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Advances required to improve image quality in medical radiography – a statistical problem

Image quality in medical radiography is a statistical problem. Images are formed when x-ray quanta deposit energy into a detector that normally consists of a large two-dimensional array of small (100-um square) discrete detector elements. The physical processes of energy transfer are statistical in nature and can be represented as a complex cascaded of random point processes that describe photon scatter, conversion to secondary quanta, and liberation of charge pairs. Spatial correlations in image signals introduced by these processes are largely responsible for image quality. Detector performance and the ability to produce high-quality images for low x-ray exposures is described by the Fourier-based detective quantum efficiency (DQE) which is derived from statistical decision-making theory. This talk will summarize the link between detector design and image quality through the DQE and cascaded-systems analysis. The physical processes that currently limit image quality in modern systems will be identified with attention drawn to how these detectors must be redesigned for improved image quality and dose reduction.