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Non-Destructive Diagnostics for the PUMA Antiproton Trap

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The antiProton Unstable Matter Annihilation experiment (PUMA) is aimed at investigating nuclear haloes and neutron skins, that short-lived nuclei can exhibit [1]. Antiprotons are especially suited for this investigation as they probe the outermost tail of the nuclear density distribution [2]. When antiprotons and nuclei are brought together with low relative kinetic energies, an antiproton can annihilate with a nucleon. The energy of the annihilation is carried away mainly by pions. Since the total charge of the annihilation partners is conserved, measuring the total charge of the pions will reveal the annihilation partner (n or p) and therefore the neutron-to-proton ratio at the annihilation site. The experiment is set to take place at CERN, the only location world-wide where both low energy antiprotons and short-lived nuclei can be provided. As there currently is no way to transport antiprotons to the production site of the short-lived nuclei, up to 10^9 antiprotons will be stored in a transportable cryogenic Penning trap.

To gain control over the stored antiprotons behaving as an ellipsoid plasma, information about the antiproton plasma is crucial. Complete diagnostics of the plasma include the total number of antiprotons and their spatial distribution. Following a method developed at ATHENA [3], the PUMA experiment will use a vector network analyser to measure the dipole and quadrupole oscillation frequencies of the plasma and the power transmitted though the plasma to extract the number of stored antiprotons during accumulation and transport.

In this poster, the plasma conditions of PUMA will be presented as well as the foreseen diagnostic method to be implemented.

[1] PUMA Collaboration, "PUMA: antiprotons and radioactive nuclei", Proposal SPSC P 361, CERN (2019).
[2] A. Trzcińska et. al., "Neutron Density Distributions Deduced from Antiprotonic Atoms", Phys. Rev. Lett. 87, 082501 (2001).
[3] M. Amoretti et al., "Complete nondestructive diagnostic of nonneutral plasmas based on the detection of electrostatic modes", Physics of Plasmas 10, 3056 (2003).

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