

HALL D TB: Time Resolution τ_{RES} , Estimation

Understanding BEAM Data Channel by Channel

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Beam Sample – Motivation

Time Resolution

This is one of the critical performance parameters for the detector determination of the time for events reconstruction/recognition – design, – event reconstruction, and –final physics results.

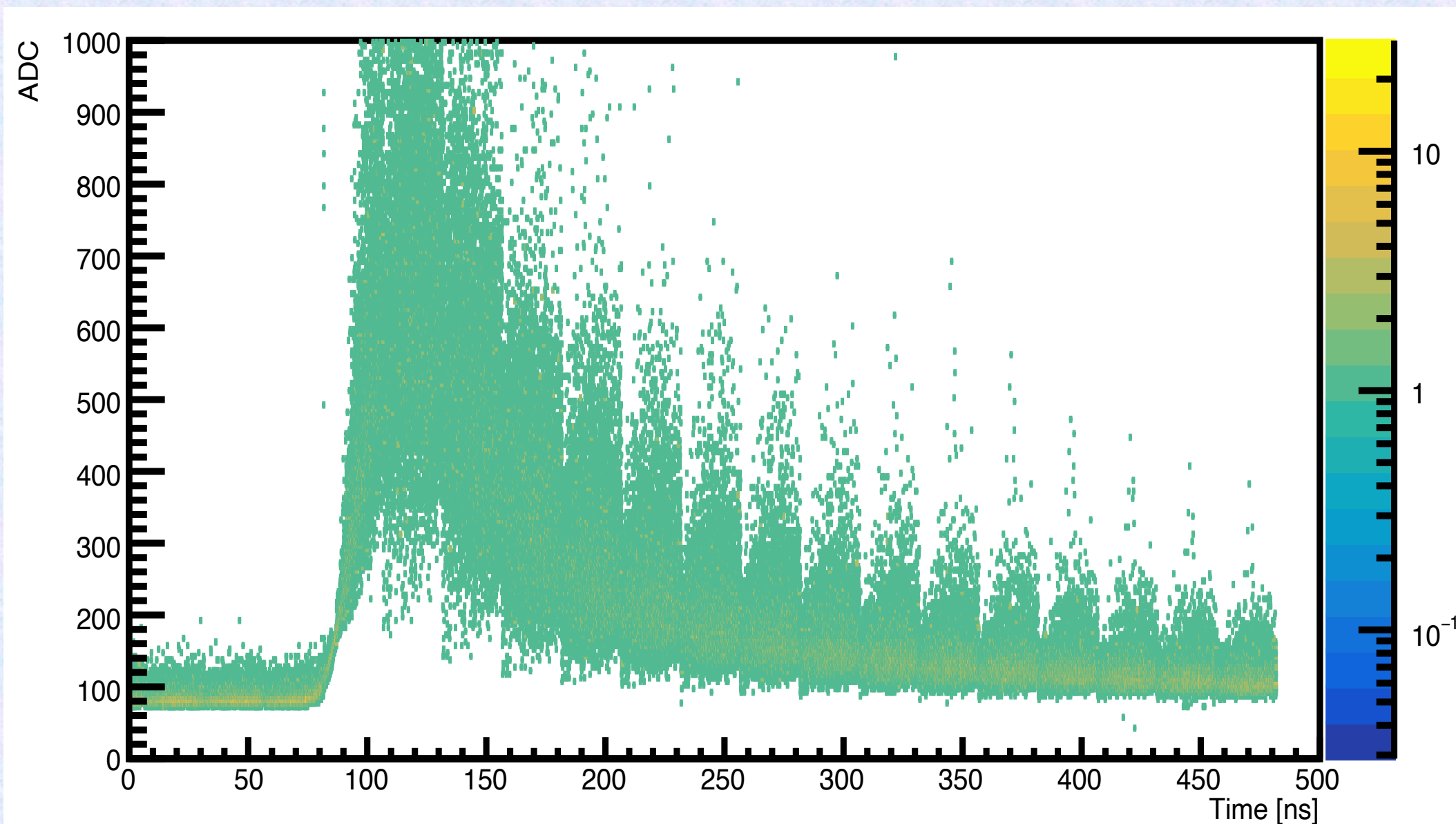
BHCal/BIC

- Background/noise suppression
- TOF particle identification
- Energy and position reconstruction
- Trigger Performance – precise timing

Goal:

- Improves PID in the Calorimeter, reducing hadronic contamination and electronic noise.

