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Silicon sensors for the AMS-L0 Upgrade: beam test setup and results

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The Alpha Magnetic Spectrometer (AMS) was installed on the International Space Station in 2011. This particle physics experiment is designed to measure the composition of cosmic rays in low Earth orbit, with the primary goal of distinguishing between antimatter and matter. AMS is equipped with a permanent magnet and multiple detectors, allowing it to analyze incoming cosmic rays with rigidities ranging from 1 GV to several TV.

To maximize the remaining data collection period before the ISS planned retirement in 2030, the AMS collaboration plans to install in 2026 an additional silicon tracking layer, on top of the existing instrument. This tracking layer, L0, consists of two planes of silicon microstrip detectors, each composed of 36 fundamental units called “ladders,” with a total effective detection area of 8 m^2. This upgrade will not only increase the acceptance of multiple analysis channels by a factor of three and extend the measurable energy range of AMS, but it will also enhance the identification of incoming particles before they interact with the detector material and undergo fragmentation.

To thoroughly validate the charge identification and spatial resolution capabilities of L0 and its ladders, we conducted multiple beam tests at CERN. These tests include beams of heavy ions and muons. In this work, we will first introduce the relevant background information, with a detailed discussion of the experimental setup used in the recent L0 beam tests. Specifically, we installed two sets of beam telescopes, one upstream and one downstream with respect to the ladder to reconstruct particle trajectories. This let us estimate the particles position at the ladder location with a precision of approximately 2 μm. We also exploited a charge detector to assist in analyzing the charge resolution of the ladder in offline analysis by having a precise reference. Finally, we will present and discuss the preliminary results from these L0 beam tests.

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