INTT hit carried-over issue - Move hits back

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INTT meeting

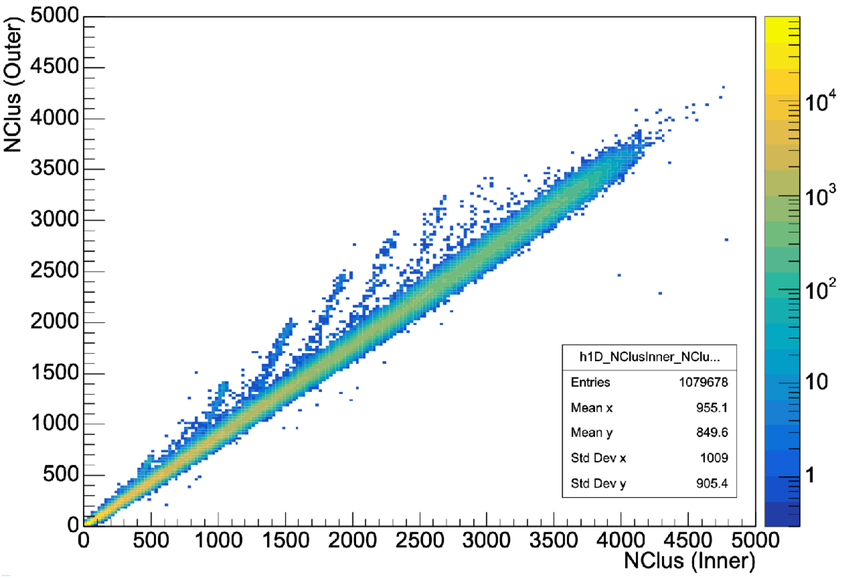
sPHENIX INTT sPHENIX 國立中央大學 National Central University RIKEN

Recap: correlations

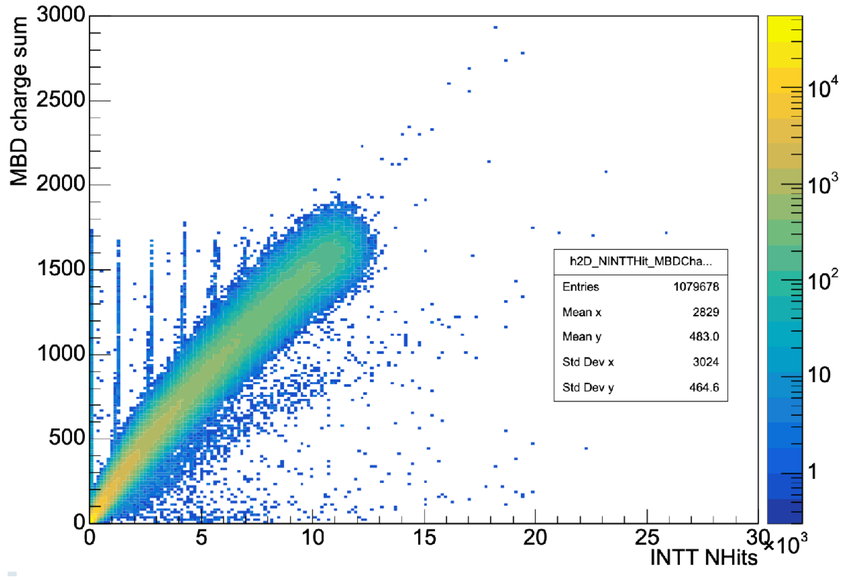
Run 54280

First 3M out of 10M were analyzed

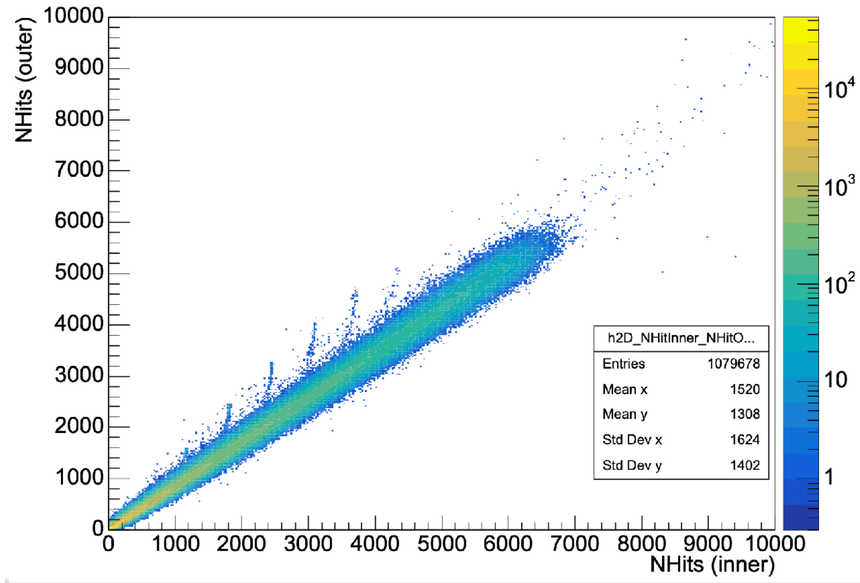
Inner-outer NClus



INTTNInttHits vs MBD charge



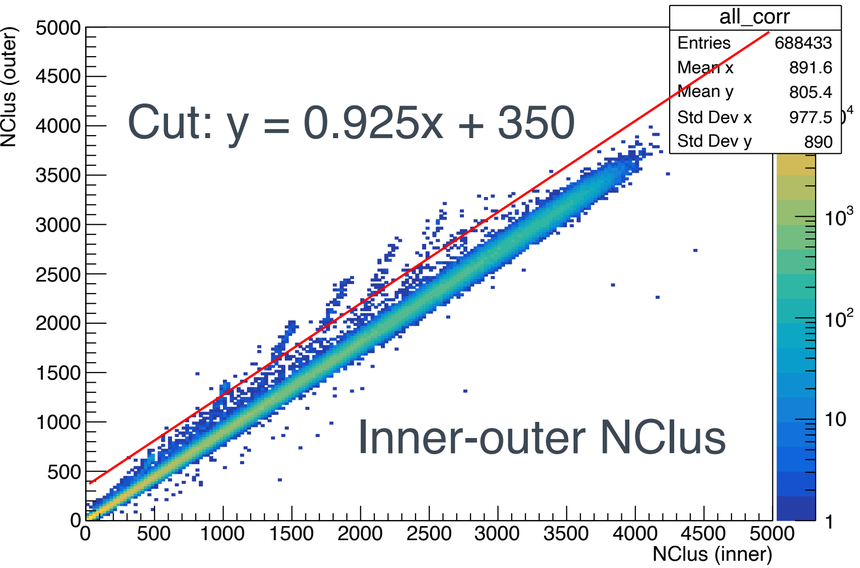
Inner-outer NInttHits

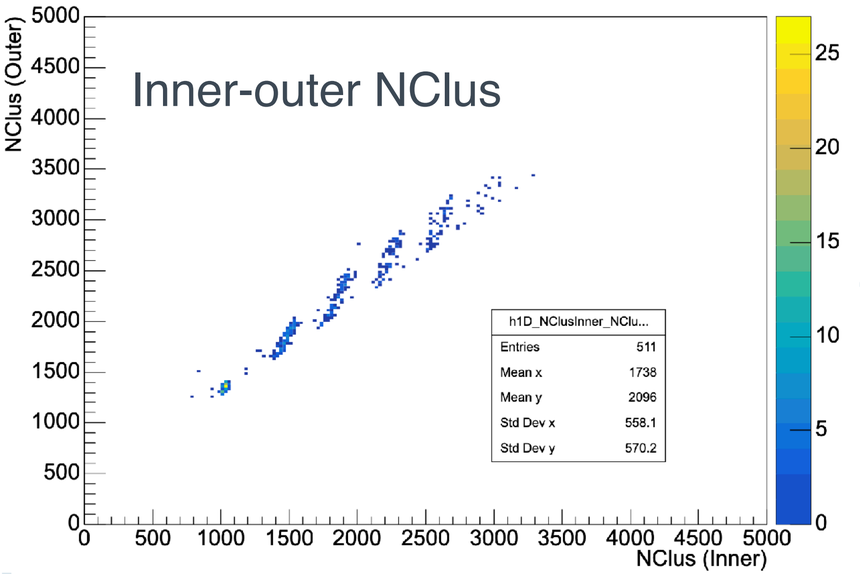


Selection

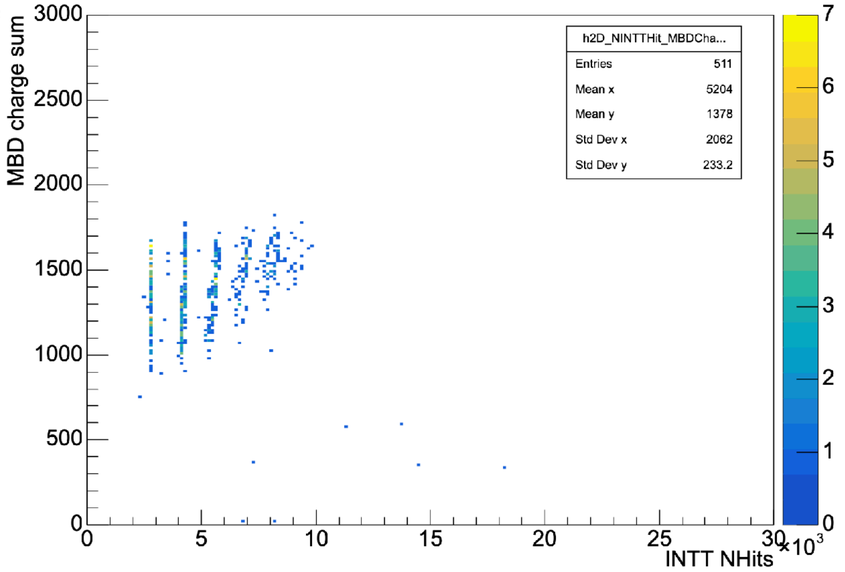
Run 54280

Only focus on the pure events of interest, the off-diagonal entries (entries above the slope cut)

