ATF February Shifts

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Outline

- Hardware set-up

- IP Box issues
- IP Kicker issues
- IPA noise
- Other issues
- Sample jump issues

- **Week 1**
  Shift 1 – Minimum jitter at IPC & noise floor measurements
  Shift 2 – 3-BPM resolution study

- **Week 2**
  Shift 3 – Upstream feedback propagating to the IP
  Shift 4 – Upstream feedback + 2BPM IP feedback

- Equipment brought back to Oxford

Hardware set-up

Upstream

- *FONT5A #5*
- Instrument **P2, P3 and MFB1FF**
- Synchronisation signal sent from FONT5A #5 AUX Out C to the FONT5A #4 at the IP via the feed-forward cable.
- Firmware: IPFB_FW_160217ab_1843kBaud (Upstream coupled-loop feedback, without PLL)

IP

- *FONT5A #4*
- Instrument IPA, IPB and IPC **Y information** + **Y Reference.**
- Receiving synchronisation signal from FONT5A #5 upstream.
- Sending synchronisation signal sent from FONT5A #4 Aux Out B (using special firmware provided by Glenn) to the FONT5 #1
- Firmware: PROM_IPFB_FW_2BPM_100217 (2BPM IP feedback with synchronisation signal from Aux Out B)

- *FONT5 #1*
- Instrument IPA, IPB and IPC **X information** + **X Reference**
- Receiving synchronisation signal from FONT5A #4.
- Firmware: PROM_IPFB_FW_121016aa (loaded for this trip - firmware version previously loaded on the upstream board)

IP box issues

- Pre-beam both upstream and downstream IP boxes were **not responding to remote communication**.
- The IP boxes were removed from the tunnel and everything was temporarily plugged into wall sockets.

- Tsukada-san fixed the issue by setting **enable DHCP** on the IP box settings.
  (It is not clear why they were working before this trip, but not now, or whether this setting was enabled previously and lost due to some hard re-set?)

- Access was taken before shifts to reinstall the IP boxes.
- Whenever sample jumping returned it could be removed by power cycling the FONT board remotely via IP box.

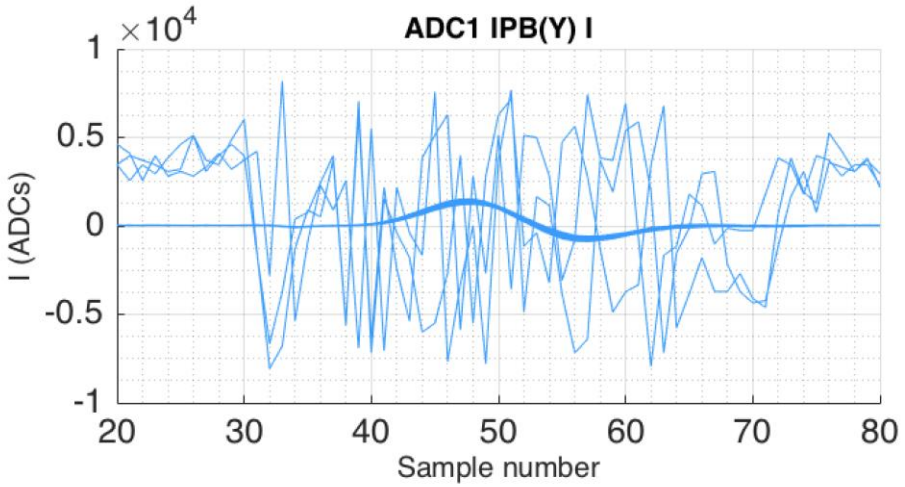
- In the second shift of week 1 the IP power box **stopped responding** again.
- During an access we tried removing things sequentially, and found it could cope with the FONT5A, FONT5 and SIS, but once the kicker amplifier was added it stopped responding.
- Consequently, we left the kicker amplifier plugged into the wall.

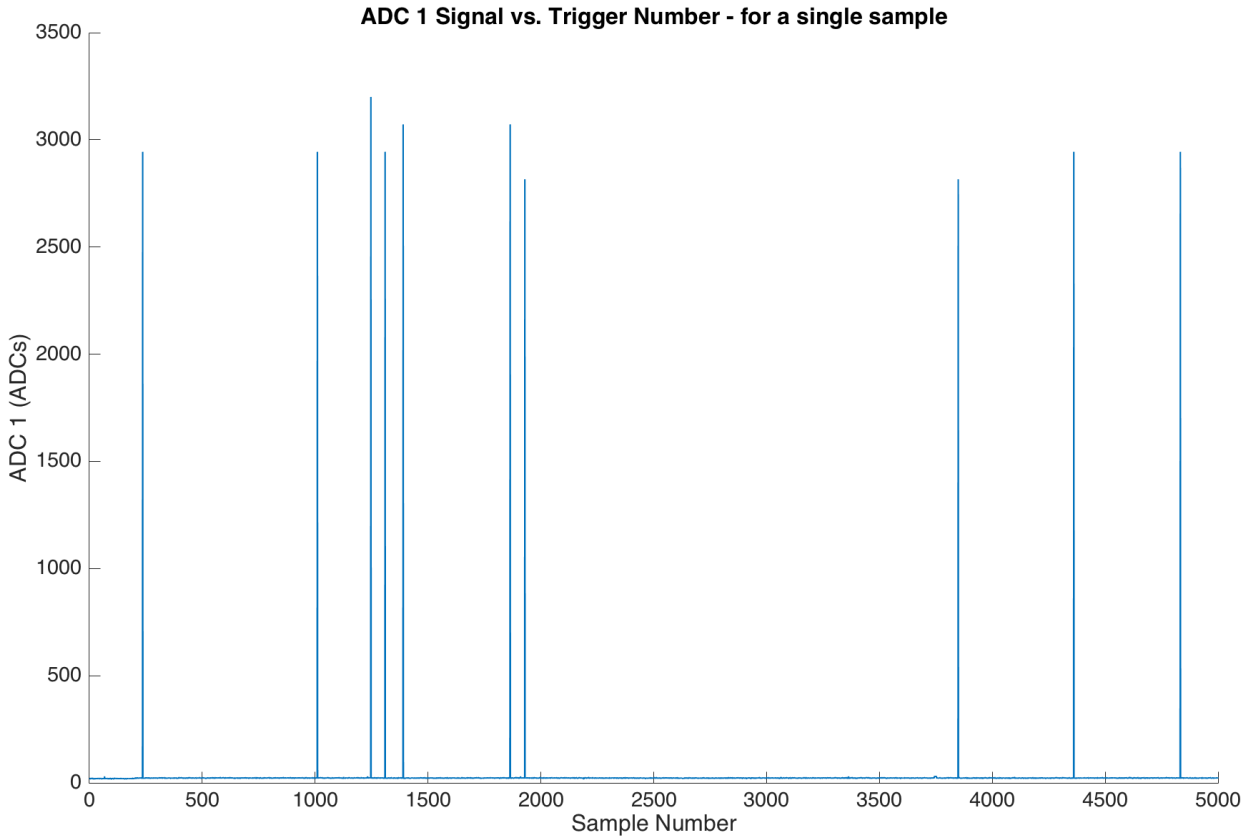
Kicker issues

- Following first week IP power box issues, the kicker amplifier was left plugged into the wall.
- In the second shift of the first week we were unable to kick the beam.
- On Monday week 2 prior to beam we checked the DAC output to the kicker from the FONT 5A board, and it was fine.
- However, whilst in the tunnel we also noticed that the kicker amplifier (TMD3) was **sporadically triggering** (we could hear it clicking), despite no trigger output being sent from the FONT 5A board. Consequently we left the kicker unplugged.
- Took an access at the beginning of the final shift to switch the IP kicker amplifier with one of the upstream amplifiers (TMD1, the one from K1), under advisement from Oxford. This was subsequently used successfully on shift in IP feedback.
- We have now brought the former IP kicker amplifier (TMD3) back to Oxford.

ADC1 noise

- Throughout the February shifts we continue to observe high-level ADC noise on several triggers on ADC1 of both FONT boards.
- The temporal occurrence seems random.





Other issues

- FONT5A #4 requires AUX Out C to be patched to the front panel. It currently has a special version of 2BPM IP feedback firmware with the synchronisation signal temporarily patched out via AUX Out B.

- FONT5 #1
  - when we power cycle it remotely via the IP box we could not recover it
  - adjusting the power input connection cable/port (which is very unstable) by hand during an access caused it to recover
  - the problem with power cycling repeated during the same shift: no time for a second access
  - JTAG connection is very temperamental
  - trigger connection also failed on one occasion even though it was powered – again fixed by adjusting the connection (may have nudged something else?)

- Stripline phase shifter not responding
  - one of them failed to respond to the LabView DAQ. Fortunately it was already reasonably well set up, so we managed without changing the phase shifter setting at any future point. There was no time to troubleshoot this.

