

AbstractID: 9617 Title: An Analytical Approach to Correction for x-ray Scatter in Heterogeneous Medium

Purpose: To approximately express first order Compton scatter fluence as a function of primary fluence at detector, and to develop a method for scatter correction based on the analytical approximation.

Methods and materials: From the Klein-Nishina formula for the first order Compton scatter we derive an approximate form in which the function characterizing the scattering object is separated from the known information on the imaging system, including the geometry and the source photon spectrum. Based on the strong correlation between the unknown 3-D object function and its projection, which can be measured, we estimate the first order scatter and the primary fluence through an iterative scheme. We use a Catphan phantom to experimentally measure primary and scatter fluences, as well as simple Monte Carlo models to determine primary and any order scatter fluences through computer simulation. These experimental and Monte Carlo results are utilized to validate our analytical approach.

Results: For simple object models, our approximation results are within 2% of relative error from the exact solution (obtained using the Klein-Nishina formula and verified with from Monte Carlo simulations). For the Catphan phantom, the relative error is within 3% between the estimated and experimentally measured primary fluences. Tomographic image reconstructions from scatter corrected projections show clearly the advantages of our scatter correction scheme in improving the accuracy of CT numbers and soft-tissue contrast.

Conclusion: Our analytical scheme can estimate primary and first order scatter x-ray fluences to high accuracy without requiring any additional imaging time and dose to the patient. It can be employed for scatter correction in a variety x-ray transmission imaging applications, including cone beam CT at both kV and MV photon energy ranges. The correction process is also computationally efficient - it requires a few seconds of processing time per projection image.