AbstractID: 2008 Title: Incorporation of Anatomical Noise in Generalized DQE Analysis of Advanced Flat-Panel Detector-Based Imaging Systems

Analysis of detective quantum efficiency (DQE) is an important component of investigation of advanced imaging technologies based on flat-panel imagers (FPIs). Traditional DQE and task-based descriptions are limited, however, in that they take no account of "background" or "anatomical" noise, even though such noise can be the most significant factor limiting detectability, often outweighing quantum or electronic noise. We incorporate anatomical noise in experimental and theoretical descriptions of "generalized DQE" as defined in ICRU Report #54, by inclusion of an additional spatial-frequency-dependent noise, $S_B(f)$, corresponding to background fluctuations. Previous work modeling S_B in proportion to $1/f^{\beta}$ shows β in the range 2 – 4 for breast and chest radiography. We extend such investigation across a spectrum of advanced applications of FPIs, from radiography/fluoroscopy, to dual-energy, tomosynthesis, and cone-beam CT, hypothesizing that S_B reduces in magnitude and frequency content across these applications – maximized for radiography and minimized to residual in-plane structure for cone-beam CT. We quantify S_B by measurements in patients and cadavers for a variety of anatomical sites (head, chest, and abdomen). By incorporating the results in the generalized DQE and combining with a variety of idealized task functions (detection, discrimination, and localization) we show that anatomical noise dramatically influences task-based performance and optimization (e.g., optimal kVp, geometry, pixel size, and reconstruction filter). Account of anatomical noise is therefore critical to performance analysis, and measurements of S_B provide a valuable "atlas" of spatial-frequency-dependent anatomical noise for incorporation with generalized DQE of advanced imaging technologies.