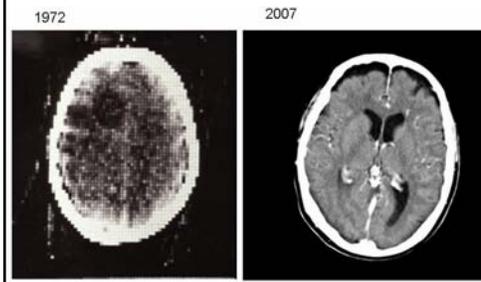


## Digital Imaging in Contemporary Healthcare

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### **Some milestones in Digital Medical Imaging (approximate years)**

2009	PET/MR
2007	Digital tomosynthesis
2002	3T MRI
2001	PET/CT
2000	SPECT/CT
1999	Digital mammography
1998	Multislice CT
1996	VHF Digital Ultrasound
1995	DR Flat panel system
1993	Functional MRI
1990	Spiral CT
1988	EPID
1983	CR systems
1981	PET Scanner
1980	MR scanner
1979	DSA
1978	SPECT
1972	CT scanner
1969	Ultrasound Scanner



#### Main technology drivers:

- Computer systems
- Reconstruction software
- Digital detectors
- Hospital Networks (PACS)

#### Main healthcare drivers:

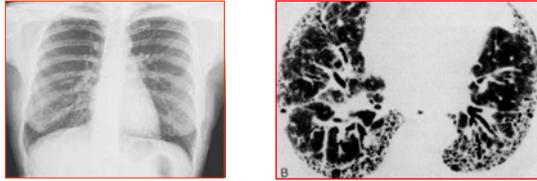
- Precise diagnostics
- Increased patient throughput
- Decreased cost

#### New medical speciality (Imaging)

#### Rapid Medical Physics development

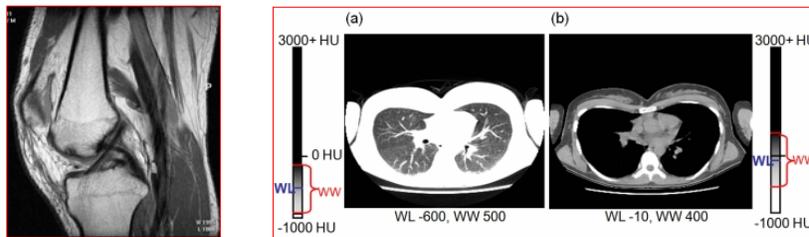
### Main advantages of Digital Medical Imaging

-Reconstruction allows unique view inside the body (non-destructive testing)



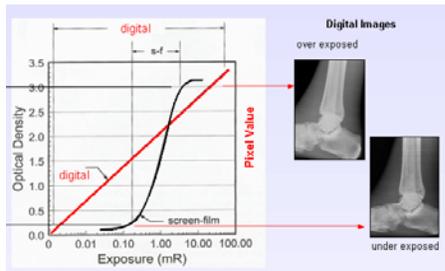
- Dramatically improved contrast resolution

CT (and DR) - 10 times better Contrast compared with classical Radiography

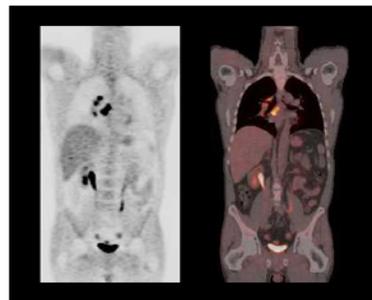


### Main advantages of Digital Medical Imaging

- Dramatically increased image dynamics (1:10 000)

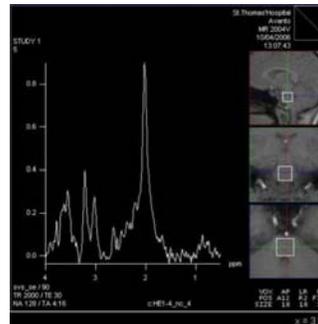
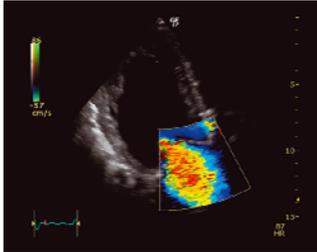


- Physiological imaging (Functional Imaging)



### Main advantages of Digital Medical Imaging

- Various measurements from the image

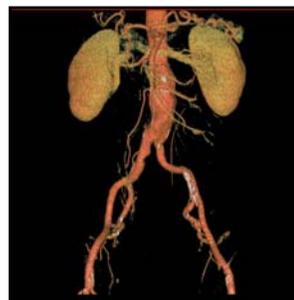


- Image fusion (from various modalities)



