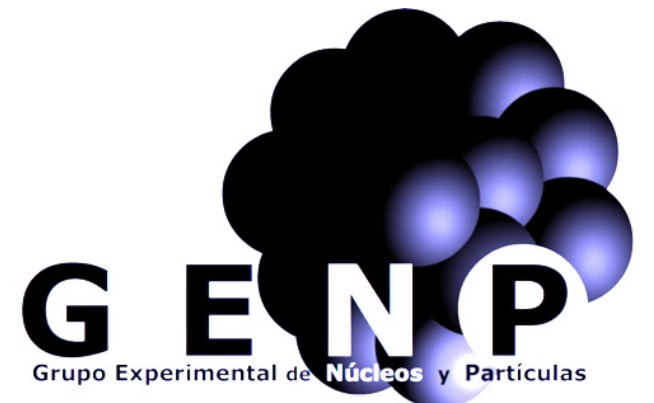


# $(p,2p)$ events in the CALIFA calorimeter

## Experiment s455: Analysis Report



## 1. Experimental set-up

## 2. Analysis of the $^{238}\text{U}(p,2p)^{237}\text{Pa} + \text{fission}$ channel

### 2.1. Timestitching issues & data sorting

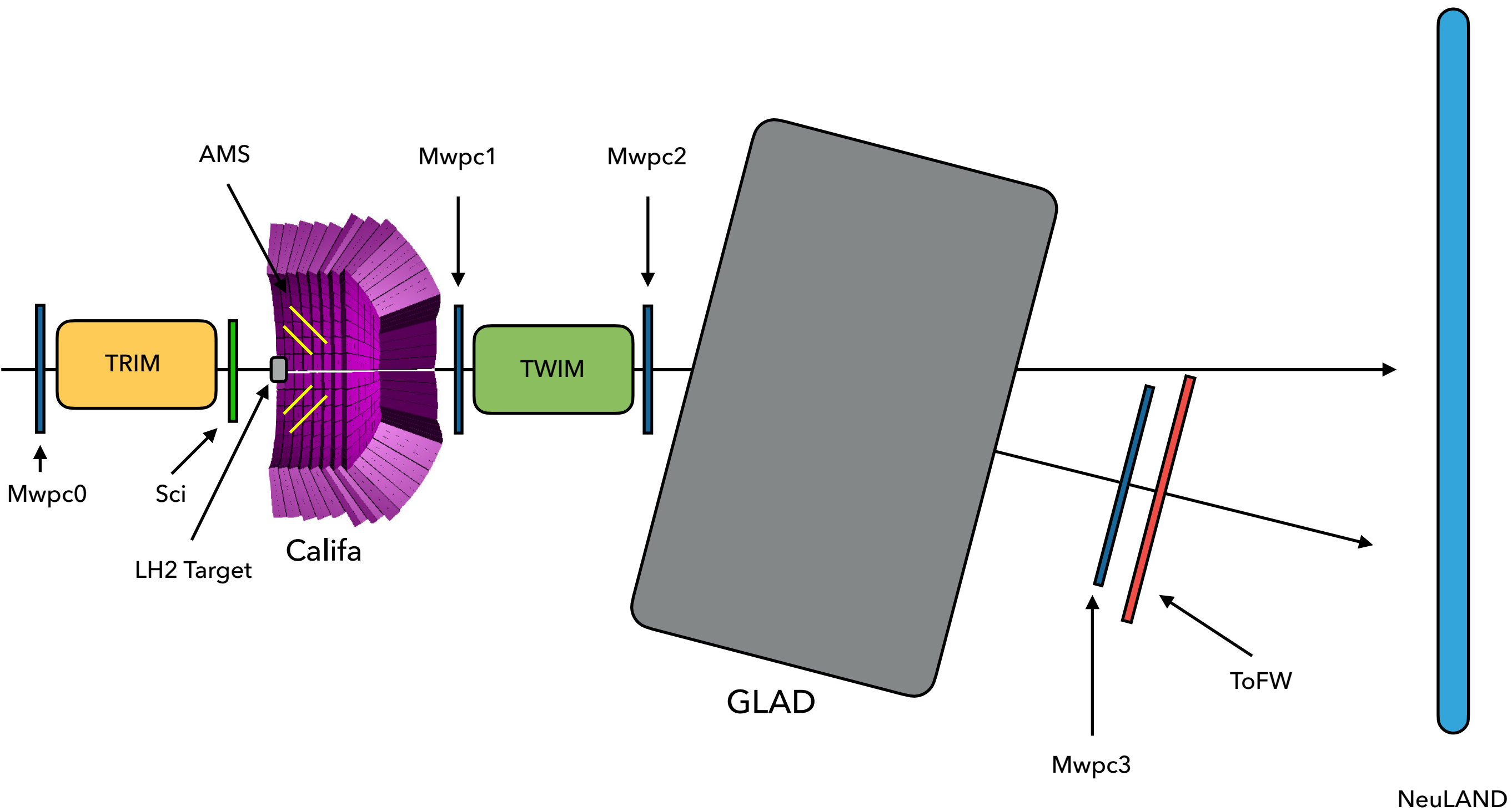
### 2.2. Event selection

### 2.3. Angular correlations

## 3. Simulations

### 3.1. INCL

## 4. Preliminar results and next steps



During the experiment we saw a strange behaviour in CALIFA :

