Before the Era of CT……..

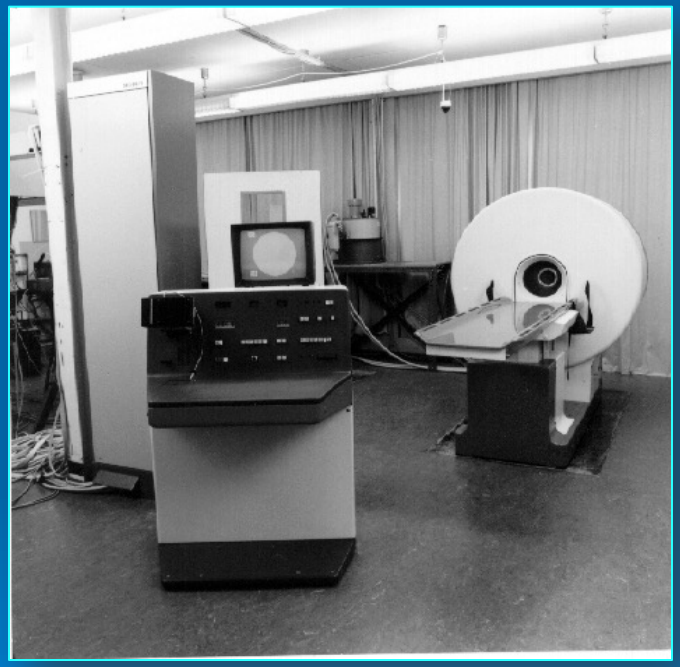
What is wrong with this image?

- Structures are superimposed
- Cannot differentiate subtle tissue densities

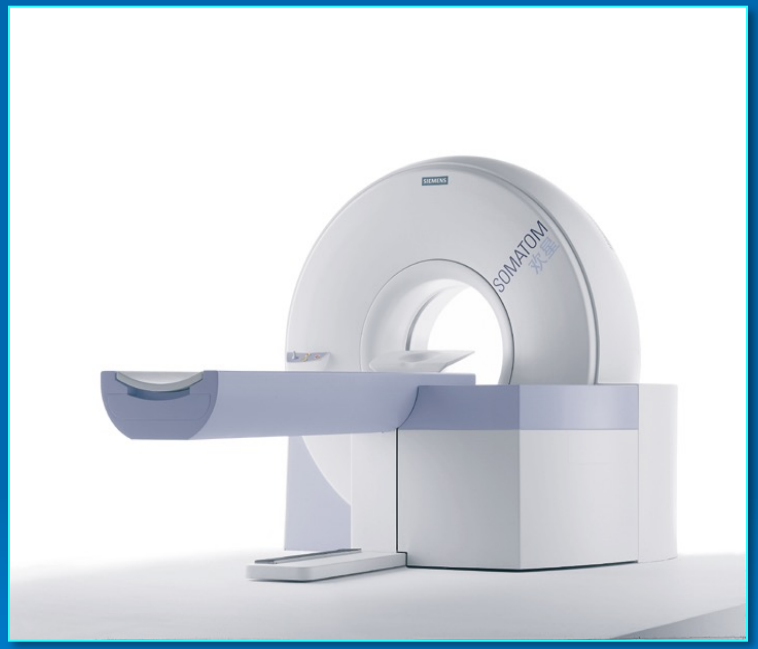
What is CT?

- Cross-sectional imaging technique
- Uses ionizing radiation - x-rays
  - ✓ Potential risk
- Image reconstruction with a computer
- “Slice” image - tomographic anatomy
- Density differentiation - grayscale image
  - ✓ Quantitative information

A look to the systems



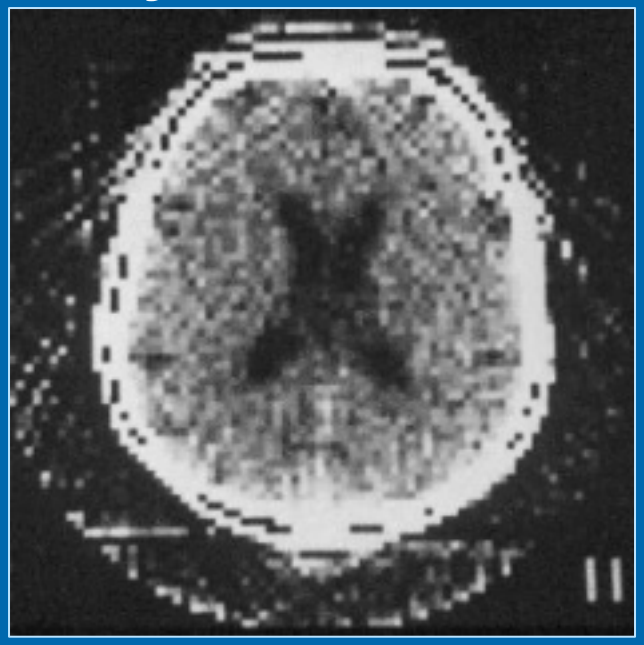
1974



2000

CT images

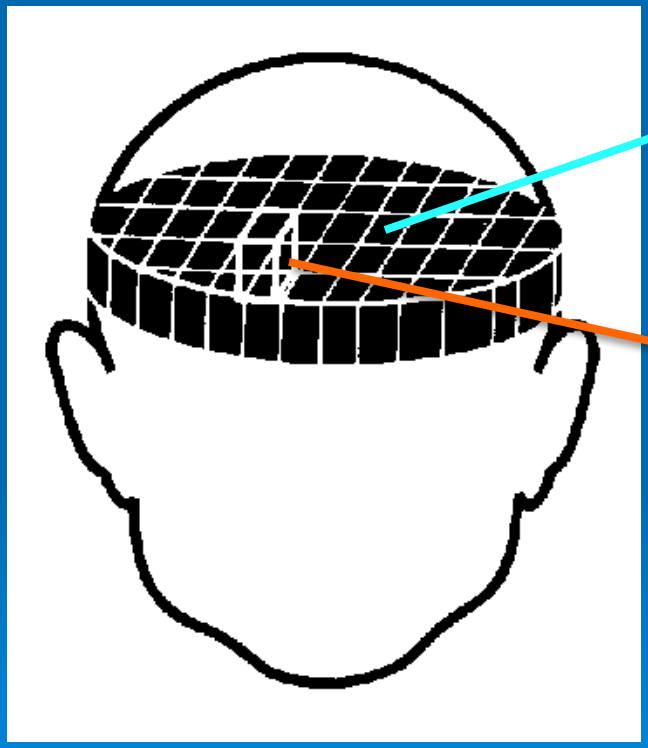
Early 1970



CT allowed for the first time to view inside the human body without doing an autopsy

- ✓ **Slice** or X-sectional image
- ✓ Tissue densities can be easily differentiated
- ✓ The density values are measured in **H.U. units** & give an indication of the tissue type

What is a matrix, pixel or a voxel?



