Status Report MEMPHYNO darkrate measurements

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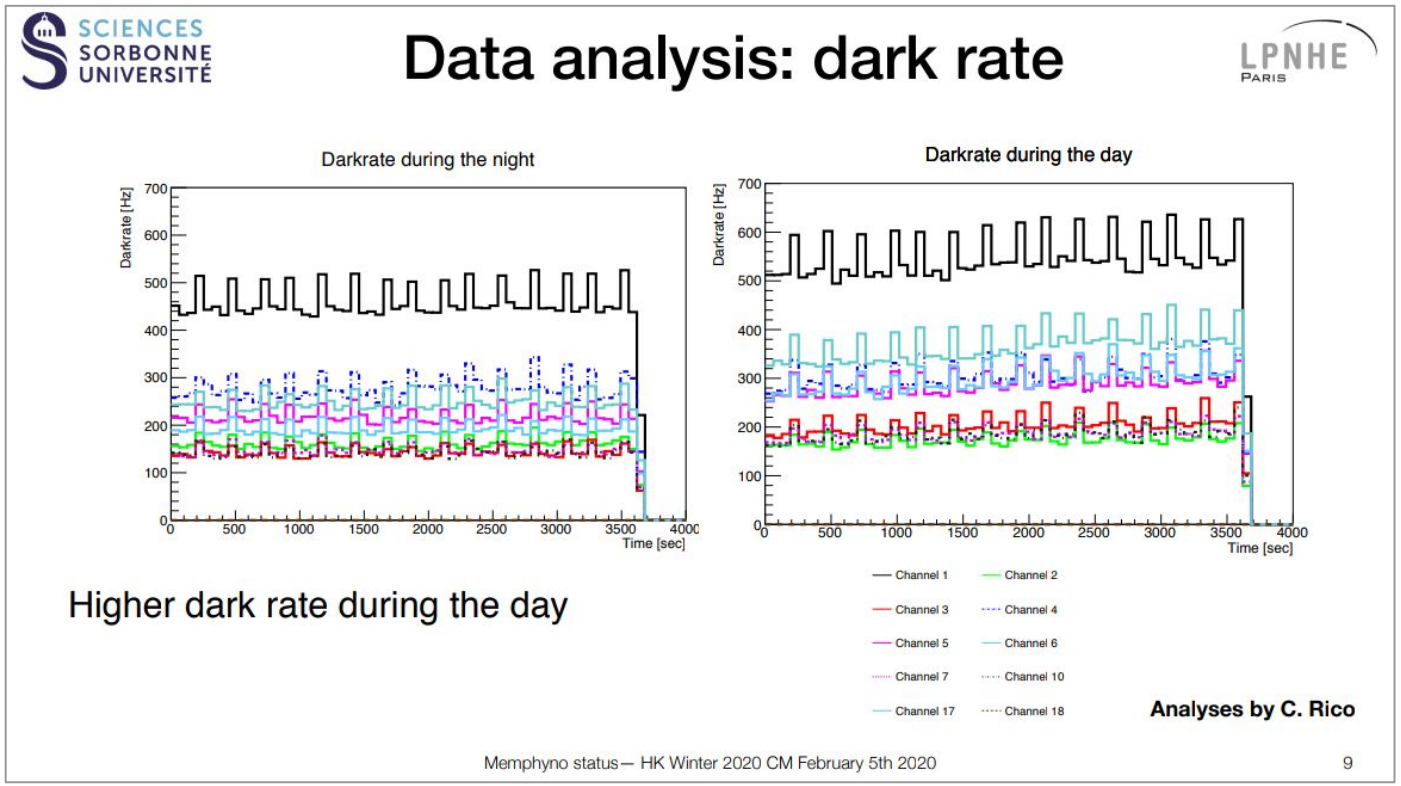
mPMT Japan meeting

Introduction (reminder)

- Fixed light leak of the MEMPHYNO's water tank at APC and took the data for 2 weeks w/o any light source (only darkhits and cosmic muon)
- Analyzed the data in order to understand about the mPMT
  - Stability of the darkrate

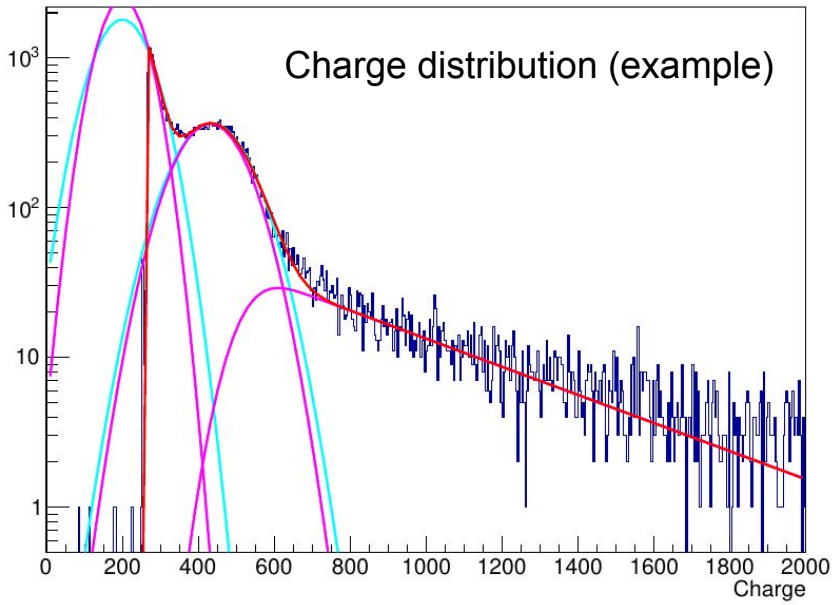


Analysis (remider)

1. Divided all hits-data by the period = 100 sec
2. Made charge-distributions for the divided time-range
3. Found 1 p.e. mean with the fitting
4. Calculated the darkrate over all run-time
    - Defined the threshold as (1 p.e. mean) x 0.8

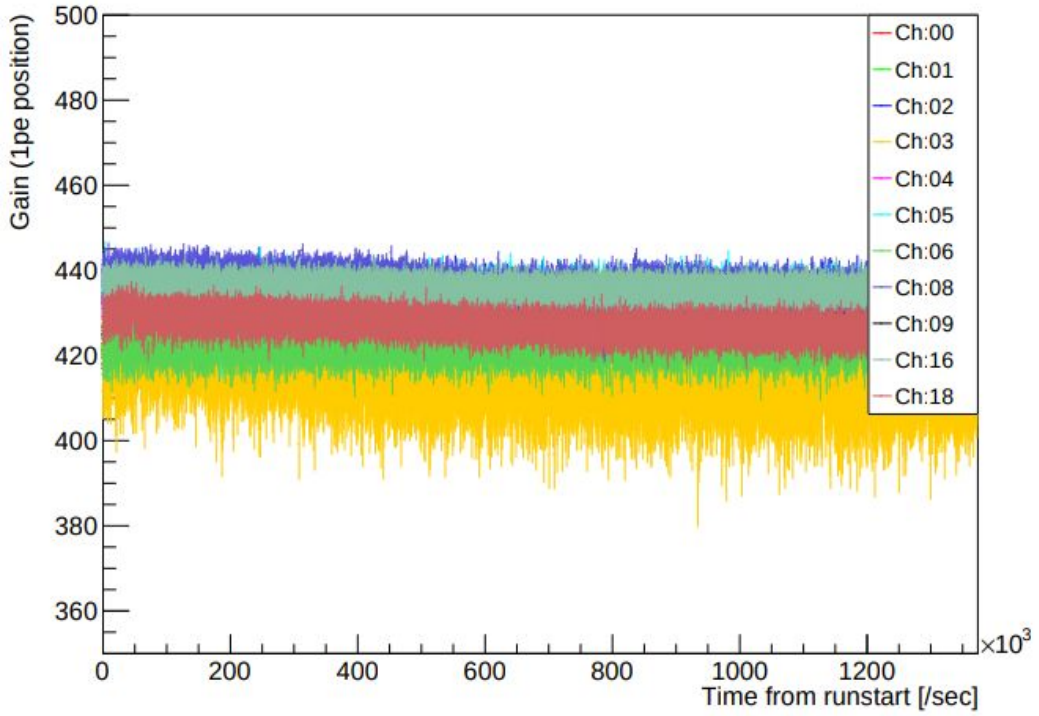
Update

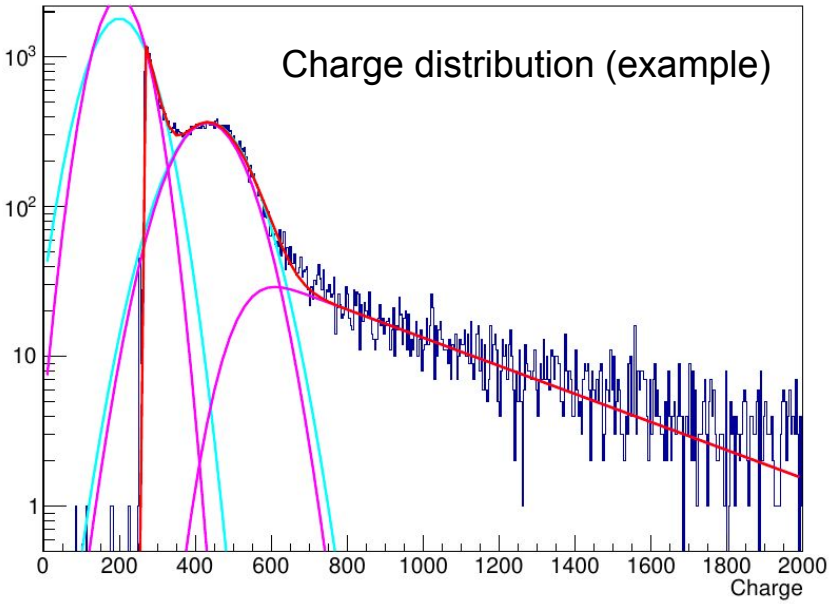
- Changed how to get 1pe peak:
  - I used the fitting that uses one gaussian (right blue peak) around 1pe peak.
    → This looks stable for long time.
  - I also confirmed that the fit 1pe position was stable
- HV data
  - → Stable within less than 0.1 %
  - But the bias between the monitored HV and the set HV of 1.5 % (this is different by channel
- Difference between day and night
  - → Stable within a few % (max 4%)
- Covariance matrix



1 pe position

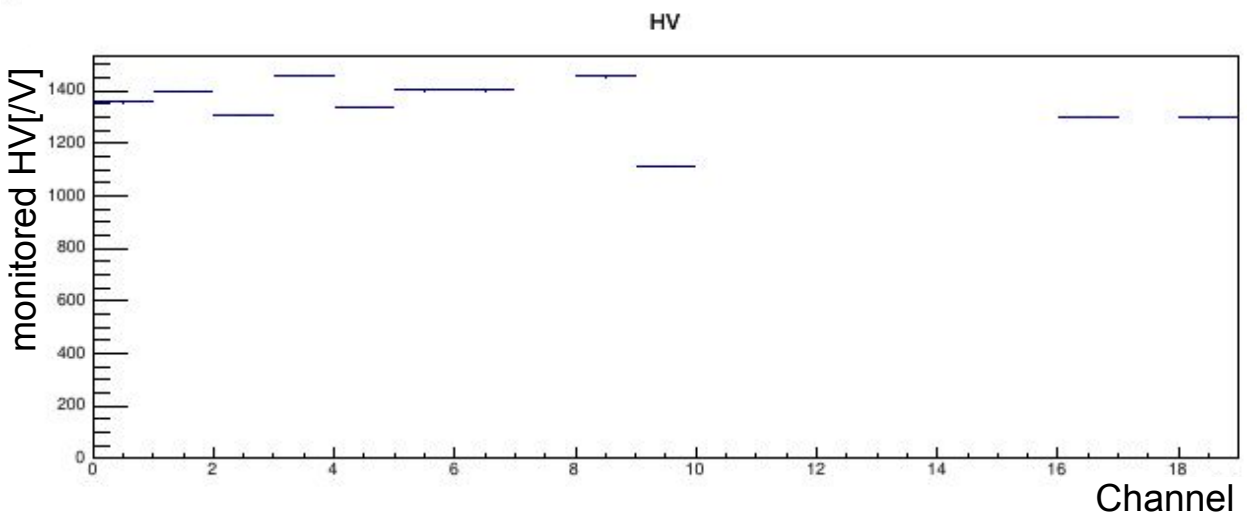
- There were large error in last dark rate plots.
- I modified the method to get 1 pe method
  - I used single gaussian (cyan) to fit 1pe peak and used its value
- Left plot shows the calculated 1pe position (gain) and its error
  - It looks stable and smaller fitting error (I put all channels in the backup slides)

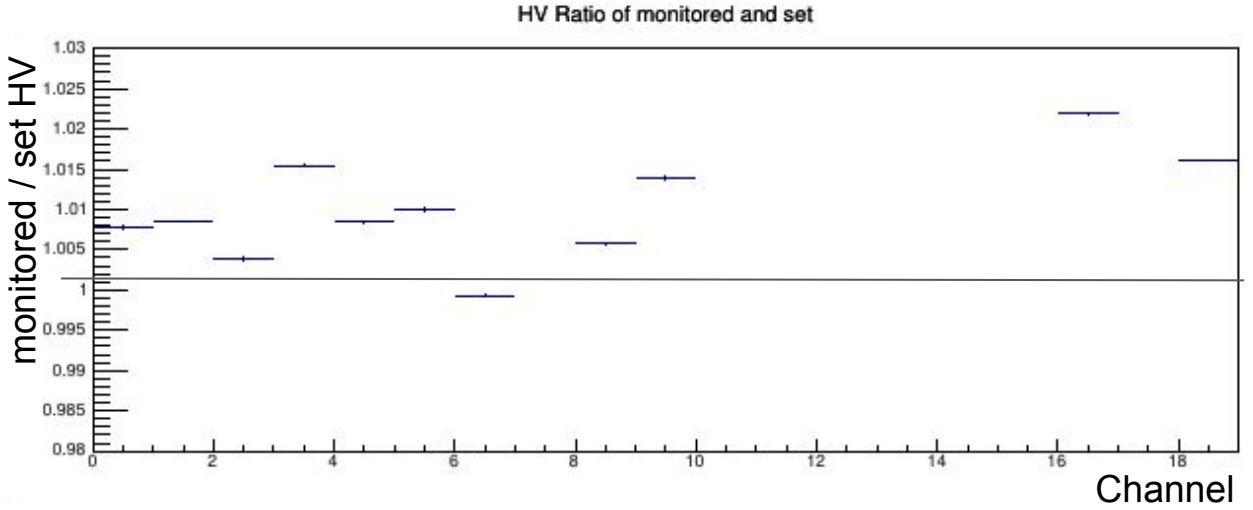




HV data

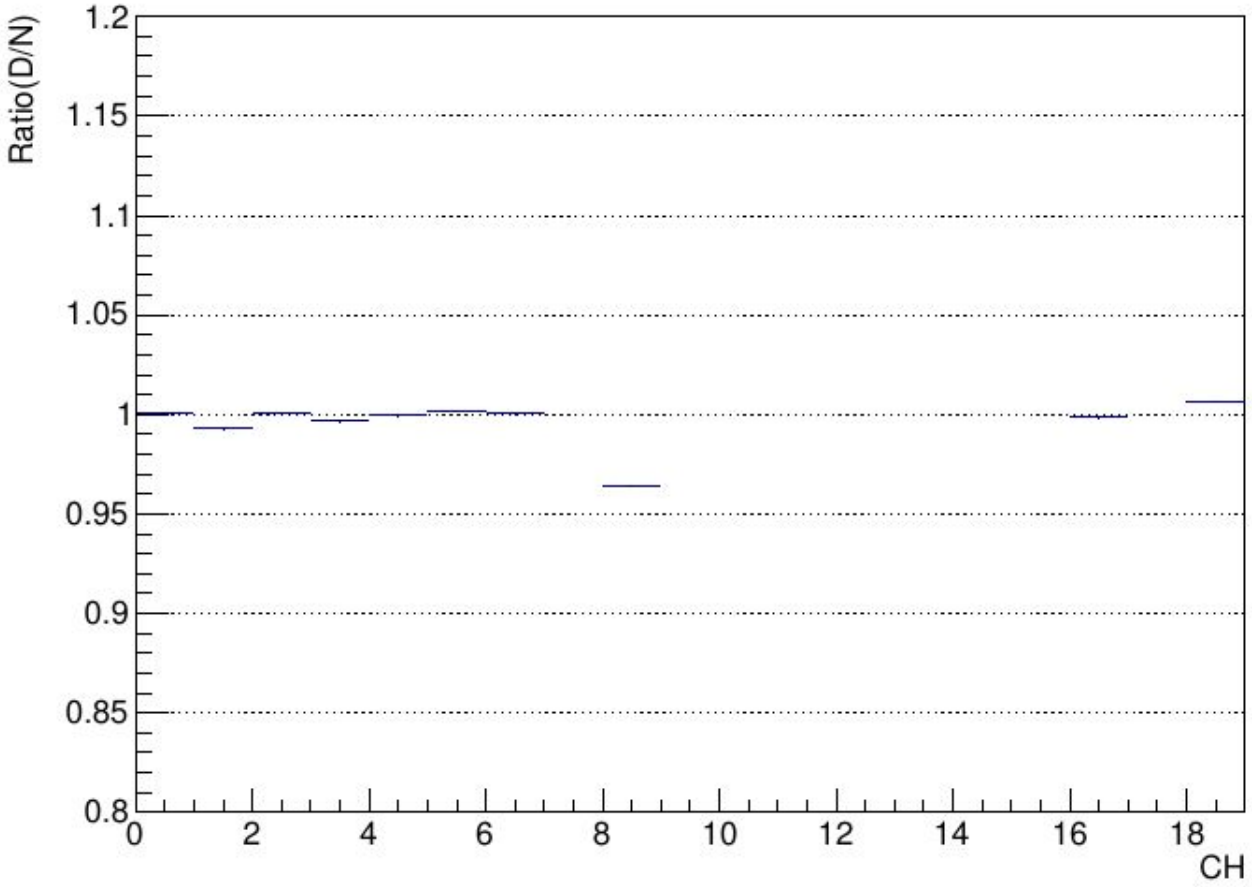
- I recorded HVs when I changed the run number.
- It looks very stable comparing to the fluctuation of the dark rate
  - Tiny error bar shows “Max(max[HV] - mean[HV] , mean[HV] - min[HV])”
-





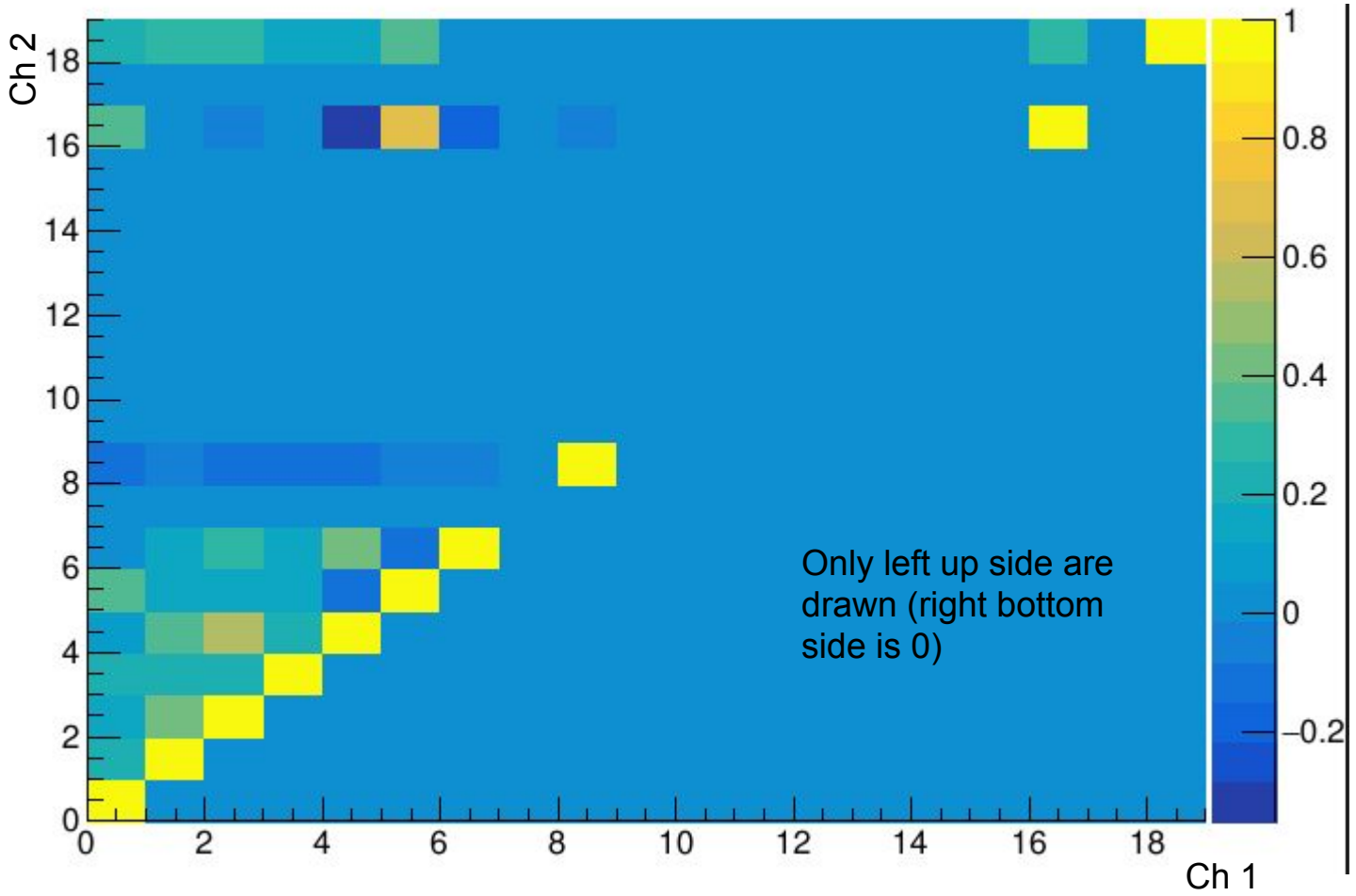
D/N differences

- I defined the day and night according to the local time:
  - Day: 10 AM ~ 4 AM
  - Night: 10 PM ~ 4 AM
- Compared the hits in day and night
  - Here I did not veto any spikes
  - → Stable < 1 % (except for ch. 8 which has large spike)



Covariance matrix

- I drew the covariance matrix of dark rate of each channel in order to extract the environmental effect
  - I expect this effect appears in all channel
  -



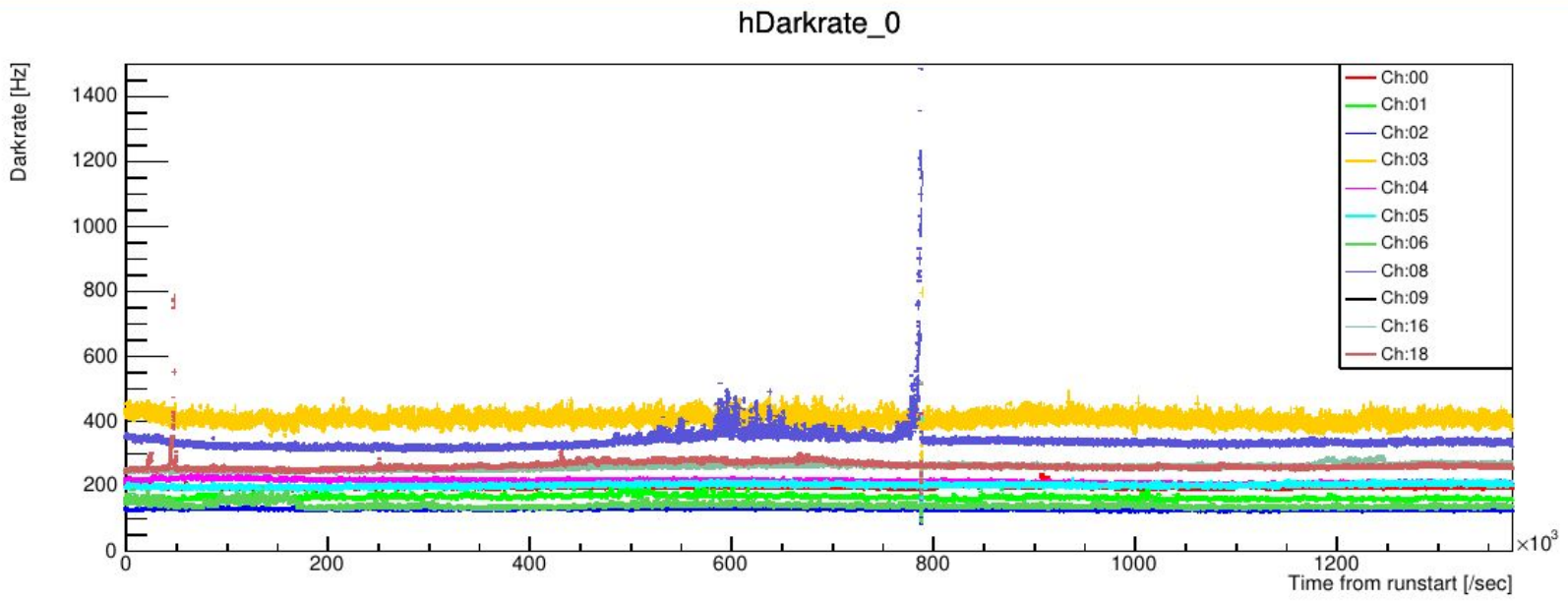
Next

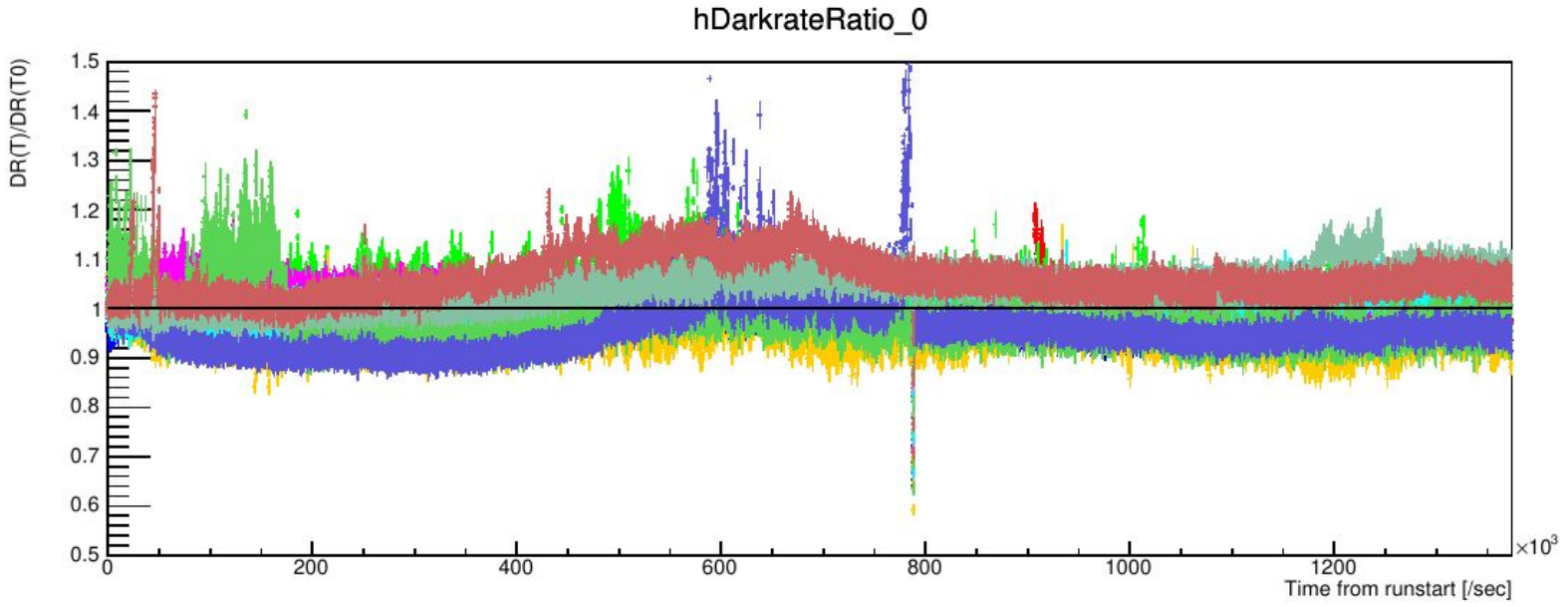
- Correlation with the temperature of the Paris
  - I found the open data of SYNOP at Orly Airport, which looks easier data format for extraction the temperature.
  - But Orly Airport is bit far from the APC. How do you think? Any other open-data?

