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The Si/CdTe semiconductor Compton camera of the ASTRO-H Soft Gamma-ray Detector

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The Soft Gamma-ray Detector (SGD) is one of the ASTRO-H instruments and will feature wide energy band (60–600 keV) at a background level 10 times better than instruments currently in orbit. The SGD achieves low background by combining a Compton camera scheme with a narrow field-of-view active shield. The Compton camera in the SGD is realized as a hybrid semiconductor detector system which consists of silicon and CdTe (cadmium telluride) sensors. The Compton camera has an overall size of 12 cm x 12 cm x 12 cm, and consists of 32 layers of Si pixel sensors and 8 layers of CdTe pixel sensors surrounded by 2 layers of CdTe pixel sensors. The total volumes of sensitive Si and CdTe in one Compton camera are 50 cm3 and 40 cm3, respectively. The detection efficiency of the Compton camera reaches about 15% and 3% for 100 keV and 511 keV gamma rays, respectively. The pixel pitch of the Si and CdTe sensors is 3.2 mm, and the signals from 13312 pixels in total are processed by 208 ASICs developed for the SGD (and HXI of ASTRO-H). Good energy resolution is afforded by semiconductor sensors and low noise ASICs, and the obtained energy resolutions with the prototype Si and CdTe pixel sensors are 1.0–1.6 keV (FWHM) at 60 keV and 1.6–2.5 keV (FWHM) at 122 keV, respectively. It results in good background rejection capability due to better constraints on Compton kinematics. Utilization of Compton kinematics also makes the SGD sensitive to gamma-ray polarization, opening up a new window to study properties of emission processes.
In this paper, we will present the details of the detector configuration and the data acquisition system of the SGD Compton camera. We will also present the performance evaluated in the final prototype, which is equivalent to the flight model.

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