A new approach for efficiency correction

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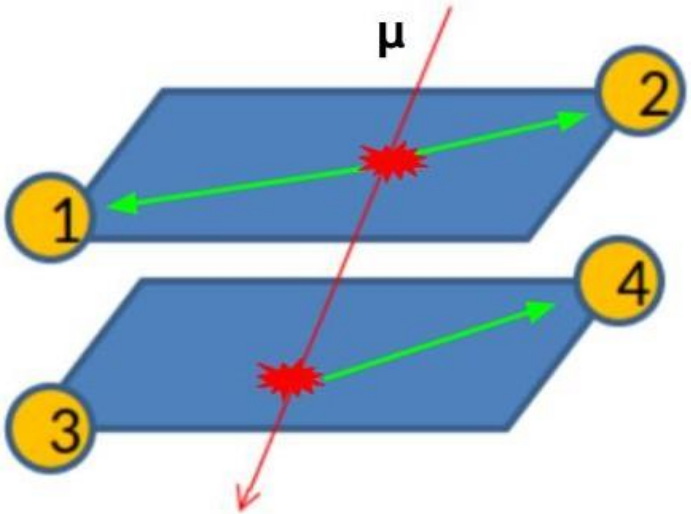
PseudoEfficiency

It estimate the efficiency of the SiPMs.

PseudoEff$_1$ of SiPM$_1$ is the fraction of events that triggered thanks to SiPM$_1$ over the total number of events in a minute.

As an example, if in a minute the SiPM3 never trigger, then his pseudoEff is 0



the “Standard Correction”

- If the real efficiency of the SiPMs e_i were known, the majRate should be corrected by dividing for a factor:

$$F = e_0e_1e_2 + \ldots + e_1e_2e_3 - 3\, e_0e_1e_2e_3$$

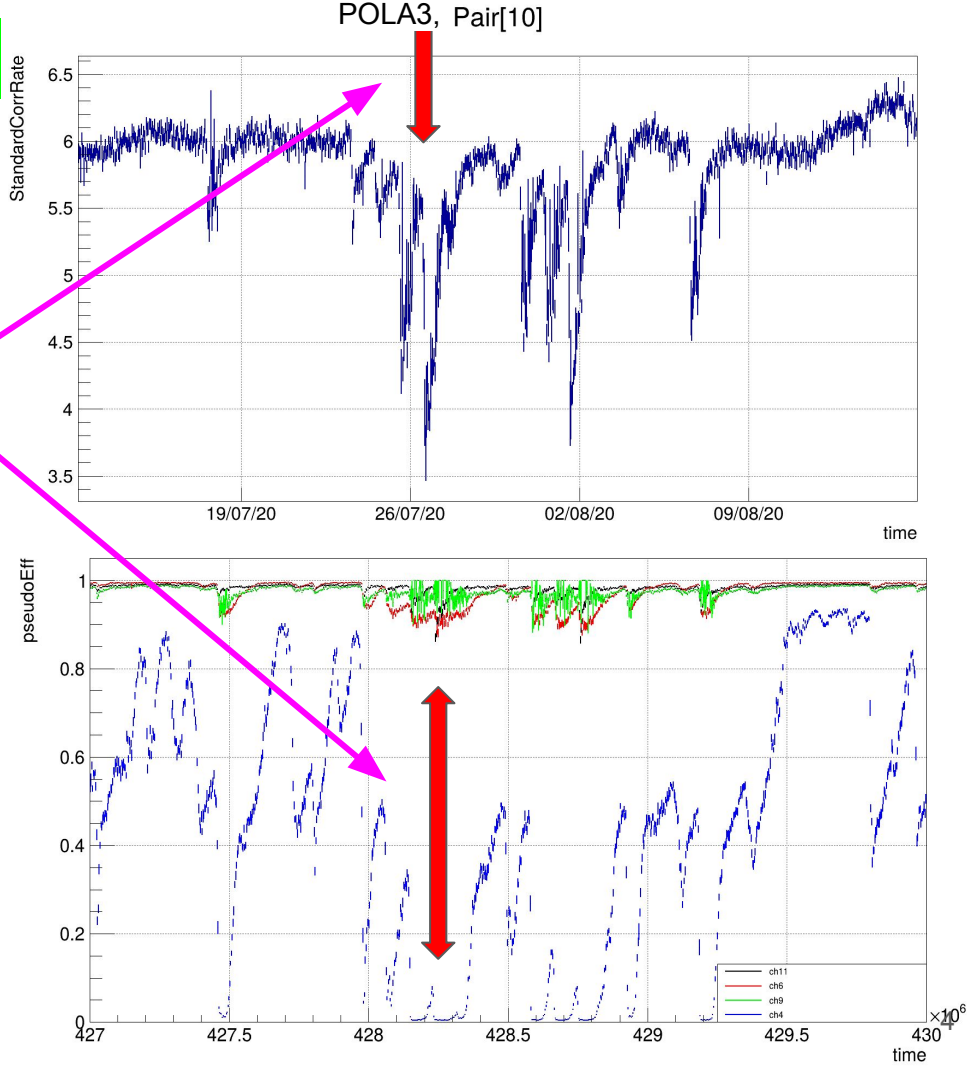
- If one assume that the pseudoEff e'_i well approximate the efficiency e_i, then one can approximate the factor by:

