

Firmware Update

29/03/2017

First Shift

15/06/2017

Data taken on shift

- Confirmed can trigger kicker amplifier and kick the beam.
- Trouble with acquisition rate of data ~10 times slower (subsequently fixed by Doug) so limited the amount of data we could take.
- Kicker scan and gain calculation.
- Data taken with single sample, integration window of 10 and of 15.
- Data all taken at 10dB.

User Errors

- One of the two gains in the wrong place.
 - Should have been non zero gains in K1P2, K1P3 but was K1P2, K2P2.
 - Correlation between two signals that were switched: 79%
- Should have redone the kicker scan with integration window set to 10 to account for different signal droop (DAC values set time depends on sample integration window).

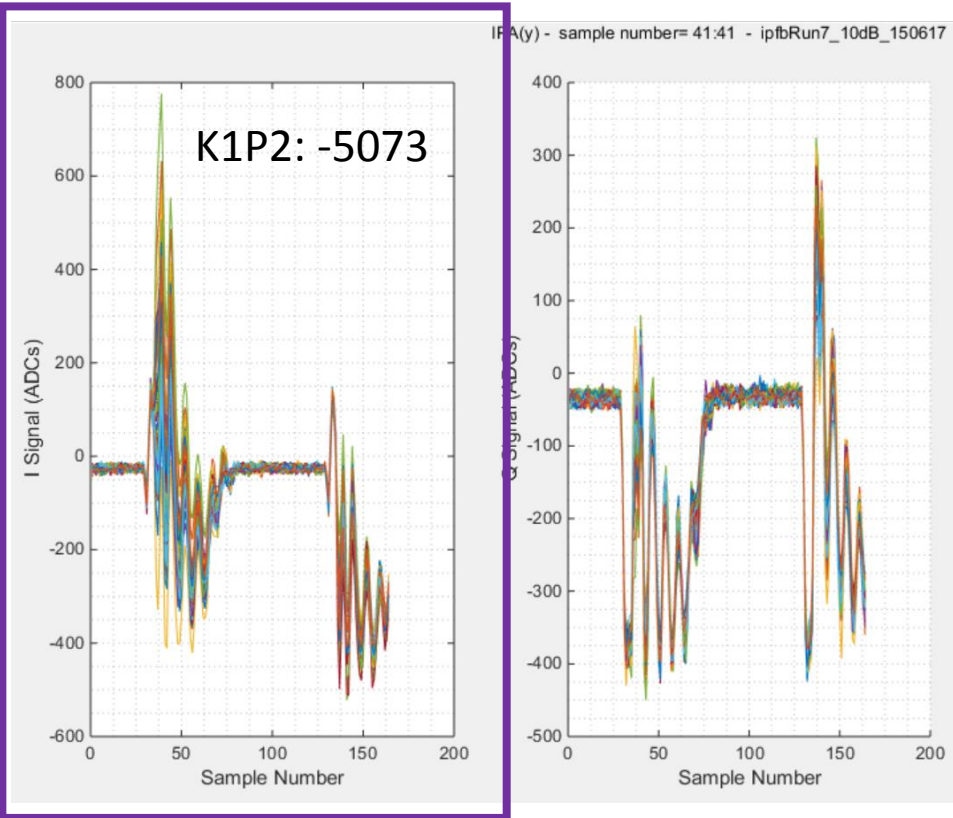
Waveforms from single sample correction

Waveforms from ipfbRun7 (15/06/2017). Feedback incorrectly performed using AI and BI.

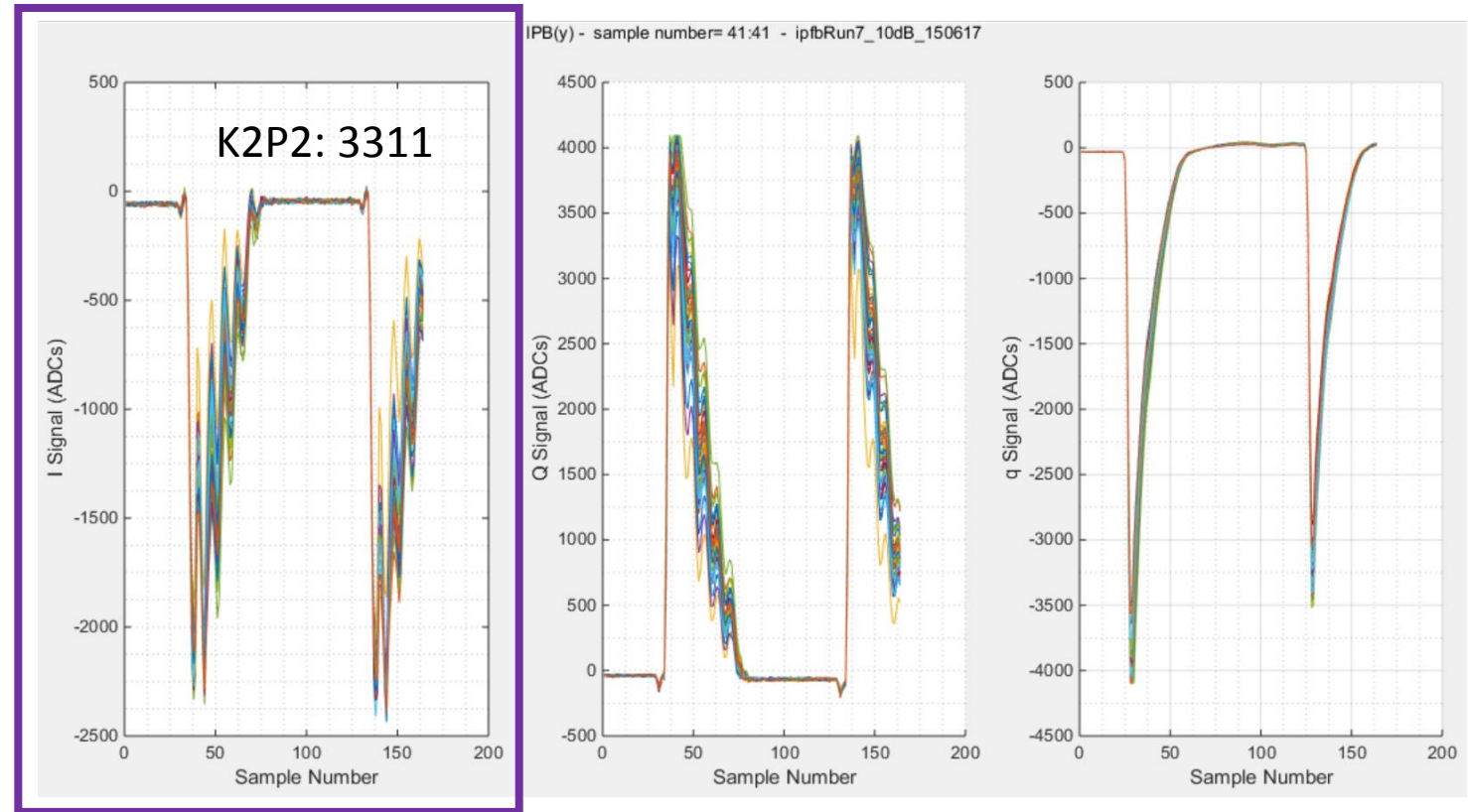
K1P2 -5073, K2P2 3311.

BI and BQ signals very large – we were just focussing on centring in IPA.

IPA (I and Q)



