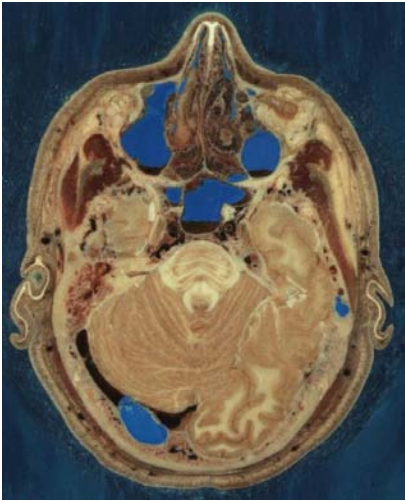


Kako stvari delujejo?

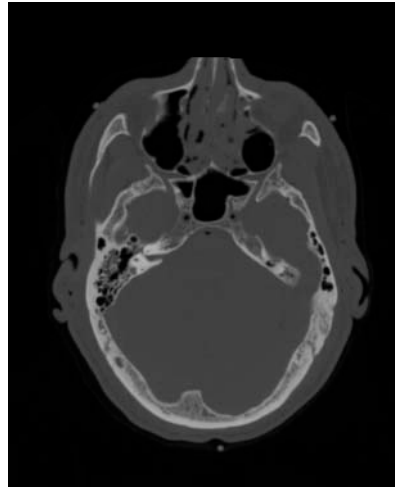
Rentgen, CT

primerjava

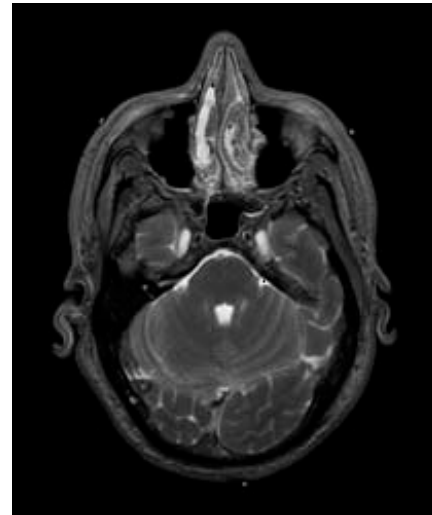
optika



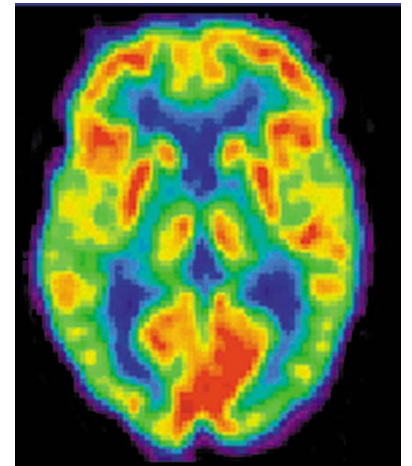
UZ



CT



MRI

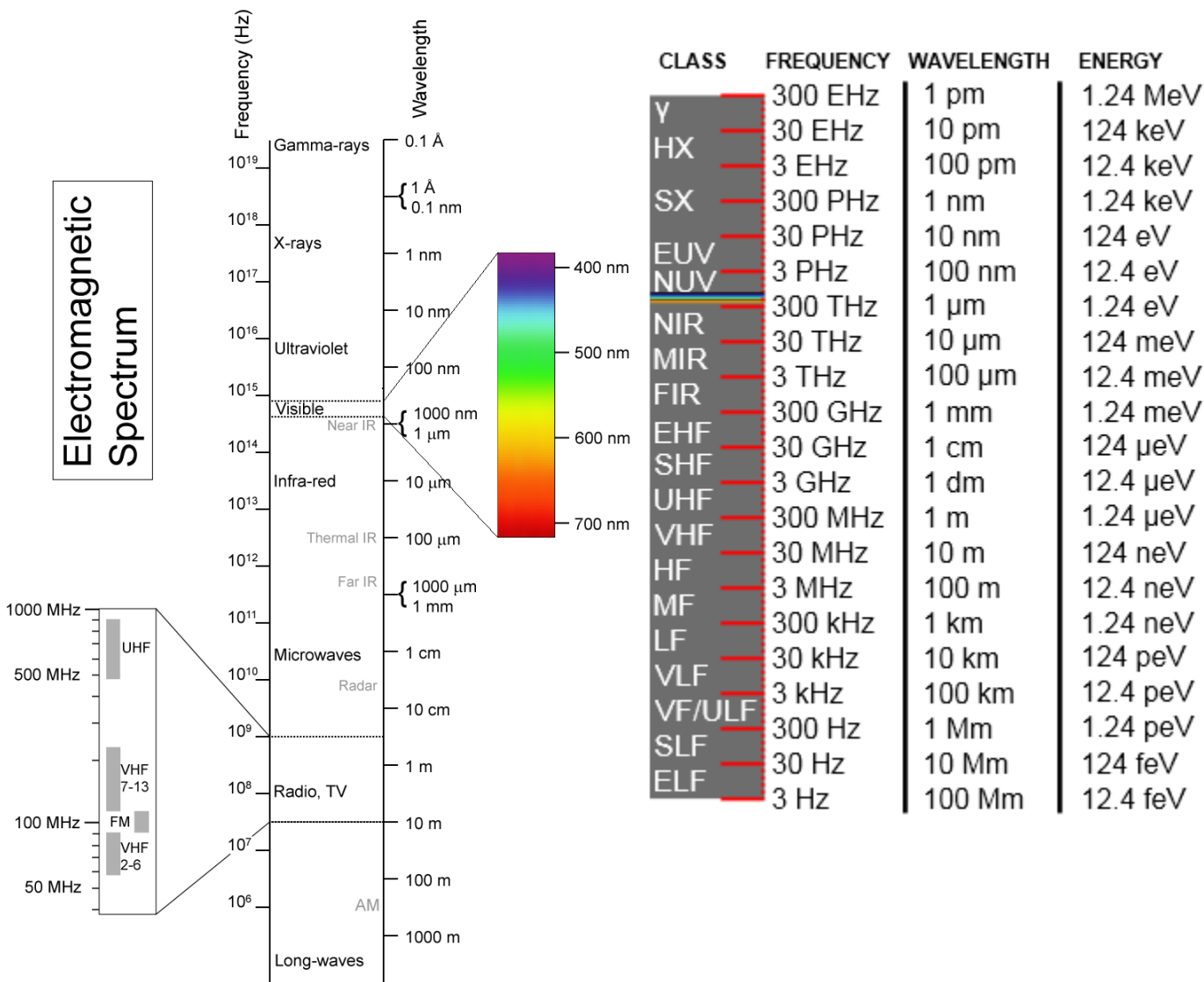


PET

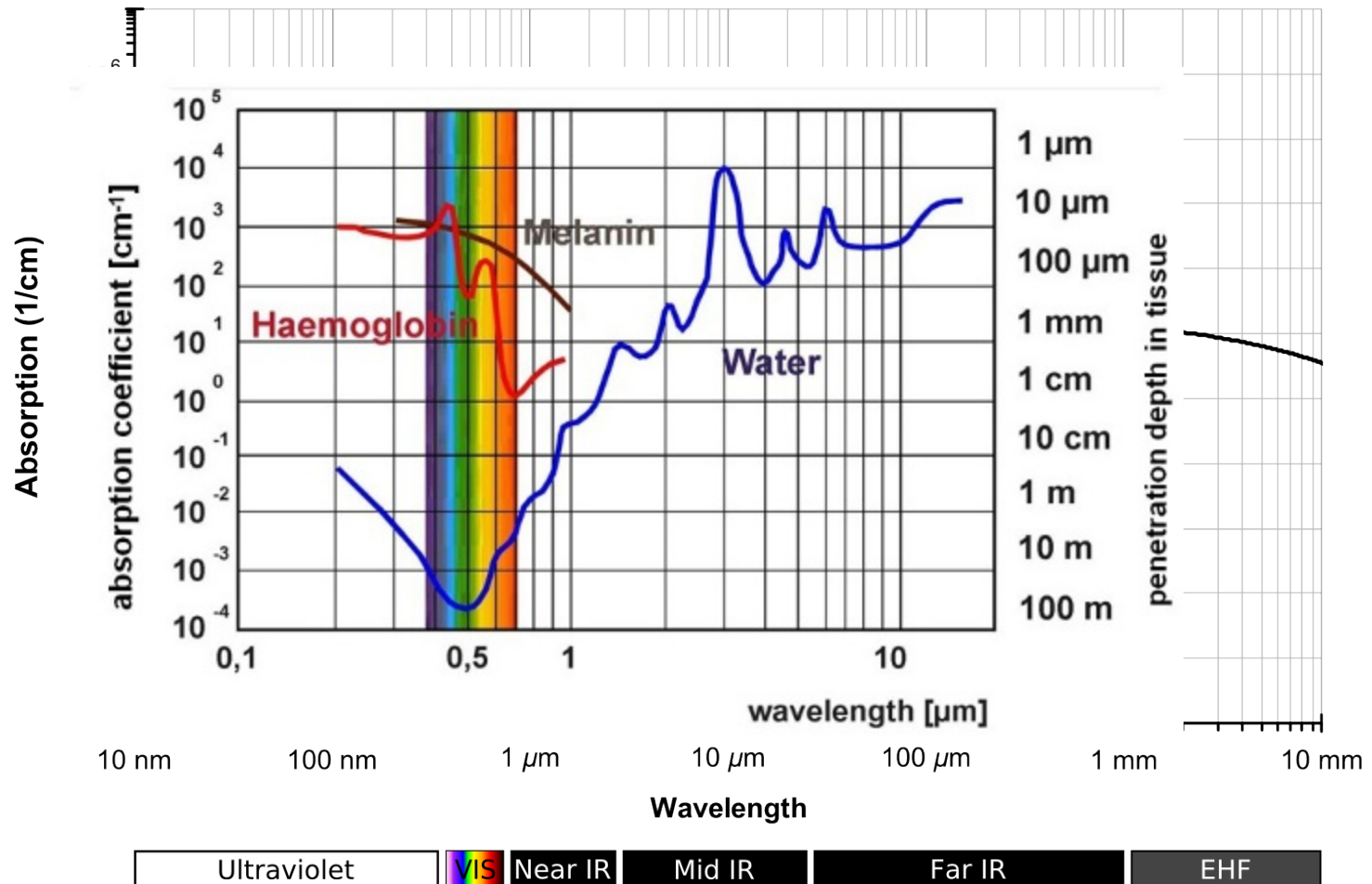
elektromagnetno valovanje

Radio: plazemske oscilacije
 mikro – IR: plazemske, rotacijske
 bližnjaIR: vibracije, plazemske oscilacije (kovina)
 Vidna: vzbujanje molekulskih elektronov, PO v kovini
 UV: vzbujanje molekulskih in atomskih valenčnih elektronov, fotoefekt
 Rentgen: izbijanje elektronov iz ovojnice, Comptonovo sipanje
 Sevanje gama: R+jedrske reakcije
 HiE gama: tvorba para

Del ec Oh-My-God,
 1991, ZDA, 3×10^{20} eV
 (50 J)



