Stereotactic cone output factors of flattening-filter-free mode photon beams - a plastic scintillation detector measurement study

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INTRODUCTION

Tiny-volume (φ<1mm) diode detectors are commonly used for measuring stereotactic cone output factors. Diode detectors are, however, known to have an over-response characteristic in small field radiation beams, due to higher mass and electron densities than water[1,2]. In this study, we present stereotactic cone collimator output factors of flattening-filter-free (FFF) photon beams measured with a near-water-equivalent plastic scintillation detector (PSD).

METHOD

The outputs of seven stereotactic cones, mounted on Edge and TrueBeam treatment machines (Varian Medical Systems, Palo Alto, CA) were measured for 6XFFF and 10XFFF photon beams using a micro PSD (1 *mm* dimeter x 1 *mm* length, Extradin Scintillator W2 1x1, Standard Imaging, Middleton, WI). The detector was placed at 5 *cm* depth with 95 *cm* source-to-surface distance (SSD) in a stack of solid water phantoms. The measured cone diameters included 4 mm, 5 mm, 7.5 mm, 10 mm, 12.5 mm, 15 mm, and 17.5 mm. Measurements were repeated twice for reduced uncertainty.

The measured outputs were compared to those of a diode detector (Edge, Sun Nuclear, Melbourne, FL). The active detection area of Edge diode detector was 0.8x0.8 mm^2. The measurement was made in water with the detector die plane setup in perpendicular to the incident beam axis.

No volume corrections were made for both detectors.

PO-GeP-T-740

RESULTS

The output factor difference between two machines were minimal (0.3% maximum). The average measured cone output factors, measured with a PSD and a diode, are presented in Figure 1 for 6XFFF and 10XFFF. The corresponding diode-to-PSD correction factors are listed in Table 1. The output factors in Figure 1 are with respect to a reference 10x10 cm^2 beam. As shown in the figure, the diode output factors were higher than those of PSD, in the range of ~1% to 10%. The differences were larger for 10XFFF than for 6XFFF and for the smaller cones.

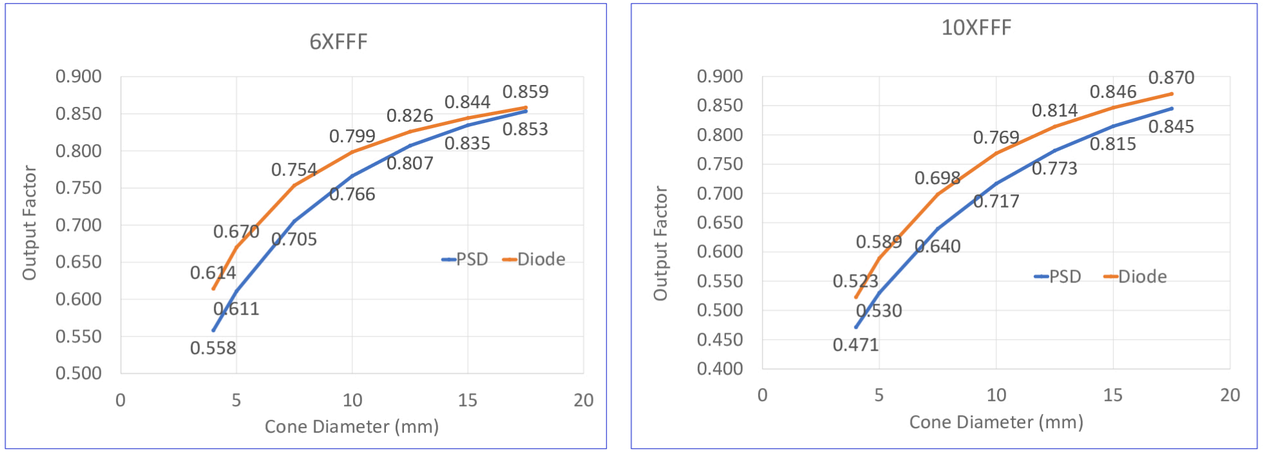

Figure 1. Average cone output factors measured with PSD (W2 1x2) and Diode (Edge).

Table 1. Diode-to-PSD correction factors

Cone (mm)	4	5	7.5	10	12.5	15	17.5
6XFFF	0.909	0.912	0.936	0.960	0.977	0.988	0.994
10XFFF	0.902	0.900	0.916	0.933	0.950	0.963	0.971

DISCUSSION

The cones of size 4 mm and 5 mm diameter are most commonly used for trigeminal neuralgia radiosurgery treatments. If the output factors, measured by an Edge diode detector, was used for treatment planning system commissioning, the actual delivered dose would be lower by approximately 9 to 10 % than the intended. In this study, the correction factors were with respect to a Edge diode detector. For different diodes, the correction factors may differ from the results in this study. Also, further verifications are needed with different types of high resolution detectors such as films or TLDs. In this study, no volume correction factors were used, which may affect up to 1% for the PSD detector[1].

CONCLUSIONS

The measured PSD output factors were considerably lower than those of diode, especially for the 4 mm and 5 mm cones: 9 % for 6XFFF and 10% for 10XFFF. Small field dosimetry is challenging. Further cross-validation is needed with other high resolution detectors such as films and thermos-luminance detectors. Also, the cone output factors may vary from installation to installation.

REFERENCES

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