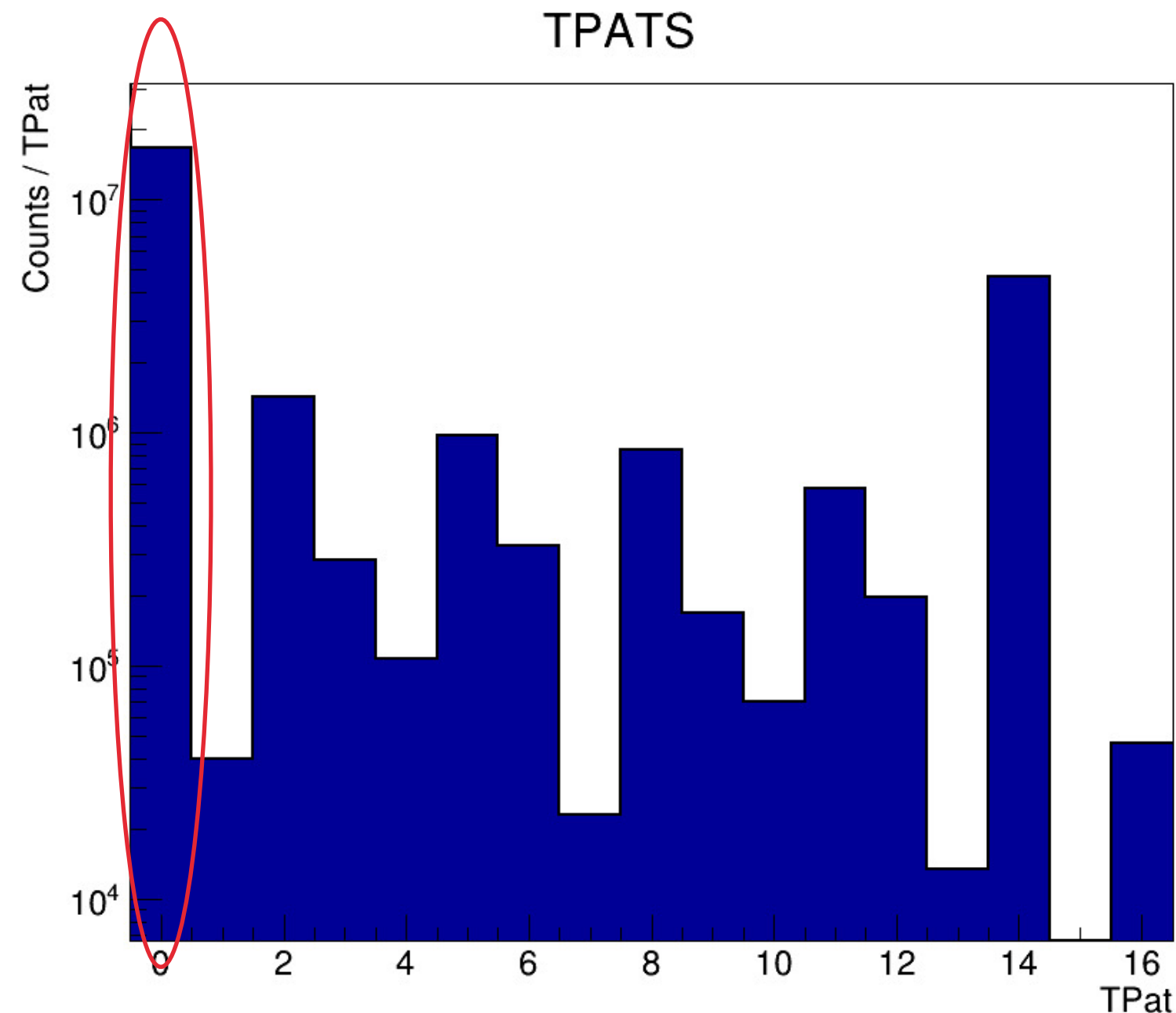
- High energy sum per event : more than 1 GeV for some events
- High Multiplicities : events with more than 200,400,600... crystals with signal

This lead to an exhaustive investigation about how Califa events were time stitched .

A solution arrived from Munich group as a new time stitching procedure for Califa



Another problem: looking at the TPat distribution :



1. Here TPat 0 means events not correlated with any other detector, coming from CALIFA
2. Those events represent a ~96 % of the files.
3. An option into R3BUcesbSource has been added to skip those events
4. With new Califa's validation trigger this should not happen again

Another problem: looking at the TPat distribution :

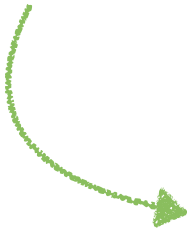
Message ID: 857    Entry time: Sat Mar 20 14:43:34 2021	
Author:	Håkan
Category:	DAQ
Experiment:	s455
Phase:	Experiment
Subject:	Data rates (amount)

The origin of the data sizes stored to disk  
(averages taken over 105 s):

ID	System	EB/node	Avg ev ev/s	Avg data MB/s	Fraction
==	=====	=====	=====	=====	=====
10	MAIN	lxir133:7700	1679.7	0.520	0.3 %
06	AMS	lxir133:7740	435.6	2.372	1.6 %
11	NL	lxir133:7790	1674.1	4.144	2.8 %
0e	SOFTOF	lxir133:7800	1700.9	0.246	0.1 %
0f	SOFMESY	lxir133:7850	1689.6	1.195	0.8 %
02	S2	r4l-13	1691.5	0.235	0.1 %
0a	CALIFA_M	x861-75	177.1	72.531	50.3 %
0b	CALIFA_W	x861-76	246.7	64.228	44.6 %
--	Total	lxlanddaq01	9354.6	143.915	100 %

1. Here TPat 0 means events not correlated with any other detector, coming from CALIFA
2. Those events represent a ~96 % of the files.
3. An option into R3BUcesbSource has been added to skip those events
4. With new Califa's validation trigger this should not happen again
5. Now we skip events without TPat in R3BUcesbSource

