AbstractID: 12658 Title: Implications for proton therapy treatment planning of tissue characterization curves from different CT scanners

Purpose: Accuracy in proton beam treatment planning is intimately related to the quality of the treatment planning CT image set characterized by Hounsfield unit (HU). Relative electron density (ED) or relative stopping power (RSP) is associated with HU for inhomogeneity corrections. Variability of these parameters from several scanners is evaluated.

Methods: HU-ED curves were obtained from 15 CT scanners and a TomoTherapy unit operated in a scanner mode from nine different institutions. In all, five different RMI467 CT phantoms were used to obtain the different curves. The ED was converted to RSP using the Bethe-Bloch formula and ionization energies in ICRU49. The various HU-RSP curves were then compared.

Results: The differences in material composition between the five RMI phantoms were well within the acceptable variation specified by the manufacturer (ranging from 8% for Lung300 to 0.5% for inner bone). The HU-RSP curve for the TomoTherapy scanner was almost linear. The calibration curves for the 15 CT scanners exhibit similar shapes and can be described by three linear segments. In the HU range -700 to zero, the HU-RSP curves are almost linear for all scanners, and are within 6% of each other. For the region immediately above water to RSP~1.1, the RSP changed slowly with HU. Above RSP=1.1, the curves increases approximately linearly with HU. Except for one CT scanner, all other curves have <5% difference. For high Z materials with RSP>1.8, present HU-RSP variation only allows linear extrapolation.

Conclusion: While most CT scanners provide very similar tissue characterization, some exhibit larger variations than others probably because of the x-ray spectrum. The RMI CT phantom could be modified to accommodate higher density materials covering the range RSP=2.0-7.0 (eg. Al-Ta) for more accurate inhomogeneity correction for high Z materials. A point at RSP~0.1-0.2 should also be added for the low density region.