$$\text{if } e'_i \approx e_i \quad \Rightarrow \quad F' = e'_0e'_1e'_2 + \ldots + e'_1e'_2e'_3 - 3\, e'_0e'_1e'_2e'_3$$

Suspect that StandCorr fails

Presence of period where the pseudoEff is low corresponds with drop in the StandardCorrRate

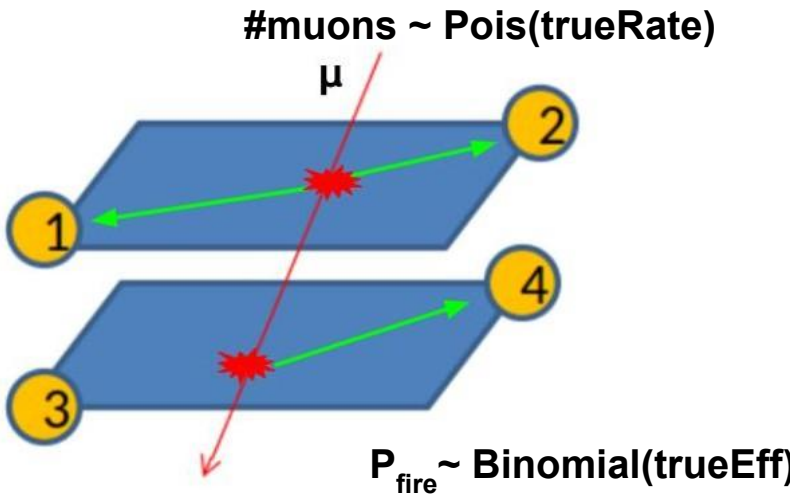
This rise the suspect that the approximation $e'_i \approx e_i$ do not hold for low pseudoEff, so the F' do not correct the rate



the “Toy model”

To understand the relation between the pseudoEff and the trueEff of the SiPMs, a toy model is implemented.

# of muons is generated according to a Pois(trueRate), while the probability of firing of each SiPM is Binomial(trueEff)



From this simulation one can study a relation:

$$(\text{trueRate}, \text{trueEff}_0, \ldots, \text{trueEff}_3) \Longleftrightarrow (\text{majRate}, \text{pseudoEff}_0, \ldots, \text{pseudoEff}_3)$$

