Event Mixup

2024/01/31

INTTMT

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What we know about Event Mixup

- Event Mixup is in the form that hit information from the previous event is mixed up with the next event.
- Most of the time the degree of Mixup is low.
- Event mixups have been observed on some runs.
- The more Multiplicity there is in the previous Event, the more likely Mixup is to occur, but there is no correlation between Multiplicity and the number of Mixup hits.

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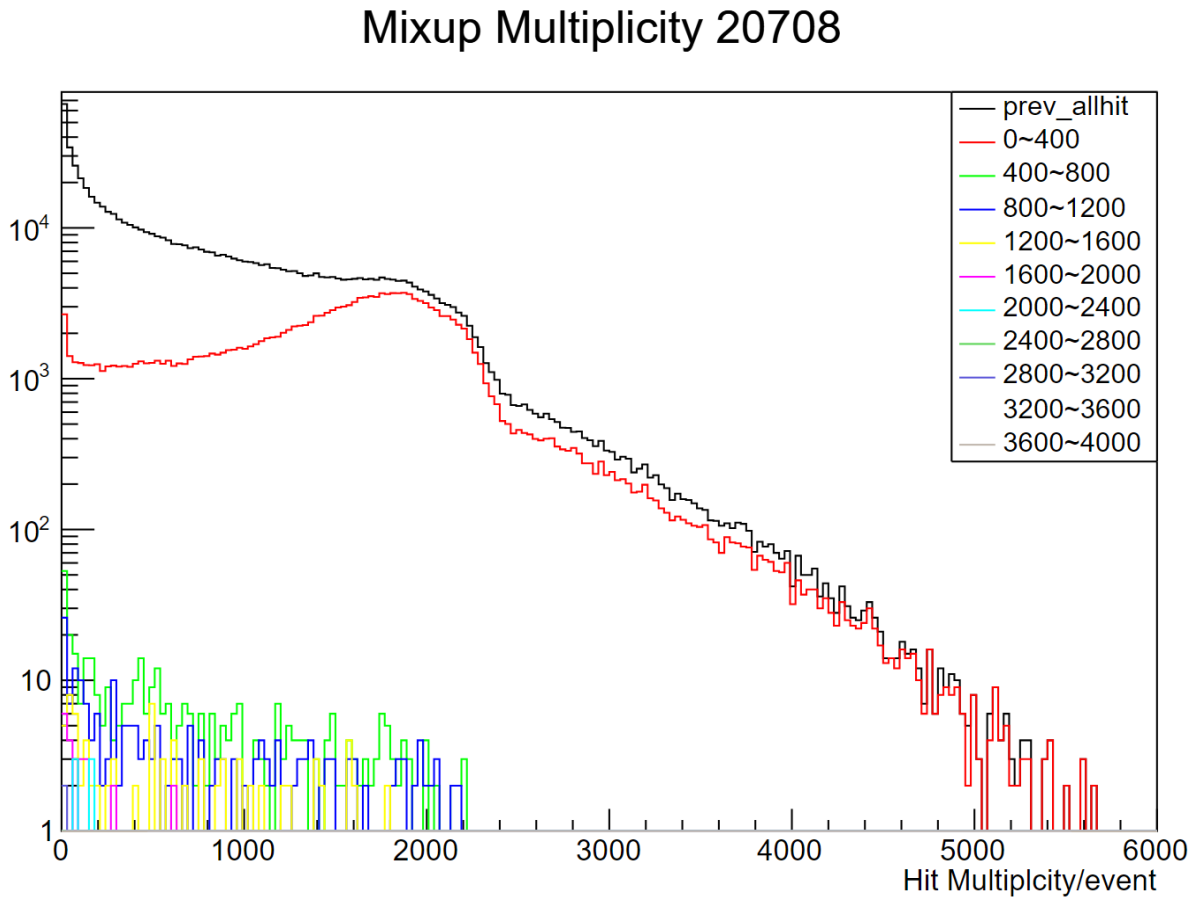
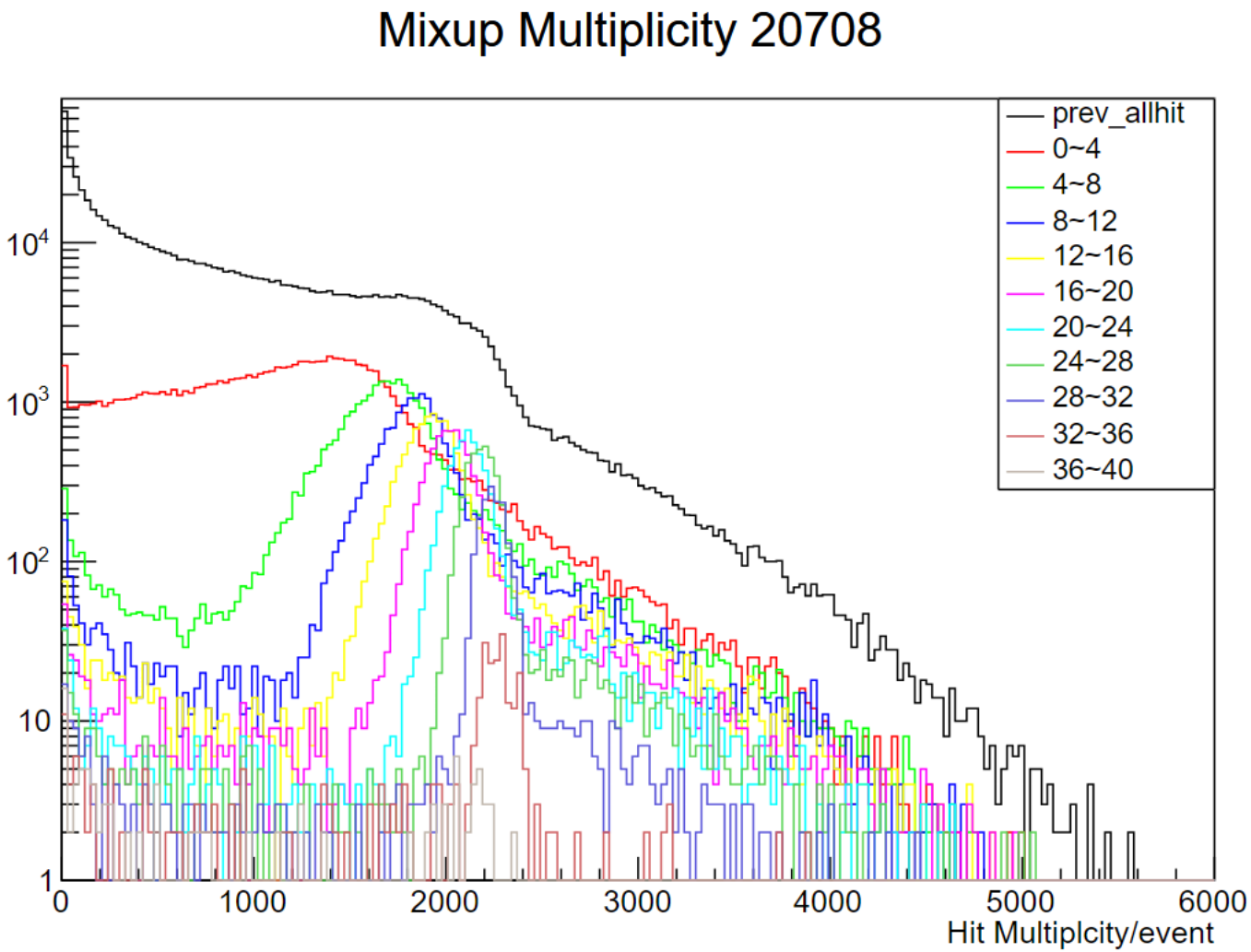
  ⇒ New results show that there is a correlation.

Hit Multiplicity (separated by number of Mixup)

- I had previously made plots separated by Mixup degree, but now I examined them separately by the number of Mixup hits.
- I found that the results(right figure) were mostly concentrated in the 1-400 range, so I chose to examine a smaller number.



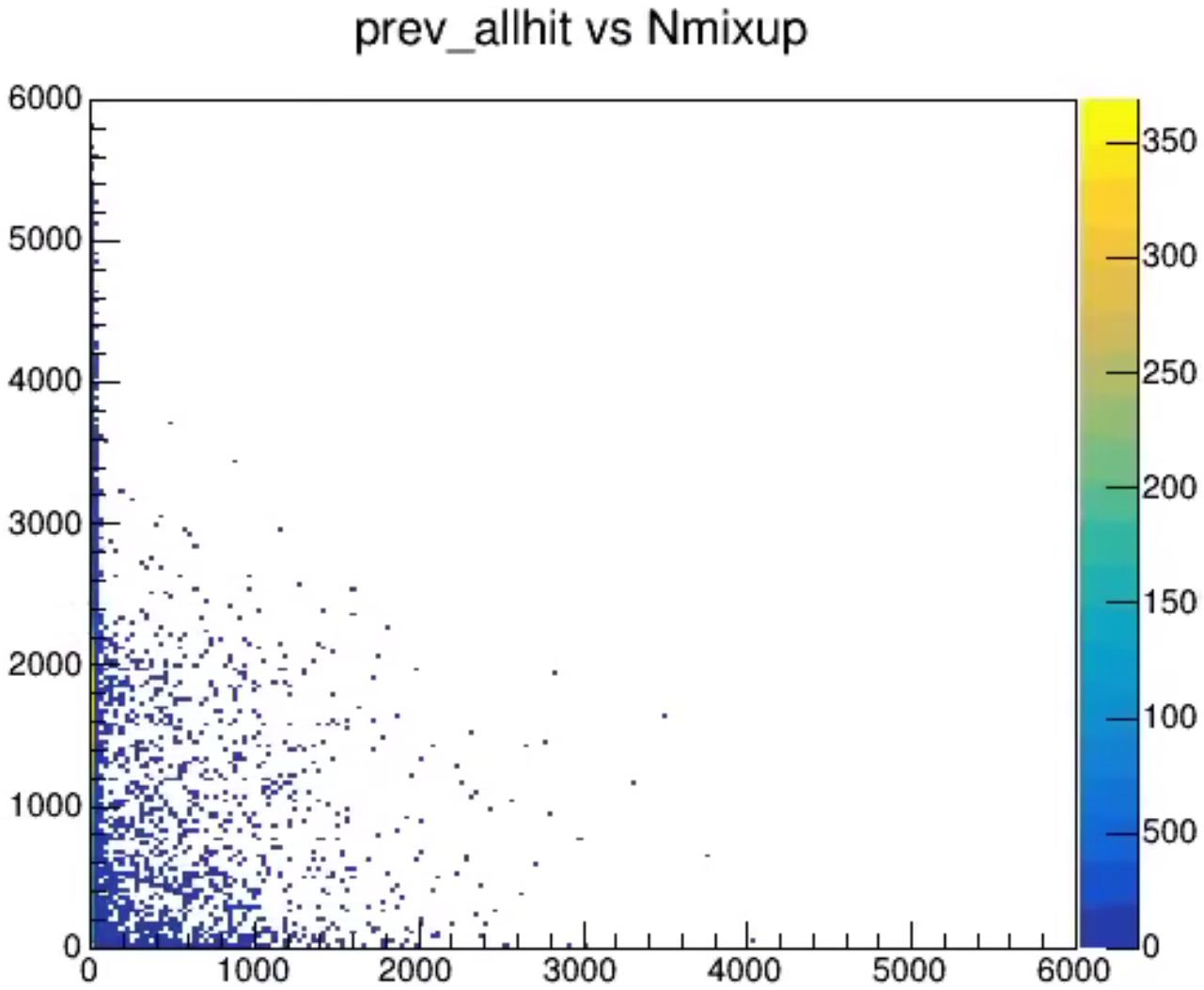
Hit Multiplicity (separated by number of Mixup)



- I examined the number of mixup from 1 to 40.
- The results confirm that as the number of mixup increases, the peak moves in the direction of increasing multiplicity.

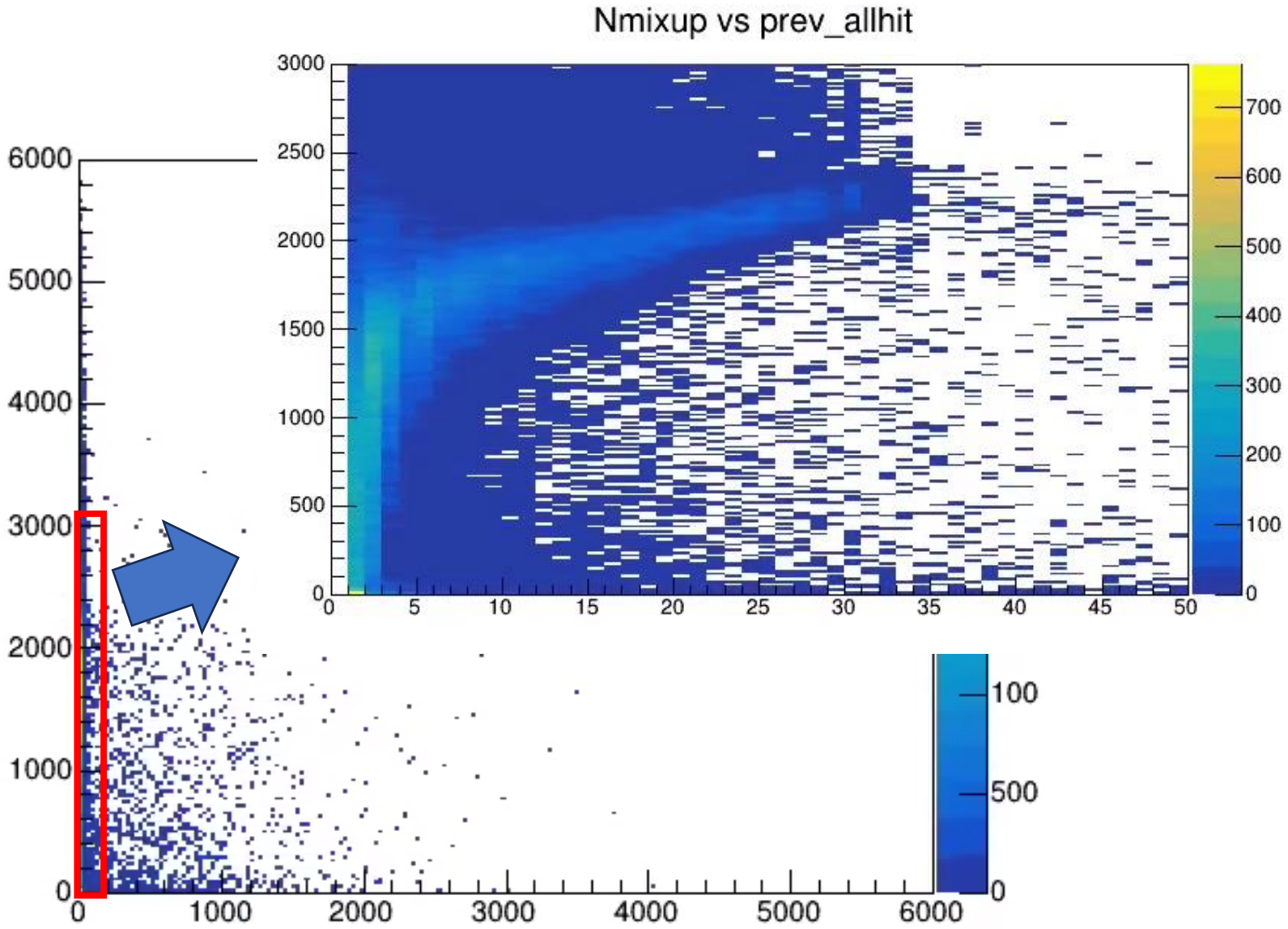
→There may be a correlation between the number of Mixup and multiplicity.

