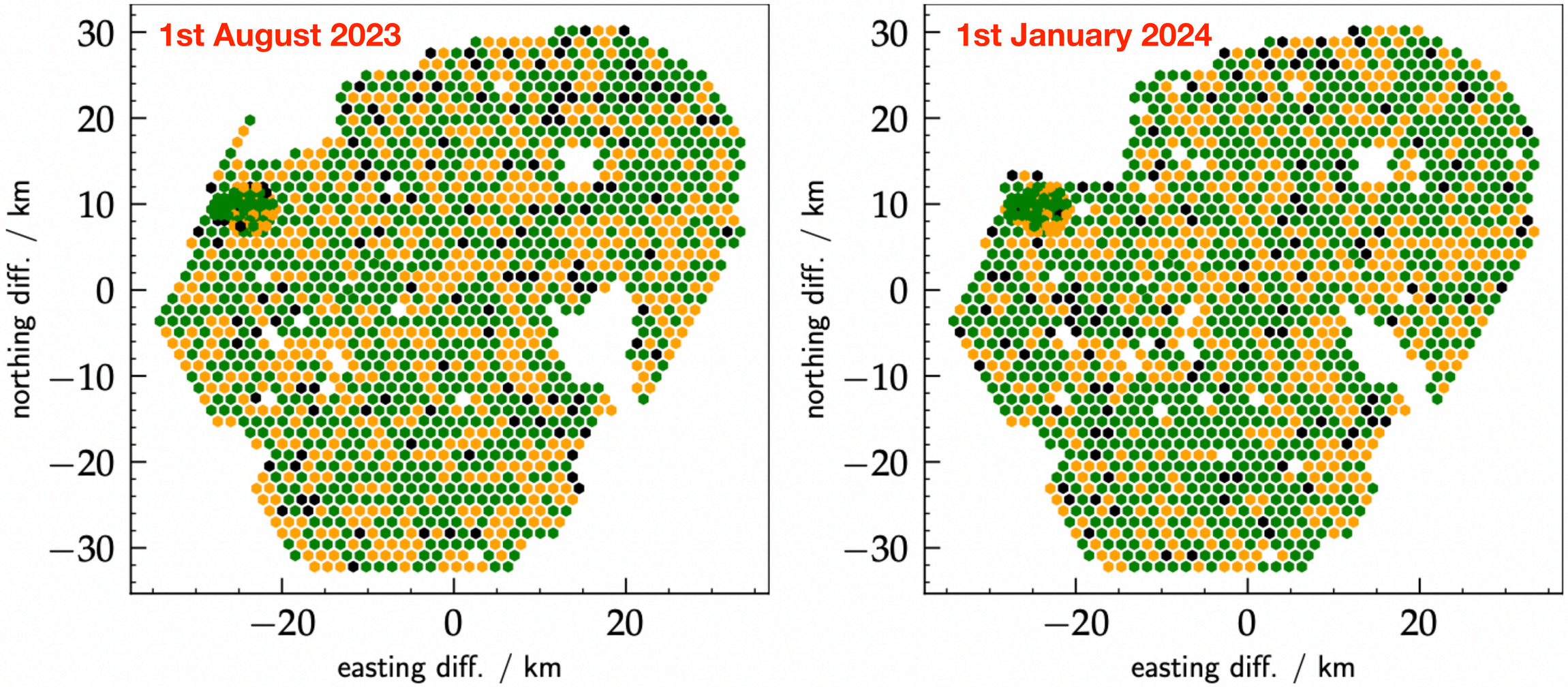
SD in the UUB era: from "commissioning" to alarms and quality cuts

Martin Schimassek & Piera Ghia (GAP-2024-025)



The so-called Martin's Maps: daily "commissioning" of the UUB-SD after applying selections based on monitoring-data studies.

Green: stations with all PMTs/channels OK; Orange: ≥ 1 PMT/channel non OK; Black: non-OK stations

SD commissioning: concept and method

CONCEPT

- UUB-SD is almost commissioned: **SDEU will pass the operation-readiness review in November.** Stations are already regularly sending to CDAS TH and ToT trigger, and traces
- Yet, **operation-readiness does not automatically mean analysis-readiness**
- **SD is a dynamic instrument**: never on any day of its existence it had all tanks and PMTs working perfectly. It thus requires a continuous (at least daily) "**performance-commissioning"**, either for physics analysis (***quality cuts***) or for maintenance (***alarms***)

METHOD

- A daily **P-commissioning cannot be performed with event-data** (too rare, ≈ 5/day/station!)
- **Monitoring-data** (mc.root files, see hands-on session) **are used** (≈ 250/day/station)
- **Key parameters**, either at PMT/channel level or station-level, **are identified**
- The study of the distribution of **mean values** of such parameters allows for setting ***tolerances,*** while their **dispersion** allows for detecting ***(in)stability*** -> identifications of abnormal PMTs/channels
- Abnormal PMTs/channels need to be **checked with low-level analysis of event-data** (e.g., amplitude and timing of signals) to verify the effects on reconstruction. **Low-level analysis can also serve to detect other anomalies** non-identified with monitoring-data

Key parameters for P-commissioning: from Phase I to Phase II

Hierarchical tests: once a PMT/channel is flagged problematic, it is not considered anymore for higher-levels checks.

Phase I

(1) PMT-Mask (changes) [AQ]

(2) Dynode and anode baselines (mean and s.d.) [AQ]

(3) Dynode/anode ratio (mean and s.d.) [AQ]

(4) VEM Peak (s.d.) [A]

(5) ToT rate [M]

[AQ] = alarm & quality=cut; [A] = alarm only; [M] = monitoring only

Phase II

(1) PMT-Mask (changes) [AQ]

(2) HG and LG baselines (mean and s.d.) [A]

(3) VEM Peak (mean and s.d.) [A] (Q, TBD)

(4) VEM Area/Peak (AoP) [A] (Q,TBD)

(5) HG/LG ratio (mean) [A]

(6) ToT rate [A]

