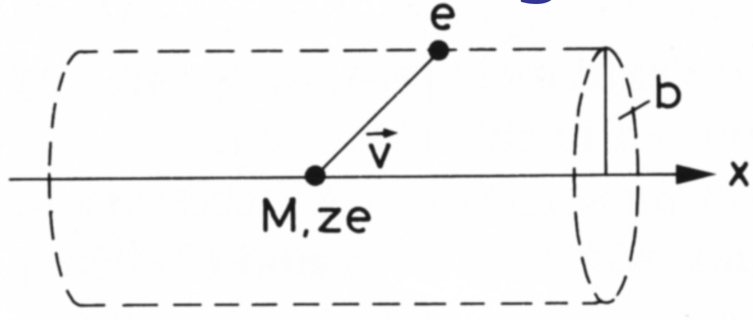
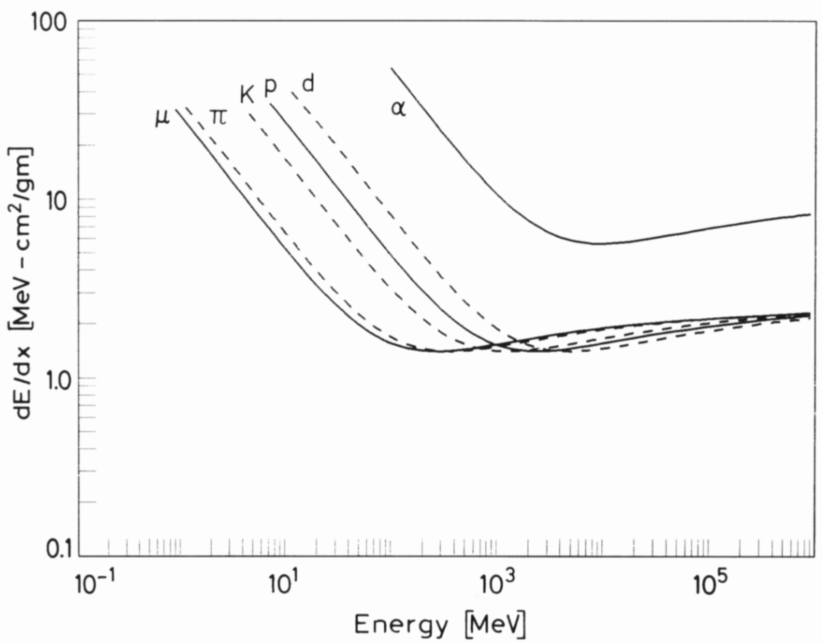
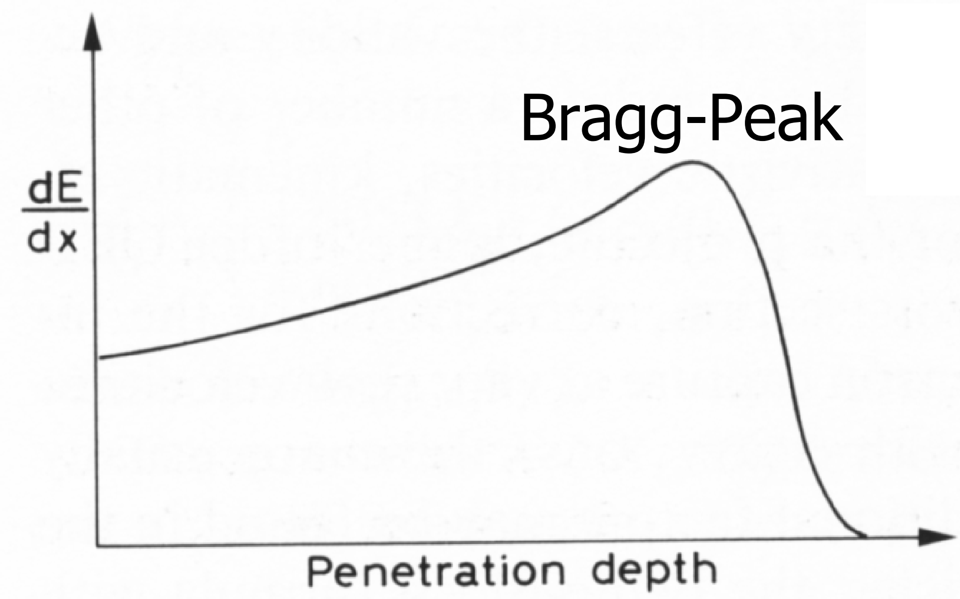
Wechselwirkung geladener Teilchen mit Materie