From cosmic studies



The event signals technically arrive in batches/packets every 25 ns .

A single-phase waveform with events saved as [asics][channel][sample], where we have 2 possible asics, 72 possible channels and 20 possible samples recorded.

Pedestal (0–80 ns):

Stable electronics baseline (~ 100 ADC)

Fast Rise (80–110 ns):

Sharp increase due to cosmic arrival

Pulse Peak (~ 100 – 140 ns):

High ADC (up to ~ 1000)

Driven by cosmic strength+ detector gain

Exponential Decay:

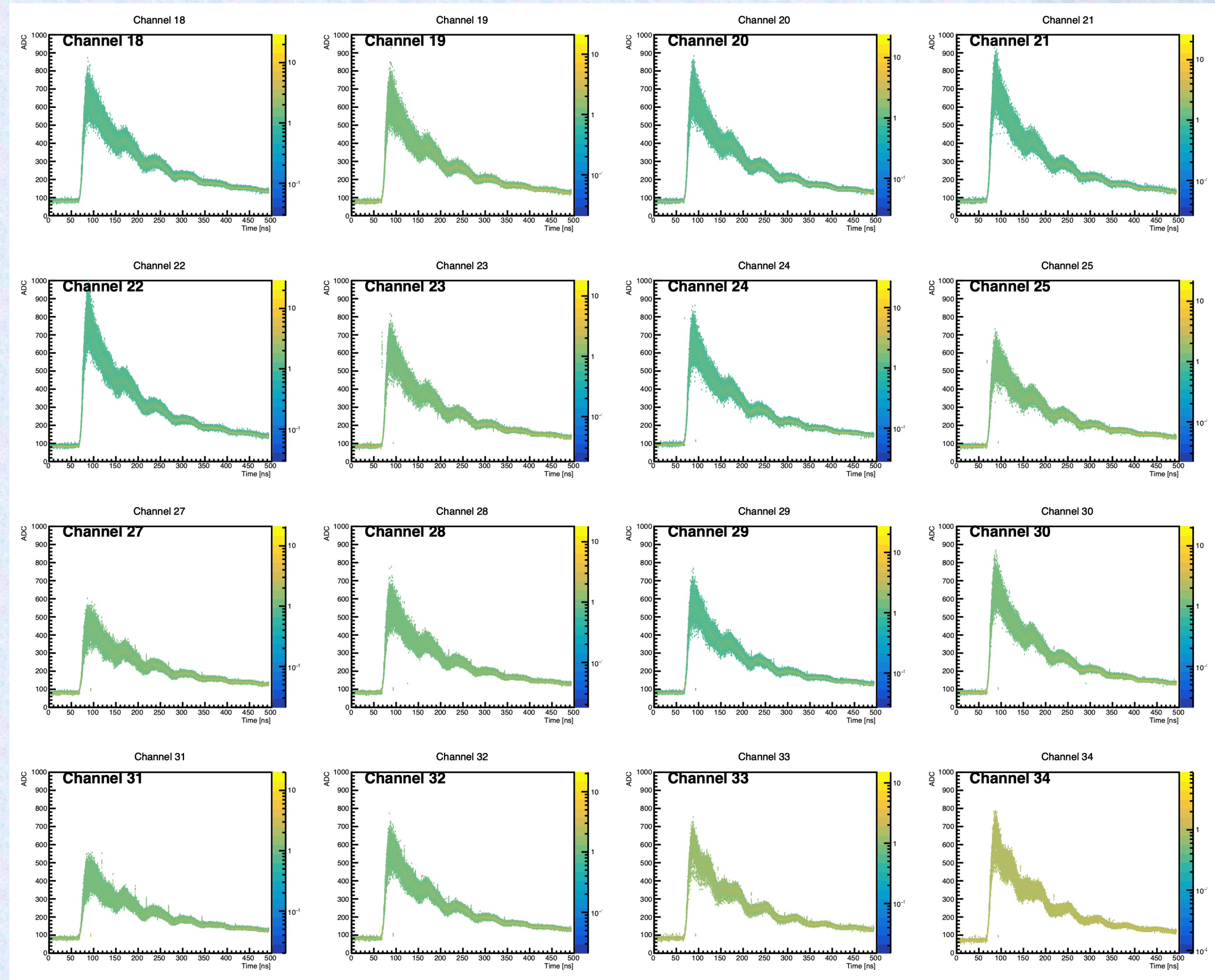
Signal decreases as electronics shaping dissipates charge

From LED Sample – Channel by Channel

Why Channel by Channel?

