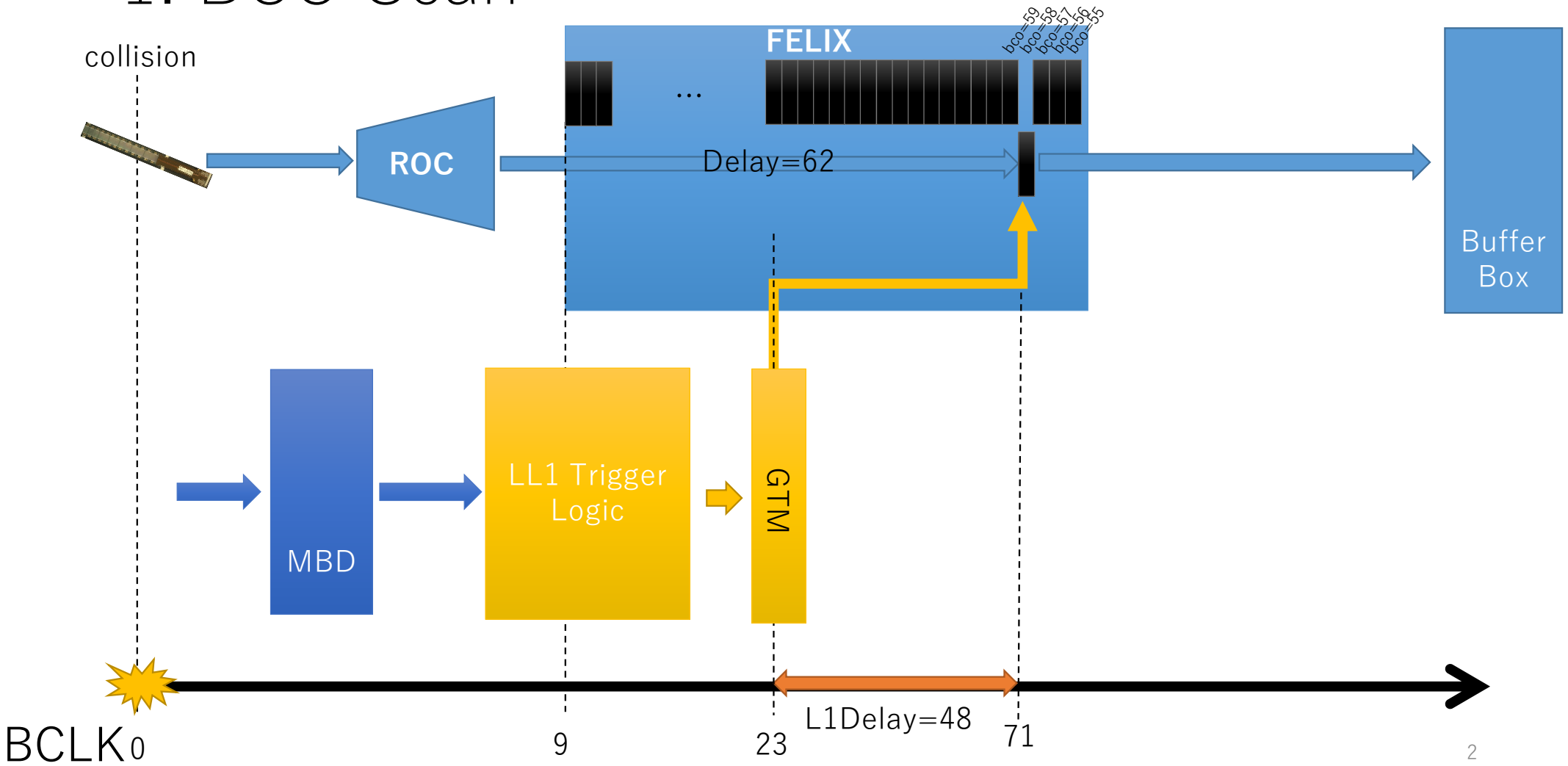
# Commissioning Plan
# ~ Timing Tune ~

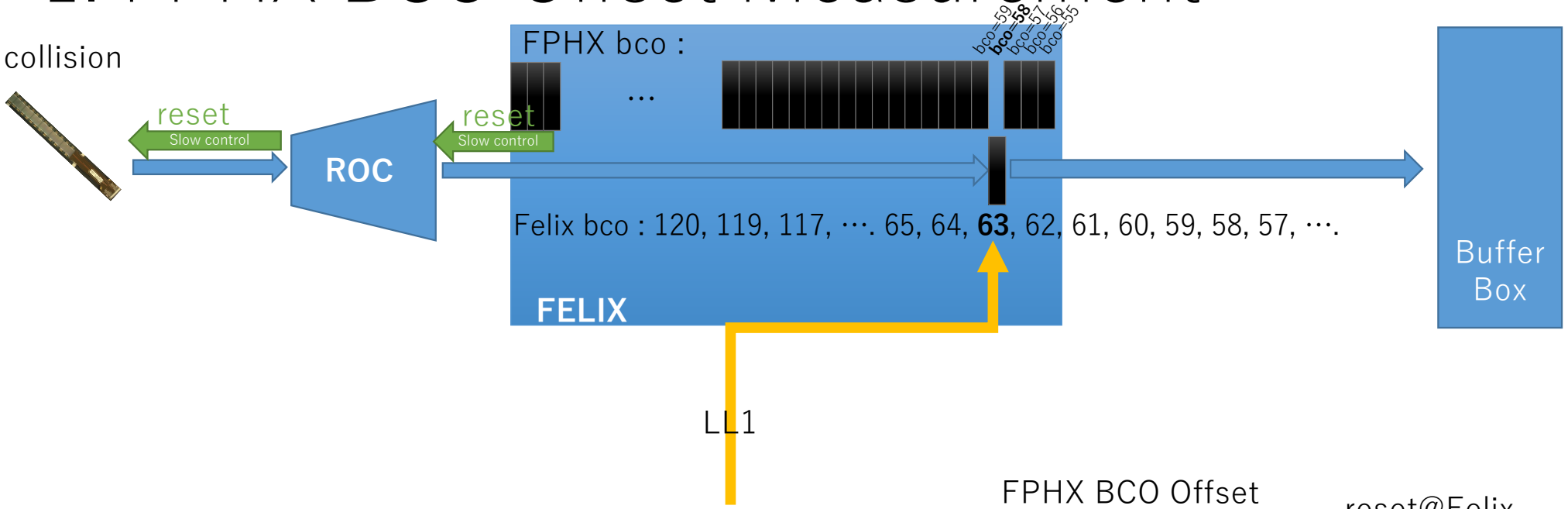
RIKEN/RBRC

Itaru Nakagawa

# 1. BCO Scan


collision
FELIX
bco=59
bco=58
bco=57
bco=56
bco=55
...
ROC
Delay=62
Buffer Box
MBD
LL1 Trigger Logic
GTM
BCLK 0
9
23
L1Delay=48
71

# 1. FPHX BCO Offset Measurement




7-bit BCO counters

FPHX BCO Offset

reset@Felix

| FPHX | … | 5 | 4 | 3 | 2 | 1 | 0 | Slow control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Felix | | | | … | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

# FPHX BCO Offset Measurement

| Transmission Frame | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| SOF | Felix Channel | Max Words | Payload | | | | | |
| 24 bits | 4 bits | 4 bits | 224 bits | | | | | |
| CAF0F0 | U | F | UUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUU | | | | | |

The transmission frame payload sends, 224 bits at a time, the event frame. The event frame has a variable length, depending on the number of hits of the collision.

| Transmission Frame Payload - Event Frame | | | | |
|---|---|---|---|---|
| | | | | |
| SOF | GTM BCO | | | Hits |
| 24 bits | 40 bits | | | (N*32) bits |
| CADEAD | UUUUUUUUUU | | | ? |

]

| General | | Felix Full | Amplitude | Full ROC | Full FPHX | FPHX BCO | ADC | Chip ID | Channel ID |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 bit | 6 bits | 1 bit | 1 bit | 7 bits | 3 bits | 6 bits | 7 bits |

