Procedure of ProtoDUNE Inactive FE channel Investigation

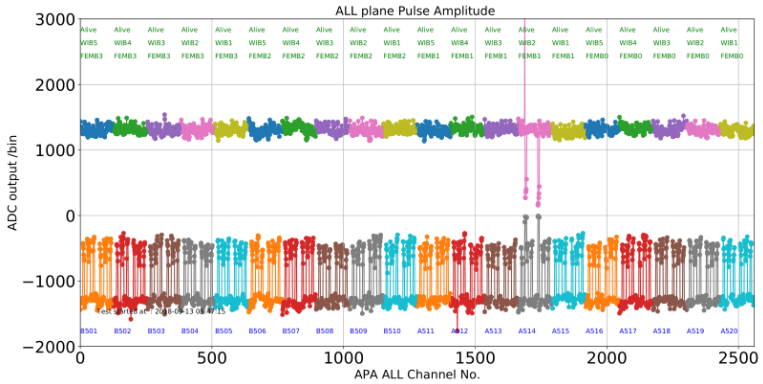
05/10/2020

Inactive FE channel observed during commissioning

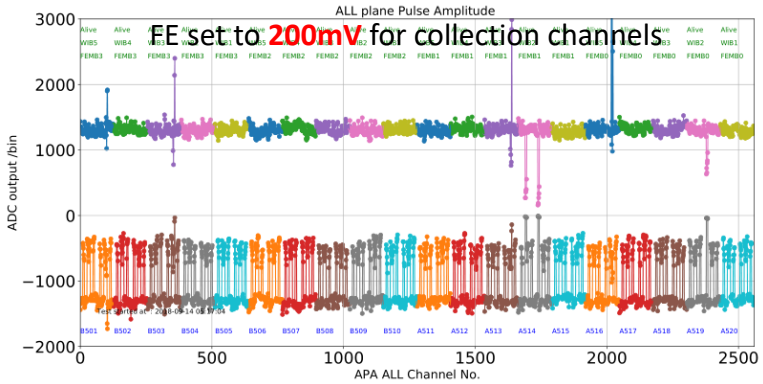
- 09/13/2018
  - No inactive FE channels
- 09/23/2018 after drift ramped up to 180kV
  - 4 inactive FE channels
- 12/17/2019
  - Total 6 inactive FE channels
- Confirmed by both DAQ data and CE local diagnostics

Observed by DAQ data		Observed by CE local diagnoistics									
David_dead_ch	david_dead_chn_loc	dead in 09/13/18	dead in 09/23/18	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
11842	femb120x03	no	Yes	A120	0	2	CEbox014	X03	30	140	20
4411	femb515x12	no	yes	A515	0	1	CEbox147	X12	53	140	20
4412	femb515x13	no	yes	A515	0	1	CEbox147	X13	15	140	20
10333	femb606x15	no	no	B606	4	2	CEbox133	X15	14	140	20
9260	femb601v21	no	no	B601	4	3	CEbox136	V21	73	140	20
9990	femb605x10	no	yes	B605	0	3	CEbox119	X10	52	140	20

Two channels on APA5 became inactive after drift ramped up to 180kV on 09/23/2018

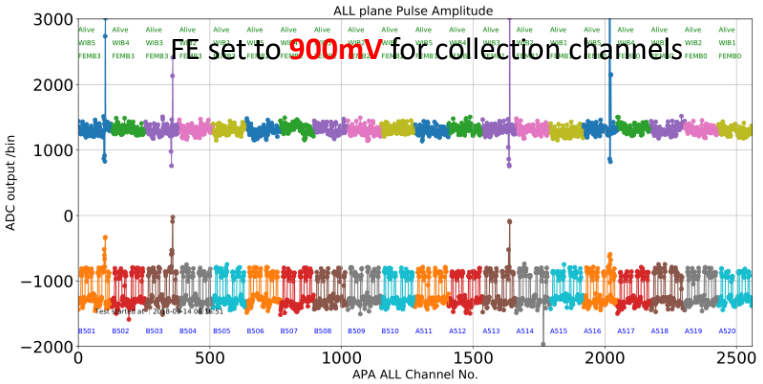


09/13 (run04chk)
Drift off, bias off, **LEDs off,** PD on, Cameras on



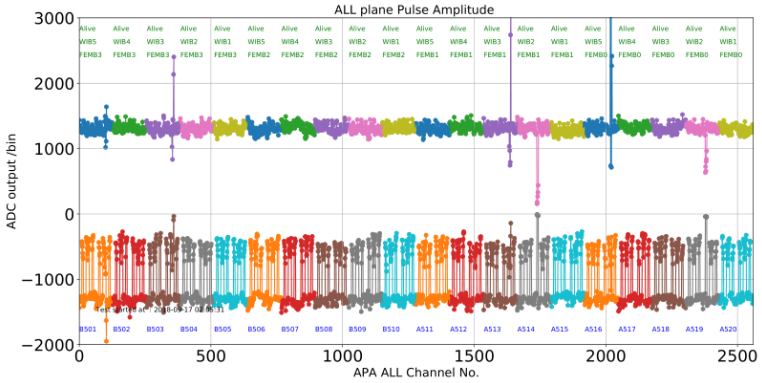
FE set to **200mV** for collection channels

