Second year Ph.D. research activity

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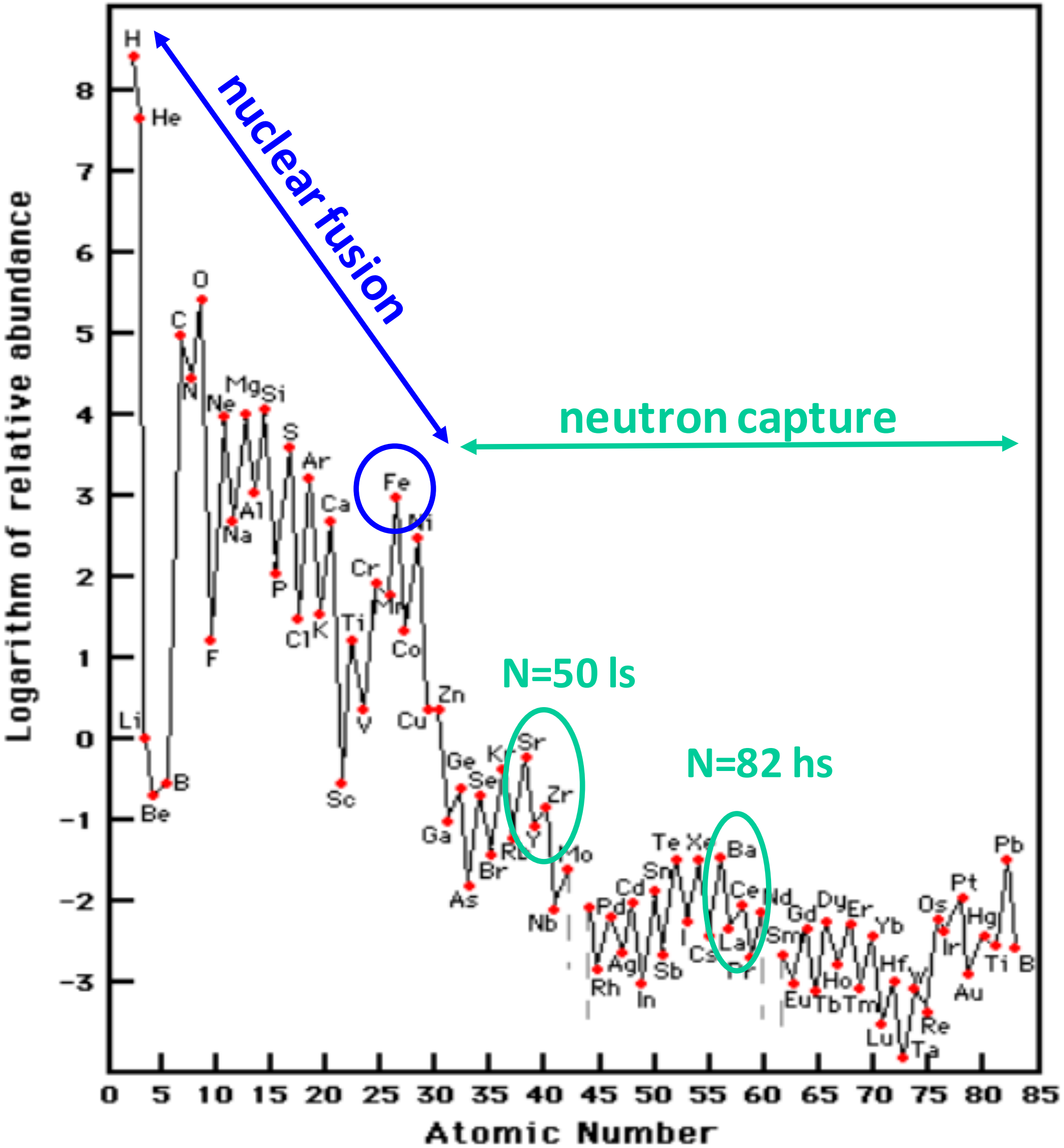
Main topics

- I stayed at CERN as an INFN Associate ("simil-fellow")
- I concluded my analysis on the $^{7}Be(n,p)^{7}Li$ cross section measurement for the Cosmological Lithium Problem
- I was responsible for the measurement of the neutron capture cross section of ^{89}Y and ^{88}Sr performed in EAR1 at n_TOF

^{89}Y and ^{88}Sr neutron capture measurement



neutron capture processes

- slow neutron capture process (s-process)
  $\tau_n > \tau_\beta$ and $n_n \sim 10^8 cm^{-3}$

- rapid neutron capture process (r-process)
  $\tau_n < \tau_\beta$ and $n_n \sim 10^{22} cm^{-3}$

s-process bottlenecks

their neutron-capture cross sections are lower than those of neighboring nuclei. As a result, they act as bottlenecks on the neutron-capture path.

^{89}Y and ^{88}Sr neutron capture measurement

The ^{88}**Sr** and ^{89}**Y** abundances in stars easy to derive thanks to a large number of strong lines in spectra.

↔

constrain **stellar models** and **astrophysical scenarios**.

^{89}**Y** hydride offers advantages as a **moderator** for high temperature thermal nuclear reactors.

