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Annihilation of low energy antiprotons in 3D pixel sensor

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The aim of AEgIS is to measure the gravitational acceleration for anti-hydrogen in the Earth's gravitational field, thus testing the Weak Equivalence Principle, which states that all bodies fall with the same acceleration, independent of their mass and composition. AEgIS will make use of a silicon detector in order to measure the deflection of anti-hydrogen from a straight path under the effect of Earth's gravitational field, by detecting the annihilation position on its surface. A position resolution better than 10 μm is required to determine the gravitational acceleration with a precision better than 10%.
The direct annihilation of low energy (˜ 100 keV) anti-protons coming from the CERN antiproton decelerator was detected with a 3D pixel sensor with FE-I4 readout, originally designed for the upgrade of the ATLAS detector at the LHC.

The presented work is part of a study conducted on different silicon sensor technologies for the realization of the silicon anti-hydrogen annihilation detector for the AegIS experiment at CERN.
We show that charged annihilation products (pions and nuclear fragments) can be detected by the silicon sensor. The present study aims at understanding the signature of an annihilation event in a 3D silicon sensor, in order to assess the accuracy that can be achieved by such a sensor in the reconstruction of the position of annihilation, when the same happens directly on the detector surface. We also present a comparison between experimental data and Geant4 simulations and previous data obtained with a silicon imaging detector. These results are being used to determine the geometrical and process parameters to be adopted by the silicon annihilation detector to be installed in AEgIS.

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