Silicon seed study

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INTT meeting

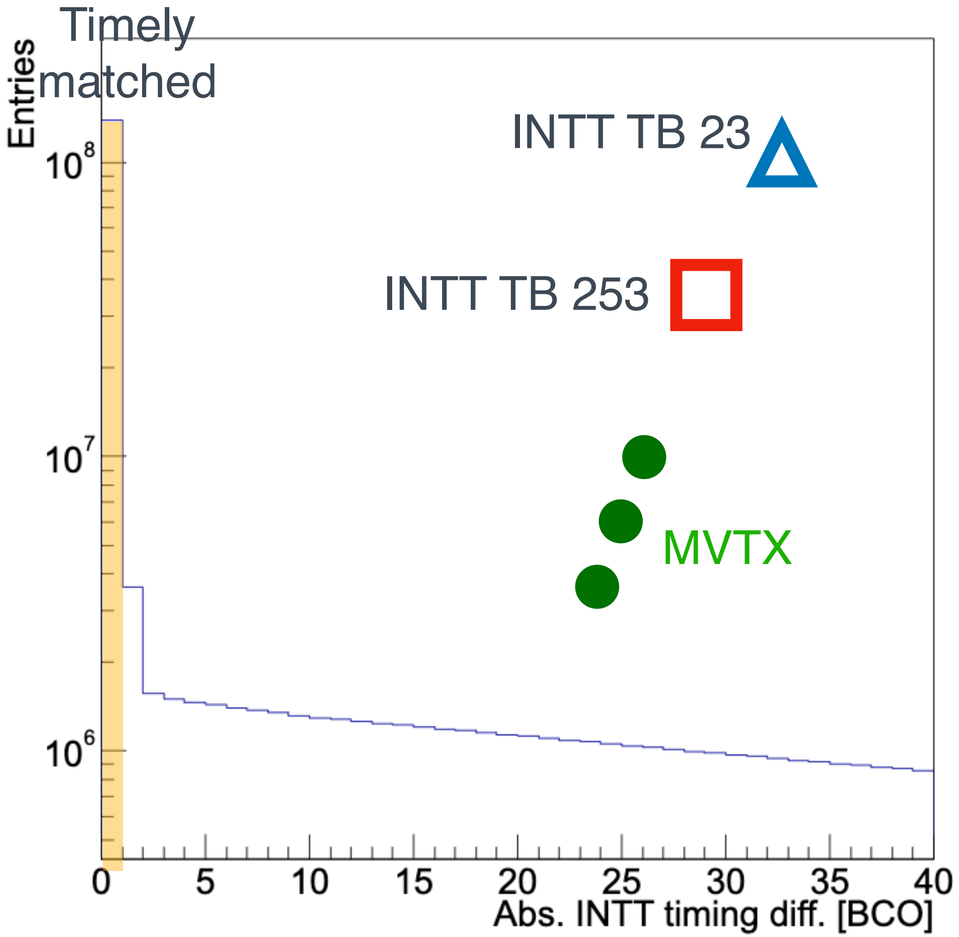
sPHENIX

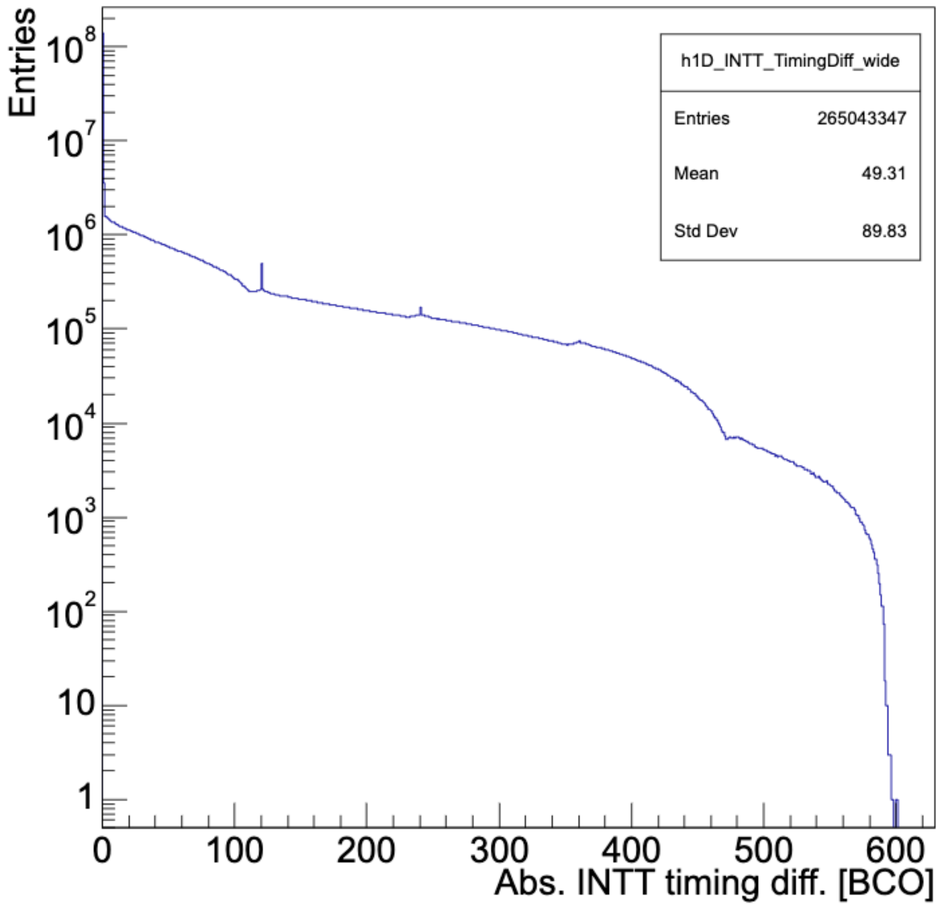
國立中央大學
National Central University

RIKEN

Timebucket difference of the INTT clusters in a silicon seed

The timebucket difference of the INTT clusters in a silicon seed, with different histogram ranges

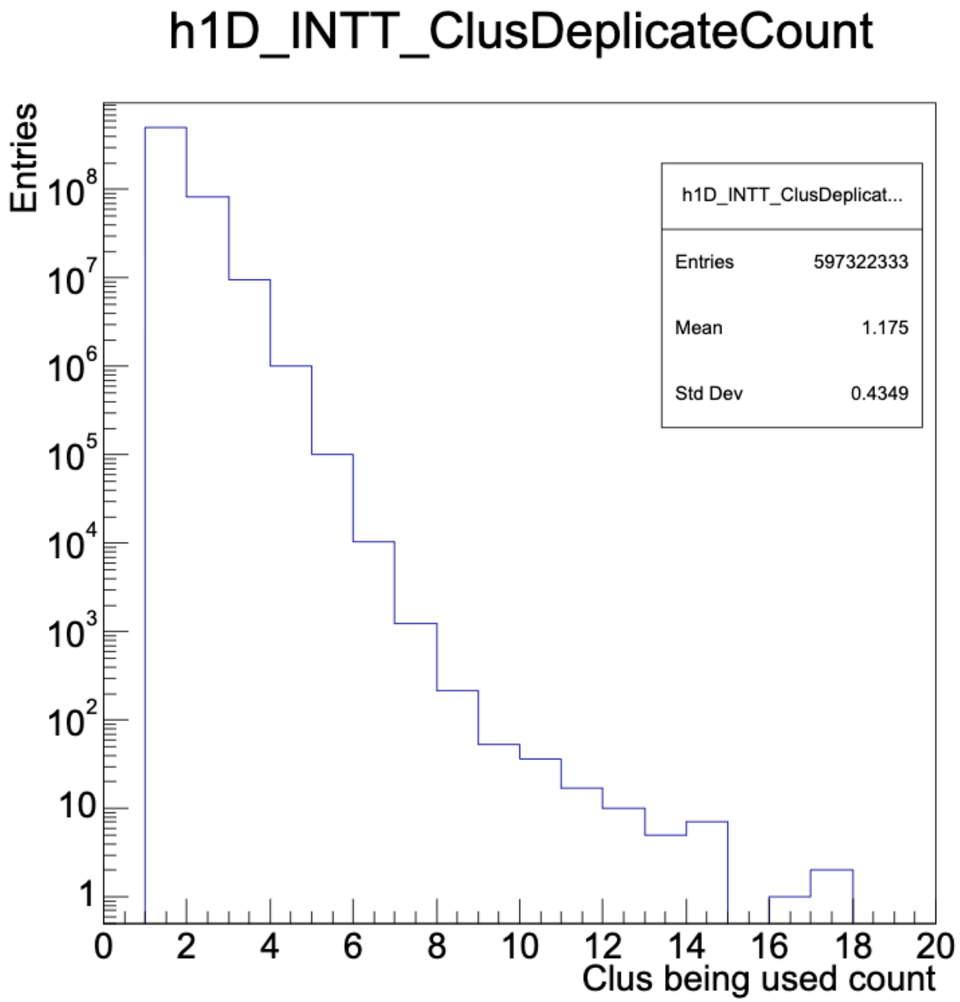


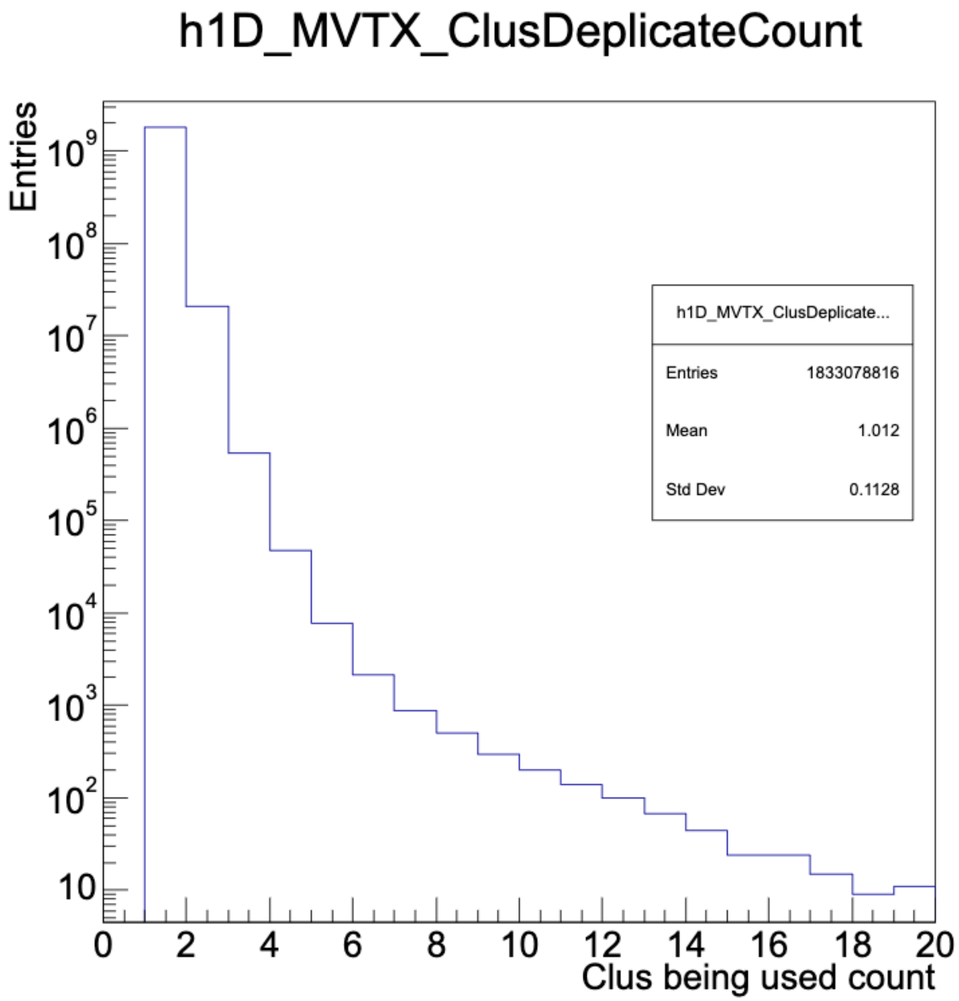


~45% of silicon seeds have INTT cluster-TimeBucket difference != 0

Cluster duplication distributions

- Number of silicon seeds that a cluster is associated with, for both INTT and MVTX, respectively