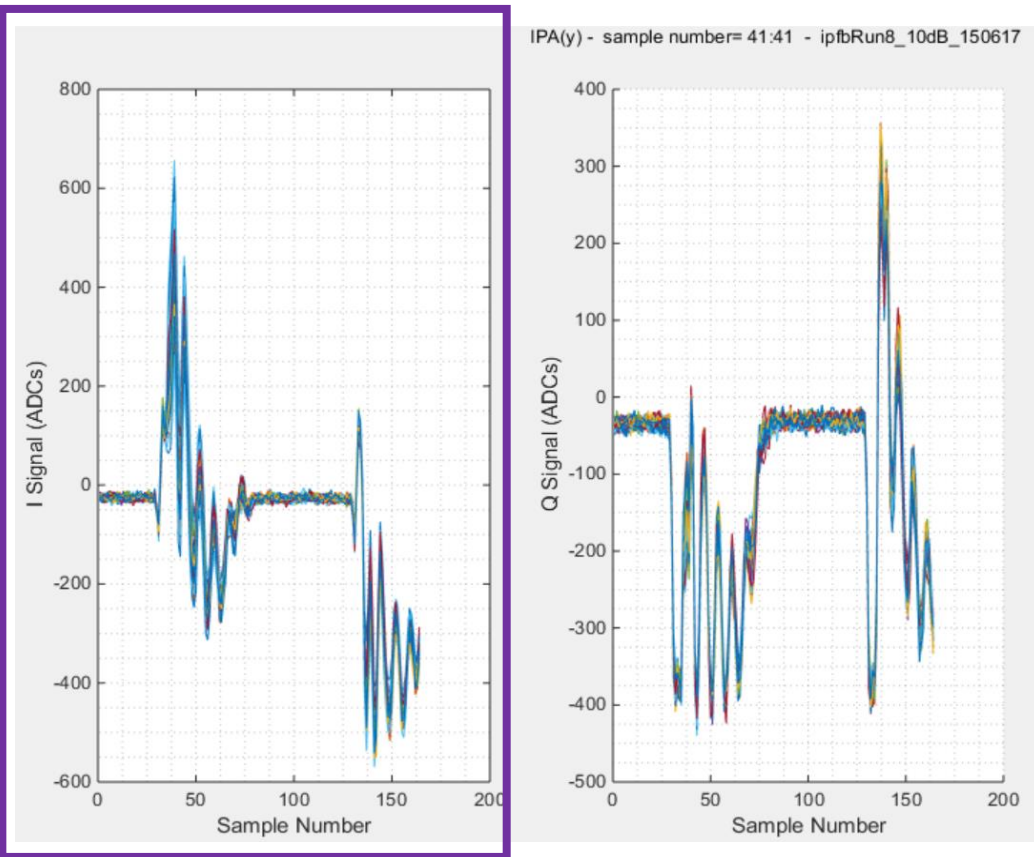
IPB (I and Q) and q



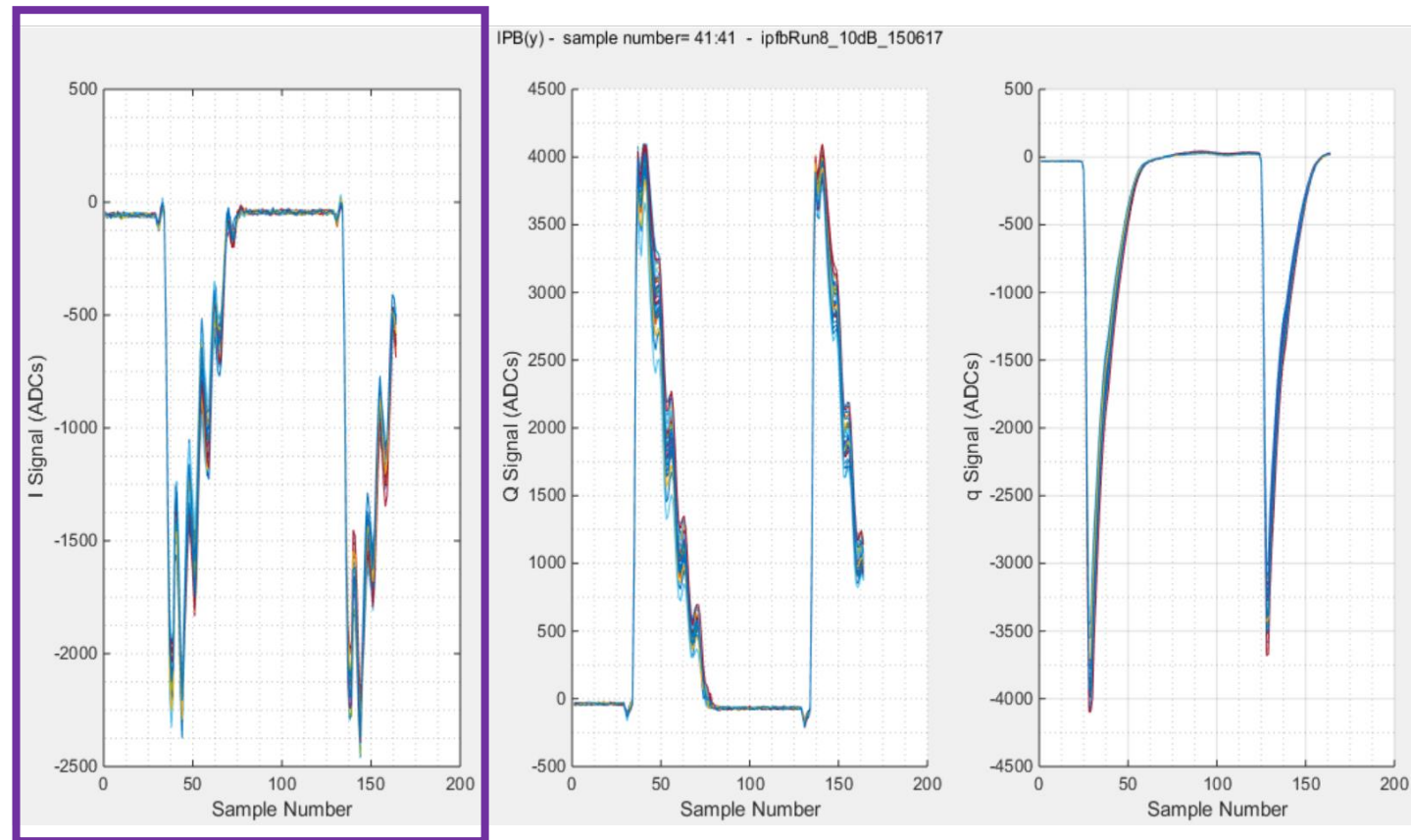
ipfbRun8

Waveforms from ipfbRun7 (15/06/2017). Feedback incorrectly performed using AI and BI.

IPA (I and Q)



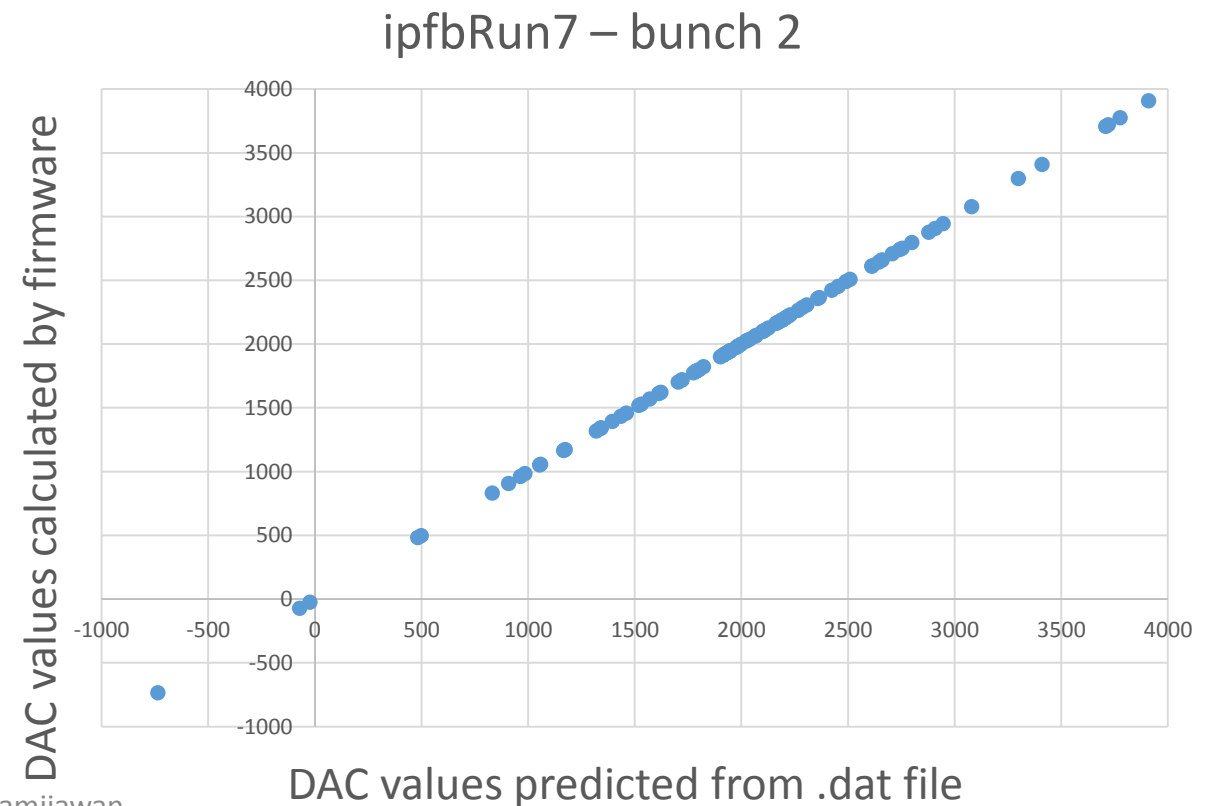
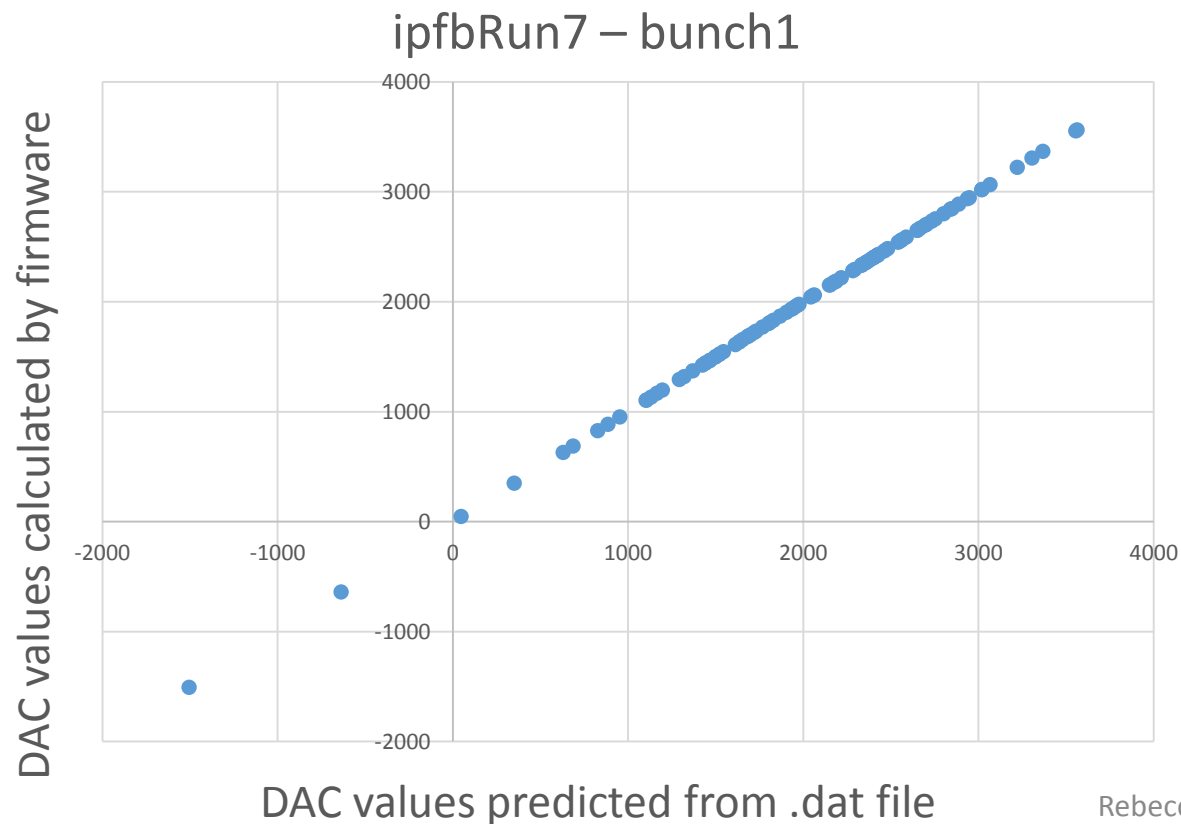
IPB (I and Q) and q



Rebecca Ramjiawan

Correct Calculation Performed by Firmware

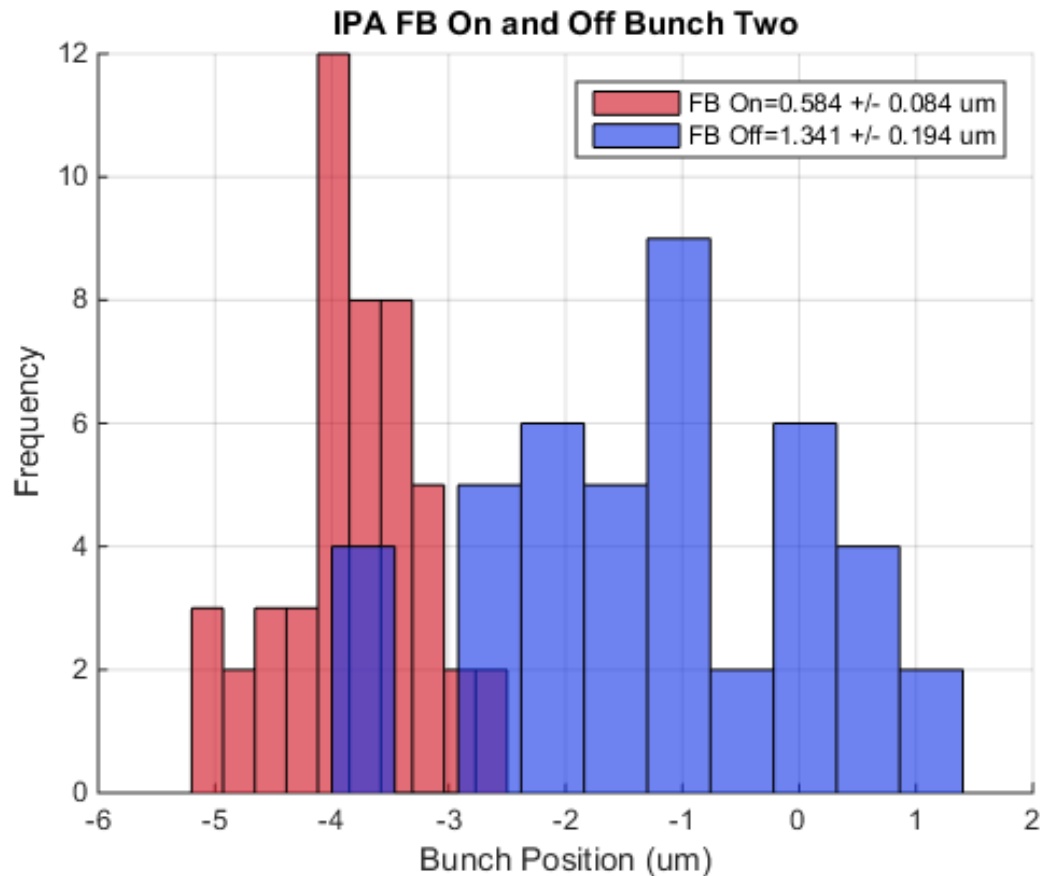
- Manually calculated DAC values (from 9 channels of data) given the sample locations and incorrect gain settings used during the shift.
- Shows 100% correlation with .dac file. (Largest deviation from expected value 1.7 DAC counts – from rounding errors).



