AbstractID: 11249 Title: Off-axis variation of the Varian OBI photon spectrum and impact on cone-beam CT image quality

Purpose: Bow-tie filters used in CBCT image acquisition alter photon spectra across the radiation field. Furthermore, incident spectra vary along the longitudinal direction of an X-ray tube due to the anode-heel effect. The goal of this study is to characterize off-axis spectral variation of a Varian® on-board kV imager and to investigate its impact on the quality of reconstructed images. **Method and Materials**: Spectra were derived by fitting the semi-empirical Birch-Marshall (BM) model to narrow-beam aluminum transmission data measured with a parallel-plate ion-chamber at different locations along the transverse axes of the OBI field. Photon spectra with and without filtration of the full and half bow-tie filters were measured. Simple analytical models for deriving off-axis spectra at arbitrary detector locations from the central-axis spectrum were developed and validated against the measured spectra. Images reconstructed from synthetic datasets with constant and spatially variant photon spectra were used to assess both bow-tie filter and anode-heel spectral hardening effects on image quality. **Results**: The derived spectra accurately reproduced the transmission measurements with mean and maximum deviations of 0.6% and 2.5%, respectively. The anode-heel effect is insignificant at small off-axis angles. The variation of aluminum HVLs of spectra is less than 0.5 mm within 3º off-axis angles. Bow-tie filters significantly alter photon off-axis spectra. The mean photon energies at 5º off-axis angle with the full bow-tie and the half bow-tie filter are 78.7 keV and 67.6 keV, respectively, compared to the central-axis mean energy of 60.0 keV. **Conclusion:** Our investigation demonstrates the feasibility of using narrow-beam transmission measurements in conjunction with the BM model to characterize relative small off-axis spectral variations. The spectra at arbitrary off-axis angles can be adequately characterized by hardening the central-axis spectra. The anode-heel effect does not significantly alter beam-hardening artifacts in the reconstructed images.

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