[AQ] = alarm & quality=cut; [A] = alarm only; [M] = monitoring only

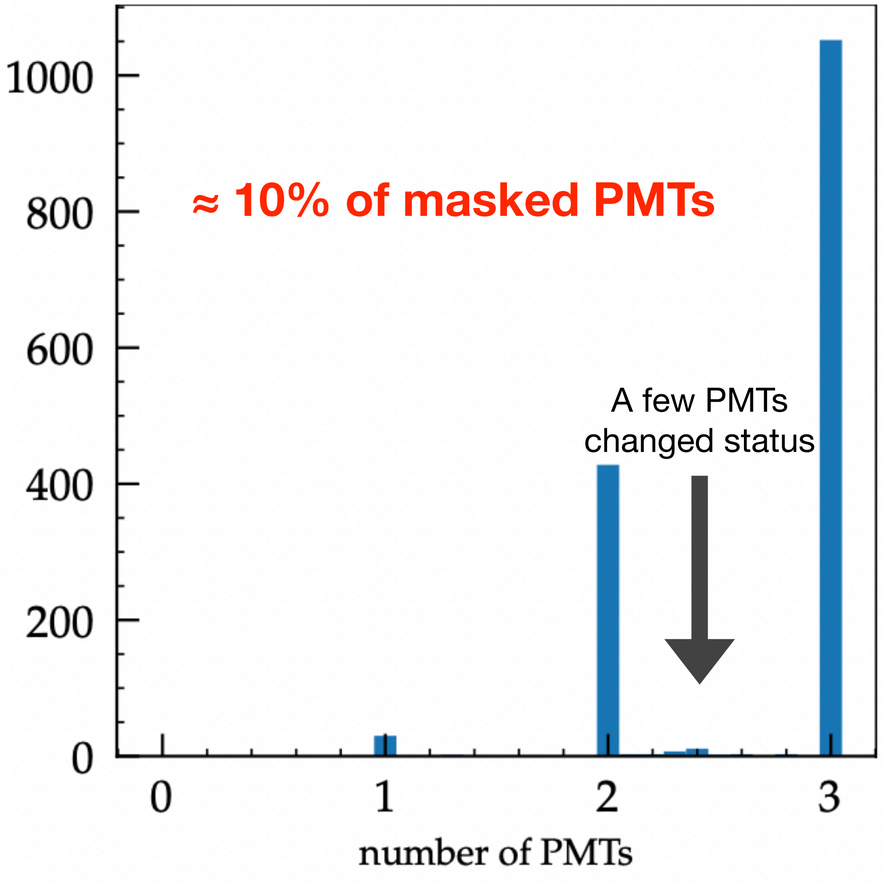
NB: Two drawbacks for phase II P-commissioning:

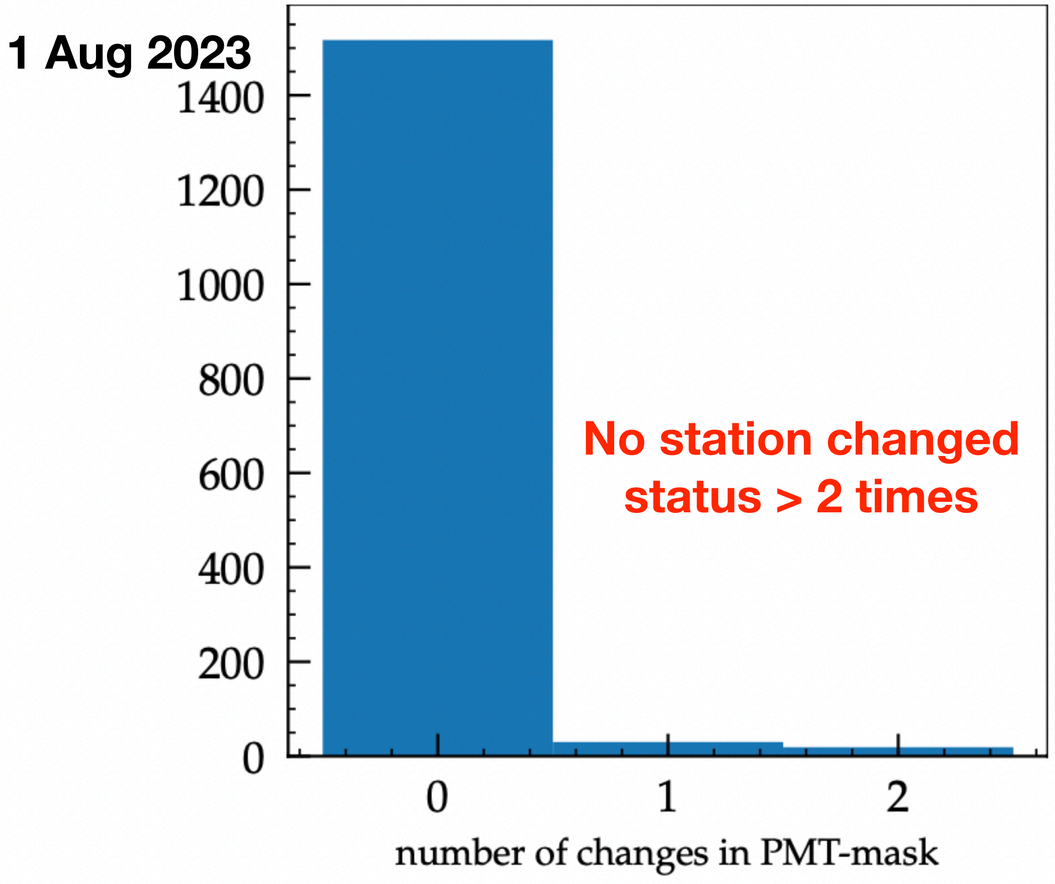
1) No longer DA ratio, excellent tracer of PMTs health;

2) Monitoring-data formed out of down-sampled and filtered traces, i.e., the FADC-related parameters are in fact only "proxies" wrt those derived from event-traces

PMT Mask

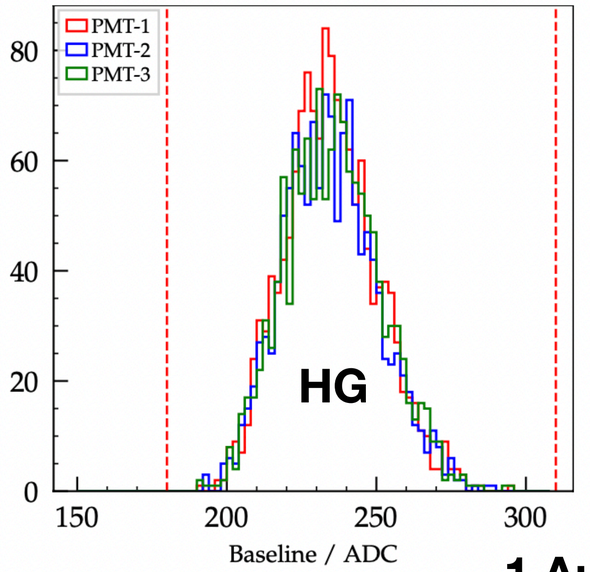
Every time that the VEM-peak value of one PMT goes above 720 or below 80 ADC channels, the LS automatically masks the PMT. Mask status changes only when the LS reboots