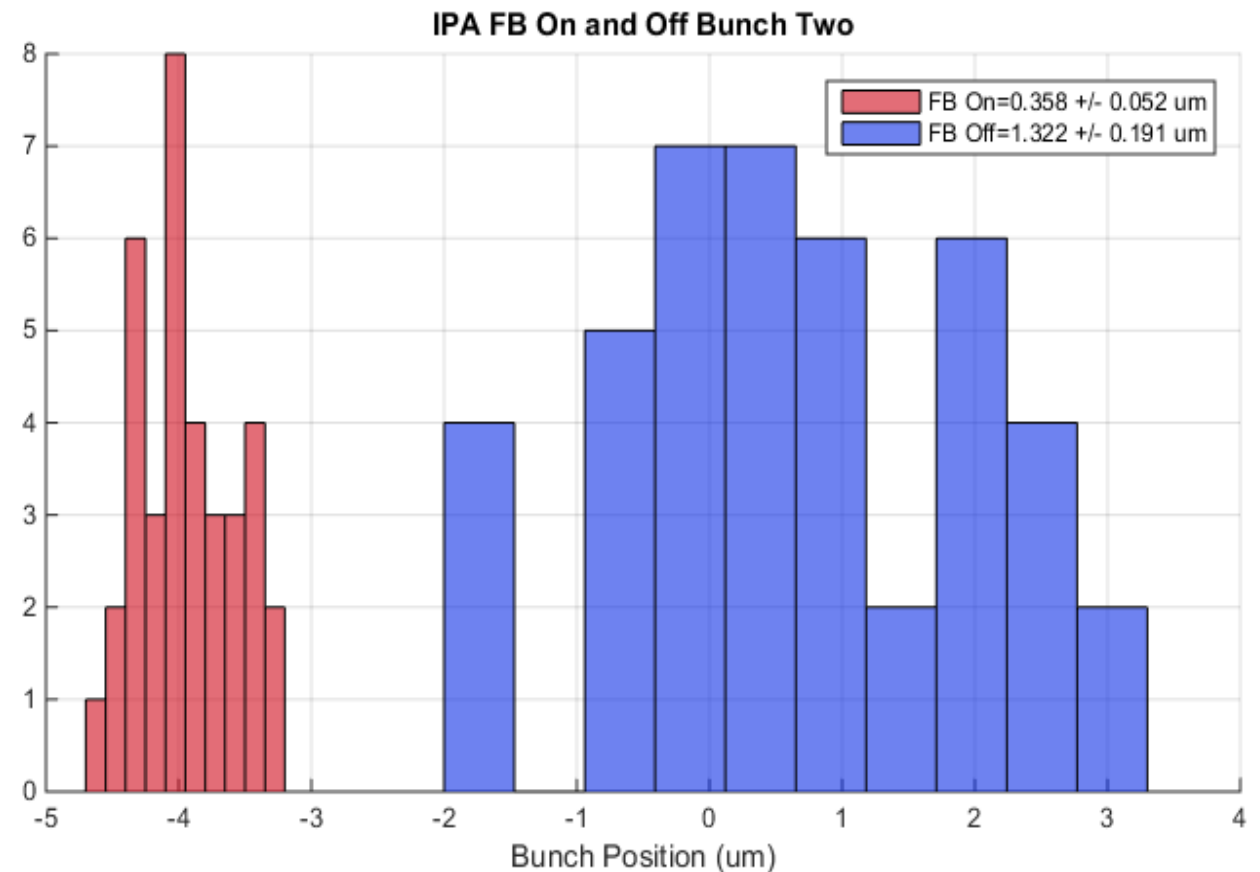
Performance on first shift

- Owl shift 15/06/2017
- ipfbRun7 (single sample), ipfbRun8 (integrated 10 samples), jitRun3 (fb off).

Feedback using a single sample



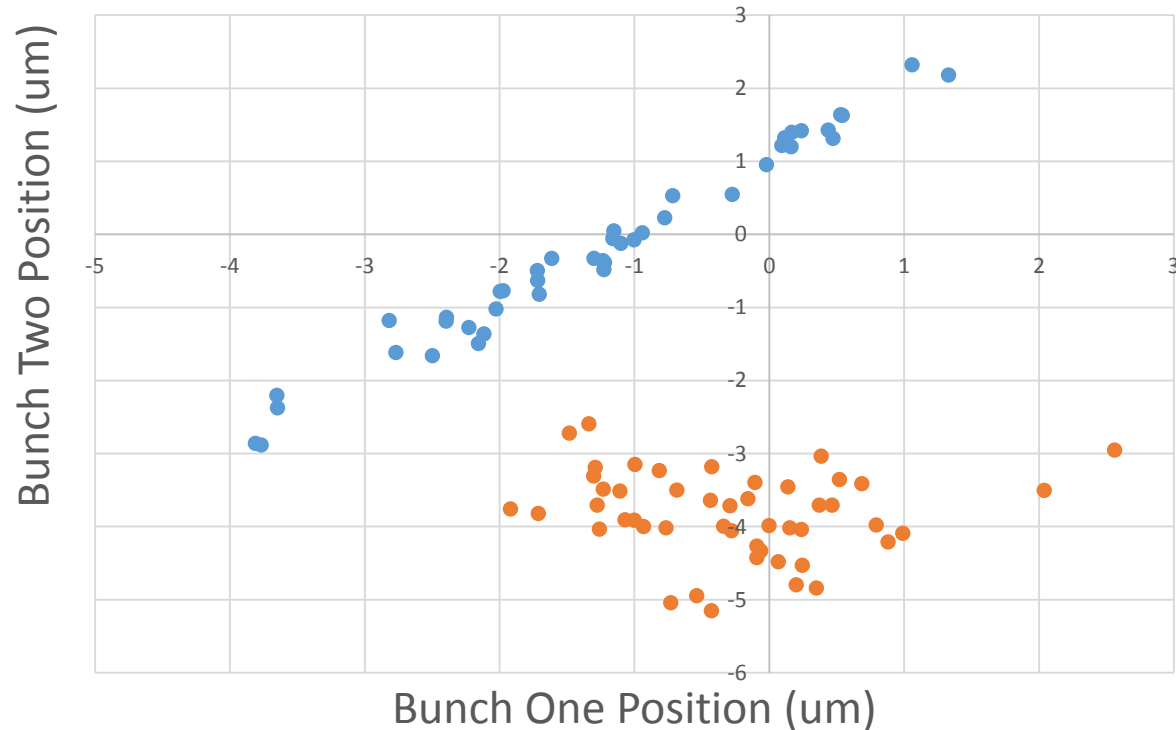
Feedback integrating over 10 samples



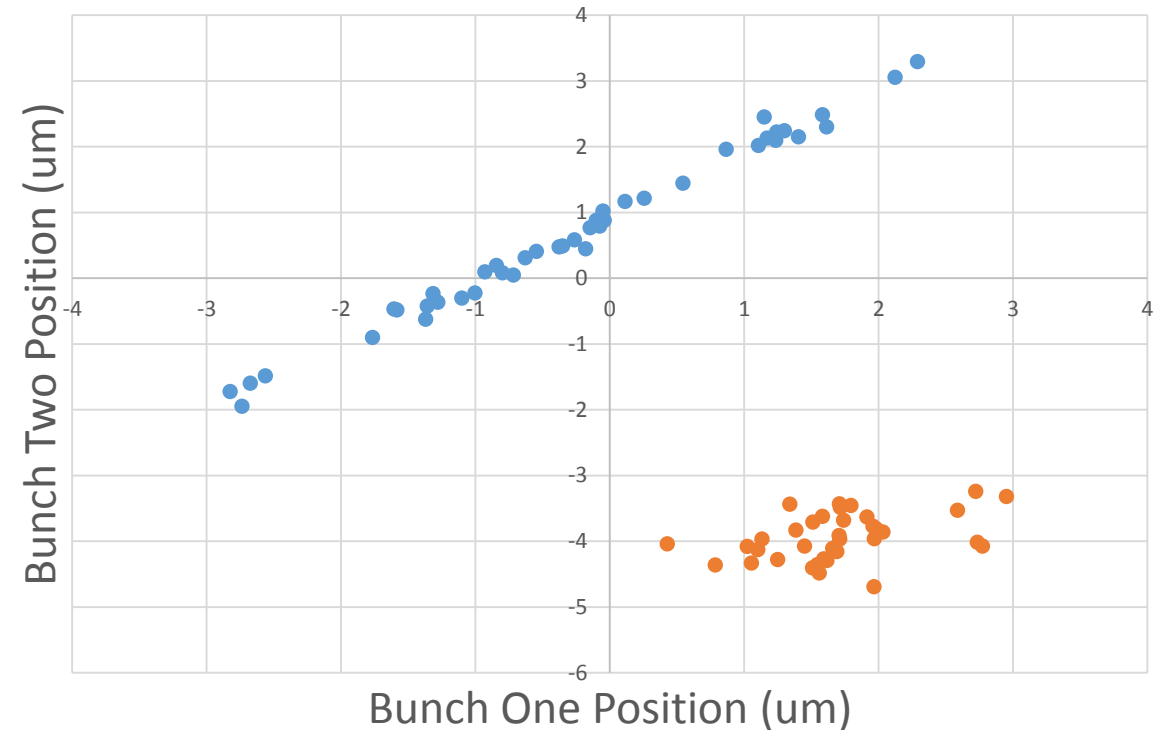
Correlation 1 sample 10 sample

- Correlation 1 sample: 99% to -10%, (ipfbRun7)
- Correlation 10 sample: 99% to 40%. (ipfbRun8)
- Not really enough triggers to get a decent estimate of correlation (errors 16% and 30%)

Single Sample

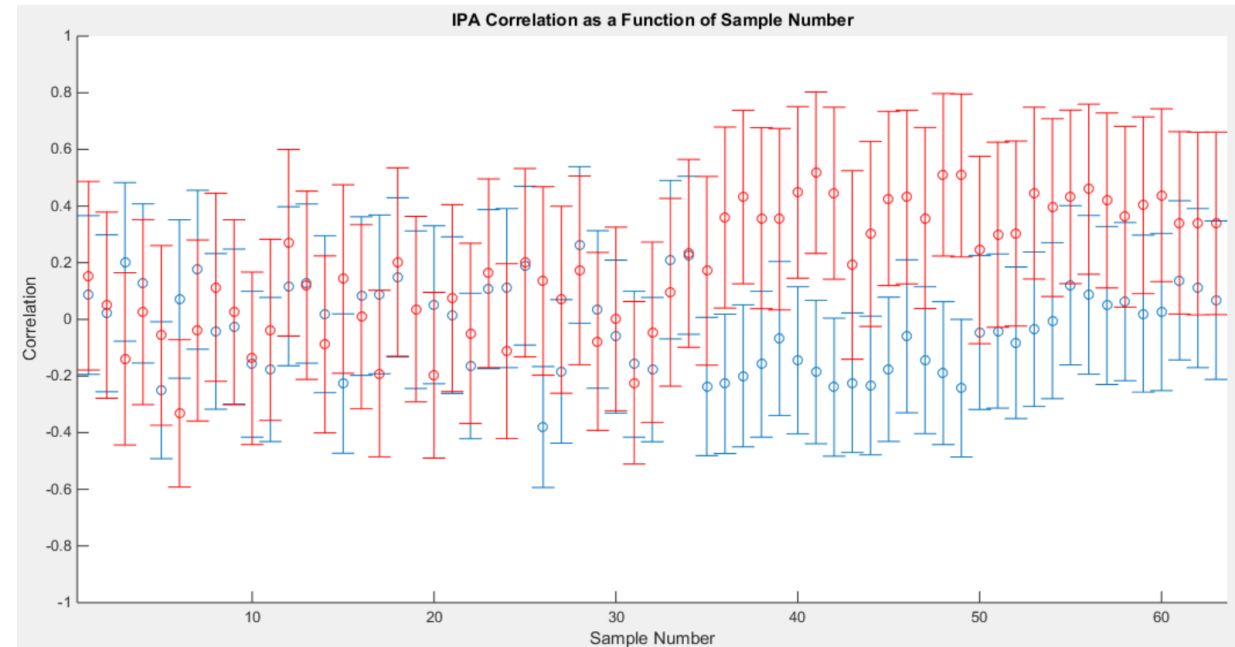
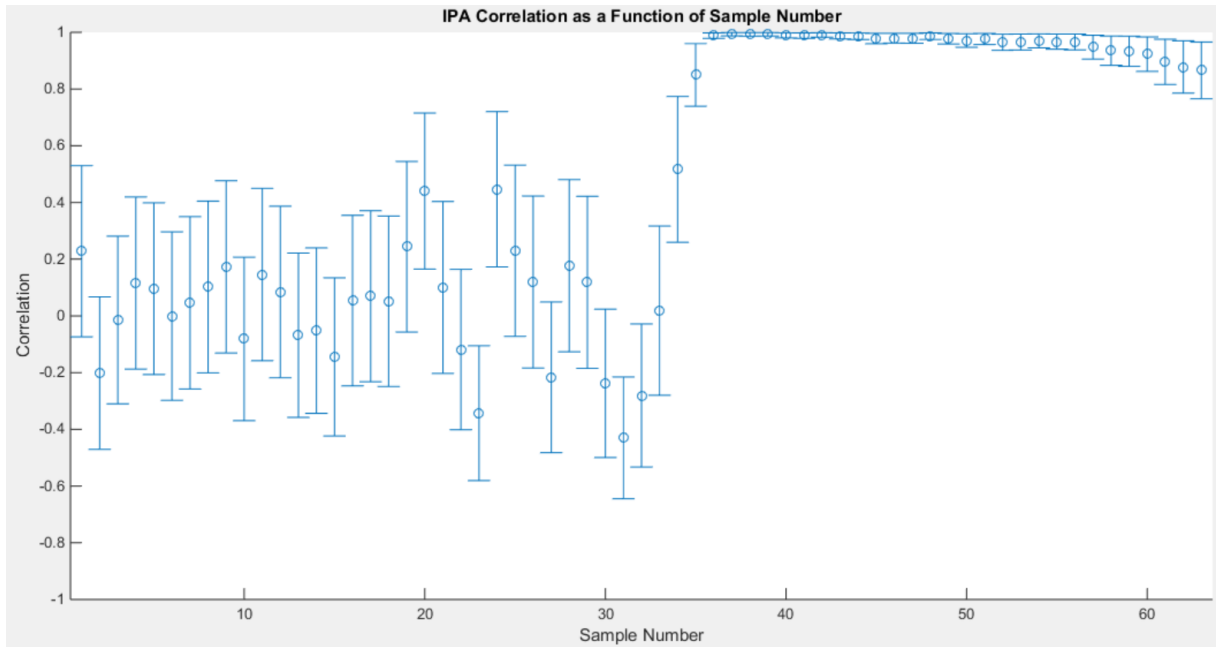


