ATF May & June

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Outline

- Summary of June Shifts
- Operational updates
  - Digitiser stabilisation
  - Movers and BPM alignment
  - 2^{nd} stage mixer optimisation
  - Reference attenuation scan
- Low charge resolution studies:
  - With C-band BPFs - dipole attenuation scan
  - No BPFs - dipole attenuation scan
- Resolution vs charge
- Resolution vs position
- Detailed look at best resolution from May

SUMMARY OF JUNE SHIFTS

- - - - - - - - - - - - WEEK 1 - - - - - - - - - - - -

- **New firmware / DAQ debugging** (nominal optics, 2 bunch-mode)
  - Single sample and integration feedback runs.

- **Resolution Studies** (high-beta optics, half of shift with 2 bunches for Alexey)
  - Low charge resolution studies with and without BPFs
  - Reference attenuation scan

- **Octupole study** with Fabien and Jonas - Resolution vs position

- - - - - - - - - - - - WEEK 2 - - - - - - - - - - - -

- **New firmware studies** (nominal optics, 2-buch mode)
  - Gain scan
  - Two-BPM feedback

- **Resolution Studies** (high-beta optics)
  - Resolution vs charge
  - Resolution vs waist position.

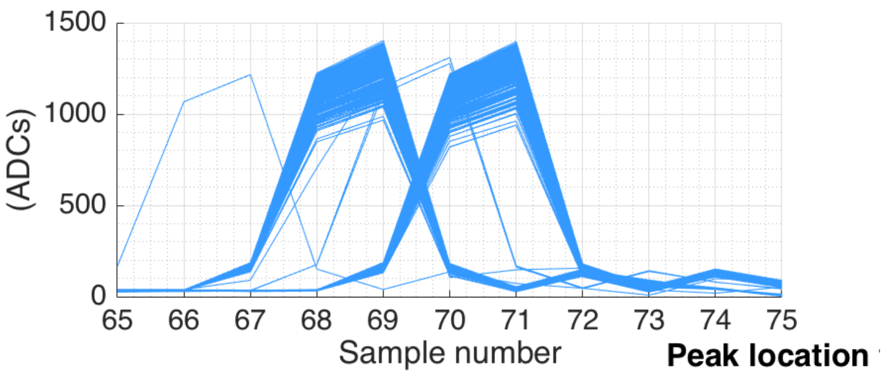
Operational updates

- Digitiser stabilisation
- Movers and BPM alignment
- 2nd stage mixer optimisation
- Reference attenuation scan

Digitisation stabilisation

On previous trips we had been observing frequent visible shifts of the beam pulse location within our digitised sampling window. This included:

- Large, permanent sample jumps (occurs on all digitiser boards, but not by the same numbers of samples)
- Rapid back-and-forth between two locations (occurs on different boards and different banks)
- Single sample jumps (occur on all banks)



- Suggested this may be due to low or unstable power supplies to the digitiser.

- A 250W 100V to 230V transformer was installed at the IP on the power supply to the FONT digitiser in May and seems to have resolved the issue.

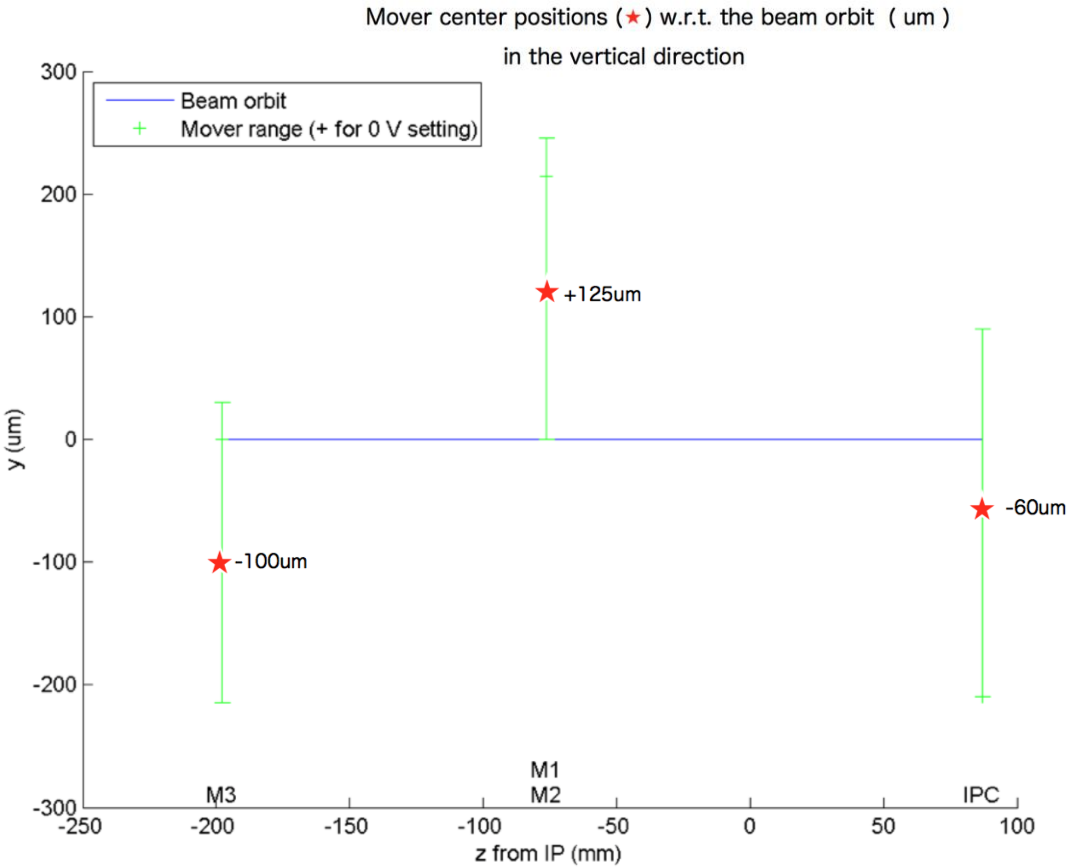
Movers & BPM alignment

- The M3 mover on the IP AB block is not functioning correctly, so was disconnected for the entire run, and all calibrations were performed using AQD0FF magnets.

- Many electronics tests performed - issue isolated to being inside the IP chamber.

- Fortunately we were still able to align all three IP BPMs successfully with this mover disabled.

