New data taking with ^{55}Fe

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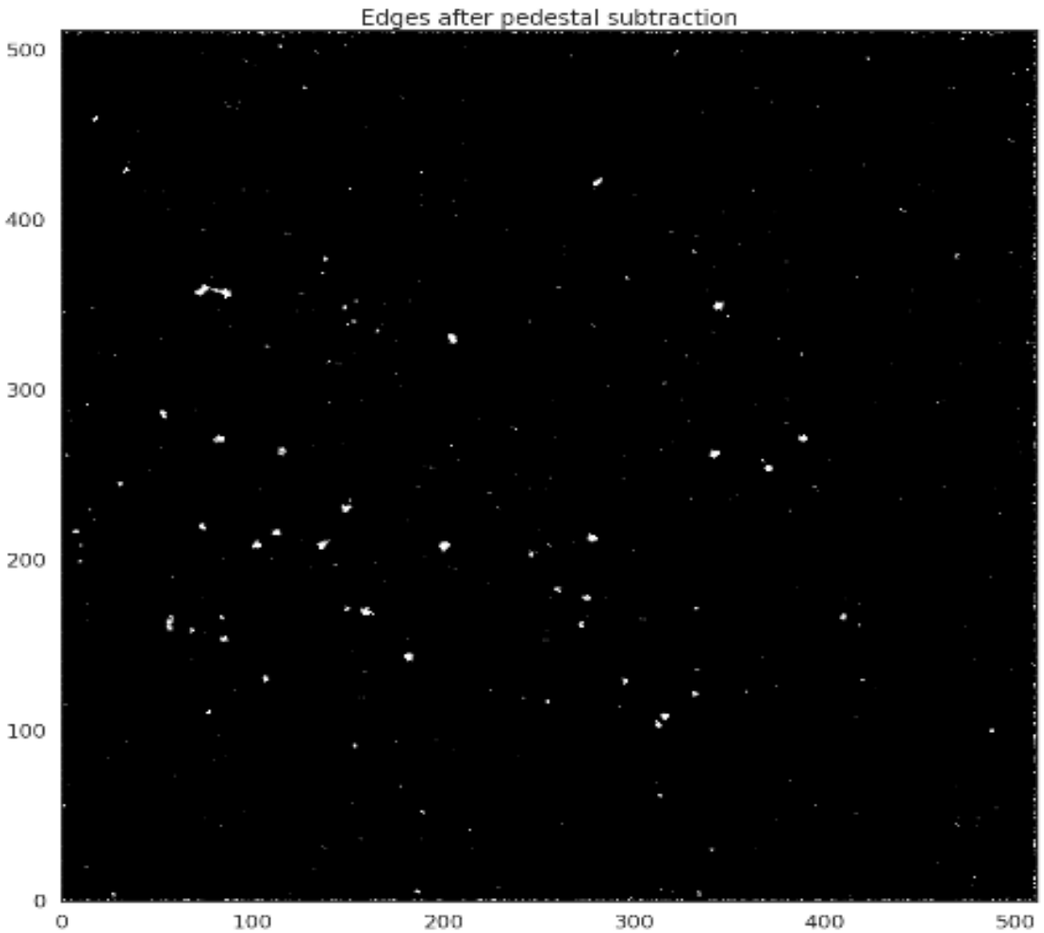
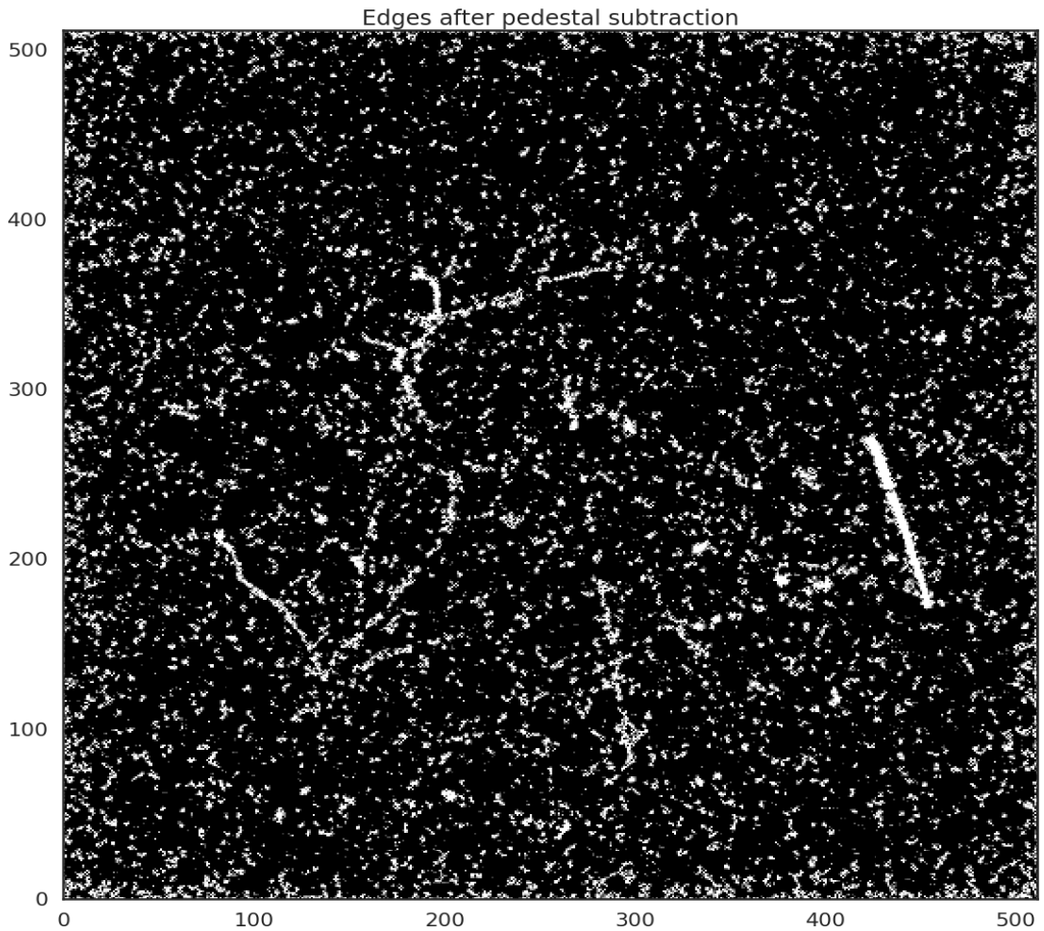
CYGNO meeting, 7 November 2019

Last meeting

- ❏ At last meeting we have report a issue on the data.
- ❏ The issue was that when applied the same preprocessing the output was a clean image in some cases and an image with a lot of noise in others.





Analysis on this issue

- Friday oct/25 we took 4 camera only runs:

  1- with the camera ON for few hours;

  2- just retaken;

  3- restarting the DAQ;

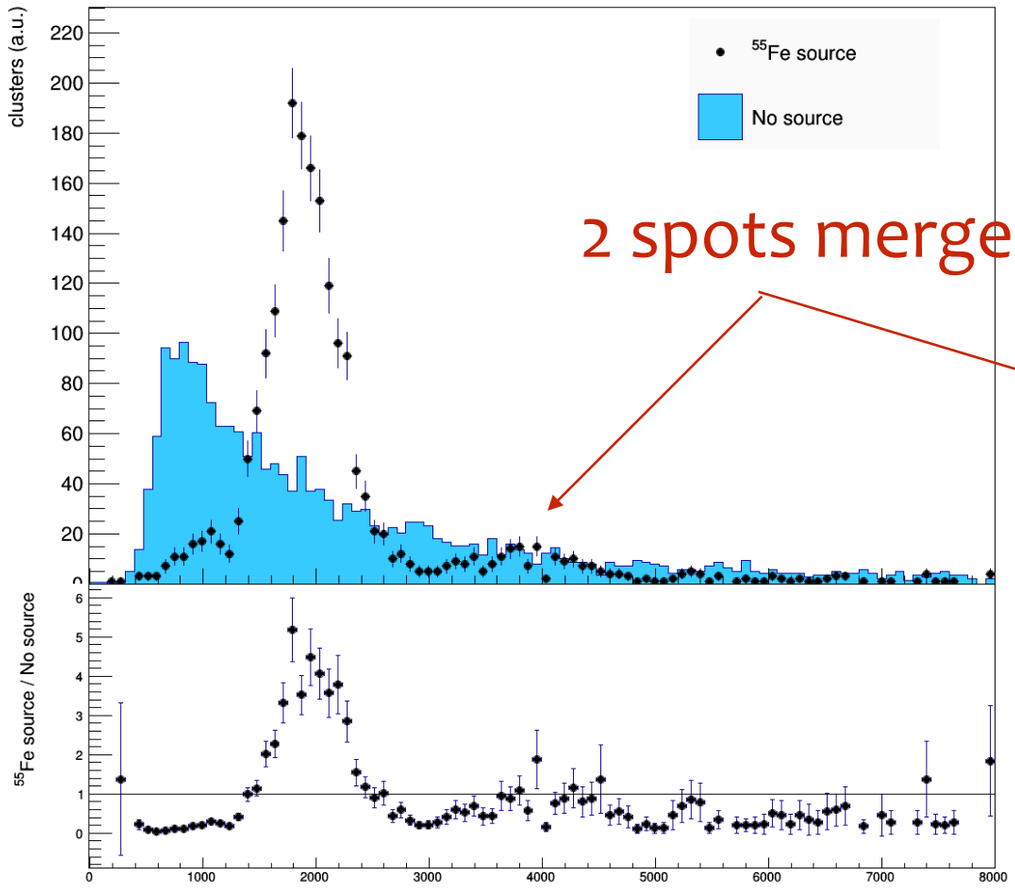
  4- restarting the DAQ and the Camera;

25 October 2019 Orca Flash black			
1631			
1632	131	100	camera only - Camera already ON for some time
1633	100	100	camera only - Just restart the aquisition
1634	100	100	camera only - After restart the DAQ
1635	100	100	camera only - Restarting the CAMERA and the DAQ

- All this runs can be used as pedestals to each other and to the runs taken the week after. So, it seems that turning off/on the camera and DAQ doesn't change the pedestal.
- And for some reason the pedestal is fluctuating, so by now we are taken one pedestal only run whenever we will acquisite data.

