First Look at SVD Data

run77 & run78

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Tracking Software Meeting ~ February, 23rd 2018

Caveat Emptor

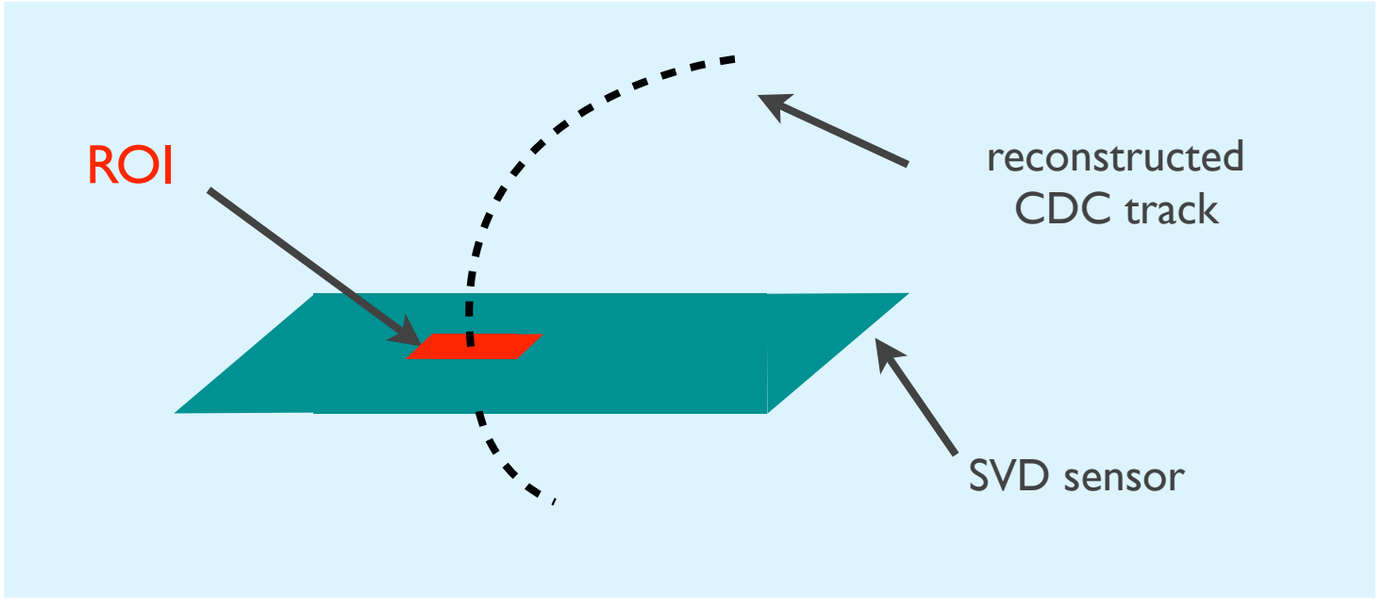
- ➡ all plots shown in these slides are PRELIMINARY
- ➡ only a few days between data taking and today (including a NRT → PSA flight, a few hours of sleep, a blocked kekcc account)
- ➡ I will show a few plots, most of them require *more* thinking
- ➡ Calibration of the Reconstruction (CoG, clusterizer) not done yet
- ➡ please, handle with care

Outline

- ☑ *Data & Software Tools*
- ☑ *Occupancy*
- ☑ *Cluster size, SNR, time, …*

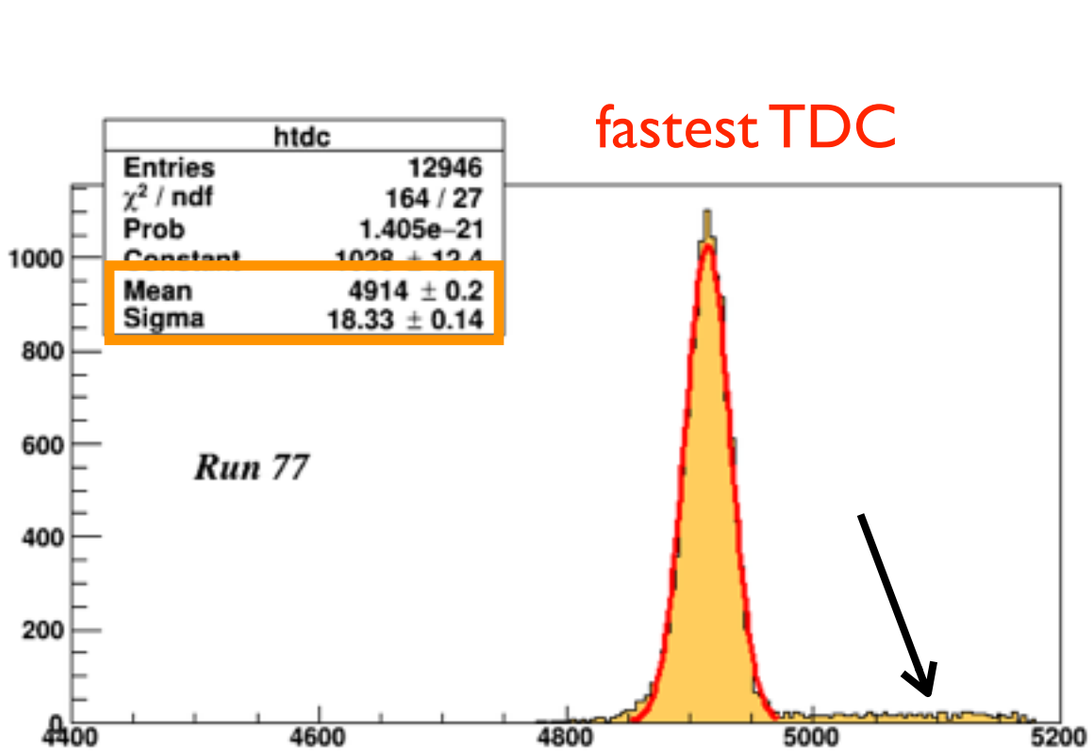
Data & Tools

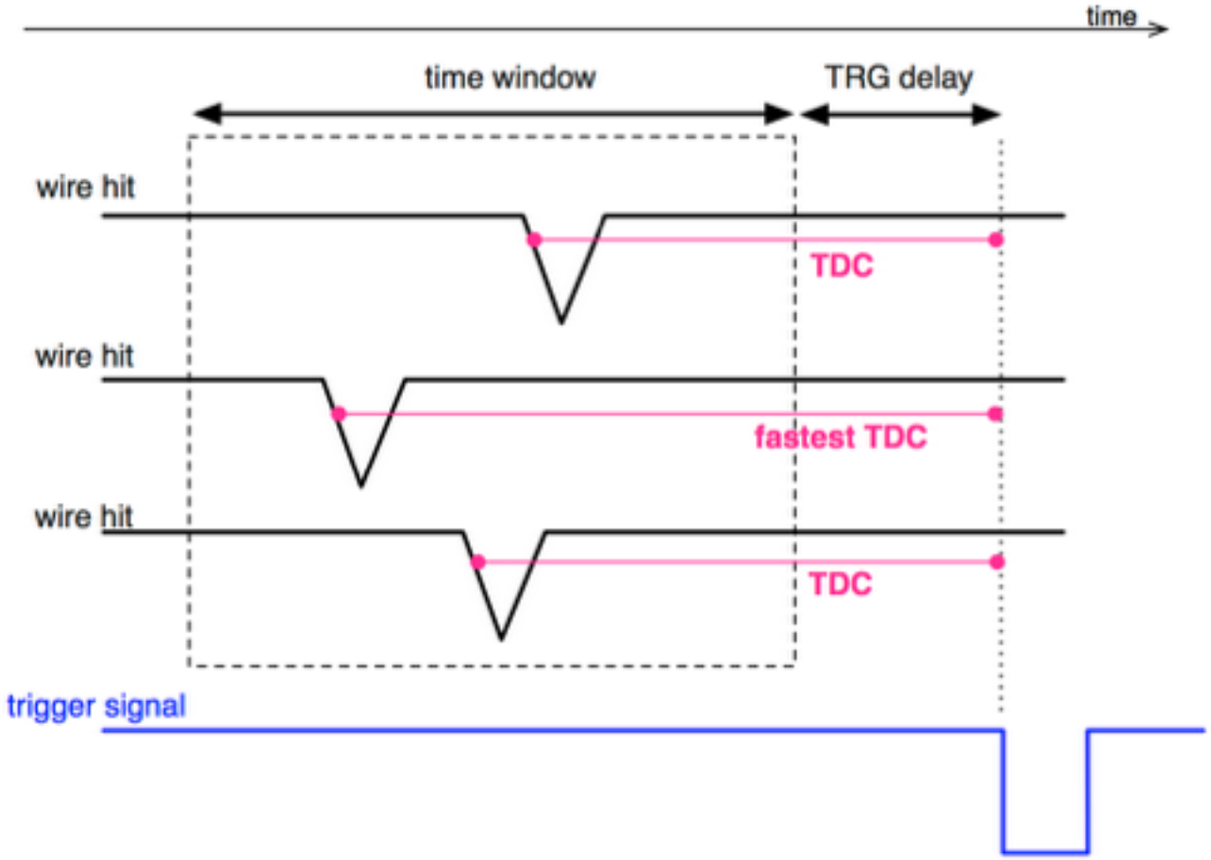
Message ID: **514**	Entry time: **2018/02/15 Thu 15:15 UTC**
JSTTime:	2018/02/16 00:15 JST
Author:	Giulia Casarosa
Type:	Cosmic Ray Run
Category:	General
Subject:	run 78: PXD+SVD+CDC+TOP+TRG+HLT



Datasets

runs	# events	magnet	sub-det	trigger	ZS	latency
77	270567	on	PXD **SVD** CDC TOP TRG HLT	ECL + CDC + 1Hz rnd	seed/ SNR = 3	158
78	282698					159





- ➡ average 4.9 μs
- ➡ *trigger jitter (?) = 18.5 ns*

TDC = timing_counter(received trigger signal) - timing_counter(wire hit)