09/14 (run01chk) **Drift = 120kV, nominal bias on**,
LEDs on, PD on, Cameras on

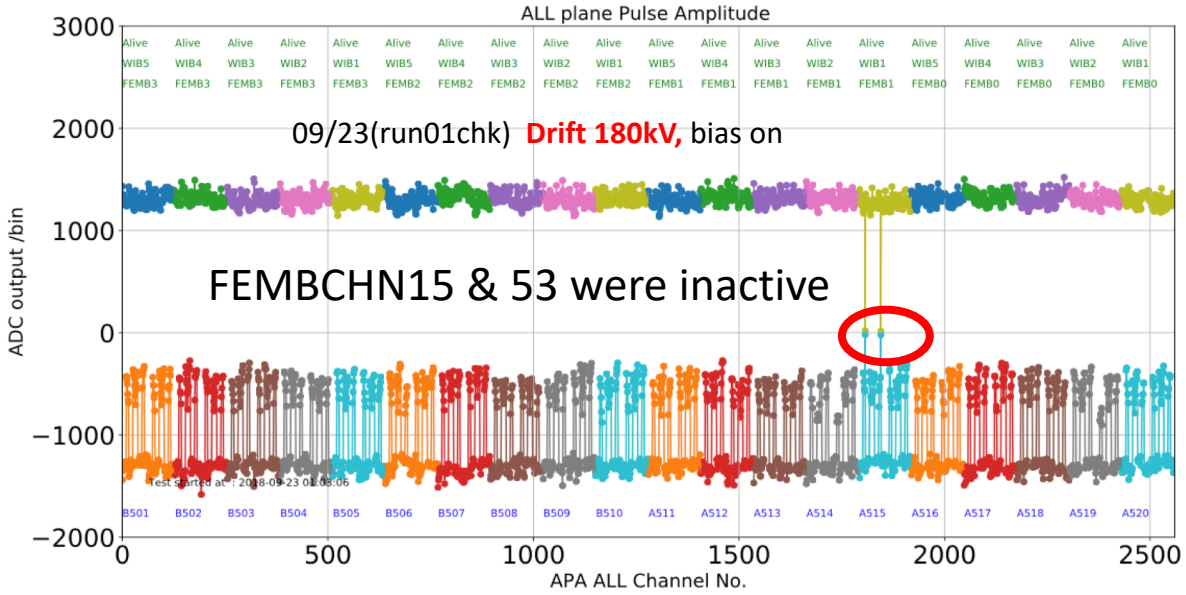


FE set to **900mV** for collection channels

09/14 (run01chk) **Drift = 120kV, nominal bias on**,
LEDs on, PD on, Cameras on



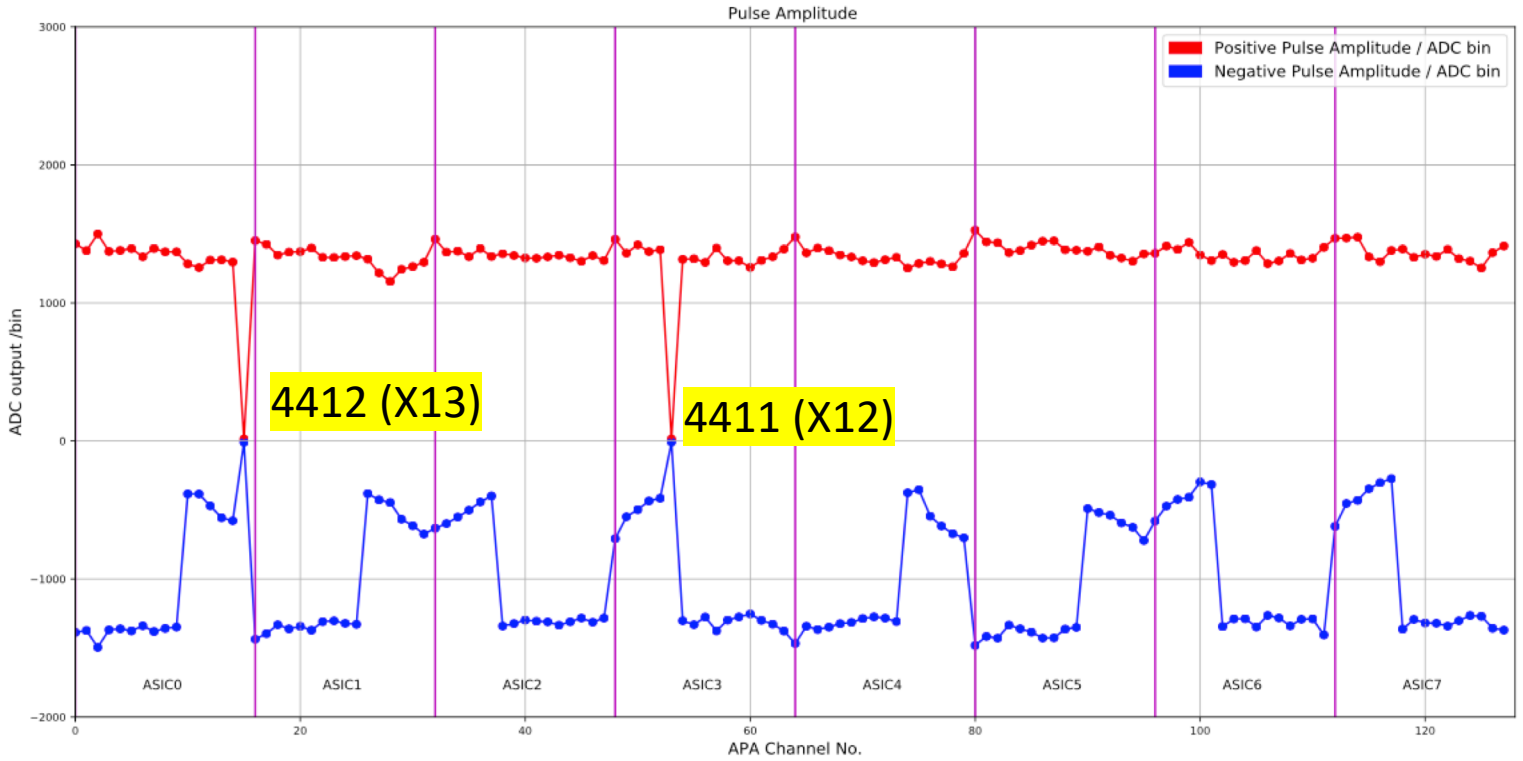
09/17 (run01chk)
Drift OFF, bias off, LEDs off, PD on, Cameras on

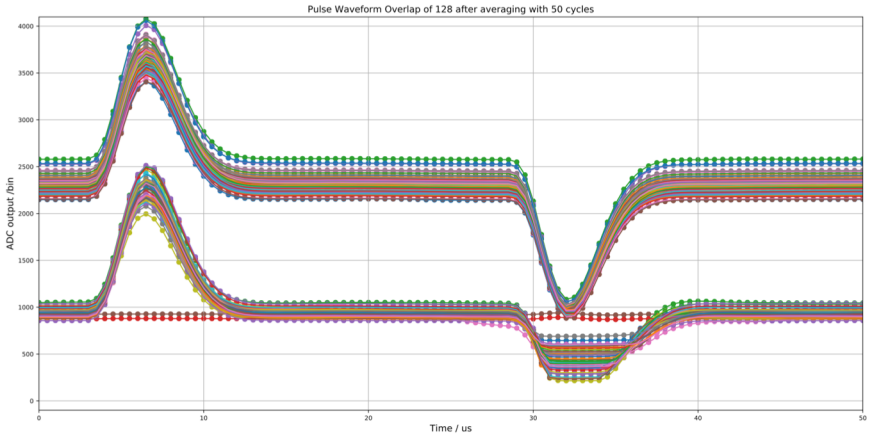


Test Result of Crate 5(1-6) WIB0(0-4) FEMB1(0-3)

- Two bad channels on FEMB1 observed by ADC on board

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
4411	femb515x12	yes	A515	0	1	CEbox147	X12	53	140	20
4412	femb515x13	yes	A515	0	1	CEbox147	X13	15	140	20

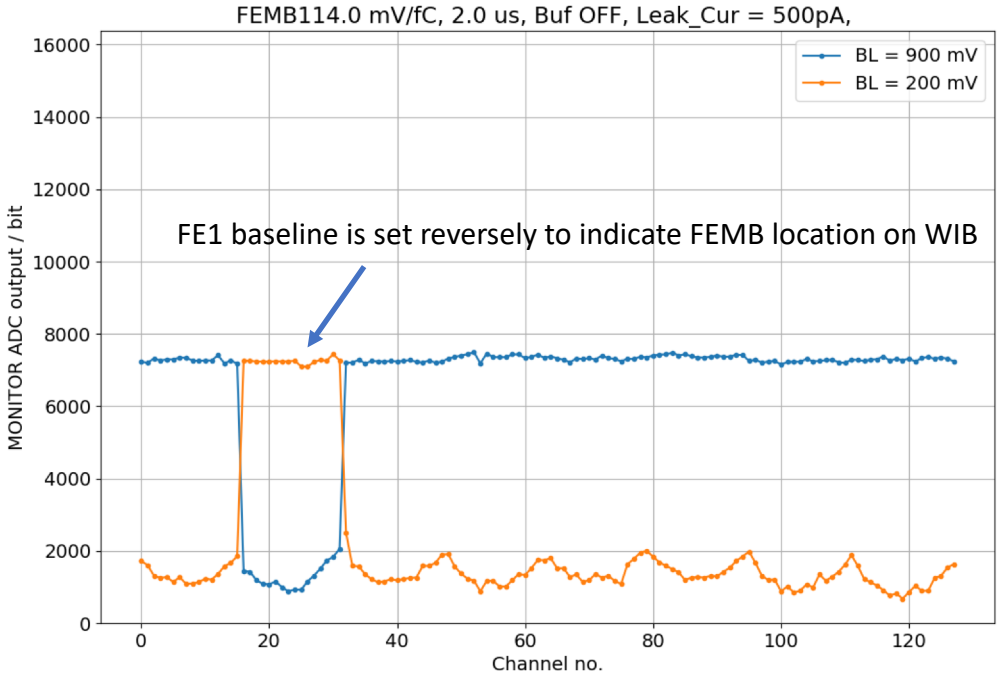




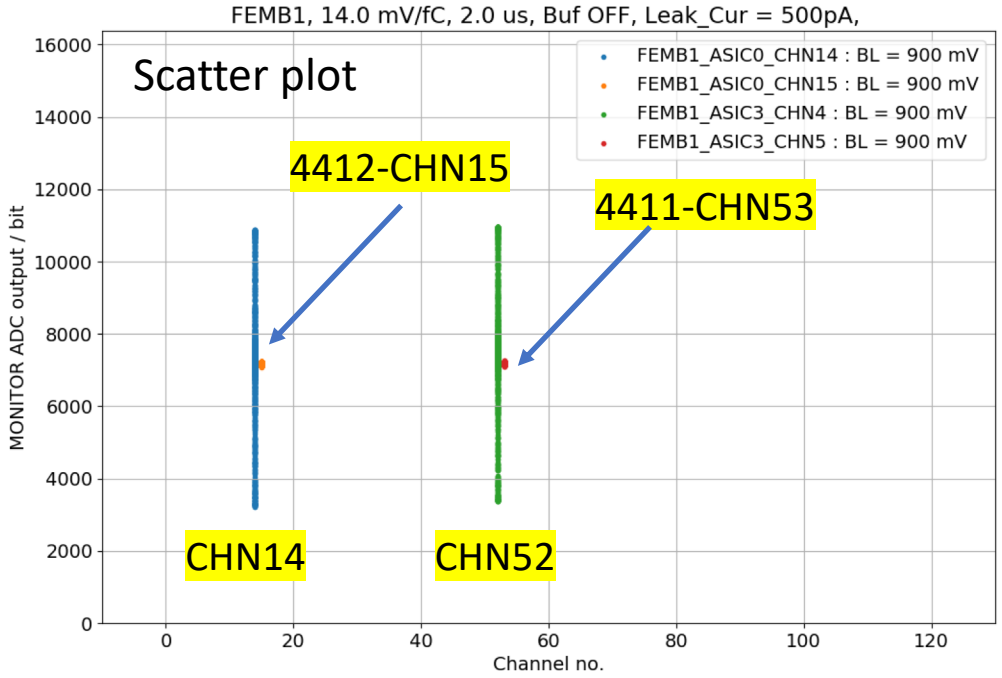
Test Result of Crate 5(1-6) WIB0(0-4) FEMB1(0-3) : 4412

