Tomography

Acquisition and Reconstruction principles

(Pascal Desbarats)
pascal.desbarats@labri.fr

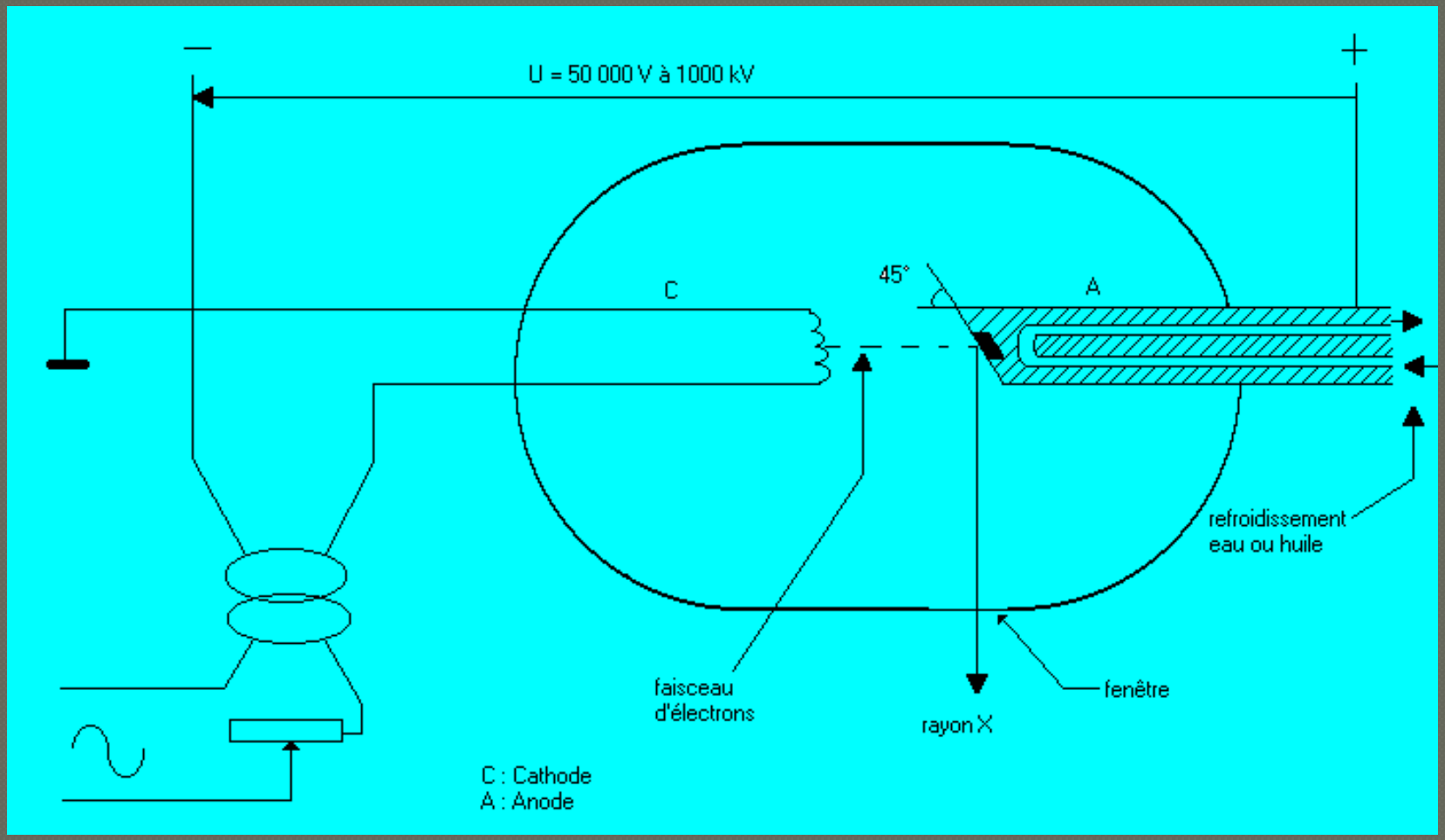
Summary

- X-Ray Tomography (CT and μCT scan)
- Reconstruction methods
- THz / PET / SPECT / Proton Imagery

X-Ray - questions

- How can we produce X-Rays ?
- Link between X-Ray frequencies and contrasts ?
- Can we « stop » a X-Ray ? What are the consequences ?
- How to evaluate X-Ray intensities in the receptors ?

