AbstractID: 5353 Title: Investigation of Imaging Performance and Acquisition Technique for a New Dual-Energy Chest Imaging System

Purpose: A novel, high-performance, cardiac-gated dual-energy (DE) chest system is under development in our lab. This paper investigates the influence of key image acquisition technique parameters (viz., selection of kVp, filtration, and dose) on DE imaging performance.

Method and Materials: Experiments were conducted on a DE imaging bench with a custom-built phantom containing simulated lung nodules of varying contrast. Performance was quantified in terms of nodule contrast-noise ratio (CNR^{DE}) in DE 'tissue-only' images. Low- and high-kVp were varied from 60-90 kVp and 120-150 kVp, respectively. Differential added filtration in low- and high-kVp projections was analyzed in terms of soft-tissue CNR^{DE} both theoretically across the entire Periodic Table (Z=1-92) and experimentally for specific material types (Al, Ce, Cu, and Ag). Allocation of dose (defined $A=ESD_{low}/ESD_{high}$) between low- and high-energy projections was analyzed at various levels of total entrance surface dose, ESD, over a broad range of allocation.

Results: The results provide valuable guidance of technique selection for high-performance DE imaging. Optimal performance was achieved at a technique of [60/130] kVp, increasing soft-tissue CNR^{DE} by 32% compared to [90/120] kVp. Differential added filtration [0.2 mm Ce / 0.6 mm Ag] increased soft-tissue CNR^{DE} by 21% compared to the undifferentiated case ([1 mm Al / 1 mm Al]). Dose allocation was found to have significant influence on performance, with CNR^{DE} increasing by more than ~30% for $A<1$ compared to higher $A>3$ (with optima suggested in the range A~0.3-0.5).

Conclusion: Knowledgeable selection of kVp pairs, differential added filtration, and dose allocation provide significant increase in the soft-tissue CNR of DE images compared to conventional or sub-optimal techniques. Quantitative theoretical and experimental evaluation demonstrates the importance of optimized acquisition techniques for high-performance DE imaging and guides the implementation of a novel DE imaging system under development for pre-clinical imaging trials.