

2x2 and FSD low energy investigations

Dec 18, 2024

2x2 Data Assessment Meeting



**COLORADO STATE
UNIVERSITY**



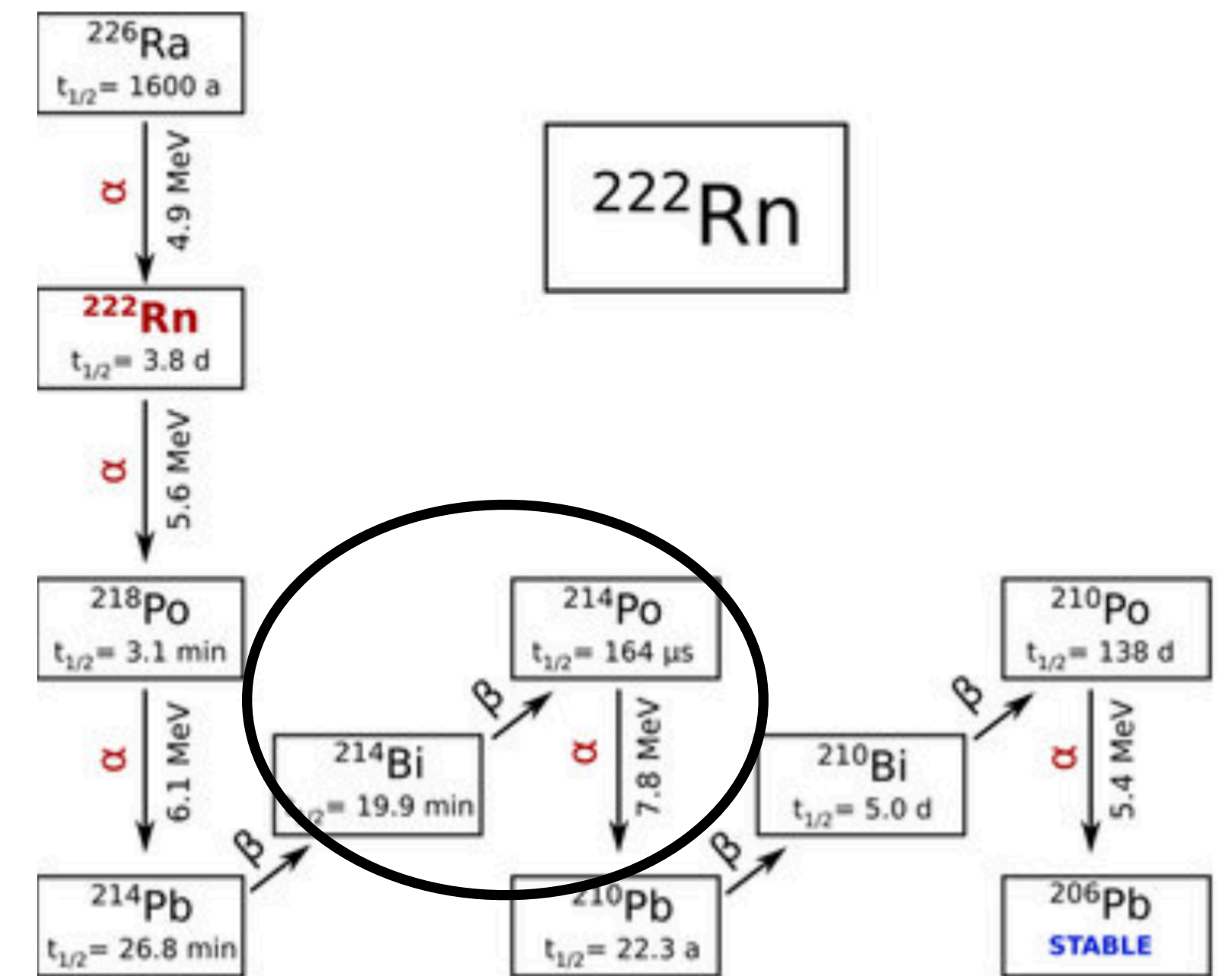
Overview

- Noise investigation in 2x2 charge data
- Issues with light data in 2x2 low threshold run
- FSD low energy C+L matching



222Rn

- 222Rn may be present in LAr due to emanation from 238U decay (i.e. from detector materials)
- Leaves a characteristic signature of a beta decay (214Bi) followed by an alpha decay (214Po) with a 164 us half life
 - Both the beta and alpha would be located at the same location, may each produce light trigger as well depending on threshold (alpha produces much more light than beta)
 - Could tag these decays using this signature to reconstruct specifically 214Bi spectrum



222Rn

- Goals:
 - See if we can detect the BiPo decay in just charge alone
 - And/Or: Reconstruct BiPo decay with light trigger(s) in low threshold runs
- Reconstructing alpha charge may not be possible
 - Alpha deposits very little ionization (~ 100 keV), possibly below charge thresholds