### Main advantages of Digital Medical Imaging

- Image post-processing / reconstruction

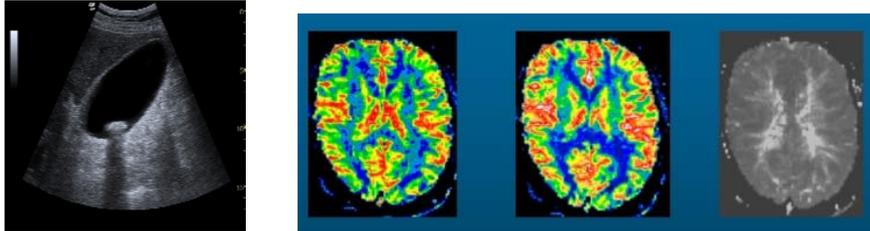


- New Working environment



### Main advantages of Digital Medical Imaging

- Methods without Patient dose



- Potential for substantial Patient Dose reduction (compared with classical)

Digital radiography ~80% reduction of dose

Digital fluoroscopy ~ 90% reduction of dose



### Main advantages of Digital Medical Imaging

- Increased patient throughput (and mass screening) – time for image available  
16 sec per DR img. ; 6 minutes per CR img. ; 10+ minutes per classical img.



- Digital archive (PACS) with enormous capacity



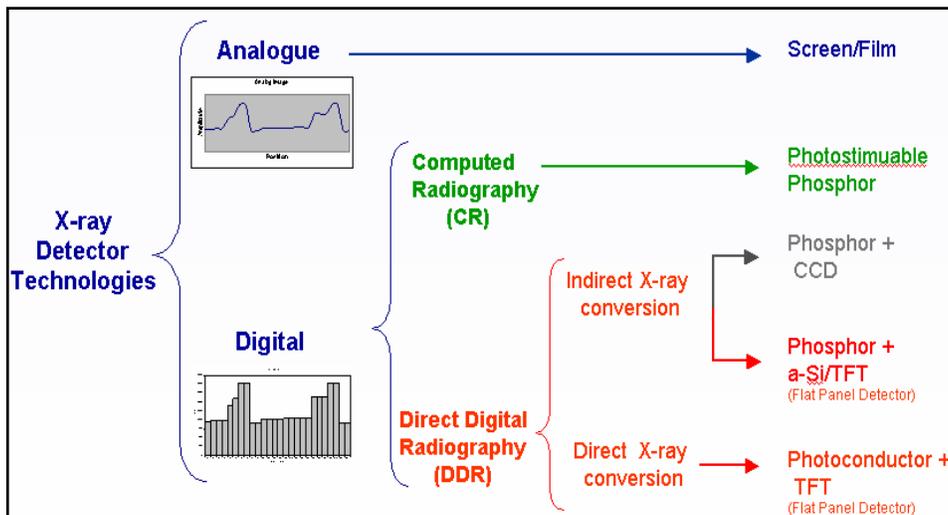


Fig.3 – Current X-Ray detector technologies for x-ray diagnostic imaging

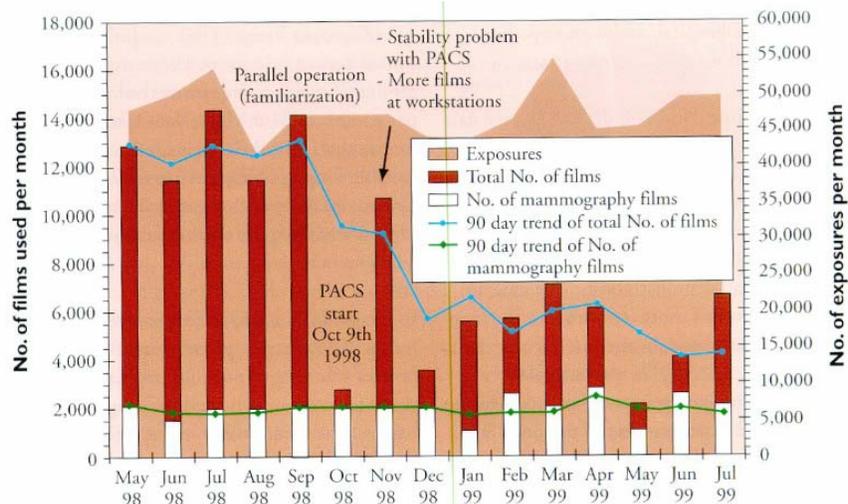
Source: A. Pascoal

Other Digital Detectors:

