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Ion microbeam studies of charge transport in semiconductor radiation detectors with three-dimensional structure

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Developments of semiconductor detectors with increased tolerance to the high radiation levels are resulting often in devices that deviate significantly from the classical planar electrode designs. Shorter collection distances that are utilised in 3D detectors (silicon and diamond) in which electrodes are penetrating into the crystal bulk, and the introduction of charge multiplication regions such as in silicon LGADs, are two strategies that have been used to increase radiation hardness. One of the possible techniques to explore charge transport properties in such three-dimensional structures is certainly IBIC –ion beam induced charge, a microprobe technique that utilizes single ions of MeV energy range which create charge pairs along the ion trajectory. By the use of different ion species and respective energies, measurable charge signals give insight into carrier transport properties in wide range of detector depths (from 1 to hundreds of micrometers), while 2D raster scanning of ions focussed to micrometre spot size provide planar distribution of charge transport efficiency. Recent improvements of the IBIC setup at the RBI microprobe facility, will be presented along with examples of interpad distance and gain suppression studies in LGAD detectors. In the context of diamond detectors, capabilities of the setup to work at elevated temperatures (up to 450 C) gave us possibilities to characterise charge transport properties and trapping levels in diamond.

Primary experiment

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