SVD Reconstruction

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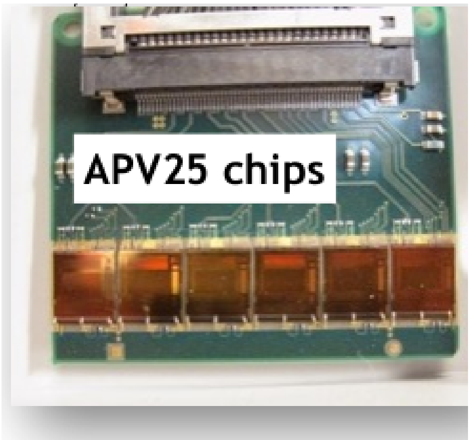
Outline

- Introduction on SVD Reconstruction
- How the SVD detector was operated during first collisions:
  - Local Runs and Condition Data
  - Configuration
  - Applied Masking
- First results with collisions:
  - Clusters related to tracks
  - SVD Performance plots
- Outlook

From Analogue to Digital



Trigger

Read-Out

FADC (Clock period: 31.44 ns)

- *digitization (10 bits)*
- *pedestal subtraction*
- *common-mode sub.*
- *zero suppression*

ShaperDigit:

6(3) samples of the APV25 signal in ADC unit

- The analogue signal produced by the APV25 read-out chips ...

  ... is retrieved going back a fixed number of cells corresponding to a fixed latency

  ... is digitized

  ... pedestal is measured during a local calibration run and it is subtracted

  ... common-mode-correction (baseline of a group of 32 strips) is computed and subtracted

  ... the zero-suppression filter is applied

$\rightarrow$ The ***ShaperDigit*** is provided as starting point for the reconstruction.

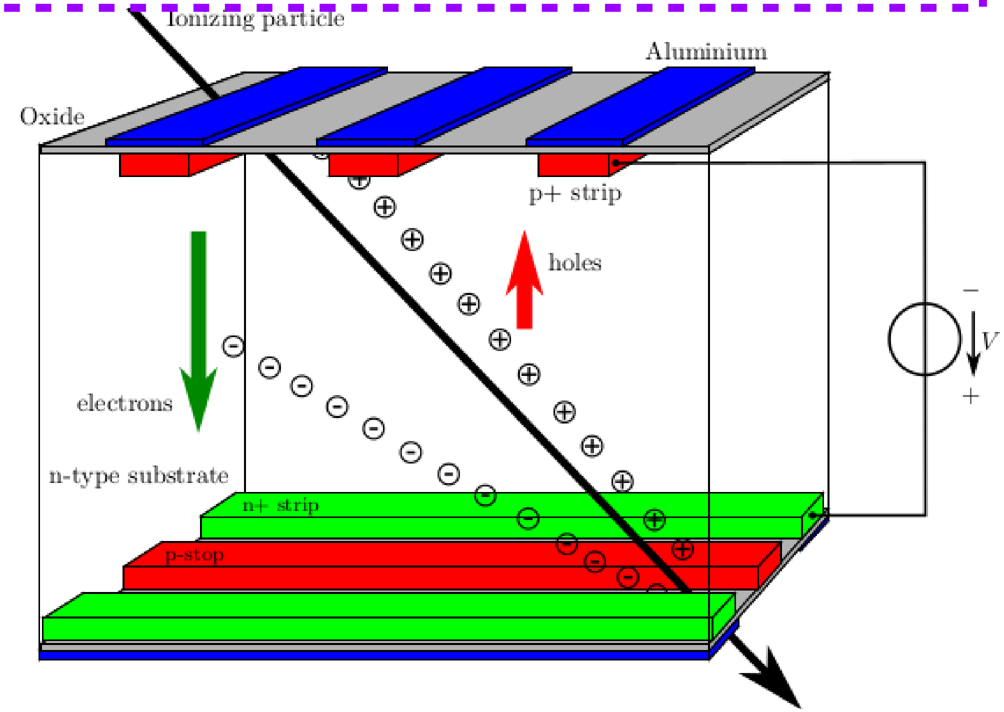
Back to the physical quantities

ShaperDigit: 6(3) samples of the APV25 signal in ADC unit

Calibrations

Charge: number of collected electrons

Time: arrival time of the incoming particle



To retrieve the the physical information the ***calibration constants*** are needed:

- The signal amplitude is proportional to the collected charges (#electrons): the ***gain*** is the conversion factor provided as ADC equivalent/22500 e-
- The ***noise*** sums up to the signal amplitude read on each strip

The calibrations are provided by *local run measurements* and stored as payloads to the ***Condition Database***. They have an associated *Interval Of Validity (iov)*, which allows to retrieve the proper set of calibrations for given **run** and **experiment** numbers.

SVD Local Runs

- The calibration constants are measured during local SVD runs (with no sparsification of data coming out of the FADC):

1) Pedestal Run
   - Randomly triggered events
   - Evaluate the pedestal for each strip

2) Noise Run
   - Randomly triggered events
   - Evaluate the noise for each strip
   - Evaluate the hit frequency of each strip (TO BE IMPLEMENTED)
   - Define the list of masked strips

3) Calibration Run
   - Injected charge to the APV pre-amplifier of each strip
   - Measure the shaper output response (sample every APV clock/8 ~ 4 ns)
   - Compute the shaper output *FWHM, peaking time, amplitude* (used for computing *gain*)

After local runs, from the measured calibration constants, the *payloads* for the **offline calibration** are generated and stored to the central DB.

NEWS from DB:

→ The new tag name for the upload of the updated calibrations is

Calibration_Offline_Development

which replaced the previous temporary tag *332_COPY-OF_GT_gen_prod_004.11_Master-20171213-230000*.

SVD configuration

- Configuring SVD implies:
  - *Load local run* measurements to FADC (pedestals, noise)
  - Define the *ZS threshold*
  - Disabled *defective strips* and chips
  - Tune the *latency*

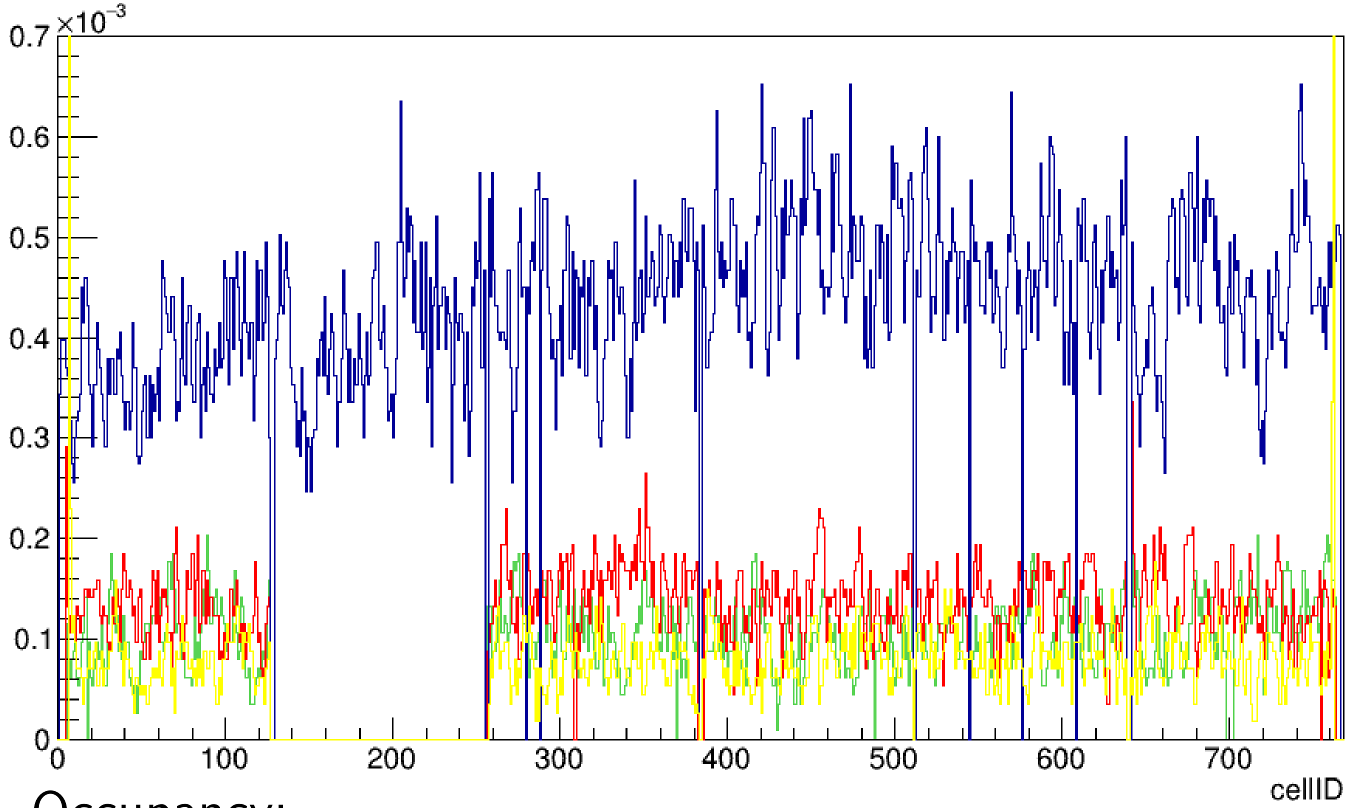
- The specific configuration for first runs with beams (analyzed here **exp 3 , runs 781, 783**) is mainly aimed at the *SVD radiation safety*.

→ Confirm and understand background composition affecting SVD.