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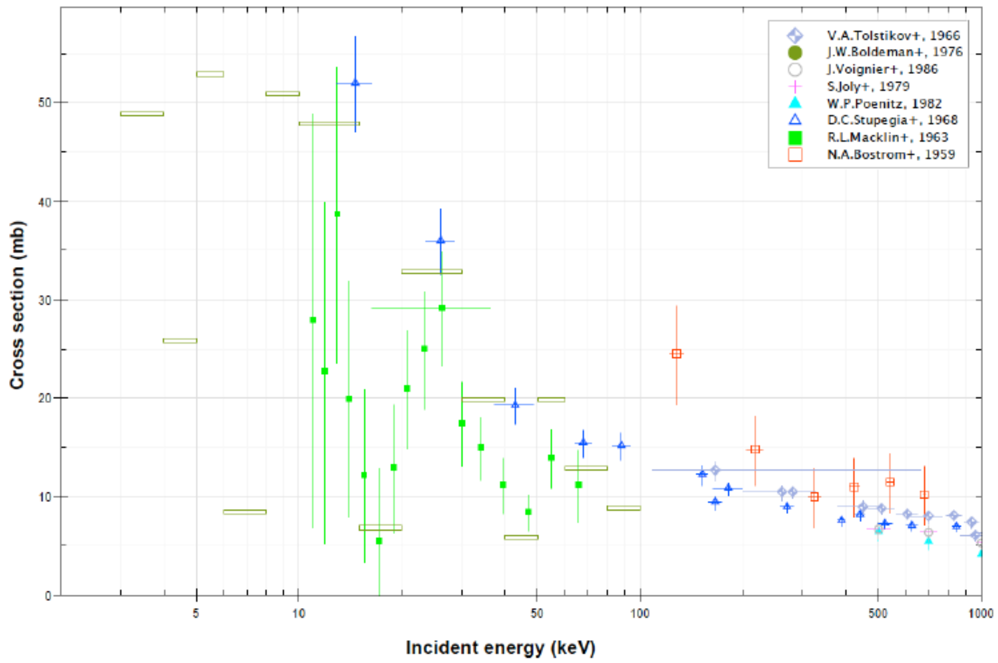
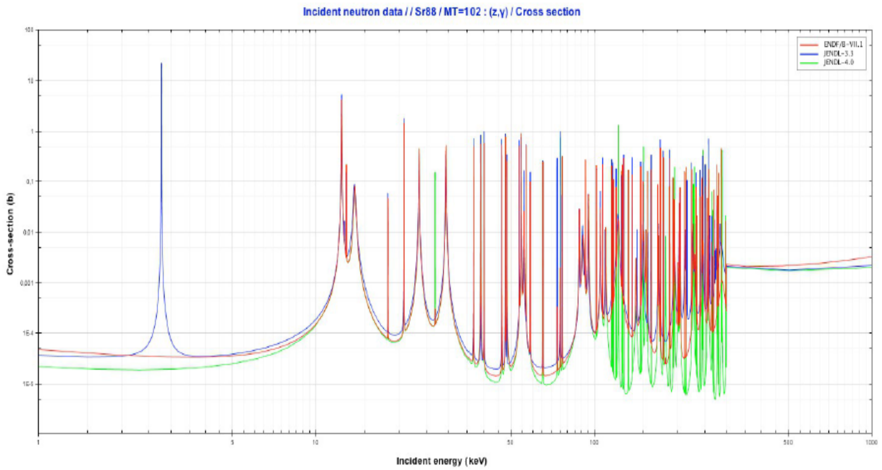
It retains its relatively high content of hydrogen at very high temperatures, between 850 °C to 1150 °C.



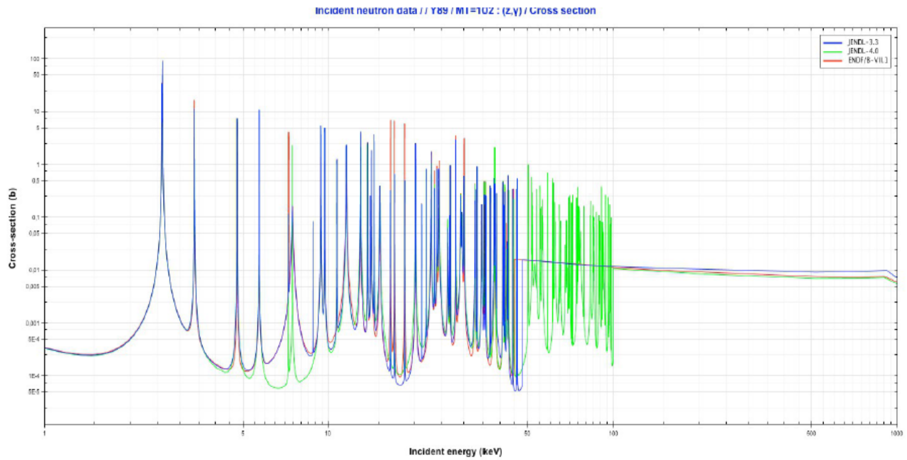
^{89}Y and ^{88}Sr neutron capture measurement

The status of the **experimental data** is also reflected in the quality of the cross sections in the evaluated data libraries.

^{88}Sr(n,γ)



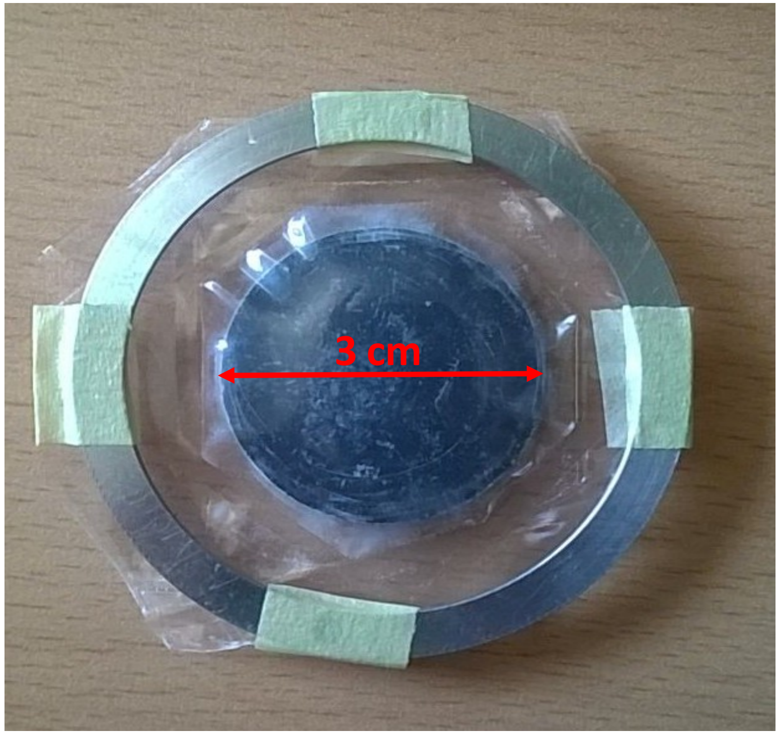
^{89}Y(n,γ)



