AbstractID: 1116 Title: A study of the impact of MLC constraints on the number of segments in step-and-shoot IMRT delivery

MLCs from three manufacturers, Elekta, Siemens, and Varian, have different mechanical constraints. They include the minimum leaf separation between opposing leaves and between opposing adjacent leaves, and the limits in interdigitation of opposing adjacent leaves. This study aims to investigate the impact of each such constraint on the numbers of segments required for realizing different intensity distributions using step-and-shoot IMRT delivery. Our findings may provide useful insights for designing future MLC systems.

To quantify the impact of these MLC constraints on the number of segments, we experimented with the static leaf sequencing (SLS) algorithm by Luan et al. on clinical intensity maps and collected the numbers of segments computed for each of the three MLC systems. Because the SLS algorithm was developed only for the Elekta constraints, we extend the algorithm to accommodate the Siemens and Varian constraints. In our extensions, we formulate the segmentation for Siemens and Varian MLCs as solving a combinatorial optimization problem of computing a minimum path-cover in a directed graph, such that each path in the resulting path-cover specifies a Siemens or Varian segment.

Our study shows:

(1) The no-interdigitation constraint alone can cost 27% more segments than the minimum leaf separation constraint.

(2) Among the three MLCs, Elekta requires the most segments. Siemens requires 25% less segments than Elekta; Varian requires 45% less segments than Elekta and 27% less than Siemens.

Also, experiments on our extended SLS algorithm for Siemens and Varian MLCs showed an improvement of about 8% over Xia and Verhey's algorithm.