Sample jump issues

- Large permanent sample jumps
  - they occur on all FONT boards, but not by the same numbers of samples
  - on average it occurs once every few hours. Some shifts not observed at all
  - when running feedback this requires we repeat all the set-up

- Single sample permanent sample jumps
  - they occur on all FONT boards, by the same single sample
  - we observed this twice in all data from February

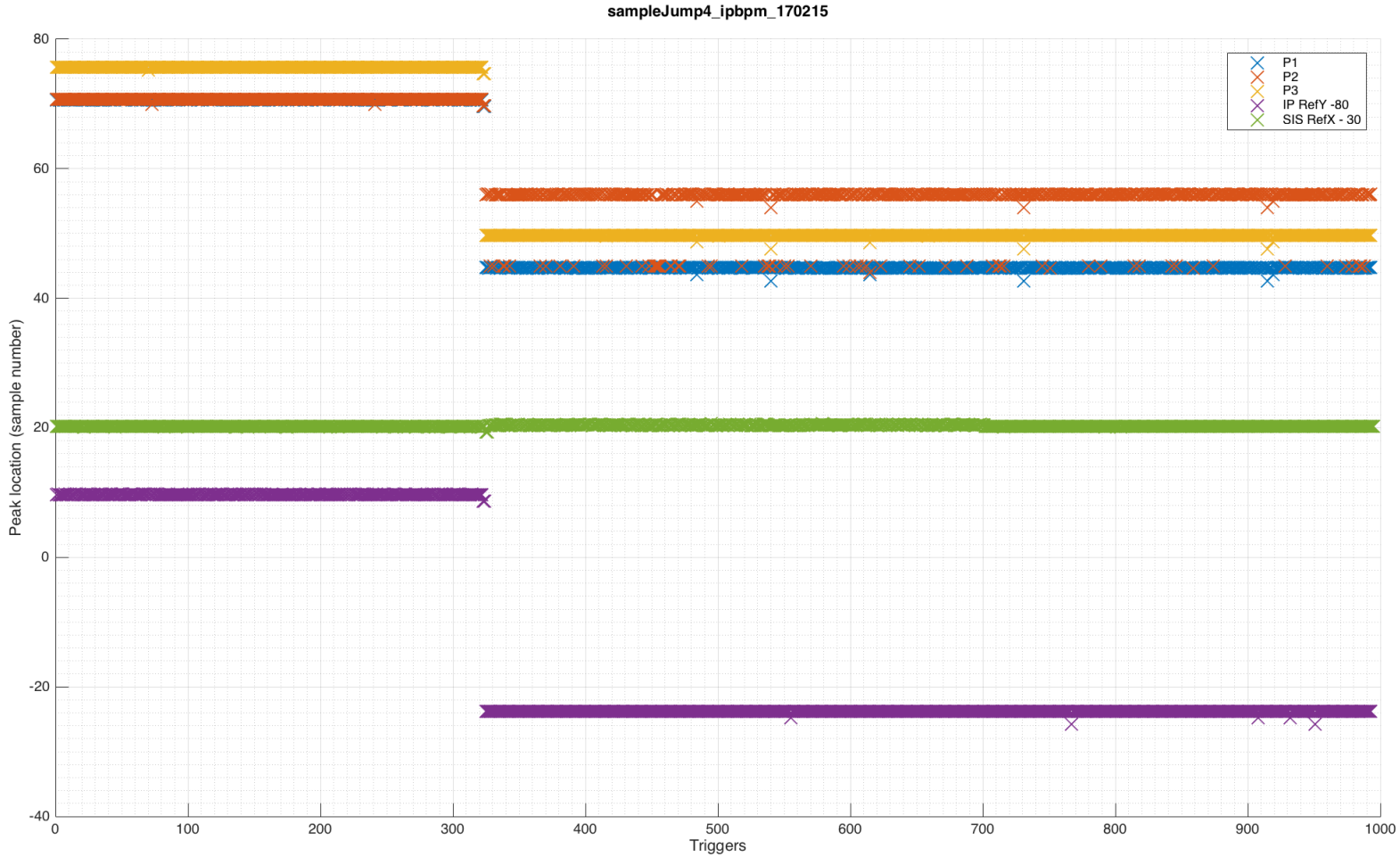
- Rapid sample jumping back and forth between two locations
  - not observed on all banks e.g. frequent sample jumps on banks 1 and 3, but stable on bank 2
  - usually occurs about once a shift
  - fixed by power-cyling the board, which again requires we repeat all the set-up

- Single trigger sample jumps
  - the average 400-trigger jitter run contains around 2 of these
  - they occur on all banks
  - they are removed in analysis so we ignore them

Example of large permanent sample jumps

Temporal plot of peak location from maximum of the fit to the peak (i.e. interpolating between sample numbers)

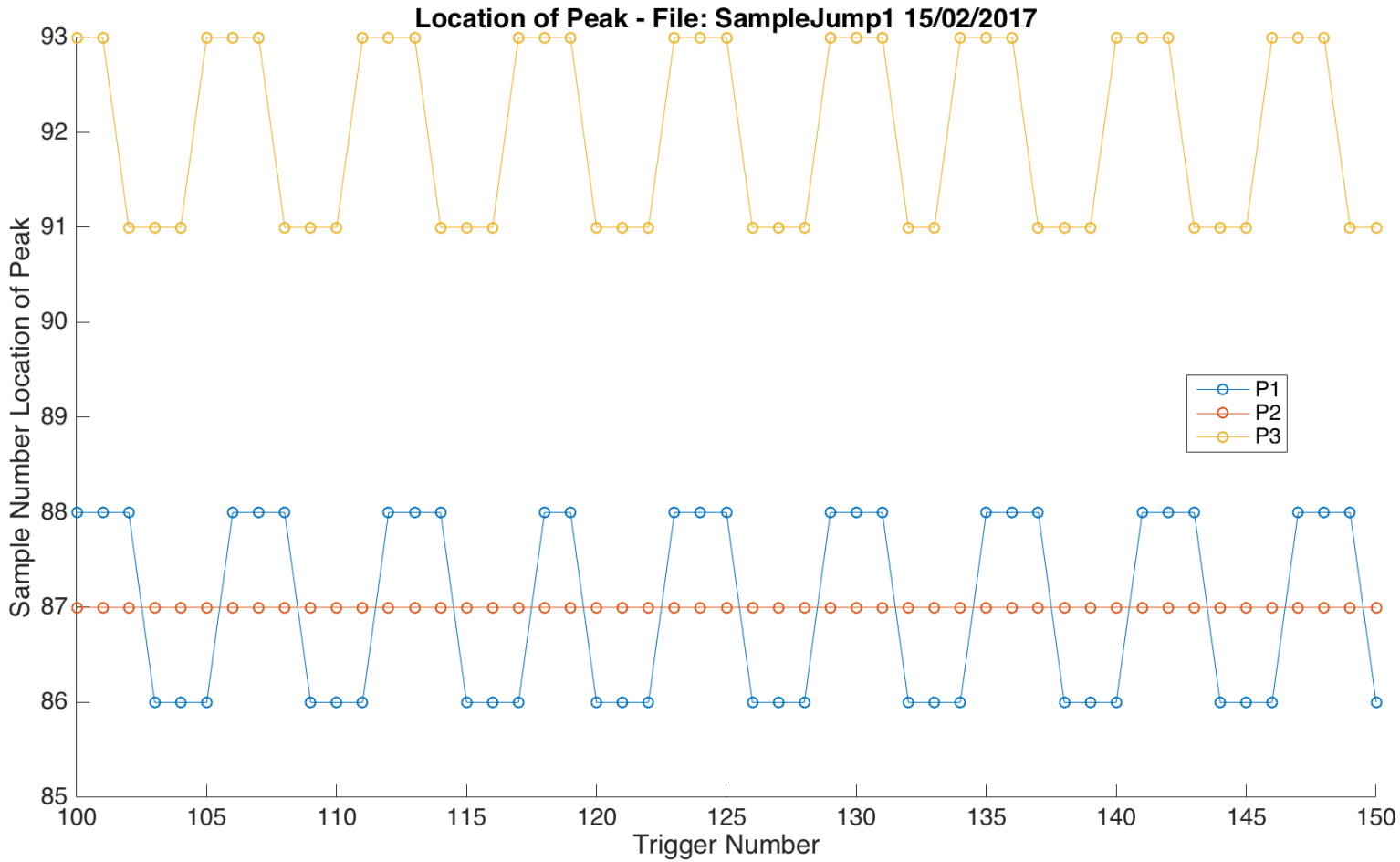
For example, here occurring on both FONT boards, but not by the same amount.



Example of rapid sample jumping back and forth

Temporal plot of peak location on the upstream FONT board for the data from P1 (bank 1), P2 (bank2) and P3 (bank 3)

For example, here the rapid sample juping is occurring on banks 1 and 3, but not on bank 2.

