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P1.54: Imaging Performance of Wide-Field X-ray Transient Localization Experiment onboard Microsatellite KOYOH

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Since direct gravitational wave and neutrino detections has achieved [1], a new field of research called multi-messenger astronomy has emerged, which combines multiple signals beyond electromagnetic waves to investigate astrophysical phenomena more deeply. KOYOH is a microsatellite project that monitors and observe X-ray transients associated with gravitational waves, developed by Kanazawa University. It rapidly alerts other telescopes to the trigger time and direction of the detected X-ray sources. Accurate measurement of the precise direction of gravitational wave sources promotes the identification of their host galaxies and follow-up observations in other wavelengths. This satellite has two mission instruments: a wide-field X-ray imaging detector, and a wide-field gamma-ray detector. The X-ray imaging detector system is referred to as Transient Localization Experiment (T-LEX) [2]. T-LEX is designated to have a field-of-view of 1 steradian, an energy range of 2 –20 keV, and localization accuracy of 15 arcminutes. The unique feature of this project is the ability to perform wide-field imaging with sensitivity to X-rays below 10 keV. It consists of silicon strip detectors (SSDs) with analog/digital Application Specific Integrated Circuits (ASICs) [3] for low energy X-ray signal readout and two sets of one-dimensional random-aperture coded mask imaging system made of 50-μm-thick tungsten plate. The mask and SSD is positioned at a distance of 68.6 mm, and the pitch of the aperture elements of the mask and the electrodes of the SSD is 0.3 mm. To demonstrate the imaging performance, we performed experiments in which X-ray beams were irradiated onto the flight model of the detector (as shown Figure 1) from various angles. We calculate the cross correlation between the mask's aperture pattern and the detector image, which results in the appearance of a peak at the shifted position corresponding to the arrival direction as shown in Figure 2. In this experiment, we varied the incident angle from -20 degrees to +20 degrees at 5-degree intervals and investigated the peak position of the reconstructed image. As expected from geometric considerations, a response that depends on the tangent with respect to the incident angle was confirmed. The discrepancy between the angle response predicted by a geometric model using the design parameters and the experimental results was found to be up to a maximum of 16 arcminutes. On the other hand, by leaving the design parameters free and fitting them to best replicate the experimental angular response, we obtained parameters that satisfy the 15-arcminute requirement at the all incident angles. We intend to carefully determine the optimal values of geometric parameters in the angular response model, including on-board calibration after satellite launch. In this presentation, we report the result of the imaging performance experiment.

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