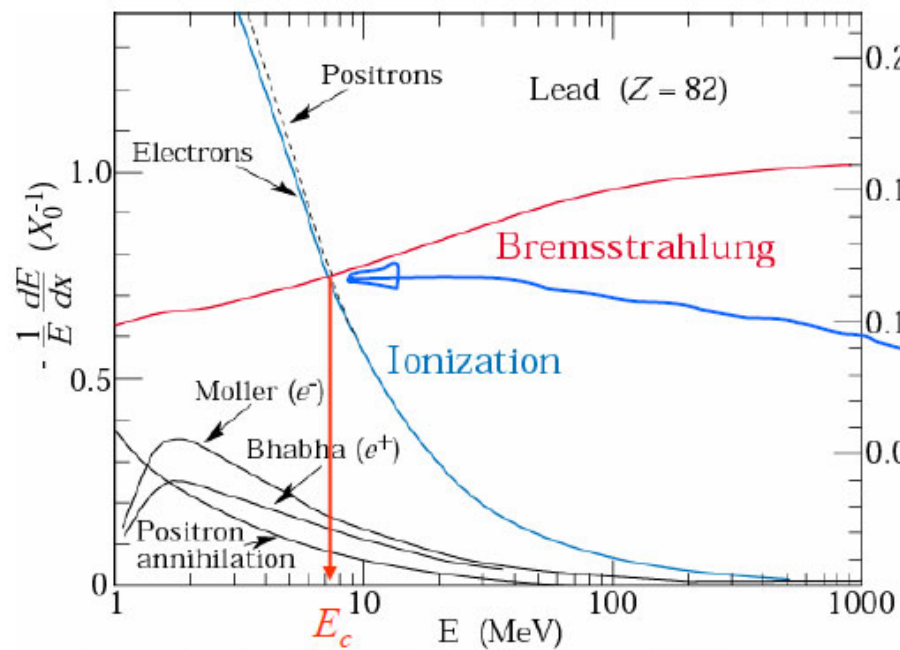


Pair production



Critical Energy

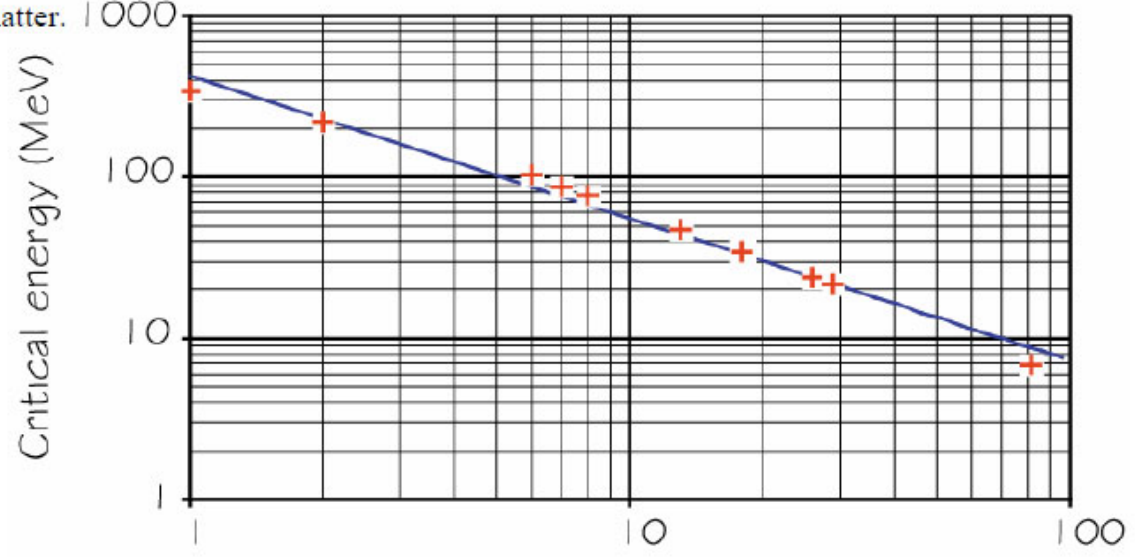
Critical energy E_c

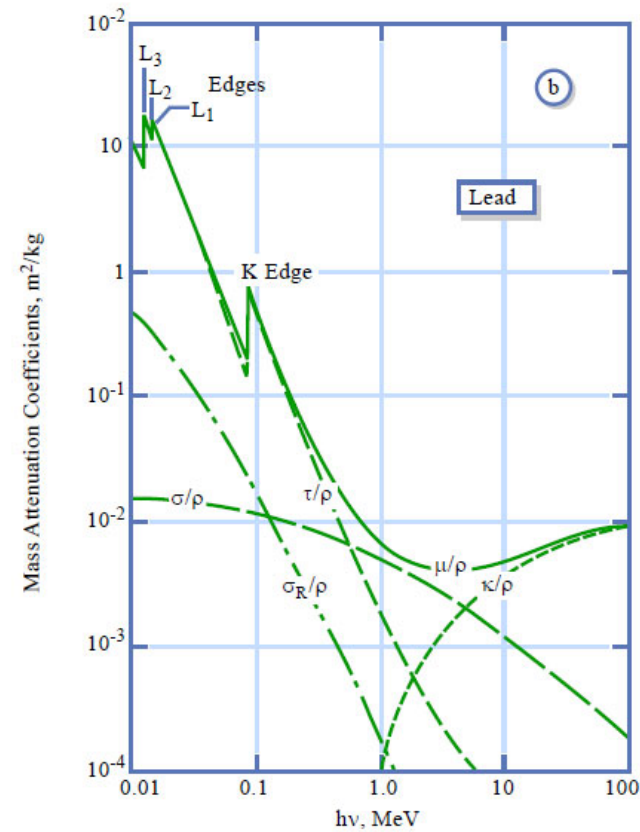
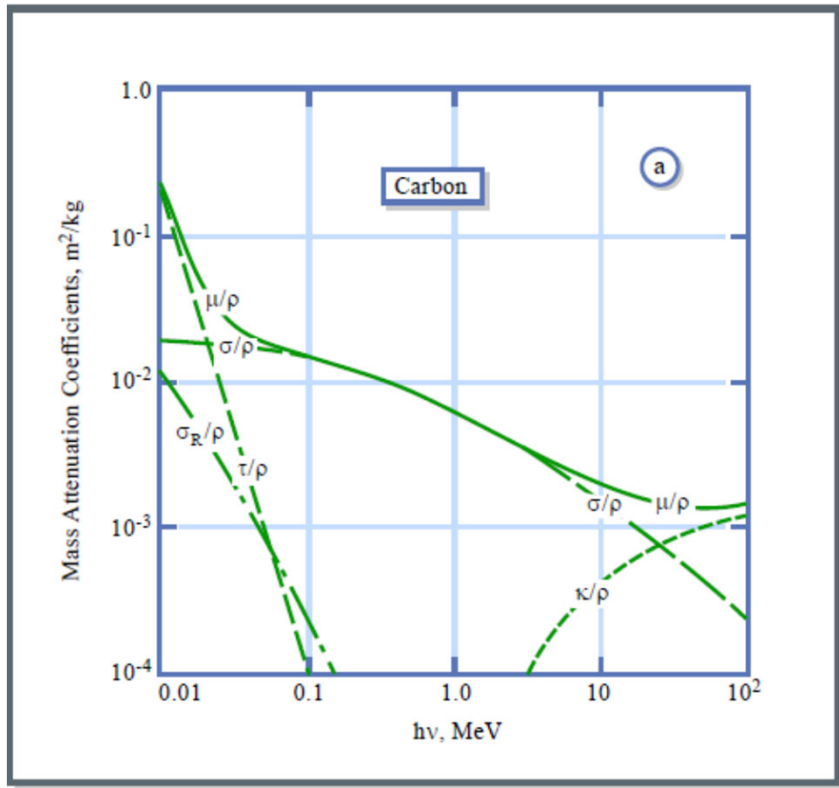
Ionization = Bremsstrahlung