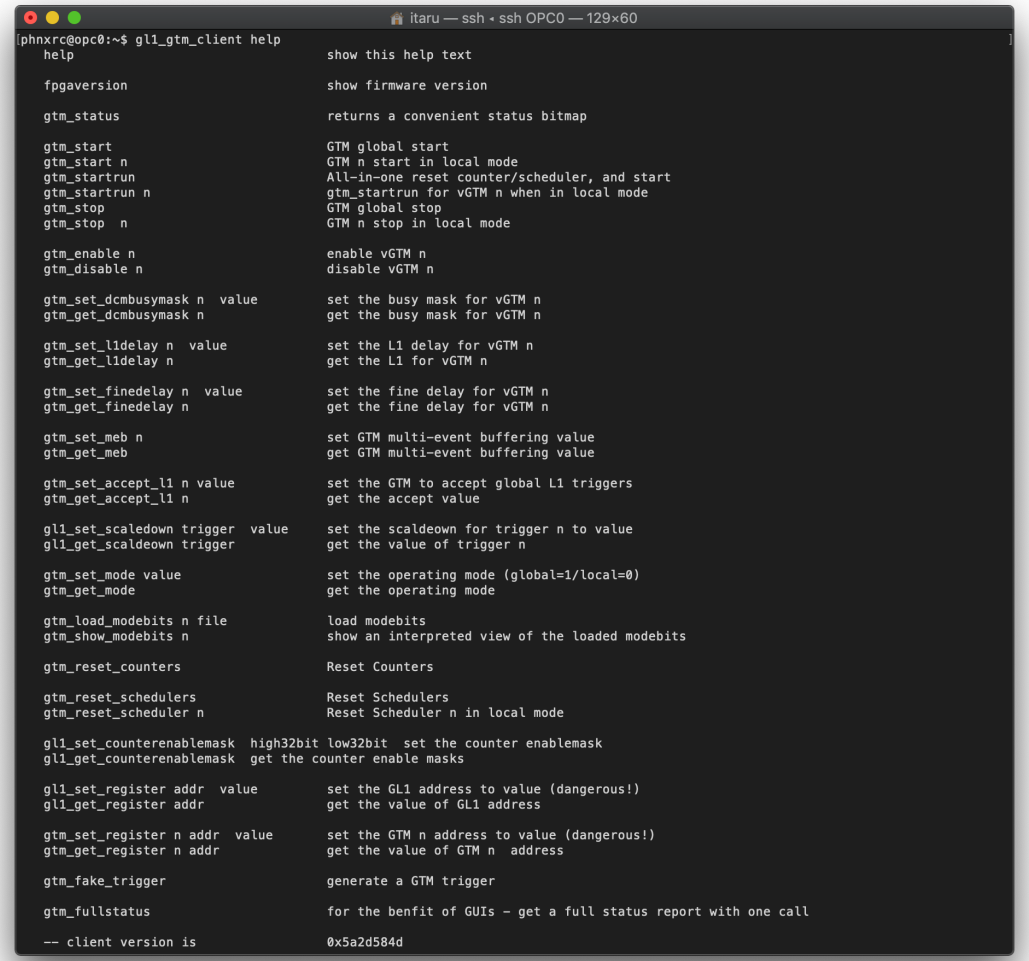
If (Physics mode){

XXXXXX?
Felix BCO

} else {
amplitude
}

Inject Felix the 6 most significant bits out of 7 bits. This way we will know the offset within 2BCO precision
FPHX_BCO_Offset = Felix_BCO – FPHX_BCO
The final offset is to be made by another measurement with 6 least significant bit injection to data stream.

# Changing LV1 Delay from the command line




- No GUI is available
- Change the LV1 delay from command line

| command | explanation |
|---|---|
| gtm_set_l1delay n value | set the L1 delay for vGTM n |
| gtm_get_l1delay n | get the L1 for vGTM n |
| gtm_set_finedelay n value | set the fine delay for vGTM n |
| gtm_get_finedelay n | get the fine delay for vGTM n |

