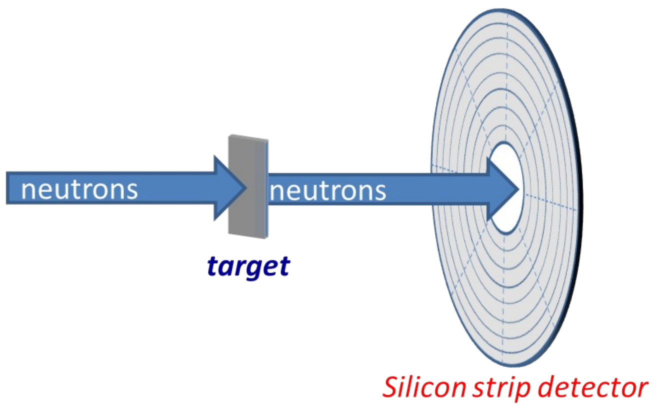
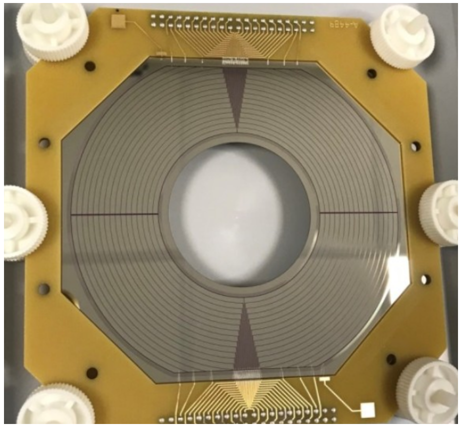
# Annular silicon detector for (n,cp) and particle discrimination

# Motivations



## NTD strip detectors

Thickness: 300 µm
Outer Diameter: 96 mm
Central Hole: 46 mm
No of Rings (Junction): 16
No of Elements (Junction): 64
No of Sectors (Ohmic): 16

**Separazione p – α con PSA in rear side injection mode**

- *Soglia in energia 2 ÷ 3 MeV*
- En < 15MeV..?

**Huge list, one can select the most important isotopes, for example Tungsten, used in the divertor of DEMO**

| Nuclide | Abund. | Reaction | Comment |
|---|---|---|---|
| Cr-50 | 4.3% | (n,α)(n,p) | No/little data |
| Cr-52 | 83.8% | (n,α) | One data set only |
| Cr-53 | 9.5% | (n,α) | No data |
| Cr-54 | 2.4% | (n,α)(n,p) | Lack of data below 14 MeV |
| Mn-55 | 100% | (n,α)(n,p) | Discrepant data |
| Fe-56 | 91.7% | (n,α) | One data set only |
| Fe-57 | 2.1% | (n,α)(n,p) | Lack of data / No data for (n,α) |
| Zr-90 | 51% | (n,α) | No data |
| Zr-91 | 11% | (n,α) | No data |
| Zr-92 | 17% | (n,α) | Lack of data below 14 MeV |
| Nb-93 | 100% | (n,p) | No data |
| Mo-92 | 15% | (n,p) | No data |
| Mo-94 | 9.2% | (n,α)(n,p) | Lack of data / No data for (n,α) |
| Mo-95 | 16% | (n,α) | One data set only |
| Mo-96 | 17% | (n,α) | No data |
| Mo-97 | 9.6% | (n,α) | No data |
| Mo-98 | 24% | (n,p) | Lack of data below 14 MeV |
| Mo-100 | 9.6% | (n,p) | Lack of data below 14 MeV |

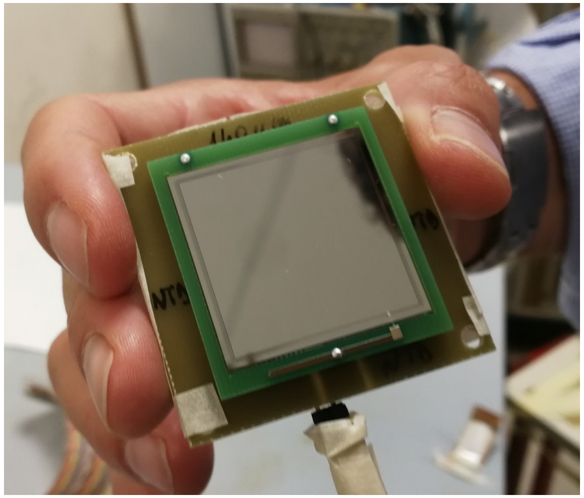
| Nuclide | Abund. | Reaction | Comment |
|---|---|---|---|
| Ta-181 | 100% | (n,α)(n,p) | Lack of data below 14 MeV |
| W-182 | 26% | (n,α)(n,p) | Lack of data / No data for (n,α) |
| W-183 | 14% | (n,α)(n,p) | Lack of data / No data for (n,α) |
| W-184 | 31% | (n,α)(n,p) | Lack of data below 14 MeV |
| W-186 | 28% | (n,α)(n,p) | Lack of data below 14 MeV |

