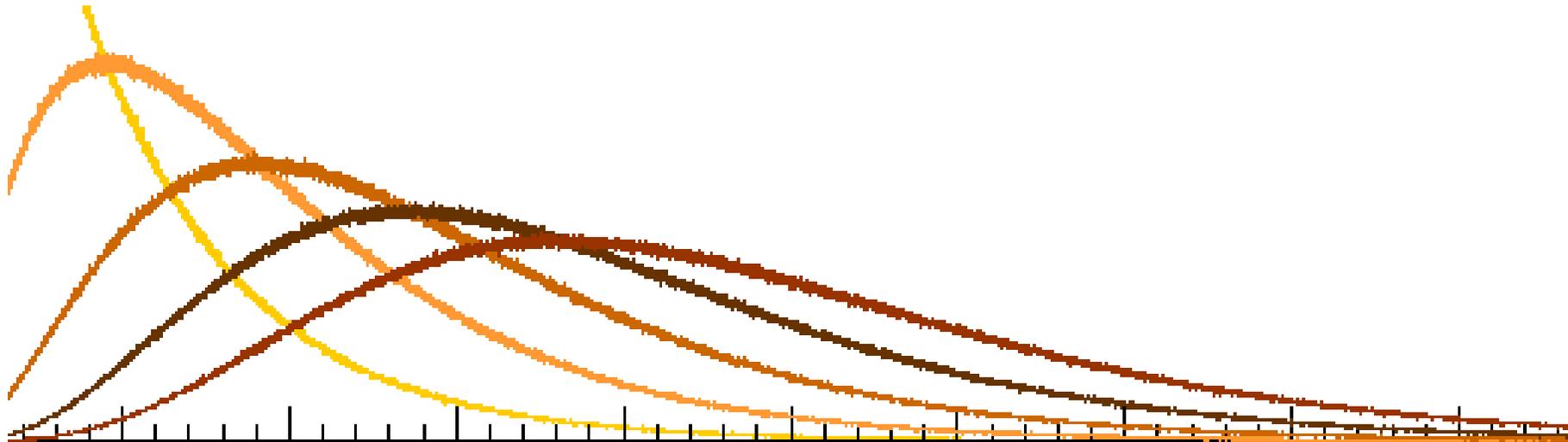
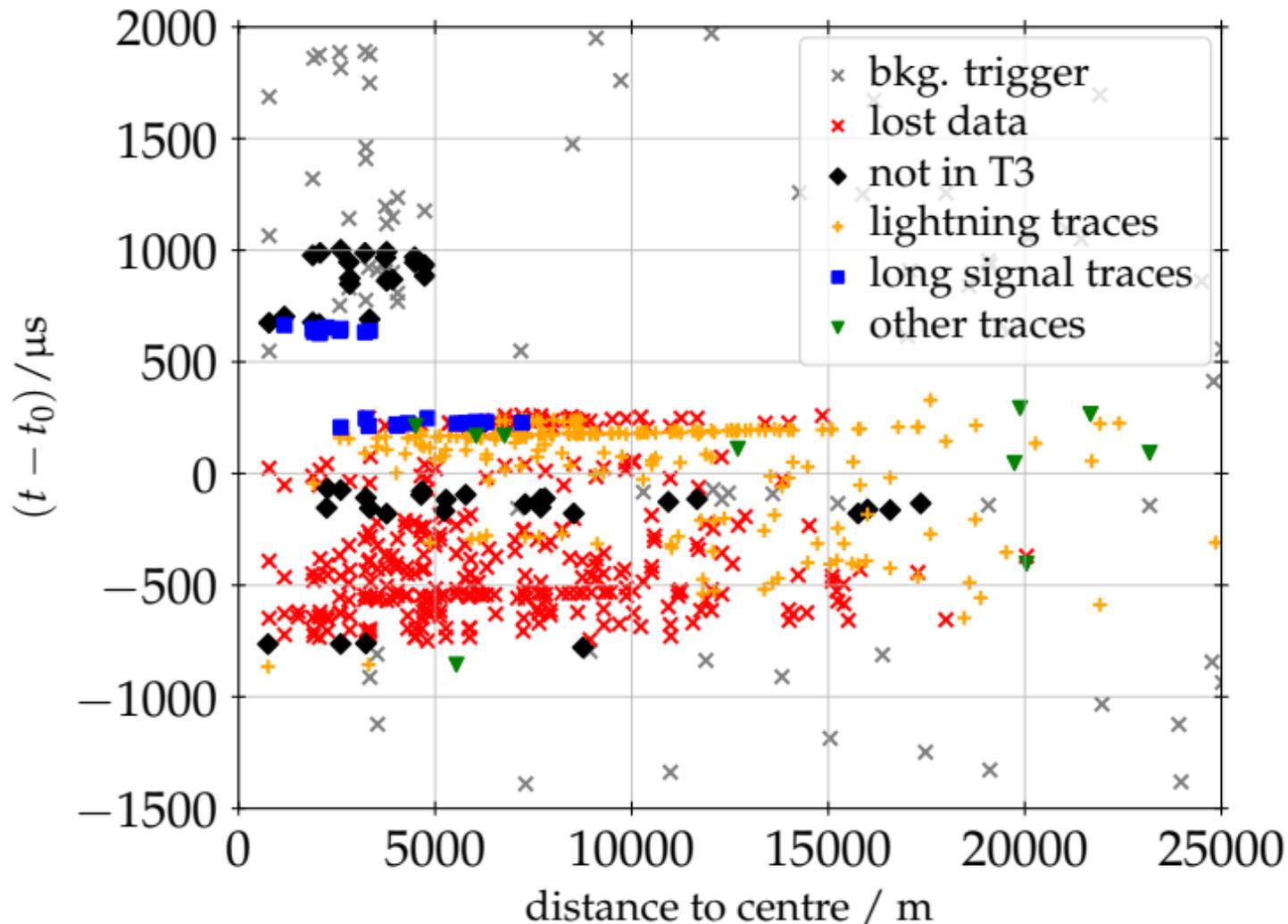


SD-Triggers: Dead-Times and other features

Martin Schimassek, Xavier Bertou, Darko Veberič



Where did this come up again?



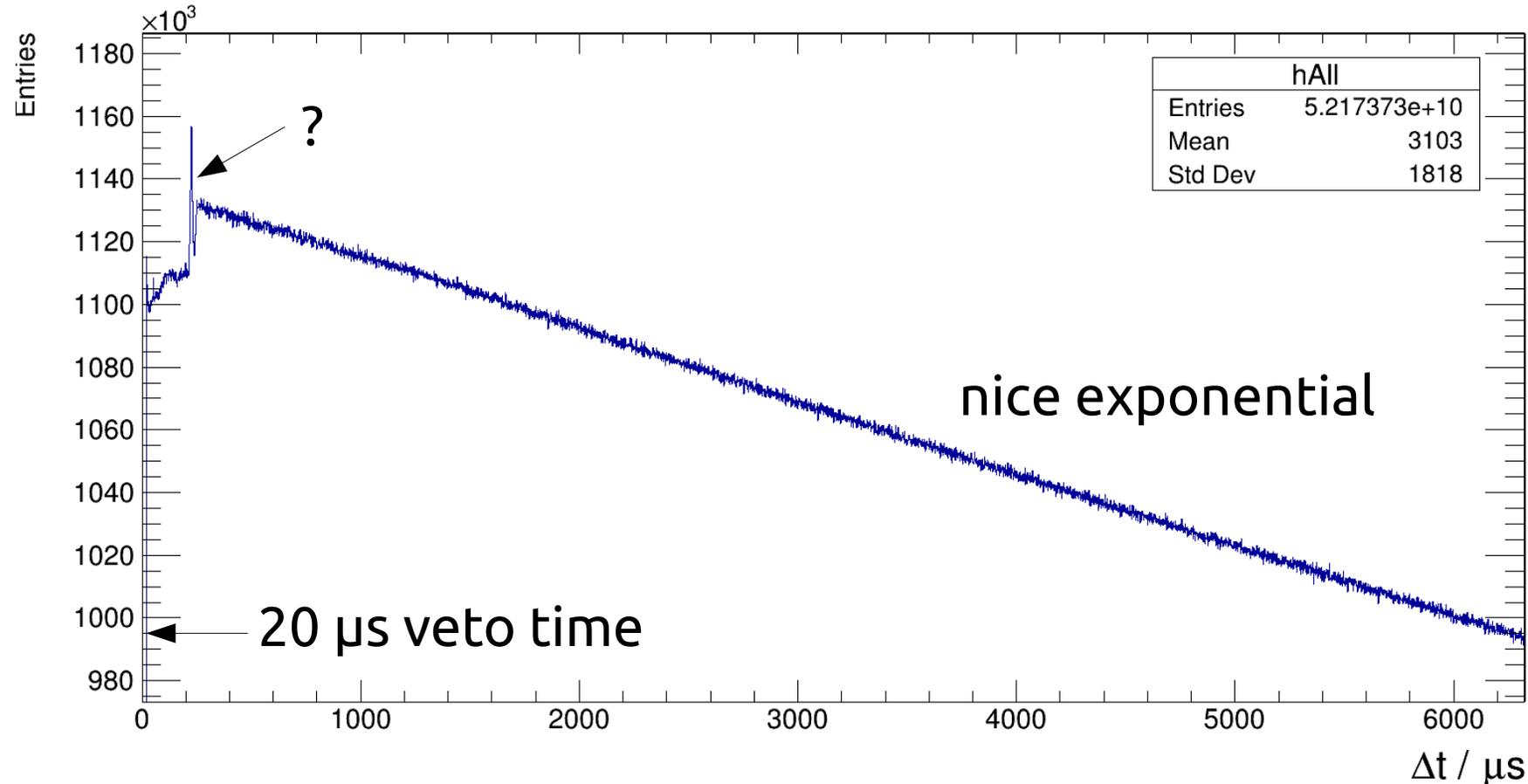
- searching for an explanation of why Sd-'rings' are rings

