AbstractID: 13203 Title: Incorporating the tongue-and-groove effect in direct aperture optimization

Purpose: To develop a new direct aperture optimization method that explicitly incorporates dose calculation inaccuracies due to the tongue-and-groove effect by using lower and upper bounds on the dose distribution delivered to the patient. The goal is to develop a treatment plan that is robust with respect to dose calculation inaccuracies due to the tongue-and-groove architecture of MLC systems.

Method and Material: Most IMRT treatment plan optimization models ignore the tongue-and-groove effect until the leaf-sequencing phase. However, the presence of the so-called “tongues” may lead to underdosing since it causes part of the radiation to be blocked or scattered. It is therefore preferable to integrate the tongue-and-groove effect into the treatment plan optimization phase. Since it is difficult to determine, in an optimization setting, the exact delivered dose in the presence of the tongue-and-groove effect, lower and upper bounds on the dose received by each voxel as a function of aperture intensities are incorporated instead. A direct aperture optimization model is formulated in which overdosing (underdosing) penalties are applied to the upper (lower) bounds. This model is then solved for an optimal set of apertures and corresponding intensities.

Results: For a set of ten clinical head-and-neck cancer cases, robust treatment plans with tight dose distributions in targets and critical structures are obtained. This is contrasted with the very loose bounds on the dose distribution that are obtained by solving a traditional treatment plan optimization model.

Conclusion: This work introduces a direct aperture optimization method that incorporates the tongue and groove effect. The approach provides a tight bound on the dose distribution in target voxels in order to limit the target under dosing.