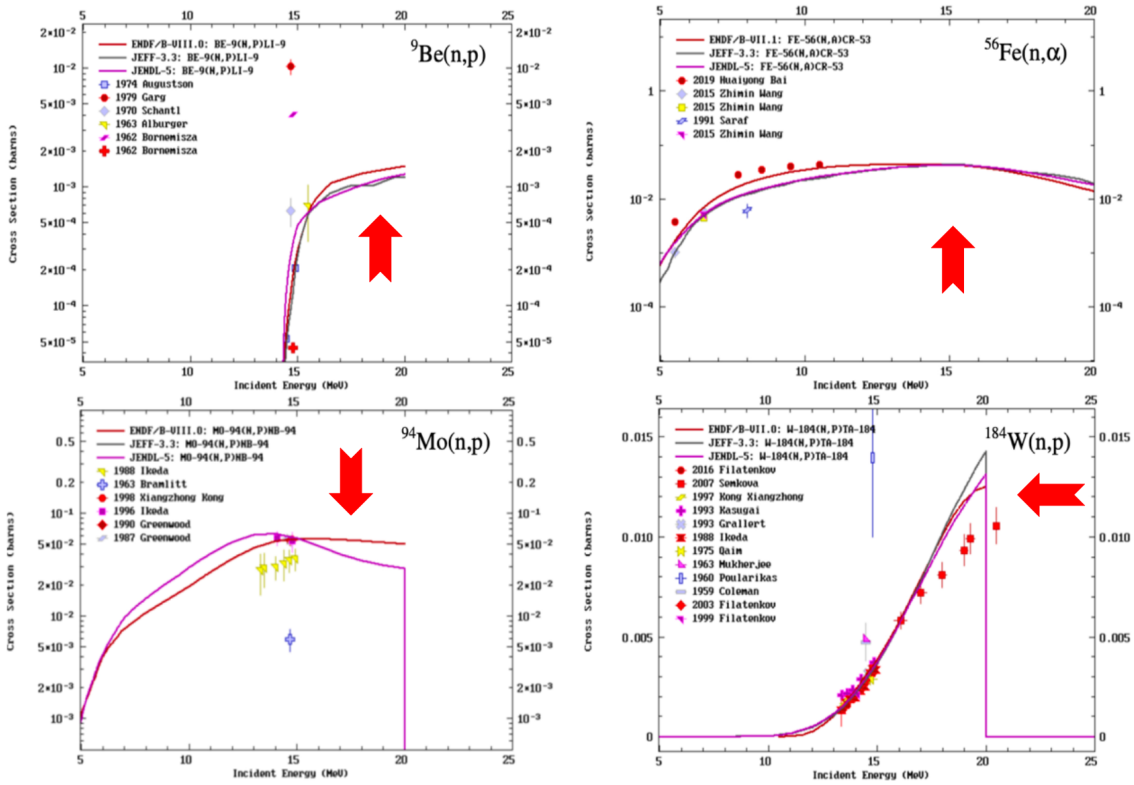
^{12}C(n,p) measurement with annular silicon detector

Motivation

Neutron induced reactions with production of l**ight charged particles** are of great interest for a wide range of fields.

- **Nuclear Reactors**: the production of H and He gas lead to the weakening of structural materials (embrittlement) like the tokamak walls
- **Nuclear Astrophysics**: (α,n) cross sections may be deduced from the (n,α)
- **Theoretical Models**: refinement of models require accurate data that is often missing

