AbstractID: 3434 Title: Proton Treatment Planning for Mobile Lung Tumors

Purpose:
Traditional treatment planning methods may lead to lung proton treatment plans in which the apparent and actual dose distributions may be significantly different due to respiratory motion. We are developing strategies for designing compensator-based 3D proton treatment plans using 4D CTs (composed of 3D CTs at a sequence of respiratory phases) for mobile lung tumors and assessing the validity of these strategies using 4D dose computation methods.

Method and Materials:
4D CTs for a population of lung cancer patients were used to obtain tumor targets and critical structures. The internal target volume (ITV) was the composite of target volumes on the 4D CT. For each patient, we evaluated four compensator design and planning strategies based on (1) the average CT obtained by averaging all phases of the 4D CT; (2) free breathing CT; (3) maximum intensity projection (MIP) CT; and (4) the average CT with the CT numbers inside the tumor volume replaced by the corresponding MIP CT numbers. For each strategy, the resulting apparent dose distribution was compared with the corresponding 4D dose distribution computed by deforming dose distributions of each phase to the reference phase and summing.

Results:
The composite 4D dose coverage of the target was significantly superior for method (4) while normal tissue doses were slightly higher though well below the limits. A seemingly conservative compensator design using MIP for the entire image, not just the target volume (Method 3), resulted in poor proximal target coverage due to over-estimation of the densities of intervening tissues.

Conclusion:
3D proton plans based on the CT obtained by averaging the 3D CTs comprising the 4D CT, and with the CT numbers in the tumor volume replaced by the corresponding MIP CT numbers, is an effective approach to achieve good tumor coverage and acceptable normal tissue sparing.