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RD50 activities on radiation tolerant silicon detectors

It is foreseen to significantly increase the luminosity of the LHC by upgrading towards the HL-LHC (High Luminosity LHC), resulting in unprecedented radiation levels, significantly beyond the limits of the silicon trackers currently employed. All-silicon central trackers are being studied in ATLAS, CMS and LHCb, with extremely radiation hard silicon sensors to be employed on the innermost layers. Within the RD50 Collaboration, a large R&D program has been underway across experimental boundaries to develop silicon sensors with sufficient radiation tolerance for HL-LHC trackers.

One research topic is to gain a deeper understanding of the connection between the macroscopic sensor properties such as radiation-induced increase of leakage current, doping concentration and trapping, and the microscopic properties at the defect level. An area of strong activity is the development of advanced sensor types like 3D silicon detectors, designed for the extreme radiation levels expected for the vertexing layers at the HL-LHC, or new sensor fabrication technologies such as High-Voltage (HV) CMOS, exploiting the wide availability of the CMOS process in the semiconductor industry at very competitive prices compared to the highly specialised foundries that normally produce particle detectors on small wafers

We will present results of several detector technologies and silicon materials at radiation levels corresponding to HL-LHC fluences. Based on these results, we will give recommendations for the silicon detectors to be used at the different radii of tracking systems in the LHC detector upgrades. In order to complement the measurements, we also perform detailed simulation studies of the sensors, e.g. device structure optimization or predictions of the electric field distributions and trapping in the silicon sensors.

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