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Development of X-ray/Gamma-ray Imaging Spectrometer with Reach-through APD Arrays

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It is important to obtain wide band X-ray/gamma-ray spectra at the same time in order to probe efficiently the emission processes or the structures of transient object such as gamma-ray bursts. We have developed, for future missions, an X-ray/gamma-ray detector utilizing reach-through type avalanche photodiode (APD) array (8- and 16-segments) with the area of $1.6 \times 1.8 \text{ cm}^2$. Excellent uniformity over the segments was achieved both in gain and energy resolution, where the deviations are less than 1.5 and 2%, respectively. We optically coupled the APD arrays with segmented CsI(Tl) scintillators fabricated to fit the APD pixel sizes. We irradiated gamma-ray source from the side of the APD. With this configuration X-rays are directly absorbed with the APD while gamma-rays are stopped by the CsI(Tl) where the APD works as a scintillation detector. These two events are discriminated by the differences in signal rise time using shaping amplifier with a time constant of 50 nano and 2 micro-seconds. We demonstrated that the two components were clearly separated and energy coverage was from about 1 keV to 1 MeV. Typical energy resolution for 662 keV and 32 keV was 8% and 9% (detected directly by the APD). These results shows that our detector can be used as a nice 1-dimensional imaging spectrometer. We propose to employ two sets of this detector for X- and Y- axis together with coded aperture masks for imaging the sky.

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