

Time-of-flight measurement with the ALPHA-g Barrel Scintillator detector for gravitational studies of antimatter

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The ALPHA-g experiment recently made headlines for the first direct measurement of the gravitational free-fall of anti-hydrogen. Crucial to this milestone is a detector system capable of accurately recording the vertical position of annihilating anti-atoms, with two critical requirements: precise localization of anti-hydrogen annihilations into the “up” or “down” regions, and effective discrimination against the cosmic ray background. To accomplish this, charged pions produced in the annihilation are tracked using a radial time projection chamber detector, and fitted to a common vertex. These pions are also detected by the “Barrel Scintillator” detector, composed of 2.6-meter plastic scintillator bars with silicon photomultipliers at both ends. The arrival time of photons at the silicon photomultipliers is used to determine the time of the pion hitting the bar. This timing information is then used as part of a multivariate analysis to reject externally incident cosmic rays. This poster showcases the time calibration procedure used to obtain time-of-flight measurement of cosmic rays in the Barrel Scintillator, and the background rejection algorithm that will be used for forthcoming ALPHA-g measurements of the gravitational behaviour of anti-hydrogen.

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