- What is the goal of preparing our detector in such a configuration?
  - Being sensitive to *beam background occupancy* ($\sim 10^{-3}$ on L3 from simulation) and measure it.
    - exclude strips with *high firing rate* because of noise (noise occupancy) → tighten the ZS threshold (applied SNR $>$ 5 cut on seed)

Online FADC Mask

- List of disabled chips and strips at FADC level for **run 781, 783, exp 3.**
  - L4.1.2, L5.1.2, L6.1.2, U side, one chip disabled → corresponding to 1/6 U side off on the central sensor, next to the slanted one, for L4, L5, L6.
  - L4.1.1 U side, chip 1 disabled → 1/6 of L4 slanted sensor off + ~20 masked strips randomly distributed.
  - On average 15-20 masked strips randomly distributed per side/sensor.

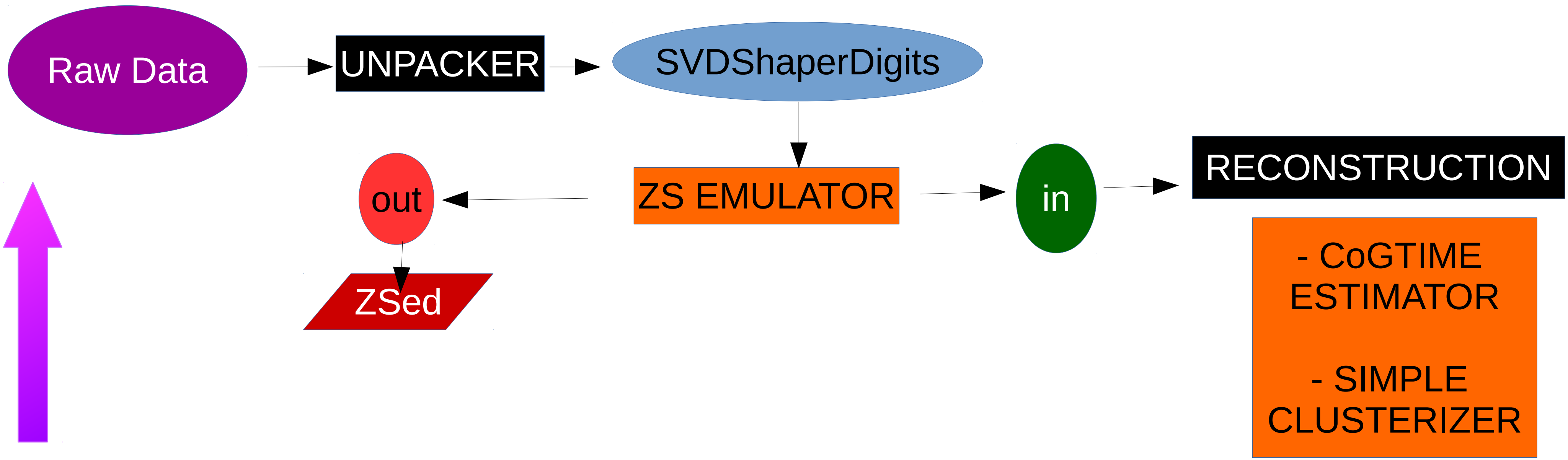


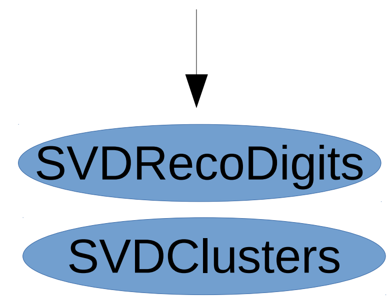
Occupancy:

L3.1.2 U side, L4.1.2 U side, L5.1.2 U side, L6.1.2 U side

- Important to evaluate SVD efficiency and performance given a certain fraction of masked strips.

SVD Reconstruction Chain





- **Zero Suppression** = only strips with Signal to Noise Ratio (SNR) > $ZS_{threshold}$ pass the filter (applied ZS cut = 5).
- The **ZS emulator** can apply *offline* the ZS cut, or tighten it.

First Data

***Disclaimer**: Data have been reconstructed in the last few days. We have just started looking at them, every result must be taken with caution.*

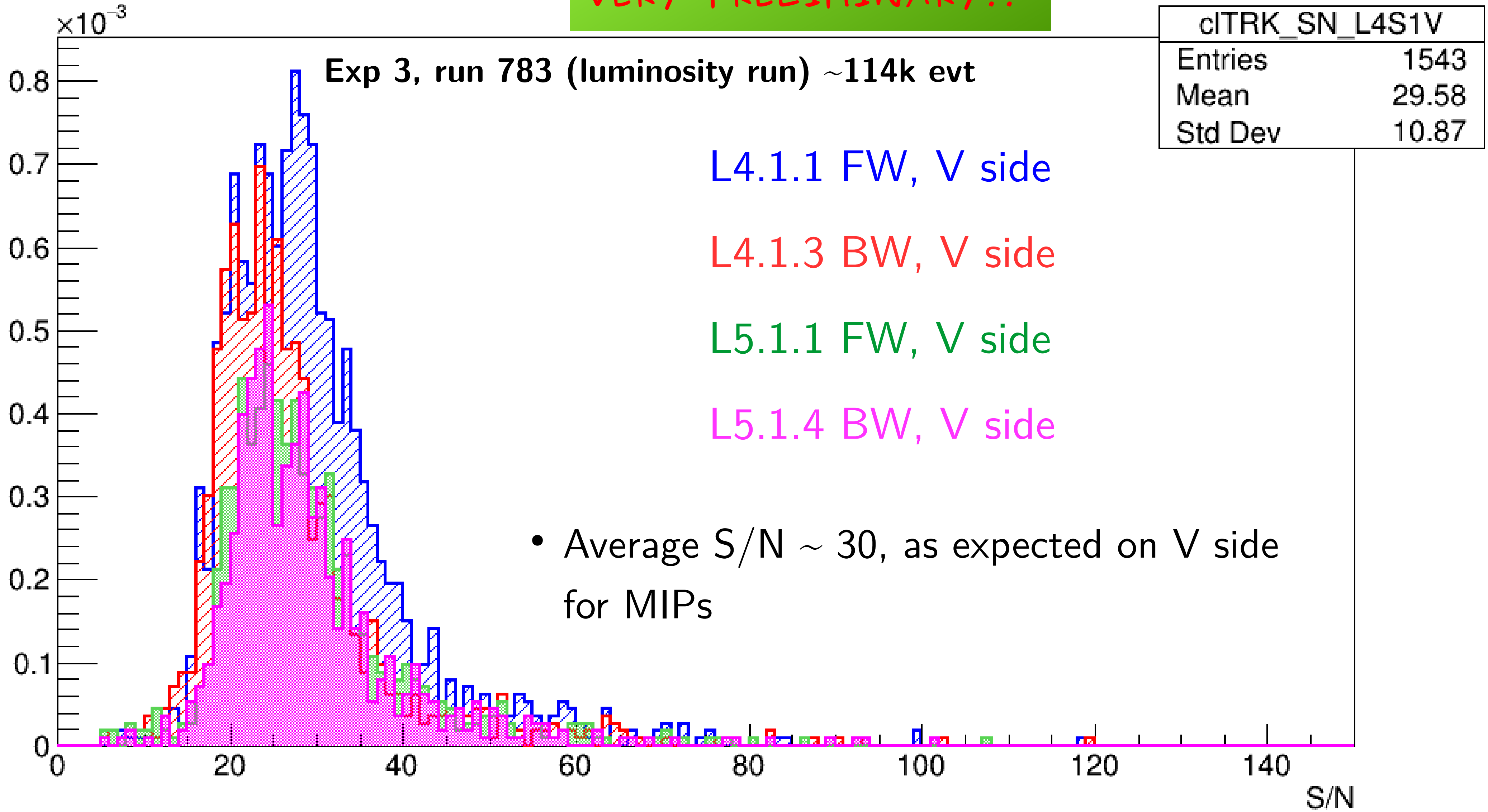
The data sample:

- Exp 3, run 781, 783 – *luminosity run*, May 6th.
- Calibration constants retrieved for central DB, global tag *332_COPY-OF_GT_gen_prod_004.11_Master-20171213-230000.*
- Alignment constants provided by Tadeas are applied.
- The cut on cluster time in the *SpacePointCreator* has been disabled.
- **First look at clusters related to beam background tracks!**

  → further details on the CoG time (cosmics data reconstruction) in Luigi talk.

