

## Test Beam Results on 3D pixel sensors for the CMS Tracker Upgrade at the High-Luminosity LHC

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The High Luminosity upgrade of the CERN Large Hadron Collider (HL-LHC) requires new high-radiation tolerant silicon pixel sensors for the innermost part of the tracking detector in the CMS experiment. The innermost layer of the tracker, which is as close as 3 cm from the interaction point, will be exposed to a fluence of  $2.6 \times 10^{16}$  neq/cm<sup>2</sup> during the high-luminosity operation period. The 3D pixel sensor technology has been proven to be the best option for such a layer in terms of radiation tolerance and low power consumption. An extensive program aiming at 3D pixel sensors has been carried out in the context of the CMS tracker R&D activities. The sensors have been produced by the FBK (Trento, Italy) and CNM (Barcelona, Spain) foundries. They are interconnected with the CROCv1 readout chip, which is a prototype of the final version that will be mounted in the upgraded tracking detector. The modules have been tested on beam at CERN and DESY, before and after irradiation up to an equivalent fluence of about  $1.6 \times 10^{16}$  neq/cm<sup>2</sup>. An overview of the results obtained in the latest beam test experiments will be presented, including hit detection efficiency and spatial resolution. The analysis of collected data shows excellent performance, with around 98% hit detection efficiencies measured after irradiation.

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