10 sample integration



Correlation as a Function of Sample Number

Red – 10 sample integration (under correction), ipfbRun8
Blue – 1 sample integration (over correction), ipfbRun7
Limited improvement to correction by incorrect gain location.

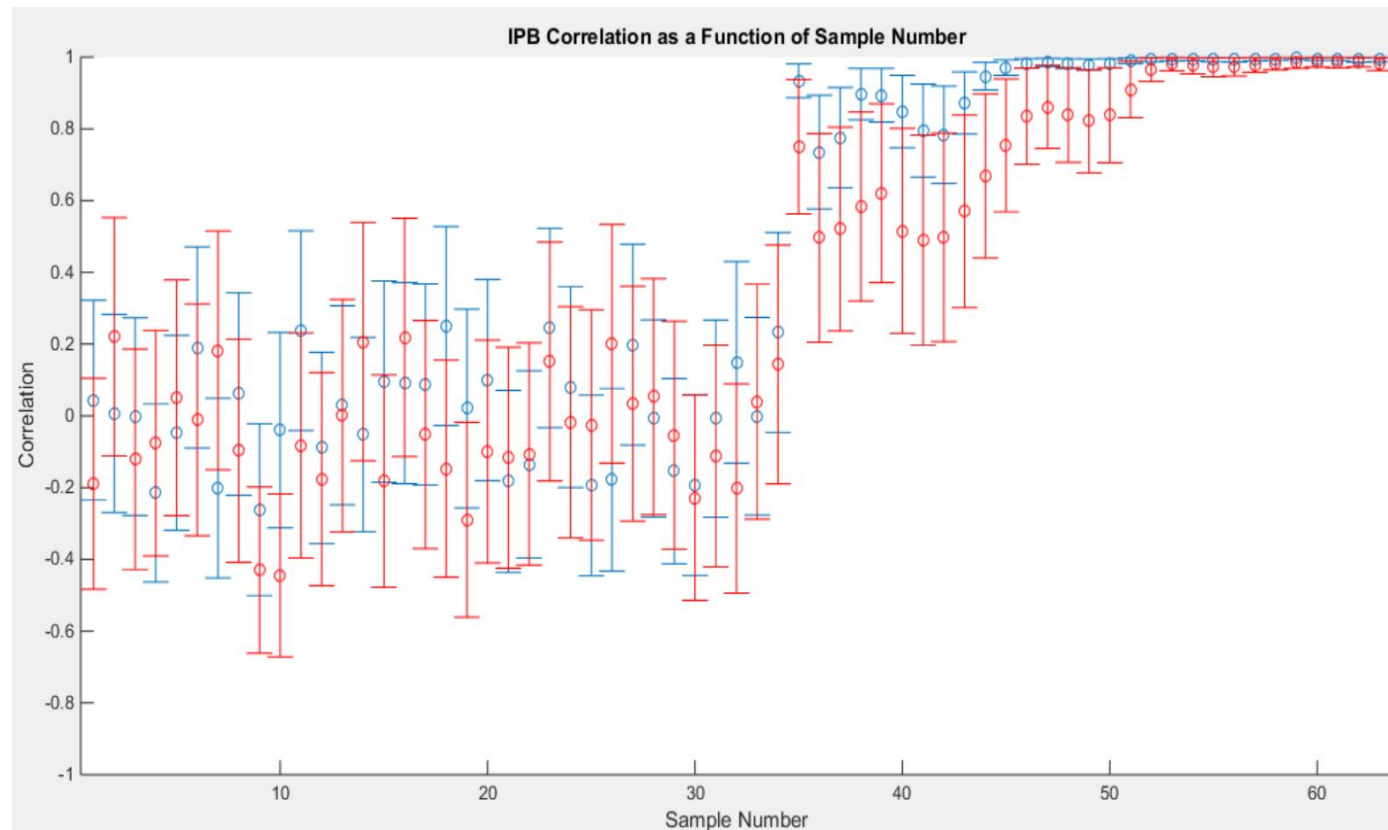


Correlation as a Function of Sample Number

Feedback was unintentionally operated with one gain using data from IPA (I) and IPB (I), not IPA (I and Q).

ipfbRun7 Single Sample Correction – blue

ipfbRun8 10 Sample Integrated Correction - red



Second Shift

20/06/2017

Data taken on shift

- Attempt single loop FB correcting at IPB:
 - Scan across gains – measure jitter and correlation across gain scan.
- Attempt to run 2 BPM feedback correcting at IPB:
 - In single sample mode: stabilises most triggers but with saturation of feedback signal on others.
 - Didn't manage to successfully run 2 BPM feedback with 10 sample integration due to time constraints.

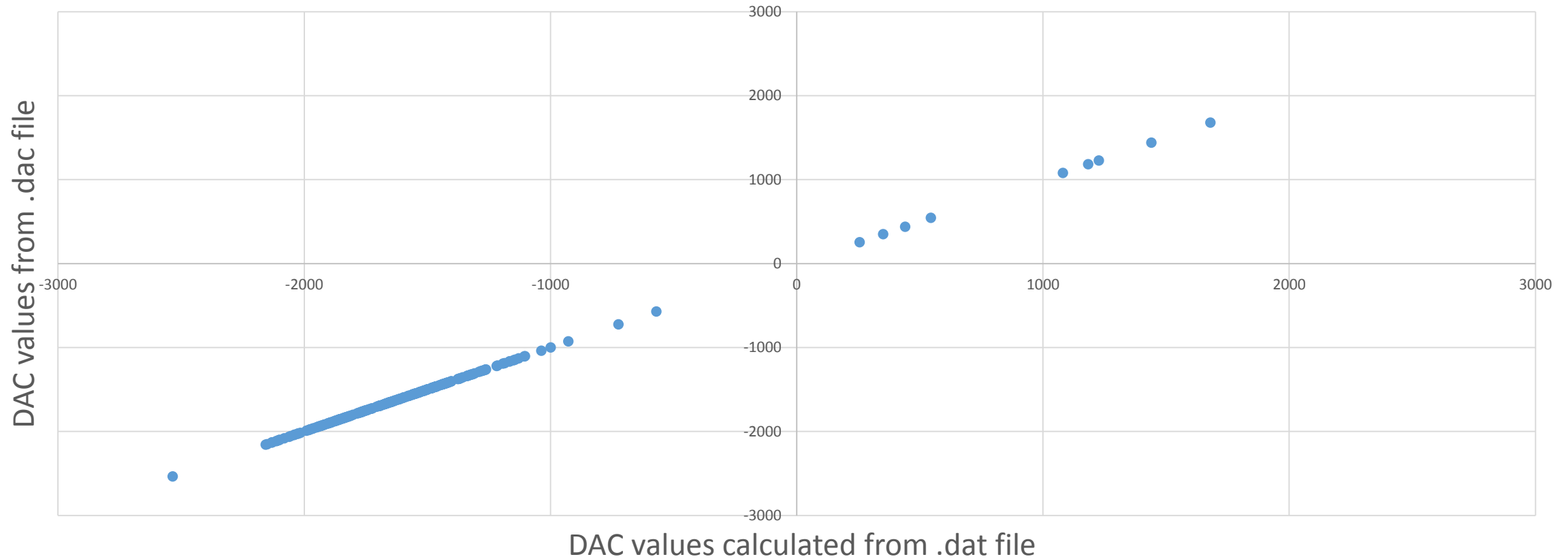
Problems on shift

- Working at 30dB because of static erratic feature made centring beam within kicker dynamic range difficult.
- Tried running with waist on IPB but correlation too low so work just off waist.
- Exceeding dynamic range of kicker for many of the triggers when working with 2 BPM feedback.
 - Introduce saturation if value overflows +/- 4095 to prevent values wrapping round. ✓
- We had problems with the second bunch trajectory changing meaning we had to recalibrate etc.

ipfbRun12 - second bunch

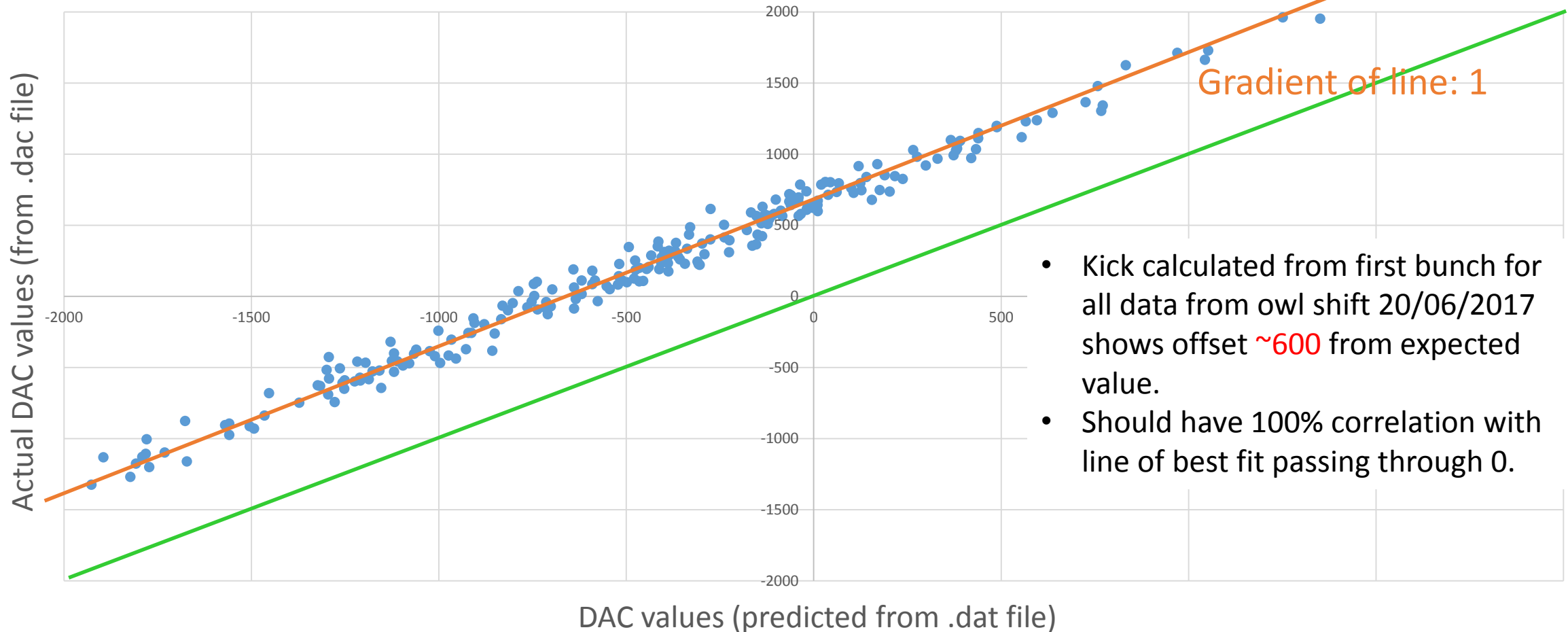
- 100 % correlation between predicted DAC values and actual DAC values.
Single sample FB.