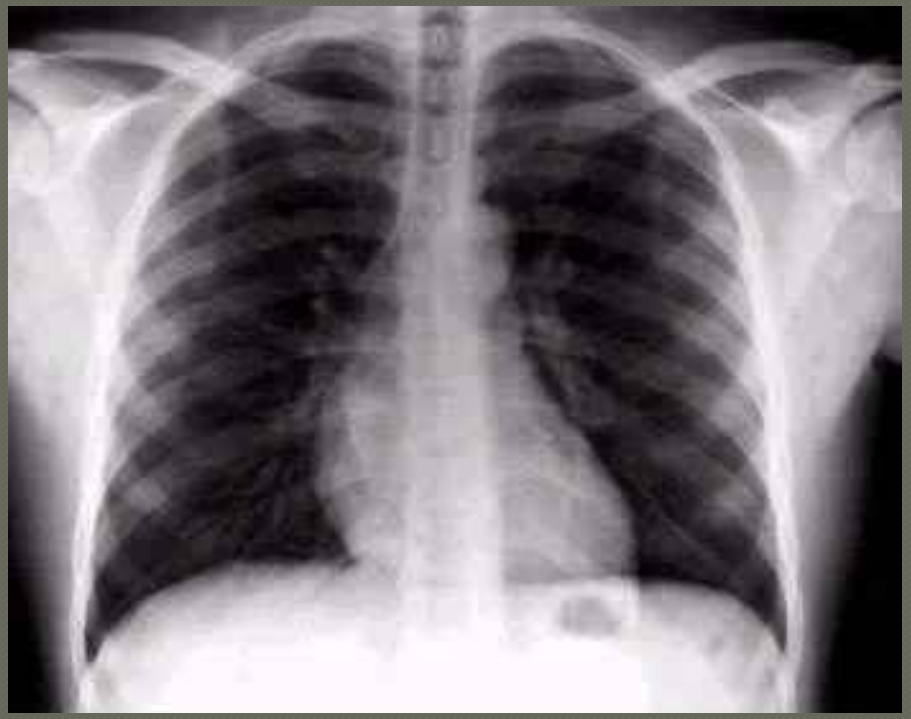
Radiography principles- 1
X-Ray emission



Radiography principles – 2 Acquisition setup

- The object is placed between the source and the receptor (photograph, screen or digital grid)
- Problem of orientation
- Problems of image deformation (higher in the corners of the image)
- Radiation dose

