

The second look at INTT Run24 AuAu collision data

Cheng-Wei Shih
National Central University & RIKEN

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INTT meeting

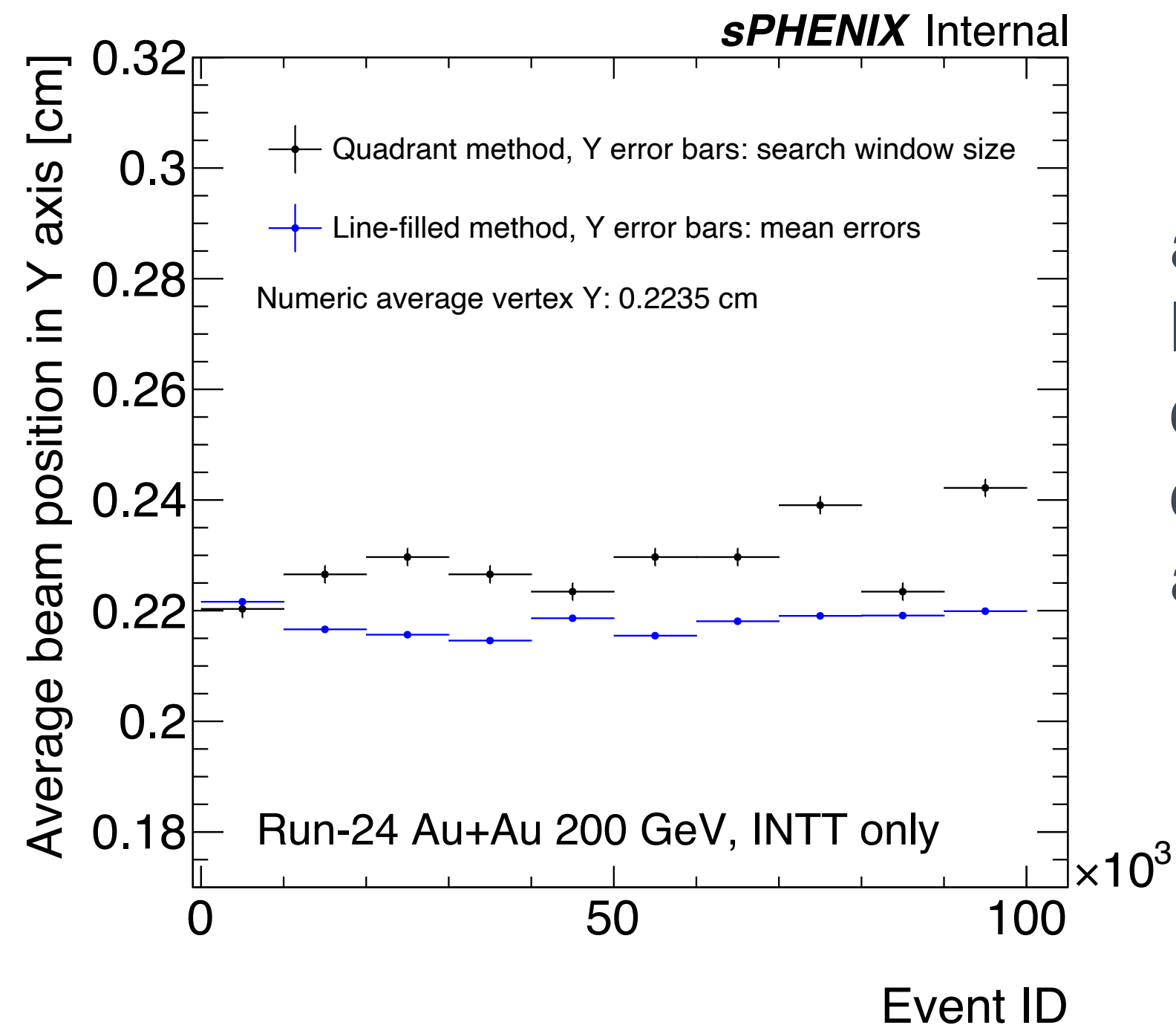
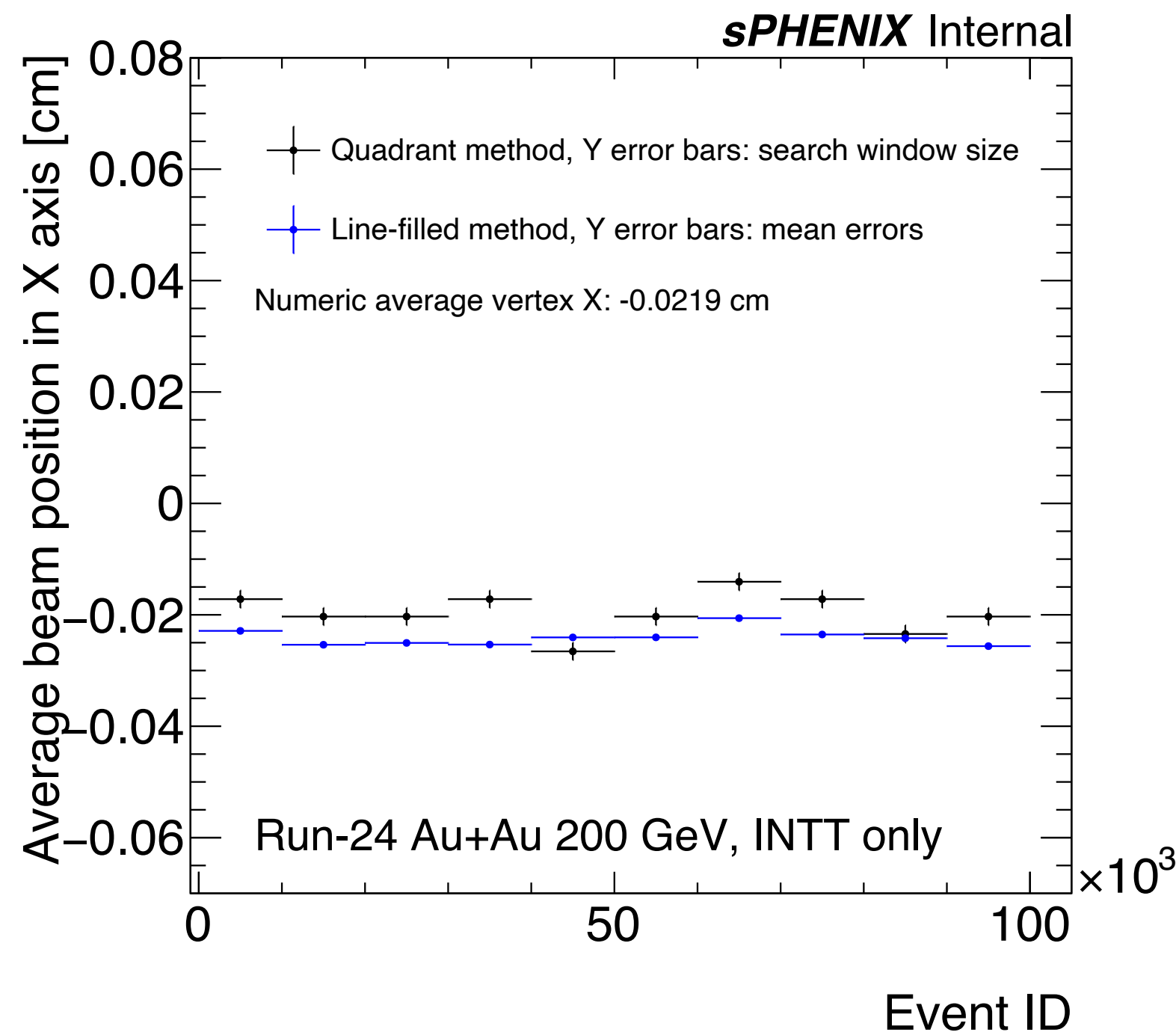


國立中央大學
National Central University



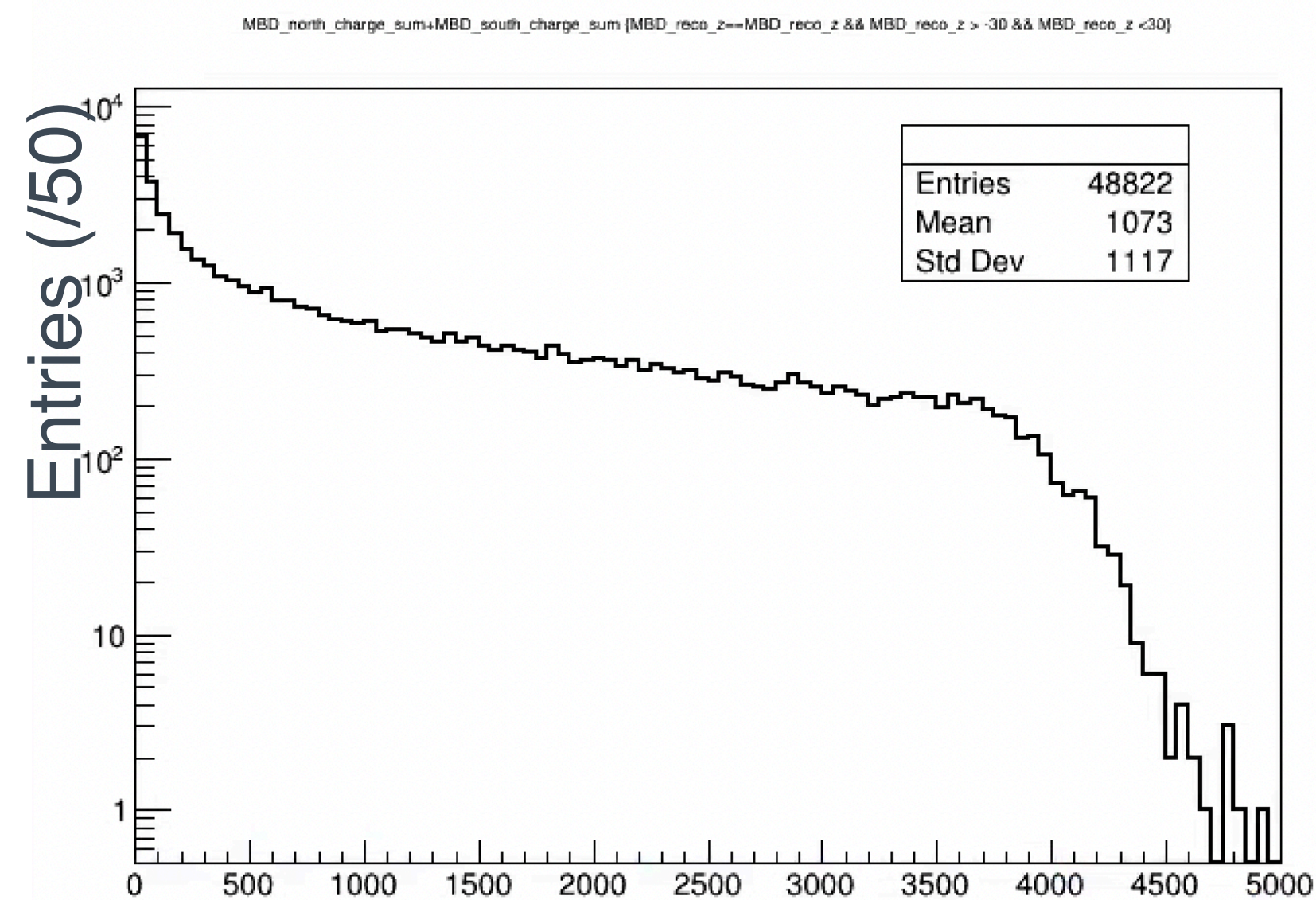
Average vertex XY

- **INTTRAWHIT** DST, **MBDPacket** DST from official production
- **INTT_TrkrHitSet**, **INTT_TrkrCluster**, **MBDout** DSTs privately generated
- Hot channel mask & BCO_diff cut applied (maps produced by Jaein)
- Require the events firing the trigger of “MBD N&S ≥ 2 , vtx < 30 cm”
- Low multiplicity selected ($20 < N$ good clusters* < 350)

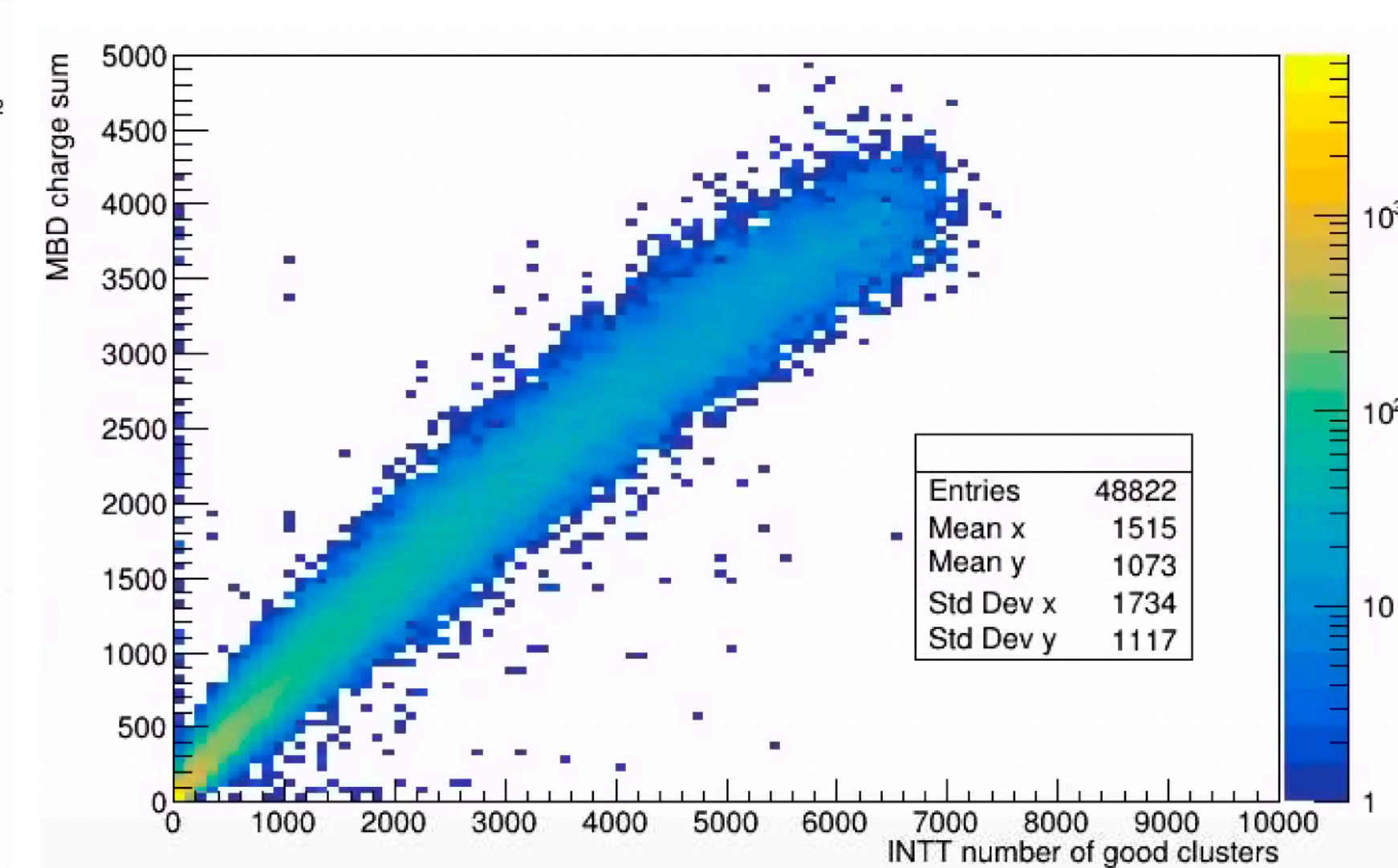
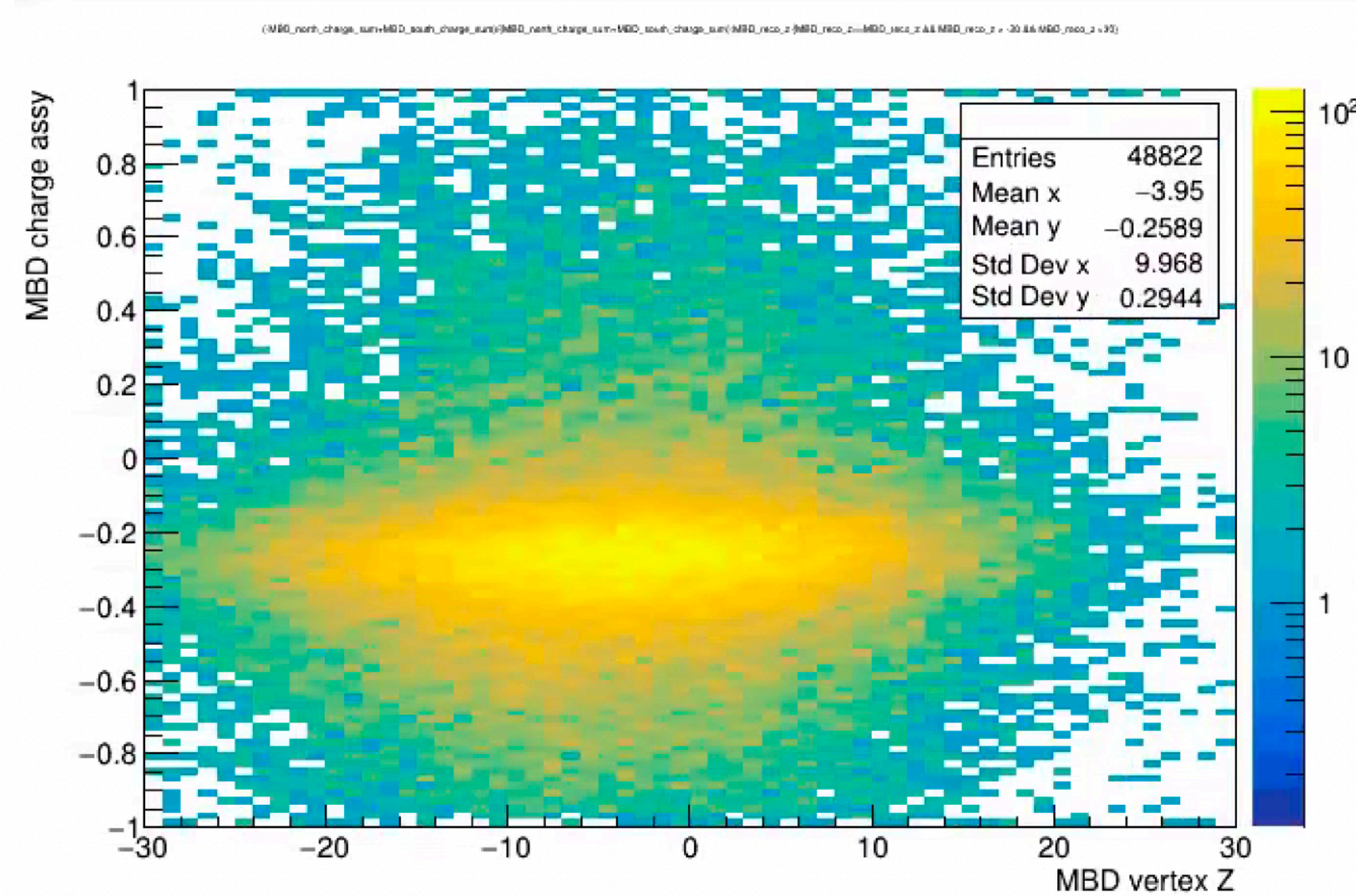


a line filled X : -0.0240694 +/- 0.00150677
line filled Y : 0.217875 +/- 0.00222706
quadrant X : -0.0196875 +/- 0.00354779
quadrant Y : 0.229063 +/- 0.00687816
avg: {-0.0218784 * cm, 0.223469 * cm}

- **INTTRAWHIT** DST, **MBDPacket** DST from official production
- **INTT_TrkrHitSet**, **INTT_TrkrCluster**, **MBDout** DSTs privately generated
- Hot channel mask & BCO_diff cut applied (maps produced by Jaein)
- $MBD_vtxZ == MBD_vtxZ \ \&\& \ |MBD_vtxZ| \leq 30 \text{ cm}$
- $MBD \text{ charge assy} = (\text{south_charge_sum} - \text{north_charge_sum}) / (\text{total_charge_sum})$

