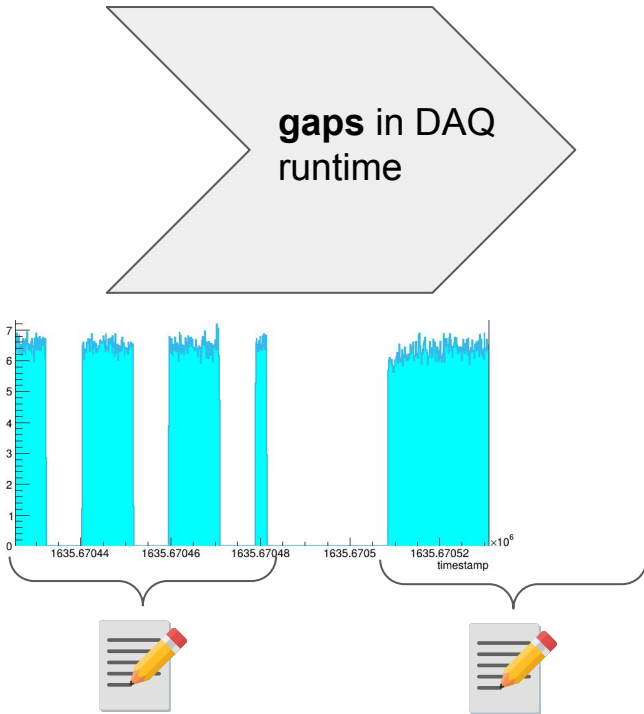


ALPACA Deadtime PSI2021

Livetime evaluation in ALPACA

Livetime: Fraction of time, where events are recorded properly

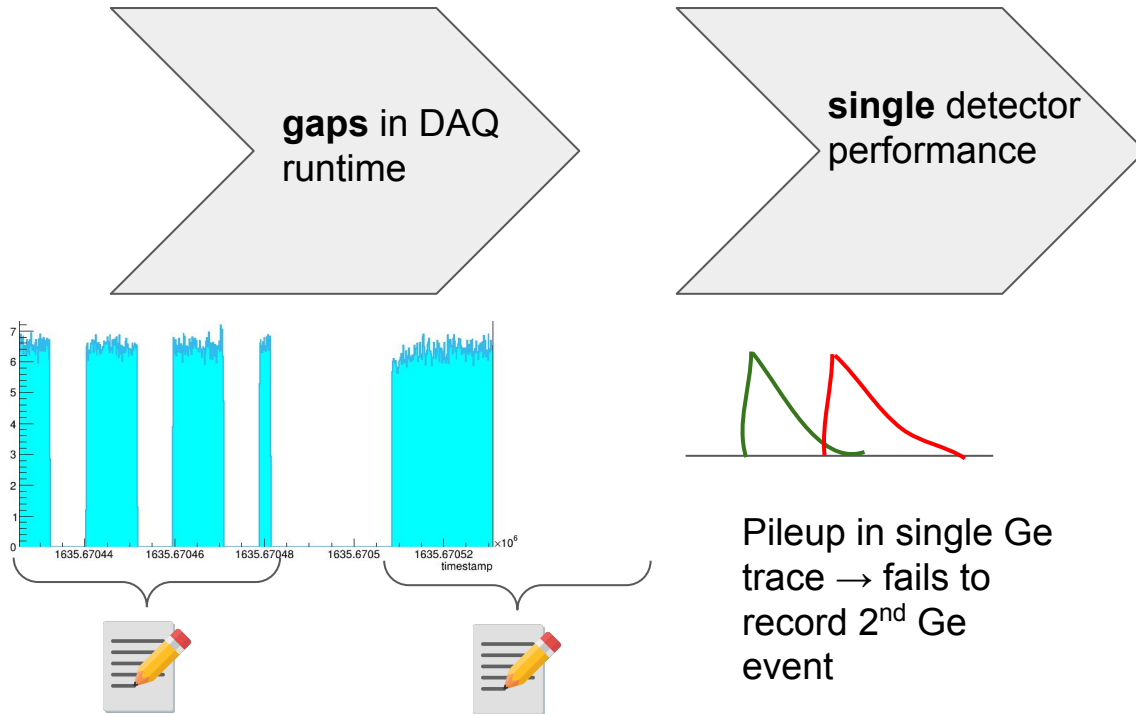
Divided here into different consecutive steps with **cumulative** reduction of livetime:



Livetime evaluation in ALPACA

Livetime: Fraction of time, where events are recorded properly

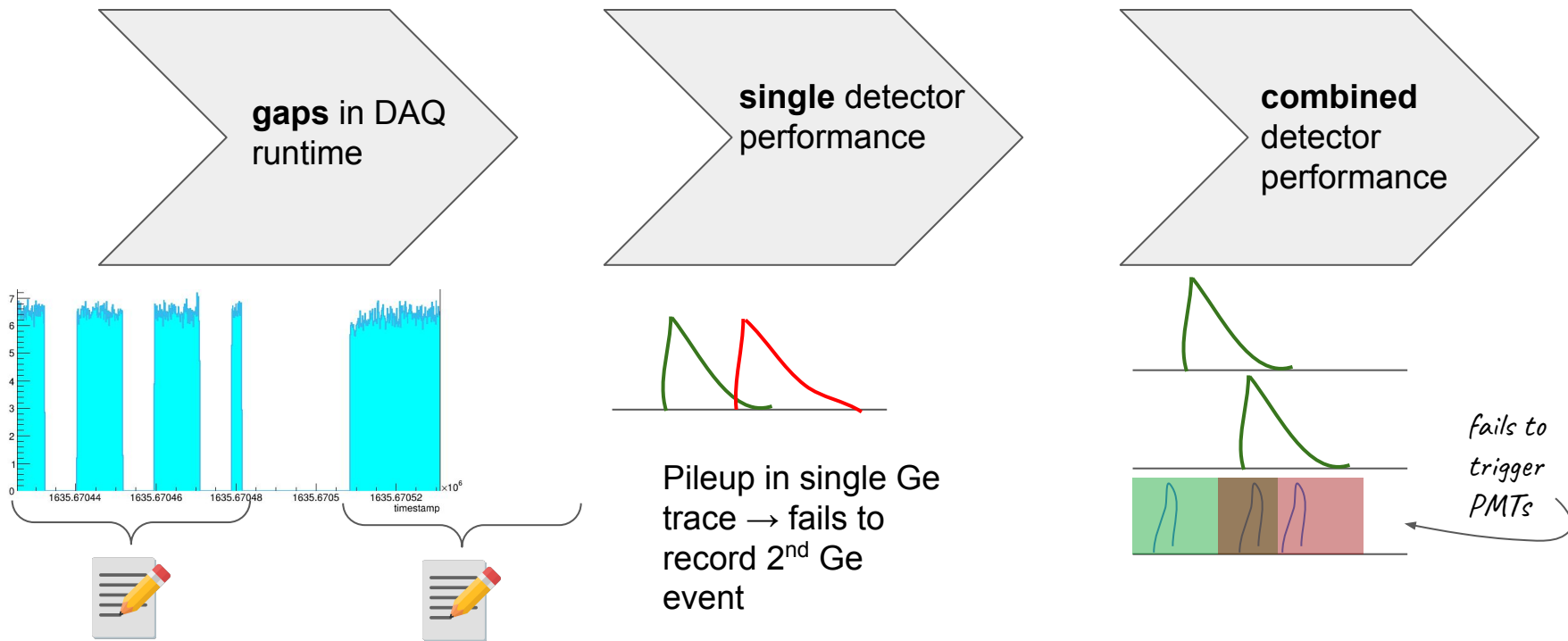
Divided here into different consecutive steps with **cumulative** reduction of livetime:



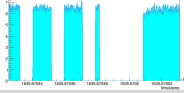
Livetime evaluation in ALPACA

Livetime: Fraction of time, where events are recorded properly

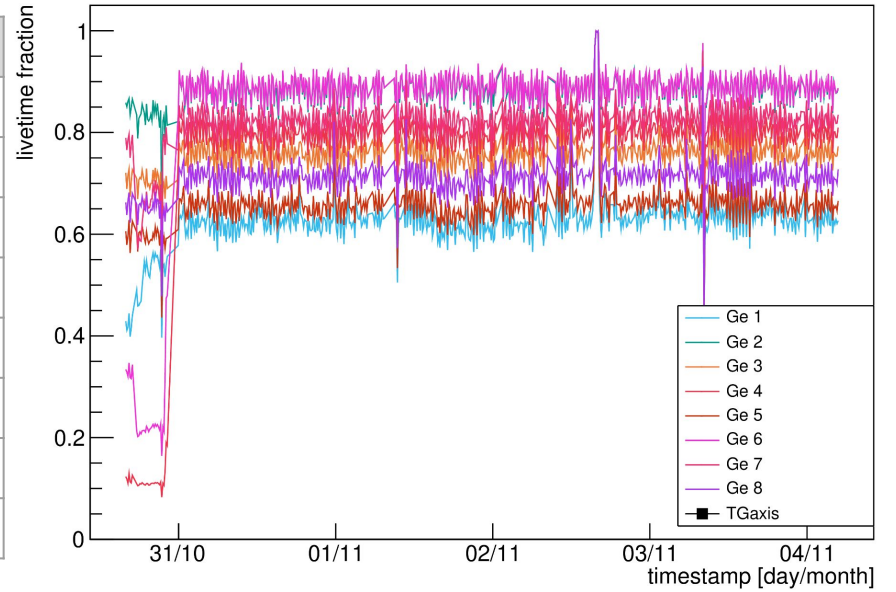
Divided here into different consecutive steps with **cumulative** reduction of livetime:



