

Chip saturation and hit carried over issues of INTT

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National Central University

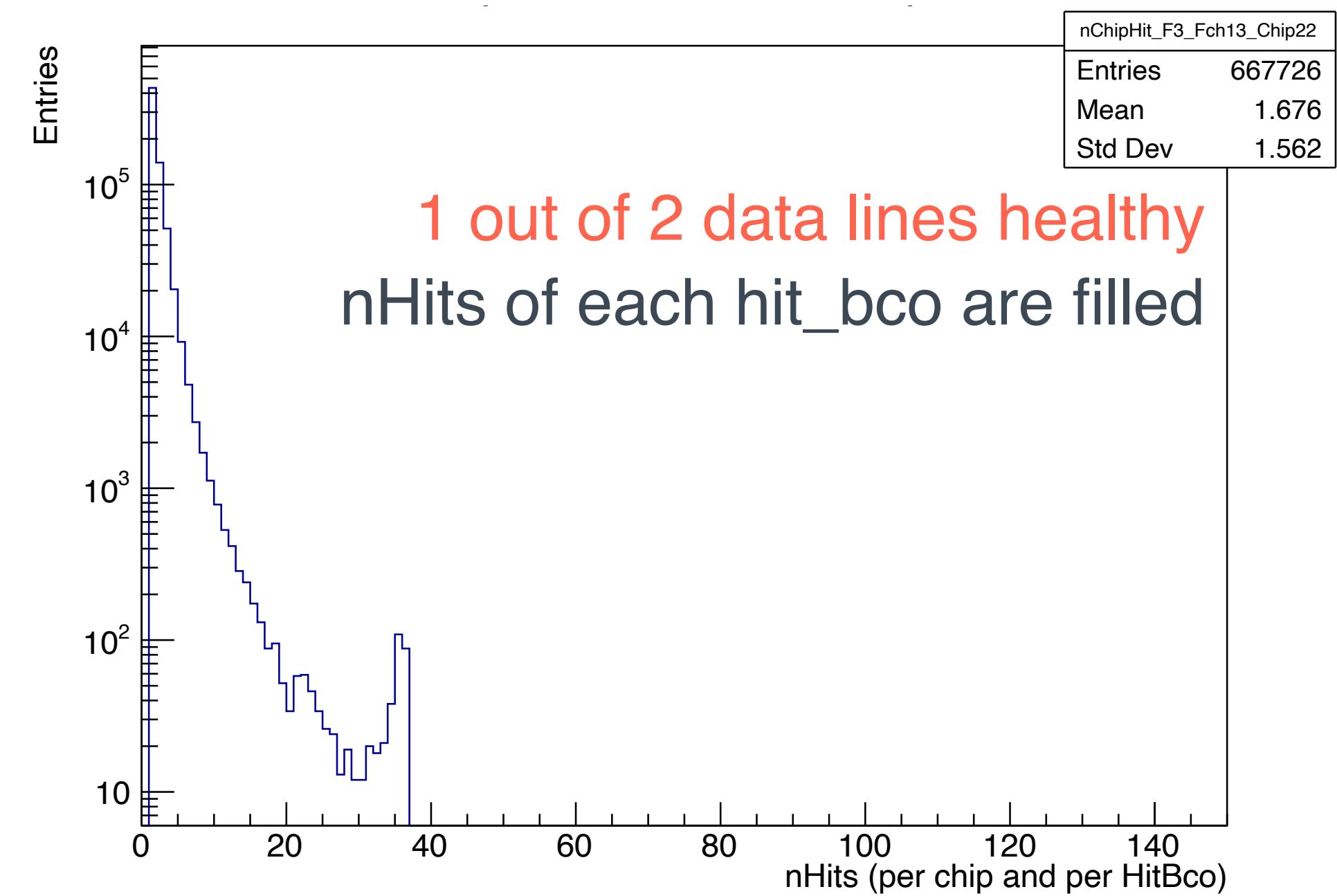
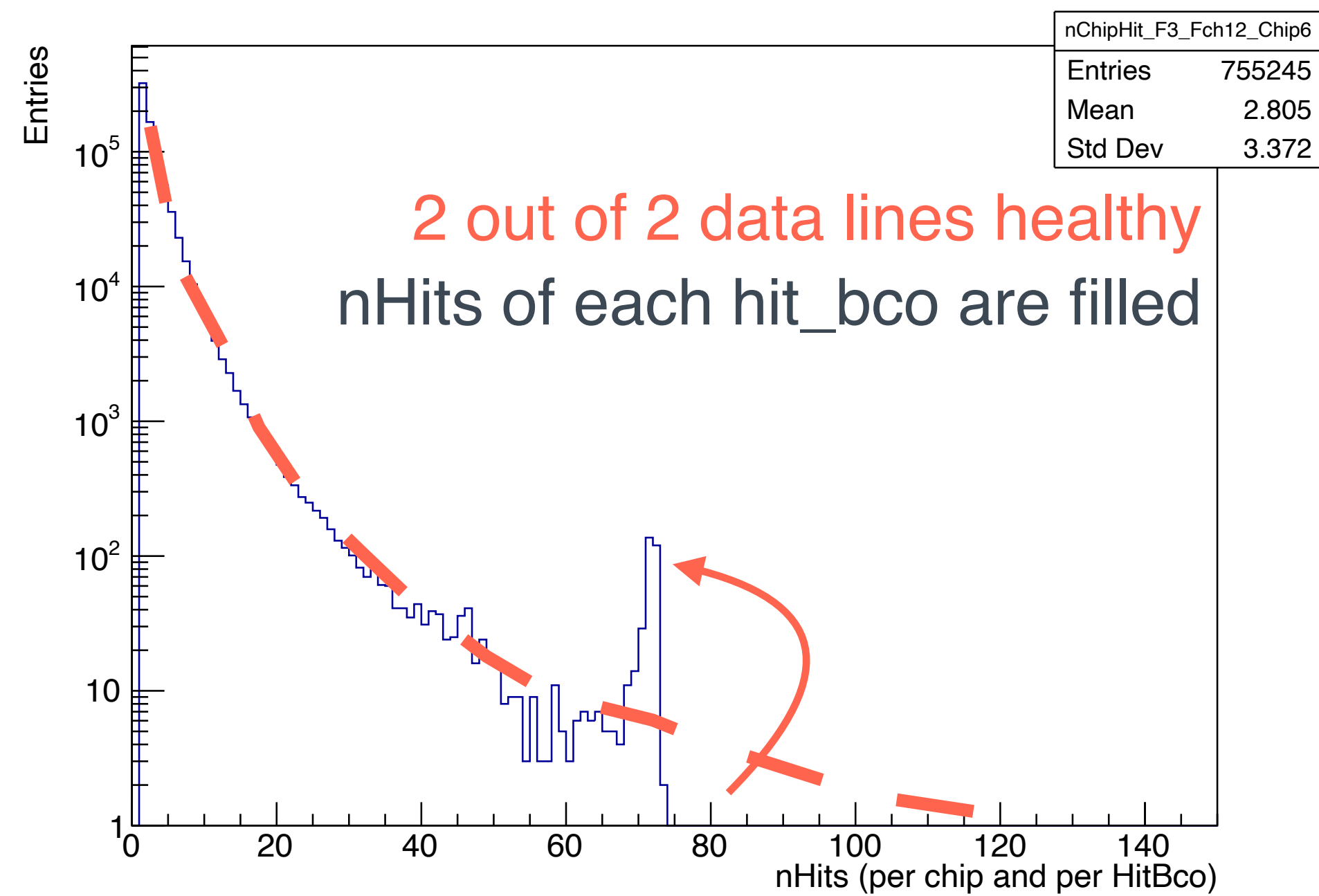


- Two issues are identified/confirmed recently that might impact to the INTT operation in run 2025
 - Chip saturation issue:
 - The INTT hits are rejected by FELIX if they arrive at FELIX too late
 - Hit carried over issue (The hits in one event are split into two events):
 - The next trigger sent to the FELIX too quick that the FELIX is still waiting for the hits arriving and processing those hits for the previous event
 - This problem can be more severe in Run25 (due to even higher trigger rate, ~10k Hz?)
- We would like to propose/discuss the potential mitigation strategies
- The plots shown in the slides were made with the run 54280 taken in Run24

Runnumber	Collision species	Field	Trigger rate	INTT FELIX open
54280	Au + Au	zero-field	~ 3000 Hz	60

Chip saturation issue

Count the number of hits of each chip, per hit_bco (Clone hits are removed*)

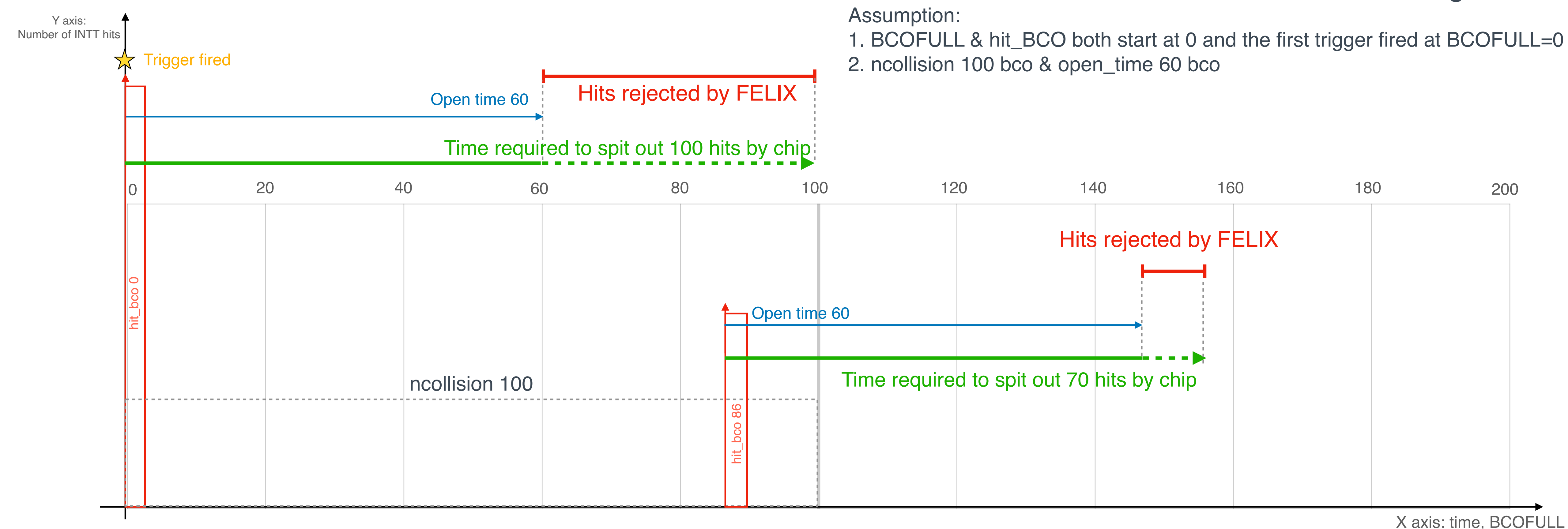


- The distinct cutoff in the right edge of each distribution indicates that INTT has chip saturation issue
- All chips (2912 chips) are suffered from the saturation issue

*(CloneHit: same FELIX, FELIX_ch, chip_id, chan_id, hit_bco)

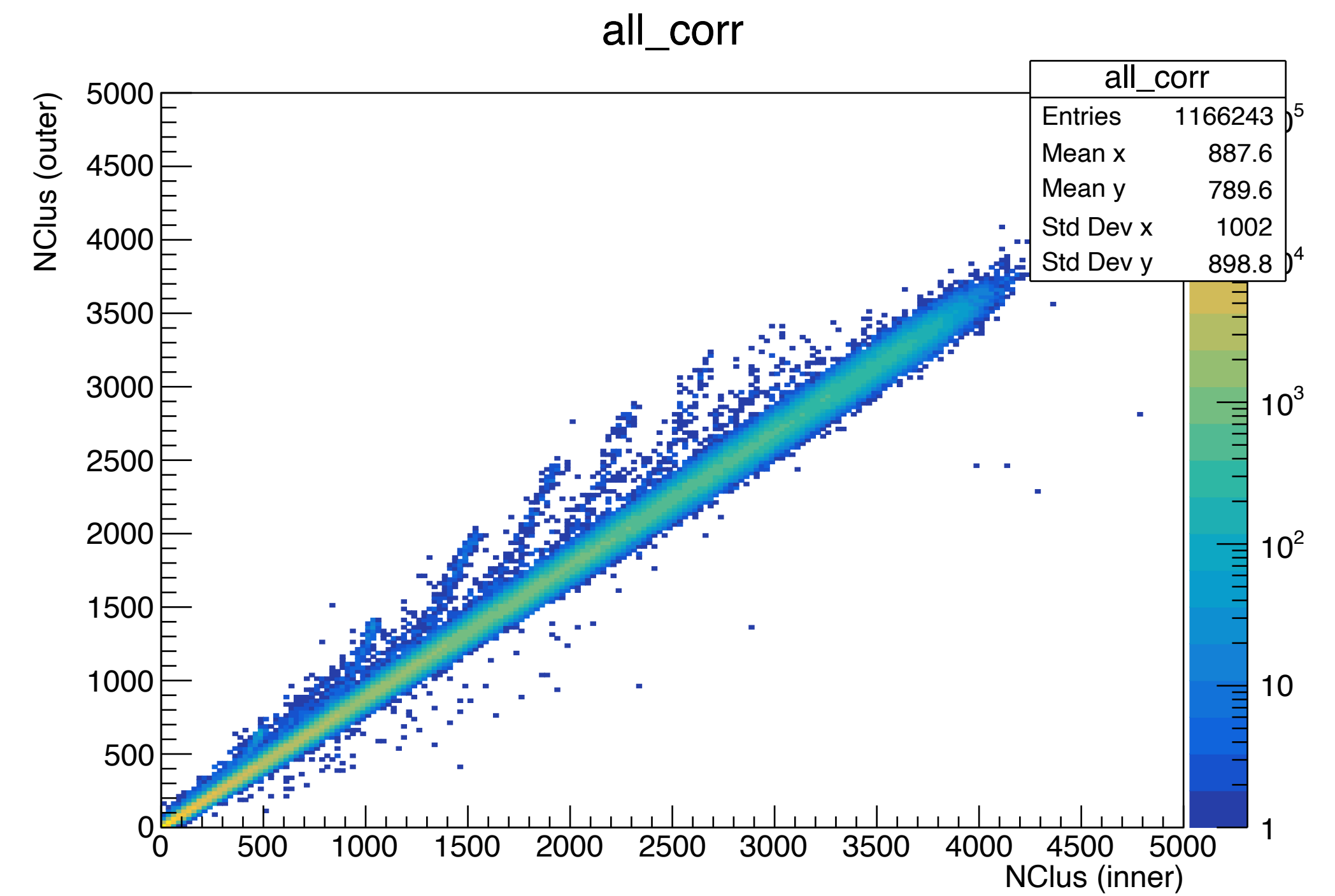
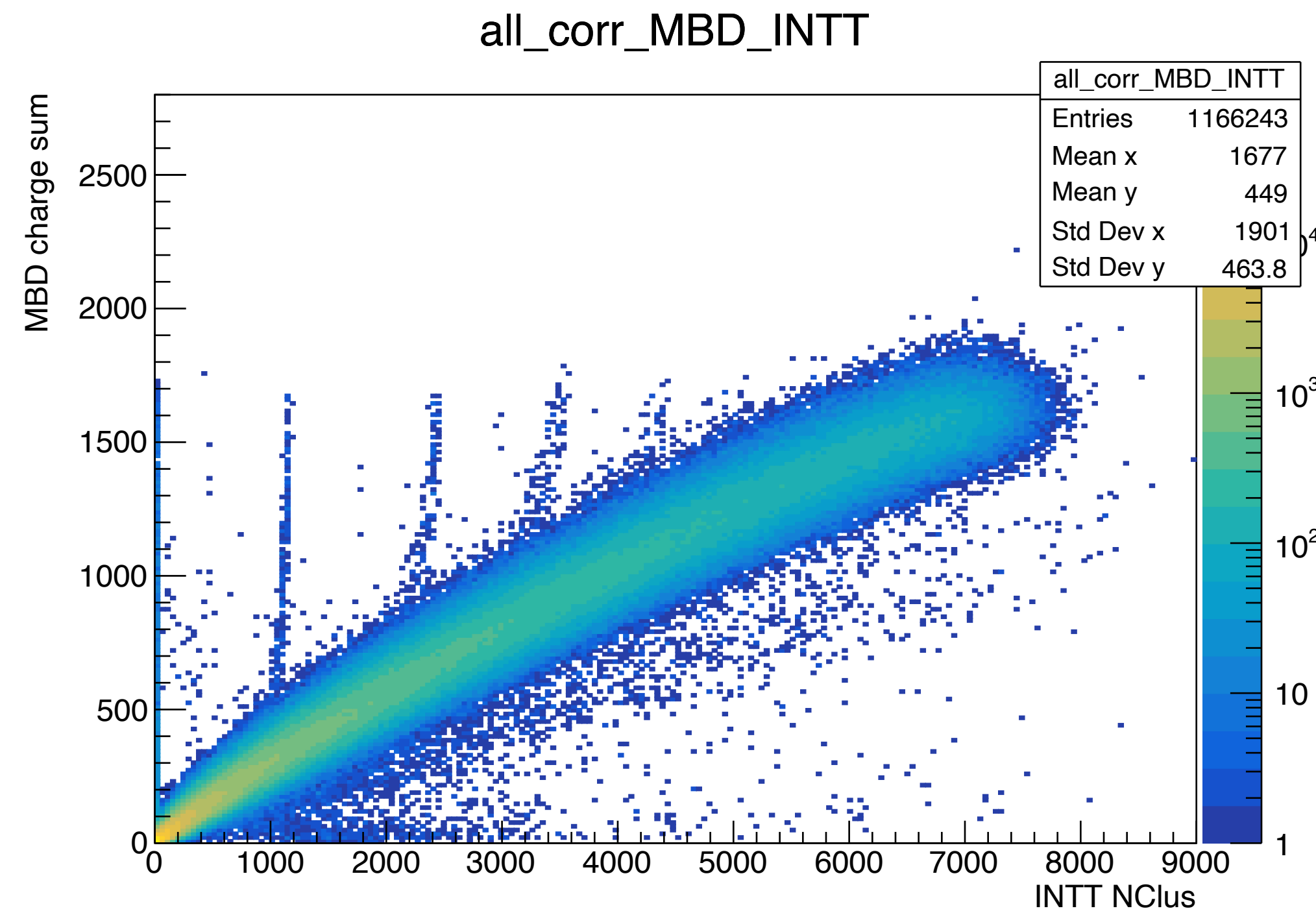
Note: the FPHX goal of hit transmission from chip to ROC: 4 hits in 4 BCOs

