Updates on Noise Filtering

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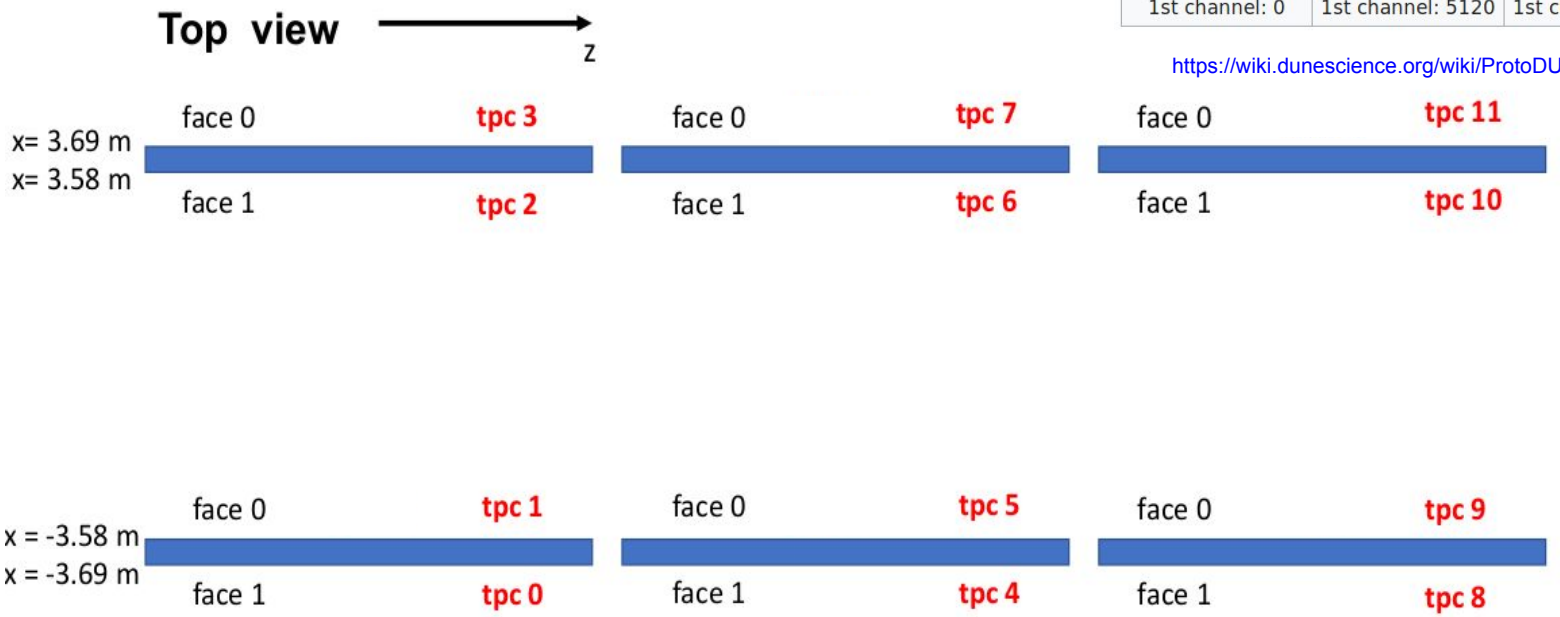
Outline

- “Bipolar” noise
- Noisy / Bad channels

protoDUNE geometry

APA5 US-DaS FEMBs 501-520 TPS1 TPC 2 (3) FEMB IDs 20-39 1st channel: 2560	APA6 MS-DaS FEMBs 601-620 TPS3 TPC 6 (7) FEMB IDs 60-79 1st channel: 7680	APA4 DS-DaS FEMBs 401-420 TPS5 TPC 10 (11) FEMB IDs 100-119 1st channel: 12800
APA3 US-RaS FEMBs 301-320 TPS0 TPC 1 (0) FEMB IDs 0-19 1st channel: 0	APA2 MS-RaS FEMBs 201-220 TPS2 TPC 5 (4) FEMB IDs 40-59 1st channel: 5120	APA1 DS-RaS FEMBs 101-120 TPS4 TPC 9 (8) FEMB IDs 80-99 1st channel: 10240