Electron (positron) interaction with matter. 1000

$$E_c \propto Z^{-0.9}$$

→





Mass attenuation coefficients for carbon (a) and lead (b). τ/ρ indicates the contribution of the photoelectric effect, σ/ρ is that of the Compton effect, κ/ρ that of pair production, and σ_{R}/ρ that of Rayleigh (coherent) scattering. μ/ρ is their sum, which is closely approximated in Pb by the τ/ρ curve below $h\nu = 0.1$ MeV.

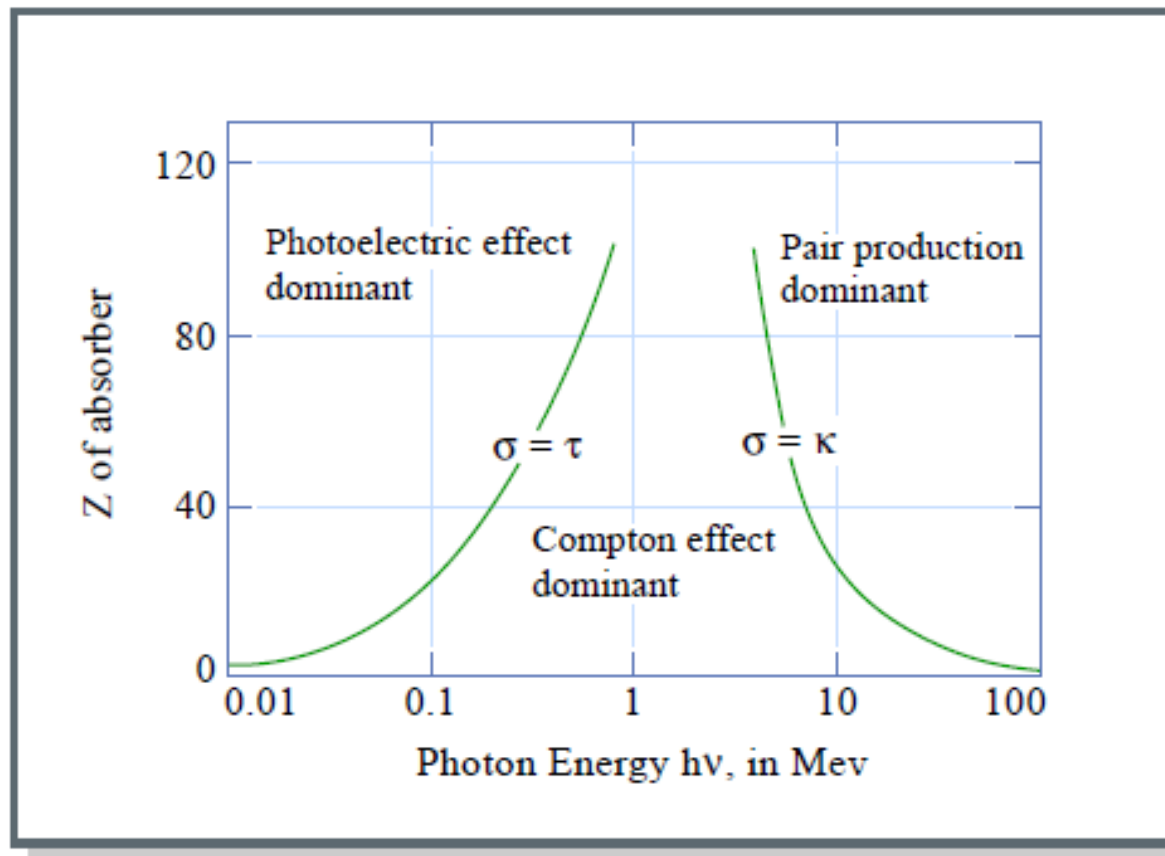


Figure by MIT OCW.

Table 2.3. Radiation lengths for various absorbers

Material	[gm/cm ²]	[cm]
Air	36.20	30050
H ₂ O	36.08	36.1
NaI	9.49	2.59
Polystyrene	43.80	42.9
Pb	6.37	0.56
Cu	12.86	1.43
Al	24.01	8.9
Fe	13.84	1.76
BGO	7.98	1.12
BaF ₂	9.91	2.05
Scint.	43.8	42.4

Table 2.2. Critical energies of some materials

Material	Critical energy [MeV]
Pb	9.51 ←
Al	51.0
Fe	27.4
Cu	24.8
Air (STP)	102
Lucite	100
Polystyrene	109
NaI	17.4
Anthracene	105
H ₂ O	92

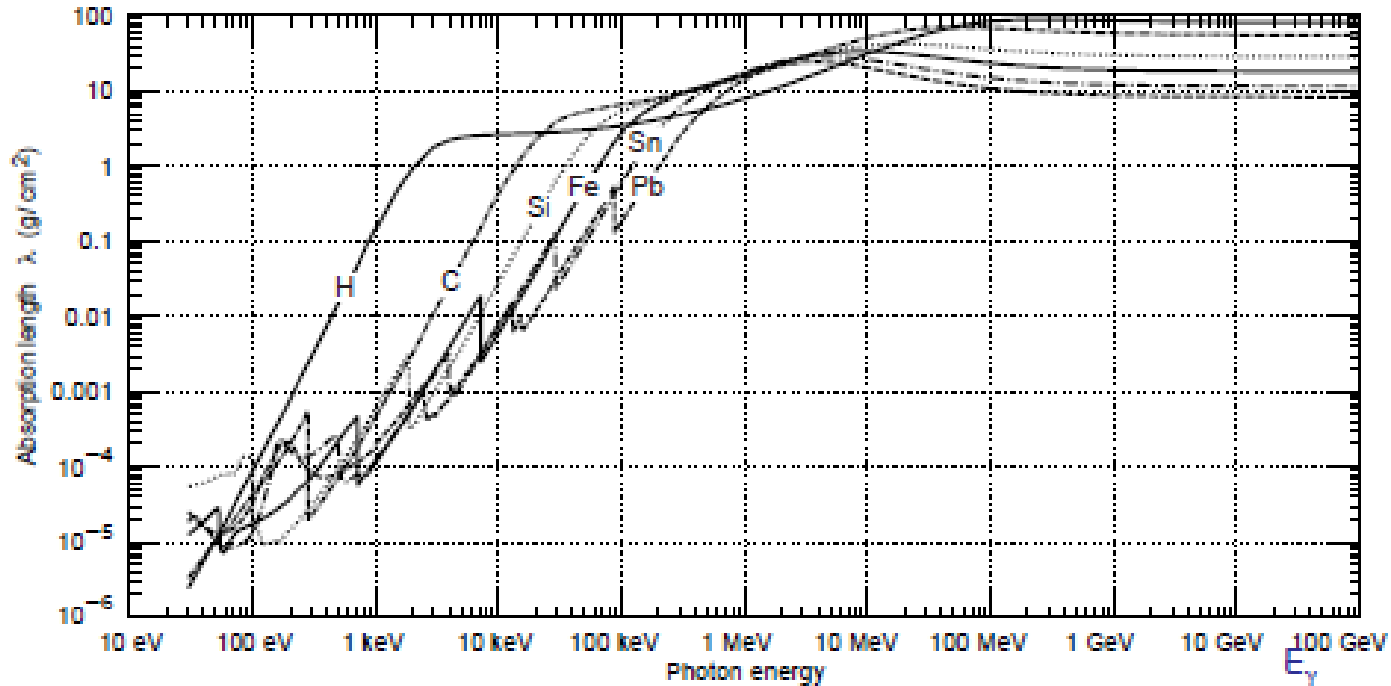
Photon Absorption Length λ

Definition of mass absorption coefficient: $\lambda = \frac{1}{(\mu/\rho)}$ [g cm⁻²]