In single event



1. Assume in the triggered event (hit_bco 0, BCOFULL=0), there is one chip detecting 100 hits. It's going to take a period of time (~ 100 BCO) to send out all the hits
2. When FELIX detects the first hits with the "hit_bco_0", it's going to open a certain time window (controlled by open_time) to accept the hits with "hit_bco_0", vice versa.
3. Assuming open_time is 60. There will be ~ 40 hits that cannot make it to arrive at the FELIX on time. They are therefore dropped by FELIX

Hit carried over issue

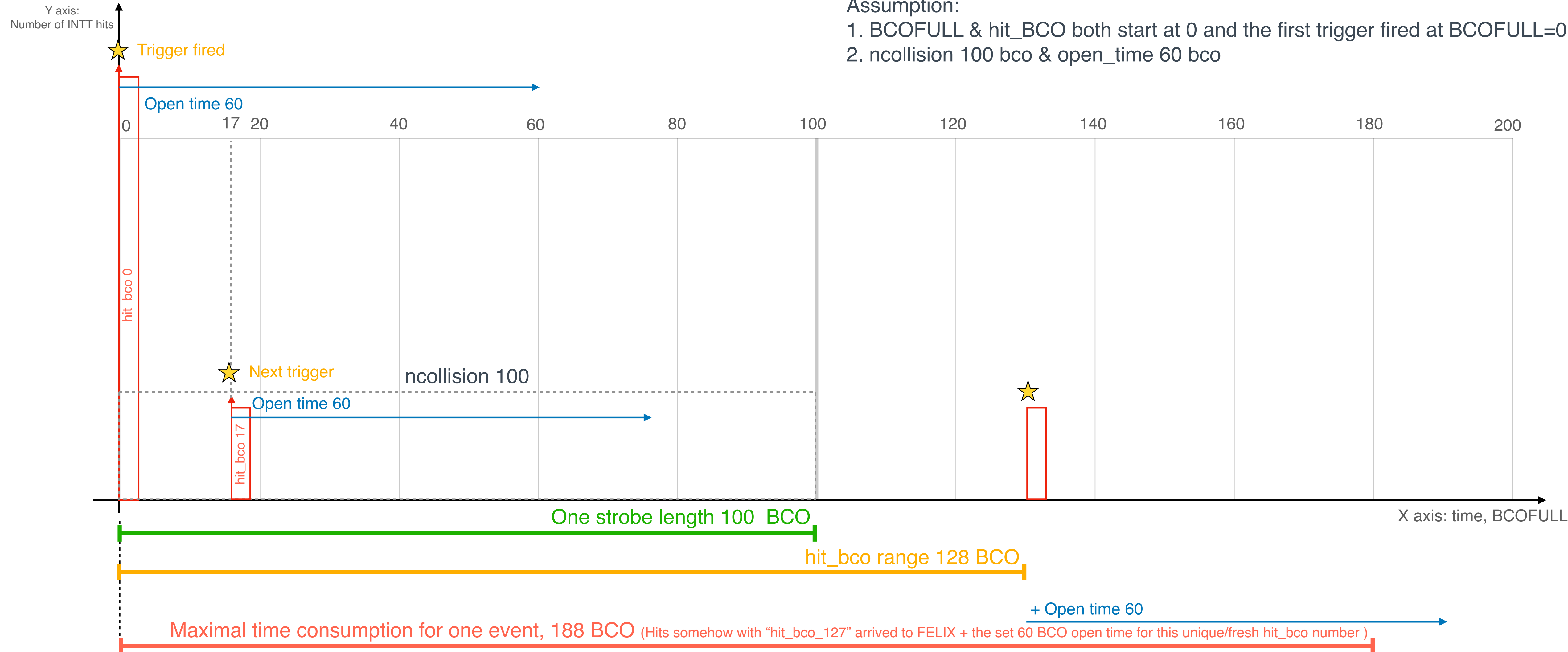


- Off-diagonal entries observed in the number of inner v.s outer clusters and number of INTT clusters v.s MBD charge sum correlations
- Those entries were later identified to be due to hits carried over to the next event (INTT hits in one event are split into two events)

Note: the FPHX goal of hit transmission from chip to ROC: 4 hits in 4 BCOs

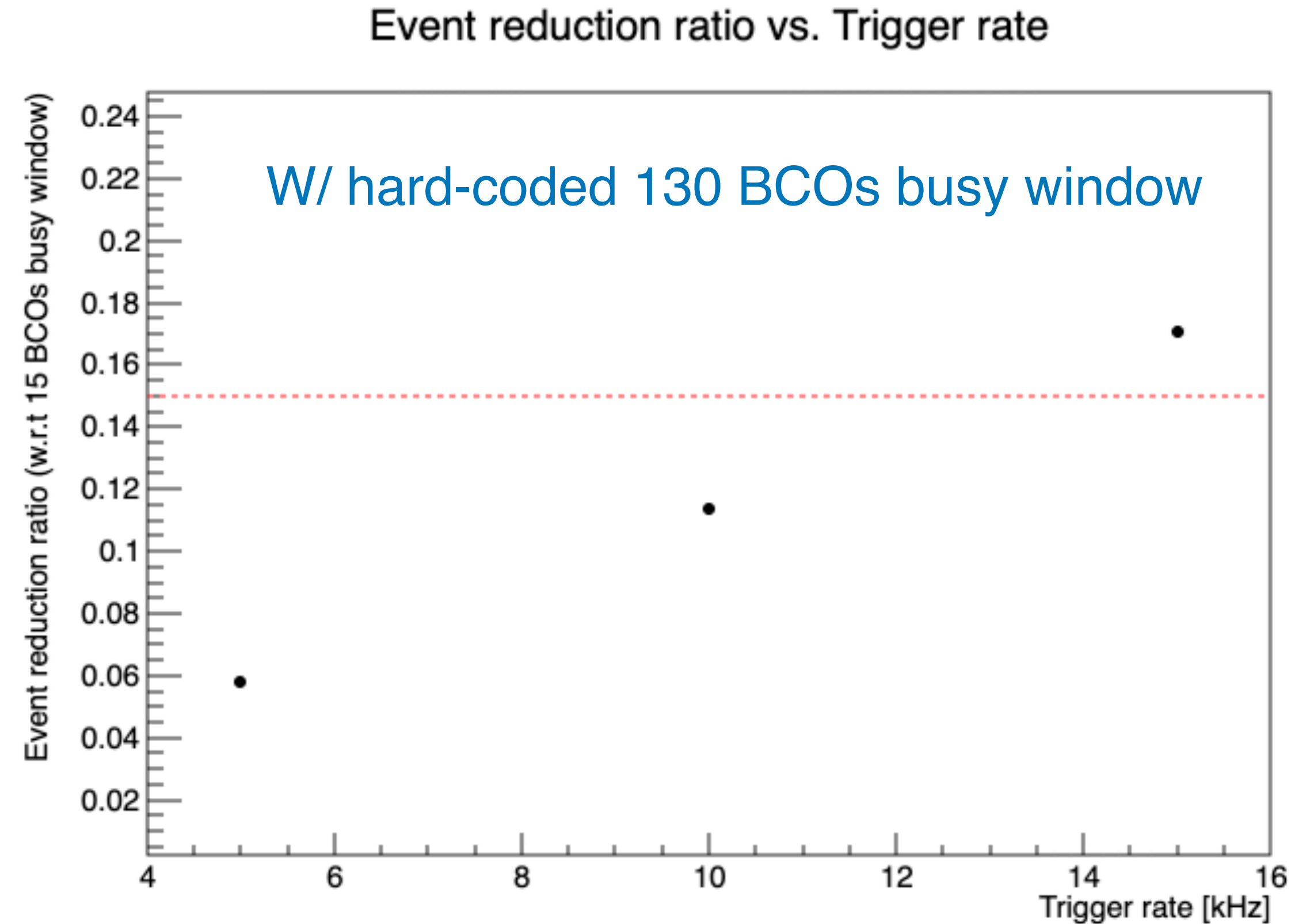
Assumption:

1. BCOFULL & hit_BCO both start at 0 and the first trigger fired at BCOFULL=0
2. ncollision 100 bco & open_time 60 bco



- According to Raul, he didn't expect that the next trigger would be sent to subsystems within ~200 BCOs. Raul will check what will happen if next trigger conflicts with FELIX open_time

- Chip Saturation issue
 - Increase the `INTT FELIX open\_time` to the maximum (128 BCOs)
 - Do the open_time scan in Run25 if time can be assigned
- Hit carried over issue
 - Run with the current configuration and remove the problematic events in the offline analysis
 - The hard-coded GTM busy (say 130 BCOs)...? ▲ (Trigger rate reduction)
 - Dynamic busy implementation in the FELIX (need additional development)
 - Any other ideas? ▲ (Trigger rate reduction)



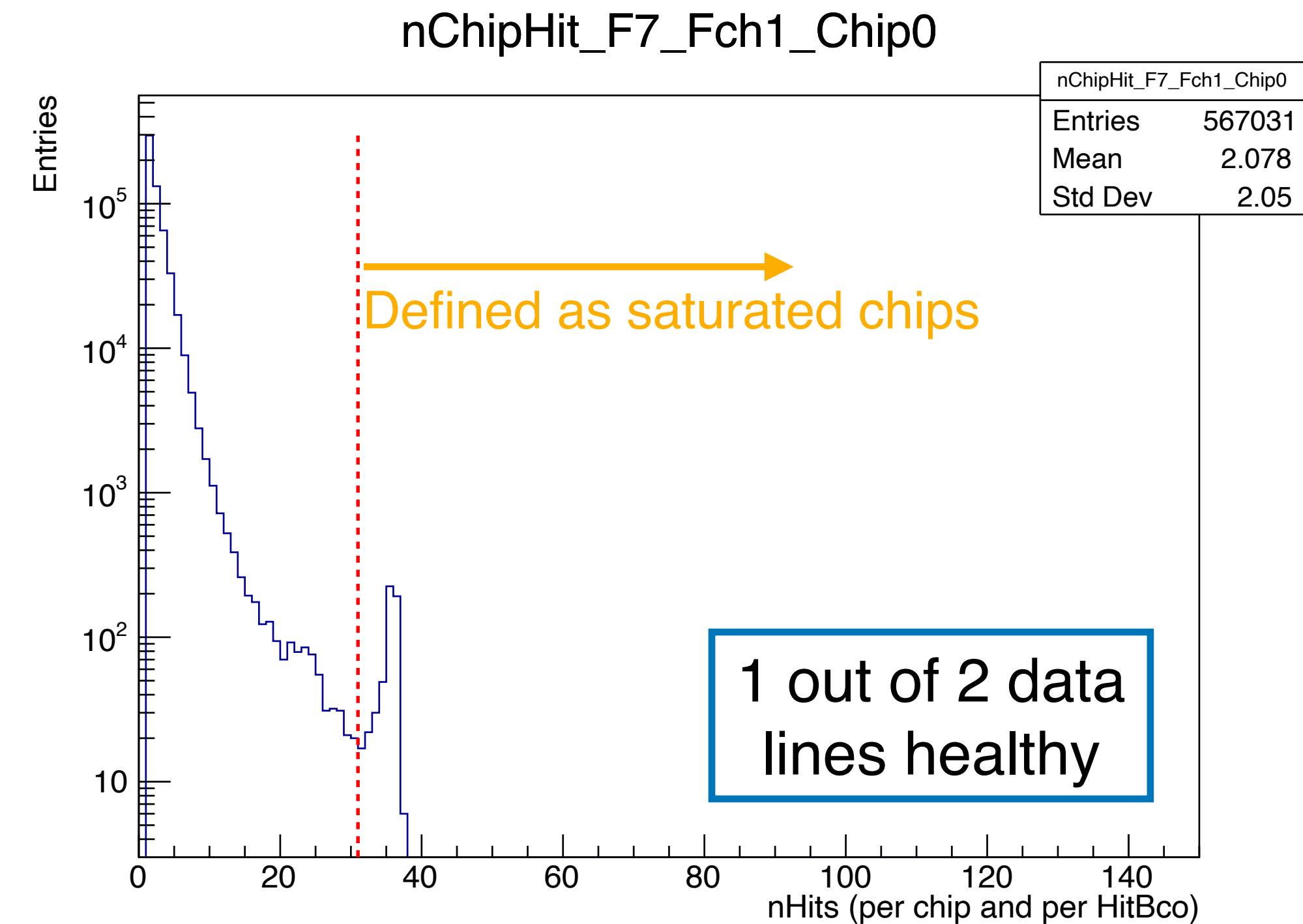
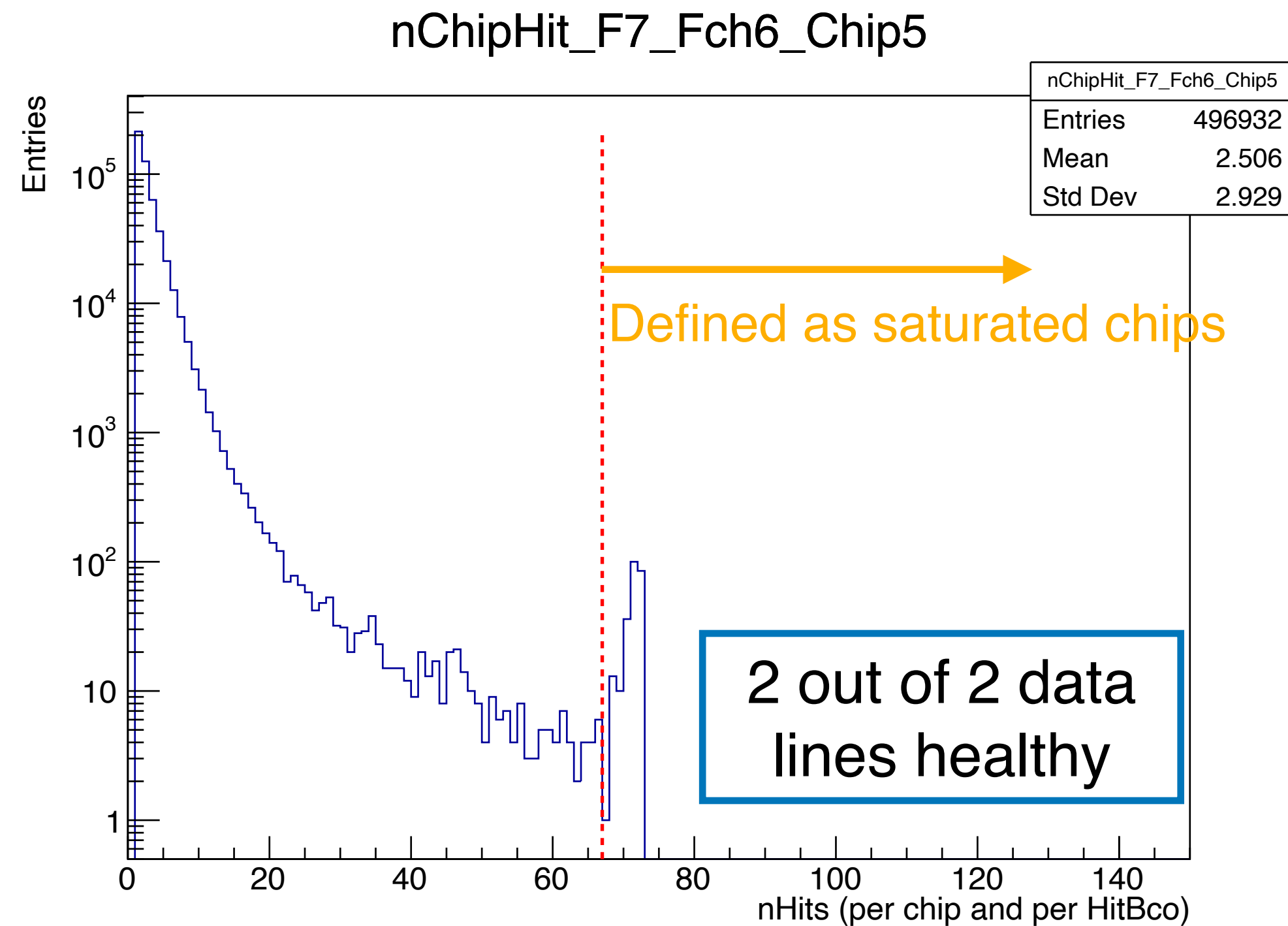
- With the trigger rate of 10k Hz, ~11.4% of the triggered events (w.r.t to the current 15 BCOs busy window) will be rejected if 130 BCOs busy window is set
- In the other words, if we keep the same configuration for Run25, up to ~11.4% of INTT events would have the hit-carried-over issue