# 2. BCO Timing Scan

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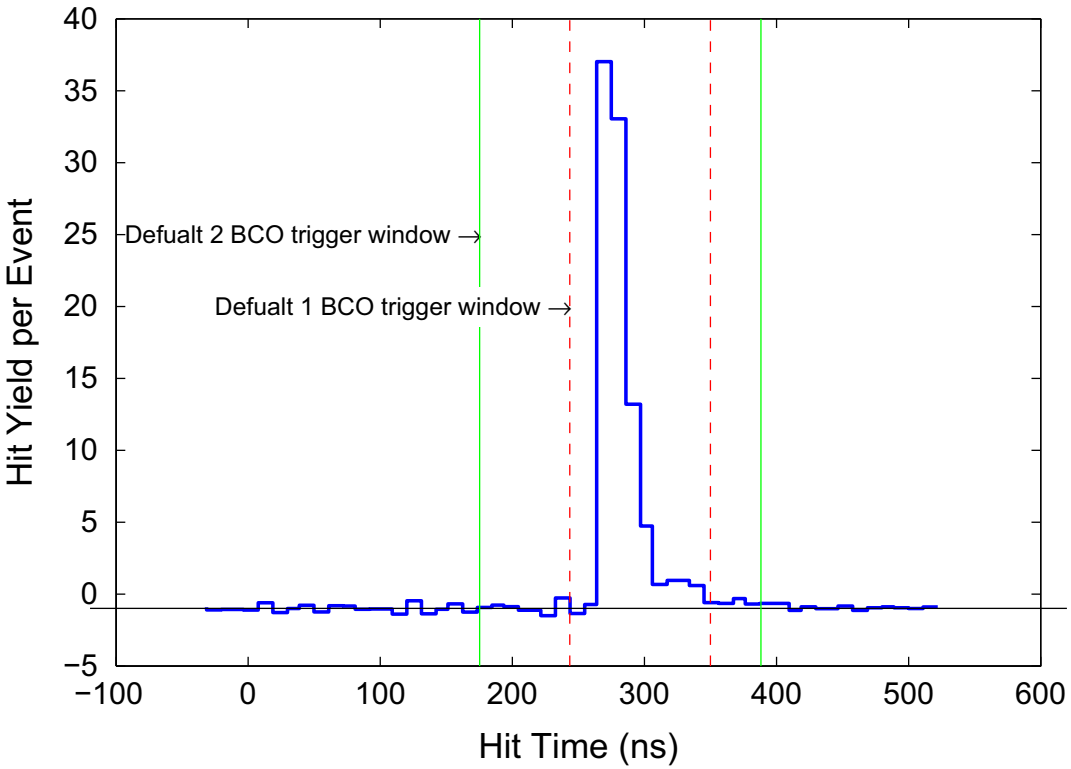



**Fig. 32.** Timing distribution of the FVTX hits relative to the RHIC beam clock.

Software: Average Rates/ladder vs. latency

*6.1. Timing*

The distribution in time of FVTX hits is studied relative to the RHIC collision time by comparing the hit rate at different FVTX delay values relative to the RHIC beam clock. The timing distribution for two sectors of wedges in the south arm is shown in Fig. 32. Most hits fall in a window ∼30 ns wide.

Two standard trigger timing configurations were used during FVTX operation, as shown by the vertical lines in Fig. 32: during relatively low trigger rate running (in heavy ion systems) hits arriving in a time window two RHIC beam clocks (BCO) wide (1 BCO∼106 ns) are accepted. In high trigger rate p+p running, a 1 BCO-wide window is used to avoid recording accidental hits from neighboring beam crossings (1 BCO apart).

On 2023/01/12 22:22, Huang, Jin wrote:

That was exactly how it was done and highly recommended for intt too. It took few hours of a special low bunch fill to perform this scan, shifting BCO phase 19-20ns at a time. That appears the only way to set timing for the sub-bco delay
Jin

**n_collision** parameter is to be started with 2~3. **n_collision**=0 setting may not relevant until Raul resolve the asynchronous clock issue between felix servers.