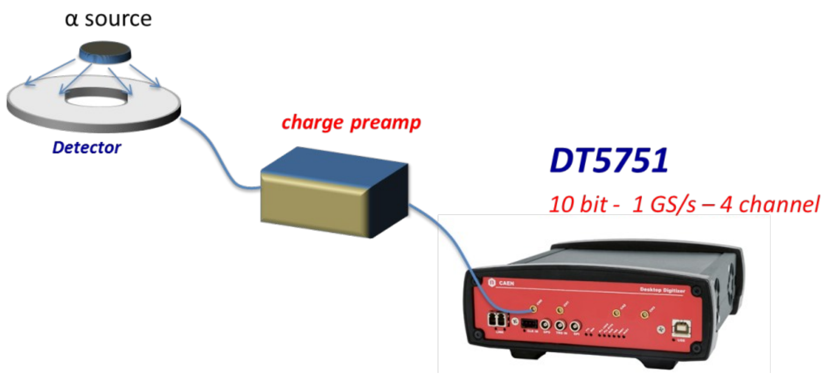
**Almost all measurements to be done in EAR2, with improved detection systems (in order to reach 14 MeV).**

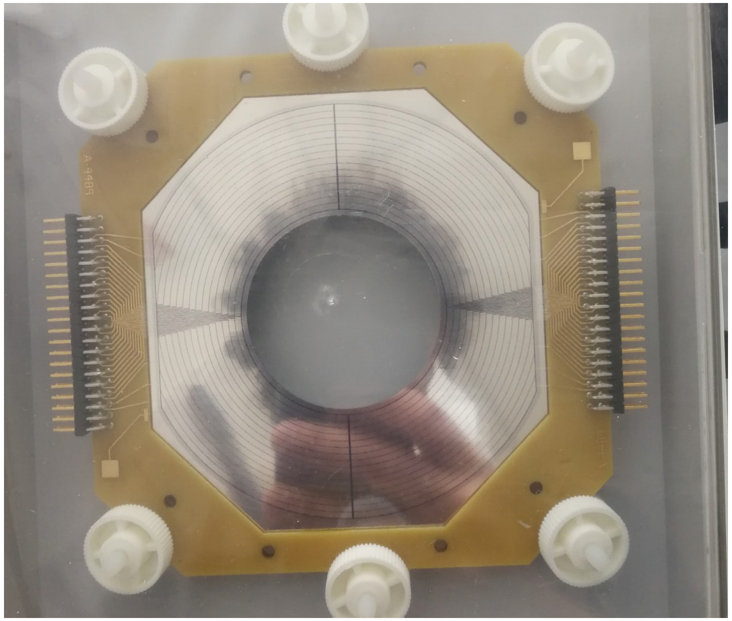
# Test of PD with silicon detectors

What we are dealing with:

1. **Different detectors** annular-stripped and single pad
2. **New DAQ** with high sampling rate (1GS/s)
3. **New routine** to analyze the waveforms
4. **Data analysis with root** (as usual)
5. **MC simulations** for calibration





# Quantities of interest

A dedicated Signal Analyzer is being developed at LNS, with the support of Gianfranco Vecchio.

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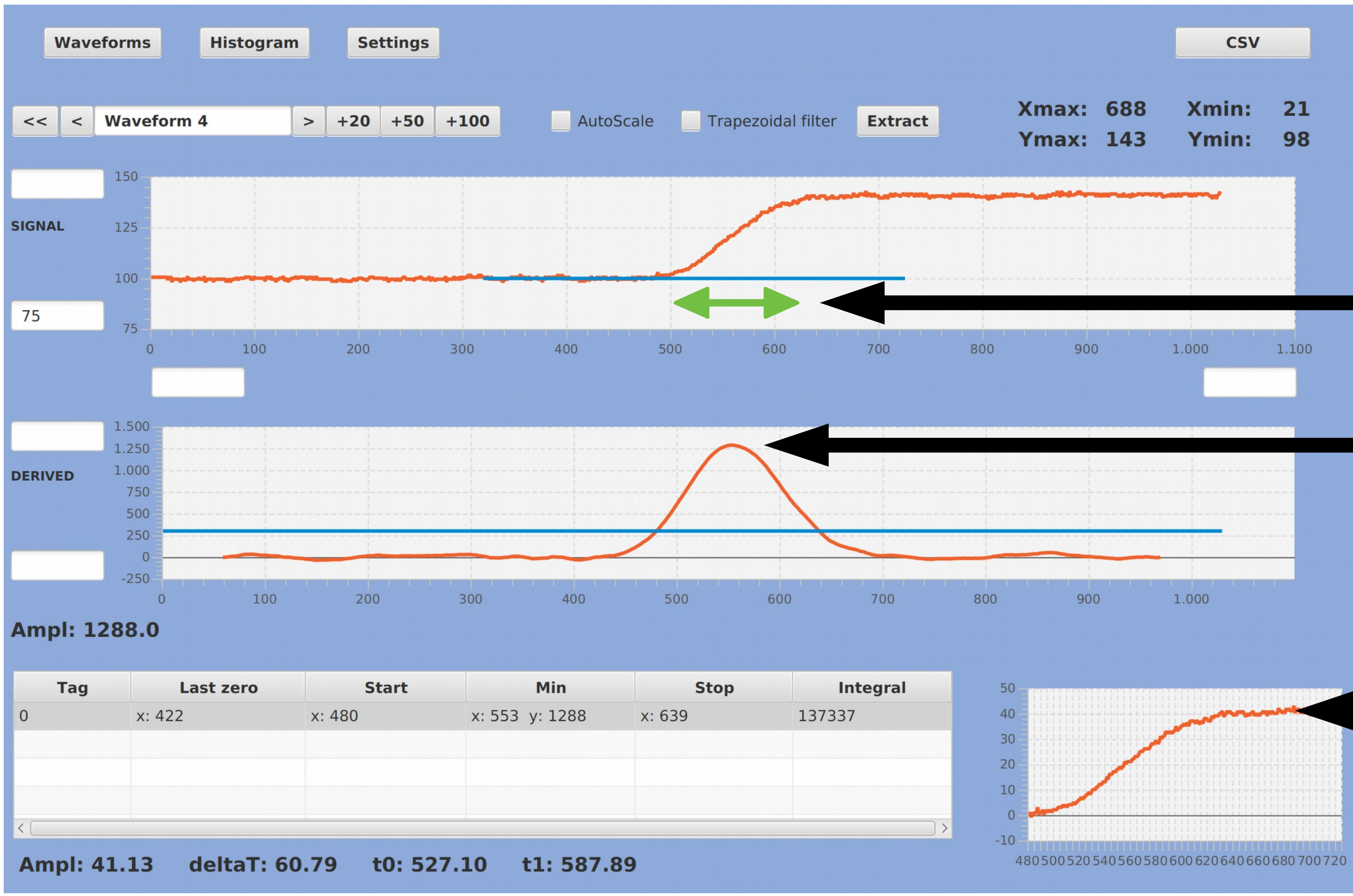