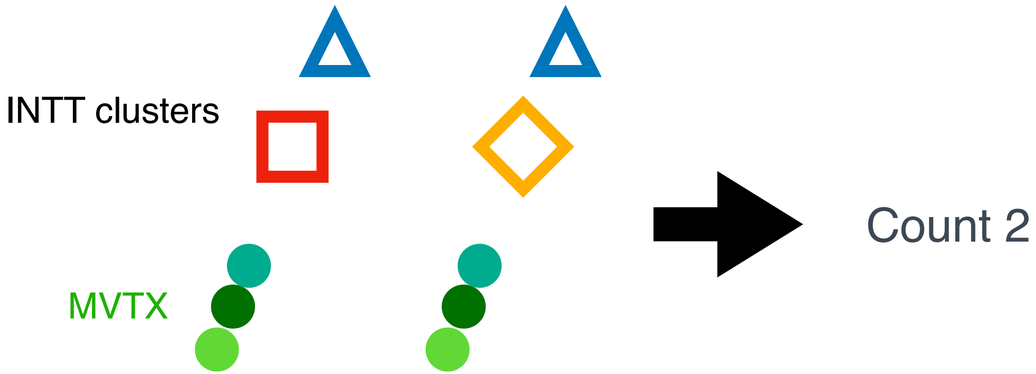


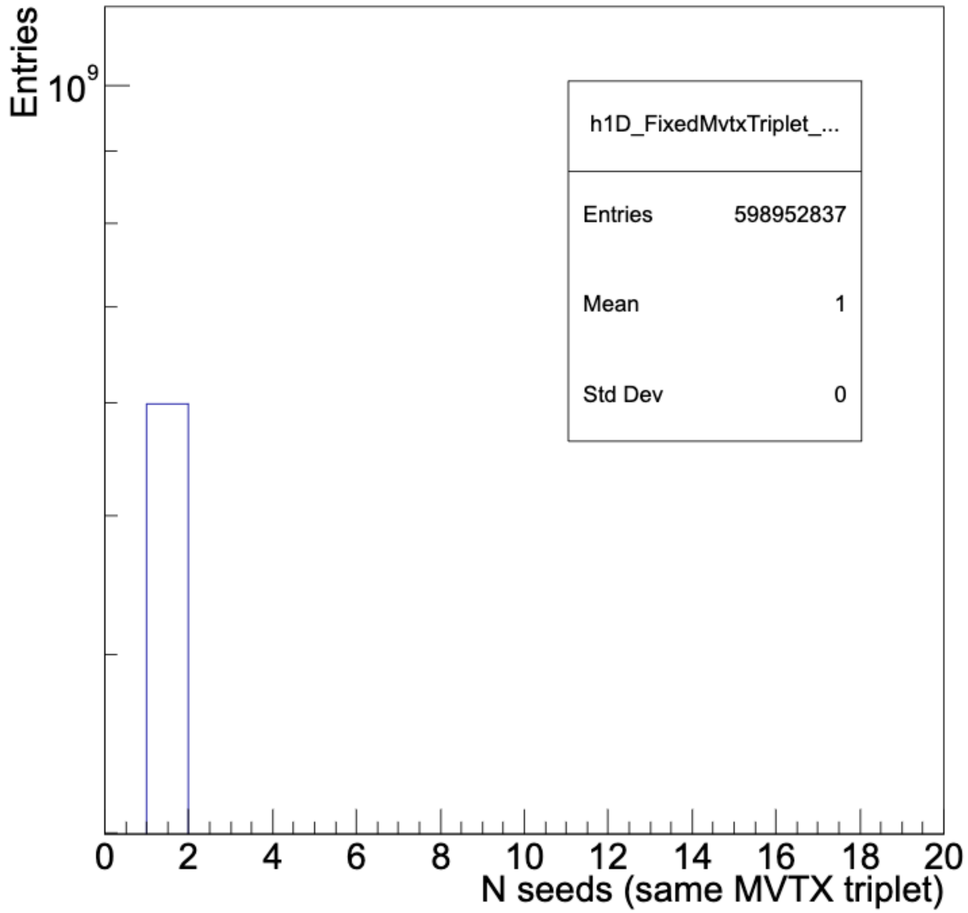


One cluster is allowed to be associated with multiple silicon seeds

Track variety

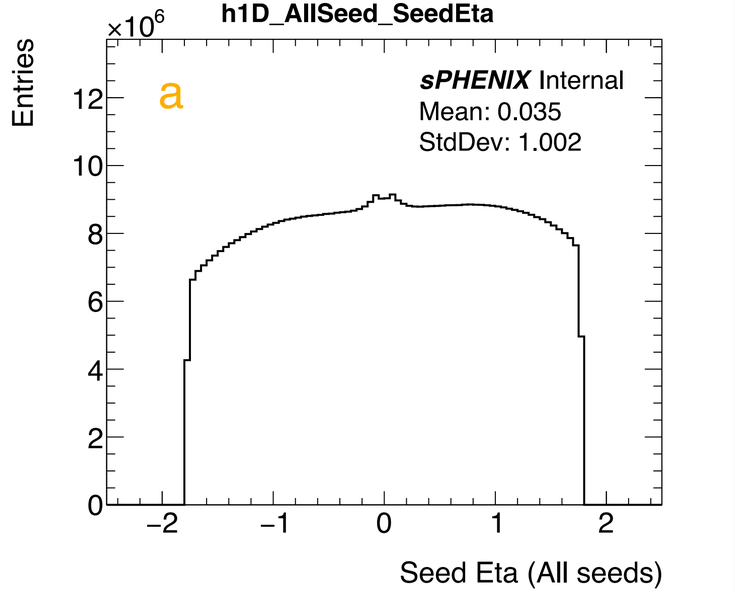
- Distribution of the number of silicon seeds with a given MVTX triplet (quadruplet)
  - Using cluster_key to fix the clusters of the MVTX-triplet (quadruplet), regardless the order

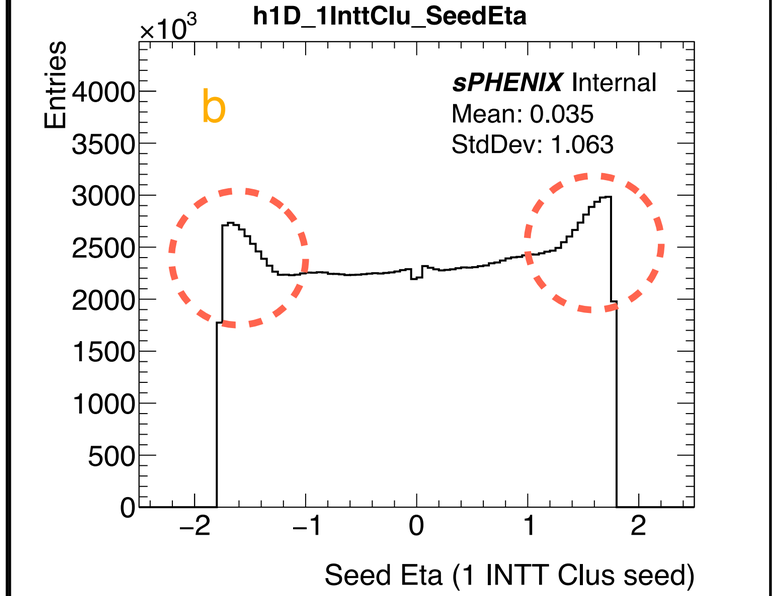


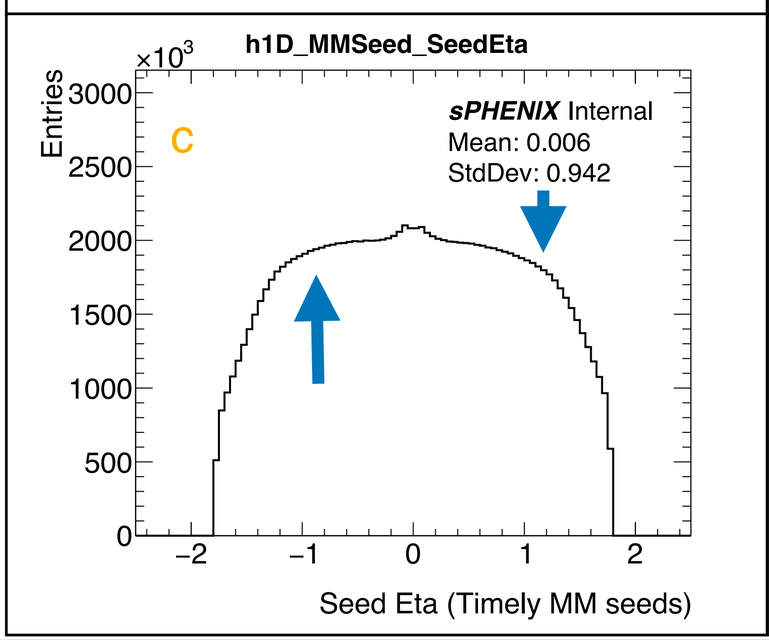


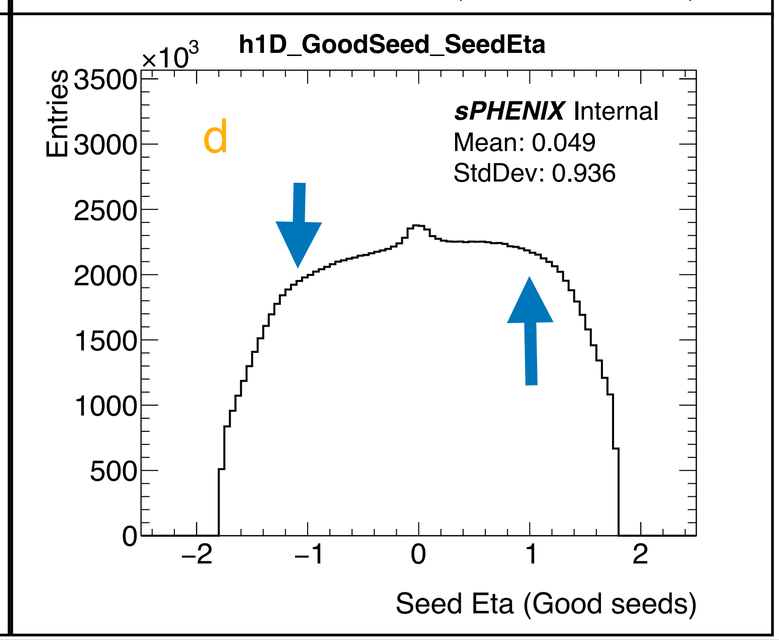
For one set of MVTX clusters, currently it only corresponds to one silicon seed

Seed behavior - seed eta

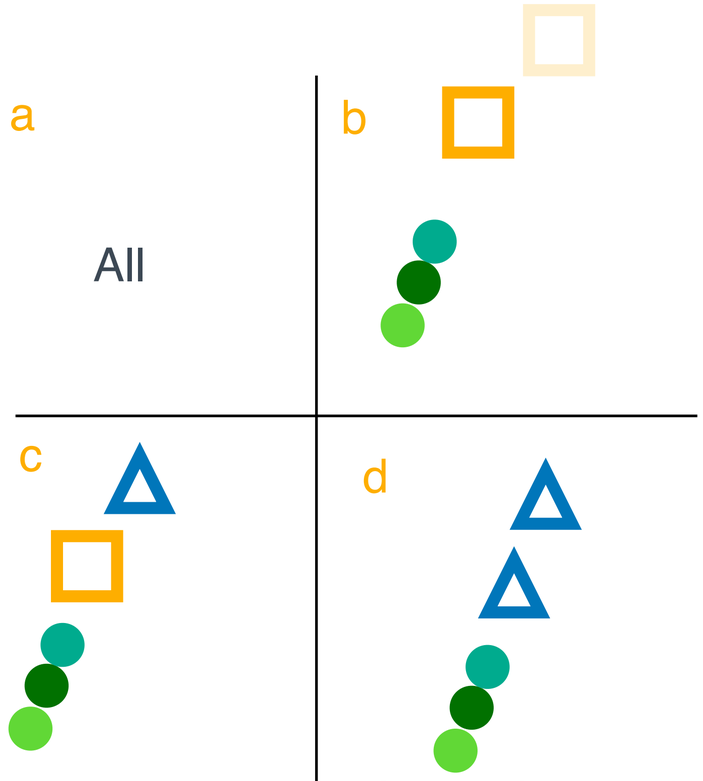








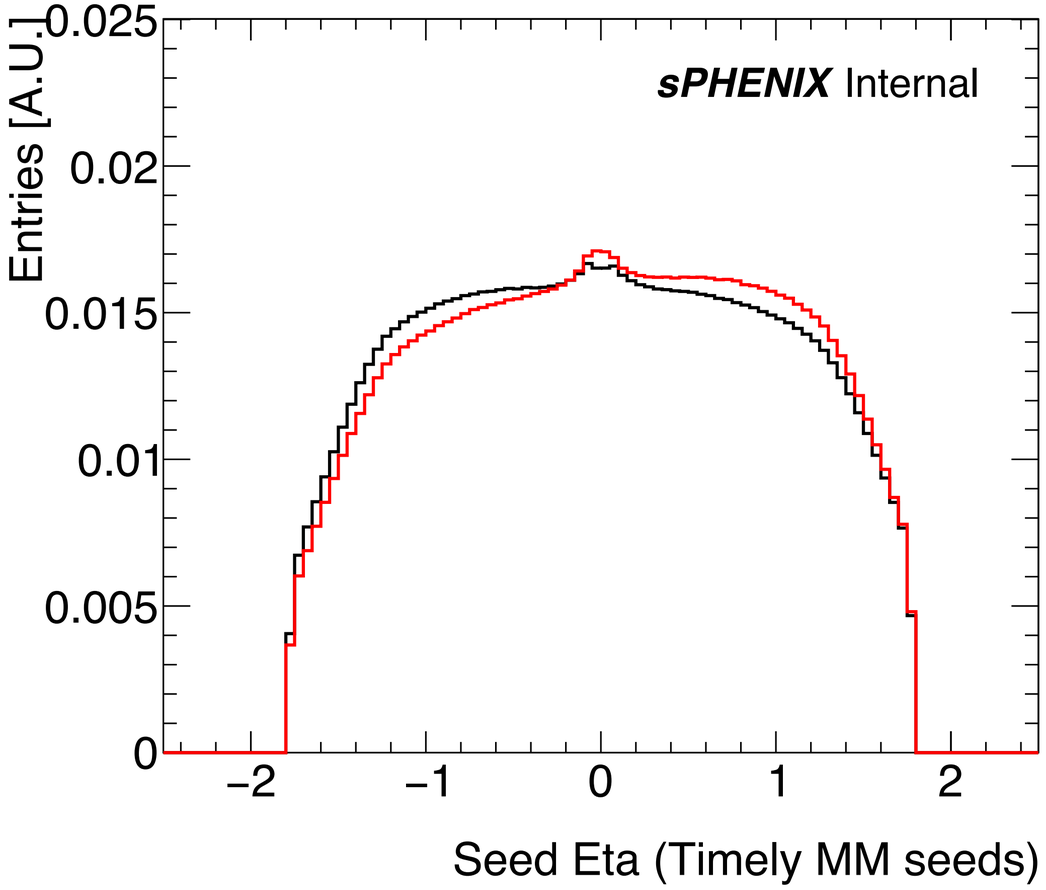
a: All silicon seeds
b: Seeds with only 1 INTT cluster
c: Seeds with 2 INTT clusters (Timely mismatched)
d: Seeds with 2 INTT clusters (Timely matched)



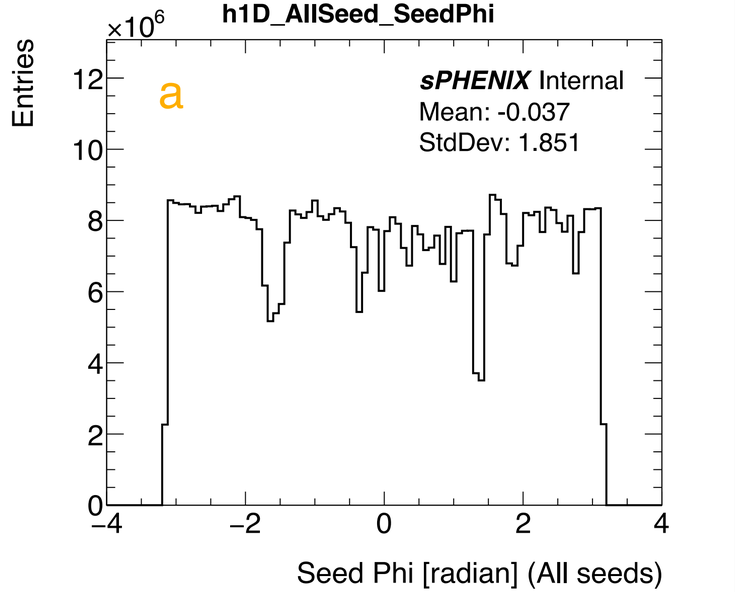
Seed behavior - seed eta

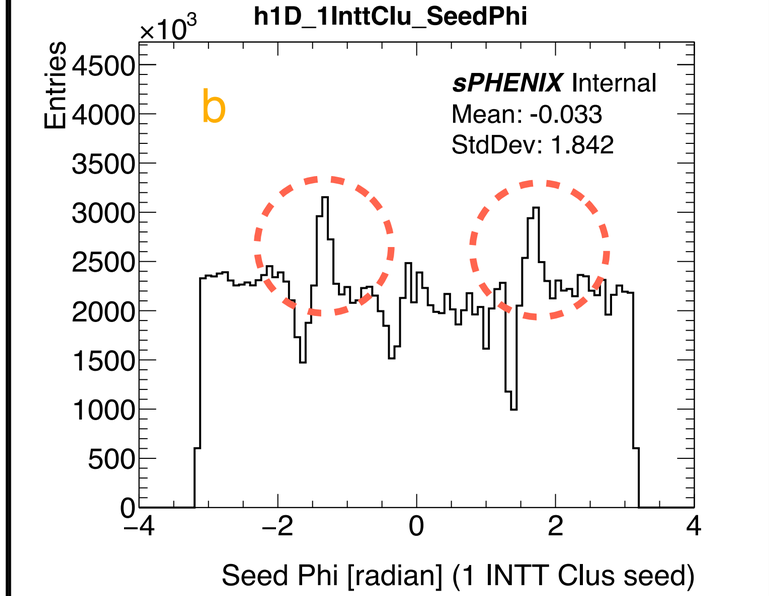
Black: Seeds with 2 INTT clusters (Timely mismatched)

