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Monte Carlo simulations for a low energy antiproton-nucleus annihilation study

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The antiproton-nucleus ($\bar{p}A$) annihilation is one of the main processes in antimatter studies, as antiparticles are mostly detected through their annihilation. Despite its significance, the process itself is not well established and the lack of models for low energies complicates the simulation of detectors for the experiments conducted at CERN's Antiproton Decelerator.
Previous measurements of charged particles resulting from $\bar{p}A$ annihilations have shown that the FLUKA model exhibits the closest agreement with experimental data, while the Geant4 FTFP model shows significant discrepancies both on the multiplicities of minimum ionising particles (MIPs) and heavily ionising particles (HIPs). Both models were developed for high energy application and have not been extensively validated for sub-keV energies.
In addition, the Geant4 FTFP model predicts that at 250 eV energies a substantial fraction of antiprotons will not annihilate, but scatter off the target foil. The FLUKA model completely lacks the capability to simulate this process at energies below 1 keV.
For this reason a systematic study of $\bar{p}A$ annihilations at 250 eV on a variety of thin target foils is being set up at the ASACUSA facility. This experiment will provide data on MIP and HIP multiplicities, as well as the ratio of annihilating to reflected antiprotons. Such data will enable a study of the possible final state interactions triggered by the primary annihilation mesons, as well as their branching ratios. The results will be implemented for assessment of simulation models such as the Liège Intranuclear Cascade model, and their potential tuning.

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