$^{56}Fe(n,\gamma)$ and $^{93}Nb(n,\gamma)$ with C6D6

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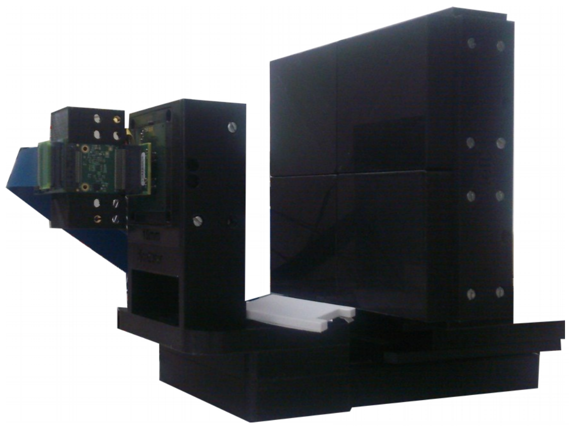
i-TED Commissioning

Proof-of-principle and a full performance evaluation of a demonstrator for i- TED.

@EAR1

^{56}Fe sample
- Disk
- 20 mm (Ø)
- 0,84 mm
- 2,1035 g



@EAR2

^{93}Nb sample
- Disk
- 20 mm (Ø)
- 0,6 mm
- 2,5028 g

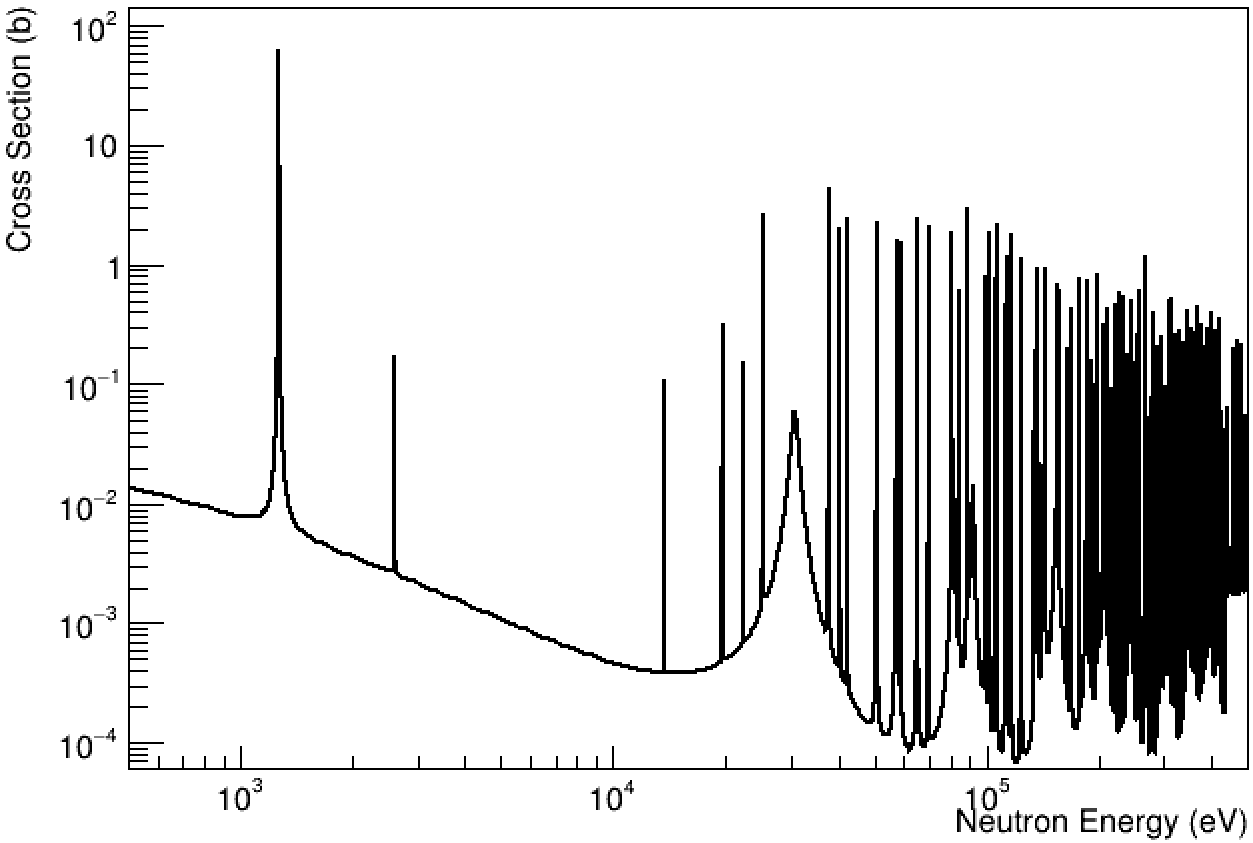
** Thanks to ILL and especially to Ingolf Mönch for the ultrapure ^{93}Nb sample.*

^{56}Fe(n,γ) with C6D6 @ EAR1

Motivations:

- It has an isolated resonance at 1.15 keV.
- Which was used at nTOF to validate the weighting function technique for C6D6.

^{56}Fe(n,γ) JANIS estimation

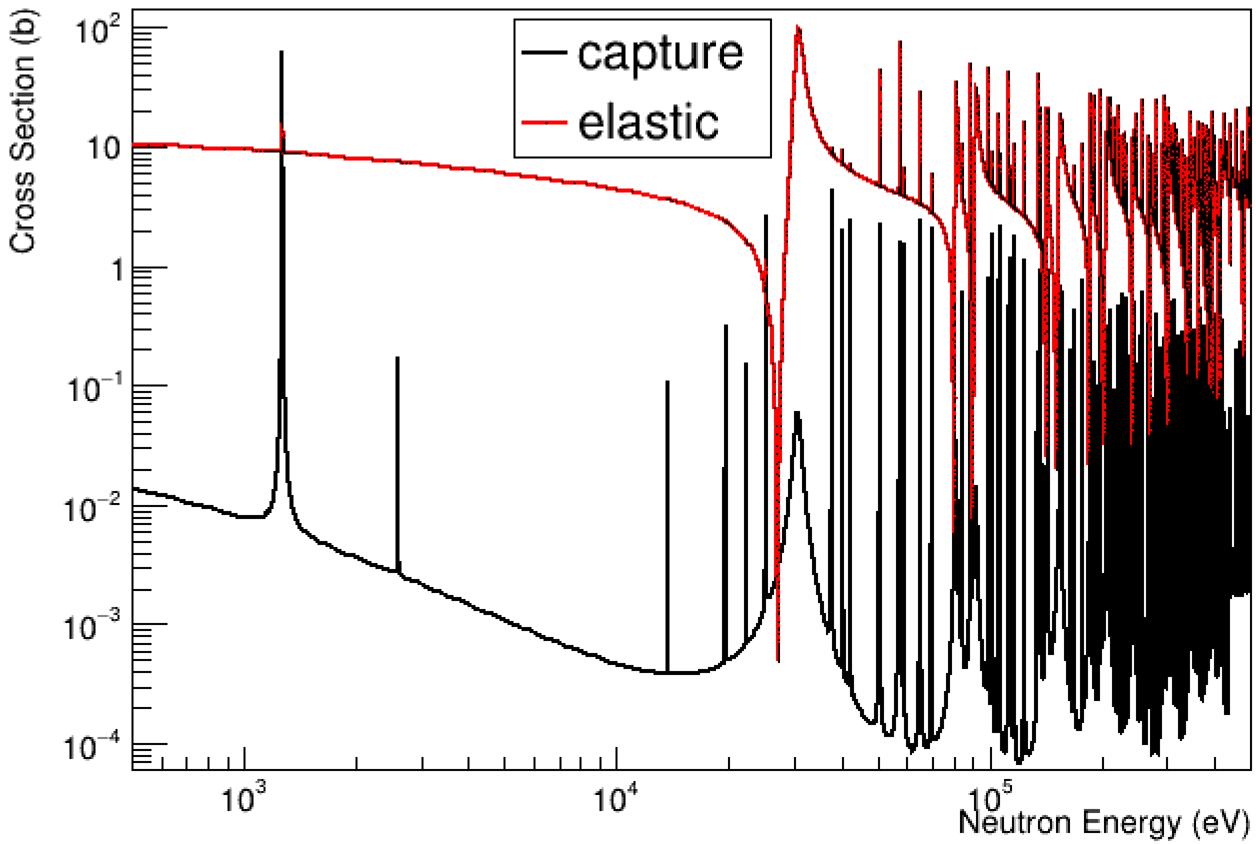


$^{56}Fe(n,\gamma)$ with C6D6 @ EAR1

Motivations:

- Its neutron capture cross-section is three orders of magnitude less than the elastic one. Great for the development of the technique (Compton Imaging).

$^{56}Fe(n,\gamma)$ JANIS estimation



^{56}Fe(n,γ) with C6D6 @ EAR1

By the way…

- Being the seed of the s-process, ^{56}Fe has been recently found to be very relevant for nucleosynthesis in LM-AGB stars.

Uncertainties in s-process nucleosynthesis in low-mass stars determined from Monte Carlo variations

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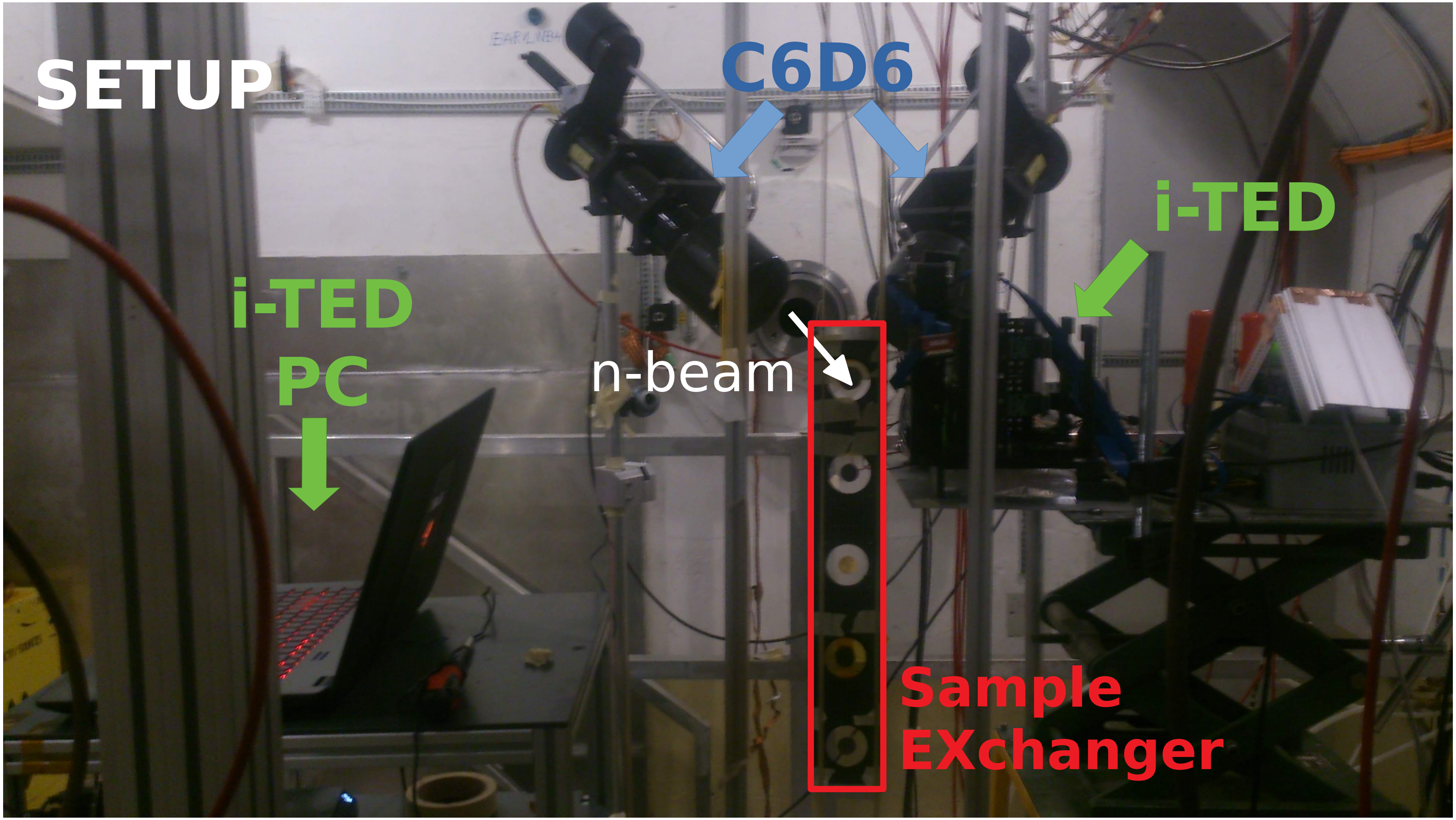
ABSTRACT

The main s-process taking place in low-mass stars produces about half of the elements heavier than iron. It is therefore very important to determine the importance and impact of nuclear physics uncertainties on this process. We have performed extensive nuclear reaction network calculations using individual and temperature-dependent uncertainties for reactions involving elements heavier than iron, within a Monte Carlo framework. Using this technique, we determined the uncertainty in the main s-process abundance predictions due to nuclear uncertainties linked to weak interactions and neutron captures on elements heavier than iron. We also identified the key nuclear reactions dominating these uncertainties. We found that β-decay rate uncertainties affect only a few nuclides near s-process branchings, whereas most of the uncertainty in the final abundances is caused by uncertainties in neutron-capture rates, either directly producing or destroying the nuclide of interest. Combined total nuclear uncertainties due to reactions on heavy elements are in general small (less than 50 per cent). Three key reactions, nevertheless, stand out because they significantly affect the uncertainties of a large number of nuclides. These are ^{56}Fe(n,γ), ^{64}Ni(n,γ), and ^{138}Ba(n,γ). We discuss the prospect of reducing uncertainties in the key reactions identified in this study with future experiments.

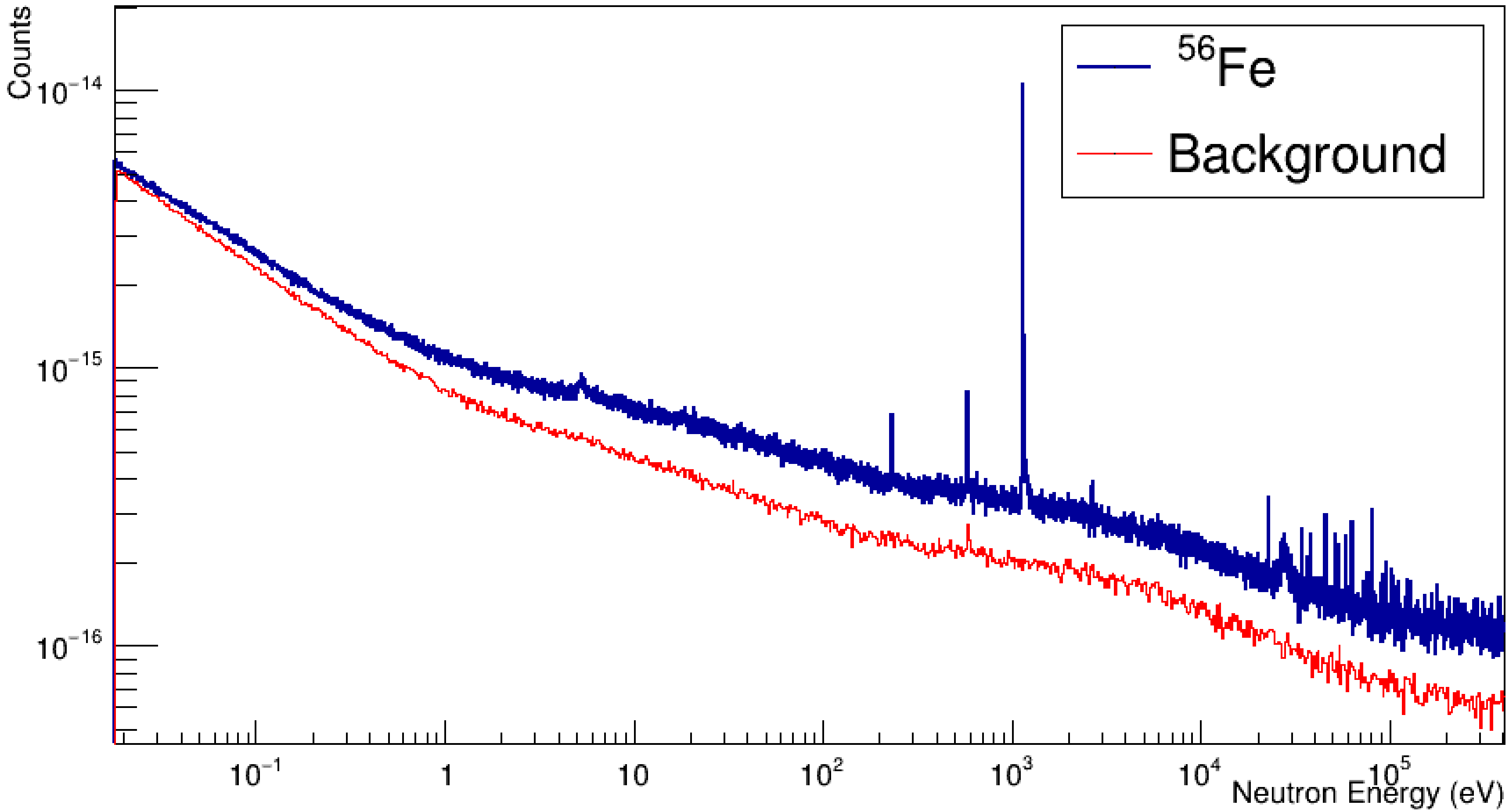
Key words: nuclear reactions, nucleosynthesis, abundances – stars: abundances – stars: AGB and post-AGB – stars: evolution – stars: low-mass.