- need to understand why we trigger and why not

→ available data: T2Dumps, sd-data

→ use time differences of triggers to understand when triggering is possible

The situation previously



- time differences between two triggers of a station summed over all stations

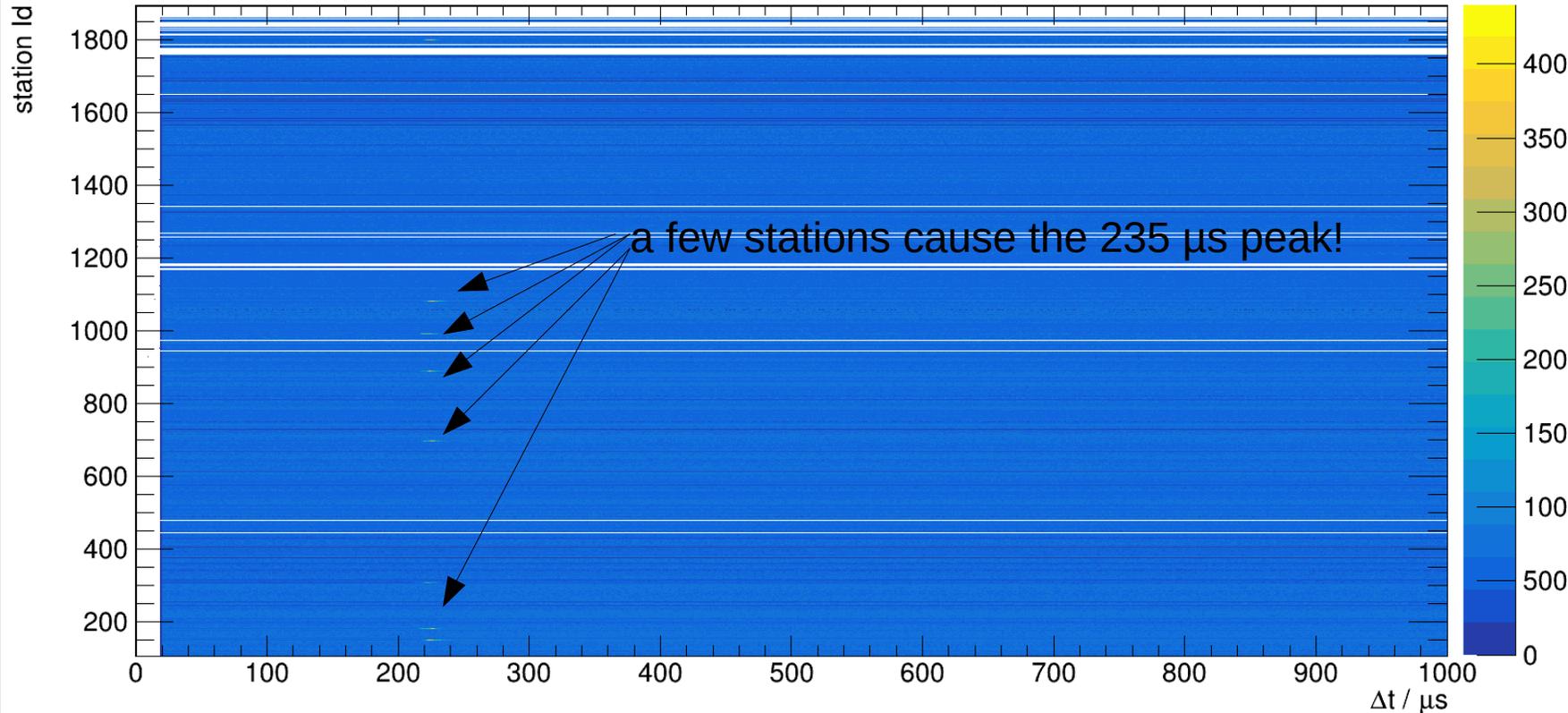
- mostly very well explained by the expected exponential

- veto period of 20 μs

- not-understood features at small time differences

[was shown before in LTP meetings in 2018]

Trying to explain the features



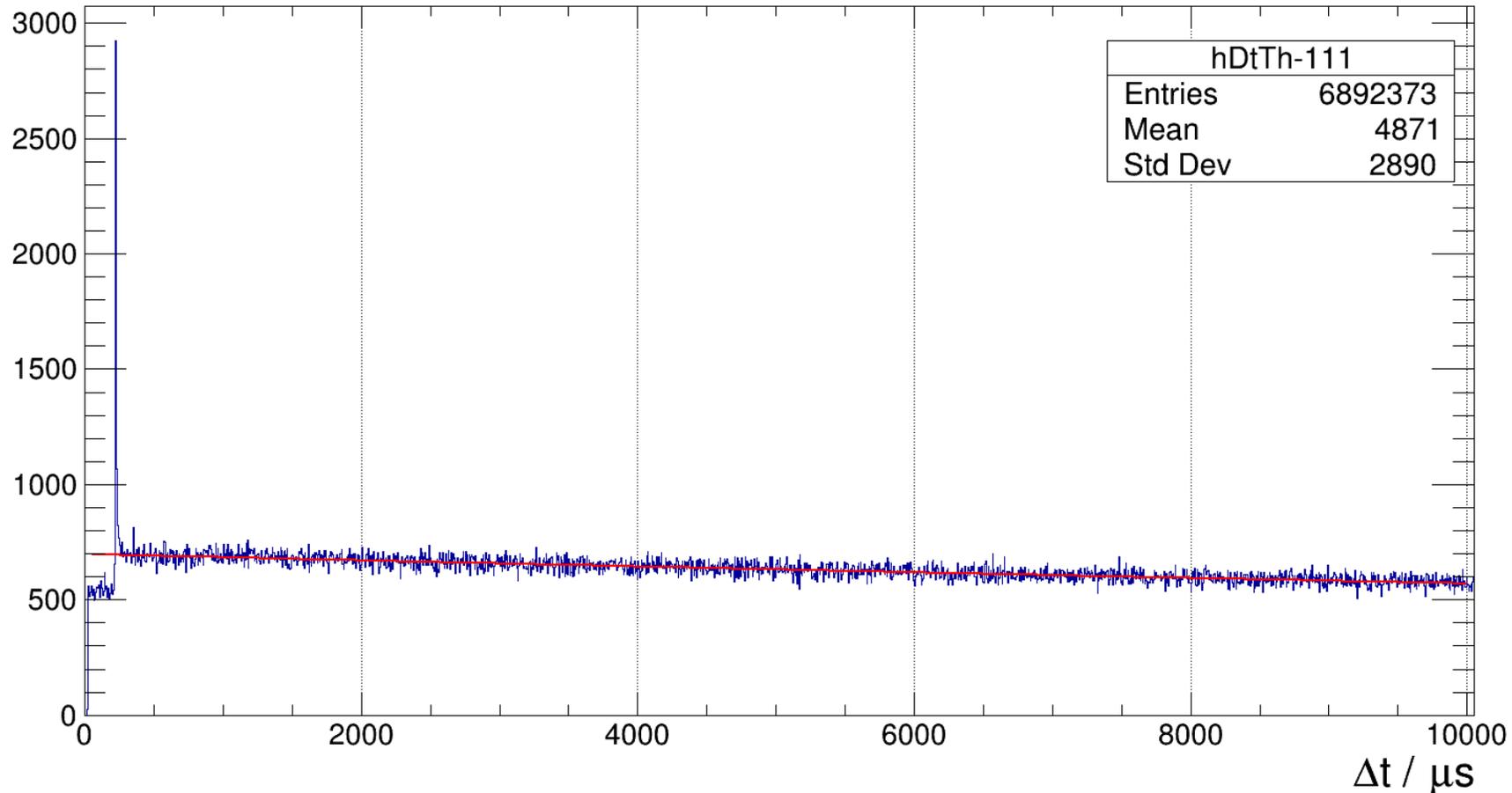
- peak originates from a handful of stations [also shown previously]

