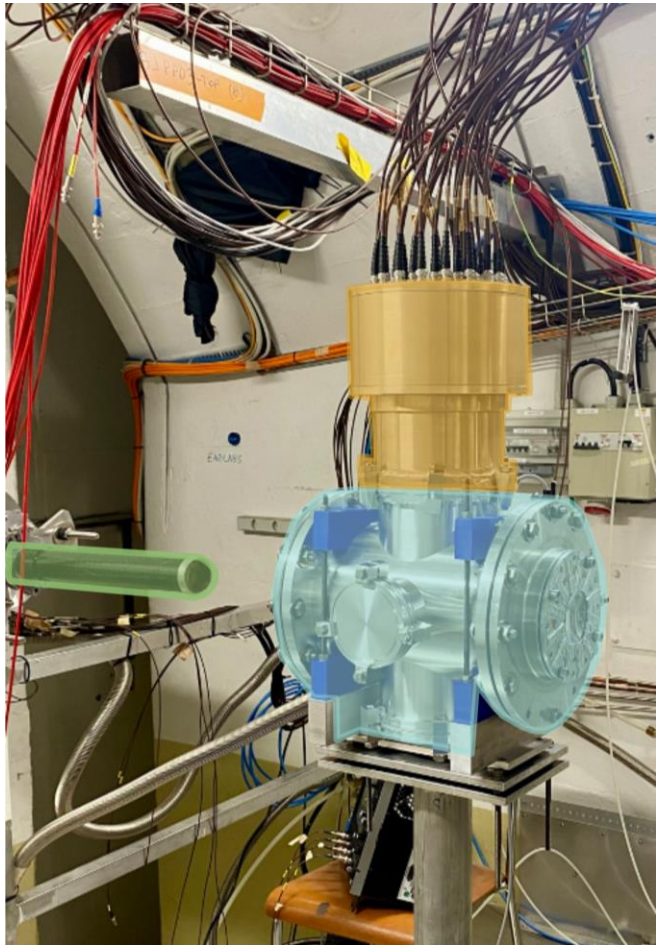
Analisi dati $^{12}C(n,cp)$ con silicio anulare

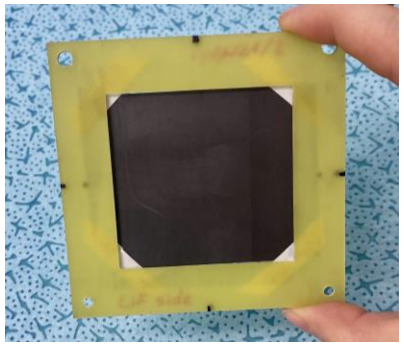
Validate the technique by measuring the 12C(n, cp) cross sections

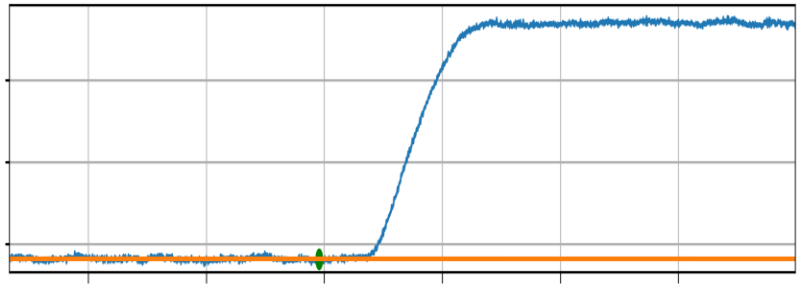


Sept 2023

Target Specifications :

1. **PE** & **Li-6** deposited on **Mylar**
2. **Rigid Graphite**
3. **Empty** (yellow frame)



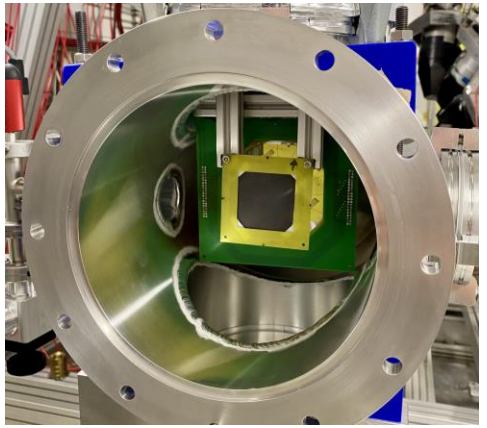


Optimized hardware:

- Great signal / noise achieved
- Complete shielding from EMC

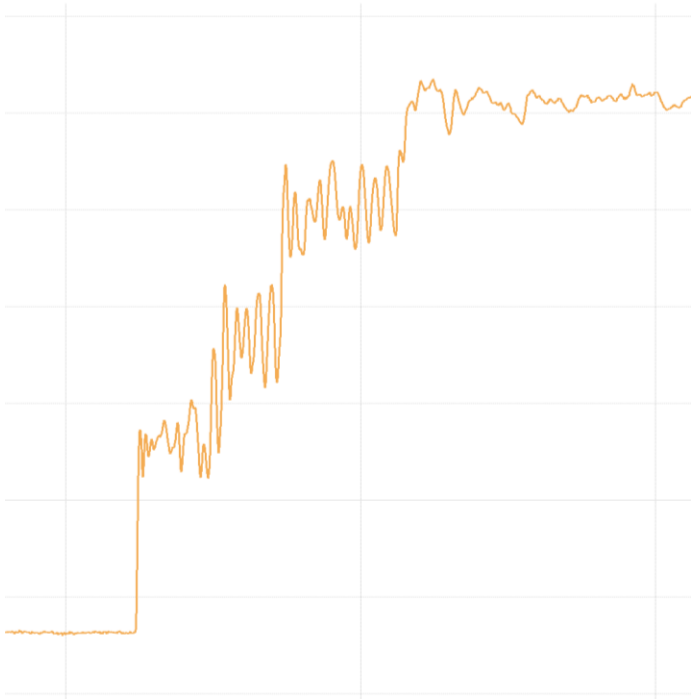
Adopted Configuration for Pulse Shape:

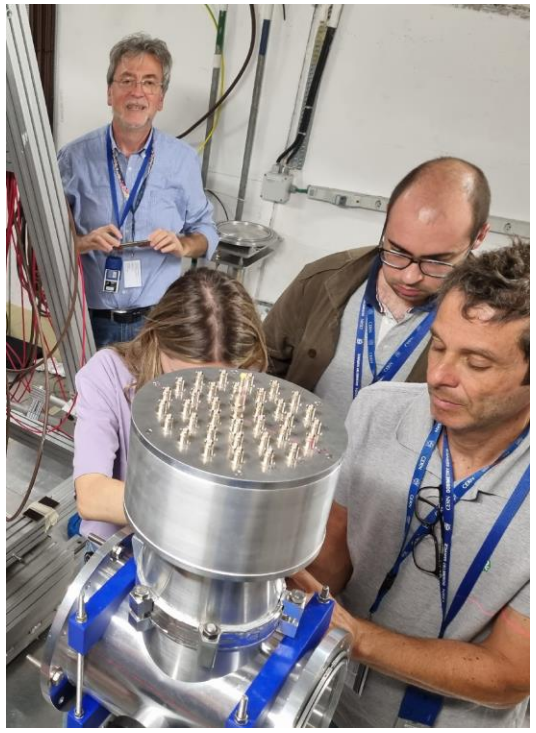
- **Reversed-Injection**
- **Full-Depletion Voltage (FDV) to maximize the performance**

