

Flat Panel Digital X-ray Detectors



GE Healthcare Global Flat Panel X-ray
Manufacturing Center in Upstate New York

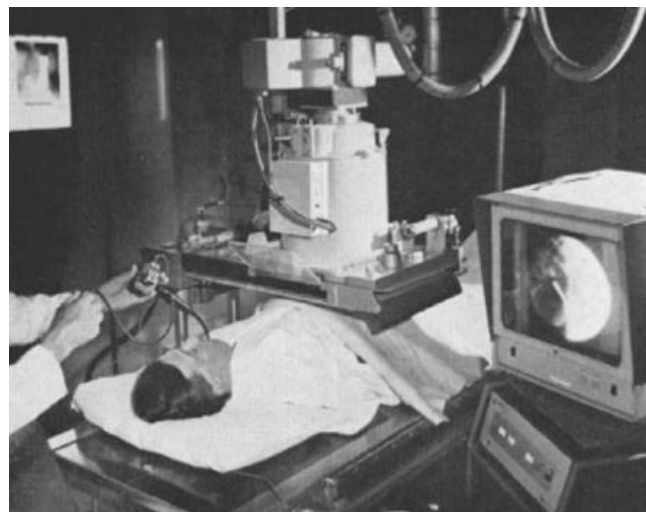
A Brief History of X-ray Imaging



1900: Chest X-rays



1917: Fluoroscopy During WW I

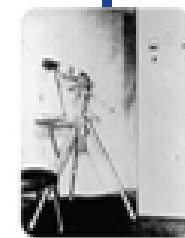


1940-1960's : image intensifier and coronary artery imaging

1995



100 years of x-ray film and 40 years of image intensifiers

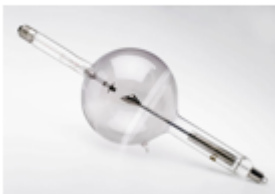


1966: Mammography

1930's-1950's : Shoe fitting



1895: First X-rays



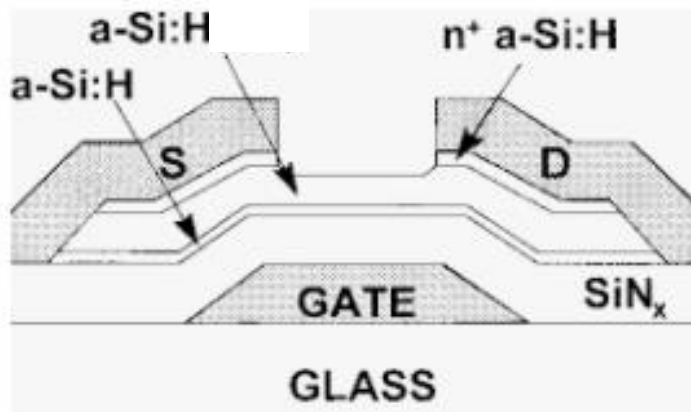
1913: Coolidge Tube

Technology Disruption : Thin Film Transistor

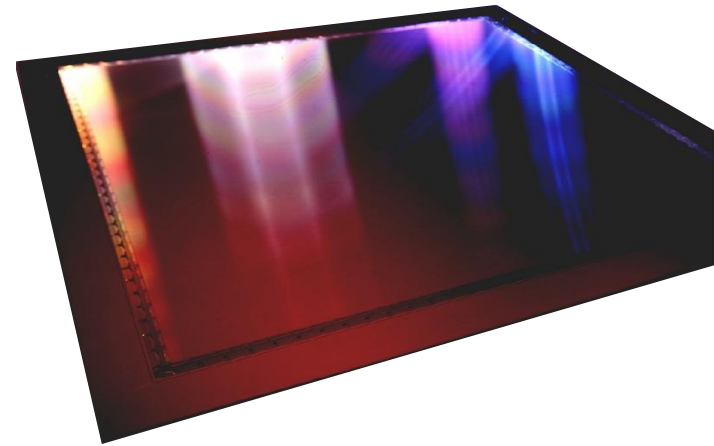
History

- 1950's - 1970's : Research on Thin Film transistors
- 1980's : Amorphous Silicon (a-Si) based TFT allows commercialization