A look at each channel helps reveal:

- Hidden problems with the hardware in order to understand and correct the timing shift, gain variation, baseline shift, and noise differences.
- Outliers related to bad channel
- Calibration issues



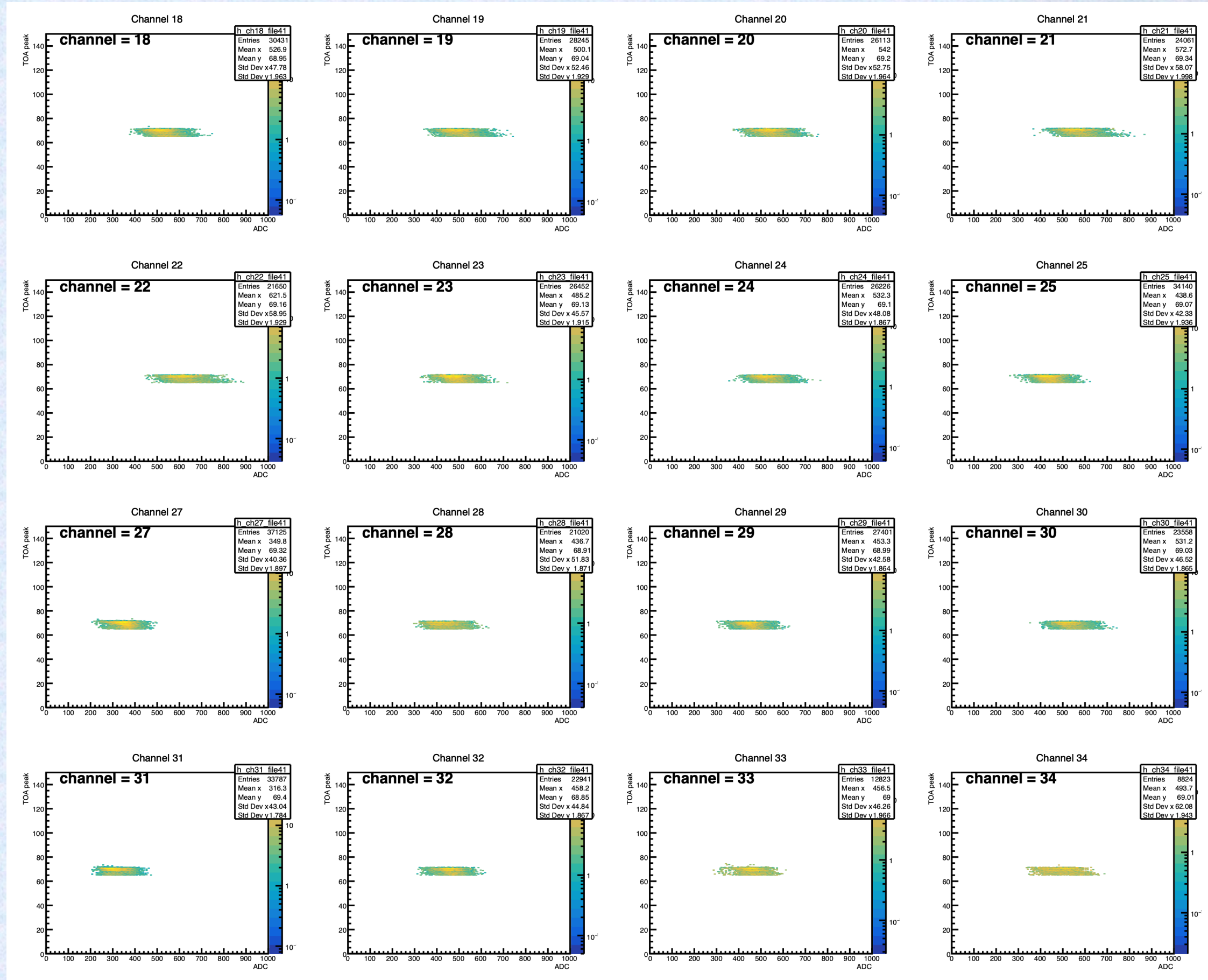
NB: 1-7, 9-16, 35-43, and 45-52 and not connected while 8, 17, 26, 35, 44, 53, 62, and 71 are skipped bc CEAN compactibility

LED Sample – ADC_vs_TOA 2D Diagnostic Plots

Each point represents *One event*
ADC value at the *Time of arrival*.