- origin of those peaks is unknown

- detection of those stations was changed here to a KS-test

[was shown before in LTP meetings in 2018]

New rejection algorithm



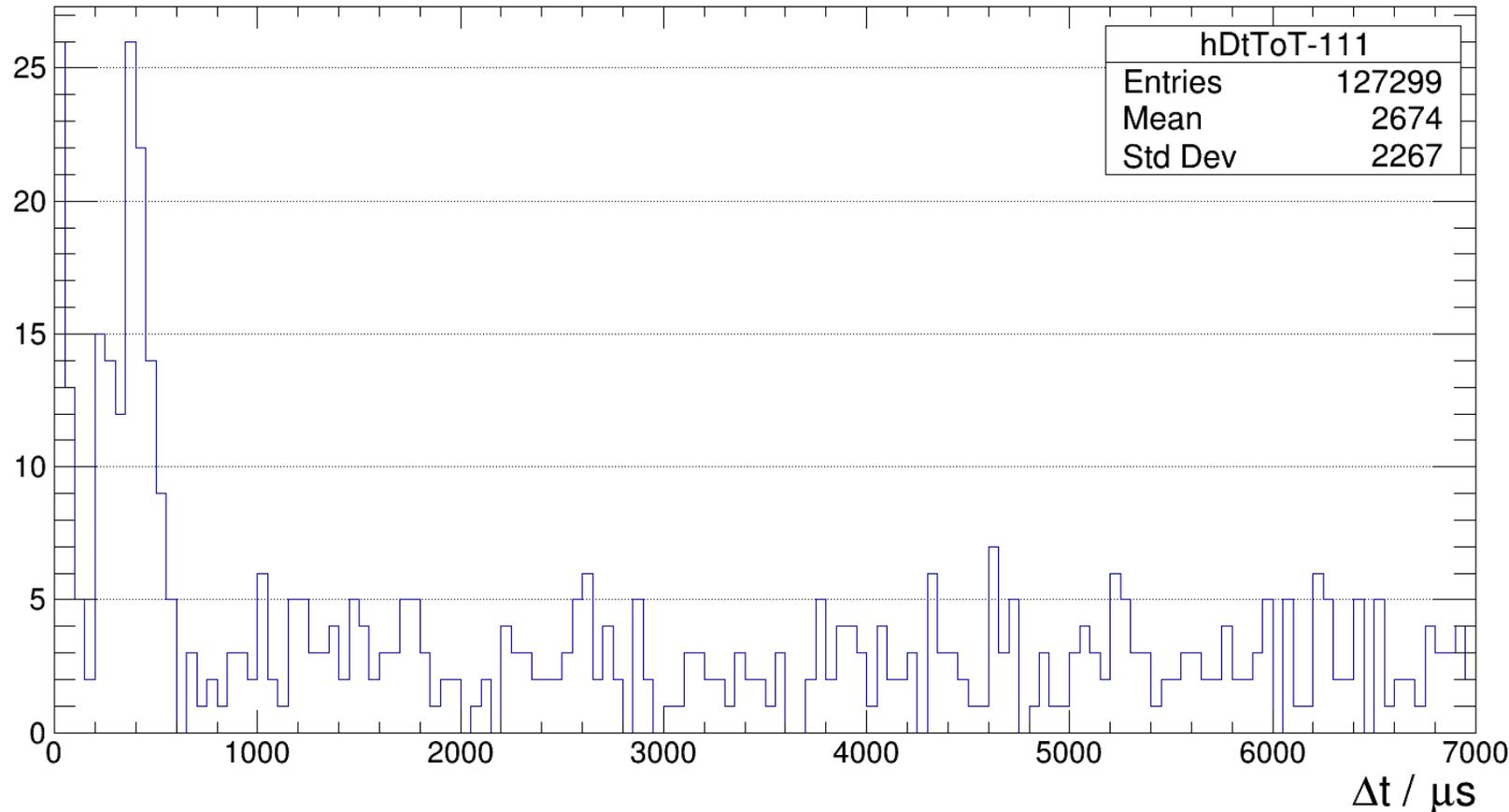
Here: station 111, with Th-T2 only.
Data: 01-05 June 2016

- remove outliers by comparing with a expected function

- expect:
- exponential decay [fit shown in plot]
- 20 μs veto
- $\sim 250 \mu\text{s}$ plateau of fewer triggers

