AbstractID: 13842 Title: A Novel Dose Reconstruction Method for Four-Dimensional Treatment Planning

Purpose: To present a novel dose mapping algorithm that takes into account heterogeneity effects of radiation energy distribution in 4D planning, and compare it with two well-established dose calculation strategies.

Method and Materials: A 4DCT dataset was imported into Eclipse and the end-inhalation image (EI) was used to develop a free-breathing lung cancer radiotherapy treatment plan. The EI was registered to the end-exhalation image (EE, reference) using a B-Spline deformable registration algorithm. The resultant displacement map Φ, defined from EE to EI, was iteratively reversed to generate a self-inverse consistent map Φ_R. With the Eclipse Advanced Planning-Interface (API, Varian Medical Systems), the mass density matrix of EI was derived from the treatment plan and mapped to EE using Φ_R. The dose was calculated on the EI using the AAA algorithm and multiplied by the mass density matrix of EI to generate the deposited energy. The energy was then mapped to the image EE again using Φ_R. The warped dose D on the EE image was calculated as the ratio of the mapped energy and mass (REM). For comparison, two additional approaches were used that warped the dose on EI with Φ: center of mass (COM) and trilinear dose interpolation (TRI). The three dose reconstruction strategies were then compared on the reference image (EE).

Results: The average spatial difference between the composition of Φ and Φ_R and the identity map was approximately 0.0 mm. On average, the dose to 95% of the ITV (D95) was 70.2%, 67.5%, and 64.3% for the REM, TRI, and COM methods, respectively. The dose difference between COM and REM was up to 14.5% at the high gradient beam edges.

Conclusion: The independent mappings of mass and energy may help minimize heterogeneity-induced dose interpolation errors, thereby improving dose mapping accuracy in 4D treatment planning.