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Precision Antihydrogen Annihilation Reconstructions using the ALPHA-g Apparatus

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The ALPHA (Antihydrogen Laser PHysics Apparatus) experiment aims to provide a possible solution to the baryonic asymmetry problem by testing CPT (charge conjugation, parity reversal, time reversal) theory and observing whether antimatter follows Einstein's Weak Equivalence Principle (WEP), where the acceleration due to gravity that a body experiences is independent of its structure or composition. A measurement of this nature has never been done before, as previous experiments used charged particles which meant the experiments were dominated by electromagnetic forces. The ALPHA-g apparatus will use electrically neutral antihydrogen produced in a vertical Penning-Malmberg trap and hold the antihydrogen in a magnetic well. Once the antihydrogen is released, the position of the resulting annihilation can be reconstructed with a radial TPC (time projection chamber) surrounding the trapping volume [1].

Position information can be determined by the signal generated by the products of the annihilations as they travel through the TPC. Tracing these products accurately to their point of origin is imperative to understanding the direction of antihydrogen. I will focus on how these calculations are done through simulations, and how the process will compare to real data. This data will be used to measure the gravitational mass of antihydrogen, making this a crucial step in testing the fundamental symmetry of matter and antimatter. The ALPHA-g apparatus is currently being commissioned at CERN, and the first gravitational measurements of antihydrogen are expected to begin in October 2021.

[1] Capra, A., et al. "Design of a Radial TPC for Antihydrogen Gravity Measurement with ALPHA-g." Proceedings of the 12th International Conference on Low Energy Antiproton Physics (LEAP2016).

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