

AbstractID: 4995 Title: MVCT superiority over kVCT in assessment of electron density for treatment planning

**Purpose:** Accurate assessment of electron density ( $\rho_e$  [electrons/cm<sup>3</sup>]) is essential for radiotherapy treatment planning, especially for protons. Measurements of  $\rho_e$  are typically performed with kilovoltage CT (kVCT) and its calibration assumes that object is tissue equivalent. In this work, we demonstrate that kVCT presents confusing information when objects have varying atomic number (Z). At the same time, we demonstrate that megavoltage CT (MVCT) may be preferred over kVCT in treatment planning since its calibrated pixel value, or CT number, is proportional to  $\rho_e$ , independent of atomic number (ignoring pair production), and is suitable for non-tissue equivalent materials (e.g. hip prostheses).

**Method and Materials:** A dual-energy kV & MVCT benchtop is used to image a tissue-equivalent phantom as well as samples with various combinations of  $\rho_e$  and Z.

**Results:** The plot of CT number to  $\rho_e$  for the tissue equivalent phantom is non-linear for the kVCT, but linear for the MVCT. For the non-tissue equivalent samples, the MVCT number increases linearly with  $\rho_e$  for all the samples, however the kV CT number to electron density is complicated by the two material components of the kV attenuation: atomic number and electron density

**Conclusion:** For all the samples presented the MVCT number increases with the electron density of the sample. The kVCT number assessment of electron density is only reliable for low atomic number materials. Beam hardening affects the kVCT number even for relatively small samples. Beam hardening effects for MVCT is slight and only apparent in large patients. Ignoring image-quality to dose considerations, MVCT should be preferred for electron density assessment.

**Conflict of Interest:**

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