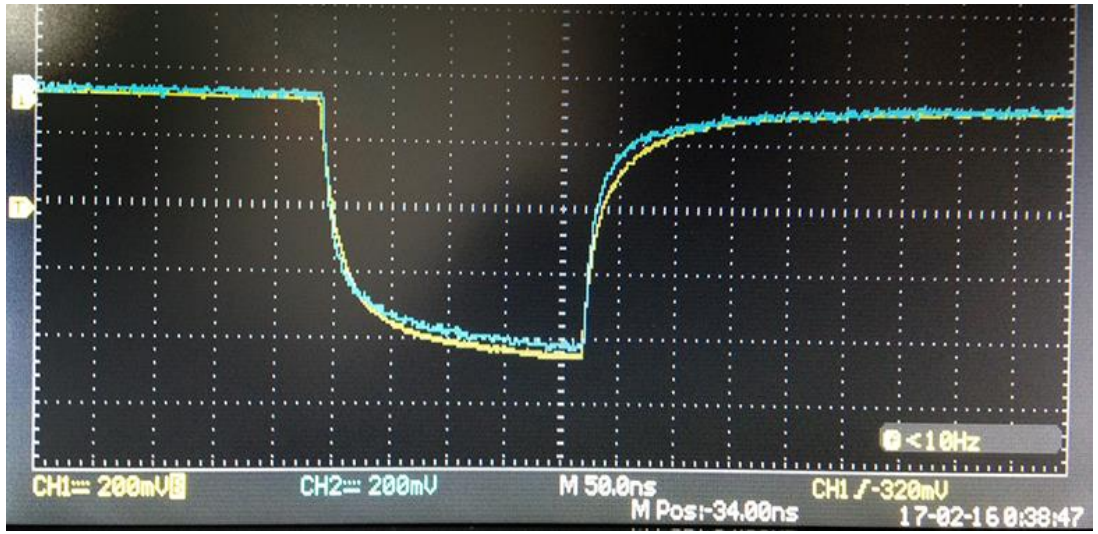


Week 1
Shift 1 - Minimum jitter at IPC & noise floor study

- Minimum jitter measurements with the beam on waist at the IPBPMs.
- On shift there was only time to perform this study at one BPM: we worked at IPC.
- Measure jitter as a function of attenuation.
- Random jitter source scan to measure real jitter (at 10dB).
- Take new measurements of the noise floor using 70dB attenuation on the dipole.

Checking the trigger and 357 MHz signals inside the tunnel

- Beginning of shift we took an access to reinstall the fixed IP box. Checked integrity of triggers used for FONT5A and FONT5 boards (see right).



- Checked 357 MHz levels.

	LCR	C-hut	S-hut	IP
#1	10.8 dBm	5.87 dBm	0.79 dBm	-2.70 dBm
#2	10.86 dBm	7.04 dBm	2.2 dBm	-1.35 dBm

- Added 17dB amplifier and attenuators (6dBm on #1, 8dBm on #2) in the S-band hut to bring into required range. New levels:

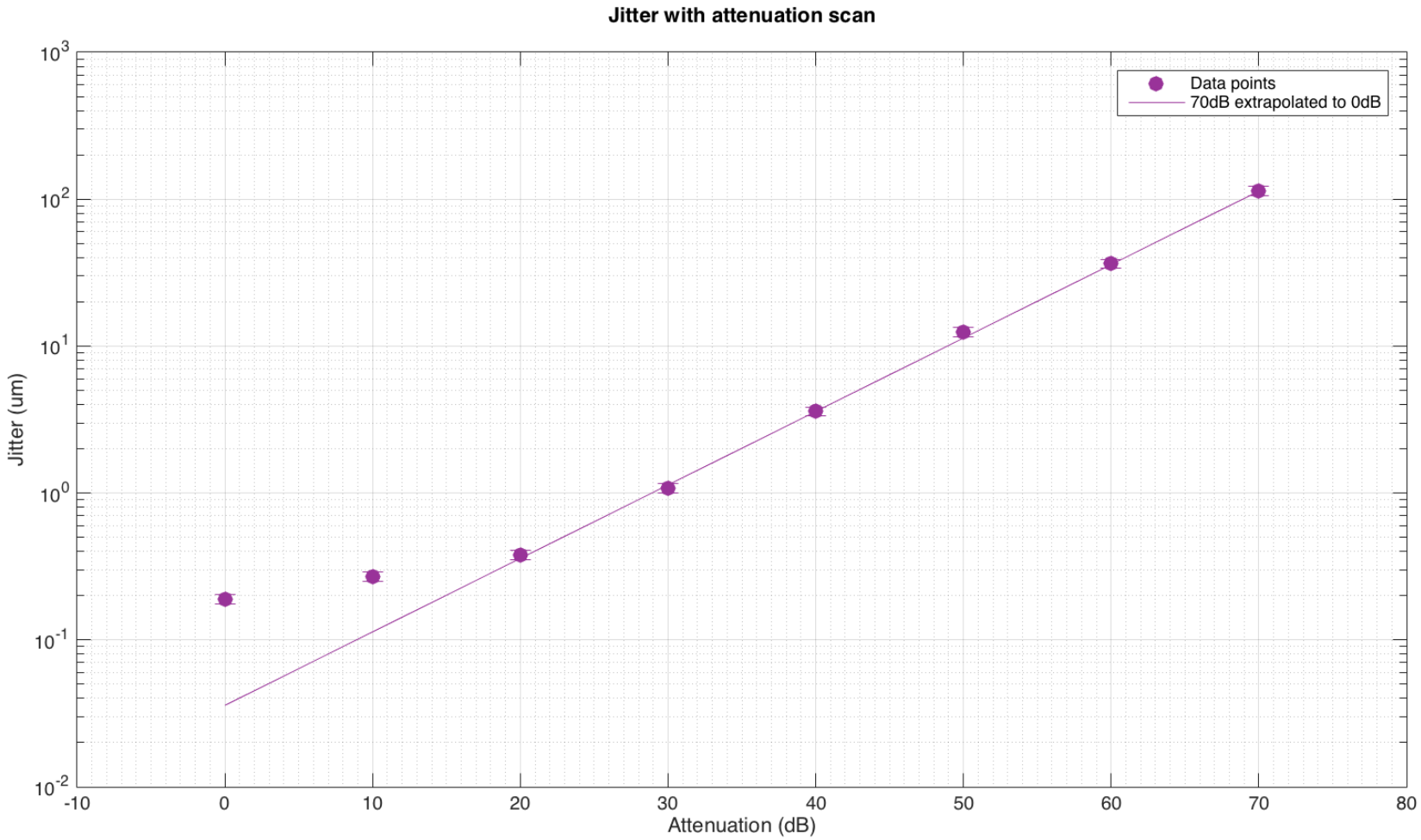
	LCR	C-hut	S-hut	IP
#1	10.8 dBm	5.87 dBm	9.94 dBm	6.24 dBm
#2	10.86 dBm	7.04 dBm	9.78 dBm	6.37 dBm

Measure the jitter on waist at IPC at different attenuations

Performed a waist scan at IPC with 10dB and then 0dB attenuation and moved to minimum jitter location.

Performed minimum jitter measurements at different attenuations:

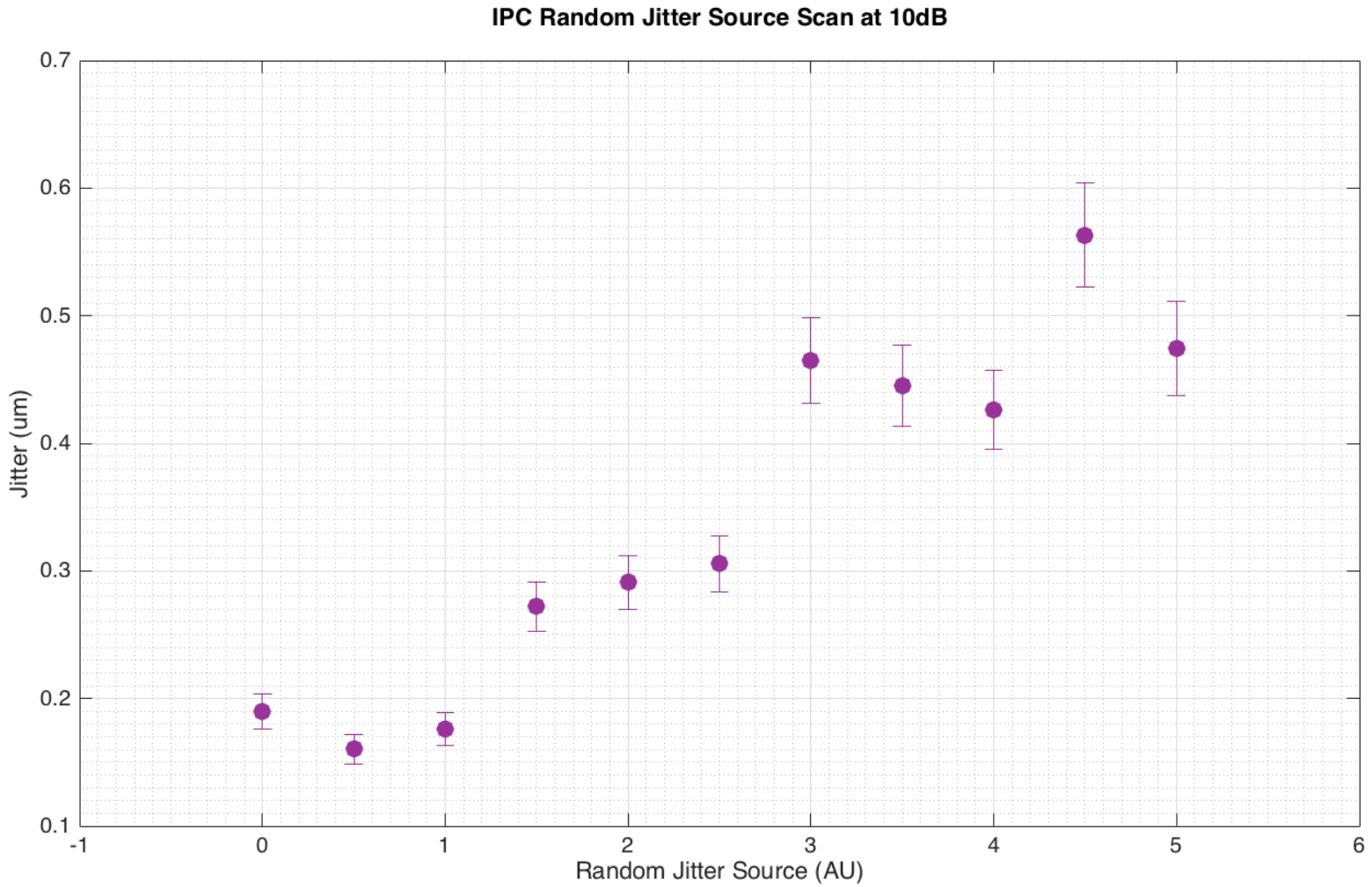
Att (dB)	Jitter (um)
0	0.19 ± 0.01
10	0.27 ± 0.02
20	0.38 ± 0.03
30	1.08 ± 0.08
40	3.6 ± 0.3
50	12.5 ± 0.9
60	36 ± 3
70	113 ± 8