Plan : Select events with  $(p,2p)$  condition

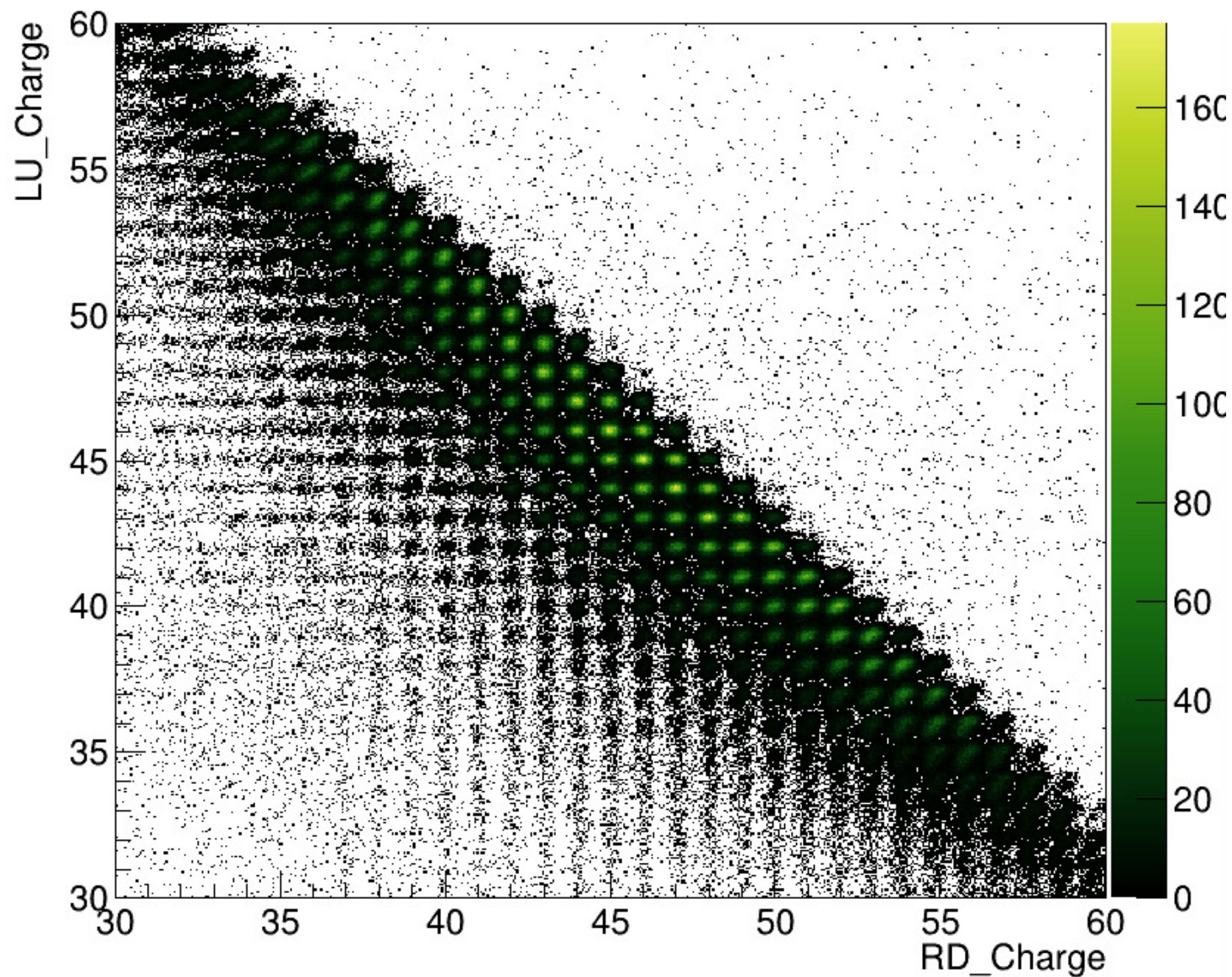
- 
- ▶ At least two hits, with at least 2 crystals with more than 100 MeV deposited
  - ▶ Calorimetric Sum must be under 600 MeV
  - ▶ Coplanar Hits within  $\pm 15^\circ$
  - ▶ Two Hits in the TWIM + Z Sum  $\in (90.5, 91.5)$ , after a proper calibration (Antia's talk)
  - ▶ TPat 4 or 10 (Sof Start + Sof Fission + Califa AND)
  - ▶ Reasonable number of crystal Hits
  - ▶ NO Conditions on polar angles