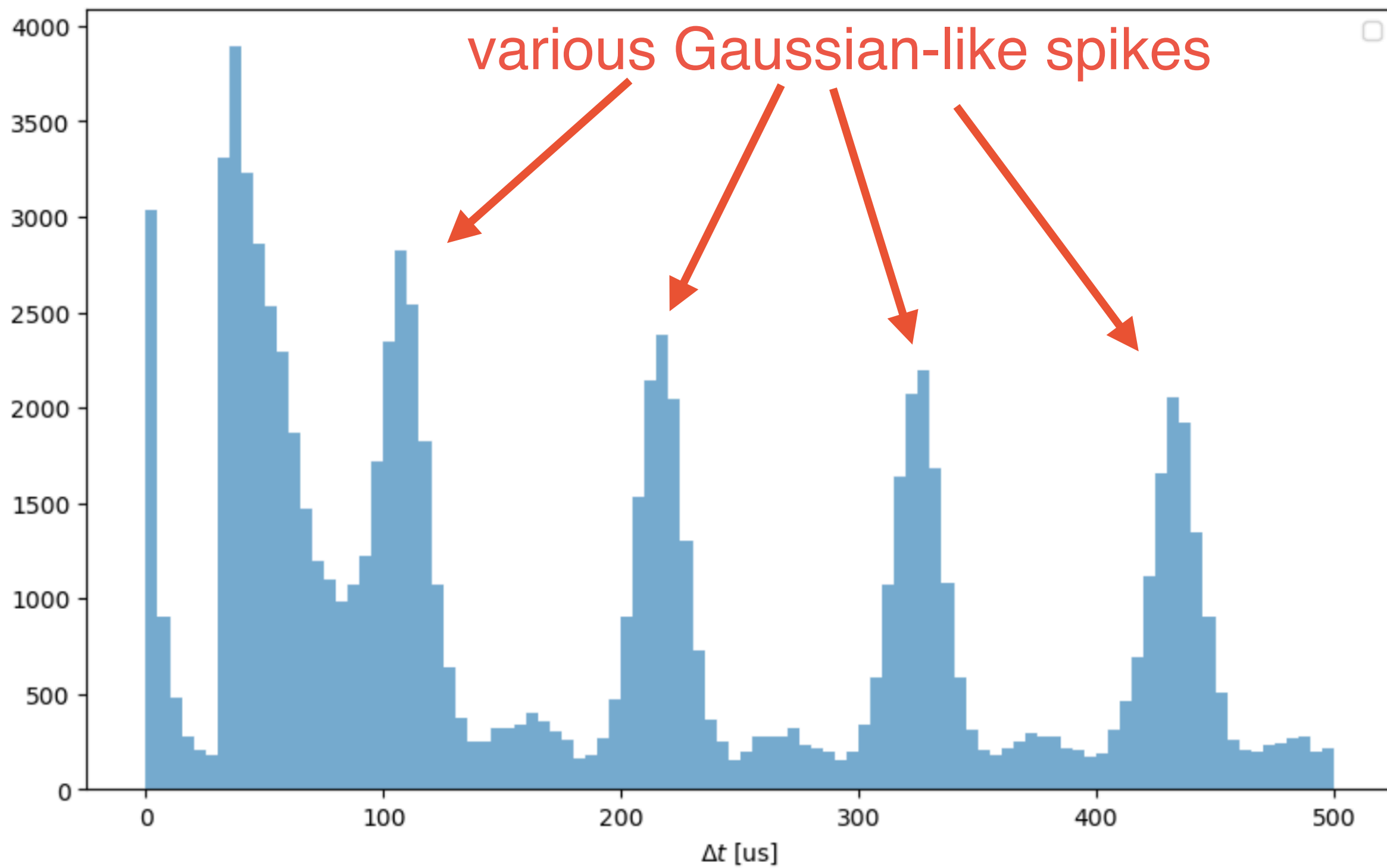


222Rn

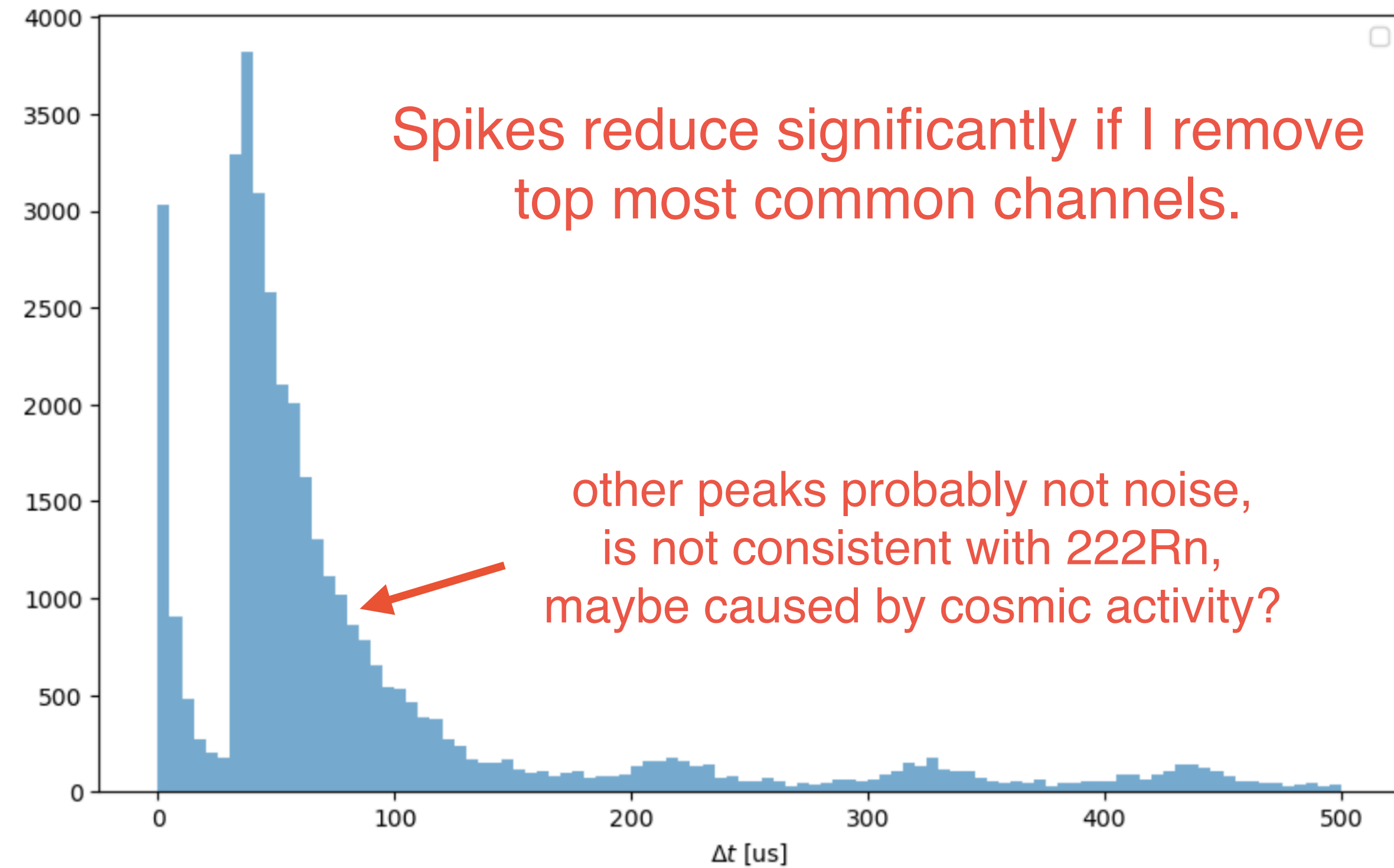
- 222Rn search methodology:
 - Cluster charge hits and identify small clusters which may be from radiologicals
 - Search for instances of two charge clusters occurring in the “same location”
 - In actuality, within ~1 cm of each other in Z, Y
 - Within 1 ms of each other



Search Results

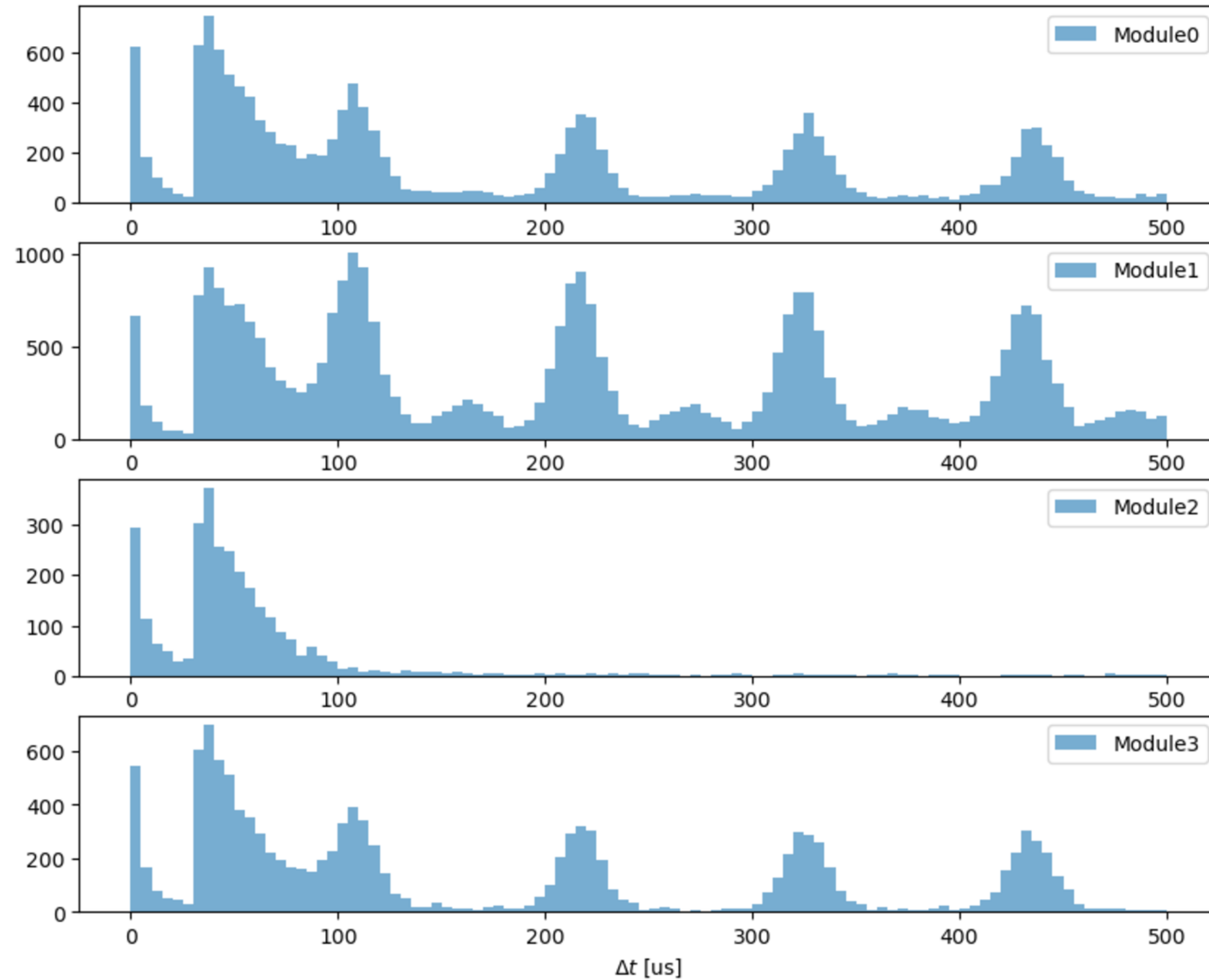


Removed top 100 most common channels.
Potential Cause: Correlated noise across many channels?



