

VEM A/P profiles extended to May 2018

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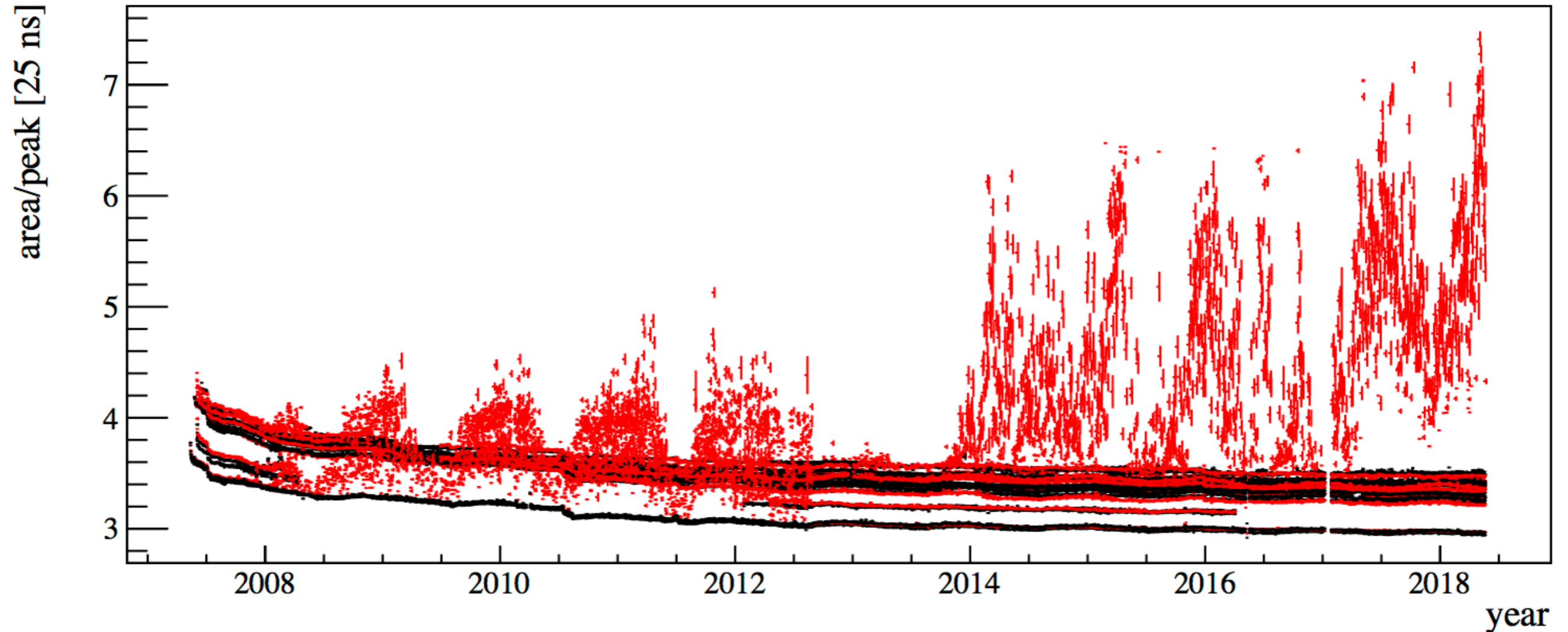
Goals of the analysis

- Answer a few questions about 10 more years of operation:
 - How much will be the A/P loss?
 - How many PMTs will we need to replace/fix? (i.e. How many new PMTs are raining /year)
 - Are the new electronics influencing the basic variables?
- How to answer?
 - Reproduce previous results (GAP2012-154, GAP2016-038, ...)
 - Improve the algorithms and include new data

Selection of “good” PMTs

	Previous report(GAP2012-154)	This report
Used data	Jan 2004 ~ Dec 2011	Jan 2004 ~ May 2018
Cuts1	<p>T1 != 0 fTubeMask = 7 or 15 fArea != 0 fPeak != 0 Variance Dynode/Anode < 4.5</p>	<p>T1 != 0 fTubeMask = 7 or 15 9 <= fArea <= 1000 9 <= fPeak <= 200 Variance Dynode/Anode < 4.5</p>
Cuts2	<p>“sweep algorithm” to discard raining PMTs</p>	<p>PMTs with RMS error > 2σ or PMTs with failed fitting are rejected</p>
# of used PMTs	2000 out of 5000 PMT remained	3177 out of 5081 PMTs remained

A/P profile examples

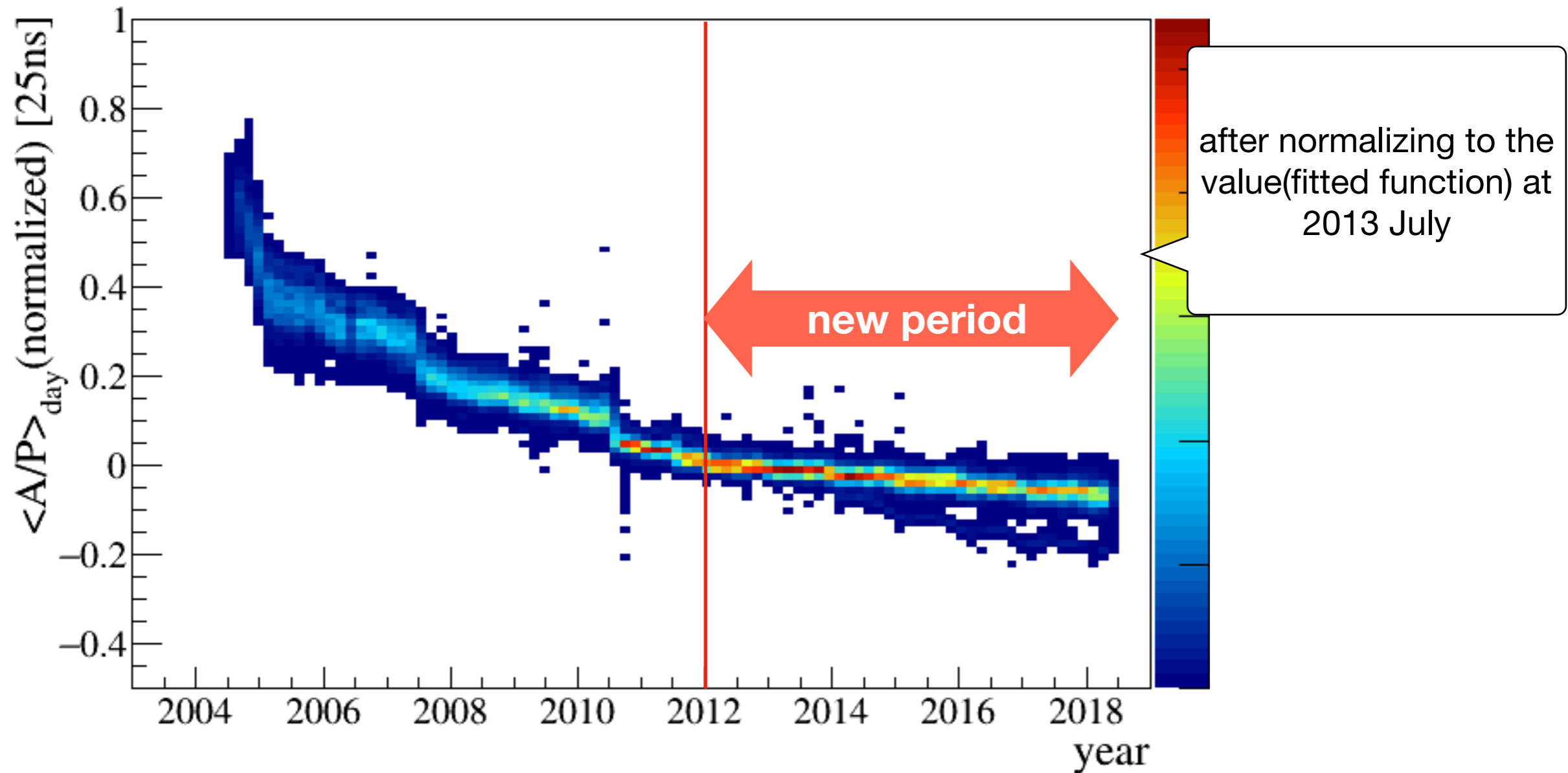


with RMS cut, large fraction of the bad PMTs(red) are rejected

Overall behavior

- Any new fault since the last report?

example of stacked A/P profiles(station ID 550 ~ 600)

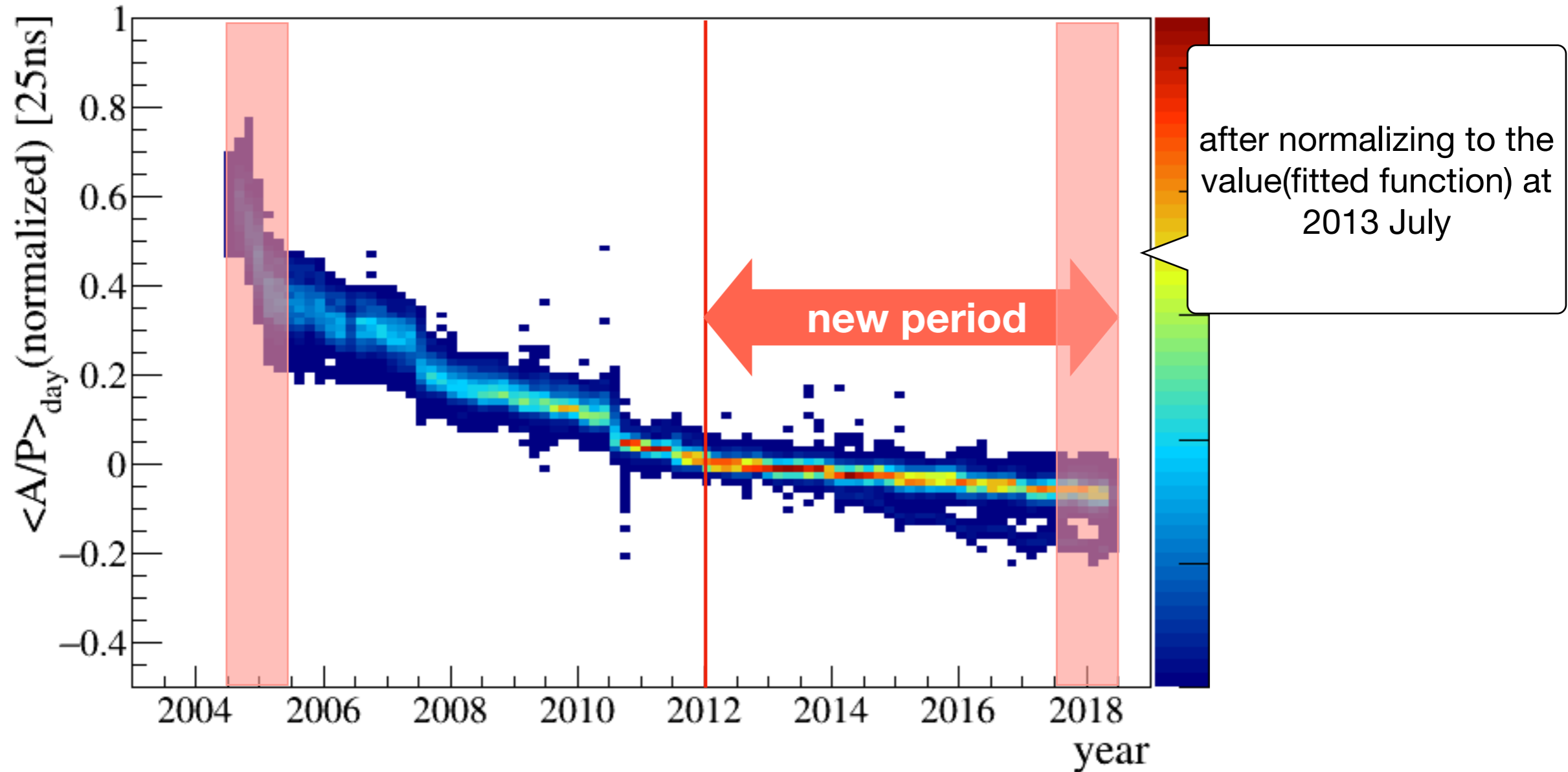


No visible discontinuity was observed in the newly investigated period

Overall behavior

- Any new fault since the last report?

