Toward realization of electron-positron plasmas in the lab:
Project overview, positron beam experiments, and linear traps

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Electron-positron pair plasmas have long been predicted to exhibit a variety of unique properties in comparison to standard electron-ion plasmas. Only recently, though, have developments in non-neutral plasma physics and in the quality and strength of positron sources brought the goal of laboratory electron-positron pair plasmas within reach. In pursuit of this goal, there exist several interrelated challenges: availability of sufficient positrons, development of the device in which the pair plasma will be confined, and transfer of the positrons into the device. To address these challenges, the APEX/PAX (A Positron Electron eXperiment/Positron Accumulation eXperiment) collaboration is working on a number of projects in parallel, including:

- The positrons for the pair plasma will come from the NEutron-inducted POsitron source MUniCh (NEPOMUC). The energy spread and spatial profile of the beam are important for developing efficient injection schemes; measurements of these have been conducted for several different beam energies.

- The positrons from NEPOMUC are to be trapped and accumulated in PAX, composed of a series of linear, non-neutral plasma traps employing buffer and cooling gases and ultra-high-vacuum multi-cell storage. Early developmental work includes electron trapping experiments in the high-field magnet to be used for the project and positron experiments using a neon-moderated Na-22 source.

- Depending on the parallel energy spread of the NEPOMUC beam, trapping efficiency in the buffer gas trap of PAX may be reduced. Proof-of-principle simulations show, however, that a beam with an initially large energy spread can be split into multiple smaller beams, each with a smaller energy spread than the original one.