ATF2 June Shifts Cont.

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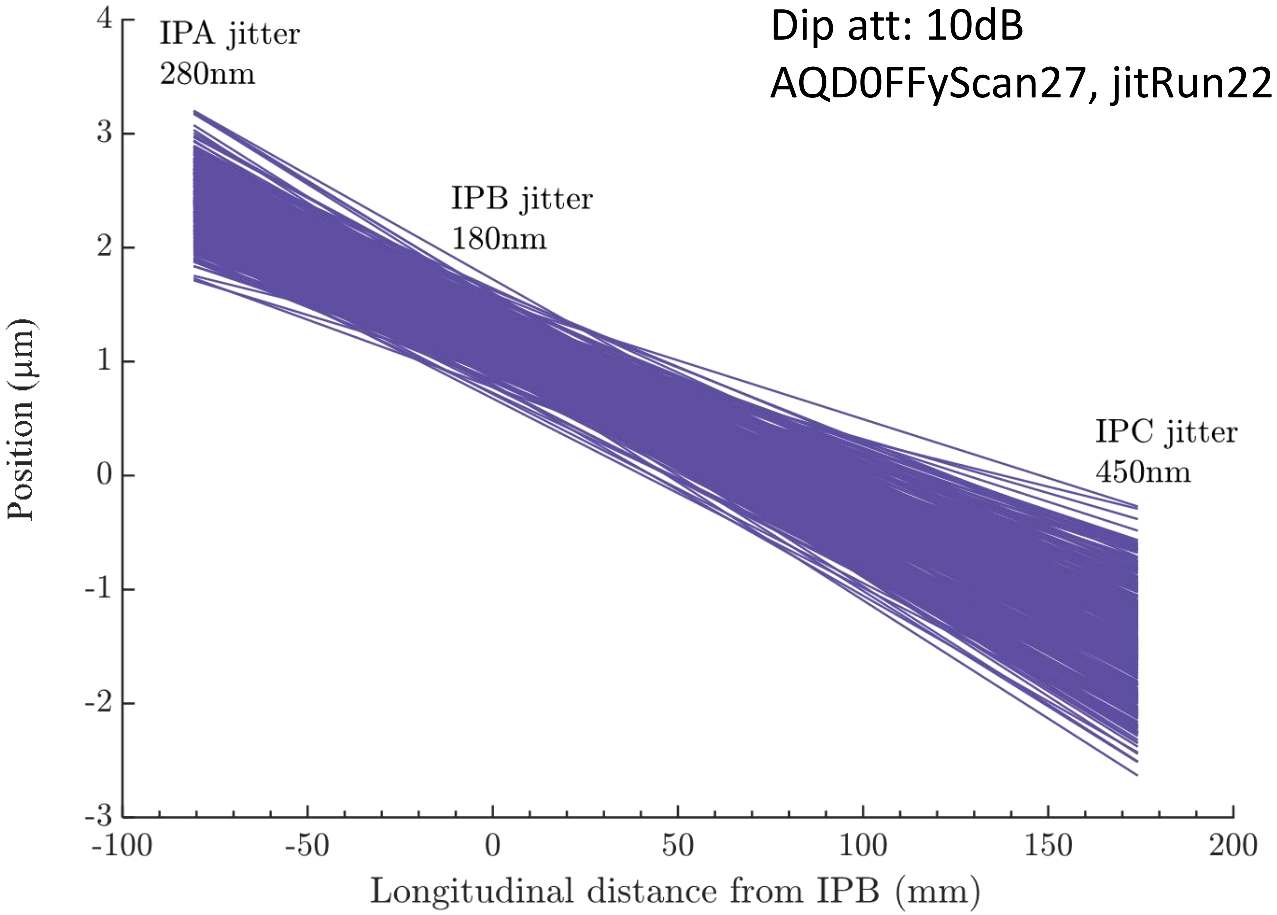
Friday, 3rd August 2018

Overview

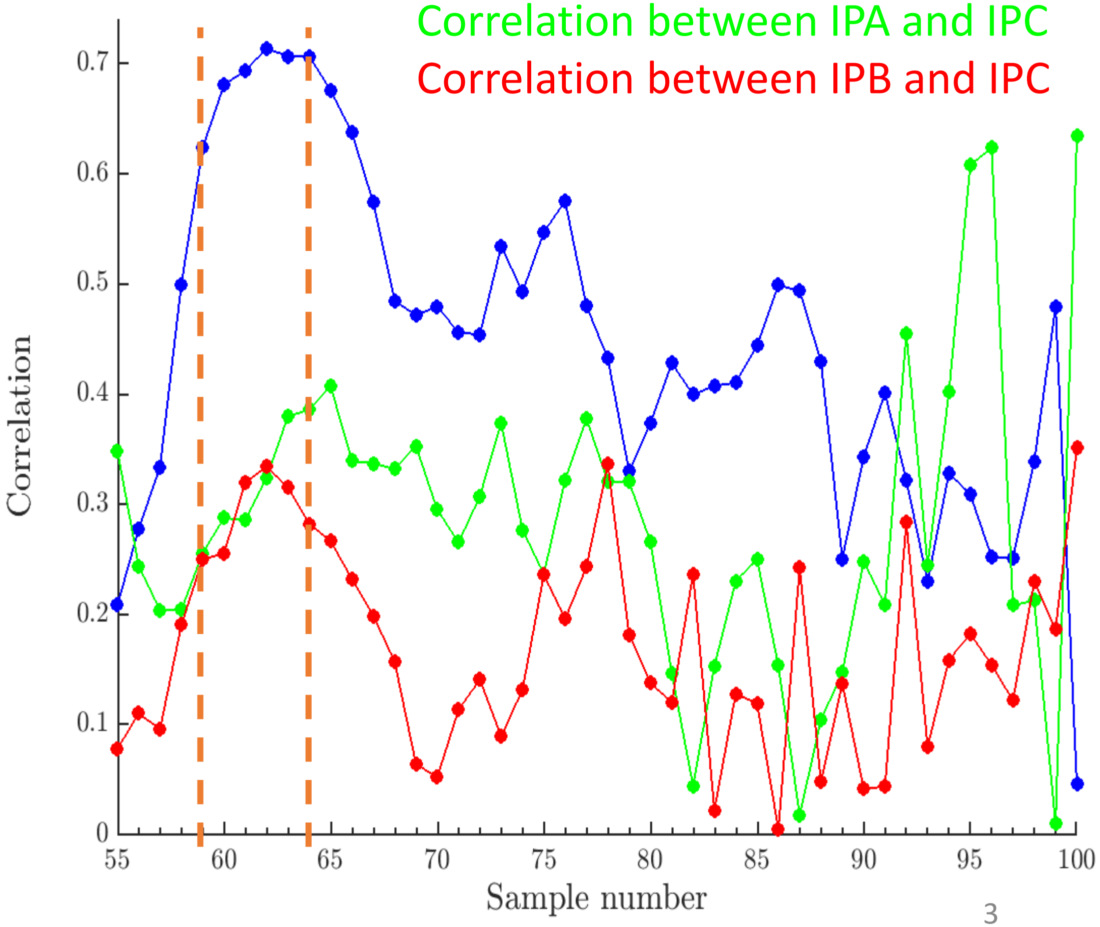
- Follow up from the previous meeting:
  - Correlation between positions measured at IPA, B, C and the optics.
  - Behaviour of waveforms as signals approach ~2000 counts.
  - Comparison of signal magnitude for quad mover calibrations and BPM mover calibrations.
  - Waveforms without C-band BPFs.
  - Studies vs. dipole attenuation.
  - Study vs. reference attenuation.
  - Study of sample numbers to use when fitting limiter phase.
- Simulations:
  - Gain scan.
  - Testing FB algorithm on modelled bunch trains.

High beta optics

Charge: 0.6e10.
Ref att: 40dB
Dip att: 10dB
AQD0FFyScan27, jitRun22.

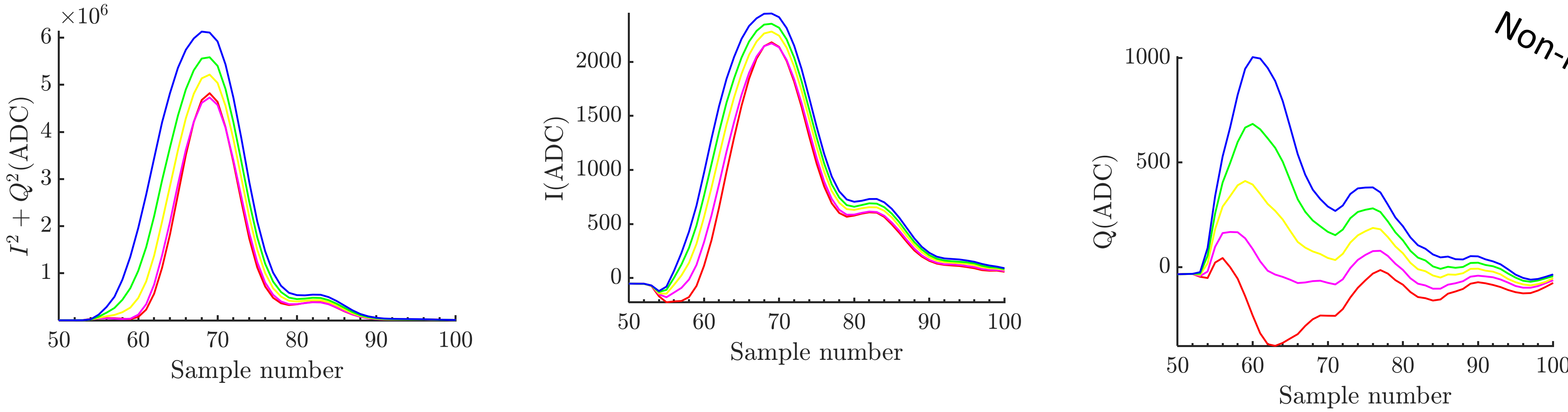


Correlation between IPA and IPB
Correlation between IPA and IPC
Correlation between IPB and IPC

