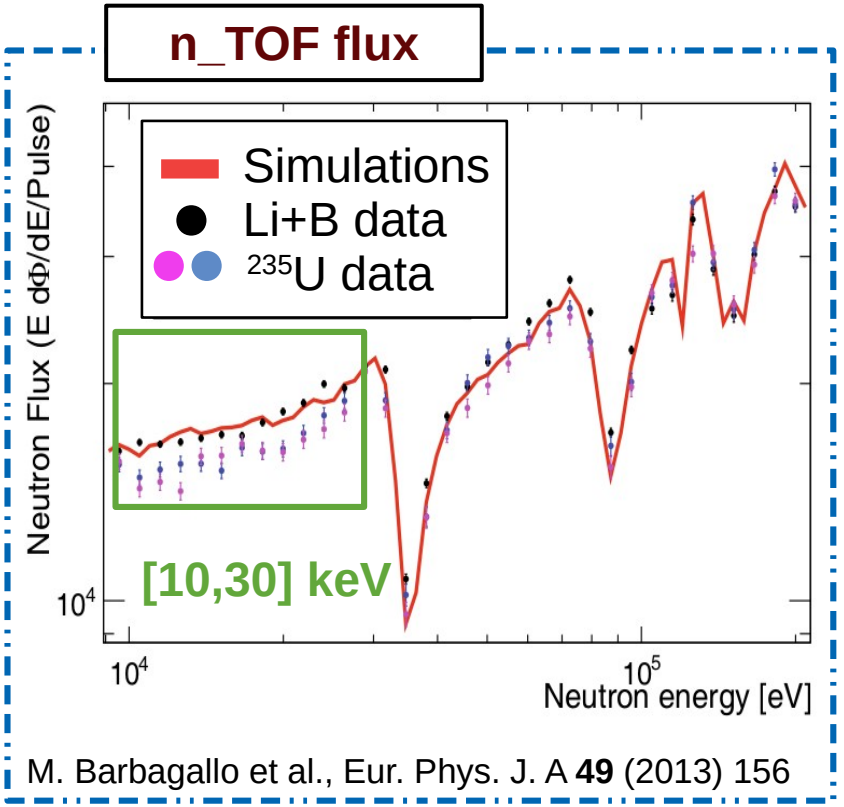
Measurement of $^{235}U(n,f)$ cross section below 170keV

Summary

1. Introduction and motivation
2. n_TOF facility and experimental setup
3. Details on analysis
4. ^{235}U(n,f) in the keV region
5. ^{235}U(n,f) at lower energies
6. Conclusions

Motivations

Discrepancies in the keV region were found during the last n_TOF flux measurement in EAR1.



^{235}U(n,f) is a IAEA standard neutron cross section at thermal and from 150 keV to 200 MeV.

^{235}U(n,f) cross-section measurement performed at n_TOF with respect to standards ^{6}Li(n,t) and ^{10}B(n,α) in the energy range th-170 keV.

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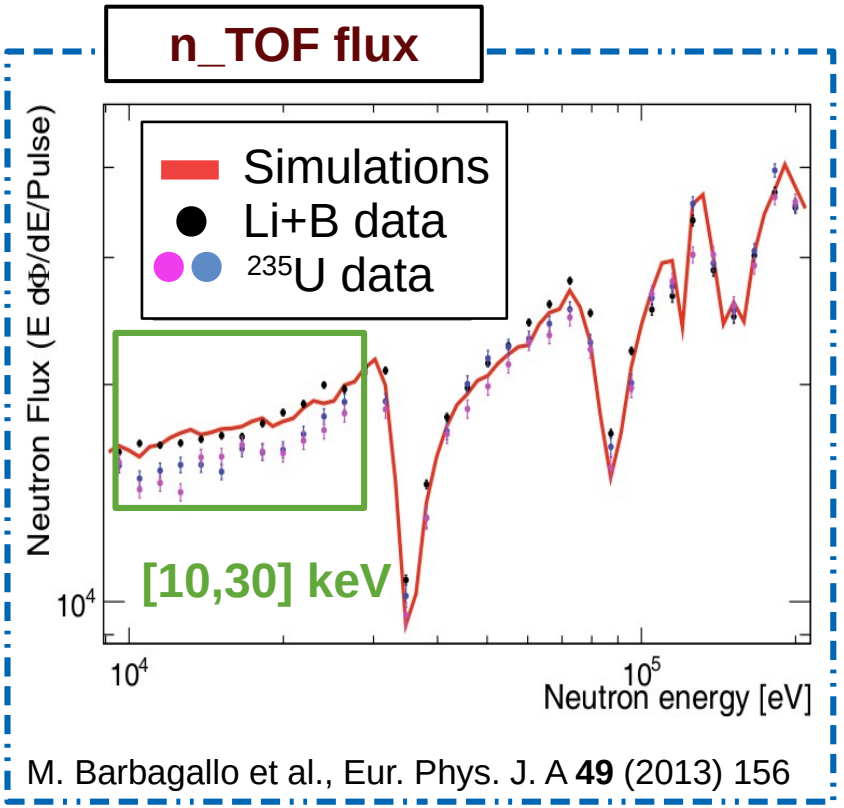

M. Barbagallo et al., Eur. Phys. J. A **49** (2013) 156

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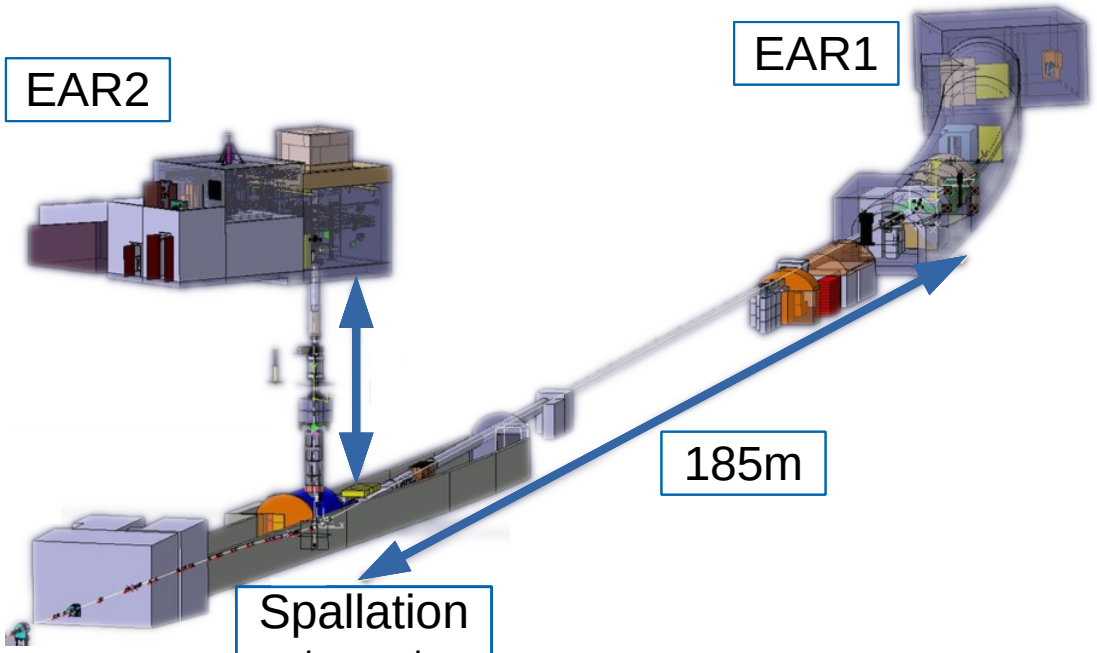
For ^{235}U(n,f) from MeV to GeV see Alice Manna talk (R402 May 23th)