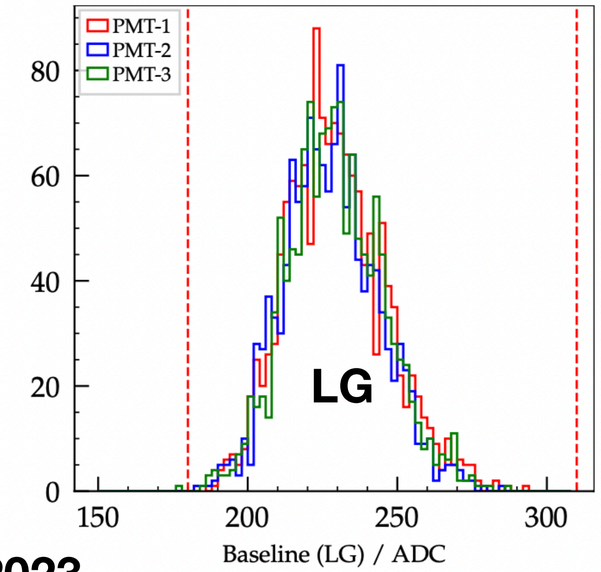


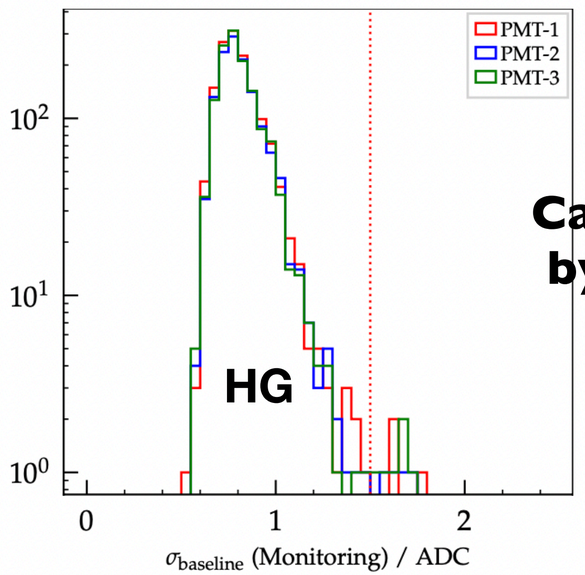


Proposal of an alert/quality selection based on the mask parameter (station-level) : same cut as used for the UB, i.e., more than 2 changes per day.

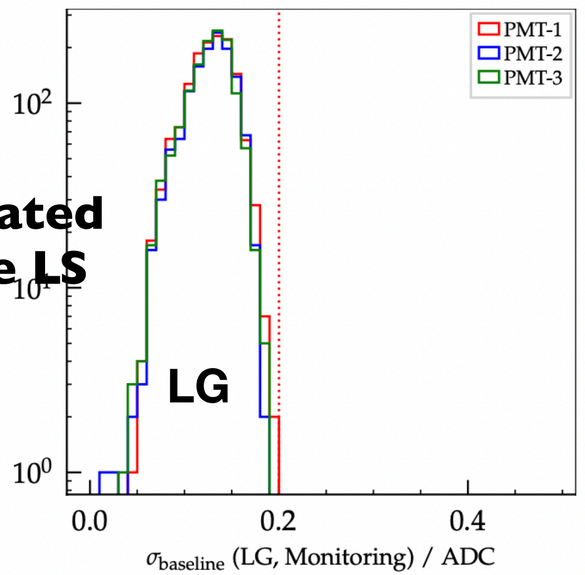
Baselines







Calculated by the LS



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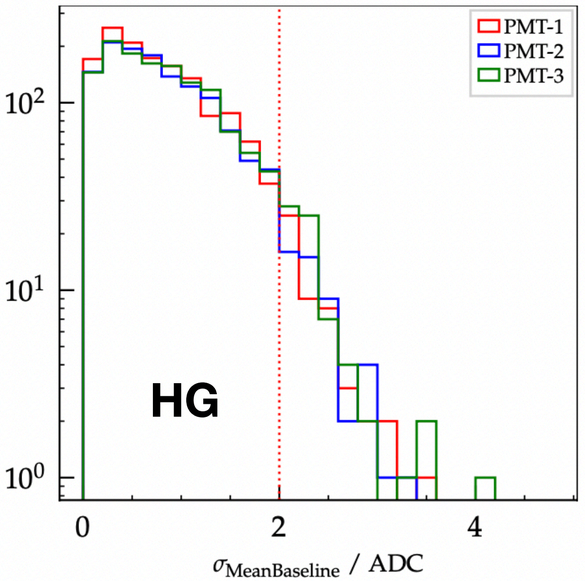

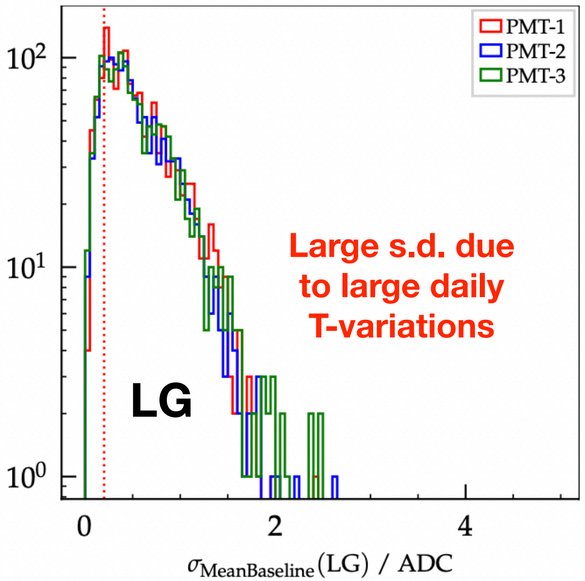

Large s.d. due to large daily T-variations

Proposal to set alarms at

150 ADC< b < 350 ADC for the mean baselines,

$\sigma_{\text{mean baseline}}$ > 5 ADC for the daily variation and

σ_{baseline} > 2 ADC for the variance in the filtered and downsampled high-gain traces.

