AbstractID: 8932 Title: Towards Quality Assurance of 4D Radiotherapy using a Deformable Lung Phantom

Purpose: To develop experimental quality assurance (QA) procedures for 4D radiotherapy verification using a deformable lung phantom.

Methods and Materials: A deformable phantom consisting of a Lucite cylinder containing a latex balloon filled with dampened natural sponges and surrounded by water was developed for this purpose. The balloon is attached to a piston mimicking the diaphragm. Nylon wires and Lucite beads, emulating vascular and bronchial bifurcations, were glued throughout the sponges aiding deformable image registration (DIR). Four EBT Gafchromic film pieces were used to measure dose in different planes of a simulated tumour and lung tissue. 3D-CT datasets (0.7x0.7x3 mm^3) of the phantom in three static breathing states (End-Exhale(EE); Mid-Inhale(MI); End-Inhale(EI)) were acquired. To evaluate film motion reproducibility, five repeat scans were obtained for each state. A four field, MLC-shaped, 3D treatment plan was delivered on the MI breathing state of the phantom and recalculated with Monte Carlo.

Results: The accuracy of DIR of the EI to EE breathing phases was 1.3($\pm$2.4) mm and the film detector motion reproducibility better than 1 mm. Film placement, localization on CT images and film dose measurements proved accurate despite slight humidity from the dampened sponges. To address this, modifications to the material choice for emulation of lung tissue are underway. The differences between measured and MC calculated dose did not exceed 2% (Δ_{RMS} < 1%) and 4% (Δ_{RMS} < 2%) within and outside the tumour, respectively.

Conclusions: Using a reproducible deformable phantom, this work aims to develop an experimental QA process for imaging, planning and delivery verification of 4D radiotherapy. The overall process of dosimeter placement, imaging and DIR, planning and dose delivery verification in the MI state of the deformable phantom was found accurate thereby opening the door to verifications of more complex planning and delivery strategies.