AbstractID: 4694 Title: Instrumentation Noise Equivalent Exposure (INEE) representation for high sensitivity x-ray imaging detectors

Purpose: For modern high-sensitivity digital imaging detectors operating at fluoroscopic exposure rates, the additive instrumentation readout noise may prevent desirable optimal quantum-limited performance. A formalism and experimental validation of the representation of instrumentation noise in terms of the equivalent x-ray entrance exposure to the detector is presented as a more practical noise measure than the equipment-invasive measurement of electrons per pixel.

Method and Materials: The instrumentation noise in terms of exposure equivalent is added in quadrature to the quantum noise to give the total measurable noise. Experimental validation was done using two different CCD-based detectors: a high-sensitivity microangiographic fluoroscope (MAF) and a less sensitive microangiographic detector (MA). Both detectors have a CsI(Tl) phosphor coupled to a fiber-optic taper followed by a CCD camera (the MAF additionally has a variable-gain light amplifier between the taper and the CCD). To determine the INEE for both detectors, a least-squares regression technique was used to fit the measured data to the theoretical equation relating the signal-to-noise ratio squared (SNR^2) to the detector entrance exposure.

Results: The SNR^2 versus exposure plot deviates from linear behavior at lower exposures as expected, and closely follows the modeled equation used to derive the INEE. The measured INEE for the high-sensitivity MAF was 0.034 μR and that for the MA was 10.8 μR.

Conclusion: A formal treatment of the instrumentation noise in terms of the detector entrance exposure was developed and validated by using two different CCD based systems of different sensitivity. This study demonstrates that the INEE is a practical way to gauge the range of quantum-limited performance for clinical x-ray imaging detectors, with the implication that detector performance at exposures below the INEE will be instrumentation-noise limited rather than quantum-noise limited.

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