Cluster S/N: L4, L5, V sides

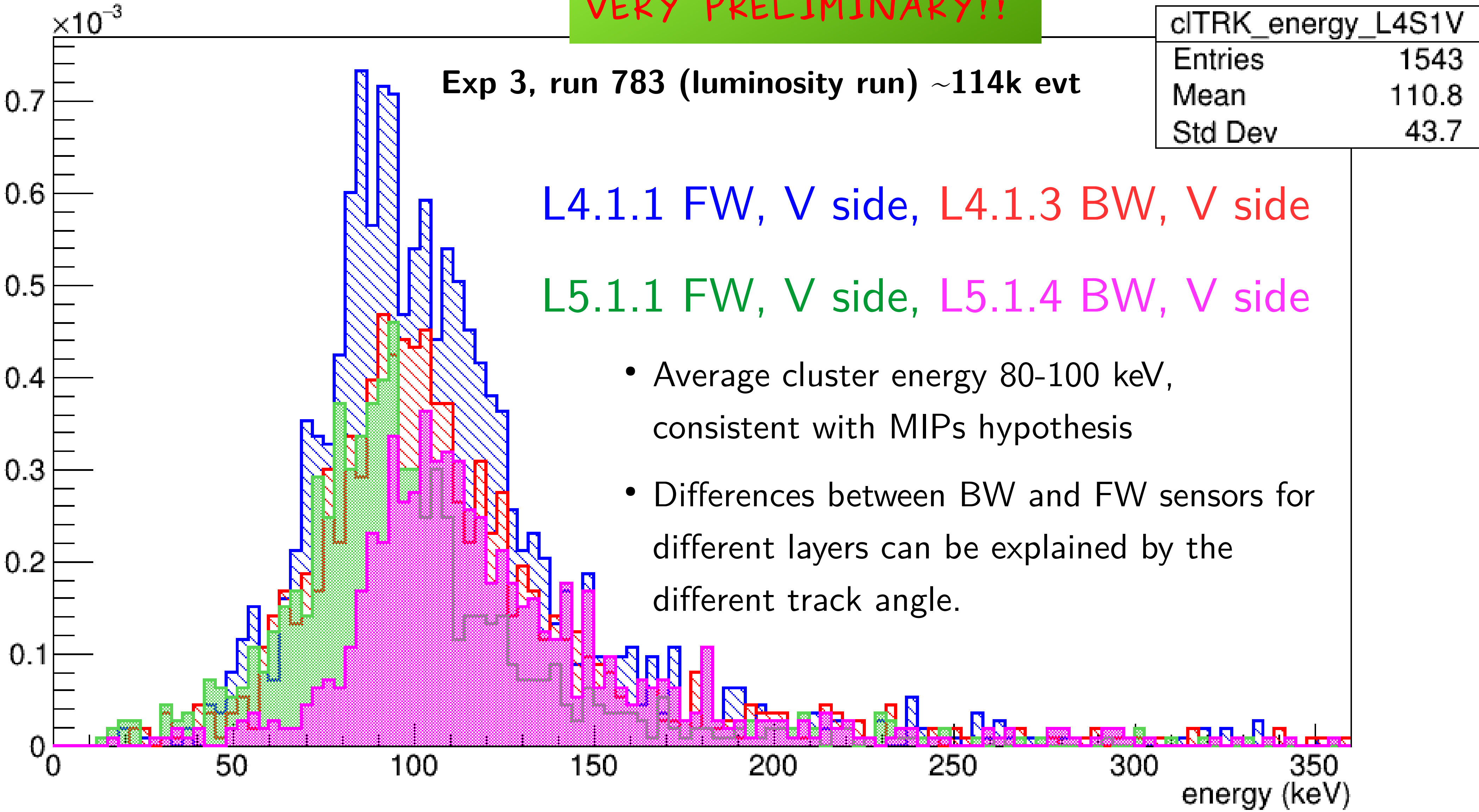
VERY PRELIMINARY!!



- Average S/N ~ 30, as expected on V side for MIPs

Cluster Energy: L4, L5, V sides

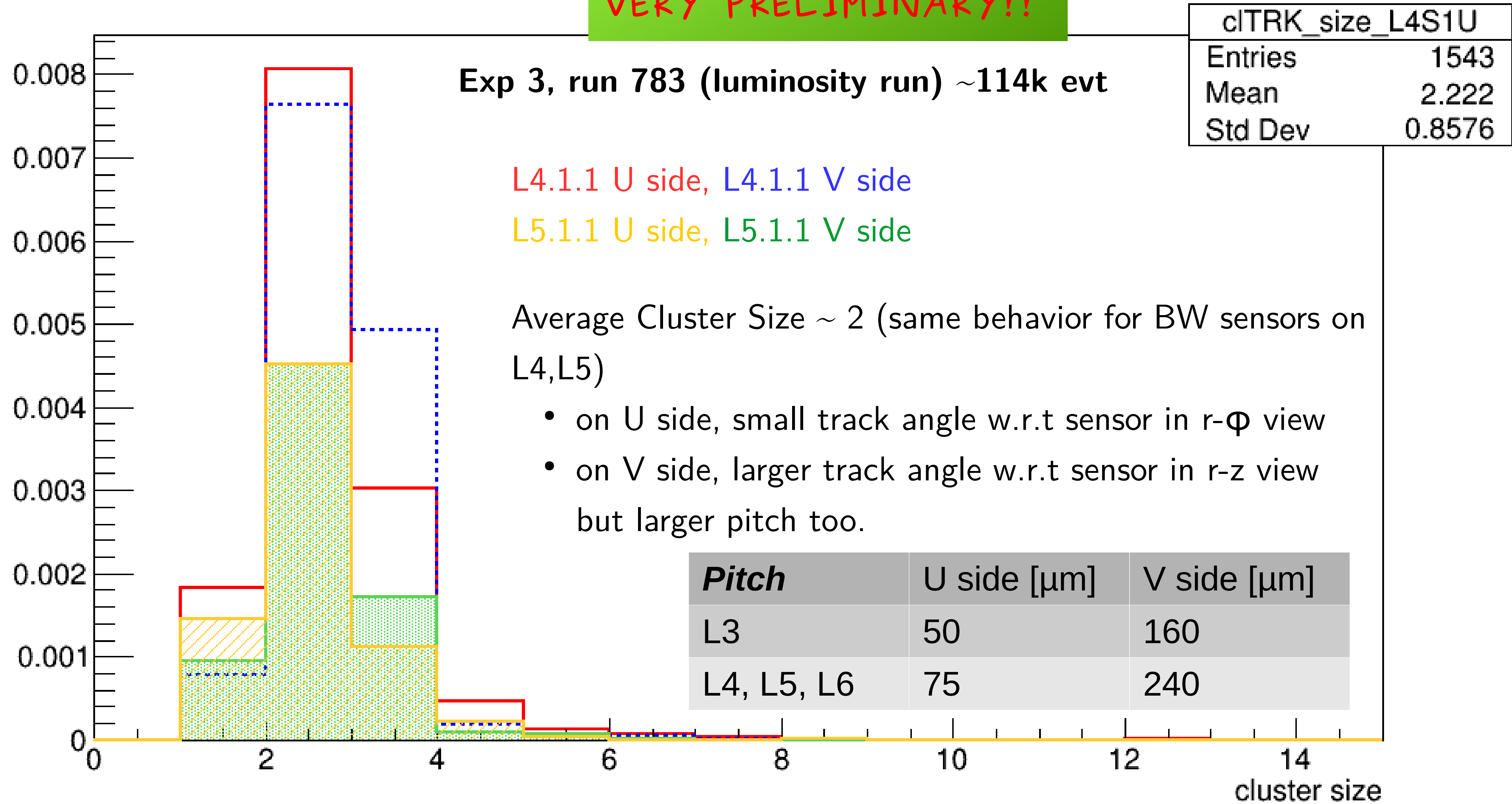
VERY PRELIMINARY!!



- Average cluster energy 80-100 keV, consistent with MIPs hypothesis
- Differences between BW and FW sensors for different layers can be explained by the different track angle.

Cluster Size: FW sensors L4, L5

VERY PRELIMINARY!!



