

AbstractID: 1688 Title: Photoelectric effect in x-ray imaging detector: Theoretical signal and noise transfer in the Fourier domain

In x-ray imaging, image signal is limited largely by the spatial distribution of how radiation energy is deposited. The distribution in turn depends on the physics of x-ray interactions. In the mammographic and radiographic x-ray energy range of 10-100 keV, most of the energy deposited in a detector is through the photoelectric interactions. This interaction results in local energy absorption plus the emission of several characteristic x rays. The reabsorption of characteristic x rays produces complex spatial distribution of energy deposit. This presentation focuses on the theoretical modeling of photoelectric effect and how photoelectric process influence imaging quality. The theoretical model based on the parallel-cascaded analysis describes signal and noise propagation through photoelectric effect in frequency space. The model includes the effects of K and L characteristic x ray reabsorption and Auger electrons on the modulation transfer function (MTF) and detective quantum efficiency (DQE). For using this model, a new theoretic expression for the characteristic transfer function (CTF) is derived based on the probability theory of random processes, describing the spatial response in the Fourier domain of characteristic x ray reabsorption. This work provides insight into the physical causes of performance limitation, useful in the design of new detectors. Results are presented and compared with Monte Carlo simulations for amorphous selenium detector, validating the developed model for MTF propagation and DQE analysis. We are extending this work to generate a complete theoretical description of x-ray physics in the Fourier space.