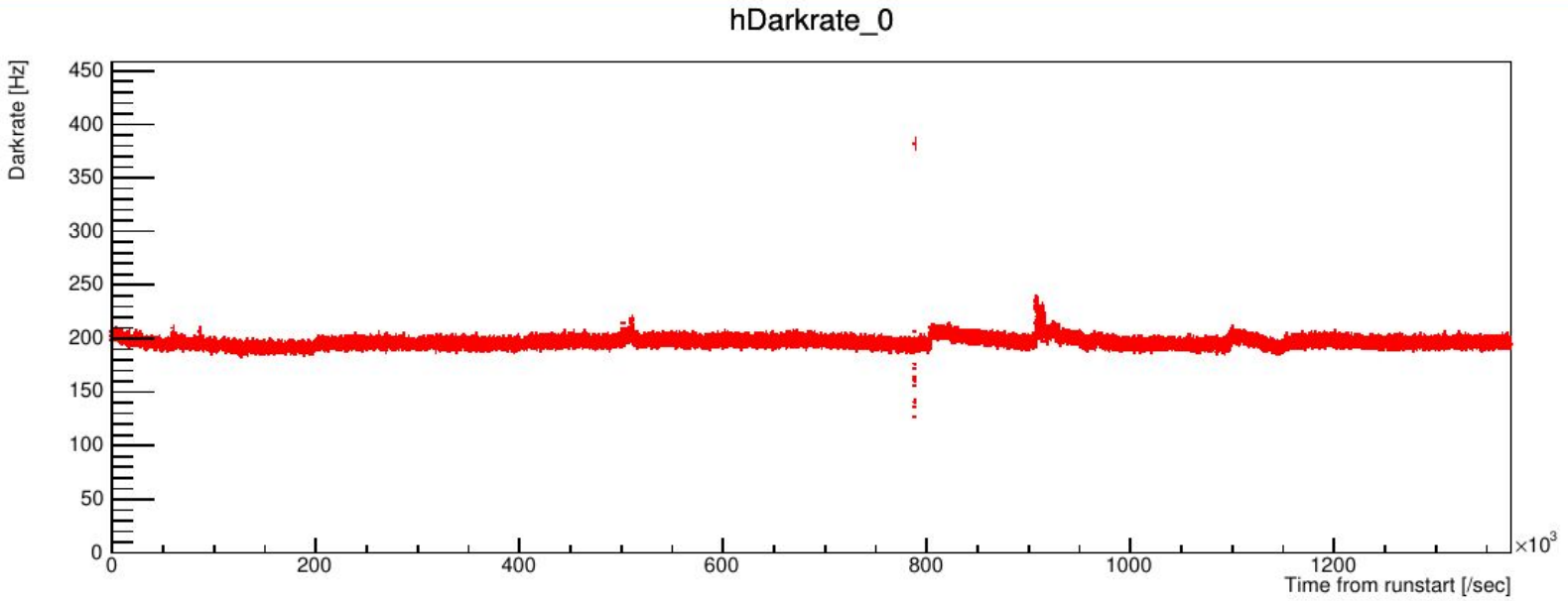
Backup

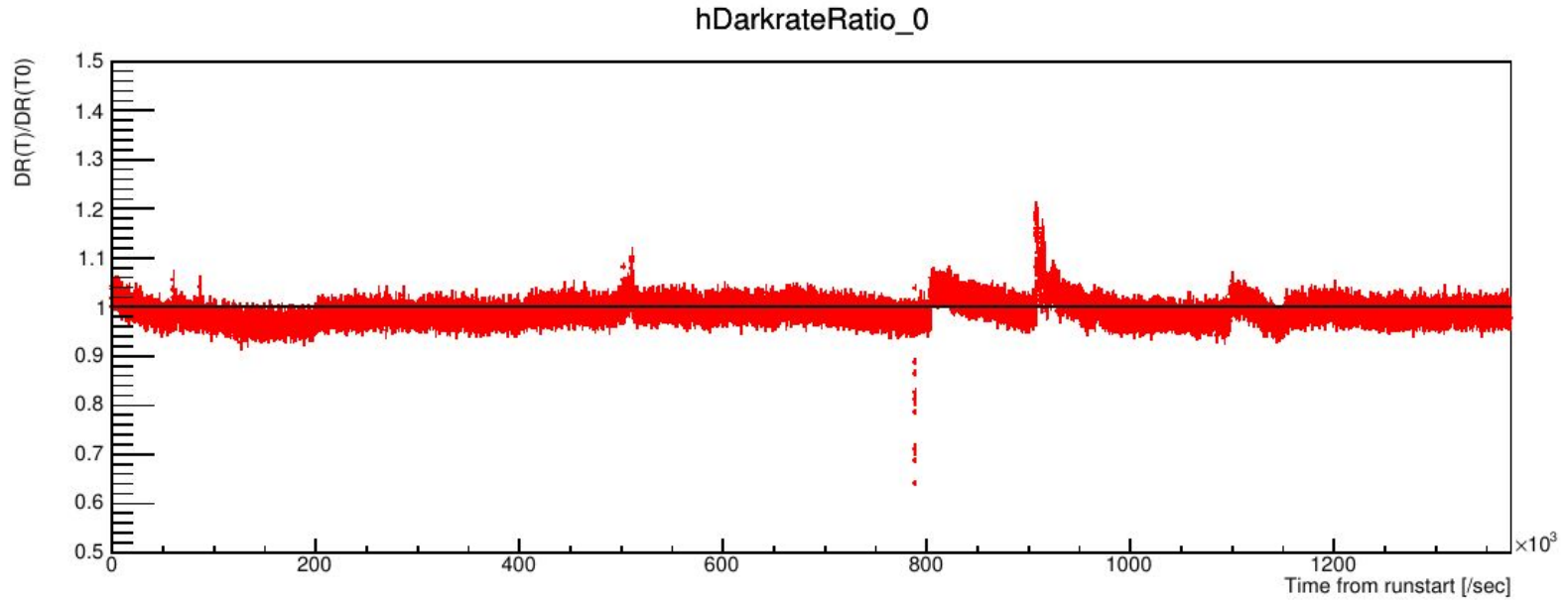
- Dark rate with new 1pe position
- HV
- Gain

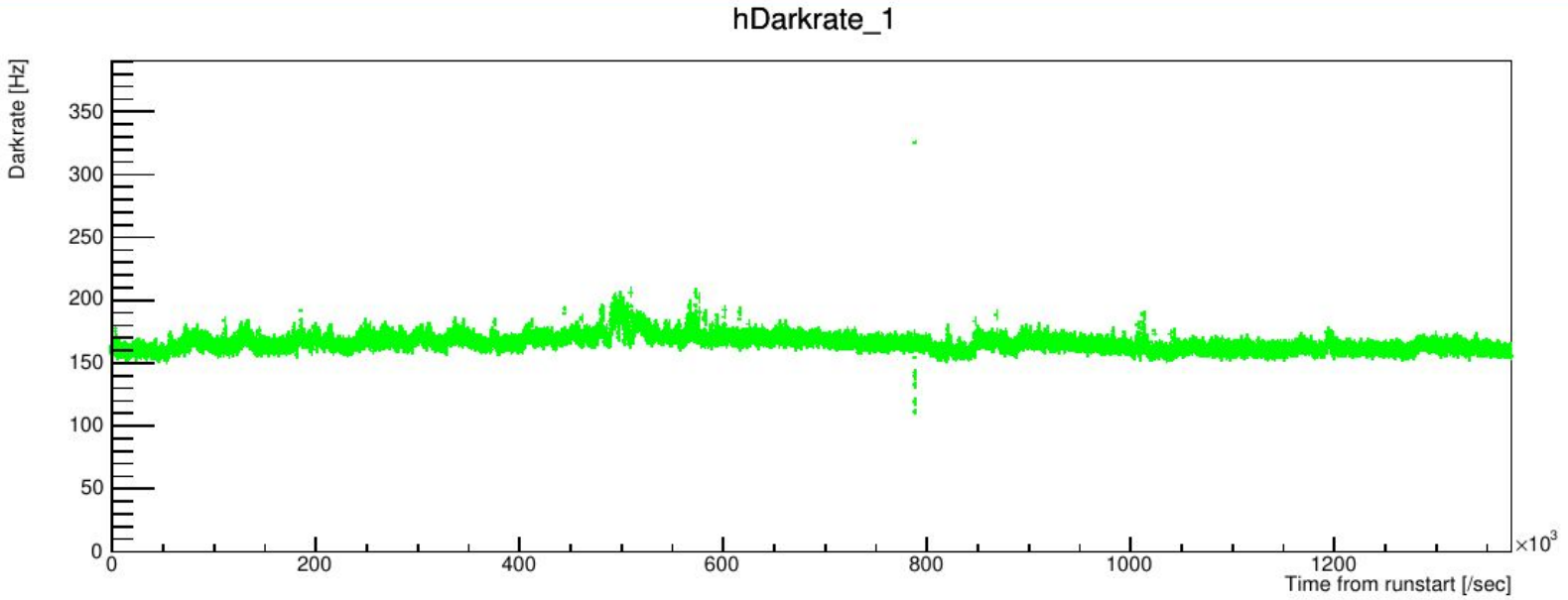
Dark rate

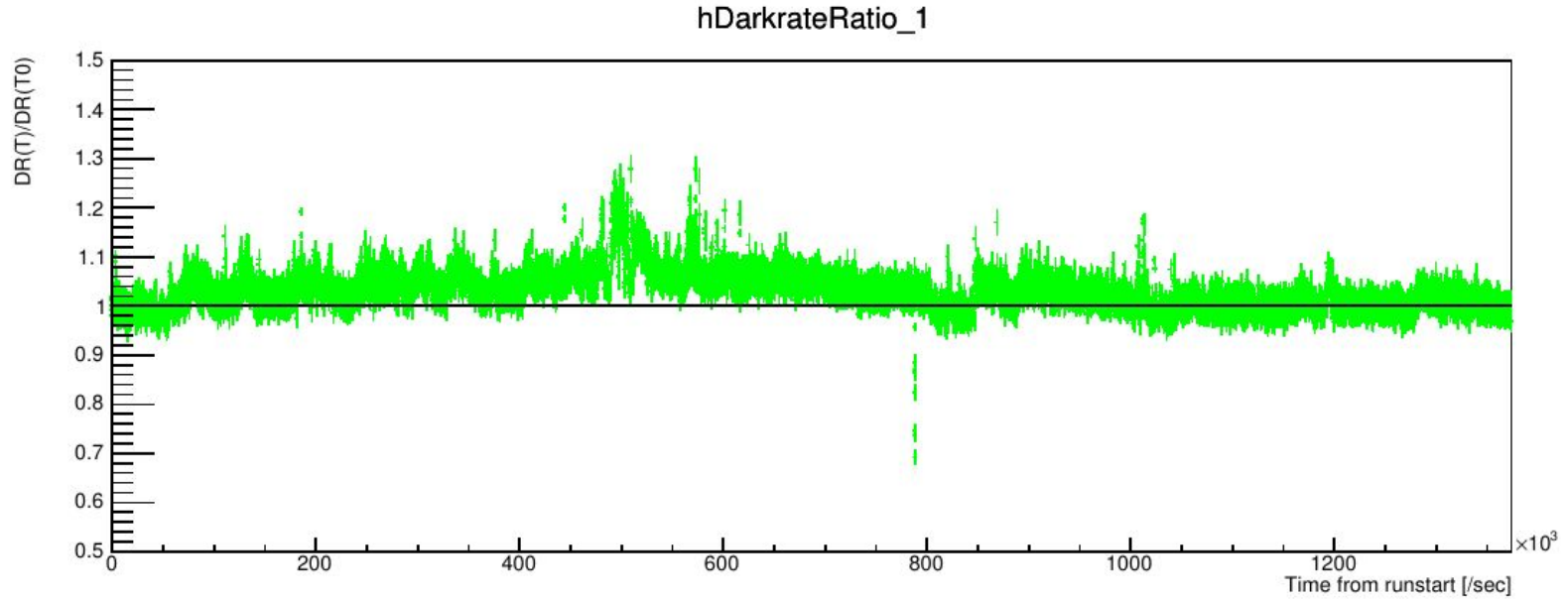

hDarkrate_0
Darkrate [Hz]
Ch:00
Ch:01
Ch:02
Ch:03
Ch:04
Ch:05
Ch:06
Ch:08
Ch:09
Ch:16
Ch:18
×10^3
Time from runstart [/sec]

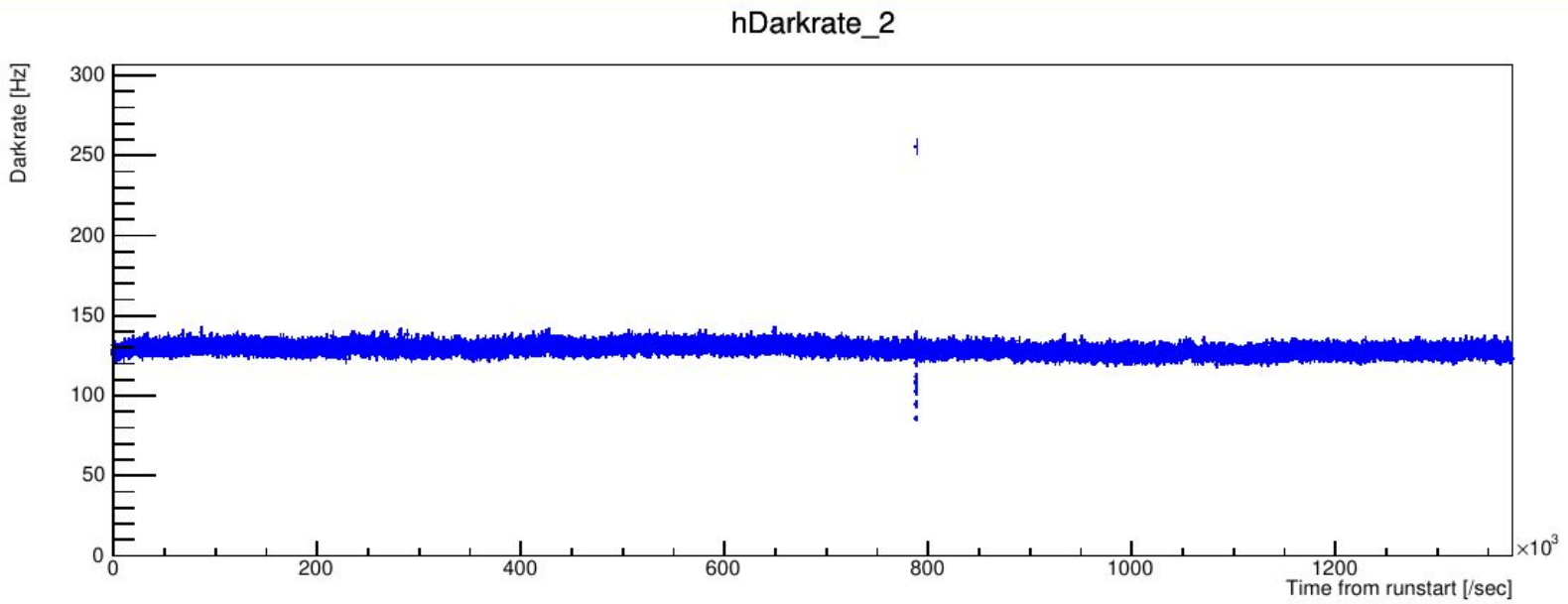

hDarkrateRatio_0
DR(T)/DR(T0)
×10^3
Time from runstart [/sec]

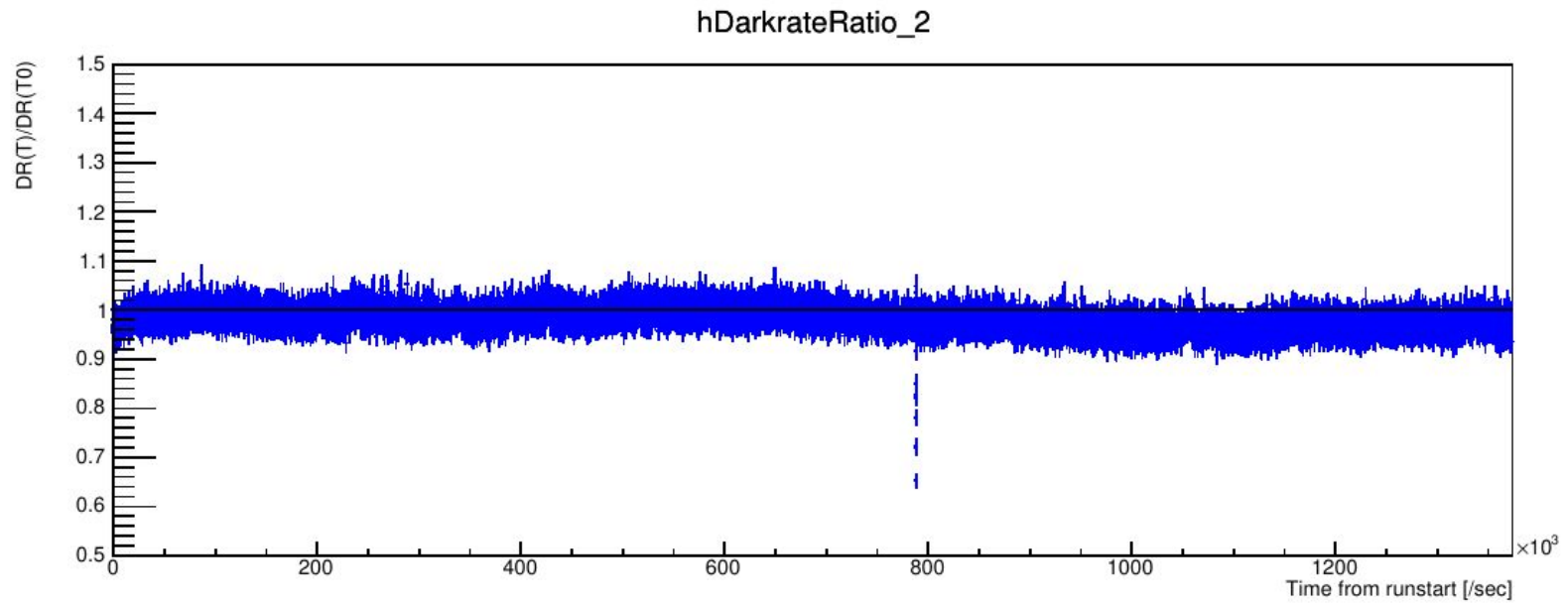

hDarkrate_0
Darkrate [Hz]
450
400
350
300
250
200
150
100
50
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

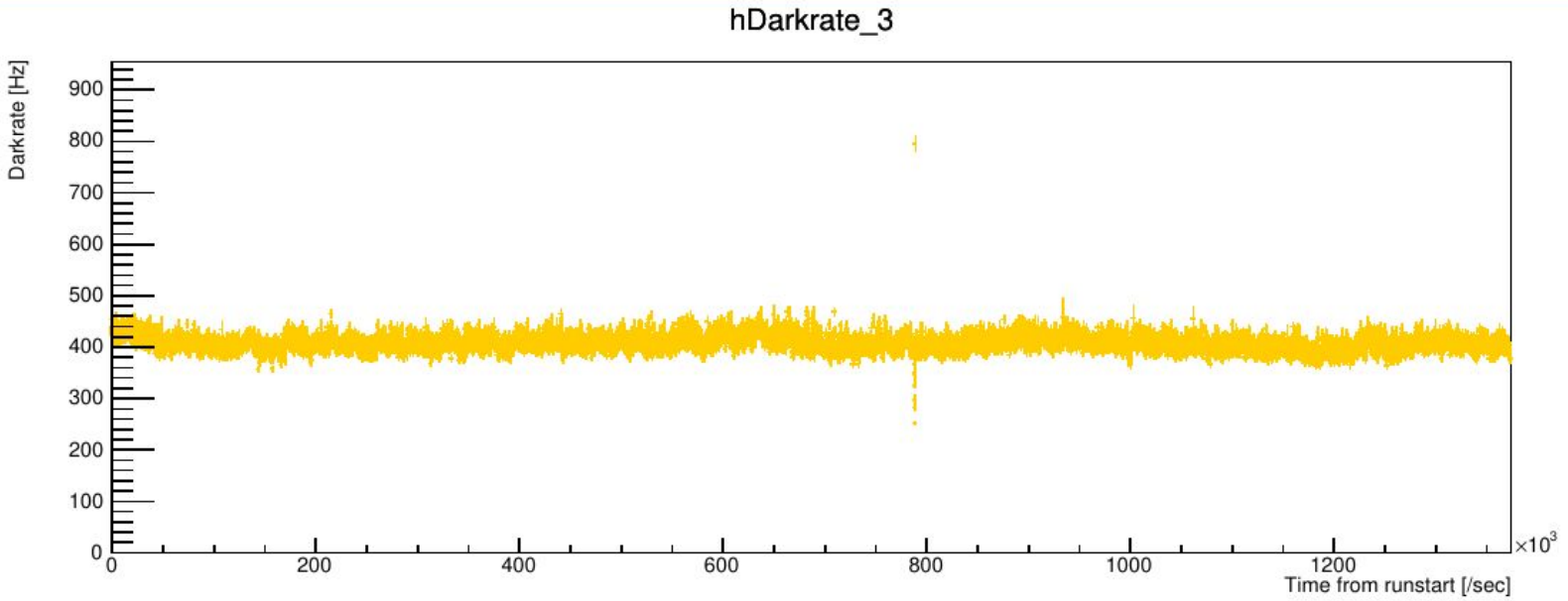

hDarkrateRatio_0
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

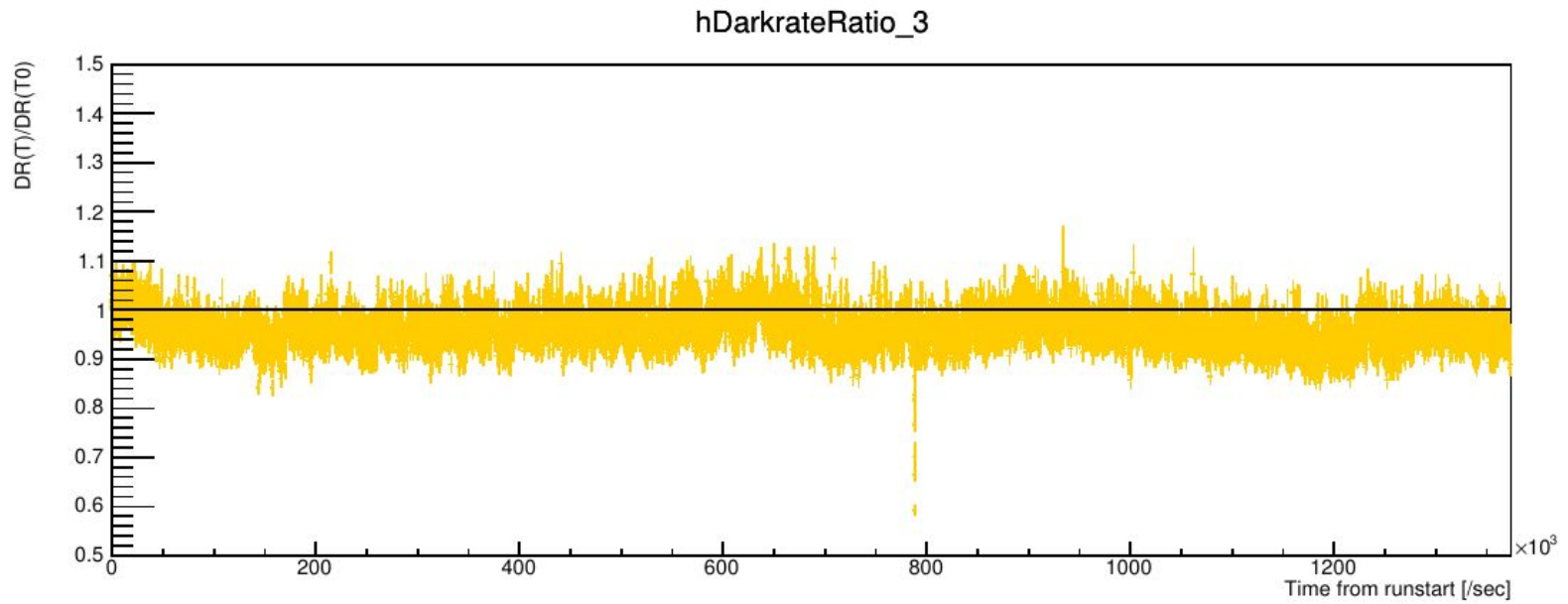

hDarkrate_1
Darkrate [Hz]
0
50
100
150
200
250
300
350
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