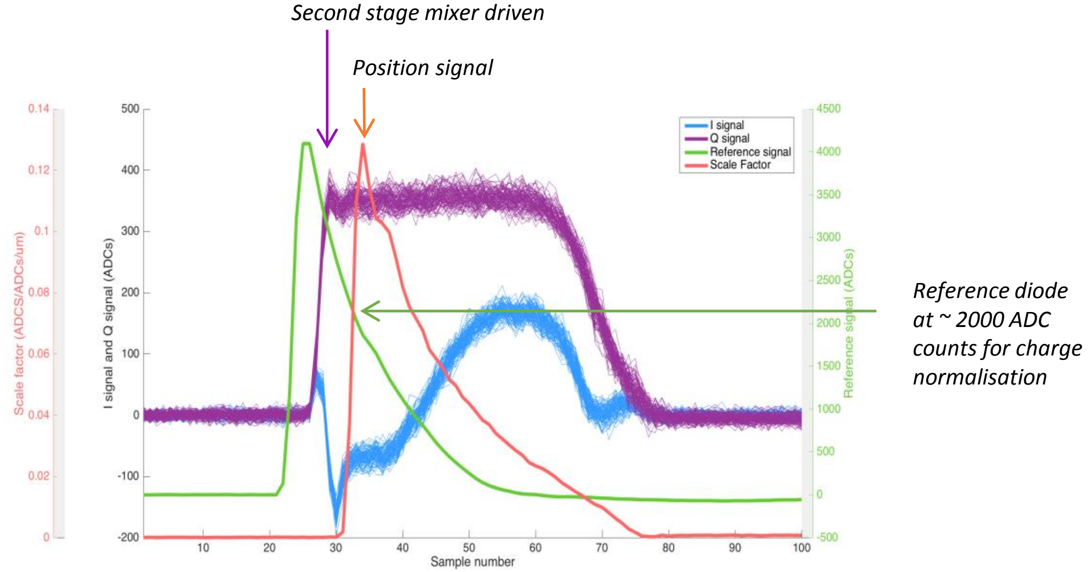
- Alignment seems to have been successfully restored from before BPM removal.



Plot by Neven and Tauchi-san

2nd Stage Mixer Optimisation

- Delay cables introduced on the reference signal to **ensure the second-stage processing mixer is driven at the correct time**.



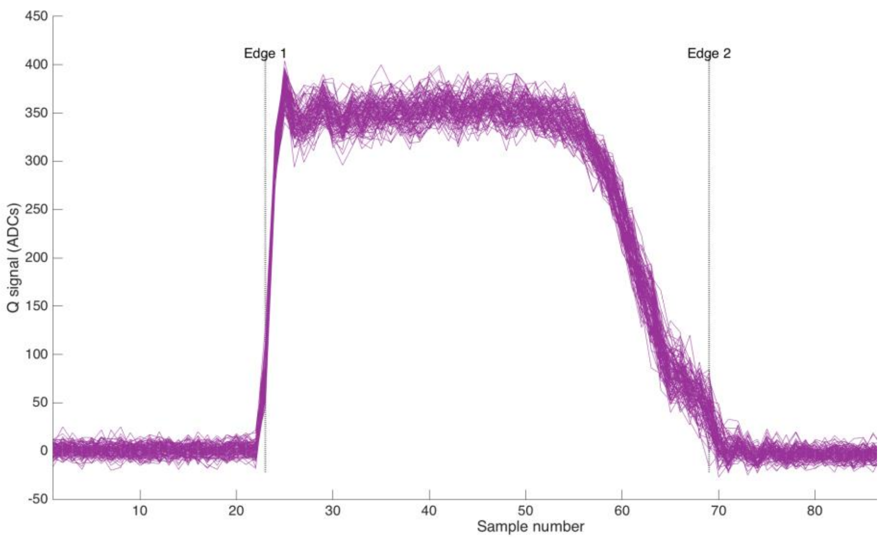
- Now systematically taking 70dB-dipole-attenuation data sets at the beginning of every shift for mixer **baseline subtraction** in analysis.

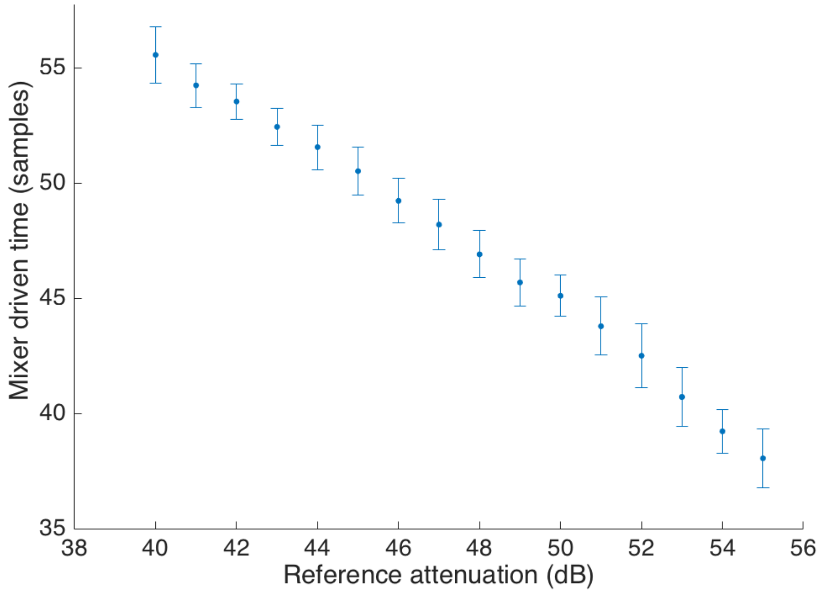
- Make sure **power levels into the mixer** are high enough:

Reference should be as close as possible to optimal level of **2000 ADCs** (defined by Honda's electronics tests & with 6dB introduced on the intensity monitor).

Reference attenuation scan

- In May we tried varying the attenuation on the reference used to drive the mixer and measured the length of time the mixer was driven at different settings.
- Used the Q mixer signal, as it has the clearest step.
- Identify edge 1 and edge 2 from when the signal rises above or falls below 10% of the maximum of the step.
- Clear dependence on mixer driven time and reference attenuation, as expected.

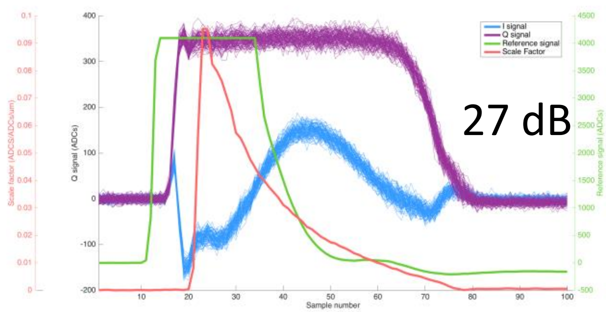


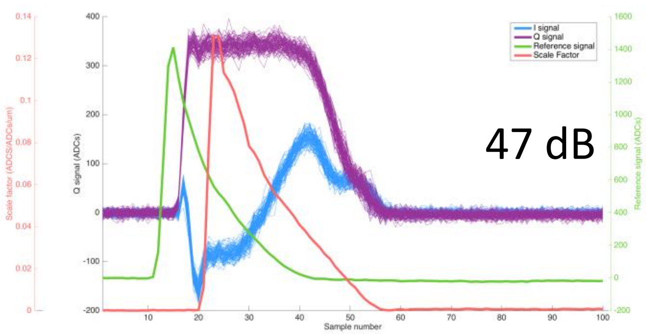


Reference attenuation scan

- In May we tried fine-tuning the reference attenuation to improve resolution, but results were inconclusive, so in June we performed a larger scan of reference attenuations.
- This study was performed with no BPFs, charge ~0.15×10^{10}.
- Reference attenuations: 27, 32, 37, 42, 47.