Number of Mixup vs previous event Multiplicity



- This figure, which I have shown before, plots the number of Mixup on the x-axis and the Multiplicity of the previous event on the y-axis.
- From here, I thought there was no correlation between the Multiplicity of the previous event and the number of Mixup hits.

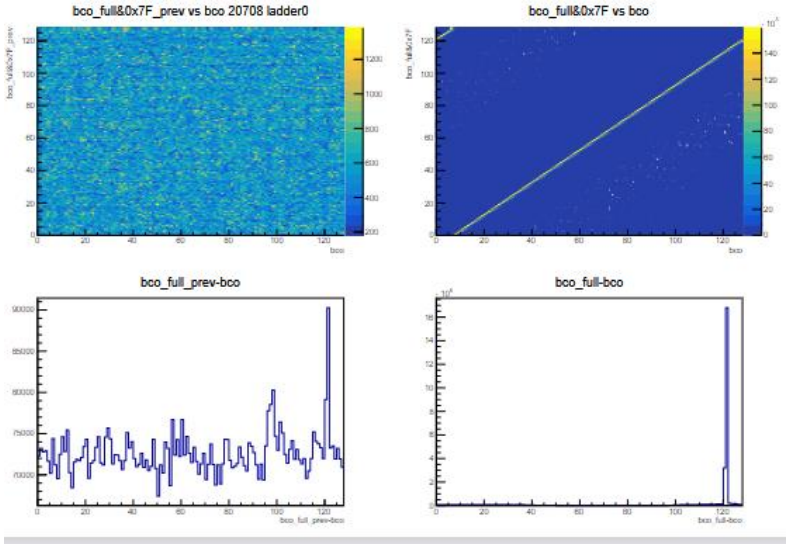
Number of Mixup vs previous event Multiplicity

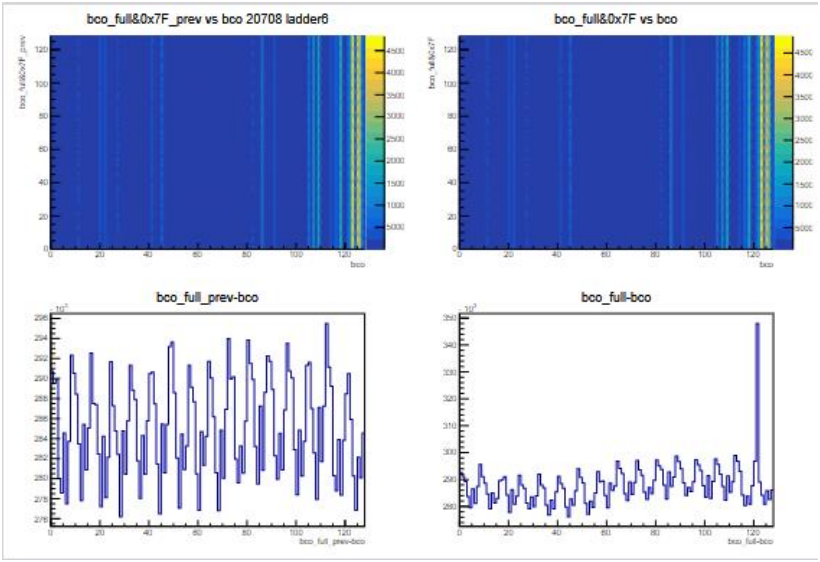


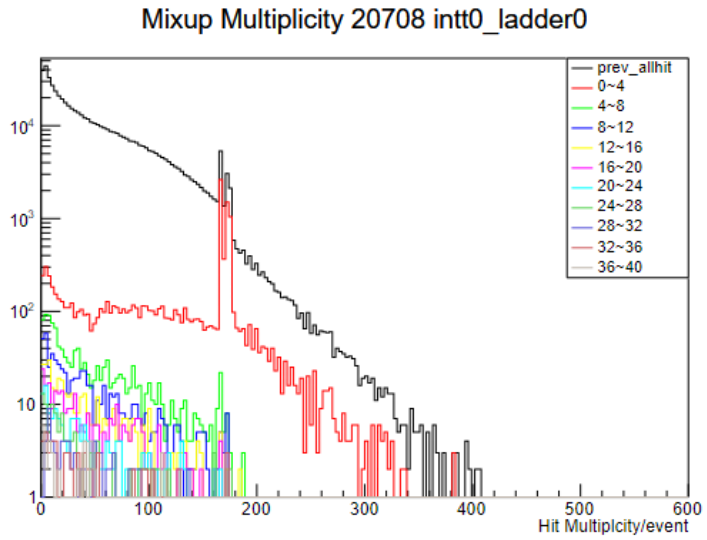
- From the results obtained from the Multiplicity distribution, a range of 0~50 on the x-axis and 0~3000 on the y-axis was chosen for the plot.
- The results confirmed the correlation shown in the figure, within the range of 1 to roughly 30 Mix up hits, the number of mix up hits are increasing with larger previous event multiplicity.

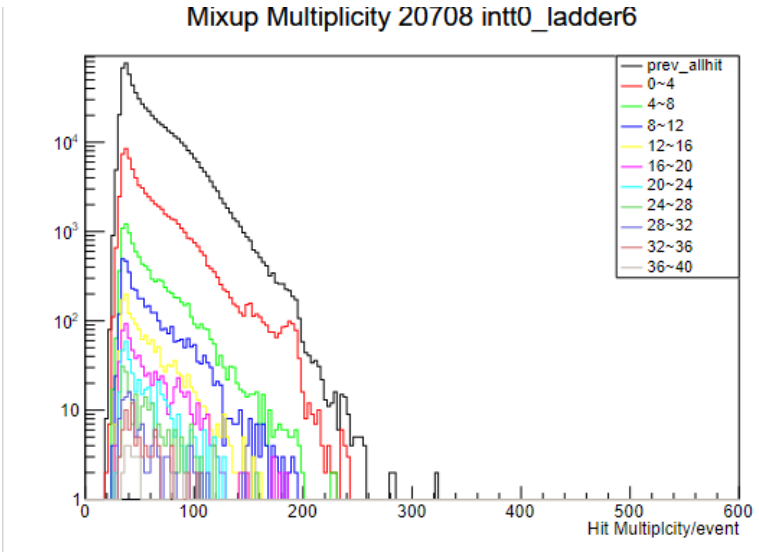
ladder by ladder

- I have examined the mixup ladder by ladder.
- I found different plots in some ladders. But I do not think it has anything with mixup.
- Because the BCO_Full-BCO plots for the same event are different. This is a different state of collision data.
- Except for these error ladders, almost all ladders have the same results, so I don't think it changes from ladder by ladder.









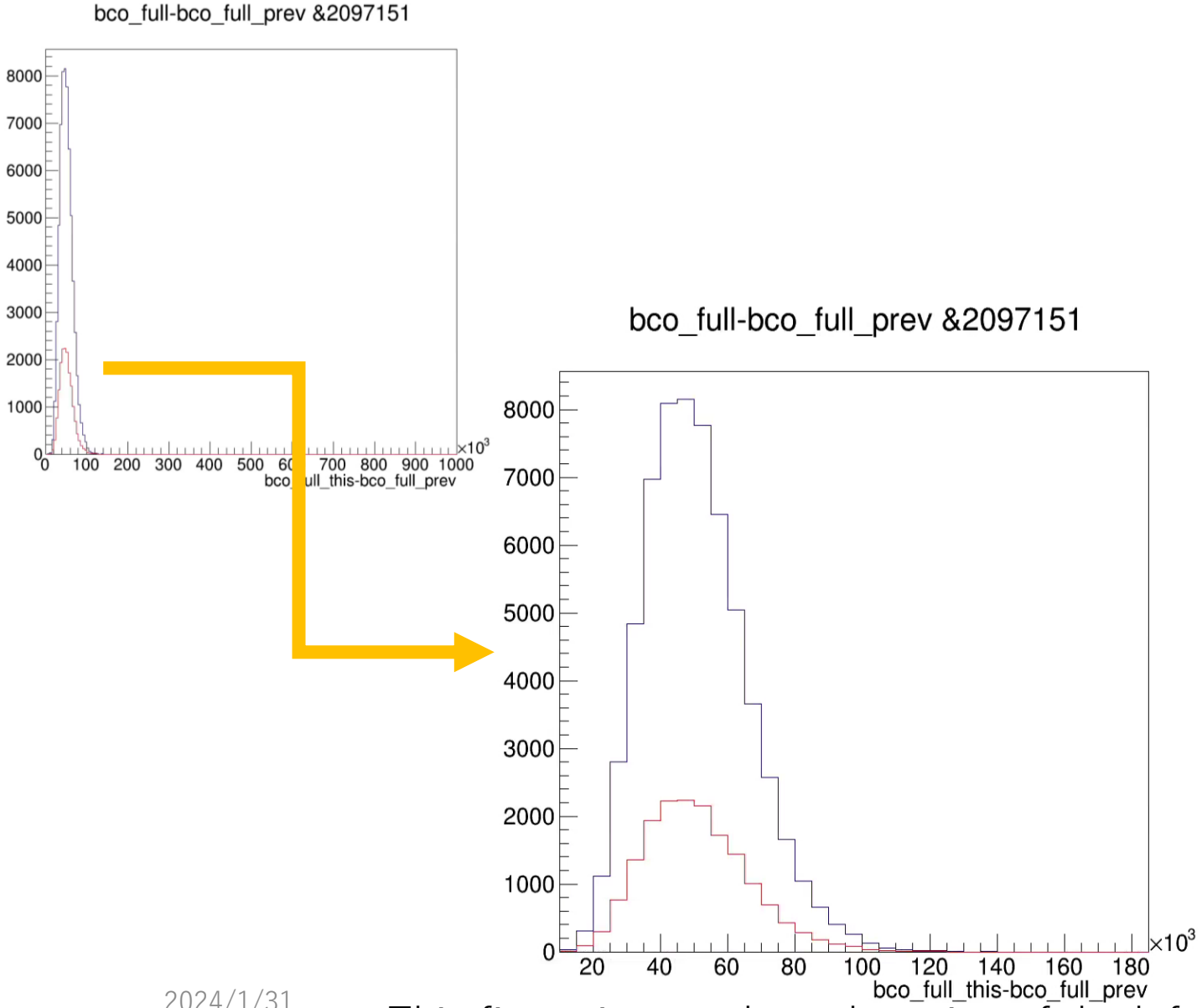
Most ladders state

Some ladders

My next step (multiplicity)

- Check with the latest data of beam
- Closer examination of the peaks in the ladder-by-ladder plot
- Examine chip by chip

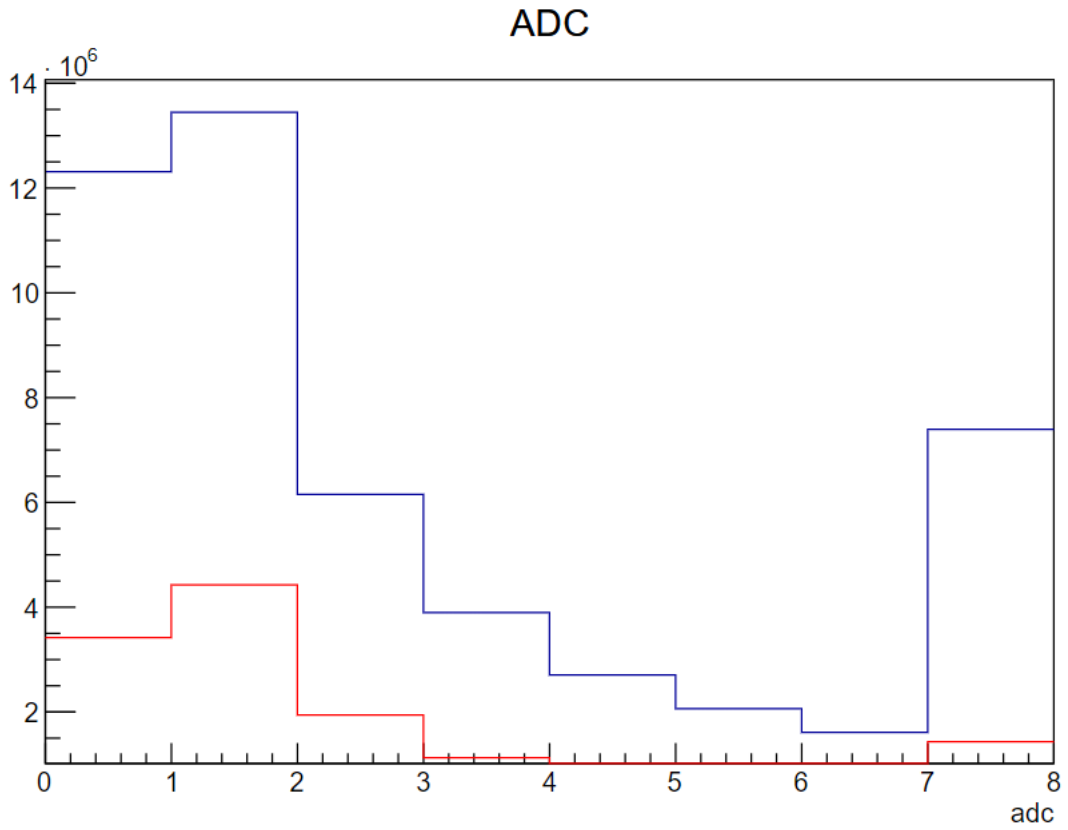
Collision interval All event and Mixup event



This figure is an enlarged version of the left figure

- 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 Mixup events and all events
  →Mixup does not change with interval width

ADC and Mixup



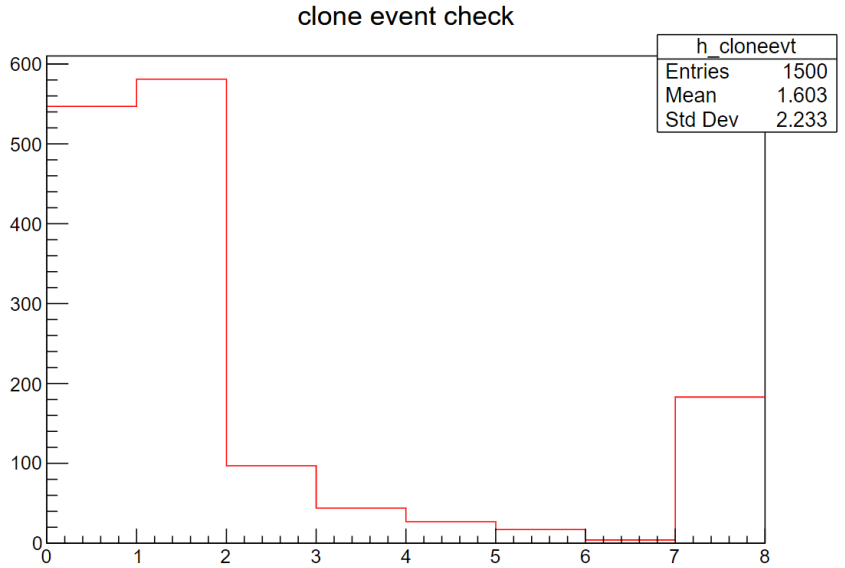
- To determine if there is a relationship between Mixup hits and ADC, I made an ADC distribution of Mixup hits.
- The left figure examines 10% of all events (Run20708intt5).
- Blue is the ADC distribution of all hits and Red is the ADC distribution of Mixup hits.
- Since there is no significant difference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