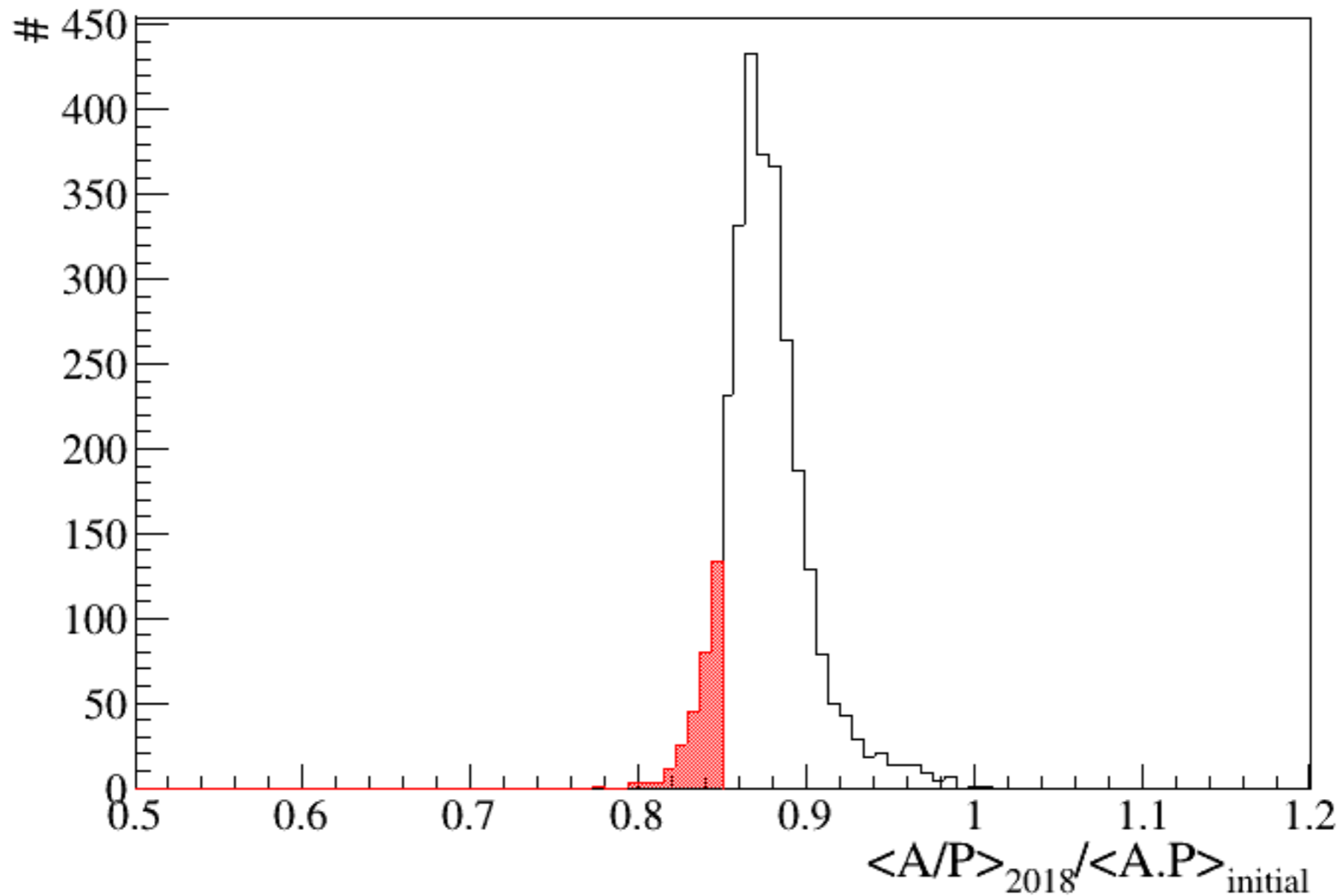
example of stacked A/P profiles(station ID 550 ~ 600)



No visible discontinuity was observed in the newly investigated period

Decrease of A/P

$\langle A/P \rangle$ in 2018 / $\langle A/P \rangle$ in the initial year

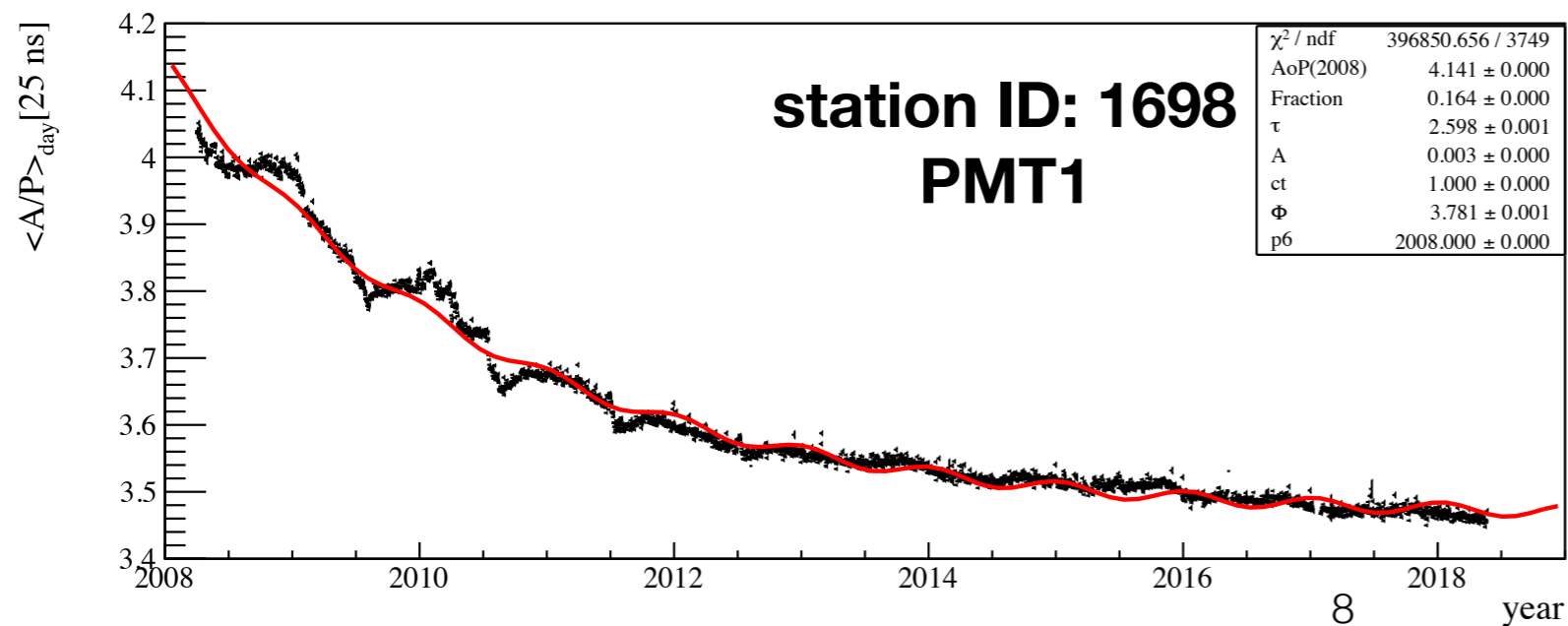
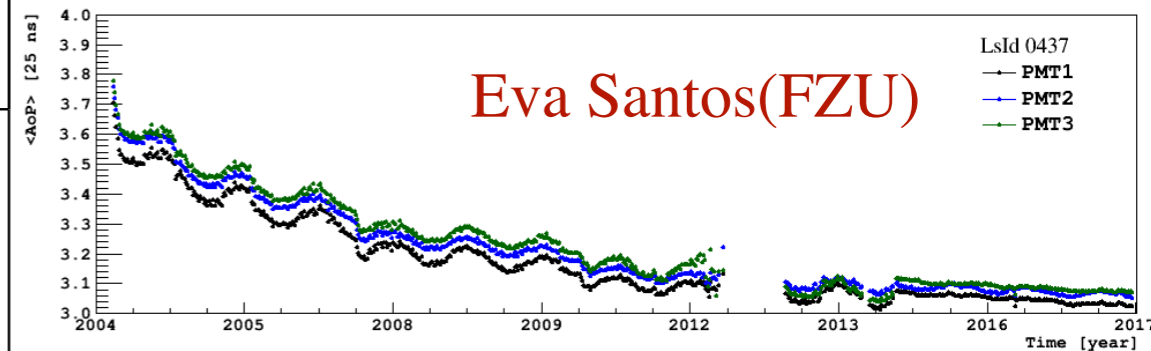
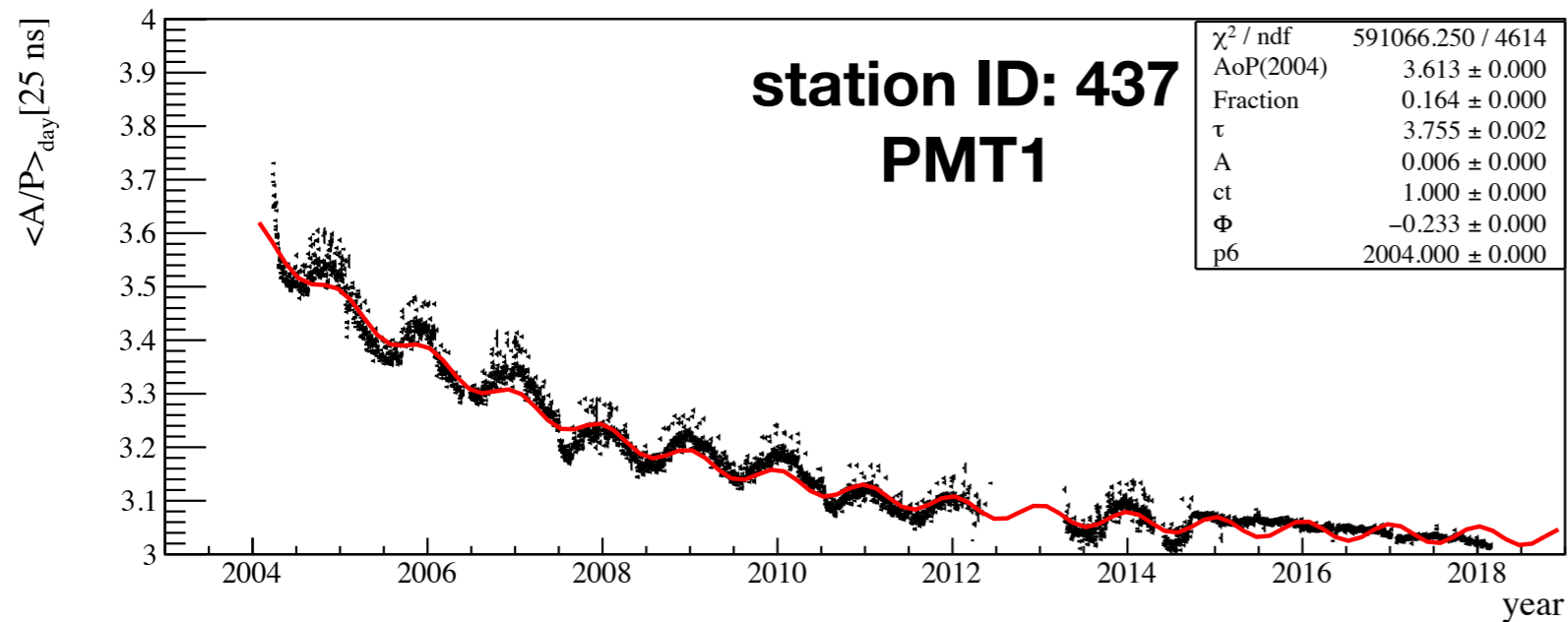


