PEPPo : A Prompt Source of Highly Spin-Polarized Positrons

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Polarized positrons, similar to polarized electrons, may be used as a direct and powerful probe to explore matter at various energy scales: utilized in the study of surface and bulk magnetization of materials, but also identified as an essential or a significant ingredient for the experimental program of present and next generation lepton accelerators (JLab, Super KEK B, ILC, CLIC). Impressive endeavors over the past 20 years have produced or demonstrated positrons with a high degree of spin polarization; however, always requiring very high energy GeV beam energy to achieve high positron spin polarization.

In contrast to this, a proof-of-principle experiment at Jefferson Lab has demonstrated a new method for promptly producing highly spin-polarized positrons using a low energy (<10 MeV) electron beam. The PEPPo (Polarized Electrons for Polarized Positrons) concept relies on highly spin-polarized electrons which shower via polarized bremmstrahlung and e+/e- creation when striking a tungsten foil.

For the purpose of demonstration the generation of positrons using an ~85% spin polarized electron beam of energy 8.2 MeV/c was performed. Positrons in the range of 3.1 to 6.2 MeV/c were magnetically collected from a low power (<50 W) tungsten foil 1 mm thick and analyzed with a Compton transmission polarimeter that had first been calibrated with a known polarized electron beam. Positron polarization was expectedly dependent on momentum, and achieved highest spin polarization >80% near the end-point energy.

While the yield of a low energy (<10 MeV) conventional positron source is expectedly low, the advent of milli-Ampere highly spin-polarized electron beams or use of higher electron beam energy ~100’s MeV implies the PEPPo concept may find practical application in a program of accelerator-based experiments. Alternatively, the PEPPo concept may provide the university or industry setting, by employing a relatively small <10 MeV production accelerator, its first possibility for a highly spin-polarized positron beam at significantly reduced cost and radiological footprint.

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