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CHARACTERIZATION OF A LOW-COST SILICON PIN DIODE FOR STEREOTATIC RADIOSURGERY DOSIMETRY

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Introduction: The stereotactic radiosurgery (SRS) is an irradiation method used to deliver high absorbed dose of radiation in one to five fractions. This technique uses small, highly-colimated beams (MLC or circular cone collimator) to irradiate intracranial lesions and functional abnormalities with high geometric precision, high conformity and dosimetric accuracy. However, is know that accurate small-field dosimetry is challenging because of several process physics, such as the loss of lateral electronic equilibrium, partial occlusion of the source and perturbation of the charged-particle fluence by the detector size used for their measurement. To minimize these effects, various types of detectors with small sensitive volumes (e.g. diodes and diamond) have been developed and characterized. The aim of this study is to evaluate the characteristics of the dosimetric system developed by Nuclear Energy Department of UFPE (DEN) for small-field photon beam dosimetry under conditions of SRS

Material and method: The Dosimetric system is composed by a detector, named diode DEN, with sensitive area of 0.35 mm^2, and an electrometer EL-DEN, developed by the DEN/UFPE. All irradiations were performed with a 10 MV-FFF photon beam produced by TrueBeam Linac (Varian). Measurements were carried out for cones with fields diameters from 4.0 to 17.5 mm . The diode was positioned at the center of solid water phantom with size 30x30 cm^2, at a depth of 5 cm for surface source distance (SSD) of 95 cm.

The main dosimetric characteristics, such as response repeatability, dose response curve, dependence with dose rate, output factors (OF), percentage depth dose (PDD) and off axis ratios (OAR) were evaluated. For benchmarking, the measurements of OF, PDD and OAR was performed again with EDGE diode (Sun Nuclear) in the same conditions.

The measurements of PDD and OAR were acquired using the IBA BluePhantom 2 water phantom, at depth 5 cm for SSD = 80, 90 and 100 cm, with cones field diameters sizes 4.0 and 7.5 mm. However, OF were measured within a total of 7 cones field diameters size range from 4.0–17.5 mm.

Results: The diode DEN response showed an excellent repeatability with a coefficient of variation less than 0.05%. The dose response curve is linear (R^2 = 1), for range of 3.0 – 25.0 Gy. The response variation to the average dose rates within the range 400-2400MU/min was about 0.5%. The maximum diference of the output factors measured with the diode DEN and EDGE in comparison with Golden Data (Varian) were, respectively, 2.96% and 3.28%. The Figure 1 presents the results obtained with these detectors, compared with GoldenData.

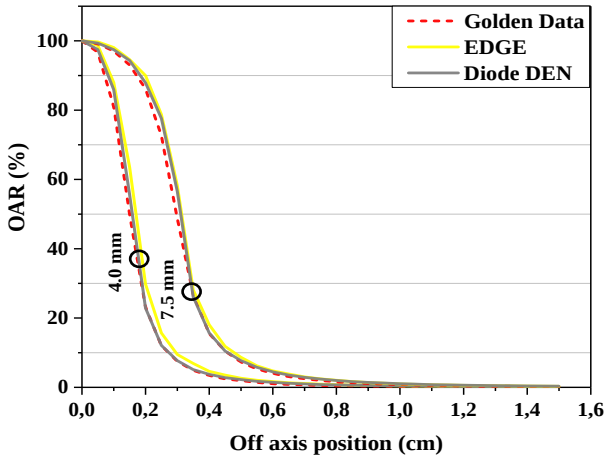

Figure 1: OAR at SSD 80 cm and depth 5 cm for cones field diameters sizes 4.0 and 7.5 mm.

Conclusions: From this study, it was concluded that diode DEN presents a reliable and economical alternative for small fields dosimetry used in treatments of SRS. This detector can be used for validation of dates obtained in commissioning of linear accelerator and inserted in Treatment Planning Systems (TPS).