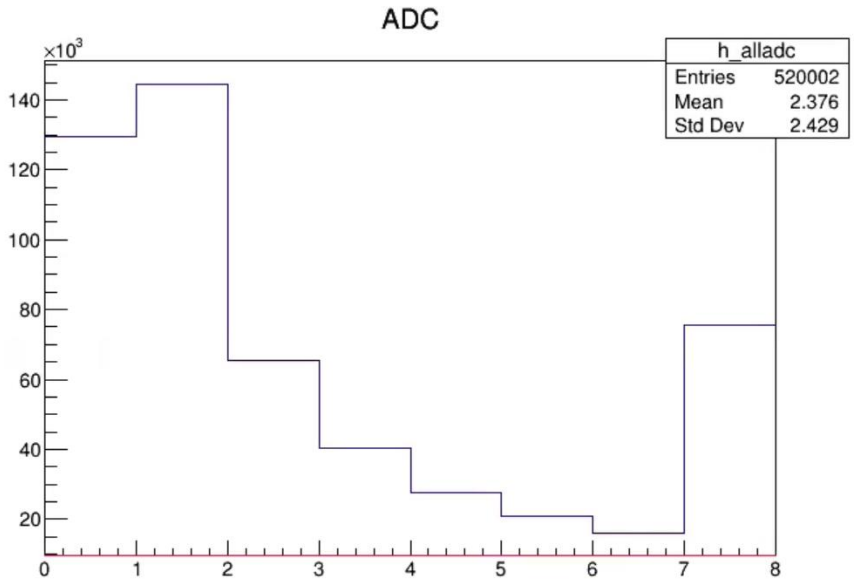
My next step

- Correlation between clone events and Mixup (I'm working on it)
- Correlation Hot channel between Mixup
- Mixup with cosmic ray data

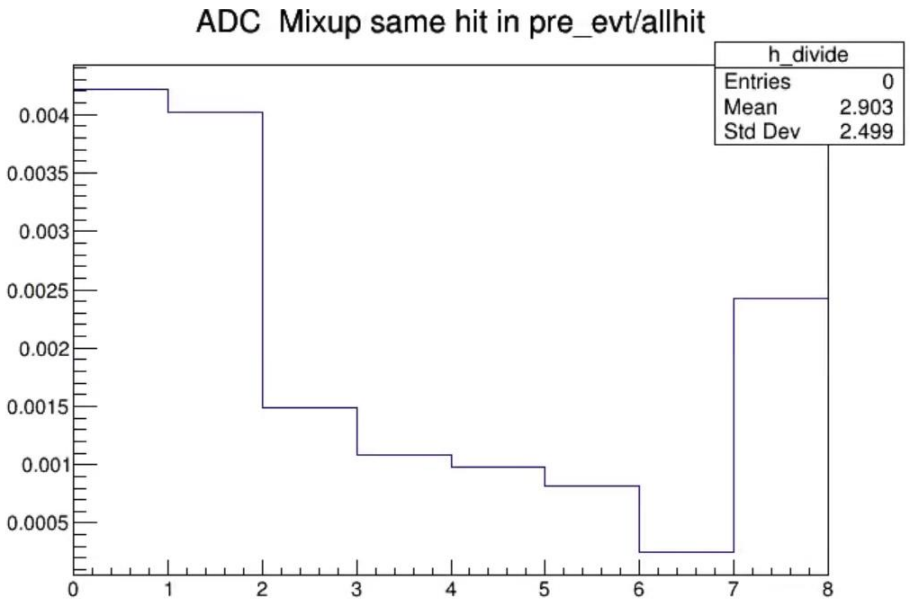
Back up

Clone event





- For Mixup hits, I checked for the same hit information (module,chip_id,chan_id,adc) in the previous event.
- If the same hit was in the previous event, the result of ADC distribution is shown above. The events examined are 10 percent of the total
- The figure below also shows the ADC distribution of all Mixup hits, and there are very few entries that are both Mixup and the same hit in the previous event.



Clone event (not clone hit)

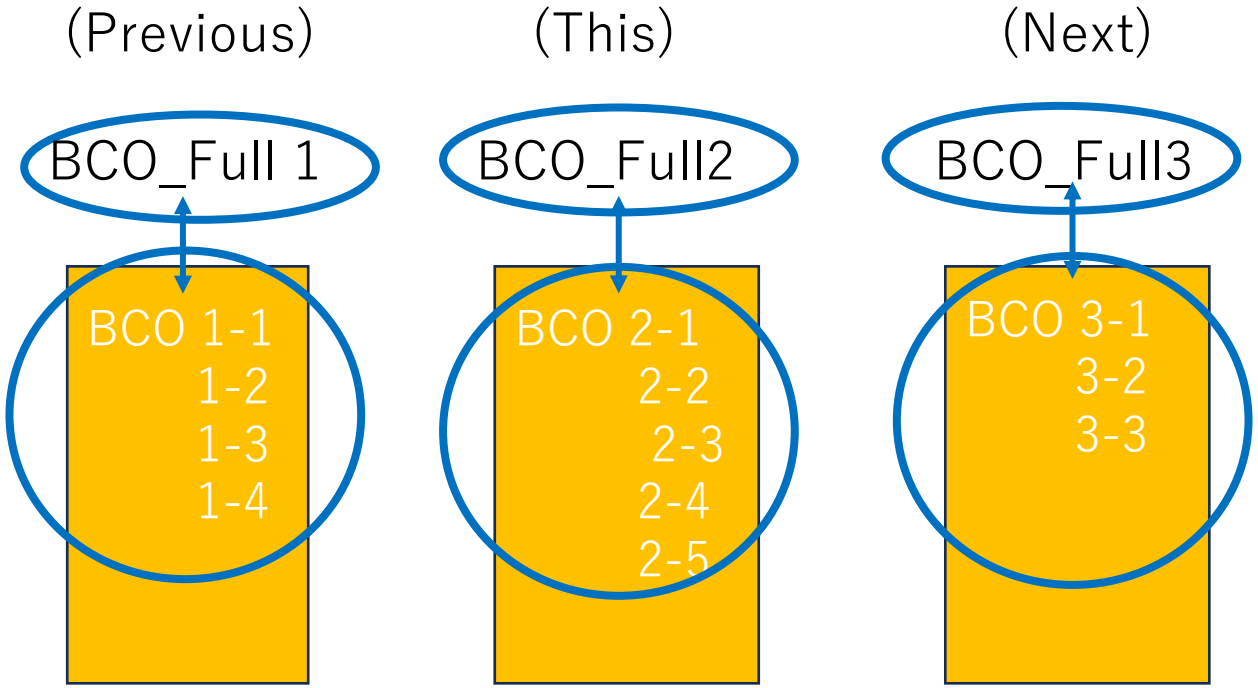
File: BeamData_20211210-0302_0.root (run52)

Row	Instance	camac_adc	camac_tdc	INTT_even	adc	ampl	chip_id	fpga_id	module	chan_id	fem_id	bco	bco_full	event
17	48			1	3	0	21	0	1	103	1	67	65475	-1
17	49			1	1	0	21	0	5	101	8	67	65475	-1
17	50			1	0	0	21	0	5	100	8	67	65475	-1
17	51			1	3	0	21	0	6	98	8	67	65475	-1
17	52			1	3	0	21	0	1	103	1	68	65476	-1
17	53			1	1	0	21	0	5	101	8	68	65476	-1
17	54			1	0	0	21	0	5	100	8	68	65476	-1
17	55			1	3	0	21	0	6	98	8	68	65476	-1

The pairs are identical! only the timing information is different!

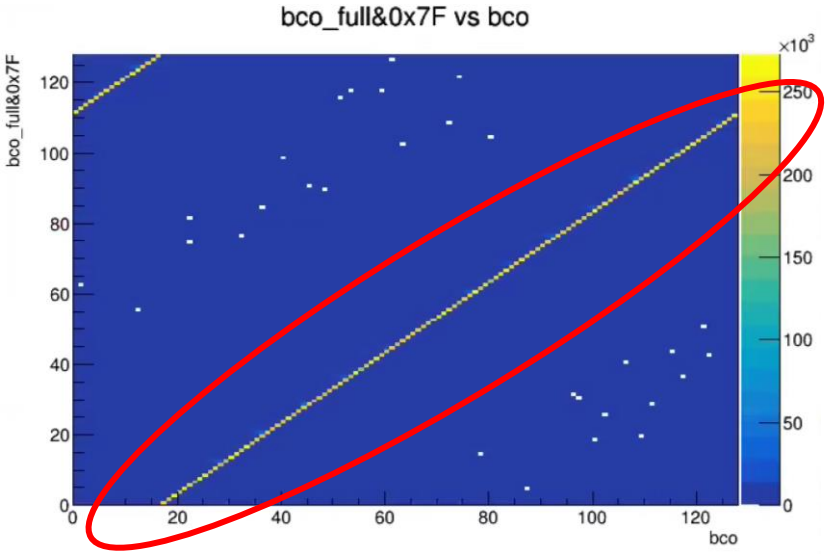
- They are in the same “trigger event”
- The two groups have identical content except the bco and bco_full
  - Are they clone event ? or just coincidence ?

BCO Correlation in for NO mix-up



Run23648 intt5

Same event BCO_Full &0x7F vs BCO

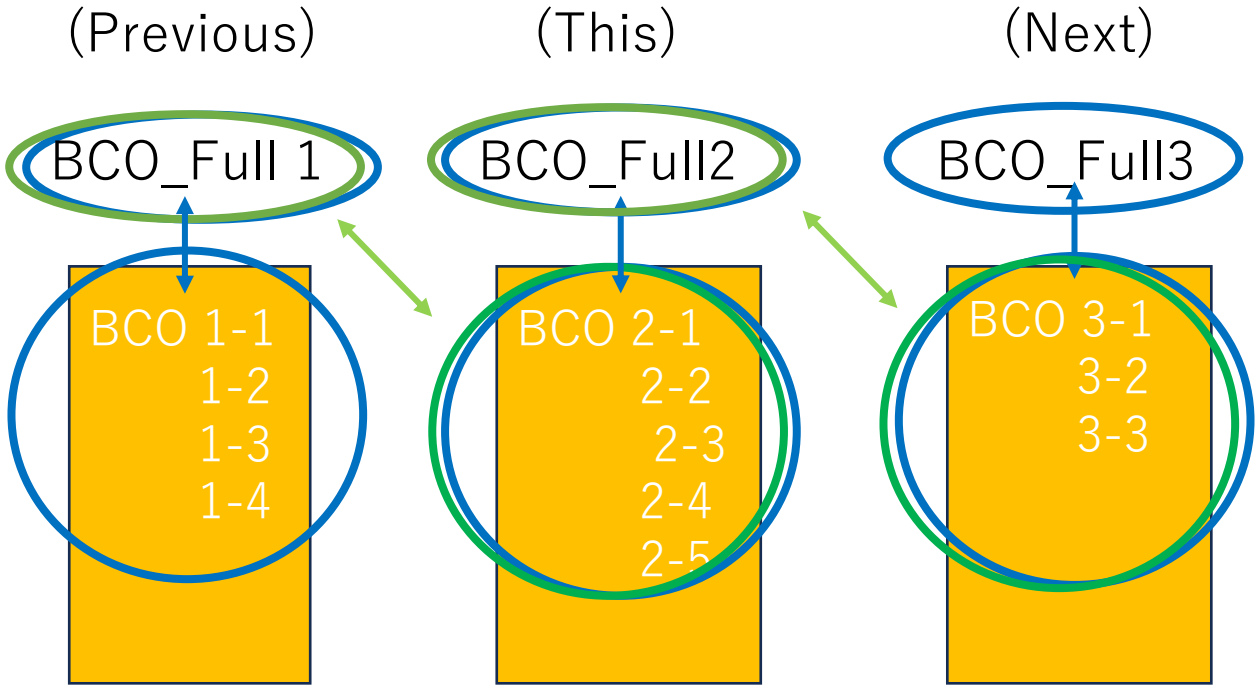


Perfect correlation observed as expected

For example, suppose that when normal and no mixup is occurring, the above figure is shown.
The figure on the right shows the correlation between BCO(x-axis) and the lower 7 bits of BCO_Full(y-axis).

BCO_Full and BCO in the same event are correlated (hit from collision).

BCO Correlation in for NO mix-up

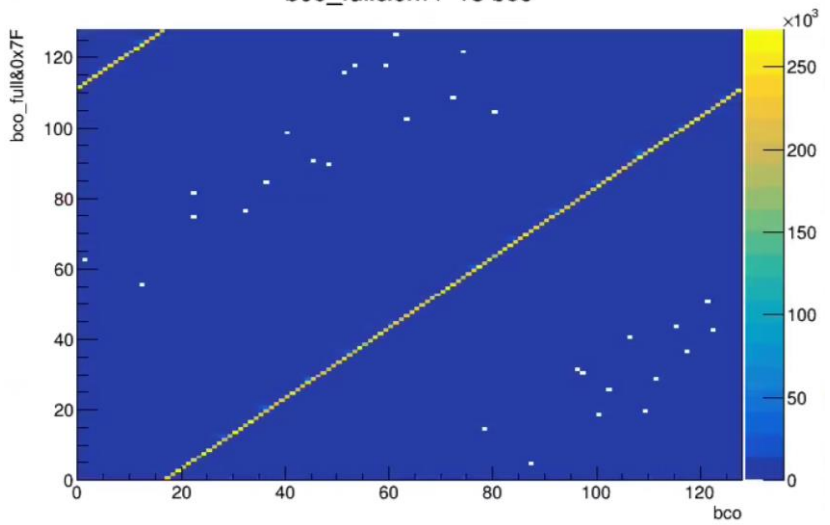


For example, suppose that when normal and no mixup is occurring, the above figure is shown.
The figure on the right shows the correlation between BCO(x-axis) and the lower 7 bits of BCO_Full(y-axis).

If we look at the plot of BCO of one event and BCO_Full of the previous event here, we don't see the correlation as we except.

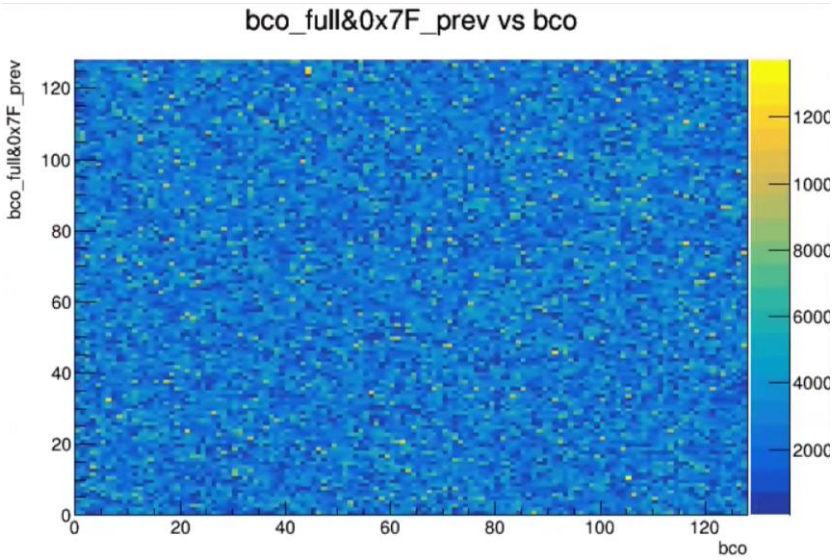
Run23648 intt5

Same event BCO_Full &0x7F vs BCO



Run23648 intt5

Previous event BCO_Full &0x7F vs BCO



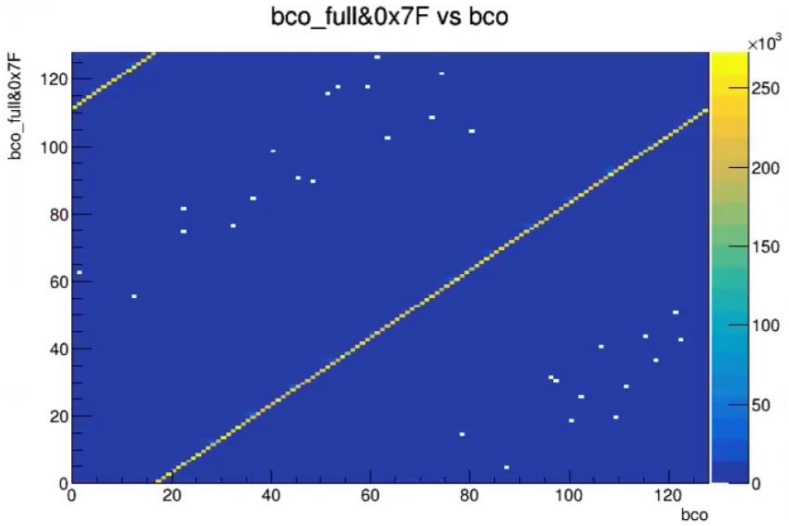


Fig.1(a)