n_TOF@CERN

neutron_Time**O**f**F**light

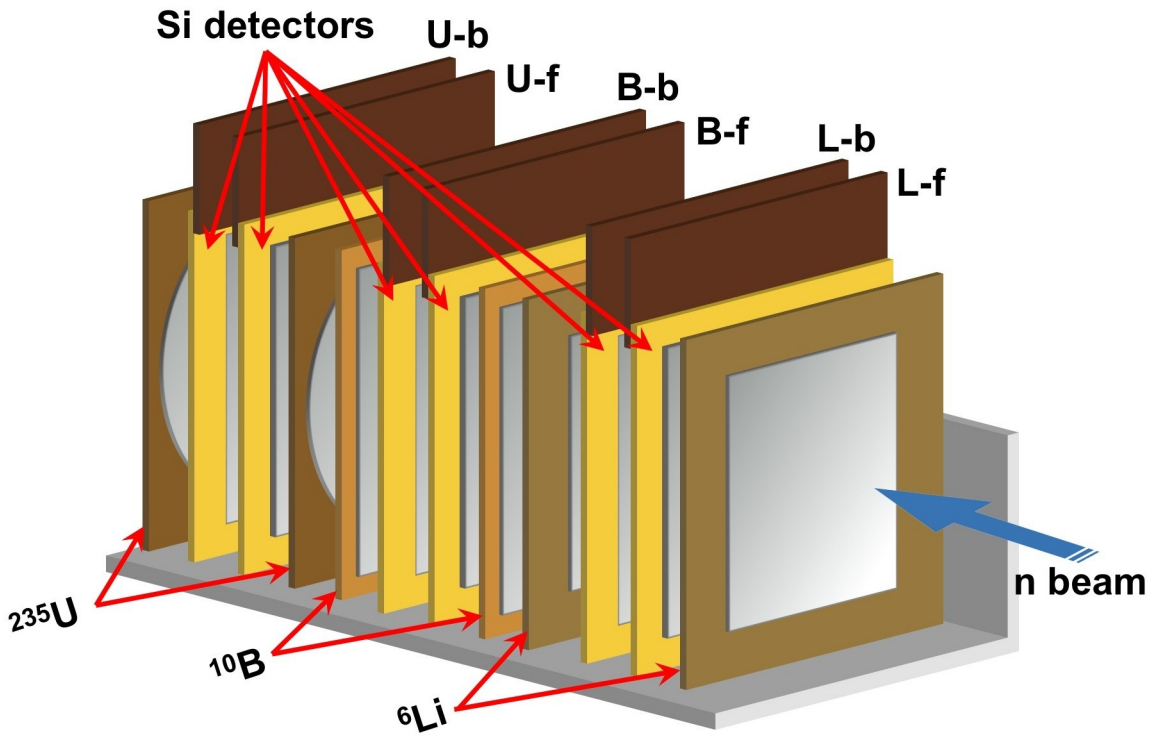


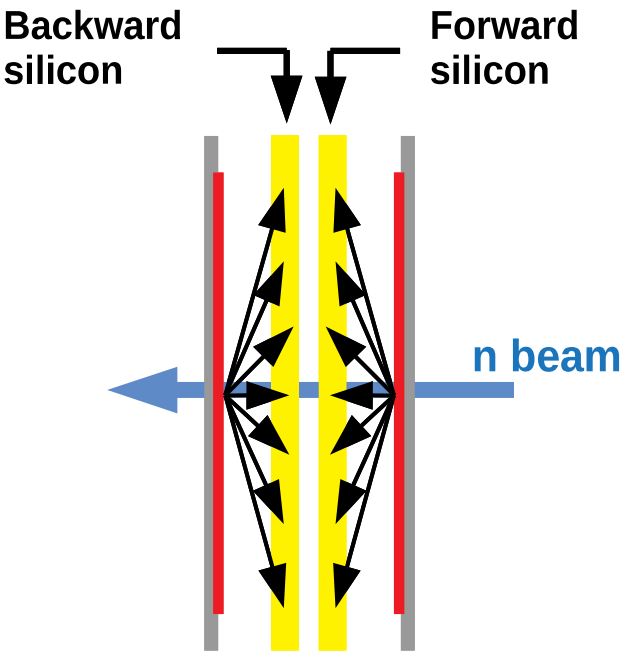
Experiment was done in EAR1

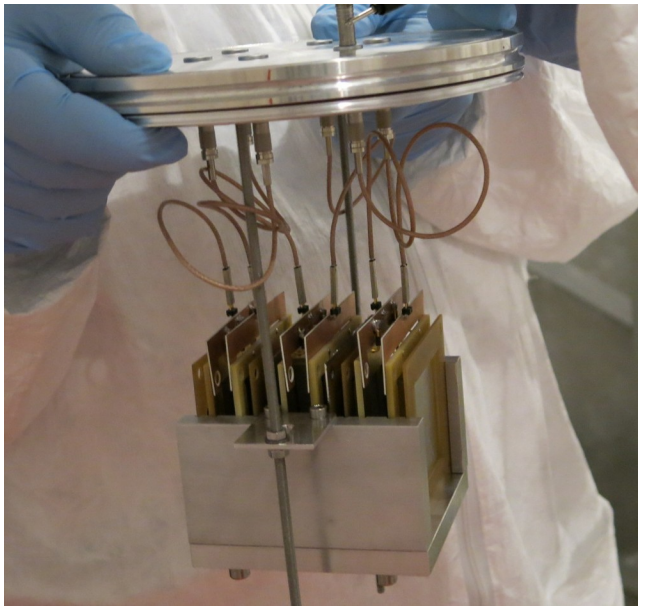
Main features:

- Excellent neutron energy resolution
- High instantaneous flux
- Wide energy spectra (from thermal to GeV)

Experimental setup

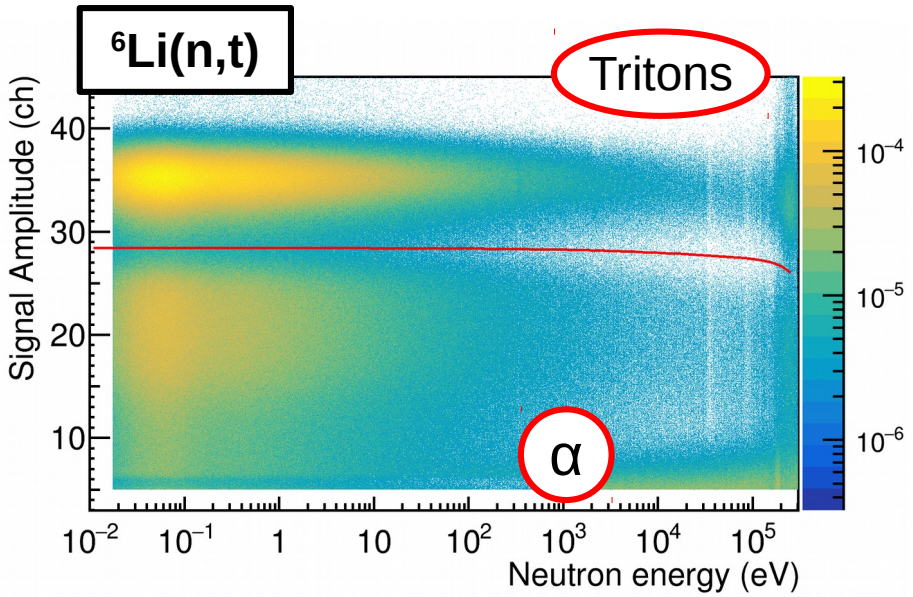


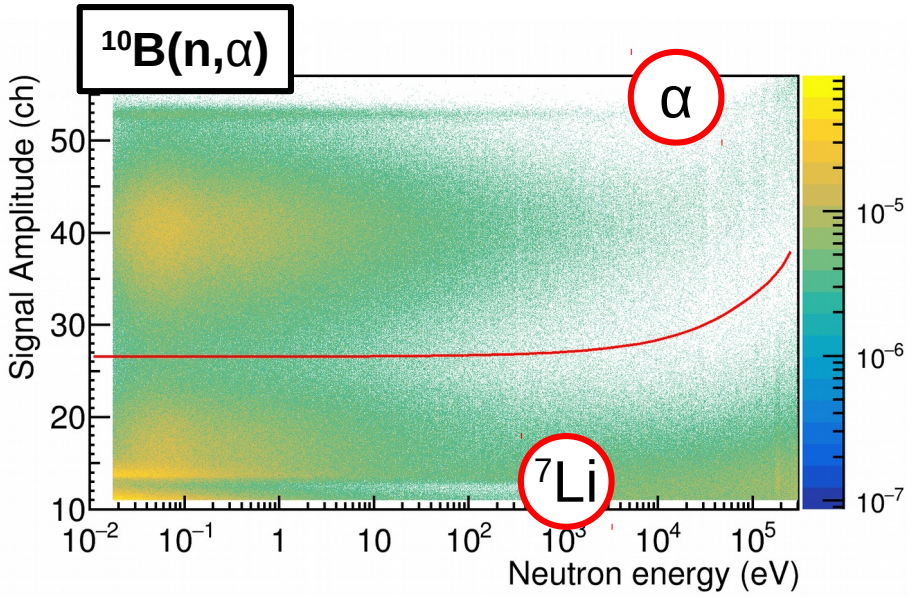




Silicon thickness: 200 um
Silicon area: 5x5 cm^2
Distance silicon-target: ~1 mm

Particle identification





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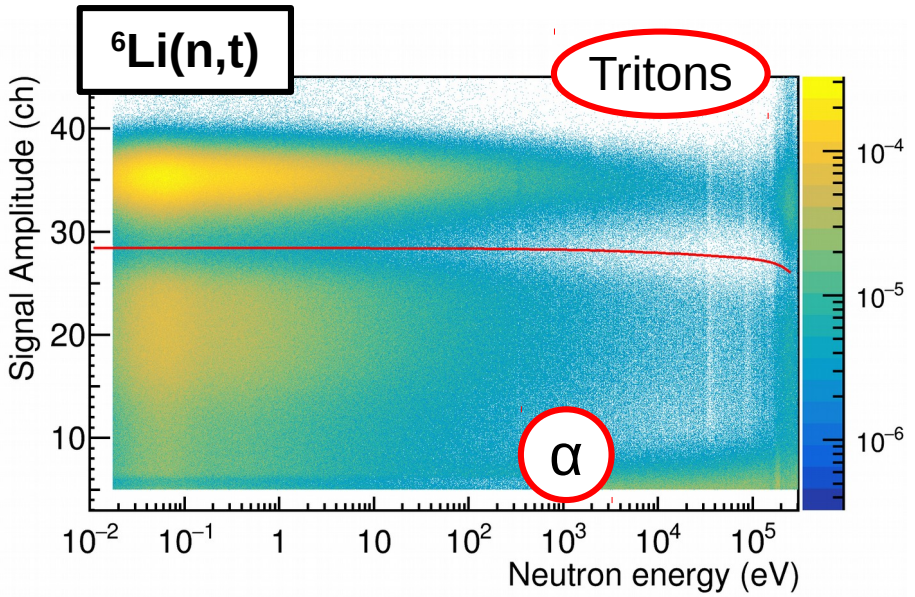
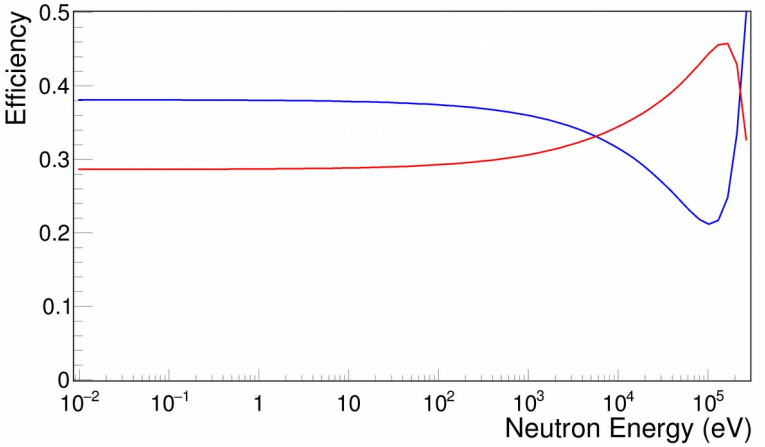
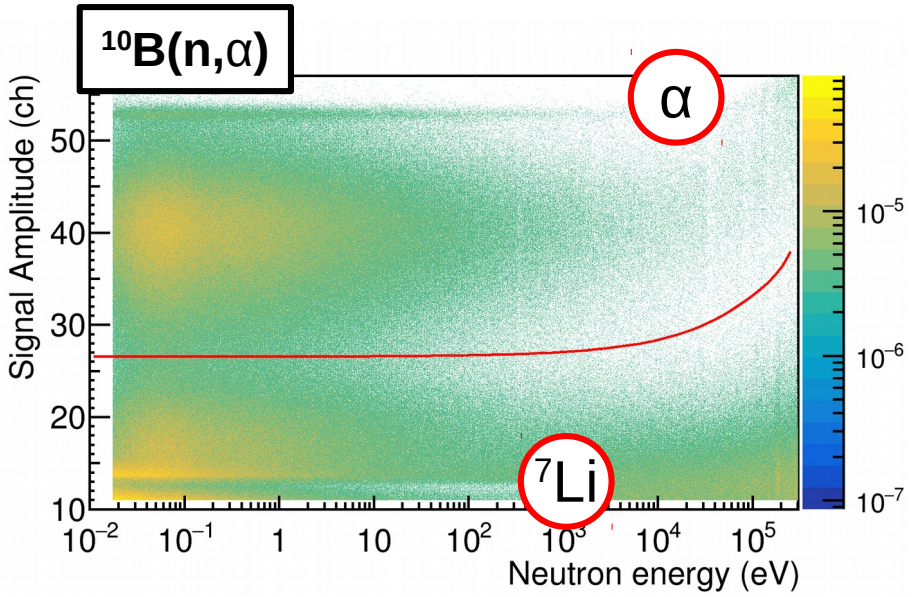
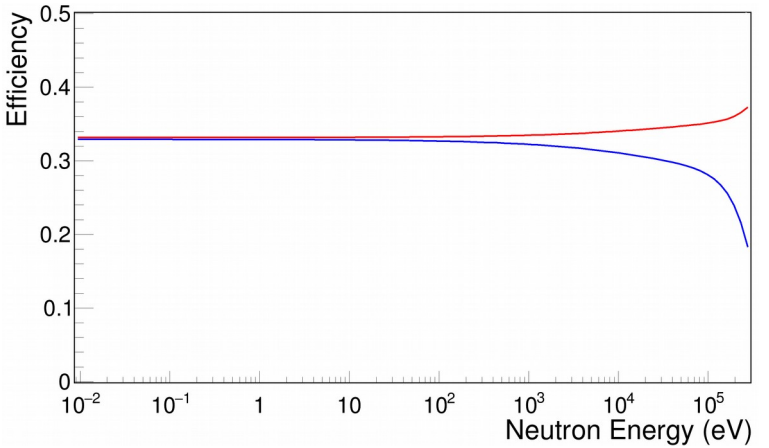