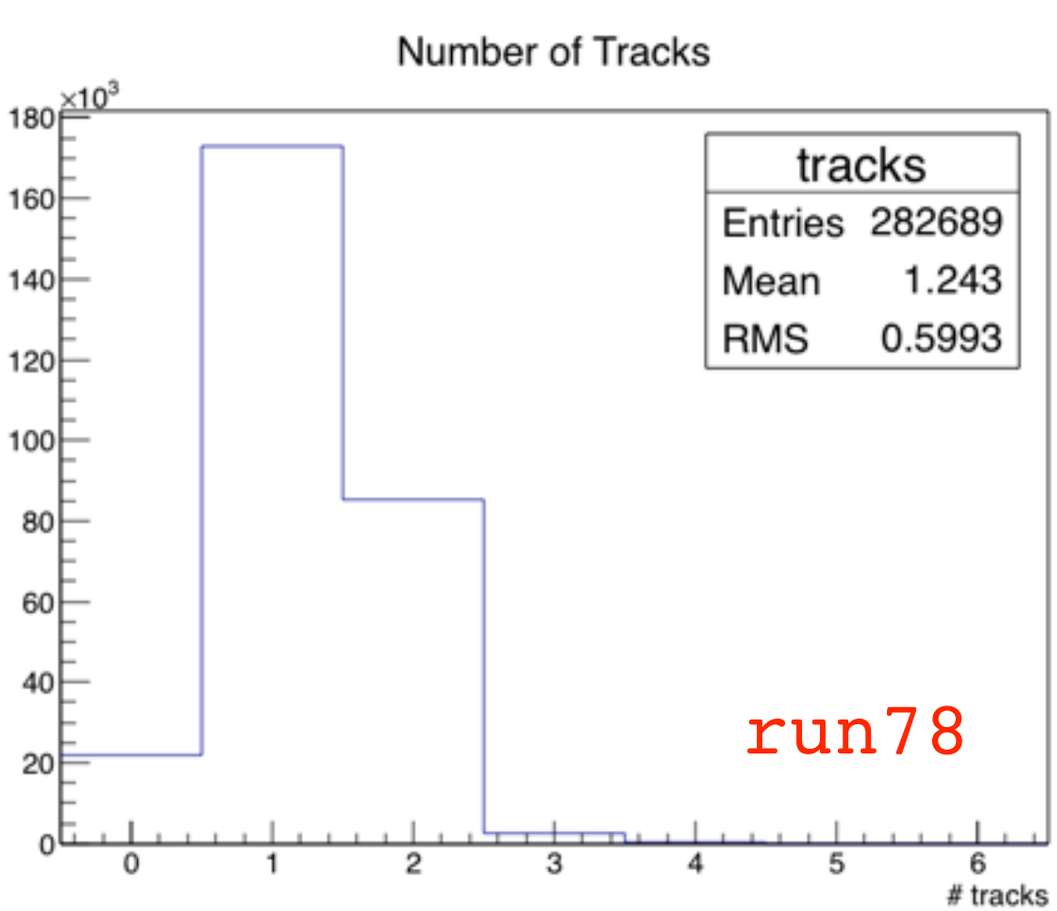
Reconstruction Tools

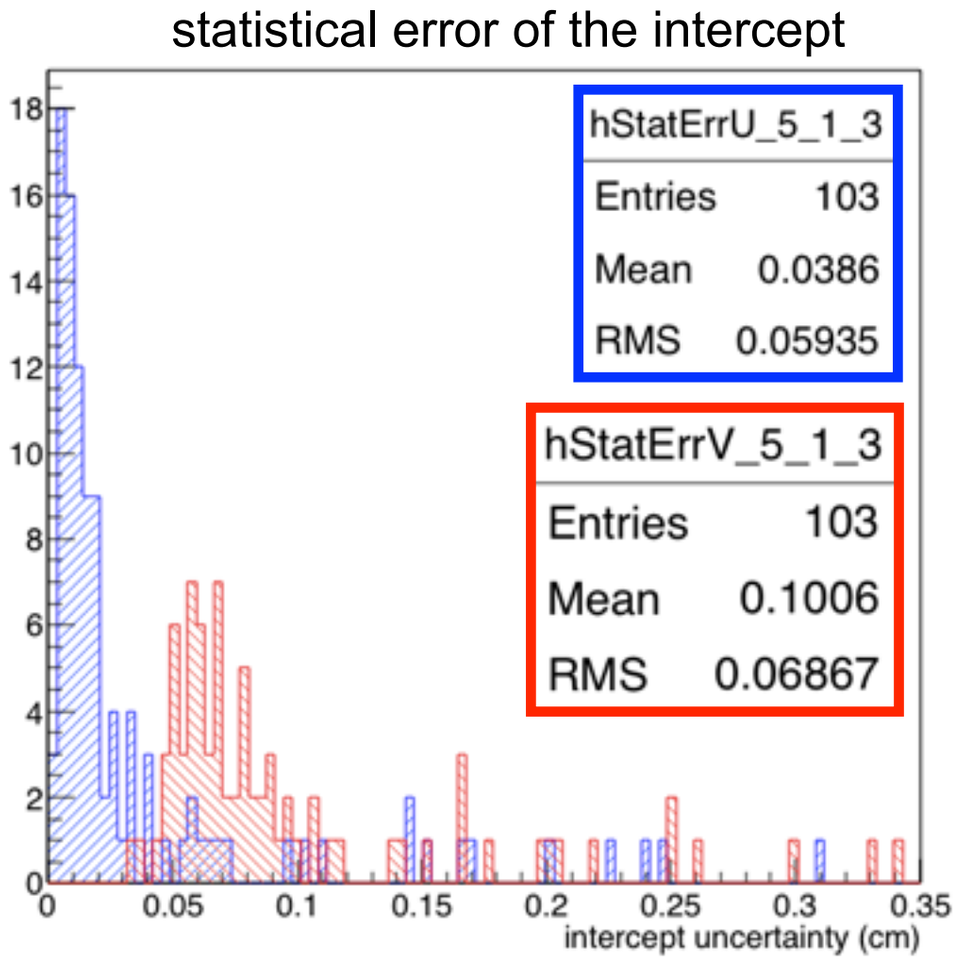
➡ **Hot Strips Filter** → merged to master

- a strip is marked as *HOT* if *only* one of the 6 samples has an amplitude that exceeds 3 times the noise of that strip (measured in local run)

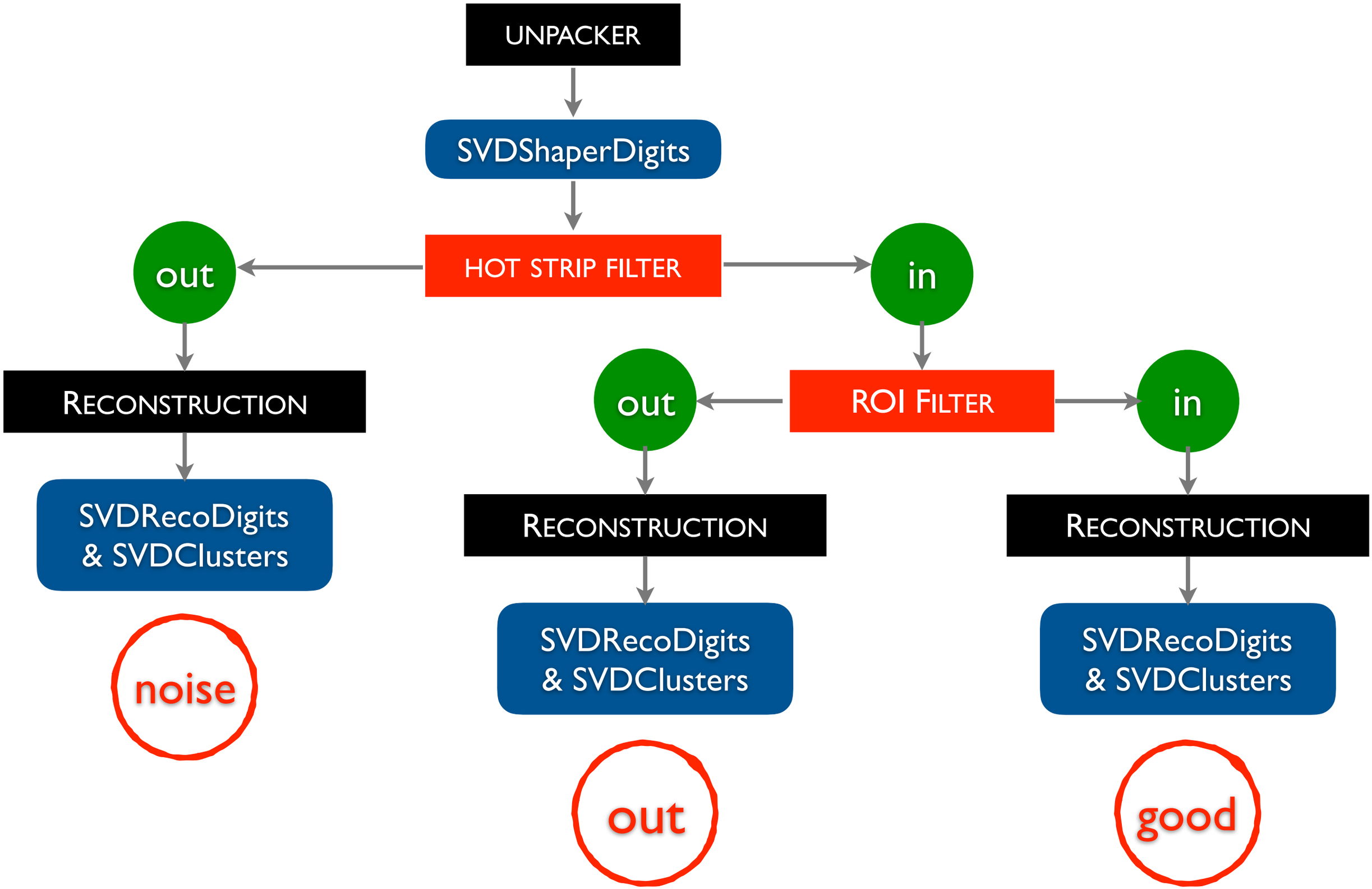
➡ **SVD ROI Finder** → merge to master?