Current flows from Source to Drain when
Voltage applied to Gate



Coupled with Photolithography, can make
uniform arrays of millions of TFT on glass

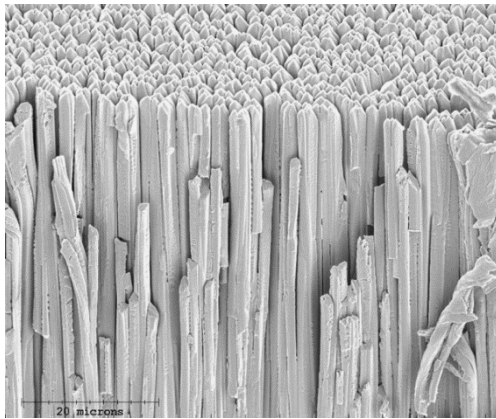


➡ Coupled with liquid crystals, can make a “flat panel” pixelated display

➡ Coupled with photodiodes and a scintillator, can make a “flat panel” xray sensor

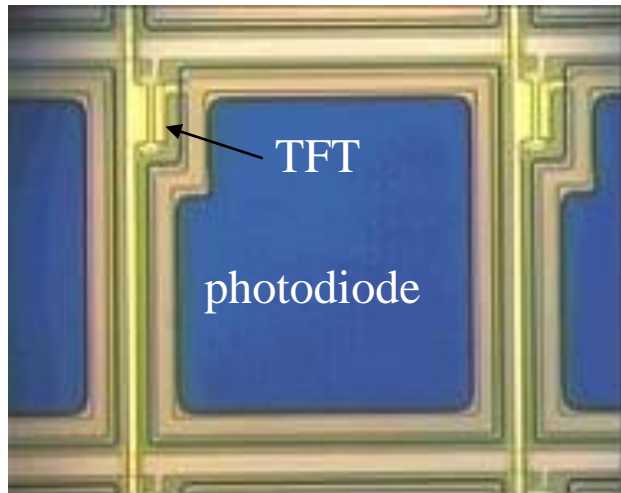
The Flat Panel Digital X-ray Detector

Scintillator (200-800 um thick)