  Example mixer baselines:



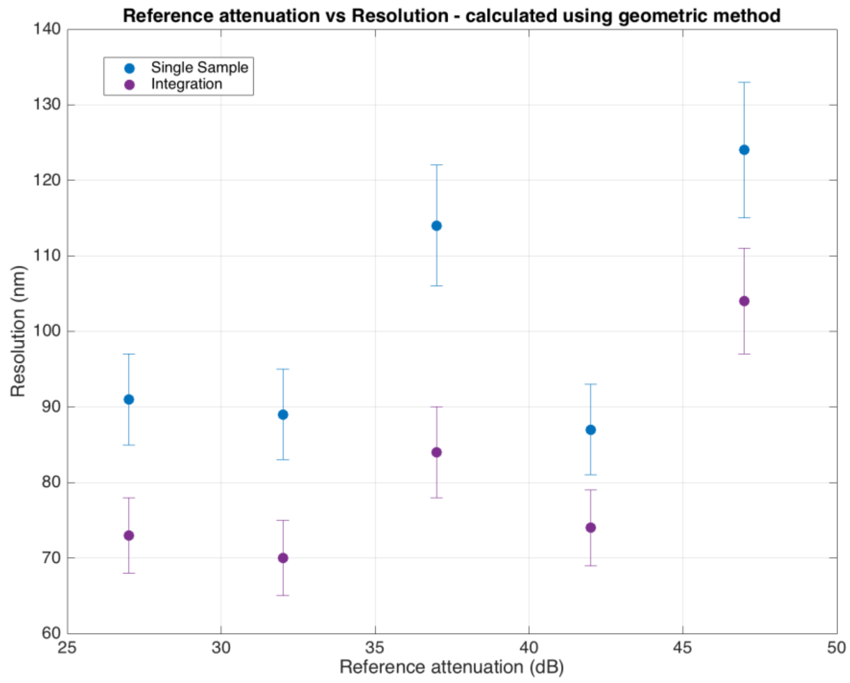


- As the attenuation is increased the length of time the mixer is driven decreases, as shown before. Reference ~2000 ADC counts is thought optimal. The sample location of this point also moves.

Ref att (dB)	Length of Q mixer baseline (samples)	Sample number where ref ~ 2000
27	60	38
32	53	31
37	48	23
42	42	17
47	36	15

Resolution vs ref attenuation

- This study was performed with no BPFs, charge ~0.15 x 10^{10}.
- The sample numbers for each data point have been optimised for lowest resolution (see table).
- Resolutions calculated using geometric method.

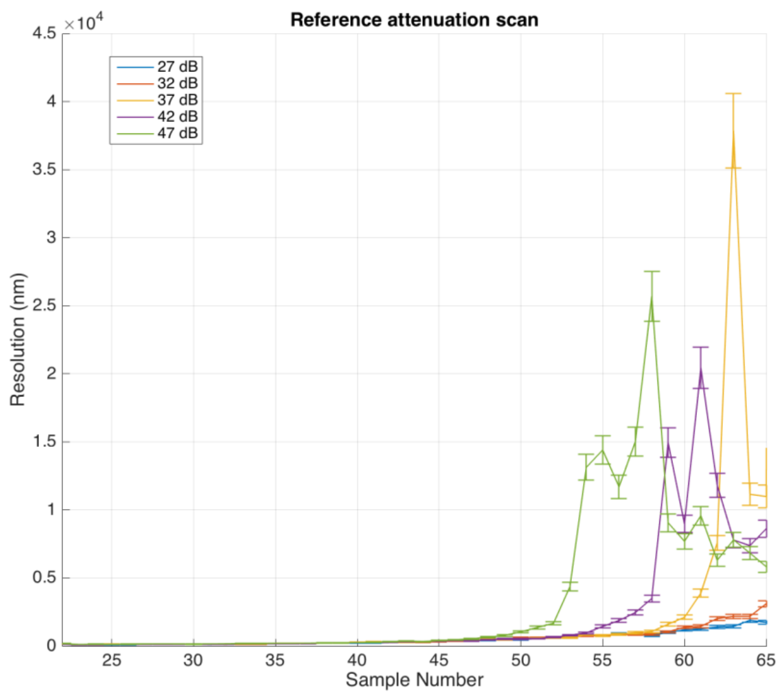


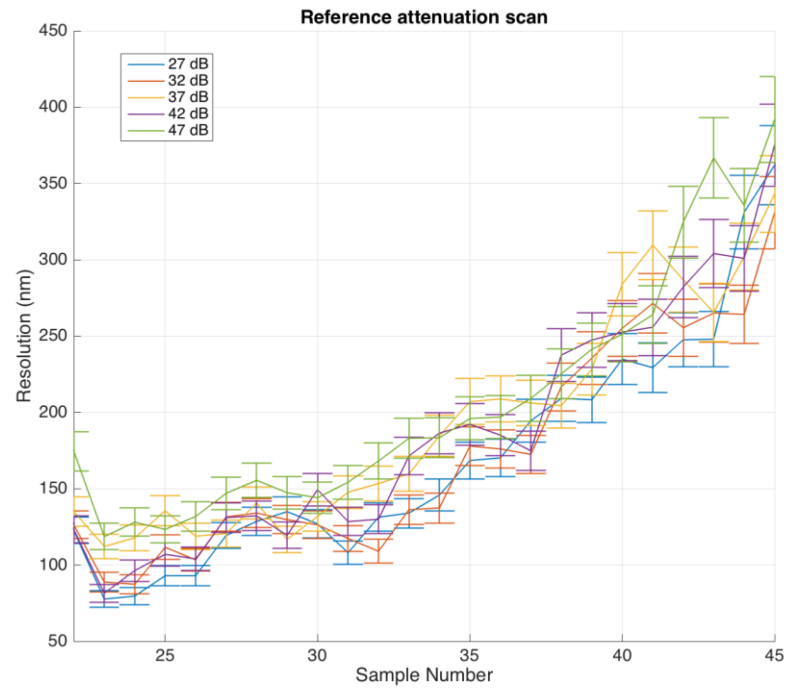
Ref att (dB)	Resolution (nm) – single sample	Uncertainty (nm)	Sample number used
27	91	6	24
32	89	6	24
37	114	8	23
42	87	6	23
47	124	9	23

Ref att (dB)	Resolution (nm) - integration	Uncertainty (nm)	Sample numbers used
27	73	5	23 - 32
32	70	5	22 - 34
37	84	6	22 - 33
42	74	5	22 - 26
47	104	7	22 - 38

Resolution vs ref attenuation

- Resolution as a function of sample number for different reference attenuations.
- Clear that resolution degrades faster in the tail of the pulse when the attenuation is higher, as the mixer is not driven long enough (plot left). However at the beginning of the pulse there is no clear benefit to a higher or lower attenuation (plot right).