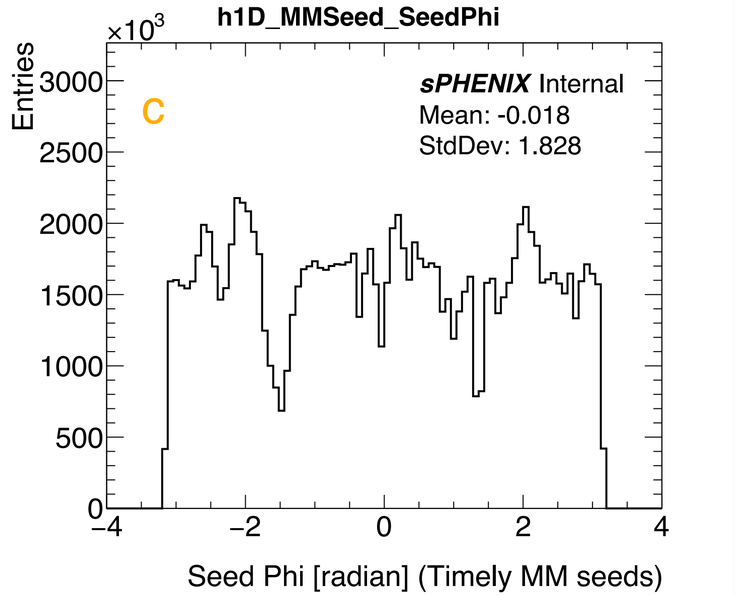
Red: Seeds with 2 INTT clusters (Timely matched, same INTT timebucket)

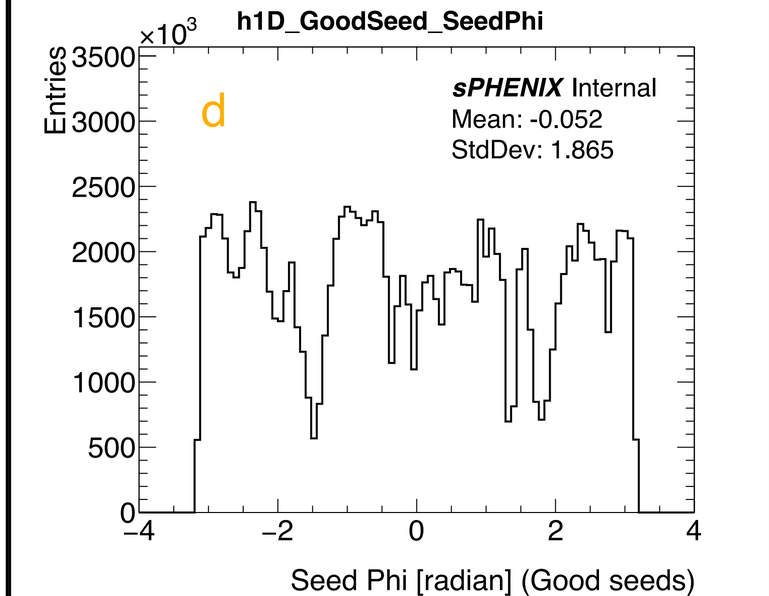


Seed behavior - seed phi









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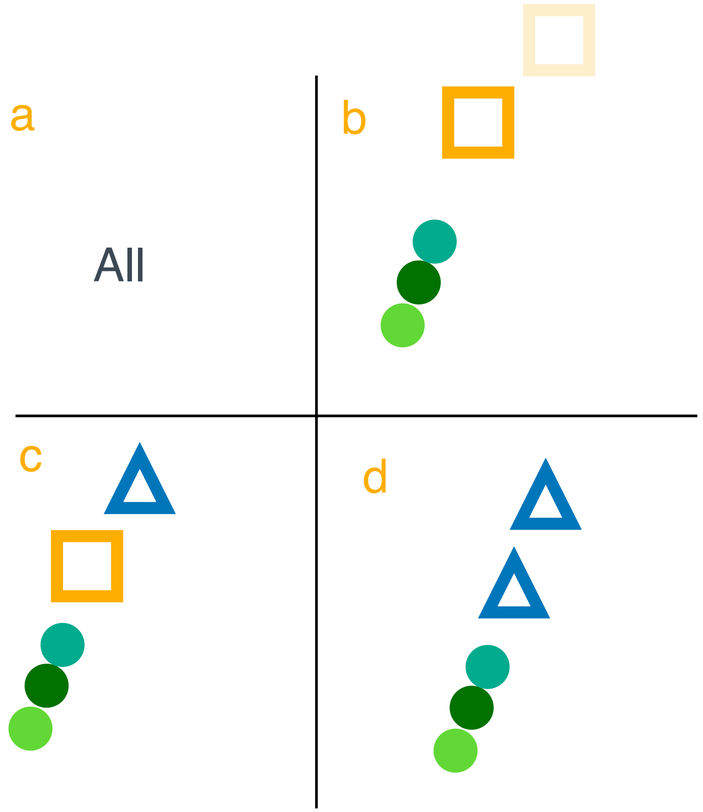
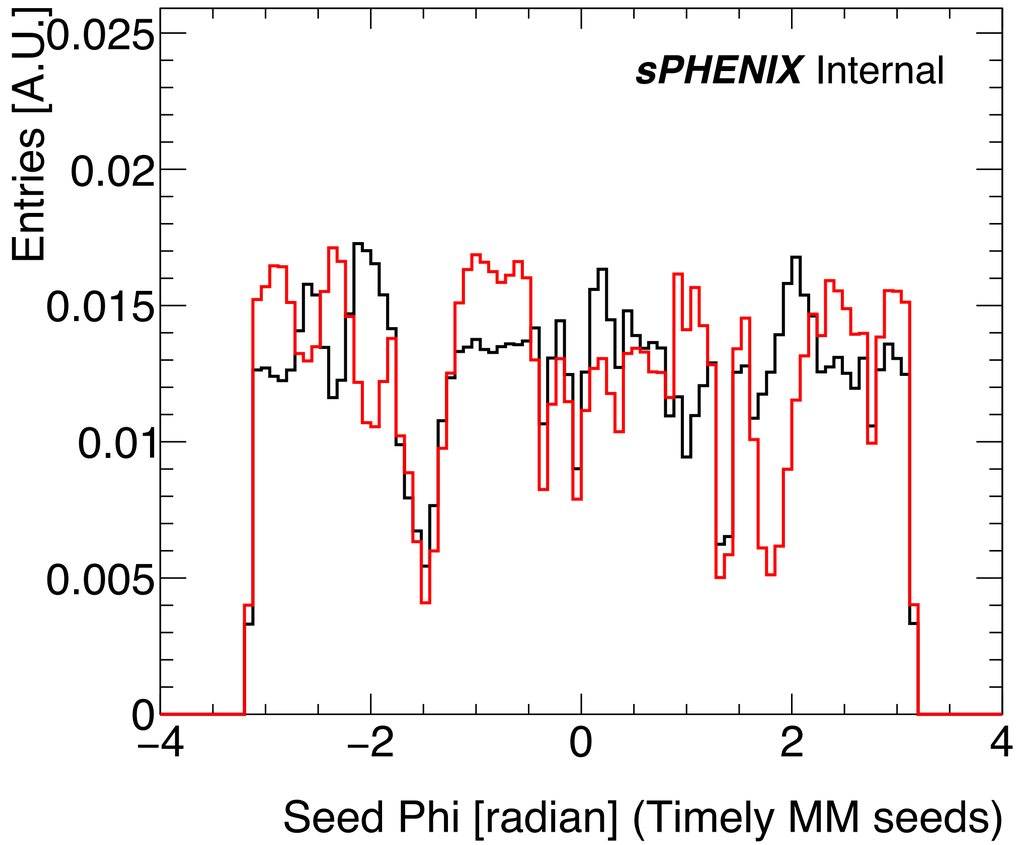


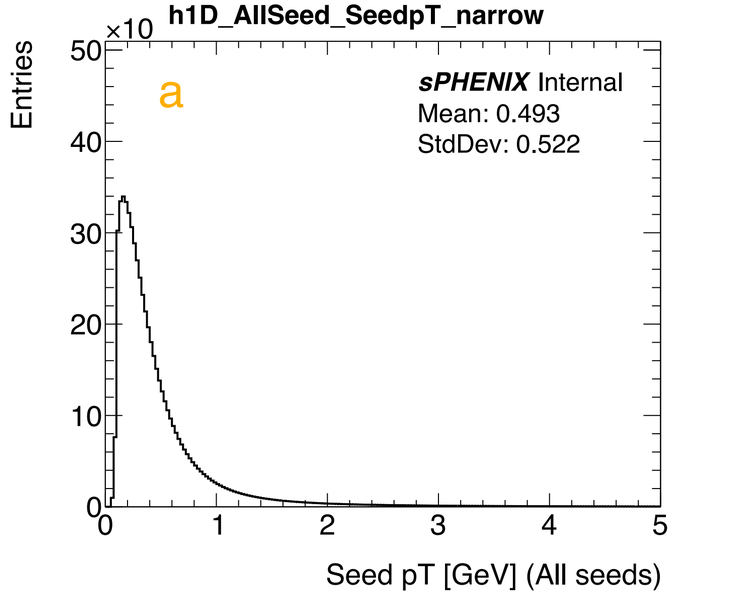
Seed behavior - seed phi

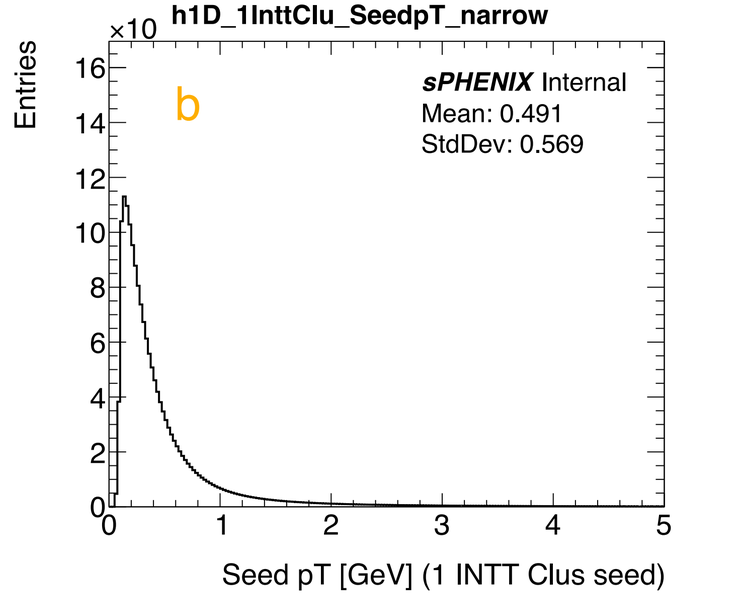
Black: Seeds with 2 INTT clusters (Timely mismatched)

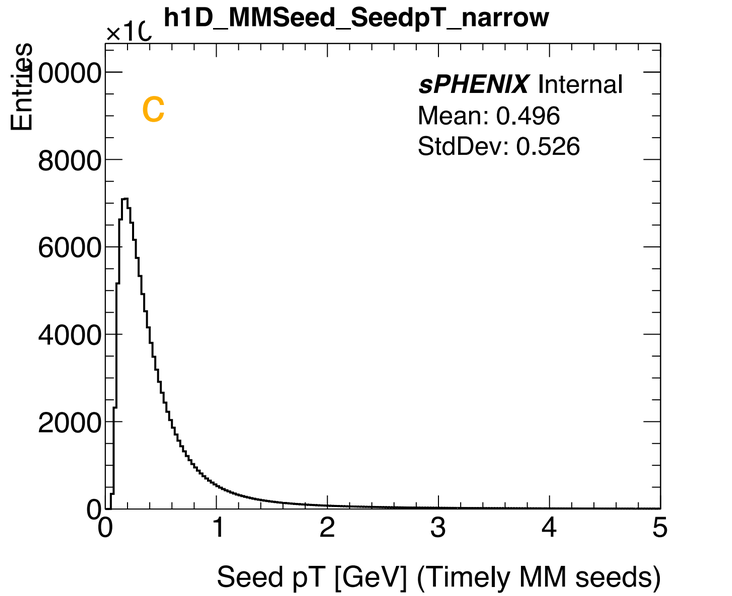
Red: Seeds with 2 INTT clusters (Timely matched) (2 INTT clusters have same timebucket)