Exp 3, run 783 (luminosity run) ~114k evt

L4.1.1 U side, L4.1.1 V side

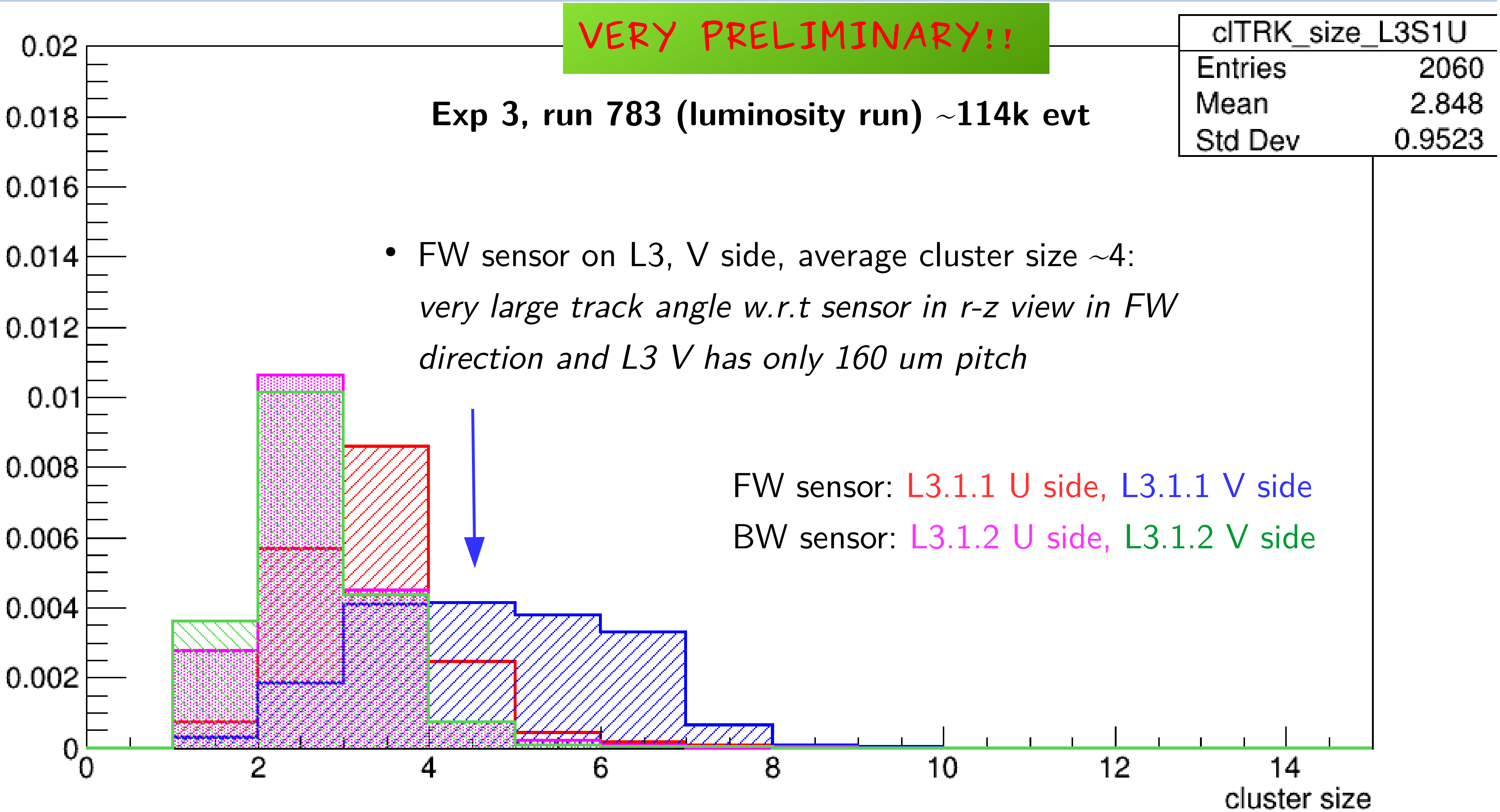
L5.1.1 U side, L5.1.1 V side

Average Cluster Size ~ 2 (same behavior for BW sensors on L4,L5)

- on U side, small track angle w.r.t sensor in r-φ view
- on V side, larger track angle w.r.t sensor in r-z view but larger pitch too.

Pitch	U side [µm]	V side [µm]
L3	50	160
L4, L5, L6	75	240

Cluster Size: L3



Exp 3, run 783 (luminosity run) ~114k evt

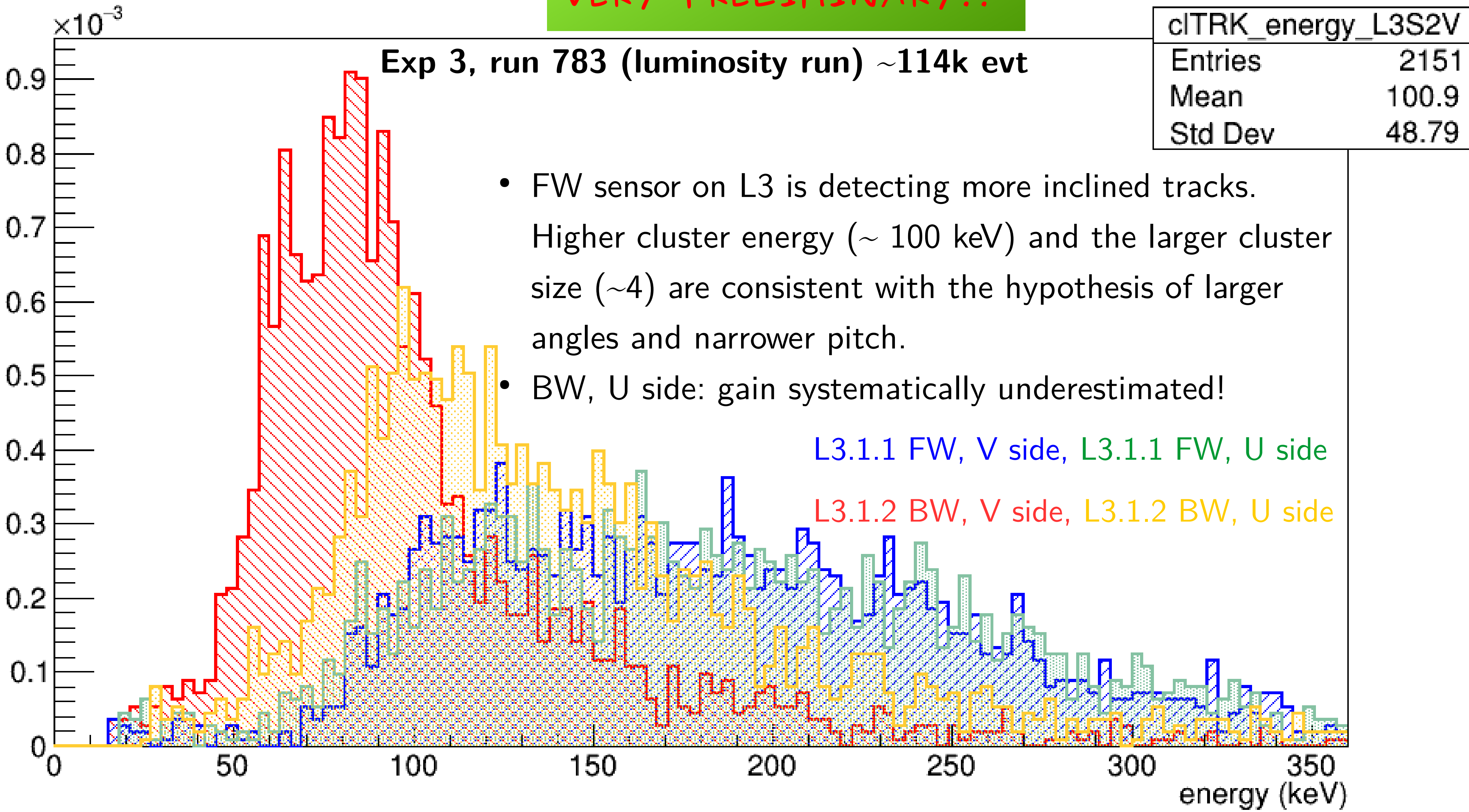
- FW sensor on L3, V side, average cluster size ~4: *very large track angle w.r.t sensor in r-z view in FW direction and L3 V has only 160 um pitch*

FW sensor: L3.1.1 U side, L3.1.1 V side

BW sensor: L3.1.2 U side, L3.1.2 V side

Cluster Energy: L3

VERY PRELIMINARY!!



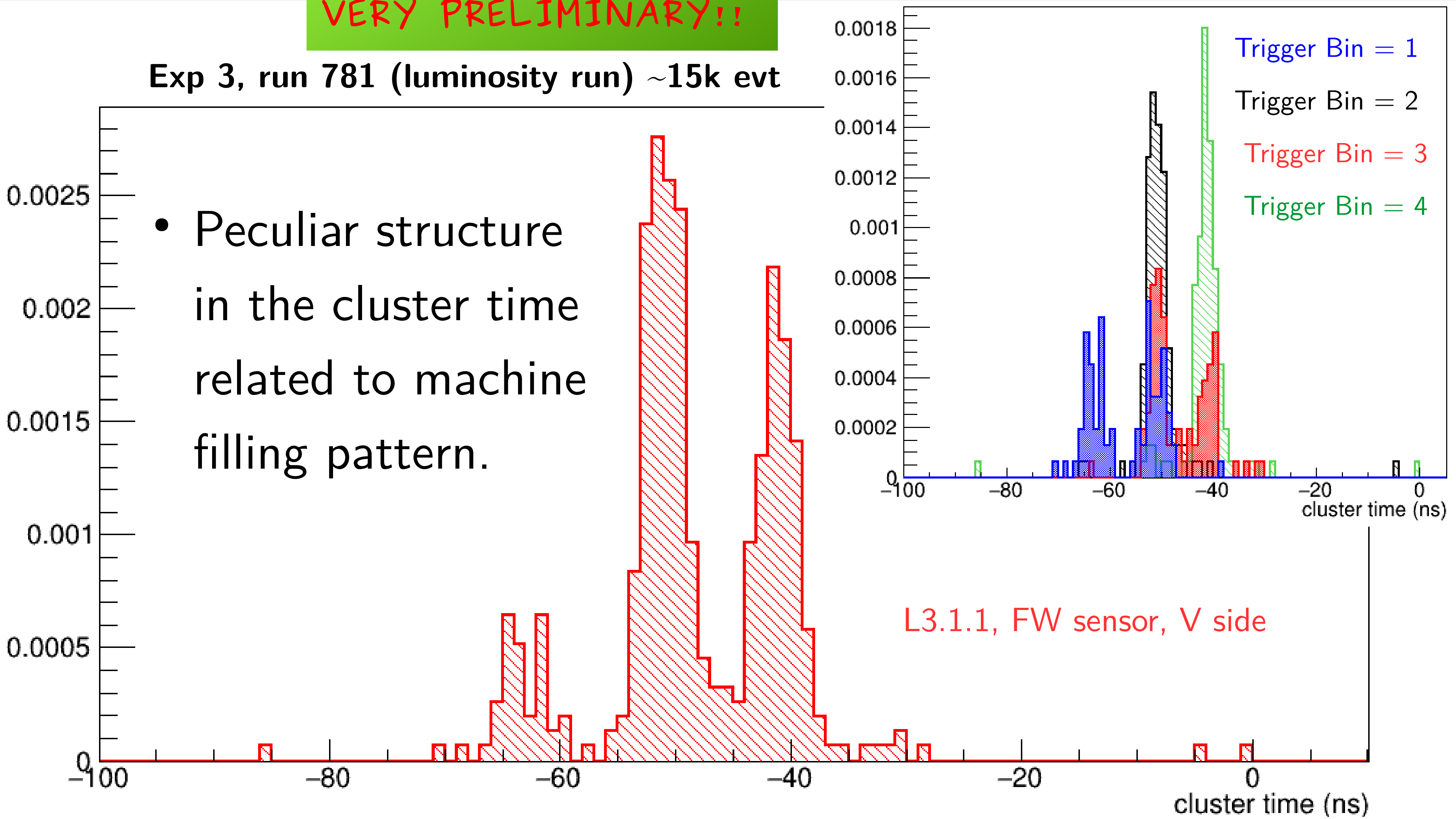
- FW sensor on L3 is detecting more inclined tracks. Higher cluster energy (~ 100 keV) and the larger cluster size (~4) are consistent with the hypothesis of larger angles and narrower pitch.
- BW, U side: gain systematically underestimated!