$$\sigma_{Ph} \propto \frac{Z^5}{E^{3.5}}$$

$$\sigma_{Compton} \propto \frac{\ln E}{E} \cdot Z$$

$$\sigma_{Pair} \propto Z^2$$



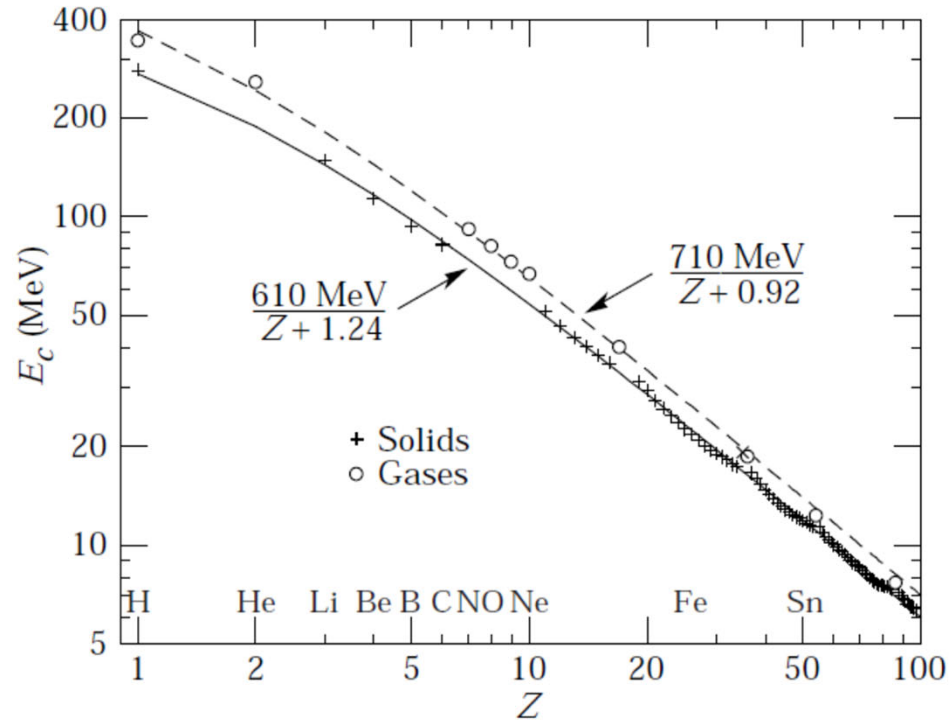


Figure 27.13: Electron critical energy for the chemical elements, using Rossi's definition [2]. The fits shown are for solids and liquids (solid line) and gases (dashed line). The rms deviation is 2.2% for the solids and 4.0% for the gases. (Computed with code supplied by A. Fassó.)

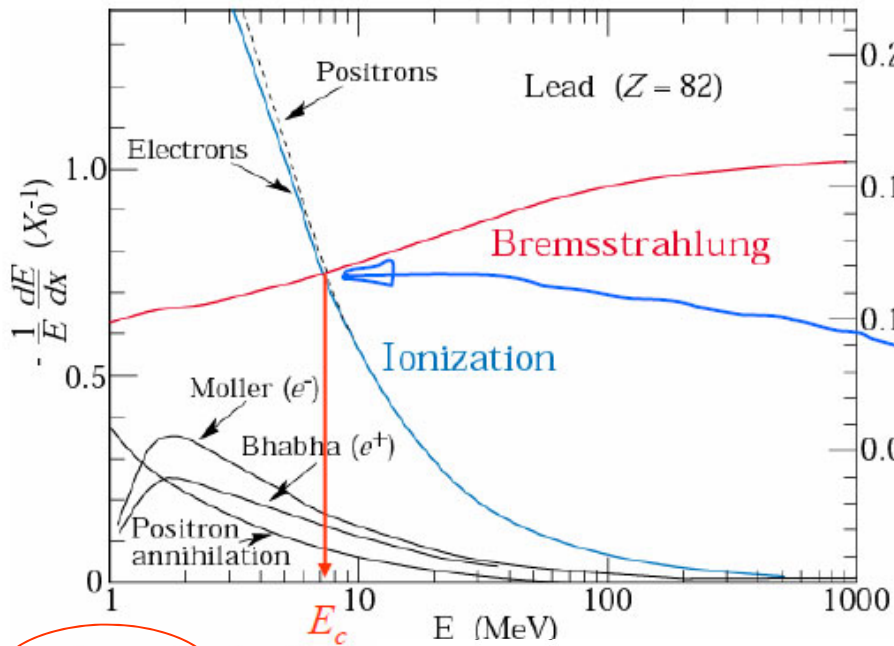
BREMMSTRAHLUNG

Table 2.3. Radiation lengths for various absorbers

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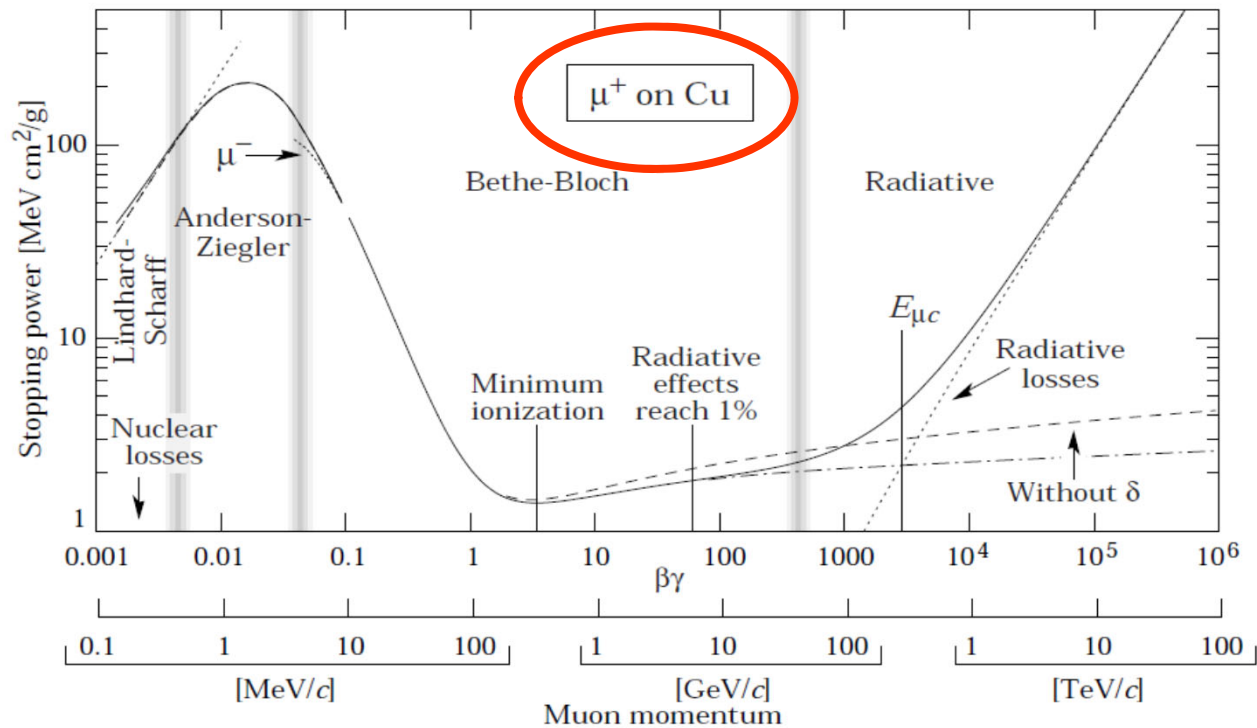