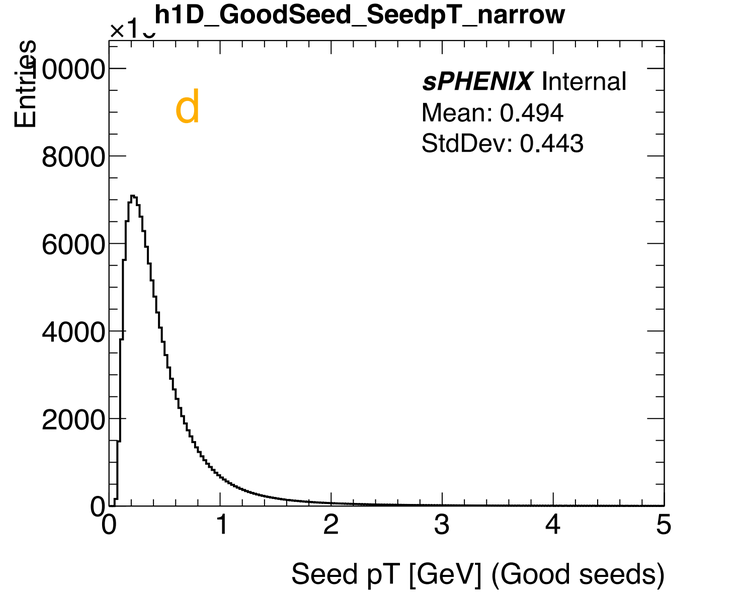


Seed behavior - seed pT









a: All silicon seeds
b: Seeds with only 1 INTT cluster
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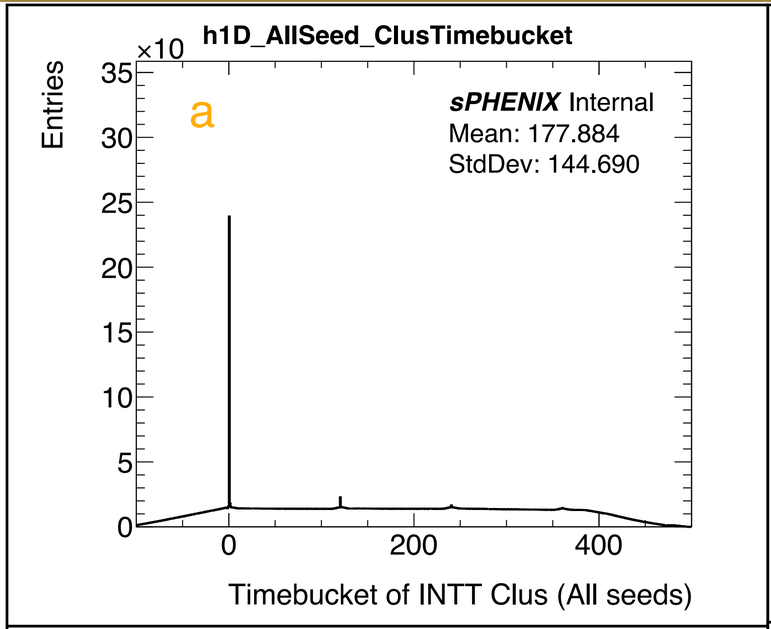
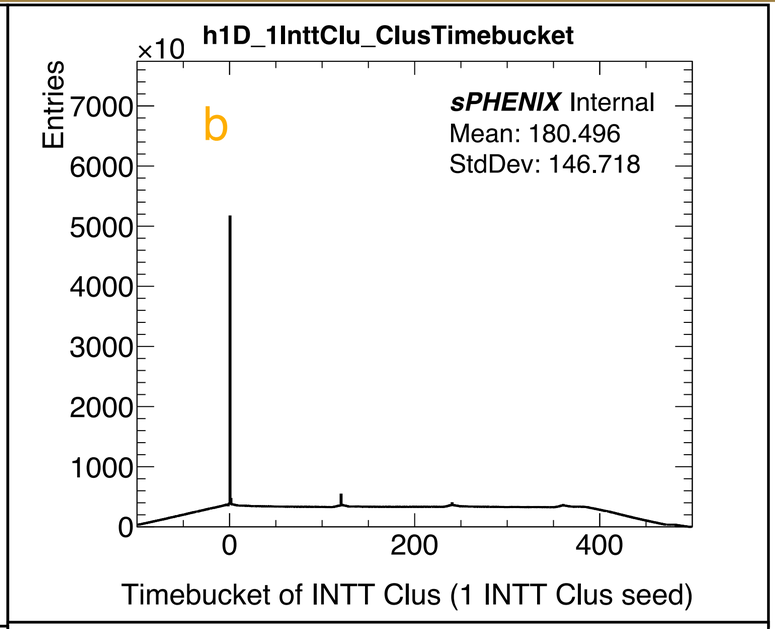
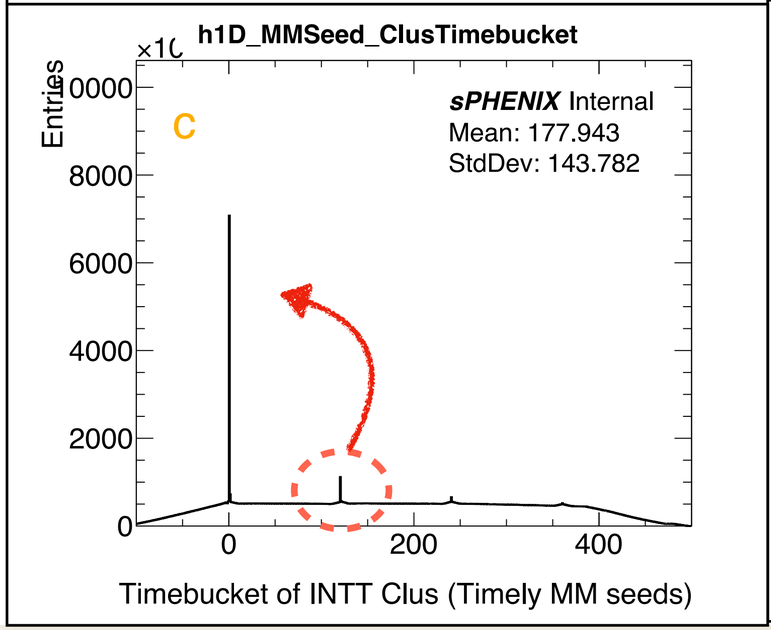
d: Seeds with 2 INTT clusters (Timely matched)

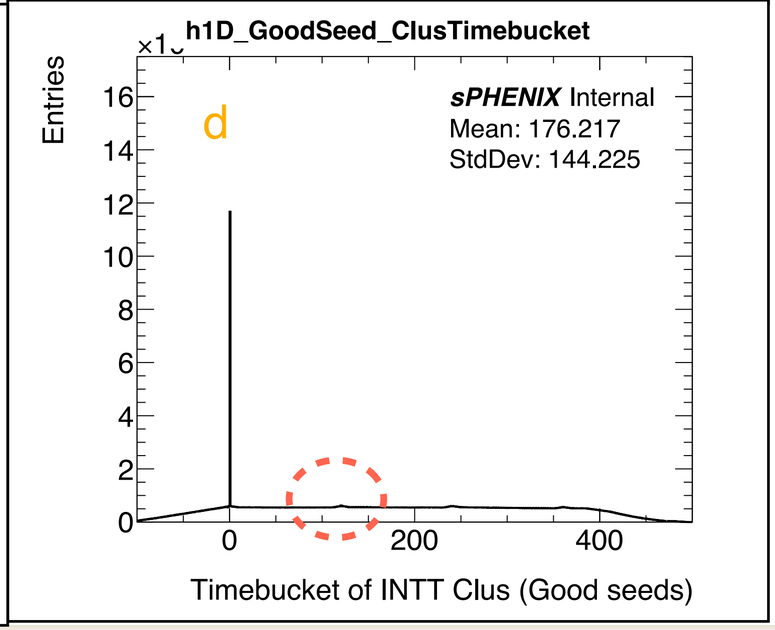
Seems to be similar

Seed behavior - INTT cluster timebucket









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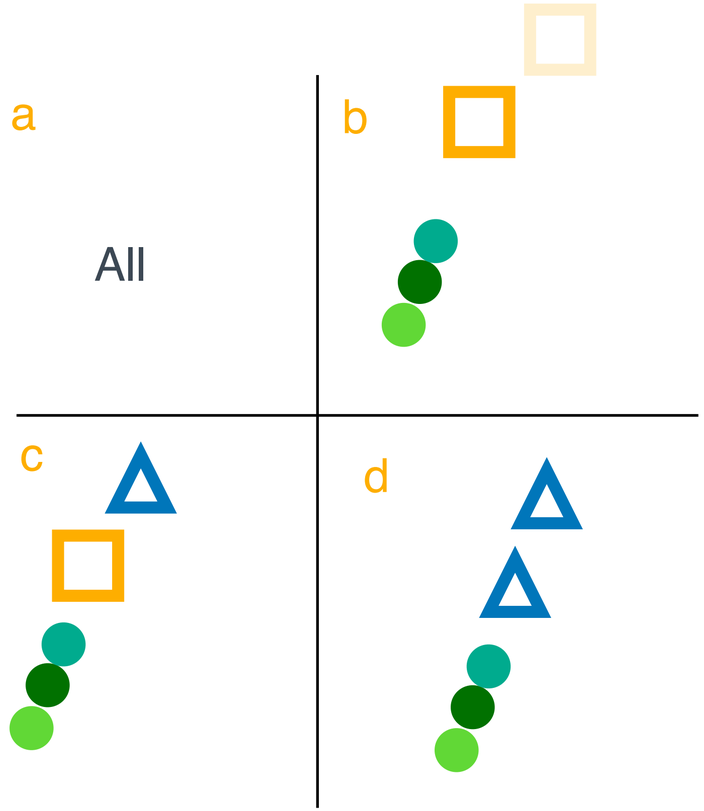
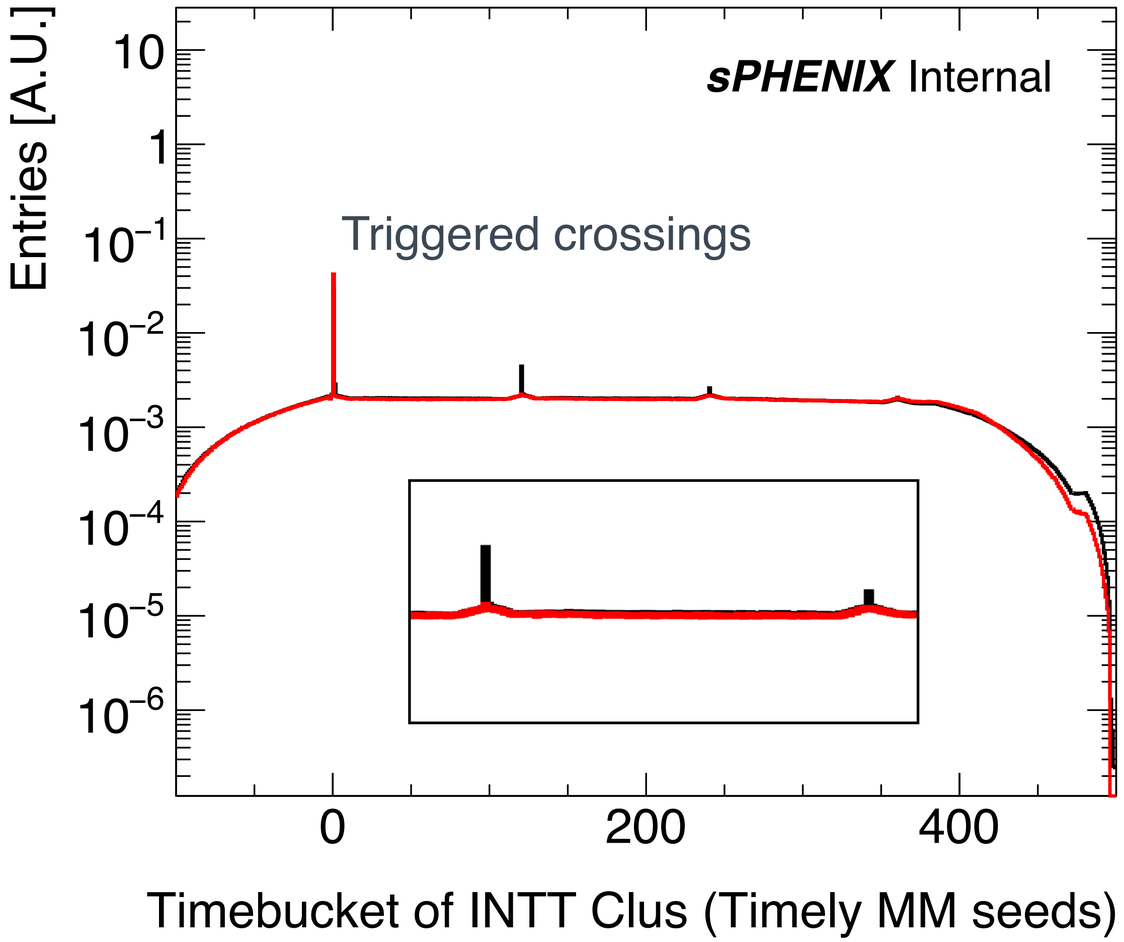


Hits been carried over,
timebucket being overwritten

Seed behavior - cluster timebucket

Black: Seeds with 2 INTT clusters (Timely mismatched)

Red: Seeds with 2 INTT clusters (Timely matched) (2 INTT clusters have same timebucket)



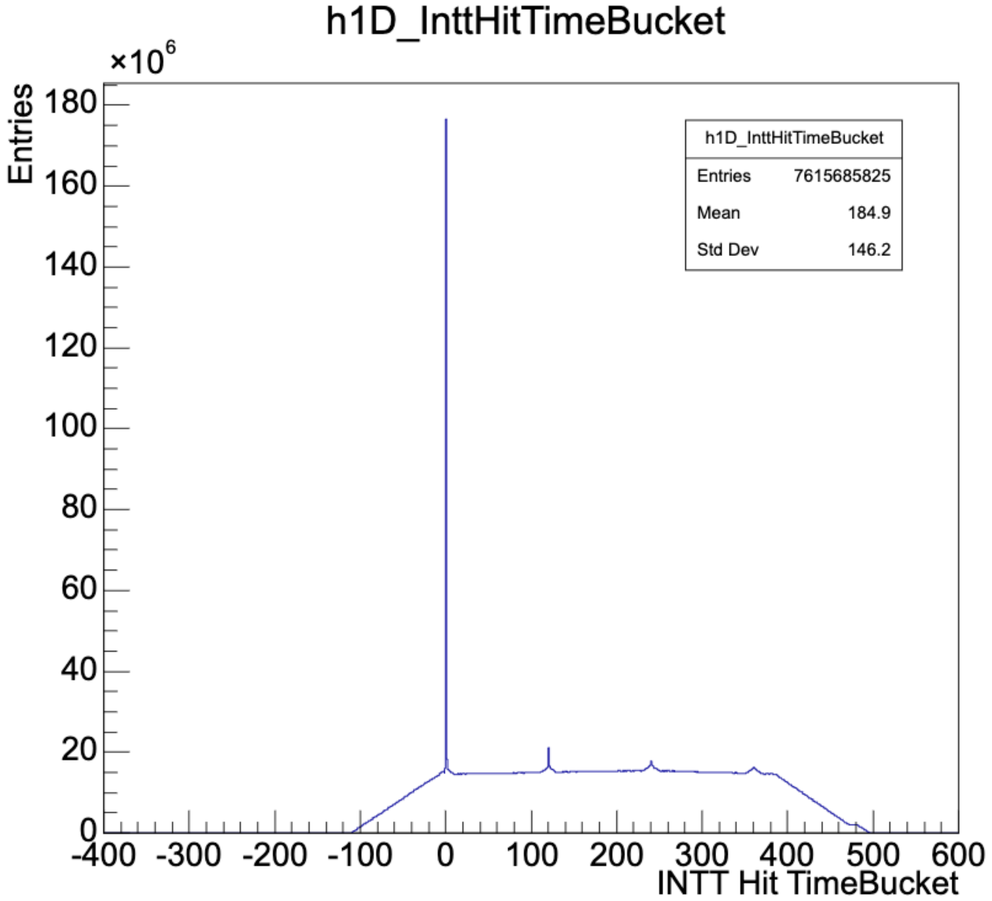
People combined 500 bunch crossings in one F4A event

