

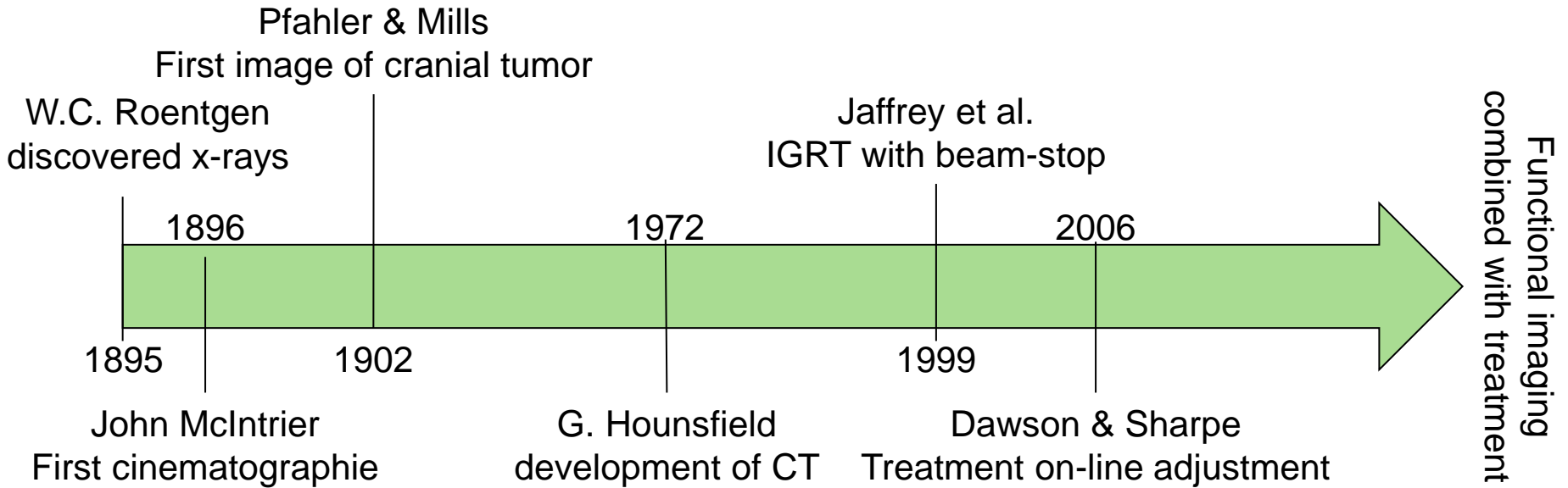


Historical Review and Modalities in Diagnostics

Daniel Bödeker



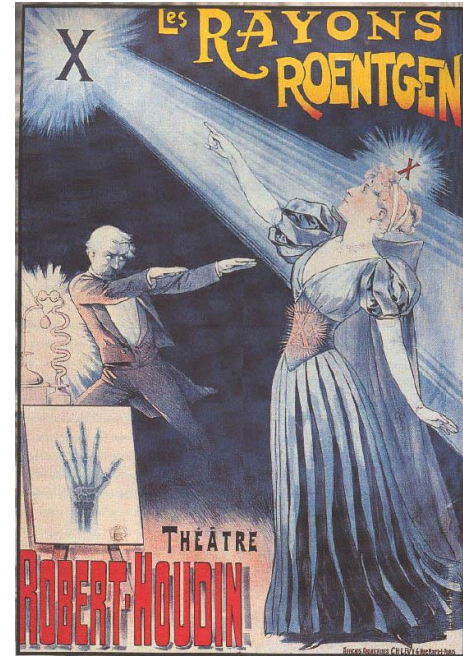
History of X-rays



Modalities

Overview

- **Projection radiography**
 - Radiography
 - Mammography
- **Fluoroscopy**
 - Fluosrcopy
 - Angiography
- **Sectional/ volume imaging**
 - Computed Tomography
 - Digital Volume Tomography
 - Tomosynthesis



Affiche de spectacle au Théâtre Robert-Houdin
(source : revue Contrastes de Guerbet, 1995)

Projection radiography

Radiography

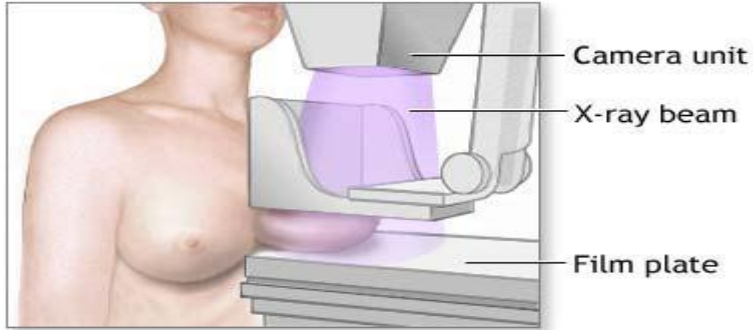
- One image only
z.B. Thorax, Lung,
- 70 – 110 kV



