

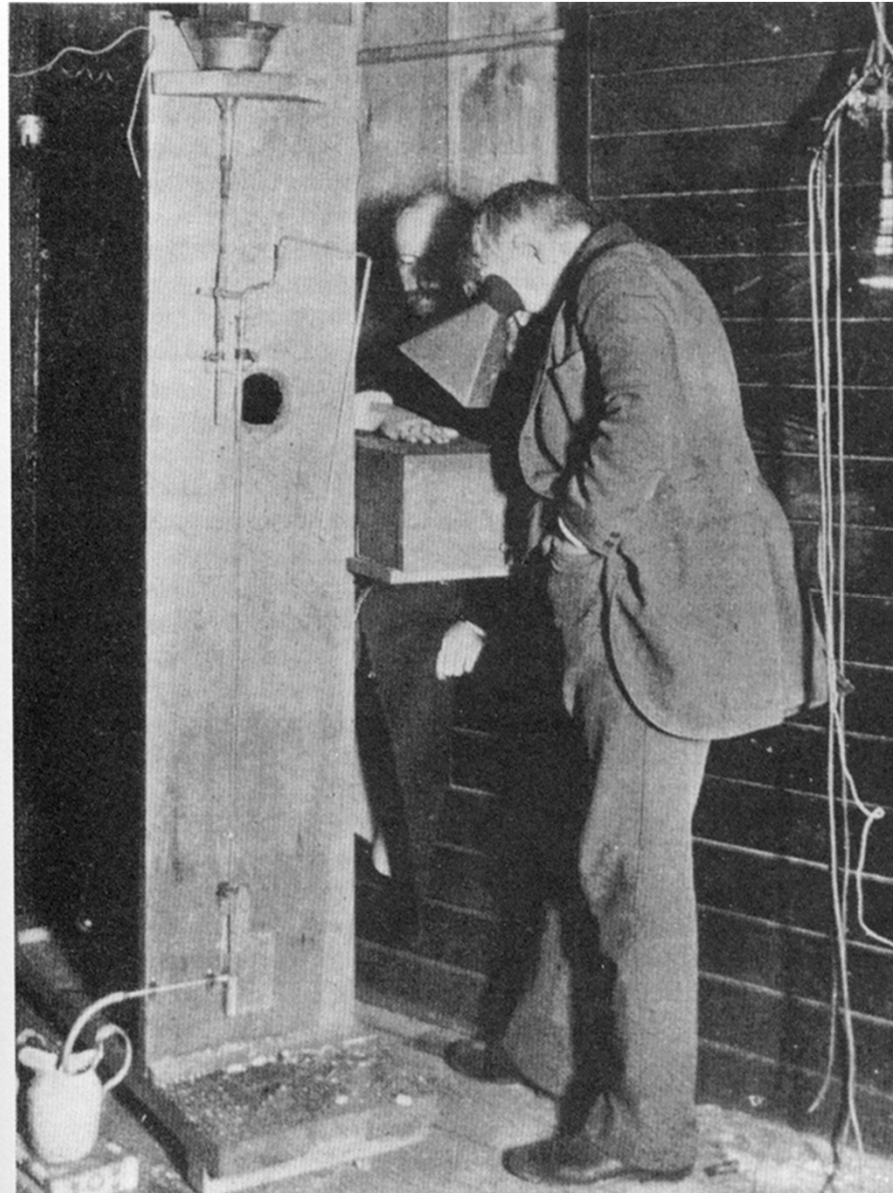
# Fluoroscopy and CT Imaging



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# Edison in his fluoroscope, 1896



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# The first commercial fluoroscope



Laboratory for F

, 2014



# X-ray + Television = Fluoroscopy

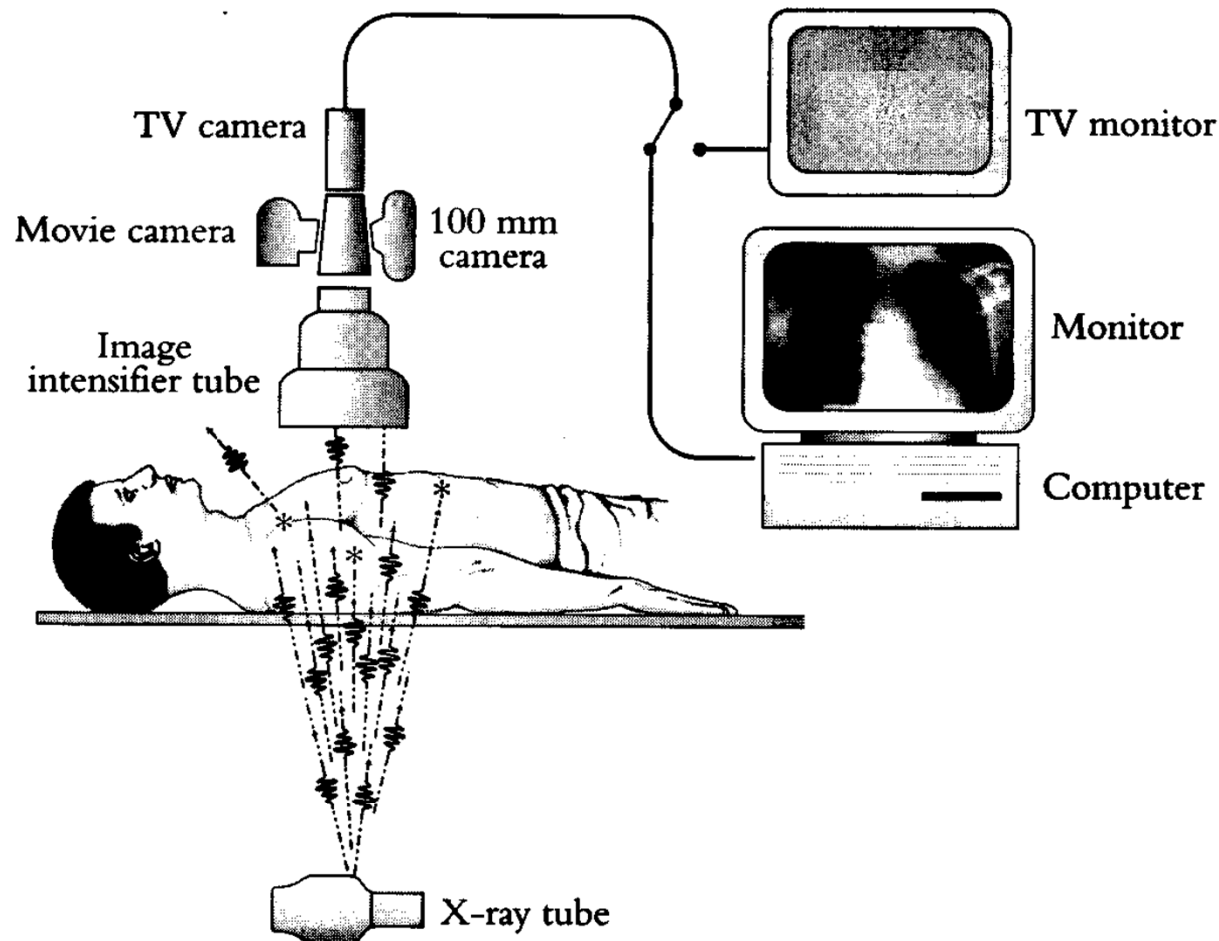
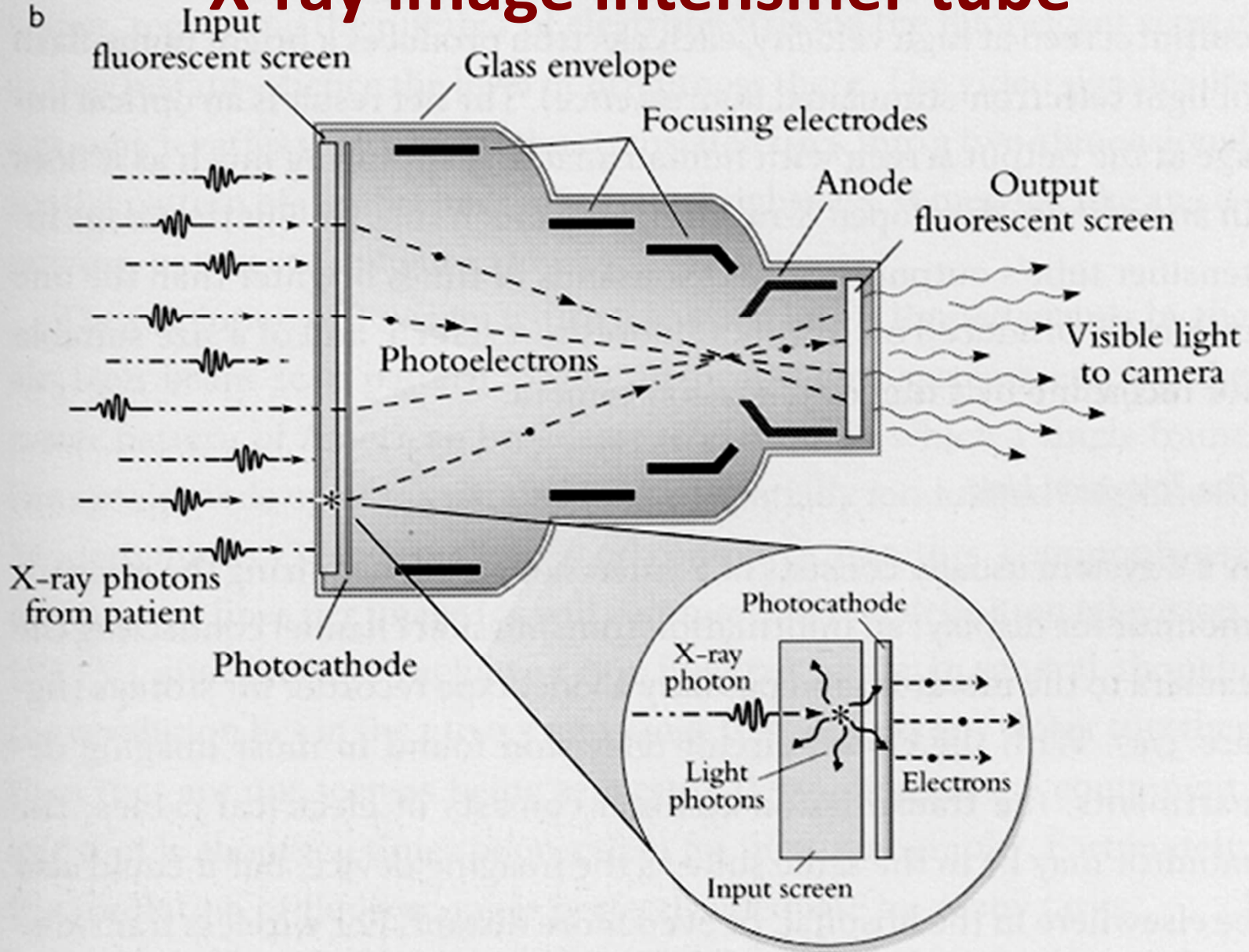


