

Performance Assessment of DR Systems

Director of Symposium
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Digital System Technologies

Projection Radiography

- Computed Radiography (CR)
 - CCD cameras
 - CMOS detectors
 - TFT Flat Panel arrays
- “Direct”
Radiography
(DR)

Speakers for DR symposium

- Robin Winsor, Chief Technical Officer
 - Imaging Dynamics Company, Calgary, AB Canada
- Richard Aufrichtig, X-ray Detector Engrg
 - General Electric Medical Systems, Santa Clara, CA
- Nikos Gkanatsios, Scientist
 - Hologic Medical Imaging, Danbury, CT

DR: “Direct” Radiography

....refers to the acquisition and capture of the x-ray image *without user intervention*

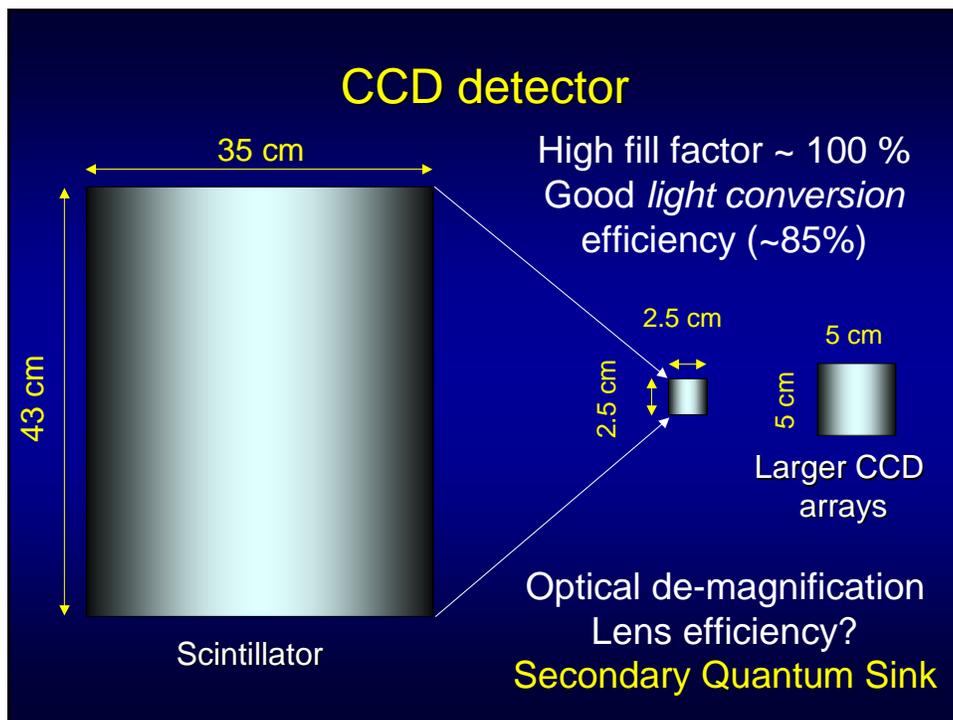
ACQUISITION

“Indirect” detector: a conversion of x-rays into light *and then* light into photoelectrons

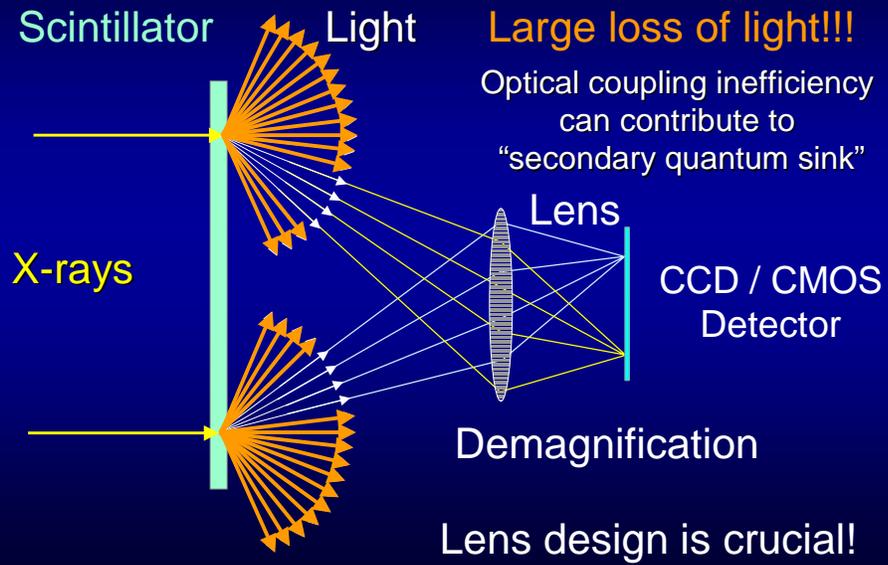
“Direct” detector: a conversion of x-rays to electron-hole pairs with direct signal capture

