BREMMSTRAHLUNG

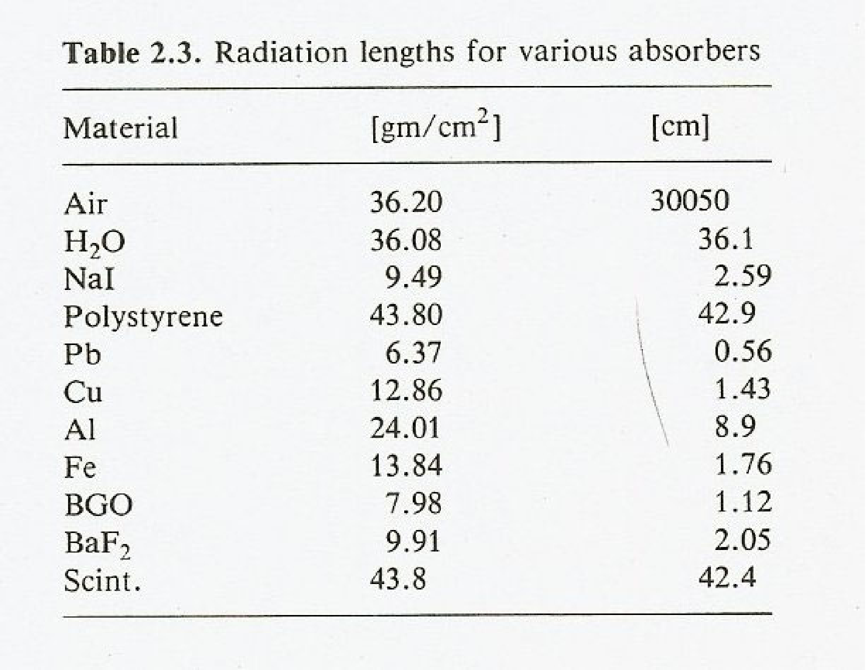


Table 2.3. Radiation lengths for various absorbers

Material	[gm/cm^2]	[cm]
Air	36.20	30050
H_2O	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

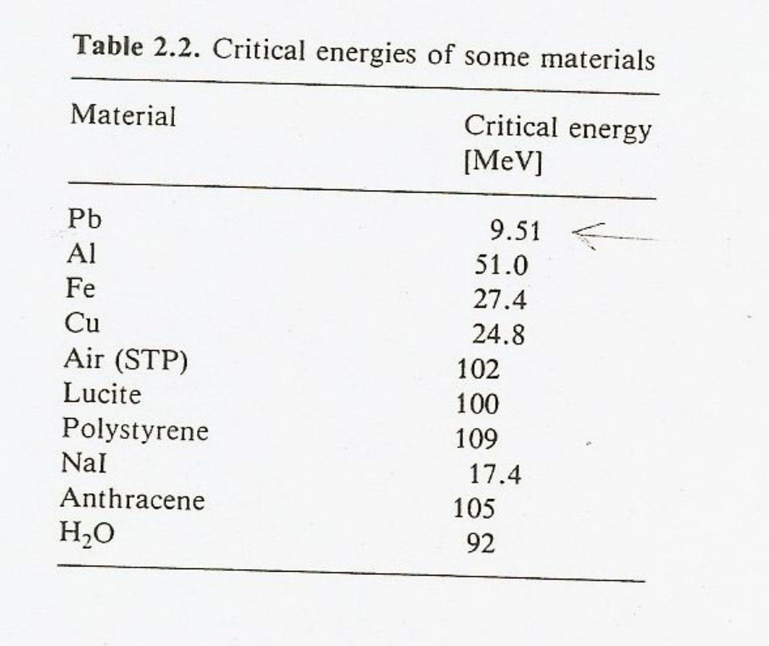
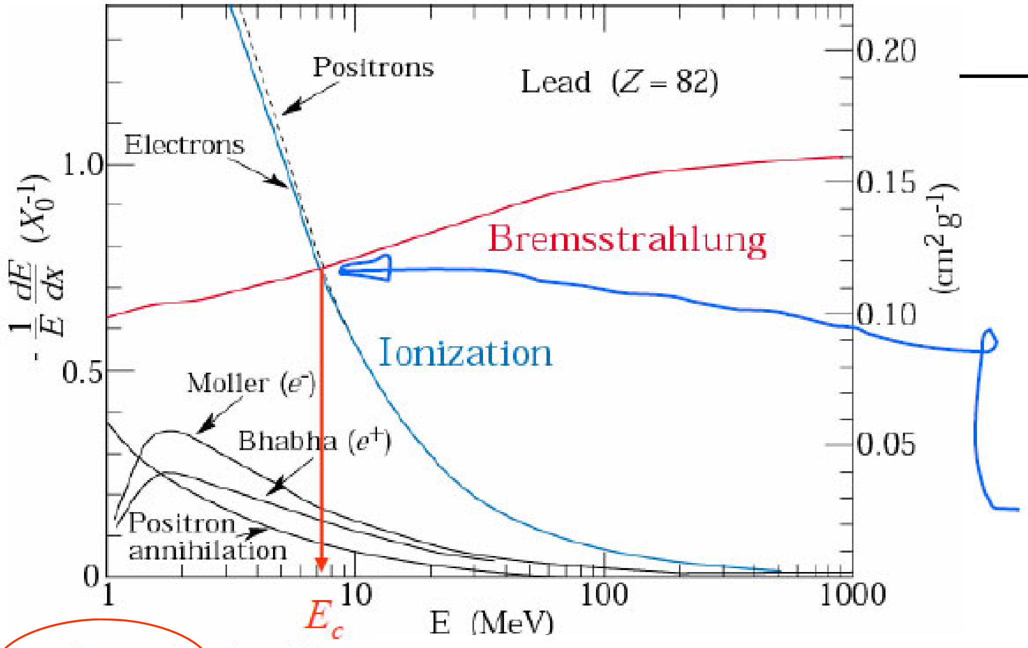