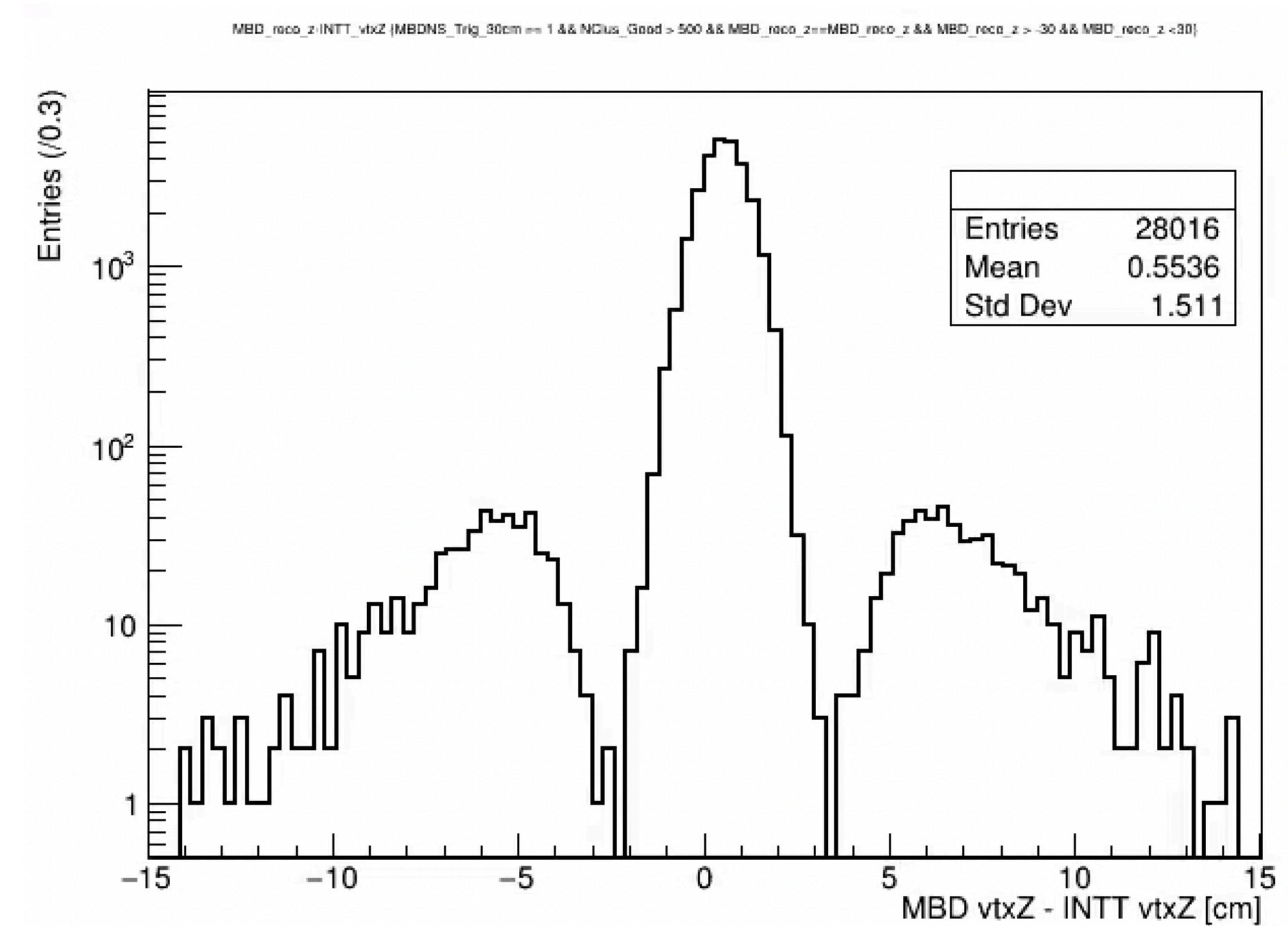
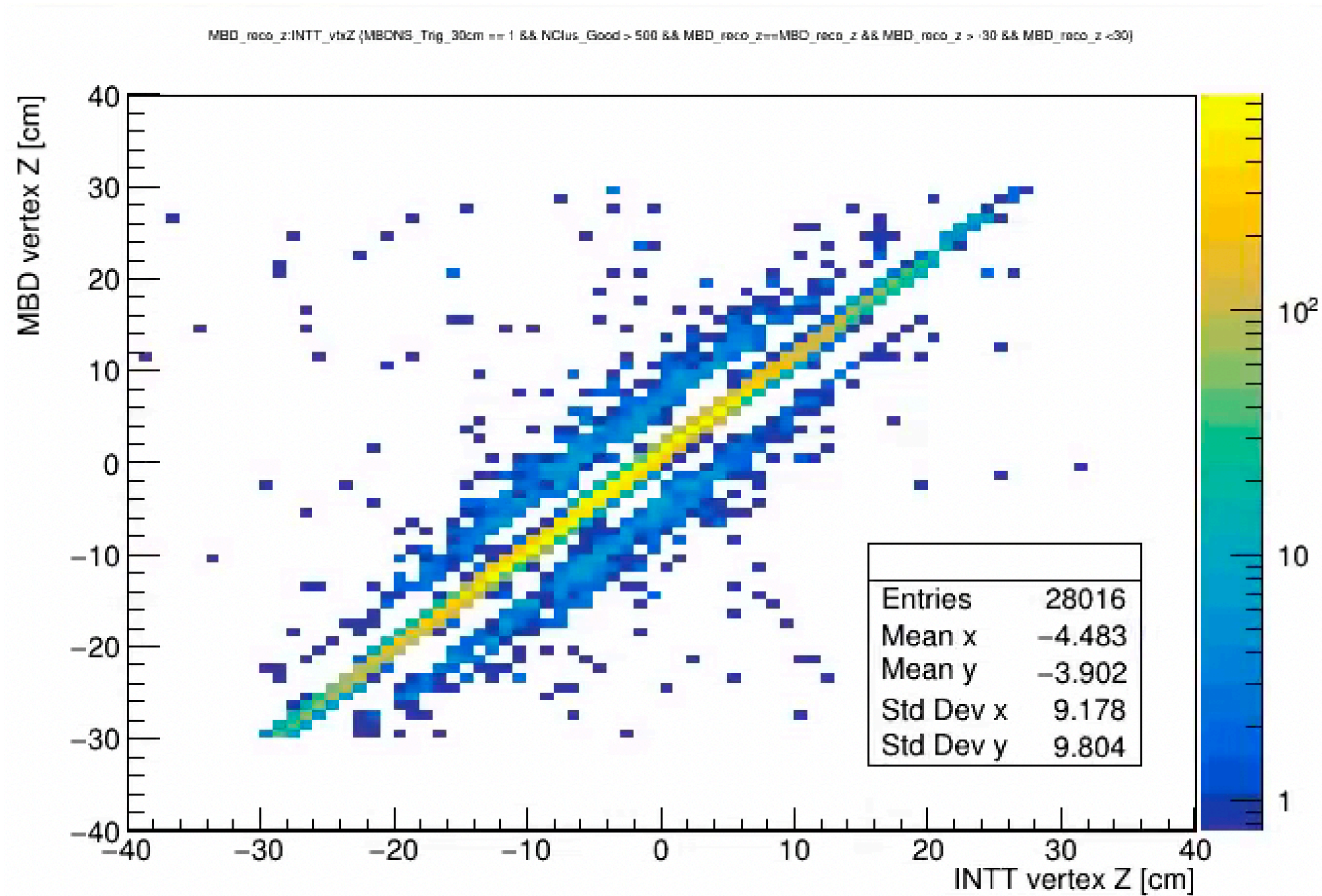


MBD charge sum



Per-event vertex Z w/ MBD

- **INTTRAWHIT** DST, **MBDPacket** DST from official production
- **INTT_TrkrHitSet**, **INTT_TrkrCluster**, **MBDout** DSTs privately generated
- Hot channel mask & BCO_diff cut applied (maps produced by Jaein)
- $MBD_vtxZ == MBD_vtxZ \ \&\& \ |MBD_vtxZ| \leq 30 \text{ cm}$
- $NClus_Good > 500$

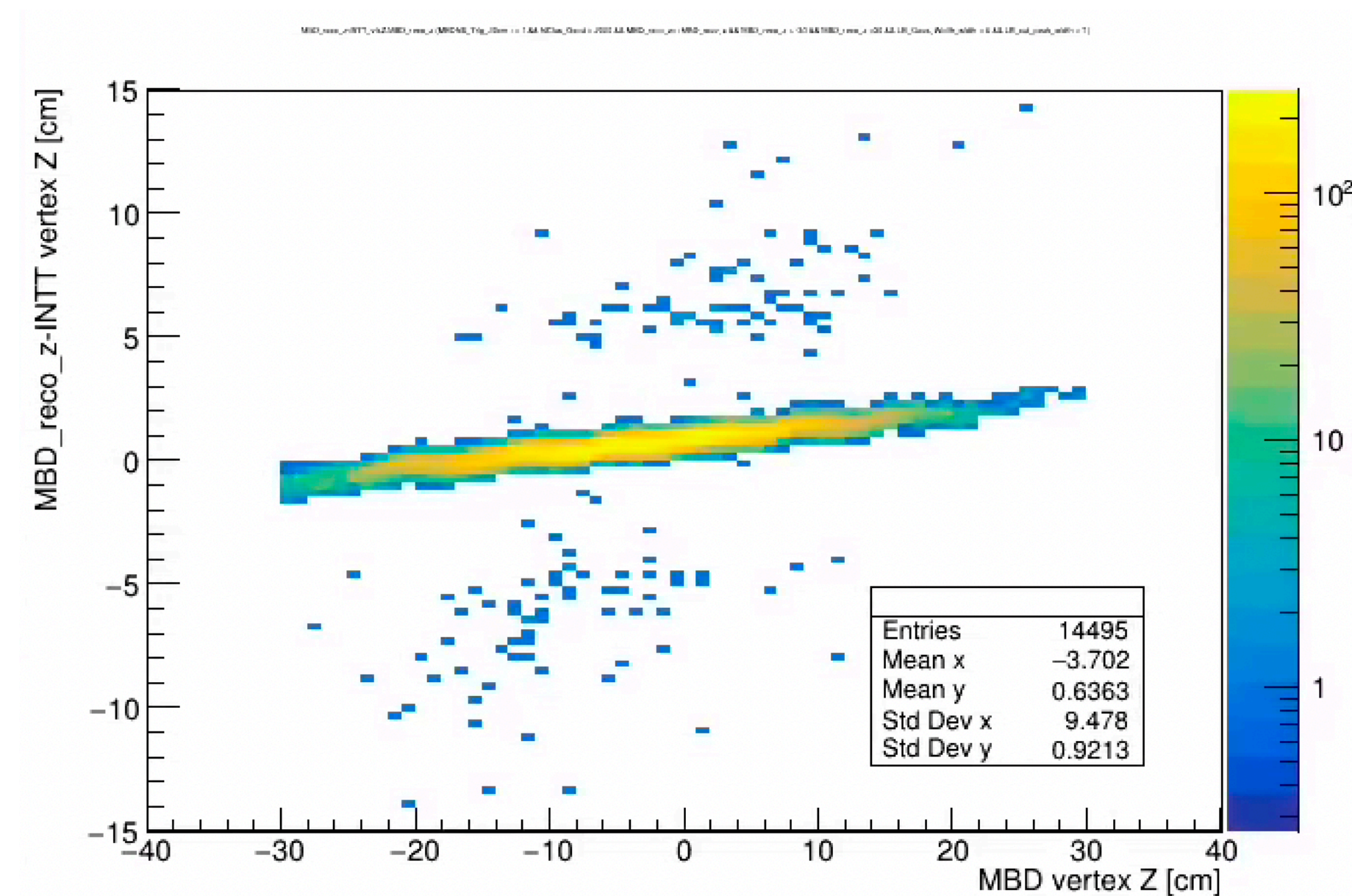
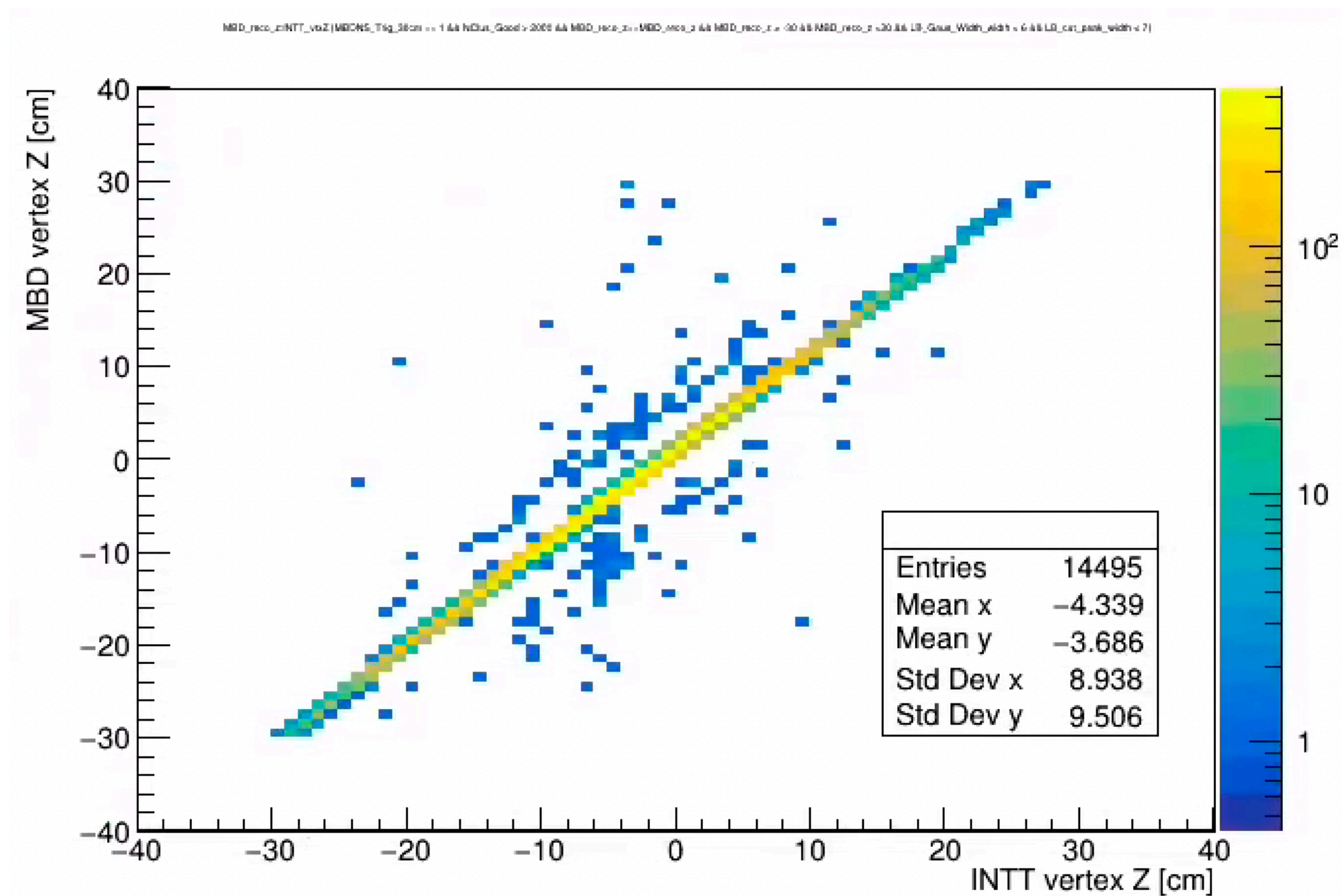


Weird satellite peaks, need more check, MBD vertex Z is not fully calibrated

*Good cluster: cluster size < 6 && cluster adc > 35

Per-event vertex Z w/ MBD

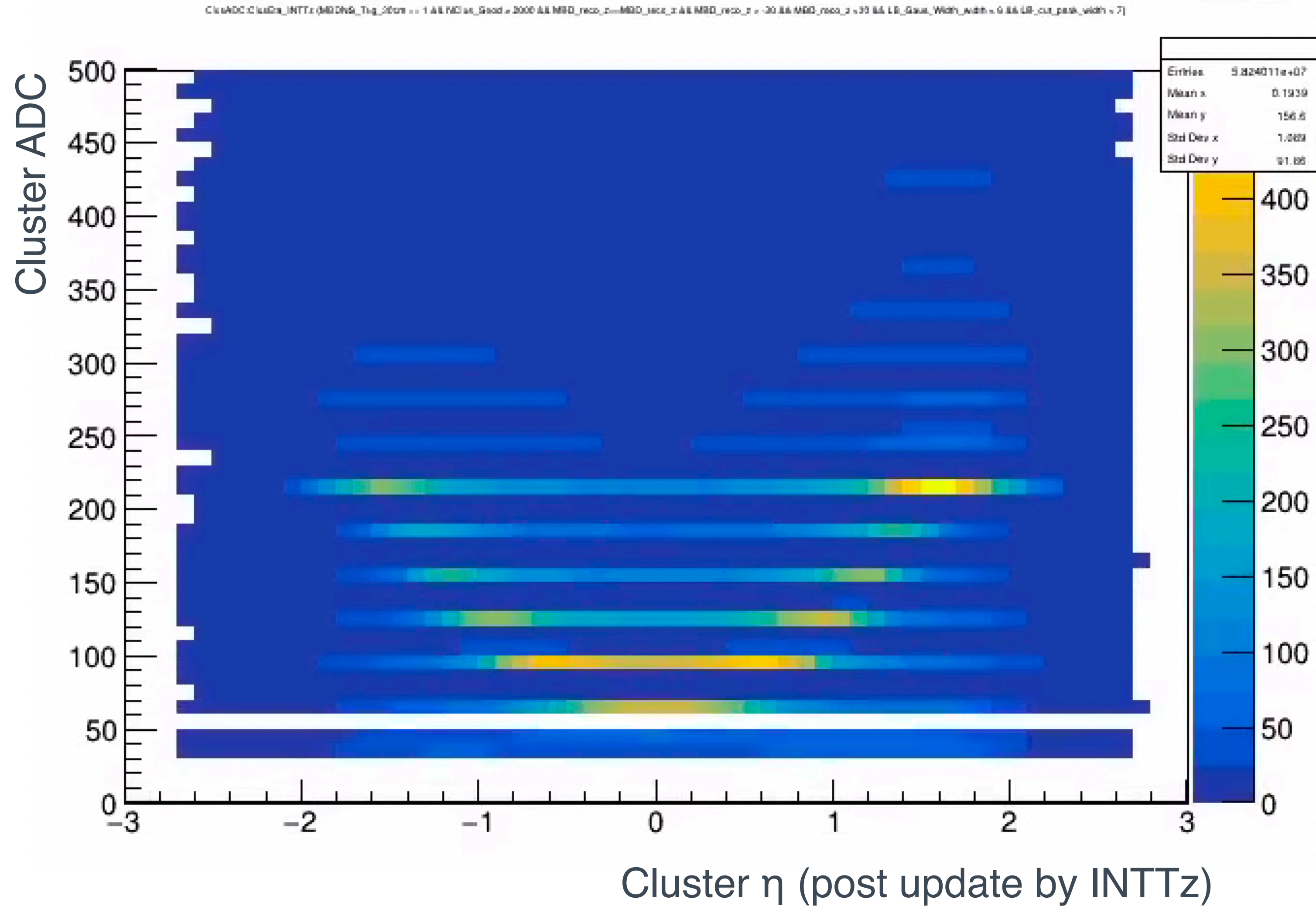
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- **INTT_TrkrHitSet**, **INTT_TrkrCluster**, **MBDout** DSTs privately generated
- Hot channel mask & BCO_diff cut applied (maps produced by Jaein)
- $\text{MBD_vtxZ} == \text{MBD_vtxZ} \ \&\& \ |\text{MBD_vtxZ}| \leq 30 \text{ cm}$
- $\text{NClus_Good} > 2000$
- INTT vertex Z quality cuts applied



