AbstractID: 3177 Title: Analyzing the accuracy of IMRT dose distributions using a dose uncertainty model

Purpose: To provide dose verification methodology using a novel dose uncertainty model.

Method and Materials: The expected value for an experimentally measured dose, $D(\vec{r})$ in space $\vec{r}$ can be expressed by $D(\vec{r}) = D_c(\vec{r}) \pm k \cdot \sigma(\vec{r}) + \varepsilon$ where $D_c(\vec{r})$ is the calculated dose distribution, *k* is the constant for confidence level, $\sigma(\vec{r})$ is the standard deviation (Gaussian distribution), and ε is the adjustable errors. The standard deviation is assumed to be a quadratic sum of the non-spatial and the spatial dose uncertainties. The product of the standard deviation and the confidence level *k* can be used as a tolerance bound for dose verification. The proposed model was verified using a Head and Neck IMRT treatment plan. Three-dimensional dose distributions from a total of 34 beam segments were extracted and a dose uncertainty map was computed to obtain the dose bound. EDR2 film was placed at the depth of 6 cm in solid water phantom to experimentally measure a dose distribution. The absolute difference between the measured and the calculated dose was compared with the dose bound using published dose comparison tools.

Results: The dose bound was found to be large at the high gradient regions and small at low dose gradient regions. Using 95% (*k*=1.96) and 99.74% (*k*=3) confidence level, the acceptance test criterion passed 98.7% and 99.89% of the IMRT fields respectively. Most of the failures were in the high gradient regions.

Conclusion: The proposed methodology is ideal for analyzing expected dose variations in IMRT fields that have contributions from high and low dose gradients of multiple subfields. None of the existing methodologies explicitly account for the spatial and non-spatial dose uncertainties. Most of these methodologies apply a single set of passive criterion. Our uncertainty model provides space-dependent tolerance level for comparison with the prediction of space-specific dose uncertainties.