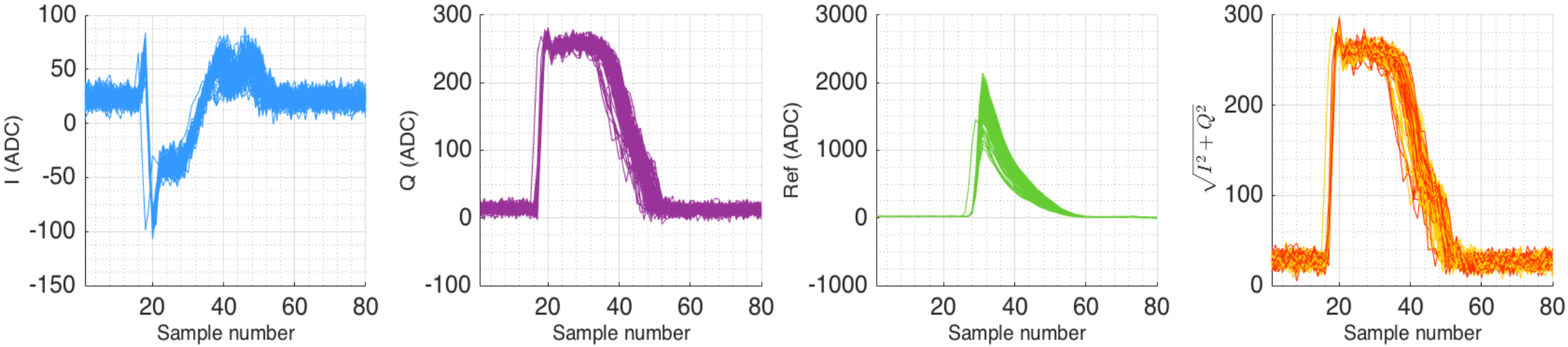
IPC jitter at 10dB with random jitter source scan upstream

Turned on the random jitter source upstream and took IPC jitter measurements at different levels.

Random Jitter Source Strength (AU)	Jitter (um)
0	0.19 ± 0.01
0.5	0.16 ± 0.01
1.0	0.17 ± 0.01
1.5	0.27 ± 0.02
2.0	0.29 ± 0.02
2.5	0.31 ± 0.02
3	0.47 ± 0.03
3.5	0.46 ± 0.03
4	0.43 ± 0.03
4.5	0.56 ± 0.04
5	0.47 ± 0.04



Noise floor measurements with 70dB attenuation on dipole



- Use calibrations taken at different attenuations to convert the jitter of this file into IPC position jitter i.e. an estimate of the noise floor at different attenuations at IPC.

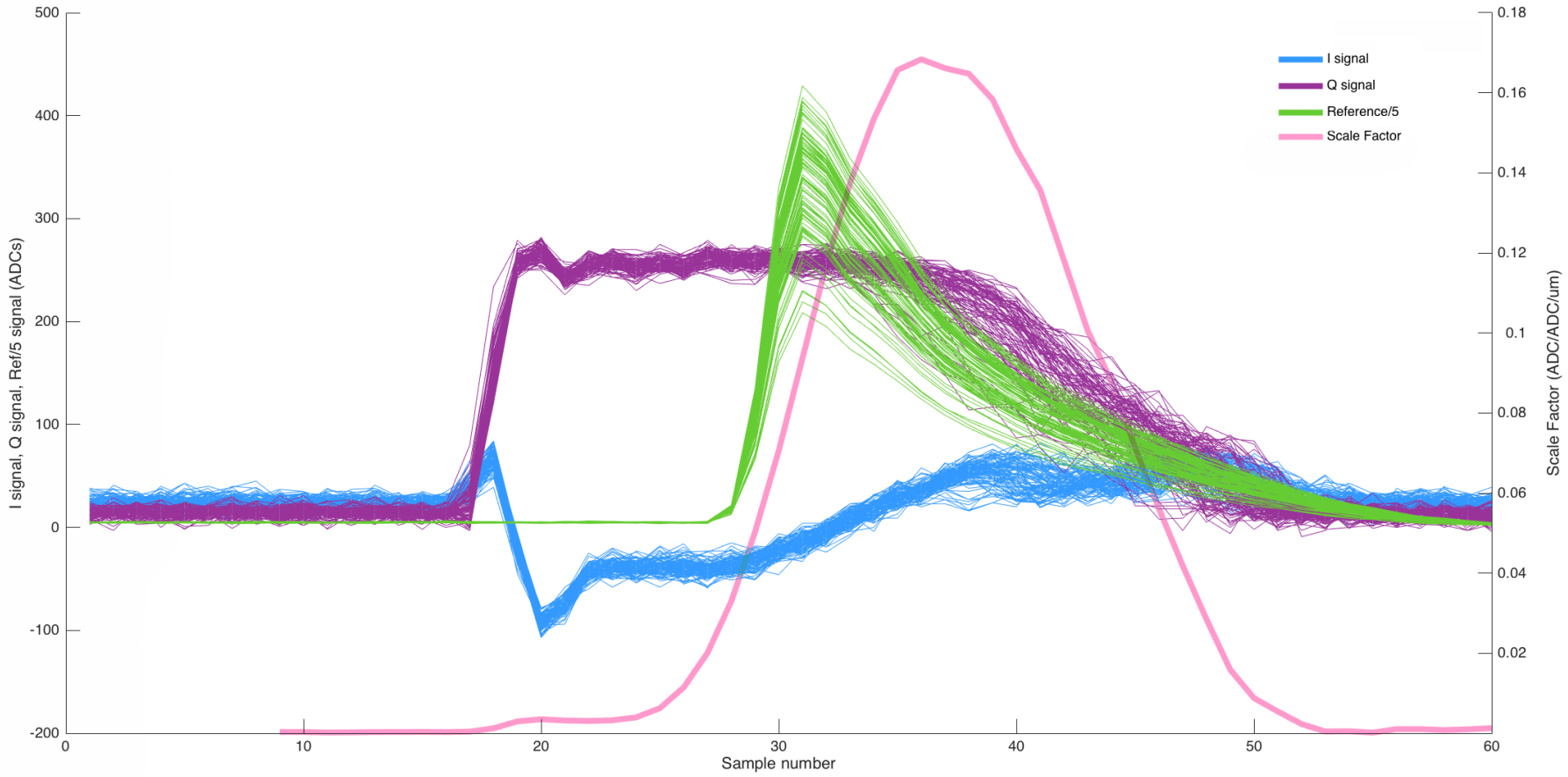
Noise floor measurements with 70dB attenuation on dipole