- generates ROIs extrapolating CDC tracks to SVD sensors

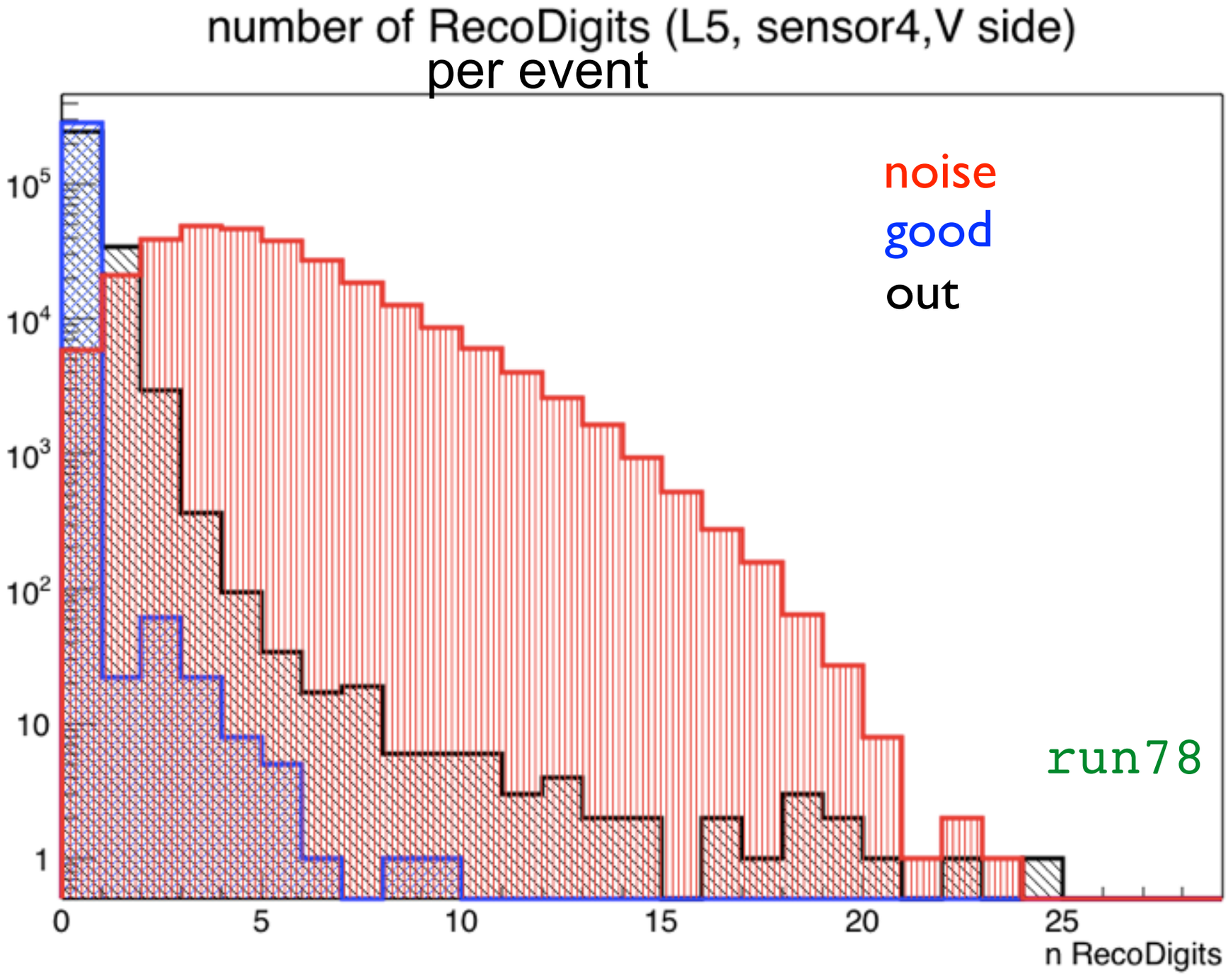




Event-by-Event Strip Classification

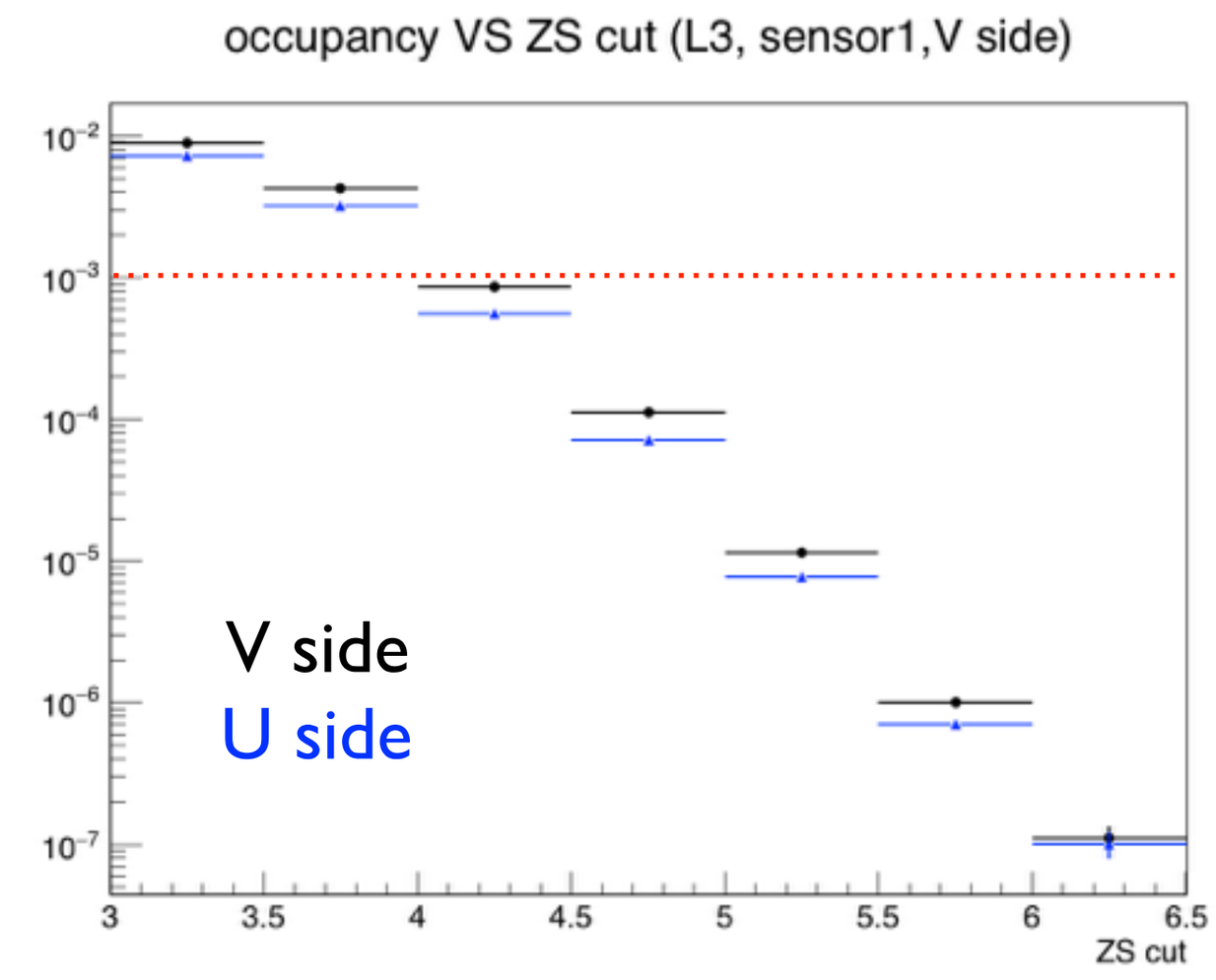


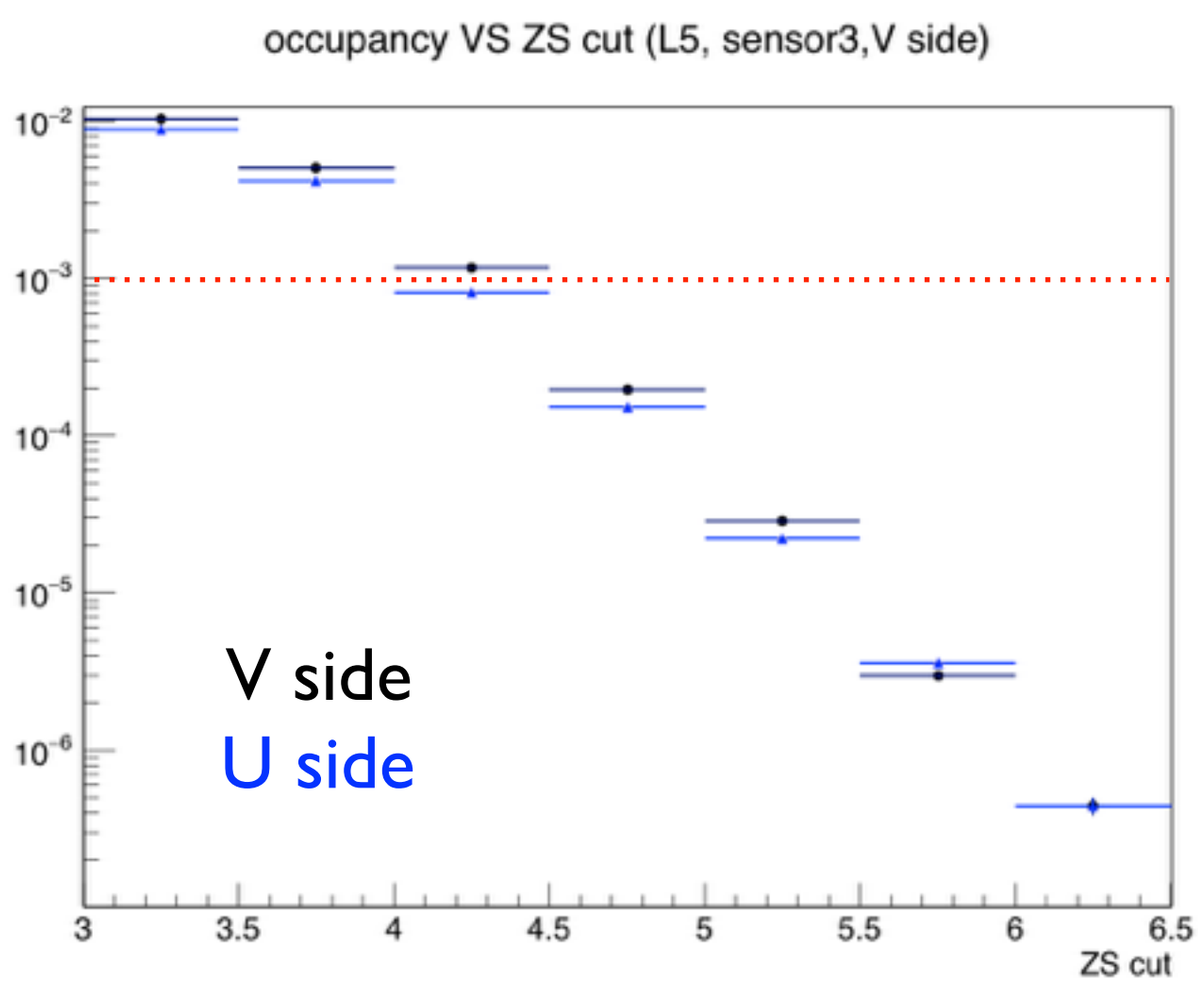
Reconstructed Strips



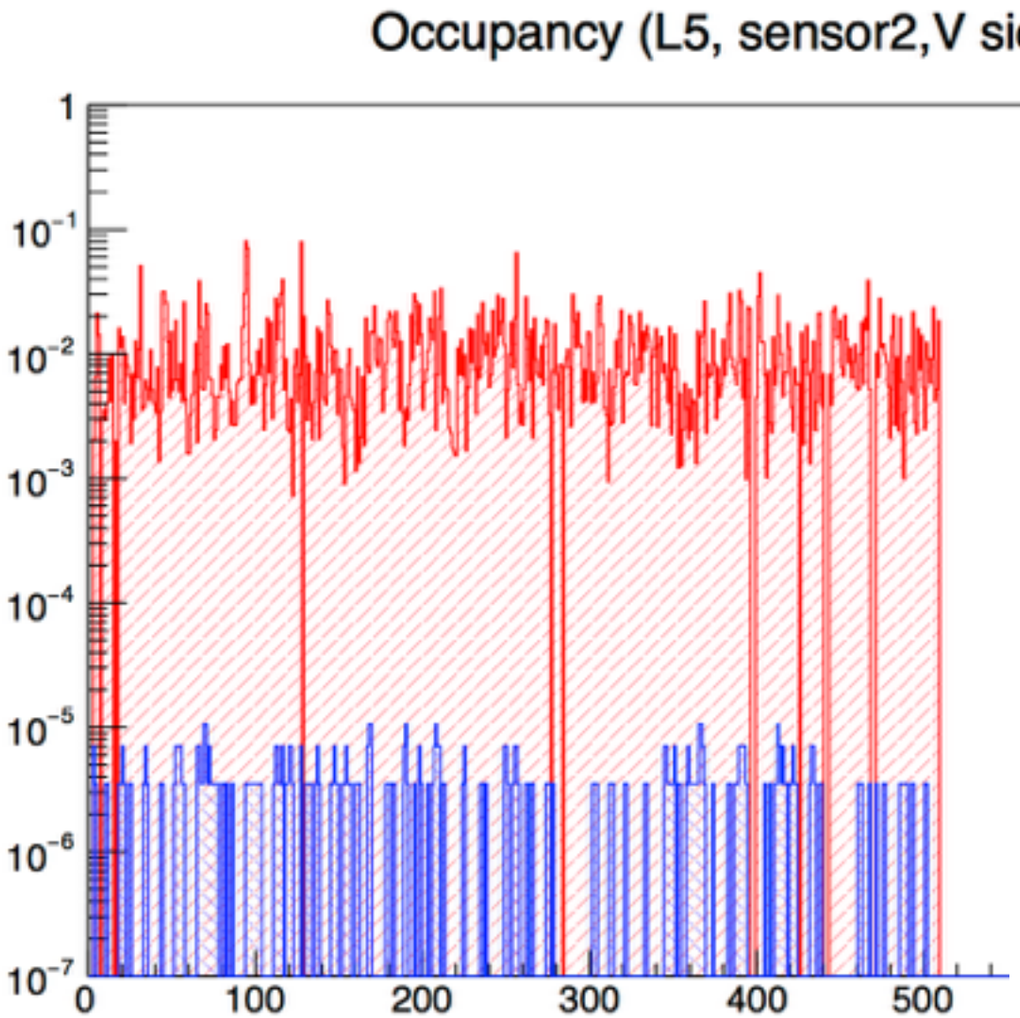
Occupancy VS Zero Suppression

- On FADC boards we select only strips that pass the Zero Suppression cut
- Zero Suppression cut: (max signal of the 6 samples) / (strip noise) > 3
- Expected beam-background occupancy at full luminosity ~ 1.5% on layer 3
- Occupancy from noise must be negligible, at least one order of magnitude smaller.