- Confirmed by monitoring

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
4411	femb515x12	yes	A515	0	1	CEbox147	X12	53	140	20
4412	femb515x13	yes	A515	0	1	CEbox147	X13	15	140	20



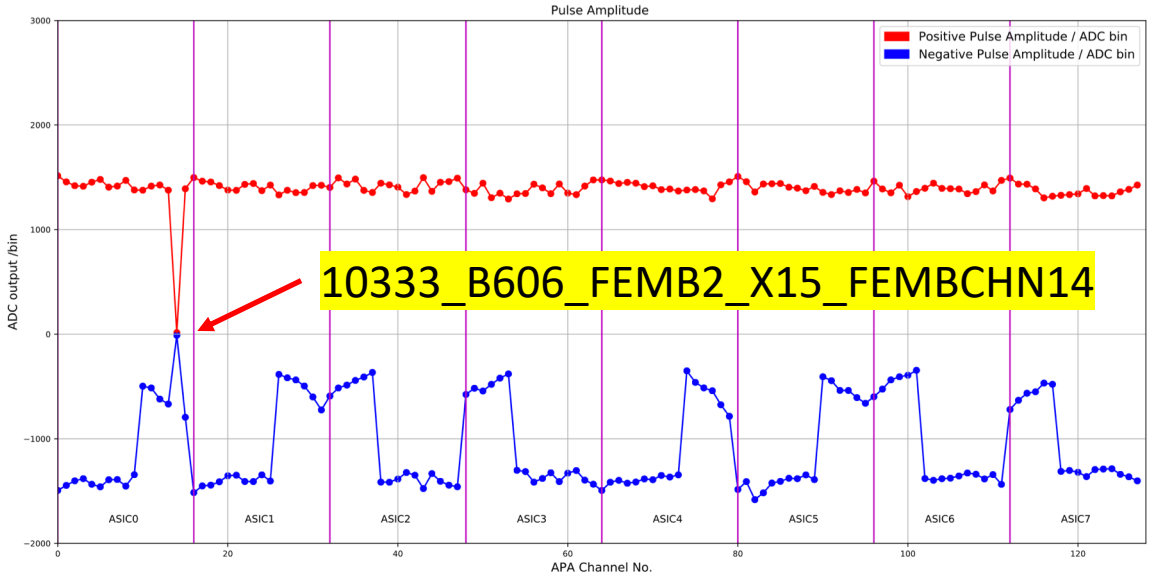
No abnormal baseline was observed

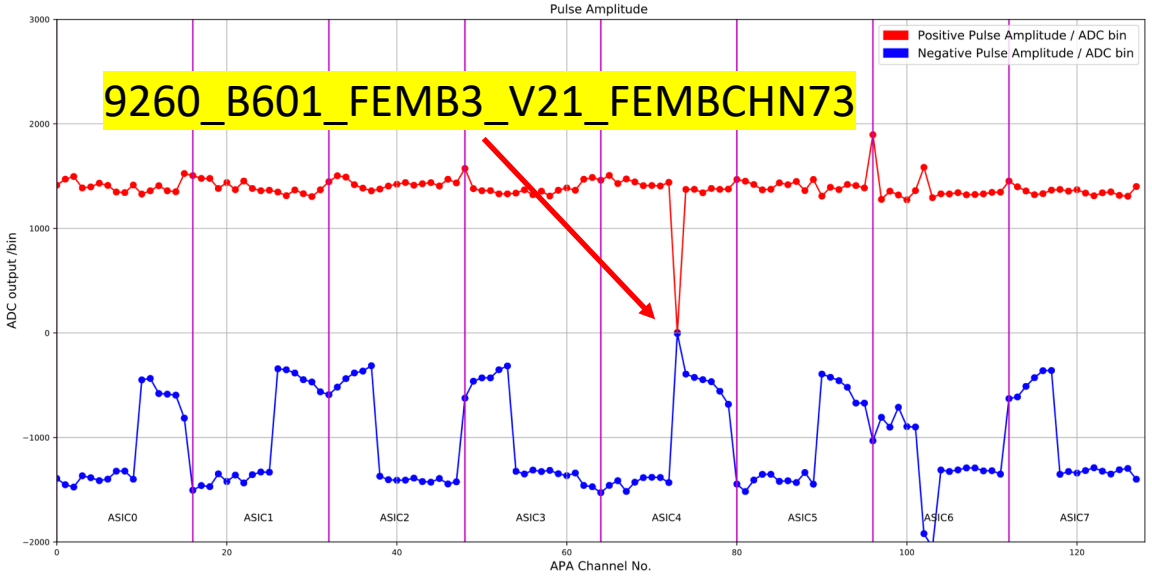


Note: Monitoring ADC on WIB currently doesn't support continuous data. 10,000 samples are taken randomly while FEMB is in ASIC-DAC calibration mode. If a channel is alive (responds to the pulses), the monitoring ADC output scatters in a wide range, as shown in CHN14 and CHN52.

Test Result of Crate 6(1-6) WIB4(0-4)

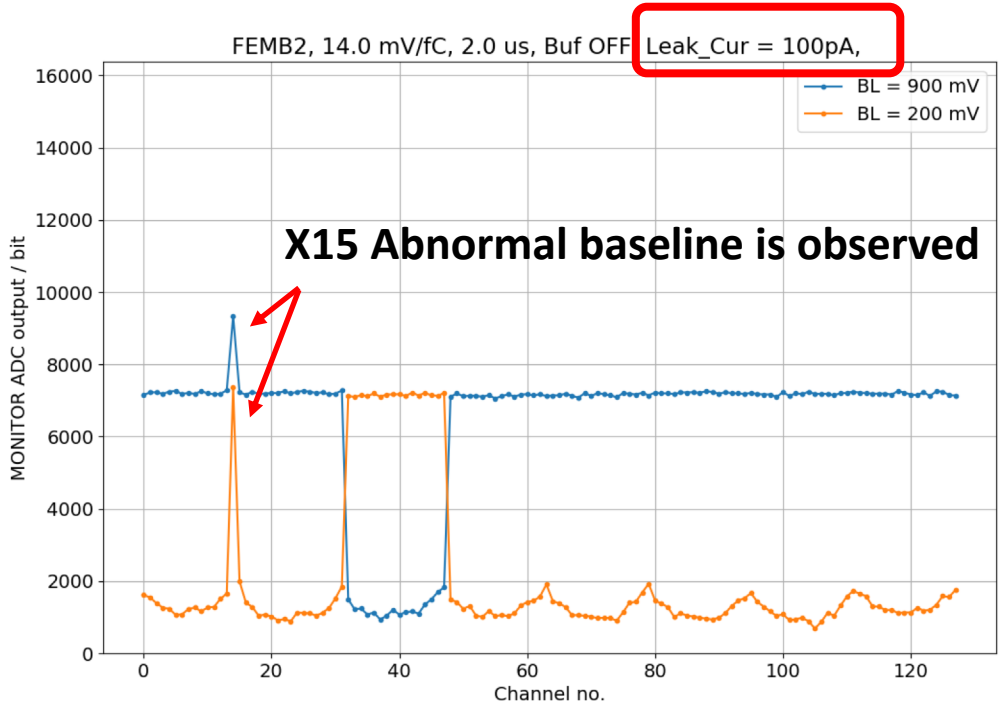
Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
10333	femb606x15	no	B606	4	2	CEbox133	X15	14	140	20
9260	femb601v21	no	B601	4	3	CEbox136	V21	73	140	20

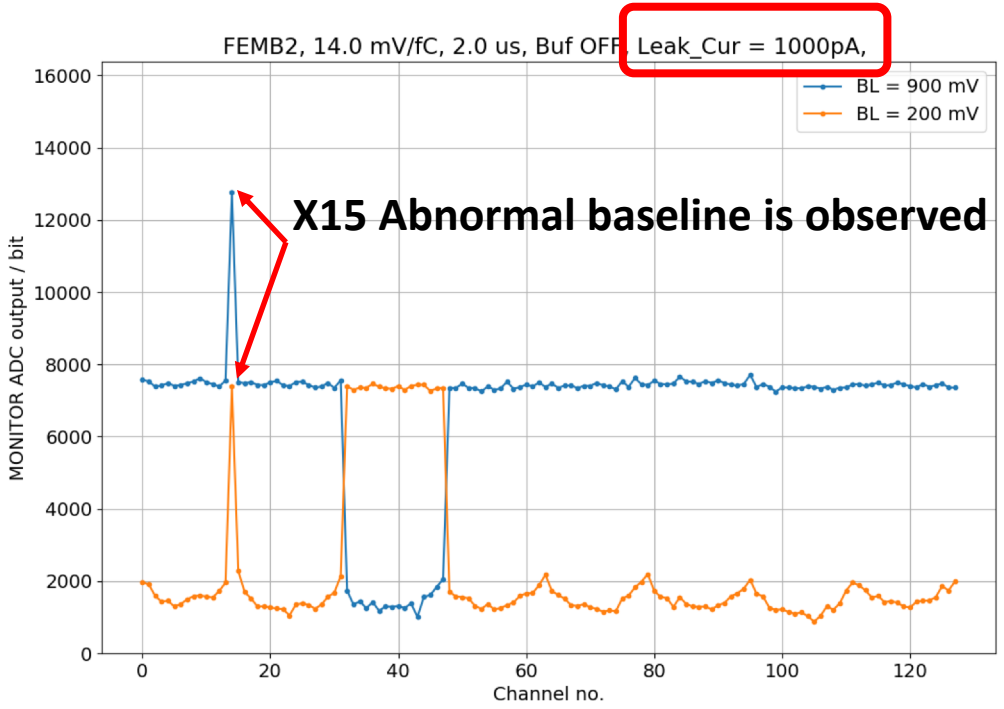




Test Result of Crate 6(1-6) WIB4(0-4): 10333

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
10333	femb606x15	no	B606	4	2	CEbox133	X15	14	140	20