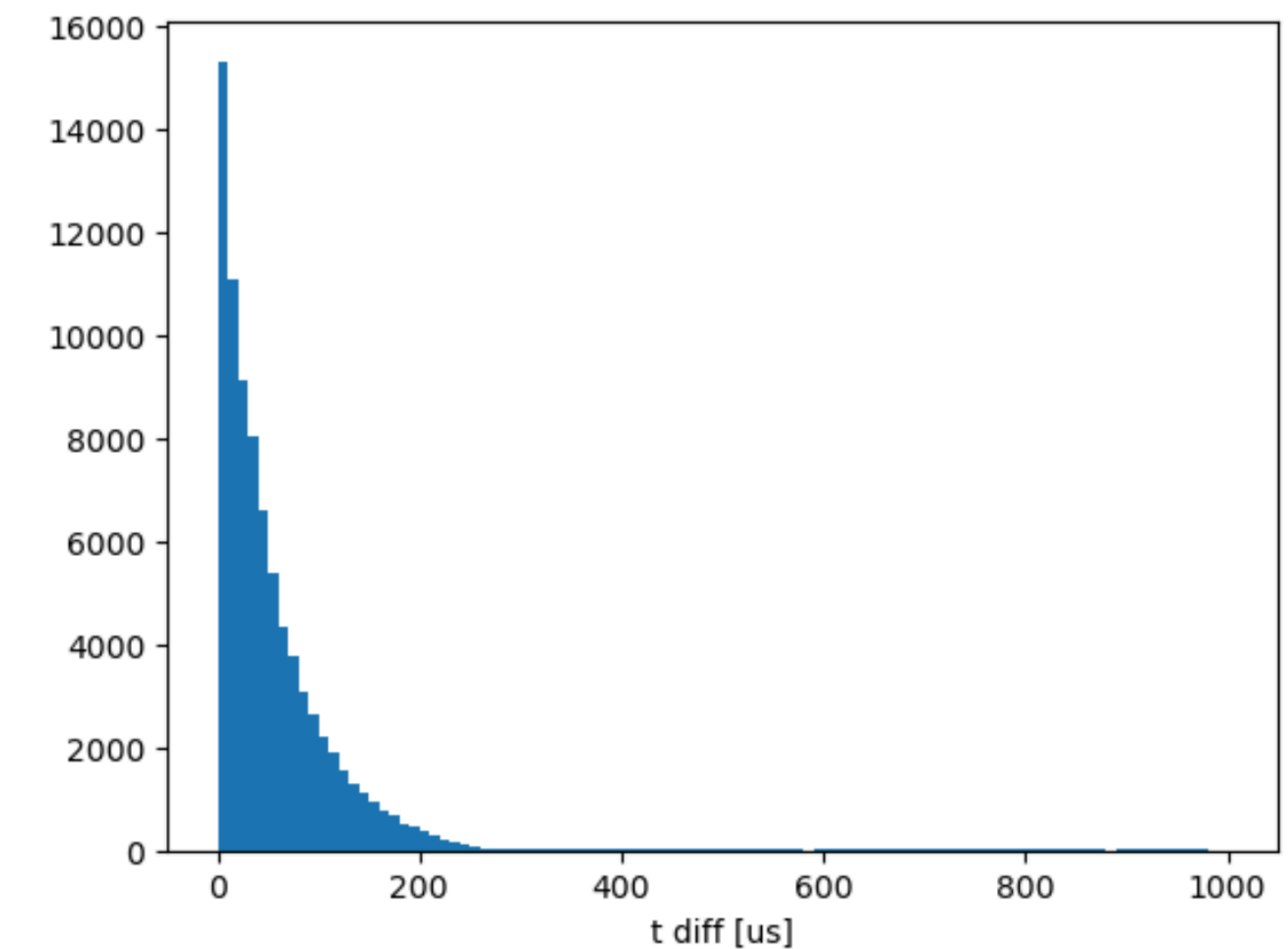
222Rn Search 2x2

Different behavior in different modules.
Noise not present in Module2.



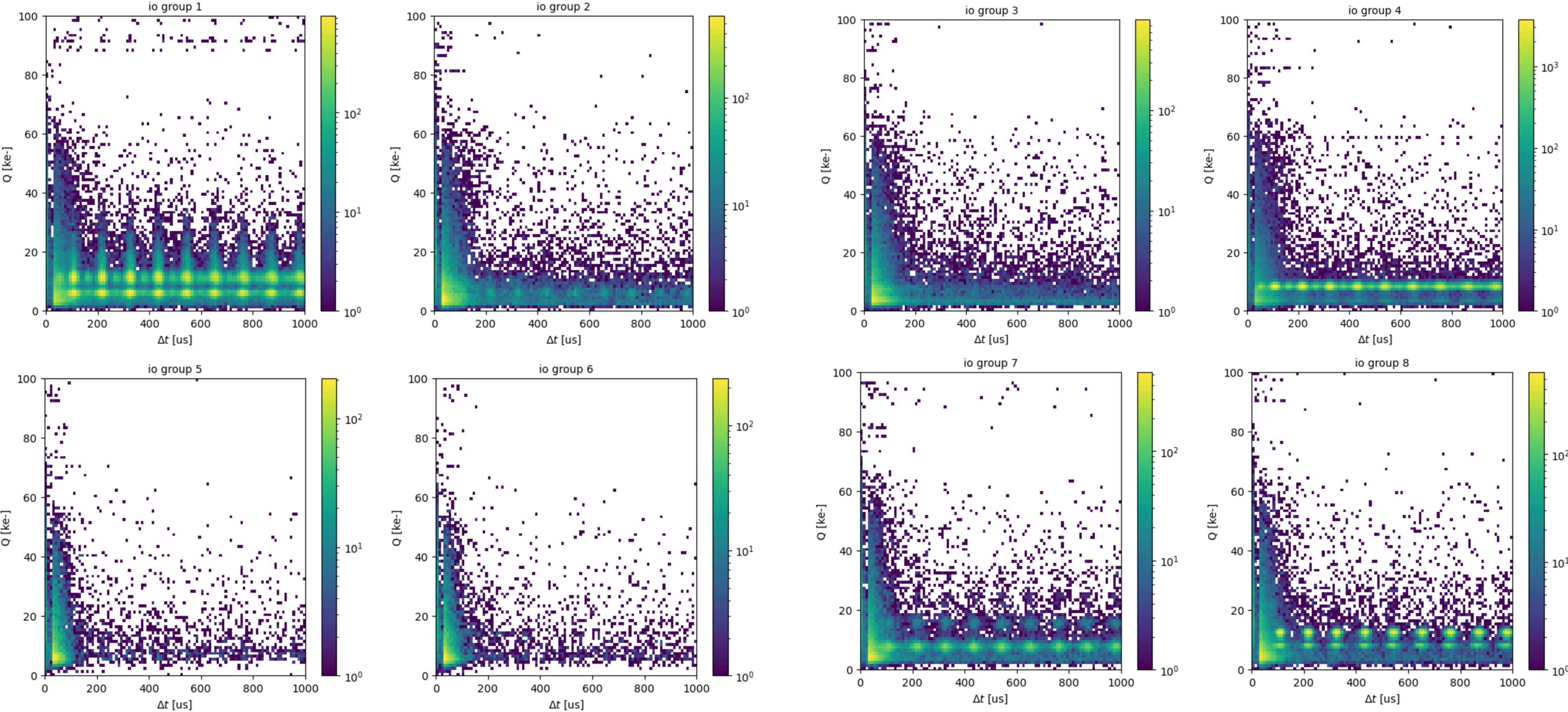
Noise not observed in FSD data

FSD



Peaks occur every ~ 100 us —consistent maybe with the periodic resets in the CRS?

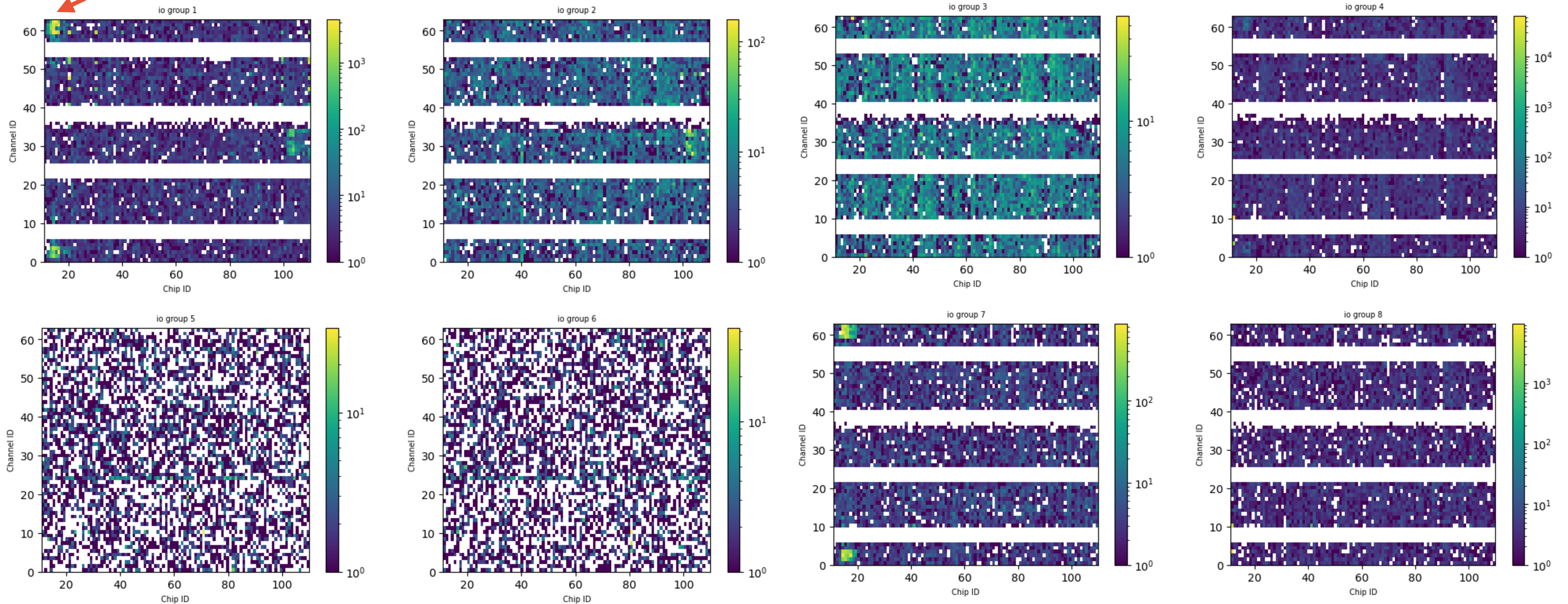
222Rn Search 2x2



222Rn Search 2x2

hot spots in some corners

Chip ID VS Channel ID



222Rn Search 2x2

- Final thoughts on this:
 - What is causing this noise?
 - Is it consistent with observations others have made in 2x2 data?