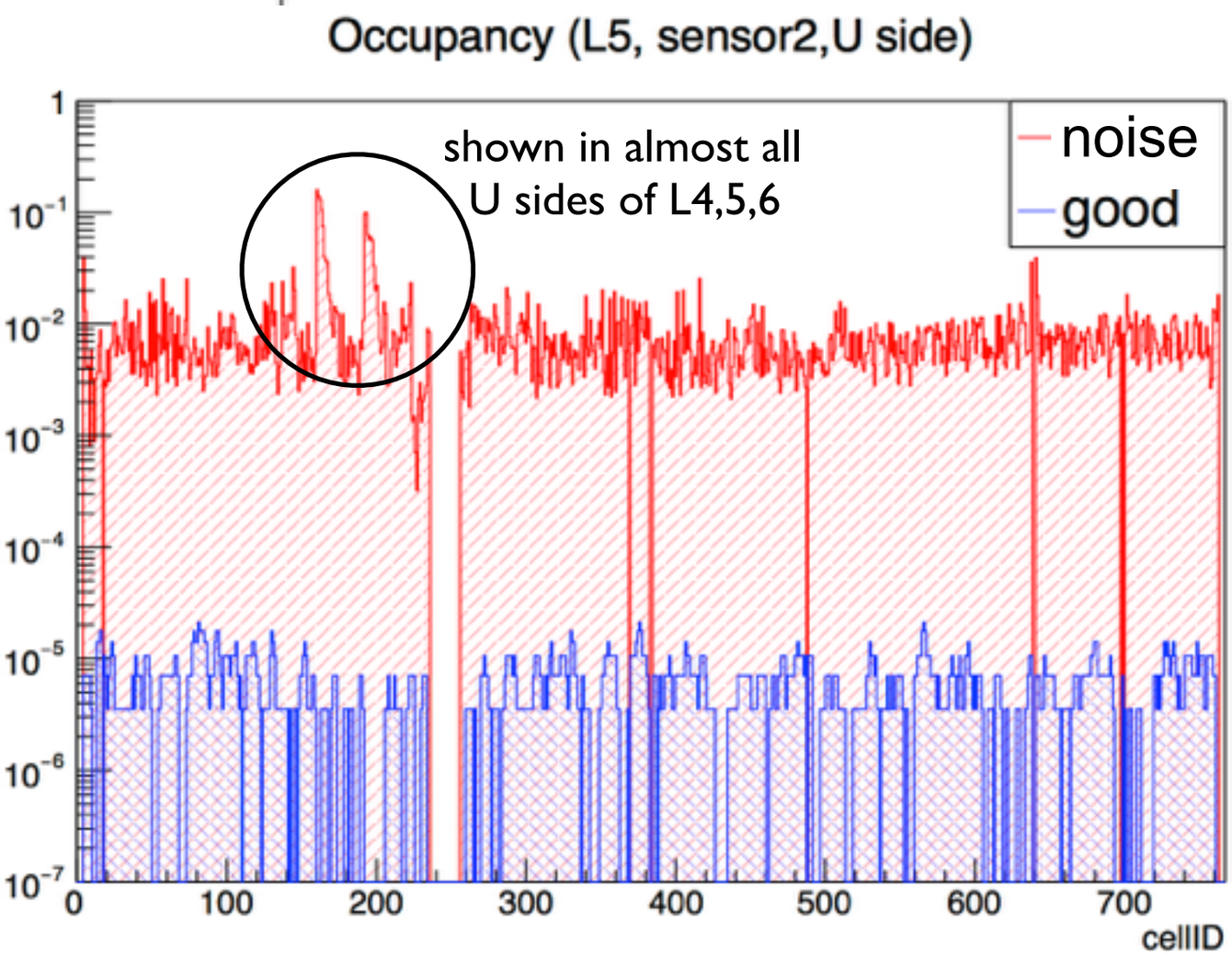




Occupancy & Hot Strips



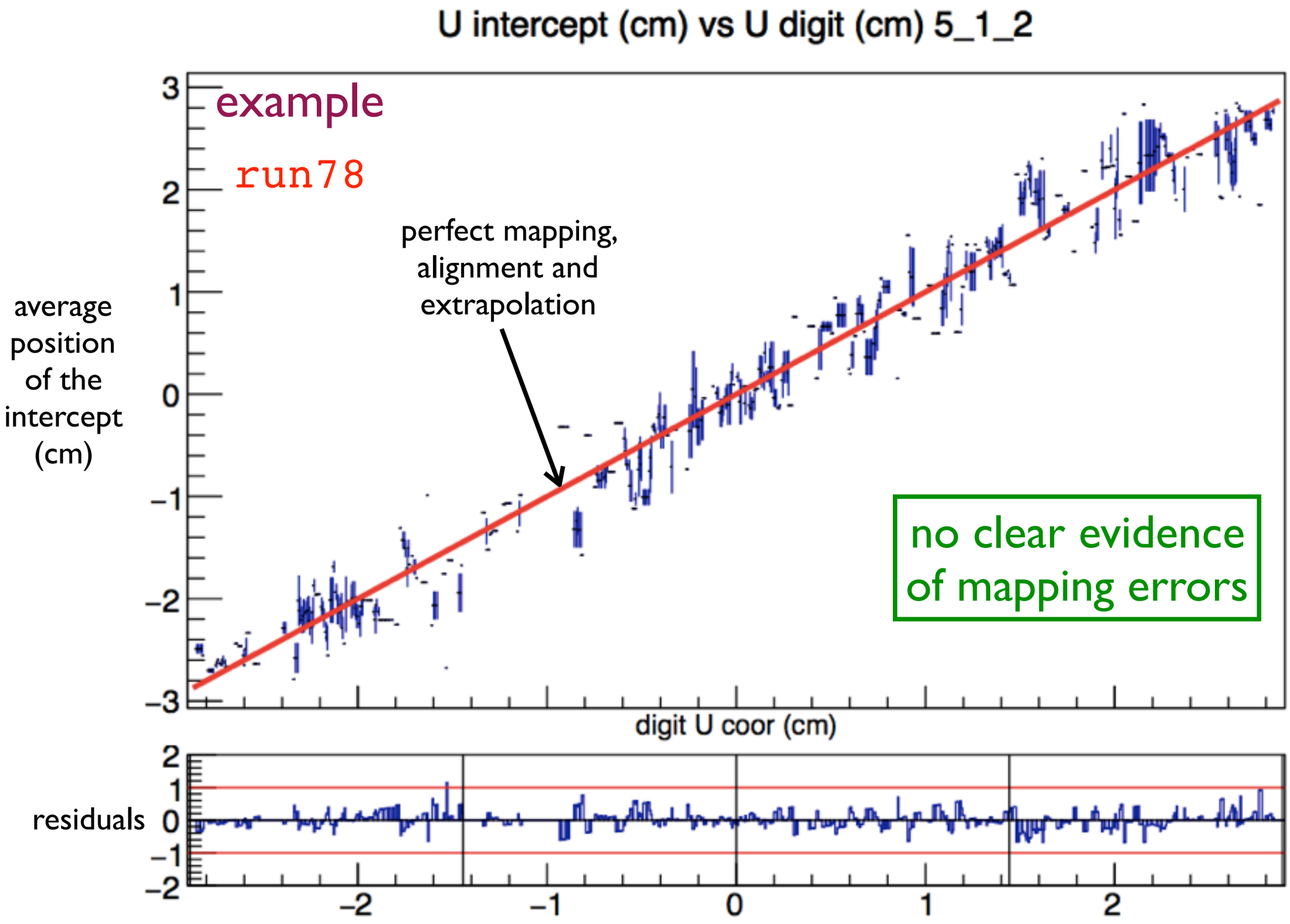
- ➡ Zero Suppression cut is quite low (SNR=3)
- ➡ average occupancy = 1%, in agreement with expectations (see backup)



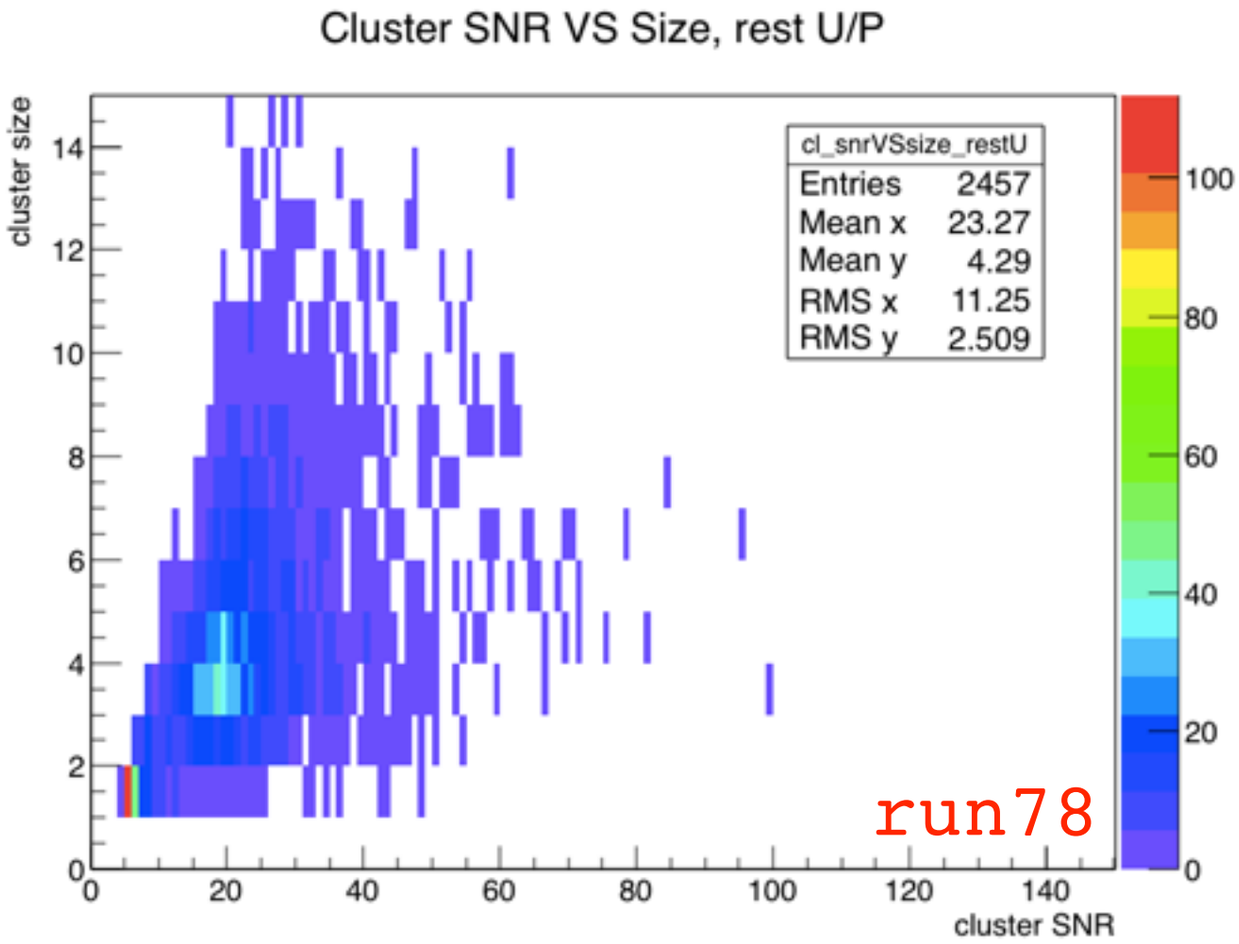
check compare_occupancy_run78.pdf, e.g.:

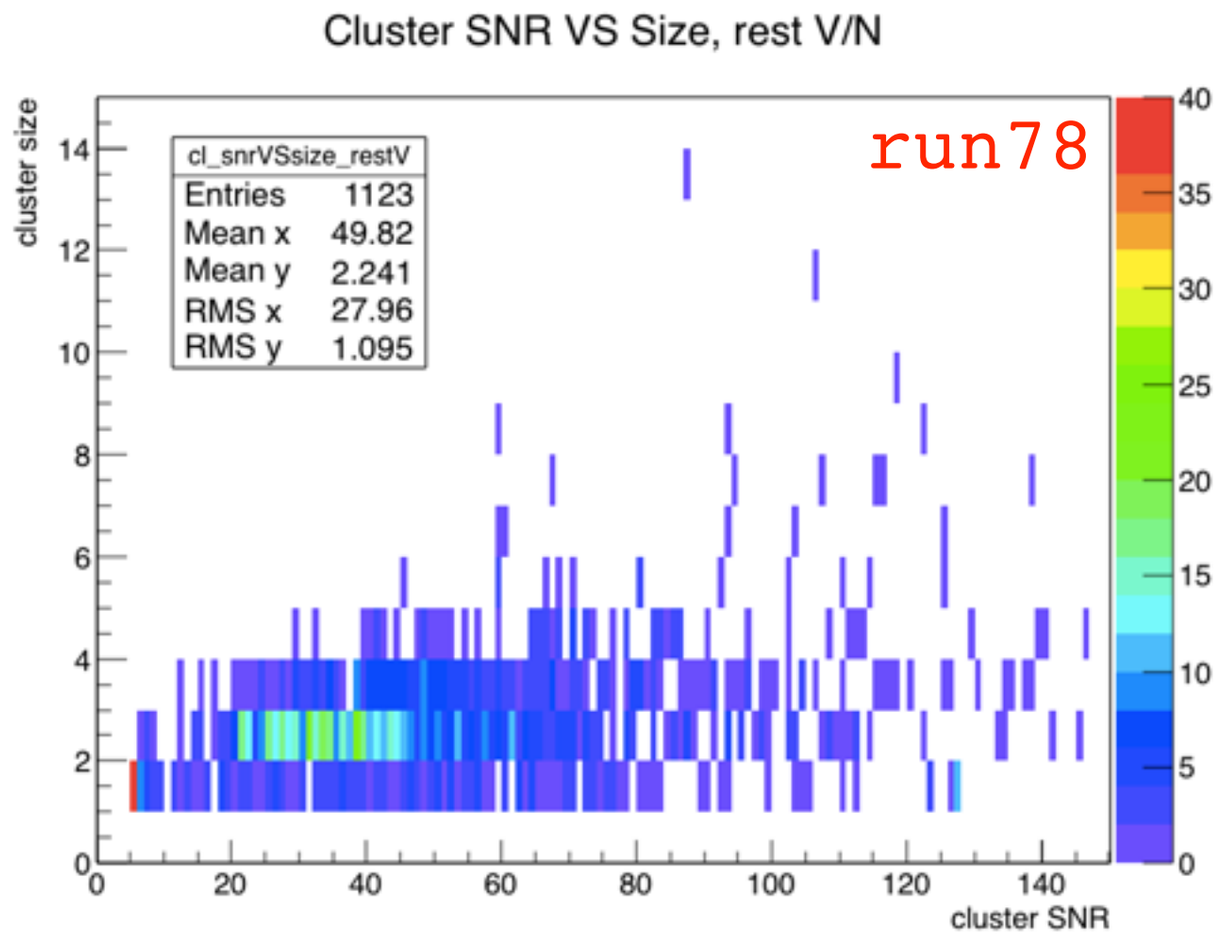
- layer4, sensor2, both sides
- later5, all sensors, U side
- layer6, sensor2, both sides
- layer 6, all sensors, U side

Residuals of Good Strips



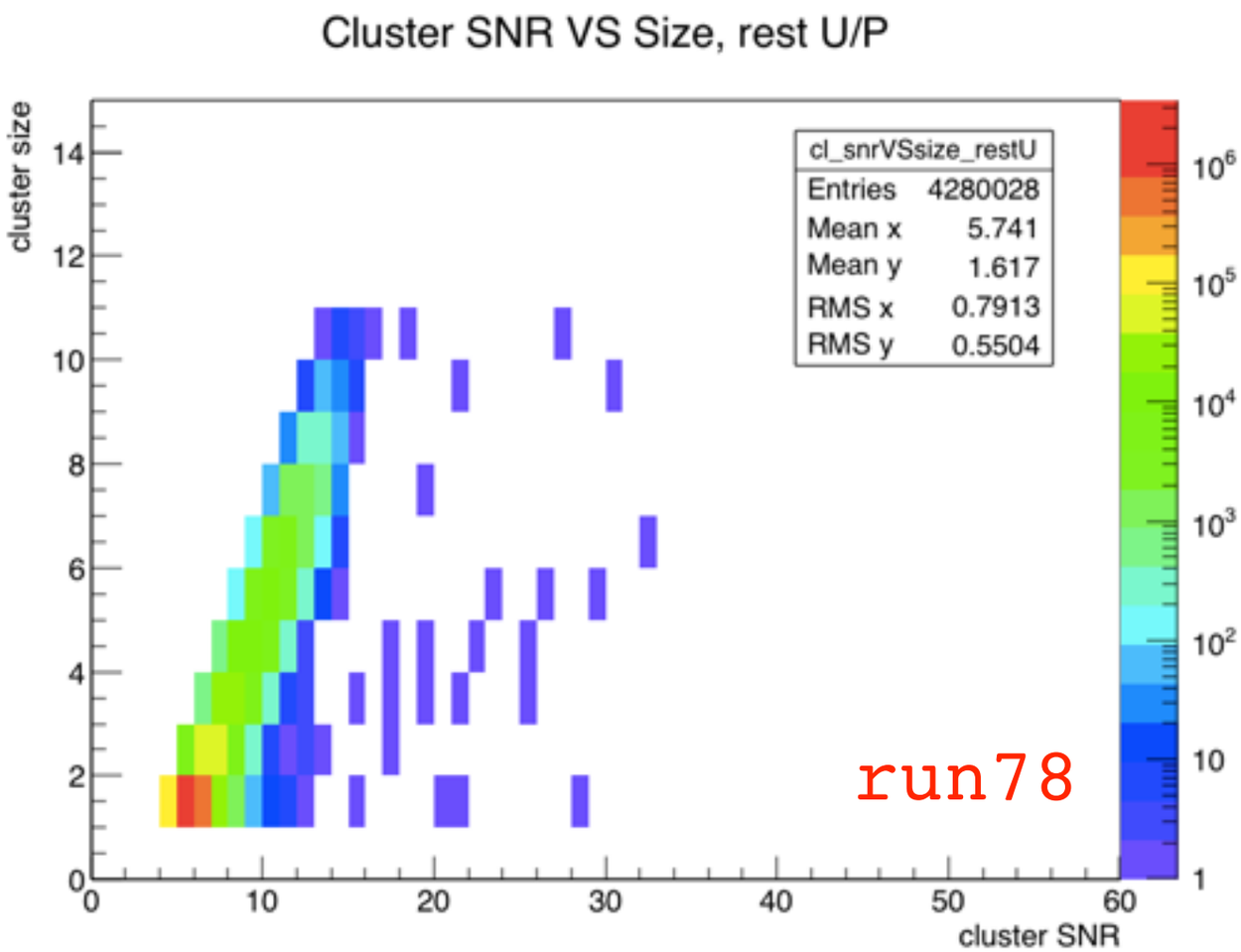
Cluster SNR vs Cluster Size, Good Strips

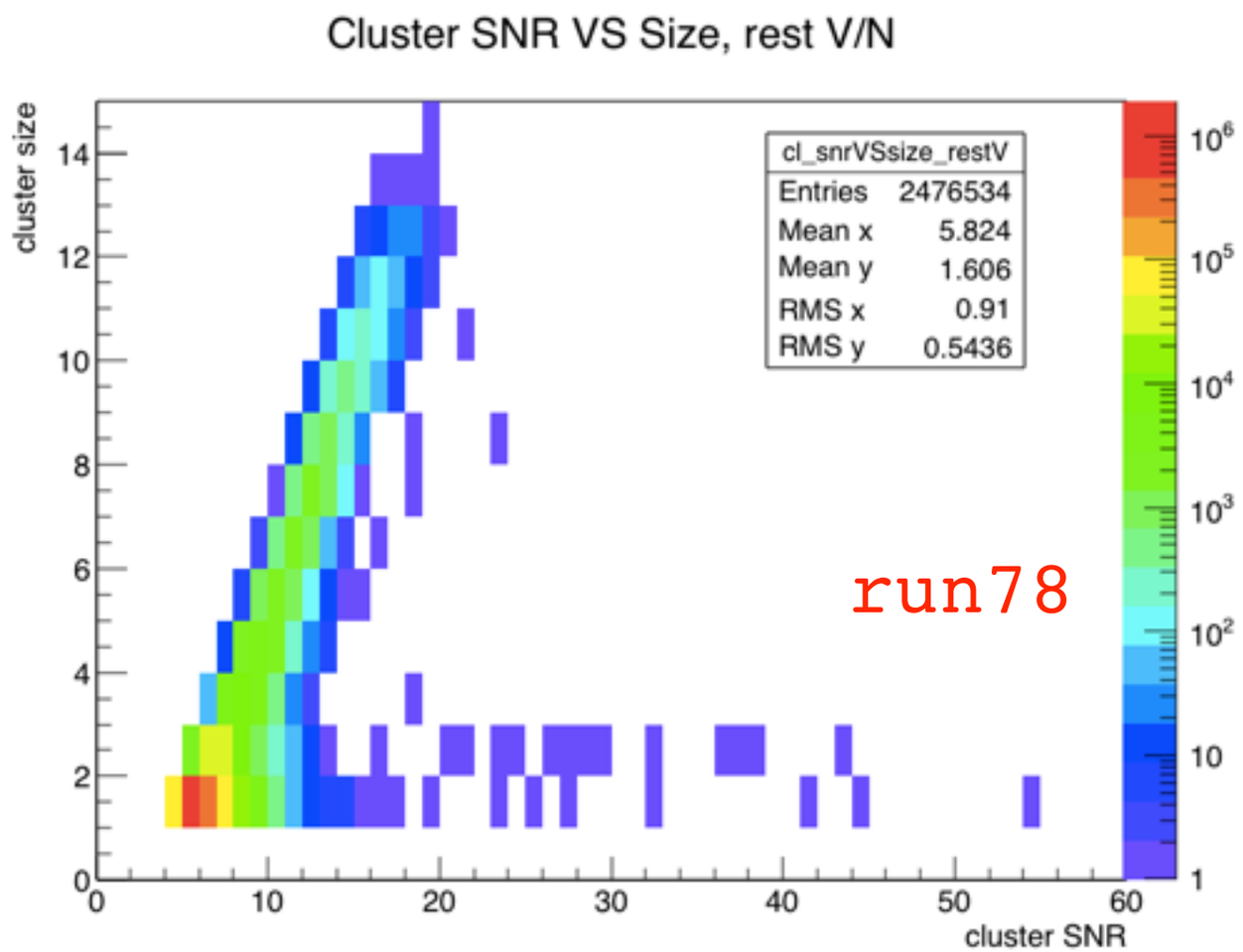




- Clusters generated by cosmics are different than the ones expected with collisions, at least for the U/P side
- Cluster Size = 1, most probable SNR < 10, probably not generated by particles
- Cluster Size > 1, SNR around 20 (U/P), 30 (V/N), as expected

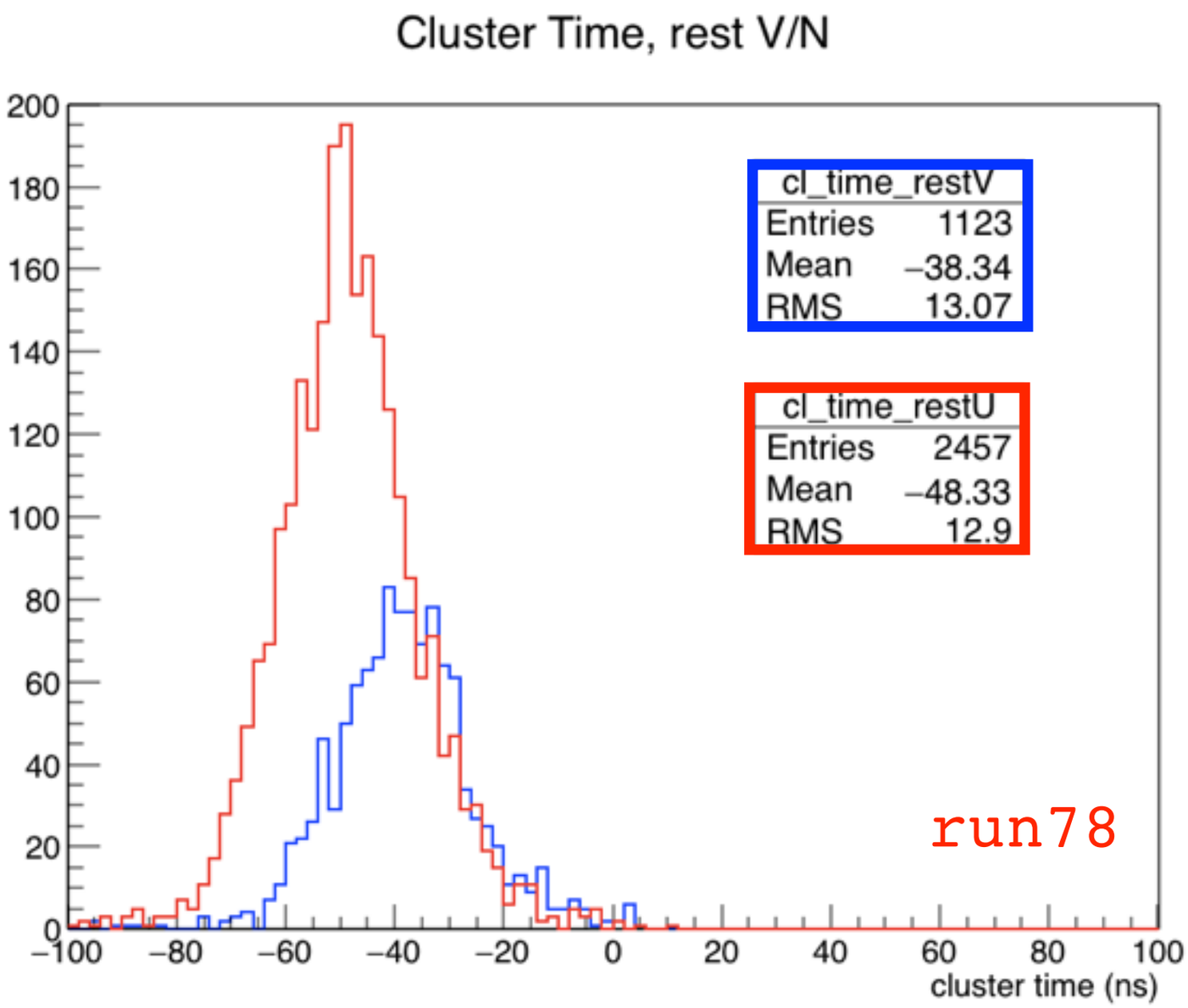
Cluster SNR vs Cluster Size, Noise Strips