- use this model and a KS-test to remove bad stations

New rejection algorithm: Side Note

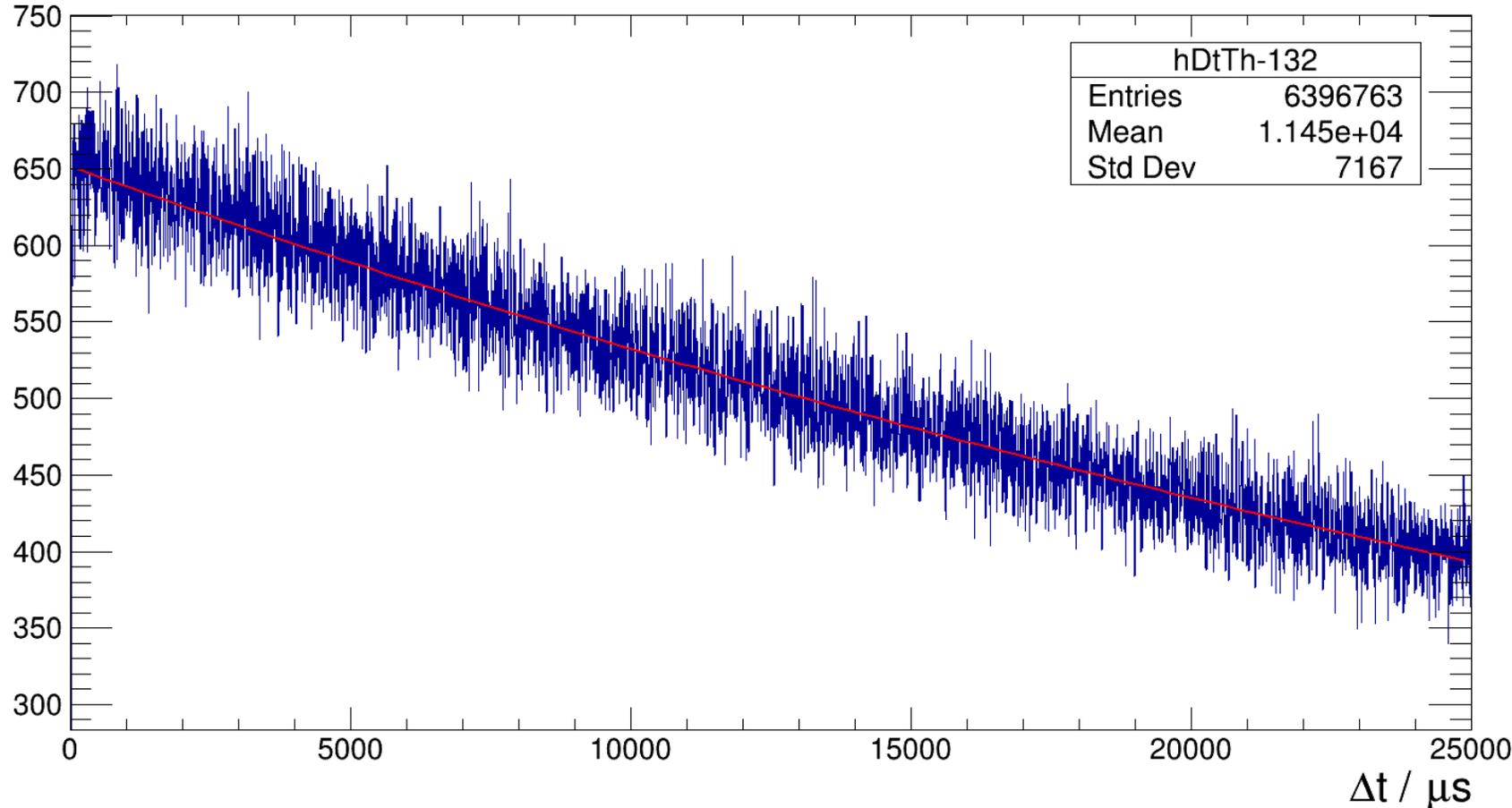


Here: station 111, with ToT-T2 only.
Data: 01-05 June 2016

- also the ToT part is odd for this station

- rejection algorithm works the same for the ToT only and is applied to both

New rejection algorithm: issues



Here: station 132, with Th-T2 only.
Data: June 2016, rejected as 'invalid Th-spectrum'

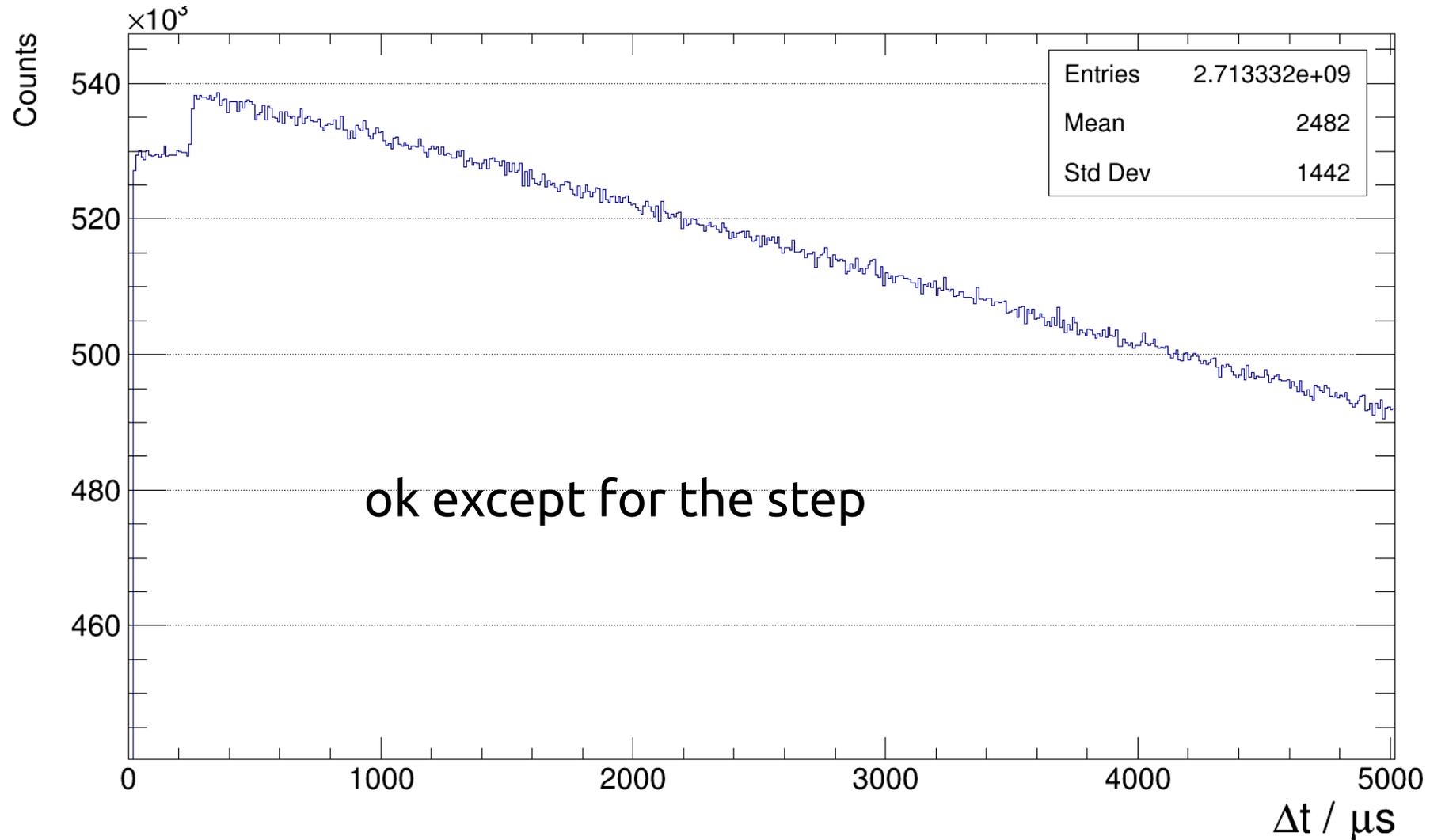
- high-false positive rate [e.g. plot]
- fits of exponential sometimes fail for unknown reason
- Caveat on that:
 - no detailed tuning performed
 - goal was to remove the bad ones for sure, so the cut is not conservative!