Table 2.2. Critical energies of some materials

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_2O	92

Critical Energy



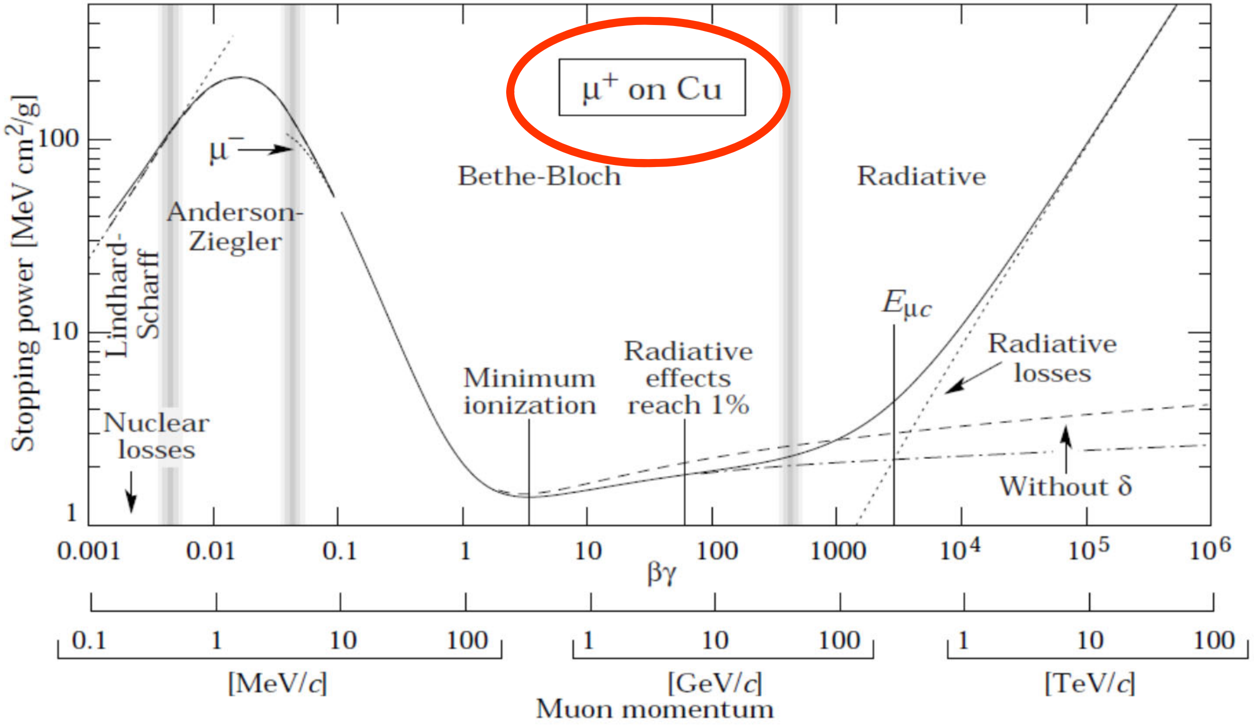
Critical energy

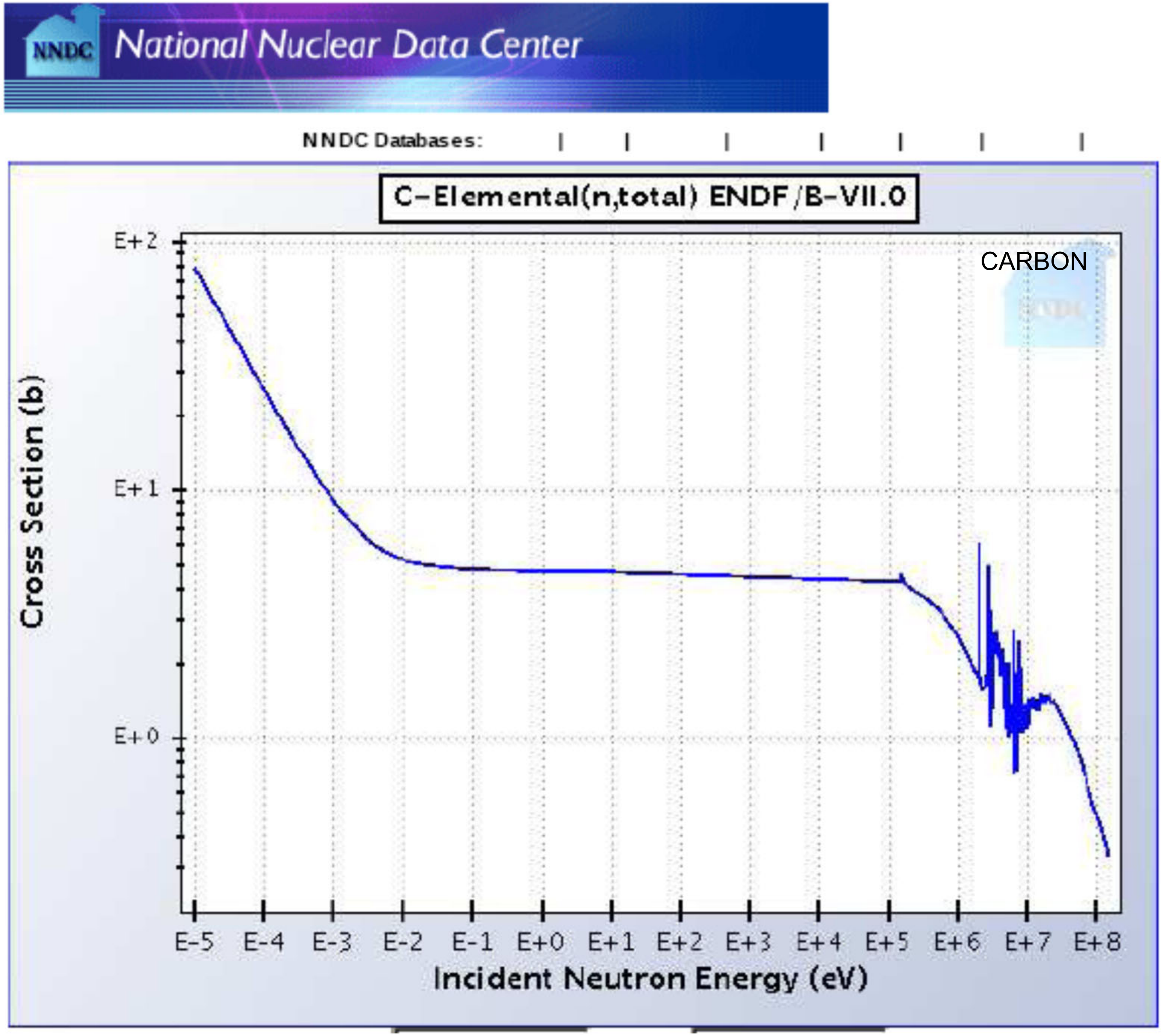
E_c

Ionization = Bremsstrahlung

Electron (positron) intera

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




NNDC
National Nuclear Data Center
NNDC Databases:
C-Elemental(n,total) ENDF/B-VII.0
CARBON
NNDC
Cross Section (b)
E+2
E+1
E+0
E-5
E-4
E-3
E-2
E-1
E+0
E+1
E+2
E+3
E+4
E+5
E+6
E+7
E+8
Incident Neutron Energy (eV)