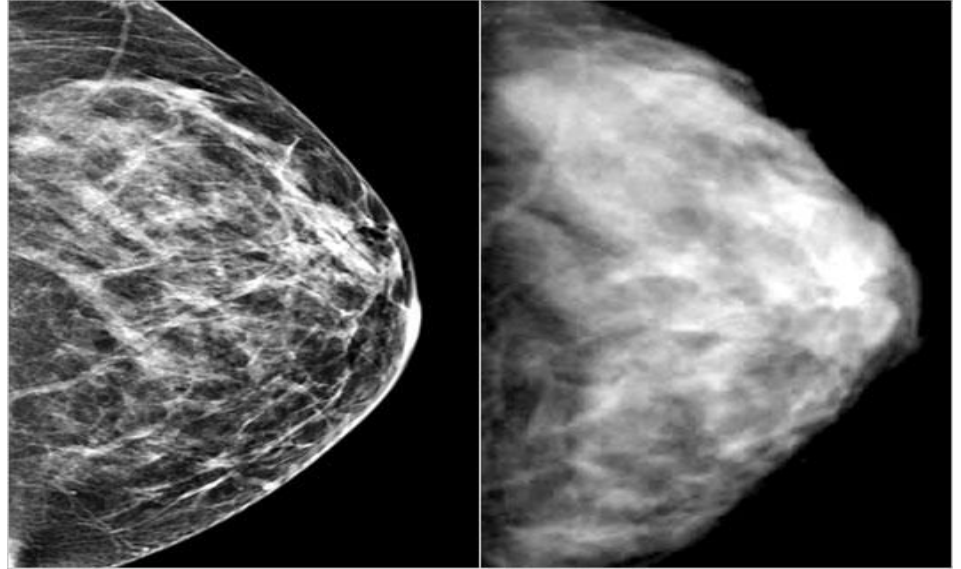
Projection radiography

Mammography

- Breast Image
- Tube voltage 22 – 45 kV



In mammography, each breast is compressed horizontally, then obliquely and an x-ray is taken of each position



Fluoroscopy

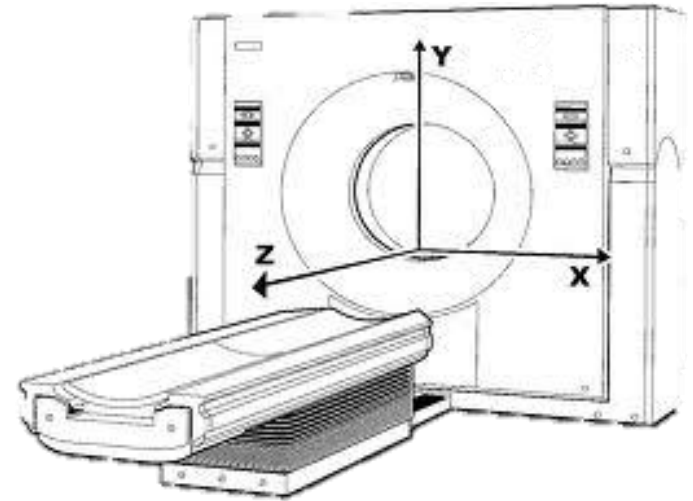
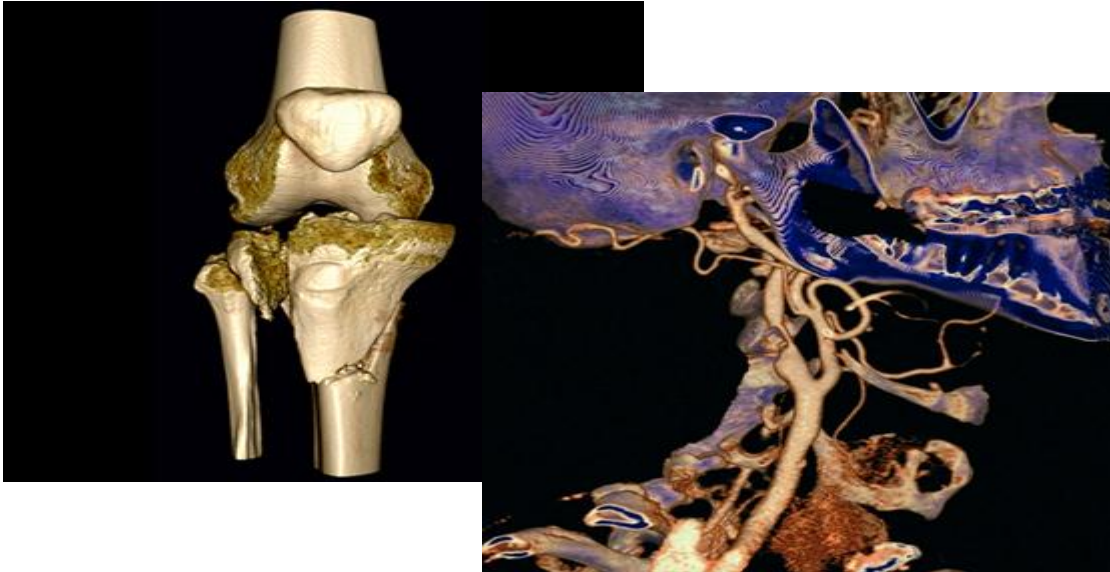
- Series or Cine-mode
i.e. moving effects or vessels
- 40 – 90 kV



