AbstractID: 7176 Title: System quantification for micro CT

Purpose: To report our efforts of the development for the software tool with the latest parallel computing techniques to characterize the various physical properties for the micro CT.

Method and Materials: Various physical aspects in the micro CT imager were investigated with the strategies of mathematical modeling and computer simulation. The simulated elements included were the x-ray focal spot blurring, scattering kernel, point spread function, quantum noise, detector blurring, and system noise. The projections of the mathematical phantoms were analytically calculated using the Radon transform formalism. Simulated noises were then added to those projection images and the final images were obtained from the image reconstruction algorithms including the exact, approximate, and iterative methods. A dedicated random number generator for the noise simulation was developed to produce un-correlated random number sequences. A randomness test of the intra- and inter-correlation for the random number sequences was also developed to validate the quality of noise simulation. The Monte Carlo code, BEAMnrc06, was used to evaluate the x-ray photon scattering kernel, point spread function, and the simulated exposed dose level.

Results: Our preliminary results indicated that the various noise properties can be quantified by using the noise simulation and noise power spectrum calculations. The scattering kernel was determined by using the Monte Carlo method according to the actual x-ray tube geometry and was in agreement with the experimental measurement. Lower bound of the delivered dose level was determined based on the simulated low-dose images reconstructed form the higher-dose images. The motion artifact was also quantified based on the Fourier analysis in the spatial frequency domain.

Conclusion: We have developed a computer simulation package where the key substances such as the quantum noise were included. The simulated results were used to quantify the micro CT imager and the optimized system performance can be achieved.