https://wiki.dunescience.org/wiki/ProtoDUNE_geometry



Noise history

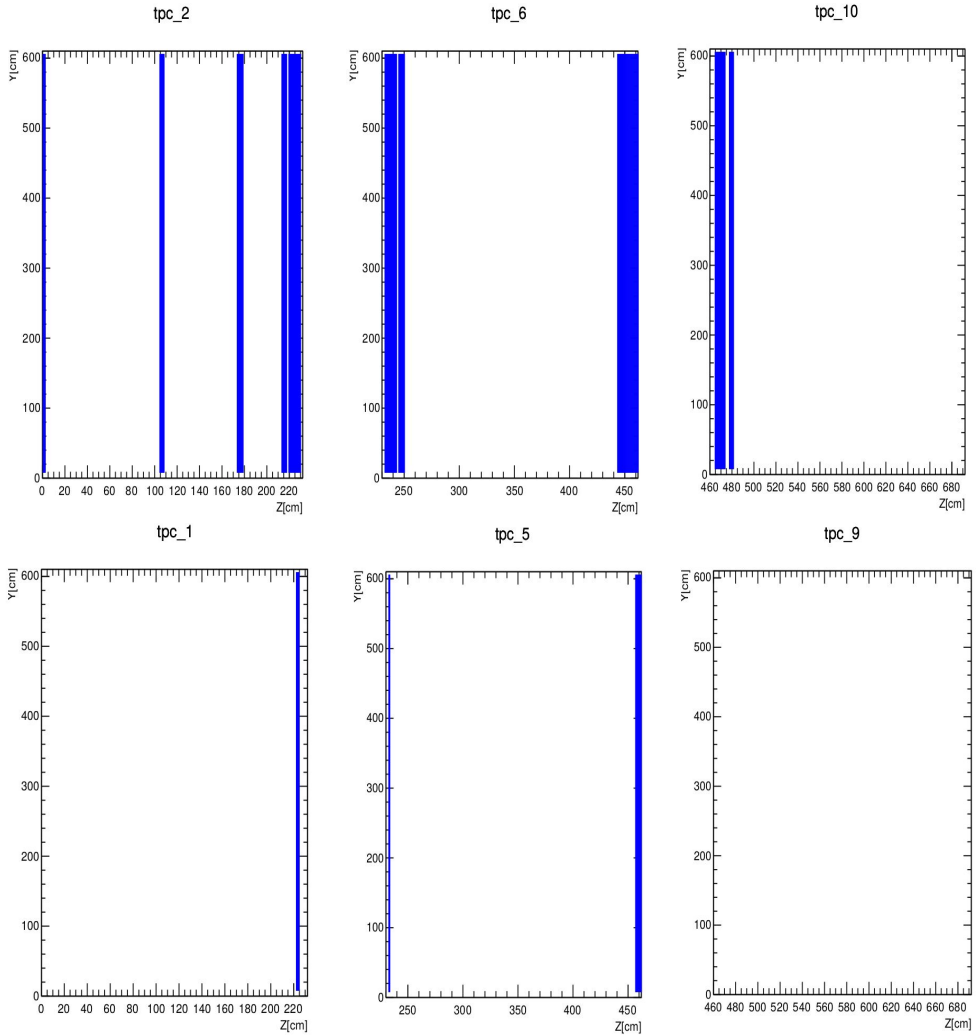
run number	HV	SSP	config	date	comment
5414	180	on	np04_WibsReal_Ssps_BeamTrig1GeV_00012		
5298	140	on	np04_WibsReal_Ssps_BeamTrig1GeV_00008	Oct 15	good
HV supply replacement 2018-10-17 15:25 https://pdspelog.web.cern.ch/elisa/display/8127					
5376	180	off	np04_WibsReal_Ssps_BeamTrig1GeV_00010	Oct 17	good, Run taken with 2 APAs and new power supply
5386	180	on	np04_WibsReal_Ssps_BeamTrig1GeV_00011	Oct 17	nosiy, SSP on but SSP503 off
5387	180	on	np04_WibsReal_Ssps_BeamTrig1GeV_00011	Oct 17	noisy, SSP on but SSP503 off
6129	180	on	np04_WibsReal_Ssps_CRT_prescale3_00003	12-11	
6141	180	on	np04_WibsReal_Ssps_CRT_prescale3_00003	12-11	noisy
6142- 6148			ToyComponent_EBwriting00026		
6149- 6154			np04_felix_hit_find_00002		
6154	180	off	np04_felix_hit_find_00002	12-12	
6155	130	**off**	np04_WibsReal_Ssps_CRT_prescale3_00003	12-12	good
High Voltage supply replacement: https://pdspelog.web.cern.ch/elisa/display/9786					
6156	180	off	np04_WibsReal_Ssps_CRT_prescale3_00003	12-12	good
6157	180	off	np04_WibsReal_Ssps_CRT_prescale3_00003	12-12	good
6158	180	**on**	np04_WibsReal_Ssps_CRT_prescale3_00003	12-12	good
6212	180	on	np04_WibsReal_Ssps_CRT_prescale3_00003	12-17	good
6303	180	on	np04_WibsReal_Ssps_CRT_prescale3_00003	Jan 12	many missing channels

Channels with high RMS (Run 5424)

- Run 5424 Event 40460
- Drift side wires (Collection plane only)

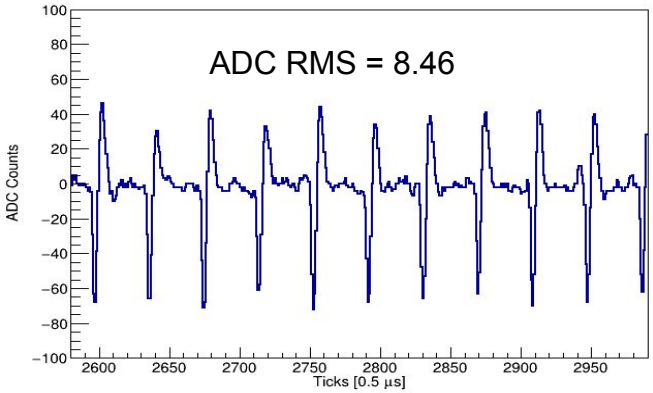
		BadCh
APA 3	tpc 1	12
APA 5	tpc 2	59
APA 2	tpc 5	15
APA 6	tpc 6	75
APA 1	tpc 9	0
APA 4	tpc 10	29

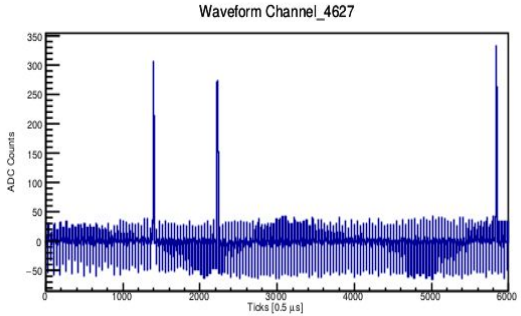
- 190 noisy channels

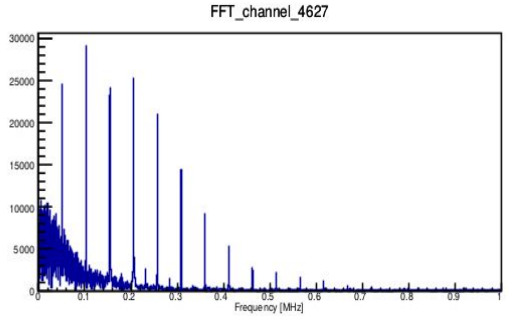


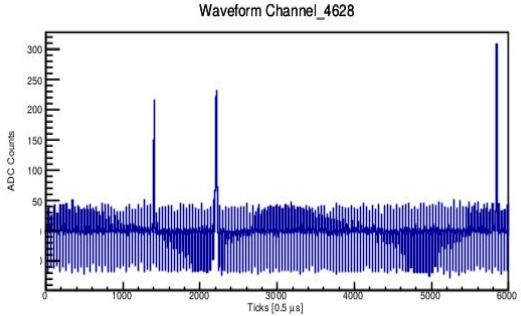
APA 5

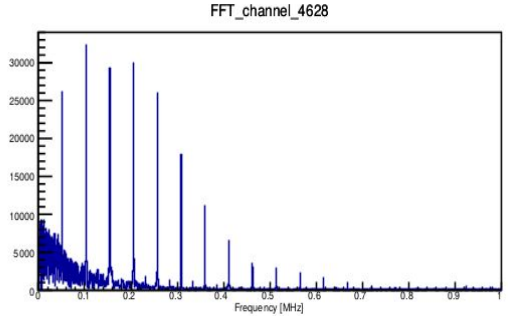
- ~59(46) bad channels in tpc 2(3)
- ~105 channels display noise at ~ 0.0518, 0.1036, 0.1554, 0.2072 ... MHz
  (Harmonics of 0.0518 MHz)
- Abnormal waveform

