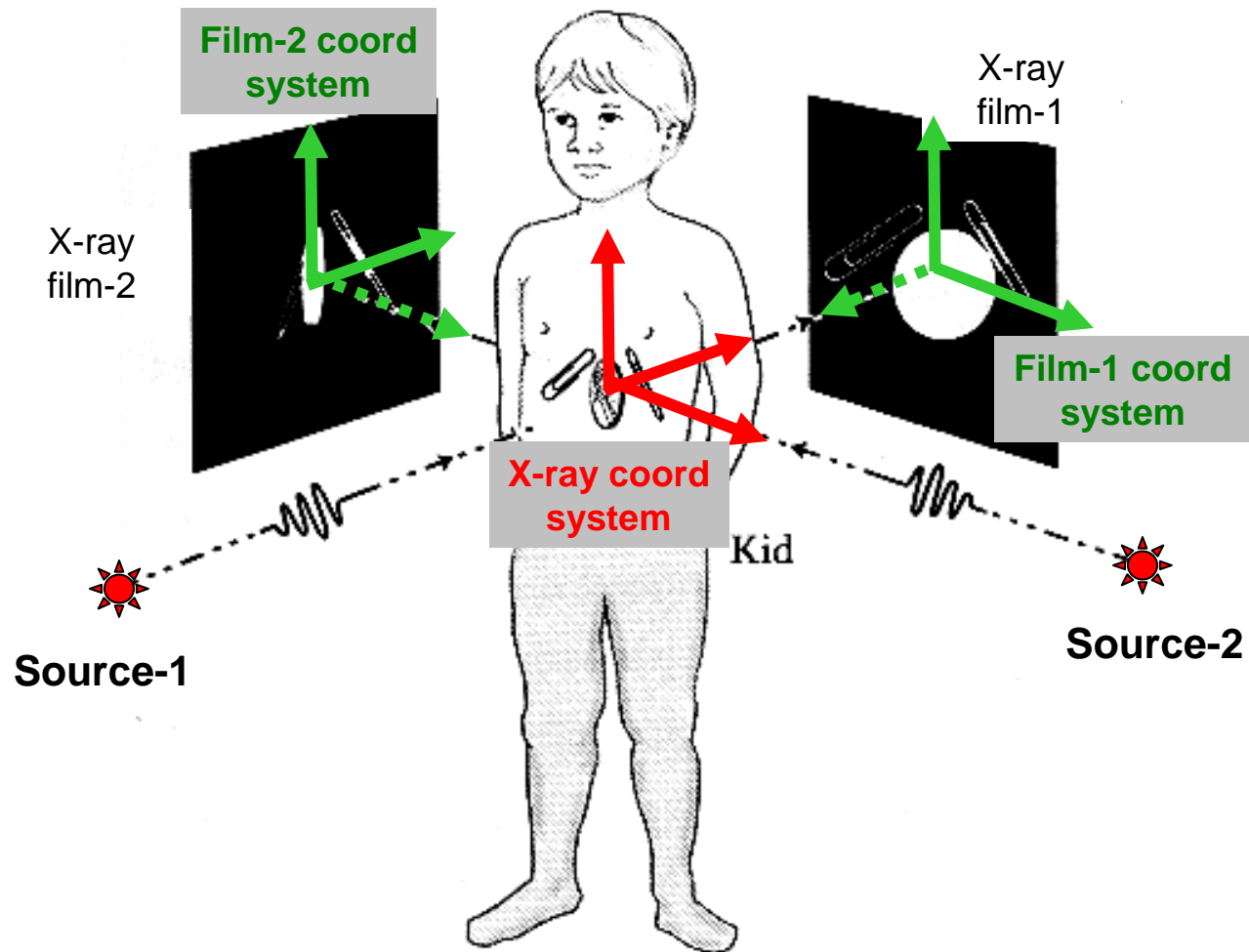
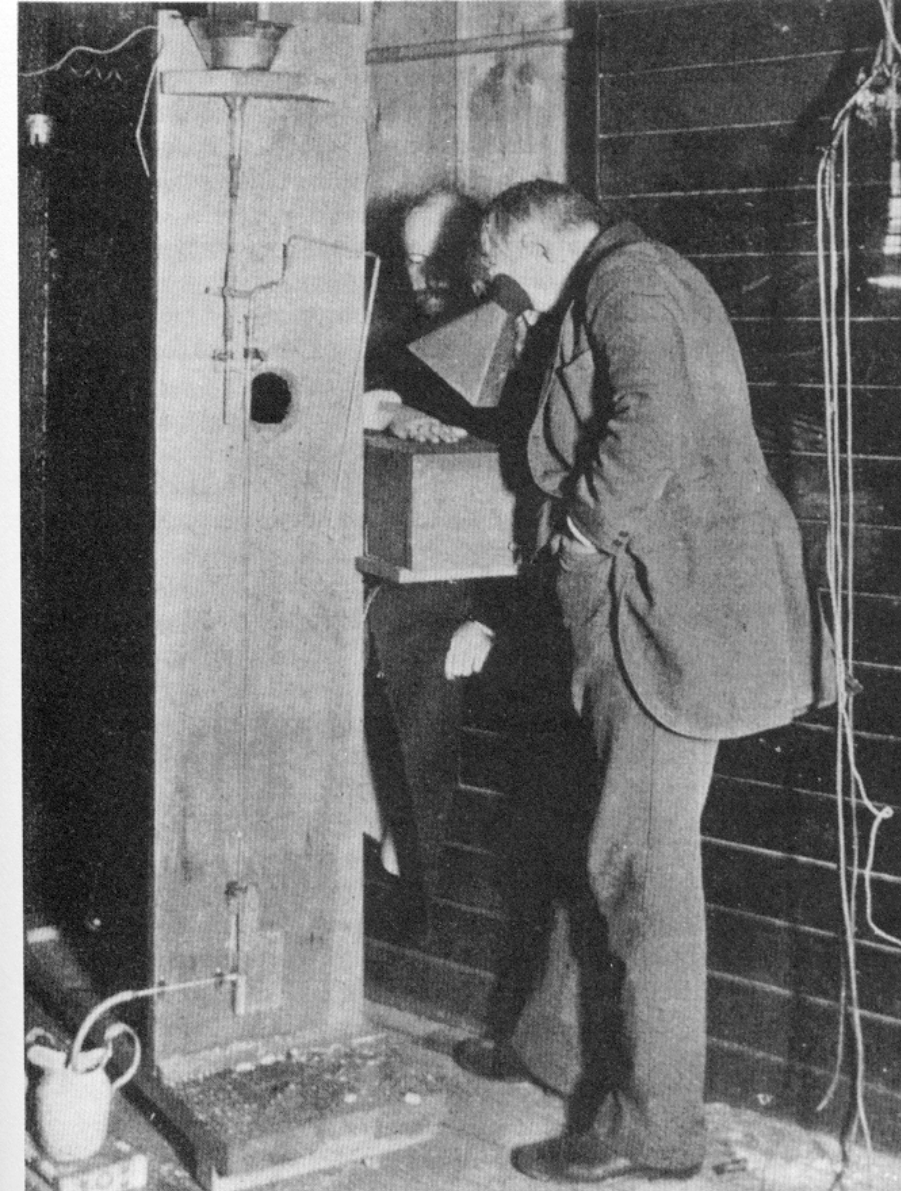


