AbstractID: 11721 Title: Motion and Delivery Management with Novel 4D-Optimization

Purpose: Intensity modulated radiation therapy (IMRT) has the ability to deliver highly conformal dose distributions to tumors of complex shapes. However, motion uncertainties can substantially degrade the quality of an otherwise optimized treatment plan. We present a novel 4D-optimization technique that exploits time effects and provides plans which are robust against tumor motion and warrant deliverability.

Method and Materials: Our 4D-optimization technique takes all registered breathing phases into account. All 4D CT data are conformally registered. To account for lung tissue inhomogeneities, we use Monte Carlo dose calculations. The 4D-optimization method seeks to minimize the overall dose subject to i) lower bounds for tumor voxels and ii) upper bounds for remaining voxels, and iii) closeness of the beamlet intensities for neighboring phases.

Results: Based on a clinical lung cancer case, our 4D-optimization method delivers robust plans that significantly outperform the gating-based optimal plans both in terms of target coverage as well as OAR sparing. In fact, the EUD to the PTV deviates only by 0.1% from the prescribed dose for our 4D method, whereas the gated EUD deviates by 2%. Moreover, since the 4D-robust plan is quasi-static and can be delivered over all breathing phases, it warrants for a reduction in delivery errors and is less sensitive to motion uncertainties. Note that gating is quite sensitive to the choice of the gated phase and, thus, requires enlarged margins. Furthermore, due to reduced number of segments needed, we report an increase in delivery efficiency.

Conclusion: Our proposed 4D optimization method delivers plans that are robust against motion uncertainties. Moreover, the plan is also inherently robust against sequencing and delivery errors. Therefore, it allows to reduce margins on the ITV. The method outperforms gating both in dose coverage as well as delivery robustness and increases the delivery efficiency.