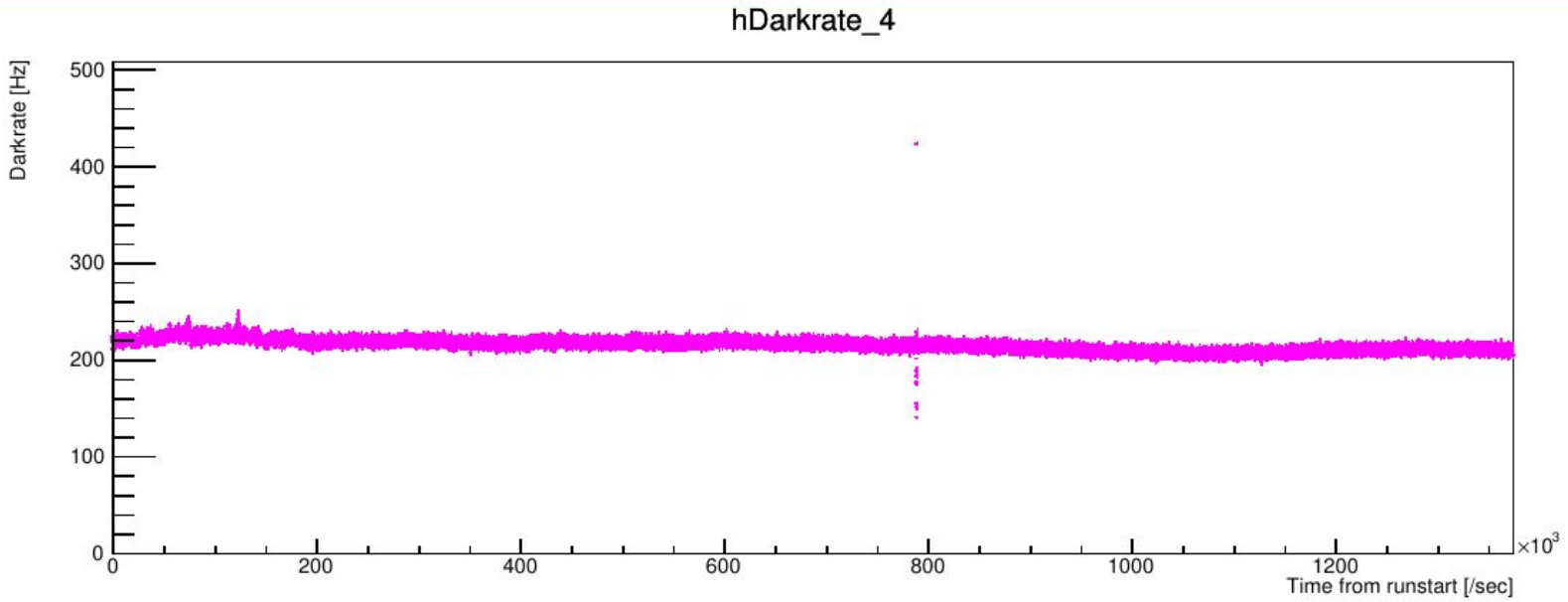

hDarkrateRatio_1
DR(T)/DR(T0)
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

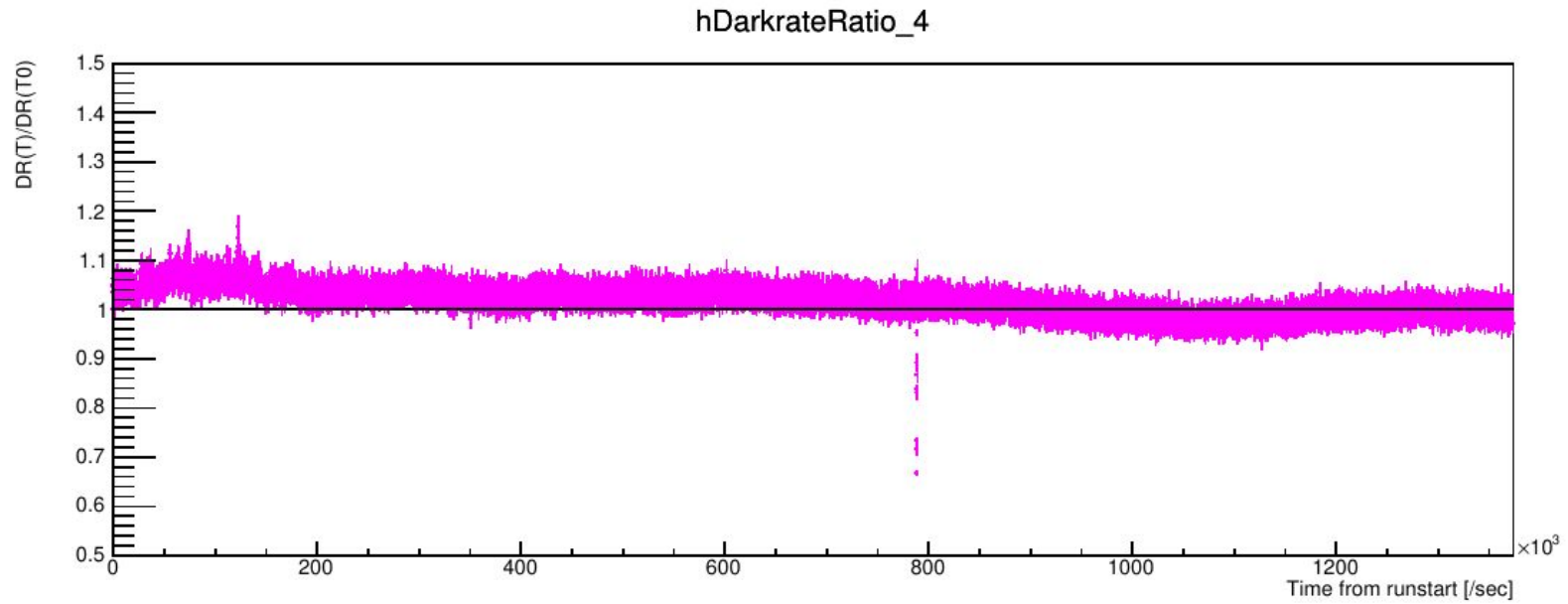

hDarkrate_2
Darkrate [Hz]
300
250
200
150
100
50
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

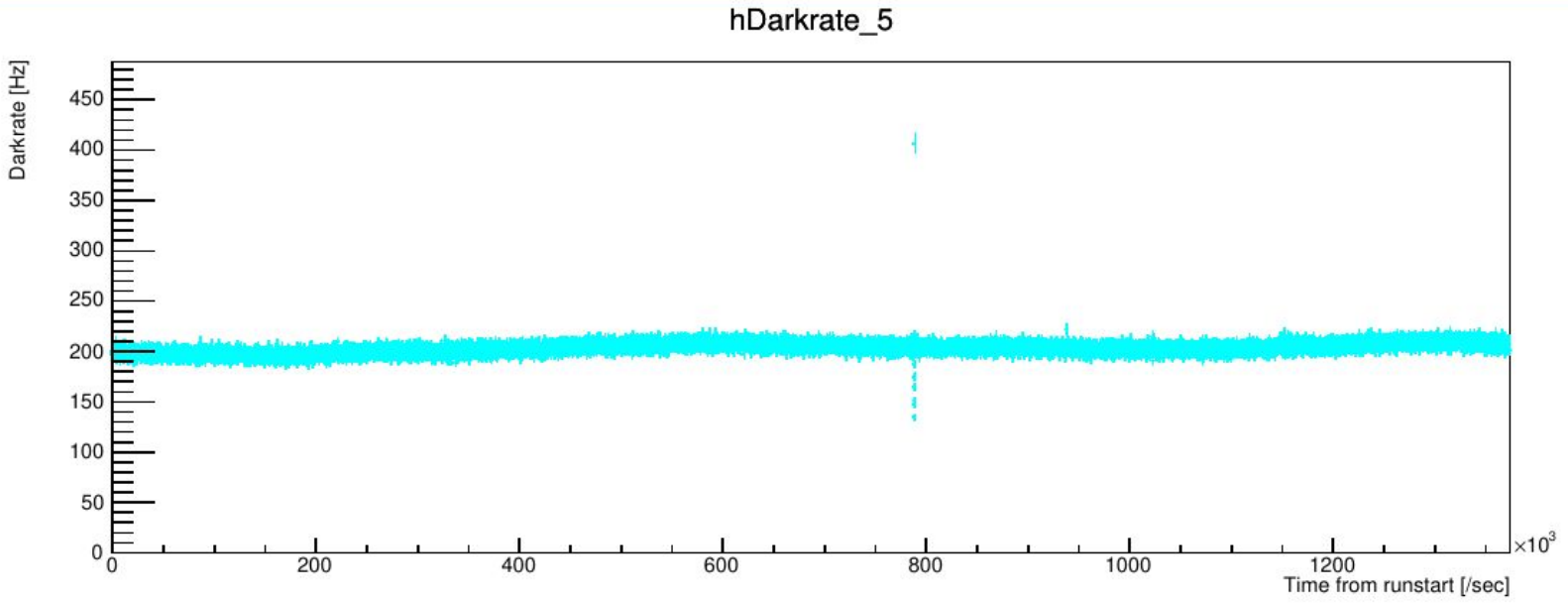

hDarkrateRatio_2
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

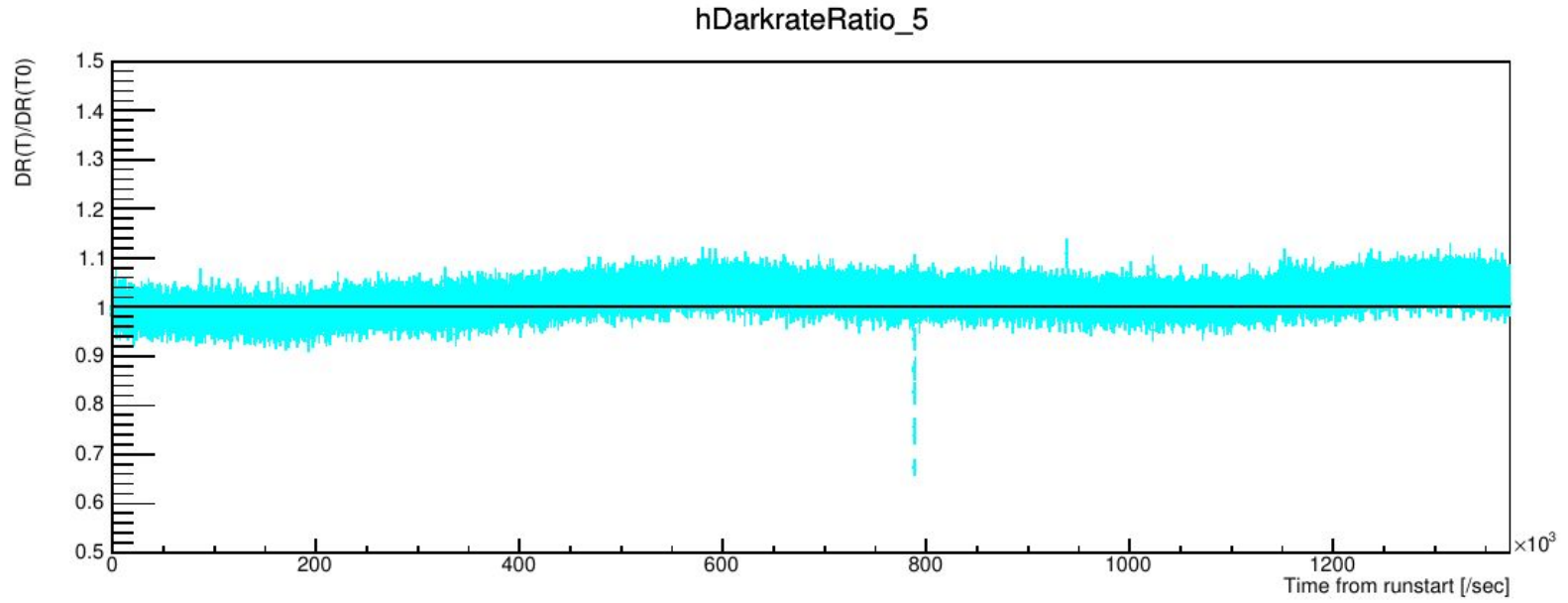

hDarkrate_3
Darkrate [Hz]
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

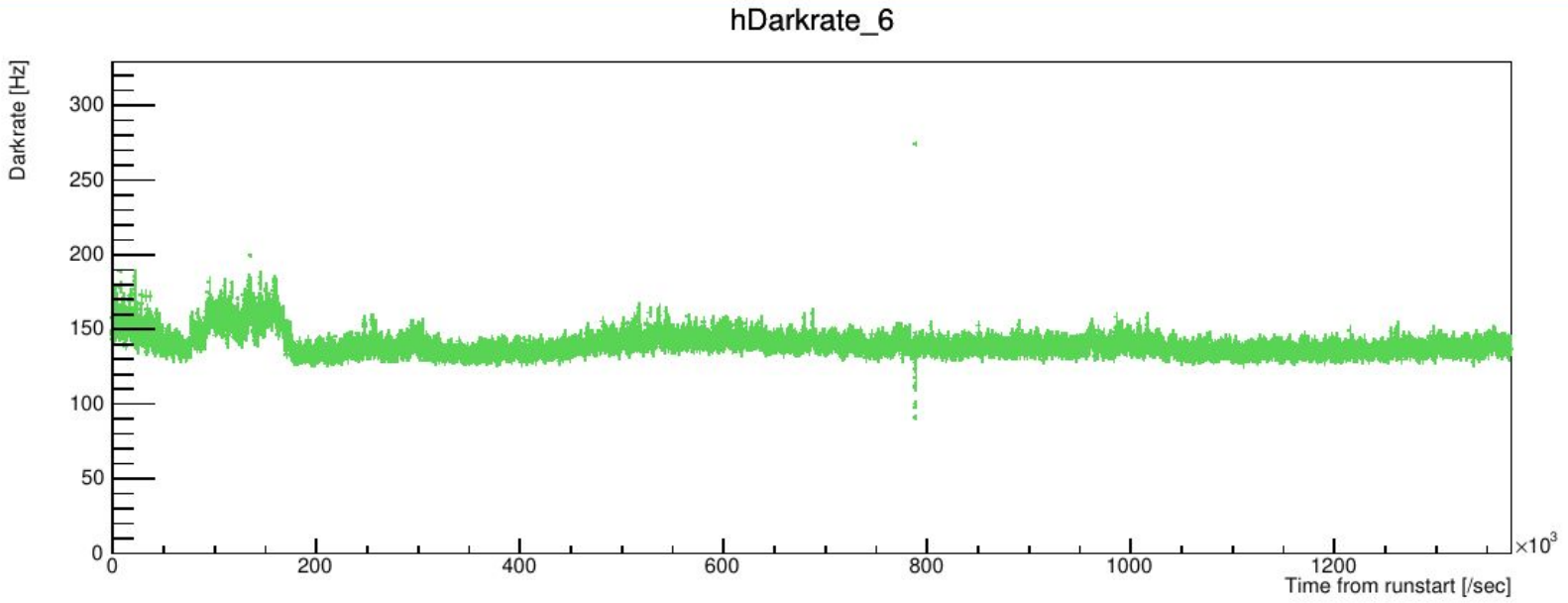

hDarkrateRatio_3
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

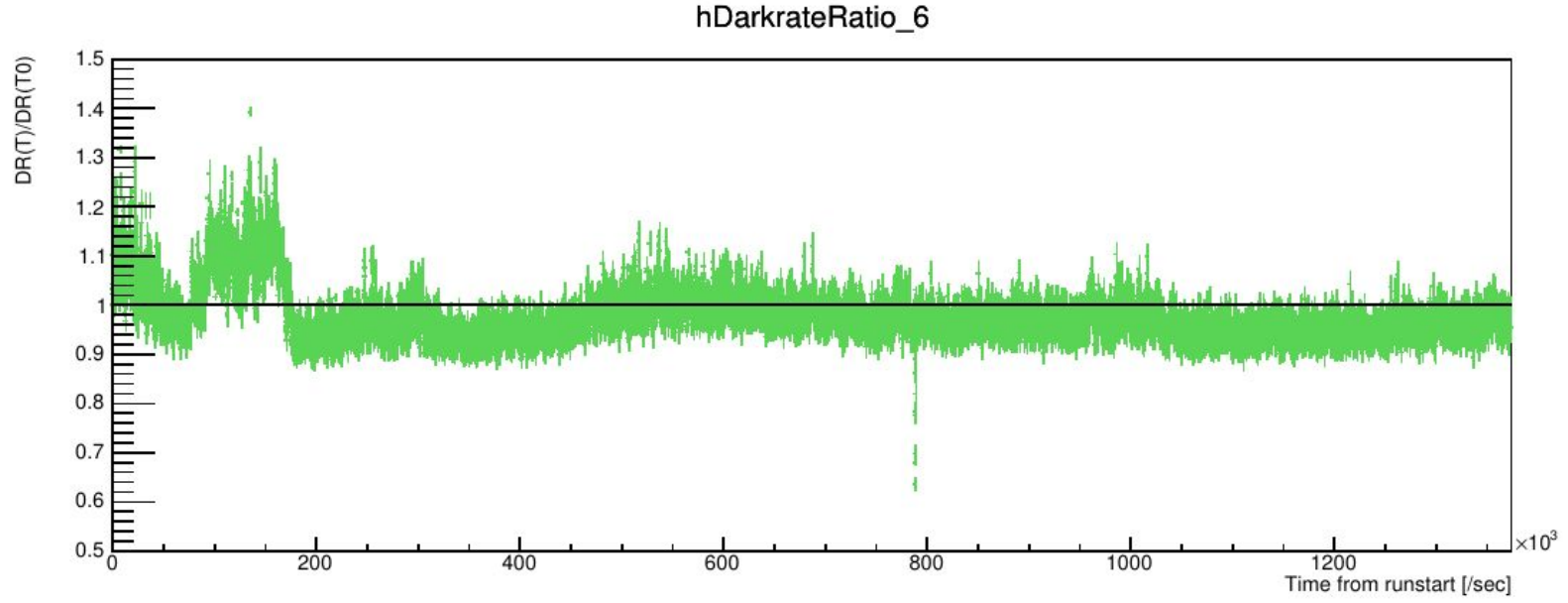

hDarkrate_4
Darkrate [Hz]
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

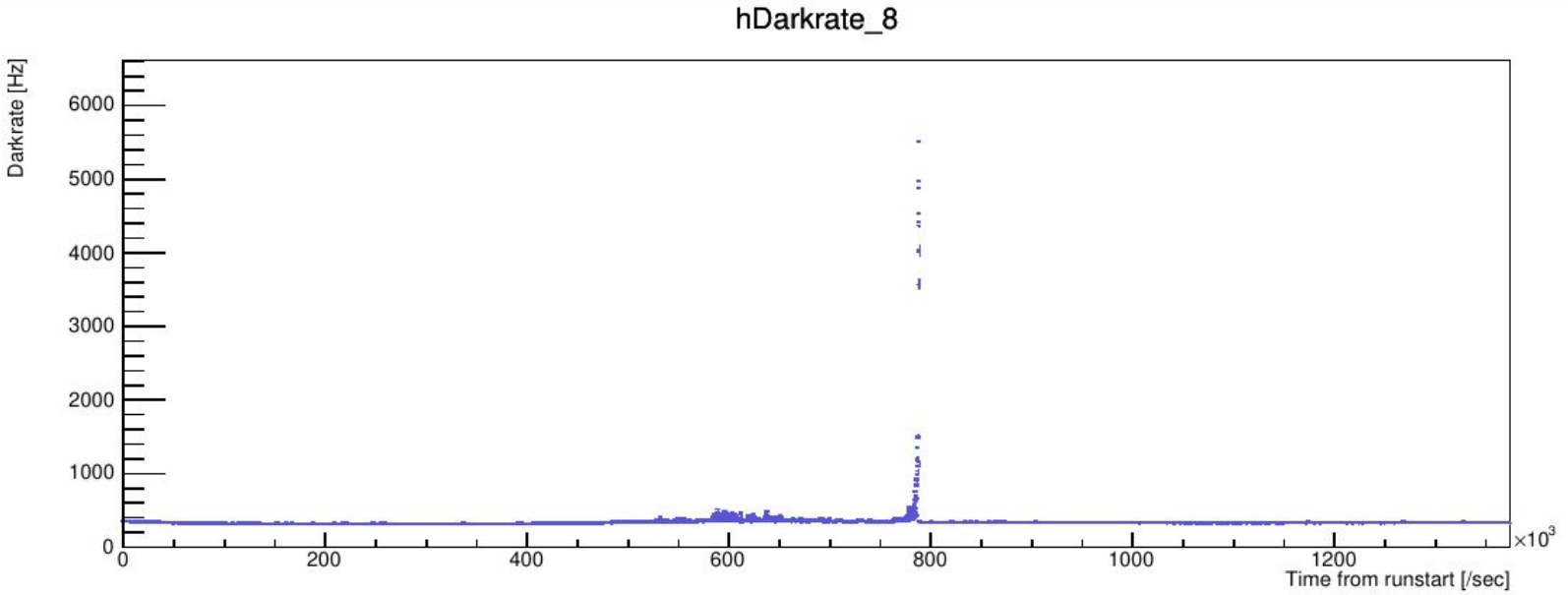

hDarkrateRatio_4
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

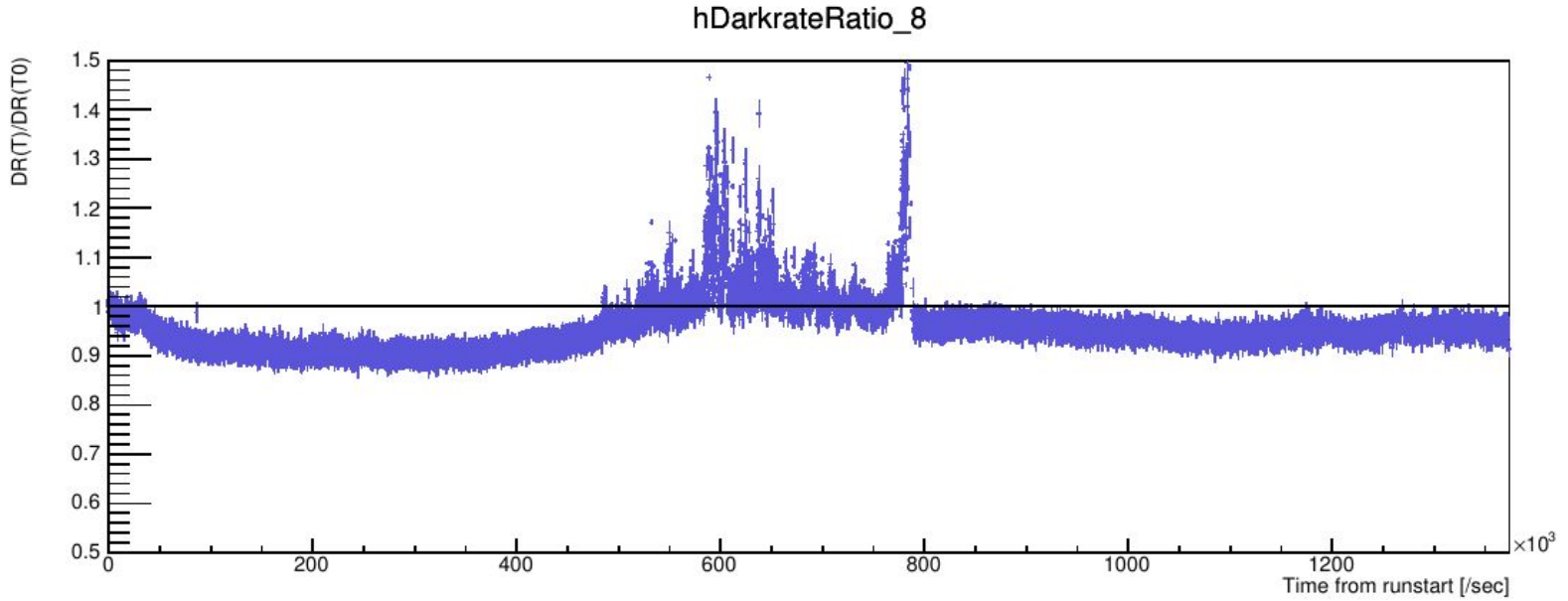

hDarkrate_5
Darkrate [Hz]
0
50
100
150
200
250
300
350
400
450
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

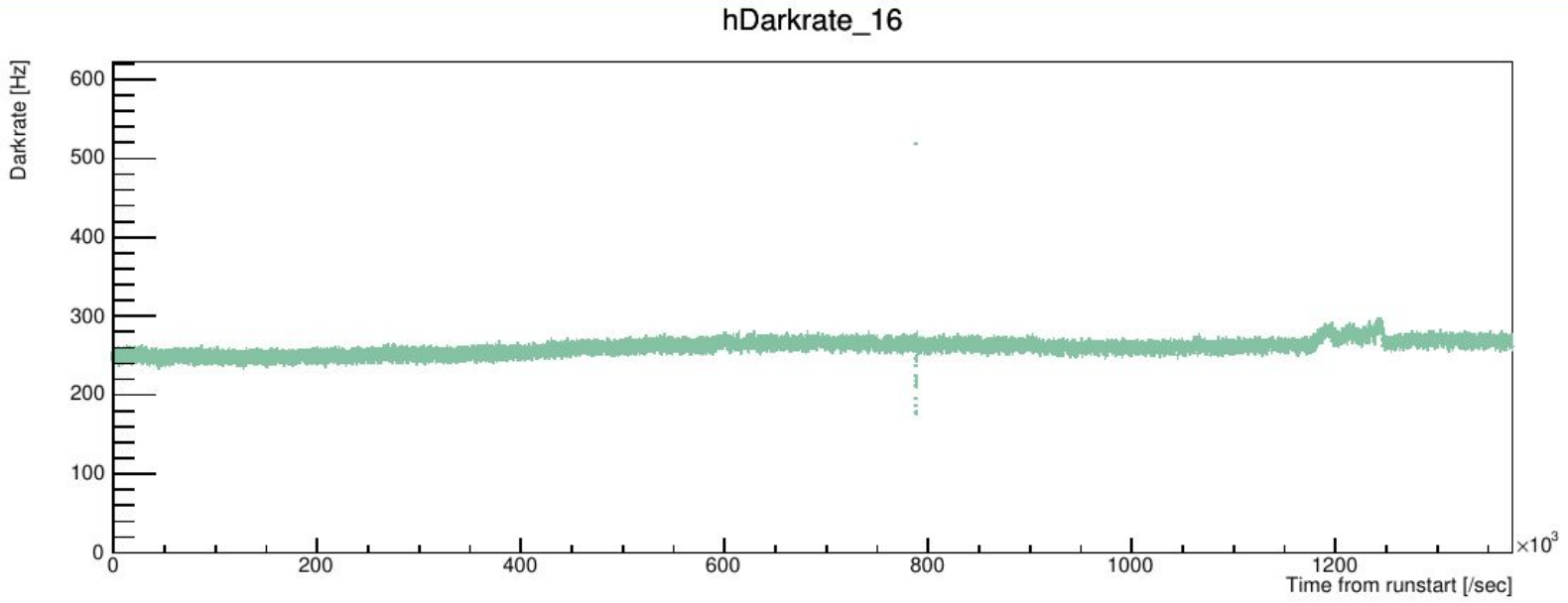

hDarkrateRatio_5
DR(T)/DR(T0)
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