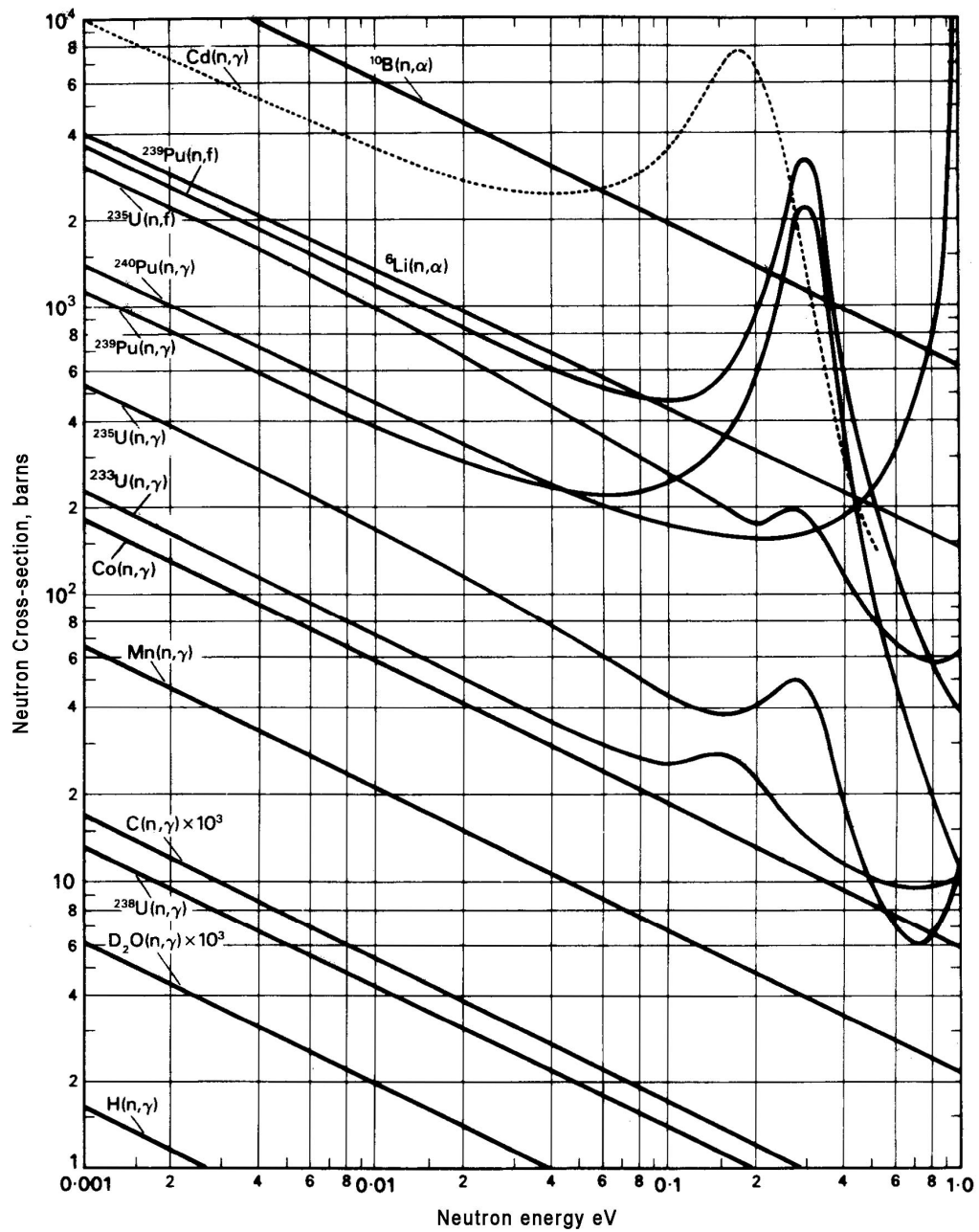
Critical Energy

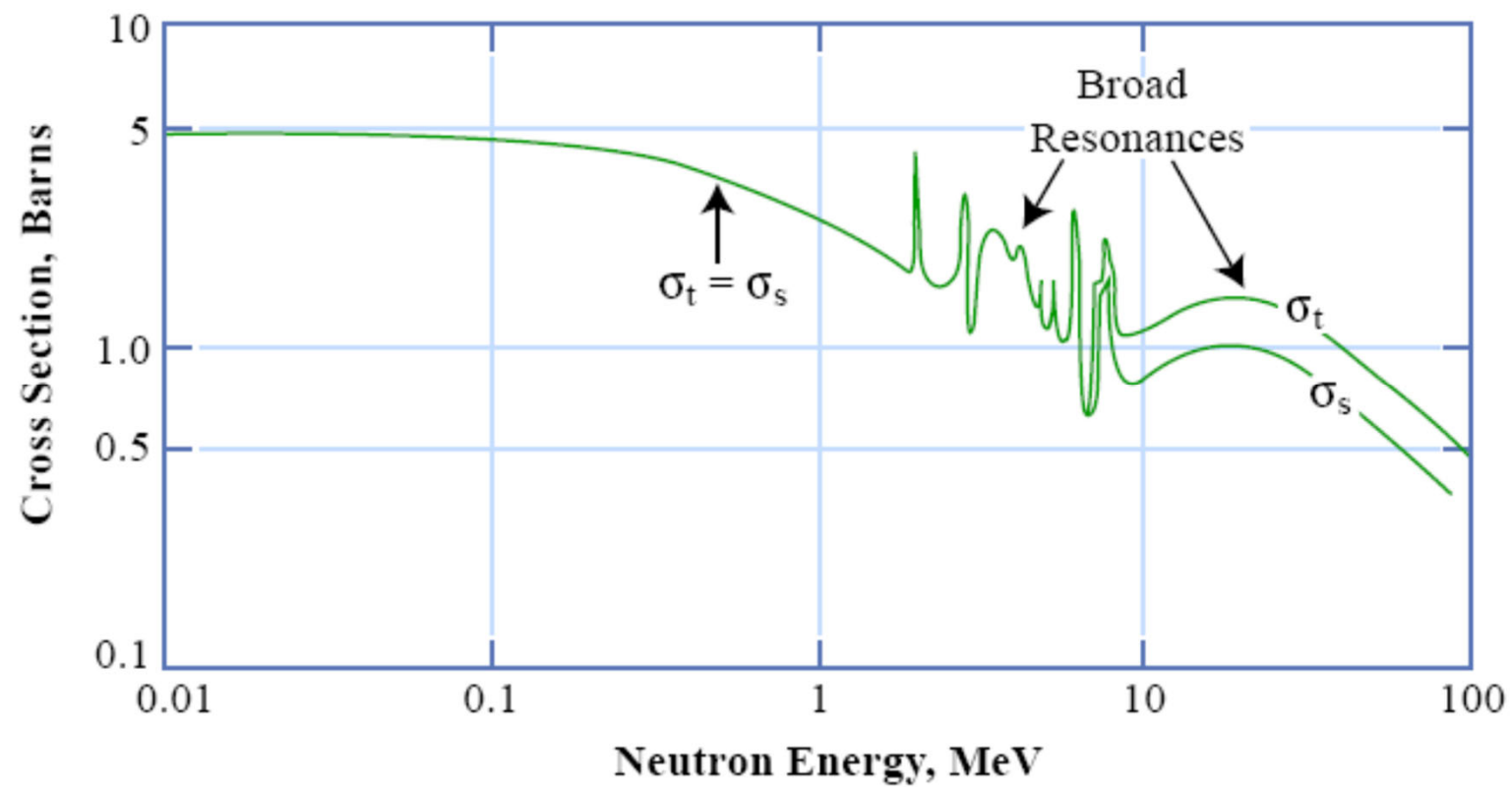
Critical energy E_c
Ionization = Bremsstrahlung

