Overview

- Introduction
- Light & Endoscopy
- X-Rays
- Magnetic Resonance Imaging
- Nuclear imaging
- Ultrasound imaging

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X-Ray

Short History :

– Photography, XIXe.

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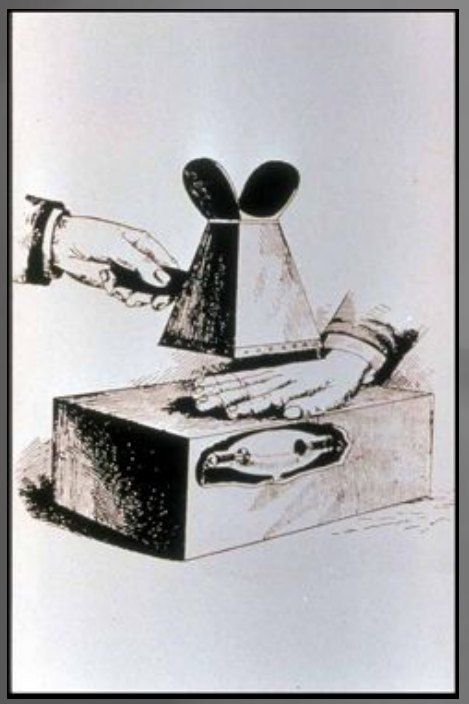

X-Ray

Short History :

- Photography, XIXe.
- 1895 Roentgen discovers X-Rays
- 1896 First Fluoroscopes (Thomas Edison)
- 1900 X-Rays become popular

X-Ray

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- Photography, XIXe.
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- 1896 First Fluoroscopes (Thomas Edison)
- 1901 Roentgen receive the fist Nobel Price of Physics

X-Ray

Short History :

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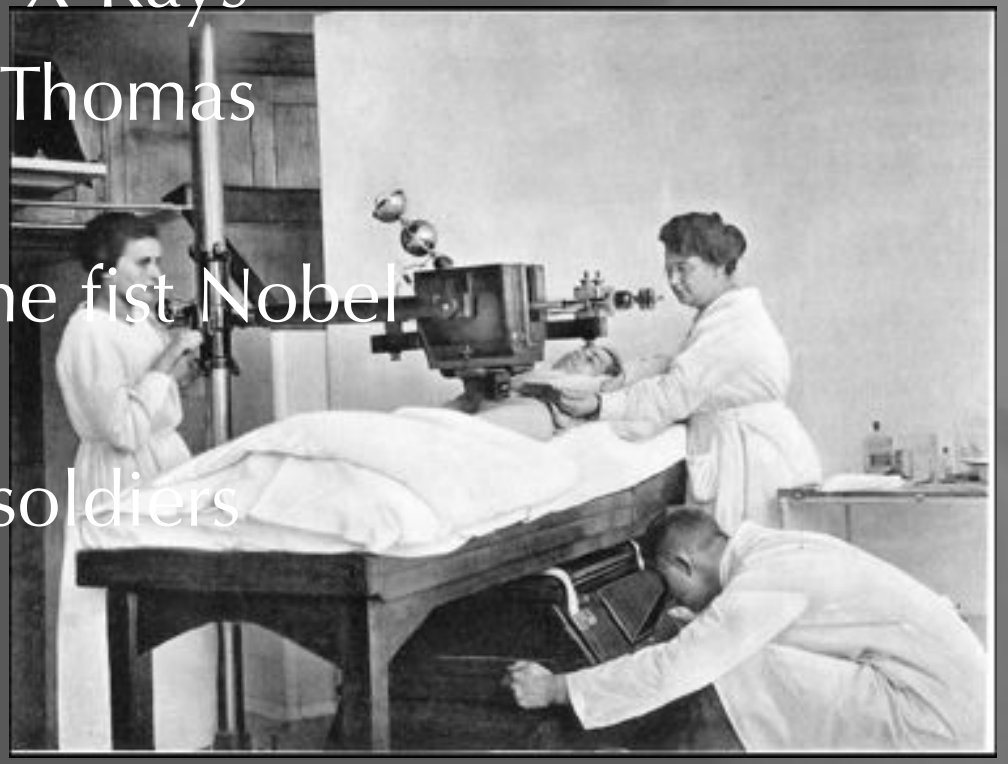
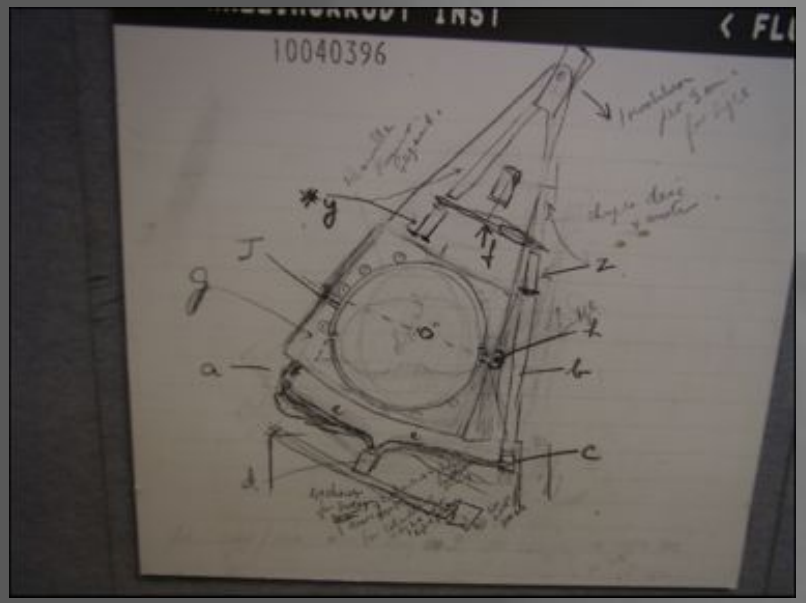
- 1901 Roentgen receive the fist Nobel Price of Physics
- 1914-1918 used to cure soldiers



X-Ray

Short Story

- 1917 Radon invents the bases of tomography.
- 1960 Allan Mac Cormack publishes the idea of scanner.