Second bunch – ipfbRun12



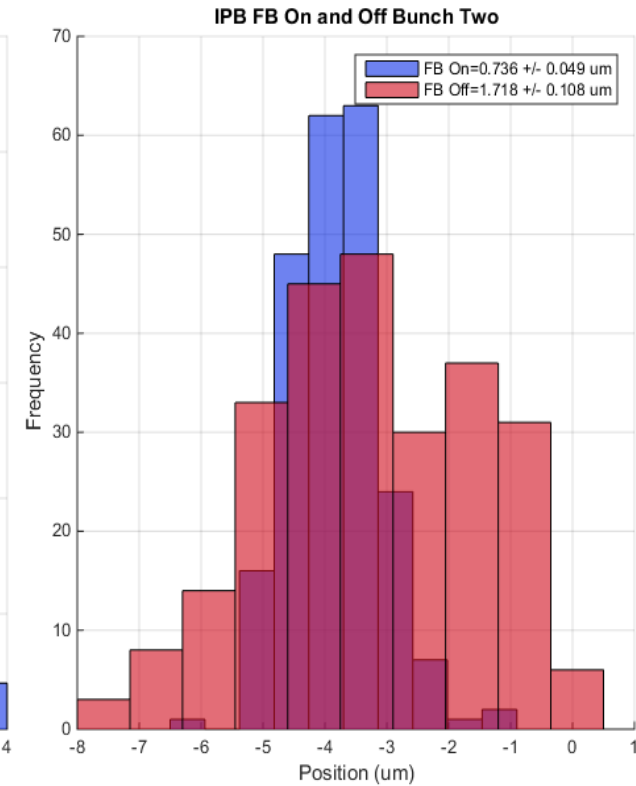
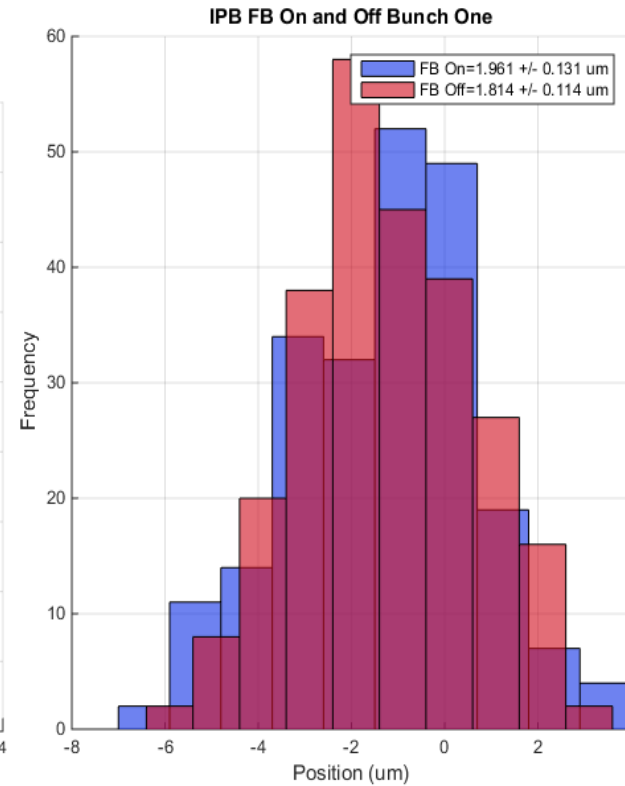
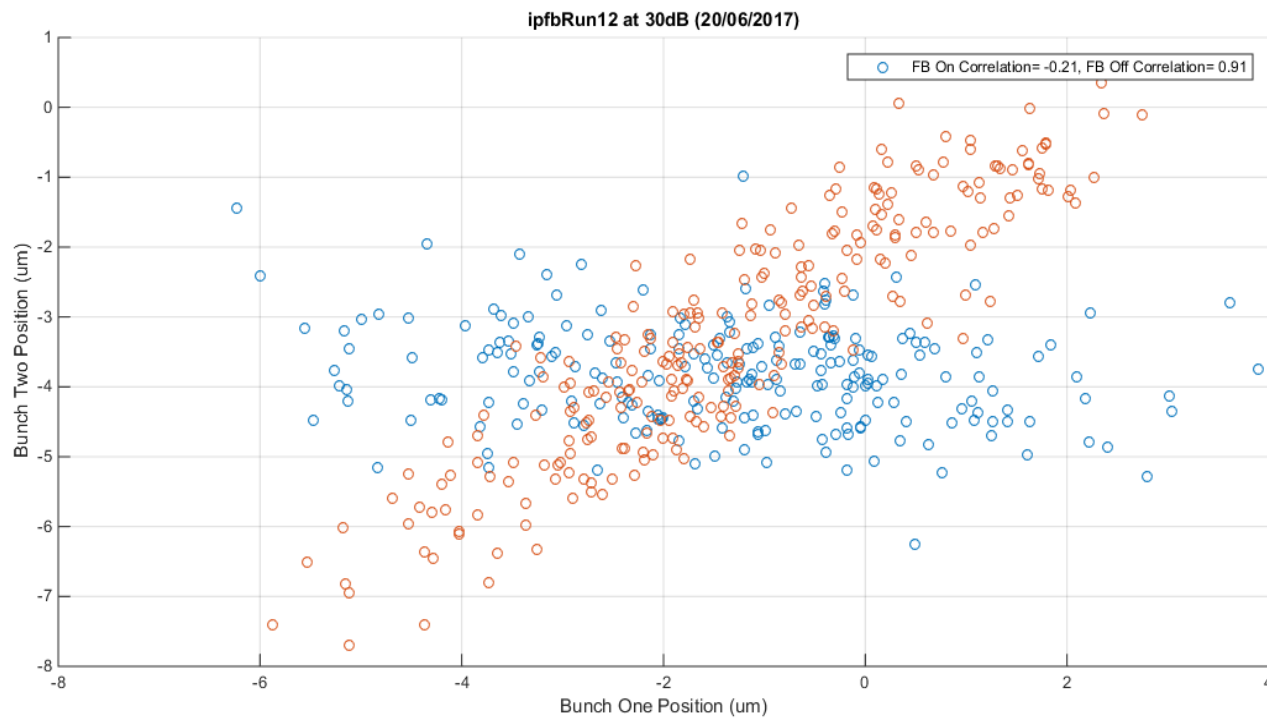
ipfbRun12 – Bunch One

ipfbRun12 Owl shift 20/06/2017 – single loop FB



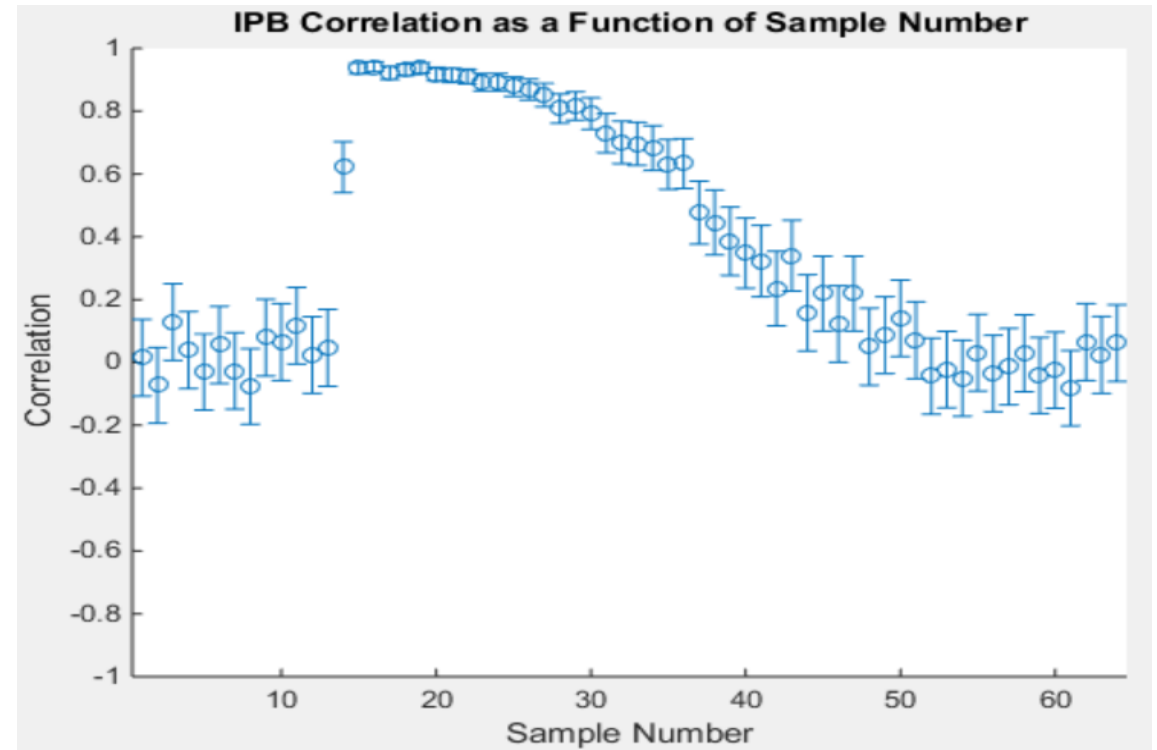
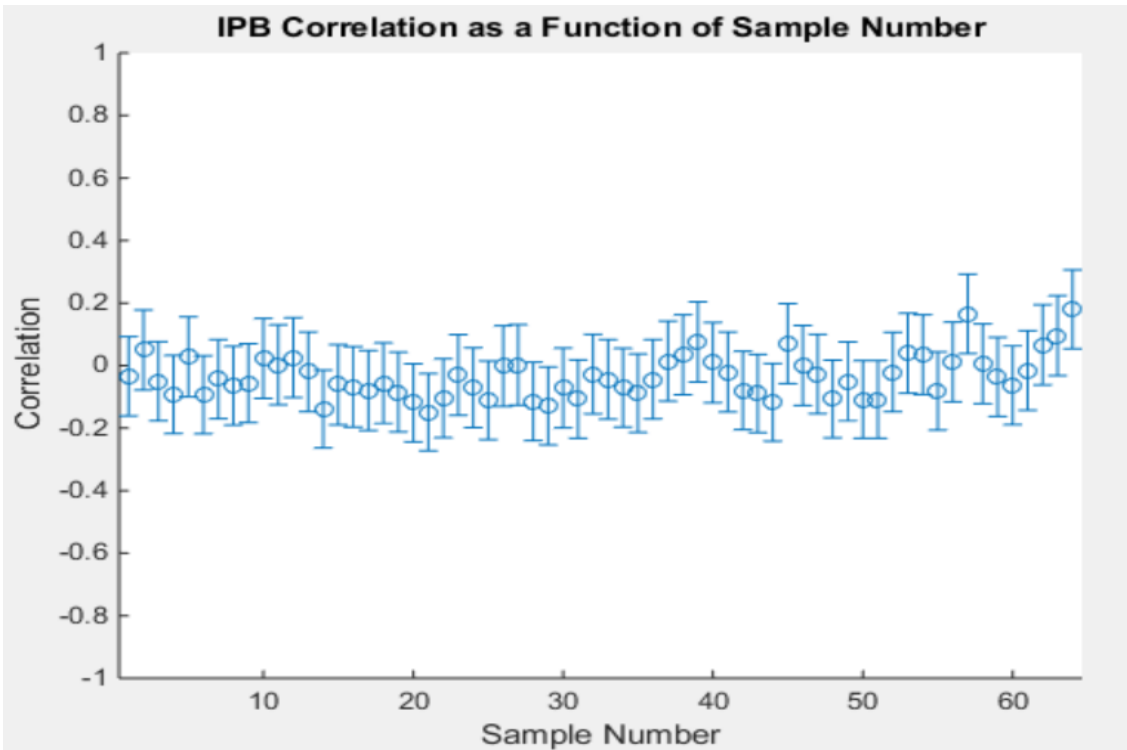
ipfbRun12

- Single BPM feedback correction at IPB
- Correlation: 91% down to -21%.
- Jitter reduction bunch two: 1.72 μm to 0.74 μm .

