Small-field output factor determination for Versa HD flattened and flattening filter-free beams with various detectors

S. Hussain[a,b,c], M.Longo[b], S.Cora[b], P.Francescon[b]

[a]The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy

[b]San Bortolo Hospital, Medical Physics Unit, Vicenza, Italy, [c]University of Trieste, Trieste, Italy

- Corresponding author: sabahu21.uet@gmail.com

UNIVERSITÀ DEGLI STUDI DI TRIESTE

REGIONE DEL VENETO ULSS8 BERICA

ICTP The Abdus Salam International Centre for Theoretical Physics

Background and Objective

- The increased use of advanced radiation treatment techniques has improved the quality of radiation treatment by enabling precise positioning of the patients and targeting of tumours with minimising doses to normal healthy tissues .
- With the adoption of these advanced techniques in modern radiotherapy, there is an increasing interest in the small field dosimetry of photon beams with both flattening filter (FF) and flattening-filter-free (FFF) as well.
- The present study evaluates the performance of various detectors for the determination of field output factors (OF) in small field dosimetry with FF and FFF beams.

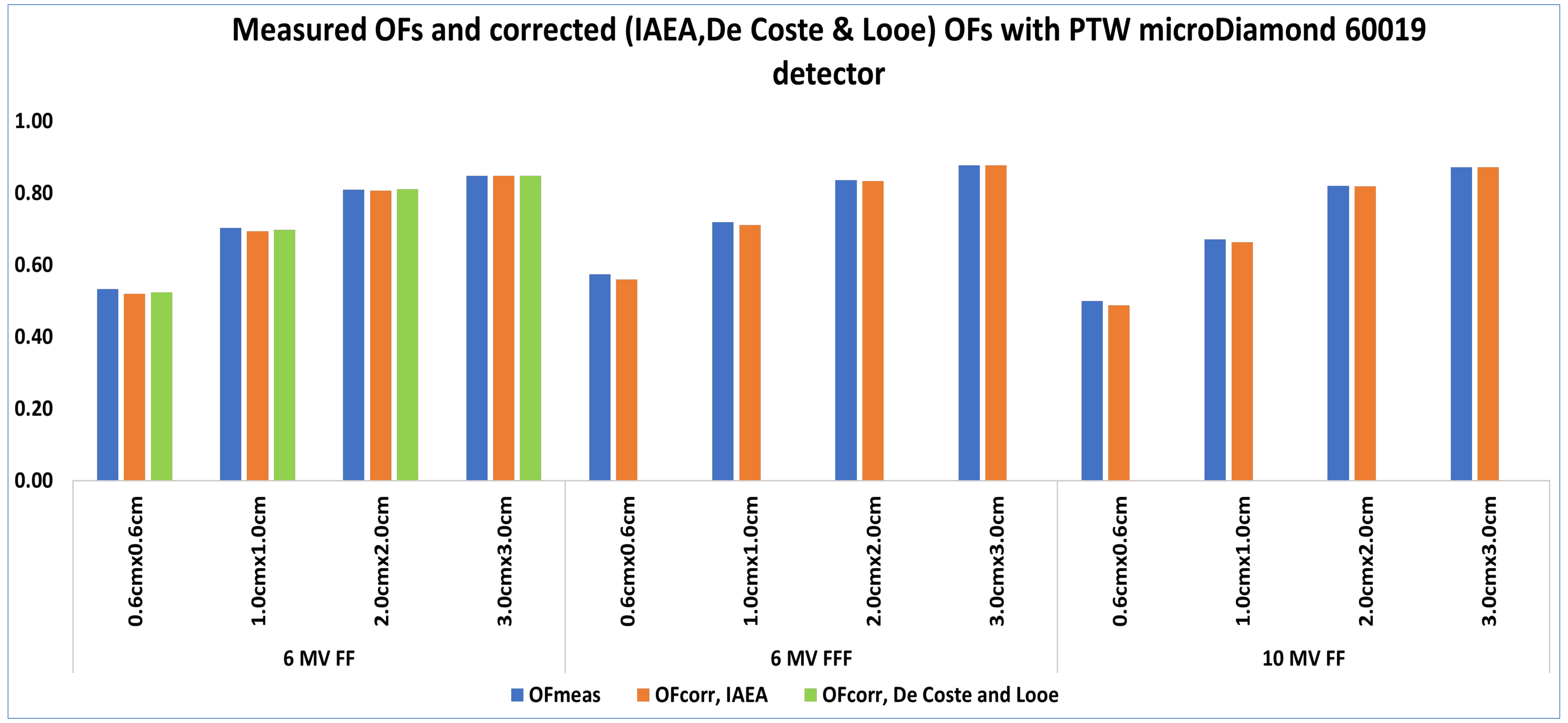
Methods

- In this study, the linear accelerator VERSA HD (Elekta, Stockholm, Sweden) of 6 MV FF, 6 MV FFF and 10 MV FF energies was used to obtain the OFs with five different detectors (PTW microDiamond 60019 (mD), PTW Diode 60018, PTW PinPoint 31014, Sun Nuclear EDGE detector 1118 and Exradin W1 plastic scintillator).
- The dose rate of 6 MV FF and 6 MVFFF can reach 600 MU/min and 1900 MU/minute respectively.
- OF measurements were performed for field sizes from 0.6×0.6 cm^2 to 3×3 cm^2 by using all energies.
- The correction factors from IAEA TRS 483 [1] and from literature data (correction factors from Looe et al [2] to mD for 6 MV FF and correction factors from Francescon et al with Monte Carlo (MC) to PinPoint detector for 6 MV FF and FFF) were applied to measured OFs in order to make a useful comparison between detectors and to evaluate their accuracy.
- The differences between measured and corrected OFs were investigated in this work.

Results and Discussion

- The standard deviation (SD) calculated on the measured OFs ranged from 0.2% to 3.7%.
- The application of the IAEA correction factors resulted in a reduced SD, ranging between 0.2% and 2.7% considering all field sizes and energies.
- Higher differences in OF values before and after the correction were observed in FFF beams than in FF beams as well as in the smallest field (0.6×0.6 cm^2) for all detectors.
- The PinPoint detector under responded for the smallest fields (especially for 0.6×0.6 and 1×1 cm^2) for all energies due to its higher active volume compared to those of the other detectors.
- The results has been shown in Figure 1 only for mD detector for the comparison between the measured OFs (OF meas), corrected with IAEA and corrected with DeCoste and Looe correction factors for all field sizes and energies.

Figure 1: Differences between measured OFs and corrected (IAEA ,De Coste & Looe) OFs with PTW microDiamond 60019 Detector



The OFs calculated using the IAEA correction factors were found consistent with those obtained applying the imbalance correction factors for mD detector with differences within 0.7% for 6 MV FF . The corrected OFs differences between IAEA and MC for PinPoint detector were within 3% for both 6 MV and 6 MV FFF.

Conclusions

- The outcome of this study demonstrated that all the investigated detectors are suitable for small field dosimetry.
- The differences in dose response between the detectors used in this study reduced significantly by implementing the correction factors reported in IAEA TRS 483 and in literature for all investigated small fields and energies.

References

[1] PALMANS, H, et al., "Dosimetry of small static fields used in external photon beam radiotherapy: Summary of TRS-483, the IAEA–AAPM international Code of Practice for reference and relative dose determination." Medical physics 45.11, (2018): e1123-1145.

[2] LOOE, H.K., et al. "The role of radiation-induced charge imbalance on the dose-response of a commercial synthetic diamond detector in small field dosimetry". Medical physics 46(6), (2019): 2752-2759.