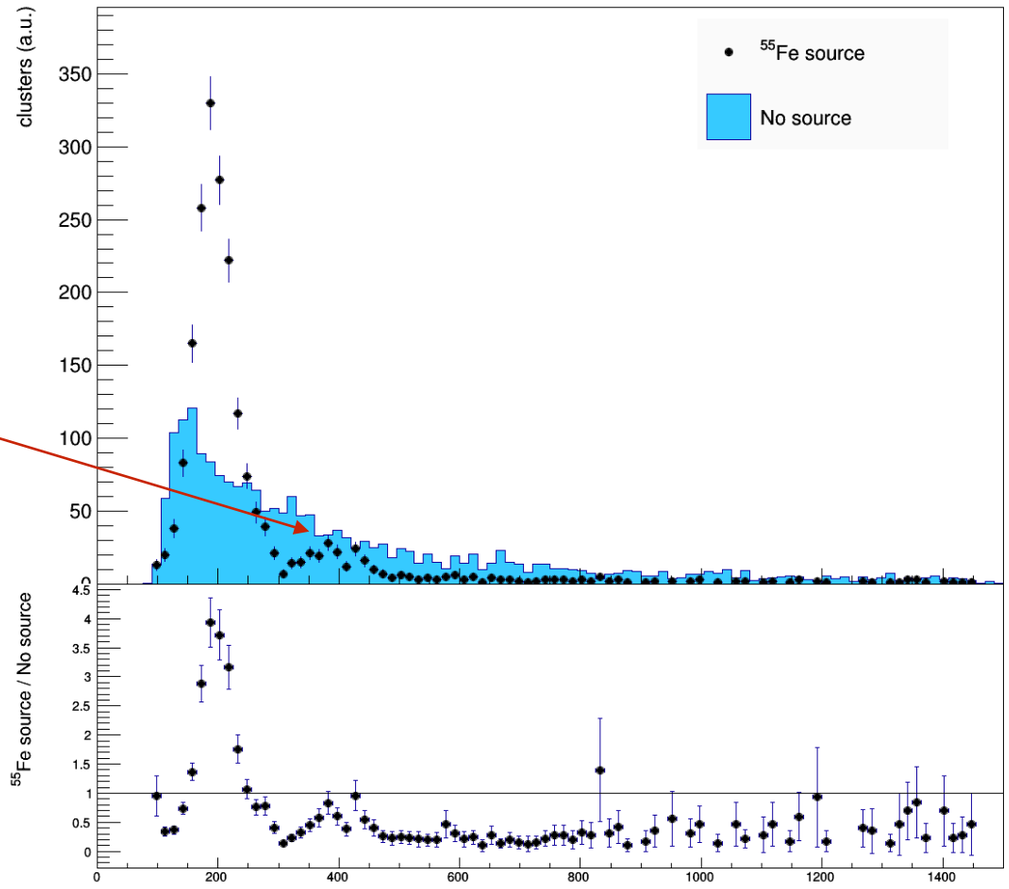
First look at ^{55}Fe

- Clusters from 100 images (100ms exposure) with Fe55 and 1000 images w/o source. Select tight region inside FC (500 x 500 pixels)



light yield~2000 photons

V_{GEM}=460V

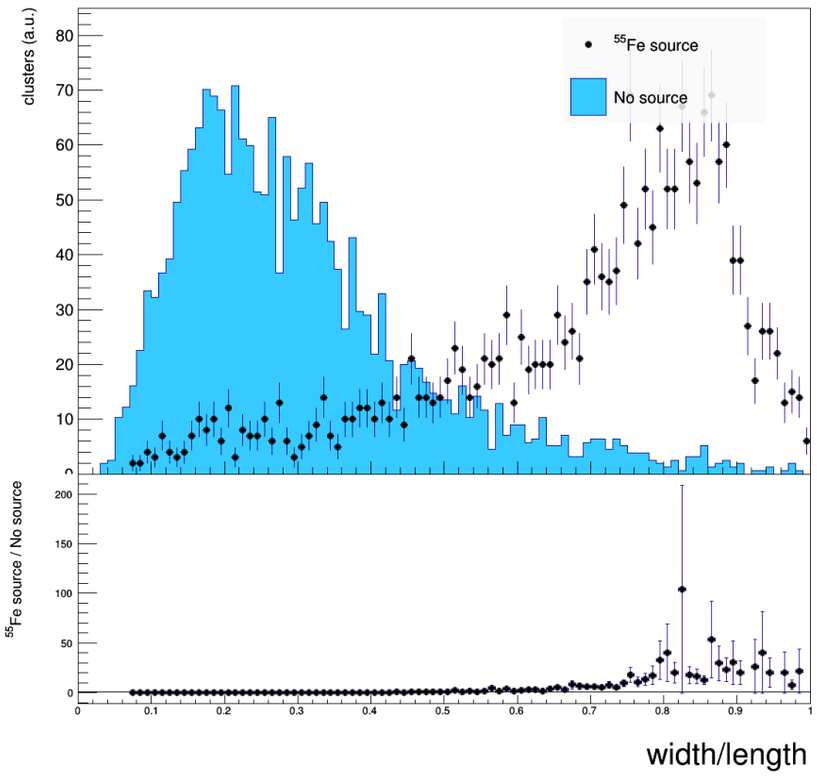


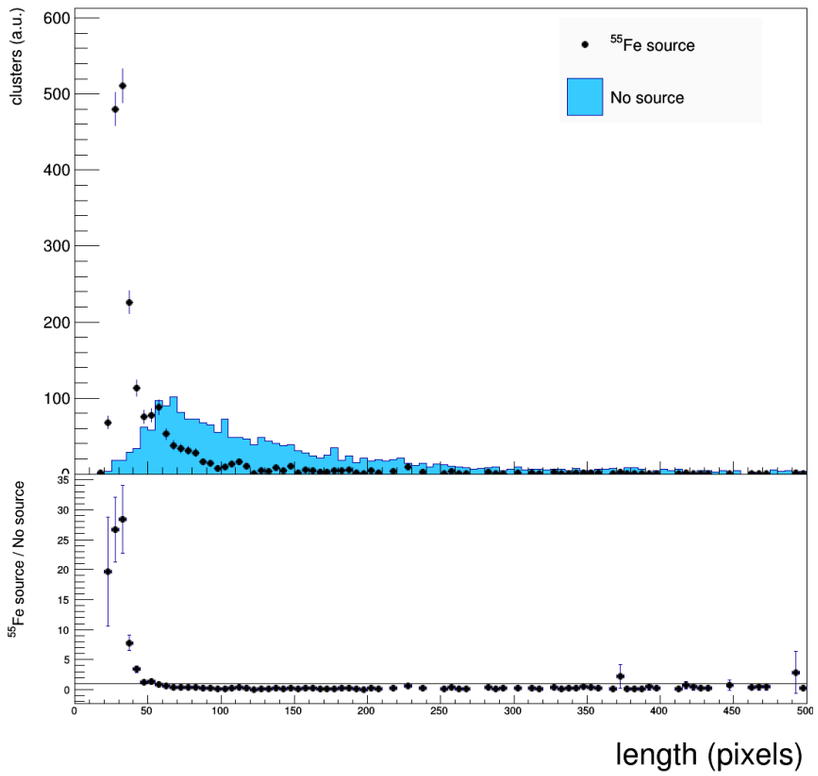
200 pixels/spot

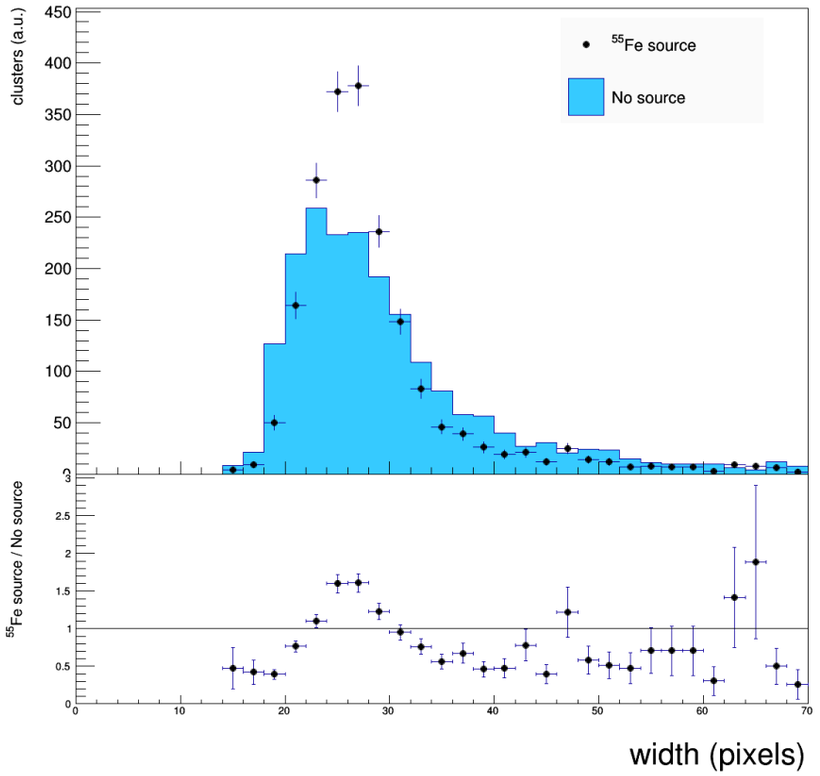
V_{GEM}=460V

cluster shapes

- cluster width/length useful to select “round” vs “snake” clusters.