Overlay plots of

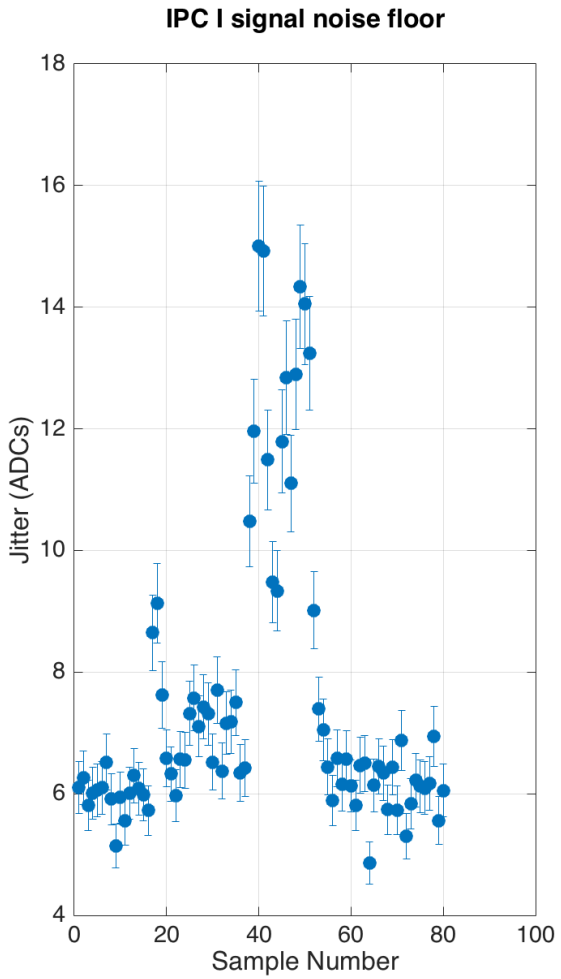
- I signal
- Q signal
- Referennce / 5
- Scale factor (calculated using 0dB calibration)

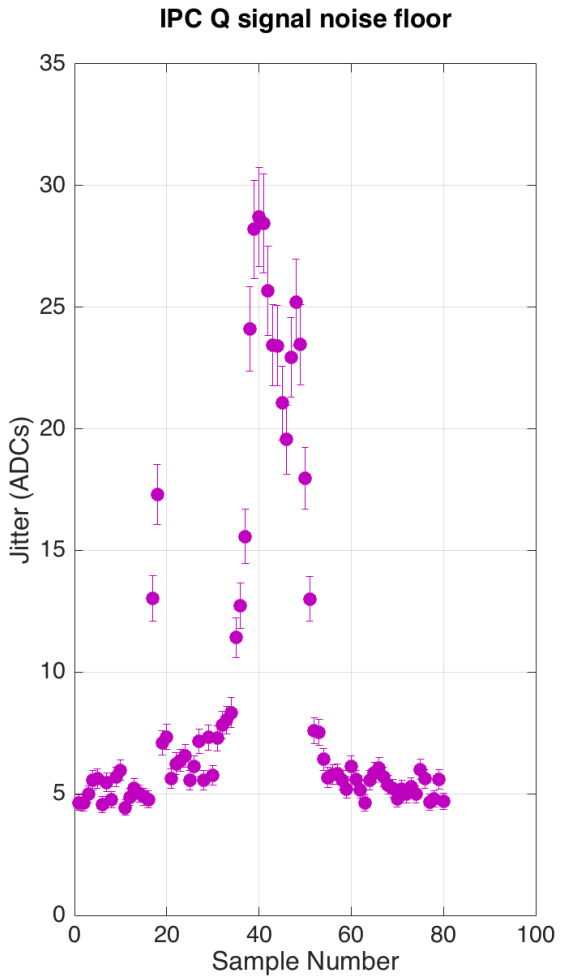
to compare the timing and amplitude of the different waveshapes.

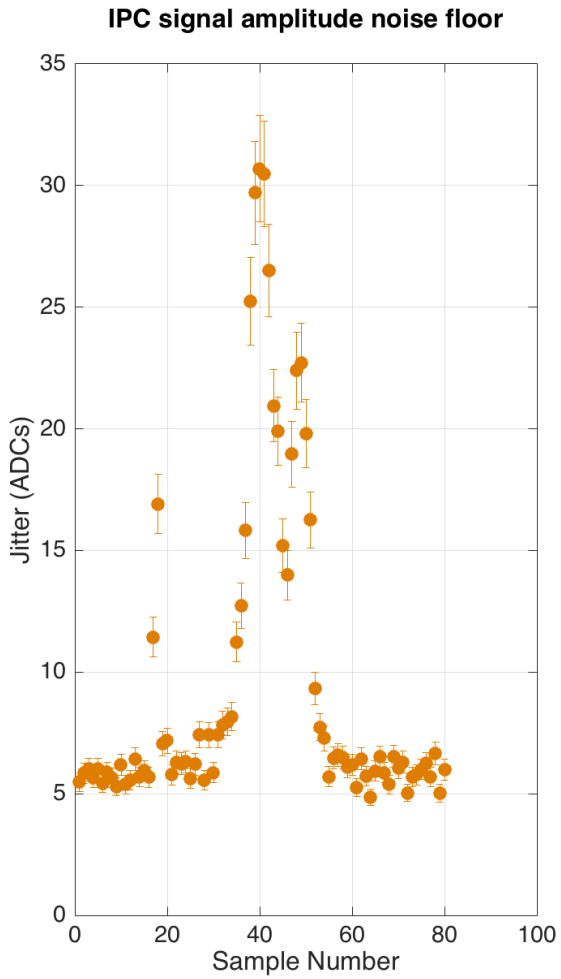
Note: Reference monitor signal is delayed by ~ 42 ns (15 samples) relative to the reference signal going into the second stage mixer using delay cables to account for the delay introduced on the dipoles because of the BPFs.



Noise floor in ADCs in the I and Q signals







Plot shows the jitter of the 70 dB data set in ADCs as a function of sample number along the pulse.

I Signal
Q Signal
$\sqrt{(I^2+Q^2)}$

Week 1
Shift 2 – 3-BPM Resolution Study

- High-beta optics, two bunches.
- Centre the beam in X and Y in all three BPMs using the IP mover system.
- Jitter run + calibrate all three BPMs at (in X and Y) at various attenuations and different charges to calculate the resolution of the IP system.

Summary of shift

- This shift started halfway through the Owl shift, so Okugi-san gave us detailed instructions for changing to high-beta optics. Unfortunately this process is very complex and it took us several hours to resolve issues. Resolved when Okugi-san arrived.

- Accesses required for previously mentioned IP box issues.

- Alignment of all three BPMs took ~ 1 hour, but we now have a system in place for doing this.
  - Place all BPMs at the centre of their mover range.
  - Find the minimum AQD0FF in I/Q in IPA and IPB.
  - Adjust the angle of AB block to minimise difference in minimum signal size AQD0FF current between all four channels.
  - Move the AB block, maintaining the same angle, until it is possible to minimise the signals in IPC simultaneously.
  - Fine tune the angle of the AB block and AQD0FF mover setting to account for new beam trajectory.
  - Use IPC movers to minimise the signal at IPC.
  - Repeat for X and Y.

- Significant beam drift observed on this shift that required frequent re-centering of the beam. (ATF feedback not running?)

- Completed two charge scans and one attenuation scan.

- Attempted to set up the 2-BPM feedback study, but found we could not kick the beam and ran out of time.

Week 2
Shift 1 (& Shift 2a) – Upstream feedback propagation to the IP

- Nominal optics, two bunches, high charge.
- Set-up upstream feedback.
- Measure the feedback jitter correction upstream, and the correction propagated downstream with the IP BPMs.

Summary of shift

- Moved the waist to IPC for IP measurements.

- Frequent trigger (i.e. odd to even trigger) jumps made it difficult to use the LabView automatic scan system to calculate gains. Therefore we had to calculate the gains offline, but they did agree with the online calculations when we eventually managed to obtain an automatic scan without trigger jumps.

- No correction observed at P2 or MFB1FF using coupled loop feedback.
  Ran in single look feedback, and observed good correction with K2P3, but could observe no correction from K1P2.
  After the shift we determined, with Doug's help, that this was due to not having K1 bunch strobe select turned on in the DAQ.

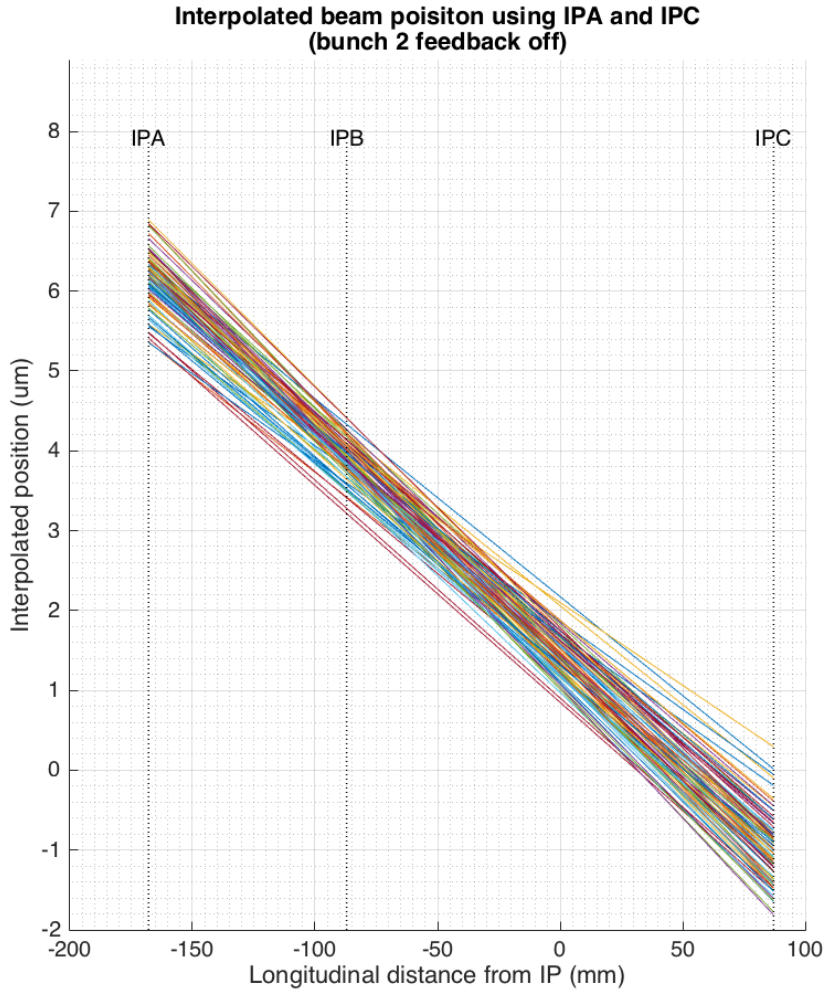
- Decided to use the first half of the final shift to continue this study.
  Feedback correction observed in P2, P3, MFB1FF and at the IP.

