First results of the ^{243}Am(n,f) measurement at EAR1 and EAR2

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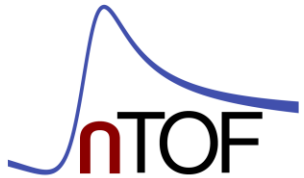
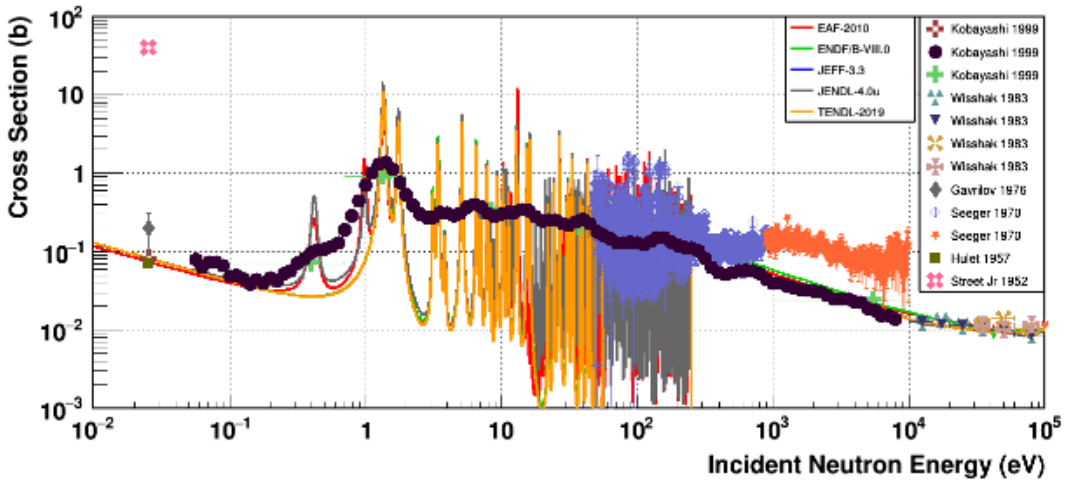
Nikolaos Patronis, Michael Kokkoris, Roza Vlastou and the
n_TOF collaboration

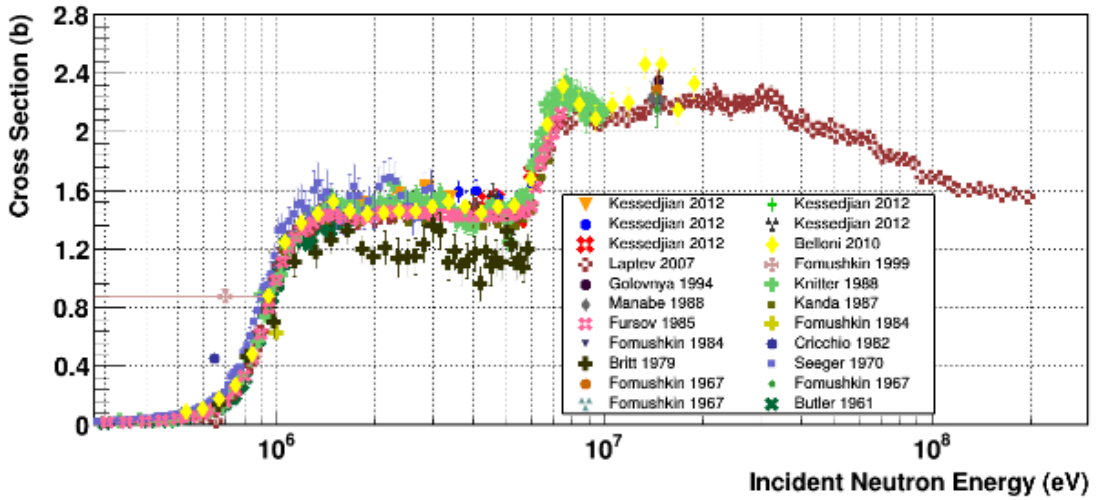


Motivation

- Am Isotopes are classified as **high-level nuclear waste** from nuclear reactors.
- ^{243}Am ($T_{1/2}$ = 7364y) contributes to the radiotoxicity of nuclear waste via **^{239}Pu production** through decays.
- Important candidate for use as **burnable actinides** in future reactors.
- **High accuracy nuclear fission data** are required
- NEA Nuclear Data High Priority Request List (https://www.oecd-nea.org/dbdata/hprl/search.pl?vsec=on)

Present Status of ^{243}Am(n,f) Data





- Lack of good quality datasets. High discrepancies and poor resolution
- Inconsistencies between evaluated libraries
- Aim of this work: To provide a **single high-quality dataset** from thermal up to 100s MeV for the first time.

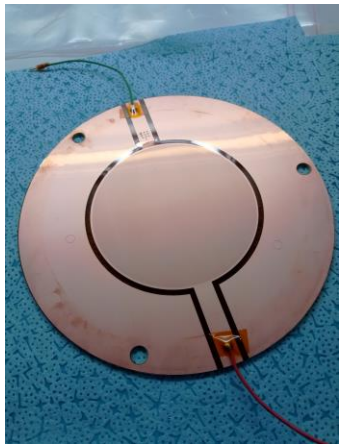
^{243}Am Samples

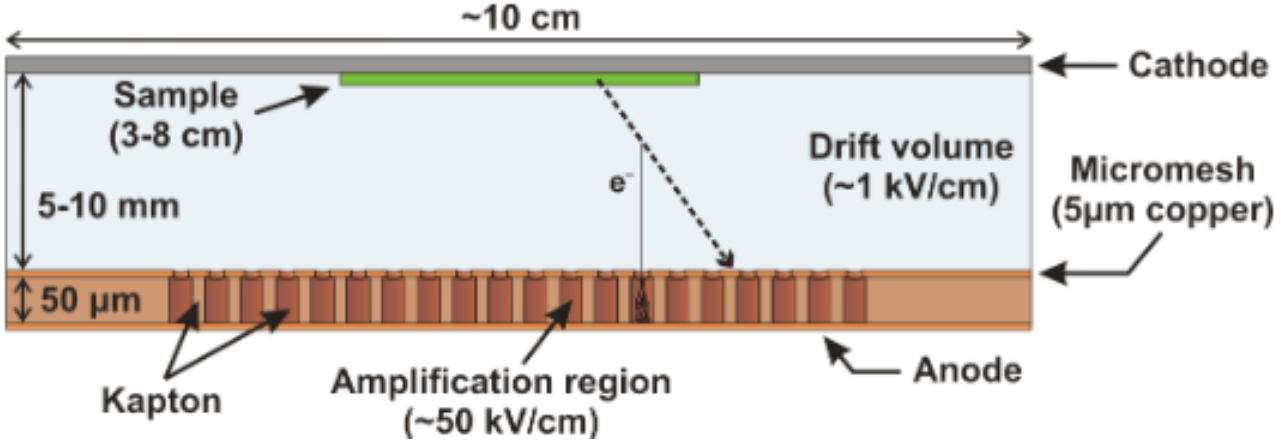
- **High-Purity** ^{243}Am samples provided by the **EC-JRC Geel target Laboratory**
- **6-cm** diameter disk deposited on a thin Al backing.
- Target mass spread in multiple samples with hybrid thick-thin configuration.

1. Avoid pile-up and keep high reaction rates in all regions
2. Protect Detectors from potential radiation damage.

- Total activity ~160Mbq.

