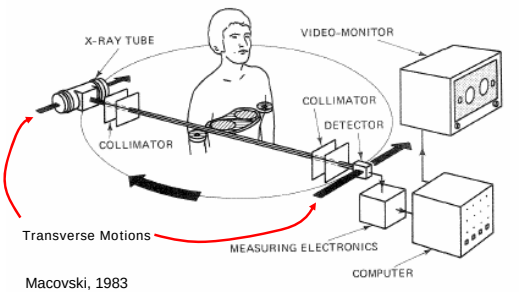
X-Ray Computed Tomography

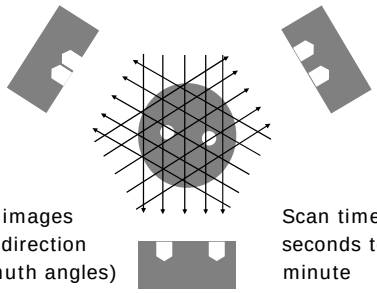
- Tomography, from Greek:
  - *tomos (*to "cut" or "section") + *graphein* (to "write")
- Tomogram is image of *slice* through some 3D volume
- CT scanner uses X rays, radiation sensors, and computers to produce X-ray images of planes through body
- Mathematical basis for CT developed by Johan Radon in 1917
  - to solve some differential equations
  - Image of unknown object can be produced from "infinite" number of projections through object
- Practical application in 1960s by Cormack
  - Made possible by digital computer
- First practical scanner built in 1972 by Hounsfield
  - First modern imaging modality for probing inner depths of the body, slice by slice
- Cormack and Hounsfield won Nobel Prize in 1979

Computed Tomography



Macovski, 1983

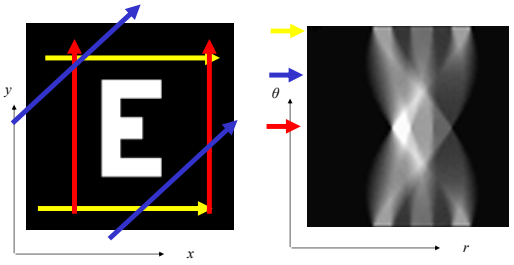
CT Acquisition



Take X-ray images along each direction (many azimuth angles)

Scan times of seconds to one minute

Plot 1-D X-ray Image vs. Angle



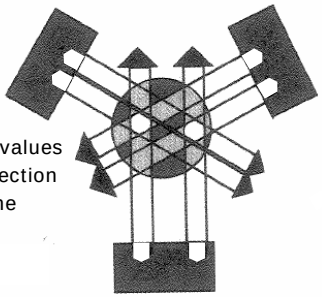
"Sinogram"
(curves are "pieces" of sine waves)

Radon Transform

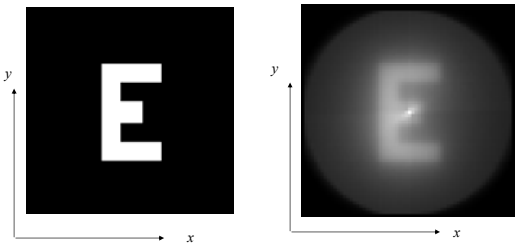
- Calculated by "summing up" gray values along parallel or converging lines
  - converging lines ⇒ "fan-beam CT"
  - Summing is analogous to operation of mathematical "integration"
    - "Averaging" or "blurring" operation
    - "Lowpass Filter"

Reconstruction by "Backprojection"

"Smear" the values for each projection back along the original lines



Backprojection Produces "Fuzzy" Image



Original Object

Image Reconstructed by Backprojection Only

Backprojection Produces "Fuzzy" Image

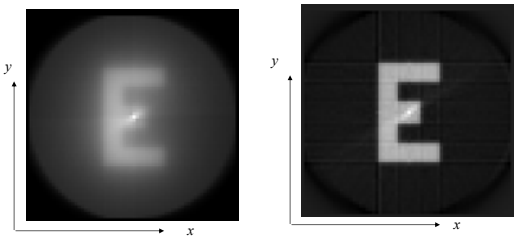


Image Reconstructed by Backprojection Only

Image Reconstructed by Backprojection with Sharpening Filter

Backprojected Image Must Be "Sharpened" to Remove Blur

- Recall: "Sharpening" is a "Differencing" Operation
- Use a *SPECIFIC* "Differencing" Filter to Fix Blurriness in CT
  - More "rapid" oscillations of original are blurred more by integral
  - Must be more compensation of "rapid" oscillations by filter

Computed Tomography Unit

Siemens, 2003