Fluoroscopy and CT Imaging

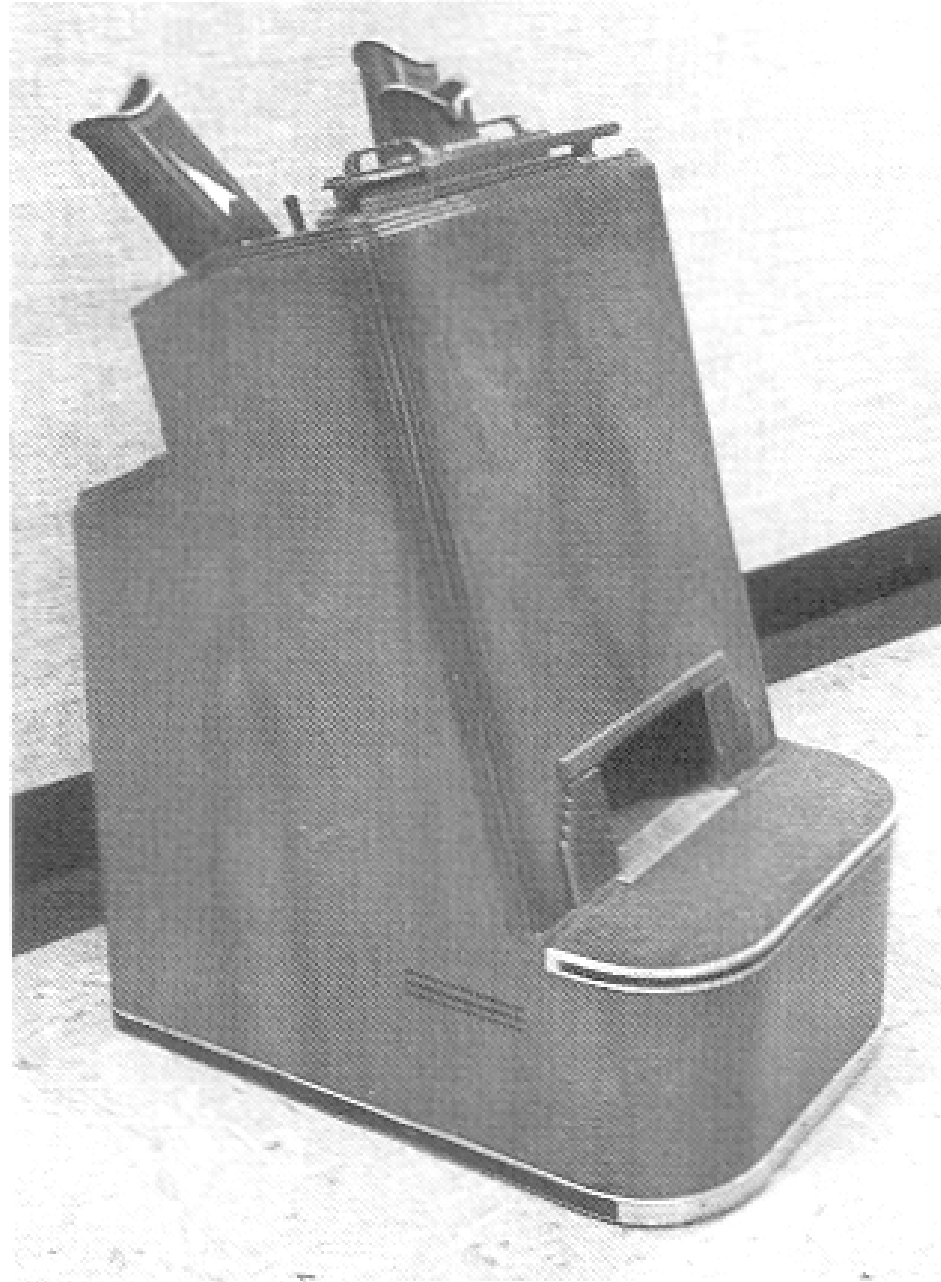
3D coordinate space



Edison in his fluoroscope, 1896



The first commercial fluoroscope



X-ray + Television = Fluoroscopy

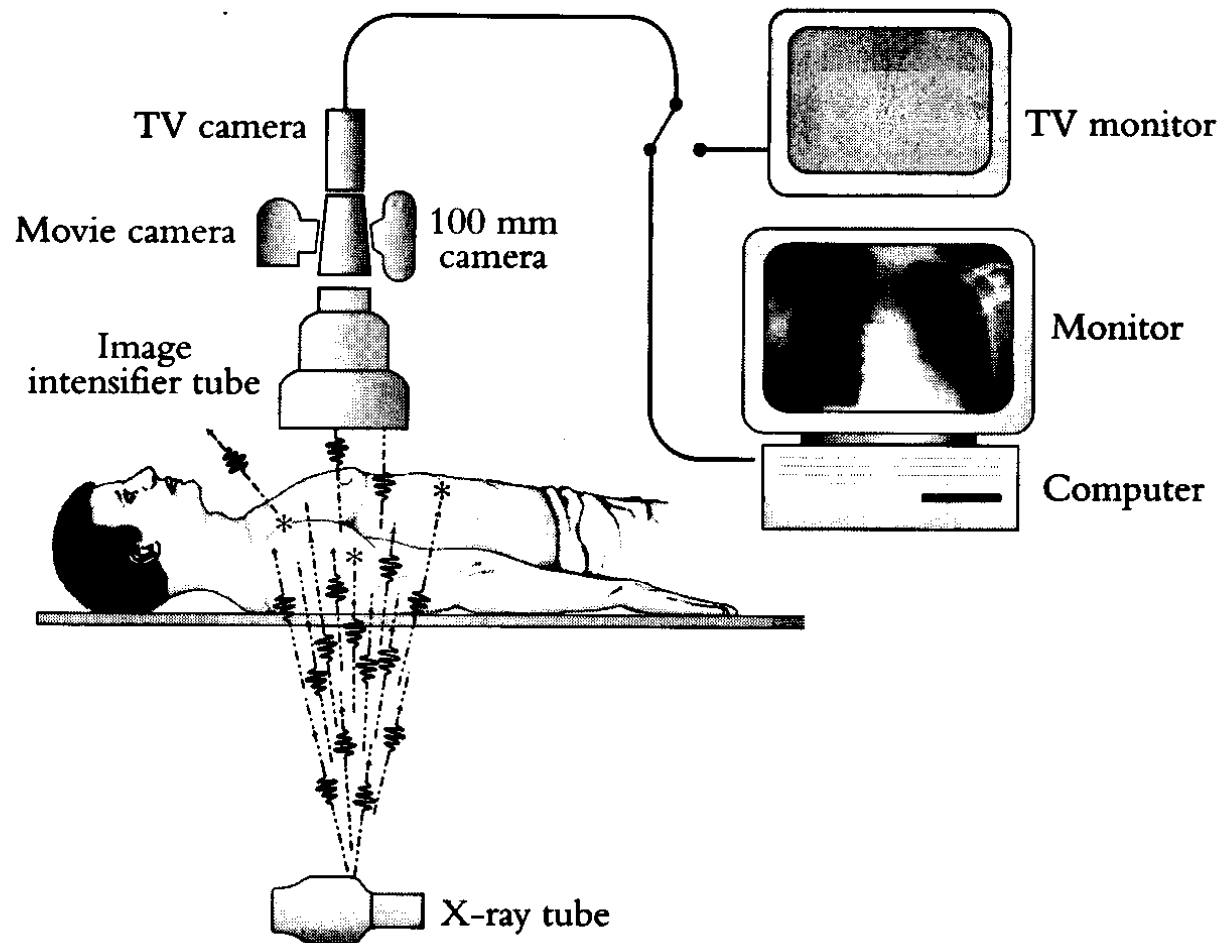
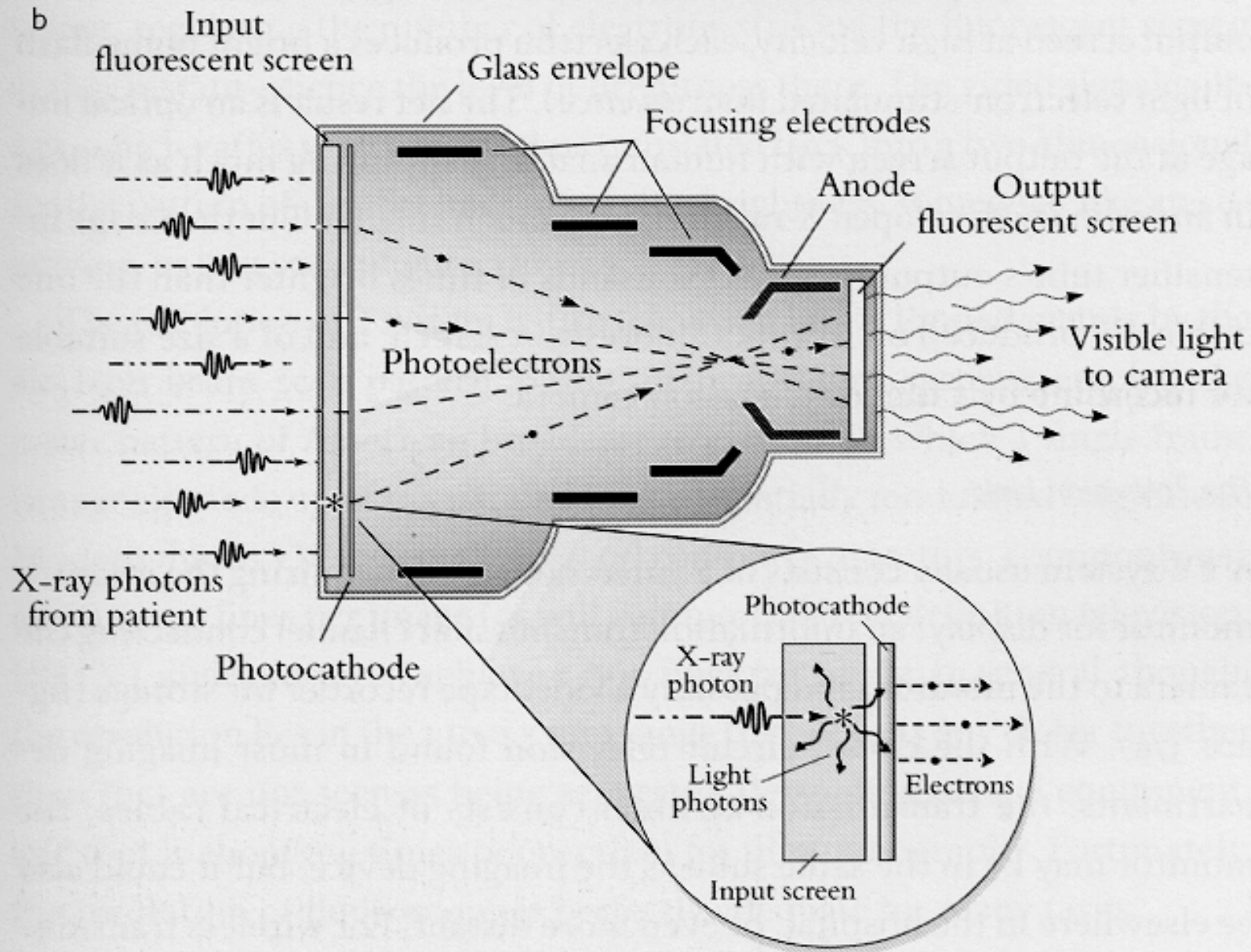
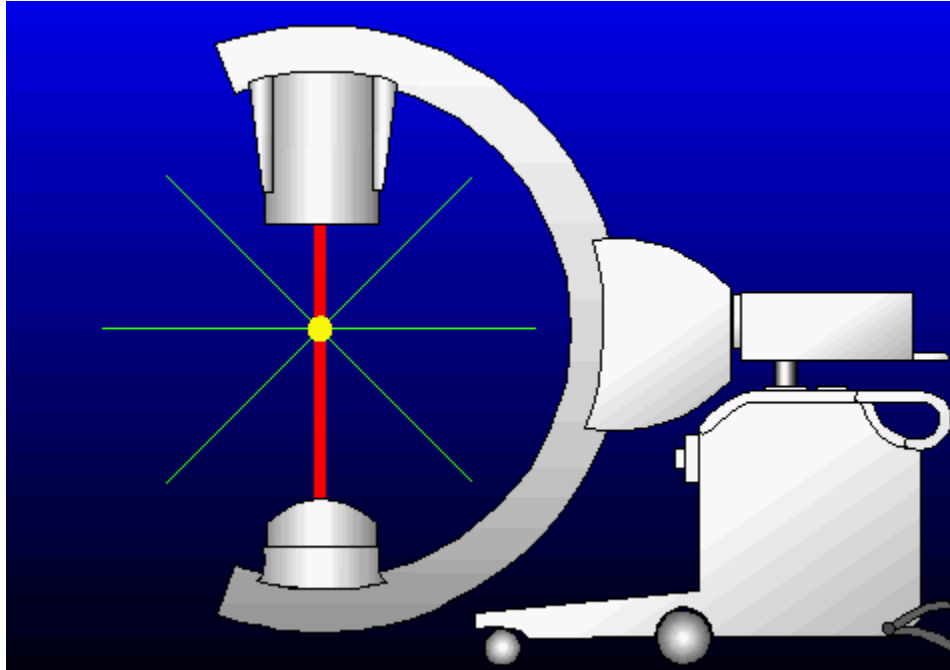