Cluster Time, L3

VERY PRELIMINARY!!

Exp 3, run 781 (luminosity run) ~15k evt

- Peculiar structure in the cluster time related to machine filling pattern.

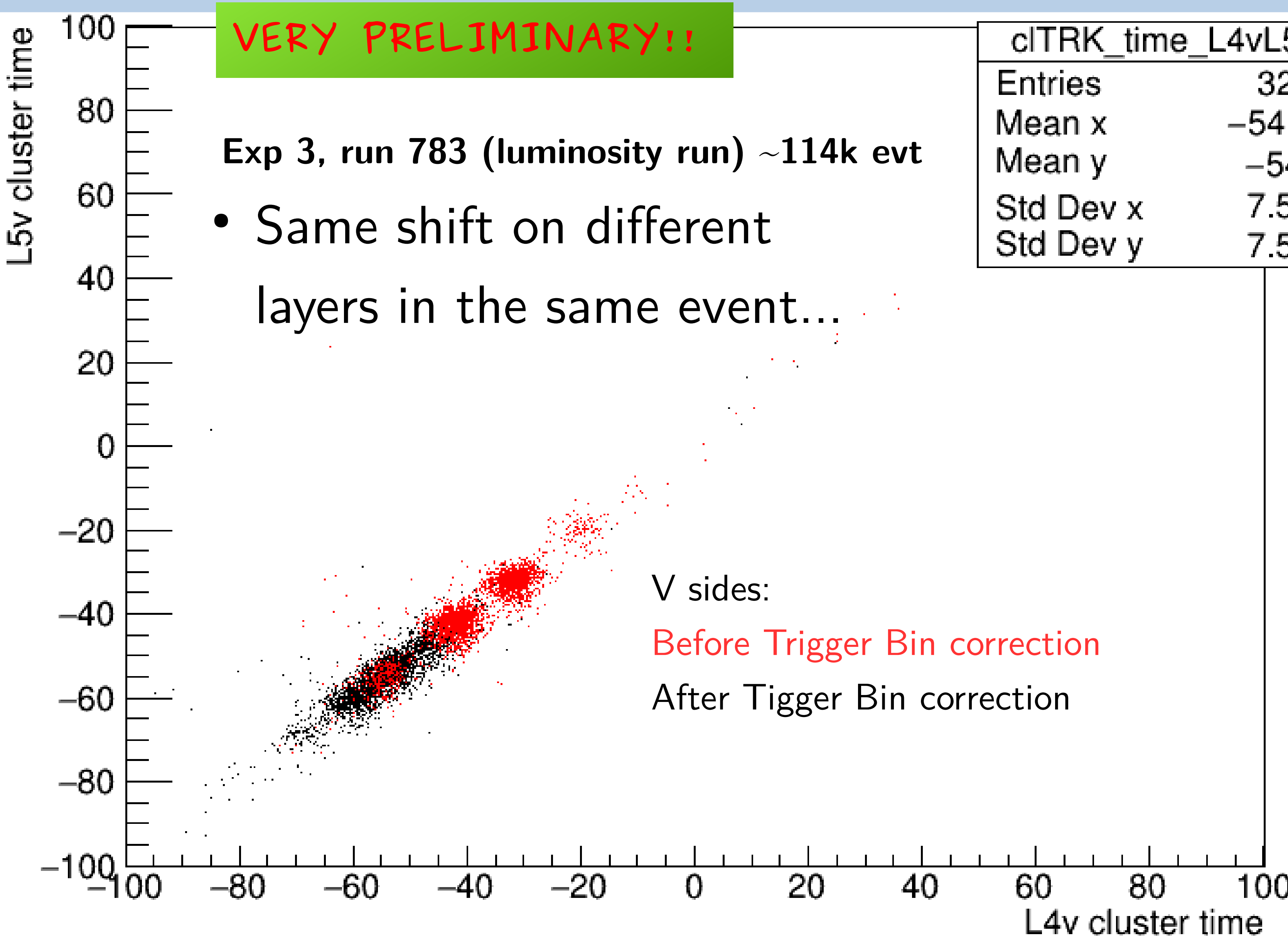


Cluster Time L5 Vs. Cluster Time L4

VERY PRELIMINARY!!

Exp 3, run 783 (luminosity run) ~114k evt

- Same shift on different layers in the same event...



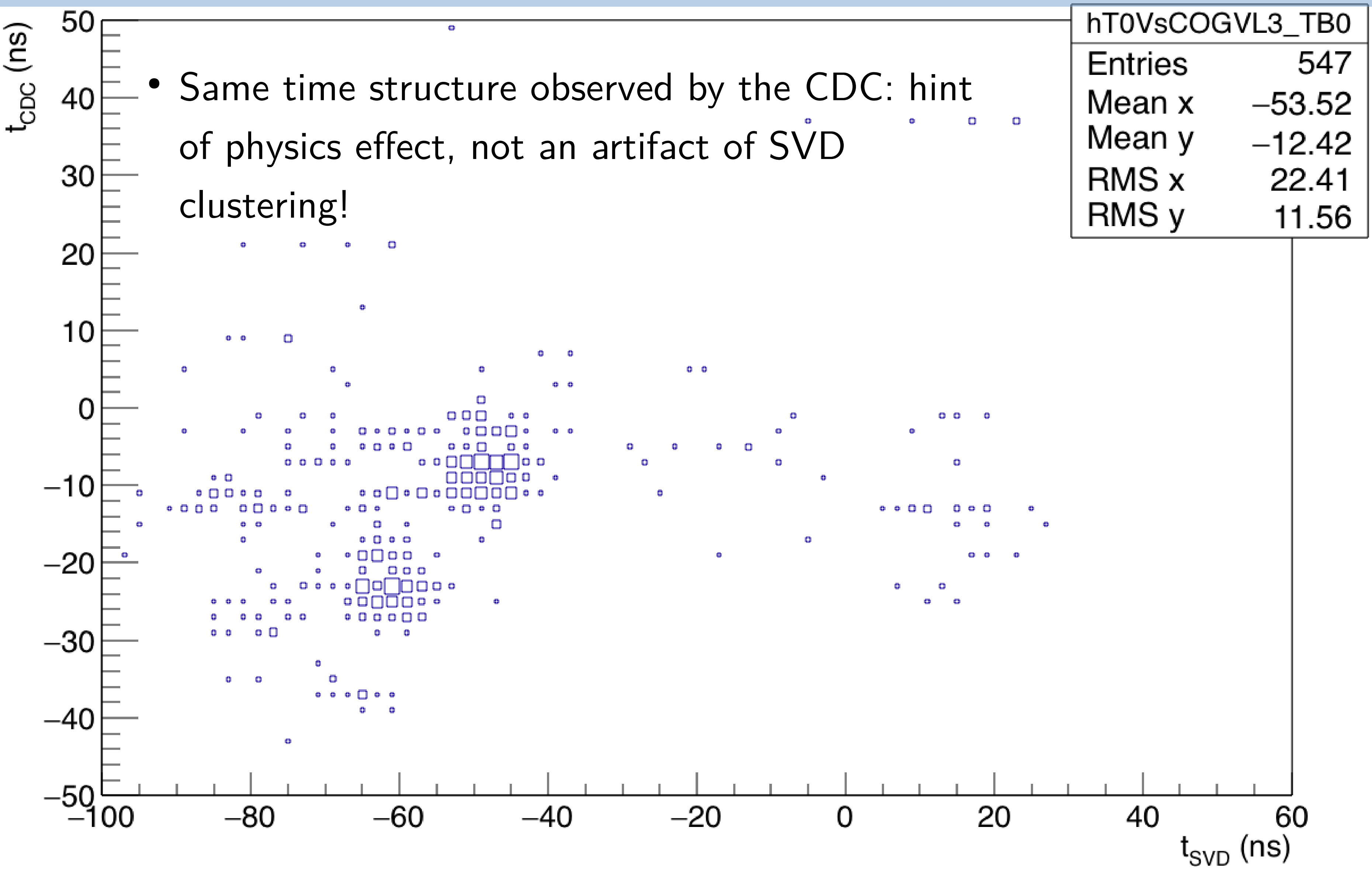
V sides:

Before Trigger Bin correction

After Tigger Bin correction

Correlation between SVD Hit Time and CDC Event Time

- Same time structure observed by the CDC: hint of physics effect, not an artifact of SVD clustering!