Examples



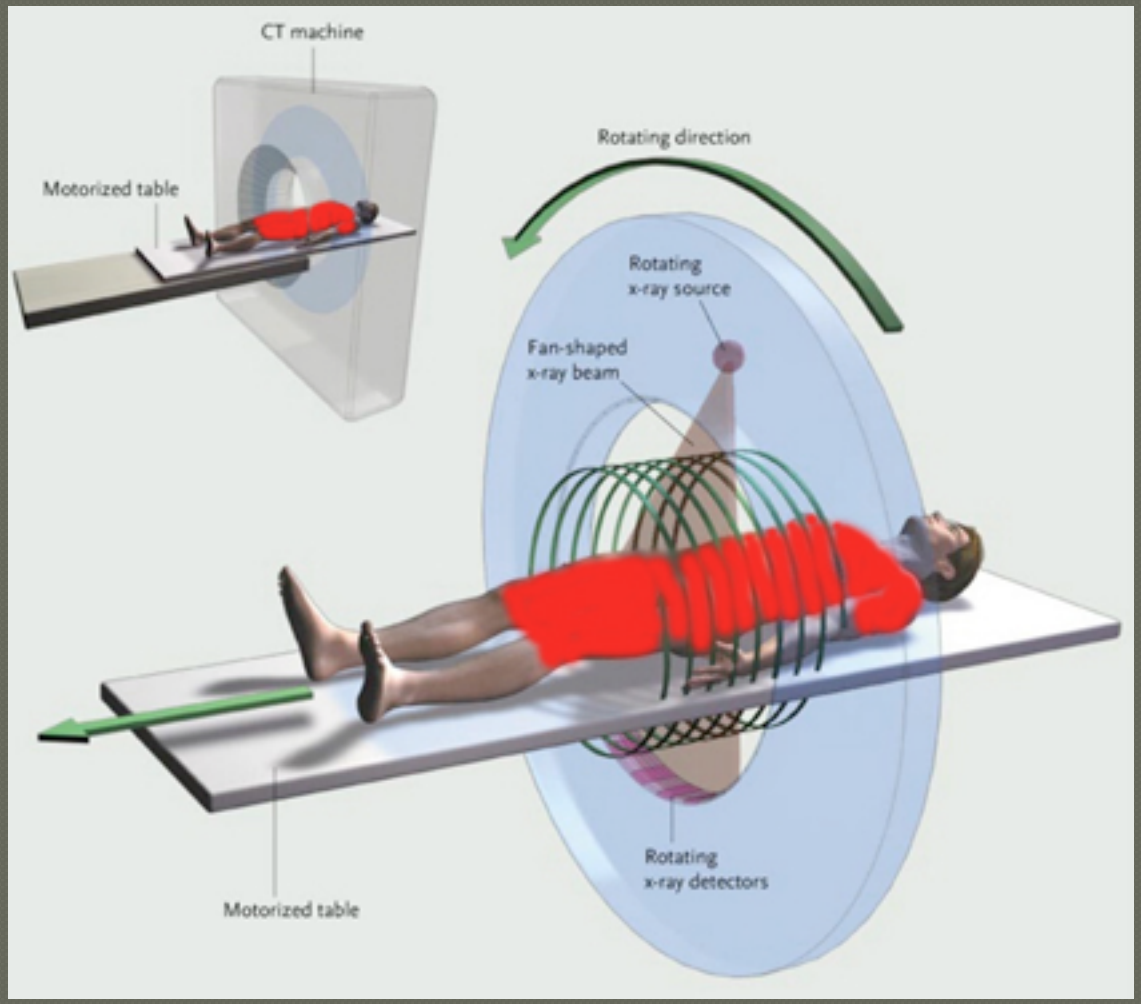
CT Scan - questions

- How to go from a radiography to a 3D image ?
- How can we minimize the radiation dose ?
- Image artefacts ?