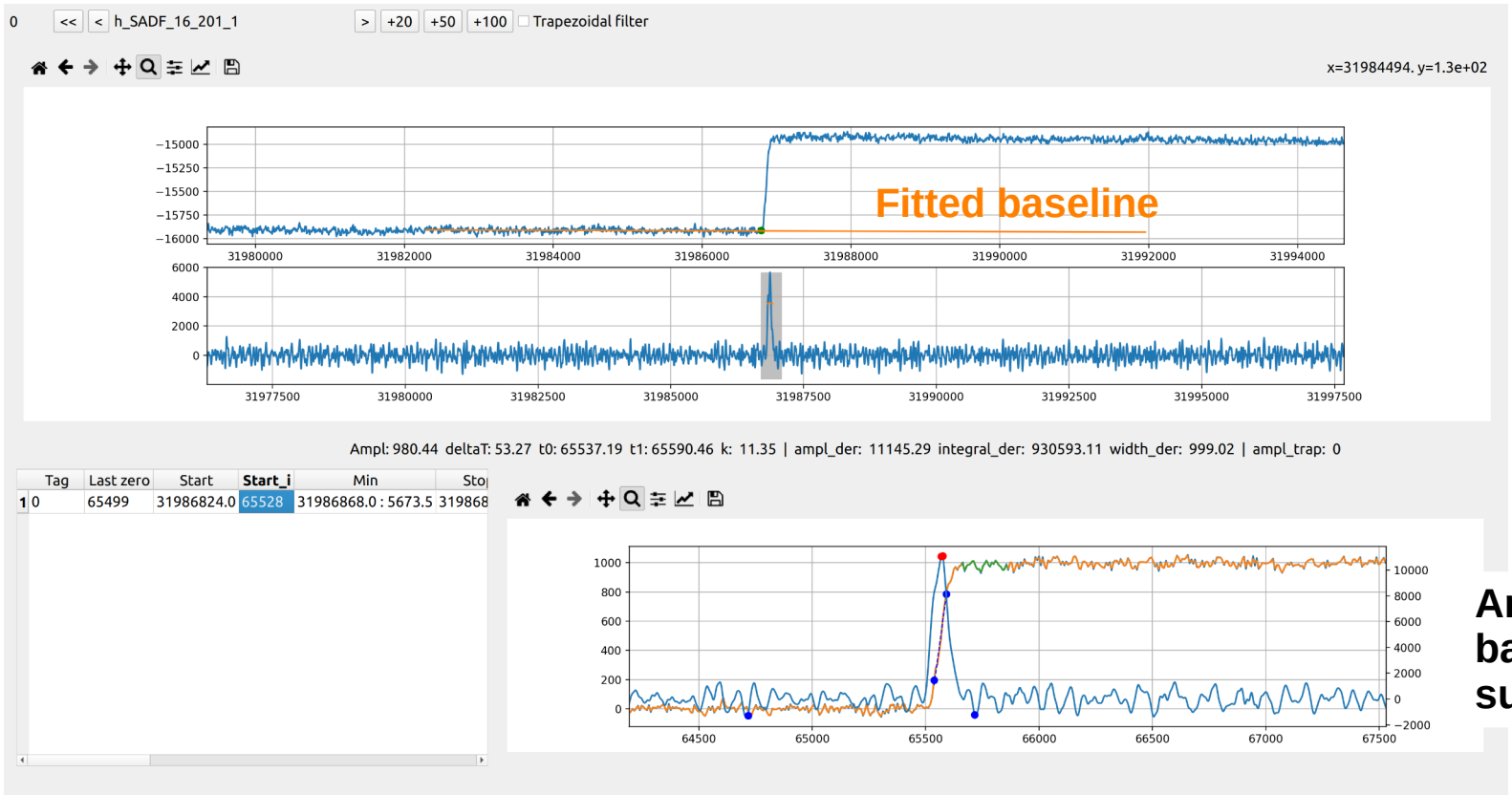


New Pulse Analysis routine

Original movie

Derivative

Tagged signals



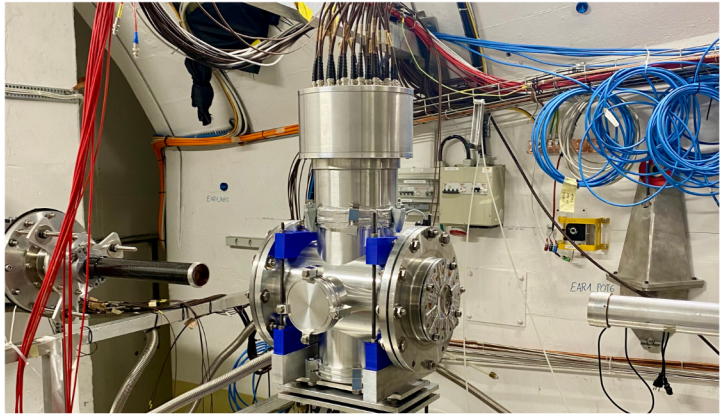
Analysis after baseline subtraction

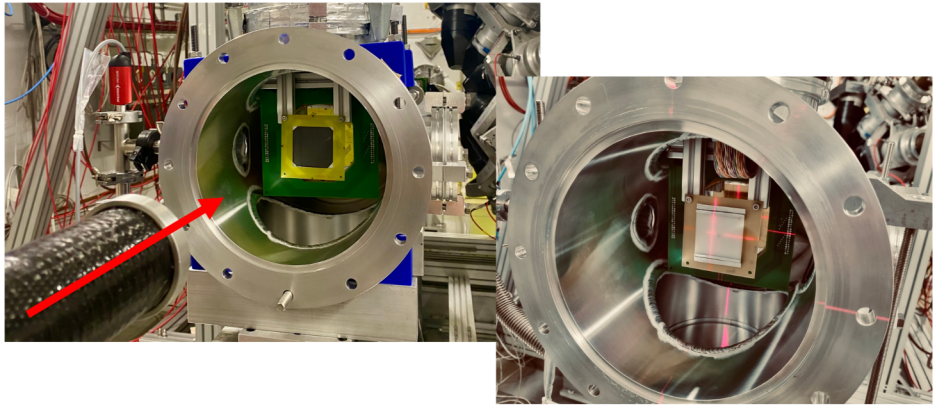
Setup – ^{12}C EAR1

For the validation of the technique we measured the ^{12}C(n,p) cross section in EAR1 + test in EAR2

Samples:

- **PE** (1mm) + **Li-6** (100 µm/cm2) deposited on Mylar (1.6 µm thick)
- **Rigid Graphite** (0.25 & 0.5 mm)
- **Dummy (only the frame)**



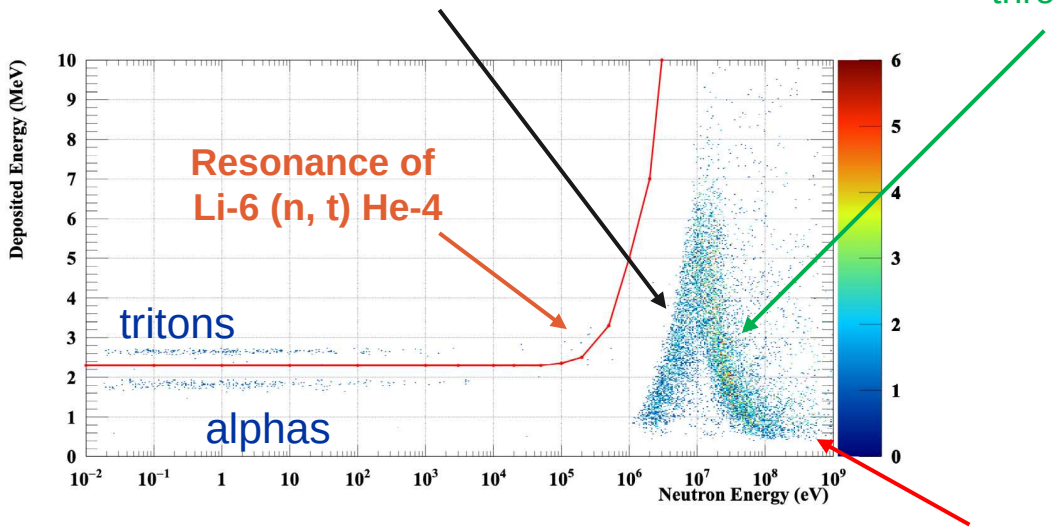


LiF + PE

Good response from the combination of LiF + PE, we observe tritons and alpha at low energy and the protons above 1 MeV.

Protons: **Full-energy** deposition

Protons Punching
through the silicon wafer



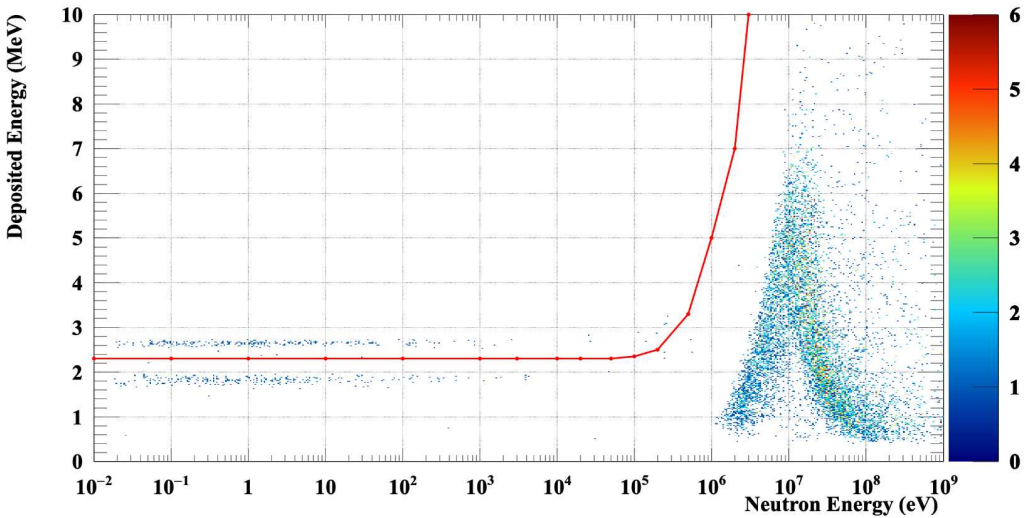
Maximum neutron energy hundreds of MeV

Courtesy of S. Goula

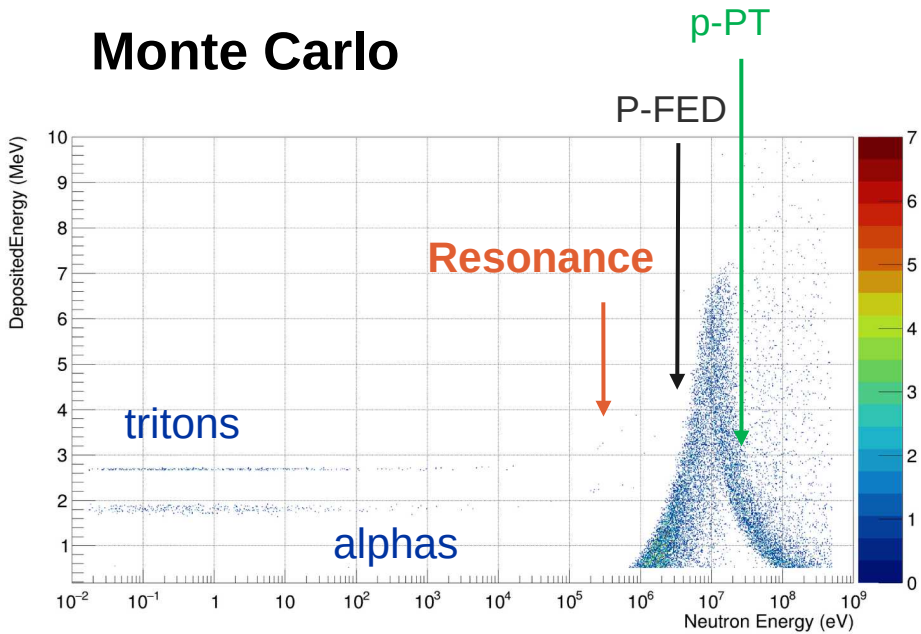
LiF + PE – Monte Carlo

Good agreement with MC data (Geant4).