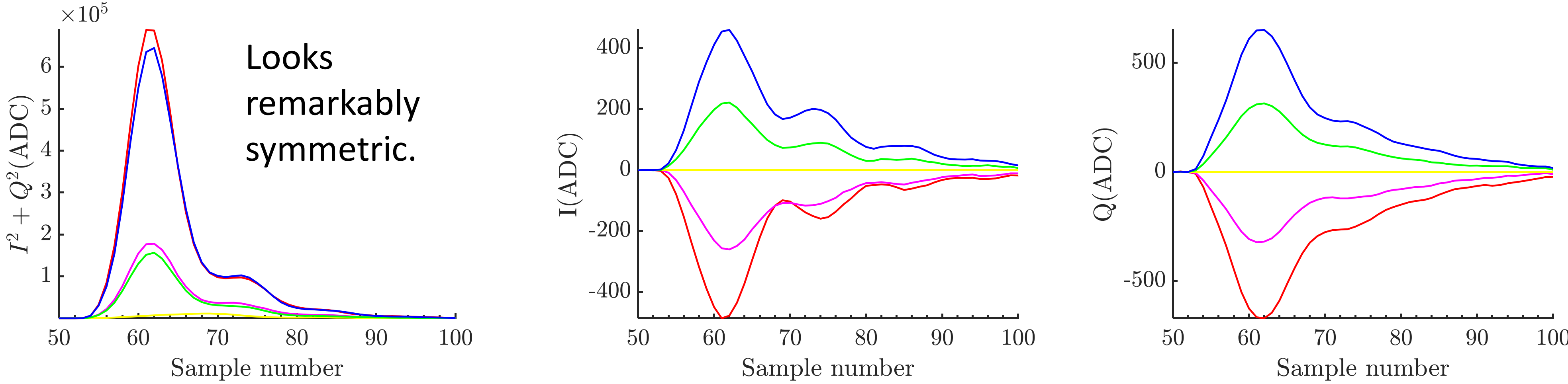


IPyCal5 - IPB

Non-mean subtracted



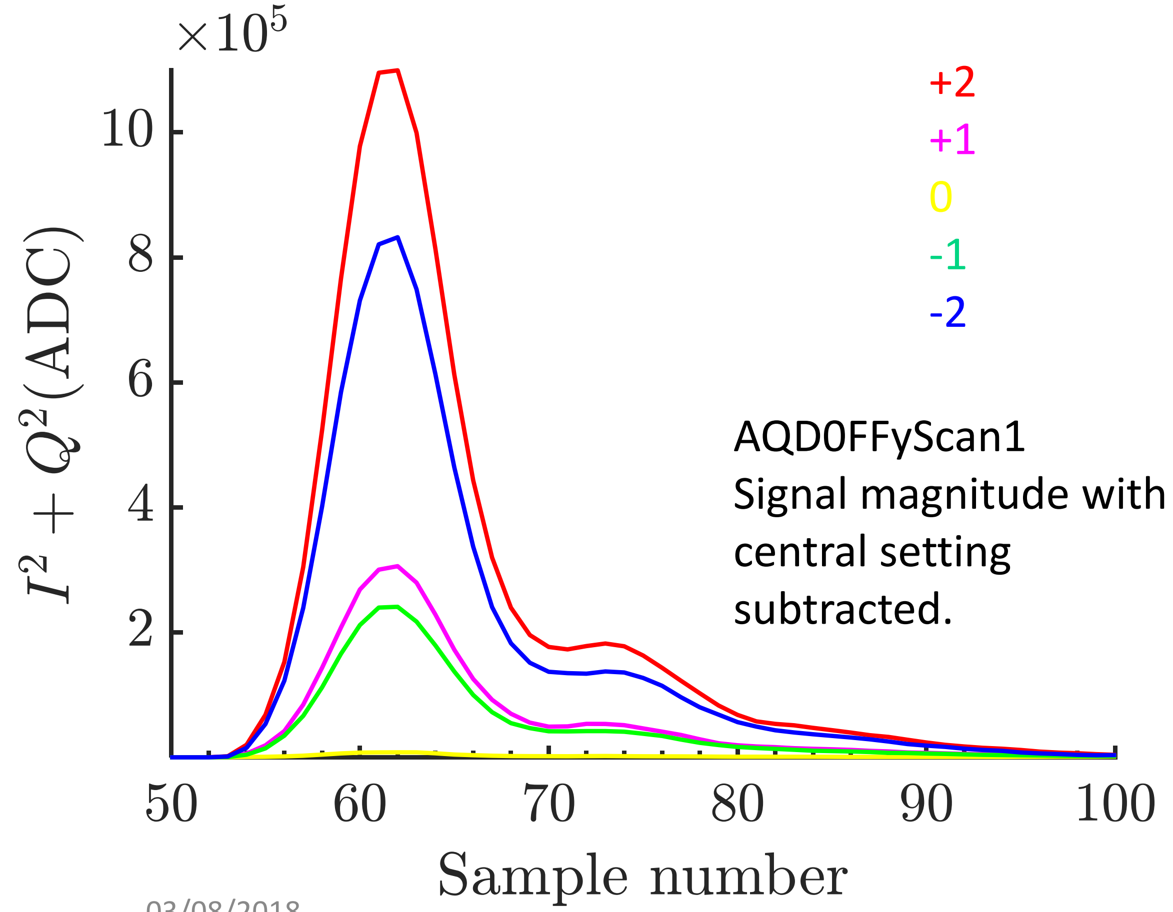
Mean subtracted

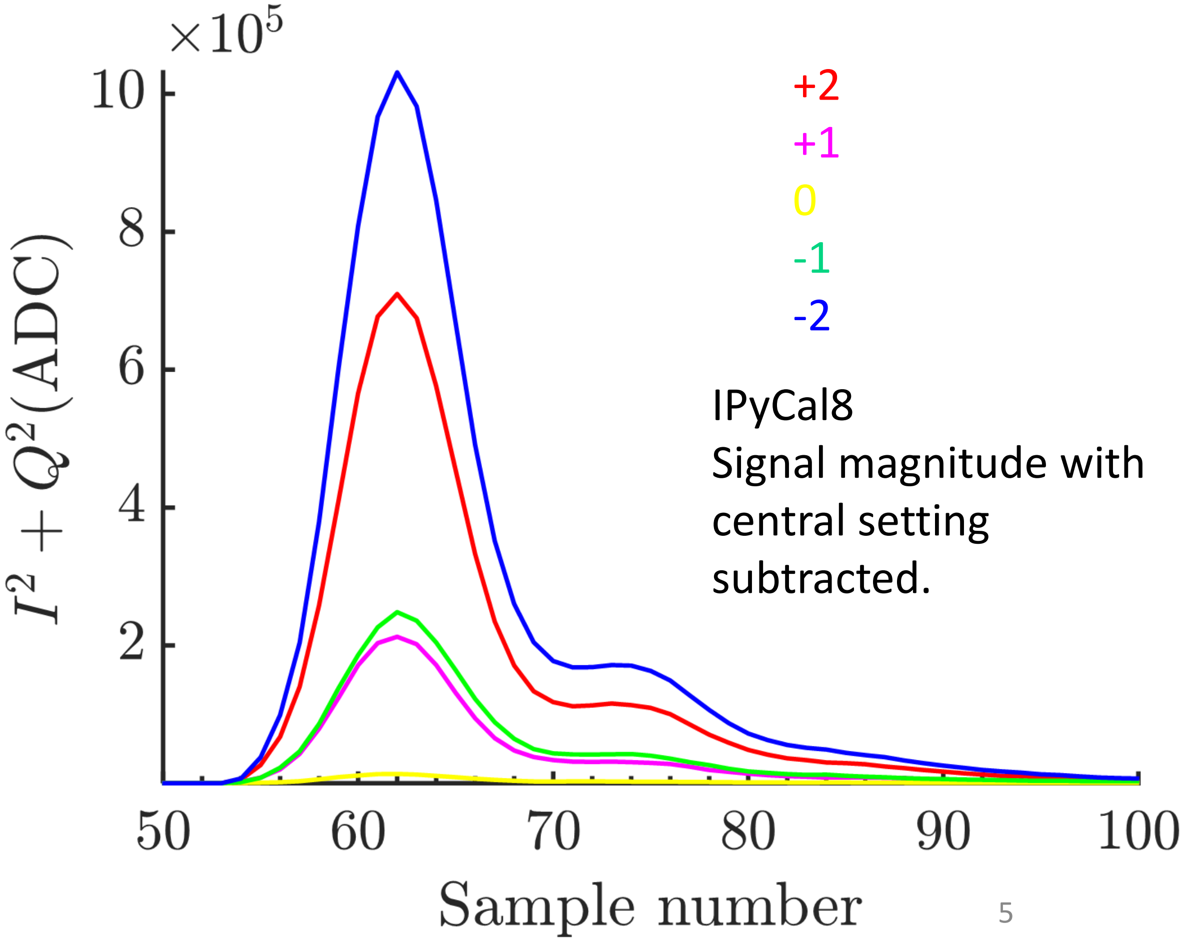


Looks remarkably symmetric.

AQD0FFyScan1, IPyCal8 (15/06/18)

Comparison of signal magnitude across calibration for quad mover calibration and BPM mover calibration.

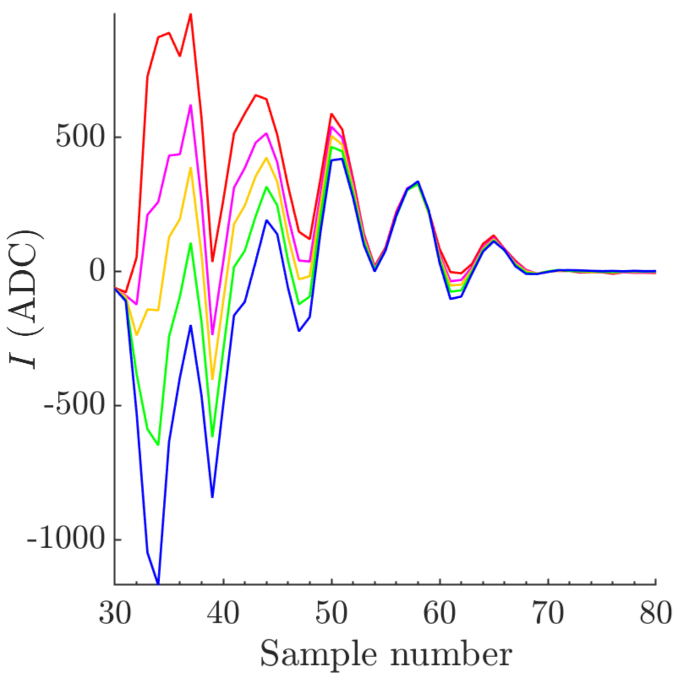


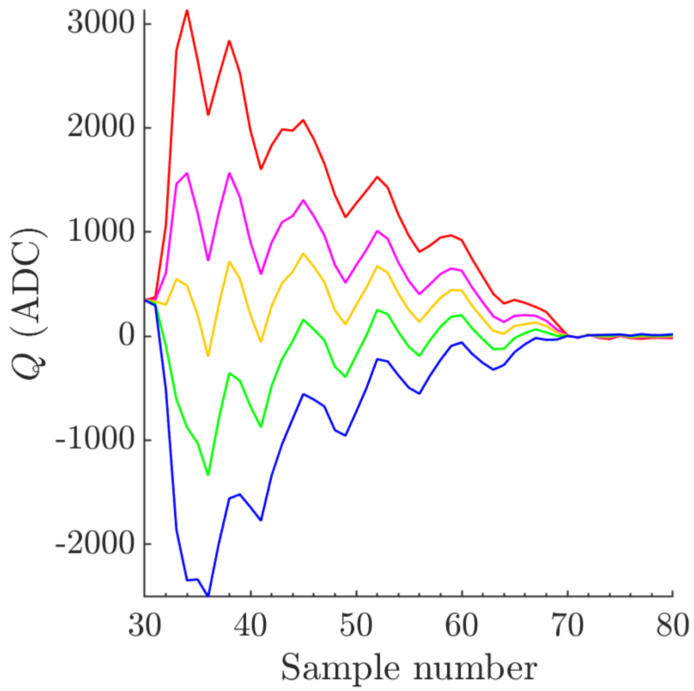


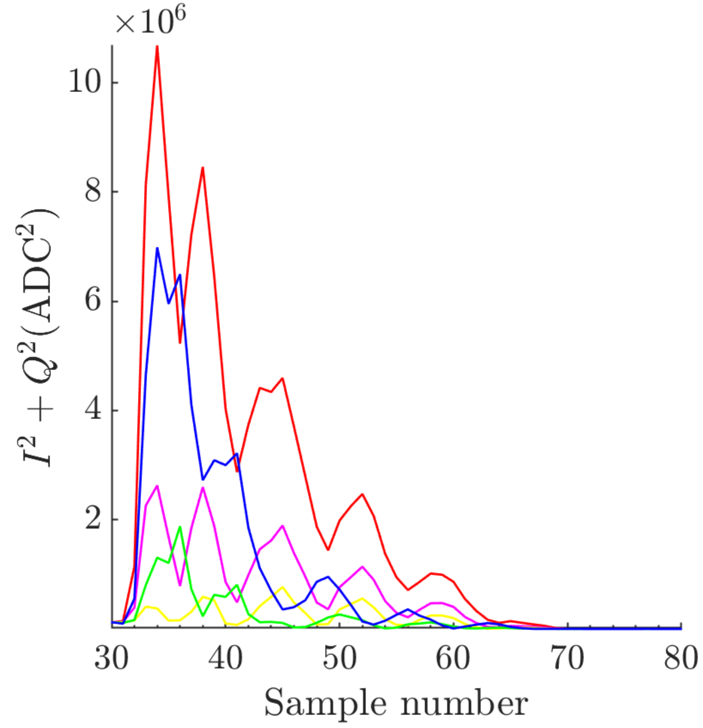
Waveforms with no C-band BPFs

Without central setting subtracted.
26th May 2017.

