



Istituto Nazionale
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Fundamental
Physics and
Applications



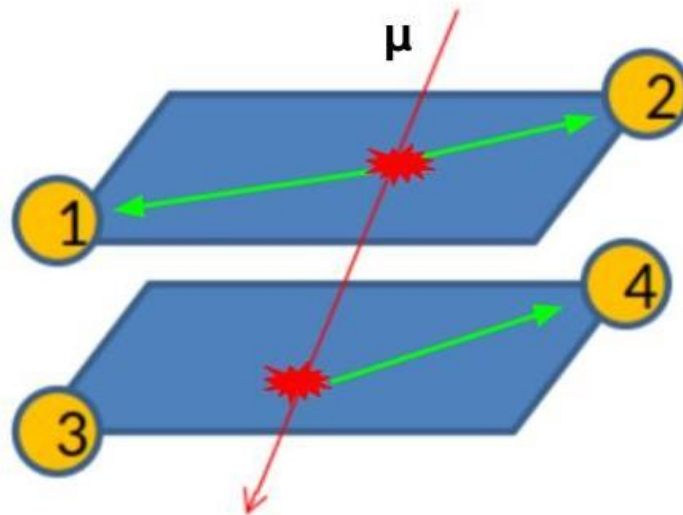
a “toy-model” for POLA-R efficiency corrections

PseudoEfficiency

It estimate the **efficiency of the SiPMs.**

PseudoEff₁ of SiPM₁ is the fraction of events that triggered thanks to SiPM₁ 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:

$$F = e_0 e_1 e_2 + \dots + e_1 e_2 e_3 - 3 e_0 e_1 e_2 e_3$$

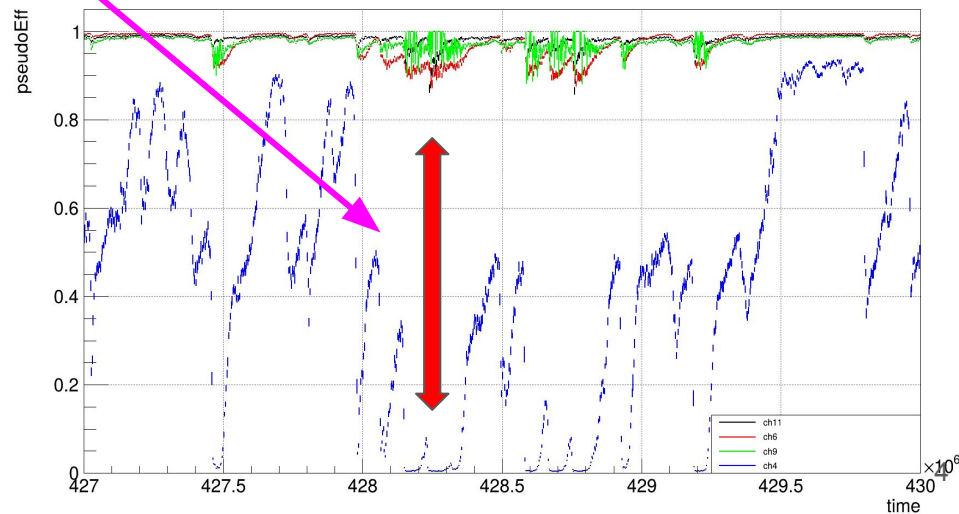
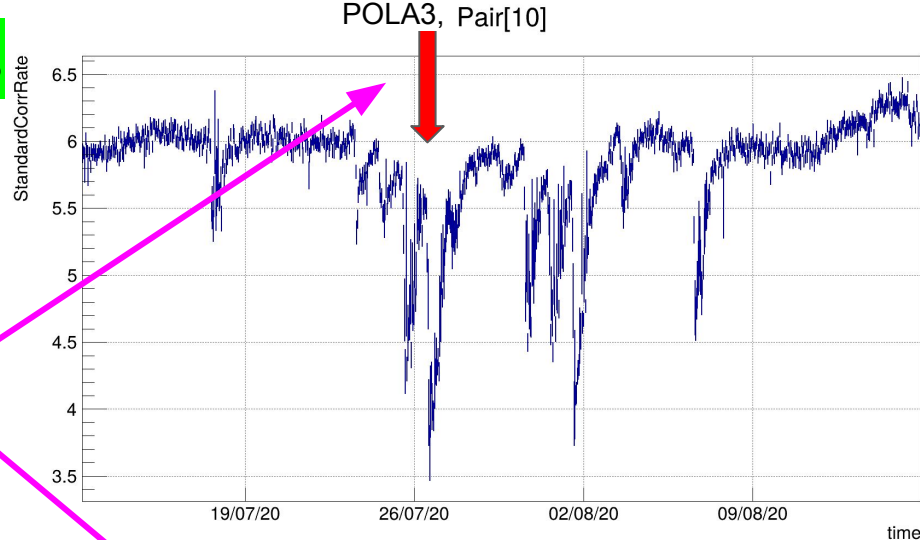
- If one assume that the pseudoEff e'_i well approximate the efficiency e_i , then one can approximate the factor by:

$$\text{if } e'_i \approx e_i \quad \Rightarrow \quad F' = e'_0 e'_1 e'_2 + \dots + e'_1 e'_2 e'_3 - 3 e'_0 e'_1 e'_2 e'_3$$

Suspect that StandCorr fails

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

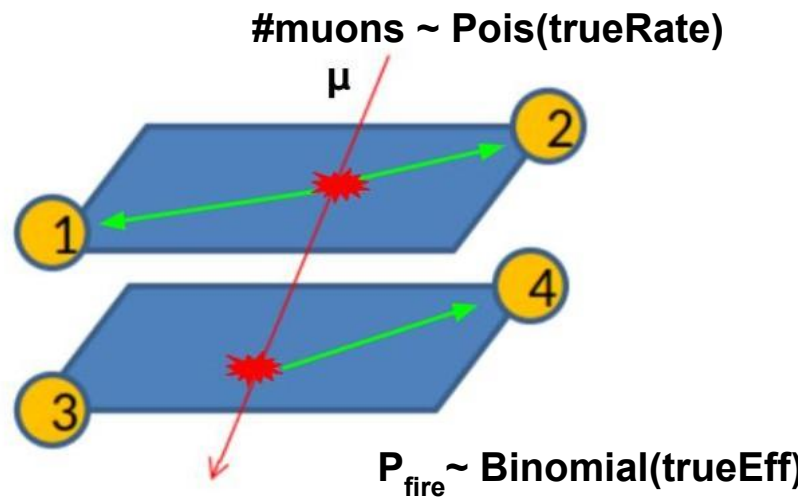
This rise the suspect that the approximation **$e'_i \approx e_i$** do not hold for low pseudoEff, so the F' do not correct the rate



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:

$$(\text{trueRate}, \text{trueEff}_0, \dots, \text{trueEff}_3) \longleftrightarrow (\text{majRate}, \text{pseudoEff}_0, \dots, \text{pseudoEff}_3)$$

Toy model: fixed trueRate

The **trueRate** here is **fixed**, while the efficiency for each SiPMs is distributed **$\text{trueEff}_i \sim \text{Uniform}(0,1)$**