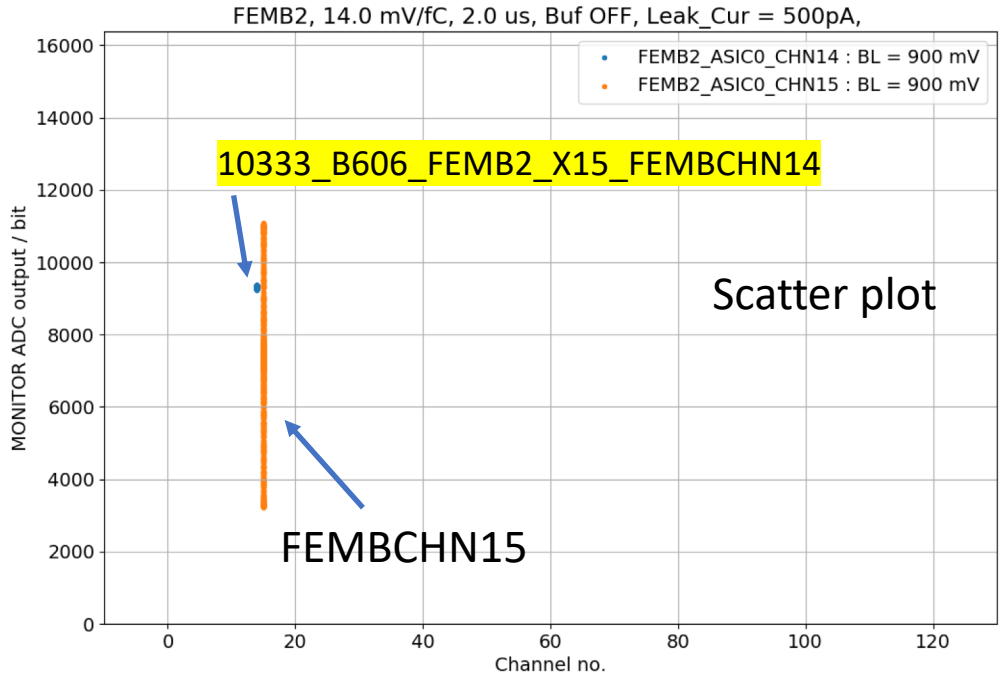


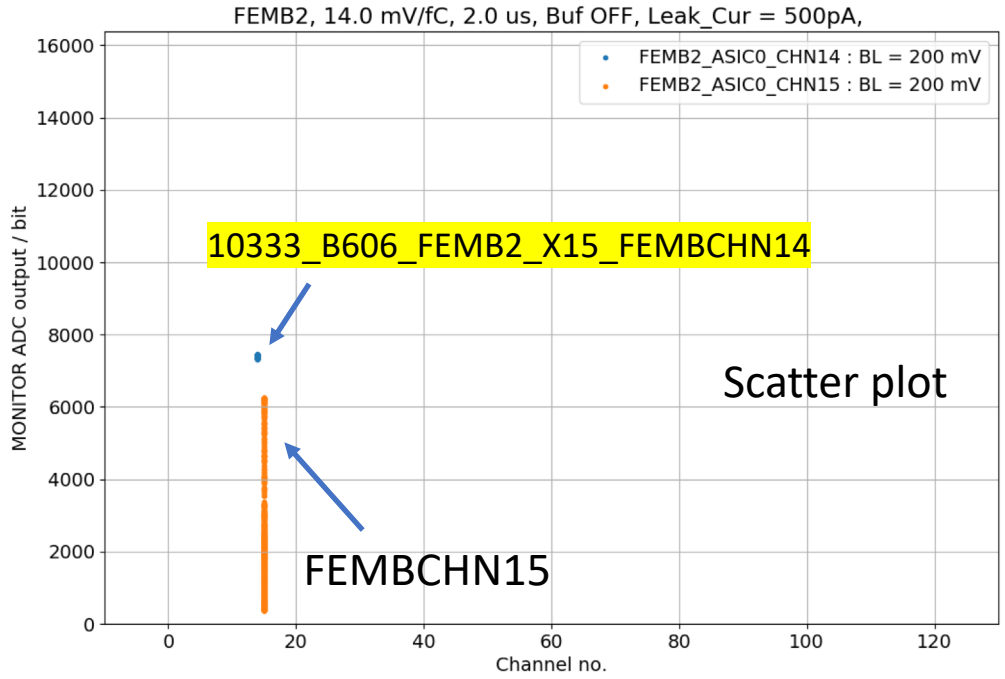
Note: FE2 baseline is set reversely to indicate FEMB location on WIB

Test Result of Crate 6(1-6) WIB4(0-4): 10333

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
10333	femb606x15	no	B606	4	2	CEbox133	X15	14	140	20

Confirmed that inactive channel “10333_B606_FEMB2_X15_FEMBCHN14” is caused by dysfunctional FE channel



