Contribution ID: **119** Type: **Poster**

Annihilation-gamma spectra of magnetically confined positrons scattering, cooling, and forming positronium

Friday 6 December 2024 13:45 (3 hours)

We present the time and energy spectra of the annihilation gammas of magnetically confined positrons undergoing collisions and charge exchange with background gas, He, and CF_4 . The spectra are collected by a BGO (Bismuth Germanate) detectors in low-gain and high-gain mode. In high-gain mode, three detectors collect pile-up signals from timed electrostatic ejections. In low-gain mode, a 21-BGO (Bismuth Germanate) detector array situated in re-entrant ports 1 cm from the confinement volume detects ~10,000 gammas per shot. FPGA processing timestamps detections to 8 ns accuracy and records photon energy with 66 keV resolution. The spectra reveal elastic collision rates, inelastic cooling times, and a shift in the loss mechanism from positronium formation to collisional transport to the wall. This work opens the way for studying e+ diffusion in inhomogeneous fields, as well as e+ and positronium interactions with confined electrons and ions, which is essential for interpreting astrophysical and solar annihilation spectra.

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Session Classification: Poster Session

Track Classification: Positrons