Experimental

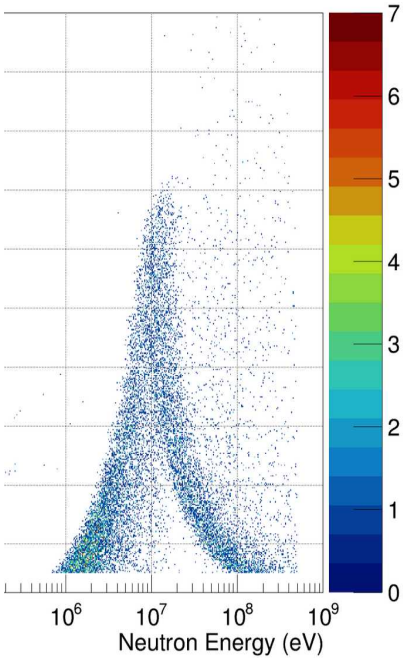


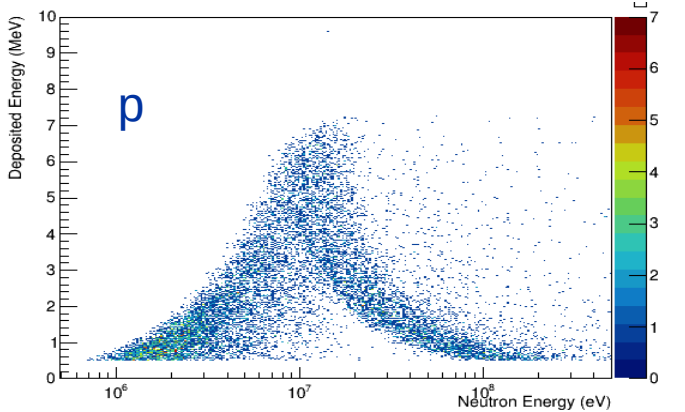
Monte Carlo

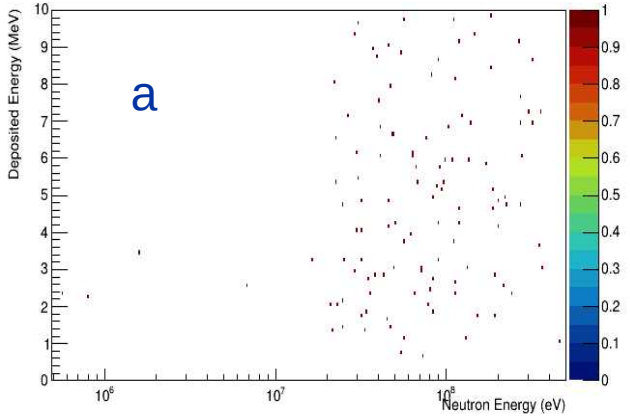


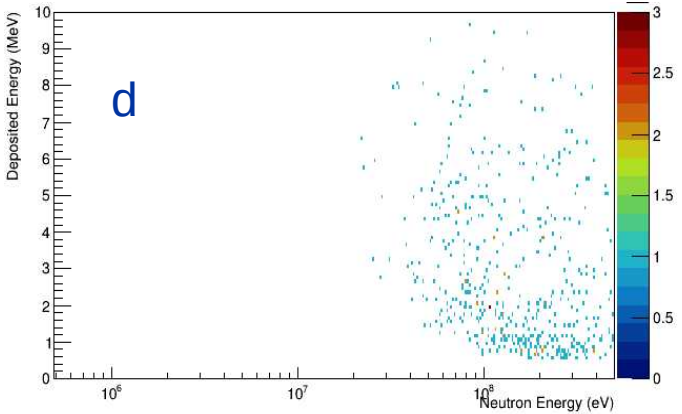
Courtesy of S. Goula

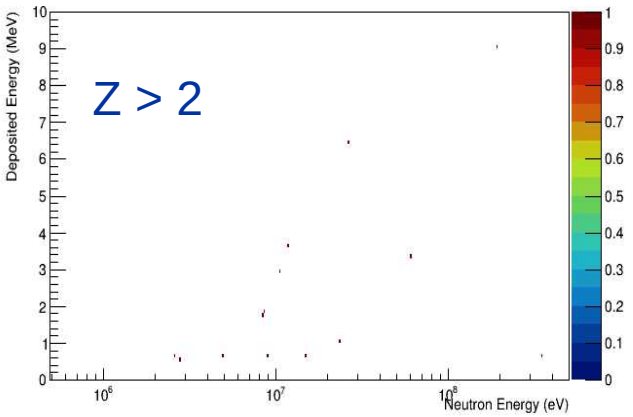
LiF + PE – Monte Carlo









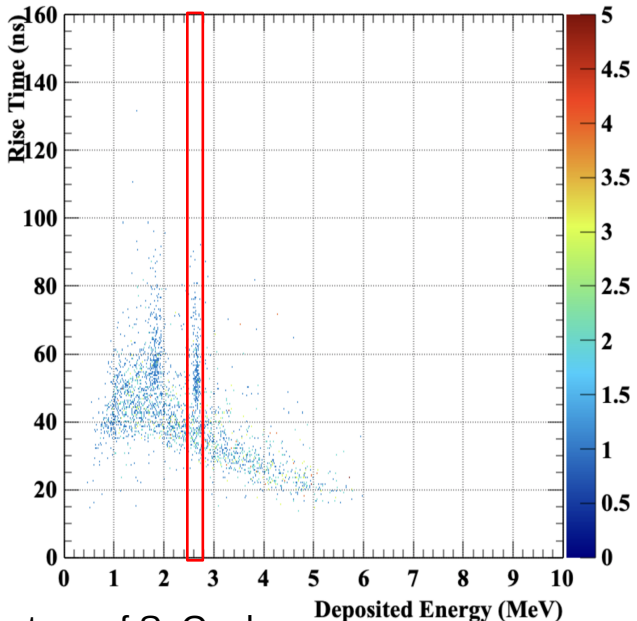


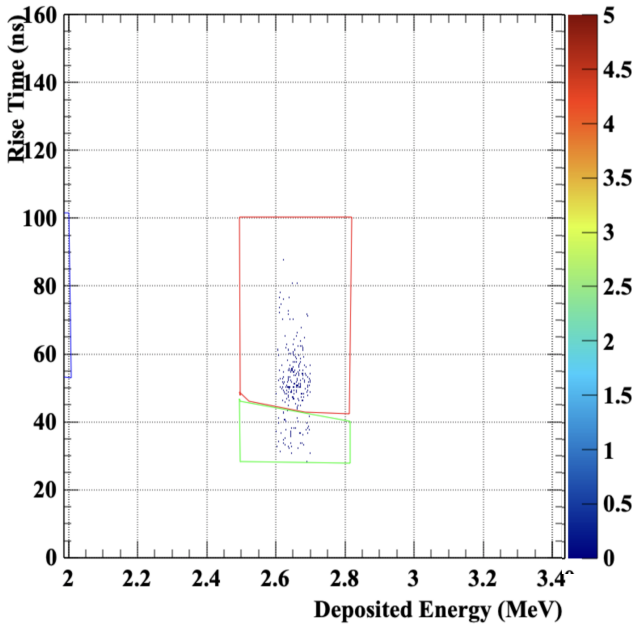
Courtesy of S. Goula

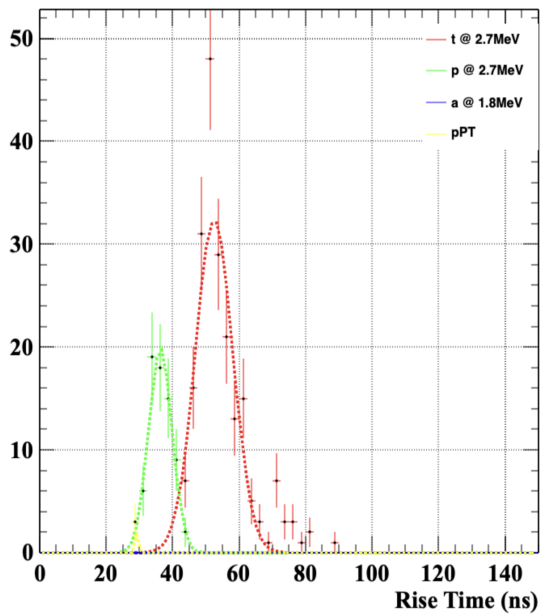
LiF + PE – Exp. Data

First particle identification **proton / tritons at 2.7 MeV based on rise time.**

Neutron energy lower than 8 MeV and Deposited Energy: 2.6-2.7 MeV; **FoM p/t: 0.7497**



