

Event Mixup

20240815

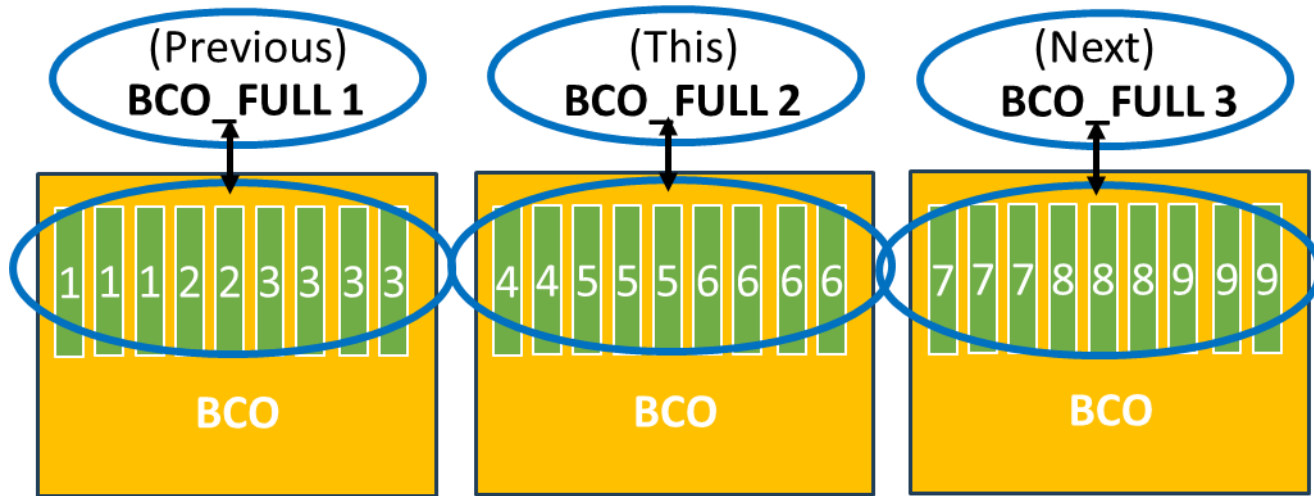
NWU Mai Kano

Event Mixup status

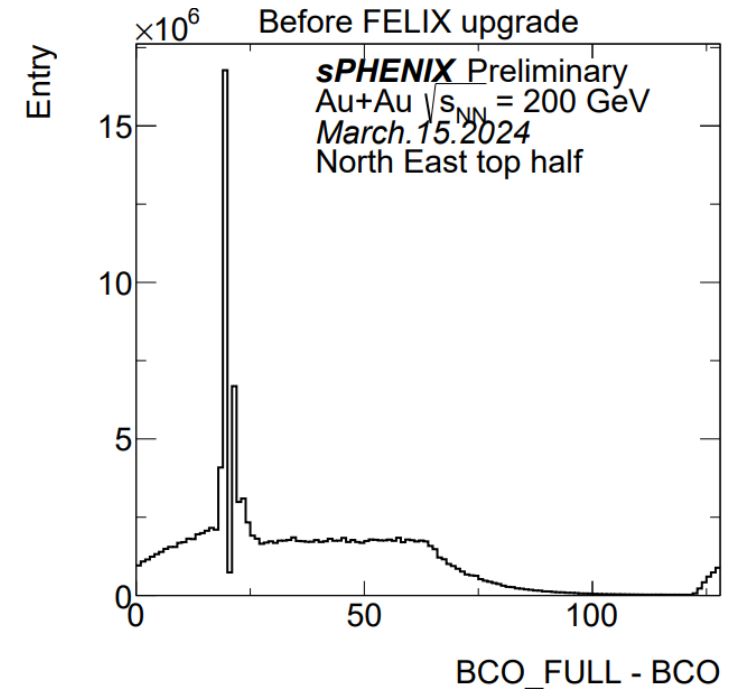
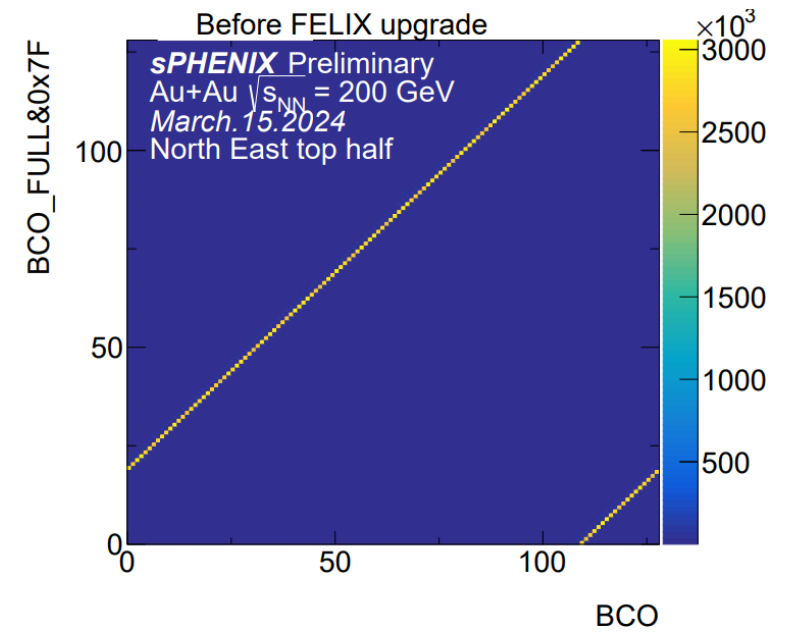
- I will talk about Event Mixup to report on the current status of INTT data readouts in Run24 at JPS meeting.
- At this point, I would like to reiterate the current status of the Event Mixup at Run23,24 and decide on a future course of action.

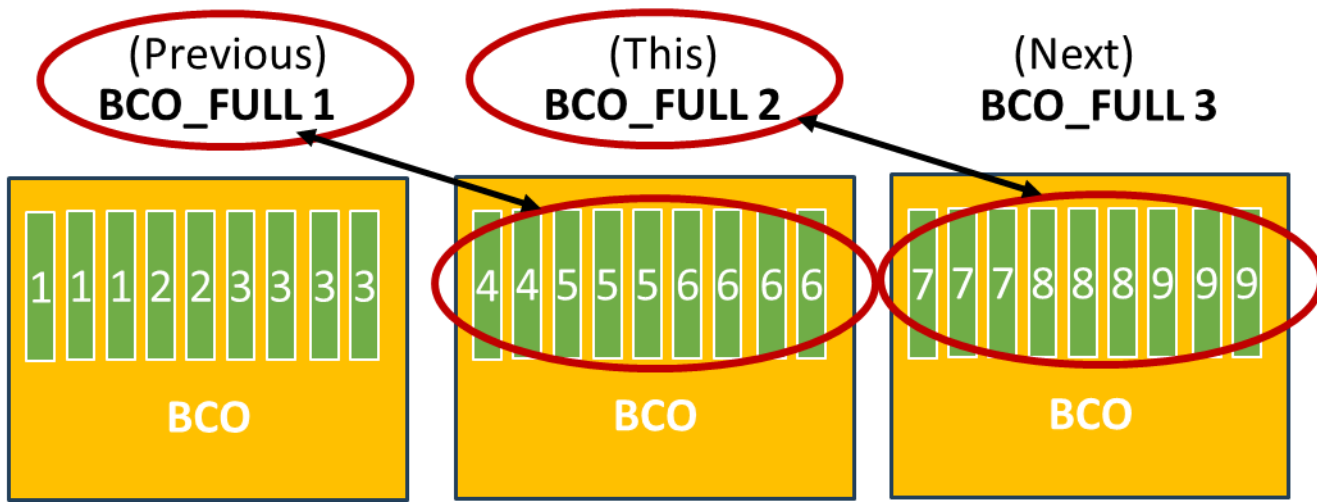
What we know about Event Mixup in Run23

- Event Mixup is in the form that hit information from the previous event is mixed up with the next event.
- Event mixups have been observed on some runs. The number of mixup hits correlates with the multiplicity of the previous event.
- Event Mixup were also found in the data after the Felix upgrade, but Event Mixup were less likely to occur after the upgrade.

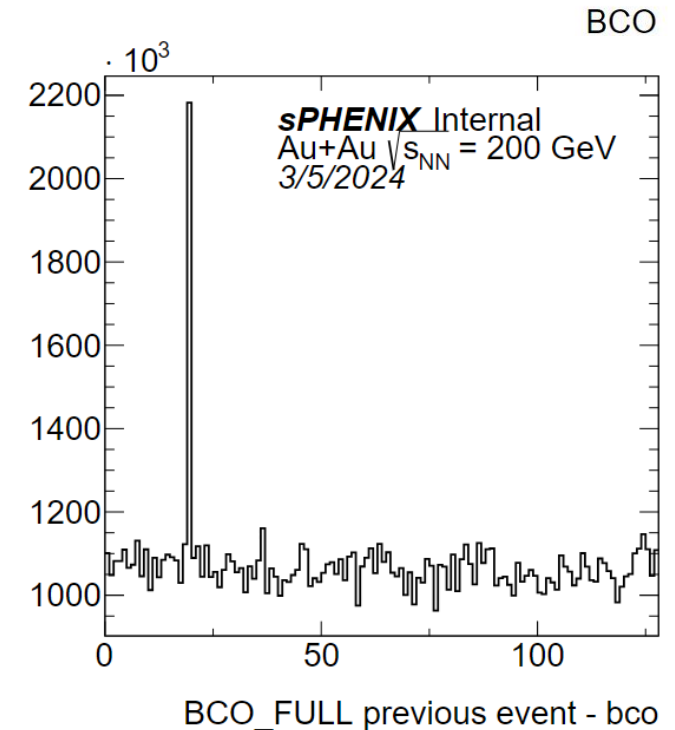
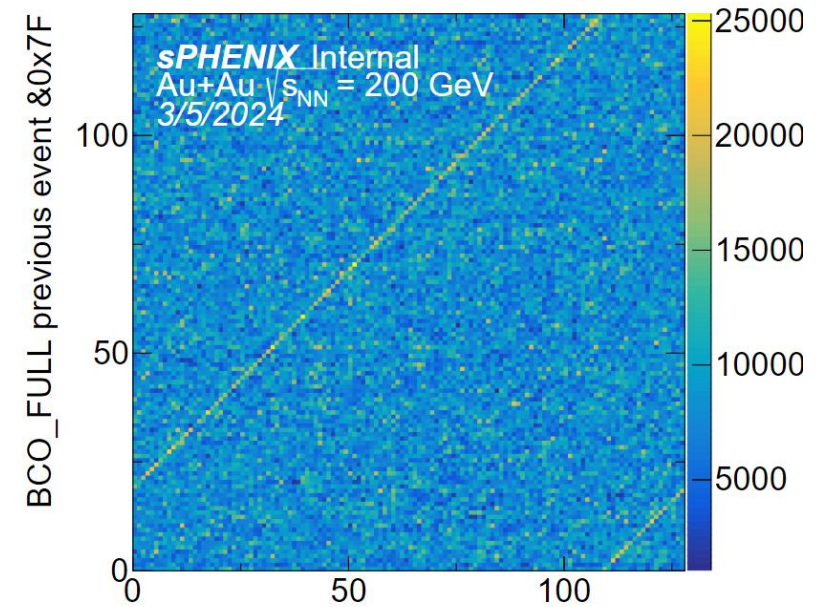


- Above figure shows the correlation between BCO and BCO FULL low 7bits. A clear correlation is seen.
- Below figure shows the BCO FULL low 7bits – BCO.
- This indicates INTT hits are well tagged by correct BCO time stamp in the data.





- Above figure shows the correlation between BCO and BCO FULL low 7bits of previous event.
- Below figure shows the BCO FULL low 7bits of previous event – BCO.
- There should be no correlation between the BCO_Full of the previous event and the BCO of this event, but the correlation as shown on the figure.
- This suggests that the previous and current collision data are mixed.



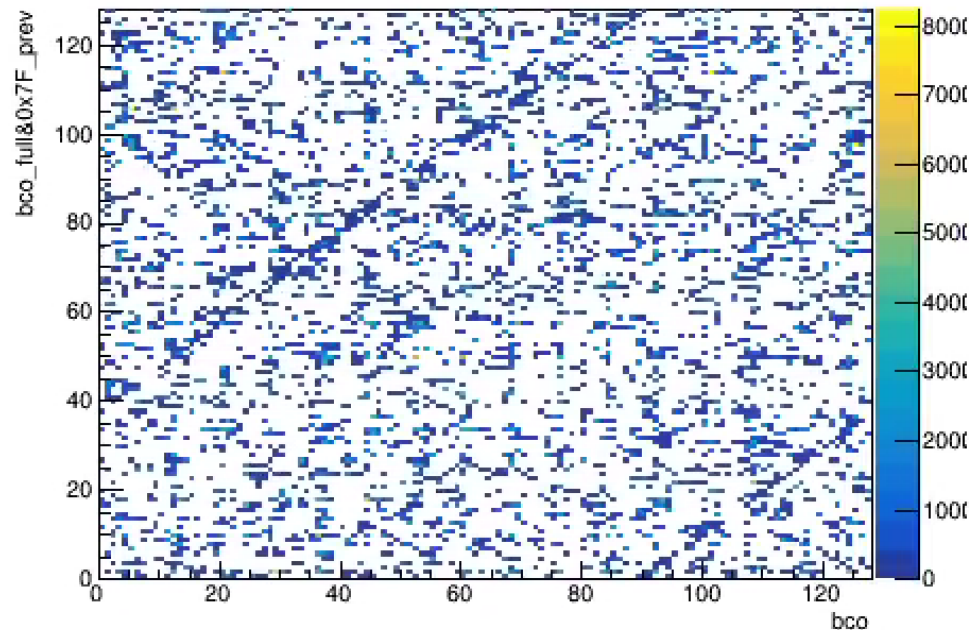
How about the correlation between “This” and “Next” events?

Run23896 intt5

This Run is what I think the Mixup is occurring

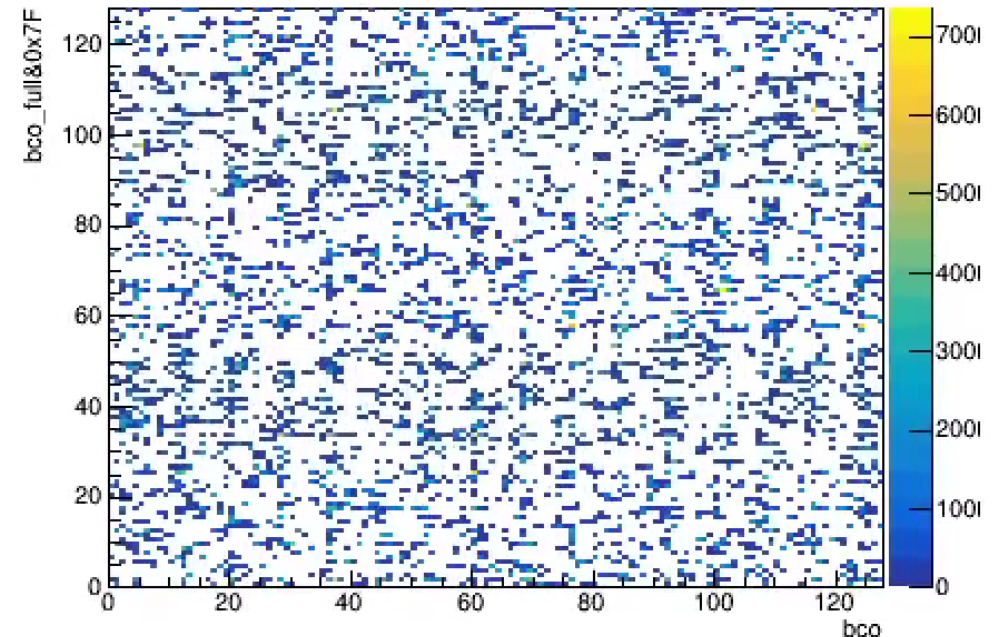
BCO vs previous event BCO_Full

bco_full&0x7F_prev vs bco intt5-00023896



BCO vs next event BCO_Full

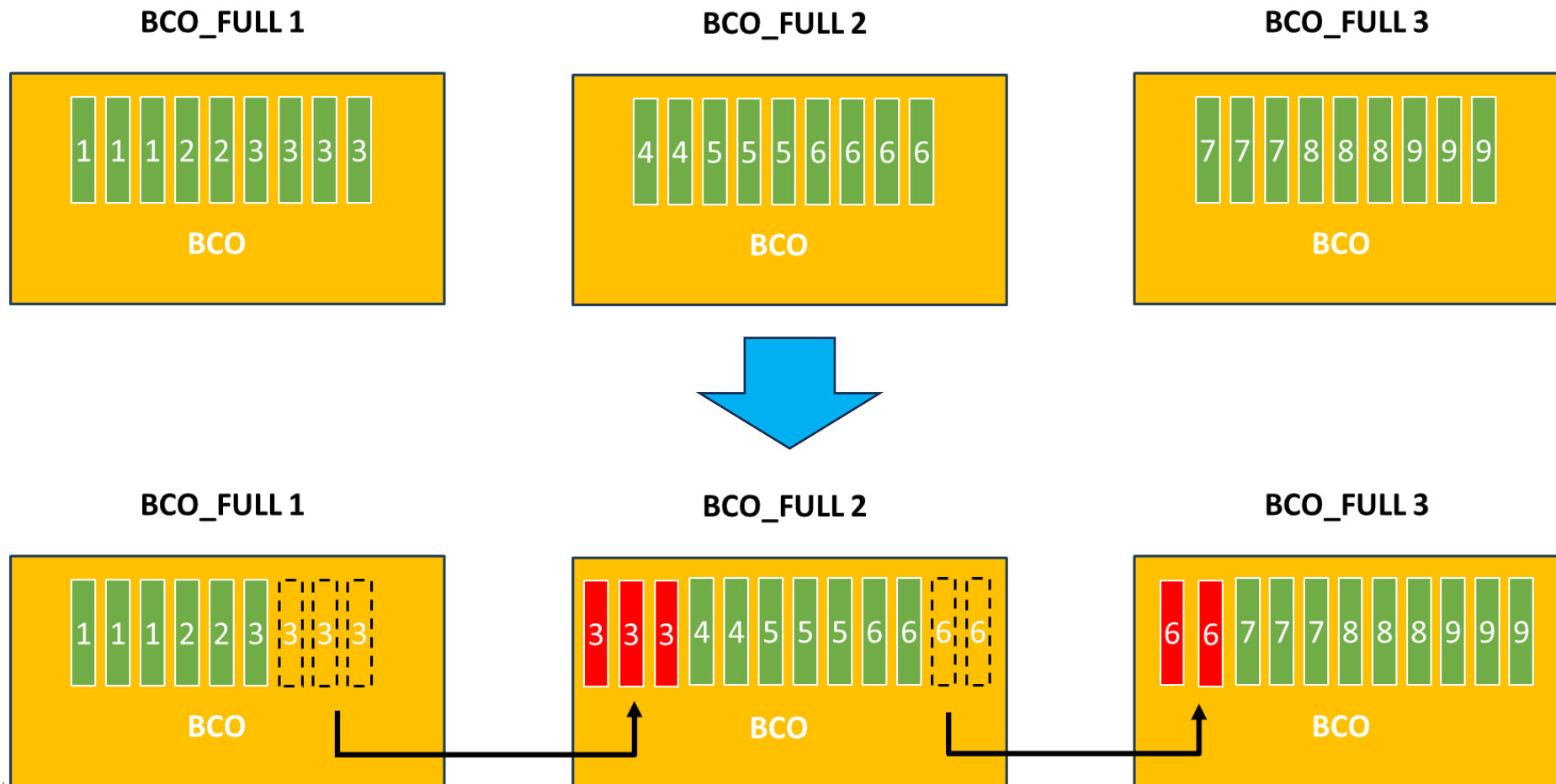
bco_full&0x7F_next vs bco



Next I looked at BCO_Full for the next event vs BCO and the correlation that was there when looking at BCO_Full for the previous event disappeared.

What's happening in the case of Event Mix-up?

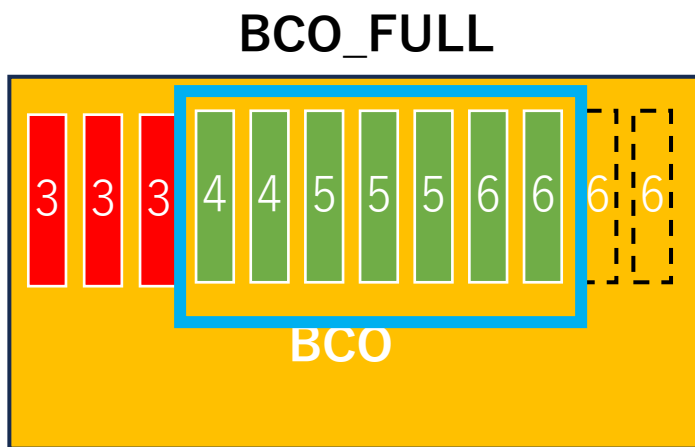
From the results, Event Mixup is in the form that hit information from the previous event is mixed up with the next event, as shown in the following figure.



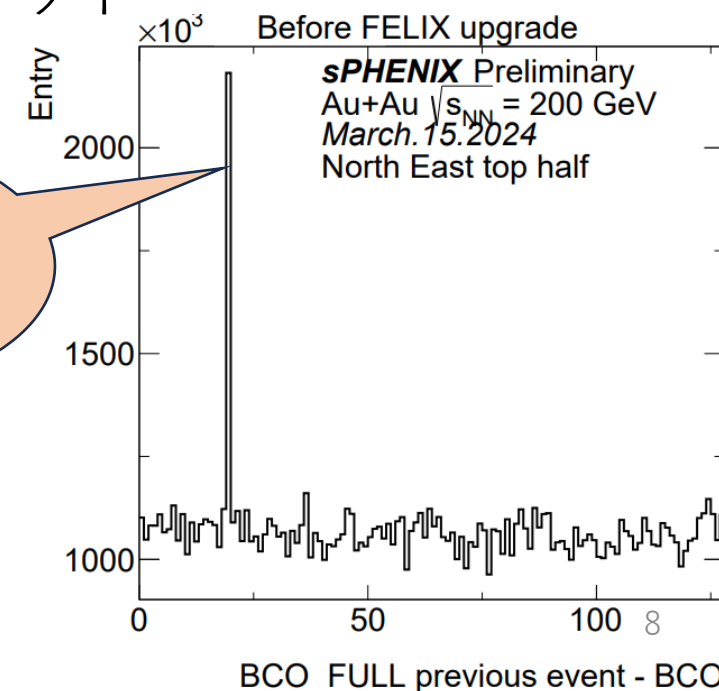
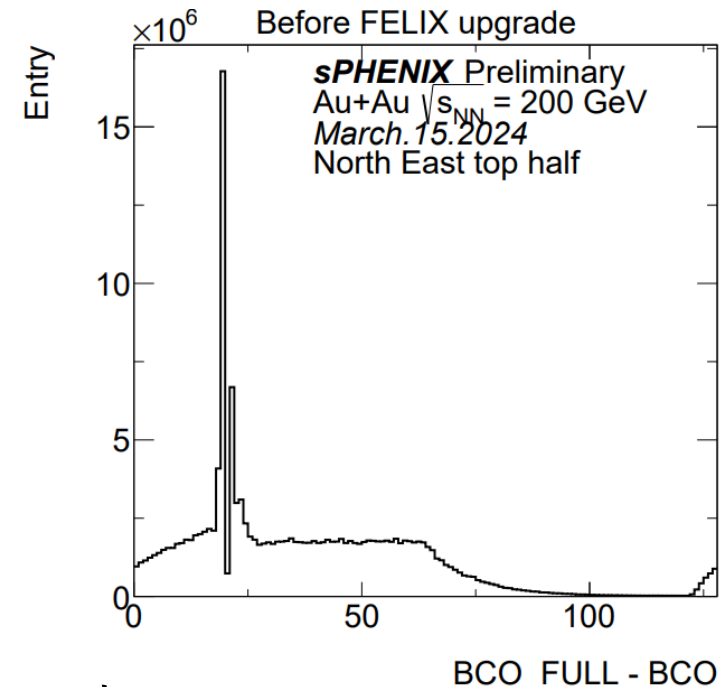
Mixupヒットの判定方法

- BCO_FULL - BCO を用いて判定
 - ① BCO_FULL (現在) - BCO (現在)
 - ② BCO_FULL (前) - BCO (現在)同じ位置にあるピークをMixupと定義