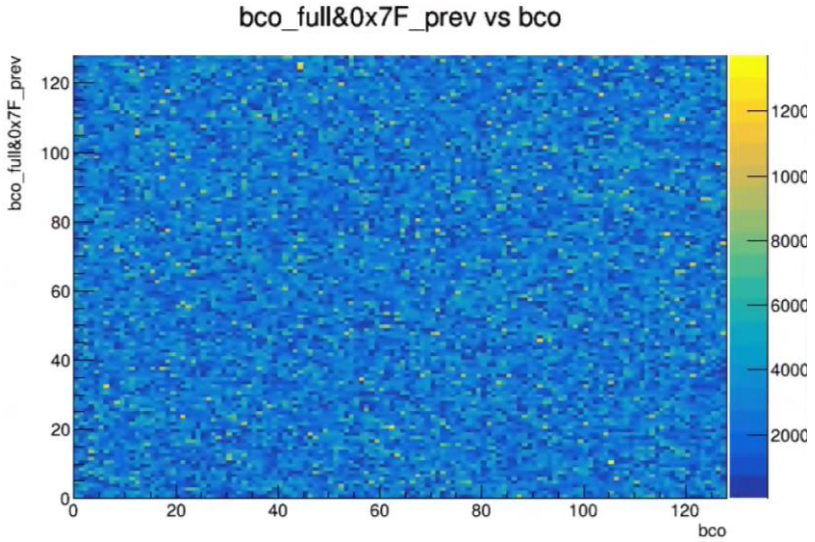


Fig.1(b)

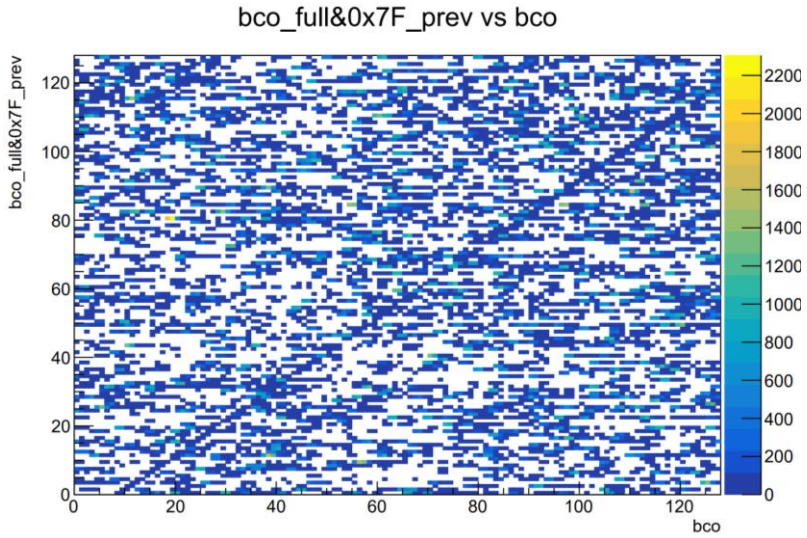


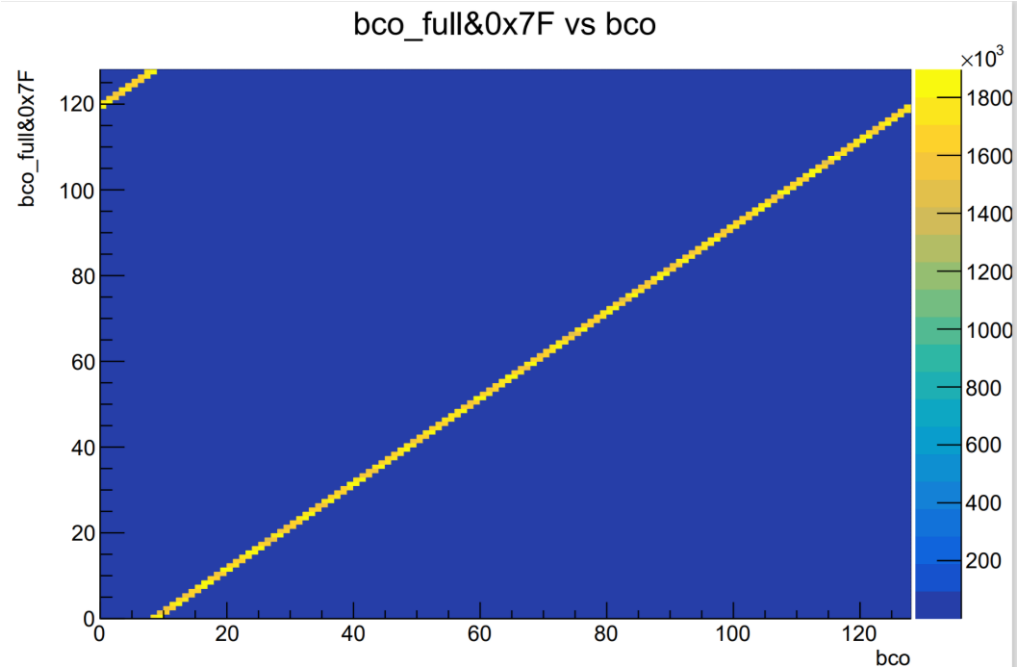
Fig.1(c)

BCO Correlation in for mix-up

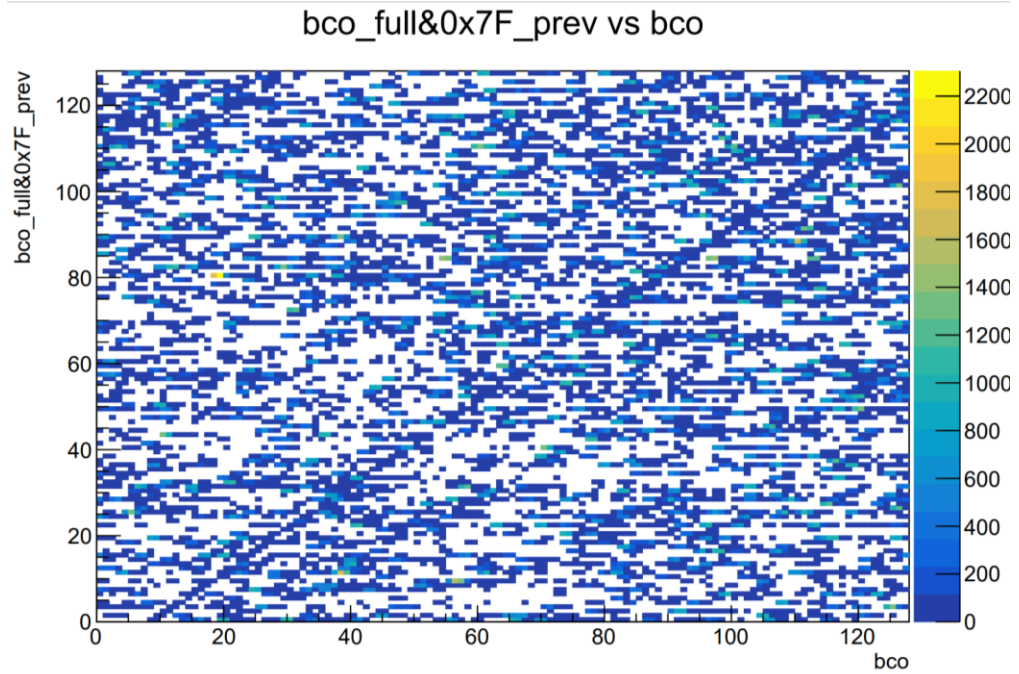
Run20444 intt5

However, the plot of BCO_Full vs BCO showed that there is a correlation in the results of some runs.

Same event BCO_Full &0x7F vs BCO



Previous event BCO_Full &0x7F vs BCO



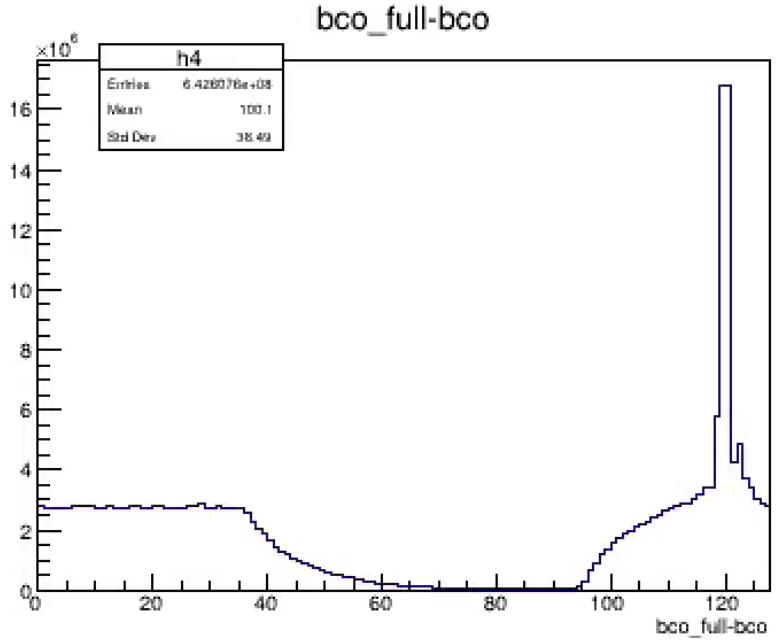
There should be no correlation between the BCO_Full of the previous event and the BCO of this event, but the correlation as shown on the right figure suggests that the data from the collision of the previous event has been mixed up with this event. →**Event Mixup is occurring.**

BCO_Full_prev-bco Mixup

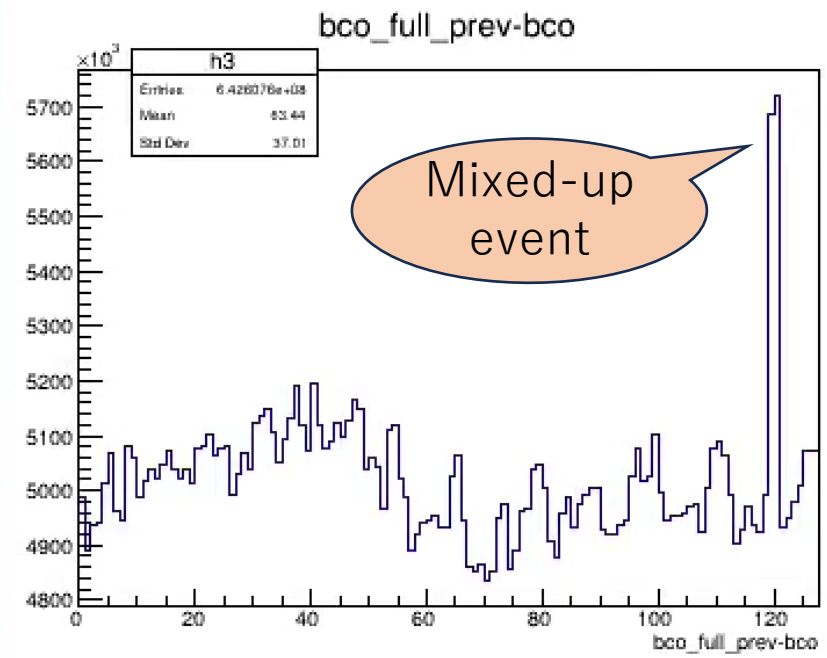
Run20444 intt5
This Run was measured with n_collision=127

- Also, when looking at the BCO_Full of the previous event -BCO at the Run where the Mixup is believed to have occurred, I could see the peak standing in the same position as the BCO_Full-BCO of the same event

Same event BCO_Full &0x7F - BCO



Previous event BCO_Full &0x7F - BCO

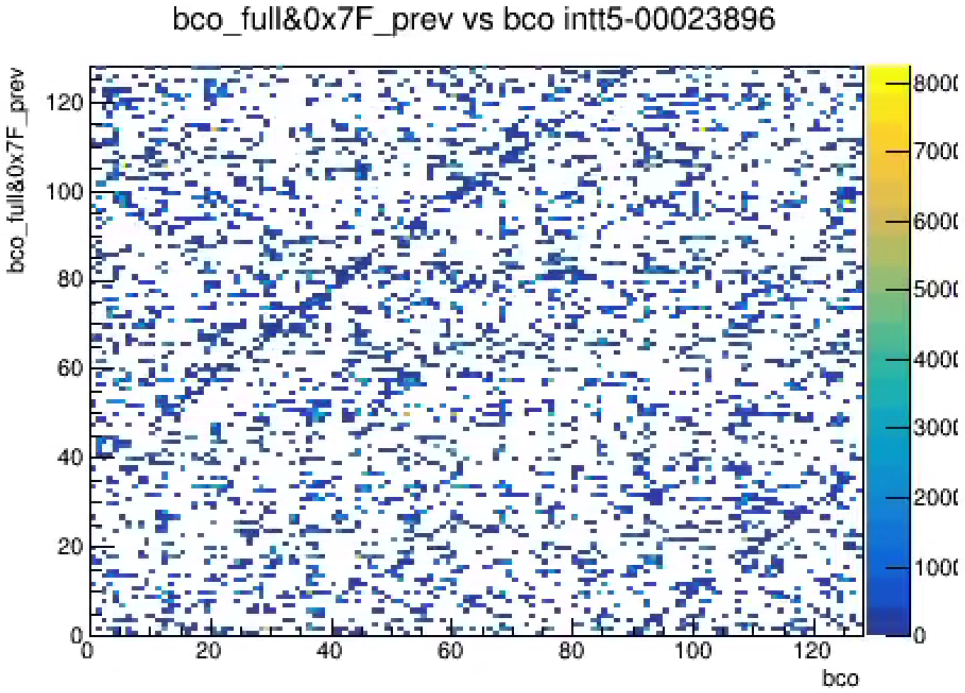


From this result, I think that the data from the collision of the previous event has been mixed up.

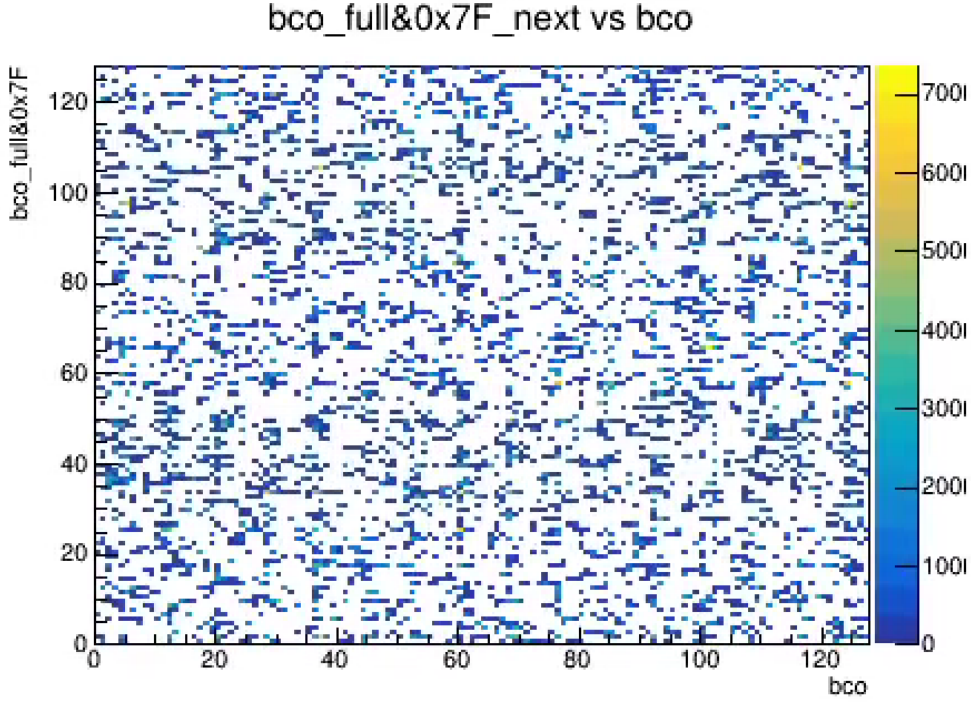
How about the correlation between “This” and “Next” events?