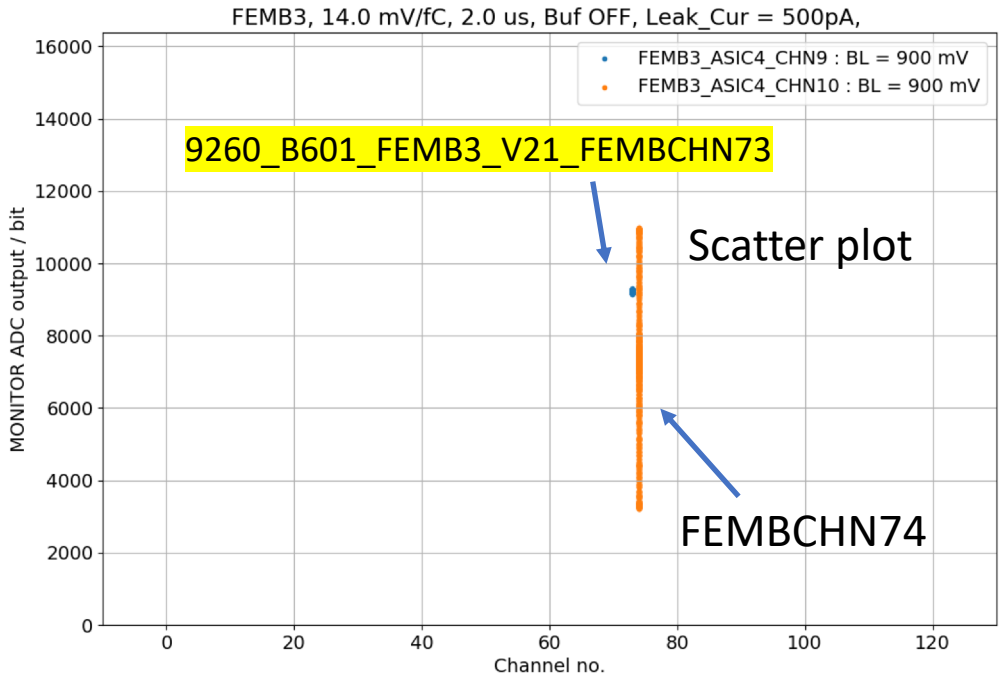


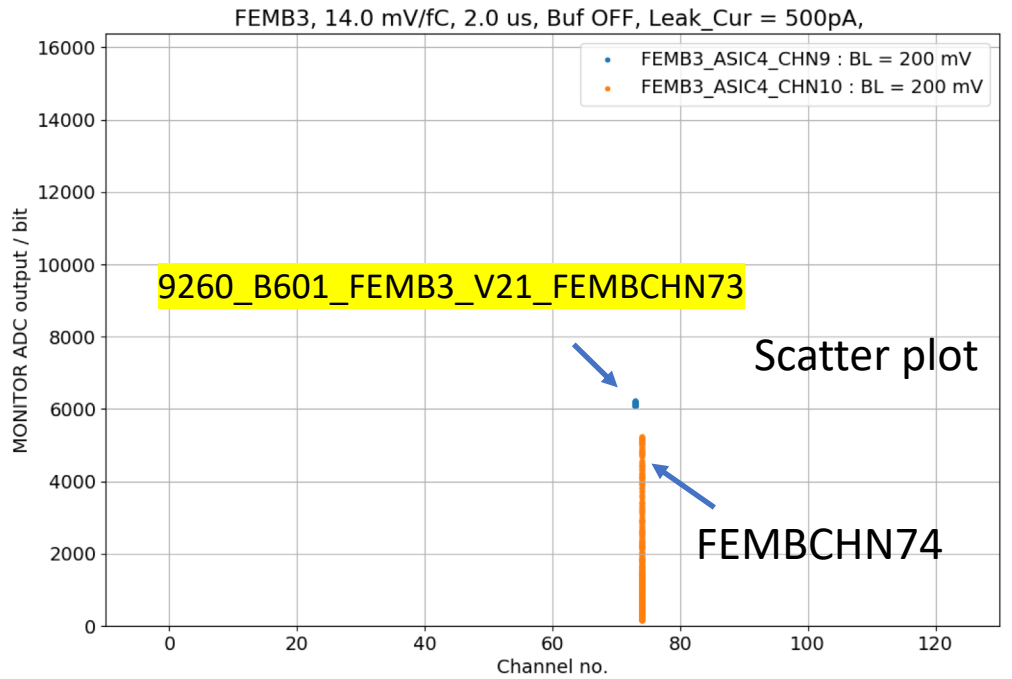
Note: Monitoring ADC on WIB currently doesn’t support continuous data. 10,000 samples are taken randomly while FEMB is in ASIC-DAC calibration mode. If a channel is alive (responds to the pulses), the monitoring ADC output scatters in a wide range, as shown in CHN15.

Test Result of Crate 6(1-6) WIB4(0-4): 9260

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
9260	femb601v21	no	B601	4	3	CEbox136	V21	73	140	20

Confirmed that inactive channel “9260_B601_FEMB3_V21_FEMBCHN73” is caused by dysfunctional FE channel

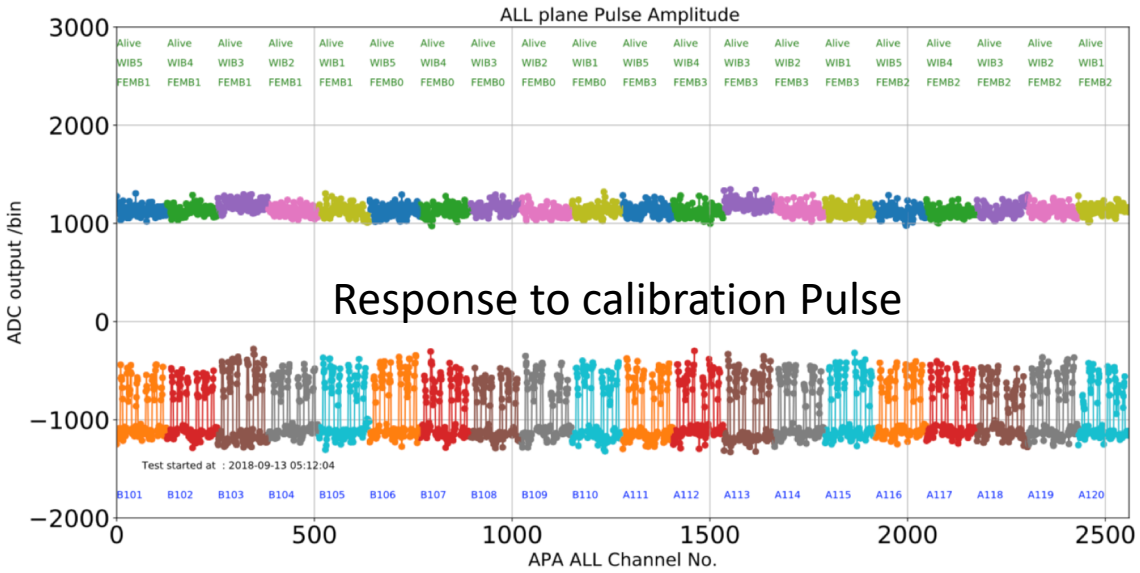




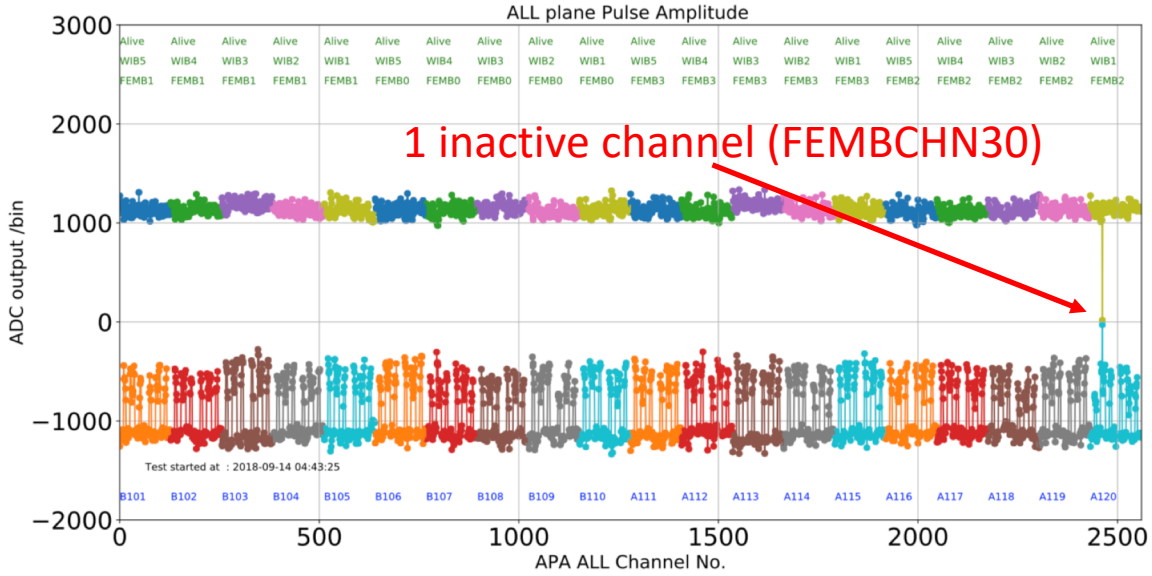
Note: Monitoring ADC on WIB currently doesn’t support continuous data. 10,000 samples are taken randomly while FEMB is in ASIC-DAC calibration mode. If a channel is alive (responds to the pulses), the monitoring ADC output scatters in a wide range, as shown in CHN74 .

CH 11842 was confirmed inactive after ramped up drift to 120kV

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
11842	femb120x03	Yes	A120	0	2	CEbox014	X03	30	140	20



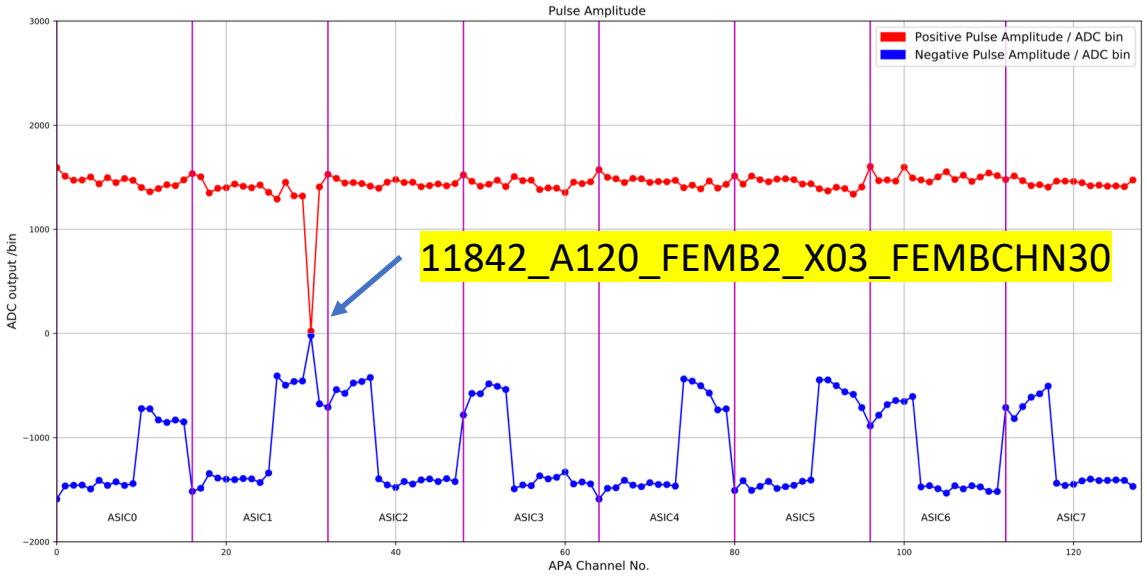
APA1 (2018-09-13 05:12:04, HV off, bias off)