And see what happens with the **opening angle** distribution

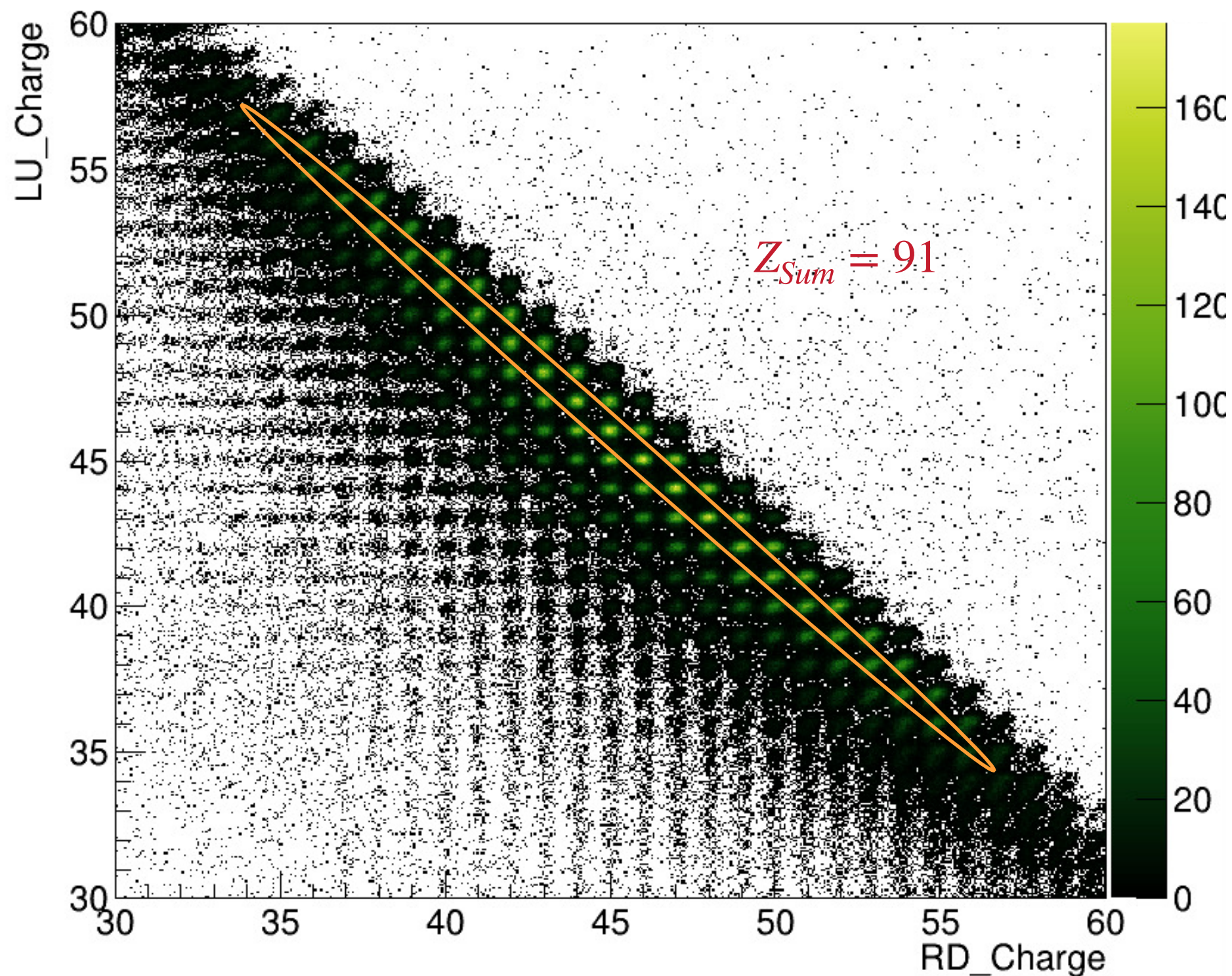


TWIM: Charge Vs Charge (LU\_RD)