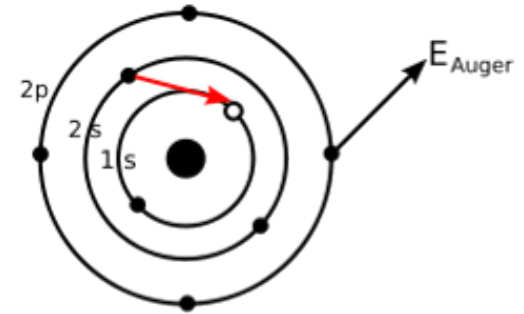
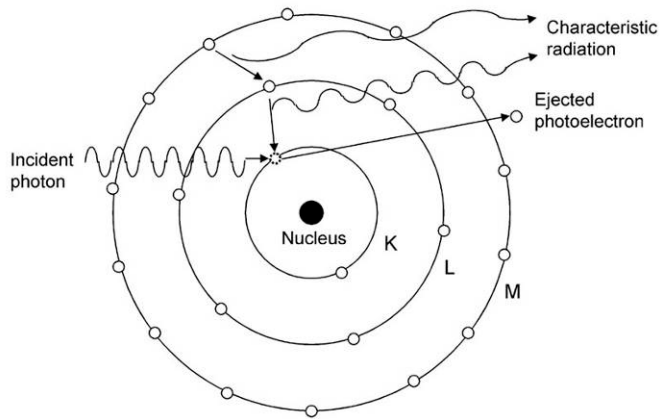
absorpcija EMV v tkivu



Interakcija ionizirajočih fotonov s snovjo

Interakcija fotonov -1

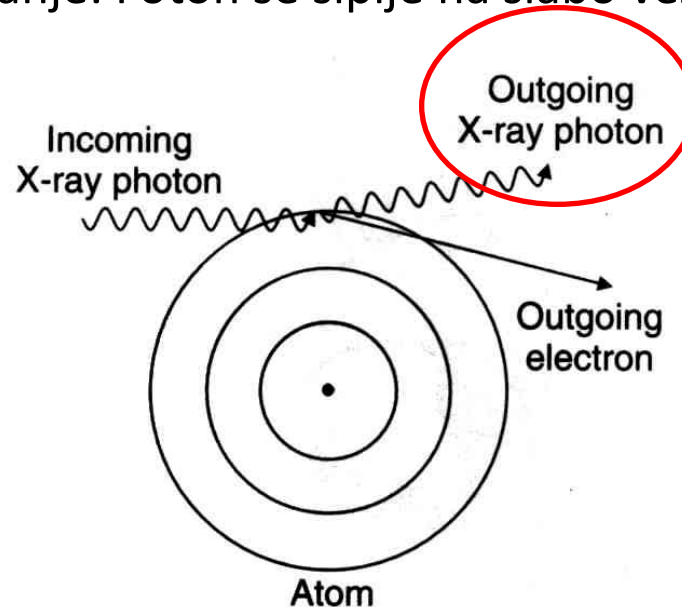
Fotoefekt (vaja FP 68: $E=h\nu - A_i$)



Interakcija ionizirajočih fotonov s snovjo

Interakcija fotonov -2

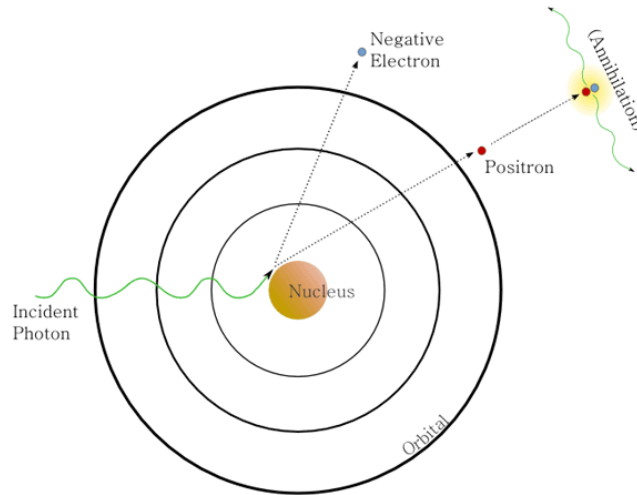
Comptonovo sipanje: Foton se siplje na slabo vezanih elektronih.



Interakcija ionizirajočih fotonov s snovjo

Interakcija fotonov -3

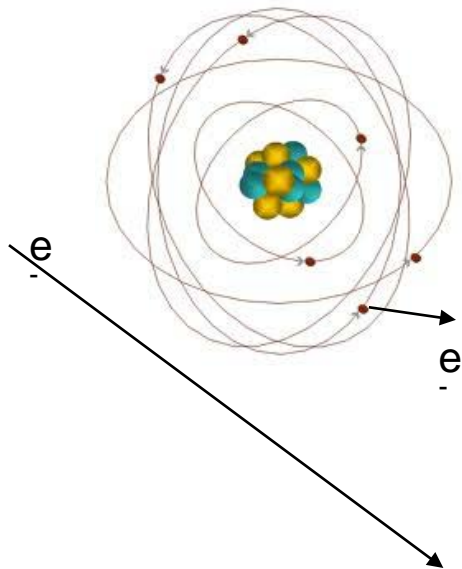
Produkcija para elektron in pozitron



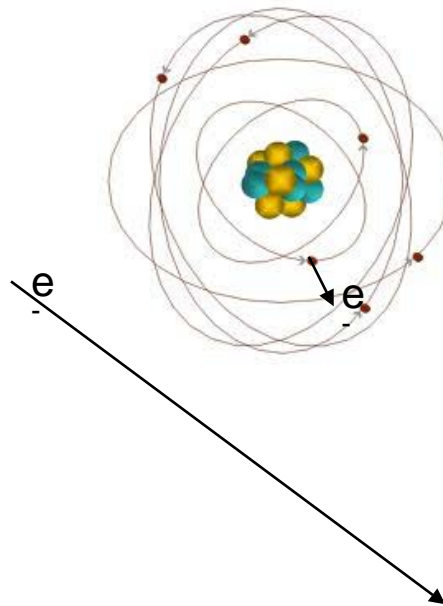
Interakcija delcev s snovjo

- Nabiti delci interagirajo predvsem preko štirih procesov:

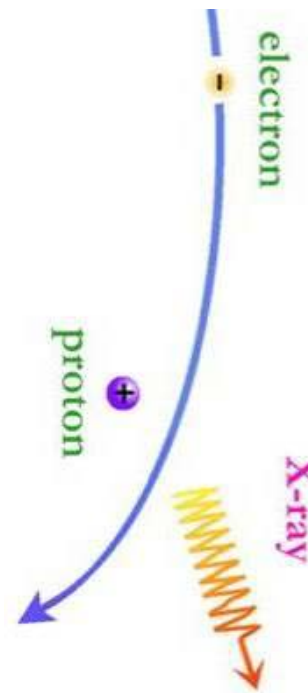
ionizacija



vzbujanje



zavorno sevanje



Čerenkovo sevanje



rentgensko sevanje

elektromagnetno sevanje

0,01 do 10 nm (120 eV do 120 keV)

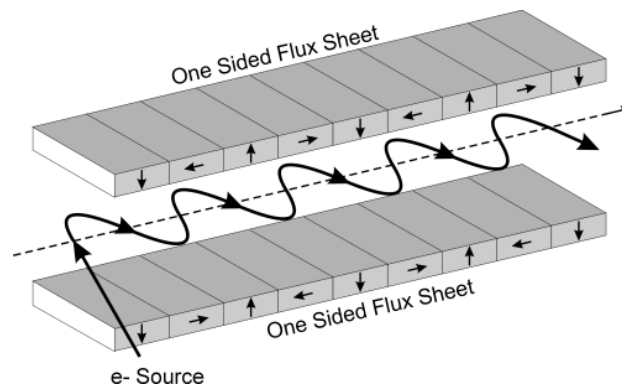
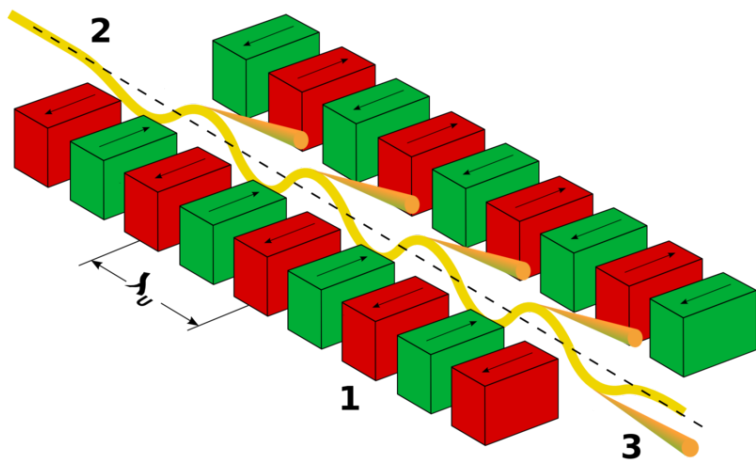
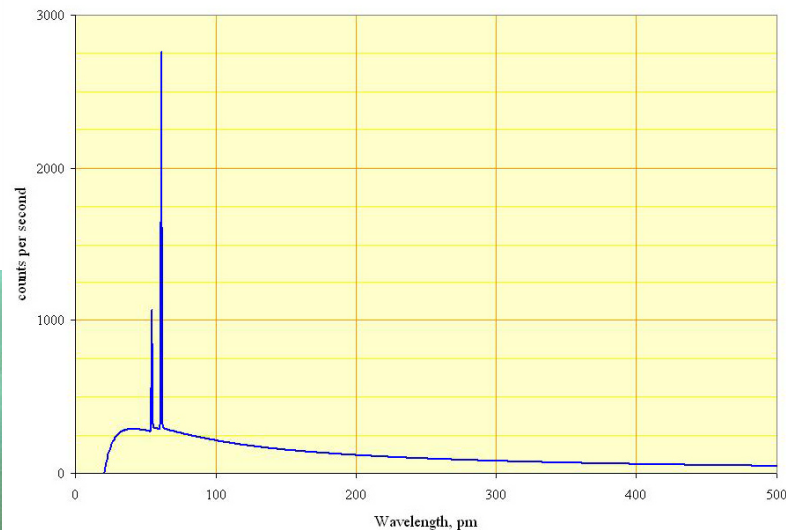
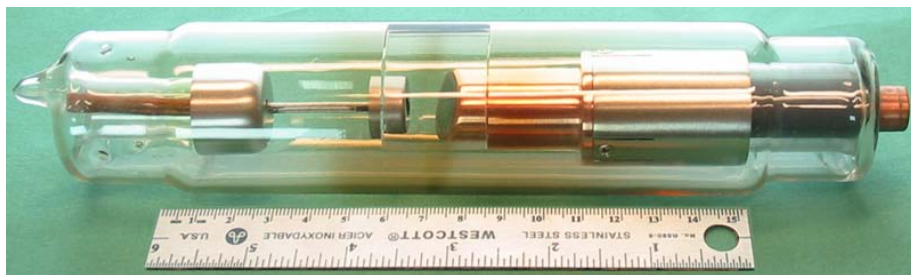
(med UV in sevanjem gama)

Mehki od 0,12 do 12 keV (10 do 0,10 nm)

Trdi 12 do 120 keV (0,10 do 0,01 nm)