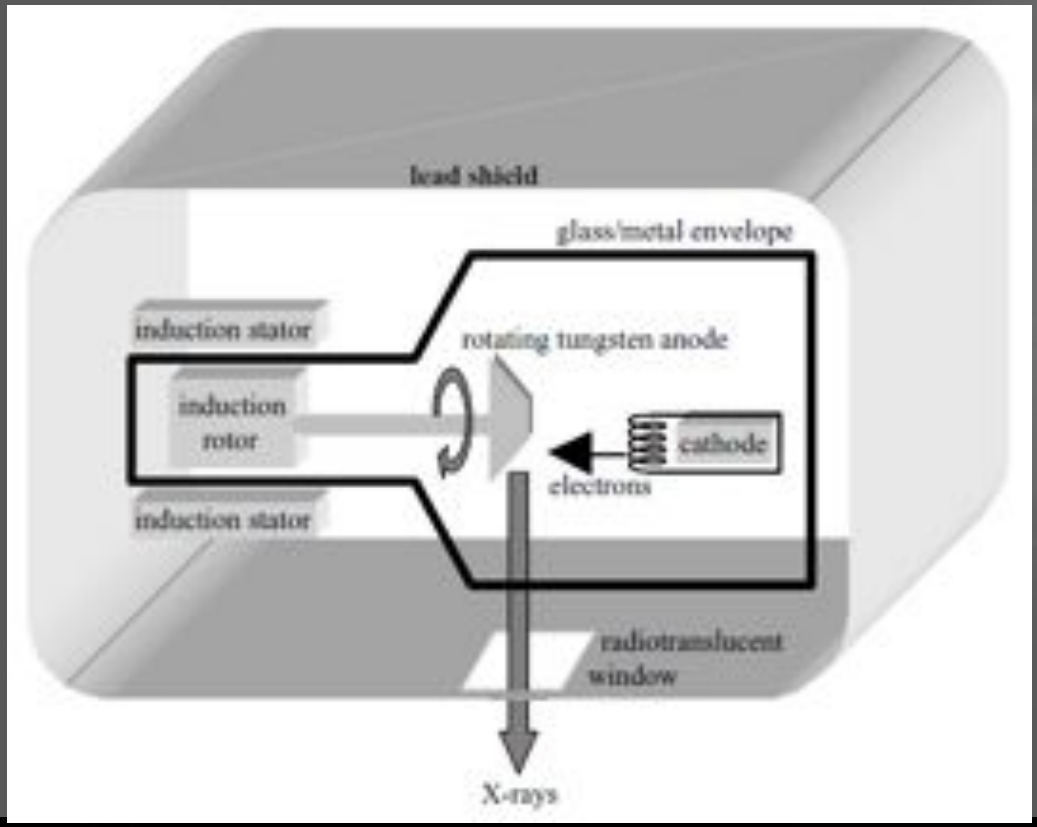
X-Ray

Short Story

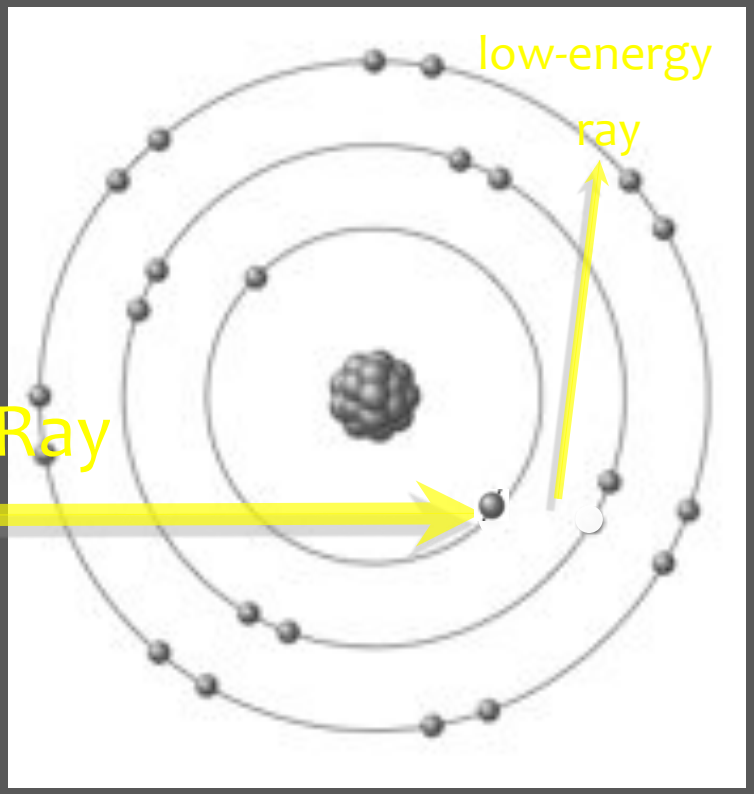
- 1917 Radon invents the bases of tomography.
- 1960 Allan Mac Cormack publishes the idea of scanner.
- 1972 First Medical X-Ray Scanner (Hounsfield)
- 1979 Hounsfield and Mac Cormak receive the Nobel Price of medicine

X-Ray Production

- Acceleration of a ray of electrons to hit tungsten anode

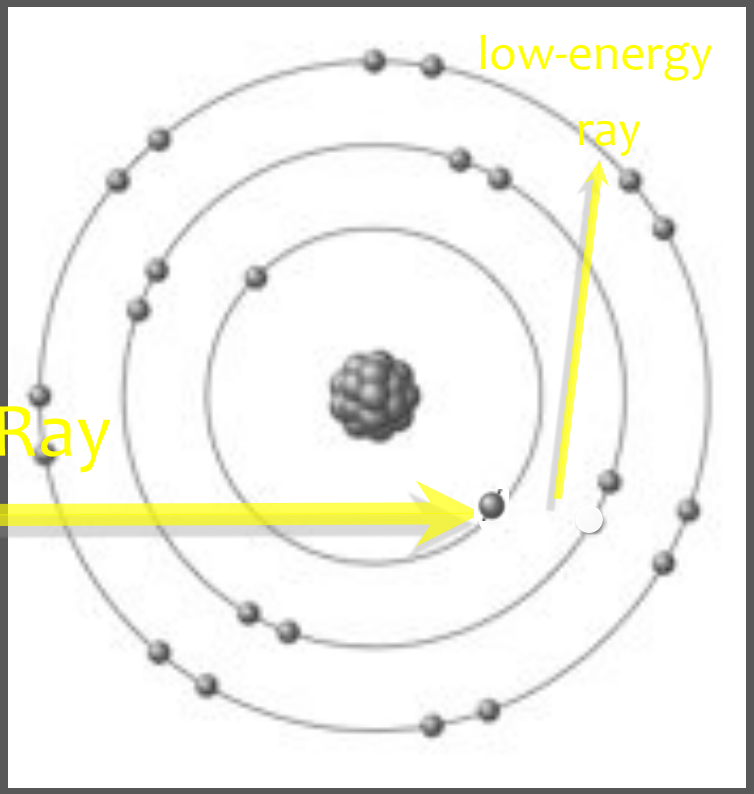


Interaction X-Ray / Matter



Photoelectric Effect

- low energy X-Rays
- appears when
  - high matter density
  - Z^3
  - Large for
    - lead (Z=82)
    - barium (Z=56)
    - iodine (Z=53)

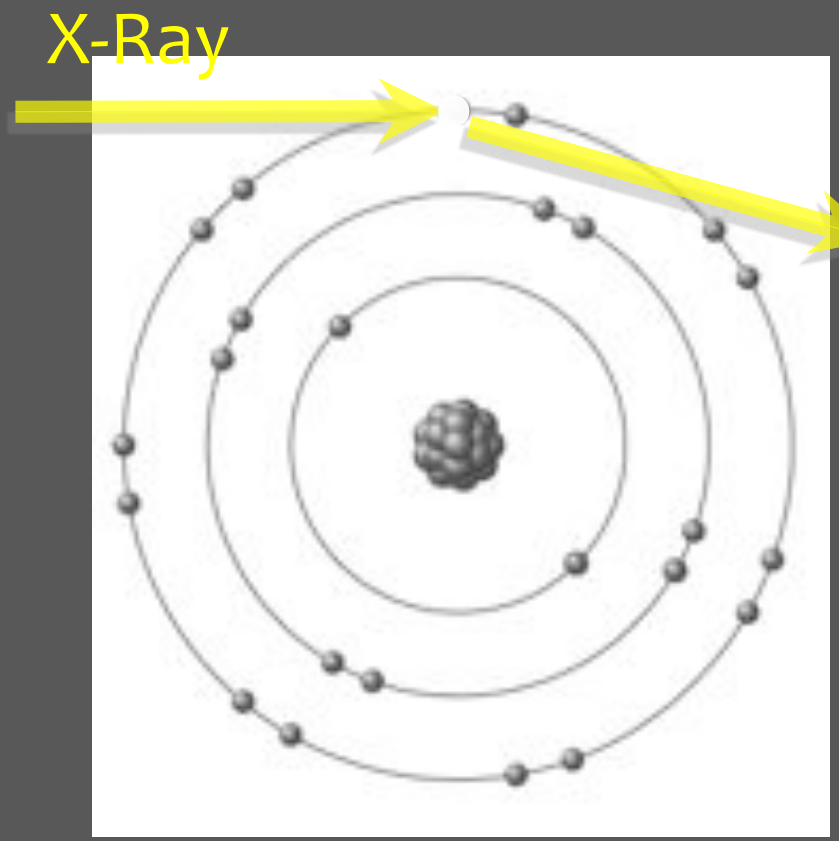


Interaction X-Ray / Matter

Photoelectric Effect

- Consequences
  - X-Ray stopped
  - Production of a photon
  - Production of a cation

