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Recent results on 3D double sided detectors at CNM-IMB

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The upgrade of the LHC to HL-LHC envisaged for 2020 requires silicon detectors of unprecedented radiation tolerance for the silicon tracking detectors. The very high luminosity foreseen (2.5 x 1034cm-2s-1) implies that the innermost layers detectors, at about 3 cm from the interaction point, of the vertex detector will be exposed to fluence up to 1.4x1016cm-2 1 MeV neutron equivalent for the 2020 upgrade over the expected years of operation. Present vertex detectors, relying on highly segmented silicon sensors, are designed to survive fast hadron fluence of about 1015cm-2. Under these conditions, detector performance is limited since a large number of defects are introduced into the device. During detector operation, the charge carriers created by ionizing radiation are trapped into those defects with discrete energy levels in the band-gap of the silicon substrate, resulting in incomplete charge collection.
Silicon detectors with cylindrical electrodes (so called 3D detectors) offer advantages over standard planar photodiodes as more radiation hard radiation sensors. 3D detectors with the double sided geometry have been fabricated at CNM clean room facilities. Different geometries including pixel detectors for high energy physics experiment and synchrotron imaging , short strip detectors with the same inter-column spacing as proposed for the ATLAS and CMS pixel detector upgrades foreseen for 2020.
The 3D detector is shown to have superior charge collection characteristics even at the highest fluences even when compared to planar devices operating at 1000V, which is in excess of that presently possible in the ATLAS experiment. Annealing studies of the collection efficiency and the main electrical characteristics of the detectors are also investigated. The experimental results are compared to the simulation of charge transport in the devices.

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