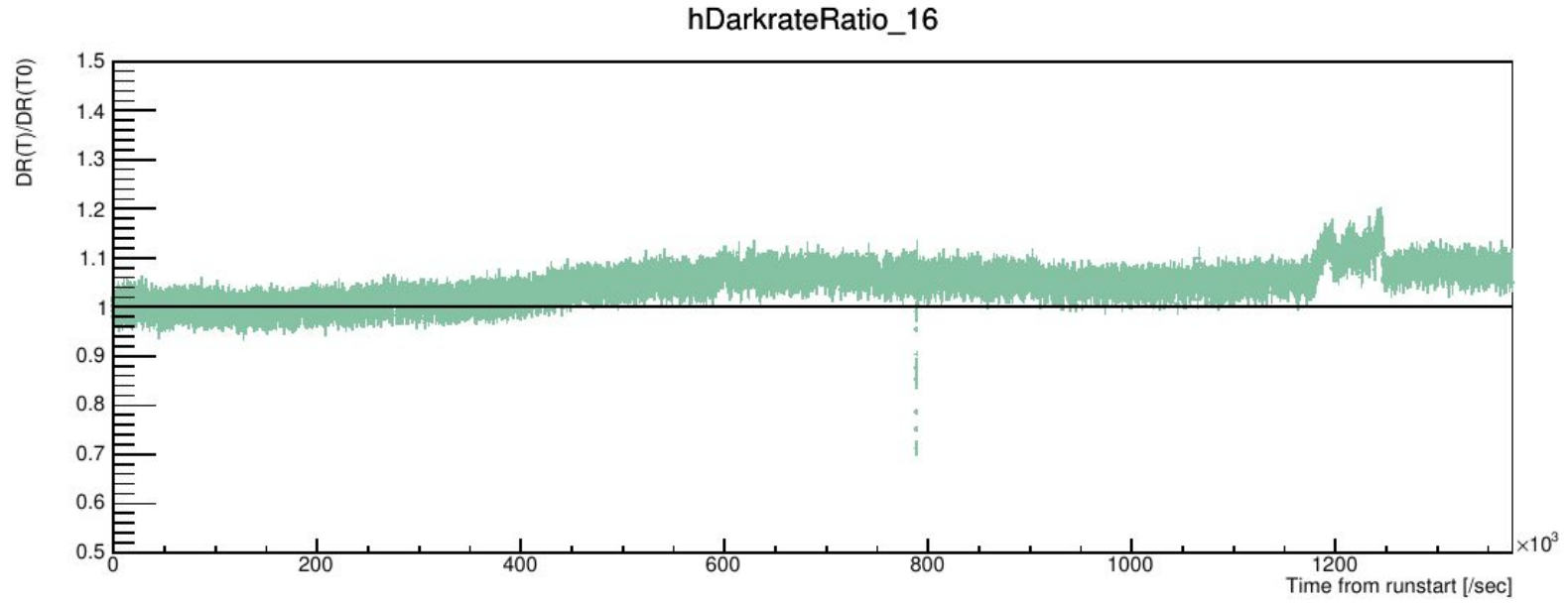

hDarkrate_6
Darkrate [Hz]
300
250
200
150
100
50
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

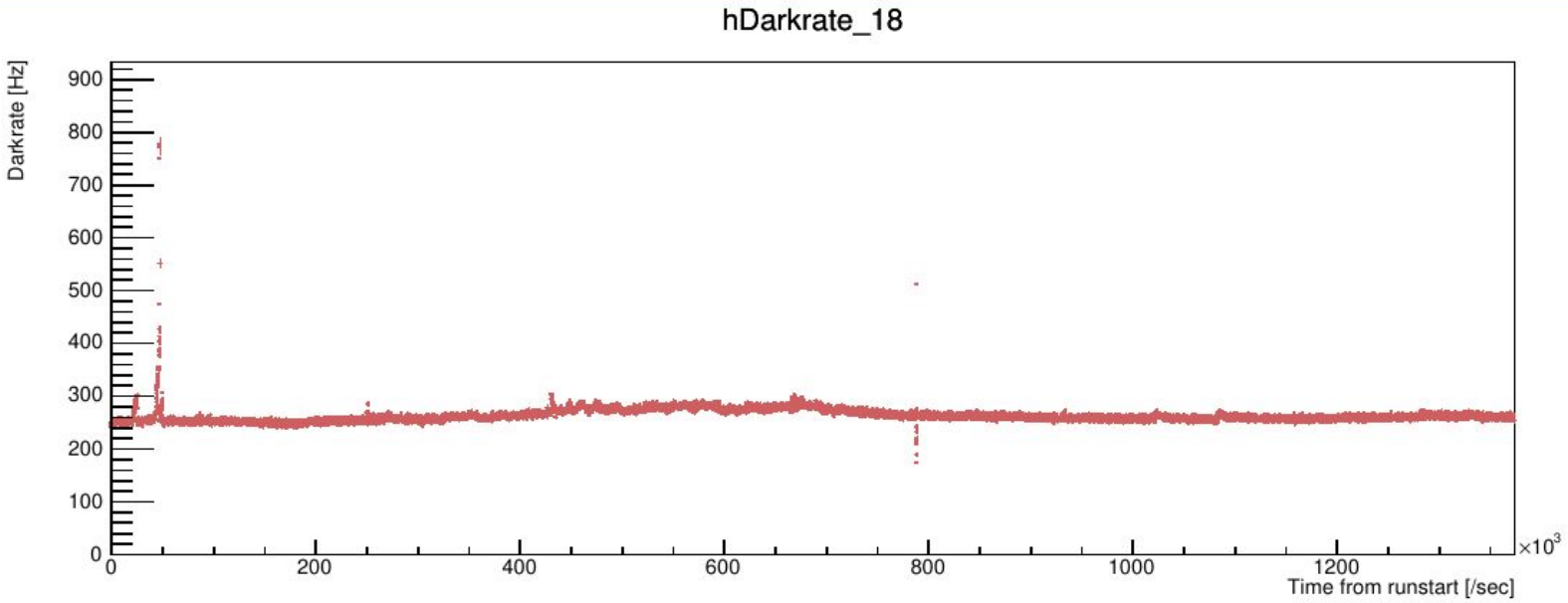

hDarkrateRatio_6
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

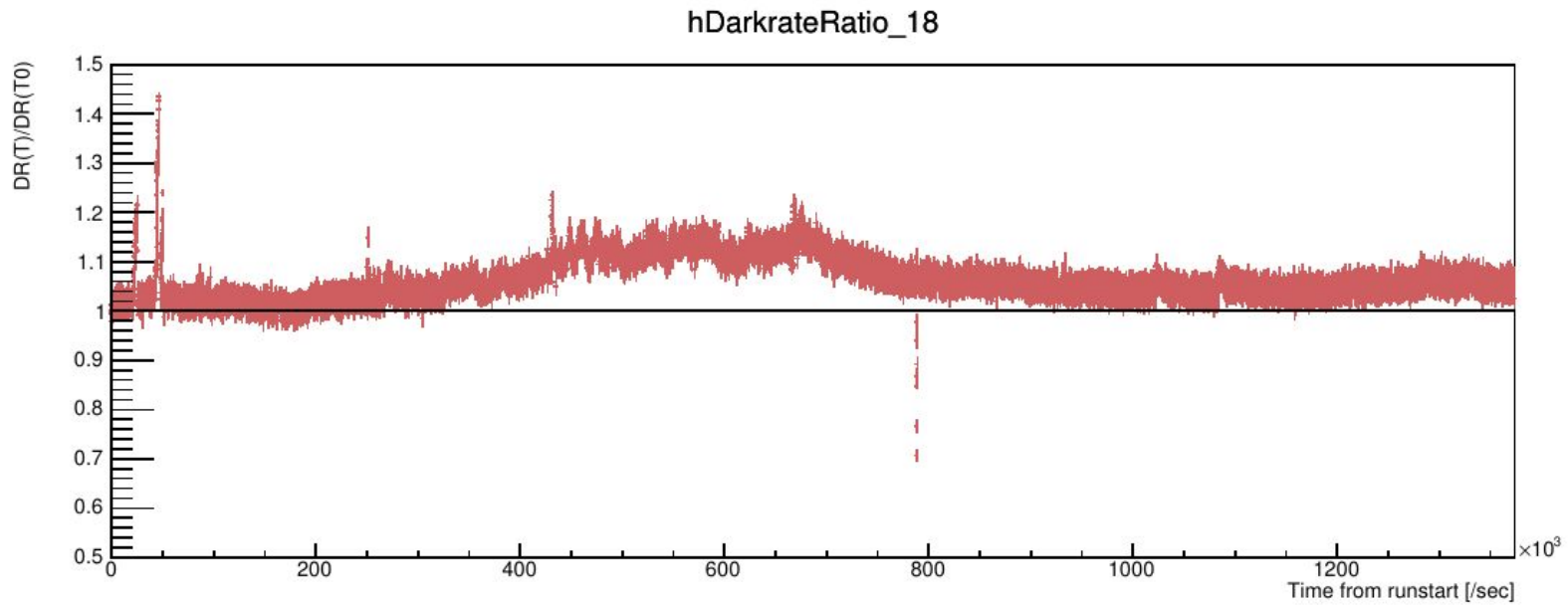

hDarkrate_8
Darkrate [Hz]
6000
5000
4000
3000
2000
1000
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]


hDarkrateRatio_8
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

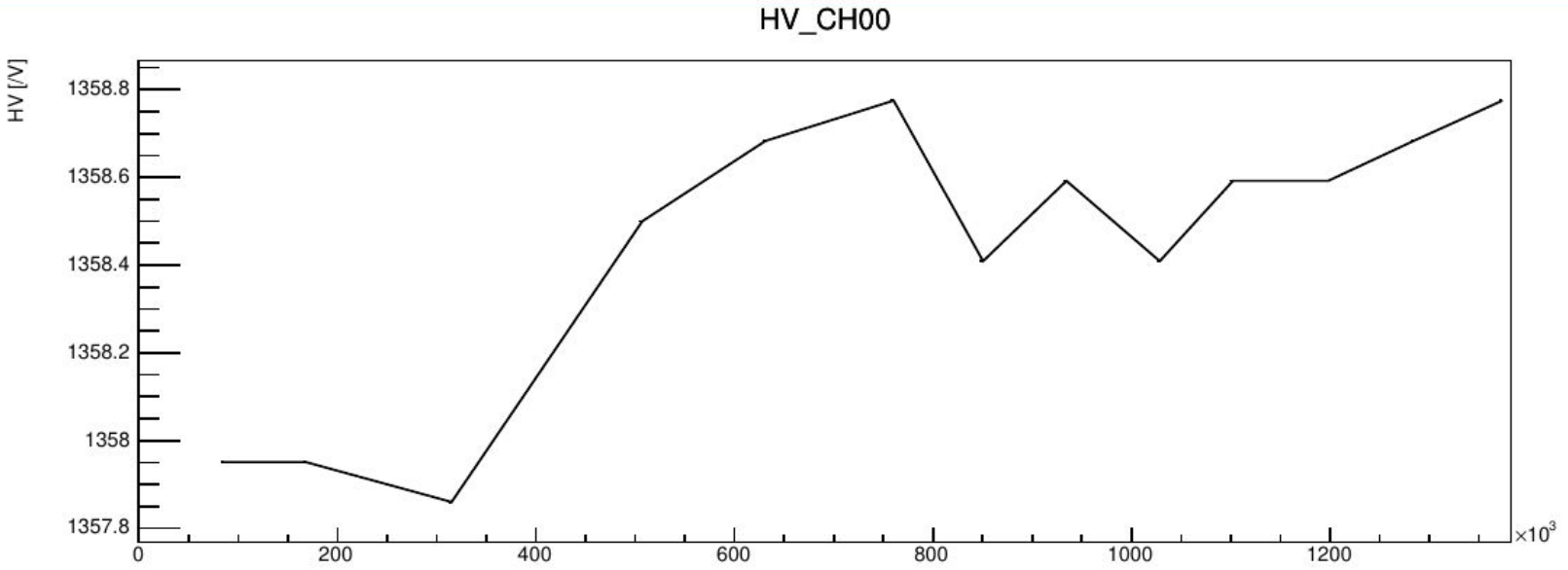

hDarkrate_16
Darkrate [Hz]
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

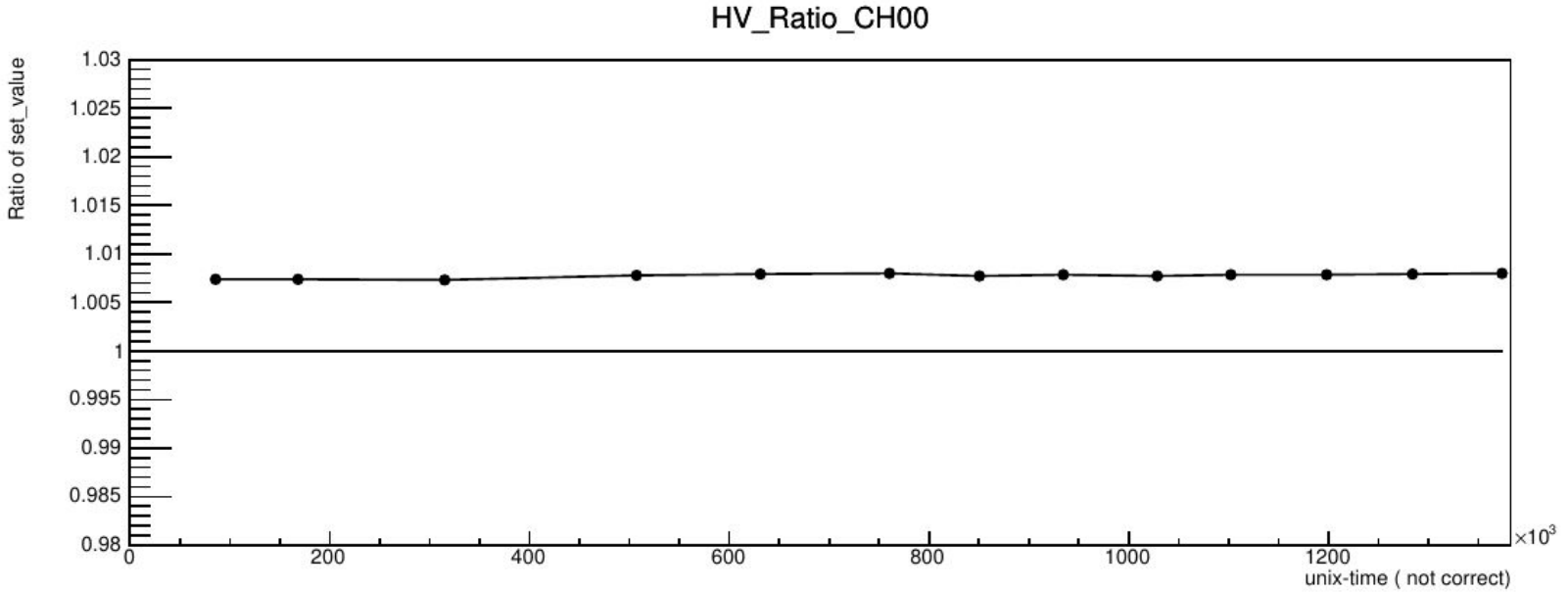

hDarkrateRatio_16
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

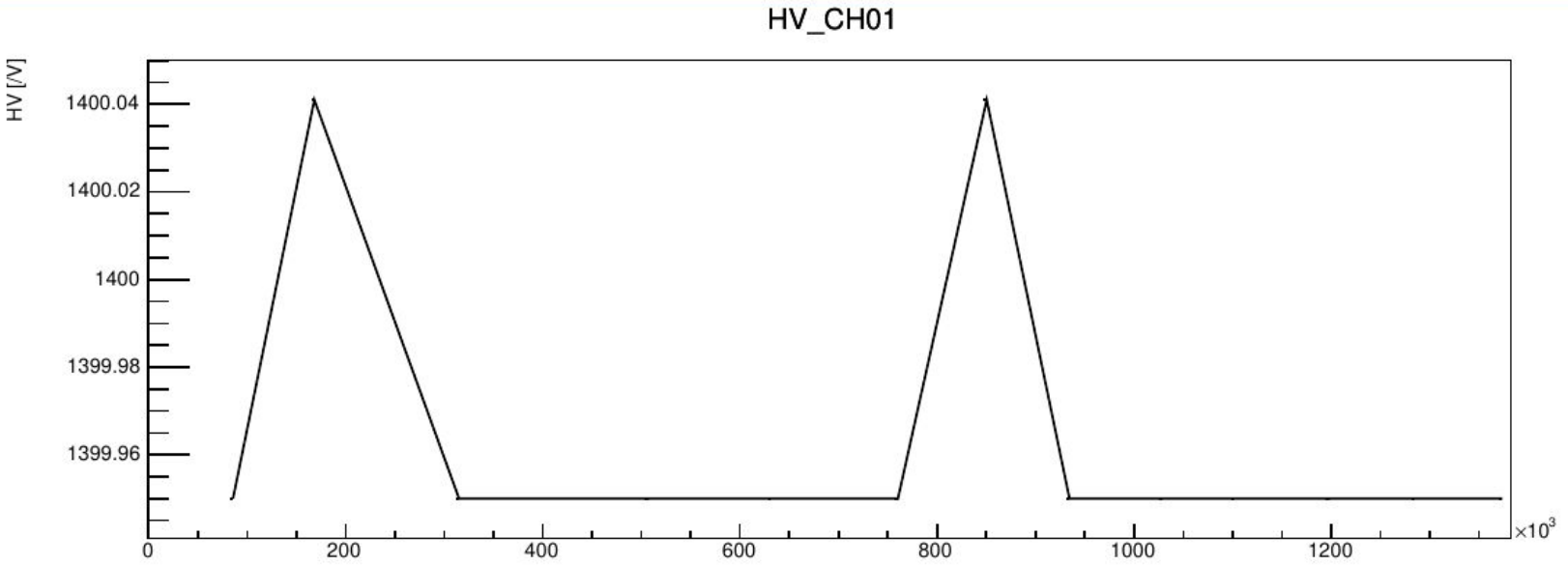

hDarkrate_18
Darkrate [Hz]
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10³
Time from runstart [/sec]

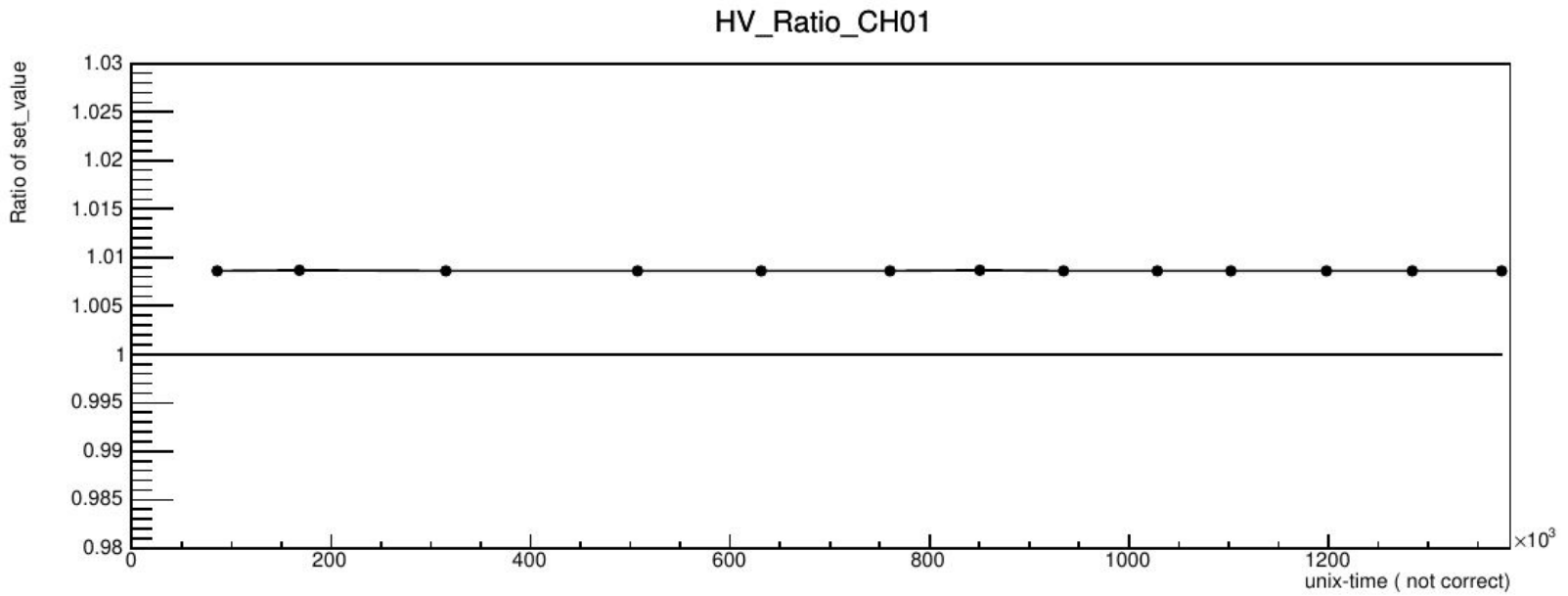

hDarkrateRatio_18
DR(T)/DR(T0)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000
1200
×10³
Time from runstart [/sec]

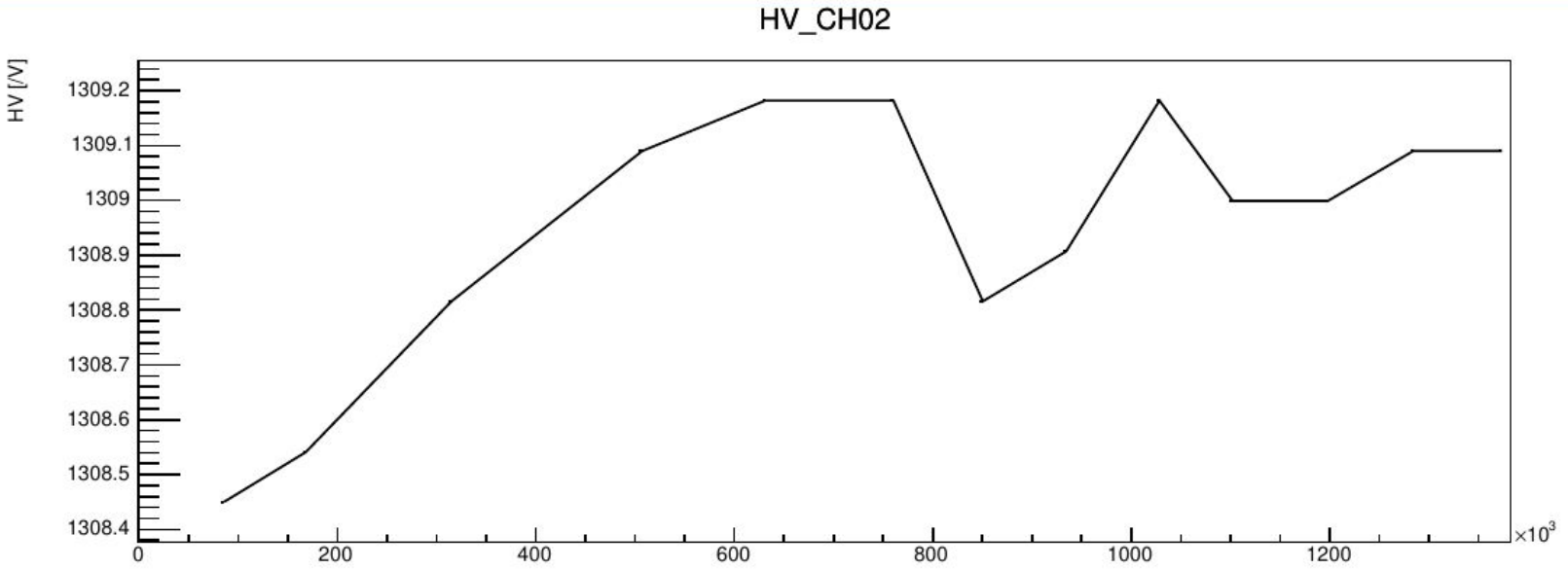
HVs

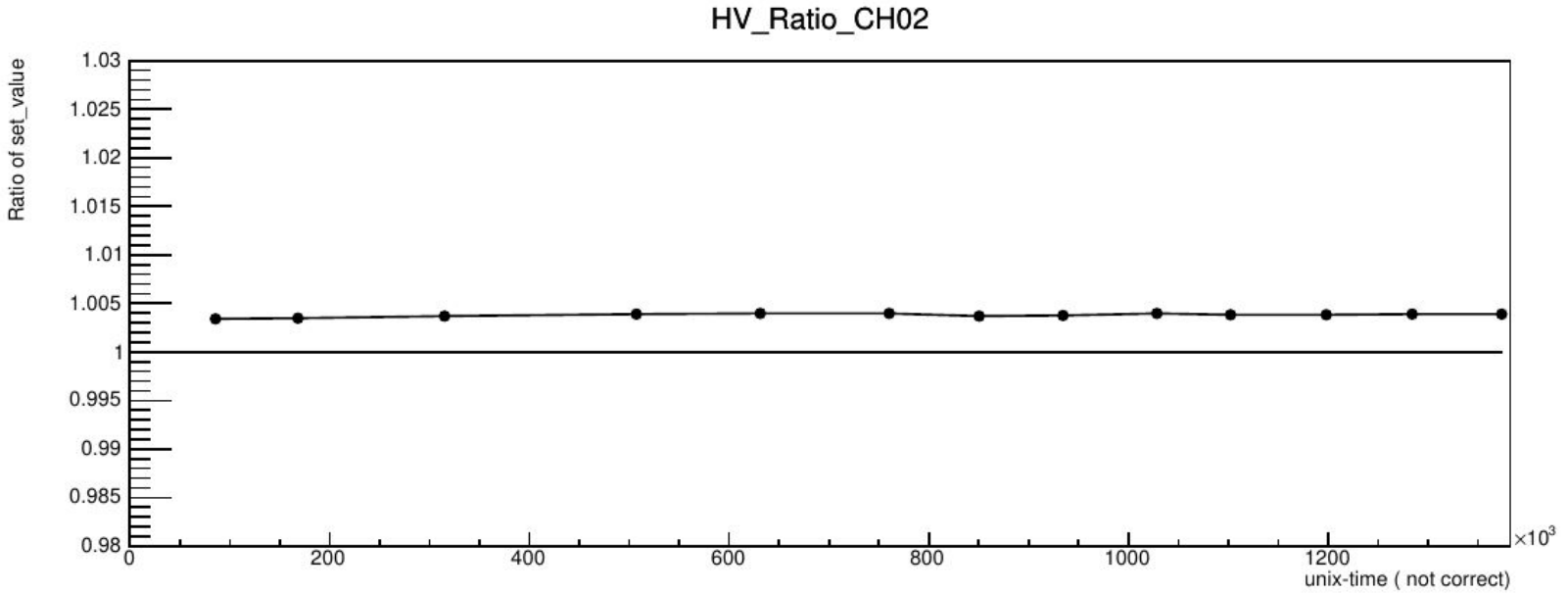

HV_CH00
HV [/V]
1358.8
1358.6
1358.4
1358.2
1358
1357.8
0
200
400
600
800
1000
1200
×10³

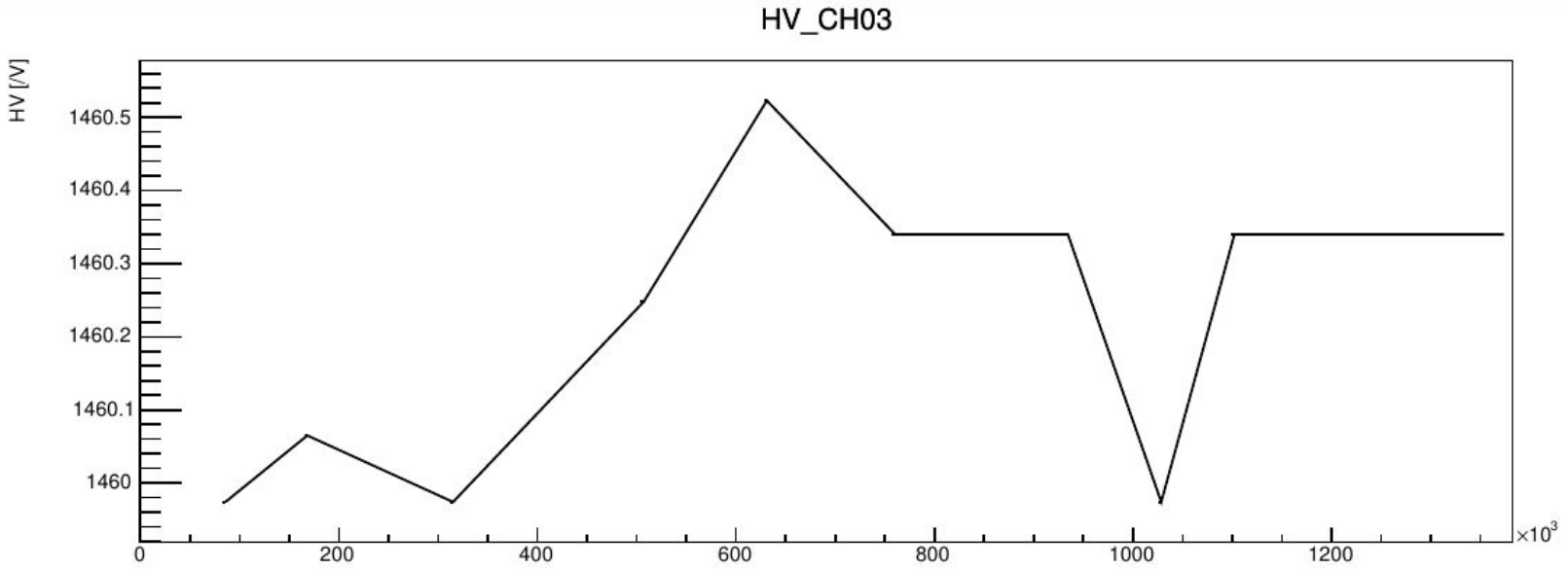

HV_Ratio_CH00
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10³
unix-time (not correct)

