AbstractID: 8405 Title: Effect of CT calibration phantom size on the range in Proton Radiation Therapy

Purpose: The range of a proton beam in the patient is estimated using the relationship between CT numbers (HU) and relative linear stopping powers (RLSP). The purpose of this study is to assess the range uncertainties introduced by the size of the phantom used for determining the calibration curve.

Methods and Materials: CT scans were performed on tissue equivalent inserts placed at the center of two phantoms of different sizes representing human head and body with a GE Lightspeed 16-slice CT scanner. The HU to RLSP calibration curve was established for each phantom based on a stoichiometric calibration technique. For each planning CT image data set, two plans were generated using head and body calibration curves, respectively. The range difference between two corresponding fields was evaluated using distance-to-agreement (DTA) along the beam direction in a homogenous water phantom in water equivalent thickness (WET). The DTAs were calculated with a threshold of percent dose difference of 3%. Plans for four prostate and four lung patients were investigate.

Results: The measured CT number for the same insert placed in two phantoms of different sizes could differ up to 200 HU for the bone equivalent materials. The maximum dose difference between two proton plans generated with head and body calibration curves could be up to 33%. The difference in DTA was up to 2.4 mm WET for prostate patients and 5.4 mm WET for lung patients.

Conclusion: The calibration phantom size could contribute up to 5.4 mm WET range uncertainties for the lung patients in our study. The current practice is to use average calibration curve to minimize the uncertainty. Advanced imaging techniques such as dual-energy CT scans could be utilized to reduce the uncertainty in CT numbers. Other factors that introduce range uncertainty in proton therapy will be investigated in future.