Need to be re-defined once the monitoring-data will be formed from full-bandwidth traces

VEM Peak

In the absence of the DA ratio parameter, we use the VEM peak as a tracer of PMT problems.

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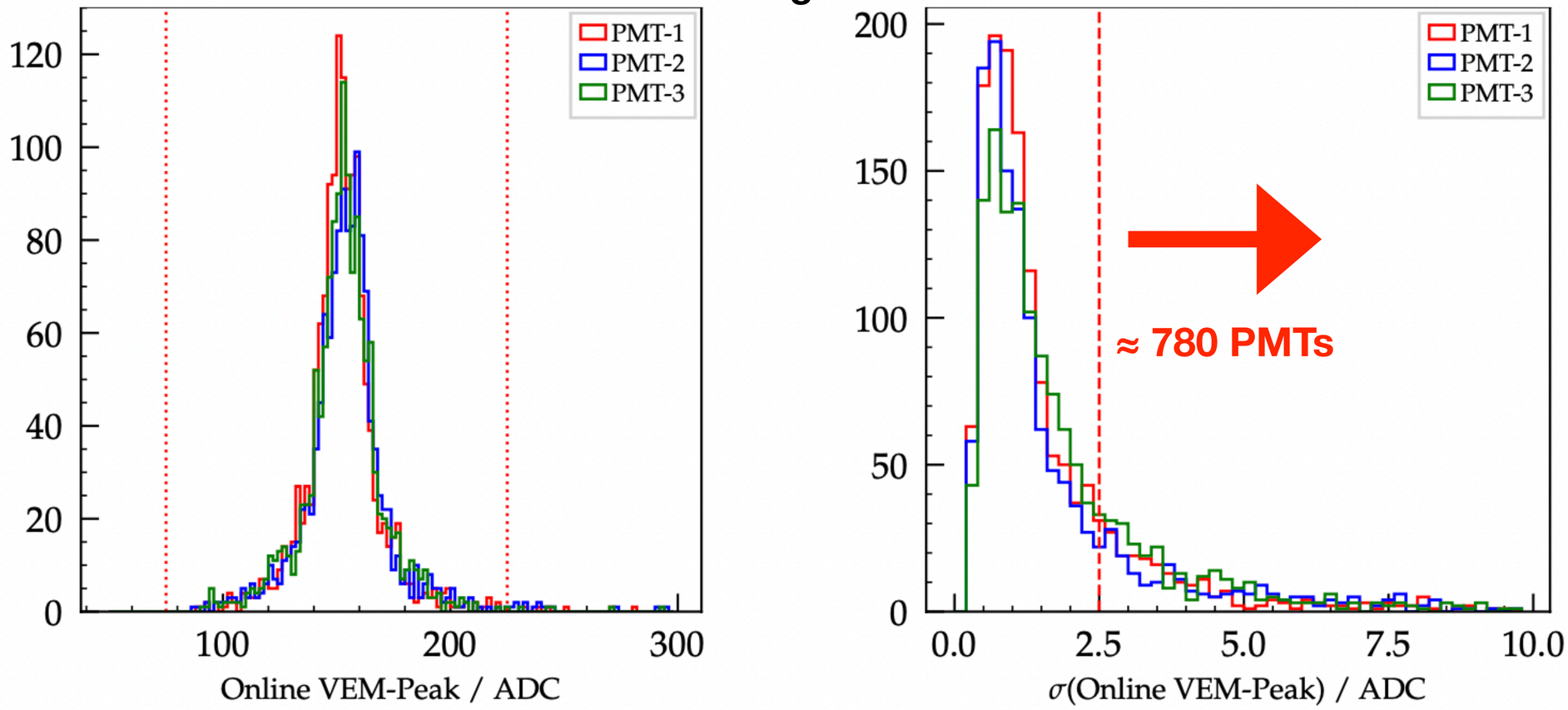
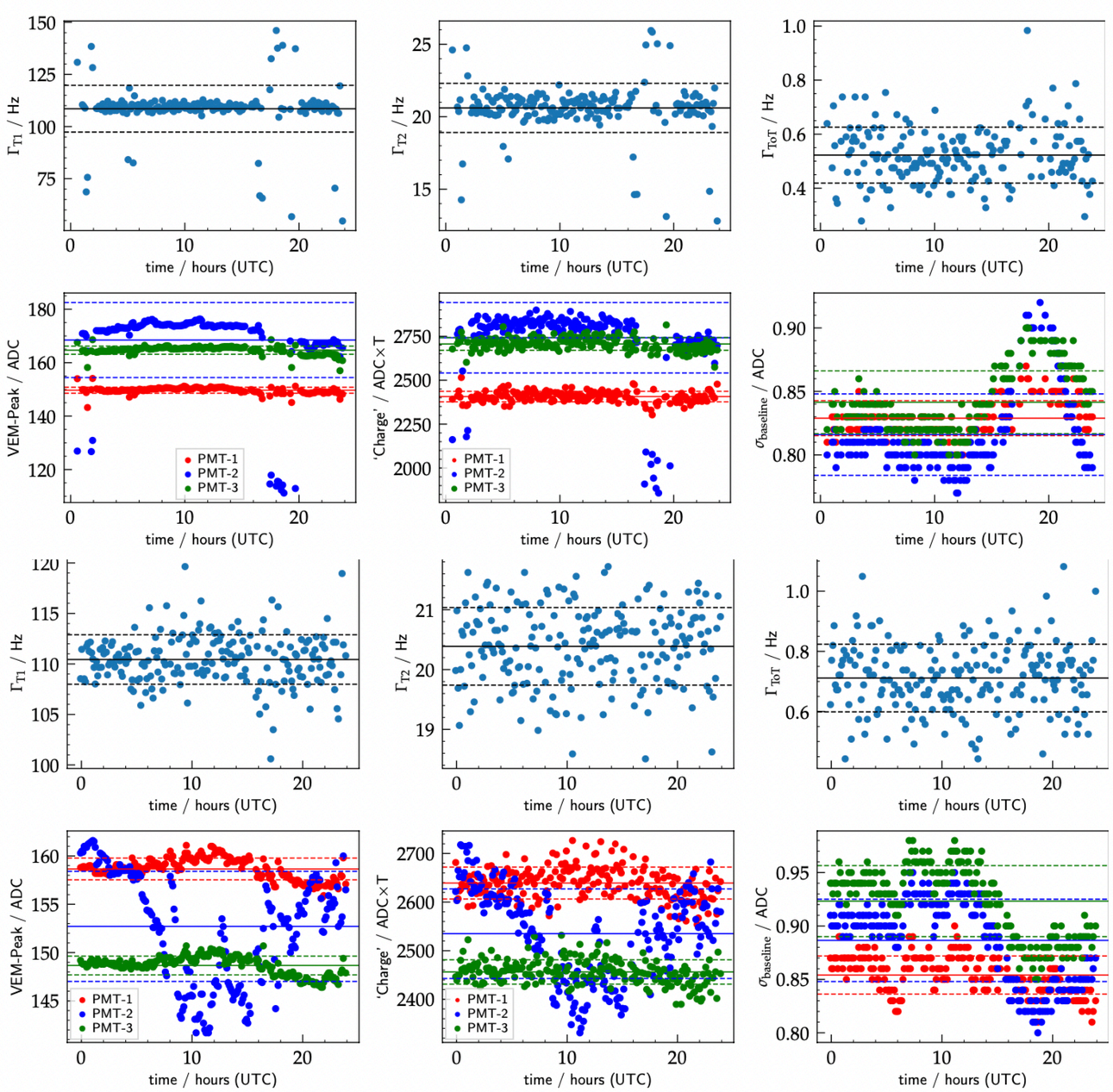