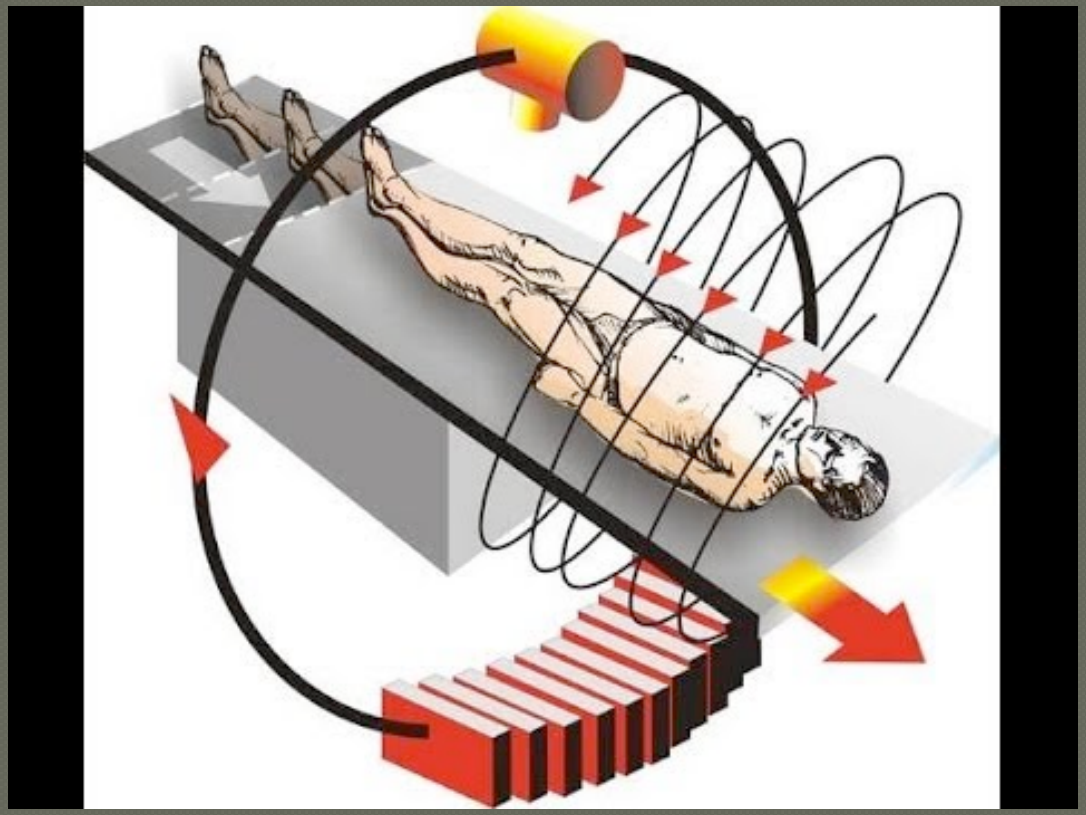
Two samplings

- Space sampling
- Intensity sampling (Hounsfield Units vs Graylevels)

