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P-stop isolation study of irradiated n-in-p type silicon strip sensors for harsh radiation environment

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In order to determine the most radiation hard silicon sensors for the CMS Experiment after the Phase II Upgrade in 2023 a comprehensive study of silicon sensors after a fluence of up to 1.5e15 neq/cmˆ2 corresponding to 3000fb-1 after the HL-LHC era has been carried out. The reuslts led to the decision that the future Outer Tracker (˜20cm < R < ˜110cm) of CMS will consist of n-in-p type sensors.
This technology is more radiation hard but also the manufacturing is more challenging compared to p-in-n type sensors due to additional process steps in order to suppress the accumulation of electrons between the readout strips. One possible isolation technique of adjacent strips is the p-stop structure which is a p-type material implantation with a certain pattern for each individual strip. However, electrical breakdown and charge collection studies indicate that the process parameters of the p-stop structure have to be carefully calibrated in order to achieve a sufficient strip isolation but simultaneously high breakdown voltages.
Therefore a study of the isolation characteristics with four different silicon sensor manufacturers has been executed in order to determine the most suitable p-stop parameters for the harsh radiation environment during HL-LHC. Several p-stop doping concentrations, doping depths and different p-stop pattern have been realized and experiments before and after irradiation with protons, neutrons and x-rays have been performed and compared to T-CAD simulation studies with Synopsys Sentaurus. The measurements combine the electrical characteristics measured with a semi-automatic probestation with Sr90 signal measurements and analogue readout. Furthermore, some samples have been investigated with the help of a cosmic telescope with high resolution allowing charge collection studies of MIPs penetrating the sensor between two strips.
The conclusion on this study will be presented.

Author: PRINTZ, Martin (KIT - Karlsruhe Institute of Technology (DE))

Presenter: PRINTZ, Martin (KIT - Karlsruhe Institute of Technology (DE))

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