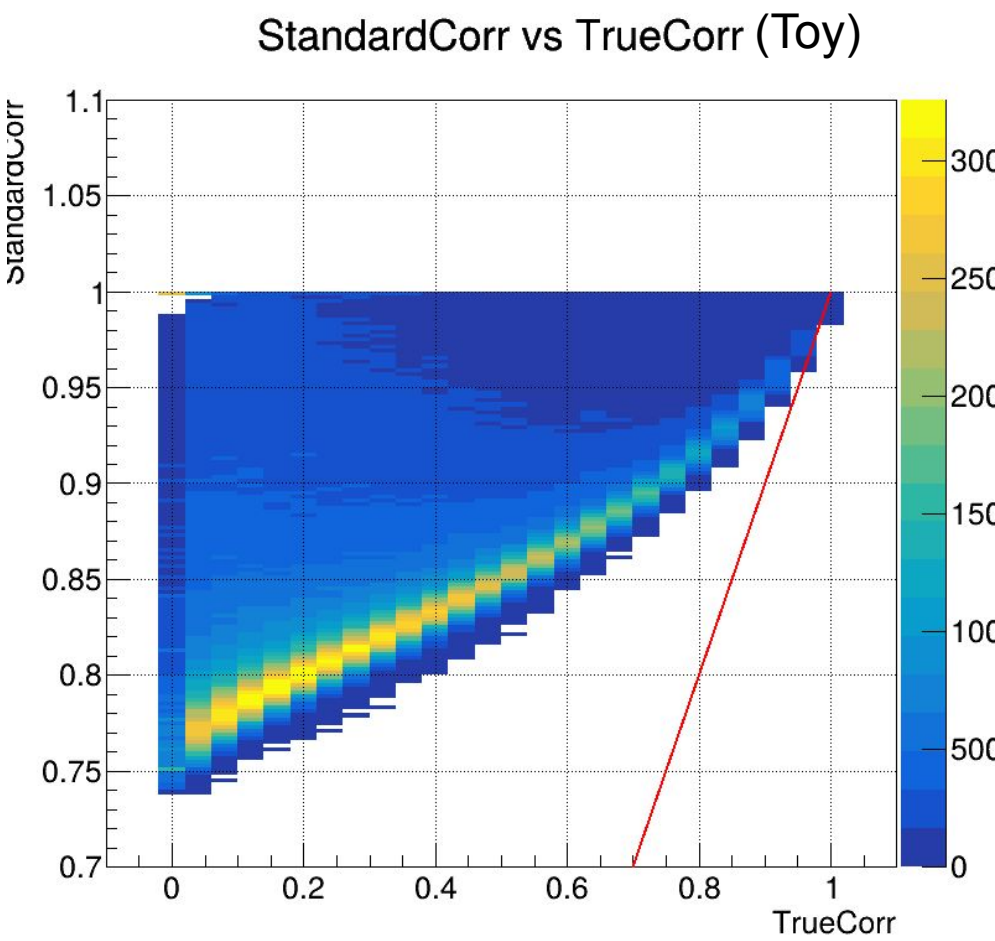
Toy model: fixed trueRate

The trueRate here is fixed, while the efficiency for each SiPMs is distributed $trueEff_i \sim Uniform(0,1)$

StandardCorr calculate the correction factor using the $pseudoEff_i$ while TrueCorr calculate the correction using the $trueEff_i$.

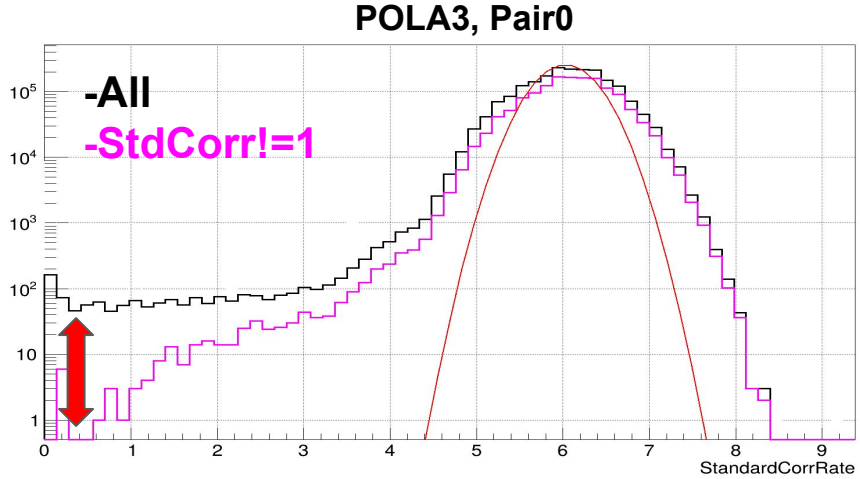
StandardCorr is systematically higher than TrueCorrection.
This is due the fact that:

