Contribution ID: **91** Type: **Oral**

Performance Evaluation of Event-Driven SOI Pixel Detector "XRPIX8.5" for Cosmic MeV Gamma-ray Observation

Thursday 7 December 2023 12:40 (20 minutes)

Cosmic MeV gamma-ray observations are important for understanding physics in high-energy astronomical objects such as gamma-ray bursts and blazars. However, there has been no progress since COMPTEL on board the Compton Gamma Ray Observatory in the 1990s, thus a new satellite for MeV gamma-ray observations is needed. Compton scattering is the dominant interaction between MeV gamma-rays and matter. The minimal way to reconstruct the arrival direction of an incident gamma-ray is to utilize both the deposit energy and hit position measured in both the scatterer and absorber, giving an event circle. In order to improve the angular resolution, one can measure the track of the Compton-scattered electron with a pixel sensor and utilize the estimated initial momentum of the electron to reduce the circle to an arc. We have been evaluating an event-driven Silicon-on-Insulator (SOI) pixel detector XRPIX8.5 as a scatterer for future MeV gamma-ray telescopes. XRPIX is a detector that incorporates both a thick depletion layer and high-speed, low-noise CMOS pixel circuits simultaneously by utilizing SOI technology and issues trigger and coordinate information immediately after detecting signal. The pixel size of XRPIX8.5 is 36 um square and thus it is expected to measure electron tracks for gamma rays with the energy of several hundred keV since, for instance, an electron with the energy of 300 keV creates a track of ˜500 um in silicon. In this contribution, we report on the evaluation of the depletion layer thickness of XRPIX8.5, which can be fully depleted at room temperature, the sensor response when irradiated with gamma-rays such as 662 keV of Cs-137 and 511 keV of Na-22, and a method for estimating the initial direction of electron track.

Submission declaration

Original and unplublished

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Session Classification: Day 4 - Session 2

Track Classification: Applications in astrophysics