New rejection algorithm: conclusions

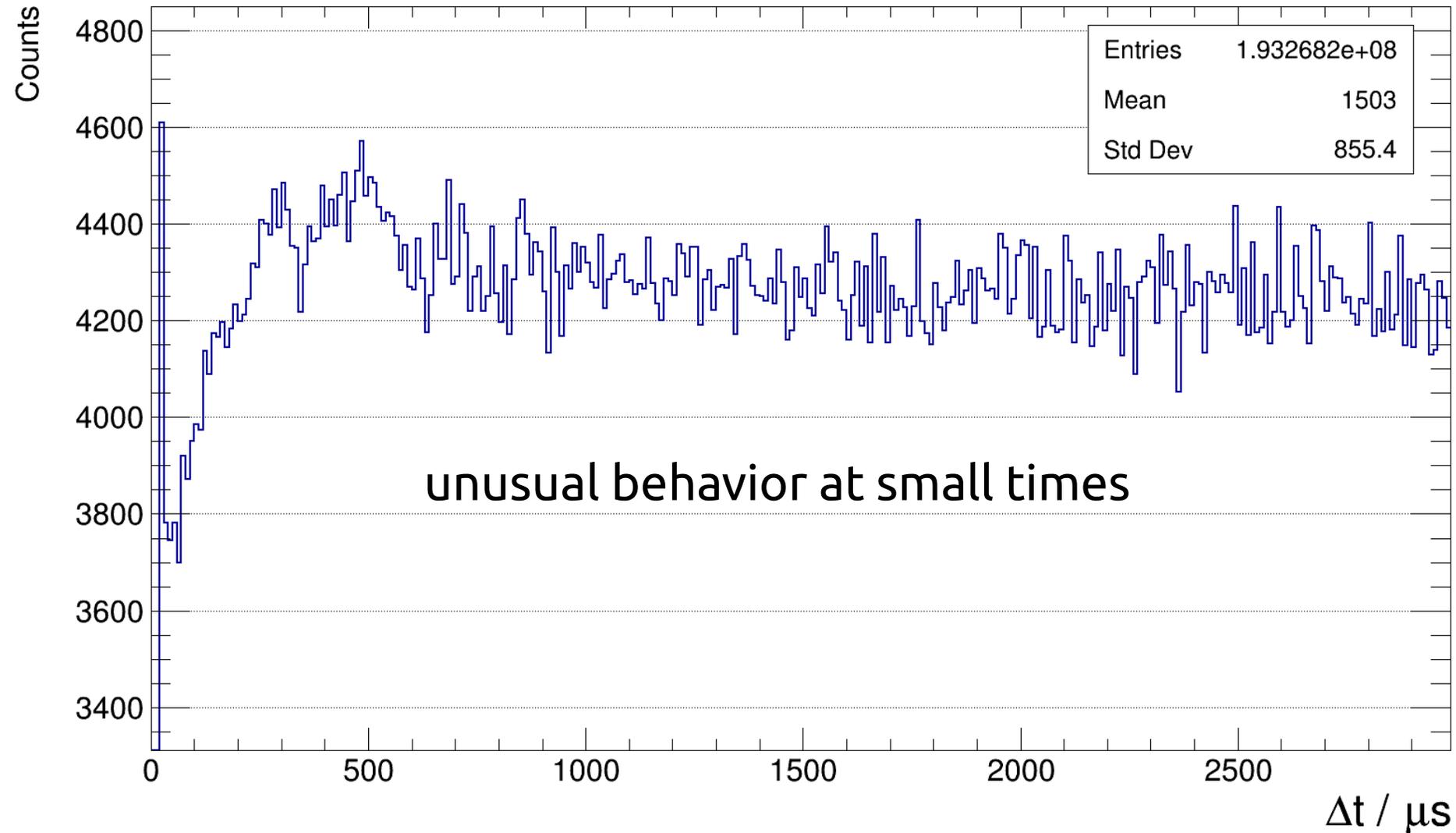


- better:
 - no detailed focus on a certain peak → more general in finding anomalies
- problems:
 - high-false positive rate
 - fits of exponential sometimes fail for unknown reason
 - some arbitrary choices on details of model function (250 μ s dip)
 - needs rejection of lightning periods!
- Caveats:
 - no detailed tuning performed
 - goal was to remove the bad ones for sure, so the cut is not conservative!
- for now no updates planned: we stumbled on this during other work only (if we find issues with the data from stations affected by this, we will reconsider)

Cleaned Spectra: Threshold T2s



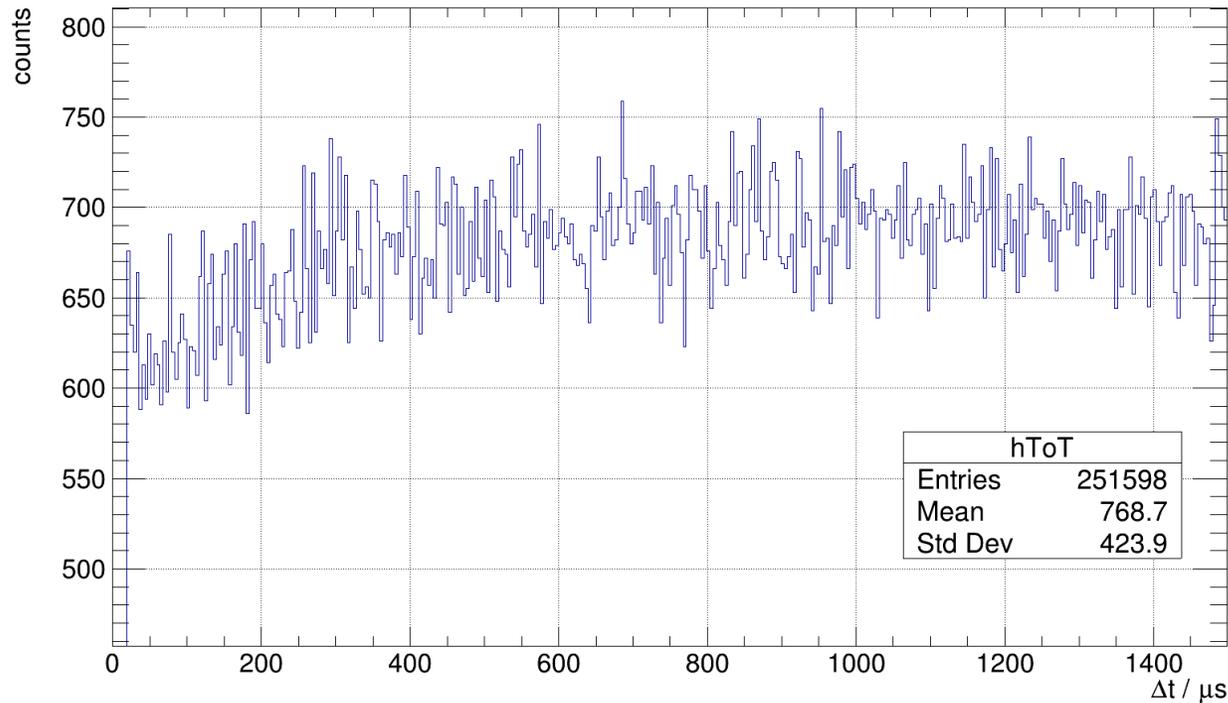
Cleaned Spectra: ToTs



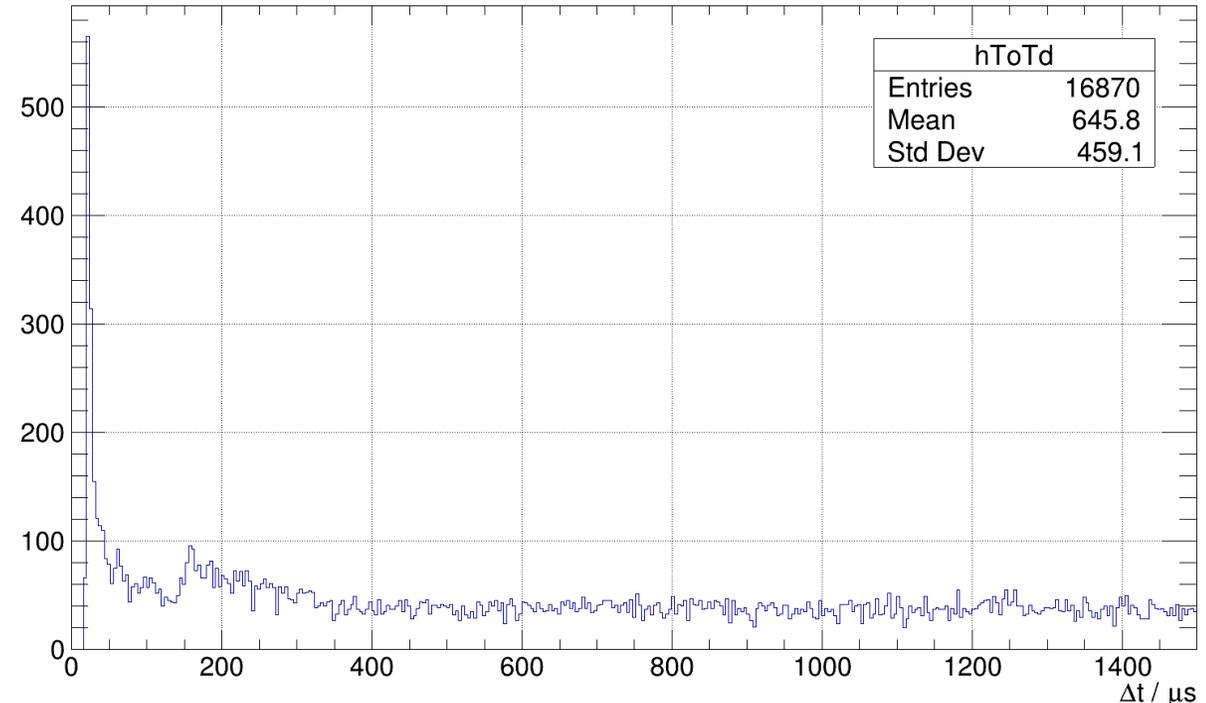
Cleaned Spectra: ToTs



Newer data: trigger flags are sent in more detail
ToT, ToTd and MoPS can be distinguished (in T2Dumps, Xb is not using this!)