Note : MBD vertex Z is not fully calibrated

Cluster ADC - η correlation

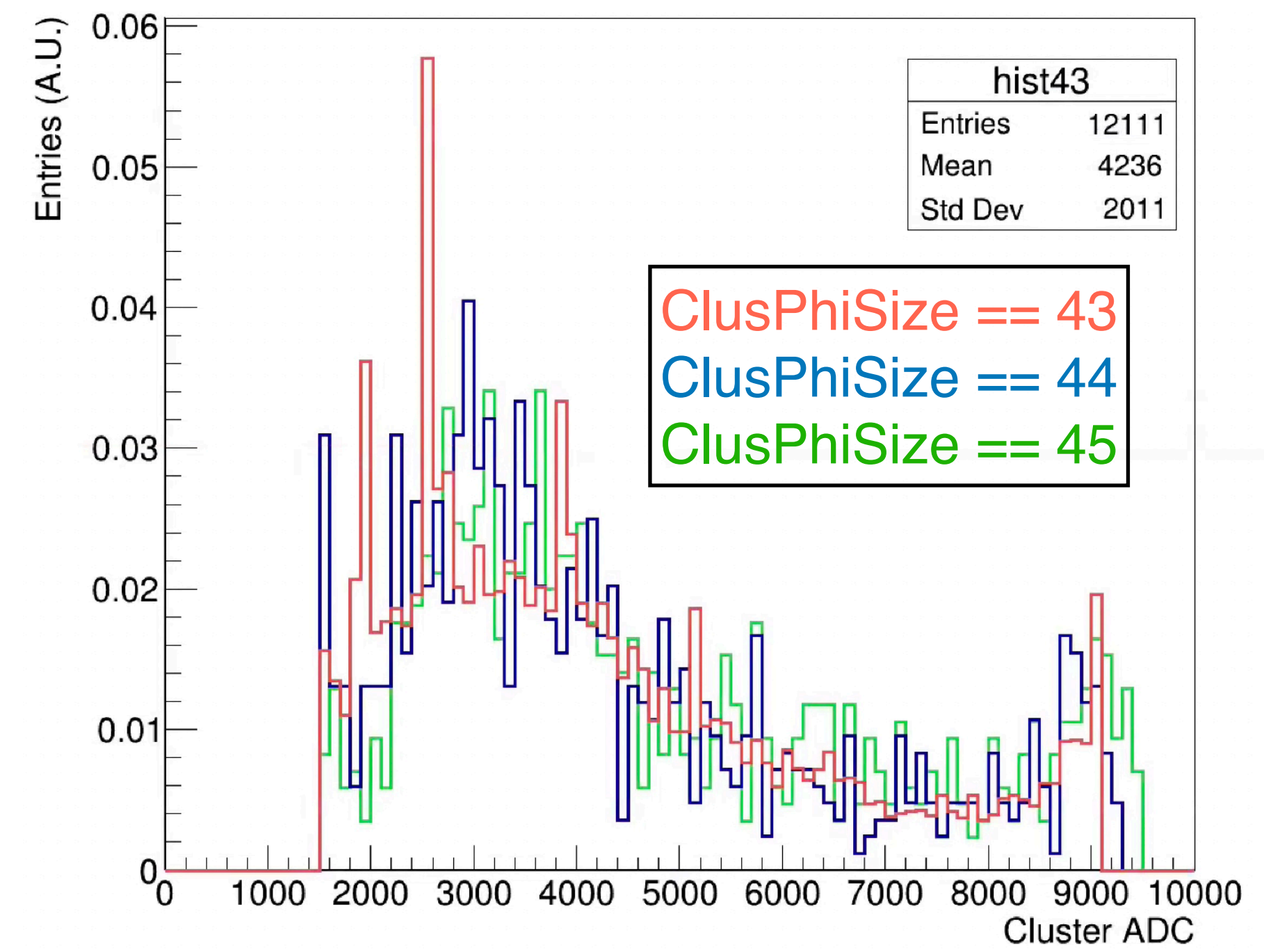
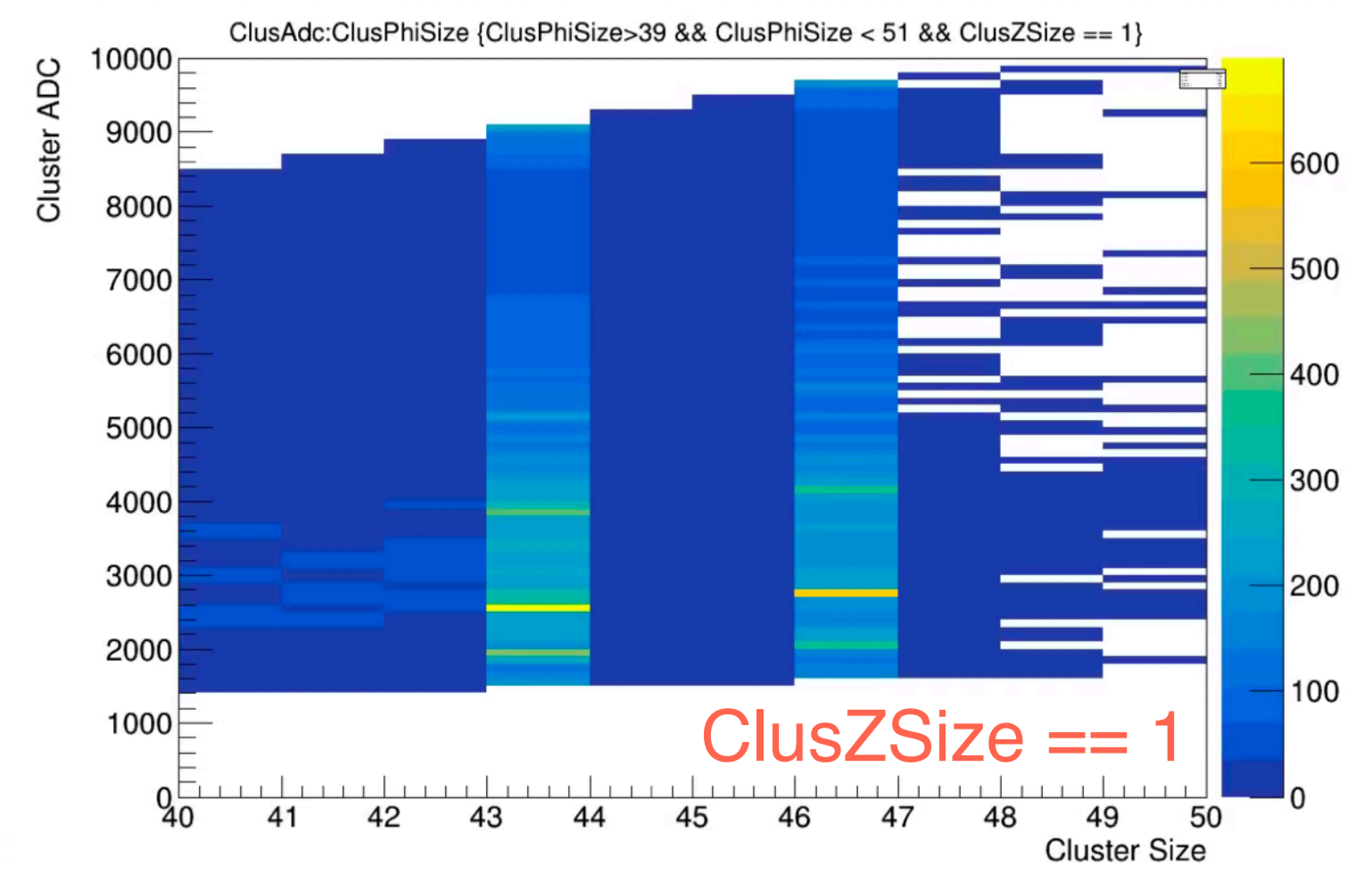
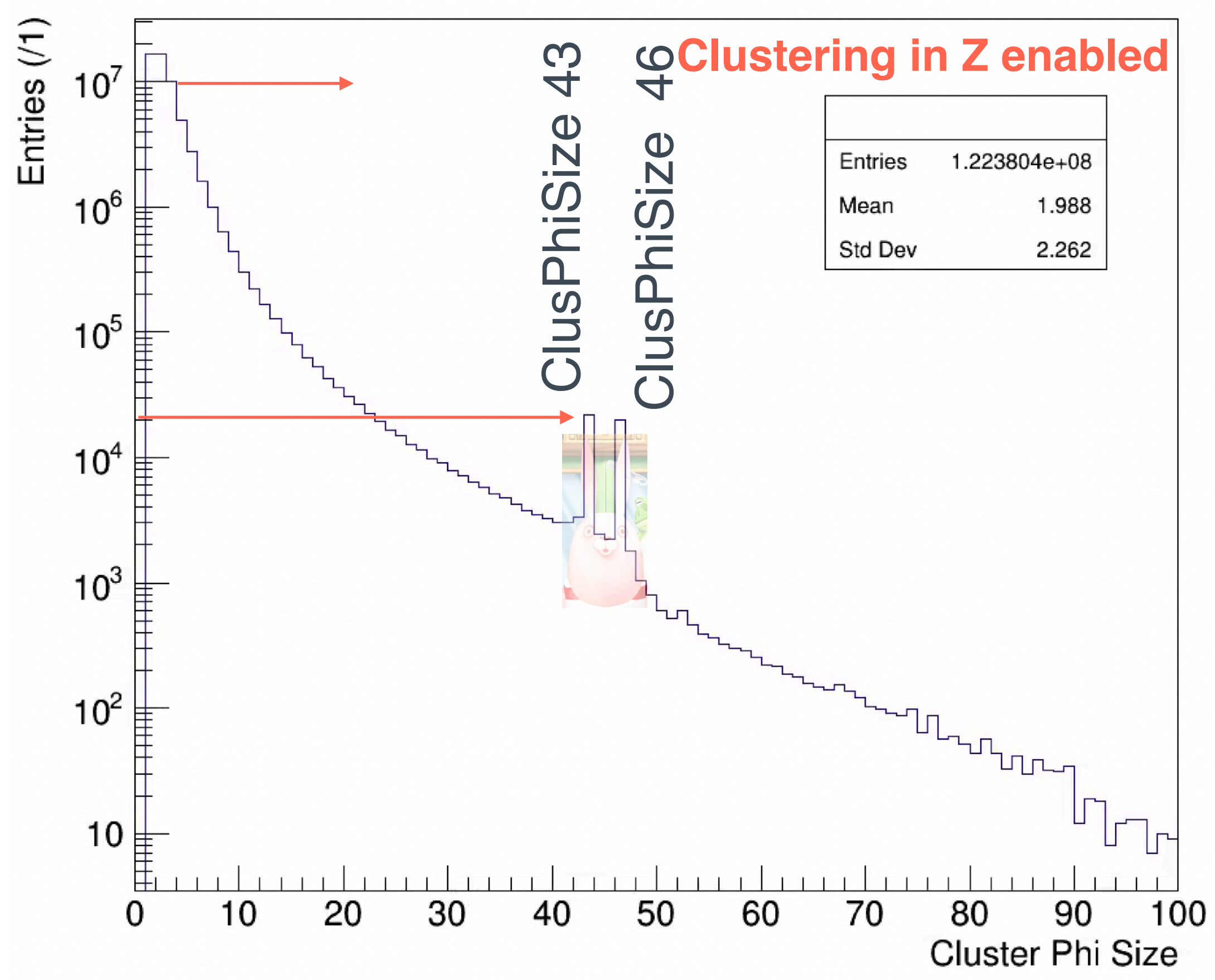
First 100k events



Sanity check - Cluster phi size distribution



First 100k events



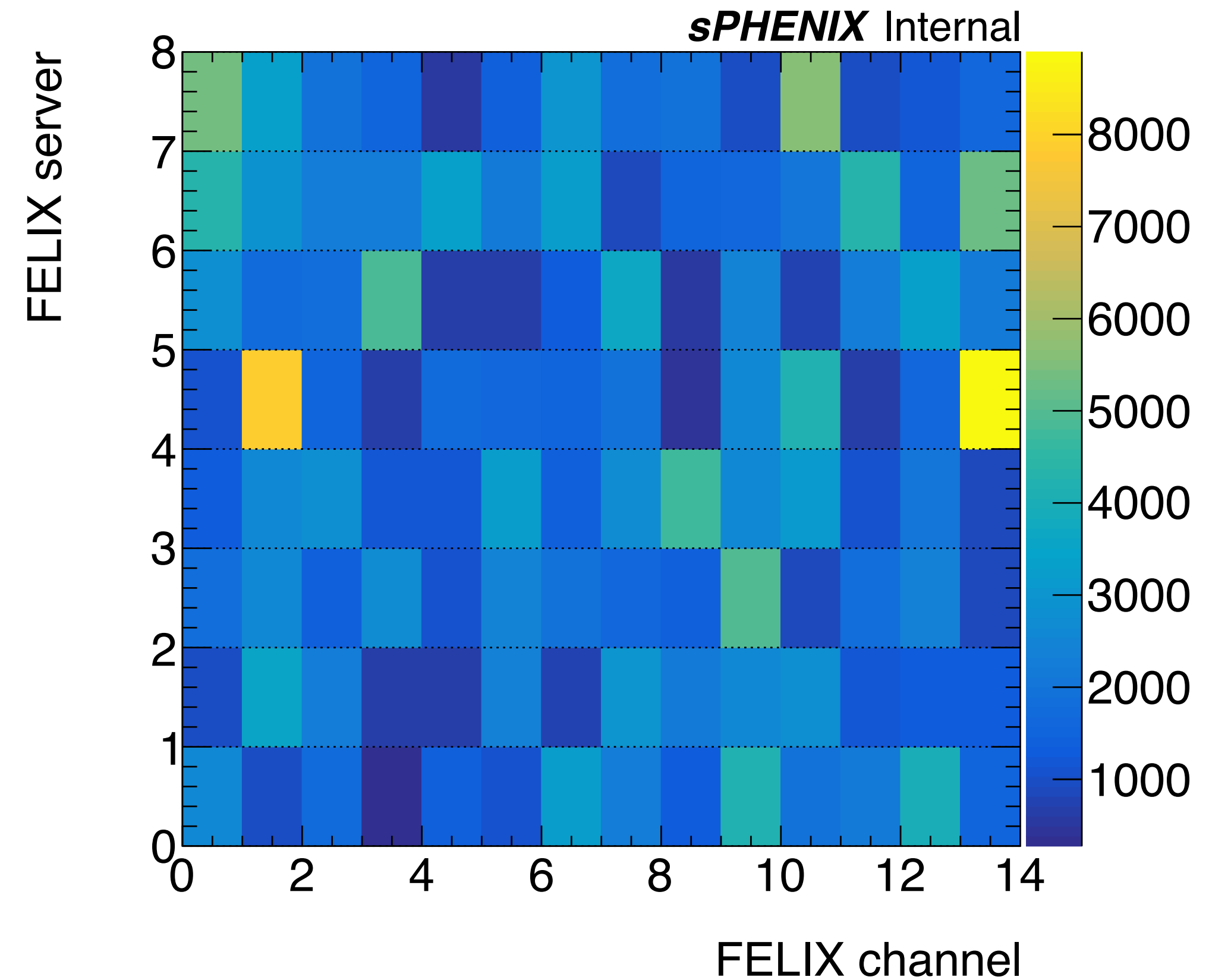
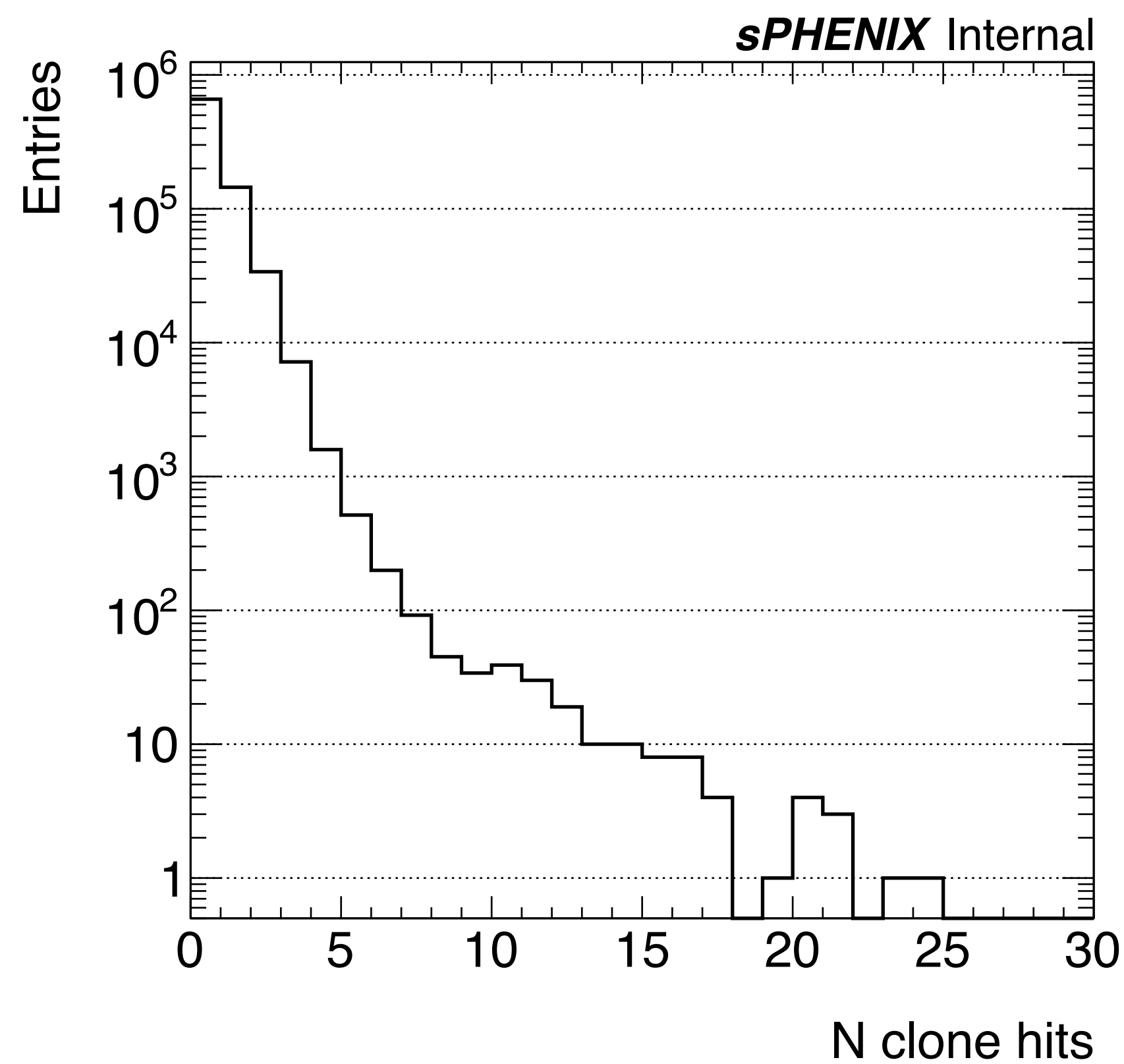
This has been known since Run 2023, but still lack of proper explanation

More about data sanity check

The followings are the study
based on the **INTTRAWHIT**

Sanity check - clone hit

- Clone hit definition: in one event, the hits with the same FELIX_server, FELIX_ch, chip_id, channel_id, and FPHX_bco



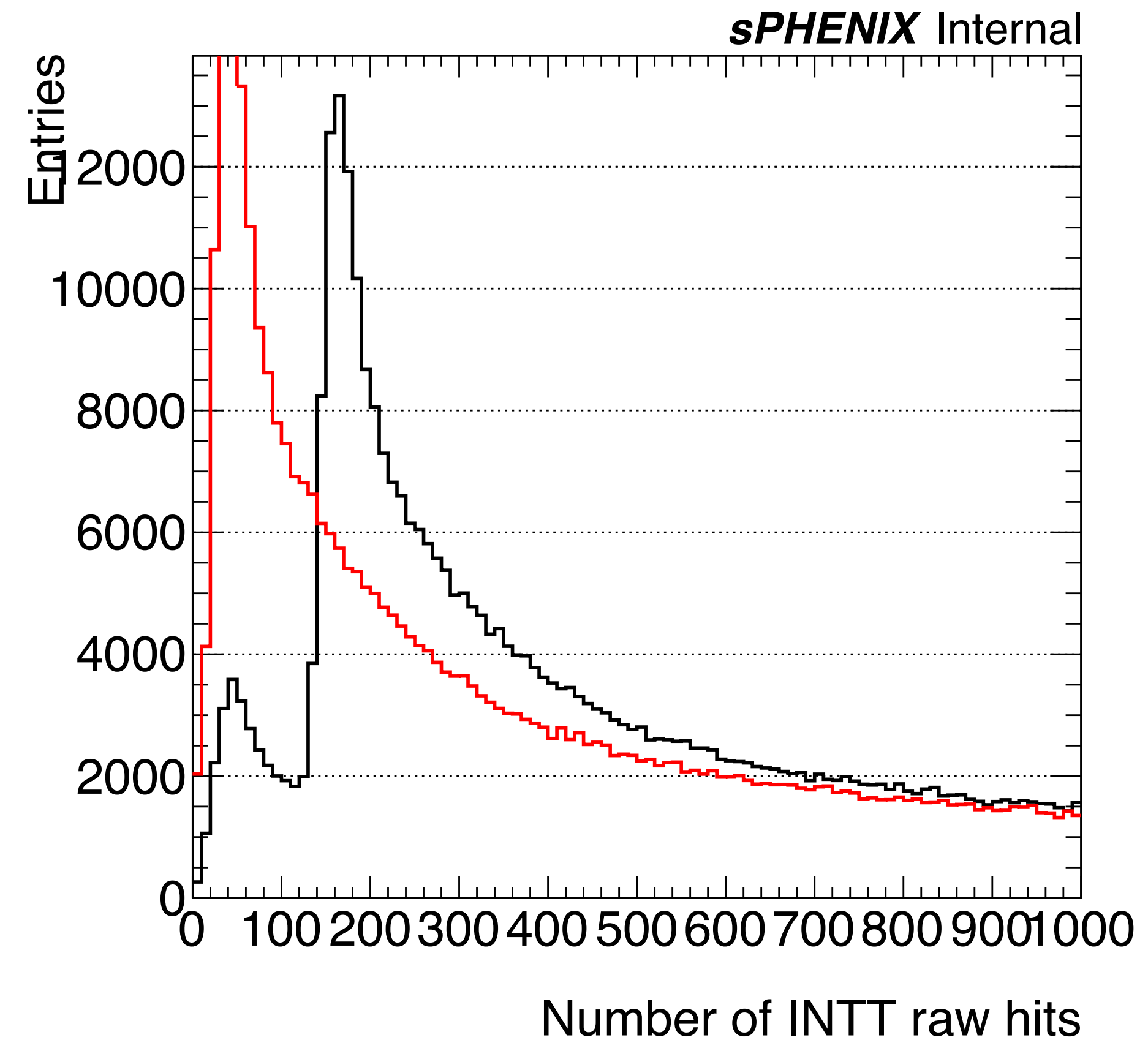
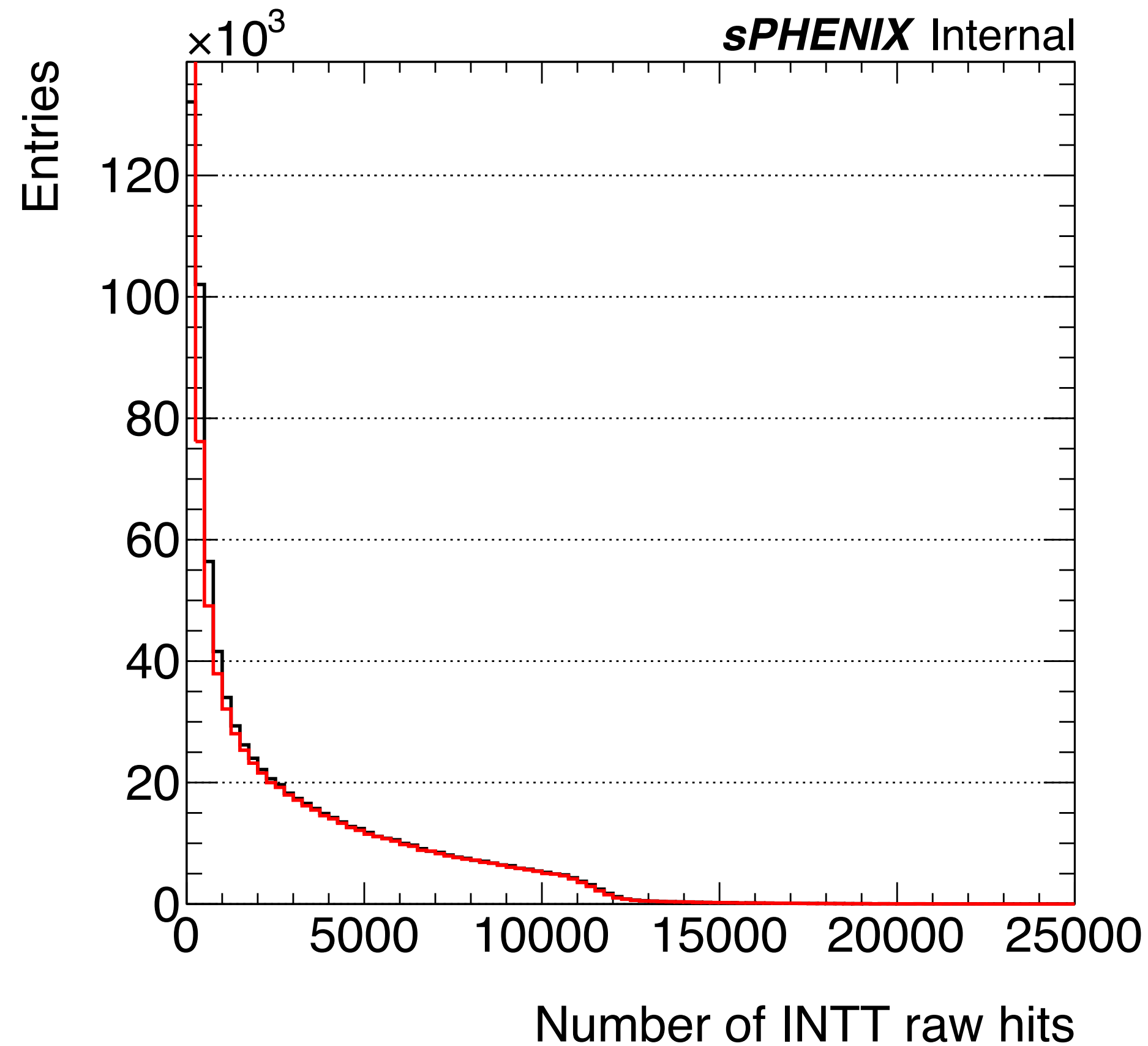
nEvent_post_trigger_cut*: 847117
nEvent_with_clone_hit: 188475
clone hit ratio: 0.22249

