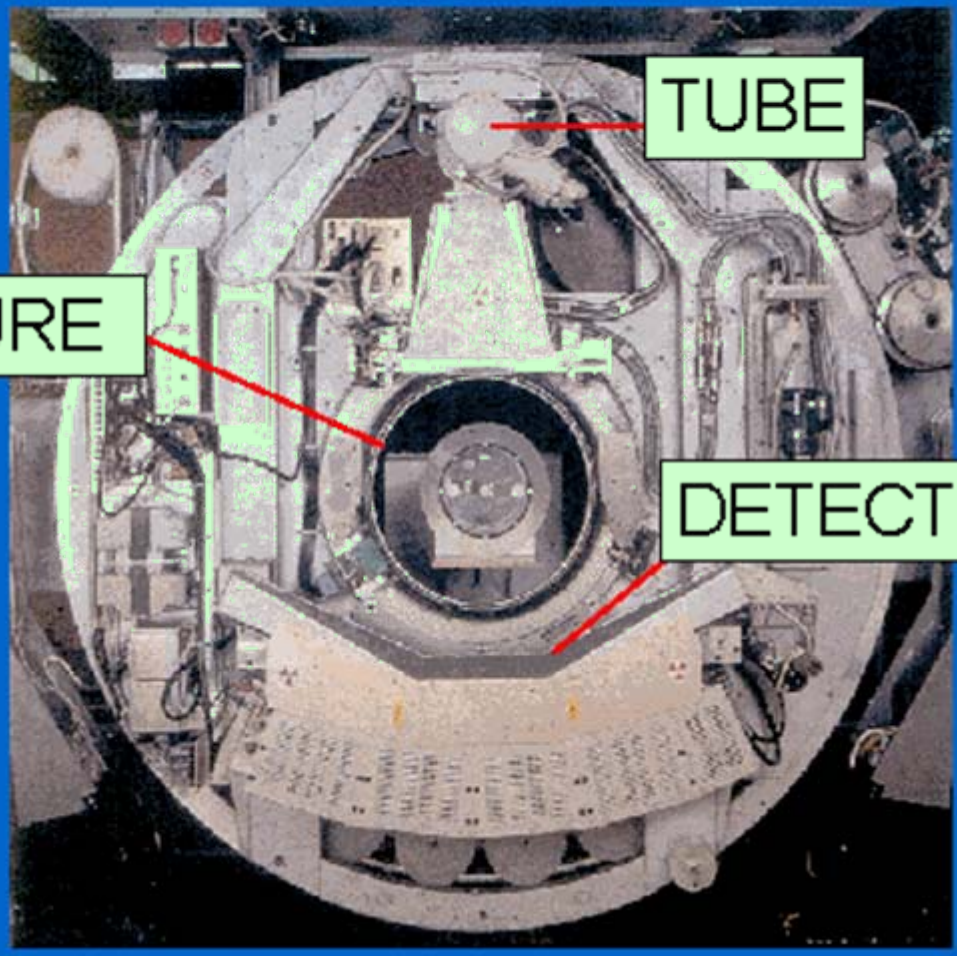
CT - suplement

http://www.impactscan.org/slides/xrayct/sld010.htm

In Practice



Principles of tomographic imaging

- Use series of 2D views of an object to calculate its shape in the 3rd dimension

Planar x-ray

Sinogram

Reconstructed image

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- Use series of 2D views of an object to calculate its shape in the 3rd dimension