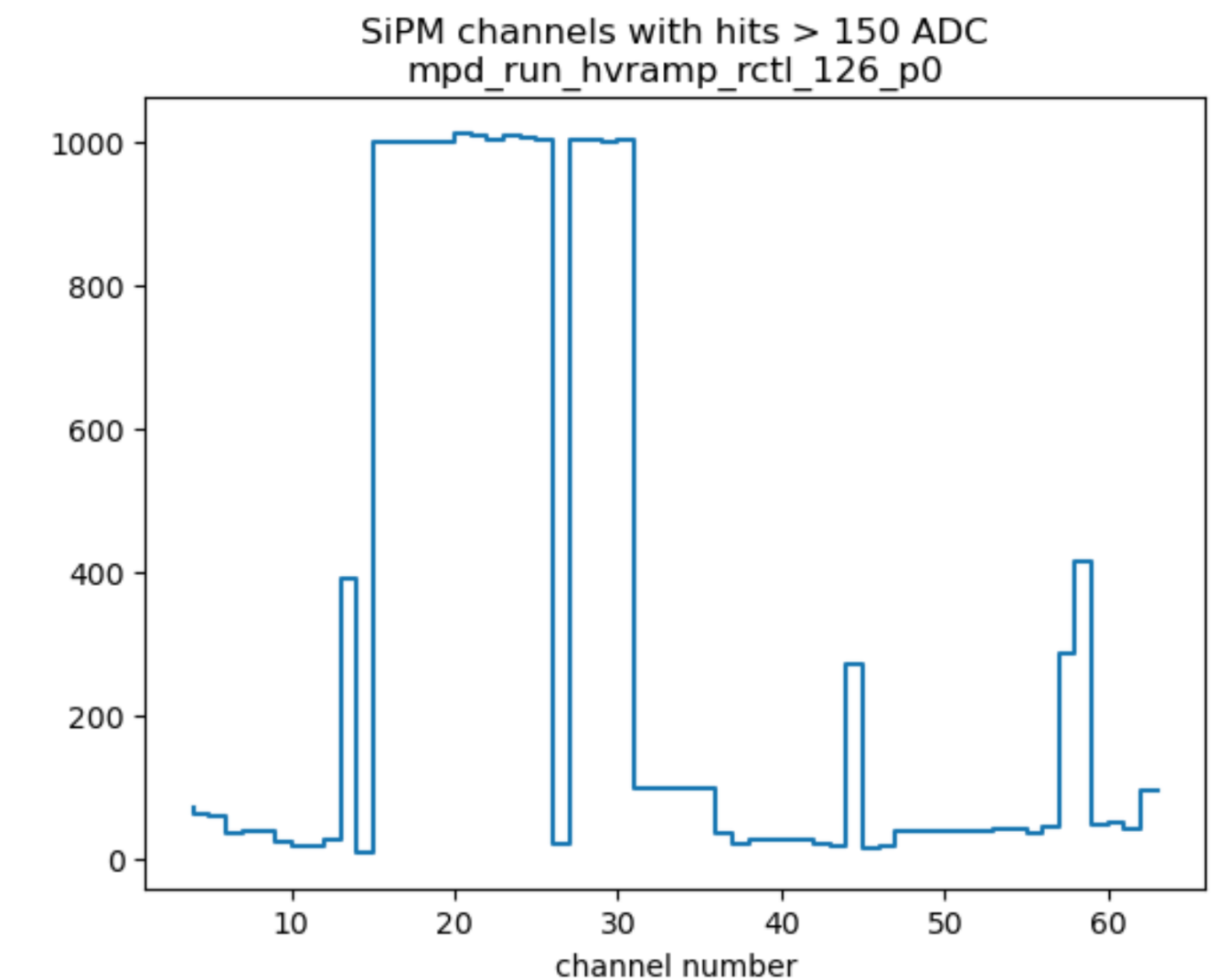
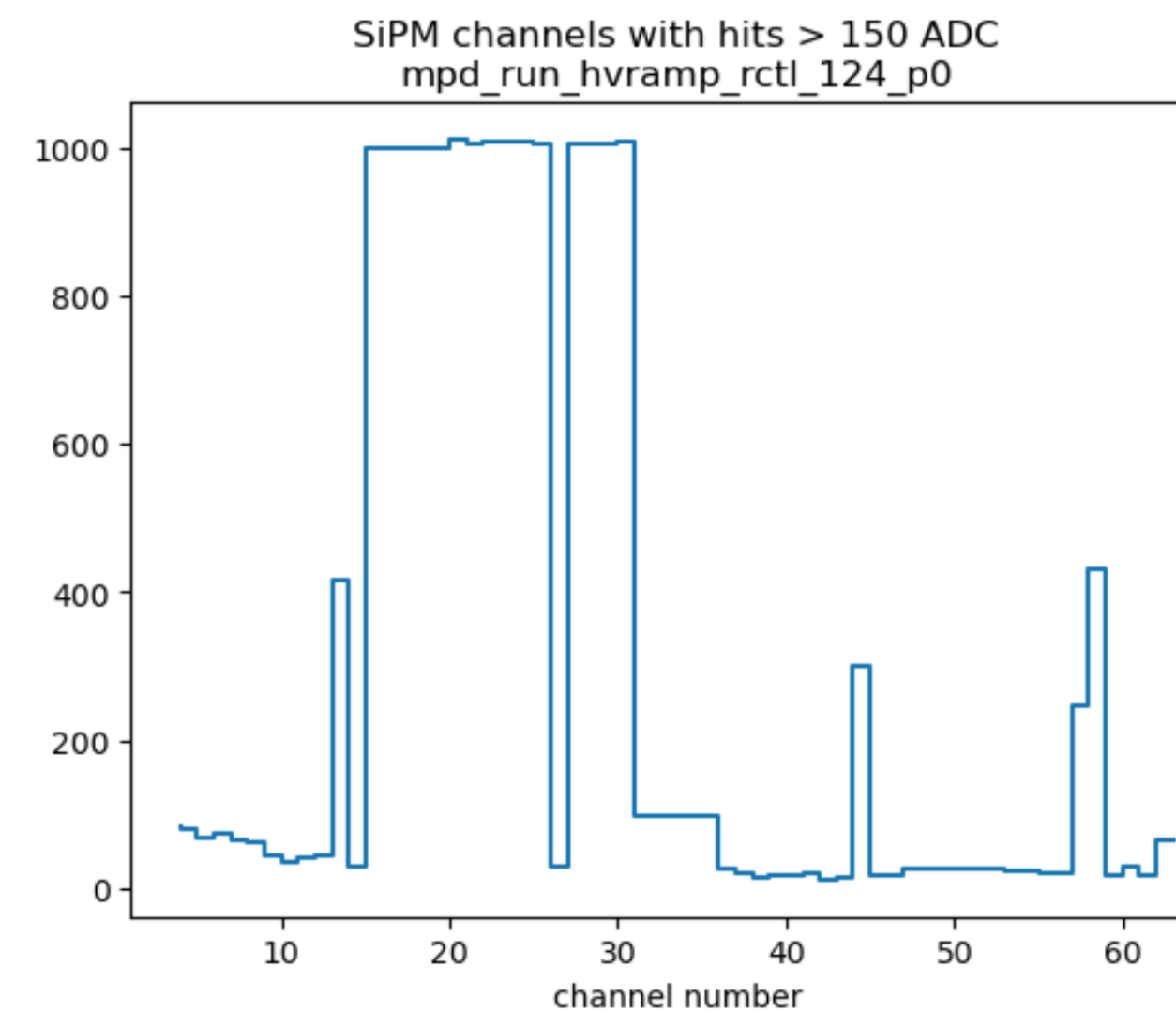
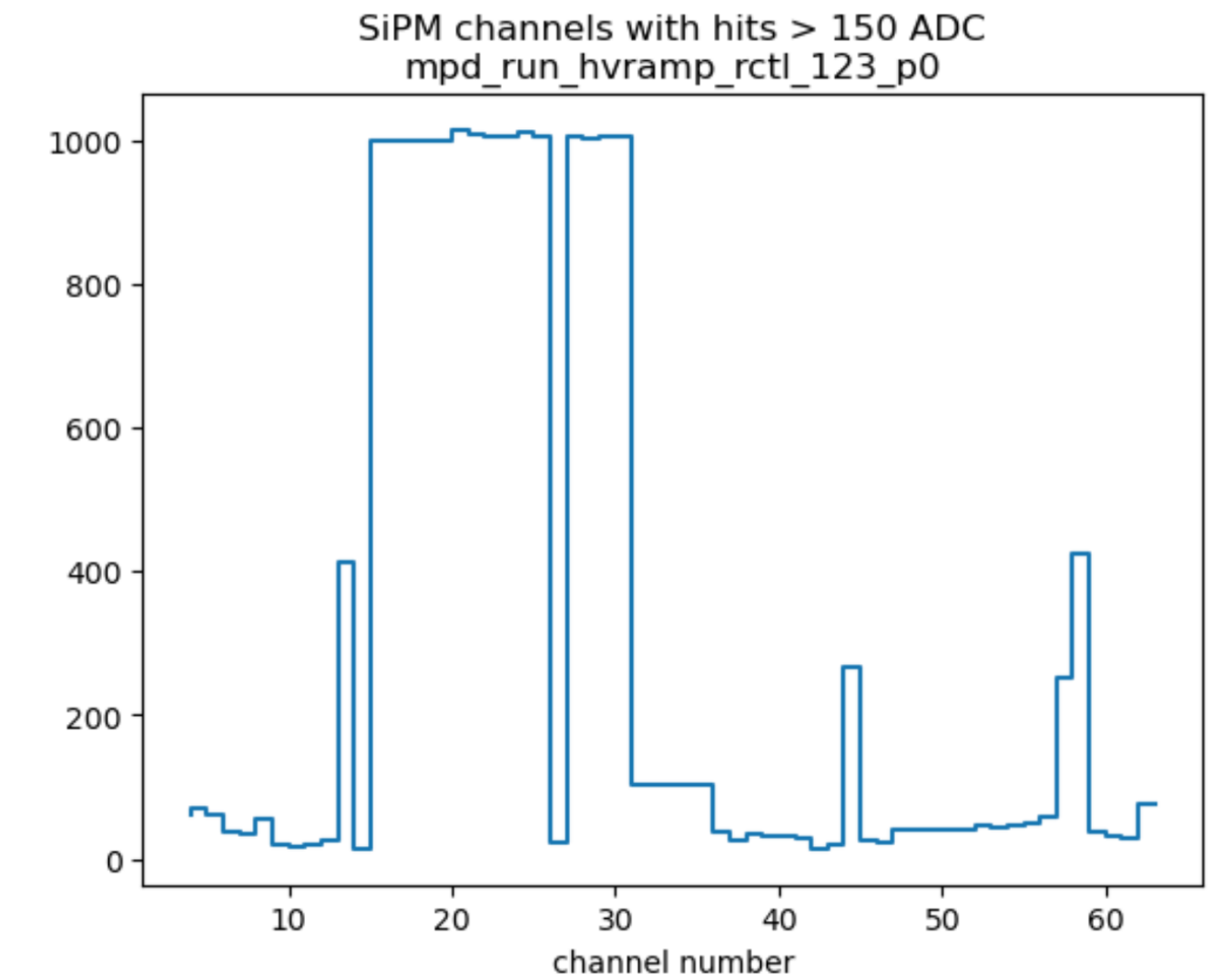
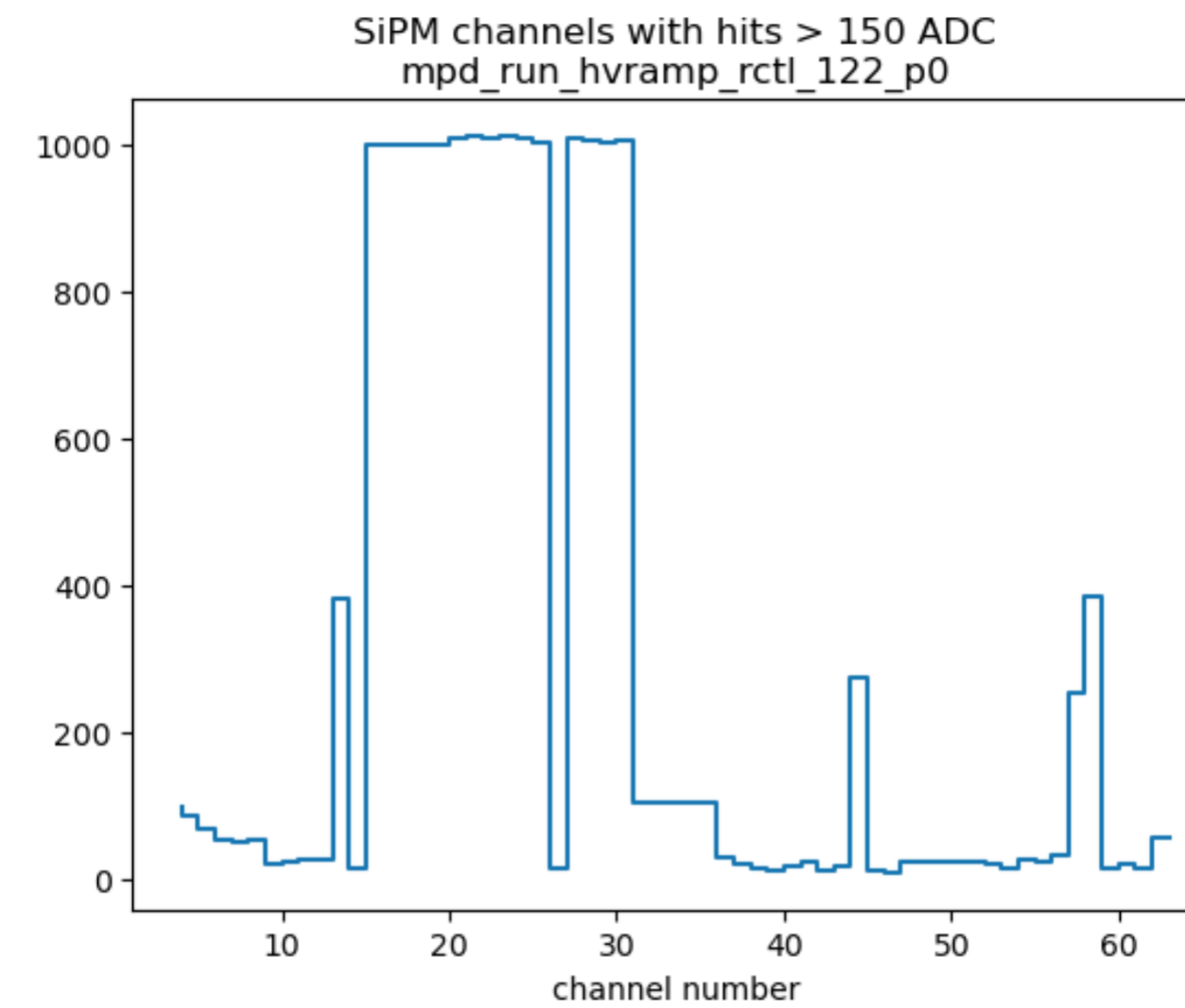


