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Design and Development of an Event-driven SOI Pixel Detector for X-ray Astronomy and Light Dark Matter Search

We have been developing monolithic active pixel detectors, named "XRPIX"based on the silicon-on-insulator (SOI) pixel technology, for future X-ray astronomical satellite missions. Our objective is to replace X-ray Charge Coupled Devices (CCD), which are now standard detectors in the field. The XRPIX series offers good time resolution (~1 μs), fast readout time (~10 μs), and a wide energy range (0.5–40 keV) in addition to having imaging and spectroscopic capability comparable to CCDs. XRPIX contains a comparator circuit in each pixel for hit trigger (timing) and two-dimensional hit-pattern (position) outputs. Therefore, signals are read out only from selected pixels. X-ray readout by this function is called "event-driven readout".
In our previous studies, we successfully demonstrated X-ray detection by the event-driven readout. We improved the X-ray spectral performance by introducing in-pixel charge-sensitive amplifier circuit in the frame readout mode, which an analog signal from all pixels periodically. We achieved an energy resolution of 320 eV (FWHM) for 5.9 keV X-rays with which Mn-Kα and -Kβ lines are resolved for the first time in the XRPIX series. Recently, we designed the first prototype to achieve a large-area device for satellite loading. The detector is 24.6 mm × 15.3 mm in size and consists of 608 × 384 pixels. The pixel size and the imaging area are 36 μm × 36 μm and 21.9 mm × 13.8 mm, respectively. Moreover, We propose a light dark matter search experiment using the XRPIX. In this presentation, we report on the design and evaluation results of the new device, and the plan about a light dark matter search experiment.

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