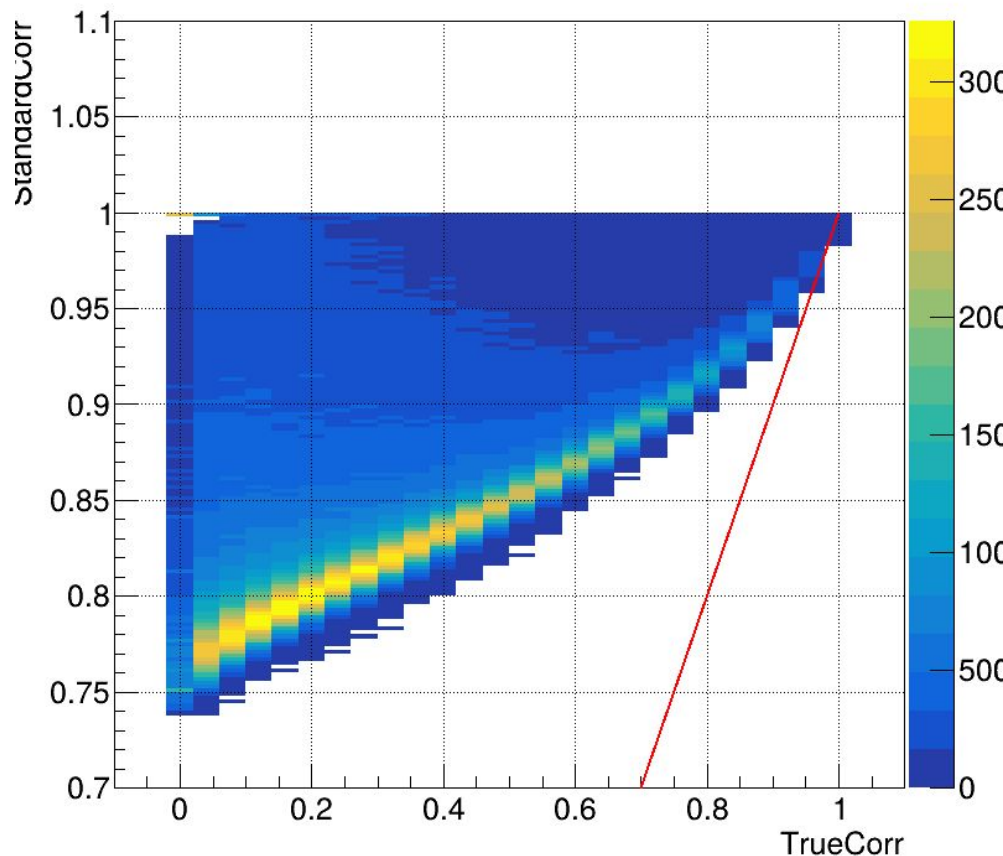
StandardCorr calculate the correction factor using the **pseudoEff_i** while TrueCorr calculate the correction using the **trueEff_i**.

StandardCorr is systematically higher than TrueCorrection.

This is due the fact that:

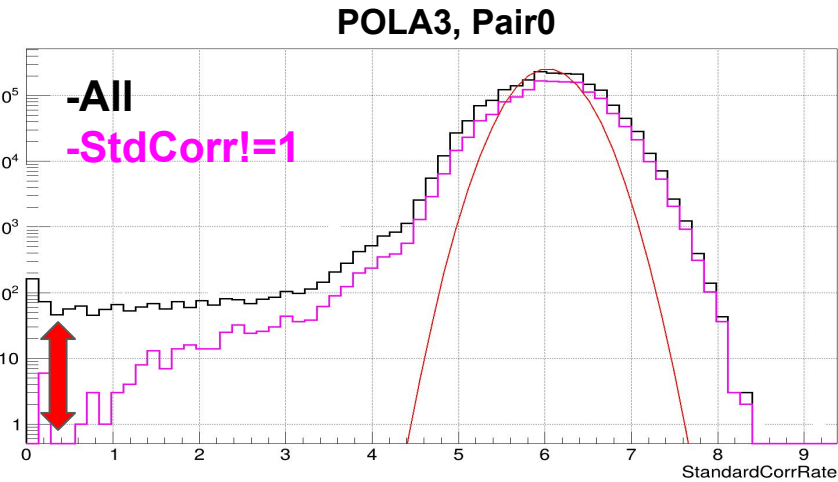
$$\text{pseudoEff} > \text{trueEff}$$

StandardCorr vs TrueCorr (Toy)