- Image Intensifiers with digital output (as in DSA)
- CCD-based detectors

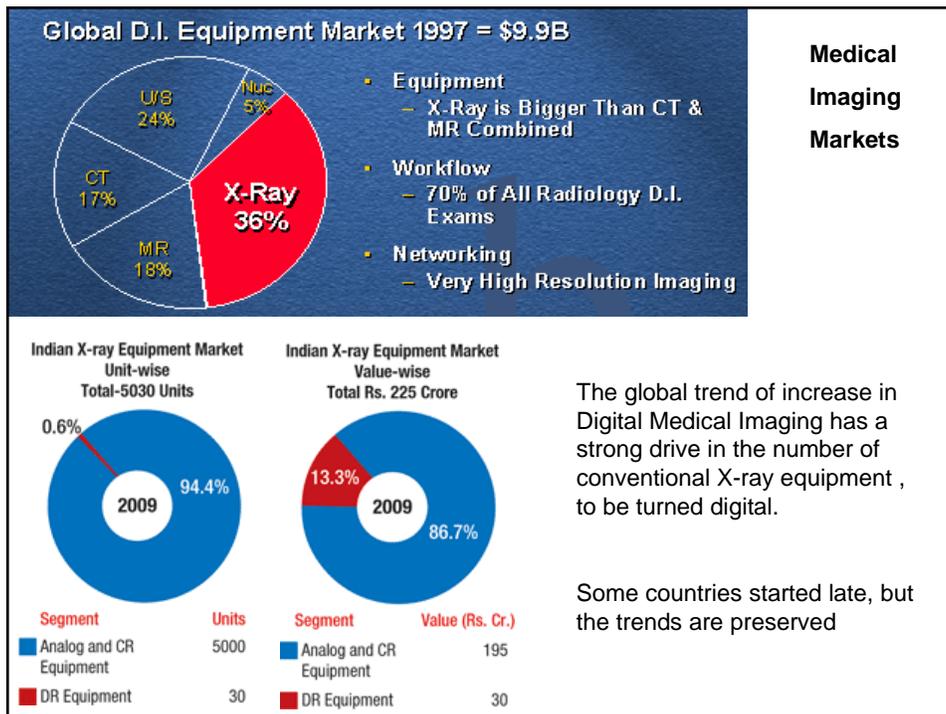
### Main advantages of Digital Medical Imaging

- Reduced cost per investigation (mainly due to eliminating film & film processing plus associated staff cost)



### Main challenges of Digital Medical Imaging

- Large number of new methods and necessity of constant re-training
- Reducing the Imaging staff (due to equipment automatisation)
- Change in the organisation of work in Imaging Departments/Hospitals
- Increased cost of equipment and rooms for it  
(currently ~10% of all hospital budget is associated with Imaging equipment)
- Increased number of investigations (and Patient Dose !)  
CT and Interventional Radiology – the highest patient doses
- Image processing changes the 'real image' (can't be used as evidence)



**Recent figures for the trend in development of Digital Medical Imaging**

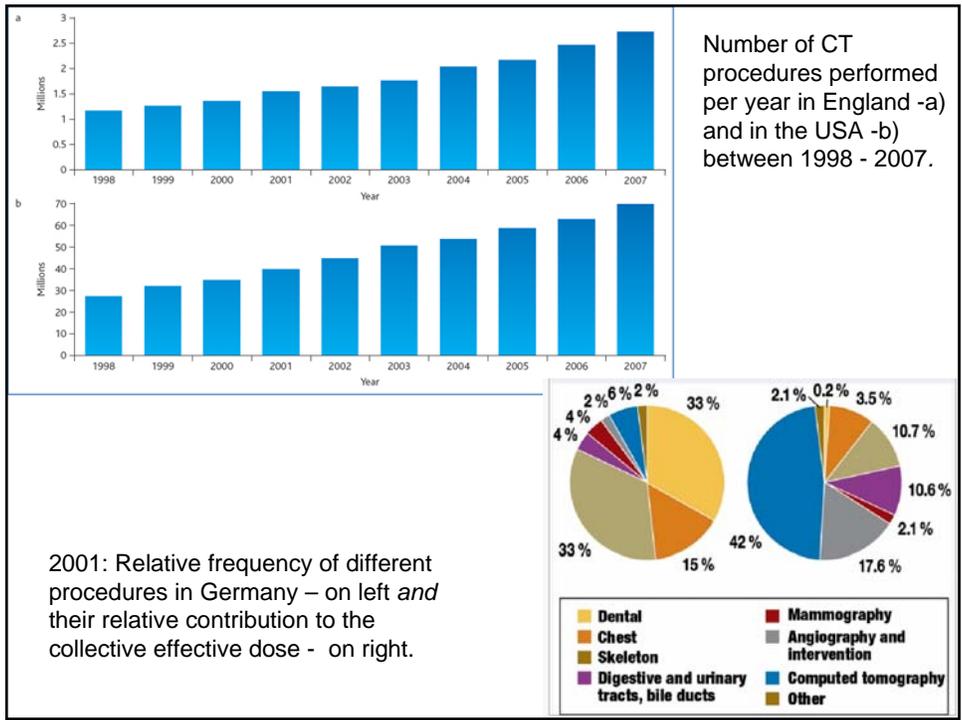
2007: Manufacturing of flat panels (DR) planned to increase with 40%

