

AbstractID: 11715 Title: kV beam model for OBI and extraction of water equivalent depths for primary and scatter contributions

Purpose: To develop a phenomenological kV beam model and address attenuation/scatter in radiographic images obtained with the Varian OBI system for the purpose of cone-beam imaging: CB-CT/radiography/tomosynthesis. To perform realistic calculation of attenuation/scatter distributions (x,y) . To characterize kV beam in terms of minimum number of parameters.

Method and Materials: Radiographs of homogeneous solid water phantom for various depths and field sizes are taken, with/without bowtie filter. These images are then analyzed to determine parameters of the model, and their dependence on depth and field size is described by analytical functions. The model is applied to predict the detector signal for arbitrary objects. The detector response is conveniently factorized into different contributions, with each contribution having an analytical representation. A weighted sum of three Gaussians in each direction models the deposition kernel. Detector response arising from the first Gaussian term can be interpreted as primary signal while the second and third Gaussians constitute short- and long-range scatter. Thus, a prediction of the detector response for a variable-thickness phantom has primary and scatter components. Various techniques of scatter removal from the measured radiographs are investigated.

Results: This model accurately predicts detector response of varying-depth phantoms such as multi-step and cylindrical phantoms. Scatter contributes over 30% to the total signal for 20cm-thick phantom. Calculated Scatter-to-Primary Ratio (x,y) is large as reported in literature on Monte Carlo studies. Water equivalent thickness related to primary and scatter contributions are calculated from the measured radiographs. These results indicate an improved model-based calibration technique suitable for CB-CT reconstruction.

Conclusion: A phenomenological kV beam model is found to be accurate in characterizing kV beam, prediction of detector responses for known objects, and calculation of water equivalent thickness from radiographs of unknown objects. Primary vs scatter contributions in detector response and water equivalent thicknesses are derived.