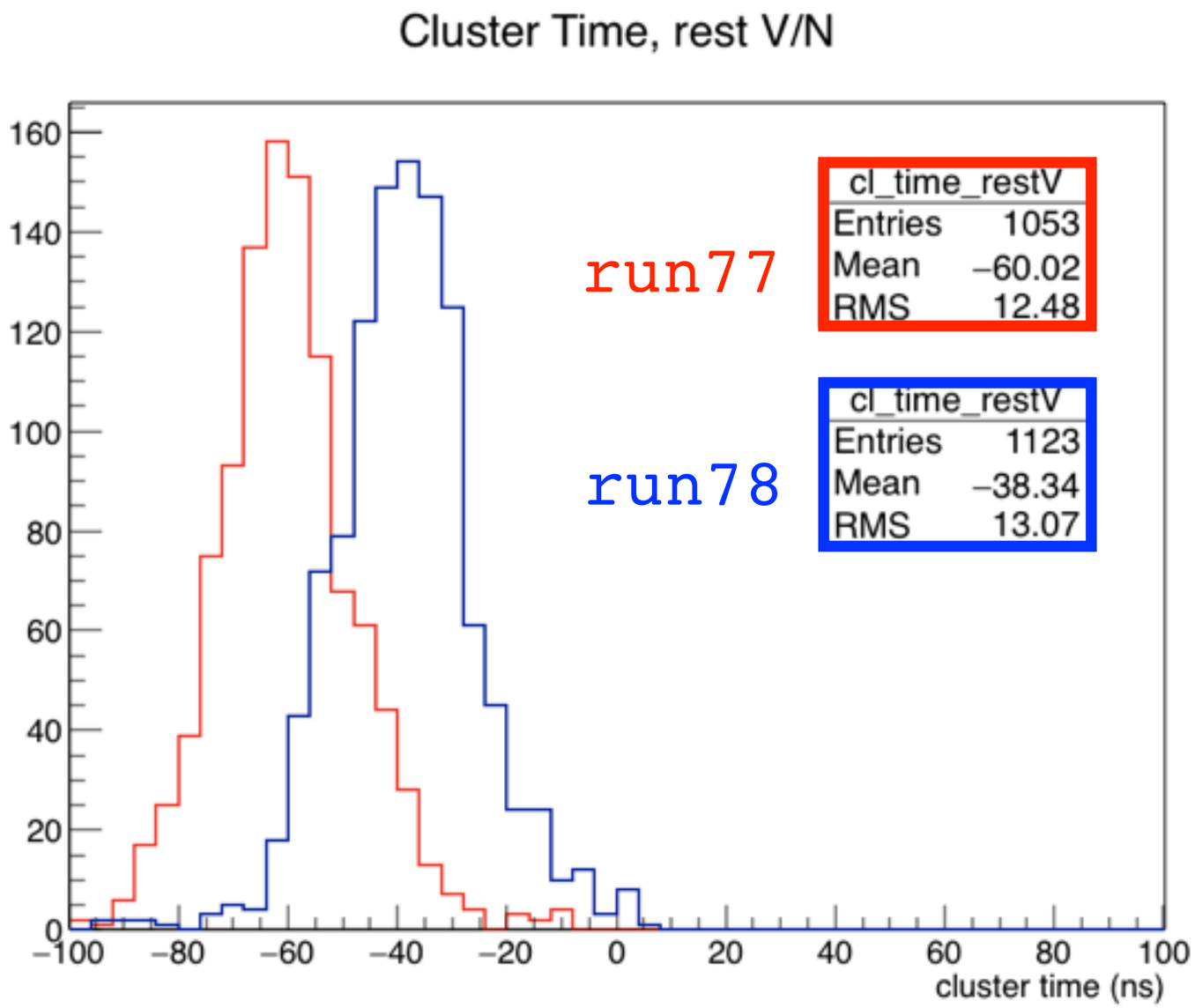
- wait, noisy strip clusters?? Maybe a common mode effect, under investigation.
- Cluster Size = 1, most probable SNR < 10
- Cluster Size > 1, SNR increasing, due to nearby noisy strips. See occupancy plots.
- SNR < 20

Cluster Time, Good Strips



- CoG is not calibrated yet, differences between U and V cluster times *should* disappear
- RMS order of 10 ns, includes contribution of trigger jitter! CoG applies a factor of around 13/18 = 0.7, and RMS is reduced.

Cluster Time, run77 vs run78



- ➡ CoG calibration depends on the latency
- ➡ average of run78 differs from the average run 77 by 22 ns (less than one clock = 31 ns), compatible with the aforementioned factor = 0.7

SVD Efficiency Measurement

- What is the inefficiency introduced by a non optimal latency or a "too high" trigger rate? (we're taking dedicated runs to investigate this possible issue)

- Estimate the relative efficiency of two configurations: count the number of *empty* ROIs in both runs
  - assuming that each ROI contains at least one good strip
  - assuming that the ROI-Finding efficiency is independent of the latency (true)
  - normalize to the number of events in the run
  - take the ratio of *empty* ROIs in the two configurations

- A preliminary estimation indicates that there are no big differences in efficiency between the two latency configurations. The numbers need to be confirmed before being quoted.

- Plan for the next days:
  1. move the SVD ROI Finder in a clean branch (from the master)
  2. debug the algorithm
  3. merge with master, and maybe include it in release-01-02

Conclusions

➡ This is just the beginning, a lot to study and to understand with cosmics:

- characteristics of noise (occupancy, ZS, time structure, …)
- impact of latency configuration and trigger rate on the SVD efficiency, using ROIs
- CoG calibration, using ROIs

➡ Next steps:

- improved CoG calibration (T0 estimation + strips related to tracks)
- Clusterizer calibration (clusters related to tracks)
- SVD Efficiency: we would like to use CKF, but we would need to exclude one layer from the tracking, is it possible?
- note: currently there is a cut on time in the SpacePointCreator that prevents to use SVD clusters for tracking.

➡ We may soon need some help with:

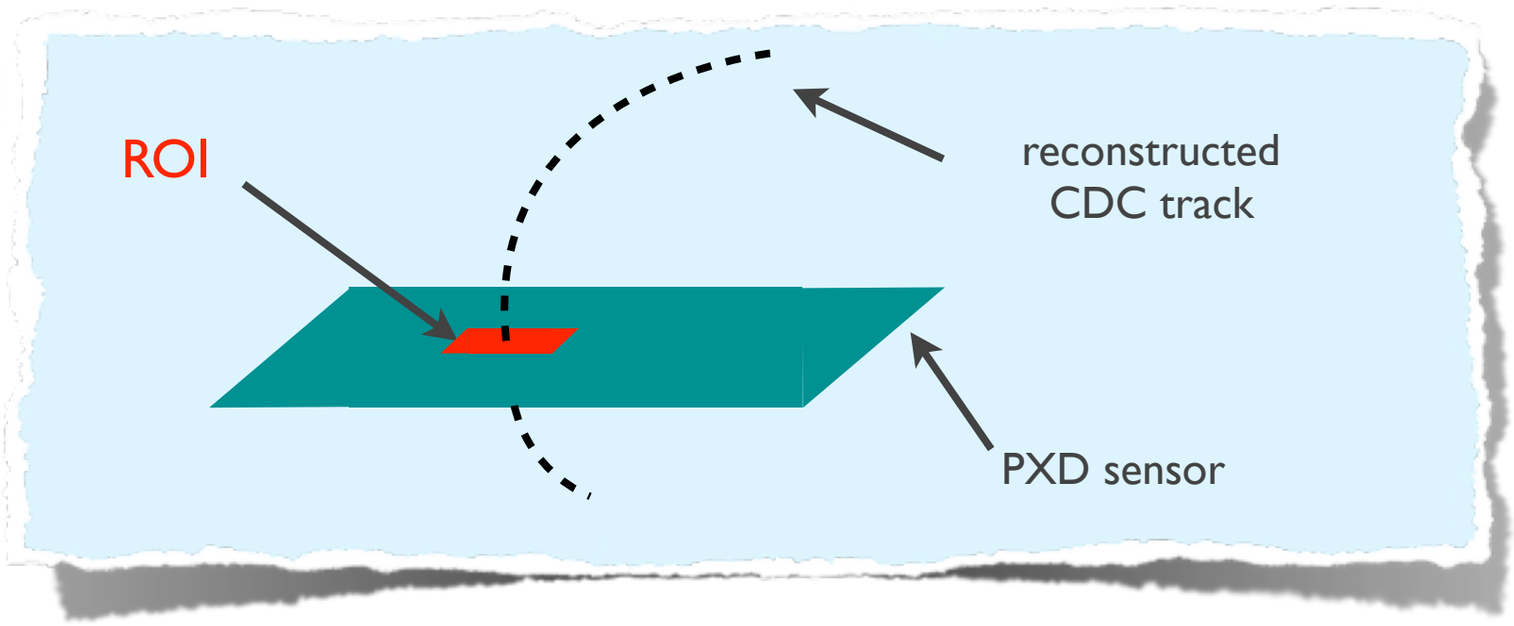
- CDC T0 estimation
- CKF

SVD ROI Finding

➡ In order to select the strips actually crossed by a cosmic, an SVD ROI Finder module has been written

➡ The idea is the same of the PXD ROI Finder module:

1. takes CDC tracks
2. extrapolates towards SVD sensors and find the intercept with the sensor plane
3. defines a rectangular region around the intercept
4. overlaps this region with the sensor, translating the ROI in min and max U/V strips

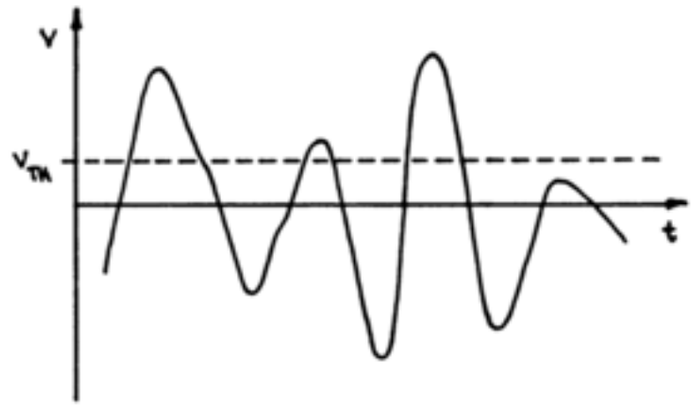


Gaussian Noise (w/o Shaper!)