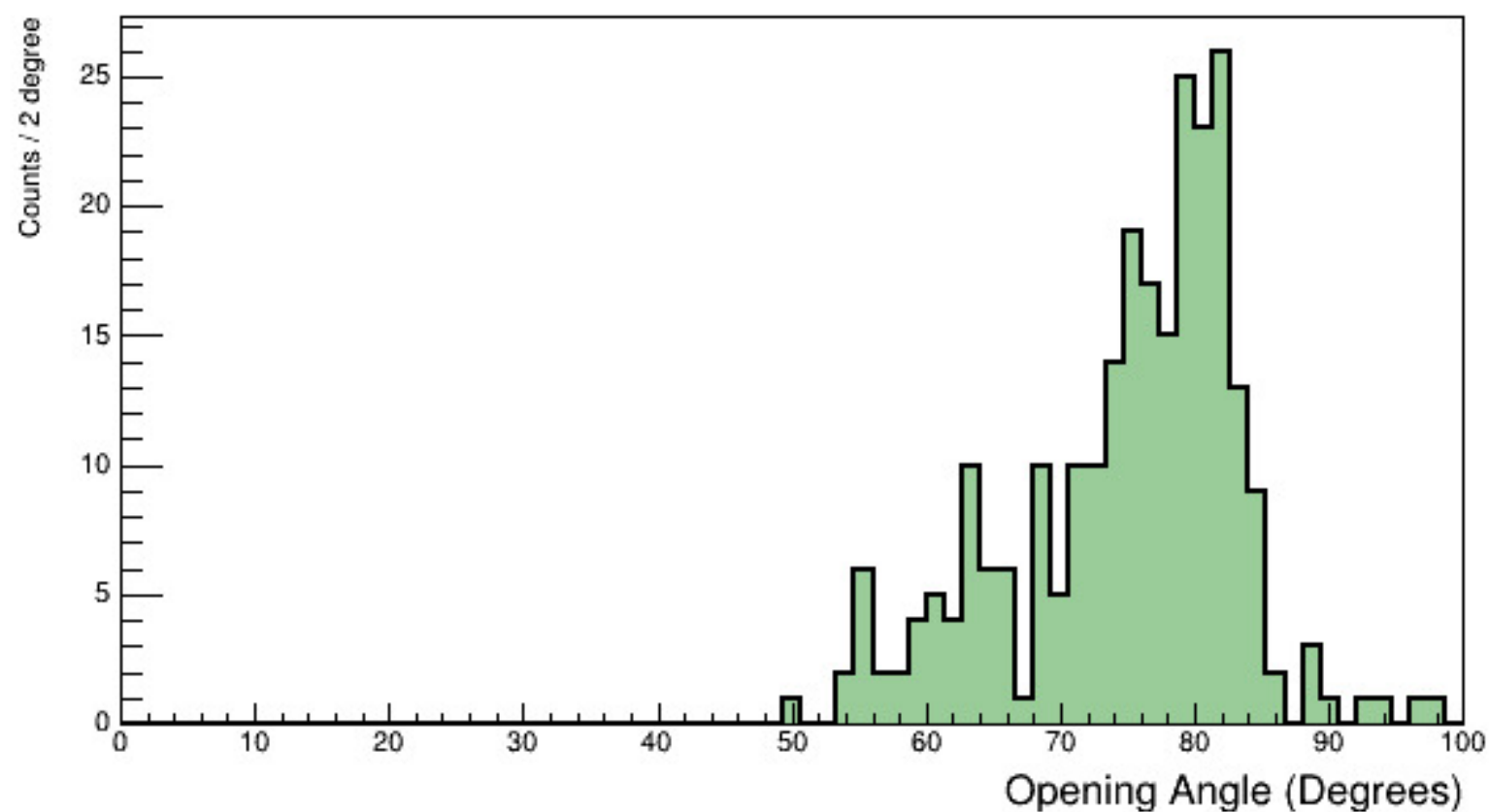




## TWIM: Charge Vs Charge (LU\_RD)

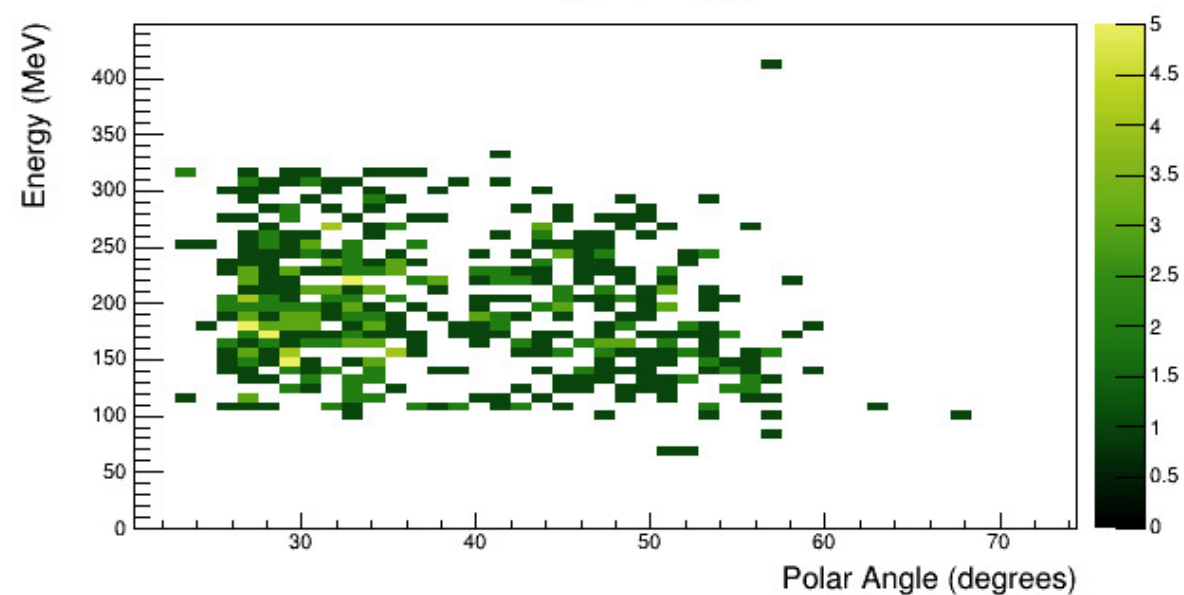


Opening Angle

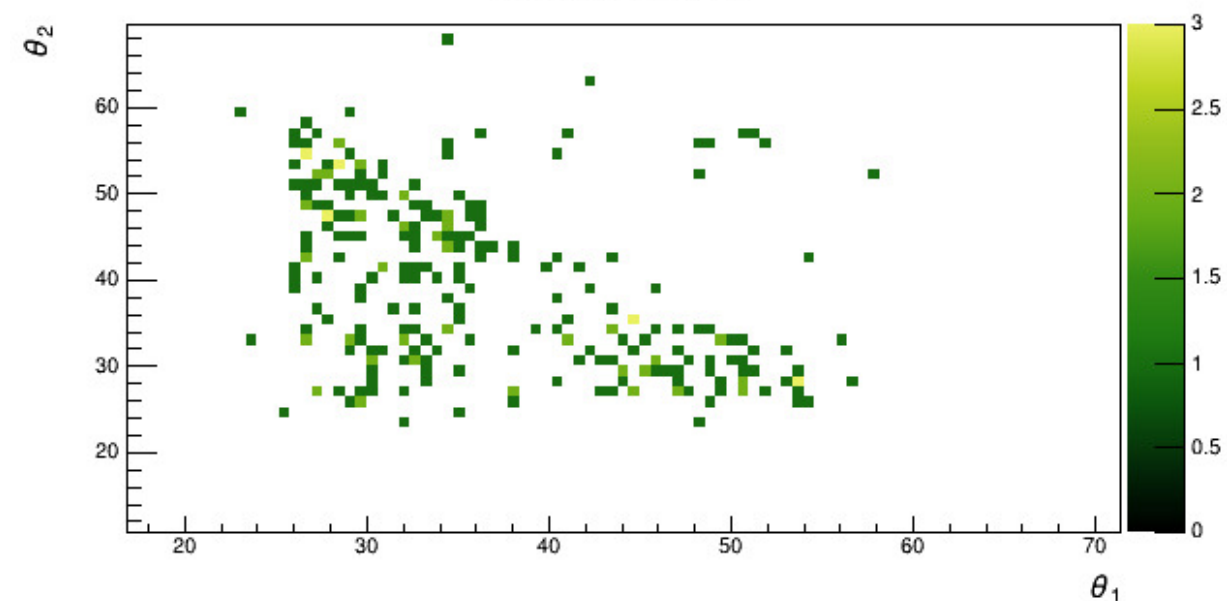


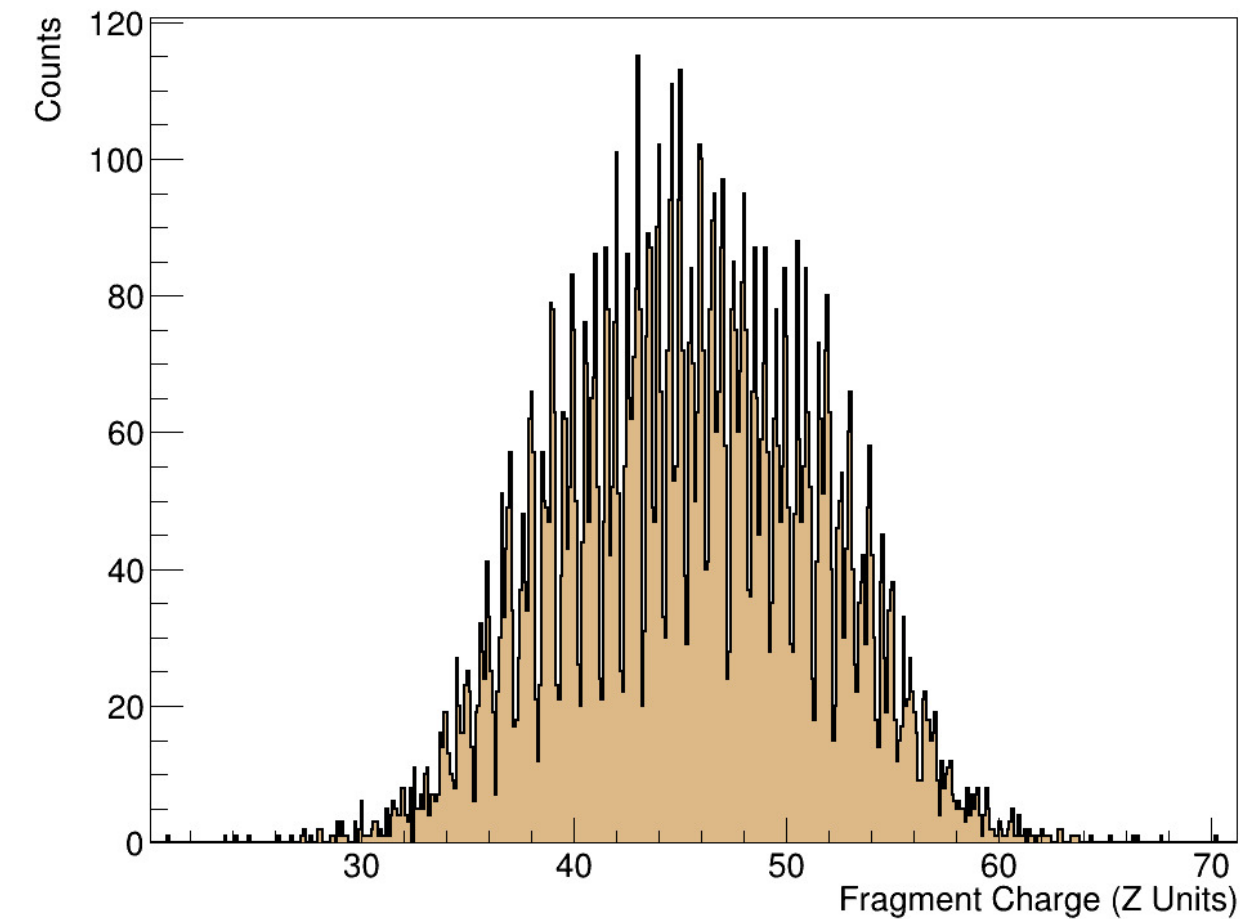
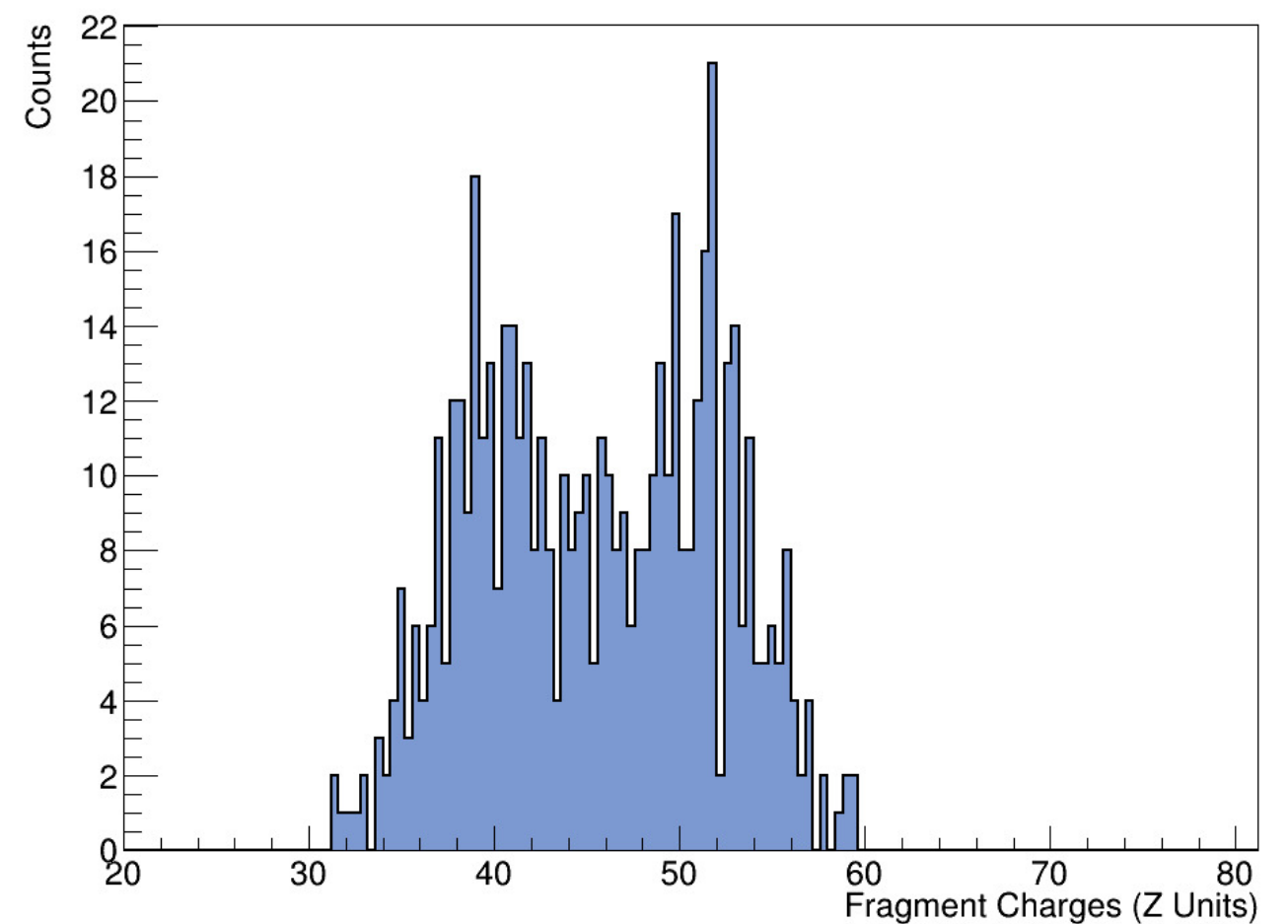
Opening angle seems to be well reconstructed

Angle Vs Energy



Angular Correlations



Fragment Charge Distribution :  $Z_{Sum} = 91$ Fragment Charge Distribution :  $Z_{Sum} = 91$ 

+

 $(p,2p)$  Conditions

**Asymmetric Fission  $\rightarrow$  Low excitation energy  $\rightarrow$  Coming from Proton knockout**

Let's now compare with INCL simulation :

### INCL

- ▶ IntraNuclear Cascade model
- ▶ Full reaction simulation
- ▶ More realistic, rescattering is included
- ▶ Can be used to simulate Califa real response to particles coming from a  $^{238}\text{U} \rightarrow \text{LH2}$  reaction.