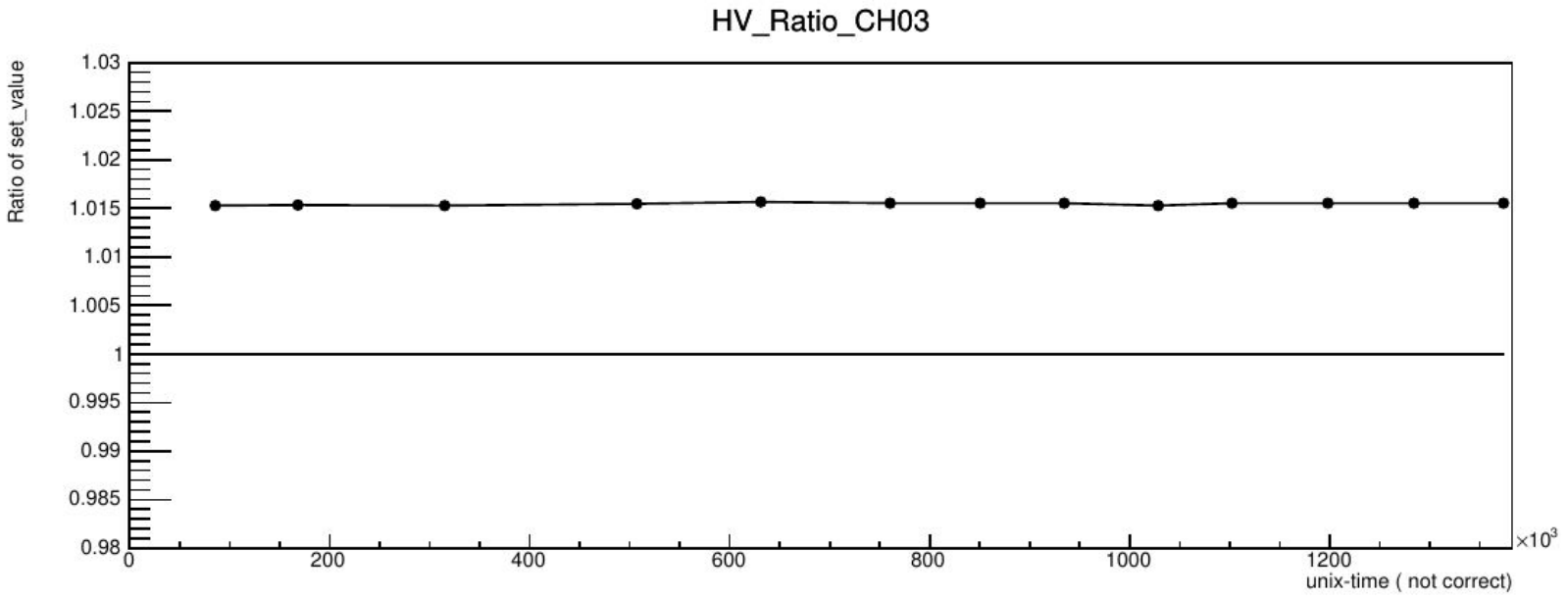

HV_CH01
HV [V]
1400.04
1400.02
1400
1399.98
1399.96
0
200
400
600
800
1000
1200
×10^3

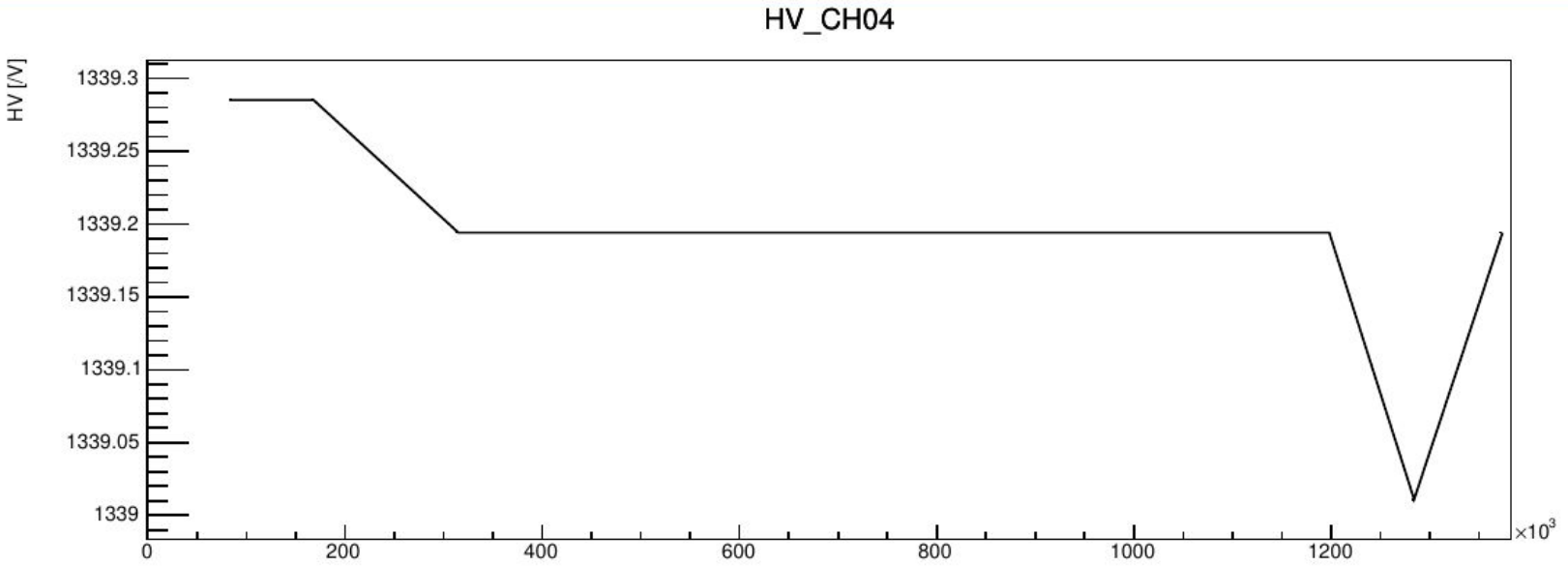

HV_Ratio_CH01
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10^3
unix-time (not correct)

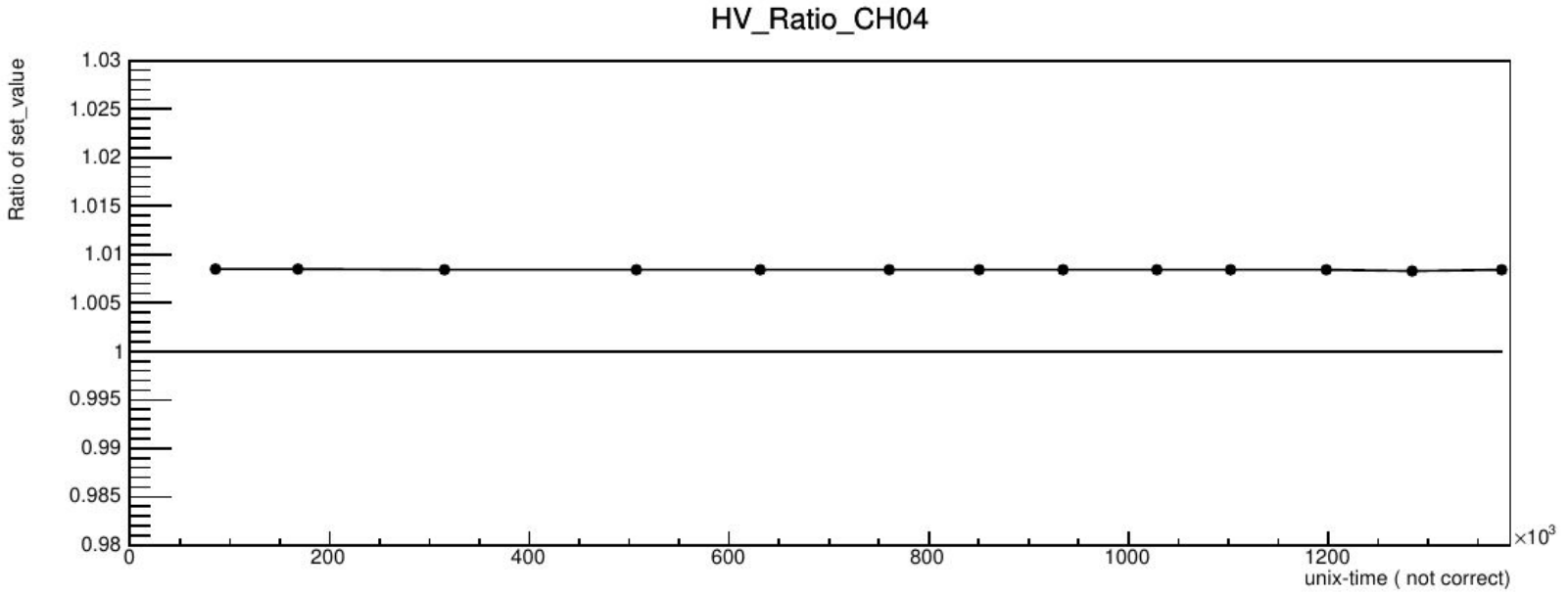

HV_CH02
HV [/V]
1309.2
1309.1
1309
1308.9
1308.8
1308.7
1308.6
1308.5
1308.4
0
200
400
600
800
1000
1200
×10³

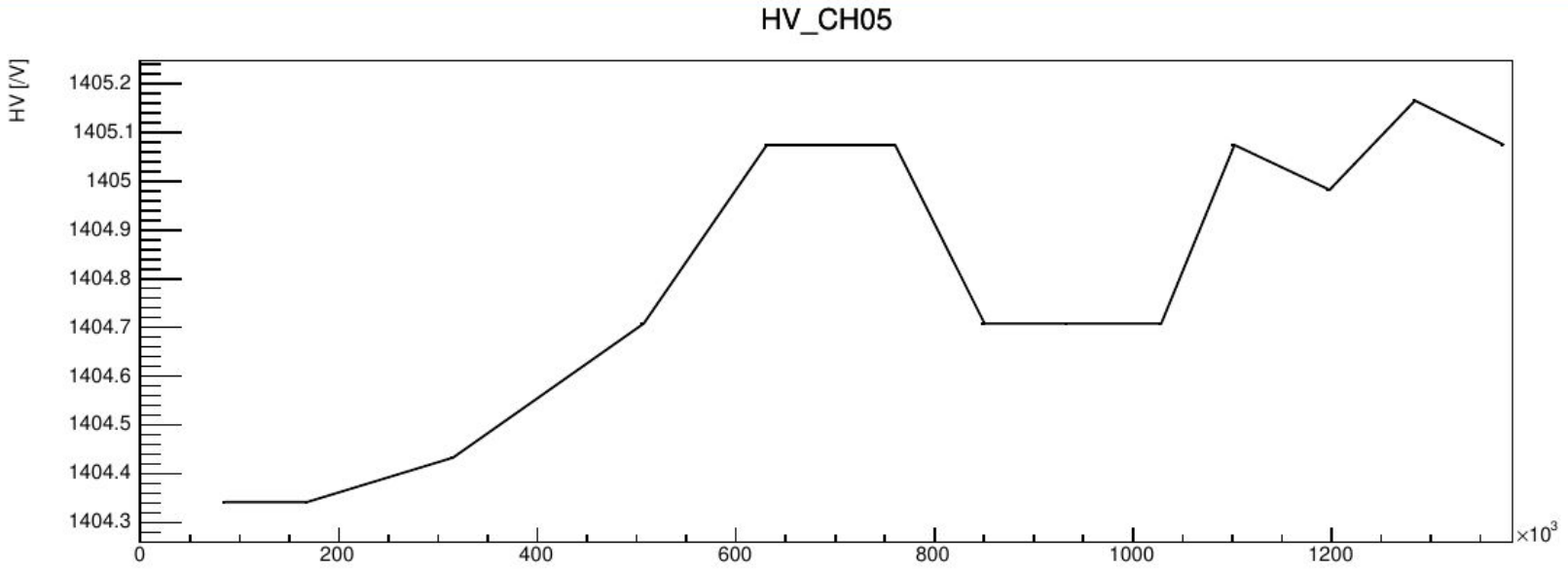

HV_Ratio_CH02
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10³
unix-time (not correct)

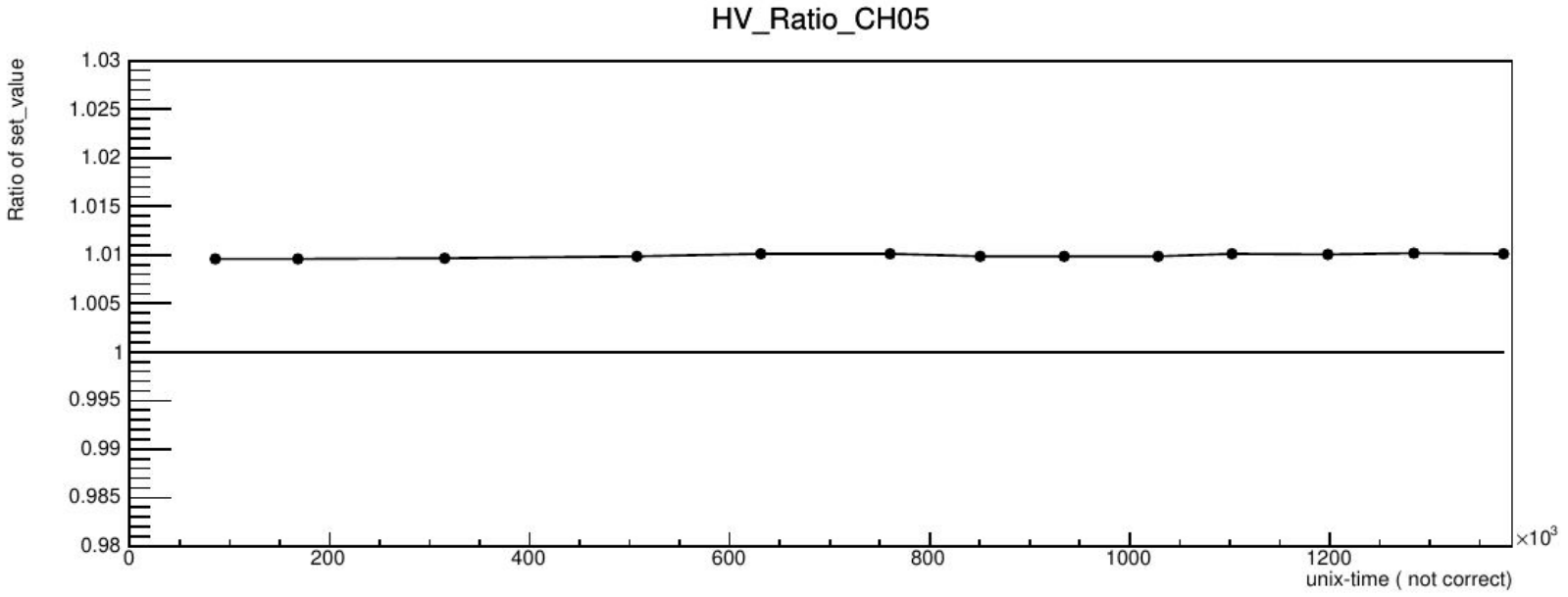

HV_CH03
HV [/V]
1460.5
1460.4
1460.3
1460.2
1460.1
1460
0
200
400
600
800
1000
1200
×10^3

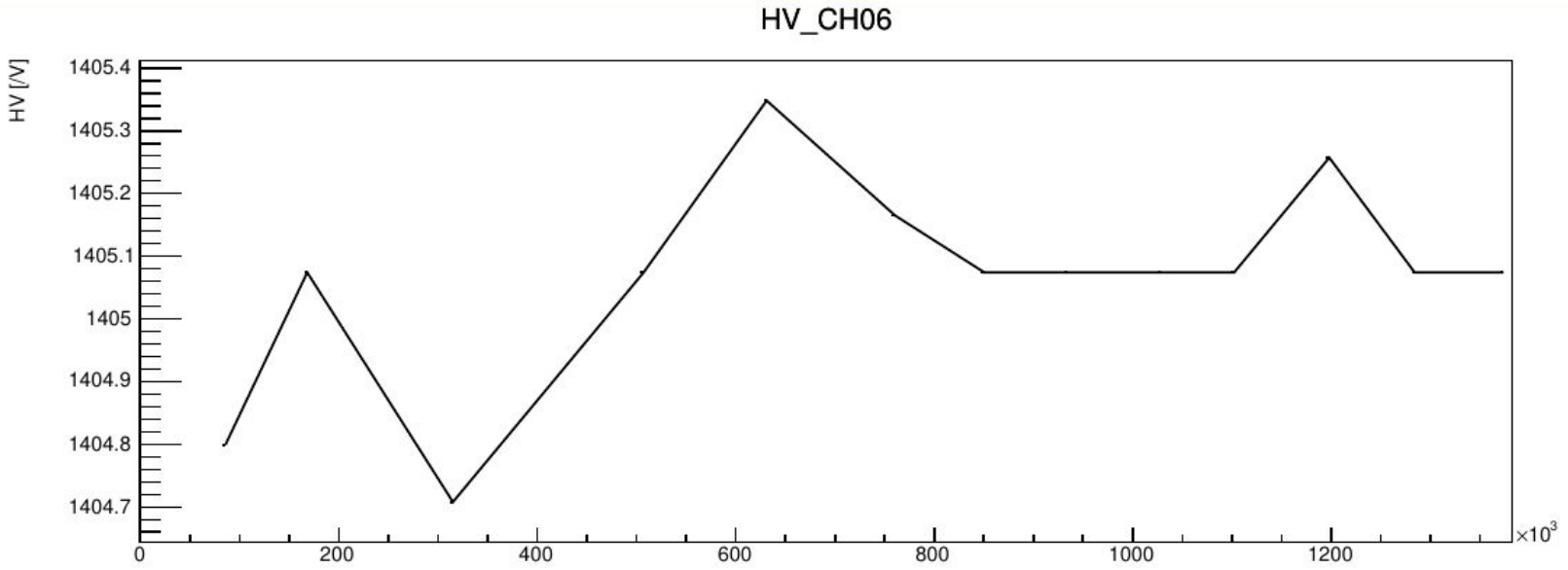

HV_Ratio_CH03
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10^3
unix-time (not correct)

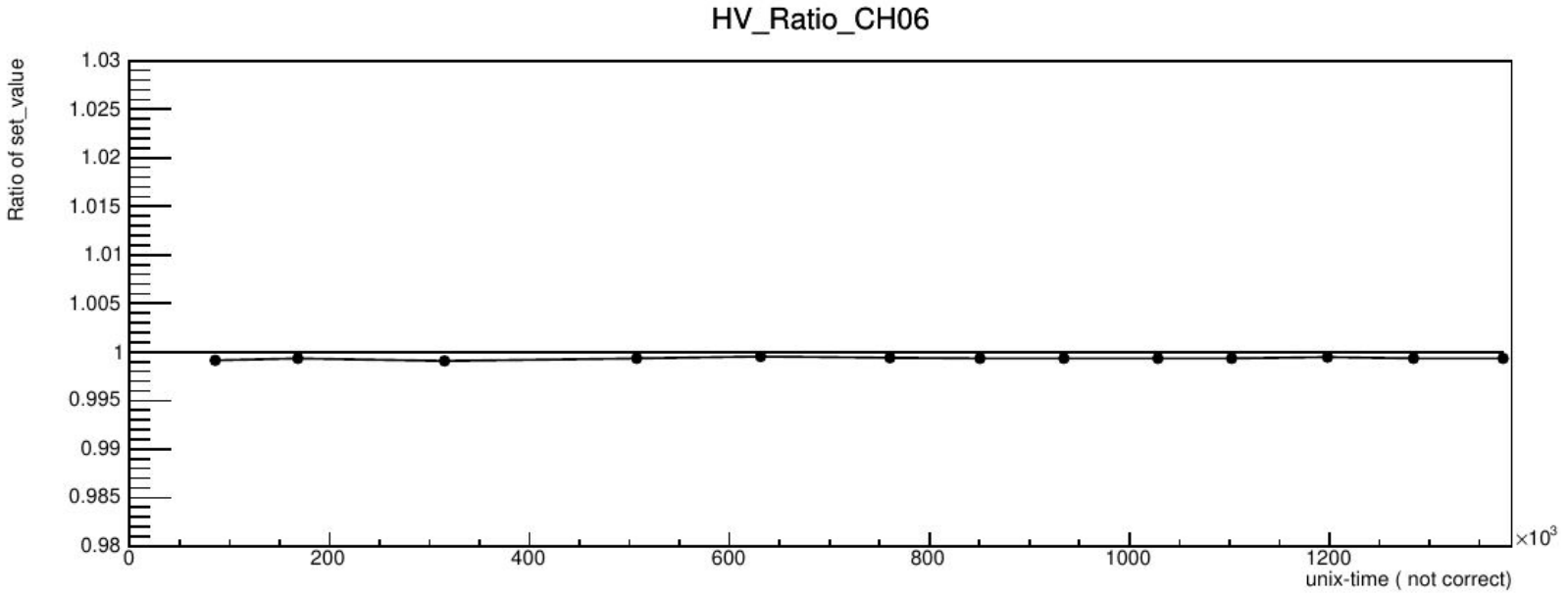

HV_CH04
HV [V]
1339.3
1339.25
1339.2
1339.15
1339.1
1339.05
1339
0
200
400
600
800
1000
1200
×10³

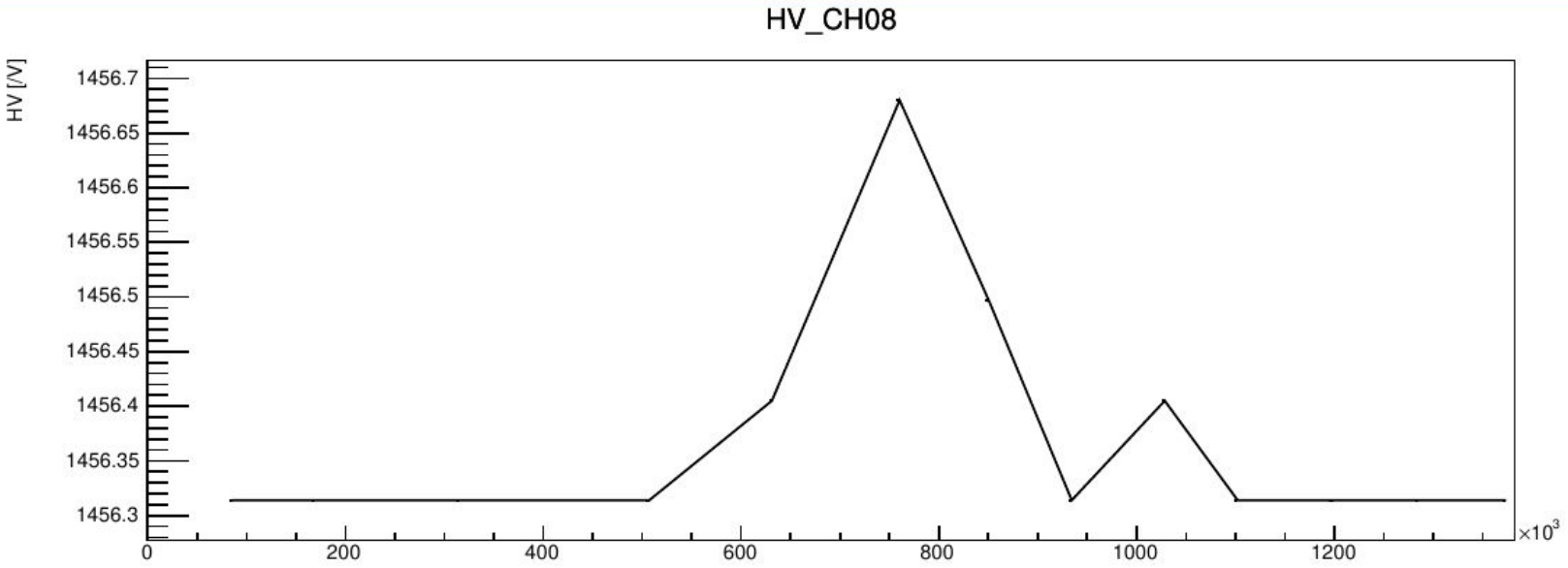

HV_Ratio_CH04
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10³
unix-time (not correct)