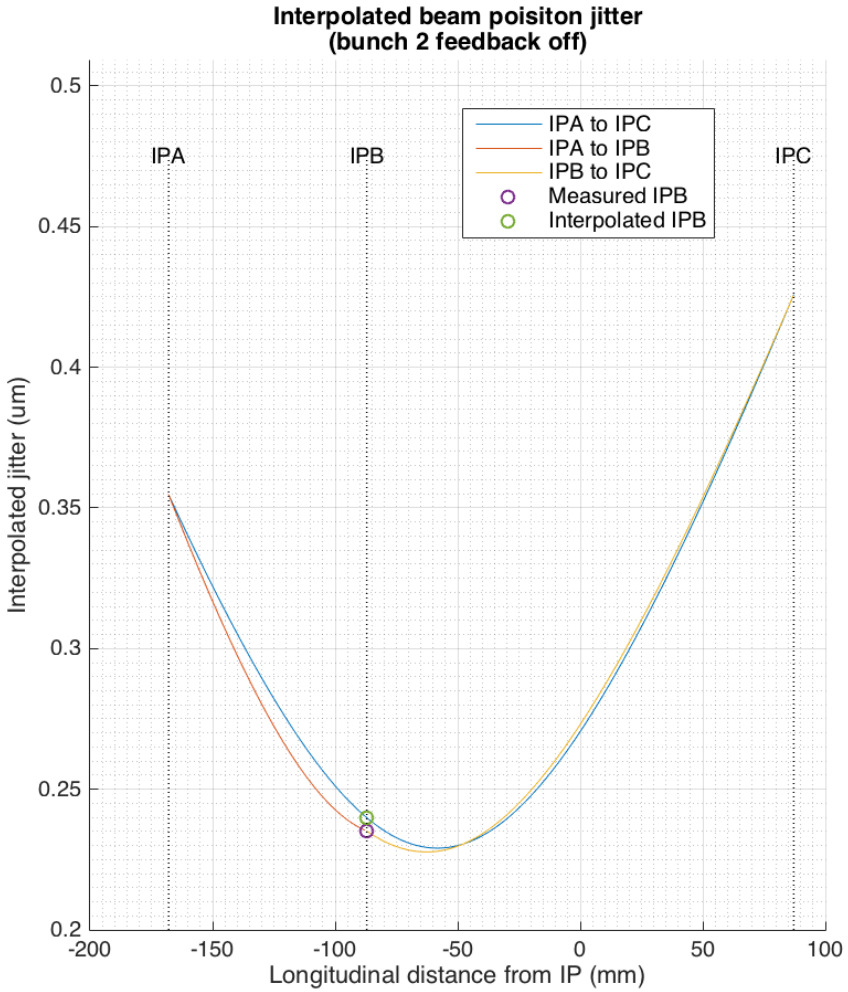
- Permanent sample jumps requiring a board power cycle and re-setup and gain calculation meant there was not time to turn on the random jitter source.

Week 2
Shift 2b – 2BPM IP feedback

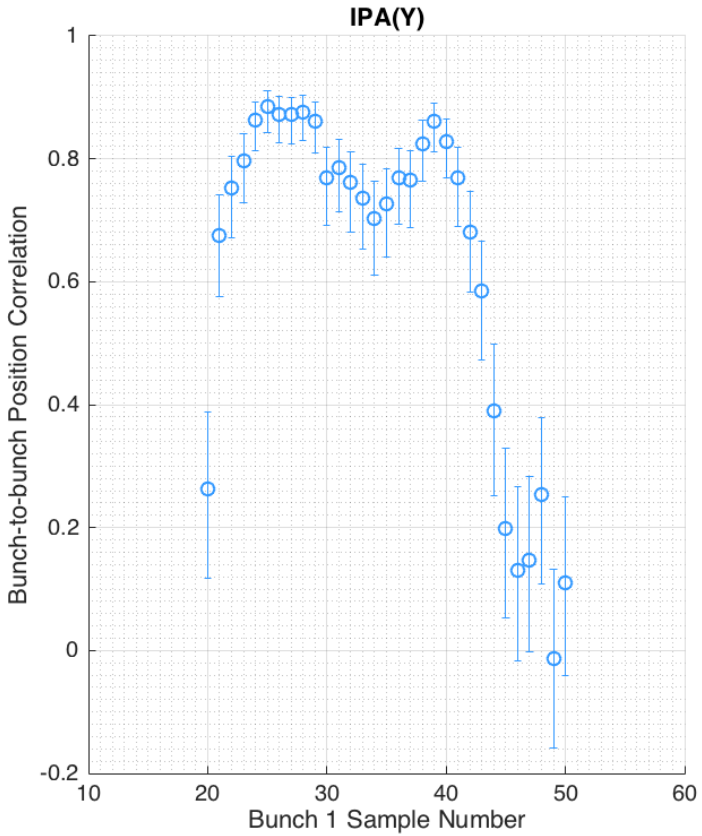
- High-beta optics, two bunches.
- Move the waist near to IPB.
- Centre the beam in X and Y in all three BPMs using the IP mover system.
- Measure the bunch-to-bunch correlation as a function of sample number.
- Set-up 2 BPM IP feedback using IPA and IPC to correct at IPB using optimal sampling.

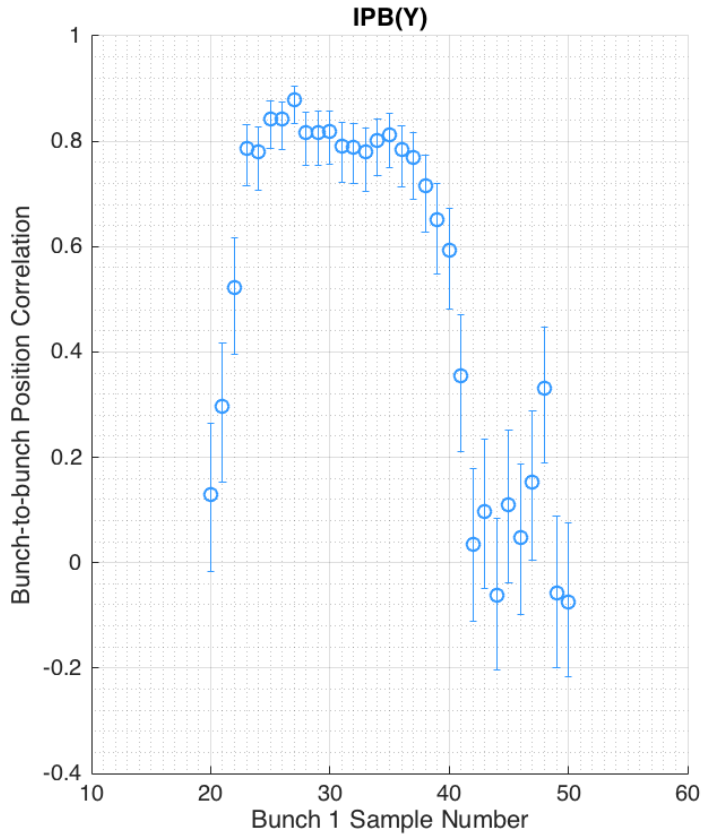
Waist location and jitter at IPA, IPB and IPC