$^{56}Fe(n,\gamma)$ with C6D6 @ EAR1



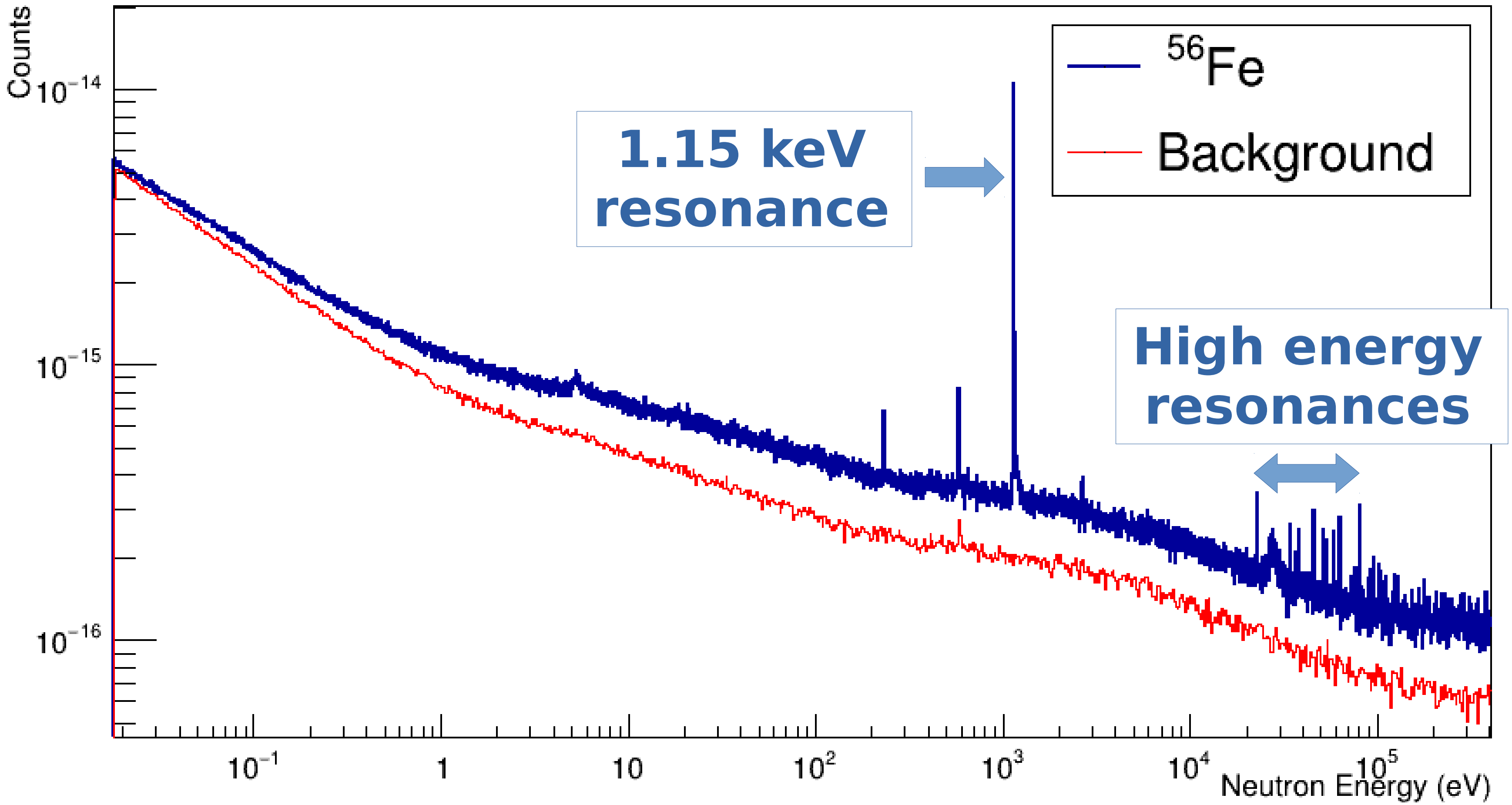
$^{56}Fe(n,\gamma)$ with C6D6 @ EAR1

PRELIMINARY RESULTS



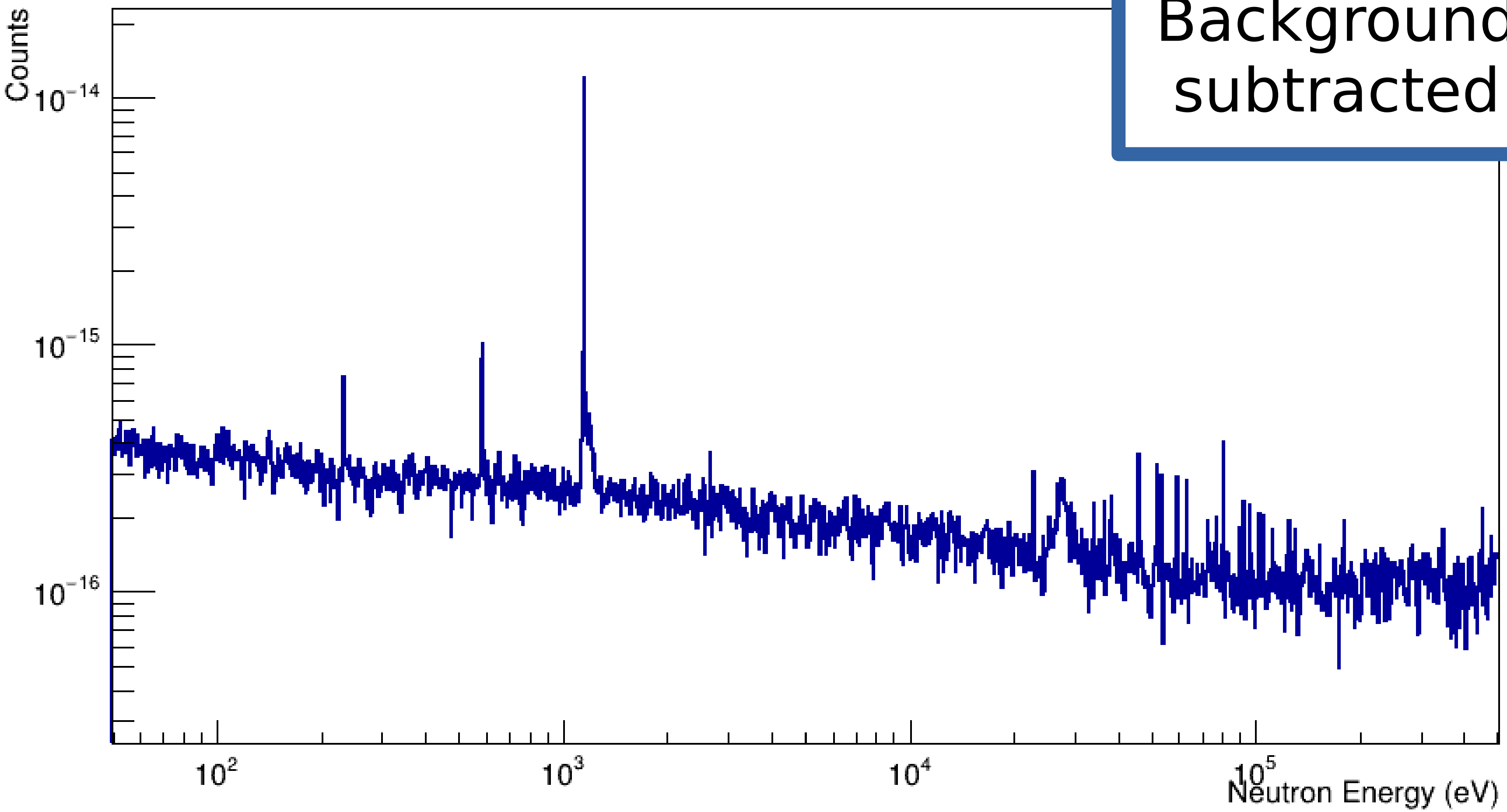
$^{56}Fe(n,\gamma)$ with C6D6 @ EAR1

PRELIMINARY RESULTS



$^{56}Fe(n,\gamma)$ with C6D6 @ EAR1

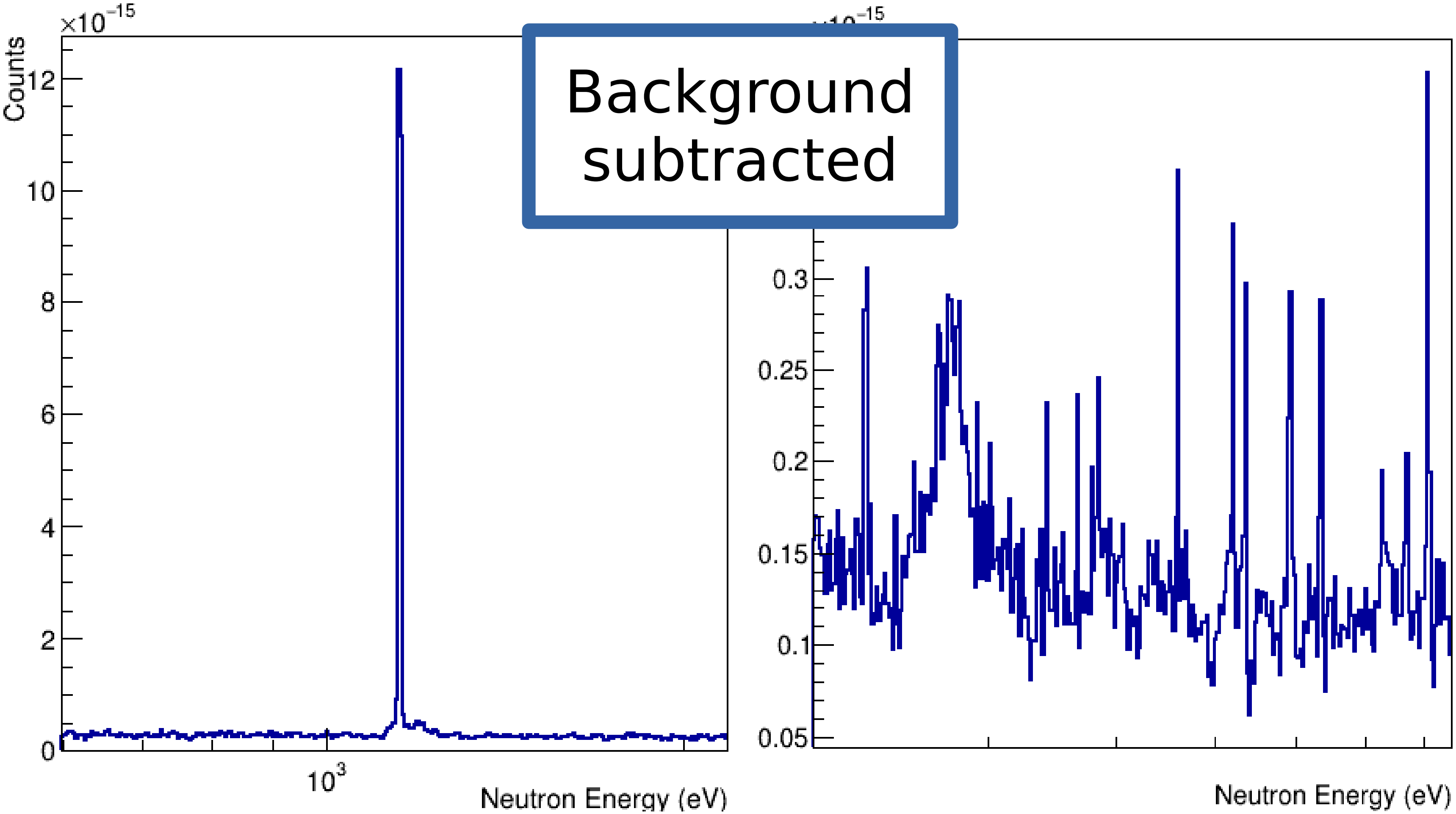
PRELIMINARY RESULTS



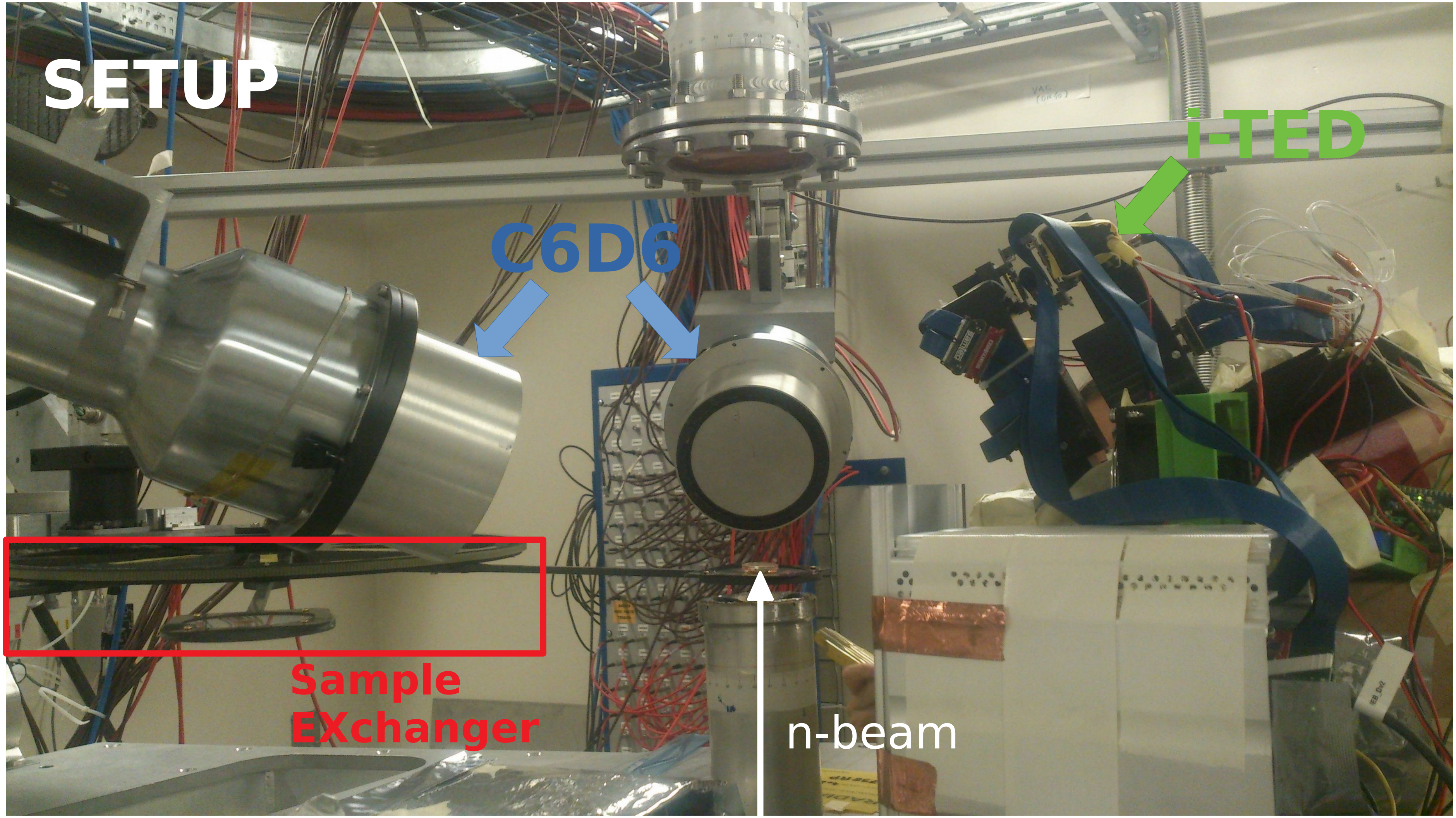
Background subtracted

