Crash course in X-ray imaging

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Inverse Problems course 2015

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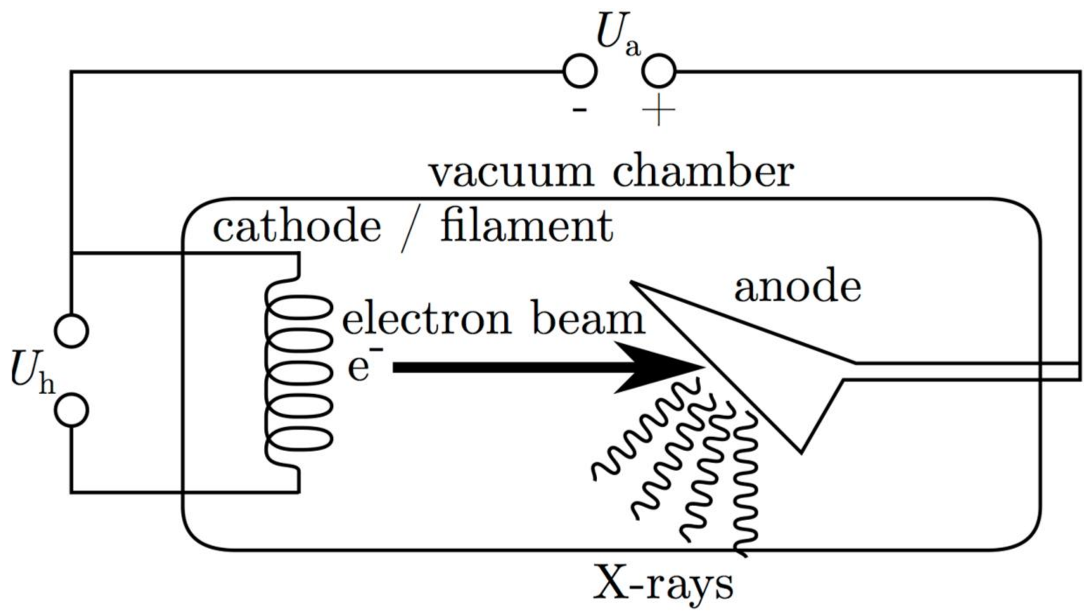
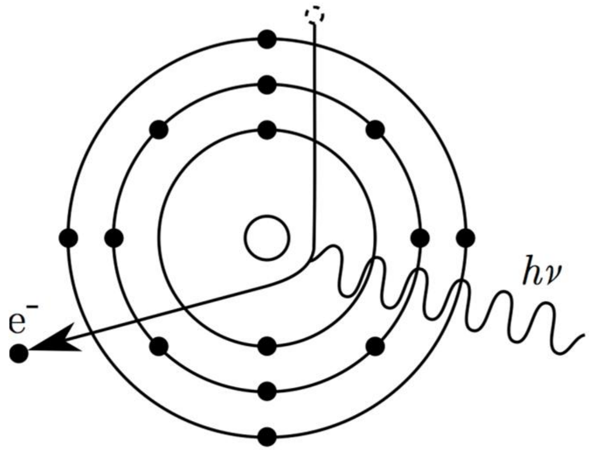
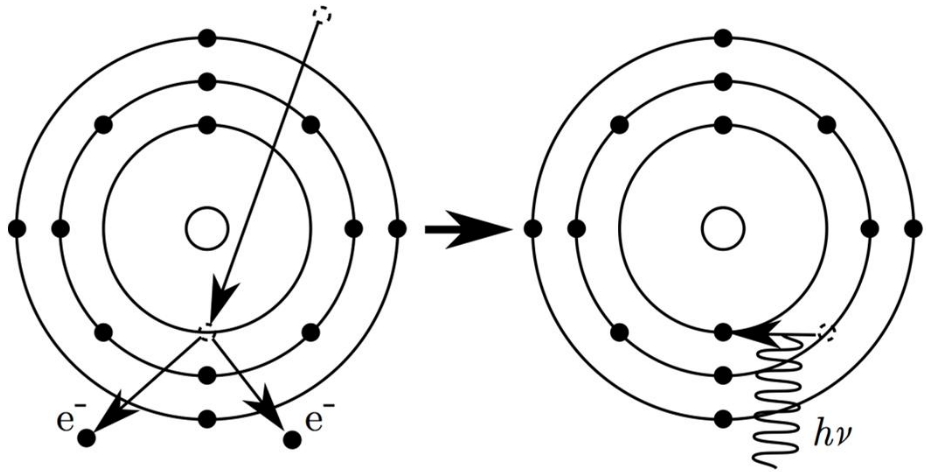
X-ray generation, part I: The X-ray tube