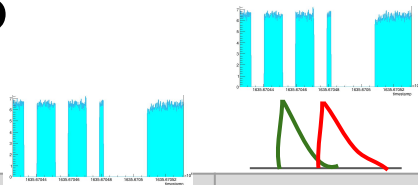
Se-76



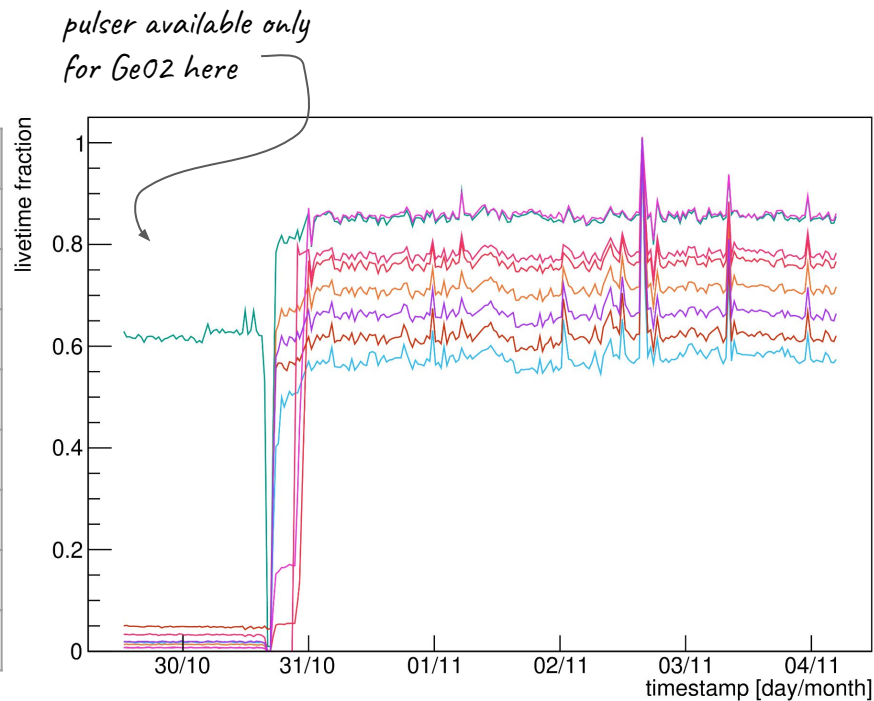
DetNr.	gaps	single	combined
0	0.632	0.579	0.158
1	0.887	0.855	0.164
2	0.762	0.715	0.161
3	0.8	0.765	0.163
4	0.662	0.622	0.162
5	0.89	0.859	0.164
6	0.828	0.783	0.162
7	0.717	0.667	0.16



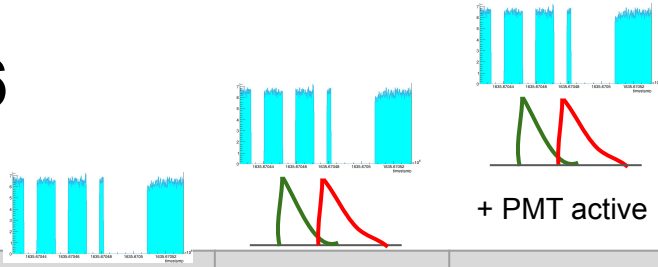
Se-76



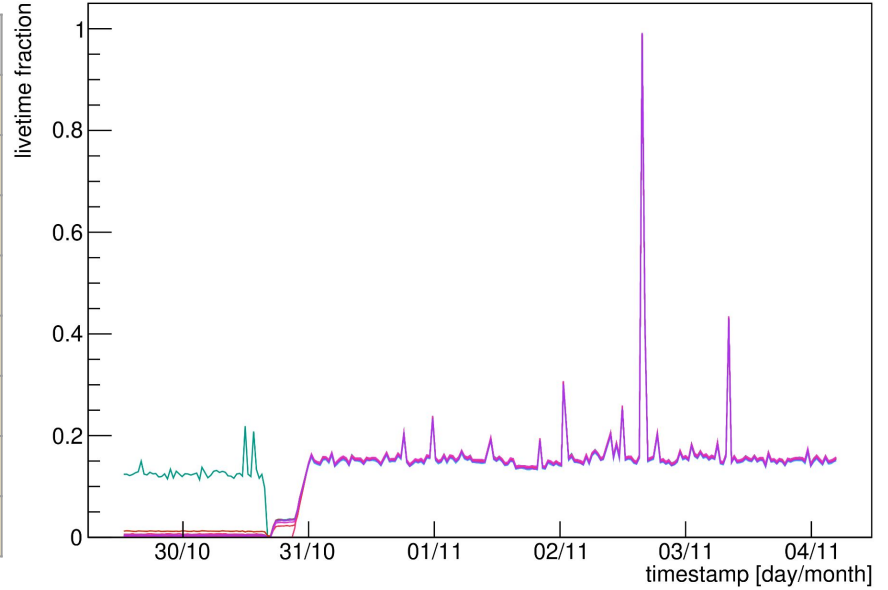
DetNr.	gaps	single	combined
0	0.632	0.579	0.158
1	0.887	0.855	0.164
2	0.762	0.715	0.161
3	0.8	0.765	0.163
4	0.662	0.622	0.162
5	0.89	0.859	0.164
6	0.828	0.783	0.162
7	0.717	0.667	0.16



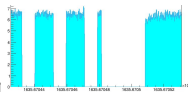
Se-76



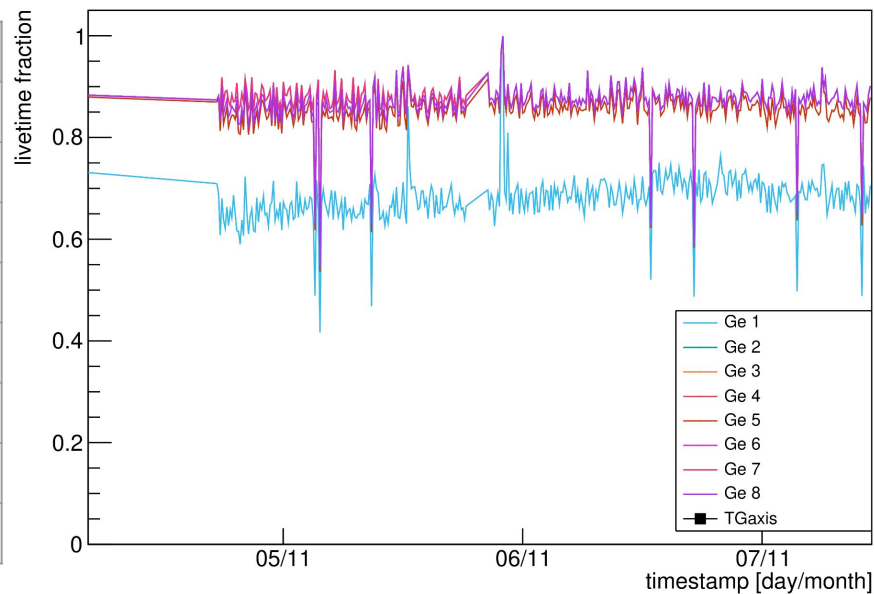
DetNr.	gaps	single	combined	
0		0.632	0.579	0.158
1		0.887	0.855	0.164
2		0.762	0.715	0.161
3		0.8	0.765	0.163
4		0.662	0.622	0.162
5		0.89	0.859	0.164
6		0.828	0.783	0.162
7		0.717	0.667	0.16



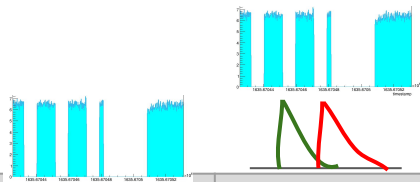
Ba-136 (last part)



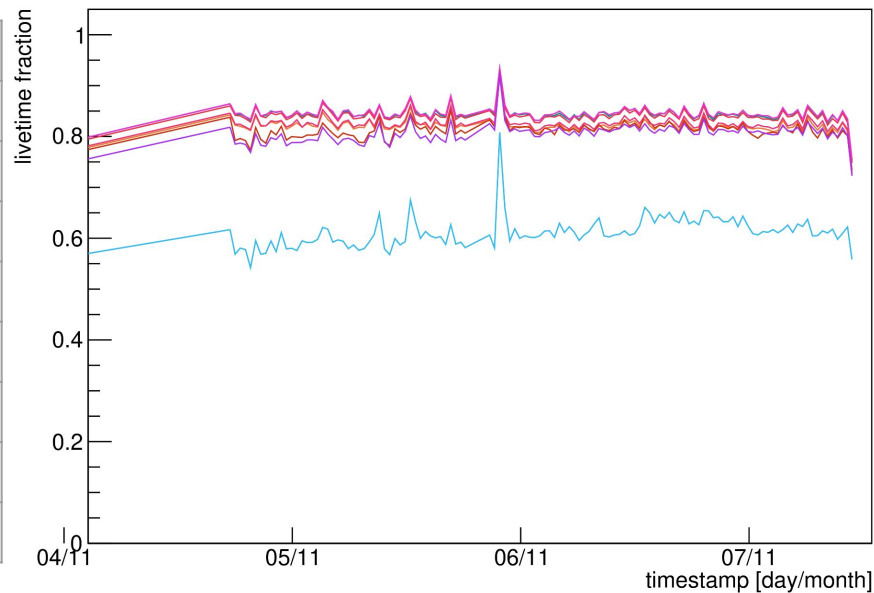
DetNr.	gaps	single	combined
0	0.685	0.609	0.207
1	0.88	0.844	0.219
2	0.88	0.822	0.214
3	0.88	0.841	0.219
4	0.858	0.812	0.218
5	0.88	0.846	0.219
6	0.88	0.826	0.215
7	0.874	0.805	0.212



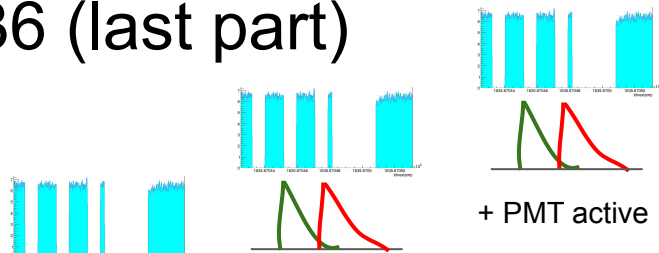
Ba-136 (last part)