Pixel
Smallest *Area* element
of the image

Voxel
Smallest *Volume*
element
of the sample, associated
to the pixel
Together, they formed a *matrix* for image display

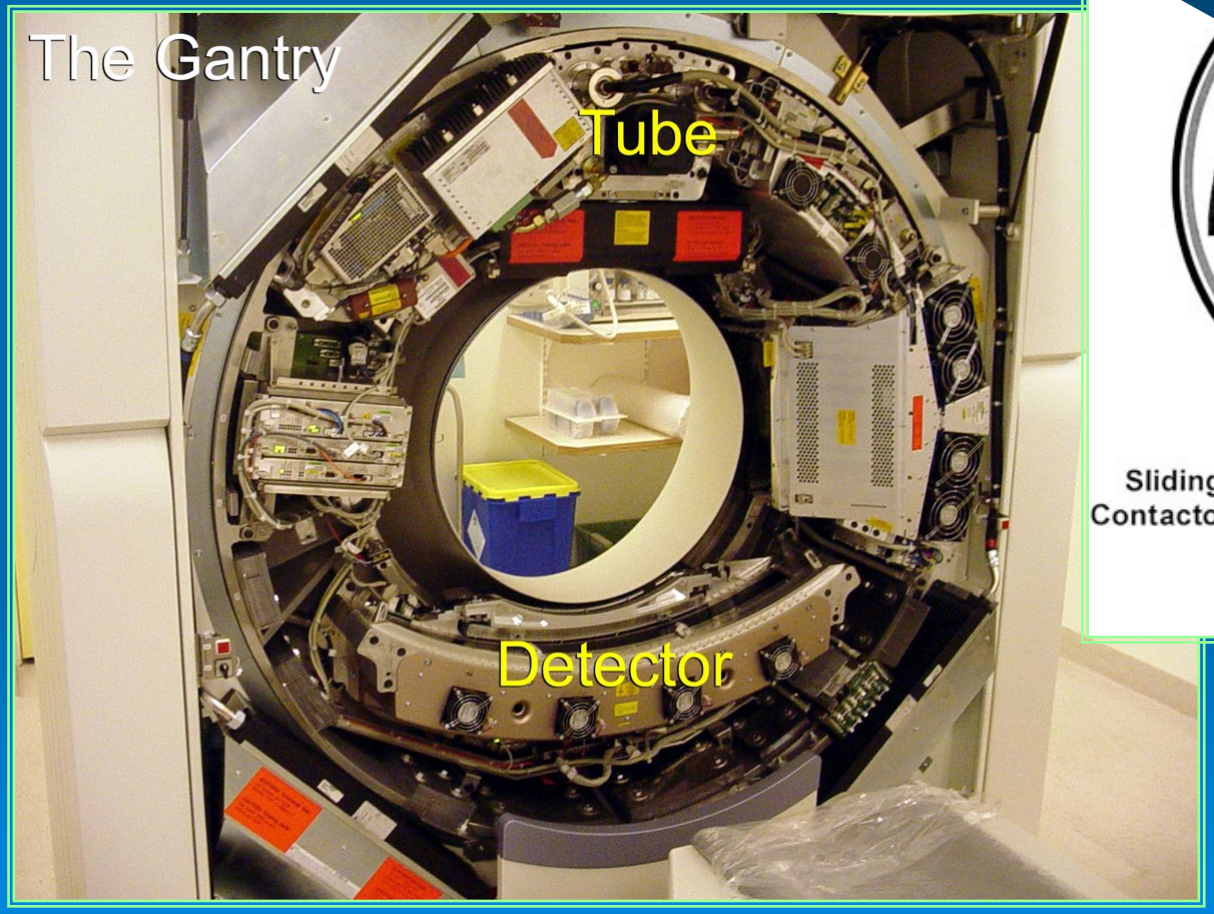
Who invented CT?

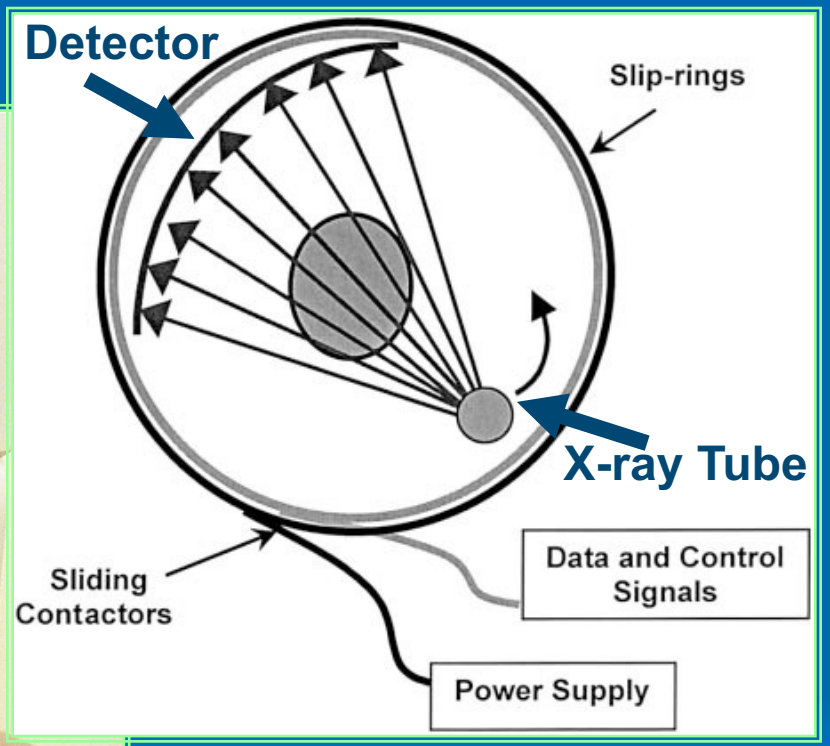
1963 - Alan Cormack developed a mathematical method of reconstructing images from x-ray projections