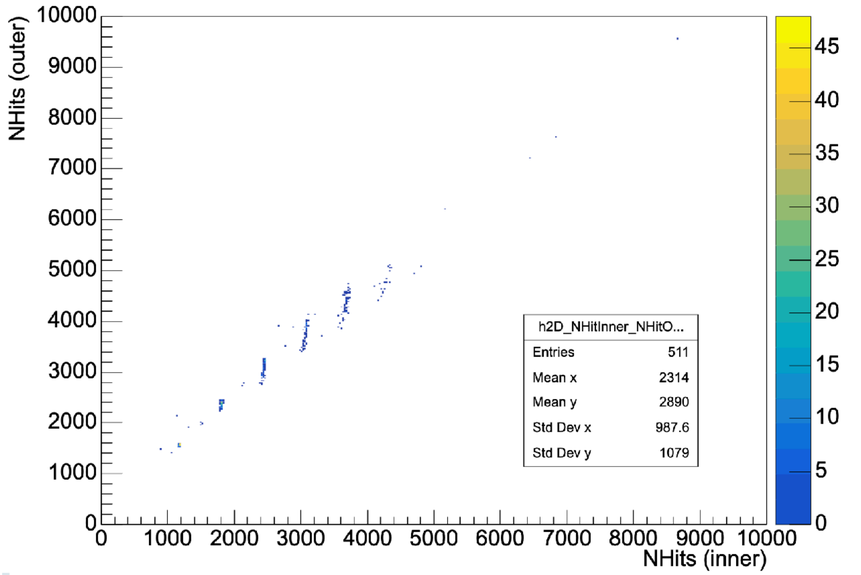




INTTNInttHits vs MBD charge



Inner-outer NInttHits



Procedures to move hits back

- In each half-ladder, the sequence of the listed hits should correspond to process sequence in FELIX
- The carried-over hits should appear in the very beginning of the file for each half-ladder
  - If **THIS_event** is truncated by the **NEXT_event** trigger while **THIS_event** hits are still being sent to FELIX, the **THIS_event** hits associated with the **NEXT_event** trigger will be saved to disk before the **NEXT_event** hits associated with the **NEXT_event** trigger coming to FELIX
- Procedures:
  - Check the **NEXT_event** of the EOI, half-ladder by half-ladder
  - In each half-ladder of **NEXT_event**, starting from the first hit, count the number of hits with hit_bco identical to the trigger hit_bco of **THIS_event**
  - Stop counting and move to the next half-ladder if the checked hit has hit_bco different from the trigger hit_bco of **THIS_event**

Example: event 2452

Event 2452 (EOI, the THIS_event), triggered hit_bco = 43

Hit_bco

```
root [3] chain->Scan("InttRawHit_bco:InttRawHit_packetid:InttRawHit_fee:InttRawHit_chip_id:InttRawHit_channel_id:InttRawHit_adc:InttRawHit_FPHX_BCO","Entry$>=2452","colsize=20",10000)
************************************************************************************************************************************************************
*    Row   * Instance *       InttRawHit_bco * InttRawHit_packetid *       InttRawHit_fee *   InttRawHit_chip_id * InttRawHit_channel_i *       InttRawHit_adc * InttRawHit_FPHX_BCO *
************************************************************************************************************************************************************
*     2452 *        0 *  1029942106868 *                3001 *                  13 *                   5 *                  58 *                   0 *                  43 *
*     2452 *        1 *  1029942106868 *                3001 *                  13 *                   6 *                  81 *                   1 *                  43 *
*     2452 *        2 *  1029942106868 *                3001 *                  13 *                   6 *                  82 *                   2 *                  43 *
*     2452 *        3 *  1029942106868 *                3001 *                  13 *                   7 *                  23 *                   3 *                  43 *
*     2452 *        4 *  1029942106868 *                3001 *                  13 *                   8 *                  98 *                   5 *                  43 *
*     2452 *        5 *  1029942106868 *                3001 *                  13 *                  23 *                  33 *                   1 *                  43 *
*     2452 *        6 *  1029942106868 *                3001 *                  13 *                  14 *                  63 *                   7 *                  43 *
*     2452 *        7 *  1029942106868 *                3001 *                  13 *                  23 *                 114 *                   7 *                  43 *
*     2452 *        8 *  1029942106868 *                3001 *                  13 *                  15 *                 112 *                   6 *                  43 *
*     2452 *        9 *  1029942106868 *                3001 *                  13 *                  24 *                  91 *                   2 *                  43 *
*     2452 *       10 *  1029942106868 *                3001 *                  13 *                  16 *                   8 *                   5 *                  43 *
*     2452 *       11 *  1029942106868 *                3001 *                  13 *                  25 *                 113 *                   1 *                  43 *
*     2452 *       12 *  1029942106868 *                3001 *                  13 *                  16 *                  21 *                   5 *                  43 *
*     2452 *       13 *  1029942106868 *                3001 *                  13 *                  26 *                  44 *                   0 *                  43 *
*     2452 *       14 *  1029942106868 *                3001 *                  13 *                  10 *                  74 *                   4 *                  43 *
```

Event 2453 (the NEXT_event)

Hit_bco

```
root [4] chain->Scan("InttRawHit_bco:InttRawHit_packetid:InttRawHit_fee:InttRawHit_chip_id:InttRawHit_channel_id:InttRawHit_adc:InttRawHit_FPHX_BCO","Entry$>=2453","colsize=20",10000)
************************************************************************************************************************************************************
*    Row   * Instance *       InttRawHit_bco * InttRawHit_packetid *       InttRawHit_fee *   InttRawHit_chip_id * InttRawHit_channel_i *       InttRawHit_adc * InttRawHit_FPHX_BCO *
************************************************************************************************************************************************************
*     2453 *        0 *  1029942106894 *                3003 *                   0 *                  35 *                  23 *                   2 *                  43 *
*     2453 *        1 *  1029942106894 *                3003 *                   0 *                  45 *                  22 *                   2 *                  43 *
*     2453 *        2 *  1029942106894 *                3003 *                   0 *                  38 *                  19 *                   3 *                  43 *
*     2453 *        3 *  1029942106894 *                3003 *                   0 *                  27 *                  41 *                   0 *                  43 *
*     2453 *        4 *  1029942106894 *                3003 *                   0 *                  46 *                  89 *                   1 *                  43 *
*     2453 *        5 *  1029942106894 *                3003 *                   0 *                  29 *                  42 *                   3 *                  69 *
*     2453 *        6 *  1029942106894 *                3003 *                   0 *                  29 *                  94 *                   3 *                  69 *
*     2453 *        7 *  1029942106894 *                3003 *                   1 *                  48 *                  29 *                   2 *                  43 *
*     2453 *        8 *  1029942106894 *                3003 *                   1 *                  33 *                  60 *                   2 *                  43 *
*     2453 *        9 *  1029942106894 *                3003 *                   1 *                  48 *                  39 *                   2 *                  43 *
*     2453 *       10 *  1029942106894 *                3003 *                   1 *                  37 *                  47 *                   3 *                  43 *
*     2453 *       11 *  1029942106894 *                3003 *                   1 *                  45 *                  67 *                   2 *                  69 *
*     2453 *       12 *  1029942106894 *                3003 *                   1 *                  47 *                  12 *                   5 *                  69 *
*     2453 *       13 *  1029942106894 *                3003 *                   1 *                  51 *                  13 *                   3 *                  69 *
*     2453 *       14 *  1029942106894 *                3003 *                   1 *                  45 *                  68 *                   7 *                  69 *
*     2453 *       15 *  1029942106894 *                3003 *                   1 *                  47 *                  13 *                   0 *                  69 *
```