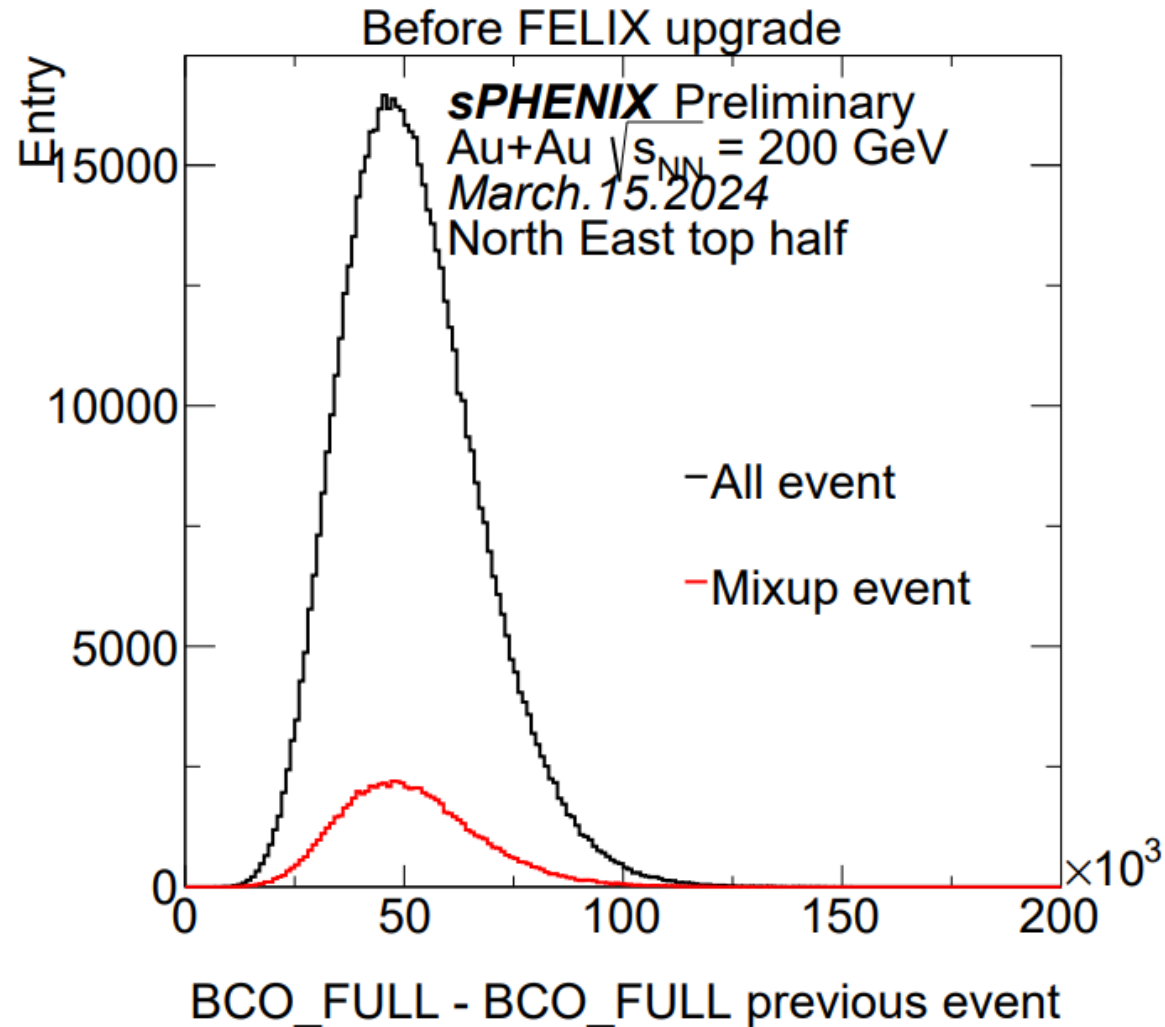
- ②に含まれる現在のイベントの衝突によるヒットをカット



Event Mixup



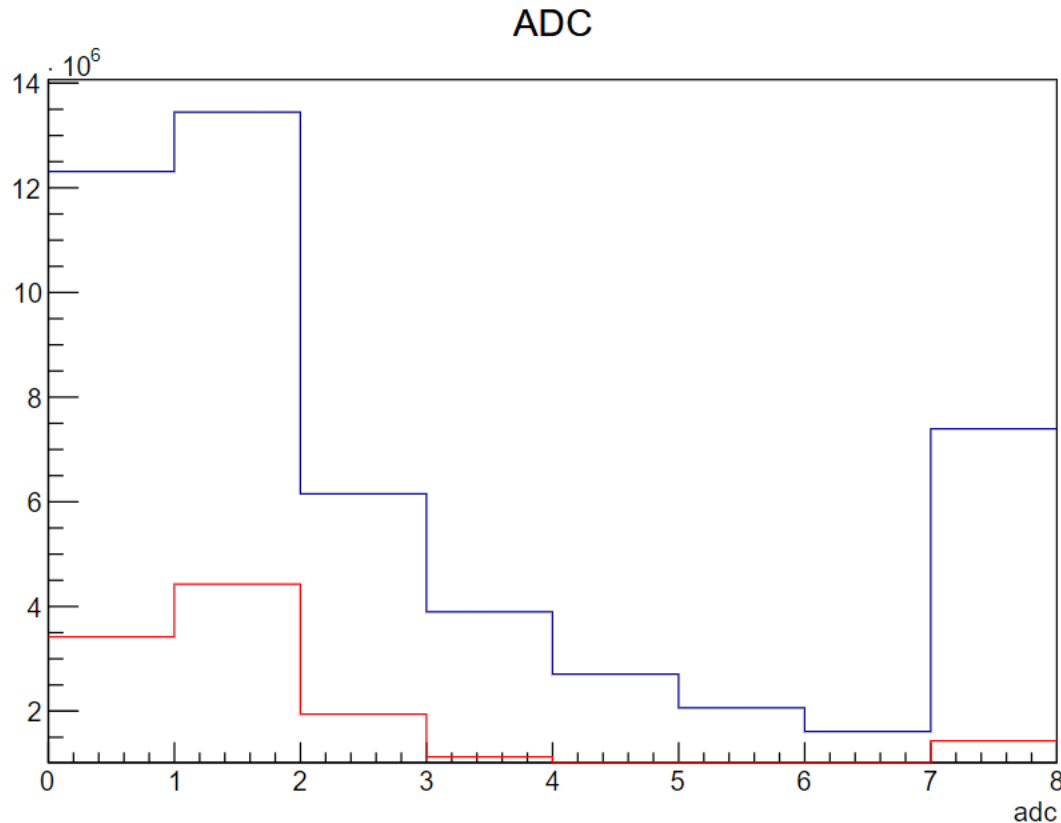
Collision interval All event and Mixup event (Before Felix upgrade)



2024/8/14

- To examine collision interval dependence, The interval distribution of the Mixup Event and the previous Event was checked.
- Results showed no change in peak position between Mixed-up events and all events. Mixed-up does not change with interval width.
- This suggests that no correlation between Event Mixup and collision interval.

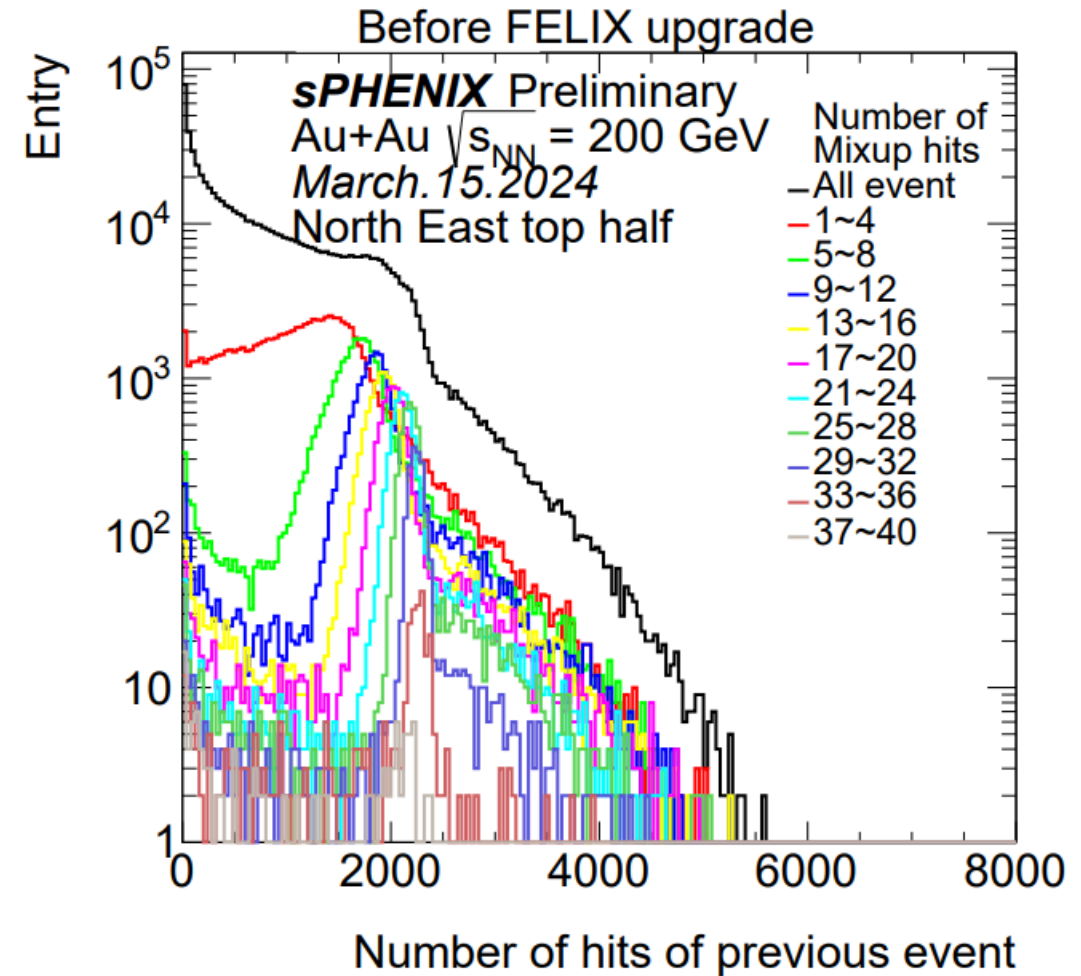
ADC and Mixup (Before Felix upgrade)



- To determine if there is a relationship between Mixup hits and ADC, I made an ADC distribution of Mixup hits.
- The left figure examines 10% of all events (Run20708intt5).
- Blue is the ADC distribution of all hits and Red is the ADC distribution of Mixup hits.
- Since there is no significant difference in the shape of the distribution from this result, I think that Mixup and ADC are not related.

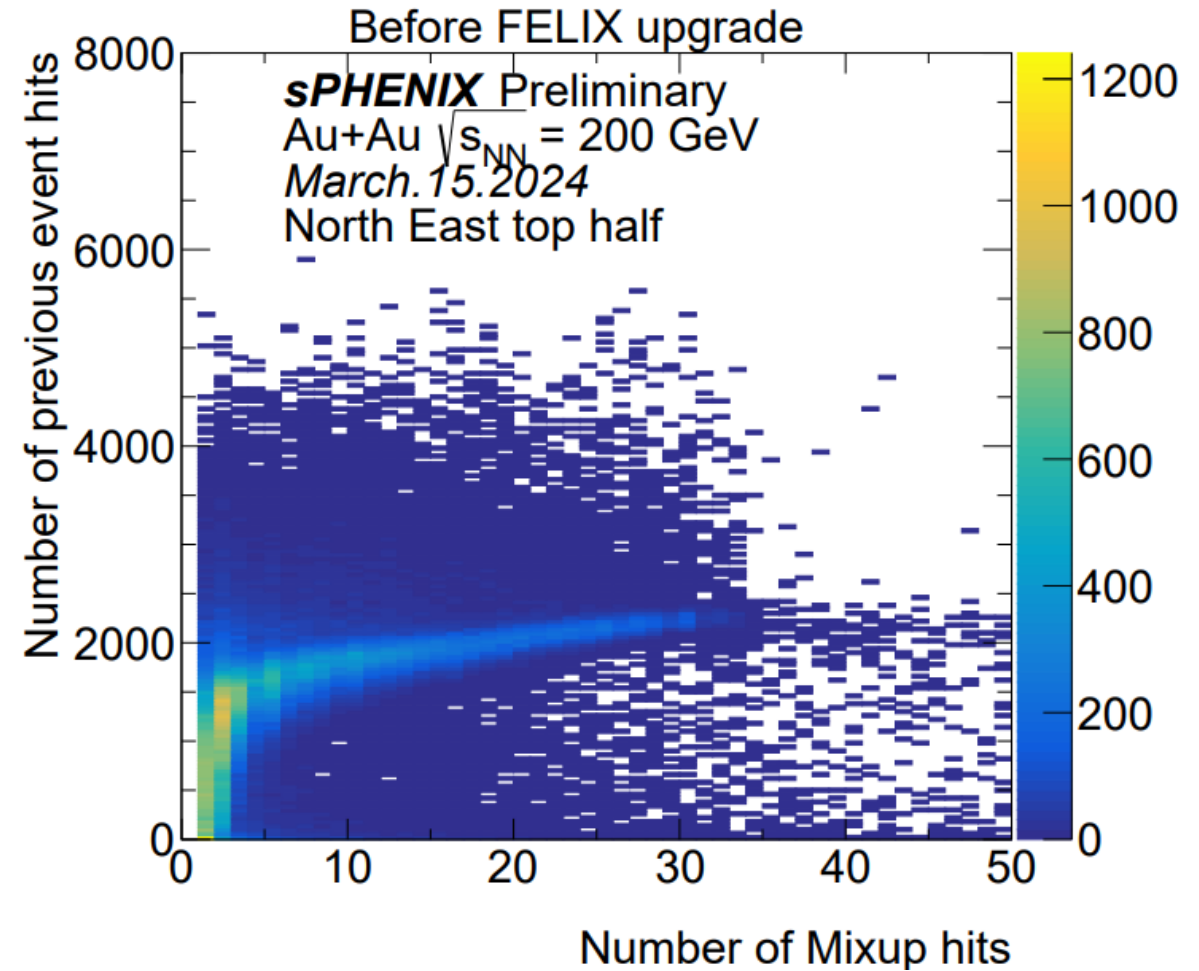
Hits Multiplicity (separated by number of Mixup)

- Figure shows hit Multiplicity of previous event distribution separated by Number of Mixed up hits from 1 to 40.
- This results confirm that as the number of mixed-up hits increases, the peak moves in the direction of increasing multiplicity with multiplicity above about 1500.
- This indicates that Event Mixup are more likely to occur when Multiplicity is above about 1500.



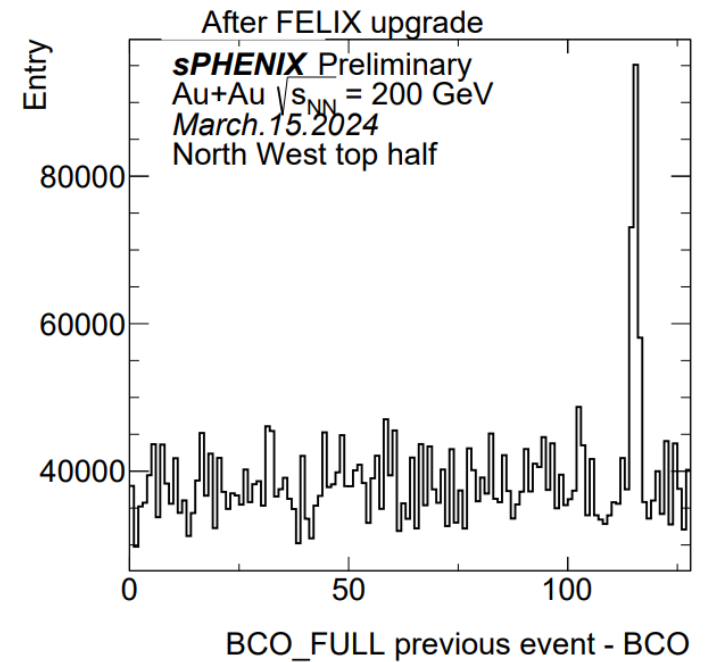
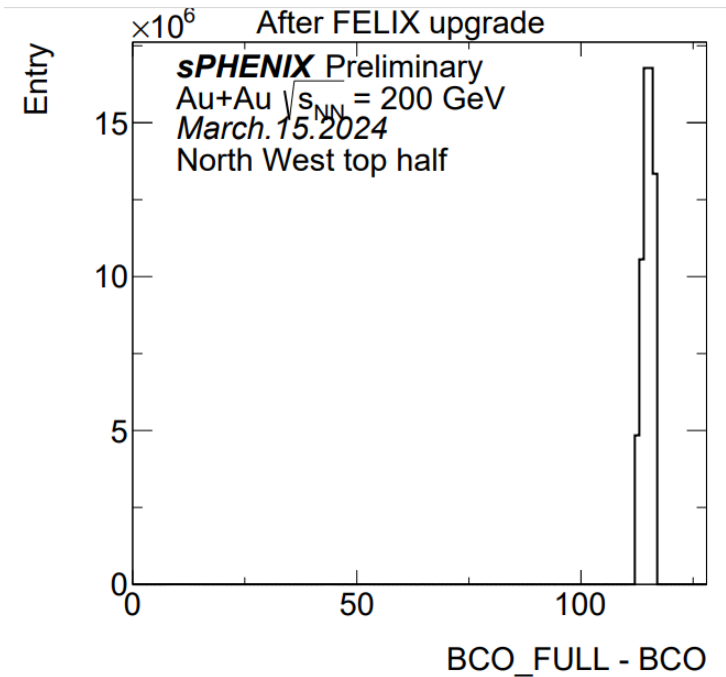
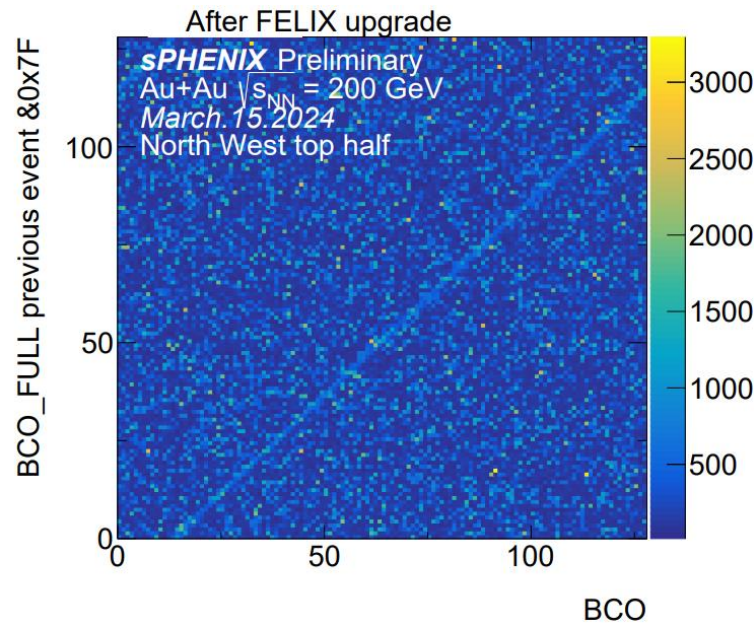
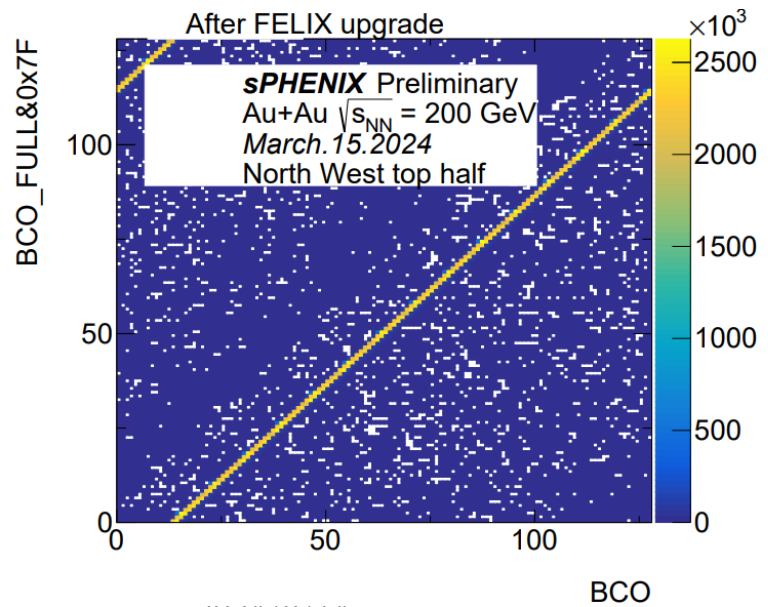
Number of Mixup hits vs hit Multiplicity

- Figure shows the correlation between Number of Mixup hits and hit Multiplicity of previous event. This figure confirms the correlation.
- Number of Mixup hits increase as the number of hits of previous event increases with the number of hits of one previous event above about 1500.



After Felix upgrade

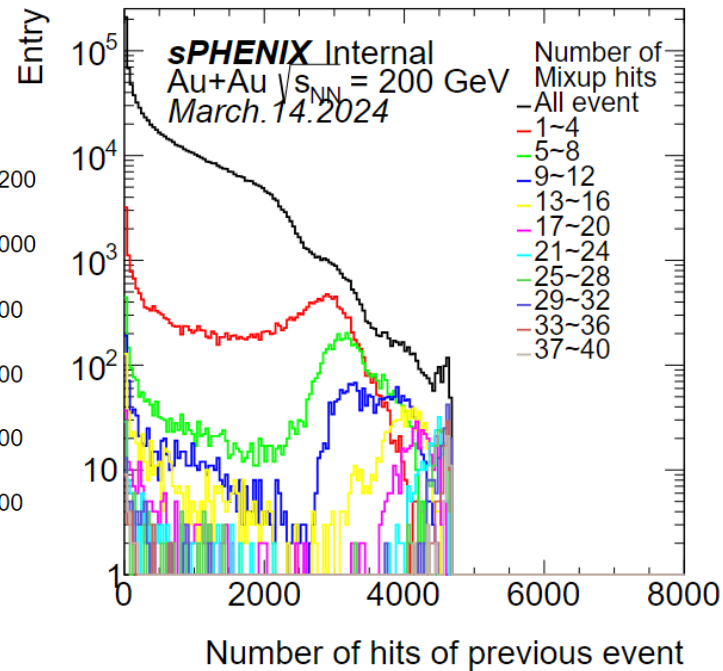
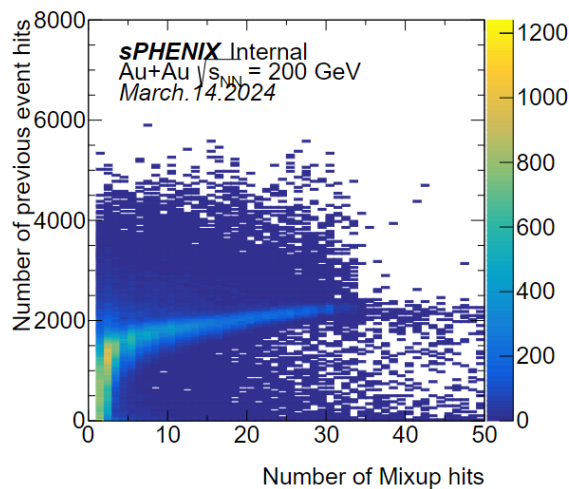
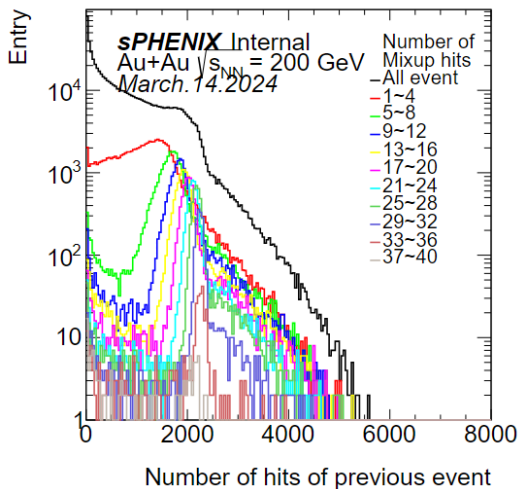
- On July 21, 2023, Felix firmware upgrade was performed, and as a result, changes were observed in Event Mixup. The plots below, using Run24768 intt6, show the current status of INTT.
- These figures confirm that Event Mixup is occurring.



