AbstractID: 2580 Title: Simplifying IMRT Plans Through Efficient Segmentation

Purpose: To analyze the various methods for creating efficient leaf sequences for an IMRT plan, subject to MLC constraints.

Method and Materials: An IMRT treatment plan can be simplified at several stages. Careful beam placement can lead to simpler intensity maps. The choice of the dose optimization engine, as well as the spatial and intensity resolution can also affect map complexity. To further reduce the total number of segments and monitor units, an optimal leaf sequence must be used. This reduction is accomplished by a combination of segment extractions and sweeps. The algorithms involve the determination of MLC shape and MUs. Some algorithms use predefined MUs according to a sequence (e.g. Power of two, Half-Maximum, Triangular numbers), while others optimize the MU selection by evaluating the complexity of the difference between the intensity map and the segment being considered. The selection of the MLC shape can also be achieved through a predetermined geometric process (e.g. largest area, largest area with maximum intensity, leftmost segment, graph theory) or by minimizing the complexity of the difference map. In this step, the machine constraints and the desire to reduce the tongue and groove effect are considered, as they can dramatically increase the number of segments and MUs. Once the leaf sequences have been generated, an examination of the plan may reveal degradation in the DVHs, and appropriate leaf-sequence modifications can help restore the plan quality.

Results: Plans with beams that have minimal critical structure involvement and modulate with more leaves yield less segments and MUs. Optimizers that use gradient methods rather than simulated annealing tend to reduce modulation scaling factors by a factor of 2 to 3. A map resolution of 10 to 15 intensity levels and a leaf spacing of 6 mm produce a reasonably efficient plan without sacrificing its quality, provided that the leaf sequence is optimized by minimizing the difference map complexity. The collision constraint increases the number of segments and MUs by about 20%, and various levels of tongue and groove correction provide an additional increase of about 20 to 30%. Post processing can remove low weight segments, and leaf positions can be adjusted to eliminate hot and cold spots.

Conclusion: In order to simplify an IMRT plan, one must take advantage of all the options that affect the leaf sequencing process, including beam placement, map resolution, segmentation algorithm choice and post-processing.

Educational Objectives:
1. To understand the importance of beam selection and set-up prior to plan optimization.
2. To know the impact of map resolution set-up on complexity and the achievement of clinical goals.
3. To know the limitations and strengths of the various algorithms for leaf sequencing and how to choose the appropriate one.
4. To become familiar with the post-processing of leaf sequences.