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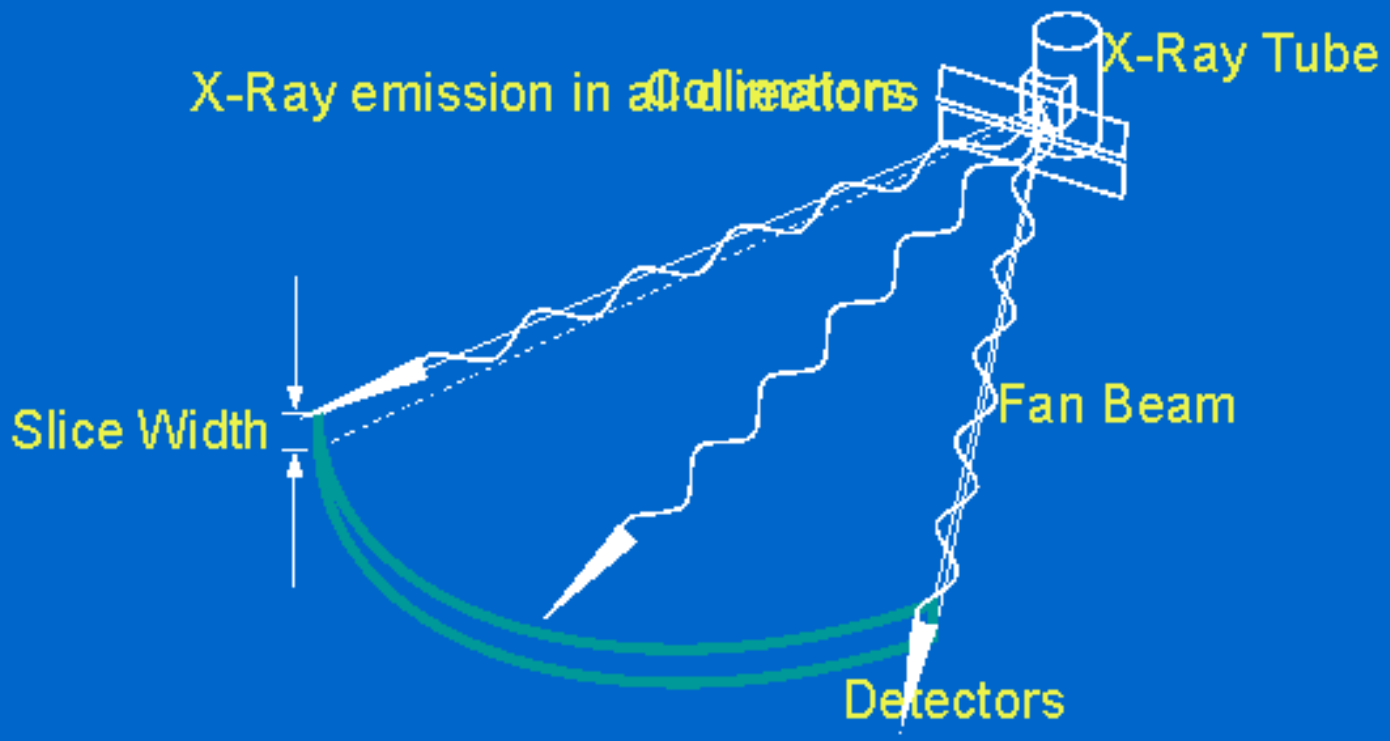
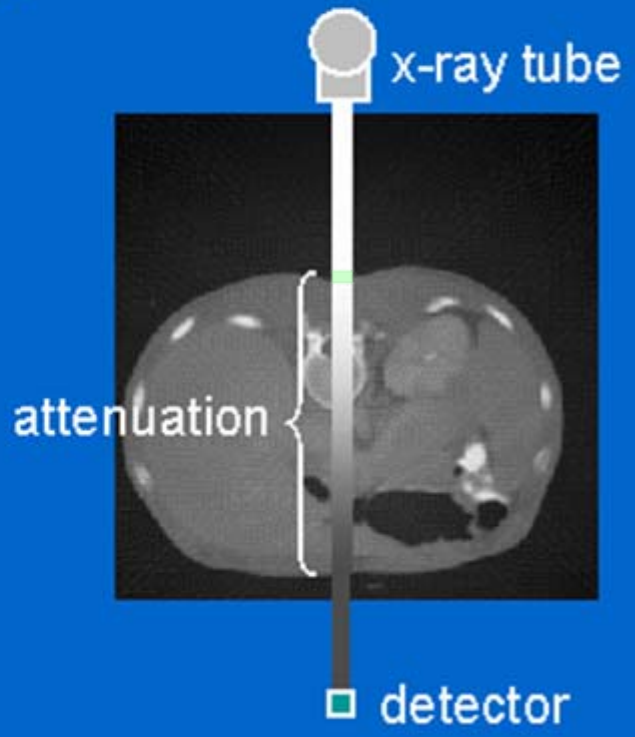
Data acquisition