Back up

Chip saturation issue

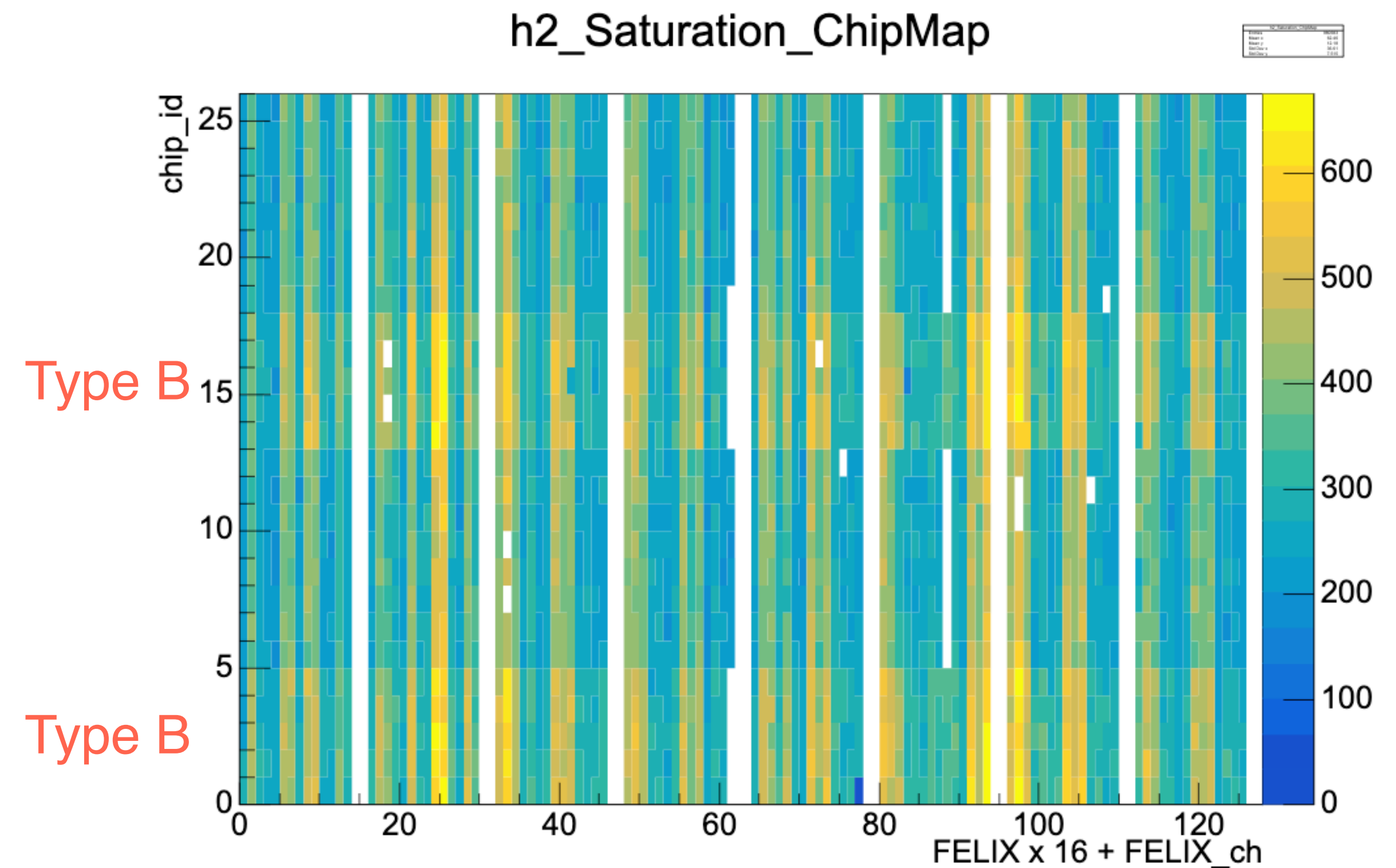
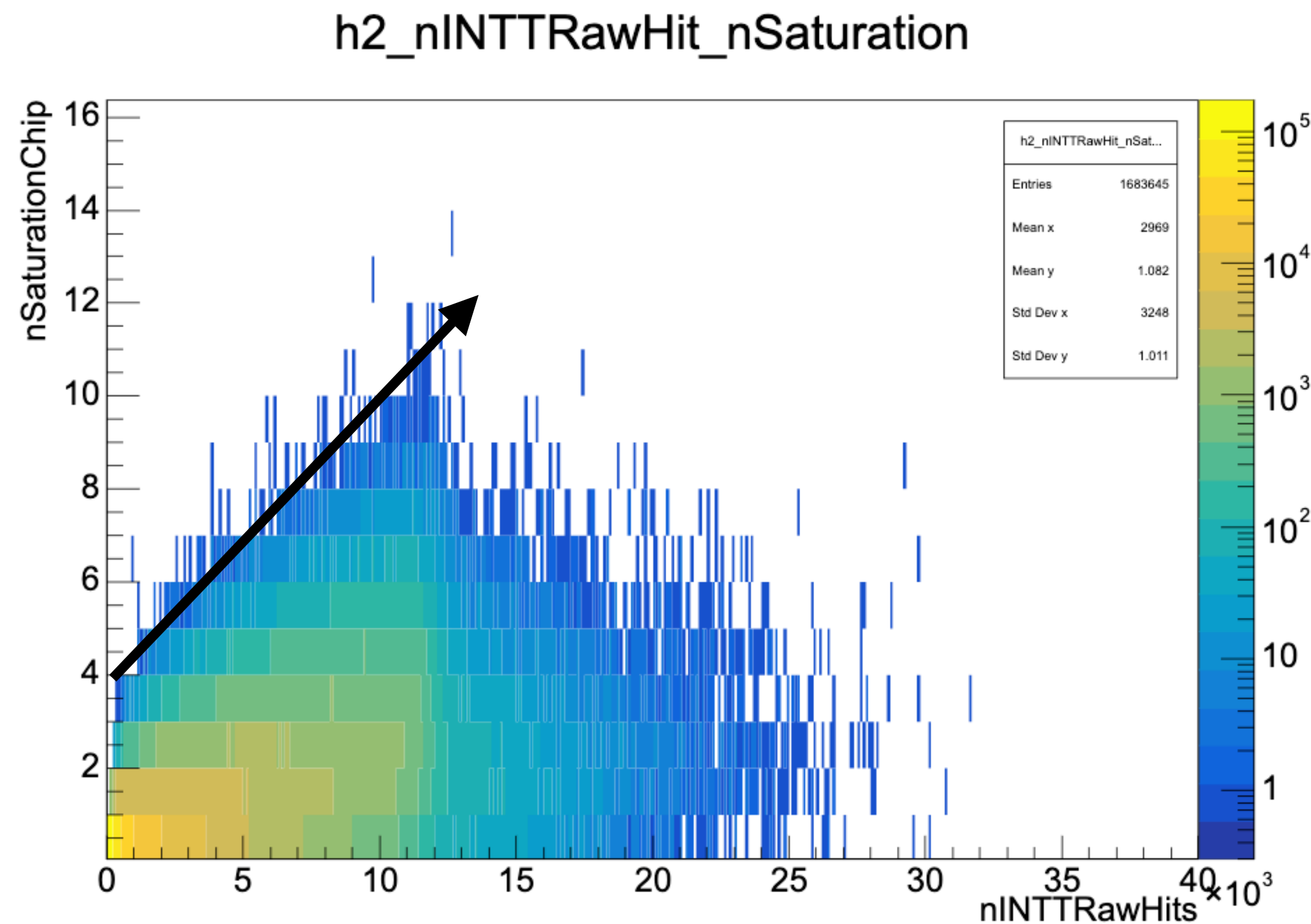
Selection

```
std::pair<double,double> normal_range = {60,80};  
double normal_threshold = 67;  
  
std::pair<double,double> halfentry_range = {30,40};  
double halfentry_threshold = 31;
```



Try to have the selections to pick up the chips saturated

Number of the chips saturated



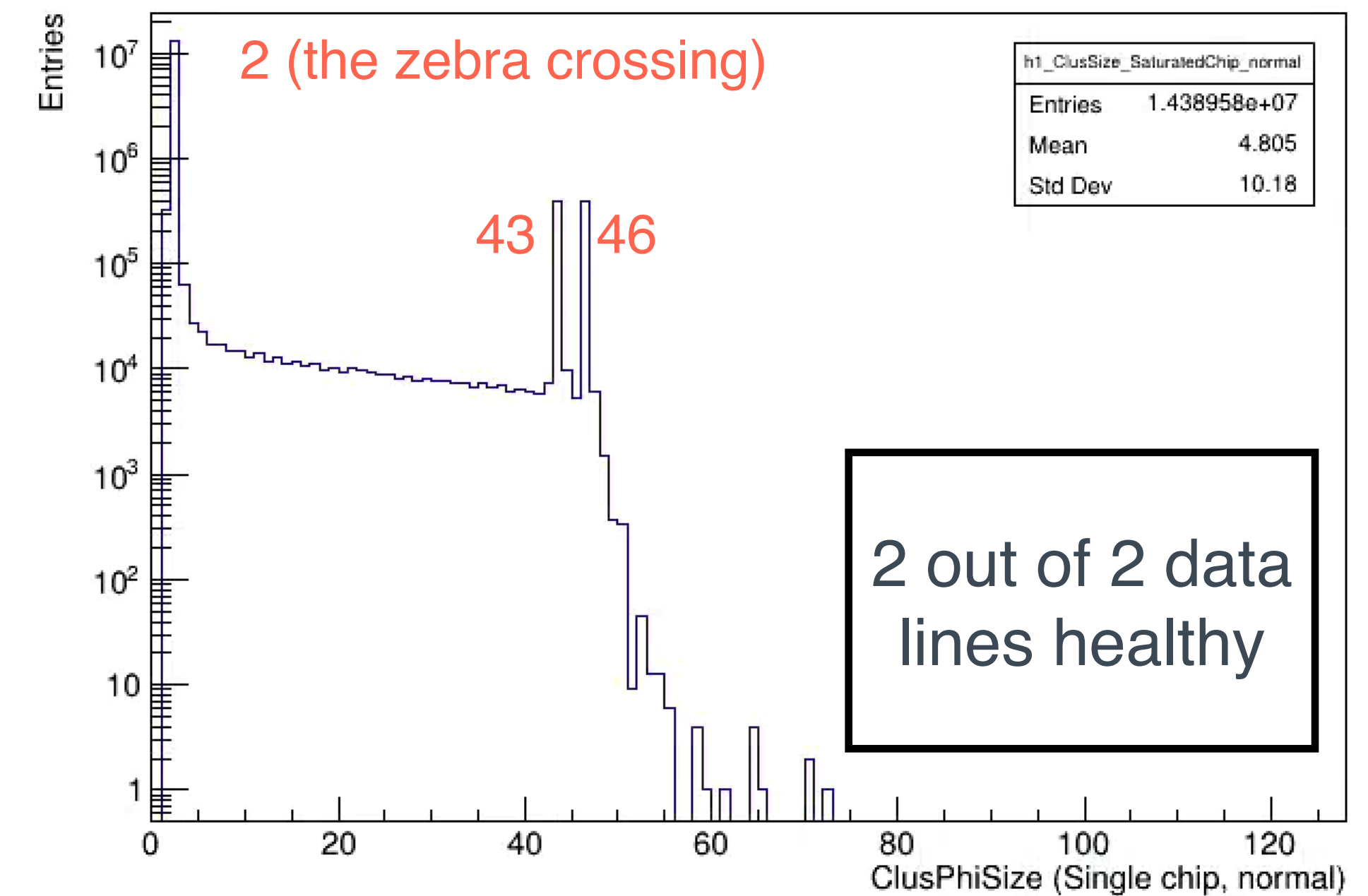
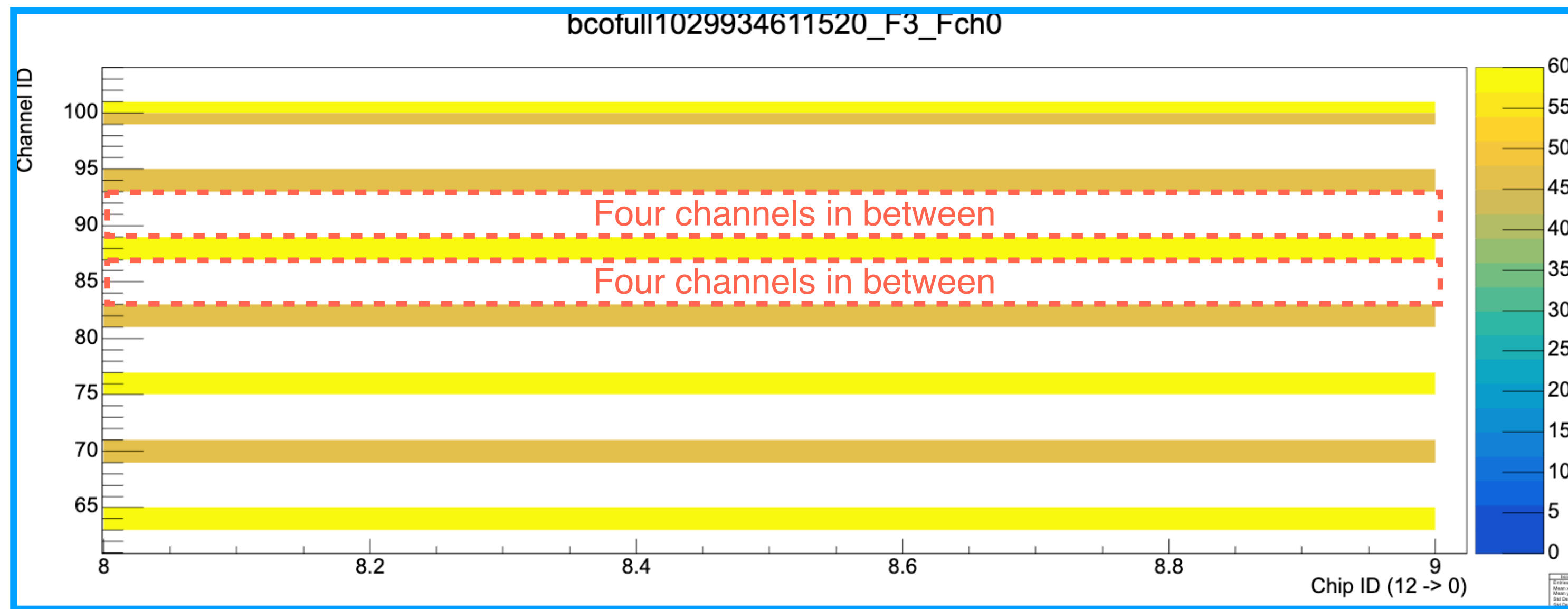
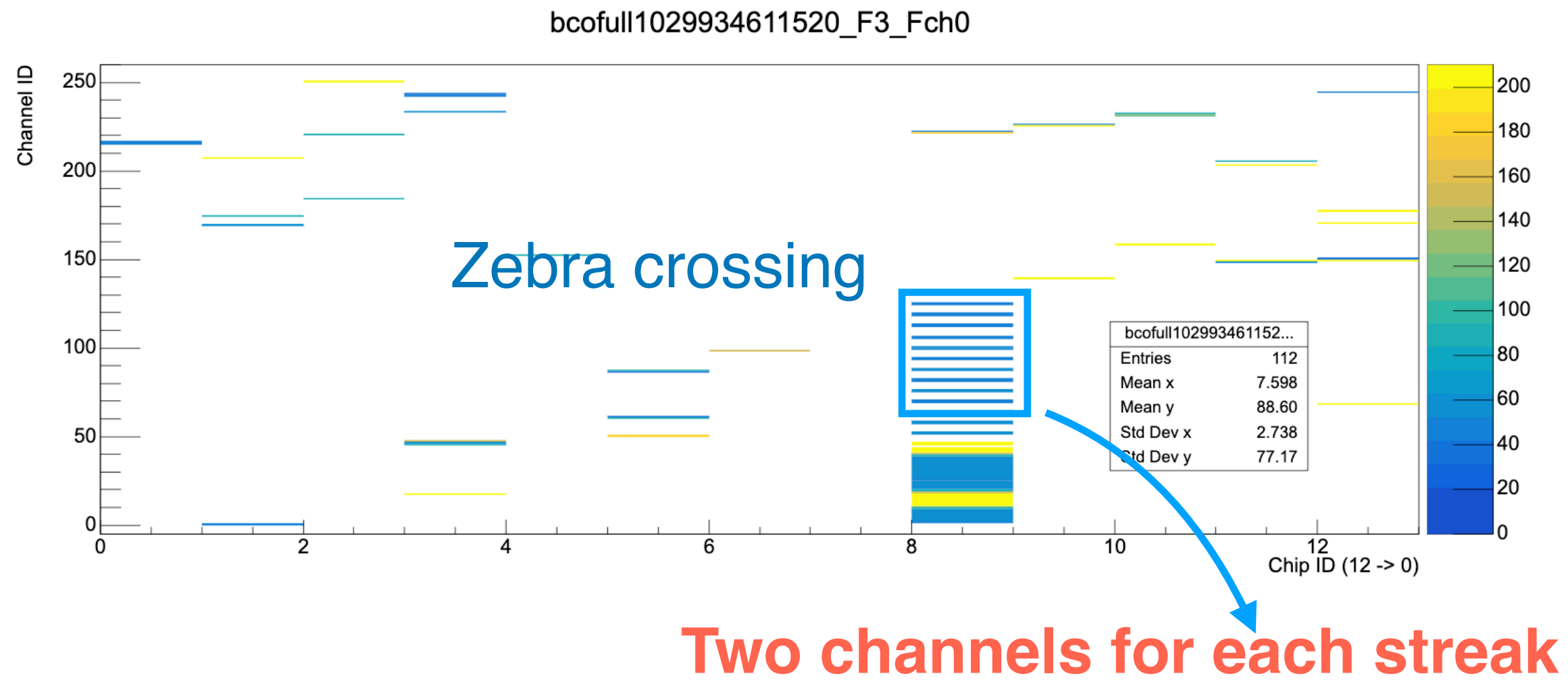
In the worse case, 12 out of 2912 chips are saturated in one event