Proposal to set an anomaly-alert at Mean(VEM-Peak) < 50 ADC and <Mean(VEM-Peak) > 300 ADC.

And an instability-alert at $\sigma_{\text{VEM-Peak}}$ > 2.5 ADC

To confirm these selections for quality cuts, more studies are required on monitoring- and event-data

Examples of VEM Peak identified as "unstable"



The (preliminary) instability-alerts on the VEM peak identify true and false bad-PMTs

e.g.

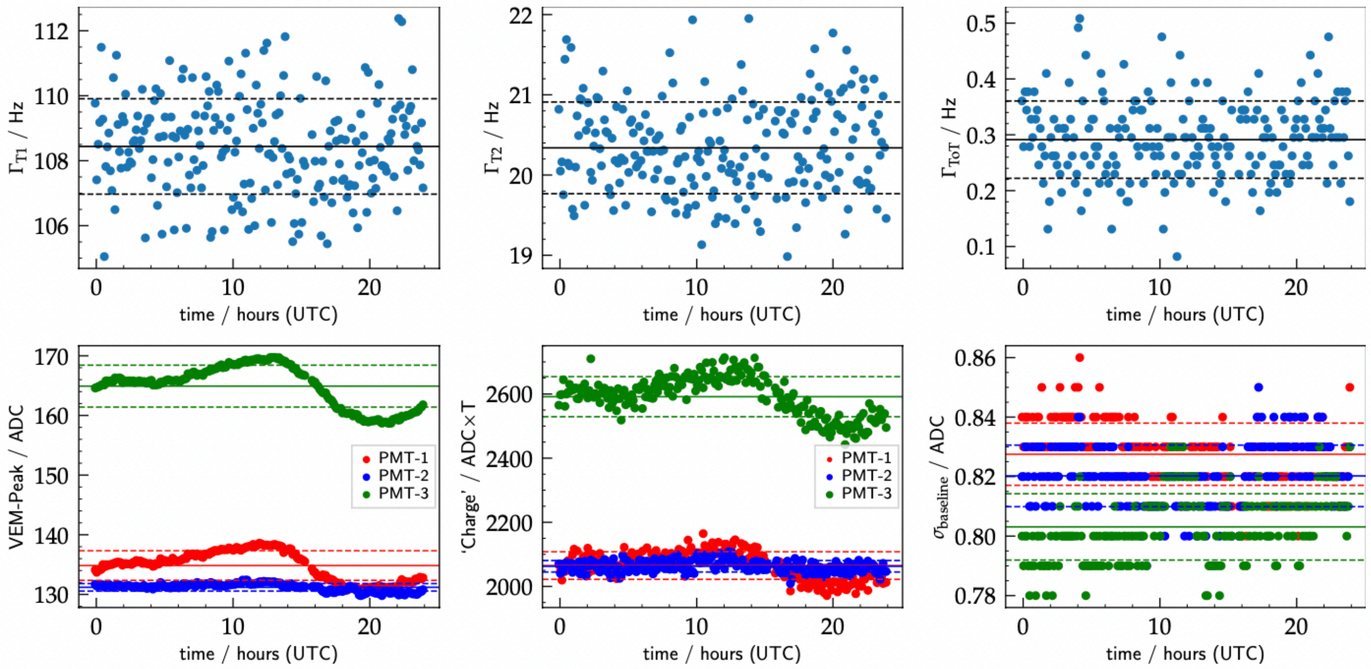
Henna (156): PMT2 unstable, LS triggers affected

Weni-Hue (510): PMT2 unstable, LS triggers not affected

Examples of VEM Peak identified as "unstable"

The (preliminary) instability-alerts on the VEM peak identify true and false bad-PMTs

Chiribita



The (preliminary) instability-alerts on the VEM peak identify true and false bad-PMTs

e.g.