Select good events

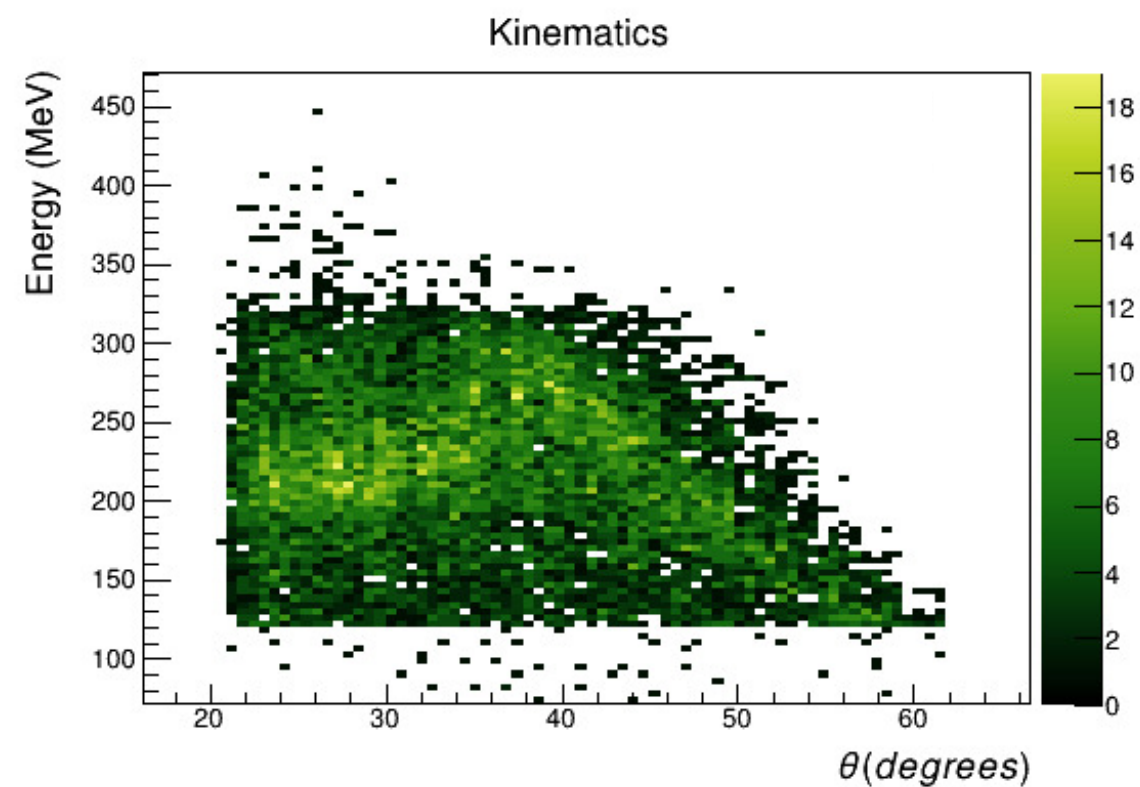
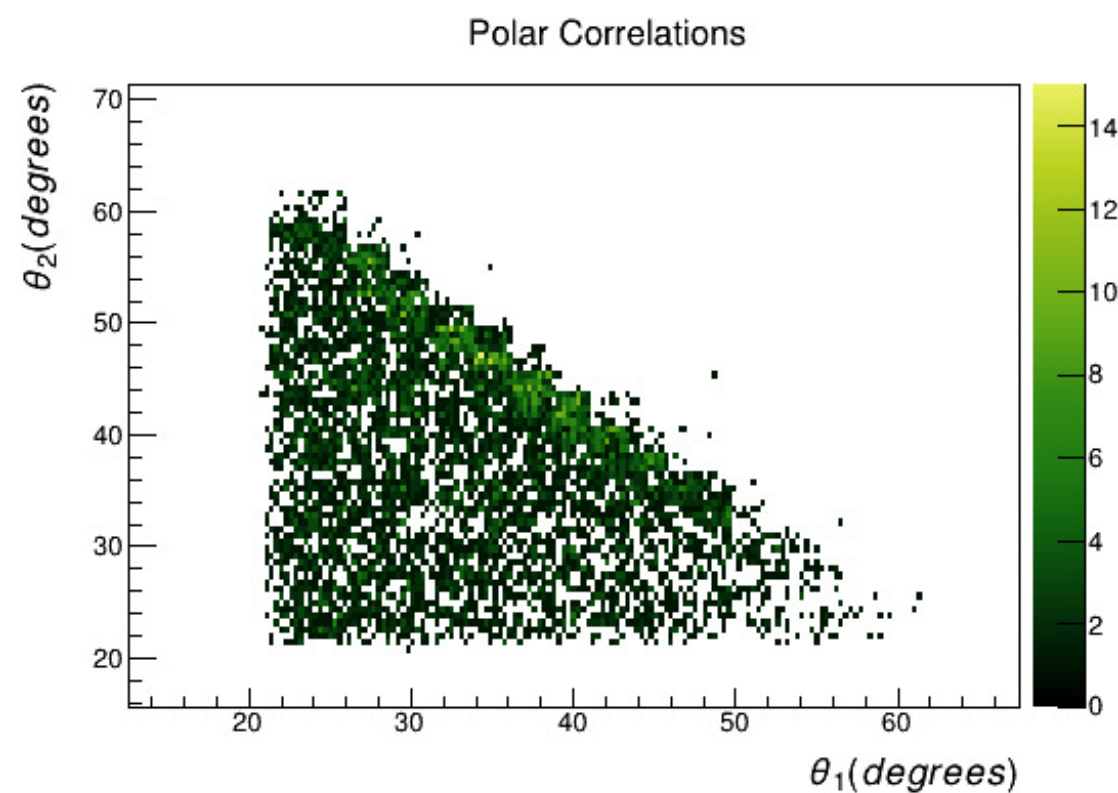
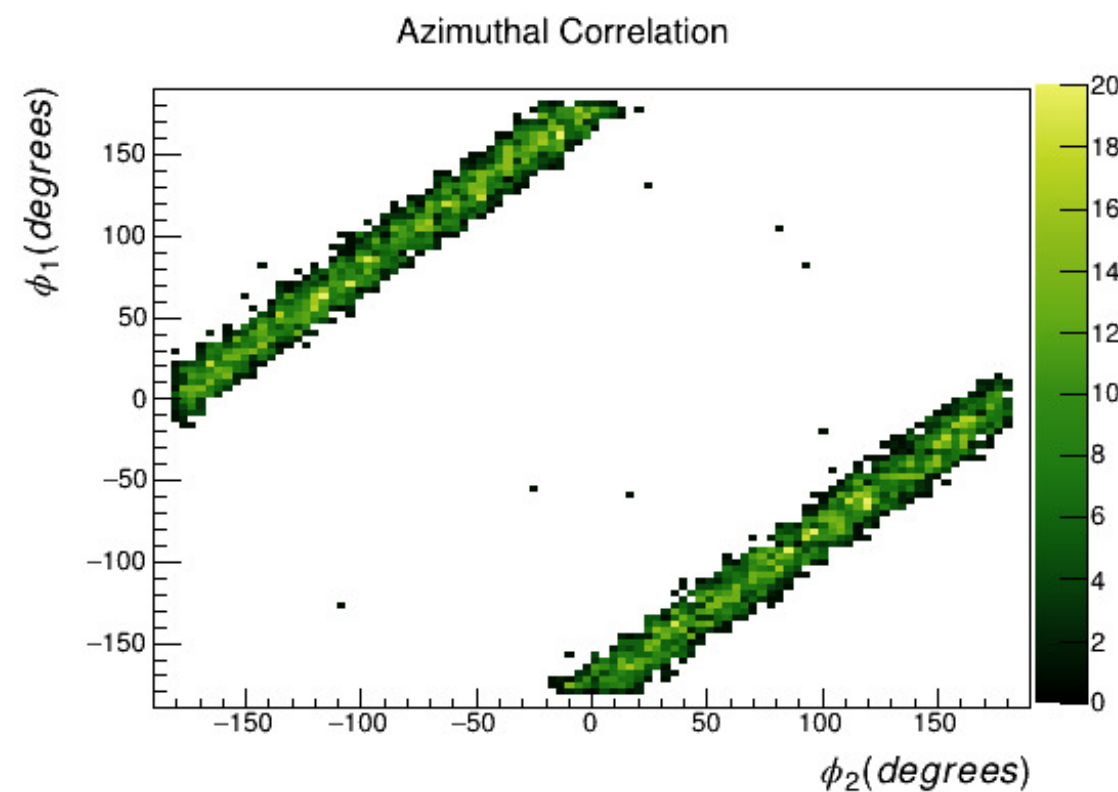
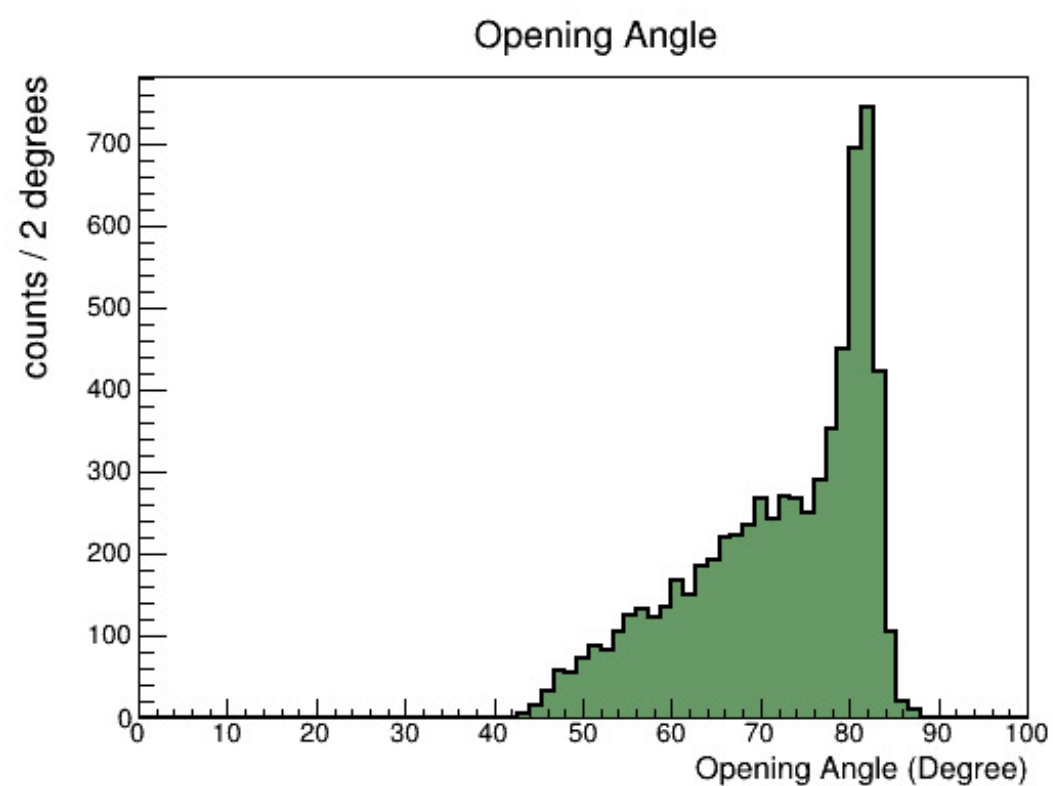


### Proton removal + fission:

Two Protons  
+  
Neutrons  
+  
Gammas  
+  
Two fission fragments

 **To the simulation!**







Total reaction cross section can be estimated taking into account califa's efficiency  
for  $(p,2p)$  detection ( 44 % ) :

$$\sigma = 37.58 \pm 2.38 \text{ mb (th. estimation of } \sim 20 \text{ mb)}$$

PRELIMINAR ESTIMATION

**1. Get more statistics**

**2. Start looking at AMS and other buddies**

**3. Improve  $(p,2p)$  selection criteria**

**4. Construct proton reconstruction algorithms for punch-through**

**5. Study effects of DAQ crashes during the experiment**