FELIX: 3003 & fee: 0

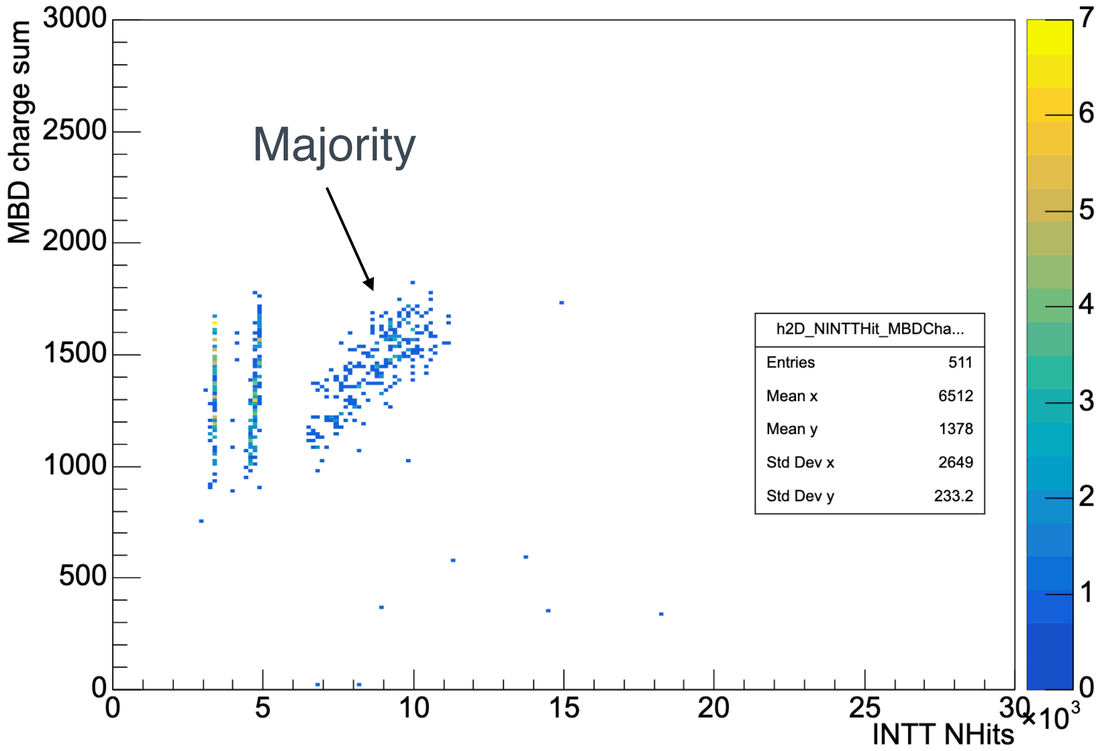
Carried-over hits from event 2452

FELIX: 3003 & fee: 1

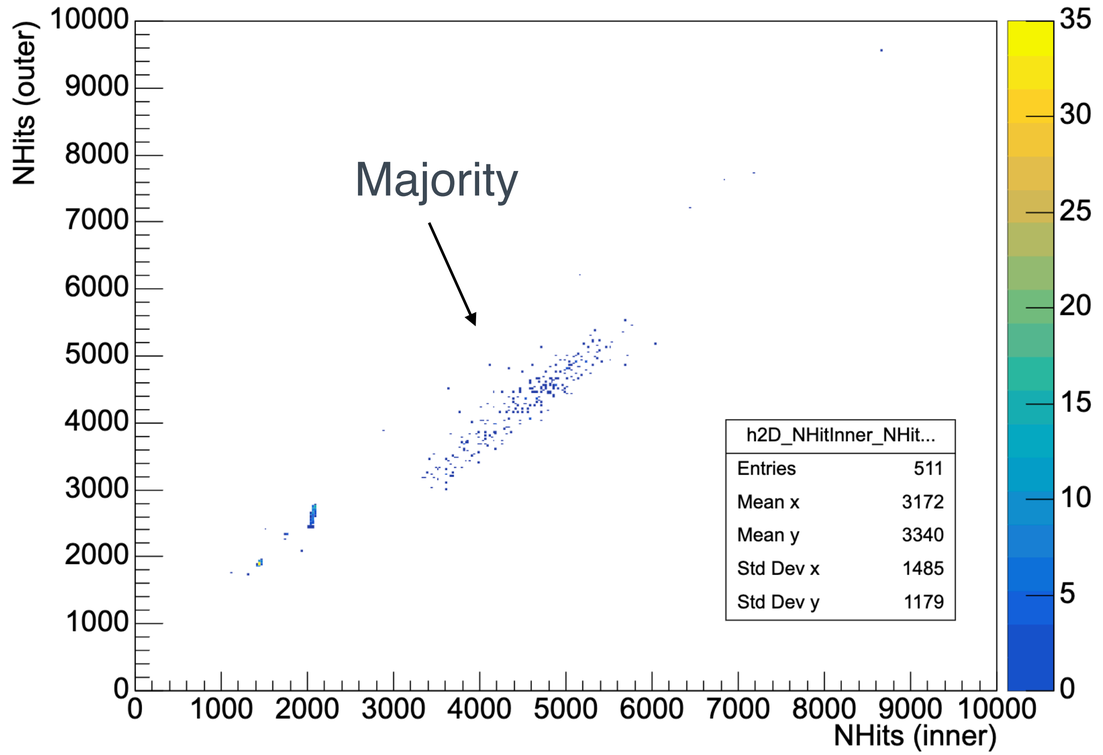
Carried-over hits from event 2452

Results

INTTNInttHits vs MBD charge



Inner-outer NInttHits

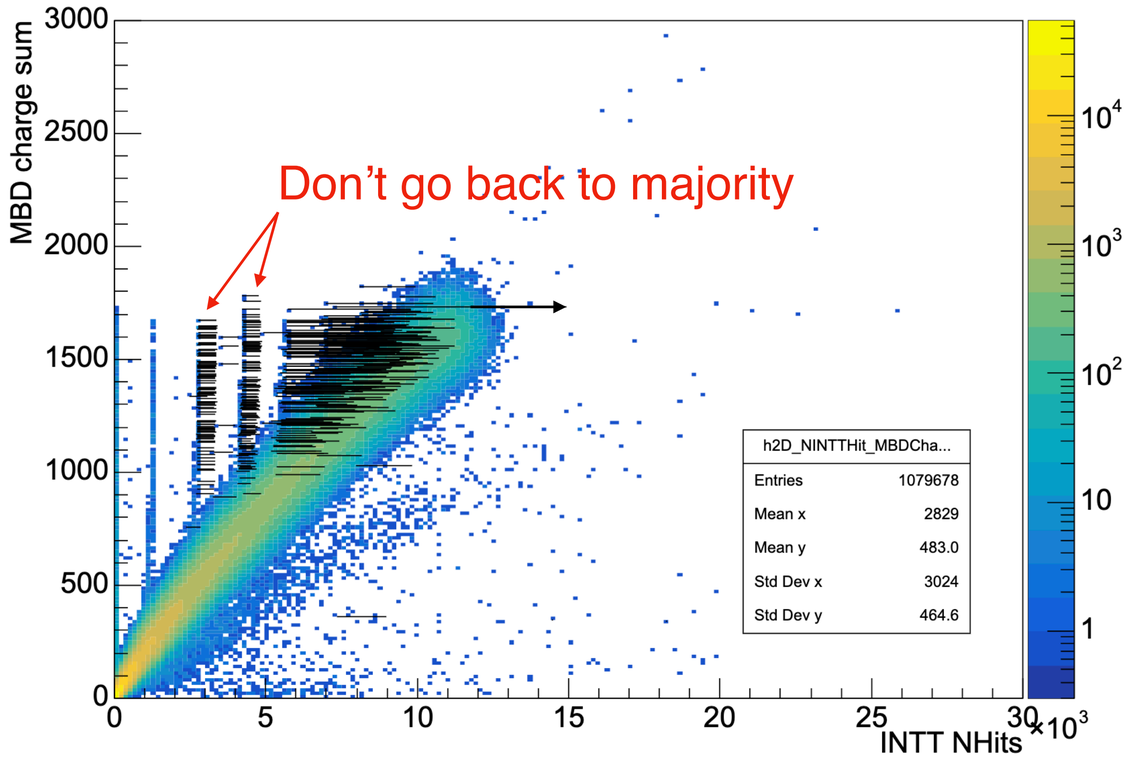


This method works for some of events 😨😱

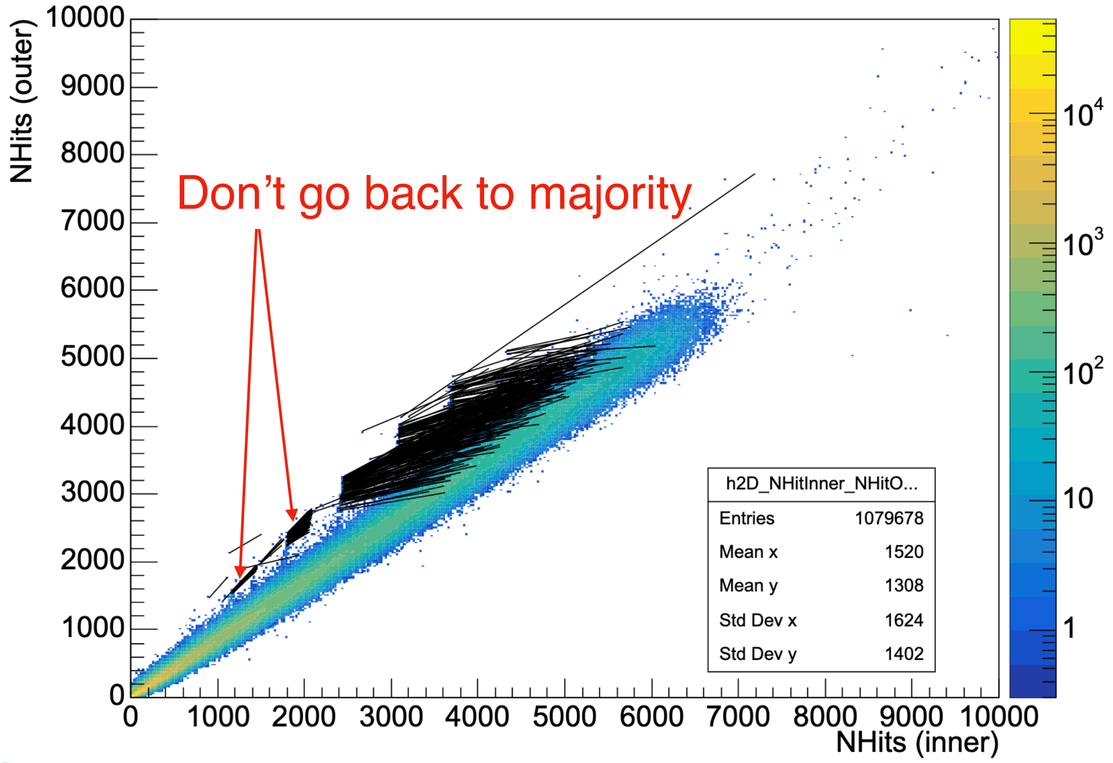
Results

Lines indicate the locations of EOIs, and the new locations after moving hits from **NEXT_event** back