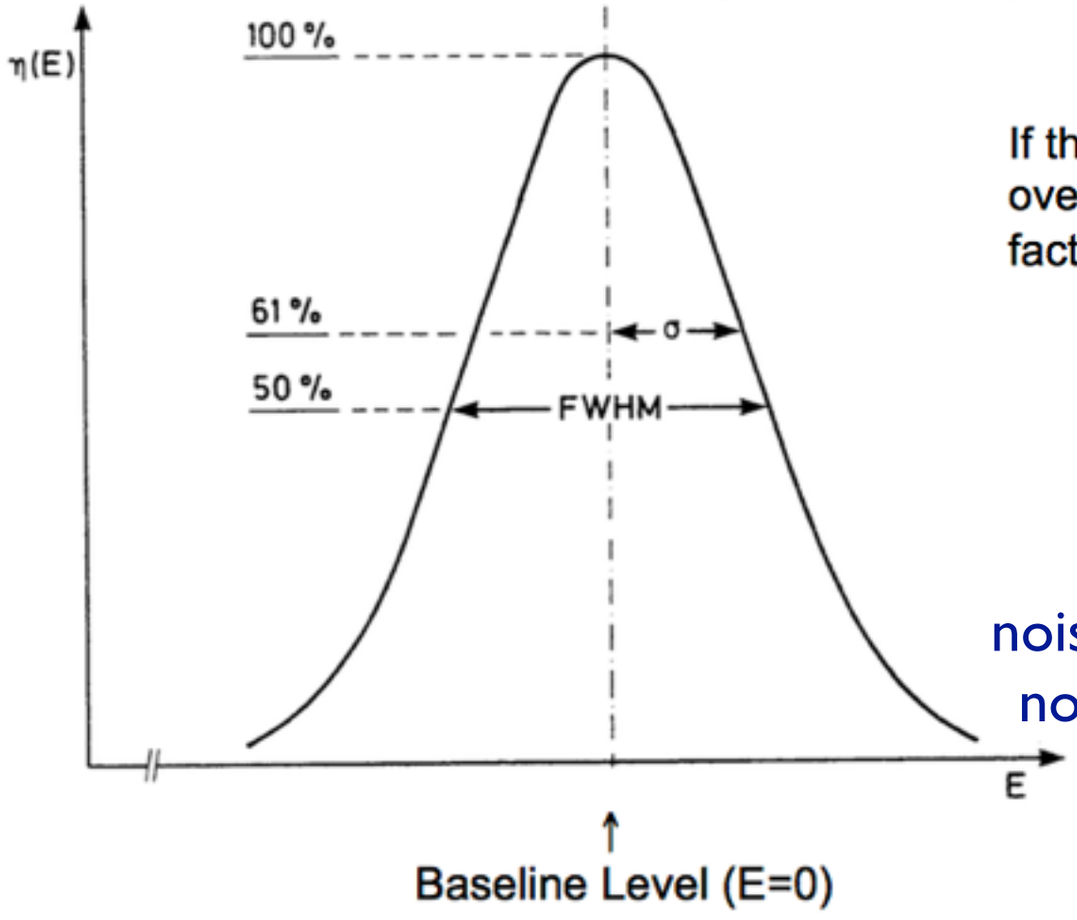
source: Spieler

Consider the system at times when no detector signal is present.

Noise will be superimposed on the baseline.



The amplitude distribution of the noise is gaussian.



If the system were sensitive to pulse magnitude alone, the integral over the gaussian distribution (the error function) would determine the factor by which the noise rate f_{n0} is reduced.

noise rate

$$\frac{f_n}{f_{n0}} = \frac{1}{Q_n\sqrt{2\pi}} \int_{Q_T}^{\infty} e^{-(Q/2Q_n)^2}\, dQ$$

noise rate with no threshold

noise charge (ENC)

threshold charge

http://www-physics.lbl.gov/~spieler/physics_198_notes/PDF/VIII-6-rate.pdf

Gaussian Noise with a Shaper

source: Spieler

- …but: the pulse shaper broadens each noise impulse → the time dependence is equally important!
  - For example, after a noise pulse has crossed the threshold, a subsequent pulse will not be recorded if it occurs before the trailing edge of the first pulse has dropped below threshold.
- The combined probability function for gaussian time and amplitude distributions yields the expression for the noise rate as a function of threshold-to-noise ratio:

$$f_n = f_{n0} \cdot e^{-Q_T^2/2Q_n^2}$$

APV25 (τ = 50 ns, Δt = 6x31.44 ns = 189 ns) with ZS $Q_T/Q_n = 3$

noise rate:

$$f_n = f_{n0} \cdot e^{-Q_T^2/2Q_n^2} = 53 \text{ kHz}$$

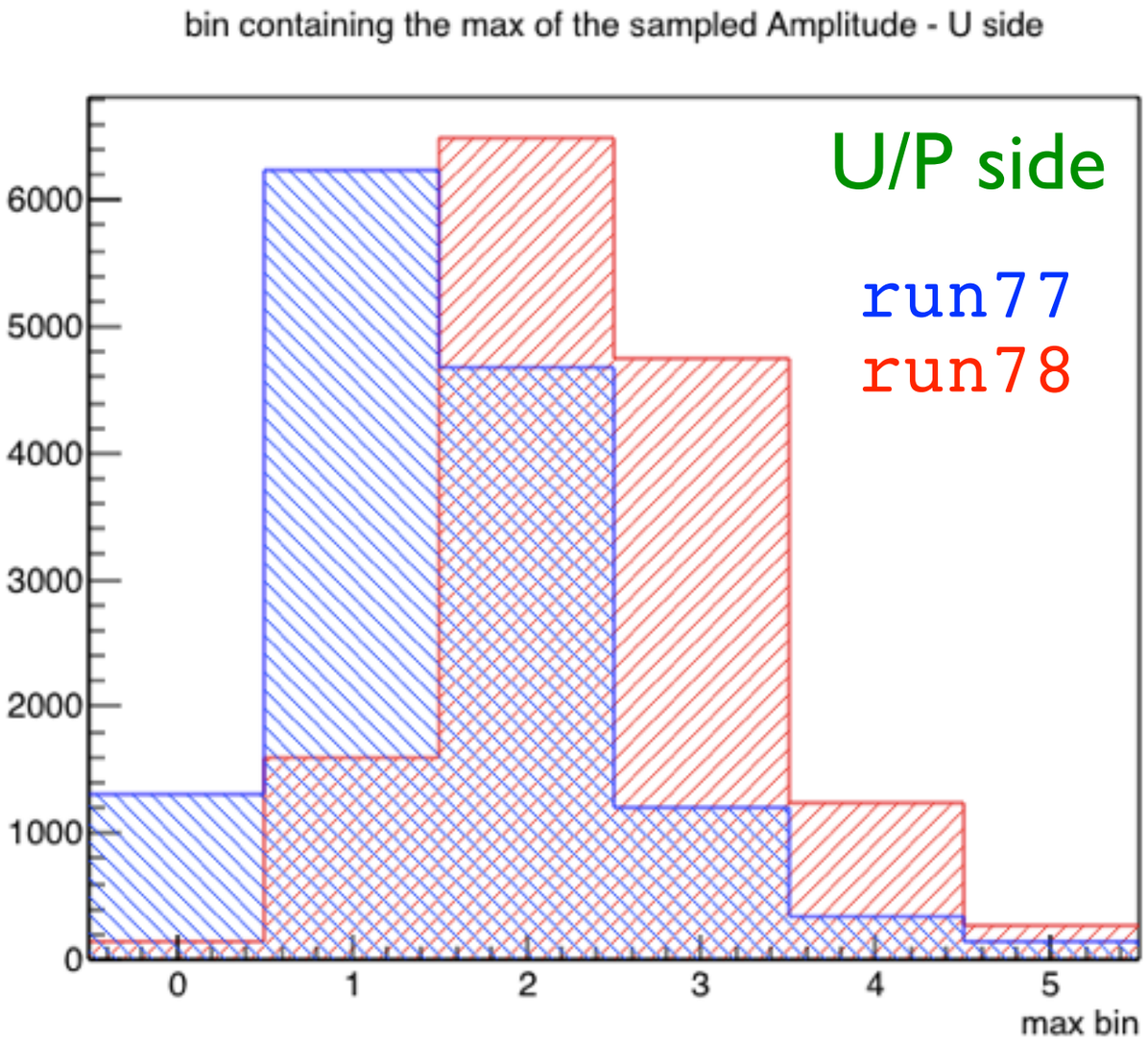
occupancy:

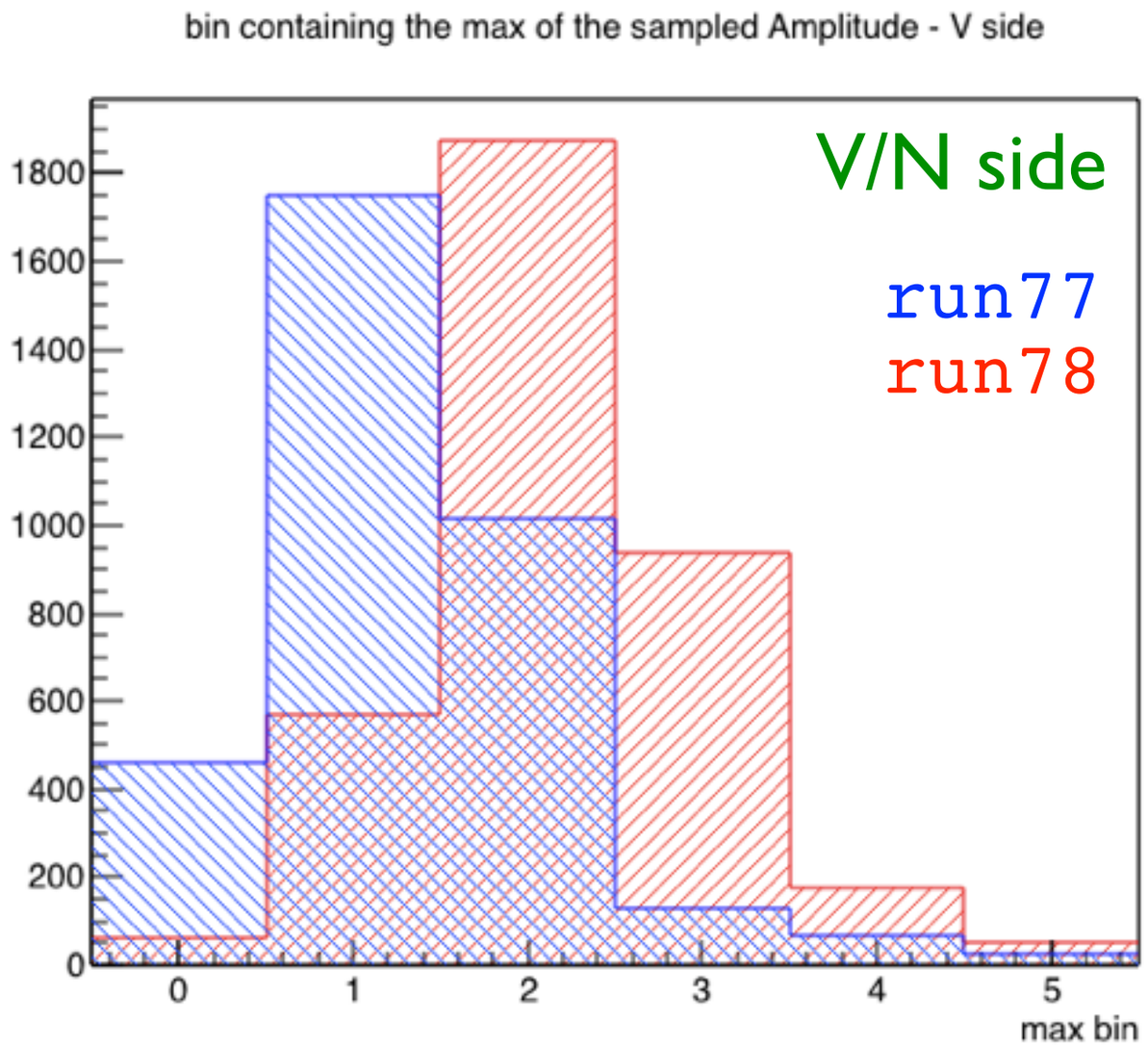
$$P_n = \Delta t \cdot f_n = 1\%$$

in agreement with what observed!