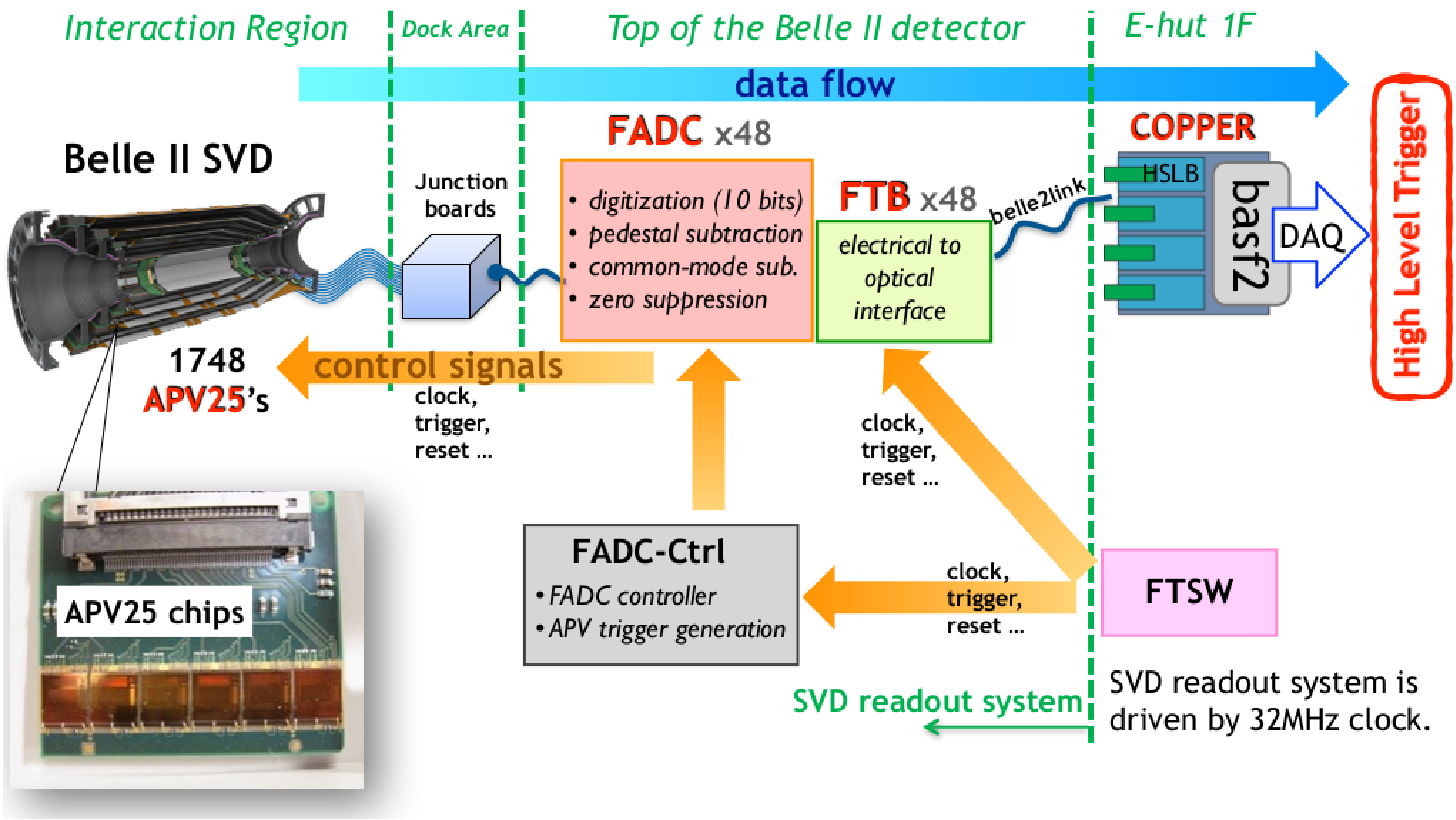
Conclusions

- On the observed Clusters related to Tracks…
  - nice result to see them, SVD reconstruction is working!
- On the measured cluster properties…
  - *S/N, Size, Energy*: consistent with what we would expect for real tracks from MIPs.
  - Differences observed on *L3*: consistent with the hypothesis of more inclined tracks w.r.t. the sensor (L3 FW not slanted!) + narrower pitch, as expected from our detector geometry.
  - Peculiar structure observed in the *cluster time* distribution is confirmed by the correlation with the CDC event time: it seems to come from a physics effect and is related to machine filling pattern.
- On next plans:
  - Reconstruction parameter tuning and optimization… but first let's focus on understand what we observed!

Backup

SVD Read-Out System (Phase 3)

Slide by G.Casarosa @BPAC, October 2017

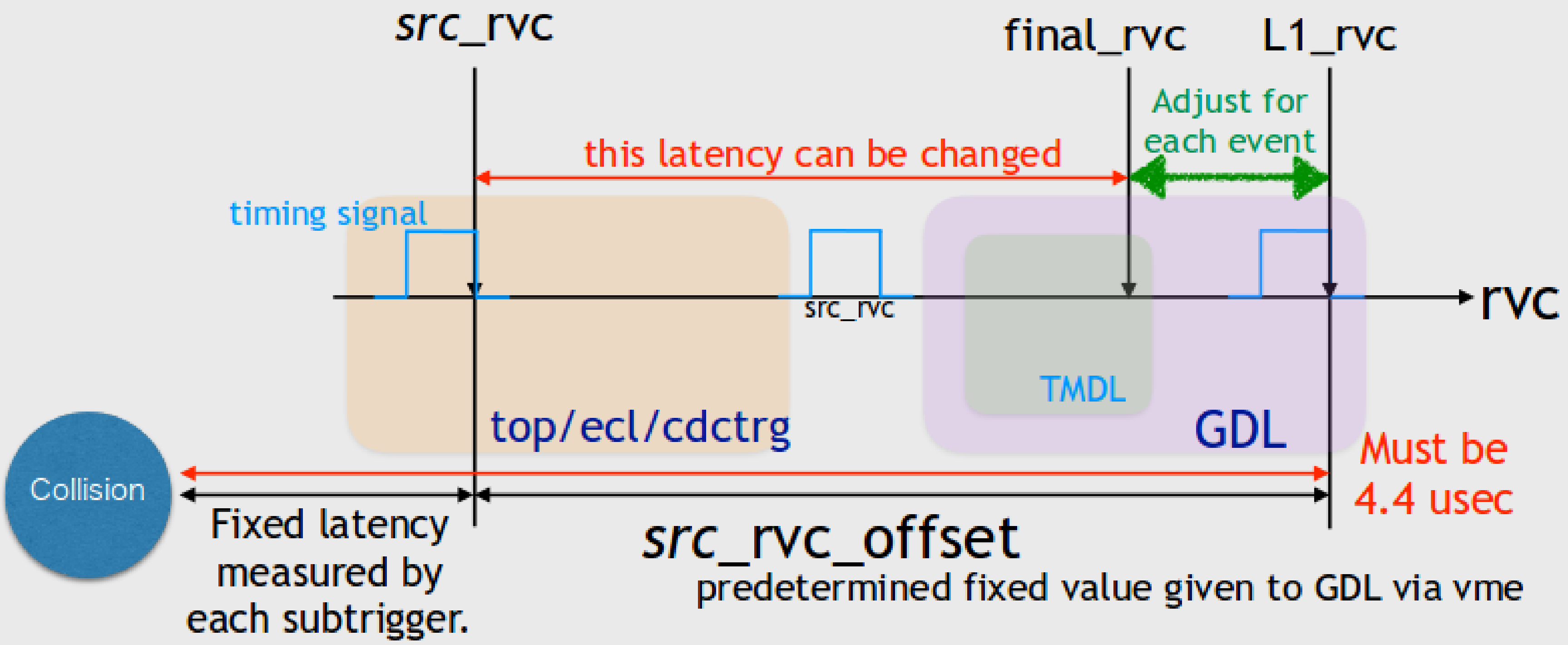


SVD readout system is driven by 32MHz clock.

Trigger: timing adjustment

Slide by H. Nakazawa, SW October 2017

- Timing signal provided by TOP, ECL, CDC
  - Signal Signal produced at fixed latency from beam beam collision
- Adopted in order of TOP, ECL, CDC
- Use Timestamp (revolution clock) value rather than received timing
- Adjust timing event by event



↔ = src_rvc + src_rvc_offset - final_rvc

Hot Strips Masking

- We want to be sensitive to beam background looking at the sensor integrated occupancy → the hot strips should not contribute significantly to the total occupancy:
  - expected beam bkg occupancy on L3 = 0.2%
  - average noise occupancy with ZS = 5 is of the order of 10^{-5}: $\frac{\sum_{i \neq hot} f_i}{768} \simeq 10^{-5}$
- Suppose we have *one* single hot strip per side, what occupancy can we afford? Setting the limit on the average occupancy at 10^{-4} (to be on the safe side):

$$\frac{1}{768}\left(f_s + \underbrace{\sum_{i \neq s} f_i}_{\text{NEGLIGIBLE}}\right) < 10^{-4} < 2 \cdot 10^{-3}$$

$$f_s < 768 \cdot 10^{-4} \simeq 5 \cdot 10^{-2}$$

- Assuming at worst 10 hot strips per side, the upper limit would be 5 10^{-3} and adding another safety factor of 10, we get an upper limit for the single strip occupancy on L3:

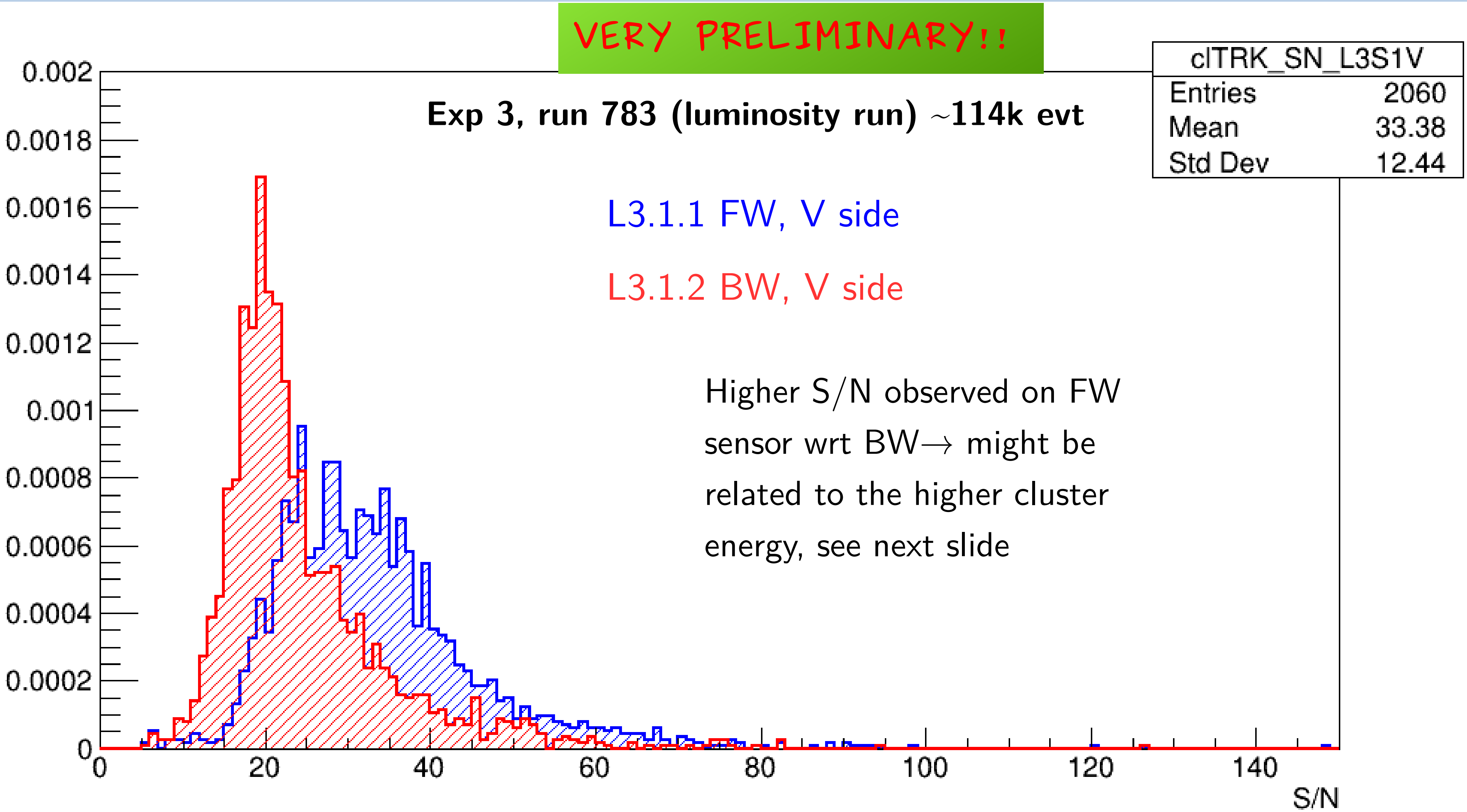
$$\boxed{f_s(L3) < 5 \cdot 10^{-4}}$$

- For the external layers we can relax this limit by one order of magnitude:

$$\boxed{f_s(L456) < 5 \cdot 10^{-3}}$$

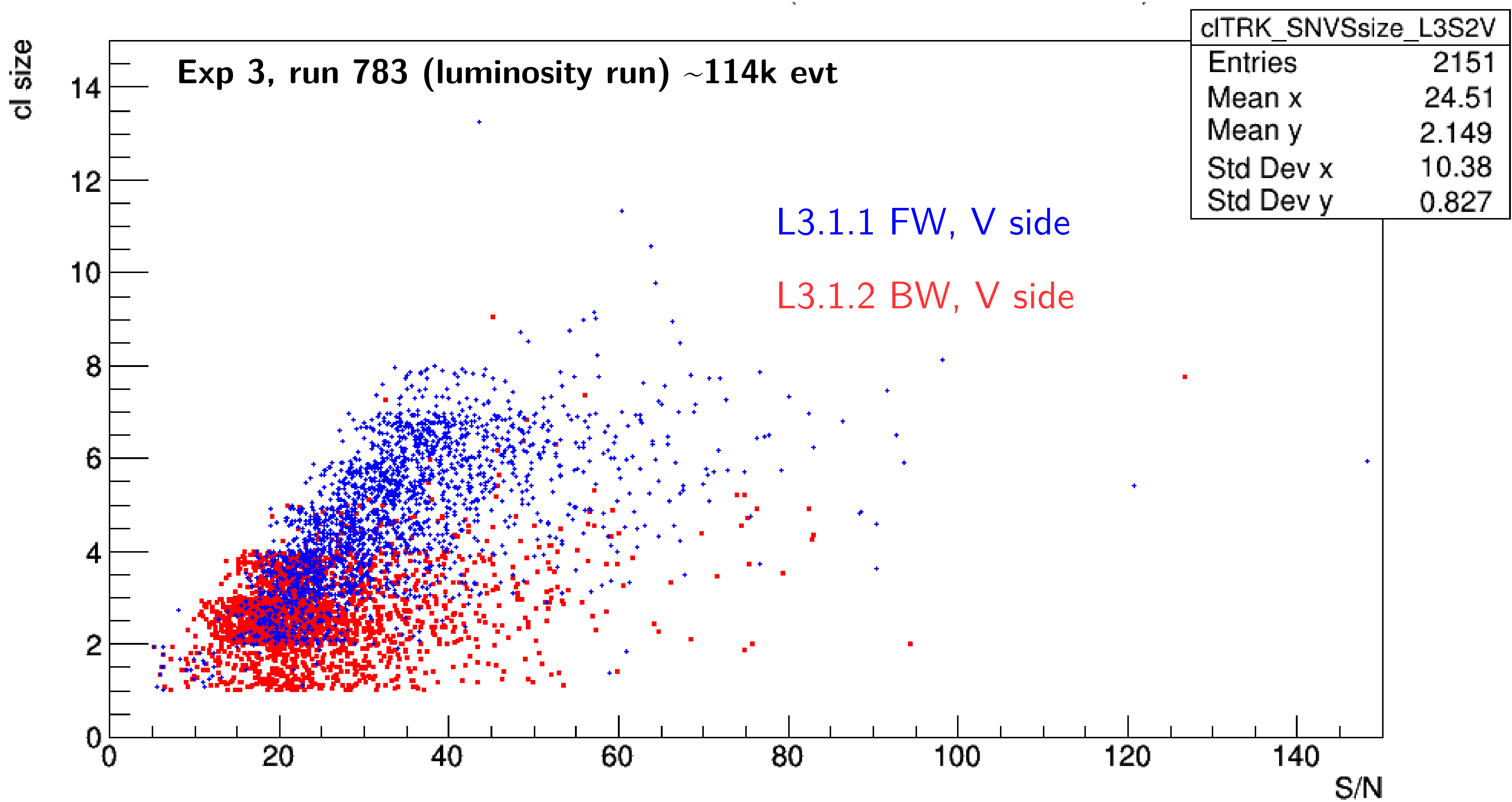
Courtesy of G.Casarosa

Cluster S/N: L3, V side



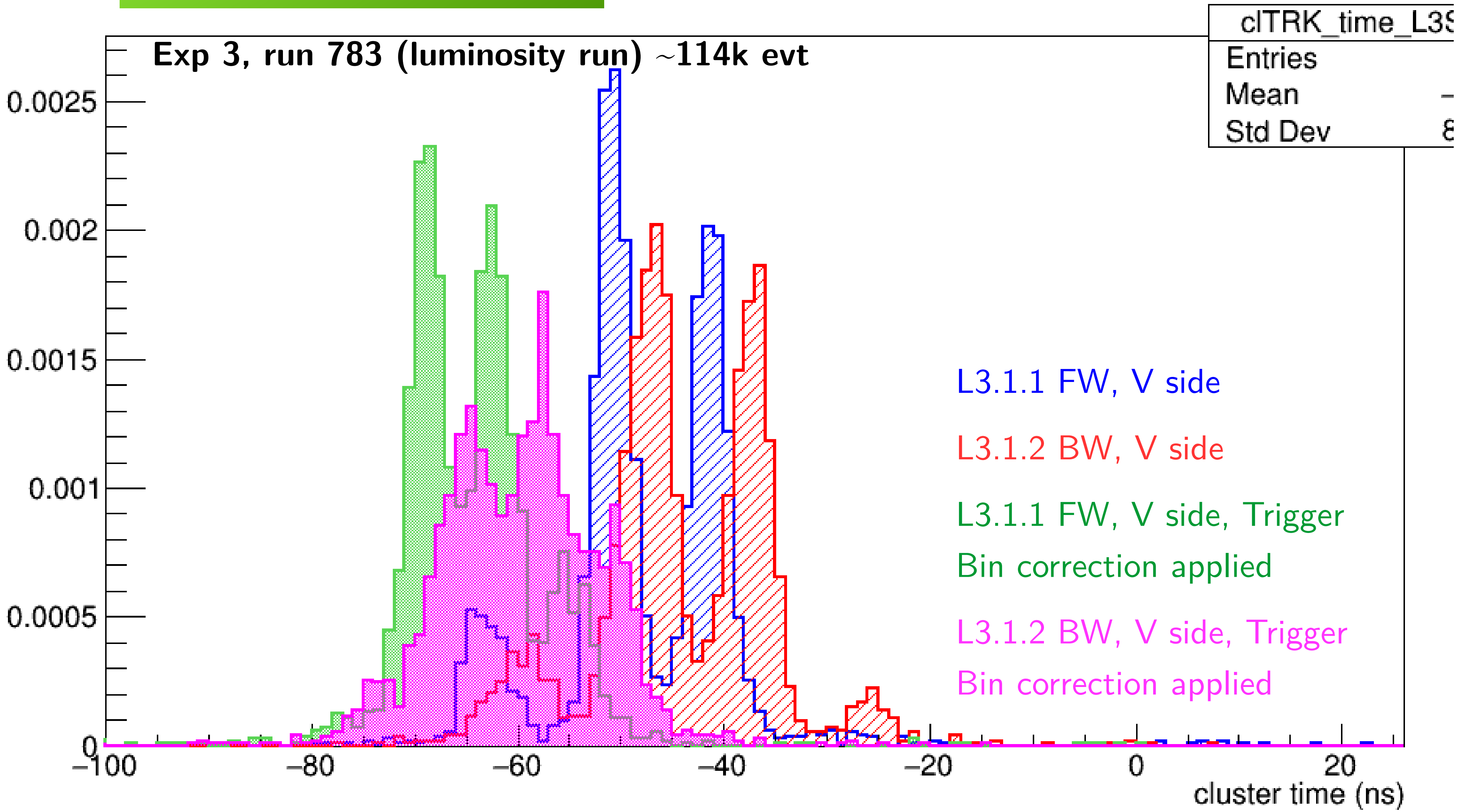
Higher S/N observed on FW sensor wrt BW→ might be related to the higher cluster energy, see next slide

