Progress towards a magnetically confined electron-positron pair plasma

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The APEX collaboration is aiming to magnetically confine a low-temperature electron-positron pair plasma [1] in a levitated superconducting coil. Such pair plasma represents a unique state of matter whose experimental realization is still pending.
In a prototype magnetic dipole trap the basis for the realization of a laboratory pair plasma is provided. Positrons from the NEPOMUC facility at FRM II near Munich are guided towards this confining device. It consists of a supported, cylindrical permanent magnet, surrounded by a cylindrical set of ten electrodes. These electrodes are segmented and can be biased individually either by applying static or time varying potentials. To inject positrons into the confining magnetic field, a drift across magnetic field lines is required. We induce this process by a pair of ExB plates, placed at the injection port. Extensive investigations of the large parameter space spanned by the conceivable electrostatic and magnetic field configurations deepened the understanding of the injection process and resulted in injection efficiencies of 100% [2] and positron confinement times exceeding one second [3].
As a next step towards a mixed state of positrons and electrons, a compact electron gun placed upstream the beam line creates an electron beam propagating parallel to the positron beam. It was demonstrated that both electrons and positrons can be injected into the confinement volume simultaneously by using the parameters originally optimized for efficient positron injection. For diagnostics, both the annihilation counts of positrons as well as the electron current are measured. Eventually we aim to magnetically confine an electron-positron pair plasma using a levitated superconducting coil. Injecting this two-species mixture simultaneously into the confinement volume is an important step towards this goal. In this contribution the aforementioned milestones as well as future prospects of the APEX project will be discussed.

References

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