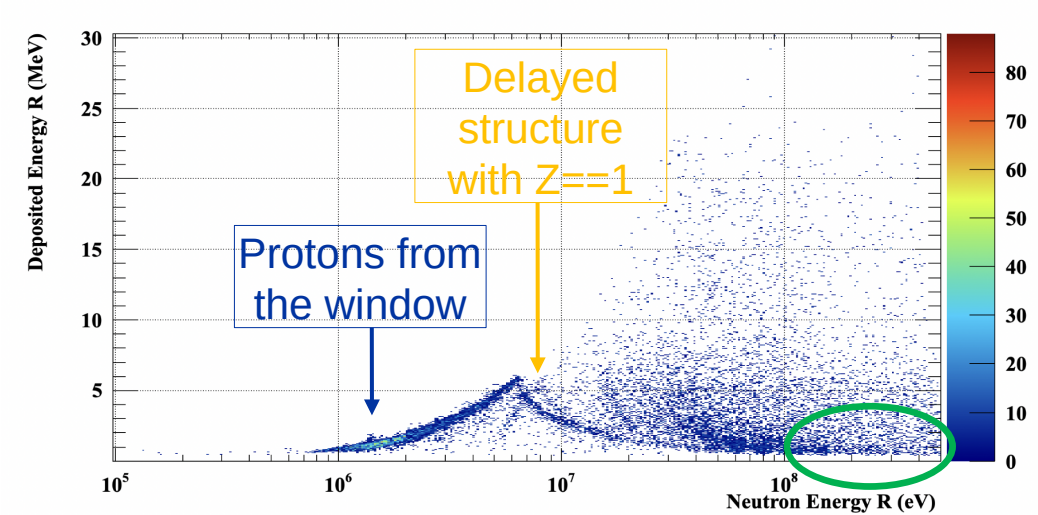




Courtesy of S. Goula

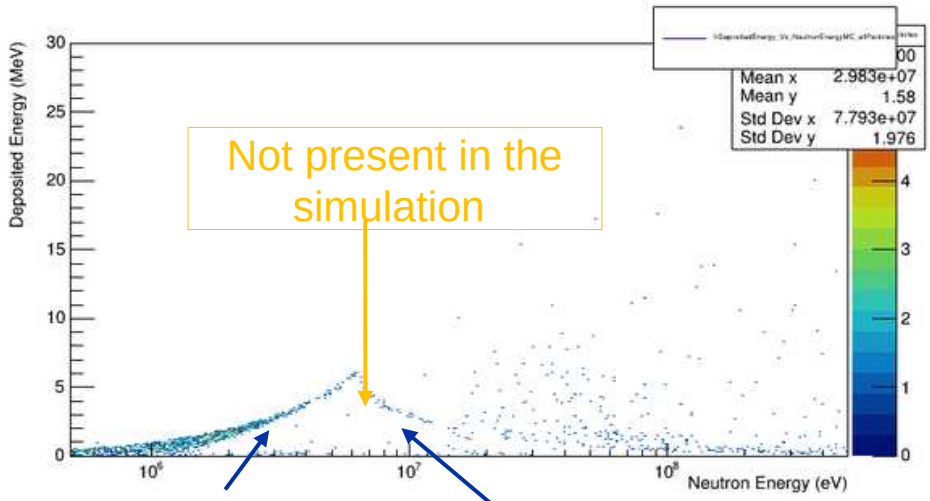
Empty – Exp. Data vs MC

Experimental



Maximum neutron energy hundreds of MeV

Simulation

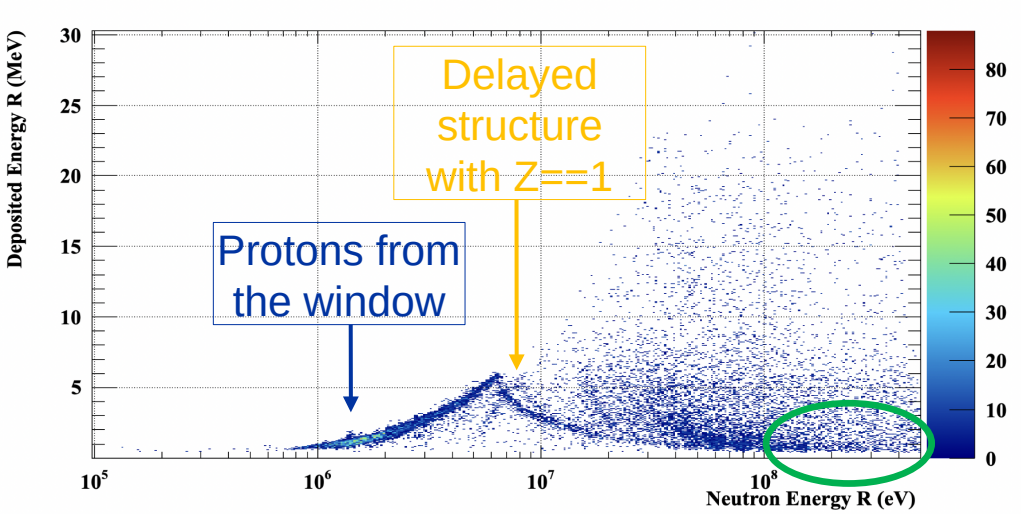


Courtesy of S. Goula

Empty vs C12 data

Empty

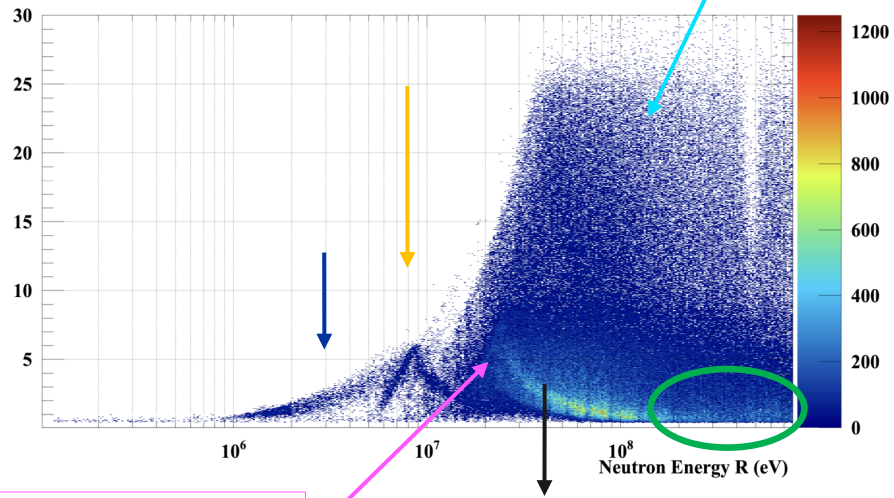
1.27E+17 POT



Maximum neutron energy hundreds of MeV

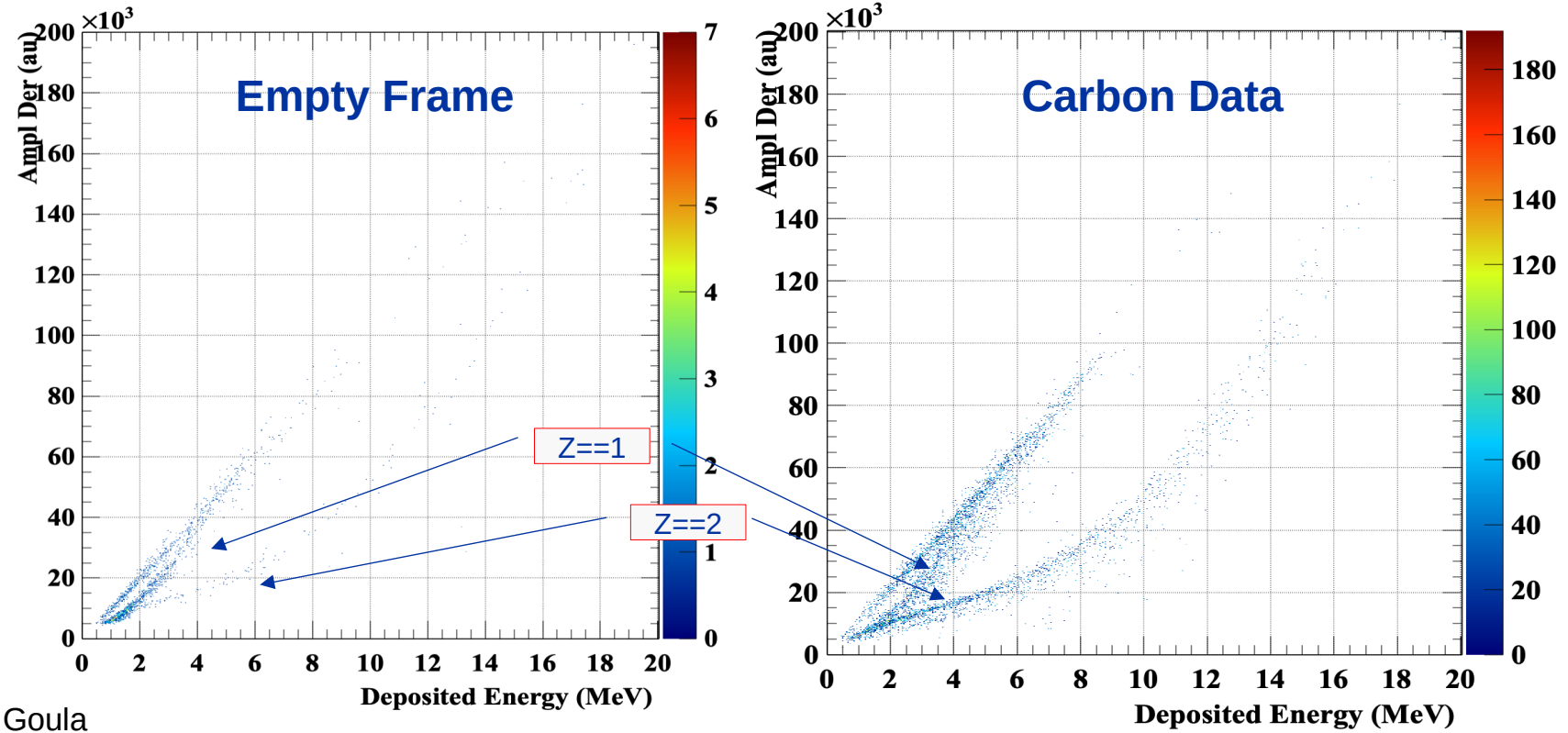
Thin C-12:

- 8.1E+17 POT