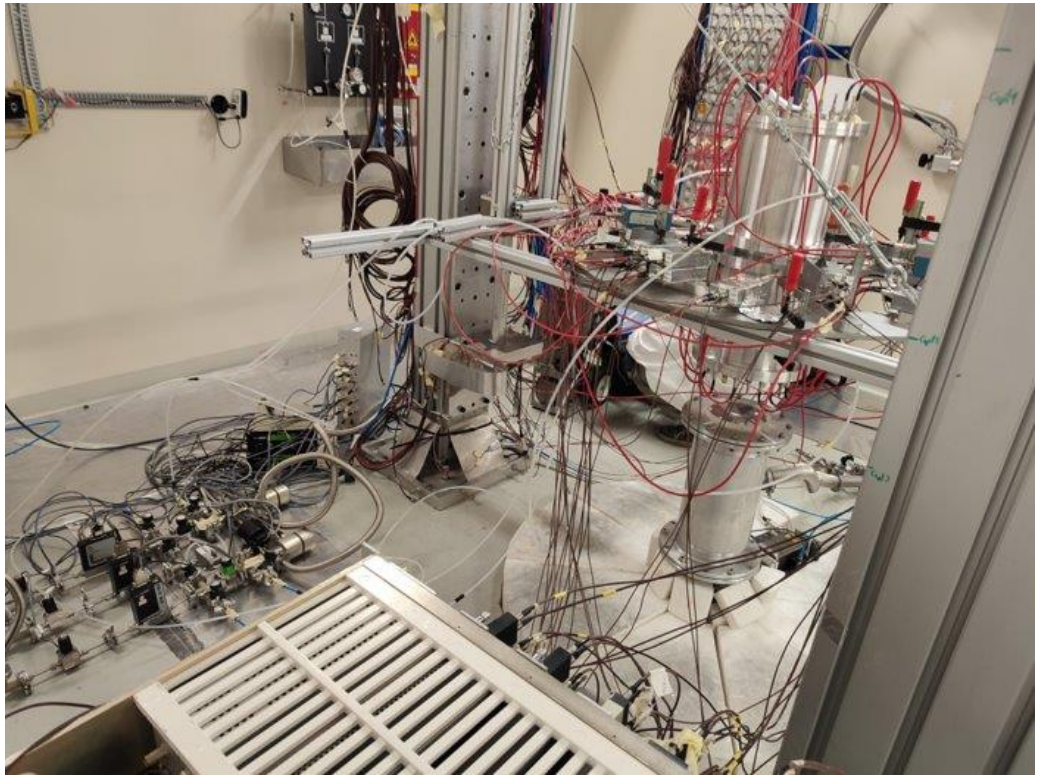
Detector system

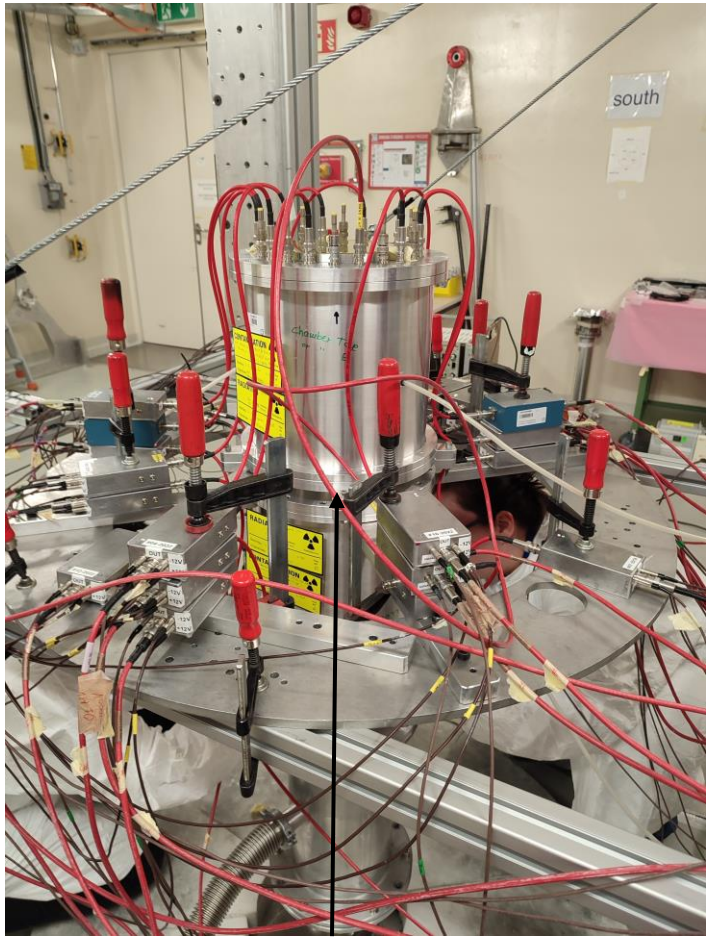




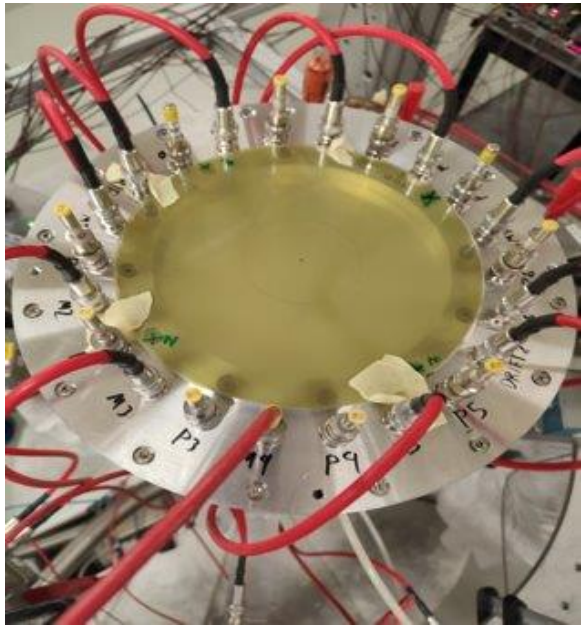
- Total of 20 micromegas detectors housed in 2 Chambers
  - 6 x ^{243}Am thick targets (EAR1 + EAR2 resonances)
  - 5 x ^{243}Am thin targets (EAR2 above threshold)
  - 5 x ^{235}U targets (thin + thick) ^{10}B and ^{238}U as reference
  - 2 x Empty samples

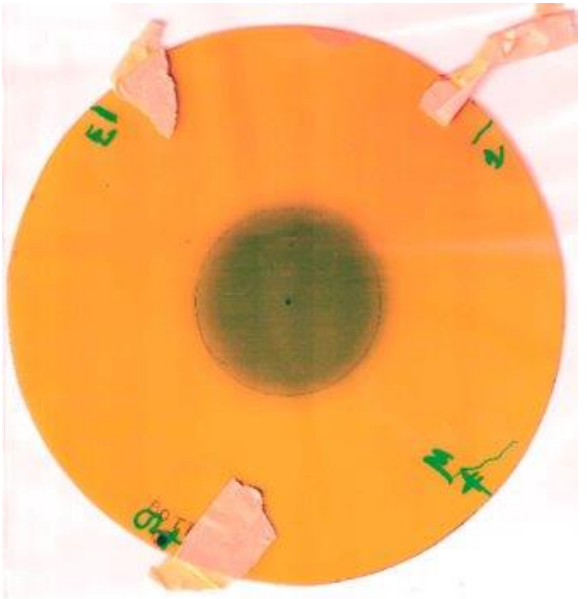
Experimental Setup at EAR2





Neutron beam

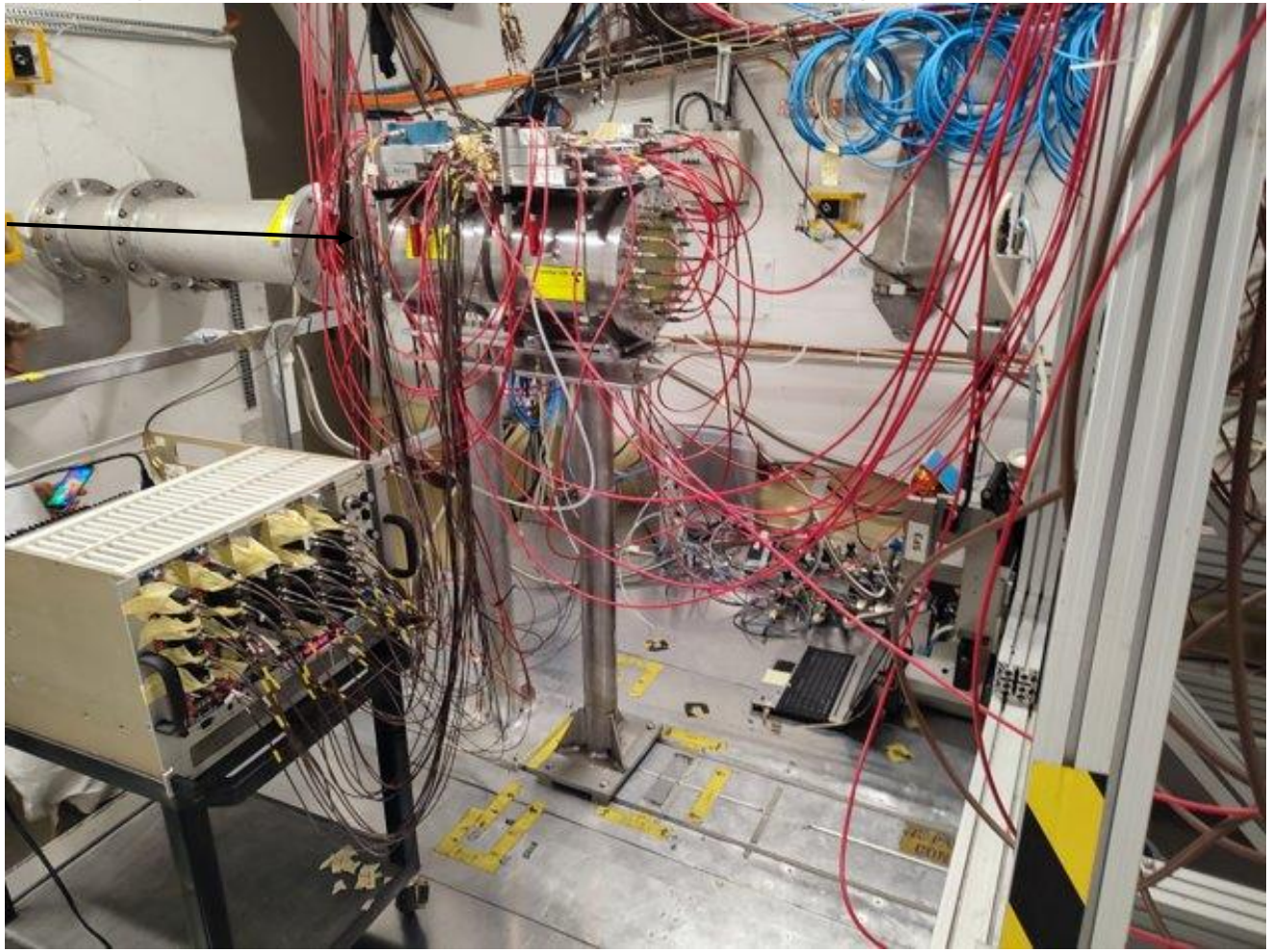


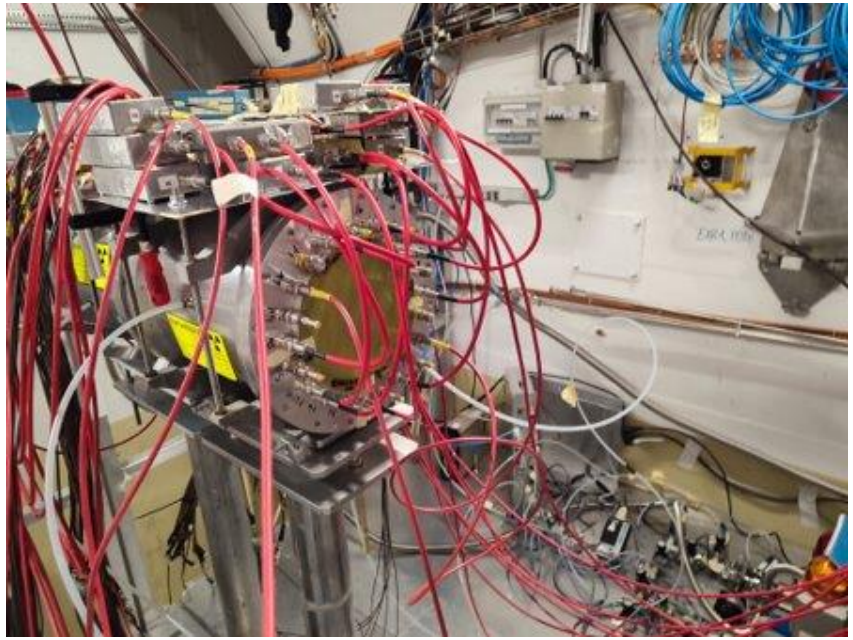


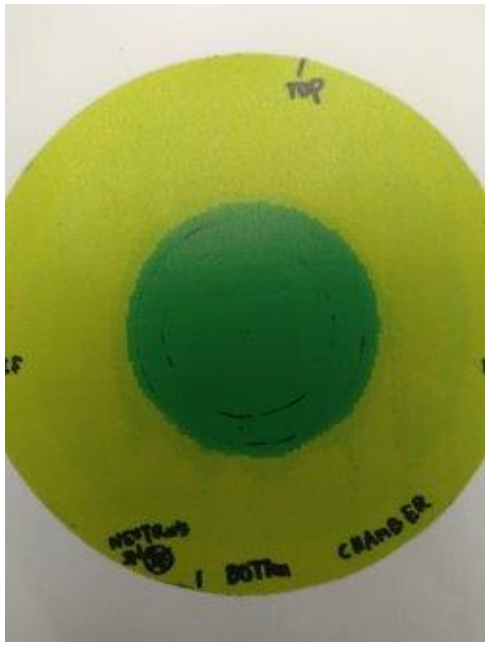
- Run at EAR2 from June 7th – July 11th
- Total Useful Statistics: 32.116e+17 protons