2x2 Light Data

- I have been looking at light data for the low threshold runs in 2x2
 - Useful for low energy studies:
 - Improve selection purity in low energy C+L matching
 - Pulse shape discrimination for betas/alphas
 - Light yield measurements
 - Encountered some issues in the light data and need input from experts
 - In light hit finding I am not finding all the channels I expect to see hits coming from

2x2 Light Data Issues

- Histograms of channels with hits shown for runs 50028 - 50031 (Module-1)
 - Note: The low threshold run was done in multiple runs, in each run triggering only on four sum channels at a time.
- 50028 triggered on TPC2 ACLs, 50029 on TPC3 ACLs, 50030 on TPC2 LCMs, 50031 on TPC3 LCMs
- Plots look identical, ~same number of hits, not expected
- Top channels only cover ~2 sum channels, not the four expected



Channel histograms in flowed light file. Look identical in the original binary files

2x2 Light Data Issues

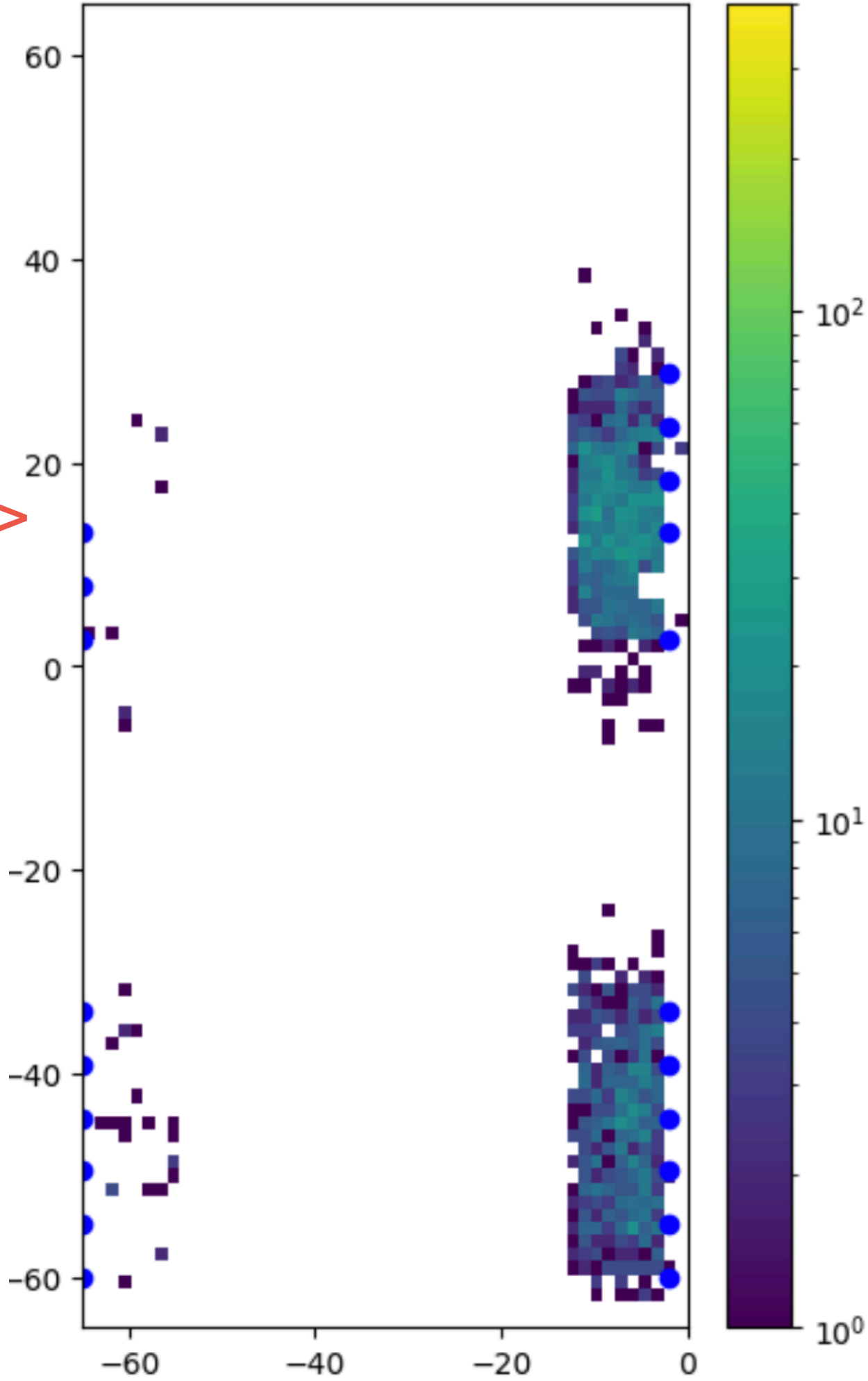
Example from one run.