Run23896 intt5
This Run is what I think the Mixup is occurring

BCO vs previous event BCO_Full

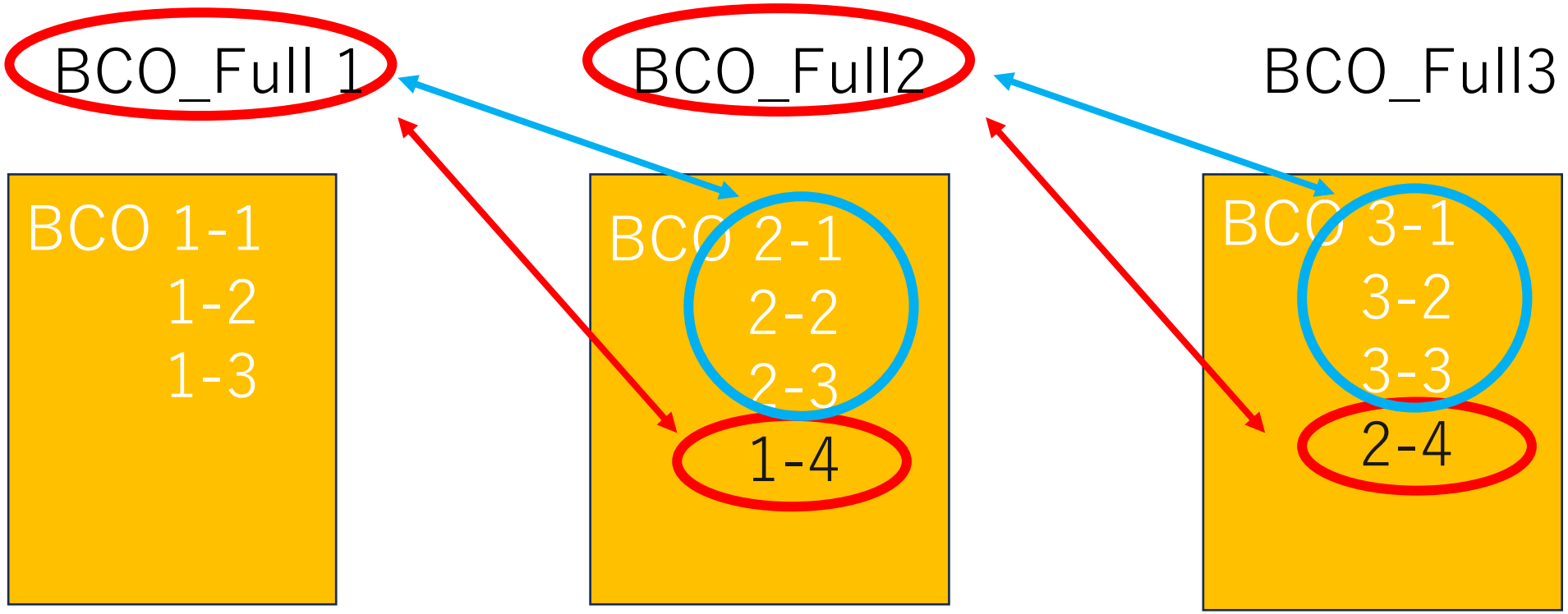


BCO vs next event BCO_Full



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.

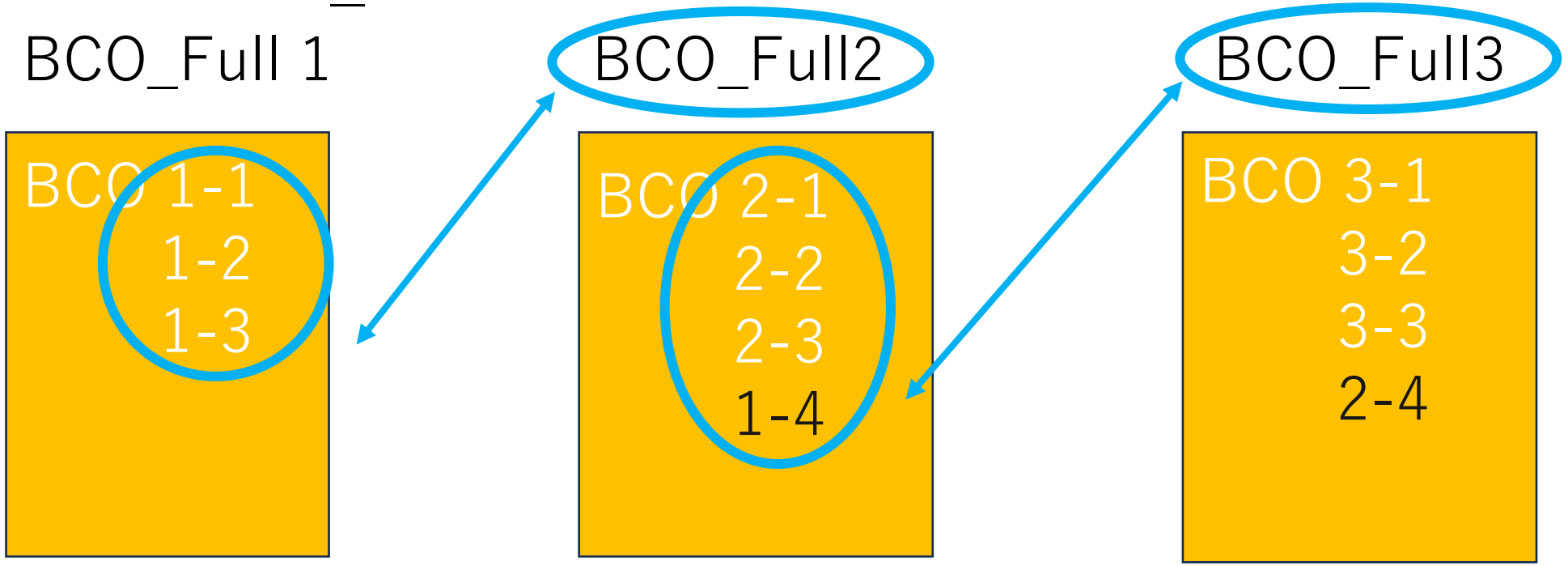
Why this event BCO vs prev event BCO_Full have correlation



The red circled areas are correlated because the information is from the same collision.

The blue circled area do not match, so there is no correlation.

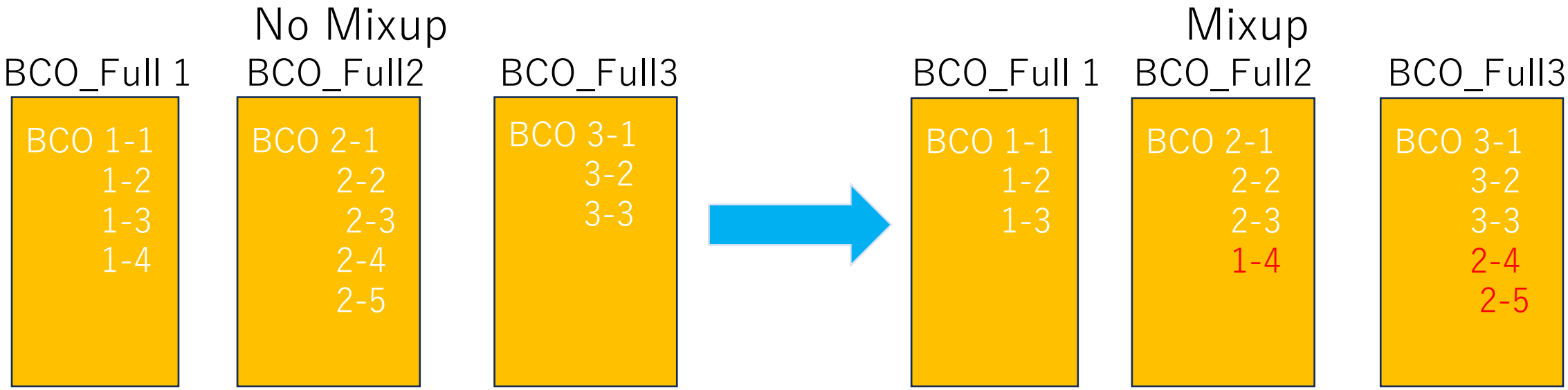
Why we don’t observe the correlation in this event BCO vs next event BCO_Full



There is any combination of data for the same collision and there is no correlation because the labels do not match, as shown in the blue circles.

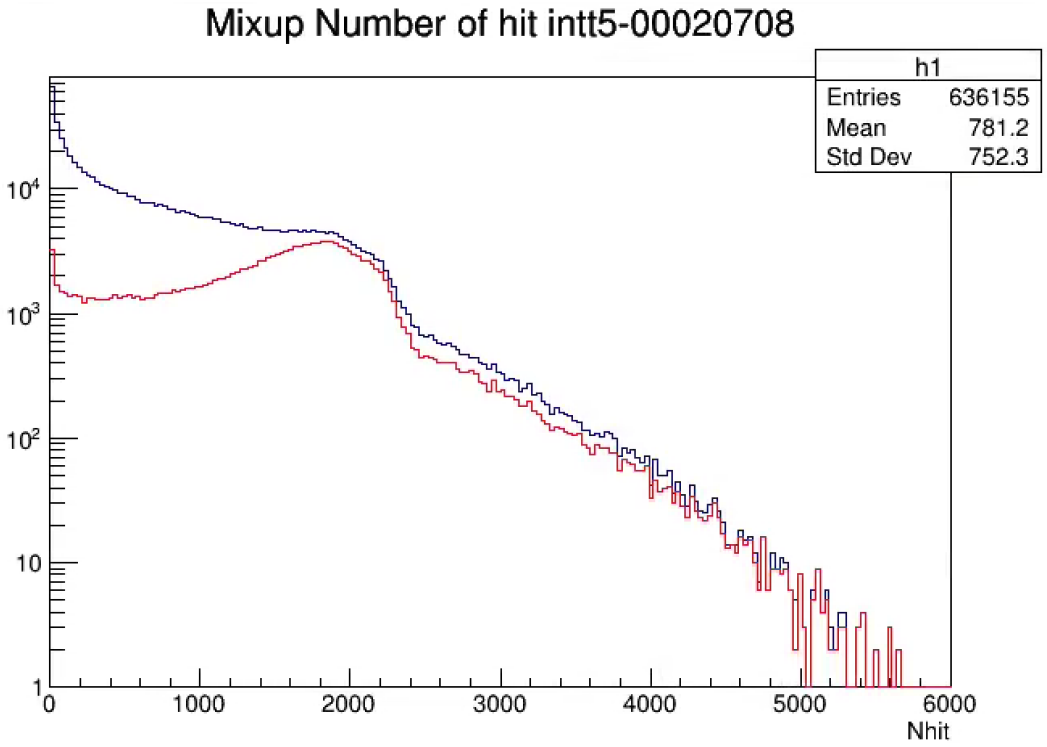
What's happening in the case of Event Mix-up?

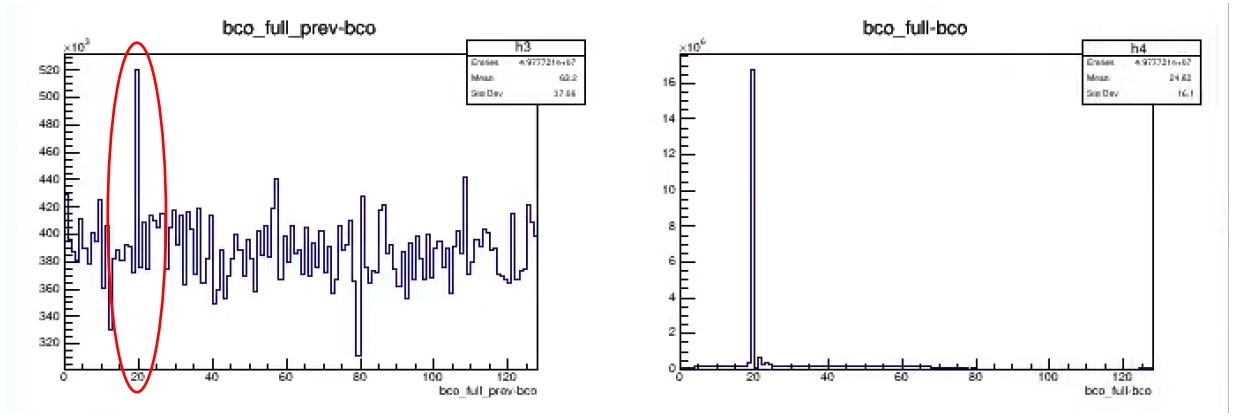
- From the results so far, Event Mixup is in the form that hit information from the previous event is mixed up with the next event, as shown in the following figure.
- I know that there are Runs where this is happening and Runs where this is not happening, I suspect high multiplicity event causes the event mixup.



Multiplicity dependence Run20708 intt5

Black: All events Red: Mixup events

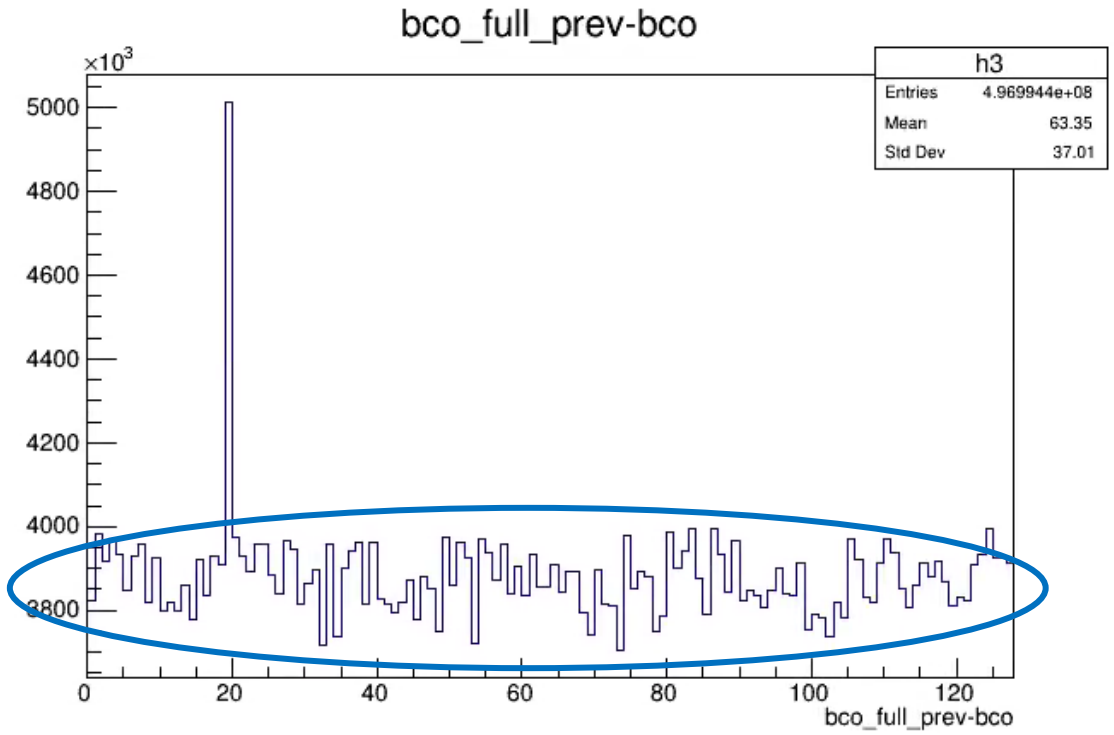




- Number of hit are plotted in black for all events and in red only for events where mixup are occurring.
- I had selected BCO_Full_prev-BCO=19 events for Mixup.