X-Rays



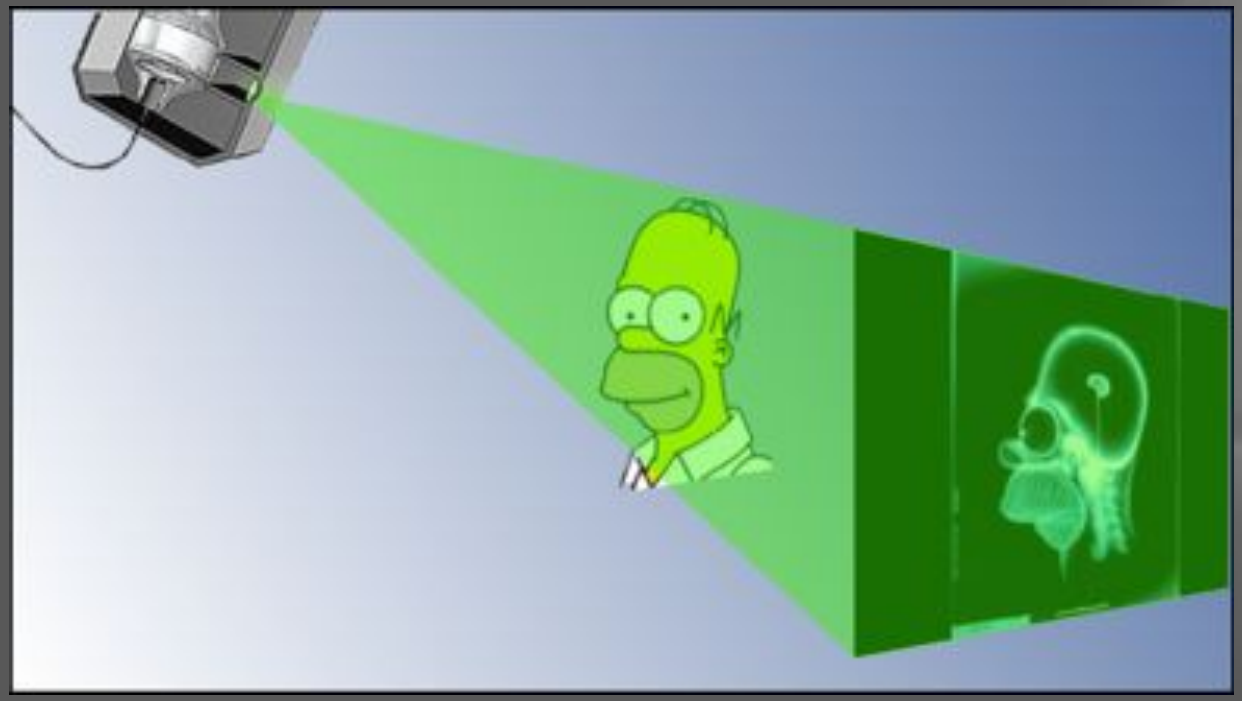
Interaction X-Ray / Matter

Compton Effect/Scattering

- high energy X-Rays
- appears when
  - ✓high matter density
- Consequences
  - X-Ray deviated
  - loss of energy
  - Production of a photon
  - Production of a cation

X-Ray Photography

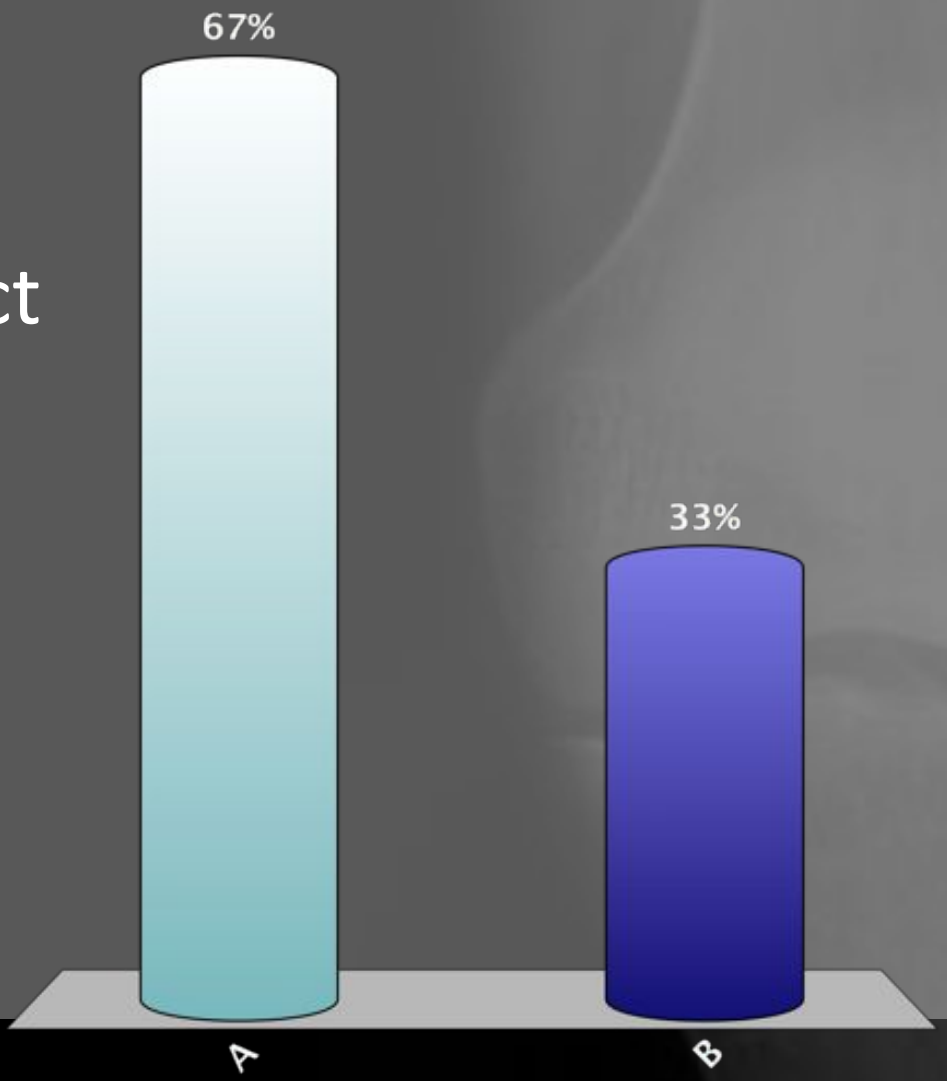
Principle: attenuation of X-Rays differs according to tissues (thickness, density, Z, X-Ray energy)



