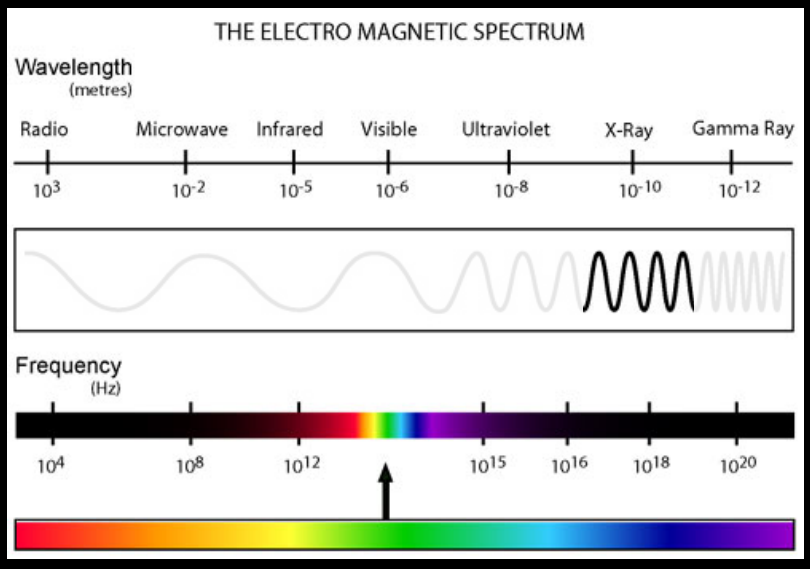
X-ray Basics

X-ray Basics: Basic Physics



X-ray Basics: Basic Physics

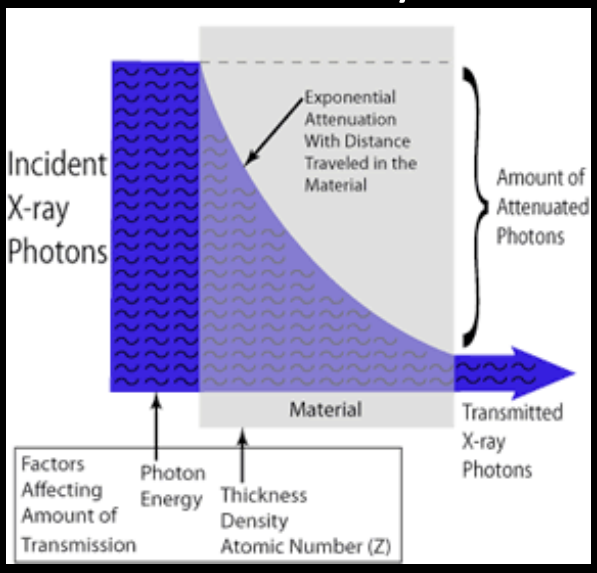
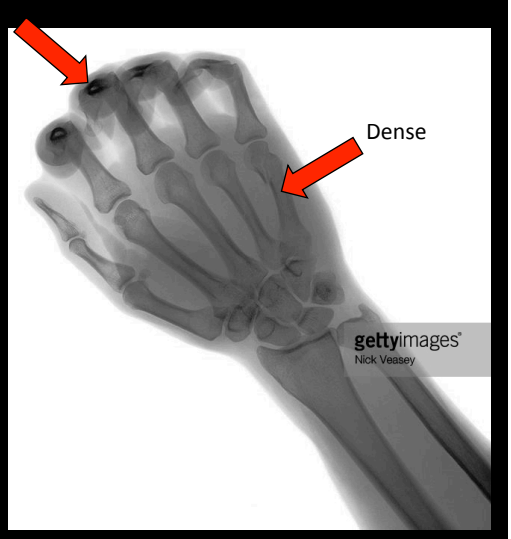
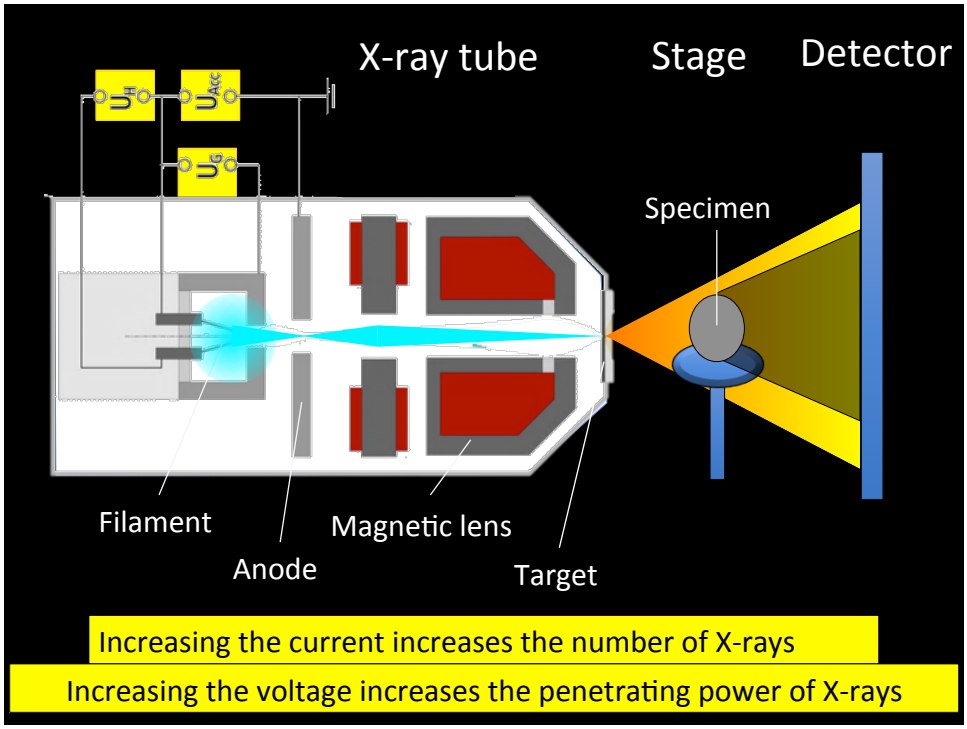