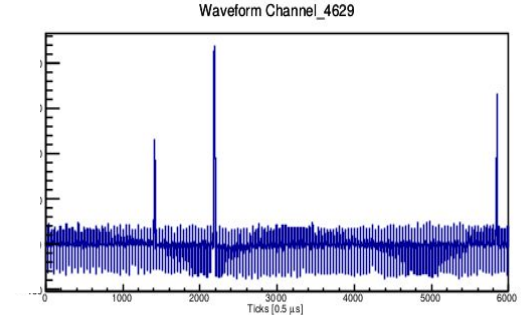


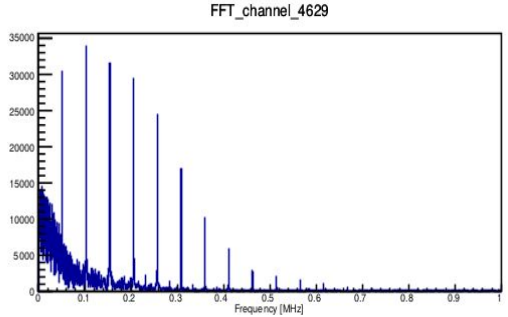












Run 5424

APA5 US-DaS FEMBs 501-520 TPS1 TPC 2 (3) FEMB IDs 20-39 1st channel: 2560	APA6 MS-DaS FEMBs 601-620 TPS3 TPC 6 (7) FEMB IDs 60-79 1st channel: 7680	APA4 DS-DaS FEMBs 401-420 TPS5 TPC 10 (11) FEMB IDs 100-119 1st channel: 12800
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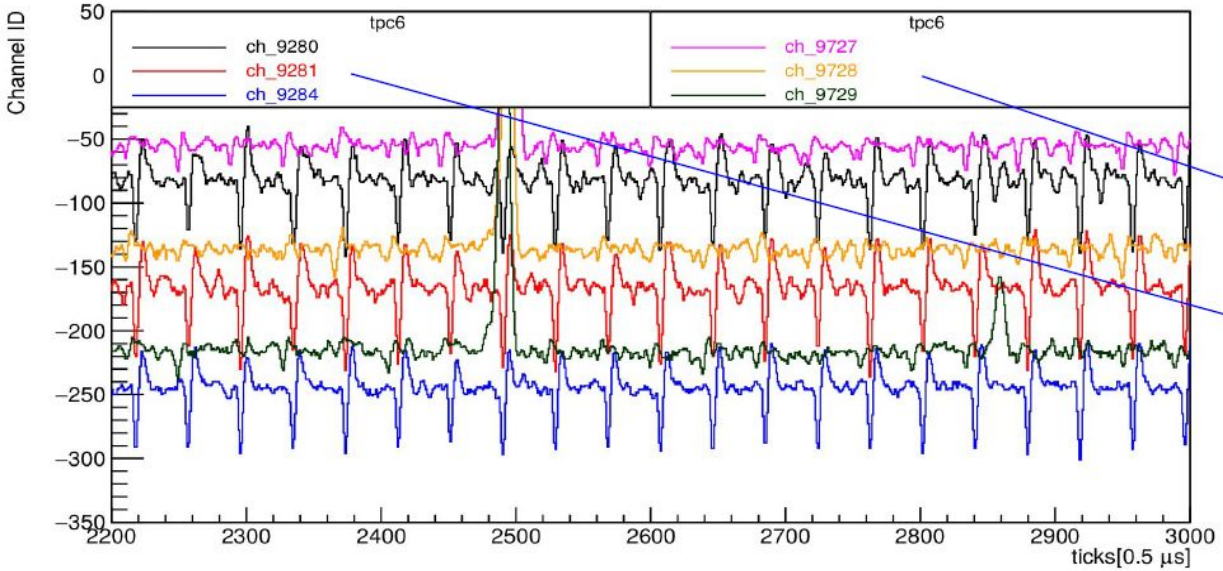
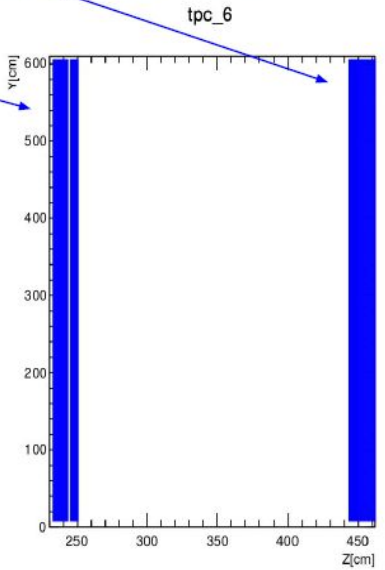
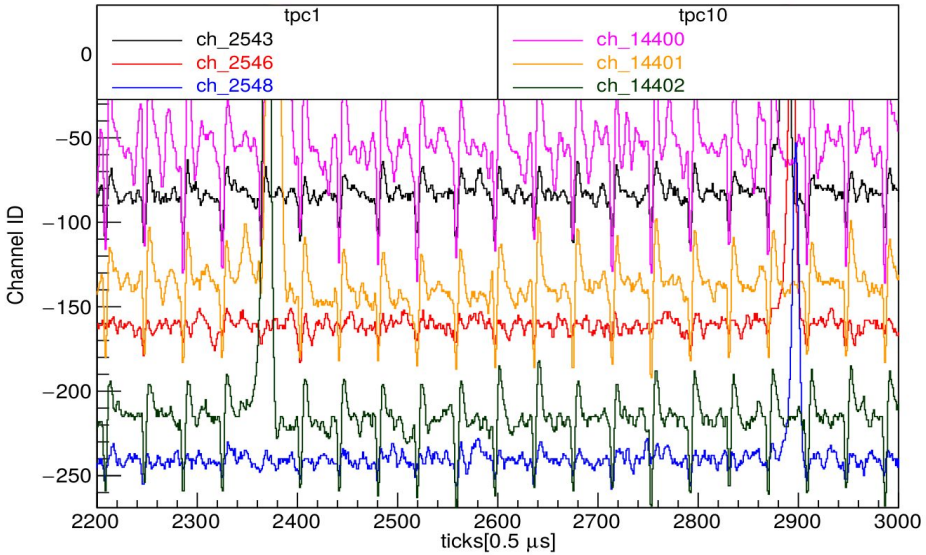




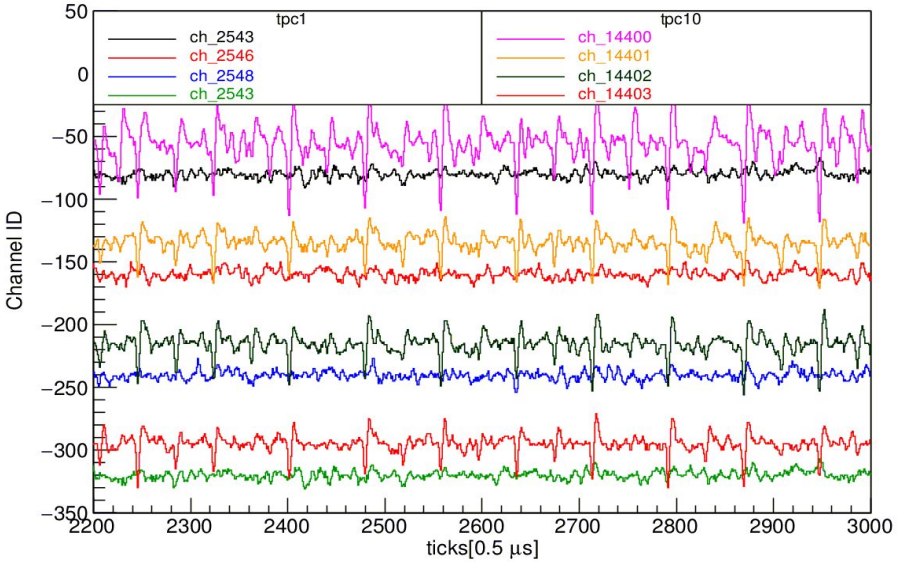
- The excess noise in adjacents wires from the same tpc is isochronous e.g (ch 9280, 9281, 9284)
- Distant wires from the same tpc display a phase offset, also the magnitude is decreasing as we move from left to right e.g (ch 9280 and ch 9727)

After HV replacement on 10/17/18

Run 5424 October



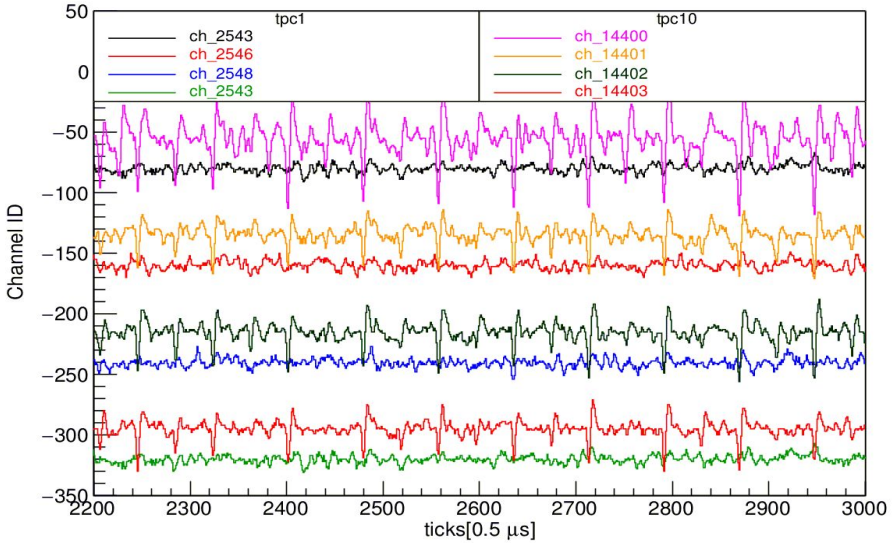
Run 6141 December



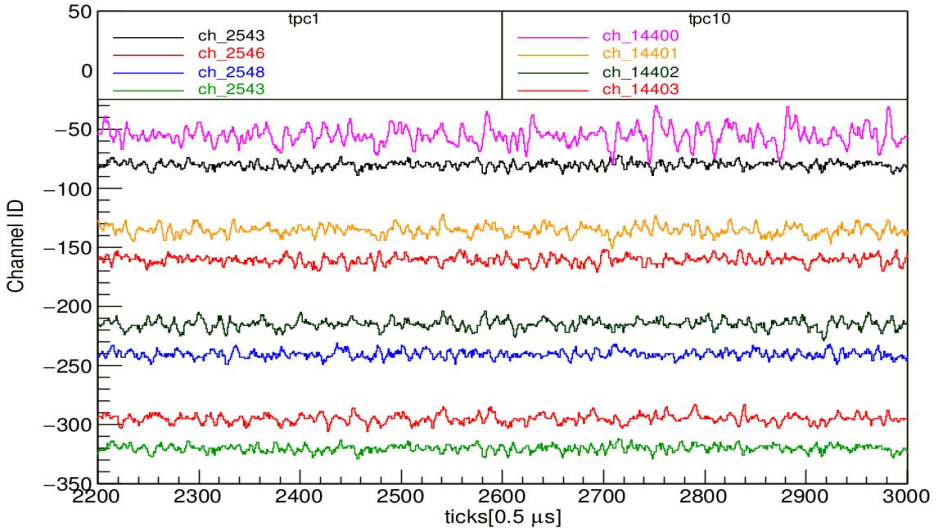
- This problem shows up after the HV replacement on 10/17

Before HV supply replacement on 12/12/18

Run 6141 SSP ON 12/11



Run 6155 SSP OFF 12/12

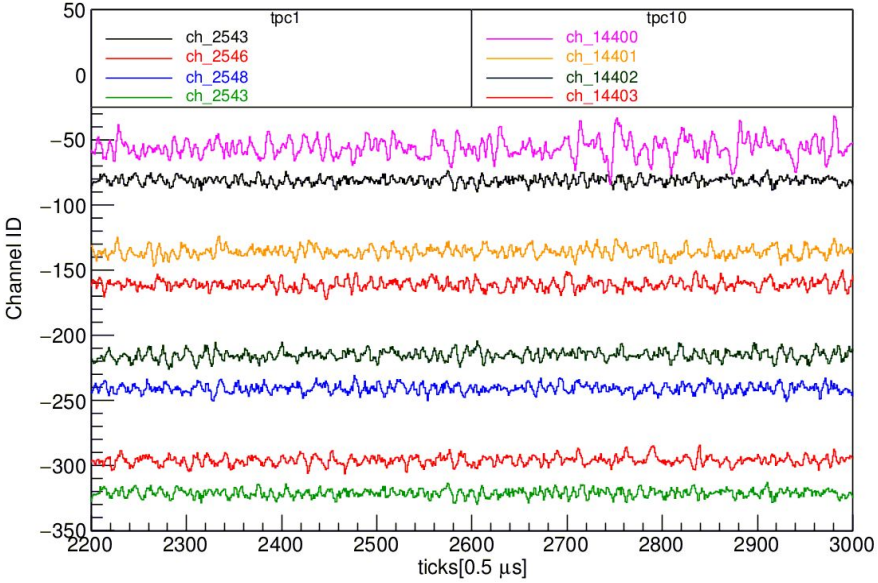


- The noise is reduced when SSP's voltage is OFF

Right before and right after HV replacement on 12/12

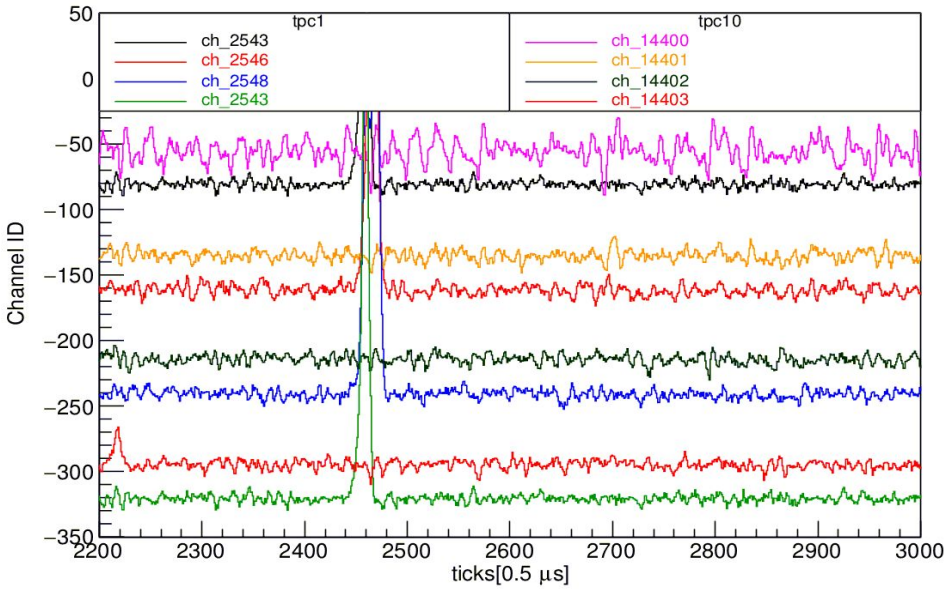
Before

Run 6155 SSP OFF 12/12



Run 6156 SSP OFF 12/12

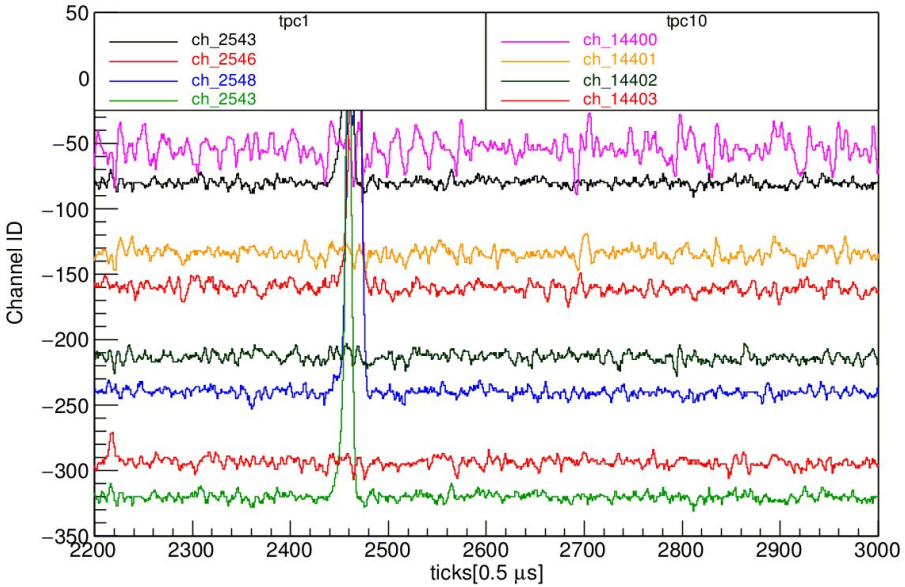
After



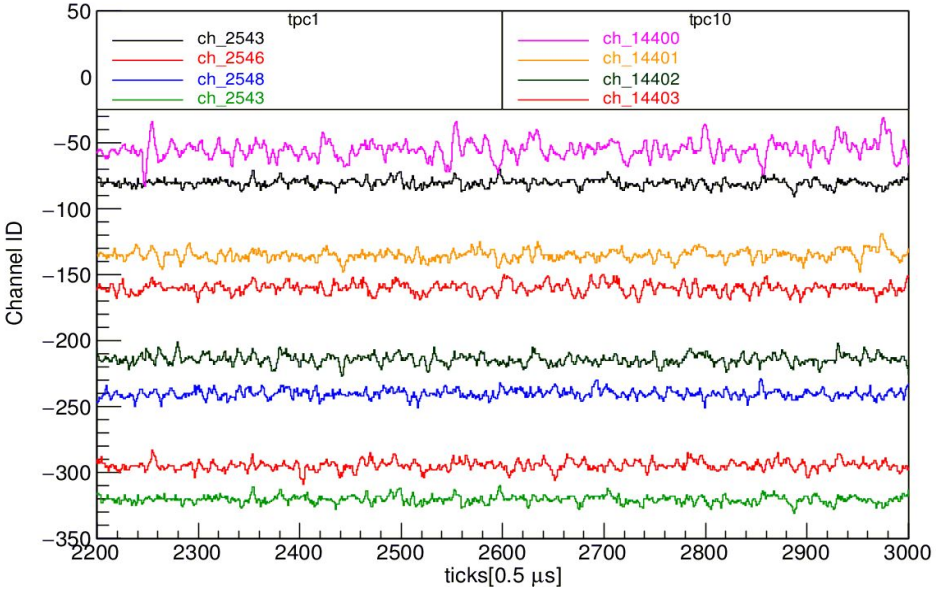
- After the HV supply was replaced we observed only some channels with the bipolar noise