Acquisition - principle

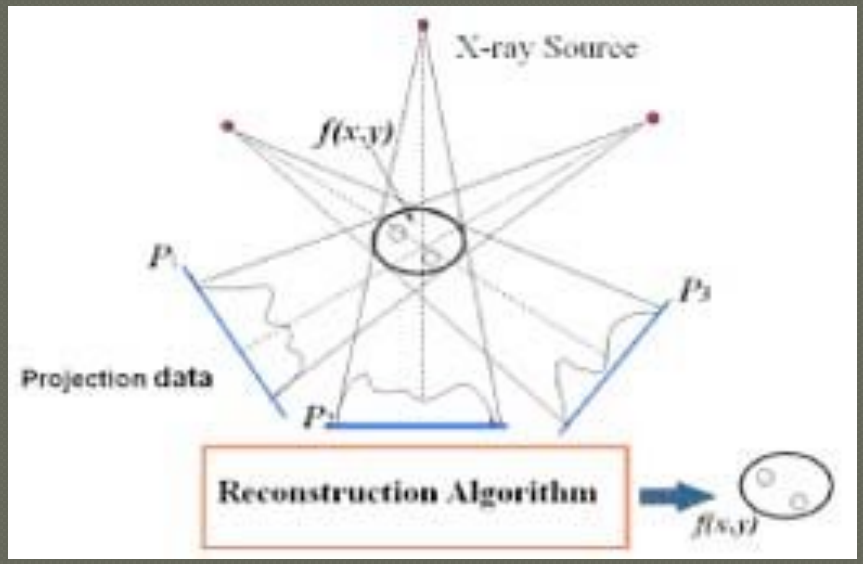


Slice-by-slice / spiral acquisition



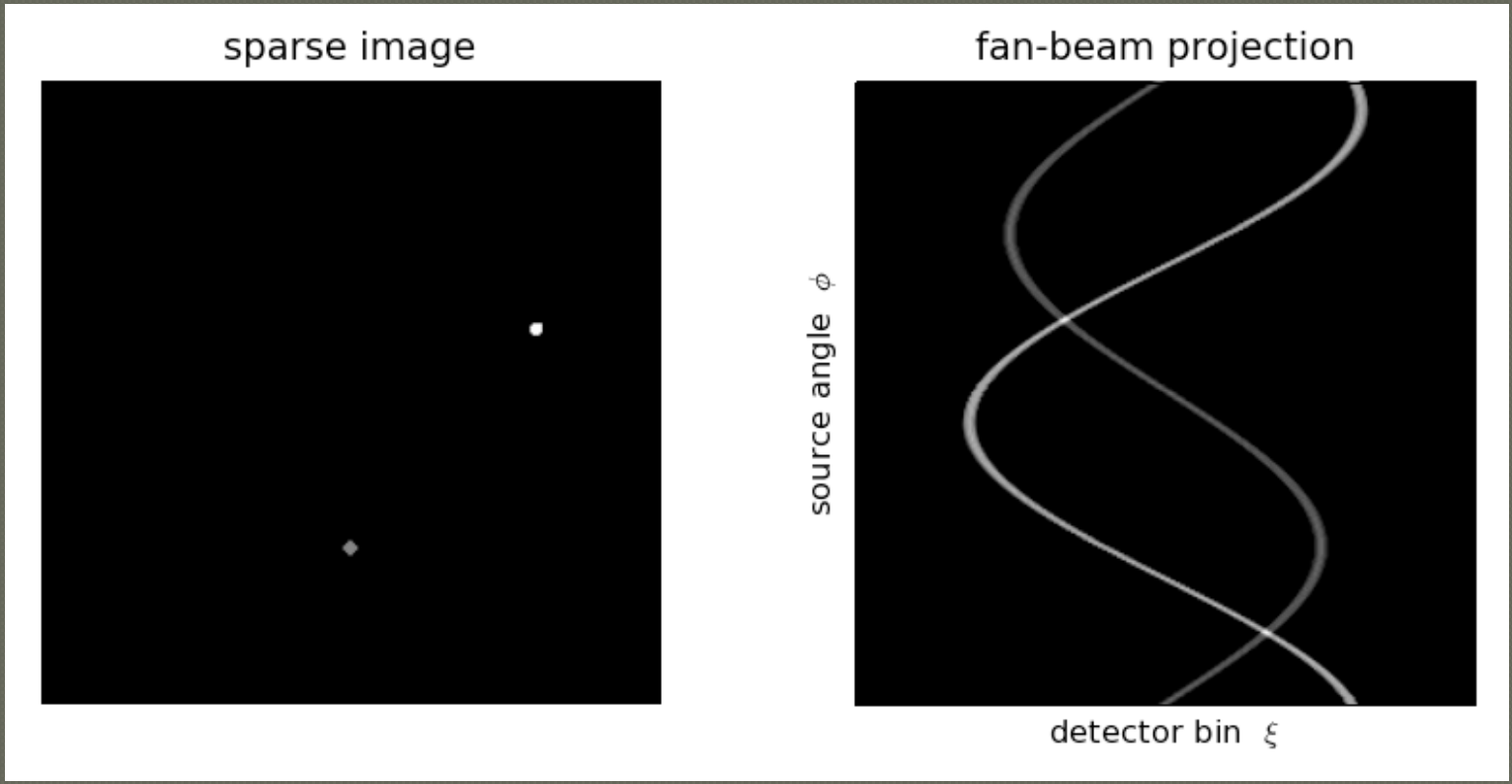
+ multi-detector (minimize motion blur, increase the acquisition speed)

Reconstruction - principle

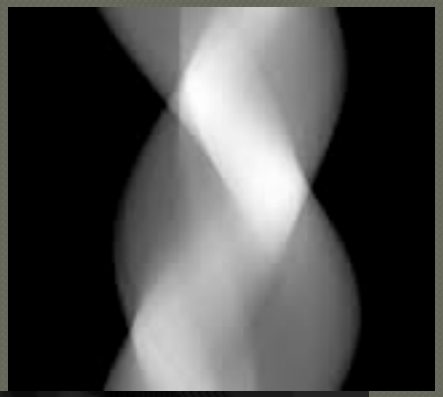


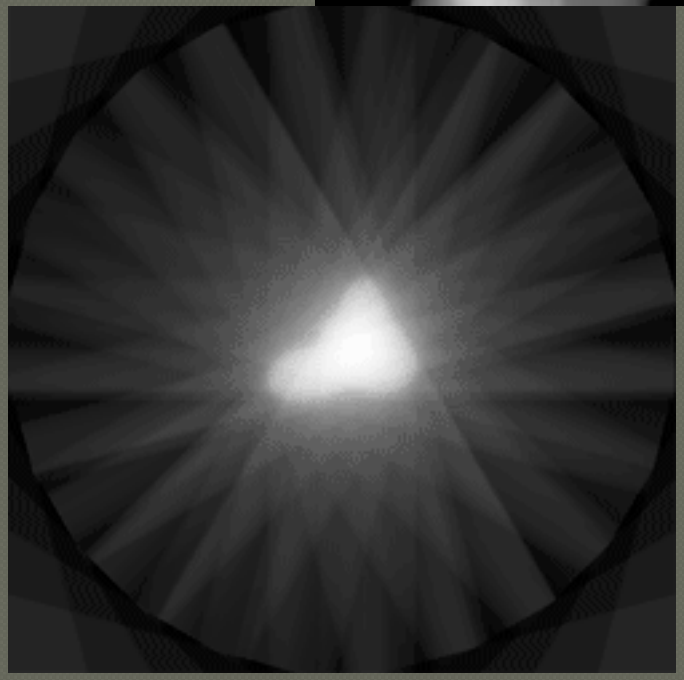
- Projections = attenuation of the X-Ray through the object
- Sinogram = image in which each line is a projection