Figure 9. Fluoroscopy. The radiant energy from an X-ray tube passes through the patient, and the resulting X-ray shadows are transformed by the image intensifier into a bright image of visible light three centimeters or so in dimensions. This optical image, in turn, is captured by a 100 mm camera, a movie camera, or a video camera.

X-ray image intensifier tube

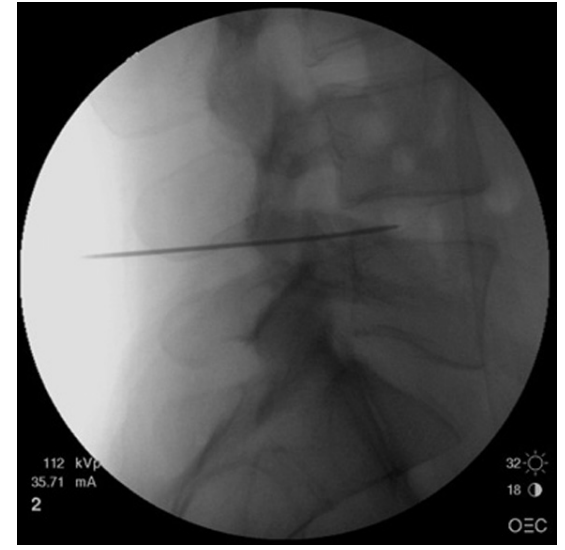
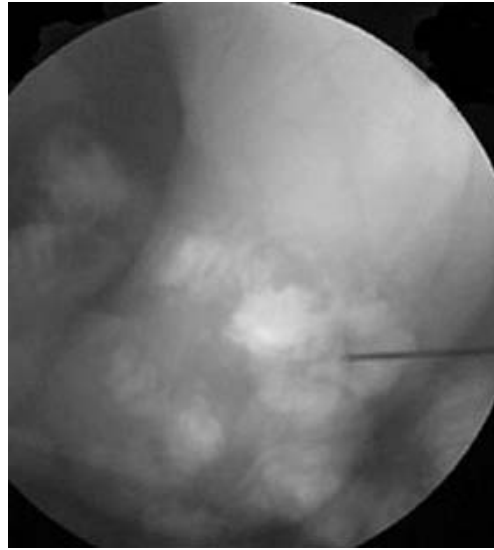
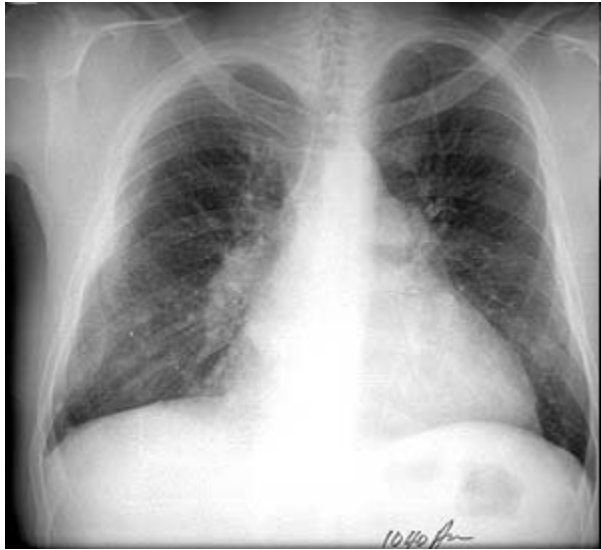


C-arm fluoroscopy



Siemens

Fluoroscopy images



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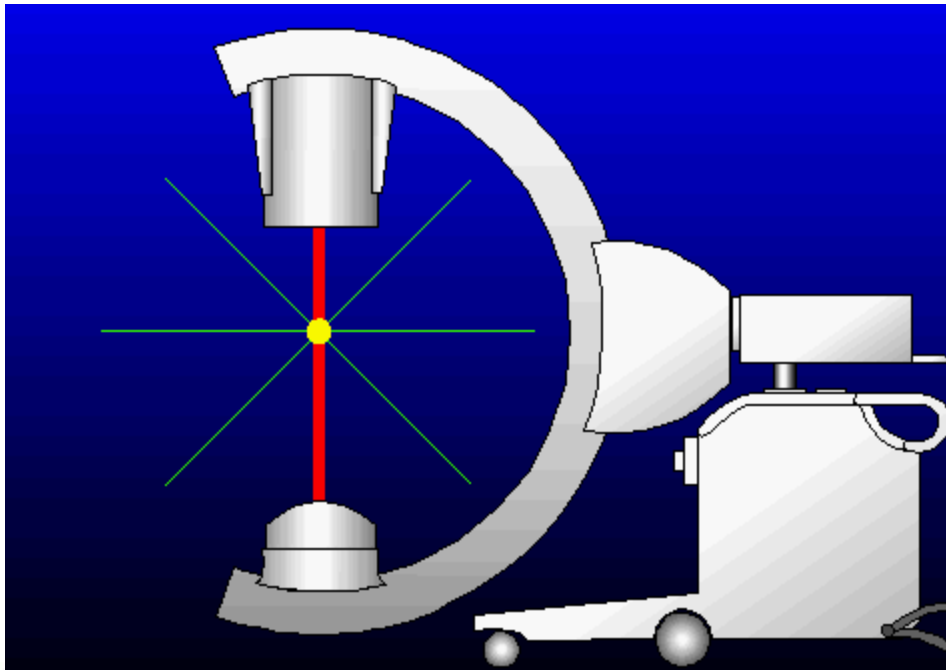
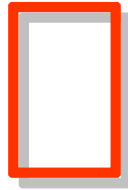
IM: 1