Electron (positron) intera

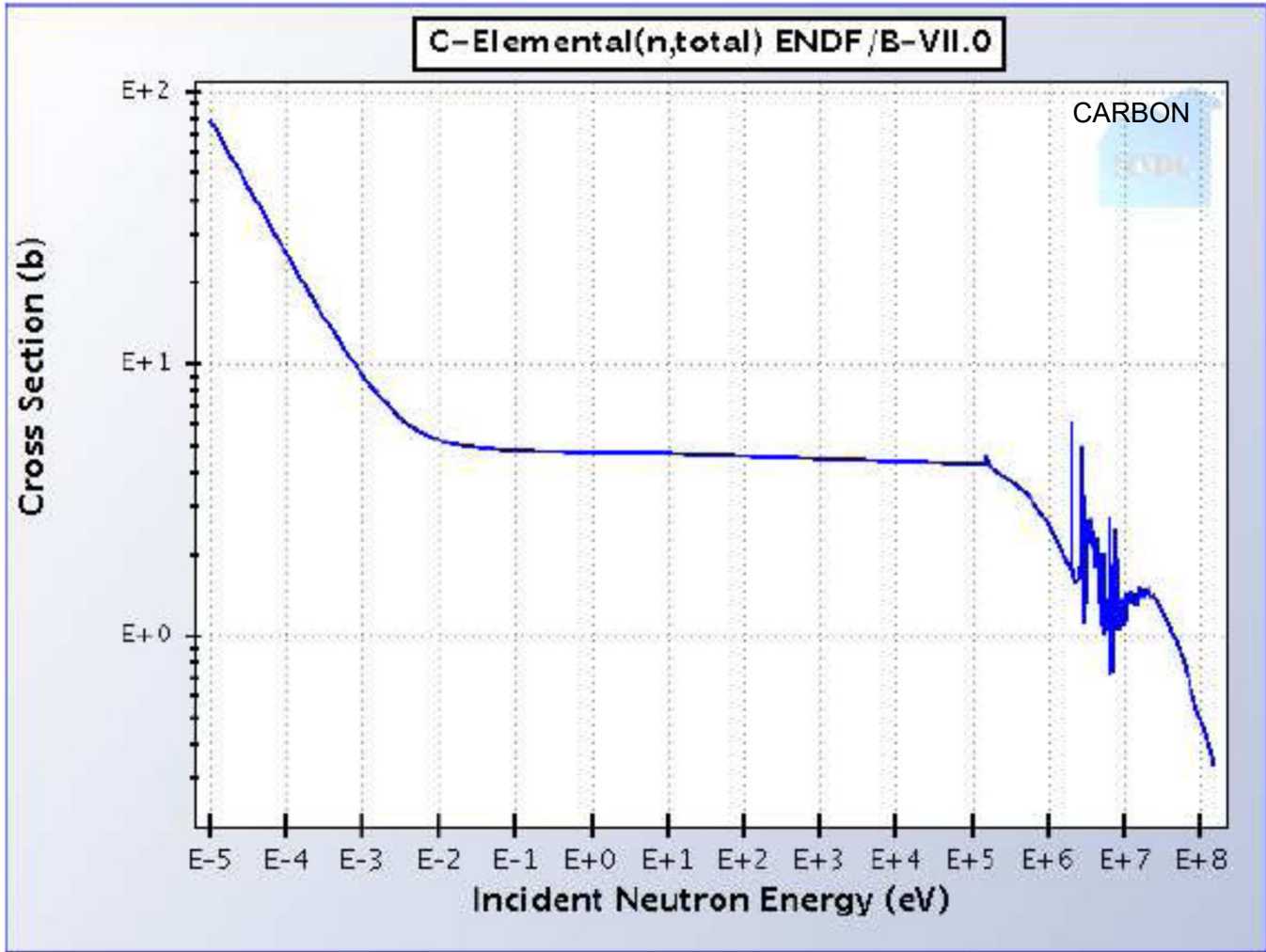
$$E_c \propto Z^{-1}$$







NNDCC Databases: | | | | | | |



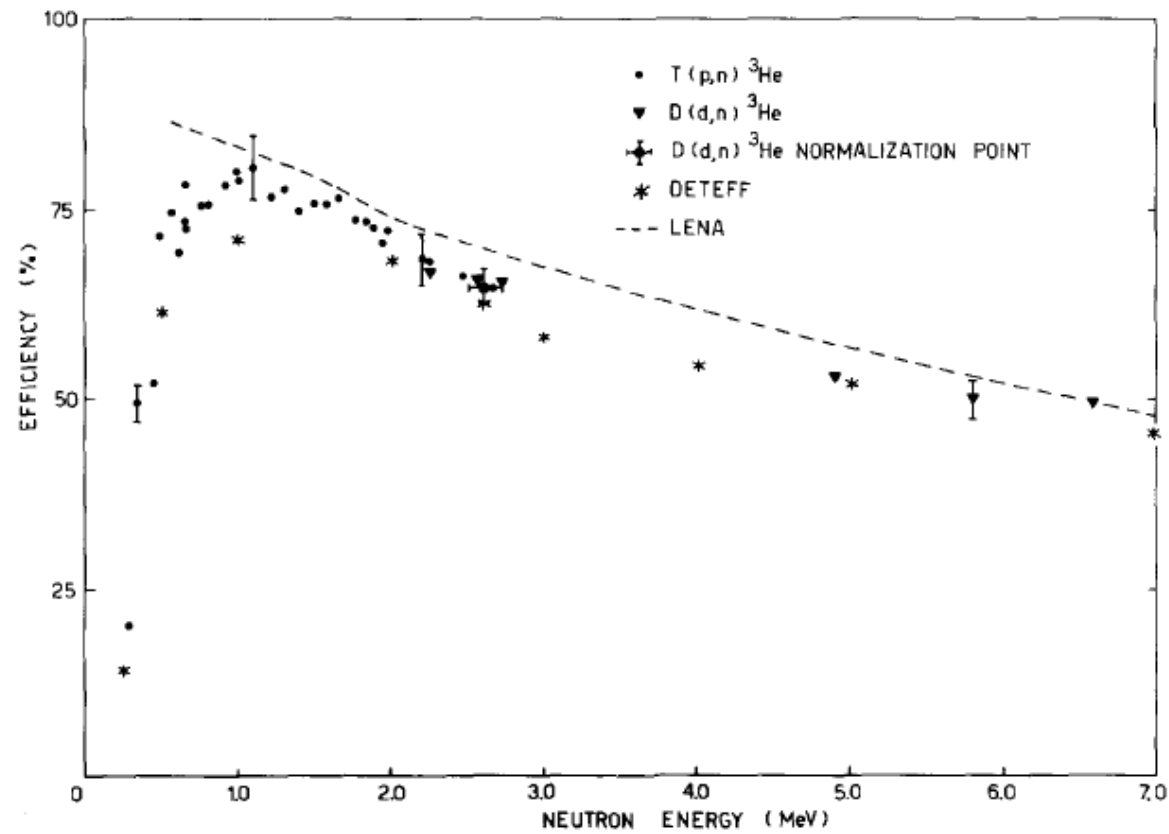


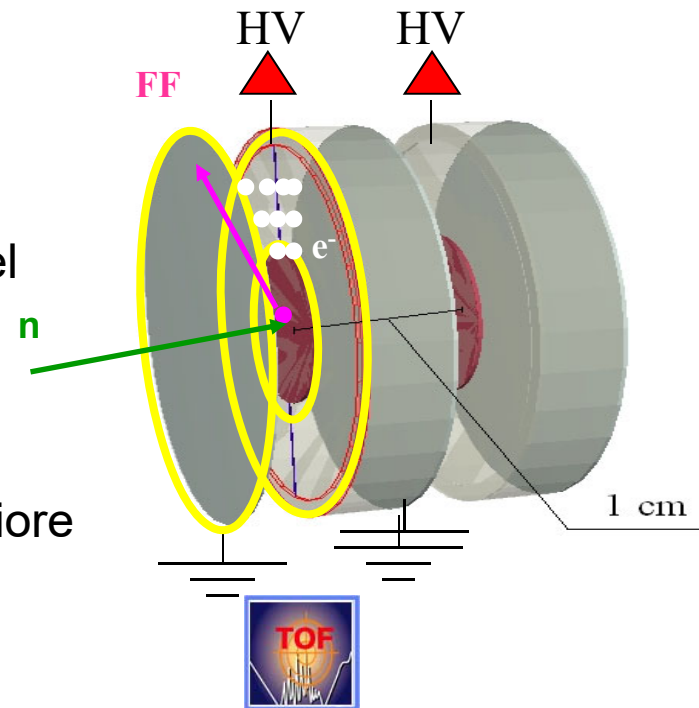
Fig. 1. Experimental neutron detection efficiency of the 10.0 cm \times 10.0 cm NE104 scintillator. DETEFF and LENA refer to the Monte Carlo calculations of refs. 7, 8.



MAIN

Principio di funzionamento

- La camera a ionizzazione è composta da uno stack di celle che si ripetono modularmente
- ogni cella è composta da 3 elettrodi
 - finestra di Al messa a terra
 - supporto di Al, connesso a High Voltage (il target è “dipinto” su entrambi i lati del supporto)
 - finestra di Al messa a terra
- quando un n colpisce il target, può causare fissione. Il FF è emesso nel gas e lo ionizza. Si formano coppie *elettrone-ione* e gli *elettroni* driftano verso l'elettrodo a potenziale maggiore





Pulse shape analysis

- La perdita specifica di energia ($-dE/dx$) di particelle cariche in un mezzo è descritta dalla formula di Bethe:

carica (e) e rest mass (m)
dell' elettrone

densità atomica (N), numero atomico (Z) e
potenziale di ionizzazione (I) del mezzo

$$-\frac{dE}{dx} = \frac{4\pi e^4 z^2}{m_0 v^2} \cdot N \cdot Z \left[\ln \frac{2m_0 v^2}{I} - \ln \left(1 - \frac{v^2}{c^2} \right) - \frac{v^2}{c^2} \right]$$

carica (ze) e velocità (v) della
particella che provoca ionizzazione

- I termini elevati al quadrato incidono maggiormente
- A parità di cammino particelle con numero atomico maggiore (z) perdono più energia nel mezzo.

