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Progress toward creation and study of positron-electron plasma using the NEPOMUC positron source

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A Positron-Electron eXperiment (APEX) aims to produce a magnetically confined, low temperature positron-electron plasma in order to test predictions that such a system with equal mass but oppositely charged species, in contrast to nearly all laboratory and astrophysical plasma, is remarkably stable and exhibits other unique plasma characteristics. The magnetic trap consists of a levitated superconducting coil (a=7.5 cm, I=54 kA-turns) that produces a dipolar magnetic field (maximum field around 1 tesla). To reach plasma conditions at a temperature of kT~ 1 eV, in the confinement volume of V≈10 liters, will require injection of between 10^{10} and 10^{11} positrons (and an equal number of electrons) into the trap (see talks by A. Deller and M. Singer on plans to accumulate positrons from the NEPOMUC beam to create large pulses). In this talk, we present design details[1] and construction progress for the levitated dipole trap as well as results of experiments in a prototype trap that uses a supported permanent magnet (0.6 T at the pole surfaces). Positrons are successfully injected into the field of the permanent magnet using a combination of ExB drift, magnetic mirroring, and electrostatic reflection. Injection efficiency is preserved even in the presence of a substantial electron space charge[2], which is encouraging for our first load electrons into the trap before injecting positrons to form the plasma. Plans for installation of the levitated dipole system at the NEPOMUC facility will be presented.
[1] M.R. Stoneking, et.al., J. Plasma Phys. **86**, 155860601 (2020).
[2] M. Singer, et al., Phys. Plasmas **28**, 062506 (2021).

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