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APEX-LD: a levitated dipole trap for the confinement of an electron-positron pair plasma

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Magnetic dipole traps have demonstrated good confinement properties for both non-neutral and quasi-neutral plasmas, making this a highly suitable type of trap for the creation and study of low-temperature, long-lived electron-positron pair plasmas. To generate such a plasma, the APEX (A Positron-Electron eXperiment) Collaboration is planning to inject positrons (supplied by the reactor-based beam NEPOMUC, then collected into pulses in a buffer-gas trap) into a compact levitated dipole magnetic field (APEX-LD), which is previously loaded with a comparable population of electrons. The dipole field of APEX-LD arises from a persistent current within the "floating coil"(F-coil): a 15-cm-diameter, closed, high-temperature superconducting (HTS) coil. To avoid the use of mechanical supports the F-coil is levitated from above by an open, copper "lifting coil." A second HTS "charging coil"inductively charges the F-coil to a magnetic flux density on-axis of B = 0.5 T. Feedback-stabilization, implemented on a FPGA controller, enables over three hours of levitation. The design of APEX-LD, and magnetic field line visualizations from initial confinement experiments are presented. The future addition of an actively-cooled thermal radiation shield surrounding the trapping region will slow the resistive decay due to thermal warming, therefore increasing levitation time. This shield will also host the electrodes required to steer cold, dense pulses of e+ on to confining field lines.

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