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Performance of 3D trench pixel sensors irradiated up to $10^{17}\ n_{eq}\ cm^{-2}$

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The continuous increase of instantaneous luminosity in high energy physics experiments will severely affect the occupancy of tracking detectors, drastically reducing event reconstruction efficiency.
In the case of the Upgrade II of the LHCb experiment at CERN, the detector will operate at an instantaneous luminosity of about $1.5 \times 10^{34}\ cm^{-2}s^{-1}$. In these conditions, approximately 2000 tracks from 40 proton-proton interactions will cross the vertex detector every 25 ns. To properly reconstruct primary and secondary vertices the development of sensors and electronics capable of measuring the particle hit time with an accuracy of 50 ps, together with a spatial resolution of about 10 μm and an unprecedented radiation hardness, is needed.
3D trench silicon pixels, developed by the INFN TimeSPOT collaboration, is a technology aiming to fulfil these requirements. These 150 μm active thickness, 55 μm × 55 μm silicon pixels, which consist of 40μm-long planar trench electrodes located between two continuous bias electrodes, provide a time resolution of about 10 ps and 99% detection efficiency for minimum ionizing particle detection. Two irradiation campaigns of these sensors have been carried out in 2021 and 2023, with maximum irradiation fluences of $2.5 \times 10^{16}\ n_{eq}\ cm^{-2}$ and $1.0 \times 10^{17}\ n_{eq}\ cm^{-2}$ respectively. Results from beam test and laboratory characterizations of the irradiated sensors will be shown at the Conference. 3D trench-type silicon sensors are proving to be a promising candidate for future vertex detectors operating at very high instantaneous luminosity.

Collaboration

Role of Submitter

I am the presenter

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