- *My name is Godfrey Hounsfield*
- *I work for the Central Research Labs. of EMI, Ltd in England*
- *I developed the the first clinically useful CT scanner in 1971*

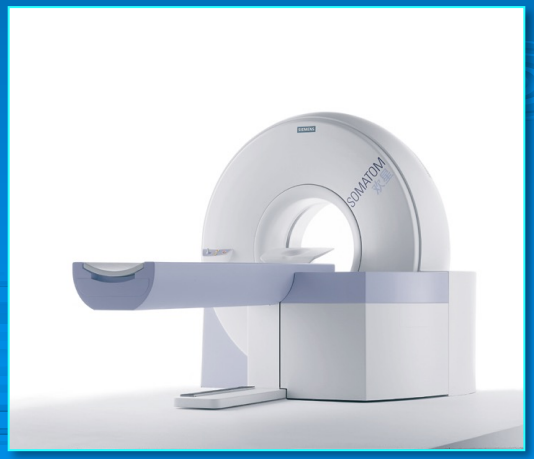
Hounsfield, an engineer, together with the physicist Cormack, received the Nobel Prize for Medicine and Physiology in 1979

The CT scanner

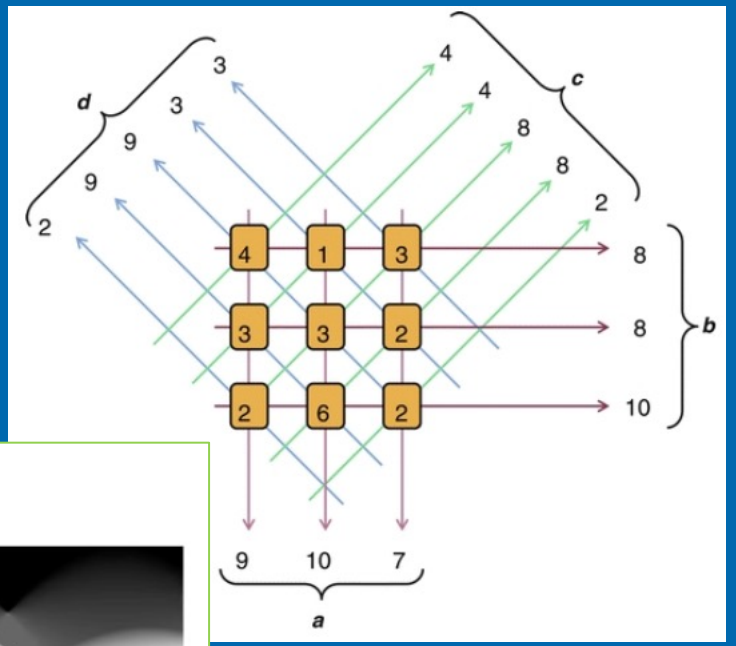


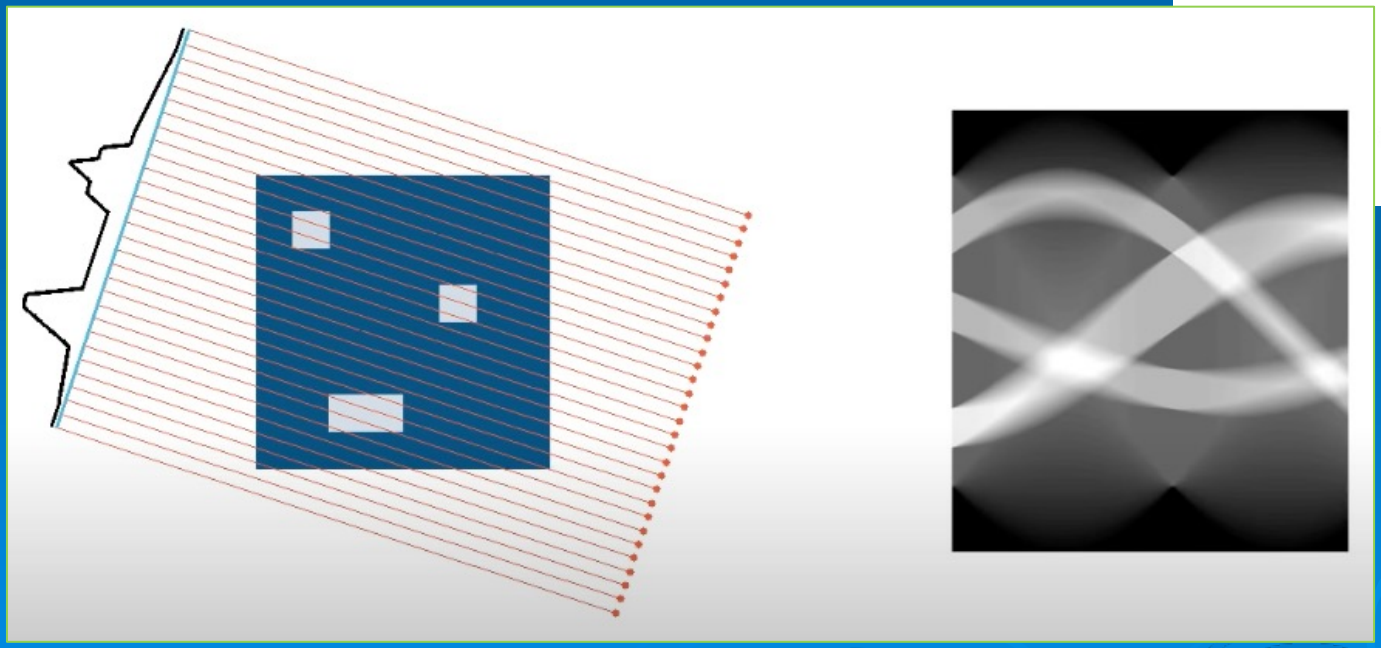


https://www.youtube.com/watch?v=8_QU2k4TnSk



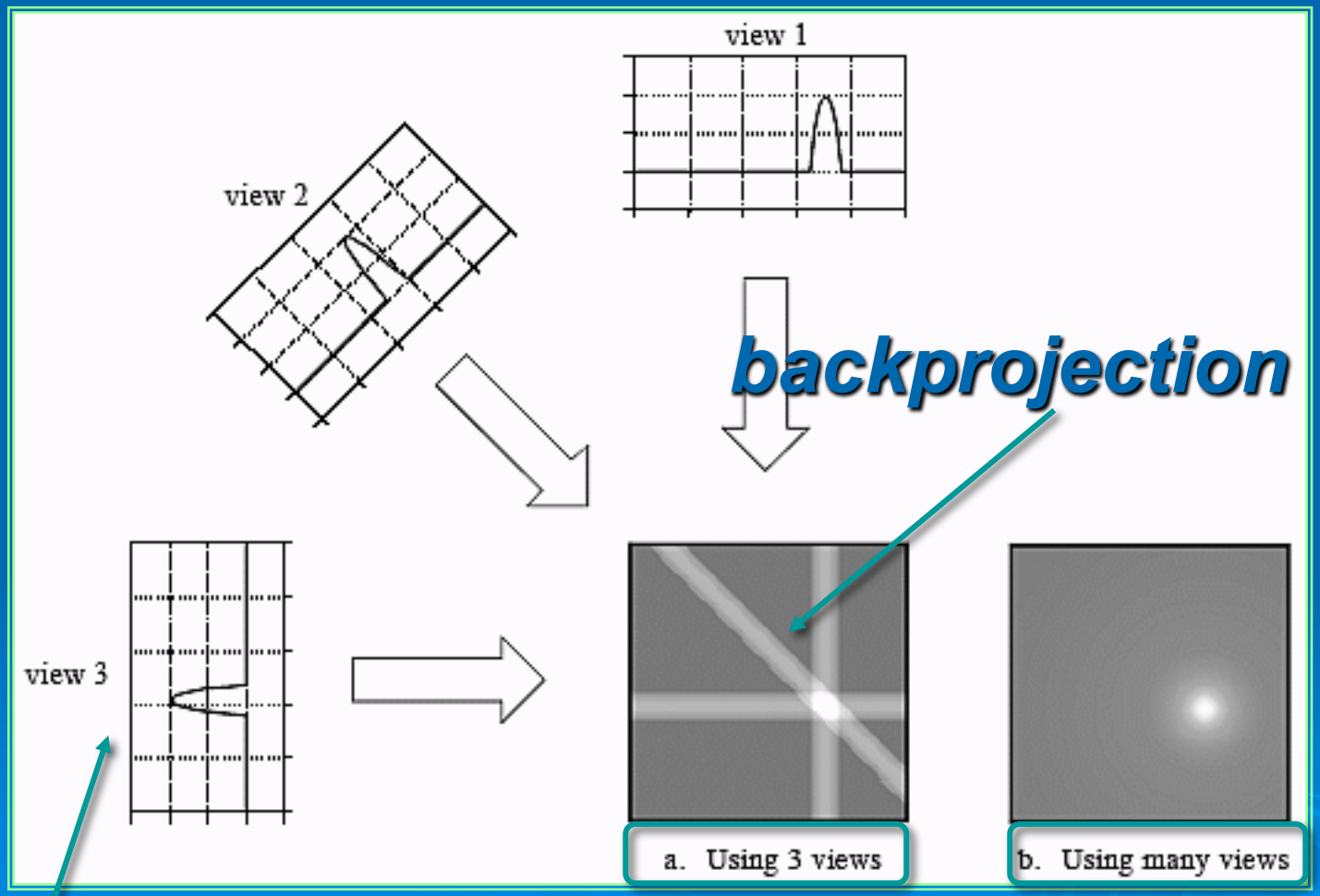
CT data acquisition





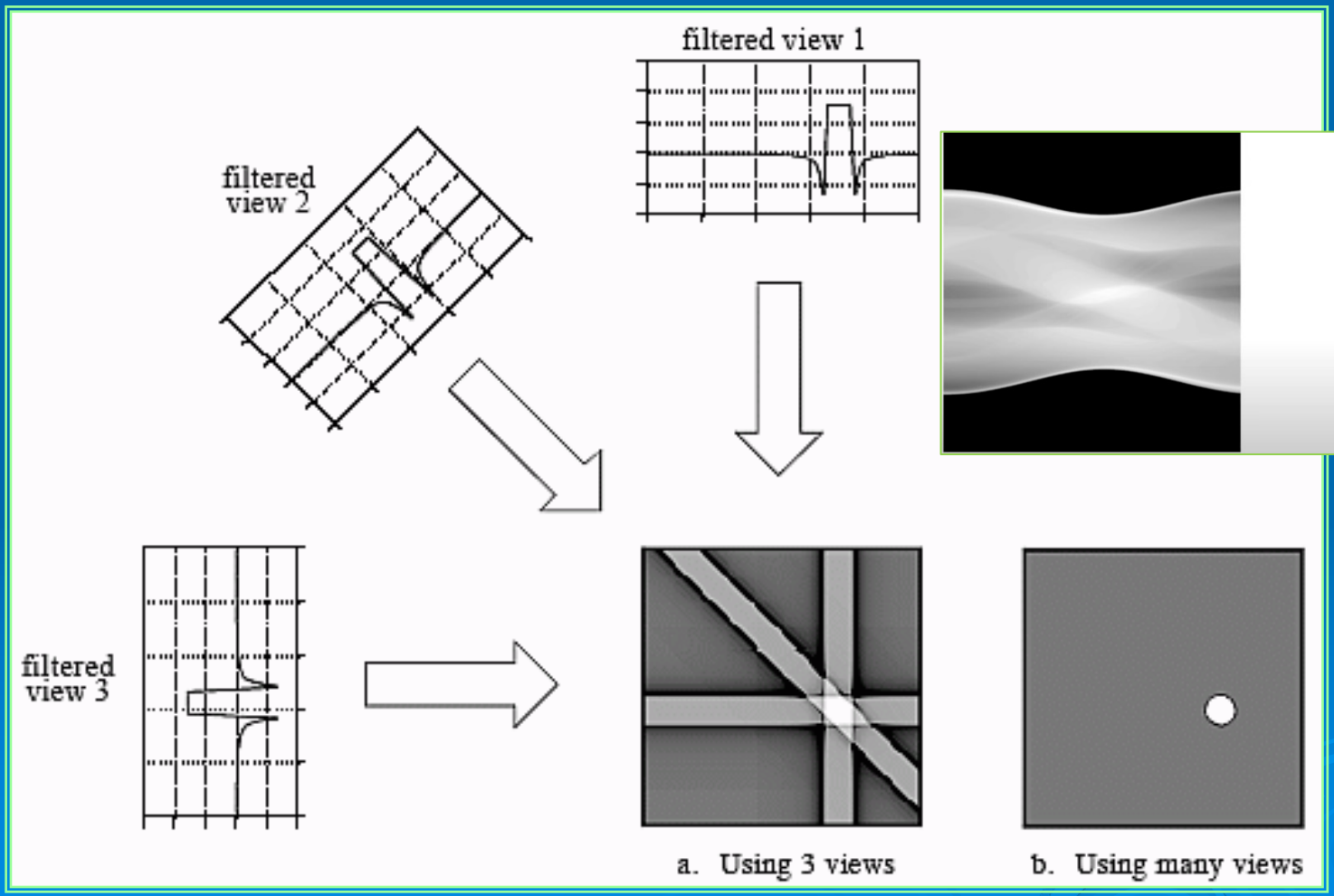
https://www.youtube.com/watch?v=8_QU2k4TnSk