dE/dx für schwere geladene Teilchen

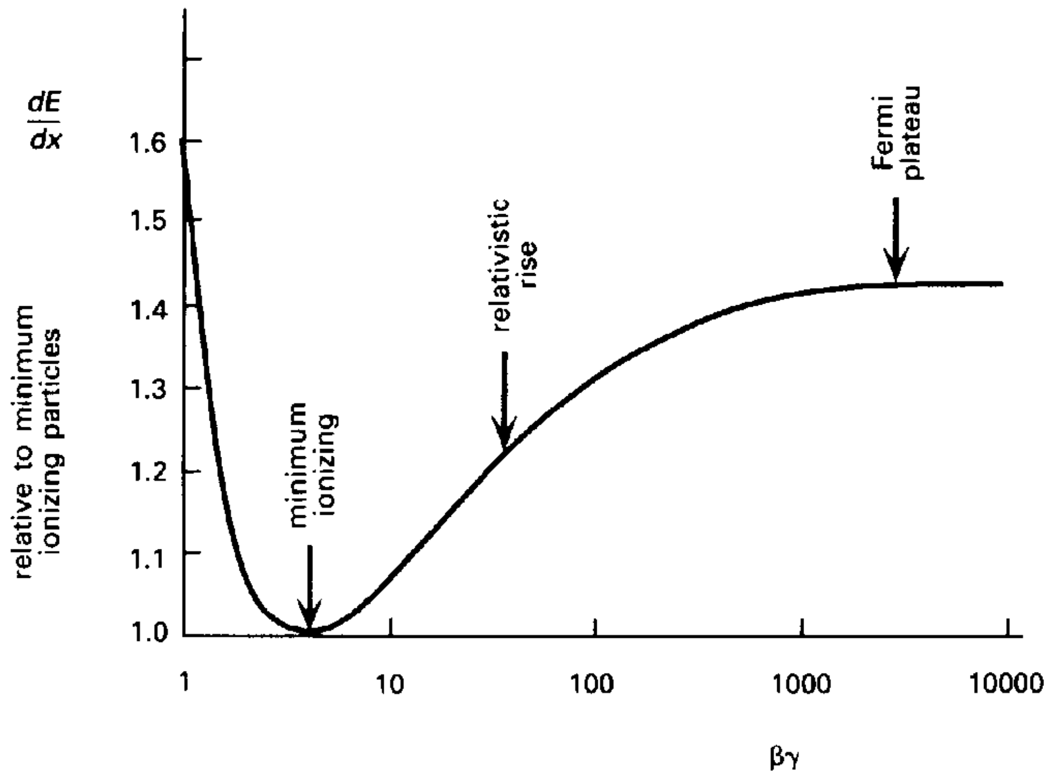




Bragg-Kurve

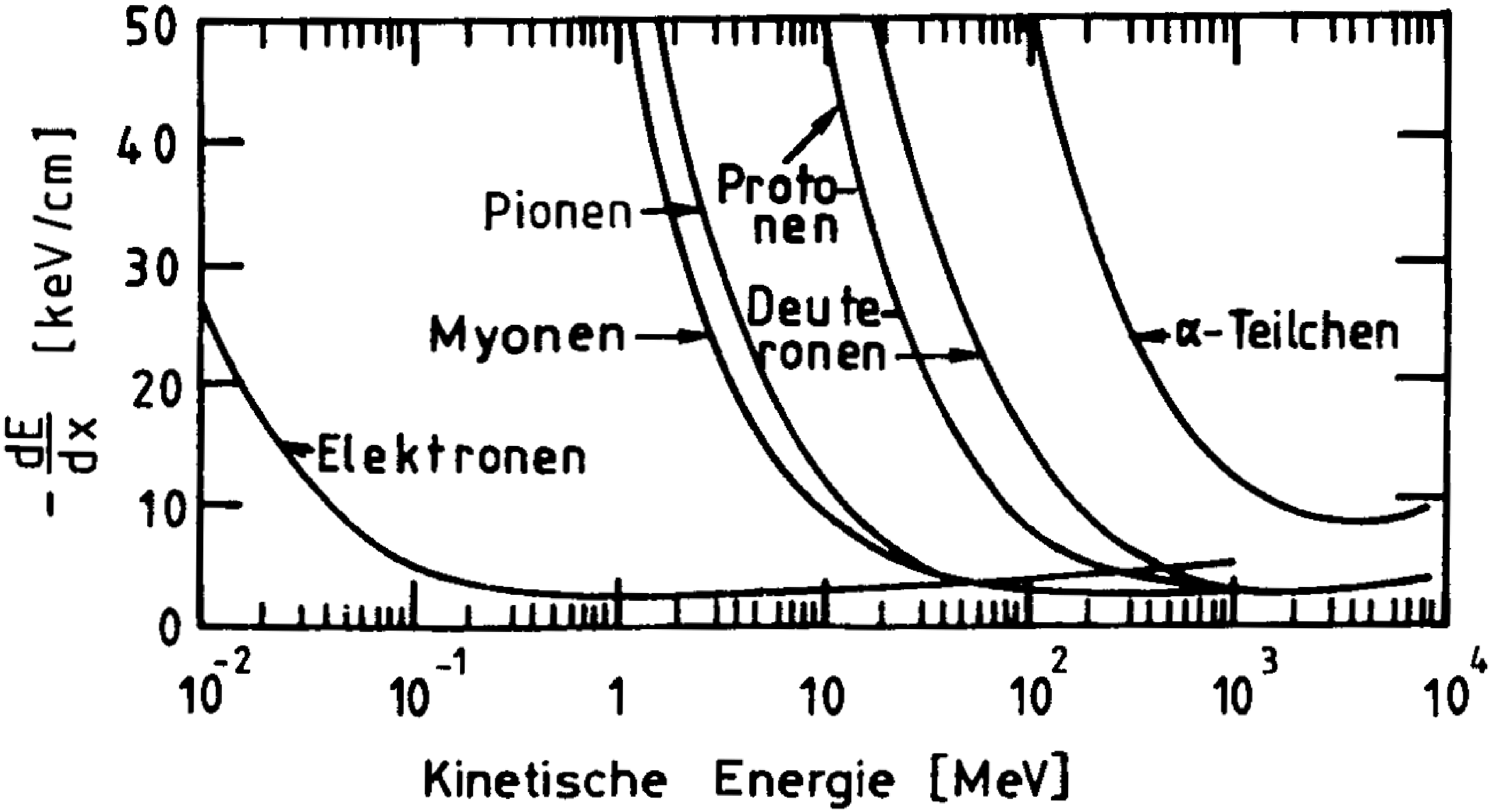


