AbstractID: 9513 Title: A Comparison of Geant4 and DPM for 4D Monte Carlo of Lung IMRT

Purpose:
Respiratory motion during IMRT for lung tumors presents a particular challenge. Geant4 is an attractive tool for investigating motion effects since it can accommodate time-dependent geometries. Leaf positions and patient geometry may be updated during the course of the simulation and interplay effects directly studied. Here we investigate the applicability of Geant4 for patient dose calculations in the lung, comparing field-by-field results for an IMRT patient with results obtained using the code DPM.

Method and Materials:
Geant4, being a general purpose code, has many adjustable parameters available to the user and their default values may not be appropriate for patient dose calculations. Additionally, while it can import CT data and accurately model the complex patient geometry, it is not optimized for fast patient dose calculations. In particular, it does not efficiently handle voxel-to-voxel variations in material density. We modified the Geant4 (release 9.0) source code to optimize the handling of density variations in the voxelized patient to greatly speed up simulation time. Similar modifications had been made to an earlier release (release 5.0) for proton therapy but this is the first such optimization for IMRT. As part of our project on using Geant4 for 4D dose calculation in the lung we compared the results from Geant4 using different user parameters with the results obtained using DPM for a five-field IMRT treatment plan for a lung patient.

Results:
The efficiency of Geant4, version 9.0, was greatly improved by modifying the voxel tracking algorithm. We found that DPM and Geant4 agreed to within a few percent after adjusting just two user parameters, the simulation stepsize limit and the secondary range cutoff (1 mm and 0.1 mm, respectively).

Conclusion:
Geant4 provides a natural platform for 4D studies and has been shown to be sufficiently accurate for patient dose calculations in lung.