Assuming those chips have all channels fired, $(128 - 73) * 12 = 660$ hits are dropped by FELIX servers

$660 / (13000 + 660) = \sim 5\%$ of the hits are missing

But we might gain more clusters (non-physical)

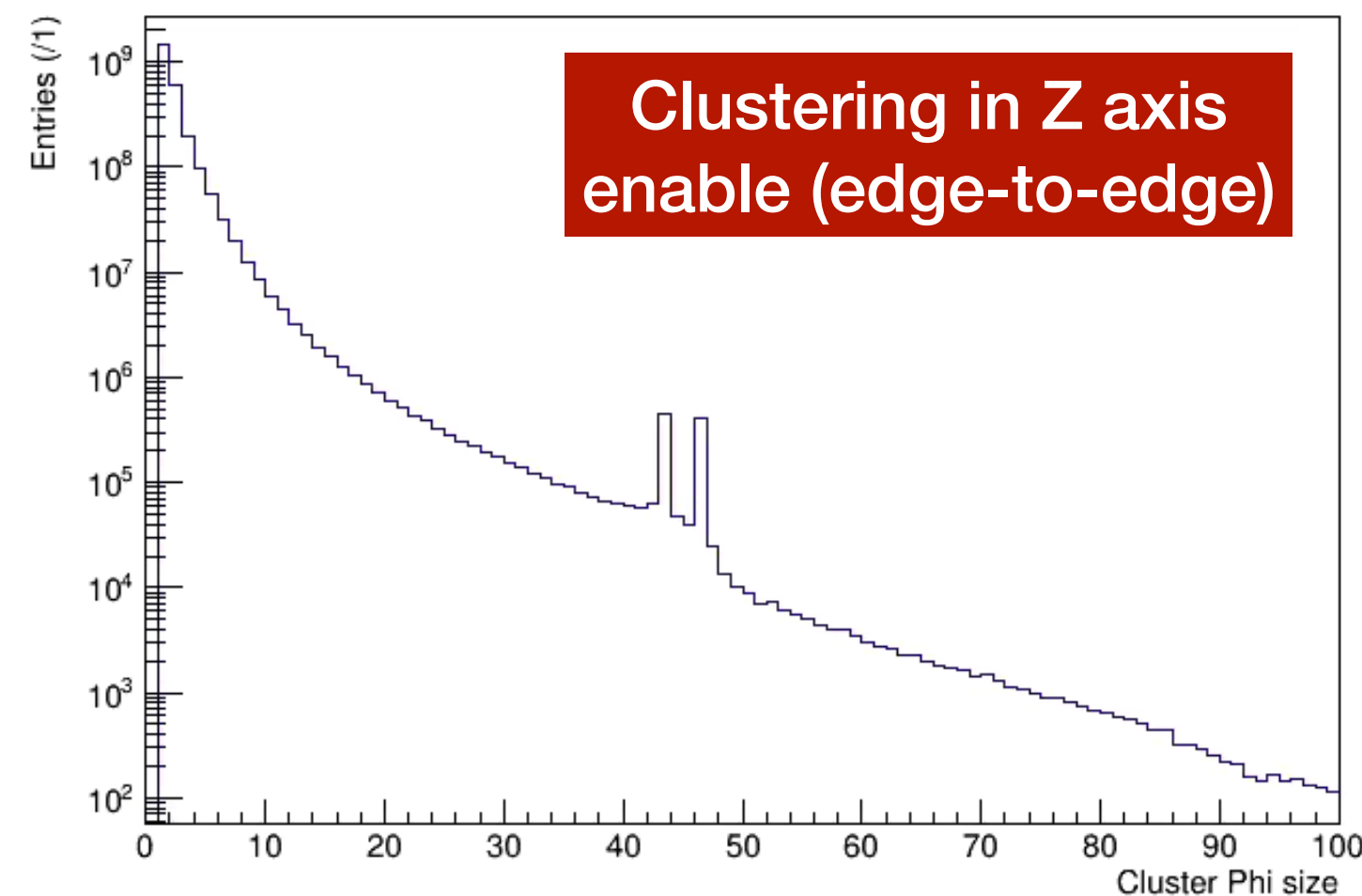
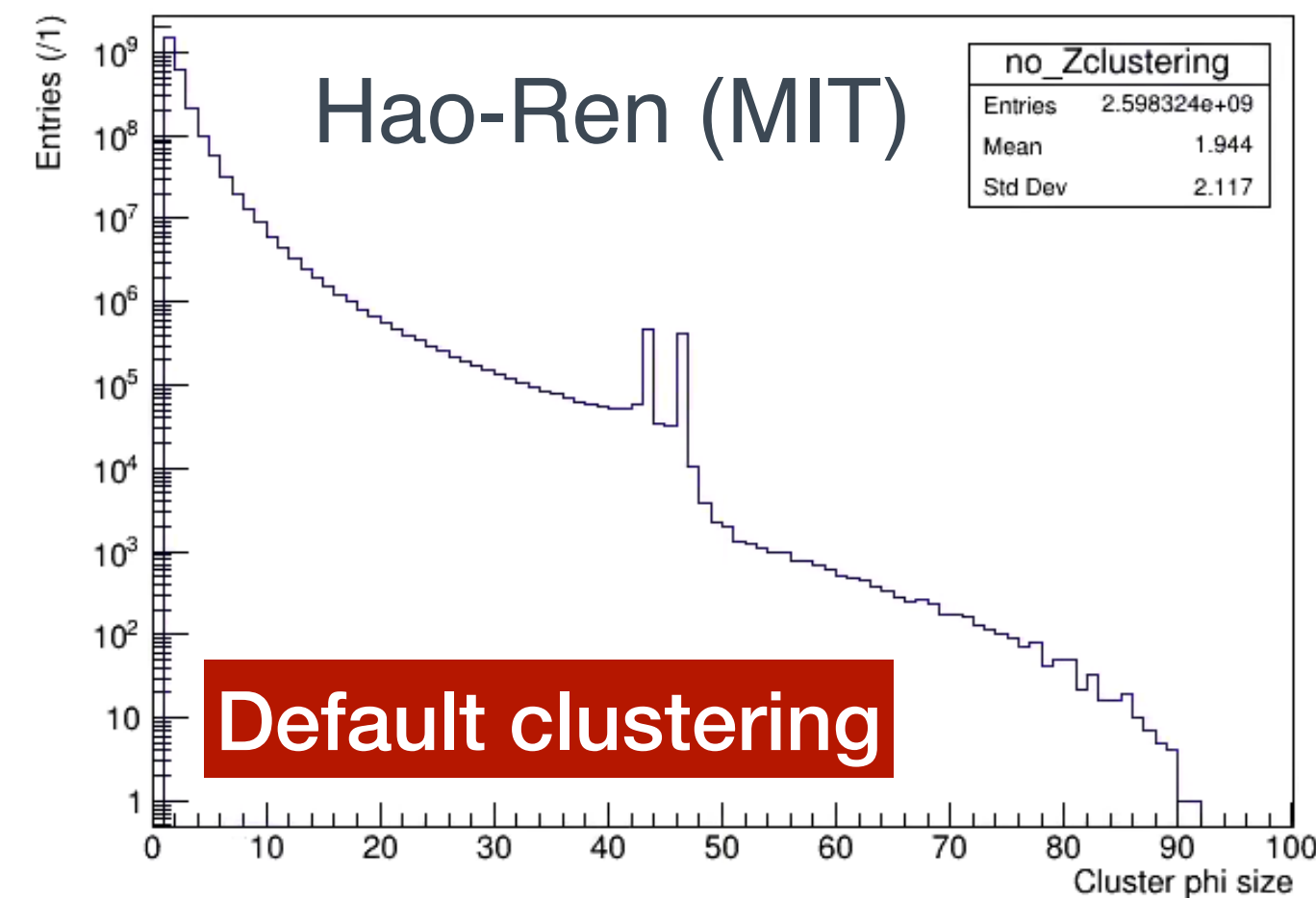
Chip saturation, the patterns



