

Resolution Study cont.

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Outline

Look at different files from the May/June run and attempt to identify common conditions for achieving good resolution results.

- Study 1: Comparing repeat resolution runs with no changes.
 - Investigate three poor performing results closely.
 - Rolling resolution study for all data files from this study combined.
 - Investigate anti-correlation of I and Q signals → look at I' and Q' instead.
 - Look at how theta changes across a jitter run.
- Study 2: Comparing different runs across a shift.
 - Investigate particularly good/bad data sets more closely.
 - Look at I' and Q' instead of I and Q.
 - Look at how theta changes across the jitter runs.
 - Look at how theta changes with the reference attenuation.

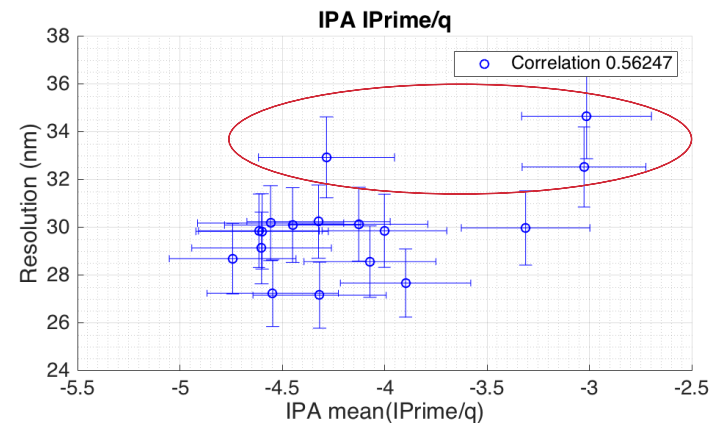
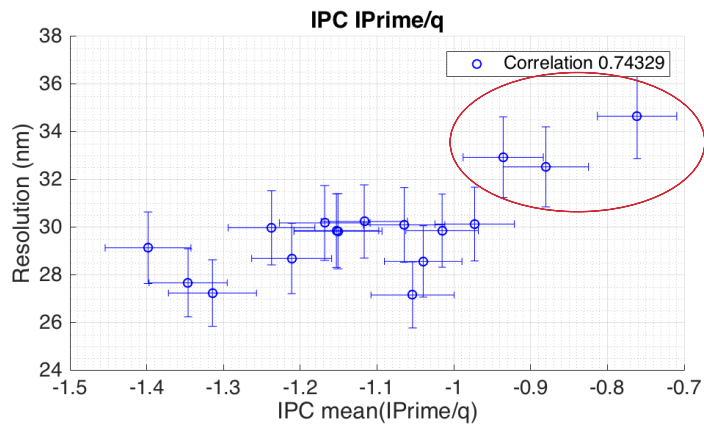
Study 1

- Three consecutive data runs combined to give 17 x 200-trigger data sets
- Study showed > 70% correlations between mean IPC I/q, Q/q, I'/q and geometric resolution. Also showed > 50% correlations between mean IPA I/q, Q/q, I'/q and geometric resolution.
- Mostly due to three data points → Investigate these more closely.

jitRun13(1:200)

