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Radiation effects in the CMS phase 1 pixel detector

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The Compact Muon Solenoid (CMS) pixel detector has been replaced in 2017 to meet the challenges of the high-pileup and high-luminosity environment from proton-proton collisions at the Large Hadron Collider (LHC). The current phase 1 CMS pixel detector has 4 barrel layers and 3 endcap disks to maintain tracking performance at instantaneous luminosities of 2x10e34/cm2/s, and now has withstood fluences up to 1e15 neq/cm2. The detector uses modules with n+ in n sensors of 100x150um2 with an active layer of 285um. The sensors are connected to PSI46dig readout chips, except for the innermost barrel layer where sensors are connected to PROC600 chips that have been designed especially to handle the high rates of the innermost layer.

In this presentation we discuss radiation-induced changes in pixel sensor and chip properties including depletion voltage and leakage current, as well as operational experience and lessons learned in dealing with these changes. We also present variations of radiation-induced changes with temperature, fluence, and time and results on performance and tracking observables. A model of these radiation-damaged induced pixel sensor properties is compared to data and is used to predict the sensor properties over the course of the LHC run 3.

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