Sectional/ volume imaging

Computed Tomography

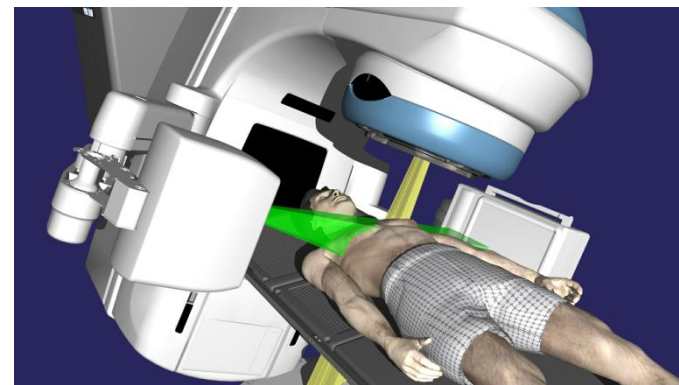
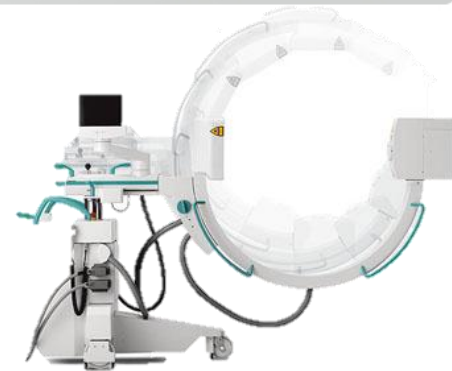
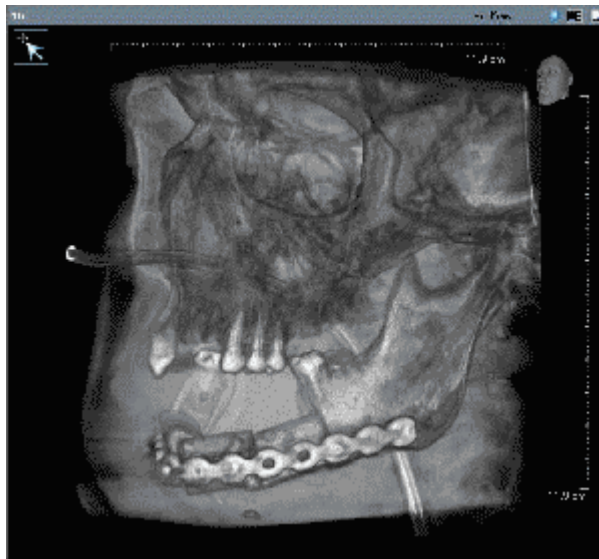
- 3 D images
- Tube voltage 90 - 160 kV