pseudoEff > trueEff

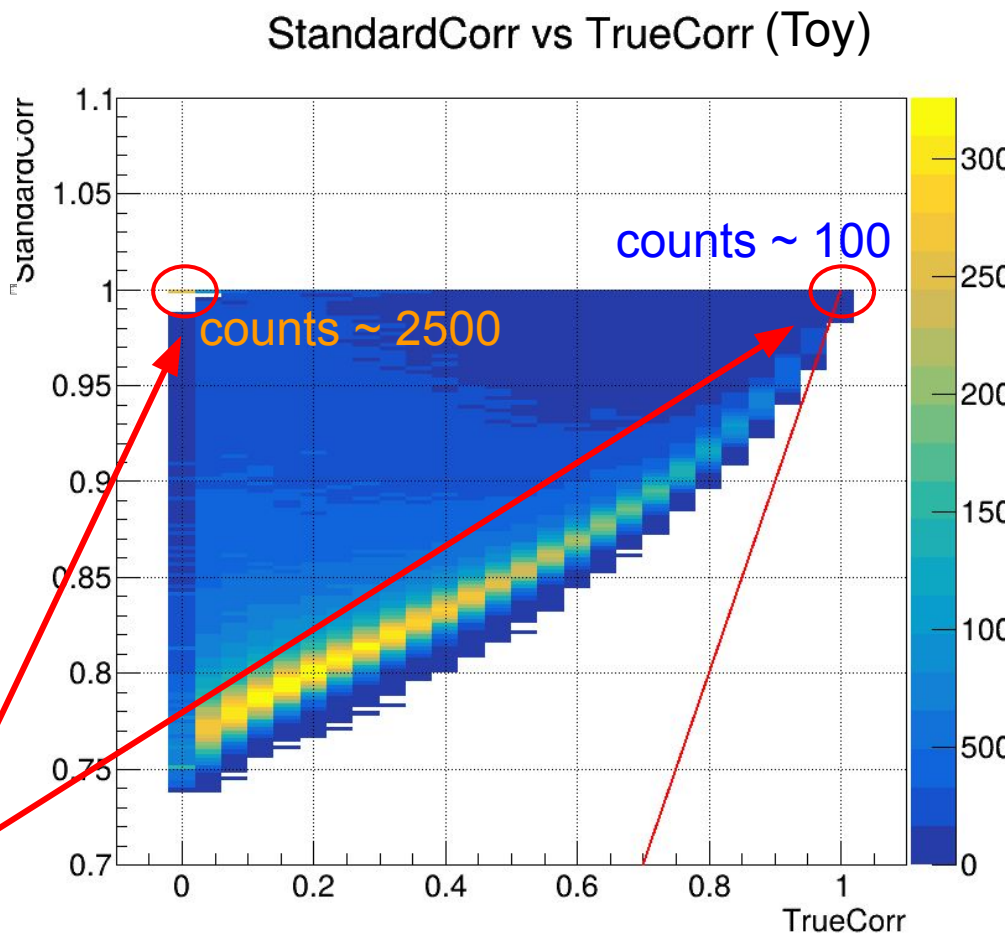


Toy model: fixed trueRate

We observed before that StandardCorr=1 was related to low rate



Toy confirm that probability of StandCorr=1 is higher for low pseudoEff compared to high one!