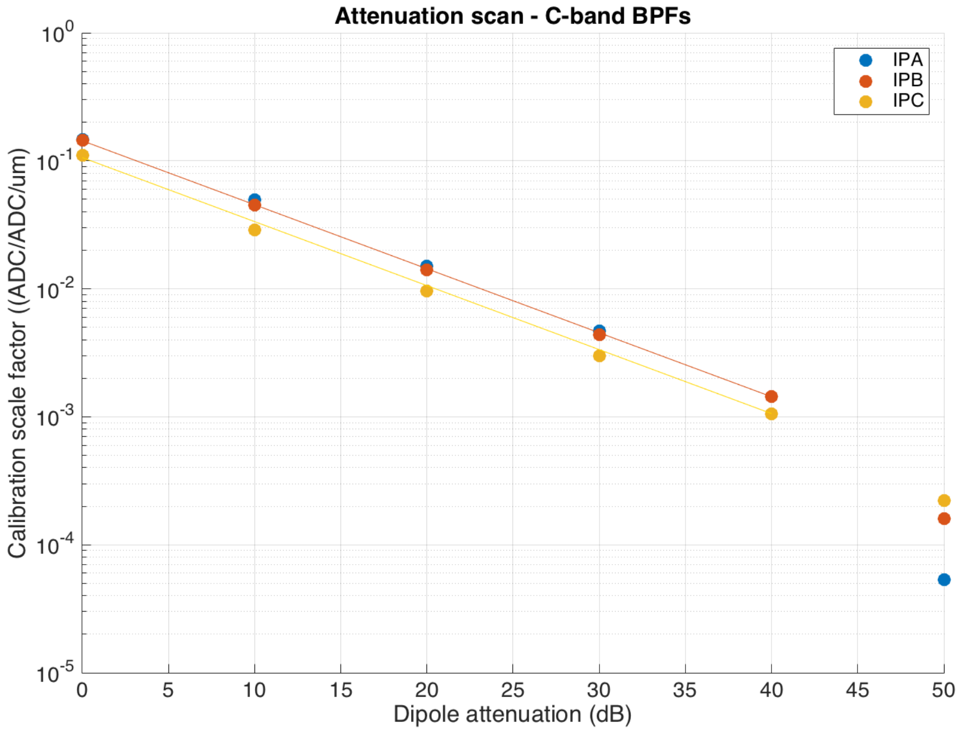


Low charge resolution studies

- With C-band BPFs - dipole attenuation scan
- No BPFs - dipole attenuation scan

Calibration vs dipole attenuation

- This study was performed with C-band BPFs, charge ~0.15 x 10^{10}.
- Used single sample #23 to calculate scale factor from calibration runs at different attenuations.
- Line shows 40dB result extrapolated to 0dB.

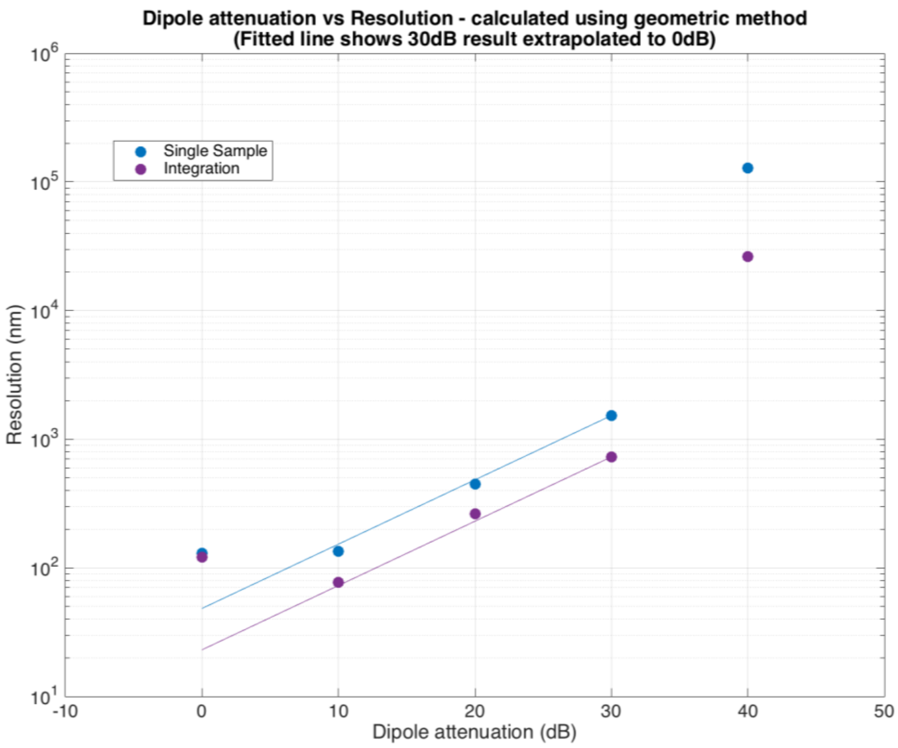


	Calibration Scale Factor ((ADC/ADC)/um)		
Dipole att (dB)	IPA	IPB	IPC
0	-0.15	-0.15	0.11
10	-0.050	0.045	-0.029
20	-0.015	-0.014	-0.0096
30	0.0047	0.0044	-0.0030
40	-0.0014	-0.0014	0.0011
50	-0.000053	-0.00016	0.00022

Signal levels too low on 50dB calibration.

Resolution vs dipole attenuation

- This study was performed with C-band BPFs, charge ~0.15 x 10^{10}.
- The sample numbers for each data point have been optimised for lowest resolution (see table).
- Resolutions calculated using geometric method.



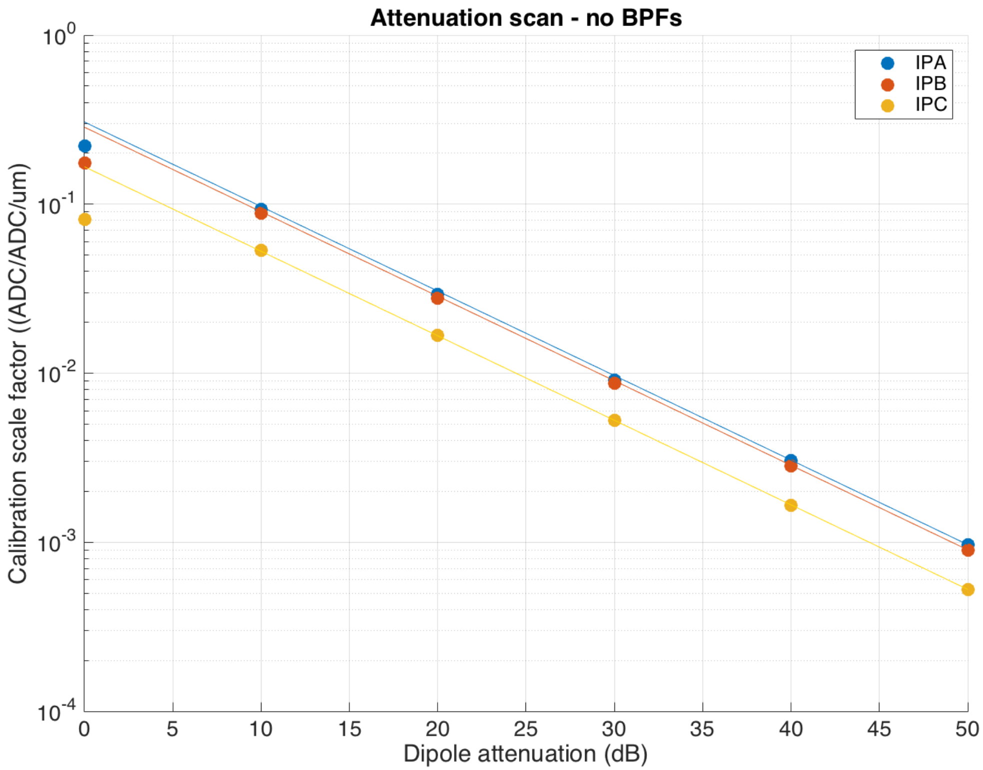
Dipole att (dB)	Resolution (nm) – single sample	Uncertainty (nm)	Sample number used
0	130	10	23
10	135	18	22
20	446	44	23
30	1527	169	23
40	128110	16010	23

