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Simulations of Inter-Strip Capacitance and Resistance for the Design of the CMS Tracker Upgrade

An upgrade of the LHC accelerator, the high luminosity phase of the LHC is foreseen for 2023. The tracking system of the CMS experiment at HL-LHC will face an intenser radiation environment than the present system was designed for. This requires an upgrade of the full tracker, which will be equipped with higher granularity as well as radiation harder sensors, which can withstand higher radiation levels and higher occupancies.

In order to prepare for HL-LHC, the CMS tracker collaboration has started a campaign to identify the future planar silicon sensor technology baseline for a new tracker. The campaign includes a large variety of 6 inch wafers of different thickness, ranging from 50 µm to 300 µm, which are explored on Float-Zone, Magnetic Czochralski and Epitaxial silicon both in n-in-p and p-in-n diodes as well as in multi geometry strip sensors.

To address the problems caused by the intense radiation environment extensive measurements and simulation studies have been initiated for investigating these different design and material options for silicon micro-strip sensors.

The simulation studies are based on commercial packages (Silvaco and Synopsys T-CAD) and aim to investigate sensor characteristics before and after irradiation for fluences of up to $1.5 \cdot 10^{15} n_{eq}/cm^2$. A defect model was developed to implement the radiation damage and tuned to fit experimental measurements.

This talk covers the simulation of the inter-strip capacitance and resistance both before and after irradiation. Both properties are crucial for the design of future sensors, being responsible for strip noise and isolation, in turn affecting resolution. A detailed understanding of these parameters is required for an optimal sensor design for the future CMS tracker.

A comprehensive simulation study will be shown, encompassing all configurations of n- and p-type bulk material, within the latter differentiating between p-stop and p-spray isolation. The effects of strip width, pitch, surface charge density and irradiation fluence will be systematically parametrized and a comparison between simulation and measurement drawn, followed by conclusions for the design of the future CMS tracker sensors from a TCAD simulation perspective.

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