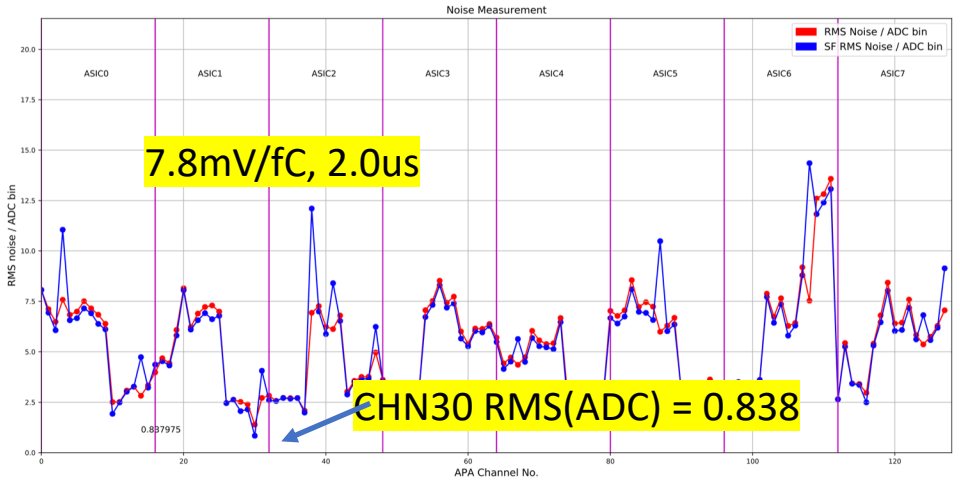
2018-09-14 04:43:25 (HV = 120kV)

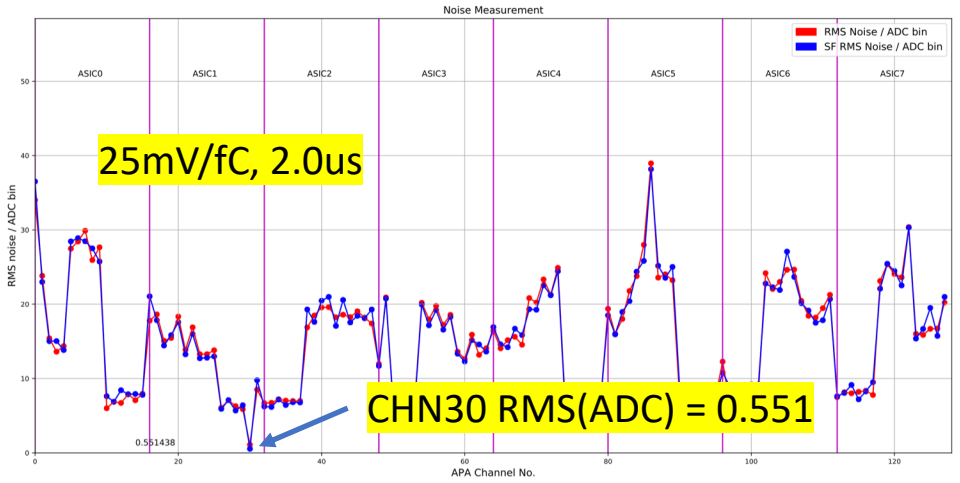
Test Result of Crate 1(1-6) WIB0(0-4)

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
11842	femb120x03	Yes	A120	0	2	CEbox014	X03	30	140	20



Inactive channel observed by P1 ADC

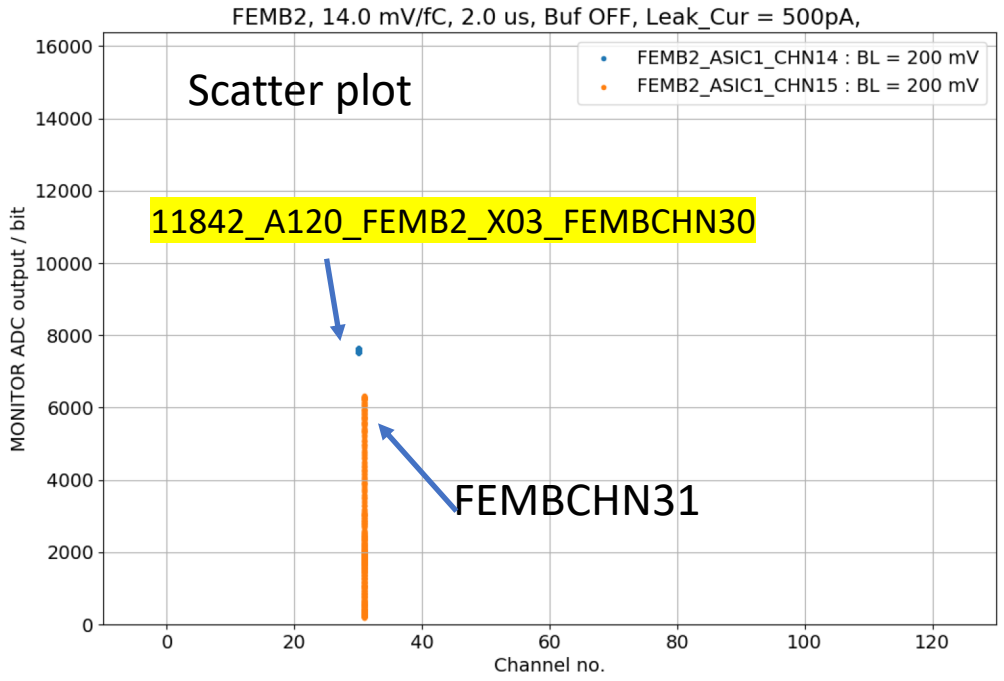


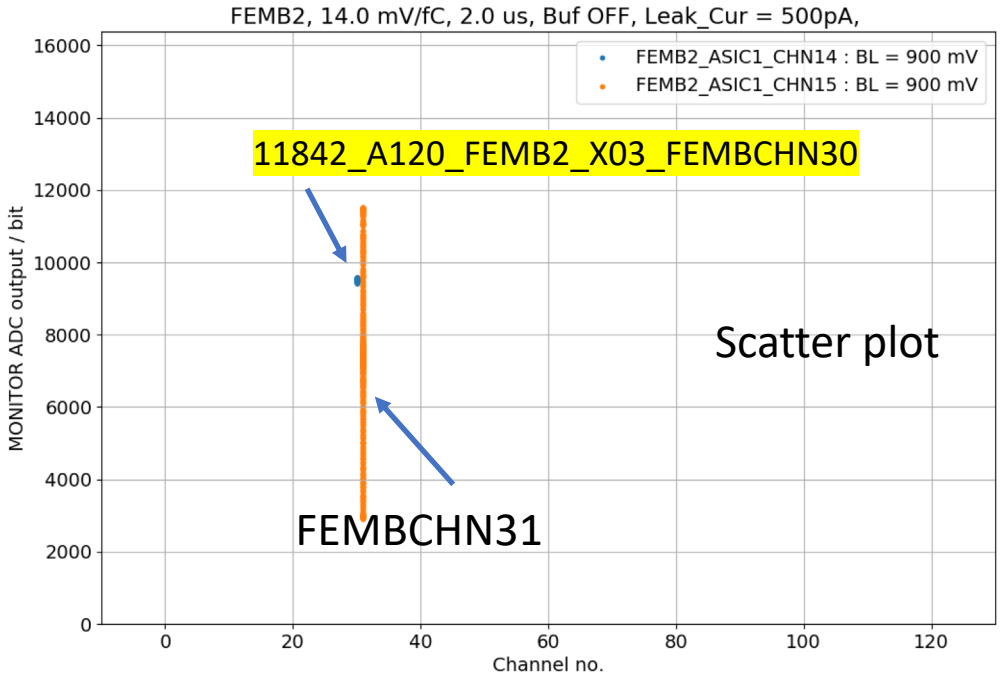


Test Result of Crate 1(1-6) WIB0(0-4): 11842

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
11842	femb120x03	Yes	A120	0	2	CEbox014	X03	30	140	20

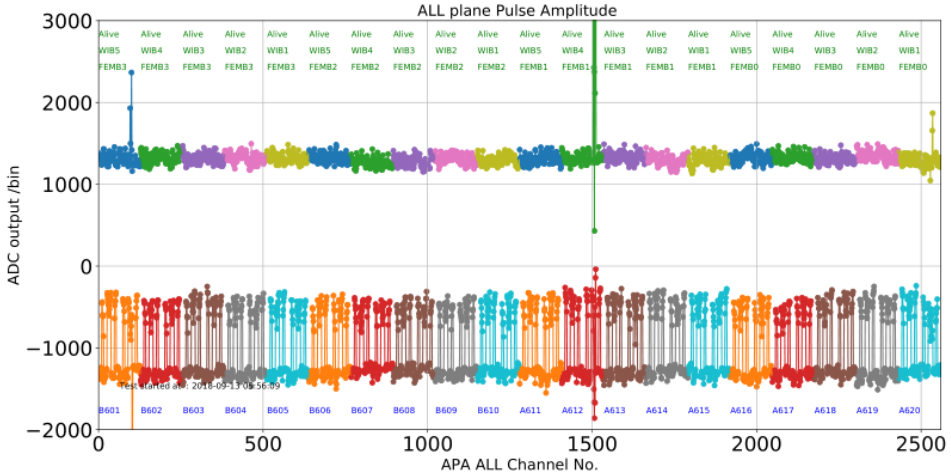
Confirmed that inactive channel "11842_A120_FEMB2_X03_FEMBCHN30" is caused by dysfunctional FE channel





Note: Monitoring ADC on WIB currently doesn't support continuous data. 10,000 samples are taken randomly while FEMB is in ASIC-DAC calibration mode. If a channel is alive (responds to the pulses), the monitoring ADC output scatters in a wide range, as shown in CHN31.