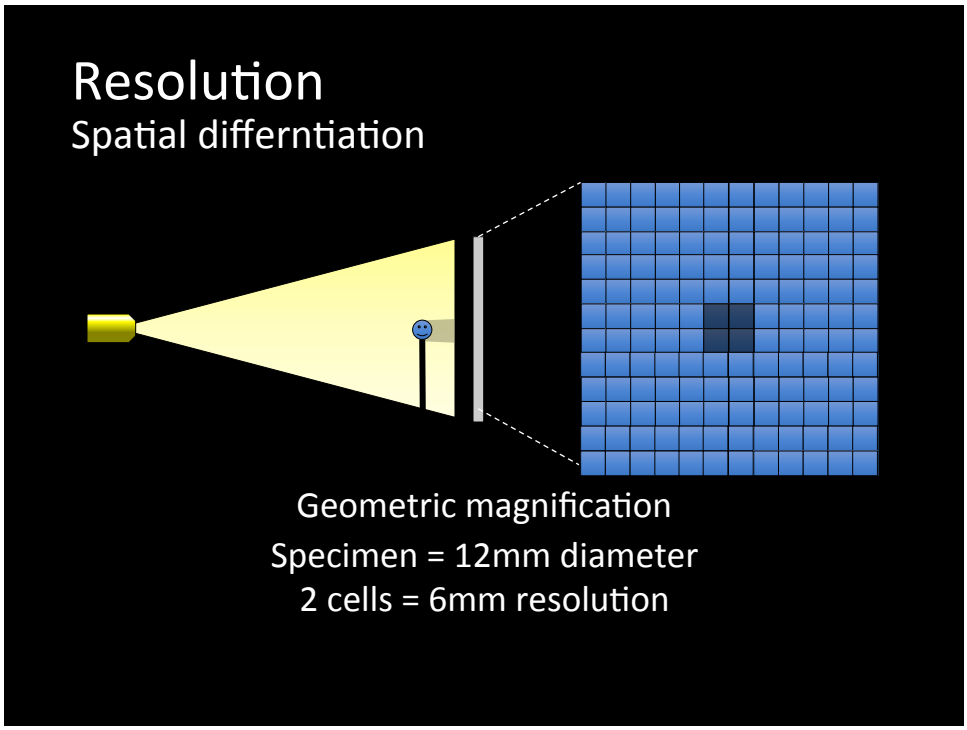
Image Source: http://www.ndted.org/EducationResources/CommunityCollege/Radiography/Physics/radmatinteraction.htm