Still some clone hits in data

*Trigger: MBDNS_vtxZ30cm

Number of raw hit distribution

- Black dist: `inttcont->get_nhits()`;
- Red dist: Hot channel mask (Jaein's map), hitQA, clone hit removal were applied



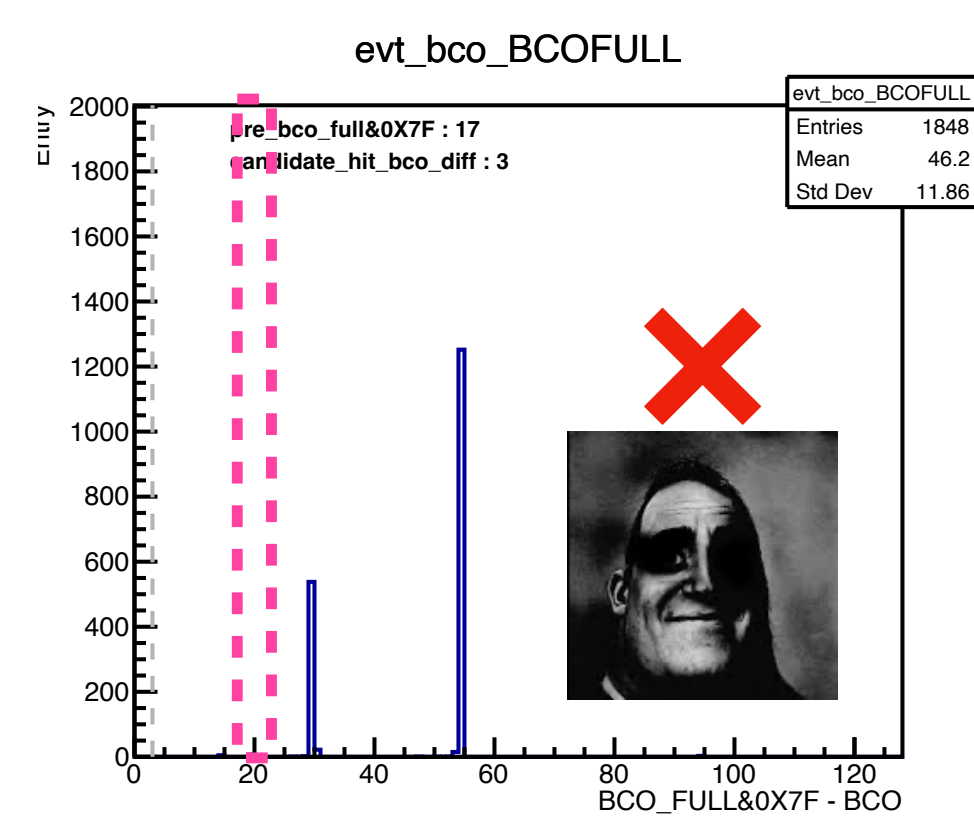
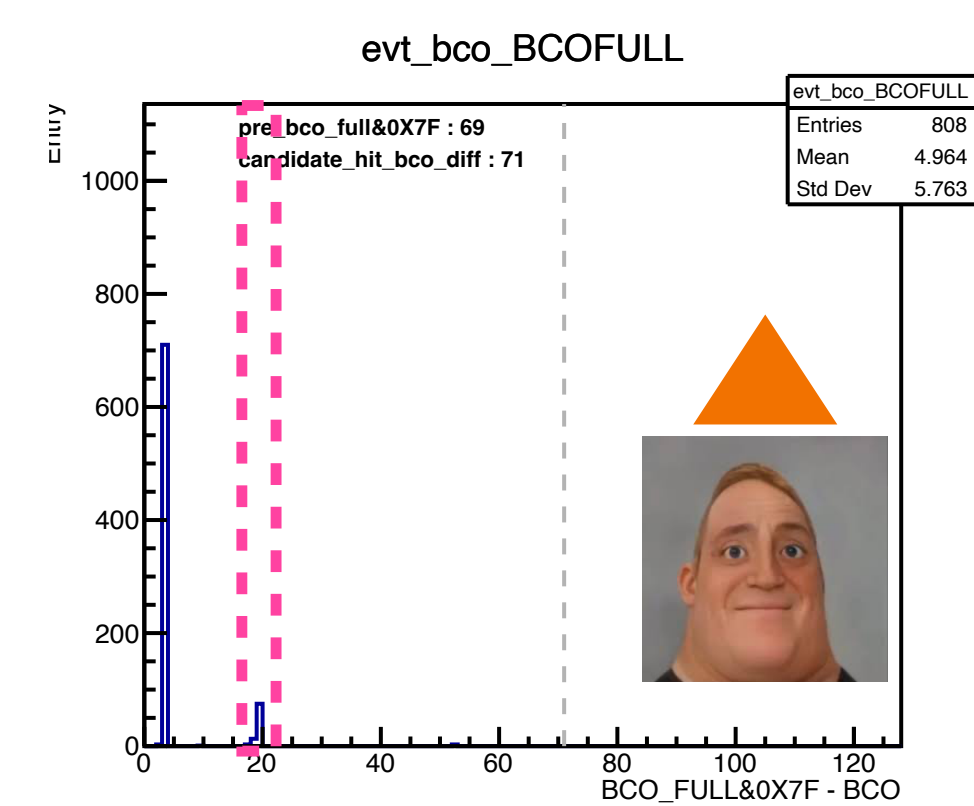
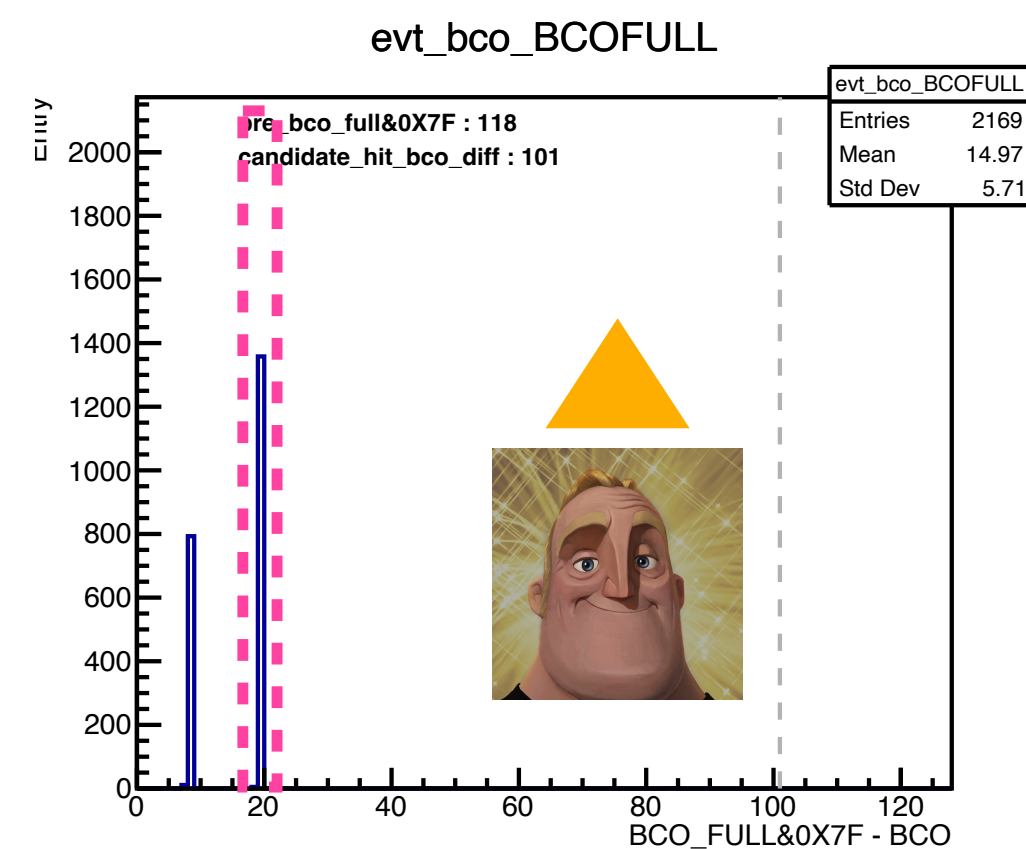
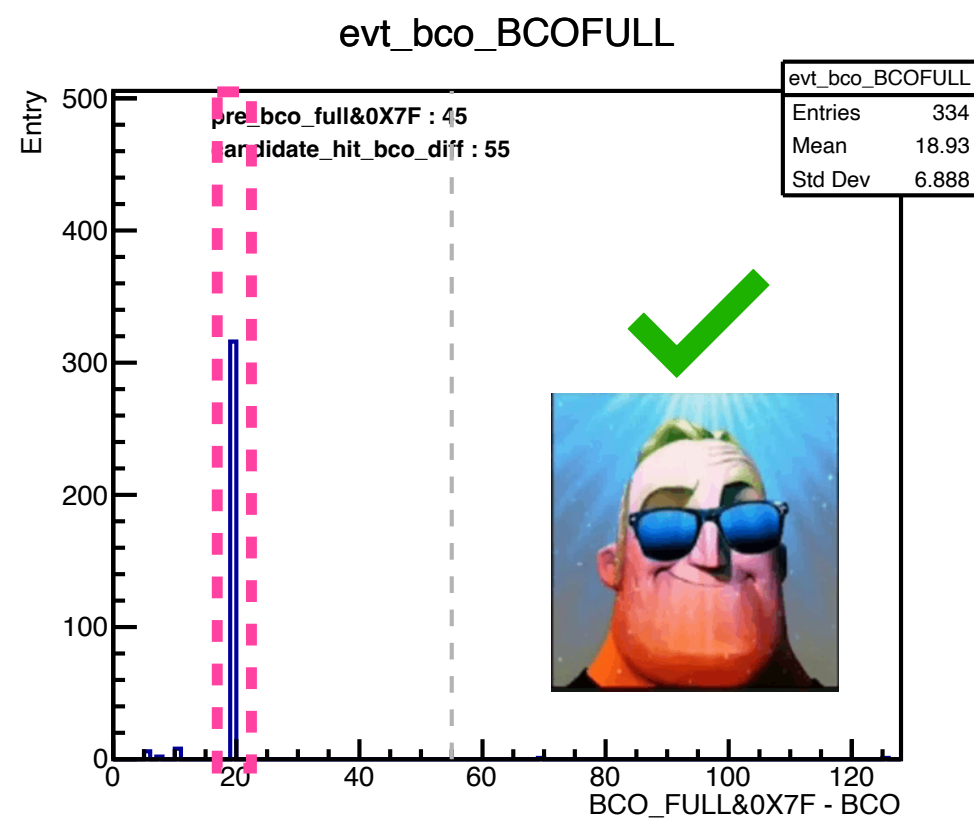
The distribution looks reasonable after the calibrations applied

Per event bco_diff distribution

File: beam_intt5-00020708-0000_event_base.root (clone hits are removed in first step)

Recap

Showing 4 events below as example
One spike at 19 is expected, at least, my thought



However, it is NOT the case

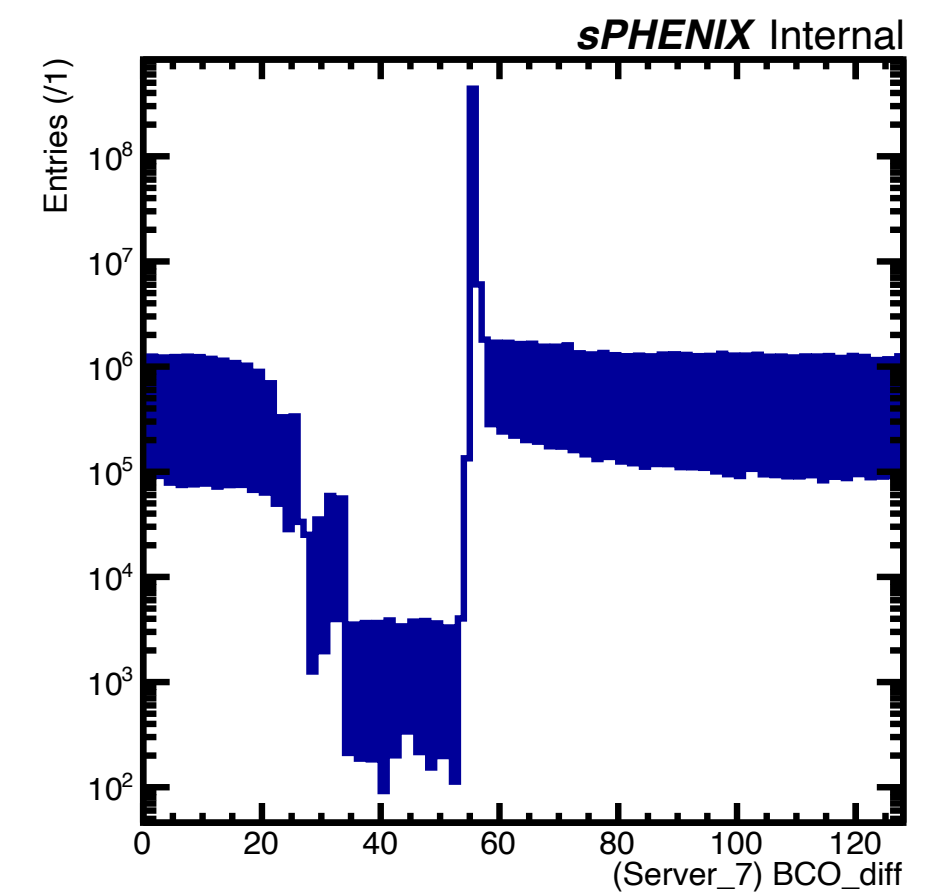
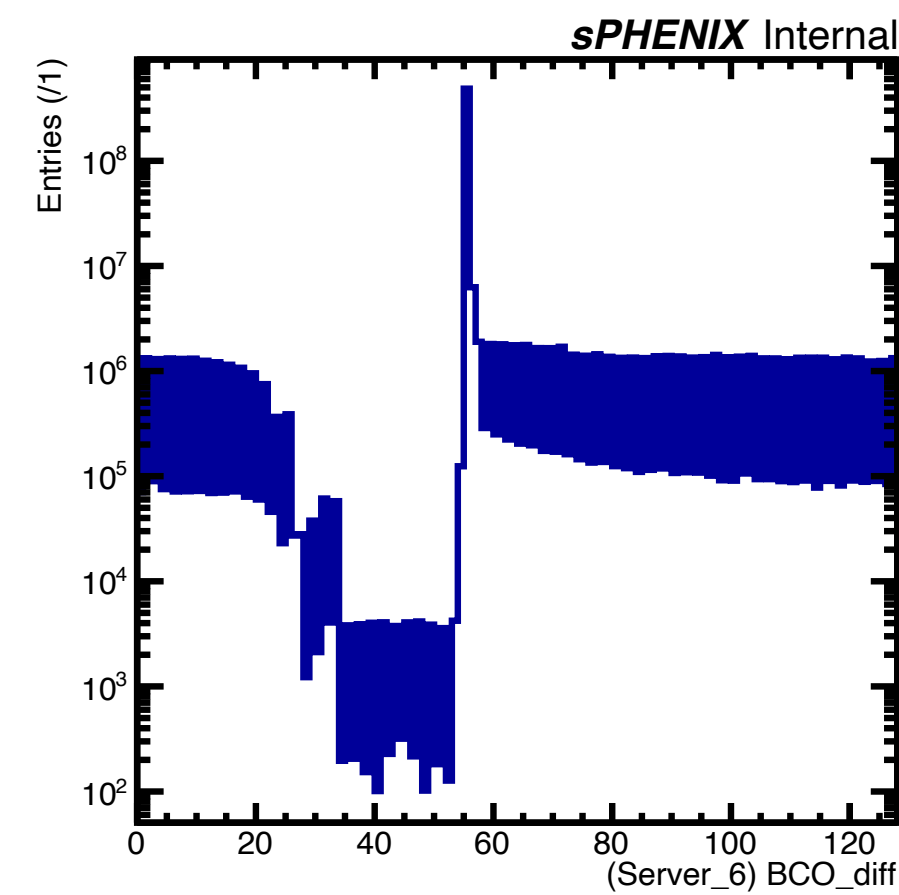
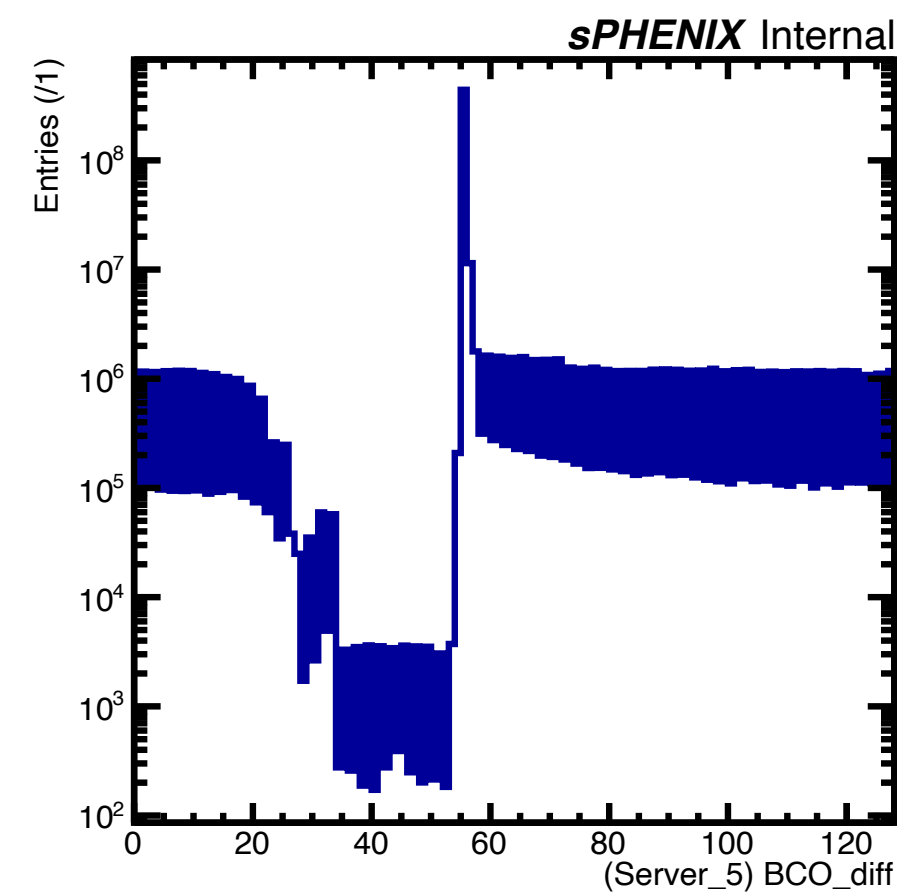
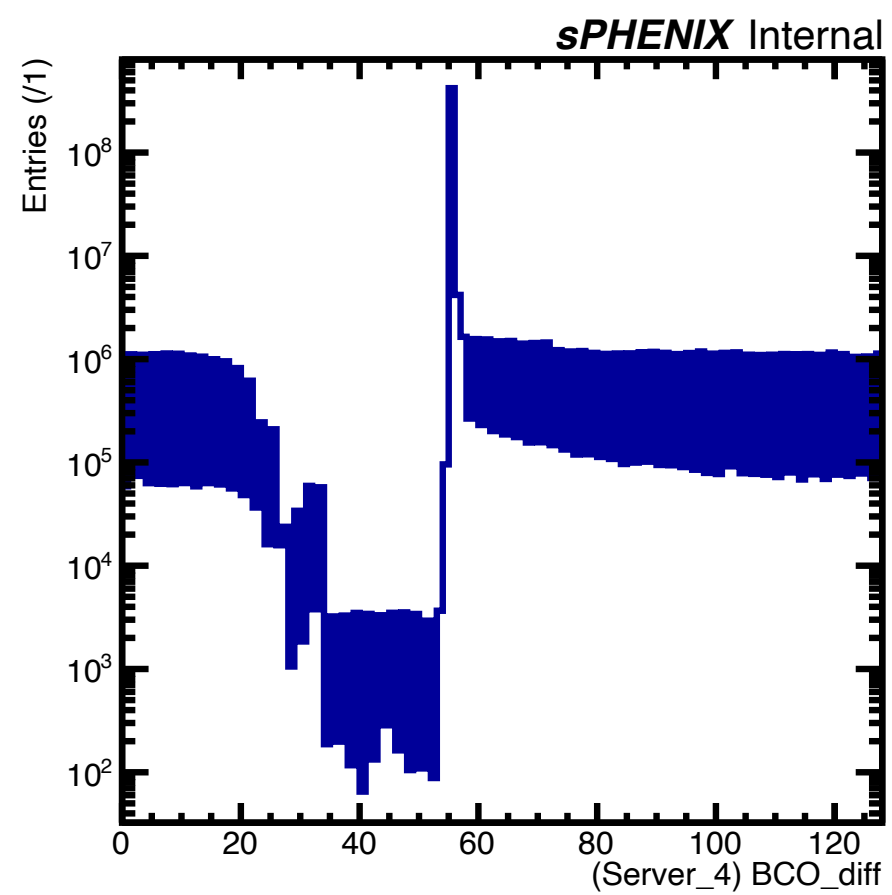
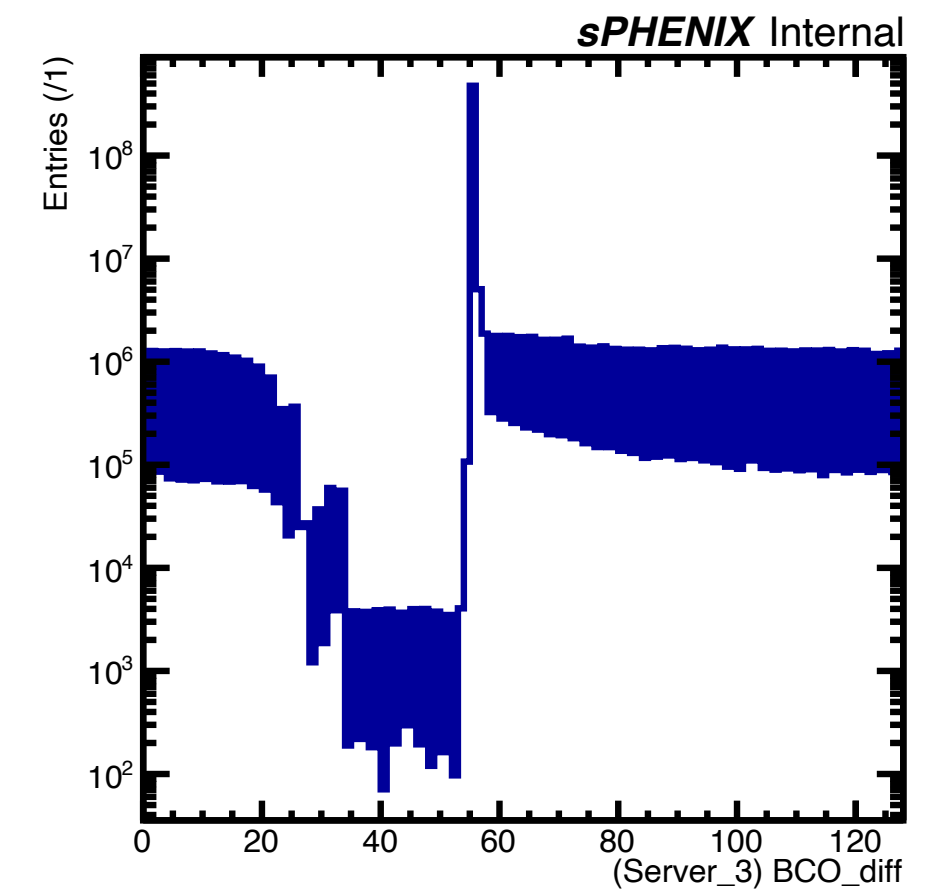
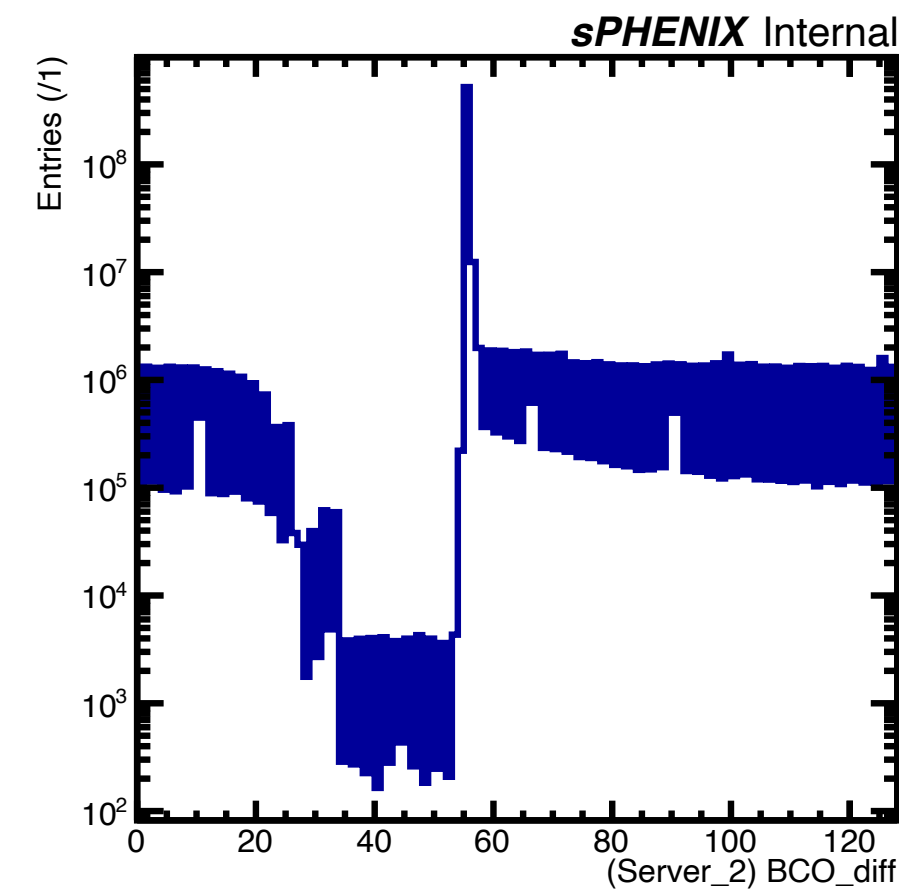
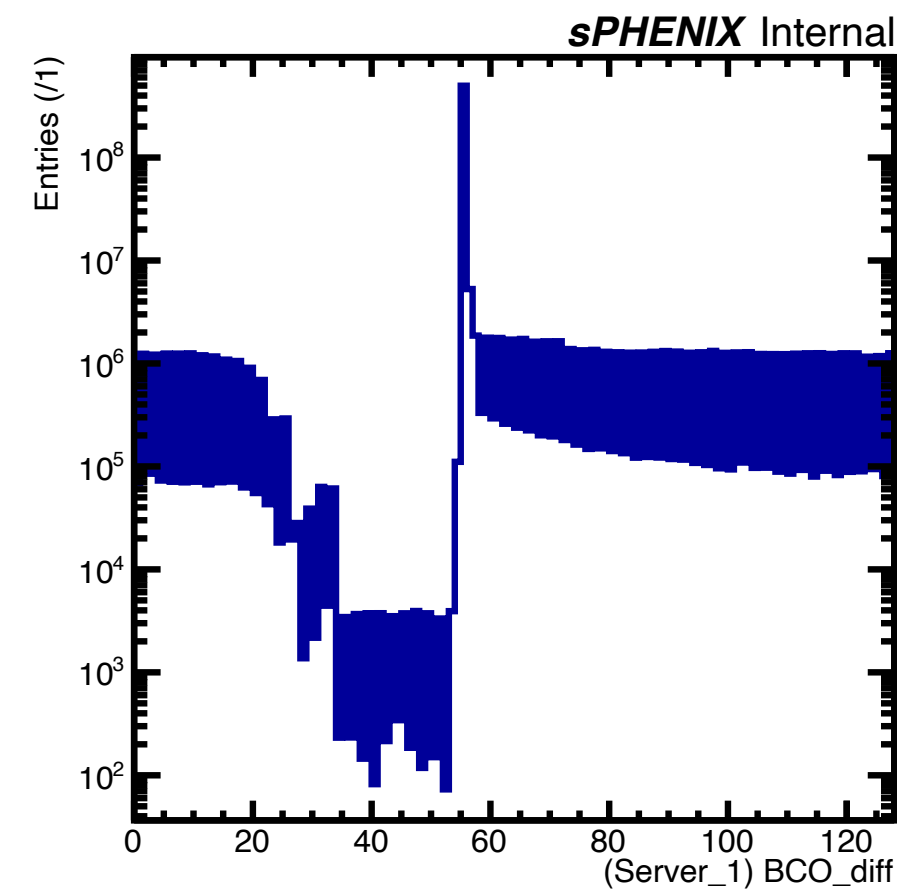
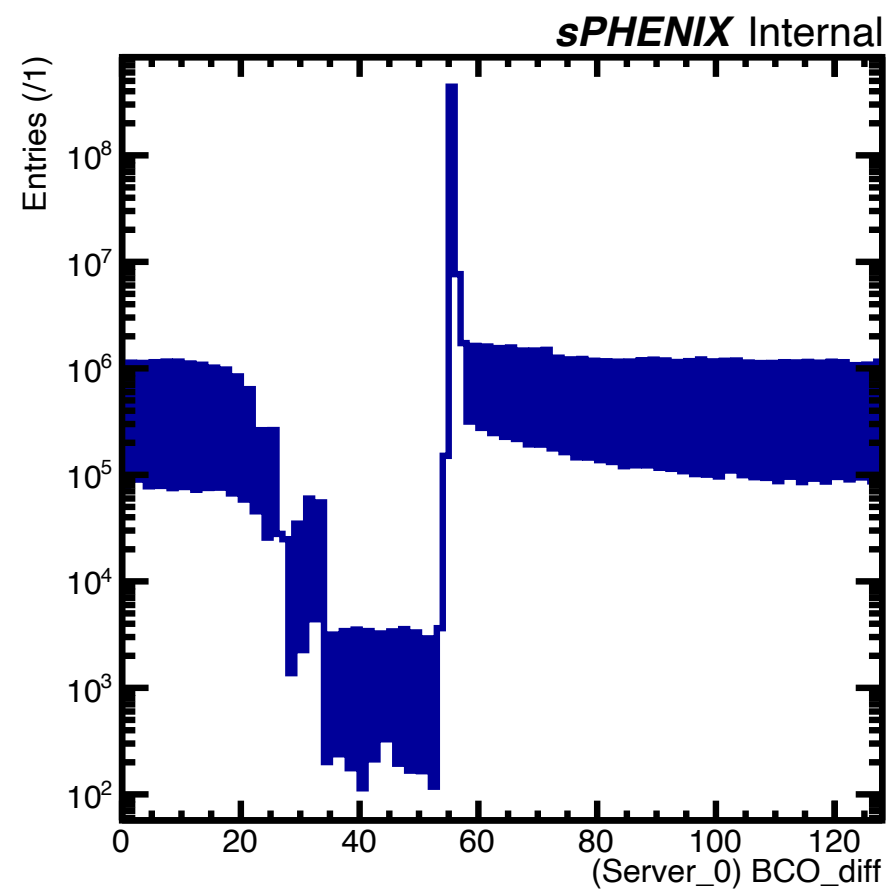
There are some events whose spikes are not in the expected location