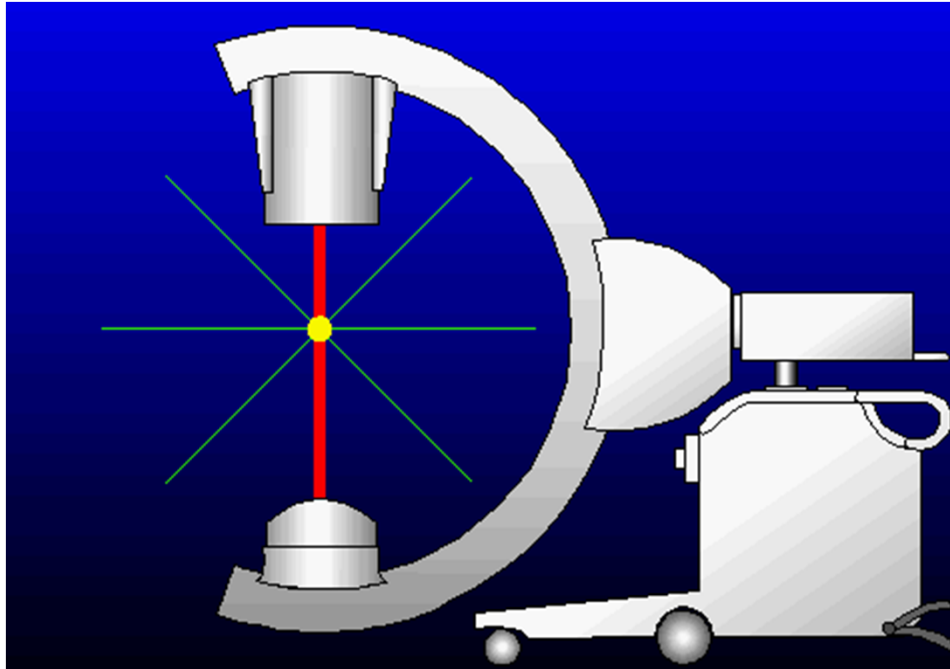
Figure 9. Fluoroscopy. The radiant energy from an X-ray tube passes through the patient, and the resulting X-ray shadows are transformed by the image intensifier into a bright image of visible light three centimeters or so in dimensions. This optical image, in turn, is captured by a 100 mm camera, a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



# X-ray image intensifier tube



# C-arm fluoroscopy



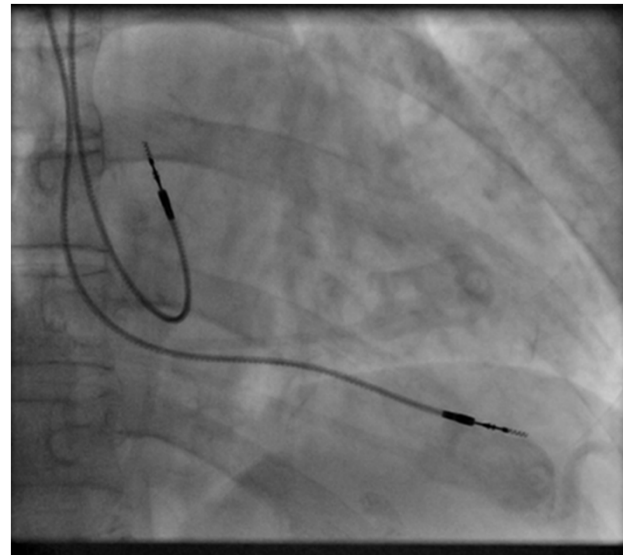
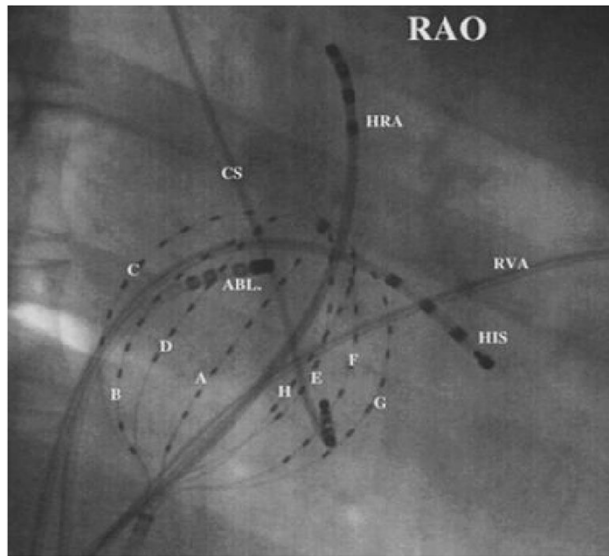
Siemens



