AbstractID: 9213 Title: Influence of photon scatter modeling on image reconstruction accuracy in CBCT

Purpose: One method for scatter correction in cone beam computed tomography (CBCT) is to compute the scatter with a Monte Carlo simulation. The accuracy of this approach may be influenced by the accuracy of the underlying photon scattering cross sections. The purpose of this study is to investigate the effect of the level of sophistication of photon interaction models on the computed scatter in CBCT and its influence on the accuracy of image reconstruction.

Method and Materials: The investigation is performed using egs_cbct, a new EGSnrc based code for use in CBCT imaging. The EGSnrc treatment of Rayleigh scattering is improved to include measured molecular coherent scattering form factors (MCSFF) in addition to the commonly used independent atom approximation form factors (IAAFF). A more accurate algorithm for sampling coherent scattering angles is also added. Three photon scatter models are investigated: Compton scattering according to the Klein-Nishina equation and no Rayleigh scattering (simple); Bound Compton scattering modeled in the relativistic impulse approximation (RIA) and IAAFF; RIA and MCSFF. Scatter calculation and image reconstruction accuracy is tested for a 30 cm diameter water sphere with and without inserts of varying density and materials for a scan with 180 projections.

Results: The simple model is not sufficiently accurate for estimating photon scatter in CBCT. The influence of MCSFF on the computed scatter distributions is small and only noticeable at the edges of the phantom. No significant difference in the accuracy of the reconstructed images is observed between the MCSFF and IAAFF coherent scattering models.

Conclusion: Rayleigh scattering must be included in the Monte Carlo simulation to estimate the scatter in CBCT imaging. The inclusion of molecular interference effects in coherent scattering has no significant effect in the image reconstruction process.