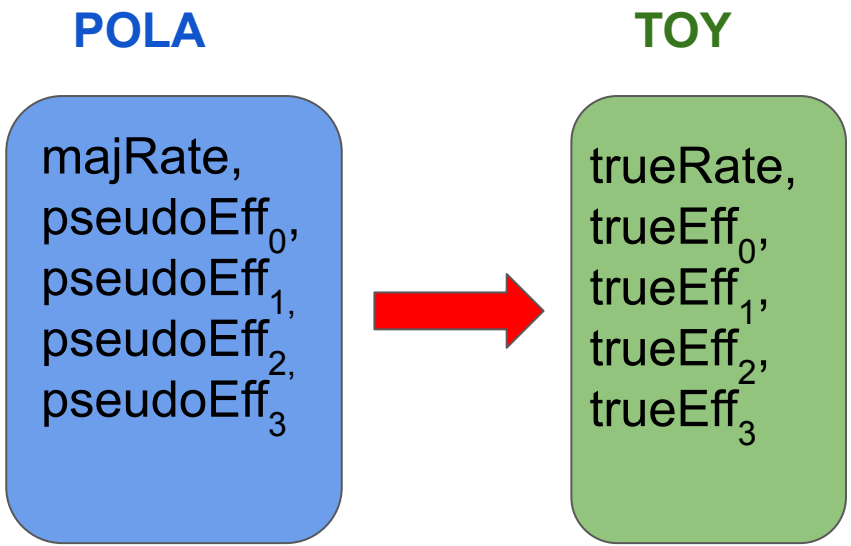


Toy model: application to POLA data

Idea: obtain an extensive toy simulation that explore all the possible POLA configuration,

then use the toy map to link POLA configuration to toy configuration

This permits to obtain an estimation of the trueEff$_i$ to be used to calculate the correction factor