simple backprojection



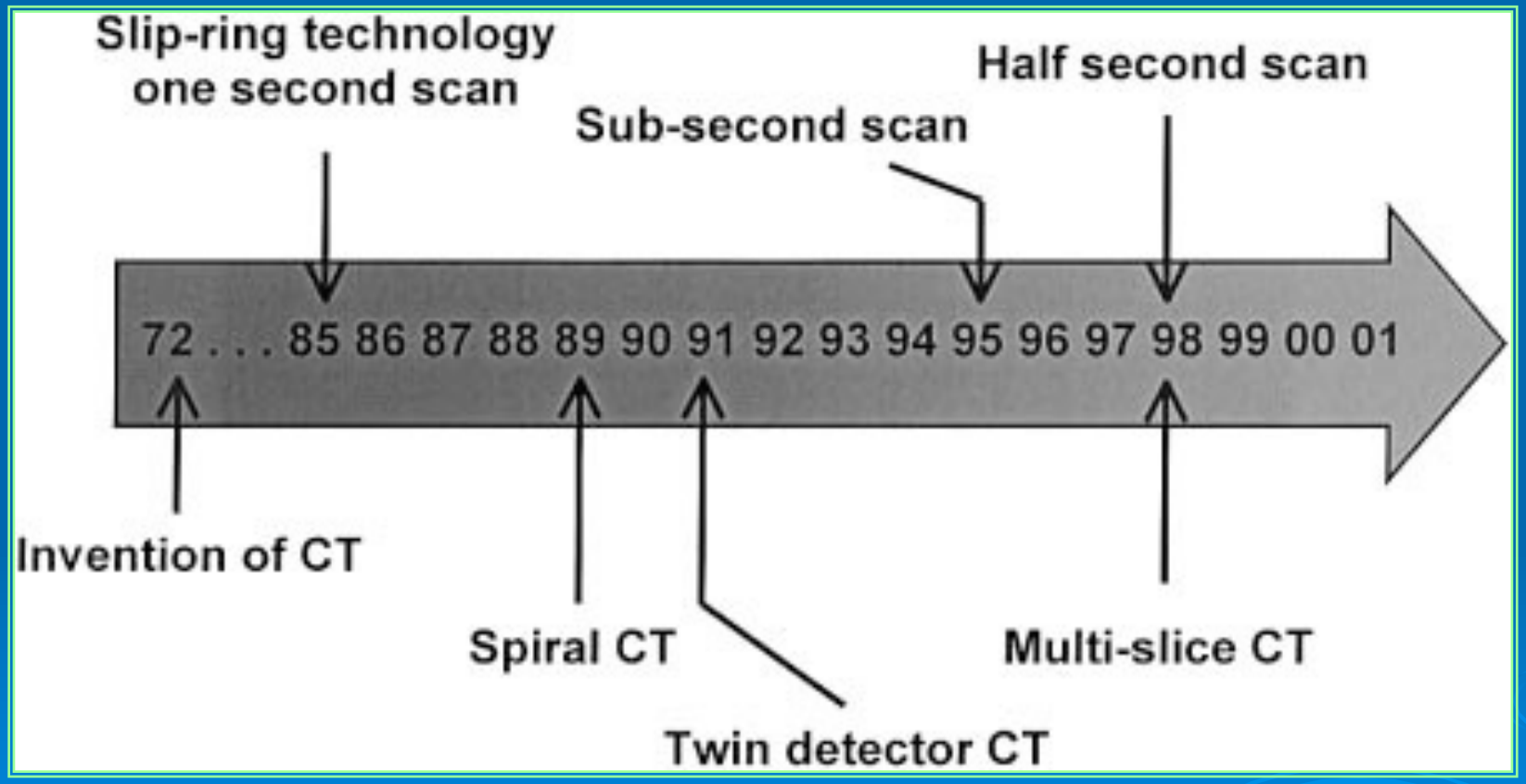
projections

the filtered backprojection

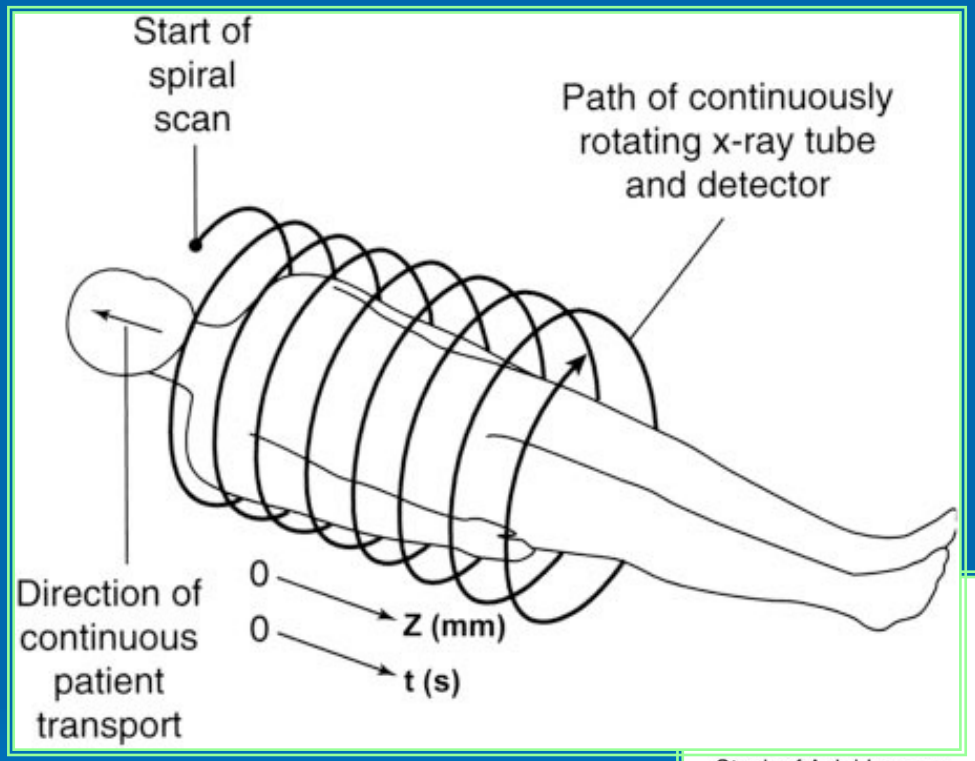


- https://www.youtube.com/watch?v=ddZeLNh9aac&t=0s

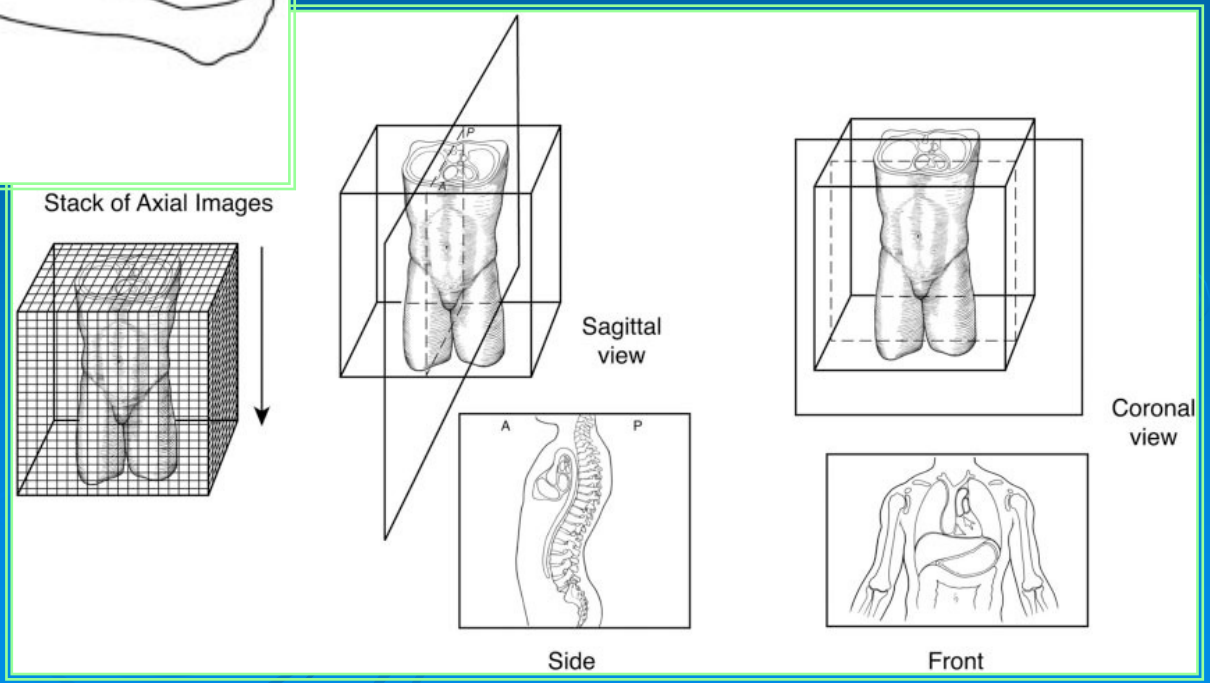
Image acquisition time



Spiral CT

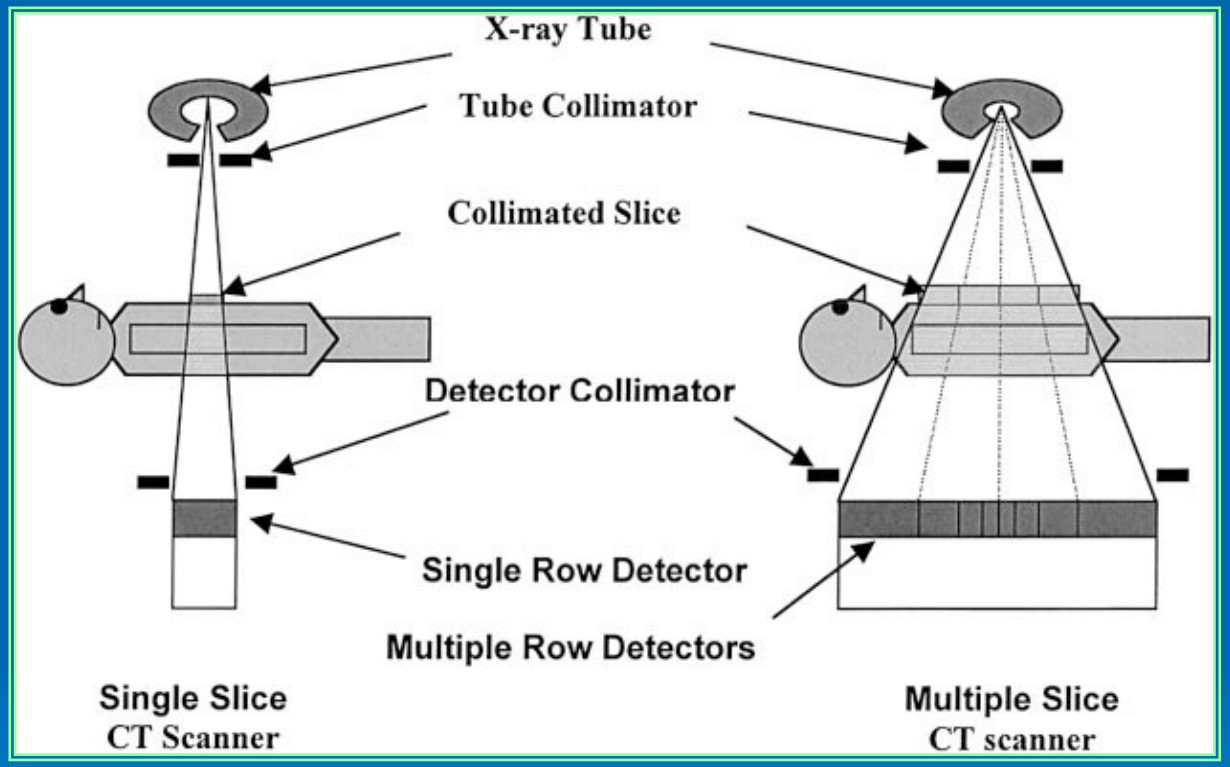