One side appears basically empty —>

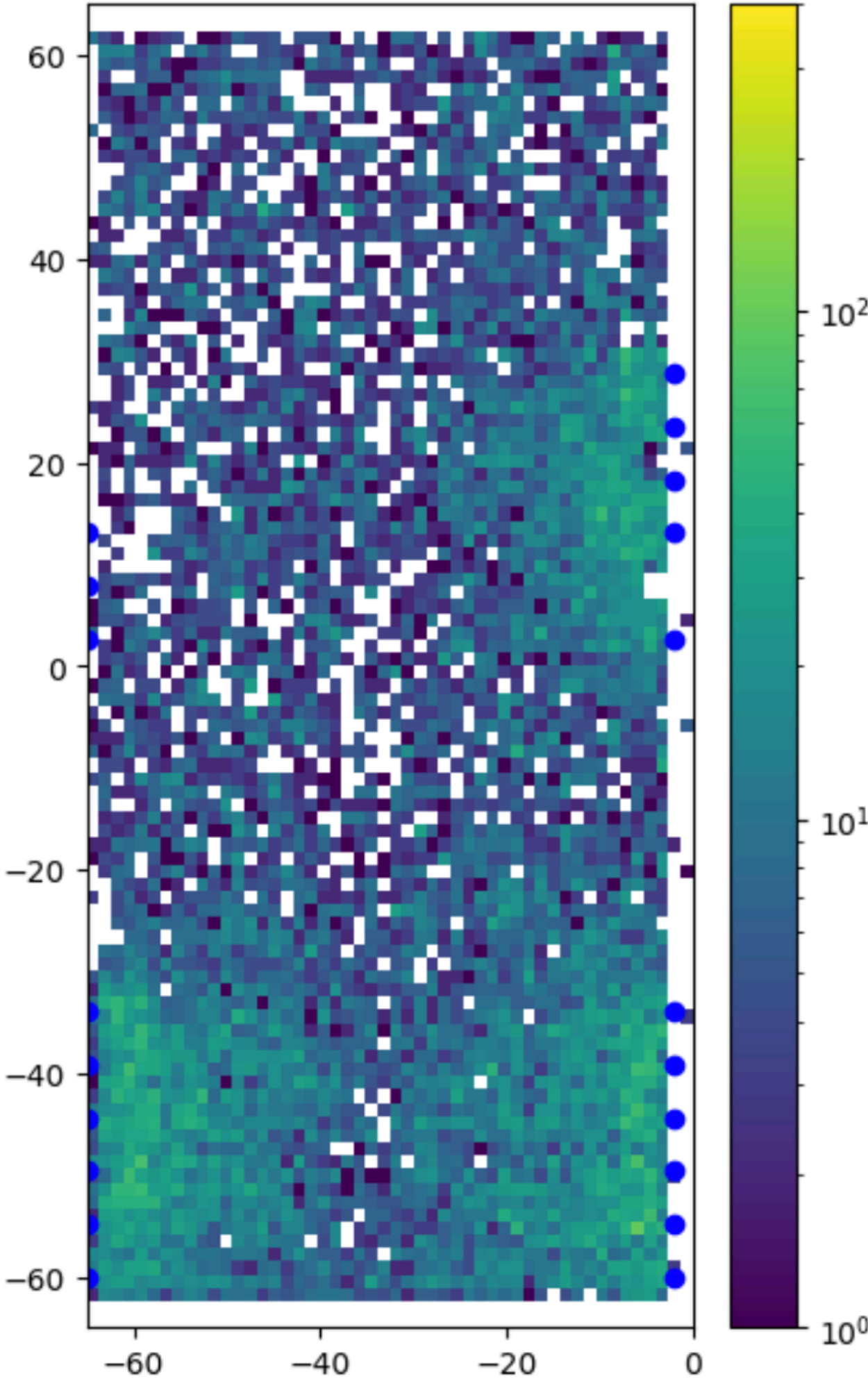
Optical proximity cut: Requires low energy clusters to be close to the light detector that produced a hit

Dots in blue were the top channel positions (don't may too much attention)

w/ optical proximity cut



w/o optical proximity cut



2x2 Light Data Issues

- Takeaways:
 - Need expert input... I have no idea what is going on here
 - Question: Is there a problem in the data, or not? If so, is the light data junk for this run?
 - I have not looked at other normal runs, but I assume they don't have the same issue since no one else has reported it.