# 2. BCO Phase Scan

RateAnalyzer

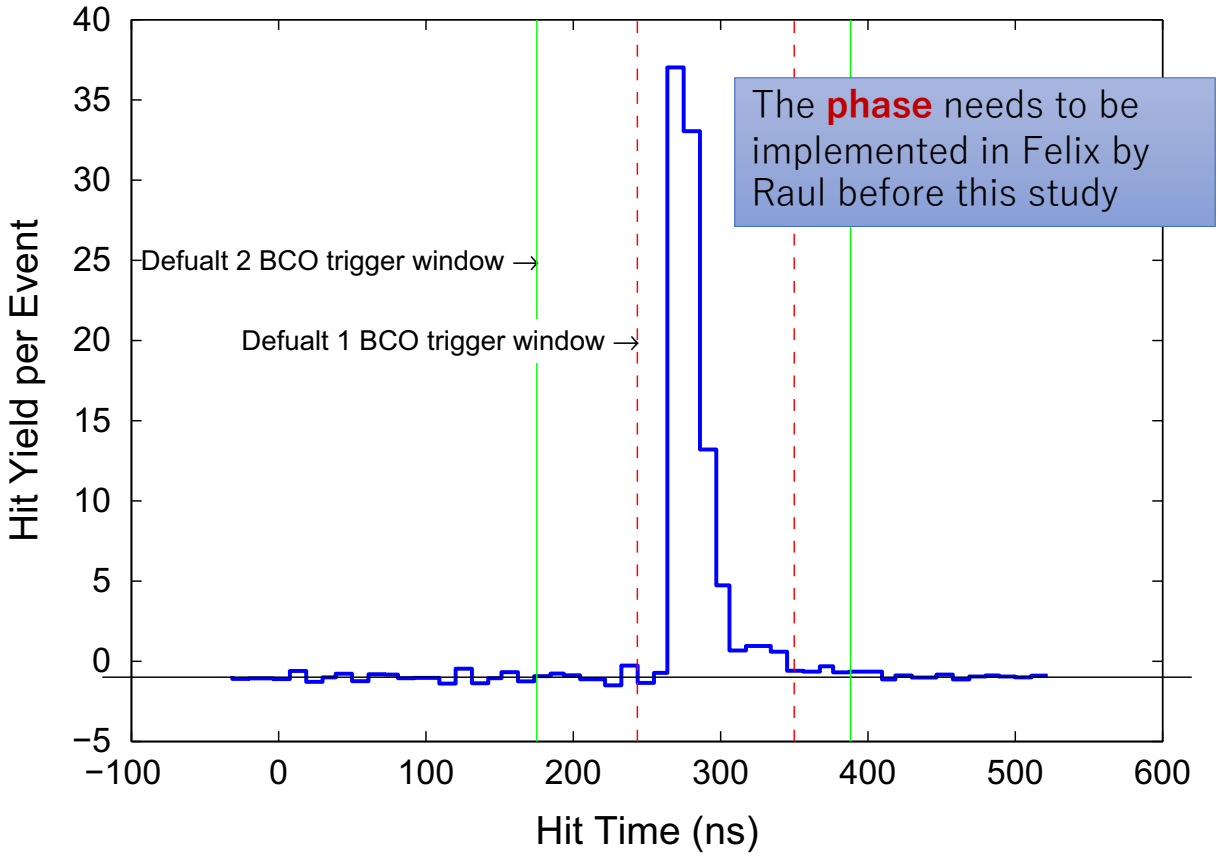
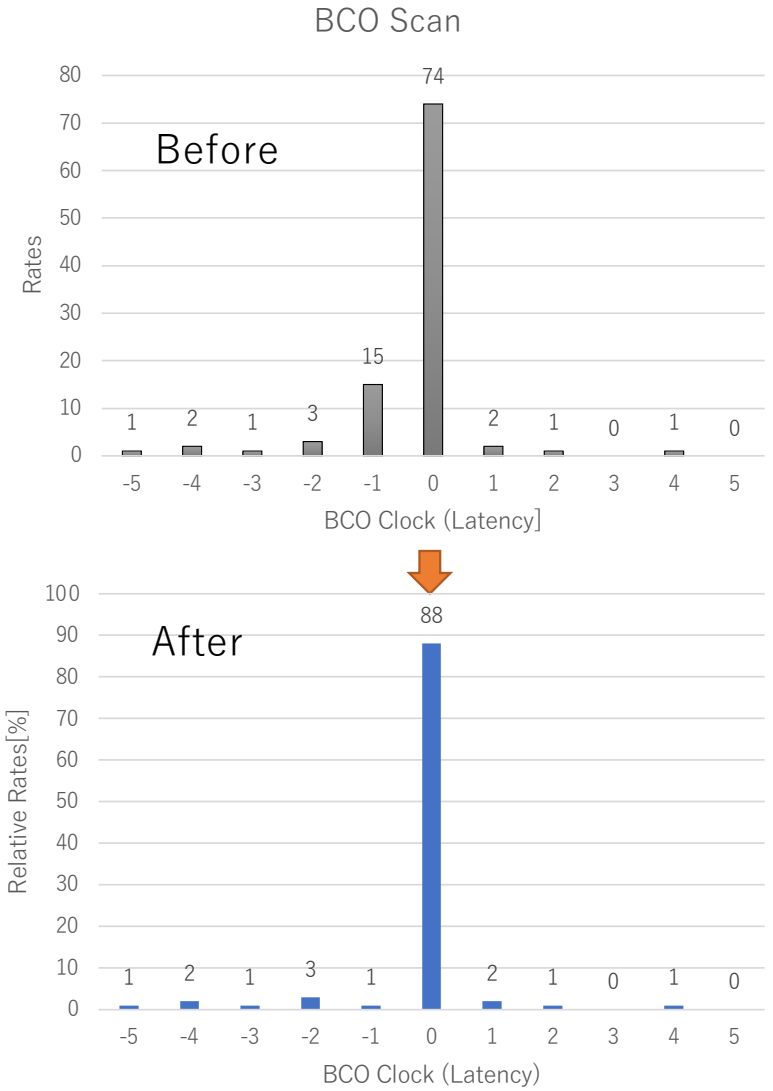