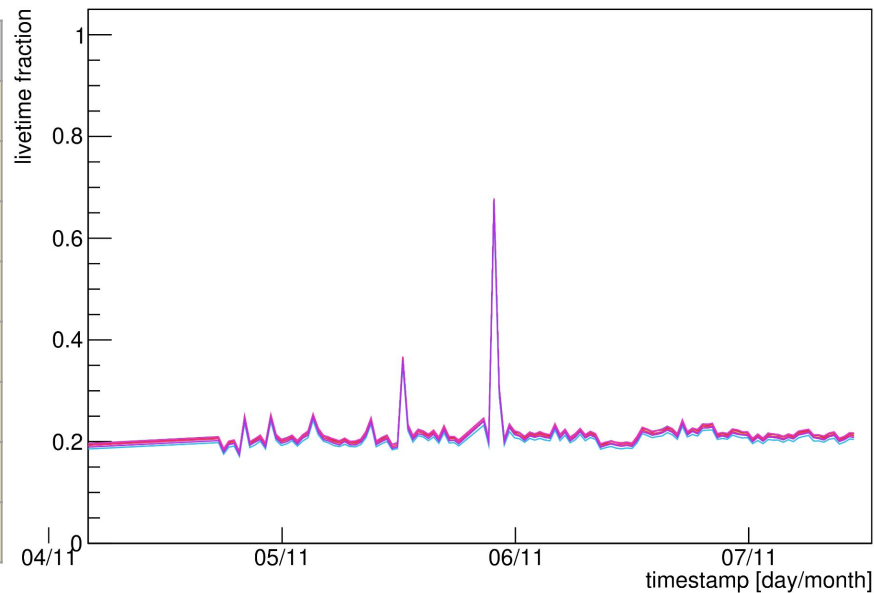
DetNr.	gaps	single	combined
0	0.685	0.609	0.207
1	0.88	0.844	0.219
2	0.88	0.822	0.214
3	0.88	0.841	0.219
4	0.858	0.812	0.218
5	0.88	0.846	0.219
6	0.88	0.826	0.215
7	0.874	0.805	0.212



Ba-136 (last part)

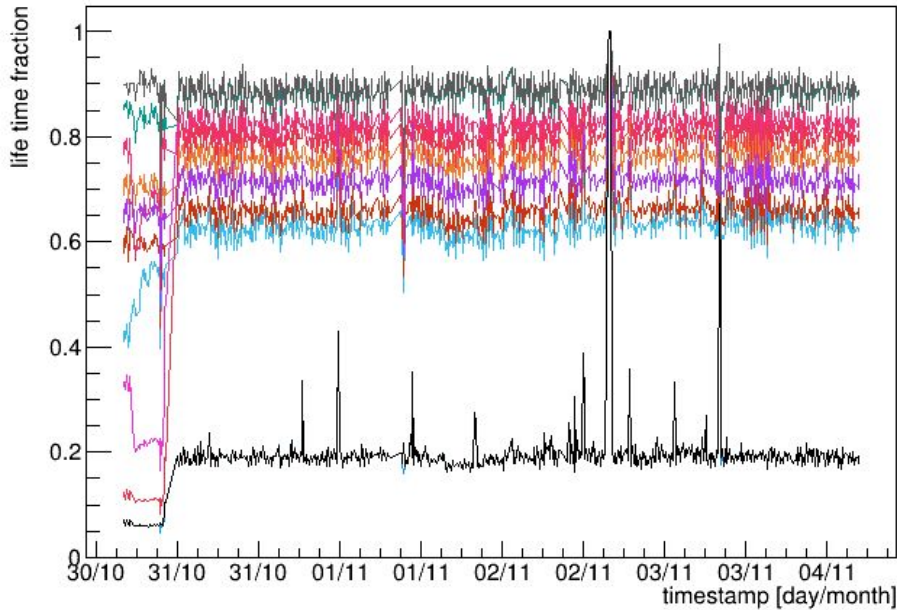


DetNr.	gaps	single	combined
0	0.685	0.609	0.207
1	0.88	0.844	0.219
2	0.88	0.822	0.214
3	0.88	0.841	0.219
4	0.858	0.812	0.218
5	0.88	0.846	0.219
6	0.88	0.826	0.215
7	0.874	0.805	0.212

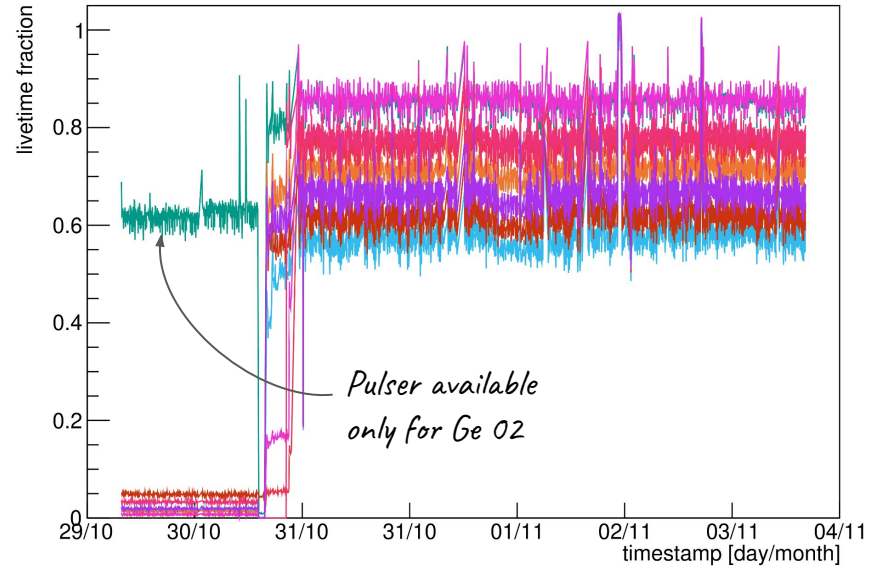


Cross-checking results from both approaches

Gaps only



Test pulse triggers in tier3



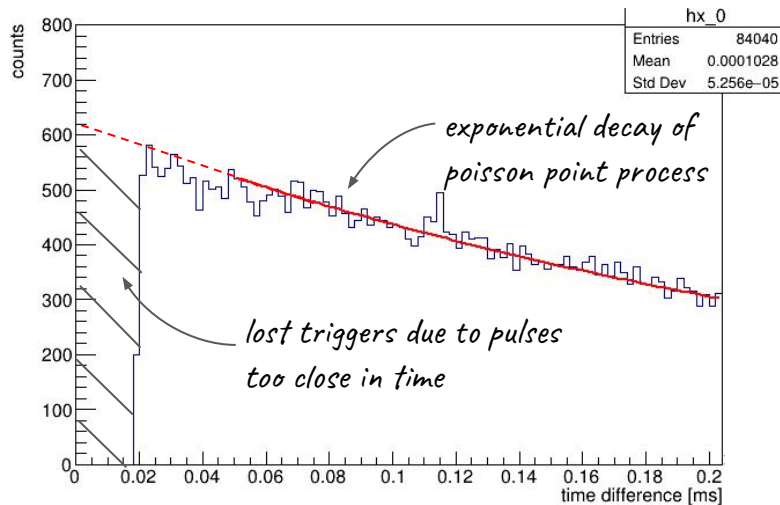
no intrace pileup for gap analysis → extract intrace pileup from pulser analysis

Comparing results from both approaches

Compare gap and pulser analyses:

For pulser analysis: remove deadtime caused by intrace pileups

→ reproduce output of gap analysis

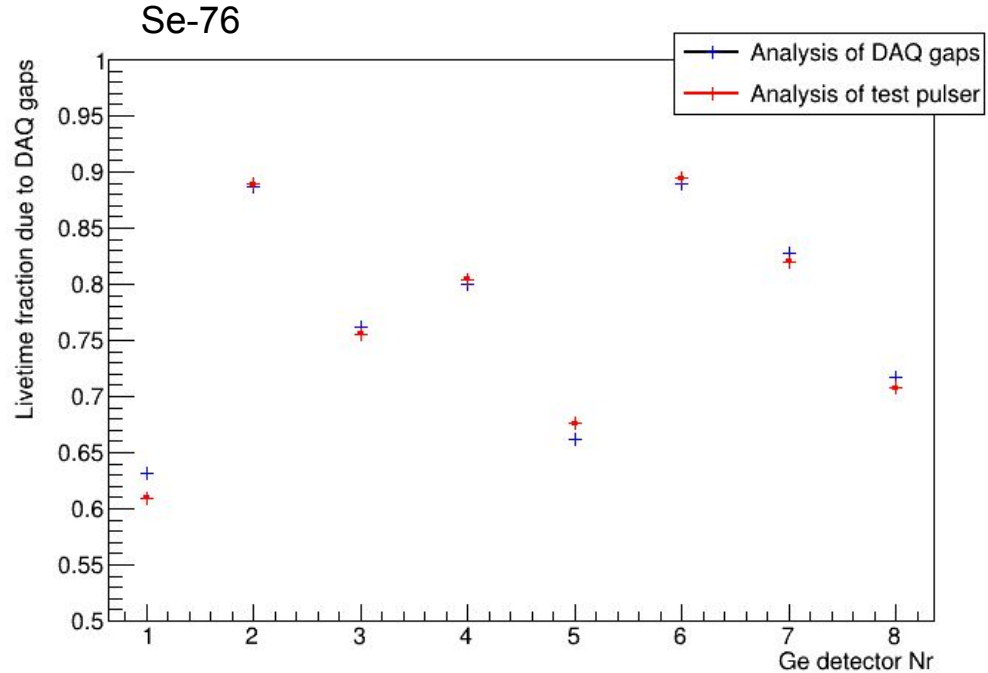
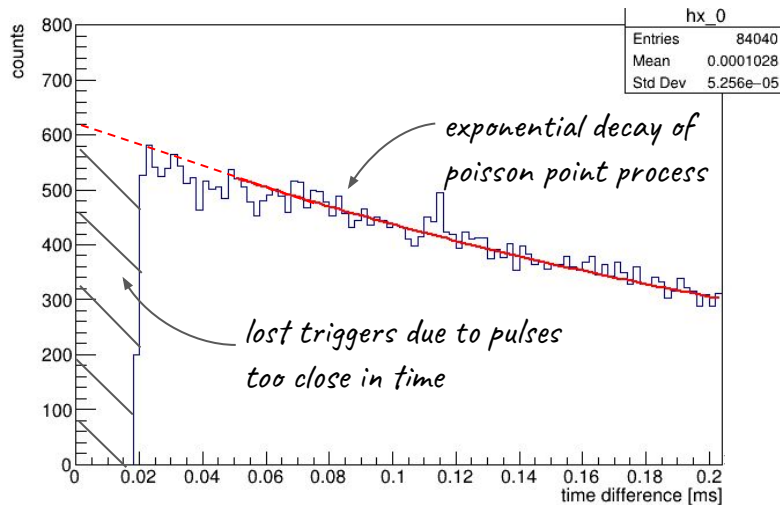