+2
+1
0
-1
-2

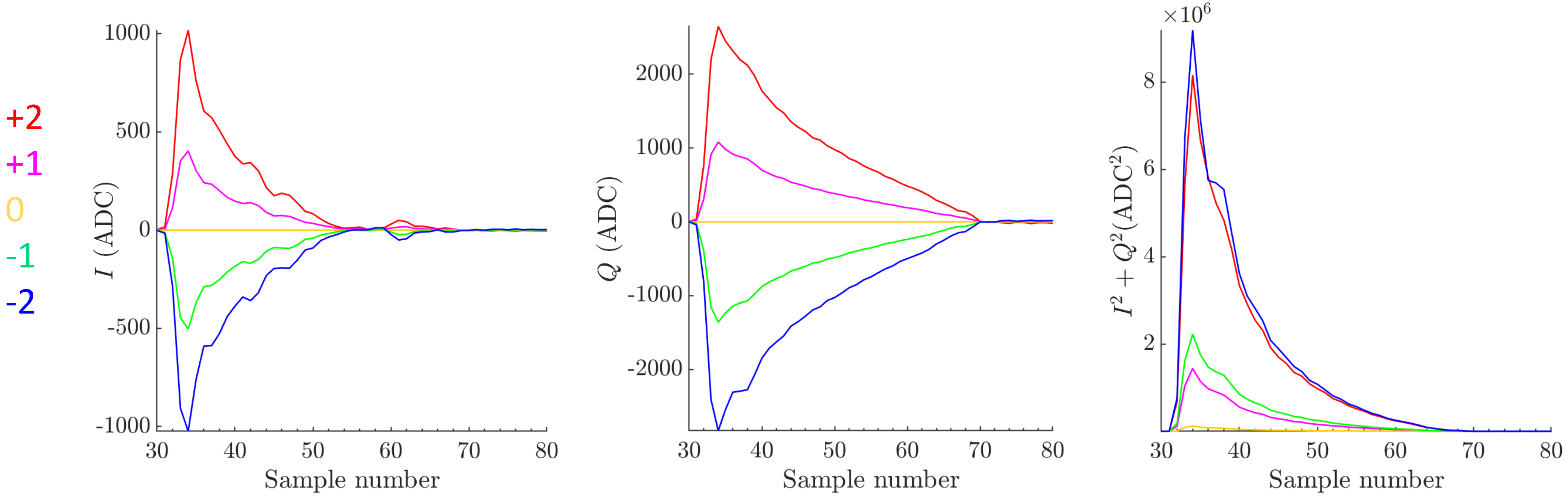




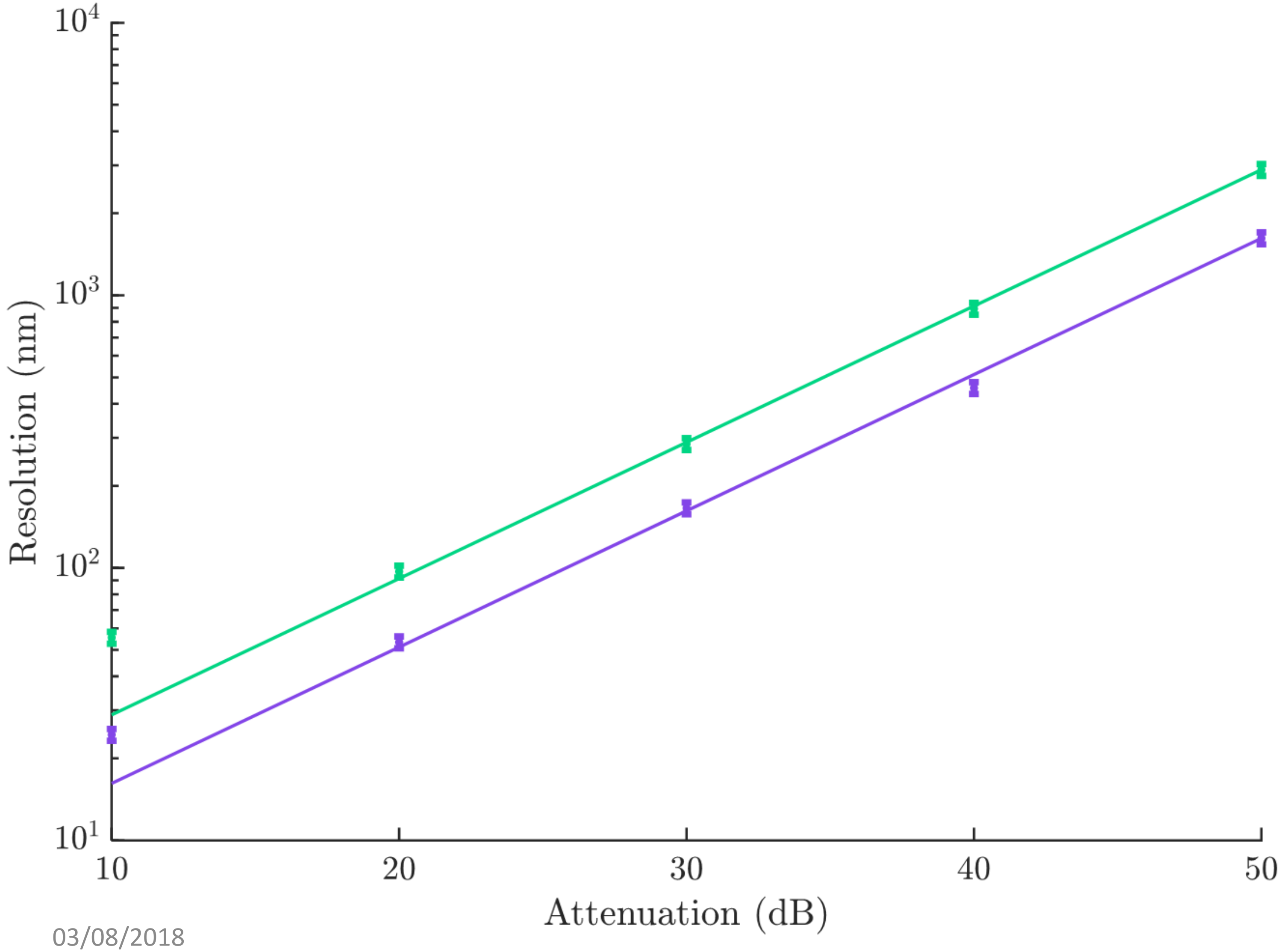


Waveforms with no C-band BPFs

With central setting subtracted.
26th May 2017.



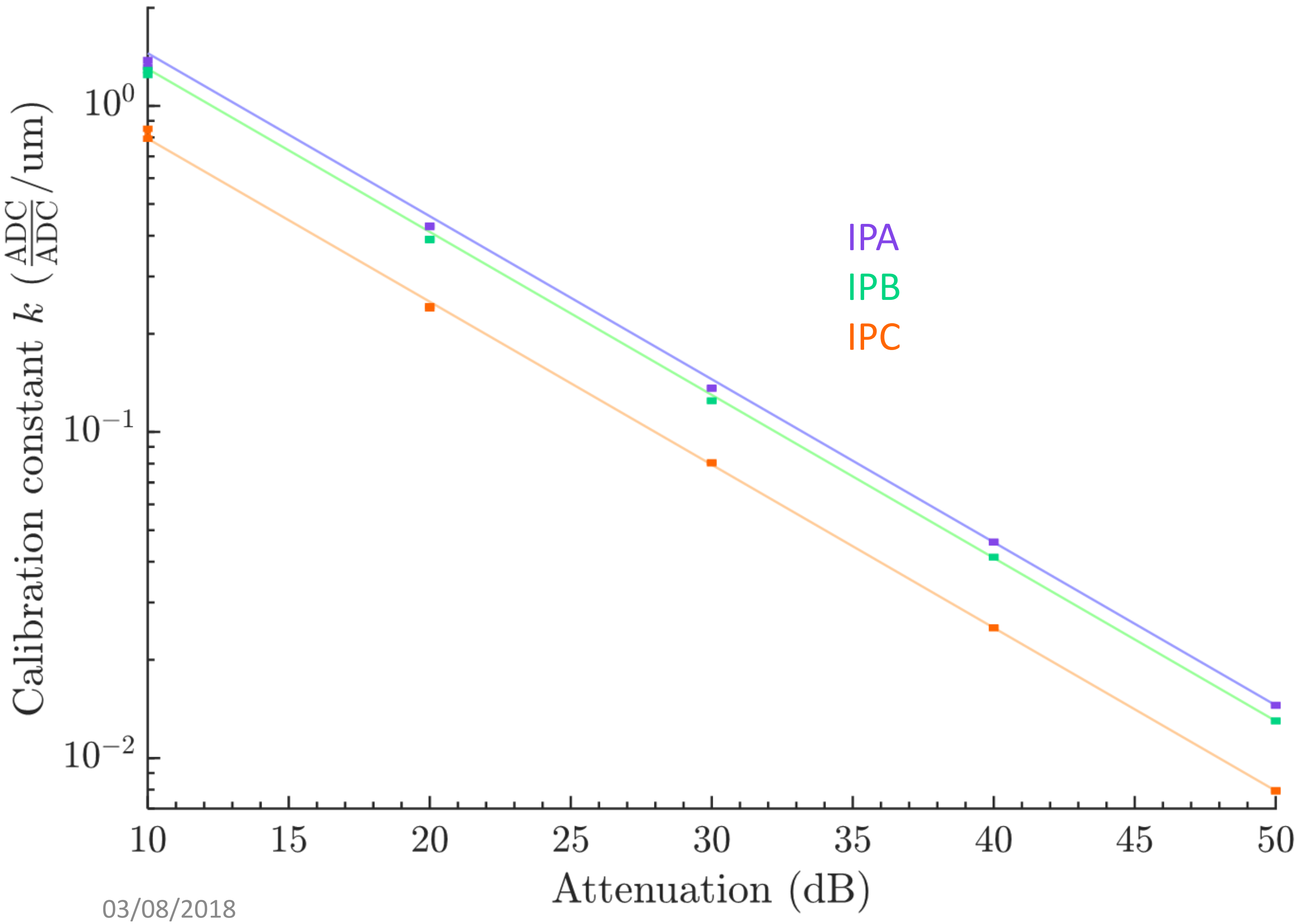
Geometric Resolution Vs. Attenuation



- Geometric resolution as a function of attenuation.
- Single sample
- Integrated range 59:64.
- 15/06/2018
- Lines represent scaling from 50 dB.

Attenuation (dB)	Single sample resolution (nm)	Integrated sample resolution (nm)
10	55	24
20	97	54
30	285	165
40	894	457
50	2890	1619

Calibration constant vs. attenuation

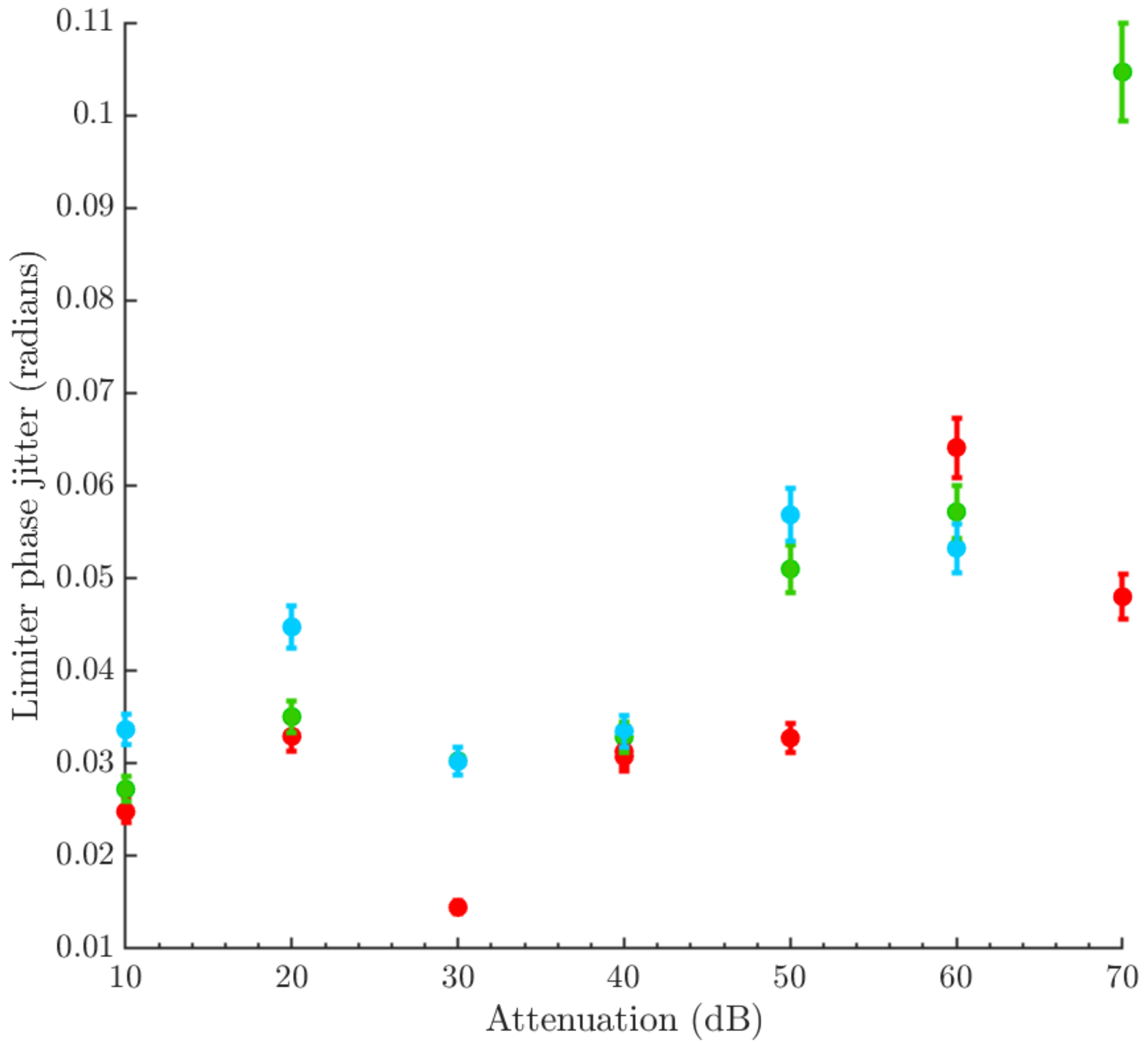


Scaling of calibration constant from 50 dB shown.