305 PMTs among 2925 PMTs (10.4%) experienced larger loss than 85% ...

Examples of fit

fitting function(as in the 2012 GAP note):

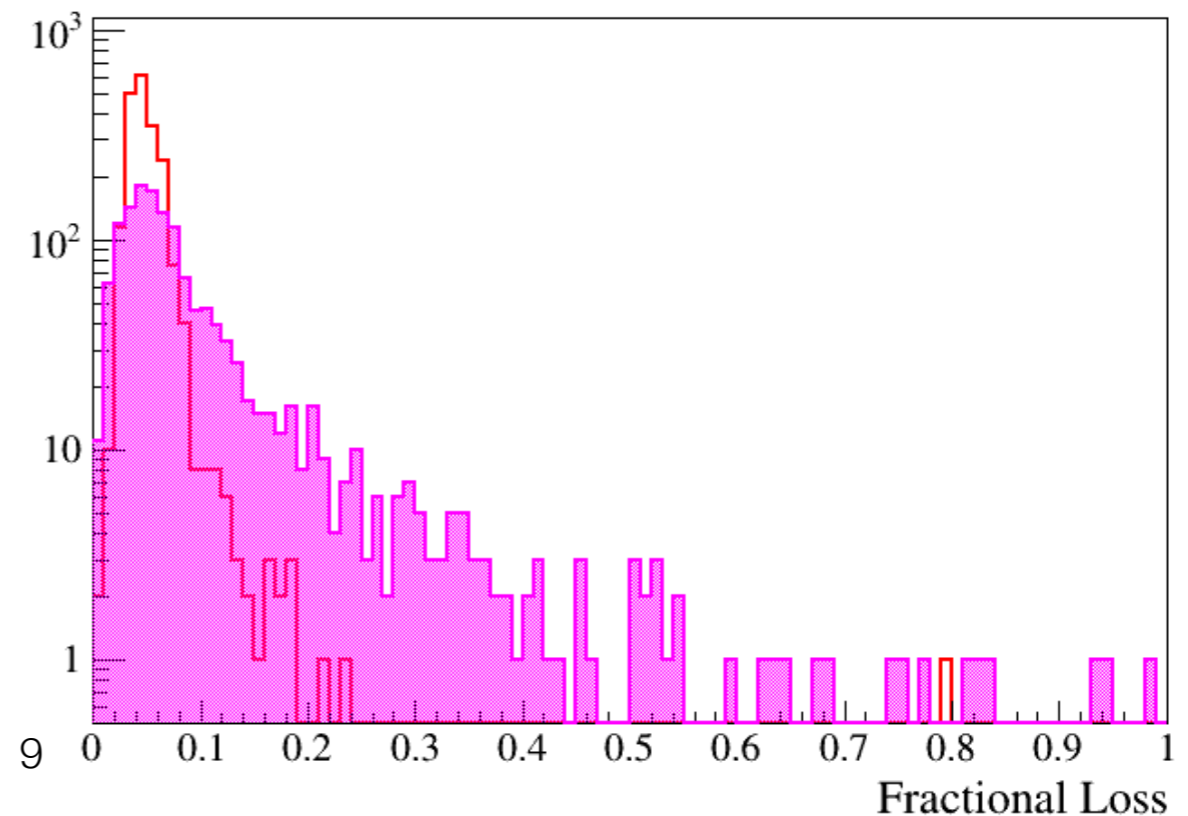
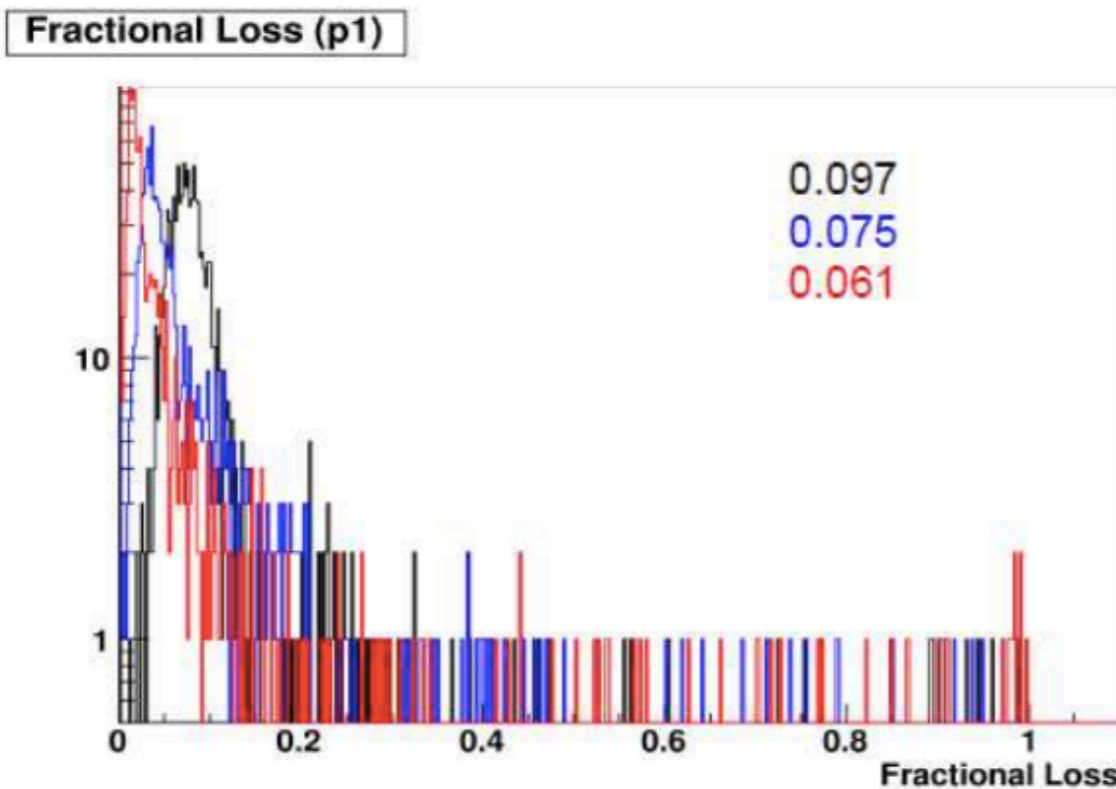
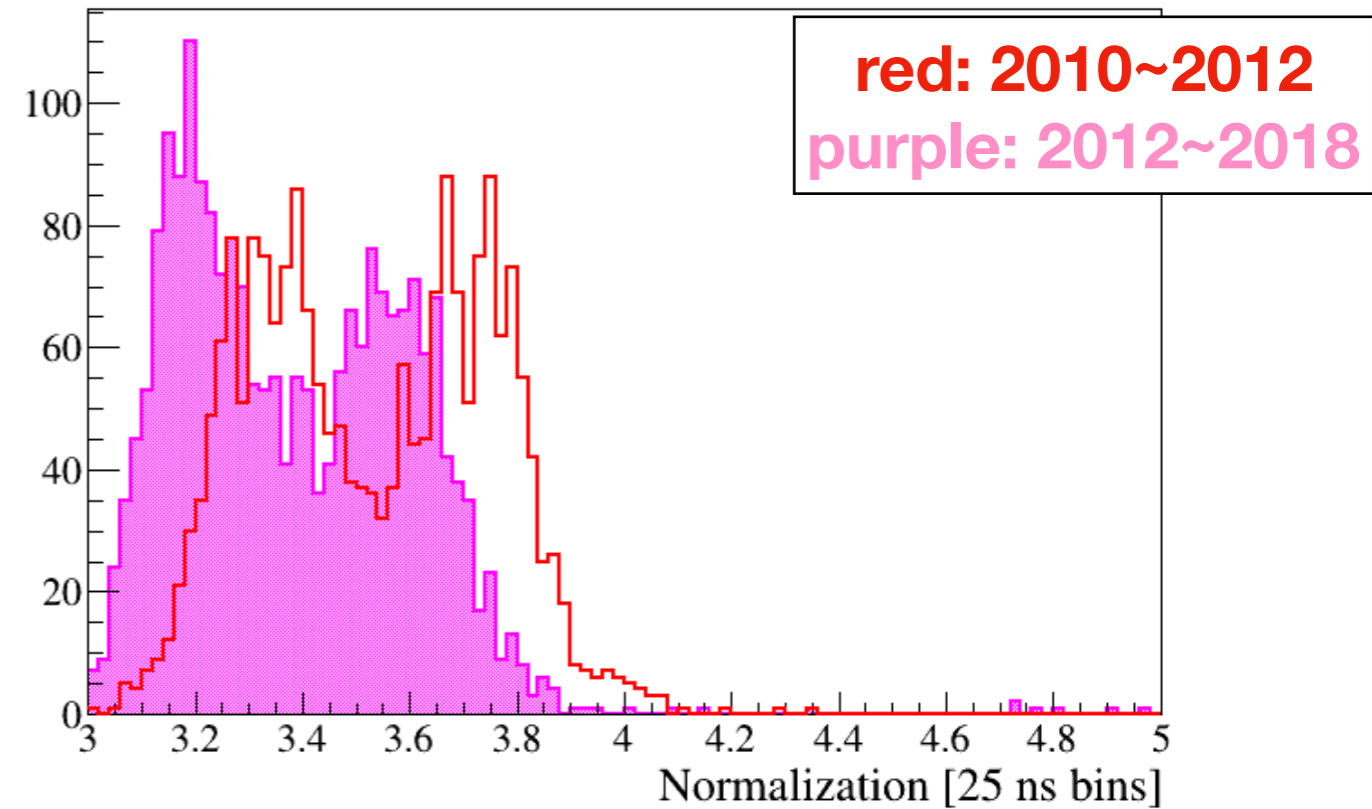
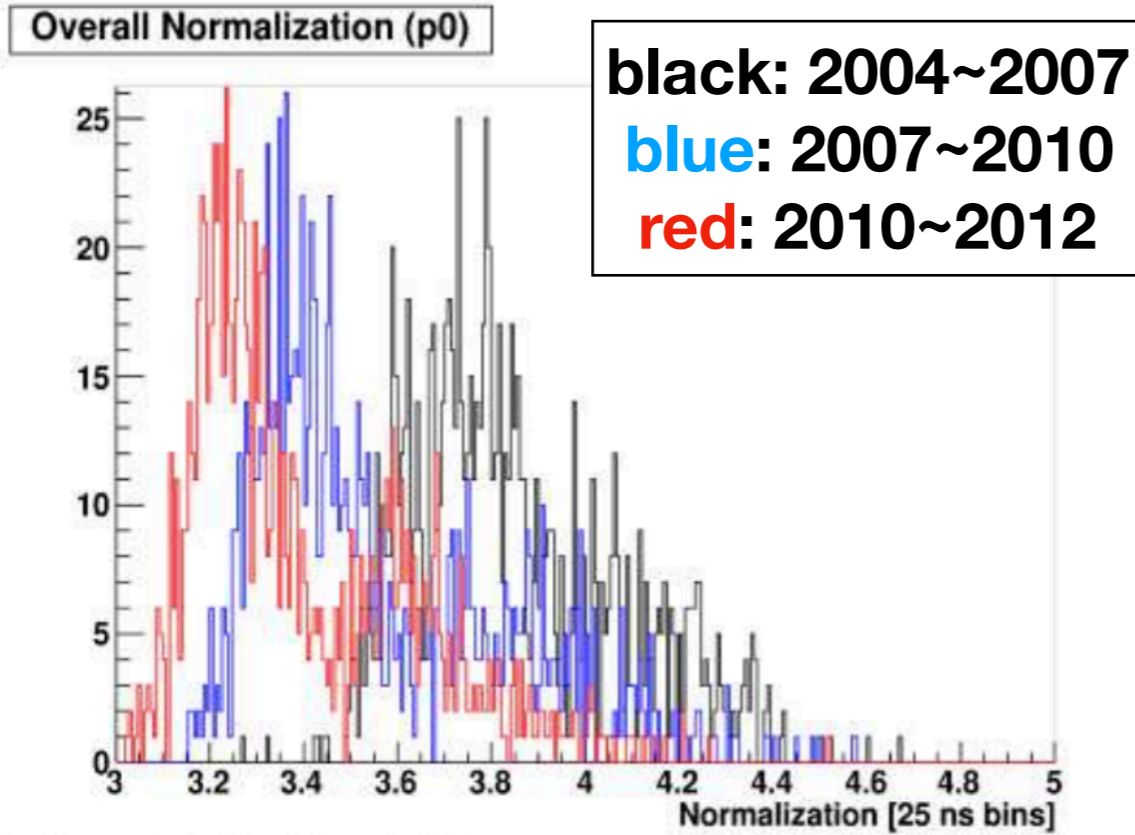
$$A/P = A/P_0 \times [1 - \text{frac} \cdot (1 - e^{-\frac{t}{\tau}})] \times [1 + A \cdot \sin(2\pi(\frac{t}{T} - \phi))]$$