Comparing results from both approaches

Compare gap and pulser analyses:

For pulser analysis: remove deadtime caused by intrace pileups

→ reproduce output of gap analysis



Fits quite nicely!
→ Validates gap analysis

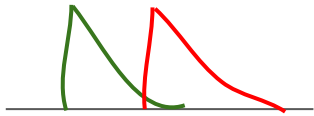
Conclusions

- Can evaluate effective livetime of all channels and investigate different contributions
- Test pulser necessary for steps beyond DAQ time gap investigation
- Results:
 - Se-76: ~ 80% (gaps only) → ~ 75% (single performance) → ~ 16% (combined)
 - Ba-136: ~ 90% (gaps only) → ~ 85% (single performance) → ~ 21% (combined)
→ Most deadtime introduced by failing PMT triggers
- Gap and pulser analysis cross-checked using time-difference distribution

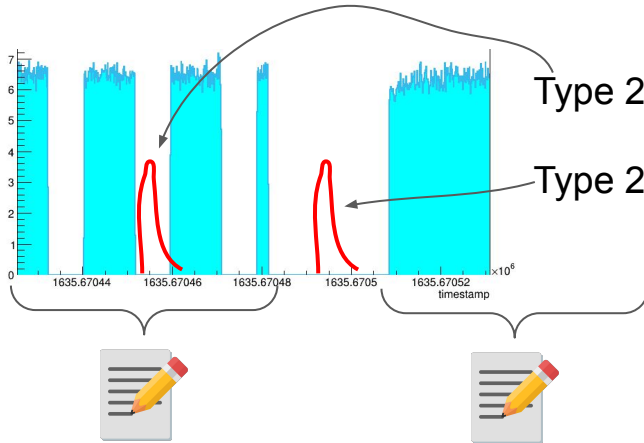
BACKUP

What classes of deadtime do we have in ALPACA?

Deadtime: Fraction of time the DAQ was not able to start event recording on possible triggers



Type 1) Intrace pileup; DAQ window blocked due to previous trigger



Type 2a) Deadtime within a file ("bank swap")

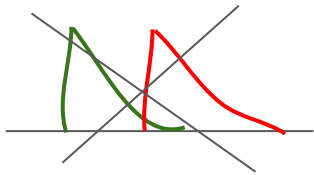
Type 2b) Deadtime between files ("file swap")



NOT deadtime: DAQ paused

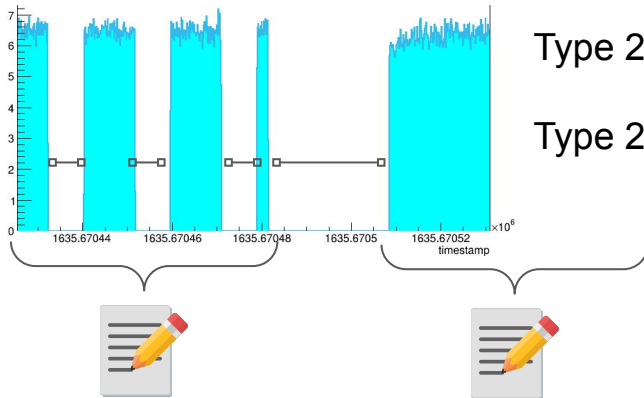
1st approach: "Gap analysis"

Check **gaps** between **consecutive timestamps**; report every gap > 100 ms



Type 1) Intrace pileup; DAQ window blocked due to previous trigger

invisible in gap analysis



Type 2a) Deadtime within a file ("bank swap")



Type 2b) Deadtime between files ("file swap")



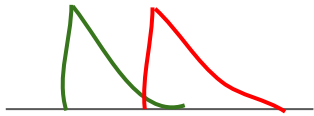
Regard any gap > 60 s as DAQ paused



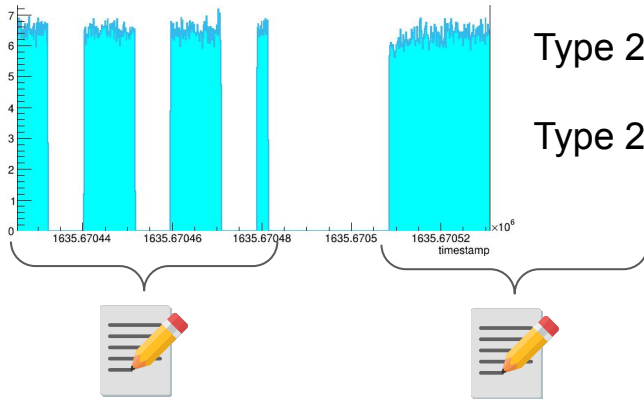
NOT deadtime: DAQ paused

2nd approach: “Test pulser analysis”

Count **number of test pulser events** recorded; we know that it should be **30 Hz** if no deadtime



Type 1) Intrace pileup; DAQ window blocked due to previous trigger



Type 2a) Deadtime within a file (“bank swap”) ✓



Type 2b) Deadtime between files (“file swap”) ✓



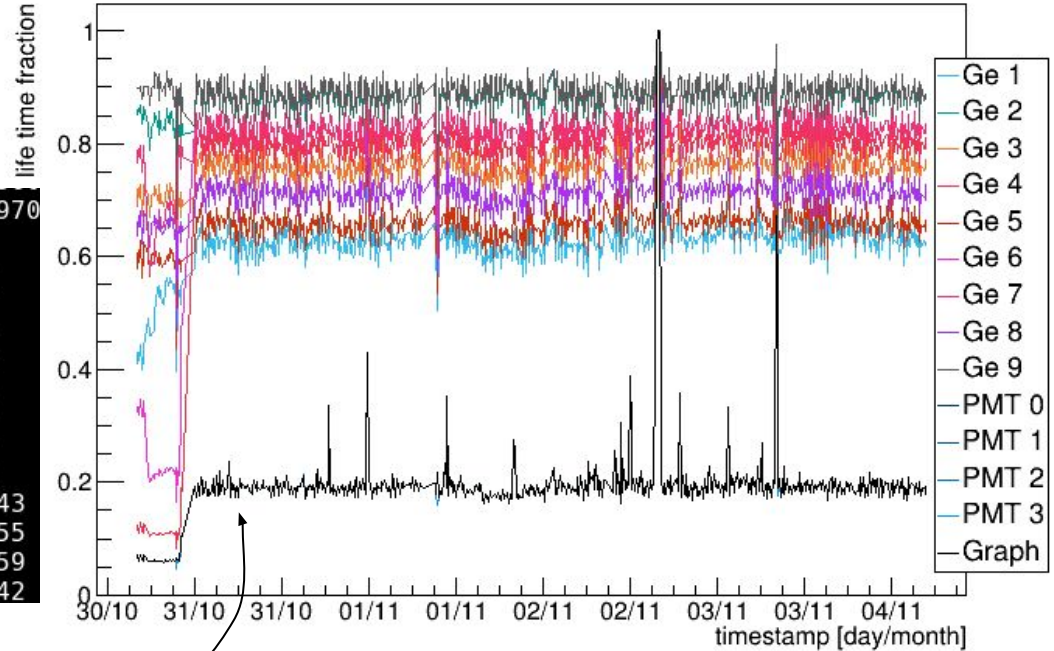
NOT deadtime: DAQ paused

Gap analysis Se-76

entire system

```
Lifetime fraction: 0.200295, losstime fraction: 0.79970
Extracting individual detectors from combined:
lifetime in Ge1: 0.631921; losstime in Ge1: 0.368079
lifetime in Ge2: 0.886663; losstime in Ge2: 0.113337
lifetime in Ge3: 0.762479; losstime in Ge3: 0.237521
lifetime in Ge4: 0.799976; losstime in Ge4: 0.200024
lifetime in Ge5: 0.662194; losstime in Ge5: 0.337806
lifetime in Ge6: 0.889862; losstime in Ge6: 0.110138
lifetime in Ge7: 0.827673; losstime in Ge7: 0.172327
lifetime in Ge8: 0.717338; losstime in Ge8: 0.282662
lifetime in PMT0: 0.200357; losstime in PMT0: 0.799643
lifetime in PMT1: 0.200345; losstime in PMT1: 0.799655
lifetime in PMT2: 0.200341; losstime in PMT2: 0.799659
lifetime in PMT3: 0.200358; losstime in PMT3: 0.799642
```