Large FOV Radiography Systems

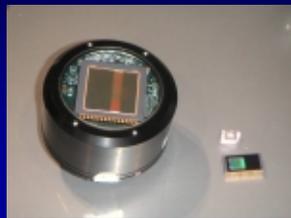
- Computed radiography
- **CCD linear array and CCD camera systems**
- Thin Film Transistor indirect acquisition
- Thin Film Transistor direct acquisition



Light emission & Optical coupling

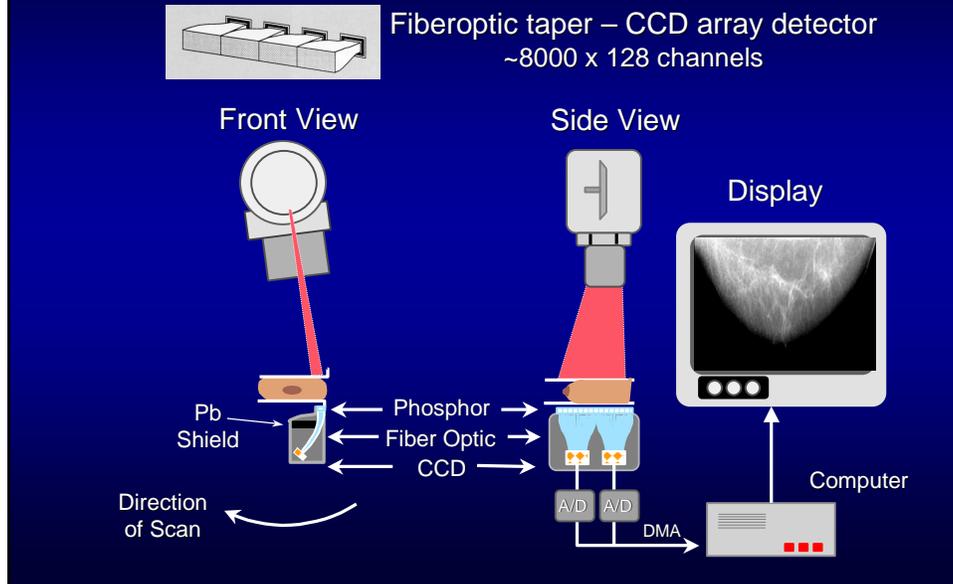


Optically Coupled CCD cameras



Direct acquisition
Optical design potentially suffers from poor lens collection efficiency -- "secondary quantum sink"

Scanning-slot Digital Mammo System



Large FOV Radiography Systems

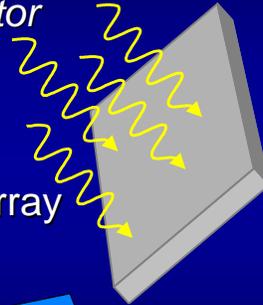
- Computed radiography
- CCD linear array and CCD camera systems
- Thin Film Transistor indirect acquisition
- Thin Film Transistor direct acquisition

Thin-Film-Transistor Array

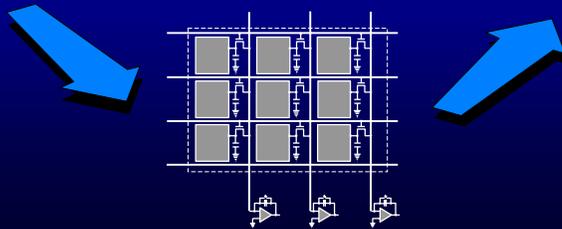
Laptop display
Photo-emitter



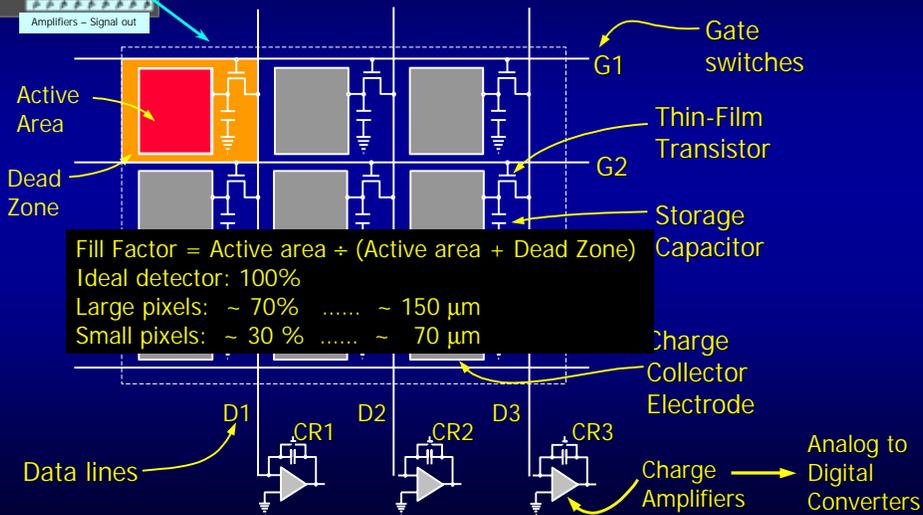
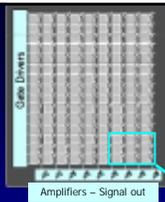
X-ray converter
Photo detector