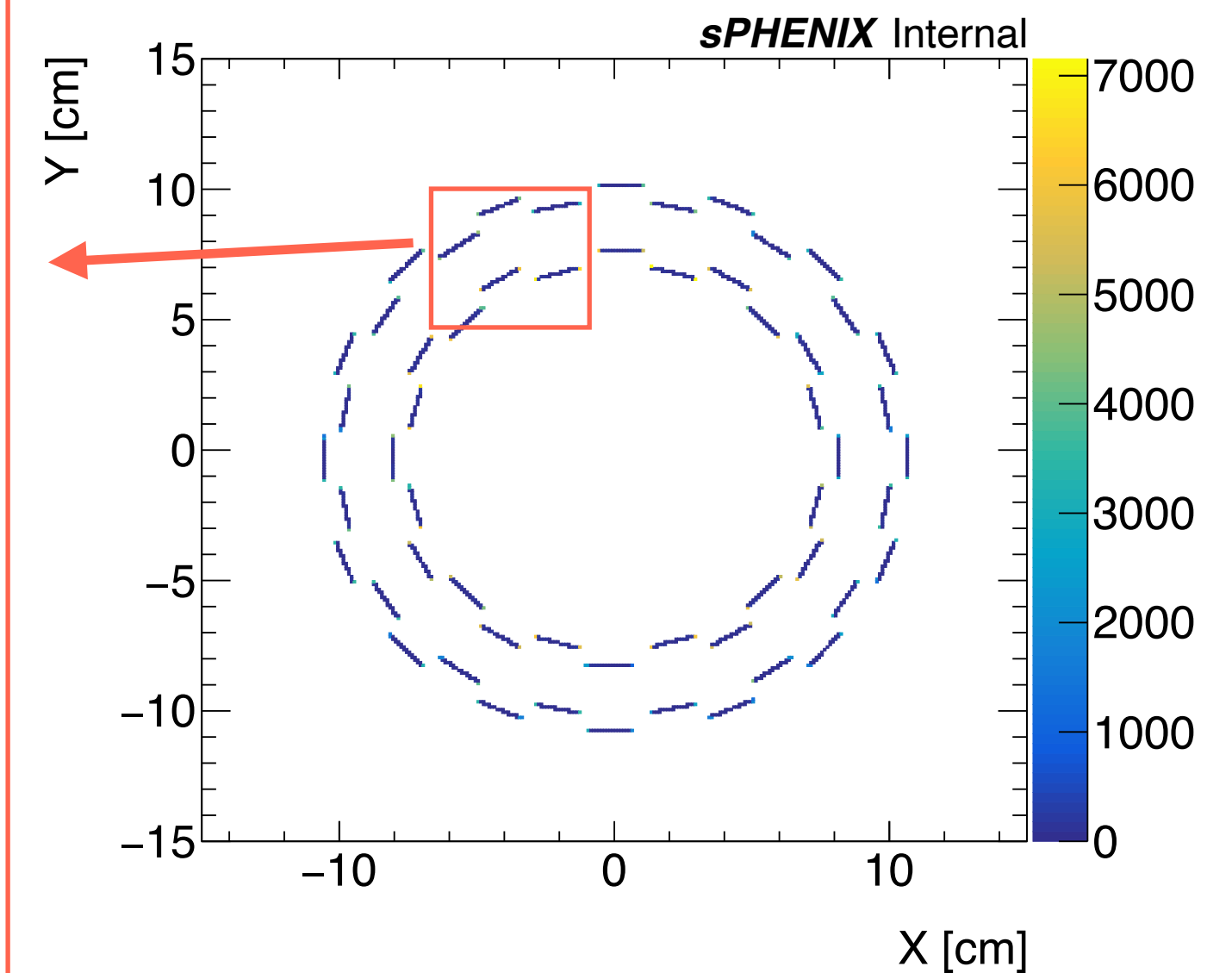
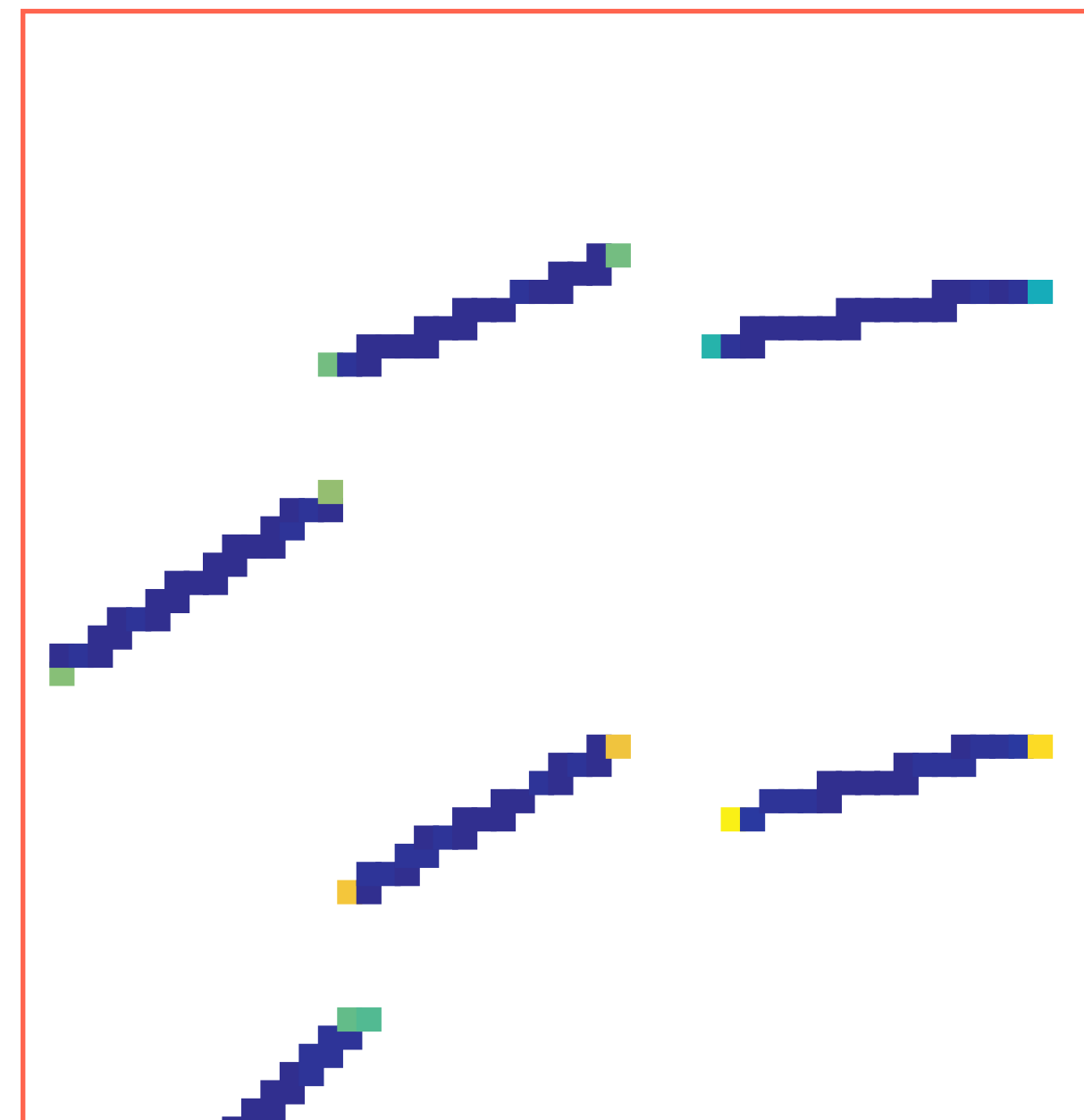
The pattern : big chunk + zebra crosswalk, and big chunk always closer to the edge

Cluster phi size distribution

- There are two spikes in the cluster phi size distribution regardless the clustering requirement
- Issue was first spotted by Hao-Ren (MIT) with run 23 Au+Au data (it's the problem across the runs)

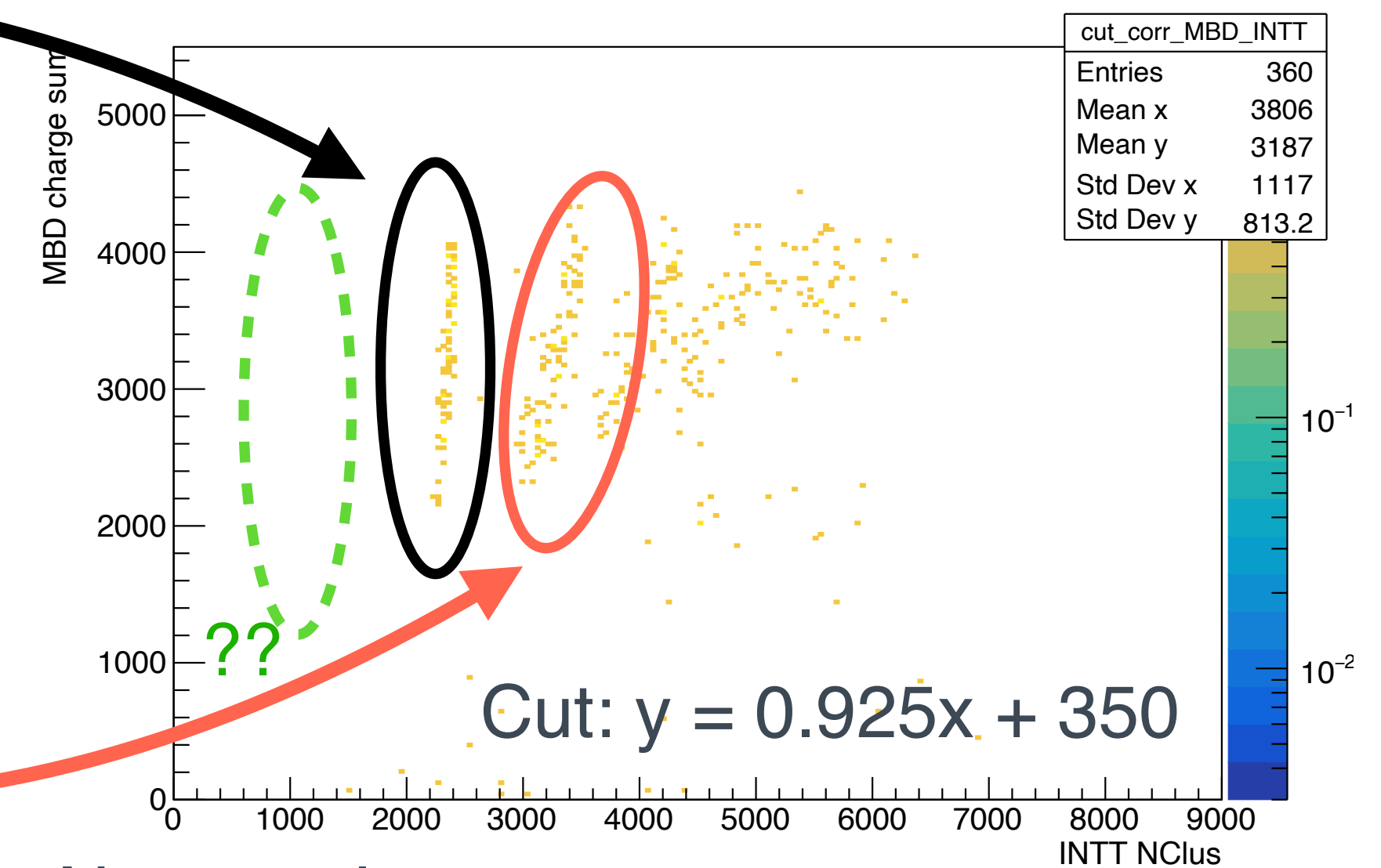
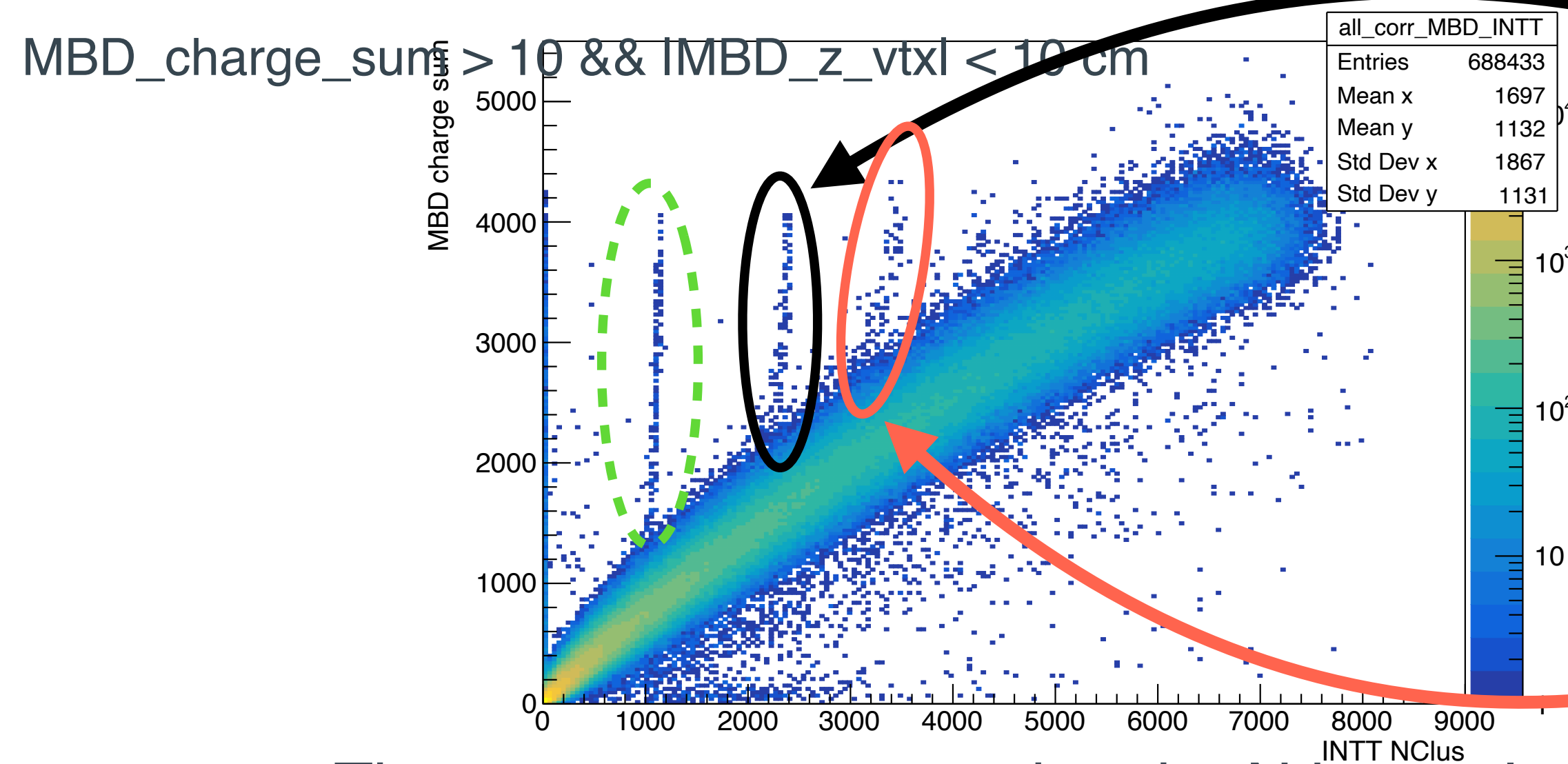
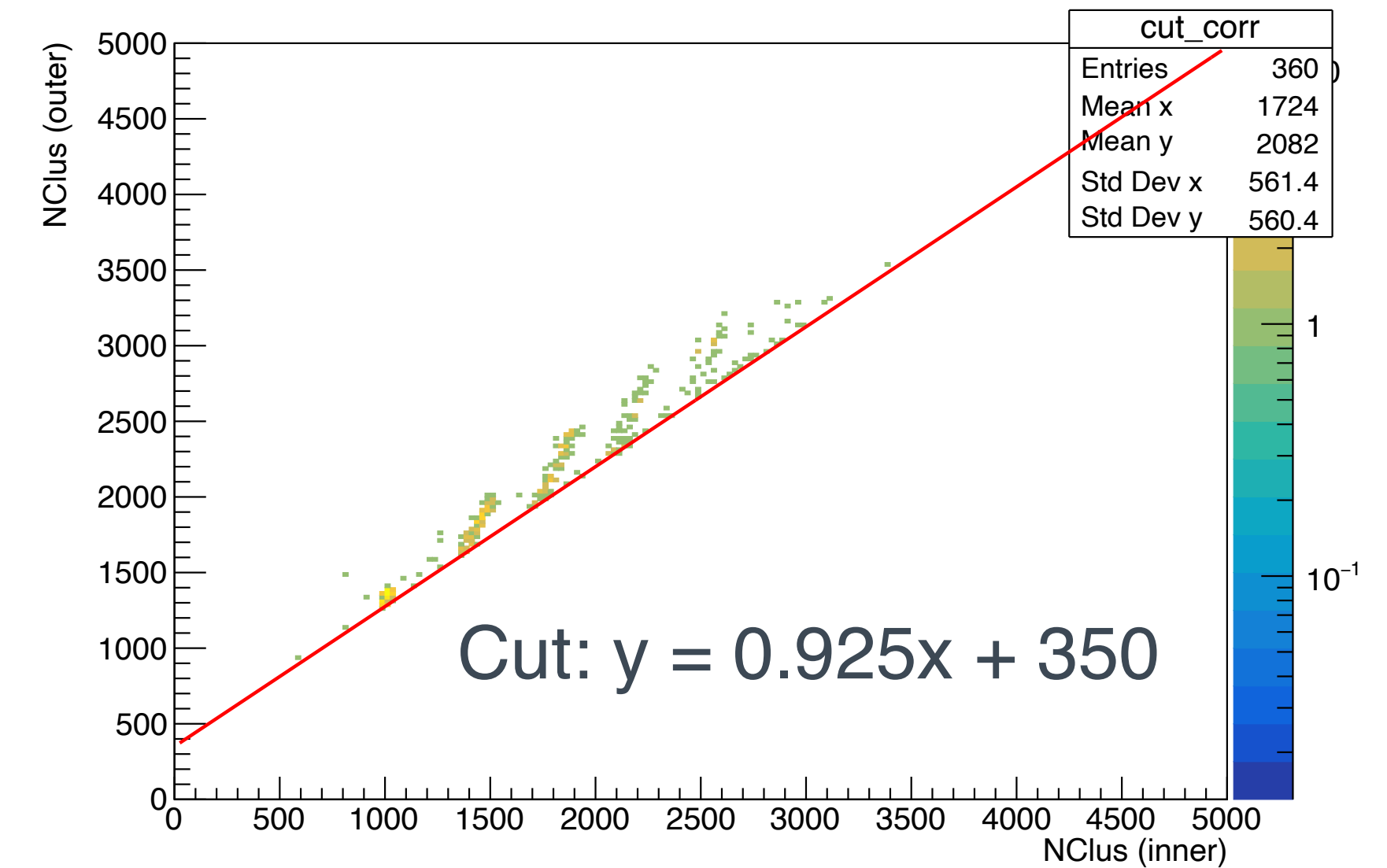
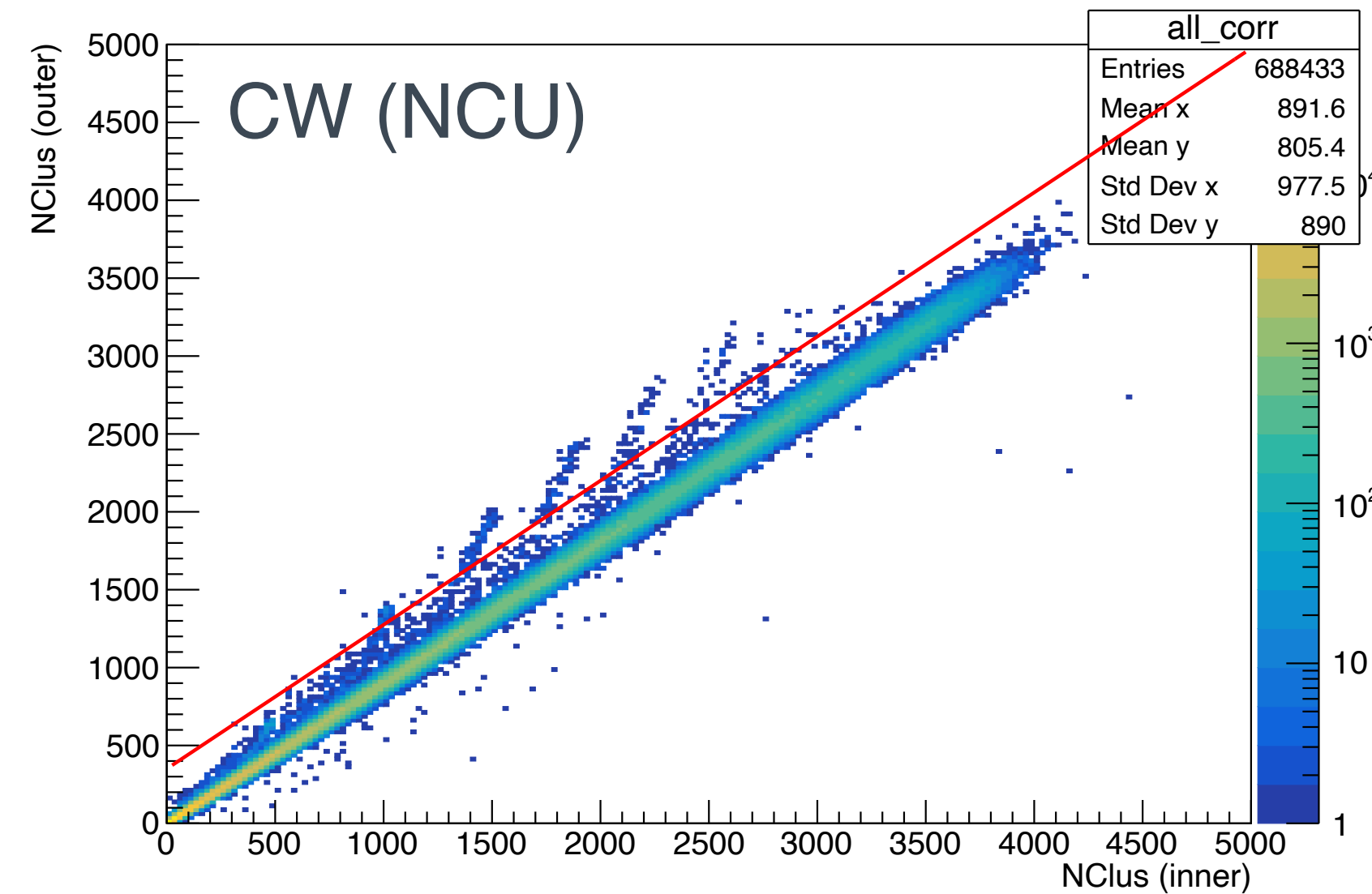