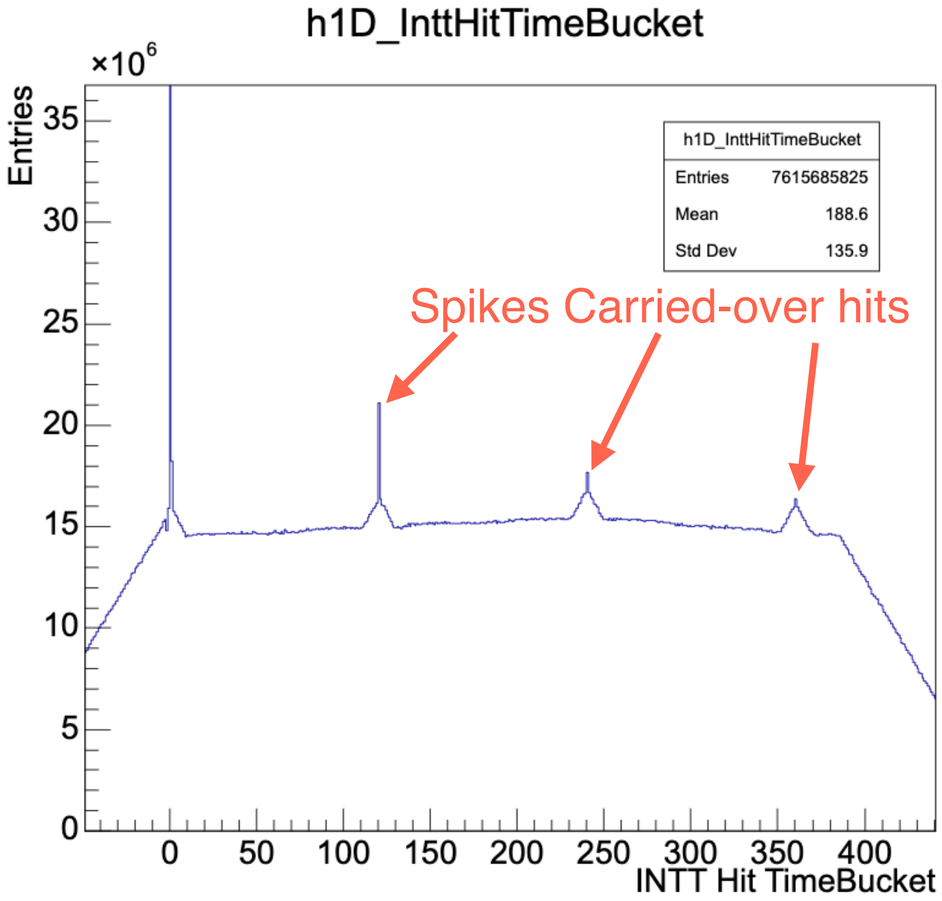
INTT cluster timbucket:
INTT_bco_full + INTT_hit_bco - offset - GL1BCO

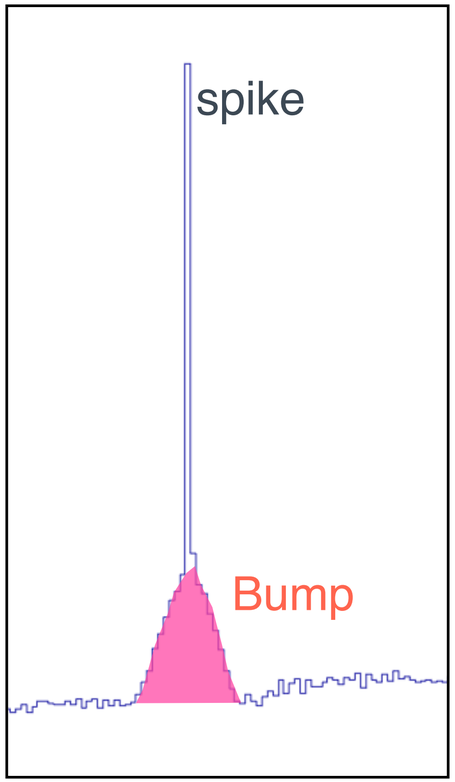
Spikes retain in black histogram: real seeds, but INTT clusters different timebucket due to carried-over-hit issue

INTT RawHit study

The timebucket of INTT Rawhit
(clone hit removal, hitQA, bad channel removal)



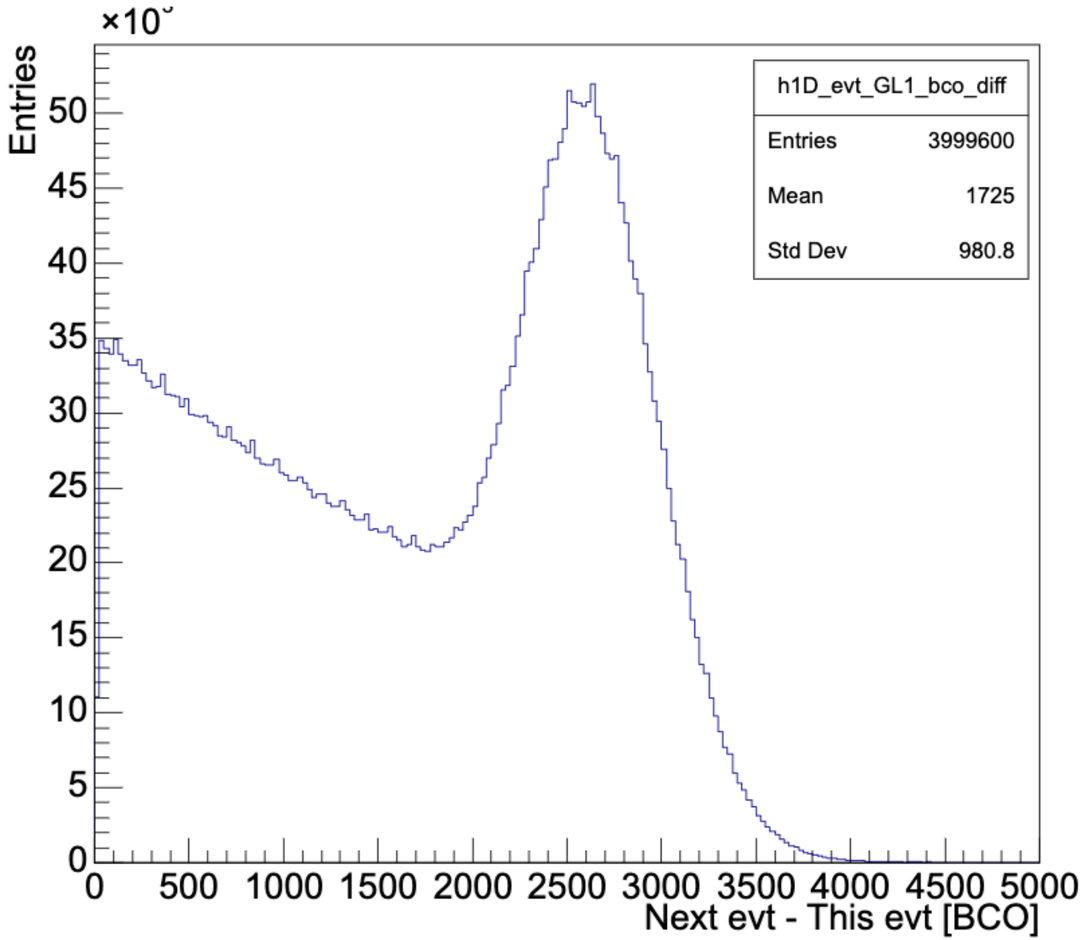


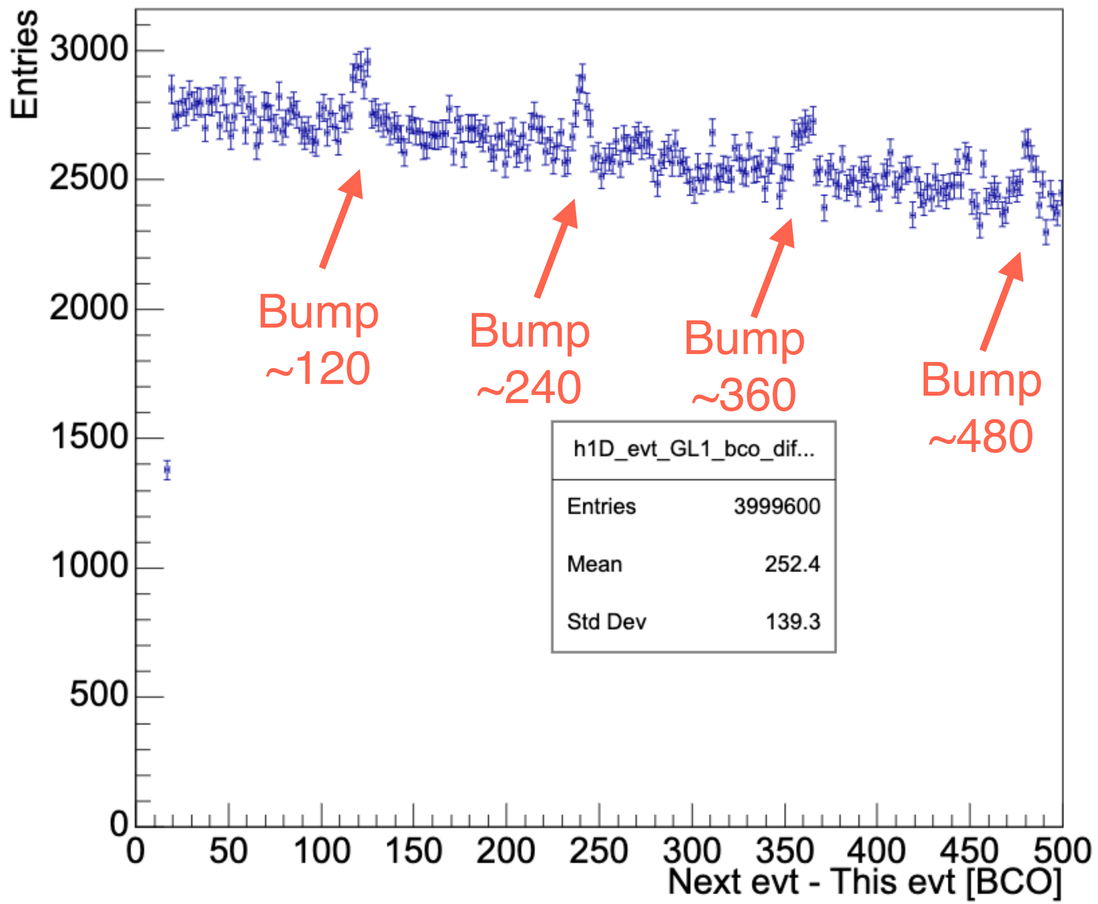


Carried-over hit in INTT streaming data: studied by Mai and Takashi previously
The bumps: maybe something different…

GL1 BCO, event interval

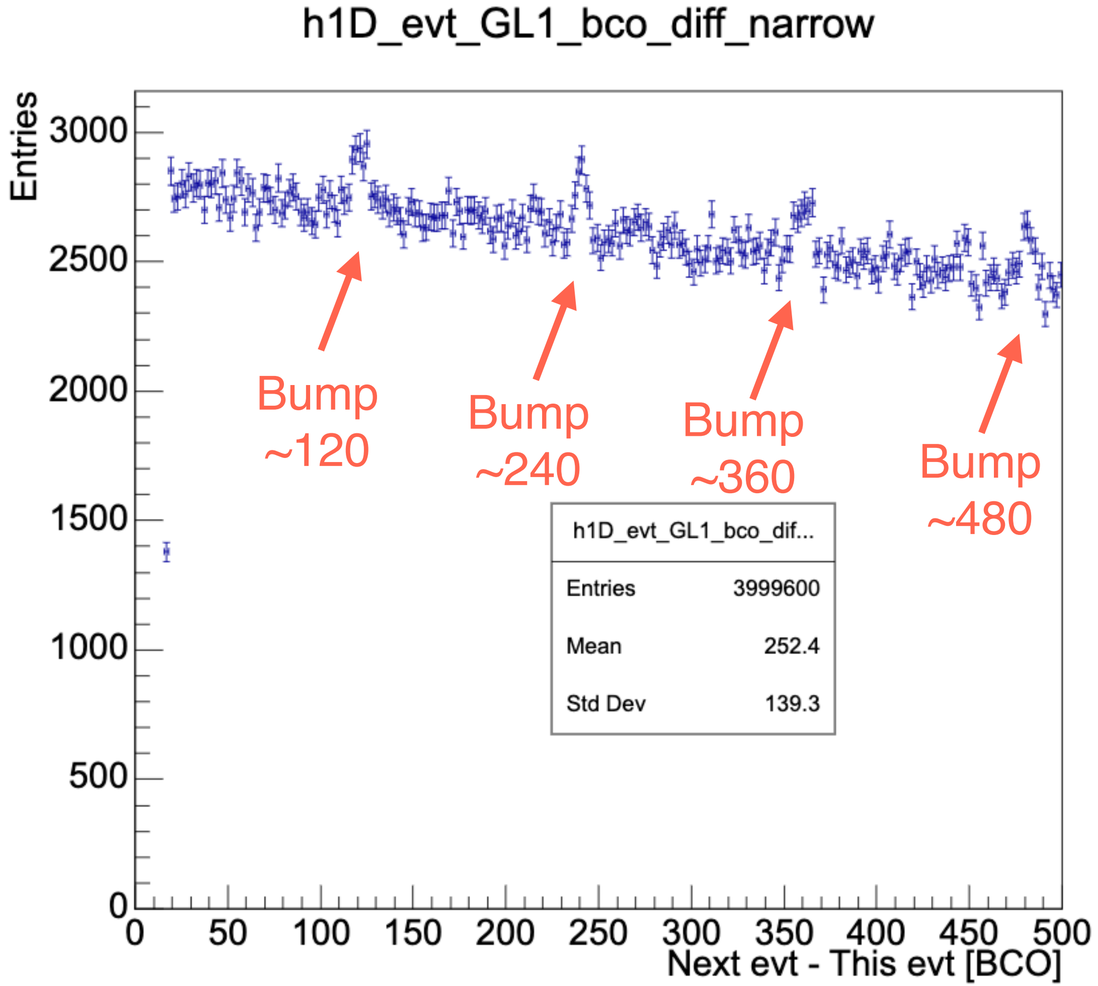
One F4A event has 500 bunch crossings, and is assocaited with GL1 information