The standing order of the INTT calibration (INTT bco_diff cut) in the offline analysis may have to be optimized (at least for the run23 analyses)

For example, The current scheme will discard most of the hits of the ▲ event, but the event will still be kept, which could introduce the bias

Sanity check - BCO diff cut

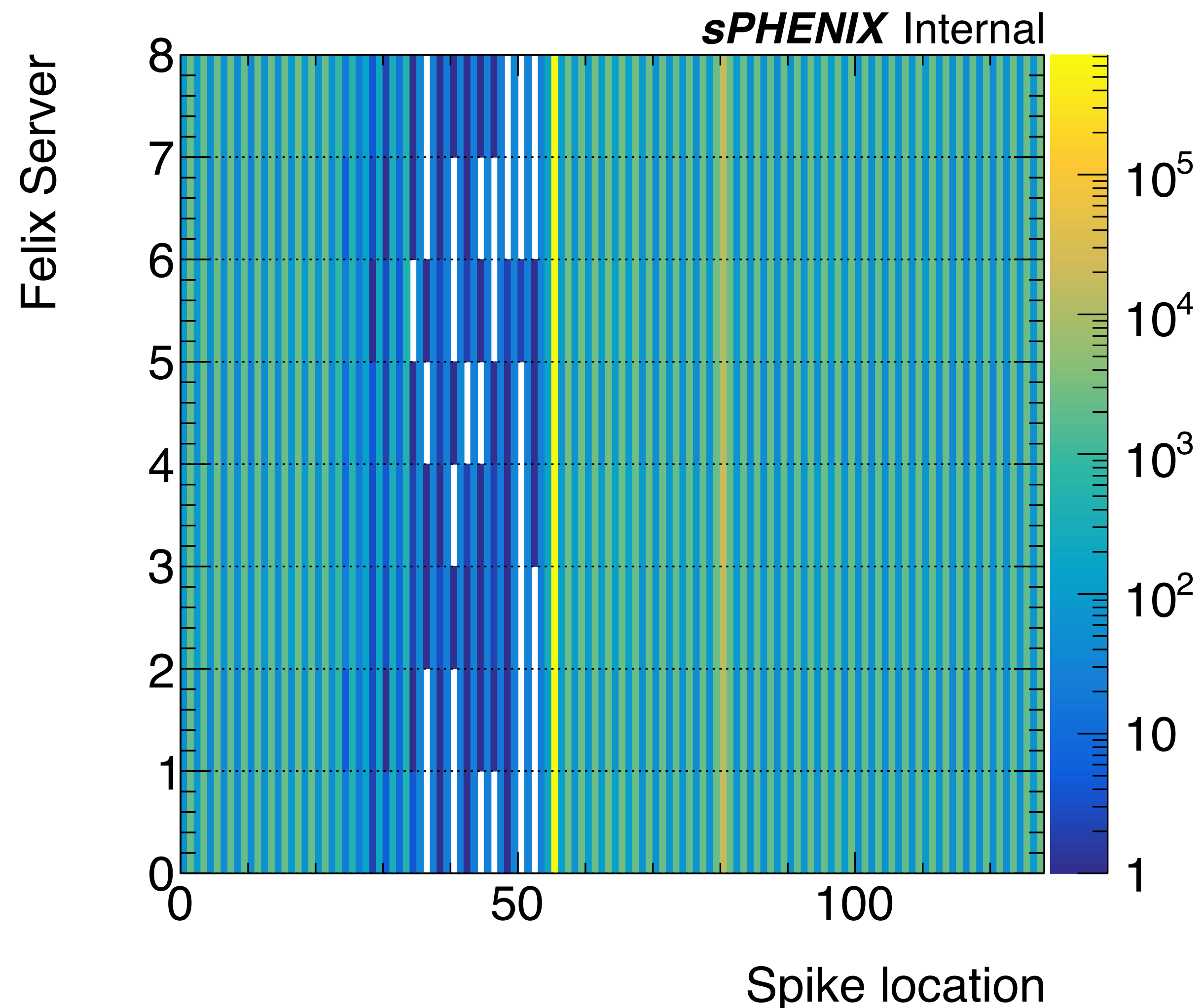
- Hot channel mask (Jaein's map), hitQA, clone hit removal were applied



Be able to reproduce the BCO difference distribution of each FELIX server
All the servers have the spike at 55, which is good 👍

Sanity check - BCO diff cut

- Hot channel mask (Jaein's map), hitQA, clone hit removal were applied



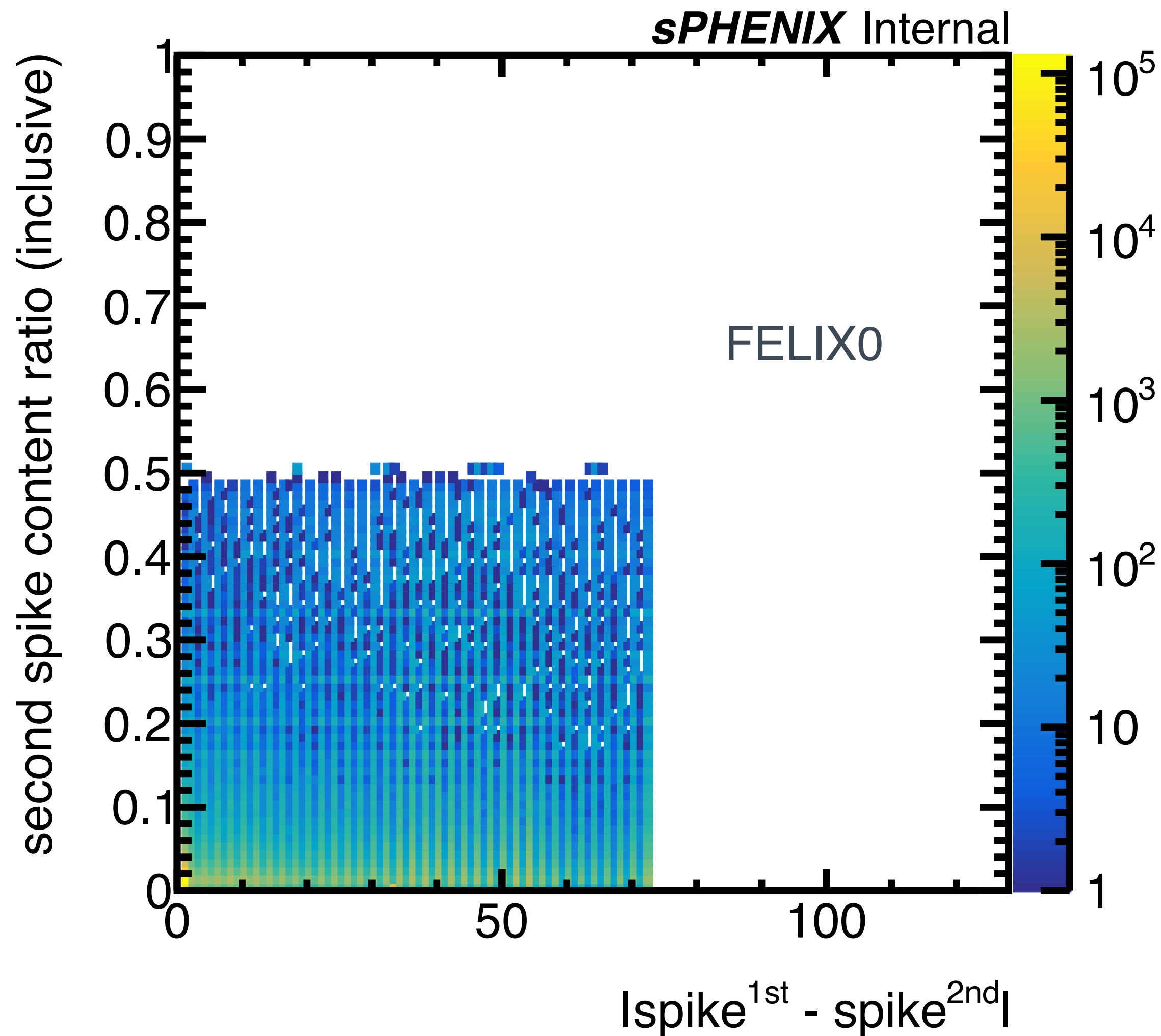
nEvent_post_trigger_cut*: 847117
nEvent_good_spike: 638497
Good spike ratio: 0.753729

(nEvent_good_spike: if the spikes of all eight FELIX servers are at the majority bin)

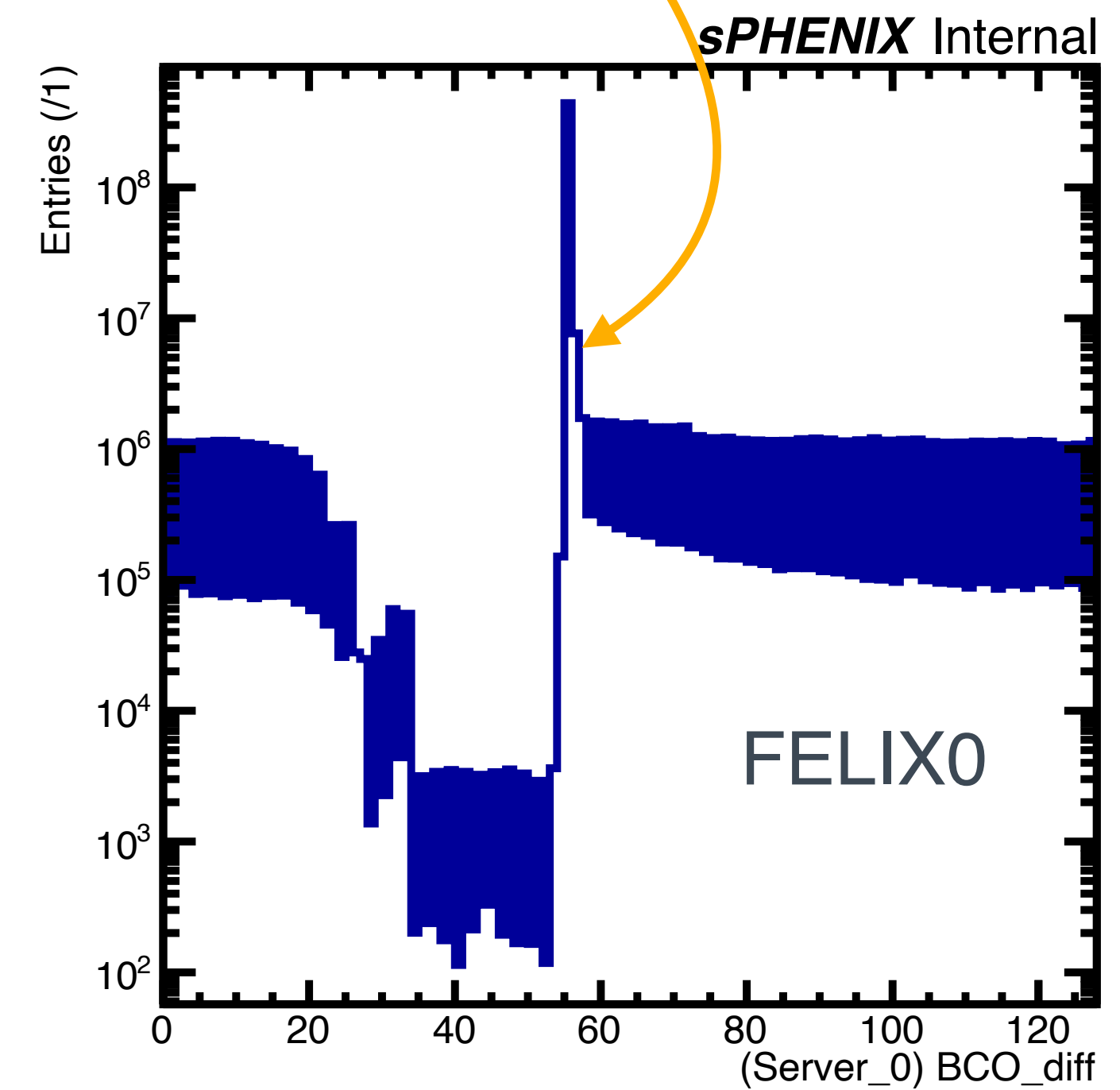
Not all the events have the peaks at the expect location