INTTNInttHits vs MBD charge

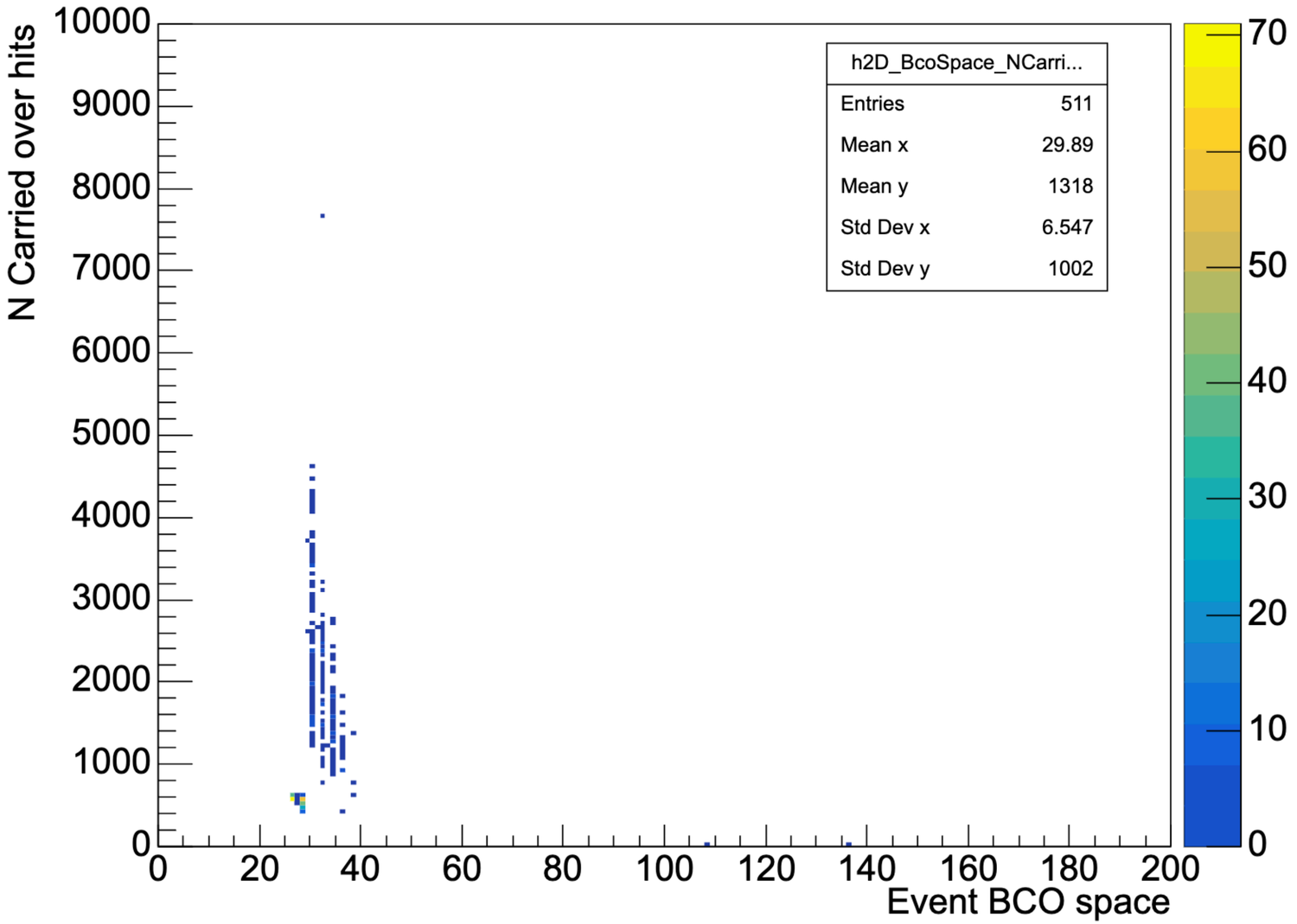


Inner-outer NInttHits

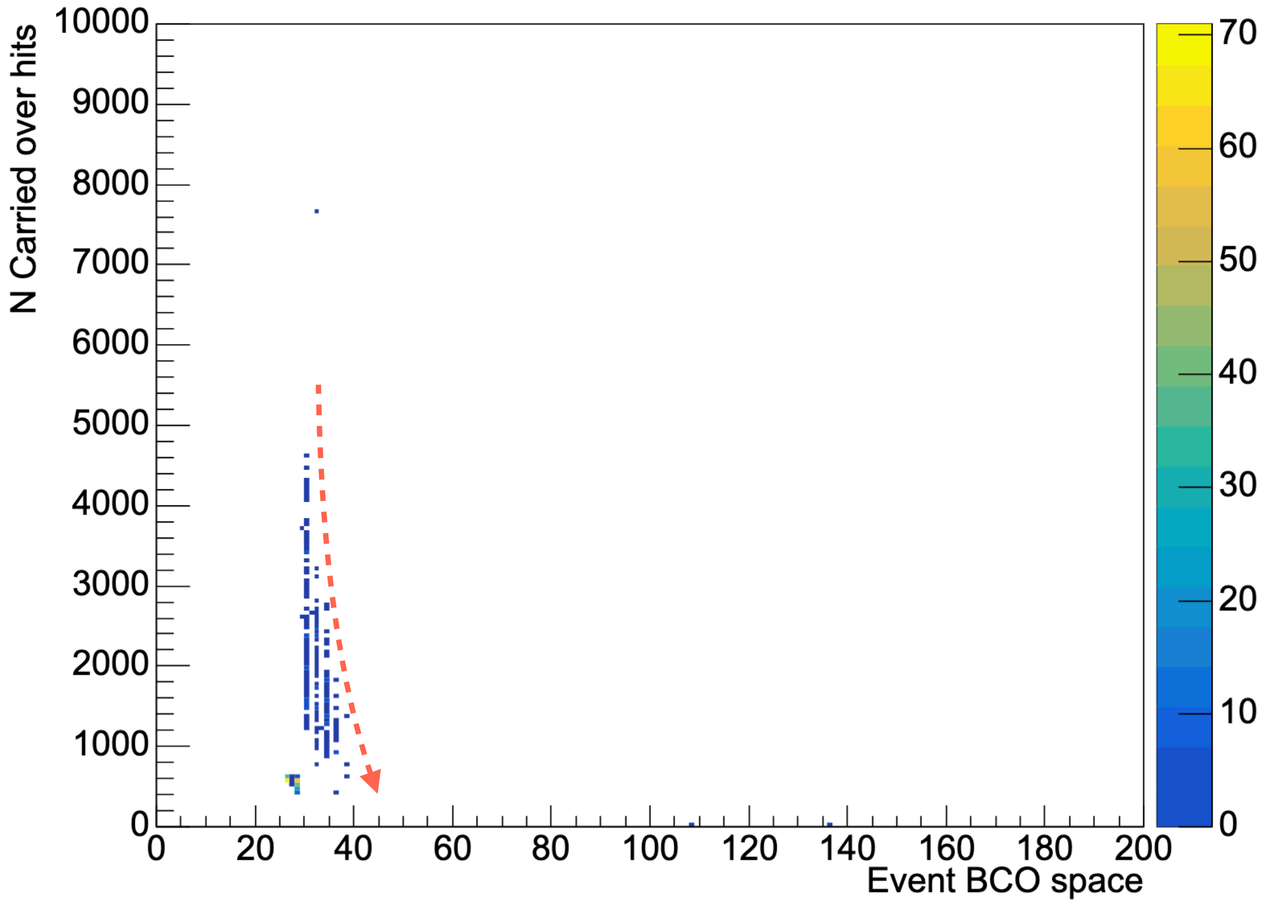


This method works for some of events 😨😱

Results

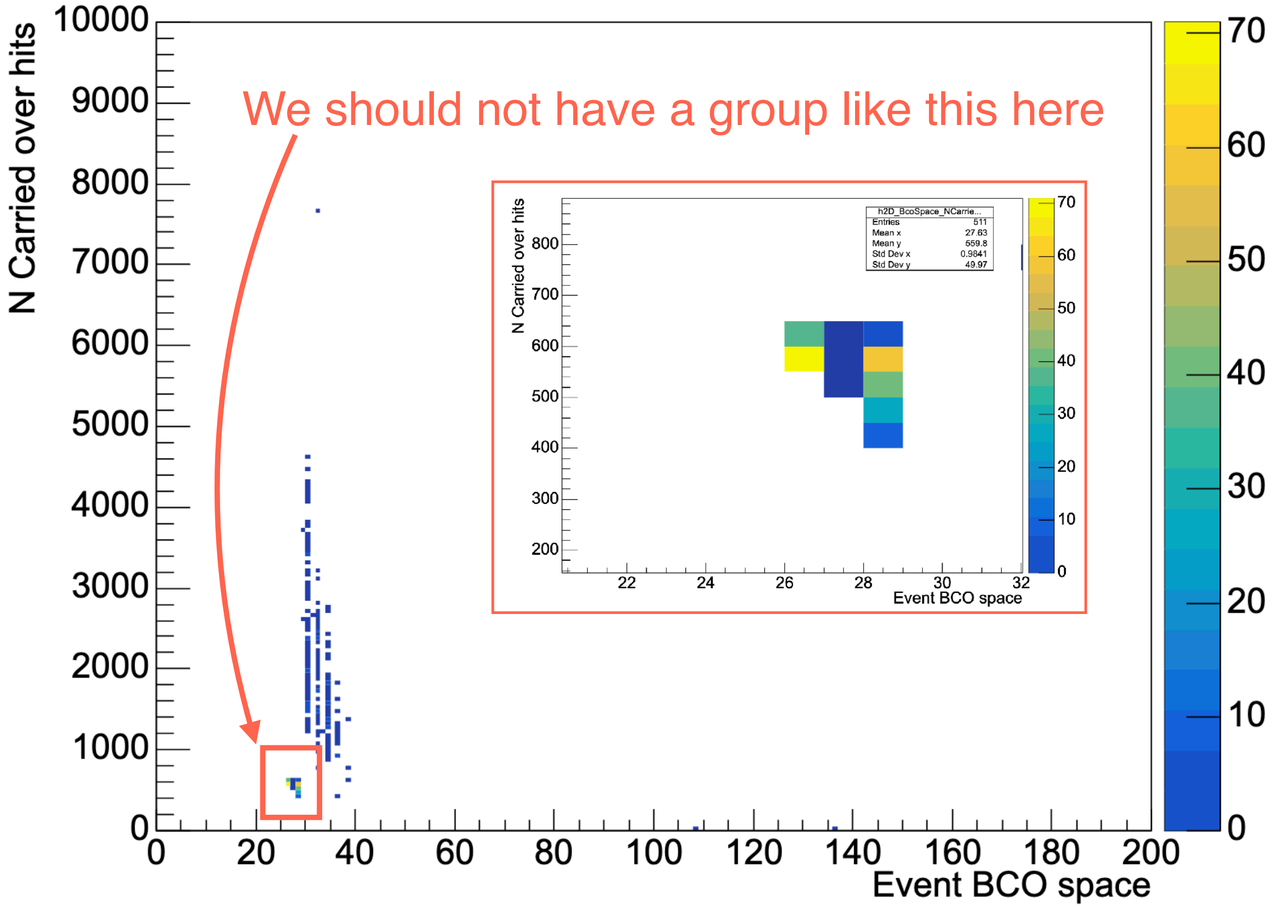

h2D_BcoSpace_NCarri...
Entries 511
Mean x 29.89
Mean y 1318
Std Dev x 6.547
Std Dev y 1002
N Carried over hits
Event BCO space
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
0
20
40
60
80
100
120
140
160
180
200
0
10
20
30
40
50
60
70