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# Some fluoroscopy images



# Biplane fluoroscopy



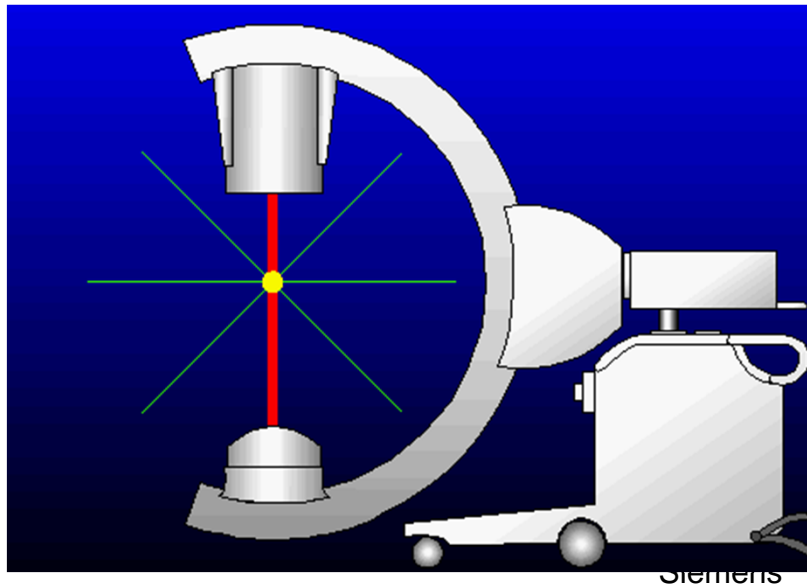
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# Pros and Cons for C-arm in Surgery

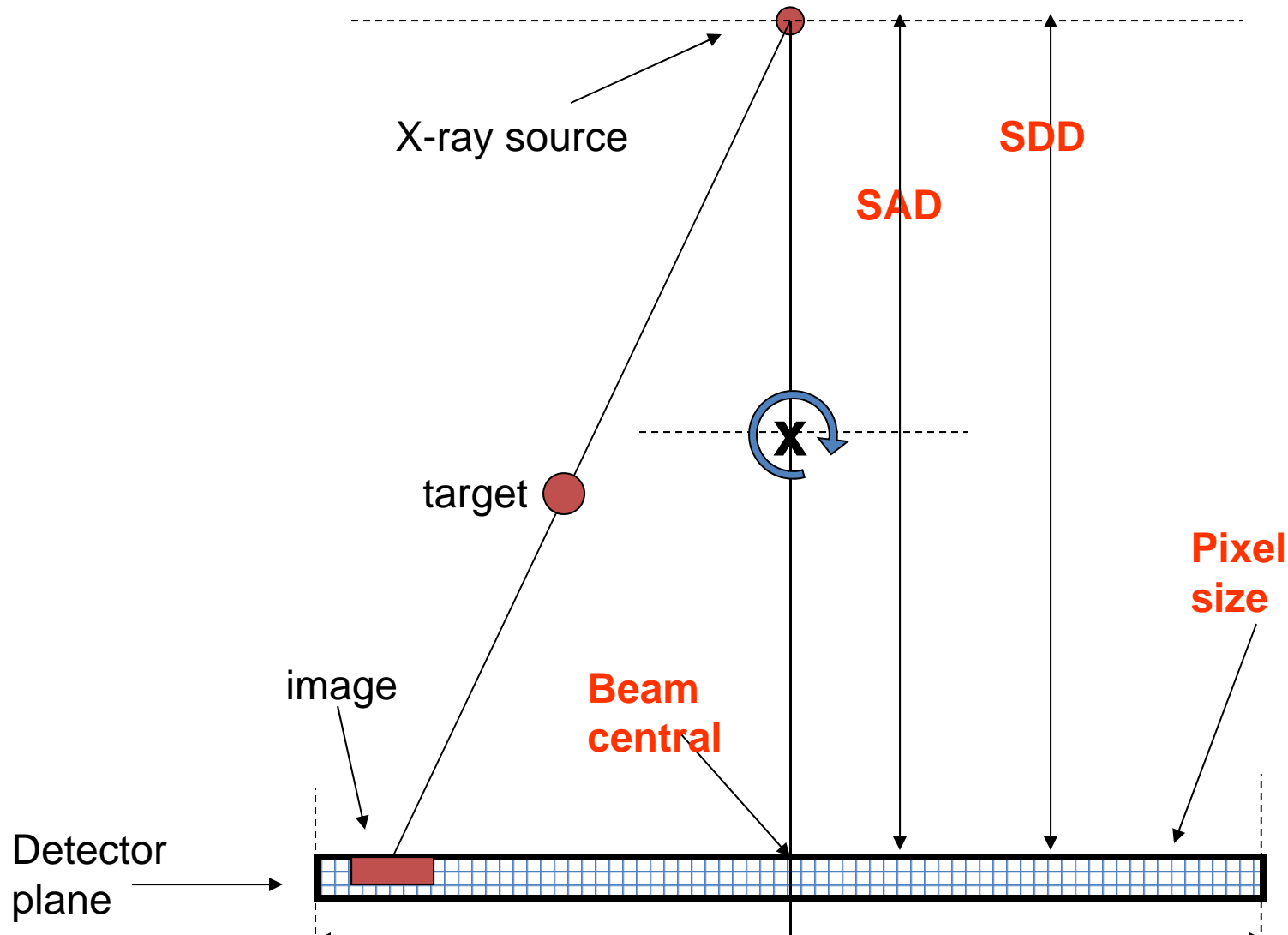
- Mobile
- Real-time
- Inexpensive
- Good bone contrast
- Broad insurance coverage



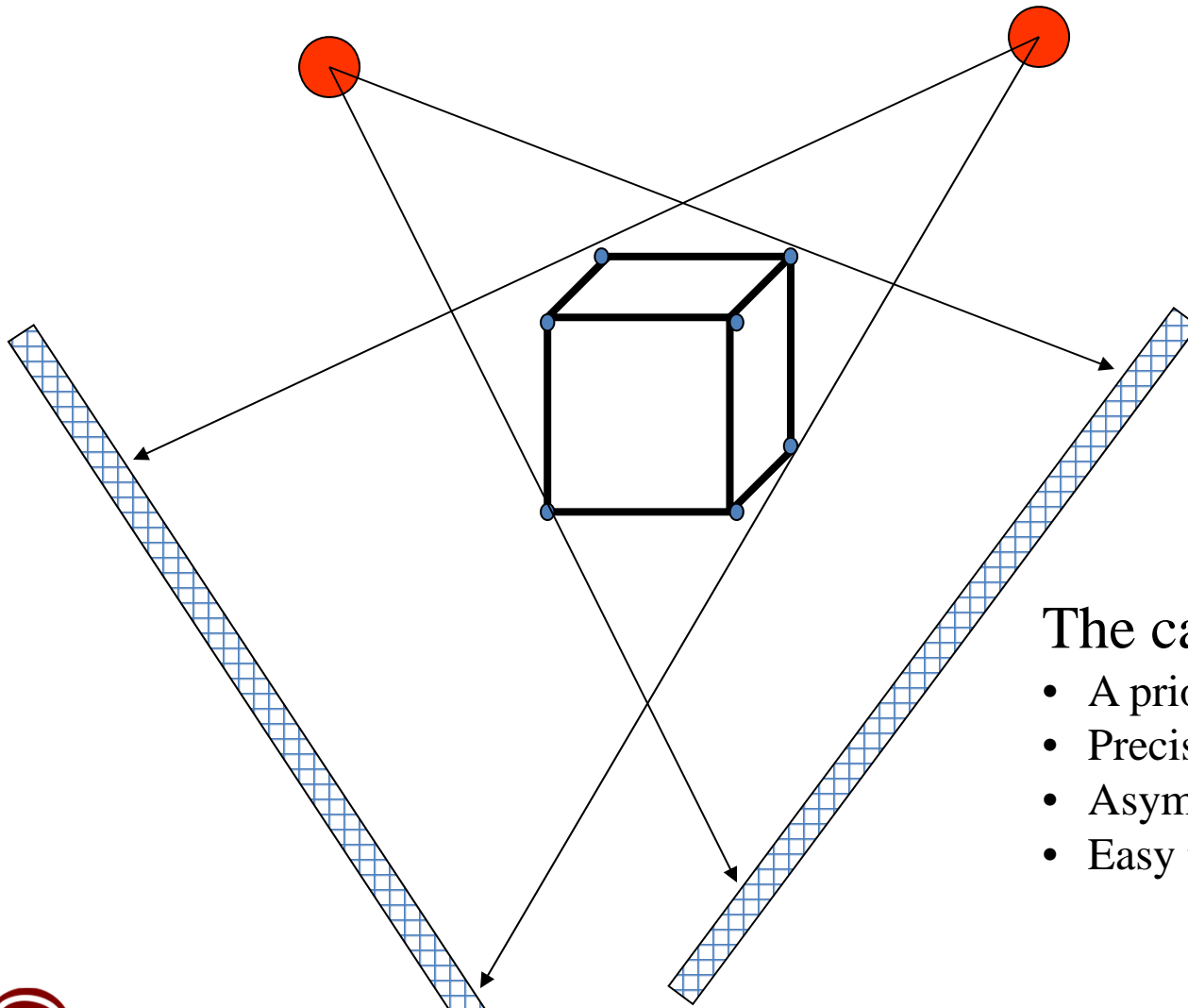
- Poor soft tissue contrast
- Limited rotation
- Limited field of view (9-15")
- Often non-isocentric
- Object truncation
- High X-ray dose to all parties
- Need for calibration
- Poor/no joint encoding
- Image warping
- Loss of depth & volume