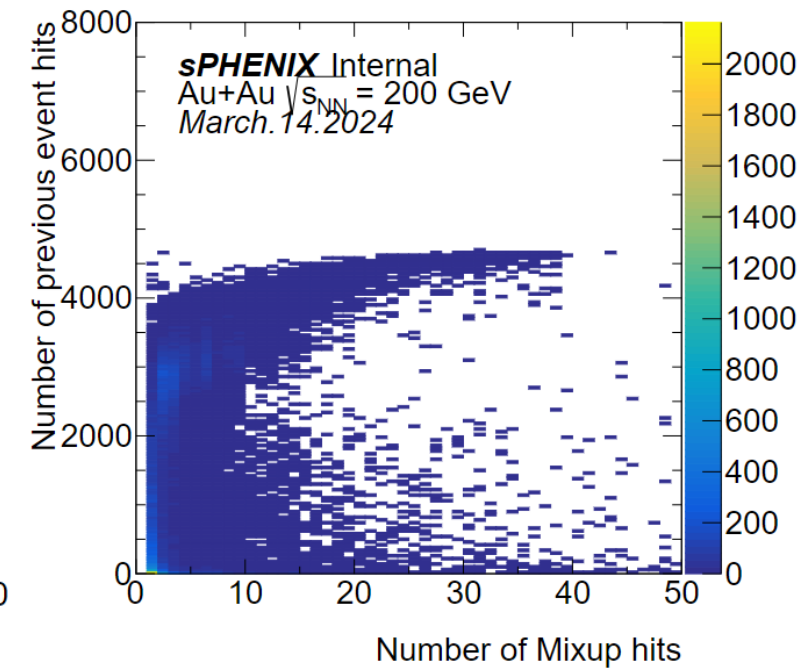
After Felix upgrade

- In the Multiplicity distribution, The position of the peak shifted toward the larger side, and Event Mixup were more likely to occur when the number of hits in an event was greater than 3000.
- In other words, we found that Event Mixup were less likely to occur after the upgrade.
- Similarly, the correlation between Number of Mixup hits and hit Multiplicity, the position of the correlation moved above 3000.

Before



After



Run23 summary

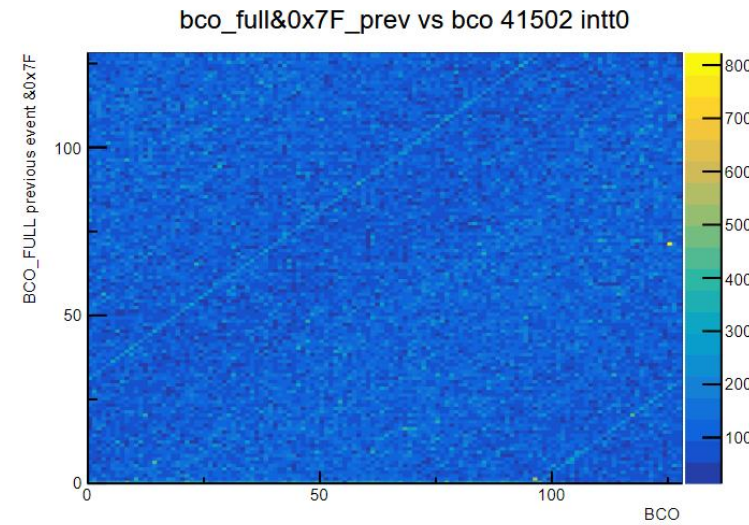
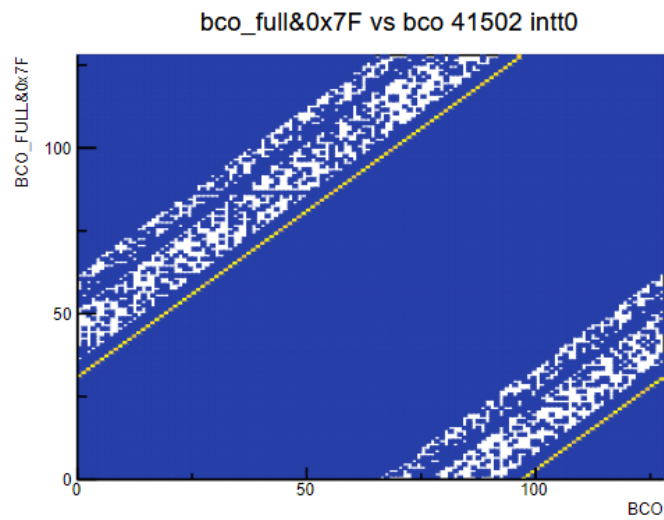
- The number of mixup hits correlates with the multiplicity of the previous event.
- Event Mixup were also found in the data after the Felix upgrade, but Event Mixup were less likely to occur after the upgrade.

Event Mixup in Run24

- I checked the status of Event Mixup with some data in Run24 .
- From this we know that Event Mixup are also occurring in p-p collisions.
- I checked Mixup fraction

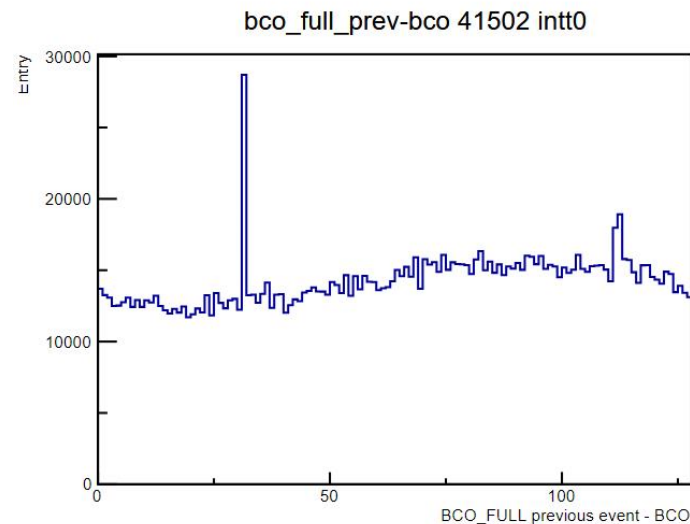
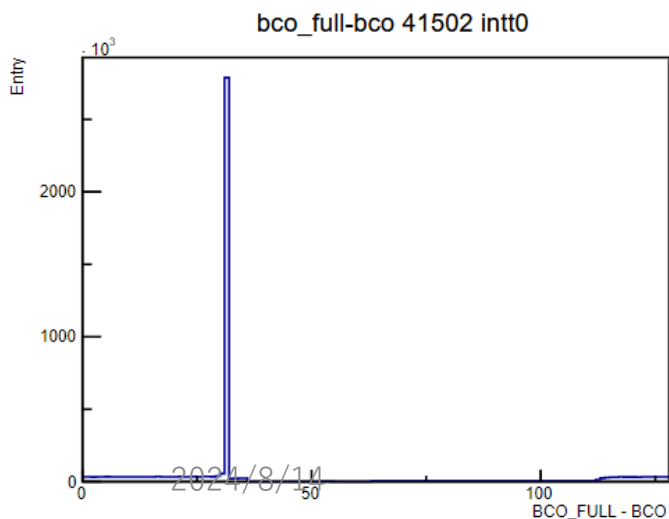
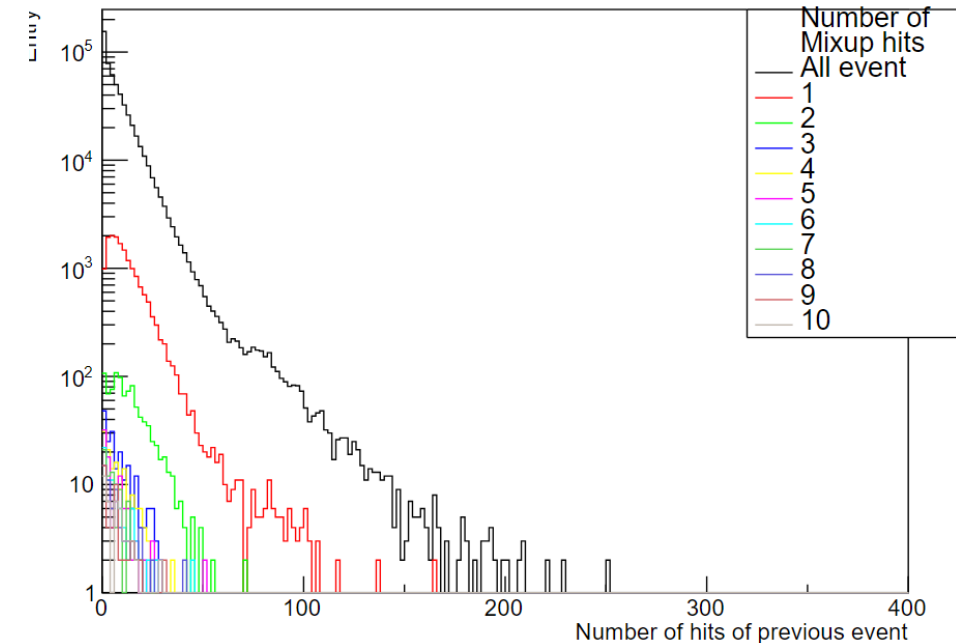
Run24 p-p

Run41502(5/2) open time=35 n_collision=100 intt0

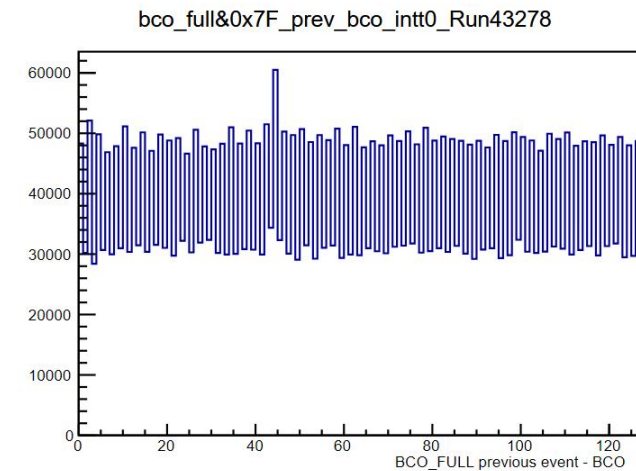
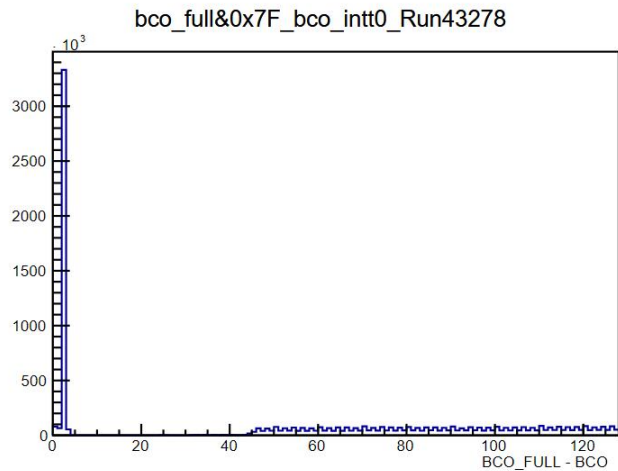
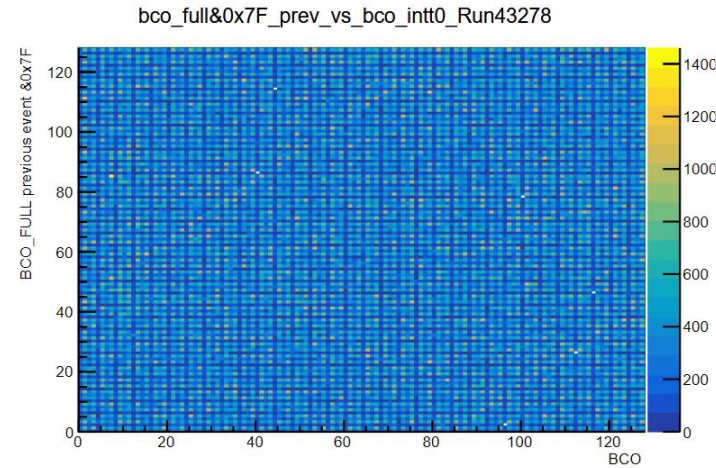
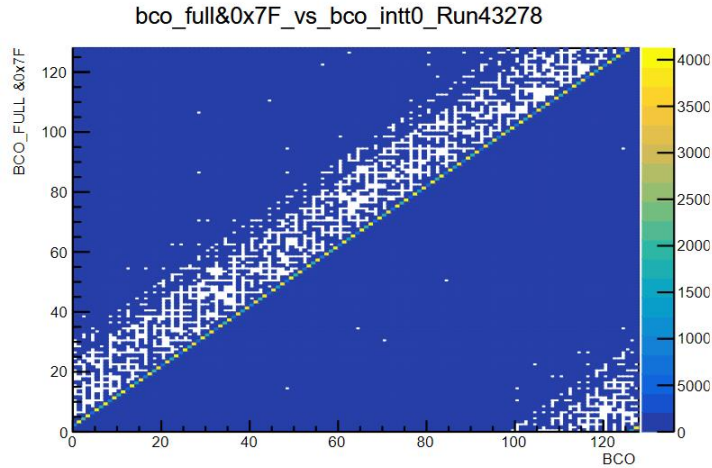


The other Felix are in the same state. These results indicate that Event Mixup occur even in p-p collisions with low multiplicity.

Mixup Multiplicity 41502 intt0

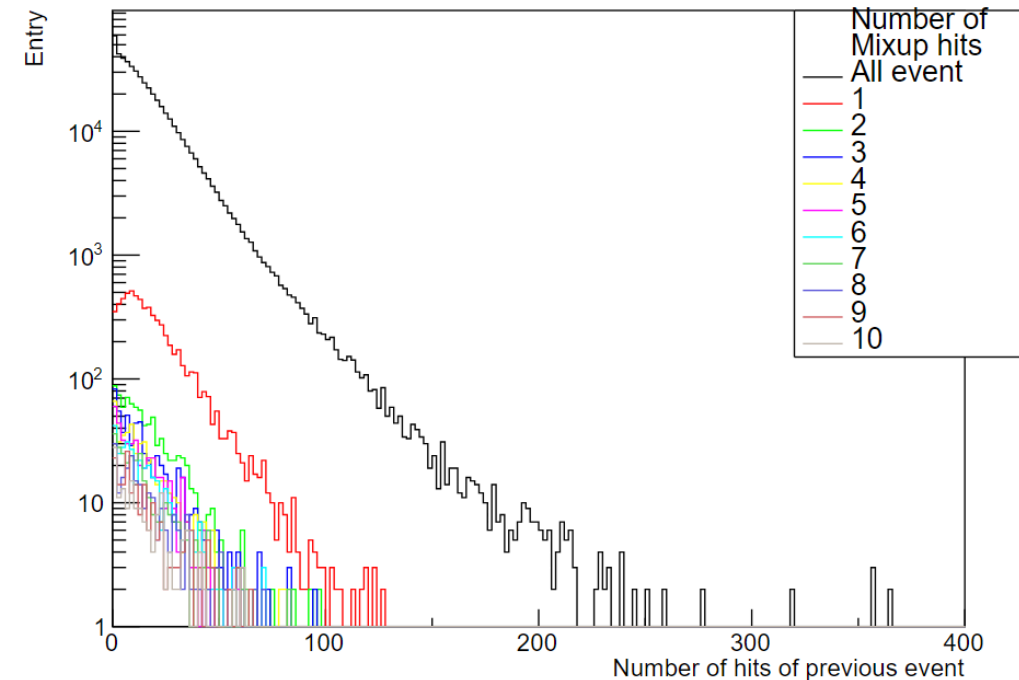


Run24 p-p Run43278(5/20) open time=55 n_collision=100 intt0



The other Felix are in the same state. These results indicate that Event Mixup occur even in p-p collisions with low multiplicity.

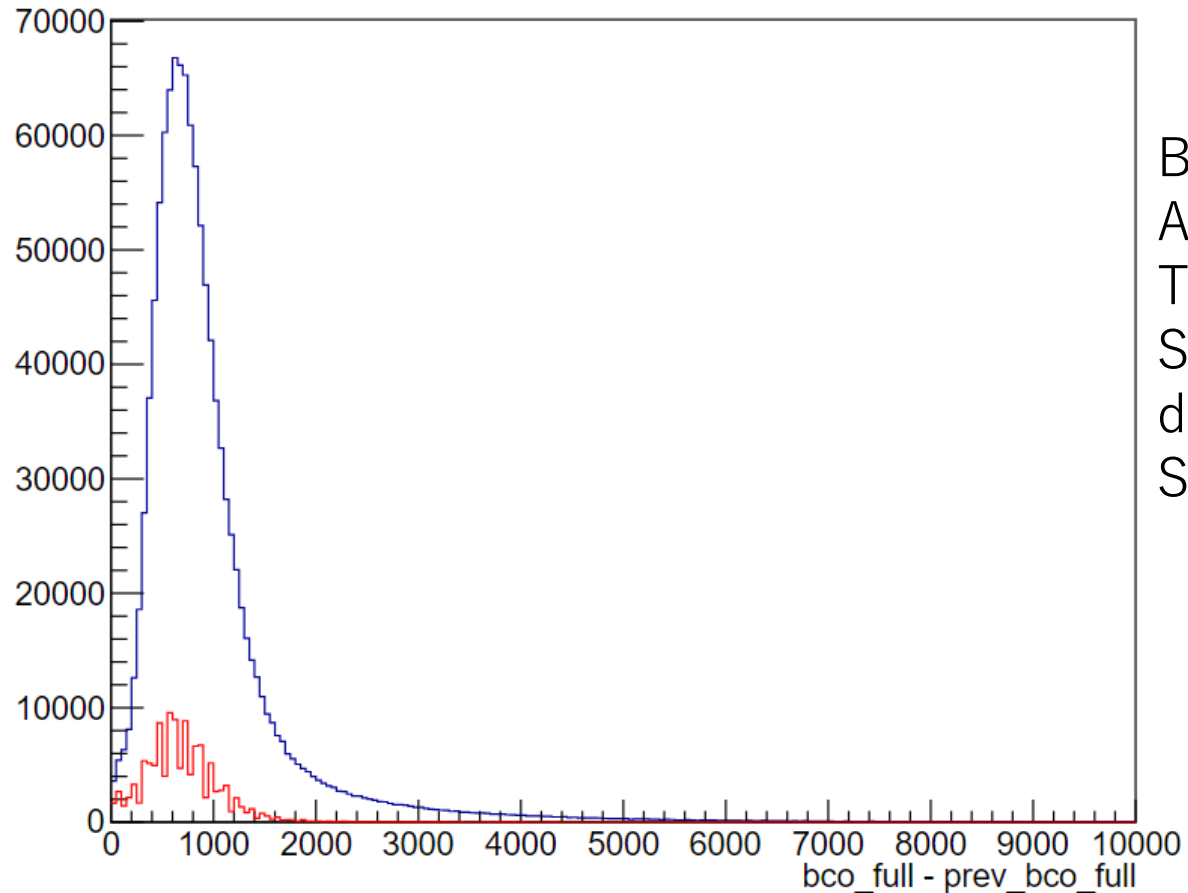
Mixup Multiplicity 43278 intt0



Collision interval

bco_full - prev_bco_full_Run43278

Run43278 open time = 55 n_collision=100



BCO_Full – previous BCO_Full

All event (black) Mixup event (red)

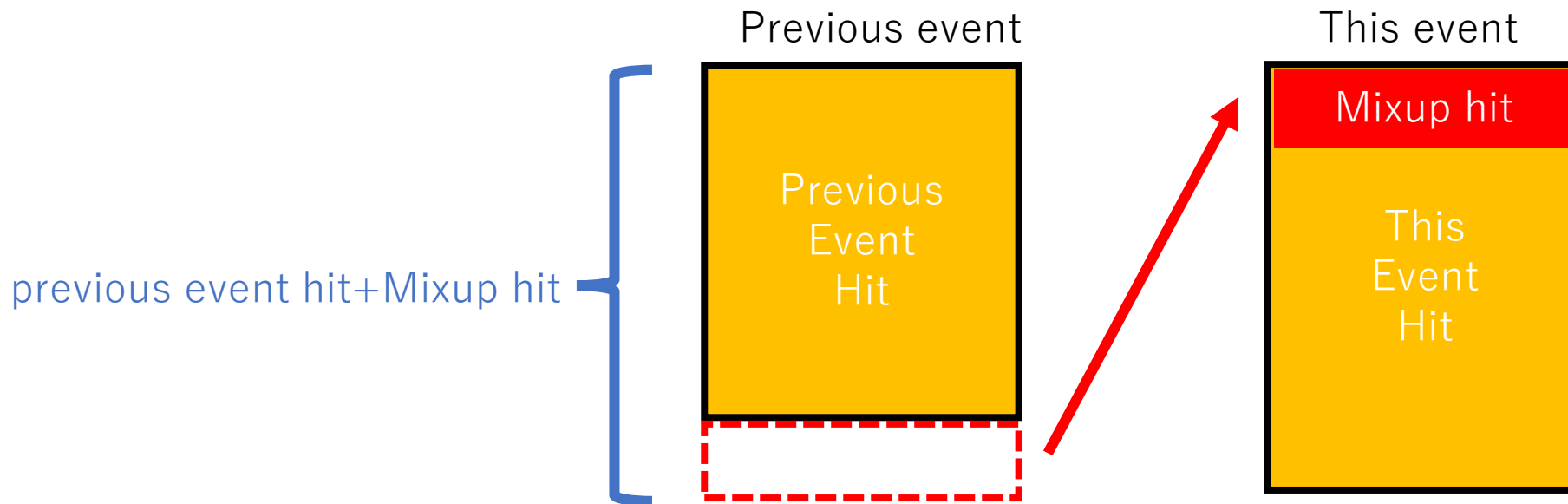
The peaks do not appear to be significantly misaligned.
So I think Mixup don't have collision interval dependence.

Similar results were obtained for other Runs.

Mixup event · hit fraction

$$\text{Mixup Event fraction} = \frac{\text{Mixup Event}}{\text{All Event}} \times 100 [\%]$$

$$\text{Mixup Hit fraction} = \frac{\text{Mixup Hit}}{\text{Previous Event Hit} + \text{Mixup Hit}} \times 100 [\%] \quad \text{Average} = \frac{\text{Mixup Hit fraction}}{\text{Mixup Event}}$$



To be able to see how many mixups are occurring, I calculated the fraction of events where mixup are occurring and the fraction of mixup hits. Both are multiplied by 100 and changed to percent.

