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Characterisation and preliminary results on 3D trench pixel sensors irradiated up to $10^{17}\,1MeV\,n_{eq}\,cm^{-2}$

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The LHCb experiment at CERN is preparing a major upgrade to cope with the increase of instantaneous luminosity at LHC scheduled for Run 5. LHCb 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 collisions 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 $50\,ps$ and a spatial resolution of 10 μm is crucial, in order to maintain the current vertex reconstruction efficiency also at high luminosity. 3D trench silicon pixels, developed by the INFN TimeSPOT collaboration, is a technology aiming to fulfill these requirements. These $150\,m$ active thickness, $55\,m \times 55\,m$ silicon pixels, consisting of $40\,m$-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. The increase of the instantaneous luminosity will require detectors able to withstand the increased radiation damage.
For this reason, sensors irradiated at different radiation levels (from 10^{16} and up to $10^{17}\,1\,MeV\,n_{eq}\,cm^{-2}$) are being tested.
Preliminary results, that will be presented at the conference, show that 3D trench-type silicon sensors are proving to be a very promising candidate for future vertex detectors.

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