Ionisationsverlust geladener Teilchen

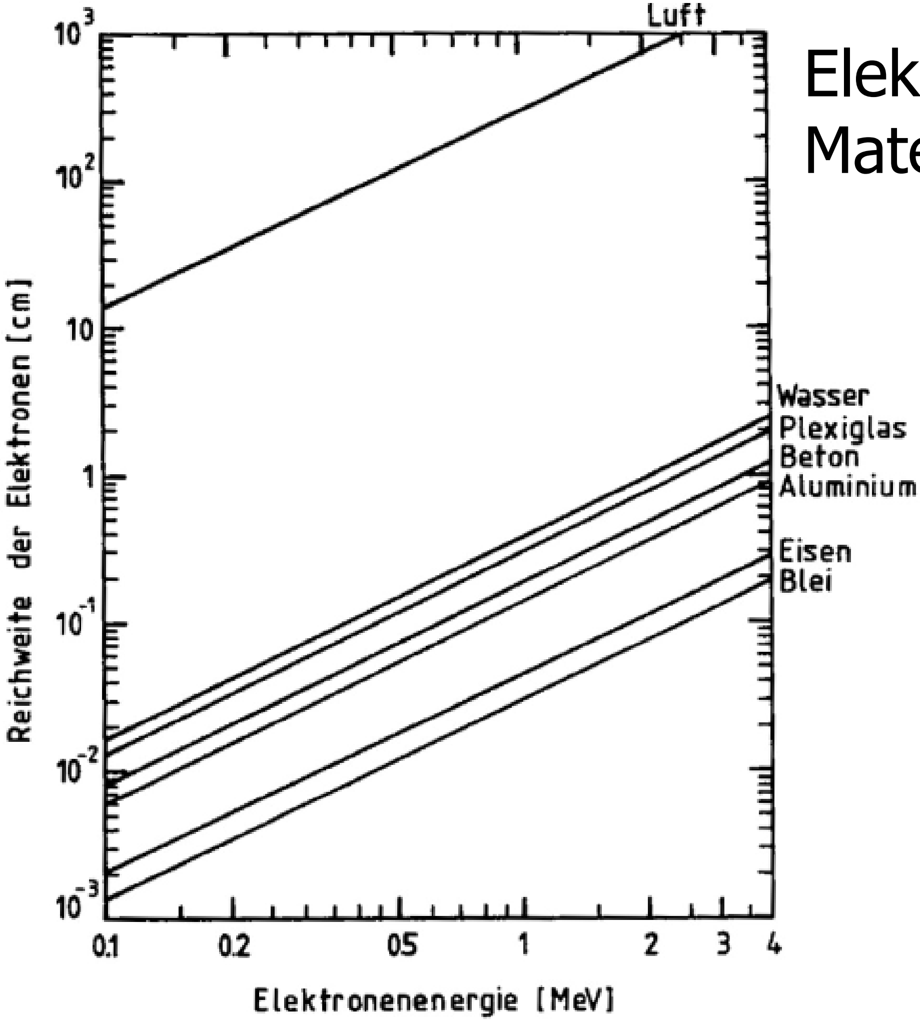


Energieverlust durch Ionisation

Energieverlust geladener Teilchen in Luft