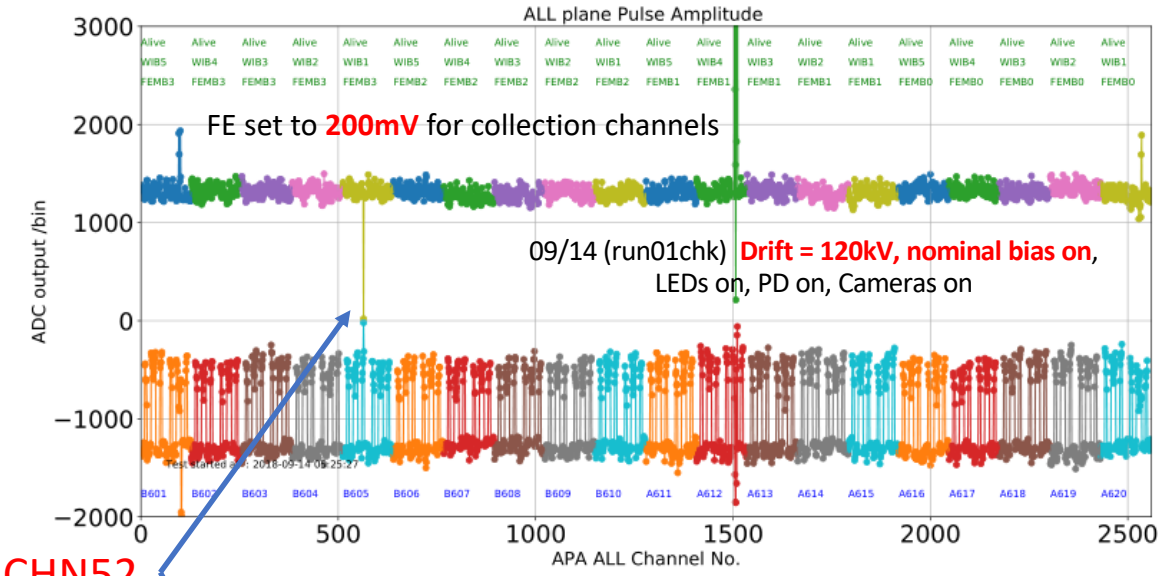
CH 9990 was confirmed inactive after ramped up drift to 120kV

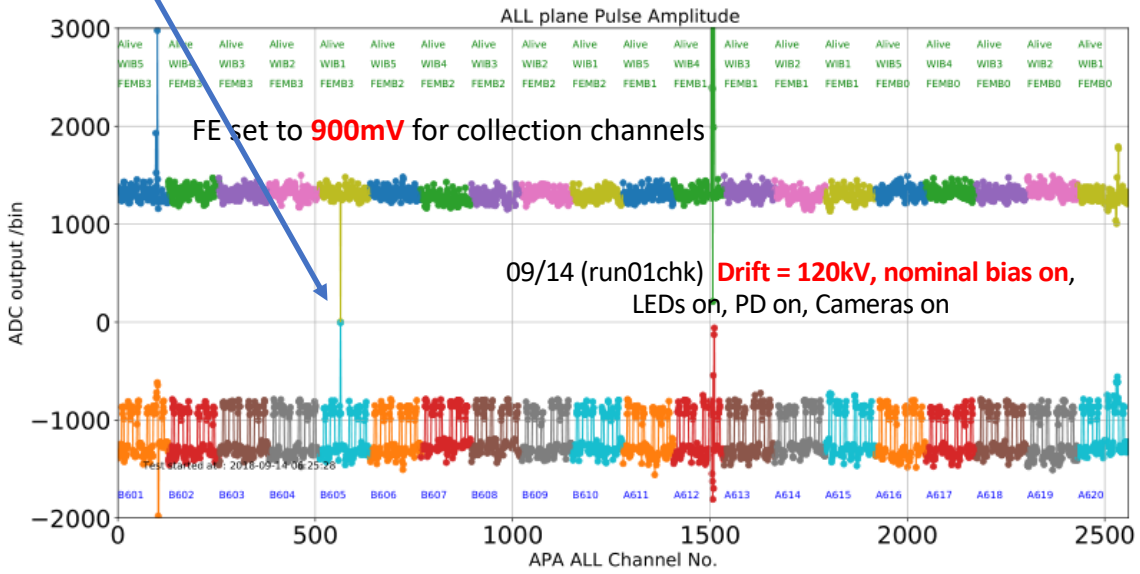


09/13 (run04chk)
Drift off, bias off, **LEDs off,** PD on, Cameras on

An inactive Channel appeared after cathode ramped up to 120kV. It is unrecoverable.