**Fig. 32.** Timing distribution of the FVTX hits relative to the RHIC beam clock.

Software: Average Rates/ladder vs. latency



STEP-1. 3BCO window* Coarse scan
STEP-2. 1BCO window Coarse scan

*BCO window has to be implemented as external parameter of Felix firmware by Raul

- Hit Yield/Chip, Rates/half ladder
  - Evaluate jitters between chips and ladder
- Instruction how to change the latency. (Itaru)

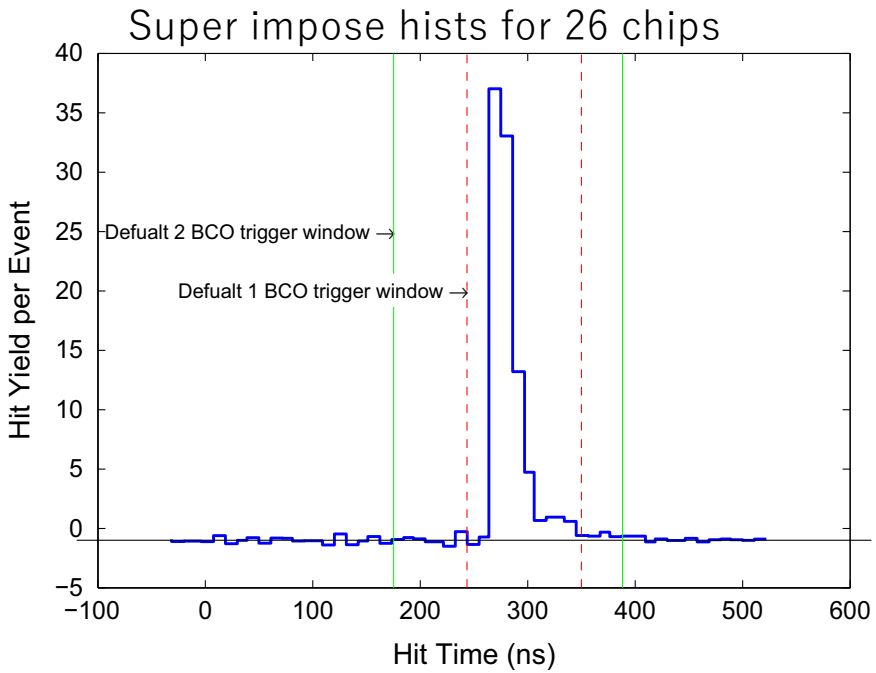
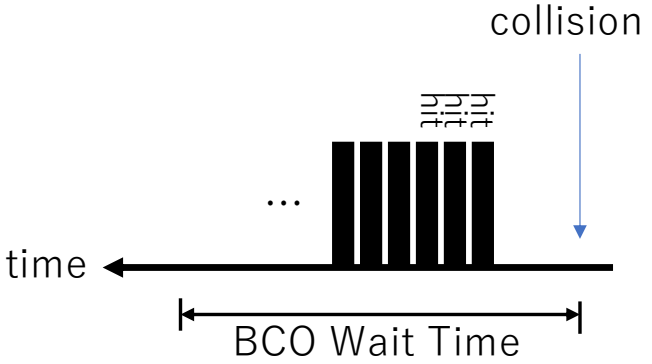