*black = effective live
time fraction for entire
system*



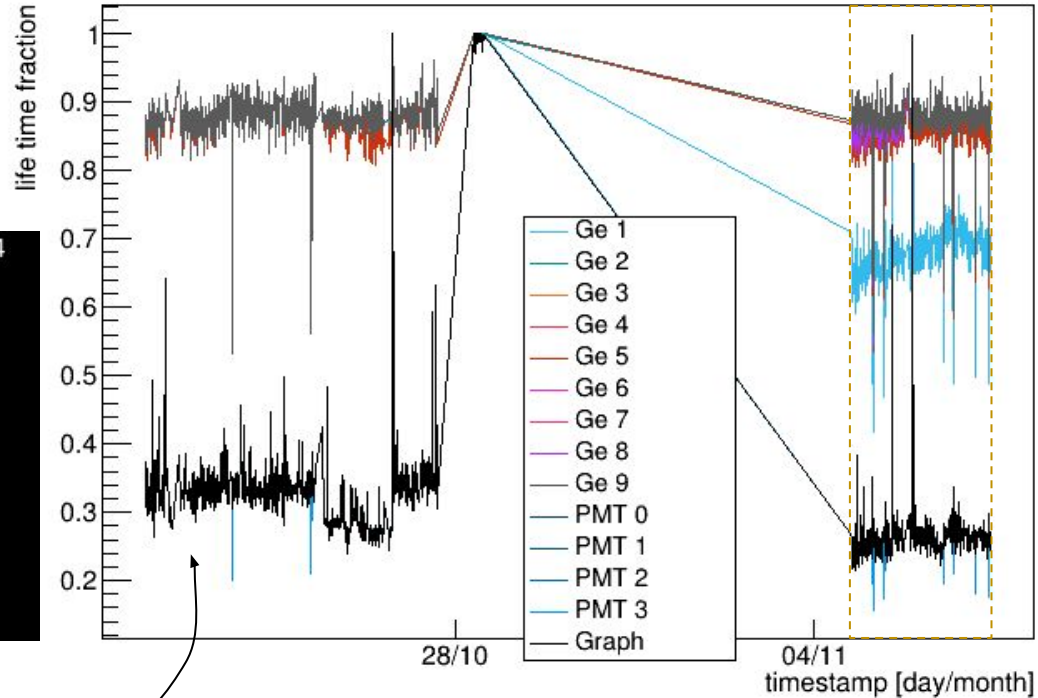
Gap analysis Ba-136

entire system

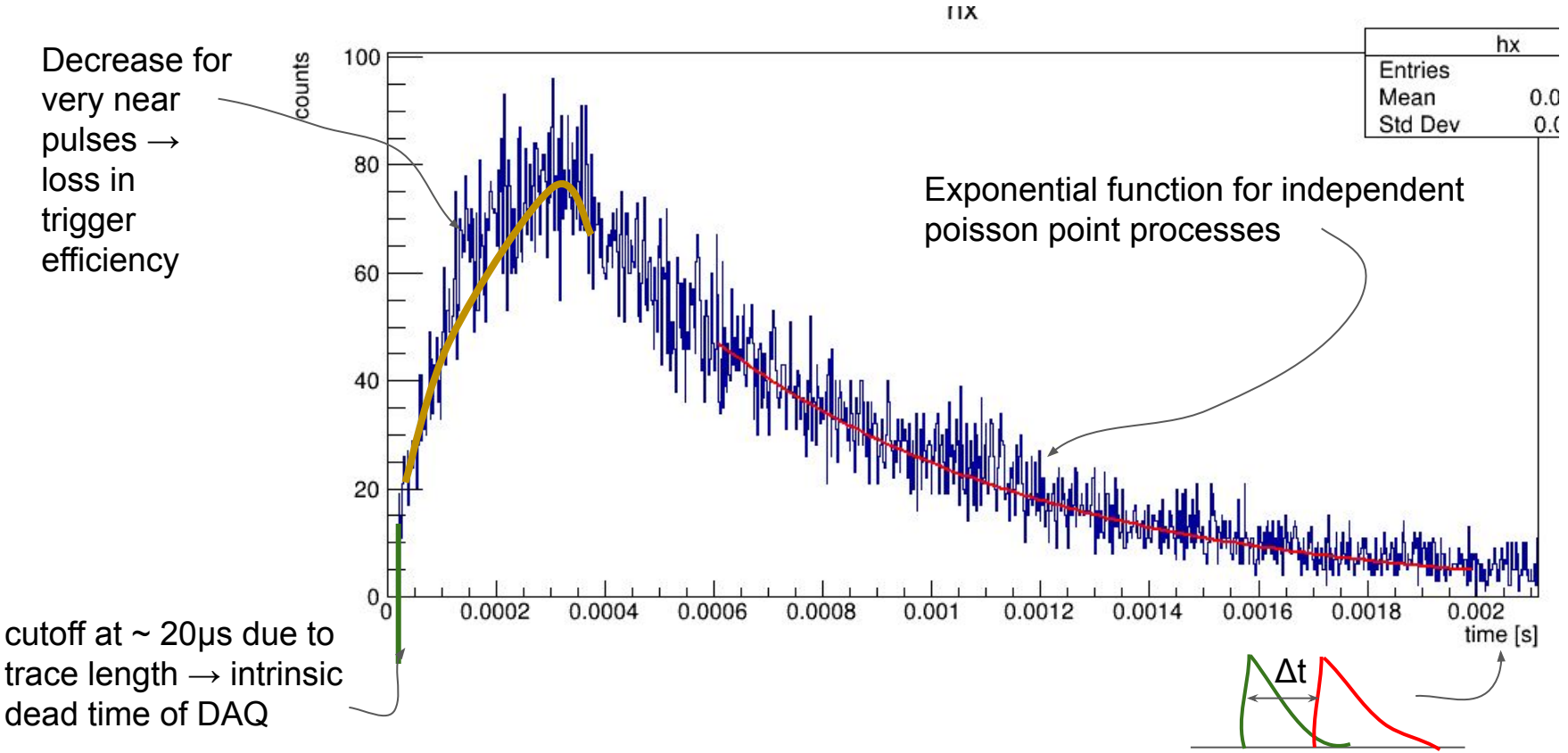
Only last range:

```
Lifetime fraction: 0.267046, losstime fraction: 0.732954
Extracting individual detectors from combined:
lifetime in Ge1: 0.684866; losstime in Ge1: 0.315134
lifetime in Ge2: 0.880097; losstime in Ge2: 0.119903
lifetime in Ge3: 0.880099; losstime in Ge3: 0.119901
lifetime in Ge4: 0.880099; losstime in Ge4: 0.119901
lifetime in Ge5: 0.857889; losstime in Ge5: 0.142111
lifetime in Ge6: 0.880097; losstime in Ge6: 0.119903
lifetime in Ge7: 0.880098; losstime in Ge7: 0.119902
lifetime in Ge8: 0.87399; losstime in Ge8: 0.12601
lifetime in PMT0: 0.267107; losstime in PMT0: 0.732893
lifetime in PMT1: 0.267092; losstime in PMT1: 0.732908
lifetime in PMT2: 0.267088; losstime in PMT2: 0.732912
lifetime in PMT3: 0.267107; losstime in PMT3: 0.732893
```

*black = effective live
time fraction for entire
system*



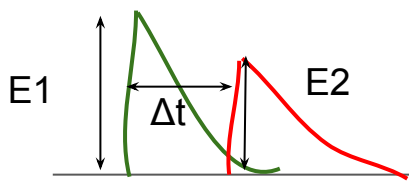
Deadtime from intrace pileup



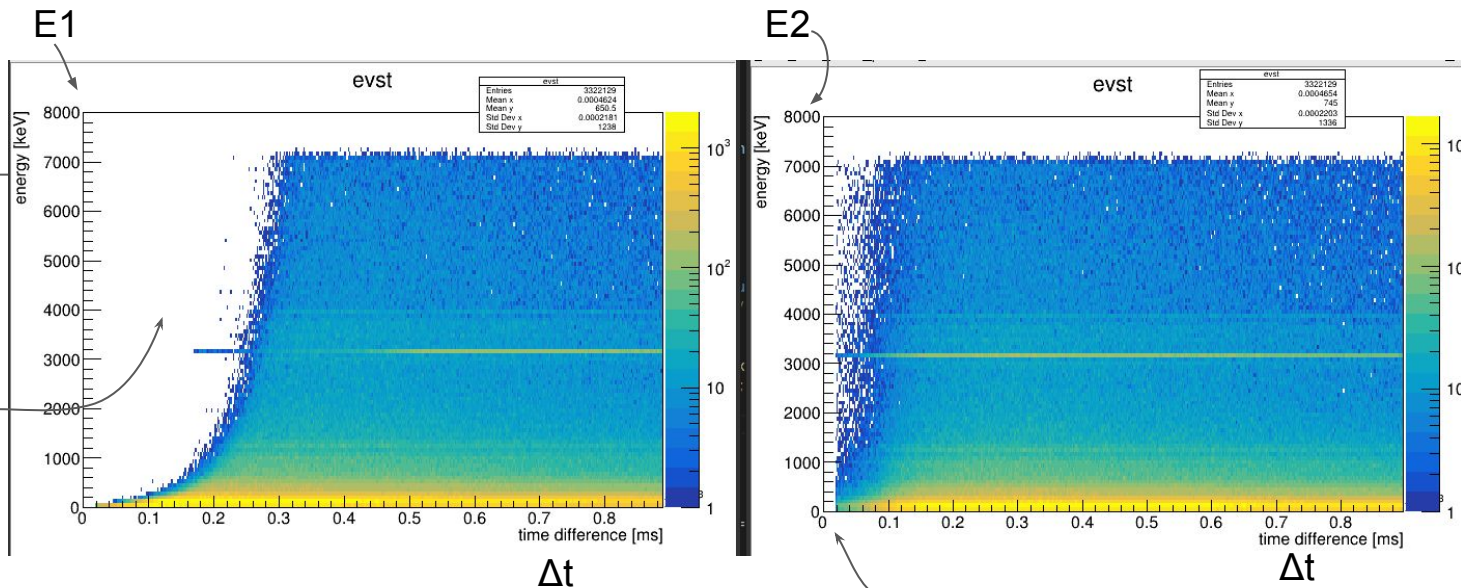
Intrace pileup

Efficiency to detect 2nd pulse

Even for very close pulses, no dependence on energy of 2nd visible \rightarrow looks like we have **no energy-dependent trigger efficiency**