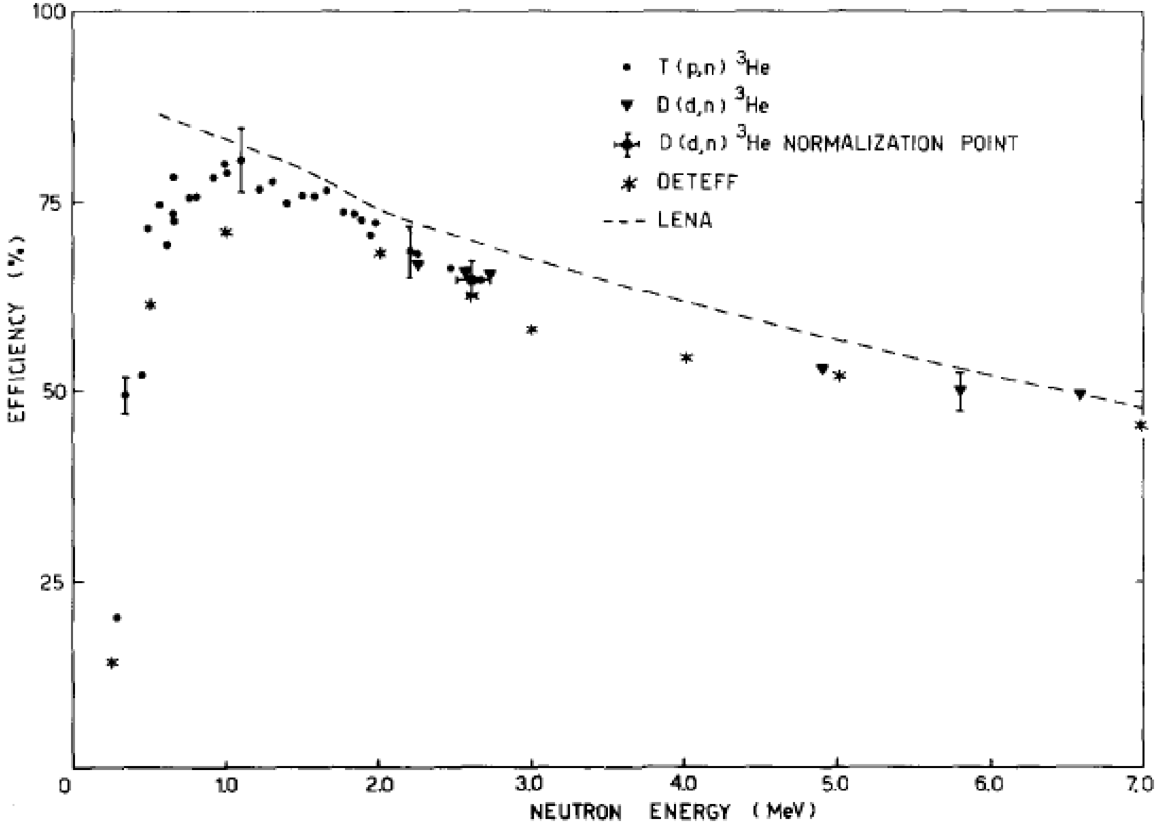
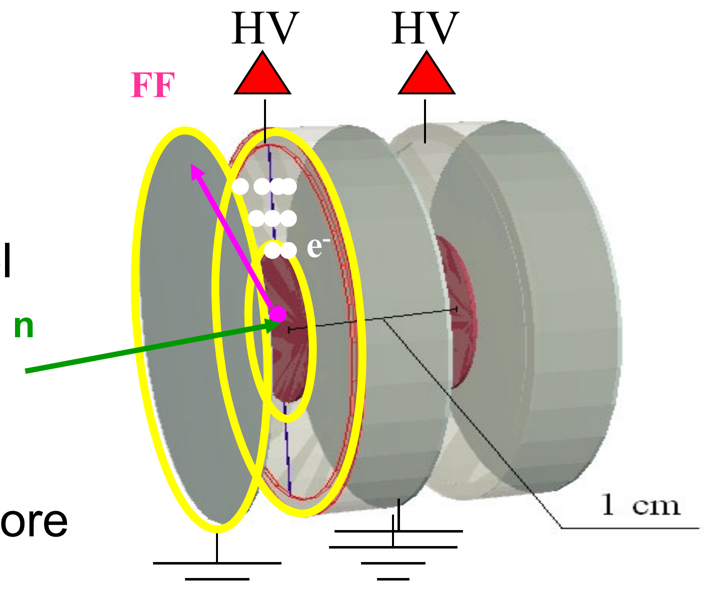