Sectional/ volume imaging

Volume Tomography

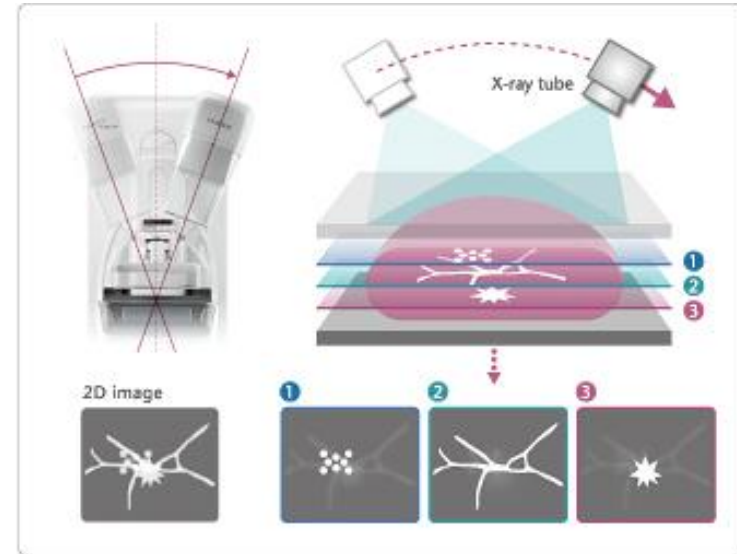
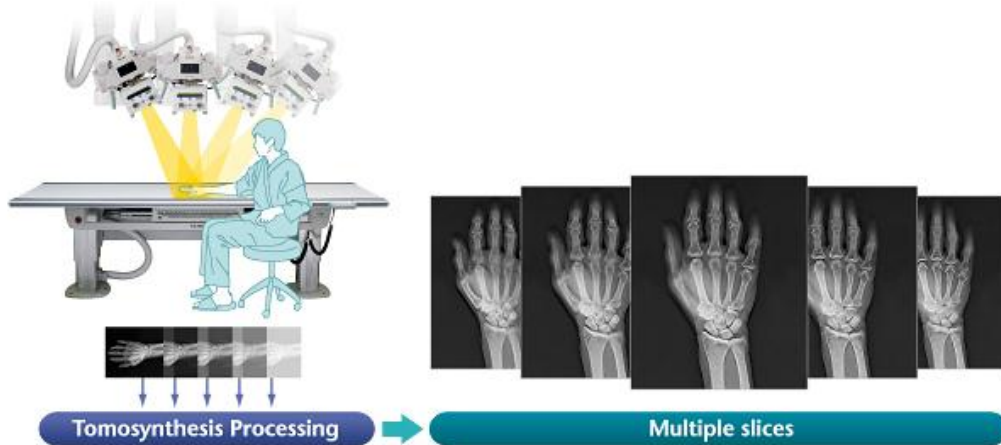
- 3D Image (ConeBeam CT)
- 40 – 120 kV



Sectional/ volume imaging

Tomosynthesis

- Projection radiography system
Series of 2D Images from different angles
- kV same as in Projection Radiography



Why we do, what we are doing?

Why we do all these tests?

An important goal of radiology is

... to produce images that provide adequate diagnostic information,...

... while keeping radiation exposure to the patient
“As Low As Reasonably Achievable” (ALARA)
(Cember, 1976).



Why we do, what we are doing?

Why we do all these tests

The Risk of X-ray examinations



Figure 6b. Erythema about 3 weeks after procedure in Fig. 6a.



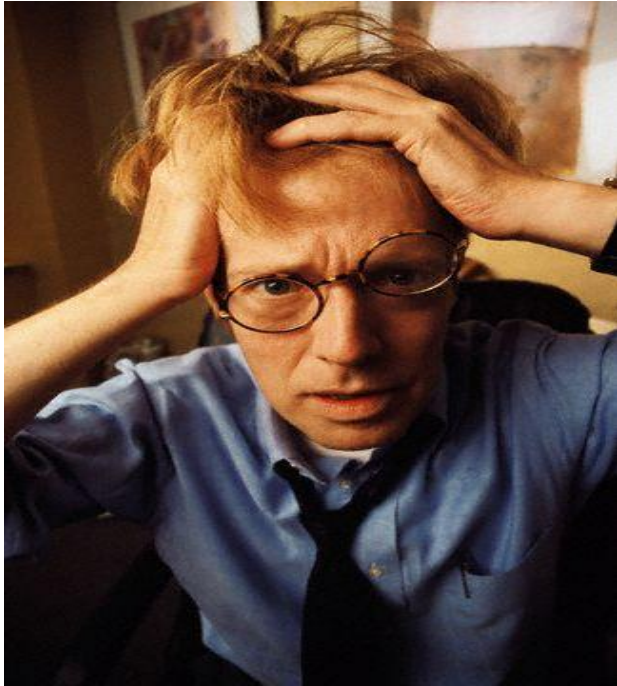
Figure 6c. Ulcer about 5 months after procedure in Fig. 6a.



Figure 6d. Extent of injury with humerus visible about 6.5 months after procedure in Fig. 6a.