Run24 pp

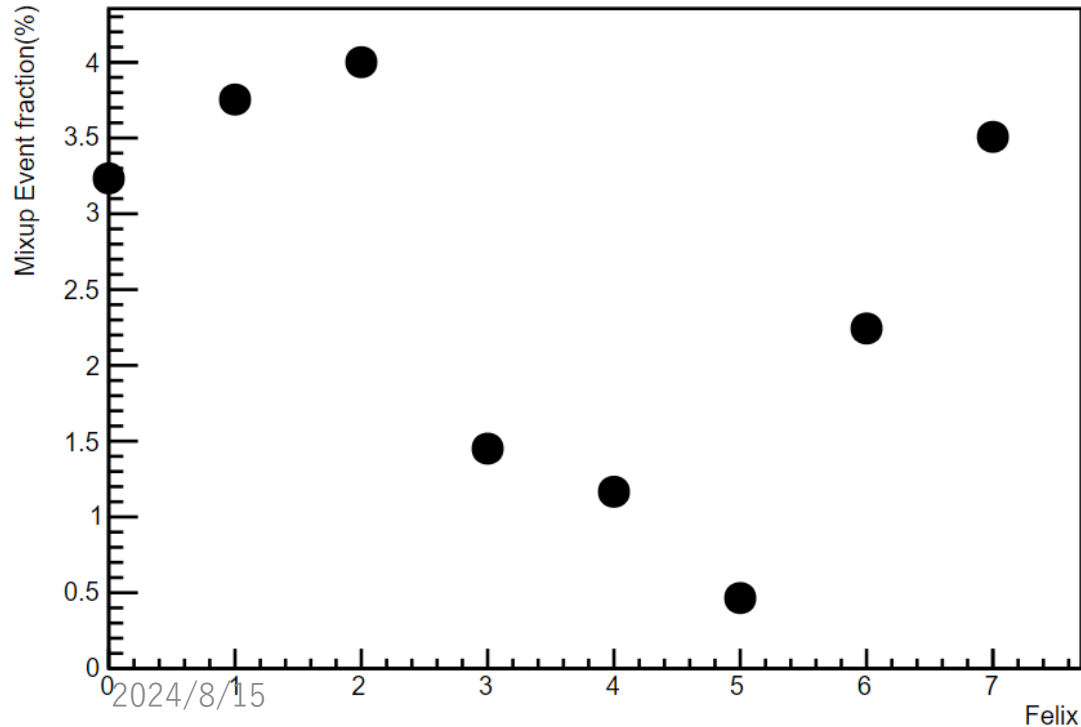
Run41502(5/2) open time=35 n_collision=100

$$\text{Mixup Event fraction} = \frac{\text{Mixup Event}}{\text{All Event}} \times 100$$

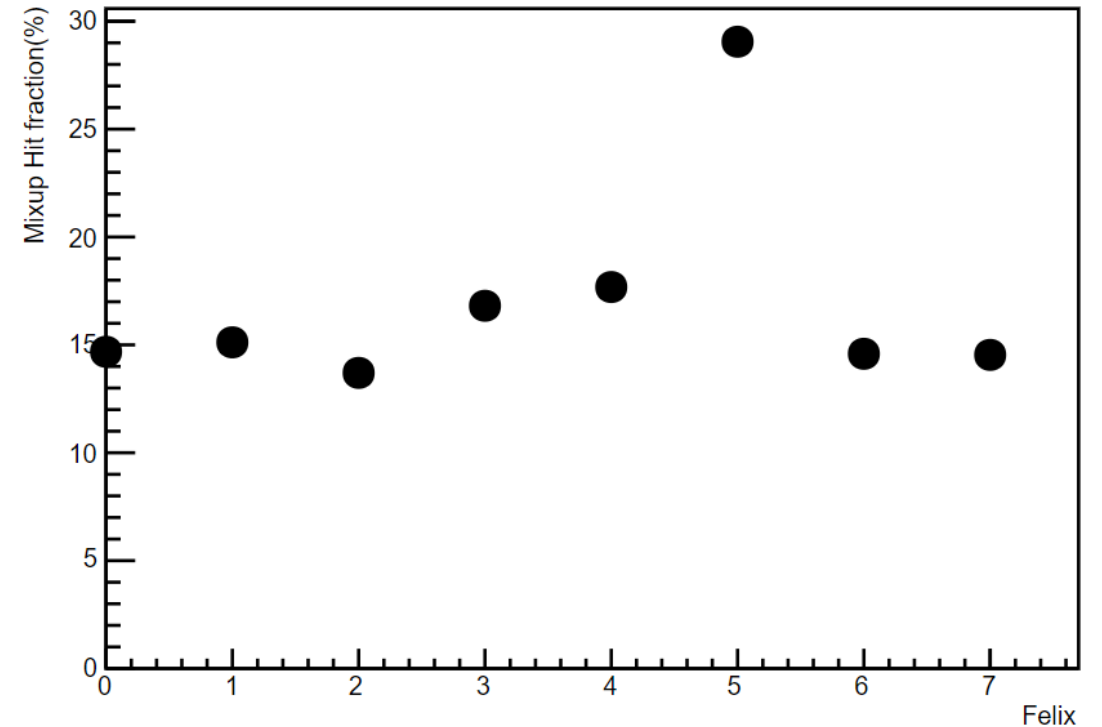
$$\text{Mixup Hit fraction} = \frac{\text{Mixup Hit}}{\text{Previous Event Hit} + \text{Mixup Hit}} \times 100$$

$$\text{Average} = \frac{\text{Mixup Hit fraction}}{\text{Mixup Event}}$$

Mixup event fraction



Mixup Hit fraction



Run24 p-p

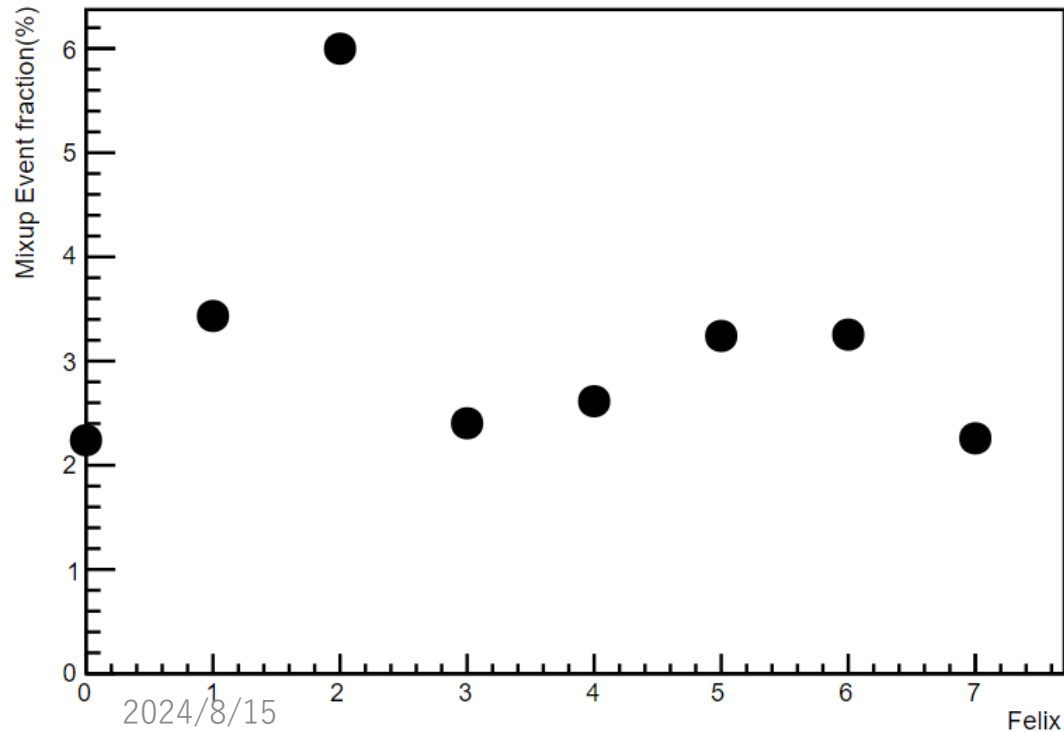
Run43278(5/20) open time=55 n_collision=100

$$\text{Mixup Event fraction} = \frac{\text{Mixup Event}}{\text{All Event}} \times 100$$

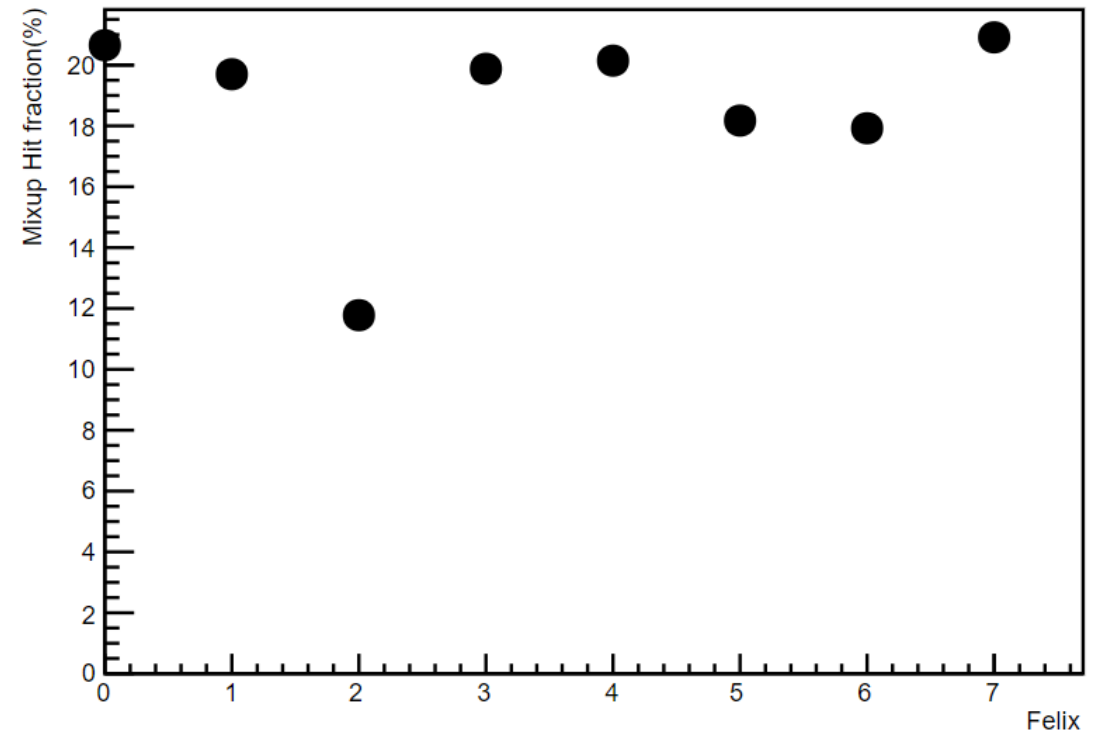
$$\text{Mixup Hit fraction} = \frac{\text{Mixup Hit}}{\text{Previous Event Hit} + \text{Mixup Hit}} \times 100$$

$$\text{Average} = \frac{\text{Mixup Hit fraction}}{\text{Mixup Event}}$$

Mixup event fraction



Mixup Hit fraction



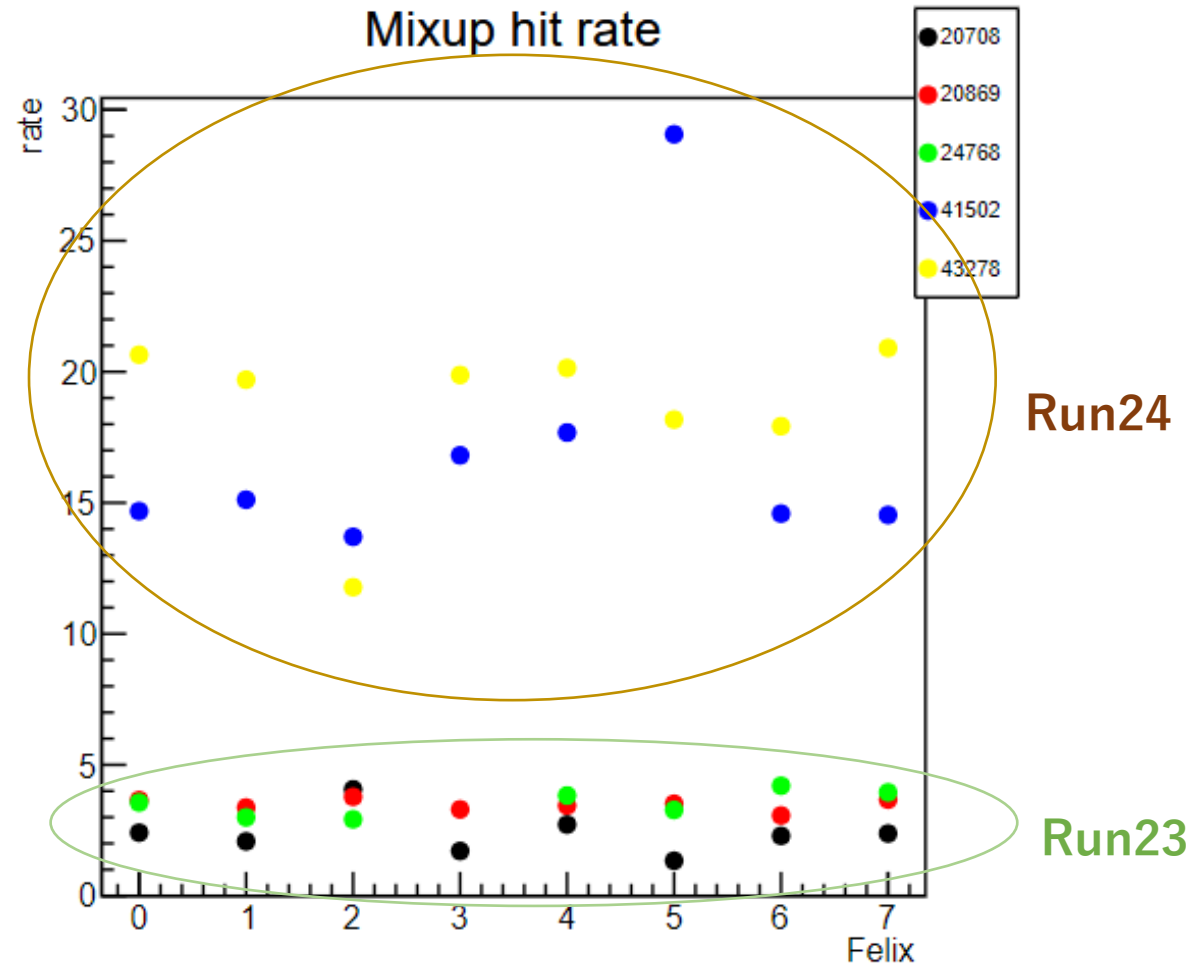
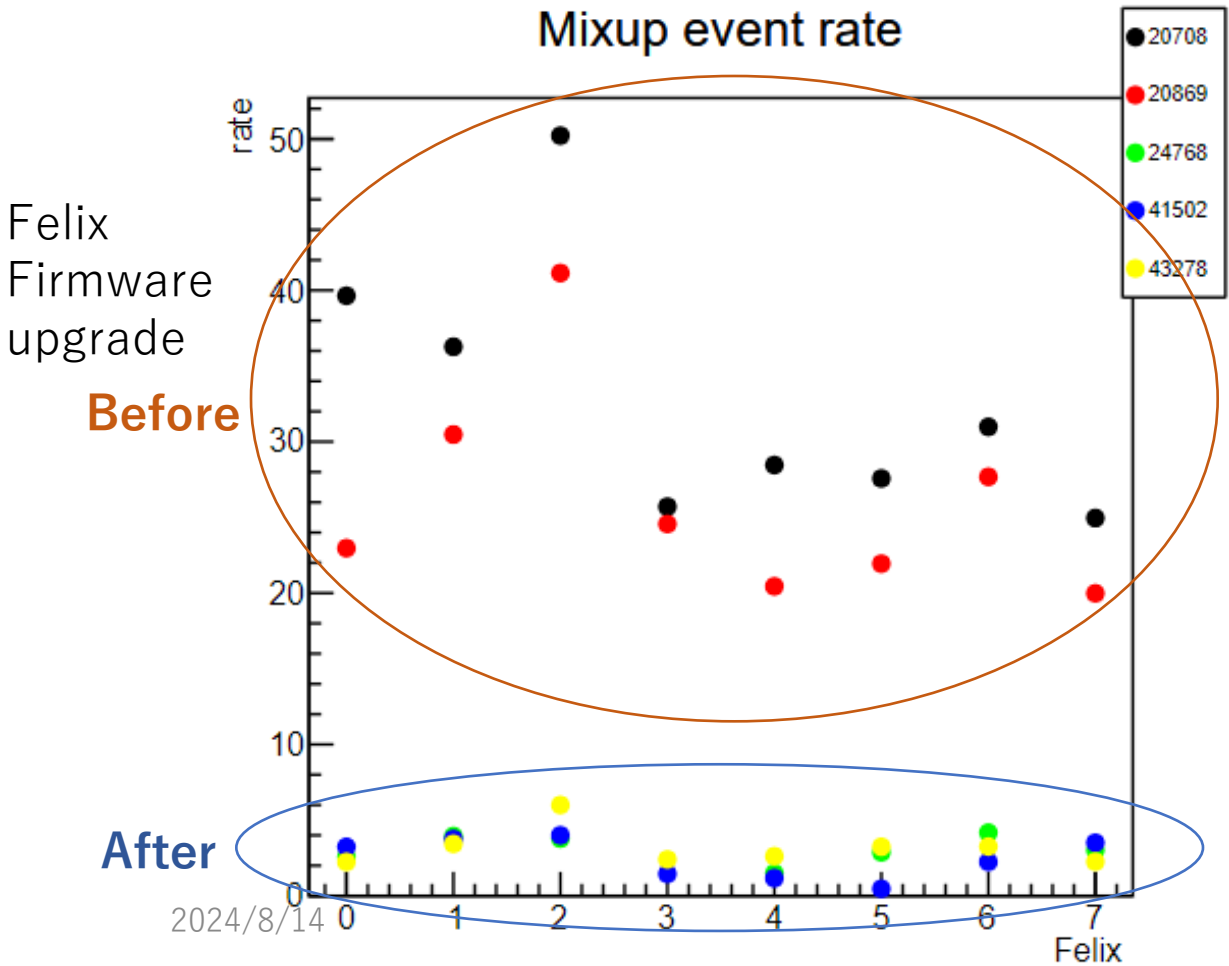
Run23 · Run24 fraction

Mixup event fraction[%]=(Mixup Event)/(Entries) × 100

Mixup hit fraction[%]=(Mixup hit)/(Previous event hit + Mixup hit) × 100

Average (Mixup hit fraction)/(Mixup Event)

- Event fraction results show that the Mixup Event fraction was lower after the firmware upgrade. This suggests that mixups are less likely to occur than before.
- Run24 had higher fractions than Run23 in the Mixup hit fraction.

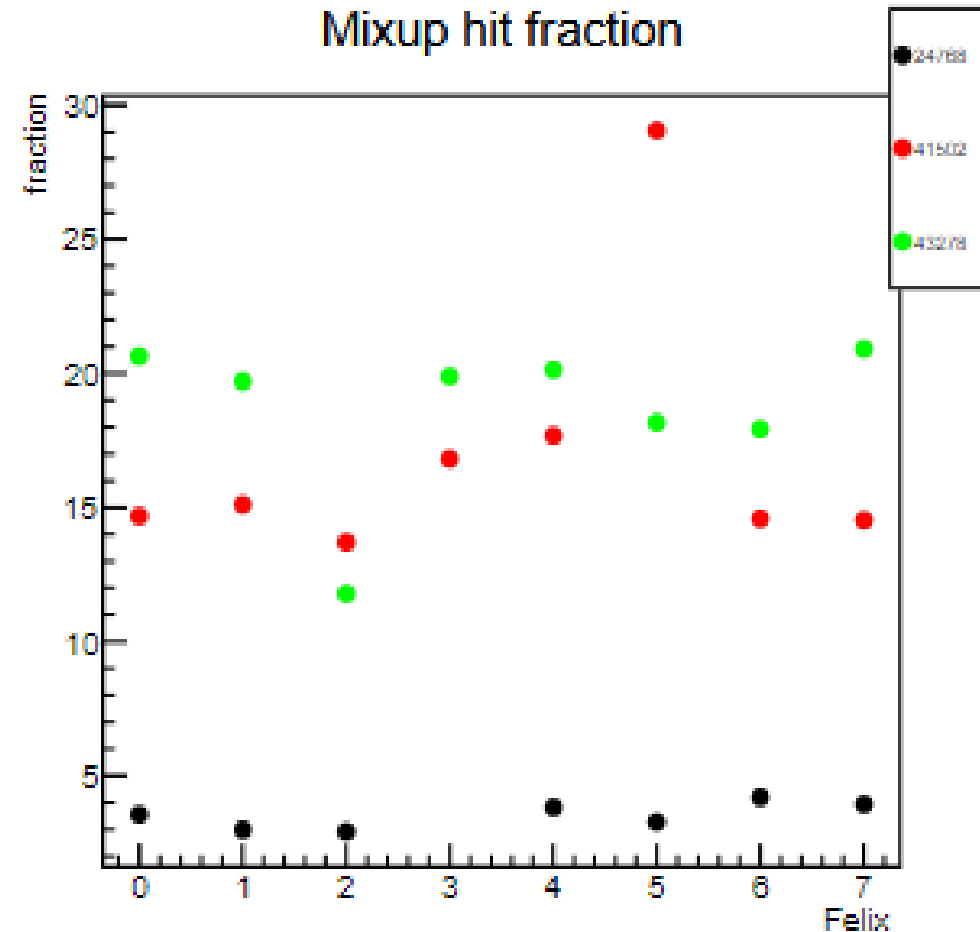
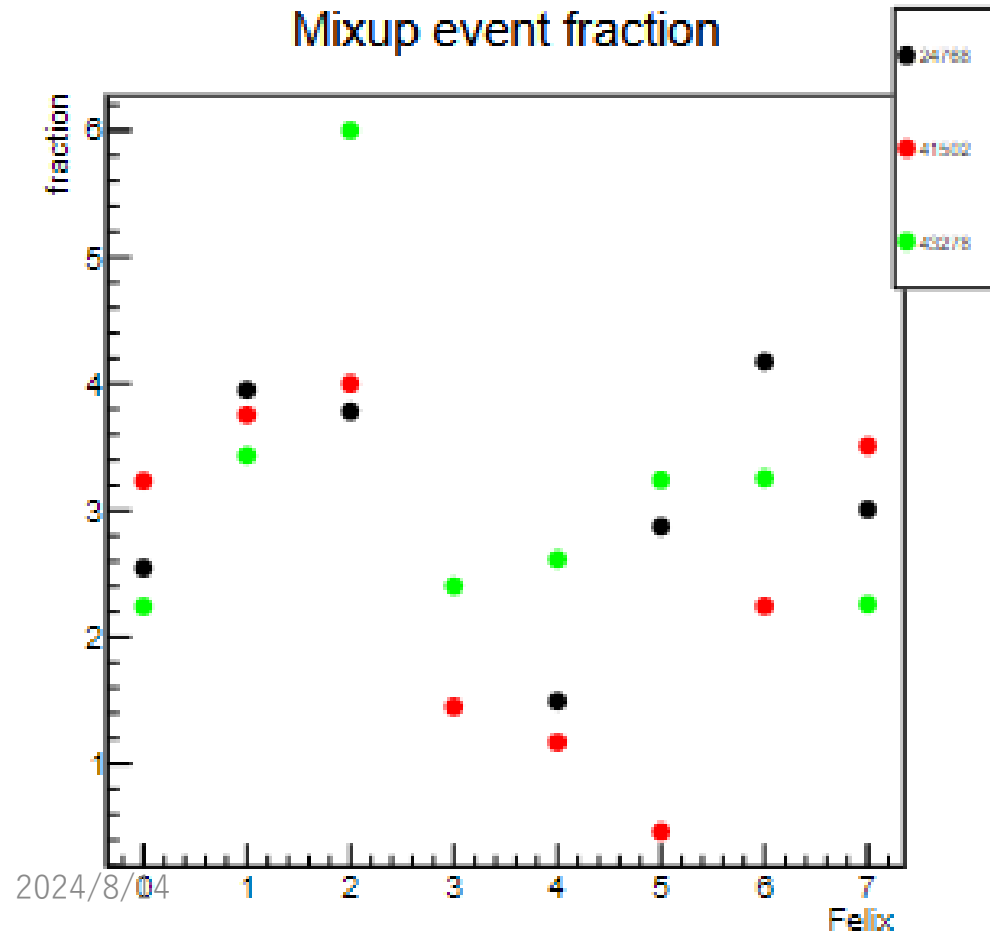


Fraction after firmware upgrade Run23,24

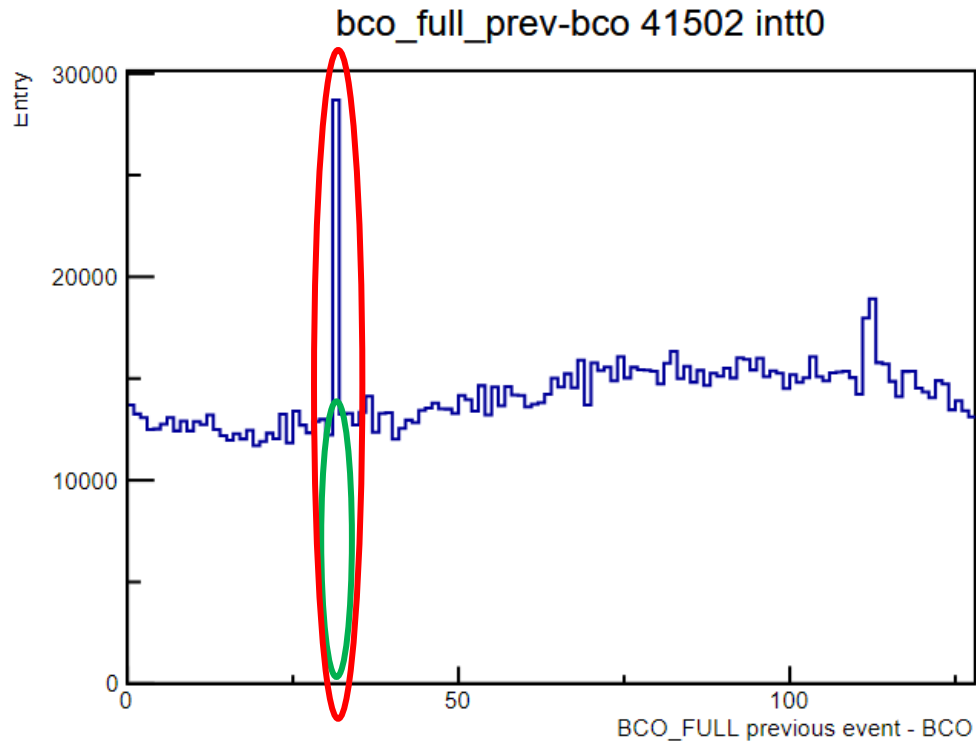
Mixup event fraction[%]=(Mixup Event)/(Entries) × 100

Mixup hit fraction[%]=(Mixup hit)/(Previous event hit + Mixup hit) × 100

Average (Mixup hit fraction)/(Mixup Event)



Hit fraction Run24

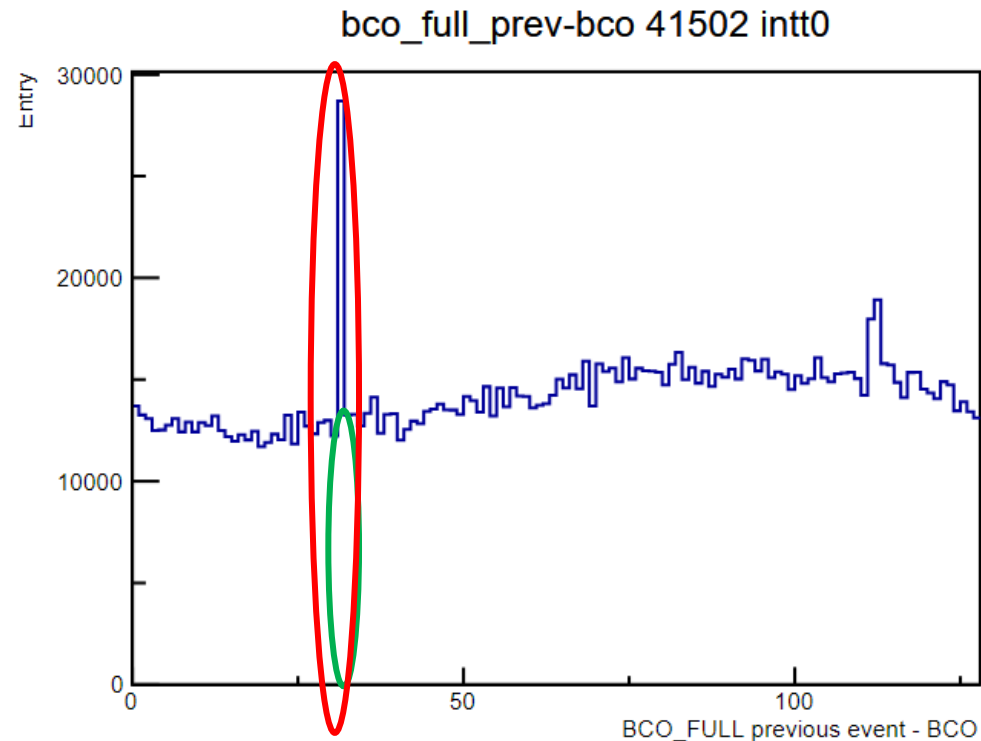


The baseline level of p+p is much higher than that of Au+Au, and I think that the p+p contains a large amount of background that is mistakenly judged as a mixup hit, resulting in a high hit fraction. I plan to calculate the hit fractions after subtracting the baseline in the mixup hit counts.