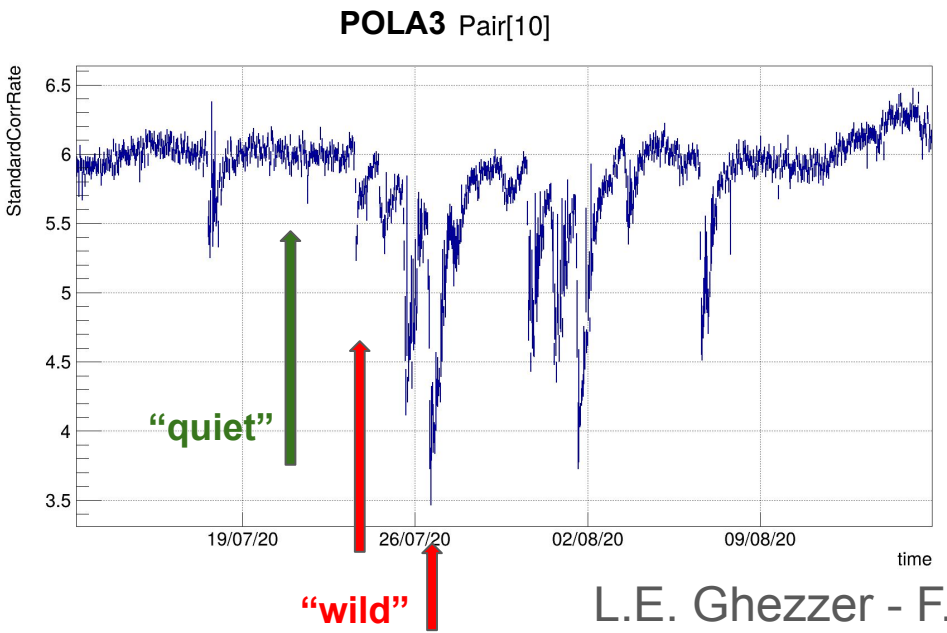


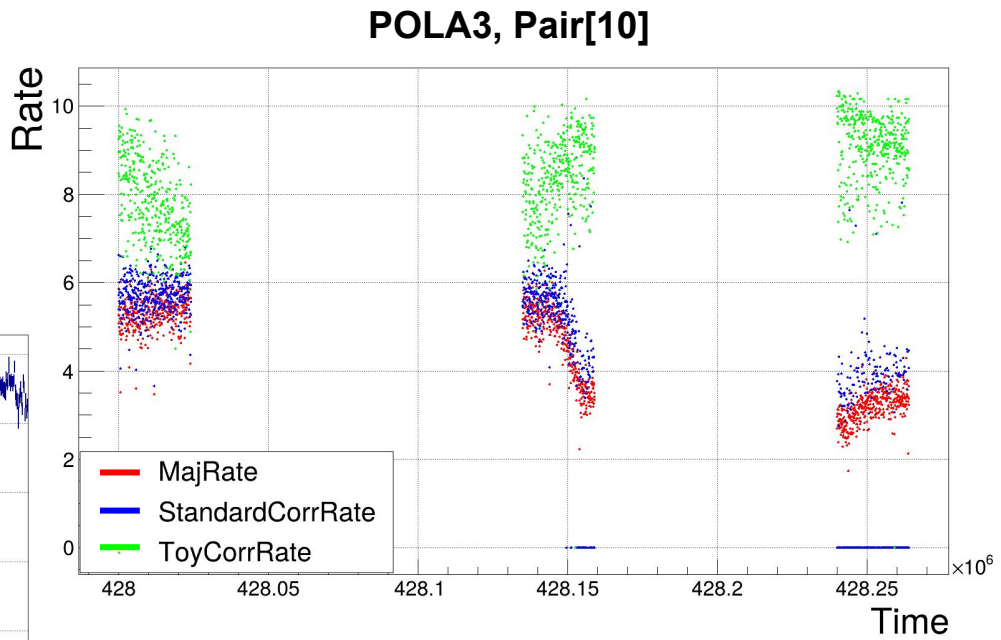
Toy model: test on “wild” periods

Test the toy correction on:

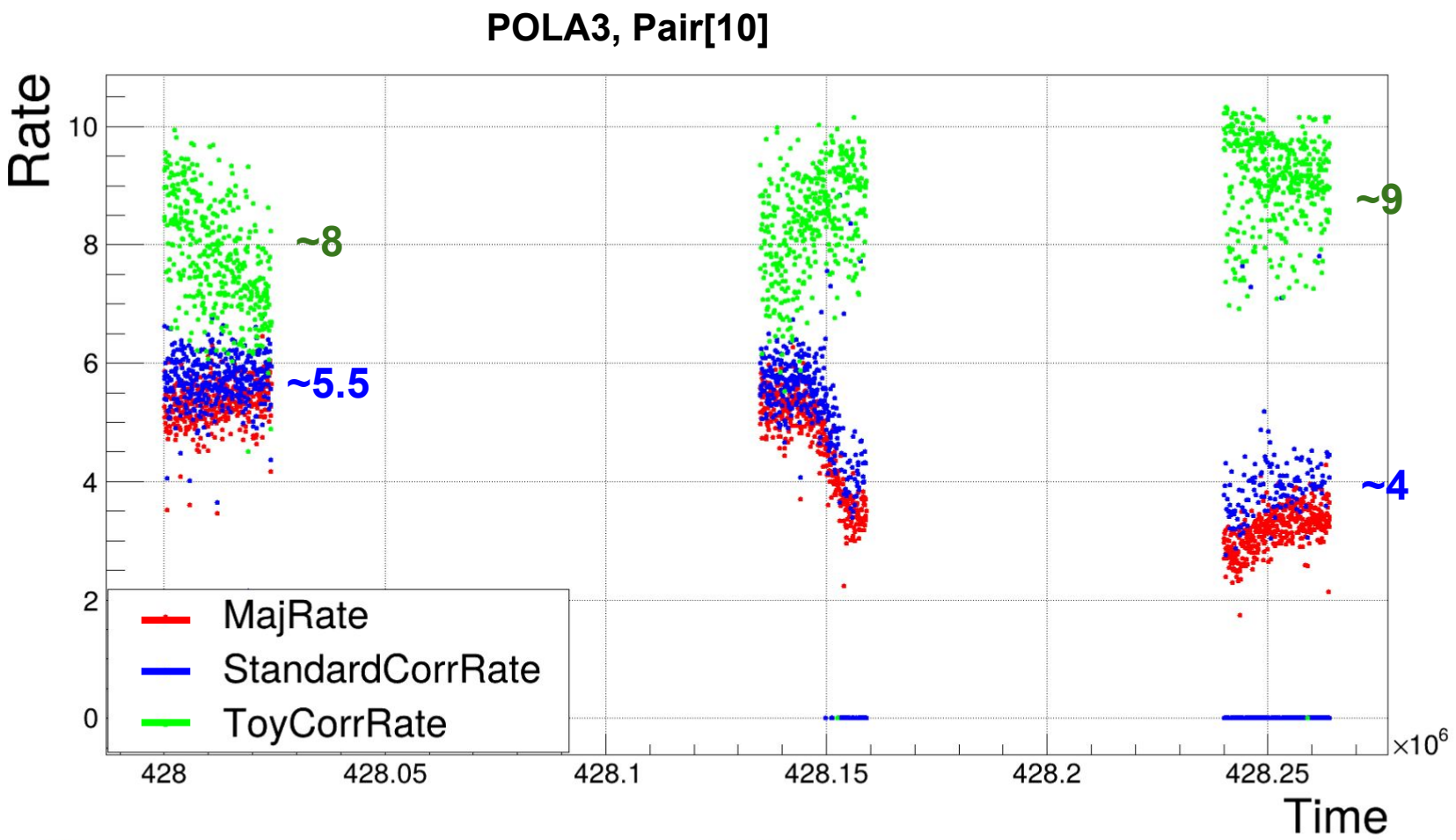
- **1 “quiet” period**
- **2 “wild” periods**

(where the StandardCorr have violent drops)





Toy model: test on “wild” periods



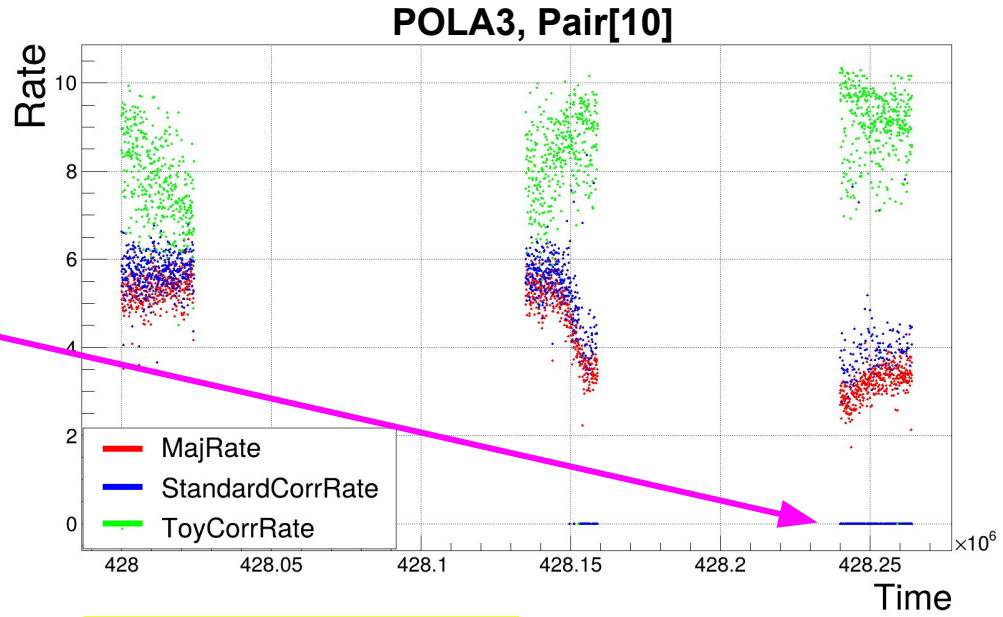
Anomalous minutes?

