Development of Radiation Tolerant Silicon Tracking Detectors

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Abstract:

The luminosity upgrade of the Large Hadron Collider (LHC) towards the sLHC (Super-LHC) will increase the radiation dose seen by the experiments by roughly an order of magnitude compared to the LHC. The elevated radiation levels will require the LHC experiments to upgrade their tracking systems with extremely radiation tolerant silicon detectors, capable of withstanding up to a 1-MeV neutron-equivalent fluence of 10^{16}cm^{-2} for the innermost tracking layers.

The presentation will briefly review the basic mechanisms leading to the radiation induced degradation of silicon detectors; put forward the limitations of today's tracking detectors and then focus in more detail on recent results on radiation hardening technologies developed for the sLHC. In particular radiation damage studies on silicon detectors designed and produced on various n- and p-type silicon materials (Float-Zone, epitaxial and Czochralski silicon) of different thickness will be presented and compared. Some qualitative explanations of the observed differences will be given including some recent observations on charge multiplication processes in very heavily irradiated silicon sensors. Finally, novel detector concepts like 3D detectors and detectors based on other semiconductor materials like diamond will be briefly touched and compared to planar silicon sensors in order to explain and outline the present research activities of the big LHC Experiments and CERN R&D collaborations.