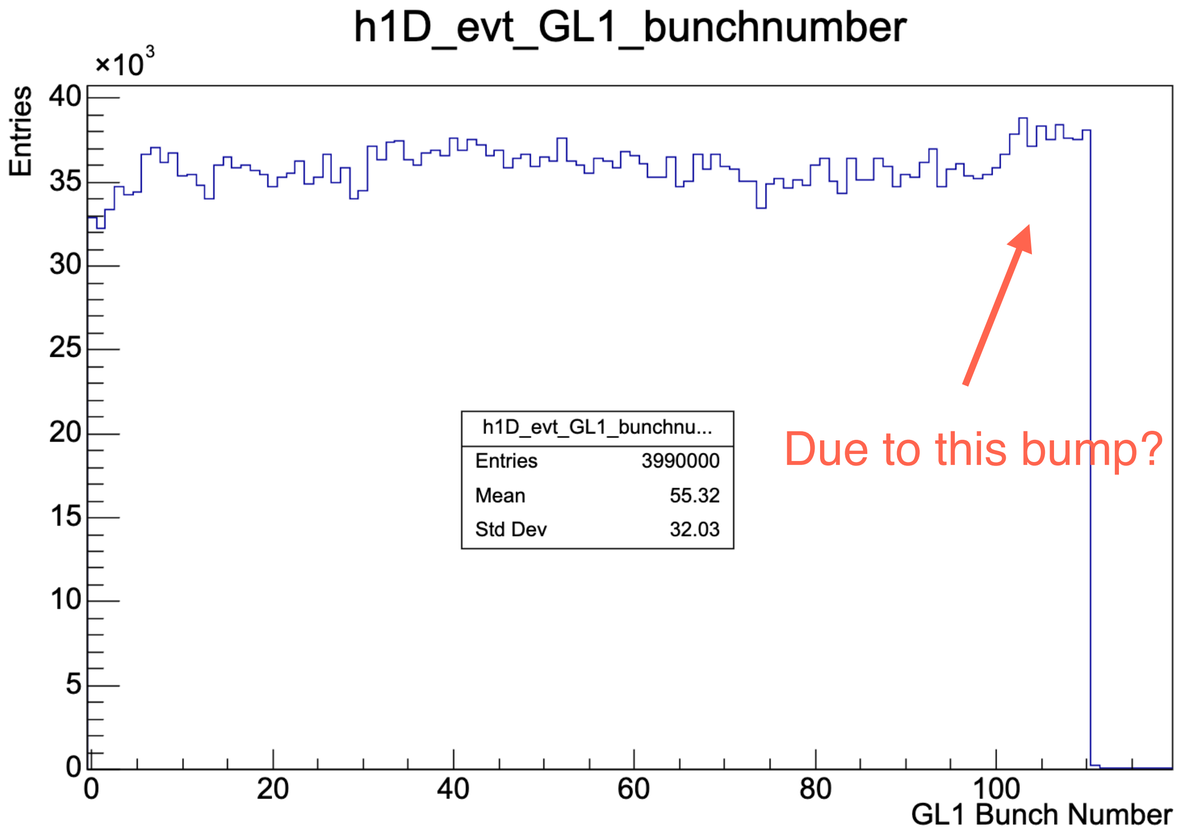


Q1: not sure why the distribution looks like this
Q2: not sure why there are bumps

GL1 BCO, event interval



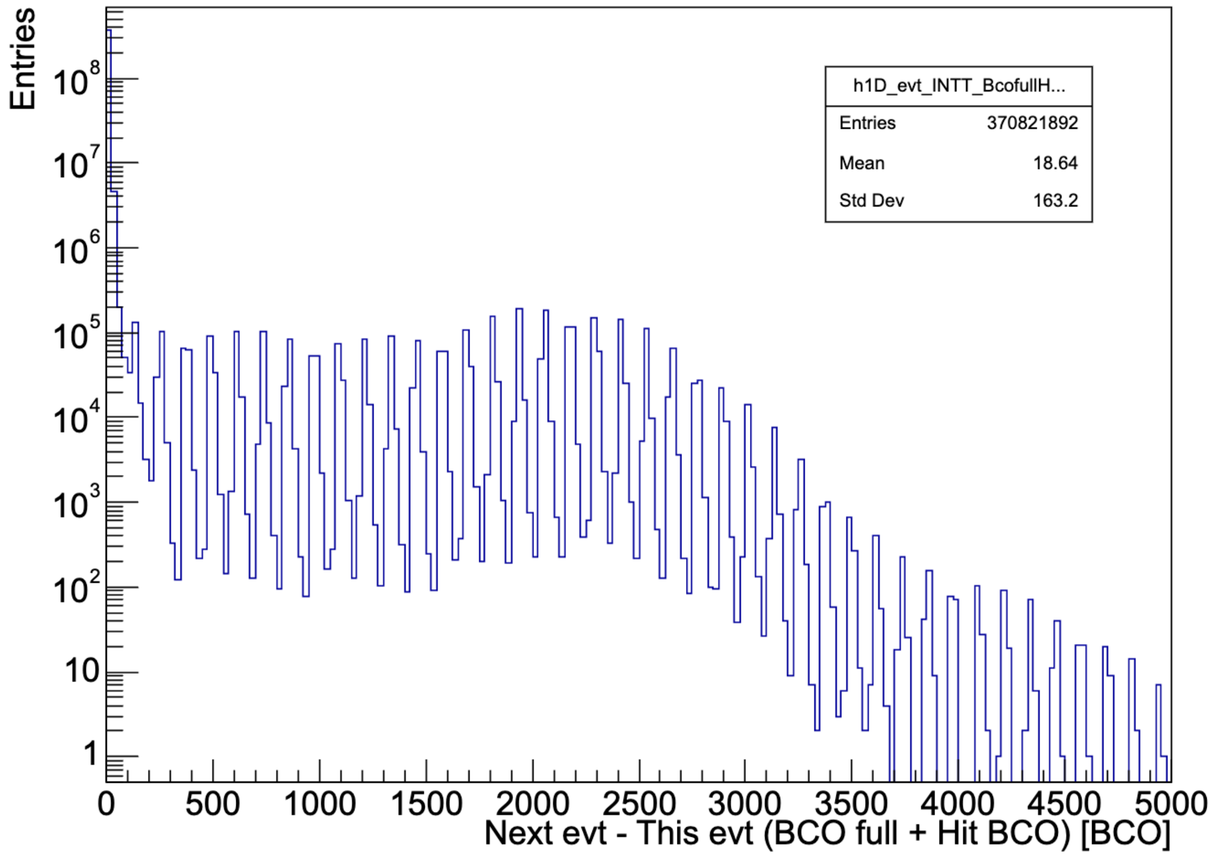
Bunch crossings that fire trigger

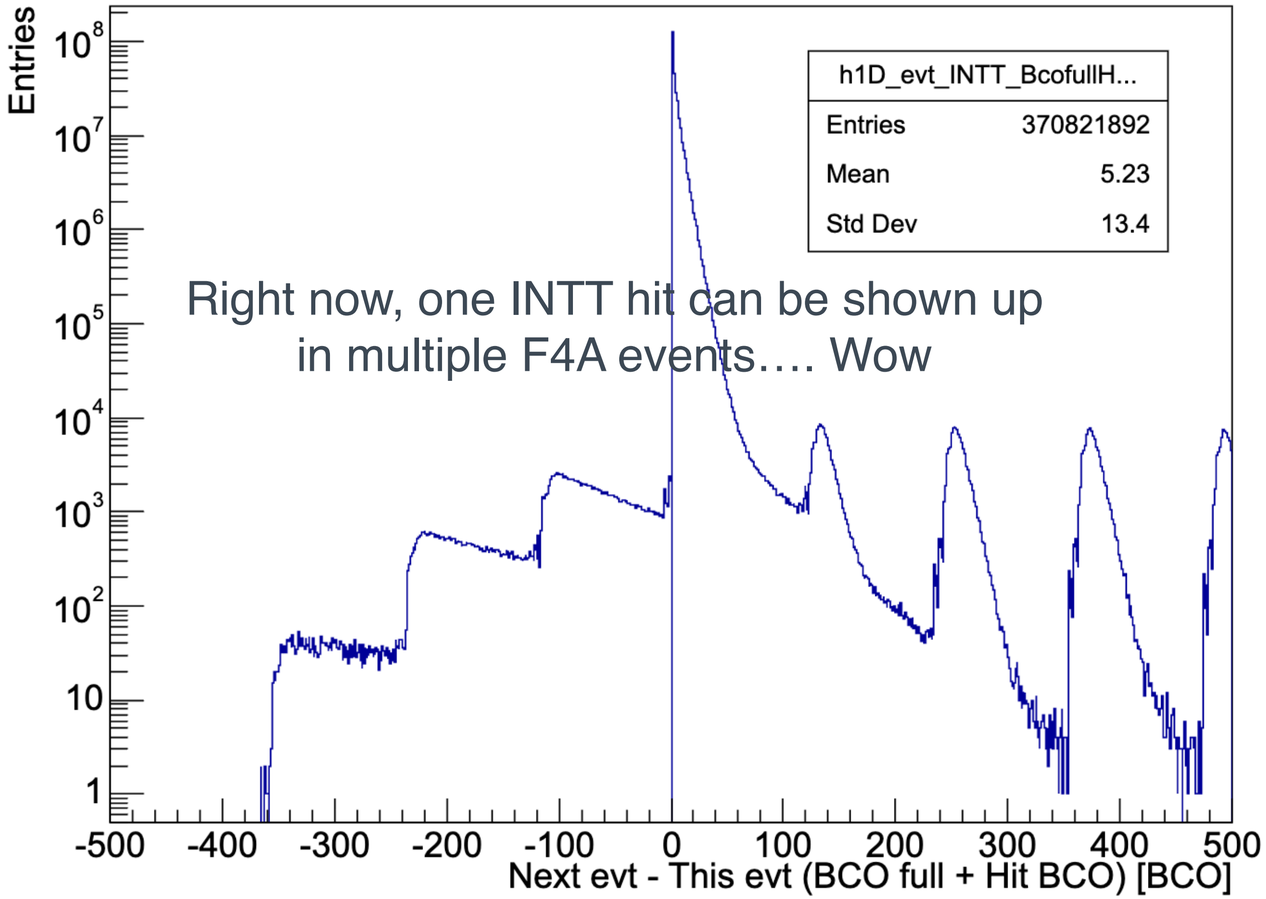


Event interval in streaming readout

Procedures:

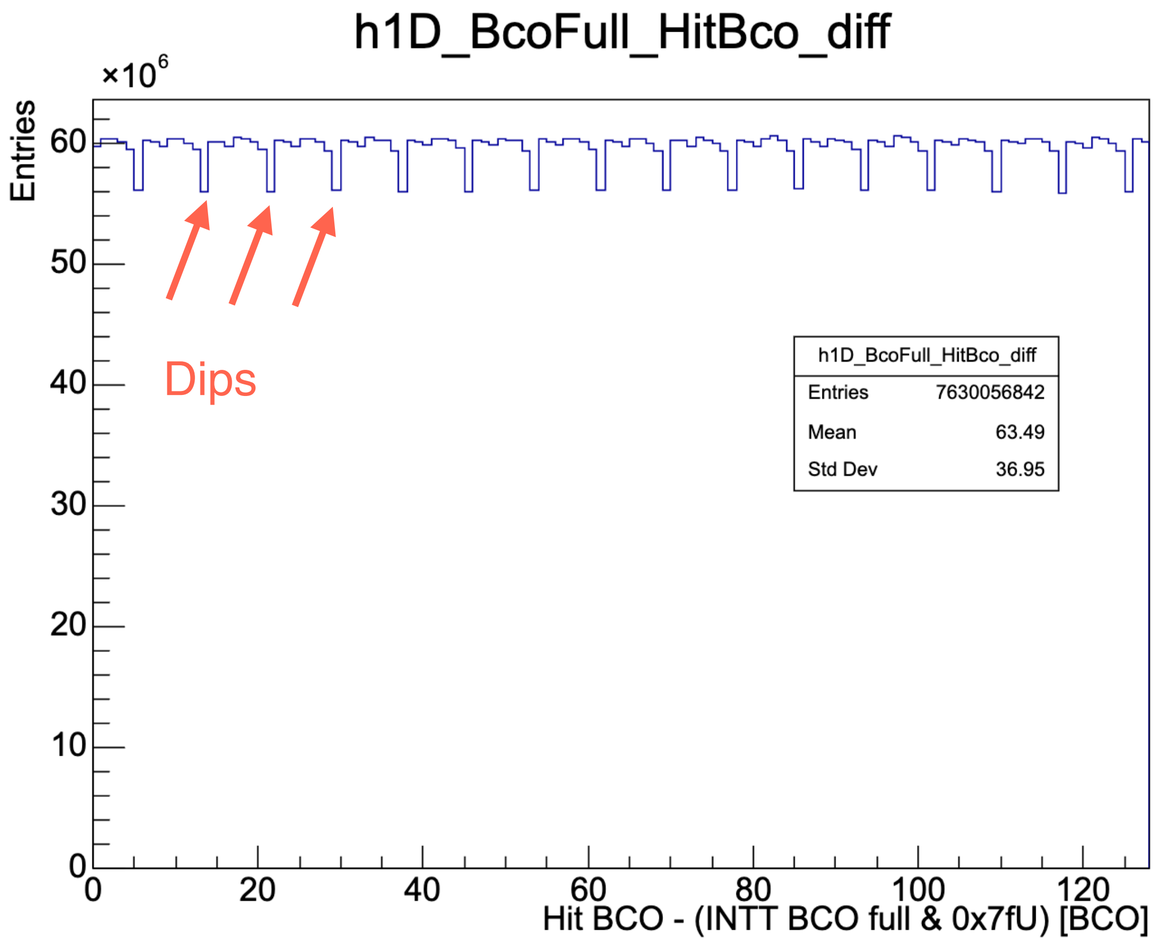
1. pick up all the unique INTT_bco_full+INTT_hit_bco (AbsBCO)
2. In one F4A event, sort those unique AbsBCOs
3. push back those sorted unique AbsBCOs to a global vector