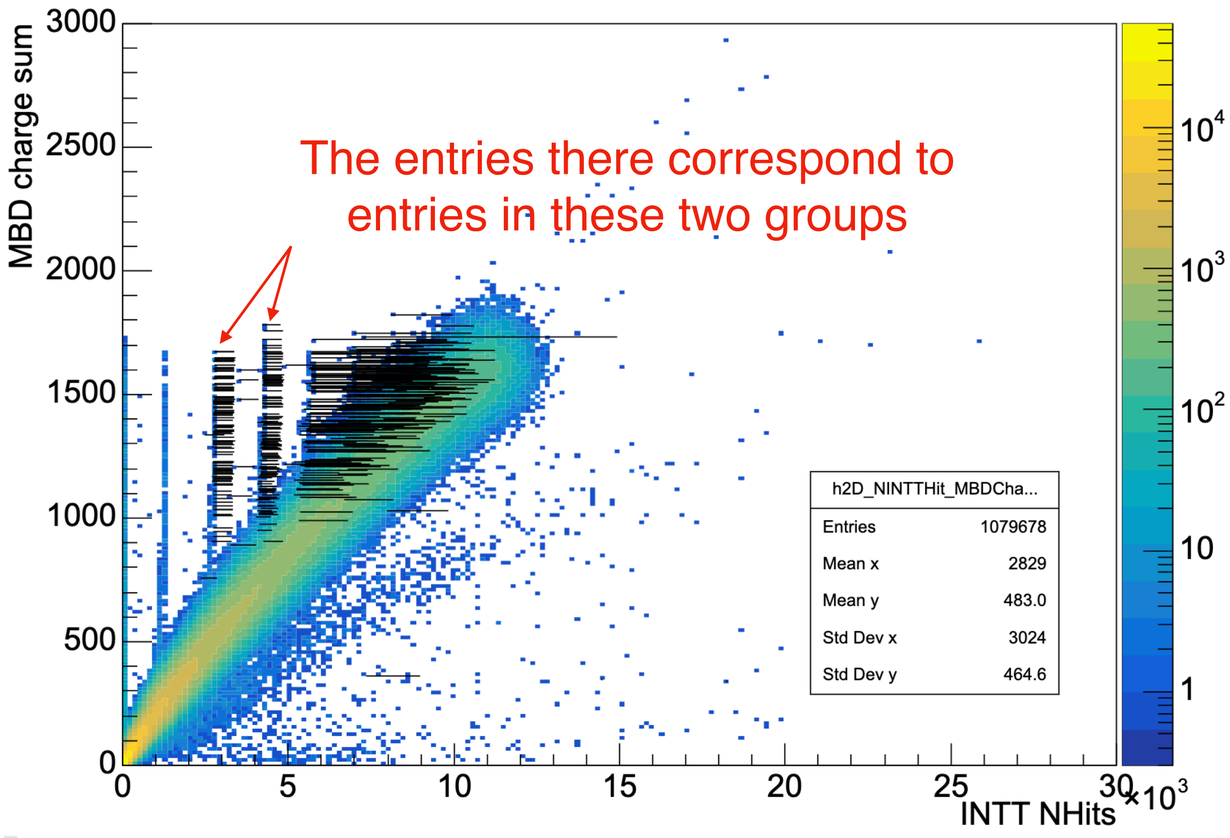
Results



This contour seems reasonable. Longer event BCO space leads to longer time for FELIX to process THIS_event, resulting in less number of carried-over hits

Results

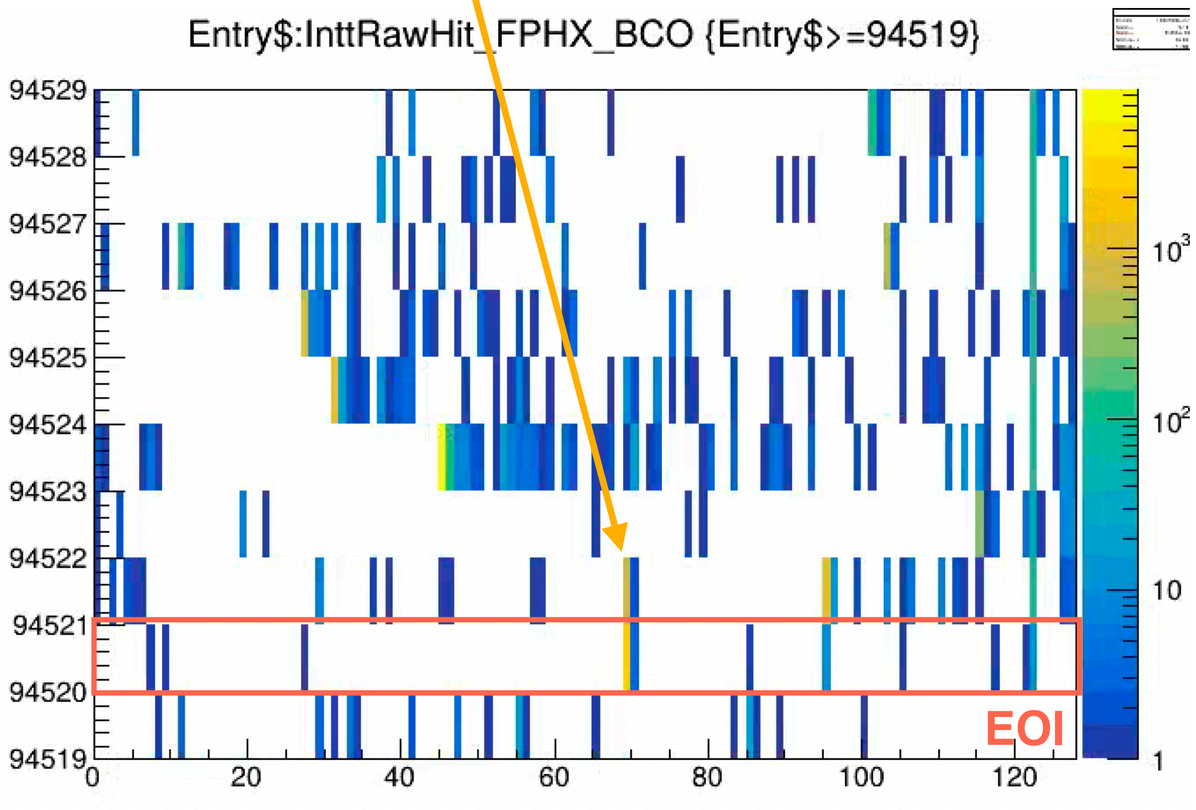


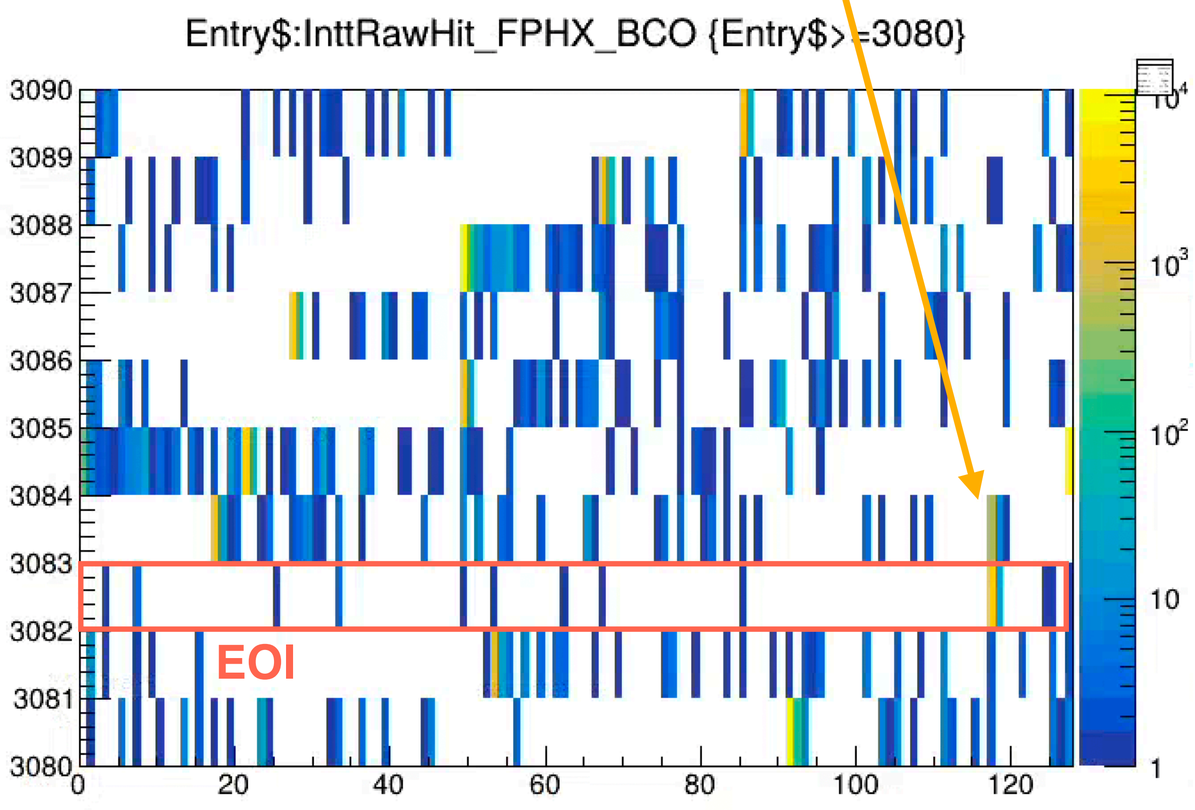


They do have hits carried over to the their next events, but the amount is not enough to recover them back to majority (Could possibly be due to the ncollision=100)

Event display, hit_bco vs EventID

X axis: hit_bco (0 - 127)
Y axis: EventID





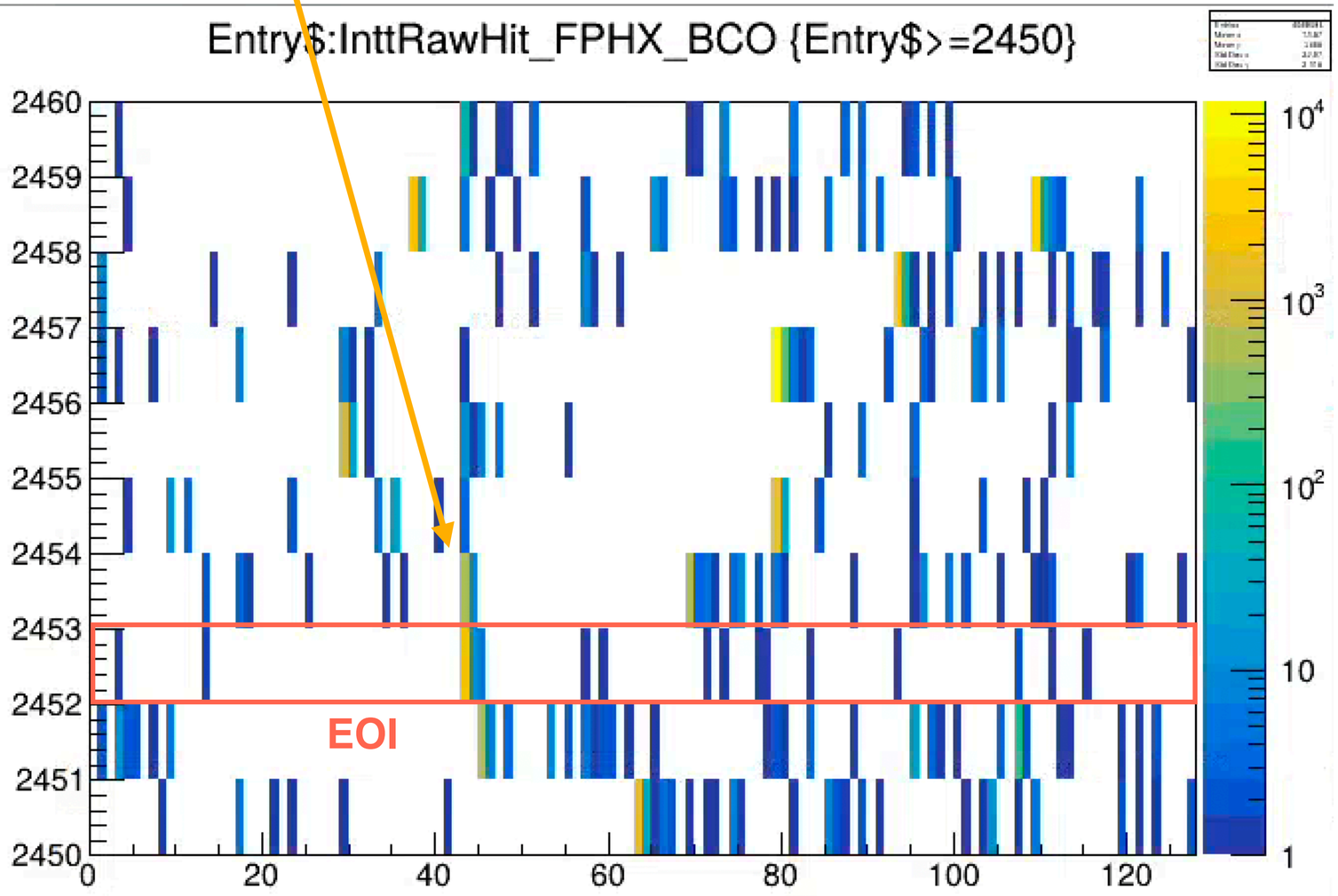
Throughout the preceding 10 events, there is no more carried-over-like hit