$^{56}Fe(n,\gamma)$ with C6D6 @ EAR1

PRELIMINARY RESULTS

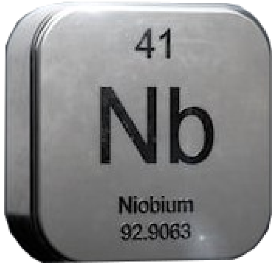


^{93}Nb(n,γ) with C6D6 @ EAR2

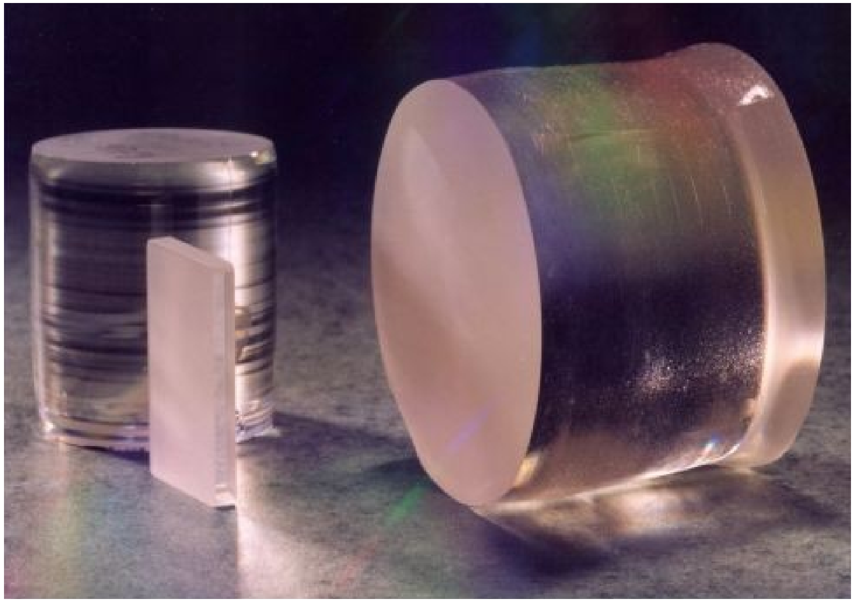


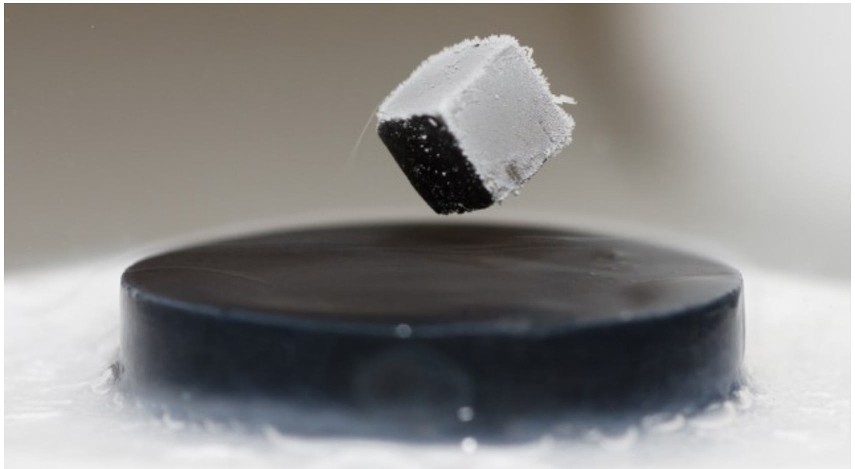
^{93}Nb(n,γ) with C6D6 @ EAR2

Motivations:



- Available ultra-pure sample.
- Material very interesting for its application in lens, allows as well as superconductor.