After HV replacement

Run 6156 12/12 SSP OFF



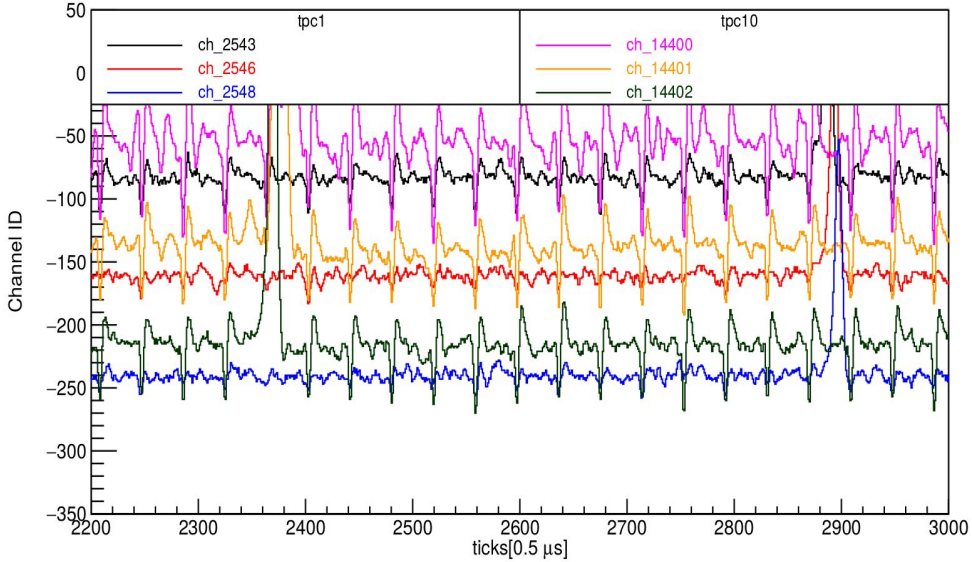
Run 6158 12/12 SSP ON



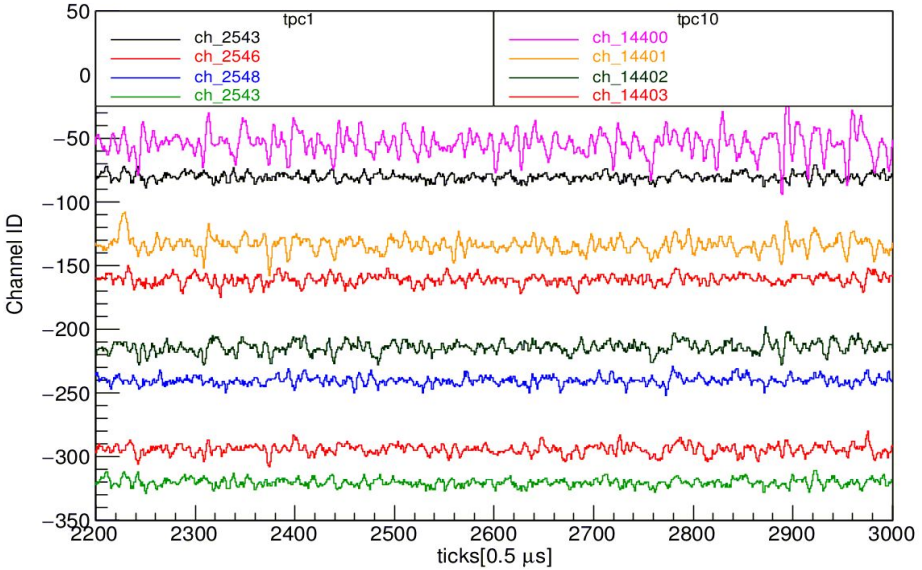
- Both SSP on and off won't give such noise, although we still see a few channels with this noise e.g ch 14400

Another Example

Before (run 5424)

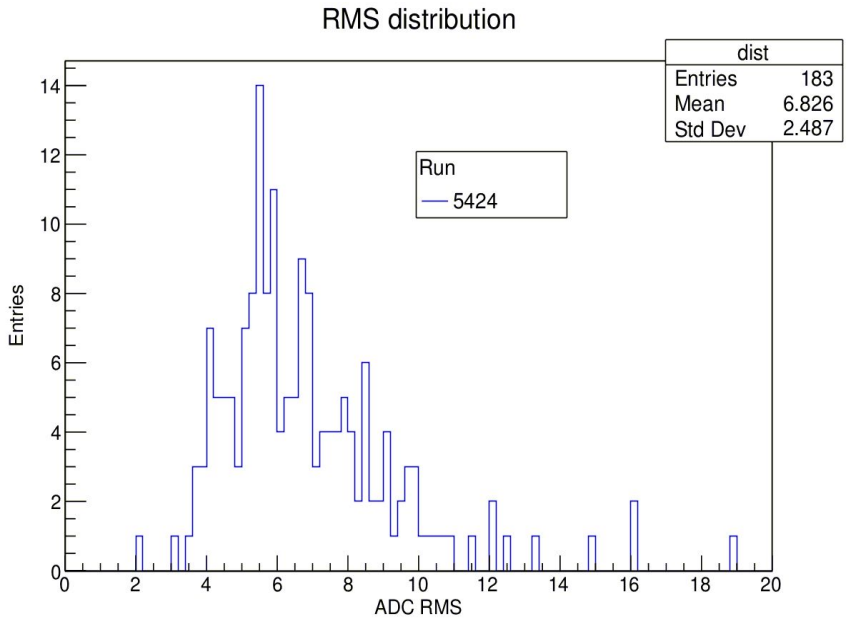


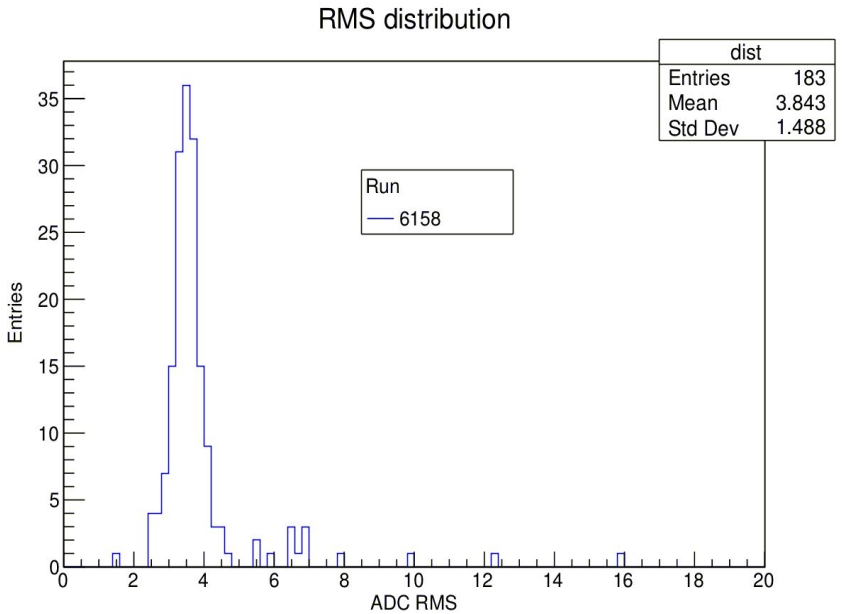
After (run 6212)