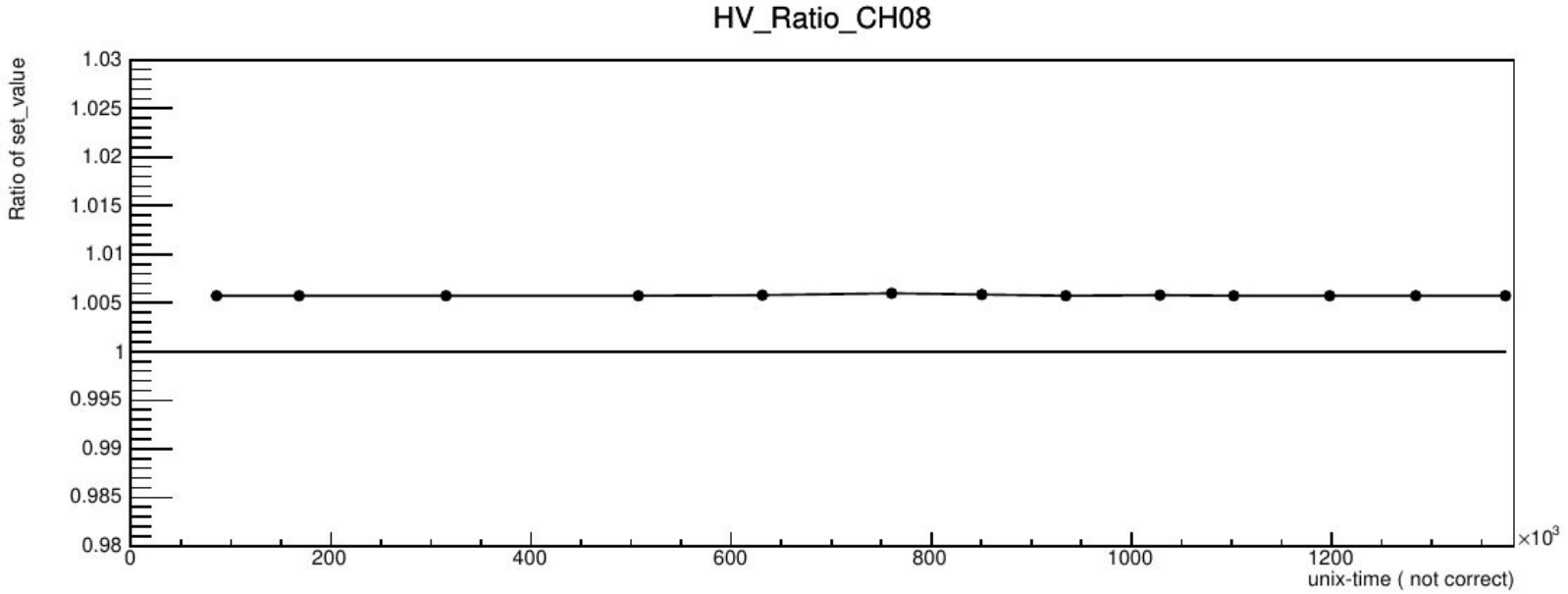

HV_CH05
HV [/V]
1405.2
1405.1
1405
1404.9
1404.8
1404.7
1404.6
1404.5
1404.4
1404.3
0
200
400
600
800
1000
1200
×10^3

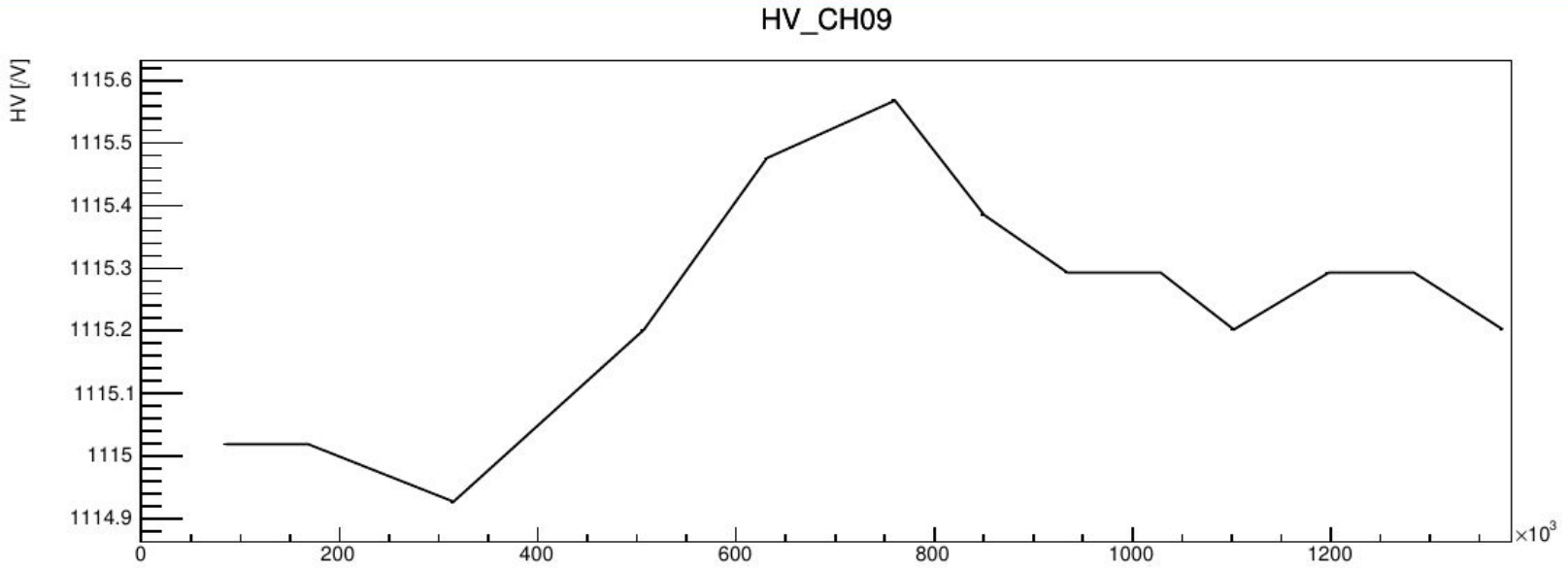

HV_Ratio_CH05
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10^3
unix-time (not correct)

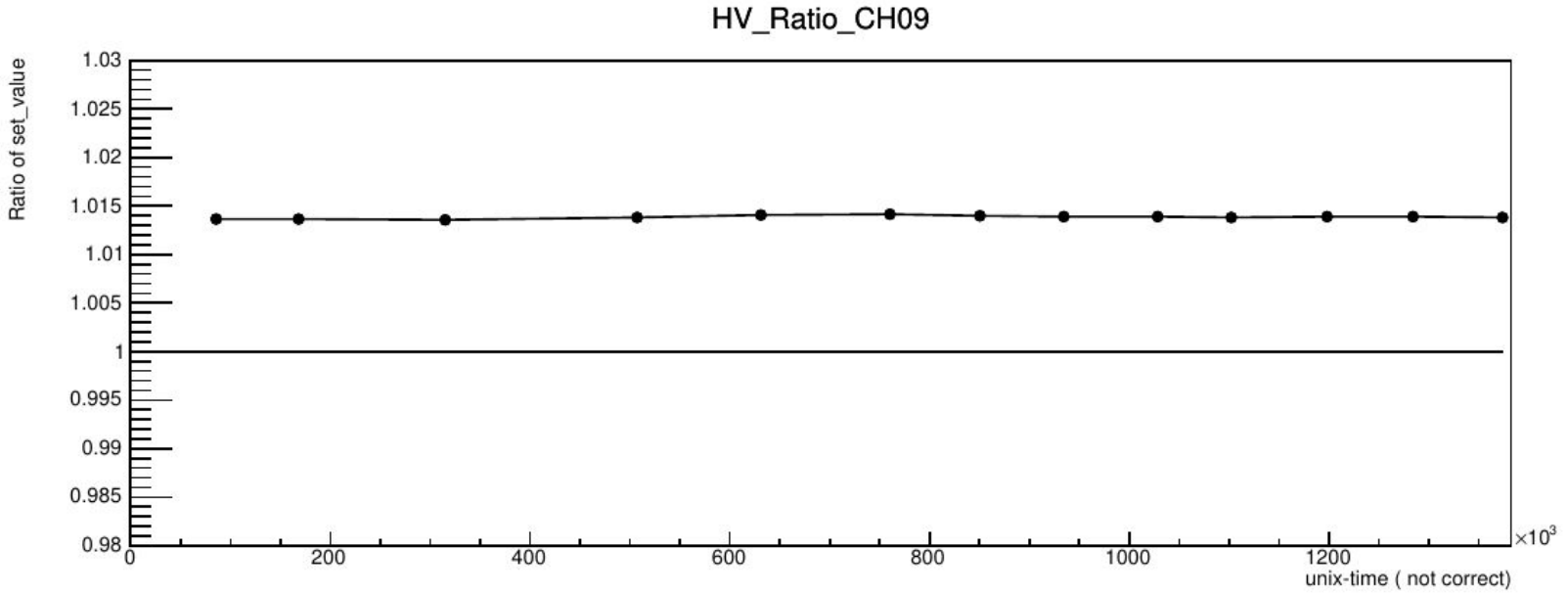

HV_CH06
HV [/V]
1405.4
1405.3
1405.2
1405.1
1405
1404.9
1404.8
1404.7
0
200
400
600
800
1000
1200
×10^3

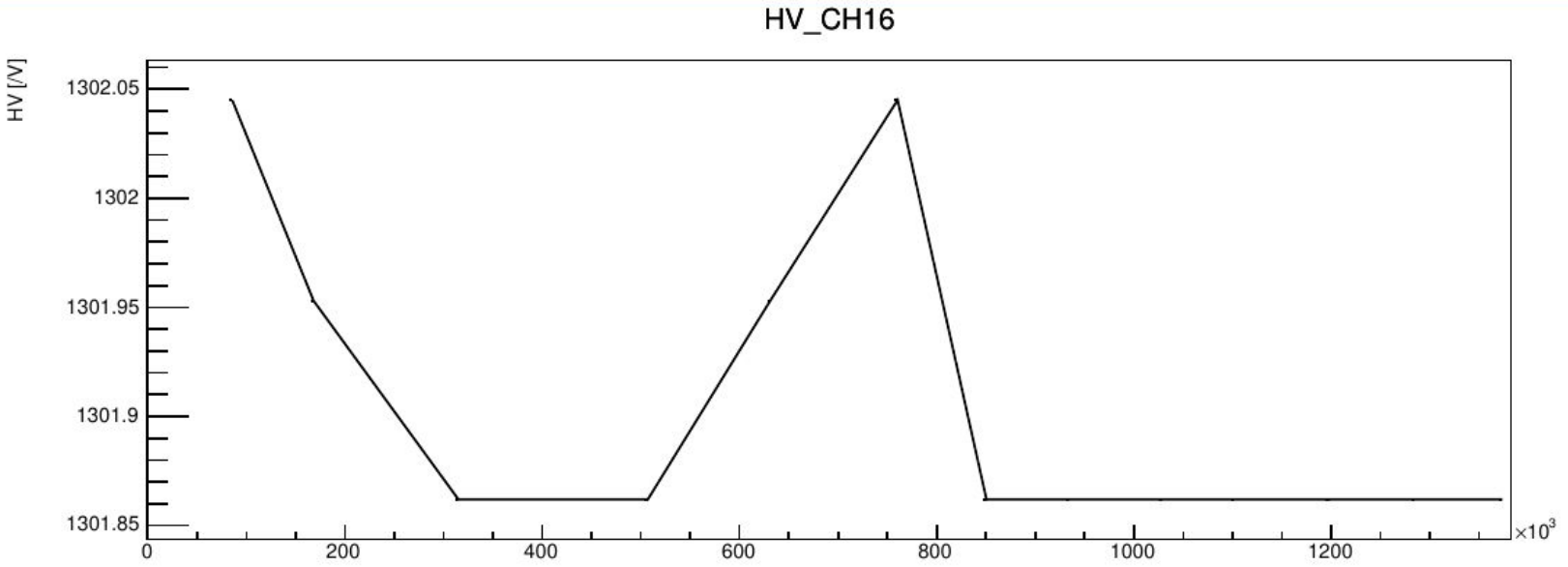

HV_Ratio_CH06
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10^3
unix-time (not correct)

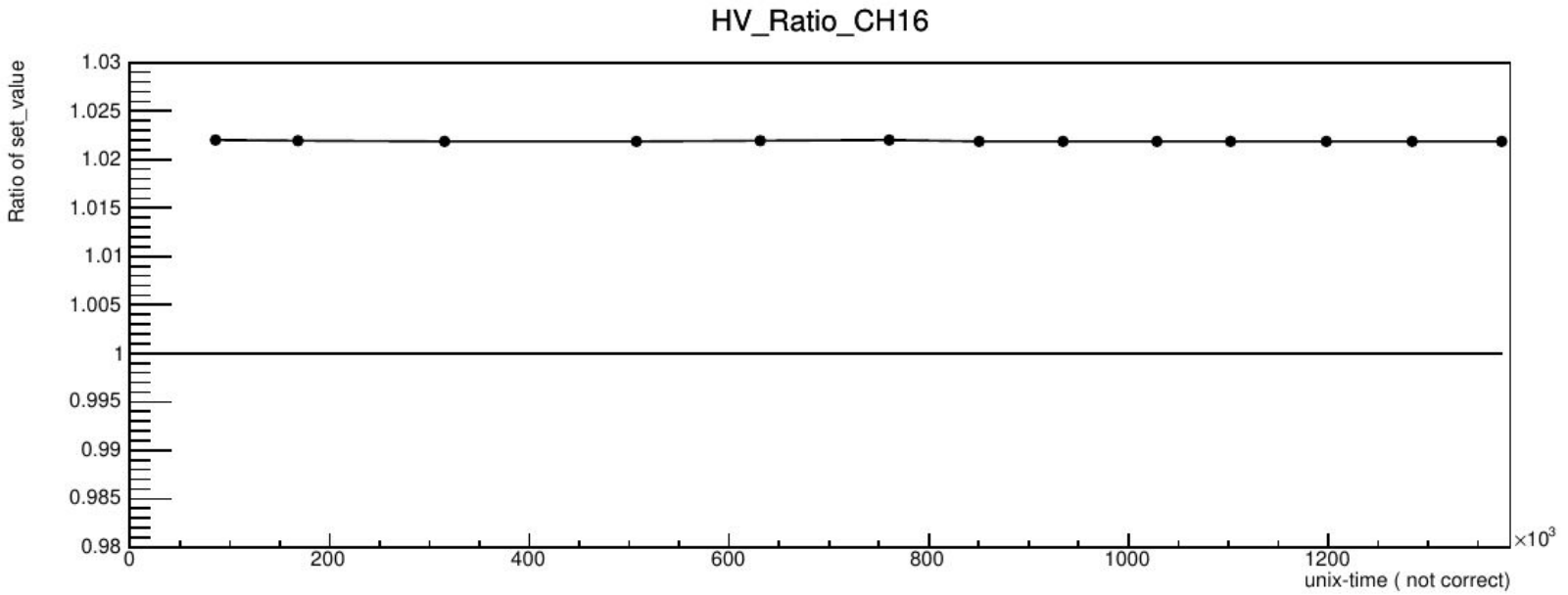

HV_CH08
HV [/V]
1456.7
1456.65
1456.6
1456.55
1456.5
1456.45
1456.4
1456.35
1456.3
0
200
400
600
800
1000
1200
×10^3

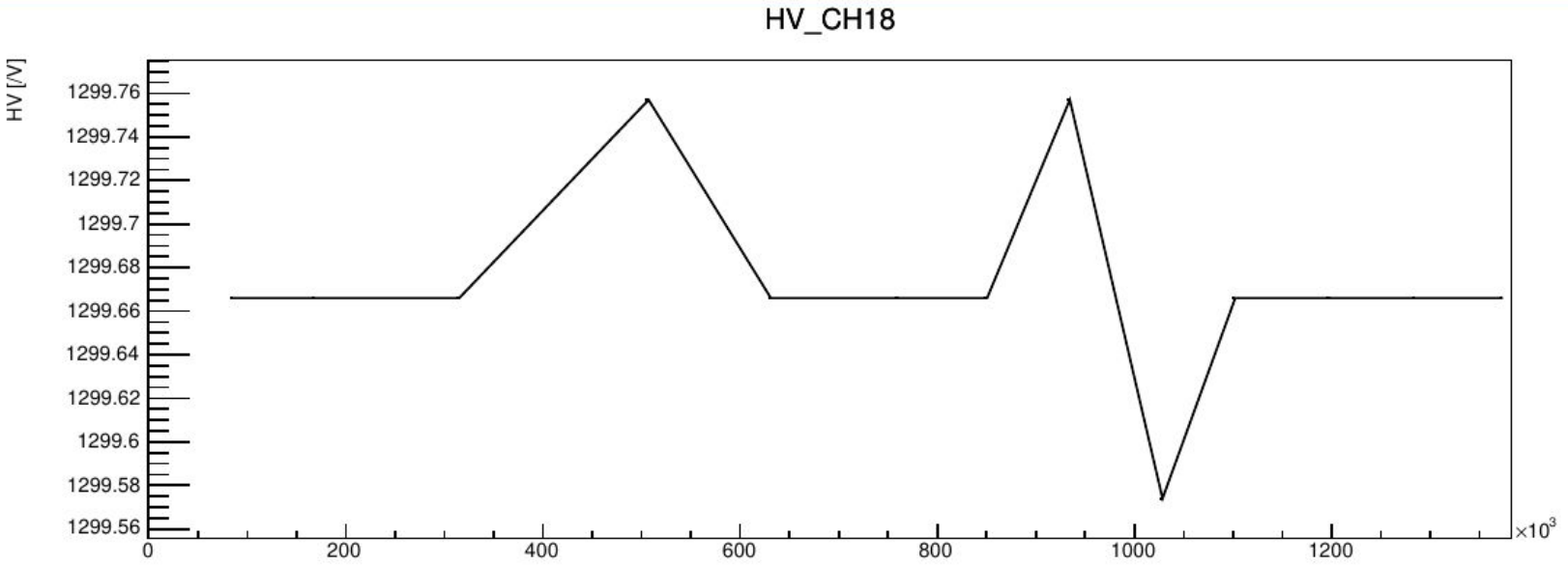

HV_Ratio_CH08
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10^3
unix-time (not correct)

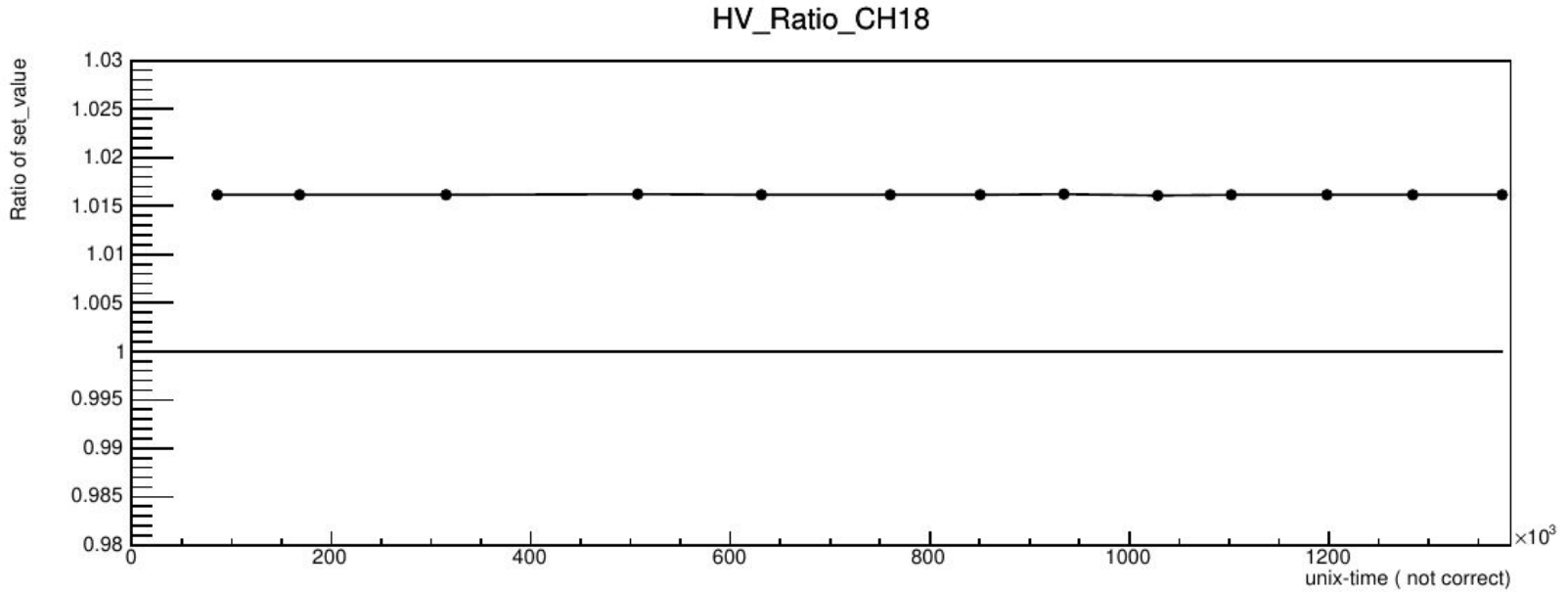

HV_CH09
HV [/V]
1115.6
1115.5
1115.4
1115.3
1115.2
1115.1
1115
1114.9
0
200
400
600
800
1000
1200
×10³


HV_Ratio_CH09
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10³
unix-time (not correct)

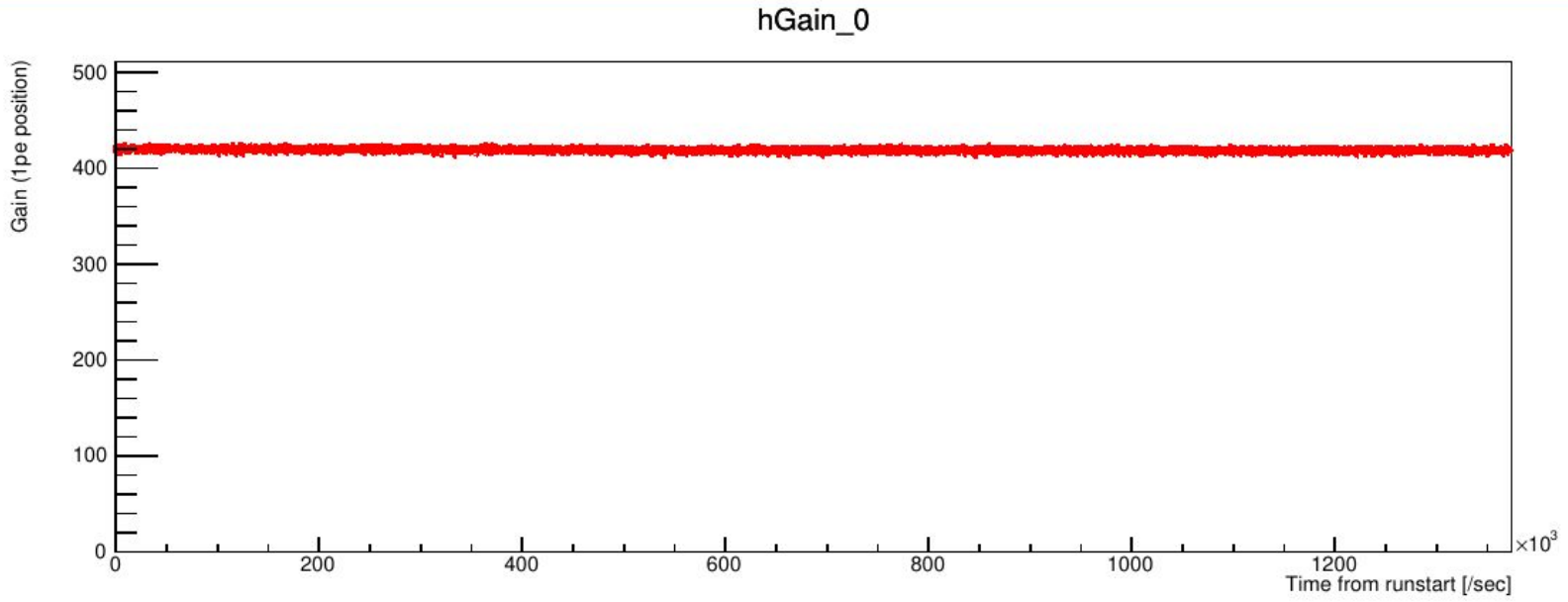

HV_CH16
HV [V]
1302.05
1302
1301.95
1301.9
1301.85
0
200
400
600
800
1000
1200
×10³

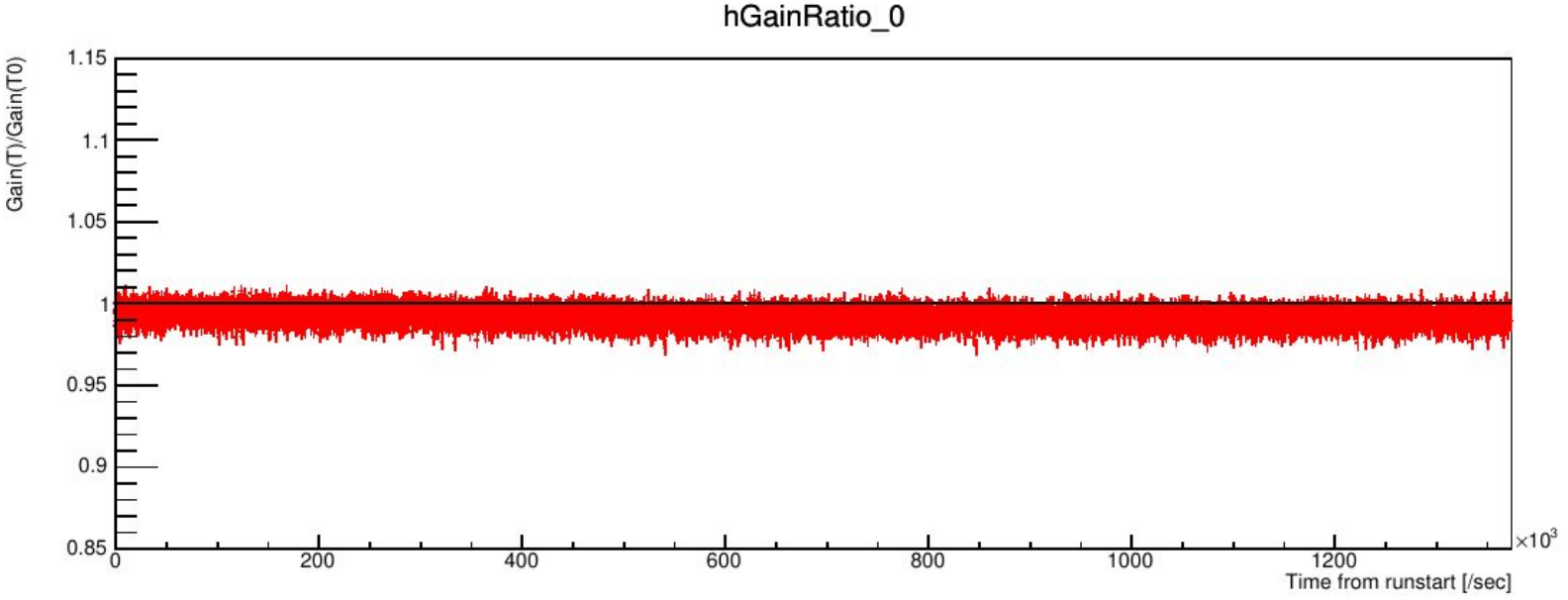

HV_Ratio_CH16
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10³
unix-time (not correct)

