AbstractID: 7493 Title: Realistic estimation of proton range uncertainties and dosimetric implications

Purpose: This study aims to obtain a realistic estimate of proton range calculation uncertainties resulting from the calibration curve of CT-number to proton stopping power conversion, which determines the accuracy of proton dose distribution prediction. Range in tissue is determined by integration of proton stopping power along its path, and uncertainties on the CT calibration curve translate directly into ambiguities on the range. Uncertainties of calibration curves arise mainly from dependence of CT number on the size of imaged object.

Method and materials: Materials used include an electron density phantom (CIRS) scanned on Brilliance CT (Philips) and irradiated on Proteus235 proton therapy system (IBA). The modular phantom can simulate a head, a medium and a large body and houses inserts made off 13 tissue substitutes. Hounsfield numbers were measured for different phantom configurations. Mean value and standard deviation established for each insert over all configurations were used to generate three calibration curves. Insert material stopping powers were measured and calculated. All curves were applied to patient data and resulted to three proton ranges from the skin to PTV distal edge.

Results: CT number uncertainties were found to increase with physical density, from 3 CT numbers standard deviation for lung (0.5g/cm3) to 140 for dense bone (1.8g/cm3). Range uncertainties for different patients, treatment sites and field orientations vary from 1.5 to 2.4% or 1.6 to 4.5mm. Modulation uncertainties, for every case were less than 1mm and depended on bone in the PTV.

Conclusion: Range uncertainties due to CT number variability as a result of beam hardening artifacts are significant for tumor local control as well as sparing of neighboring critical structures. Future work includes patient size specific curves that will reduce the range uncertainty.