AbstractID: 5040 Title: A Robust Approach to IMRT Optimization

Purpose: To demonstrate the advantages of using a robust optimization methodology in IMRT treatment planning to mitigate the effects of intra-fraction uncertainty induced by breathing motion.

Method and Materials: A robust optimization framework was developed to directly incorporate breathing uncertainty into IMRT optimization. Data for this model was obtained from four patients, totaling 95 traces of motion data gathered from an external marker. This data was used to create a "nominal" probability density function (PDF) that was used in the planning, and also "error bars," which outlined the allowable deviations from the nominal PDF. A computer phantom was used to evaluate the robustness of an optimized beamlet solution in the situation where the realized PDF differed from the nominal (planned) one. The robust formulation was compared to two other formulations: a nominal formulation, which did not take uncertainty into account, and a margin formulation, which used an optimized margin to combat uncertainty.

Results: With uncertainty in the PDF, the nominal solution led to significant hot and cold spots within the tumor. Both the robust and margin solutions were able to deliver the required dose to the tumor under the realized uncertainty, however, the robust solution did so while delivering approximately 38% less dose to the healthy tissue. More fundamentally, the robust formulation was mathematically proved to be a generalization of both the nominal and margin formulations, thus defining a "continuum of robustness" that allows the user to modulate his or her conservatism to customize treatment plans based on the case at hand.

Conclusion: This work demonstrates the potential of using robust optimization in IMRT treatment planning to improve healthy tissue sparing while maintaining tumor coverage in the presence of uncertainty, and also the flexibility afforded to the treatment planner to make suitable decisions regarding trade-offs of conflicting objectives.