**Rise time**

(10%-90% or 20%-80%?)

**Max slope**

(Pulse current)

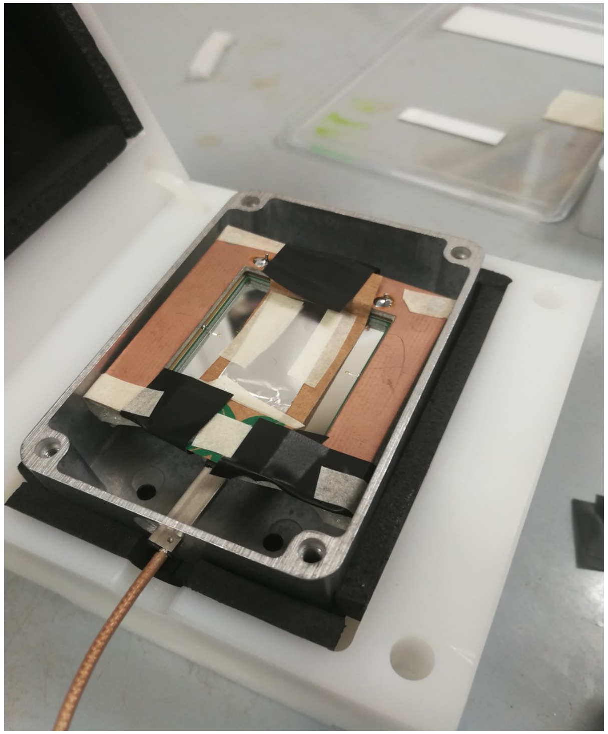
**Amplitude**

(Max/Integral/ Trapezoidal filter)