The positions of the clusters with phi size 43 or 46 (default clustering)



They tend to appear at the edge of sensor

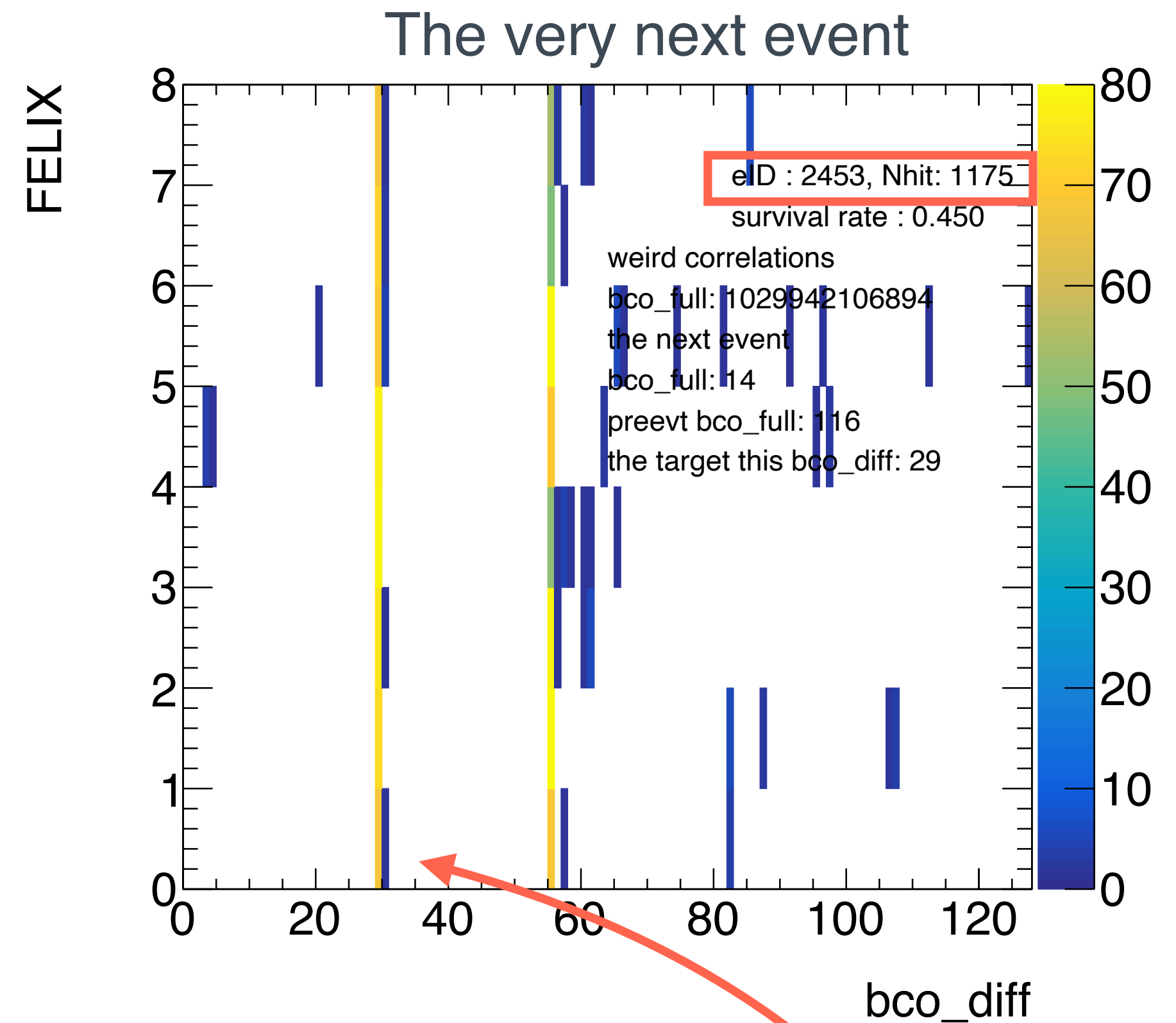
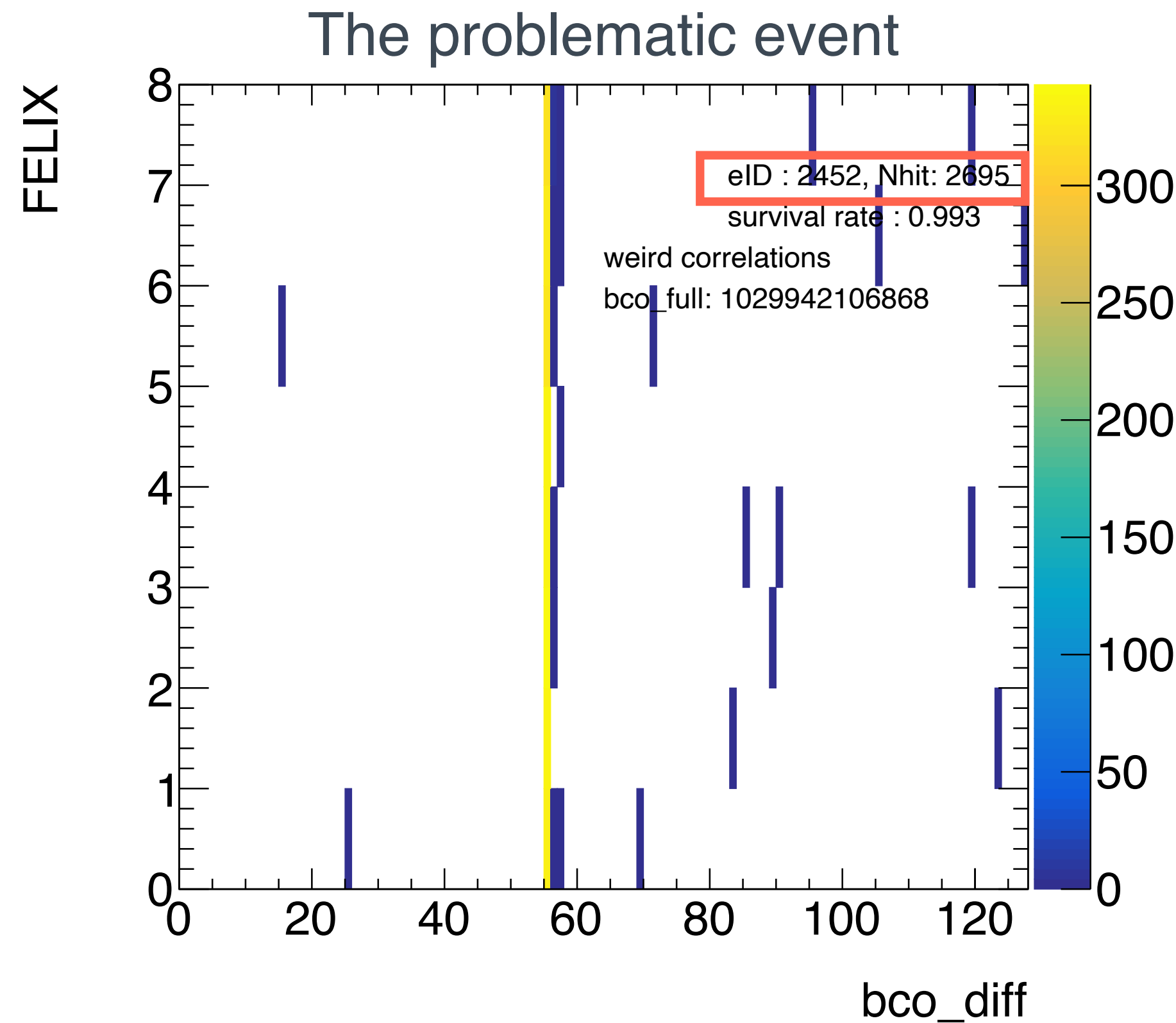
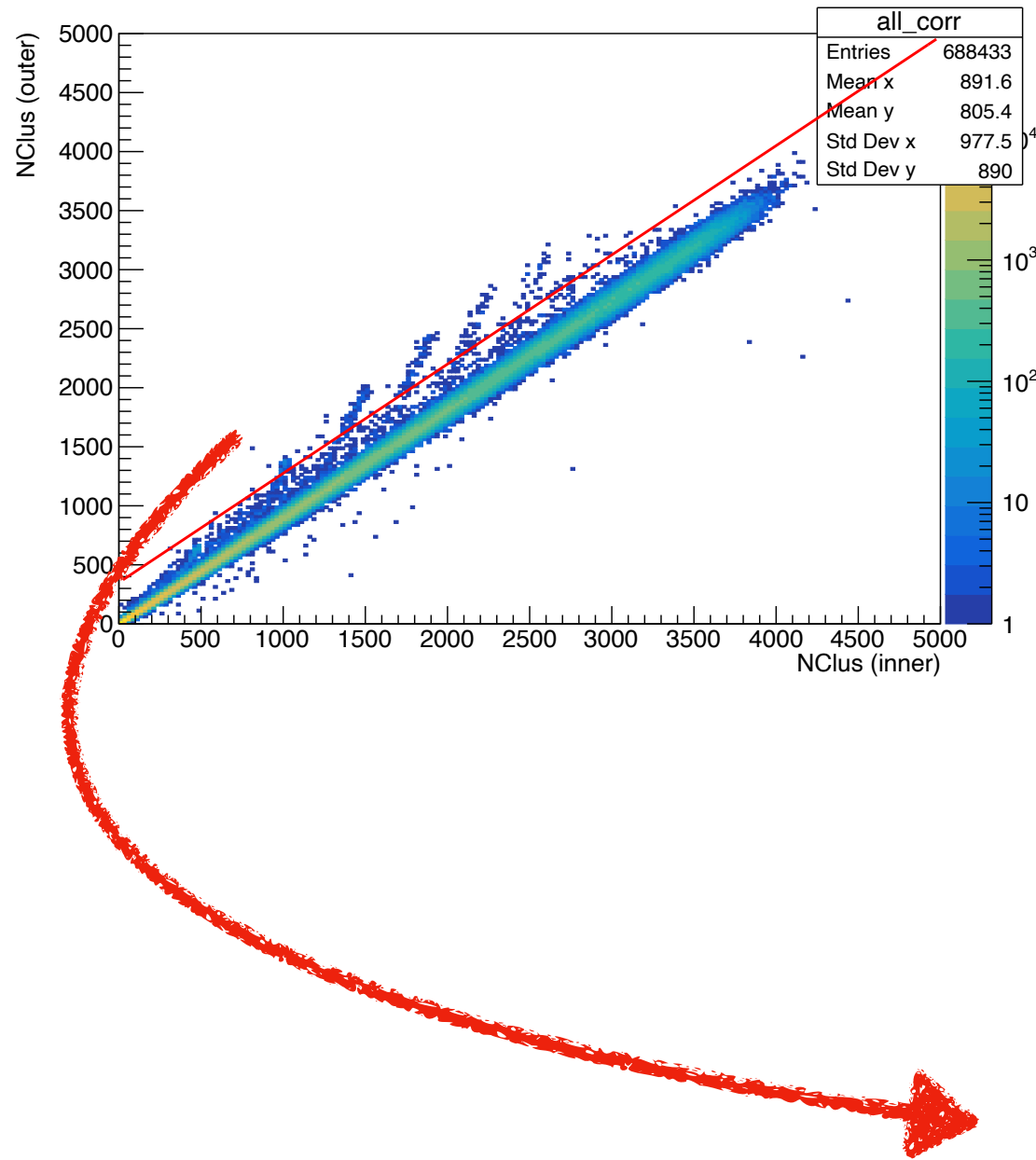
Hit carried over issue



There are some events that the N inner cluster < N outer cluster

The outliers are correlated to the outlier groups in the MBD-INTT multiplicity correlation