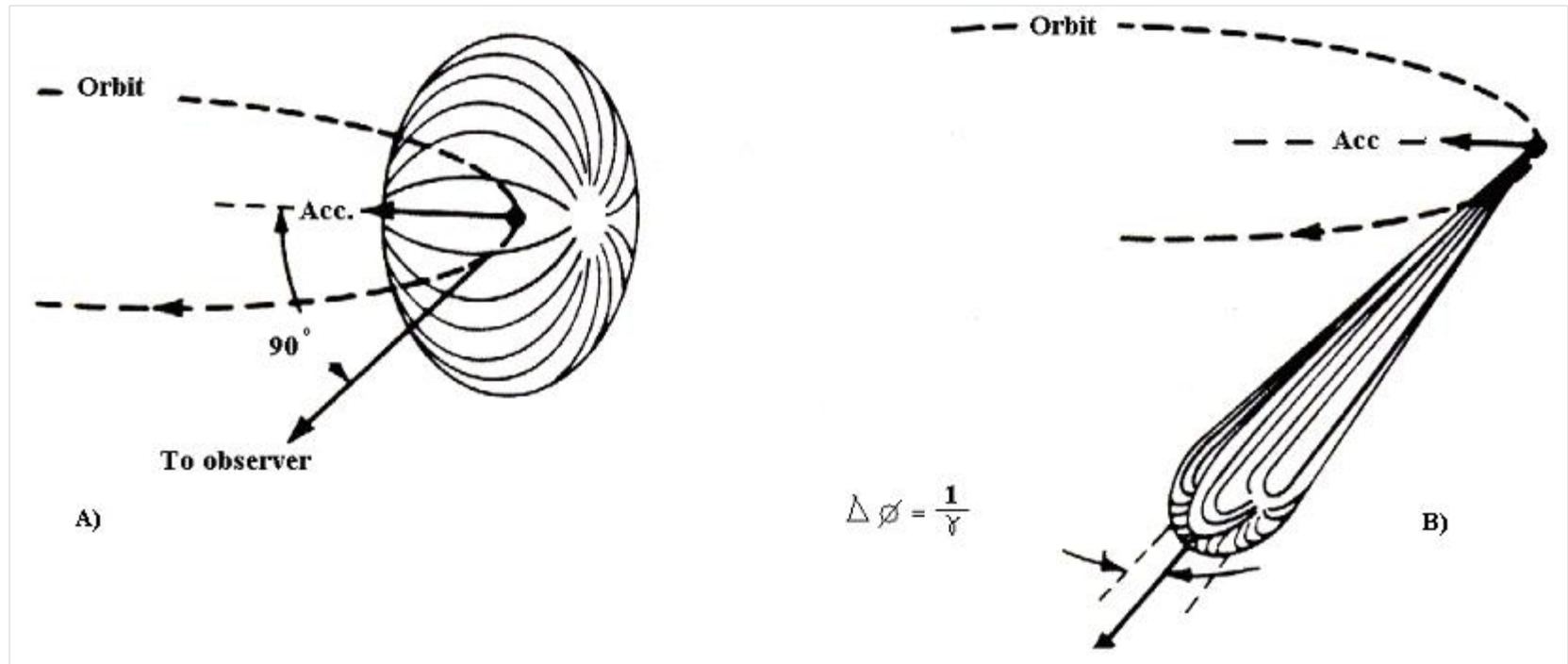
rentgen - vir

rentgenska cev
rentgenska fluorescenca
pospeševalni ki delcev
(undulator, wigglers)



rentgen - vir

sevanje pospešeni h naboj ev

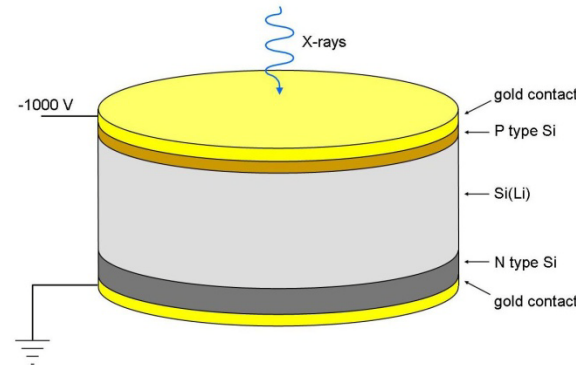
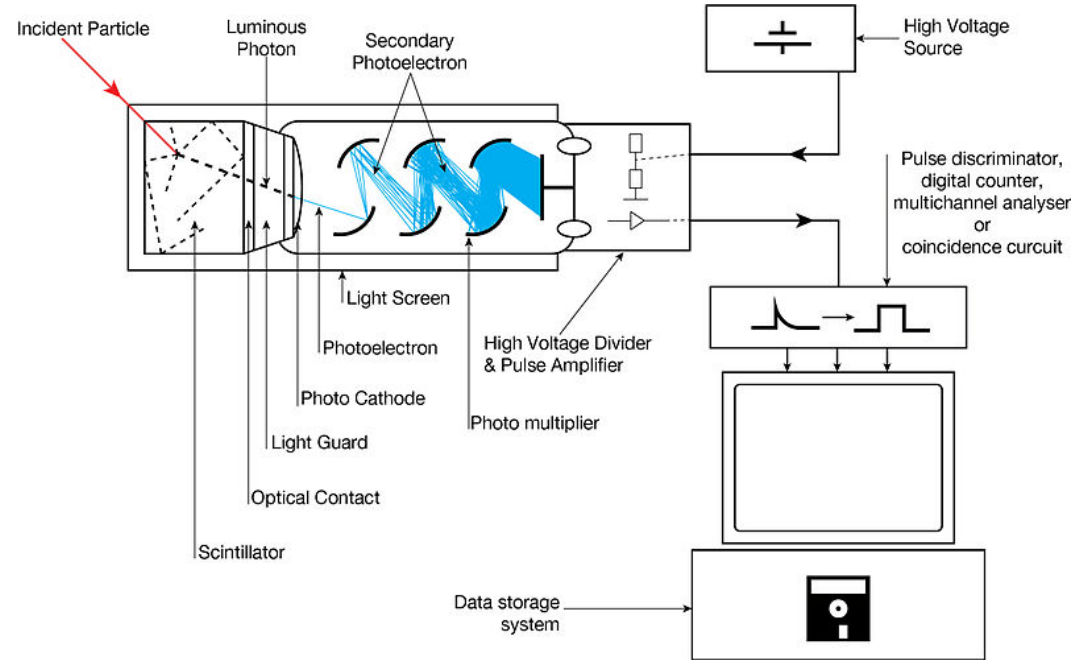
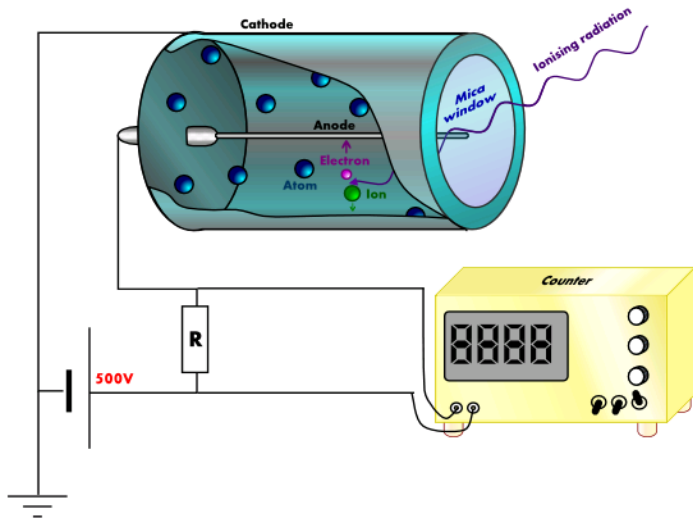