Biplane fluoroscopy



Pros and Cons for C-arm in Surgery

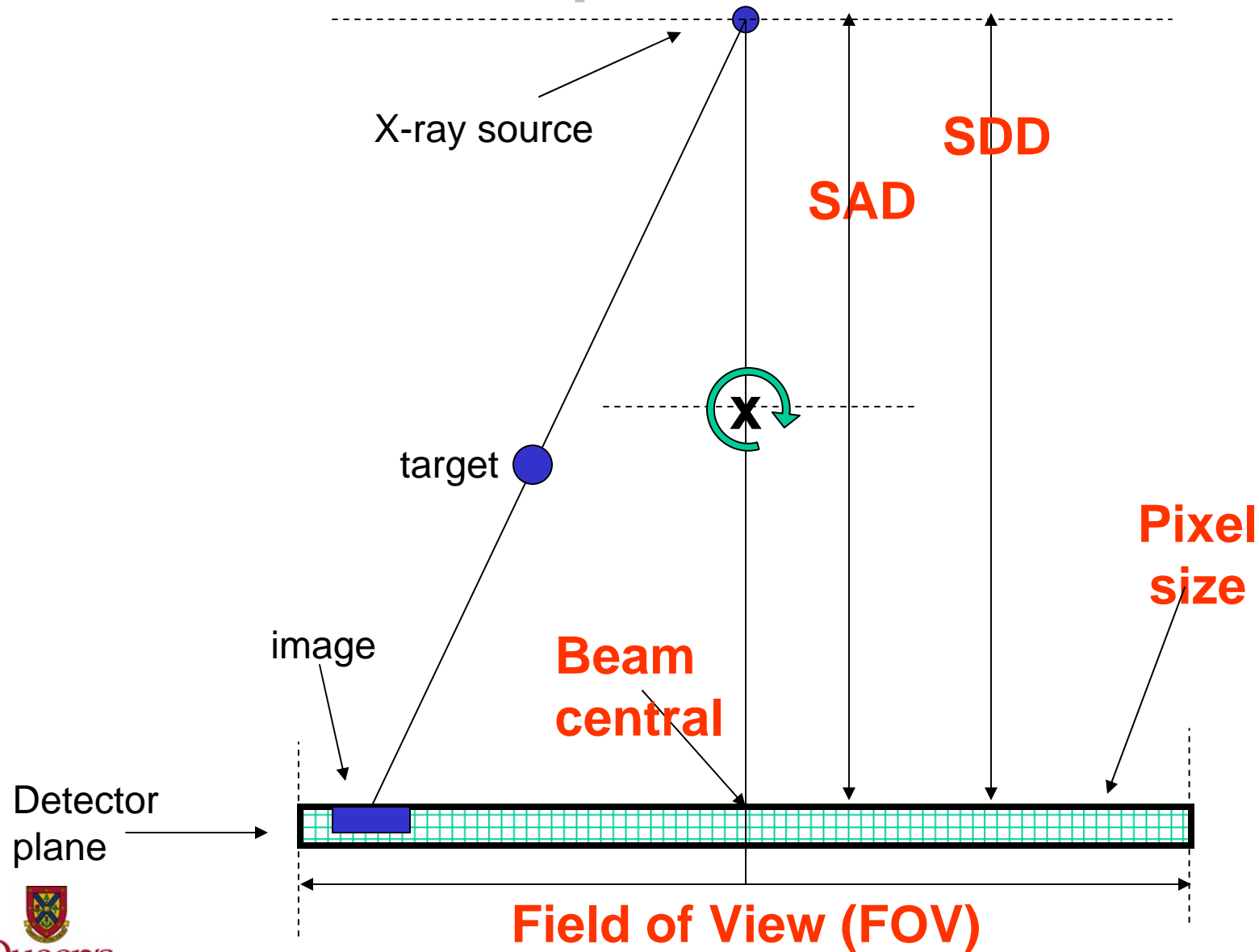
- Mobile
- Real-time
- Inexpensive
- Good bone contrast
- Broad insurance coverage



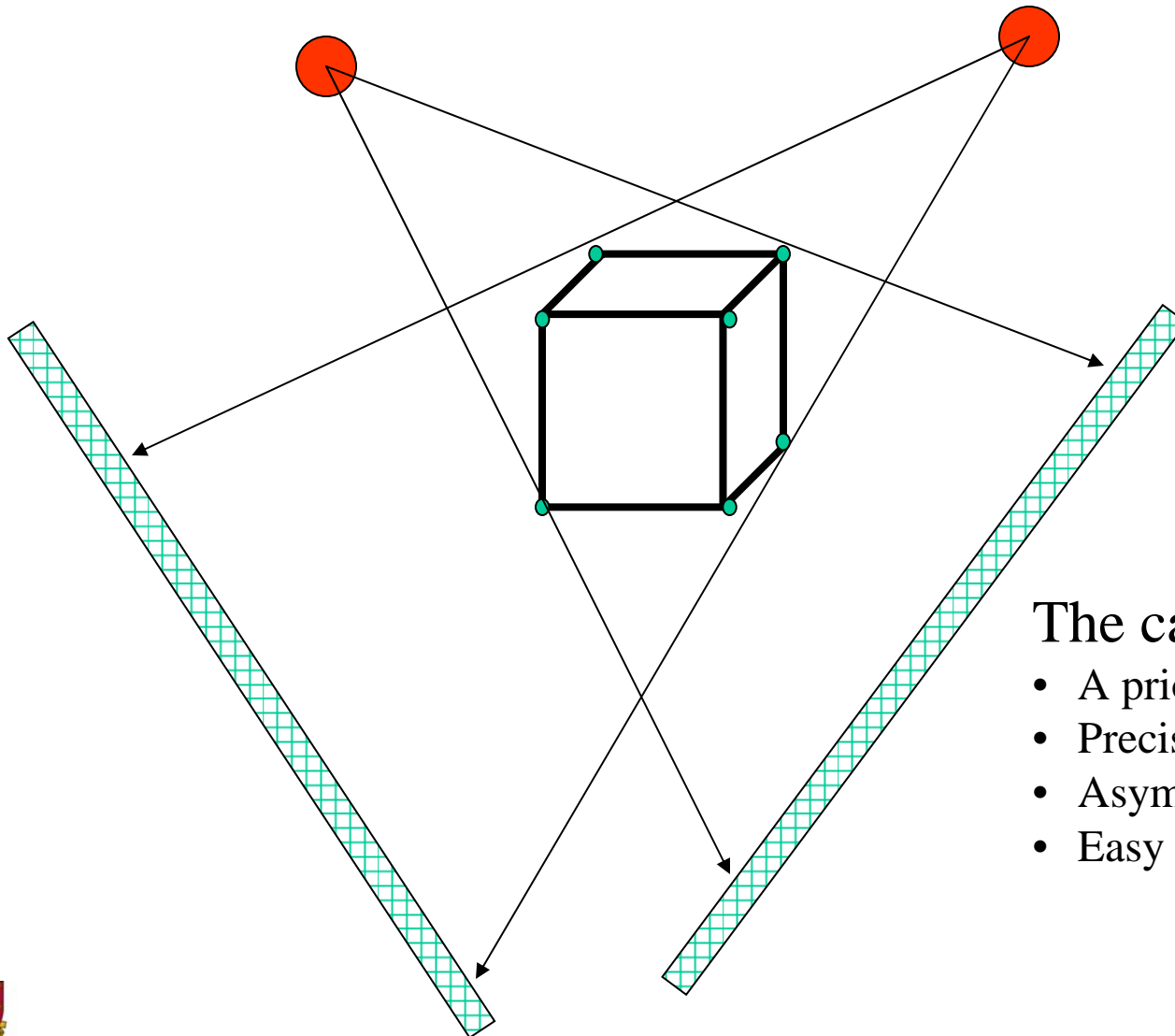
- Poor soft tissue contrast
- Limited rotation
- Limited field of view (9-15")
- Often non-isocentric
- Object truncation
- High X-ray dose to all parties
- Need for calibration
- Poor/no joint encoding
- Image warping
- Loss of depth & volume



Calibration = determine unknown constant parameters



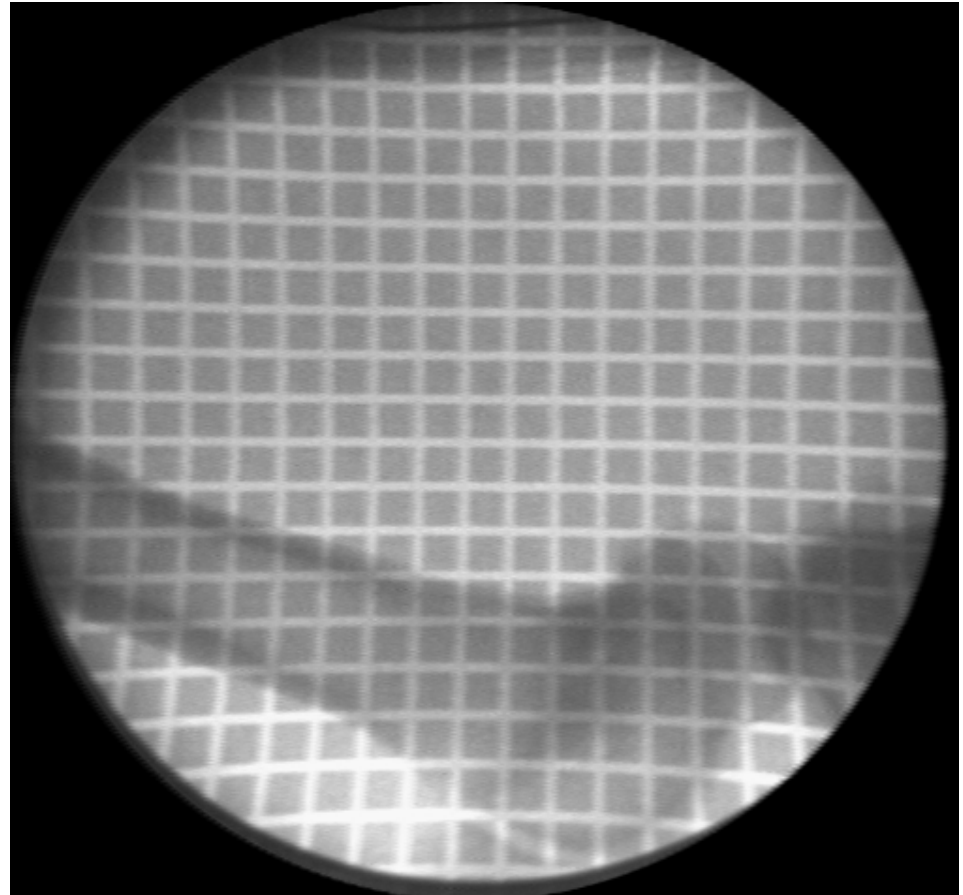
Typical calibration: shoot images from various angles of a known object and calculate unknown C-arm parameters