Fig. 1. Experimental neutron detection efficiency of the 10.0 cm × 10.0 cm NE104 scintillator. DETEFF and LENA refer to the Monte Carlo calculations of refs. 7, 8.

MAIN

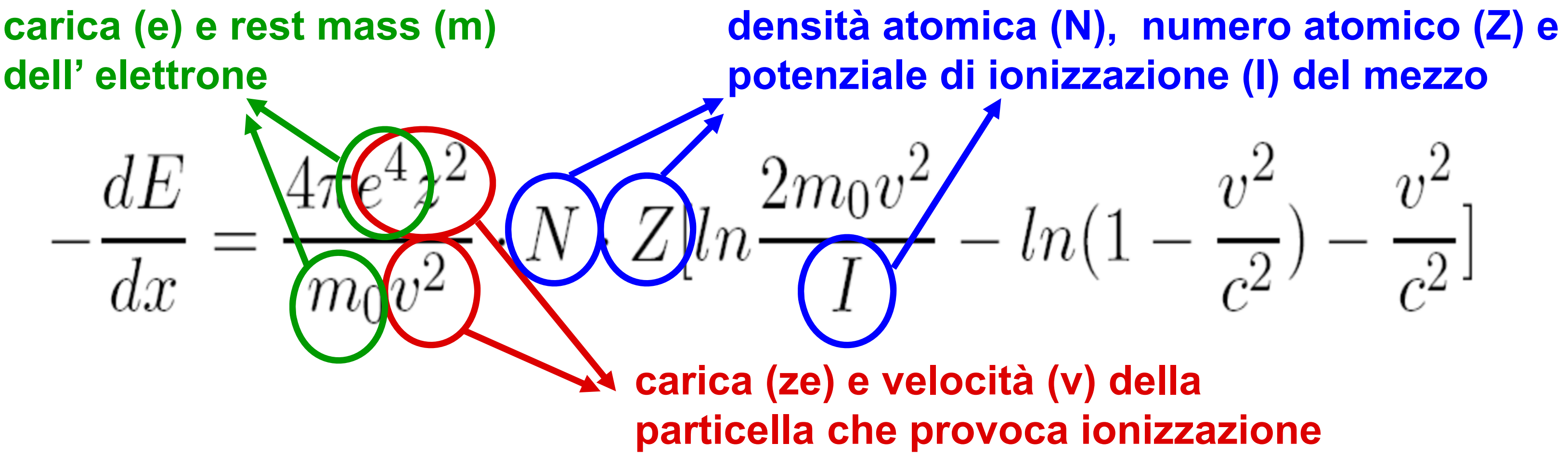
Principio di funzionamento

- 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

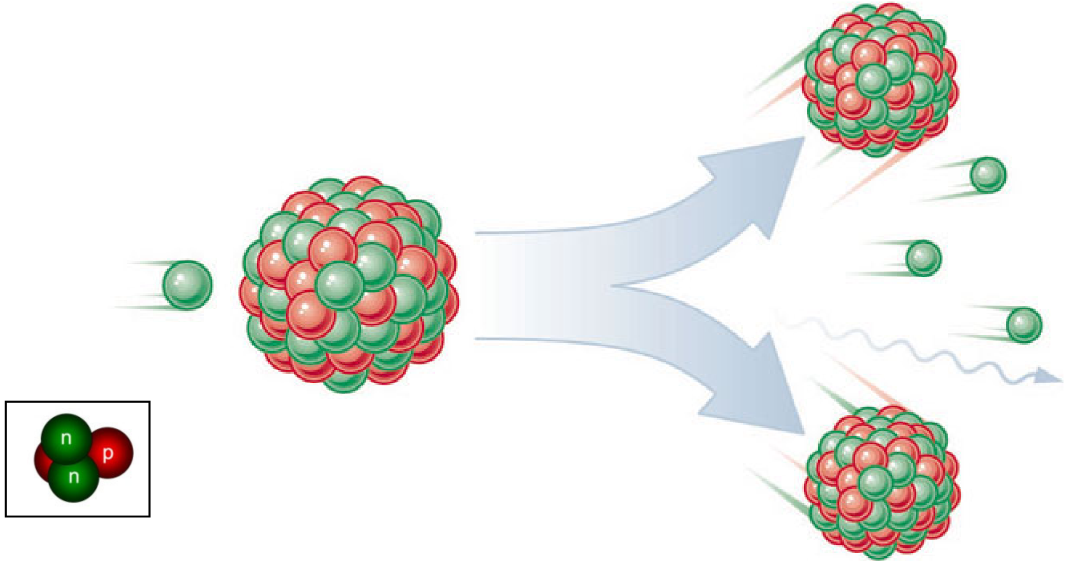
$$-\frac{dE}{dx} = \frac{4\pi e^4 z^2}{m_0 v^2} N Z \left[ln\frac{2m_0 