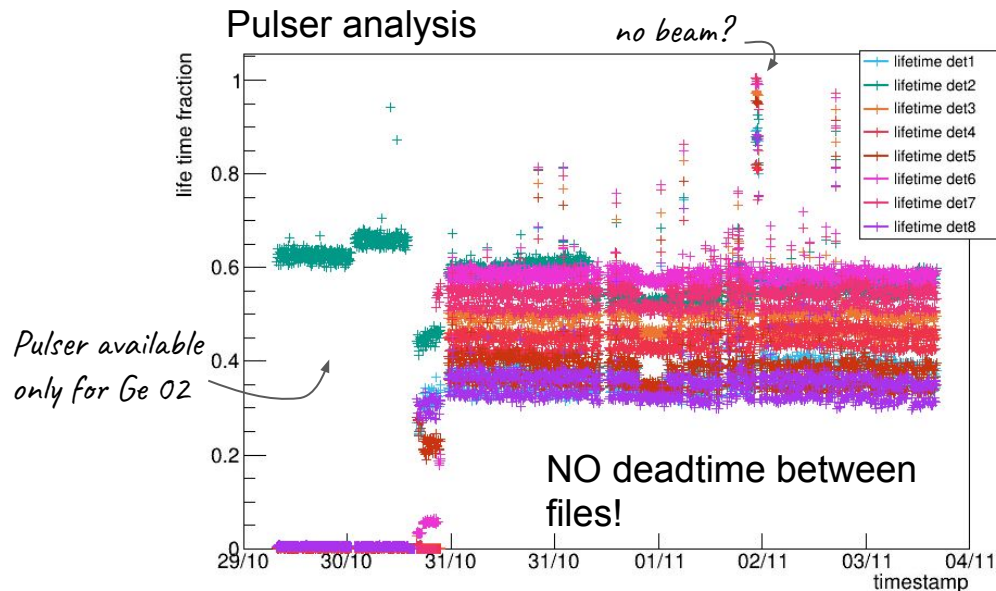
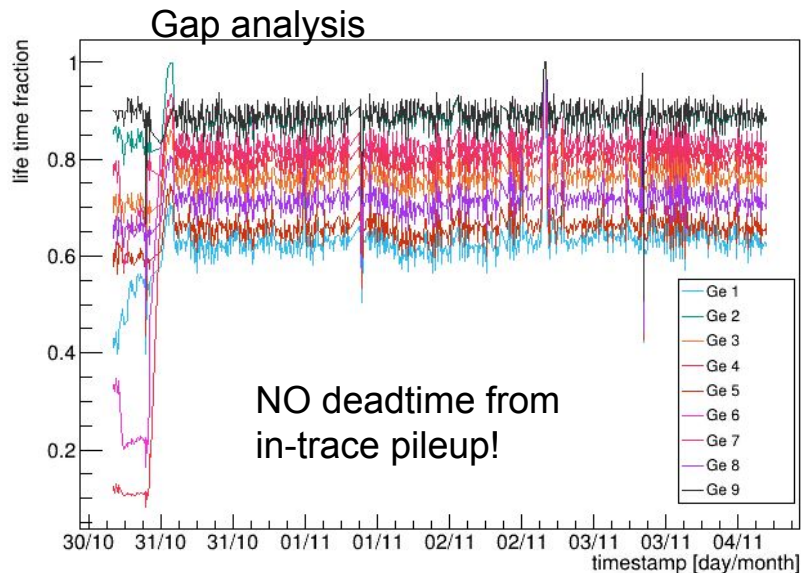
very close pulses:
2nd pulse more difficult to detect if 1st was large



hard DAQ cutoff

Comparison: lifetime from gaps vs lifetime from pulser

Se⁷⁶

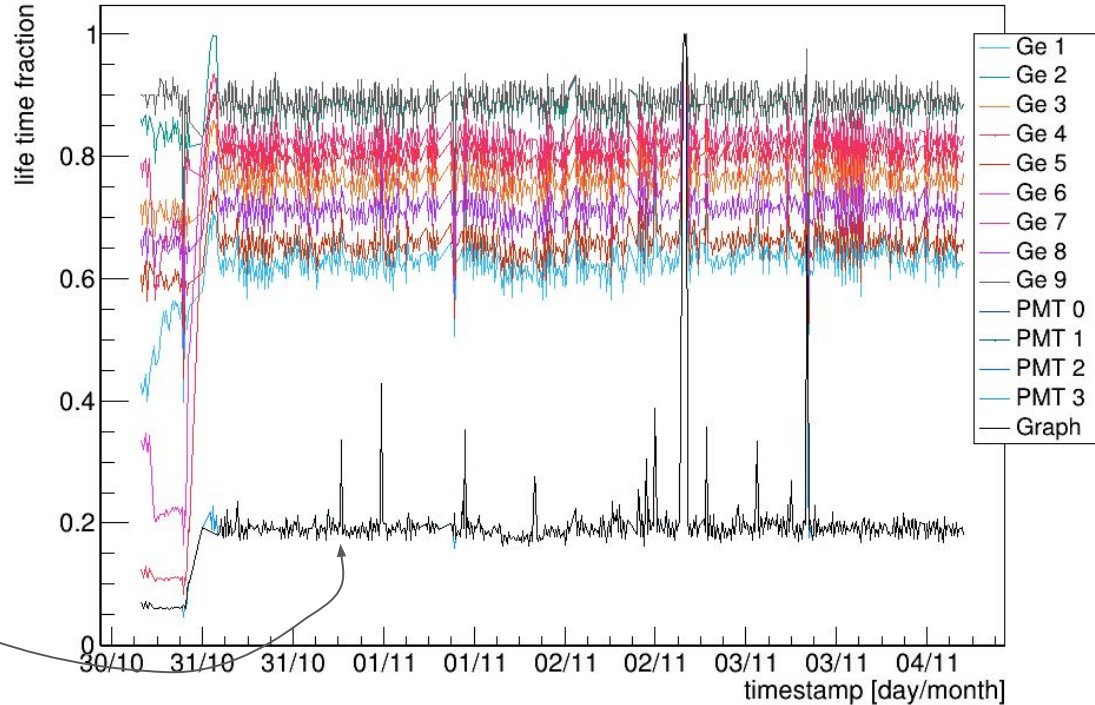


Lifetime from pulser much lower →
presumably due to in-trace pileup:
need to finish cross-check of methods!

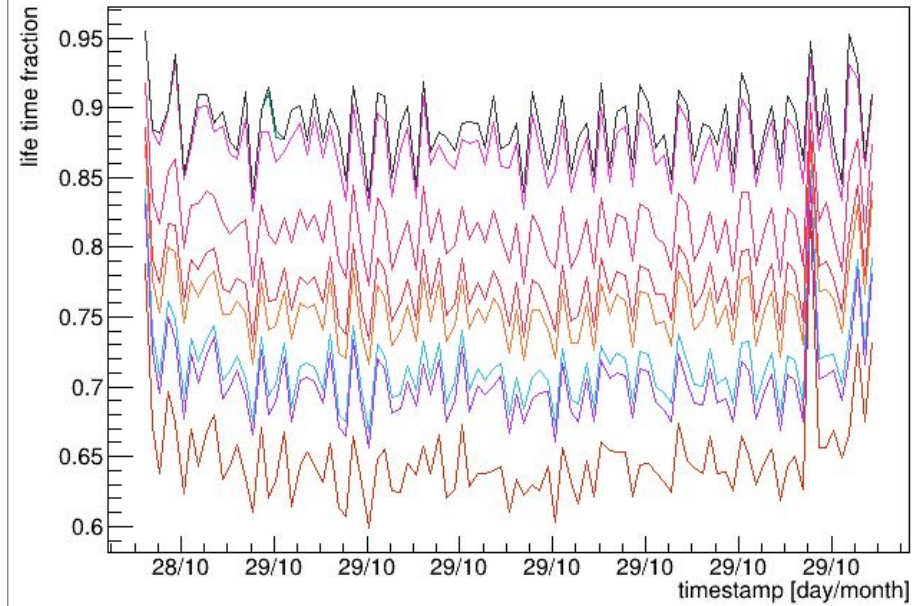
Se-76 gap analysis

Channel	Runtime [s]	lost time [s]	loss fraction [%]
Ge 1	321661	138058	42.9204
Ge 2	321706	42107	13.0887
Ge 3	321685	88249.1	27.4334
Ge 4	321678	87887.9	27.3217
Ge 5	321668	125583	39.0412
Ge 6	321692	53441.9	16.6128
Ge 7	321697	65591.3	20.3892
Ge 8	321678	105098	32.6719
Ge 9	321707	39718.6	12.3462
PMT 0	321580	298020	92.6737
PMT 1	321580	298024	92.6751
PMT 2	321580	298026	92.6755
PMT 3	321580	298020	92.6736

life time fraction of complete system driven by PMTs



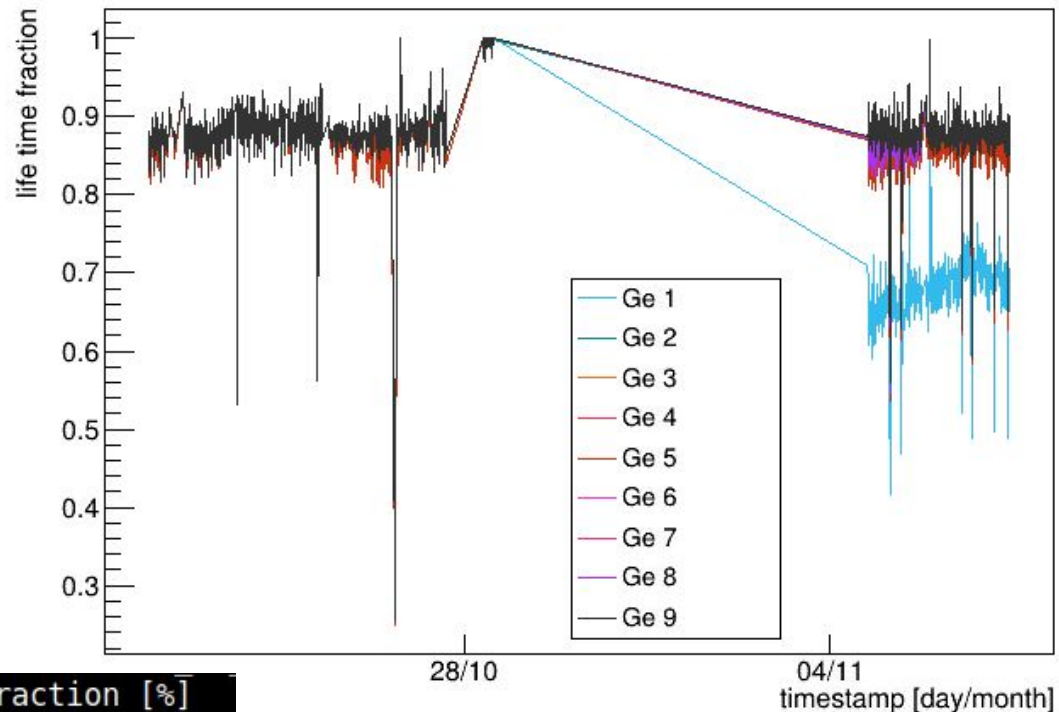
Se-nat



Channel	Runtime [s]	lost time [s]	loss fraction [%]
Ge 1	56821.9	16196.4	28.5037
Ge 2	56833	6439.75	11.331
Ge 3	56824.4	13760.6	24.216
Ge 4	56825.4	12746.6	22.4313
Ge 5	56818.3	20021.4	35.2375
Ge 6	56831.8	7176.51	12.6276
Ge 7	56827.6	10476.3	18.4352
Ge 8	56821	16885.3	29.7166
Ge 9	56833	6434.57	11.3219