The calibration fixture:

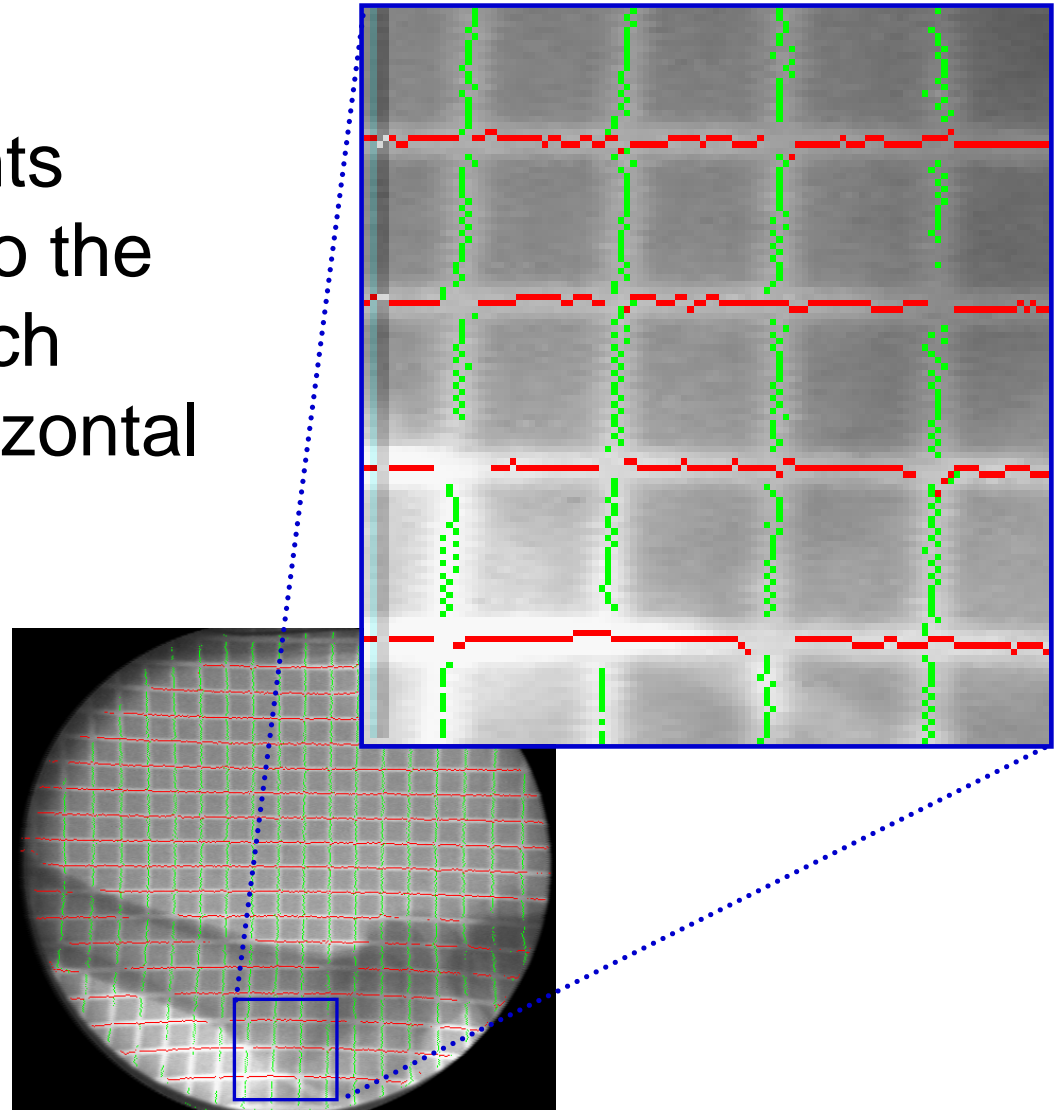
- A priori known
- Precisely machined
- Asymmetric
- Easy to pick feature points

Image warping



Dewarping step-1: Find groove points

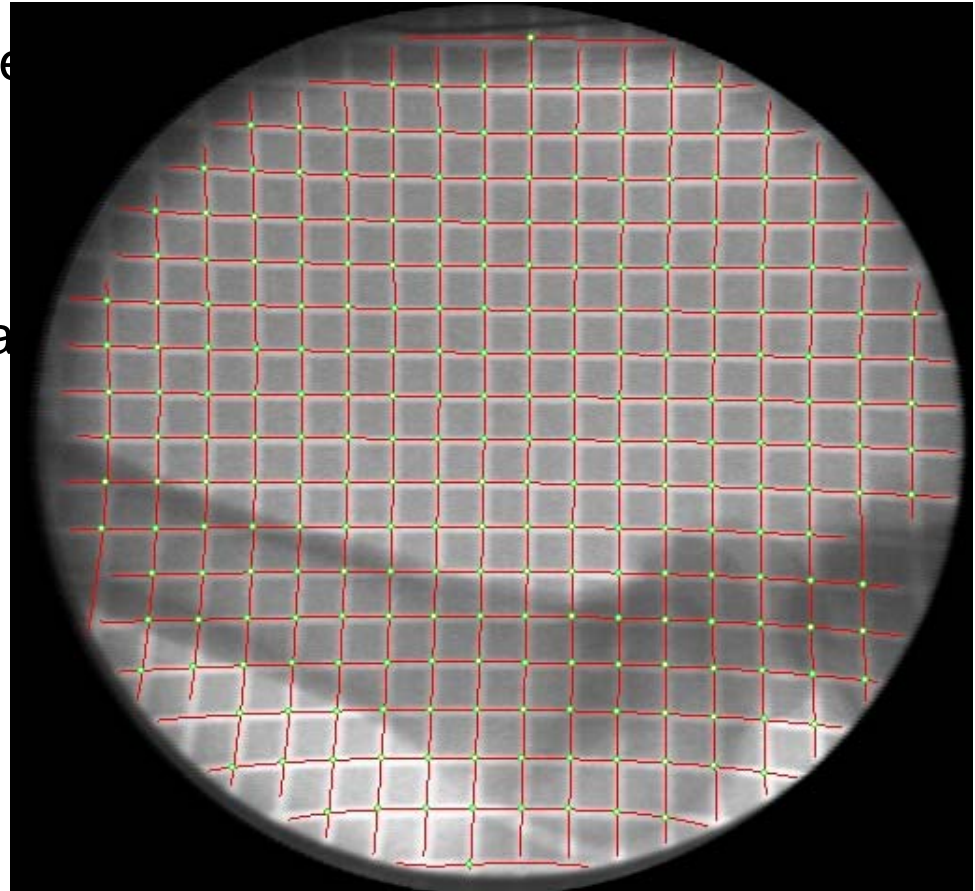
- Find image points corresponding to the centerline of each vertical and horizontal groove



