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Small-Field Beam Modeling in Halcyon: Findings on Output Factors and Beam Scanning Profiles

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Abstract
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Abstract

Objectives:

To investigate the accuracy of small field dosimetry compared to treatment planning system (TPS) beam modeling on a Halcyon (Varian Medical Systems, Inc., Palo Alto, CA).

Methods:

Output factors (OF) and beam scanning profiles are acquired on a Halcyon with PTW 60019 microDiamond (active volume 0.004cc) and PTW 31010 Semiflex (active volume 0.125cc) in a PTW BEAMSCAN water phantom (PTW Dosimetry, Germany). OF is measured at 95cm Source-to-surface distance (SSD) and 5cm depth and 90cm SSD and 10 cm depth. OF is daisy chained at 4cm x 4cm field size. The profiles are measured at 90cm SSD and multiple depths (1.3, 5, 10, 20, 30cm). Dose calculation algorithms used are Eclipse v 15.6 with Acuros XB (AXB) algorithm v 15.6.06 and anisotropic analytical algorithm (AAA) v 15.6.06 (Varian Medical Systems, Inc., Palo Alto, CA).

Results:

The measured OF agreed well with Varian's published measurement data, which is in the TPS beam configuration, with a maximum deviation of 1.24% for 1cm(Y) x 2cm(X) for SSD 90cm, 1.18% for 2cm(Y) x 2cm(X) for SSD 95cm. The TPS calculated OF showed a larger difference for small fields of Y< 2cm. At 95cm SSD, measured OF to AAA agreement for Y=1cm is between 1.92% (1cm (Y) x 1cm (X)) to 2.89% (1cm (Y) x 6cm (X)); measured OF to AXB agreement for Y=1cm is between 1.43% (1cm (Y) x 1cm (X)) to 3.86% (1cm (Y) x 2cm (X)). At 90cm SSD, measured OF to AAA agreement for Y=1cm is between 2.55% (1cm (Y) x 1cm (X)) to 3.46% (1cm (Y) x 4cm (X)); measured OF to AXB agreement for Y=1cm is between 2.23% (1cm (Y) x 1cm (X)) to 3.13% (1cm (Y) x 2cm (X)). The profiles' overall gamma passing rate for 1% and 1mm criteria is 99.75% where inline penumbra showed the largest difference compared to TPS.

Conclusion(s):

TPS beam modeling for the MLC needs further improvement, particularly for the tongue and groove, to achieve closer agreement with measurement data.