How to calculate

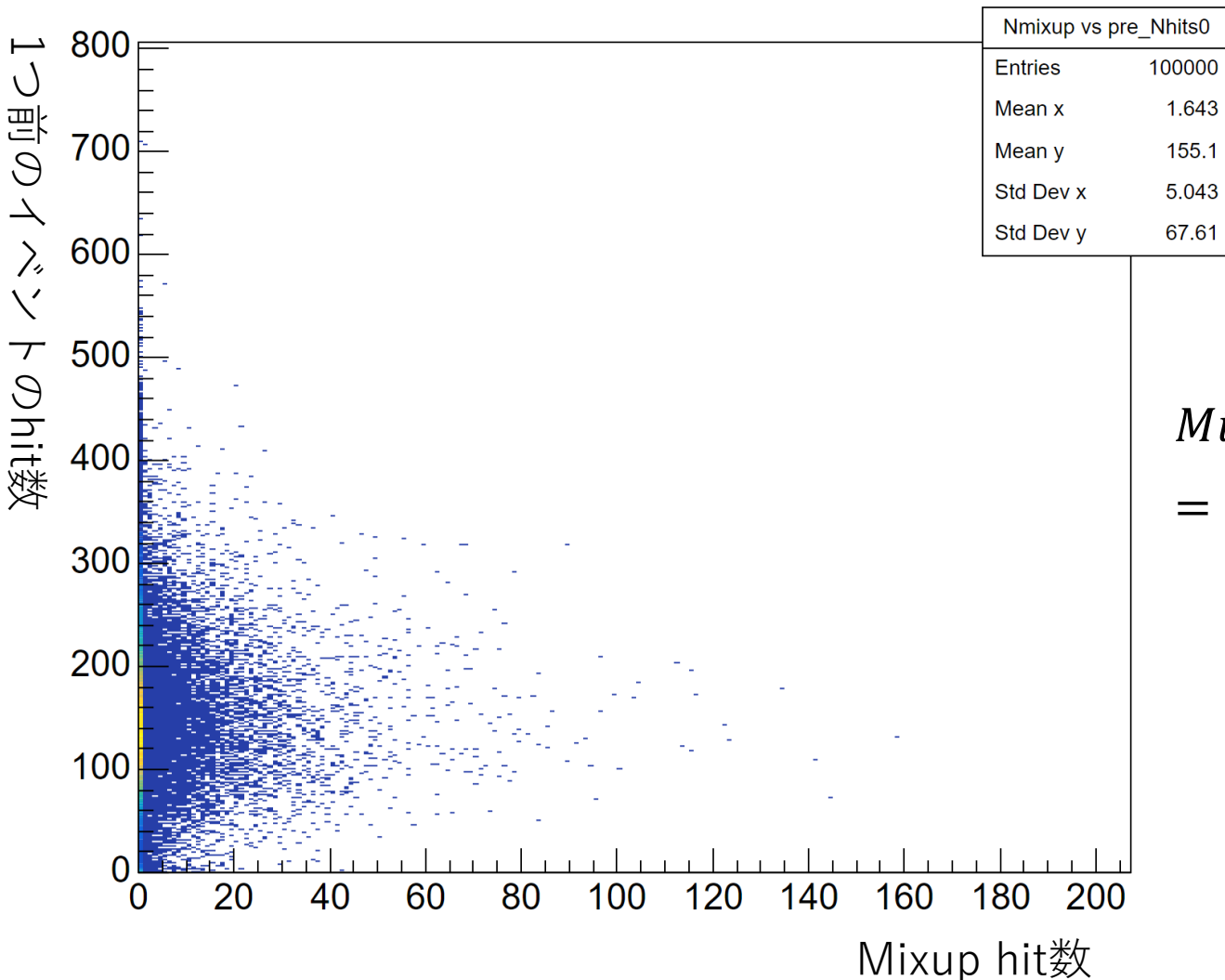
- **Mixup Hit fraction** – **Random Hit fraction** = **True Mixup hit fraction**

Random Hit fractionはMixup hit のピークの ± 2 binの平均から求める



Mixup fraction

Nmixup vs pre_Nhits0_Run47892



まず左図のように
横軸1イベント内のMixup hit数
縦軸1つ前のイベントのhit数
としたプロットから、各点で

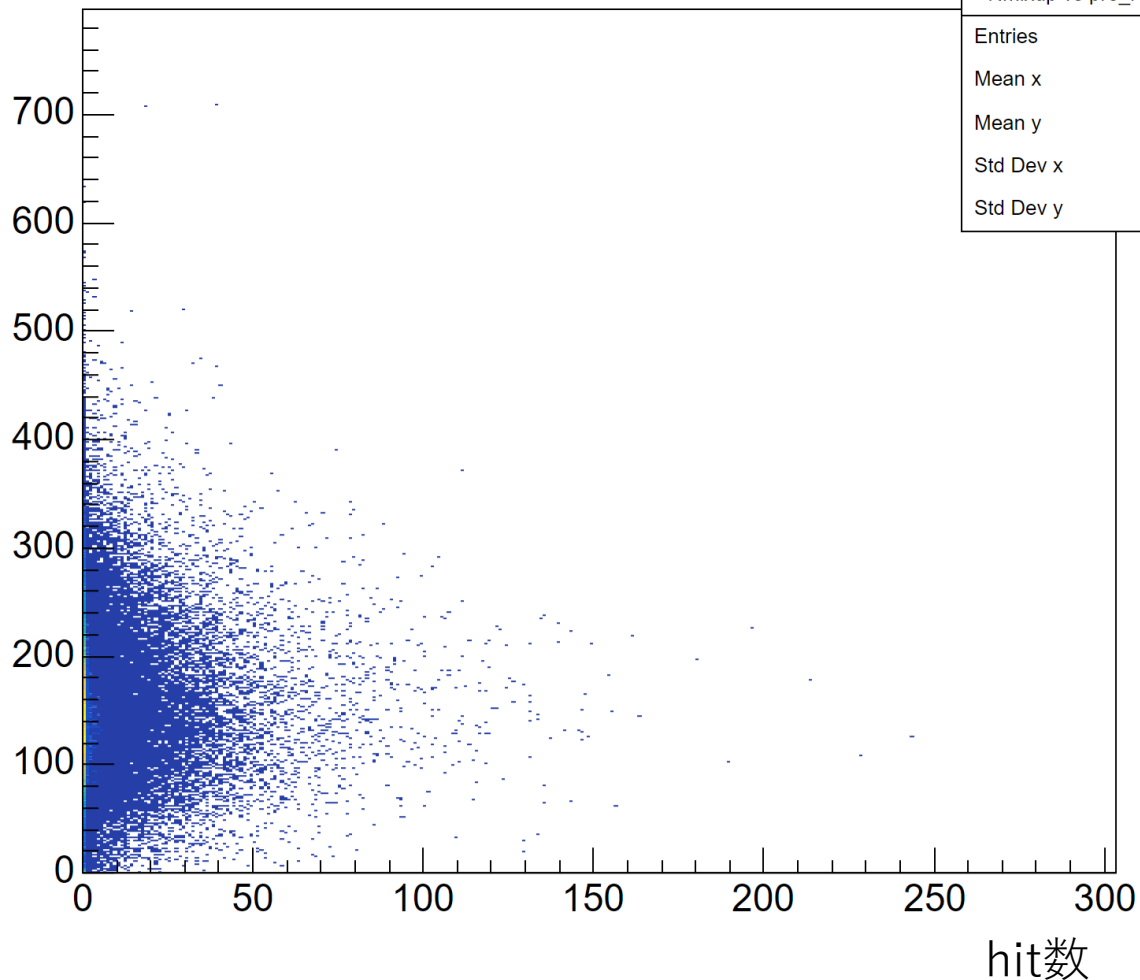
$$\text{Mixup Hit fraction} = \frac{\text{Mixup Hit}(x)}{\text{Previous Event Hit}(y) + \text{Mixup Hit}(x)} \times \text{Entries}$$

を計算し、全エントリーで平均をとる

Mixup fraction

Nmixup vs pre_Nhits others 4bin0_Run47892

1つ前のイベントのhit数



次にMixupのピークの±2binの同様な分布
横軸1イベント内のhit数
縦軸1つ前のイベントのhit数

$$\text{Around } \pm 2\text{bin Hit fraction} = \frac{\pm 2\text{bin Hit}(x)}{\text{Previous Event Hit}(y) + \pm 2\text{bin Hit}(x)} \times \text{Entries}$$

すなわちベースラインの割合を計算し、
1binあたりのrandom hit fractionの平均を求める

Event base root file , DST file (each felix)

- 得られた結果を比べようとしたが、そもそも以前使っていたroot file とDST fileの中身が異なり、fractionを計算するのに影響があるので比較できず

Event base

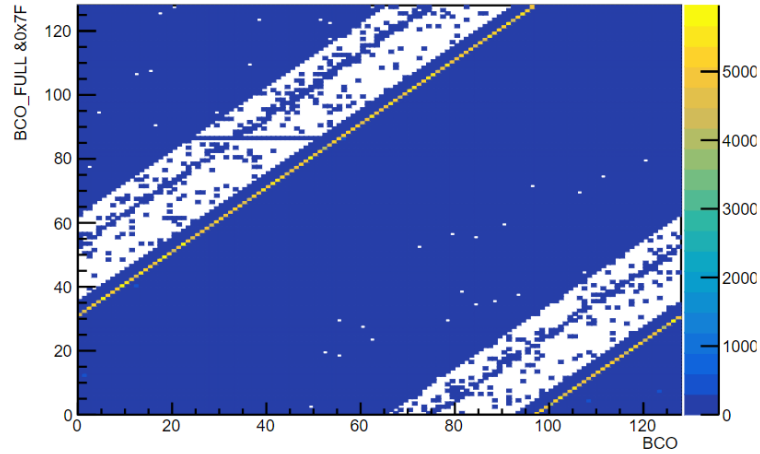
1	13974
2	3
3	2
4	9
5	88
6	16
7	3
8	14
9	73
10	20
11	6
12	16
13	0
14	0
15	5
16	5
17	9
18	139
19	2
20	15

DST

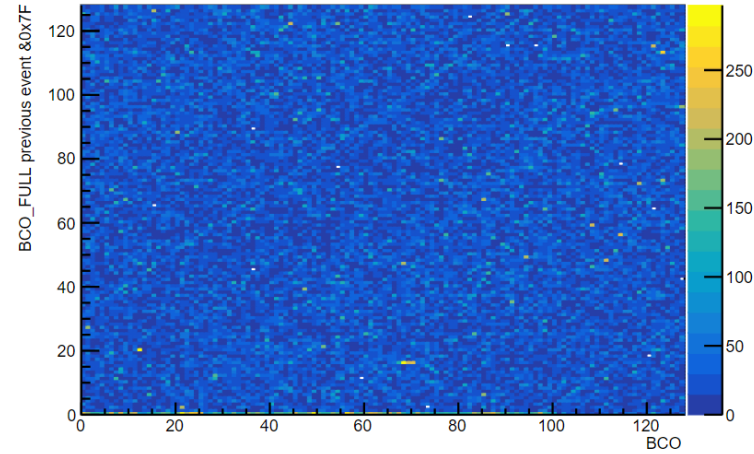
1	13507
2	2
3	9
4	88
5	16
6	3
7	14
8	73
9	20
10	6
11	16
12	5
13	5
14	9
15	139
16	2
17	15
18	0

Run41502 inttt0

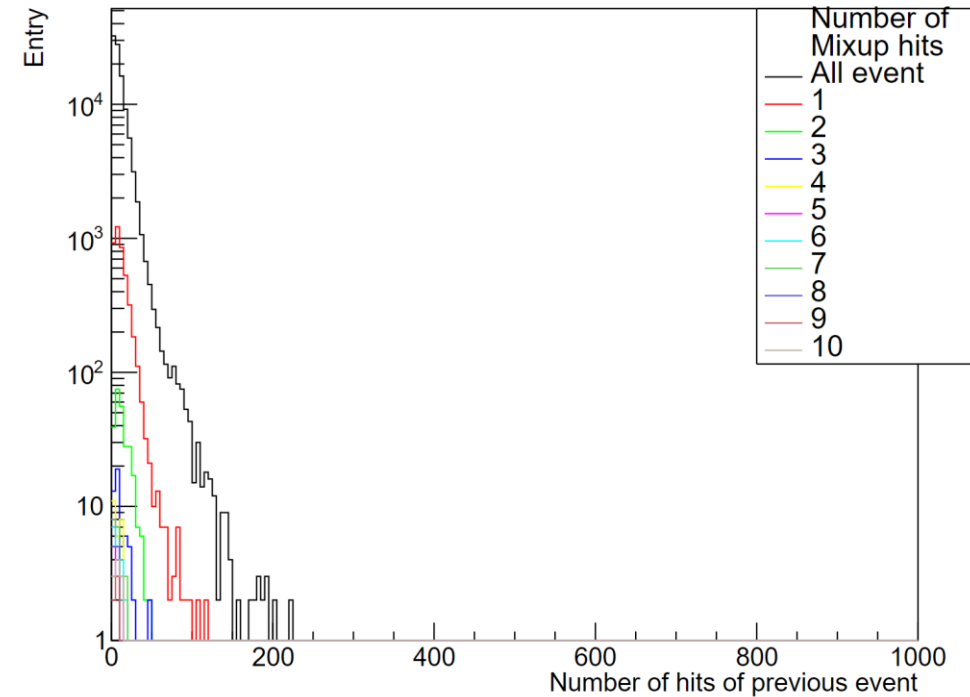
bco_full&0x7F_vs_bco_inttt0_Run41502



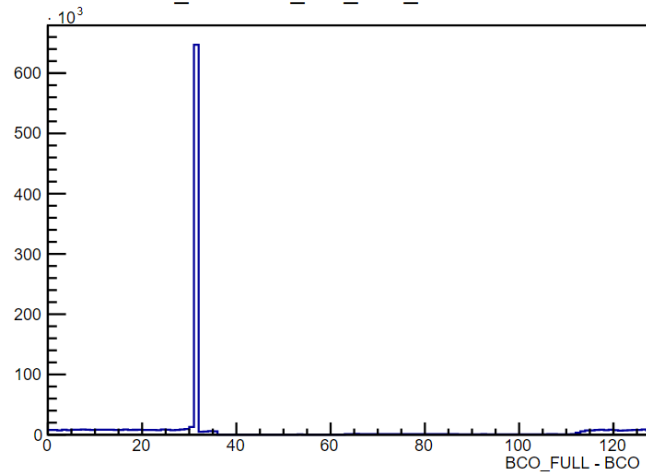
bco_full&0x7F_prev_vs_bco_inttt0_Run41502



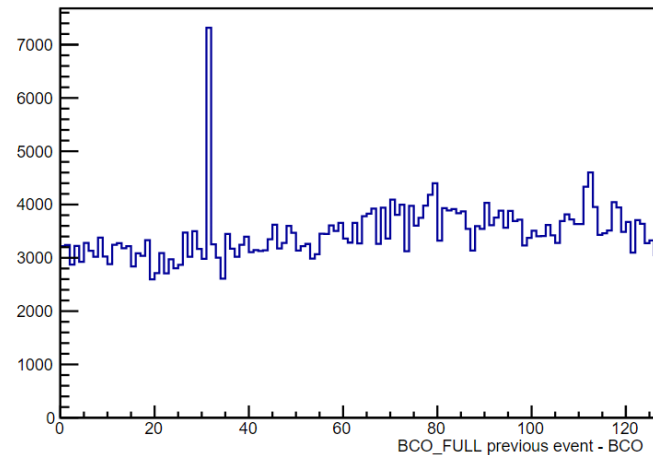
allmulti_inttt0_Run41502: with clone cut



bco_full&0x7F_bco_inttt0_Run41502



bco_full&0x7F_prev_bco_inttt0_Run41502

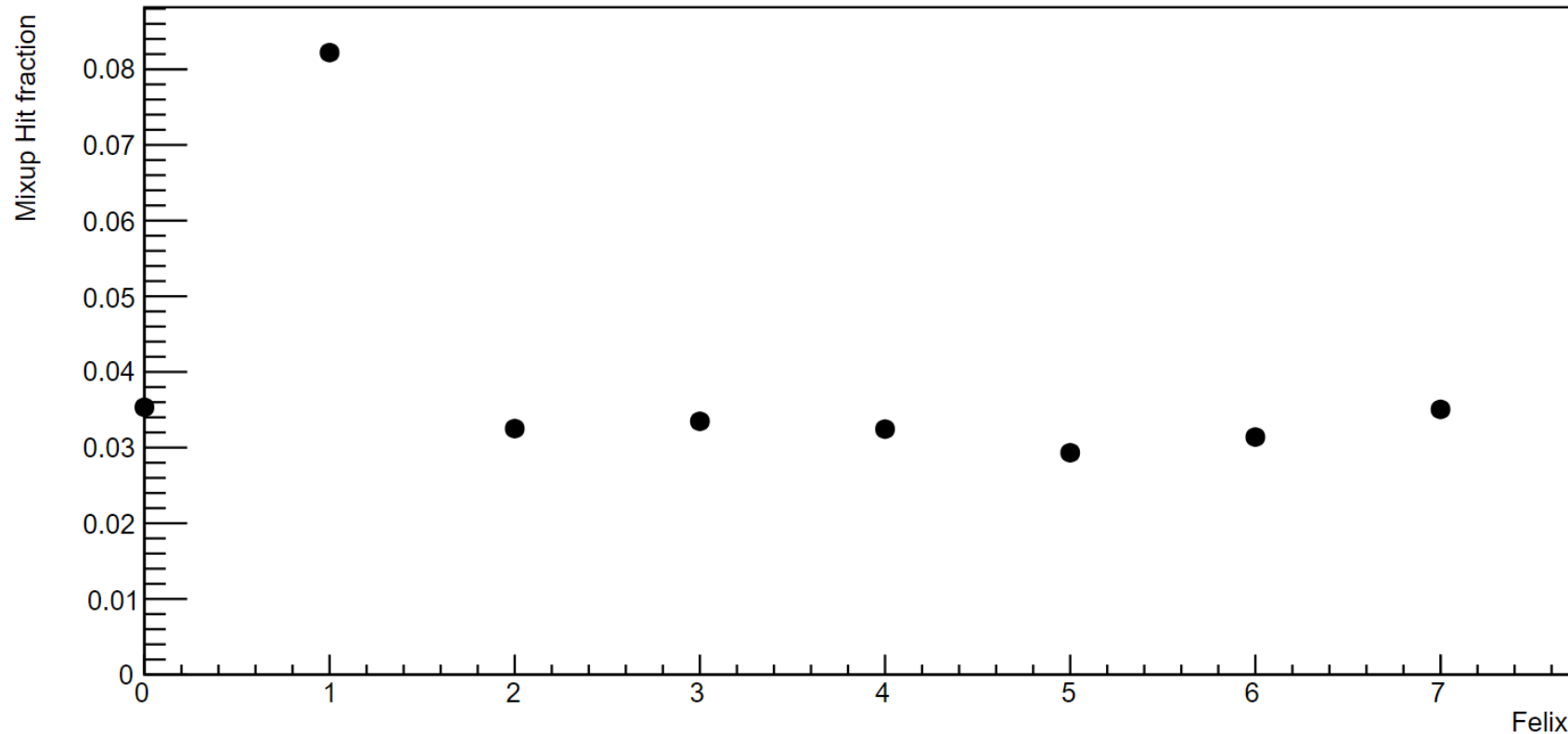


Run41502

$$\text{Mixup Hit fraction} = \frac{\text{Mixup Hit}(x)}{\text{Previous Event Hit}(y) + \text{Mixup Hit}(x)}$$

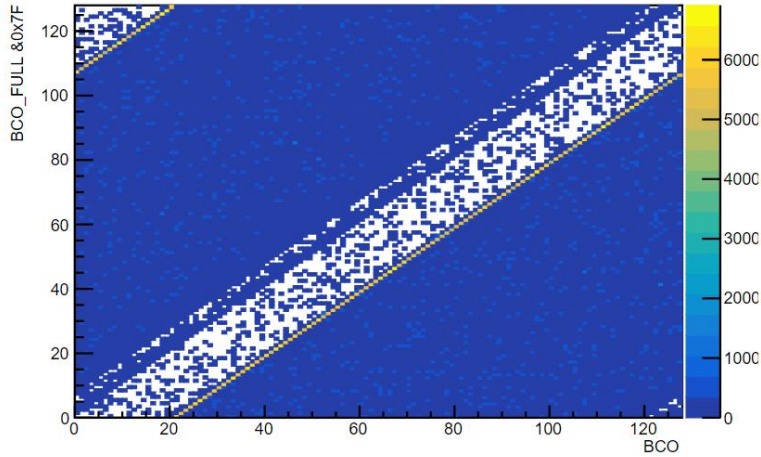
Event Mixup が起きていると考えられるRunにおいて
Mixup hit fractionはおおよそ3~4%という結果となった

Mixup Hit fraction Run41502

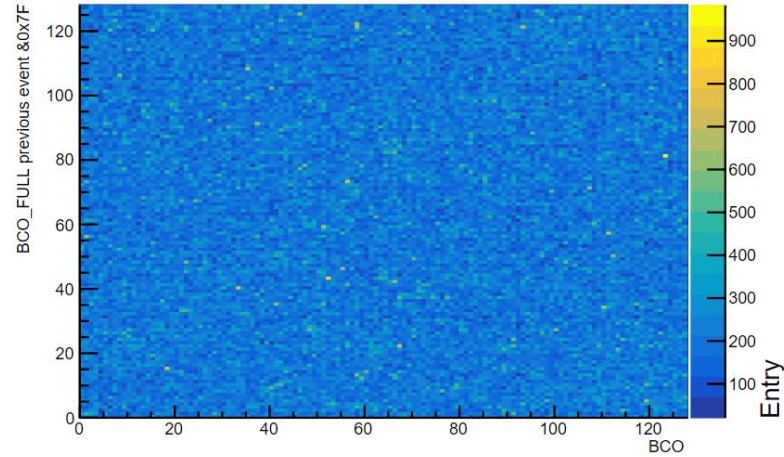


Run49737 inttt0

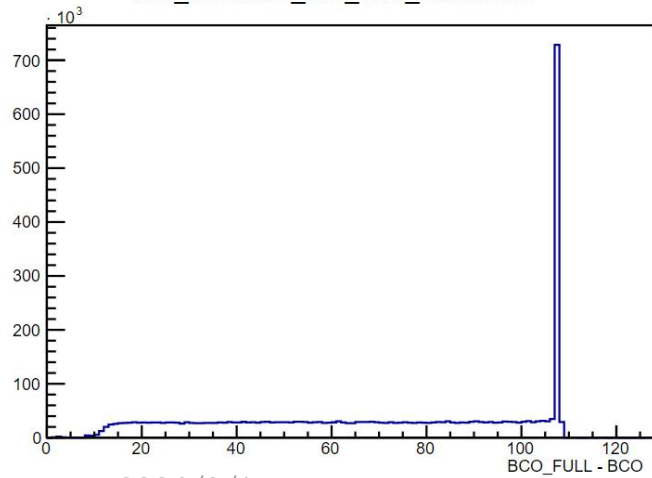
bco_full&0x7F_vs_bco_intt0_Run49737



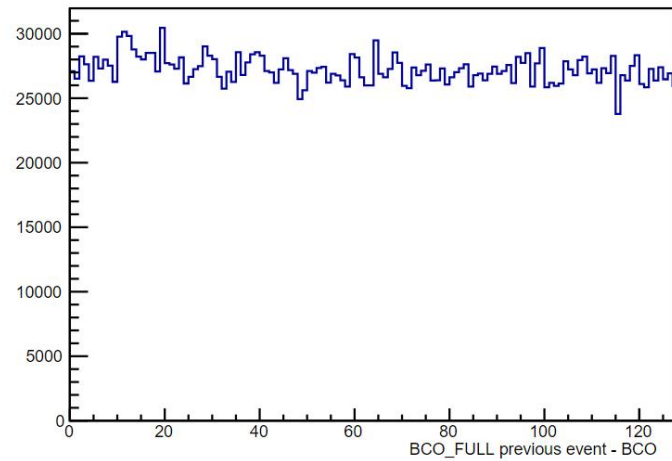
bco_full&0x7F_prev_vs_bco_intt0_Run49737