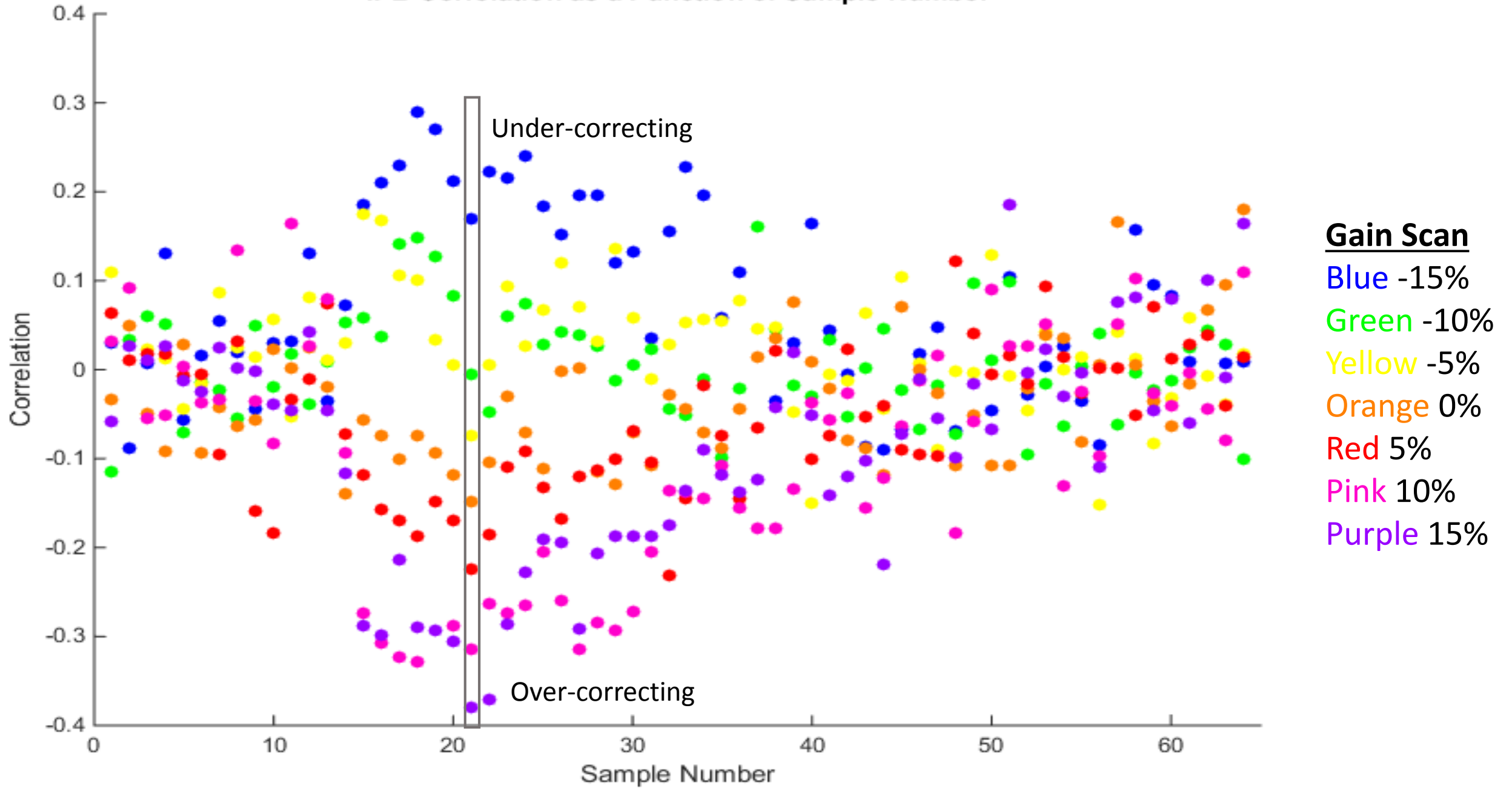


ipfbRun12 Correlation

- Nominal gain – produced smallest jitter but not best correction of correlation (which was with gain -10%).
- Sample number 21 used for single loop FB correcting at IPB.



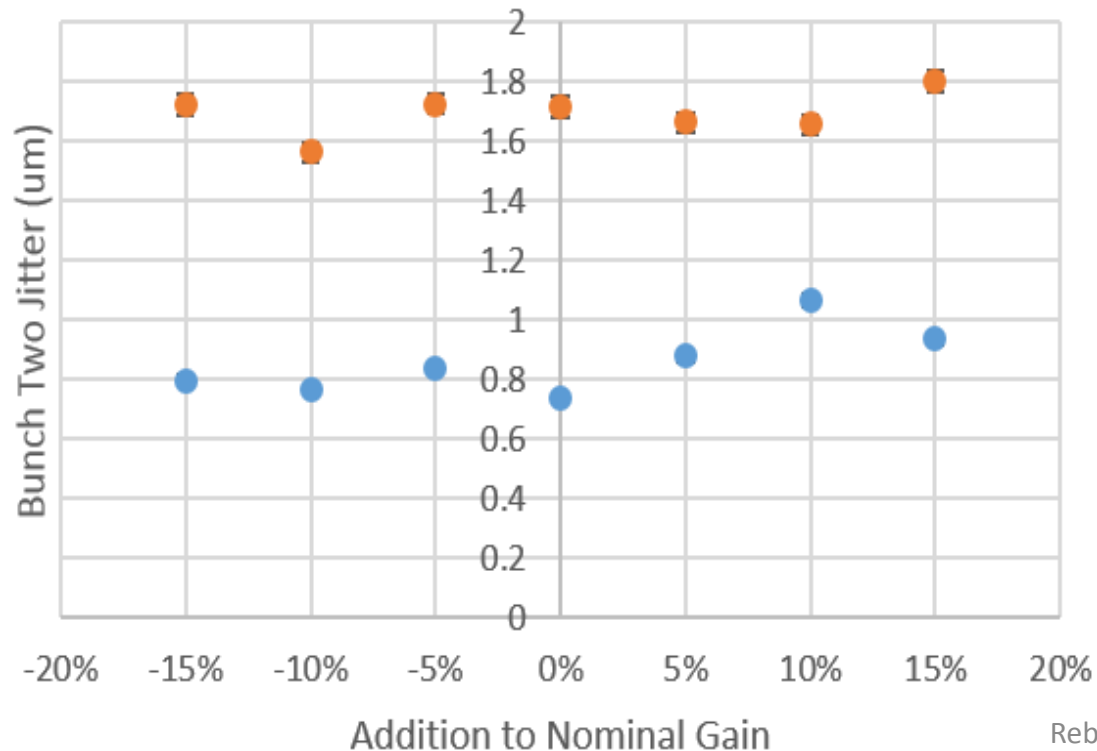
IPB Correlation as a Function of Sample Number



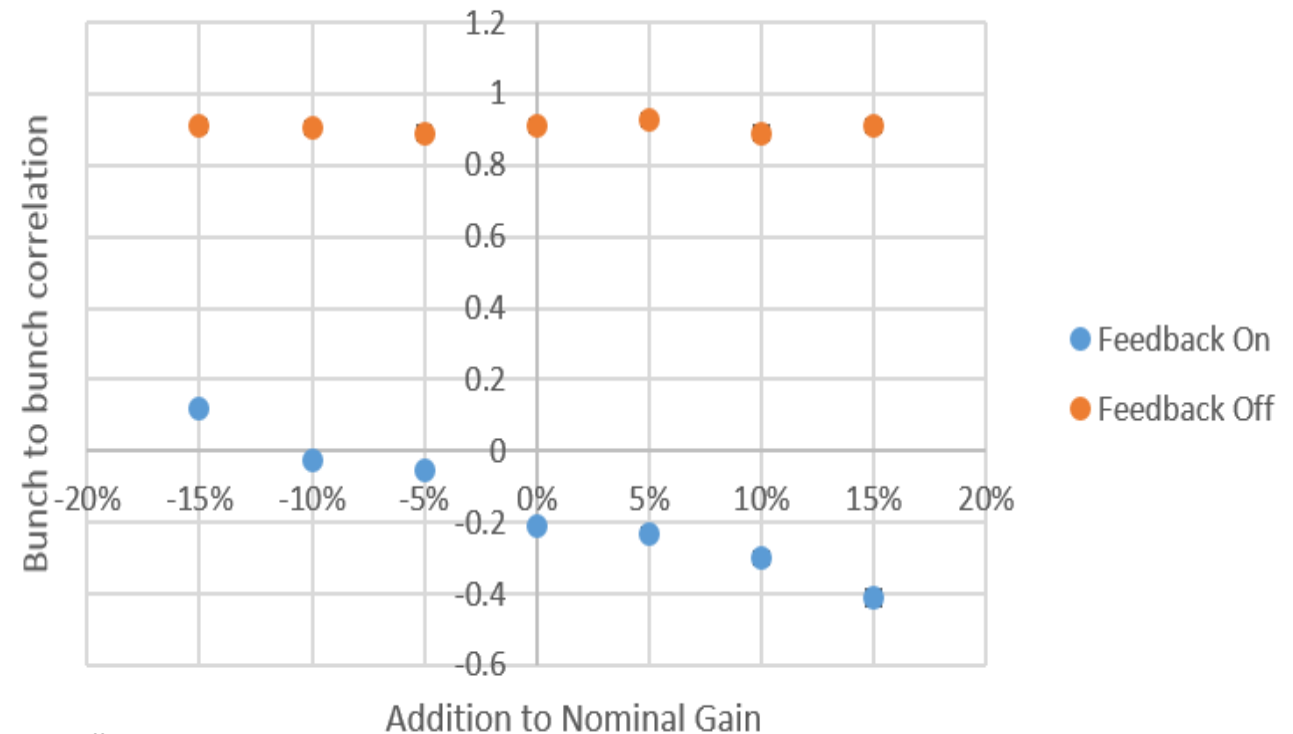
Single BPM feedback at IPB

- Varying gains for single loop feedback stabilising at IPB.
- Correlation scan optimum performance at -10% is consistent with the 90% correlation before feedback is applied.