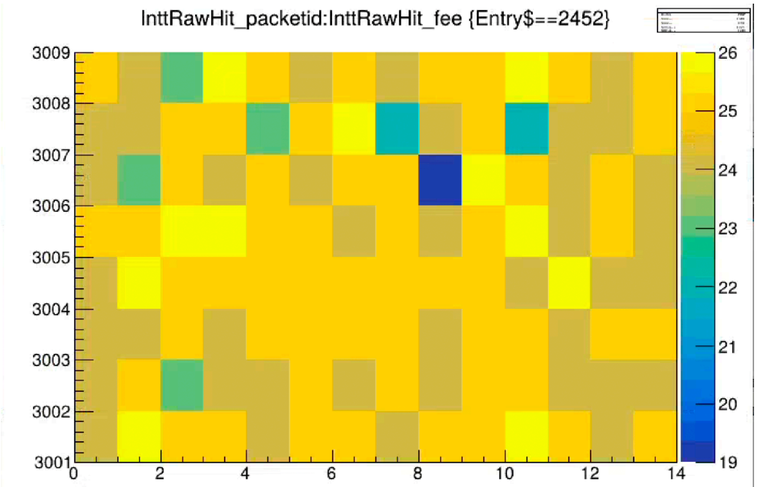
We have events with carried-over hit issue that cannot be fully recovered. It seems that the hits are just not in the file (Could possibly be due to the ncollision=100)

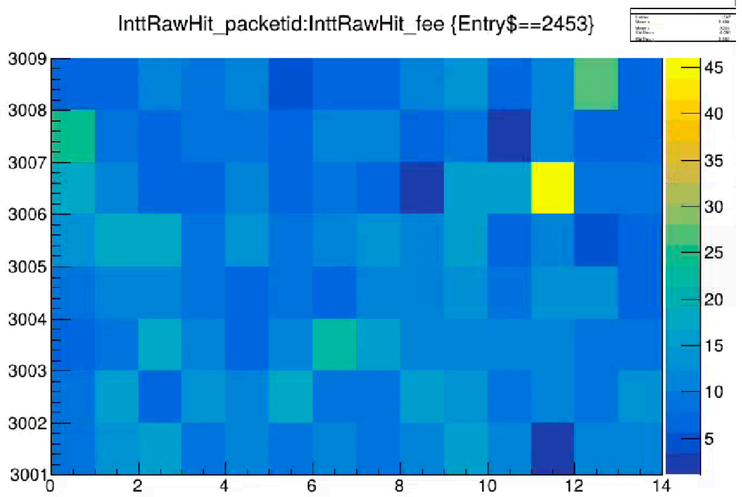
Event display, hit_bco vs EventID

Carried over hits

X axis: hit_bco (0 - 127), Y axis: EventID







The FELIXs are working just fine

We have events with carried-over hit issue that cannot be fully recovered. It seems that the hits are just not in the file (Could possibly be due to the ncollision=100)

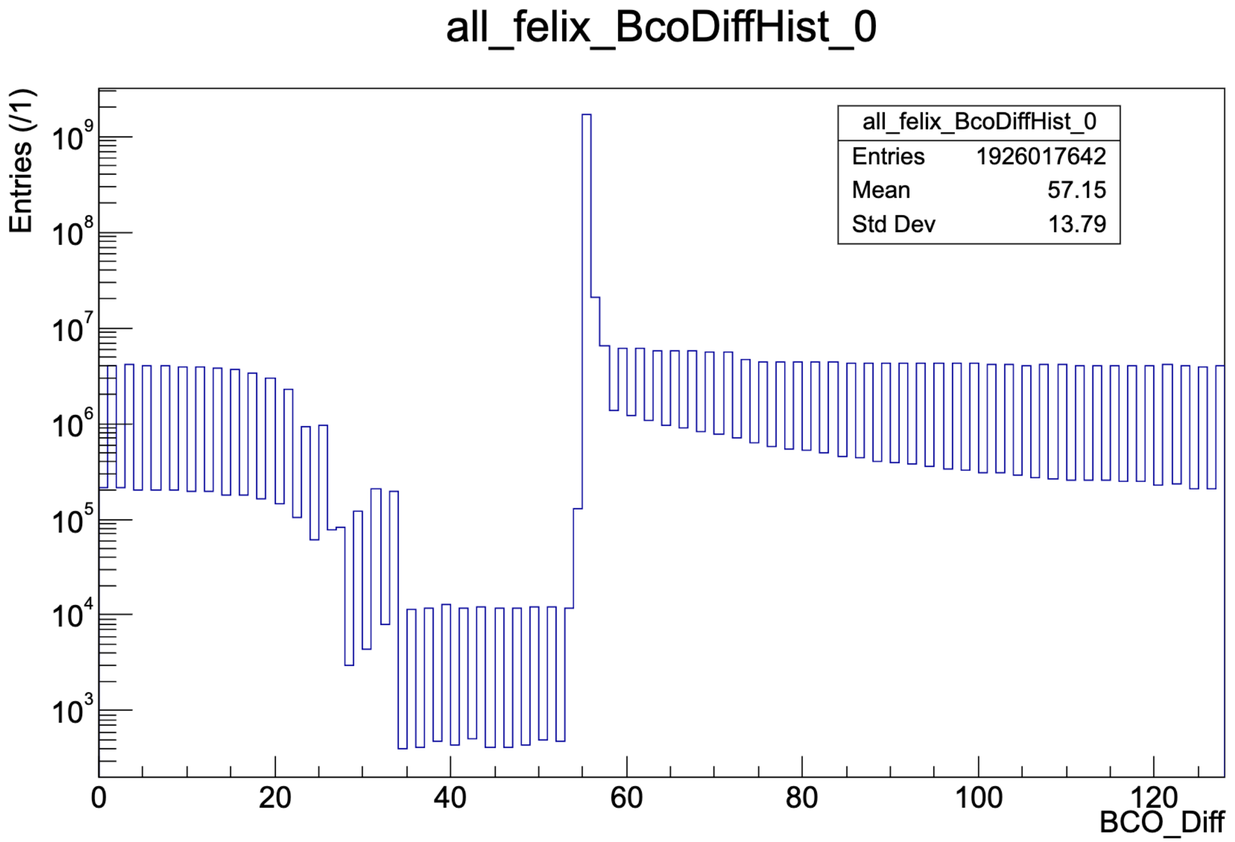
The module prepared for INTT run25 commissioning

- https://github.com/ChengWeiShih/INTT/tree/main/general_codes/CWShih/INTTRawHitSanityCheck

- Features:
  - Reads INTTRawHit DST (GL1Packet required for background rejection)
  - Options for HitQA, bad-channel mask and clone hit removal

- Outputs
  - TH1D : BcoDiff distribution (each server)
  - TH2D : NInttRawHit_inner vs NInttRawHit_outer (Triggered BcoDiff spike location required)
  - TH1D : Cluster Phi Size (single chip)
  - TH1D : NInttHit (per chip and per BCO)
  - TH2D : INTT spike content ratio vs NINTTRawHit (Triggered BcoDiff spike location required)
  - A ROOT TTree of INTTRawHit ntuple