Ref att (dB)	Resolution (nm) – integration	Uncertainty (nm)	Sample numbers used
0	121	9	17 - 32
10	77	11	20 - 40
20	263	26	19 - 31
30	728	80	17 - 31
40	26148	3321	25 - 38

Calibration vs dipole attenuation

No BPFs

- This study was performed with no BPFs, charge ~0.15 x 10^{10}.
- Used single sample #26 to calculate scale factor from calibration runs at different attenuations.
- Line shows 40dB result extrapolated to 0dB

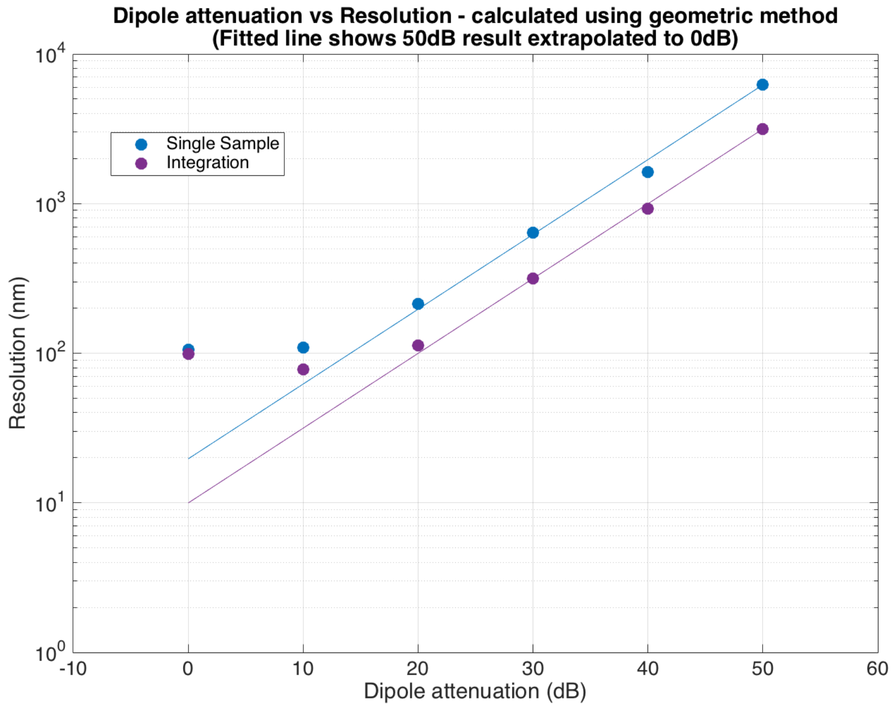


	Calibration Scale Factor ((ADC/ADC)/um)		
Dipole att (dB)	IPA	IPB	IPC
0	-0.22	-0.17	0.082
10	-0.093	-0.088	0.053
20	-0.029	-0.028	0.017
30	-0.0091	-0.0087	0.0053
40	-0.0030	-0.0028	0.0016
50	-0.00097	-0.00090	0.00053

Resolution vs dipole attenuation

No BPFs

- This study was performed with no BPFs, charge ~0.15 x 10^{10}.
- Sample numbers for each data point have been optimised for lowest resolution (see table).
- Resolutions calculated using geometric method.



Dipole att (dB)	Resolution (nm) – single sample	Uncertainty (nm)	Sample number used
0	106	8	26
10	109	8	23
20	213	16	23
30	637	46	24
40	1629	121	24
50	6221	451	24

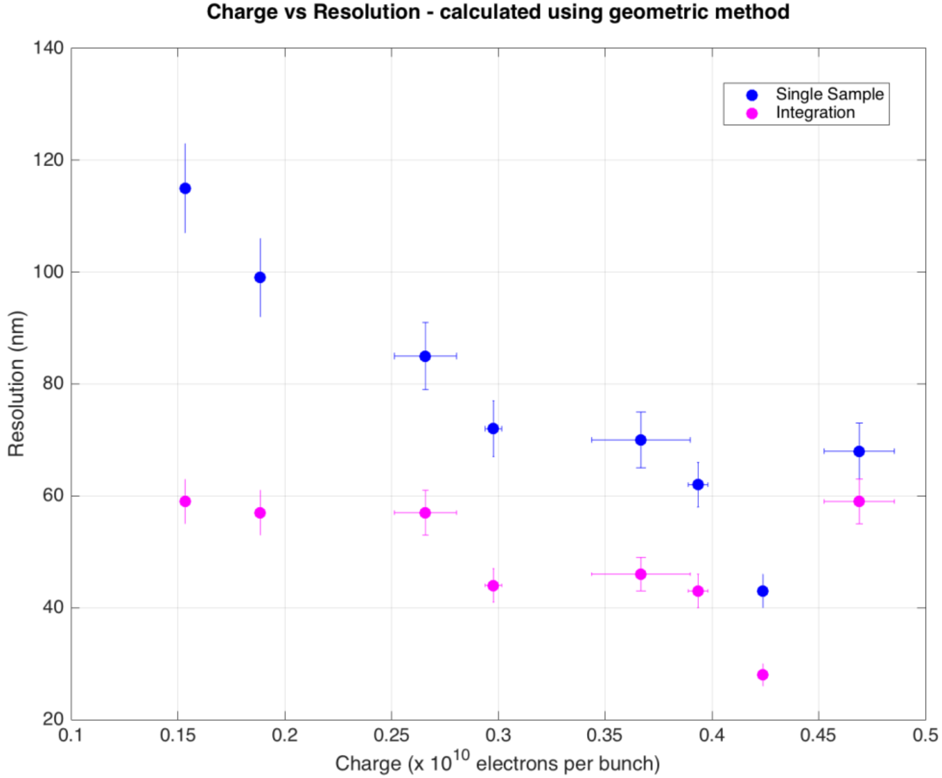
Ref att (dB)	Resolution (nm) – integration	Uncertainty (nm)	Sample numbers used
0	99	7	26 - 43
10	78	5	22 - 33
20	113	8	22 - 37
30	316	22	22 - 38
40	922	67	23 - 34
50	3154	227	22 - 35

Resolution vs charge

Resolution vs charge

- This study was performed with C-band BPF, because static signal was very large on shift and it proved impossible to minimise signals without them.
- Sample numbers for each data point have been optimised for lowest resolution (see table).
- Resolutions calculated using geometric method.

