SU-GG-T330

Experimental Comparison of Six Commercial Dosimetry Diodes for Measurement of Stereotactic Radiosurgery Cone Factors

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Purpose

The purpose of this work is to measure SRS cone factors with commercially available diodes to determine the "best" instrumentation for beam data acquisition in small field dosimetry.

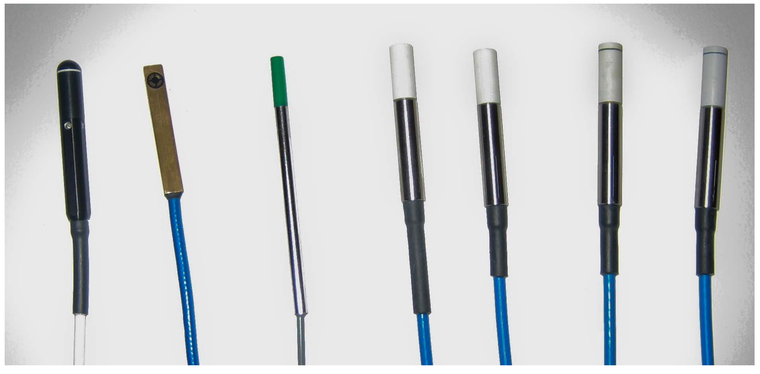
Innovation/Impact

While there have been Monte-Carlo studies of detector response measuring output factors in small field dosimetry (1), we have performed the first measurement using all commercially available diode models. Our data will provide guidance for clinical physicists who are commissioning an SRS machine as to which detector and measurement setup will provide the most accurate results.

Materials & Methods

Measurements were made in 6 MV photon beams with fixed SRS cones for two accelerator-based SRS systems: a Varian Clinac 2300iX (Varian/ZMed cones) at 600 MU/min and a CyberKnife G4 at 800 MU/min. Measurements were made at 1.5 cm depth in water using the IBA Dosimetry "blue phantom" 3D scanning system, controlled by OmniPro-Accept software.

The same author performed set-ups on both machines for consistency. The detector position on the beam central axis was verified by performing a cross-profile scan (Figure 2). Source-to-detector distance was 100 cm for the Clinac, 80 cm for the CyberKnife. Two curves were calculated for the Clinac, one directly from 10x10 diode measurements and the other indirectly by "daisy-chaining" diode measurements to a 10x10 reference ion chamber measurement through an intermediate 4x4 square field. CyberKnife factors were calculated directly from measurements in the 60 mm reference field. Daisy-chaining proved to be no major change for the CyberKnife, since the 60 mm collimator is already fairly small. Six commercial diodes were evaluated: PTW TN60008, TN60012, TN60016, TN60017; IBA SFD; Sun Nuclear EDGE; Exradin SD1.



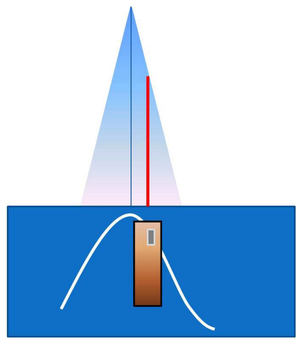


Figure 2: Schematic to demontrate the need for a cross-profile scan to determine accurate detector centering. The active area of the diode (grey) may be offset from the housing (brown). The beam central axis laser (red) is within a certain tolerance (~1 mm) of the beam central axis. To achieve an accurate detector setup to get reproducible results and accurate cone factor measurements, a cross-profile scan of the field should determine the detector position.

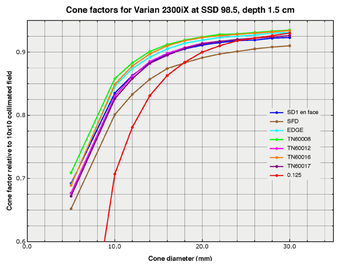


Figure 3a: Cone factors for the Varian 2300 iX. At a field size of ≤ 20 mm, the ion chamber volume becomes too large for an accurate measurement.