Experimental Setup at EAR1

Neutron beam



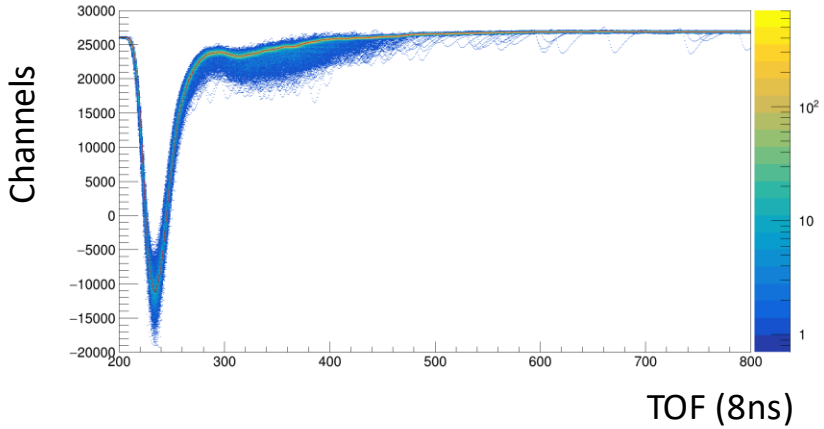




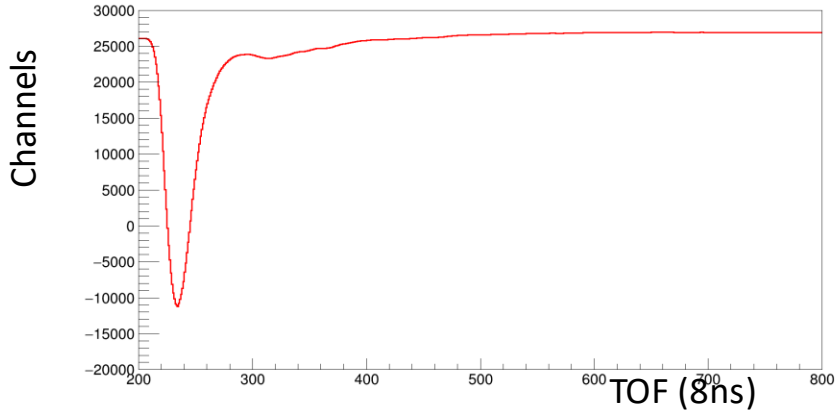
- Run at EAR1 from July 19th - August 22nd
- Total Useful Statistics 37.089e+17 protons

Average γ-flash shape: ^{243}Am

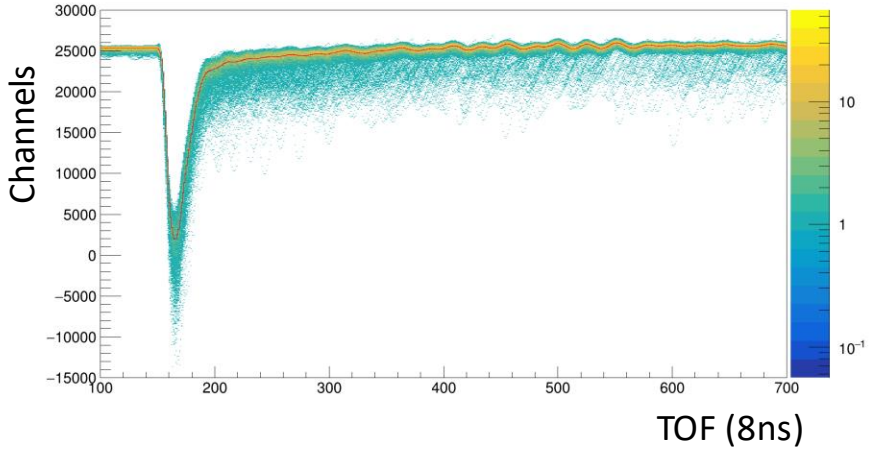
γ-flash Stack

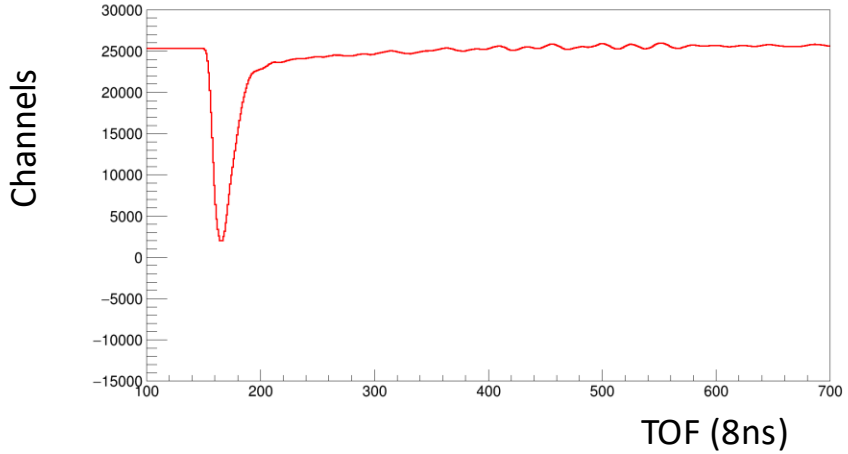


Average Shape



EAR2

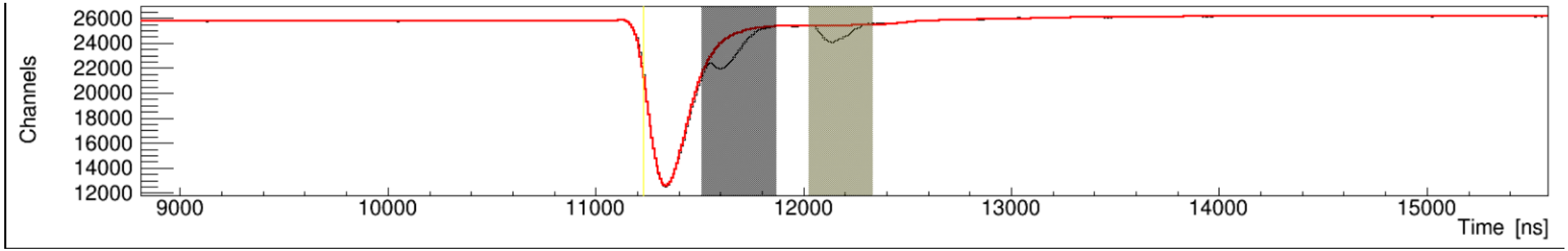




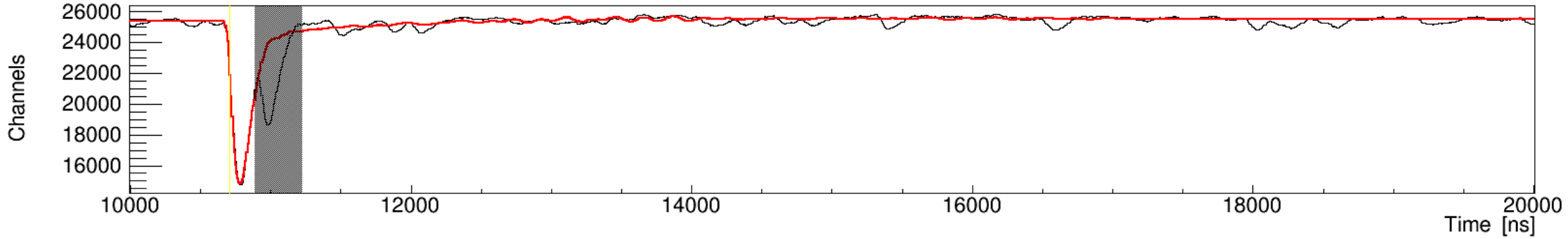
EAR1

- Extracted average pulse shape for both EARs and both Dedicated and Parasitic pulses on all detectors
- Shown: Dedicated pulses. Similar shapes for Parasitic