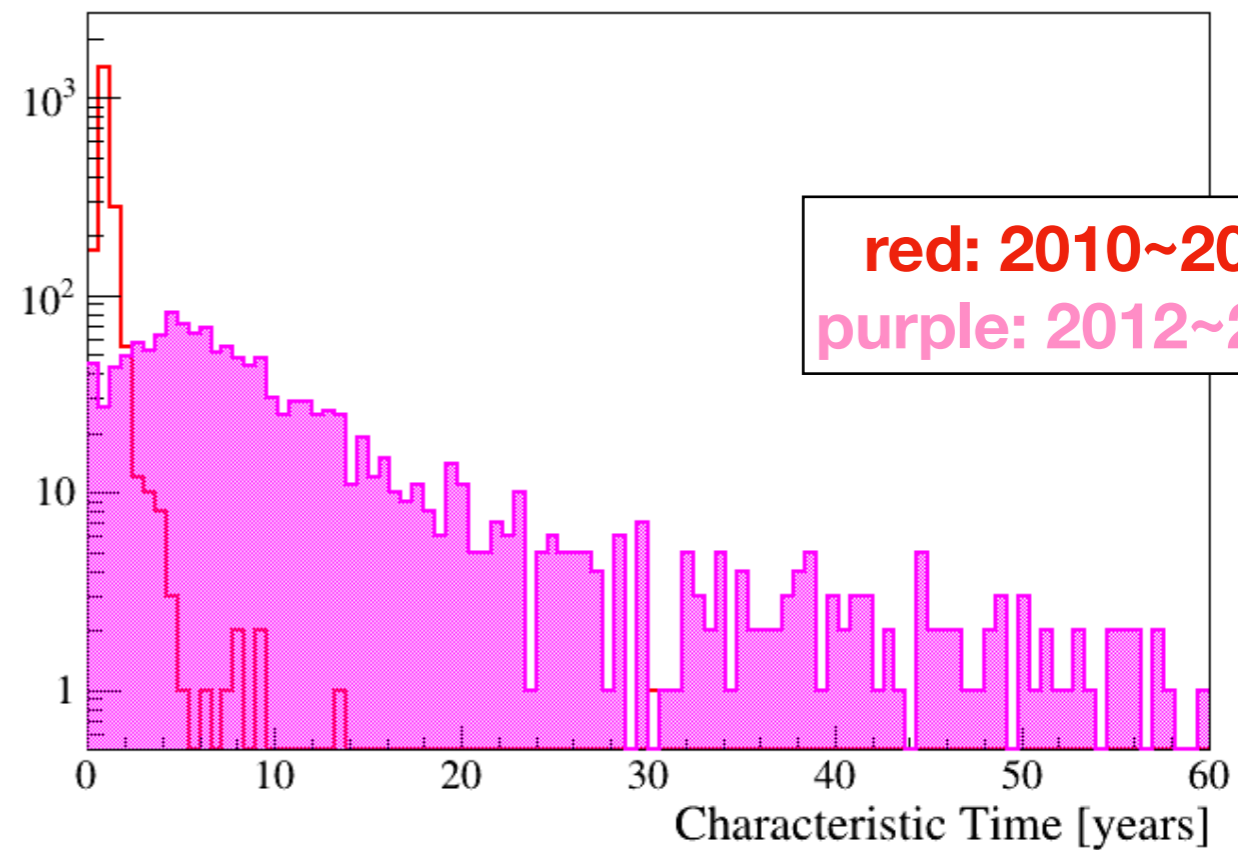
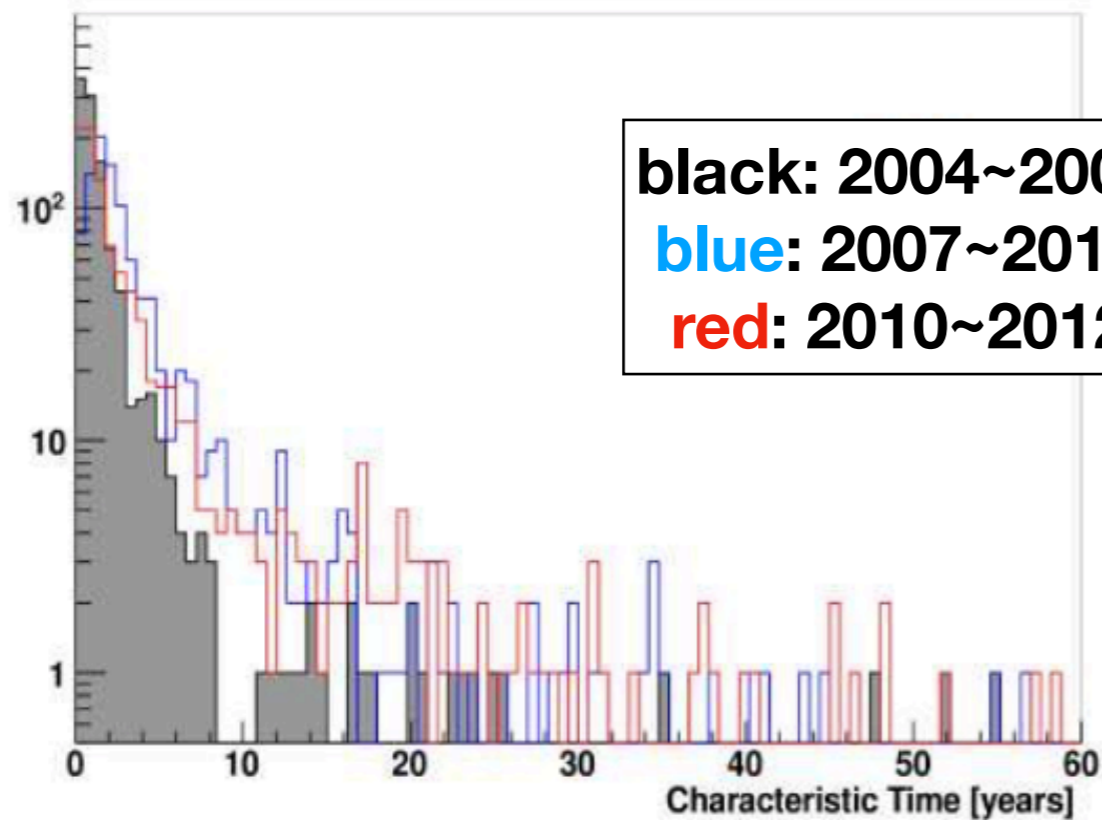
Fitted parameter distributions

