Independent verification of the pre-installed beam model in Tomotherapy

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Background and Objective

Helical Tomotherapy (HT) is a pre-commissioned equipment in the sense that it comes to the site with a pre-installed beam model that only needs to be verified by the customer as part of commissioning process. The aim of the present work was to report the local procedures for independent verification of the pre-installed beam model – gold standard (GS) dosimetry in HT. A similar work was published for another 3D motorized phantom, Blue Phantom Helix from IBA [1] but using the MP3-T these are the first dosimetry results presented for helical Tomotherapy.

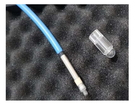
Methods

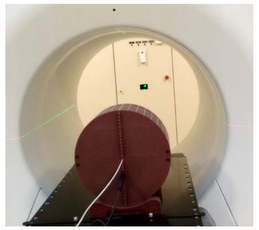
The standard Tomotherapy quality assurance package includes: 2 ionization chambers Exradin A1SL, one TomoElectrometer with 8 channels and a 2D TomoScanner water tank, all from Standard Imaging. The longitudinal and transverse dose profiles as well as the percent depth doses for the three field sizes – 1, 2.5 and 5 cm length – were measured during the installation process with the 2D TomoScanner water tank and compared to GS dosimetry. After the acceptance tests (ATP), independent dosimetry was repeated using a MP3-T motorized water phantom from PTW, equipped with a 3D scanning arm, the beam data acquisition software MEPHYSTO mcc 3.2, the same A1SL ionization chamber and a PTW 31016 PinPoint 3D chamber.

For absolute dose calibration the machine specific reference (*msr*) field concept [2] has been used and an independent audit was carried out by an IAEA expert. This procedure complemented the proposed one in ATP, which corresponded to the calculation in the Tomo TPS of a helical IMRT plan to deliver a uniform 2 Gy dose to a cylindrical structure centrally placed in the Cheese phantom corresponding to one of the A1SL chambers volume (in the figure). This irradiation configures a plan class specific reference (pcsr) field [3].

PTW MP3-T motorized water phantom


Exradin A1SL chamber


PTW 31016, PinPoint 3D


Cheese Phantom

Results and Discussion

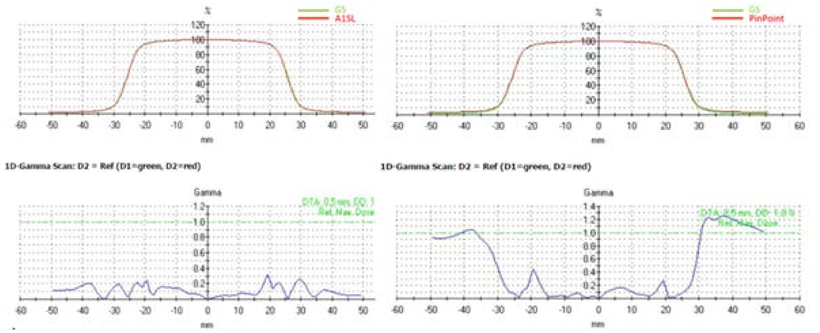


Fig. 1 - Longitudinal profiles at 15 mm depth and SSD=85 cm for 5x25 cm^2 field size for A1SL (left) and PinPoint chambers (right) and corresponding gamma analysis against GS with tolerances at 1%DD/1% DTA.

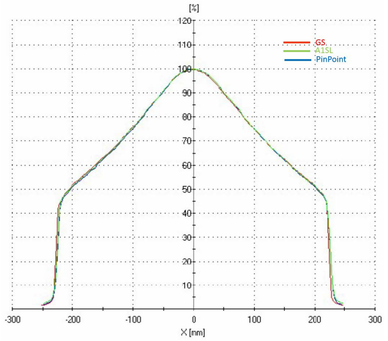


Fig. 2 - Transverse profiles for the 2.5x40 cm^2 field size at 10 cm depth, SSD=85 cm, for GS, A1SL and PinPoint chambers.

- PDD results for the two data sets – using A1SL and PTW 31016 PinPoint 3D chambers with the PTW MP3-T motorized water phantom - were within 1% to the GS using the 2D TomoScanner, well below the required Accuray ratio criteria of 2% PDD ratios;
- Longitudinal profiles for the three field sizes – 1, 2.5 and 5 cm – using both chambers complied almost everywhere with 1%/1mm gamma criteria when GS is taken as reference, except in a limited region outside the larger field, where the standard 2% dose criterion was required (Fig. 1);
- Transverse profiles exhibiting the FFF characteristic cone-shape were measured with all MLC leaves opened which corresponds to 40 cm width at isocentre. FWQM of these profiles at 10 cm depth met 1% tolerance from GS for both measurement sets, even at a deeper depth than 15 mm as required by ATP for this parameter (Fig. 2);
- For absolute dose calibration in static *msr* field the percent deviation from the external audit was 0.2%;
- A perfect agreement between helical and static deliveries has been assured and maintained within less than 0.5% since ATP.

Conclusions

- Independent verification of the pre-installed beam model – gold standard dosimetry - in helical Tomotherapy was reported and proven to be in closer agreement than the Accuray acceptance tolerance levels.

References

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[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Dosimetry of small static fields used in external beam radiotherapy, Technical Reports Series No. 483, IAEA, Vienna (2017).
[3] Langen, K.M., et al., QA for helical tomotherapy: Report of the AAPM Task Group 148, Med. Phys. 37 (2010) 4817–4853.