- In this example the noise is significantly reduced after the HV supply replacement

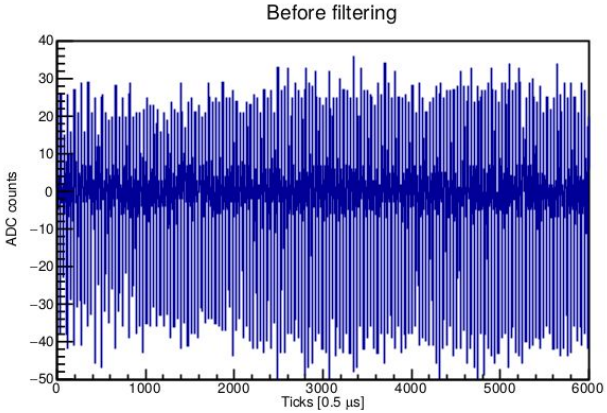
RMS distribution

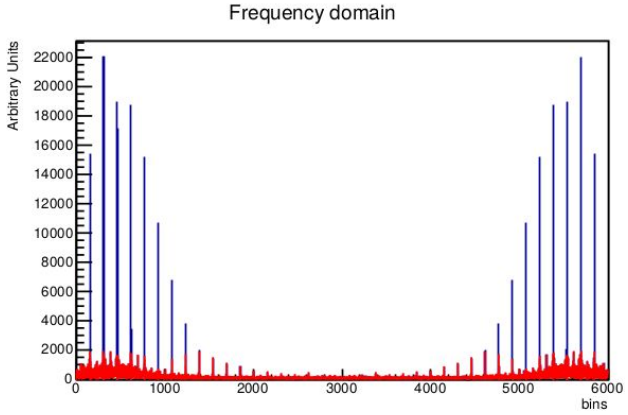




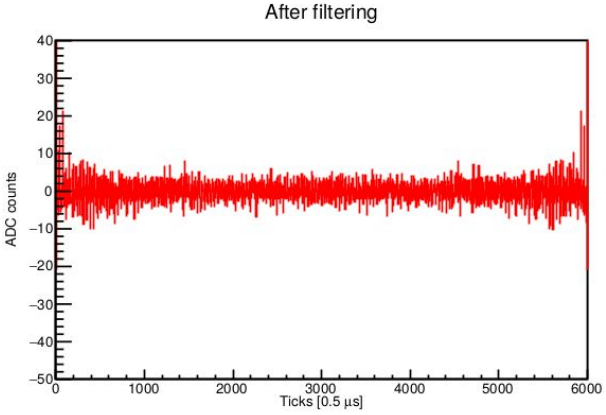
- After HV replacement on 12/12 many channels show an ADC rms less than 4

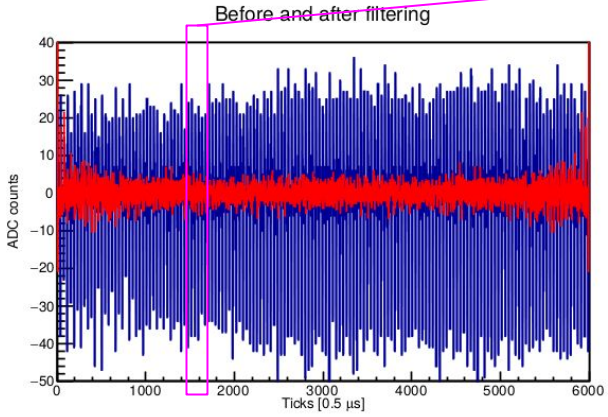
Preliminary noise filtering

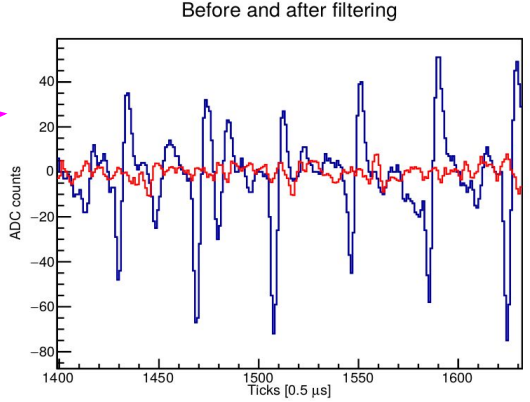




The problem is significantly suppressed after zeroing-out spikes in frequency domain