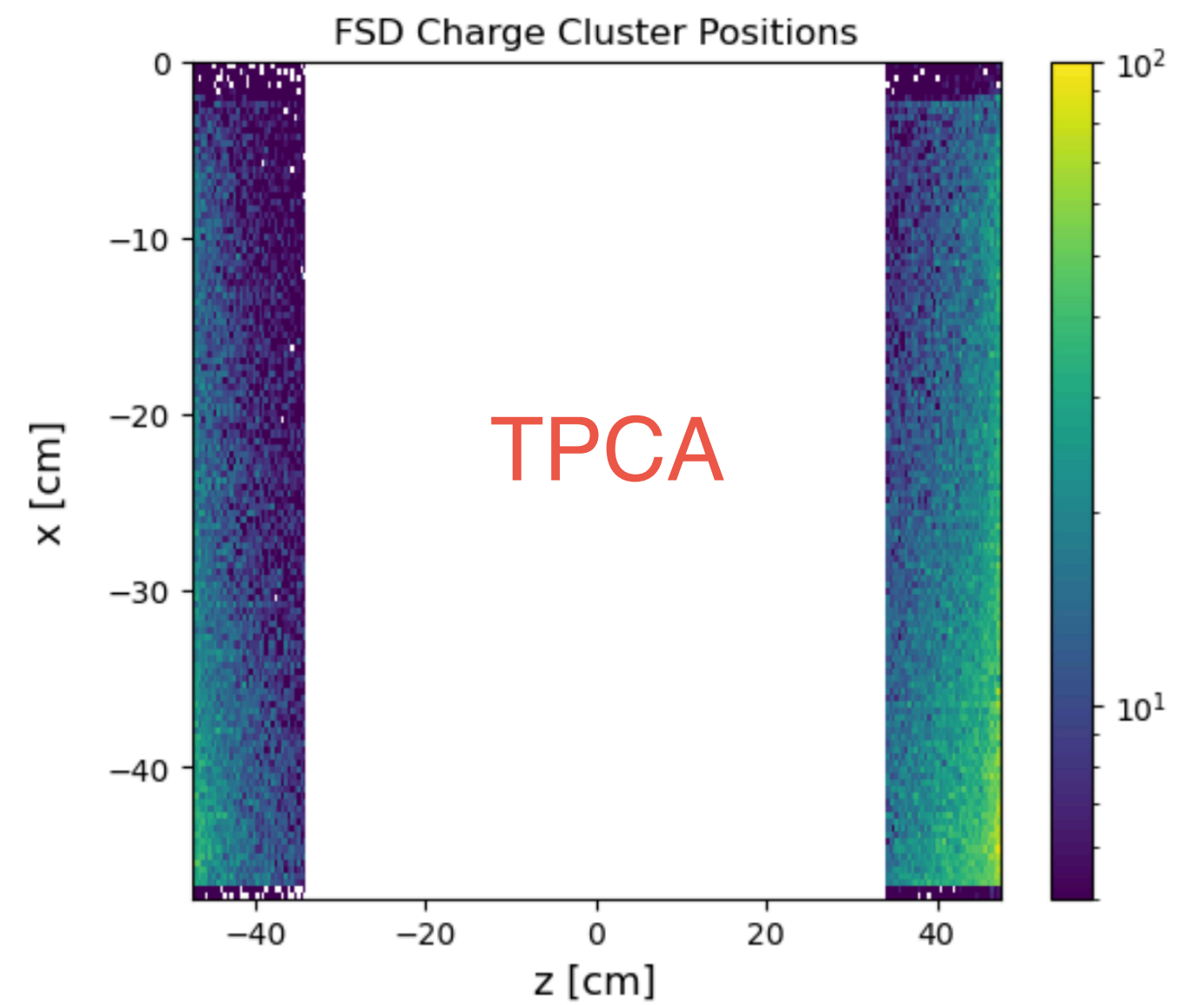
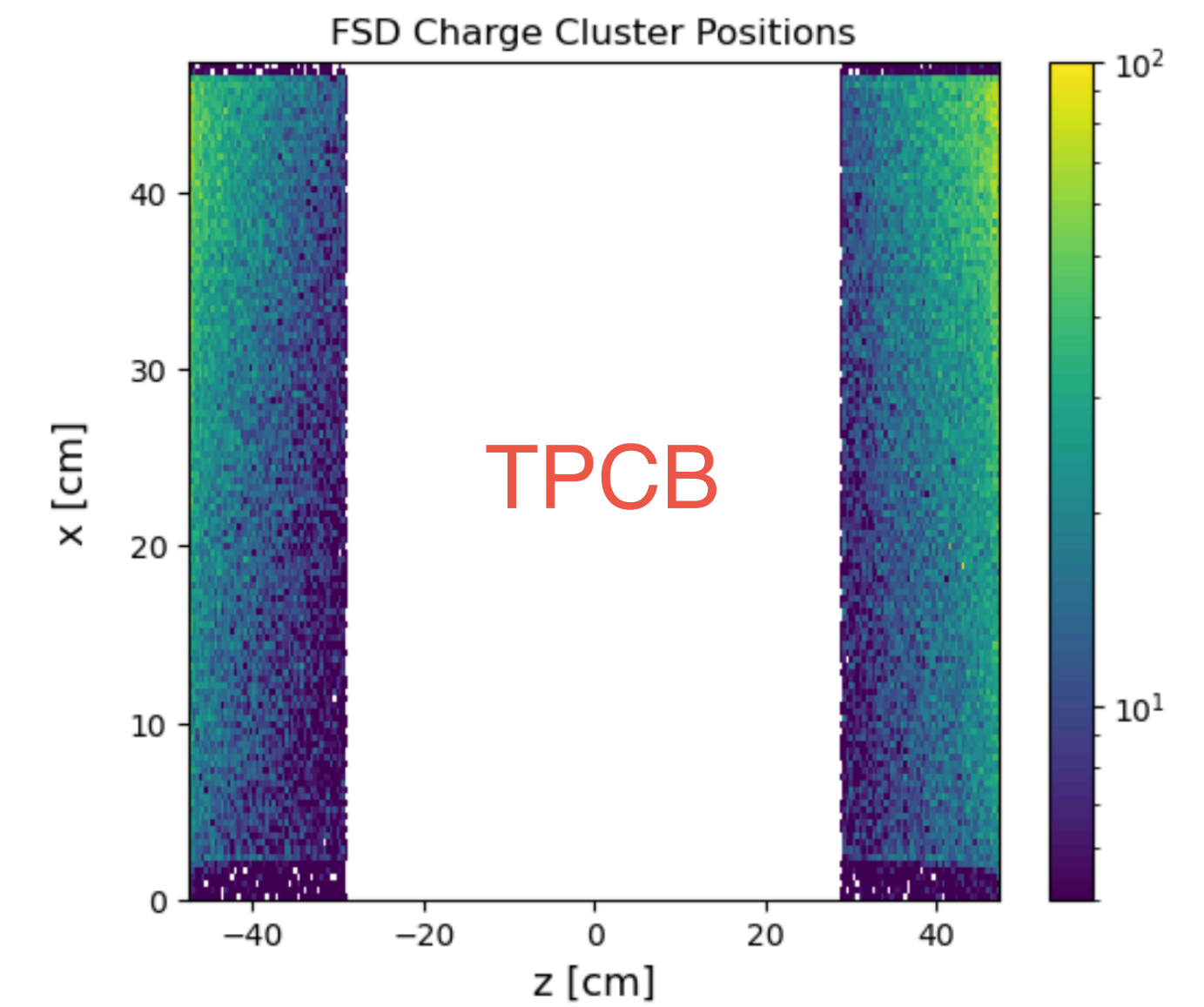
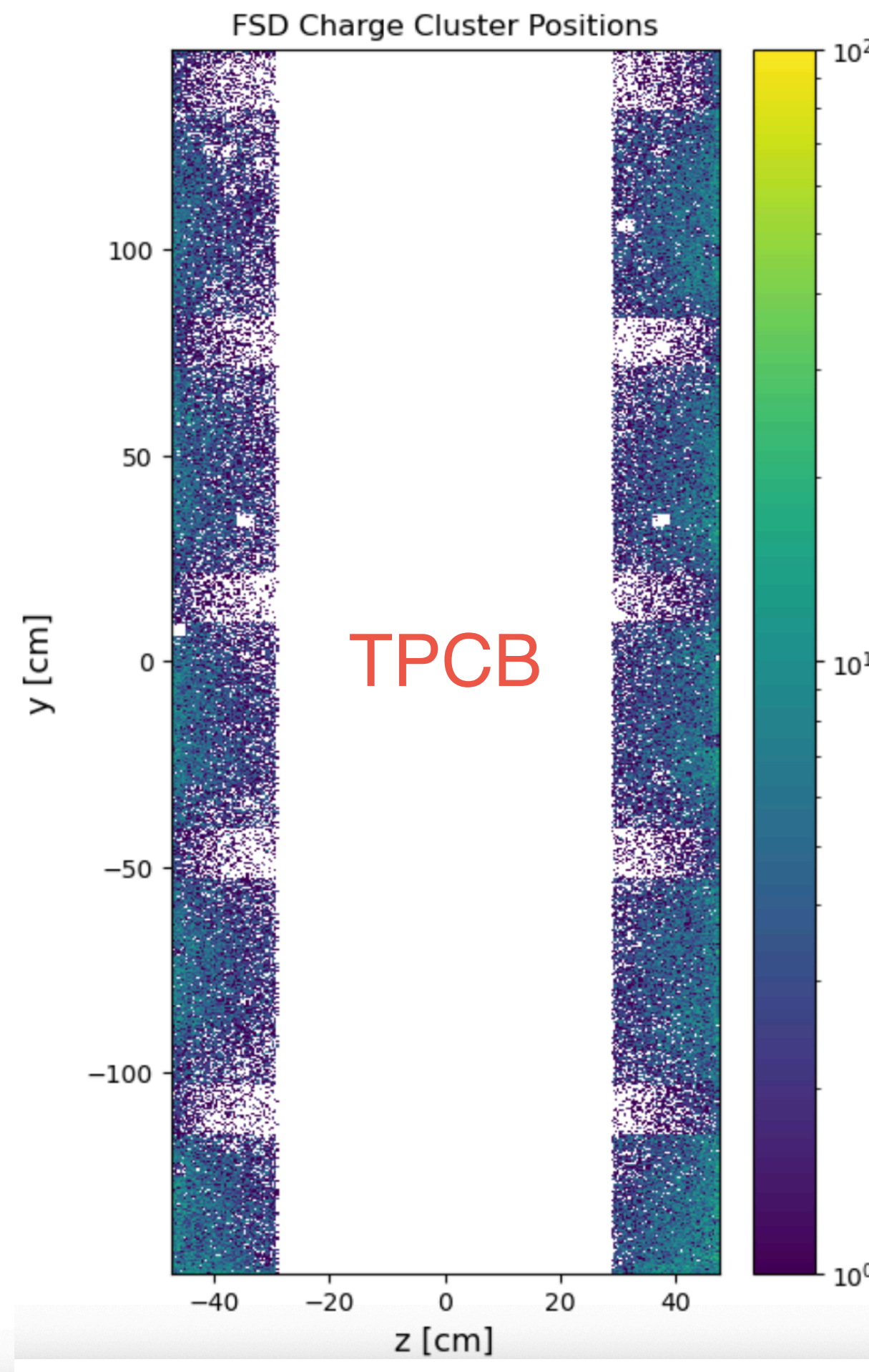
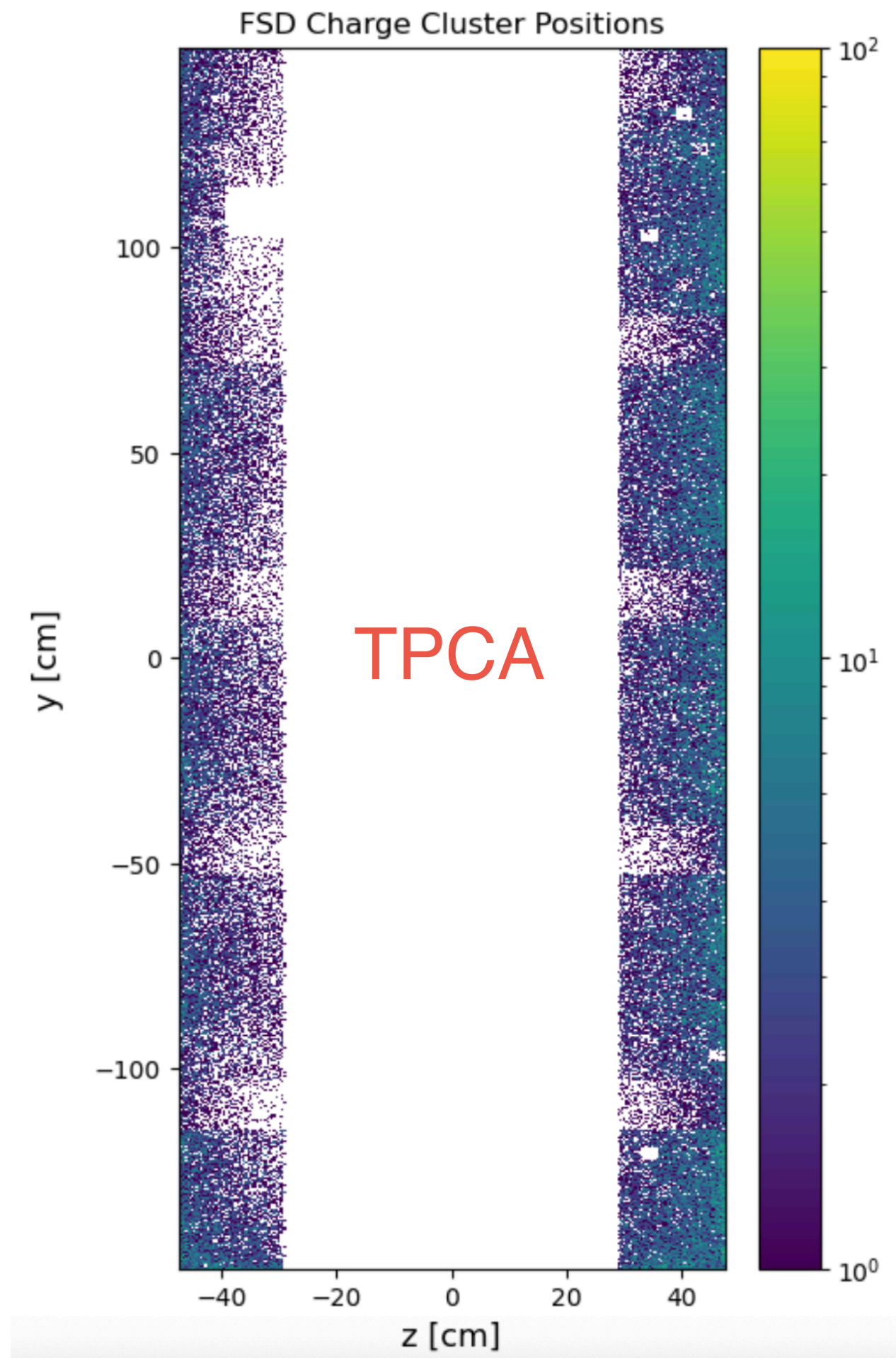
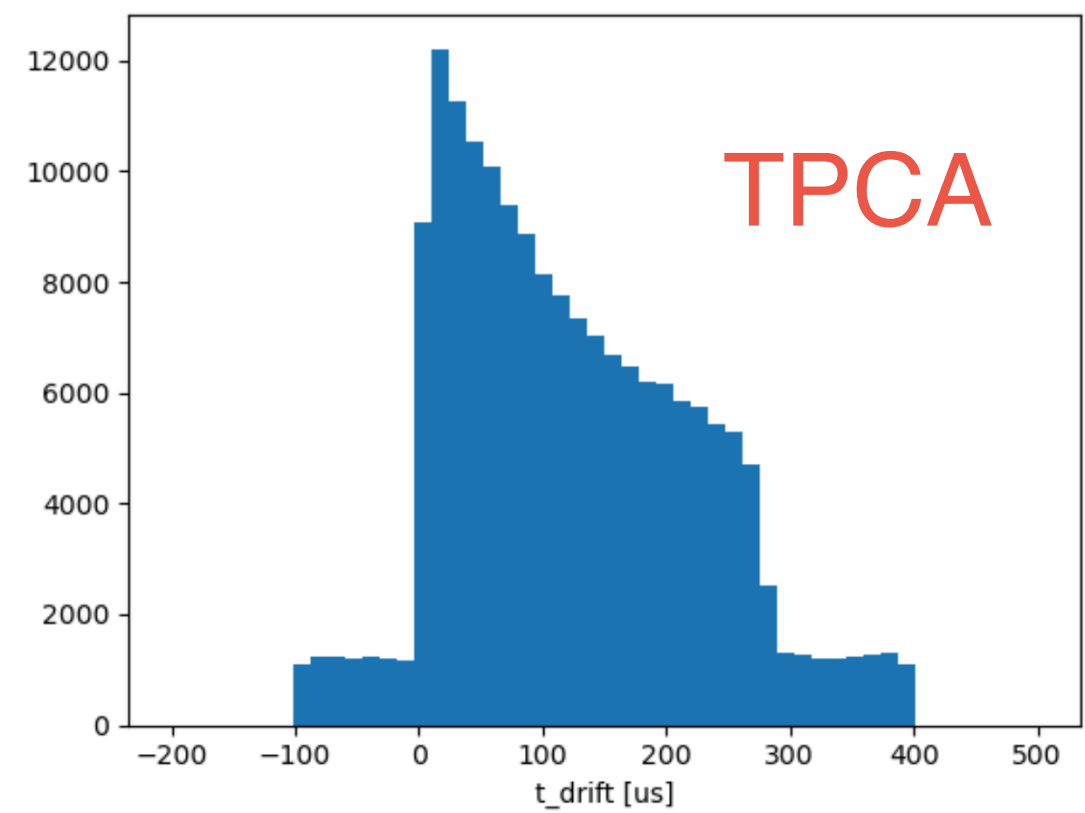
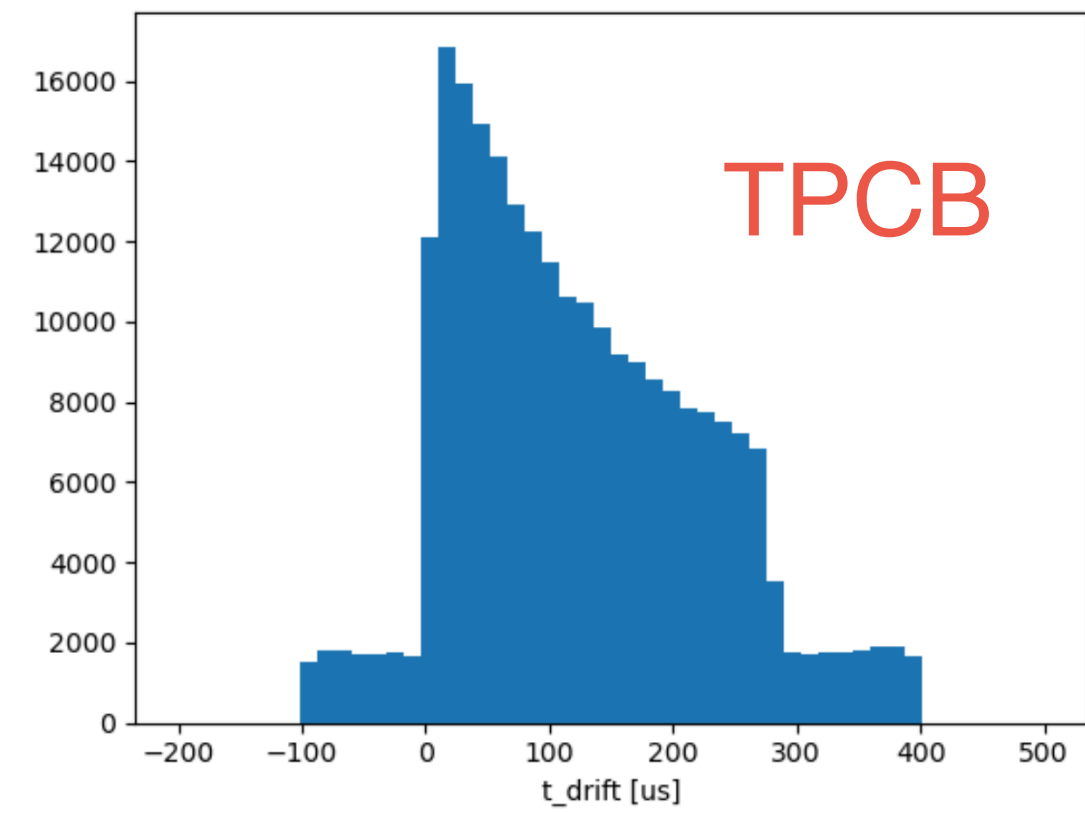
FSD Low Energy C+L Matching