Courtesy of S. Goula

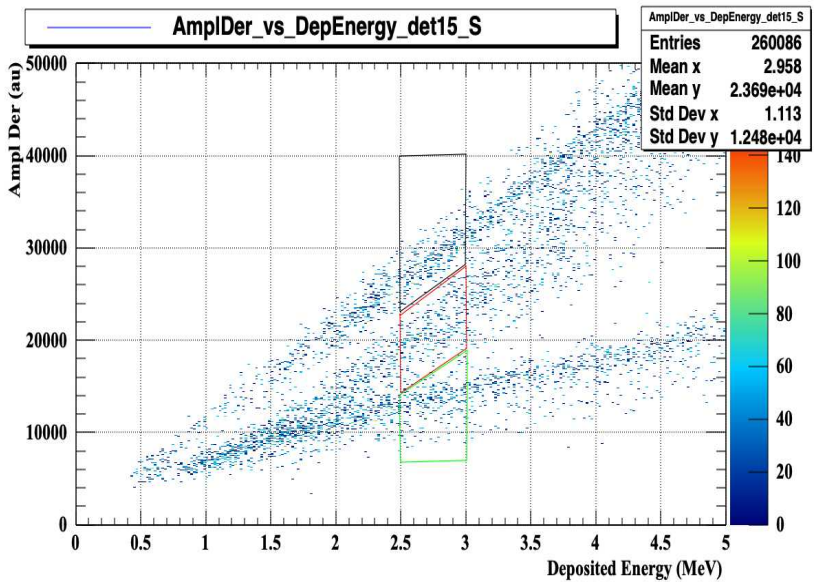
Empty vs C12 data – Matrix for PID

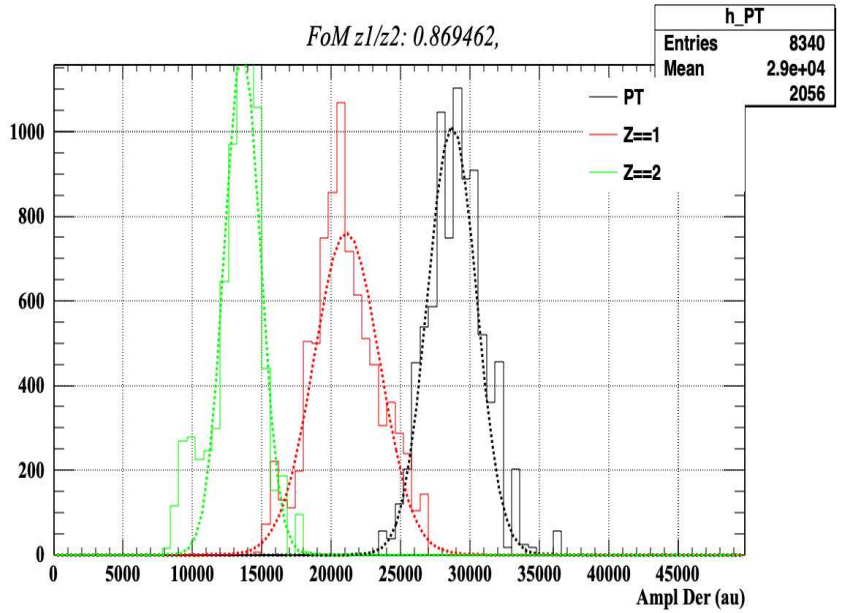


Courtesy of S. Goula

C12 data – Particle identification

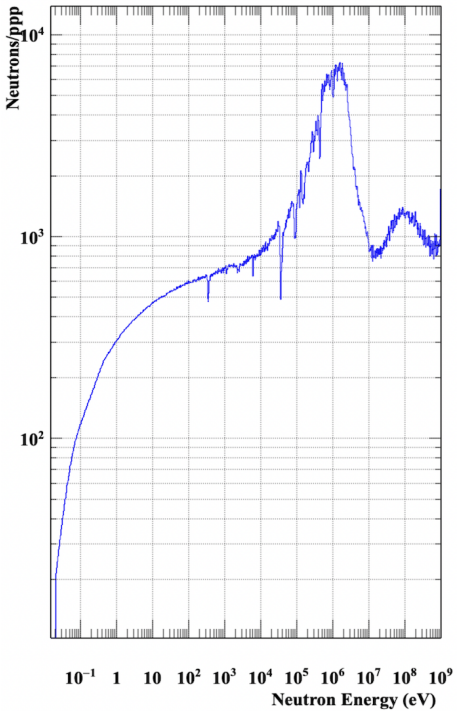
In the interval 2.5 to 3 MeV a **FoM of 0.87** is obtained between Z=1 and Z=2 (good separation).



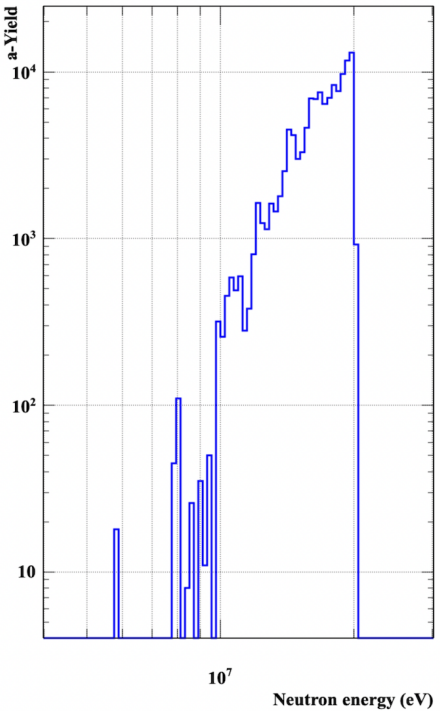


Courtesy of S. Goula

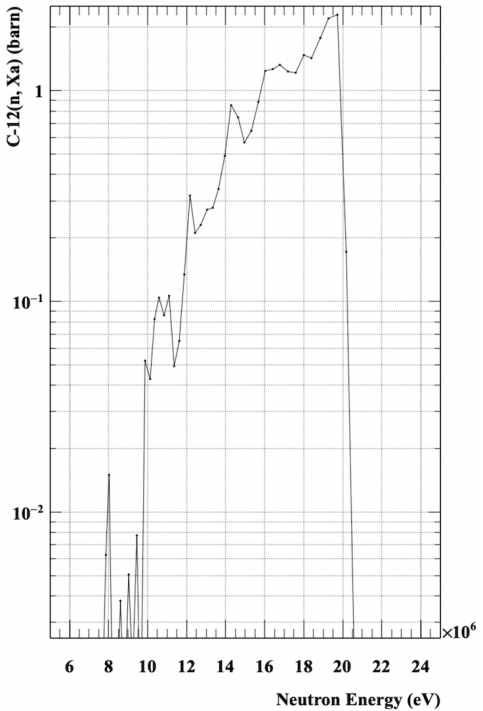
Integral cross section (n,a)