Signal Analyzer



EAR2
243Am
thin

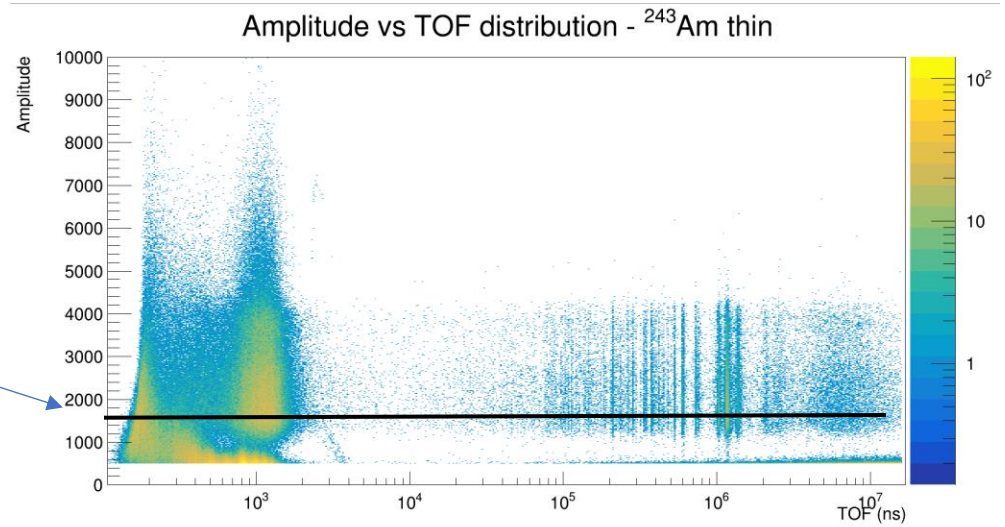


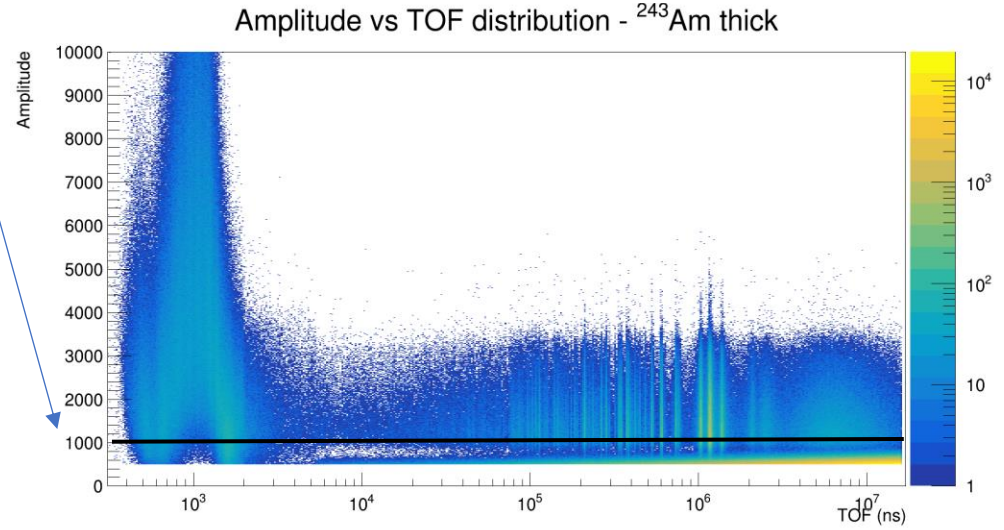
EAR1
243Am
thick

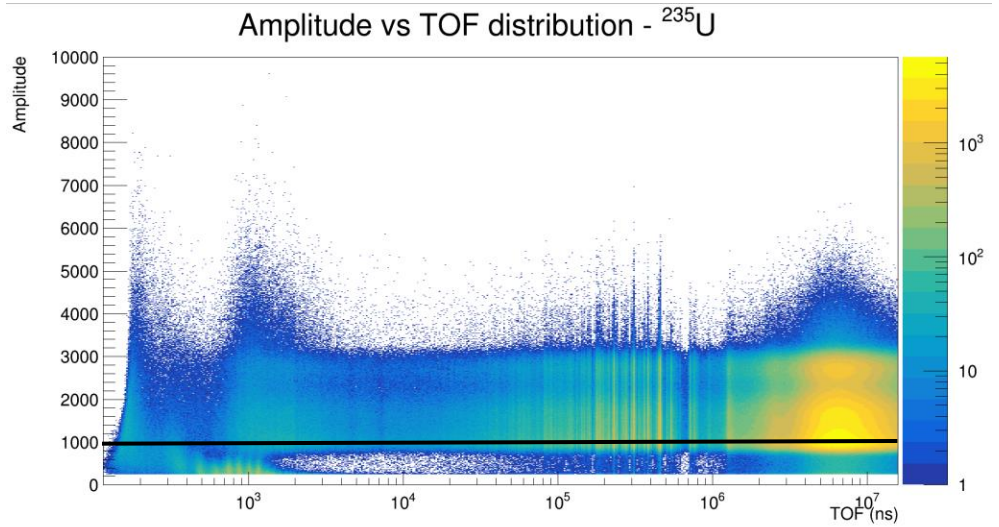
- Good average γ-flash shape for both EARs
- Can properly recognize pulses for high TOF
- Prominent Oscillations in EAR1. Small compared to signals

Amplitude vs TOF distributions EAR2

Amplitude cut



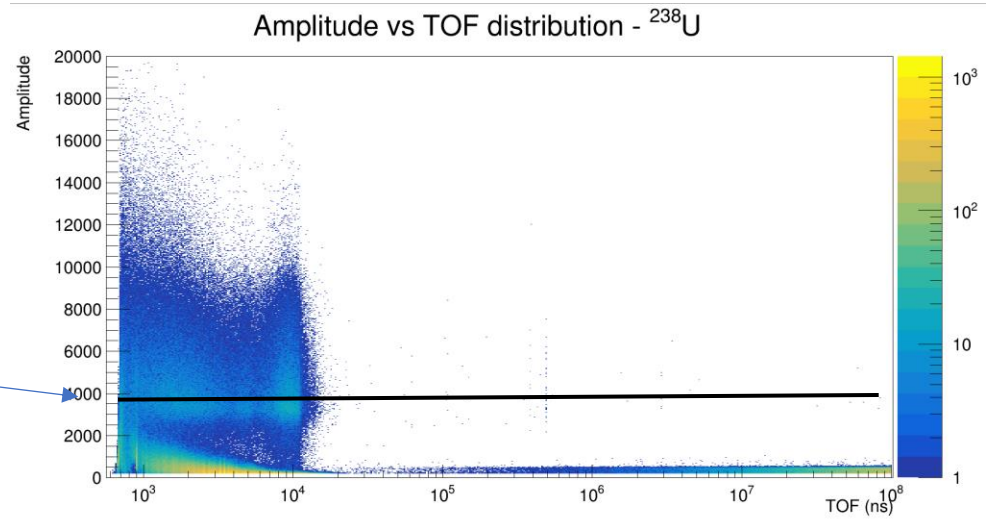


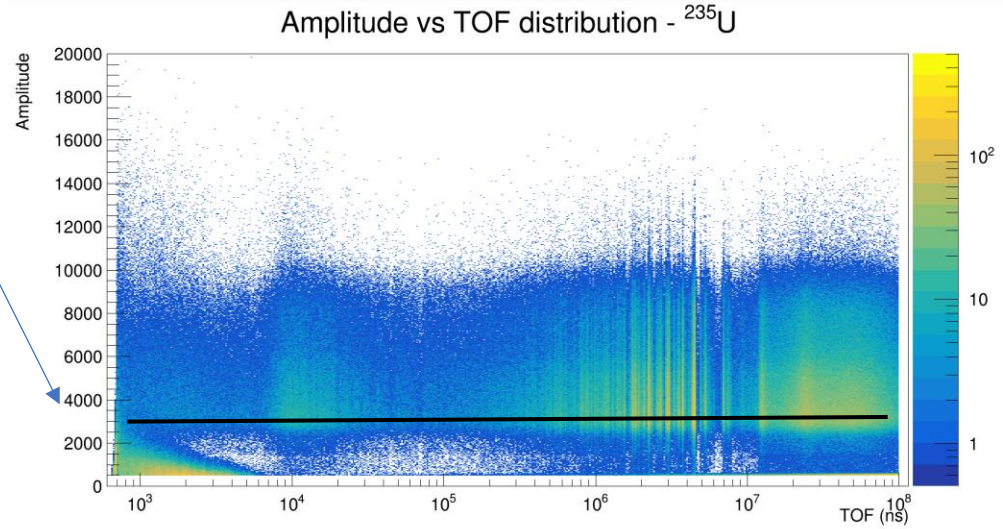


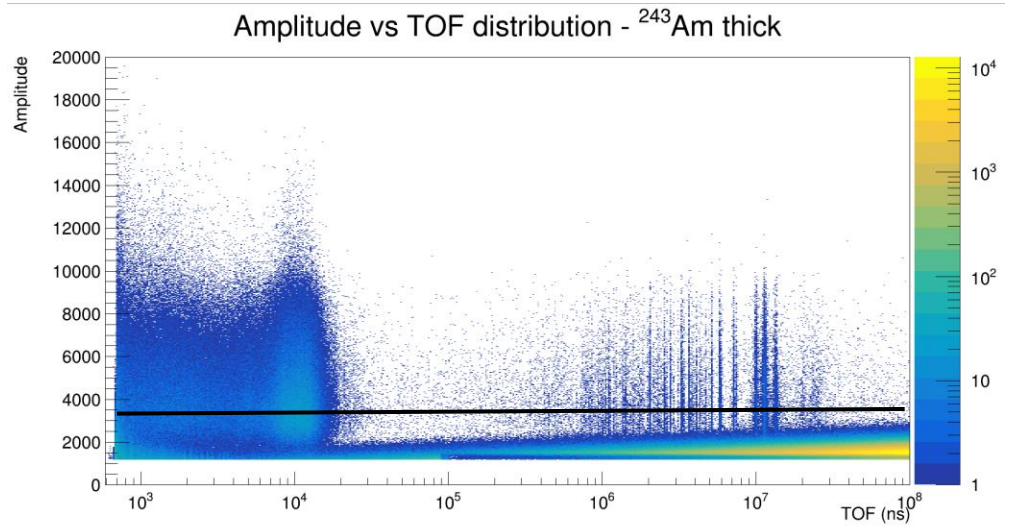
- **Good separation** between alphas and fission fragments for thin ^{243}Am targets
- Applied high flat amplitude cut to remove the alphas and the effects of the γ-flash at higher energies

Amplitude vs TOF distributions EAR1

Amplitude cut



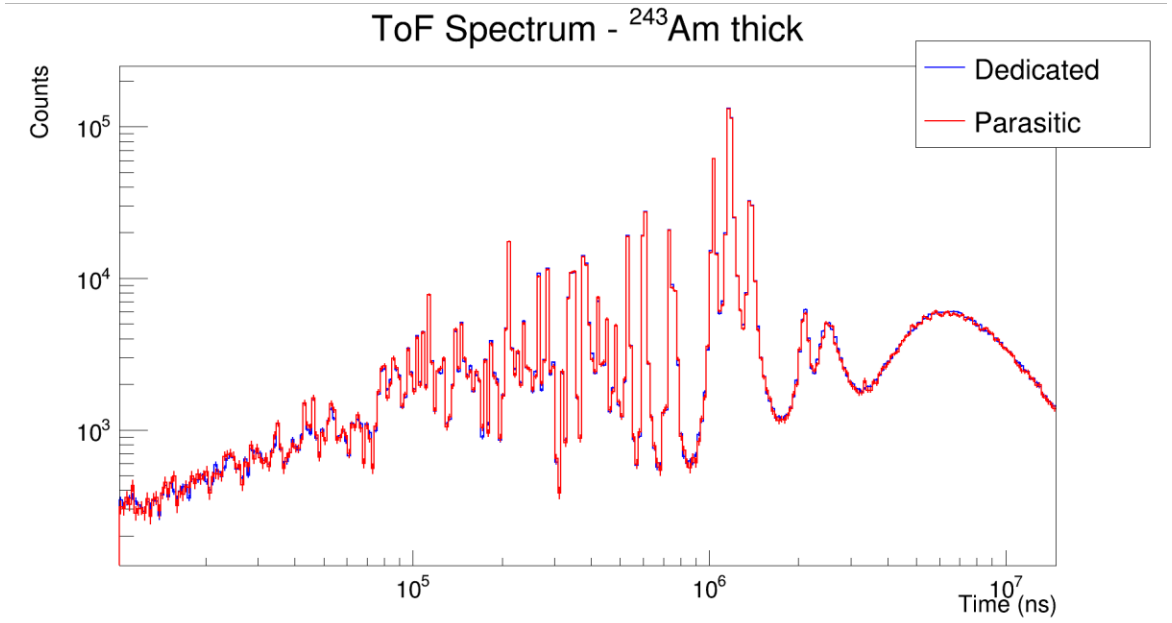




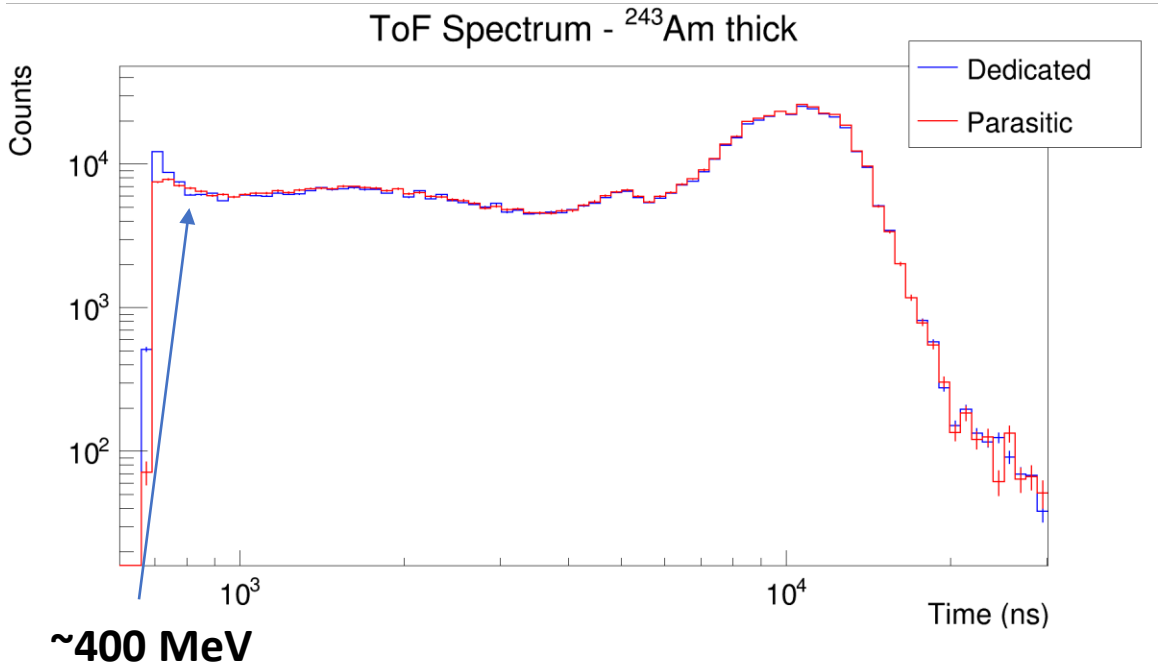
- **Good separation** between alphas and fission fragments for thin ^{243}Am targets
- Applied flat high amplitude cut to remove the alphas and the effects of the γ-flash at higher energies