During X-Ray imaging, images gray levels are due to

A. The Campton Effect

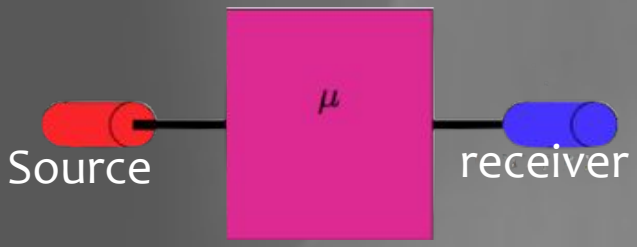
✓B. The Photolectric Effect



X-Rays

- X-Ray Attenuation

$$I_R = I_S e^{-\mu x}$$



I_s : source intensity

I_R : measured intensigy

μ : attenuation coefficient

Hounsfield Units

$$\frac{\mu_X - \mu_{H_2O}}{\mu_{H_2O}} \times 1000HU$$

Tissue	Hounsfield Unit
Air	-1000
Fat	-120
Water	0
Muscle	+40
Bone	+1000

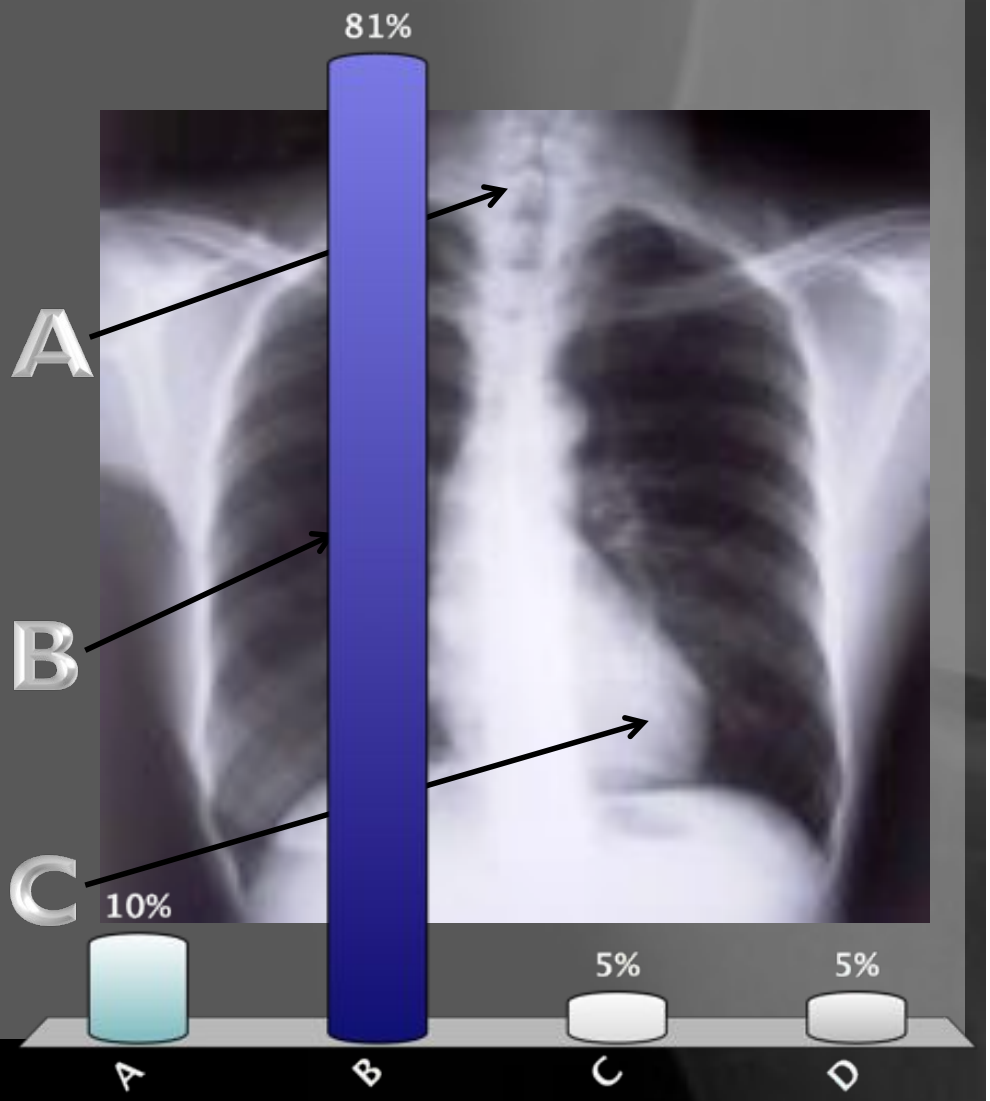
On this X-Ray image, A represents…

A. Air

✓ B. Bone

C. Muscle

D. Skin/Fat



M2 MoSIG
Medical Imaging Simulation & Robotics

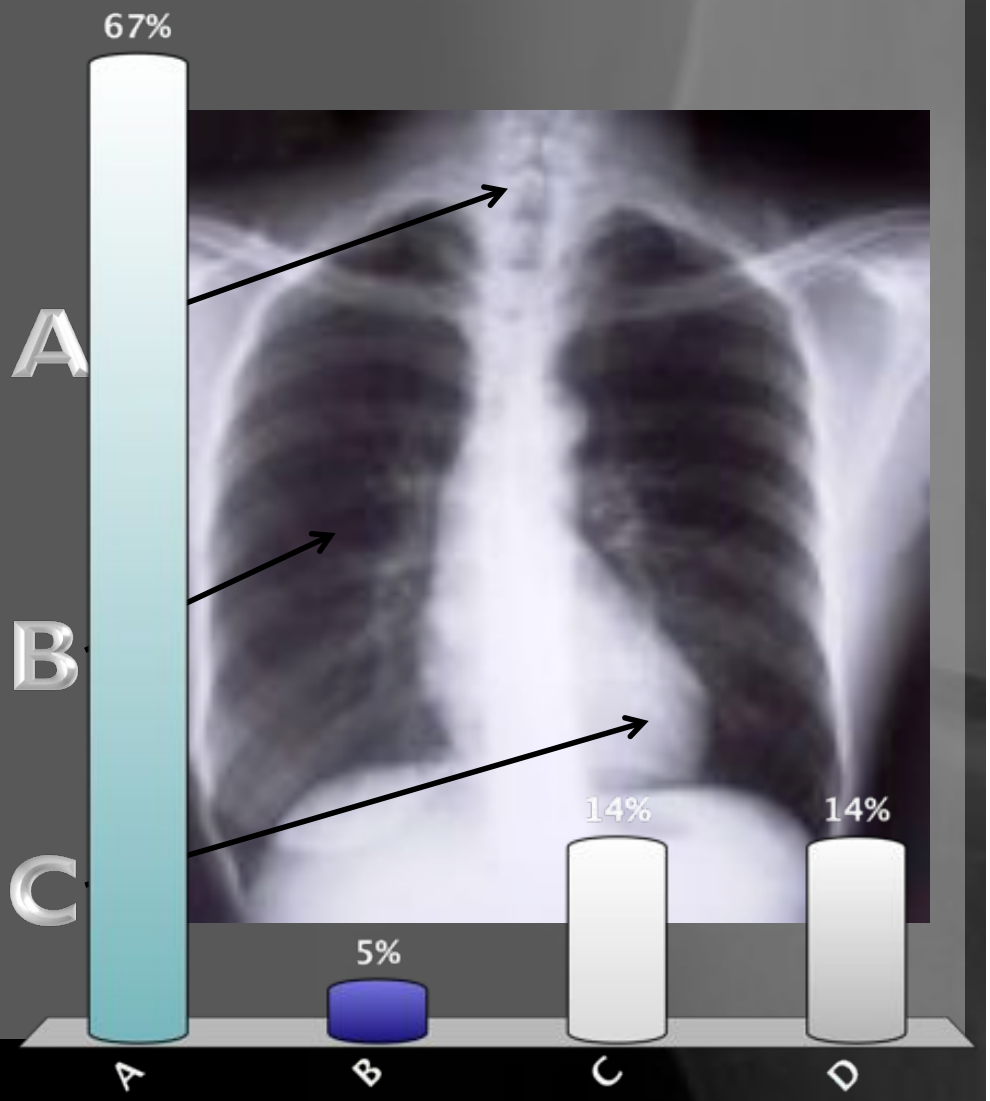
