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Radiation tolerance of thin LGAD detectors and in-depth study of ILGAD timing performance

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A comprehensive radiation tolerance study of LGAD pad-like sensors manufactured at IMB-CNM and irradiated at CERN's PS-IRRAD proton facility up to a fluence of $3 \times 10^{15} n_{eq}/cm^2$ is presented here. Two different active thicknesses were studied: 35-microns and 50-microns; the effect of carbon co-implantation on the radiation tolerance was also investigated.
The building block LGAD sensor of proposed timing detector systems for the LH-LHC is designed as a pad diode matrix. The timing resolution of this LGAD sensor is severely degraded when the MIP particle hits the inter-pad region since there is no amplification in this region. This limitation is named as the LGAD \textit{fill-factor problem}. To overcome the fill factor problem, a p-in-p LGAD (Inverse LGAD) was introduced. Contrary to the conventional LGAD, the ILGAD has a non-segmented deep p-well (the multiplication layer). An in-depth study of the timing performance of an ILGAD prototype is presented. The realistic systematic effects that may degrade its timing performance are quatified. These studies were performed within the context of the RD50 collaboration and partially funded by the H2020 EU project AIDA-2020.

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