# Test with nTD single pad and LiF

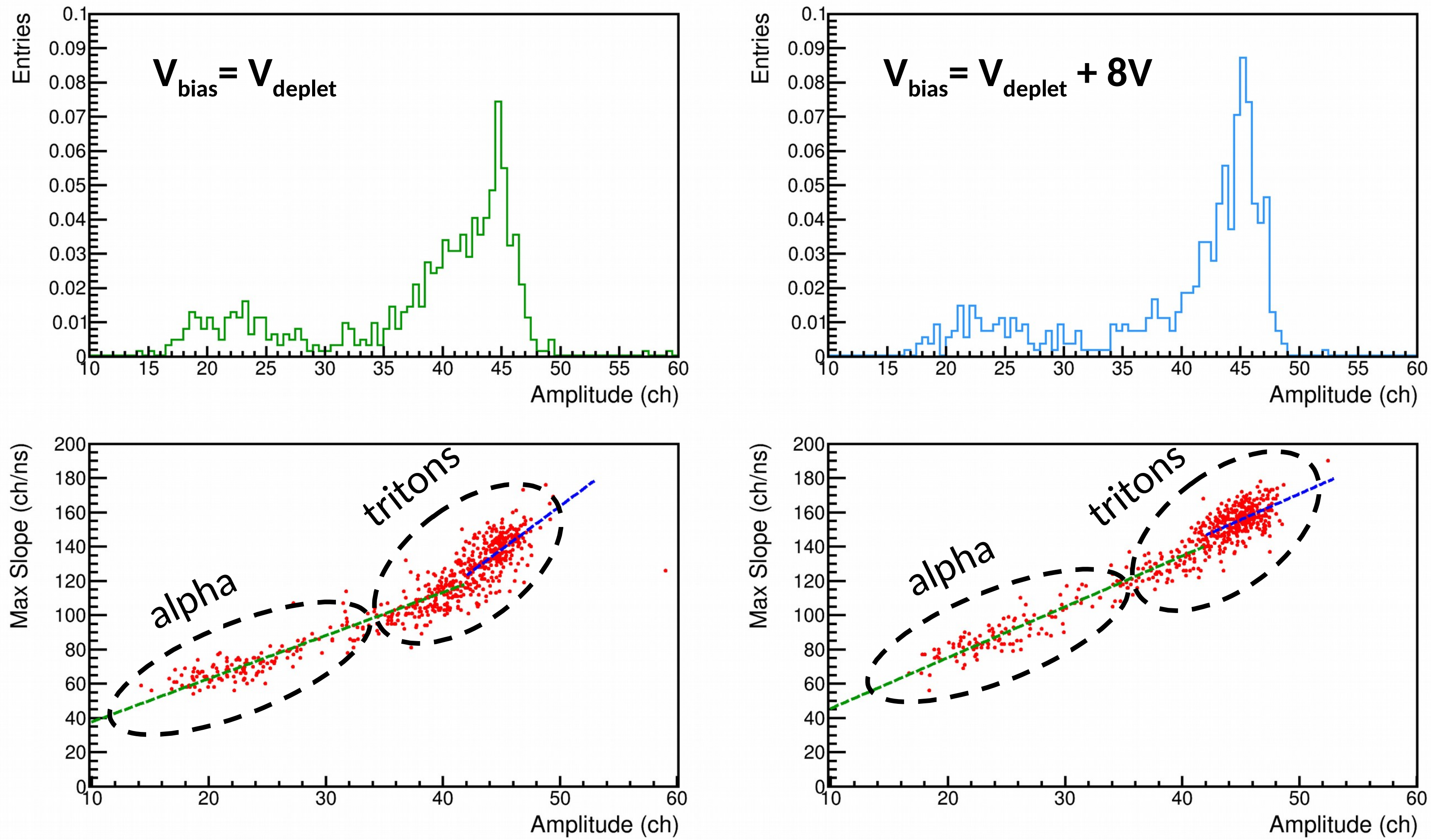
First test made with a single pad nTD detector 3x3cm$^2$ coupled with a thin LiF sample (1.9um) on the rear side.

The detector was been placed inside a polyethylene box and exposed to the intense neutron source available at LNS.