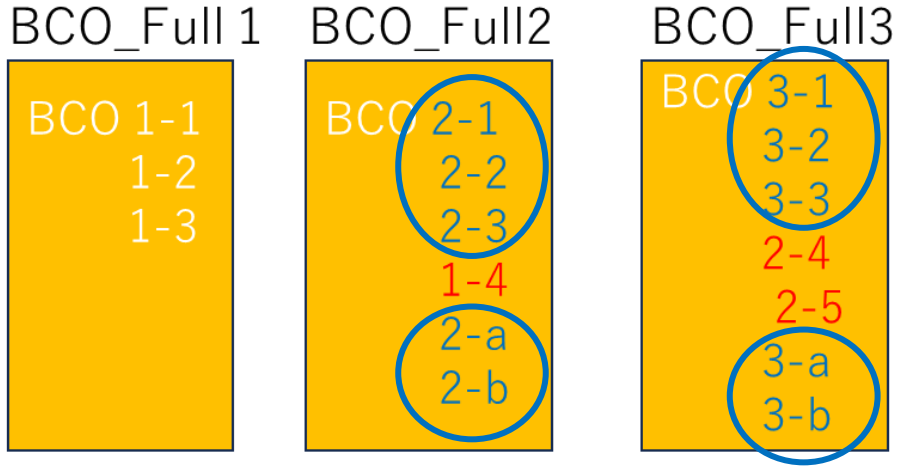
- Left plot shows that **there is multiplicity dependence in the mixup.**
- Many mixup is occuring where Multiplicity is high.

Re-thinking how to determine Mixup.



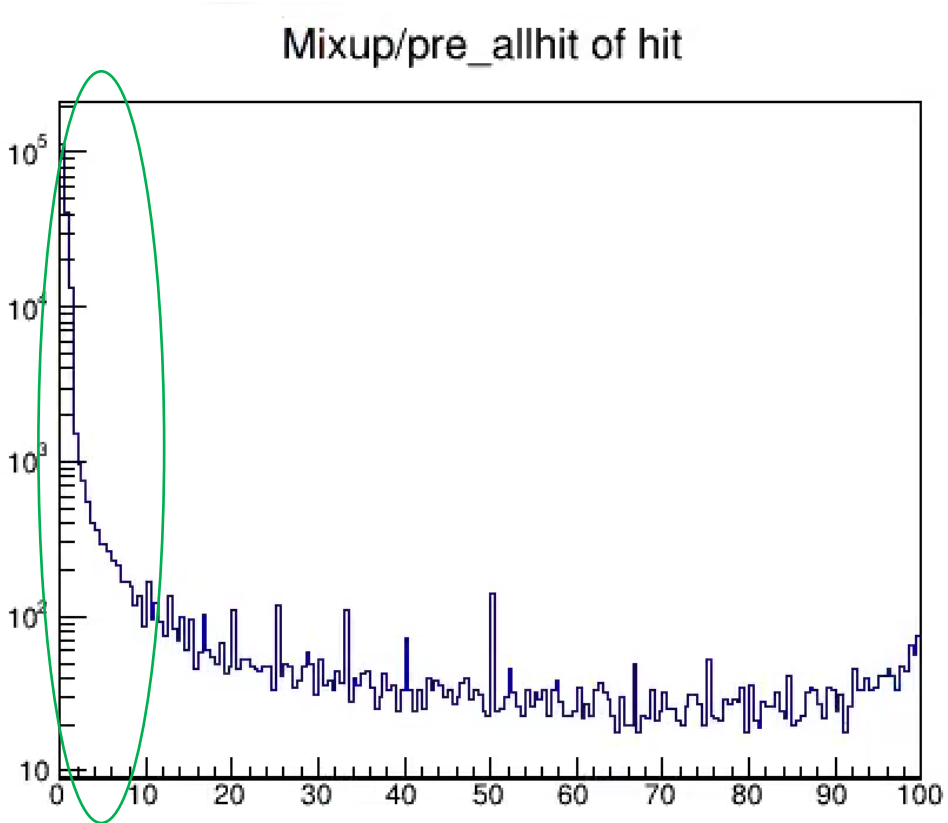
Possible non-peak inclusions:
- collision hits of this event(2-1~3,3-1~3)
- just noise hits(2-a,2-b,3-a,3-b)

- I had determined that all hits that peaked in BCO_Full_prev-BCO were mixups.(For example, this run peaks at BCO_Full_pre-BCO=19. If a hit takes this value, the hit is considered a mixup.)
- However, hits that were not mixup were also determined to be mixup.(Random hits circled in blue)
- I am trying to get rid of the random hits and correctly select only the mixup hits but have not yet completed it.
- I've learned a few things in the course of my research to accomplish this, and I'll report them on the next pages.

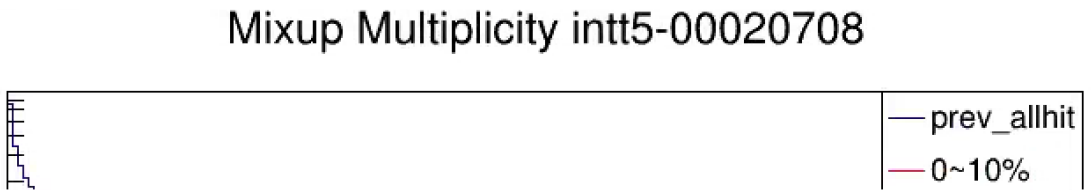


Mixup/prev allhit +Mixup Run20708

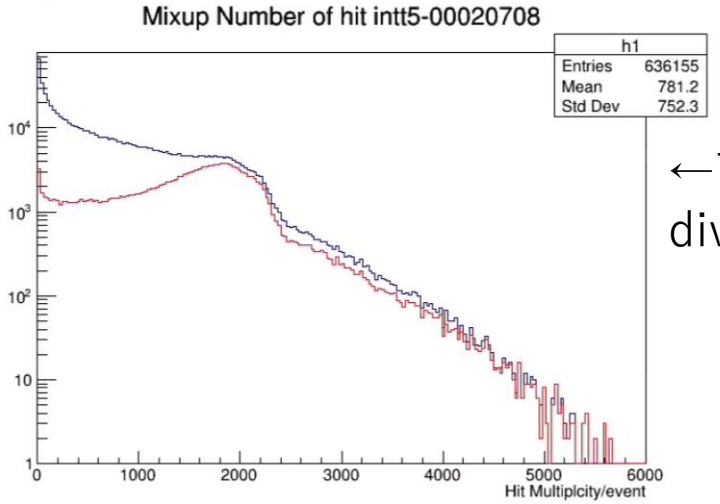
- First, to quantify how much of a Mixup event it is(degree of Mixup),
  I plotted the
  number of Mixup hits /(number of previous event hits + number of Mixup hits) ×100
- I counted hits with prev_BCO_Full-this_BCO=19 as Mixup hits.(No other cut)
- Results indicate that 0-10% is the most common. we found that the degree of Mixup was low.



Multiplicity(Nhit of mixup/(Nhit of pre_event+Nhit of mixup)*100)

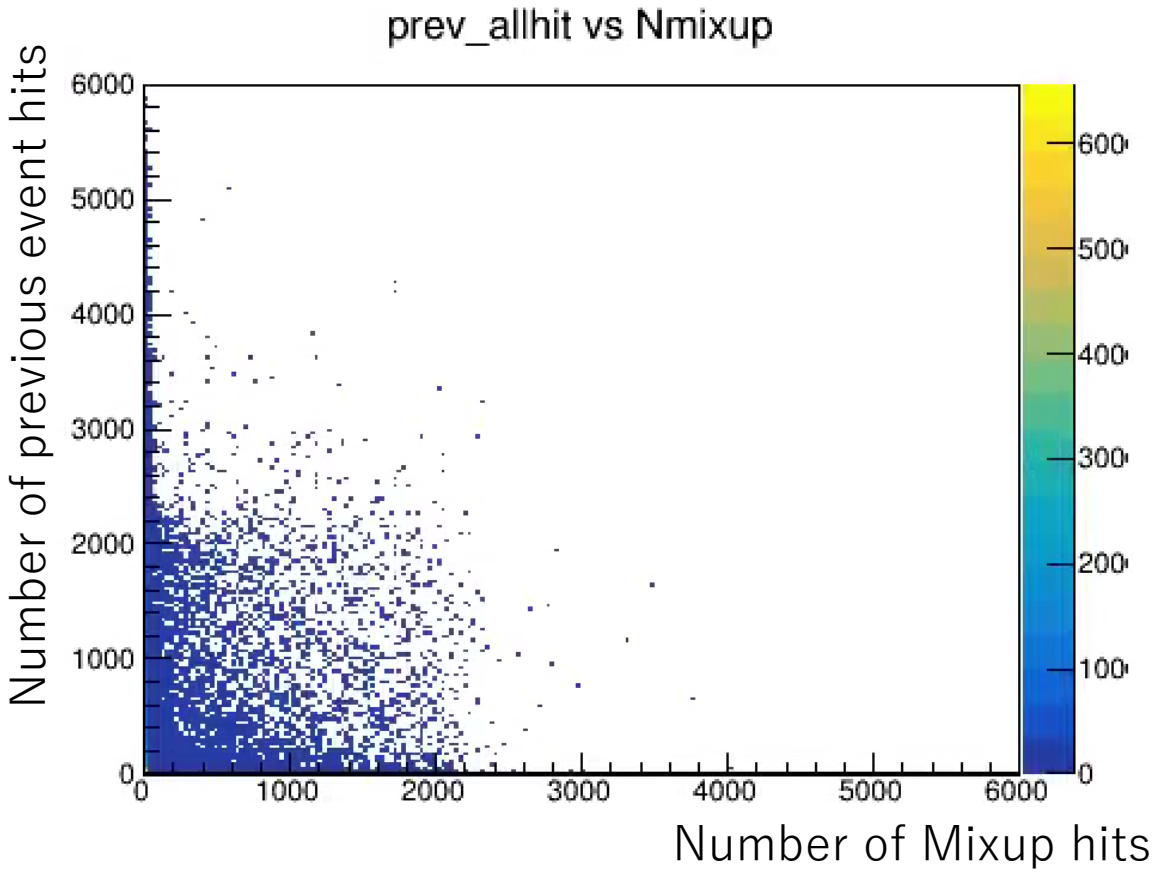


- Multiplicity was plotted separately by Mixup degree.
- Since we knew from the previous plot that 0-10% was the most common, it was predictable and correct that 0-10% in this plot would be the closest to the shape of the plot that was not divided by degree.



←The plot that was not divided by degree

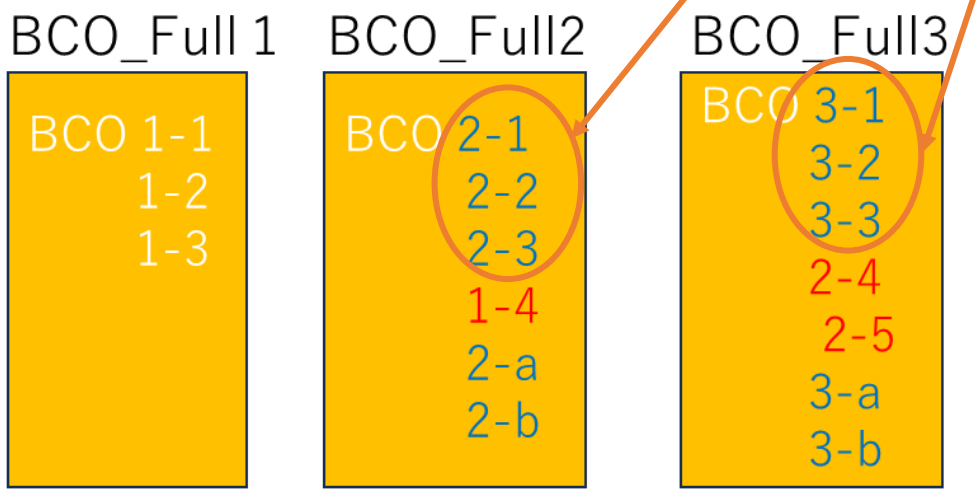
Number of Mixup hit vs prev_allhit Run20708

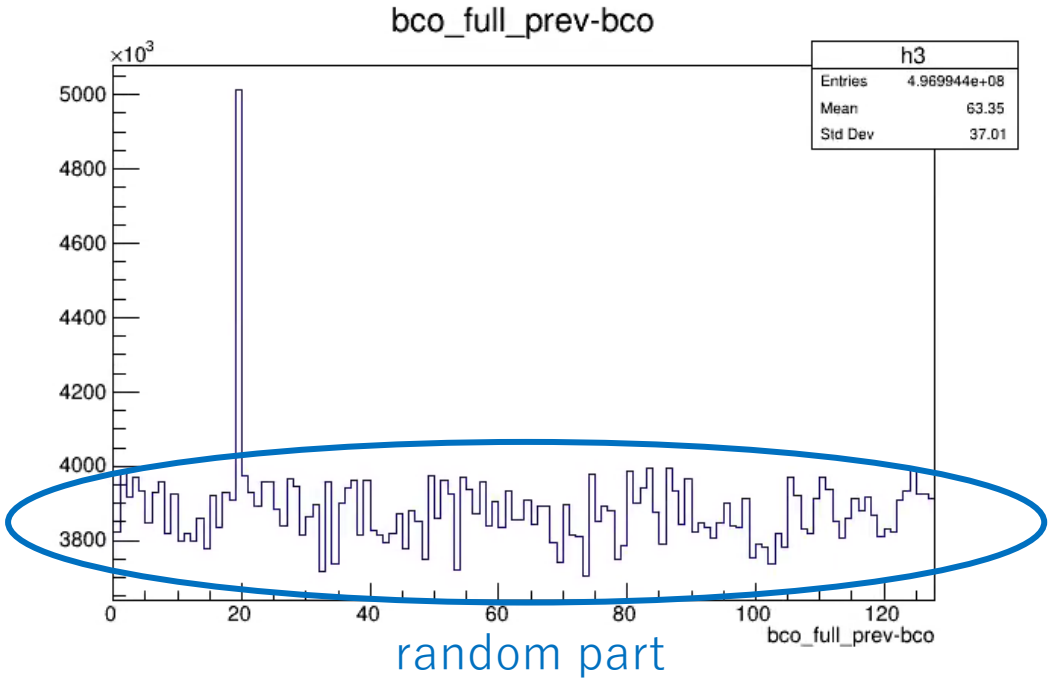


- This plot has Number of Mixup hits on the horizontal axis and Number of previous event hits on the vertical axis.
- The results showed no correlation between the number of hits from the previous event and the number of mixup

Cut to determine mixup hit

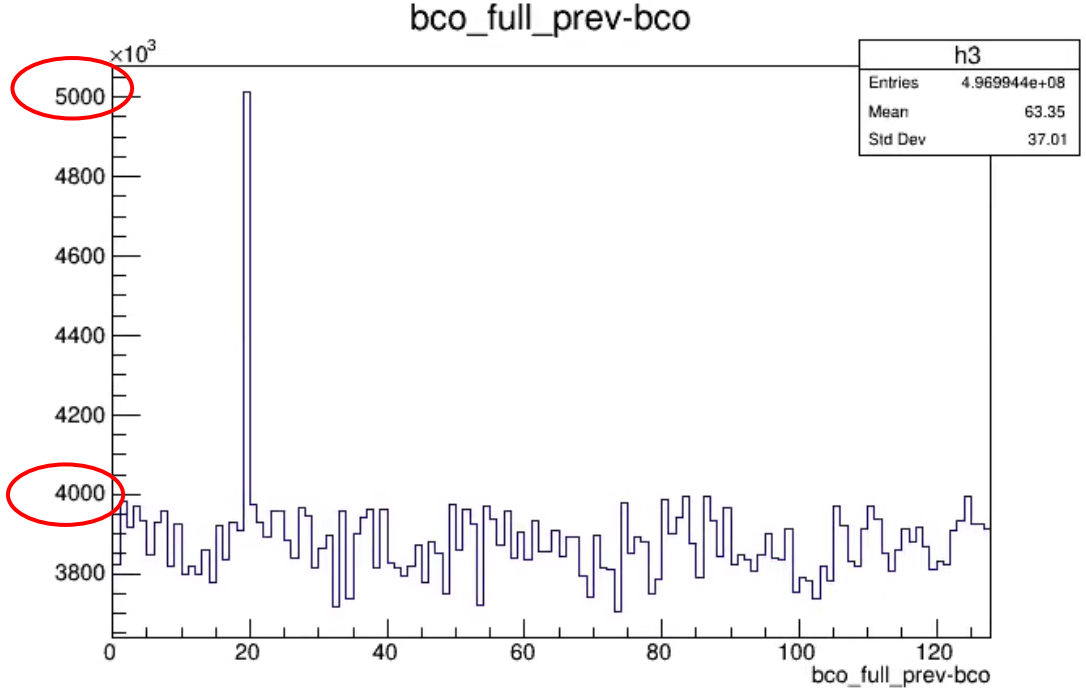
- So far, I wanted to use the Mixup degree to determine if it was a Mixup, so I have explained the results of my research on that.
- Next I will explain I cut **the collision hits of this event** to reduce the random part.