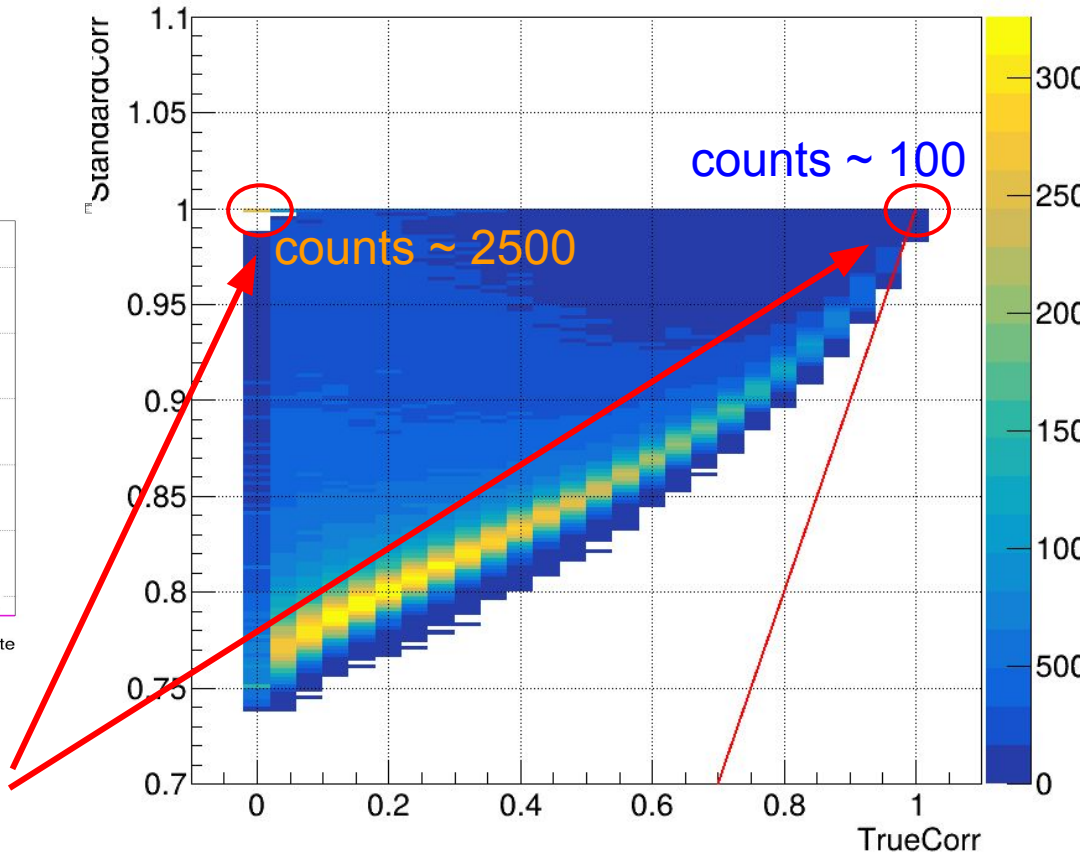
Toy model: fixed trueRate

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!

StandardCorr vs TrueCorr (Toy)



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**, to be used to calculate the correction factor

POLA

majRate,
pseudoEff₀,
pseudoEff₁,
pseudoEff₂,
pseudoEff₃



TOY

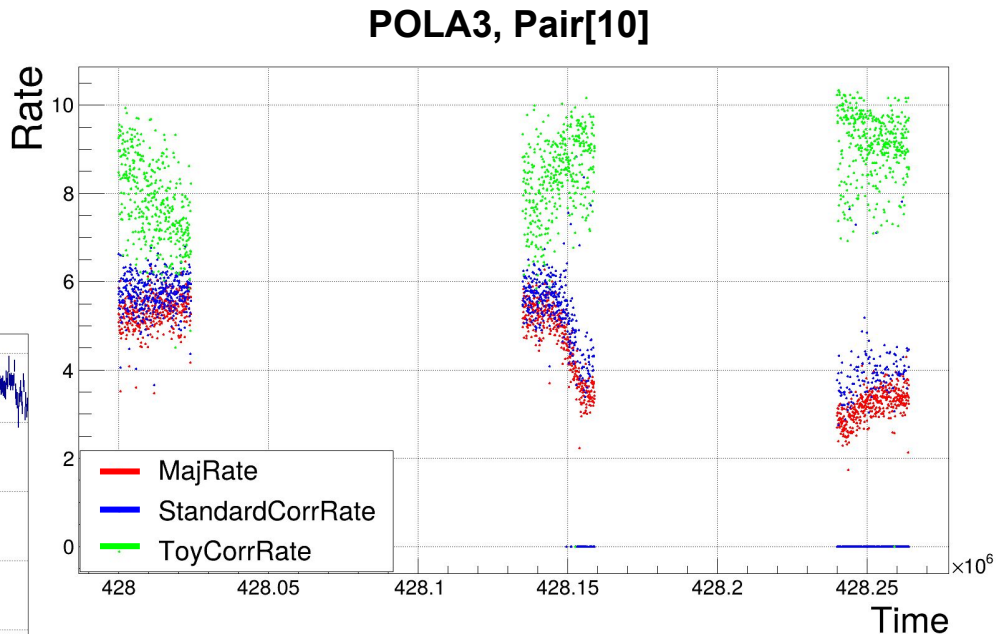
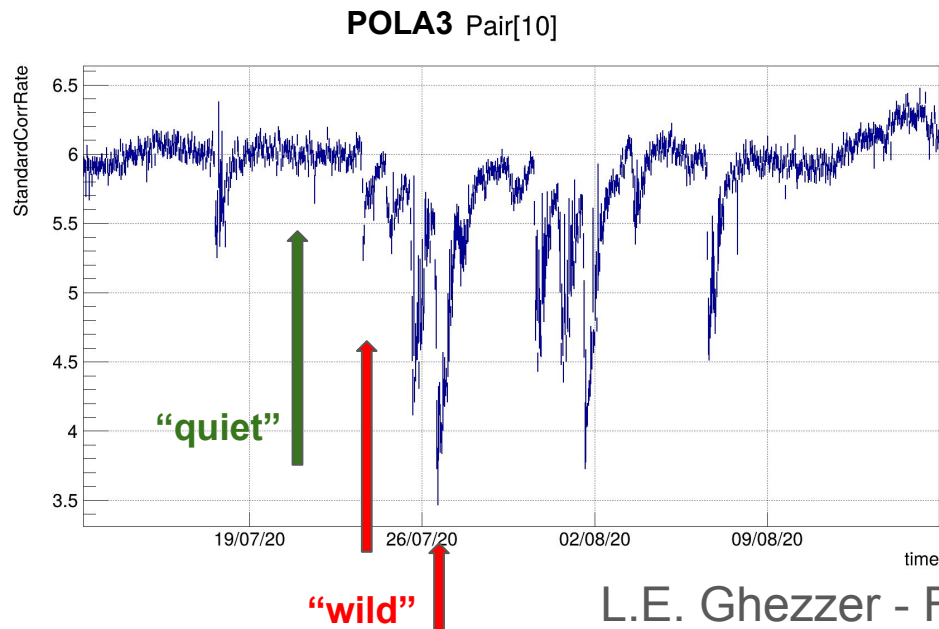
trueRate,
trueEff₀,
trueEff₁,
trueEff₂,
trueEff₃

Toy model: test on “wild” periods

Test the toy correction on:

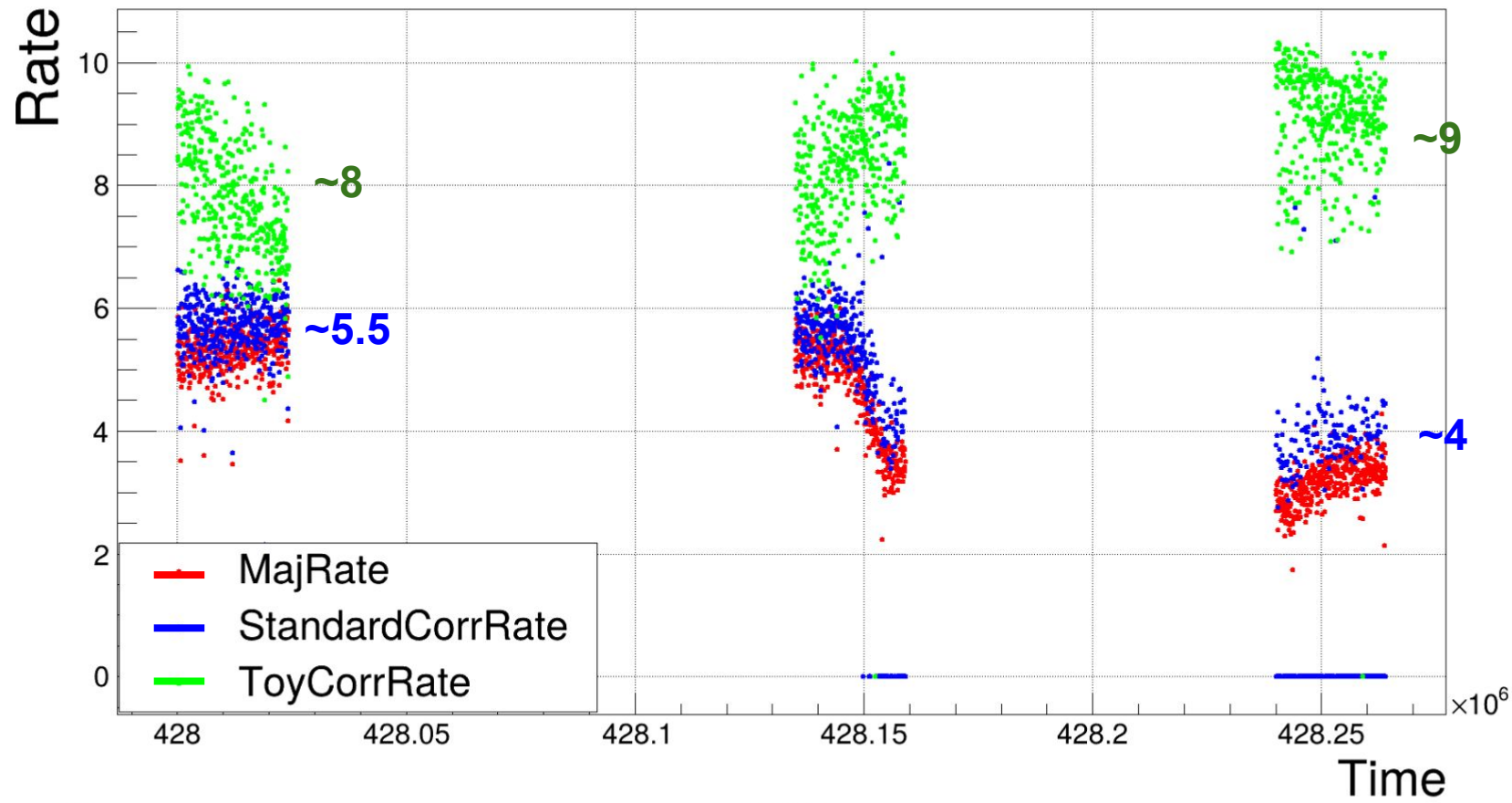
- 1 “quiet” period
- 2 “wild” periods

(where the StandardCorr have violent drops)



Toy model: test on “wild” periods

POLA3, Pair[10]



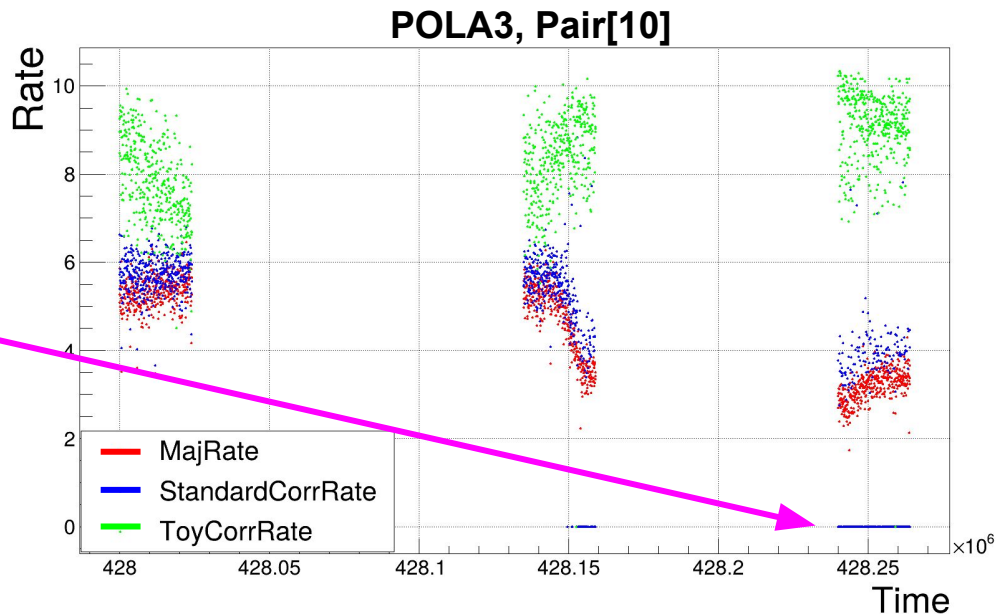
Anomalous minutes?

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