# Calibration = determine unknown constant parameters



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

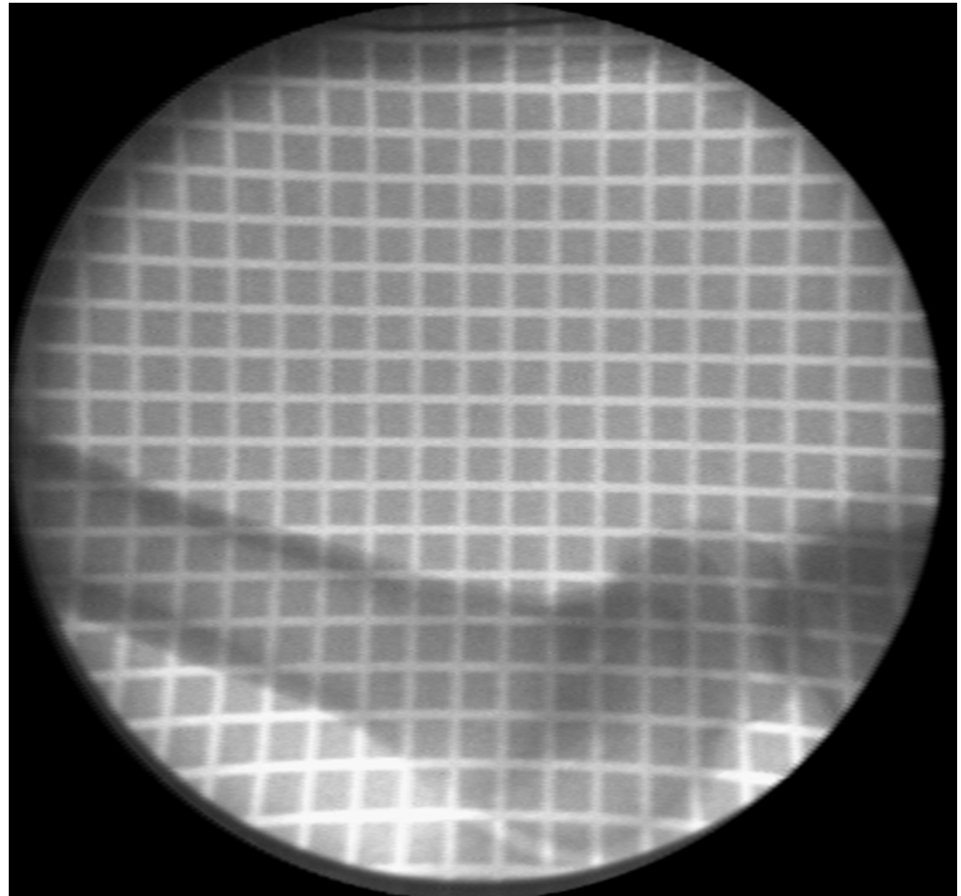
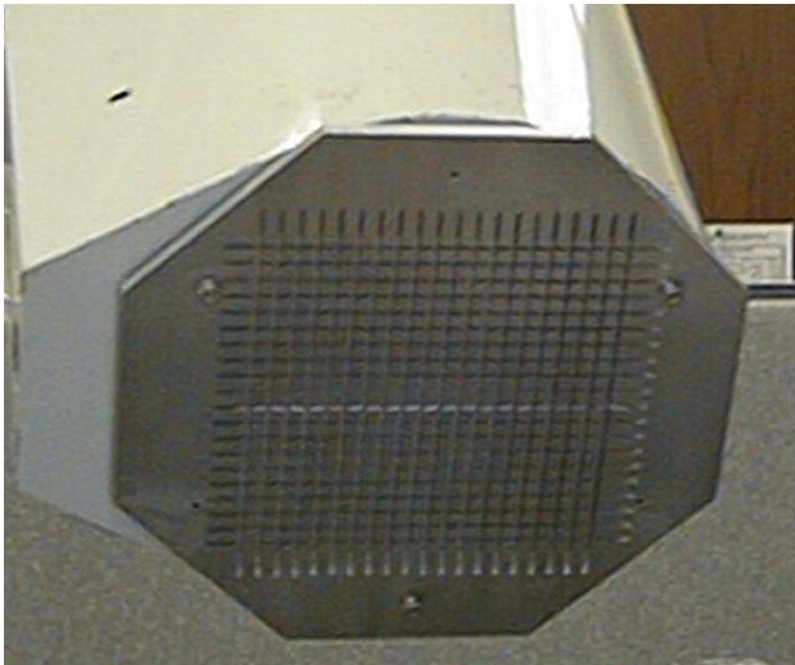


## The calibration fixture:

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



# Image warping



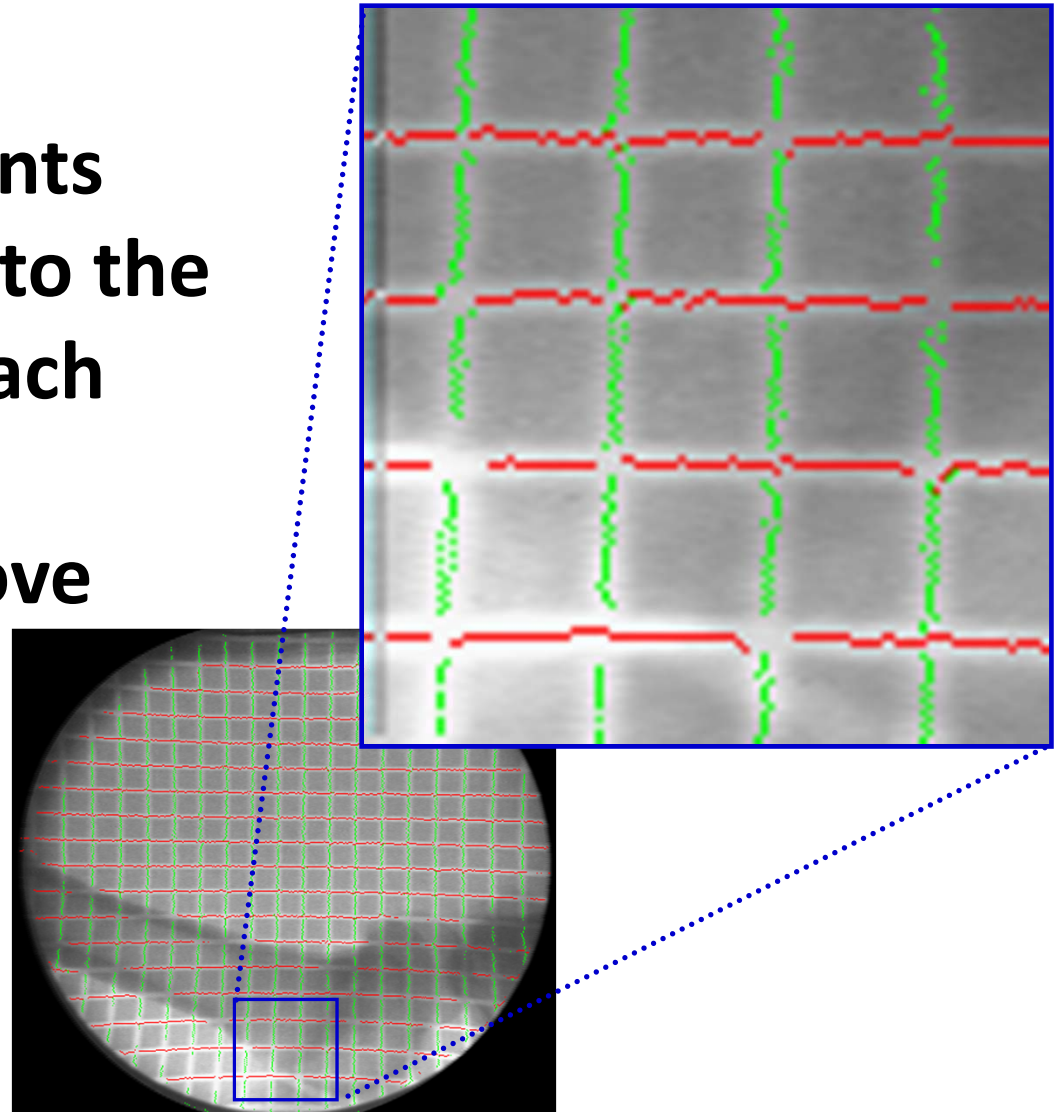
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Courtesy of Yao & Taylor