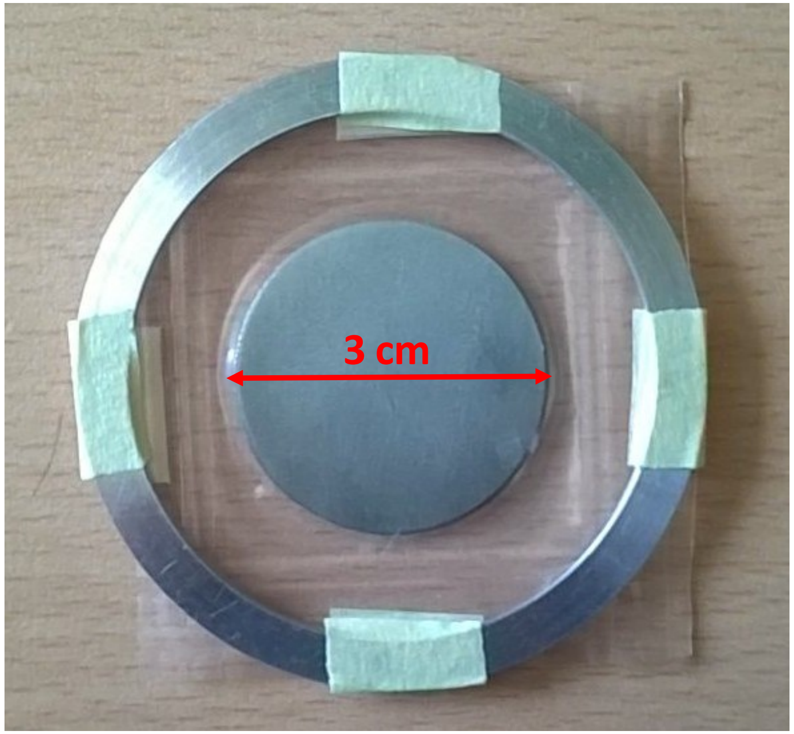
^{89}Y and ^{88}Sr samples

^{88}**Sr** is the most abundant Sr isotope (82% in the Sun)

^{89}**Y** is the only stable isotope of Y

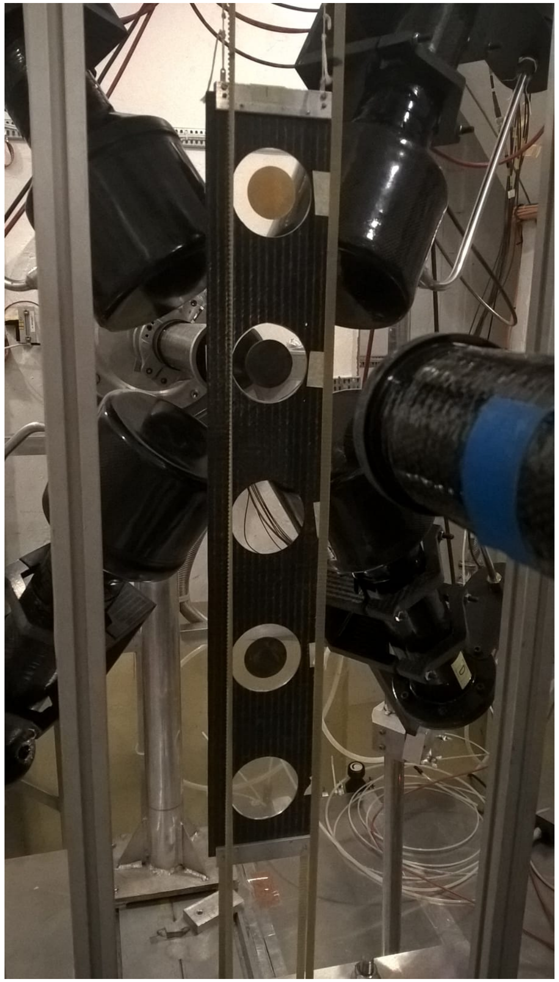


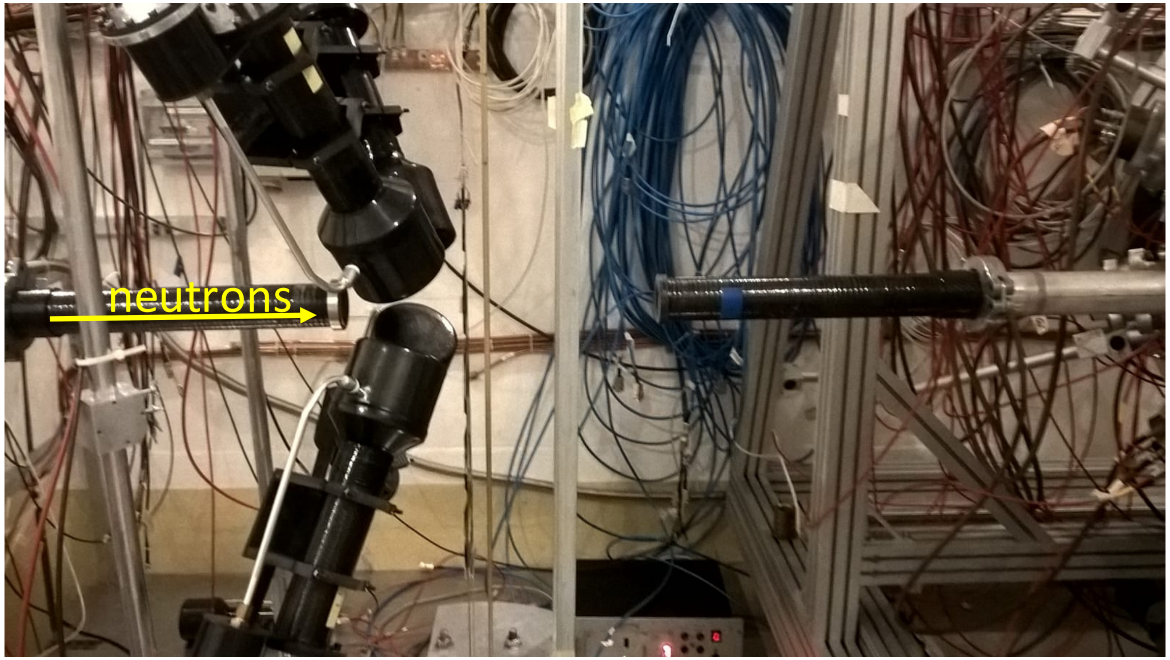
carbonate powder with an enrichment > 99.9%