v^2}{I} - ln\left(1-\frac{v^2}{c^2}\right) - \frac{v^2}{c^2} \right]$$

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.

Il metodo del rapporto

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



$$R_b = \sigma I_a N$$

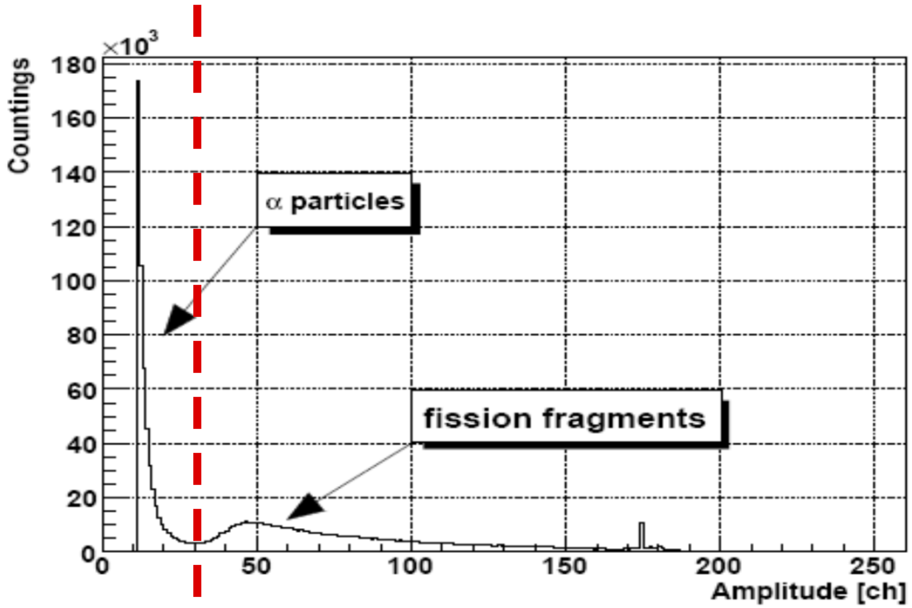
R_b = emission rate → Determinato contando i FFs

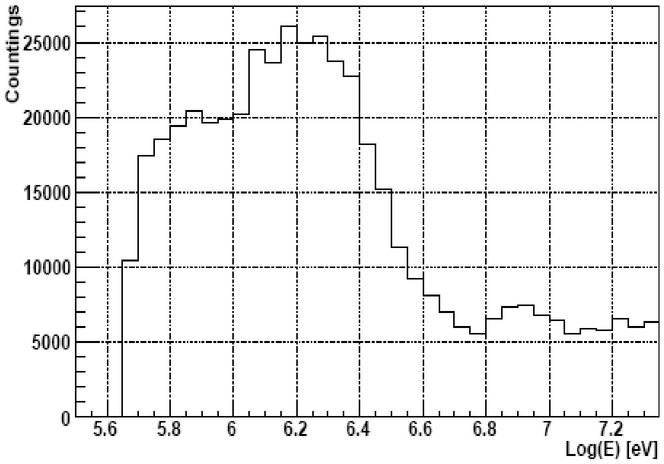
N = nuclei/area → Noto se nota la geometria del campione

