Near-lossless positron injection into a dipole magnetic field

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The nucleation and trapping of a small-Debye-length, electron-positron pair plasma in a toroidal device will enable laboratory studies of these systems, which are predicted to have novel properties significantly different from those of standard electron-ion plasmas — e.g., "remarkable stability" [1]. A key prerequisite is the development of a scheme that enables efficient injection of positrons from an external source, across flux surfaces, into the confinement region.

Previously, the NEPOMUC (NEutron-induced POsitron source MUniCh) beam was injected with 38% efficiency into the dipole field of a supported permanent magnet and subsequently trapped [2]. Essentially lossless injection into the same device has now been demonstrated. This was accomplished by tailoring positrons' 3D guiding-center drift orbits via optimization of electrostatic potentials applied to various plates and wall segments, thereby producing localized particle transport via the $\mathbf{E} \times \mathbf{B}$ drift. Experimental results are in excellent agreement with numerical simulations (Fig. 1), enabling a comprehensive understanding of the process. This paves the way for upcoming experiments, in which dense pulses of positrons will be injected into the dipole field of a levitated coil.

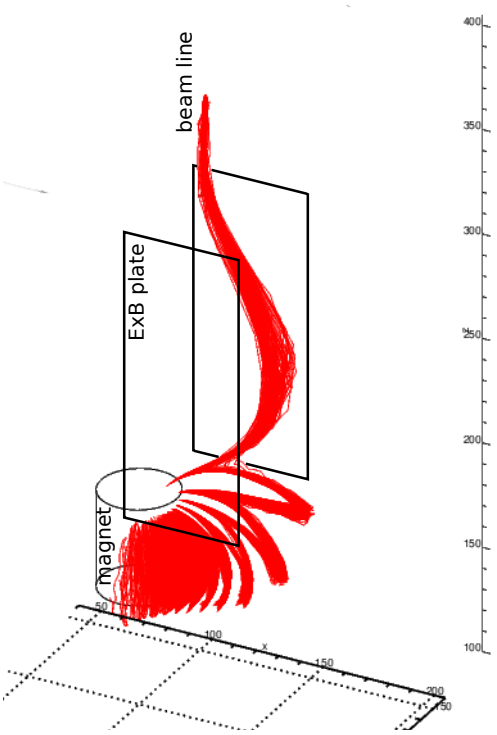

Figure 1: *Simulated trajectories of a finite-temperature positron bunch being losslessly drift-injected into a dipole trap.*

References

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[2] H Saitoh, et al. *New J. of Physics*, 17(10):103038, 2015.