AbstractID: 2936 Title: A Method to Model 4D Organs for Monte Carlo Radiation Dosimetry

Purpose: The objective of this study is to construct a detailed 4D standard patient testbed for studying effects of organ motions on treatment planning.

Method and Materials: Segmented Visible Human images, containing 80 organs and tissues defined in a 3D static model called VIP-Man, were combined with Non-Uniform Rational B-Splines (NURBS) and clinically obtained respiratory motion data to deform the surfaces of the lungs. Deformable image registration was performed to establish correct spatial definition of the organ boundaries. A lesion in the left lung was simulated. The 4D model containing 3D anatomical information for each of the eight simulated motion phases was then re-voxelized before being defined in the EGS Monte Carlo code. A hypothetical 3D static treatment plan for the lung lesion was considered in the Monte Carlo simulations.

Results: Normalized doses to the lesion are plotted for each of the respiratory phases. It has been found that the lesion could be under-dosed by as much as 40% for different respiratory phases and for the irradiation conditions considered in this study. Although more analysis is underway, this study clearly demonstrates that the motion of the organs can be accurately modeled and implemented in the Monte Carlo code for 4D dose calculations.

Conclusions: A partial-body 4D VIP-Man model has been developed using the NURBS and clinical respiratory data, and implemented into the EGS Monte Carlo code for dose calculations. The detailed anatomical information in this 4D model makes it a very convenient research tool to study radiation treatment planning and medical imaging involving moving organs and tissues. This study also identified issues to be further addressed for routine clinical research and applications. The procedures can be extended to patient specific models constructed, for example, from multi-slice CT data.