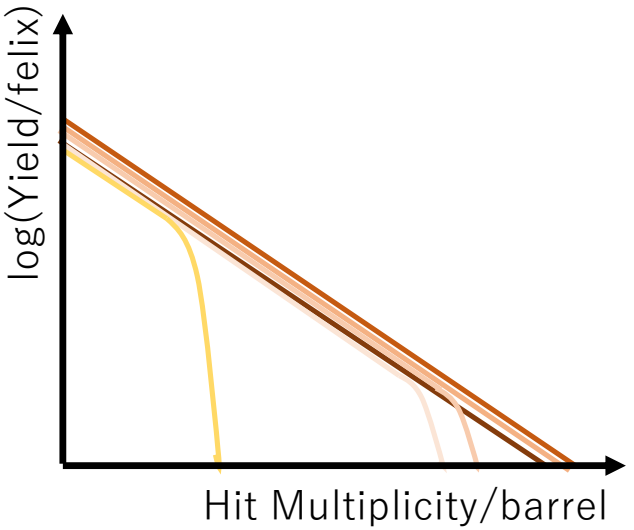

**Fig. 32.** Timing distribution of the FVTX hits relative to the RHIC beam clock.

BWSel Dependence?

# Felix BCO Wait Time Scan

- Start with the BCO wait time* sufficiently wide (60BCLK=max depth of FIFO in ROC?) at the beginning.
- The scan is to be done for 60->50->40->30->20->10BCLK window.
- Compare the hit multiplicity distribution/chip (tracklet/track multiplicity for further sophisticated analysis).
- Optimal window would be selected at the saturated point. (f.i, multiplicity of 60=50=40>30>20>10, then 40 is the optimal window).

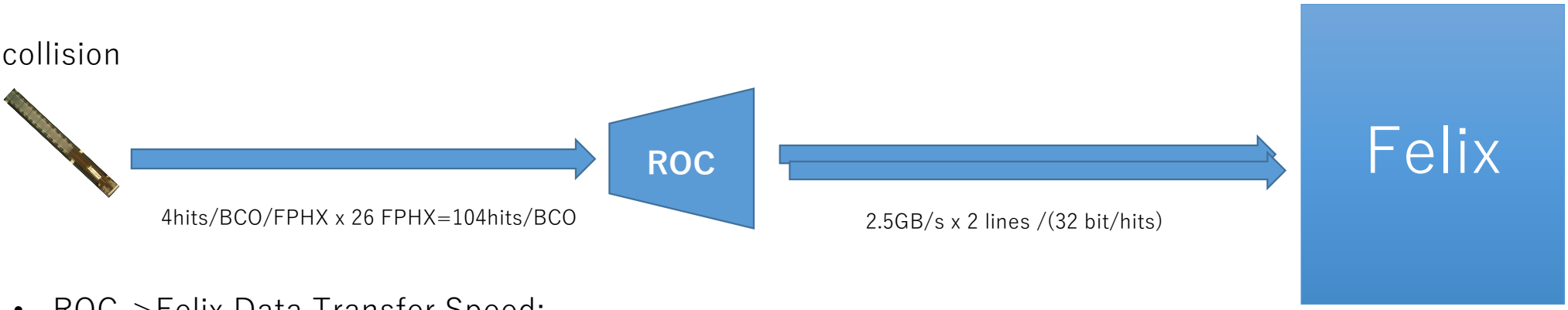



Software : hit multiplicity/felix distribution

*BCO wait time window has to be implemented as external parameter of Felix firmware by Raul
* Need to confirm with Raul if this wait time is equivalent with the "Busy" status to be sent to GTM based on the philosophy of the commissioning. (= no LVL1 trig while cumulating data of a given BCO.) See 230506_PacketStrategy.pptx