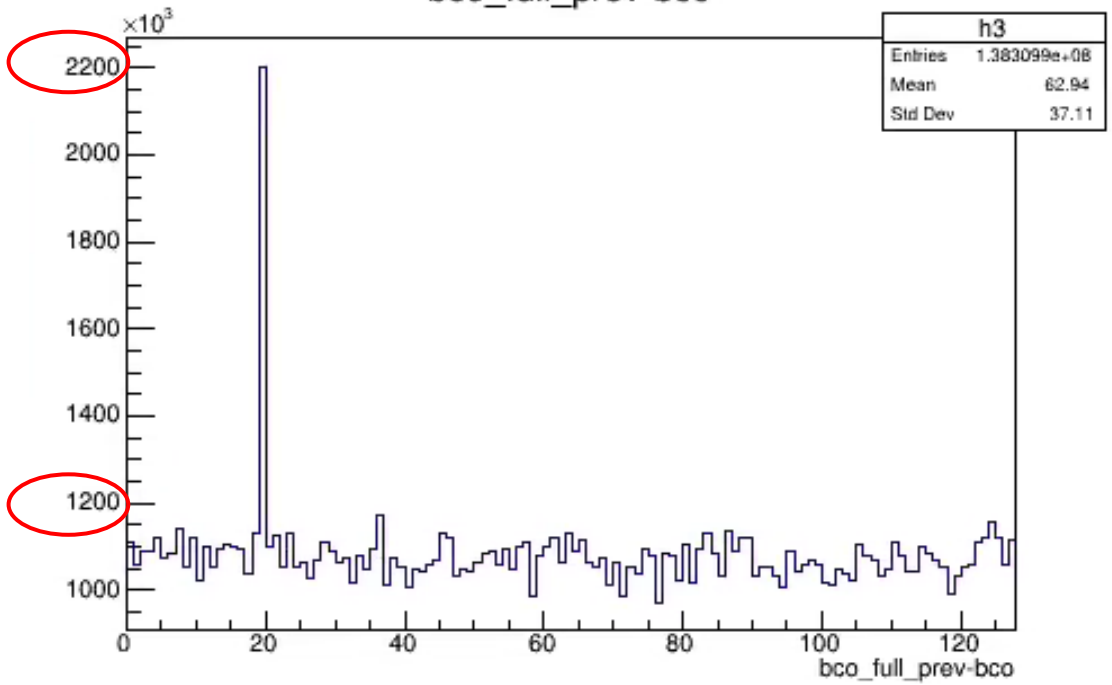


Collision hit of this event cut

Before



After



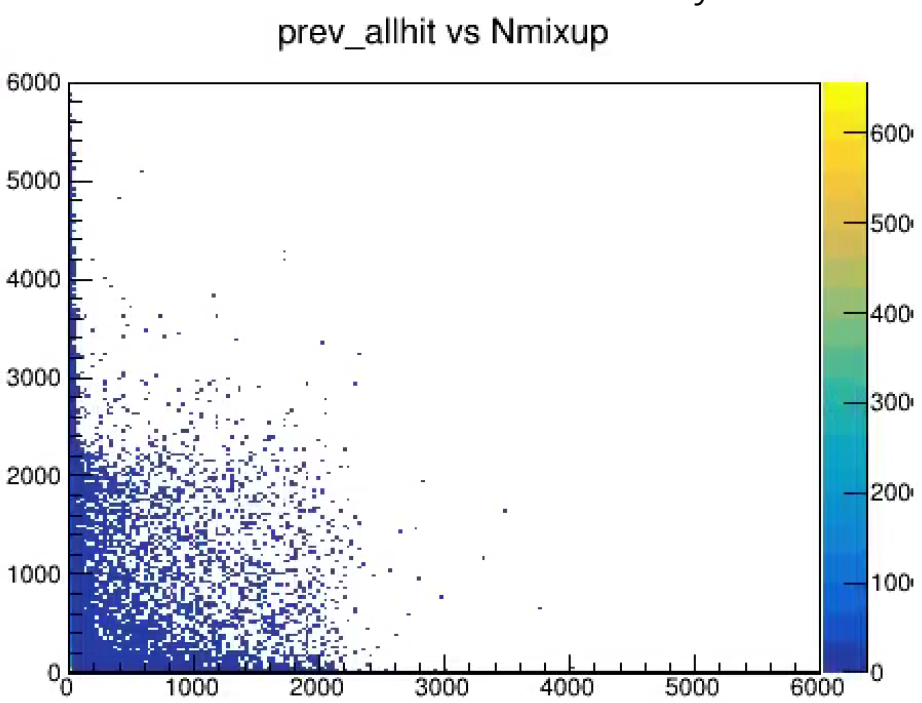
- Cutting the collision hits for this event and plotting BCO_Full_prev-BCO, the random portion of the hits decreased, as can be seen value of the vertical axis.
- I didn't get rid of all the non-mixup hits, but I did succeed in reducing them.
- So I reflected that in the plot I showed you before.

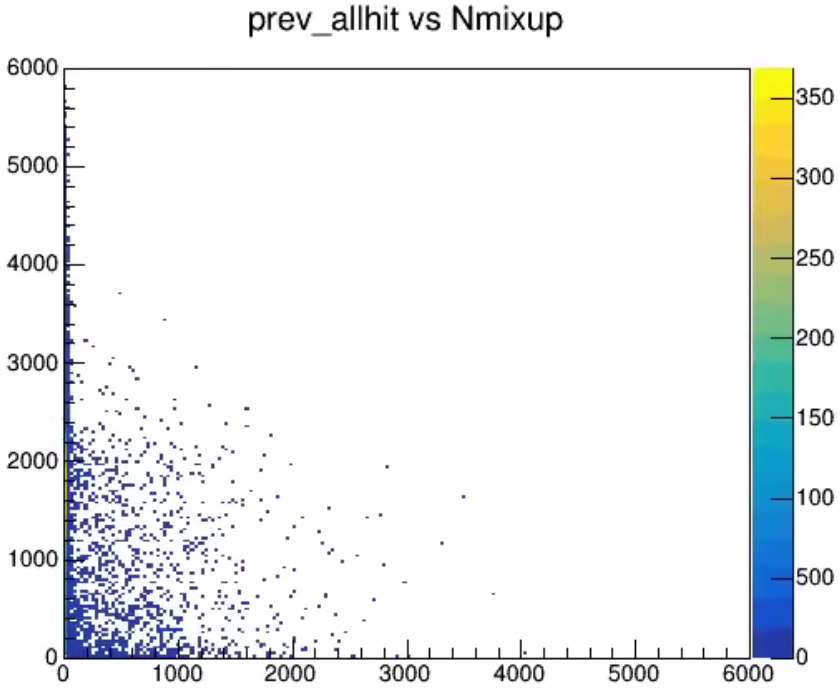
Mixup hit vs prev_allhit with this event hit cut

Before

x axis Number of Mixup hits
y axis Number of previous event hits

After





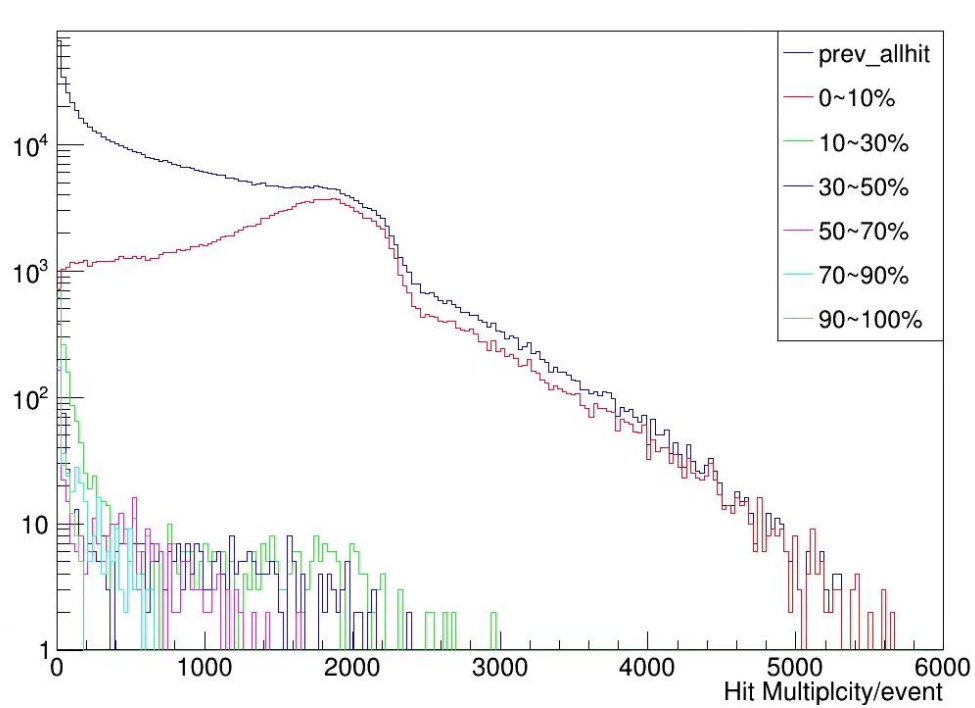
Applying a cut to this plot showed a change in the distribution, but the correlation remained the same and was not visible

→ No correlation between the number of previous event hits and the number of mixup hits

Multiplicity with this event hit cut

Before

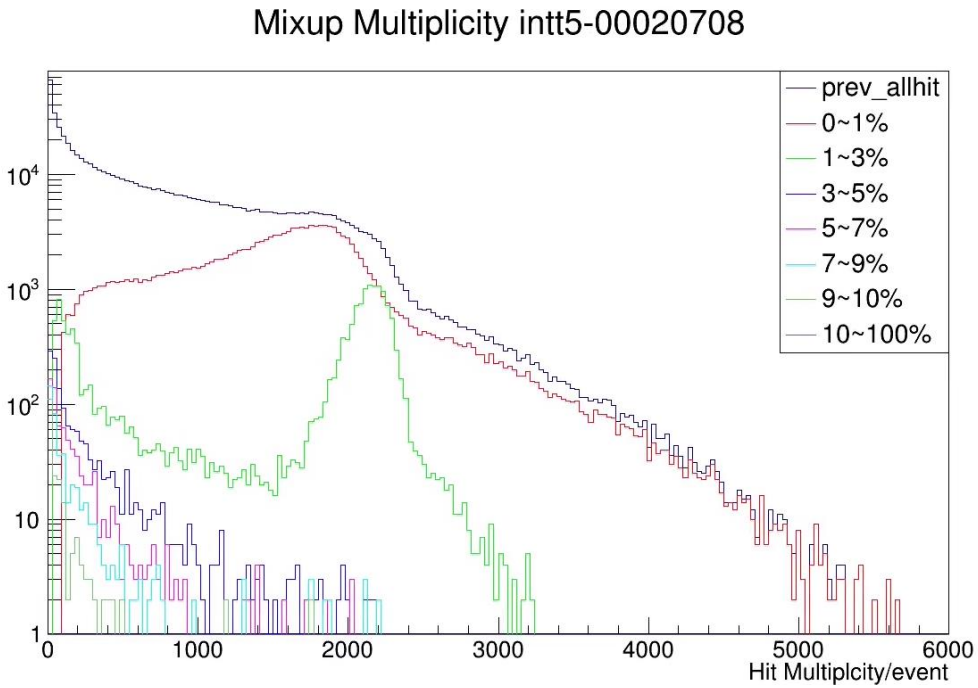
After

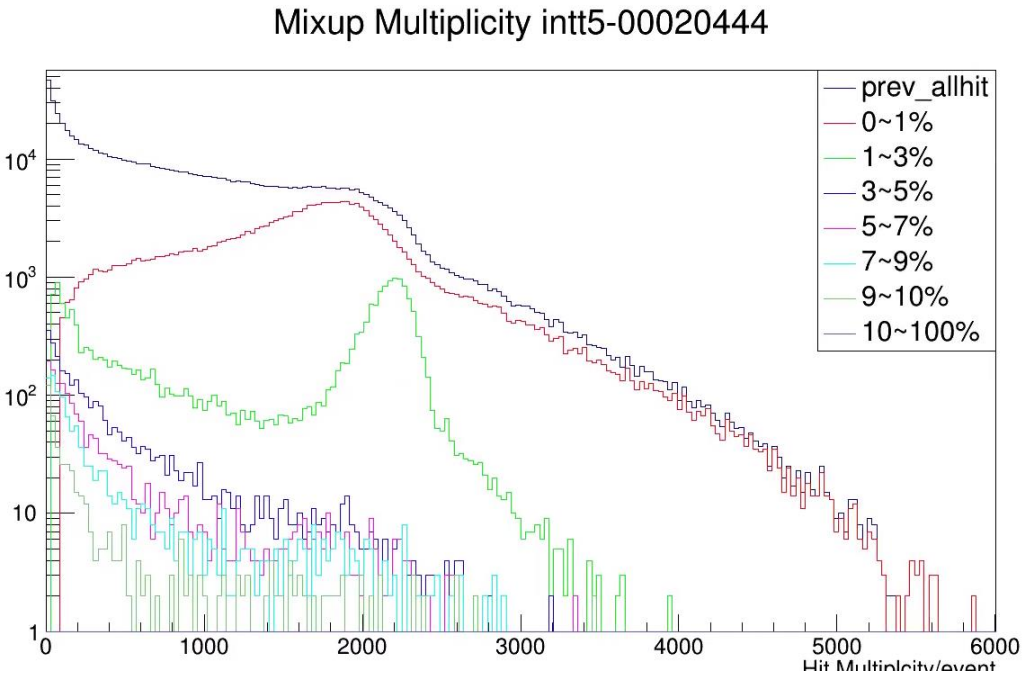


When the cut was applied to the Multiplicity distribution, the distribution was almost the same for 0-10%, but decreased for 10-100%.

→ 10% and above would have had more hits in the random portion (collision hits for this event).

