Flat Panel Imaging Technology for Real-time and High Resolution Diagnostic X-ray Applications

R.E. Colbeth, R. Harris, I.D. Job, I.P. Mollov, B. Nepo, R. Fong, K. Gray, S. Boyce, N. Taie, J. Pavkovich, M. Batts, E. Shapiro, E. Seppi, C.Webb, M. D. Wright, J. M. Yu
Varian Medical Systems, Palo Alto, CA

Abstract: Two flat panel imagers based on a 127µm amorphous silicon photodiode array are described. The PaxScan 2520 is a multi-mode imager for fluoroscopy, cine and radiography applications. The PaxScan 4030 has the smallest pixel pitch of any commercially available amorphous silicon radiography panel.

Key Words: X-ray, flat panel, amorphous silicon, fluoroscopy, radiography, real-time

INTRODUCTION

Currently, Varian Medical Systems (VMS) produces two types of flat panel imagers based on a 127µm pixel amorphous silicon photodiode array coupled to an x-ray scintillator. The PaxScan 2520 is a multi-mode imager capable of both high resolution radiography, at repeat rates up to 7.5 frames per second (fps), and low dose fluoroscopy at 30 fps. The PS2520 has an active area of 17.9 x 23.8cm. The PaxScan 4030 is a dedicated radiography product, having an active area of 28.2 x 40.6cm.

METHOD

Physics measurements and example images from clinical applications are provided below. For each of these panels, a variety of x-ray scintillator screens are available so that the panel can be optimized for the intended application. Figure 1 shows the MTF of the panel as a function of screen type. In the 2520, the multi-mode capability is achieved by trading-off resolution against data rate. The data rate is reduced through summing or binning neighborhoods of pixels at the sensor level. Figure 1 also shows the MTF of a PS2520 panel with a CsI scintillator, as a function of the different binning modes. Through electronic binning and the choice of scintillator, the spatial resolution, frame rate and sensitivity of the panel is easily customized.

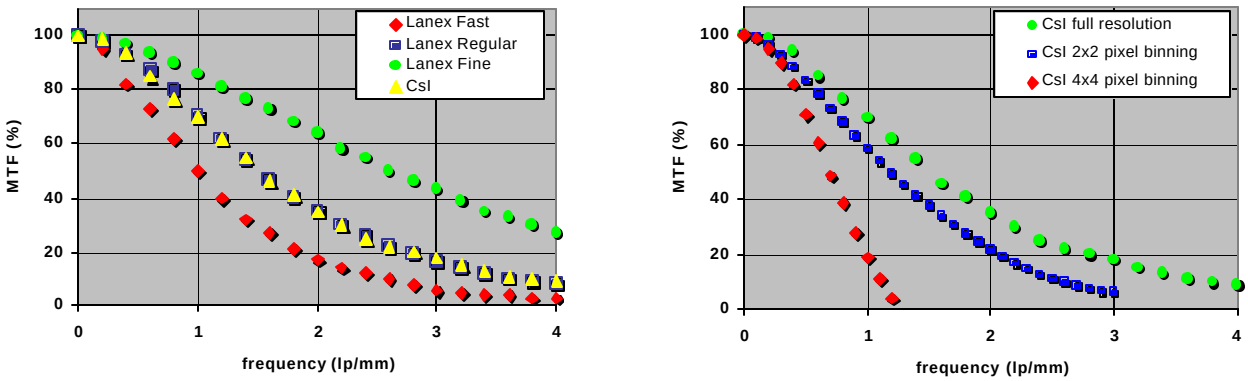

Figure 1. MTF vs. electronic pixel binning and choice of scintillator screen.

Both the PS2520 and the PS4030 panels can accept a wide latitude of exposure. Figure 2 shows a neo-natal catheter placement taken at 1/8 the dose typically used by film in this application. Because the DQE of the CsI coated PS2520 is superior to film, it is possible to gain significant dose reduction in this dose critical application. In addition, the PS2520 is a real-time acquisition device, which makes possible dramatic increases in patient throughput. Figure 3 shows the DQE of the PS2520 over the radiographic exposure range. Figure 4 shows the measured DQE for a CsI 2520 over the fluoroscopic and cine dose range. The DQE measurements follow the procedures

outlined in references [1,2]. Figure 5 shows a single frame from a fluoro loop of a vertebroplasty performed with the Marconi FACTS C-arm, which is based on the PS2520 [3].

