AbstractID: 8404 Title: Noise Evaluation of a New Solid-State X-Ray Image Intensifier (SSXII)

Purpose: To measure the impact of thermal and multiplication-excess noise and the instrumentation-noise equivalent exposure (INEE) of a new solid-state x-ray image intensifier (SSXII) based on electron-multiplying CCDs (EMCCDs). **Method and Materials:** The SSXII consists of a 350μm thick CsI(Tl) phosphor grown on a fiber-optic plate optically coupled to a Peltier cooled EMCCD camera with a fiber-optic input window via a 4:1 minifying fiber-optic taper. The EMCCD provides signal multiplication gain prior to the read-out electronics, thereby eliminating this primary noise source, effectively allowing for instrumentation-noise free operation even at very low x-ray exposures. Two additional potential noise sources, thermal and multiplication-excess noise, were investigated. Thermal noise was determined using a linear fit of dark-signal variance versus integration time at a constant readout rate. Multiplication-excess noise was determined using signal variance normalized to gain versus signal plots. The gradient of a linear fit to this data at 1x gain as compared to higher gain values (up to 14x) was used to determine the excess noise factor (ENF). Overall noise-performance was then determined using the INEE. **Results:** Thermal noise was measured to be < 2% of the maximal signal (12-bits) with an EMCCD gain of 275x and an integration time of 30 ms, and is considered an upper bound under typical clinical operating conditions, indicating thermal noise has a negligible impact on overall image quality. The ENF was unity for the range of gains tested, suggesting the inherent excess noise of the electronic-multiplication process has little effect when imaging secondary quanta from an x-ray converting phosphor. An INEE of < 0.2μR further demonstrates the SSXII's capability to operate instrumentation-noise free at very low x-ray exposures. **Conclusion:** The SSXII provides quantum-noise-limited performance well below typical fluoroscopic exposure levels with negligible thermal and multiplication-excess-noise.

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