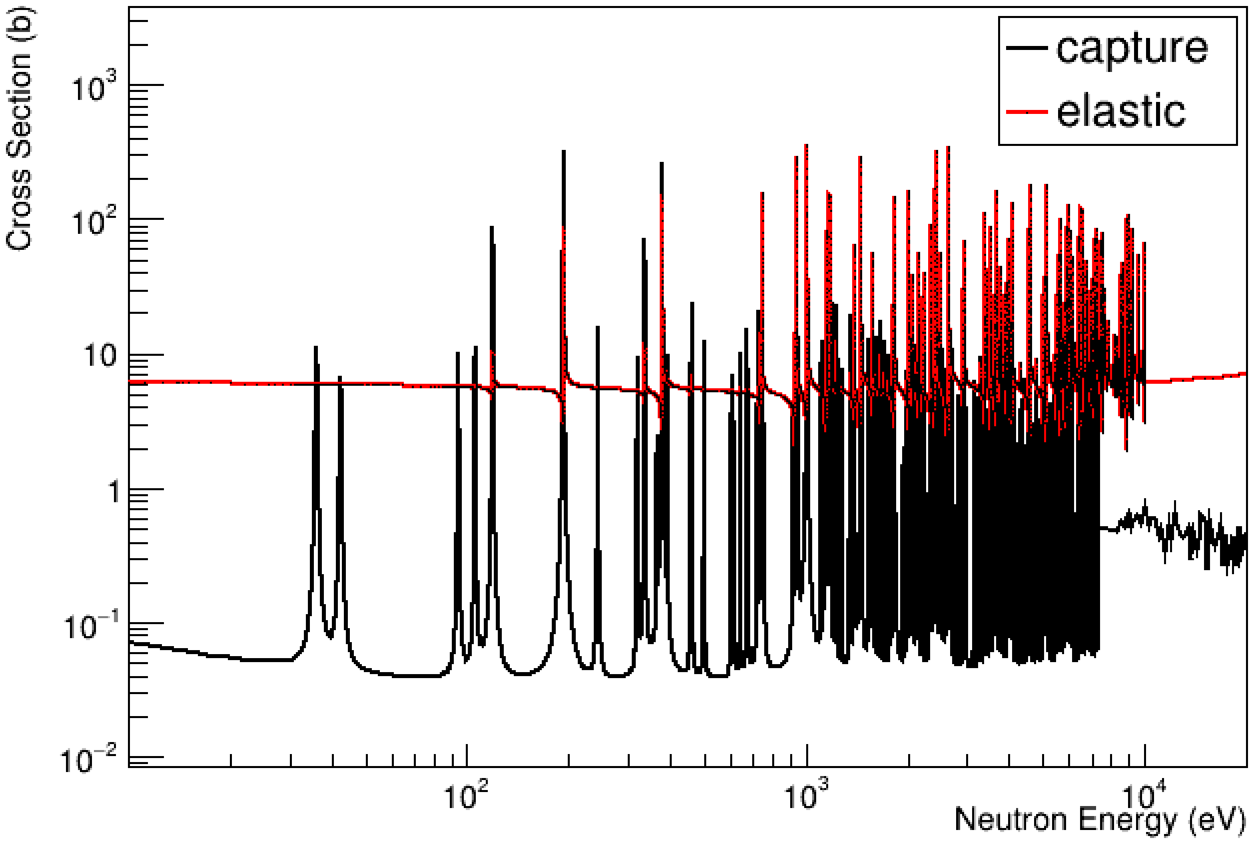


$^{93}Nb(n,\gamma)$ with C6D6 @ EAR2

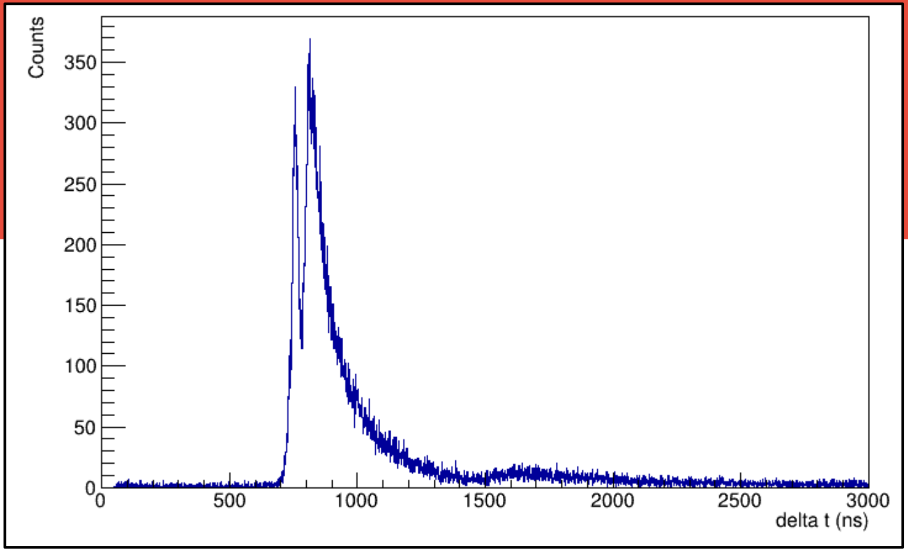
Motivations:

- As iron, it has a neutron capture cross-section is lower than the elastic one, about two orders of magnitude.