It shows how signal amplitude and timing are correlated, allowing to evaluate timing resolution, detect time-walk effects, validate pulse fits, and diagnose detector or electronics/hardware problems.

The *pulse timing stability*

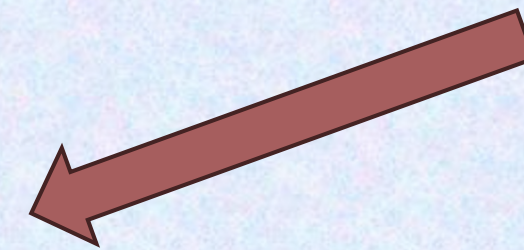


NB: 1-7, 9-16, 35-43, and 45-52 and not connected while 8, 17, 26, 35, 44, 53, 62, and 71 are skipped

LED Sample – Channel by Channel τ_{RES}

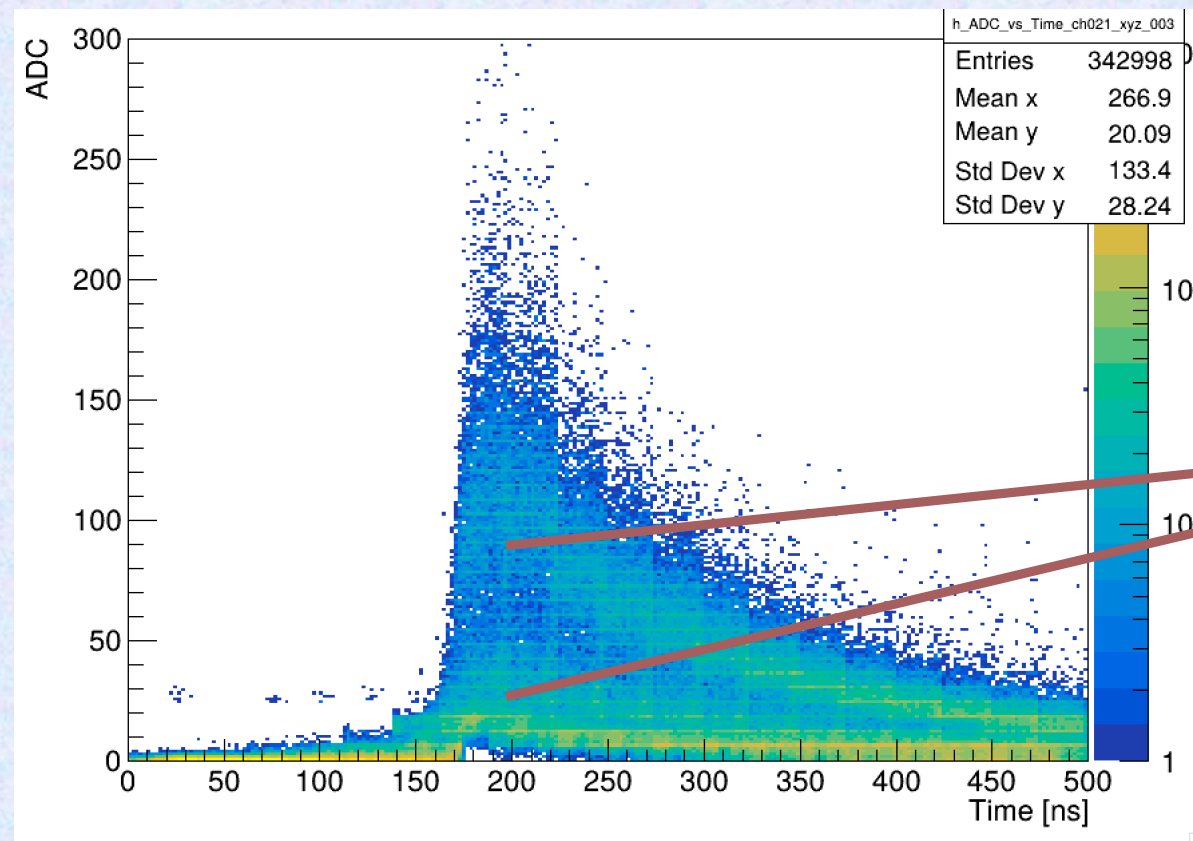
Zooming into the
channel 21

Skipped 2 Steps