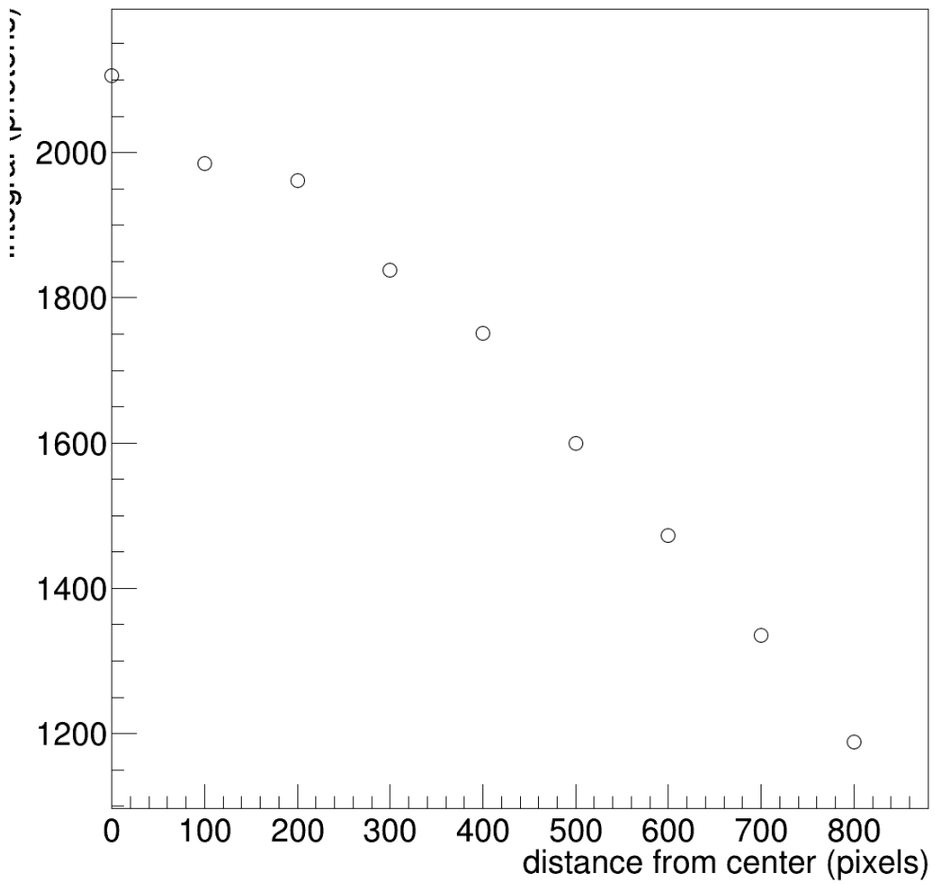
We have data with ^{60}Co

We will compare cosmics vs ^{60}Co

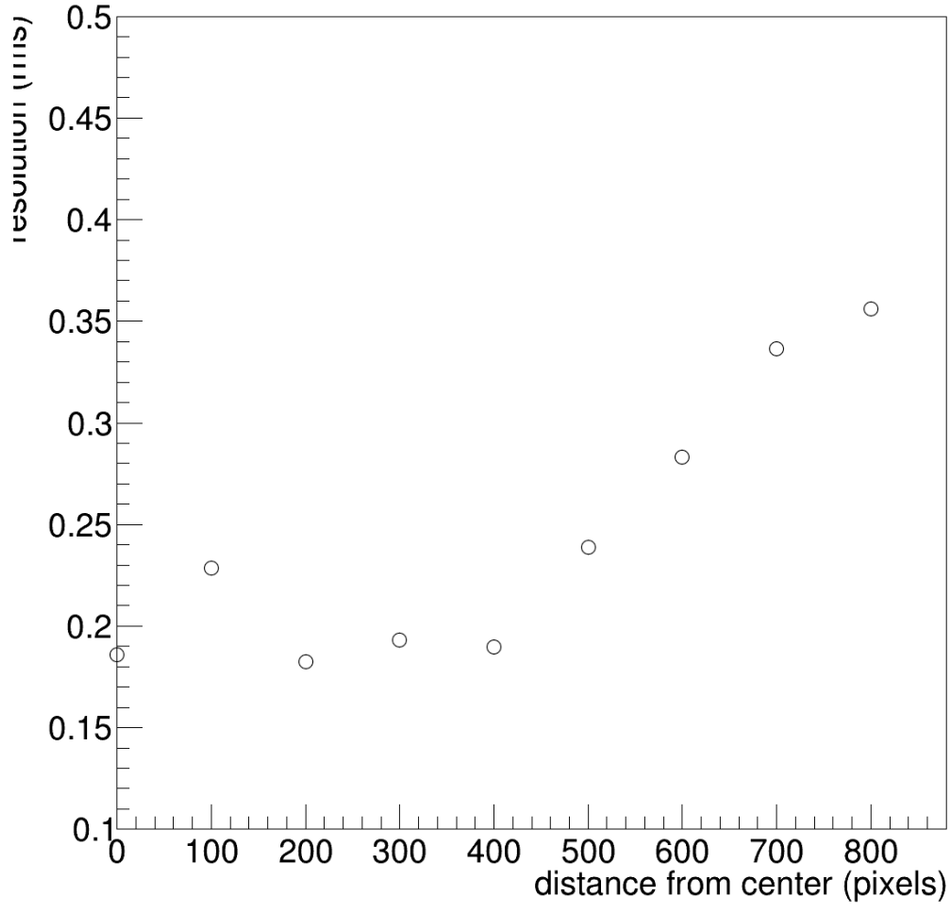
(and we may do a template fit to extract Co yield)

light yield & resolution vs R

- check the energy resolution and light yield as a function of the distance from the center of the field cage
- each point is an exclusive annulus of Rmin<r<Rmax



light yield drops of ~50% from the center to the borders of the FC

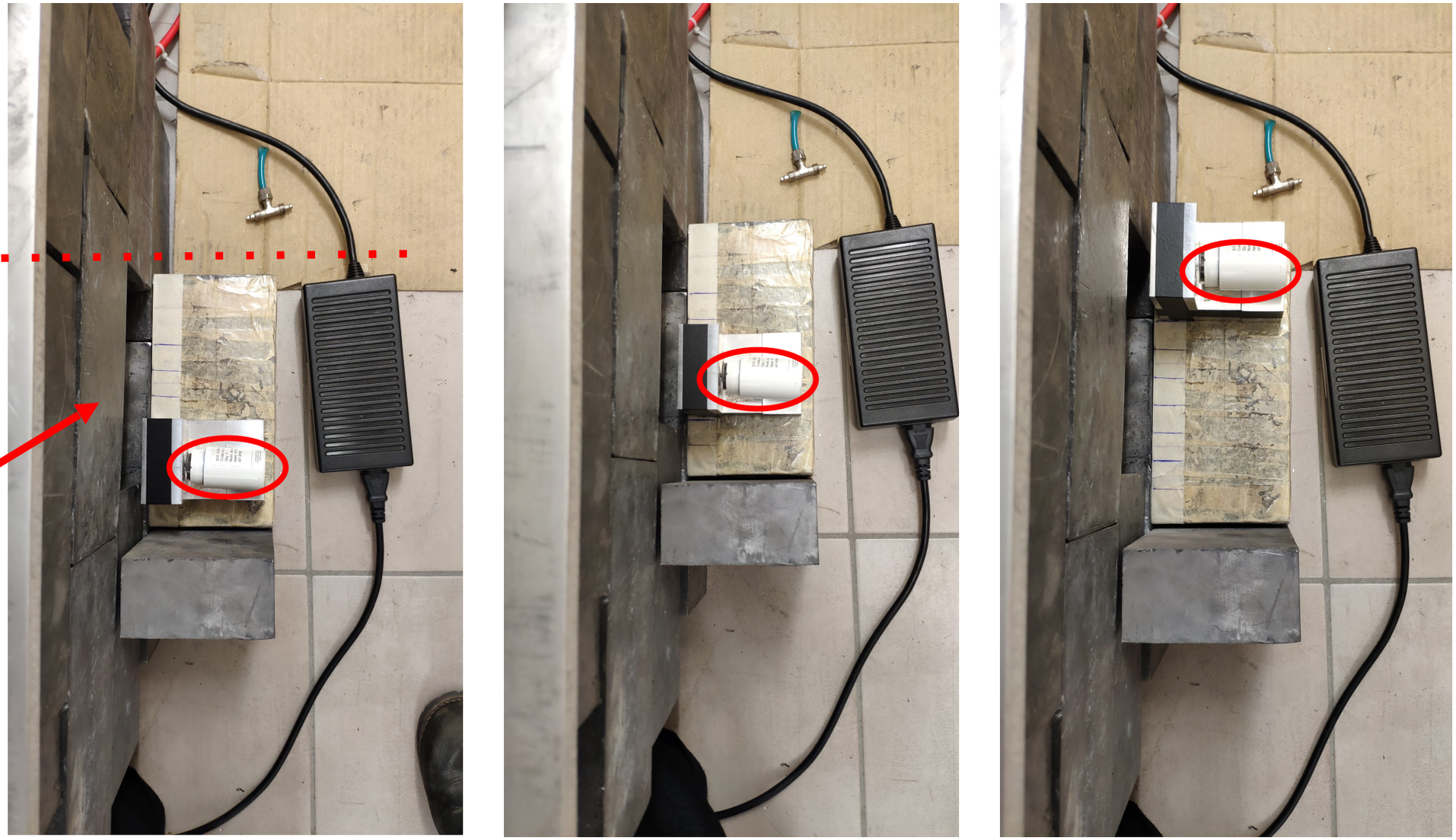


resolution ~20% up to R=500 pix worsens beyond that

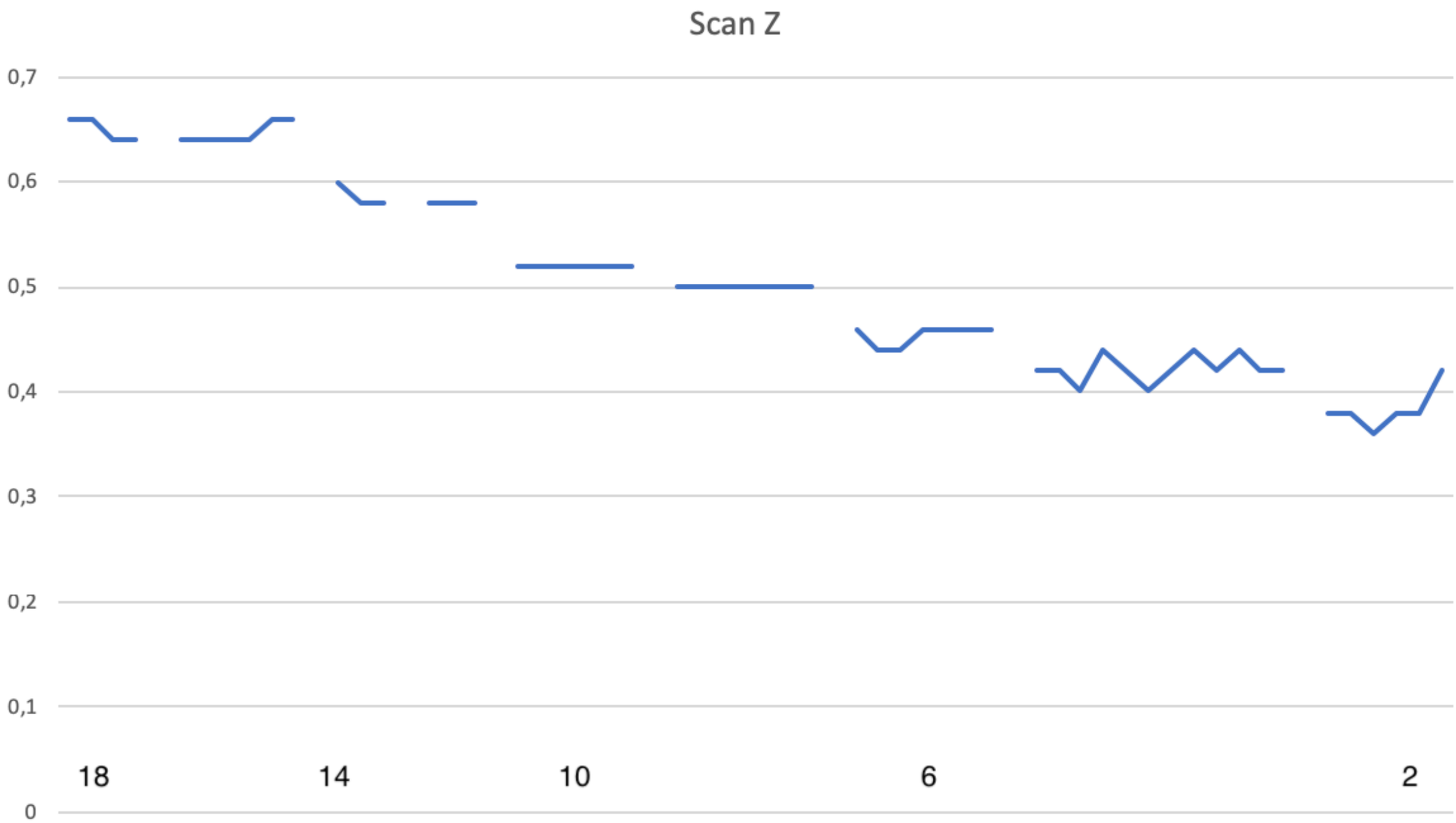
Analysis with 55Fe data placing the source in different positions

GEM

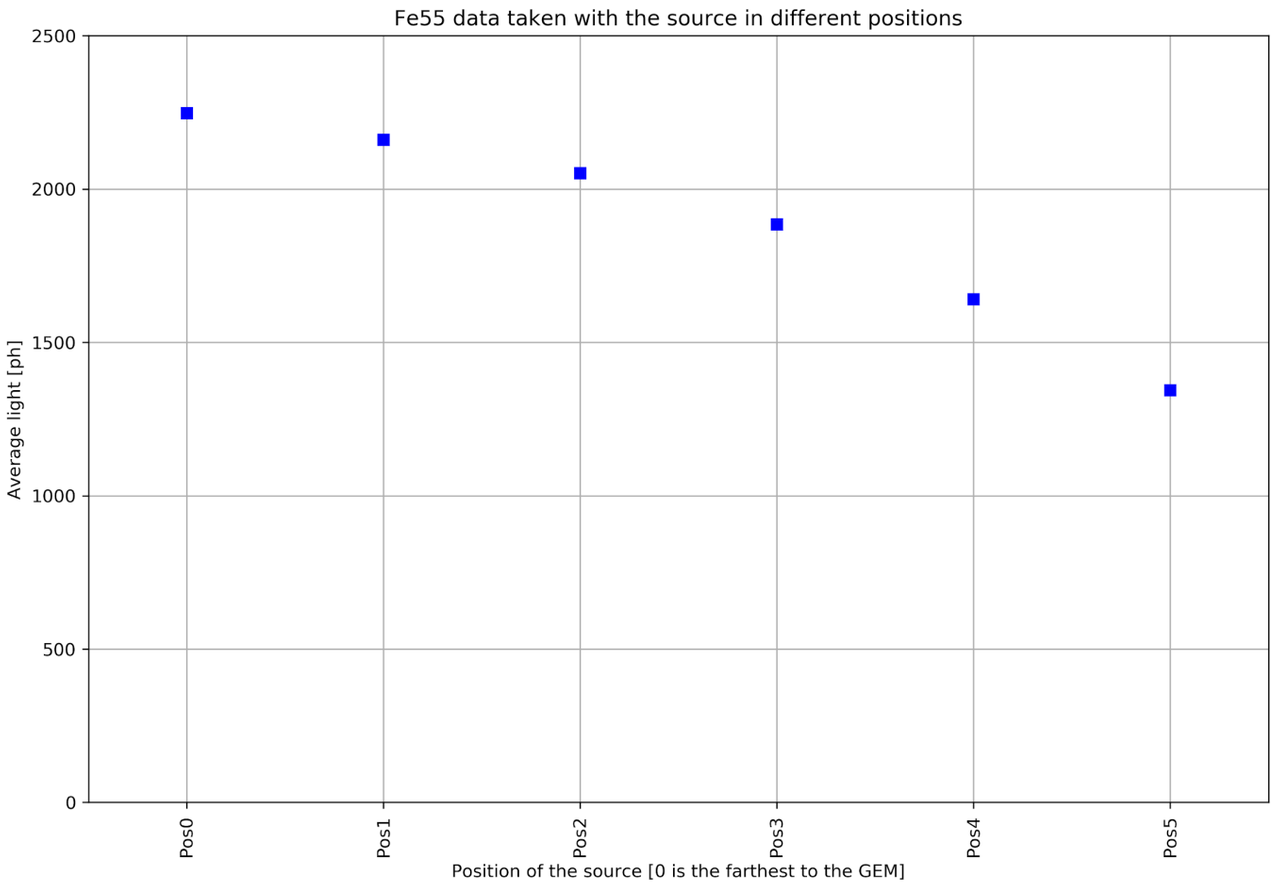
A slot without the Pb brick

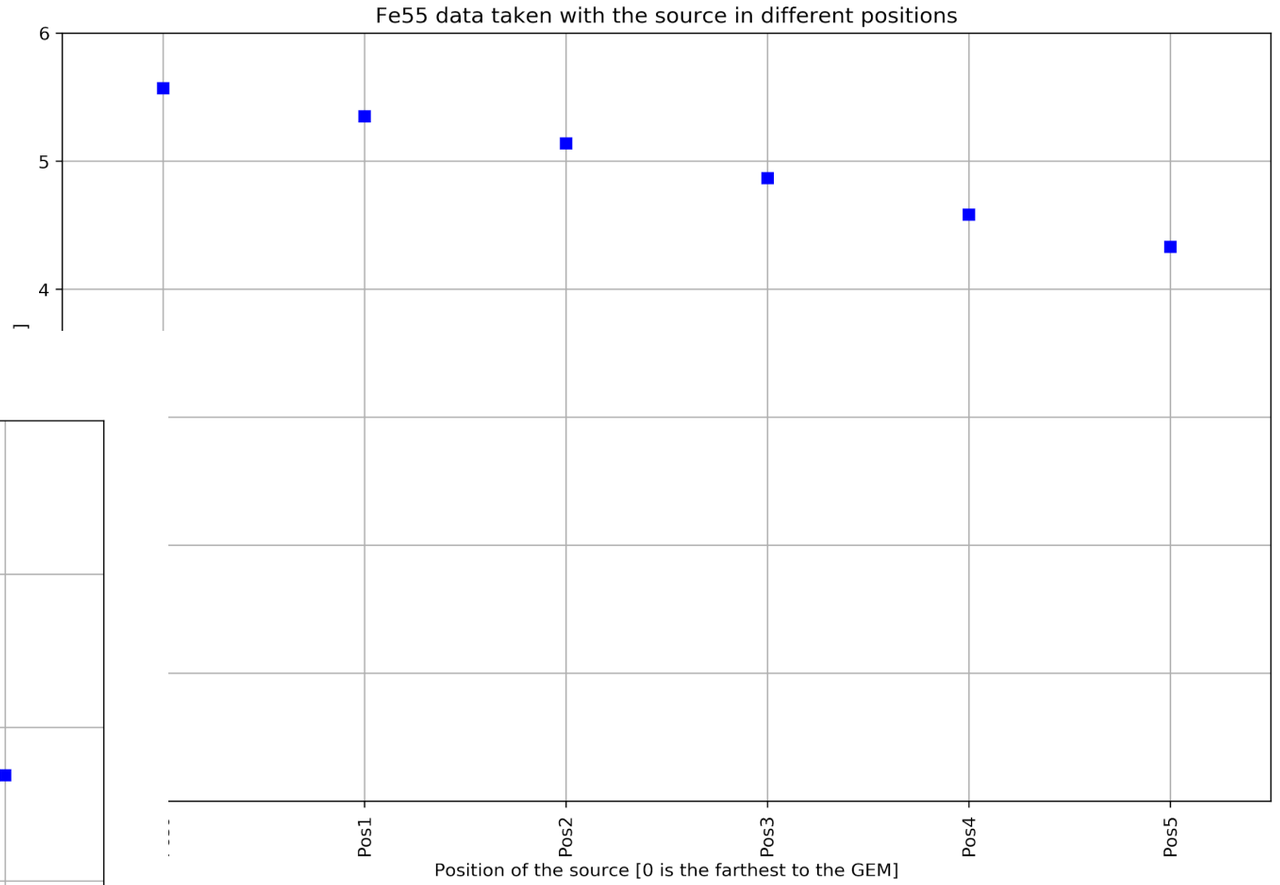


Current drawn with 55Fe data placing the source in different positions



Analysis with 55Fe data placing the source in different





The light and length of the 55Fe spots are decreasing when you move closer to the GEM.

Superclustering (a.k.a. Join The Dots)

&

PMT data with ^{55}Fe

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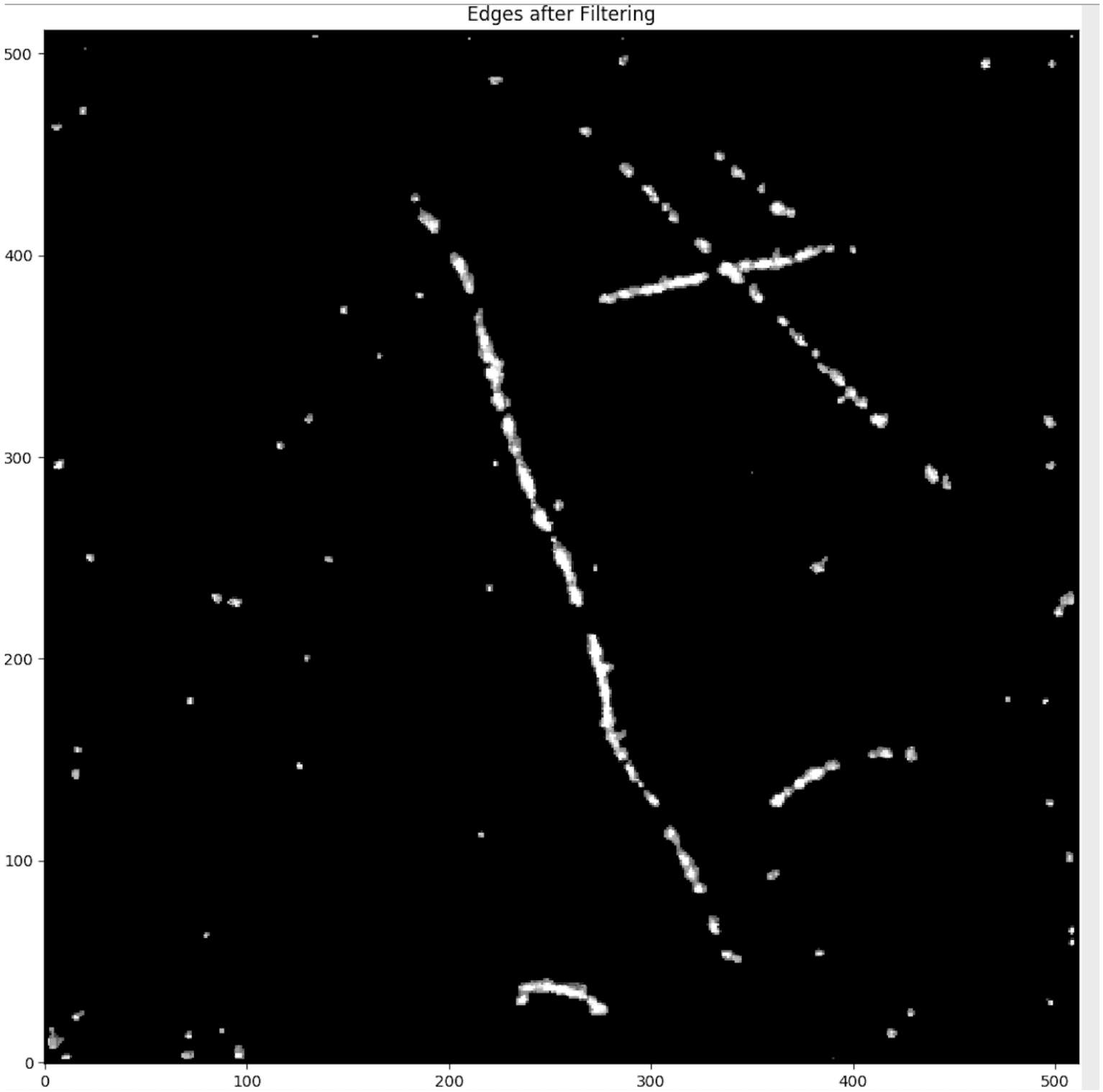
To need or not to need

- In CYGNO underground @ atm pressure, **clustering with i2DBSCAN is probably sufficient**
  - tracks are <1cm short
- For calibration with Fe55, also i2DBSCAN is sufficient (spots)
- But in presence of cosmic rays + their secodaries (δ rays) on surface, need to contain the full energy of the track
  - => JOIN THE DOTS GAME!
- Supercluster is another algorithm using iDBSCAN clusters as “seeds”

Example



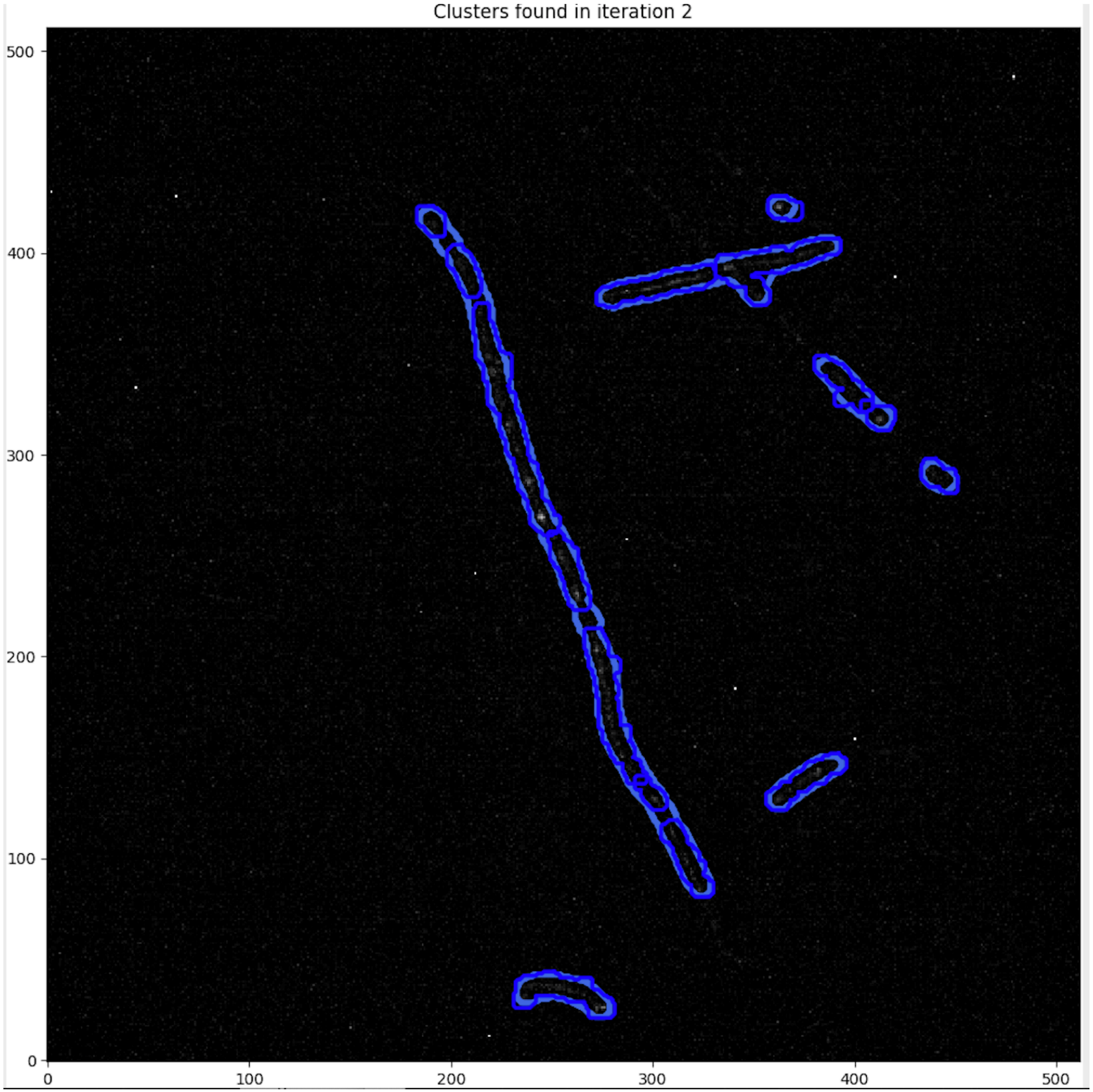
- Because the **noise cleaning, zero supprression**, clusters in the gas, GEM patterns, etc, **holes appear along tracks**
- **DB scan will not follow the full path**
- **but already finds most of the pieces**

Seeds for deeper search

- Reminder: DBSCAN is run on rebinned image (4x4 = 1 “macro-pixel”)
- For initial DBSCAN, a tight noise reduction is needed to decrease the combinatorics (CPU limits)
- Once found these clusters:
  - use any macro-pixel belonging to a cluster as a “seed” for a supercluster step
  - open a window around each seed (3x3 or 5x5 pixels tried) in full readout (no zero-suppression, no topological / median filters) since this is an “interesting” region = “FR”
  - compute Gaussian gradients in these FR regions to find where the light goes from 0 to the one within the cluster
  - Apply the algorithm Morphological GAC(*) around these high gradients regions to find the contours
- Two choices:
  1. run the supercluster on the OR of all iDBSCAN iterations
     - PRO: if pieces of a track are split in different iterations, this would recover
     - CON: it=3 is currently too bkg-polluted
  2. run the supercluster separately for each iteration
     - PRO: do not pollute with it3; it1 separates efficiently alphas/nuclear recoils
     - CON: cannot join split tracks
  - For what we need (low occupancy), they are equivalent. Chosen 2

(*) don’t think bad, Italians, it stands for “Geodesic Active Contour”

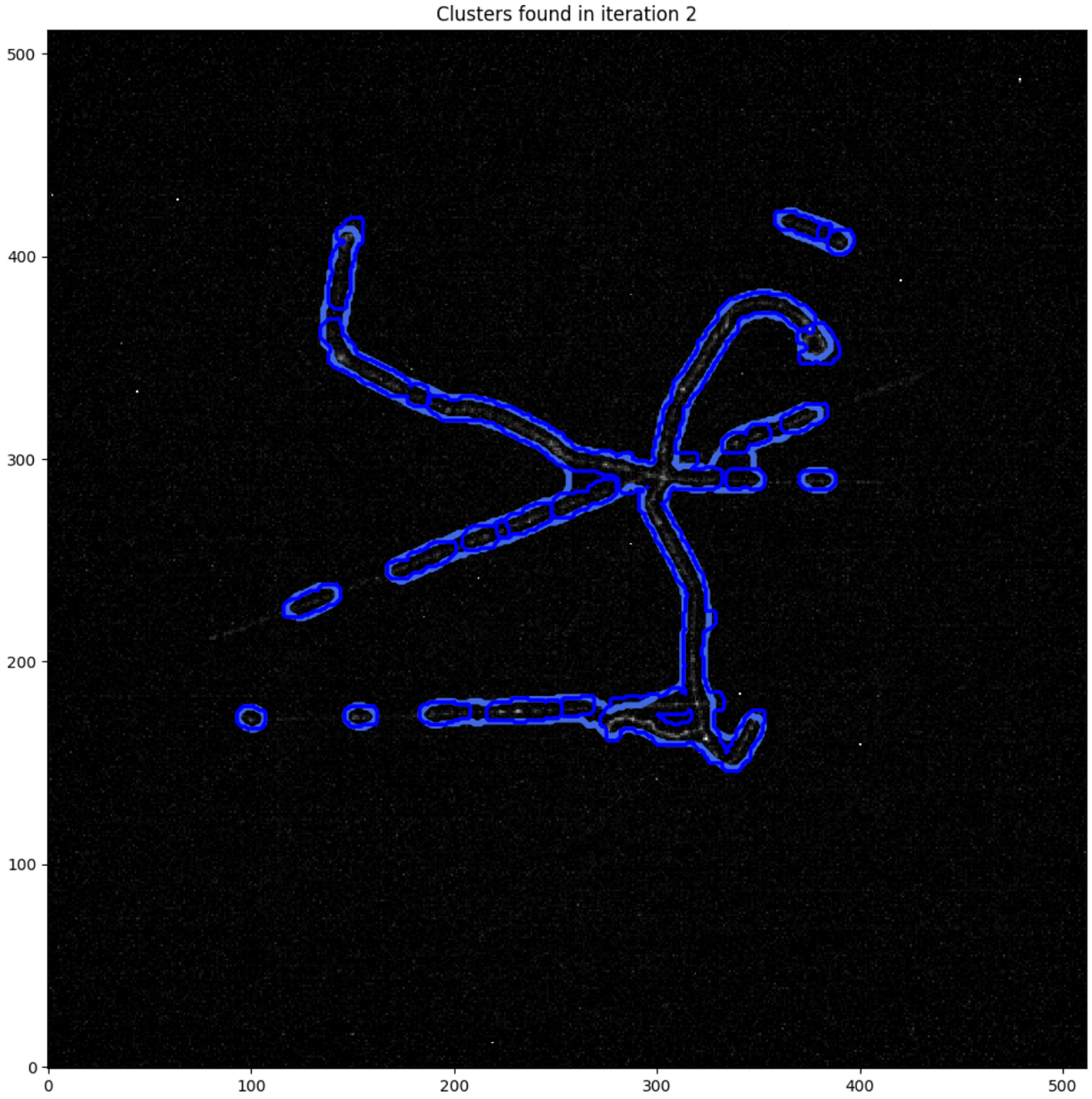
Example of SuperCluster

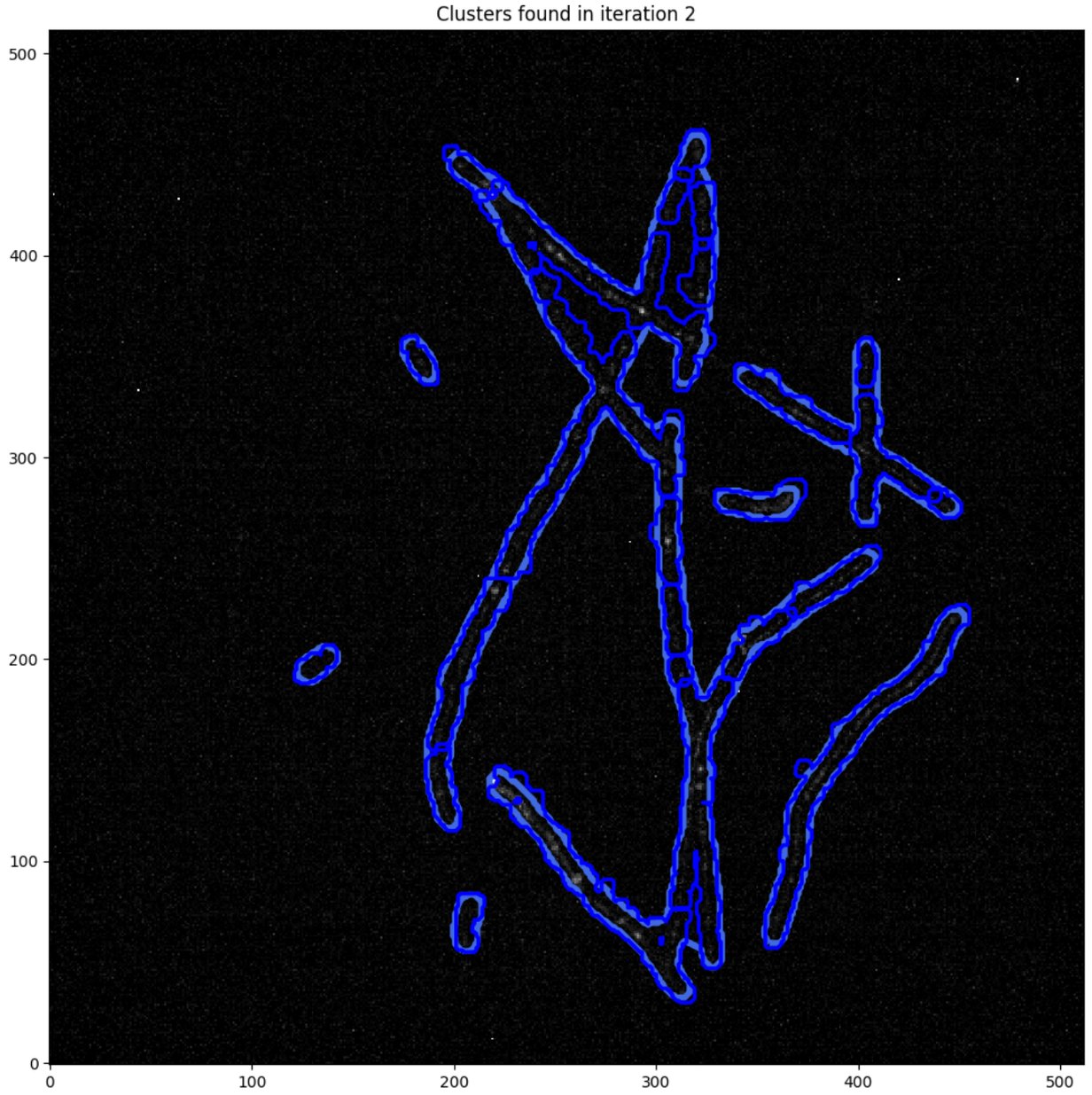


- Dark blue = iDBSCAN clusters in iteration 2
- Light bold blue = superclusters in iteration 2

but with cosmics bad things can happen

100 ms exposure inside the lead coffin

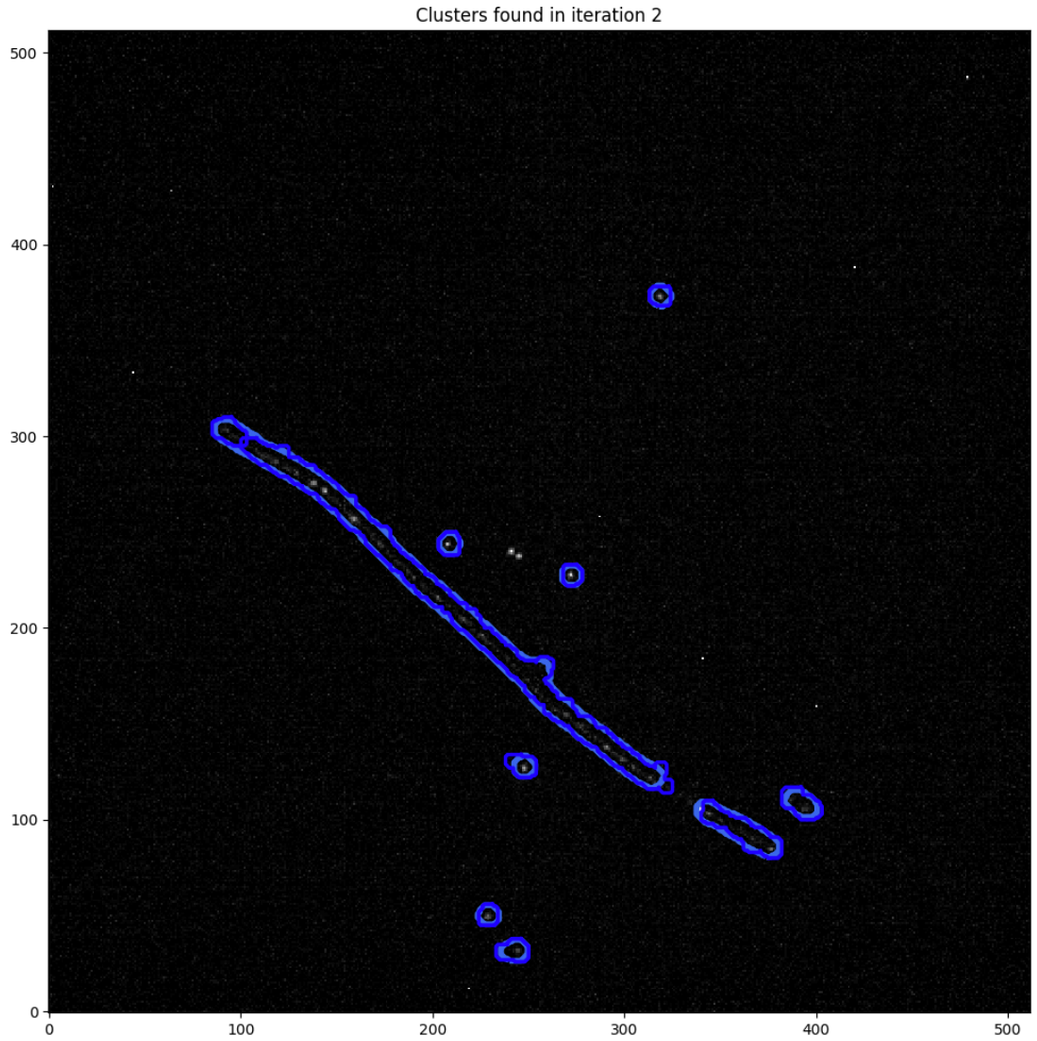


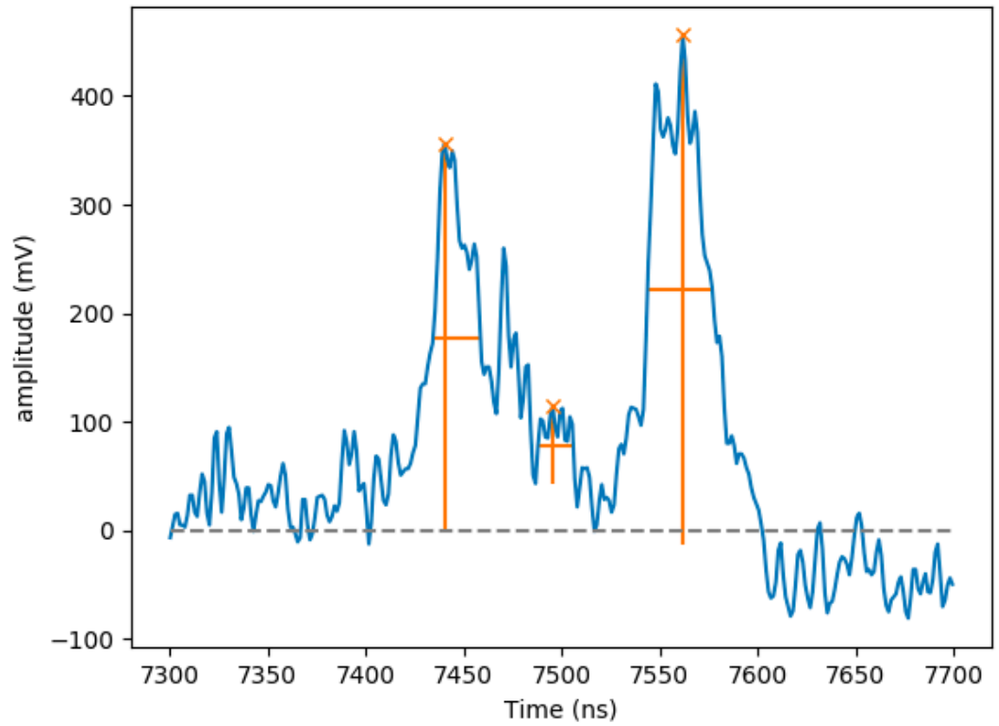


- but I don’t think we care too much of these cases
- The purpose is mainly single cosmic+delta ray, electrons from Co60, AmBe…

PMT vs CAMERA

- Took several data with PMT @ 1.4 kV and camera. Picture triggered by PMT
- Will look at the runs with “strong” 55Fe source positioned at different heights of the FC
- NOTA BENE: cosmics are very frequently visible in all the pictures.
  - we reduced the exposure to the minimum for the DAQ to work: 40ms





intermezzo

- Resumed/debugged the code of the peak finder in the PMT waveform
- Run simultaneously to the camera reconstruction in order to correlate the two informations
- It calculates simple variables (tot, charge integral), but also find peaks and saves, for each peak in the waveform:
  - height (wrt baseline), prominence (wrt local baseline), fwhm, peak time, risetime, falltime
- These if needed has to be tuned, but for the following only TOT and integral are used

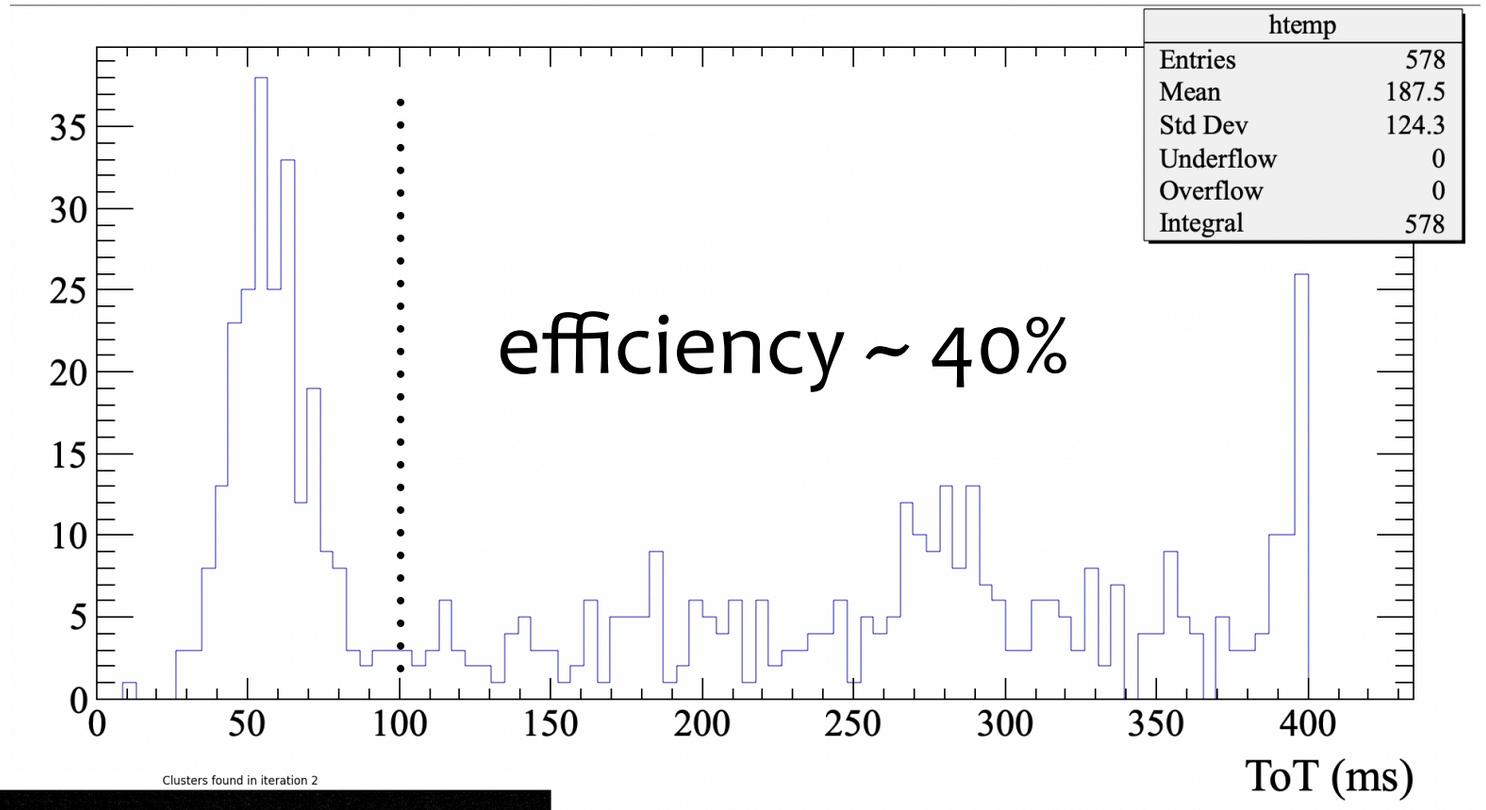
Runs taken on Nov4

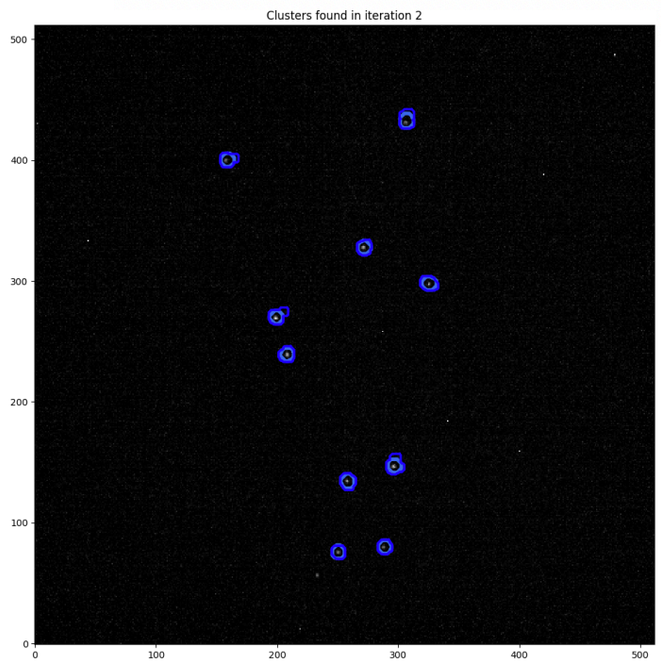
- Position # correspond to the axis in next pages
- Positions 2,3 are ~middle of the FC

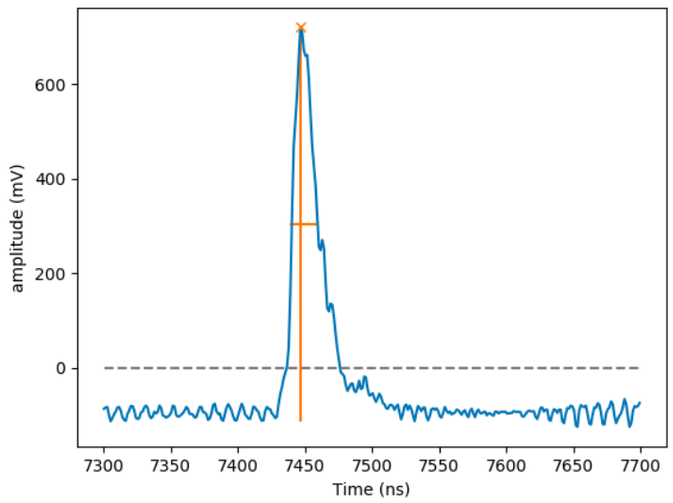
1	File name	saved events	CMOS Exposure Time (ms)	comments	Nominal Flux He/CF4	He:CF4	Transfer field strength (kV/cm)	GEM 3 (V)	GEM 2 (V)	GEM 1 (V)
867	1753	20	40	Strong Fe55 with Pb case and PMT	150/100	60/40	2.5	460	460	460
868	1754	100	40	Strong Fe55 with Pb case and PMT - Position 0	150/100	60/40	2.5	460	460	460
869	1755	100	40	Strong Fe55 with Pb case and PMT - Position 1	150/100	60/40	2.5	460	460	460
870	1756	100	40	Strong Fe55 with Pb case and PMT - Position 2	150/100	60/40	2.5	460	460	460
871	1757	100	40	Strong Fe55 with Pb case and PMT - Position 3	150/100	60/40	2.5	460	460	460
872	1758	100	40	Strong Fe55 with Pb case and PMT - Position 4	150/100	60/40	2.5	460	460	460
873	1759	100	40	Strong Fe55 with Pb case and PMT - Position 5	150/100	60/40	2.5	460	460	460

Selection

- Filter the events with TimeOverThreshold TOT<100 ms to select the events triggered by Fe55 spot