Calculated as integrated sample calibration constant (6 samples).

	k_IPA	k_IPB	k_IPC
10	1.350706	1.266394	-0.82215
20	0.427324	0.389031	-0.24138
30	0.136261	0.124654	-0.08045
40	0.045973	0.041329	-0.02507
50	0.014513	0.012993	-0.00793

Limiter phase jitter vs. ref attenuation



High charge
Medium charge
Low charge

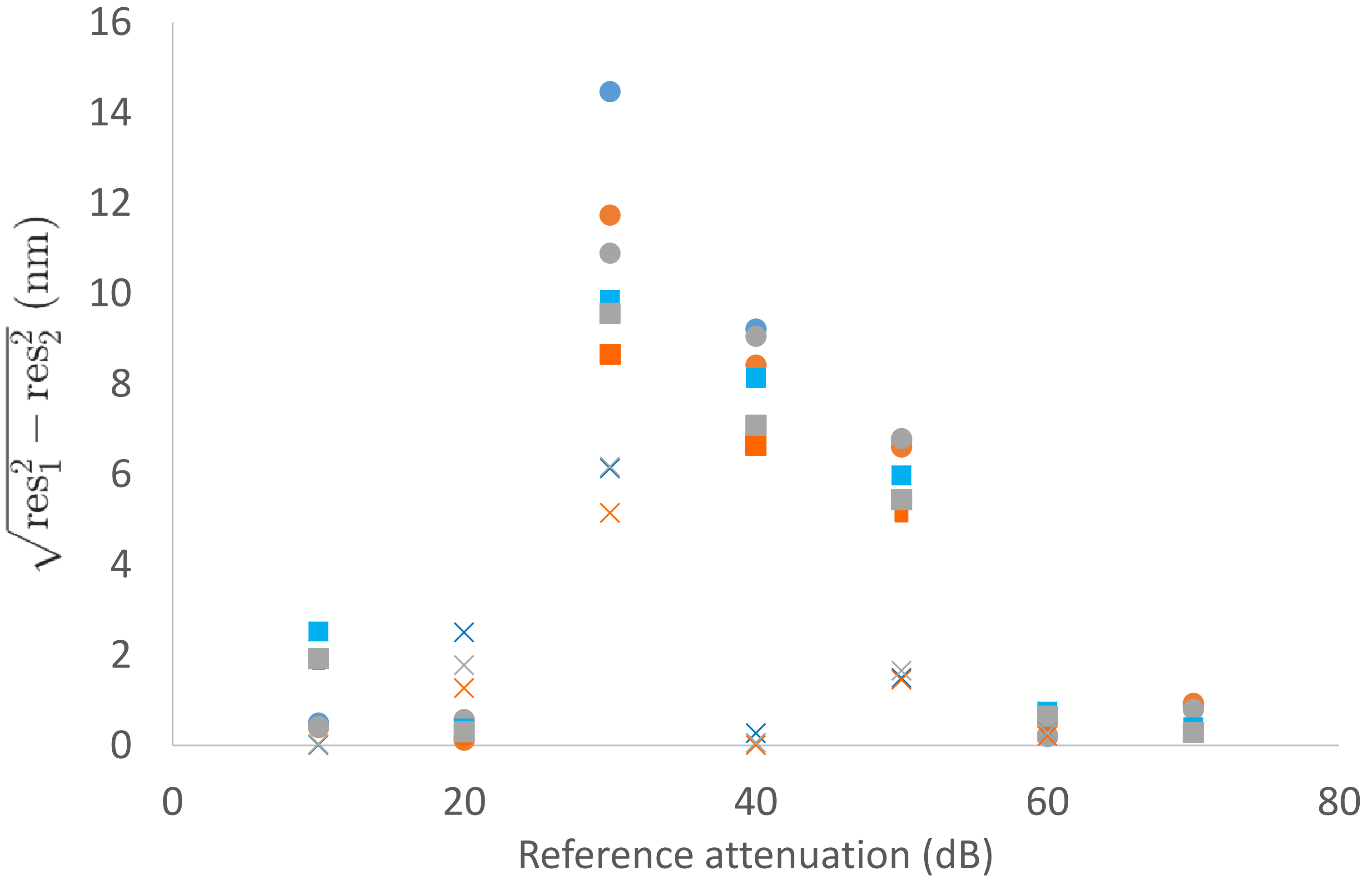
Charge as measured by upstream system

- Low: ~900 ADCs
- Mid: ~1700 ADCs
- High: ~1950 ADCs

9 samples analysed, with the window just after the limiter signal became un-saturated (or just after the peak if never saturated).

Standard errors given.

Improvement from fitting limiter phase



- Fitting to position compared with fitting to position and limiter phase.
  Res_1=fitting to position.
- Res_2=fitting to position and limiter phase. As expected from:

$$y = \frac{I'}{q} + \frac{Q'}{q} \times \delta\theta_{IQ}$$

Improvement to fitting only really seen for reference attenuations which mean the limiter phase samples used coincide with the dipole samples used. E.g 30, 40 dB.

IPA, IPB, IPC

High charge ●

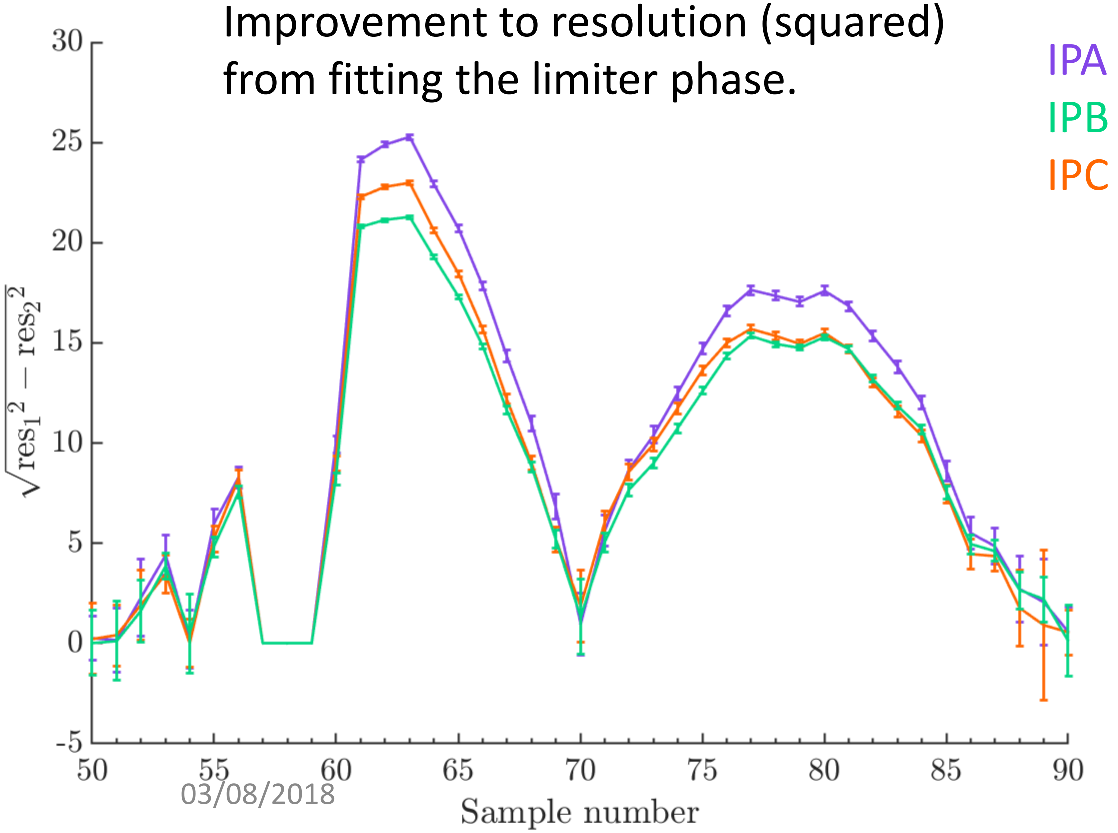
Mid charge ▪

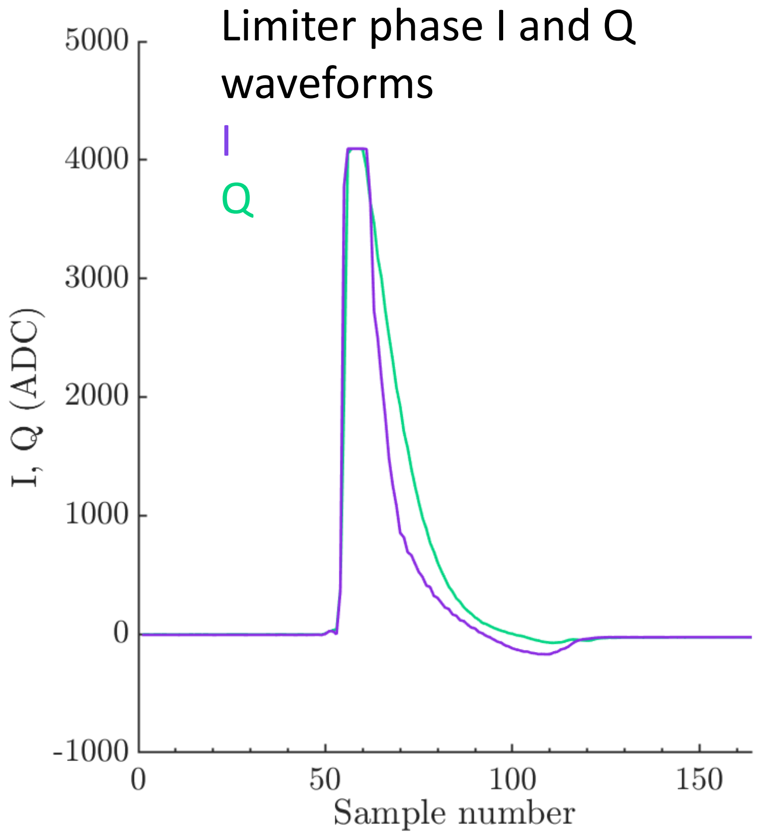
Low charge x

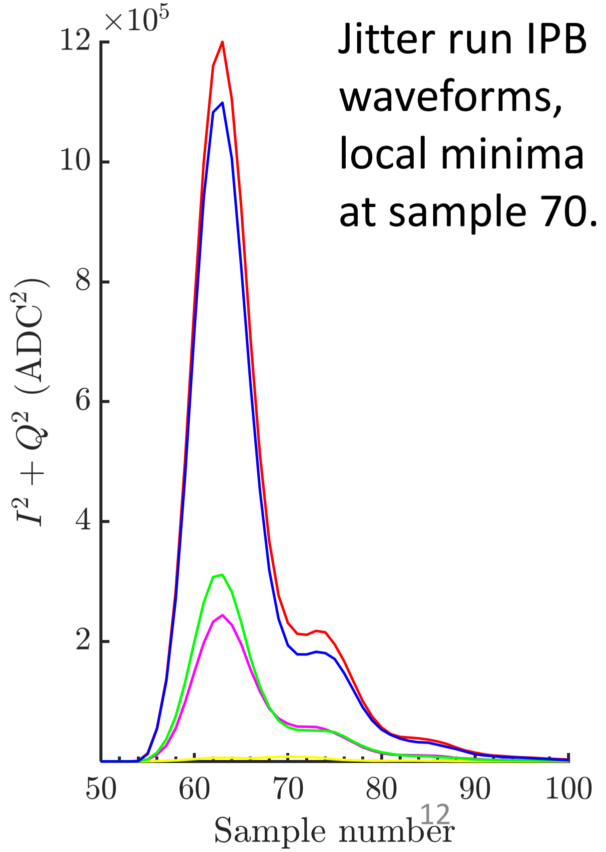
➢ Low charge at 40 dB suspect.

Improvement to resolution by fitting limiter jitter

Studying improvement to the resolution from fitting the limiter phase, as a function of the limiter phase sample used.
AQD0FFyScan19, jitRun14. – high charge setting ~0.7e10. Dipole att. 10 dB, reference att. 30dB.