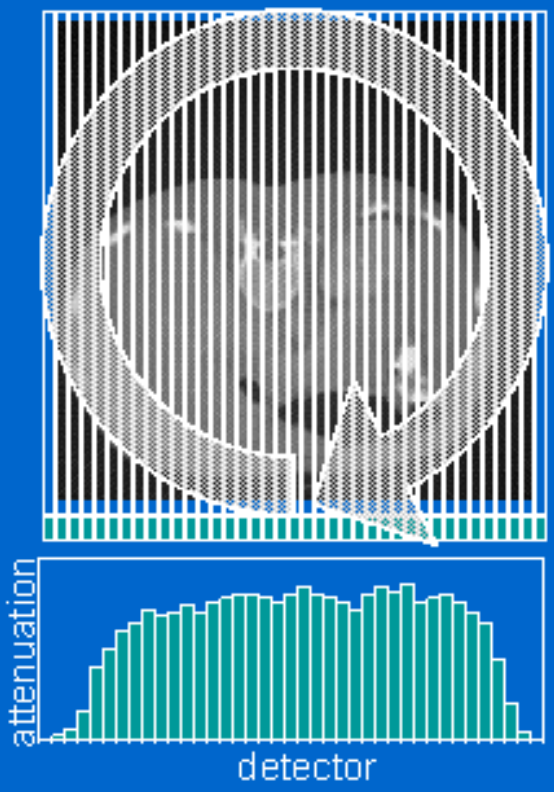
What are we measuring?

- Measuring linear attenuation coefficient, μ, between tube and detectors
- Attenuation coefficient is a measure of how rapidly x-rays are absorbed within material

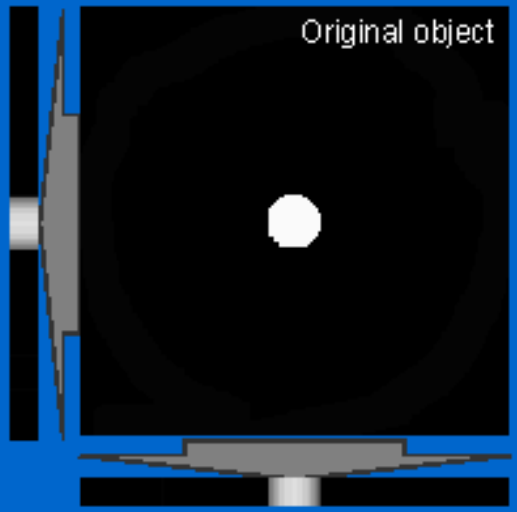


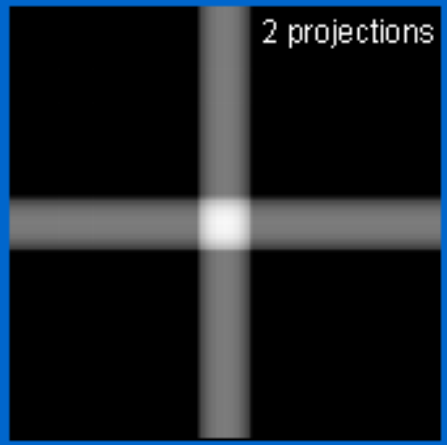
Projections

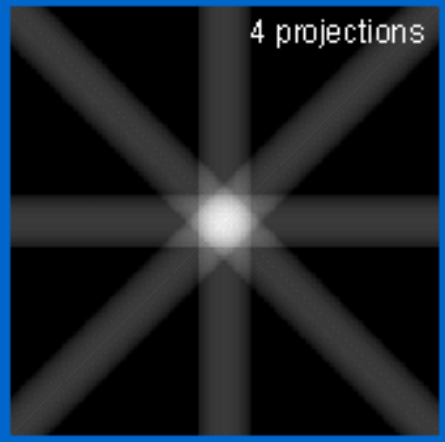
- 2D views - 'projections' at angles all the way round the patient
  - rotate tube and detectors around patient
  - sample μ at each detector for each rotation angle
  - generate series of projections