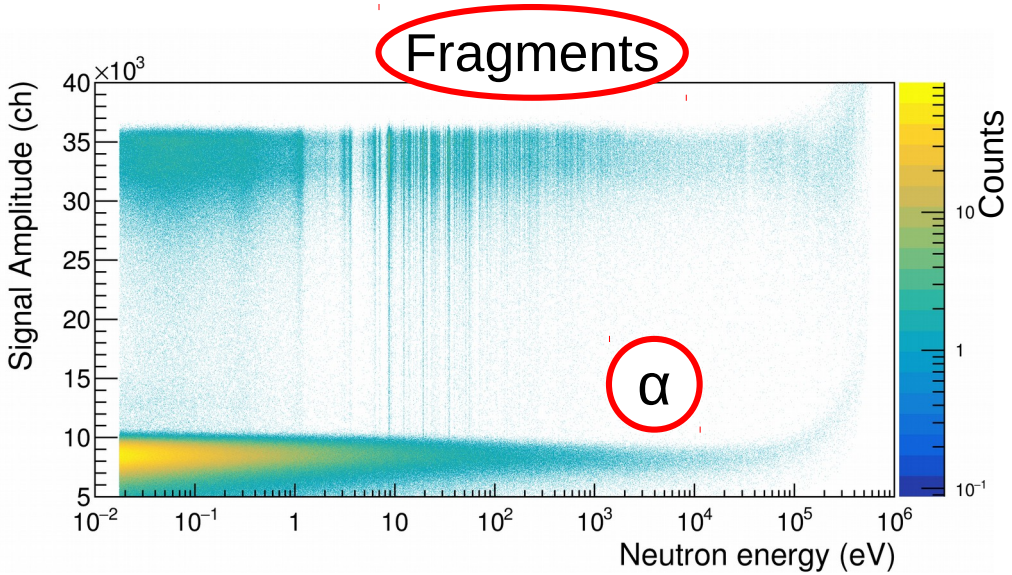


Forward direction

Backward direction



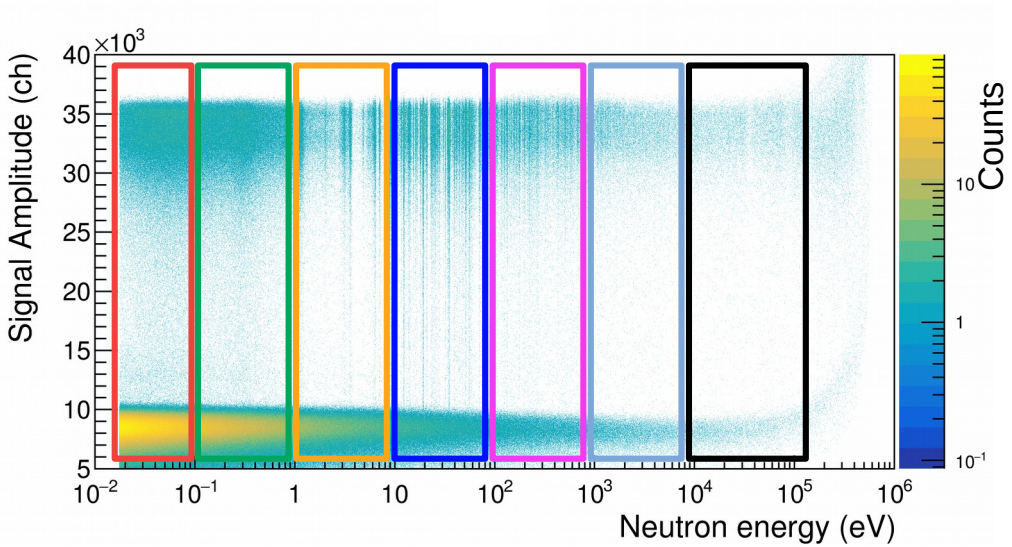
Fission Fragments discrimination



Clear separation up to hundred of keV

Efficiency is constant

Fission Fragments discrimination



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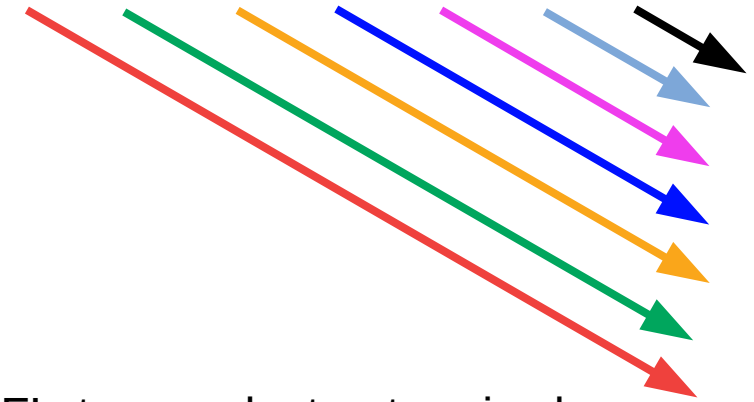
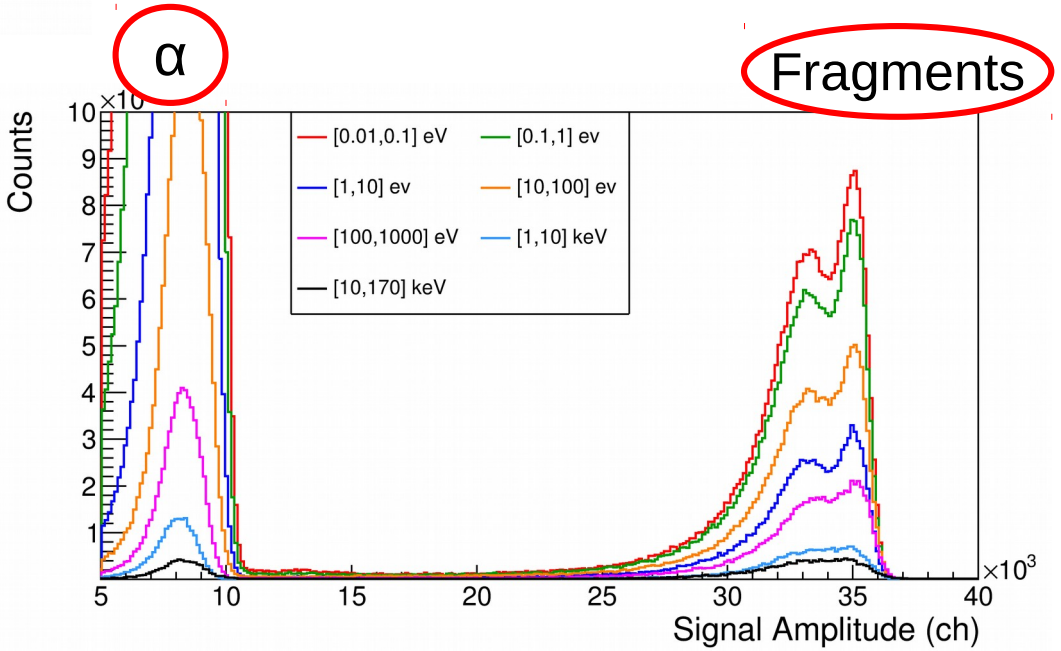
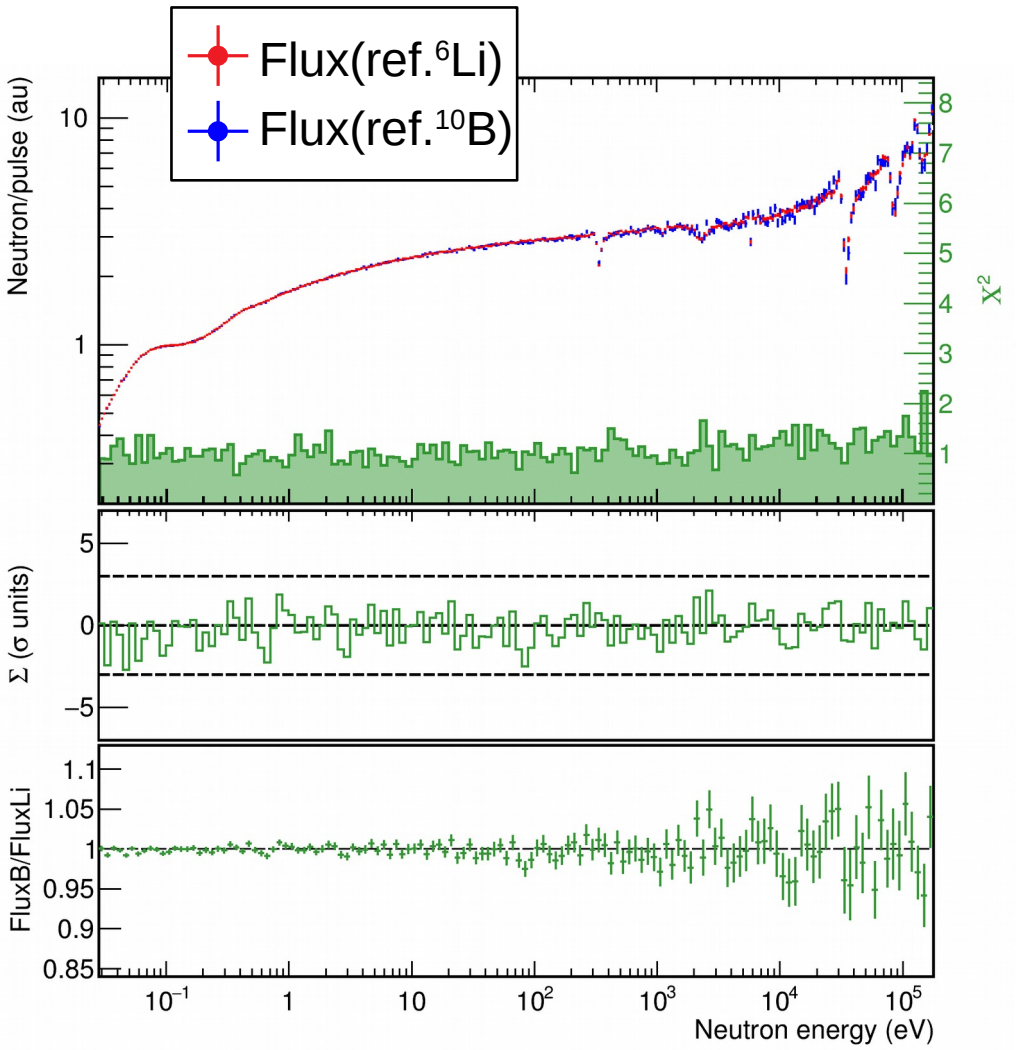