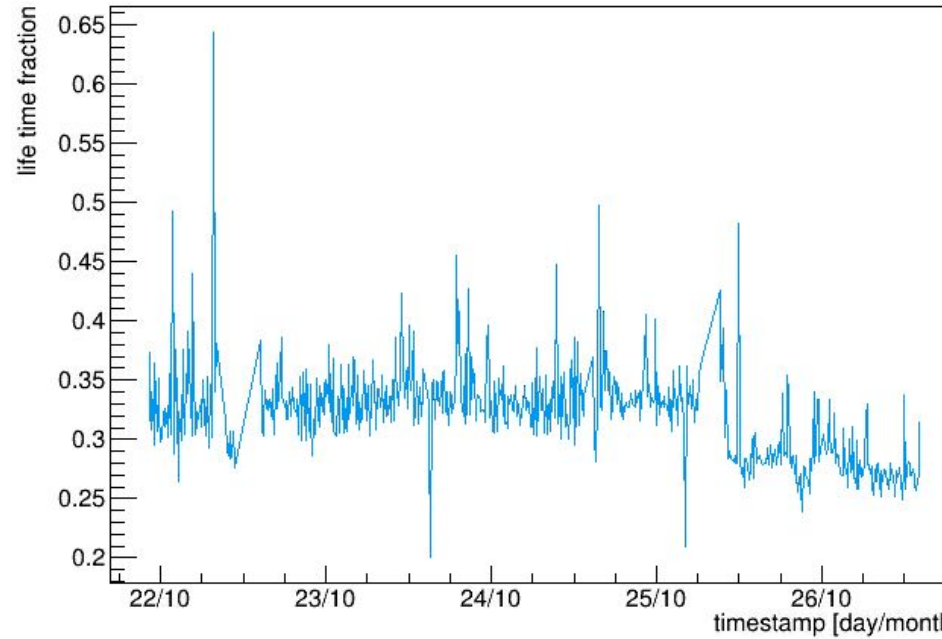
(PMT pending)

Ba-136 Ge



Channel	Runtime [s]	lost time [s]	loss fraction [%]
Ge 1	681492	123941	18.1867
Ge 2	681498	79995.7	11.7382
Ge 3	681498	79974.7	11.7351
Ge 4	681498	79974.7	11.7351
Ge 5	681497	87162.4	12.7898
Ge 6	681498	79978	11.7356
Ge 7	681498	79975.5	11.7353
Ge 8	681498	81350.5	11.937
Ge 9	681498	79989.9	11.7374

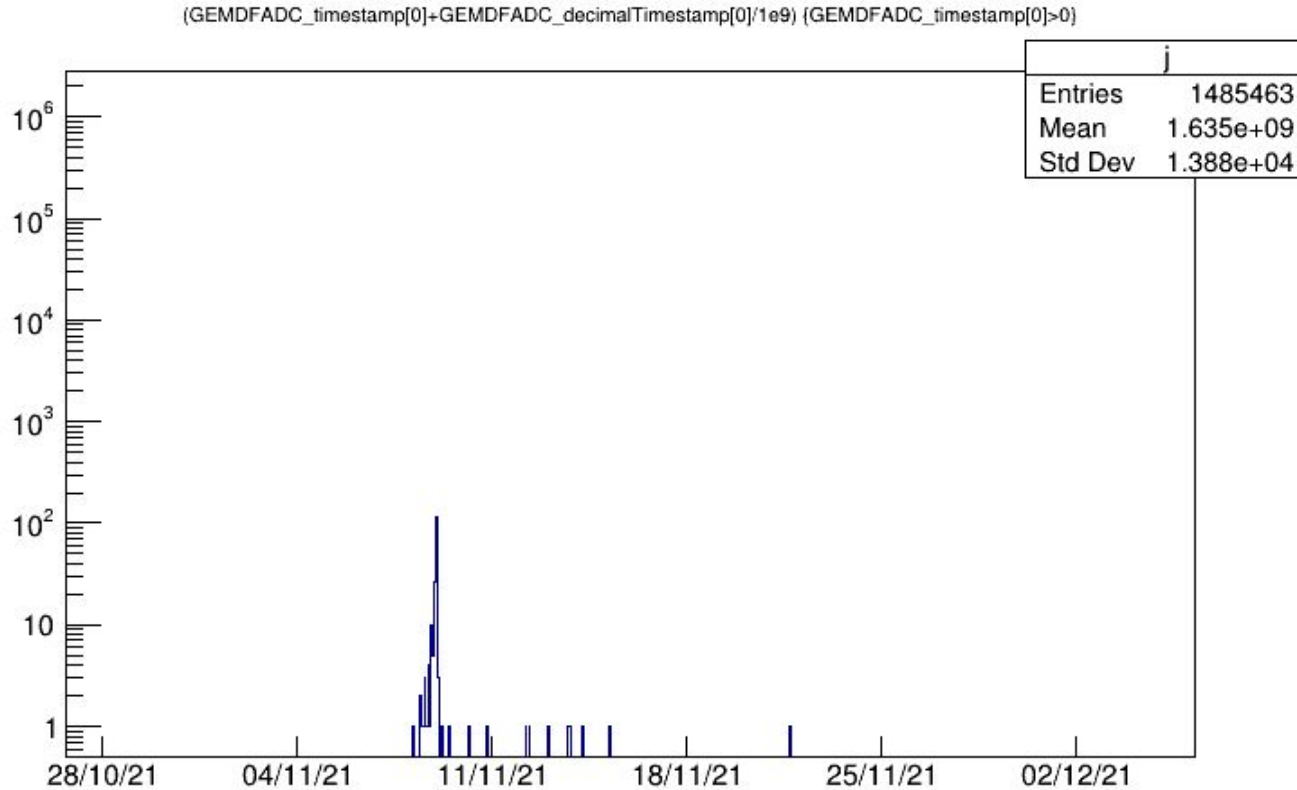
Ba-136 PMT



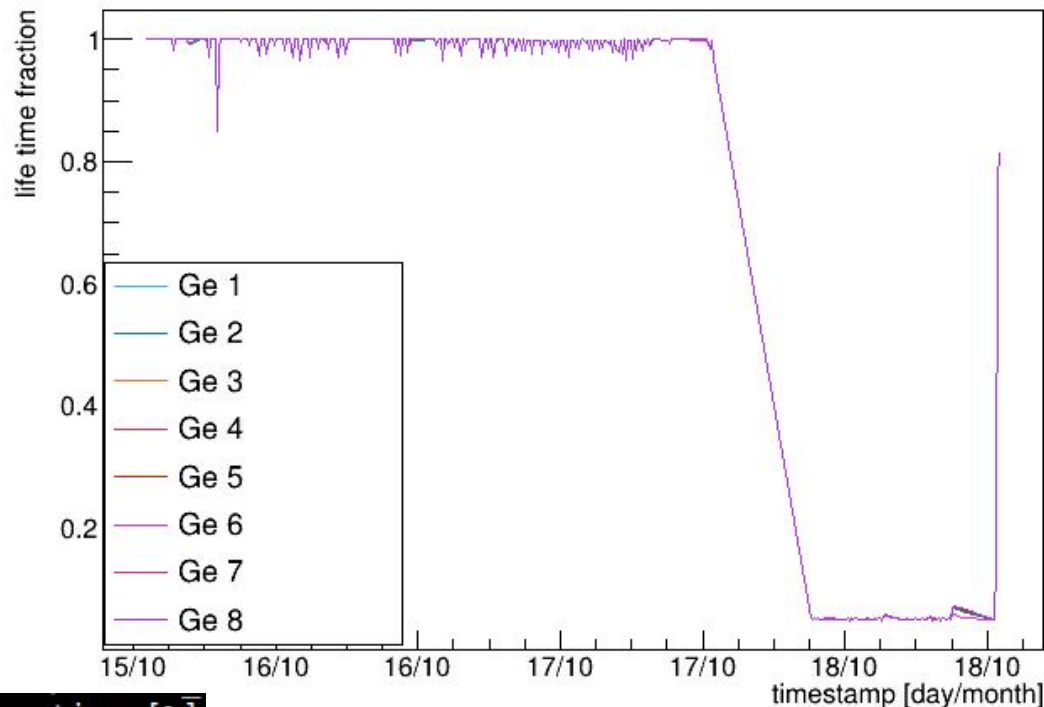
BUG! -> MESSEUP UP TIMESTAMPS

Channel	Runtime [s]	lost time [s]	loss fraction [%]
PMT 0	-4.47383e+06	460977	-10.3038
PMT 1	-5.05044e+06	462843	-9.16441
PMT 2	-6.31792e+06	461060	-7.29765
PMT 3	-3.40227e+06	460978	-13.5491

