AbstractID: 8695 Title: Improved Lesion Conspicuity in Dual-Energy Imaging of the Chest: From NEQ to Observer Performance

Purpose: To derive Fourier metrics of imaging performance (e.g., NEQ) in dual-energy (DE) imaging of the chest that agree with human observer performance and to employ the resulting theoretical framework to system optimization with respect to lung nodule conspicuity.

Method and Materials: The NEQ was computed using cascaded systems analysis extended to DE imaging and combined with a Fourier description of imaging task to yield an estimate of observer SNR (i.e., detectability index and A_Z). Theoretical results were compared to human observer performance assessed in multiple alternative-forced choice (MAFC) tests across a broad range of imaging conditions. The modeled observer SNR was used as an objective function for optimizing DE acquisition techniques and decomposition algorithms. A method for optimizing system performance for multiple imaging tasks was also investigated.

Results: Theoretical calculations of the DE NEQ agreed well with measurements, and the task-based detectability index was found to provide a strong predictor of human observer performance. Results identified [60/150] kVp as the optimal energy pair, with a weak dependence on high kVp. Optimization of the DE decomposition algorithms yielded significant improvements in lesion conspicuity – e.g., improving detection from barely visible (A_Z <0.7) to highly conspicuous (A_Z ~1) at fixed dose to the patient. Optimal dose allocation (the fraction of total dose delivered in the low-energy image) was found to range significantly – from 0.22 to 0.76 – depending on the choice of decomposition algorithm and imaging task.

Conclusions: A theoretical model of DE imaging performance was derived and validated in comparison to human observers. The resulting framework provides a valuable guide to system optimization over a wide range of acquisition and decomposition conditions, yielding significant improvement in lung nodule conspicuity.