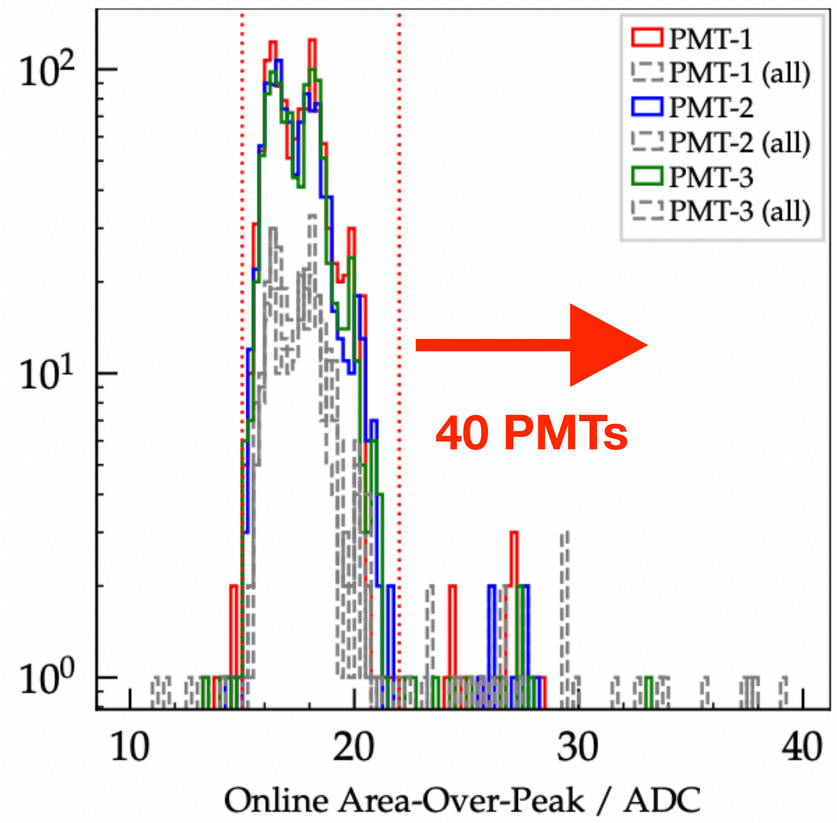
Chiribita (107): PMT1 and PMT3 show just a large dependence on temperature

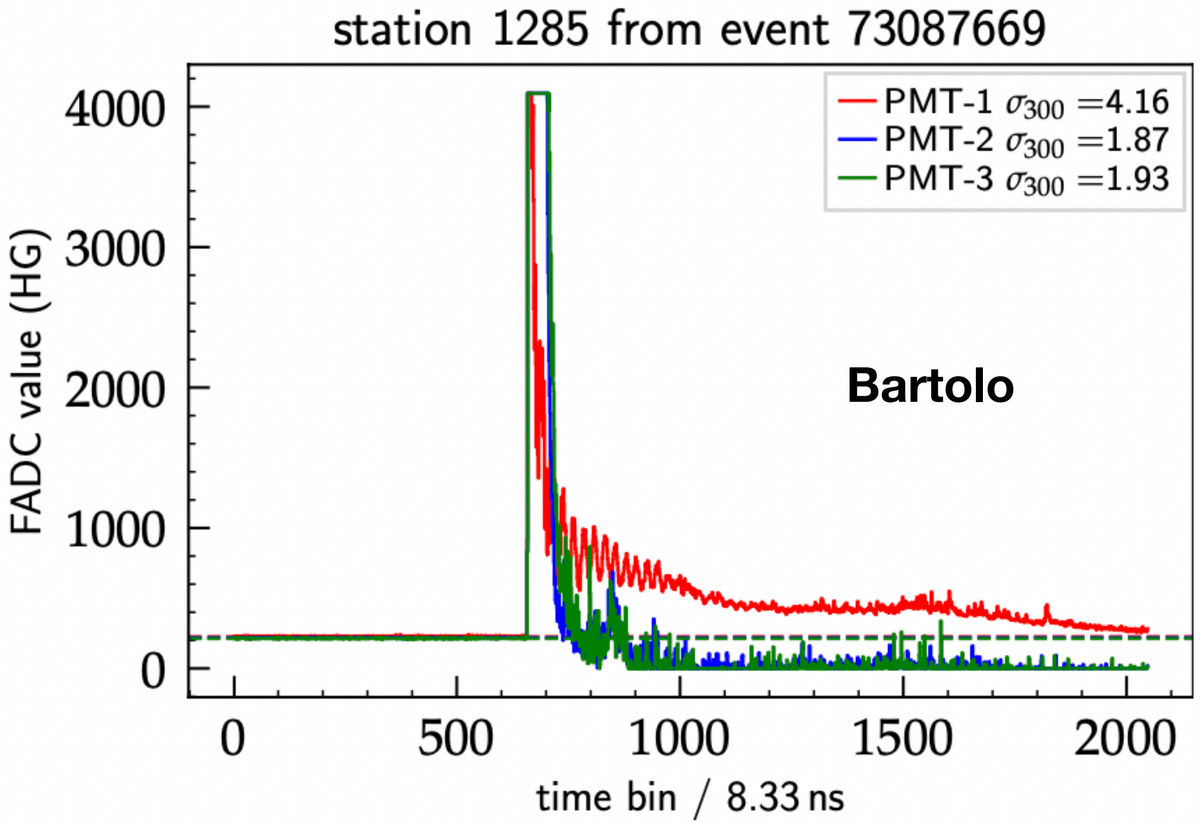
To get a list with a higher "purity" of truly problematic PMTs, the tolerance on $\sigma_{\text{VEM-Peak}}$ may be obviously changed (at the risk of non-identifying true bad-PMTs)

A study on temperature dependence of the VEM peak is recommended

"Pseudo" VEM Area/Peak

In the absence of the DA parameter, we also use the "pseudo" VEM area/peak as a supplementary tracer of PMT problems, namely of unusual signal-decay time



