Abstract for an Invited Paper  
for the DPP09 Meeting of  
The American Physical Society

Tailored Positron Beams from Trapped Single-component Plasmas
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There are a number of important uses of antiparticles (e.g., positrons and antiprotons) including the creation of antihydrogen, modeling astrophysical processes, and the characterization of materials and material surfaces. Much of this progress has been driven by the development of new plasma techniques to accumulate, manipulate and store antiparticles. This talk focuses on recent work\textsuperscript{2,3} to create specially tailored positron beams with small transverse spatial extent $\rho_b$, narrow energy spreads $\Delta E$, and high brightness by pulsed extraction from plasmas in a Penning-Malmberg trap. Experiments are presented using electron plasmas for increased data rate. By briefly lowering the exit-gate potential, beam pulses ($\Delta t < 10 \, \mu\text{s}$) from near the plasma center are created with $\rho_b = 2\lambda_D \left( \text{HW} \frac{1}{e} \right)$ and $\Delta E \approx T$, where $\lambda_D$ is the plasma Debye length, and $T$ is the plasma temperature. Specifically, by tailoring the plasma temperature to $T \approx 25 \, \text{meV}$ and density to $n_0 \approx 10^{10} \, \text{cm}^{-3}$, beams are created with $\Delta E < 35 \, \text{meV}$ and $\rho_b < 50 \, \mu\text{m}$. A nonlinear model for beam extraction is used to derive expressions for the beam amplitude $N_b$, transverse spatial profile $\sigma_b(r)$, and single particle energy distribution as a function of the exit-gate potential $V_E$, trap wall radius $R_W$, and plasma parameters.\textsuperscript{3} All predictions are verified for a wide range of plasmas. Protocols to optimize $\rho_b$ and $\Delta E$ for various applications will be discussed. Prospects for cryogenic beams and pulsed extraction from the confining $B$ field (to $B = 0$, for brightness enhancement and electrostatic focusing) will be discussed along with selected applications.

\textsuperscript{1}This work is done in collaboration with J. R. Danielson and C. M. Surko and is supported by NSF grant PHY 07-13958.