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Radiation effects in the CMS phase 1 pixel detector

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An upgraded silicon pixel detector has been installed in 2017 in the Compact Muon Solenoid (CMS) to cope with the harsh environment of the even increased luminosity of the proton-proton collisions at the Large Hadron Collider (LHC) and maintain high tracking performance at instantaneous luminosities of $2\times10^{34}cm^{-2}s^{-1}$, and fluences up to $1 \times 10^{15}n_{eq}/cm^2$. The phase 1 CMS pixel detector has 4 barrel layers and 3 endcap disks, with the innermost layer placed at just 2.9 cm from the beam line. The detector uses modules with n+ in n sensors of $100\times150\mu m^2$ with an active layer of $285\mu m$. 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. We also present variations of radiation-induced changes with temperature, fluence, and time. A model of these radiation-damaged induced pixel sensor properties is compared to data for both the central and the two endcap regions.

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