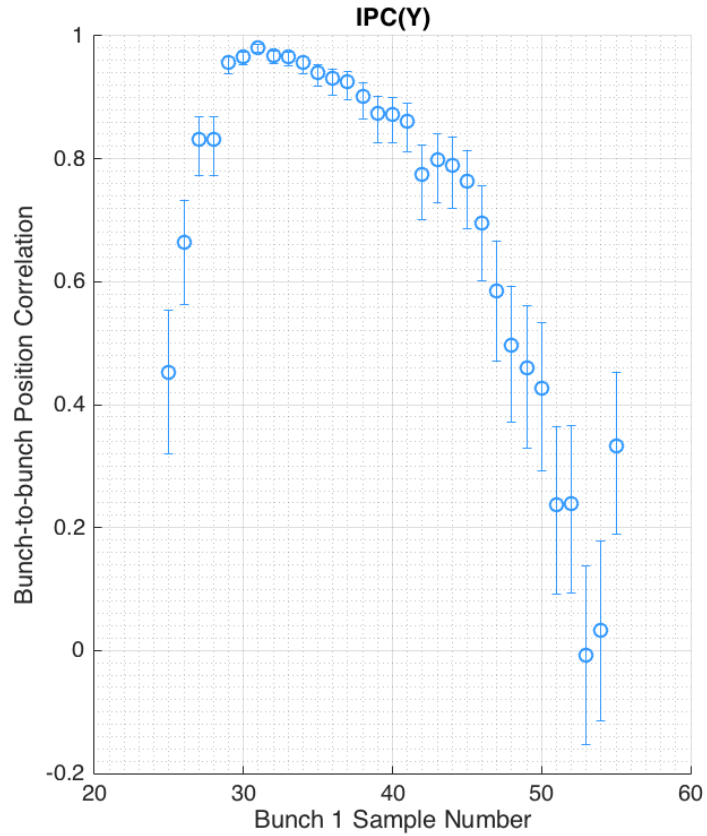




Bunch-to-bunch correlation as a function of sample number

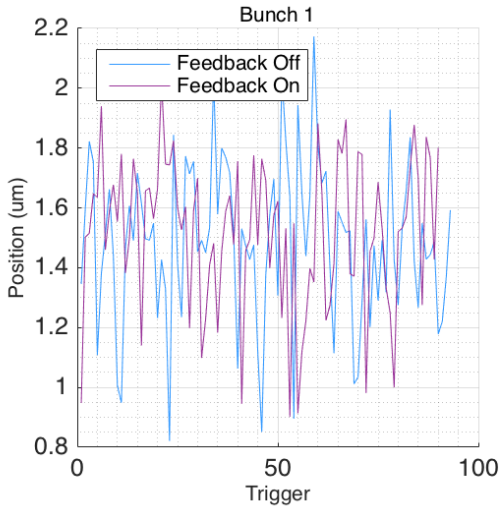


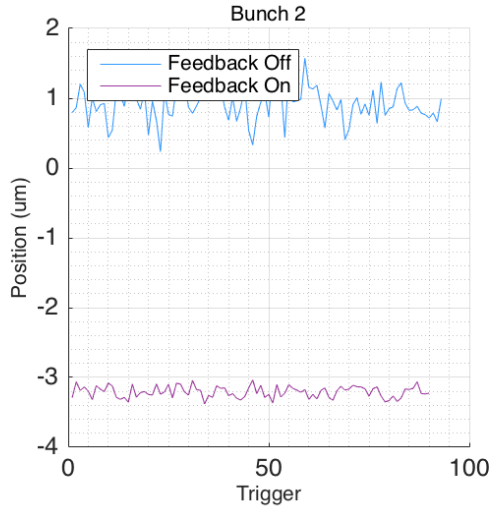


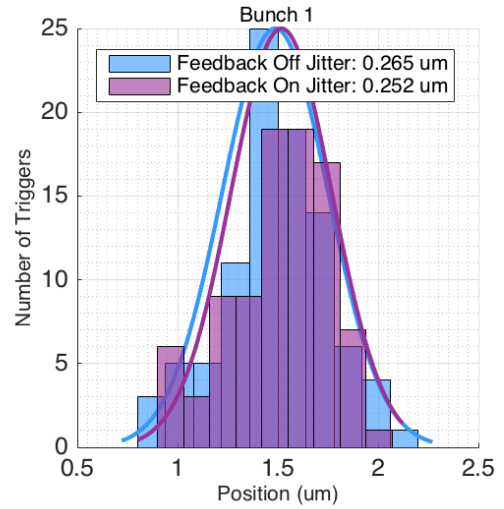


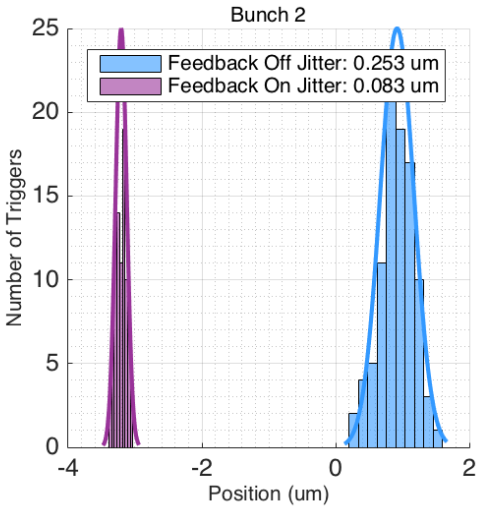
- Highest correlation at samples 25 / 25 / 30. Select these for feedback. (Note: IPC is 5 samples later than IPA and IPB)