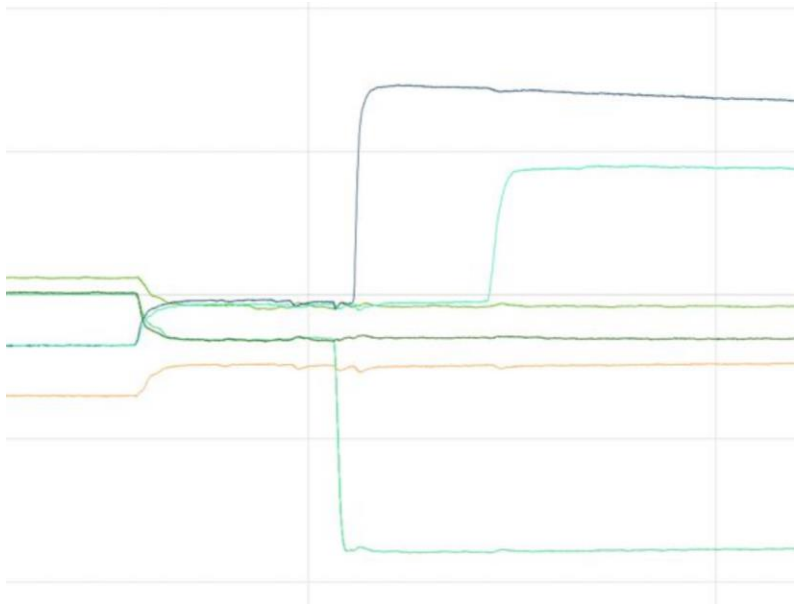


EMC Investigation

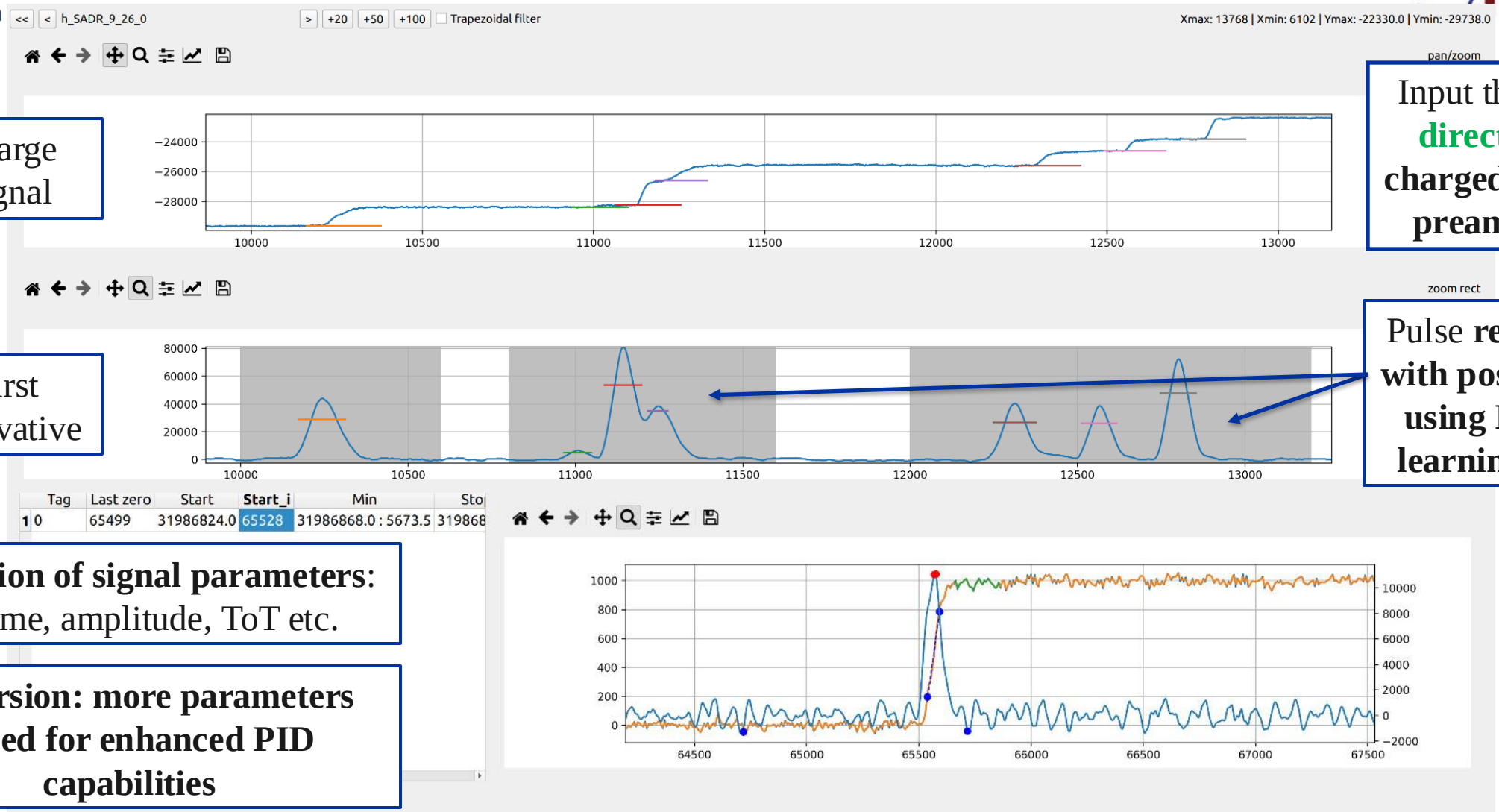
The silicon project required a detailed investigation of a beam-induced electromagnetic disturbance in EAR1. The issue was solved thanks to the support of LNS personnel, introducing new methodologies to project and test detectors.







Digital PSA Software



Charge Signal

First Derivative

Input the signals **directly** from **charged-sensitive preamplifiers**

Pulse **recognition with possibility of using Machine learning (CNN)**

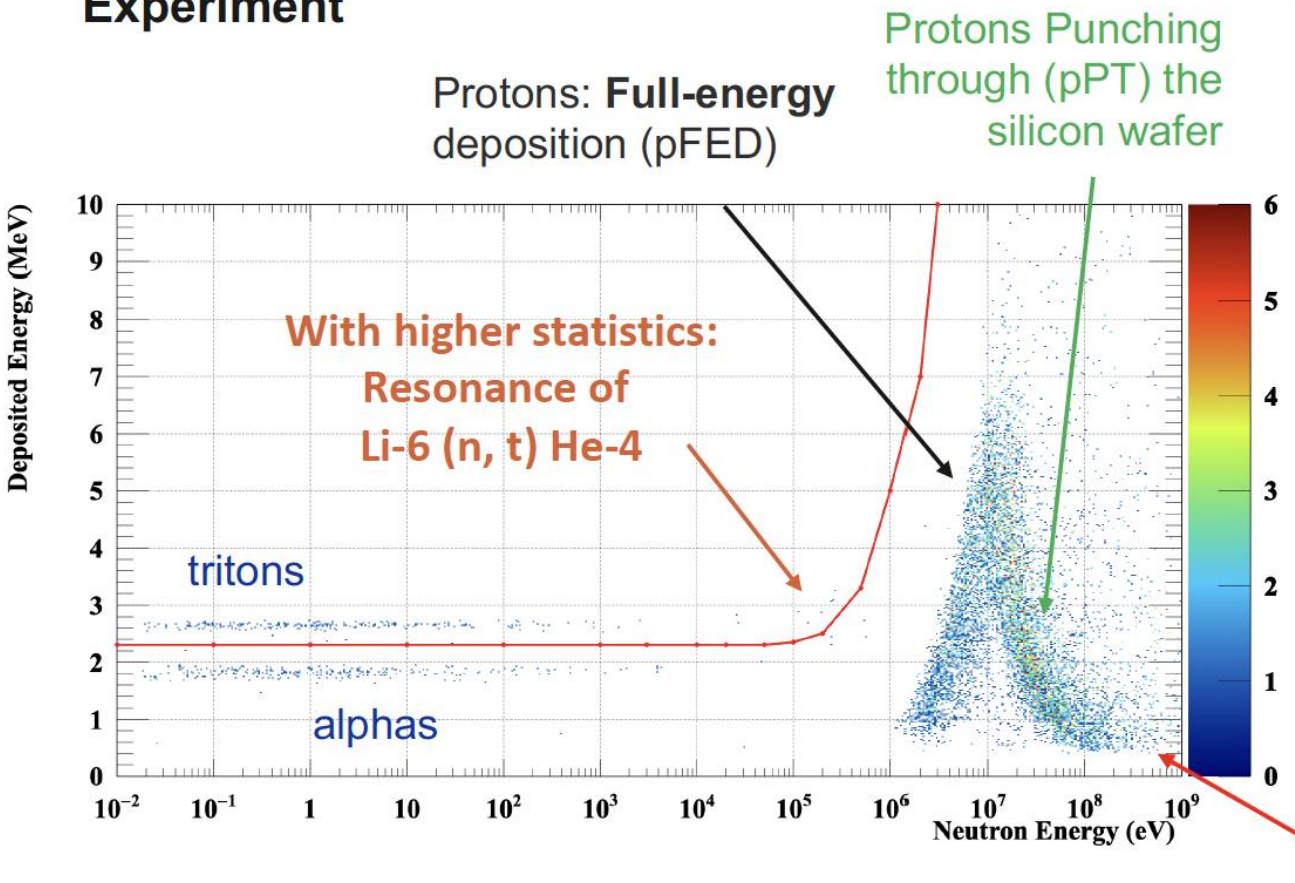
Extraction of signal parameters: rise time, amplitude, ToT etc.