X-ray Basics: Imaging Concepts

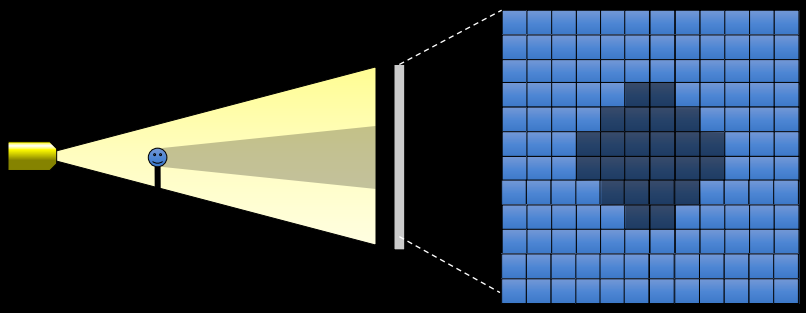
- Image = X-ray Population Map
- Dark Areas
  - = Sample Absorption
    - = less photons
- Bright areas
  - = Sample Transmittance
    - = more photons




X-ray tube
Stage
Detector
Specimen
Filament
Anode
Magnetic lens
Target
Increasing the current increases the number of X-rays
Increasing the voltage increases the penetrating power of X-rays

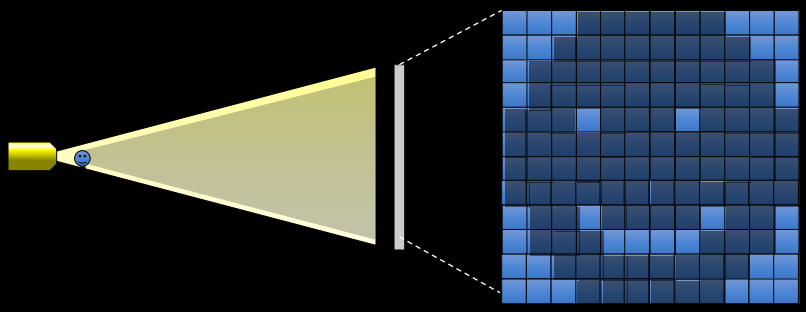

Resolution
Spatial differntiation
Geometric magnification
Specimen = 12mm diameter
2 cells = 6mm resolution