$^{93}Nb(n,\gamma)$ JANIS estimation



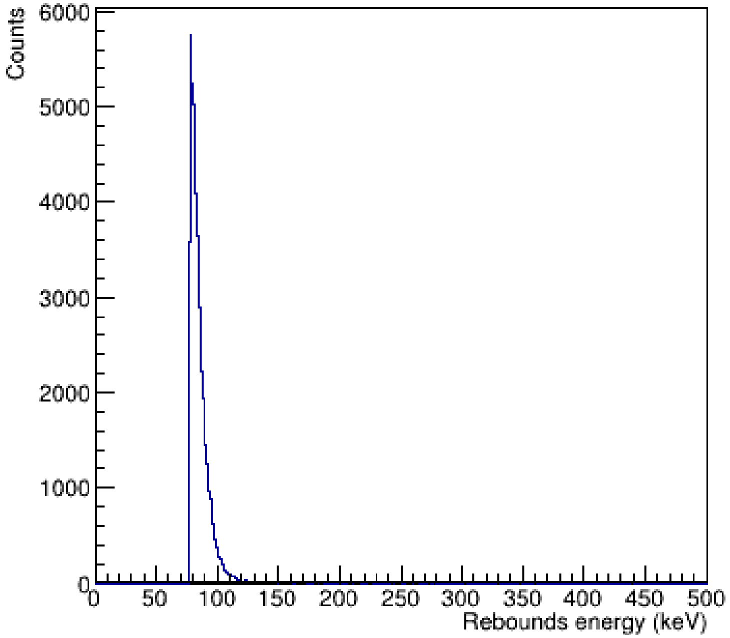
^{93}Nb @ EAR2



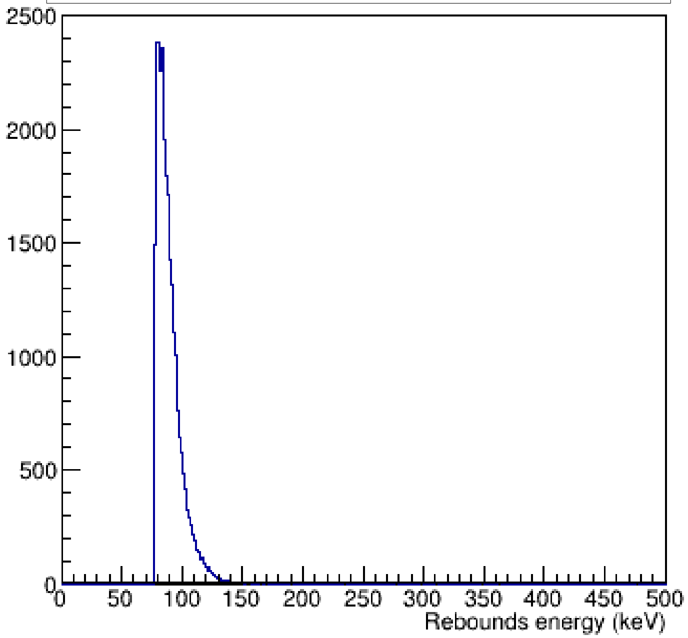
REBOUNDS

Threshold ~150 keV

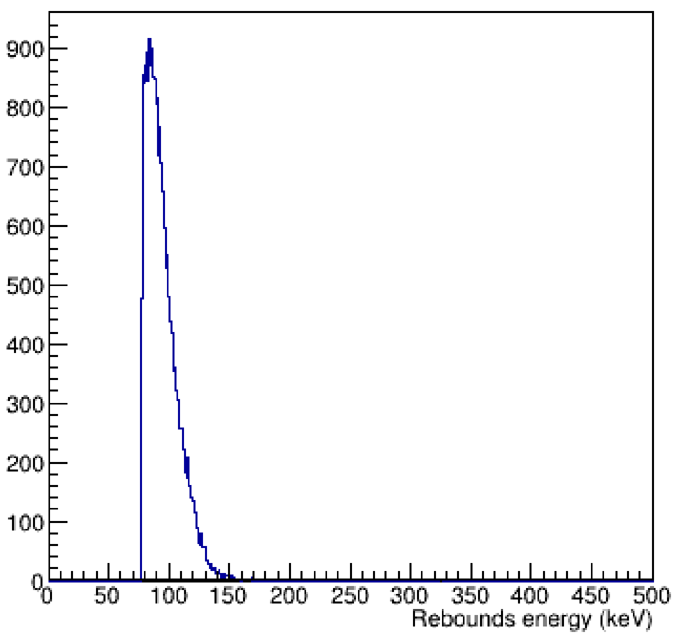
1 MeV < $A_{M\text{-}S}$ < 2 MeV



2 MeV < $A_{M\text{-}S}$ < 3 MeV

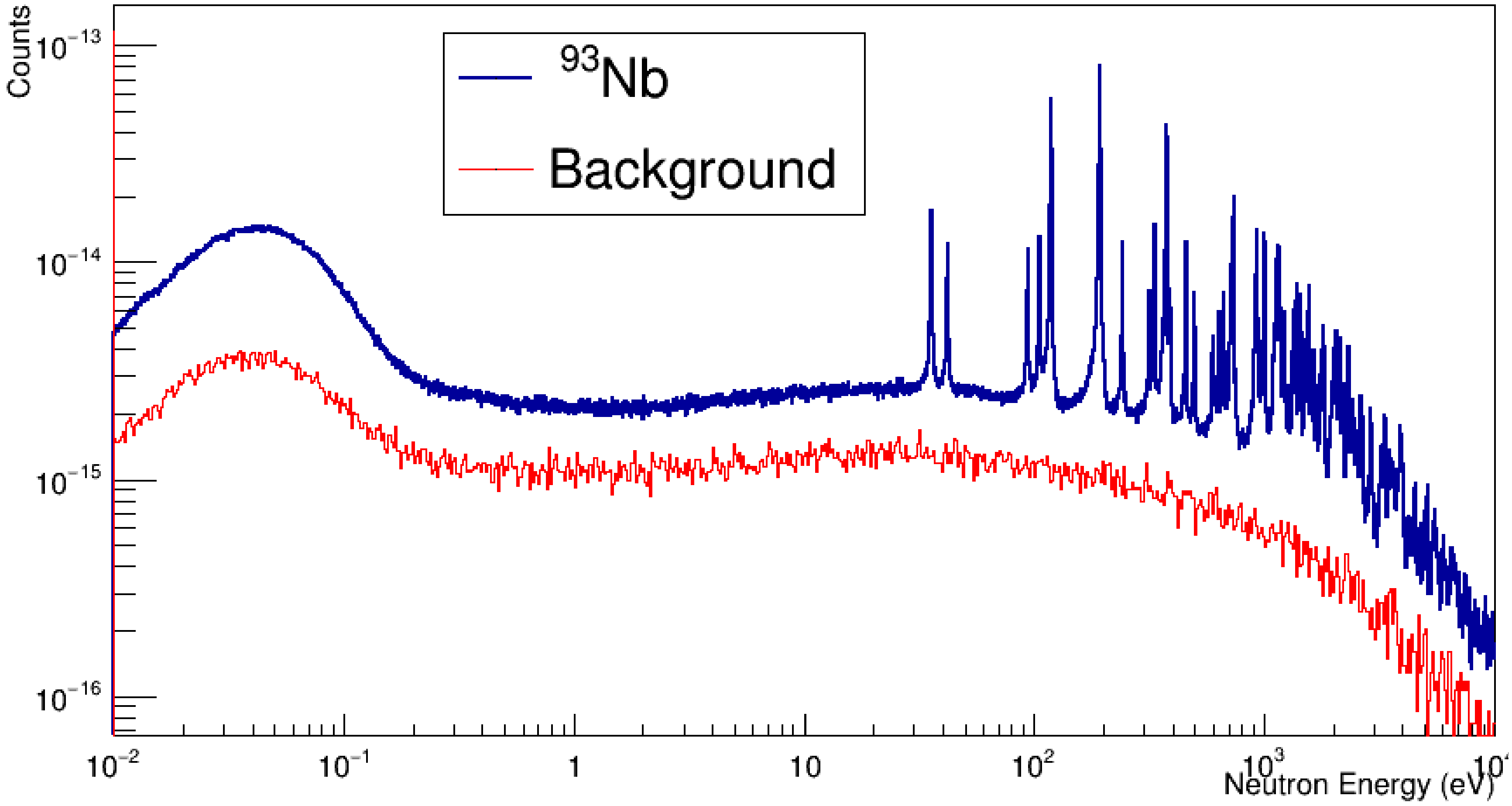


3 MeV < $A_{M\text{-}S}$ < 4 MeV



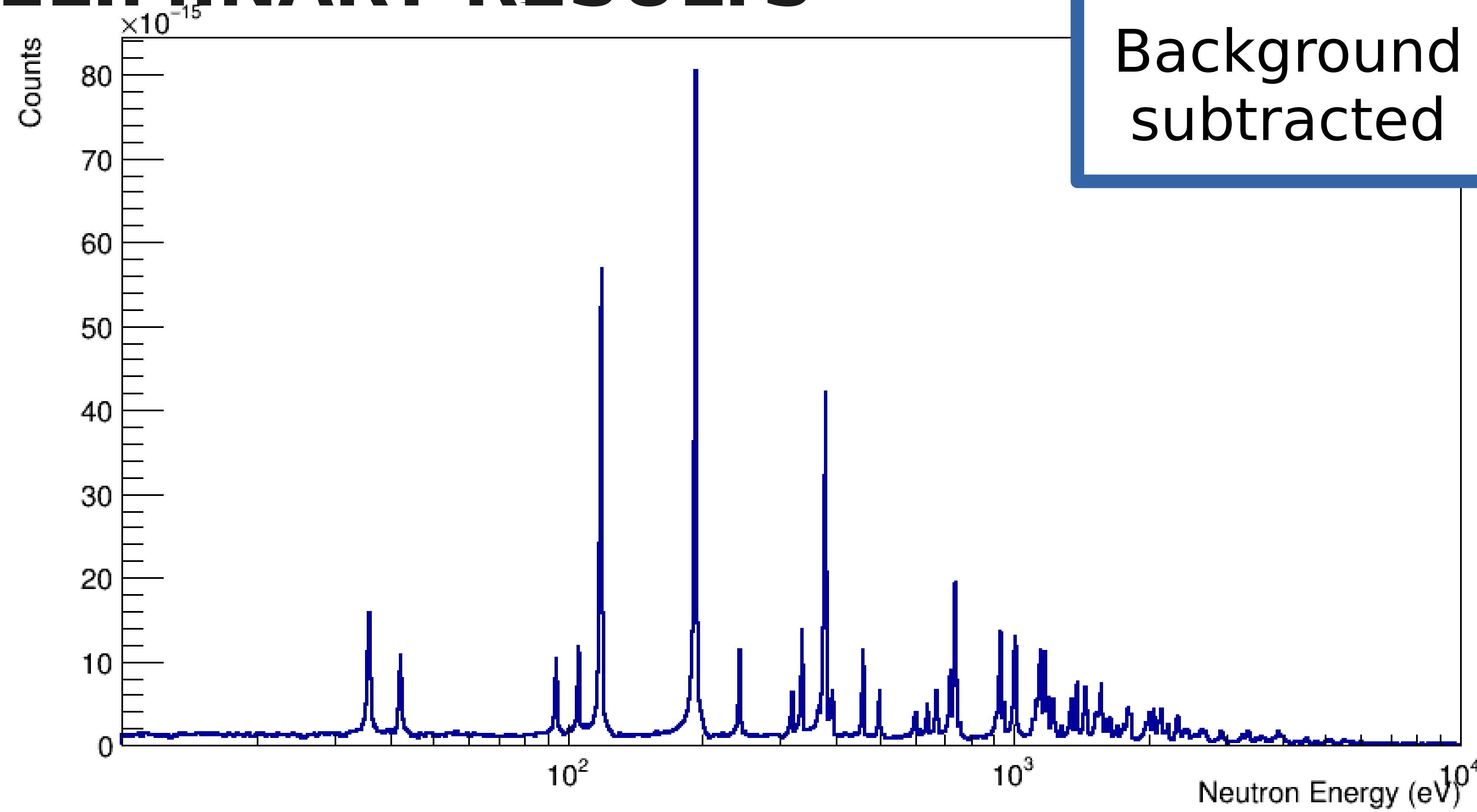
^{93}Nb(n,γ) with C6D6 @ EAR2

PRELIMINARY RESULTS



^{93}Nb(n,γ) with C6D6 @ EAR2

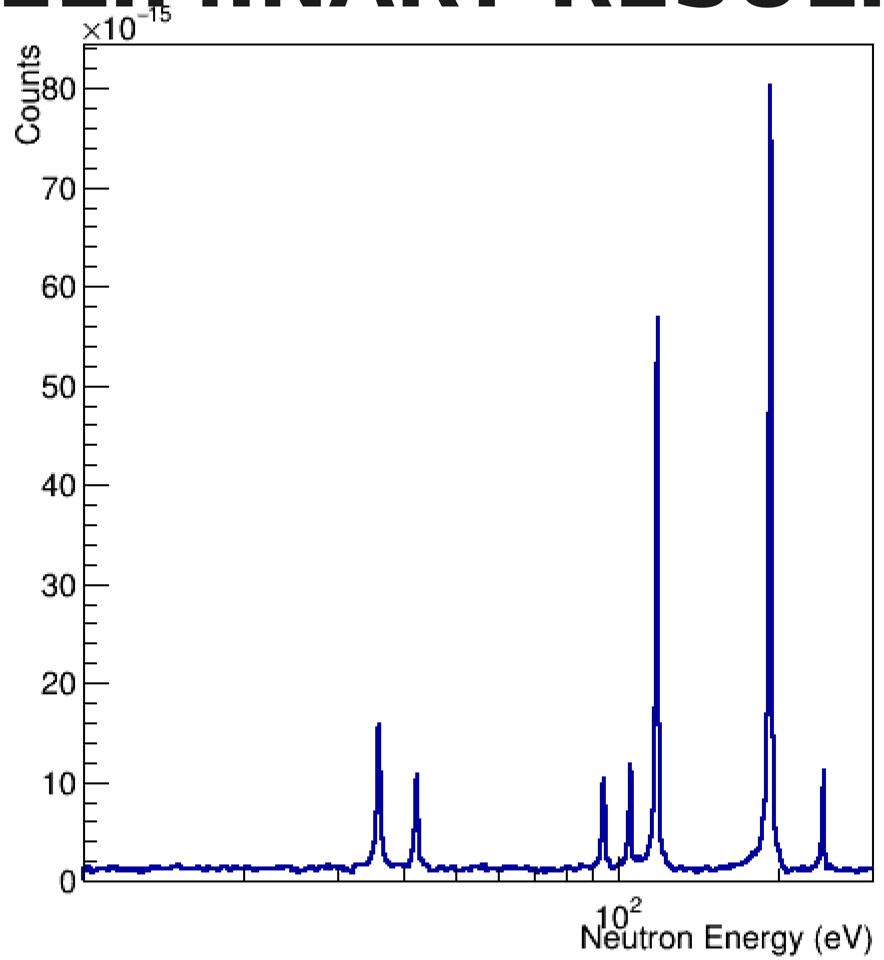
PRELIMINARY RESULTS

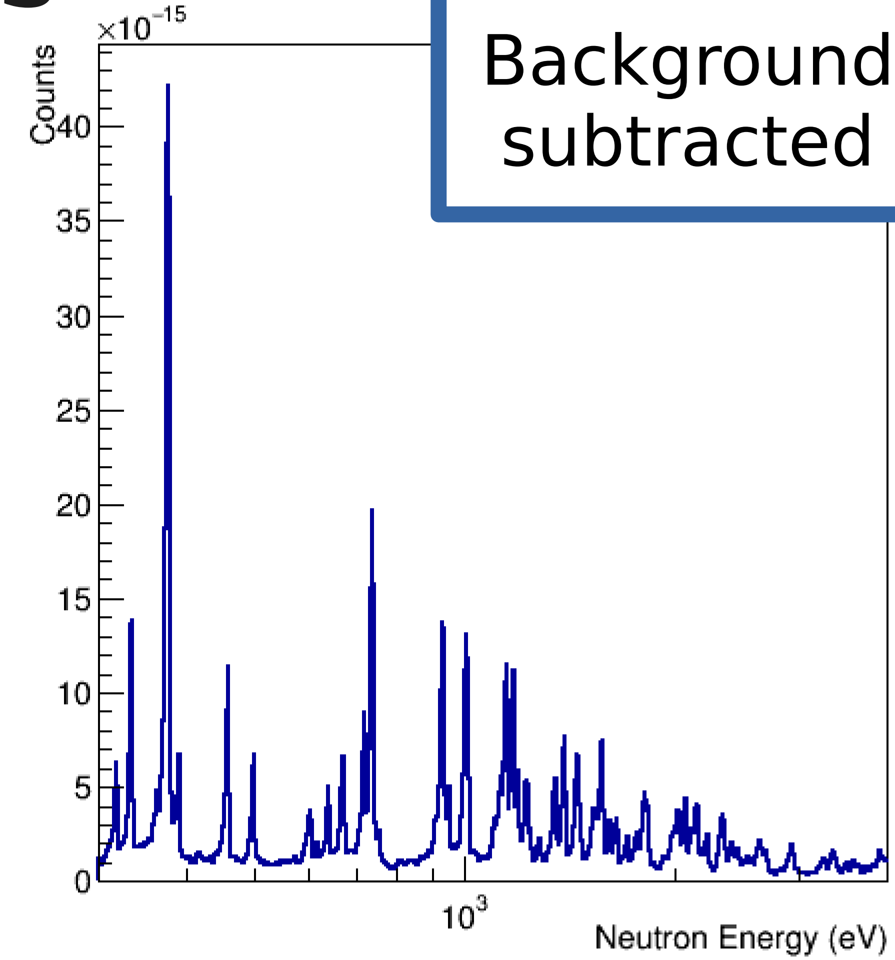


Background subtracted

^{93}Nb(n,γ) with C6D6 @ EAR2

PRELIMINARY RESULTS





Background subtracted

^{56}Fe & ^{93}Nb measurements

SUMMARY

- With the objective of evaluating the performance of i-TED, we have measured the $^{56}Fe(n,g)$ and $^{93}Nb(n,g)$ cross sections with C6D6 detectors at n_TOF EAR1 and EAR2.
- At this point, the statistics and quality of the C6D6 data looks good as to determine the capture yield and cross sections.
- Ongoing work …
    - → MC simulations to calculate Wfs and apply the PHWT.
    - → Determination of the capture yield.
    - → Evaluate the astrophysical interpretation.
    - → Compare these results versus the i-TED results in order to evaluate the performance of i-TED.