I_a =neutron "beam" intensity ? → Ratio method

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

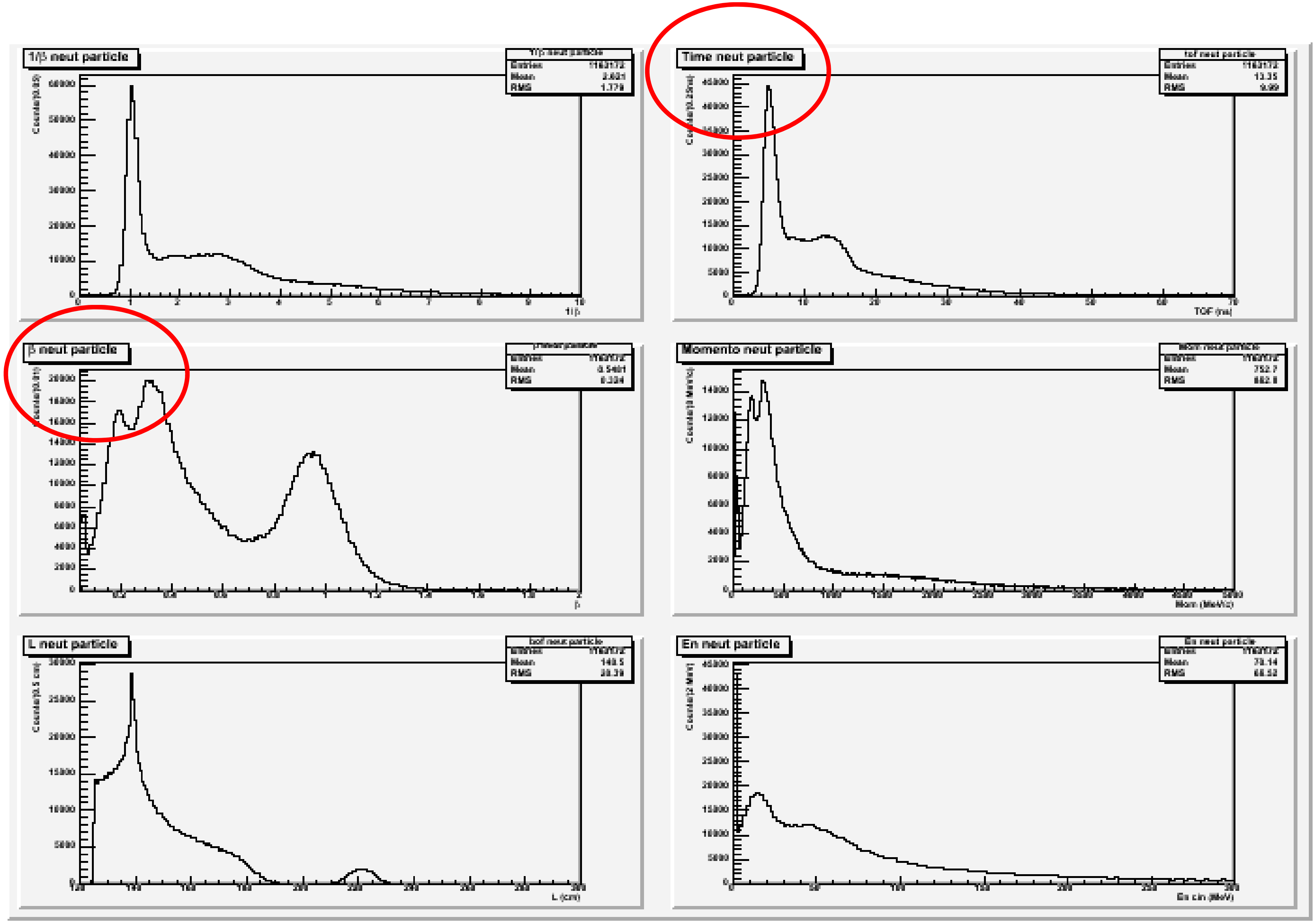
- Come visto prima i FFs possono venire isolati in base all'analisi della forma dell'impulso del segnale indotto dalla fissione