metal disk with a purity of 99,9%

Experimental set – up

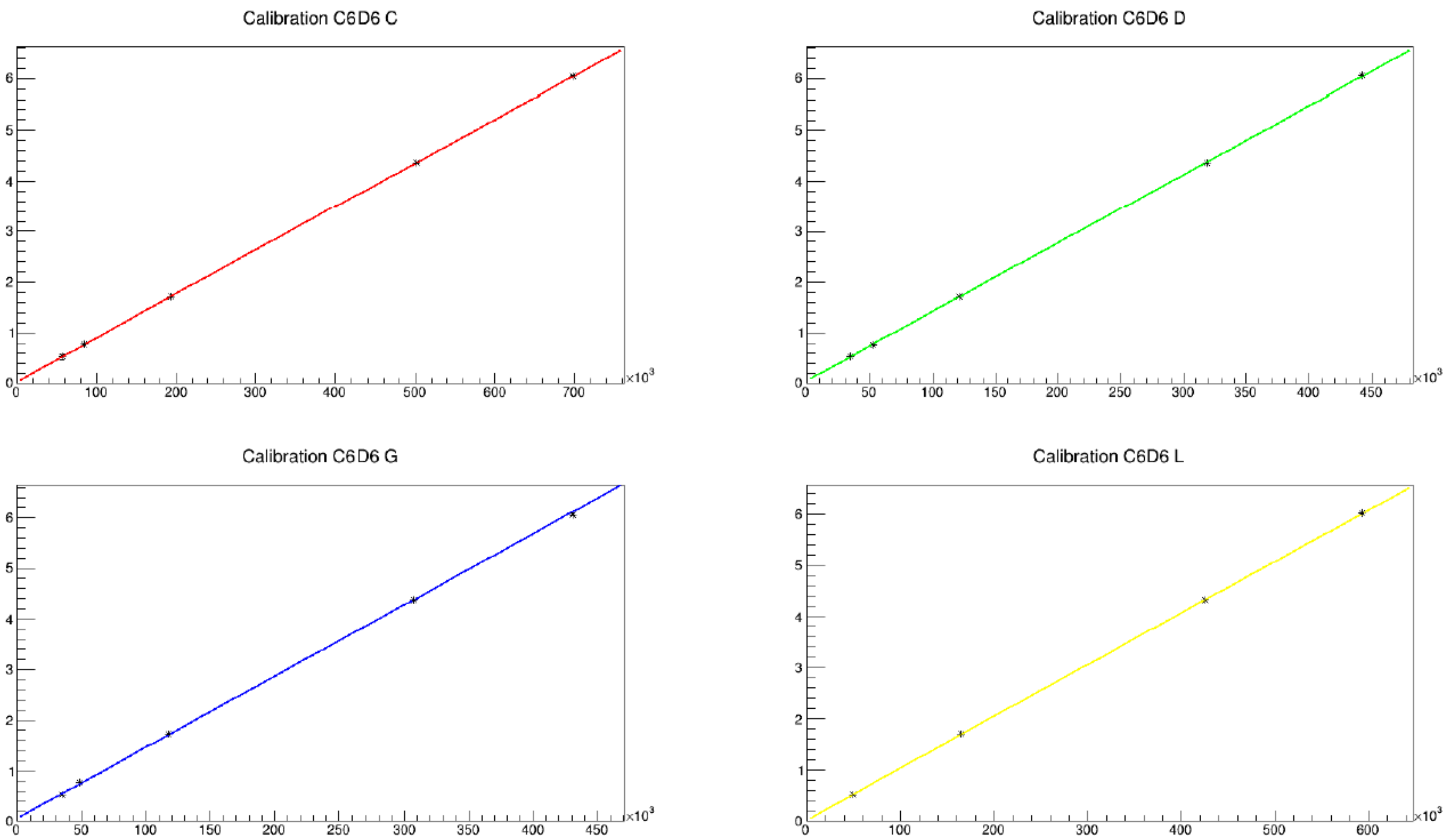




- SiMon a silicon based neutron beam monitor based on the $^{6}Li(n,t)\alpha$ reaction
- 4 C_6D_6 Liquid scintillators
- Sample Exchanger

Energy calibration of the C6D6 detectors

Calibration γ-ray sources: $^{137}\mathrm{Cs}$, $^{88}\mathrm{Y}$, AmBe, CmC



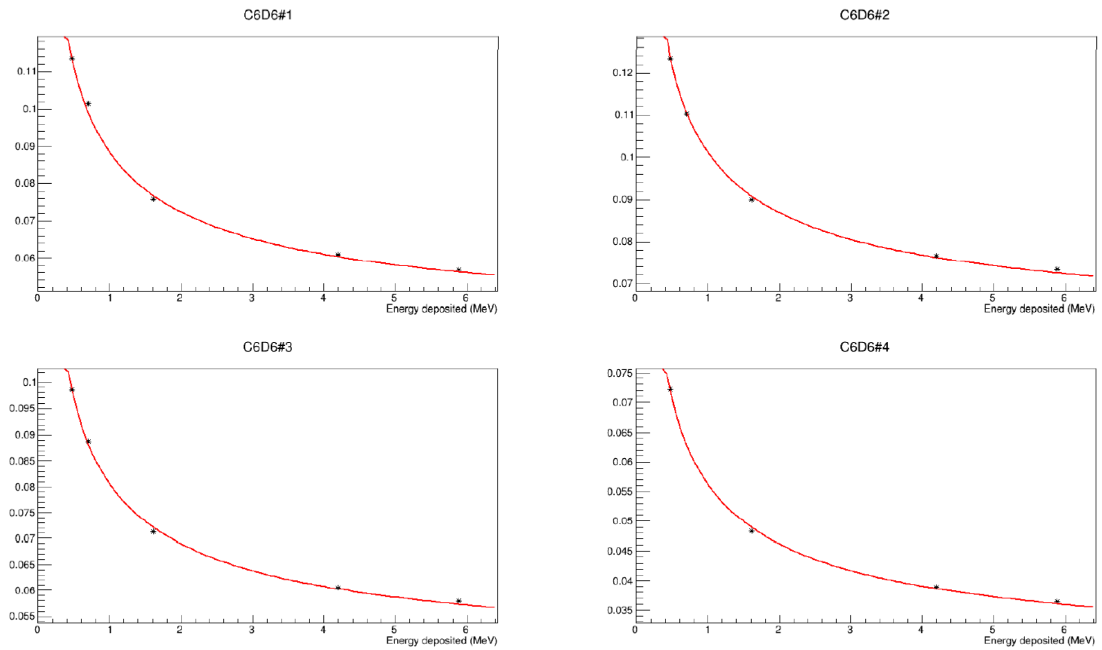
Pulse height weighting technique

The weighting functions ensure that the efficiency ε_γ of a detector is linear with the E_γ