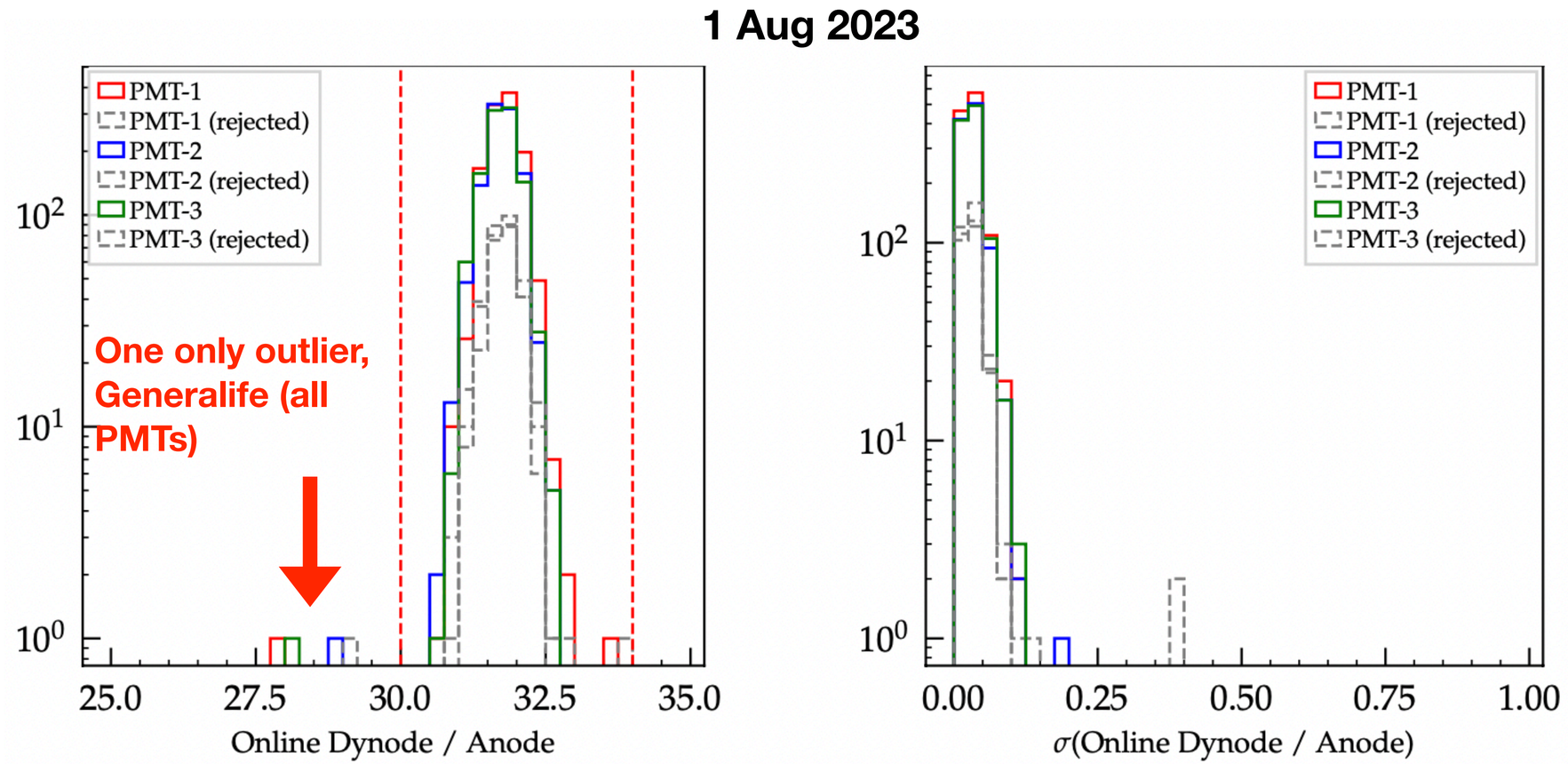


Proposal to set an alert on the current "pseudo" AoP if the value is outside the tolerances 15 < AoP < 22

N.B. Tolerances to be revised once the calculation of the VEM charge is updated

HG/LG ratio (aka "dynode/anode" ratio)

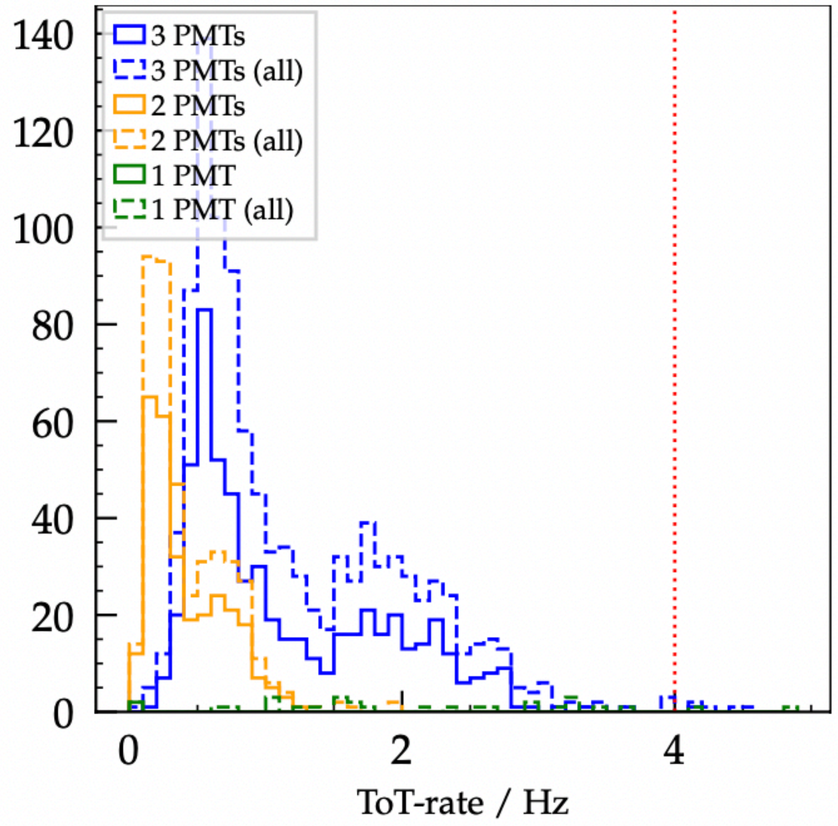
Amplification now in the electronics: even so, monitoring the HG/LG ratio on long-term may be wise



Proposal to set tolerances at 29 < HG/LG < 33 to alert on outliers that may indicate failures

ToT rate

ToT-rate tests are useful for monitoring the shape of signals, to which this trigger is very sensitive