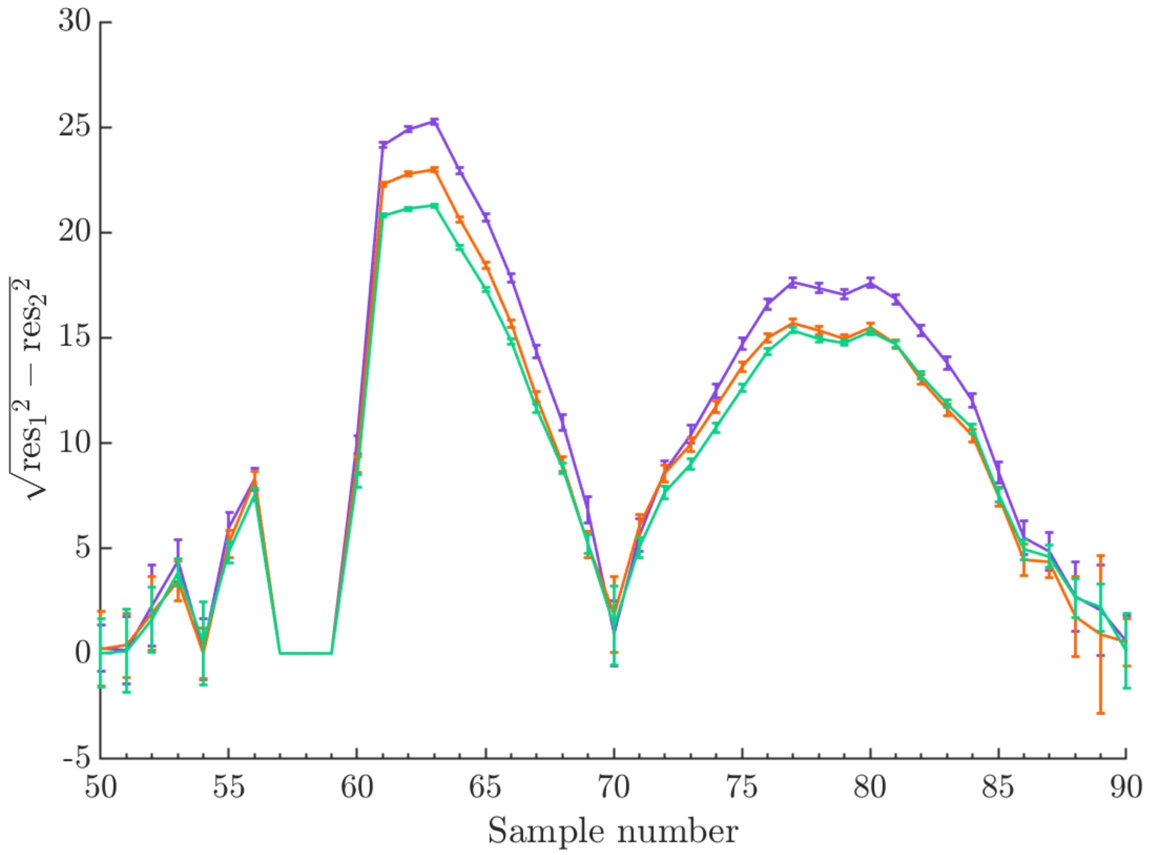


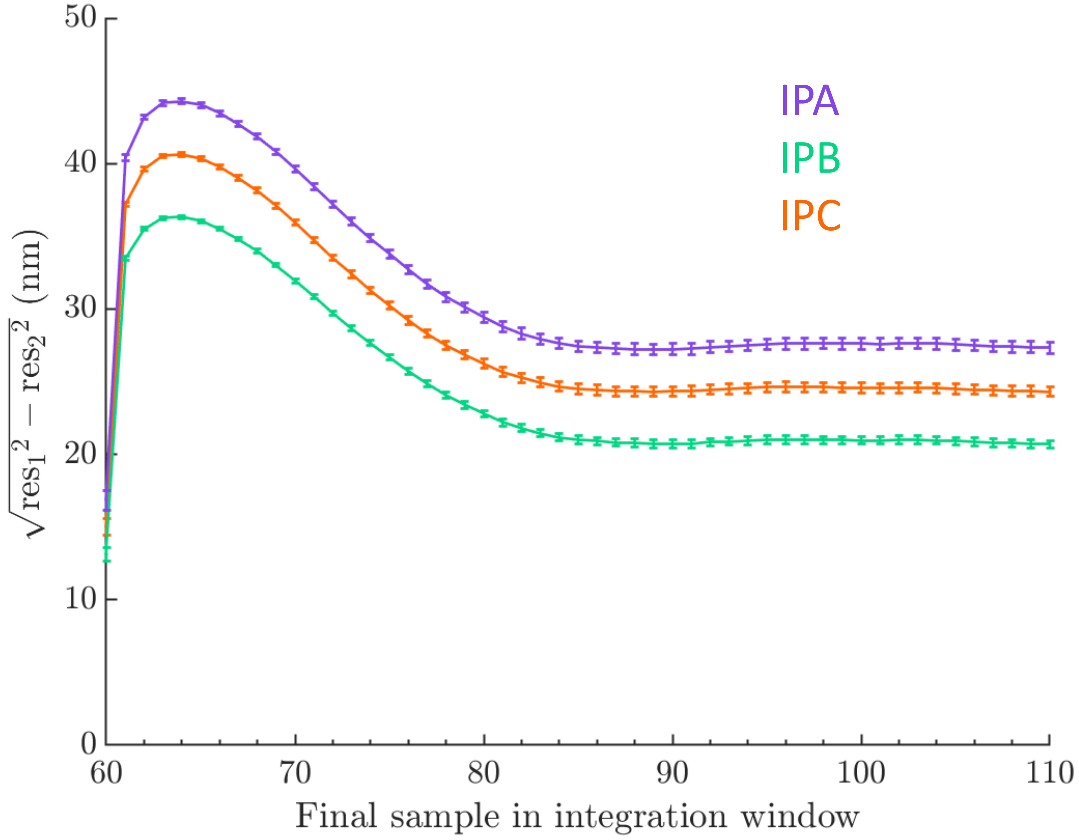




Improvement to resolution by fitting limiter jitter

The improvement to the resolution from fitting the limiter phase, as a function of the sample range of the limiter signal used.





Simulations

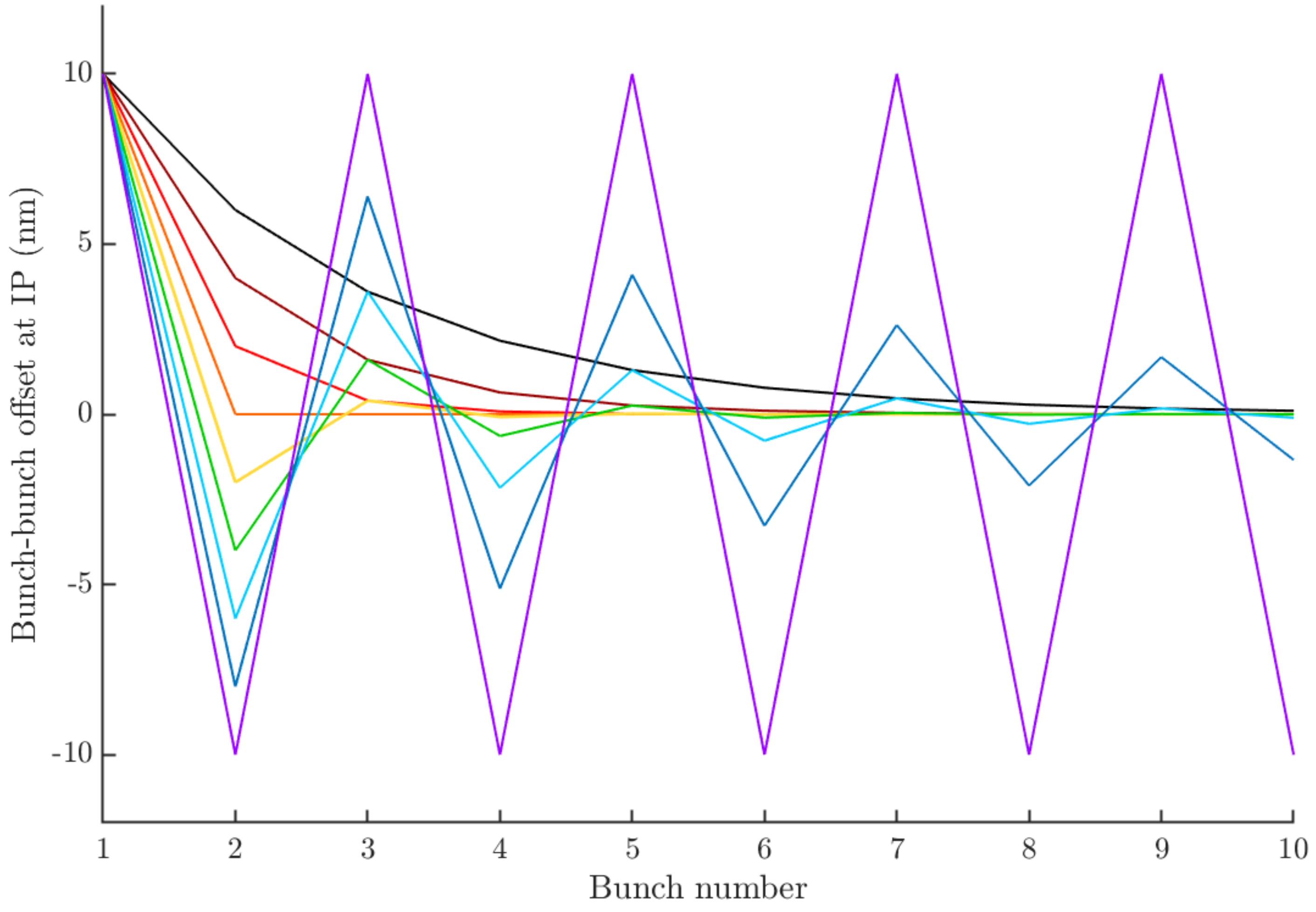
Modelled deflection angle curve as function of different parameters – bunch size (x,y), bunch length, number of particles per bunch, energy.

Modelled bunch train and performance of P, PI feedback on the modelled trains – largely shown in previous presentation (6th March 2018).

Simulations

- Gain scan
- Deflection angle curves for a range of values for: bunch size in x, y, number of particles per bunch, bunch length, energy.
- Luminosity vs. resolution, correlation etc
- Proportional and Proportional Integral FB on a bunch train with drift across the train. Study of the effect of changing the coefficient for the integral term.
- Proportional and Proportional Integral FB on a bunch train with harmonic across the train.
- FB operating of train with different frequencies of harmonic. Impact on luminosity.
- Effect of random noise/reducing the bunch-bunch correlation.
- How averaging over bunches in a bunch train improves the performance if the degradation to luminosity comes from effects uncorrelated between bunches. Investigate weighted averaging, for cases where there are effects both correlated and uncorrelated between bunches.

Gain scan



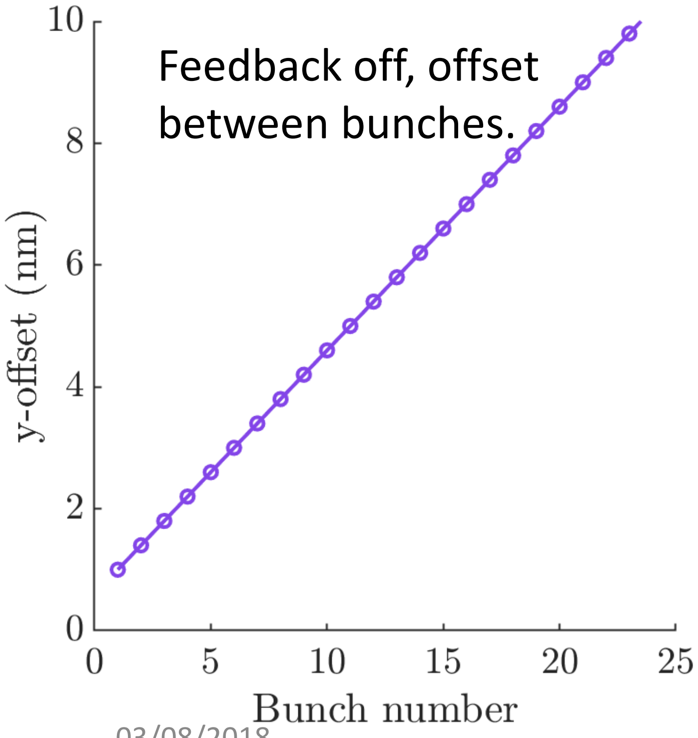
Rigid bunch trains with 10 nm initial offset and proportional gain feedback. Scaling the feedback gain.

