Basis of CR
Computed Radiography

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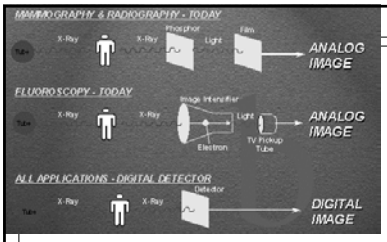
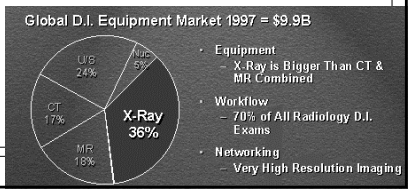


Computed Radiography (CR) refers to new types of X-ray detectors (i.e. replaces the X-ray Film)

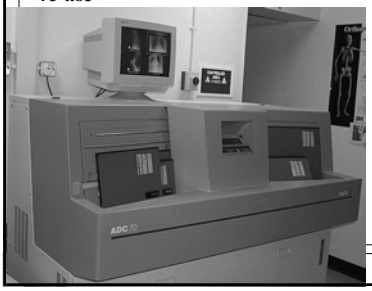
The CR output media is a digital image, which can be processed, printed and stored in PACS

Most of the X-ray examinations are radiography based



CR system using laser stimulated ***storage phosphor screens***

Very similar radiographic usage: ***X-tube>patient>cassette>Reader>>re-use***



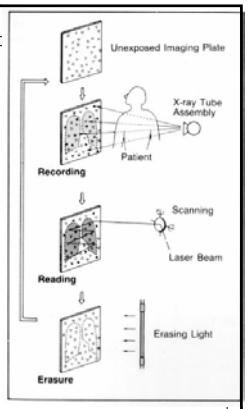
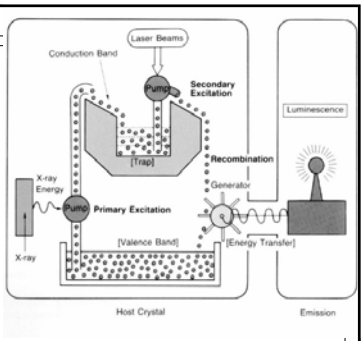
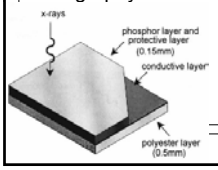


Photo-stimulated luminescence mechanism

The storage phosphor, usually made from **BaFX:Eu²⁺ (X=Cl, Br, I)** is contained within a cassette, similar in appearance to those used in film-screen radiography.





Eu^{2+} >> x-ray >> Eu^{3+} + *free e*

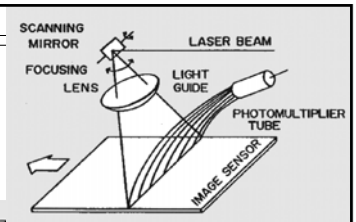
free e >> into bromine energy traps

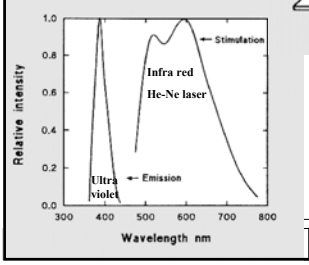
Eu^{3+} + *free e* >> IR laser >> Eu^{2+} + PSL (390 nm)

He-Ne laser stimulus infra-red (632 nm)

Eu characteristic radiation (PSL) – 390 nm (ultra-violet)

Fast scanning (PSL~0.8 ms)

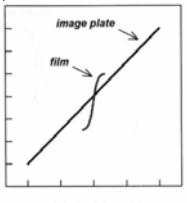




Commercial plates matrix:

1760x2140 (standard resolution):
2000X2510 (high resolution)

Resolution ~ 3 - 5 lp/mm (12 bits)



Storage-Phosphor (CR) against Film-Screen

-Much higher dynamics of CR (1:10000)

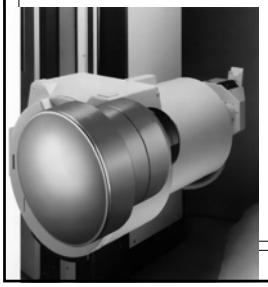
-Virtually no bad CR exposures (repetition)

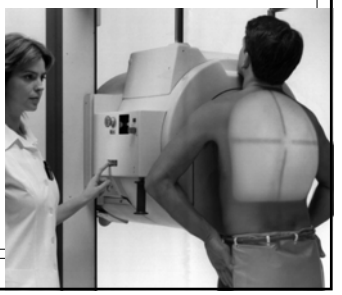
-Very good contrast of CR

- Image processing in CR plus edge enhance
- Digital storage and retrieval of CR images
- Patient dose reduction
- Radiographic techniques preserved
- Film still with better resolution (mammo)
- Often CR images printed with laser imager

Digital Radiography based on Image Intensifier systems is one of the first digital methods, which is still used, based on:

Image Intensifier >> TV camera >> ADC >> Computer

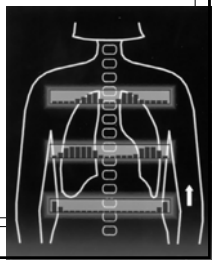




Scanning radiography - Advanced Multiple Beam Equalisation Radiography (AMBER)

- Narrow X-ray tube beam (4 cm) - min scatter!