On this X-Ray image, B represents…

A. Air

✓ B. Bone

C. Muscle

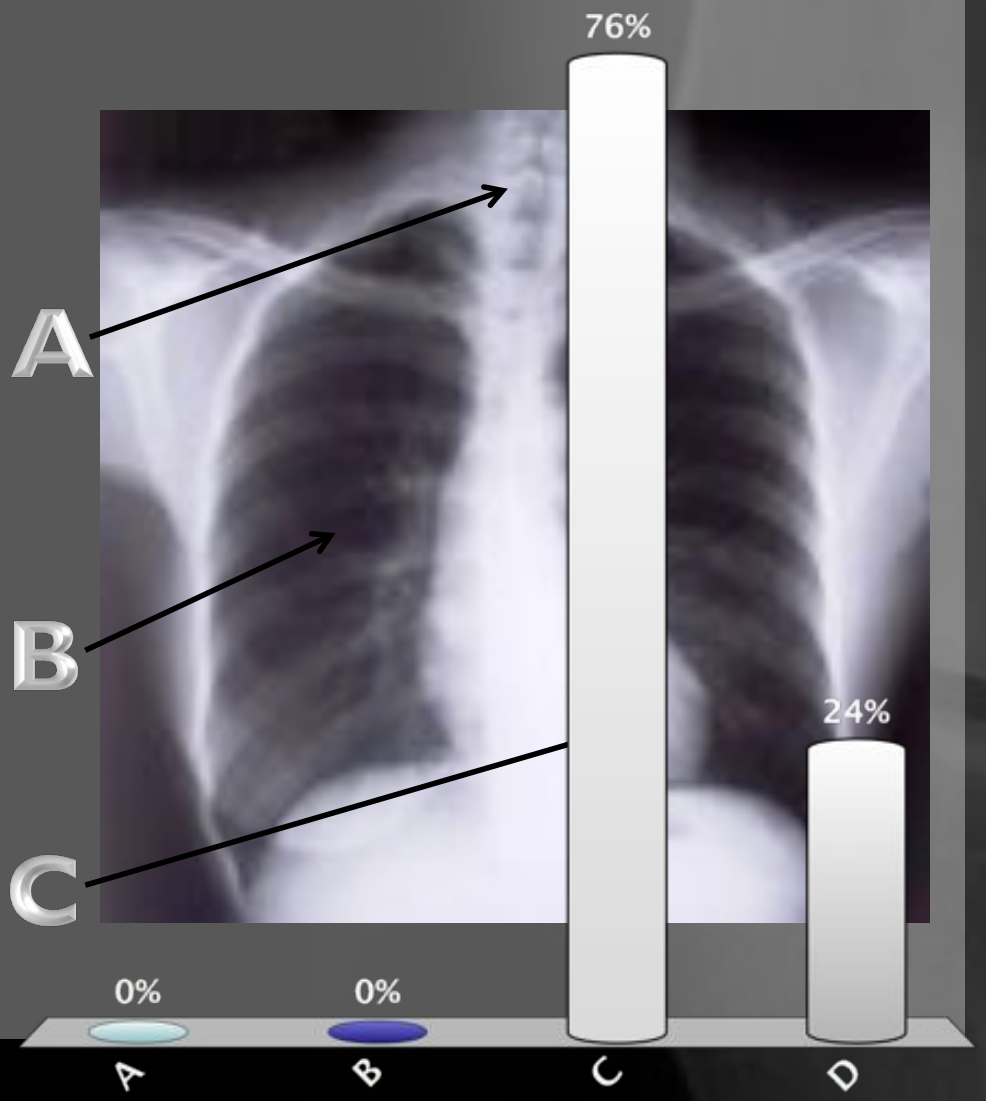
D. Skin/Fat



M2 MoSIG
Medical Imaging Simulation & Robotics

On this X-Ray image, C represents…

A. Air
B. Bone
✓ C. Muscle
D. Skin/Fat

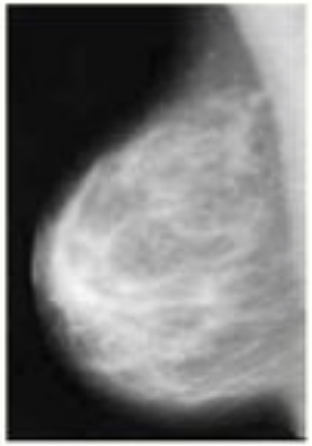


M2 MoSIG
Medical Imaging Simulation & Robotics

X-Ray Photography

- Examples

Fracture

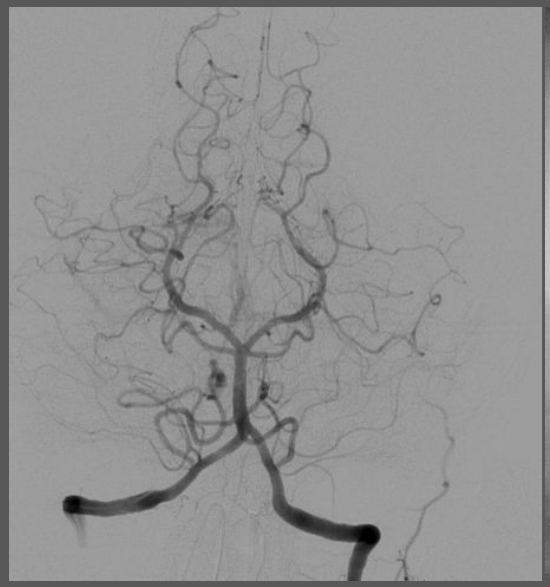
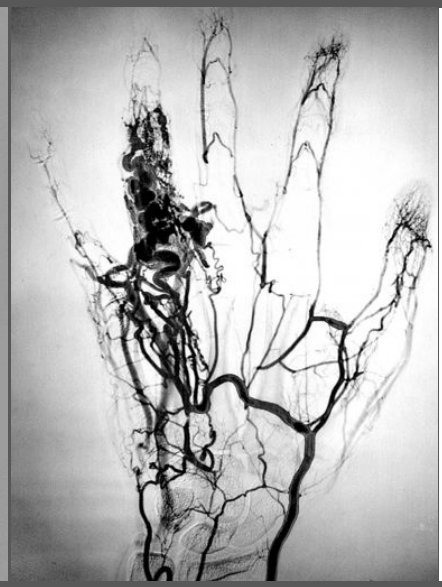
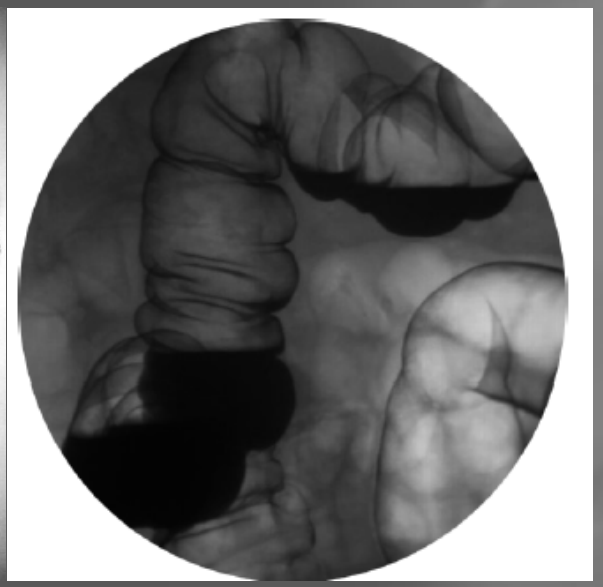


Mammographie

Tube digestif

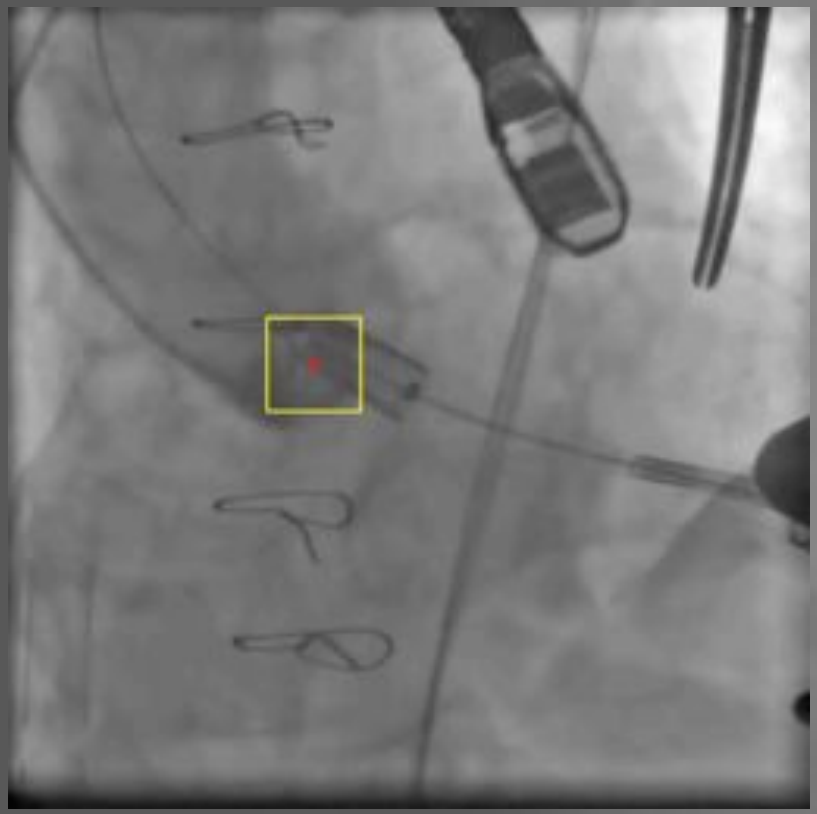
X-Ray Photography

- Contrast Media (angiography)