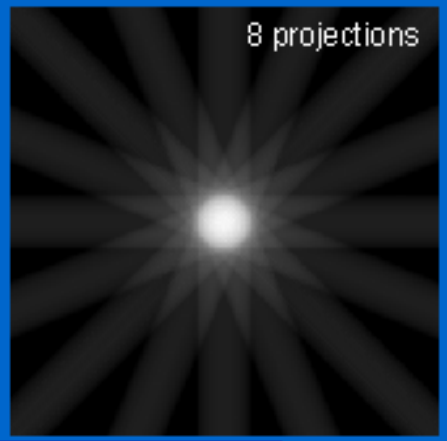


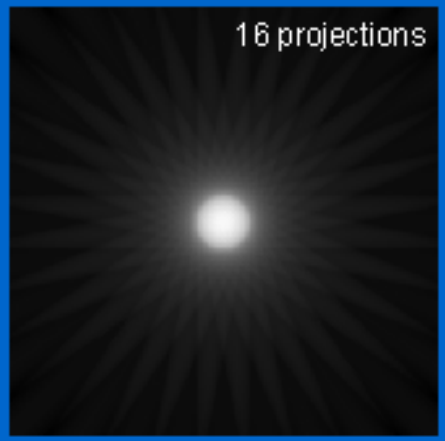
Back Projection







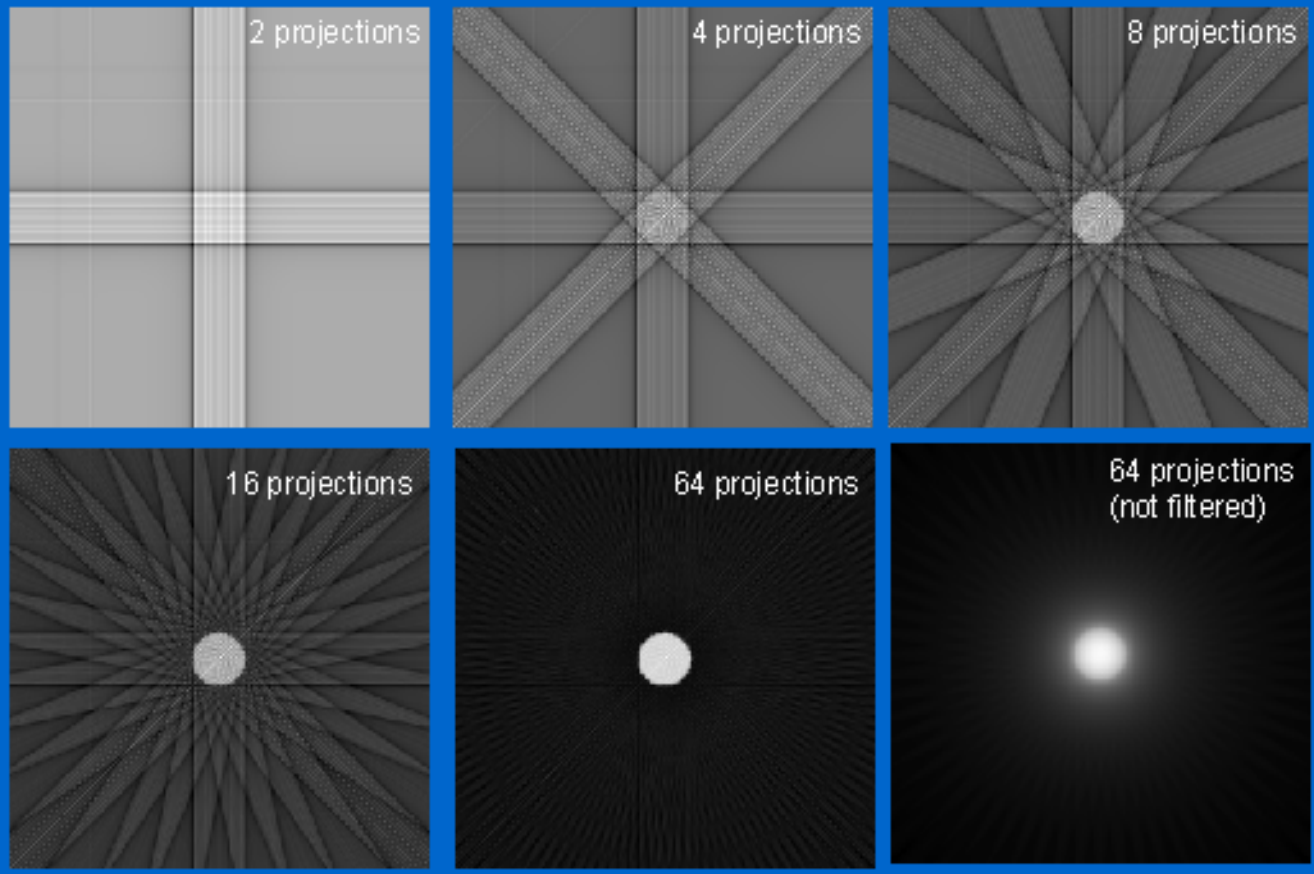




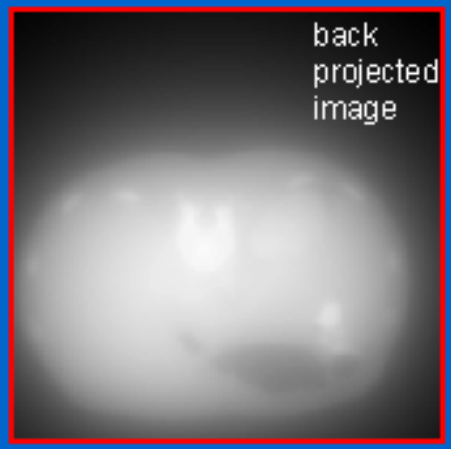
Filtered back projection

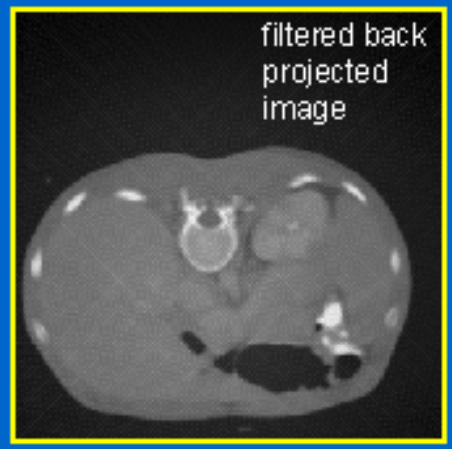
- Back projection produces blurred trans-axial images
- Projection data needs to be filtered before reconstruction
- Different filters can be applied for different diagnostic purposes
  - Smoother filters for viewing soft tissue