The weighting function W(E) is determined by minimizing the expression:

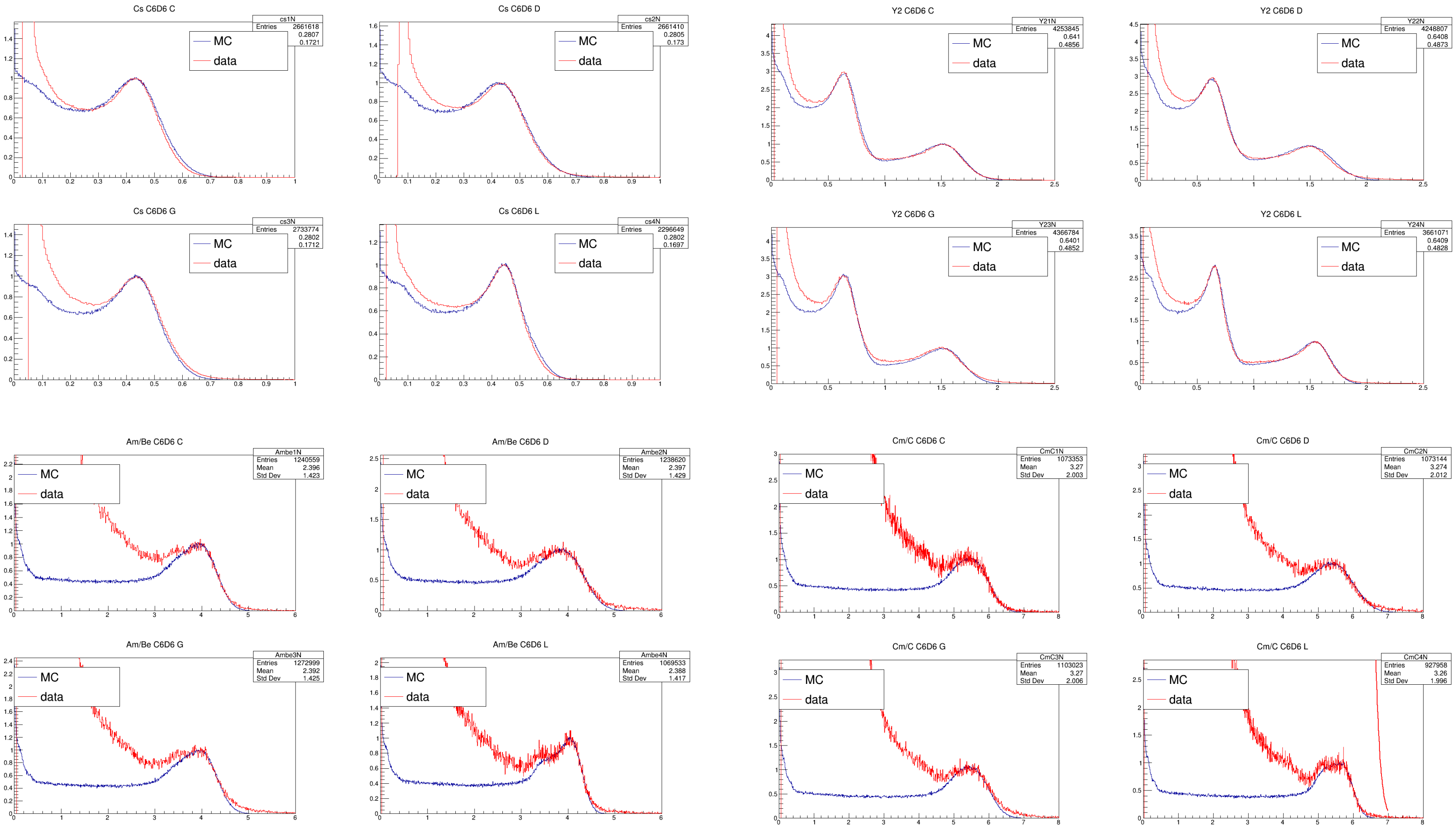
$$\sum_j \left[\int W(E')R(j;E')dE' - \alpha E_\gamma(j) \right]^2$$

R(j;E) is the simulated detector response to a γ ray of energy Eγ convoluted with the **Experimental Resolution Functions**