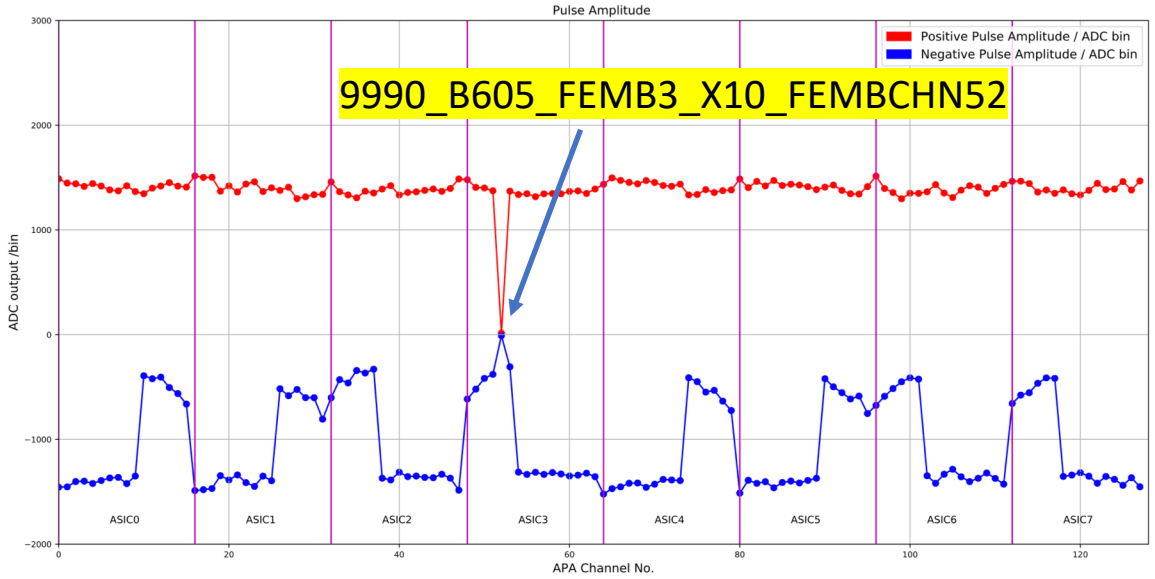
FEMBCHN52



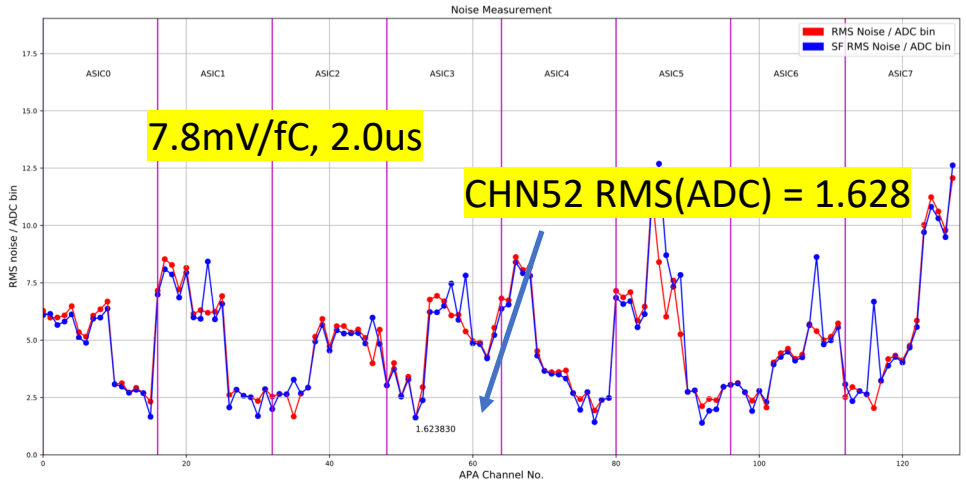


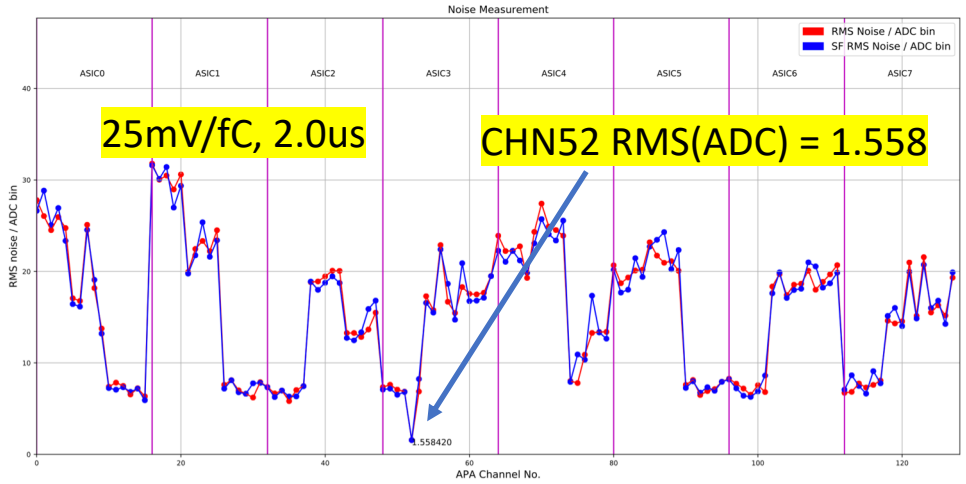
Test Result of Crate 6(1-6) WIB0(0-4)

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
9990	femb605x10	yes	B605	0	3	CEbox119	X10	52	140	20



Inactive channel observed by P1 ADC

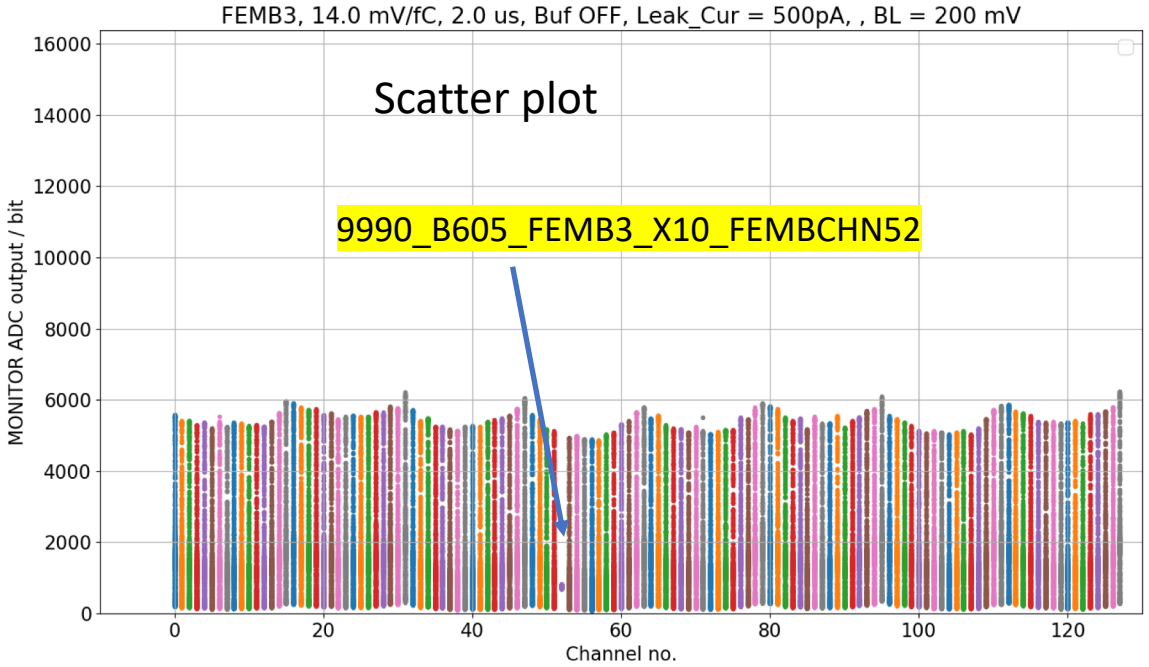


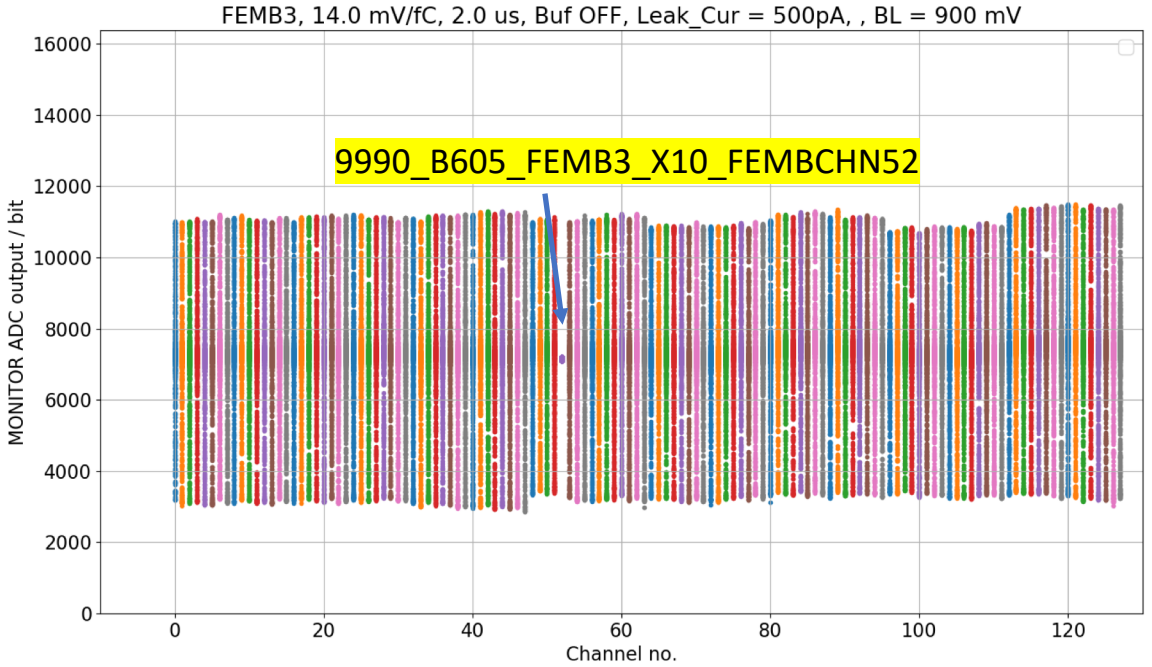


Test Result of Crate 1(1-6) WIB0(0-4): 9990

Observed by DAQ data		Observed by CE local diagnoistics								
David_dead_ch	david_dead_chn_loc	dead in 09/23	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
9990	femb605x10	yes	B605	0	3	CEbox119	X10	52	140	20

Confirmed that inactive channel "9990_B605_FEMB3_X10_FEMBCHN52" is caused by dysfunctional FE channel





Note: Monitoring ADC on WIB currently doesn't support continuous data. 10,000 samples are taken randomly while FEMB is in ASIC-DAC calibration mode. If a channel is alive (responds to the pulses), the monitoring ADC output scatters in a wide range, as shown in other channels.

Summary

Observed by DAQ data		Observed by CE local diagnoistics									
David_dead_ch	david_dead_chn_loc	dead in 09/13/18	dead in 09/23/18	apaloc	wib	femb	cebox	wire	fembchn	gain	tp
11842	femb120x03	no	Yes	A120	0	2	CEbox014	X03	30	140	20
4411	femb515x12	no	yes	A515	0	1	CEbox147	X12	53	140	20
4412	femb515x13	no	yes	A515	0	1	CEbox147	X13	15	140	20
10333	femb606x15	no	no	B606	4	2	CEbox133	X15	14	140	20
9260	femb601v21	no	no	B601	4	3	CEbox136	V21	73	140	20
9990	femb605x10	no	yes	B605	0	3	CEbox119	X10	52	140	20

- 6 channels have been damaged during detector operation. Causes are still unknown, there will be more investigations in the next weeks for trying to reconstruct what happened during those days.

- Inoperative CE channels are now confirmed in the FE by bypassing the P1 ADC with the FE ASIC monitoring output.

- Many thanks to Francesco and Serhan for coordinating the test and moving the special WIB between APAs.