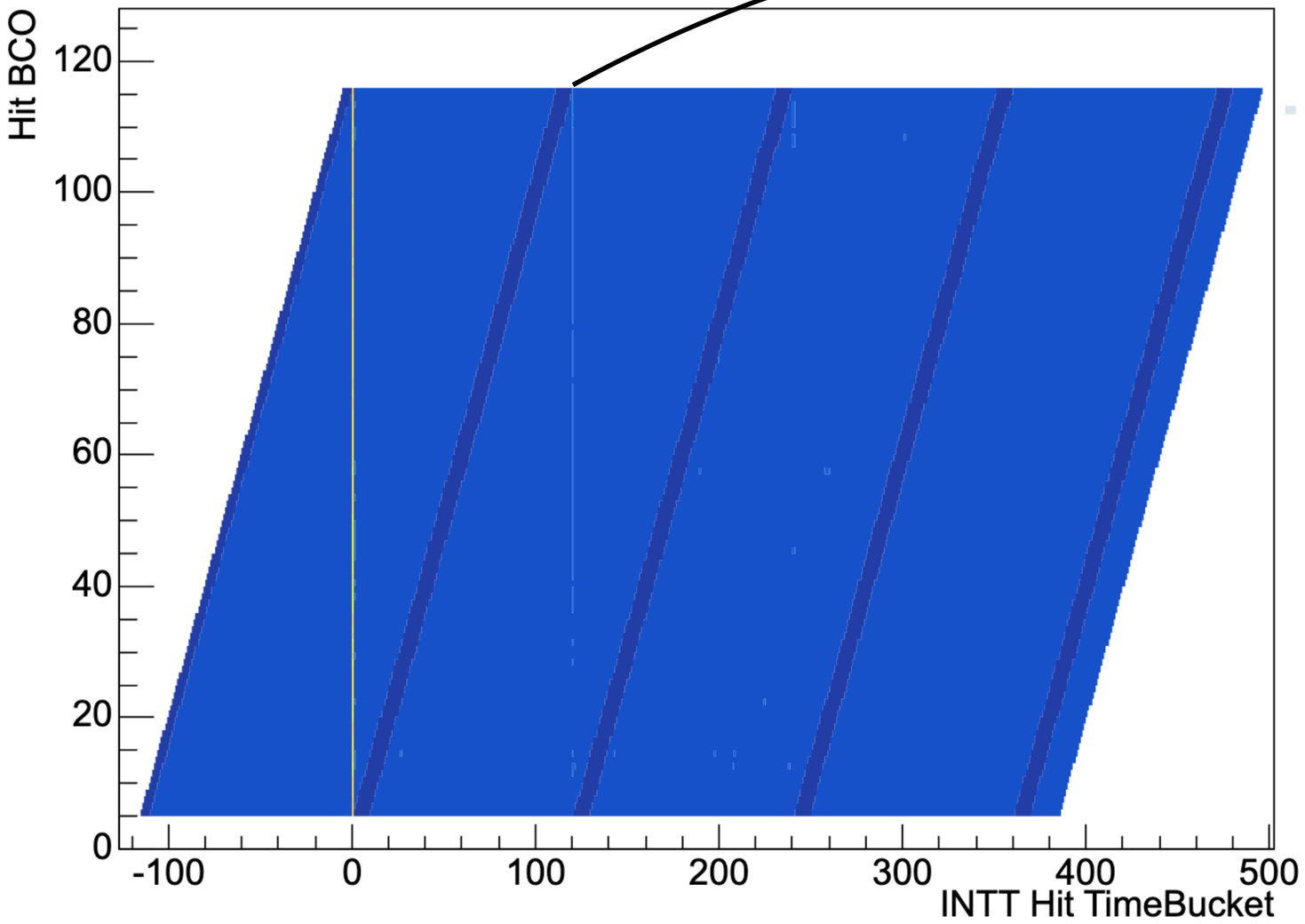
Not sure why there are negative entries and bumps

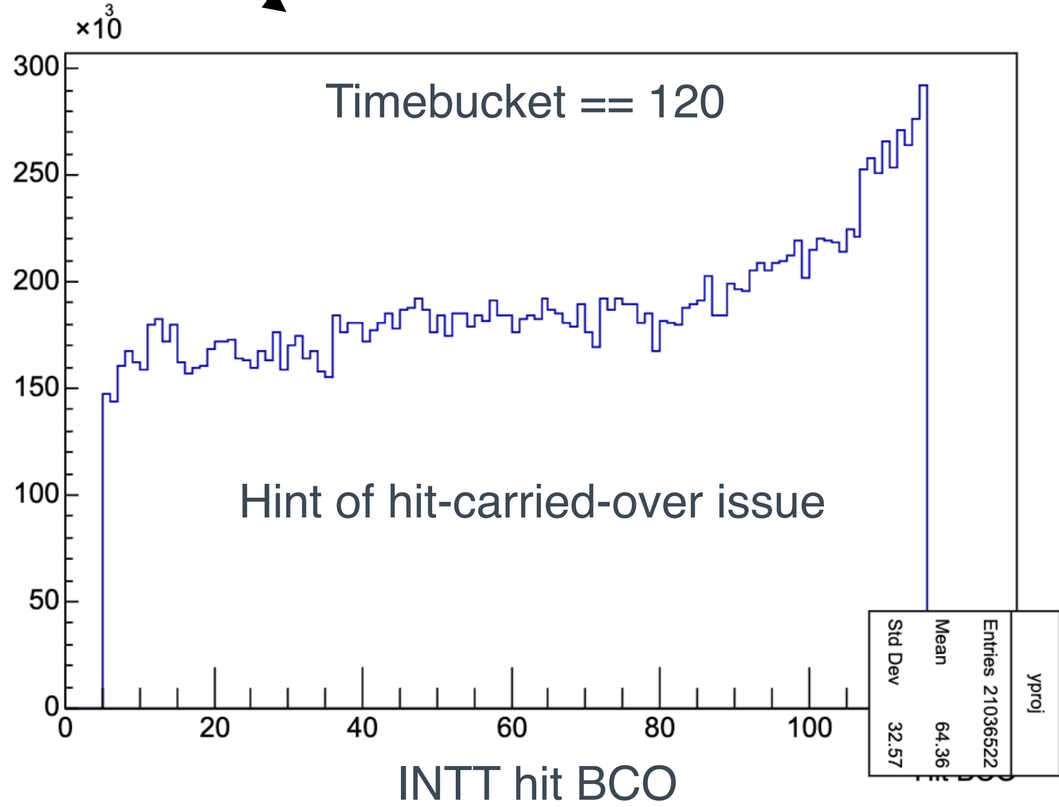
INTT rawhit, BcoDiff



Are those dips expected?

Hit carried over issue in INTT streaming data





How can we recover it…?

Carried-over hit in INTT streaming data: studied by Mai and Takashi previously

Summary

- In the current seeding algorithm, one cluster can be associated with multiple seeds
- In the current seeding algorithm, one set of MVTX triplet only associates one seed

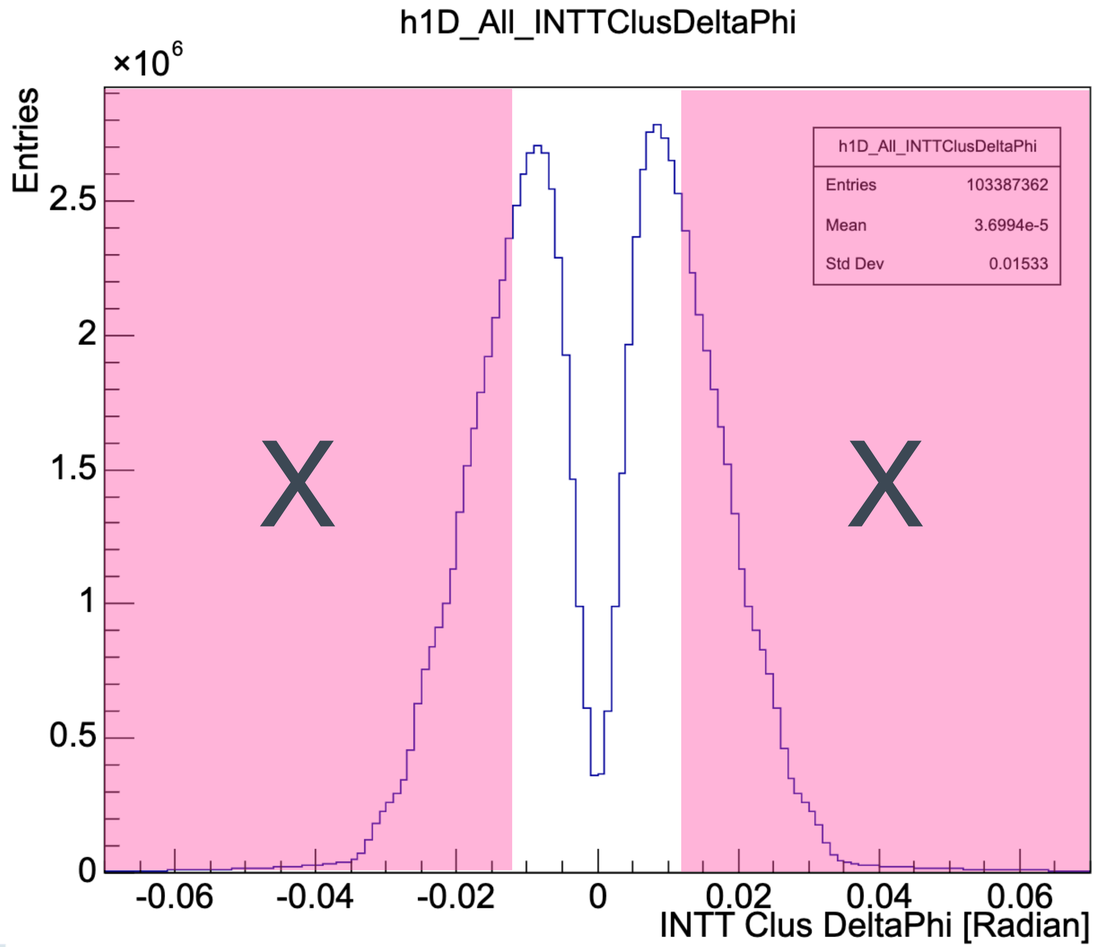
- In the seed eta, phi, and INTT-cluster-timebucket distributions, the shapes are different between good seeds and seeds with non-zero INTT cluster-timebucket difference

- Starting from the INTTRawHit level, five INTT events have been combined into one F4A event
  - The same thing should happen for MVTX as well

- So, it's (very) likely that there are some fake MVTX triplets. Therefore, currently, (I think) it's not a good idea to use silicon seeds to study the INTT hit detection efficiency (because of fake MVTX-triplets)
  - MVTX-triplet + 2 INTT clusters
  - MVTX-triplet + 1 INTT cluster -> this is your inefficiency ()

  - effi: (MVTX-triplet + 2 INTT cluster) / (MVTX-triplet + 1 INTT cluster) + (MVTX-triplet + 2 INTT cluster)

- Several dumps observed in event interval distributions (by GL1Bco, INTTAbsBco)



pT > 500 MeV/c
EMCal data, GL1Bco

Back up

Configuration

- Analysis build: 515
  - using local trackreco package cloned from GitHub on Sep 25, 2025
- Run number: 53018 (Run24 pp run, one of the runs in the good run list)
- Cluster DST file:
  - /sphenix/lustre01/sphnxpro/production/run2pp/physics/ana504_2024p023_v001/DST_TRKR_CLUSTER/run_00053000_00053100/dst/DST_TRKR_CLUSTER_run2pp_ana504_2024p023_v001-00053018-*.root
- CDB flag: “ProdA_2024”

```
auto silicon_Seeding = new PHActsSiliconSeeding;
//silicon_Seeding->Verbosity(1);
silicon_Seeding->Verbosity(ActsSeeding_Verbosity);
silicon_Seeding->setStrobeRange(-5,5);
silicon_Seeding->setinttRPhiSearchWindow(0.2);
silicon_Seeding->setinttZSearchWindow(1.0);
silicon_Seeding->seedAnalysis(false);
```

