AbstractID: 6690 Title: A Generalized Dose Uncertainty Model and Its Application to Dose Verification

Purpose: To investigate robustness of improved dose uncertainty model and its applicability to dose verification.

Method and Materials: Previously, we developed a dose uncertainty model by introducing space-oriented and non-space-oriented dose uncertainties, and a novel scheme of accounting dose accumulation history. Although the model was able to provide good estimations, its application was limited to cases with a few mm range of spatial displacement. In this study, we have improved and generalized the model by incorporating a convolution method. The new model categorizes uncertainty sources from both treatment machine and patient into eight degrees of freedom. Probability density functions are convolved with dose calculation to obtain dose uncertainty maps. For this study, input parameters were determined through 6-year annual QA data, 64 setup measurements using an IR camera, and 105 dose measurements of seven dose levels. To examine applicability of the model to dose verification, treatment plans of four test patterns were made and delivered to film-phantom dosimetry system. Percentage of measured points within the dose uncertainty bound (pass rate) was evaluated with confidence interval of the uncertainty to verify the robustness of the model.

Results: Mechanical setup accuracies were 0.2±1.0 mm (x), 0.1±0.9 mm (y), 0.0±1.1 mm (z), 0.0±0.1° (pitch), 0.0±0.0° (roll), 0.1±0.2° (yaw), and 0.0±0.0° (collimator). The relative dose perturbation at 200 cGy was 0.4%. The uncertainty distributions were obtained with these measured model parameters and dose verification pass rates were evaluated according to the confidence interval of dose bound. The pass rates showed similar trends as theoretical statistical confidence. For test patterns, the pass rates by the uncertainty-based test with three standard deviations were similar to those obtained in conventional γ-test with 3% and 3 mm criteria.

Conclusion: With a few simple test fields, robustness of the approach and possibility of application to dose verification were observed.