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# X-ray response evaluation in subpixel level for X-ray SOI pixel detectors

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We have been developing X-ray SOIPIX detectors named XRPIX for future X-ray astronomical satellites. SOIPIX is the CMOS pixel sensor with Silicon On Insulator (SOI) technology. XRPIX can detect the hard X-ray photons up to a few tens of keV thanks to its thick depletion layer with a thickness of a few hundreds of $\mu$m. Moreover, it has a high time resolution of a few $\mu$s and a moderate energy resolution comparable to that of CCDs. In our previous work using the prototype XRPIX named XRPIX1b_FZ with 500 $\mu$m thick depletion layer, we found that detection efficiency in subpixel is not uniform by irradiating 17.7 keV energy X-ray to the front side (circuit layer side of XRPIX) of the device at SPring-8. Relative detection efficiency compared to the highest efficiency at center area of a pixel is $95.6 \pm 2.9\%$ at boundary with the adjacent pixel, and $79.4 \pm 2.4\%$ at intersection of pixel boundaries (corner of a pixel). According to the electric field simulation, this phenomenon results from the electric field structure in the sensor layer. Then, we developed a device with a new pixel circuit layout in order to improve the charge collection efficiency. In this study, we evaluate the uniformity of detection efficiency in subpixel level using the newly developed XRPIX named XRPIX3b_FZ with 310 $\mu$m thick depletion layer. We scanned the device with a step size of 6 $\mu$m by irradiating monochromatic soft X-ray collimated beam size of 4 $\mu$m at KEK photon factory. As a result, relative detection efficiency at 5 keV energy X-ray compared to the center of a pixel is $98.4 \pm 3.5\%$ at boundary of two pixels, and $96.3 \pm 3.9\%$ at corner of a pixel. Therefore, we confirmed the improvement of the variation of the detection efficiency in the device with new circuit layout. In this presentation, we will also report the uniformity of gain and energy resolution in subpixel level.

**Primary author:** Mr NEGISHI, Kousuke (Tokyo University of Science)

**Co-authors:** Dr TAKEDA, Ayaki (University of Miyazaki); Mr MATSUMURA, Hideaki (Kyoto University); Mr HAYASHI, Hideki (Kyoto University); Prof. KURACHI, Ikuo (HIgh Energy Accelerator Research Organization); Mr TACHIBANA, Katsuhiro (Kyoto University); Mr YARITA, Keigo (Tokyo University of Science); Mr OONO, Kenji (Tokyo University of Science); Mr FUKUDA, Kohei (University of Miyazaki); Dr MORI, Koji (University of Miyazaki); Mr TAMASAWA, Koki (Tokyo University of Science); Dr HAGINO, Kouichi (Tokyo University of Science); Mr TAKEBAYASHI, Nobuaki (University of Miyazaki); Mr YOKOYAMA, Shoma (University of Miyazaki); Prof. KISHIMOTO, Shunji (KEK); Mr HARADA, Sodai (Kyoto University); Dr TANAKA, Takaaki (Kyoto Univsersity); Dr KOHMURA, Takayoshi (Tokyo University of Science); Prof. TSURU, Takeshi (Kyoto University); Mr KOGISO, Taku (Tokyo University of Science); Prof. MIYOSHI, Toshinobu (KEK); Prof. ARAI, Yasuo (High Energy Accelerator Research Organization (JP)); Mr NISHIOKA, Yusuke (University of Miyazaki)

**Presenter:** Mr NEGISHI, Kousuke (Tokyo University of Science)

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