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Towards Annihilation Studies with Slow Extracted Antiprotons

A number of experiments at CERN's Antiproton Decelerator aim to measure the properties of antihydrogen to find structural differences hinting at CPT symmetry breaking that would explain the observed baryonantibaryon asymmetry in our universe. These experiments detect antihydrogen through annihilation making the antiproton-nucleus (pbar-A) annihilation one of the main processes of interest.

The Monte Carlo simulations of these events rely on physics models developed for high energies and theoretically extrapolated to lower energies. Previous measurements from the AD experiments, including the ASACUSA-Cusp collaboration, show that the simulations do not reproduce the measured data. As even the annihilation mechanism itself is not well understood, a permanent parasitic beamline for slow extraction of antiprotons is being set up at the ASACUSA facility, in order to measure the p̄A annihilation at rest for fifteen nuclei.

The design of this beam line relies on bending and focusing elements, including an electrostatic quadrupole deflector and steering Einzel lenses that were simulated and designed using the SIMION simulation software. The aim of the simulations is to achieve a design capable of a 90° bend while providing good beam characteristics with minimal transmission losses. The optimization of the geometry and the applied voltages was achieved using a combination of several methods, such as geometry sweeps, the Nelder-Mead method and simulated annealing.

The total multiplicity of the annihilation prongs and their kinetic energy distribution will be measured with a novel detection system using Timepix4 pixel detectors covering most of the solid angle. Individual annihilation events will be reconstructed by extrapolating the recorded pion tracks, revealing their angular distribution. This poster will give an overview of the current status and progress of the experiment whose results will be implemented in a new simulation code for antiproton-nucleus reaction.

Scientific topic

Symmetries

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