Hit carried over issue

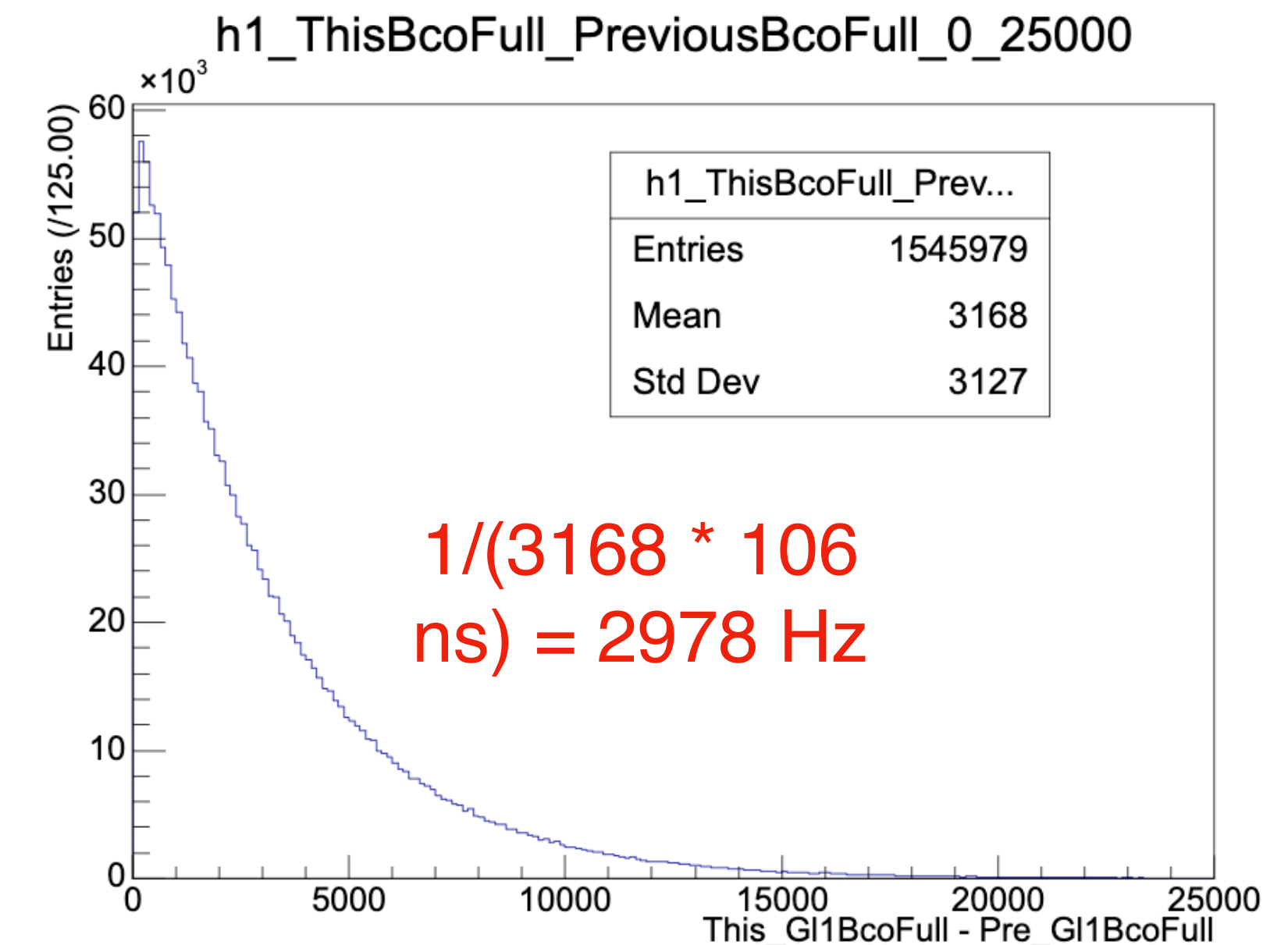
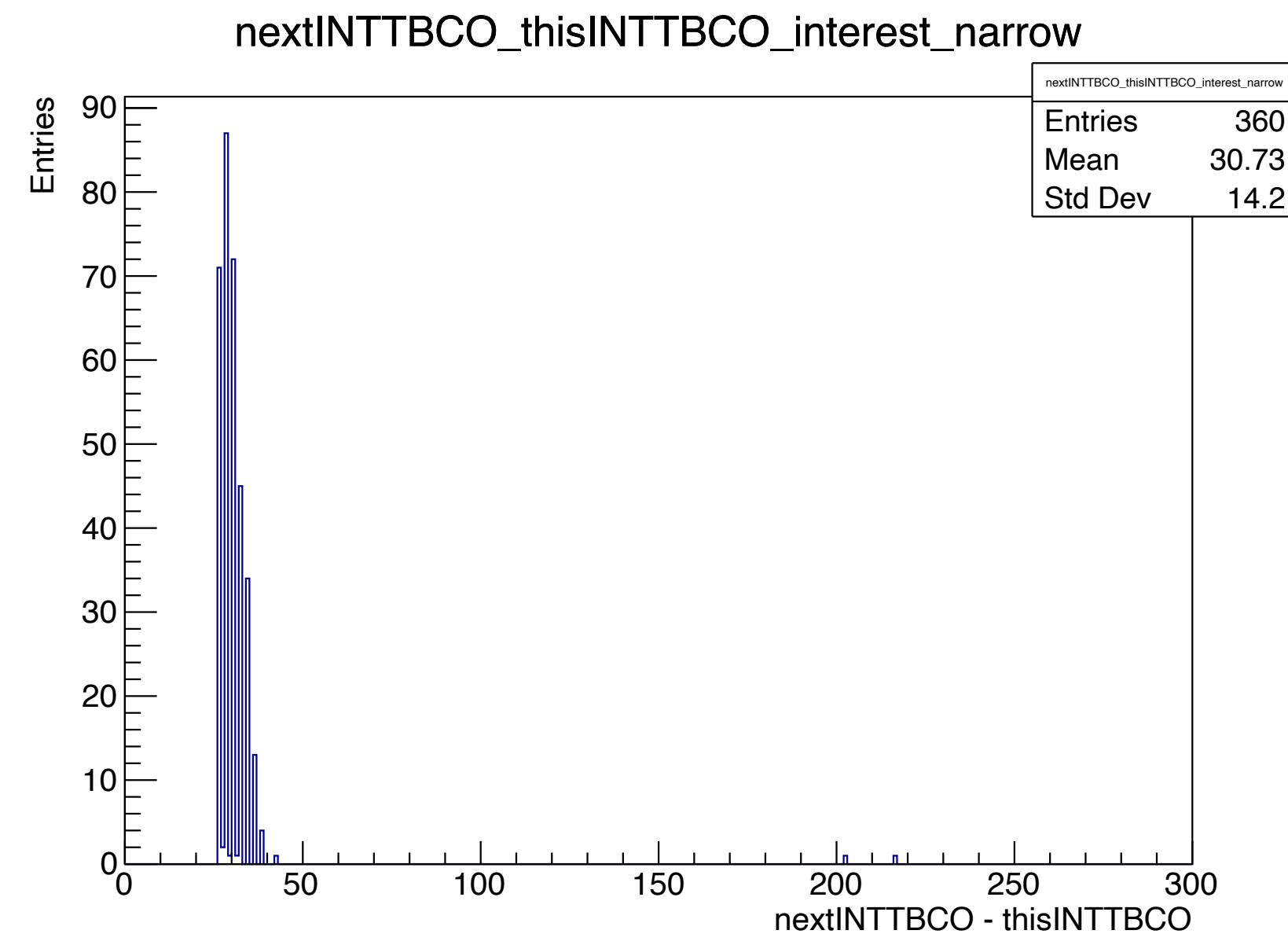
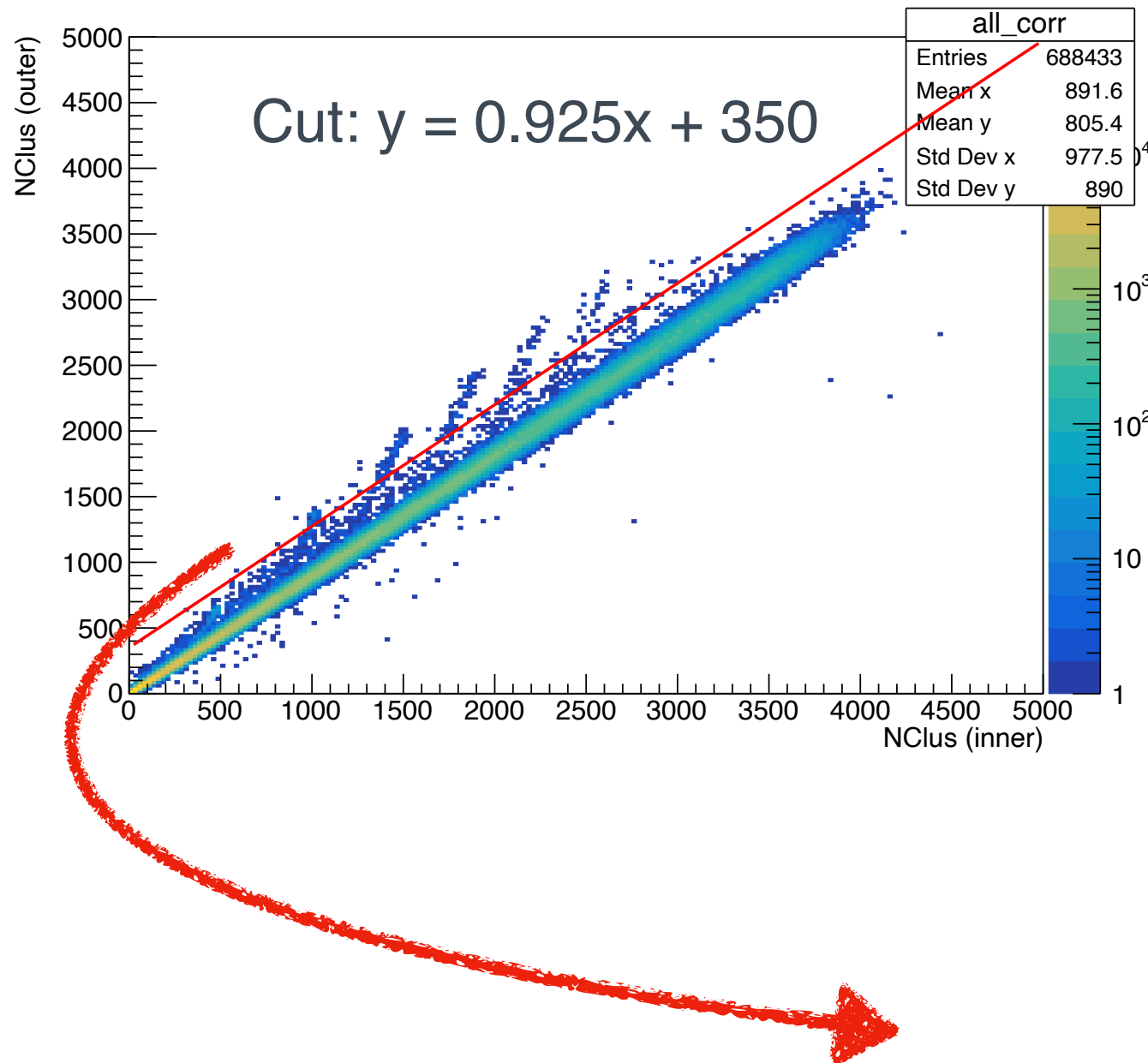


INTT has hits carried over

- In this event, if the hits are carried over to the next event, the “**time_bucket of this_hit_bco w.r.t next_BcoFull**” would have to be **29**, where you can see the yellow strip in the right plot
- The evidence of hits varied over to the next event

(1)	this bco_full & 0x7fU	116
(2)	correct hit_bco	43
(3)	Next bco_full & 0x7fU	14
(4)	(2) - (3)	29

Hit carried over issue



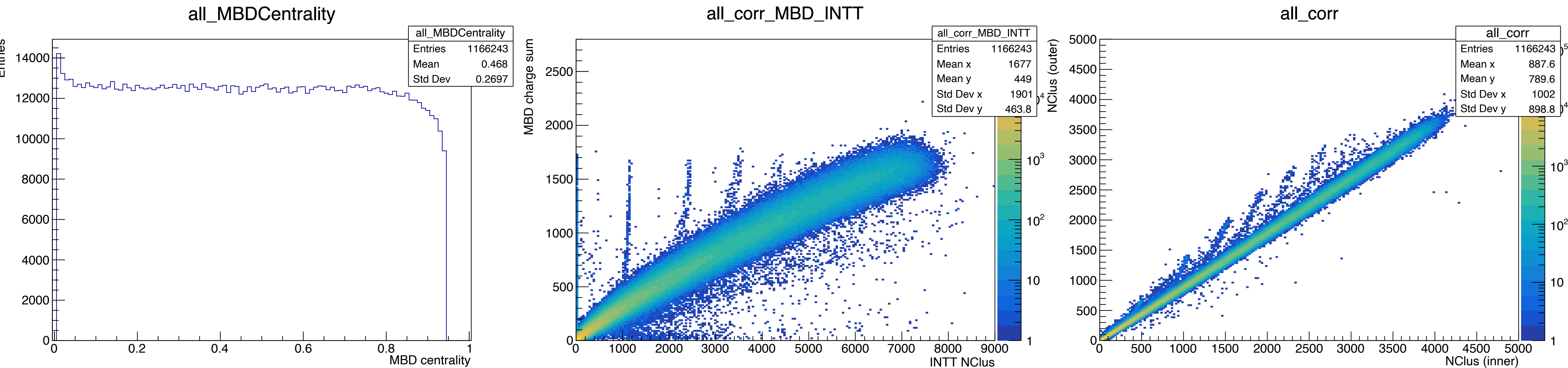
The very next events of the problematic events are very close to problematic events in time wise

Hypothesis: Hits in FELIX been assembled with INTTheader (INTT_bcofull) and sent out to the down stream. Since FELIX receives new trigger, the previous INTT_bcofull is overwritten. The hit assembly continues, but with the new INTT_bcofull

Can we probably just have a simple “BCOFULL_diff” cut?

