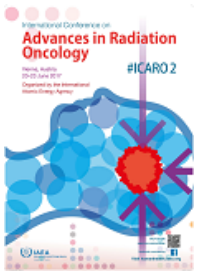

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Application of output correction factors for three small beam radiation detectors: comparison of results for a TrueBeam Stx linac

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Purpose

To compare and analyze the corrected out factors resulting from three different radiation detectors for small fields of a TrueBeam STx® linac.
Materials and Methods

Detector signal ratios ($M_{Qclin}^{fclin}/M_{Qmsr}^{fmsr}$) were measured for a 6 MV WFF (with flatting filter) photon beam of a TrueBeam STx linac. The following nominal square field sizes were used: 0.5, 1.0, 2.0, 3.0, 4.0, 6.0, and 10 cm^2. The small fields were set by the jaw collimators and their actual size was verified and recorded. The radiation measurements were performed in liquid water at 10 cm depth with a source to surface distance of 100 cm. The detectors used were a synthetic diamond (model PTW-60019, manufactured by PTW-Freiburg, Germany), a mini-ionization chamber (model PTW-31016, manufactured by PTW-Freiburg, Germany) and a silicon diode detector (model SFD, manufactured by IBA-Dosimetry, Germany). The operation and characteristics of each detector can be found elsewhere on the literature. Each detector is referenced in this work by its commercial name: microDiamond (PTW-60019), SFD (SFD silicon diode) and PinPoint 3D (PTW-31016). A UNIDOS electrometer (PTW-Freiburg, Germany) was used to measure the detector signal. In the case of the ionization chamber, all the measured signals were corrected by the influence quantities. The signal ratios were corrected by applying the specific correction factors for each detector and field size. The output correction factors ($k_{Qclin,Qmsr}^{fclin,fmsr}$) were taken from TABLE 26 of TRS 483 draft from a linear interpolation as a function of the actual field size used in this work. The msr field was set to 10 cm^2. The resulting corrected output factors were compared for each detector. The metrics used for comparison were the statistical dispersion of the data, and the mutual difference of the output factors ($\Omega_{Qclin,Qmsr}^{fclin,fmsr}$) for each detector. Also, a brief comparison of the output correction factors with the daisy correction method was performed for the 4 and 6 cm^2 field sizes.
Results

The actual field sizes show a variation up to 10% for field sizes greater than 1 cm^2. For the smaller field size (0.5 cm^2), it was impossible to perform the measurement. This field size was redefined with different jaw settings to allow the measurement. The Figure 1a shows $M_{Qclin}^{fclin}/M_{Qmsr}^{fmsr}$ as a function of the actual field size expressed as the equivalent square field size. It can be observed the typical behavior of the signal ratios for each detector. The differences between the measurements are greater for the smaller field sizes (< 1.0 cm2), up to 5.6% for 0.5 cm2 field size. The Figure 1b shows the corrected out factors ($\Omega_{Qclin,Qmsr}^{fclin,fmsr}$). It can be observed an agreement between the $\Omega_{Qclin,Qmsr}^{fclin,fmsr}$ better than 1% for all field sizes. However, it can be observed that the field size of 1.0 cm2 shows the higher dispersion of the results 0.8%. The mutual difference analysis shows that the microDiamond detector has a difference up to 2.3% relative to the other detectors at the 1.0 cm^2 field size. Also, the comparison of the daisy chain $k_{Qclin,Qmsr}^{fclin,fmsr}$ with those from TRS 483 showed a good agreement better than 0.7%.

Conclusions

The application of the output correction factors to the signal ratio for each detector to obtain the corrected output factors, shows an overall excellent agreement (<1%) between the radiation detectors and field sizes used in this work. The 1.0 cm^2 field size showed the highest dispersion, 0.8%. The mutual difference analysis showed that the output factors measured with the microDiamond detector differ from the other detectors up to 2.3% for the 1.0 cm2 field size. The comparison of the daisy chain $k_{Qclin,Qmsr}^{fclin,fmsr}$ with those from TRS 483 showed a good agreement better than 0.7%. In the near future more detectors will be added to this work.

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