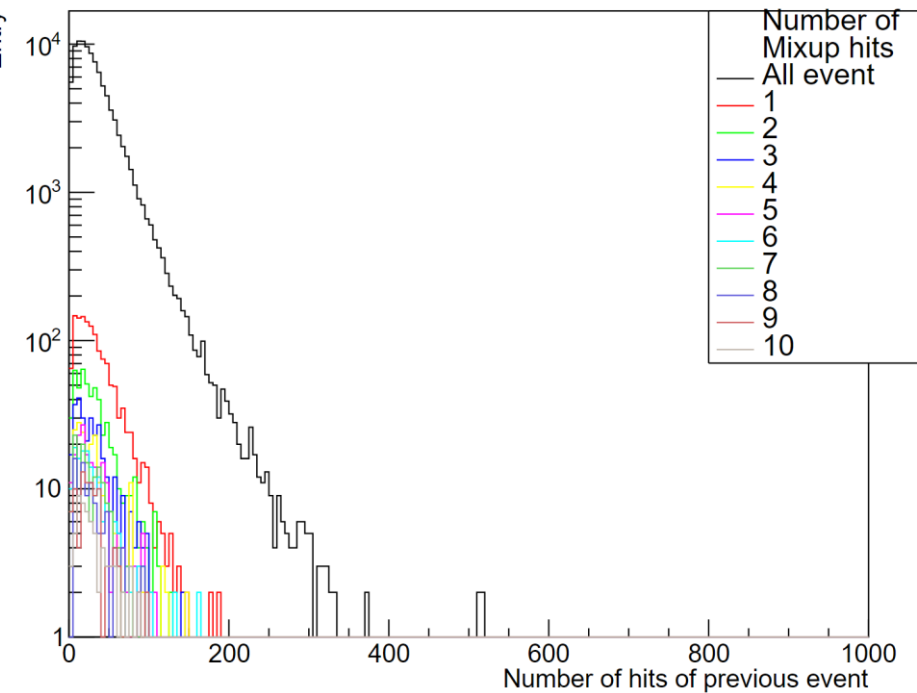
bco_full&0x7F_bco_intt0_Run49737



bco_full&0x7F_prev_bco_intt0_Run49737



allmulti_intt0_Run49737: with clone cut



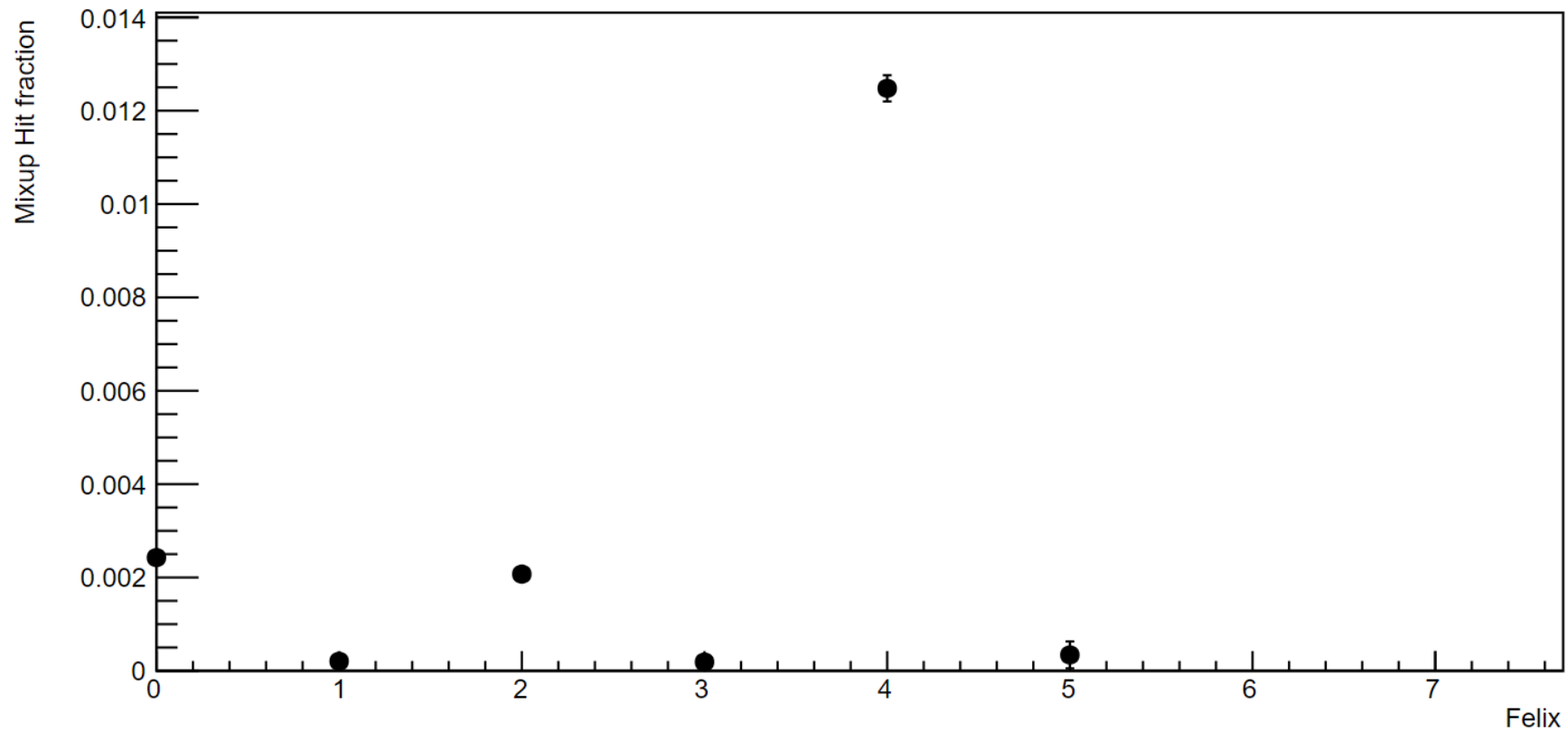
2024/8/15

Run49737

$$\text{Mixup Hit fraction} = \frac{\text{Mixup Hit}(x)}{\text{Previous Event Hit}(y) + \text{Mixup Hit}(x)}$$

Event Mixup が起きていないと考えられるRunにおいて
Mixup hit fractionはおおよそ0~0.4%という結果となった

Mixup Hit fraction Run49737

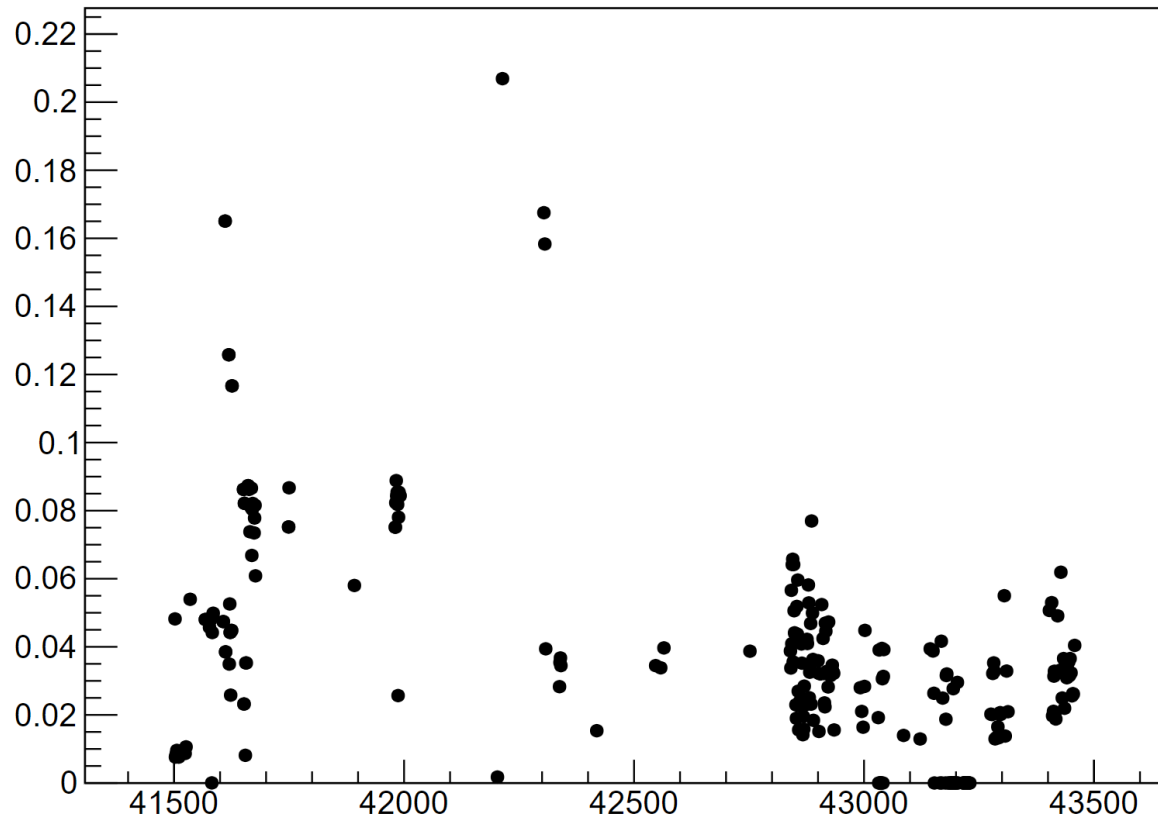


Run24 Mixup fraction

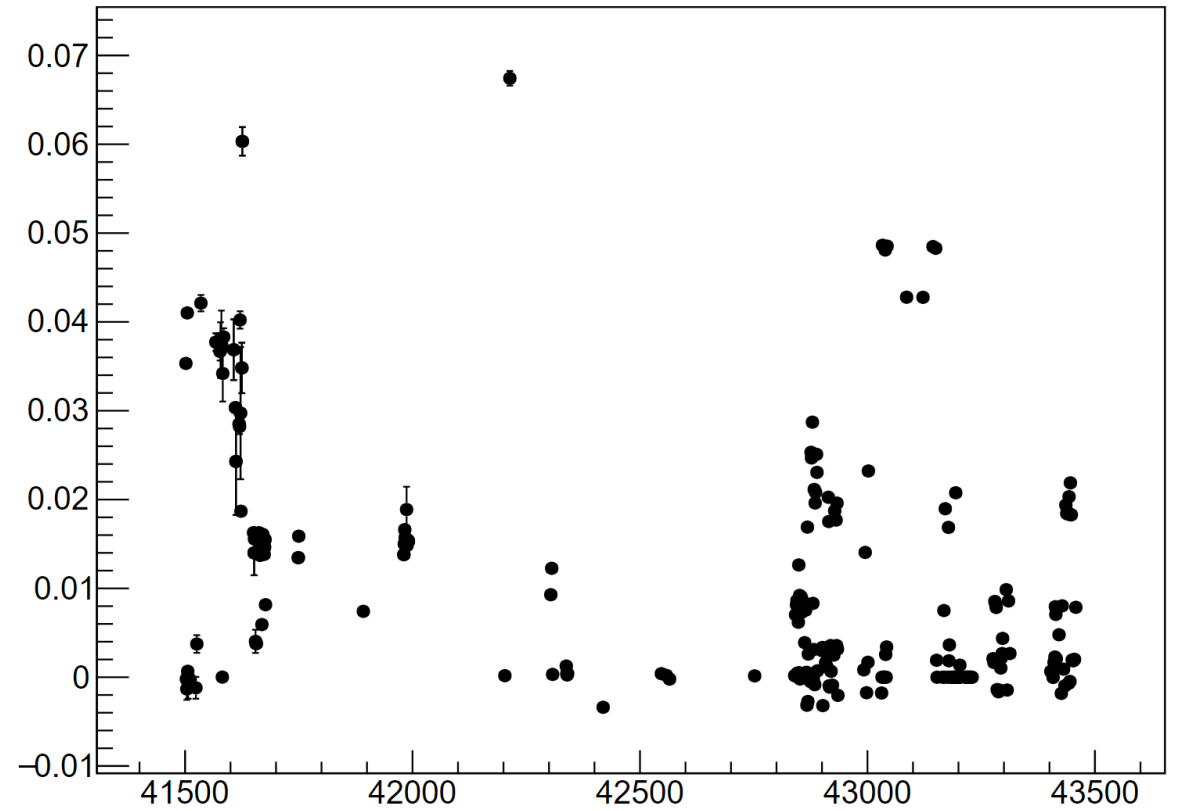
- 各FelixごとにRun41502~49737(途中見れていないRunあり)
Mixup Event fraction及びMixup hit fractionを計算しグラフにした
- ここではcollision hit, clone hit, hot channel cutを行ったうえで
Mixup hit を判定しfractionを計算