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

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


1/β neut particle
1/β neut particle
Entries 1163172
Mean 2.601
RMS 1.779
Counts/(0.02)
1/β
Time neut particle
tof neut particle
Entries 1163172
Mean 13.35
RMS 9.99
Counts/(0.25ns)
TOF (ns)
β neut particle
β neut particle
Entries 1163172
Mean 0.5401
RMS 0.324
Counts/(0.01)
β
Momento neut particle
Mom neut particle
Entries 1163172
Mean 752.7
RMS 682.8
Counts/(5 MeV/c)
Mom (MeV/c)
L neut particle
bof neut particle
Entries 1163172
Mean 148.5
RMS 28.39
Counts/(0.5 cm)
L (cm)
En neut particle
En neut particle
Entries 1163172
Mean 78.14
RMS 68.52
Counts/(2 MeV)
En cin (MeV)

Neutron detection efficiency

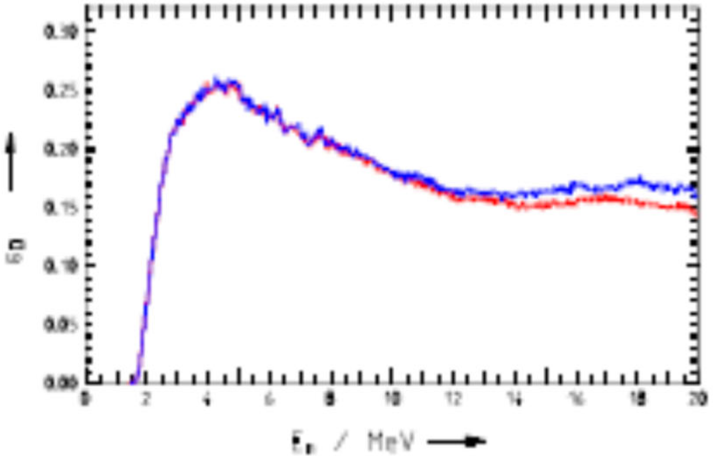
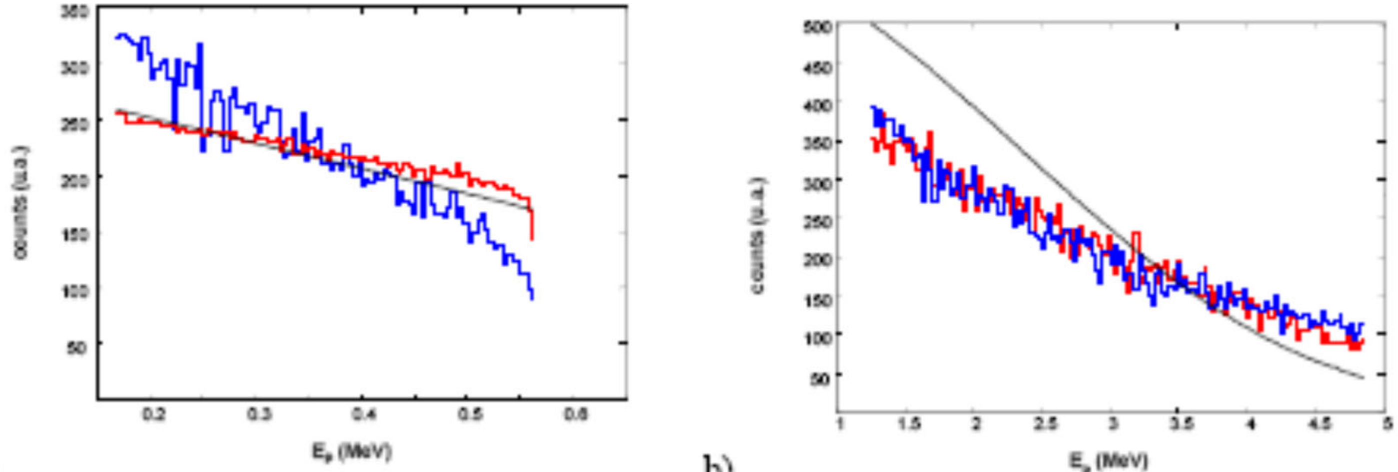


Figure 2: Neutron detection efficiency ε_D of an NE213 scintillator, 255 mm in diameter and 51 mm in length, for neutron energies up to 20 MeV and a threshold of about 2 MeV
($E_{eee} > 0.46$ MeV)

(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).



a) b)

Figure 1: Proton recoil spectra obtained with monoenergetic neutrons (blue), calculated with MCNPX (red) and with the Snidow algorithm (black): a) SP2-4 with neutrons at 565 keV. b) SP6 with neutrons at 4.5 MeV.