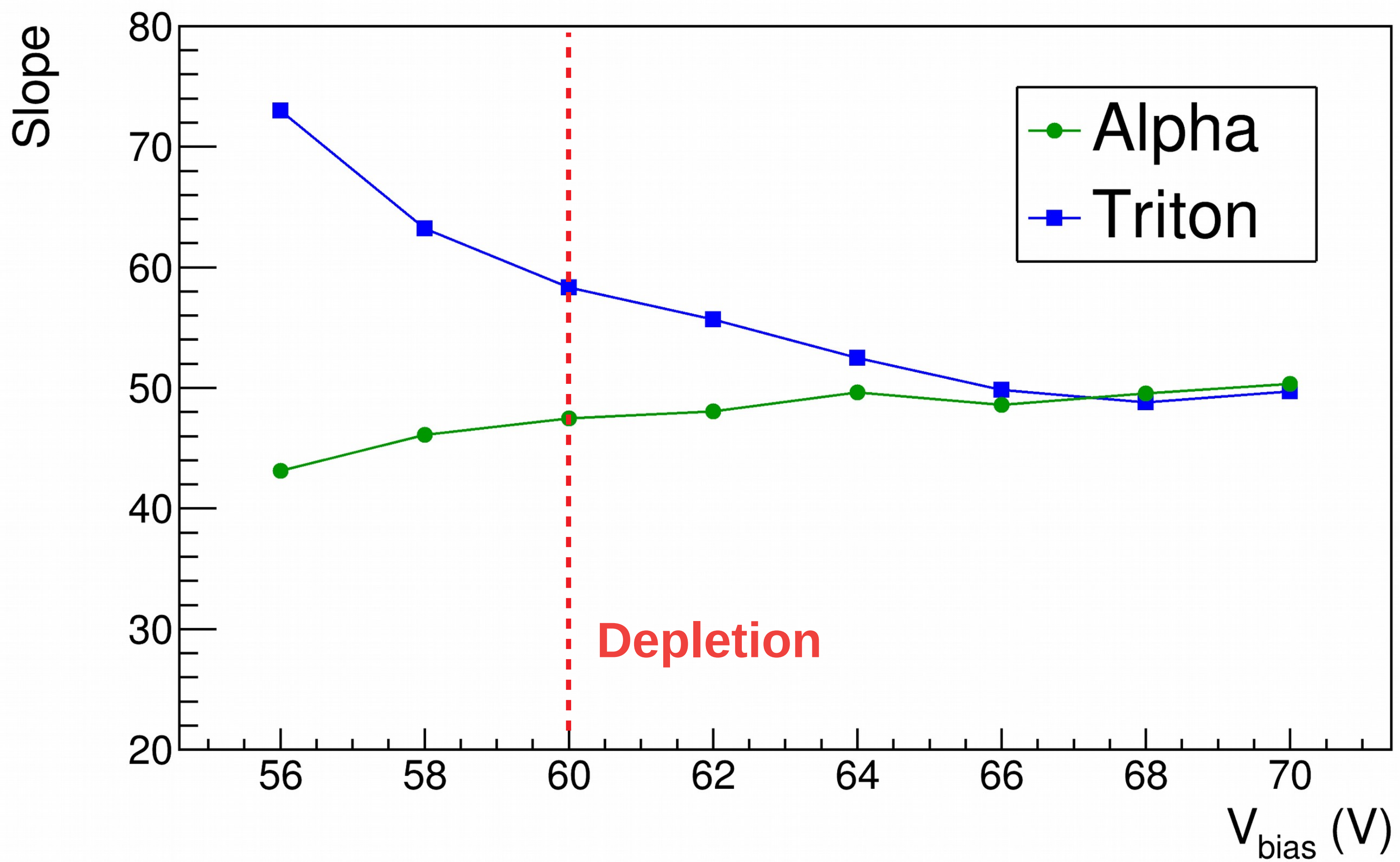


# Test with nTD single pad and LiF

As expected, a change in the slope is observed when the bias voltage is close to the depletion value.