Fluoroscopy

- low-energy x-rays
- continuous and real time imaging



Another Video

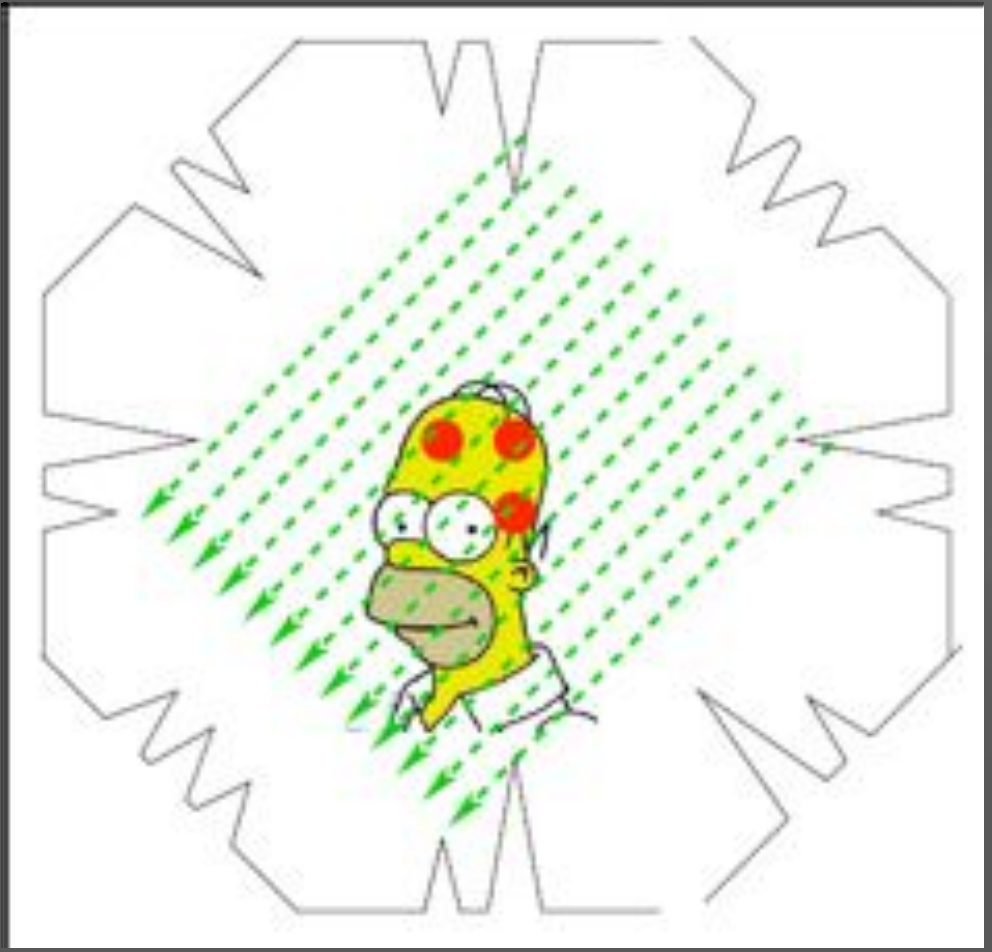
X-Ray 2D images

- Anatomical Information
- Good contrast bone/soft tissues
- 70% of medical images
- Dangerous

  precautions must be taken for patients (definition of dose and areas exposed to x-rays) and for radiologist
- Loss of information 3D -> 2D

Computed Tomography

Mac Cormac's idea: 2D reconstruction from 1D Projections



Computed Tomography

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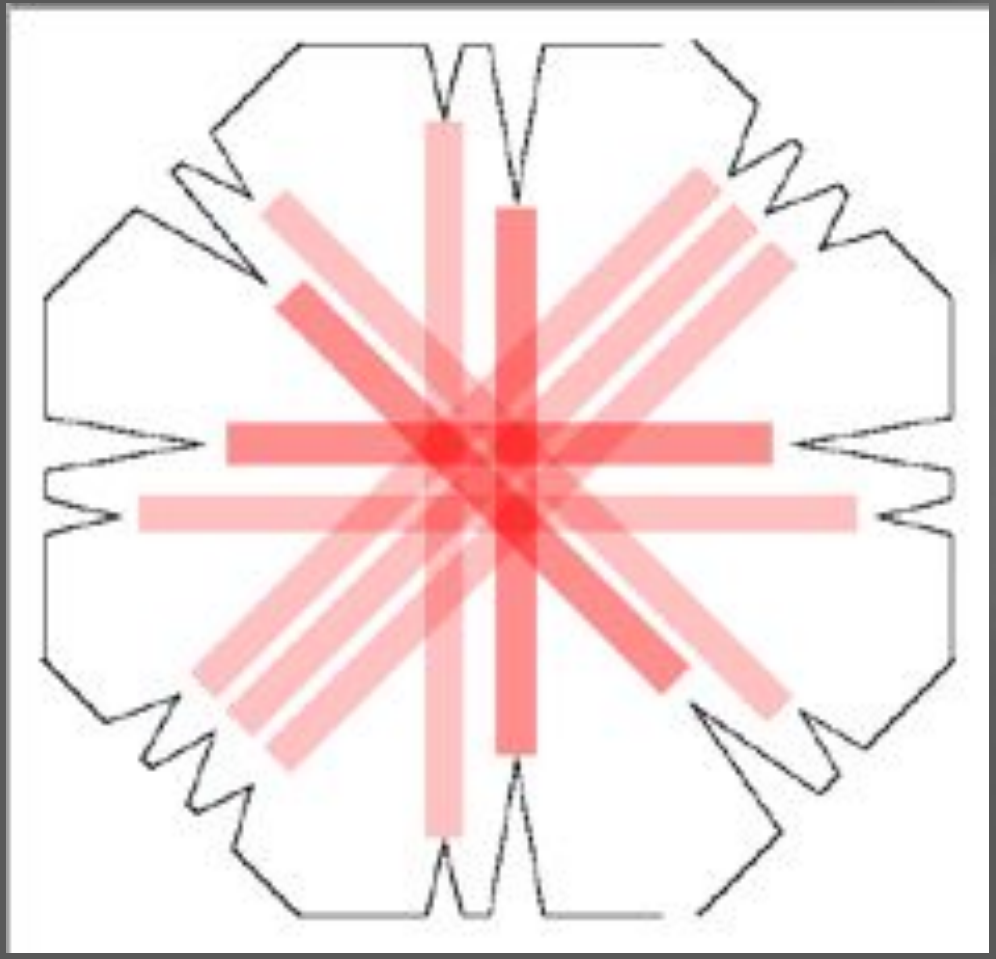
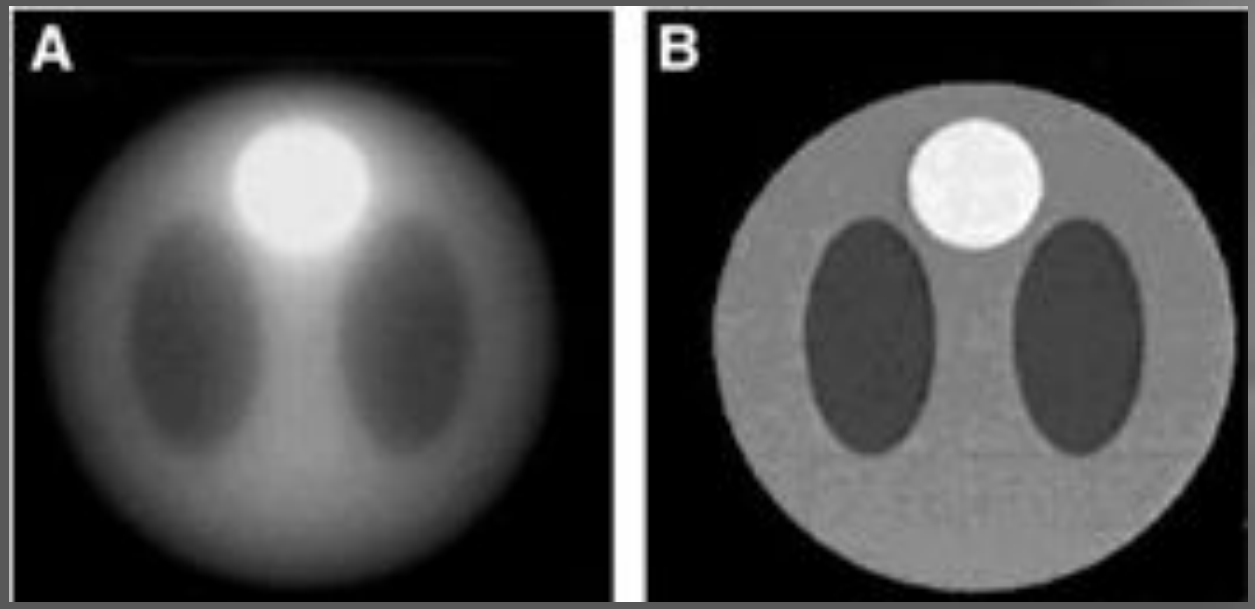