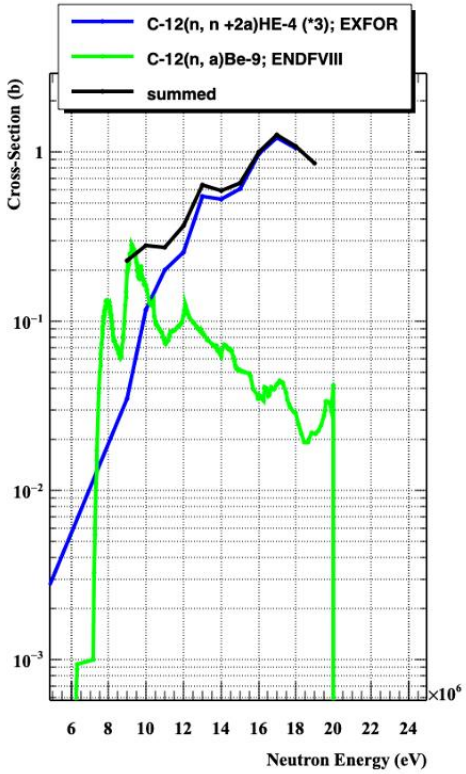
Evaluated Flux



Experimental Data



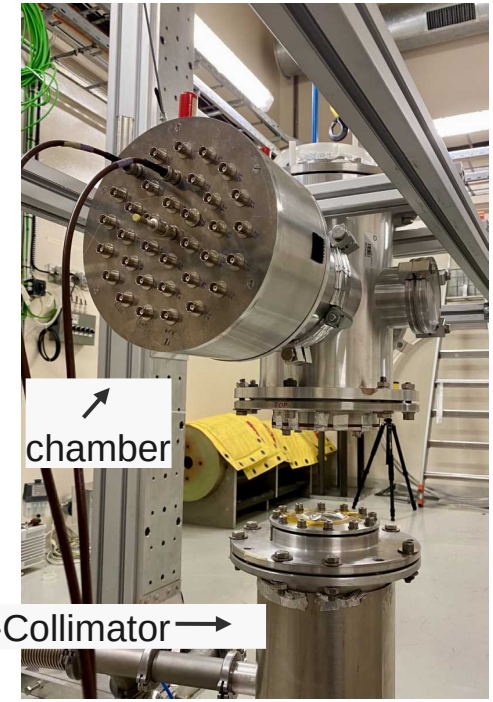
C-12(n,Xa)