Sanity check - BCO diff cut

- Hot channel mask (Jaein's map), hitQA, clone hit removal were applied



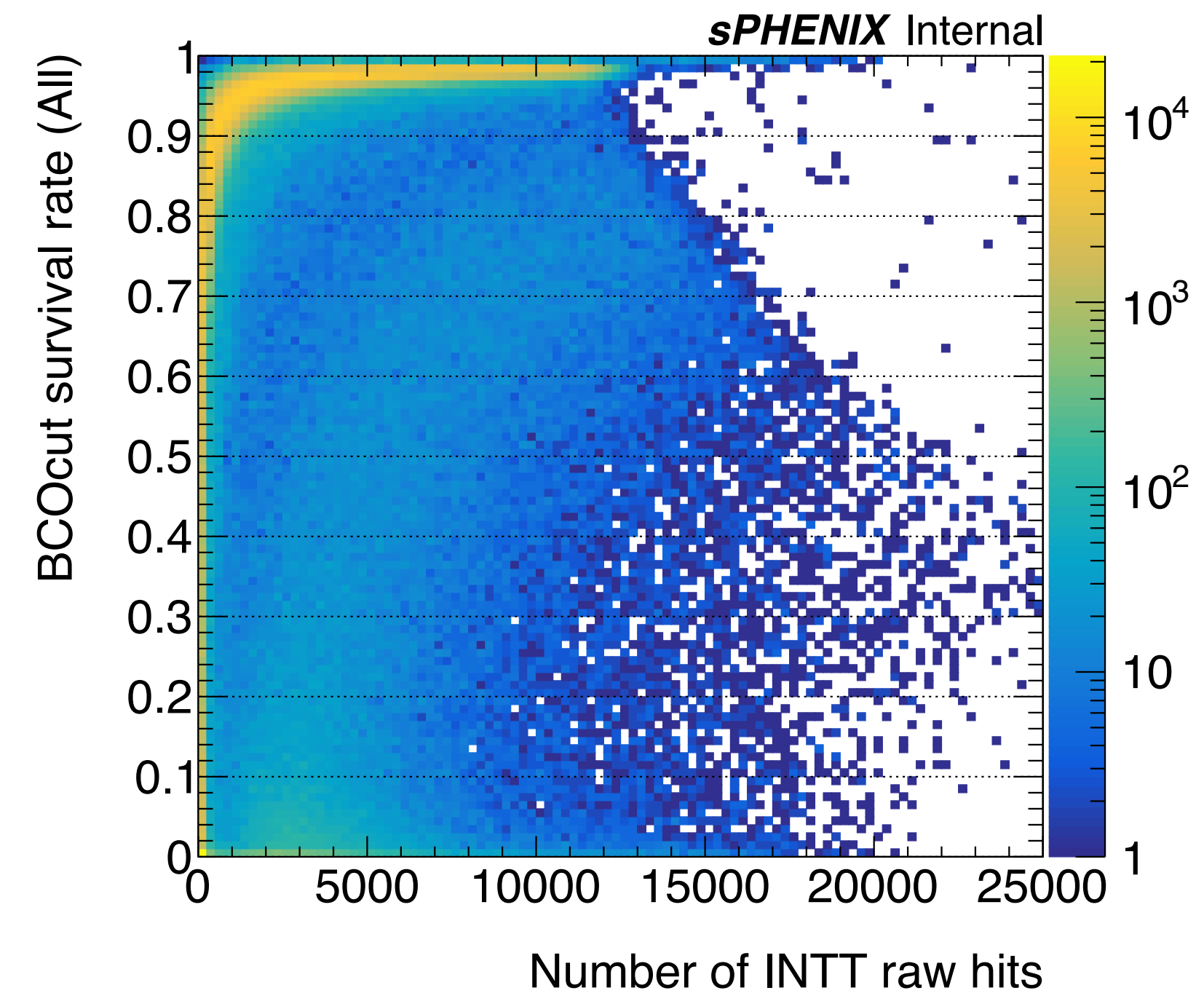
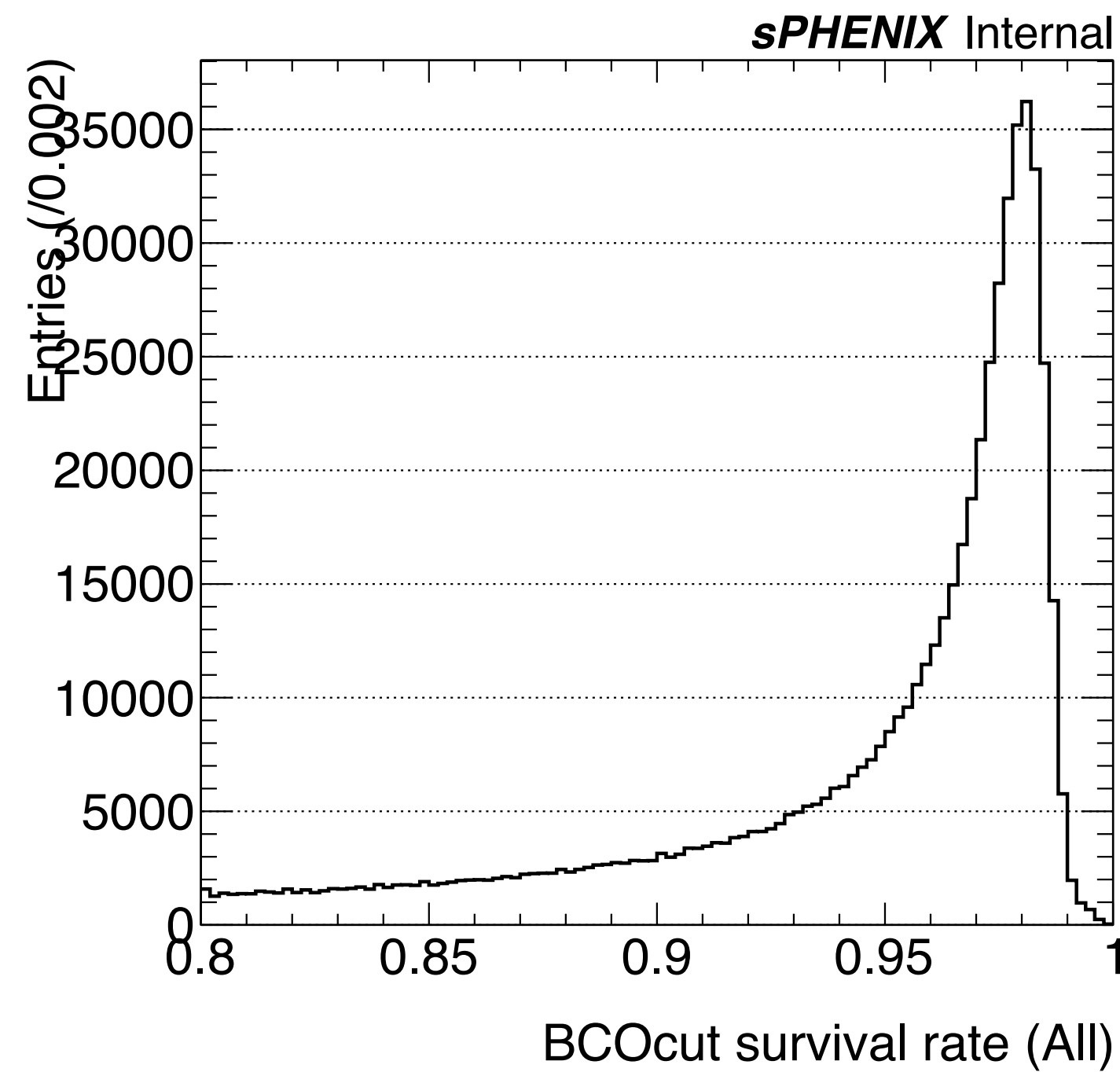
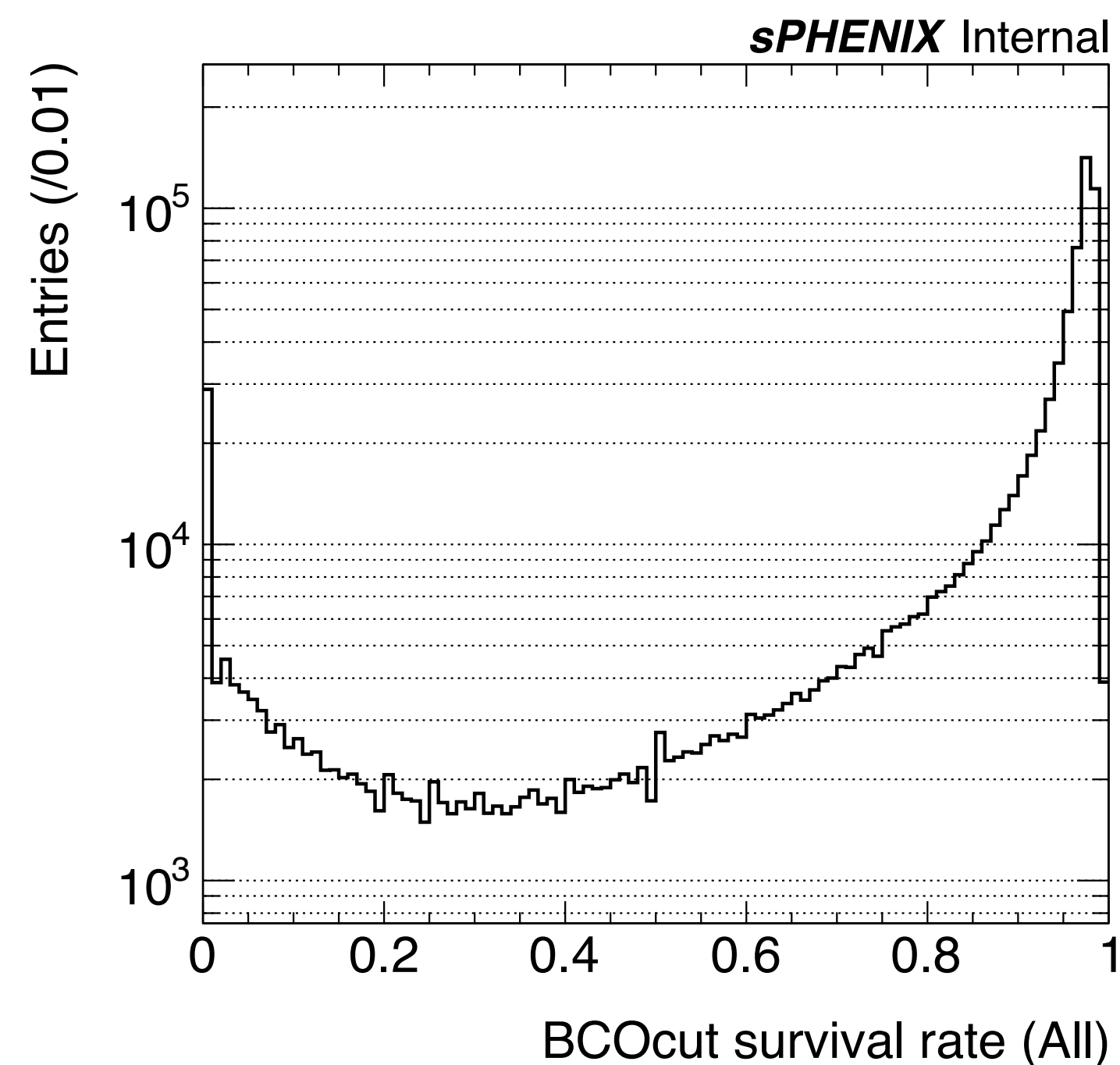
Expected second spike location



The second spike can be far away from the first spike

Sanity check - BCO diff cut

- Hot channel mask (Jaein's map), hitQA, clone hit removal were applied
- Accept the hits with the bco_diff of 54, 55 (spike), 56
- Survival rate: (number of hits accepted by BCOcut / all_Hits)

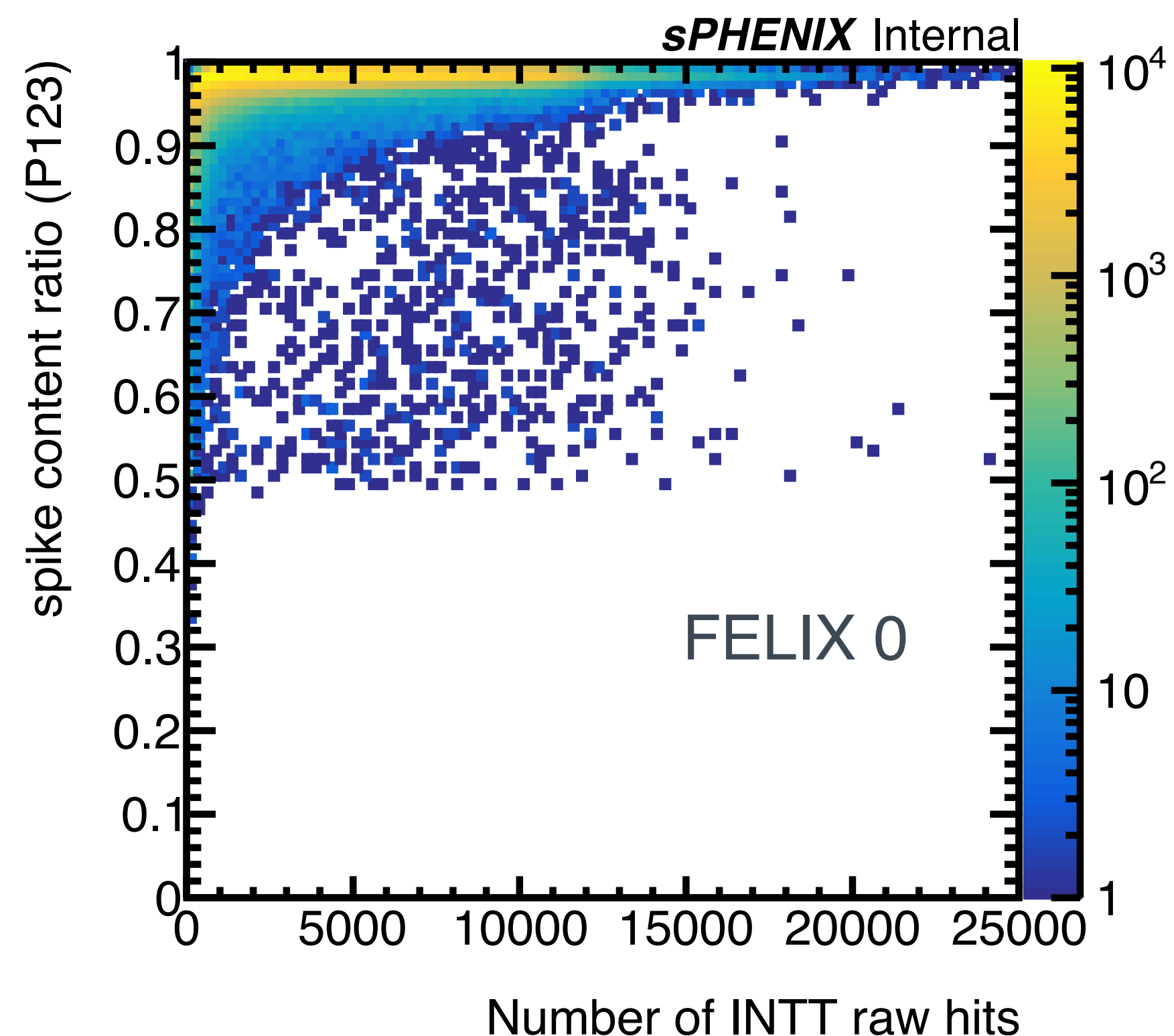
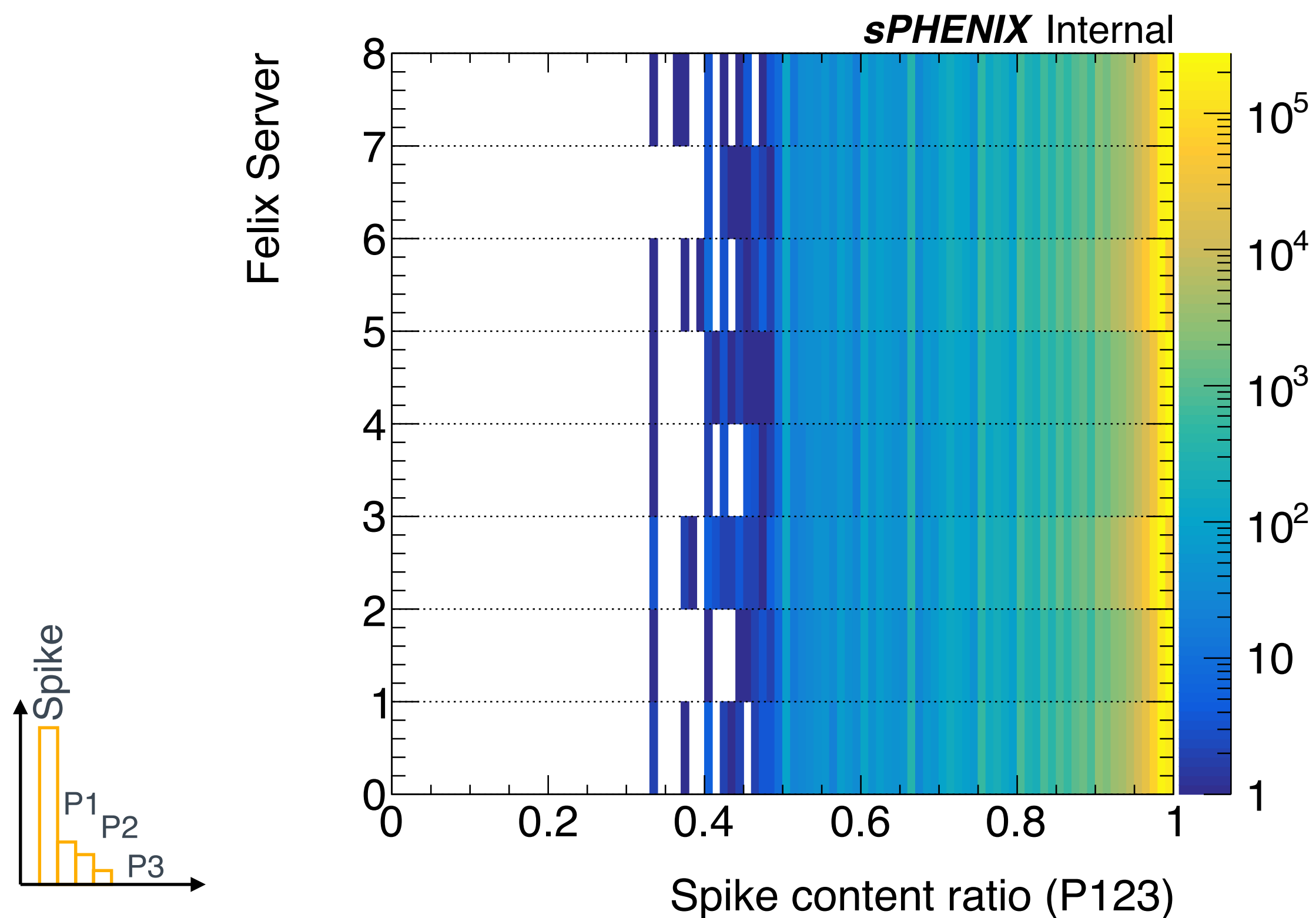


nEvent_post_trigger_cut: 847117
nEvent_BCOcut_98survival: 118184
BCOcut_98survival_ratio: **0.139513**

- To early to conclude the justification of applying this cut, as too many sources could reduce the survival rate
- Here just provide you a reference

Sanity check - INTT timing resolution

- Hot channel mask (Jaein's map), hitQA, clone hit removal were applied
- Only the FELIX servers w/ expected spikes are filled



$$\text{Ratio_P123} = \frac{C_{55}}{C_{55} + C_{56} + C_{57} + C_{58}}$$

- spike_content_ratio_P123 Mean: 0.980138, StdDev: 0.0309565
- spike_content_ratio_PM123 Mean: 0.979865, StdDev: 0.0316666

