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Evaluation of X-ray astronomical SOI CMOS pixel sensor aimed at improving charge-collection efficiency

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We have been developing monolithic active pixel sensors for X-ray astronomy, referred to as “XRPIX”, based on silicon-on-insulator (SOI) CMOS technology. Each pixel has a buried p-well (BPW) around sense node at the pixel center to suppress the back-gate effect. In our early device, XRPIX1b, charge-collection efficiency (CCE) was degraded because the in-pixel circuitry placed outside the BPW affected the electric fields of the sensor layer. Our next device, XRPIX2b, improved the CCE by rearranging the placement of the circuitry on or near the BPW. However, the CCE at the pixel borders was still lower than that at the pixel center. Based on this result, We developed a new device, XRPIX6H, with more concentration of the circuitry inside the BPW. We measured the X-ray response of XRPIX6H and confirmed further improvement of the CCE at the pixel borders. A simulation study on the electric field convergence toward the sense node about XRPIX2b and XRPIX6H are also presented.

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