Dewarping step-2 : Fit 5'th order Bernstein Polynomial Curves

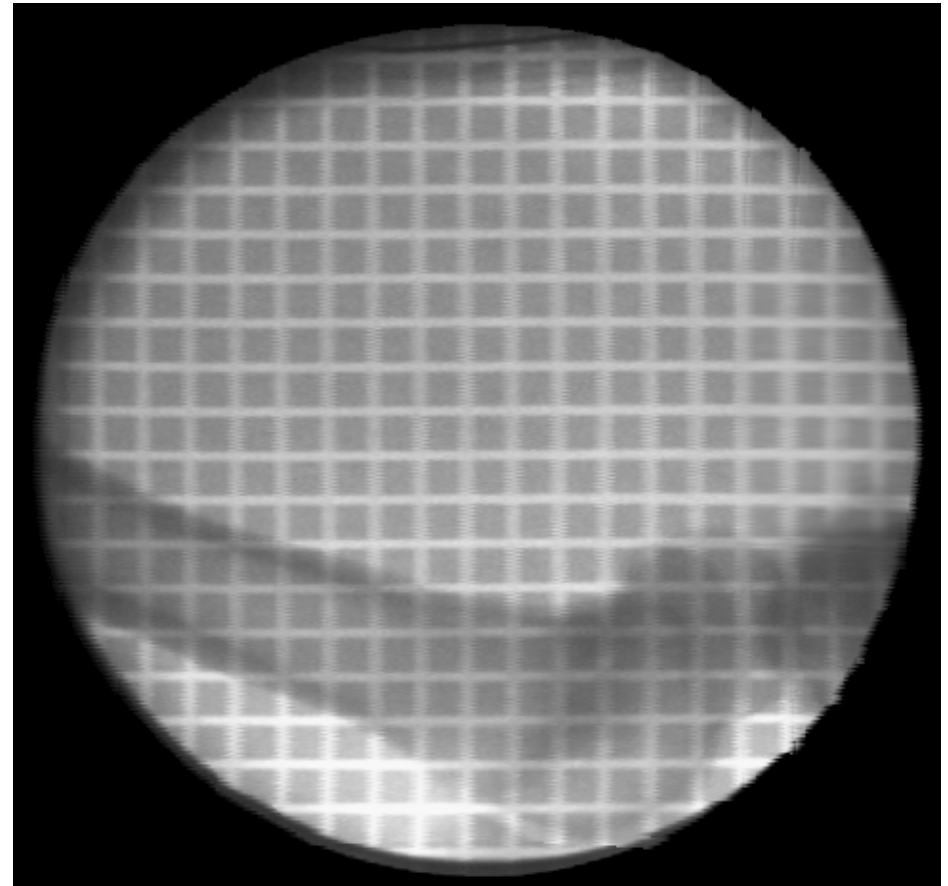
- Fit a least square smooth curve to each vertical and horizontal groove
- 5'th order Bernstein Polynomial

$$B(a_0, \dots, a_5; v) = \sum_{k=0}^5 a_k \binom{5}{k} (1-v)^k v^{5-k}$$

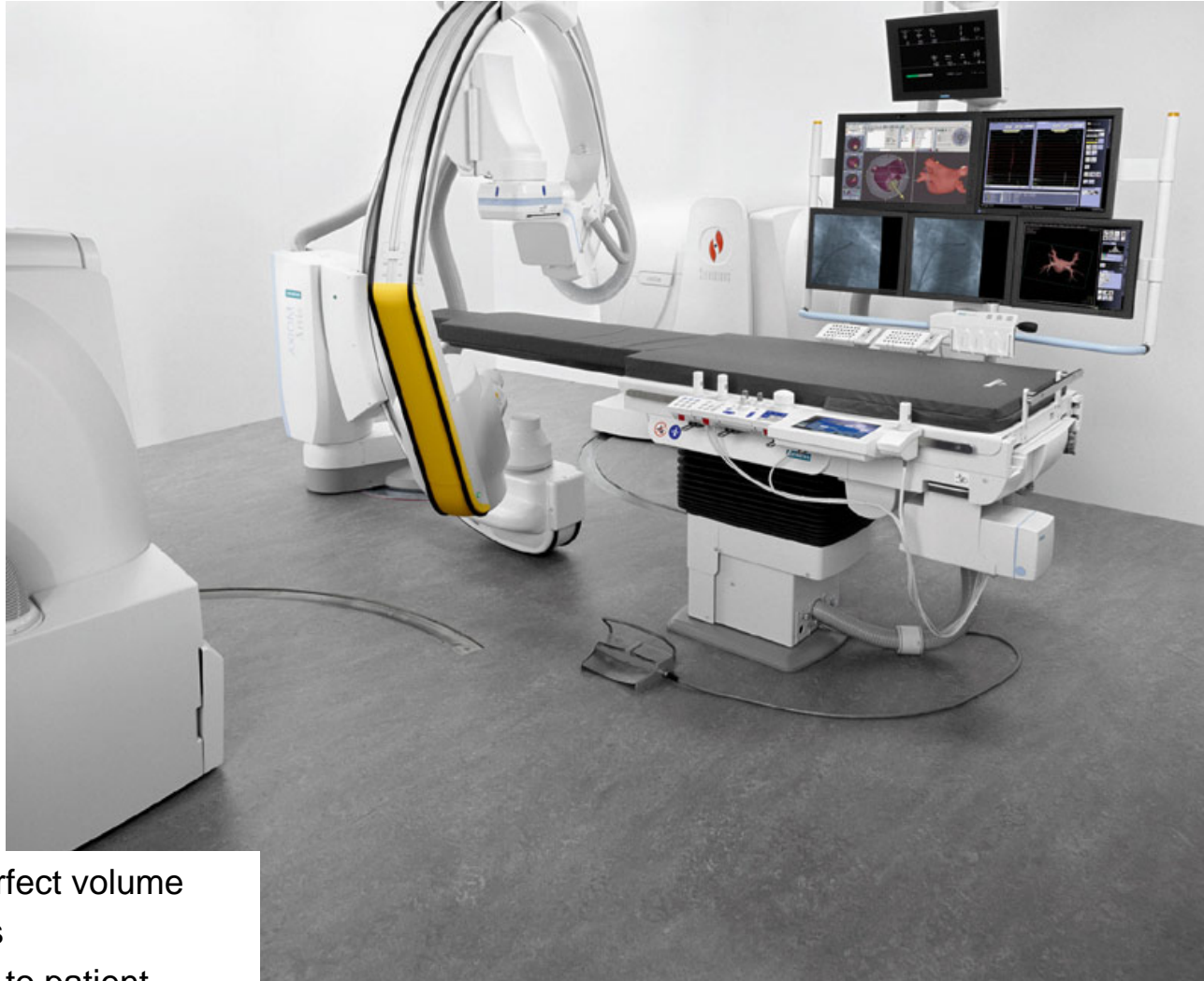


Dewarping step-3 : Unbend the plate's image

- Unbend the Bernstein polynomial to straight lines
- Employ a two pass scan line algorithm to dewarp the image with using bilinear interpolation

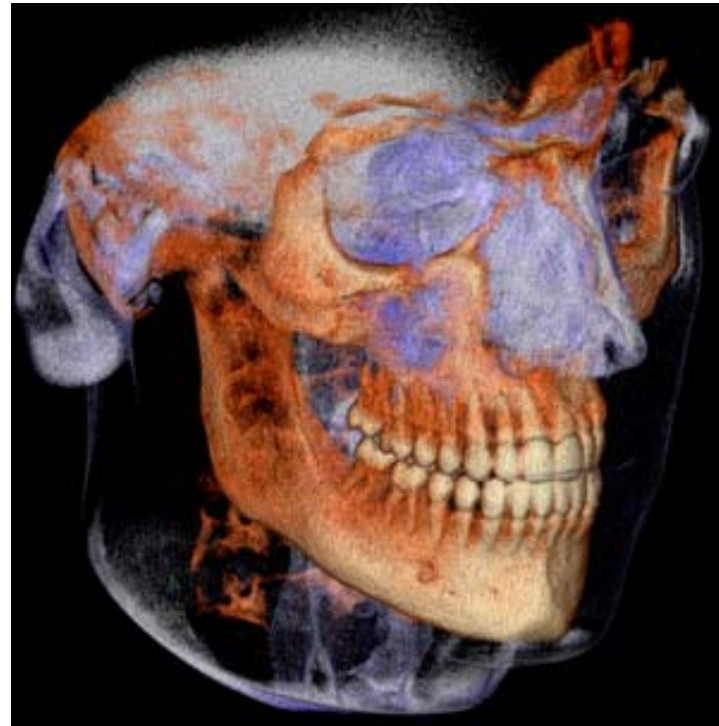
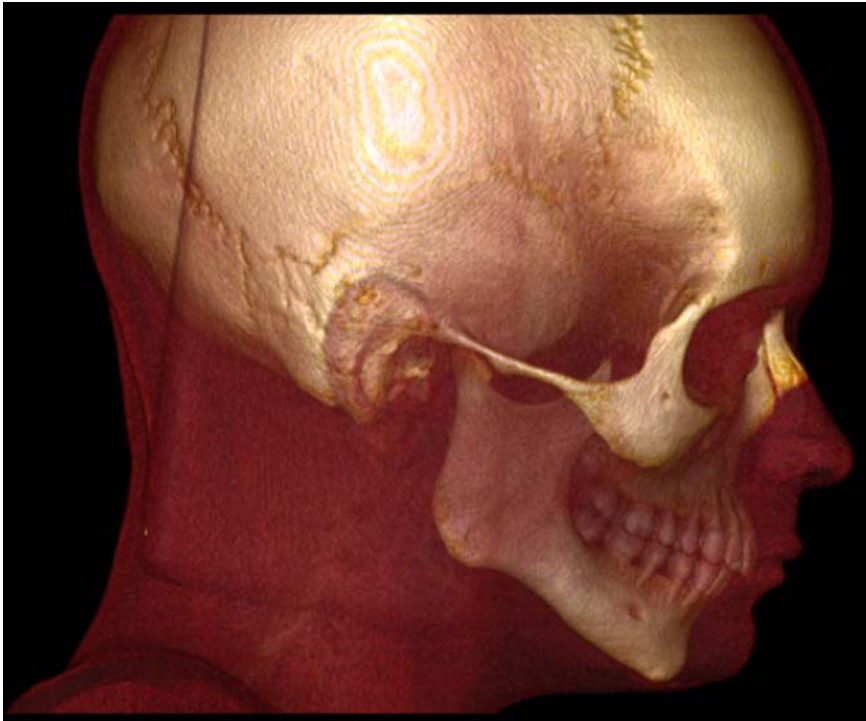