CT Coronary Angiography

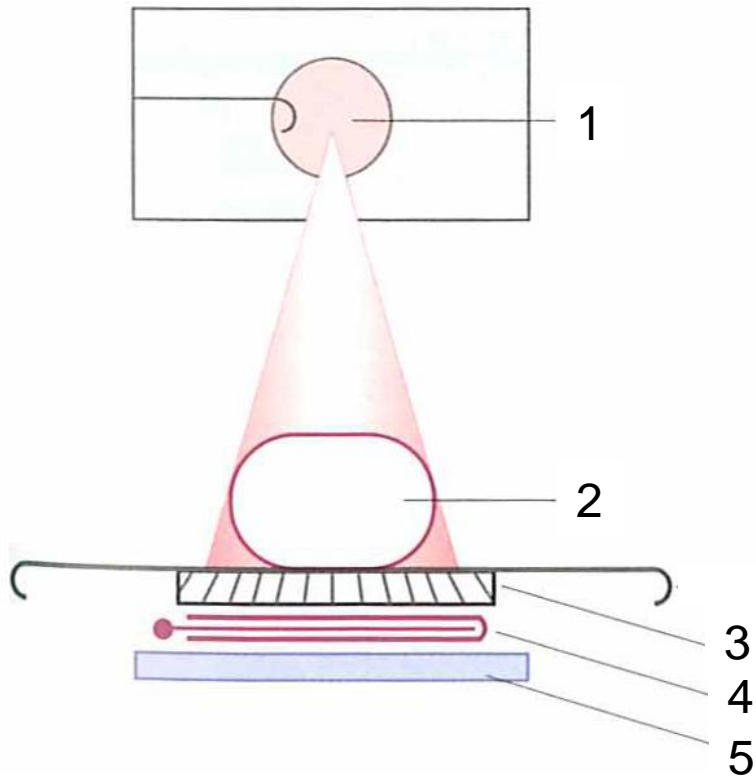
Challenges



- **How to keep the ALARA - principal**
- **What about Quality Assurance?**



Dose reduction from system in projection radiography



1. X-ray tube



2. Object

3. Grid

4. AEC Chamber

5. Image detector

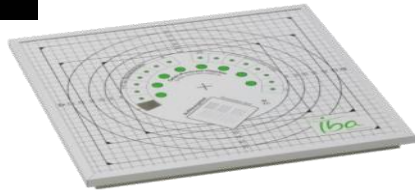
What does Quality Assurance mean?

Radiology

Image Quality

+

Dose
(Beam Quality)



Actual Size of the Unit



Image Quality

Projection radiography / Fluoroscopy

- ✓ Light field / beam field
- ✓ Spatial resolution
- ✓ Dynamic range
- ✓ Low contrast
- ✓ Distortion

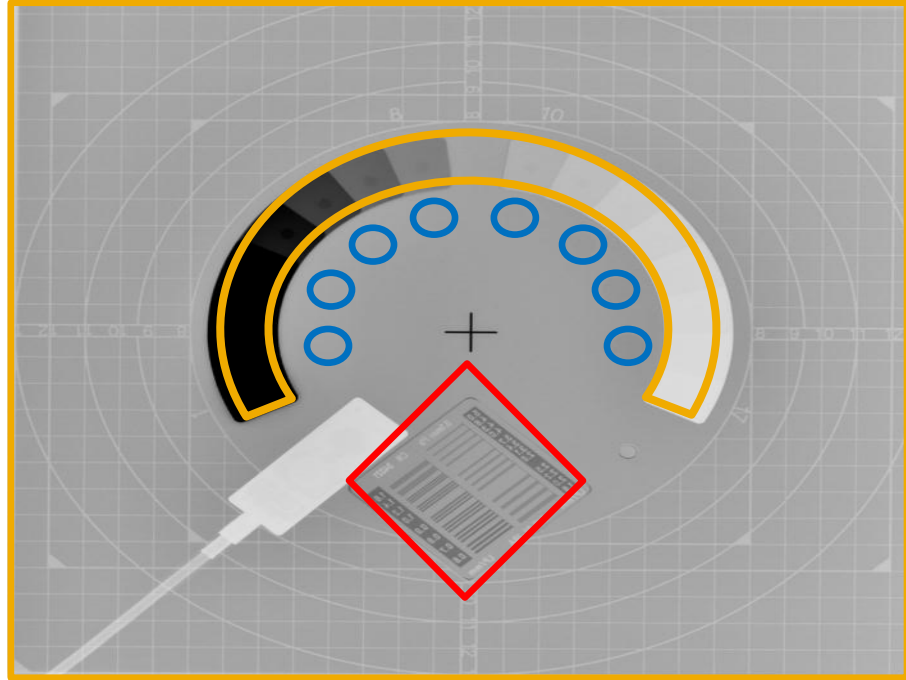
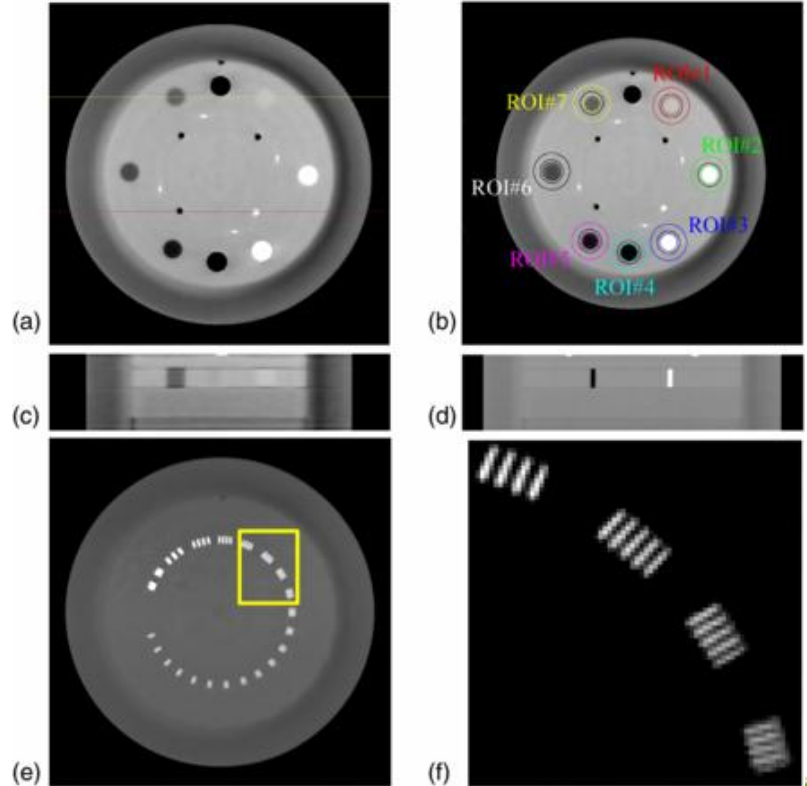