2012 GAP note

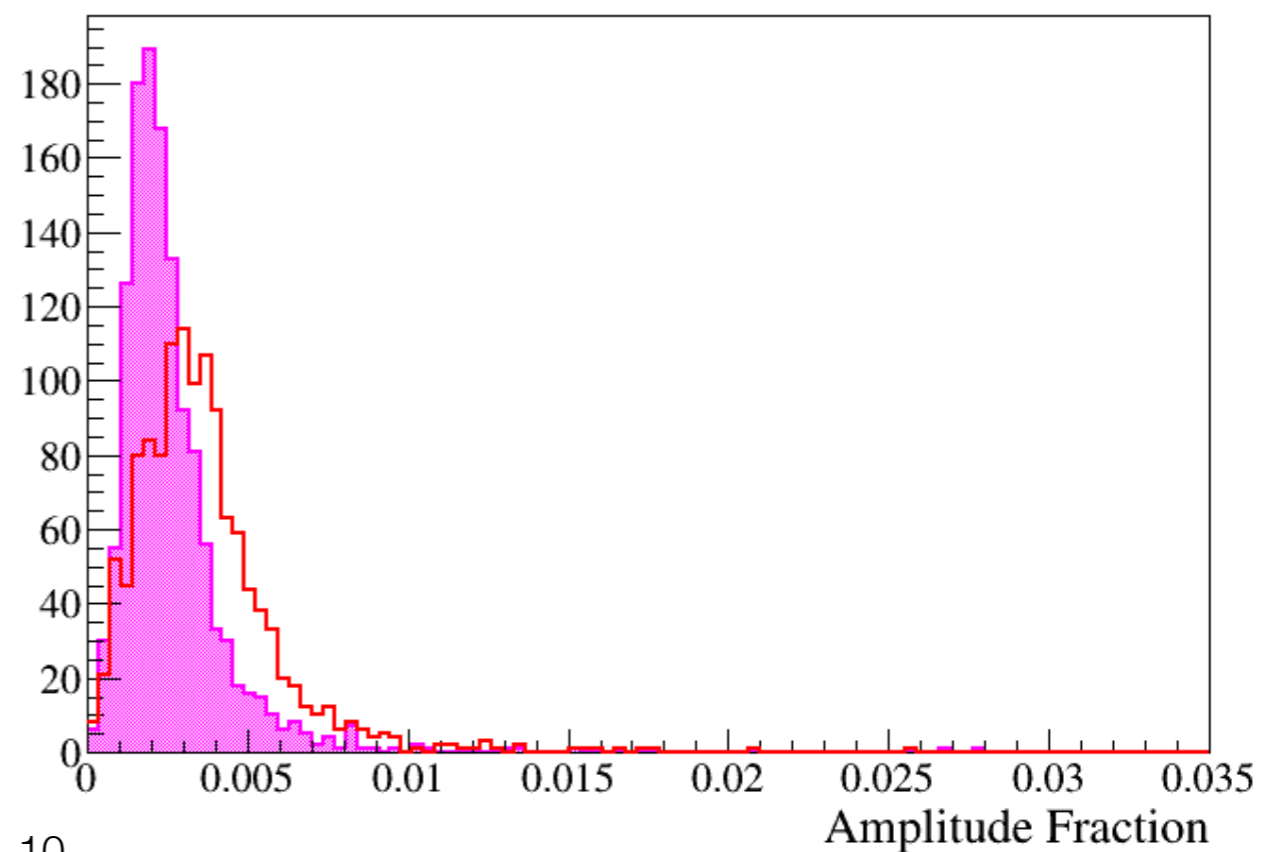
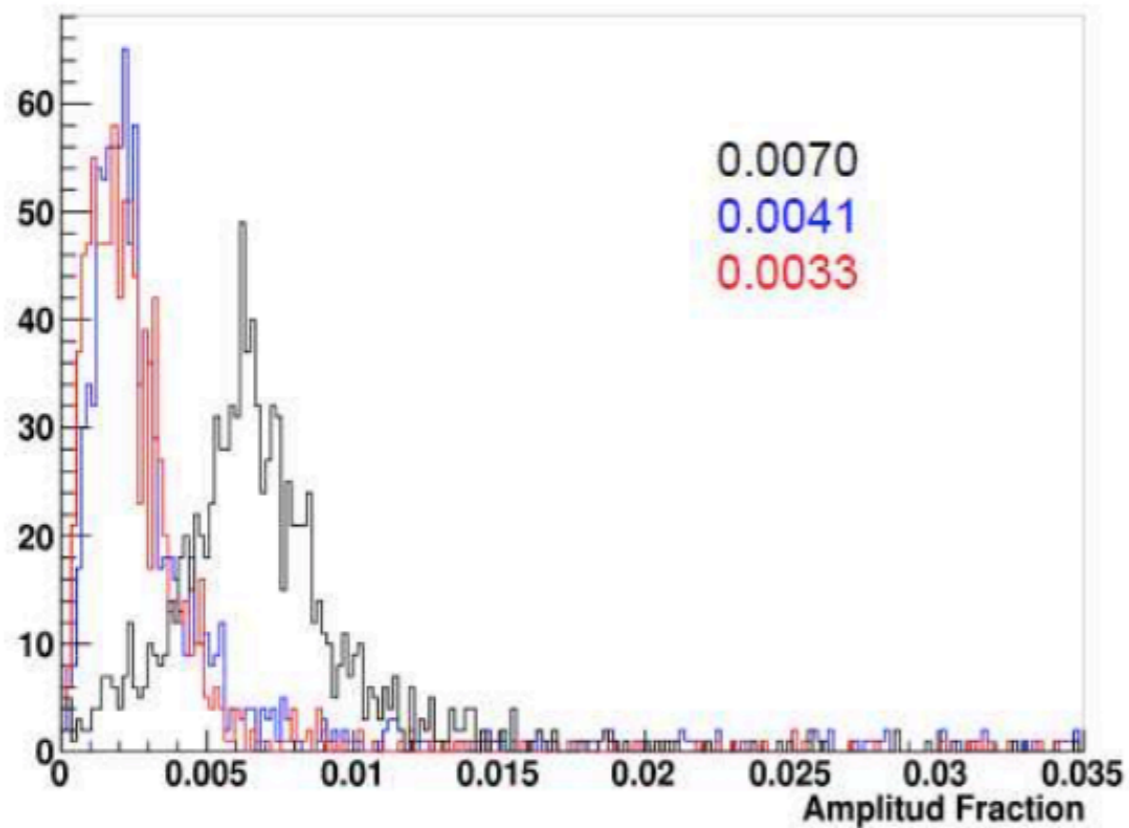
this work(2012~2018)



Characteristic Time (p2)



Seasonal Amplitud (p3_2)

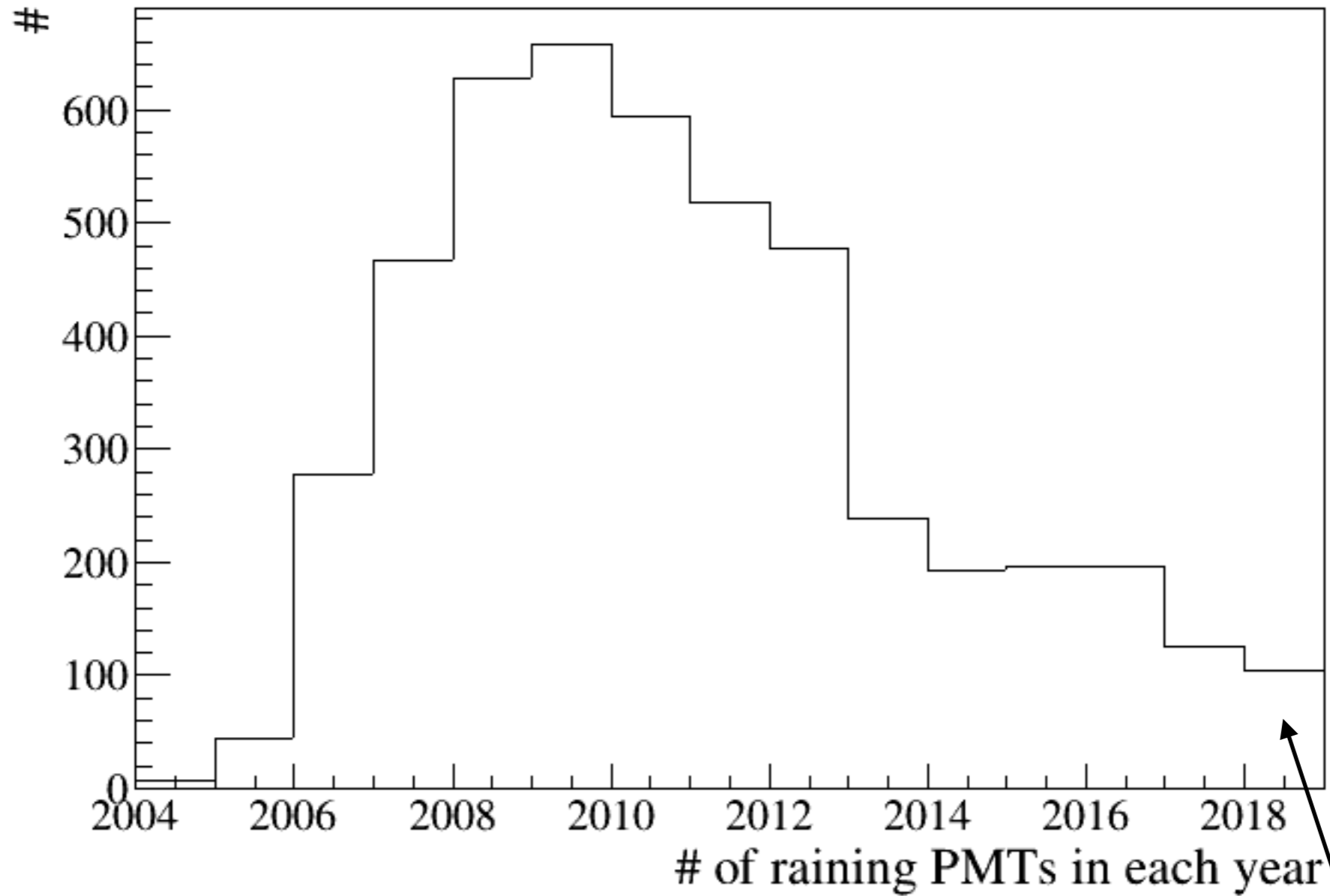


Next steps

- Understand the discrepancy between previous analysis and this work
- Improve fitting in general(i.e. shift the overall discrepancies happened in 2007,2010)
- Clean up data sample(i.e. stronger cut to reject raining & jumping PMTs remaining)

“Raining” PMTs

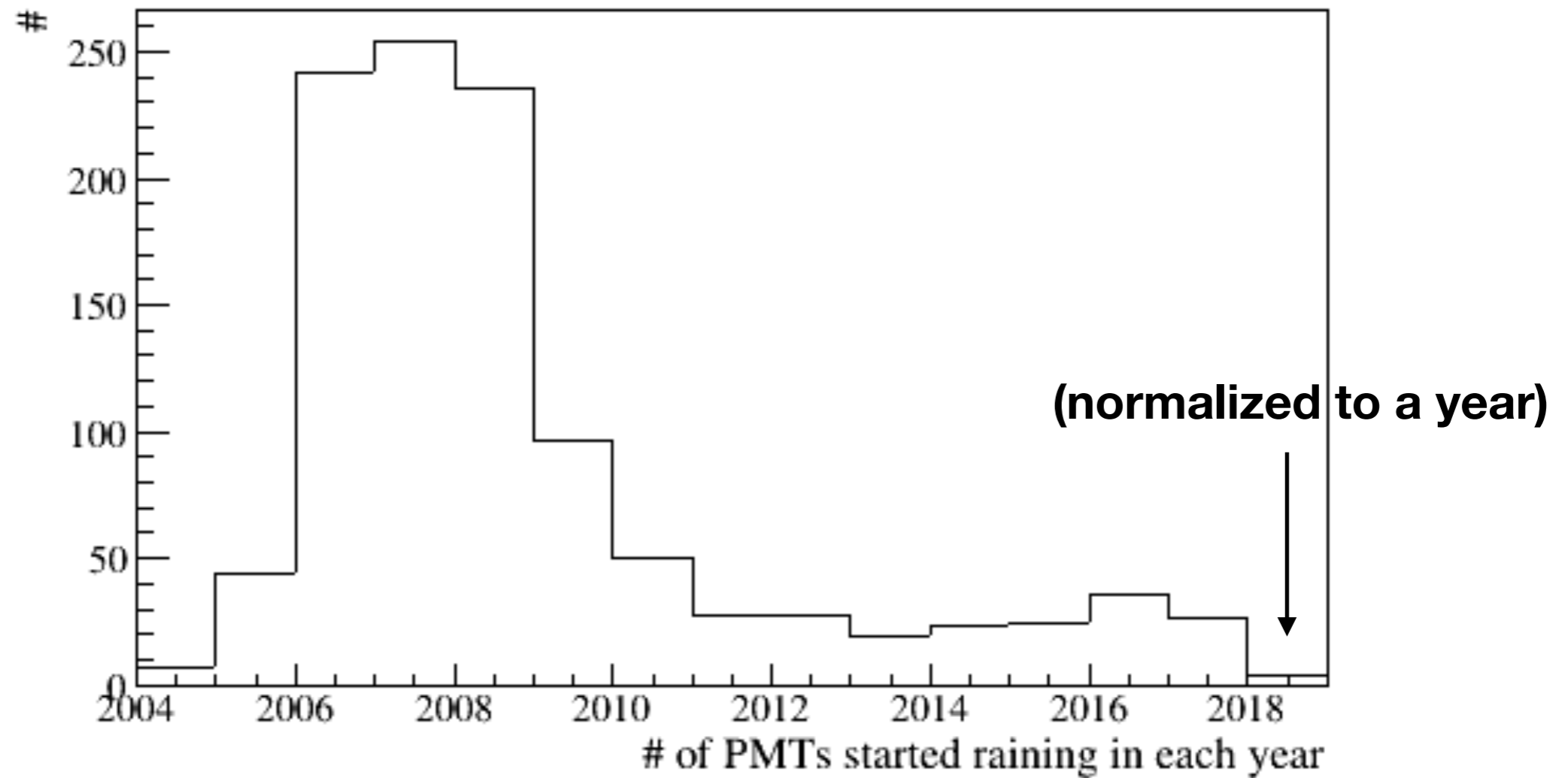
Definition of “raining year”: $\text{RMS}/\text{year} > 0.09$