Cluster S/N Vs. Cluster Size, L3

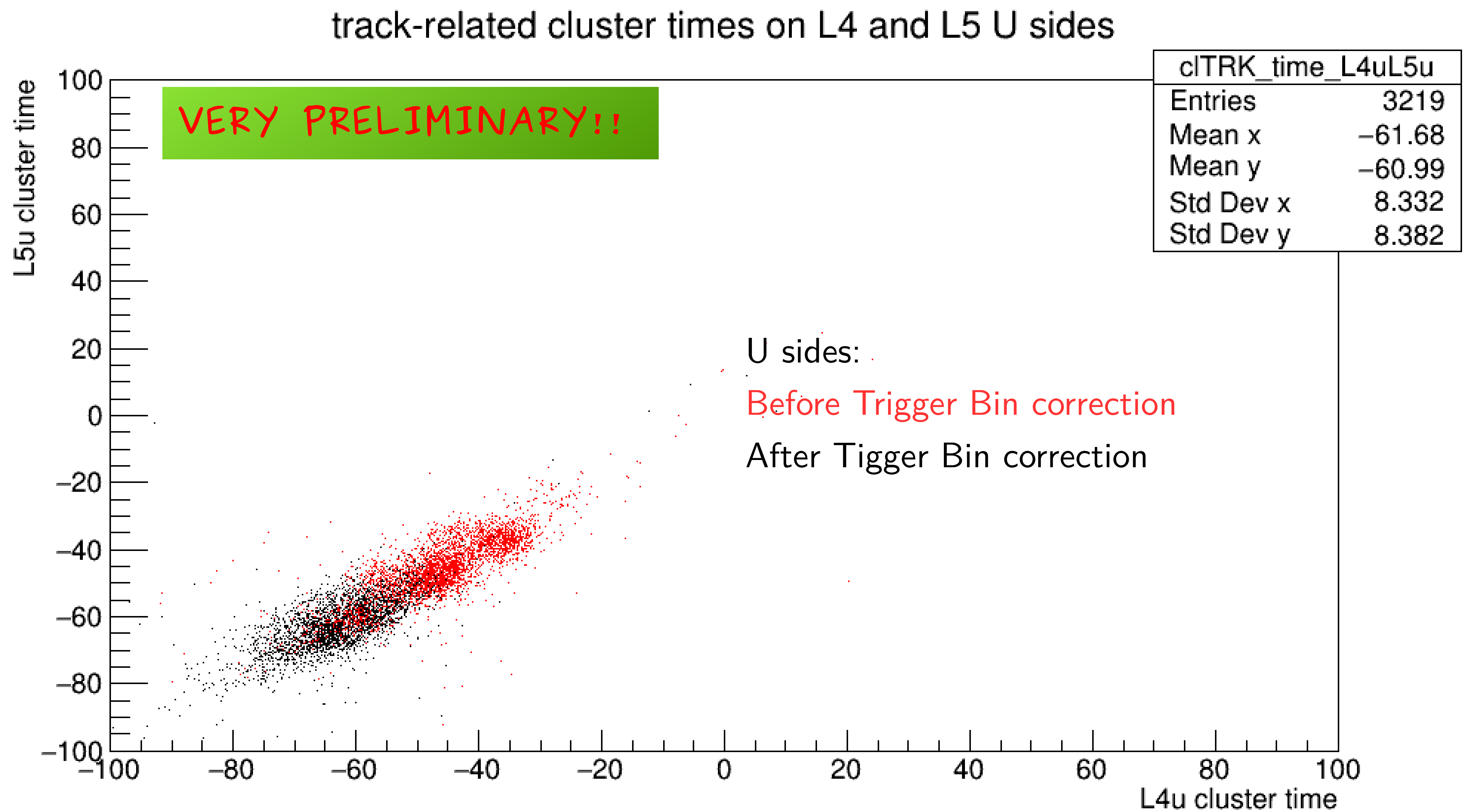


Cluster Time: L3, V sides

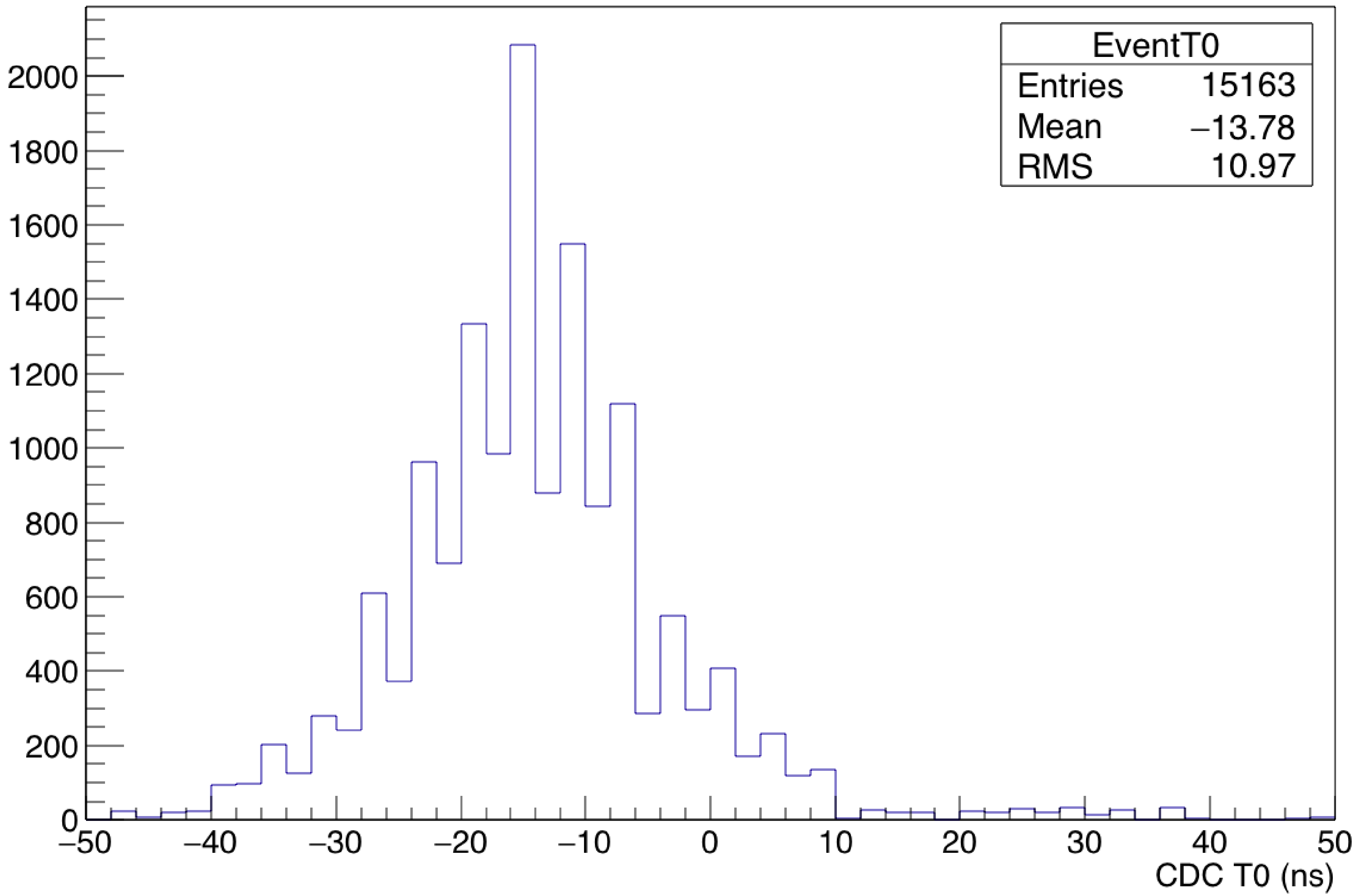
VERY PRELIMINARY!!



Cluster Time: correlation plot L4-L5



Event T0 from CDC



Cluster Time: remarks

- Peculiar structure observed in Cluster time distribution
- Correlation plot L4 Vs L5: event per event same shift
- Correlation with CDC Event time also observed (hint of physics effect...)
- Started investigating the issue
- Cosmic Run data give different distributions $\rightarrow$ See Luigi talk for further investigation