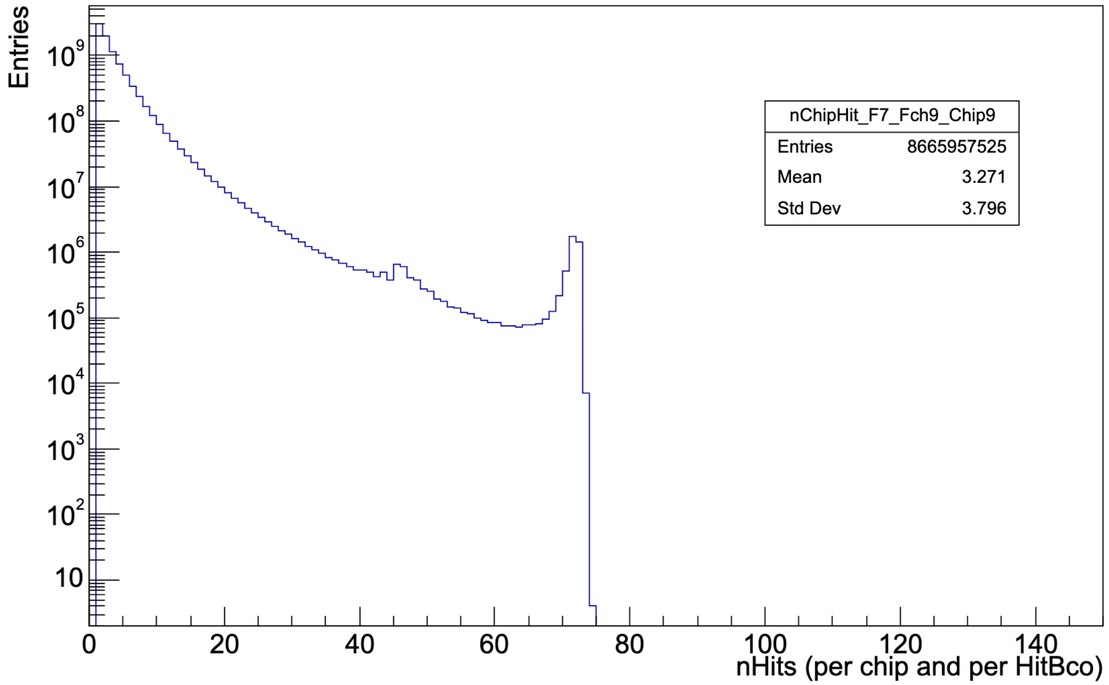
INTT BcoDiff distribution



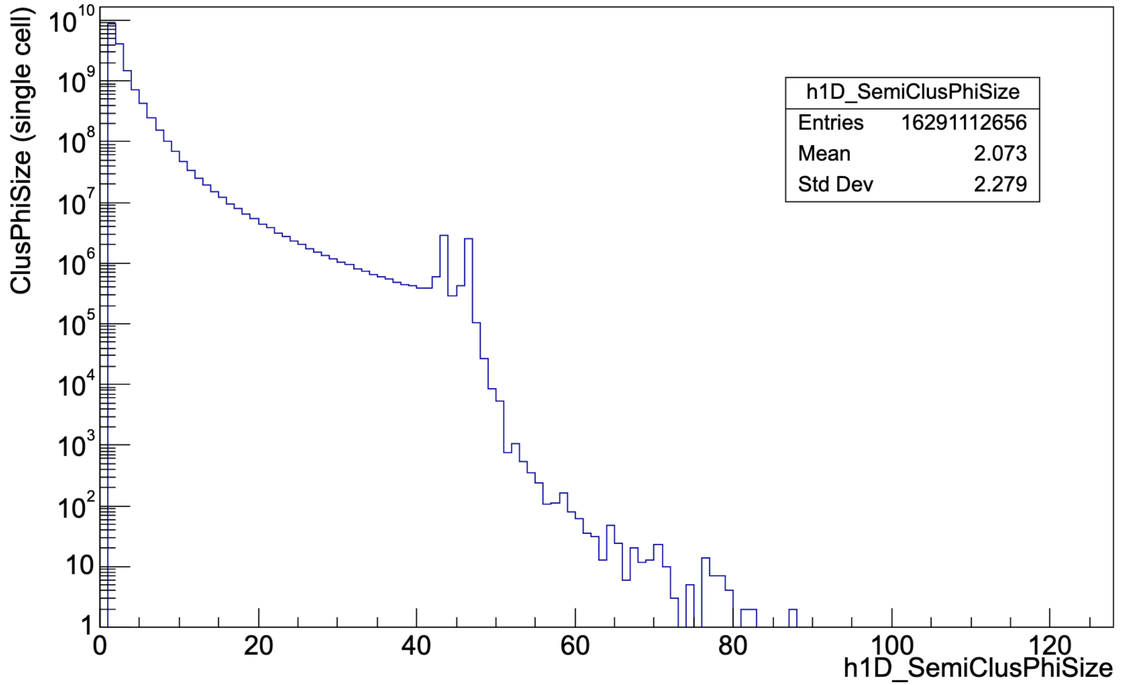
Server by server

For chip saturation issue

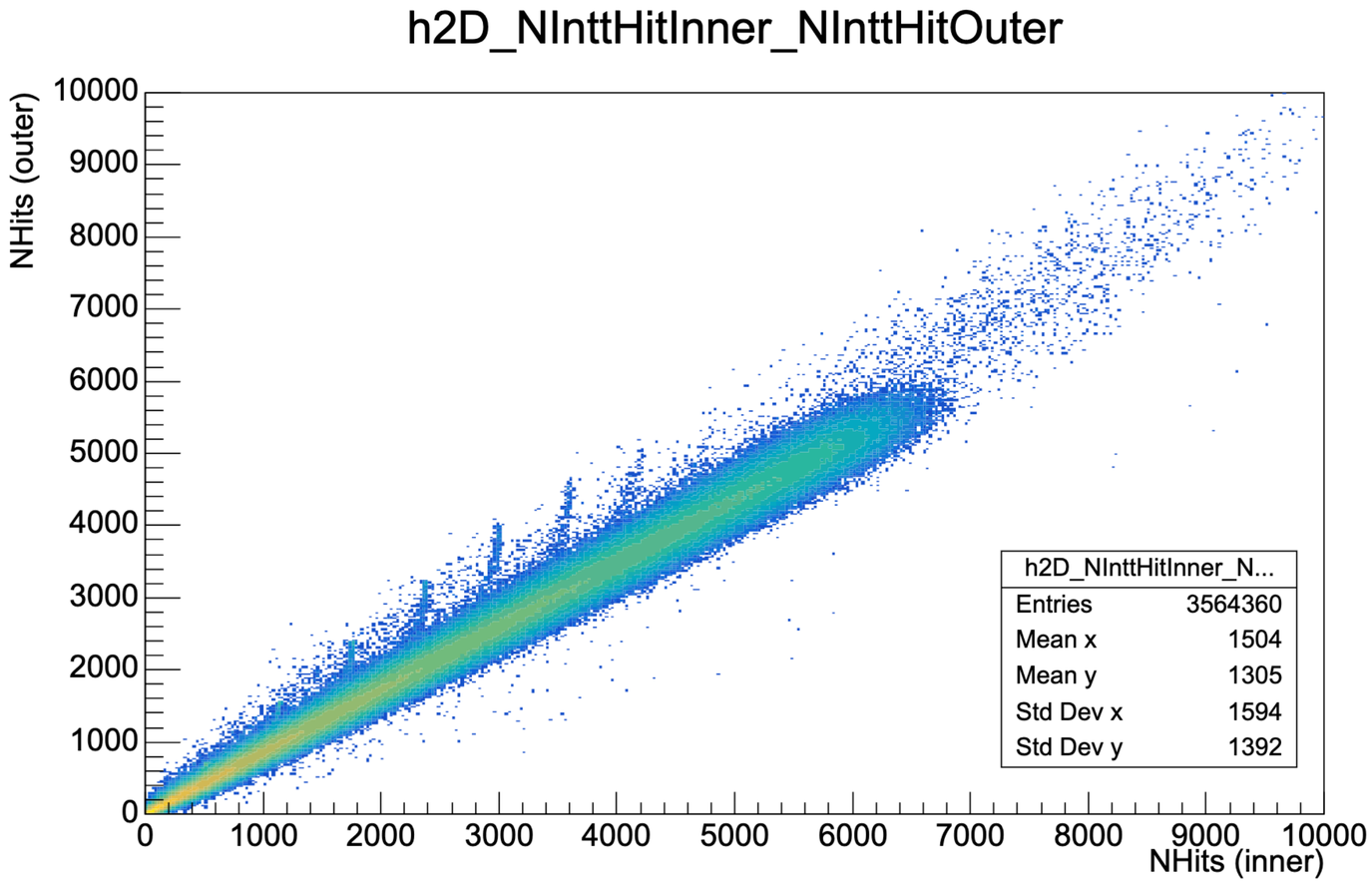
NInttHit distribution (per chip and per BCO)



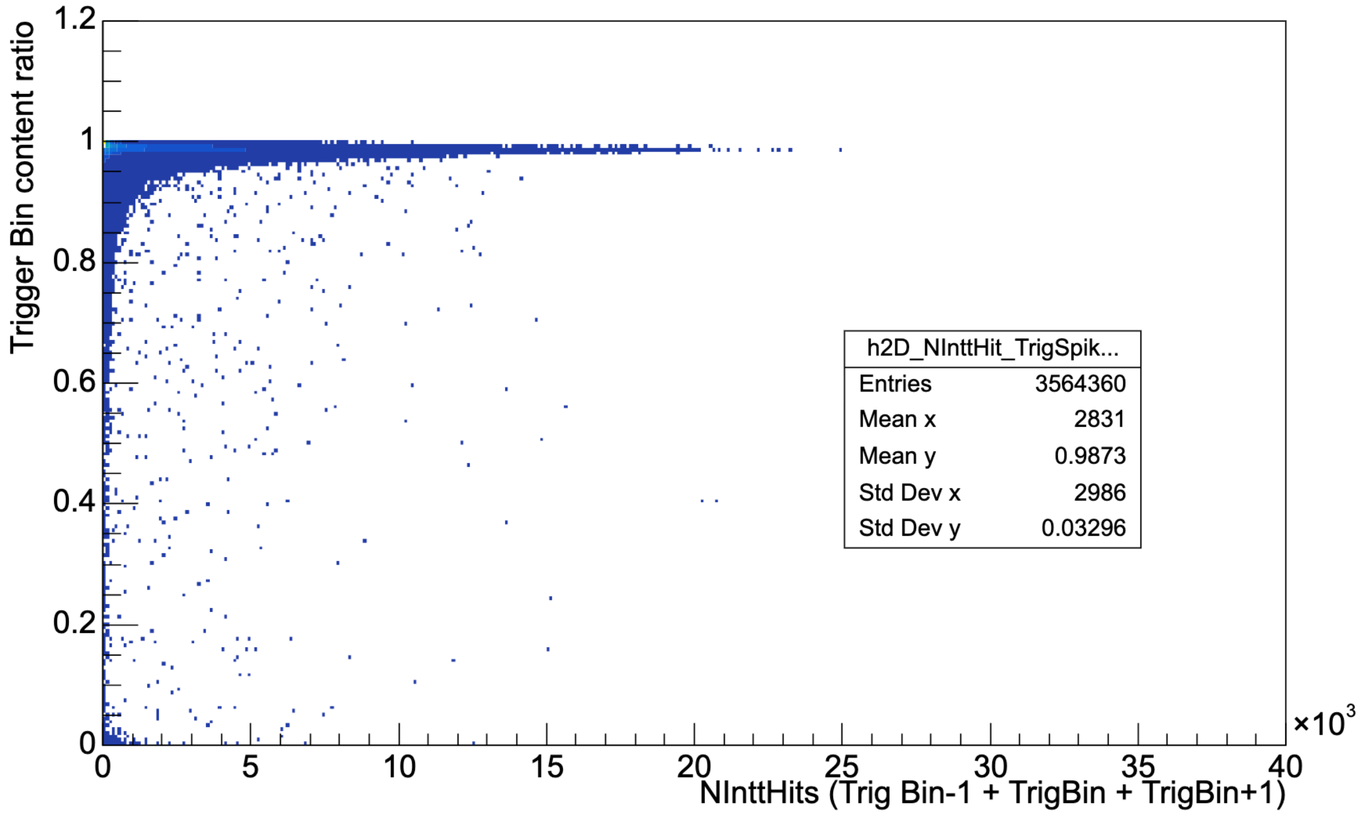
Cluster phi size distribution (per chip and per bco)



