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Beam Test Characterization of CMS Silicon Pixel Detectors for the Phase-1 Upgrade

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The Silicon Pixel Detector forms the innermost part of the CMS tracking system and is critical to track and vertex reconstruction. Being in close proximity to the beam interaction point, it is exposed to the highest radiation damage in the silicon tracker.

In order to preserve the tracking performance with the LHC luminosity increase which is foreseen for the next years, the CMS experiment has planned to build a new pixel detector with four barrel layers mounted around a reduced diameter beam pipe, as compared to the present three layer pixel detector in the central region. A new digital version of the front-end readout chip has been designed and tested; it has increased data buffering and readout link speed to maintain high efficiency at increasing occupancy. In addition, it offers lower charge thresholds that will improve the tracking efficiency and position resolution. Single chip modules have been evaluated in the DESY electron test beam in terms of charge collection, noise, tracking efficiency and position resolution before and after irradiation with 26 GeV protons from the CERN Proton Synchrotron equivalent to the fluence expected after 500 inverse femtobarn of integrated luminosity in the fourth layer of the pixel tracker. High efficiency and an excellent position resolution have been observed which are well maintained even after the proton irradiation. The results are well described by the CMS pixel detector simulation.

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