Eindringtiefe



Elektronen in verschiedenen Materialien

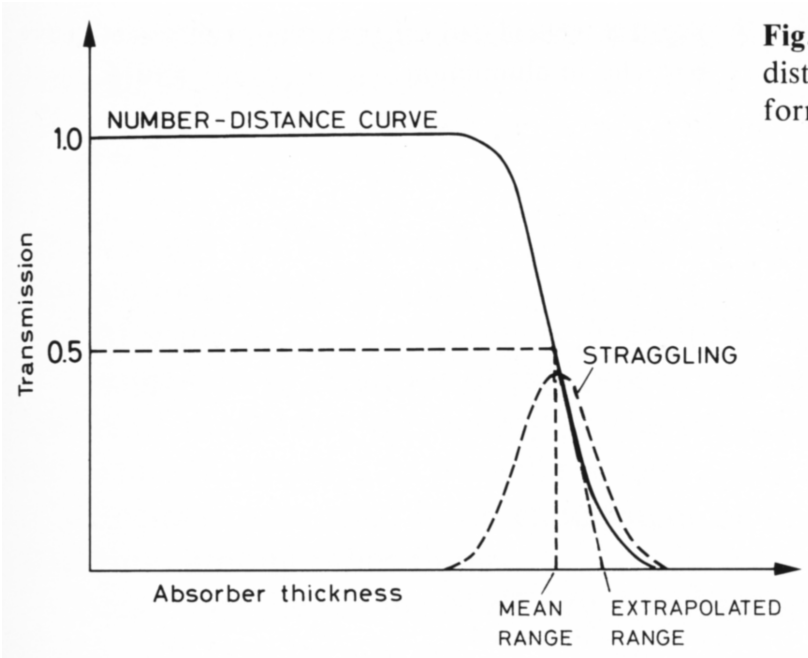
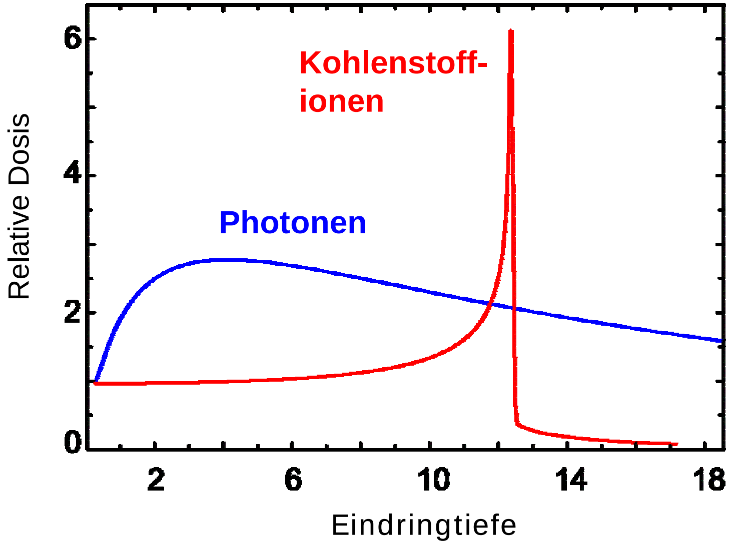