Image Quality

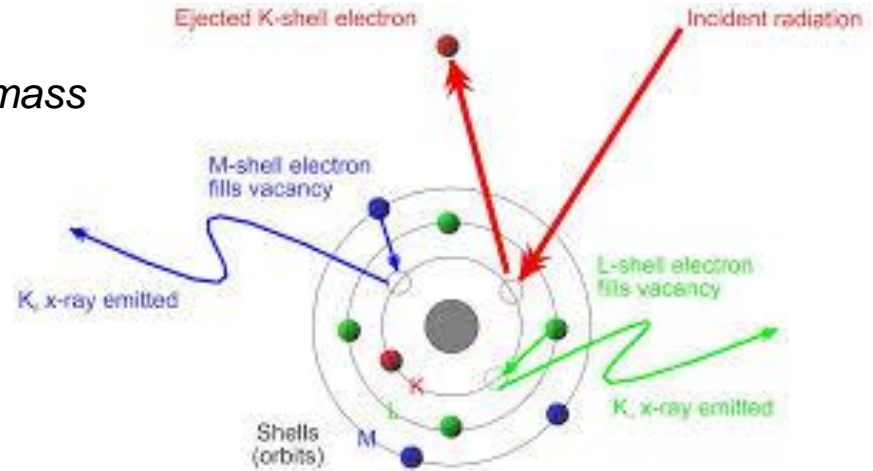
Computed Tomography

- ✓ Spatial resolution
- ✓ Dynamic range
- ✓ Low contrast
- ✓ Distortion



Beam Quality

- The Beam Quality can be specified by
 - Dose [Gy]
 - Kinetic Energy released per unit mass
 - Entrance dose [K_e]
 - kV/ keV [kV / PPV]
 - Maximum electron energy
 - Half Value Layer (HVL) [mm Al]
 - Thickness of Aluminum needed to half the dose



Dose measurement devices

Solid state detector vs. Ionization chamber

Since years physicist are discussing, if the ionization chamber or the solid state detector is better...



...I will not have an answer for this question.