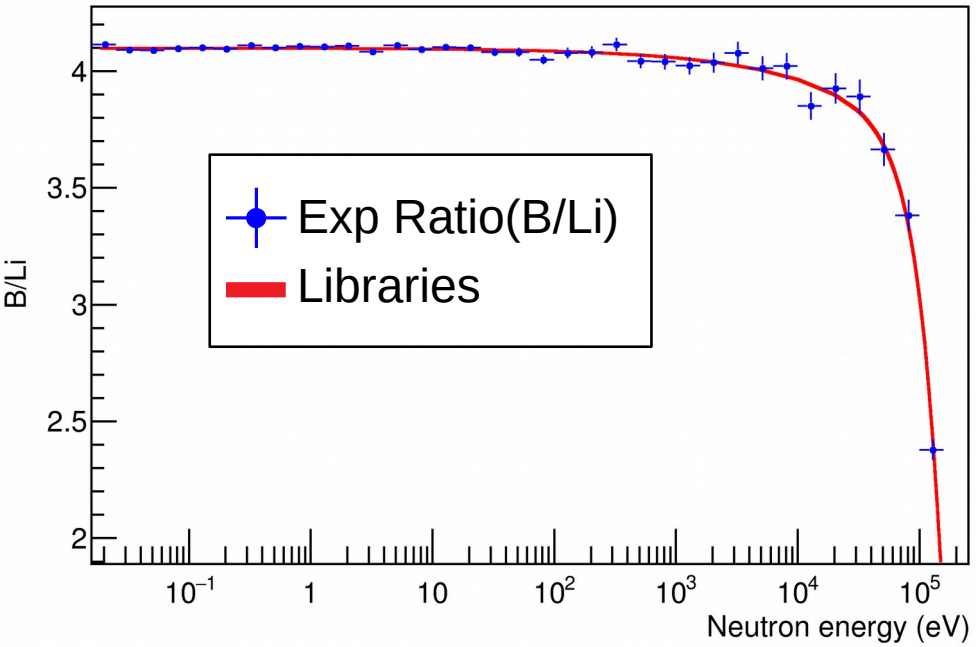
FF's two peak structure is clear in the amplitude spectra



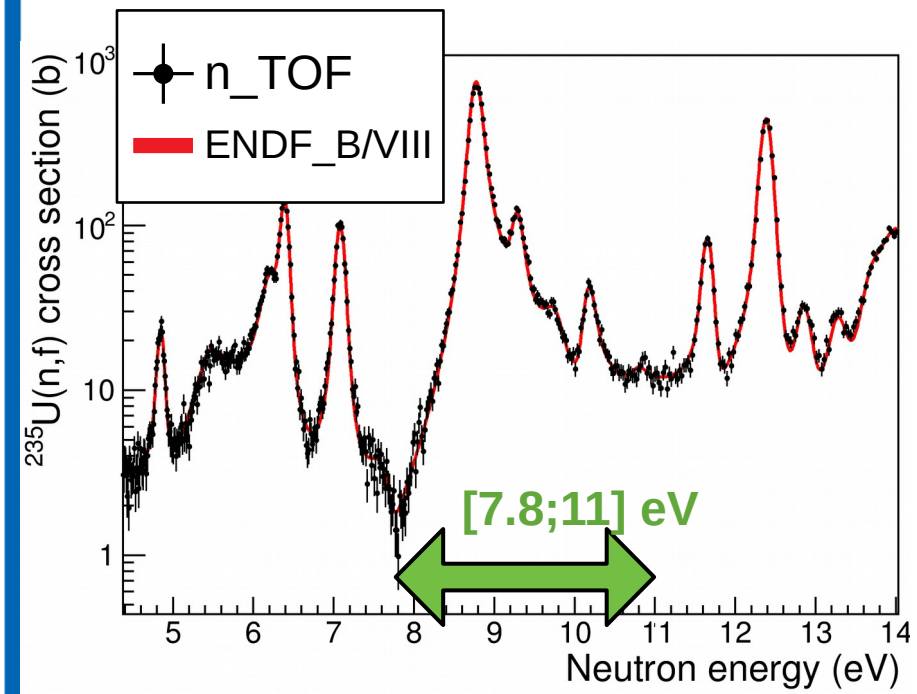
Measured flux – Ratio B/Li



Good agreement between boron and lithium data.



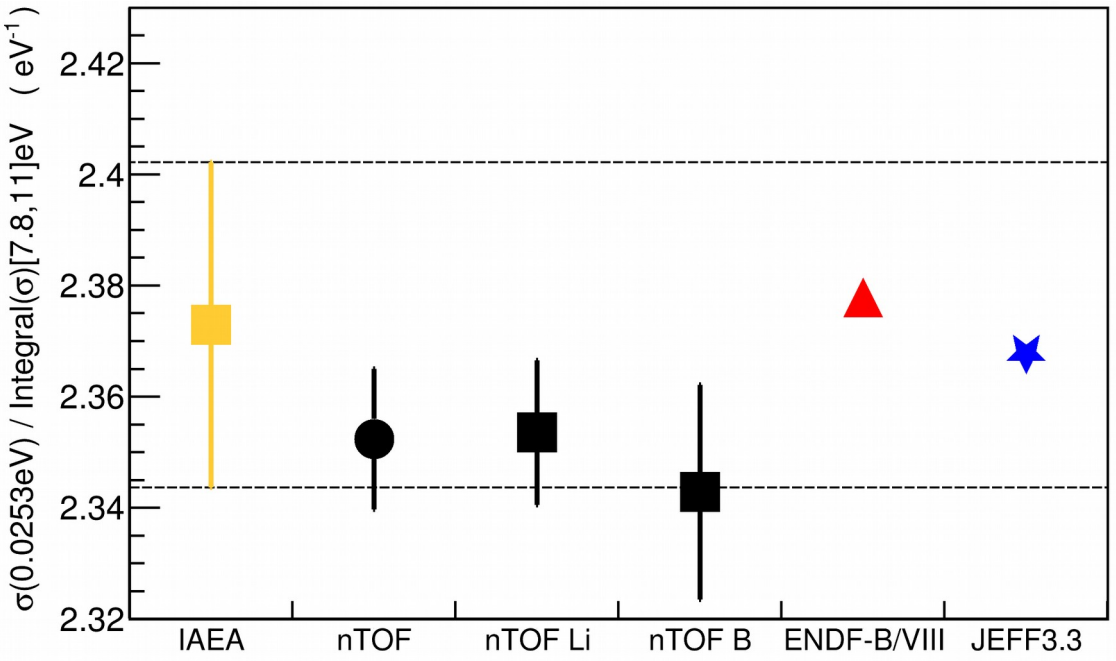
Normalization to [7.8,11]eV



⇒ Negligible border effect (two minimum)