~100 PMTs are currently raining

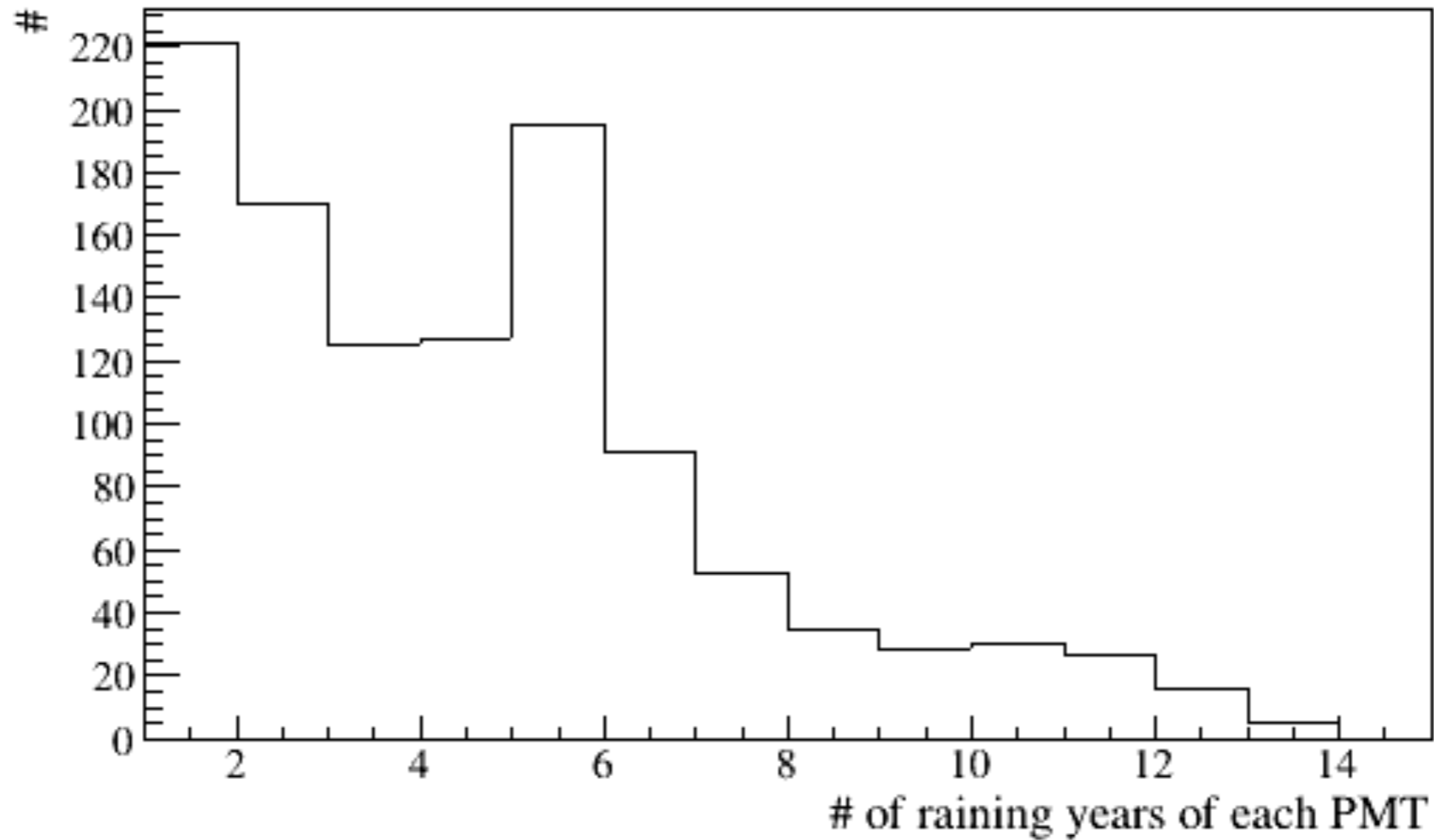
“Raining” PMTs

Definition of “raining year”: $\text{RMS}/\text{year} > 0.09$



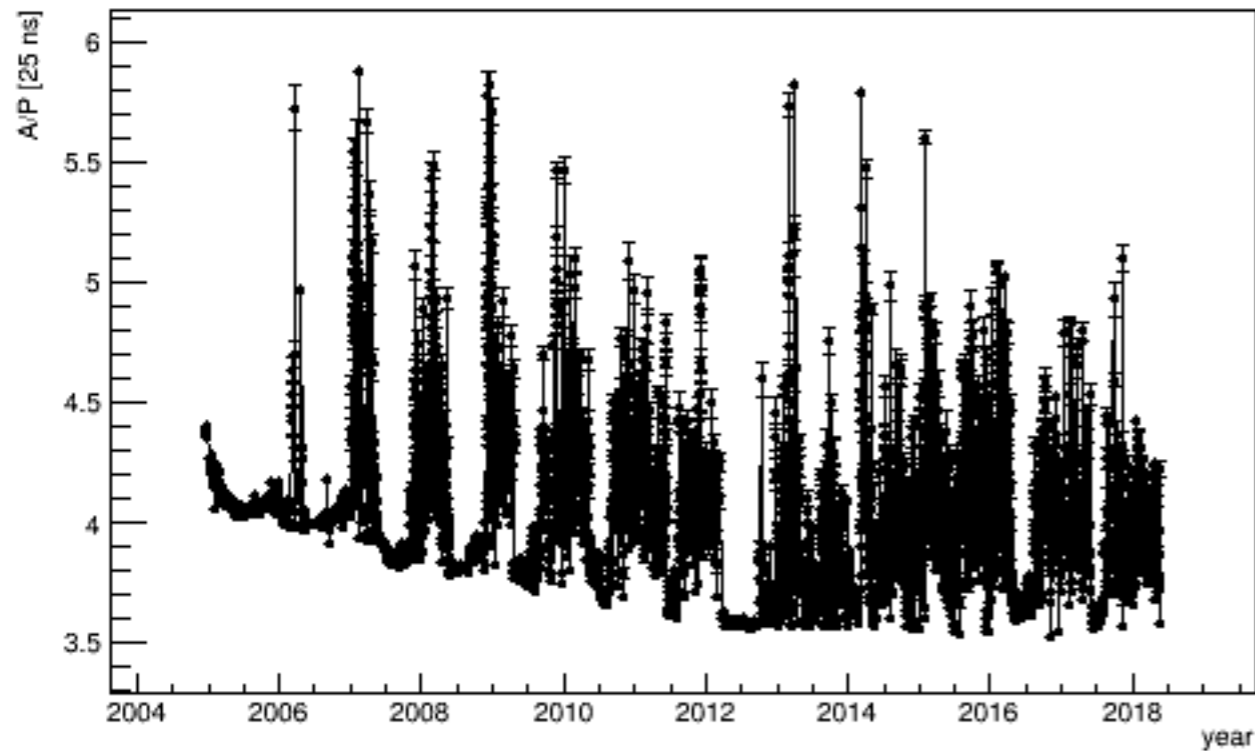
“Raining” PMTs

Definition of “raining year”: $\text{RMS}/\text{year} > 0.09$

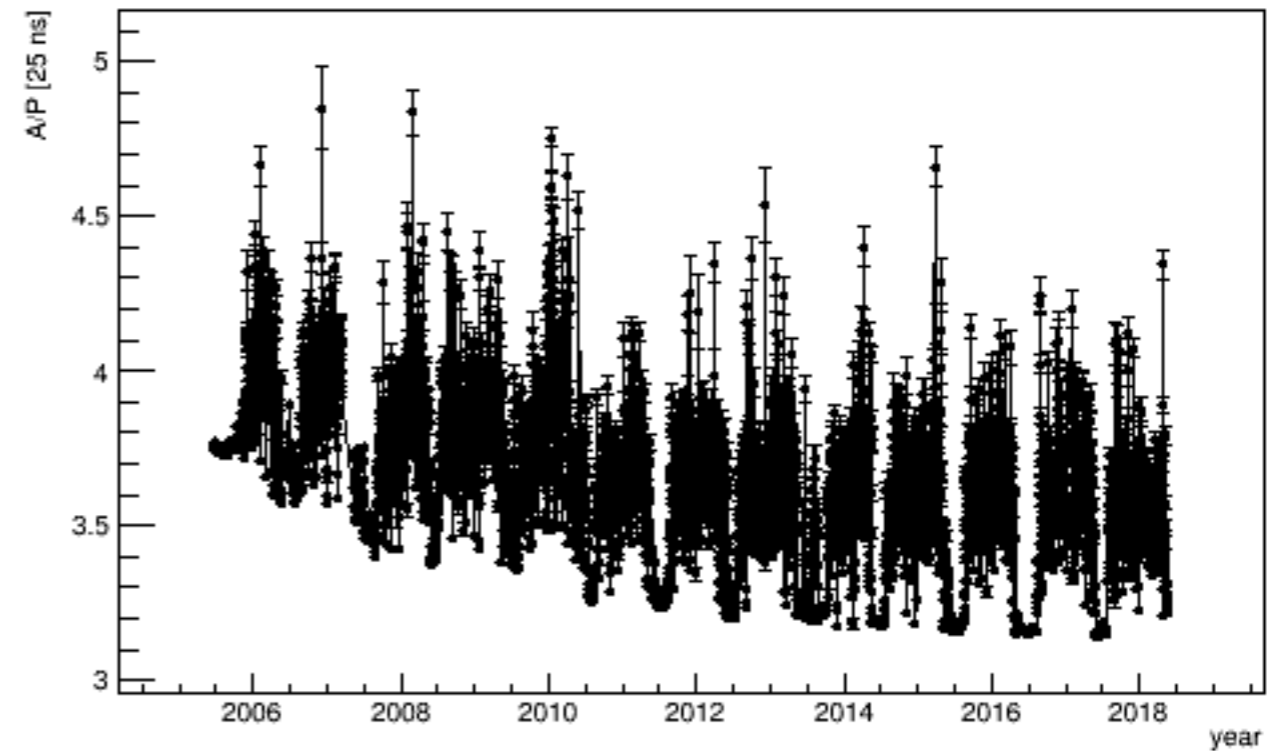


Examples of “Raining” PMTs

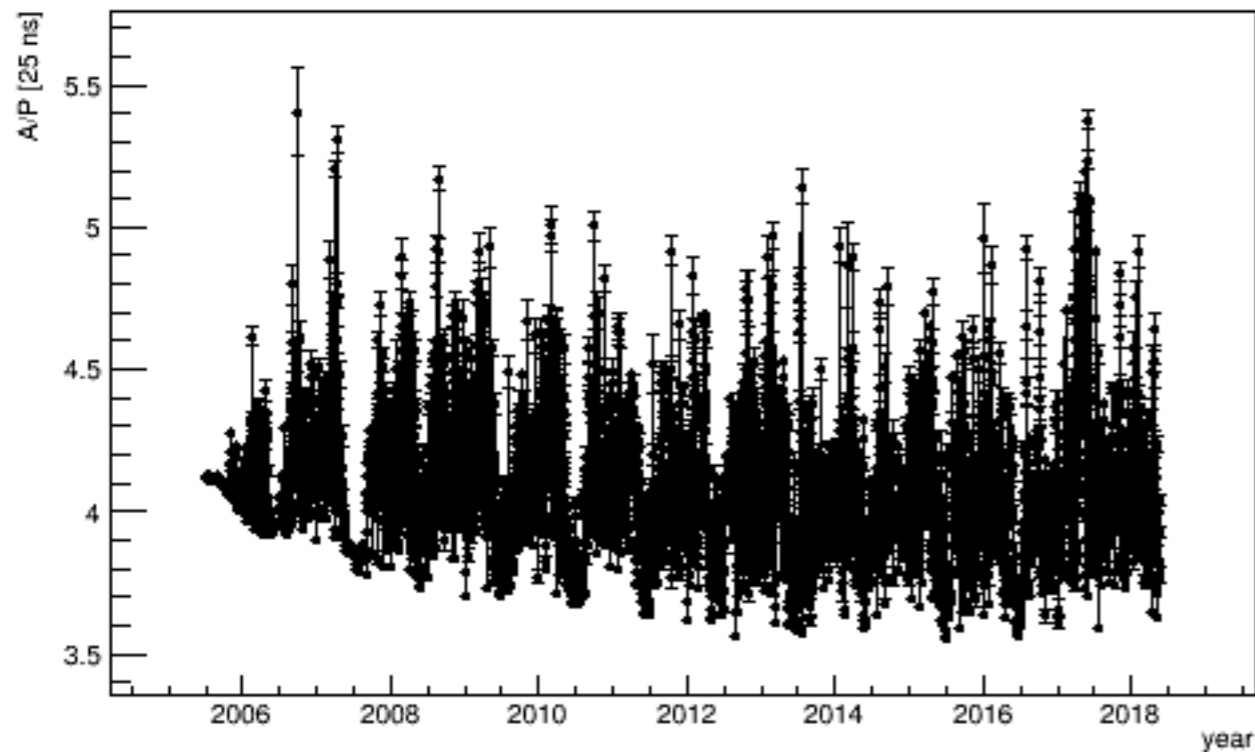