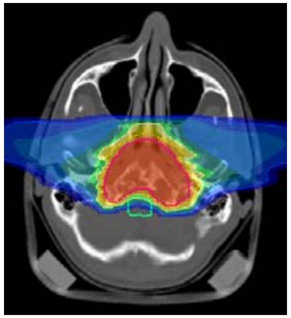
Fig. 2
distrib
form

Krebstherapie mit Ionenstrahlen

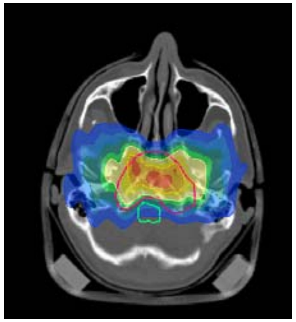
millimetergenaue Energieabgabe



Bestrahlungsplan



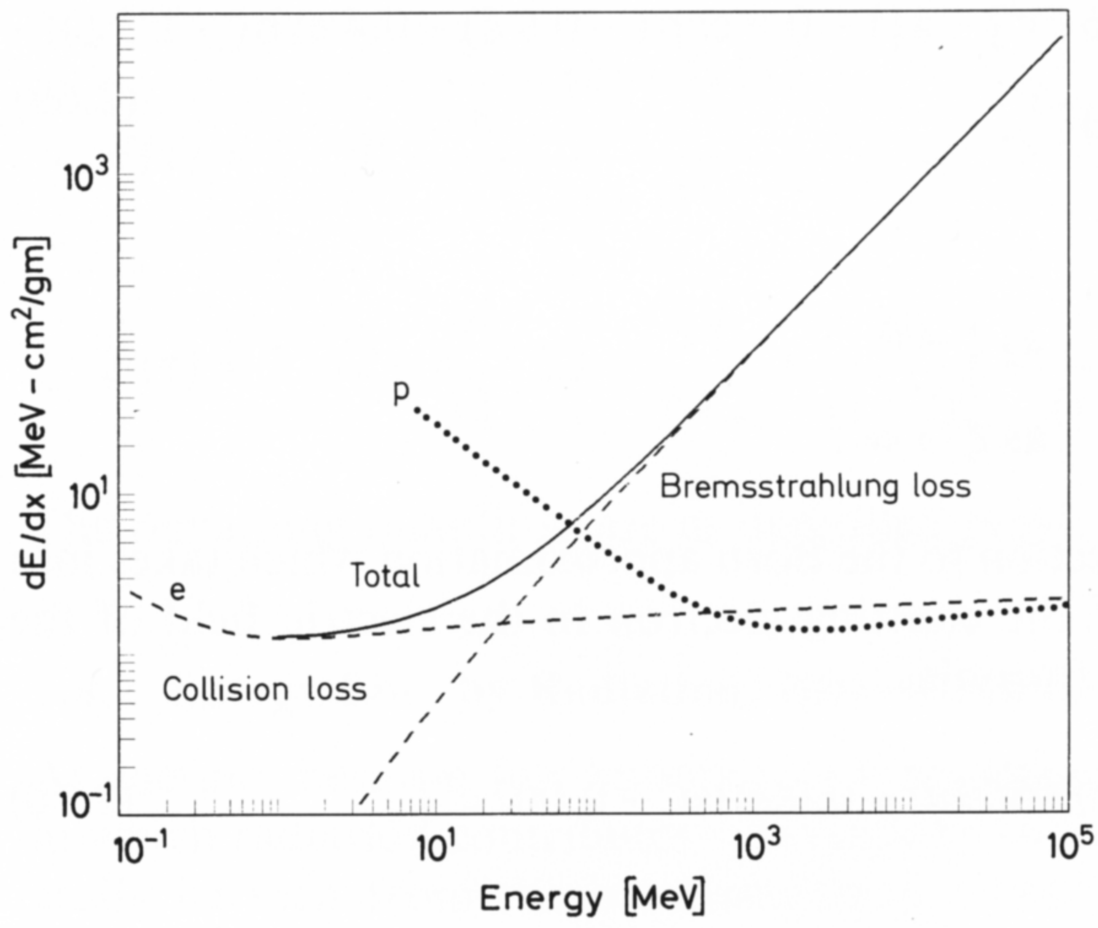
Überwachung durch PET



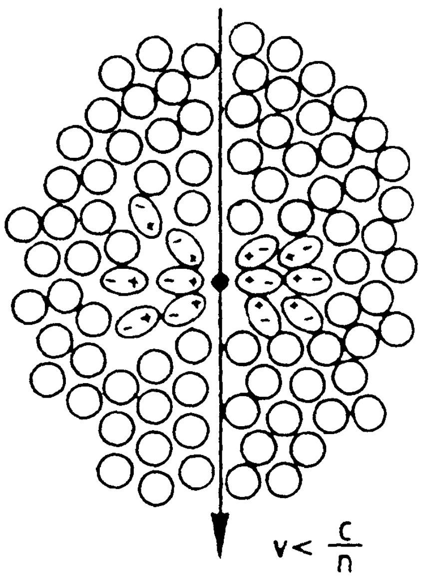
GSI Pilotprojekt:

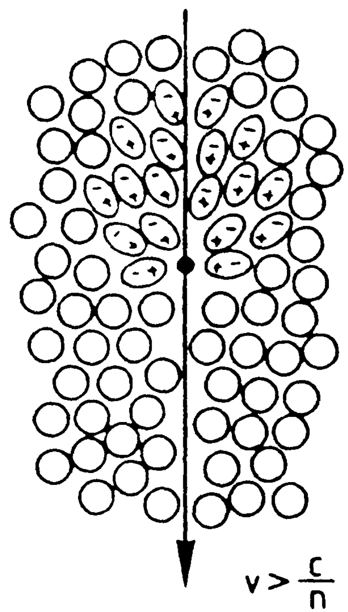
- bisher 112 Patienten
- sehr geringe Nebenwirkungen
- kein erneutes Tumorwachstum im bestrahlten Bereich

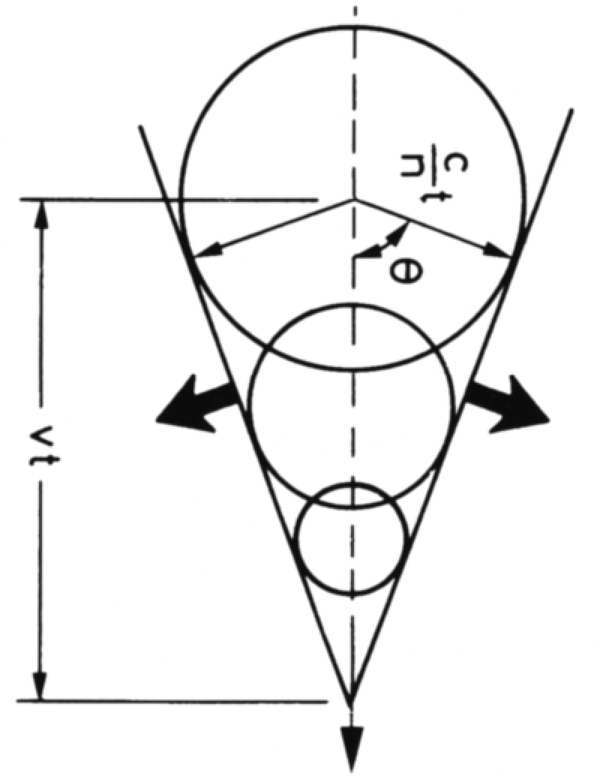
Energieverlust von Elektronen in Cu



Čerenkov Licht

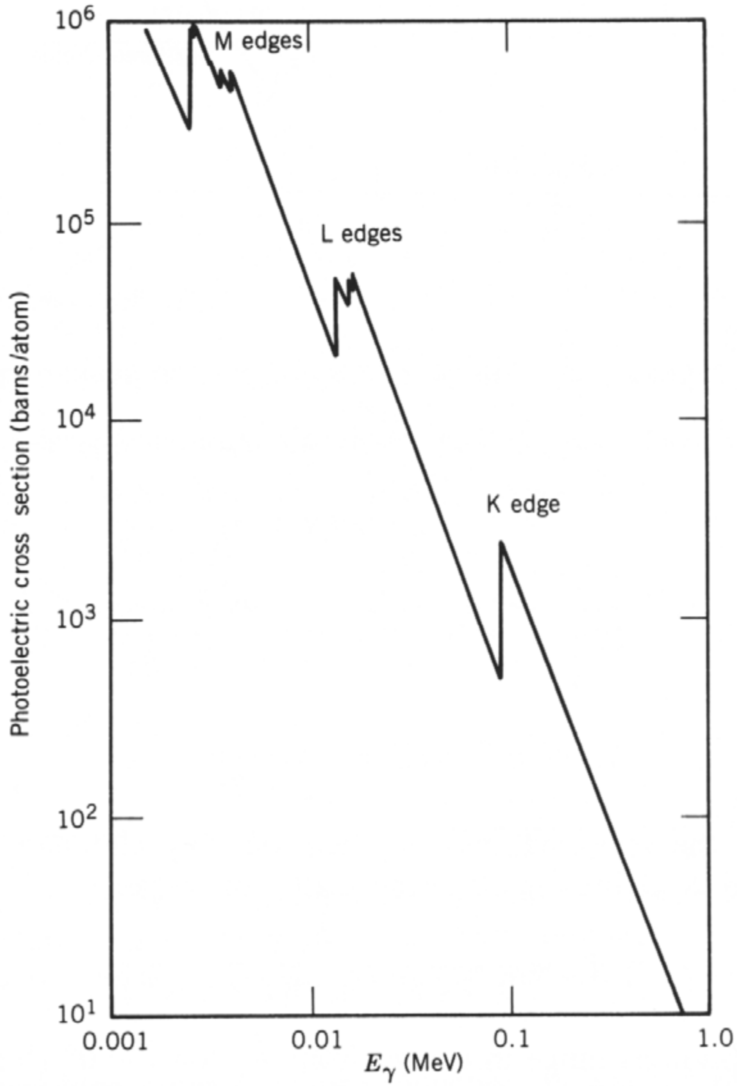




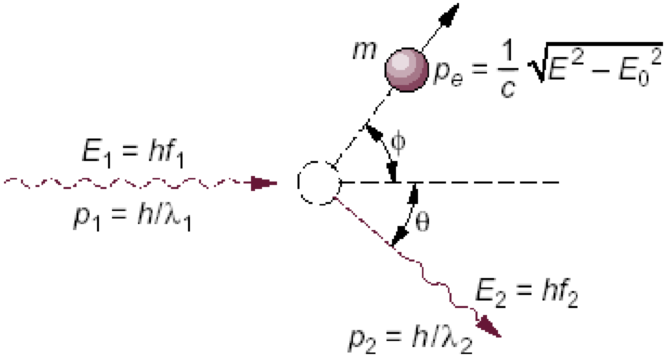


Photoelektrischer Effekt