TOF distribution: Dedicated vs Parasitic Pulses

EAR2



EAR1

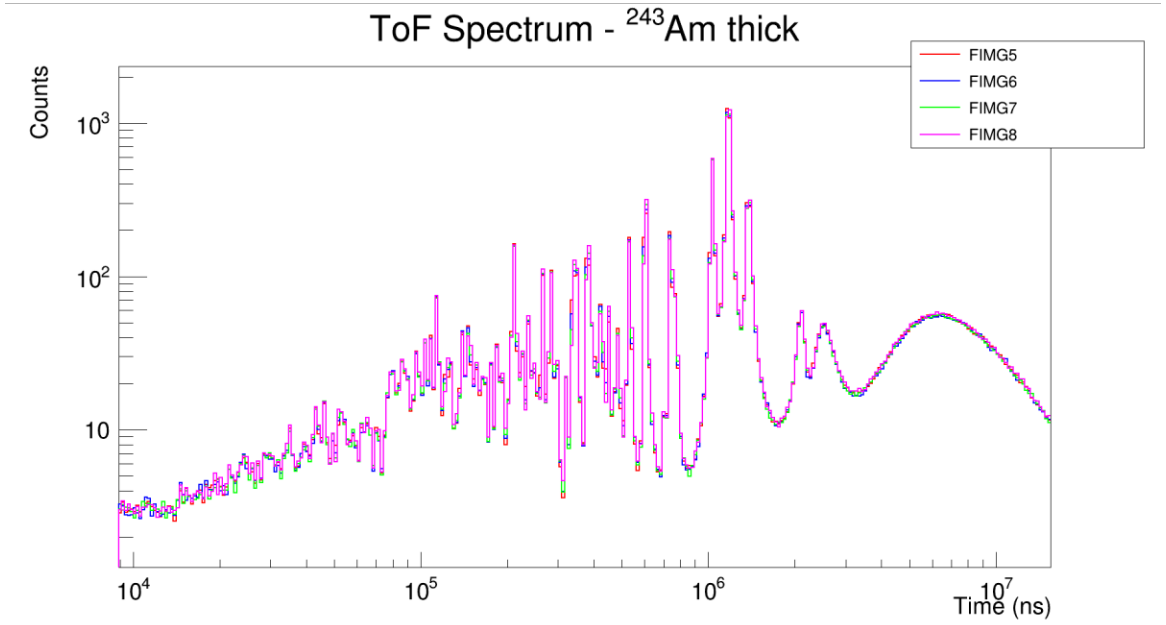


~400 MeV

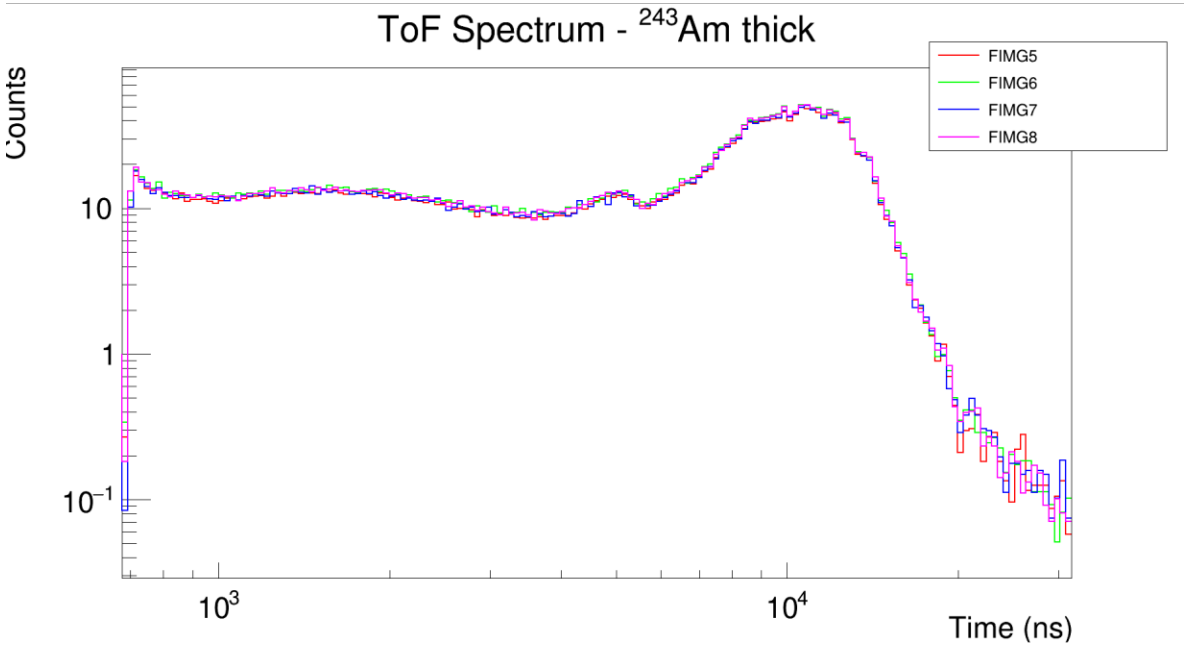
- EAR2: **Very good agreement** in thermal and resonance region
- EAR1: Good agreement until about **400 MeV.**

TOF distribution: Comparison between detectors:

EAR2

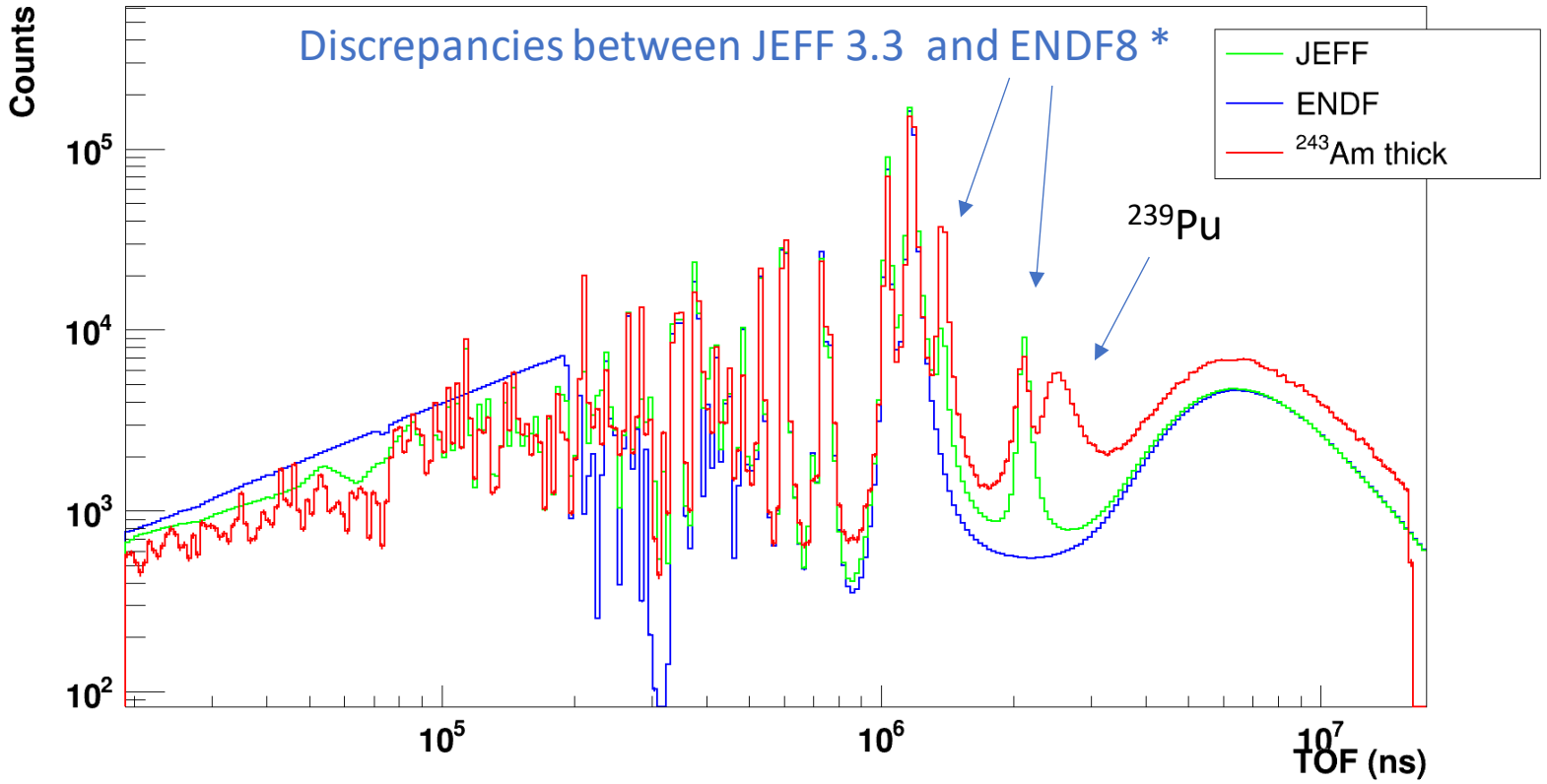


EAR1



- Good agreement between all detectors in both EAR1 and EAR2

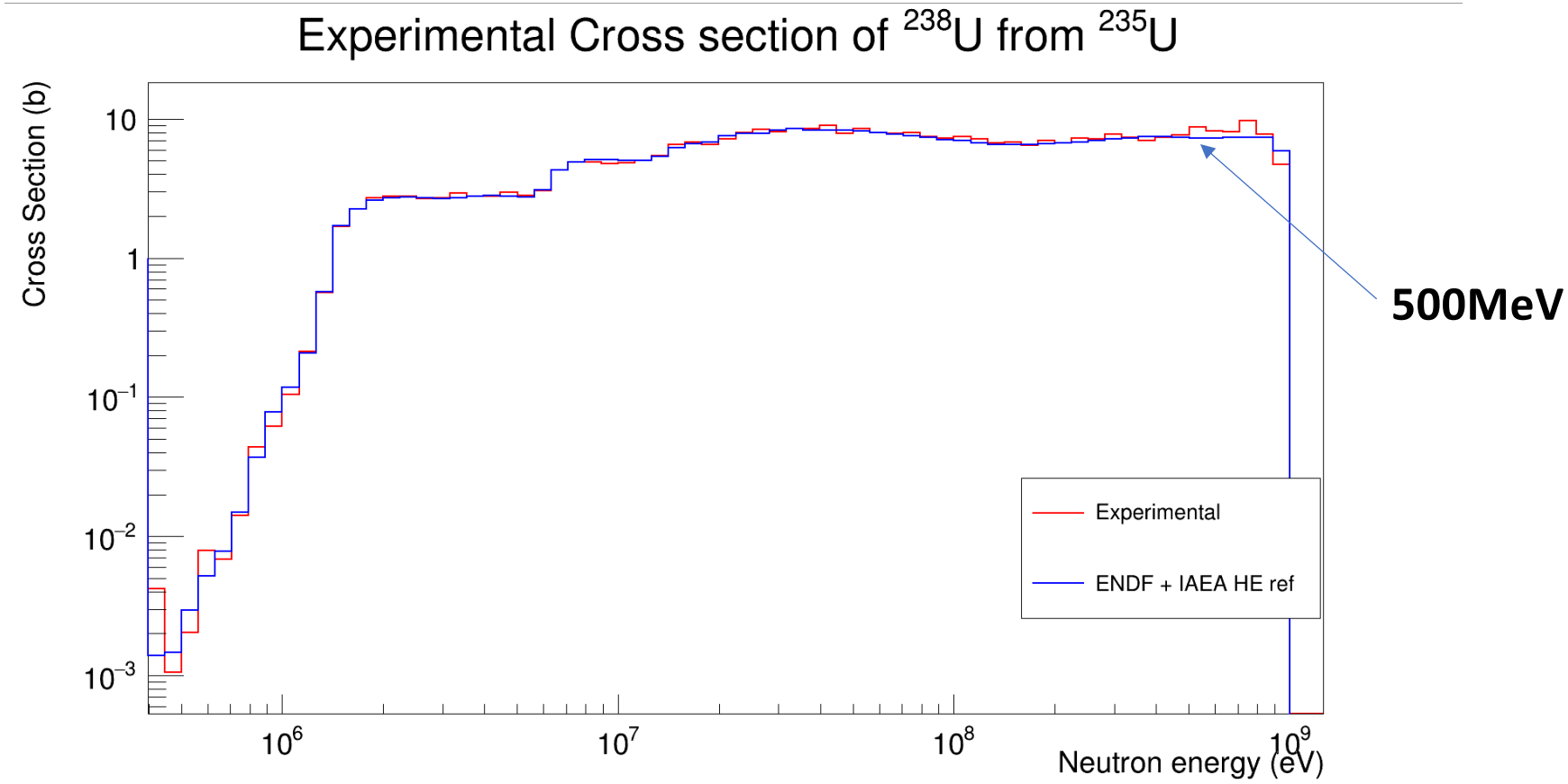
Comparison between experimental data and Transport code: EAR2



- Comparison between experimental counts and expected counts using the transport code for thick ^{243}Am targets

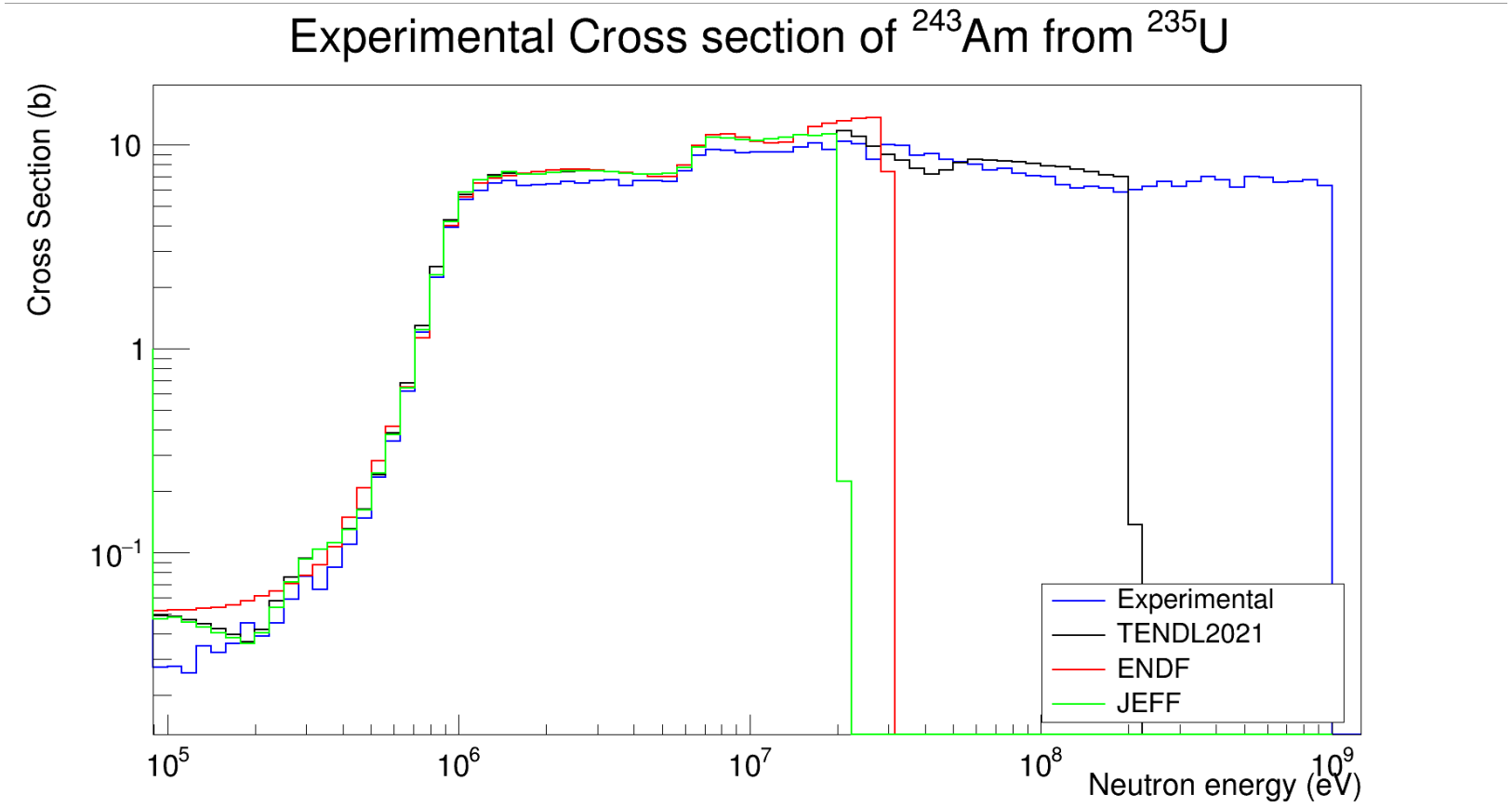
* We seem to **confirm JEFF 3.3,** to be verified once the material characterisation is complete

Preliminary cross-section EAR1: ^{235}U



- ^{238}U cross section using ^{235}U as reference
- **Only Parasitic Pulses**. Full Statistics 10.455e+17 protons
- Only amplitude cut correction applied
- **Excellent agreement until 500 MeV.** Slight differences until 1 GeV

Preliminary cross-section EAR1: ^{243}Am



- ^{243}Am cross section using ^{235}U as reference
- **Only Parasitic Pulses**. Full Statistics 10.455e+17 protons
- Only amplitude cut correction applied
- Slight underestimation compared to the libraries. Cross section smooth till 1 GeV

Conclusions and next steps

- First results are very encouraging
  - Manageable levels of contaminants contribution
  - EAR2: Good statistic at thermal and resonance region
  - EAR1: ^{238}U cross section estimated until 500 MeV – 1 GeV
- Next Steps
  - Finalize PSA parameters
  - Target characterisation at NPL
  - Calculate correction factors
  - Simulations
  - Comparison of the results from EAR1 and EAR2
  - ...

Thank you for your attention

Special Thanks to

All of the local team at nTOF
The JRC target preparation lab
Oliver, Oscar, Jean-Francois, Laurent, Alice

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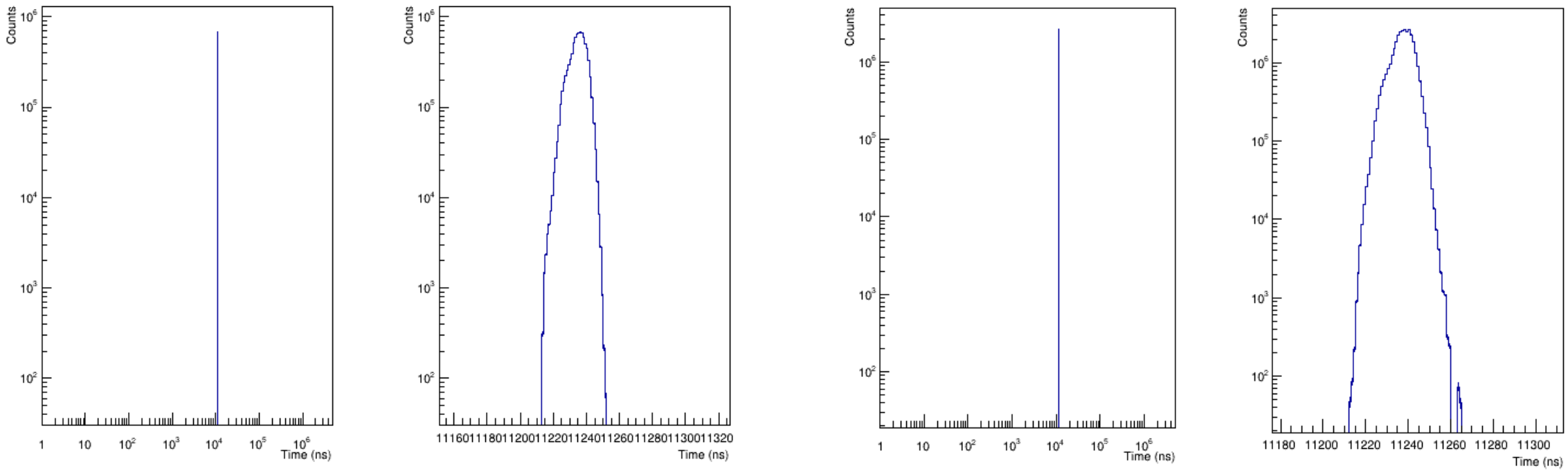
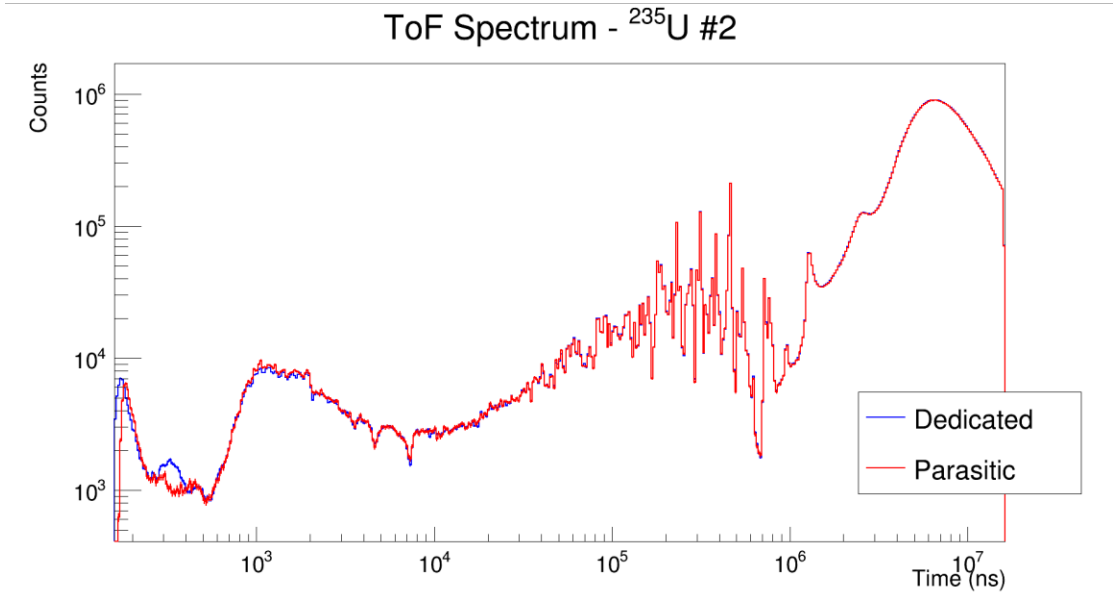
Tflash distributions