# Data Transmission Speed




- ROC->Felix Data Transfer Speed:

$$\frac{2\times 2.5\ GB/s}{32\ Bits/hit} = 1.56\times 10^{8}\ hits/s = 15.6\ hits/100\ ns \sim 15\ hits/BCO$$

- Total time for the maximum 104 hits to be transferred to Felix (if all hits are ready to be transmitted at same time)

$$\frac{104\ hits}{15\ hits/BCO} \sim 7 \text{ or } 8 \text{ BCOs}$$

In reality, the last hits are received 4BCO later from the first hit, which may cause further stretch in the above transmission time. In addition, can there be more than 4 hits/BCO to be sent from FPHX?

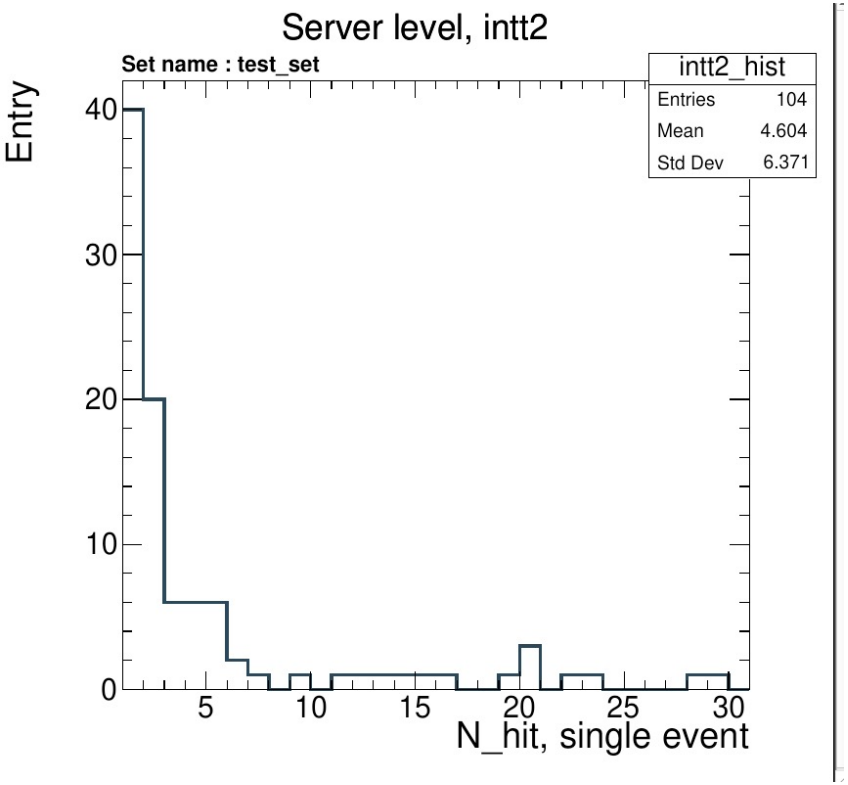
# Panels to be prepared

- 9 panels (8 hit multiplicity/felix + total hit multiplicity)
- Load multiple data files for each window setting.
- Plot different color histograms for different window setting

Pedestal data for multiplicity distribution hists development (some multiplicity events are included)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 181 | calib_packv5_051123_1909_intt7_LVDS_Scan_8_all_FC.npy | intt7 | Calibration | | 15 | LVDS Scan | No channel mask |
| 182 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt0-00000029-0000.root | intt0 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |
| 183 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt1-00006402-0000.root | intt1 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |
| 184 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt2-00006403-0000.root | intt2 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |
| 185 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt3-00006406-0000.root | intt3 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |
| 186 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt4-00006405-0000.root | intt4 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |
| 187 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt5-00006404-0000.root | intt5 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |
| 188 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt6-00006407-0000.root | intt6 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |
| 189 | /home/phnxrc/INTT/josephb/evt_to_root/intt_intt7-00006408-0000.root | intt7 | Pedestal | 10 | | Raul's GTM test | RCDAQ Trigger |

# Multiplicity Distribution Software




- Thanks to Cheng-Wei, the analysis code is available by now.
- Mai succeeded the code to execute, and possible upgrades.