Intermezzo: in ba136-05 timestamps are messed up

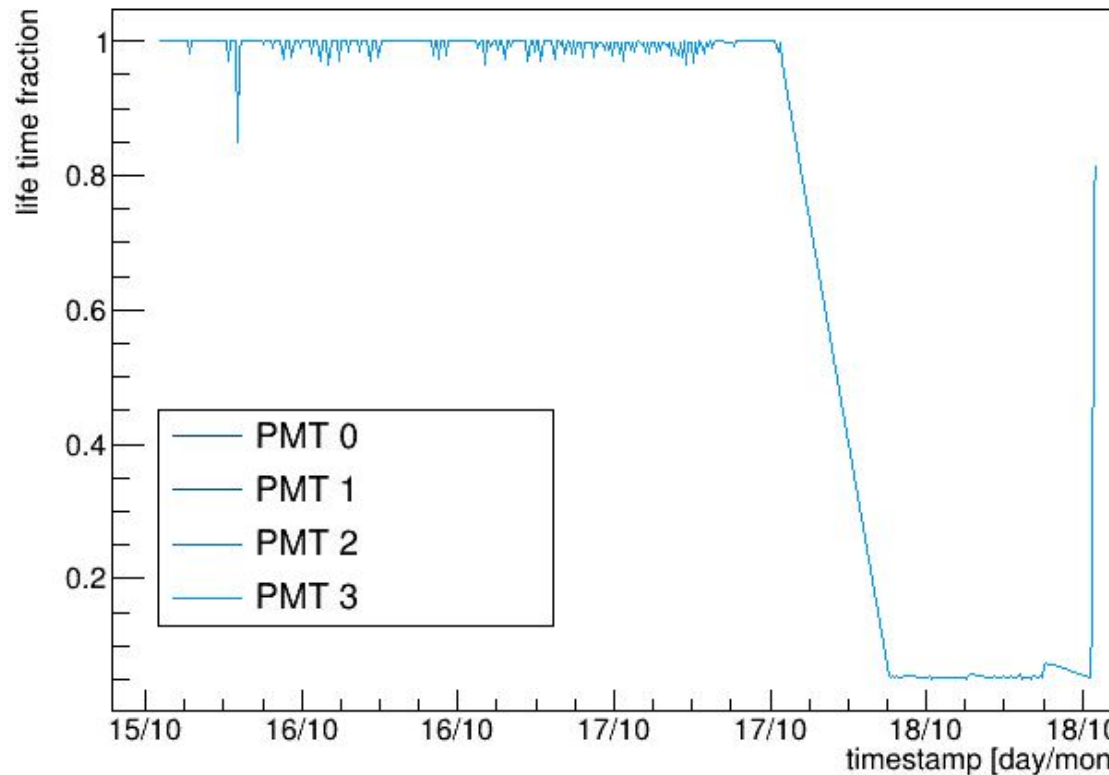


Ba-nat Ge



Channel	Runtime [s]	lost time [s]	loss fraction [%]
Ge 1	172583	36034.9	20.8797
Ge 2	172583	36072.4	20.9015
Ge 3	172583	36030.9	20.8774
Ge 4	172583	36035.2	20.8799
Ge 5	172583	36037.9	20.8815
Ge 6	172583	36102.2	20.9187
Ge 7	172583	36030.4	20.8771
Ge 8	172583	36032.1	20.8781

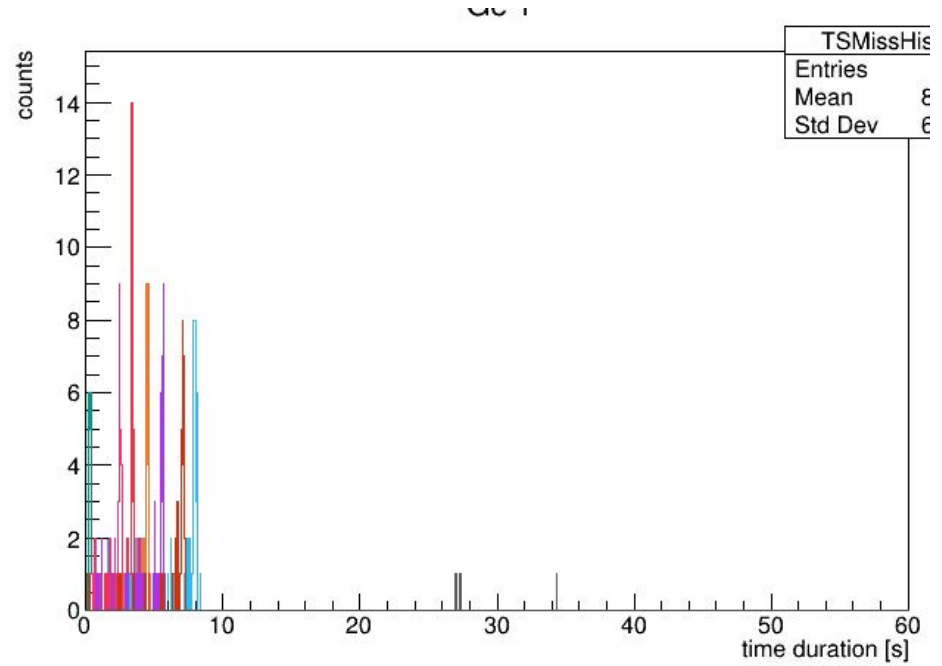
Ba-nat PMT



Channel	Runtime [s]	lost time [s]	loss fraction [%]
PMT 0	172583	36029.5	20.8766
PMT 1	172583	36029.5	20.8766
PMT 2	172583	36029.5	20.8766
PMT 3	172583	36029.5	20.8766

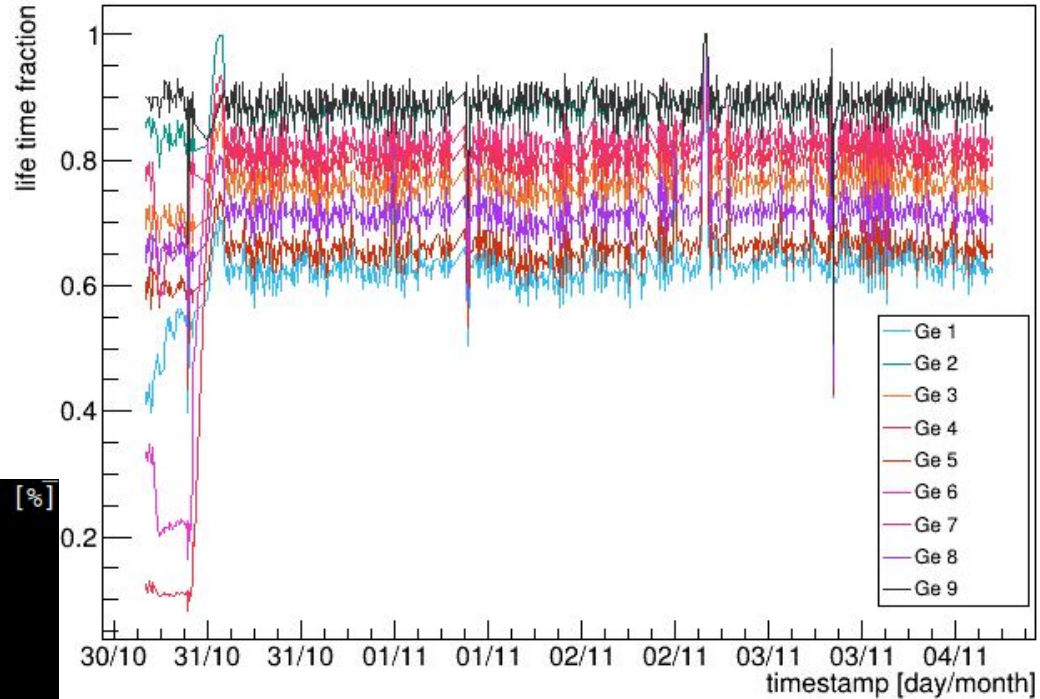
Backup

Size of gaps in regular data
taking much smaller than 60 s

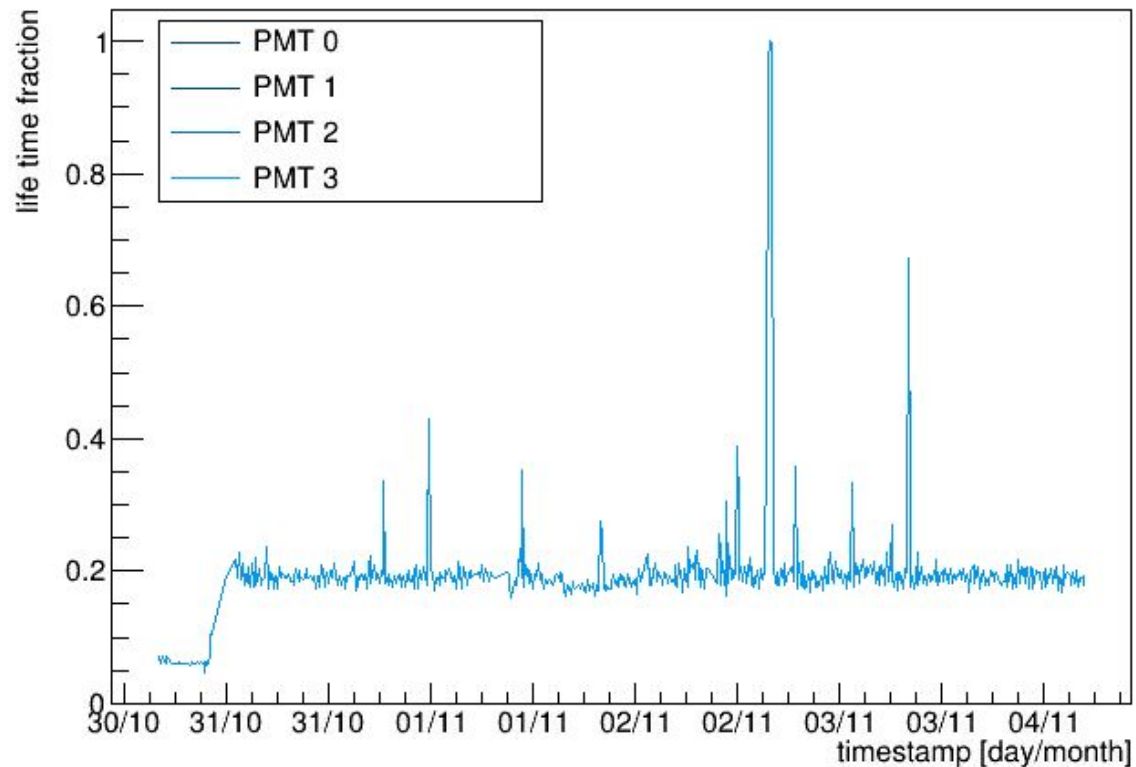


Se-76 Ge

Channel	Runtime [s]	lost time [s]	loss fraction [%]
Ge 1	321661	138058	42.9204
Ge 2	321706	42107	13.0887
Ge 3	321685	88249.1	27.4334
Ge 4	321678	87887.9	27.3217
Ge 5	321668	125583	39.0412
Ge 6	321692	53441.9	16.6128
Ge 7	321697	65591.3	20.3892
Ge 8	321678	105098	32.6719
Ge 9	321707	39718.6	12.3462



Se-76 PMT



Channel	Runtime [s]	lost time [s]	loss fraction [%]
PMT 0	321580	298020	92.6737
PMT 1	321580	298024	92.6751
PMT 2	321580	298026	92.6755
PMT 3	321580	298020	92.6736