Resolution
Spatial differntiation



Geometric magnification
Specimen = 12mm diameter
6 cells = 2mm resolution

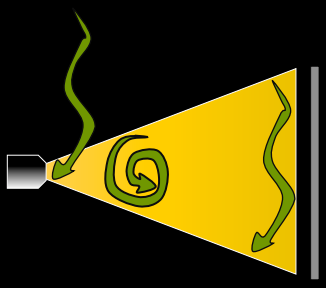
Resolution
Spatial differntiation

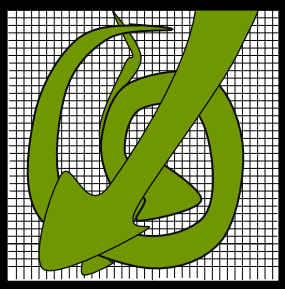


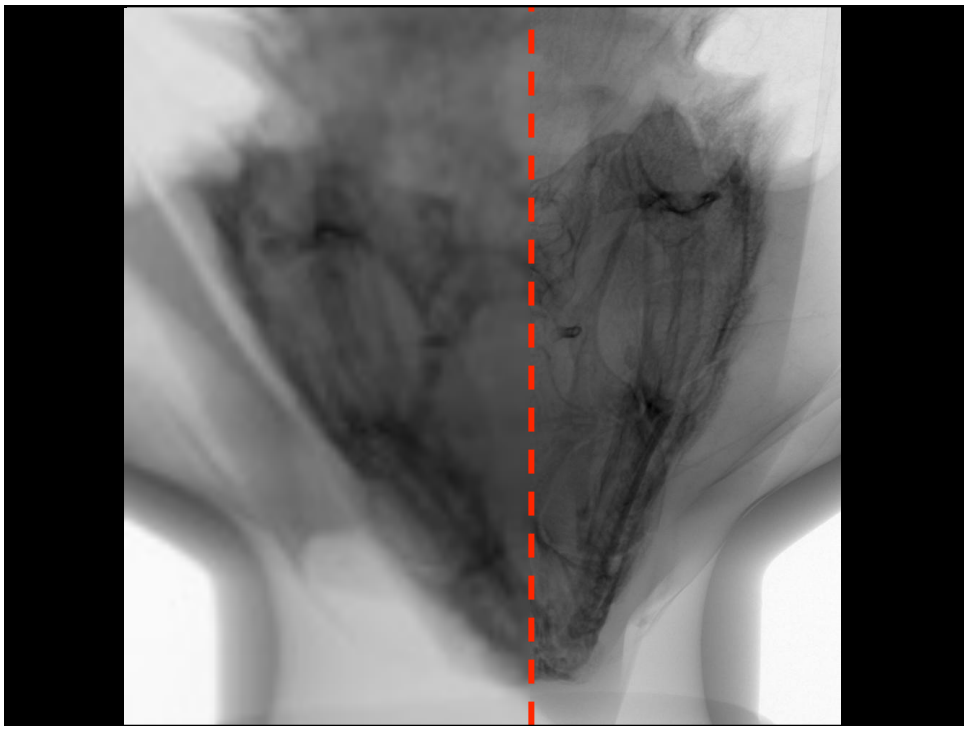
Geometric magnification
Specimen = 12mm diameter
12 cells = 1mm resolution