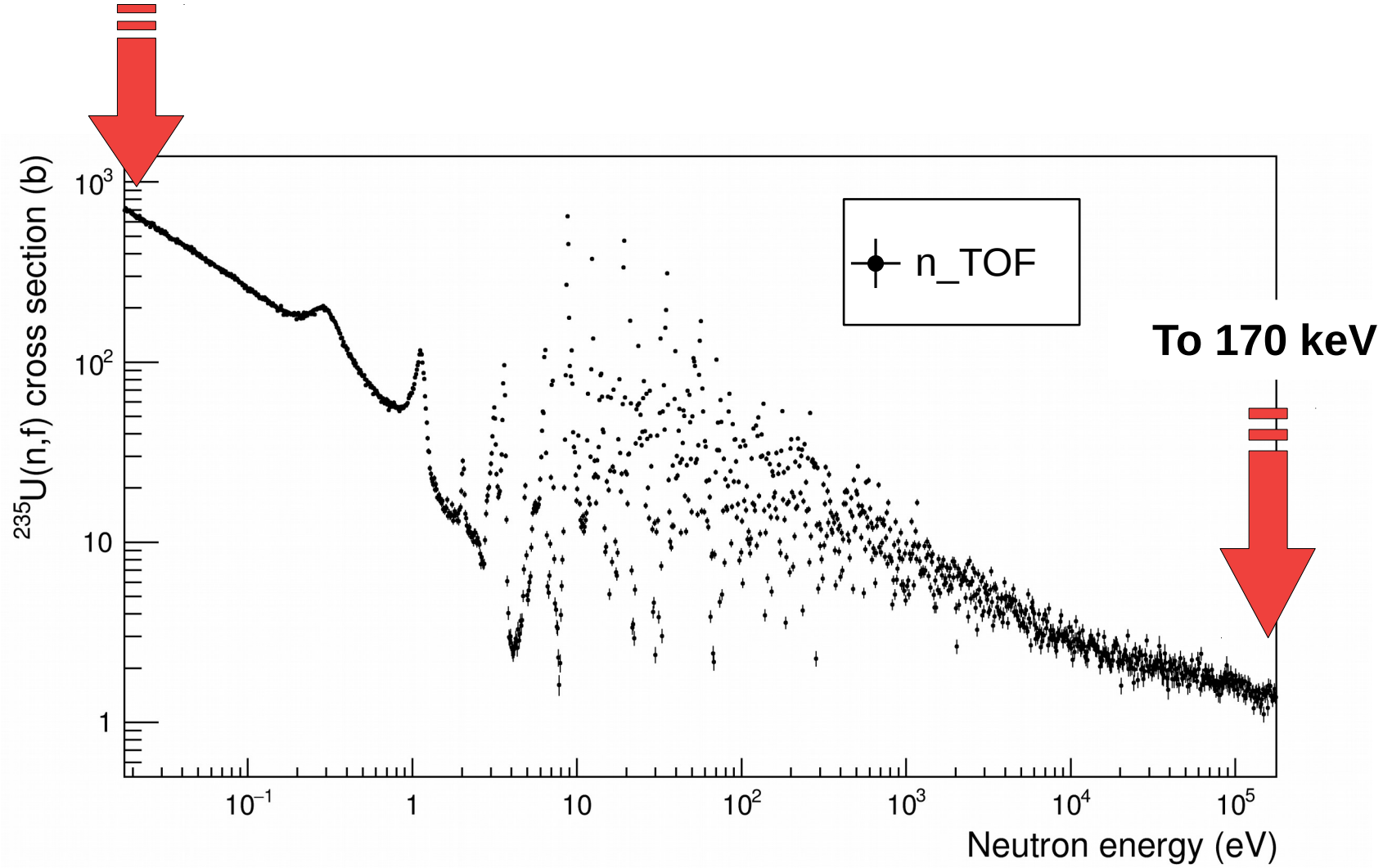
⇒ Integral [7.8,11]eV is a standard

Integral [7.8,11] eV is consistent with thermal value ⇐

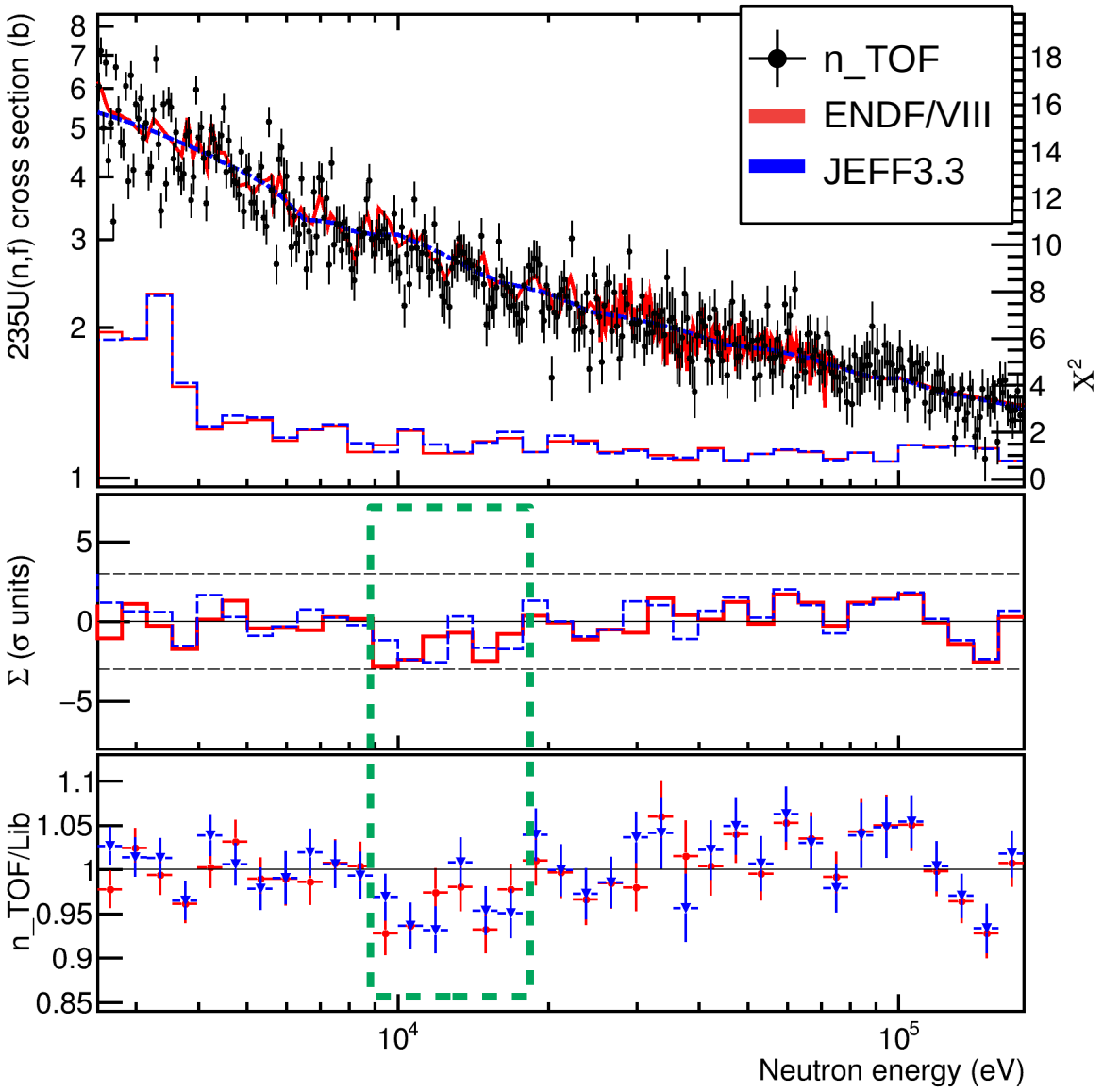


^{235}U(n,f) cross section

From thermal energy



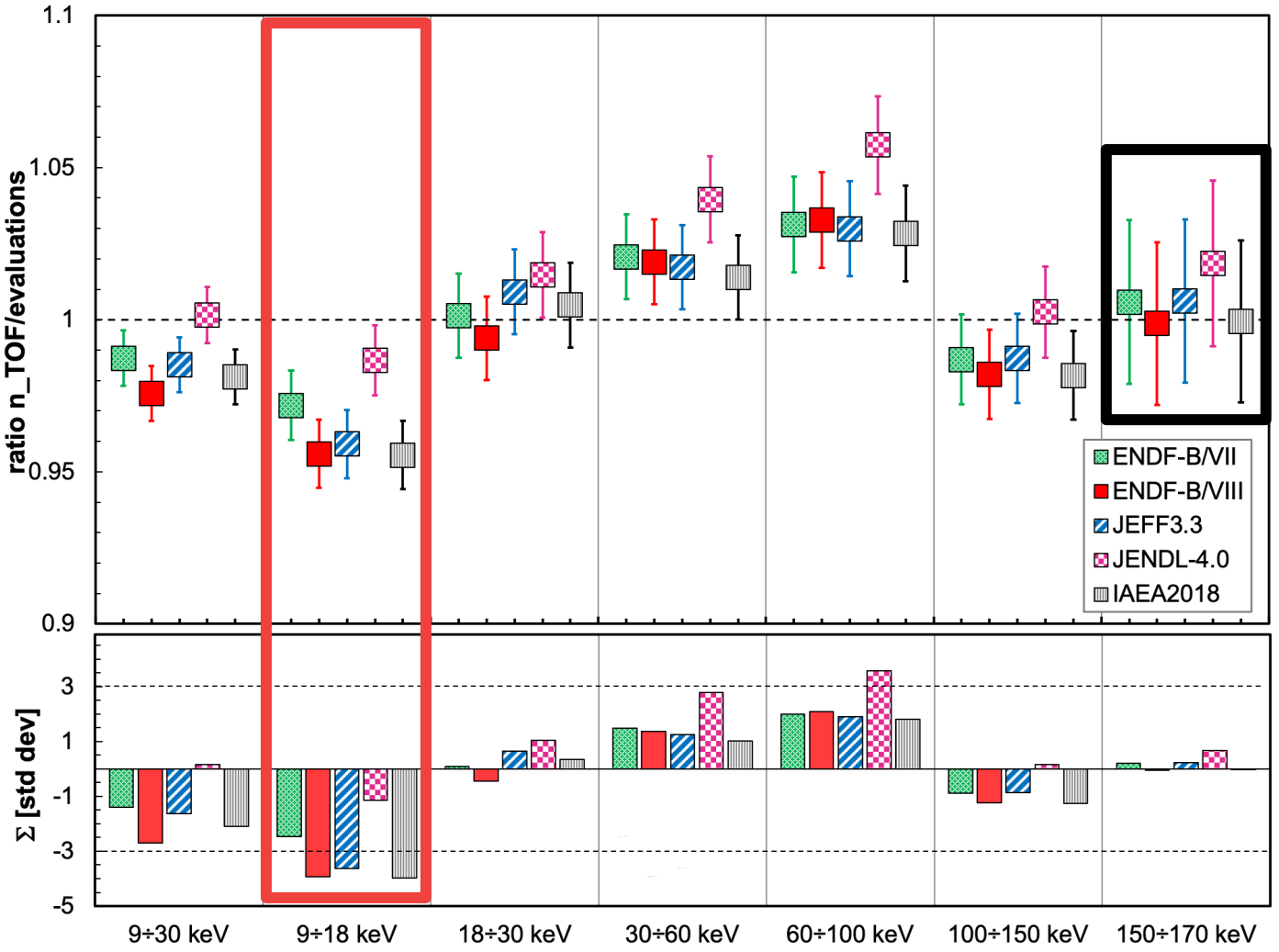
^{235}U(n,f) cross section



[9,18] keV

Experimental data are systematically lower than JEFF3.3 and ENDF-B/VIII

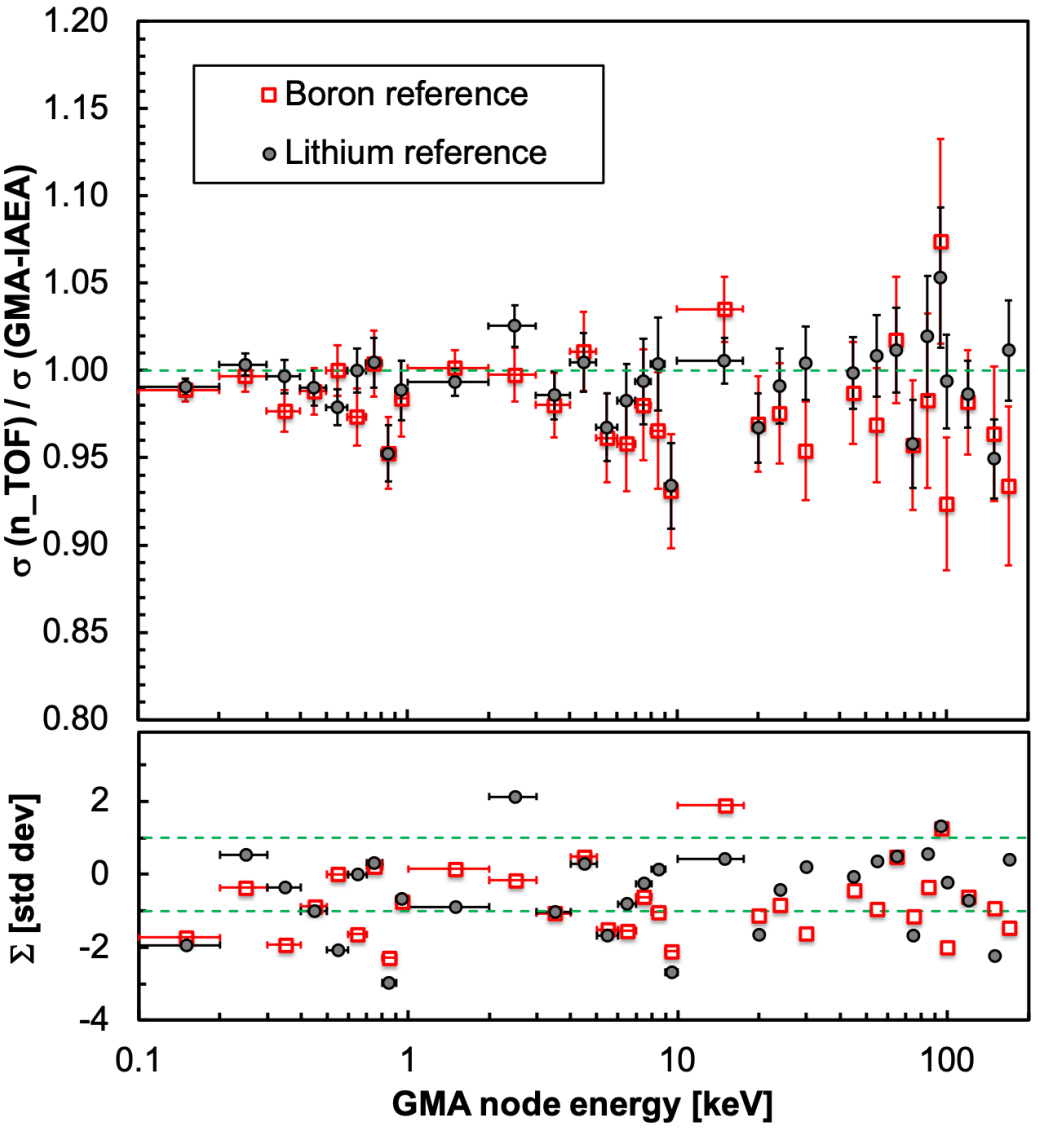
^{235}U(n,f) in the keV Region



Over 150 keV ^{235}U(n,f) is again a standard.

Most of recent the libraries overestimate ^{235}U(n,f) cross section between 9 and 18 keV.