# Dewarping step-1: Find groove points

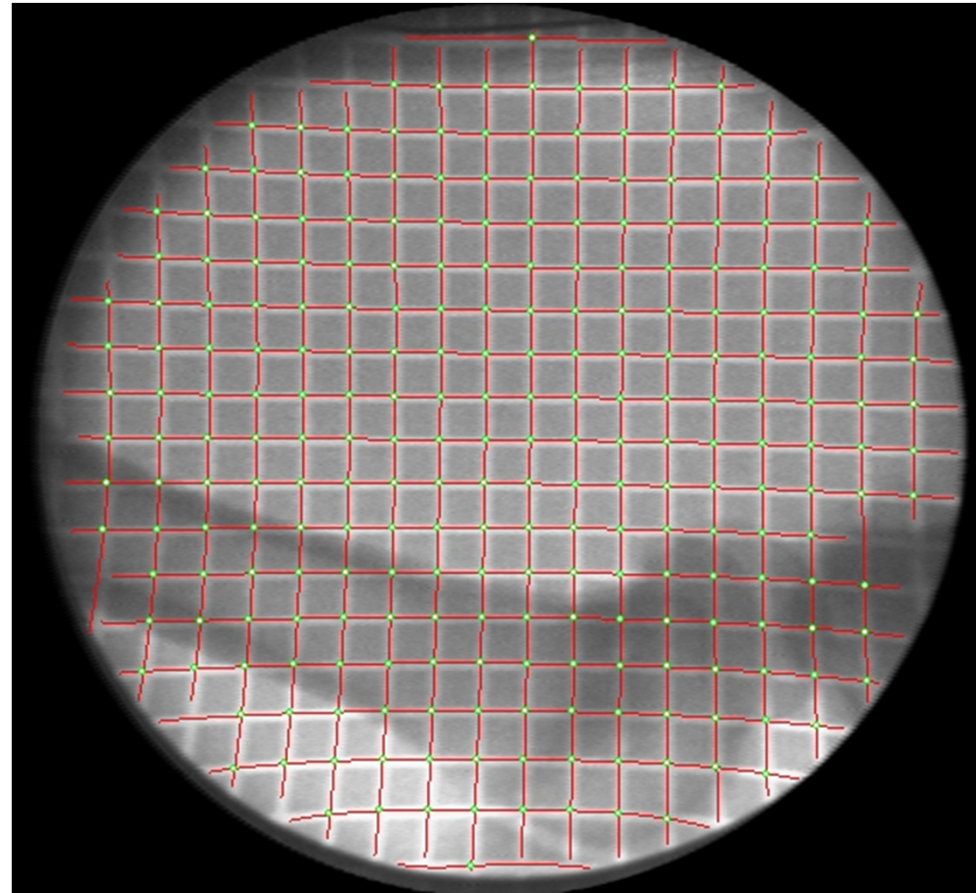
- Find image points corresponding to the centerline of each vertical and horizontal groove



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

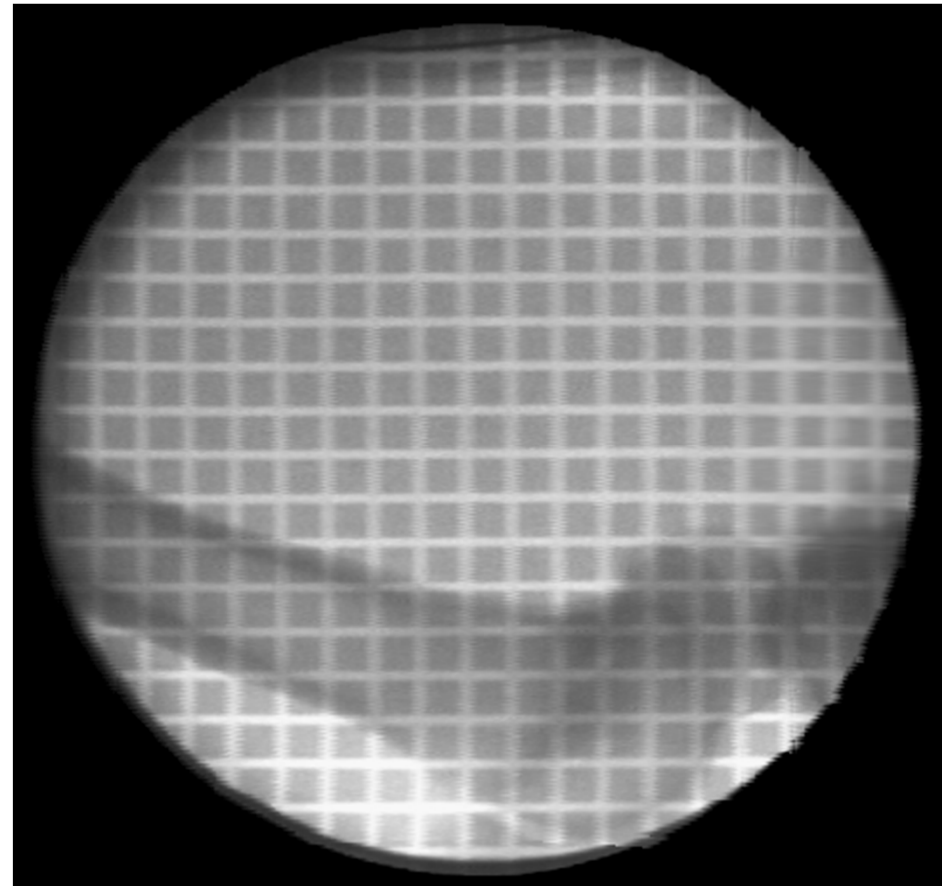
- Fit a least square smooth curve to each vertical and horizontal groove
- 5'th order Bernstein Polynomial