Full sweep cone beam



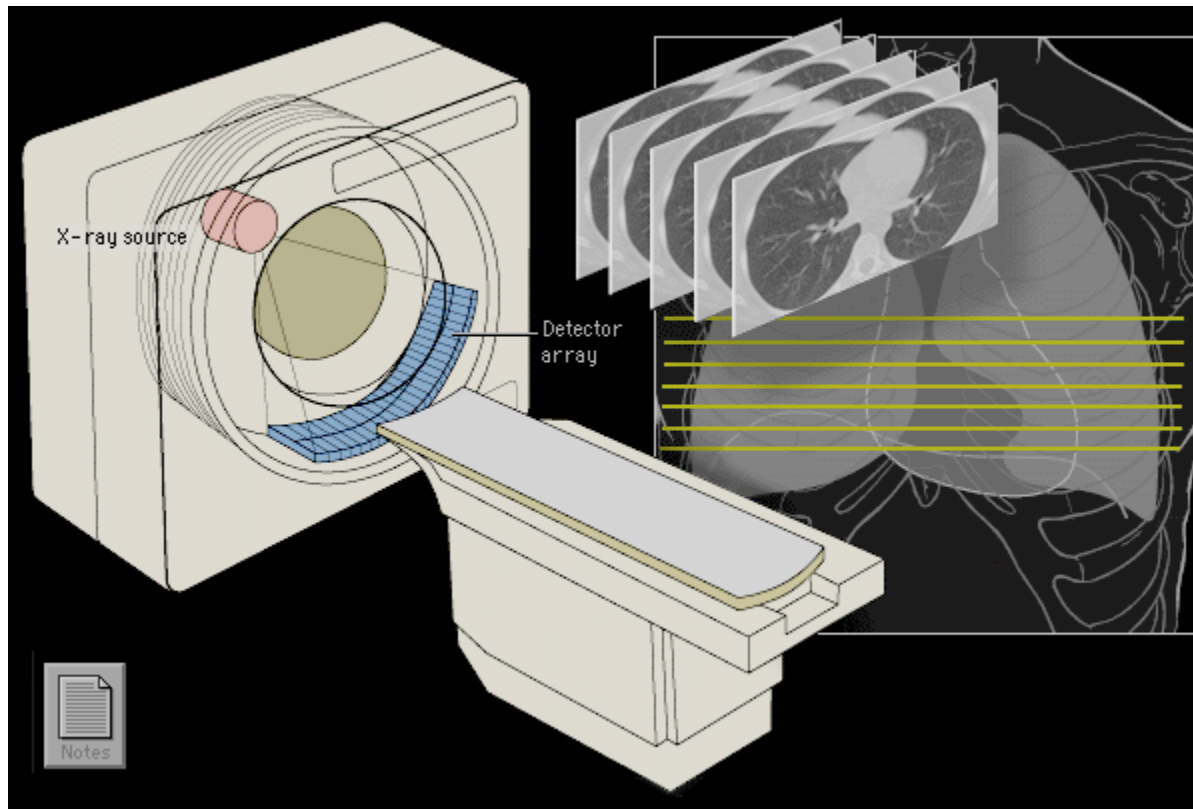
- May give perfect volume
- Lots of shots
- Lots of dose to patient
- Ever faster on computer
- Possible in realtime

Cone beam CT reconstruction examples

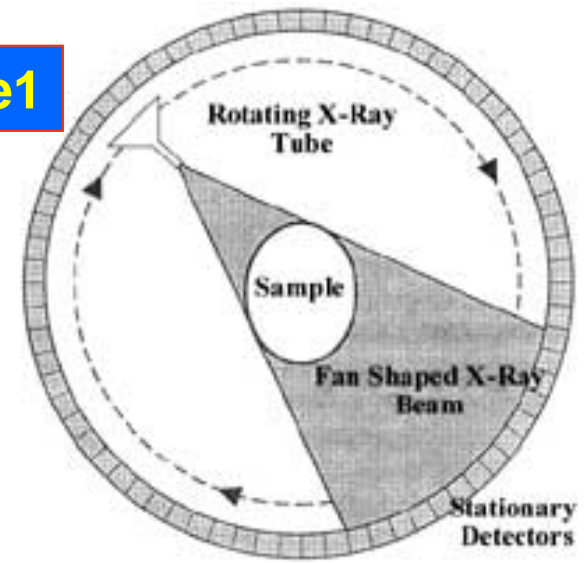


Concept of Computed Tomography (CT)

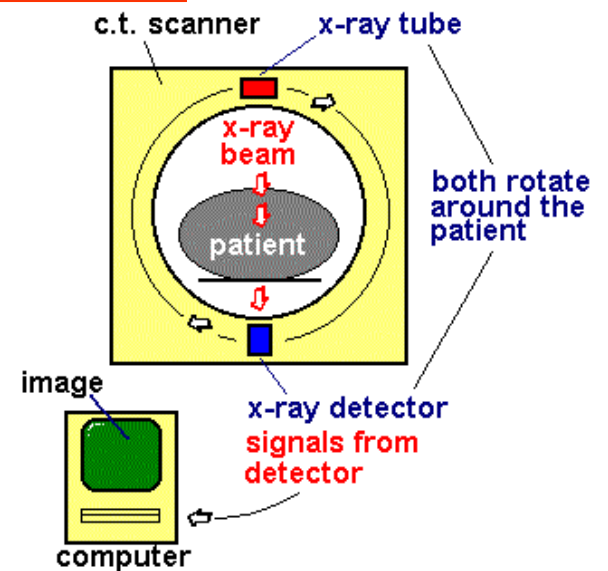
Planar fan beam



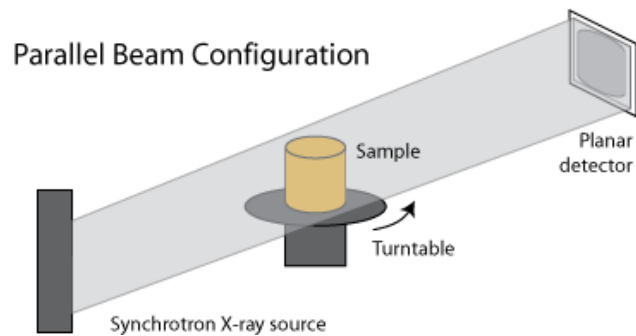
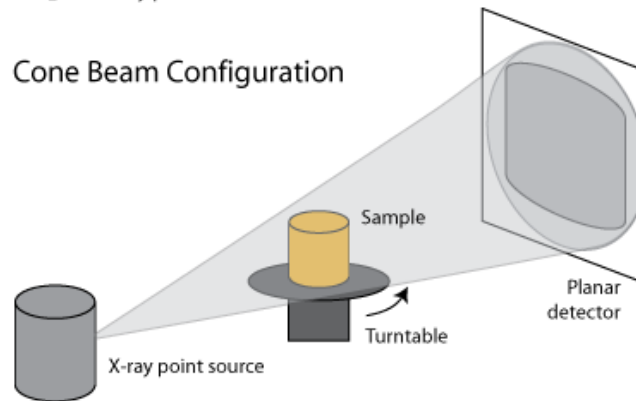
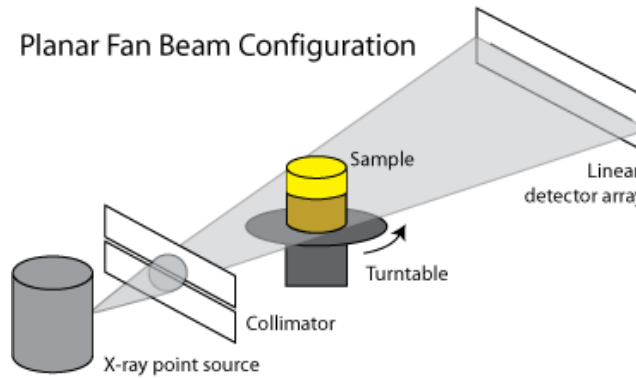
Type1