2nd Version: more parameters added for enhanced PID capabilities

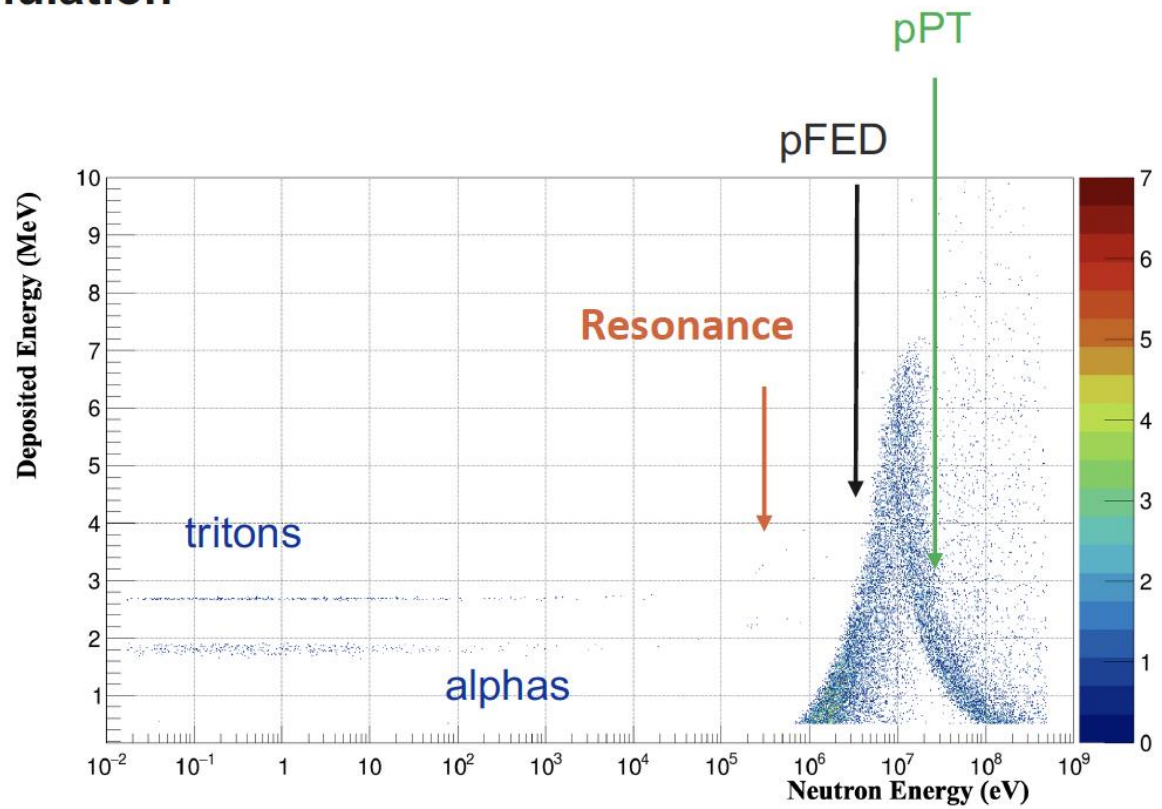
For more details: **G. Vecchio et al. DOI: 10.1088/1748-0221/17/09/P09040**

LiF & PE: Measurement VS G4 simulations

Experiment



Simulation

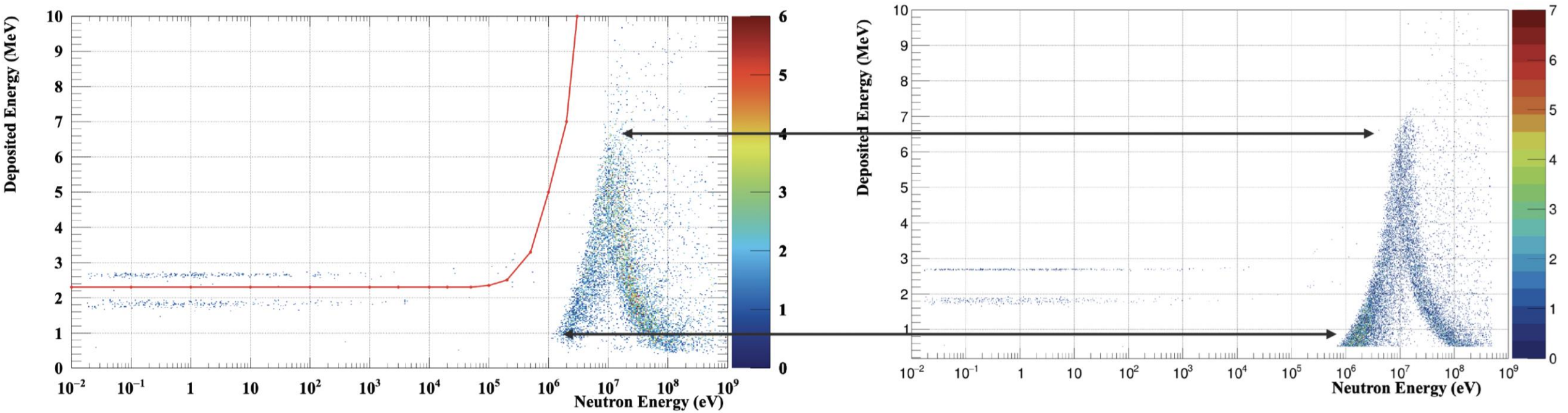


Maximum neutron energy hundreds of MeV

LiF & PE: Measurement VS G4 simulations

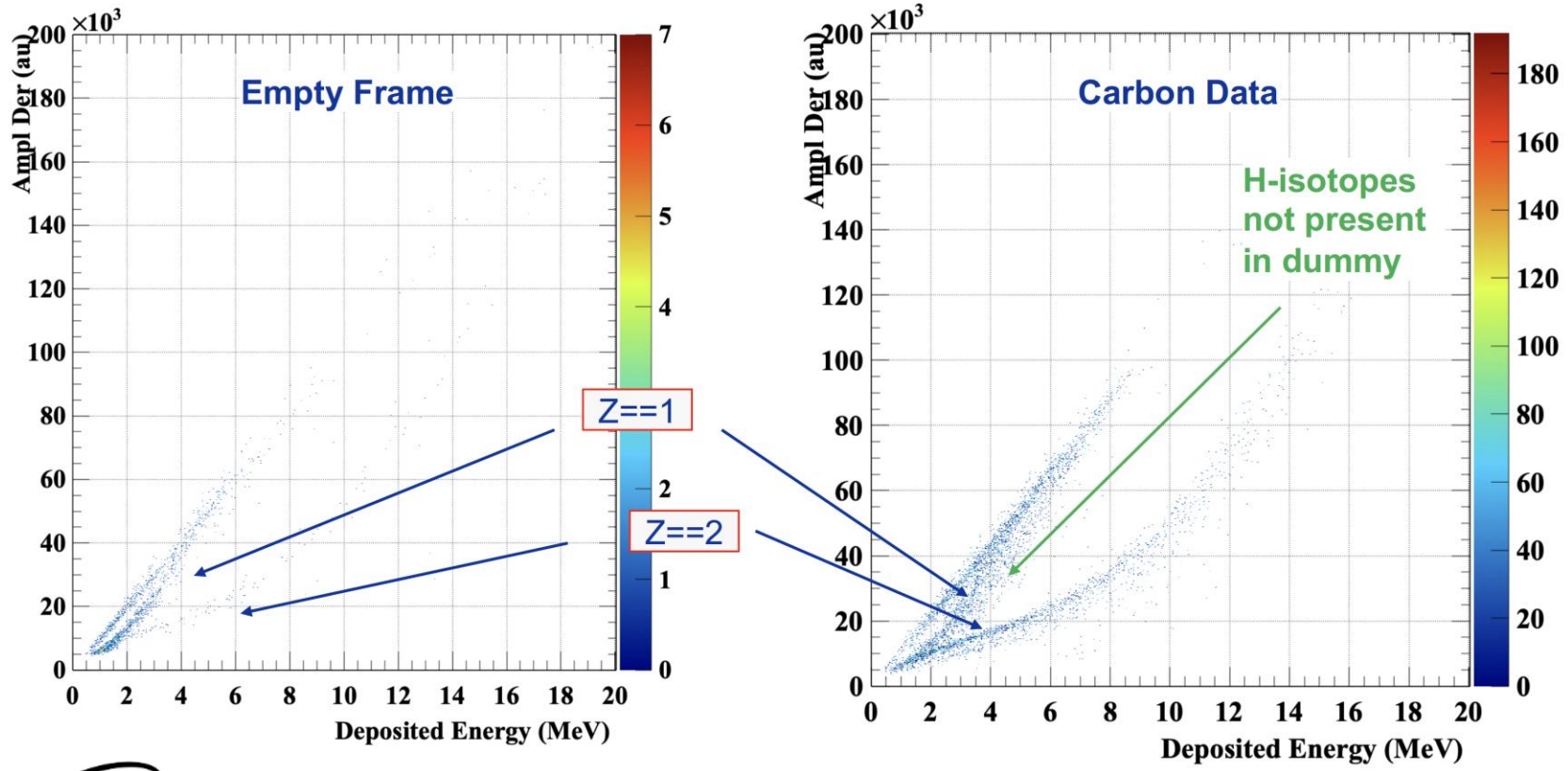
Experiment **Simulation**

Good agreement between the experimental and simulated spectra **even with a preliminary tof-to-energy**



2D matrix for Particle Identification

First matrix for Particle Identification exploiting the amplitude of the signal derivative (current pulse), **good separation between different Z**, discriminate the H isotopes (same Z different A) is more challenging.



