamber, thin window, Si-strip detectors and WFD- based DAQ) will be presented.

[1] R.J. Spiger and T.A. Tombrello, Phys. Rev. 163 (4, 1967), pp. 964.
[2] G.R. Plattner and A.D. Bacher, Physics Letters Volume 36B, number 3 (1971), pp. 211-214

Category

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