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

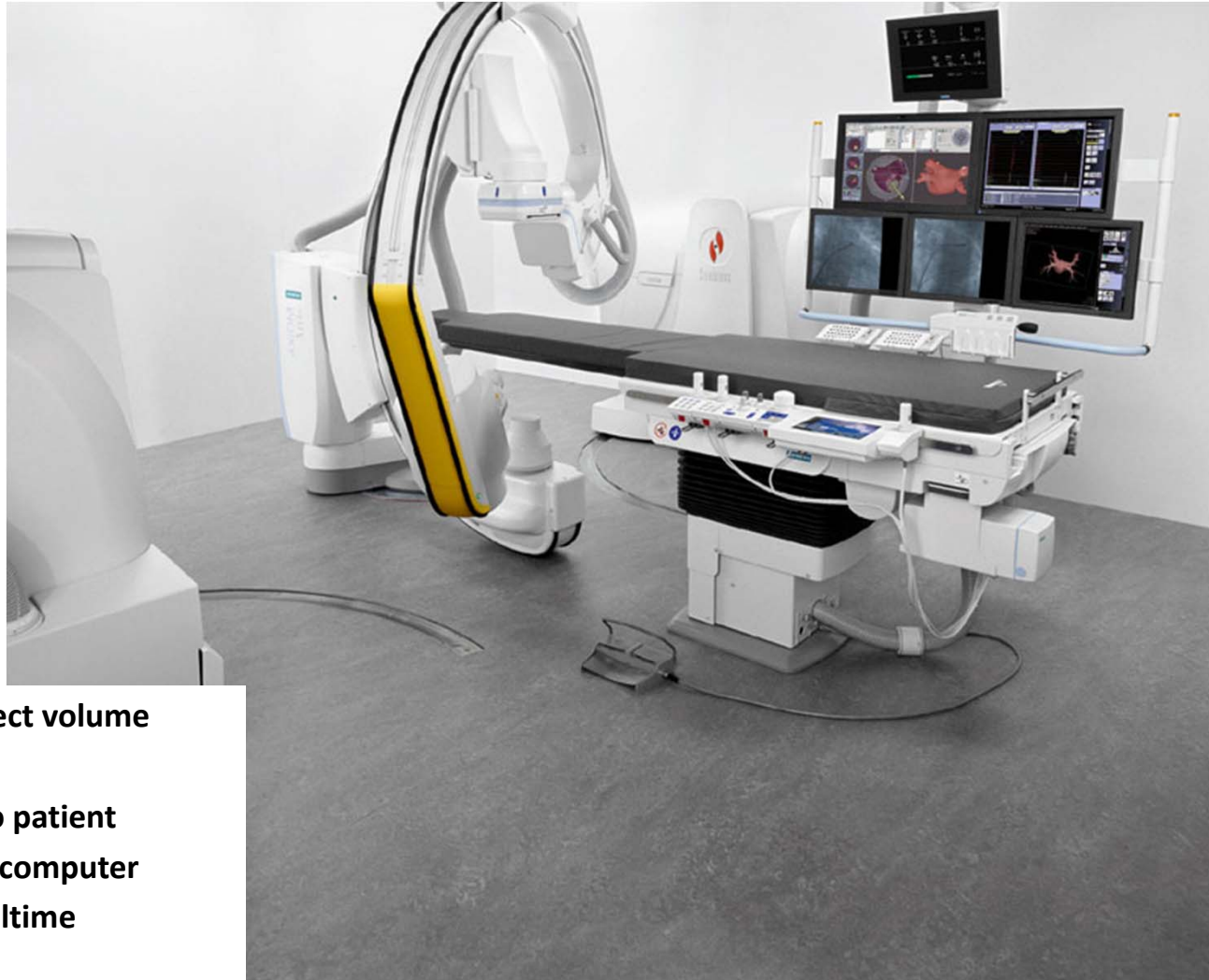


## Dewarping step-3 : Unbend the plate's image

- 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

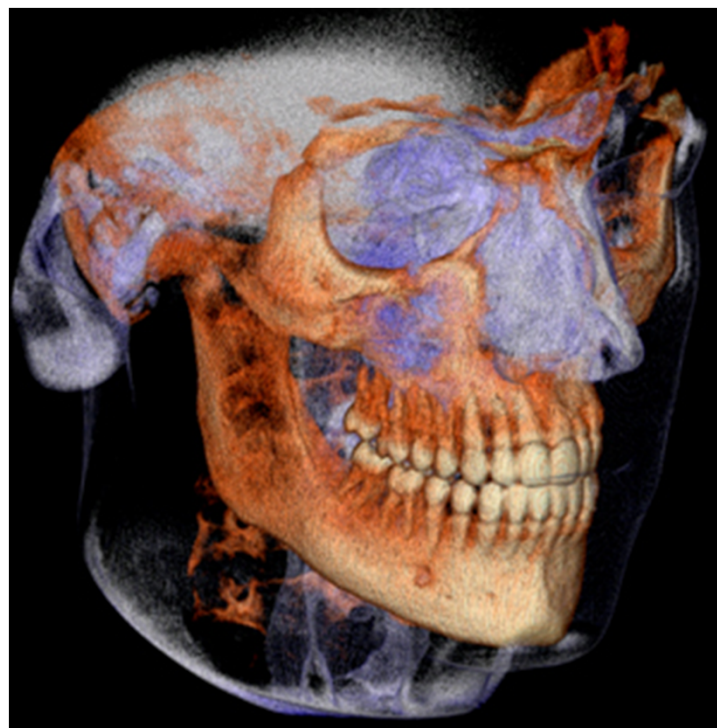


- **May give perfect volume**
- **Lots of shots**
- **Lots of dose to patient**
- **Ever faster on computer**
- **Possible in realtime**





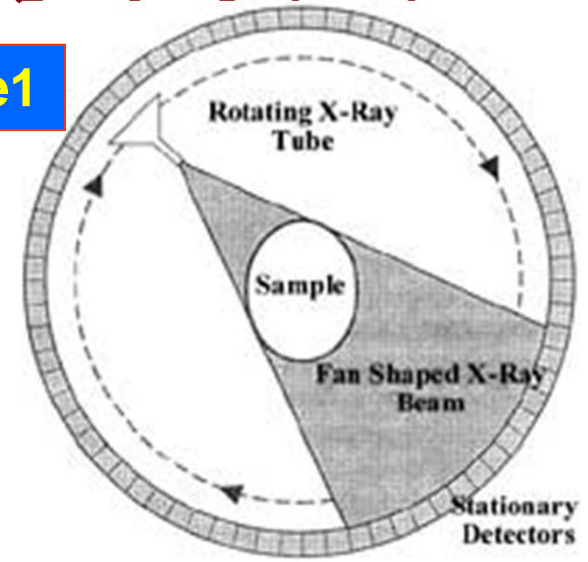
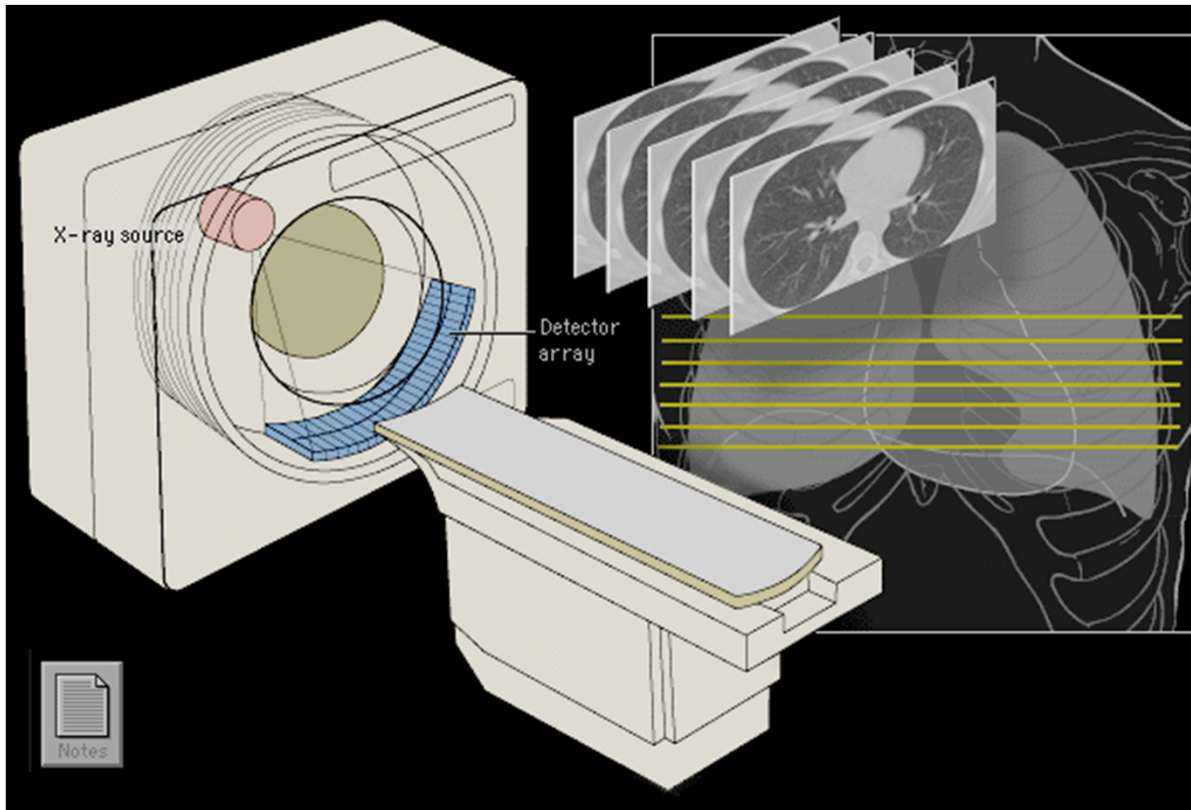
# Cone beam CT reconstruction examples