Gain:

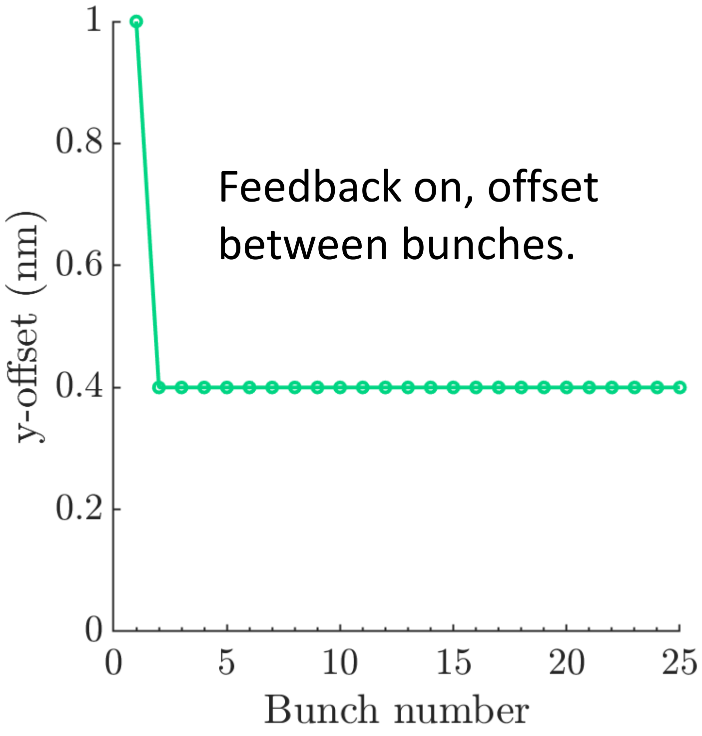
0.4, 0.6, 0.8, 1, 1.2, 1.4, 1.6, 1.8, 2

Drift (across train)

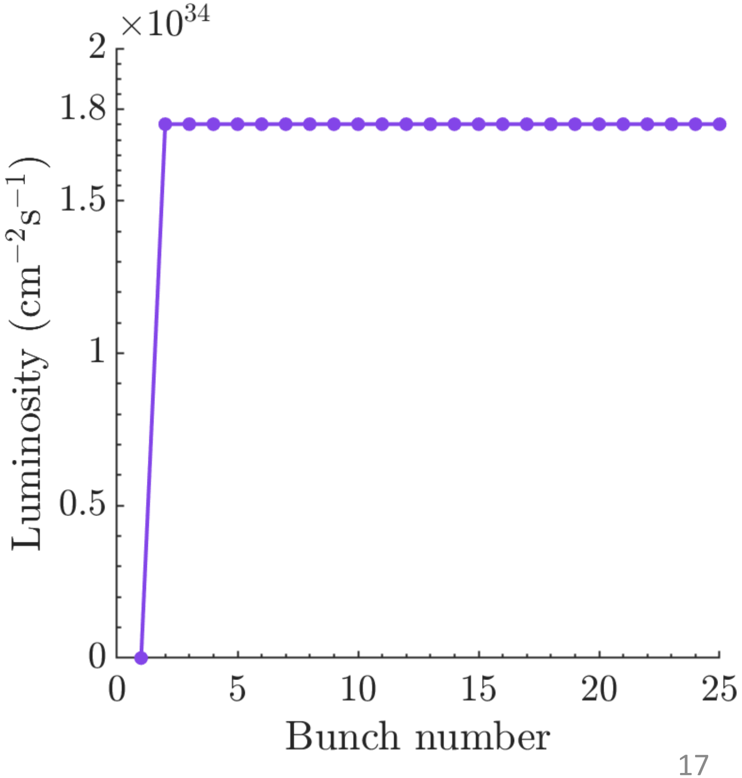
Bunch train: 1 nm initial offset with offset of 0.4 nm between consecutive bunches.



Proportional gain feedback, with 0 nm resolution. Would not take out the 0.4 nm difference between consecutive bunches.



Leading to a loss in luminosity.

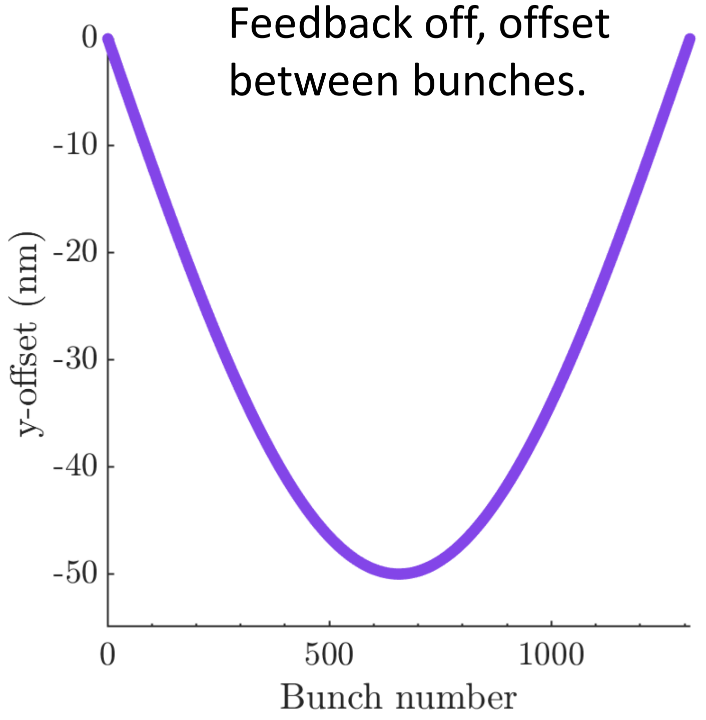


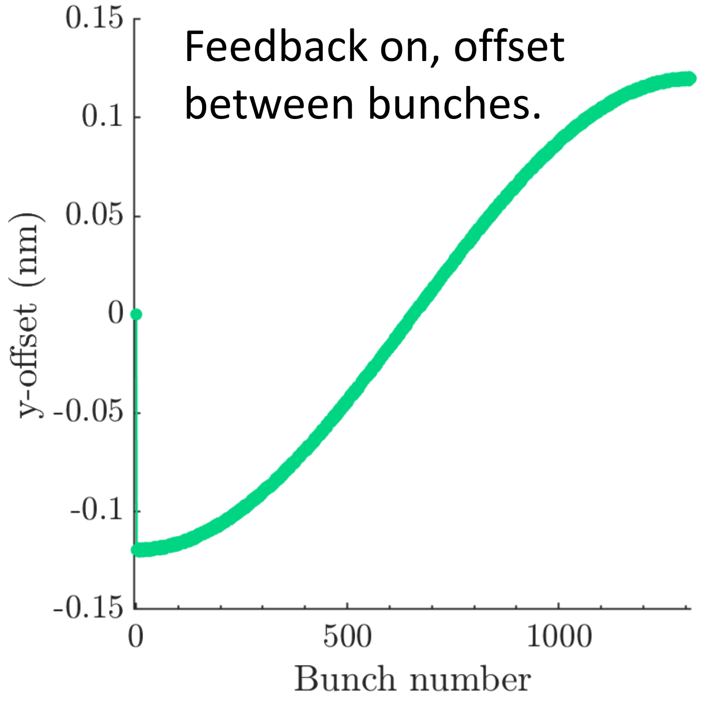
Harmonic (across train)

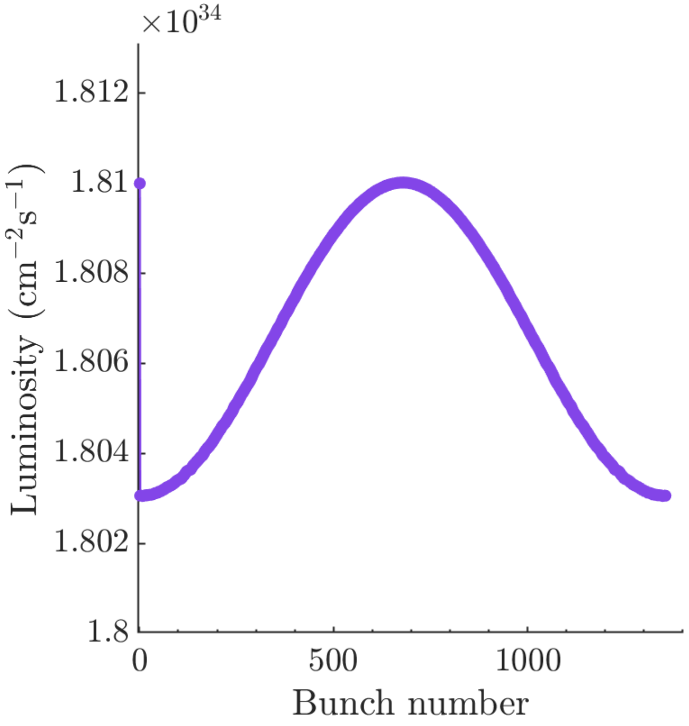
Bunch train: Banana shape (half cycle across bunch train).

Proportional gain feedback, with 0 nm resolution. Would not take out the difference between consecutive bunches.

Leading to a loss in luminosity.