st_728_pmt1



st_787_pmt2



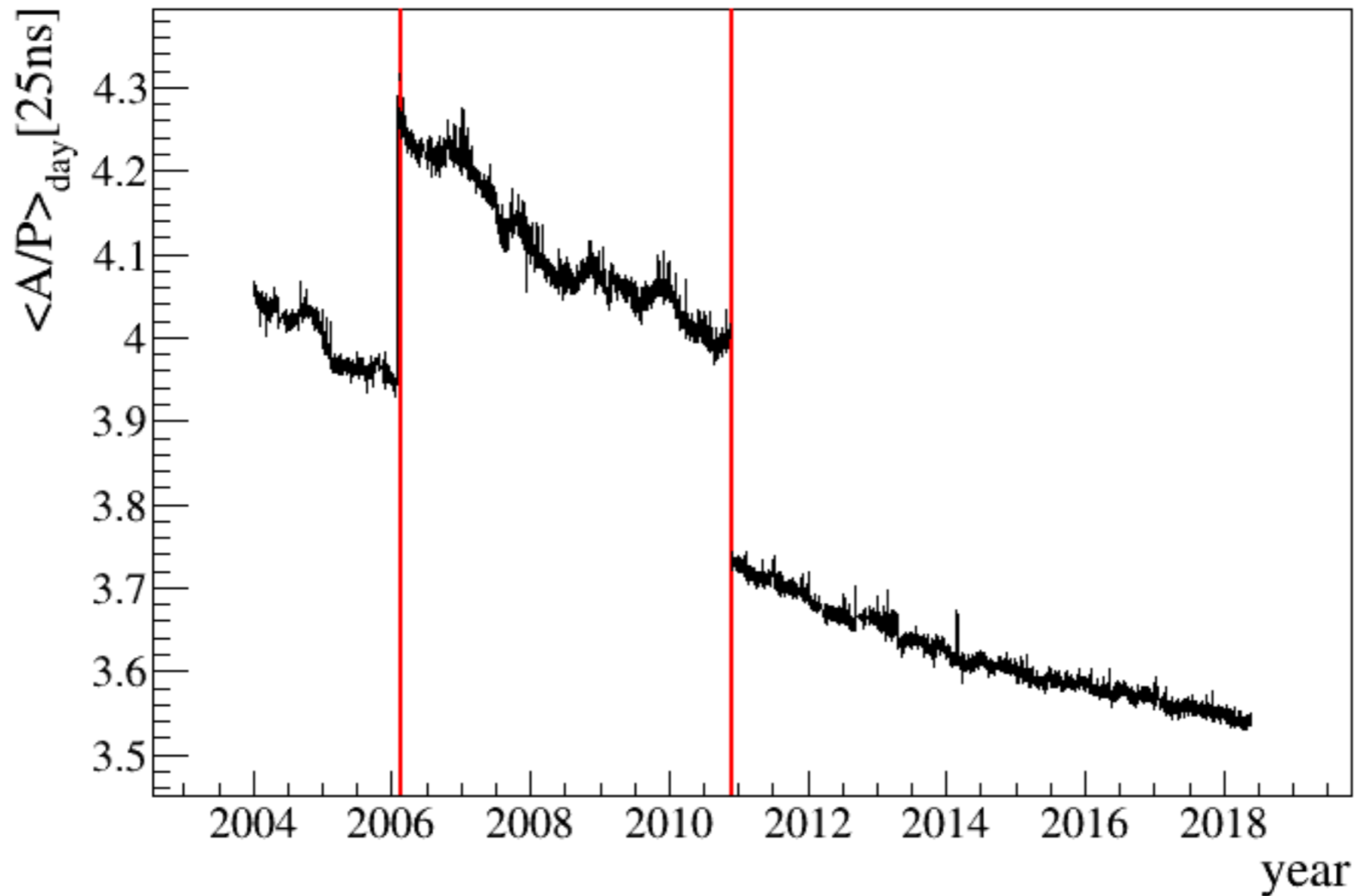
st_946_pmt3



~70 PMTs have raining years ≥ 10

“Jumping” PMTs

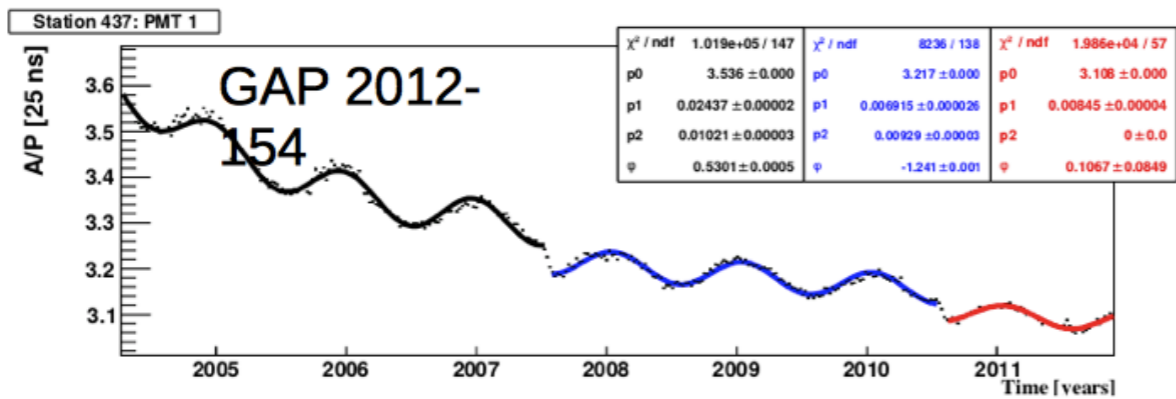
>1% decrease/increase are searched by moving timing window(size of 2 weeks)



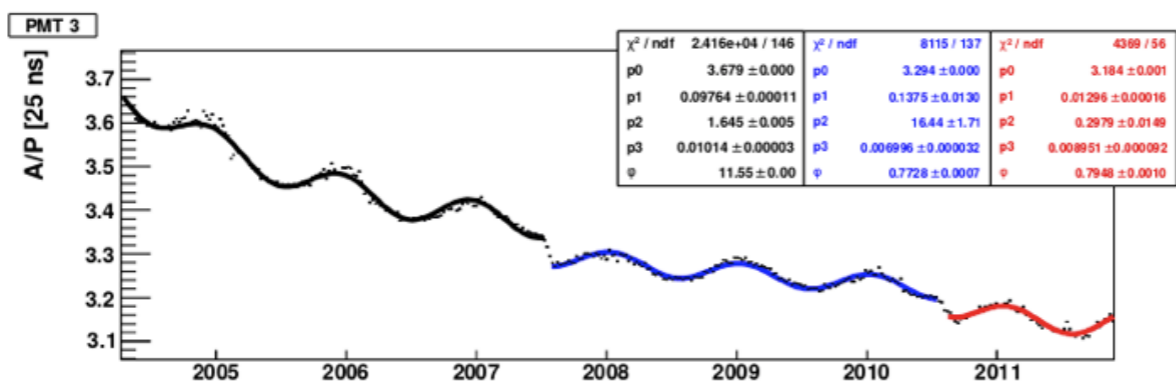
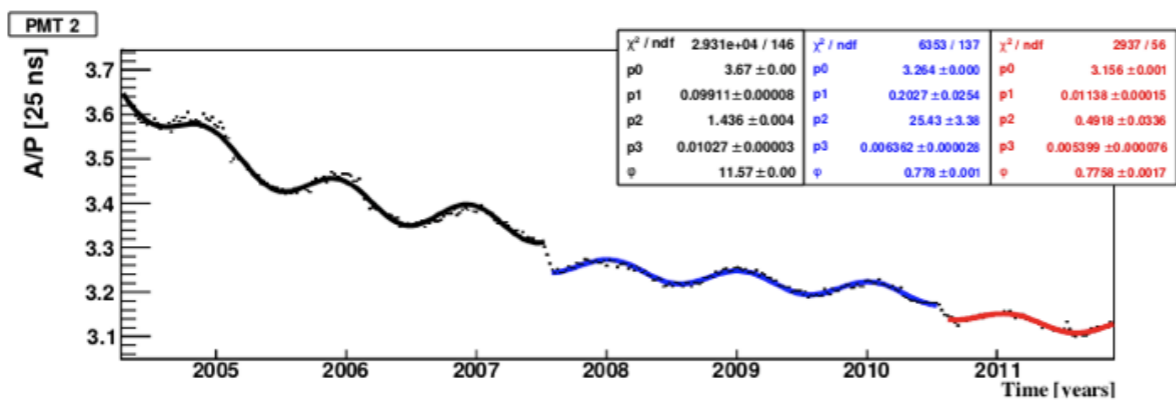
Conclusions