$$P \propto a^2.$$

$$P \propto m^{-4} \text{ a pravokoten na } v$$
$$\propto m^{-6} \text{ za a vzporeden } v$$

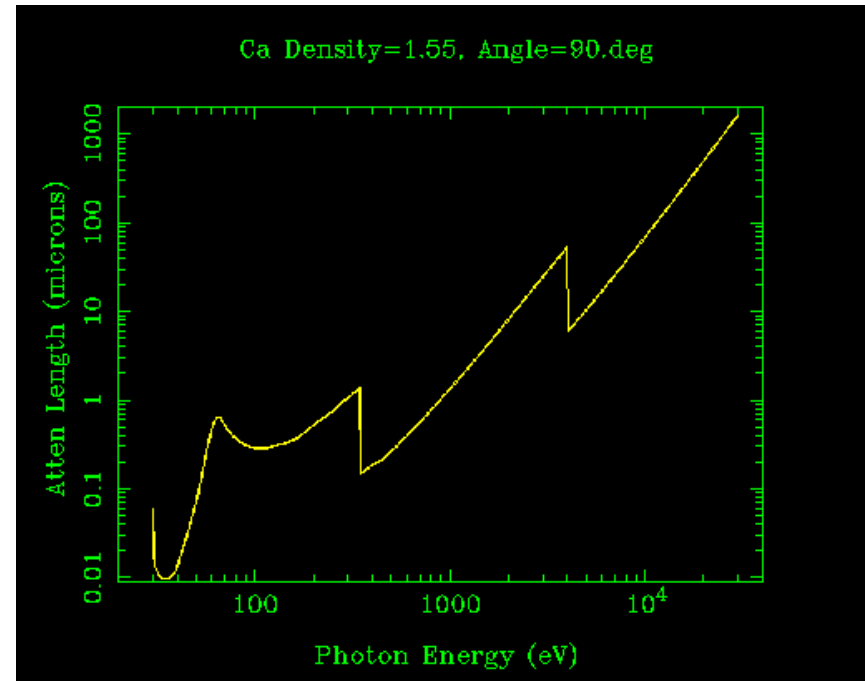
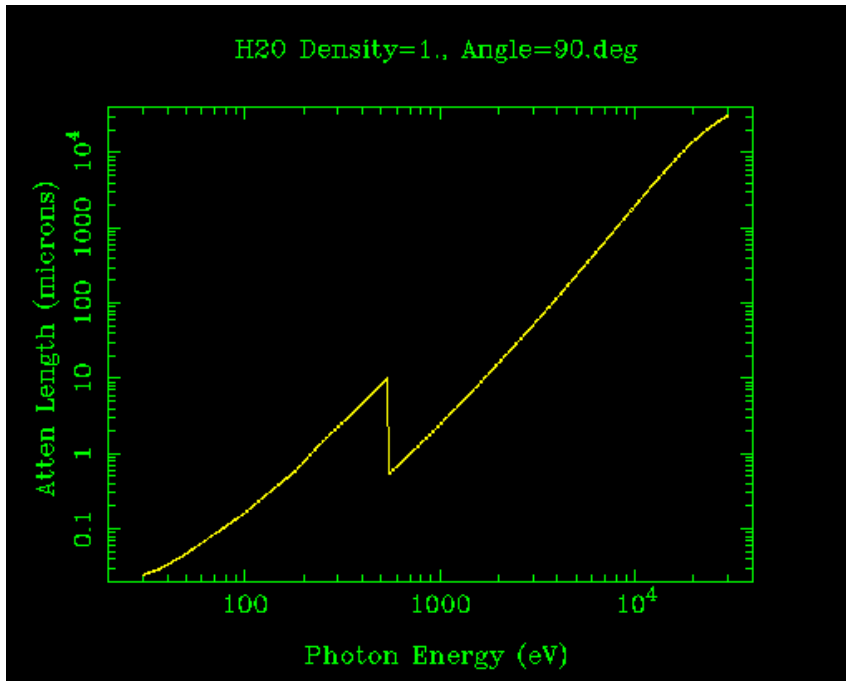
rentgen - detekcija