X-ray generation, part II
Electron-matter interactions

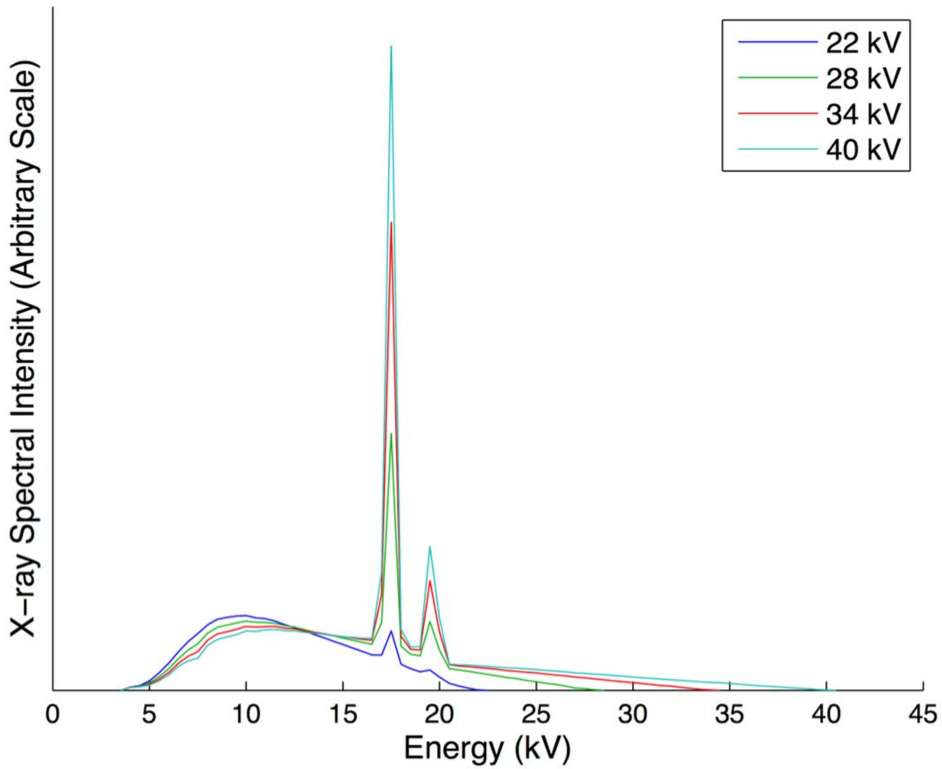


Brehmsstrahlung

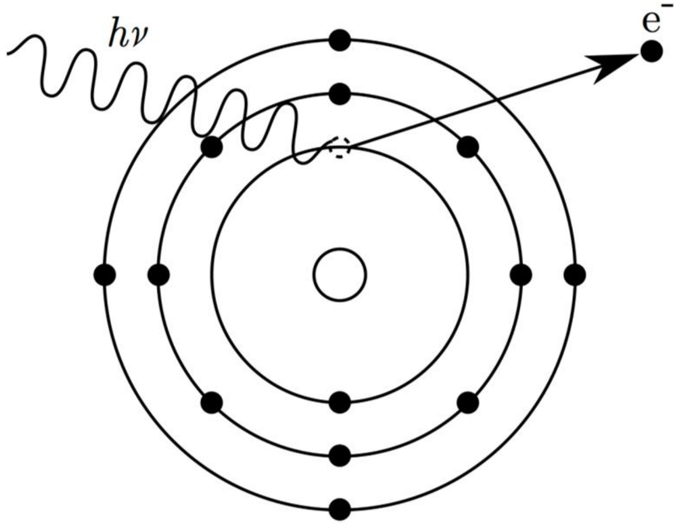


Characteristic X-rays

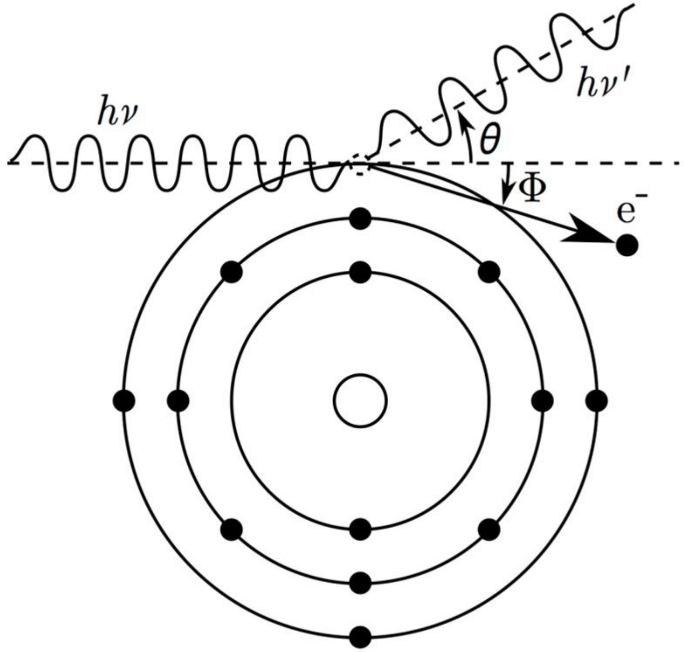
X-ray generation, part III:
Mo target energy spectrum



Photon-matter interactions



Photoelectric effect



Compton scattering

X-ray attenuation, part I: Beer-Lambert Law

- X-ray attenuation in matter is described by the *Beer-Lambert law*