1. Slice the bins
2. Gaussian fit

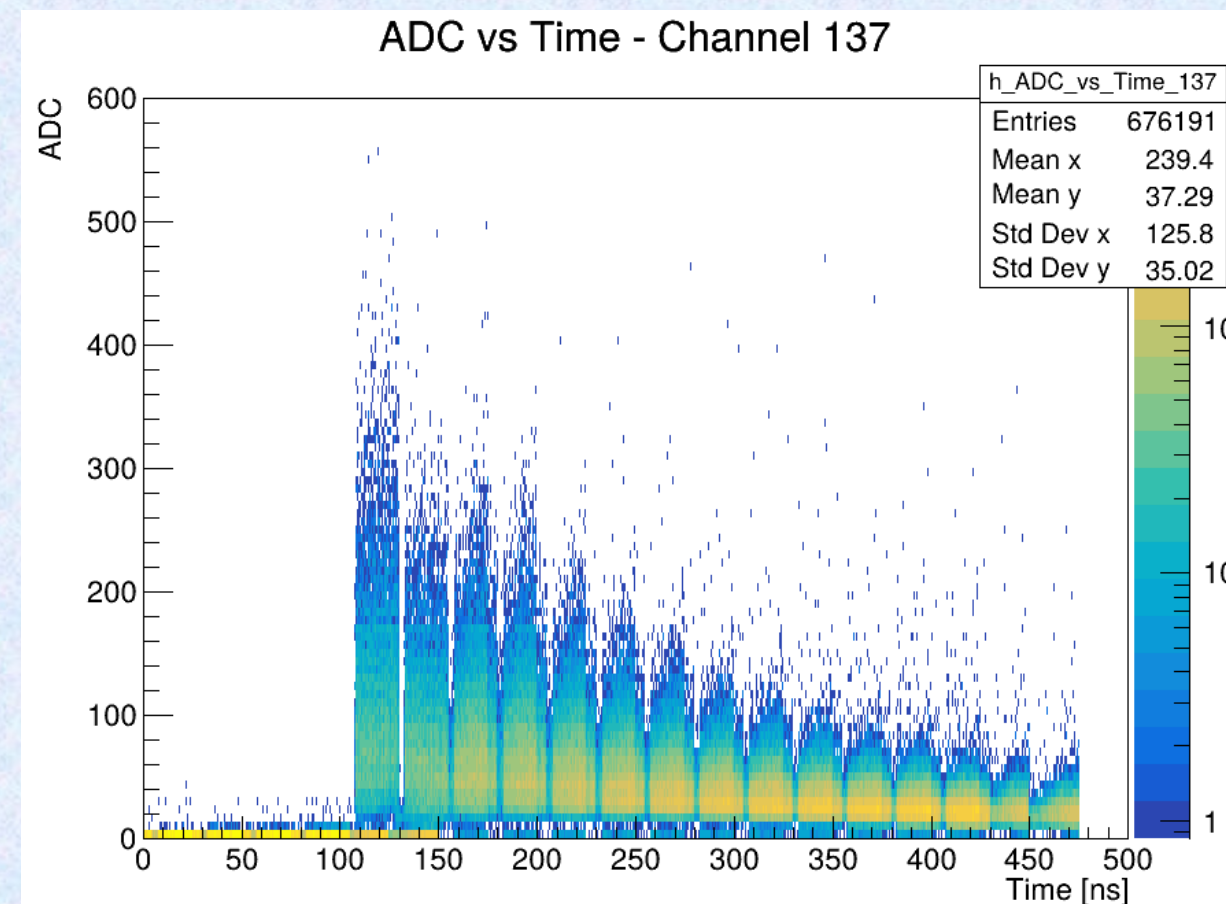
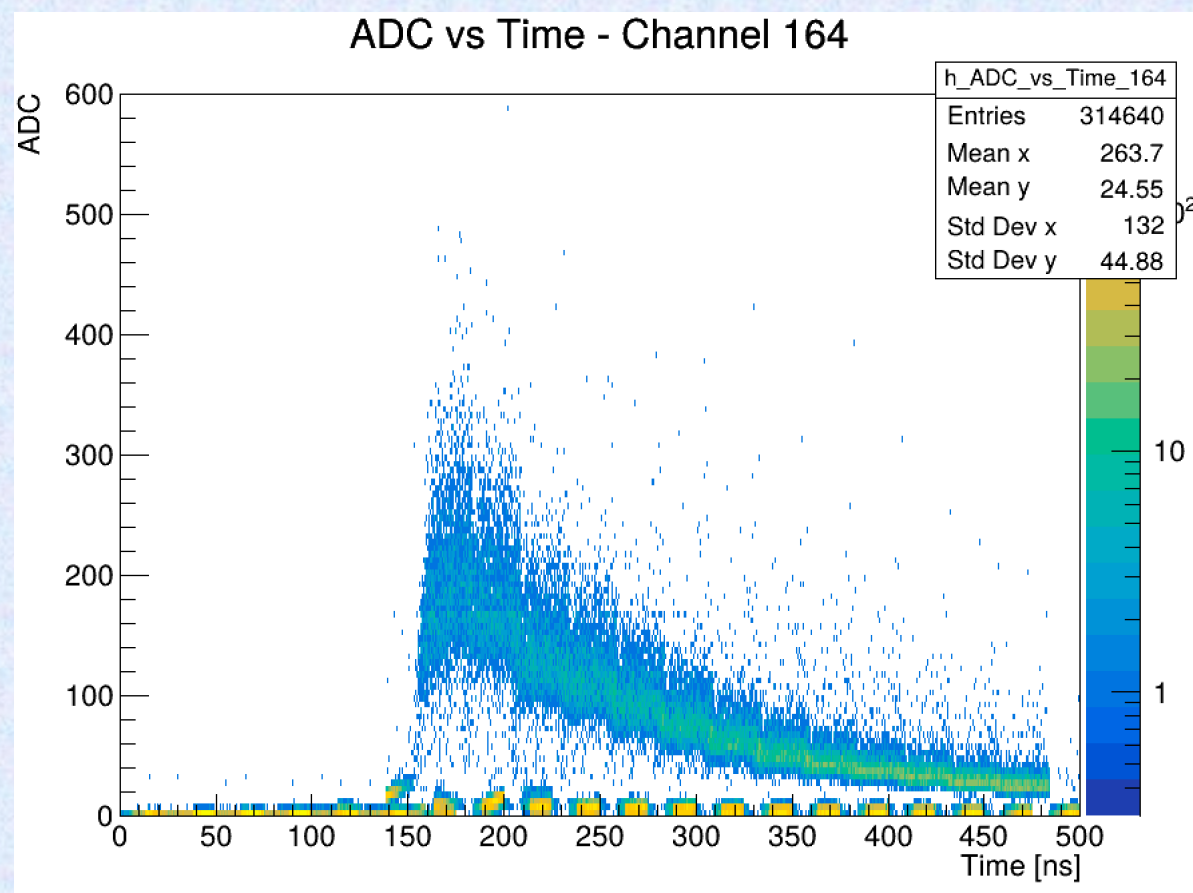
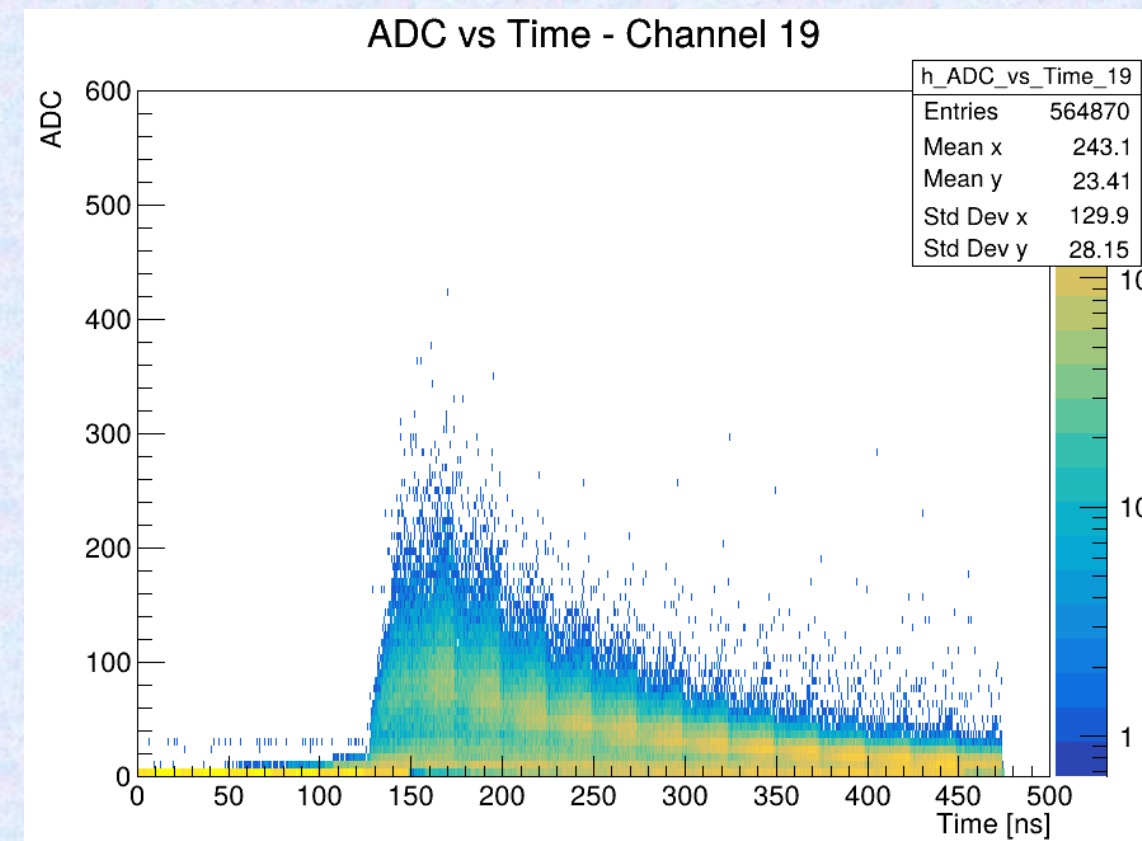