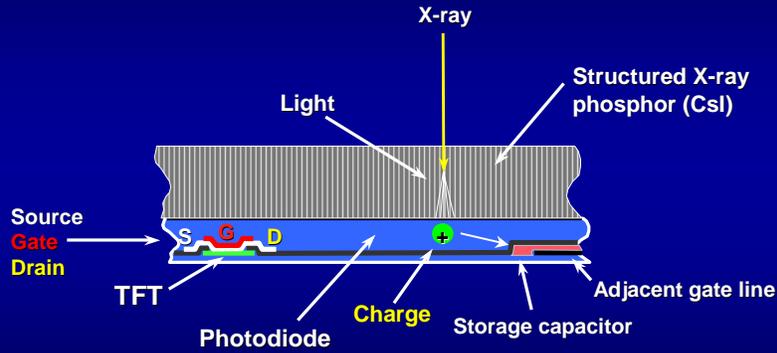
TFT Active Matrix Array



Amorphous Silicon TFT active matrix array

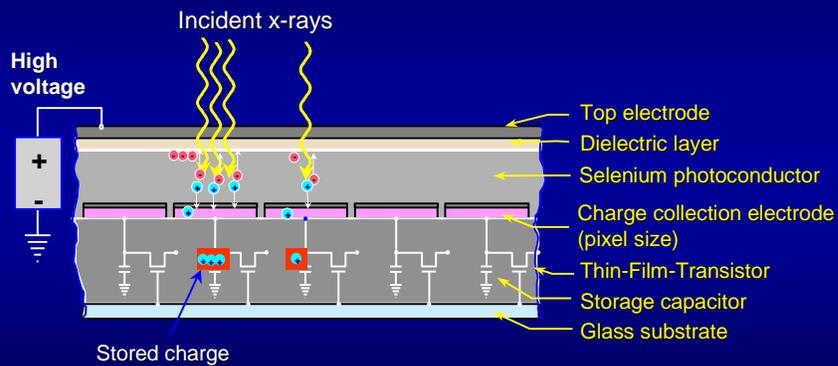


Indirect detector: *a-Si TFT/ CsI phosphor*



X-rays to light to electrons to electronic signal

Direct detector: *a-Se / TFT array*



X-rays to electrons to electronic signal

Direct / Indirect flat panel detector systems



TFT digital mammo systems



Indirect detector mammo system

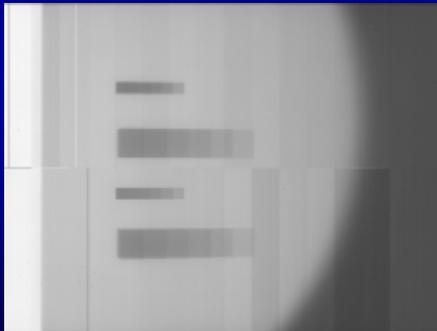
Direct detector mammo system

Digital pre *and* post processing

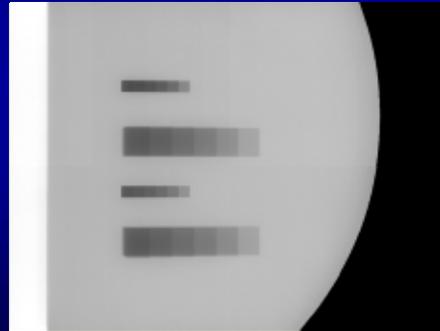
- Pre-processing
 - Bad pixel corrections
 - Shading / non-uniformity corrections
- Post-processing
 - Dynamic range compression
 - Contrast enhancement
 - Spatial resolution enhancement

Flat-field Correction

- Linear response required
- Periodic flat field acquisitions needed



Uncorrected



Contrast Enhanced

Digital Radiography and Dose

- Flexibility is a double-edged sword with DR
 - reduced retakes
 - variable speed (tailor exposure to exam)... but
 - more difficult to *correctly* use
- *All* digital detectors should monitor exposure levels
- Good image quality and *appropriate SNR* are more important than low radiation dose
- Dose for a given SNR inversely depends on DQE

Digital Radiography QC

- Information?
 - Task group #10 AAPM on Computed Radiography
 - Draft: email to jaseibert@ucdavis.edu
 - DMIST digital mammography trial
- Automated *daily* tests
 - Specified tests *must* verify adequate performance
 - Deficiencies *must* be corrected *before* imaging
- Weekly, Monthly, Semi-Annually
 - More complete, quantitative evaluation
 - Continuous analysis: correct potential problems *before* they occur

The Bottom Line

- Digital detectors *will* replace screen-film
- The system is only as good as the weakest link
 - Secondary quantum sink
 - Flat-fielding / Image processing
 - Continuing optimization and Quality Control
 - Soft copy display
- There are several viable “digital” pathways to the filmless, digital radiology department

Now to the speakers.....

- **Robin Winsor:** CCD-based digital radiography system
- **Richard Aufrichtig:** Indirect TFT detector radiography system
- **Nikos Gkanatsios:** Direct TFT detector mammography system
- Followed by a 30 minute panel discussion, so get your questions ready.....