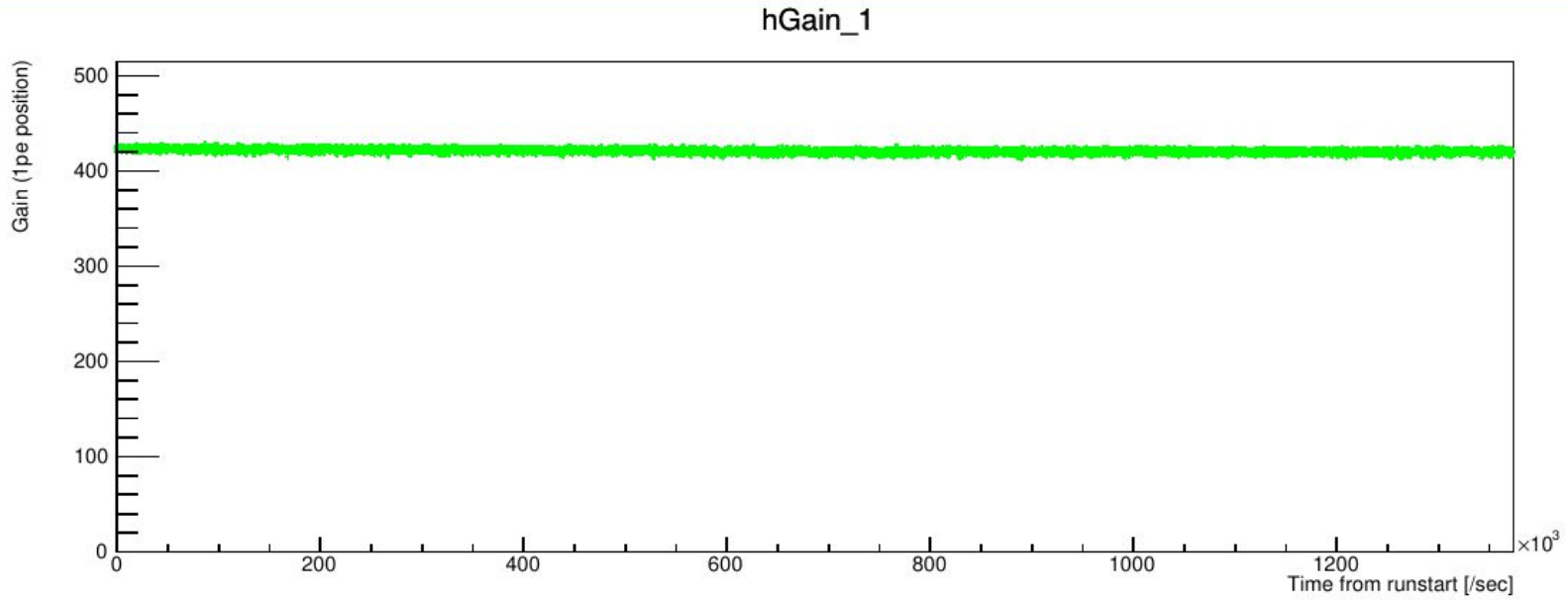

HV_CH18
HV [V]
1299.76
1299.74
1299.72
1299.7
1299.68
1299.66
1299.64
1299.62
1299.6
1299.58
1299.56
0
200
400
600
800
1000
1200
×10³

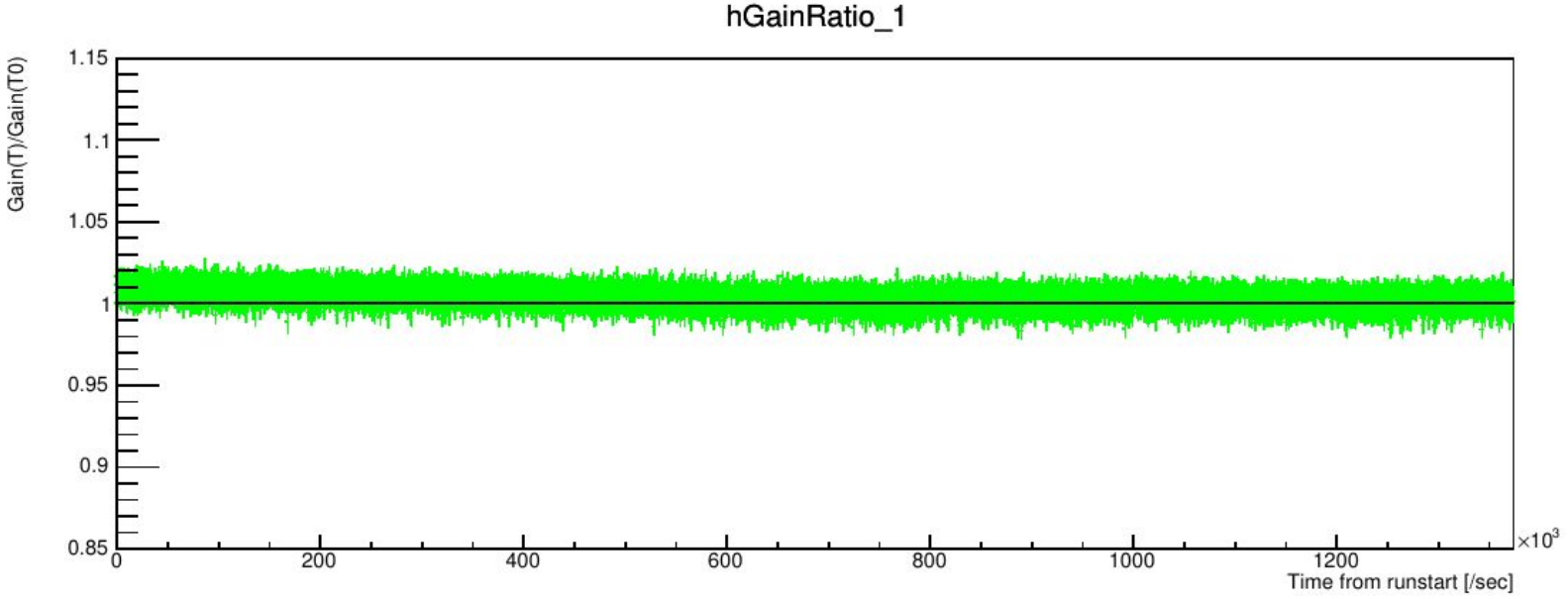

HV_Ratio_CH18
Ratio of set_value
1.03
1.025
1.02
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0
200
400
600
800
1000
1200
×10³
unix-time (not correct)