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Hall D TB Sample – Update



Double Peaks?



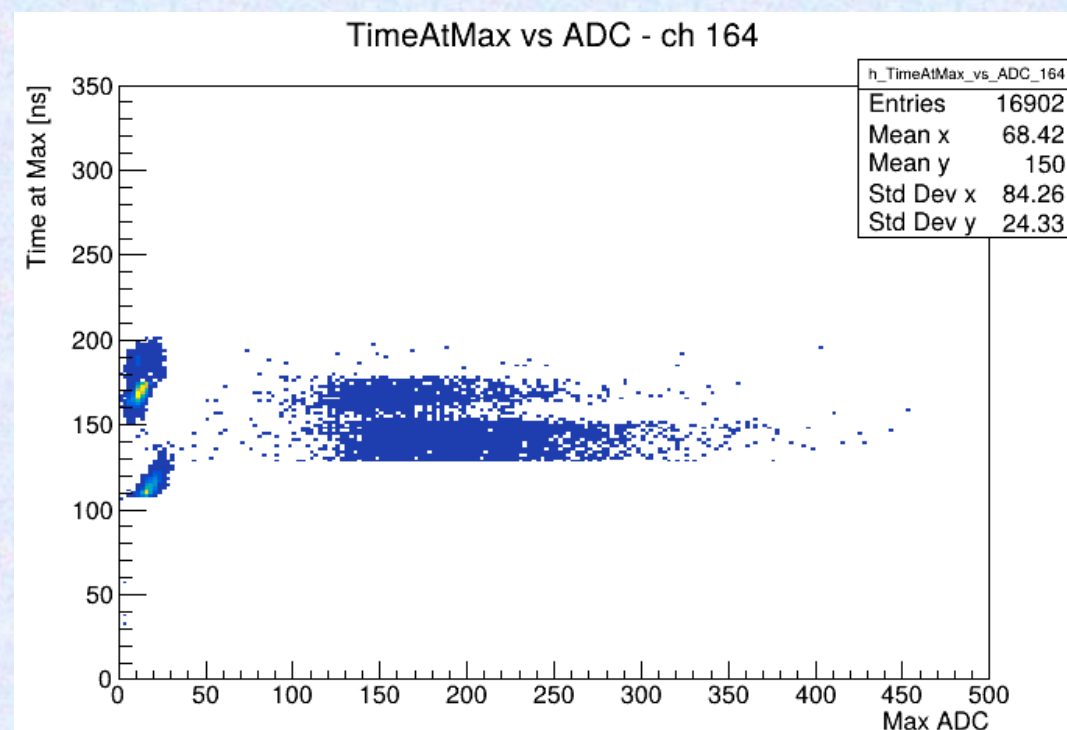
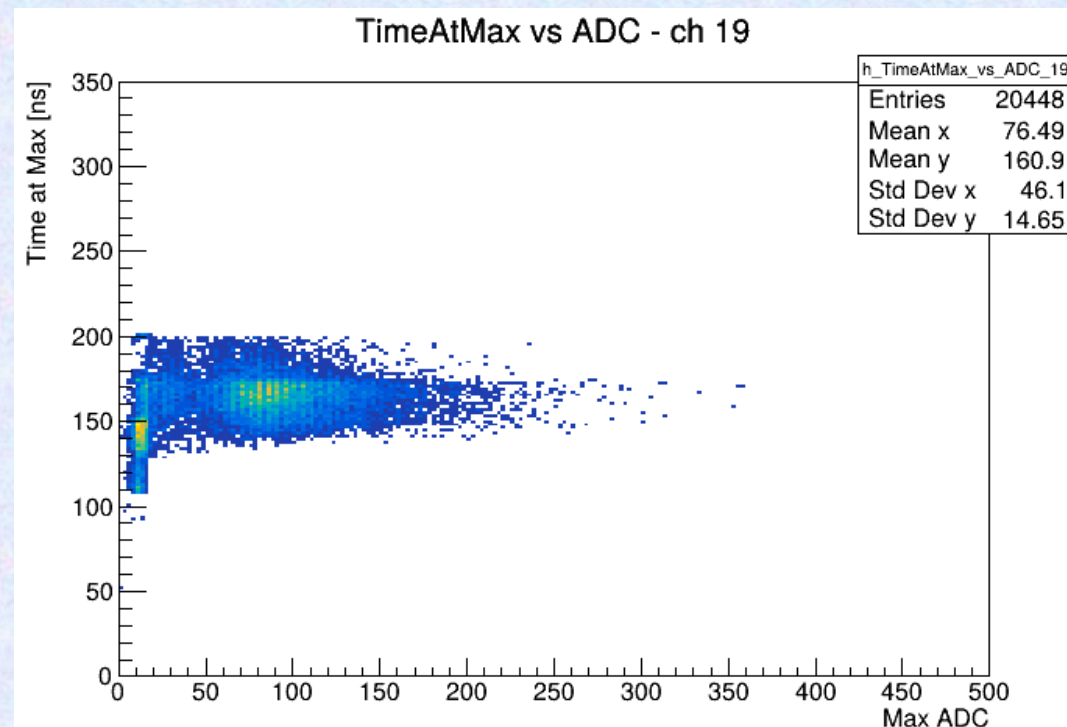
Odd!
Why and where?

ADC vs Time plots showed strong 25 ns striping. Pulse appeared as a series of separated vertical bands rather than a continuous waveform. Effect persisted across many channels.

`'/work/eic/EPIC/TestBeam/BIC/data/KCU0/beam/beam_ROC_0-00001197-0002.evt'`

Hall D TB Sample – Update

We can trust this if
ADC vs Time plots
are correct.



Next:

1. Understand where the error comes from
2. Check SFILL ADC_TOA correlations
3. Slice and fit
4. Extract the time resolution
5. Proceed to the position resolution.

'/work/eic/EPIC/TestBeam/BIC/data/KCU0/beam/beam_ROC_0-00001197-0002.evt'