$$E = h\nu - B.E.$$



Compton Effekt



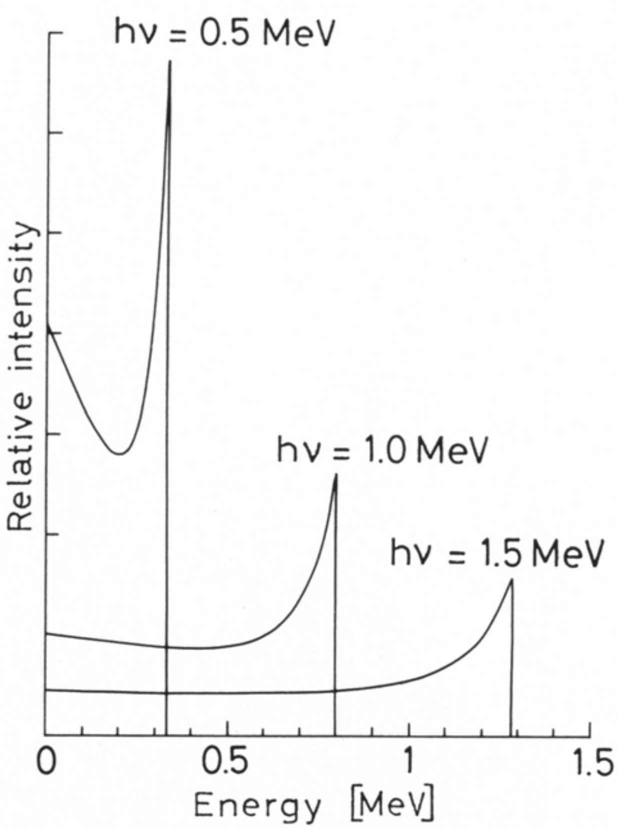
Energie des gestreuten Gamma-Photons:

$$E_\gamma' = \frac{E_\gamma \cdot m_e c^2}{m_e c^2 + E_\gamma (1 - \cos\theta)}$$

Maximale Energie des gestreuten Elektrons:

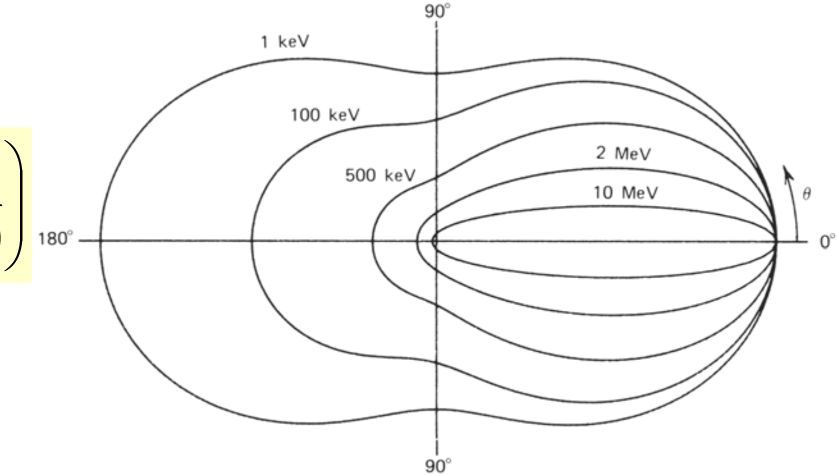
$$T(e^-)_{\max} = \frac{2E_\gamma}{m_e c^2 + 2E_\gamma}$$