For carried-over hit issue



For the quick check of INTT timing



Conclusion

- This is the first time that one tries to move the carried-over hits back to where they should be in the INTT group since 2023, when the issue was discovered
- The idea is that the carried-over hits should appear in the very beginning of the file for each half-ladder
- This method works for some of the events (around half of problematic events)
- We have events with carried-over hit issue that cannot be fully recovered. It seems that the hits are just not in the file
  - Could be due to ncollision=100
- It's actually possible that the hits can be carried-over to the next next event (or event next next next one)
  - Imaging the scenario: 20k hits, with event bco space of the preceding two events 17 BCOs and 20 BCOs
- A module is prepared for INTT Run25 commissioning
- In Run25 (or event Run24), we need a module to move hits back after decoding and before INTTRawHit DST production
- We need to have a special run with the condition
  - ncollision=127 & open_time=127, and in high trigger rate
  - Streaming with Au+Au collisions

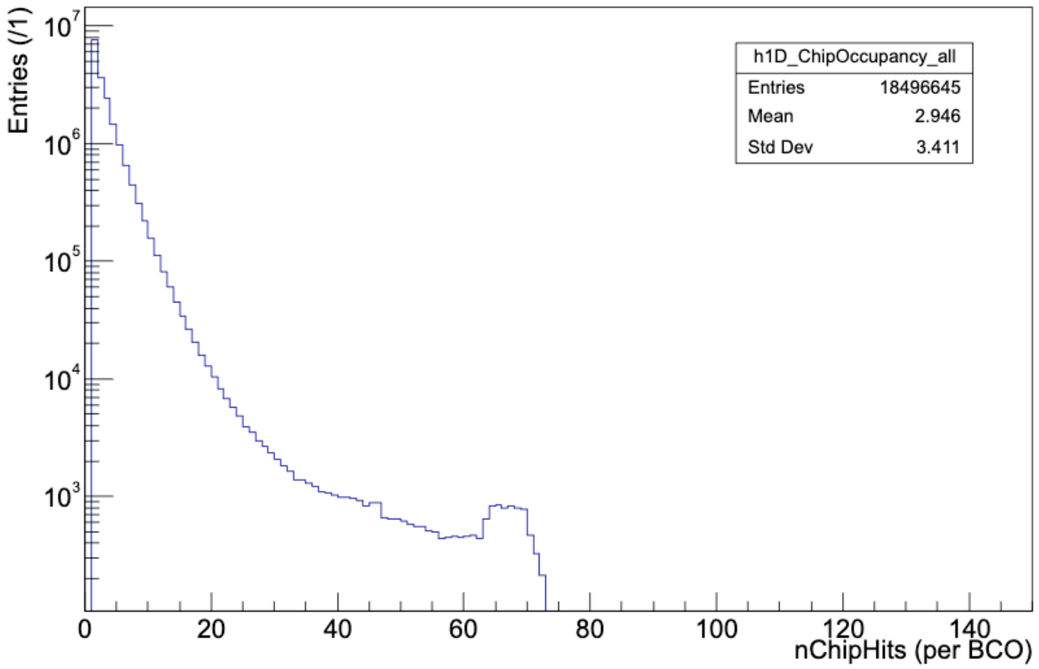
Learnt from Raul

- The unit of FELIX open_time is 2 BCOs, so we were actually running with open_time of 120 BCOs
  - But the open_time is for the whole half-ladder, not just a certain chip. From chips to ROC, all chips have their own signal lines, but from ROC to FELIX, there is just one output for one half-ladder. This explains why we still see the the cutoff in a run with open_time set to 128 (128 * 2 BCOs for all 3328 channels)
- Raul is also not sure why we still see few entries in the FELIX dead-time region
  - Can be from the “previous” buffer..? One can check what events have hits in that region (event index)
- In the streaming readout mode with Au+Au collisions
  - We know the strobe length is set to 120 BCOs
  - The timestamp (hit_bco) is reset in the abort gap region
  - If a trigger event with lots of hits occurs at “hit_bco of 118”, three scenarios could happen
    - The hits are carried-over to the next strobe (the F4A event) with their original hit_bco
    - The hits are carried-over to the next strobe (the F4A event) with hit_bco reset to 0
    - The hits are just gone
  - We need to do the test in the commissioning period
    - We just take the Au+Au collision data with our nominal streaming readout setting used in p+p
    - We could artificially make the timestamp reset happen at some where in the middle of the strobe
      - To decompose the issues, abort gap region, and the timestamp reset
      - Require 111 x 111 bunch crossings for this one
      - Raul can help to set up this

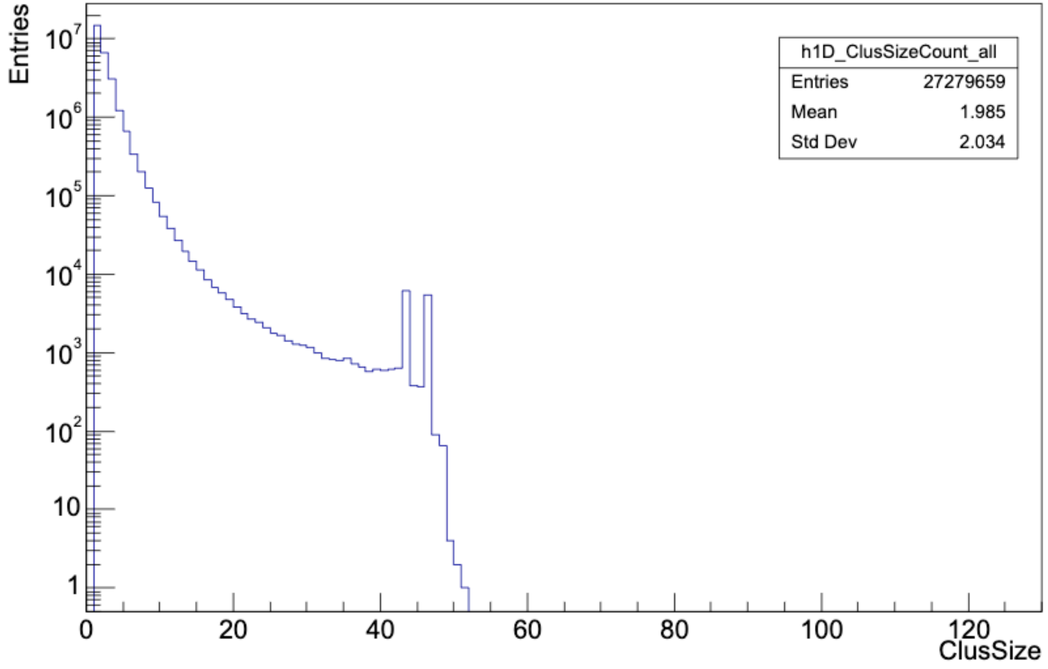
Back up

Additional check - run 8020

nChipHits per BCO of all chips



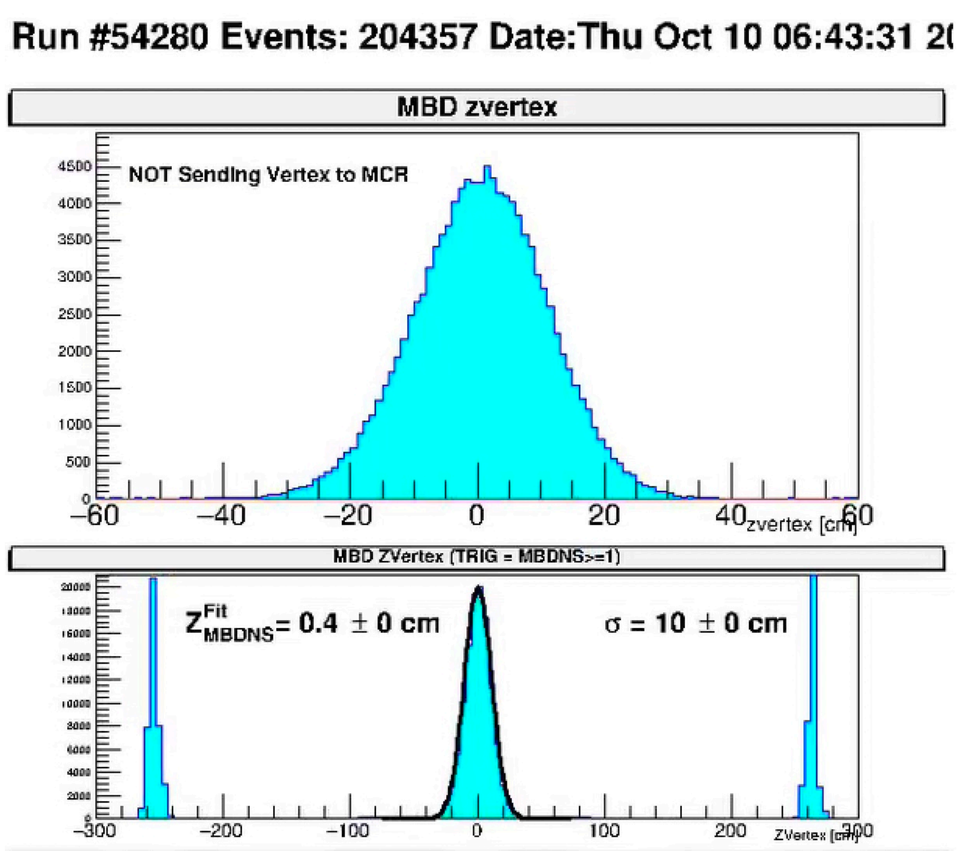
Cluster phi size of all chips



Setting open_time to 127 seems able to mitigate the saturation issue
The two spikes in the cluster phi size distribution still exist → other sources contributing to this?
We should still try to do the open_time scan in the beginning of run25

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



Trigger input channel	Name	enabled	Scaledown	Raw	Live <\div>	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