

AbstractID: 10827 Title: An enabling technology for very low exposure x-ray imaging

Purpose: Medical procedures such as cardiac catheterization, angiography and the deployment of endovascular devices are routinely performed using x-ray fluoroscopy, in which each image is obtained at very low x-ray exposures. The imaging performance of current solid-state flat panel detectors (FPD) is compromised by electronic noise at these low detector exposures (0.1-10 $\mu\text{R}/\text{frame}$). There is thus a clear need to develop an imaging detector with the quantum noise limited operation of an x-ray image intensifier and the inherent advantages of a compact solid-state device. Here we propose a technology that takes advantage of avalanche multiplication of charge in an amorphous selenium (a-Se) photoconductor. **Method and Materials:** To determine whether this technology holds promise for next-generation FPDs, we investigate the following: (1) device and material requirements for prevention of electrical breakdown, (2) leakage currents at high electric fields, (3) real-time imaging capability and linearity, and (4) the compliance of an avalanche a-Se photoconductor with low-voltage image readout electronics. **Results:** Our results show that a distributed resistive layer coupled to the avalanche photoconductor enables breakdown-free operation. We report, for the first time, avalanche gains exceeding 10^4 in a solid-state x-ray detector, and leakage currents of only ~ 10 pA/mm². The detector has a voltage-programmable avalanche gain and can be operated in a linear regime at 30 frames per second over a five order of magnitude x-ray exposure range, including the lowest clinical exposures encountered in fluoroscopy. Furthermore it is compatible with existing thin film transistor technology on which current FPDs are based. **Conclusion:** This detector technology should enable the development of next-generation dose-efficient FPDs for interventional radiology as well as advanced applications such as cone-beam computed tomography or tomosynthesis. Combined with techniques such as region-of-interest fluoroscopy, our detector technology could significantly reduce radiation dose to the patient and physician.