*Ionization chamber
is more accurate*

*Ionization chamber
are longer stable*

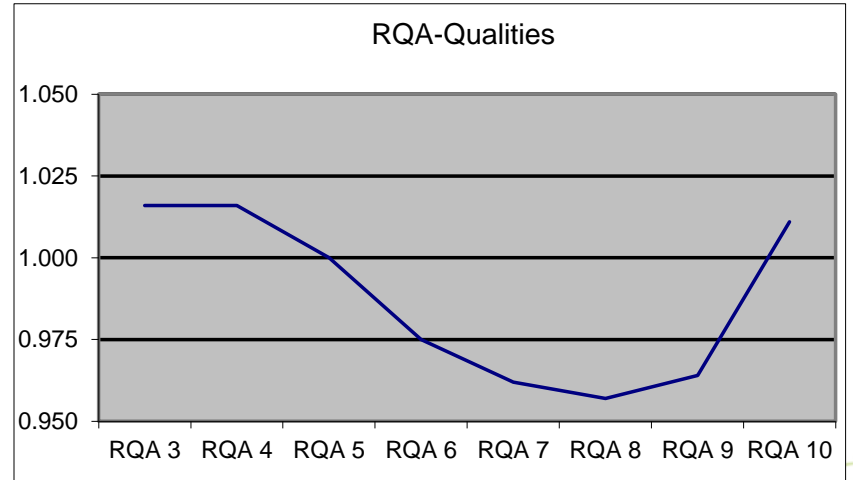
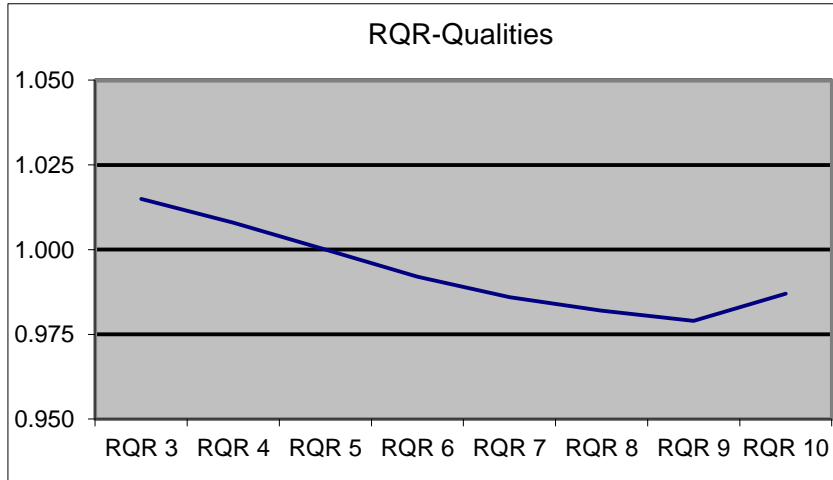
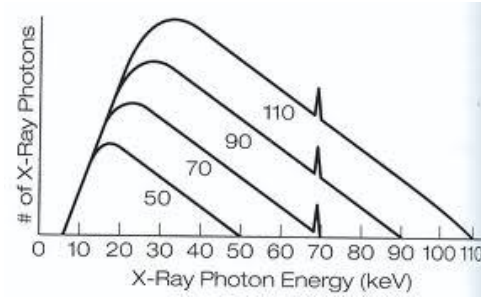
Solid state detector
is more handier

*Solid state detector
is more robust*

*Solid state detector
does not need high voltage*

Dose detector

Solid State detector



MagicMaX XR- Detector

In Radiography / Fluoroscopy



The Multidetector XR is auto corrected...

Measurin values: kV_p , PPV , HVL, Dose, Dose Rate,
Dose per Pulse and Exposure Time

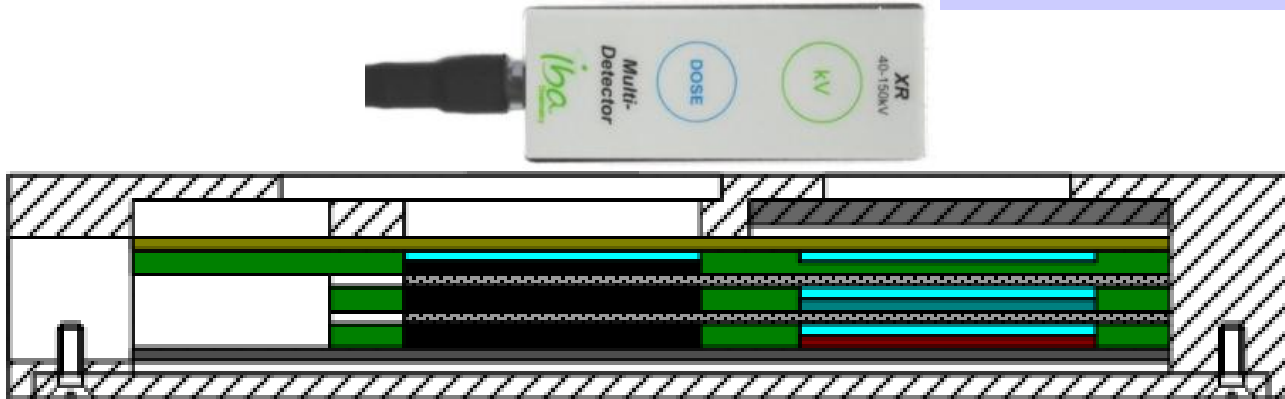
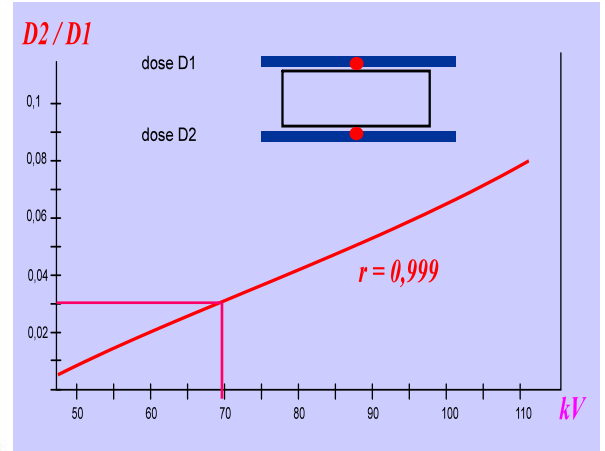