Run24 Mixup fraction intt0

Mixup event fraction for Felix = 0

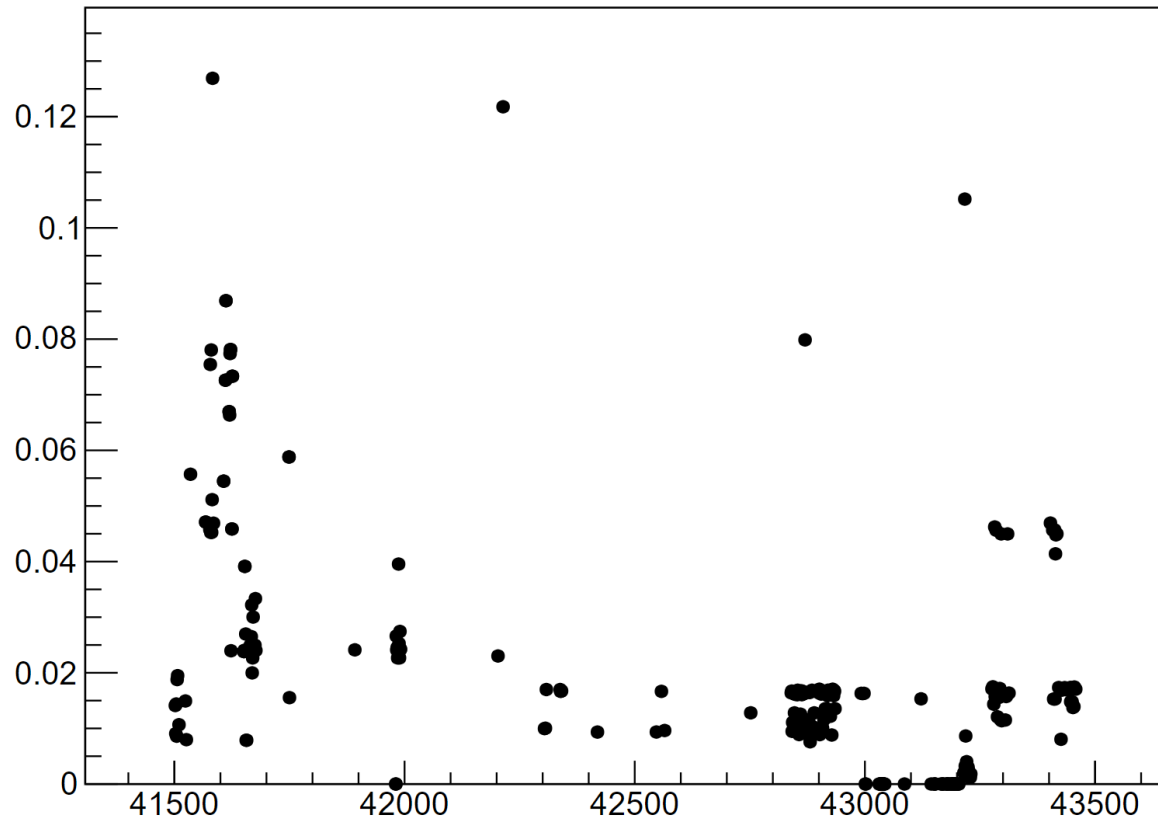


Mixup hit fraction for Felix = 0

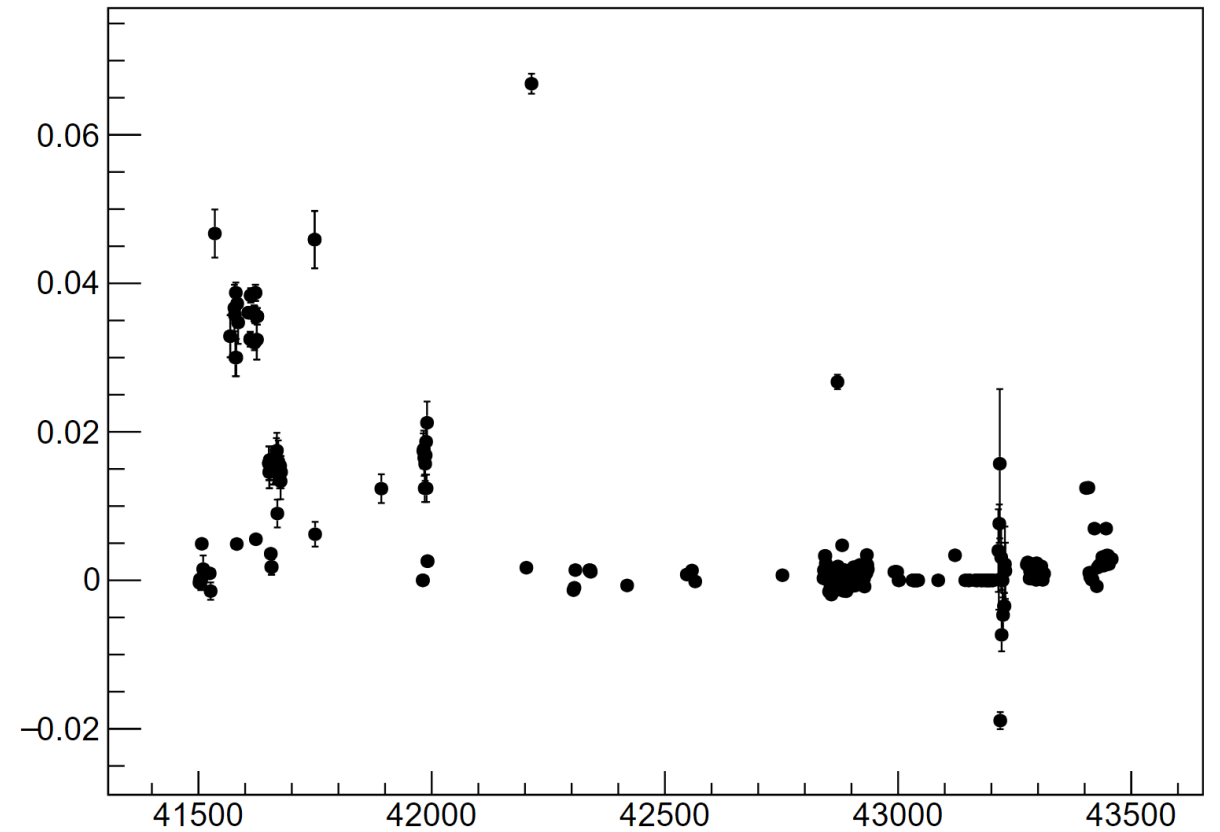


Run24 Mixup fraction intt1

Mixup event fraction for Felix = 1

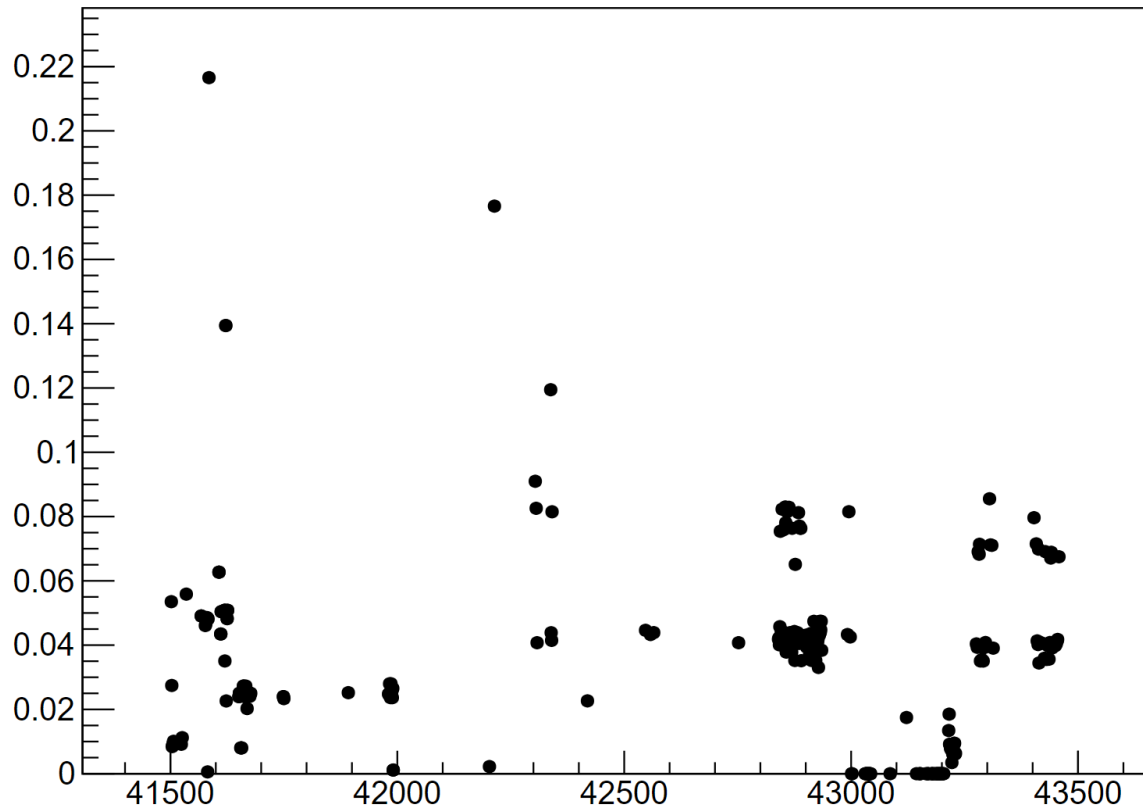


Mixup hit fraction for Felix = 1

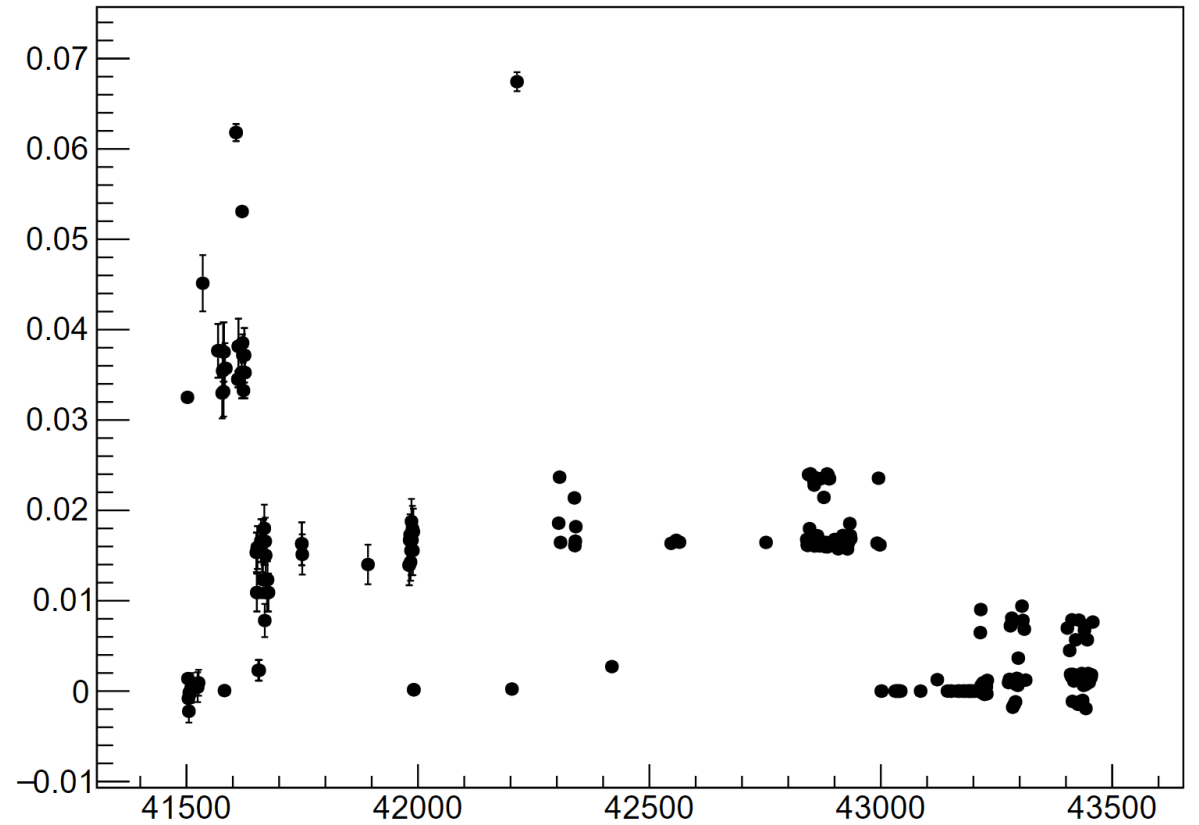


Run24 Mixup fraction intt2

Mixup event fraction for Felix = 2

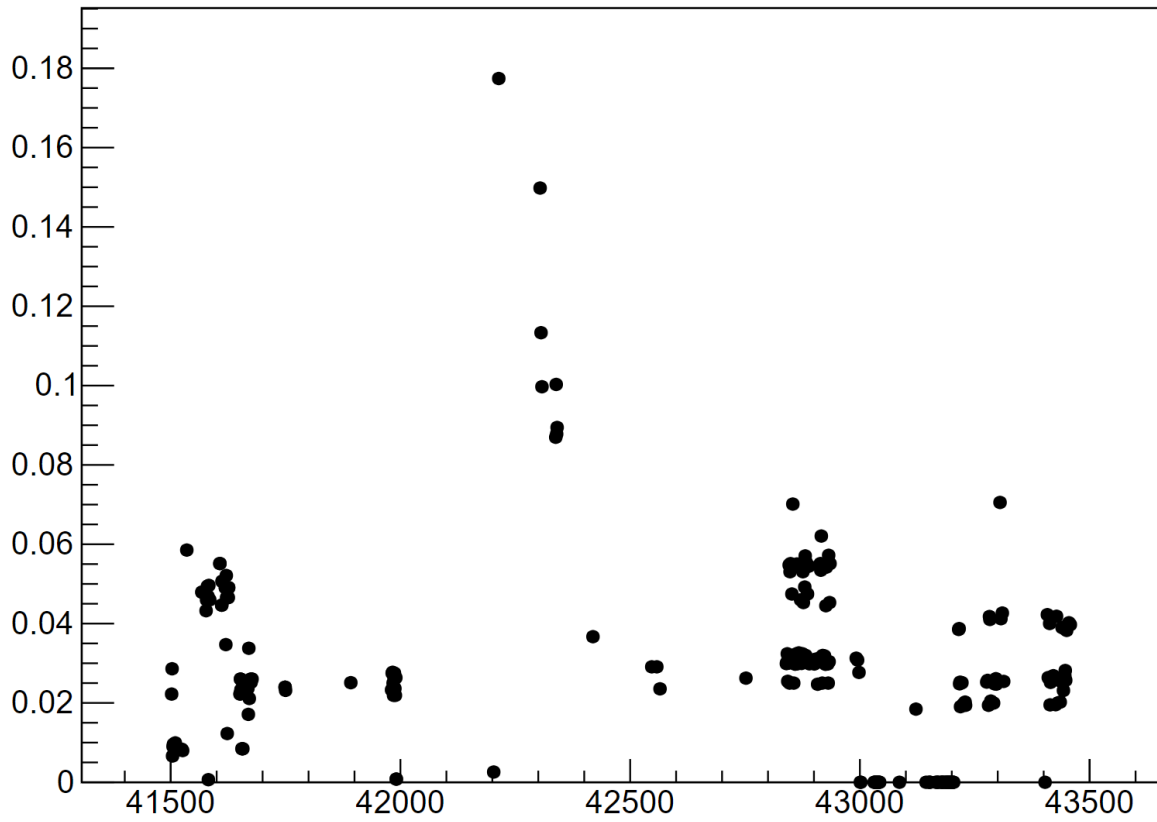


Mixup hit fraction for Felix = 2

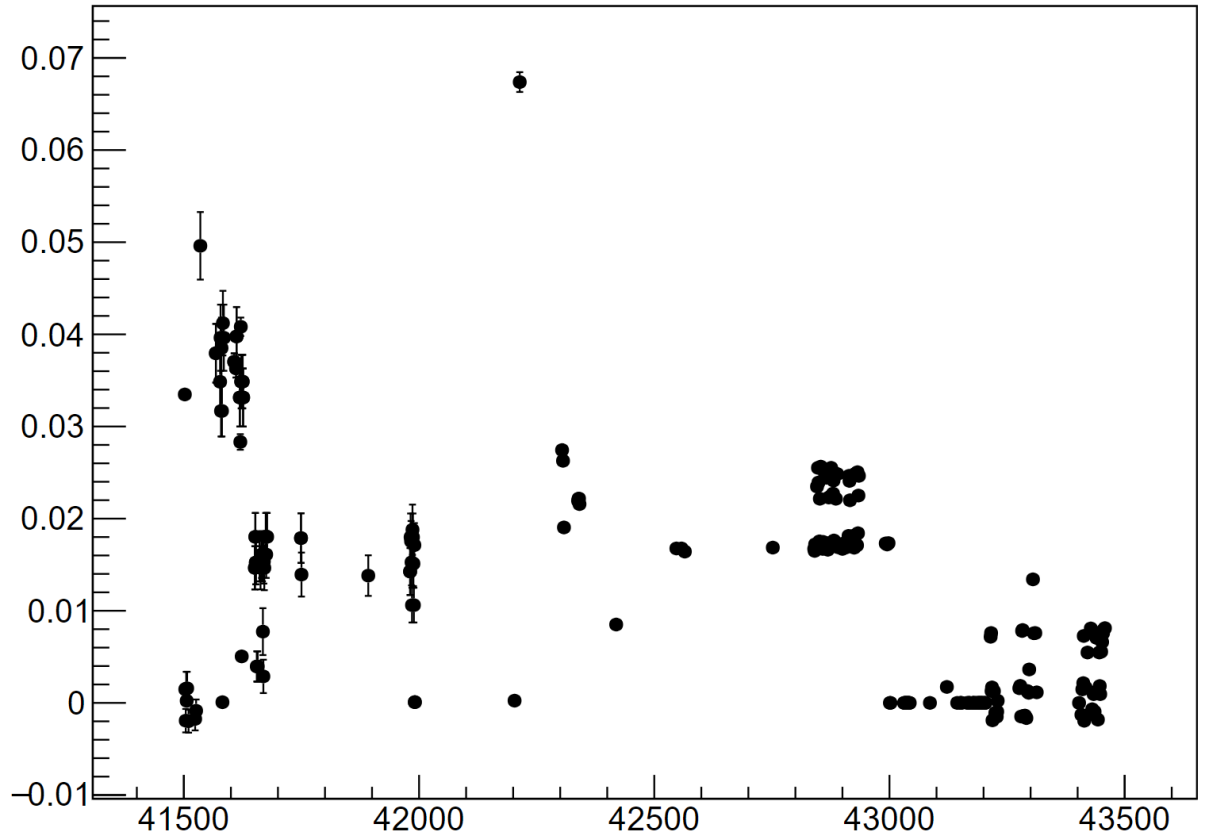


Run24 Mixup fraction intt3

Mixup event fraction for Felix = 3

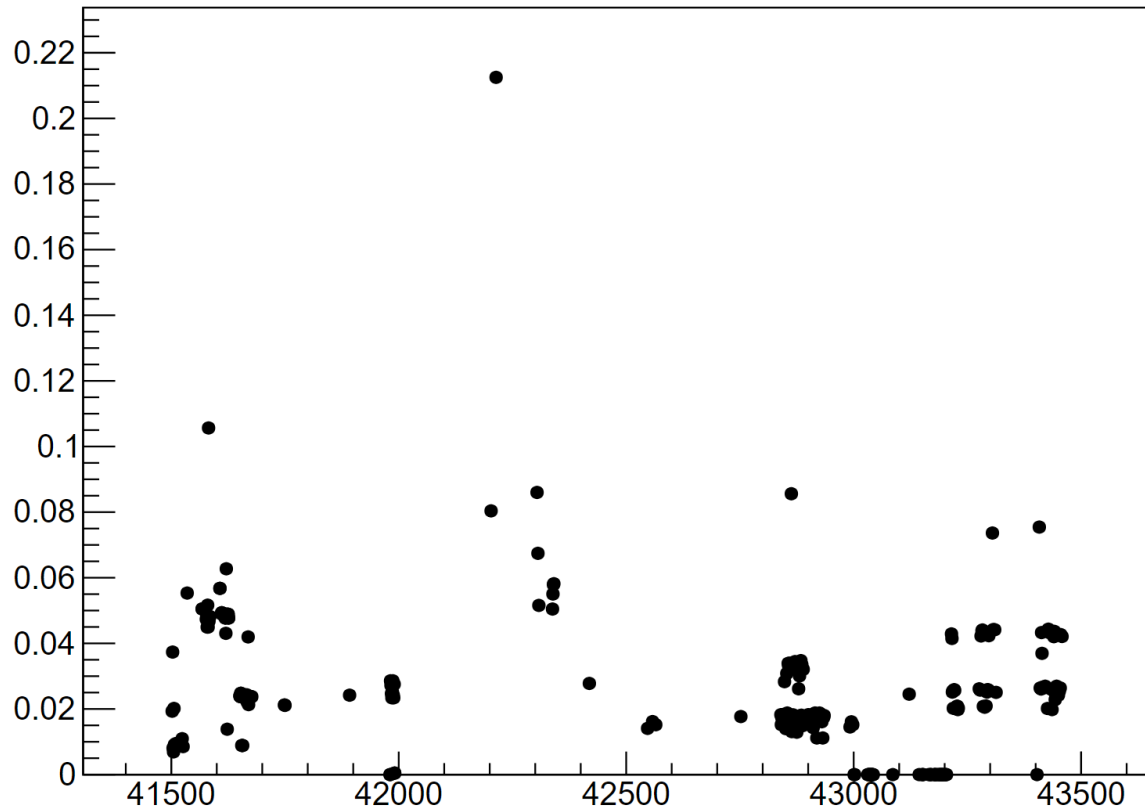


Mixup hit fraction for Felix = 3

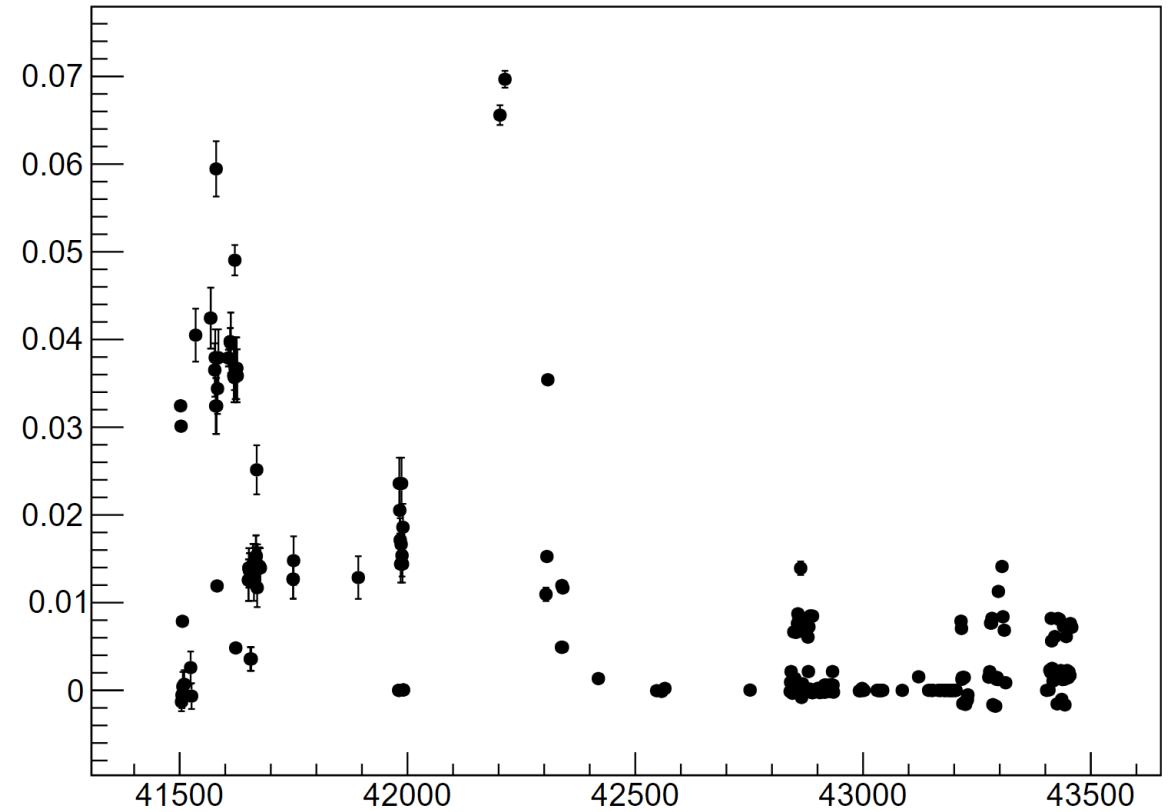


Run24 Mixup fraction intt4

Mixup event fraction for Felix = 4

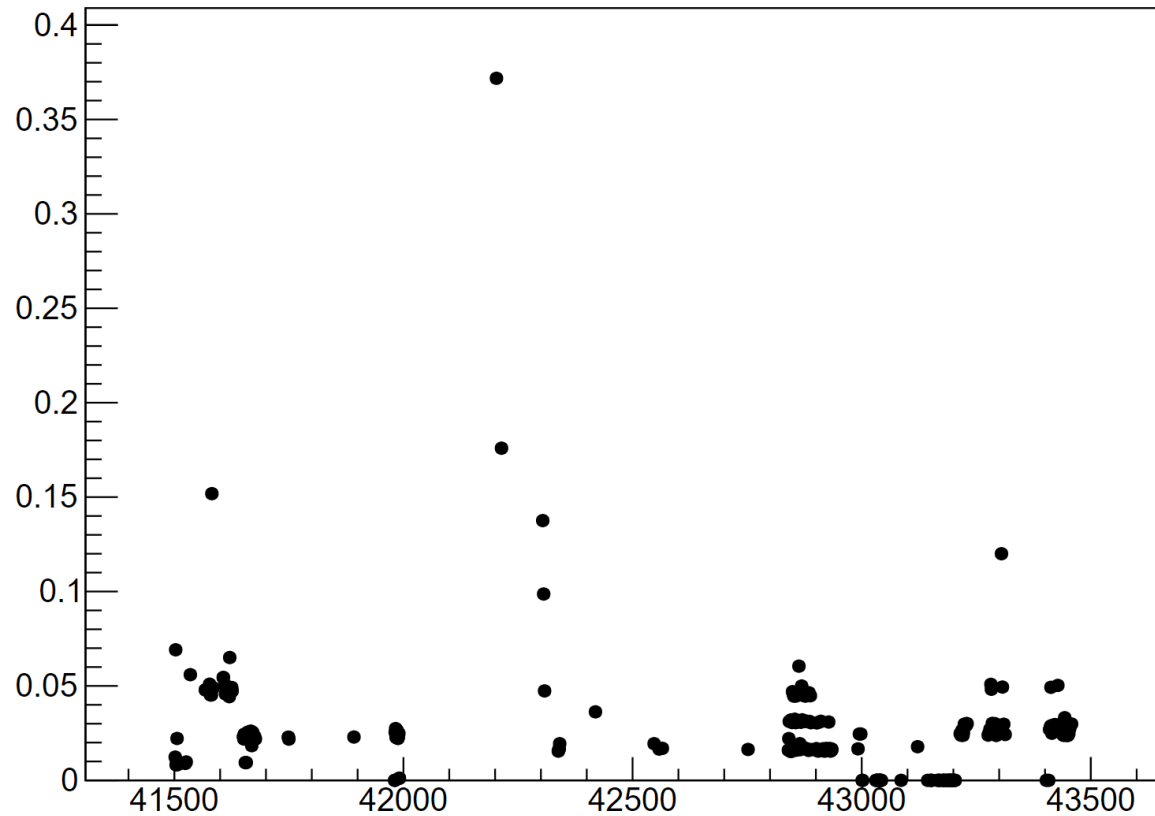


Mixup hit fraction for Felix = 4

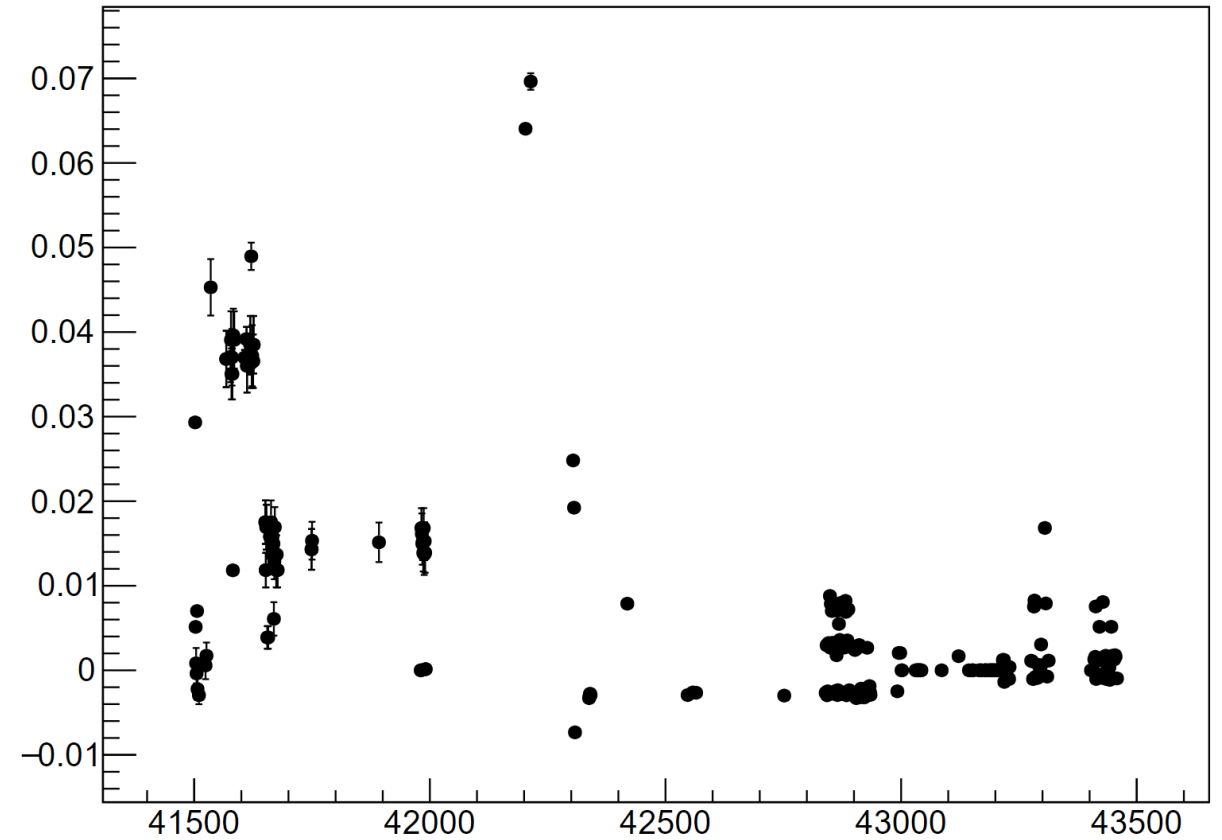


Run24 Mixup fraction intt5

Mixup event fraction for Felix = 5

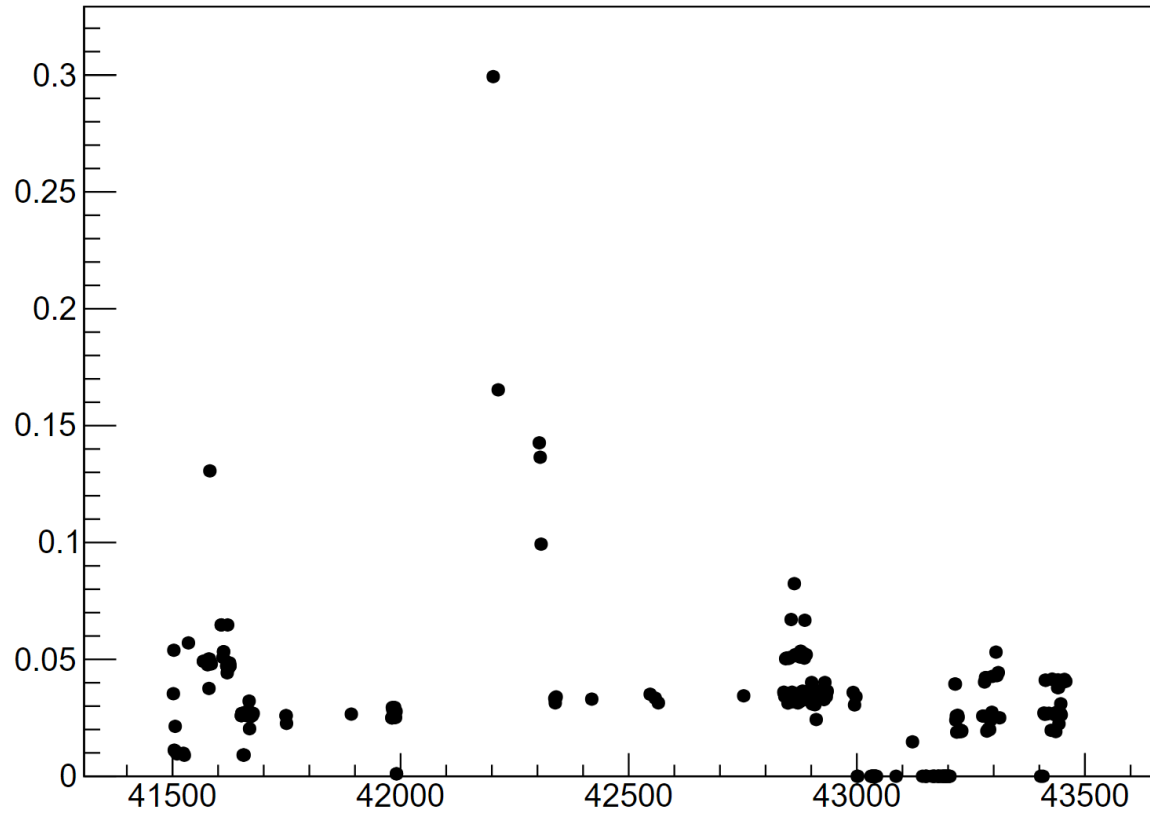


Mixup hit fraction for Felix = 5

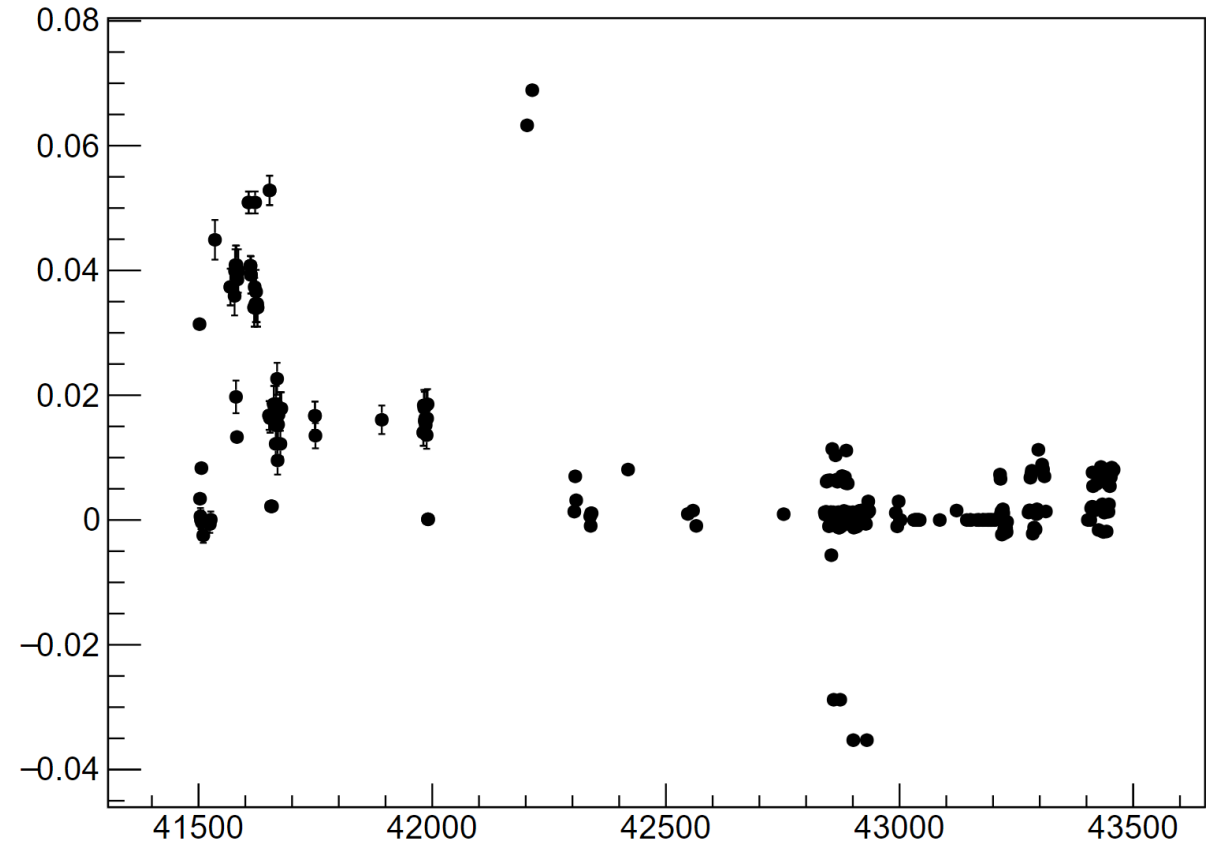


Run24 Mixup fraction intt6

Mixup event fraction for Felix = 6

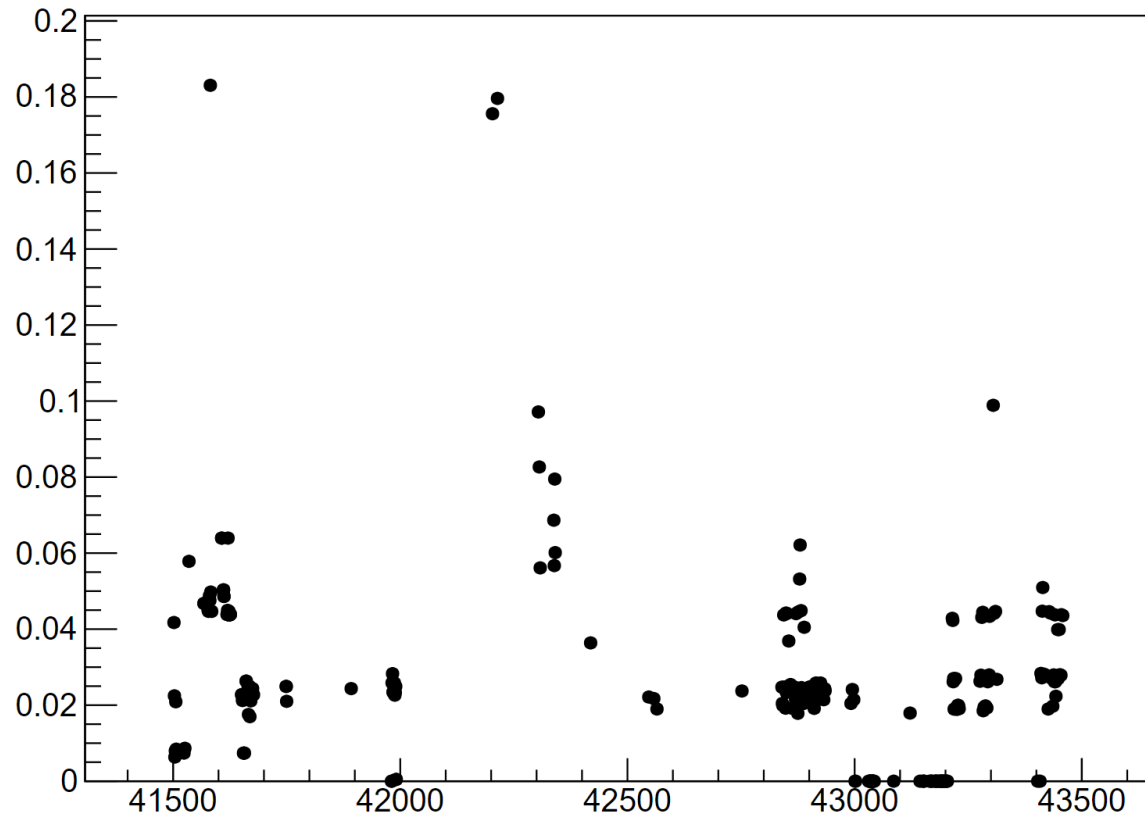