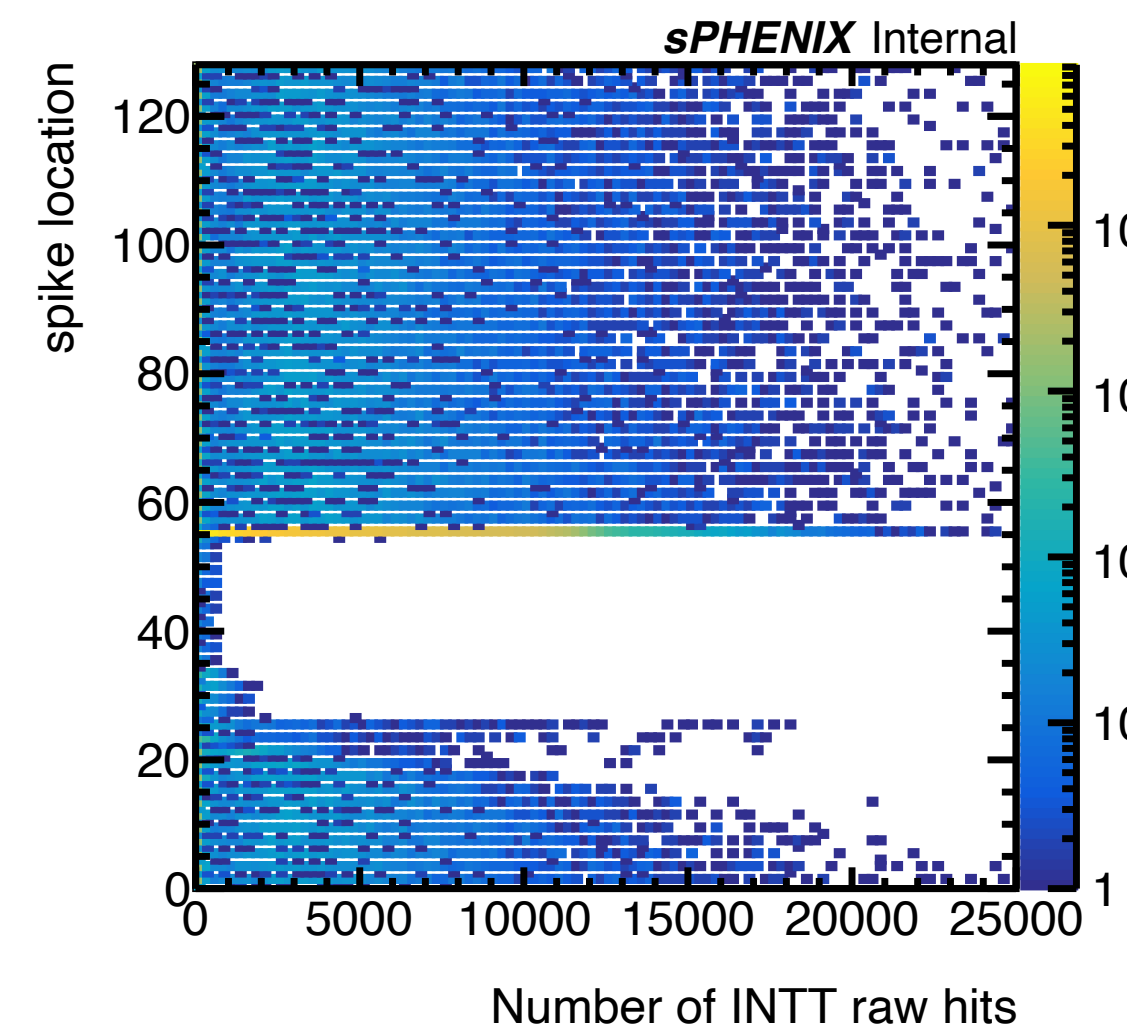
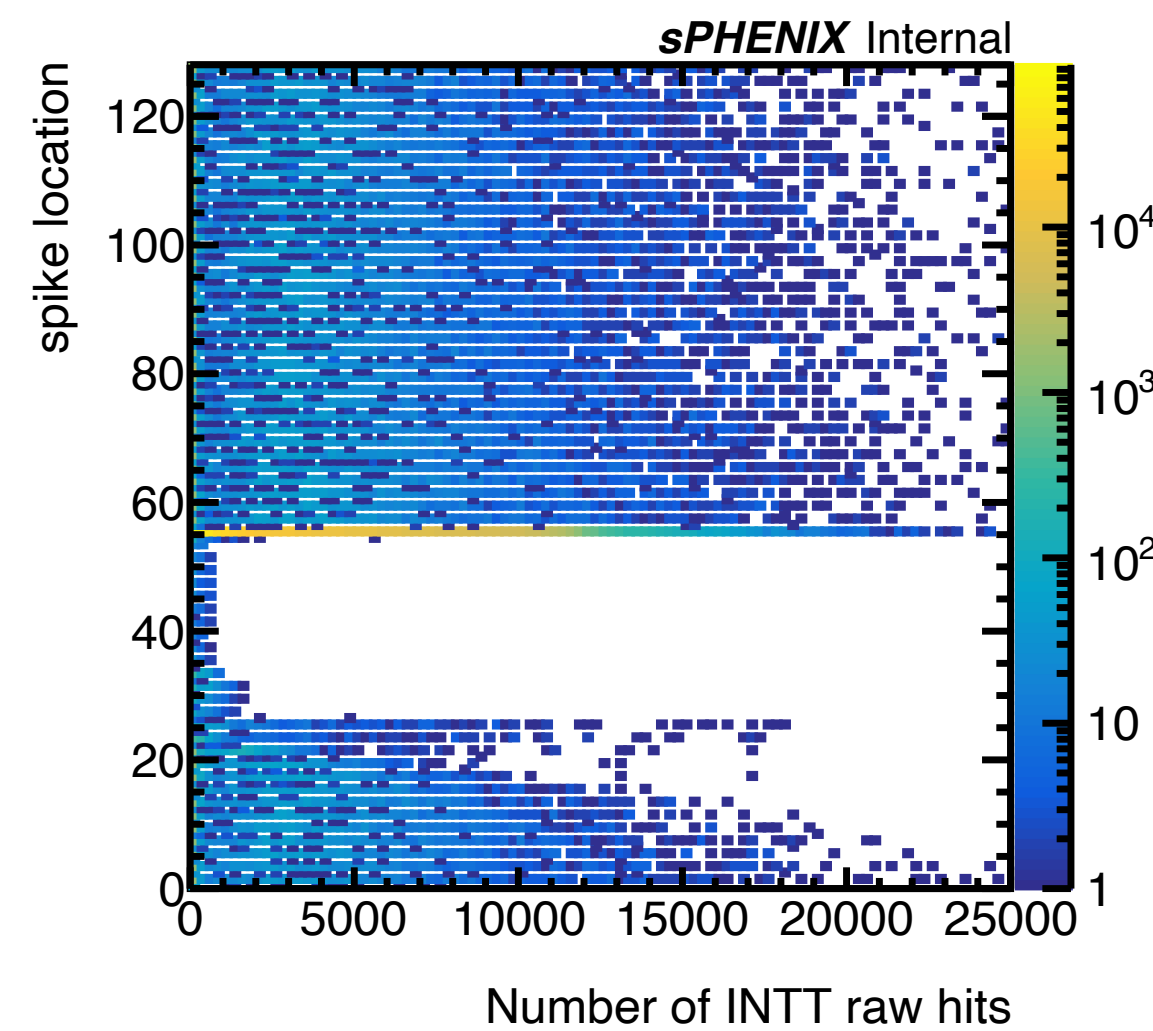
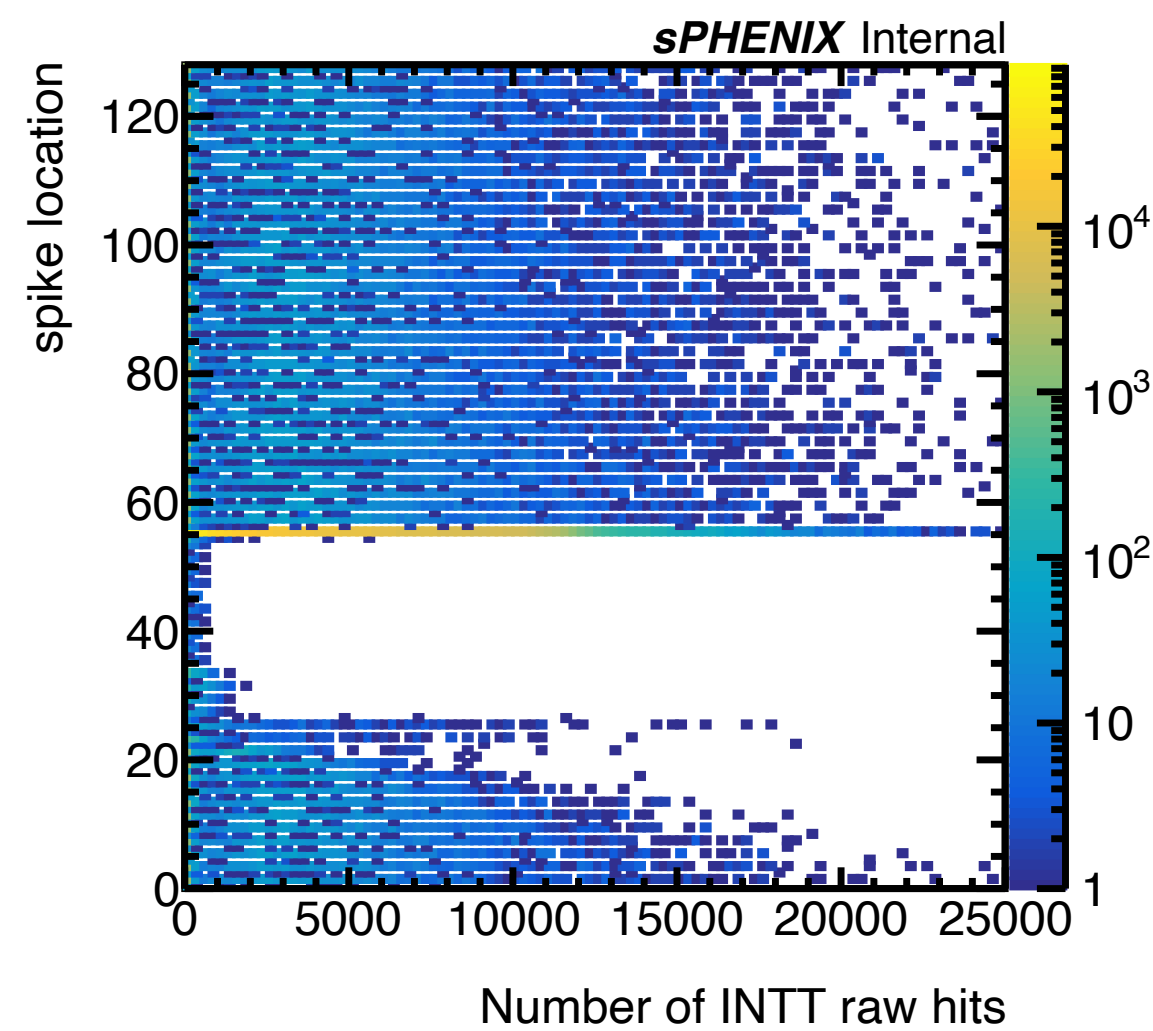
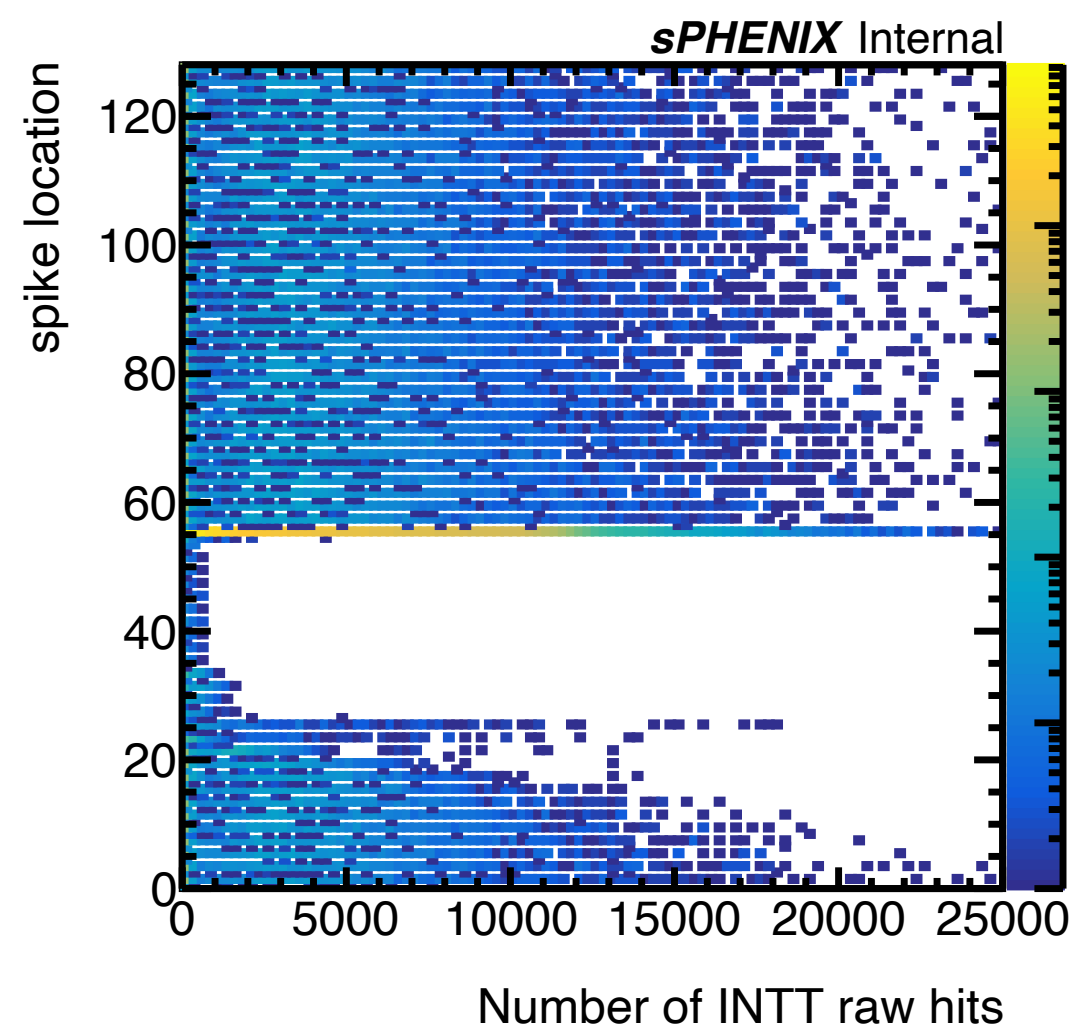
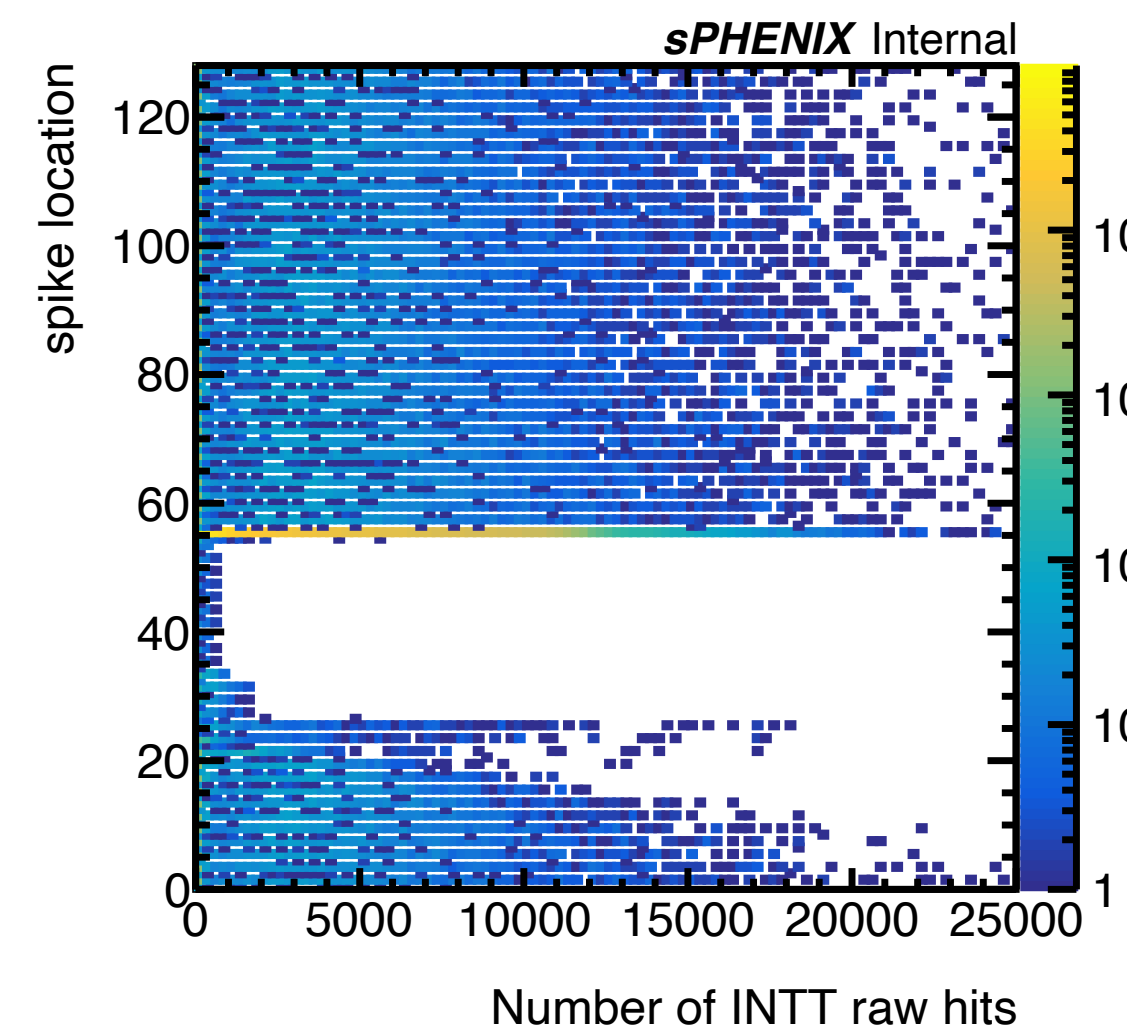
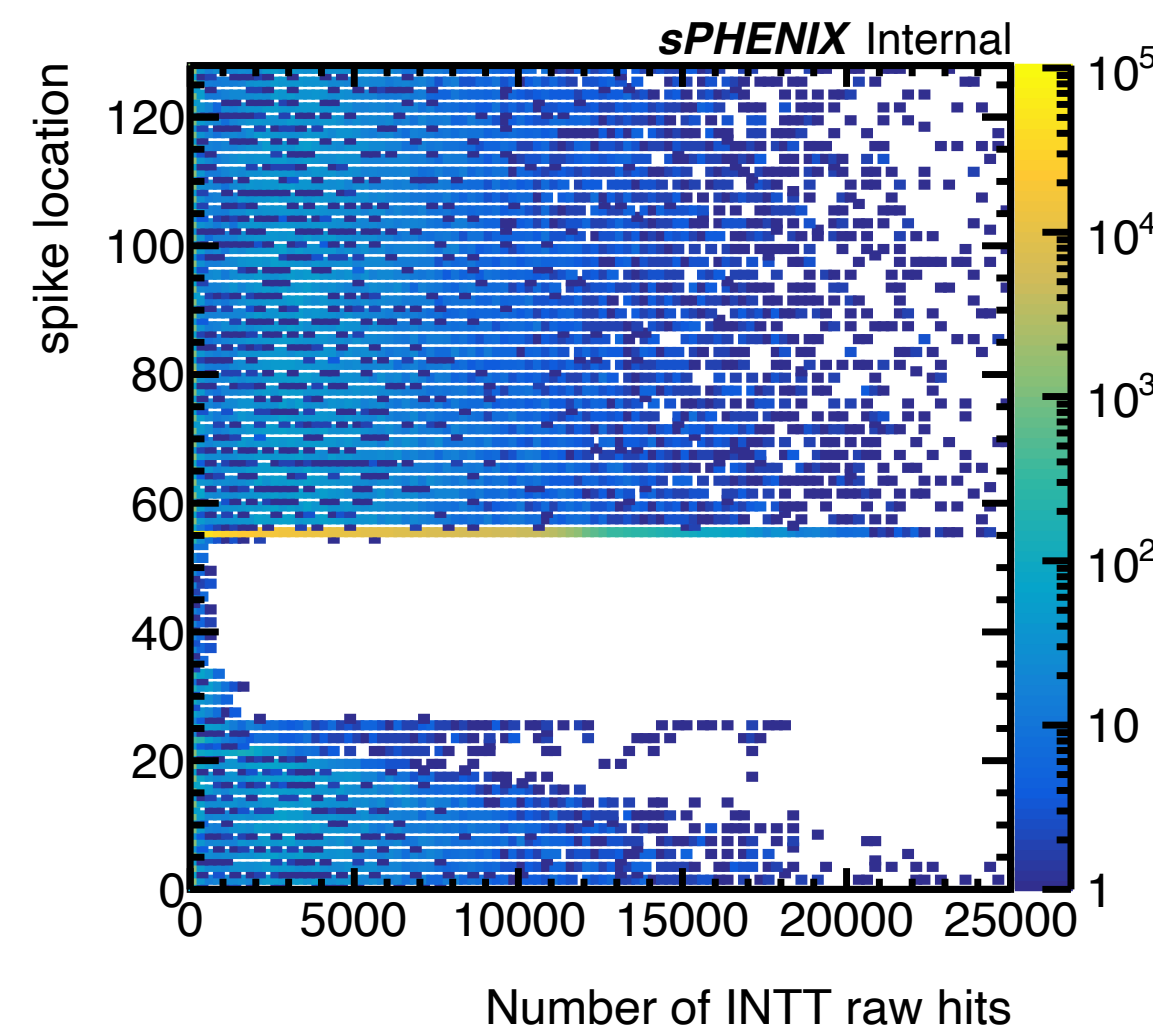
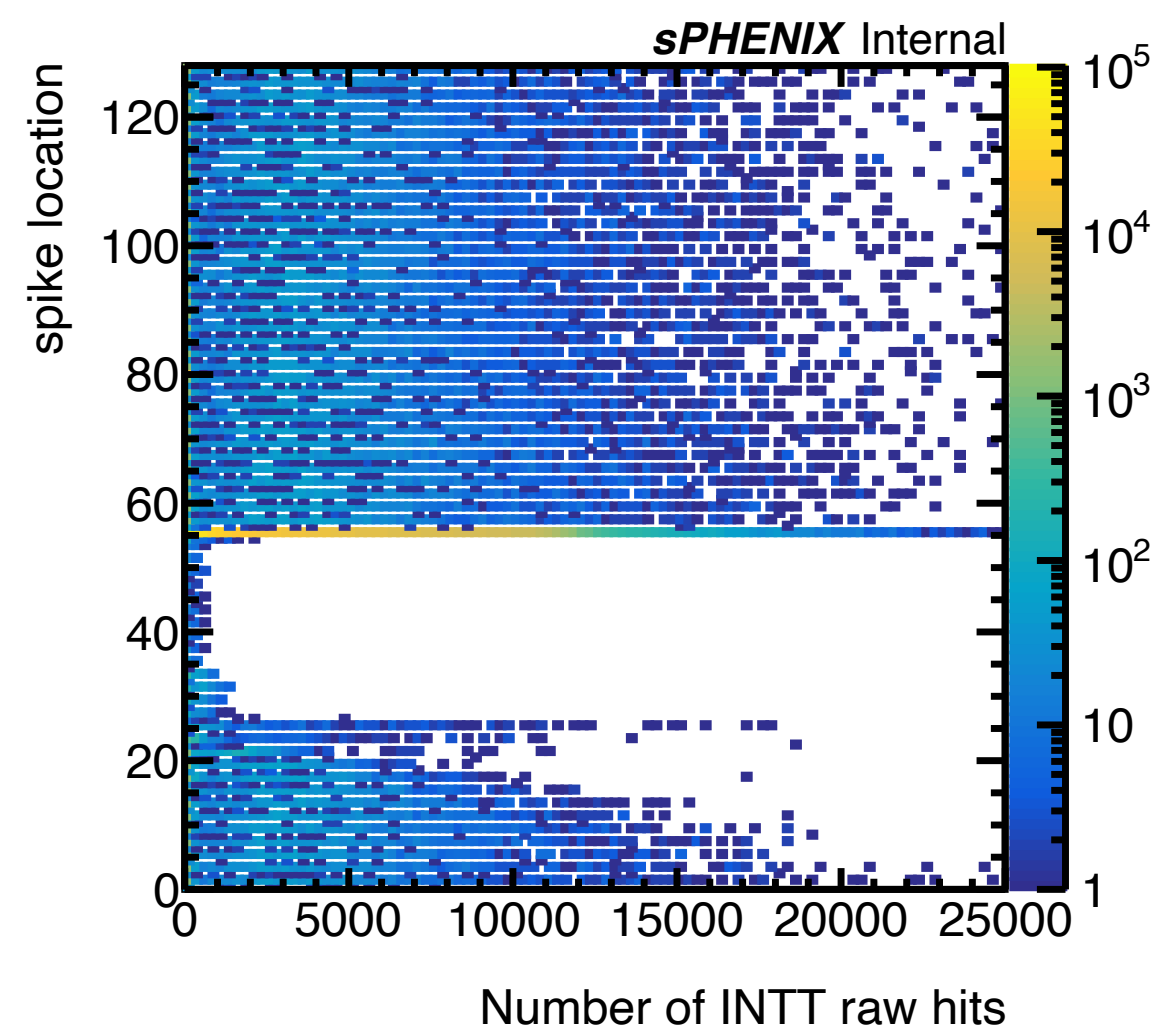
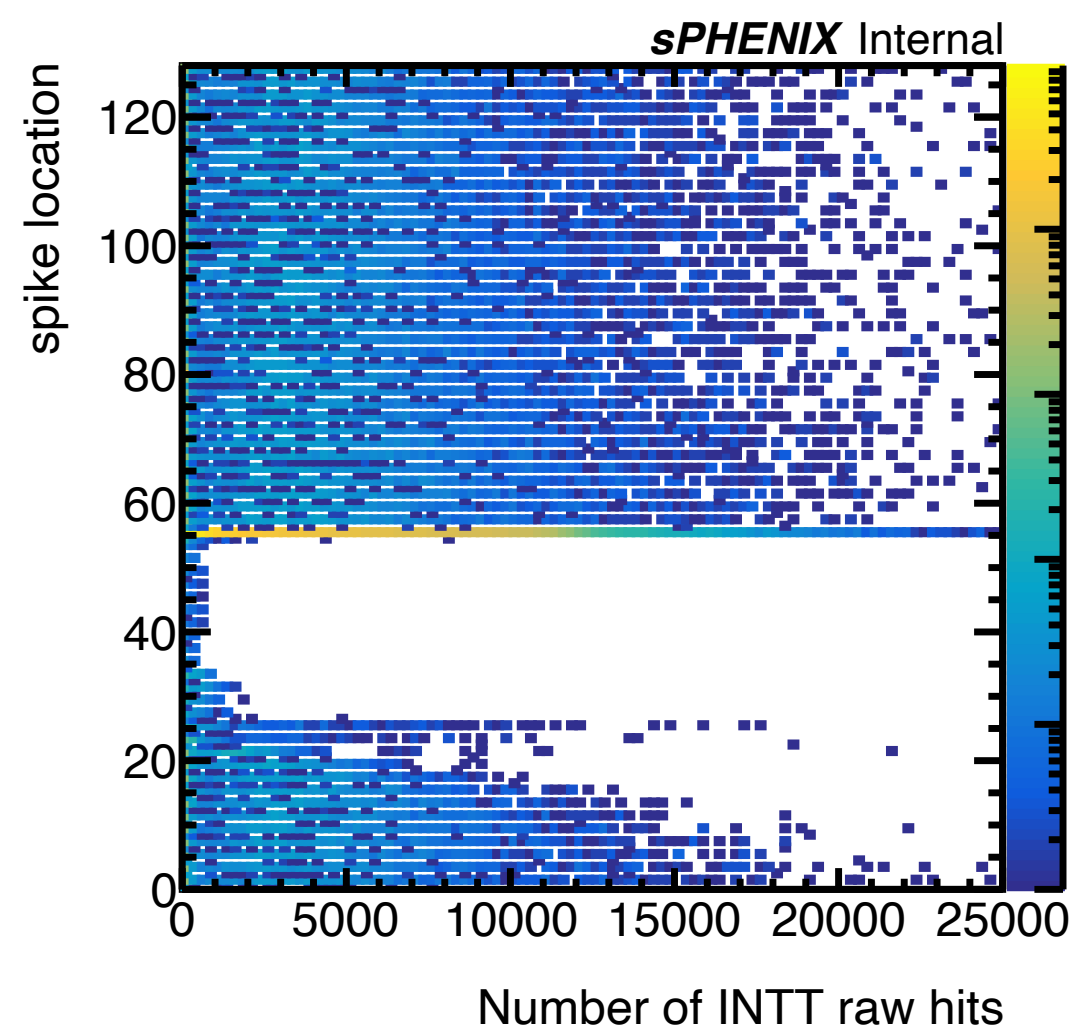
This number can be used for timing scan analysis