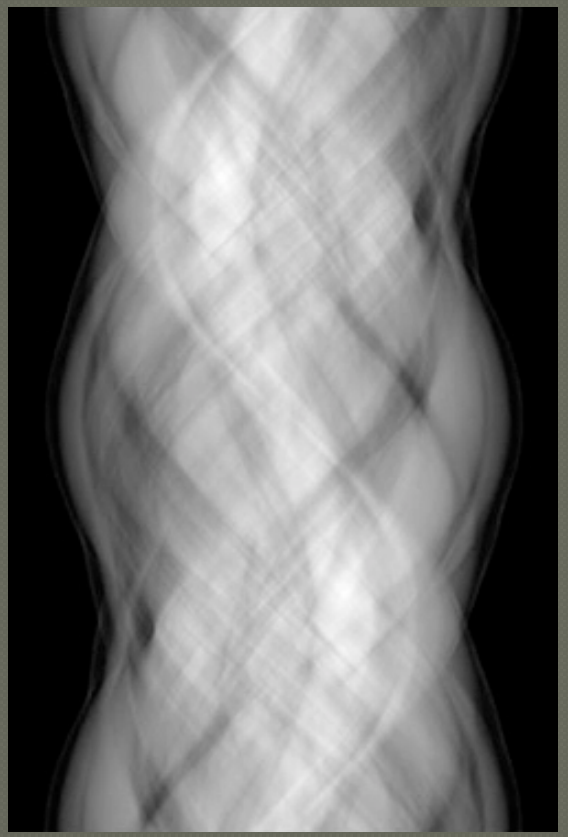
Sinogram - principle



Sinogram - examples







Reconstruction method

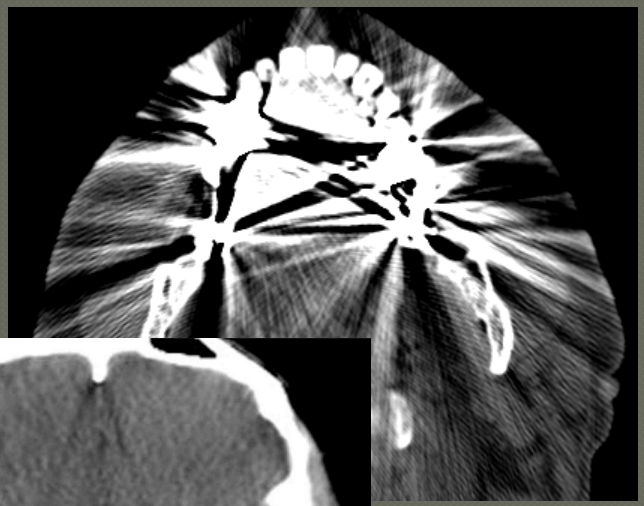
- Easiest – Radon method
  - Problems :
    - Continuous function
    - Discretization problem
- Most used – FBP (Filtered Back Projection)
  - Fast
  - Blurry (increase in low frequencies)
    - Needs to be filtered (ramp filter)
    - Problems with quantitative imaging

Other methods

- Iterative methods
  - ART (Algebric Reconstruction Technique) family of methods : SART, …
    - Slower than FBP (iteration process)
    - Problem of convergence
    - Better results -> used in CND for industry
- Statistical methods
  - MLEM family
    - Can work with sparse data (less angles for example)
- Discrete methods
  - Discrete Radon
  - Mojette

Artefacts

- Metal
- Beam Hardening
- Windmill Effect



Other tomography imagery methods

- μCT
- SPECT
- PET
- THz
- ⓘ different from tomosynthesis