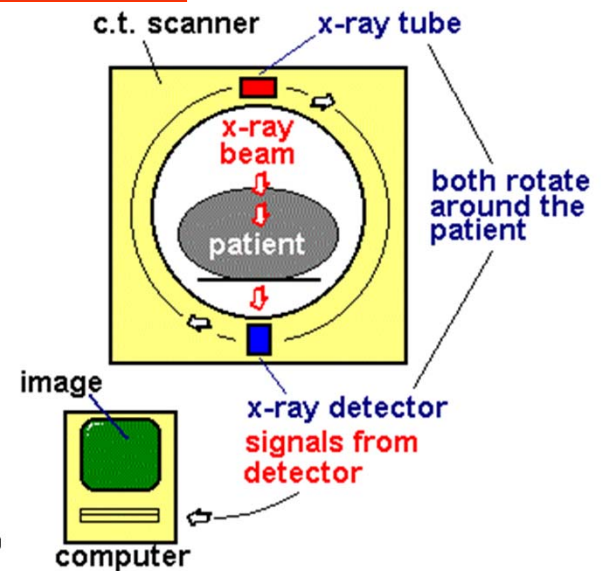
# Concept of Computed Tomography (CT)

Planar fan beam

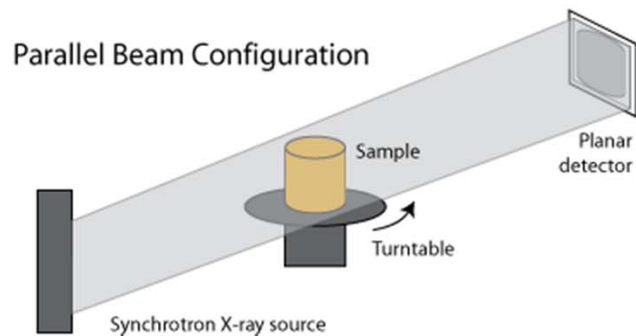
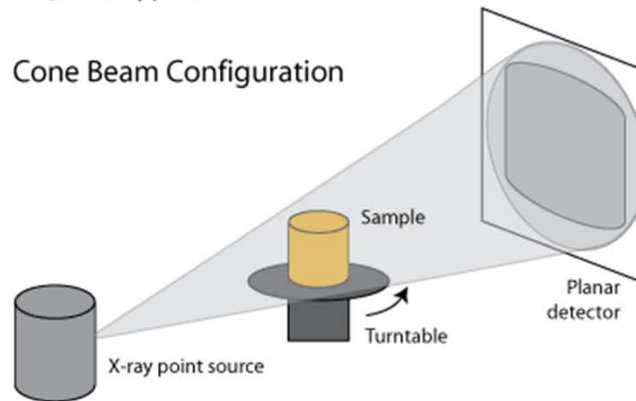
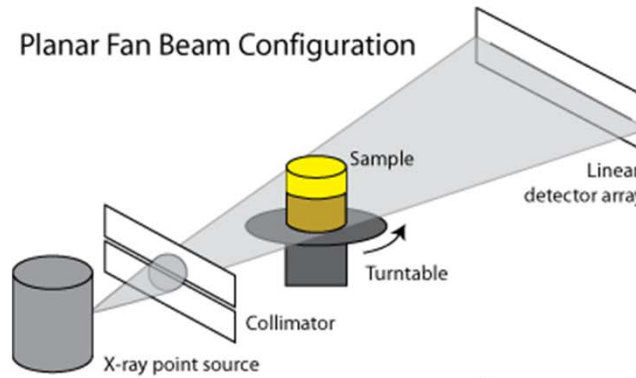
Type1