-Uses various detectors (Selenium, Xenon, Film)



Local exposition time (scan) – 50 msec

Total exposition time – 1000 msec

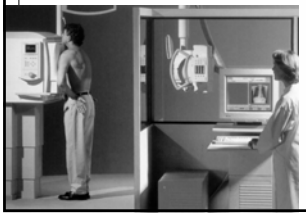
Total exposure – 64 mAs

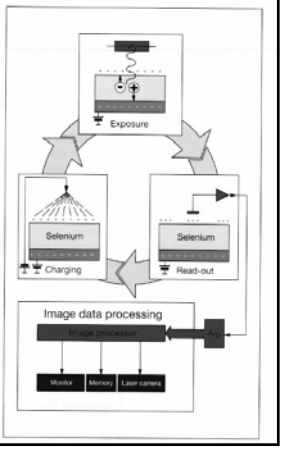
Spatial resolution depends on the detector

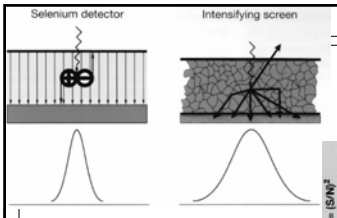
Direct Digital Radiography with Selenium Philips Thoravision

Uses amorphous Selenium (similar to xeroradiography)

Direct conversion of X-ray quanta into electrical charge – avoids noise from conversion



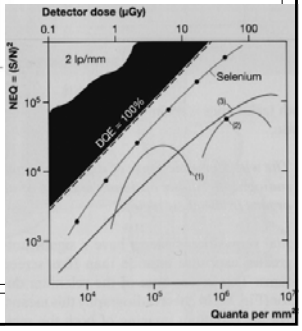




1- conventional film/screen

2 - High contrast film/screen

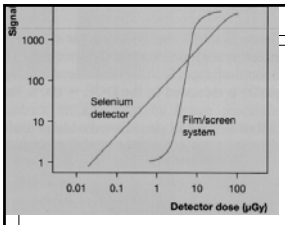
3 – Storage phosphor (CR)

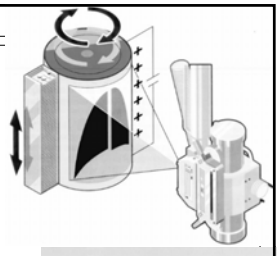


No intermediate light – the signal is transferred through electrical charge.

Very good Signal/Noise Ratio (SNR) Noise Equiv. Quanta NEQ=SNR²

Detective Quantum Efficiency (DQE) - - ideal DQE= 100% (the detector absorbs all impinging quanta)





Drum with 50 cm diameter

0.5 mm Selenium (43x49cm)

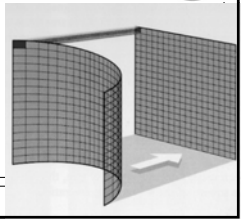
Read-our array of 36 probes

2000x2000 pixels (each 0.2mm, 14 bits)

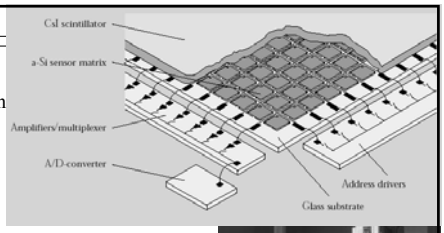
Excellent contrast (wide dynamic)

No transport of cassettes (fast radiography)

Directly linked to PACS

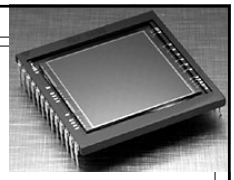


Direct Digital Radiography with Flat Electronic Detectors



Amorphous Silicon matrix with array of sensors, each with own switching element – the readout is line-by-line (through address drivers), followed by amplification and A/D converter.

The X-ray sensitive converter is normally the needle-shaped CsI (used also in Image Intens.)



Detector size 43x43 cm, matrix 3000x3000 (pixel size 0.14 mm) > Resolution ~3 Lp/mm

DQE ~ 60% (twice the conventional film/screen)

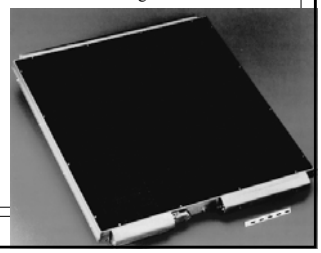
Allows integration with Bucky table (anti-scatter)

Very high workflow (patient flow)

Still quite heavy detector

Similar to CCD (mono-crystalline), but much larger due to a-Si.

Due to the rapid-sequence imaging, it is expected that in future the flat detector will replace the Image Intensifier TV systems in real-time examinations (fluoroscopy)



The digital image of CR allows archiving and share of images through PACS.

The hard-copy image of all these devices is still made on film (exposed with Laser Imager).

As in many places the diagnosis is still made from film, the final image quality will still depend on the film and imager….