AbstractID: 11564 Title: Dynamic Monte Carlo Dose Calculations for IMRT in Geant4

Purpose:
The effectiveness of IMRT to deliver highly conformal doses can be compromised in thoracic patients due to the presence of breathing motion. In order to study motion effects we have implemented a dynamic MLC model in a Geant4 based Monte Carlo system that allows movement of the leaves during the course of a simulation in direct analog to dynamic treatment delivery. We use Geant4 to investigate the effect of breathing motion in three lung patients.

Method and Materials:
We created a model of the Varian 2100C/D x/y jaws and MLC in Geant4 based on machine drawings. We validated our model by comparing open-field penumbra and closed-leaf transmission with measurements taken in-house and found in the literature. We compared field-by-field photon fluence for a seven-field IMRT treatment plan using dynamic dose delivery in Geant4 with that from an established Monte Carlo package. Step-and-shoot dose delivery was used, with each field utilizing between 23 and 39 distinct leaf configurations. Motion effects were investigated for three lung patients. For each patient, 4DCT data were binned into six breathing phases and then registered onto the exhale phase using deformable registration. Dynamic dose delivery was simulated for each breathing phase for comparison.

Results:
Closed-leaf transmission of 1.5% using our Geant4 MLC model is in good agreement with values published in the literature and exhibits the characteristic picket-fence profile expected from the tongue-and-groove geometry. Field-by-field comparison of photon fluence projected onto the isocenter plane shows 2%/2 mm agreement between Geant4 and the MLC model developed by Siebers et al (Phys. Med. Biol. **47**, 3225 (2002)).

Conclusion:
We have implemented 4D Monte Carlo in Geant4 for IMRT using an in-house model of the Varian x/y jaws and MLC. We have validated our model and simulated IMRT treatments in three lung patients based on 4DCT.