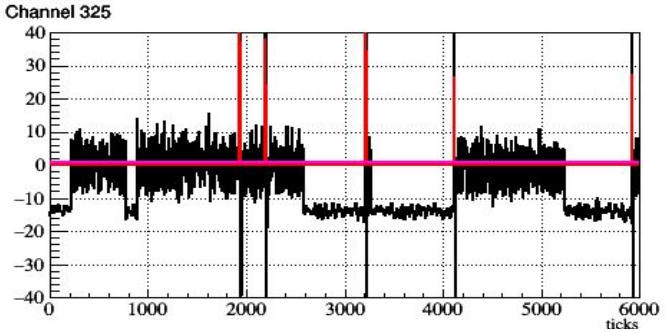


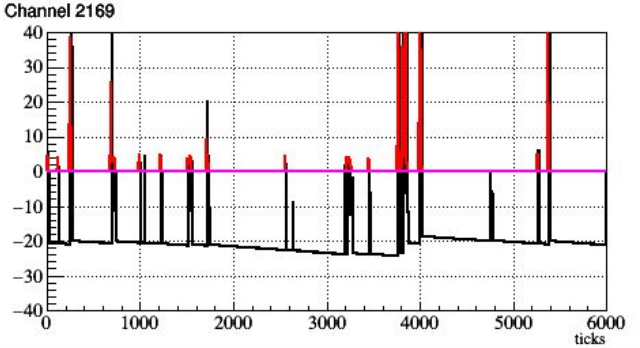


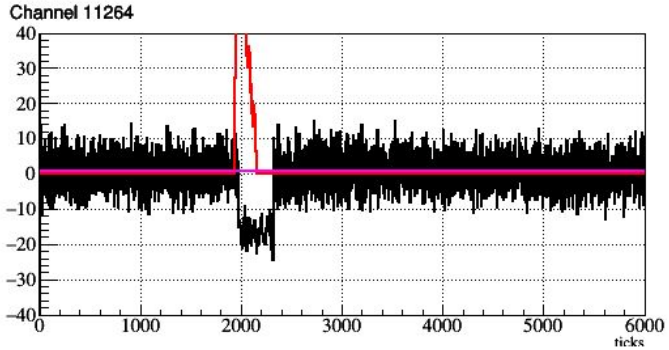


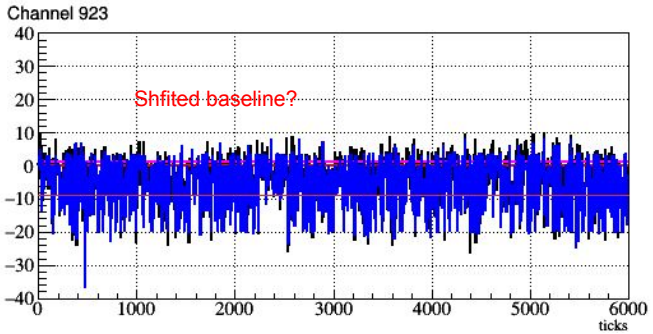
Other bad channels?

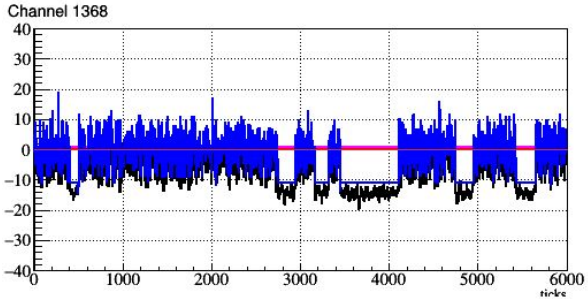
Run 6212

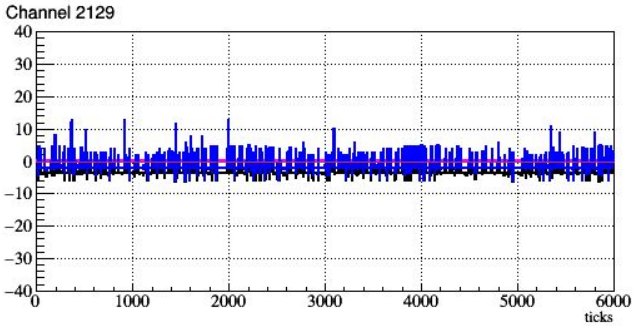


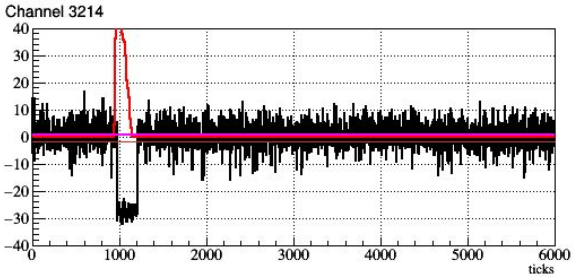


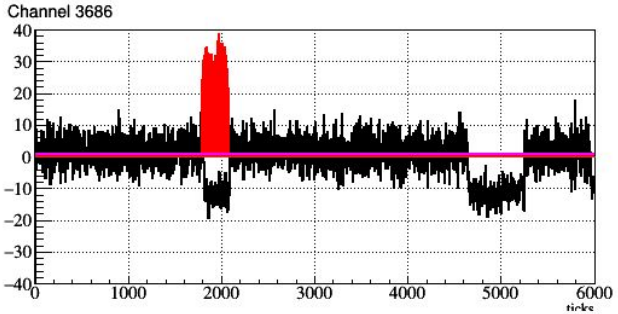


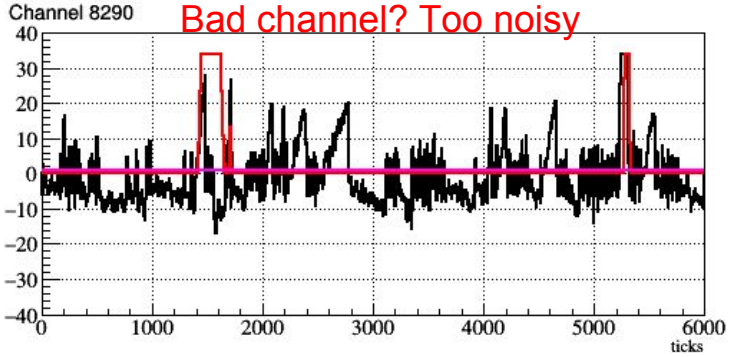


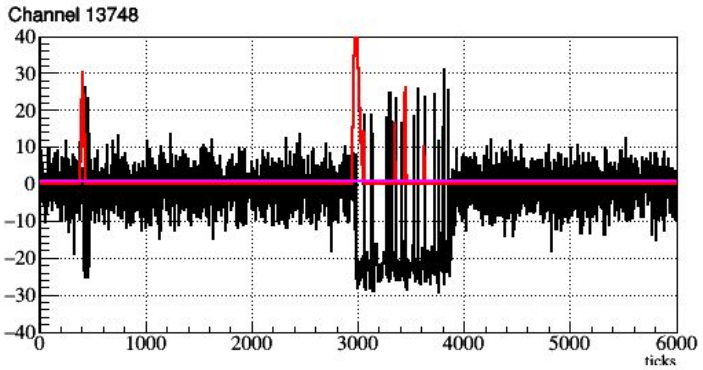

Channel 1368
40
30
20
10
0
−10
−20
−30
−40
0
1000
2000
3000
4000
5000
6000
ticks


Channel 2129
40
30
20
10
0
−10
−20
−30
−40
0
1000
2000
3000
4000
5000
6000
ticks


Channel 3214
40
30
20
10
0
−10
−20
−30
−40
0
1000
2000
3000
4000
5000
6000
ticks


Channel 3686
40
30
20
10
0
−10
−20
−30
−40
0
1000
2000
3000
4000
5000
6000
ticks


Channel 8290
Bad channel? Too noisy
40
30
20
10
0
−10
−20
−30
−40
0
1000
2000
3000
4000
5000
6000
ticks


Channel 13748
40
30
20
10
0
−10
−20
−30
−40
0
1000
2000
3000
4000
5000
6000
ticks

Summary

- The “bipolar” noise is significantly reduced after the HV module replacement (12/12/2018)
  - Although a few channels still have the problem (e.g. ch 14400)
- New bad/noisy channels were found in recent data
- Suggestions and comments are more than welcome

THANKS!