of the phantom are obtained at beam axis entrance and exit, as well as laterally. Dose distributions for two patients are calculated for clinical plans involving 6 MV and 15 MV photon beams and field-in-field techniques. Three volumes are studied, namely, PTV (516 cm$^3$) and CTVT (10 cm$^3$) for patient one, and PTVT (117 cm$^3$) for patient two. Calculations in the case of phantom and patient geometries are performed by Eclipse AAA and Acuros XB algorithms and by Oncentra CC algorithm. Corresponding Monte Carlo dose calculations are carried out using EGSnrc/BEAMnrc software. Estimates like D98% (dose to 98% of the volume) and V95% (the volume receiving 95% of the dose) are used when comparing the dose distributions. The accuracy of the different algorithms when including a bolus is investigated.

**Results:** Measurements in the phantom case show a negligible dose decrease at the phantom-in-air interface but more than 10% dose decrease at this interface laterally or at beam exit. Large uncertainties in calculated data are detected in the interface regions, namely up to 4 mm depth from the phantom-in-air interface. In the patient cases, deviations less than 3% are observed for PTV and CTVT for the dosimetry parameters D98% D2% and V105% obtained by the different algorithms and the Monte Carlo method. For PTVT, the largest deviations are between AAA and Monte Carlo data, for example, 3.6% for D98% and 9.2 % for V105%. The results are explained by the fact that PTV is large and eventual uncertainties at the boundary has smaller effect on the dose volume histograms. CTVT is small, however, the distance from the CTVT contour to the surface and to the lung interface is 4 mm or more at each slice. In the third case, a large partial volume of PTVT is located near the lung interface where the dose uncertainties are large. Furthermore, it has been found, that the algorithms reflect properly the dose changes due to bolus except for AAA, where the dose volume histograms for CTVT obtained with and without bolus can’t be distinguished.

**Conclusion:** Partial volume located near the lung interface has major effect on target coverage. The measured dose decrease and the uncertainties of the treatment planning algorithms near interfaces should be taken into account when establishing guidelines for target delineation and coverage for patients with thin chest wall.

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**Developing an in vivo dosimetry system for TomoTherapy® using the CT detector array**

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**Purpose or Objective:** The Hi-Art Helical TomoTherapy unit is a linear accelerator equipped with an on-board CT detector array. It delivers radiation in a helical fashion with daily CT imaging for image guidance and beam monitoring. In vivo dosimetry is a recognized part of treatment with the potential of improving patient safety. Conventional approaches of in vivo dosimetry cannot be implemented for TomoTherapy due to the rotational nature of the system and thus transit dosimetry is required. This study has investigated the use of the detector sinogram in performing transit dosimetry by modelling how the primary photons are influenced by scatter geometry for a static and helical field. The aim has been to produce a semi-empirical model of the exit detector signal and investigate factors that influence the signal at the imaging panel of a TomoTherapy unit.

**Material and Methods:** The detector signal profile (detector sinogram) is extracted for the DICOM data for each procedure. It contains the response at each detector channel and for each projection. The exit detector response for an open field is measured in-air with a moving couch for a static and helical delivery. The exit detector sinogram for an in-air measurement has been used as an input into a signal reconstruction model of the exit detector sinogram when a scattering medium is positioned on the couch. A simple ray-tracing model has been produced using narrow beam conditions for the attenuation of the beam in a cylindrical, uniform phantom (Tomo® Cheese Phantom). The model relies on PFR data previously determined in the department as shown in Thomas et al. (2012).

**Results:** The simulated sinogram agrees with the measured sinogram for both the static and helical deliveries within ±10% in the central region of the phantom. At the edge of the phantom this increases to ±15% due to set-up issues.
measurements were then acquired for 3 clinical prostate patients with Compass and film (one of which had failed Compass QC, likely due to narrow segments) in a solid water phantom and compared.

Results: Profile analysis of the characteristic fields showed that for narrow but long fields on axis, the agreement between Compass and film was within 3%, slightly inferior to the TPS and film comparison at 2%. The worst case was 5% for a 1 x 10 cm off-axis field and 4% for irregular fields. The clinical films demonstrated that Compass accurately modelled dose distribution with 11/12 films achieving at least 95% gamma passing at 3%/3mm with an average of 97.8 ± 2.1% (sd). The failed film achieved 93.6% passing. This was from the failed clinical plan - this is more likely due to the blurring induced by narrow segments than inaccurate delivery. Figure 1 shows (a) an isodose for a passing film and (b) a profile taken across the film. All films passed when compared against the TPS (average gamma 98.3 ± 1.3%).

Conclusion: By comparison with film measurements, it has been shown that Compass is able to reproduce the dose distribution of clinical VMAT prostate plans, and is sufficiently accurate to detect any clinically relevant errors. However, users should be aware that the resolution of the Compass reconstruction algorithm is limited when narrow segments are predominant.

References

Material and Methods: For thirty prostate dual-arc VMAT plans, the most relevant DVH indices (DI) were considered for the PTV: D98, D95, D50, D1 and Dmean. Clinical doses were computed with both, COMPASS and RayStation, which share the same calculation algorithm. Plans were delivered with a VARIAN Trilogy equipped with a Millenium 120 MLC and measured with COMPASS. RayStation vs COMPASS reconstructed doses were analyzed in terms of DI differences. The AC rely on calculating mean values (m) and standard deviations (std) of DI differences and assigning for each DI difference a confidence interval equal to 1.5•std. To assess the AC robustness in terms of system sensitivity the TG119 prostate case was optimized using a VMAT single arc technique. Three different types of errors were introduced individually in the RT-plan to mimic linac delivery inaccuracies: a) MU number modification (MU-error) from -3% to +4%, b) gantry angle shift (g-error) from 0° to 3° and c) widening of both leaf banks (w-error) from 0 to 2 mm.

Results: For RayStation vs COMPASS computed doses analysis DI differences < 0.4% have been found. In the TG119 plan PTV DI differences showed a linear trend respectively with MU-errors (see figure) and g-errors. The proposed DVH based criteria detected MU-errors below -1.8% or above 1.3% and w-errors > 1.5mm. The criteria led to the detecting of g-errors>3°.

Conclusion: By comparison with film measurements, it has been shown that COMPASS is able to reproduce the dose distribution of clinical VMAT prostate plans, and is sufficiently accurate to detect any clinically relevant errors. However, users should be aware that the resolution of the COMPASS reconstruction algorithm is limited when narrow segments are predominant.

References

Proposal for DVH oriented acceptance criteria for VMAT prostate patient specific QA
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Purpose or Objective: New hybrid systems for patient specific pre-treatment QA are suited for 3D gamma (GA) and DVH reconstructed analysis (DA). For 2D evaluations, a 3%/3mm agreement for 90-95% points is considered to be the state of art. Recent studies highlighted poor correlation between gamma passing rates and DVH clinical goals variations on PTV and OARs, so it could improve the situation to consider available DVH analysis tools. The aim of this work is to test the robustness and sensitivity of VMAT prostate patient specific DVH based acceptance criteria (AC) for QA using the COMPASS (Iba-Dosimetry) system in combination with the RayStation (Ray Search Laboratories) TPS.