AbstractID: 11289 Title: Implementation of a Dose Delivery Model to Handle Respiratory Motion with Variability

Purpose: To address the problem of respiratory motion uncertainty in IMRT and IM particle therapy by incorporating it in the optimization of the treatment plan.

Method and Materials: We propose a probabilistic dose delivery model that accounts for the uncertainty of respiratory motion. Each breathing phase has associated with it a dose matrix whose deformations are calculated from 4D-CT data. The expected dose is then the sum over all dose contributions weighted by a probability density function (PDF) that represents the relative amount of time spent in each phase. The PDF is calculated from Varian Real-time Position Management (RPM) breathing traces. The uncertainty in the breathing pattern is represented by perturbation modes of the PDF determined by a principal components analysis (PCA) of the RPM data. Treatment plans are generated to compare the standard dose model without motion considerations and the described PDF Variation Model.

Results: The concept is demonstrated for a liver patient treated with 5-beam IMRT. Five principal components represent the data set well, and two are sufficient for capturing the main features. Using the PDF Variation Model, the mean dose to the gross tumor volume (GTV) remains the same compared to a standard IMRT plan with 5-mm margins; the minimum dose to the GTV+5 mm volume decreases by 27%, and the maximum dose increases by 5%. The significant decrease in the minimum dose is not critical, as would be in the margin approach.

Conclusion: We propose a treatment planning approach that takes into account variability in the respiration PDF of a patient. PCA is used to derive the typical variations of the PDF from measured breathing traces. The resultant dose distribution is expected to reduce dose to the lung or liver compared to a margin approach, while ensuring tumor coverage in the context of variable breathing patterns.