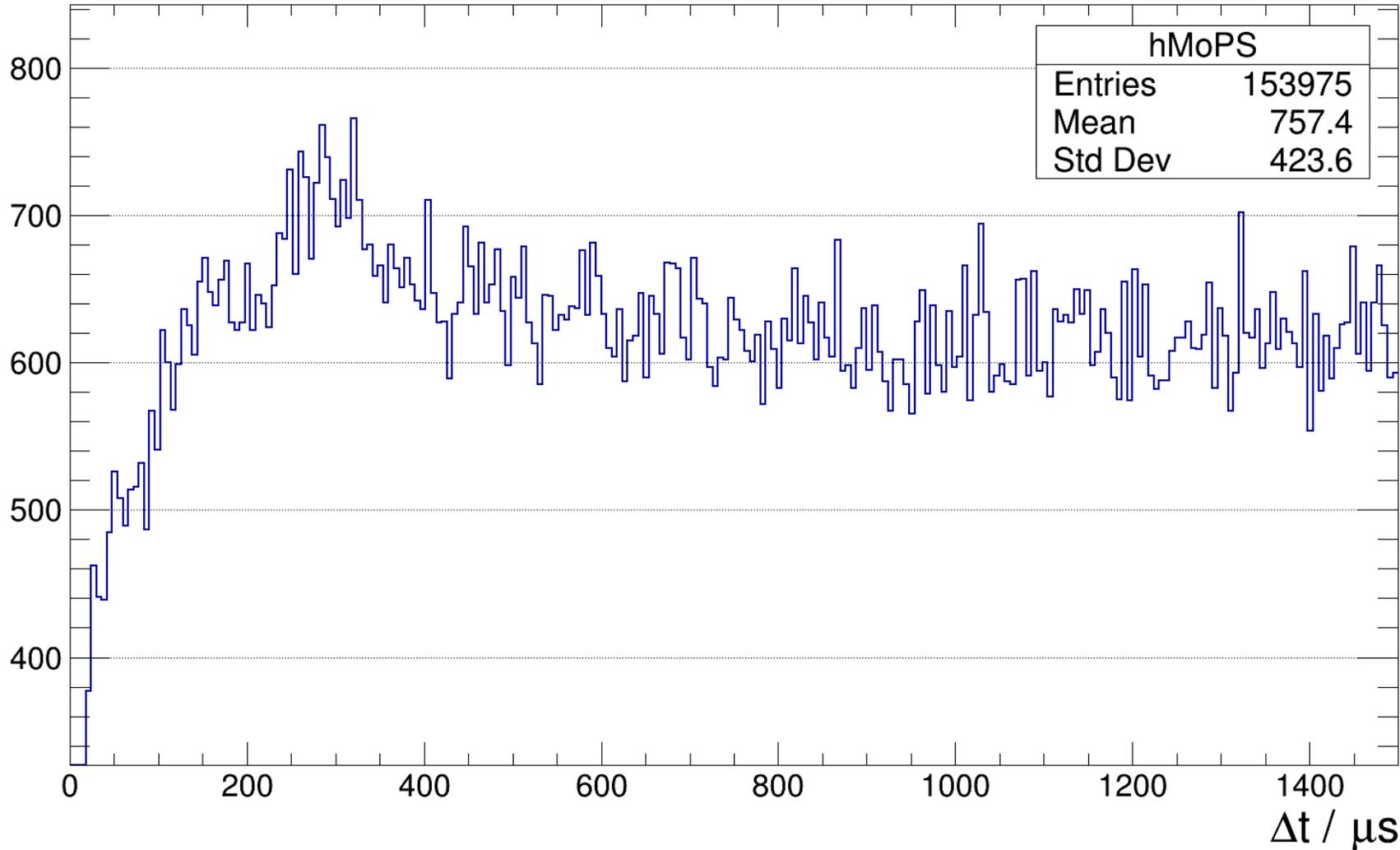


ToT: within statistics fine
[the step has a explanation]



ToTd: unexpected behaviour
reasons unknown

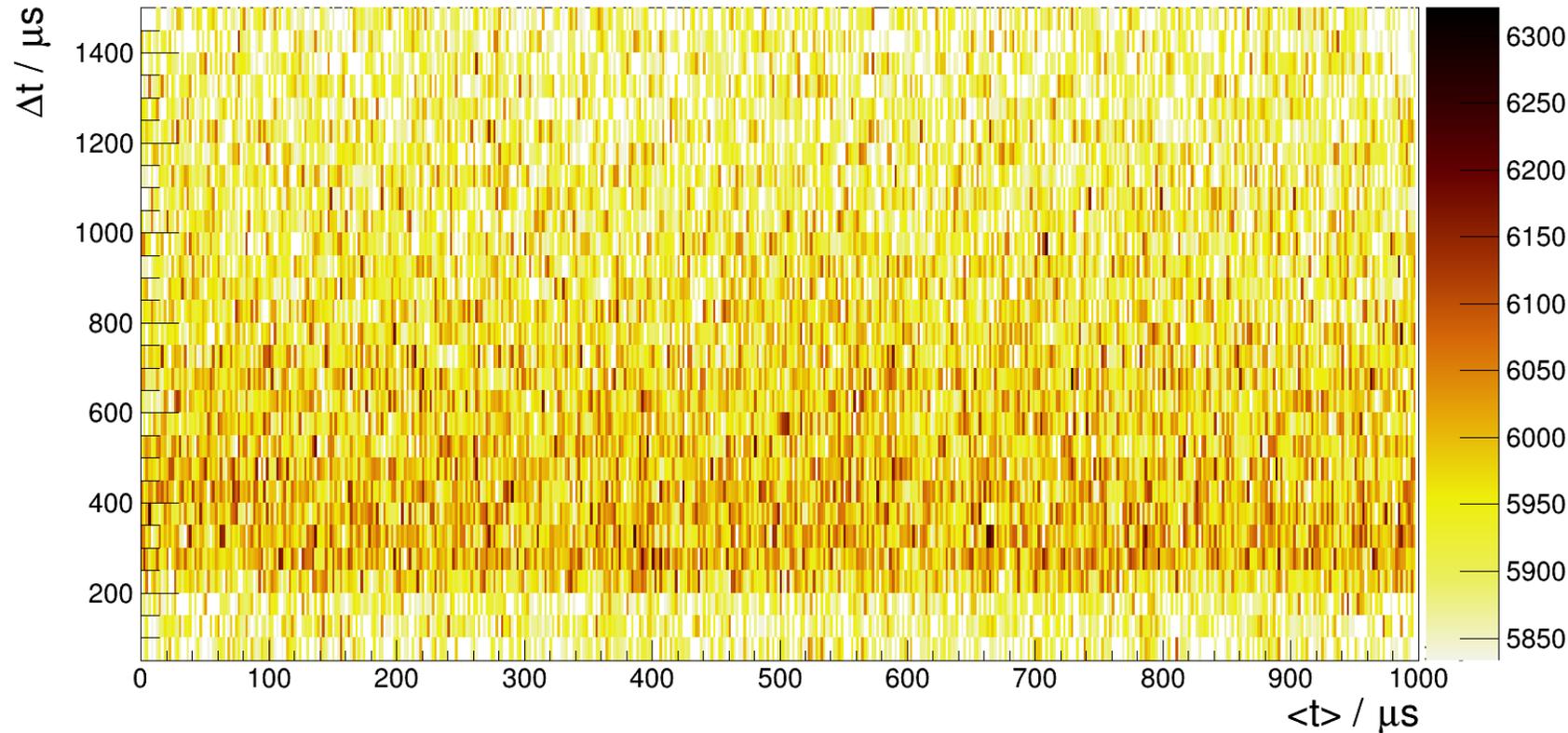
Cleaned Spectra: ToTs



MoPS:
- clear recovery structure
- overshoot

all ToTs:
unusual spectrum is mostly due to the new triggers. Details of why unknown to me.