- In homogenous matter:

$$I = I_o e^{-\mu s}$$

- In heterogenous matter:

$$I = I_o e^{-\int_{ray} \mu(x,y) ds}$$

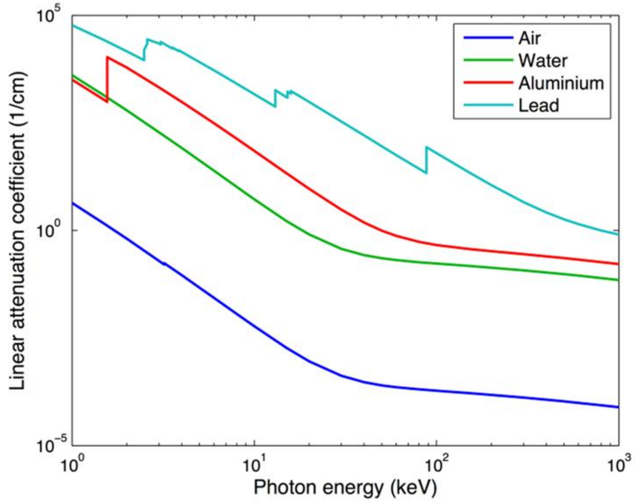
$$\rightarrow -\ln\left(\frac{I}{I_0}\right) = \int_{ray} \mu(x,y) ds$$

X-ray attenuation, part II: Energy dependency

- Attenuation coefficients are a function of energy E
  $\rightarrow$ The Beer-Lambert law must be corrected:

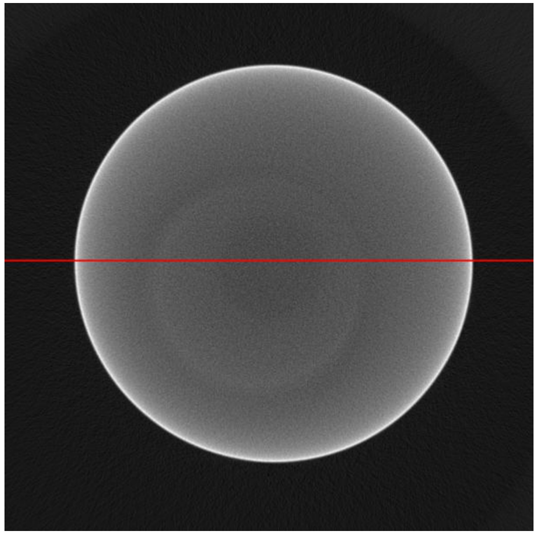
$$I = I_0(E)e^{\int_{ray} \mu(x,y,E)ds} dE$$

- It is usually assumed in tomography that μ is energy independent
  $\rightarrow$ This can lead to imaging artefacts

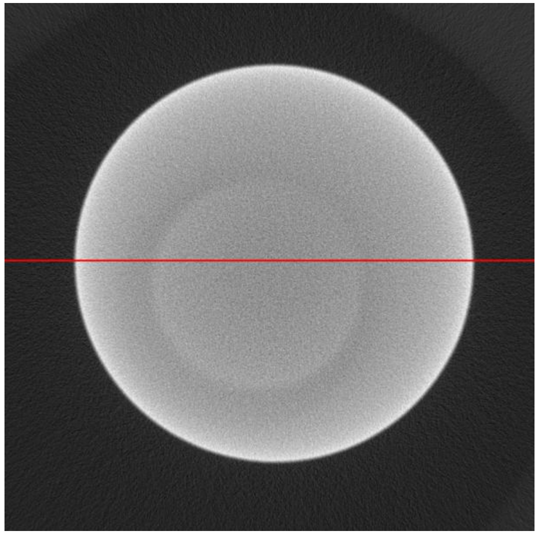


X-ray attenuation, part III: X-ray projection image

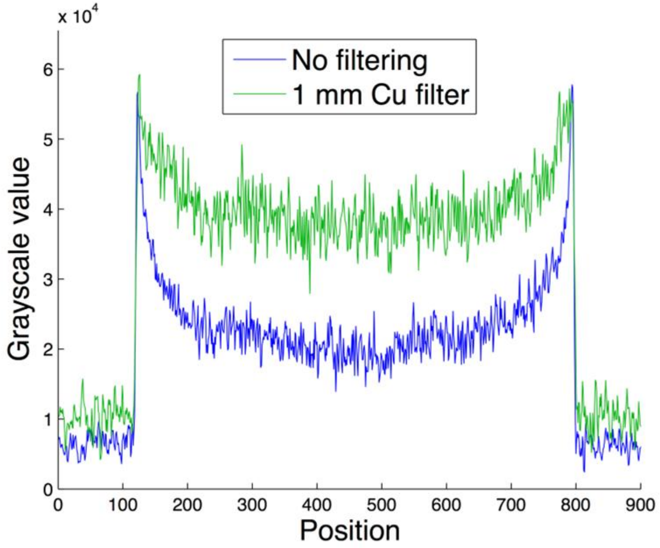
X-ray attenuation, part IV: Beam-hardening artefacts



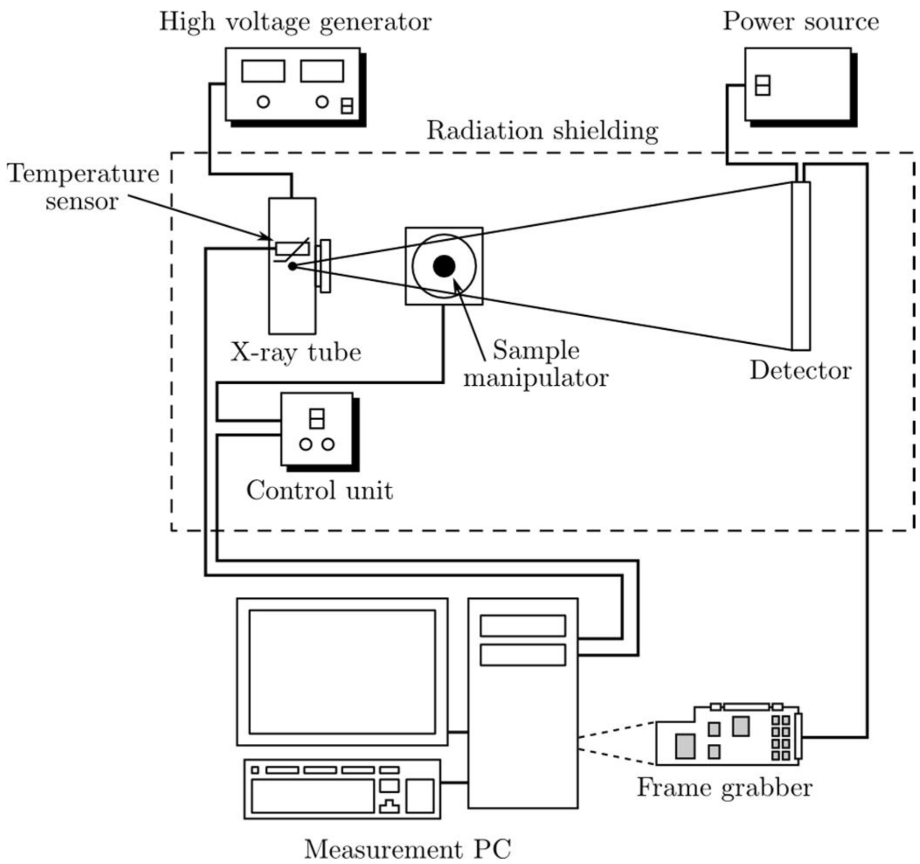
No filter



1 mm Cu filter

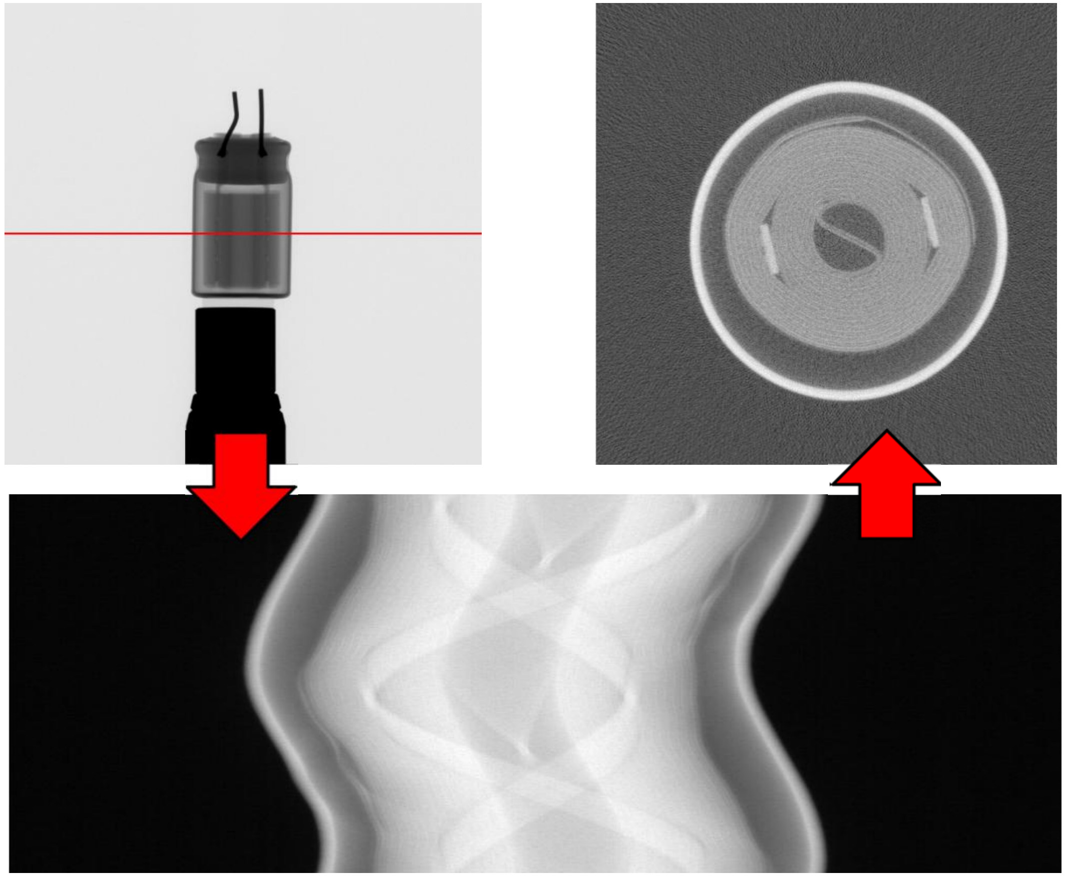


Industrial Mathematics Computed Tomography (CT) Laboratory



CT Reconstruction: Projections → sinogram → slice

$$Effective\ pixel\ size = 26.1\ \mu m$$



Questions?