Charge ($\times 10^{10}$ electrons per bunch)	Resolution (nm) – single sample	Resolution (nm) – integration
0.1534	115	59
0.1886	99	57
0.2659	85	57
0.2978	72	44
0.3668	70	46
0.3935	62	43
0.4690	68	59
0.4239	43	28



Resolution vs position

No BPFs

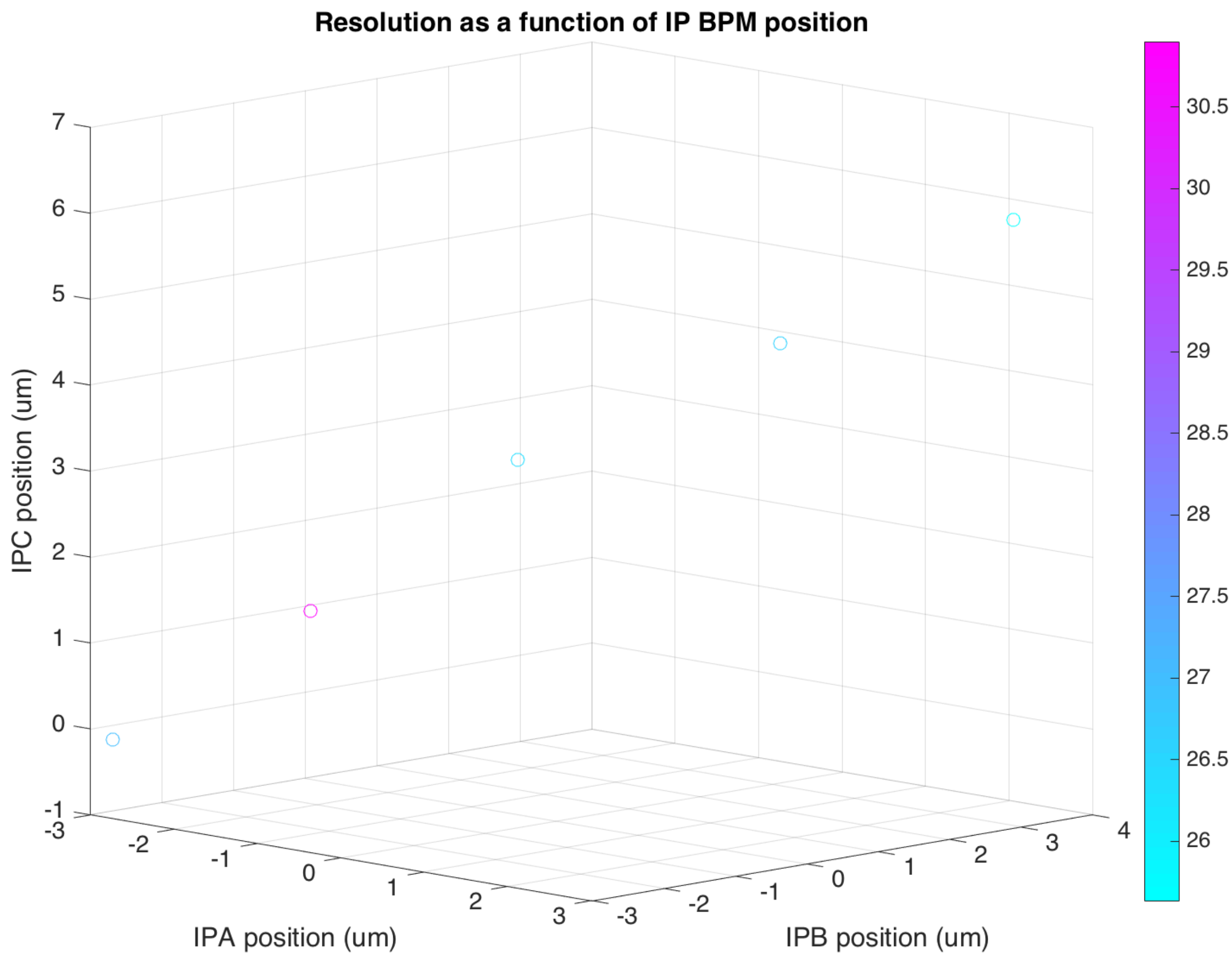
Resolution vs Y position

- Resolutions calculated using geometric method and plotted against the vertical position in IPA, IPB and IPC.
- Data taken from a calibration run changing AQD0FF. Taking 100 triggers per step.

AQD0FF setting	177	178	179	180	181
IPA (um)	-2.94	-1.71	-0.45	1.29	2.81
IPA_s (um)	0.11	0.10	0.09	0.10	0.11
IPB (um)	-2.75	-1.44	0.00	1.64	3.13
IPB_s (um)	0.04	0.03	0.03	0.03	0.04
IPC (um)	-0.15	1.36	3.12	4.54	6.01
IPC_s (um)	0.12	0.11	0.10	0.11	0.12
Resolution (nm)	27.01	30.90	26.36	26.57	25.64
Resolution_s (nm)	1.96	2.22	1.87	1.91	1.83