- High spatial resolution
- Isotropic voxel
  - High quality reconstruction in all orientations



Multiple slice CT scanner

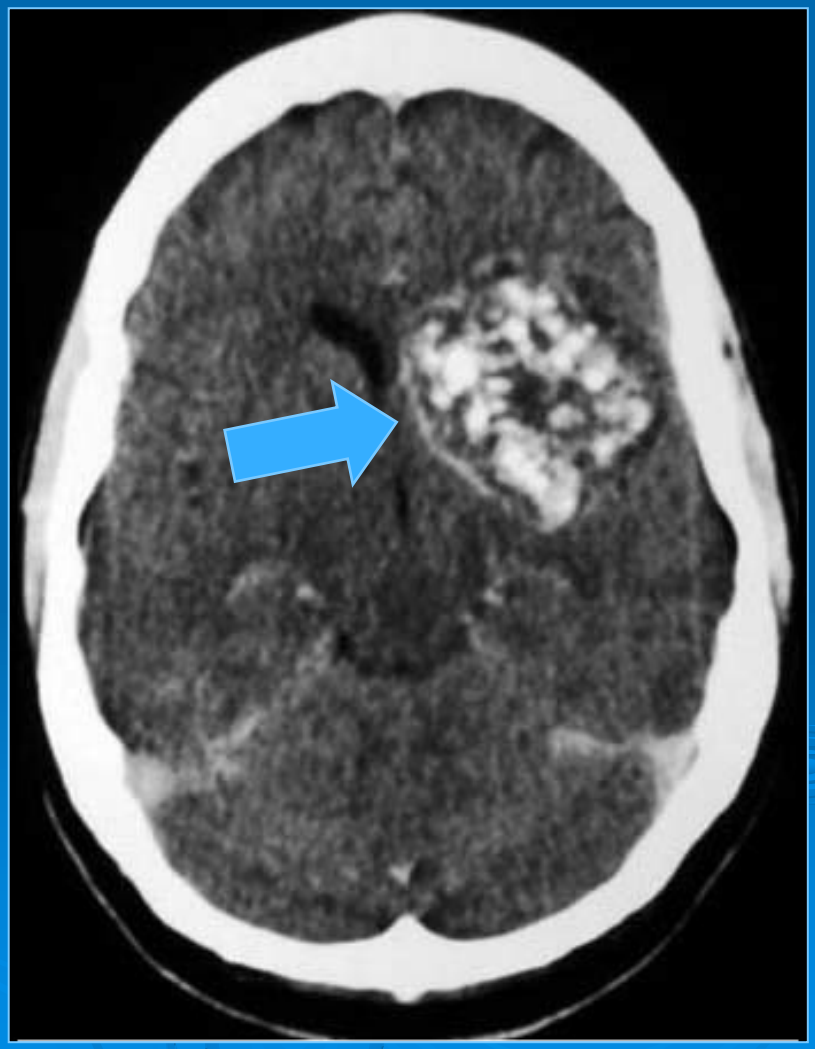
- Multiple slice in one tube rotation
- Short acquisition time



- High spatial resolution
- Isotropic voxel
  - High quality reconstruction in all orientations

Contrast agent

- Contrast agents are used to improve the visibility of internal structures
- Radiocontrast agents are typically iodine or barium compounds
  - 43-year-old woman with worsening left-sided headaches. Post-contrast CT scan shows left cavernous angioma

