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# Performance of highly irradiated pixel sensors for the CMS HL-LHC upgrade

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The CMS pixel detector upgrade for the HL-LHC must withstand unprecedented radiation fluence, up to $2 \times 10^{16}$ neutron-equivalent per cm$^2$ over the lifetime of the detector. Sensors and the RD53A prototype readout chip have been developed to deliver the needed performance, but their radiation hardness at the full expected fluence still needs to be demonstrated. We have extensively tested and operated two planar HPK pixel sensors irradiated to approximately 1.3 $n_{eq}$/cm$^2$ at the LANSCE facility. Beam tests are performed at the Fermilab Test Beam Facility (FTBF), using the 120 GeV proton beam and a "telescope" consisting of silicon strip and pixel planes. This talk presents results on the efficiency, resolution, charge response, and I-V curves of one of these sensors. With a threshold of 1400 electrons and considering active pixels only, we achieve an efficiency of over 88% at a temperature of -30C and a bias voltage of -800V.

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