Quantitative tools to assess the fidelity of treatment planning system commissioning for IMRT

Purpose: Develop tools for quantitative evaluation of beam modeling of focal- and extra-focal radiation in a 3D treatment planning system (3DTPS) for IMRT

Method and Materials: Cross-beam photon beam characteristics in a convolution/superposition-based 3DTPS (Pinnacle^3) are typically verified by comparing measured and calculated cross beam profiles for a series of field sizes defined by MLC leaf end at various depths. We employed one dimensional gamma analysis, with 1%/1mm criteria, to evaluate each beam profile. Percentage of points failing gamma analyses in high gradient region and low gradient region were respectively calculated as High Gradient Failure (HGF) and Low Gradient Failure (LGF). A mean gamma score (MGS) was also calculated. HGF, LGF and MGS were averaged over all measurement depths for each measurement field size to arrive at a single score for the evaluation of "goodness" of beam modeling. This approach was used to compute leaf-end-separation weighted average of HGF, LGF and MGS from all sub-fields sizes used in clinic for 30 Head & Neck, 30 lung and 30 prostate SMLC-based IMRT cases for four different effective source sizes ranging from 0.01 cm to 0.05, 0.1 and 0.2 cm.

Results: HGF, LGF and MGS parameters were used to evaluate the overall performance of beam modeling using different effective source sizes. The results of leaf end separation weighted averages of HGF, LGF and MGS show that the beam modeled with 0.1 cm effective source size gives the best overall performance for clinical IMRT cases planned on Pinnacle^3 3DTPS.

Conclusion: Quantities such as HGF, LGF and MGS described in this work can prove to be extremely useful tools for clinical physicists commissioning and evaluating photon beam models in 3DTPS.