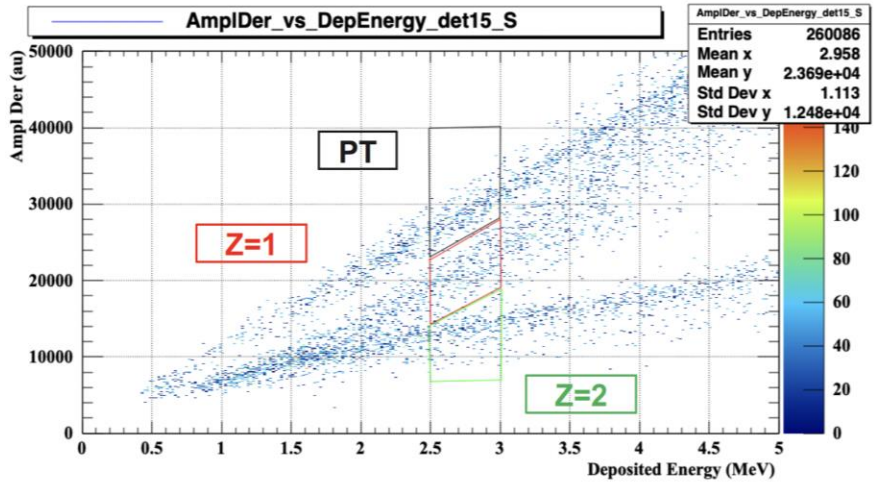
PID limits (up to now)

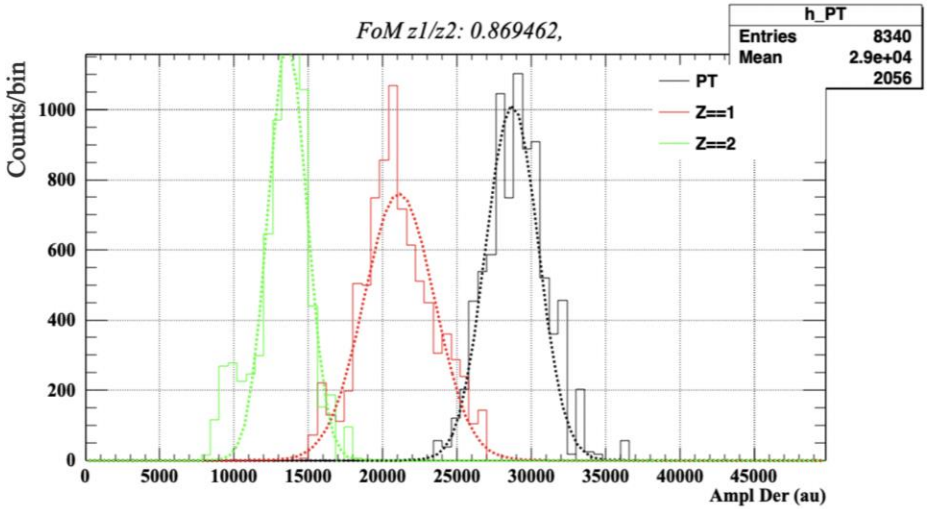
Focus on **Carbon** data:

- E_n < 20 MeV
- Deposited Energy window for projection 2.5 - 3 MeV

Factor of merit

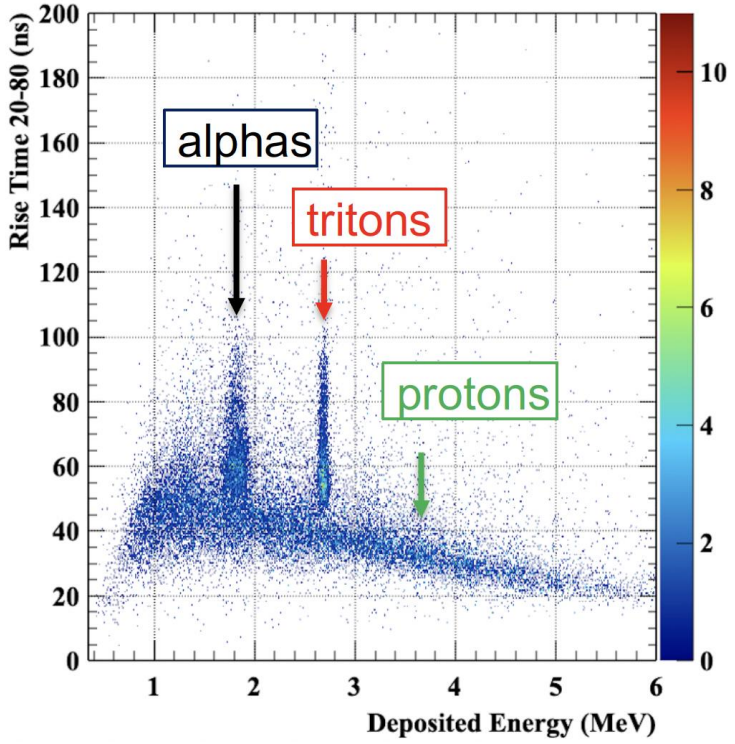
- FOM(Z=1/Z=2) = **0.87** (excellent separation!)
- H-isotopes not separated yet, need a more detailed analysis

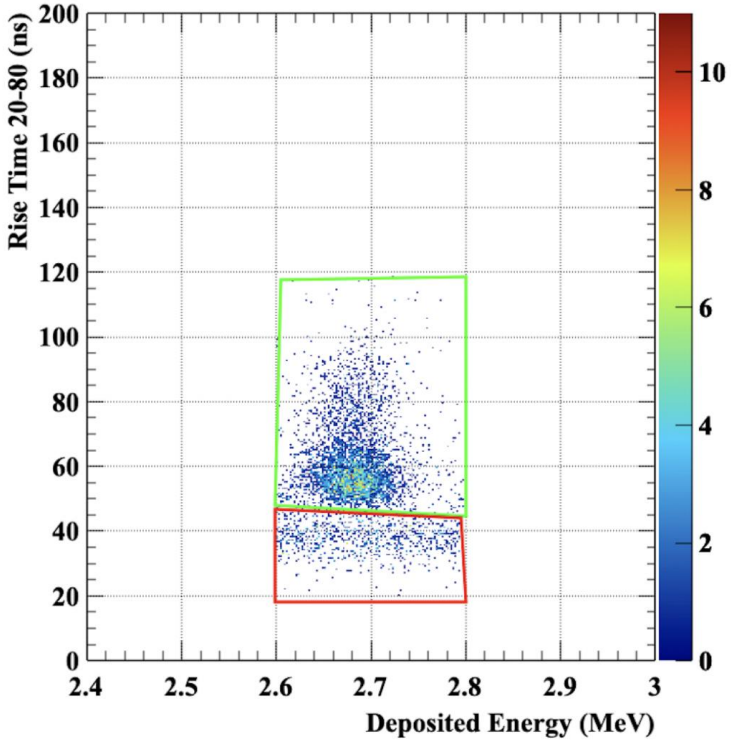


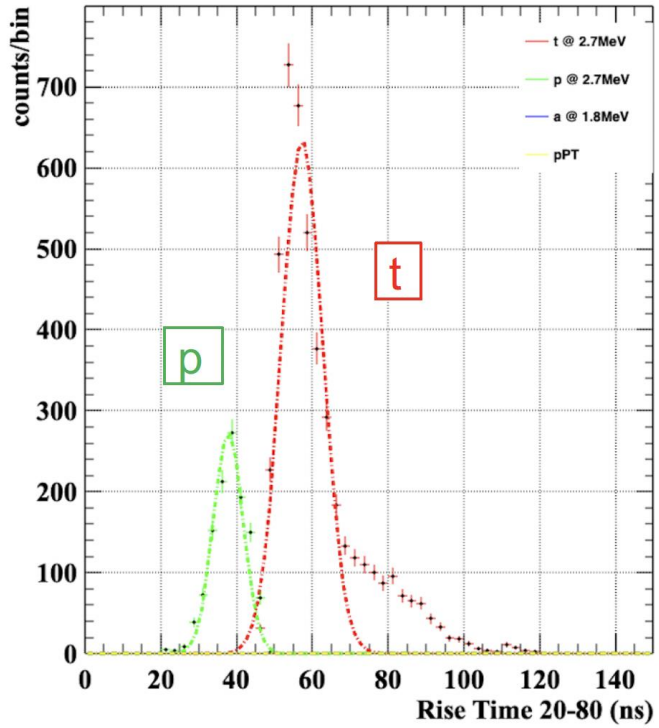


PID p/t with LiF and Polyethylene

Using only 1 parameter (rise time is not the most effective variable to consider) a **good separation between protons and tritons** is obtained (FOM = 0.88) at 2.7 MeV. A **multi-parameter analysis** will follow.





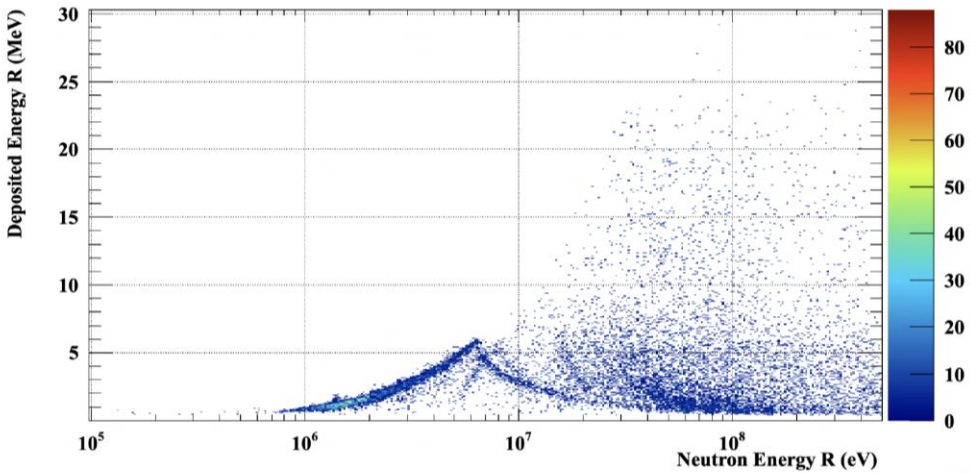


Dummy vs Carbon

Relevant proton (identified by PID matrix) background in the Dummy coming from the beamline and chamber windows.