IAEA GMA nodes

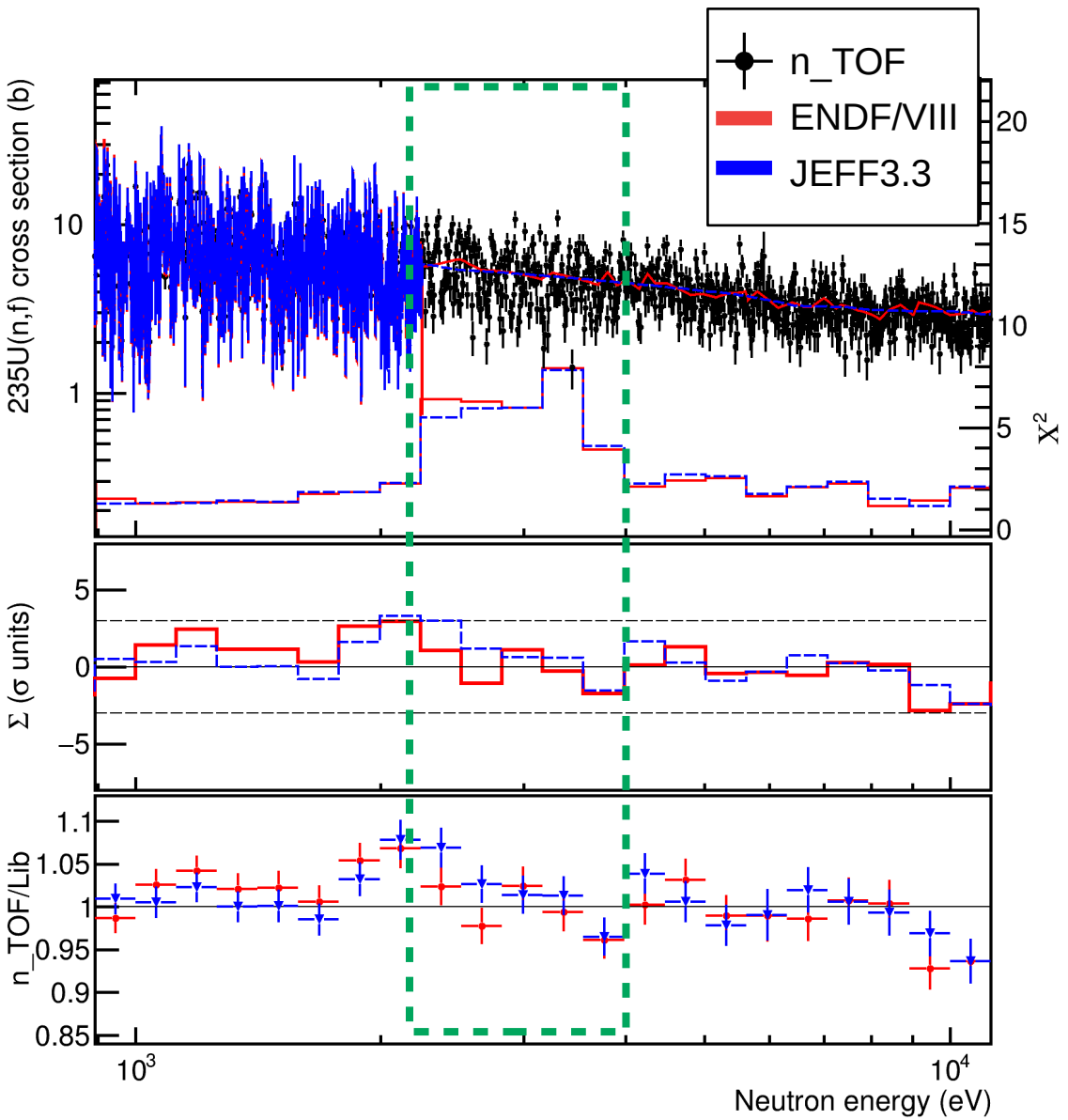


Overall agreement with point-wise reference provided by IAEA in 2018[1].

Differences for GMA points at 0.85 and 9.5 keV.

[1] Carlson et al., *"Evaluation of the Neutron Data Standards", Nuclear Data Sheets* ***148*** *(2018) 177*

RRR-URR limit



[2.2,4] keV

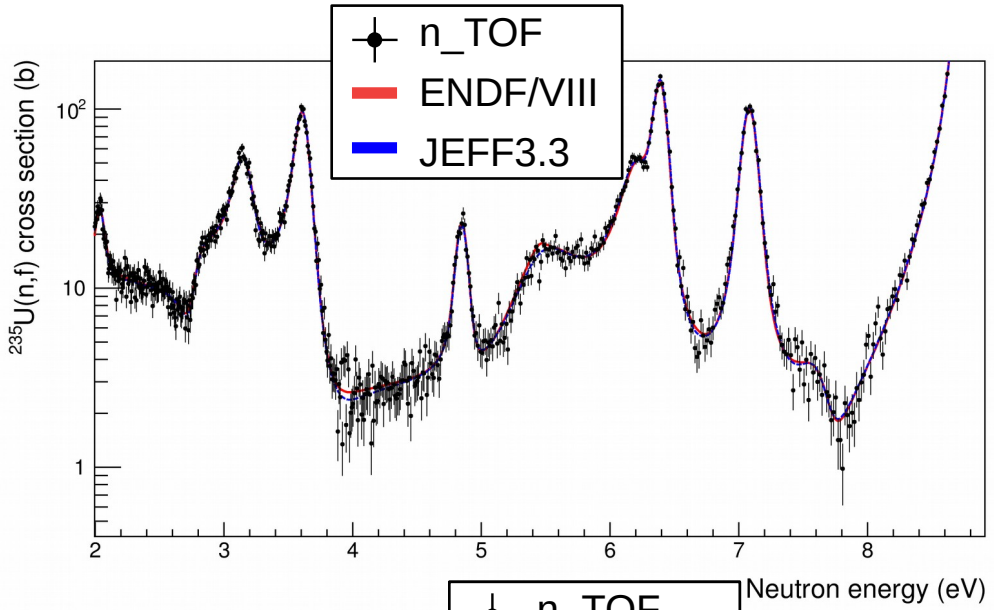
Large X² between experimental data and libraries.

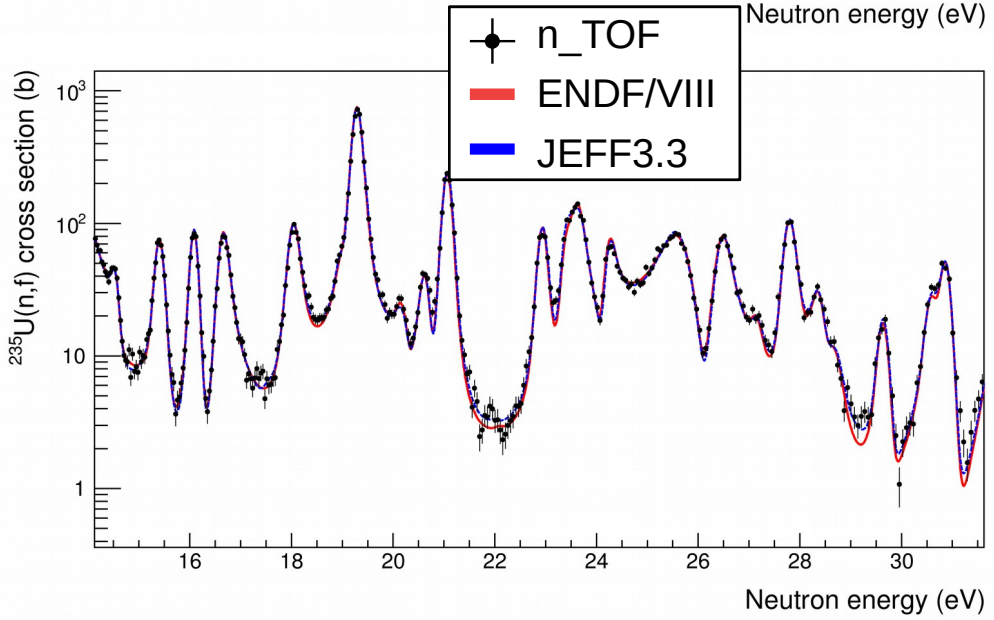
No systematic deviation.

Ratio exp/libraries ~ 1

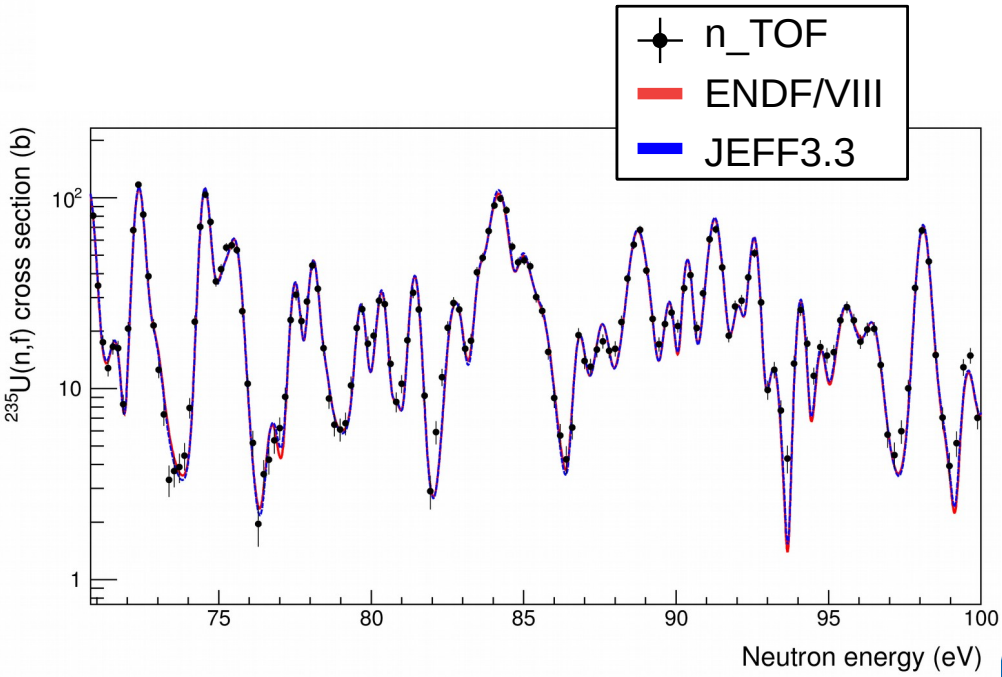
Evidences of structures in experimental data that are not present in libraries.

^{235}U(n,f) at lower energies





High quality data also at lower energies. A resonance analysis will be done soon.



Conclusions

- An accurate measurement of **^{235}U(n,f) cross section with respect to ^{6}Li(n,t) and ^{10}B(n,α) standard** has been performed at n_TOF **between thermal and 170 keV** neutron energy (paper submitted for publication).