Explaining the missing triggers



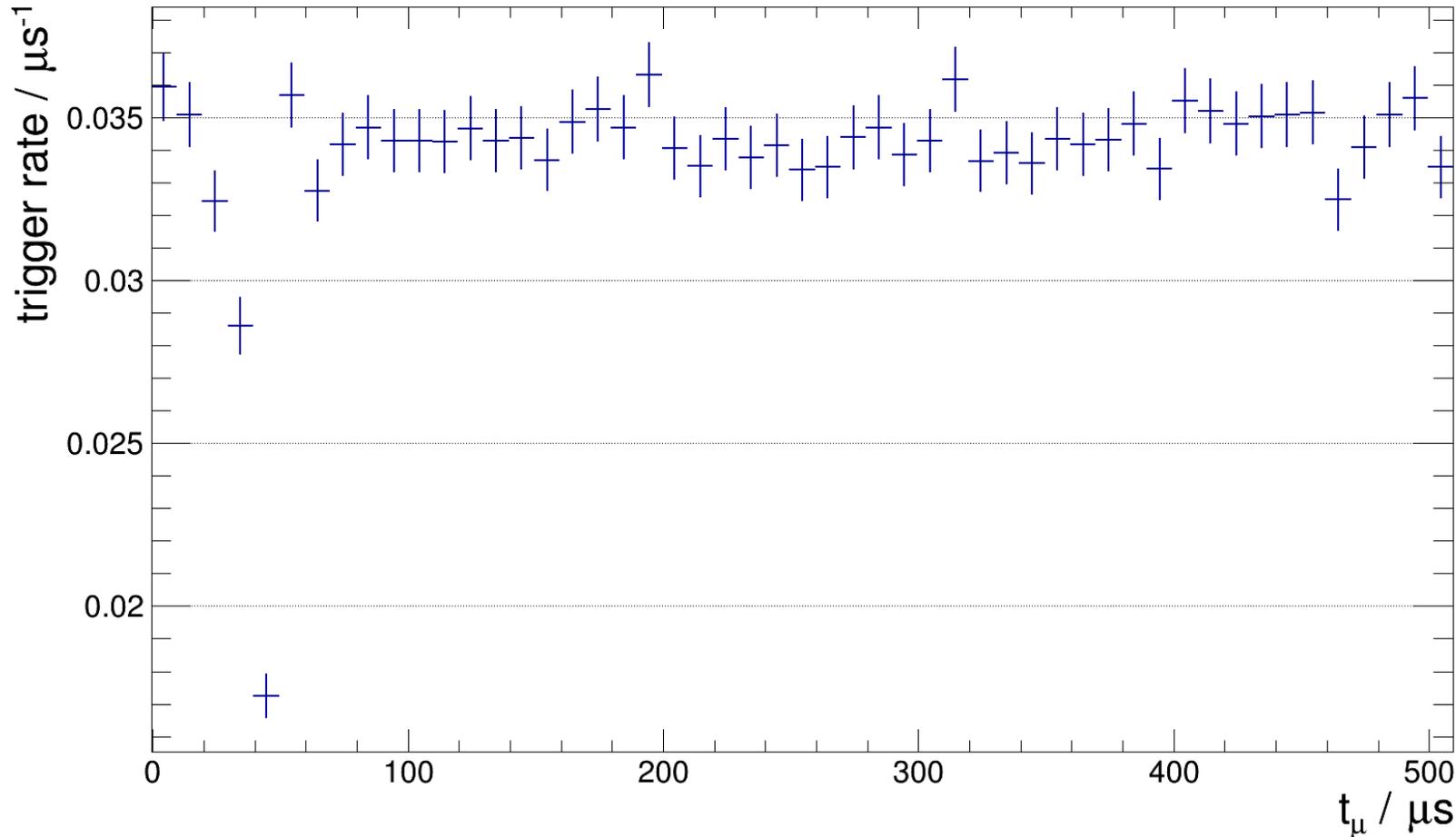
time difference of two triggers, binned by their mean μs within a second

- first idea: the highest priority of a station is to fix the GPS timing at the beginning of the second

→ is this deficit only present in the first part of a second?

→ no, visible over the whole second

Explaining the missing triggers



mean trigger rate within time bins in a GPS second
averaged over 1h of data [24.01.2016 00:00 – 01:00]

- but is the GPS calibration not visible at all?

- check by using the mean trigger rate as function of the time within a GPS second

- very minor deficit visible [nothing bad, but expected and 'good' we see it]

Explaining the missing triggers

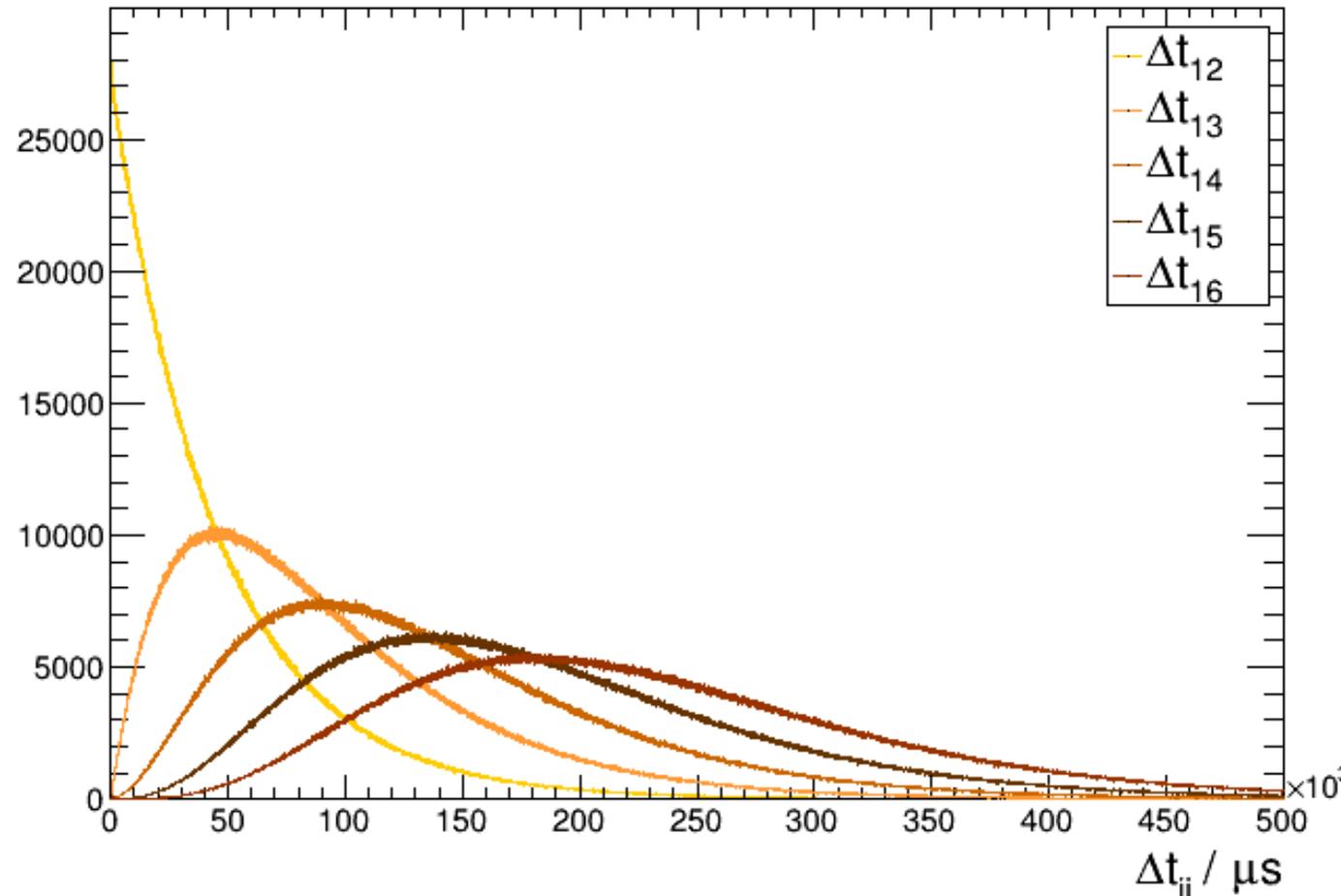


Other explanations?

- check higher-orders: i.e. the time difference of the third to the first trigger, fourth to the first trigger, ... per station

