Contribution ID: **48** Type: **not specified**

RD50: Simulation of radiation-induced defects

Mainly due to their outstanding performance the position sensitive silicon detectors are widely used in the tracking systems of High Energy Physics experiments such as the ALICE, ATLAS, CMS and LHCb at LHC, the world's largest particle physics accelerator at CERN, Geneva. The foreseen upgrade of the LHC to its high luminosity (HL) phase (HL-LHC scheduled for 2023), will enable the use of maximal physics potential of the facility. After 10 years of operation the expected fluence of above 1015 neqcm−2 for strip sensors ~20 cm from the vertex will expose the tracking system at HL-LHC to a radiation environment that is beyond the capacity of the present system design. Thus, for the required upgrade of the all-silicon central trackers extensive measurements and simulation studies for silicon sensors of different designs and materials with sufficient radiation tolerance have been initiated within the RD50 Collaboration.

Complementing measurements, simulations are in vital role for e.g. device structure optimiza- tion or predicting the electric fields and trapping in the silicon sensors. When numerical simulations are able to verify experimental results they will also gain predictive power, resulting in reduced time and cost budget in detector design and testing. The main objective of the device simulations in the RD50 Collaboration is to develop an approach to model and predict the performance of the irradiated silicon detectors (diode, strip, pixel, columnar 3D) using professional software.

The simulation of radiation damage in the silicon bulk is based on the effective mid gap levels (a deep acceptor and a deep donor level). The main idea of the model that was first proposed in 2001 and entitled later as the " PTI model"is that the two peaks in the E(z) profile of the both proton and neutron irradiated detectors can be explained via the interaction of the carriers from the bulk generated current with the electron traps and simultaneously with the hole traps. The first successfully developed quantitative models, namely the proton model and the neutron model, for the simulation of the detector characteristics like leakage current, full depletion voltage and charge collection efficiency (CCE) were built on the base of the PTI model. Recent implementations of additional traps at the SiO2/Si interface or close to it have expanded the scope of the simulations to include experimentally agreeing surface properties such as the interstrip resistance and capacitance, and the position dependency of CCE for strip sensors irradiated up to 1.5 × 1015 neqcm−2.

Insights to the development processes of the defect models and comparisons of the simulation results with measurements of several detector technologies and silicon materials at radiation levels expected for the HL-LHC will be presented.

Primary author: PELTOLA, Timo Hannu Tapani (Helsinki Institute of Physics (FI))

Presenter: PELTOLA, Timo Hannu Tapani (Helsinki Institute of Physics (FI))