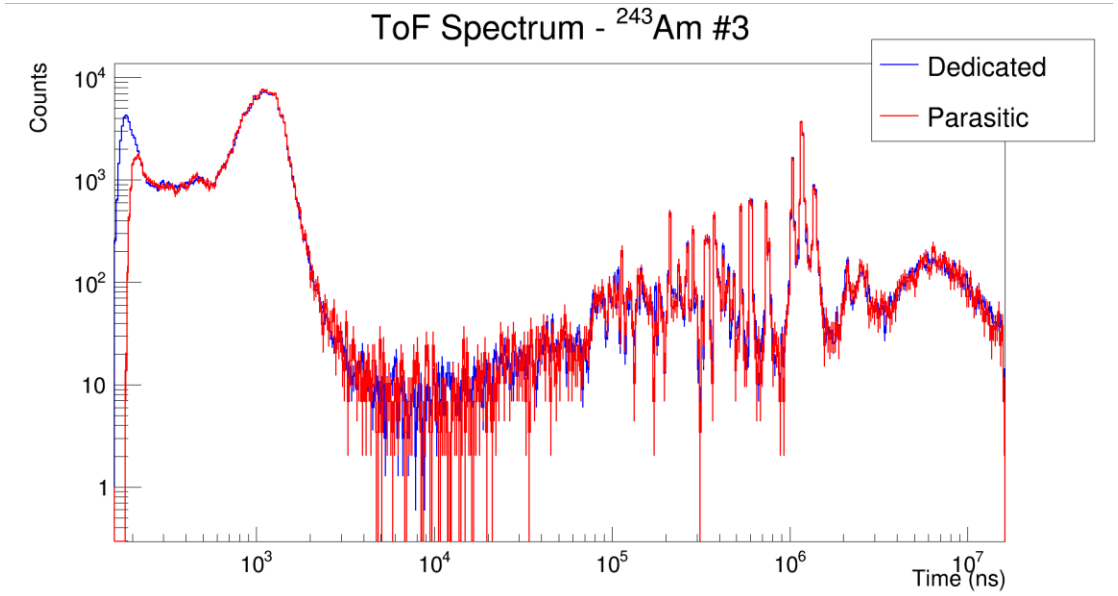
EAR2 **EAR1**



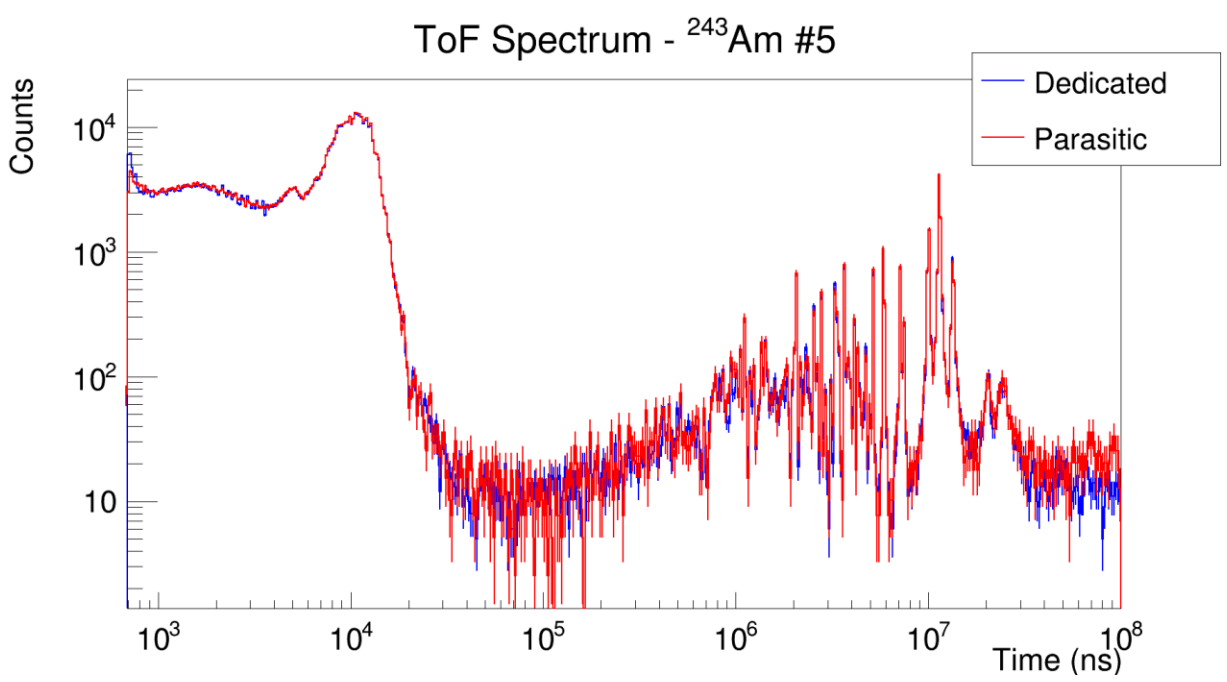
- γ-flash properly recognized in the central distribution for both EARs in both Dedicated and Parasitic Pulses
- Similar results on all detectors

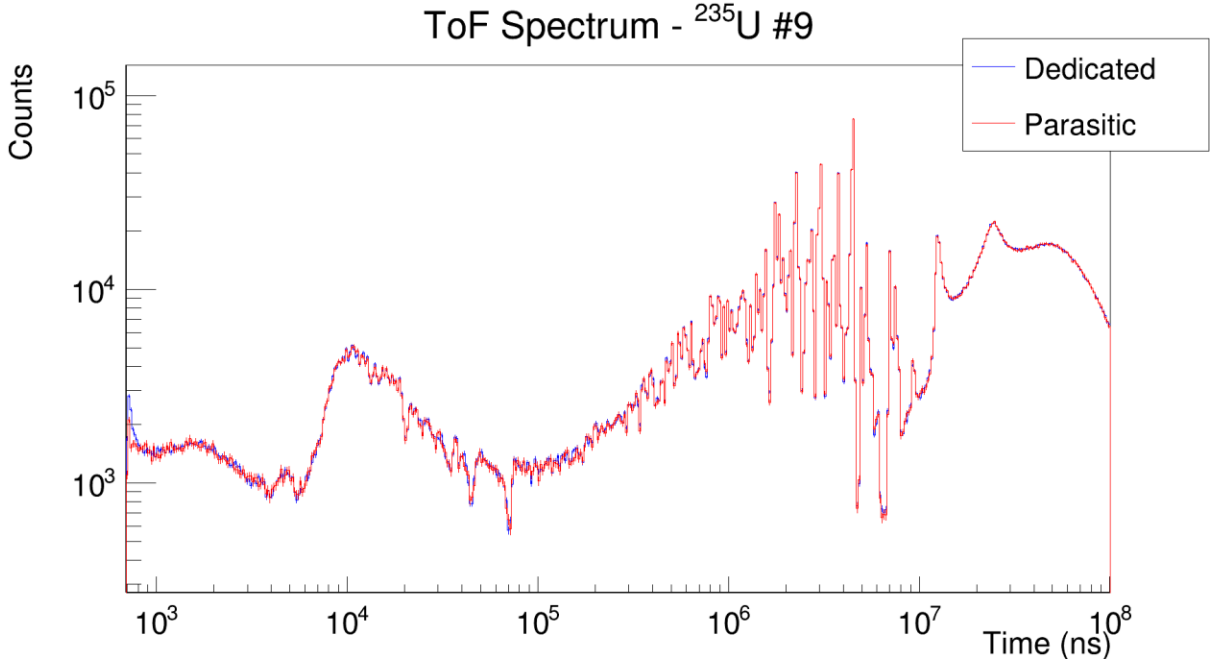
TOF distribution: Dedicated vs Parasitic Pulses EAR2



