MoPS & ToTD Status

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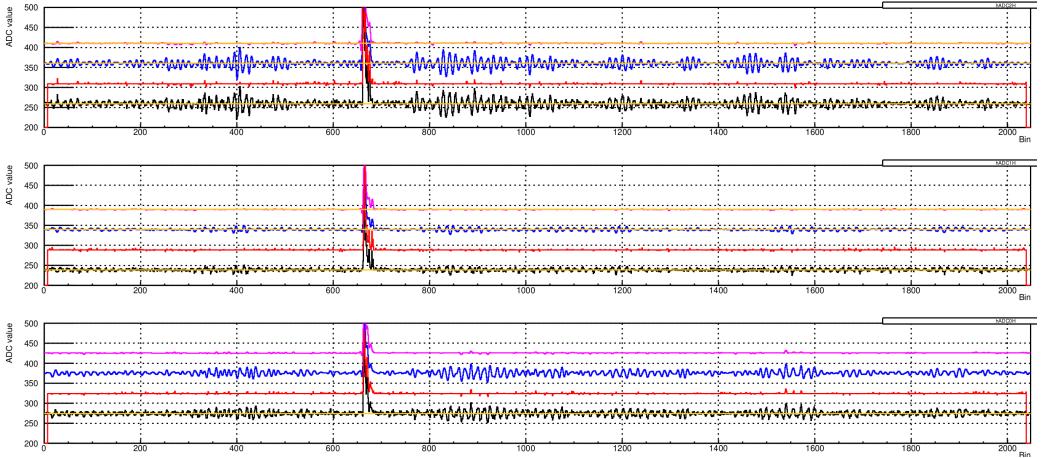
Overview

- Lightning caused large spikes in T2/T3 rates which essentially caused CDAS to crash
  - MoPS and to a lesser extend ToTD were the culprits
  - As a result MoPS & ToTd have been disabled until recently
- FPGA code was developed to mitigate the problem
  - Tested successfully in a few stations
  - Included in September firmware/software roll-out to the array
- ToTD & MoPS are now enabled
  - We have some early indications of how well this worked

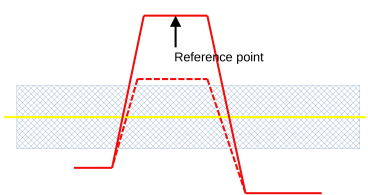
Motivation: Typical Problematic Trace



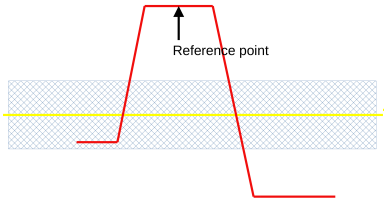
Black: Raw trace Red: Trace cleaned in software Blue: Cleaned & Filtered by software Orange: Baseline

- Oscillations cause false MoPS (and ToTd) triggers

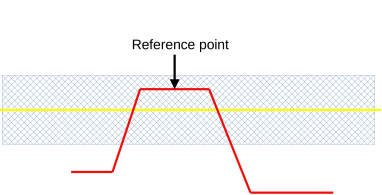
Simplified Trace Cleaner (for Triggering)



Trace modified (trigger only) – Peak & wings outside of dead band



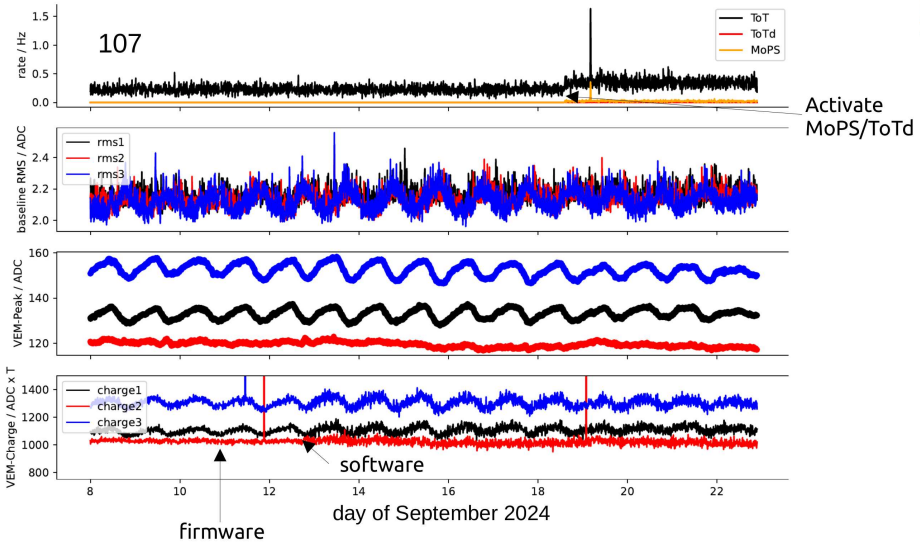
No modification – both wings not below dead band