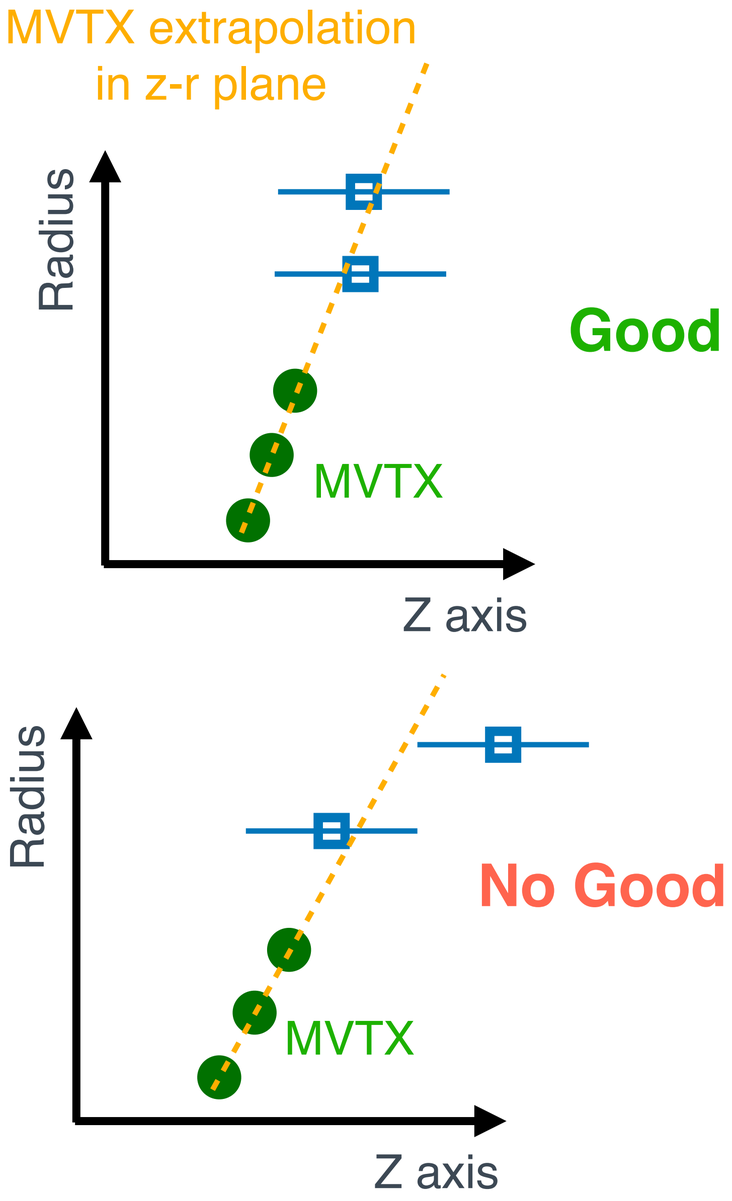
m_searchInIntt == false

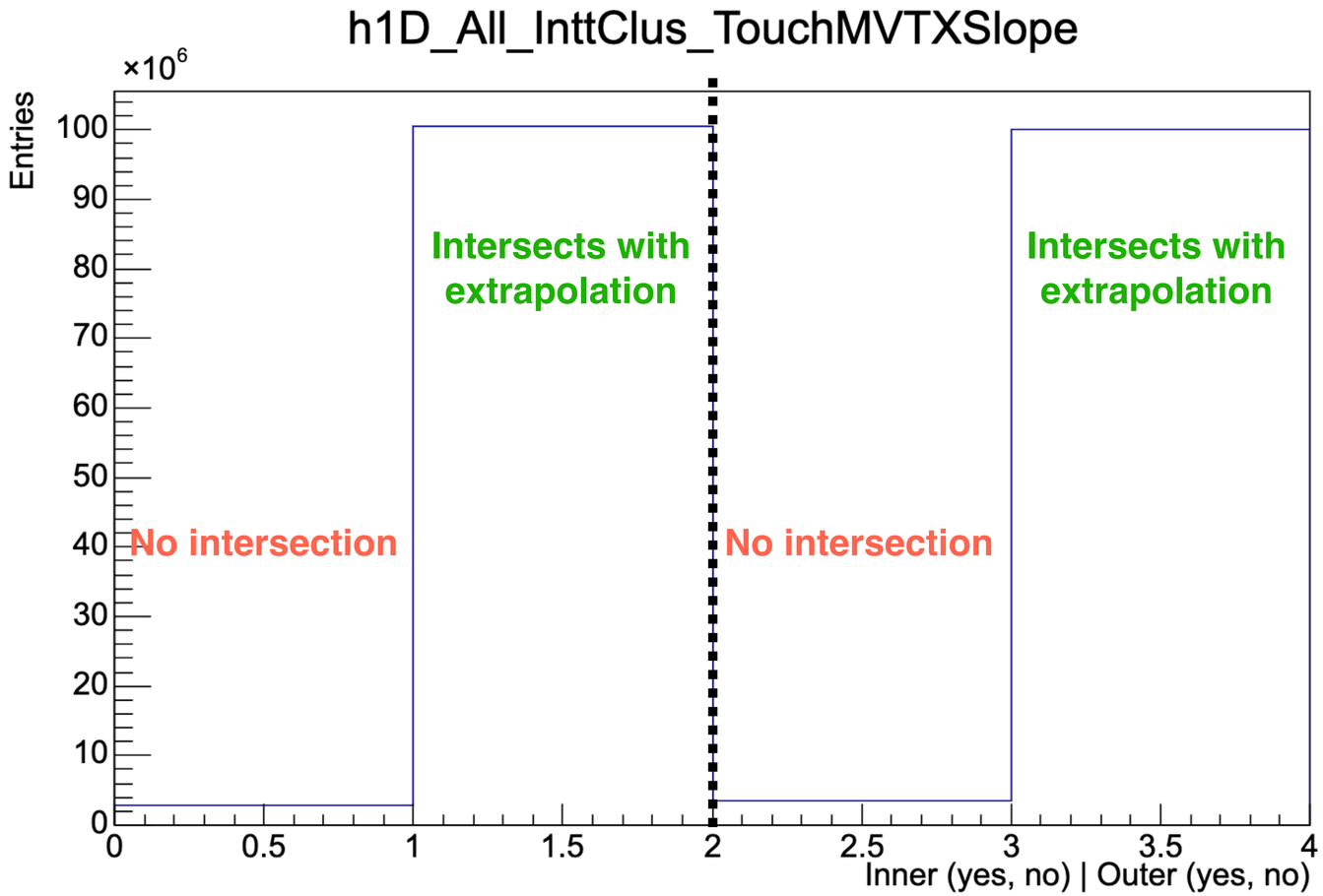
Selections

- Event selections:
  - None

- Track selections:
  - None
  - ~~nMVTX Cluster >= 3~~
  - ~~nINTT Cluster == 2~~
  - ~~!(Track charge != 0)~~
  - ~~Track pT >= 0.2 GeV && Track pT <= 10 GeV~~
  - ~~Track Eta <= 1.0~~
  - (No cut on DCA, DCAXY, track crossing value, and track-vertex association)

INTT strip intersection check





INTT cluster in inner layer **INTT cluster in outer layer**

~3% of silicon seeds have at least one INTT cluster
not intersecting with MVTX-triplet extrapolation
(with tolerance of 0.05 cm in both sides of strip)

MVTX cluster split?

The MVTX cluster, 7486127996929, is used in 7 tracks.
In this track, nINTT: 1, nMVTX: 4
The MVTX cluster, 7486127996929, position is: -0.333307 2.15619 4.71476
The MVTX cluster, 291160127963144, position is: -0.669343 2.81597 5.85756
The MVTX cluster, 291160127963145, position is: -0.665772 2.81783 5.86341
The MVTX cluster, 577170590138369, position is: -1.10697 3.72623 7.42418
The INTT cluster, position and timebucket is: 5.06989 -5.66479 13.5827 175
track pt, eta, phi, charge: 0.161452 1.24265 2.10414 -1

In this track, nINTT: 0, nMVTX: 4
The MVTX cluster, 7486127996929, position is: -0.333307 2.15619 4.71476
The MVTX cluster, 7486127996931, position is: -0.346497 2.14951 4.74088
The MVTX cluster, 291160127963145, position is: -0.665772 2.81783 5.86341
The MVTX cluster, 577170590138369, position is: -1.10697 3.72623 7.42418
track pt, eta, phi, charge: 0.568693 1.23272 1.99822 -1

In this track, nINTT: 0, nMVTX: 4
The MVTX cluster, 7486127996929, position is: -0.333307 2.15619 4.71476
The MVTX cluster, 7486127996931, position is: -0.346497 2.14951 4.74088
The MVTX cluster, 291160127963143, position is: -0.544075 2.88132 5.46288
The MVTX cluster, 577033151184897, position is: -0.824223 3.99064 6.57742
track pt, eta, phi, charge: 0.244602 0.858887 1.87799 -1

In this track, nINTT: 0, nMVTX: 4
The MVTX cluster, 7486127996929, position is: -0.333307 2.15619 4.71476
The MVTX cluster, 7486127996931, position is: -0.346497 2.14951 4.74088
The MVTX cluster, 291160127963141, position is: -0.544071 2.88132 5.45411
The MVTX cluster, 577033151184897, position is: -0.824223 3.99064 6.57742
track pt, eta, phi, charge: 0.244731 0.859363 1.87796 -1

In this track, nINTT: 0, nMVTX: 4
The MVTX cluster, 7486127996928, position is: -0.326816 2.15952 4.67584
The MVTX cluster, 7486127996929, position is: -0.333307 2.15619 4.71476
The MVTX cluster, 293359151218692, position is: -1.14153 2.78294 6.77136
The MVTX cluster, 577170590138372, position is: -1.67062 3.20034 8.14877
track pt, eta, phi, charge: 0.427114 1.61344 2.5023 -1

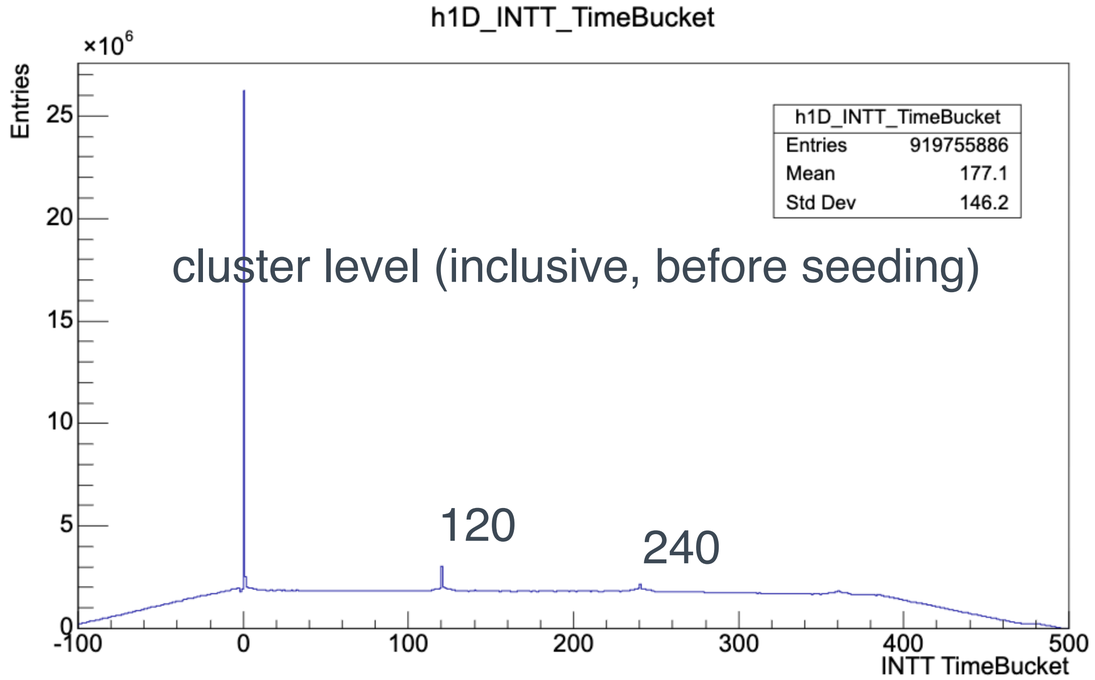
In this track, nINTT: 1, nMVTX: 4
The MVTX cluster, 7486127996929, position is: -0.333307 2.15619 4.71476
The MVTX cluster, 7486127996931, position is: -0.346497 2.14951 4.74088
The MVTX cluster, 293359151218693, position is: -1.14067 2.78396 6.77867
The MVTX cluster, 577170590138372, position is: -1.67062 3.20034 8.14877
The INTT cluster, position and timebucket is: 6.94057 -4.21435 19.5731 268
track pt, eta, phi, charge: 0.507529 1.60314 2.4502 -1

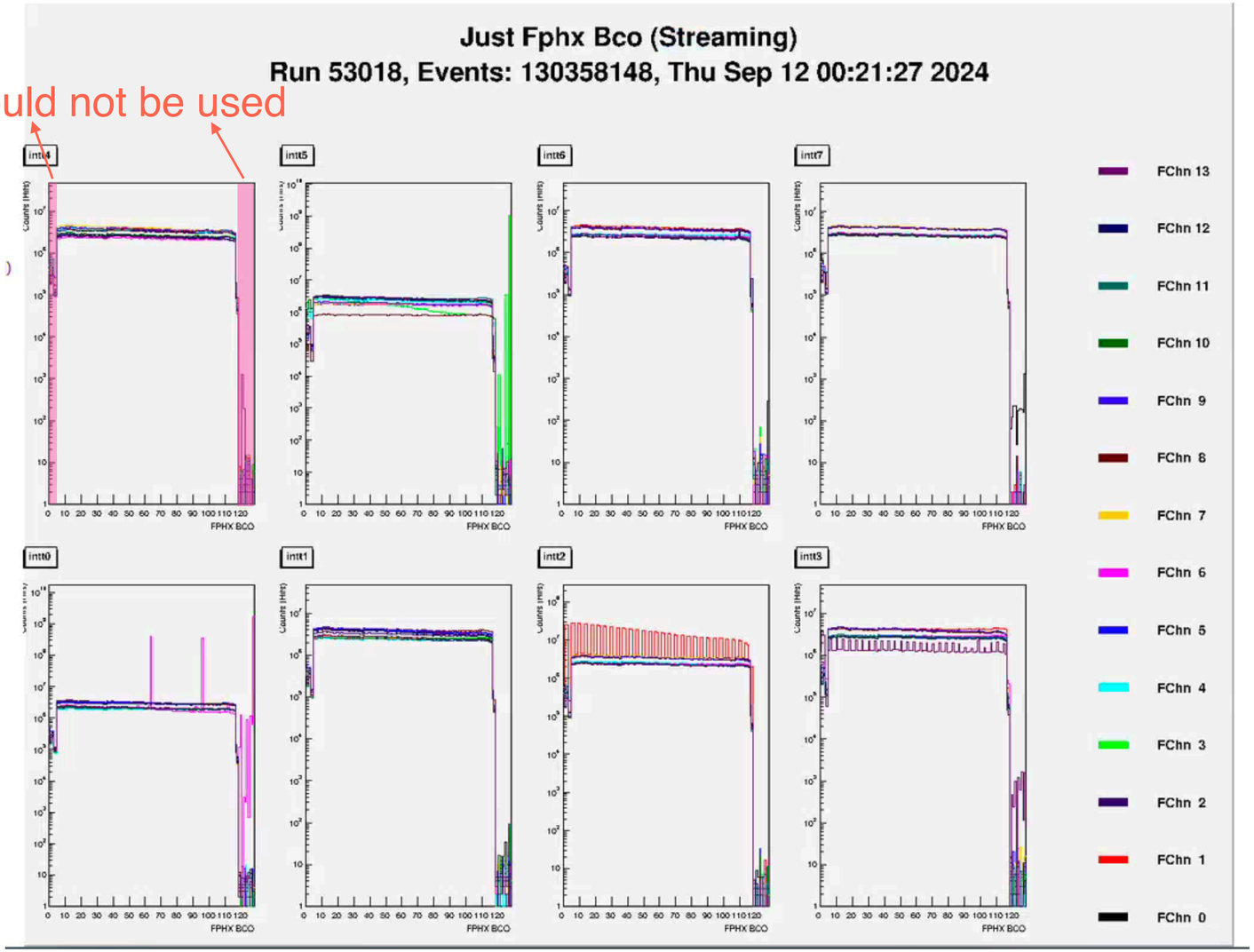
In this track, nINTT: 1, nMVTX: 4
The MVTX cluster, 7486127996929, position is: -0.333307 2.15619 4.71476
The MVTX cluster, 7486127996931, position is: -0.346497 2.14951 4.74088
The MVTX cluster, 293359151218691, position is: -1.13679 2.78861 6.77282
The MVTX cluster, 577170590138372, position is: -1.67062 3.20034 8.14877
The INTT cluster, position and timebucket is: -4.76934 5.26658 15.5794 278
track pt, eta, phi, charge: 0.138008 1.60269 2.39293 -1

_928, _929, _931 are very close to each other

INTT cluster TimeBucket distribution

Run number: 53018 (Run24 pp run, one of the runs in the good run list)





INTT alignment paramter

- INTT geometry is a bit disconnected from the real geometry
  - Some sensors are away from their own barrels after applying the alignment parameters
  - Could be due to no constraints in the radial direction in the misalignment study