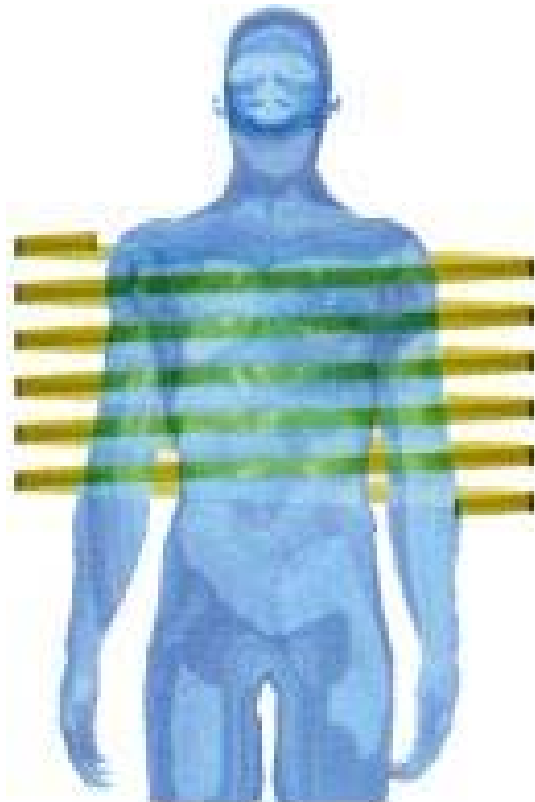
Type2



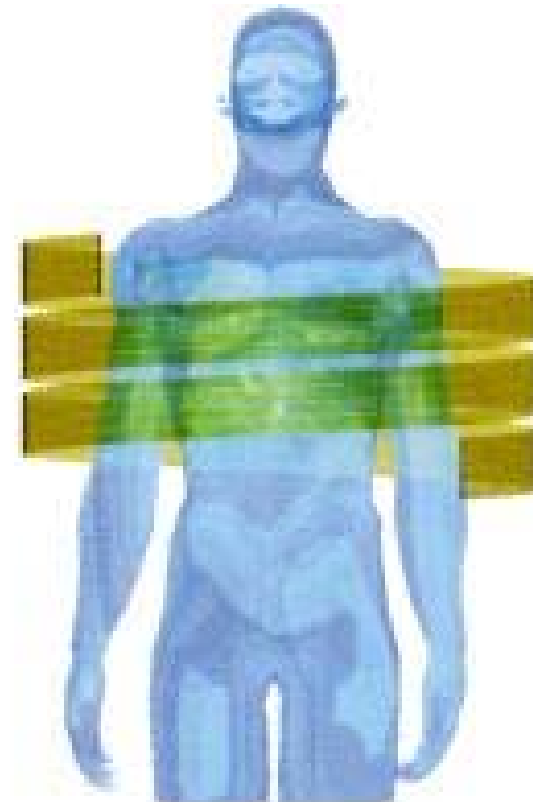
Beam configurations



Spiral CT



SINGLE SLICE SPIRAL



MULTISLICE SPIRAL

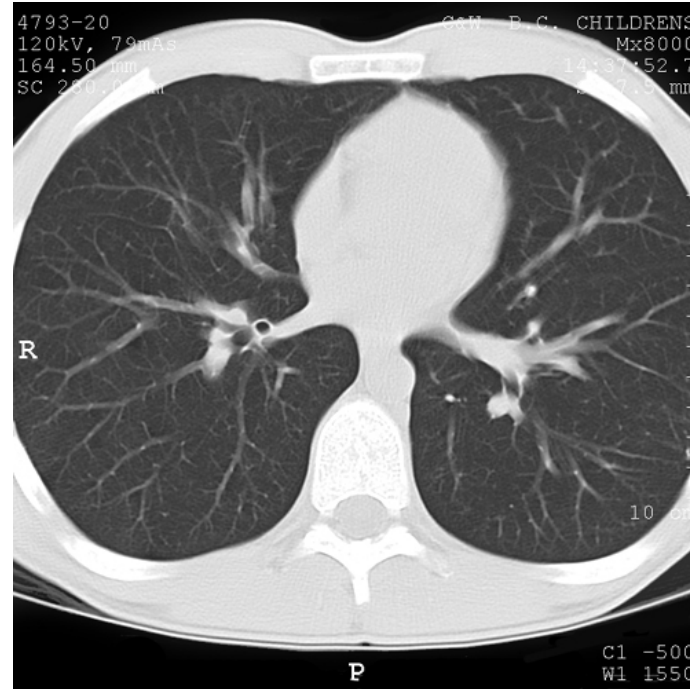
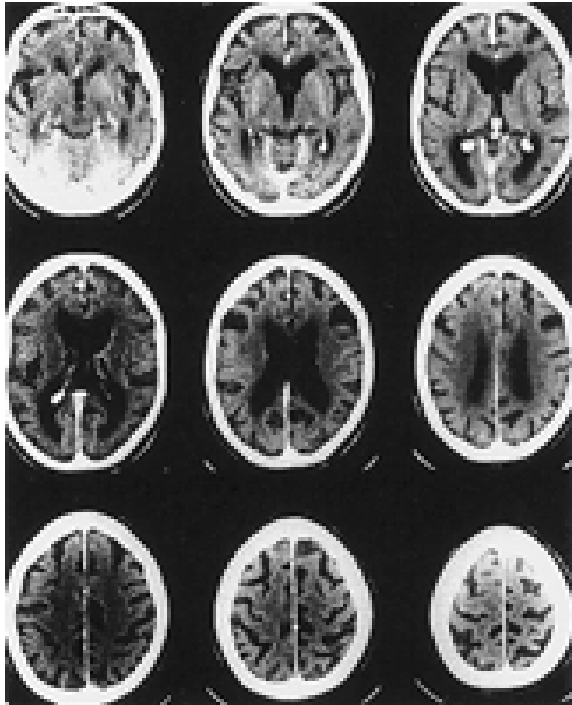
Spiral path with 4,8,16,32,64, 128, 256 rows

Scan Examples: <http://www.radiology.uiowa.edu/3d/>

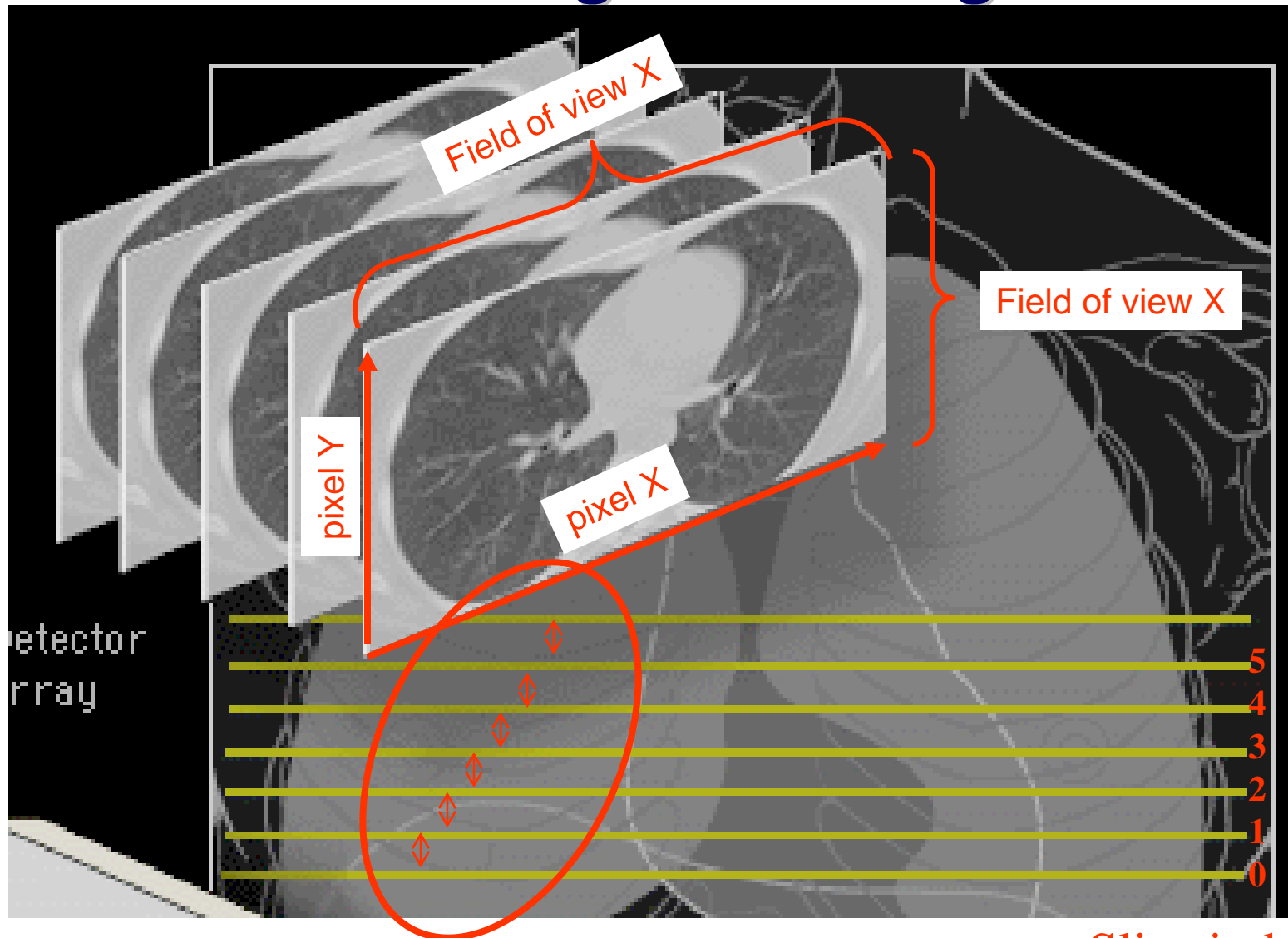
CT scanners



Examples to CT imaging



Measuring in CT image



Slice thickness

Slice index