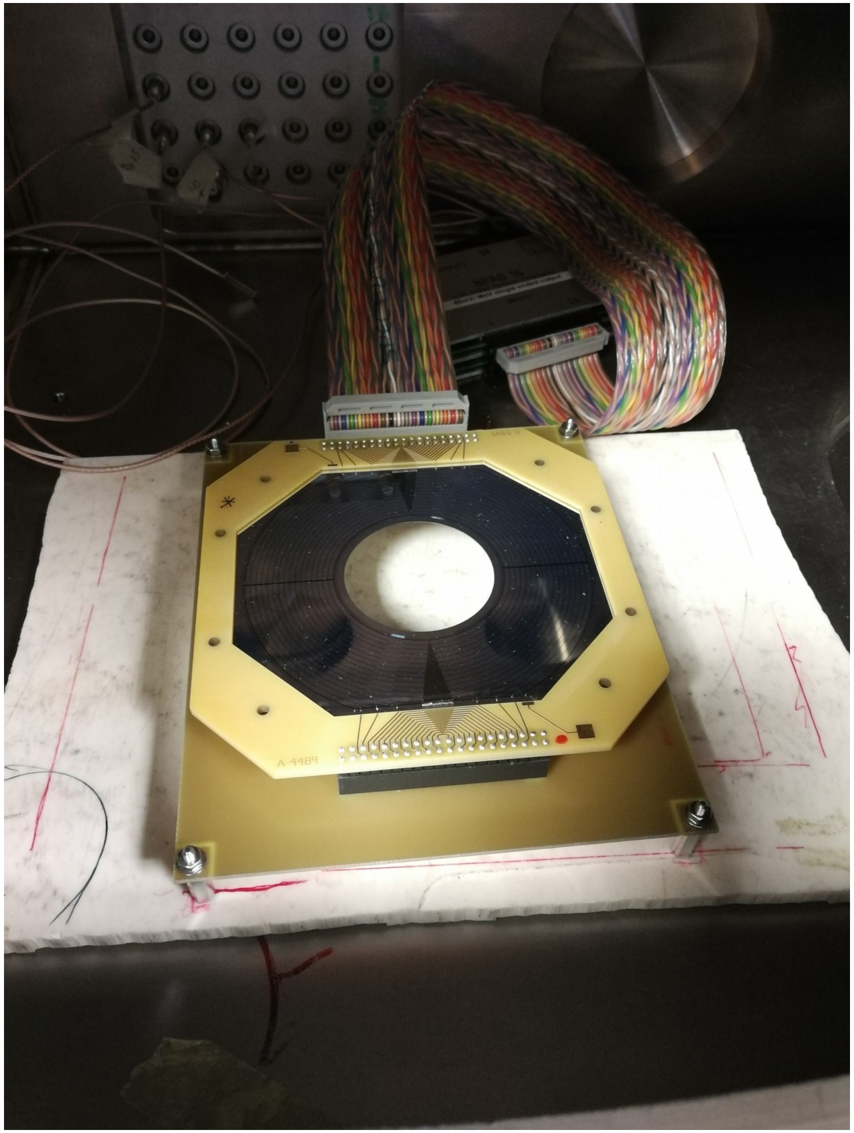
# Max Slope vs Amplitude



# Test with annular detector

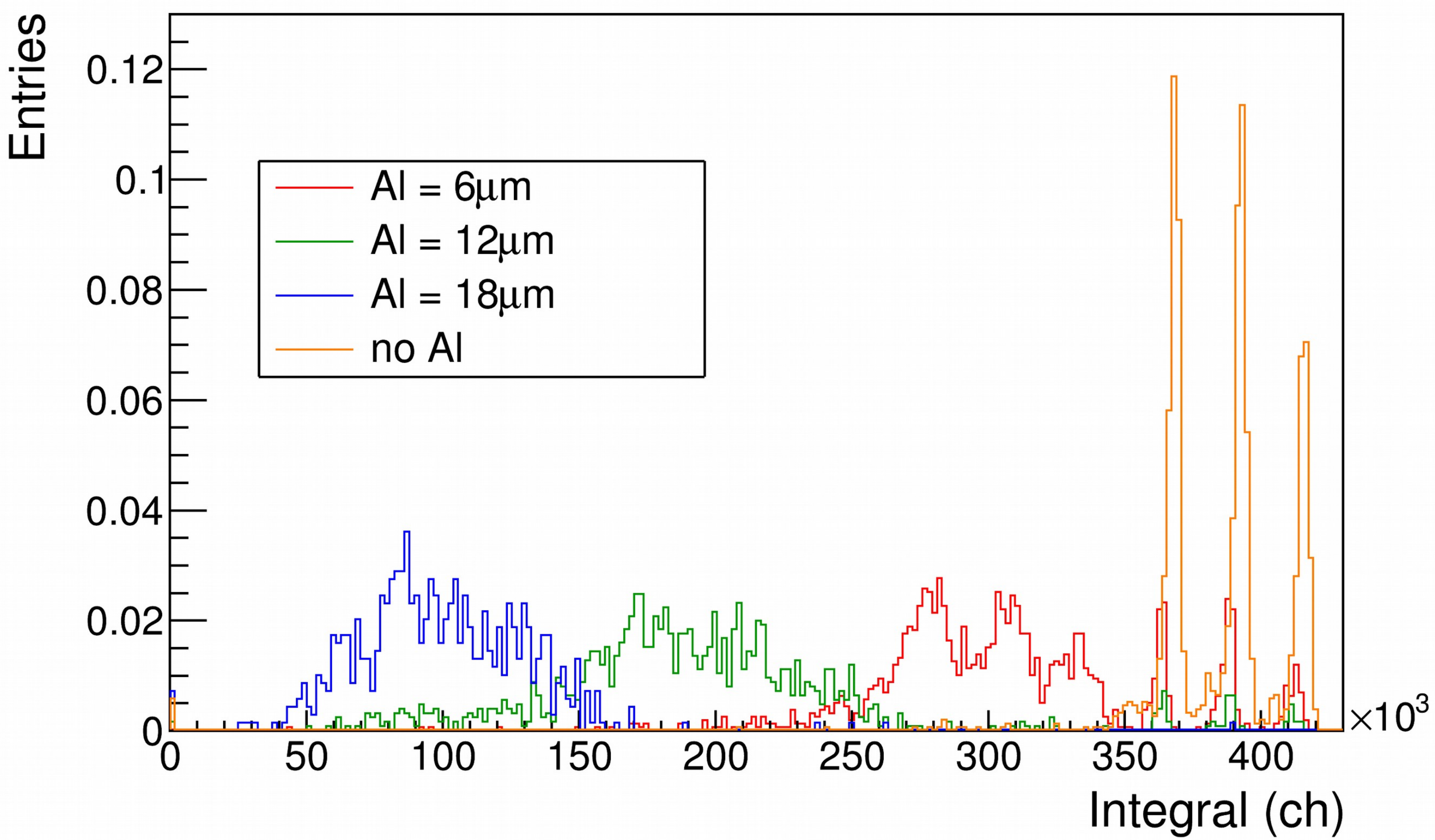
Sectors 7-8-9 tested at LNS with a dedicated configuration:

1. Vacuum chamber
2. **Three-peak alpha source**
3. **Particles injected in the rear side (16sectors)**
4. Calibrated aluminum foils to degrade the alpha energy
5. Acquiring data for one or two sectors at the same time (DAQ has only 2 channels)