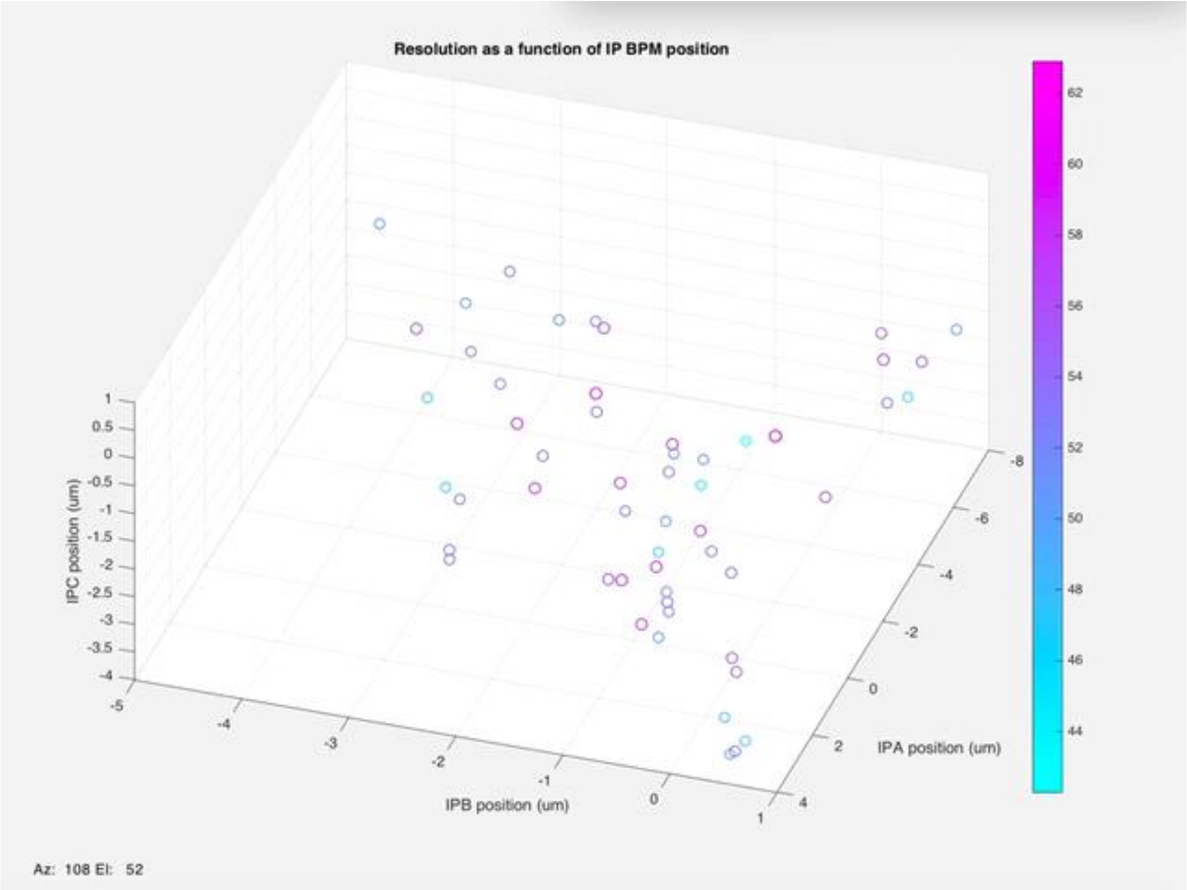
Resolution vs Y position

No BPFs



Resolution vs Y position

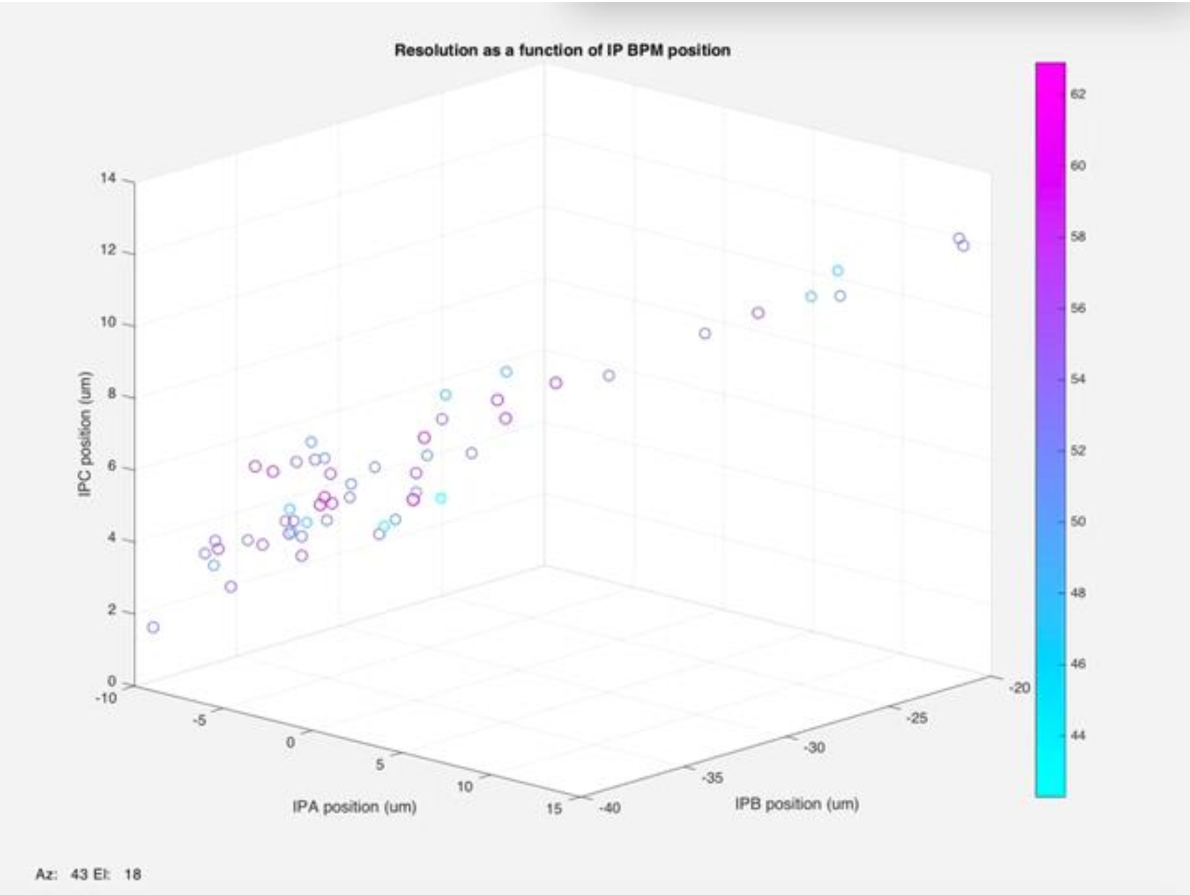
- This study was performed with no BPFs on Fabien and Jonas's Octupole study shift where they intentionally moved the position of the beam small amounts.
- Resolutions calculated using geometric method and plotted against the vertical position in IPA, IPB and IPC.



Resolution vs X position

- This study was performed with no BPFs on Fabien and Jonas's Octupole study shift where they intentionally moved the position of the beam small amounts.

- Resolutions calculated using geometric method and plotted against the vertical position in IPA, IPB and IPC.



Detailed look at best resolution from May

No BPFs

Detailed look at best resolution

Machine set-up:

- Charge ~ 0.5e10
- High-beta optics
- QD0FF = 129.5A
- Jitter IPA = 0.74um; IPB = 0.46um; IPC = 0.24um
- Mean Position IPA = 3.26 um; IPB = 10 um ; IPC = 0.12 um
- Jitter reference ~ 30 ADC counts
- AQD0FF(X) 467 um; AQD0FF(Y) 145 um

BPM set-up:

- Dipole Attenuation: Y = 10 dB; X = 20 dB
- Reference Attenuation: Y = 47 dB; X = 47 dB
- AB (Y) Mover 1: 6.25 V, 2: 6.25 V, 3: powered off 0 V.
  C (Y) Mover C: 8.75 V, D: 8.75 V, E: 6.75 V .