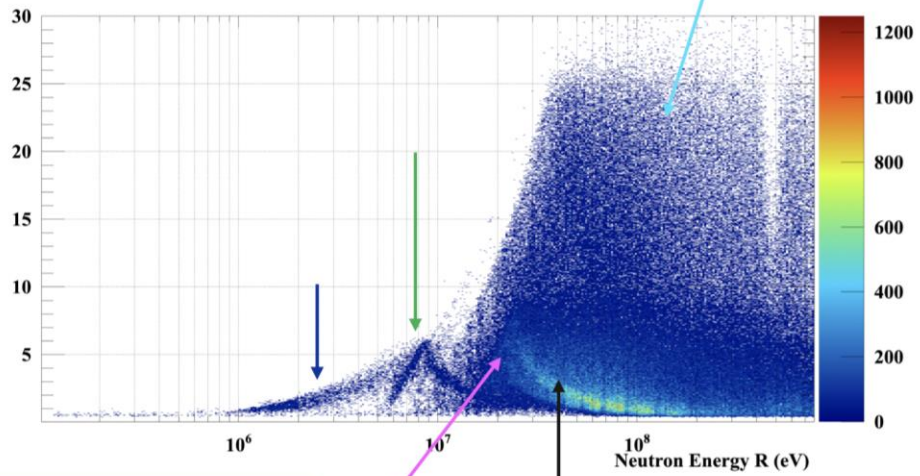
Dummy

- 1.27E+17 PoT



Thin C-12:

- 8.1E+17 PoT



Alphas and higher in Z particles

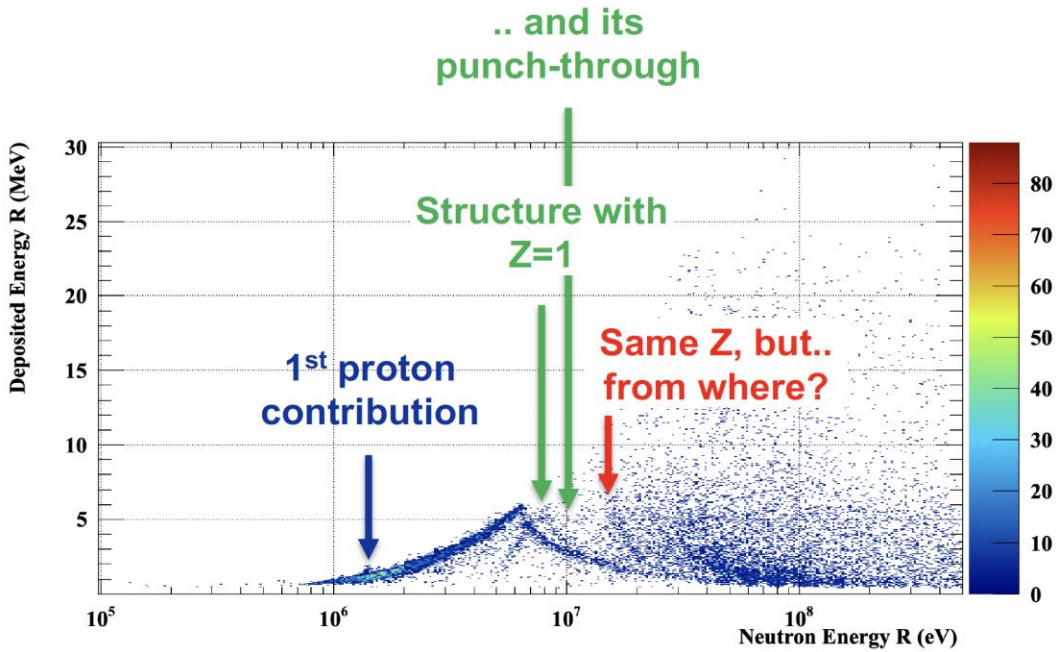
PT of C-12(n, p); Opening @ ~ 14 MeV

PT of C-12(n, d); Opening @ ~ 16 MeV

Dummy: Monte Carlo simulations

With simulations the origin of all the structures were identified and a good reproducibility of the experimental conditions was reached.

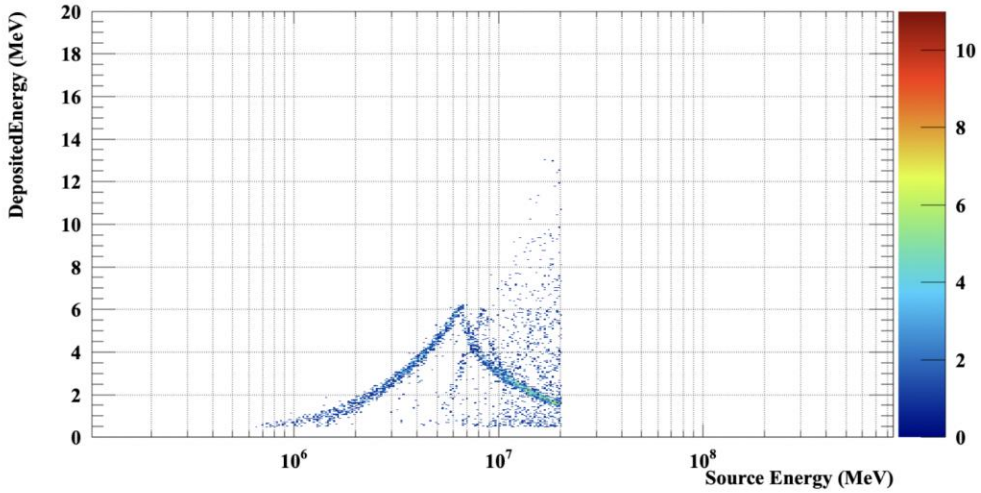
Measurement



Three well-defined structures, @ ~ 1, 4, 12 MeV

Simulation

Using a simplified version of the n_TOF beam, we conclude the following spectrum:



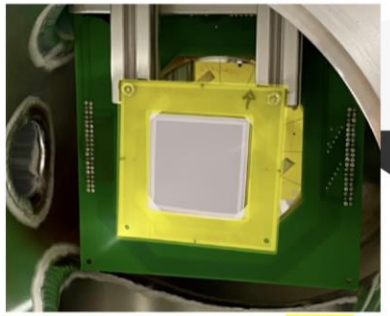
.. by selecting **only protons** and **colored** by their production volume

Dummy: Monte Carlo simulations

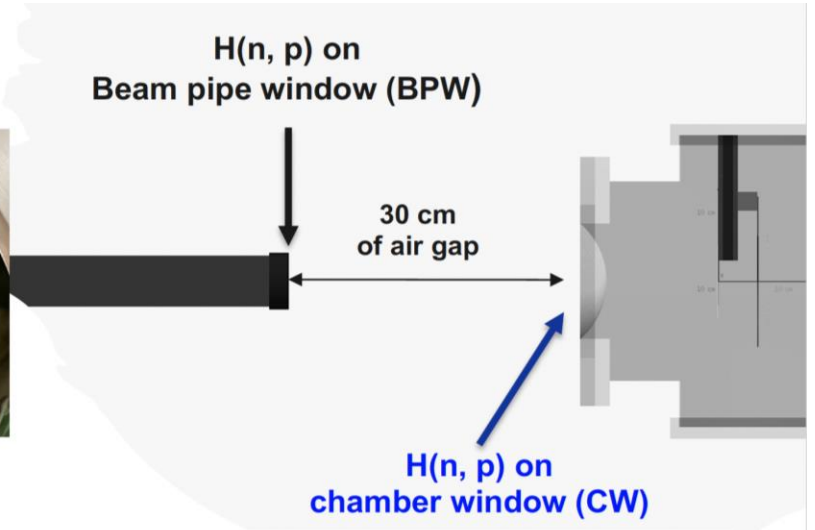
The three proton groups were analyzed with Geant4 Monte Carlo simulations:

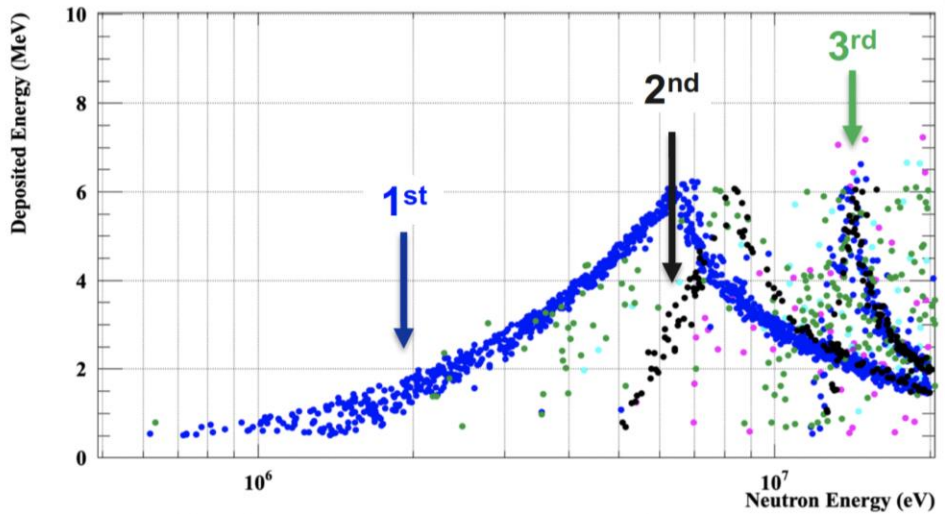
- **1st group**: Protons from the chamber window, pass through the sample holder hole, and reach the detector **with initial energy.**
- **2nd group:** Protons (~4 MeV) from the beam-line window, degraded by the air gap.
- **3rd group**: Protons (>10 MeV) crossing the sample holder from both windows.