  - Sharp filters for high resolution imaging
- Back projection process same as before

Filtered back projection



Filtered back projection





CT number scale

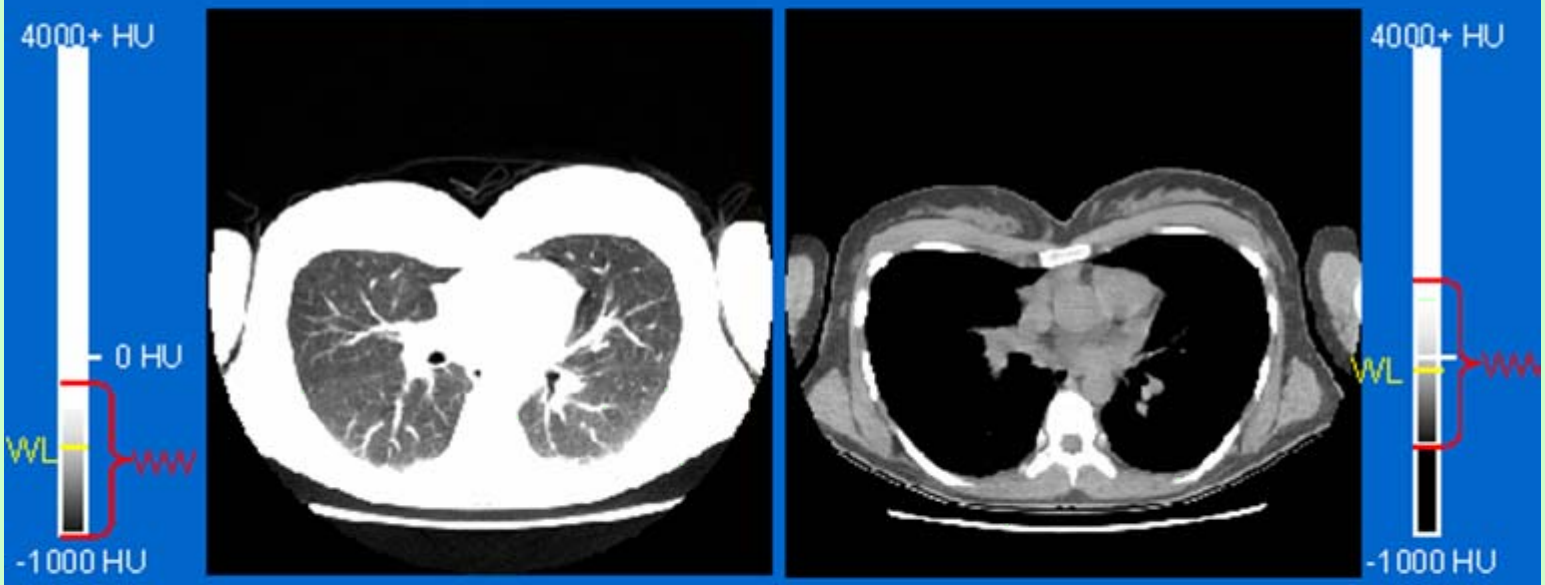
- Grey levels on CT image represent attenuation in each pixel
- Grey levels expressed in Hounsfield units (HU)
  - Water is 0 HU
  - Air is -1000 HU
  - Bone is 1000 - 3000 HU
- HU = $\frac{\mu_{object} - \mu_{water}}{\mu_{water}} \times 1000$

