

Dosimetric Data for Small Fields (Square and Stereotactic Cone) for Commissioning of 6MV FFF Beams in the RayStation Treatment Planning System

YC, Lee¹ and Y, Kim¹

¹University of Arizona, Tucson, Arizona, USA

INTRODUCTION

Commissioning photon or electron energies in a treatment planning system (TPS) is a tedious and time-consuming job but a very crucial procedure for accurate treatment delivery. For commissioning, each TPS requires specific measurement data for beam modeling. There are multiple publications on commissioning of a linac with 6MV flattening filter free (FFF) beams¹⁻⁴ but there is a paucity of information in the literature on small fields dosimetric data for commissioning 6MV FFF beams in the RayStation (RaySearch Laboratories, Stockholm, Sweden) TPS.

AIM

This work presents dosimetric data (percent depth doses (PDDs), profiles and output factors) for square fields $\leq 4 \times 4 \text{ cm}^2$ and stereotactic cones for assisting other institutions embarking on commissioning the TrueBeam STx 6MV FFF beams in the RayStation TPS. The aim of this work is to provide clinical medical physicists with good reference data for small fields which can be used for stereotactic radiosurgery (SRS) and/or stereotactic body radiation therapy (SBRT) in their own institution/clinic. The institution/clinic should have the same linear accelerator (Varian TrueBeam STx), Varian stereotactic cones and TPS to look up the data presented in this work.

METHOD

- PDDs for 5 square fields ($0.6 \times 0.6 \text{ cm}^2$, $1 \times 1 \text{ cm}^2$, $2 \times 2 \text{ cm}^2$, $3 \times 3 \text{ cm}^2$ and $4 \times 4 \text{ cm}^2$) were measured on the TrueBeam STx with 6MV FFF beams using the Sun Nuclear 3D water tank, Edge detector and Reference detector.
- Cross-line and in-line profiles for the square fields were measured at d_{max} , 5 cm, 10 cm and 20 cm and output factors at 10 cm.
- For all the measurements, SSD was set to 100 cm.
- Measurements were repeated for 7 stereotactic cones (4 mm, 5 mm, 7.5 mm, 10 mm, 12.5 mm, 15 mm and 17.5 mm in diameter) using the same setup and equipment except for profiles at 20 cm.
- For output factors, $10 \times 10 \text{ cm}^2$ was selected as the reference field. The daisy-chain method was used and field output correction factors taken from the literature⁵ were multiplied by measured output factors for square fields $\leq 2 \times 2 \text{ cm}^2$ and all the cones.

RESULTS

For square fields $\leq 4 \times 4 \text{ cm}^2$, 5 PDDs and 20 cross-line and in-line profiles were acquired. For stereotactic cones, 7 PDDs and 21 cross-line and in-line profiles were acquired. Fig. 1 shows PDDs and cross-line profiles for square fields $\leq 4 \times 4 \text{ cm}^2$. PDD parameters such as d_{max} (depth (cm) at relative dose of 100%), D10 (relative dose (%) at 10 cm) and D20 (relative dose (%) at 20 cm) are shown in Table 1. Output factors for the square fields are shown in Table 3. As expected, PDD parameters and output factors decrease with decreasing field size. The decrease of output factors is drastic for fields $\leq 1 \times 1 \text{ cm}^2$ after the field output correction factors were multiplied by measured output factors. Fig. 2 shows PDDs and cross-line profiles for stereotactic cones. PDD parameters and output factors for the cones are shown in Tables 2 and 3, respectively. Similar patterns were observed for the cones: PDD parameters and output factors decrease with decreasing cone size. Also, the decrease of output factors is drastic for cones $\leq 5 \text{ mm}$.

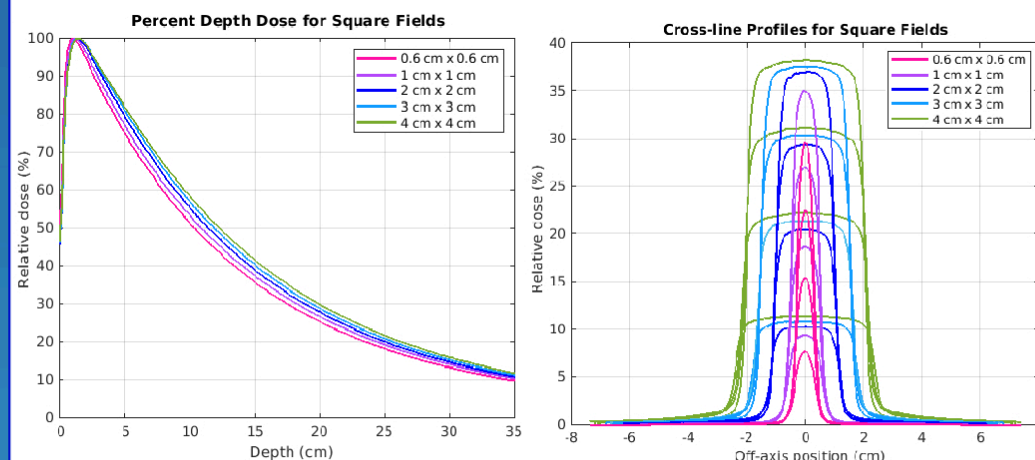


Fig. 1 PDDs and cross-line profiles for square fields $\leq 4 \times 4 \text{ cm}^2$. Profiles were measured at d_{max} , 5cm, 10cm and 20cm. SSD was set to 100 cm.

