Implementing IAEA/AAPM TRS 483 formalism for field output factors and involved uncertainties determination in small fields for TomoTherapy

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INTRODUCTION

Use of small beamlets in modern radiotherapy stresses to review the guidelines and procedures employed in standard dosimetric conditions. Recently a collaborative work by AAPM and IAEA published an international Code of Practice TRS-483. So, relative dosimetry to determine the beam quality, field output factors and involved uncertainty in small fields of TomoTherapy with ionization chamber and diode detector using TRS 483 formalism was carried out.

AIM

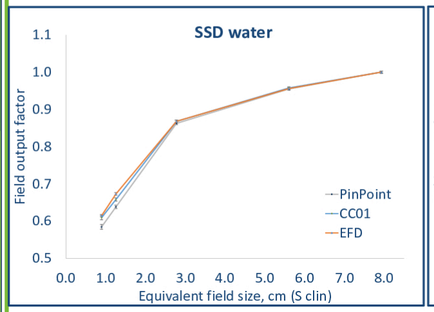
- To determine the beam quality index, $TPR_{20,10}(10)$, at hypothetical 10 X 10 cm^2 field size.
- To calculate lateral charge particle equilibrium distance (r_{LCPE}) and minimum field width condition for selection of a suitable ionisation chamber for small field dosimetry.
- To calculate the field output factors (OF) also known as corrected output factors from measured uncorrected output factors (UOF).
- To estimate and present the various components of uncertainty in the measurement with the detectors.

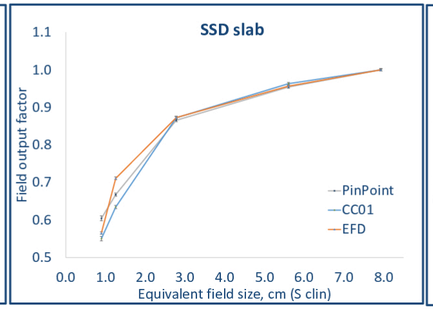
METHODS

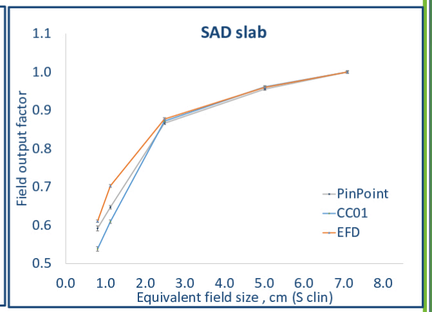
- TomoTherapy® Hi•Art® System (Accuray, USA) with a nominal 6 MV flattening filter-free (FFF) energy was used.
- Detectors used were two ion chamber: IBA CC01 (IBA Dosimetry, Schwarzenbruck, Germany); PTW PinPoint 31006 (PTW-Freiburg, Germany) and one solid-state silicon IBA unshielded electron field diode (EFD) 3G.
- Beam quality, $TPR_{20,10}(10) = \frac{TPR_{20,10}(S)+c(10-S)}{1+c(10-S)}$
- The dosimetric field width in Y-dir (A) and X-dir (B) were analysed at 50% (field width at half maximum, FWHM) as recommended in TRS 483, $S_{clin} = \sqrt{A\ X\ B}$
- Output factor, $\Omega^{f_{clin},f_{msr}}_{Q_{clin},Q_{msr}} = \frac{M^{f_{clin}}_{Q_{clin}}}{M^{f_{msr}}_{Q_{msr}}}\ k^{f_{clin},f_{msr}}_{Q_{clin},Q_{msr}}$

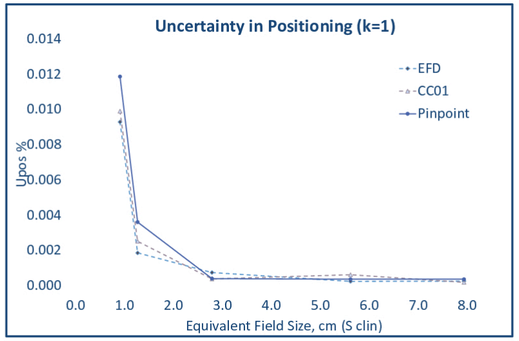
RESULTS

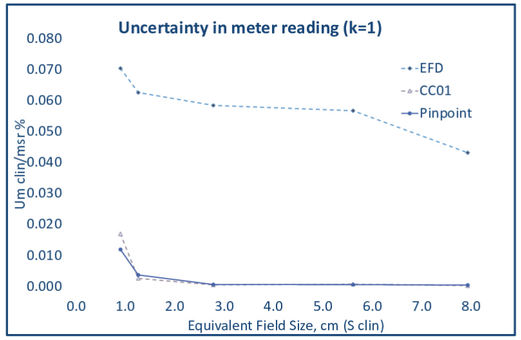
- $TPR_{20,10}(10)$ resulted in a mean value of 0.627±0.001 with a maximum variation of 0.32% among different detectors.
- The IBA CC01 and PTW PinPoint chamber resulted in the least values of minimum FWHM required to satisfy LCPE condition, with r_{LCPE} value of 0.857 cm. Field size of 2.5 X 2.5 cm^2 was taken as the intermediate field.

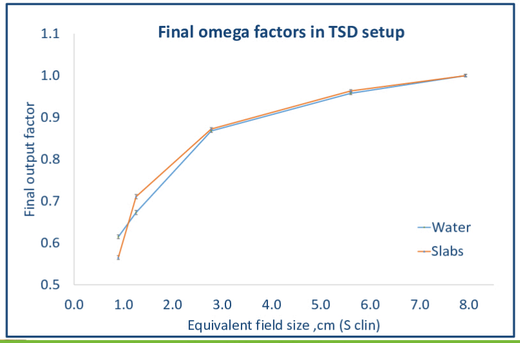


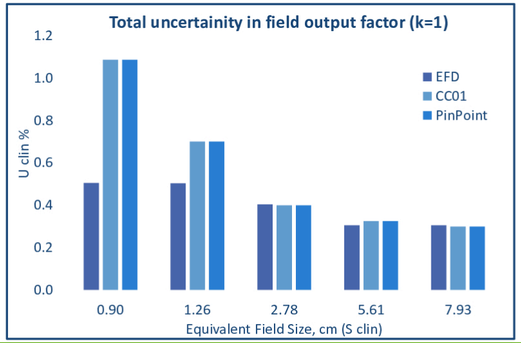












CONCLUSION

Ionization chambers and unshielded EFD diode both can be used for field output factors measurement at field sizes larger than or equal to 2.5 X 2.5 cm^2 with similar results. The uncertainty in output correction factors for ionization chambers has a higher value compared to the unshielded EFD diode. So, an unshielded EFD diode is preferred for field output factor measurement at field sizes smaller than 2.5 X 2.5 cm^2 due to its lower total uncertainty compared to ionization chambers and availability of output correction factors in TRS 483 till lower field sizes.

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