StandardCorrection fails in this "wild" periods, inspecting these events one find strange events

example POLA3, Pair[10]:

```
nEntry = 942077
ratePair[10] = 4.58333
eff[11] = 0.927711
eff[6] = 0.950617
eff[9] = 0
eff[4] = 0
```

why ratePair != 0 if two pseudoEff = 0? the ratePair should be 0 too. (status==0 true)



Access to raw data could be useful to better understand these strange events

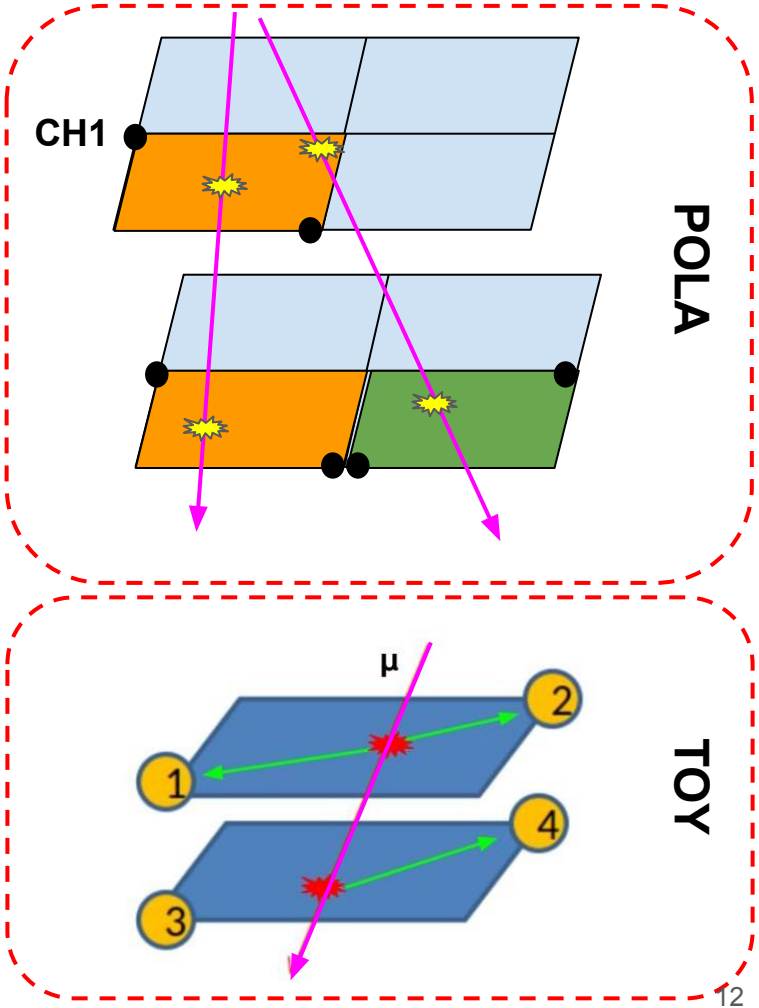
others strange nEntries for POLA3 pair 10: 942100, 942102, 942104, 942123, 942125, 942126, 942133, 942134, 942135, …

Difference between Toy and POLA

pseudoEff in POLA detectors are measured using both vertical and inclined muons. The pseudoEff of SiPM in Pair[i] depends also on events that do not crossed Pair[i]

Since vertical muons dominates, Toy simulate just a single Pair of tiles, a vertical one.

Again access on raw data could be useful to better understand and design the Toy



Backup

Comparison between the trueEff and the pseudoEff