AbstractID: 2833 Title: Impact of MLC modeling and sensitivity of its parameters on Monte Carlo simulation of IMRT

Purpose: Monte Carlo simulation (MCS) offers the most sophisticated dose calculation for IMRT with complex delivery systems using MLCs. The purposes of this work are to determine: (1) to what degree of accuracy and complexity MLCs have to be modeled in MCS; (2) what are the most sensitive tests and effective ways of determining free parameters for MCS-IMRT, including leaf density, leaf geometry, and incident electron beam source size.

Method and Materials: A generic MLC model was developed for BEAMnrc system. This model described MLCs based on matrices of regions, each of which can be independently defined for its material and geometry, allowing maximum flexibility of simulating MLCs for various manufacturers. To commission the MLC model for Varian Millenium MLC, we measured transmission ratios and intensity maps for various leaf patterns designed to magnify the effects of leaf transmission, leakage, and tongue-and-groove. In addition, TLD measurements were also taken for clinical IMRT plans using anthropomorphic phantoms. Several parameter sets of leaf density, leaf geometry, and electron source size were tested to evaluate dosimetric effects of these parameters and to determine the optimal combination.

Results:The overall-transmission ratios were strongly dependent on both leaf density and inter-leaf air gap. Meanwhile, electron source size had less effect on transmission and leakage. Inter-leaf air gap and tongue-and-groove geometry can be determined most effectively through fence-type MLC patterns. The optimal parameter range was 17.35-17.70g/cm^3 for leaf density, 0.08–0.11mm for inter-leaf air gap with detailed tongue-and-groove modeling, and 0.1-0.2cm for electron source size. With these parameters, MCS calculated and measured TLD dose showed clinical-acceptable agreement from low to high dose regions.

Conclusion: MLC modeling critically affected the accuracy of MCS for IMRT. The free parameters for the MLC have to be carefully determined by separate measurements for MCS.