AbstractID: 7094 Title: Direct aperture optimization in IMRT treatment planning

Purpose: To develop an exact approach to direct aperture optimization that can be applied to a large class of IMRT fluence map optimization (FMO) models that employ convex treatment plan evaluation criteria in the objective function and/or constraints and test its ability to obtain high-quality treatment plans using a reduced number of apertures and limited beam-on-time.

Method and Materials: An exact approach was developed that iteratively adds high-quality deliverable apertures while the treatment plan quality can be improved. The most promising new apertures are found by solving a subproblem, which can account for deliverability constraints imposed by the multi-leaf collimator (MLC) system such as interdigitation, connectedness, or rectangular shapes. The approach can explicitly account for transmission through the leaves that are not shielded by backup jaws in the MLC system. It was compared to the traditional method of solving a beamlet-based FMO model followed by a leaf-sequencing step to determine apertures and intensities.

Results: For a set of ten clinical head-and-neck cancer cases, treatment plans comparable in quality to plans obtained by the traditional method were obtained with a reduction of more than 75% in number of apertures and a reduction of more than 50% in beam-on-time, with only a modest increase in computational effort. The importance of incorporating transmission effects when assessing treatment plan quality was shown as well.

Conclusion: This work provides a direct aperture optimization method that incorporates many physical and biological treatment plan evaluation criteria, accounts for leaf transmission effects, and significantly limits both total treatment time and beam-on-time. The iterative nature of the approach allows it to be implemented in an interactive system where a trade-off can be made between treatment plan efficiency and efficacy. The ability of the approach to account for different MLC deliverability constraints allows for a comparison of different MLC architectures.