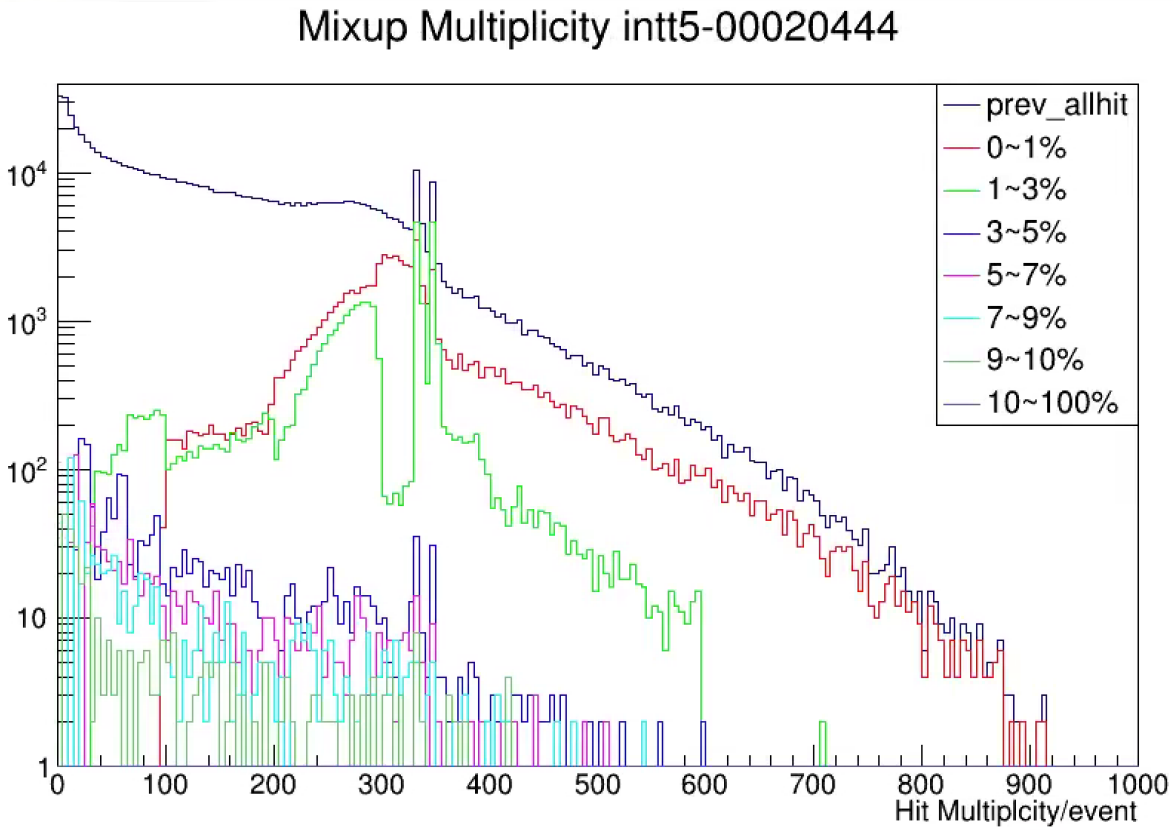
Multiplicity with this event hit cut





- When the Mixup degree of 0-10% was further examined in detail, the Multiplicity distribution of 1-3% change.
- I do not know what this means, but since the same result was obtained when I looked at another run, I do not think it depends on the run.

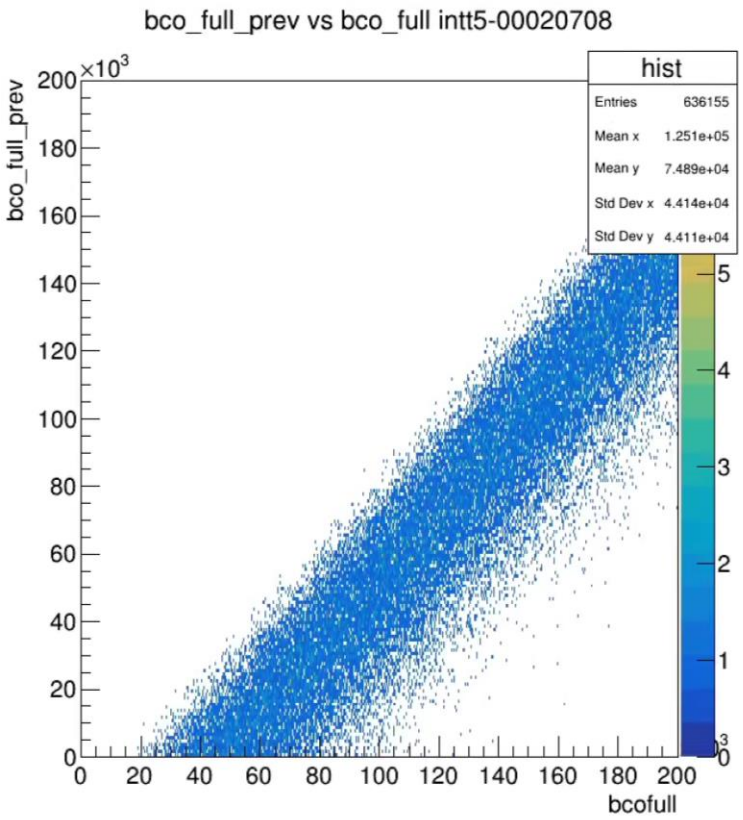
Multiplicity with this event hit cut by ladder

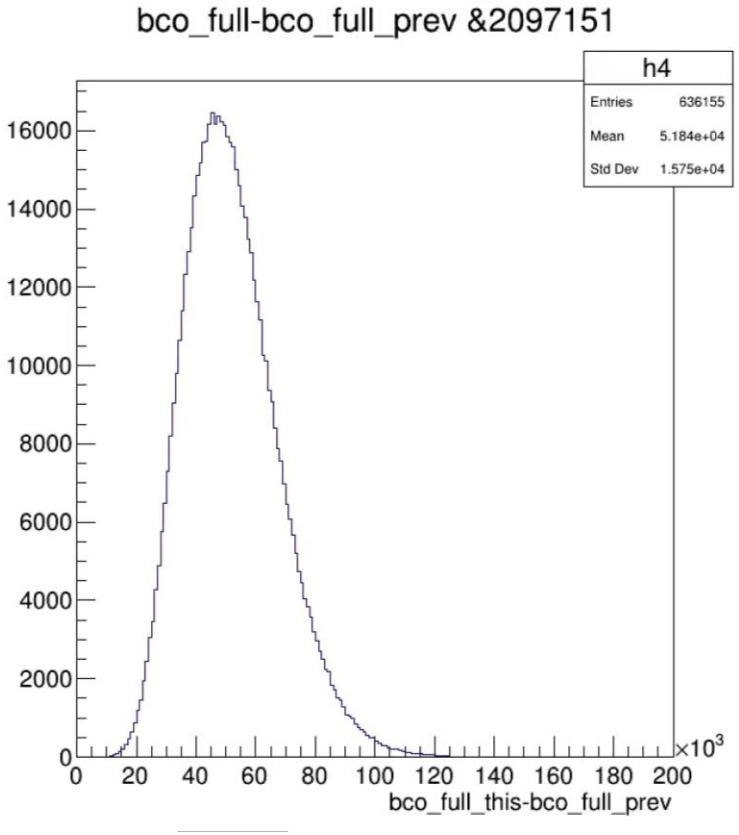


I plotted one ladder to further examine the Multiplicity distribution, and while there was still a change after 2%,
I am still looking at other ladders as I don't understand them yet.

Collision interval dependence

- BCO_Full_this-BCO_Full_prev &0x1FFFF (Lower 21 bits)Run20708

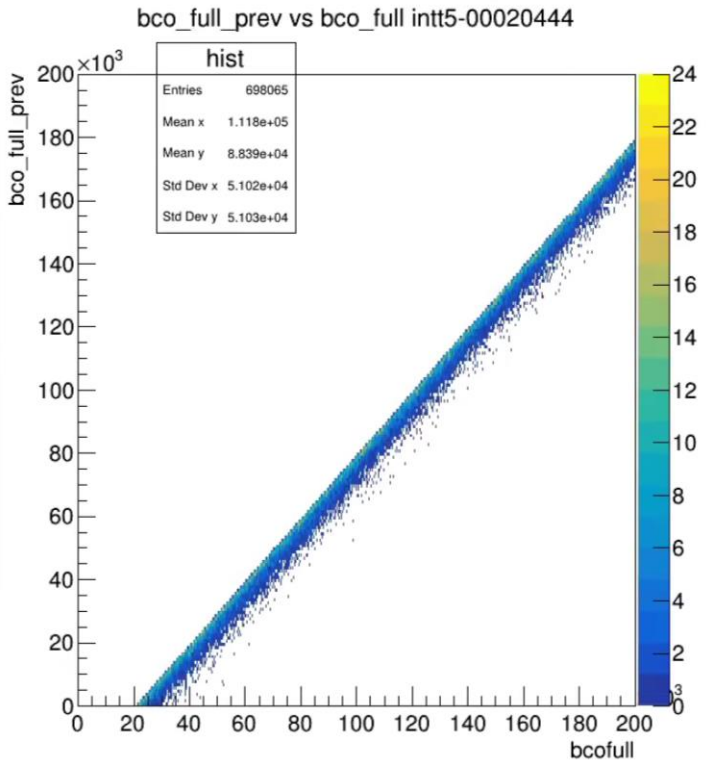


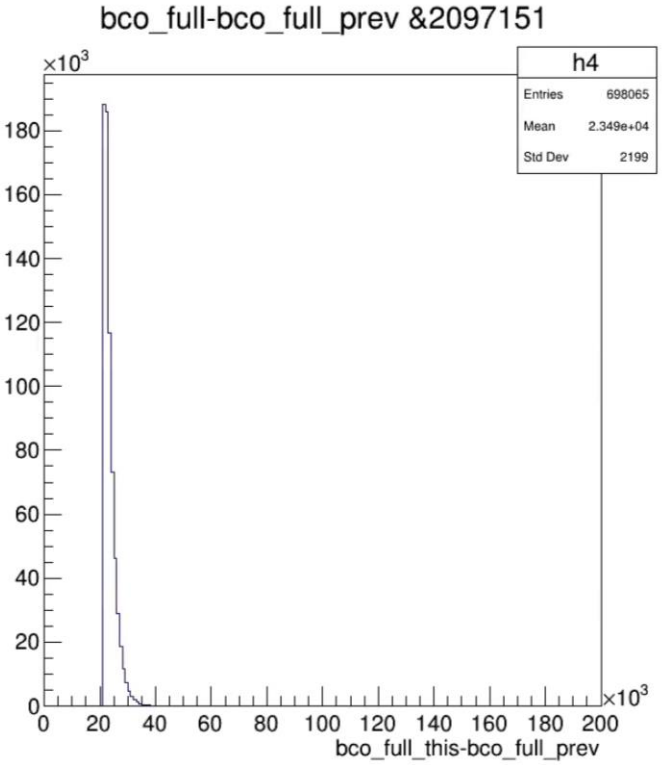


To examine collision interval dependence, I first made a plot of BCO_Full_this-BCO_Full_prev(Lower 21bits). This result shows that this run has a collision interval of about 50×10^3 Beam clocks.

Collision interval dependence

- BCO_Full_this-BCO_Full_prev &0x1FFFF (Lower 21 bits) Run20444　INTT trigger rate 450Hz

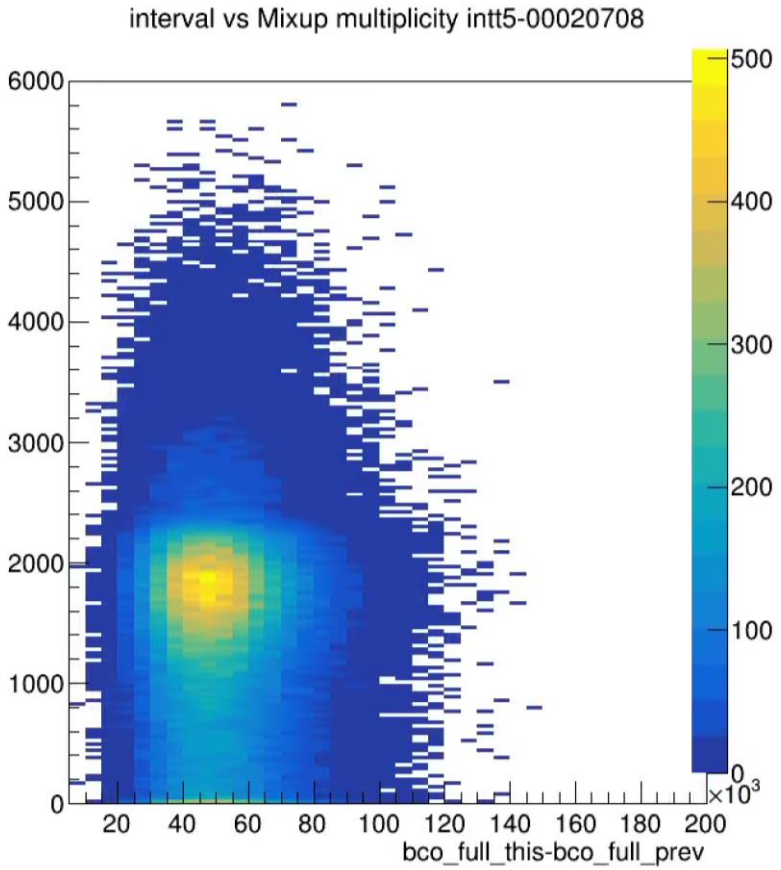


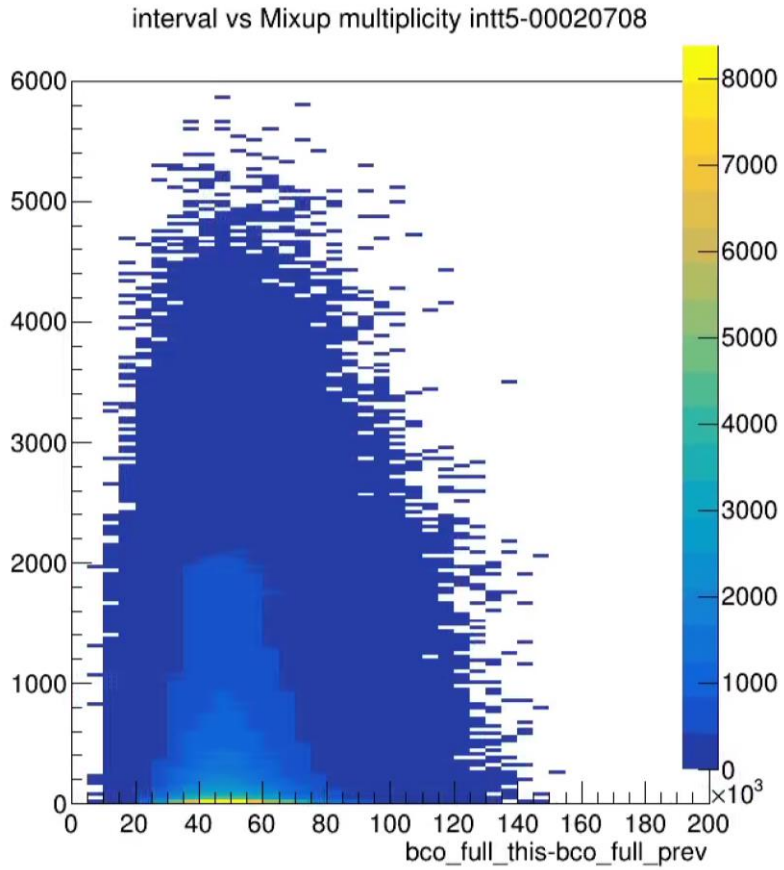


This result shows that this run has a collision interval of about 20×10^3 Beam clocks.

The difference in shape from the previous plot is likely due to the different trigger rates.

Collision interval(BCO_Full_this-BCO_Full_prev) vs Mixup Multiplicity





The left figure is interval vs the number of previous event hits, and the right figure is interval vs number of previous event hits in mixup.

I am still trying to understand more about this plot and will look at it ladder by ladder.