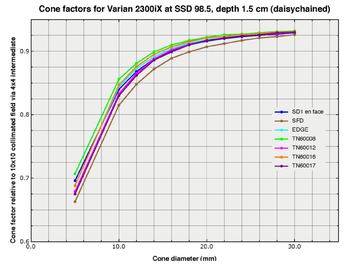


Figure 3b: Daisy-chained cone factors for the Varian 2300 iX. Daisy-chaining reduces the deviation of the SFD diode to the other diodes.

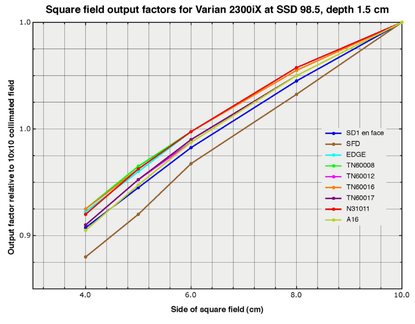


Figure 4: conventional output factors measured using each of the various detectors in the field size regime of 4 cm x 4 cm to 10 cm x 10 cm square fields.

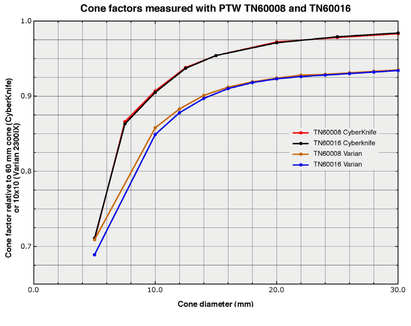


Figure 5: Comparison of the PTW TN60008 and TN60016. The only difference between the revised and legacy models is the diode material itself and the details of its pre-irradiation. Oddly, the TN60016 gives a slightly different cone factor curve in the Clinac beam from that of the TN60008 This effect remains unexplained but was verified but two independent sets of measurements.

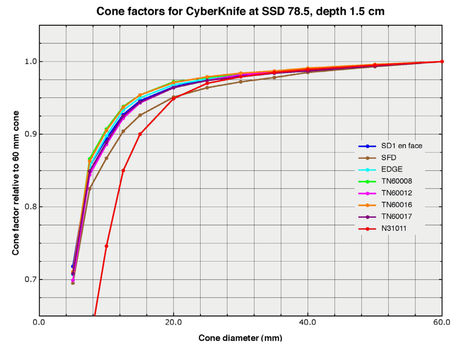


Figure 6: Cone factors for CyberKnife, normalized to the 60 mm cone. As for the 2300iX, the SFD deviates from the other diode measurements for cones smaller than 40 mm. The ion chamber volume is too large for cones smaller than 25 mm.

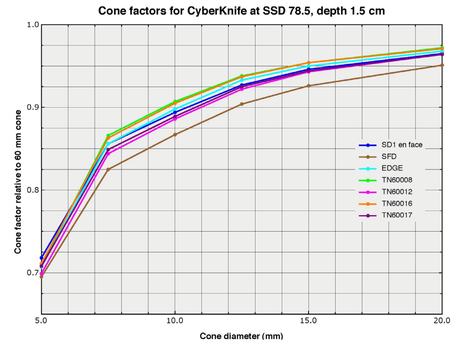


Figure 7: Close-up of Figure 6 for CyberKnife 5 mm – 20 mm cones. Five of the diodes group well.

Results

With one exception, all the evaluated devices yielded surprisingly consistent results. Adjusting the detector positioning using the cross-profile scanning method resulted in significantly reduced variability between subsequent scans. Standard deviations of Clinac factors for all diodes *excluding the outlier* ranged from approximately 0.50% at 30 mm to 1.9% at 5 mm cones size when referenced directly to the 10x10 measurement (Figure 3a). The daisy-chaining strategy reduced the standard deviation to approximately 0.14% at 30 mm and 1.7% at 5 mm (Figure 3b). Standard deviations in the CyberKnife beam ranged from 0.40% at 60 mm to 1.2% at 5 mm (Figure 5).

Conclusions

The inter-detector variation is small and appears to be systematic with detector packaging, more inherent filtration producing flatter curves for both the relatively hard Clinac beam and the softer CyberKnife beam. The daisy-chain strategy reduces the variance between diodes by about half in the Clinac beam.

References

1. Francescon P, Cora S, Cavedon C. Total scatter factors of small beams: a multidetector and Monte Carlo study. *Med Phys* 2008;35:504-513.