Abstract ID: 15052 Title: Characterizing the dynamic range and noise performance of a high-resolution EMCCD-based x-ray detector having large variable electronic gain enabling use in both fluoroscopy and angiography

Purpose:To quantitatively characterize the dynamic range and noise performance of a new custom-built, 1k by 1k, 26.4 micron square pixel, high-resolution, solid-state EMCCD-based x-ray detector.

Methods:We performed two sets of experiments: higher-exposure angiographic imaging with lower gain (< 200), and lower-exposure fluoroscopic imaging with higher gain (> 200). For each experiment, 150 flat-field images are acquired over the range of exposures for each multiplication gain. Average signal digital number (DN) versus exposure, and average variance (DN) versus exposure or signal are plotted and linearly fitted to quantitatively characterize the electronic gain, background or dark noise equivalent rms electrons, and instrumentation noise equivalent exposure (INEE), respectively.

Results:For the low gain measurements, the noise electron rms value and INEE decreases with increasing gain virtually eliminating the effect of read-noise, which is the main source of noise for conventional detectors. When the gain is increased for the low exposure measurements, dark noise from dark current and clock induced charge (CIC), which are constant with gain, become dominant and set the detection limit. With the same procedure, an additional experiment is performed to evaluate the dark noise and INEE at high gain with cooling. At room temperature, the dark noise is 1.03 e- rms and the INEE is 1.46 microR. Cooling the sensor effectively reduces the noise electrons (0.66 e- rms at 200mA pelticooler current and 0.50 e- rms at 400mA pelticooler current) and INEE (0.52 microR at 200mA pelticooler current and 0.33 microR at 400mA pelticooler current).

Conclusions:The EMCCD-based x-ray detector with large variable gain has linear performance over a wide range of exposures with a low noise floor that can be further decreased by moderate cooling. The INEE for this unique detector is substantially less than the 2 to 3 microR of conventional flat panels.

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