Figure 2. Neo-natal catheter placement.

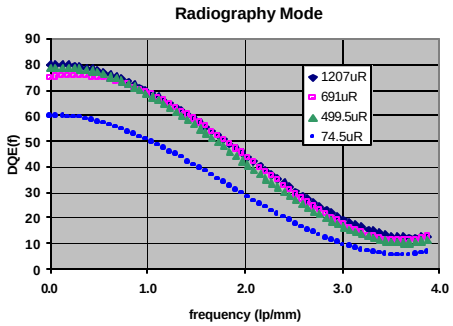

Figure 3. DQE for a CsI panel in full resolution radiography mode.

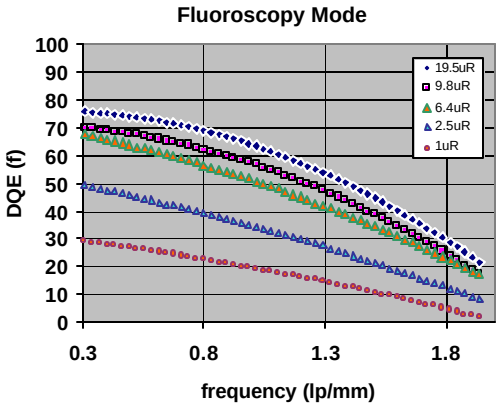

Figure 4. DQE for a CsI PS2520 in 2x2 binning fluoroscopy mode.

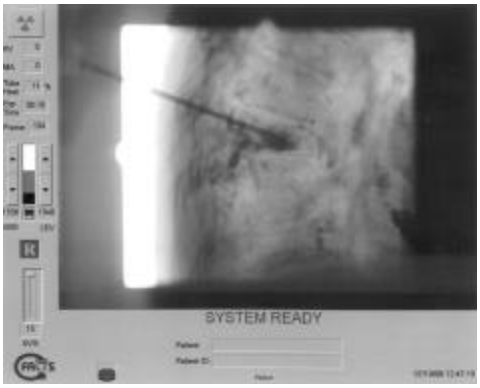

Figure 5. A single frame from a fluoro loop of a vertebroplasty performed with the Marconi FACTS system.

Currently in development is the PS4030 Angiography panel. This is a real-time 40 x 30cm panel capable of fluoroscopy, cine and radiography. This panel has a 194µm pixel pitch and a 1536 x 2048 landscape matrix. Because of the larger pixel size, this panel will be able to operate at significantly lower doses then the current 127um panels.

REFERENCES

1. P.R. Granfors,R.Aufrichtig, "DQE(f) of an amorphous-silicon flat-panel x-ray detector: detector parameter influences and measurement methodology," Proc. SPIE Med.Img.2000, vol.3977, pg.2-13, 13-15 Feb 2000.
2. J.T. Dobbins III, et al., "DQE(f) of four generations of computed radiography acquisition devices," Medical Physics, vol. 22, pg.1581-1593, 1995.
3. Private communication, Gerhard Roos, Marconi Medical Systems, April 2000.

Flat Panel Imaging Technology for Real-time and High Resolution Diagnostic X-ray Applications

R.E. Colbeth, R. Harris, I.D. Job, I.P. Mollov, B. Nepo, R. Fong, K. Gray, S. Boyce, N. Taie, J. Pavkovich, M. Batts, E. Shapiro, E. Seppi, C.Webb, M. D. Wright, J. M. Yu

Varian Medical Systems, Palo Alto, CA

Abstract: Two flat panel imagers based on a 127µm amorphous silicon photodiode array are described. The PaxScan 2520 is a multi-mode imager for fluoroscopy, cine and radiography applications. The PaxScan 4030 has smallest pixel pitch of any commercially available amorphous silicon radiography panel.