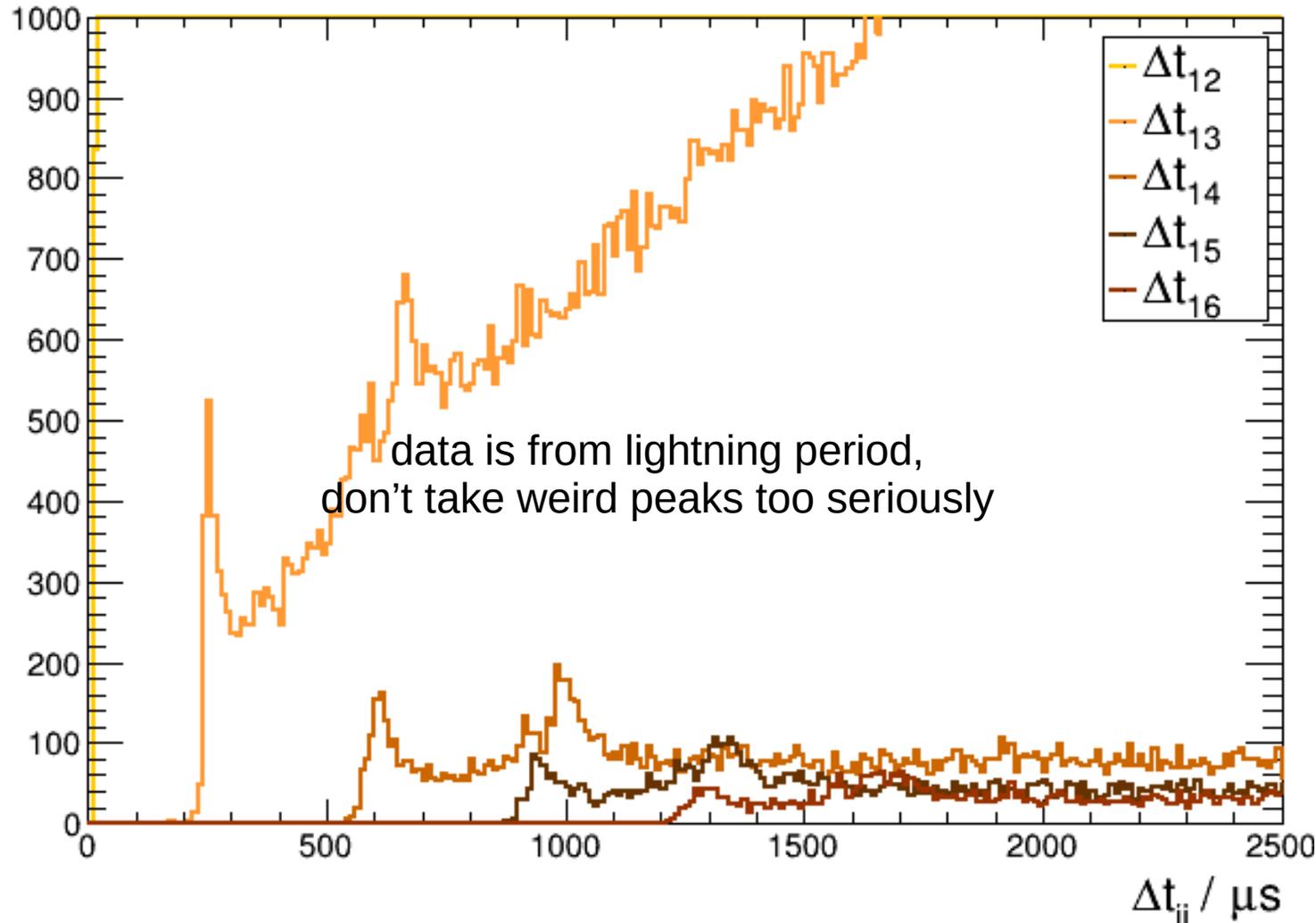
- expect: exponentially damped exponential

→ on large time scales ok!



$$\Delta t_{ij} = t_j - t_i$$

Zooming In



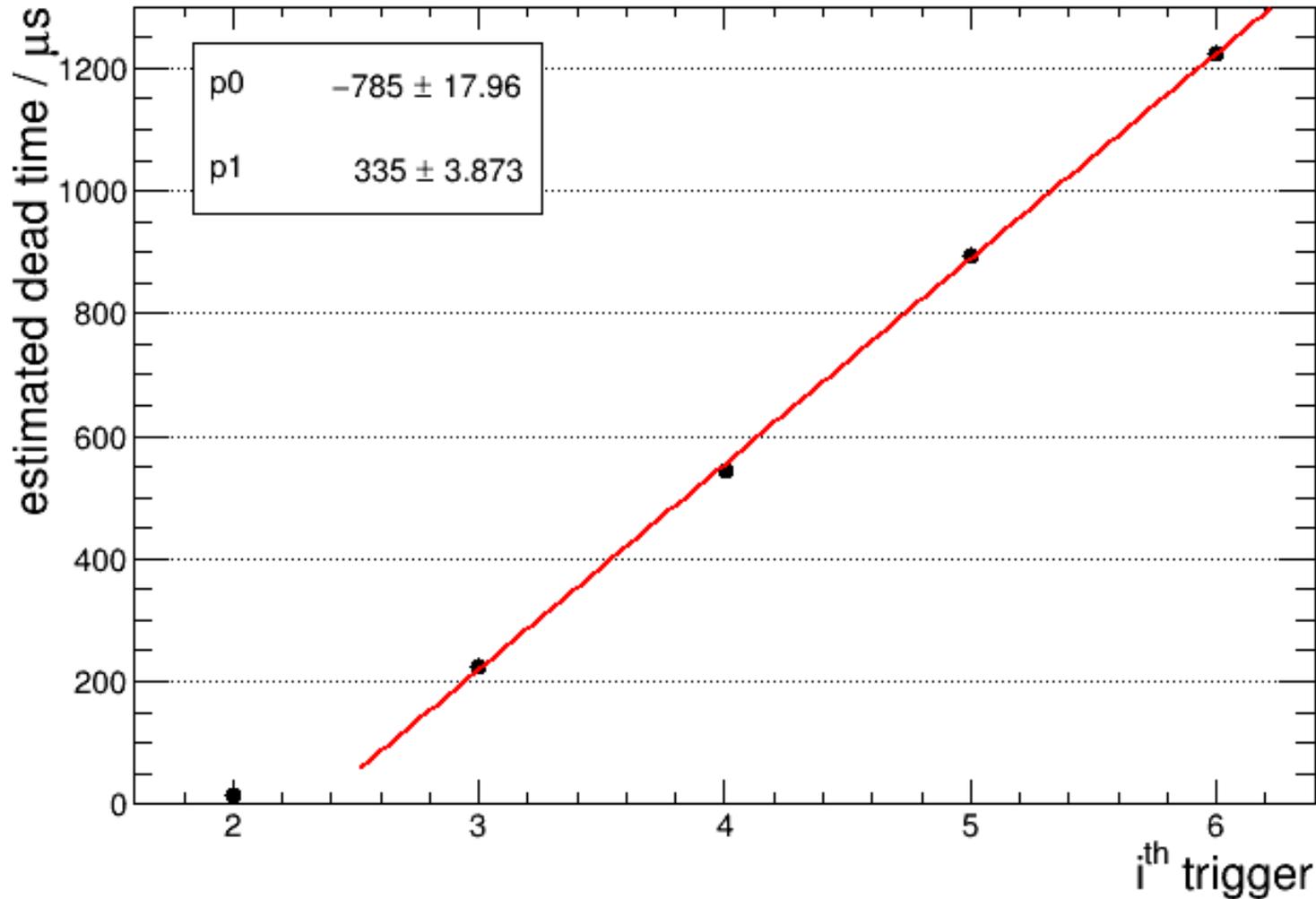
On small time scales:

- peaks, but this is lightning period [Sd-ring study]

- significant intervals without triggers!

- plot more clearly by taking the bin with >5 triggers as start time

Zooming In



Current explanation:

- the station has two ring-buffers for triggers

- after a trigger: copy into event buffer

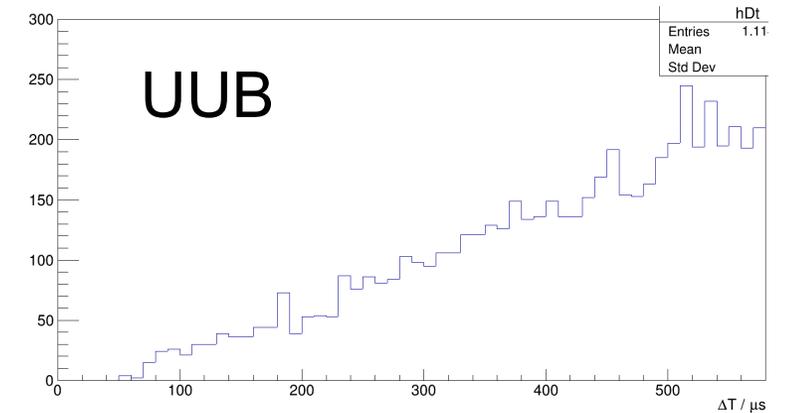
- if two triggers happen in succession: no new trigger possible until the copying is done!

Summary & Conclusion



Part 1 – Unusual stations

- rejection now with KS-test
- cut is not trying to keep as many stations as possible
- relation to high-level / trace data unknown



Part 2 – Dead Times

- GPS calibration is visible in the triggers, but a very small effect
- UB has a dead-time of about 250 μs after more than 2 triggers
- UUB probably not

• Possible effects:

- very rarely a (good) silent station in HE events
- missing triggers in extreme conditions [Sd-rings, lightning periods]

