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Segmented scintillators with SiPM readout for measuring antiproton annihilations

The Atomic Spectroscopy and Collisions Using Slow Antiprotons (ASACUSA) experiment at the Antiproton Decelerator (AD) facility of CERN [1,2] recently constructed segmented scintillators to detect and track charged pions emerging from antiproton annihilations [3]. The detectors were designed to accompany a future superconducting radiofrequency Paul trap for antiprotons, but some of the modules were recently used to assist total cross section measurements of annihilation in-flight of slow antiprotons [4].

We arranged 541 bars of cast and extruded scintillators in 11 detector modules, which provided a spatial resolution of ~ 17 mm. Green wavelength-shifting fibers were embedded in the scintillators, and read out on one side by silicon photomultipliers (Hamamatsu MPPC) with a sensitive area of $1 \times 1 \text{ mm}^2$.

The photoelectron yields of various scintillator configurations, with different fibers, silicon photomultipliers and fiber end terminations were measured using a negative pion beam of momentum $p \approx 1 \text{ GeV}/c$ at the PS facility of CERN. The detectors were also tested using the antiproton beam of the AD. Nonlinear effects due to the saturation of the silicon photomultiplier were seen at high annihilation rates of the antiprotons.

[1] R. S. Hayano *et al.*, Rep. Prog. Phys. **70** 1–71 (2007).

[2] M. Hori *et al.*, Nature **475**, 485 (2011).

[3] A. Soter *et al.*, Rev. Sci. Instrum. **85**, 023302 (2014)

[4] H. Aghai-Khozani *et al.*, Eur. Phys. J. Plus **127**, 125 (2012).

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