Contribution ID: **245** Type: **Oral presentation**

Intercalibration and comparative tests of 3D diamond and diamond on iridium detectors for medical dosimetry

Wednesday 30 June 2021 11:40 (20 minutes)

Thanks to a new emerging technology, diamond devices with 3-dimensional structures are produced using laser pulses to create graphitic paths in the diamond bulk. The fabrication of very narrow and close by columnar electrodes perpendicular to the detector surface allows the employment of a lower bias voltage at which the saturation charge velocity is reached and faster detector response, due to the decreased distance between the polarizing electrodes, compared to a planar geometry detector. Also due to the much shorter electrodes distance, the 3D diamond detector charge collection efficiency is less deteriorated by the radiation damage of the diamond material.

On the other hand, diamond tissue-equivalence, high radiation sensitivity and high resistance to radiation damage make it a good candidate for high precision measurement of the doses released during medical radiation therapy.

In medical radiation dosimetry, the use of small photon fields is almost a prerequisite for high precision localized dose delivery to delineated target volume. However, such fields have inherent characteristics of charge particle disequilibrium and high-dose gradient, making dosimetric measurements challenging. The accurate measurement of standard dosimetric quantities in such situations strongly depends on the size of the detector with respect to the field dimensions.

3D diamond detectors with small dimensions compared to the field size, have been tested under photon irradiation and evaluated for medical radiation dosimetry referring particularly to the problem of small fields dosimetry and/or of high spatial gradient fields dosimetry.

We will present results obtained with two new 3D finely segmented detectors made of a 500 um polycrystalline diamond substrate and a 500 um diamond on iridium substrate where multiple 3D cells are read in parallel when irradiated by a medical linear accelerator with the aim of understanding which substrate is the best solution for a more linear, stable and repeatable dose rate response in order to measure small field profiles in one measurement session, reducing the uncertainty of the delivered dose.

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Session Classification: Oral presentations

Track Classification: Applications