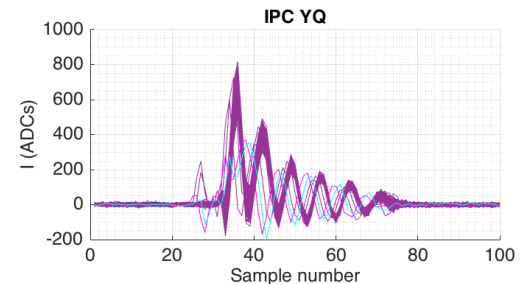
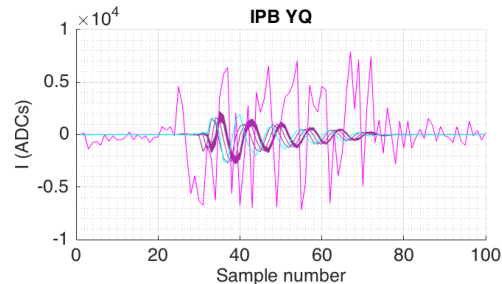
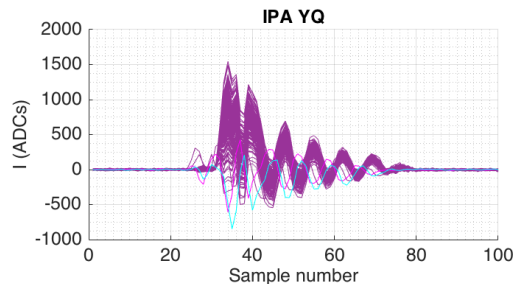
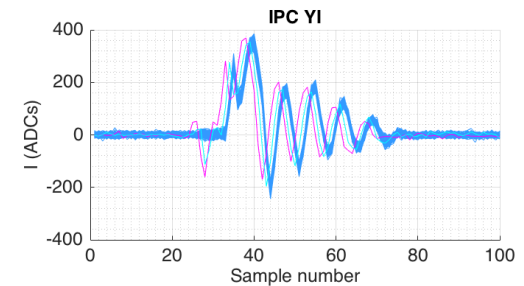
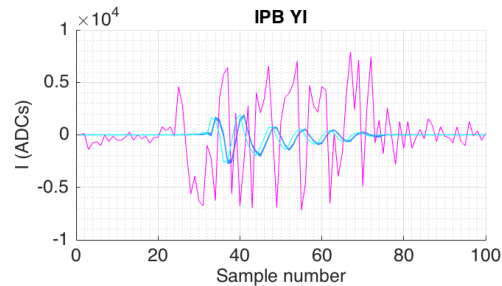
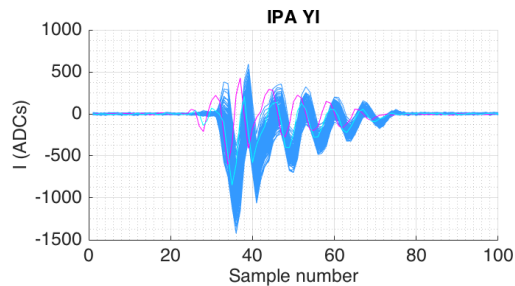
jitRun13(201:400)

jitRun14(601:800)