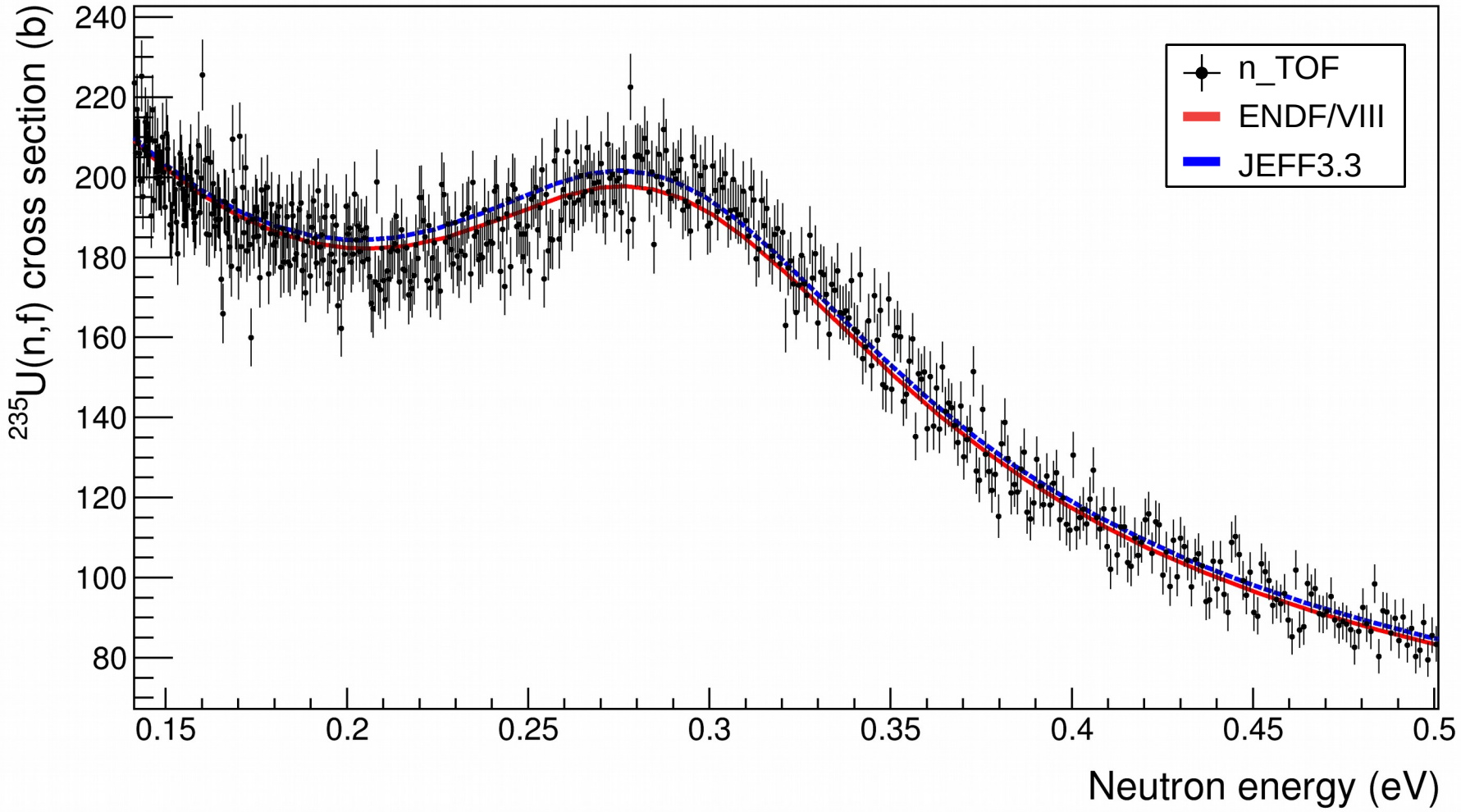
- An **overestimation** of the fission cross-section in libraries has been revealed in the **9-18 keV** neutron energy range. These new data show a nice agreement in a direct comparison with IAEA GMA nodes.

- The measurement also evidences the presence of **structures in the 2.2 – 4 keV range**, just after the end of RRR of ENDF8 and JEFF3.3.

- High quality data have been collected at lower energies and a detailed resonance analysis will be performed.

Thank you!

Backup – ^{235}U(n,f) cross section



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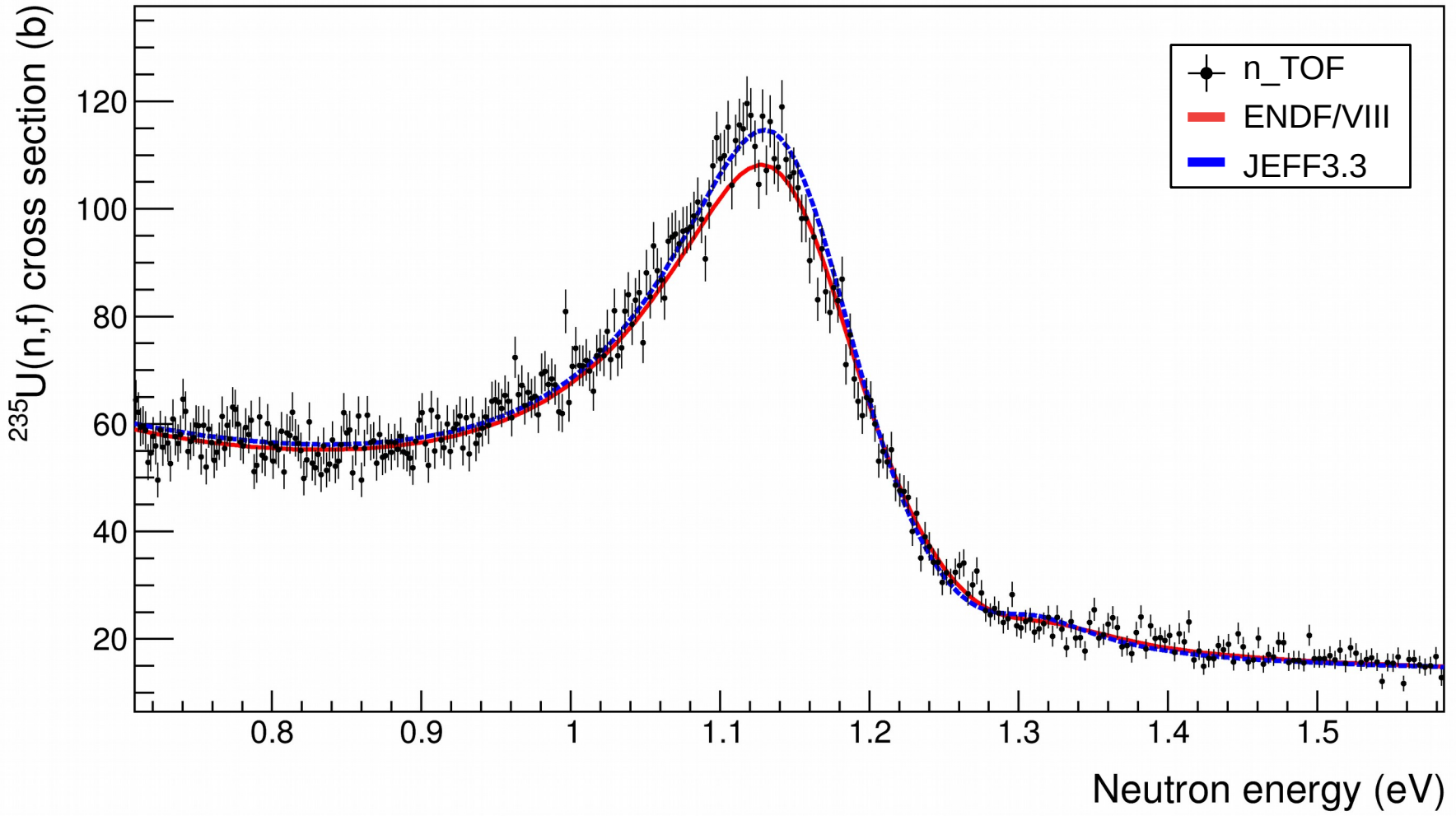

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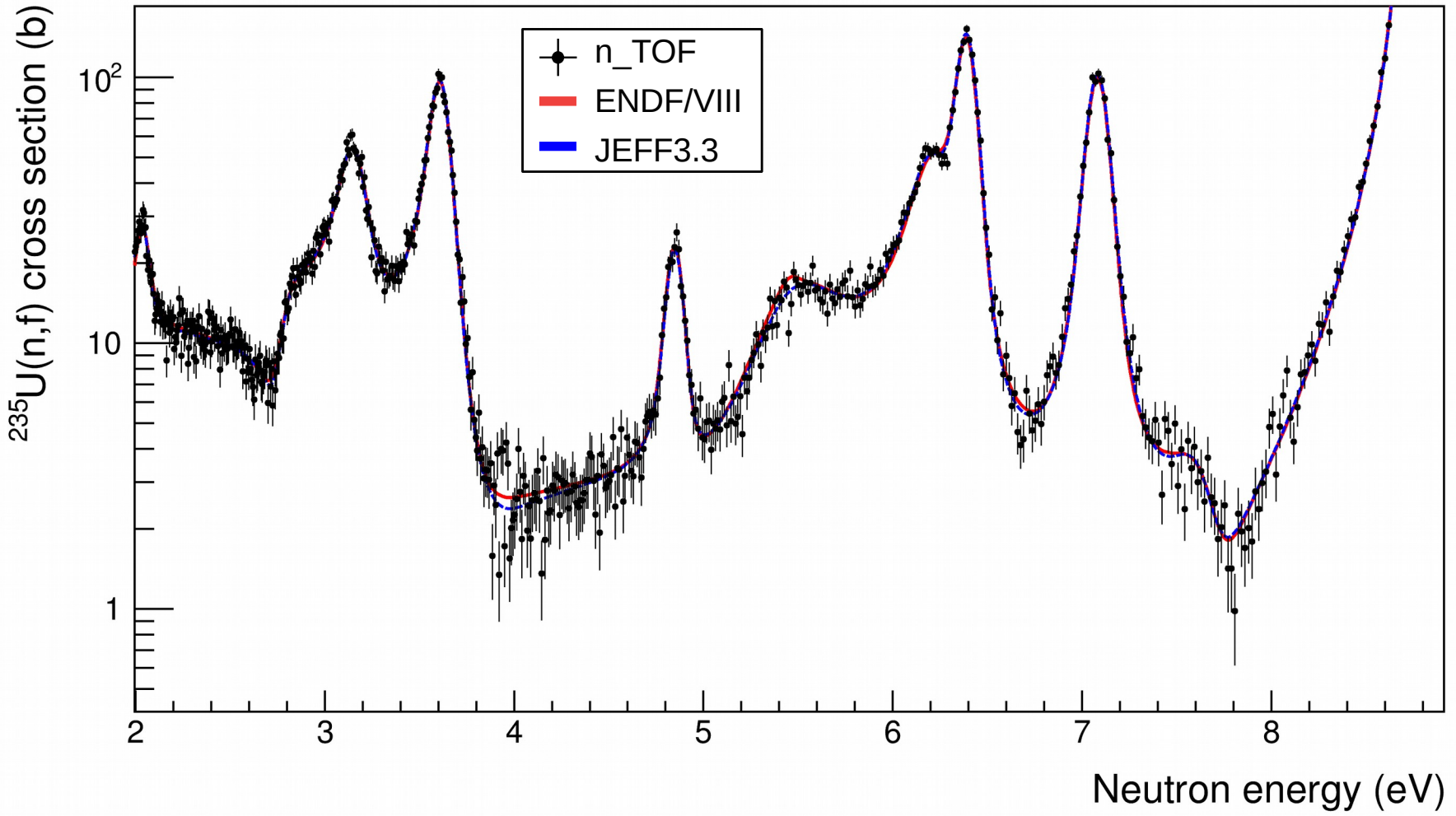