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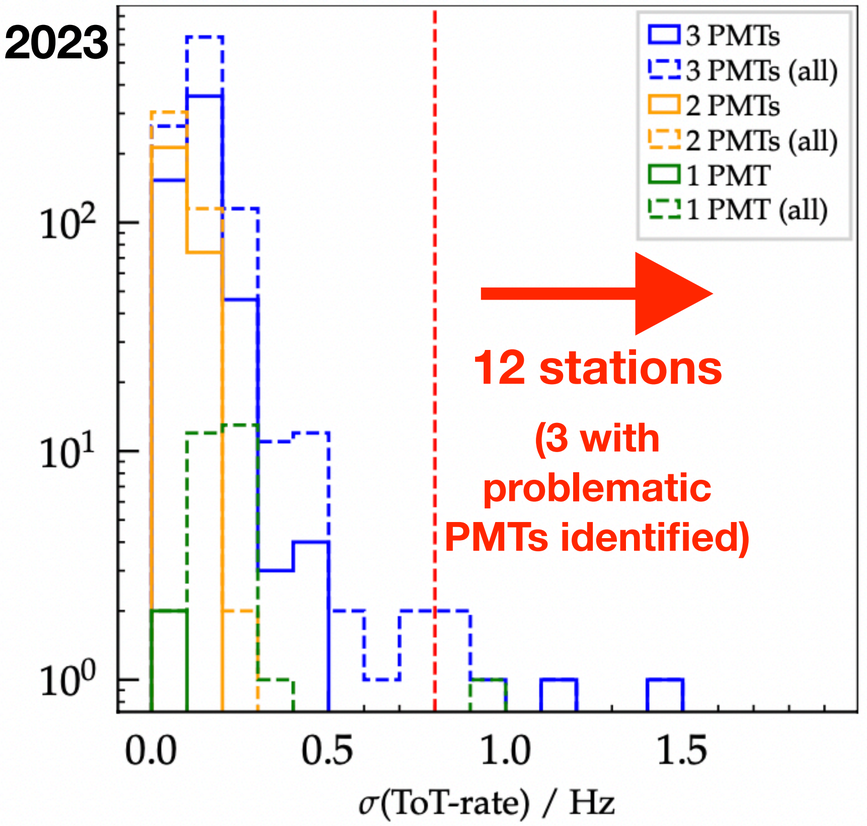
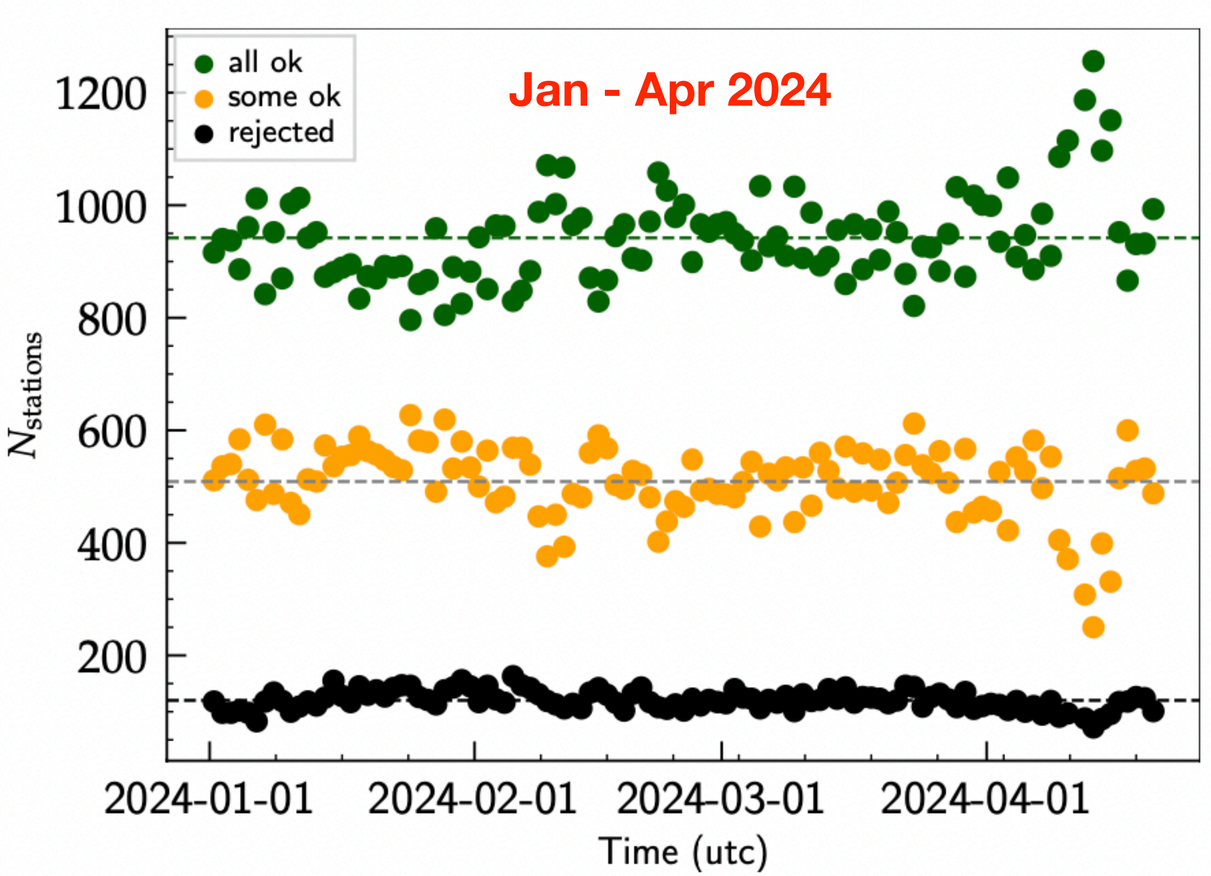


Proposal to set an alert on daily variation of the ToT rate: σ_{ToT} > 0.8 Hz

Daily P-commissioning for Phase II: conclusions (1)

Status

- Method used for Phase1-like daily commissioning has been **adapted to Phase2 monitoring-data**
- Sensible parameters to detect anomalous PMTs/ channels/stations have been identified: **mask, baselines, VEM peak and charge, HG/LG ratio, ToT rate**
- **Preliminary criteria for alarms** have been defined and proposed
- **Tools are ready to be used** to run the daily commissioning (see figure on the right)
- From an analysis over 4 months, **the number of identified anomalies look stable**



We propose that the defined alarms be activated in the Monitoring

Daily P-commissioning for Phase II: conclusions (II)

Outlook

- **No quality cuts defined yet.** A more in-depth look into PMTs or stations found “unstable" s required before defining quality cuts: **a study on the recorded traces in event-data is mandatory**
- **Alarm (and quality cuts) criteria can (must) be improved.**
  - e.g., **study of the correlation of key parameters with temperature** to distinguish true unstable PMTs/channel from temperature-sensible ones
  - **VEM-charge (and hence AoP) and baselines evaluated out of full-bandwidth traces** need to be made available in monitoring-data