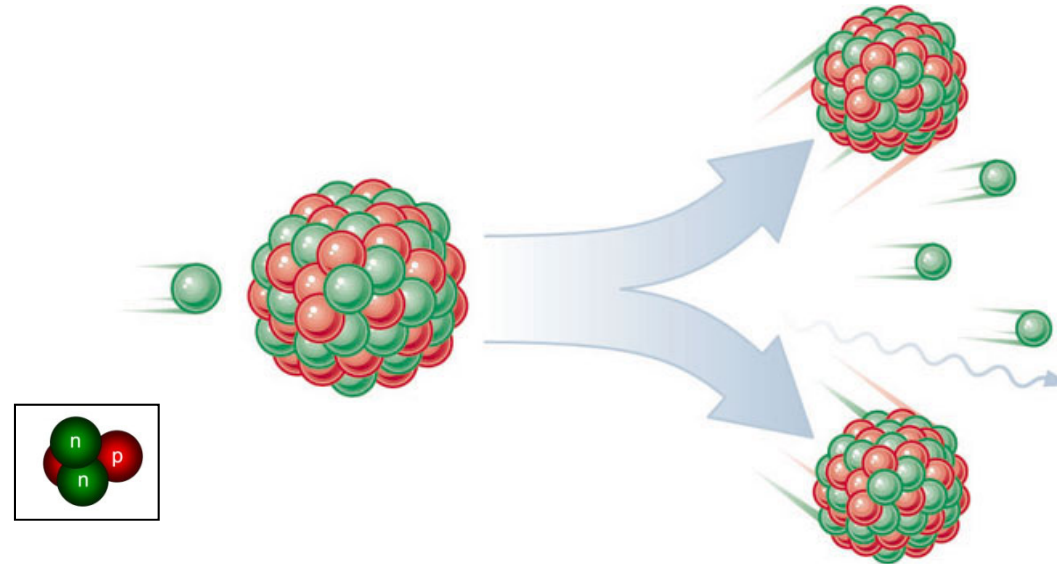




MAIN

Il metodo del rapporto

- La corrente di particelle uscenti è determinata contando il numero di FFs



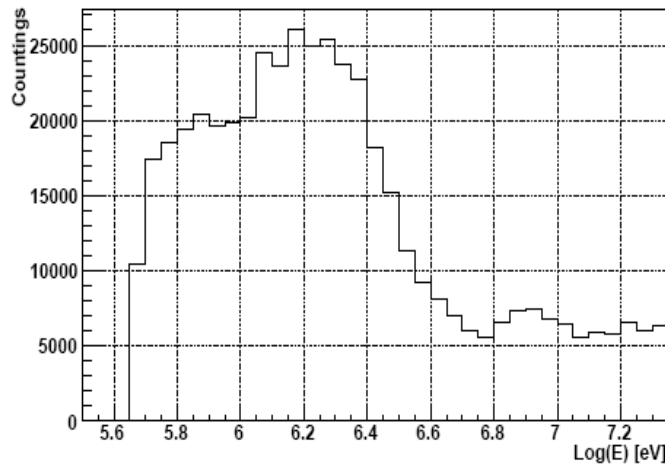
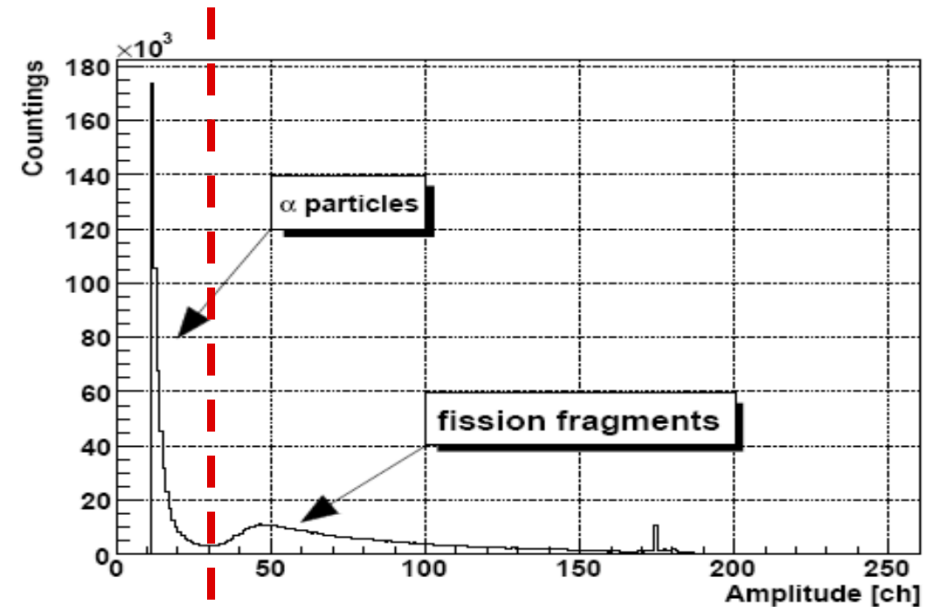
$$R_b = \sigma I_a N \begin{cases} R_b = \text{emission rate} \longrightarrow \text{Determinato contando i FFs} \\ N = \text{nuclei/area} \longrightarrow \text{Noto se nota la geometria del campione} \\ I_a = \text{neutron "beam" intensity?} \longrightarrow \text{Ratio method} \end{cases}$$