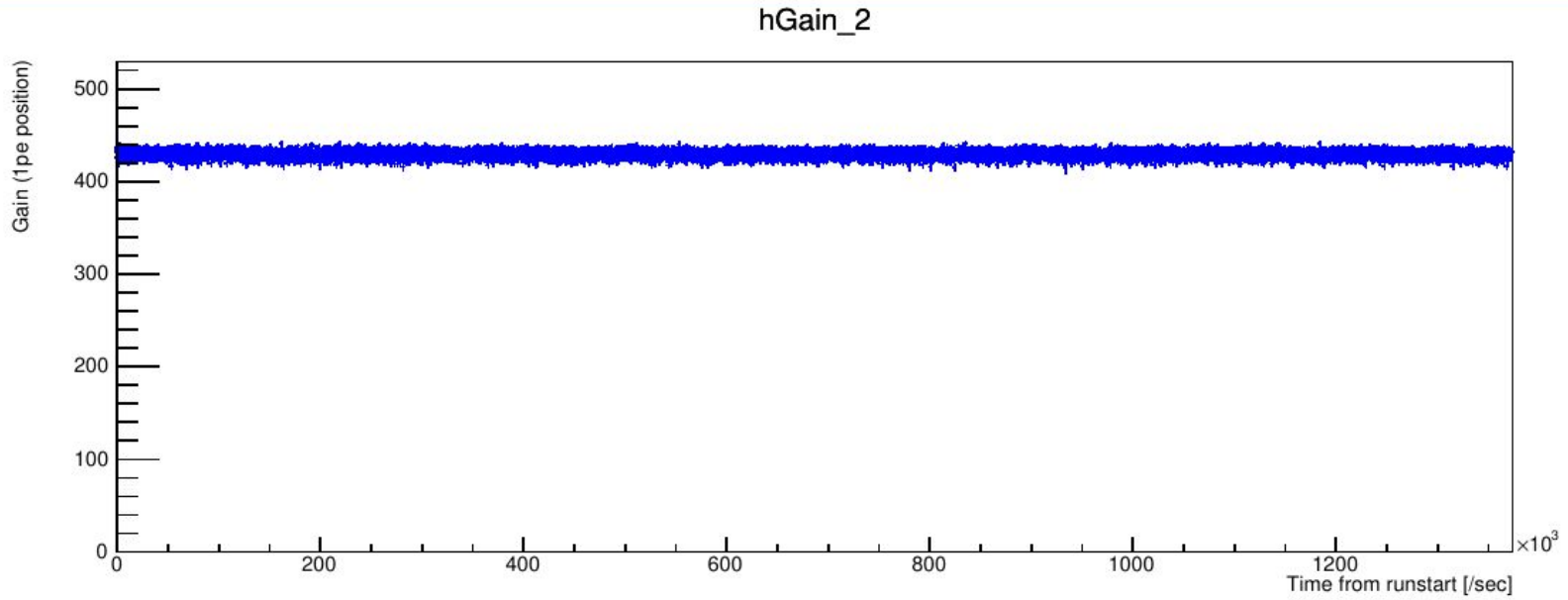
Gain

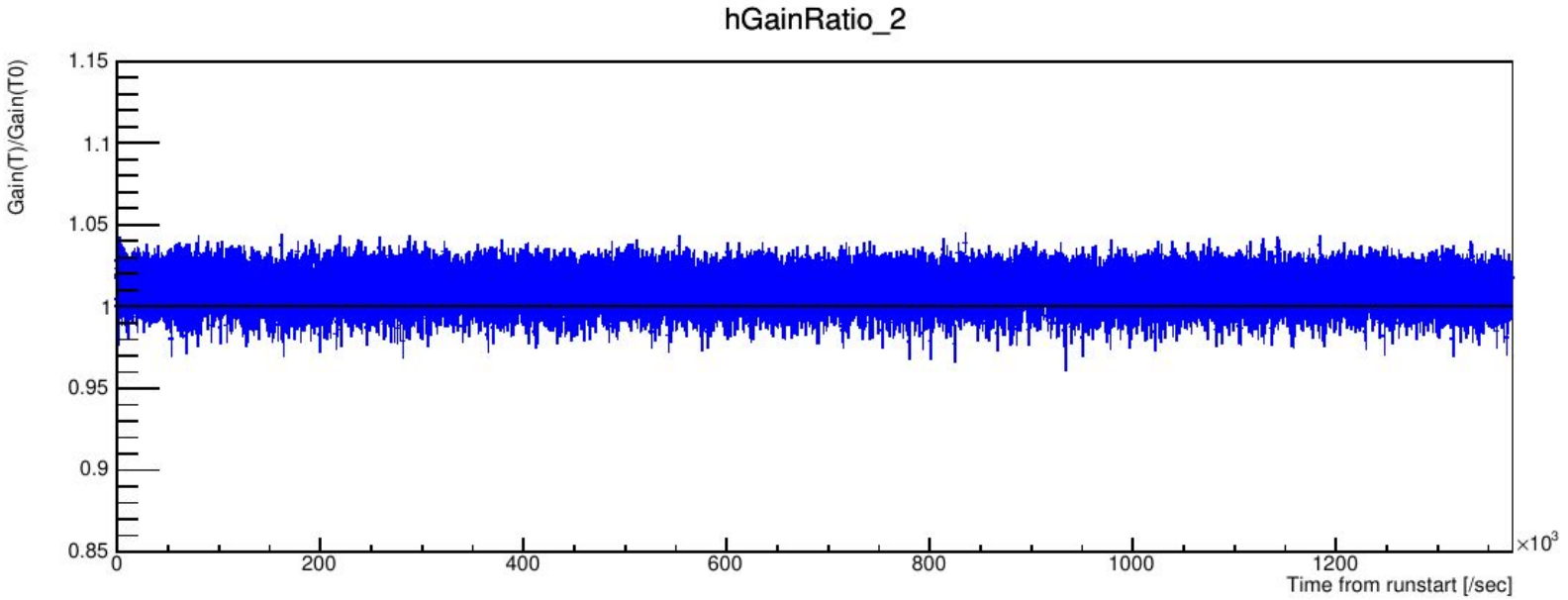

hGain_0
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

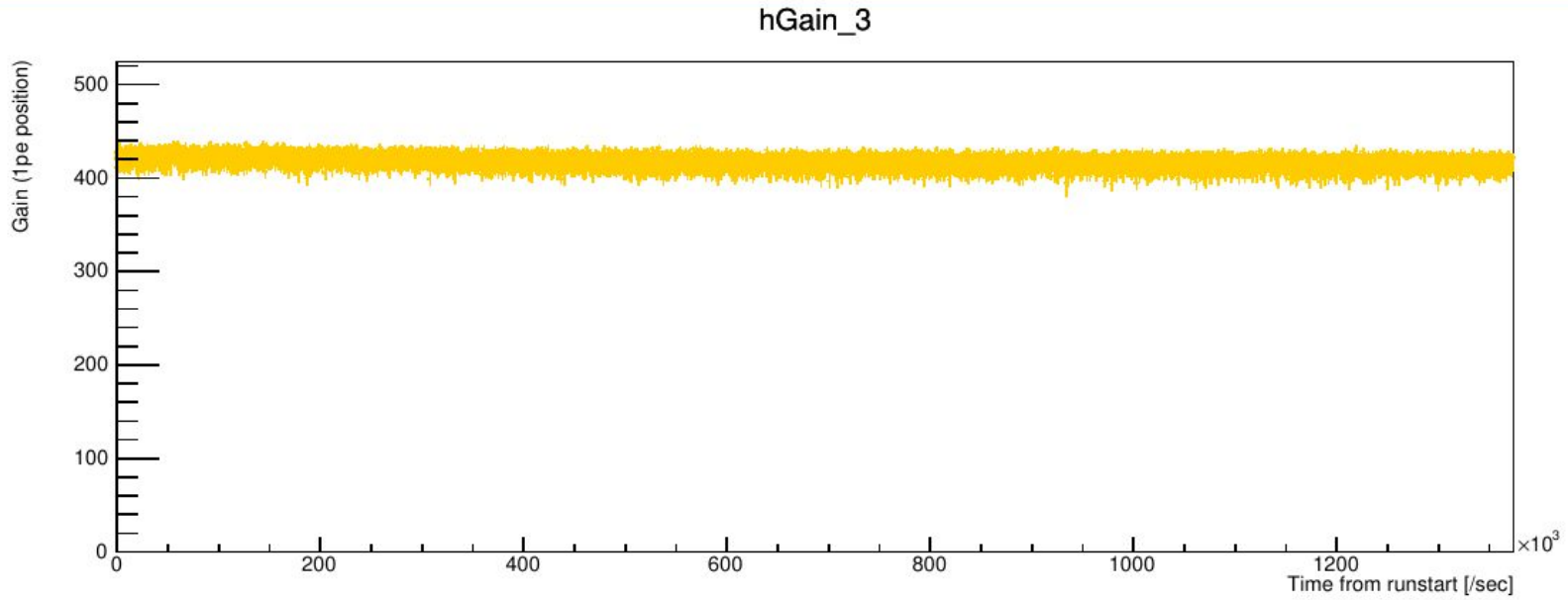

hGainRatio_0
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

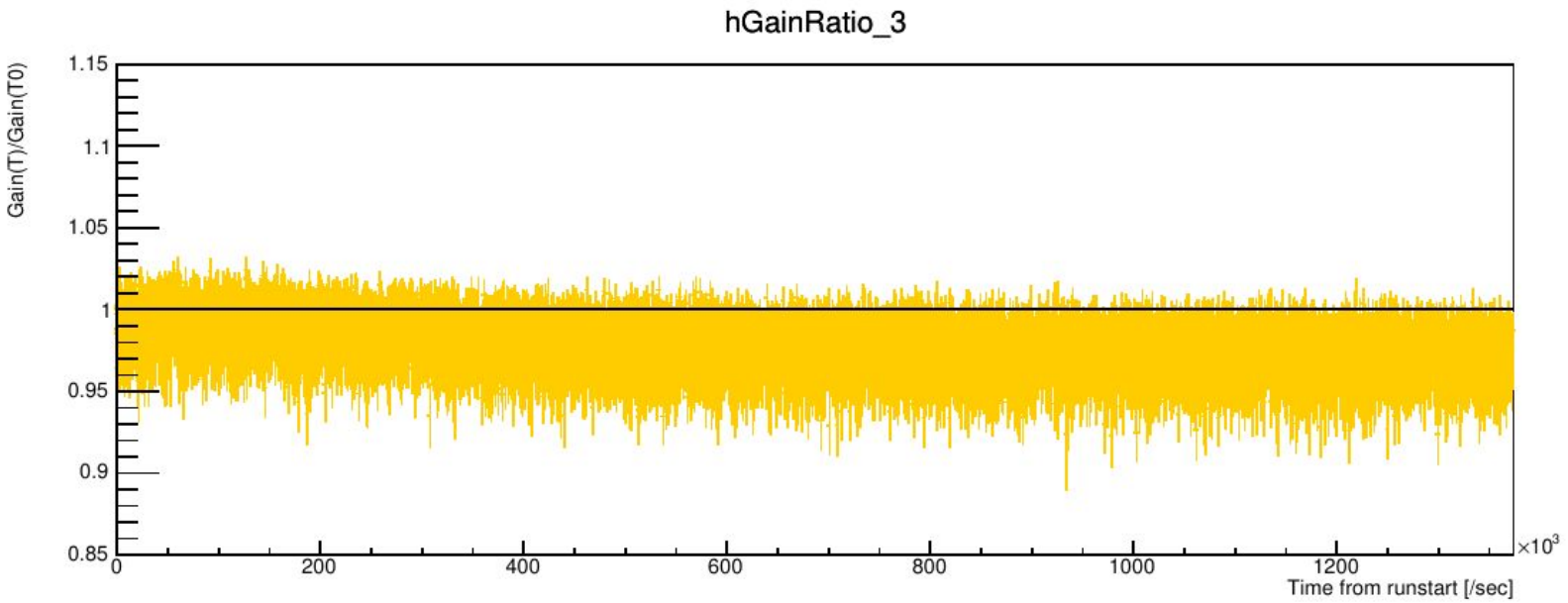

hGain_1
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

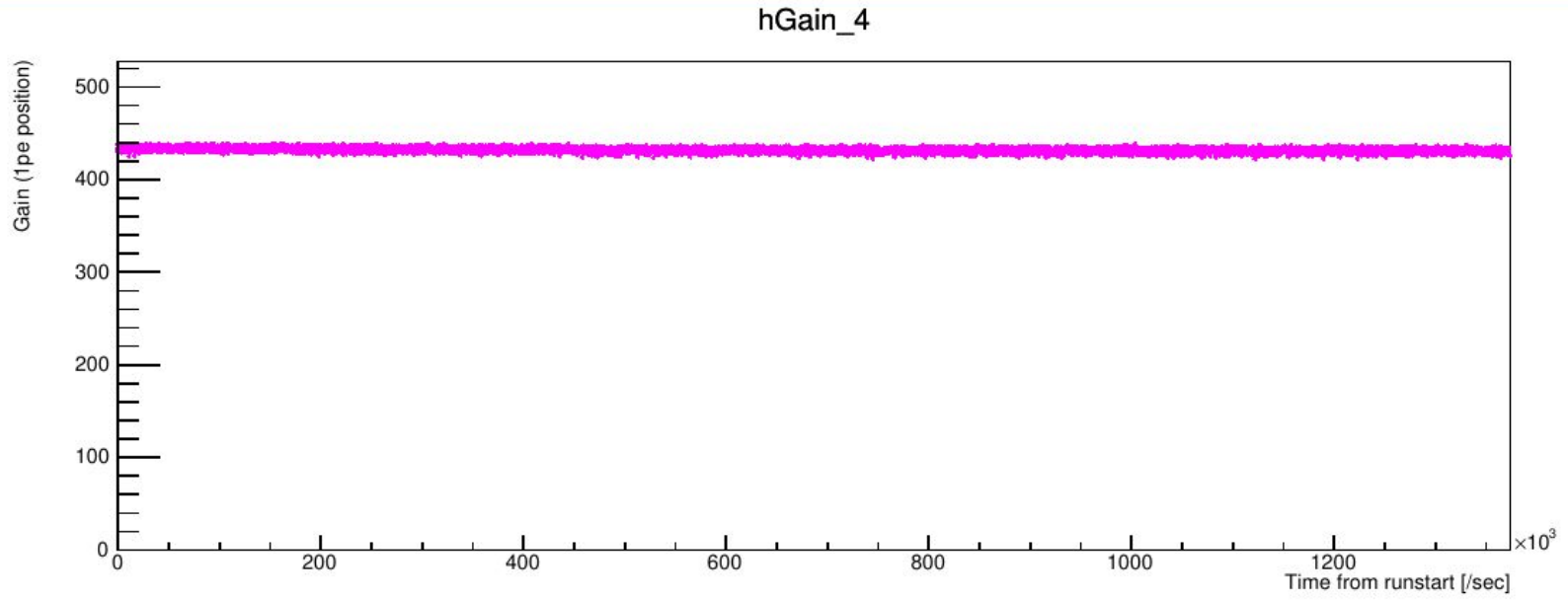

hGainRatio_1
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

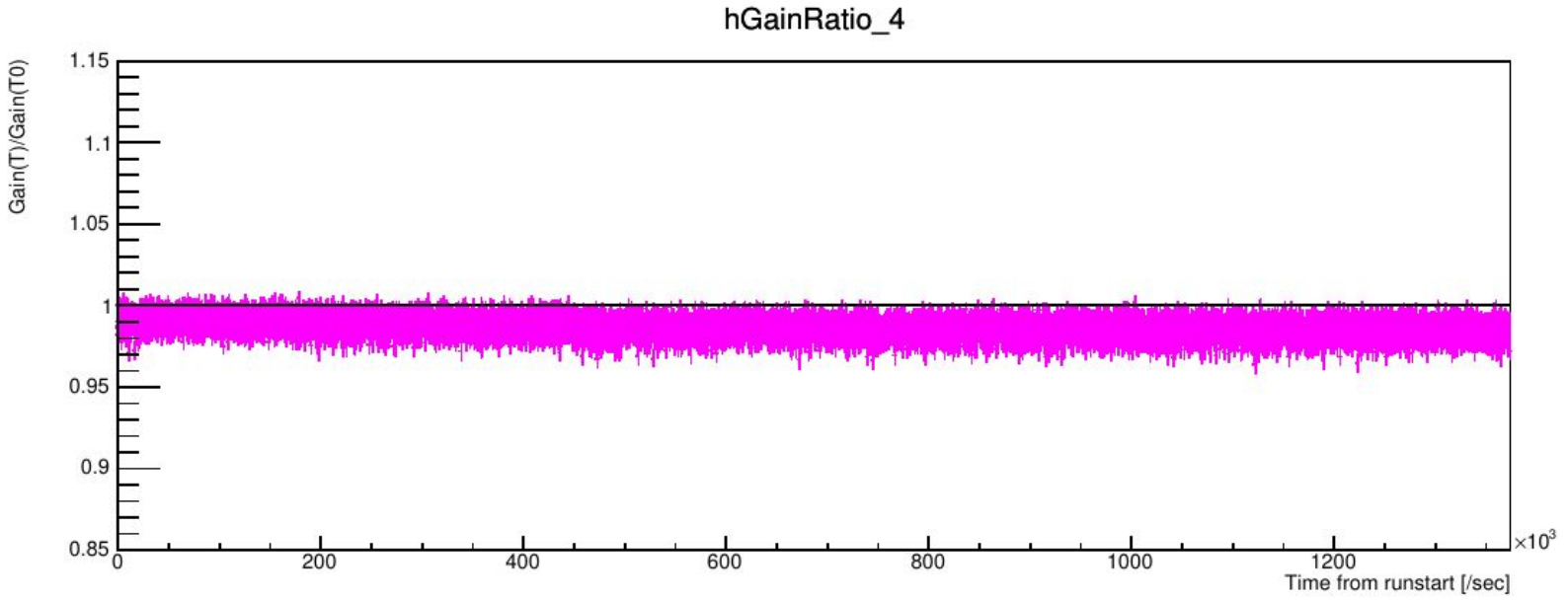

hGain_2
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

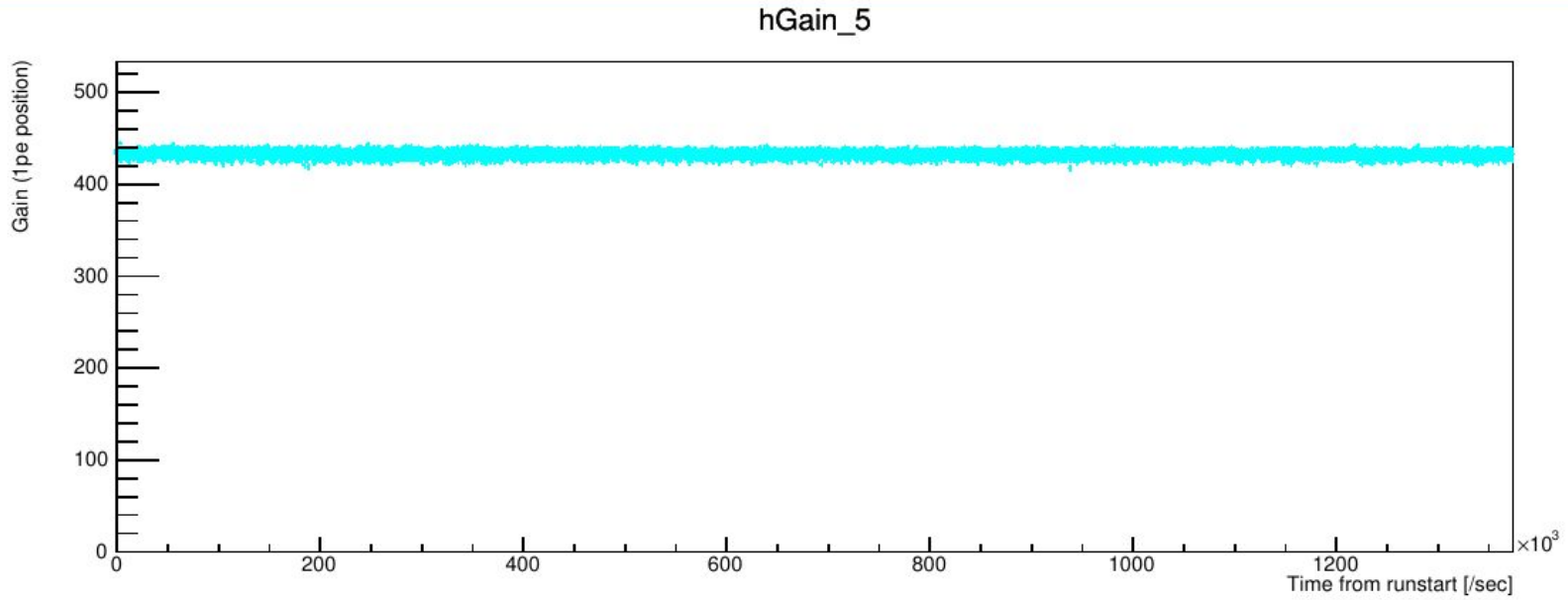

hGainRatio_2
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

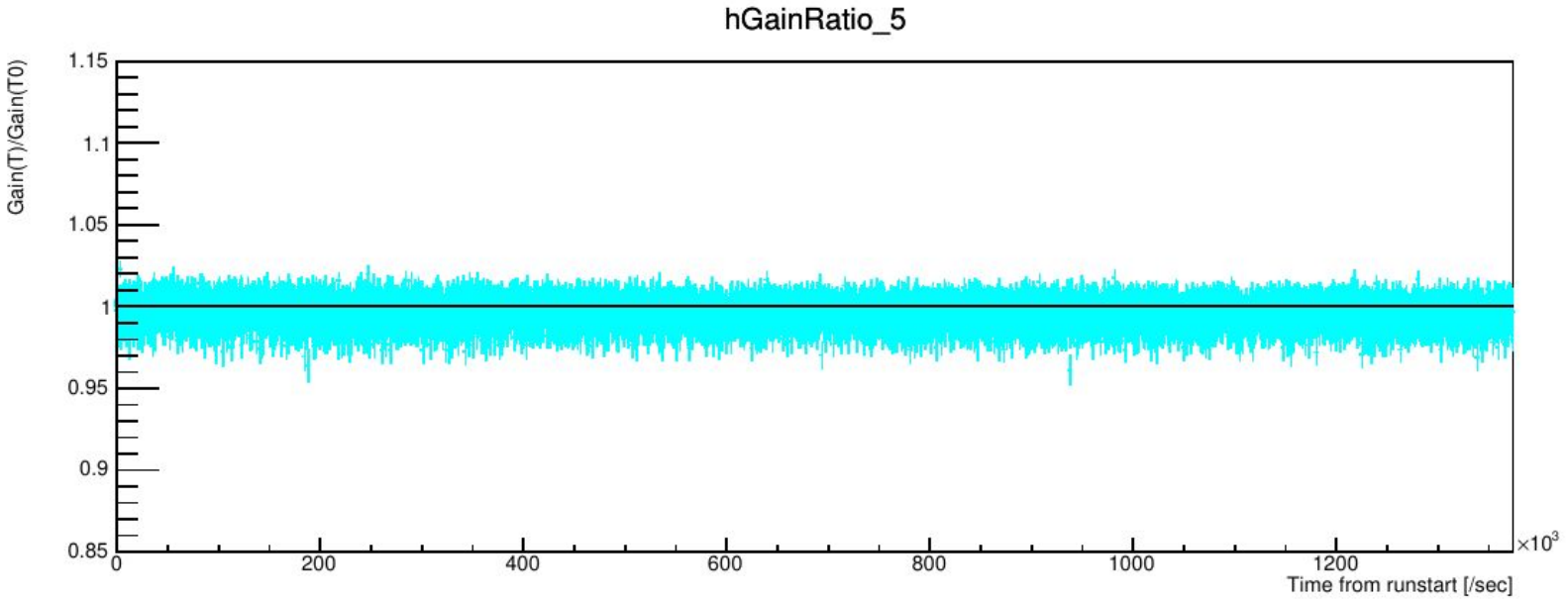

hGain_3
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

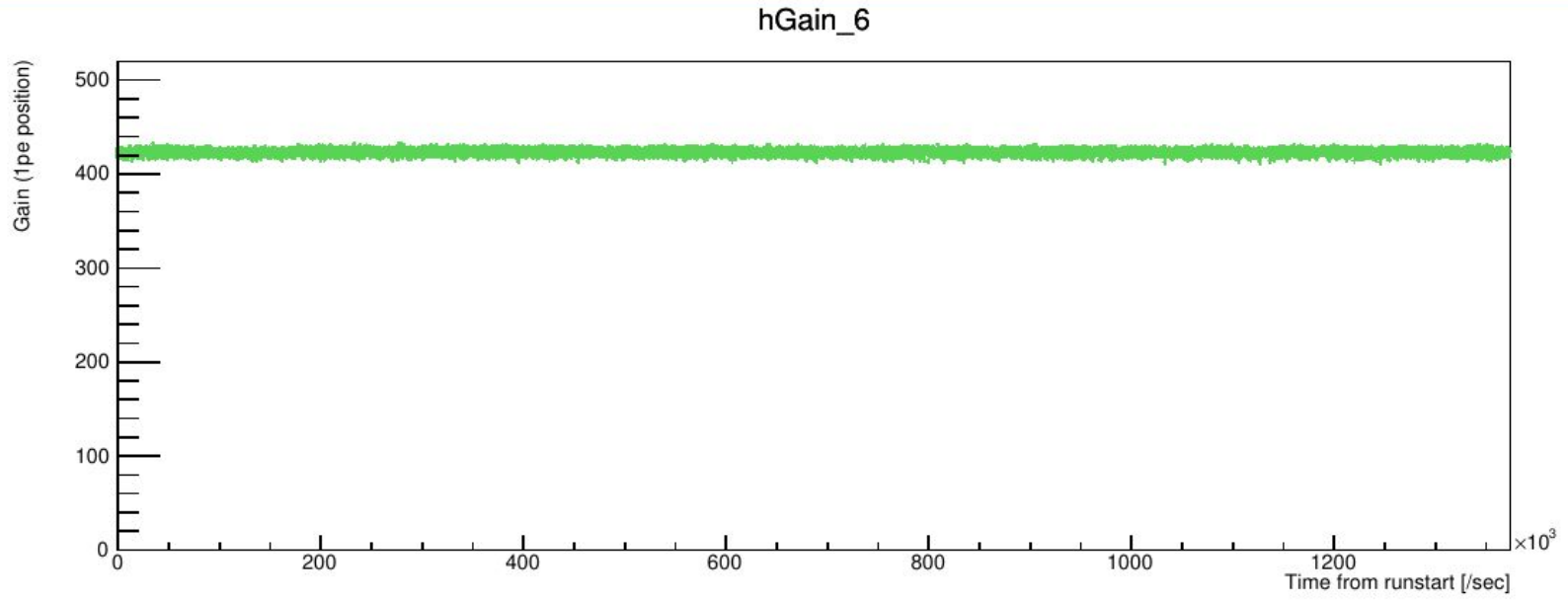

hGainRatio_3
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

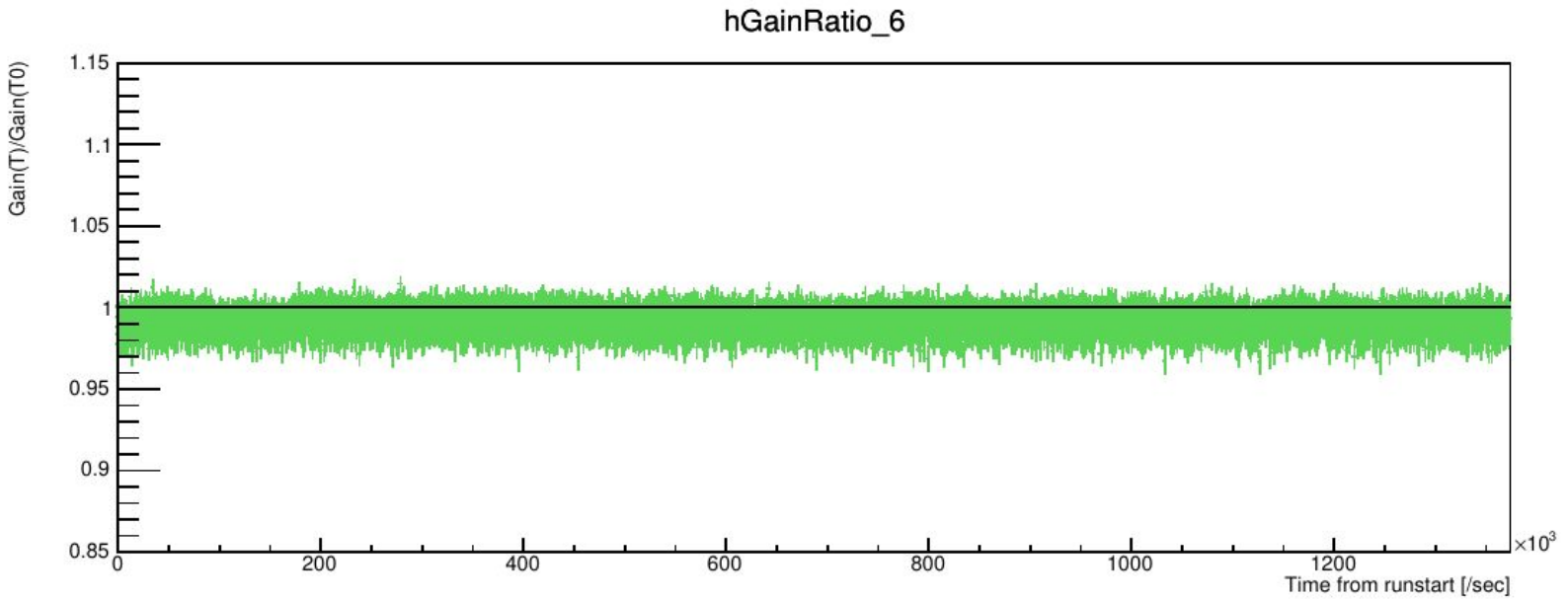

hGain_4
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

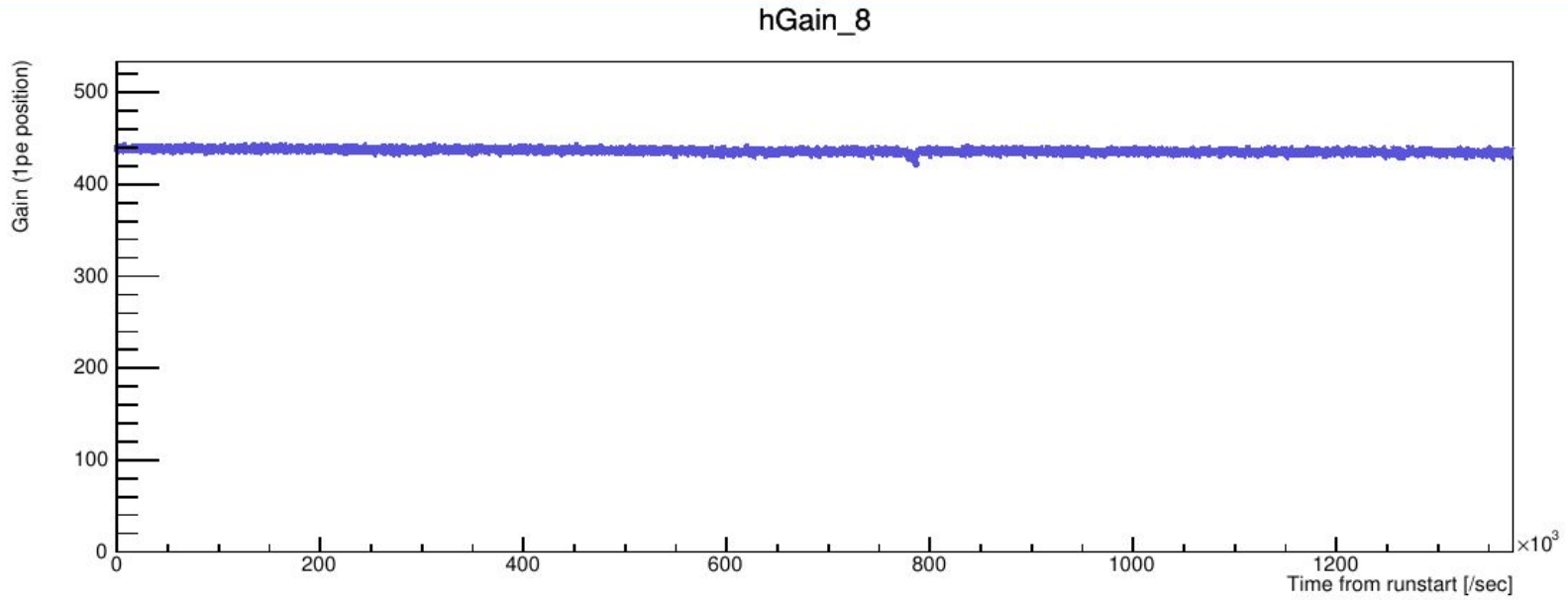

hGainRatio_4
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

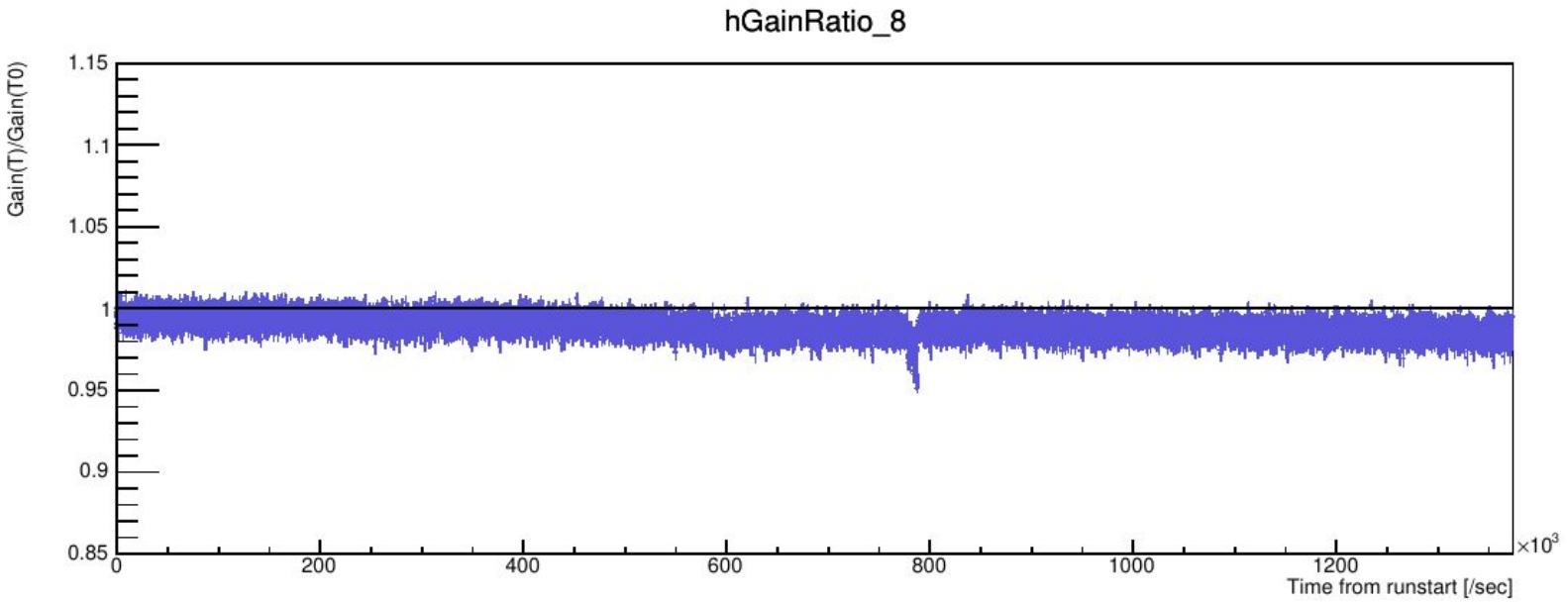

hGain_5
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

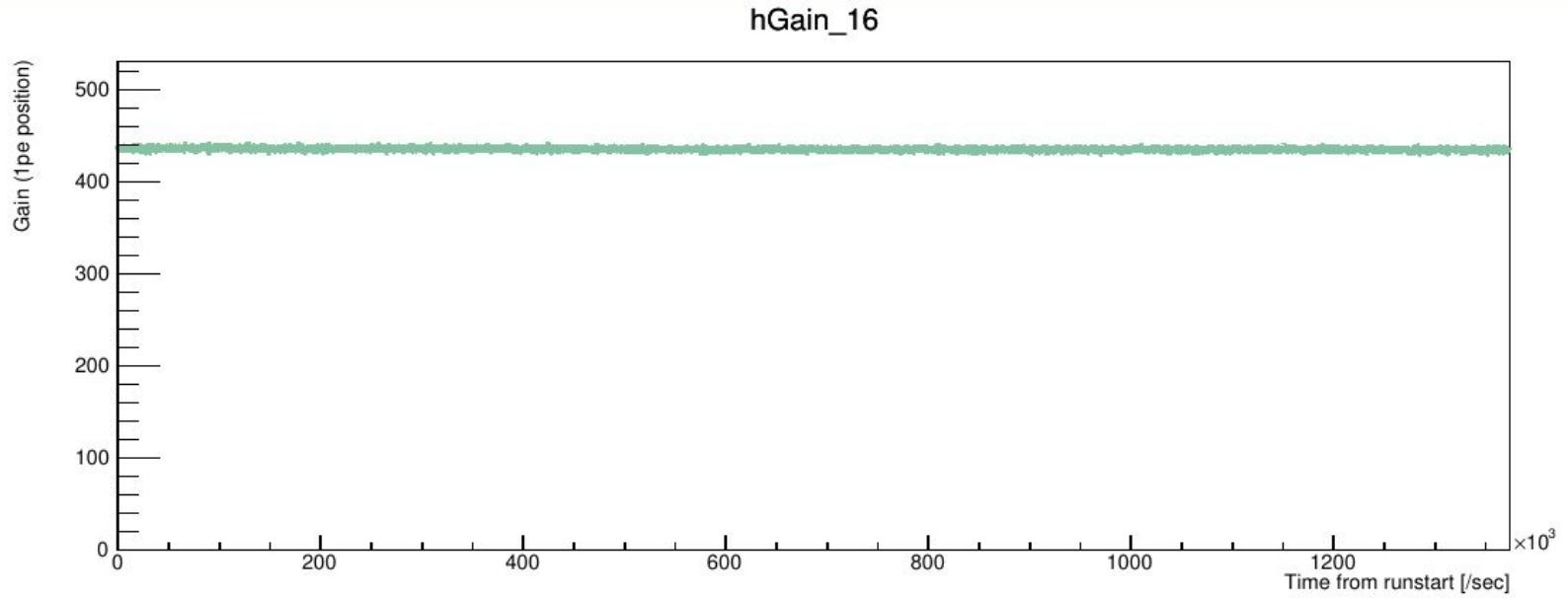

hGainRatio_5
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]

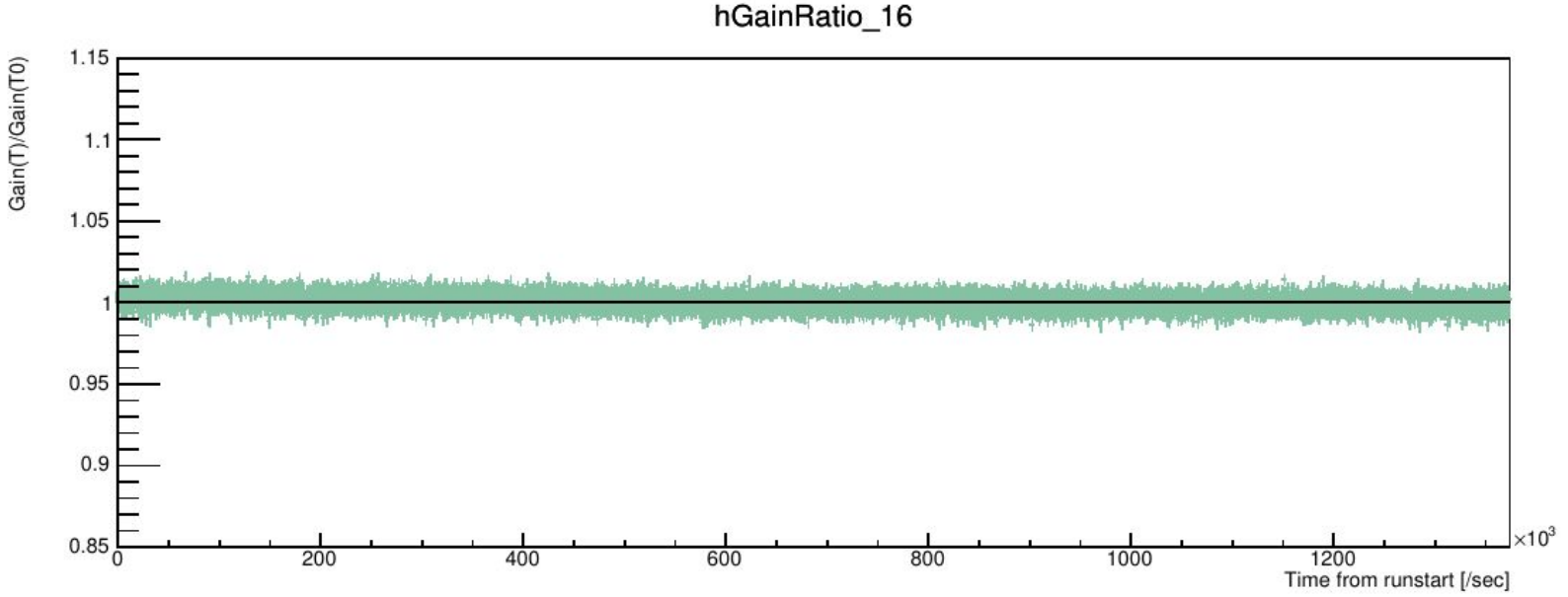

hGain_6
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10³
Time from runstart [/sec]

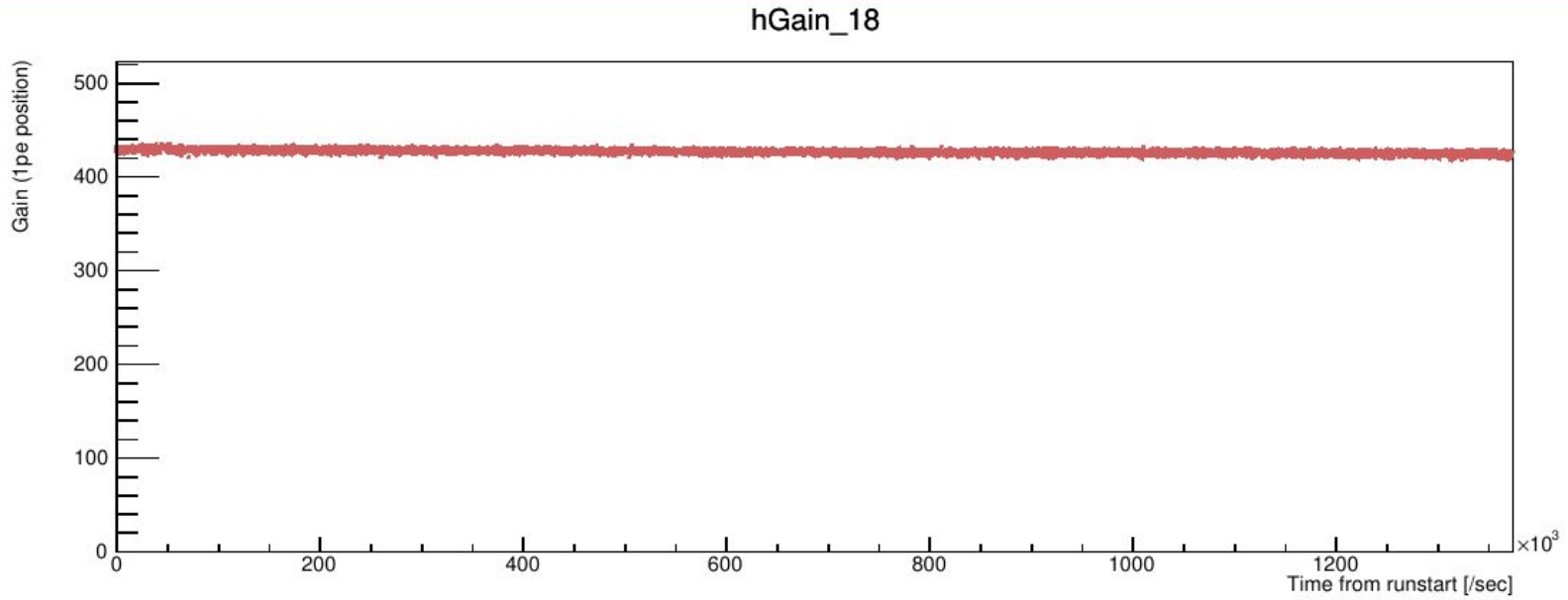

hGainRatio_6
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10³
Time from runstart [/sec]

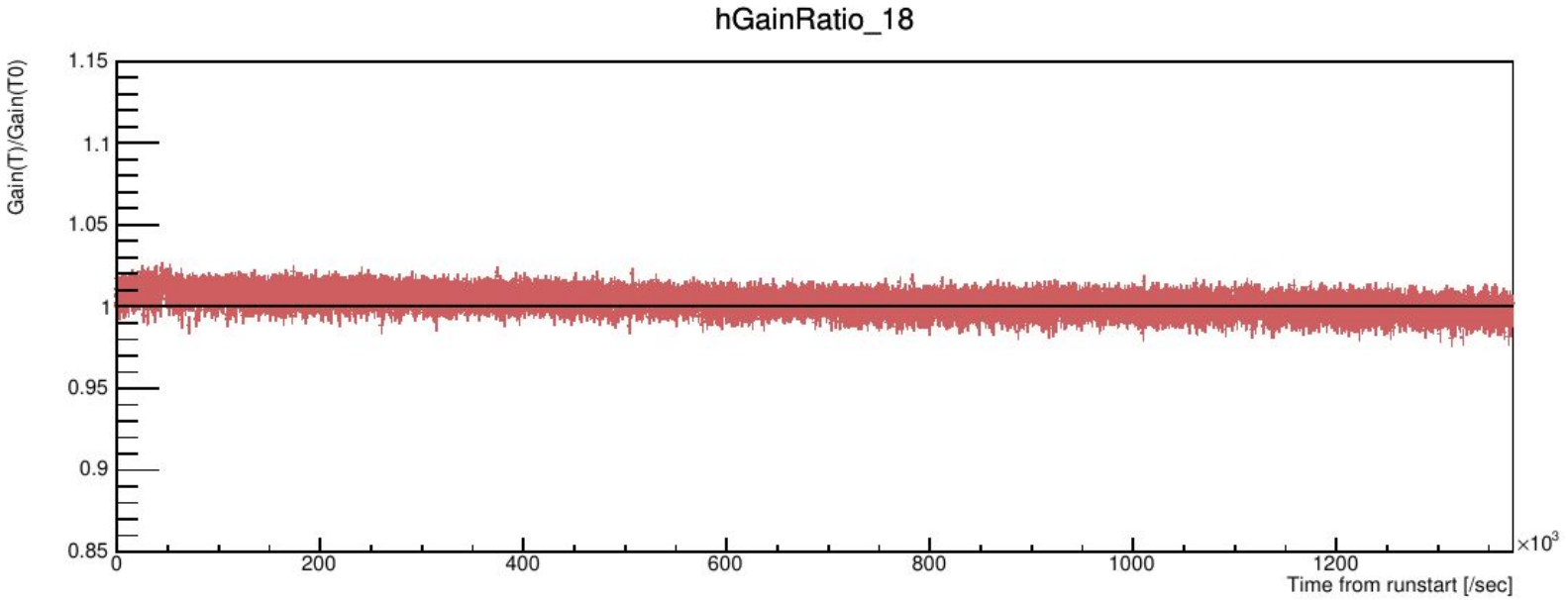

hGain_8
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]


hGainRatio_8
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]


hGain_16
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]


hGainRatio_16
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]


hGain_18
Gain (1pe position)
500
400
300
200
100
0
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]


hGainRatio_18
Gain(T)/Gain(T0)
1.15
1.1
1.05
1
0.95
0.9
0.85
0
200
400
600
800
1000
1200
×10^3
Time from runstart [/sec]