CT number window

- CT images can be displayed with arbitrary brightness and contrast
- Display is defined using window level (WL) and window width (WW)
  - WL is CT number of mid-grey
  - WW is number of HU from black -> white
- Choice of WW and WL dictated by clinical need

CT Number Window

- Same image data at different WL and WW



WL -593, WW 529 WL -12, WW 400

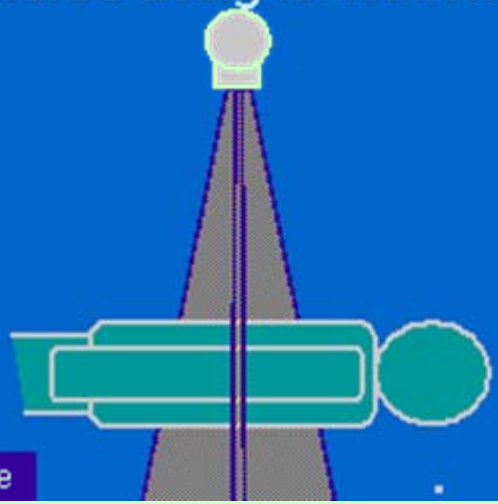
Radiation Dose

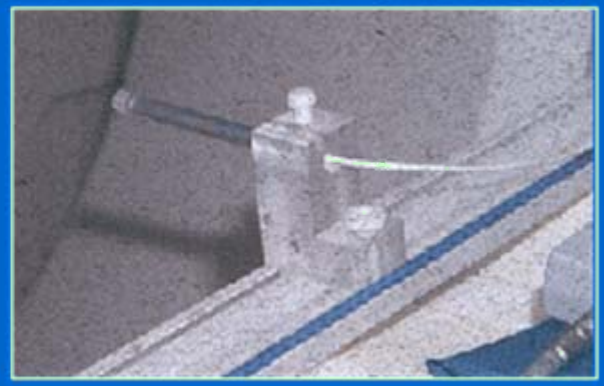
- CT scanning is a relatively high dose technique
- 1989, NRPB (UK), survey
  - 2% of examinations
  - 20% of total patient dose
- 1999, NRPB (UK), estimate
  - 4% of examinations
  - 40% of total patient dose
- Care is needed
  - in referrals
  - in examination technique