Computed Tomography

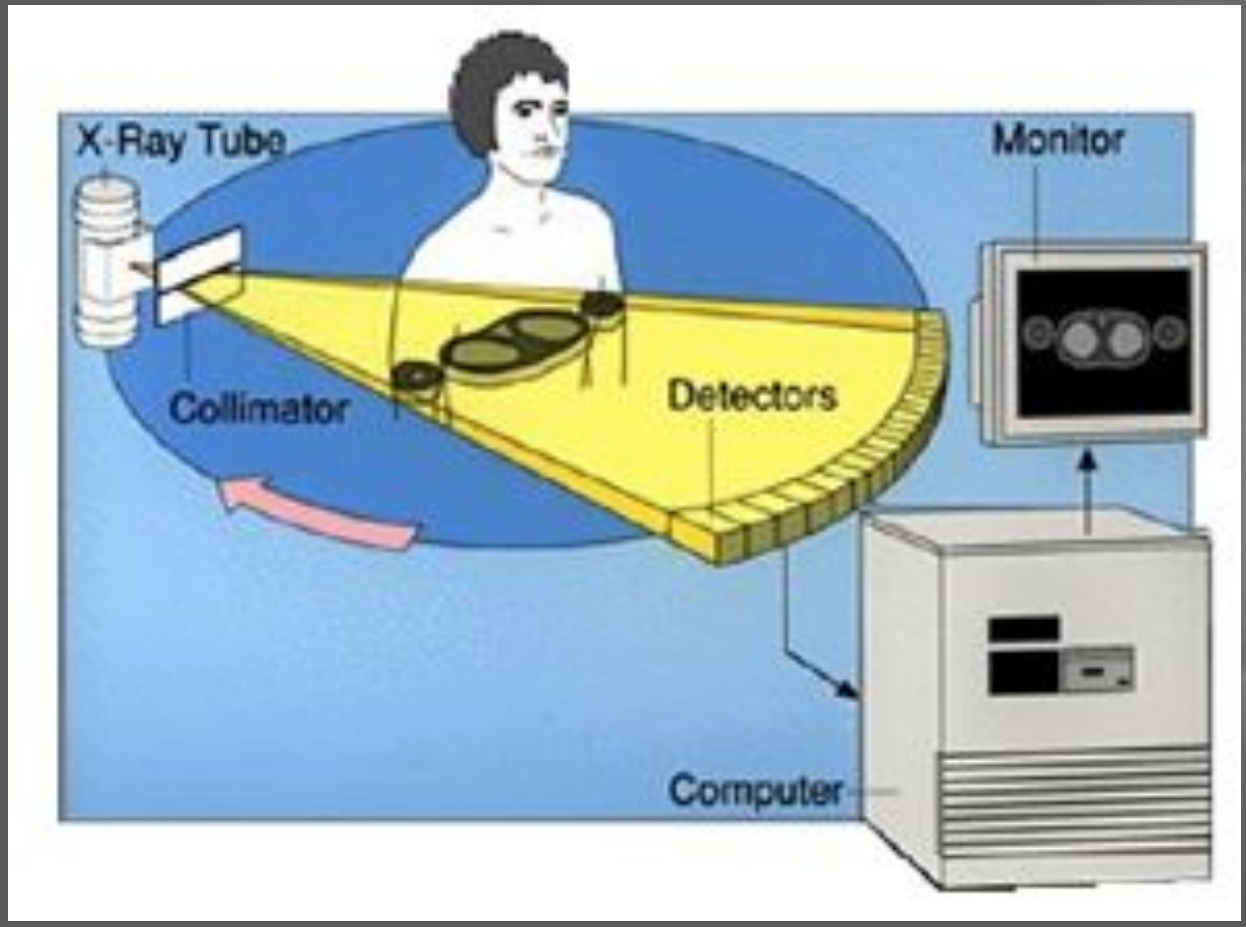
2D reconstruction from 1D projection

- ill-posed problem
- filtered back projection

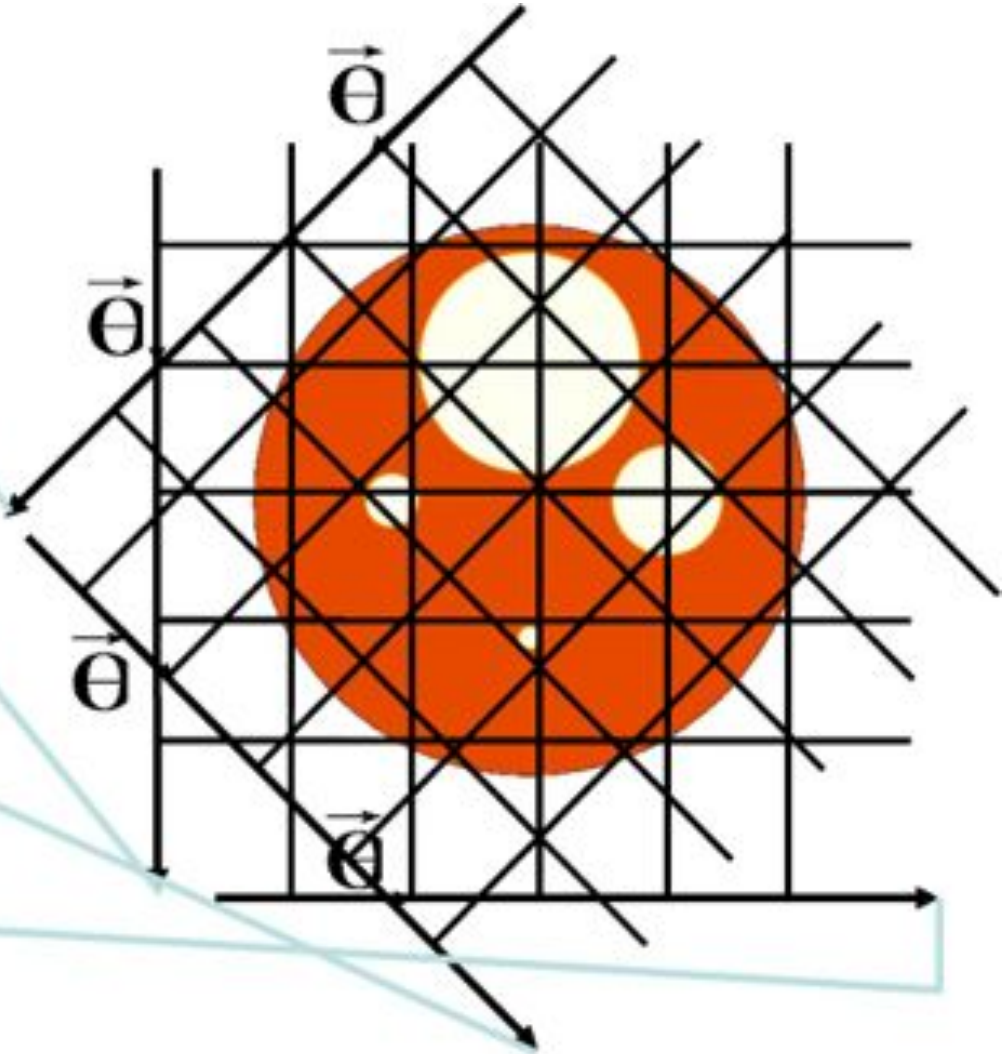


Computed Tomography

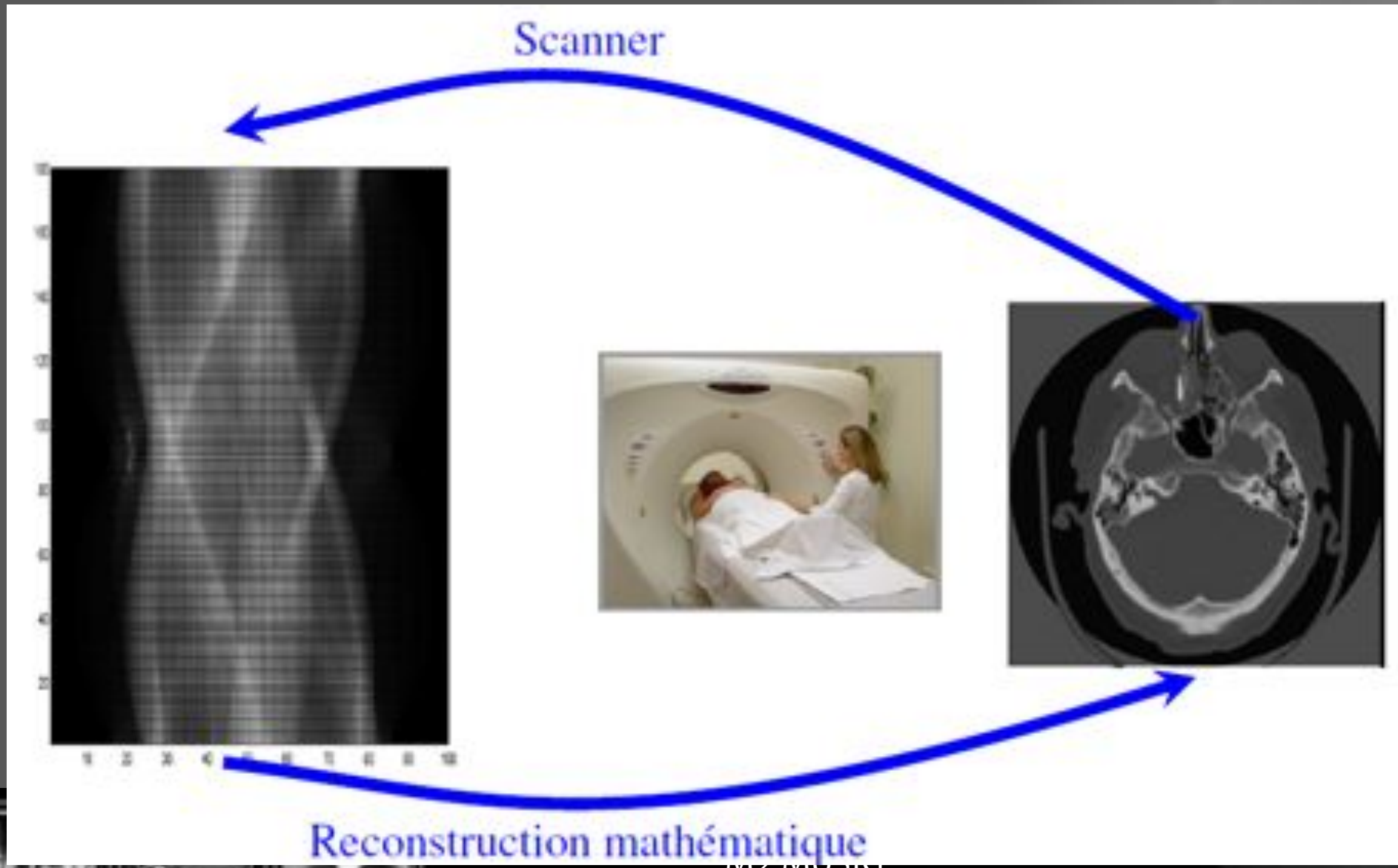
Principle



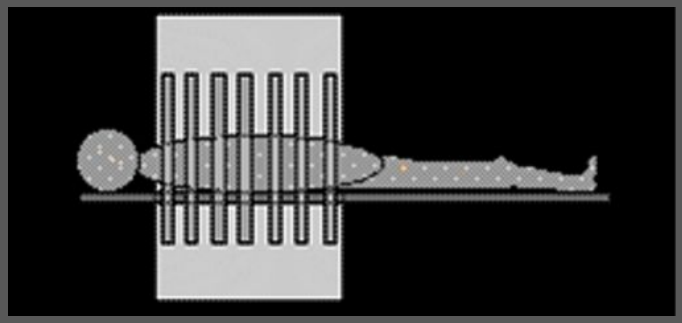
