

# Measurements with Irradiated 3D Silicon Strip Detectors

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## Abstract

To cope with the unprecedented high radiation level at the luminosity upgrade of the LHC (sLHC), novel tracking detectors are investigated. Among these, 3D silicon detectors constitute a promising option. By etching columnar electrodes of both doping types into the sensor, the distance for depletion and charge collection is decoupled from the sensor thickness. Thus, two of the main effects of radiation damage in silicon (increasing depletion voltage and trapping) can be significantly reduced. This talk presents results of measurements with irradiated 3D strip detectors produced by CNM-IMB in Barcelona, Spain. These detectors are produced in a double-sided process, meaning that one set of columns providing the Ohmic contact is etched into the silicon bulk from the back side, whereas the readout columns providing the junction are etched from the front side (see Fig. 1). Neither set of columns is passing through the silicon bulk completely.

To evaluate the radiation hardness of 3D detectors, measurements of detectors irradiated to sLHC fluences were performed. Results of test beam measurements with high energy pions at the CERN SPS and an infra-red laser setup are presented in this talk. The signal measured with the irradiated detectors at high bias voltages is substantially higher than that of unirradiated detectors, see Fig. 2. This fact indicates that the electric field in irradiated detectors exceeds the field strength required for charge multiplication due to impact ionisation. Space-resolved charge collection and noise behaviour are investigated. Further, the different signal levels of irradiated 3D detectors and irradiated planar silicon detectors are compared.

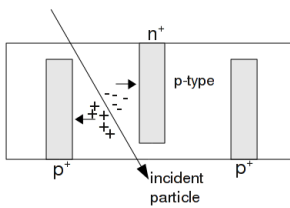


Figure 1: Principle design of a double-sided 3D detector on p-type substrate.

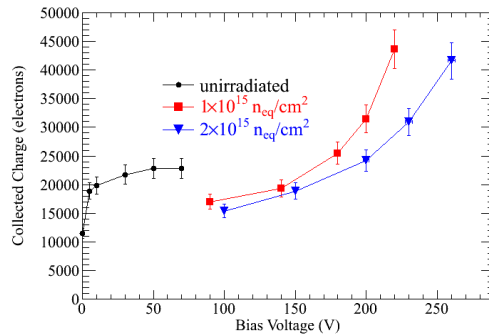


Figure 2: Collected charge of unirradiated and irradiated 3D strip detectors measured in a test beam with high energy pions.