Gain Scan - Jitter



Gain Scan - Correlation



Interleaving Feedback

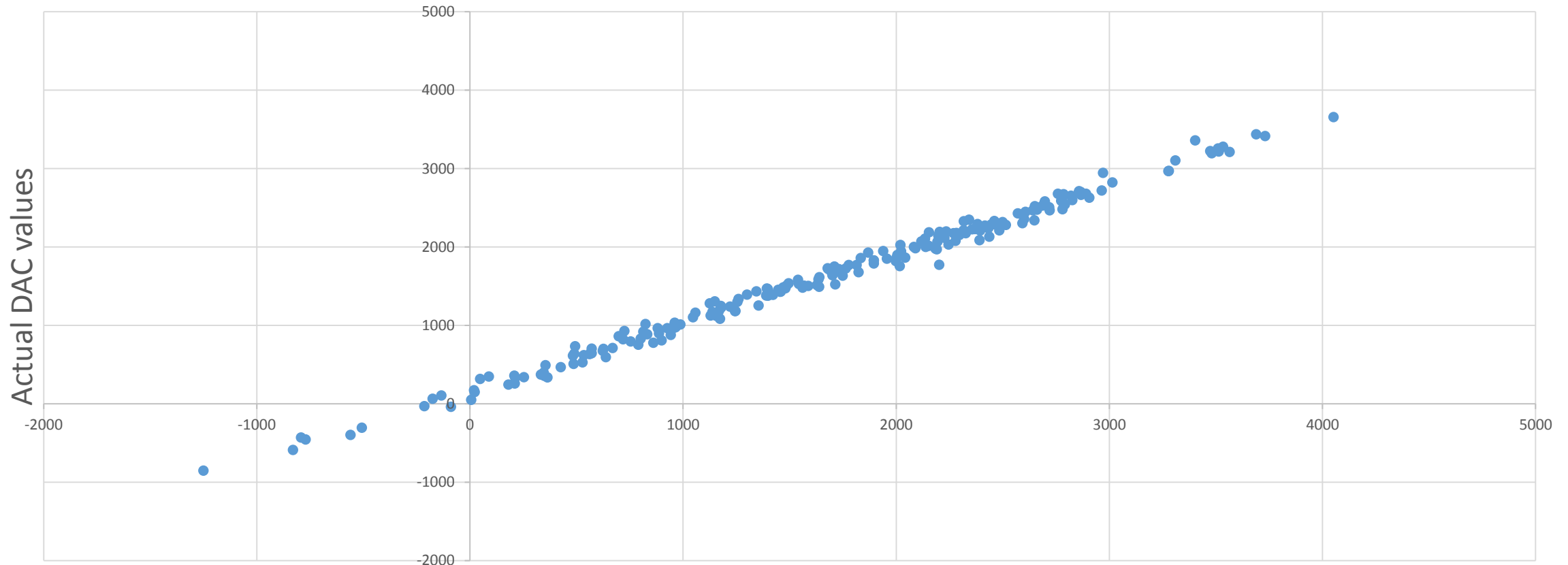
- Interleaving fb doesn't correspond well to always having full buckets?
- E.g FB Interleaved 10
- Beam 2020200202020200202020202020020200202020202
- Ends up kicking empty triggers.
- ipfbRun25 1000 triggers, 500 kicks, 233 kicks to bunches vs 267 kicks to empty triggers.
- Possibility we are losing data packets periodically?
 - We ran with 'empty trigger blk' on, and 'trig max cnt' 1, and 'trig seq sel' 0.

Double Loop FB

20/06/2017

ipfbRun25 Dual Loop –bunch one

- Predicted DAC values vs actual DAC values for dual loop fb.
- **99.7 %** Correlation between bunch one position and actual DAC value.
- In single loop mode has offset from zero and non 100% correlation.



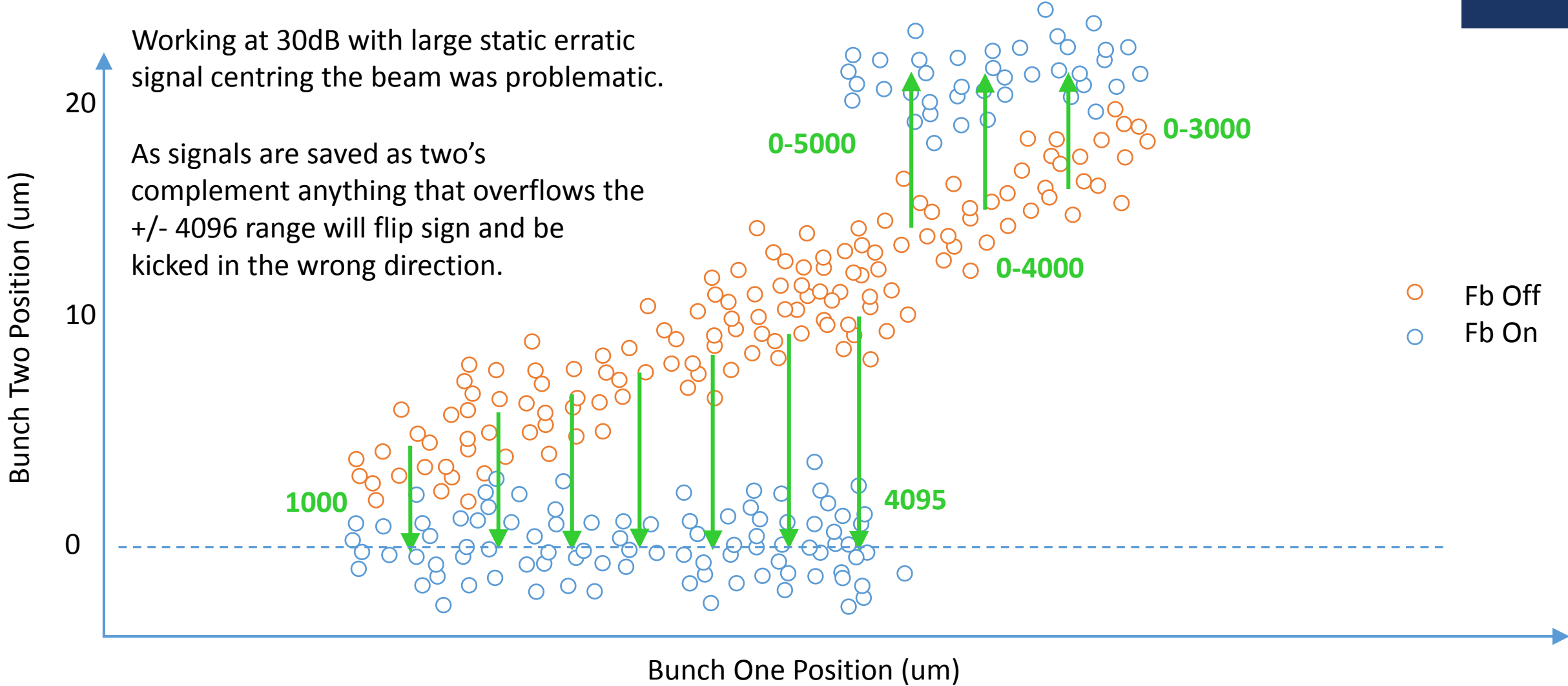
Predicted DAC values

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Simulation of firmware

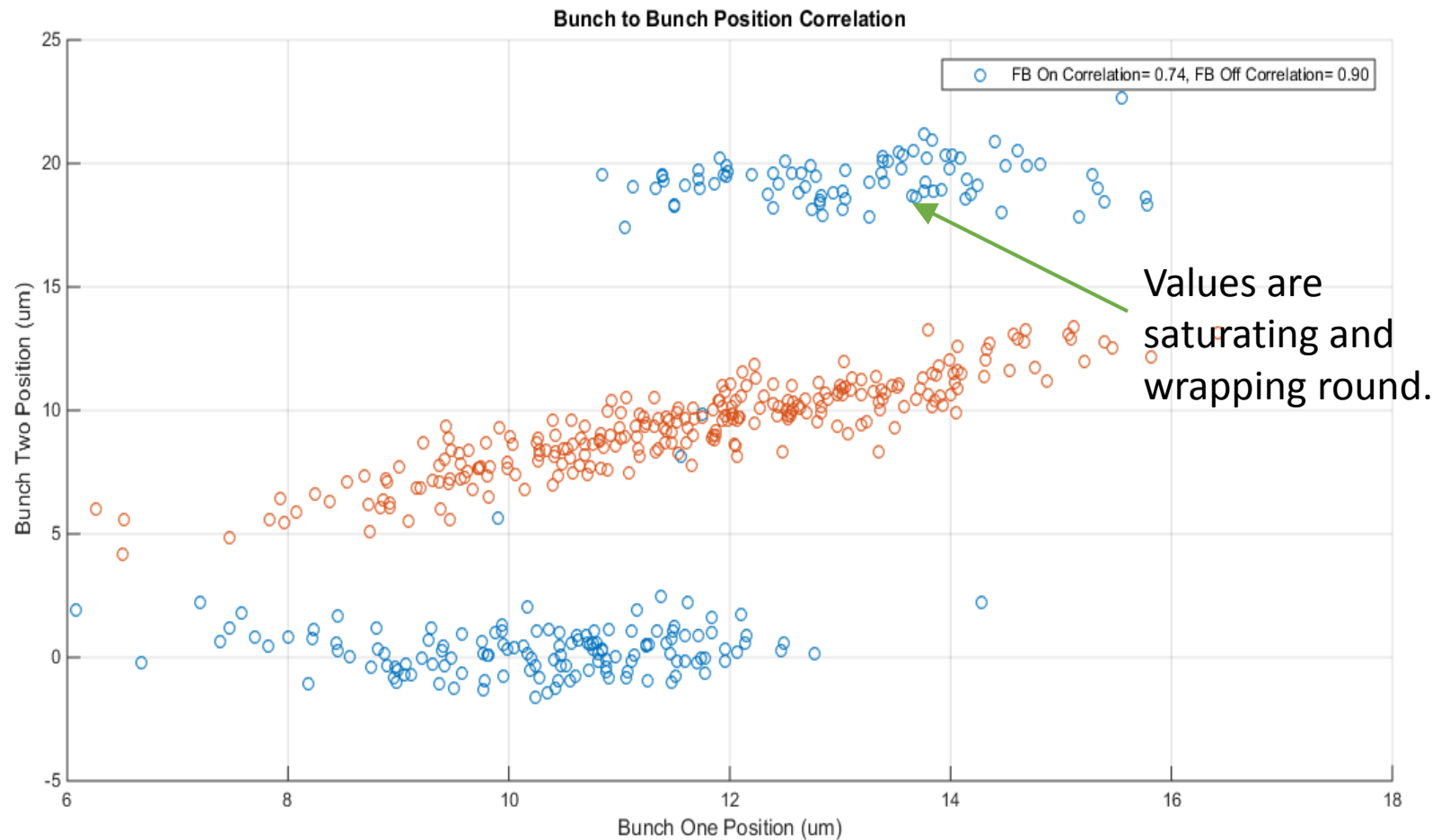
- **Simulation using the current firmware – first trigger analysed.**
 - Output from firmware on shift: **2820**.
 - Output from MATLAB analysis of .dat data: **2653**.
 - Output from firmware simulation: **2652**.
- Firmware simulation agrees with expected DAC output but not with DAC values calculated on shift.

