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Plasma Tools for Physics with Antimatter[1]

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Research is described that exploits nonneutral plasma techniques to develop new tools to accumulate, manipulate, and store positrons and to make cold, bright antimatter beams. Experiments are described that use test electron plasmas (for enhanced data rate) confined in a Penning-Malmberg trap using a 4.8 T magnetic field to provide strong cyclotron cooling. Recent progress in two areas is discussed. New results are presented for radial compression of plasmas using rotating electric fields [the "rotating wall" (RW) technique] in a novel, strong-drive regime.[3] It is characterized by rigidly rotating plasmas with the density set by the RW drive frequency. The criteria for accessing this regime, a model of the compression process, and possible limits of this technique will be discussed. Second, experiments and theory are described for the extraction of beams with small transverse spatial extent from the center of trapped plasmas.[4,5] For small-amplitude pulses, the radial beam profile is Gaussian with a minimum beam radius of 2 Debye lengths. The limits of this technique are identified, and model beam profiles for larger beams are discussed. Applications of these tools and challenges for the future will be discussed.

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[3]J. R. Danielson, C. M. Surko, and T. M. O'Neil, *Phys.Rev.Lett.* **99**, 135005 (2007).

[4]J. R. Danielson, T. R. Weber, and C. M. Surko, *Appl.Phys.Lett.* **90**, 081503 2007).

[5]T. R. Weber, J. R. Danielson, and C. M. Surko, *Phys.Plasmas* **13**, 123502 (2008).