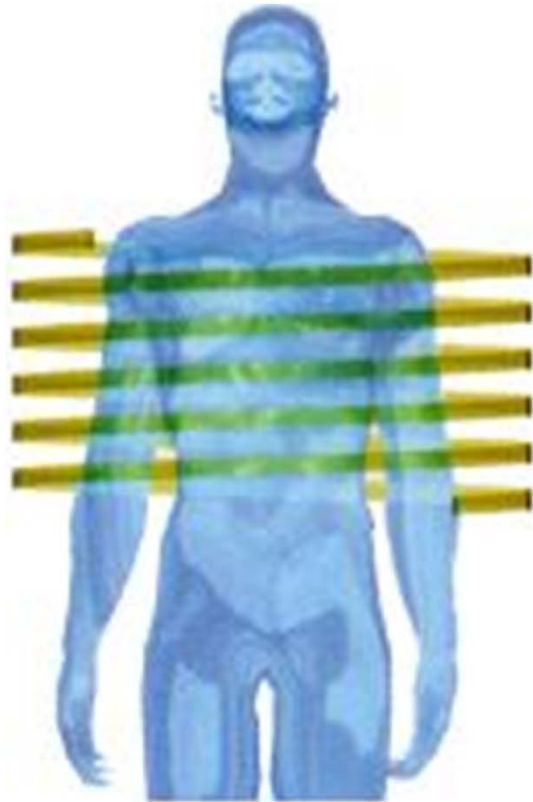
Type2



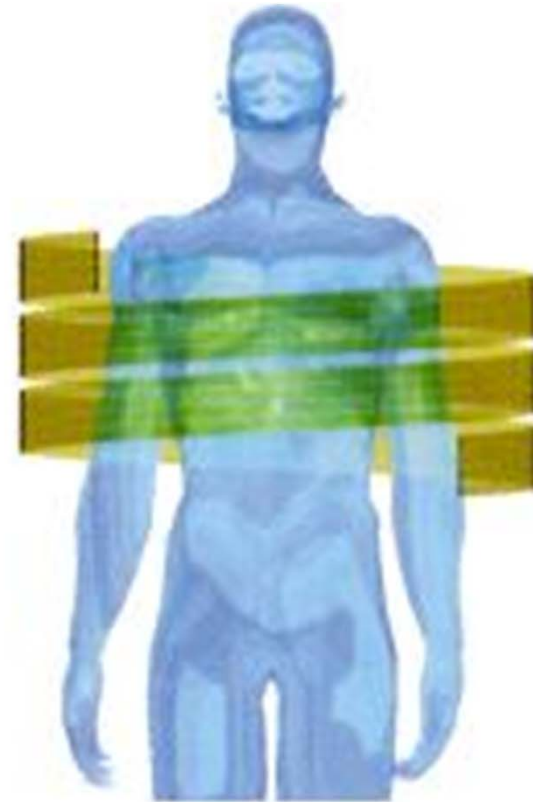
# Beam configurations



# 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/>



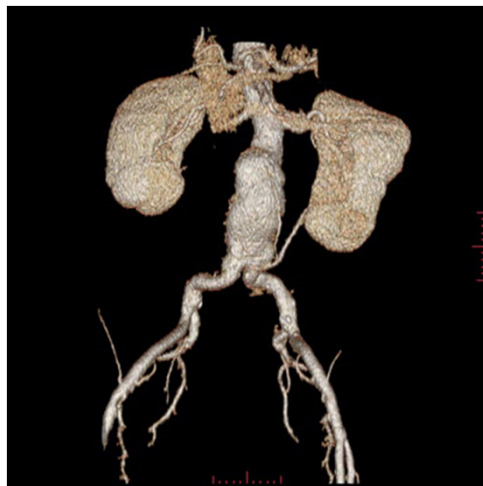
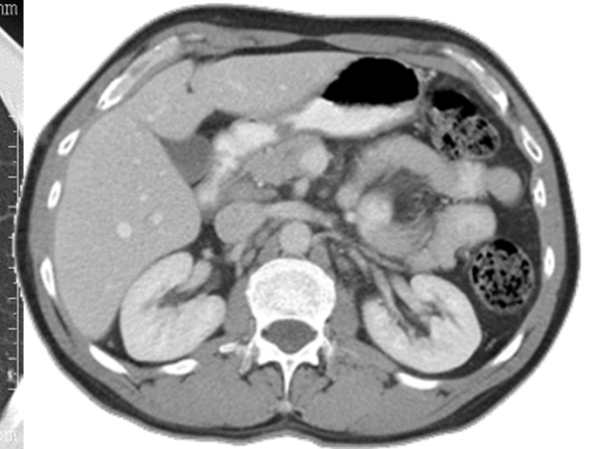
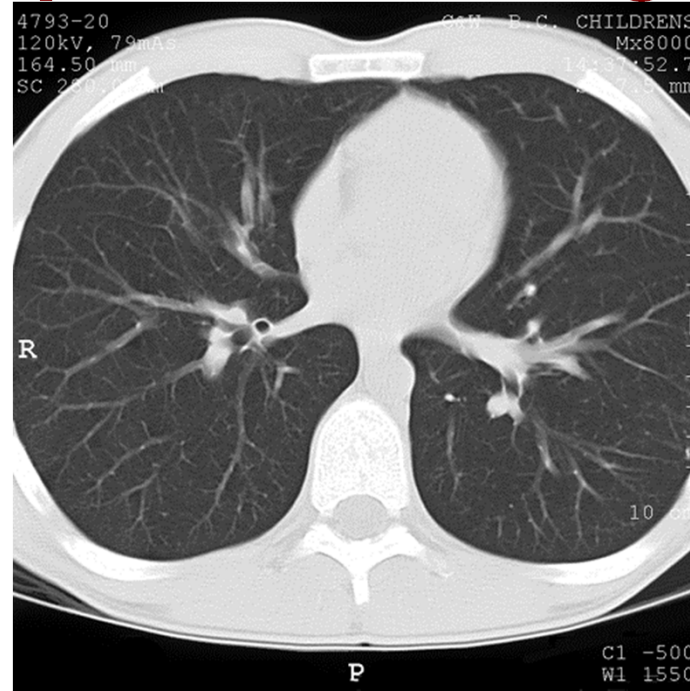
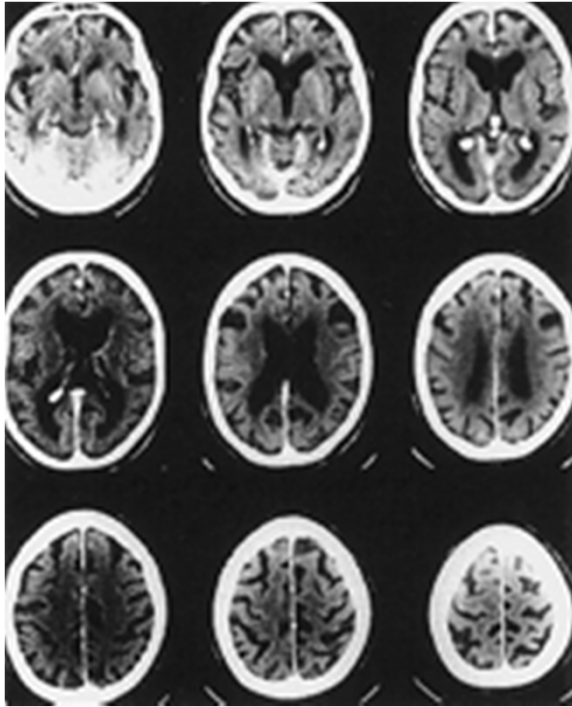
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# CT scanners



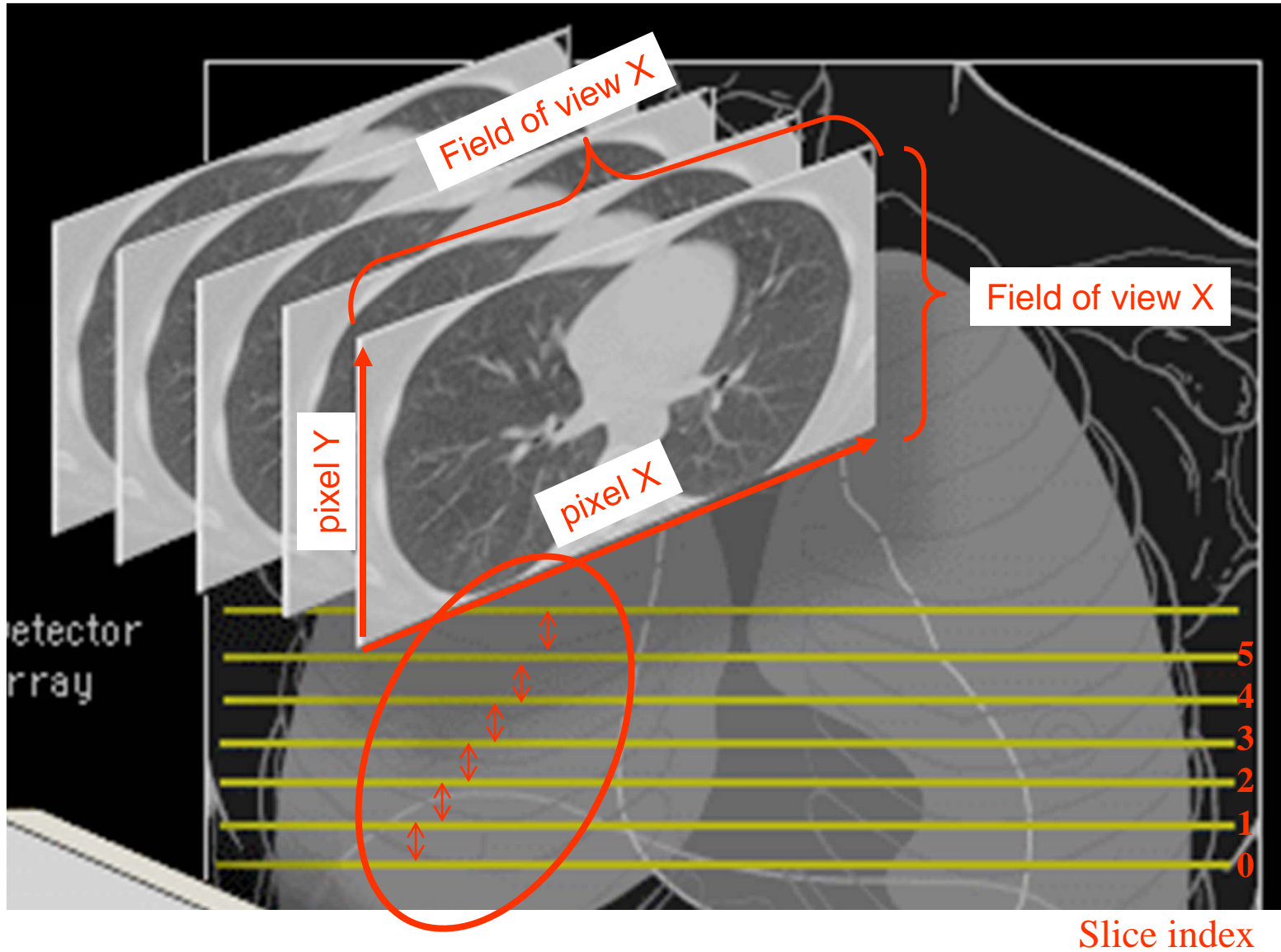
# Examples to CT imaging



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# Metric space and CT voxel space



Slice thickness