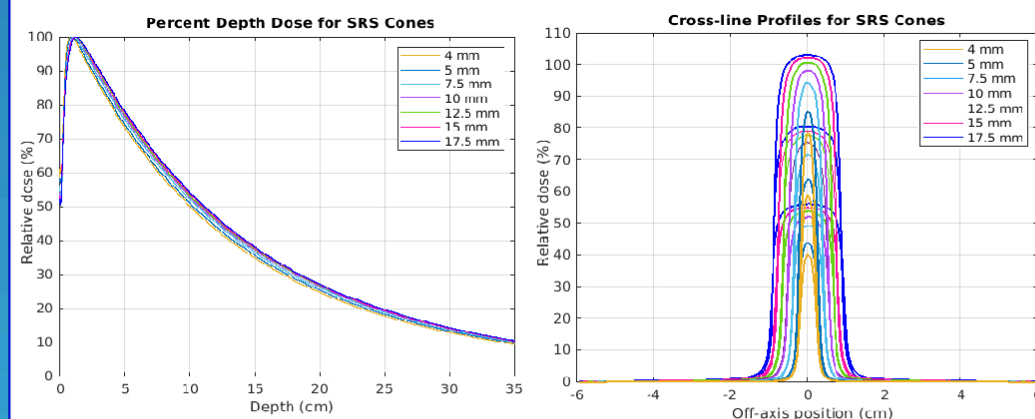


Fig. 2 PDDs and cross-line profiles stereotactic cones. Profiles were measured at d_{max} , 5cm and 10cm. SSD was set to 100 cm.

Table 1 PDD parameters for square fields $\leq 4 \times 4 \text{ cm}^2$

Field size (cm ²)	PDD parameters
0.6×0.6	d_{max} : 1.0cm; D10: 50.9%; D20: 25.2%
1×1	d_{max} : 1.1cm; D10: 53.1%; D20: 26.6%
2×2	d_{max} : 1.3cm; D10: 55.0%; D20: 27.8%
3×3	d_{max} : 1.4cm; D10: 56.6%; D20: 28.7%
4×4	d_{max} : 1.4cm; D10: 58.1%; D20: 29.8%

Table 2 PDD parameters for stereotactic cones

Cone size (mm)	PDD parameters
4	d_{max} : 0.8cm; D10: 50.1%; D20: 24.6%
5	d_{max} : 0.9cm; D10: 50.9%; D20: 25.3%
7.5	d_{max} : 1.1cm; D10: 52.1%; D20: 25.9%
10	d_{max} : 1.1cm; D10: 52.6%; D20: 26.4%
12.5	d_{max} : 1.2cm; D10: 53.1%; D20: 26.7%
15	d_{max} : 1.2cm; D10: 53.7%; D20: 26.9%
17.5	d_{max} : 1.2cm; D10: 54.1%; D20: 27.0%

Table 3 Output factors for square fields $\leq 4 \times 4 \text{ cm}^2$ and stereotactic cones

Field size (cm ²)	Output factor	Cone size (mm)	Output factor
0.6×0.6	0.572	4	0.530
1×1	0.716	5	0.583
2×2	0.811	7.5	0.667
3×3	0.843	10	0.719
4×4	0.877	12.5	0.753
		15	0.780
		17.5	0.797

CONCLUSIONS

The data presented in this work would be a good reference for the institution/clinic which will embark on commissioning the TrueBeam STx 6 MV FFF beams in the RayStation TPS for SRS and/or SBRT treatments.

ACKNOWLEDGEMENTS

None

REFERENCES

- Change Z, et al. Commissioning and dosimetric characteristics of TrueBeam System: Composite data of three TreuBeam machines. *Med Phys* 2012;37(11):6981-7018
- Gilde-Hurst C, et al. Commissioning of the Varian TrueBeam linear accelerator: A multi-institutional study. *Med Phys* 2013;40(3):031719
- Beyer et al. Commissioning measurements for photon beam data on three TrueBeam linear accelerators, and comparison with Trilogly and Clinac 2100 linear accelerators. *JACMP* 2013;14(1):273-288
- Narayanasamy G, et al. Papanikolaou N, Stathakis S. Commissioning an Elekta Versa HD linear accelerator. *JACMP* 2016;17(1):179-191
- Tanny S, Sperling N, Parsai EI. Correction factor measurements for multiple detectors used in small field dosimetry on the Varian Edge radiosurgery system. *Med Phys* 2015;42(9):5370-5376

CONTACT INFORMATION

YC Lee: ycleee@arizona.edu