

Development of Digital Signal Processing System of Avalanche Photodiode for Space Observations by Astro-H

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Astro-H is 6th Japanese X-ray space observatory which will be launched in 2014. Two of onboard instruments of Astro-H, Hard X-ray Imager and Soft Gamma-ray Detector are surrounded by many number of large Bismuth Germanate (Bi₄Ge₃O₁₂; BGO) scintillators. Optimum readout system of scintillation lights from these BGOs are essential to reduce the background signals and achieve high performance for main detectors because most of gamma-rays from out of field of view of main detectors or radio-activated materials can be eliminated by anti-coincidence technique. We apply Avalanche Photo Diode (APD) for light sensor of these BGO detectors since their compactness and high quantum efficiency make it easy to design such complicate BGO detector system. For signal processing from APDs, digital filter and other trigger logics on the Field-Programmable Gate Array (FPGA) is used after dedicated minimal analog circuits due to limitation of circuit implementation area on spacecraft. For efficient observations, we have to achieve as low threshold of anti-coincidence signal as possible. In addition, these signals should be sent to the main detector within 5 us to make it in time to stop AD conversion. Considering these requirements, we adopt two types filter to realize both quick generation of anti-coincidence signals in orbit and detail analysis after the data is down-linked. We are now in the phase of performance test by implementing such filter and trigger logics into FPGA on the Bread Board Model (BBM) of APD signal processing unit, and we also use other BBM or engineering model components, such as APD sensors and preamplifiers. In this paper, we will review our APD signal processing system and report current result of performance test.

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