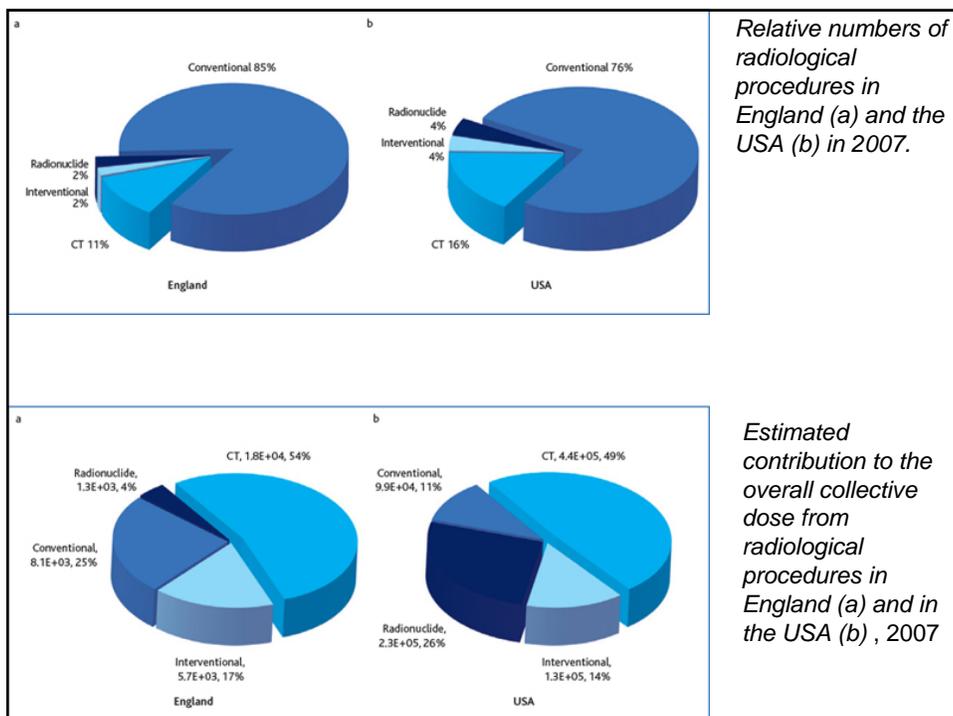
USA (2005-06) – 4860 hospitals with 16,500 radiography systems

- From these: 42% plan to buy new DR;
- 24% are planning to buy DR or CR,
- 11% plan to buy film systems

Cost of European markets for CR system in 2009 – 228 M\$  
 predicted for 2016 – 237 M\$ (0.6% growth)

Cost of European markets for DR system in 2009 – 68 M\$  
 predicted for 2016 – 111 M\$ (7.2 % growth)





**Conclusion:**

- The 'Digital Revolution' has increased enormously the breadth of knowledge for Medical Imaging (almost as in a separate profession)
- During the past 10 years the number of Digital Medical Imaging systems surpassed the number of Classical Medical Imaging Systems (globally)
- This 'Revolution' led to 90%+ Digital Medical Imaging in developed countries, but this ratio is still below 50% for the developing countries
- In the next 10 years almost all Medical Imaging systems will be Digital (globally)
- This has reflected the education and training of Medical Physicists and Engineers (as well as Radiologists)
- The education/training (and work pattern) of radiographers also changes rapidly
- The study of Digital Systems will have to include Hospital Networks and PACS
- An important issue for further development is extraction of information from digital images (through special processing and measurements)
- The systems for Image Hard Copying will continue to be developed
- A very important issue is still Radiation Dose associated with Digital Medical Imaging systems (specially due to the new opportunities for diagnosis)