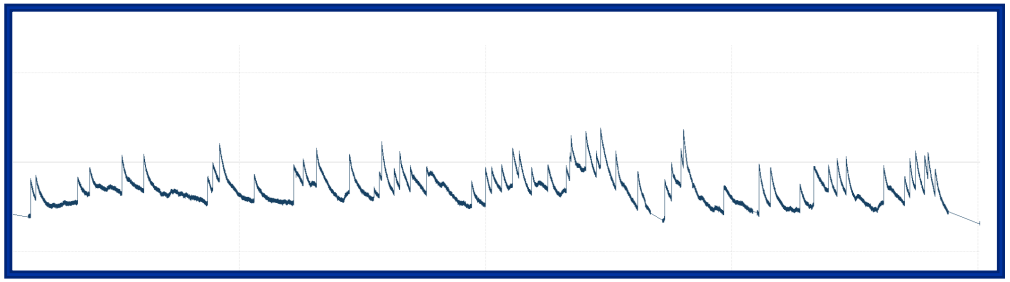


Data-bases

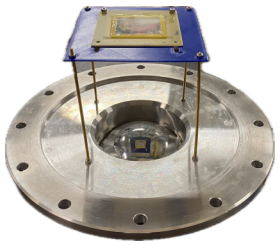
Courtesy of S. Goula

EAR2 - Setup

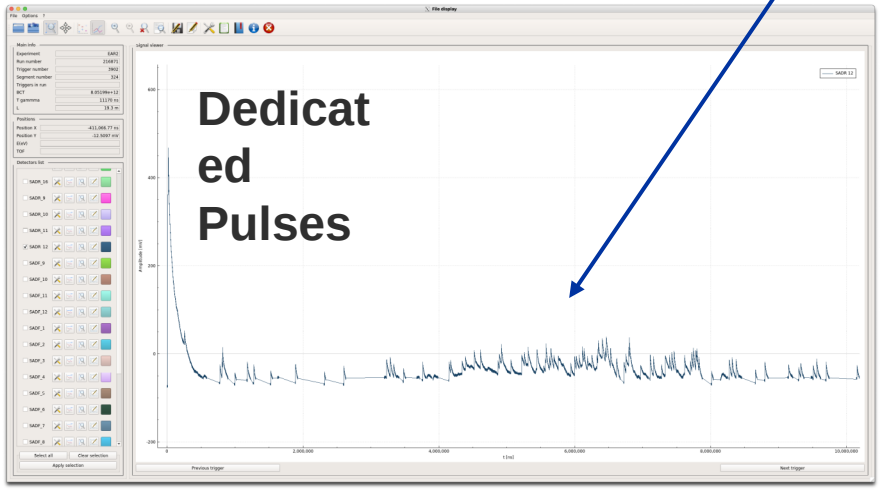




pile-up

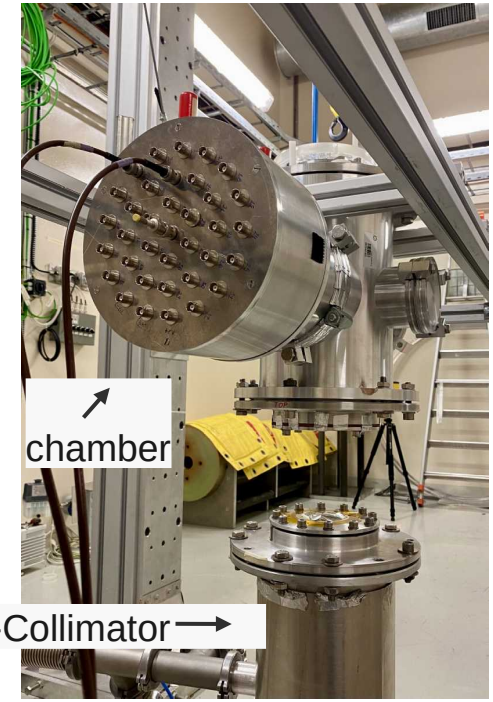


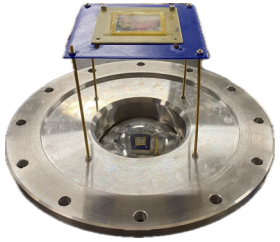
neutron beam



Courtesy of S. Goula

EAR2 - Setup

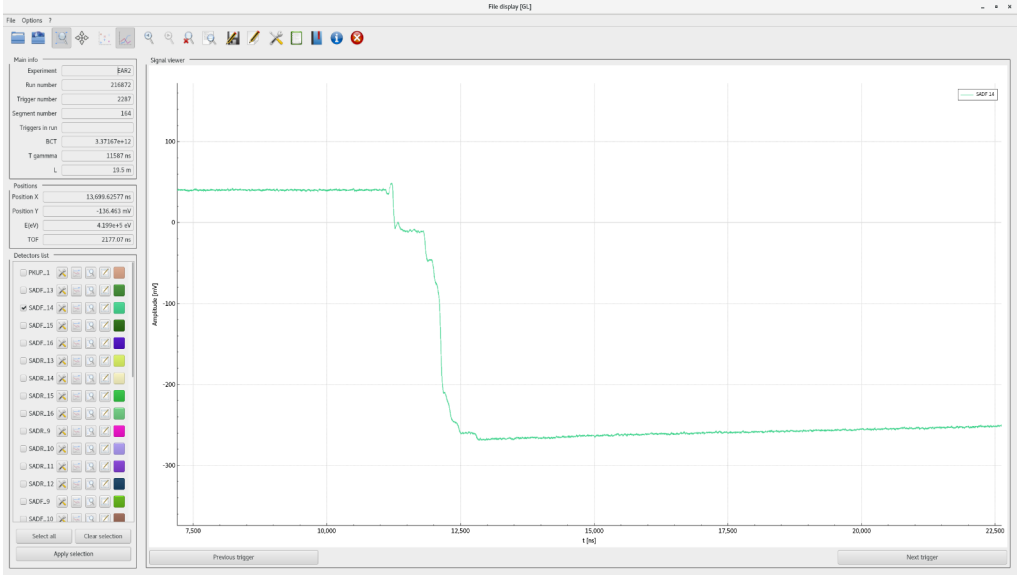




neutron beam

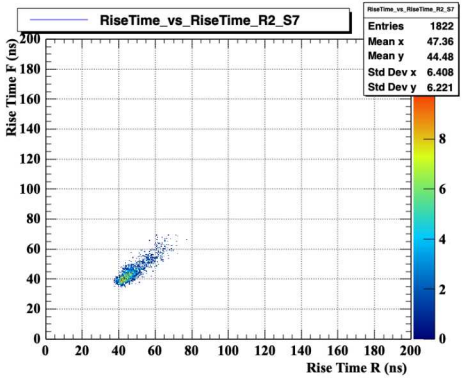
Courtesy of S. Goula

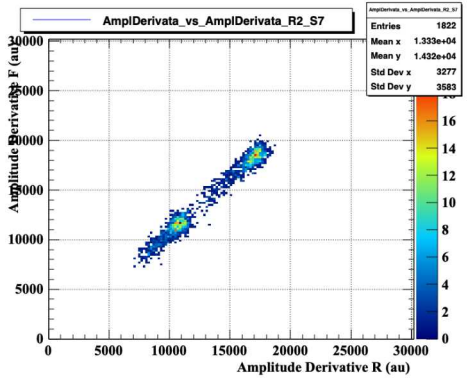
Parasitic Pulses:

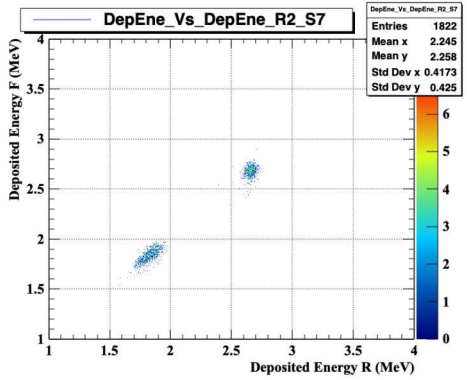


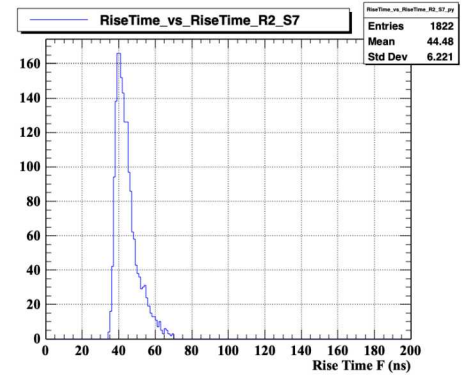
Promising behaviour

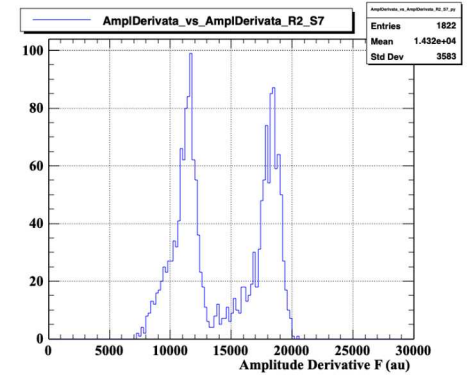
LiF Data

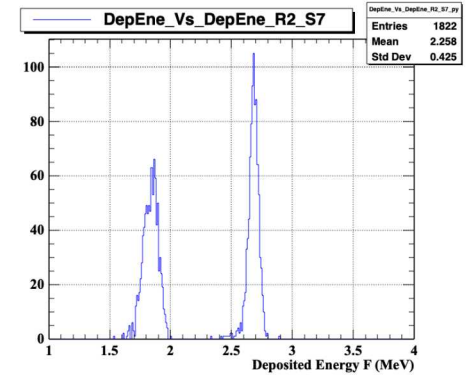












Courtesy of S. Goula

Outlook

Version 2.0 for routine expected for mid June.

Monte Carlo almost completed (need to check some when the elements inside the chamber are checked from JFG)

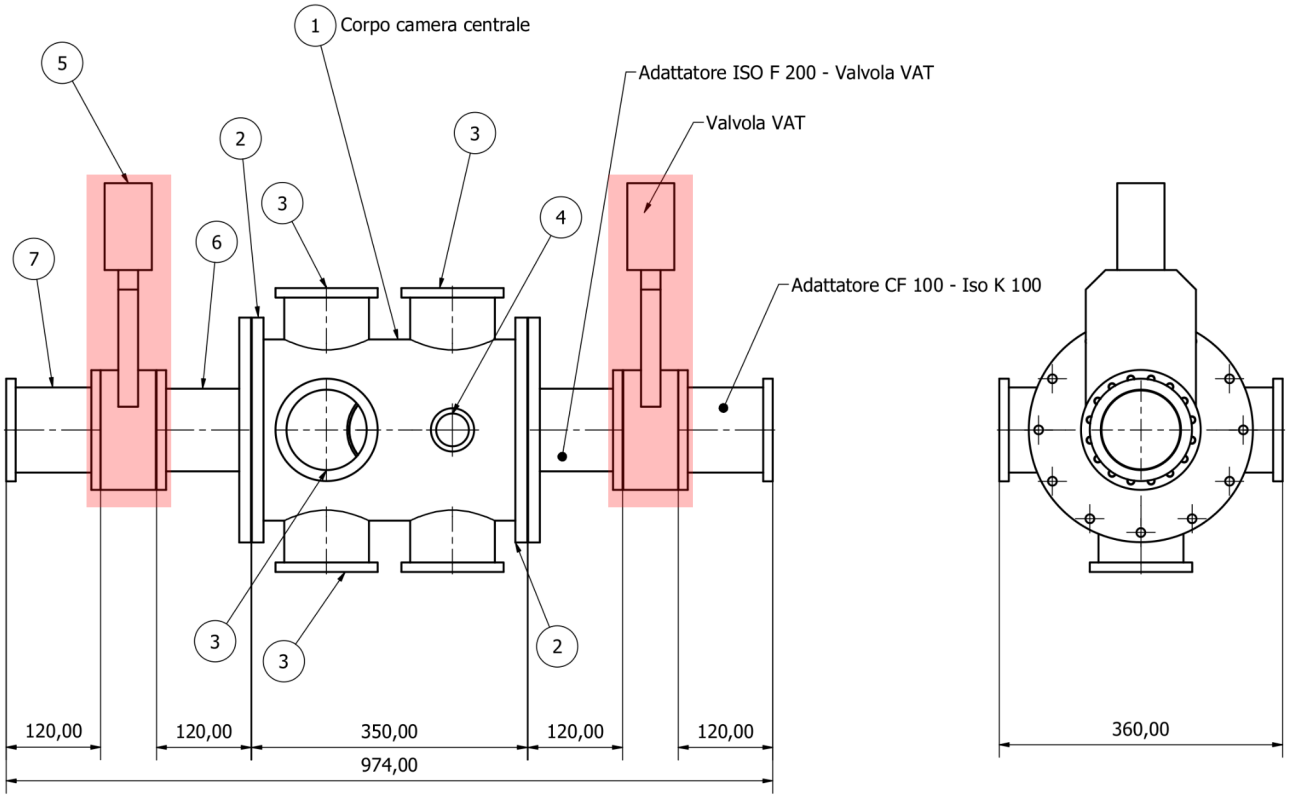
Achieved p/a and p/t separation, investigating on the strategy to obtain the p/d