Energiespektrum der Elektronen:



Compton - Effekt

Winkelverteilung

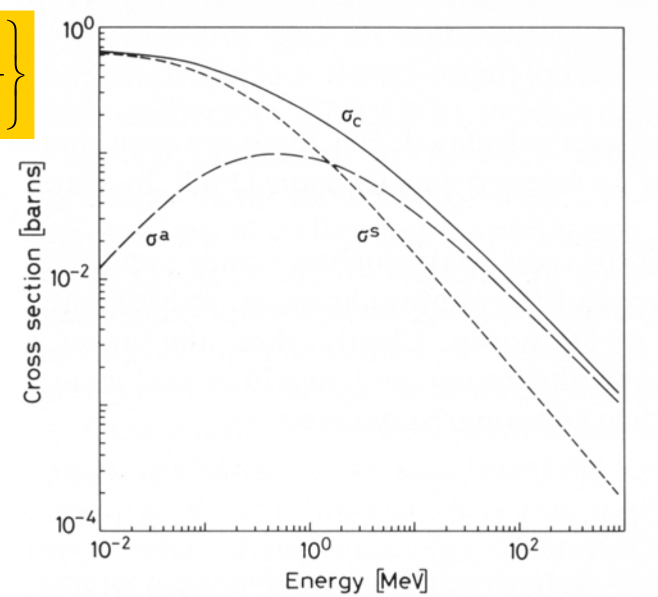


Klein-Nishina Formel:

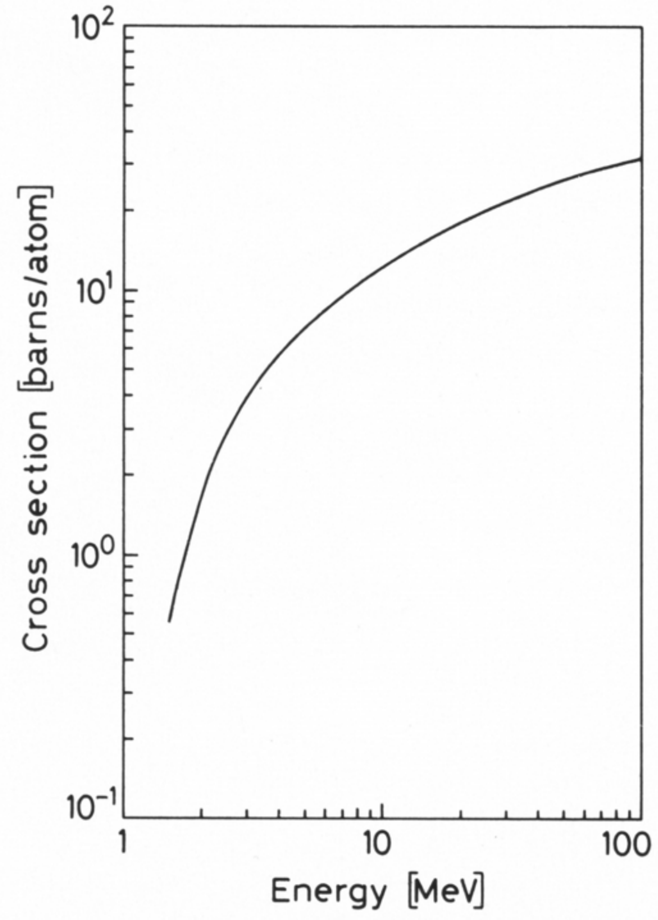
$$\frac{d\sigma}{d\Omega} = \frac{r_e^2}{2} \frac{1}{\left[1+\Gamma(1-\cos\theta)\right]^2} \left(1+\cos^2\theta + \frac{\Gamma^2(1-\cos\theta)^2}{1+\Gamma(1-\cos\theta)}\right)$$

r_e : klassischer Elektronenradius

$$\sigma_C = 2\pi r_e^2 \left\{ \frac{1+\Gamma}{\Gamma^2} \left[\frac{2(1+\Gamma)}{1+2\Gamma} - \frac{1}{\Gamma} \ln(1+2\Gamma) \right] + \frac{1}{2\Gamma} \ln(1+2\Gamma) - \frac{1+3\Gamma}{(1+2\Gamma)^2} \right\}$$



Paarbildung



Wechselwirkung von Photonen