New best resolution result

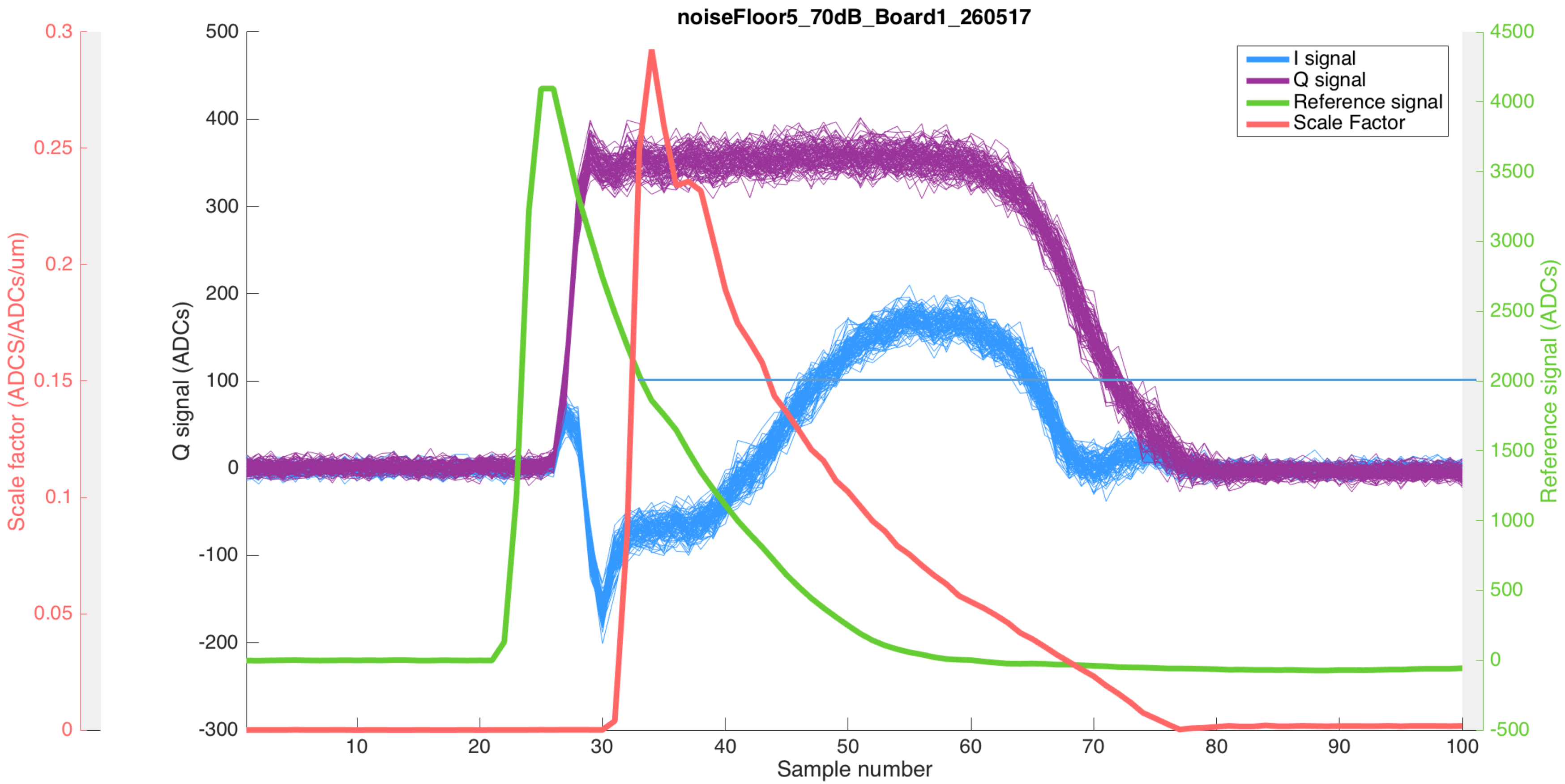
No BPFs

Single sample
Integrating 10 samples

Parameter	Geometric	Fitting	Multi-parameter fits	
No. param	2	3	6	11
Parameters used to predict vertical position at 3rd BPM.	Y1 Y2	Y1 Y2 + const.	Y1I’ Y2I’ Y1Q’ Y2Q’ + Y Ref charge + const.	Y1I’ Y2I’ Y1Q’ Y2Q’ + Y Ref charge X1I’ X2I’ X1Q’ X2Q’ + X Ref charge + const
IPA Res (nm)	47	47	42	40
IPB Res (nm)		47	37	36
IPC Res (nm)		62	32	32
IPA Res (nm)	20	20	19	19
IPB Res (nm)		20	19	19
IPC Res (nm)		21	17	17

Detailed look at best resolution

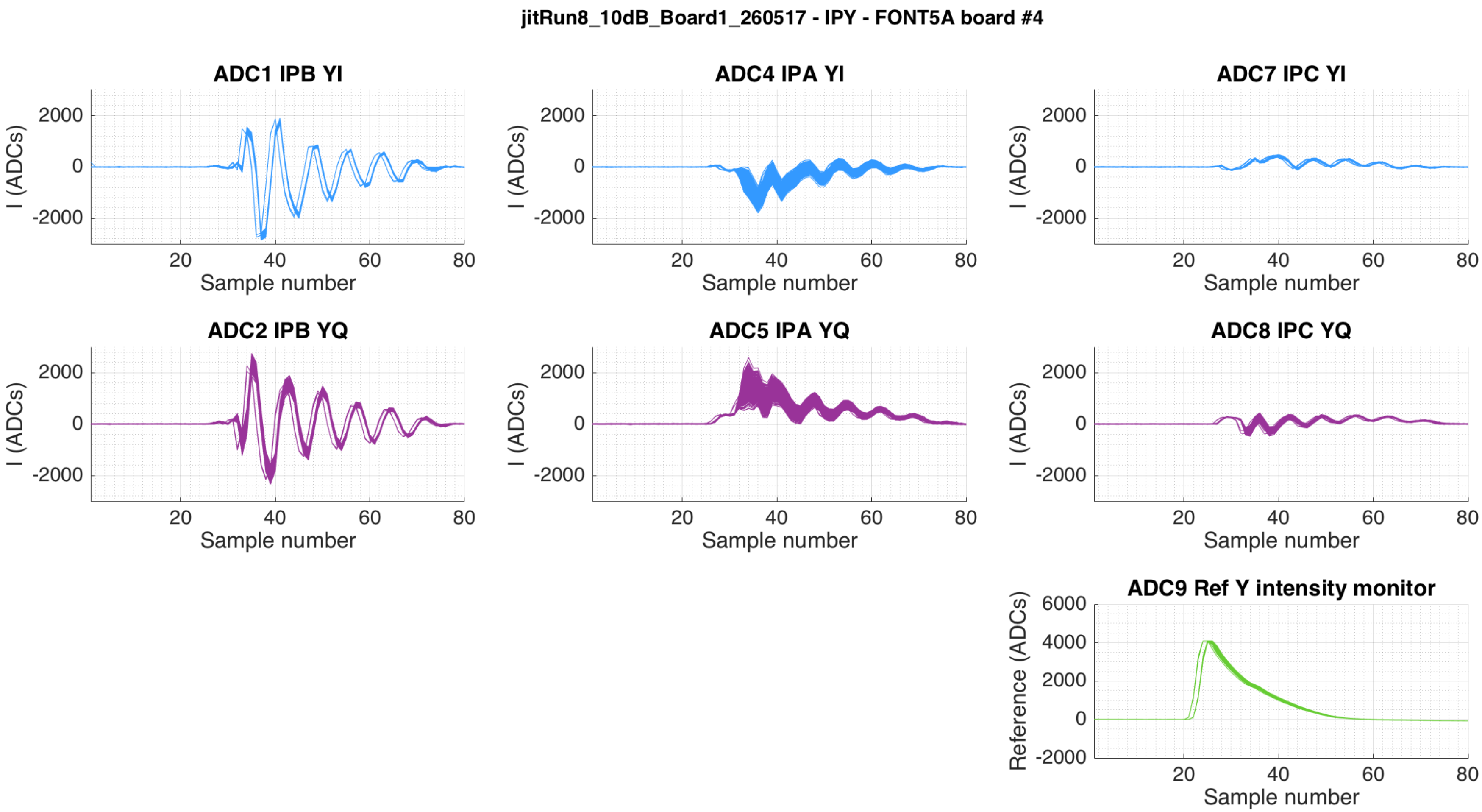
No BPFs



Detailed look at best resolution

Waveforms

No BPFs



No BPFs

Detailed look at best resolution

Calibrations