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Characterization of planar and 3D pixel sensors for the inner tracker of the CMS experiment (in-person)

Wednesday 15 September 2021 09:00 (15 minutes)

The Compact Muon Solenoid (CMS) experiment is expected to collect an integrated luminosity of 3000 or even 4000fb⁻¹ in the ultimate scenario during the High Luminosity phase of the Large Hadron Collider (HL-LHC). This scenario comes with a high number of collisions per bunch crossing, and in turn, a high level of radiation for the inner layer of the CMS tracker. The simulations estimate a 1-MeV neutron equivalent fluence, phi_eq, of 2.3\times 10¹⁶ cm⁻² at a distance of 2.8 cm from the collision point (for the integrated luminosity of 3000 fb⁻¹). The inner tracker of the CMS detector is required to withstand this range of fluence and maintain its track-finding functionality.

Planner and 3D pixel sensors with an active thickness of 150 um and pixel sizes of 25 \times 100 um² or 50 \times 50 um² have been produced by Hamamatsu Photonics (HPK), Fondazione Bruno Kessler (FBK), and Microelectronic National Center(CNM). The sensors were bumped bonded to the RD53A readout chip prototype. The sensor-chip modules were irradiated with 23 MeV and 24 GeV protons to the fluence of up to 2.4 \times 10¹⁶ cm⁻² the Karlsruhe Institute of Technology (KIT) and PS-IRRAD proton facility.

The modules were tested in the DESY II beam test facility. The hit efficiency and spatial resolution as a function of the incidence angle of pixel sensors were determined from these measurements. It has been shown that for the highest fluence, the planar modules still reach 99\% hit efficiency, required for the Phase-2 IT, at bias voltages below 800V. For 3D sensors, no significant change in efficiency was observed after irradiation. This talk presents the results for planar and 3D sensors before and after irradiation.

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