Results?	Solutions?
High background **contribution** due to the kapton windows along the beamline	Possibly estimation of the background using G4, adding substantial **uncertainties** in physics results



Empty: Just the yellow **frame**, **not** the sample present





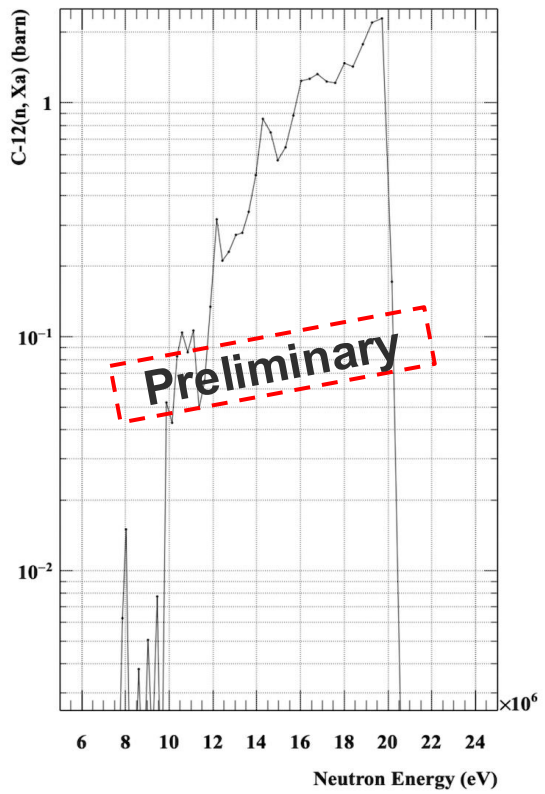
Annular: Integral 12C (n, a) cross-section

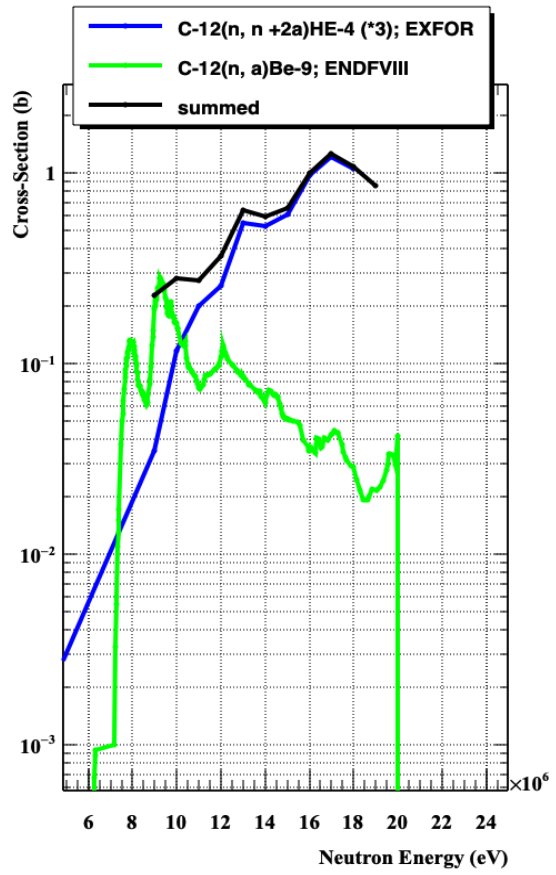
- **Preliminary results** show promising cross-section measurements
- **Agreement with datasets**
- Confirms **the validity of our approach** so far

We expect **improved accuracy** with the addendum data with a windowless configuration

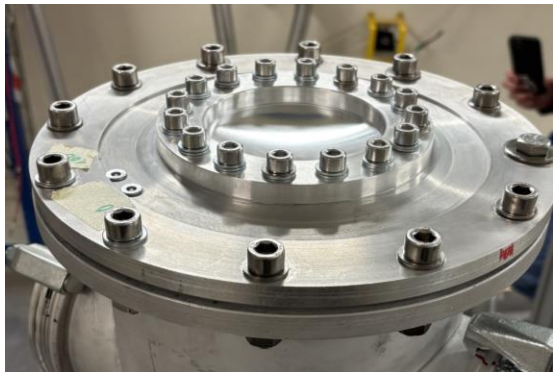
Data-bases

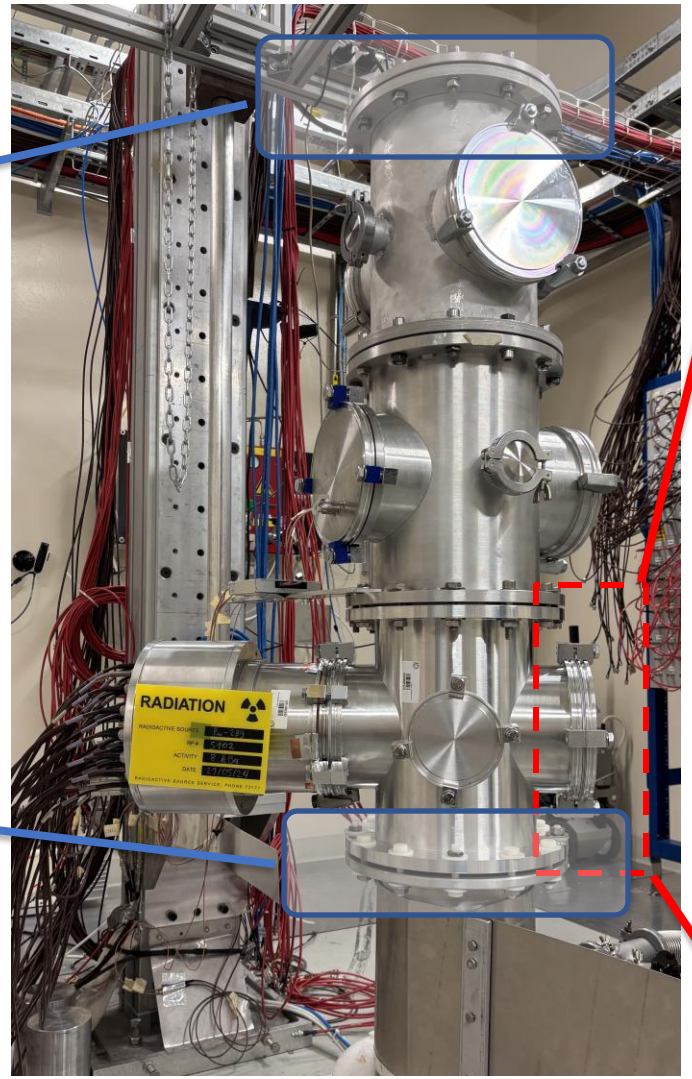
^{12}C (n, a)