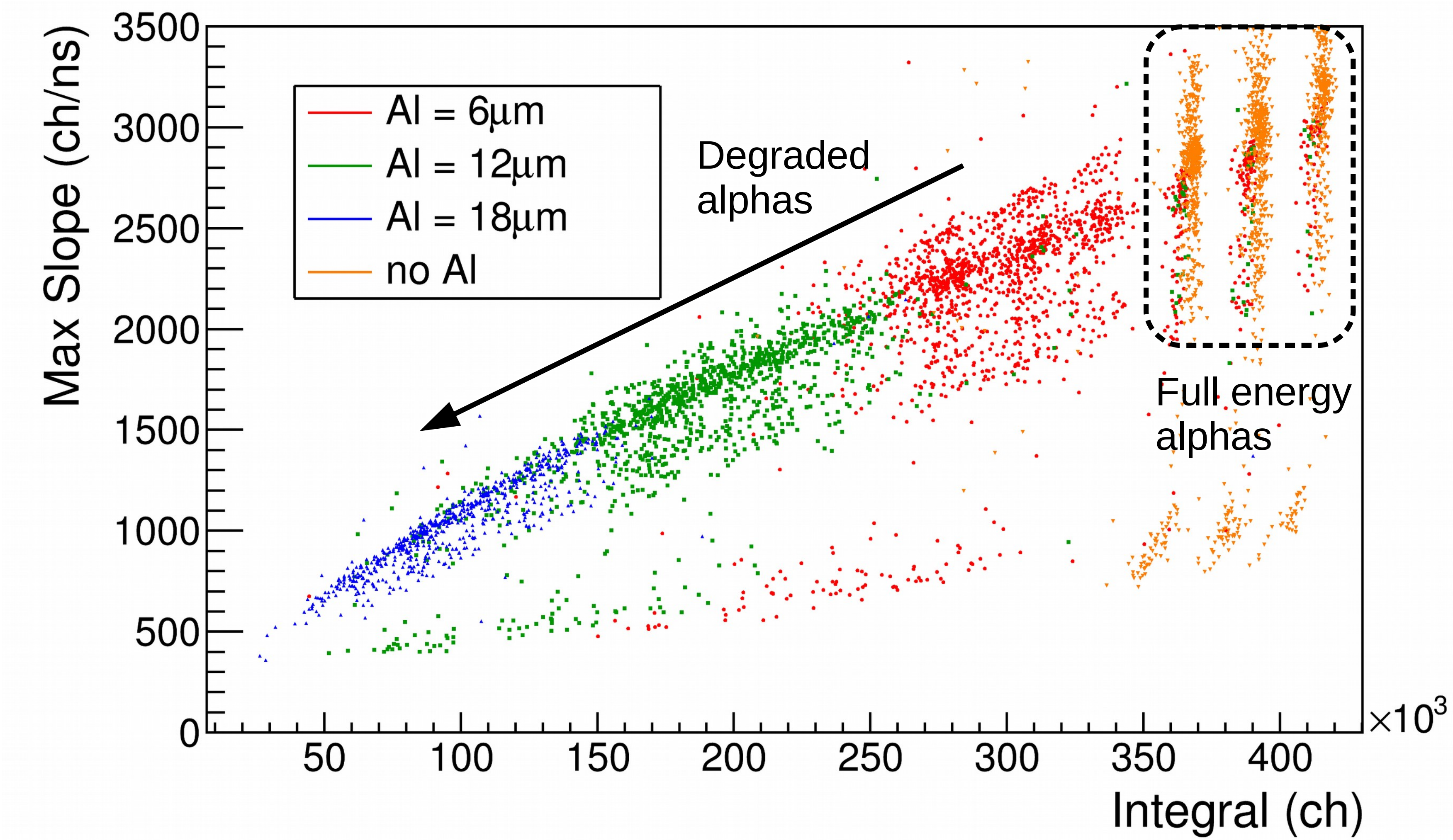


# Integral sector8

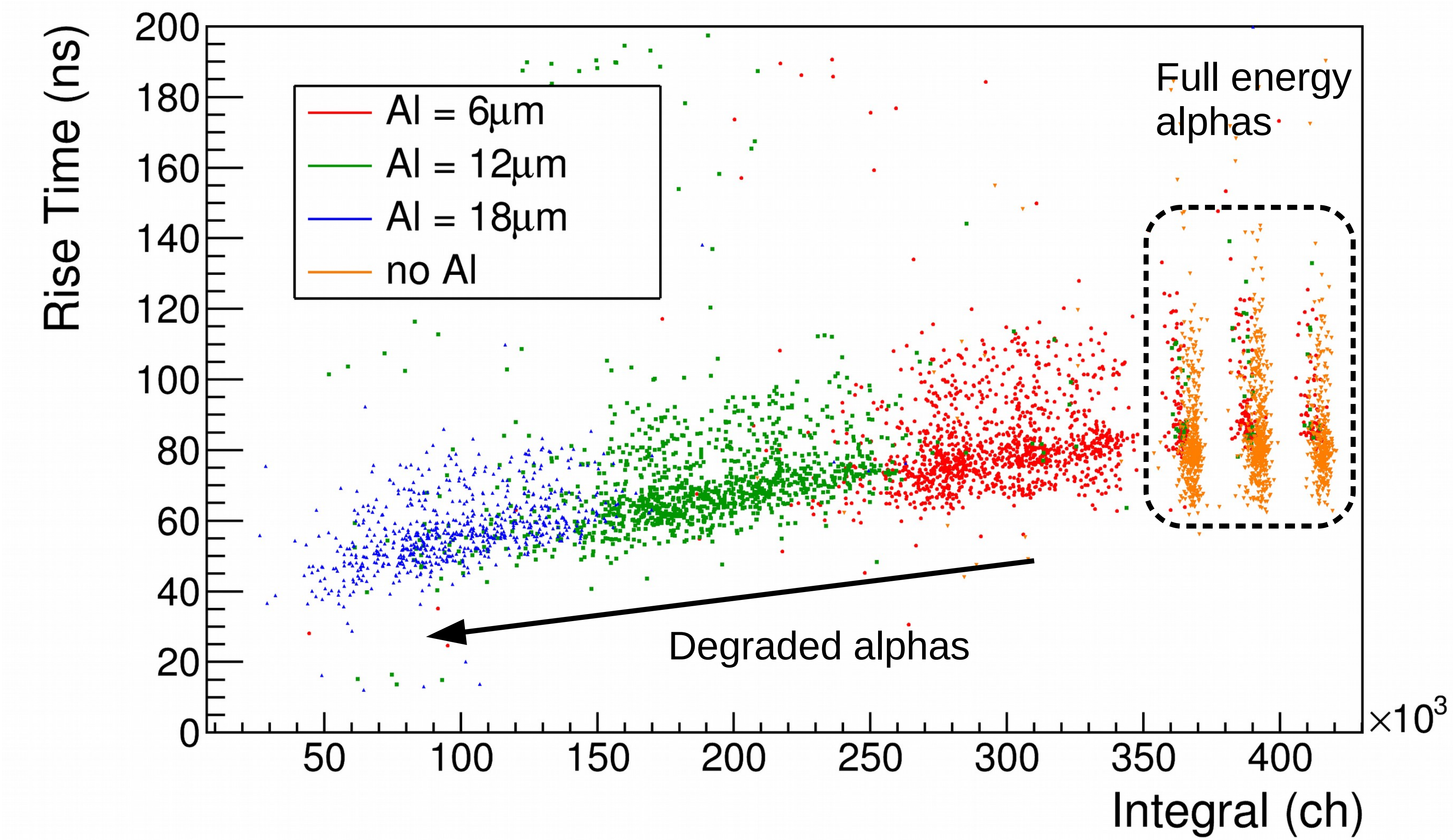
$V_{bias} = V_{depl}$



# Max Slope vs Amplitude



# Rise Time vs Amplitude



# Activities for future

**Really a lot of work!**

1. Test **other strips and sectors** of the annular detector

2. Test **annular with a LiF** sample and the neutron source at LNS

3. Improve the **LNS Signal Analyzer** and optimize the parameters used for the analysis

4. Systematic study to find the **ideal working conditions** (in particular concerning the $V_{bias}$)