kV / HVL / Total Filtration

Dose / Dose rate / Time

HVL / kV measurement principle

- We are using 3 detectors with known attenuation.
- With the calibration we are finding the ratio dependency of the detectors as a function of the keV



MagicMaX

in General

General spec.

Time

2 ms – 300 s

Time resolution

0.1 ms (Sampling rate:
10kHz)

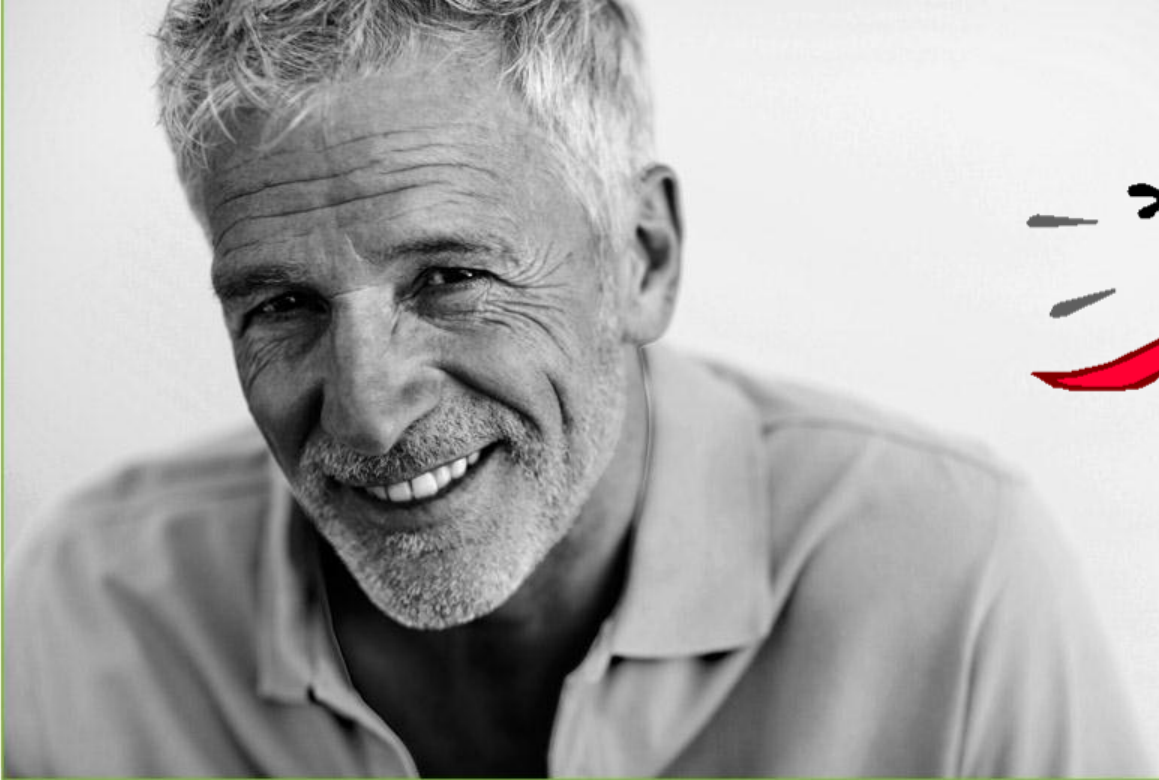
High Voltage

50V – 400 V

Size

145 mm x 90 mm x 35 mm
(5.7" x 3.5" x 1.4")

	MagicMaX Universal	MagicMaX kV/dose	MagicMaX kV	MagicMaX dose
Dose	OK	OK		OK
Time	OK	OK	OK	OK
Waveform	OK	OK	OK	OK
kV / PPV	OK	OK	OK	
HVL	OK	OK	OK	
Total Filtration	OK	OK	OK	
External dose detector	OK	OK		OK
Current Probe (mAs)	OK	OK		
Light (lux)	OK	OK		
CT - Ionization Chamber	OK			



Have fun in the practical part ;-)

Iba