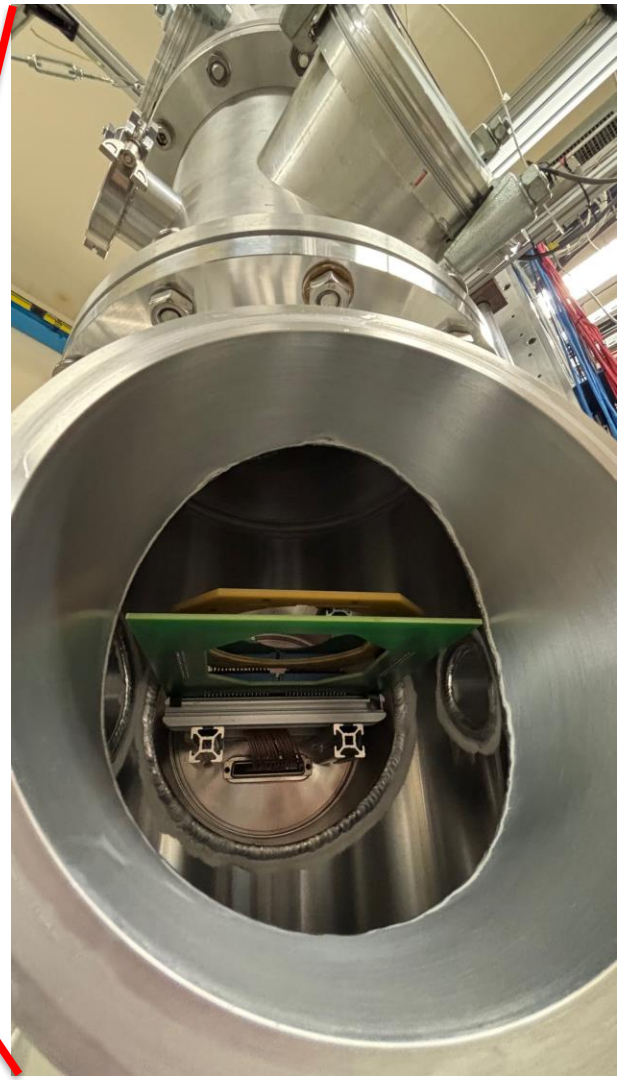




EAR2 measurement

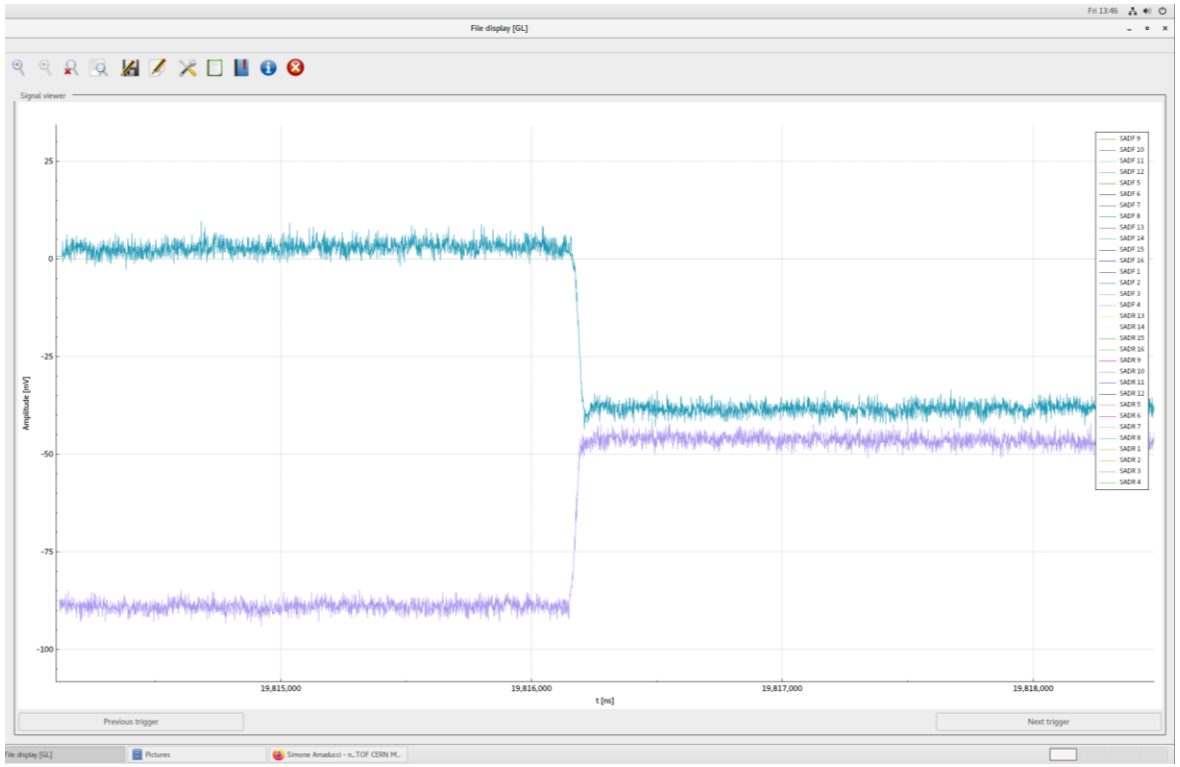


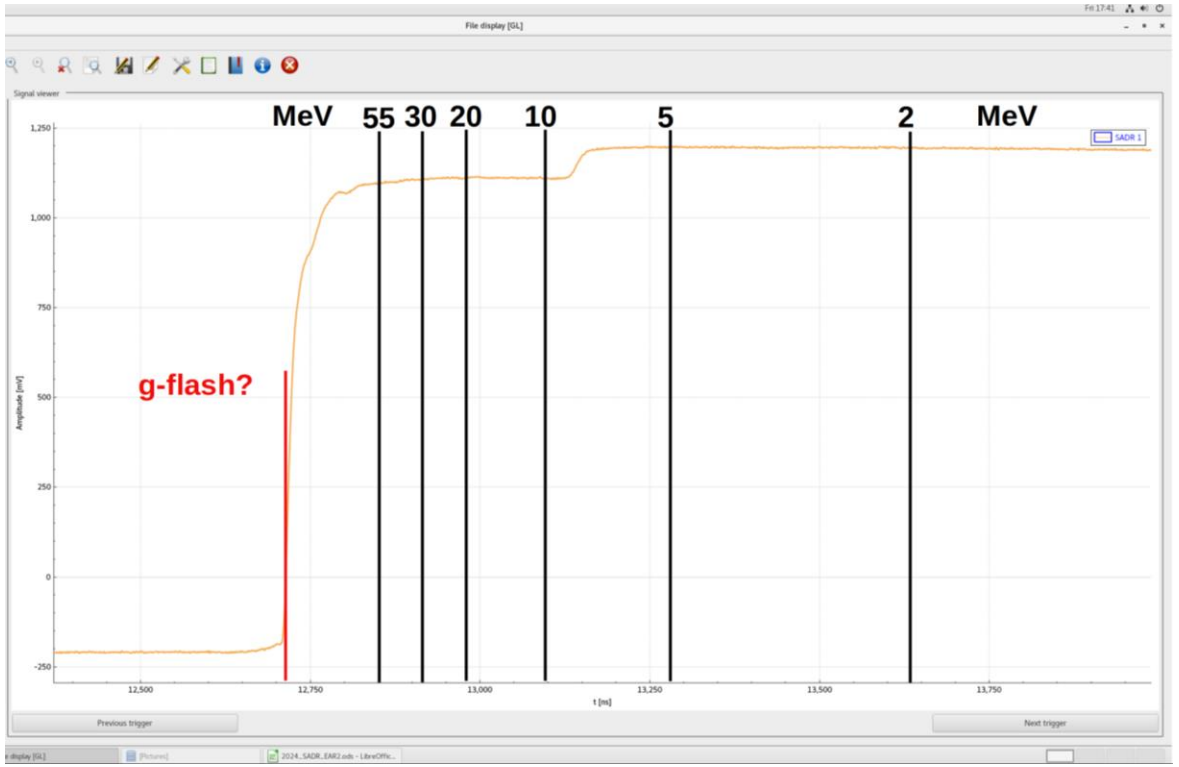




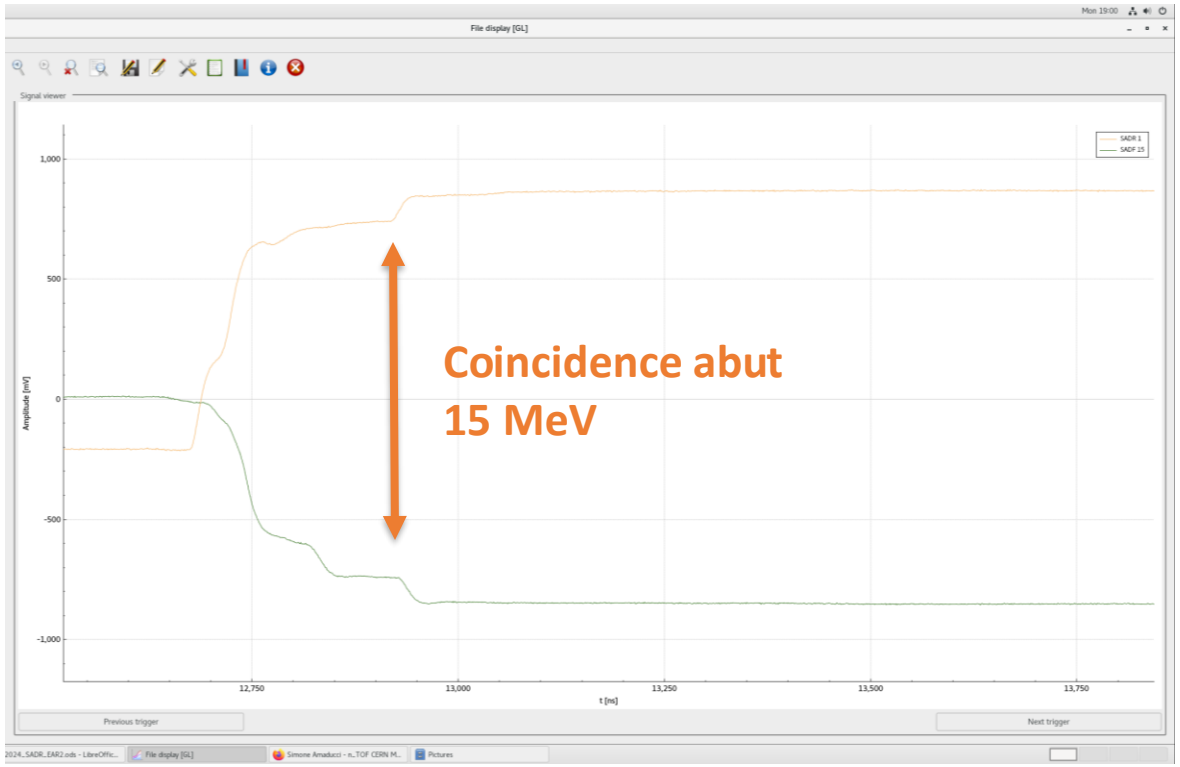
Isolation from the ground

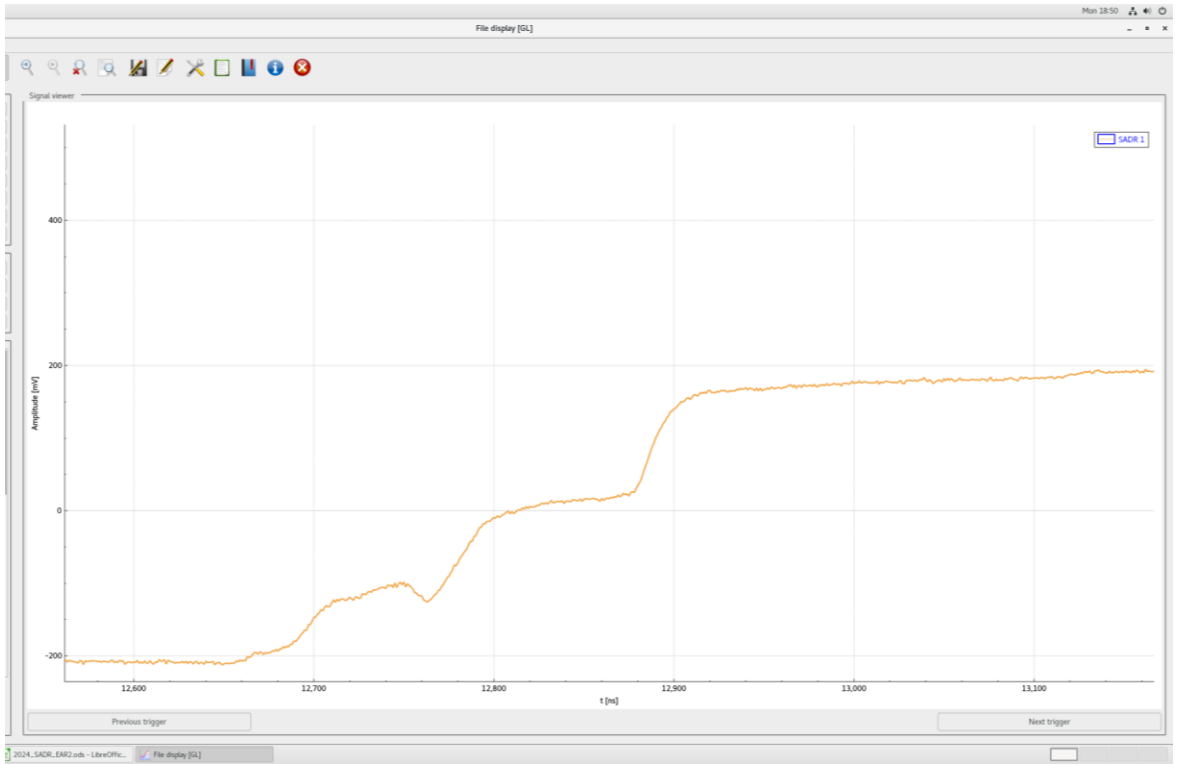
Event Display: LiF





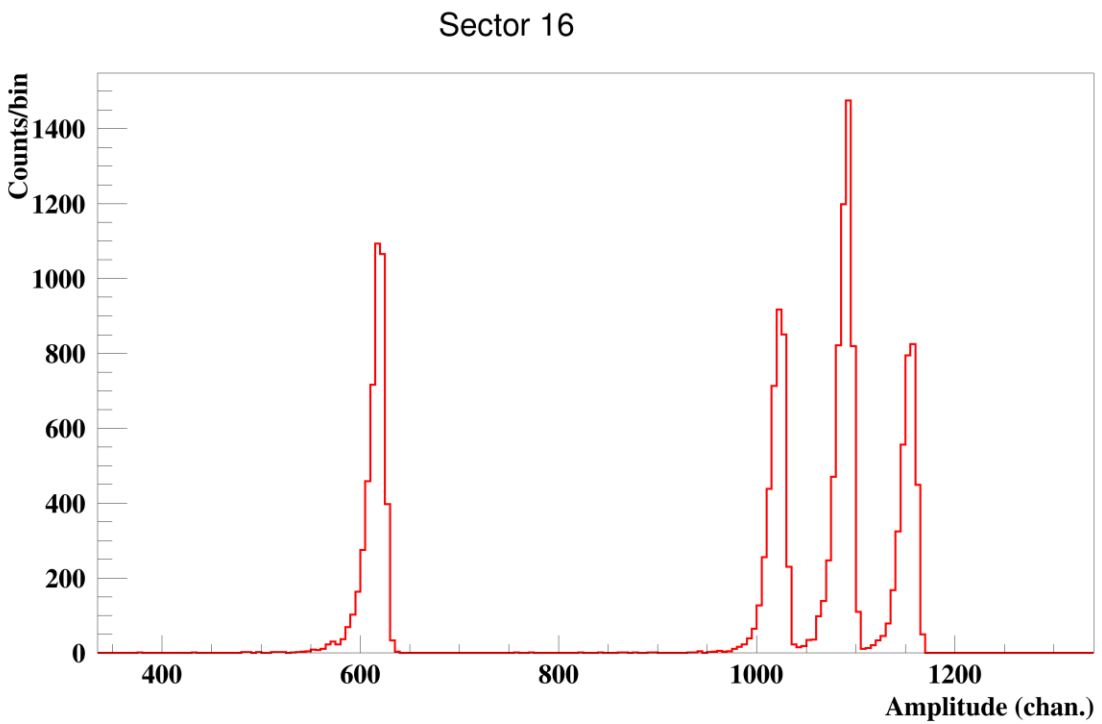
Event Display: Graphite

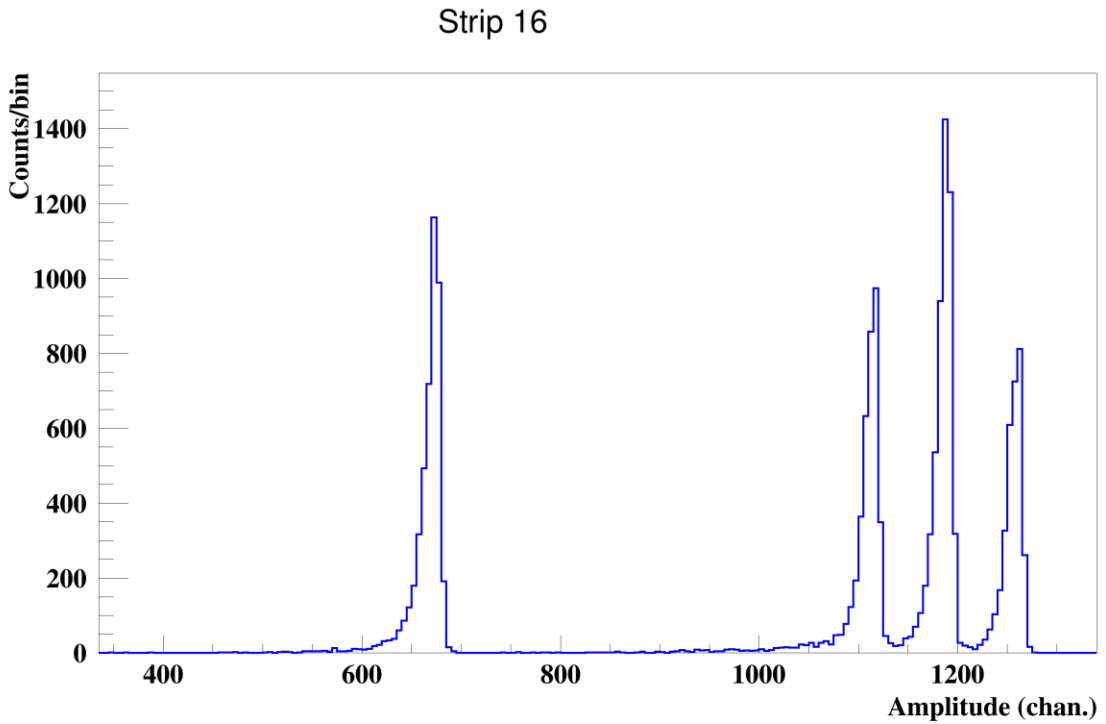




Alpha Calibration

Great response from Sectors and strips!





Conclusions

EAR1

- We are in a **good stage in the EAR1 analysis**
- **New version of the Pulse Shape** routine allow us to improve the Particle Identification
- Next year beamtime (addendum postponed to next INTC for clarifications) in **windowless configuration** will be crucial to reduce the uncertainties

EAR2

- **Measurement was successful**
- Good response to the g-flash, neutron energies in the order of **20 MeV** seems to be realistic
- Alpha data are very nice, more detailed analysis will follow