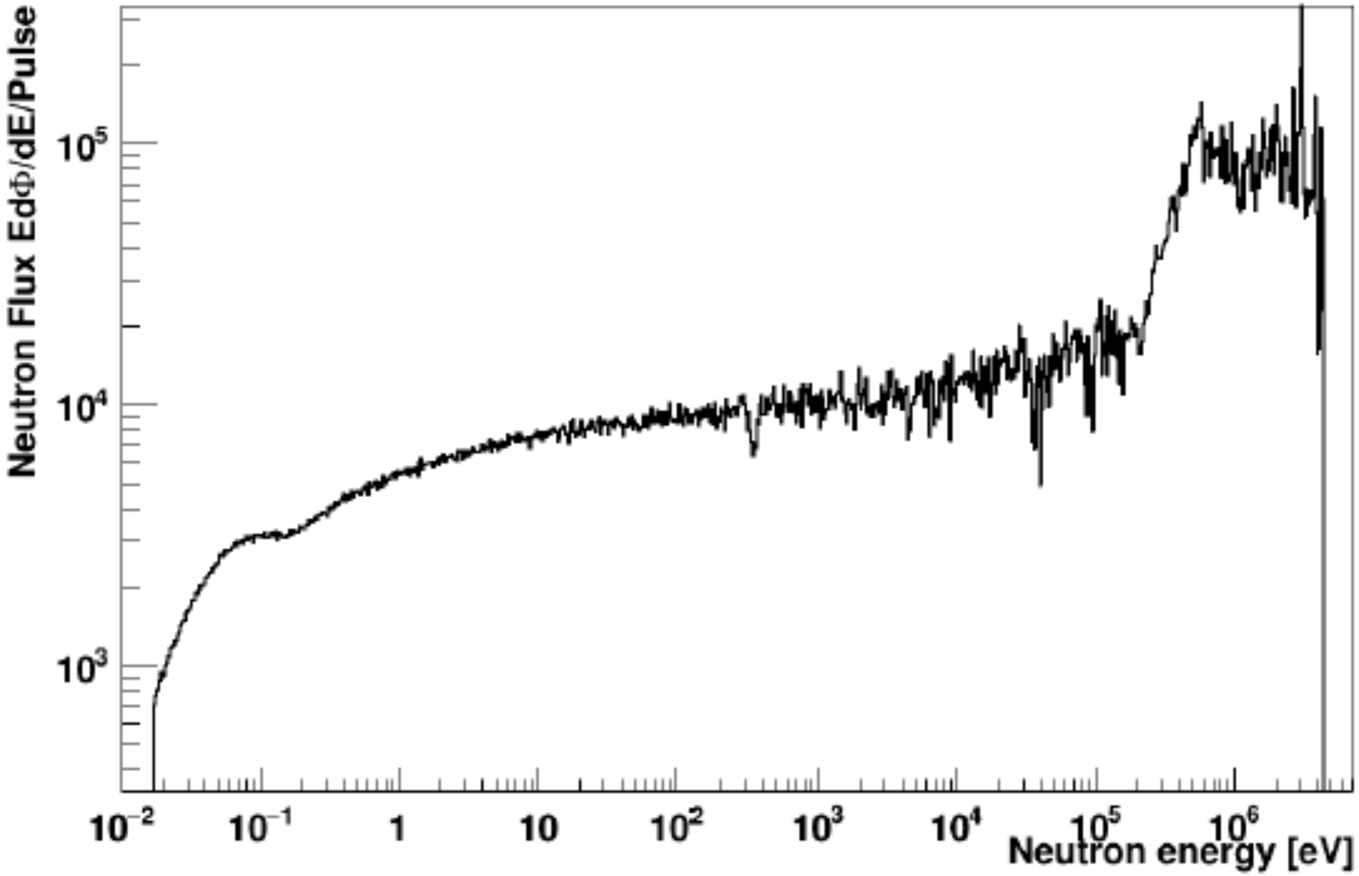


Pulse height weighting technique

Comparison between **R(j;E)** and the **Experimental Detector Response**

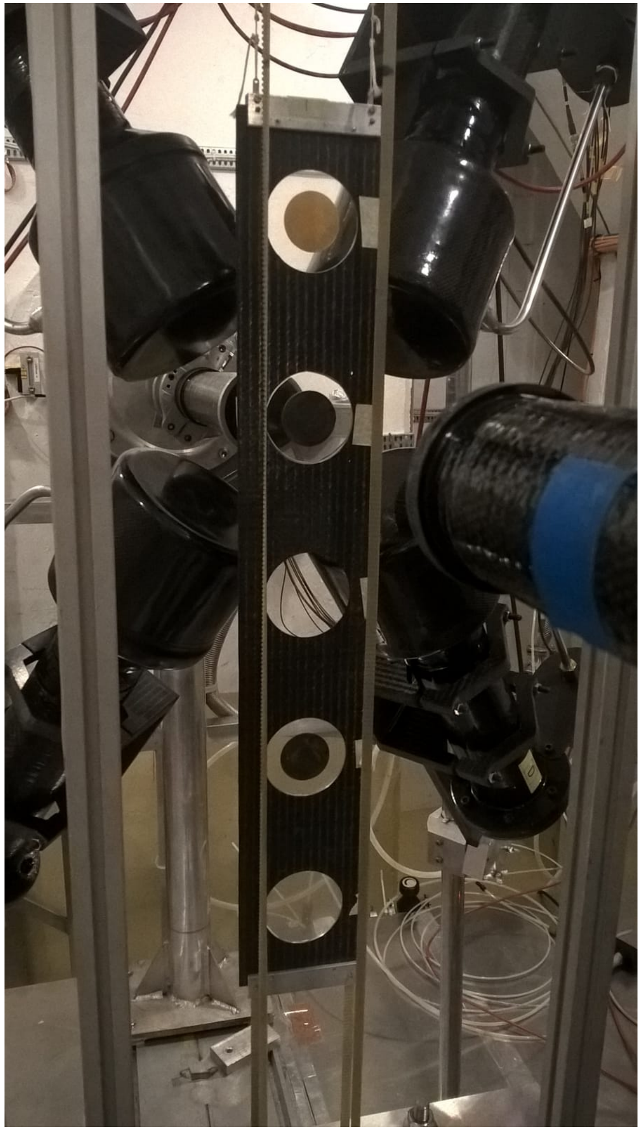


Extracted Flux in EAR1



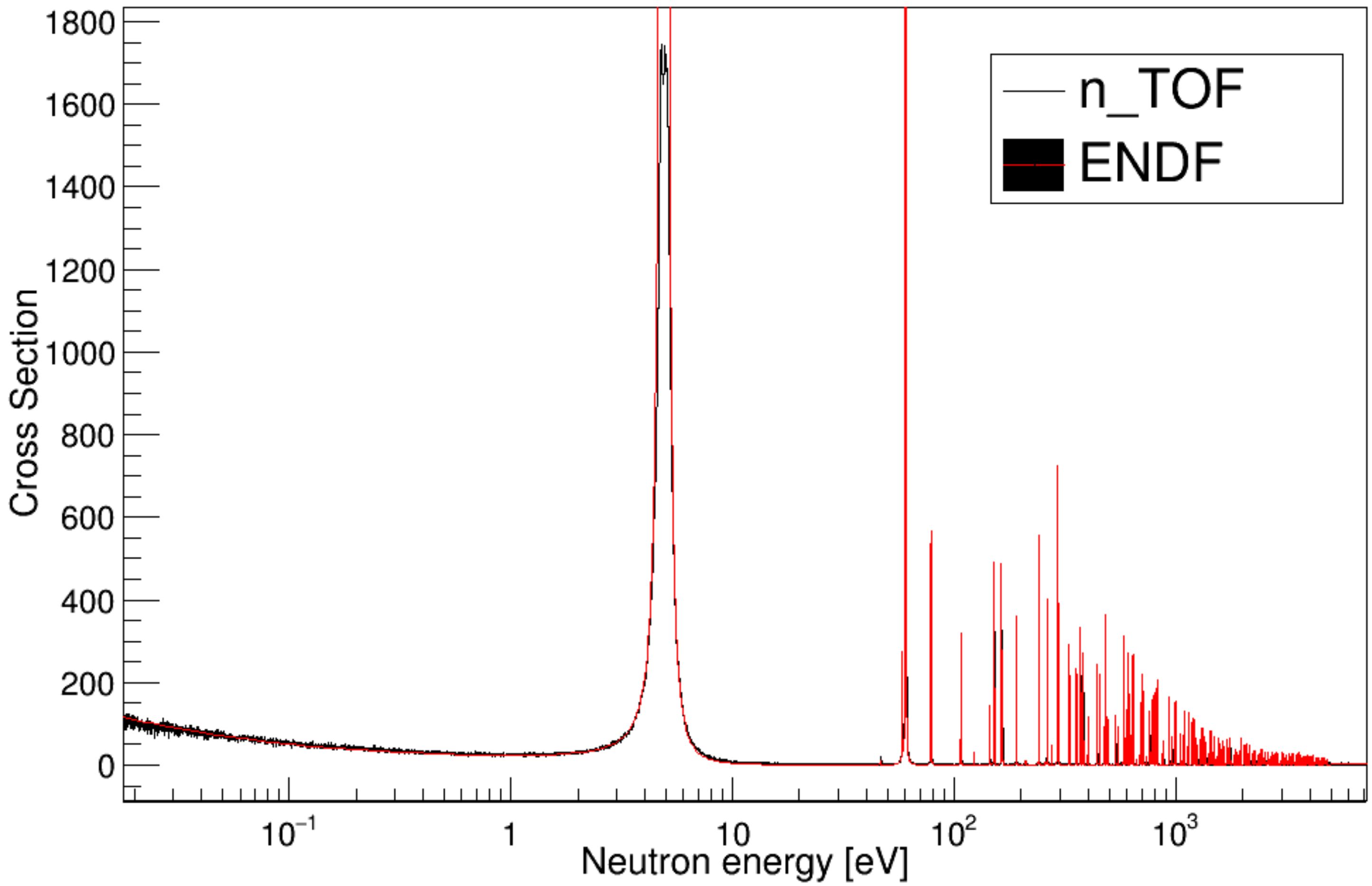