Estrazione $\sigma_{(n,f)}(E_n)$

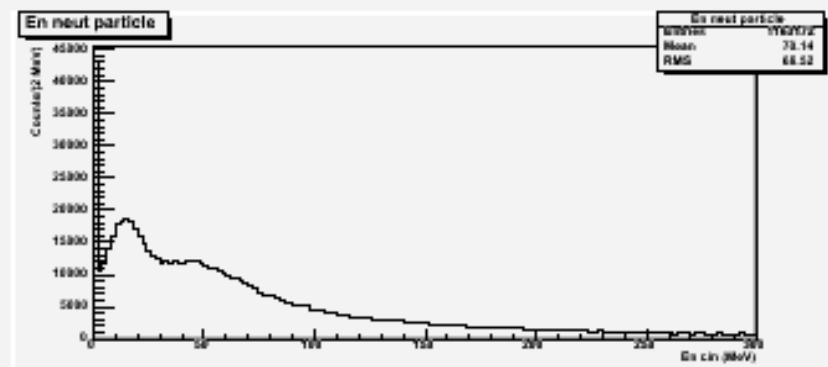
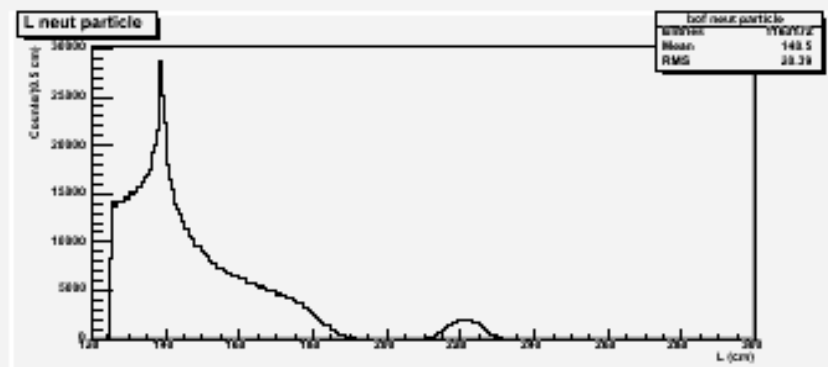
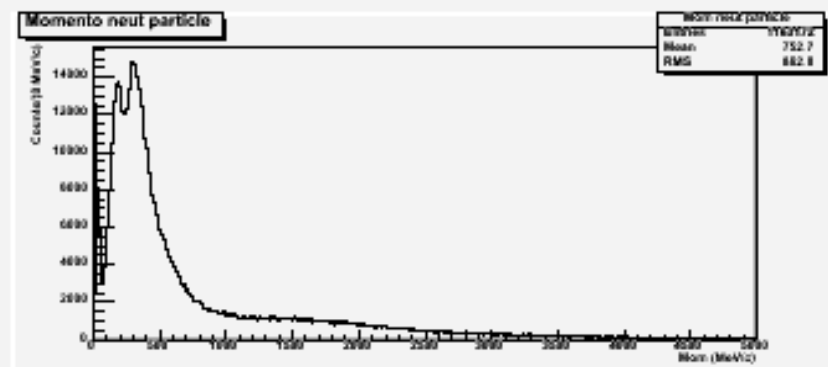
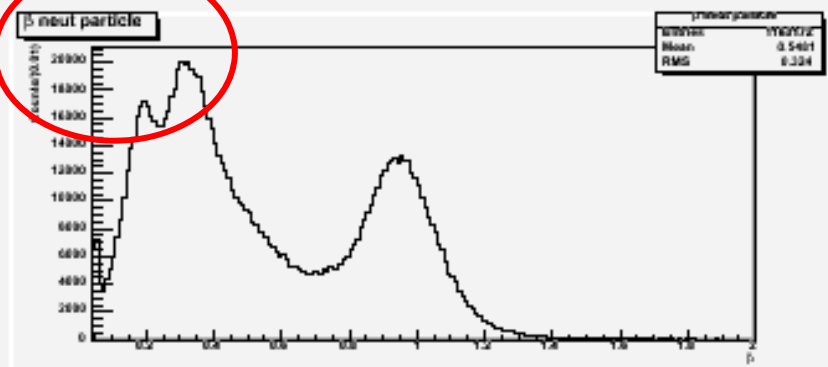
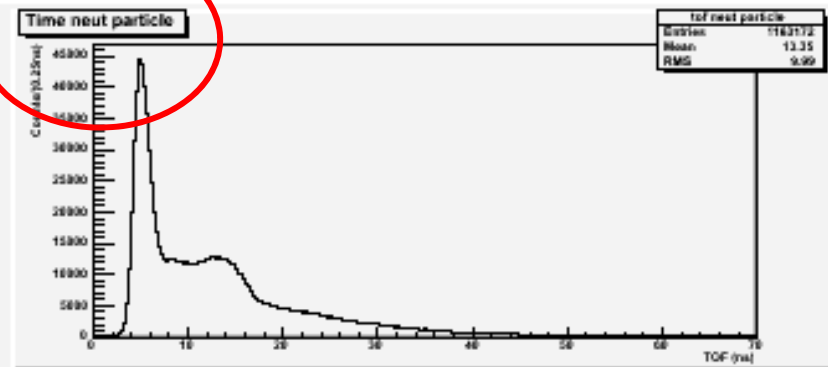
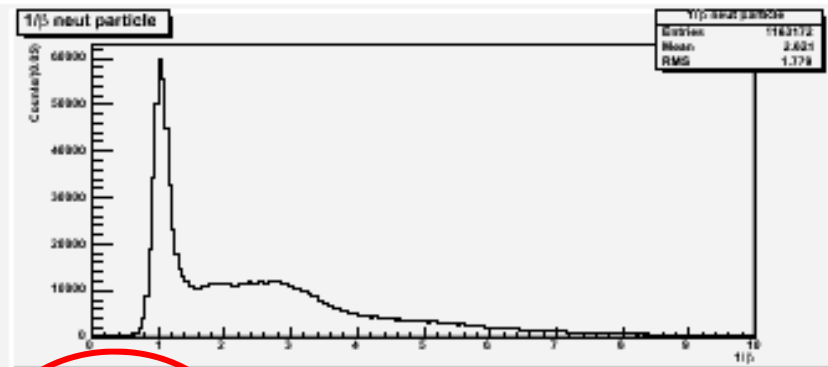
- Come visto prima i FFs possono venire isolati in base all'analisi della forma dell'impulso del segnale indotto dalla fissione



