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The performance measurements of INTPIX6 SOI pixel detector

The measurement results of monolithic pixel detector INPTIX6, designed at KEK and fabricated in Lapis 0.2~μm Fully-Depleted, Low-Leakage Silicon-On-Insulator (SOI) CMOS technology, are presented. INTPIX6 consists of 896 × 1408 integrating type pixels, 12 μm × 12 μm each. The detector prototypes were produced on three various silicon wafers CZ-n, FZ-n, FZ-p, with different resistivity and doping. In this work the comparison of general performance of these three prototypes is presented, with the detailed measurement results of the CZ-n prototype. Using ^{241}Am radioactive source the noise of readout electronic was measured, showing the ENC about 70-80~e^{-}. A particular focus of this work is the radiation hardness of the SOI pixel detector. The INTPIX6 has been irradiated up to 300~krad dose and its performance has been continuously monitored during the irradiation.

Summary

The SOI detector presented in this work is one of the INTPIX family which are designed at KEK and fabricated in Lapis 0.2~μm SOI CMOS technology. Three prototypes of INTPIX6 detectors fabricated on low resistivity wafers obtained by Czochralski method (CZ-n) and on high resistivity floating zone wafers (FZ-n, FZ-p) were measured and tested in Cracow. The measurements were focused on the INTPIX6 performance, reflected by the Equivalent Noise Charge (ENC), as a function of radiation dose.

INTPIX6 is a general purpose integration type pixel with a simple data processing circuitry to reduce pixel size and obtain better spatial resolution. The whole matrix is 896 × 1408 with pixel dimension 12 μm × 12 μm. The detailed studies confirmed a full functionality of pixel detectors made on n-type doping wafer. The first measurements of the FZ-p type detector showed slightly worse performance and additional studies are needed to make further conclusions.

The INTPIX6 parameters were studied in detail with infrared laser and X-ray sources (^{241}Am and ^{55}Fe). All the measurements were taken at about -100V back bias voltage. The performed data analysis included common mode subtraction, single pixel gain correction and hit reconstruction. Such algorithm allowed to determine the ENC in range of 70-80~e^{-} for the measurements done at room temperature and with 10~μs integration time. This result is comparable to the state of the art pixel detectors.
The ENC did not change significantly for different integration times, so the mean source of noise does not come from pixel leakage current.

The performance of the detector was studied during X-ray irradiation of the pixel matrix up 300 krads dose. The detector showed very good performance, reflected by its small ENC and negligible number of bad pixels, up to 100~krad dose. Above this value the number of noisy pixels started to increase significantly but the detector was still alive giving reasonable response to laser and X-ray signal even after 300~krad dose.

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