AbstractID: 9403 Title: Dose painting to combat tumor hypoxia while sparing urethra in prostate IMRT: a biologically-based adaptive approach accounting for setup uncertainties and organ motion

Purpose: To explore means of incorporating prostate motion and setup uncertainties into biologically-based adaptive IMRT optimization for Volumetric Modulated Arc Therapy (VMAT).

Method and Materials: IMRT planning objectives were set to produce a dose distribution, which, after accounting for setup uncertainties and prostate motion, meets the following requirements. 1) The CTV is covered with the desired dose; 2) Hypoxia volumes arbitrarily drawn inside CTV are boosted; 3) Desired urethra sparing is achieved. The objective function was based on equivalent uniform dose (EUD). Repositioning data from five prostate patients with implanted fiducial markers were used. Systematic and random uncertainties for each patient were incorporated into an in-house treatment planning platform for VMAT. During the optimization, the dose matrix was shifted based on the systematic error, then convolved with a pre-calculated Gaussian kernel to account for random errors. For each of these patients seven plans were generated using uncertainty data accumulated in 5 fraction increments.

Results: The urethra EUD increased by >5Gy when the dose distribution from the static plan was propagated to account for geometrical uncertainties. In contrast, if uncertainties were accounted for in planning, urethra EUD was reduced without compromising CTV coverage (EUD decreased <1.5Gy). For four of five patients, the repositioning data from the first five fractions was sufficient to account for uncertainty in planning. In the proposed biologically-based optimization inclusive of uncertainties, the PTV is not required. Appropriate dose coverage of the CTV is intrinsically produced by the optimization procedure. Because this coverage is typically tight and patient specific, improved normal tissue sparing was achieved. The rectal EUD was lowered by up to 23Gy compared to static plans that utilize the generic PTV concept.

Conclusion: Our approach allows the inclusion of geometrical uncertainties into biologically-based optimization of IMRT. Partial uncertainty data are sufficient to produce an optimal plan.