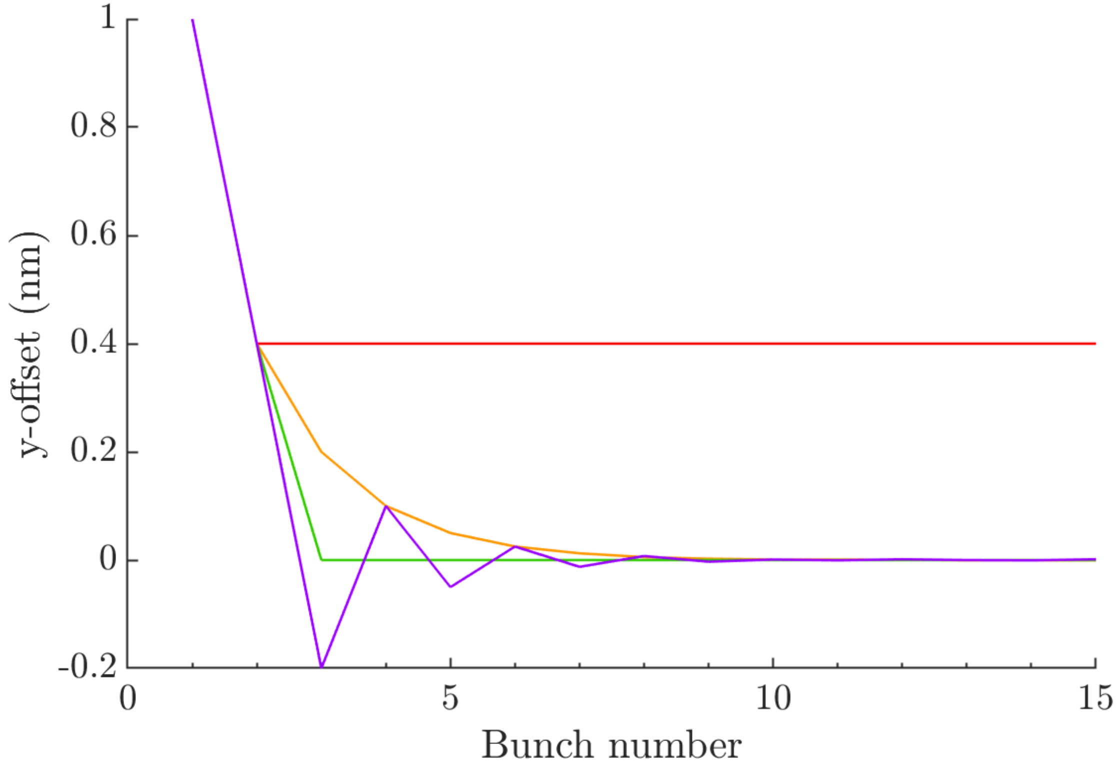


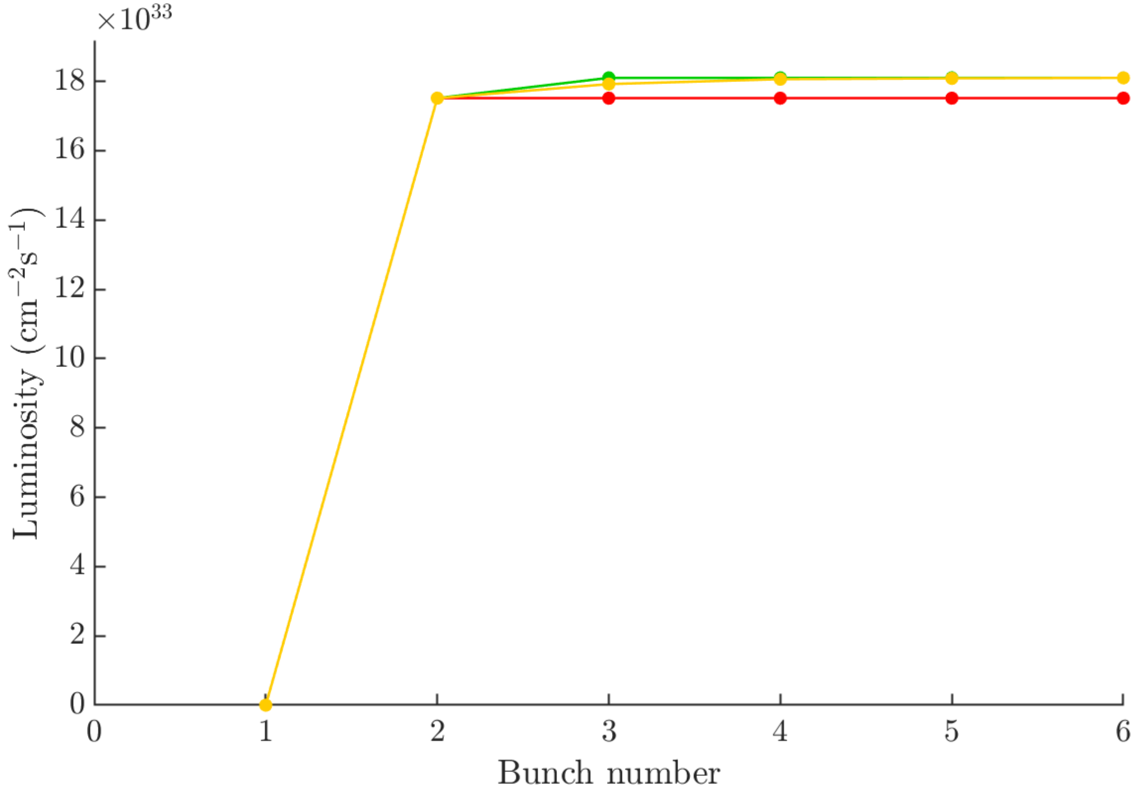




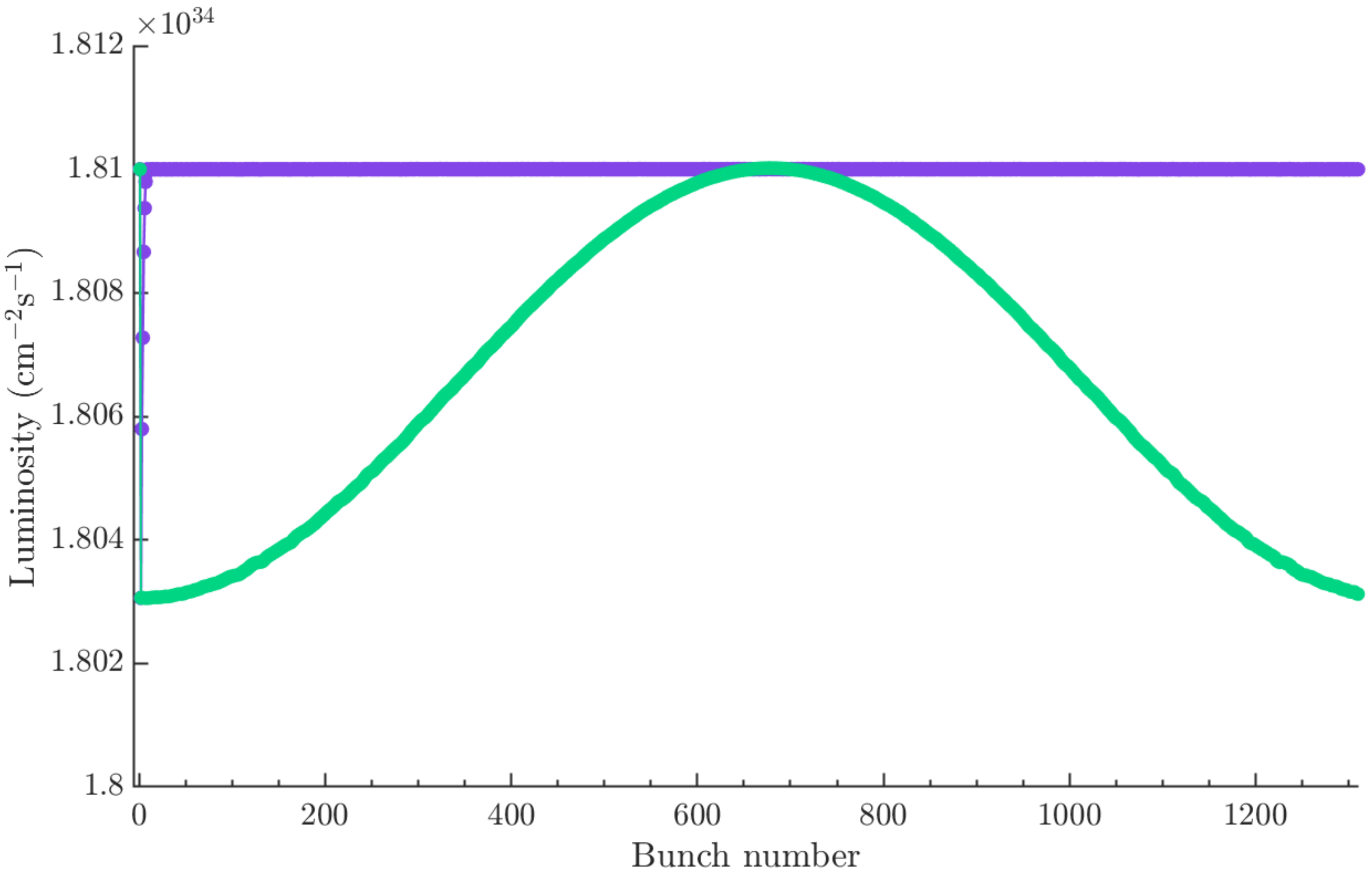
Proportional Integral Control: Drift

Drift – 0.4 nm between consecutive bunches. The 0.4 nm is not removed by just proportional feedback,





Proportional Integral Control: Harmonic



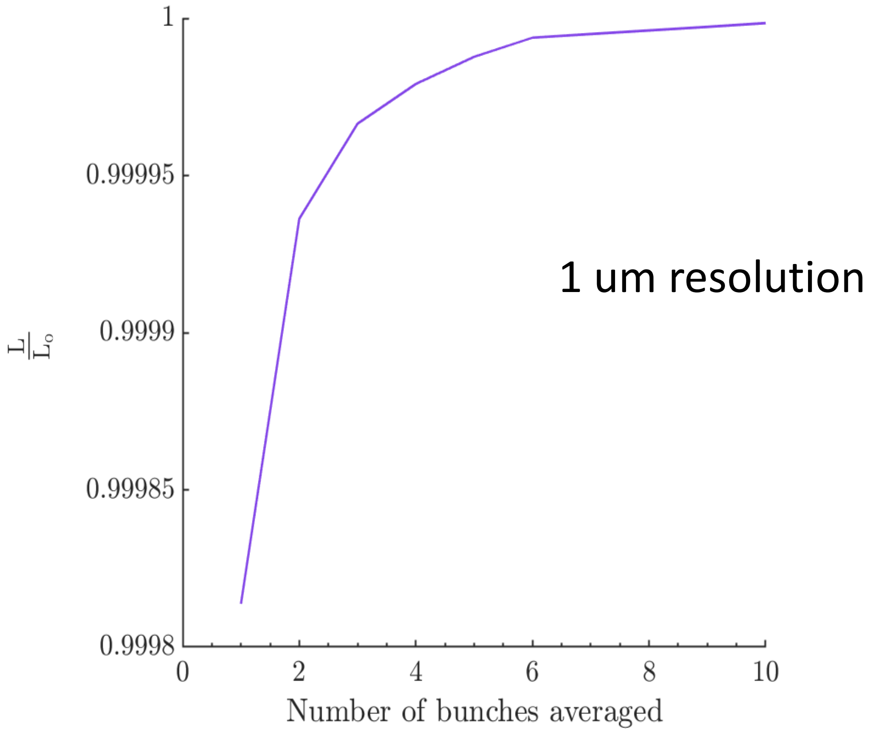
Proportional control vs. proportional integral control. For harmonic bunch train shape shown on slide 17.

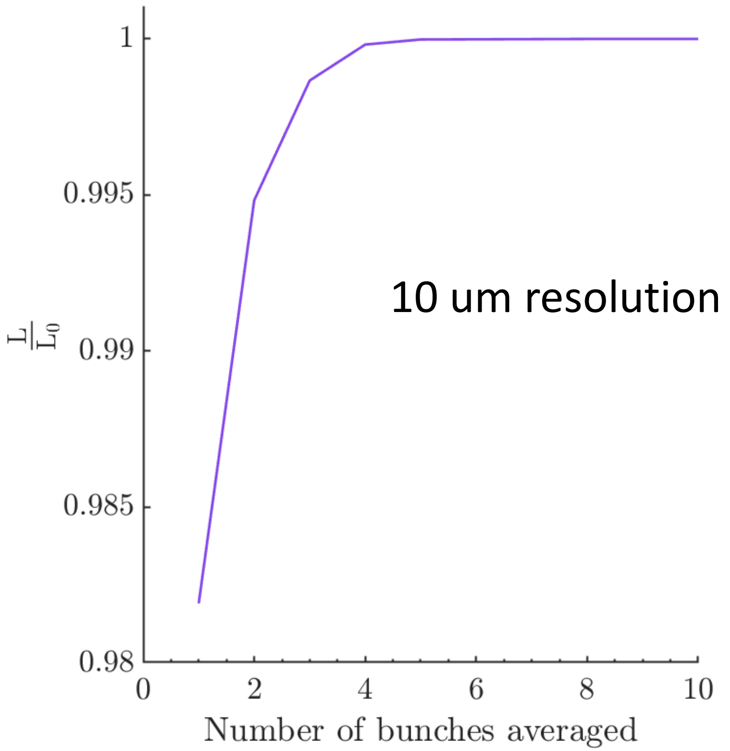
Where gain for both proportional and integral control =1.

Averaging over multiple bunches

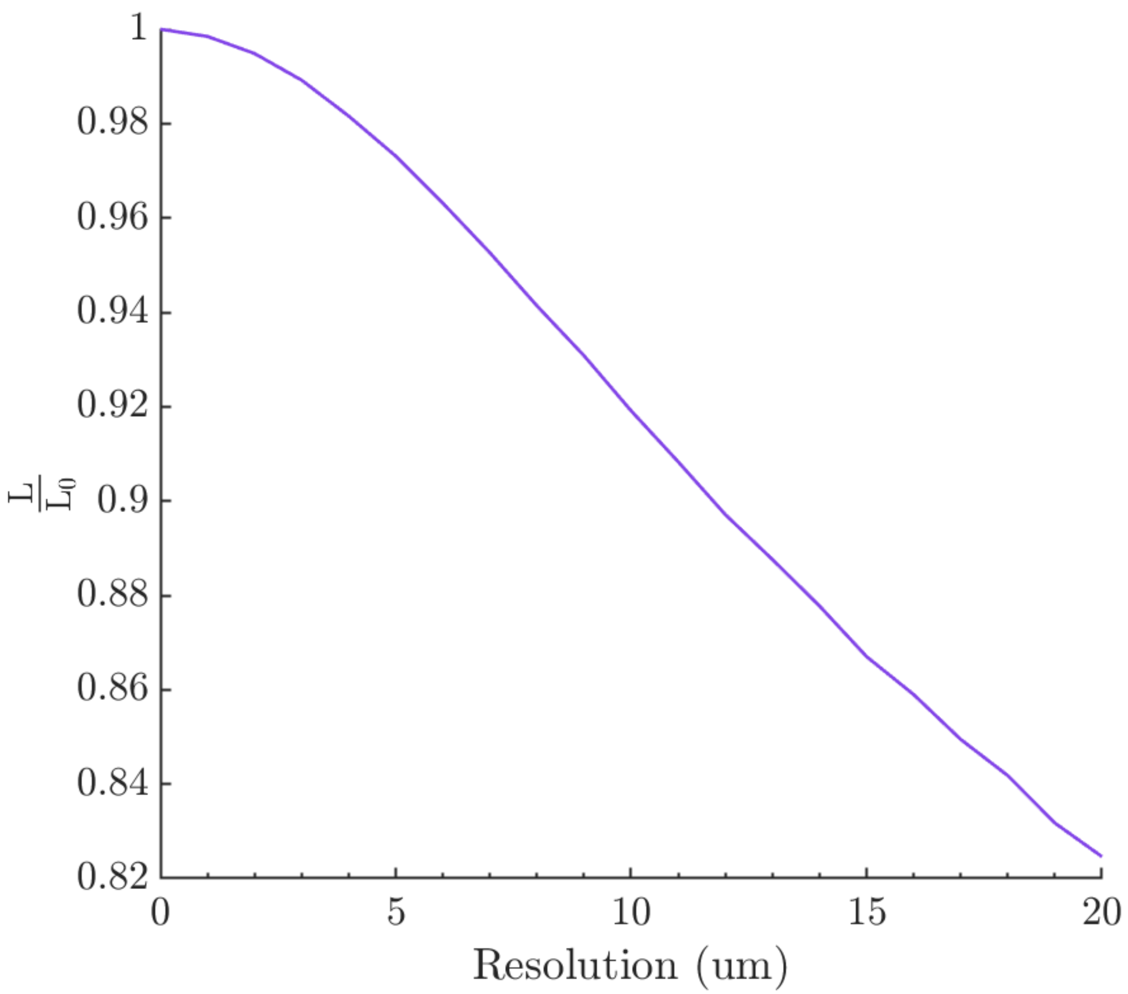
If noise added is uncorrelated between consecutive bunches, e.g resolution effects then averaging offers some improvement. Very minor improvement for resolution of 1 um.