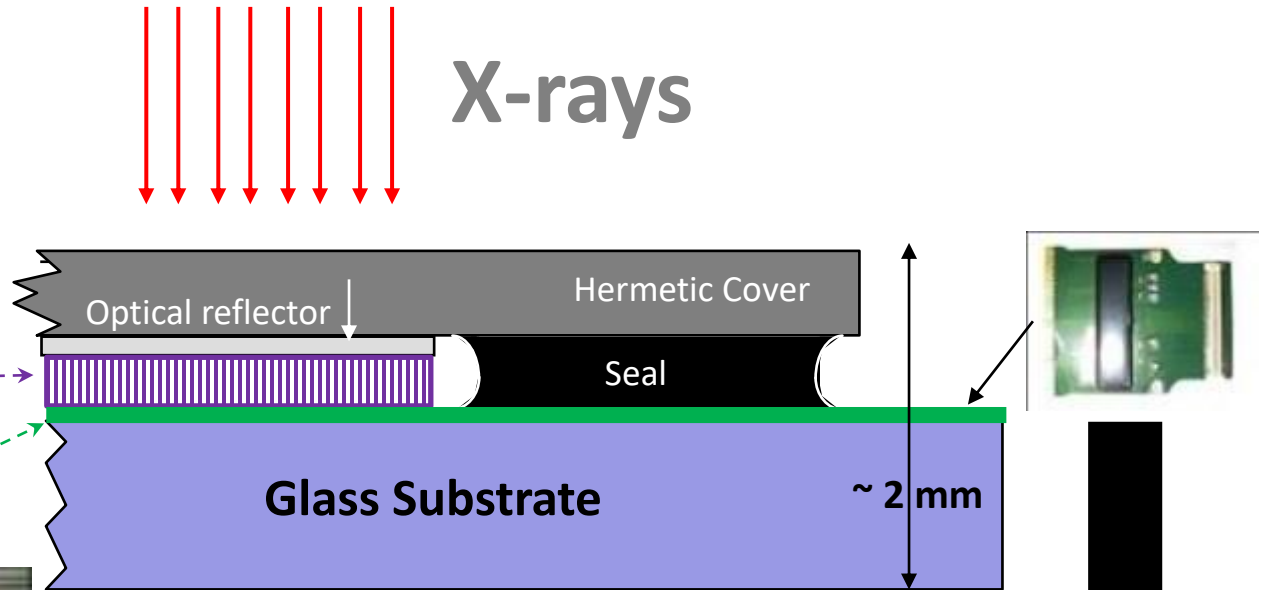


Typical Needed Size ~ 2 um

Thin Film Array of Millions of Transistors & Diodes



Typical Pixel pitch : 50-200 um

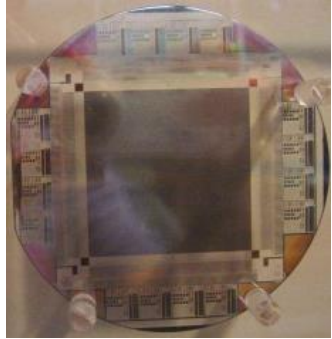


Real-Time
Digital X-ray
Image



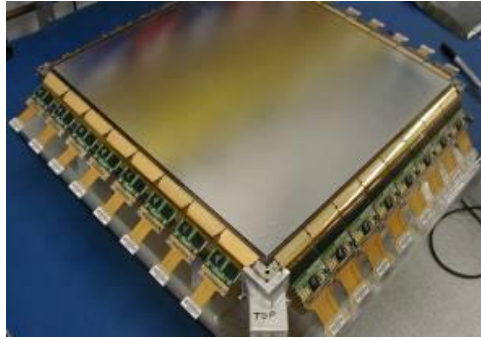
History of GE's Digital X-ray Revolution

1988:
1st a-Si
photodiode
imager



Funding (\$5M/yr)

1990-95:
Develop full imager
1995:
Trials at Mayo Clinic



Funding \$10M/yr

1996-99:
Product, process, &
supply chain dev'mt
1999-2000's:
Product launches



Funding \$10M/yr

2000 +
High volume
manufacturing



\$100M+ investment

'99: Radiography



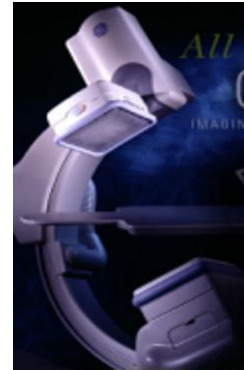
FDA Approved

'99: Mammography



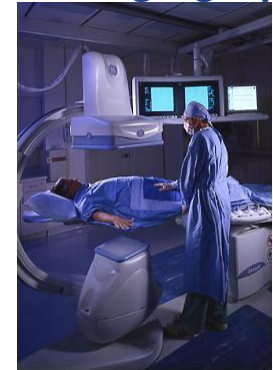
1FDA Approved

'00: Cardiac



FDA Approved

'02-04: Angiography



FDA Approved

Technology Evolution Through 2020

➤ Manufacturing Ramp-up, Cost Reductions

- Leverage \$100B's LCD Tool Investment
- High Yields, Higher Volumes, Many Vendors
- Detector Cost Fallen by 10X

➤ Competitive Technologies

- Thin film TFT with scintillator
 - High performance a-Si designs
 - IGZO (Indium Gallium Zinc oxide)
 - LTPS (low temperature polycrystalline Silicon)
- Tiled CMOS with fiber optic face plate and scintillator
- Direct conversion materials (e.g. a-Se)

➤ Advanced Applications

- Tomosynthesis
 - Combine images from different angles for low dose ~ 3D view
- Contrast Enhancement
 - Subtract images before and after contrast injection
- Packaging into (nearly) unbreakable wireless film-like cassettes