- Finally managed to combine the INTT and MBD data
 - The positive multiplicity correlation between INTT and MBD was observed!
- The INTT vertex reconstruction with first 100k events was performed
 - Average vertex XY: the discrepancy between two methods seems to be widening. Need more statistics to conclude
 - Per-event vertex Z:
 - Positive and thin correlation in vertex Z between the measurements of INTT and MBD is identified
 - Two satellite structures are found, need more investigation (MBD not fully calibrated)
- The two spikes in the cluster-phi-size are identified, same as that of run 2023 data
 - Need more investigation

- Three more things are checked, as the sanity check (Can possibly be good topic for the people starting to work on INTT)
 - Clone hit
 - We still see the clone hits in the data taken this year
 - The `nINTTRawHit` distribution after hitQA, clone-hit removal, hot-channel mask looks reasonable
 - Justification of BCO_diff cut
 - There are several events whose peak positions of the BCO_diff distributions deviate from the expected location. The current BCO_diff cut could draw the bias (of course, could be marginal)
 - INTT timing resolution
 - A quantity, `Ratio_P123` has been prepared for the timing scan analysis to learn the `INTT_delay_parameter` adjustment for next year

Back up

Spike location vs Number of INTT hits



- Au+Au collisions at $\sqrt{s} = 200 \text{ GeV}$ in zero field
- Data taking time: 1 hour (2024-10-10 05:43:52 → 2024-10-10 06:44:03)
- Number of events: 10,610,255
- Official DST production was not available* → Private production with F4A
 - .evt files → INTTRawHit DST → TrkrHitSet → TrkrCluster
 - Analysis build: ana.439
- 1M production is still ongoing, the first 10k events are analyzed

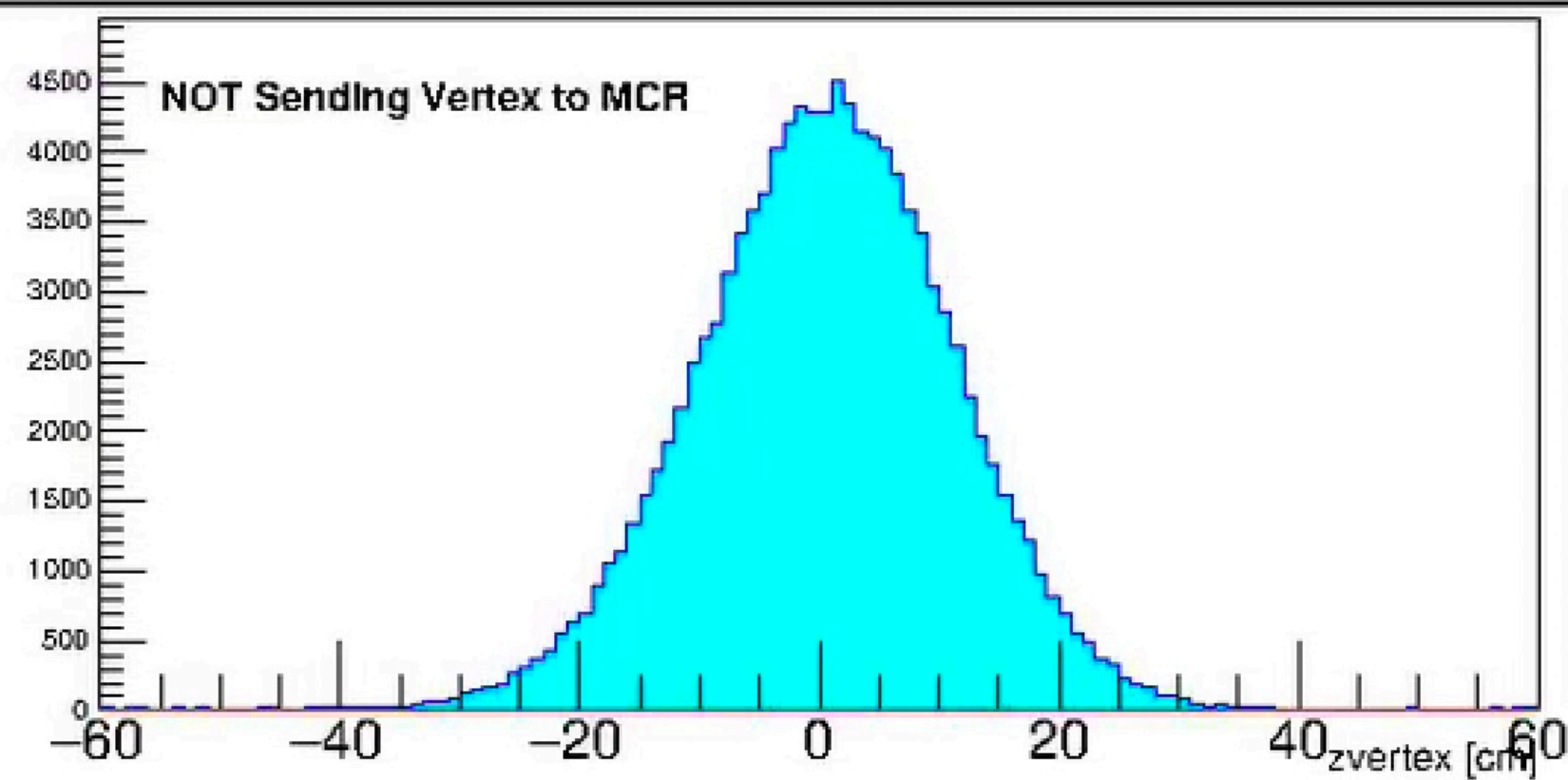
*Now we have 10k INTTRawHit available in the official production directory

Run description - 54280

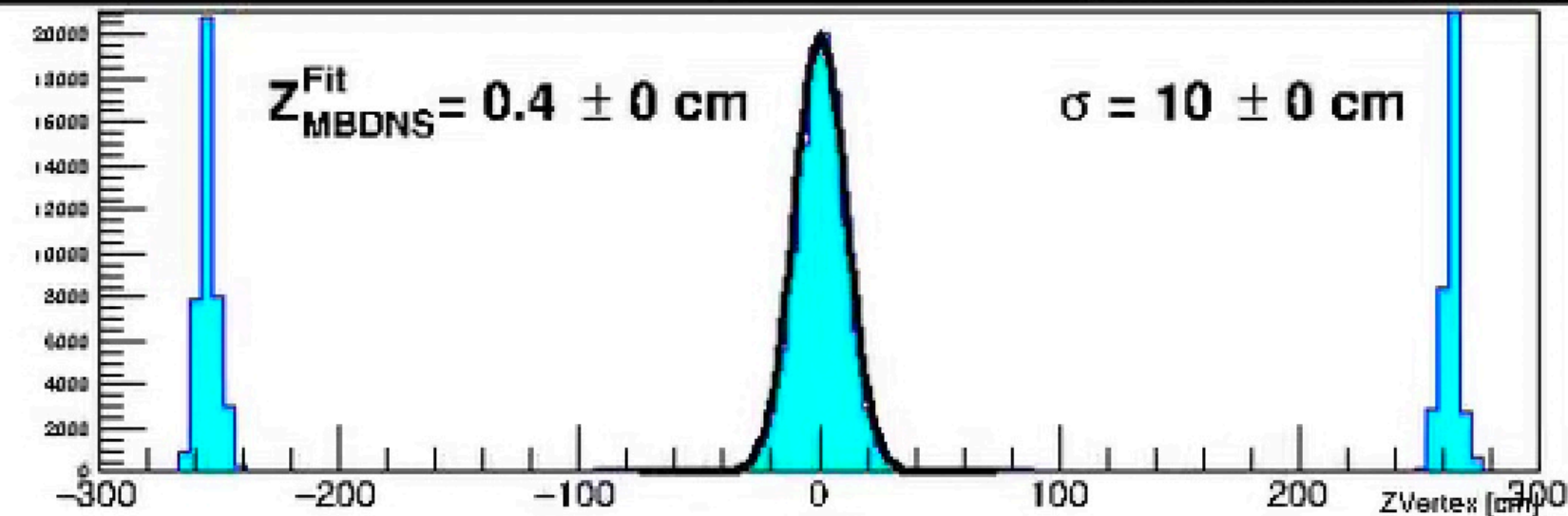
- Spike appears at each end of MBD
- The mini-bias definition is not yet available (as far as I know)
- Live trigger available to constraint the MBD vertex Z

Run #54280 Events: 204357 Date: Thu Oct 10 06:43:31 2011

MBD zvertex



MBD ZVertex (TRIG = MBDNS>=1)

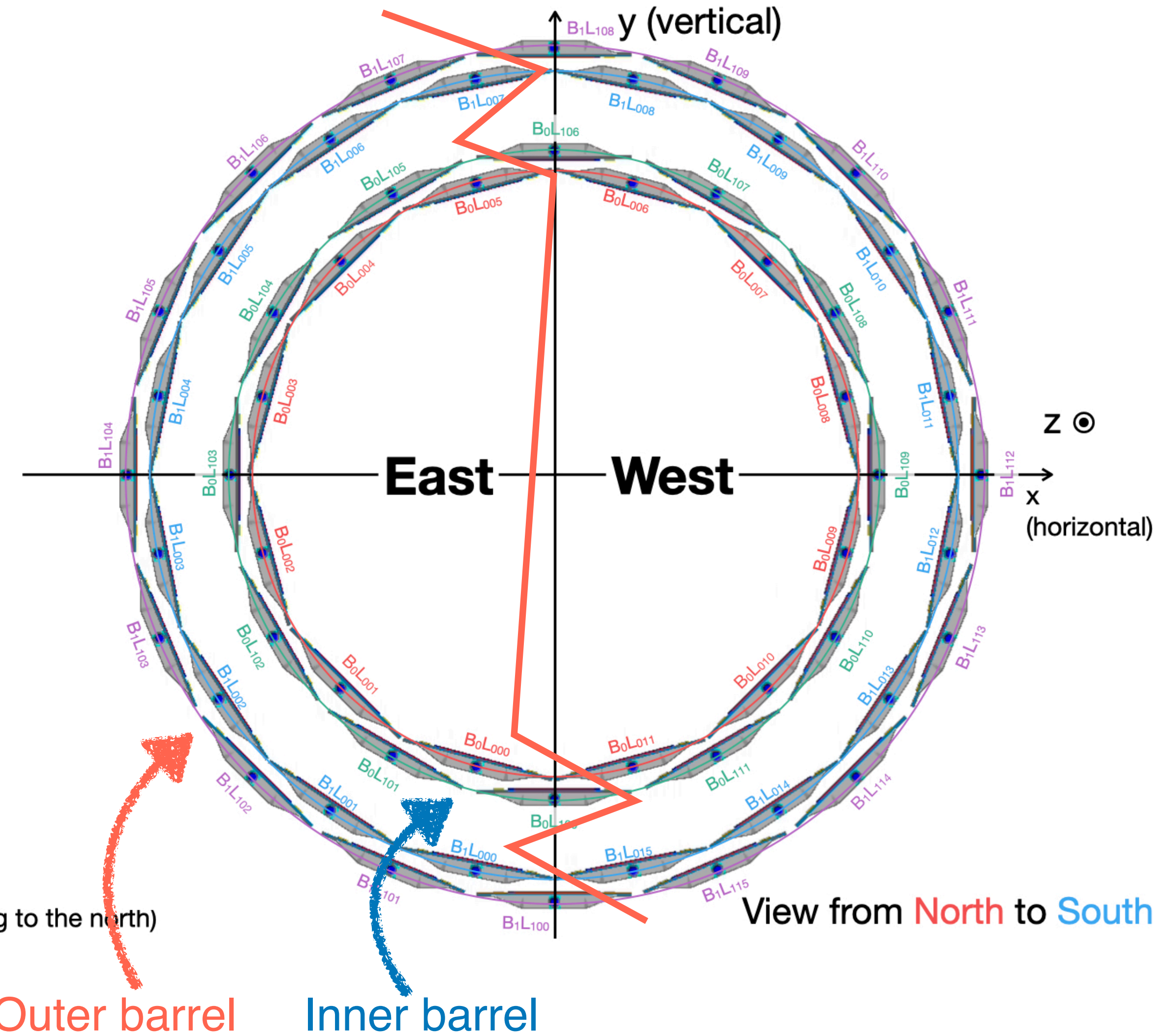
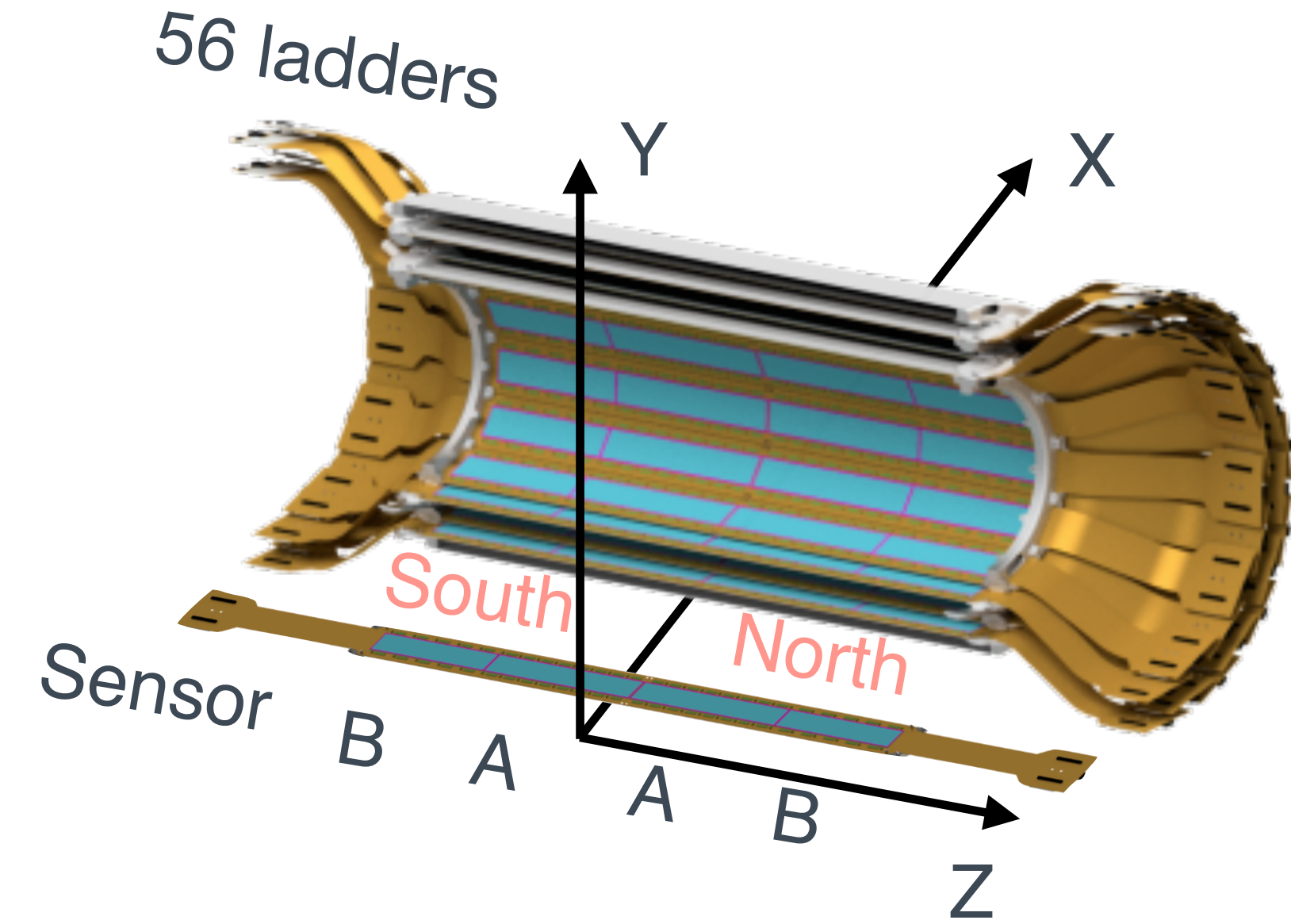


| Trigger input channel | Name | enabled | Scaledown | Raw | Live $\langle \div \rangle$ | Scaled | Live (%) |
|-----------------------|---------------------------|---------|-----------|-------------|-----------------------------|----------|----------|
| 0 | Clock | yes | 93810 | 33836274325 | 33663041357 | 358838 | 99.5 |
| 1 | ZDC South | yes | off | 102829214 | 102308816 | 0 | 99.5 |
| 2 | ZDC North | yes | off | 98430768 | 95872319 | 0 | 97.4 |
| 3 | ZDC Coincidence | yes | 60 | 9417100 | 9370209 | 153672 | 99.5 |
| 4 | HCAL Singles/Coincidence | yes | off | 30282609 | 30125423 | 0 | 99.5 |
| 5 | | yes | off | 33836274325 | 33663041357 | 0 | 99.5 |
| 6 | | yes | off | 0 | 0 | 0 | 0 |
| 7 | | yes | off | 0 | 0 | 0 | 0 |
| 8 | MBD S >= 2 | yes | off | 86958423 | 86380777 | 0 | 99.3 |
| 9 | MBD N >= 2 | yes | off | 85797943 | 85195687 | 0 | 99.3 |
| 10 | MBD N&S >= 2 | yes | 0 | 10242665 | 10187457 | 10187457 | 99.5 |
| 11 | MBD N&S >= 1 | yes | off | 18093659 | 17967450 | 0 | 99.3 |
| 12 | MBD N&S >= 2, vtx < 10 cm | yes | off | 4021509 | 4000602 | 0 | 99.5 |
| 13 | MBD N&S >= 2, vtx < 30 cm | yes | off | 5799143 | 5768655 | 0 | 99.5 |

- The INTT DST data: `/sphenix/lustre01/sphnxpro/physics/slurp/streaming/physics/new_2024p007/run_00054200_00054300`
- The INTT .evt files:

INTT: 2 sensors X 2 sides of half-ladders X 56 ladders = 224 sensors

Notation: $B_xL_yz_z$
 x: Barrel ID (0 for inner or 1 for outer)
 y: Layer ID (0 for inner or 1 for outer)
 zz: Ladder ID (from 0 to 15)



Axis (Right-handed coordinate)
 x-axis: $\vec{y} \times \vec{z}$
 y-axis: Vertically upward direction
 z-axis: The blue beam direction (pointing to the north)