3D-imaging of antimatter annihilation using the ASACUSA Micromegas tracker

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The ASACUSA collaboration aims at measuring the ground state hyperfine splitting of antihydrogen for probing fundamental symmetries. A cryogenic double cusp trap for mixing antiprotons and positrons serves as an antihydrogen source for inflight spectroscopy [1, 2]. In order to be able to monitor the antihydrogen formation process, the ASACUSA Micromegas Tracking (AMT) detector was installed for detecting and reconstructing the antiproton and antihydrogen annihilations in the trap in three dimensions [3].

The AMT detector consists out of two curved gaseous detector layers using micromegas technology [4]. The layers form two half cylinders and are mounted concentrically with the trap electrodes on the upper side of the vacuum chamber containing the trap. A single, full-cylinder layer of plastic scintillator between the two Micromegas layers provides fast signals for triggering the read ou- of the micromegas channels. As an active gas, a mixture of argon (90%) and isobutane (10%) is used. The drift region has a height of 3 mm, while the amplification region has a height of 128 μm. A relatively high drift voltage of 1600 V and an amplification potential of 460 V are applied, which sufficiently reduce the influence of the Lorentz force on the drift electrons due to the magnetic field of the trap.

Besides explaining the AMT detector in detail and describing the event reconstruction algorithm, we present annihilation data recorded during the 2016 beam time. Annihilation data from antiprotons show that the AMT detector is able to discriminate between annihilations on-axis and on the inner electrode walls of the trap [5]. The latter type of events are the primary signal candidates to be antihydrogen atoms.

[1] E. Widmann et al., Hyperfine Interactions 215, 1 (2013)
[2] N. Kuroda et al., Nature Communications 5 3089 (2014)
[3] B. Radics et al., Rev. Sci. Instrum. 86, 083304 (2015)
[4] Y. Giomataris et al., Instr. Meth. A 376 (1996)
[5] V. Mäckel et al., Nucl Instrum Methods Phys Res B 422, 1 (2018)