

Test-beam evaluation of newly developed n⁺-in-p planar pixel sensors aiming for use in high radiation environment

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Radiation-tolerant n⁺-in-p planar pixel sensors have been under development in cooperation with Hamamatsu Photonics K.K. (HPK). This is geared towards applications in high-radiation environment, such as for the Inner Trackers (ITk) placed inside the ATLAS detector in the high luminosity LHC (HL-LHC) experiment. Prototypes of those sensors have been produced, irradiated and evaluated through past years.

In the previous studies, it was reported that significant drops in the detection efficiency were observed after irradiation, especially under bias structures. The bias structures are made up of poly-Si or Al bias rails and poly-Si bias resistors. The structure is implemented on the sensors to allow quality checks to be performed before the bump-bonding process. To minimize the efficiency drop, several new pixel structures have been designed with bias rails and bias resistors relocated.

Several test-beams have been carried out to evaluate the drops in the detection efficiency of the new sensor structures after irradiation. Newly developed sensor modules were irradiated with proton-beams at Cyclotron and Radio-Isotope Center (CYRIC) in Tohoku University to see the effect of sensor-bulk damage and surface charge-up. An irradiation with gamma-rays was also carried out at Takasaki Advanced Radiation Research Center, aiming for decoupling the effect of surface charge-up from that of bulk damage. Those irradiated sensors have been evaluated with particle beams at DESY and CERN. Comparison between different sensor structures confirmed significant improvements in minimizing efficiency loss under the bias structures after irradiation. The results from gamma-irradiation also enabled cross-checking the results of a semiconductor technology simulation program (TCAD).

Co-authors: ATLAS-Japan silicon collaboration, ATLAS PPS collaboration

Primary author: KIMURA, Kimihiko (Tokyo Institute of Technology (JP))

Presenter: KIMURA, Kimihiko (Tokyo Institute of Technology (JP))

Session Classification: After dinner POSTER session, with drinks: (All presenters are requested/encouraged to attend their posters; All participants are requested to participate the session, with drinks!)

Track Classification: Pixels (including CCD's) - Charged particle tracking