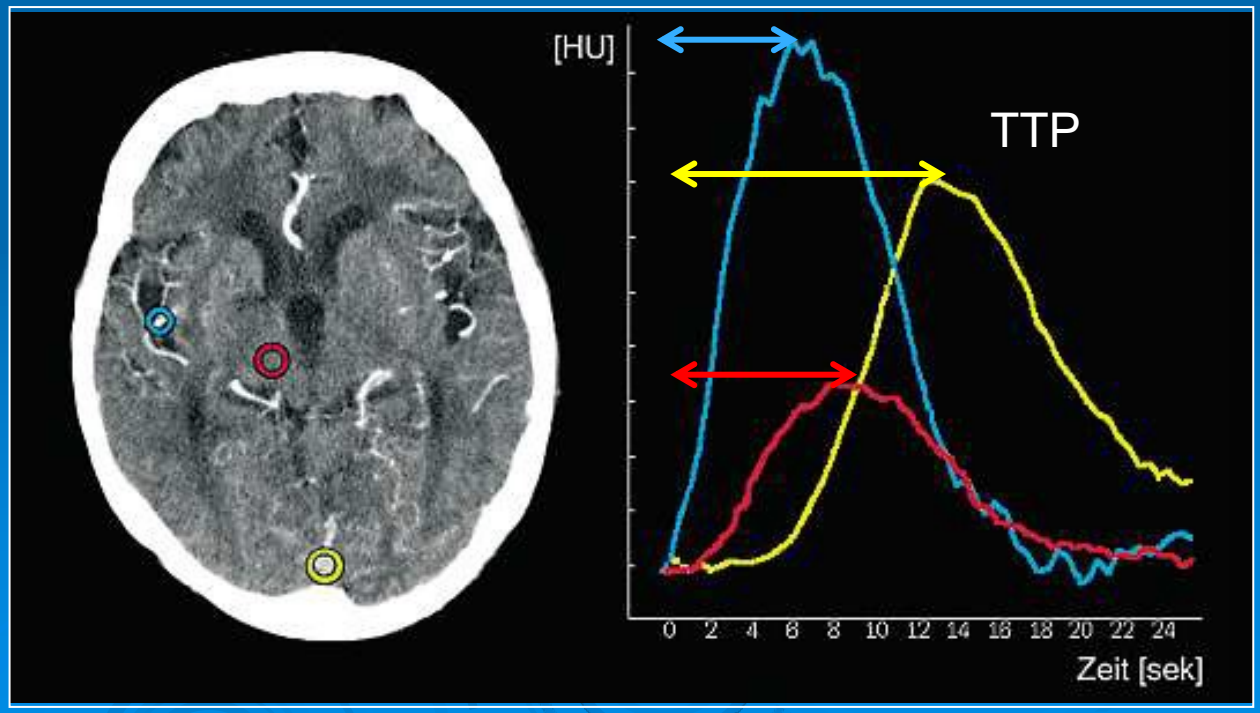


Perfusion CT

- A short intravenous contrast medium bolus is given during which several CT slices are acquired repeatedly at fixed time intervals.
- For instance, a scanning period of 45 seconds and an imaging frequency of 1 image/second.

Typical time/density curves after injection of a contrast mediumbolus in perfusion CT.

- arterial vessel
  - cerebral artery
- venous vessel
  - confluence of sinuses
- cerebral parenchyma
  - Thalamus
- TTP time to peak



M. Wiesmann

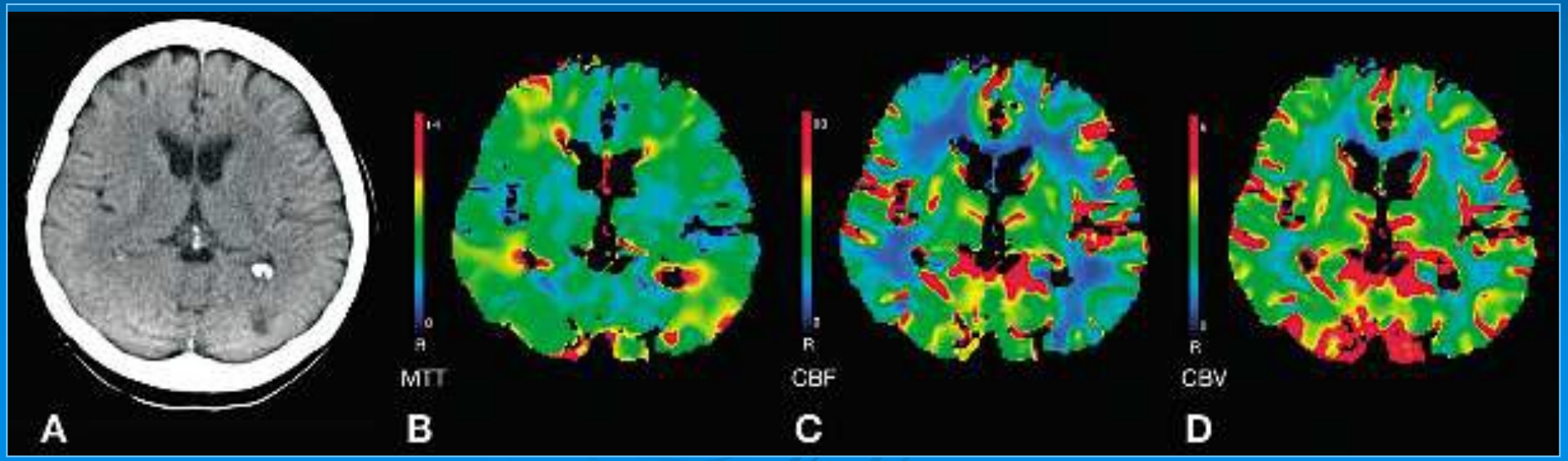
Perfusion CT

- Using various mathematical algorithms parameters denoting cerebral perfusion are calculated and represented in the form of color-coded parameter images.
- The most usual parameters are

  CBV cerebral blood volume

  CBF cerebral blood flow

  MTT mean transit time



CT angiography

- Volume-rendered reconstruction of the vessels detected by a specific algorithm according to their iodine content
- Note the complete removal of osseous structures from the dataset