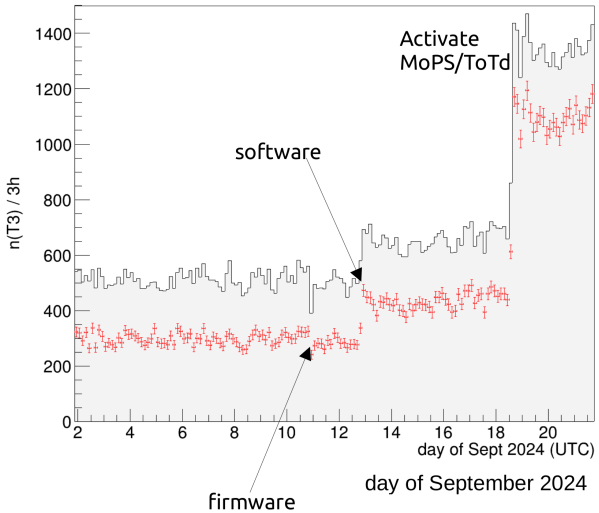
No modification – peak within dead band

- The same logic is applied to signals below baseline with wings above baseline
- Dead band is currently set quite loose to ± 4 ADC counts
- Wings are set at $5-7$ bins on either side of reference point

Timeline


107
rate / Hz
ToT
ToTd
MoPS
Activate
MoPS/ToTd
baseline RMS / ADC
rms1
rms2
rms3
VEM-Peak / ADC
VEM-Charge / ADC x T
charge1
charge2
charge3
software
firmware
day of September 2024

T3 Rates

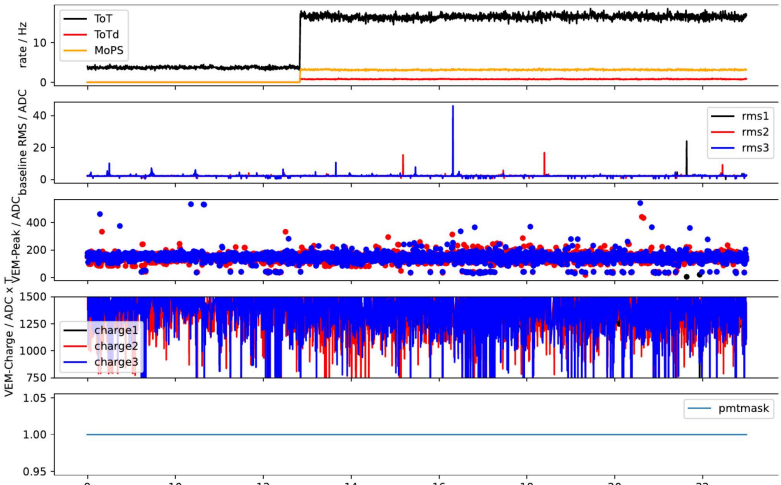


- small descrease of T3s after Deployment of new firmware: maybe just hexagon fluctuation?

- drastic increase in T3s with new triggers

- increase with software deployment down to some stations (~550) activating new triggers

But Some Problem Stations



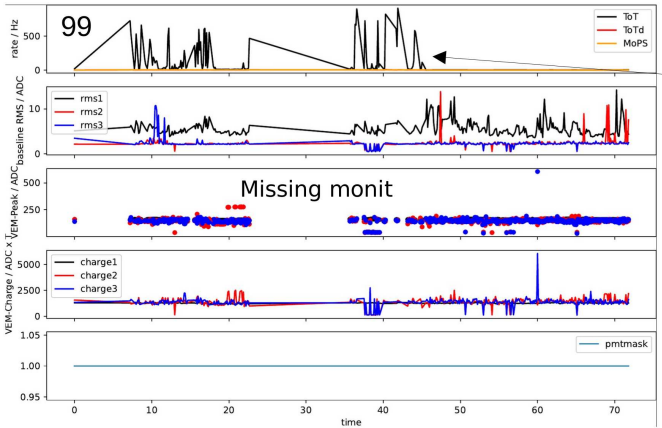
- example: station 1000
  Two masked PMTs

→ pre-update: ~5 Hz of ToT

→ post-update: ~15 Hz because new triggers are activated

→ do we want 1 PMT MoPS?!

Stations with 2 Masked PMTs

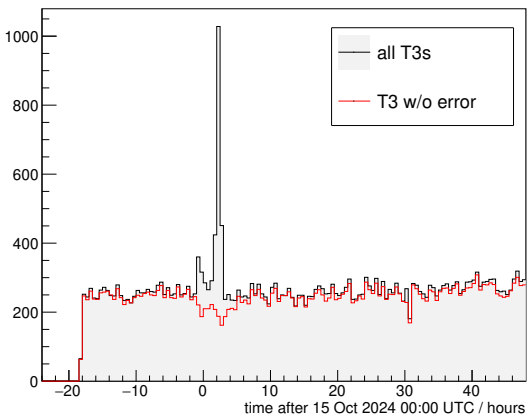


Change configuration MoPS/ToTd

time after 25 Sept '24, hours

- Mitigation: Don't trigger MoPS or ToTD if only 1 PMT.
- This was behavior in UB which had gotten mistranslated for UUB
- Before change: 58 stations ToT>5 Hz After: 14 stations (other PMT problems)

What about Lightning: A Recent Occurrence



- Difficult to tell with with few lightning events so far, but
  - Seems to be better than previously (with ToTD/MoPS enabled)
  - Burst of "bad" T3's, but at first look did not crash CDAS
  - Recovery was pretty quick

Summary

- Firmware and software deployed in September
- Minor impact of firmware on T3 rates
- ToTD and MoPS now enabled
- Disabling ToTD & MoPS when only 1 PMT reduces outliers
  - Return to UB operating conditions
- Limited data suggests array is more stable during lightning than previously