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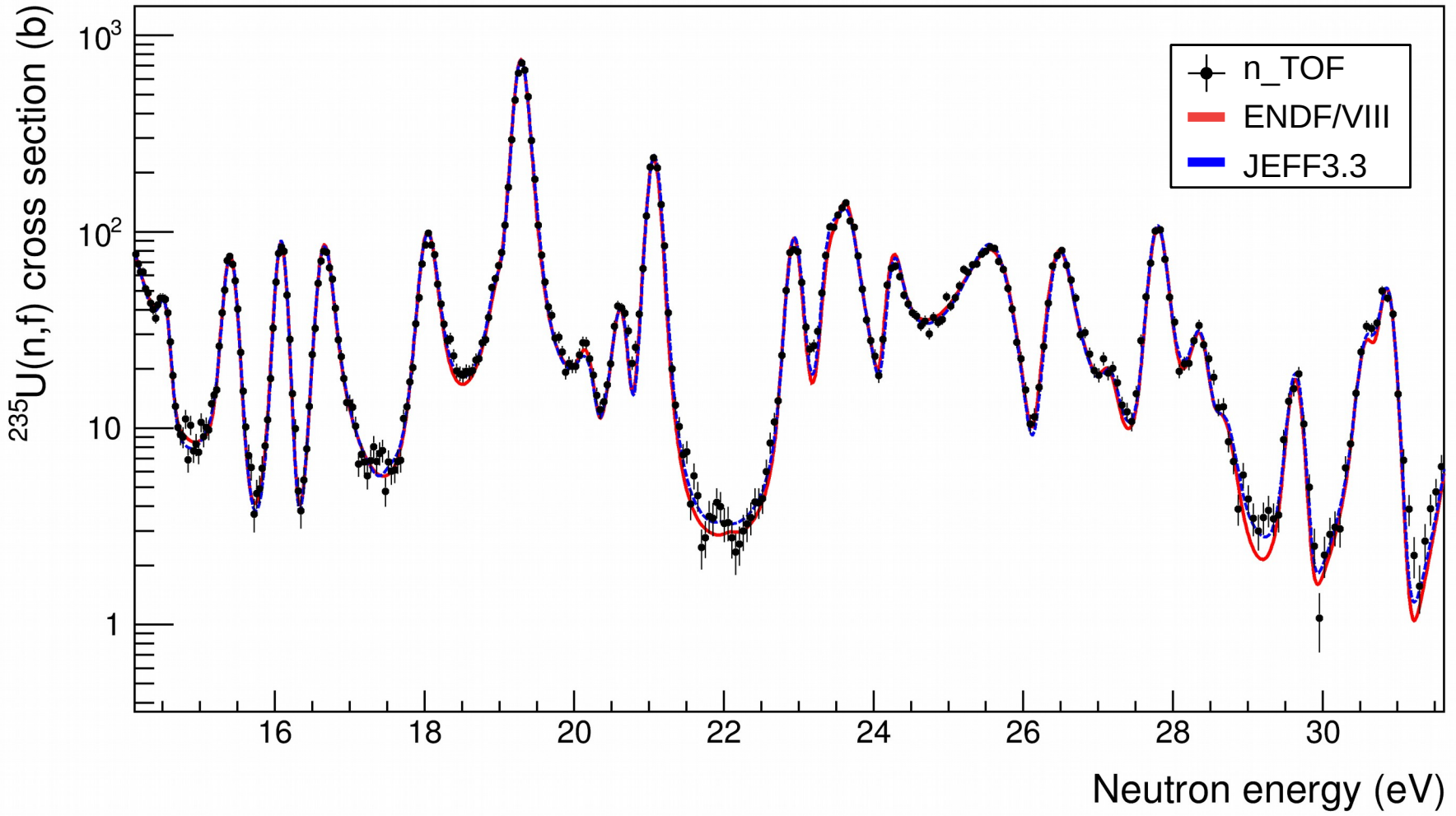
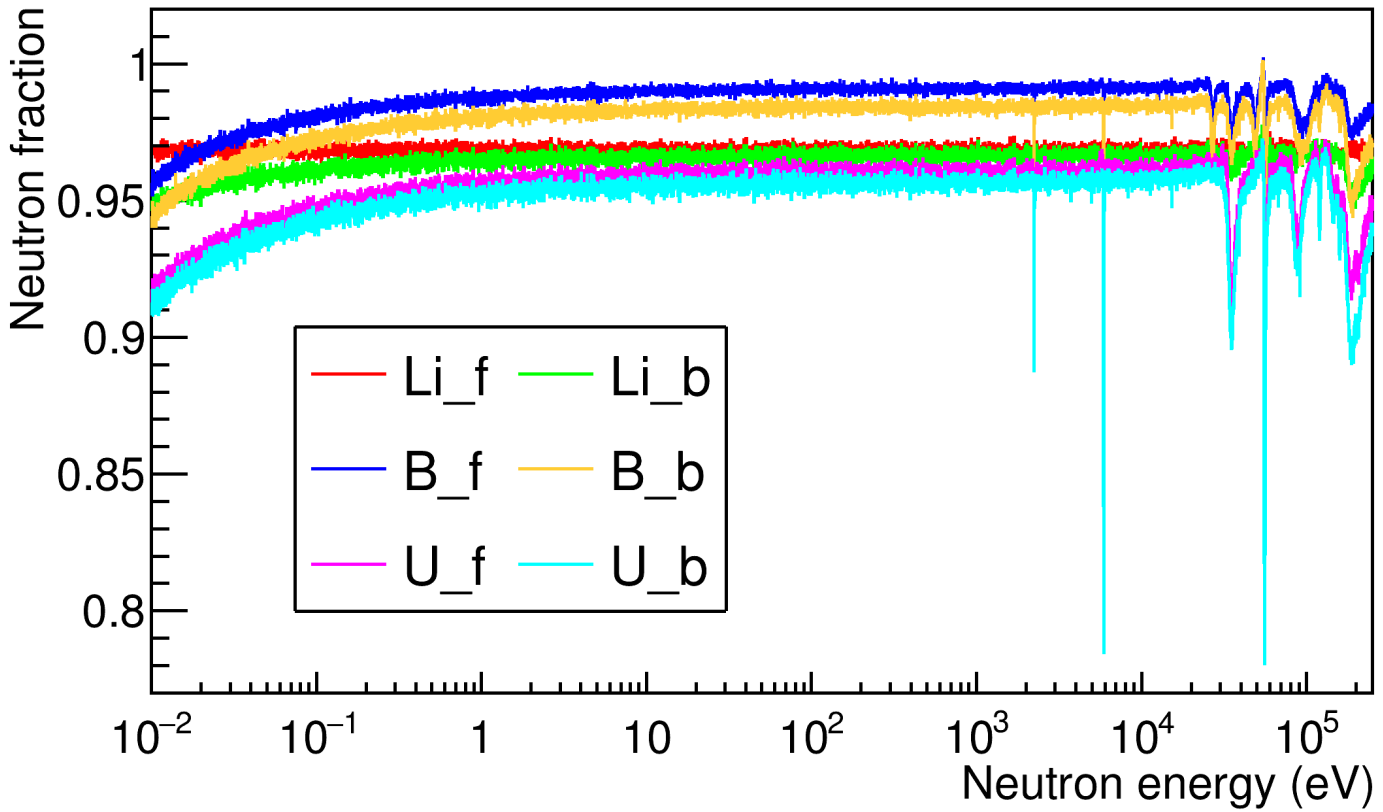
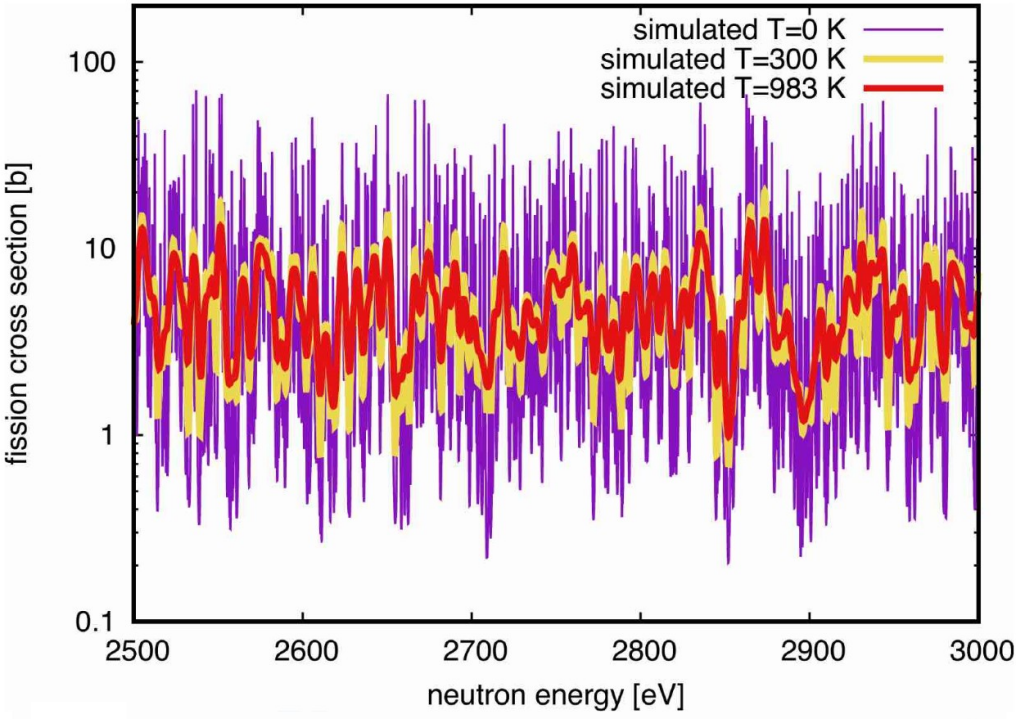


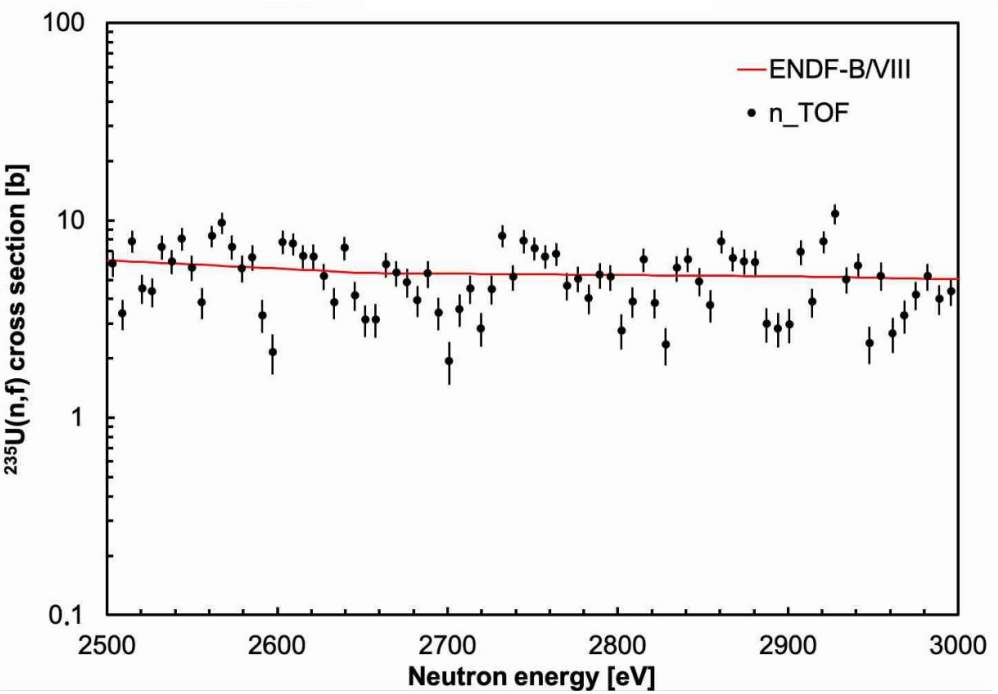
Backup – Absorption

Count rates corrected for the neutron fraction entering in the corresponding target.



[2.2,4]keV structures





Courtesy of Alberto Mengoni