Extracted flux that will be used for the determination of the capture yield

Background



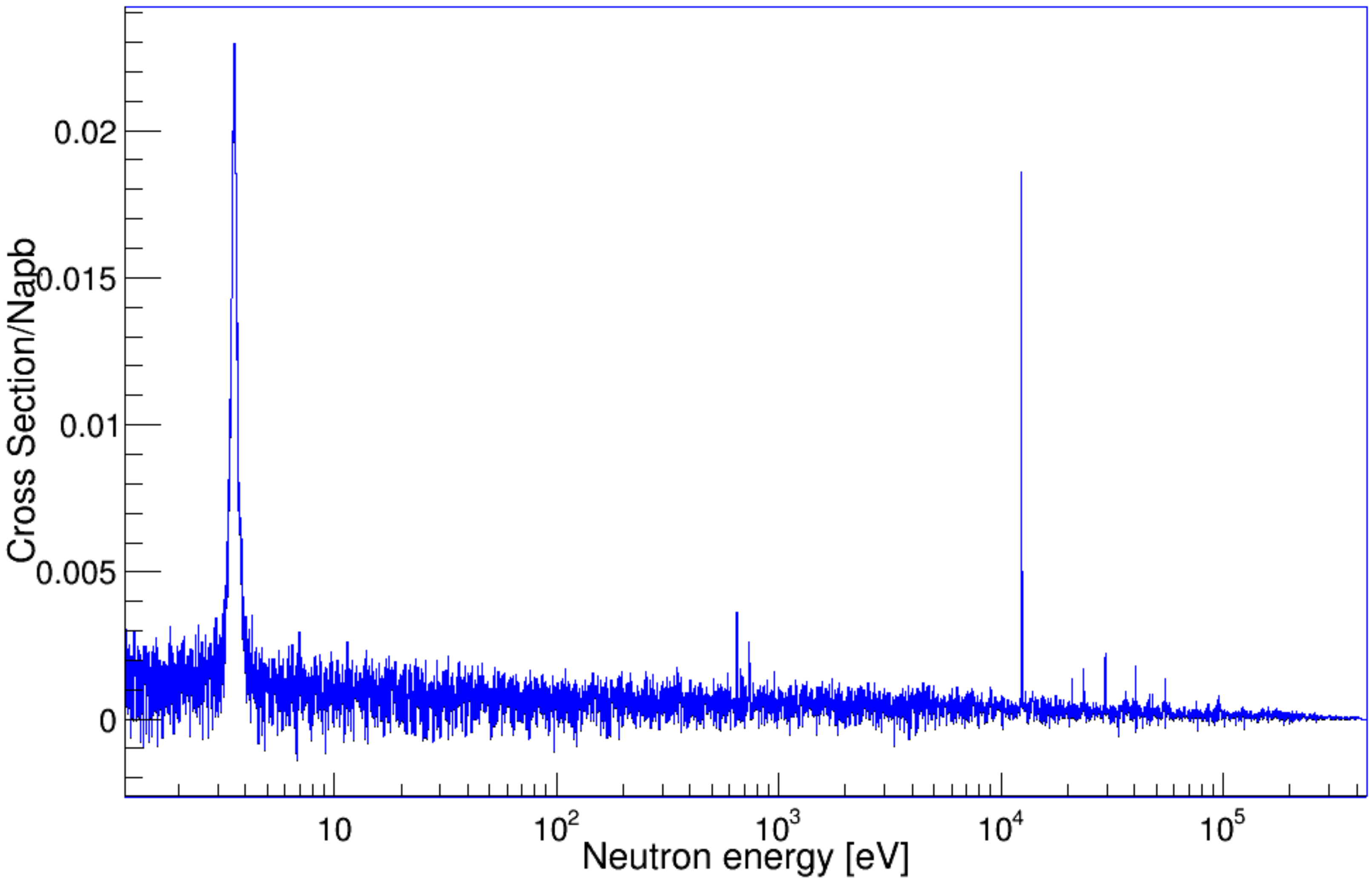
Gold	Used for the Yield normalization
Lead	Component, caused by scattered in-beam γ rays
Empty	Background related to the neutron beam
Carbon	Neutron background