New setup

Design of the full apparatus is ongoing:

- 2 DSSSD Annular + 4 DSSSD nTD 400 um ordered in March
- 10 Preamplifiers, 6 of which witch customized Bias circuit (delivered last week)
- Boards being developed at LNS aiming to have a flexible design
- Chamber design almost final
- Flanges with connectors investigating a customization to minimize steel components

New chamber



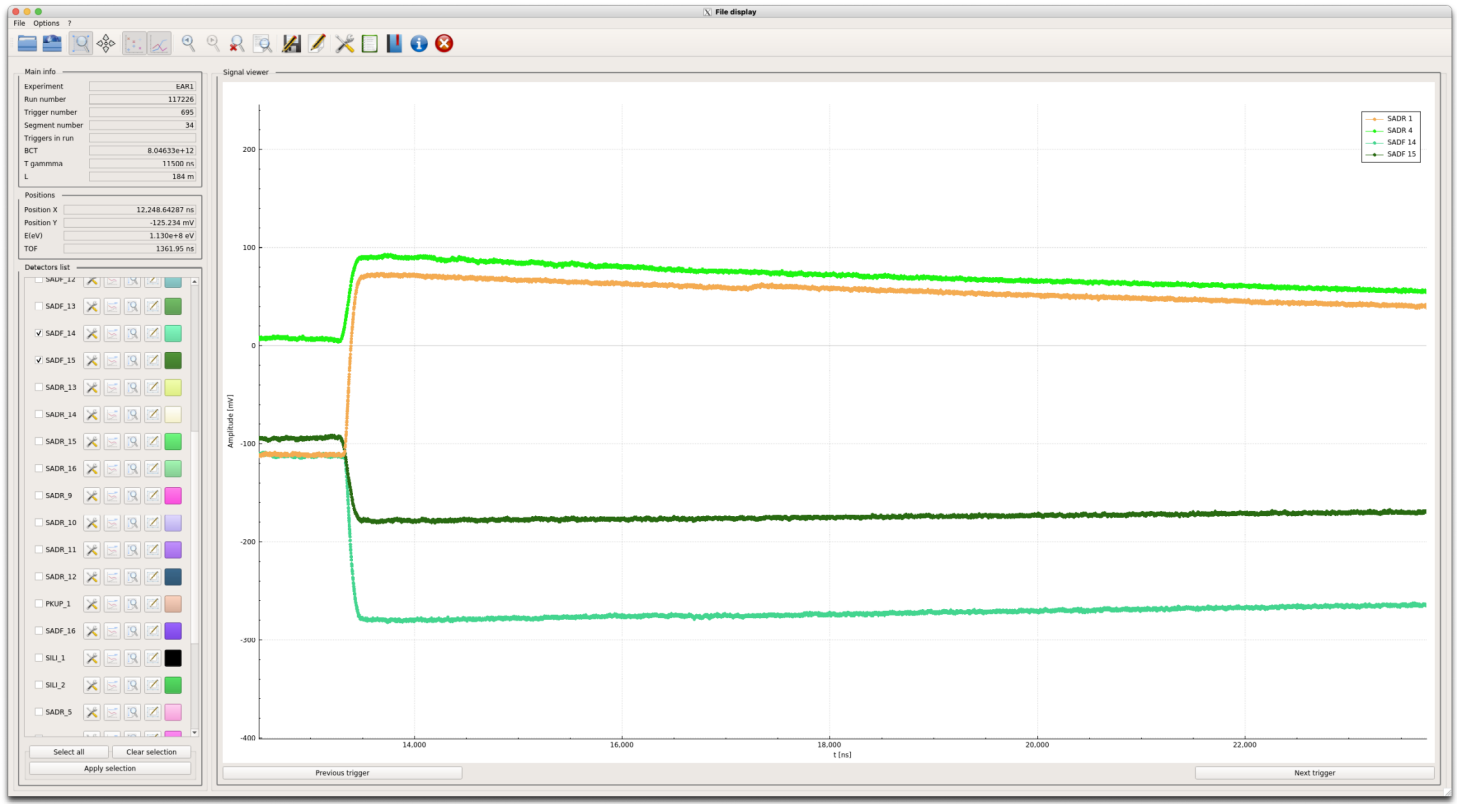
Vacuum gauges to prevent damages from window breaking

6 access points (4 for connectors, 1 for sample, 1 extra)

Thank you for your attention

Three body reactions

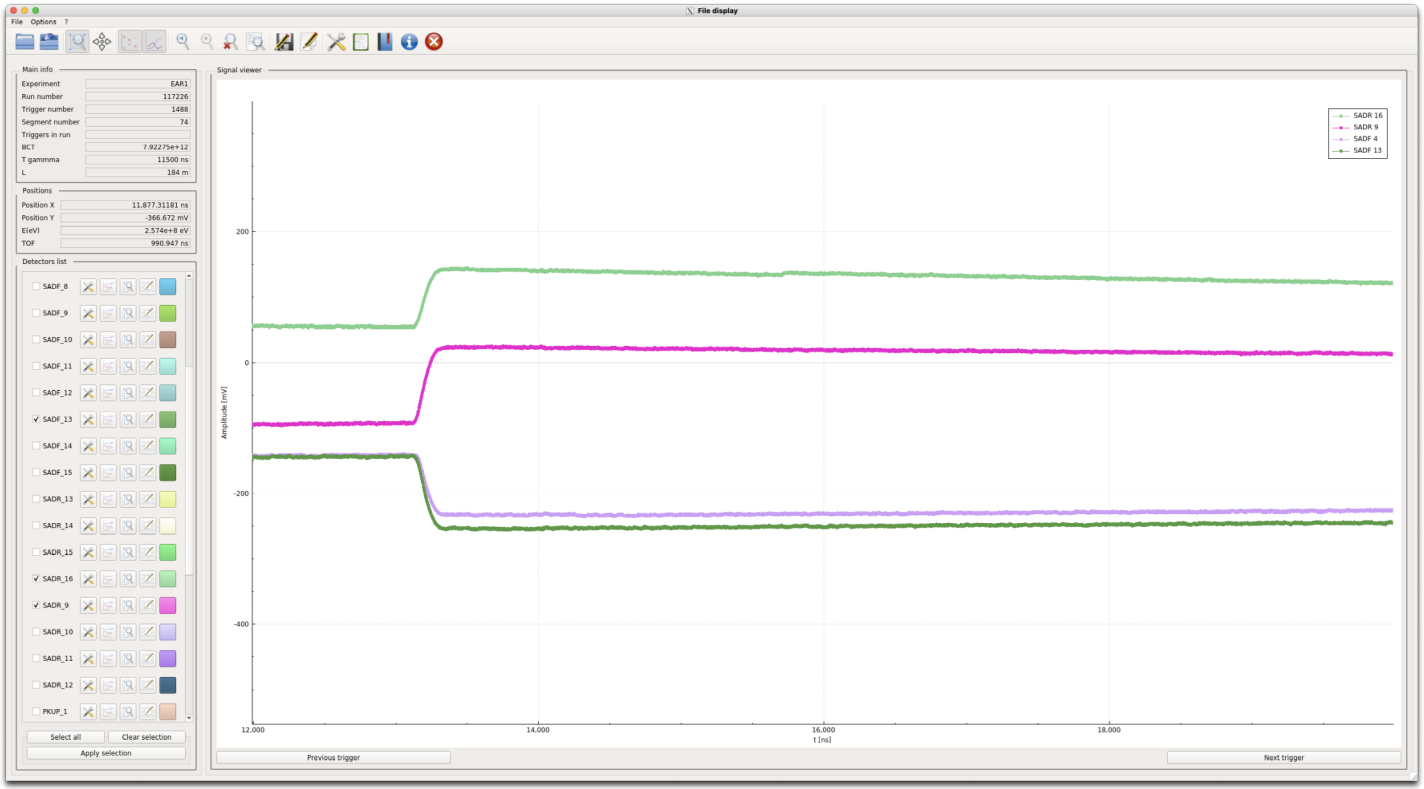
(n,p+a)



Courtesy of S. Goula

Three body reactions

(n,2+a)



Courtesy of S. Goula