Computed Tomography

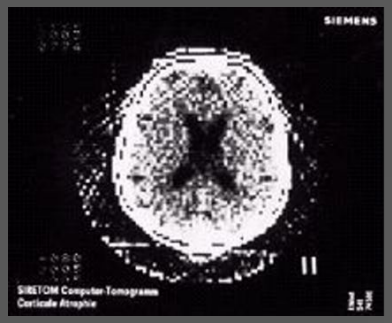


Computed Tomography

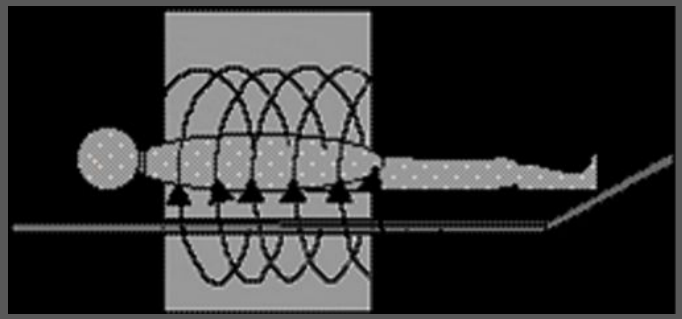


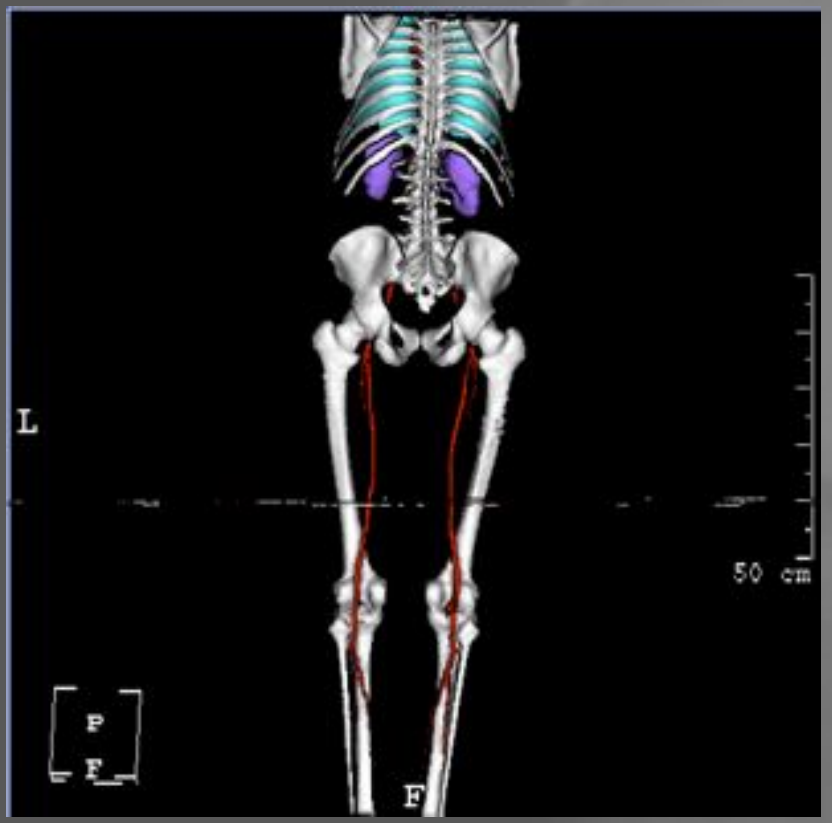
- 3D from 2D
  - 1971





  - late 80'



- Example

1 : right kidney
2 : kidney artery
3 : aorta
4 : left kidney