Gold Cross Section

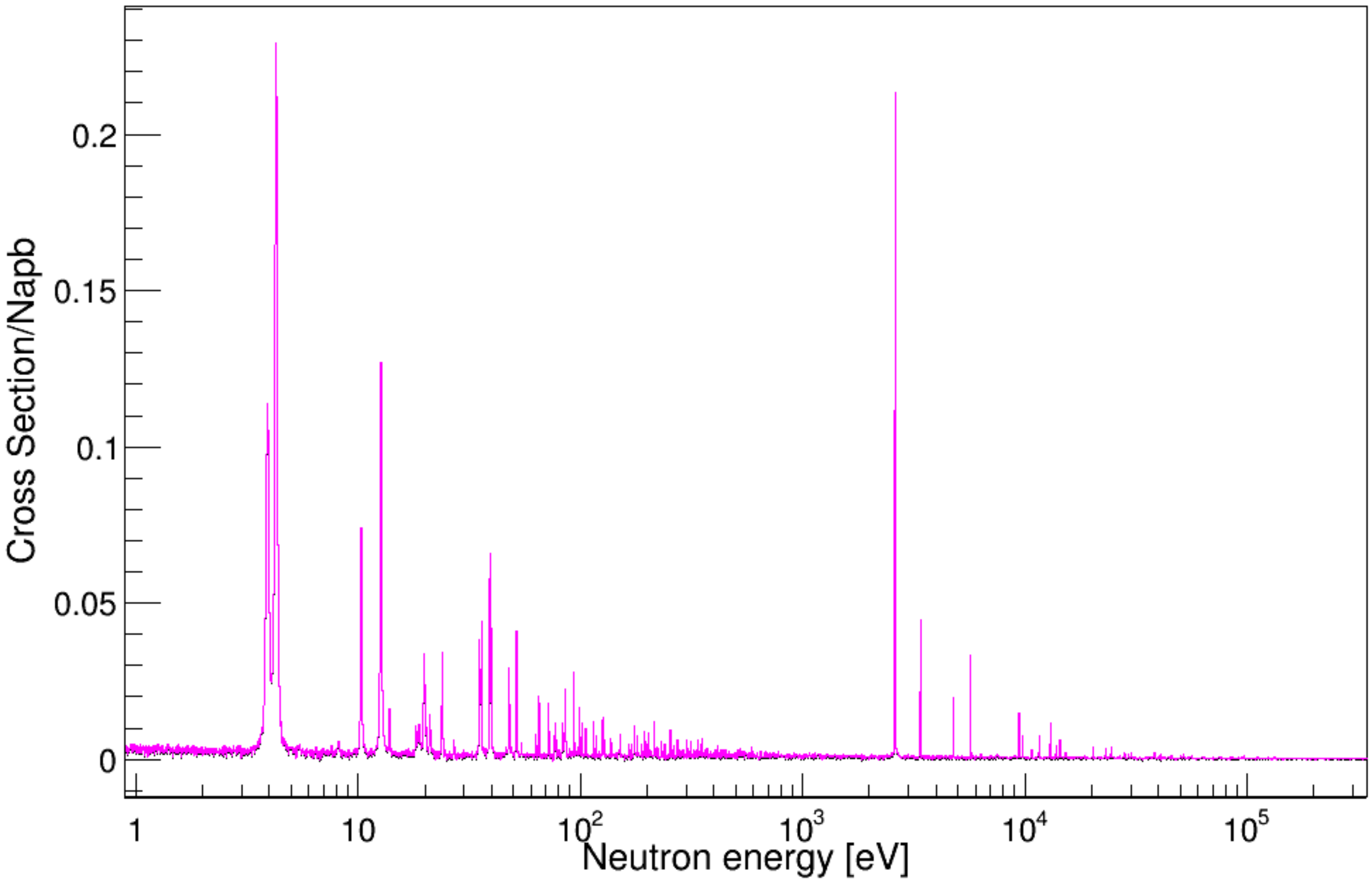


$$\sigma = \frac{Weighted\ Counts - Weigted\ Background}{\emptyset \times Napb \times N \times (Sn + Ecn * En)}$$

Preliminary results for ^{88}Sr



Preliminary results for ^{89}Y



Pubblications, Schools and Conferences

Pubblications

- M. Barbagallo et al.,The 7Be(n,α)4He reaction and the Cosmological Lithium Problem: measurement of the cross section in a wide energy range at n TOF (CERN). *Physical Review Letters 117, 152701 (2016).*
- M. Barbagallo et al. 7Be(n,α) and 7Be(n,p) cross section measurement for the Cosmological Lithium problem. *In EPJ Web of Conferences (2017)*
- *M. Sabatè Guilarte at al.* High-accuracy determination of the neutron flux in the new experimental area n_TOF-EAR2 at CERN" has been accepted for publication in the European Physical Journal A

Schools

- The 9th European Summer School on Experimental Nuclear Astrophysics 17-24 September 2017 Santa Tecla (Italy). (Measurement of the **7B**e(**n**,**p**)**7L**i cross section in EAR2@n_TOF for the Cosmological Lithium Problem)

Conferences

- IX Incontro dei Gruppi Italiani di Astrofisica Nucleare Teorica e Sperimentale Sezione INFN di Bologna Dipartimento di Fisica e Astronomia INAF 5-6 October 2017.
- (Measurement of the **7B**e(**n**,**p**)**7L**i cross section in EAR2@n_TOF for the Cosmological Lithium Problem)

Goals for the second year of Ph.D

- I will complete the analysis of the radiative neutron capture cross section of 89Y and 88Sr;
- I will write the thesis;
- I'm planning to spend few months more at CERN to participate in all other measurements that will be performed at n_TOF, helping with the experimental apparatus, the data taking and analysis;
- In 2018 I plan to attend a few conferences where to present my results, and a school in Nuclear Astrophysics;

THANK YOU FOR YOUR KIND ATTENTION!