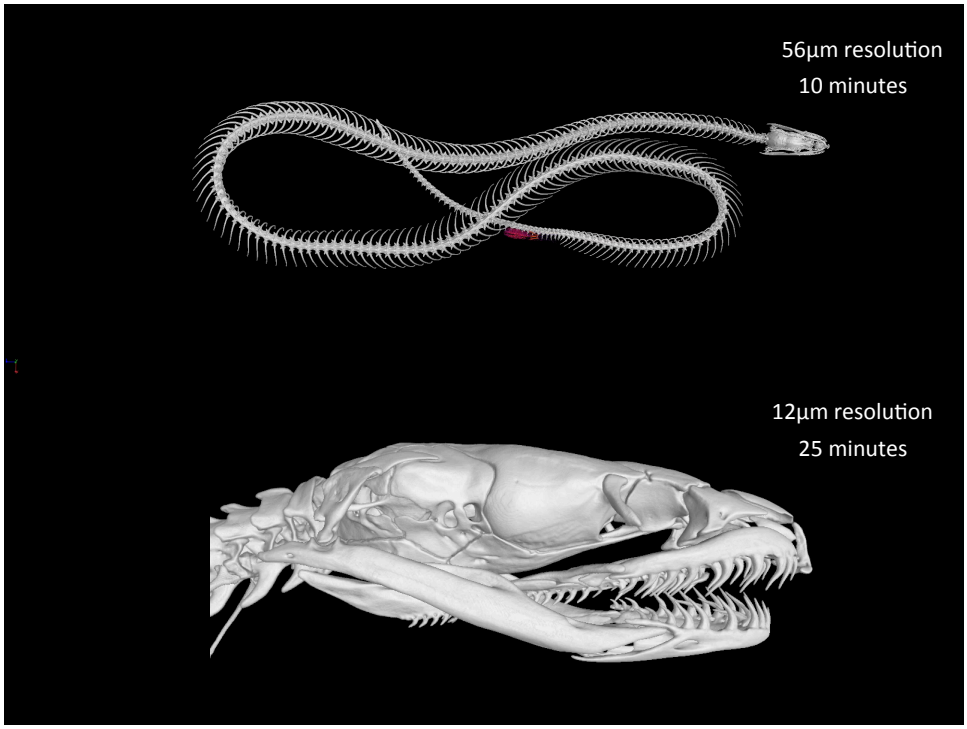
Sample preparation

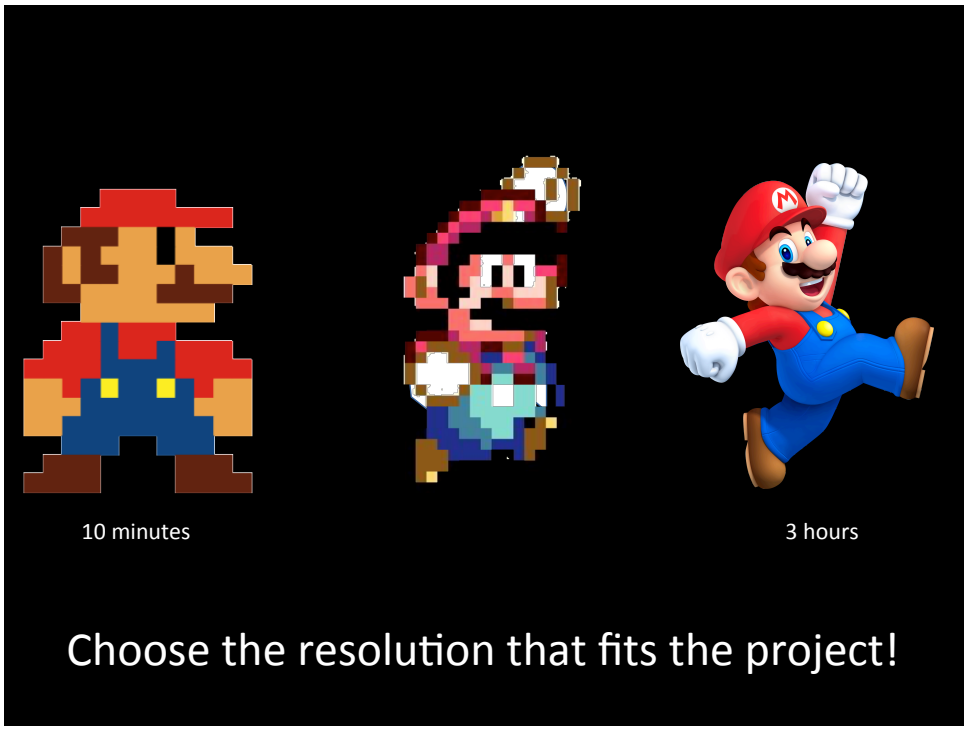
- Maximize the resolution of the scan
  - Square Detector plate
  - Efficient use of space
    - Cylindrical is better
    - Centralized position
  - Multi-scan used for odd shaped samples
    - Increased time
    - Can lead to truly colossal file sizes








56µm resolution
10 minutes
12µm resolution
25 minutes


10 minutes
3 hours
Choose the resolution that fits the project!

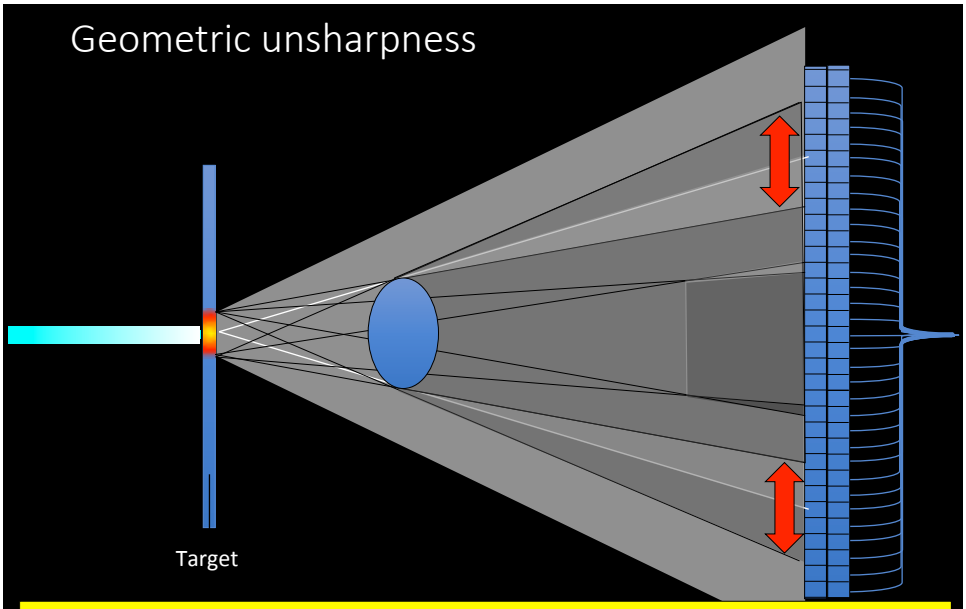
Contrast
density differentiation

- Contrast
  - X-ray energy (KV)
  - kV=X-ray penetrating power
  - Too high
    - No X-rays stopped by object
    - loss of resolvability in low density areas
  - Too low
    - All X-rays stopped by object
    - loss of resolvability in high density areas
  - Maximize grayscale range