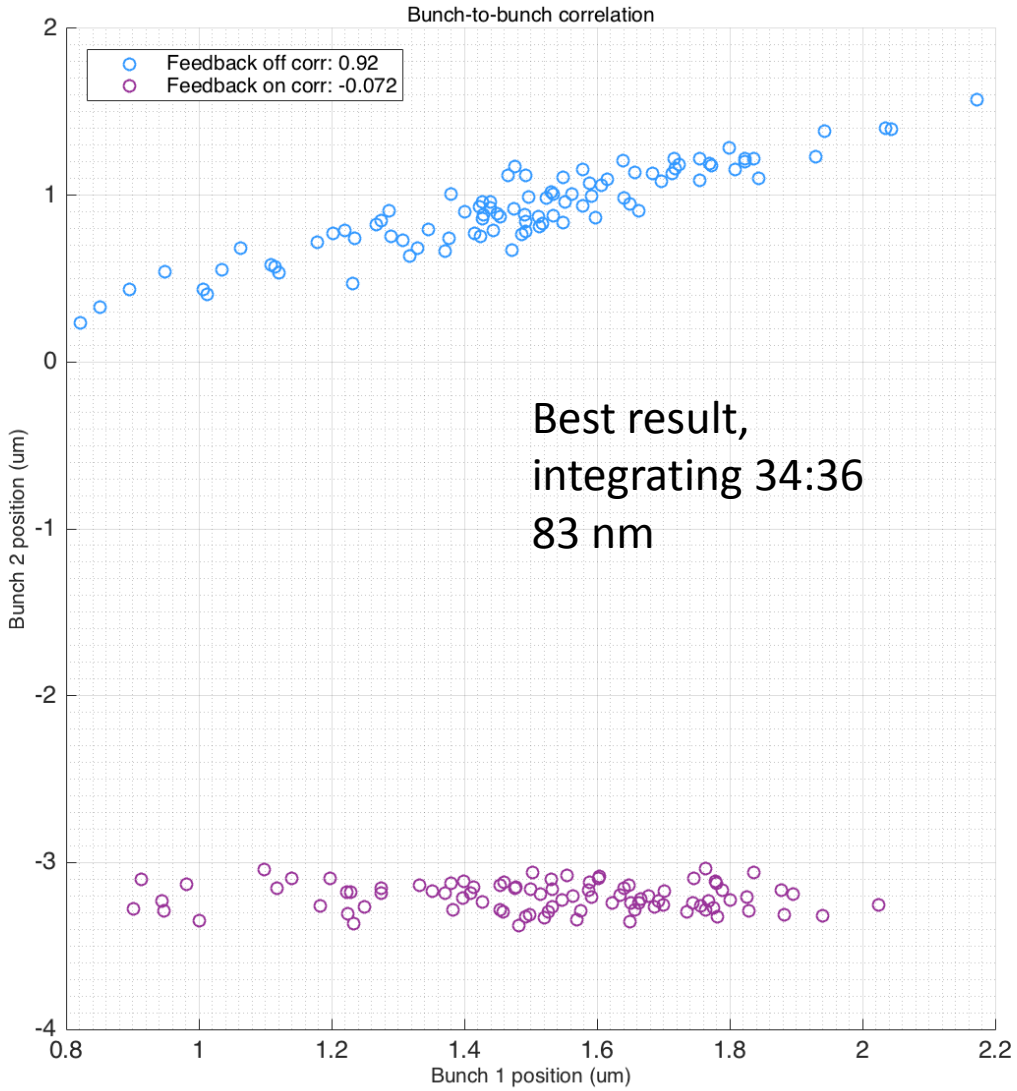
IP BPM Feedback







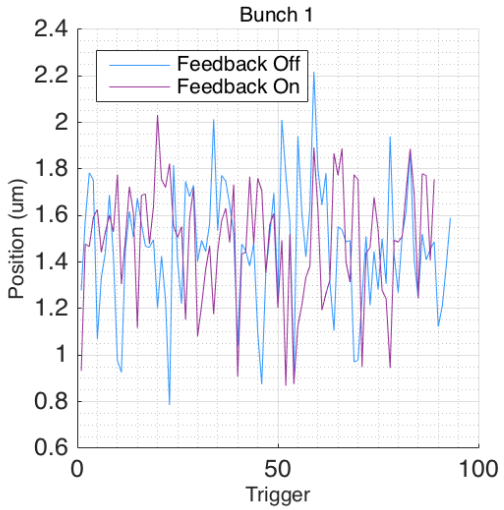


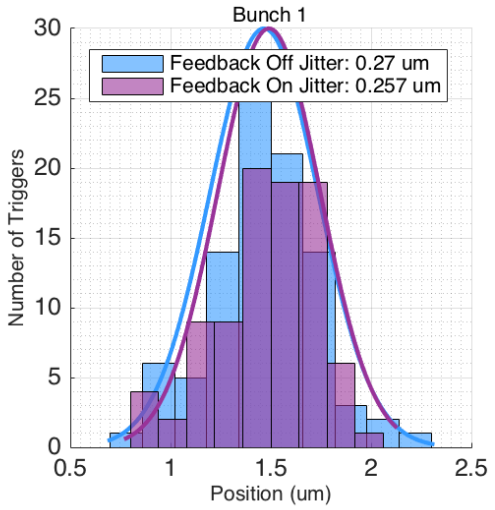


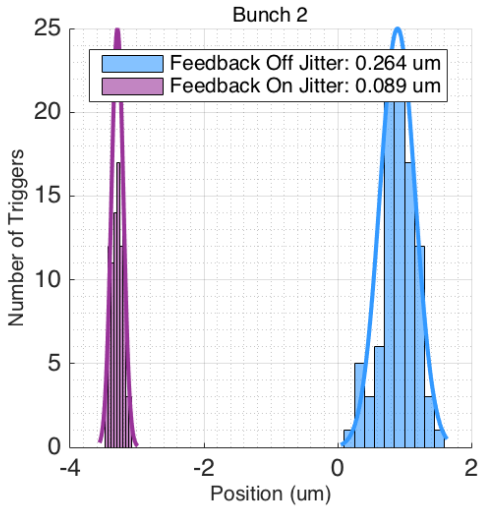
- Geometric resolution: 74 +/- 4 nm.

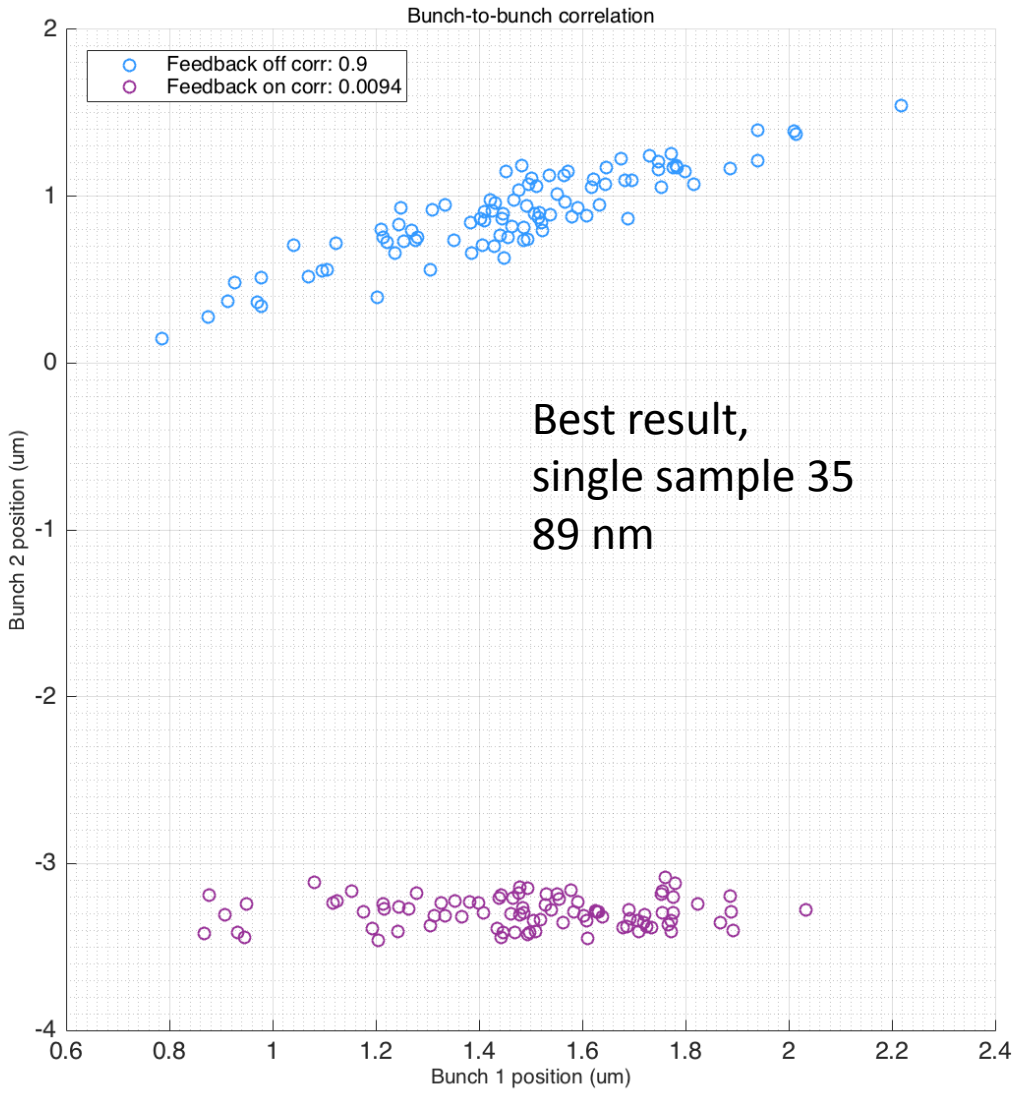
ipfbRun7_10dB_Board1_240217, Integrating samples 34:36, Reference sample 31

IP BPM Feedback







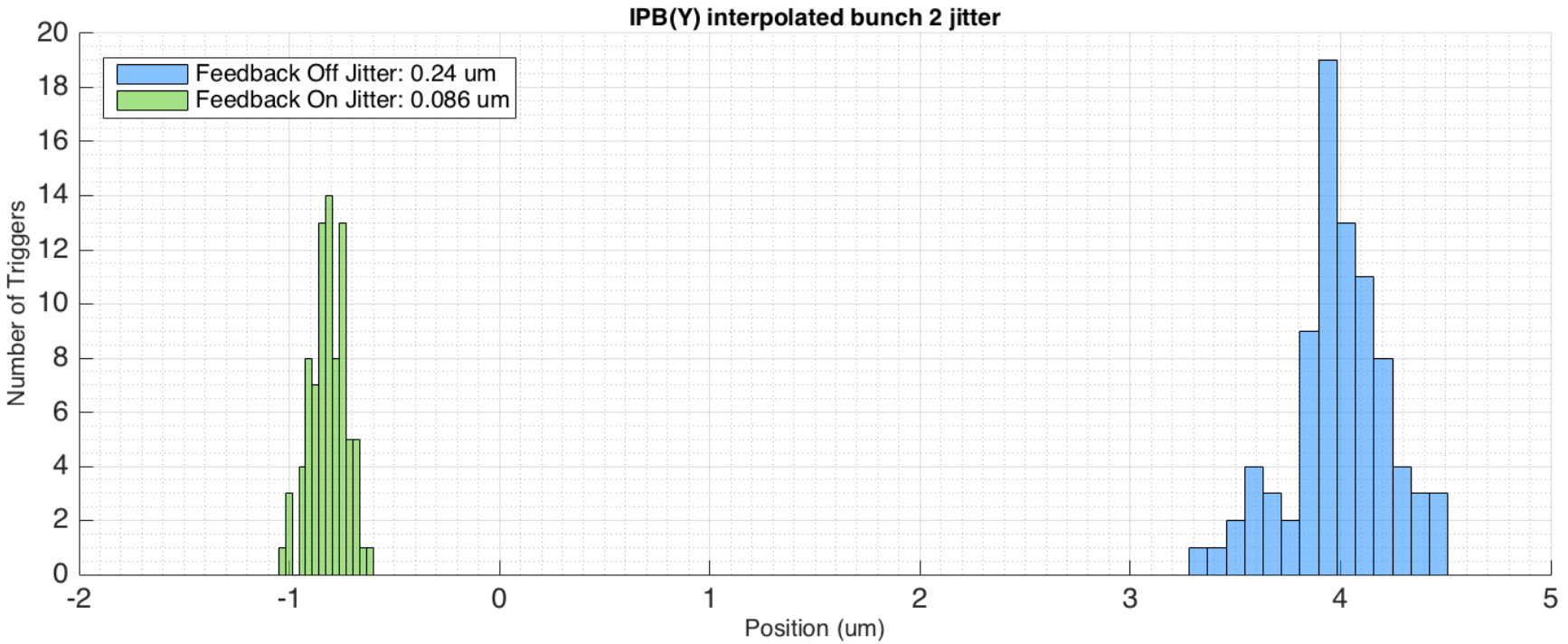


- Geometric resolution: 74 +/- 4 nm.

ipfbRun7_10dB_Board1_240217, samples 35, Reference sample 31

Predicted feedback performance using IPA and IPC

- Using single sample, predicts correction to 86 nm.



Equipment brought back to Oxford

- FONT5 #1
  - the power connection is very fragile
- FONT5A #4
  - to reconfigure for Aux Out C
- IP Kicker amplifier
  - sporadic clicking observed with no trigger input
- USB serial server
  - at Glenn's request