proporcionalni števci
 polprevodniški detektorji
 fotografski film
 scintilatorji



rentgen - absorpcija

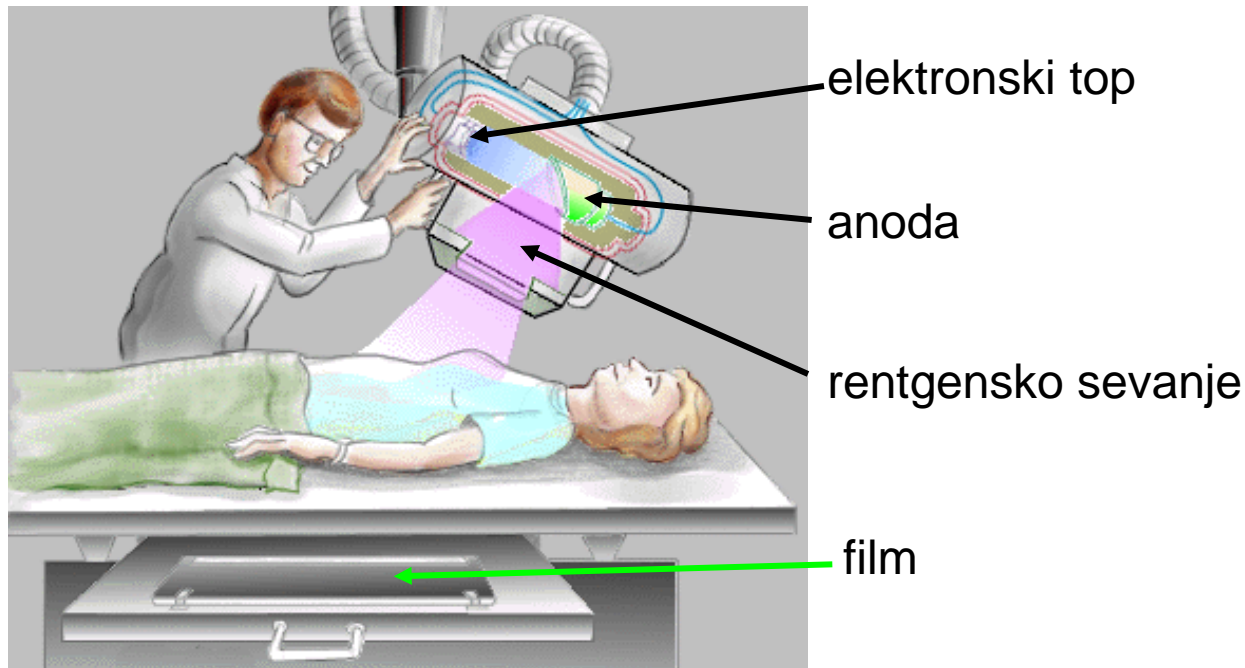
Absorpcijski koeficient



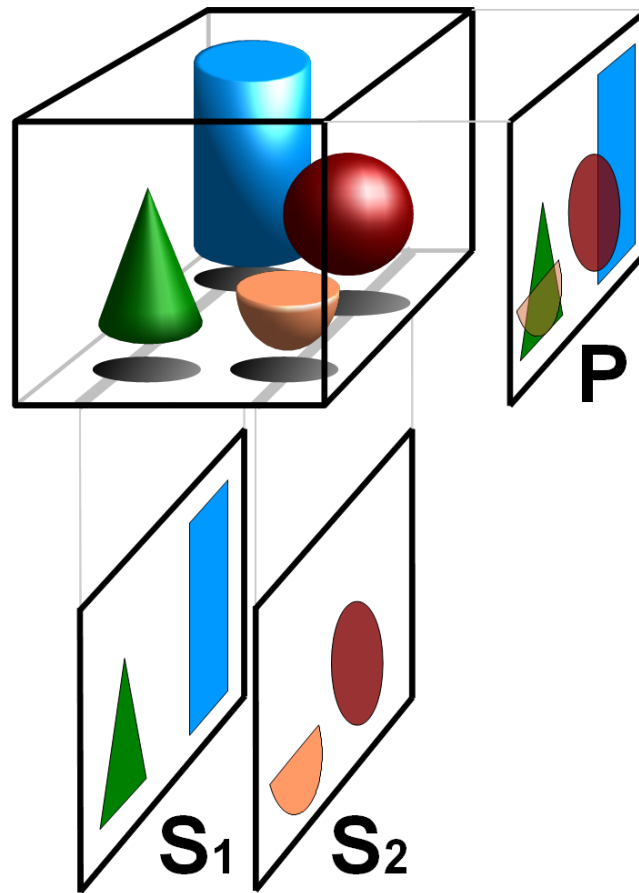
http://henke.lbl.gov/optical_constants/atten2.html

rentgen (x-rays)

- rentgensko sevanje – zavorno sevanje hitrih elektronov na anodi (volfram, baker)
- presevajo telo, zazna jih npr. fotografska plošča
- absorpcija v tkivu – sorazmerna z gostoto tkiva (močnejše v Ca kot v H, C, O)
- fotoni počrnijo ploščo
- kontrastna sredstva – tekočine s težjimi elementi (jod, barij)