- Si riempie l'istogramma del # di FFs rivelati in corrispondenza di ogni E_n

$$\sigma_{xxx}(n,f) = \sigma_{235ENDF}(n,f) \cdot \frac{Y_{xxx}}{Y_{235}} \cdot \frac{m_{235}}{m_{xxx}} \cdot \frac{A_{xxx}}{A_{235}}$$





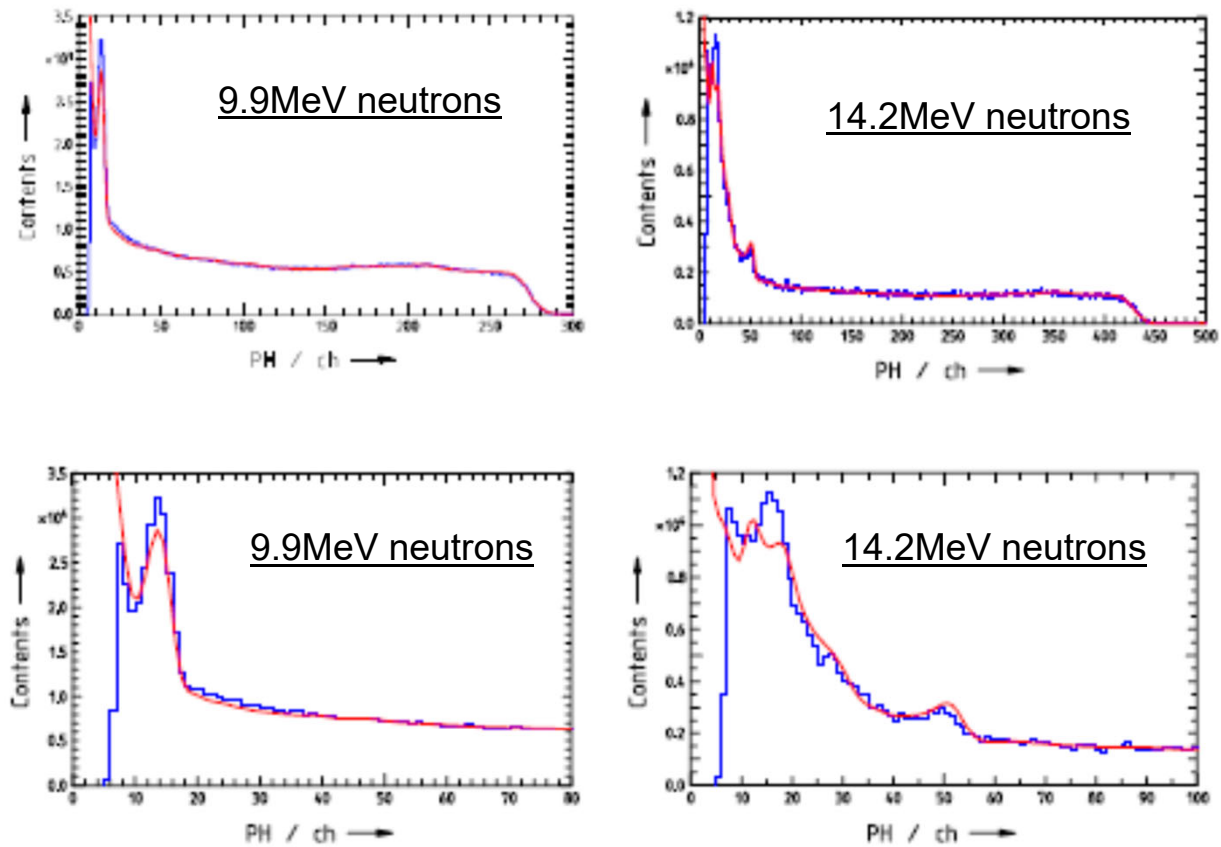


Figure 1: Comparison of response functions of an NE213-scintillator, 255 mm in diameter and 51 mm in length, for 9.9 MeV (left) and 14.26 MeV (right) neutrons, as measured (blue) and simulated (red) with version 7 of the NRESP-code [128]. Expanded plots of the low-amplitude regions are shown in the lower panels.

Neutron detection efficiency

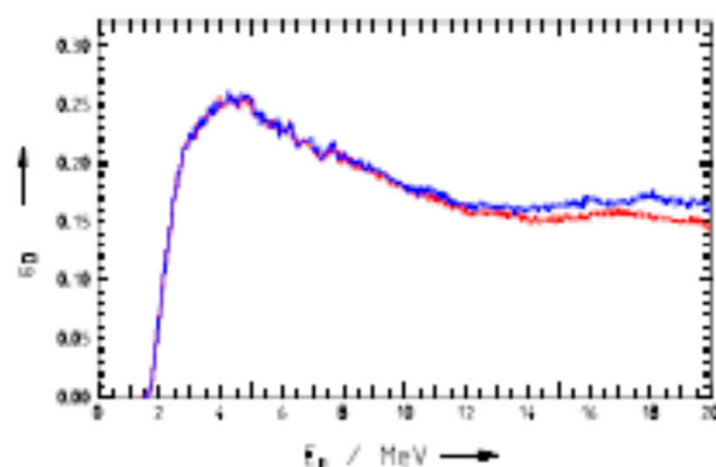


Figure 2: Neutron detection efficiency ϵ_D of an NE213 scintillator, 255 mm in diameter and 51 mm in length, for neutron energies up to 20 MeV and a threshold of about 2 MeV

($E_{\text{thr}} > 0.46$ MeV)

- (a) simulated (blue) with version 7 of the NEFF-code [128]
- (b) simulation corrected for compliance with the experimental response in the low-amplitude region (red).