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Production and characterization of large-size diamond detectors for particle tracking and medical applications

For several years, a team of 20 scientists from ESRF, IPHC Strasbourg, IPN Lyon and LPSC Grenoble has been working to study the detection properties of large-size diamond detectors from several suppliers, with the aim of achieving reliable & efficient sensors for particle tracking or medical applications. High radiation hardness and intrinsic electronic properties make diamonds reliable & very fast detectors with a good signal-to-noise ratio.

Poly- and single-crystal CVD diamond samples were tested under various ionizing particles. Their metalization was performed by using Distributed MicroWave Plasmas, a fully original technology developed by LPSC. Their applicability as particle detector was investigated using α and β radioactive sources, 95 MeV/u carbon beams from GANIL (Caen) and short-bunched 8.5 keV photons from ESRF. This last facility offers unique capability of highly focused beams, together with an energy deposition which is almost uniform in the irradiated volume, as it would be for minimum-ionizing particles or single protons and carbon ions used for hadrontherapy.

The MoniDiam project of LPSC is part of the French national collaboration CLaRyS for the on-line dose monitoring of hadrontherapy. It relies on the imaging of nuclear reaction products that are related to the ion interaction in the human tissue. The goal here is to provide large-area detectors with a high detection efficiency for carbon or proton beams, yielding time and position measurement at count rates greater than 100 MHz (beam tagging hodoscope). A time resolution ranging from 20 ps up to 40 ps and an energy resolution varying from 7 % up to 10% were measured. It allowed us to conclude that polycrystalline CVD diamond detectors are good candidates for our beam tagging hodoscope development. The final detector will be a $\sim 15 \times 15$ cm² mosaic made of stripped-diamond sensors read by a dedicated integrated fast read-out electronics (~ 1800 channels).

Experimental Collaboration

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