



Contribution ID: 301

Type: Oral Presentation

Application of the PTW microDiamond in small field dosimetry on different accelerators: Comparative measurements and Monte Carlo calculations

Wednesday 21 June 2017 09:50 (10 minutes)

Introduction - Volume averaging and detector mass-density effects are crucial for dosimetry in radiotherapy photon beams with small field size. Although for solid state detectors as silicon diodes and diamond detectors the two effects tend to balance each other, correction factors are in general required for field output factor measurements of small beams. Recently several studies have been published on output correction factors for the PTW 60019 microDiamond (mD) and a good agreement is observed for results referring to field sizes down to 1 cm. On the contrary results for very small field sizes are sometimes controversial thus requiring further investigation.

In this study output correction factors for the microDiamond are determined by Monte Carlo (MC) calculation and applied to detector measurements (OFdet) performed by a set of ten mD detectors, in 6 MV photon beams produced by different clinical accelerators. The study mainly aims at: i) assessing up to what extent the accelerator type and collimation choice affect the mD response; ii) evaluating the variability of the dosimetric properties among the investigated mD detectors; iii) checking the consistency of MC calculation for the mD by comparing the corrected OFdet results obtained both by the set of investigated mDs and commercial silicon diodes.

Materials and Methods - 6 MV beams from three linear accelerators were used: a Varian DHX, an Elekta Synergy and a CyberKnife M6 system. Nominal square field-sides of 100, 60, 30, 16, 10, 8 and 6 mm were obtained from the Varian and the Elekta accelerators. For the CyberKnife system, circular beams with a field diameter of 60, 30, 15, 12.5, 10, 7.5 and 5 mm were obtained by using fixed collimators. The accelerator outputs in terms of absorbed dose to water in reference conditions were determined by means of a Farmer-type ionization chamber according to the IAEA TRS 398 dosimetry protocol. For CyberKnife, a specific MC correction factor was applied to account for the use of 60 mm diameter as reference field size.

The mD detectors, provided with calibration factor in terms of absorbed dose to water for the Co-60 quality, were used in the clinical beams. Two PTW 60017 unshielded Ediodes were also used in the clinical beams for comparison. Using the Co-60 calibration factors and the measurements in the accelerator reference field, the variation of mD response from Co-60 quality to 6 MV clinical beams was evaluated. Field output factors were obtained from the ratio of the detector readings in the non-reference and the reference fields applying MC output correction factors specifically determined for each beam using the EGSnrc code.

The 6 MV beams produced by the three accelerators were independently simulated by means of the BEAMnrc code. The phase-space files obtained for all the field sizes considered for experimental measurements were used as input sources in the EGSnrc/egs_chamber code for calculating the output correction factors of the two types of detectors. To this purpose, the mD and the Ediode were modelled according to the blueprints provided by the manufacturer. The output correction factors were determined by calculating the absorbed dose in the detector sensitive volume and in a small voxel of water for the reference field and each non-reference field.

Results - Very homogeneous results were obtained by the ten mD detectors, with a standard deviations of OFdet values within 0.5% for all the considered field sizes. A response variation of about 2% was observed between the Co-60 quality and the clinical 6 MV beams with a maximum deviation among individual detectors below 1%. Preliminary results on mD output correction factors show a weak dependence on accelerator type and collimation system. Correction factors are within 2% for field sizes down to 5 mm. Larger corrections, up to about 5%, were obtained for the Ediode. Applying the MC calculated correction factors, field output factors

obtained by the mDs and the Ediodes agree within 1% for the CyberKnife system and preliminary results confirm such an agreement for the Varian and the Elekta accelerators as well.

Conclusions - The results of this study show that very similar dosimetric properties are obtained from ten mD detectors, thus indicating a good reproducibility of their fabrication process. On the basis of the present results, the MC method is proved to be capable of providing reliable output correction factors for the mD detector. A set of mD output correction factors is provided, with an uncertainty estimate including contributions accounting for differences among individual detectors and beams produced with different accelerators.

Institution

ENEA - Agenzia nazionale per le nuove tecnologie l'energia e lo sviluppo economico sostenibile

Country

Italy

Author: PIMPINELLA, Maria (ENEA - National Institute of Ionizing Radiation Metrology, I-00123 Rome, Italy)

Co-authors: STRAVATO, Antonella (Humanitas Clinical and Research Center, Medical Physics Unit of Dep. of Radiosurgery and Radiotherapy, Via Manzoni 56 20089 Rozzano (Milano) - Italy); VERONA, Claudio (INFN-Dipartimento di Ingegneria Industriale, Università di Roma 'Tor Vergata', Roma, Italy); VERONA-RINATI, Gianluca (INFN-Dipartimento di Ingegneria Industriale, Università di Roma 'Tor Vergata', Roma, Italy); PRESTOPINO, Giuseppe (INFN-Dipartimento di Ingegneria Industriale, Università di Roma 'Tor Vergata', Roma, Italy); MASI, Laura (Department of Medical Physics and Radiation Oncology, IFCA, I-50139 Firenze, Italy); PAGANINI, Lucia (Humanitas Clinical and Research Center, Medical Physics Unit of Dep. of Radiosurgery and Radiotherapy, Via Manzoni 56 20089 Rozzano (Milano) - Italy); ESPOSITO, Marco (Medical Physics Unit, Azienda USL Toscana Centro, Firenze, I-50012 Firenze, Italy); MARINELLI, Marco (INFN-Dipartimento di Ingegneria Industriale, Università di Roma 'Tor Vergata', Roma, Italy); FRANCESCO, Paolo (Department of Radiation Oncology, Ospedale di Vicenza, I-36100 Vicenza, Italy); RUSSO, Serenella (Medical Physics Unit, Azienda USL Toscana Centro, Firenze, I-50012 Firenze, Italy); DE COSTE, Vanessa (National Institute of Ionizing Radiation Metrology, I-00123 Rome, Italy)

Presenter: PIMPINELLA, Maria (ENEA - National Institute of Ionizing Radiation Metrology, I-00123 Rome, Italy)

Session Classification: Session 10b - Small field dosimetry

Track Classification: Dosimetry