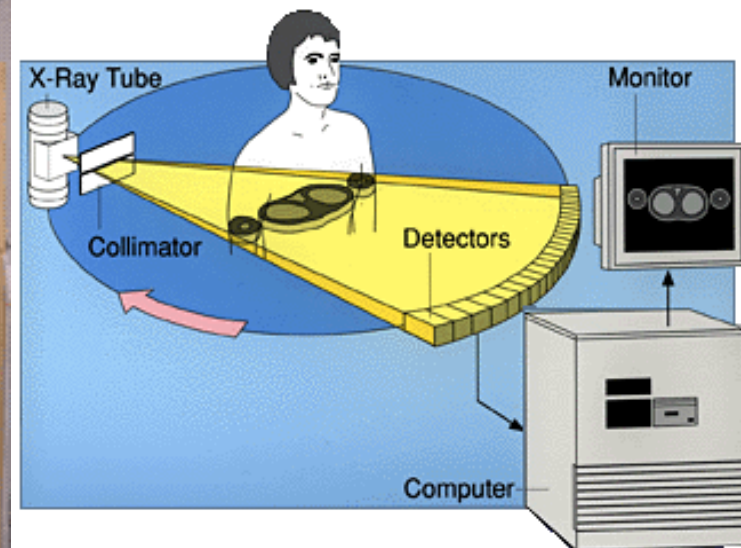
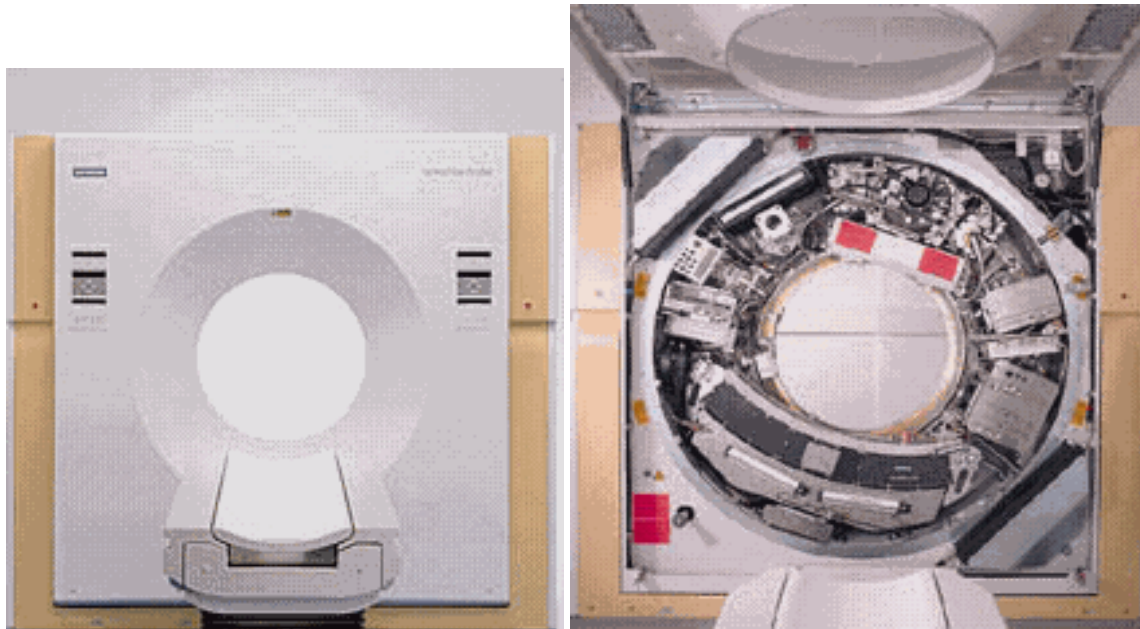


tomografija vs. projekcija



CT – računalniška tomografija (cat scan)

- premična miza, vrtljiva rentgenska cev
- sevanje zaznava scintilacijski detektor
- projekcijska rekonstrukcija slike
- za kapi

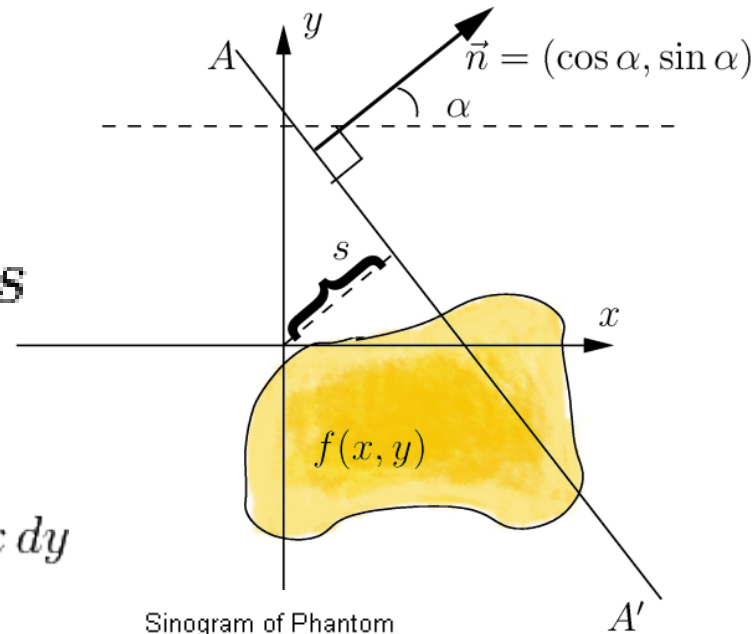


$$I = I_0 \exp \left(- \int \mu(x, y) ds \right)$$

$$p(r, \theta) = \ln(I/I_0) = - \int \mu(x, y) ds$$

$$x \cos \theta + y \sin \theta = r$$

$$p(r, \theta) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(x, y) \delta(x \cos \theta + y \sin \theta - r) dx dy$$



ρ - Radonova transformacija
(ali sinogram)