Would become important for beams with poorer bunch to bunch correlation.





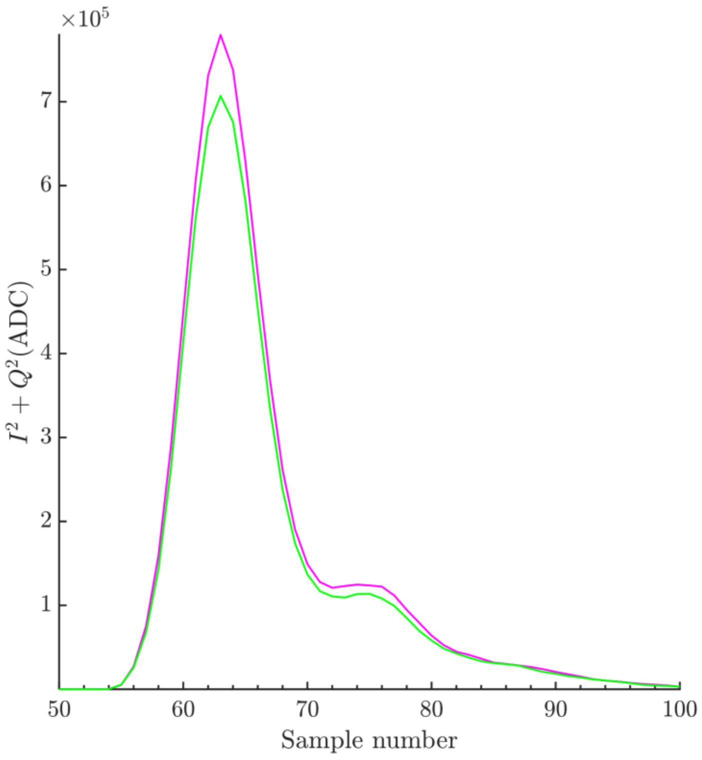
Luminosity vs. Resolution

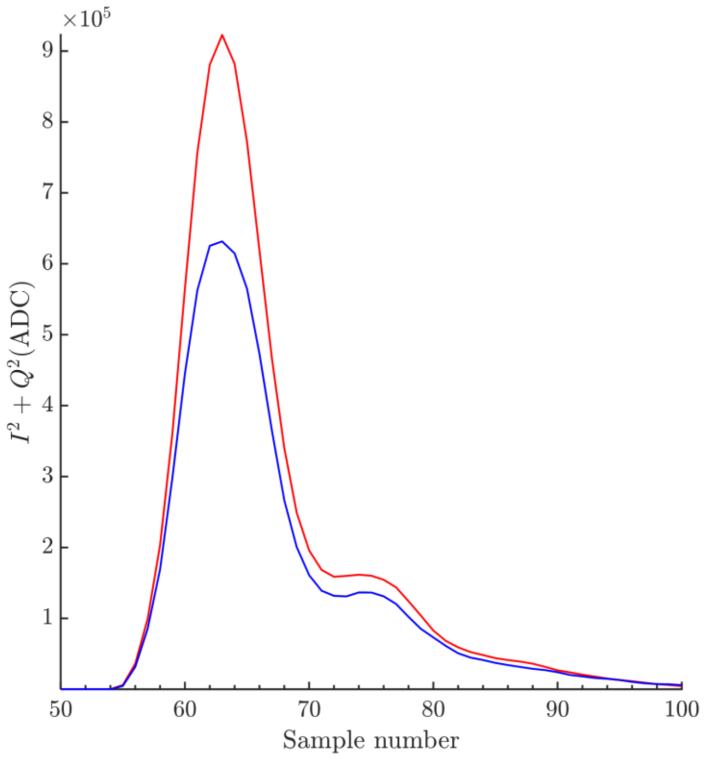


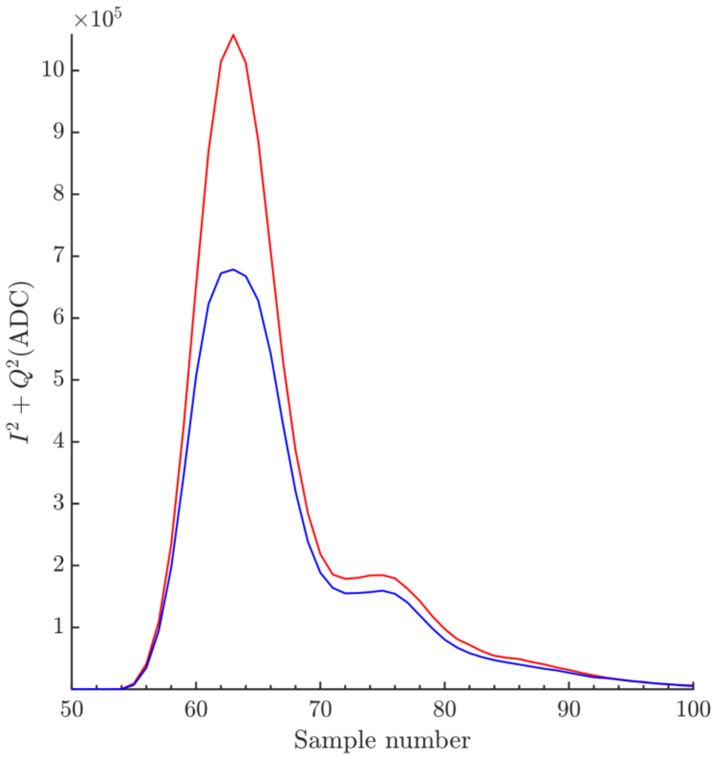
Two rigid bunch trains with zero offset, with a BPM for which I am varying the resolution.

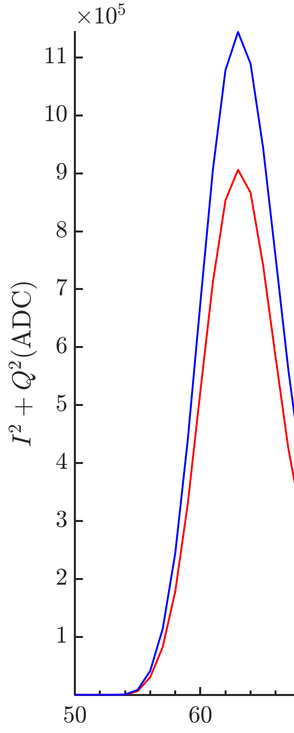
As expected, very little degradation to luminosity from a BPM with up to 1 um resolution.

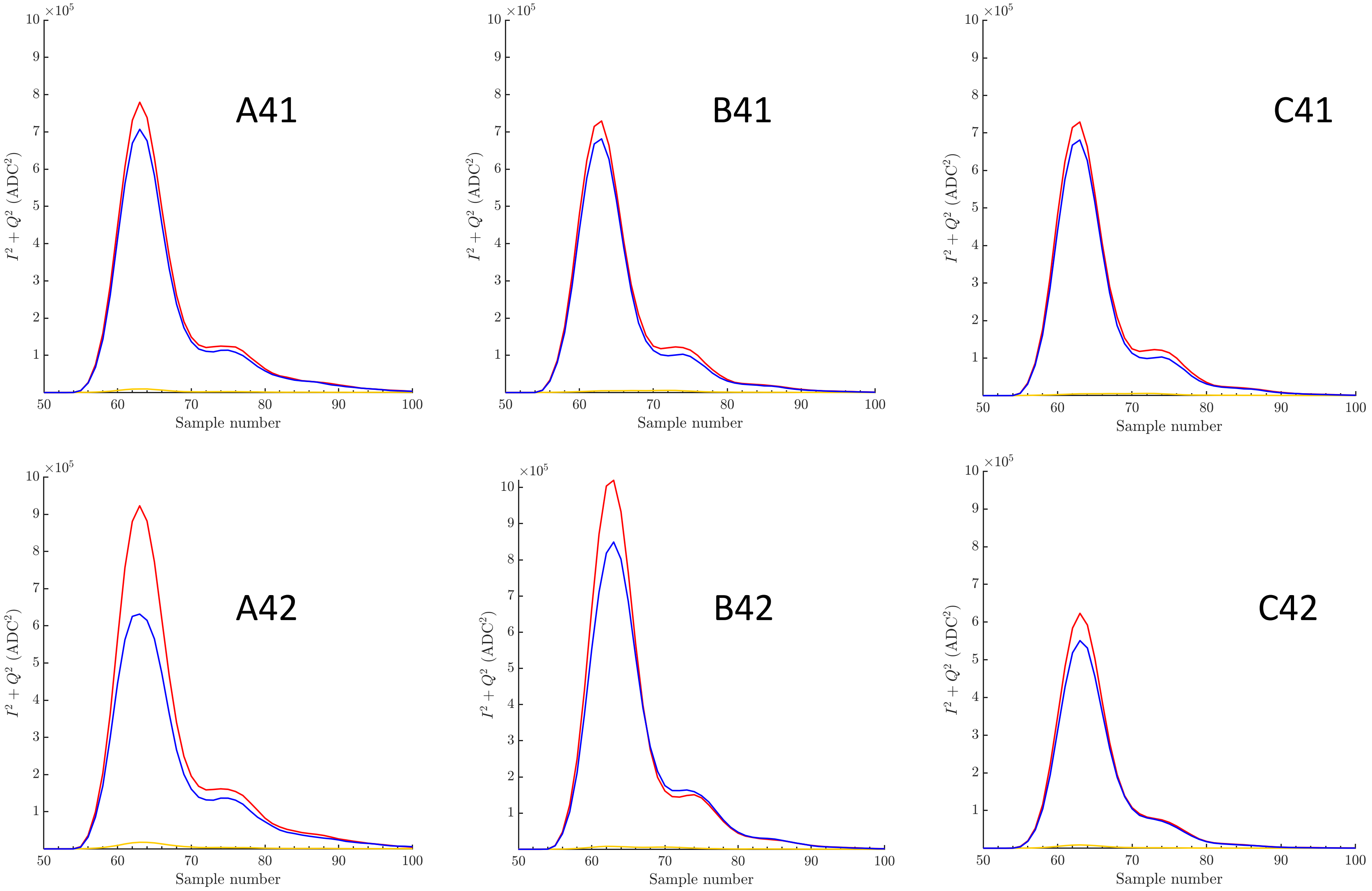
Extra Slides


×10^5
$I^2 + Q^2$(ADC)
Sample number
50 60 70 80 90 100
1 2 3 4 5 6 7


×10^5
$I^2 + Q^2$(ADC)
Sample number
50 60 70 80 90 100
1 2 3 4 5 6 7 8 9


×10^5
$I^2 + Q^2$(ADC)
Sample number
50 60 70 80 90 100
1 2 3 4 5 6 7 8 9 10


×10^5
$I^2 + Q^2$(ADC)
50 60
1 2 3 4 5 6 7 8 9 10 11


A41
B41
C41
A42
B42
C42
$\times10^5$
$I^2 + Q^2$ (ADC^2)
Sample number