Exam	Dose (mSv)
CT Chest	5
Planar PA Chest	0.02

CTDI

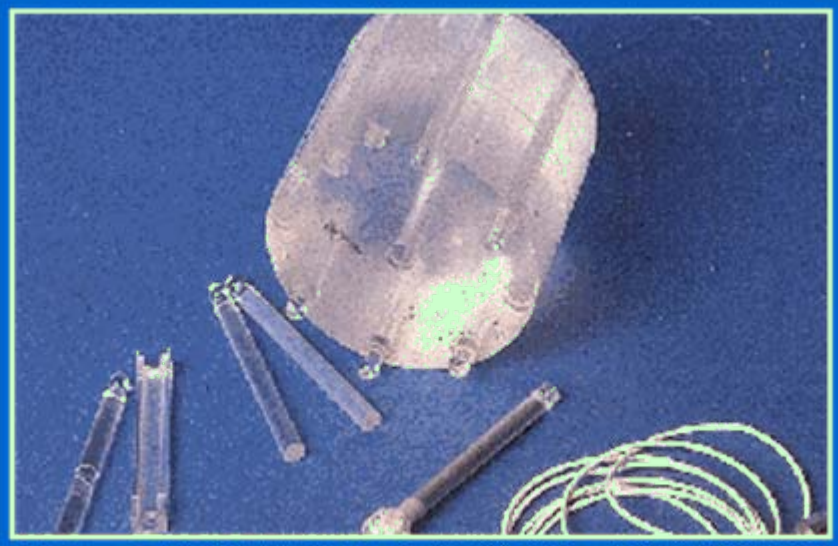
- Dose in CT is highly localised
  - Typical beam width 5-20mm, compared to 250 - 500 mm in general x-ray
- CTDI - Computed Tomography Dose Index
  - Measure of radiation dose within slice width
  - Measured using ionisation chamber, or TLD chips





CTDI (2)

- CTDI can be measured in air, or more commonly in standard Perspex phantoms
  - Head 16 cm diameter,14 cm long
  - Body 32 cm diameter, 14 cm long



Weighted CTDI

- Weighted CTDI ($CTDI_w$) is approximation to average dose in Perspex phantom
- CTDIw = 1/3 $CTDI_{Centre}$ + 2/3 $CTDI_{Periphery}$
- CTDIw values from different scanners and scan protocols can be compared as rough guide to patient dose

Local, organ and effective doses

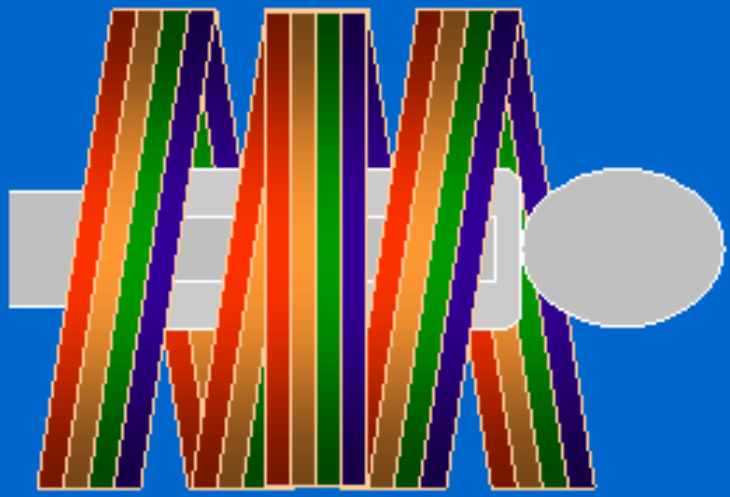
- Can use more precise methods of dose evaluation to patient
- Examine doses to individual areas and organs in patient
- Combine with knowledge of sensitivity of organs to radiation can calculate effective dose - related to risk from radiation

