AbstractID: 9740 Title: The Future of Flat Panel Imagers: From Active Matrix to Active Pixel Architectures and Many Possibilities in Between

Since the turn of the century, the phrase "Flat Panel Imager" has been increasingly used in modern x-ray imaging venues ranging from large, institutional cardiac care, radiology and radiotherapy settings to community oral surgery offices. The phrase most commonly refers to those technologies employing a large area, monolithic array consisting of a two-dimensional grid of imaging pixels fabricated on a thin glass substrate. Individual pixels are made addressable by means of an "active matrix" of switches – usually, in each pixel, taking the form of a single amorphous silicon (a-Si:H) thin film transistor (TFT) coupled to some form of storage capacitor. Two variations of this relatively simple architecture (based on so-called indirect or direct detection of the incident radiation by means of a scintillator or a photoconductor, respectively) have become almost ubiquitous for a wide variety of projection (e.g. radiography, fluoroscopy, mammography) and volumetric (e.g., CBCT, tomosynthesis) imaging applications. While offering many advantages, such Active Matrix Flat Panel Imagers (AMFPIs) are restrictive in terms of signal-to-noise performance, maximum frame rate, image artifacts, configurability and cost. These limitations are inspiring considerable innovation and creativity in imager development. Some approaches involve: high-gain photoconductors such as HgI_2 or avalanche-gain with a-Se (to improve system gain and DQE); active pixel circuits involving the inclusion of amplifiers in each pixel (to increase gain and DQE, frame rate, and to reduce artifacts); thick segmented scintillating converters (to increase x-ray quantum detection efficiency and DQE at megavoltage energies); flexible substrates (to provide lighter, flexible and more x-ray transparent substrates); and subtractive and additive printing of a-Si:H or organic TFTs (to reduce costs). In this talk, a broad overview of the state of conventional AMFPI technology, its limitations, the potential for improvement, and some of the avenues being pursued to achieve these improvements will be presented. In addition, challenges for some of these approaches, along with the long-term prospects for this general area of technology, will be reviewed, and the effect of large performance improvements on the practical implementation of advanced applications will be discussed.

Educational Objectives List:

1) Review the fundamental concepts behind the technology of flat panel imagers based on active matrix addressing.
2) Provide an understanding of the performance limitations on such active matrix, flat panel imagers (AMFPIs).
3) Outline the general approaches for achieving significant improvements over conventional AMFPI performance.
4) Detail specific improvement strategies involving front-end enhancement of converter signal and pixel level circuit modifications, which preserve the major advantages of conventional AMFPIs.
5) Discuss the long-term prospects for, and implications of flat panel imager performance improvement.