Abstract ID: 16422 Title: Efficacy of Fixed Filtration for Rapid kVp-Switching Dual Energy X-ray Systems

Purpose: Dose efficiency of dual kVp imaging can be improved if the beams are filtered to remove photons in the common part of their spectra, thereby increasing spectral separation. While there are a number of advantages to rapid kVp-switching for dual energy, it may not be feasible to have two different filters for the two spectra. Therefore, we are interested in whether a fixed added filter can improve the dose efficiency of kVp-switching dual energy x-ray systems.

Methods: Simulations were done to decompose known phantoms into basis materials of aluminum and water, using 80 and 140 kVp x-ray spectra. Precision of the decomposition was evaluated based on the propagation of the Poisson noise in the detected intensities through the decomposition function. We hypothesized that a K-edge filter would provide the energy selectivity needed to remove overlap of the spectra and hence increase the precision at constant dose. When optimizing the filter design, we considered filtration material (Z), filter thickness, and the relative power allocated to the two beams. We imposed a constraint of <50% loss of x-ray output due to filtration while maintaining constant entrance dose. The detector absorption efficiency of a CsI screen was also included in the simulation.

Results: An improvement in precision of >30% at fixed dose (or lower dose for the same precision) was achieved with optimal filtration. The optimal filter material depends somewhat on the phantom composition and ranges across the lanthanide series. Increasing filtration thickness increases the average spectral separation. When ignoring tube power limitations, the precision improvement with increasing filtration continues increasing, although sublinearly.

Conclusions: This study demonstrates the potential of fixed filtration to improve the dose efficiency and material decomposition precision for rapid kVp-switching dual energy systems.

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