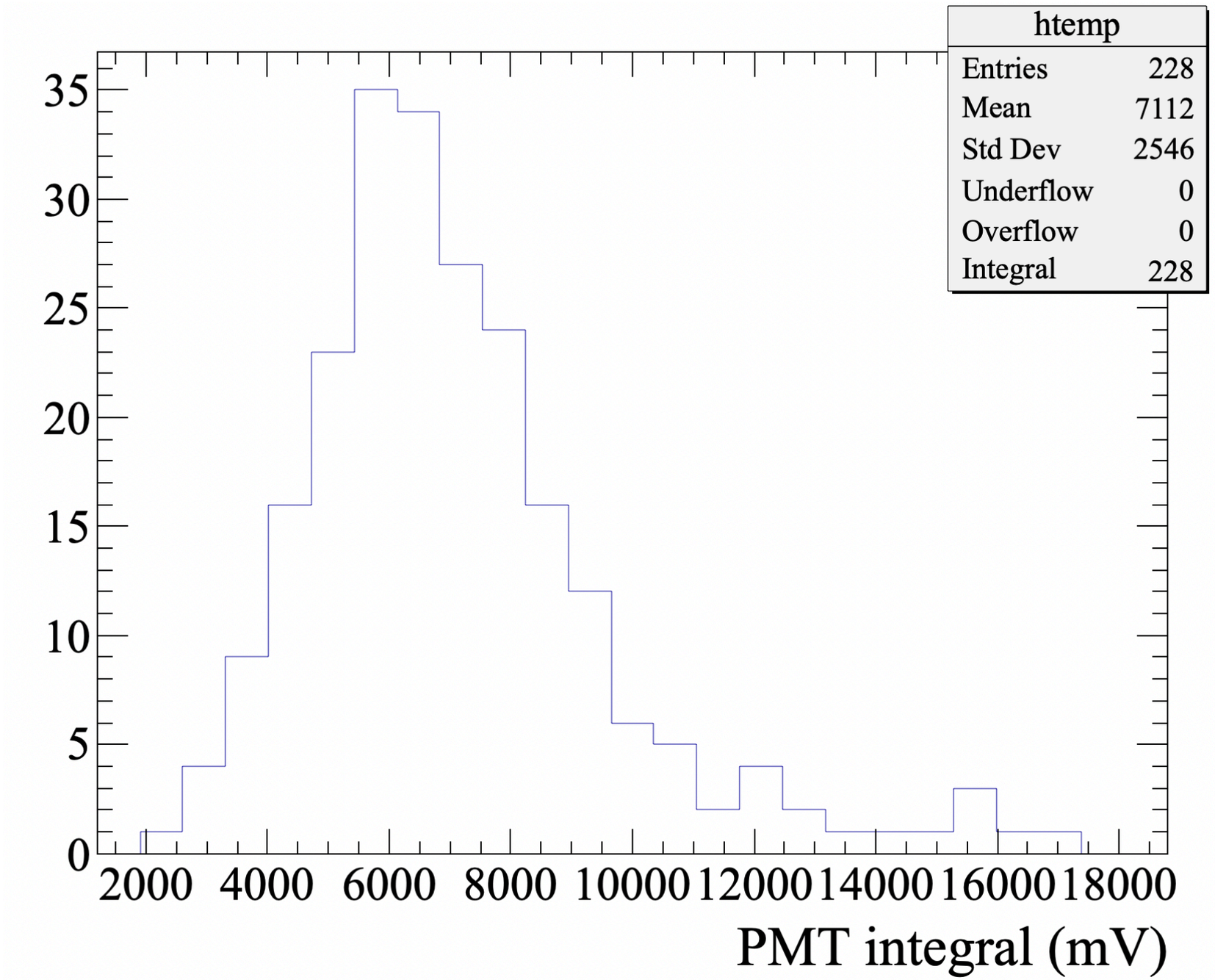






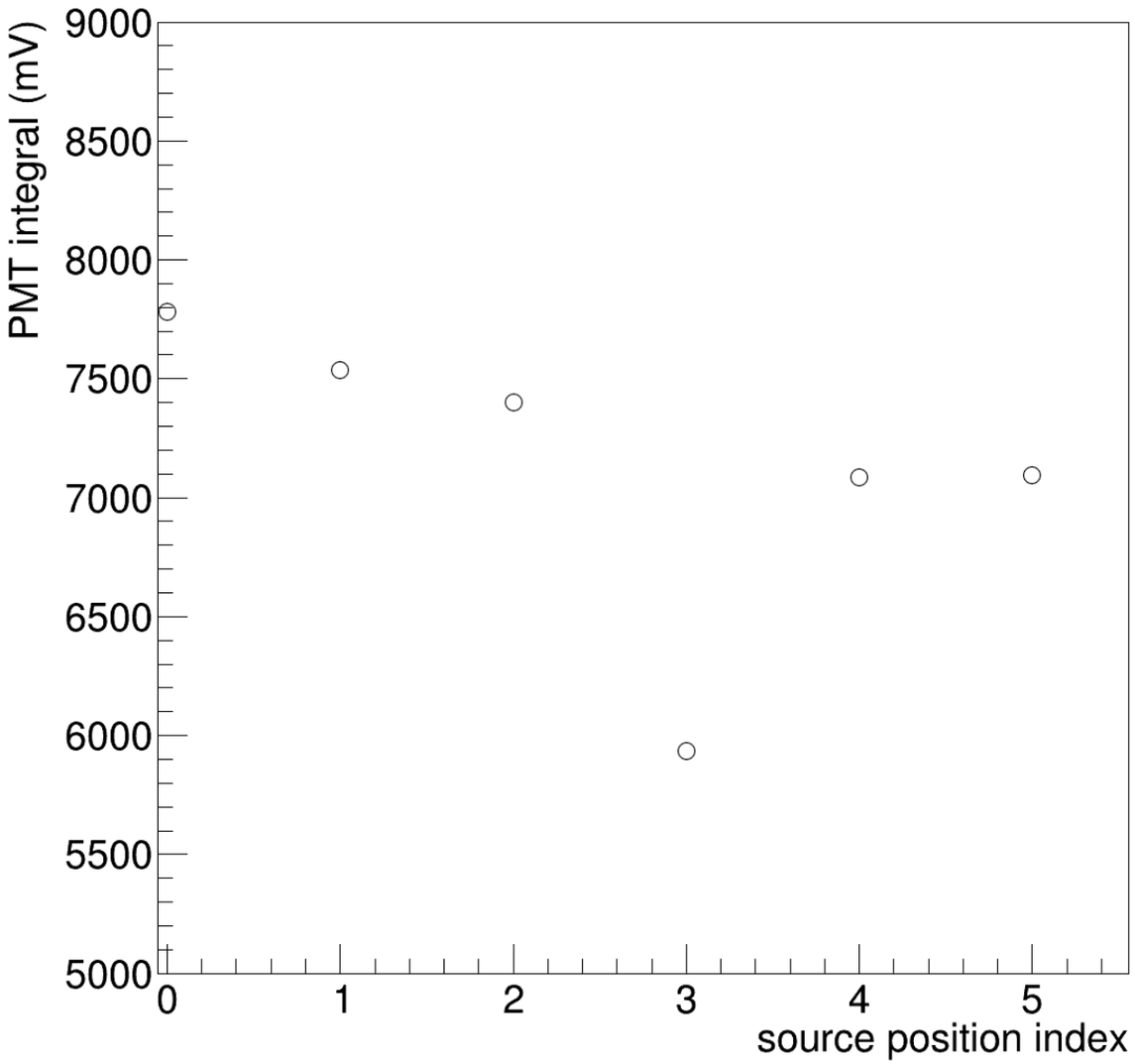
PMT integral

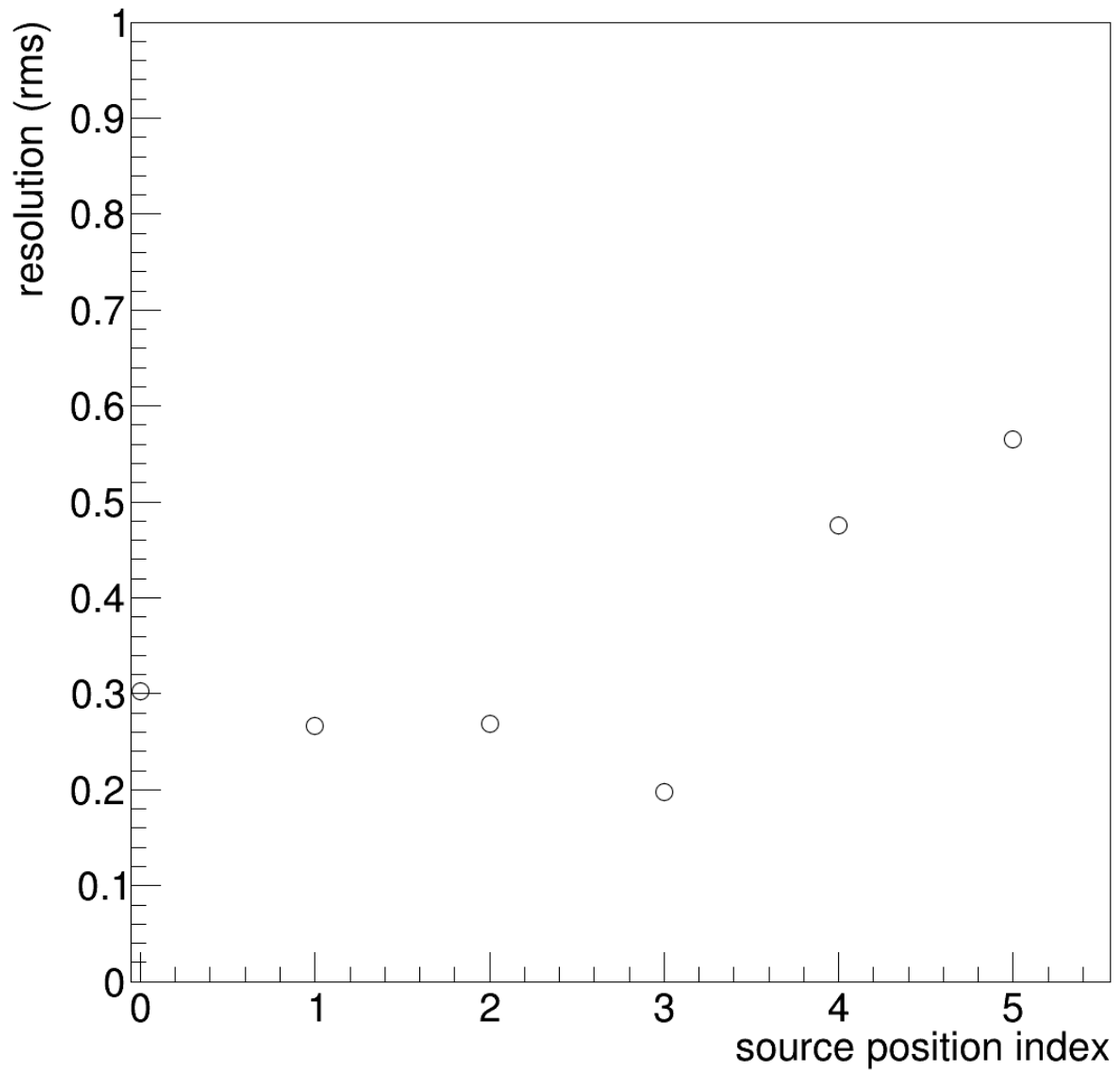
- Roughly 35% resolution (integrating over the 6 runs)



PMT integral vs Z

- PMT integral and resolution vs distance in Z of the source



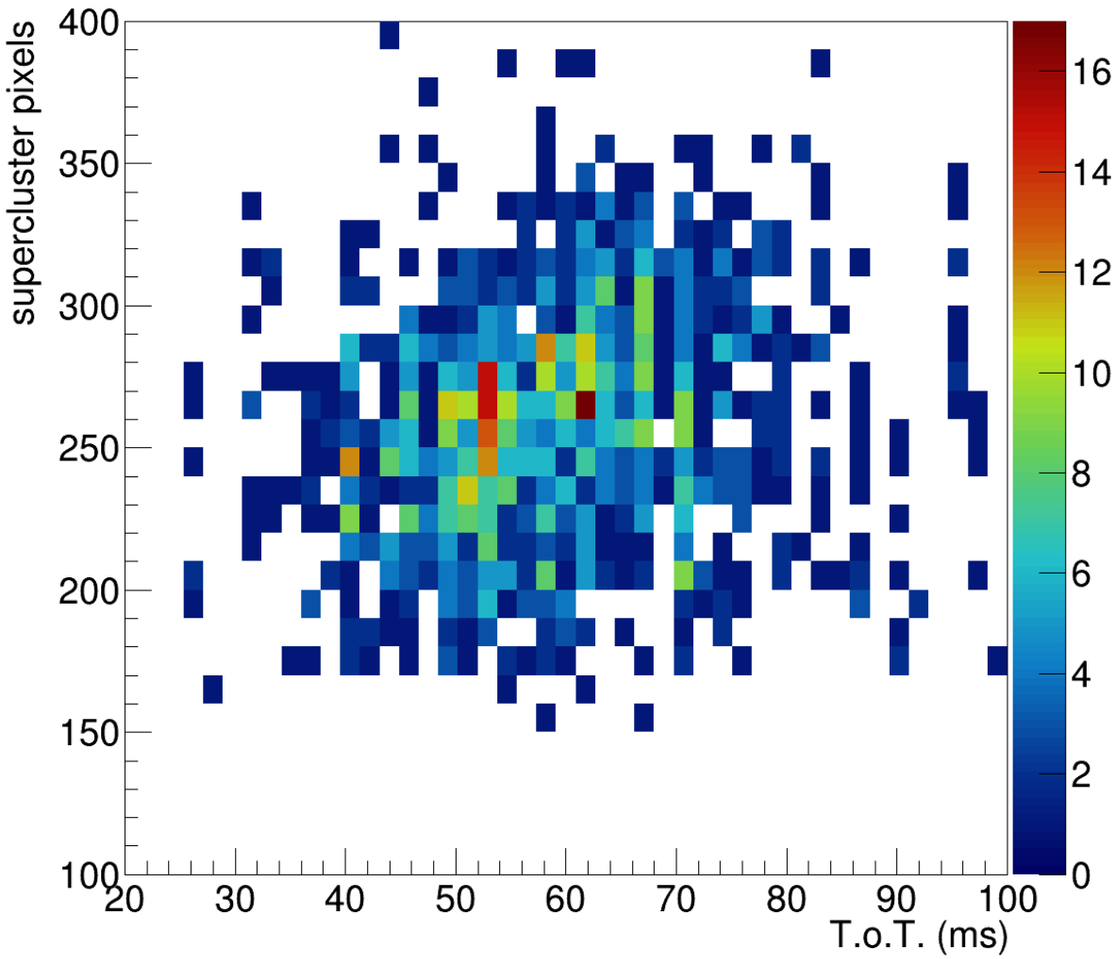


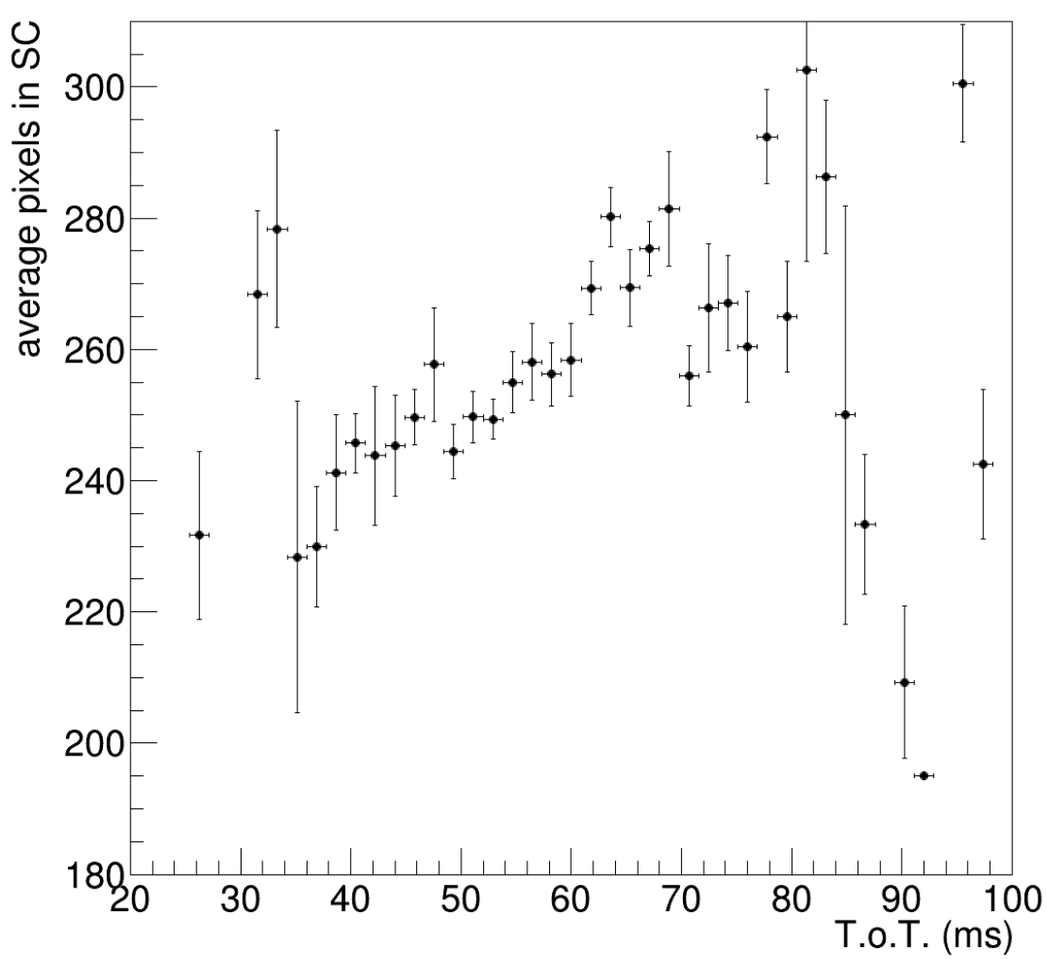
runs 2 and 3 ~ middle of the field cage.

N.B. Each point has ~40 events => 15% stat. error on the mean

Spot size vs PMT

- Only use events with PMT tot<100 ms
- supercluster (SC) selection:
  - SC “iteration”=2 (nothing in 1, 3 is garbage collector)
  - all “spot-like” SCs: width / length > 0.7
  - within FC (ellipse axes=700/700 pixels)





The End