Effects of Saturation



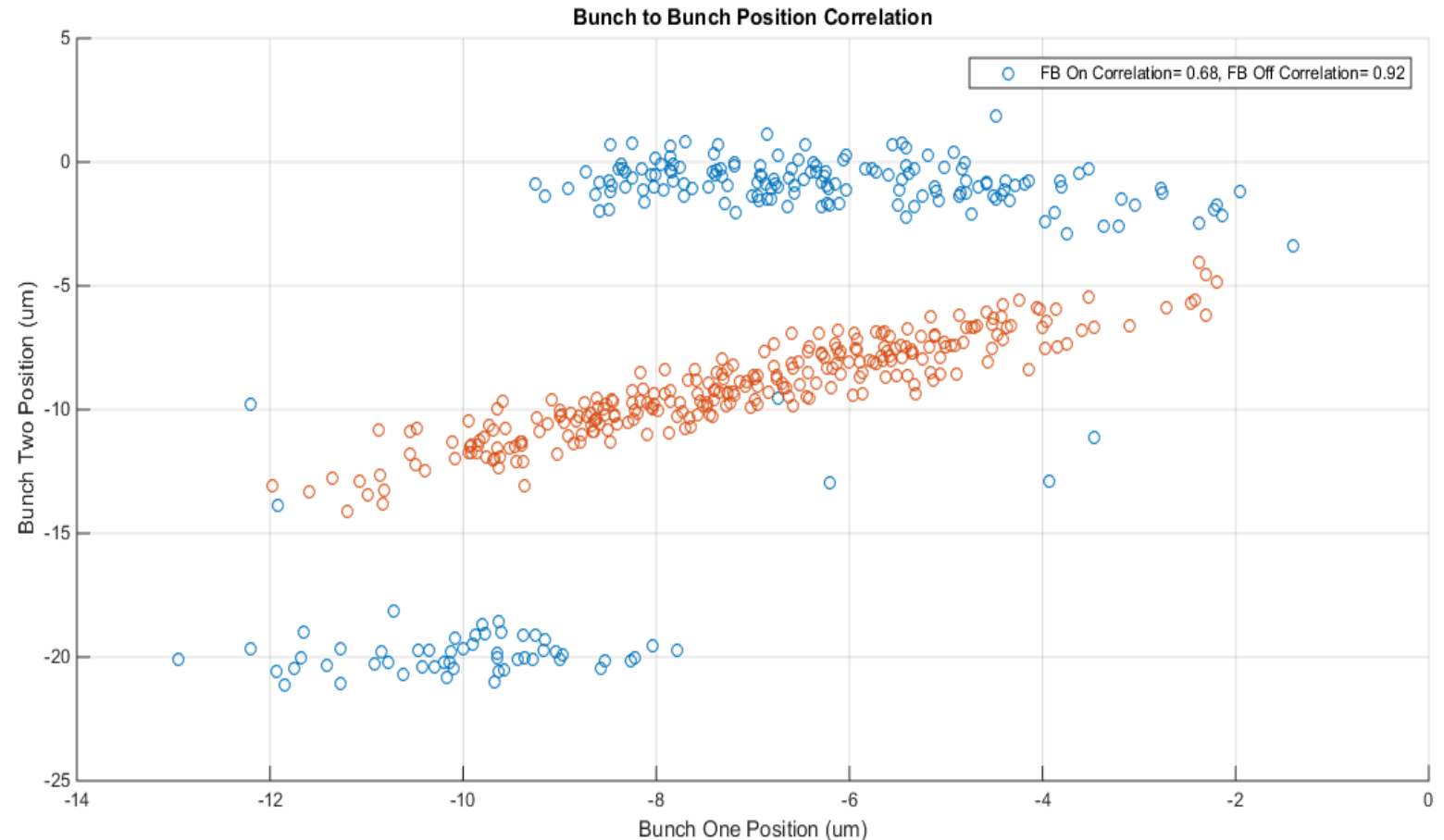
Saturation (with island at +20)

- Any triggers with a position exceeding 10um are stabilised to a different location (20um).
- ipfbRun20.
- 20 island: **19%** correlation.
- 0 island: **-3%** correlation.



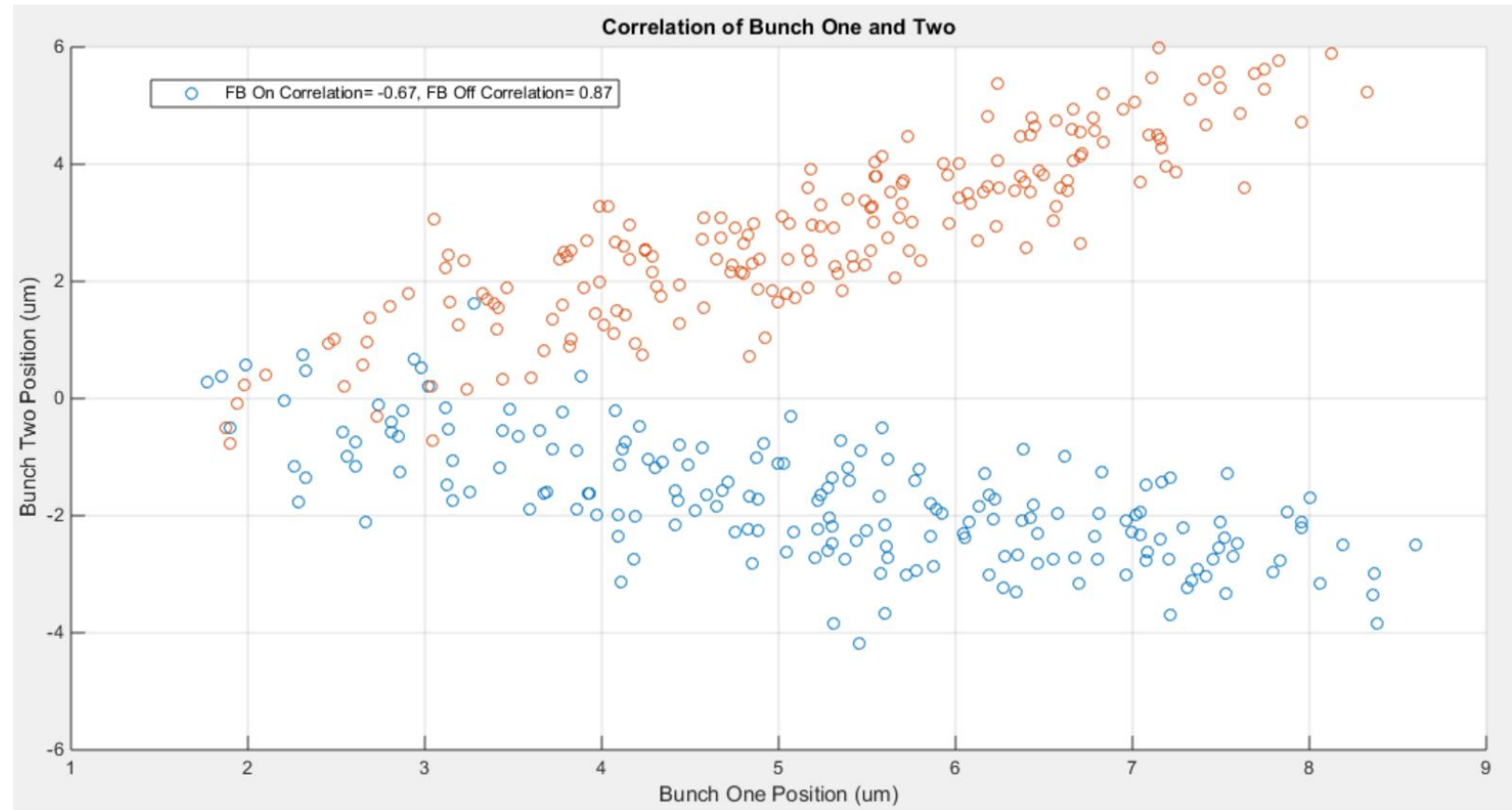
Saturation (with island at -20)

- Any triggers with a position exceeding -10 μm are stabilised to a different location (-20 μm).
- ipfbRun24 (20/06/2017)
- FB off correlation: 92%.
- 0 island: -39% correlation.
- -20 island: 14 % correlation.



ipfbRun25

- We then re-centred the beam so none of the triggers exceeded the kicker's dynamic range.
- FB Off Correlation: 87 %.
- FB On Correlation: -67 %.



Drift in Calibration Constant?

- Bunch to bunch correlation with feedback on has been drifting across the data runs.
- ipfbRun20: Correlation -3% fb on. (Correlation 90% fb off) Time stamp 08:08:04
- ipfbRun21: Correlation -11 % fb on. (Correlation 90% fb off) Time stamp 08:16:30
- ipfbRun23: Correlation -15 % fb on. (Correlation 87% fb off) Time stamp 08:33:32 (only 50 triggers)
- ipfbRun24: Correlation -39 % fb on. (Correlation 90% fb off) Time stamp 08:34:21
- ipfbRun25: Correlation -67 % fb on. (Correlation 92% fb off) Time stamp 08:42:37

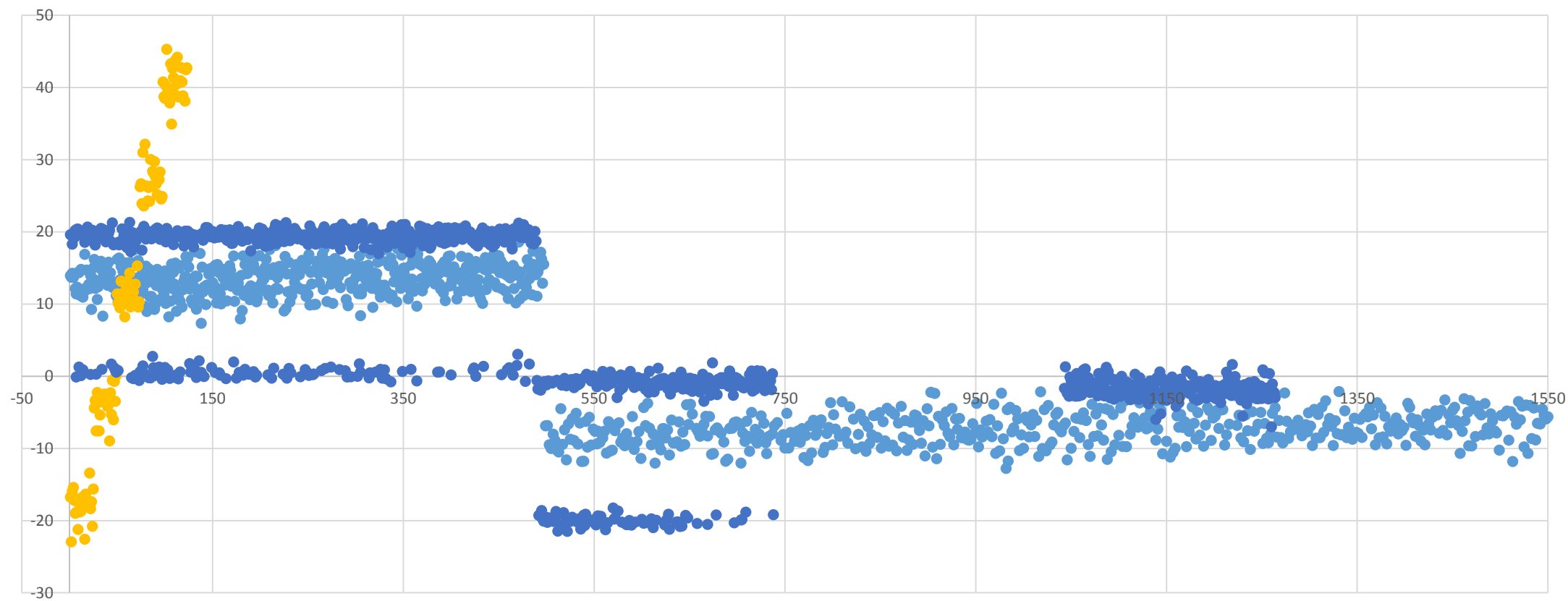
- Requires analysis into why feedback performance degrading if 'correlation-off-feedback' is not.
- (So far all I have noticed is that CQ waveform for second bunch is drifting.)

Reasons for DAC offset in Bunch One

- Nine control register values change between shifts:
 - Two are unused. (19 and 21)
 - One is interleaved on/off. (43)
 - One is bpm_sel – which BPMs to use as input to feedback. (90)
 - One is sample hold off. (91)
 - One is Trig in delay. (92)
 - Two are the bunch strobes for dipole and reference. (67 and 83)
 - And one is number of bunches to calculate a kick from. (124)
- Between our shifts - some features were changed in the DAQ that concern display of windows with/without bunches. Possibility something wrongly connected after this?
- Check using simulation that the values we got during shift aren't expected behaviour of the firmware/bugs in the code etc.

Additional Slides

ipfb 21,23,24,25



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ipfbRun21 – bunch two

Chart Title