Mixup hit fraction for Felix = 6

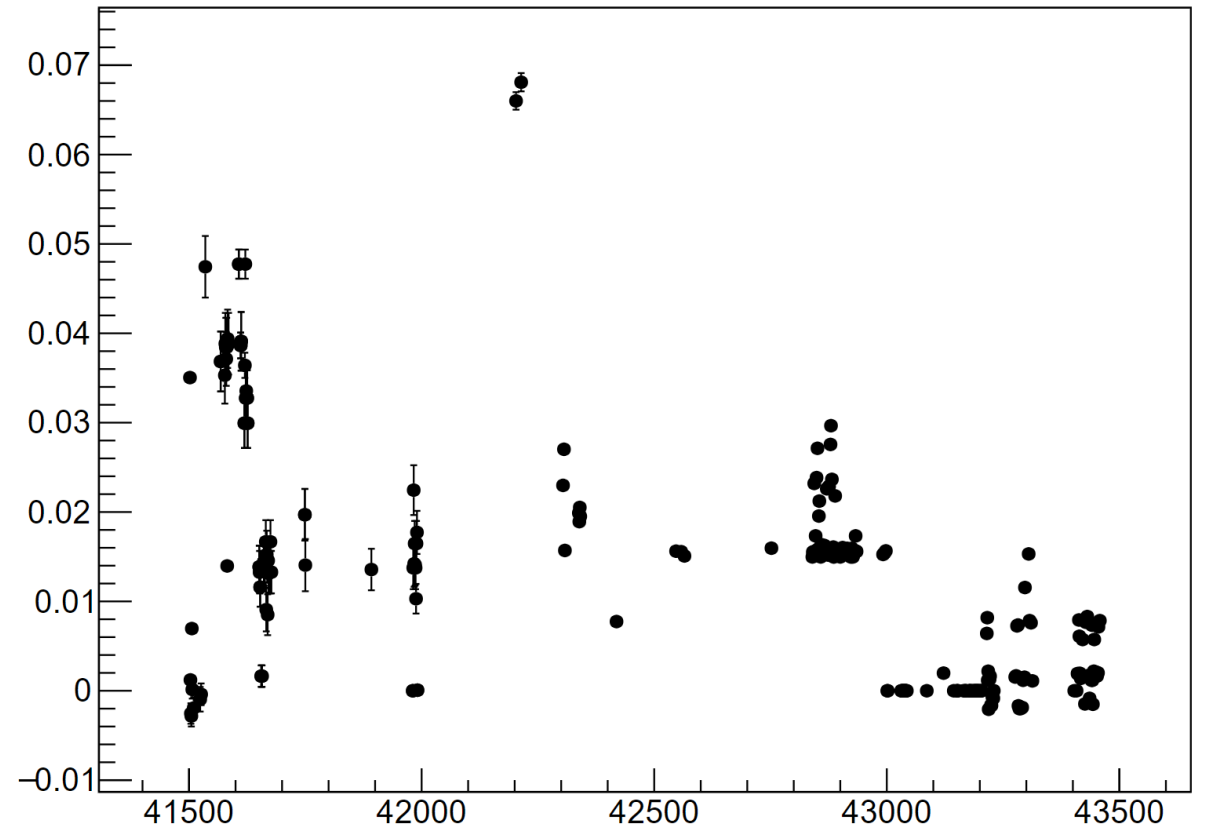


Run24 Mixup fraction intt7

Mixup event fraction for Felix = 7

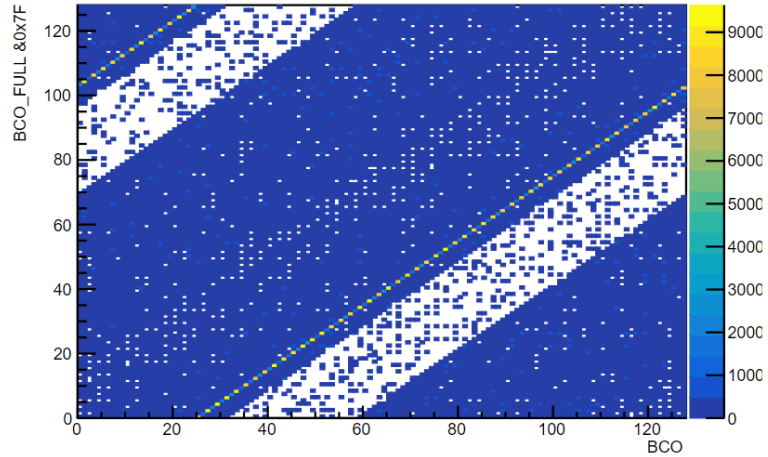


Mixup hit fraction for Felix = 7

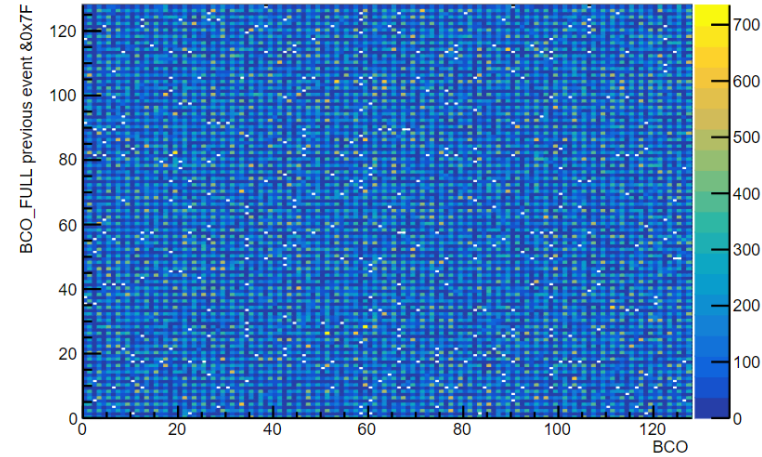


Run42214 (high fraction)

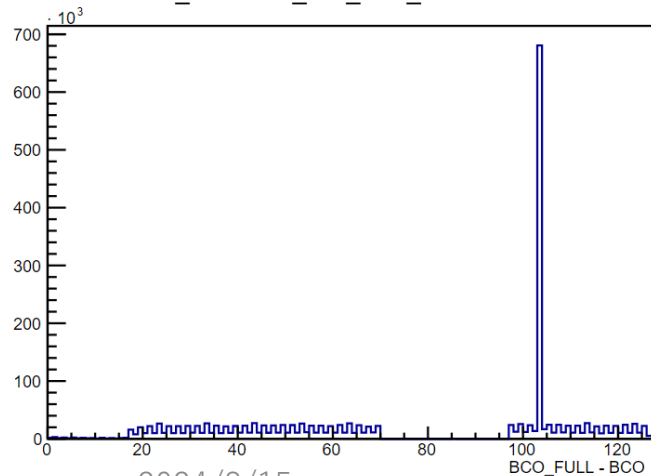
bco_full&0x7F_vs_bco_intt0_Run42214



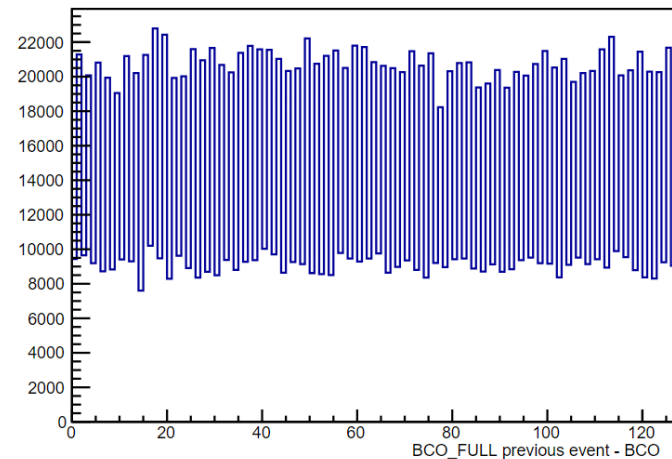
bco_full&0x7F_prev_vs_bco_intt0_Run42214



bco_full&0x7F_bco_intt0_Run42214



bco_full&0x7F_prev_bco_intt0_Run42214

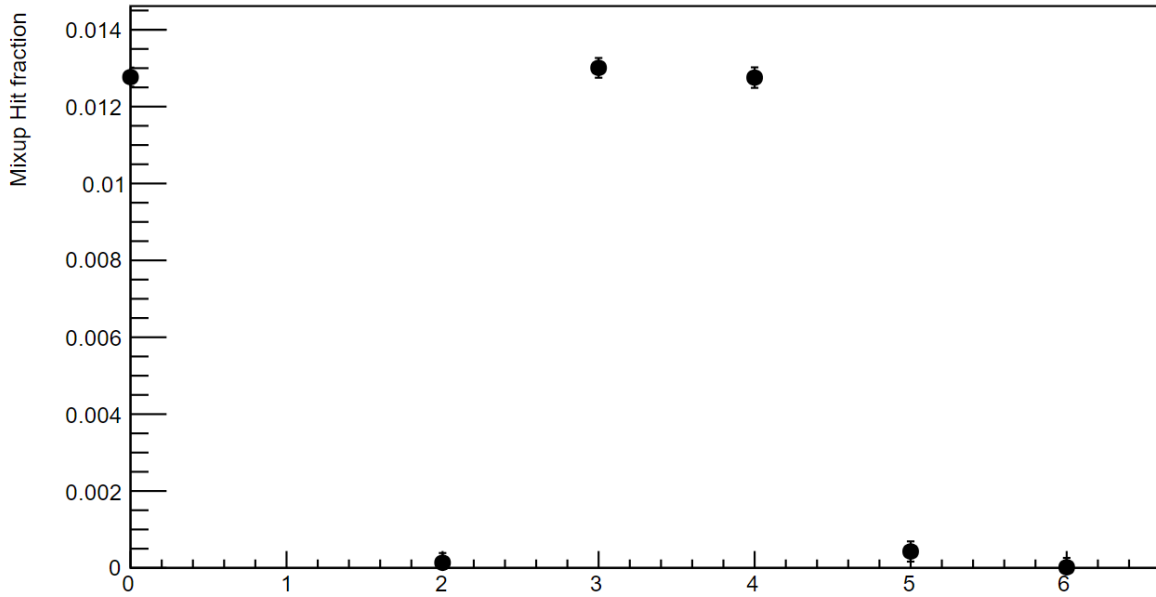


しかし高いfractionの値を出しているRunの状態を調べるとMixupは起きていないような結果だった。ノイズが多いせいか、Random hitを計算するbinが悪いせい？見直しが必要現時点ではfractionが高いと必ずMixupが起きているわけではない

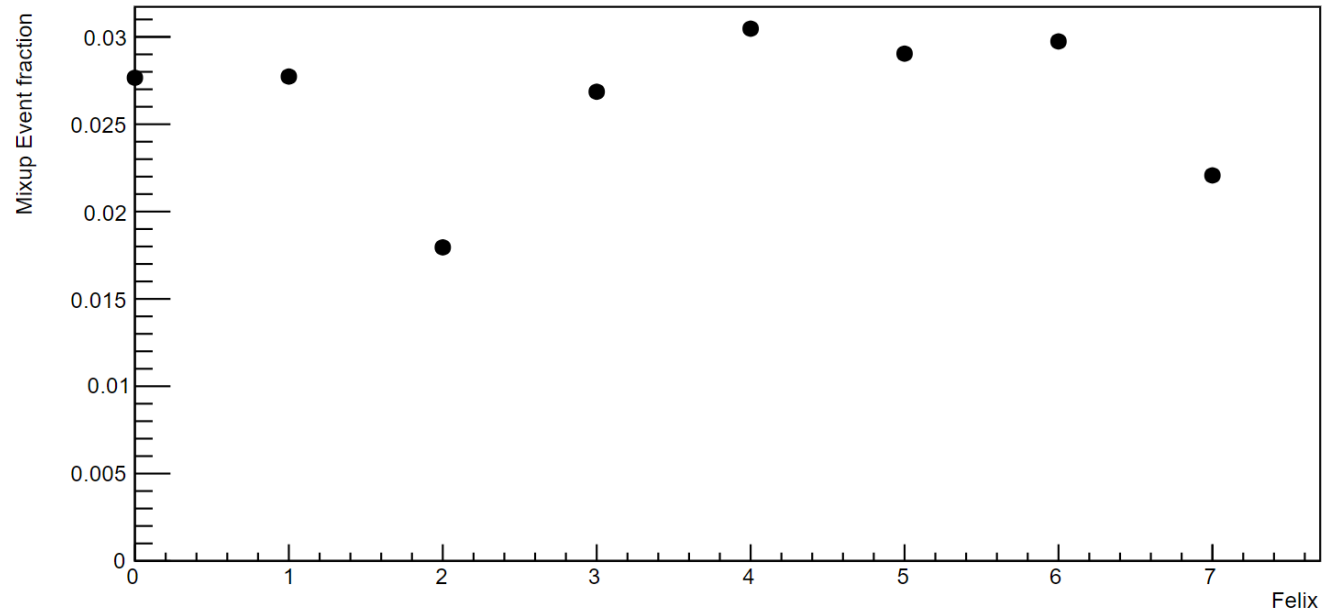
Run 24 summary

- pp衝突のデータでもEvent Mixupが起きていた
- 最近のRunではMixup fractionは低くなりEvent Mixupはほとんど起きていないと考えられる

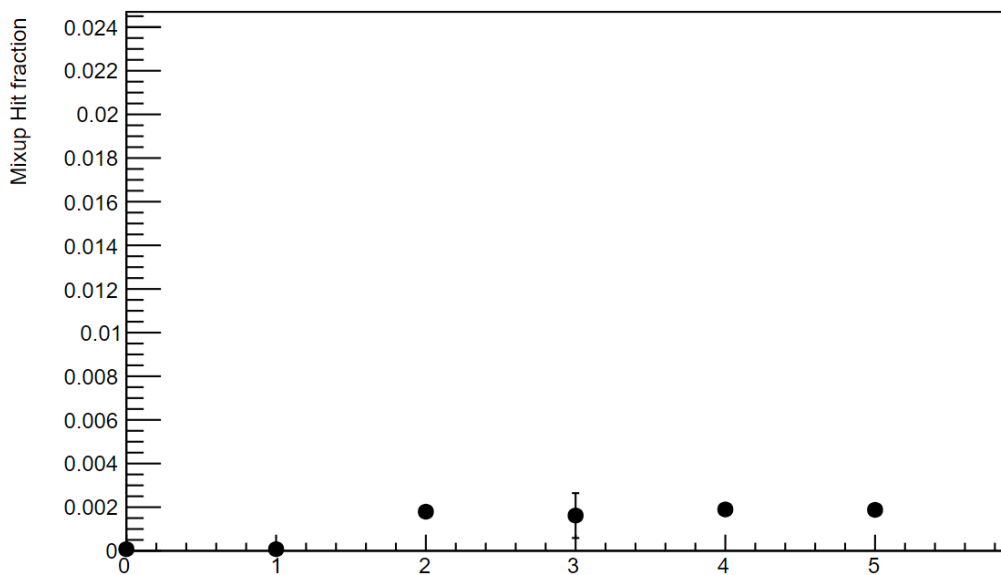
Mixup Hit fraction Run46137



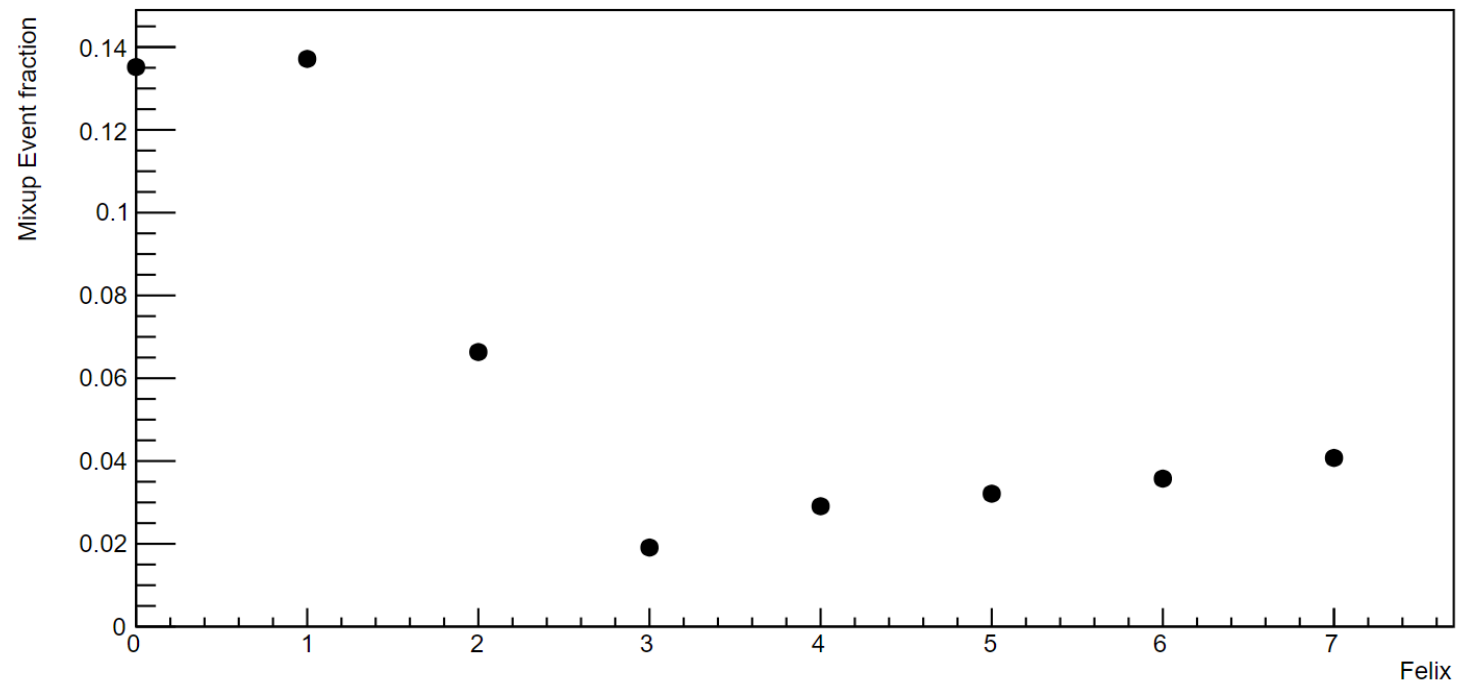
Mixup Event fraction Run46137



Mixup Hit fraction Run43278

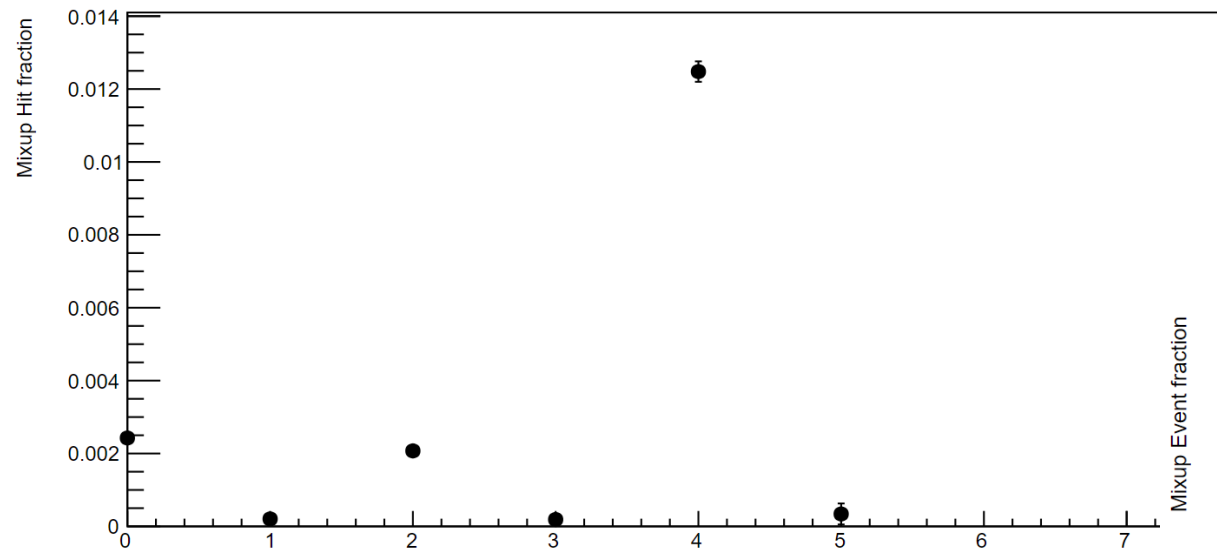


Mixup Event fraction Run43278



2024/8/14

Mixup Hit fraction Run49737



Mixup Event fraction Run49737