Noise

- Too few photons to produce a clear image
  - Grainy reconstructions
- Increase photons
  - Increase current
    = increase photons
  - Increase detector capture time
    = Increase photons

Geometric unsharpness

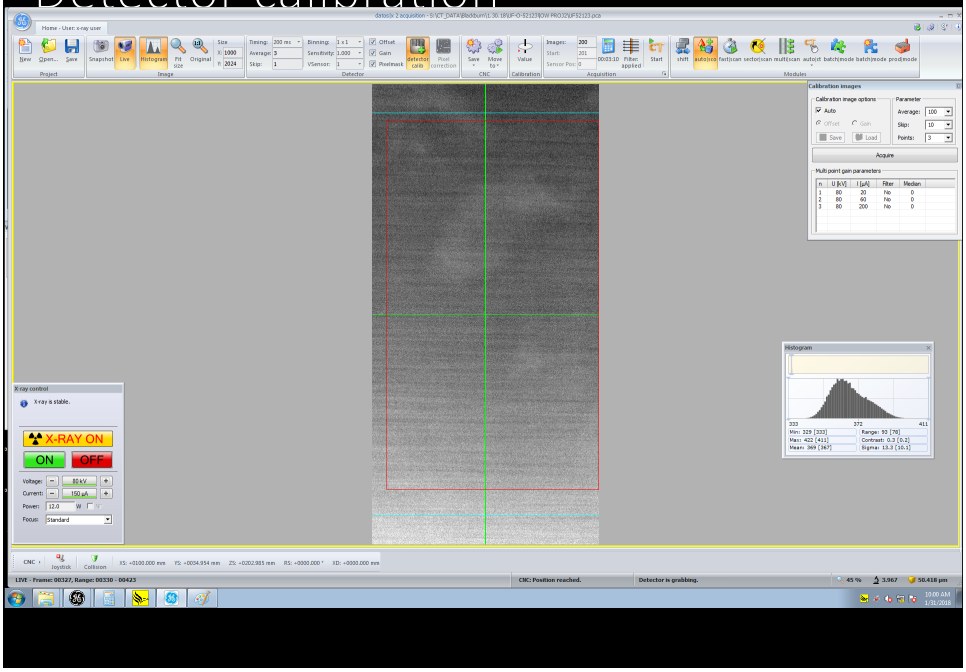


Higher

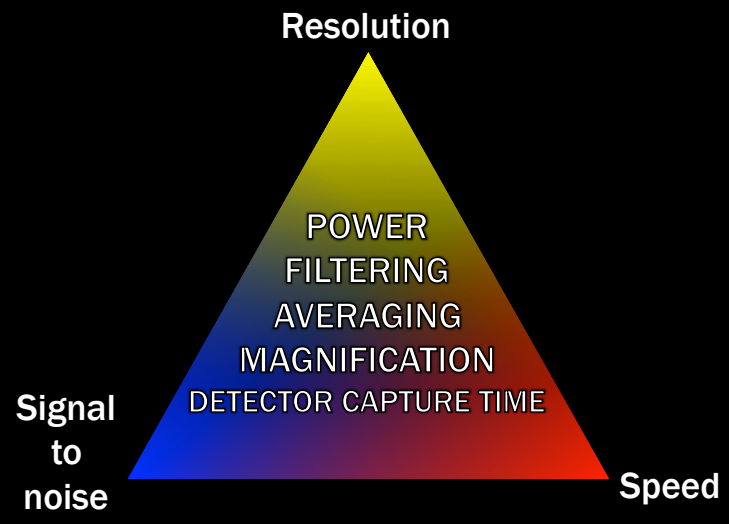
power (W) ≤ the resolution (µm)

Hi

Detector calibration



A series of trade-offs



X-ray Summary

- Voltage: Increases Penetrating Power of X-rays
- Current: Increases number / Intensity of X-rays
- Resolution: spatial differentiation
- Contrast: attenuation differentiation
- Noise- a result of insufficient signal
- Geometric unsharpness: focal spot too large