The Silicon Charge Detector of the High Energy Cosmic Radiation Detection experiment

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Abstract

The High Energy Cosmic Radiation Detector (HERD) is an experiment designed for direct measurement of cosmic rays on the Chinese Space Station in 2027. Its goals include precise measurements of cosmic ray energy spectra, mass composition, electron/positron spectra, CR anisotropy, gamma ray astronomy and indirect searches for Dark Matter. HERD features a $55X_0$, homogeneous, 3D segmented imaging calorimeter (CALO) and can detect particles from the top and 4 lateral sides, providing precise energy measurements and electron/proton separation for a wide field of view. A key detector in HERD is the Silicon Charge Detector (SCD), based on successful design of the silicon micro-strip tracking devices used also for charge measurement in the space-borne experiments in AMS-01, PAMELA, AMS-02, and DAMPE experiments. SCD measures particle charge before interaction with other materials, minimizing CR nuclei fragmentation and reducing systematics on nuclei flux measurement. The SCD design includes five thin detector units: one square-shaped unit (1.8 x 1.8 m^2) on top and four units (1.6 x 1.1 m^2) on the remaining sides. Each unit comprises eight layers of 300 μm microstrip silicon detectors on low-density aluminum honeycombs. The SCD's total active area is approximately 80 m^2. Thorough studies, TCAD and/or SPICE simulations, and accelerator tests on prototypes have been conducted to evaluate the tracking and charge resolution capabilities of the SCD. Further testing with 300 μm detectors is planned in the coming months to fully characterize the SCD's performance. We will present the results of the simulation studies and of the measured performance with particles.