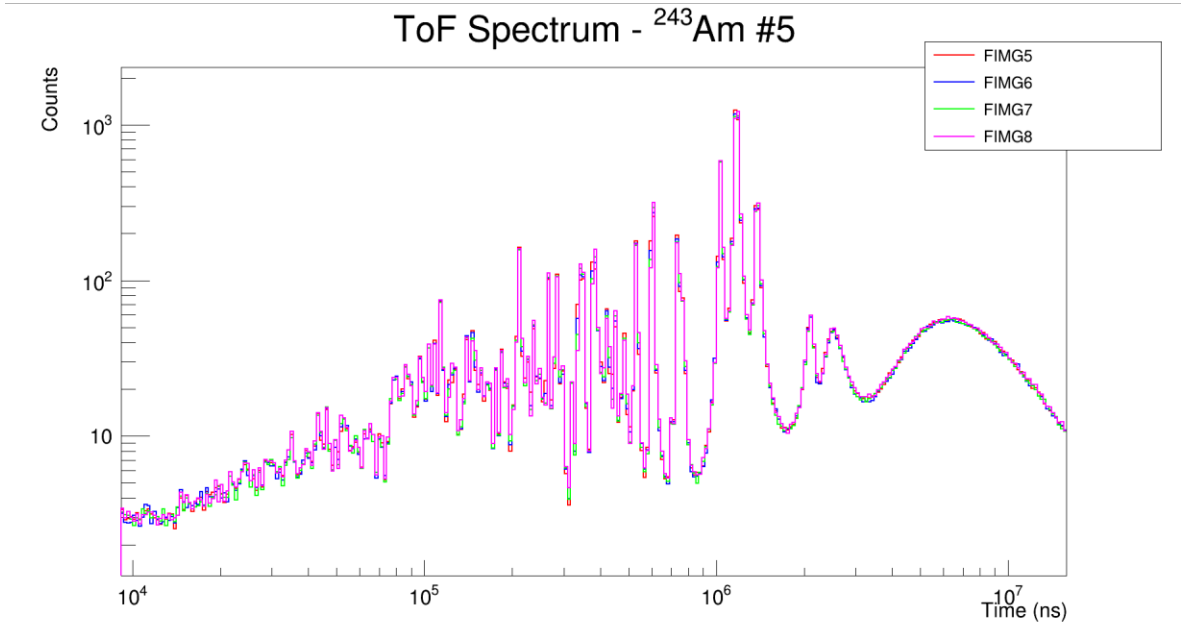


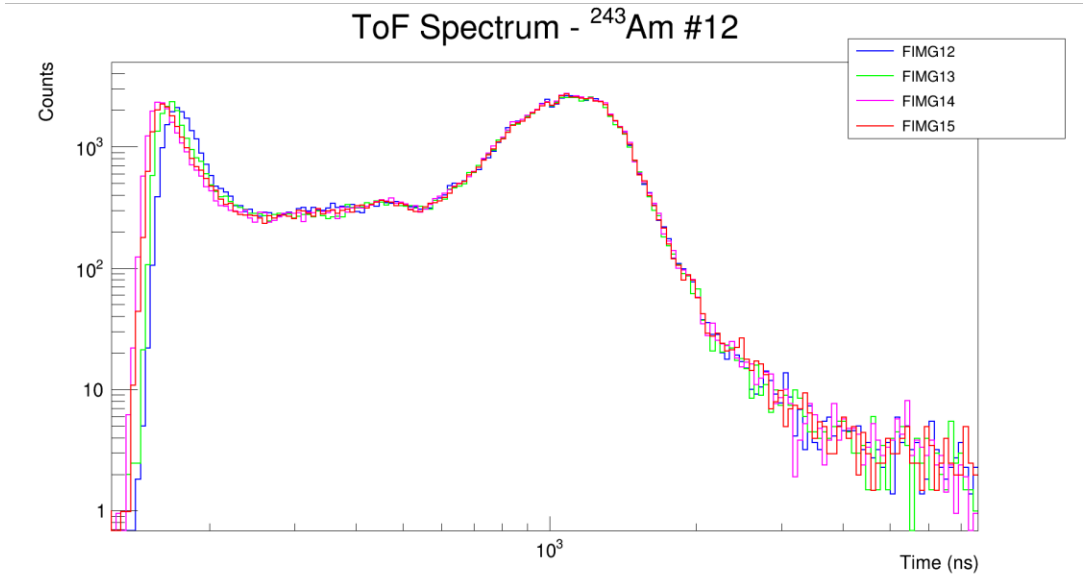
TOF distribution: Dedicated vs Parasitic Pulses EAR1



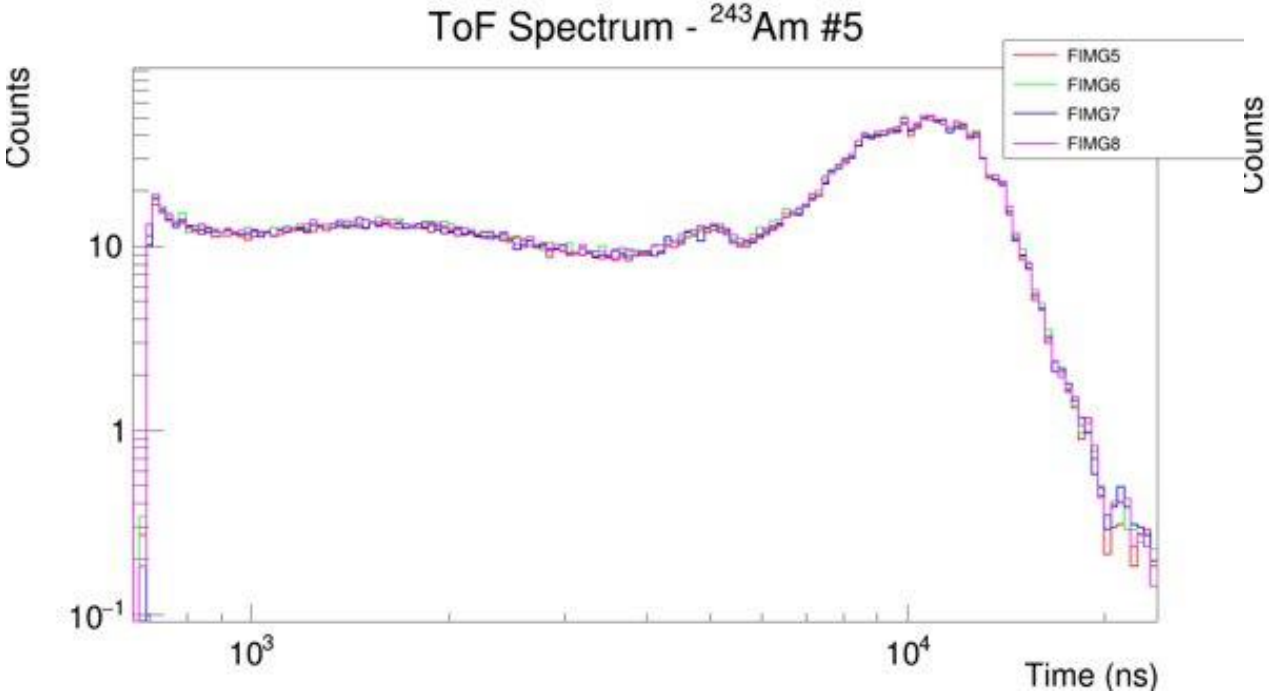


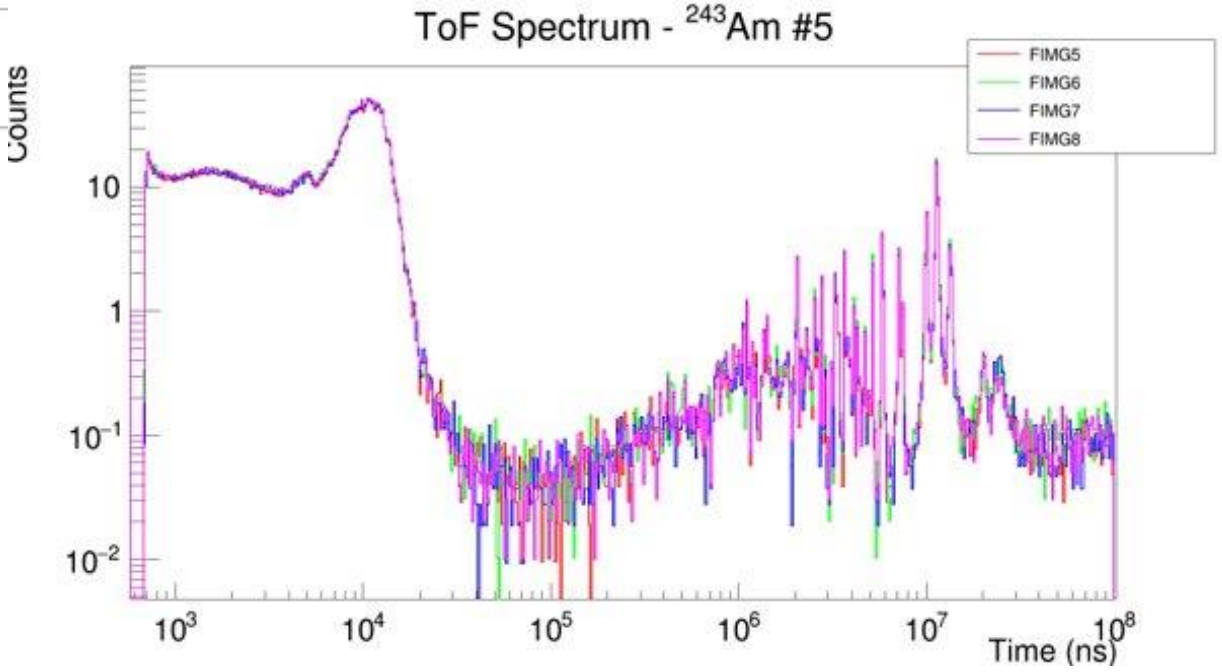
TOF distribution: Comparison between detectors: EAR2



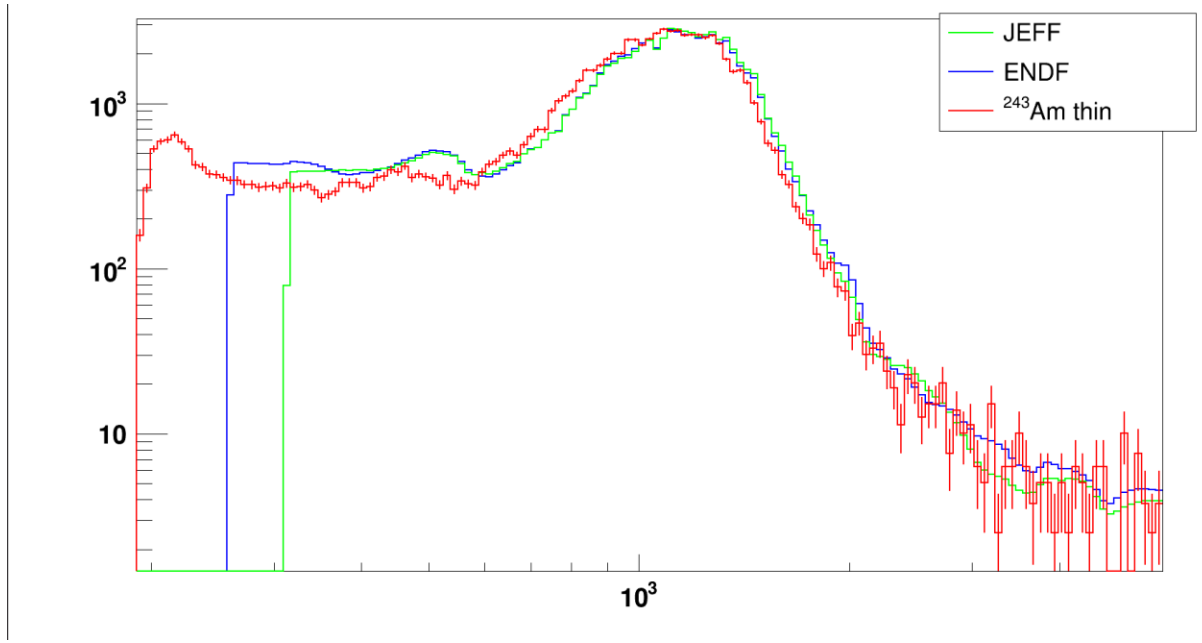


TOF distribution: Comparison between detectors: EAR1





Comparison between experimental data and Transport code: EAR2



- Deviations in Tof between experimental data and Transport code in the high energies