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Development of High Performance Avalanche Photodiodes and Dedicated Analog Systems for HXI/SGD Detectors onboard the Astro-H mission

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Hard X-ray Imager and Soft Gamma-ray Detector are being developed as on-board instruments for the Astro-H mission, which is scheduled for launch in 2014. In both detectors, BGO scintillators play key roles in achieving high sensitivity in low earth orbit, by generating active veto signals to reject cosmic-ray events and gamma-ray backgrounds from the radio-activated detector materials. Furthermore, in order to maximize background rejection power, it is important to minimize the energy threshold of this shield. As a readout sensor of weak scintillation light from a number of BGO crystals in a complicated detector system, high performance, reverse-type Avalanche Photodiodes (APDs), with effective area of 10 × 10 mm2 are being employed, instead of bulky photo-multiplier tubes (PMTs). Another advantage of using APDs is their low power consumption, although the relatively low gain of APDs (compared to conventional PMTs) requires dedicated analog circuits for noise suppression.

In this paper, we report on the development and performance of APD detectors specifically designed for the Astro-H mission. In addition to the APD performance itself, various environmental tests, including radiation hardness and qualification thermal cycling, will be described in detail. Moreover, a dedicated charge sensitive amplifier and analog filters are newly developed and tested here to optimize the performance of APDs to activate fast veto signals within a few μs from the BGO trigger. We will also report on the performance test throughout a prototype BGO detector system as a whole that mimics the data acquisition system onboard Astro-H.

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