- I have applied my low energy C+L reconstruction to FSD low threshold runs

run number	Start Timestamp [from first crs datafile]	LArPix Data Directory	Light R/O Directory	LRS sum threshold [ADC]	LRS trigger scaling	LRS VGA gain [dB]	Comments 1
Low Threshold run							
20094	2024_11_05_18_38_59_CET	/storage/data/CRS/cosmics/05Nov2024	/storage/data/LRS/low_threshold_01/	1.5K	30	10	Low threshold run. Ar39: TPC A Threshold 1500 ADC ~3 p.e rescaling: 30 rate before rescaling 6000 Hz rate after rescaling 200 Hz run duration 90 s LRS filesize: 2.8GB
20095	2024_11_05_21_02_15_CET	/storage/data/CRS/cosmics/05Nov2024	/storage/data/LRS/low_threshold_01/	1.5K	30	10	Low threshold run. Ar39: TPC A Threshold 1500 ADC ~3 p.e rescaling: 30 rate before rescaling 6000 Hz rate after rescaling 200 Hz run duration 90 s LRS filesize: 2.8GB
20096	2024_11_06_01_21_12_CET	/storage/data/CRS/cosmics/05Nov2024	/storage/data/LRS/low_threshold_01/	1.5K	30	10	Low threshold run. Ar39: TPC B Threshold 1500 ADC ~3 p.e rescaling: 30 rate before rescaling 6000 Hz rate after rescaling 200 Hz run duration 90 s LRS filesize: 2.8GB
20097	2024_11_06_03_29_32_CET	/storage/data/CRS/cosmics/05Nov2024	/storage/data/LRS/low_threshold_01/	1.5K	30	10	Low threshold run for Ar39 - same LRS configuration as the previous run

- Some notable ndlar_flow updates to feature_low_energy:
 - Simple threshold-based hit finder to find waveforms above a threshold
 - Clustering event builder, allows for charge only reco to find low energy activity w/o charge-light matching

FSD Low Energy C+L Matching



*using simple threshold based hit finder in flow, requiring charge clusters to be close to det with a hit (Det = 3 LCMs or 1 ACL)

Proximity to optical hits defined in the region $Z = \pm 20$ cm and $Y = \pm 25$ cm rel. to det center.

Backup