- New data period(2012 Jan - 2018 May) is investigated
- 10% of the PMTs showed $\langle A/P \rangle_{2018} / \langle A/P \rangle_{\text{initial}} < 85\%$
- Fitted result shows discrepancy with previous analysis -> under investigation
- Criteria to categorize raining & jumping PMTs are in development
- We started merging efforts with Eva Santos

Backup



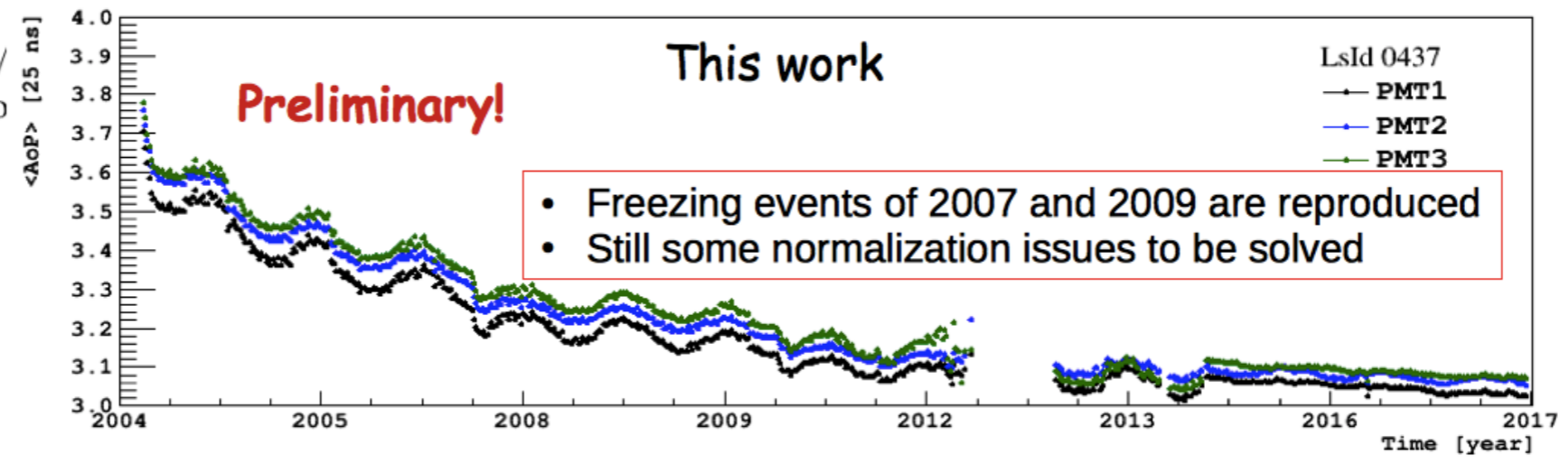
<AoP>



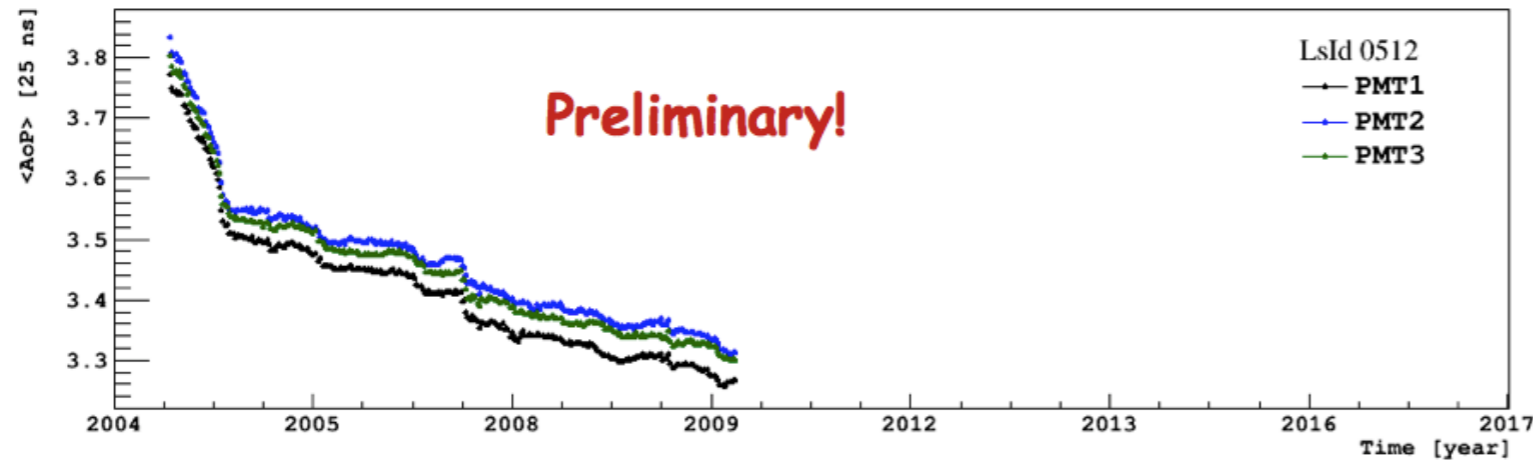
Try to apply the same cuts as in GAP 2012-154

- T1 > 0
- All PMTs working
- Area > 0
- Peak > 0
- Variance of Dynode / Anode < 4.5

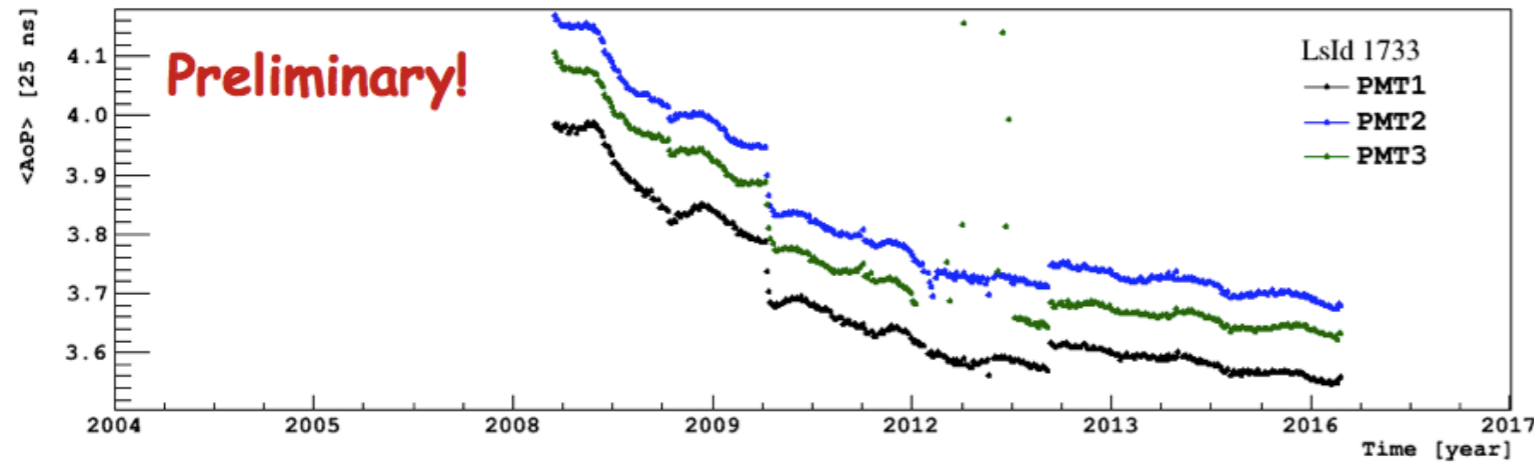
Figure 4: Evolution of A/ between and after mid July o



<AoP> for the stations with UUBs

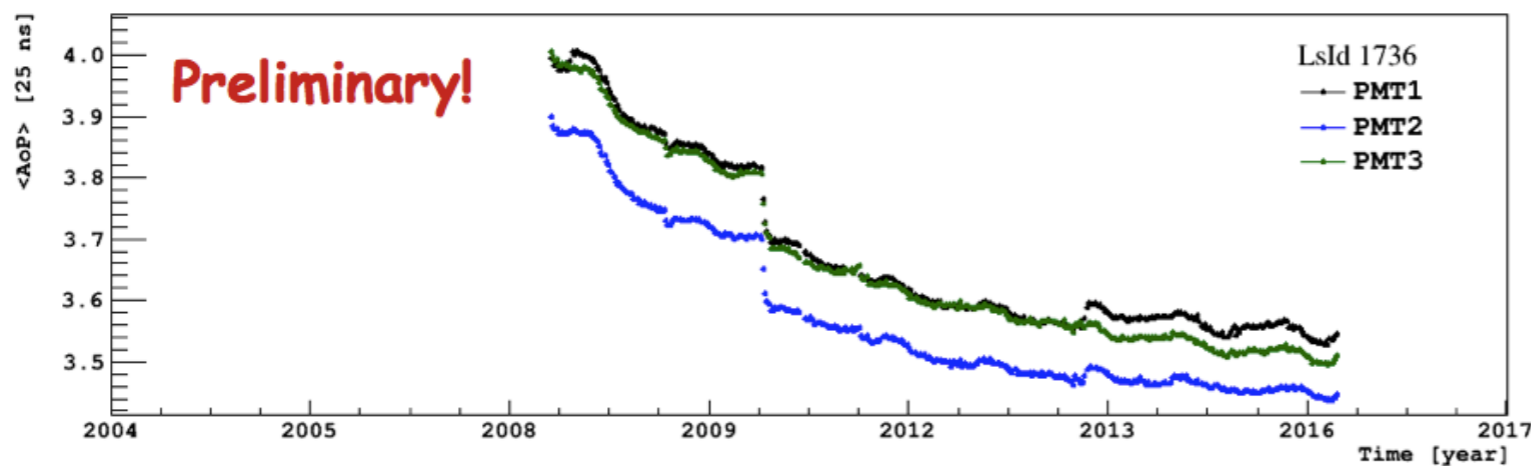


Tune previous cuts for the stations with UUBs



Why Area, Peak and RDA are zero for UUB stations?

Fill monitoring files with these data



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