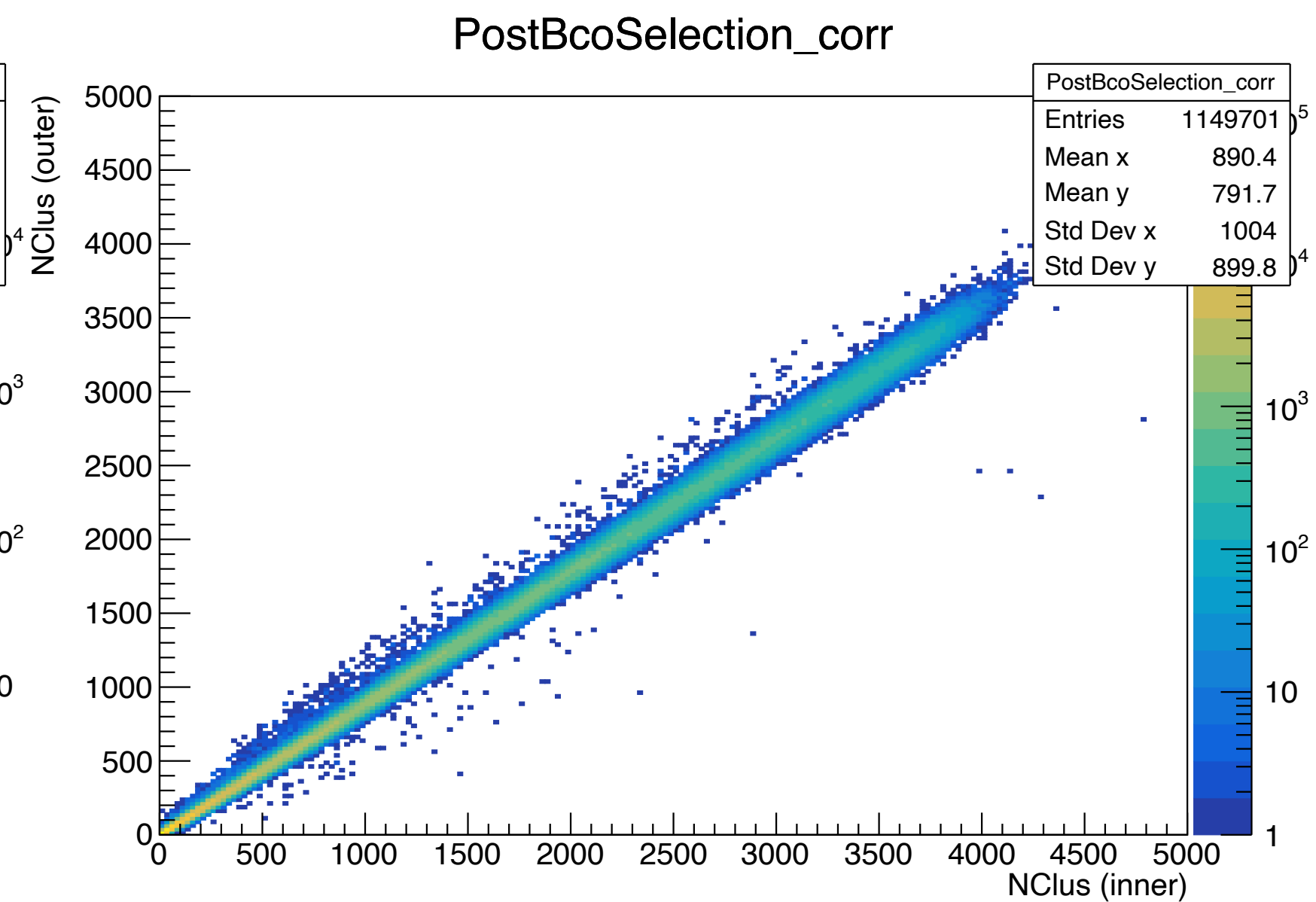
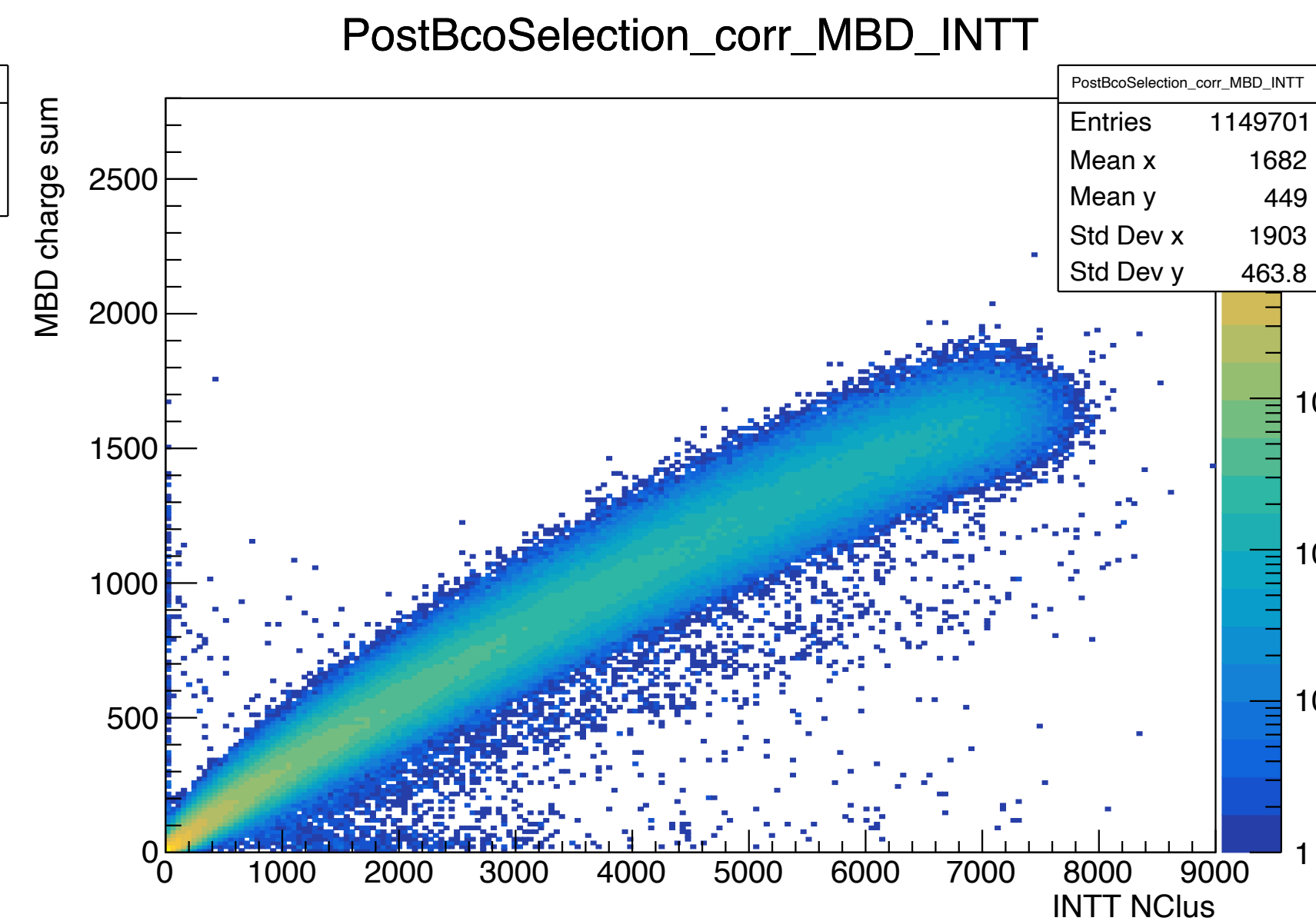
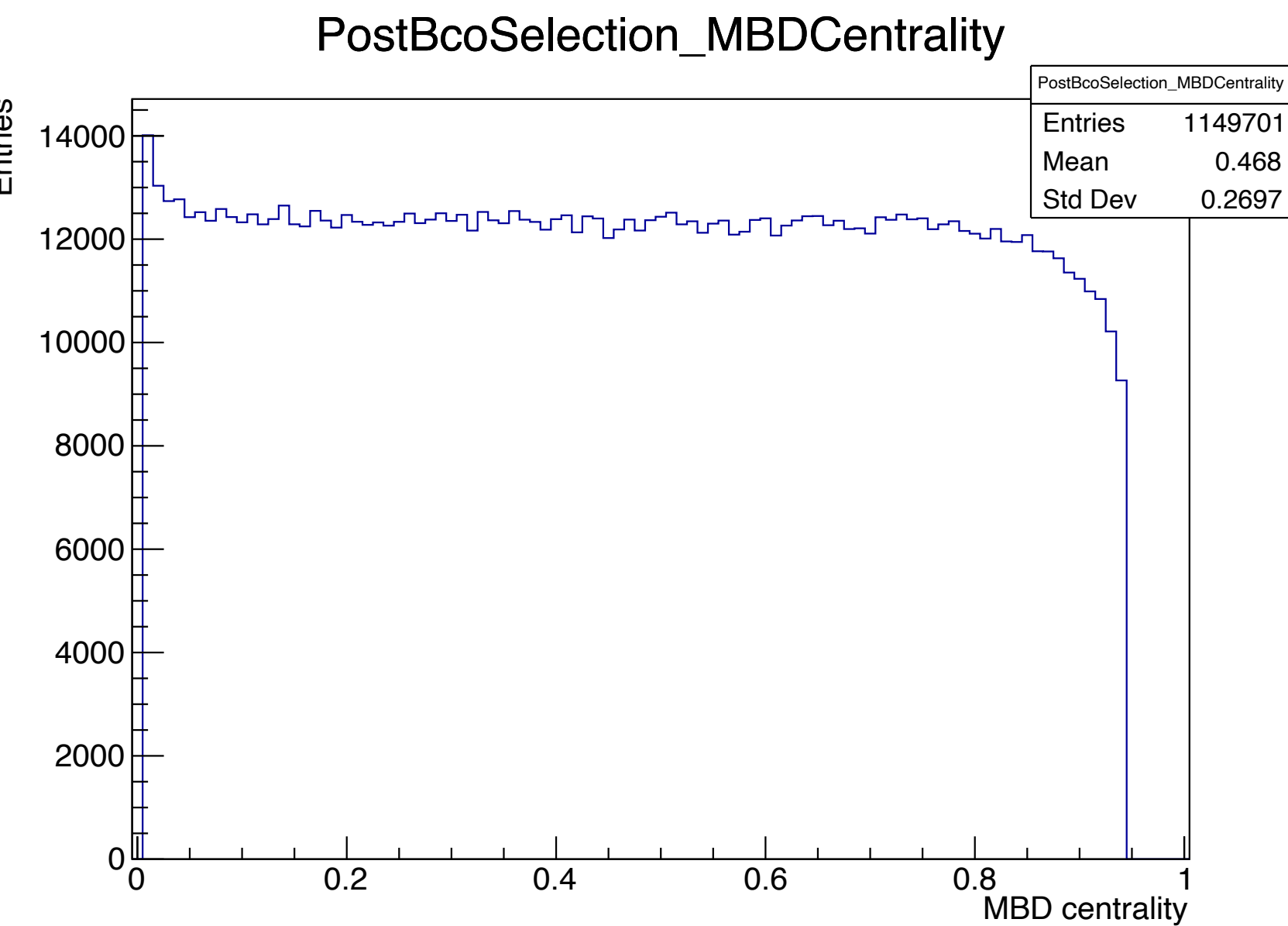
Hit carried over issue

Only evens with $-10 \text{ cm} < \text{MBD_z_vtx} < 10 \text{ cm}$ are included



Hit carried over issue

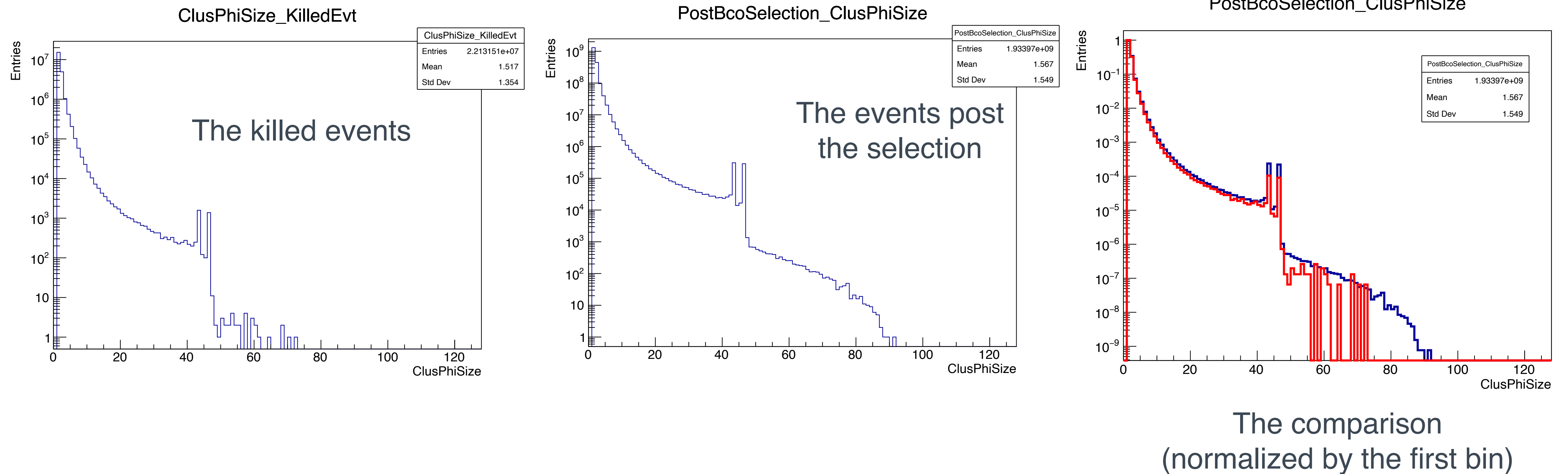
Only events with $-10 \text{ cm} < \text{MBD_z_vtx} < 10 \text{ cm}$ are included
Events w/ $\text{NextInttBcoFull} - \text{ThisInttBcoFull} > \underline{61}$ are kept



16,542 out of 1,166,243 events are excluded $\rightarrow$ 1.42%

Hit carried over issue

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Events w/ $\text{NextInttBcoFull} - \text{ThisInttBcoFull} > \underline{61}$ are kept

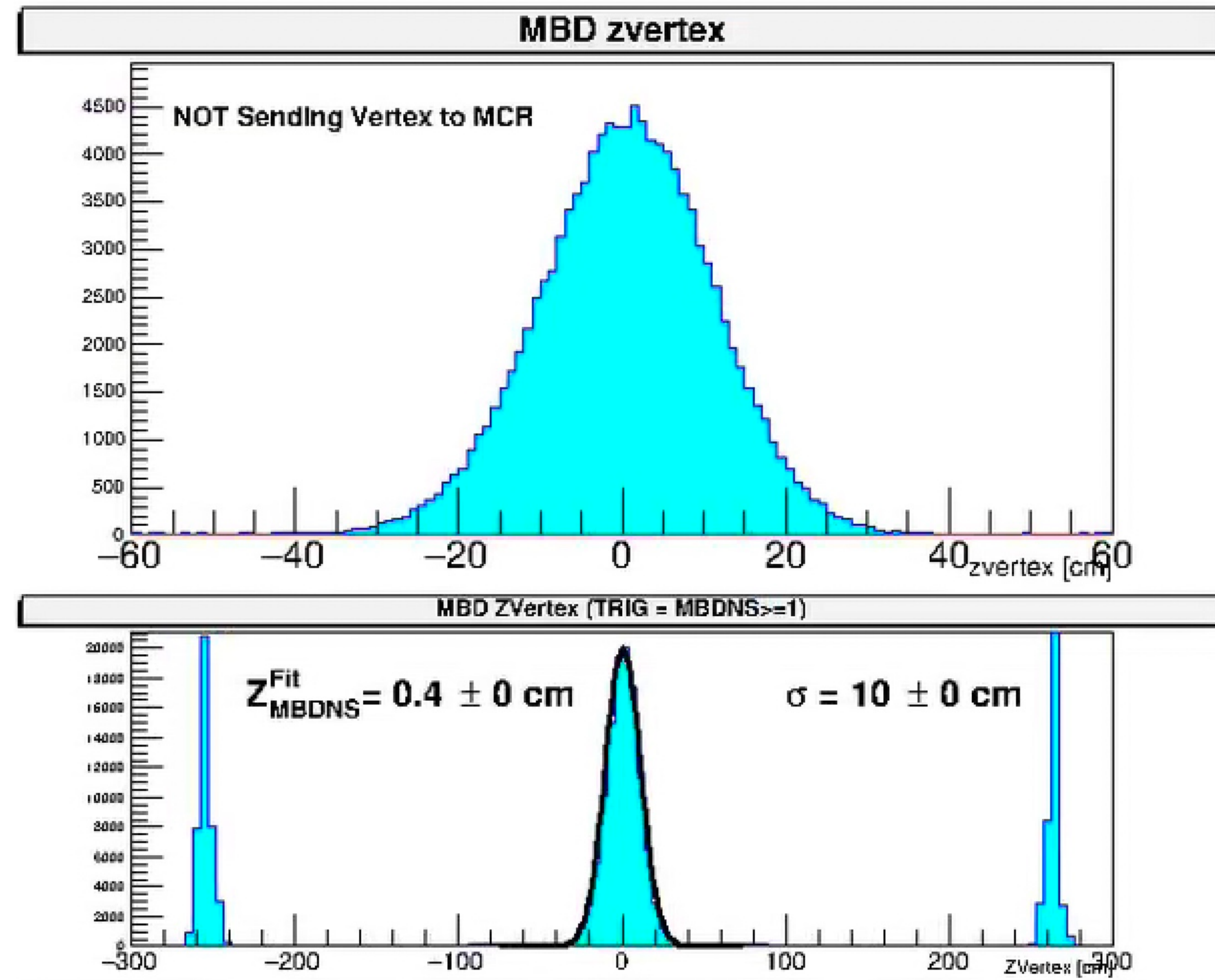


Don't get confused, the hit carried over issue is independent to the hit saturation issue

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 20



Trigger input channel	Name	enabled	Scaledown	Raw	Live	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 $\geq$ 2	yes	off	86958423	86380777	0	99.3
9	MBD N $\geq$ 2	yes	off	85797943	85195687	0	99.3
10	MBD N&S $\geq$ 2	yes	0	10242665	10187457	10187457	99.5
11	MBD N&S $\geq$ 1	yes	off	18093659	17967450	0	99.3
12	MBD N&S $\geq$ 2, vtx < 10 cm	yes	off	4021509	4000602	0	99.5
13	MBD N&S $\geq$ 2, vtx < 30 cm	yes	off	5799143	5768655	0	99.5