5. **Quantify the resolving power and the energy threshold**

6. Test the technique **at CERN with n_TOF DAQ** (and implement some the required features in the n_TOF PSA routine)

7. **Optimize the read-out**

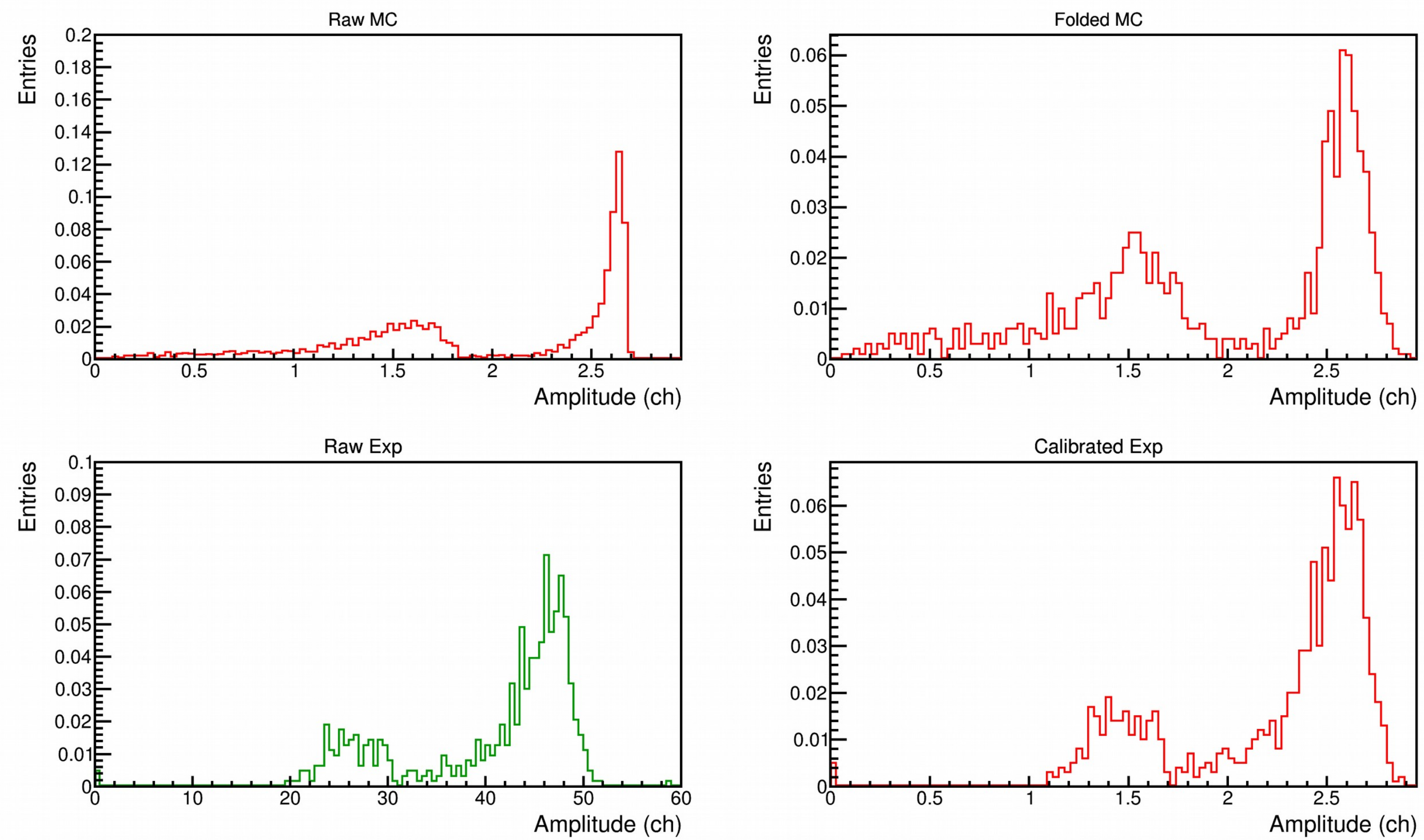
8. **Test with accelerators** to discriminate light particles

9. Study the **annular efficiency**, **inter-strip events,** etc...

# Interaction between sectors

# Backup - Calibration

A (fast) MC simulation has been made to calibrate the detectors, a good agreement has been obtained (top and bottom right panels).



# Amplitude sector8

$V_{bias} = V_{depl}$