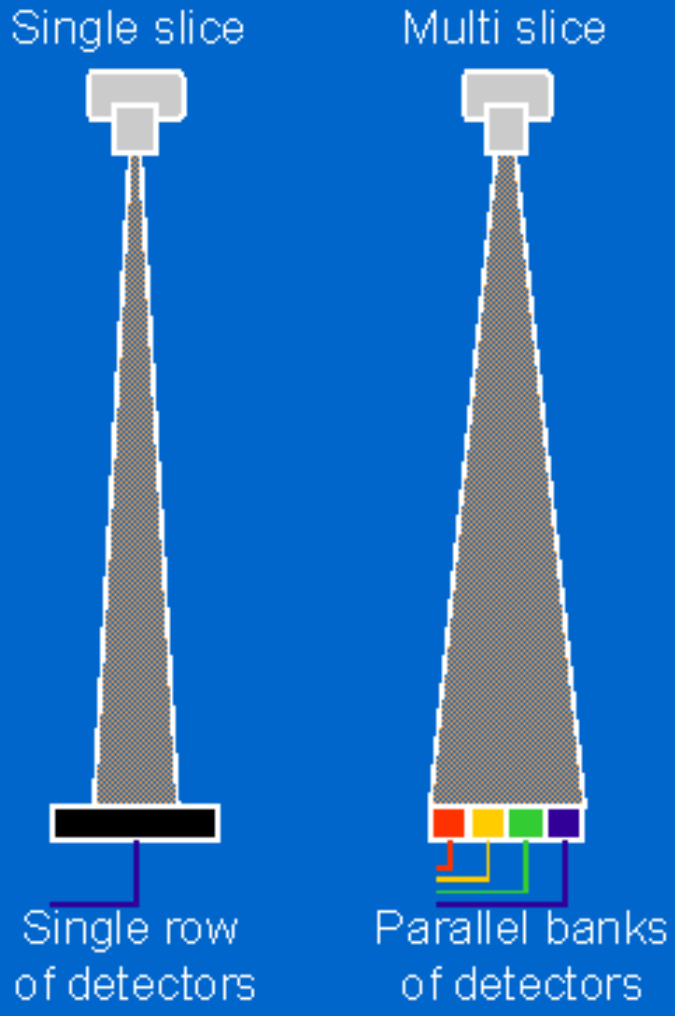
Multi-slice CT

- Multi slice detectors
- Advantages of MS CT
- Clinical advantages

Multi-slice CT

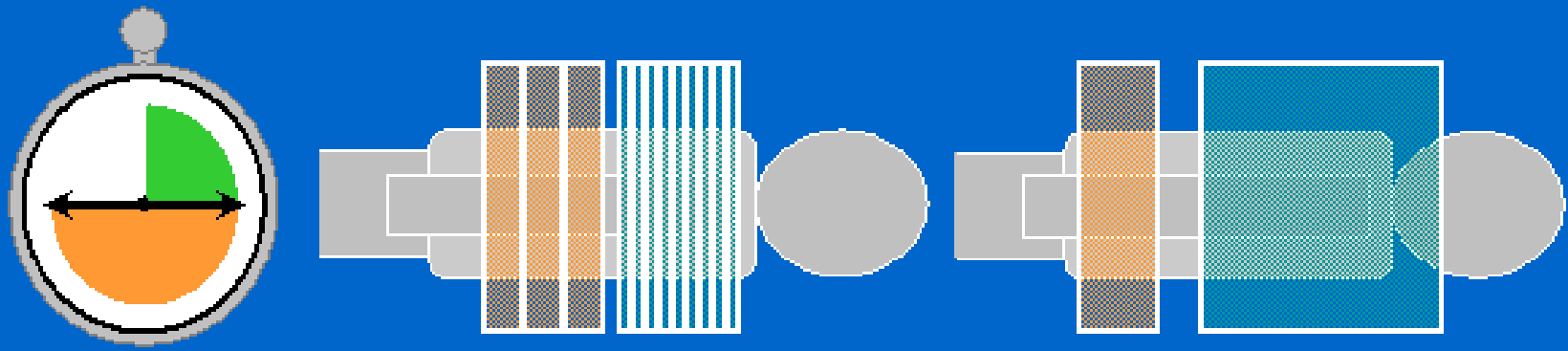
- Multi slice detectors
  - introduced 1998
  - allow acquisition of multiple slices in a single rotation





Advantages of MS CT

- Advantages of multi-slice over single-slice
  - Same acquisition in shorter time *or*
  - Thin slices give better z-axis resolution *or*
  - Scan larger volumes in the same time



Clinical Advantages

- Continued:
  - Angiography: fast scanning ensures best use of contrast. Good z-axis resolution allows imaging of narrow vessels
  - 3D imaging: large numbers of narrow slices can provide high quality volume rendering
  - Cardiac imaging: fast scans allow reduced cardiac blurring in images

Koniec CT - suplement