http://www-physics.lbl.gov/~spieler/physics_198_notes/PDF/VIII-6-rate.pdf

Latency Study for the Good Strips

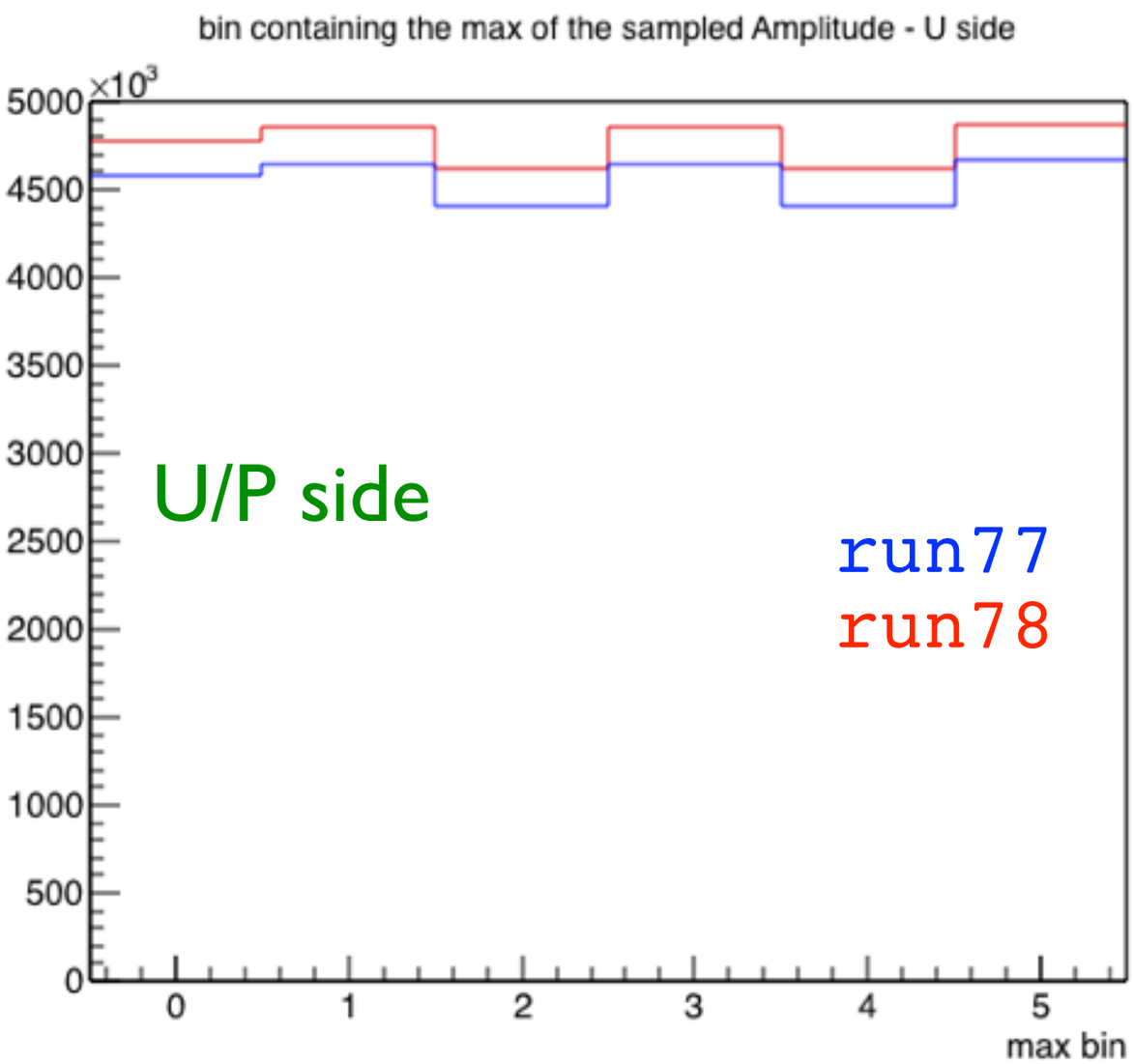


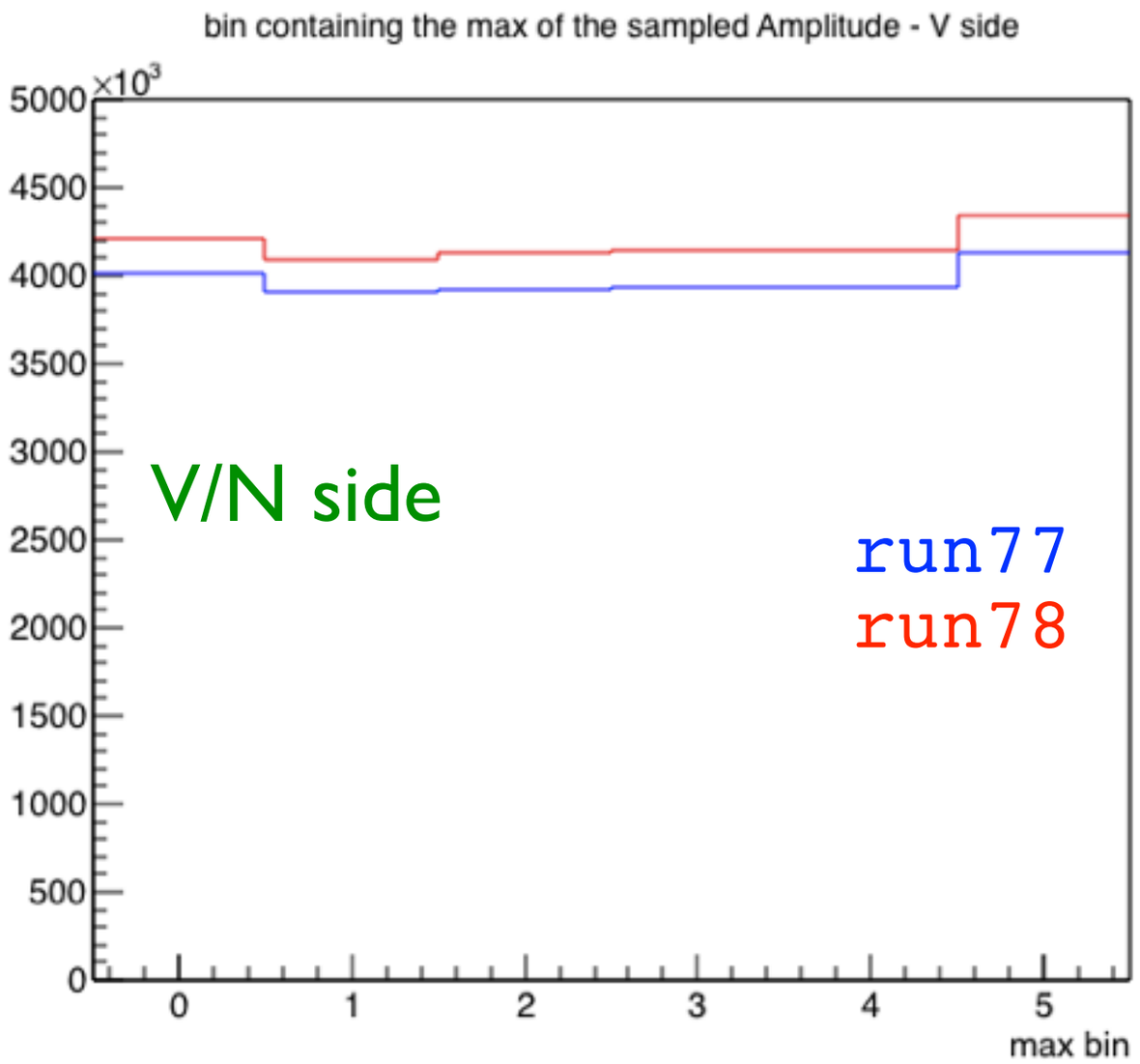


- A latency of 159 (run78) is the optimal one
- The width of the histograms is compatible with the T0 jitter of 18 ns

runs	latency
77	158
78	159

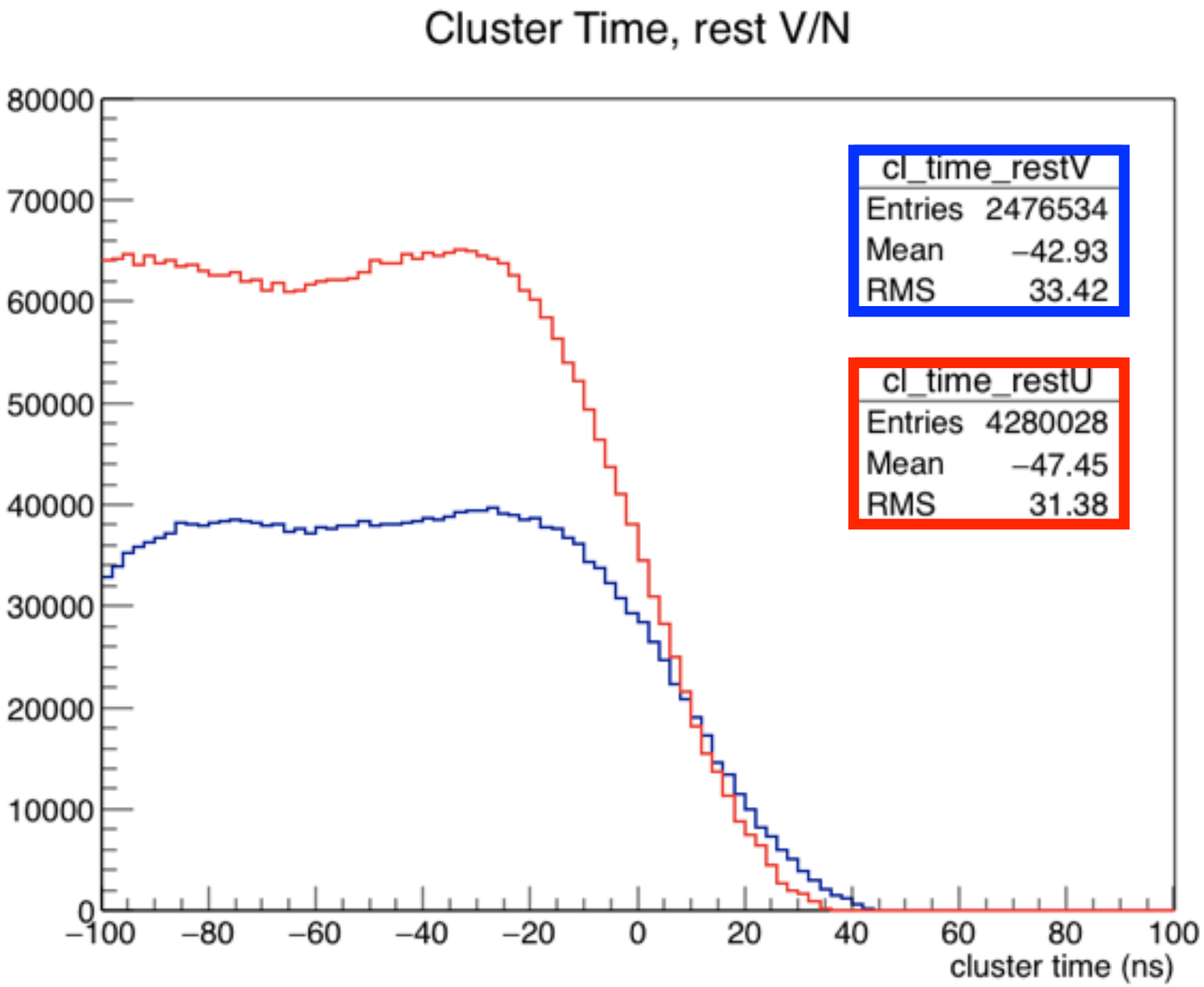
Latency Study for the Noise Strips





- Noisy strips show a flat distribution, as expected
- Similar structure for run77 and 78 → indication of the source of noise?

Cluster Time, Noisy Strips



- ➡ flat distribution: is expected hot strips are not synchronised with the trigger
- ➡ right tail is due to the CoG bias

Occupancy VS Zero Suppression

- Before setting a ZS, we need to go though all the sensors/sides, eliminate the hot strips from the occupancy evaluation, and then take a decision: