



Istituto Nazionale
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TIFPA

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Fundamental
Physics and
Applications



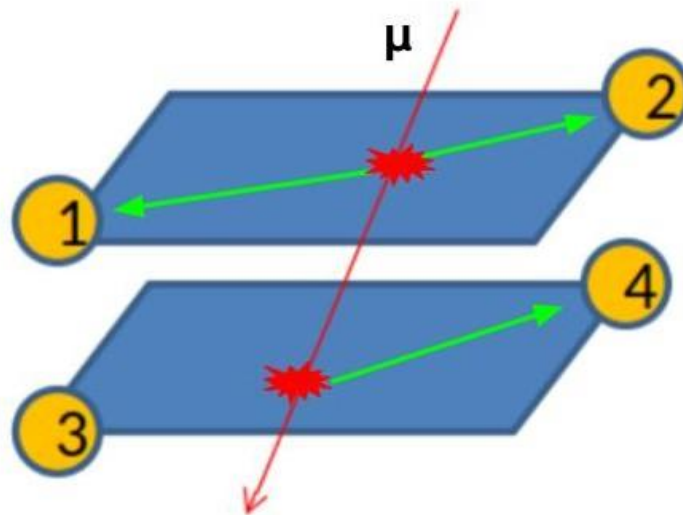
A new approach for efficiency correction

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The “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.



the “Standard Correction”

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

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

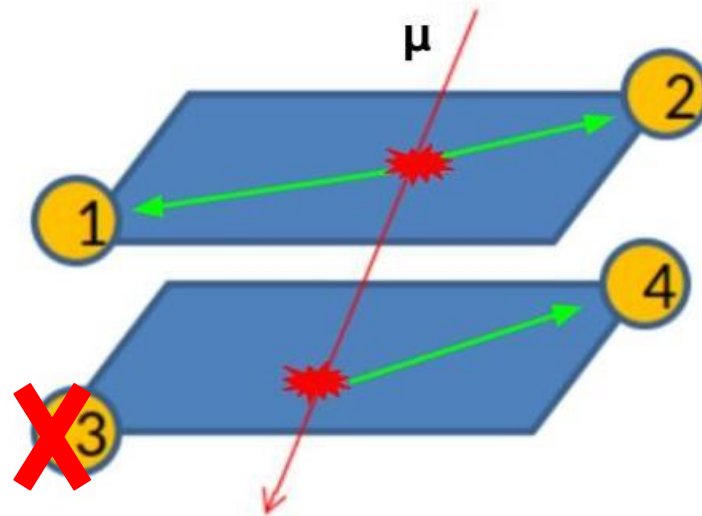
- If one assume that the pseudoEff e'_i well approximate the efficiency e_i , then one can approximate the factor by:

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

An ideal case where Standard Correction fail

Consider SiPM[3] has a low efficiency,
because the trigger condition is majority
3 over 4 SiPM

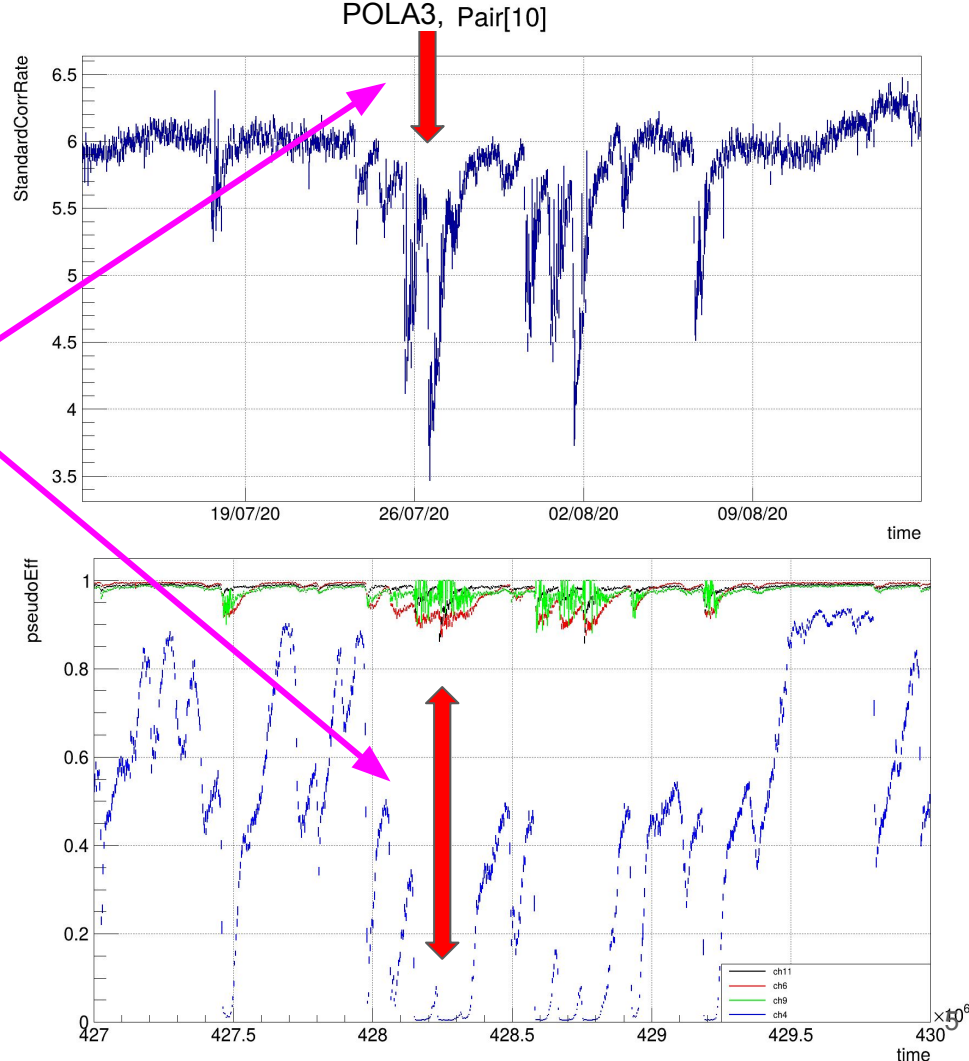
this push the PseudoEff of the other
3 channel to PseudoEff = 1



Real case were StdCorr 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



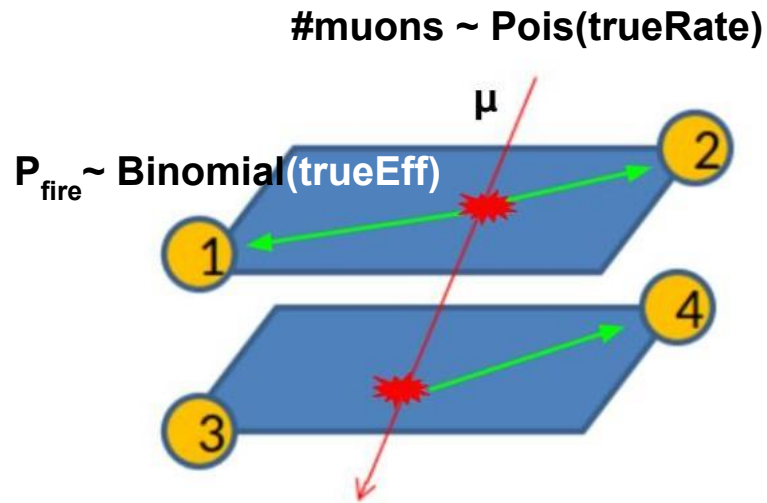
the “Toy model”

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

Probability of firing of SiPM_i is
Binomial ($p_i = \text{trueEff}_i$)

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: application to POLAR data

Idea: obtain an extensive toy simulation that explore all the possible POLAR configuration to *map* the relation between pseudoEff_i and trueEff_i

This will permit to *invert* the map to obtain an estimation of the trueEff_i from the experimental POLAR data

POLAR

majRate,
 pseudoEff_0 ,
 pseudoEff_1 ,
 pseudoEff_2 ,
 pseudoEff_3



TOY

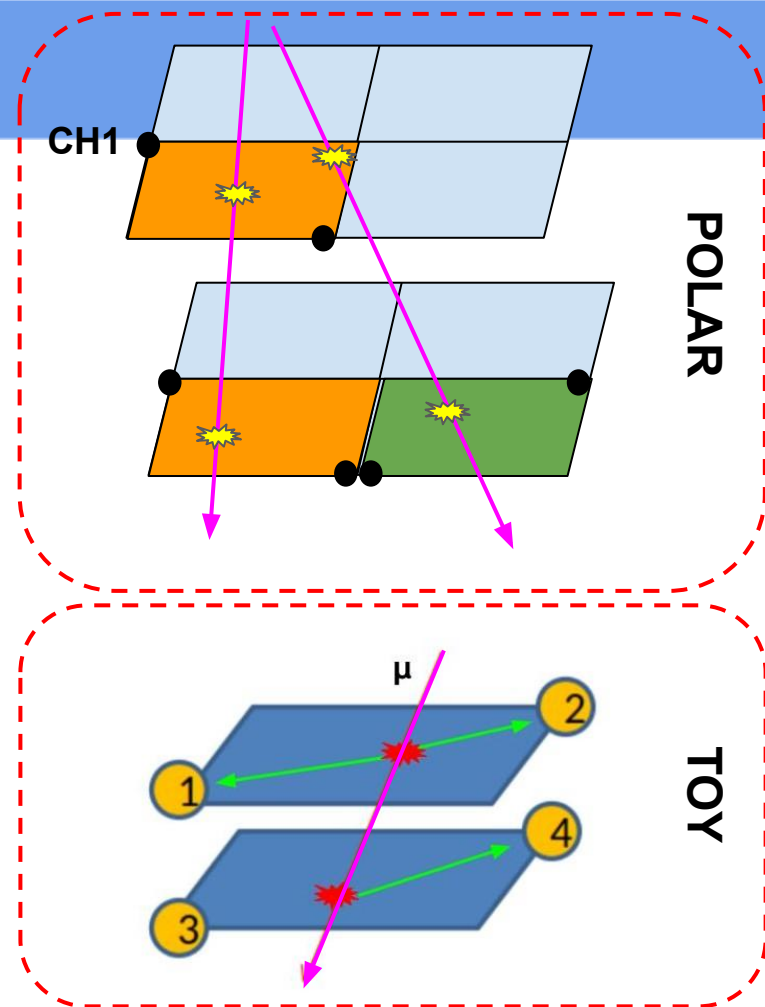
trueRate,
 trueEff_0 ,
 trueEff_1 ,
 trueEff_2 ,
 trueEff_3

Difference between Toy and POLAR

pseudoEff in POLAR detectors were measured using both vertical and inclined muons

Making a toy of this system is unfeasible, new analysis of raw data needed

F. Noferini produced a *new analysis* where pEff are calculated as the Toy

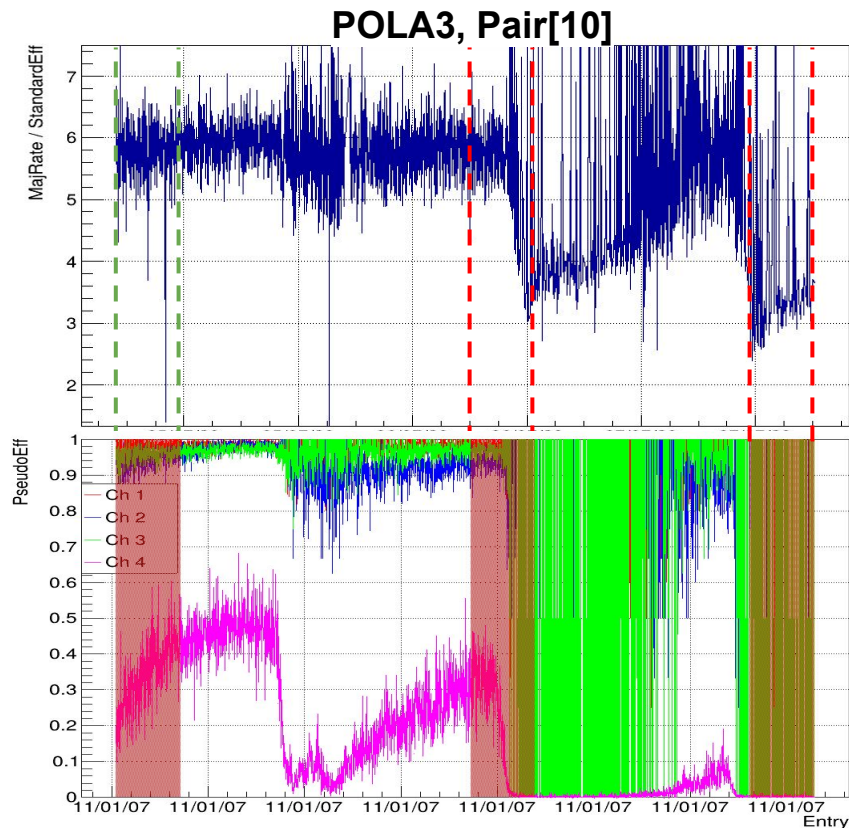


Toy correction: test on “wild” periods

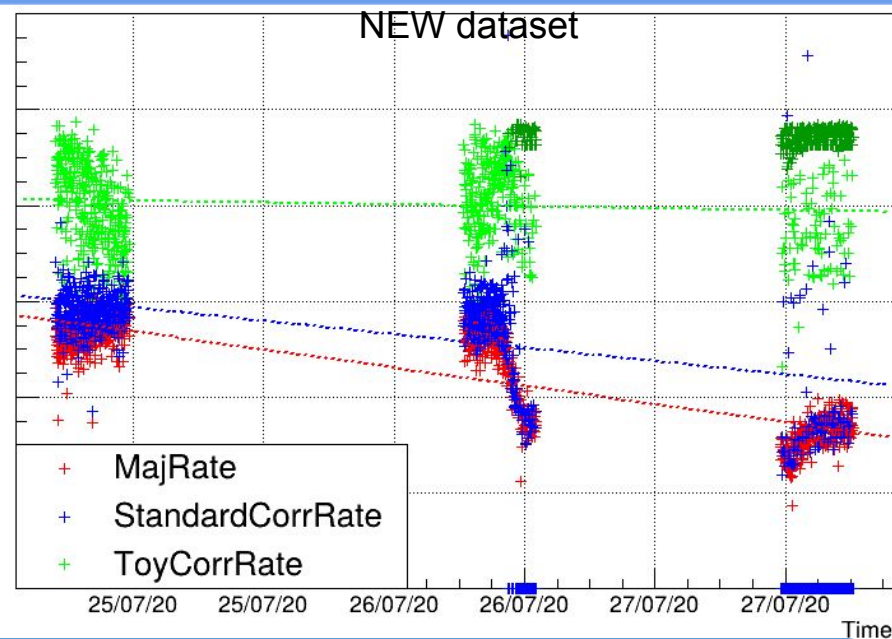
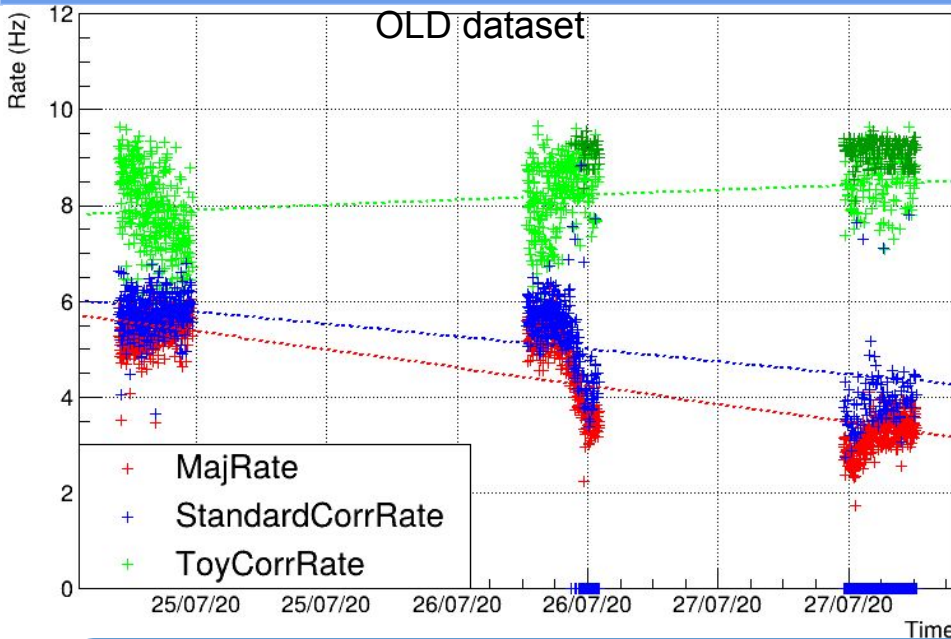
Test the toy correction on:

- 1 “quiet” period
- 2 “wild” periods

(where the PseudoEff have drops and StandardCorrection changes)



Toy correction: test on “wild” periods



Slope of the rate as an indicator of the goodness of a correction method on wild period

MajRate -1.26 ± 0.02 [Hz/day]

StdCorr -0.87 ± 0.03 [Hz/day]

ToyCorr 0.34 ± 0.04 [Hz/day]

MajRate -1.26 ± 0.02 [Hz/day]

StdCorr -0.93 ± 0.06 [Hz/day]

ToyCorr -0.13 ± 0.05 [Hz/day]

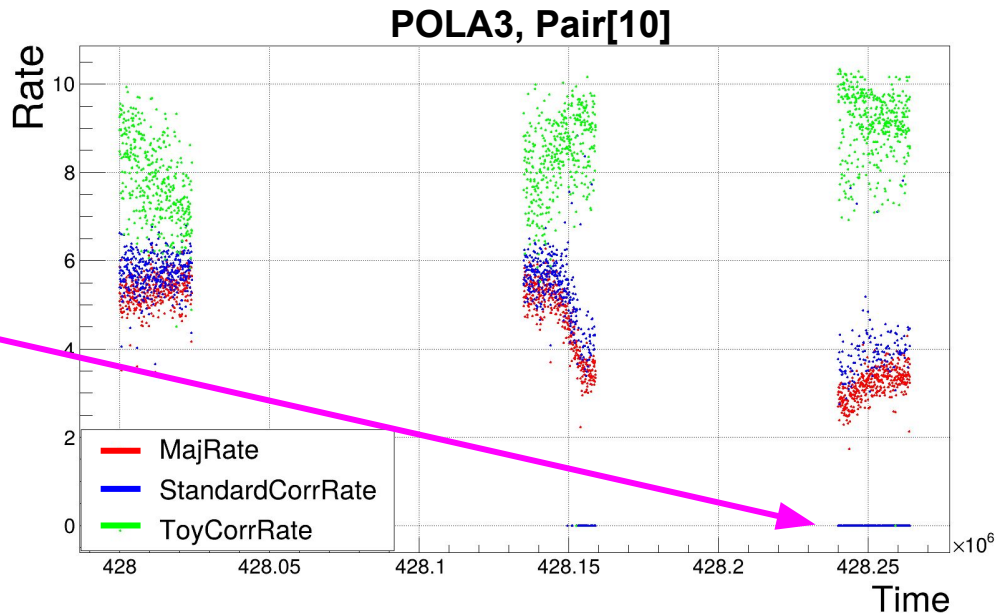
Anomalous minutes? (OLD)

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, ...

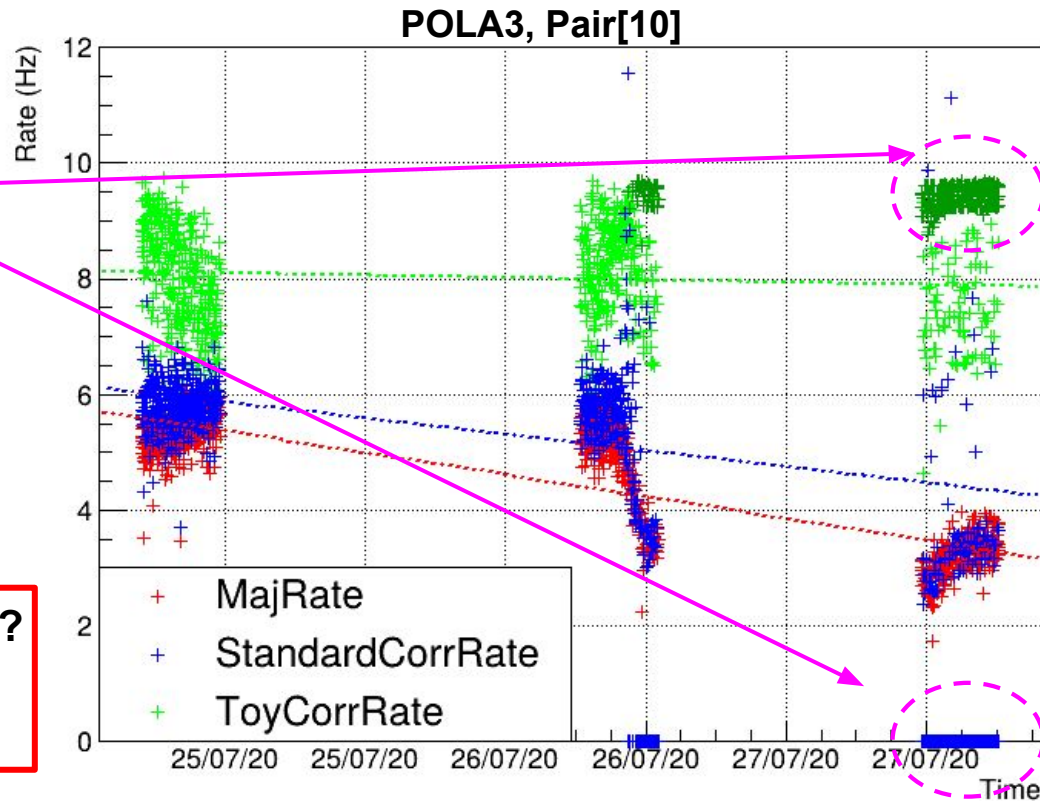
Anomalous minutes? (NEW)

In the new analysis from Noferini there are still “strange” events

example POLA3, Pair[10]:

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

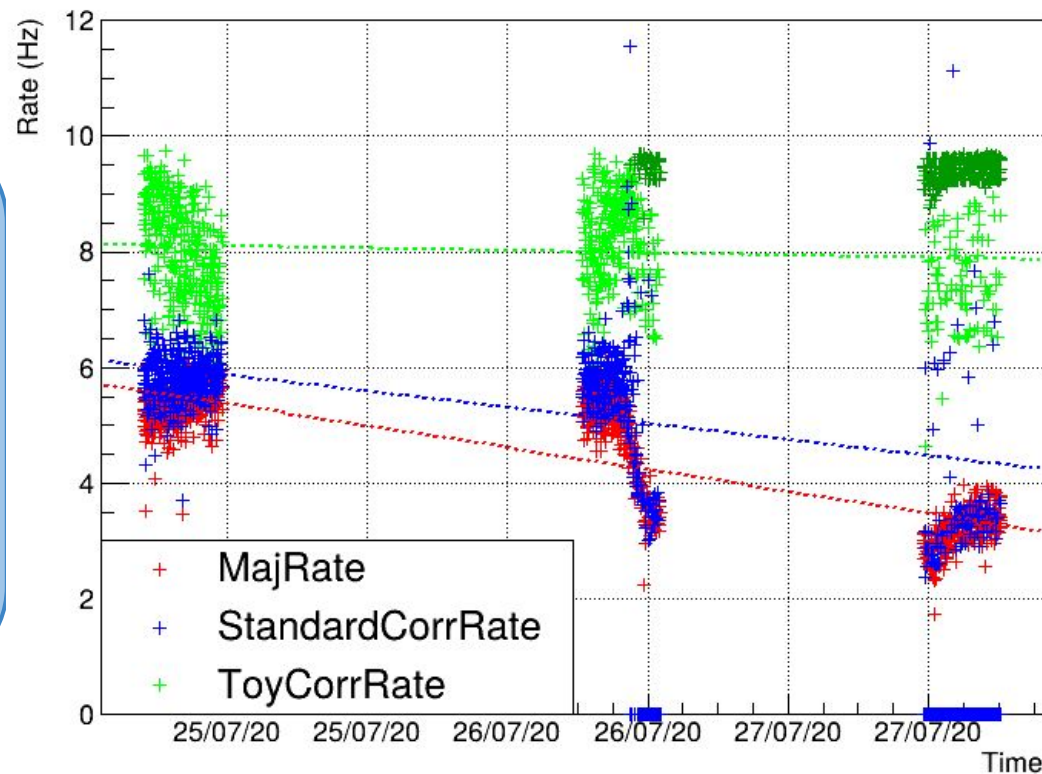
**why ratePair $\neq 0$ if *four* pseudoEff = 0?
the ratePair should be 0 too.
(status==0 true)**



Fraction of “strange” events $\sim 30\%$ in this subset

Conclusion

- Toy Correction seems promising, better performance compared to the Standard one
- “Strange” events are still present, investigation could be useful



BACKUP

Other strange events for POLA3, Pair 10

entry

942085

942100

942102

942104

942119

942123

942124

942125

942126

942133