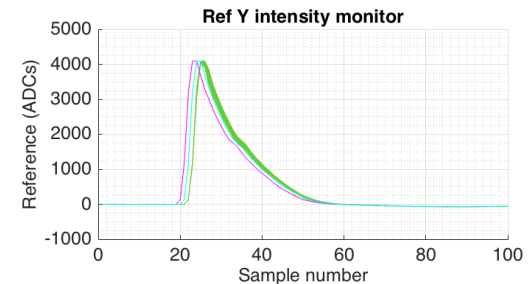


Study 1: examine cuts

- jitRun13(1:200) - Triggers 56 and 147 are problems

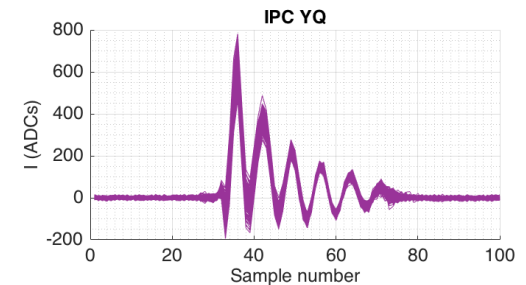
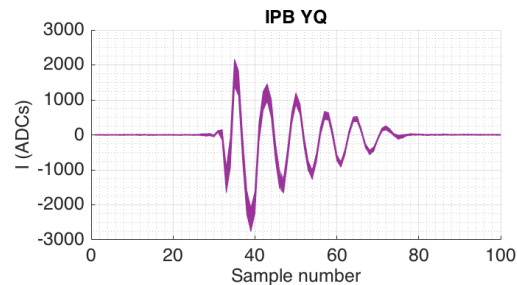
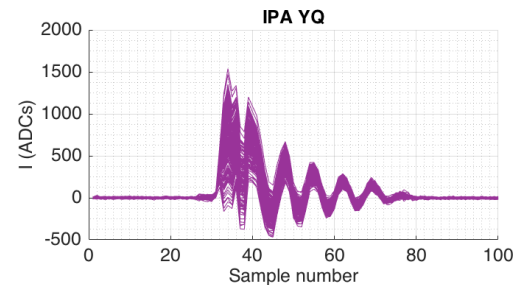
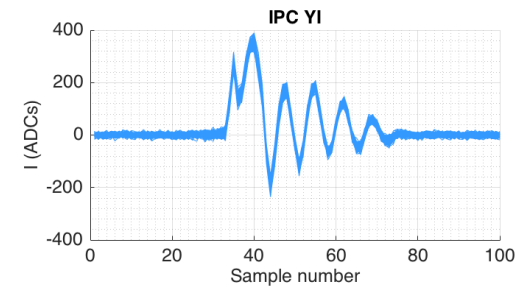
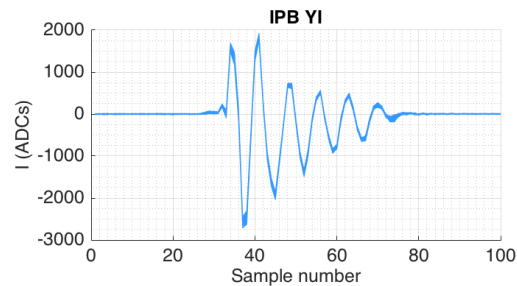
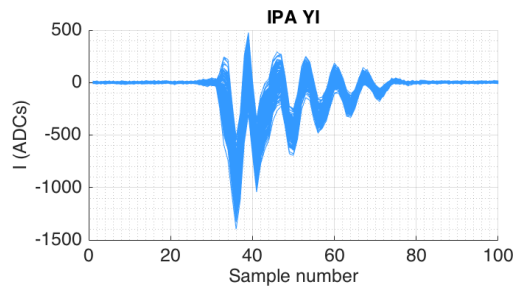


- For IPB trigger 56 gets removed on saturation cuts. Trig 147 on ref 3-sigma cut.
- For IPA and IPC, both are removed on ref 3-sigma cut.
- Four further triggers removed on I'/Q' cuts.
- Three further removed from X cuts.

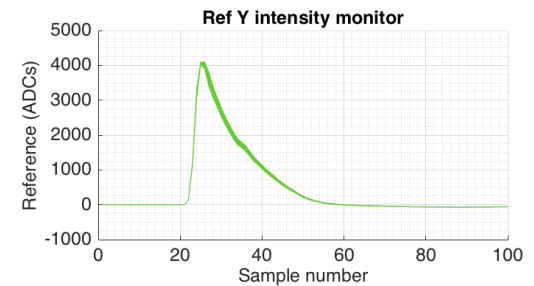


Study 1: examine cuts

- jitRun13(201:400) – No obvious problem triggers in Y

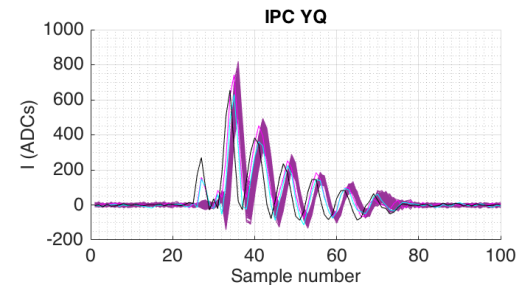
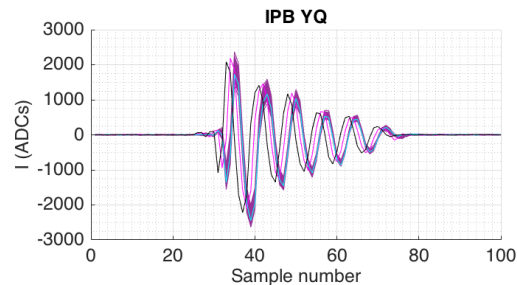
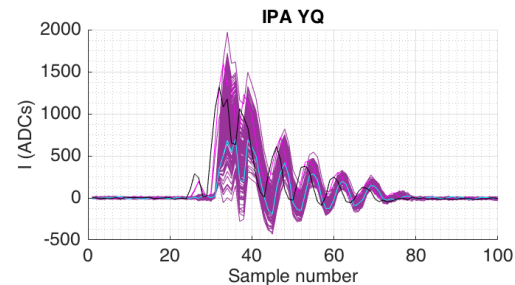
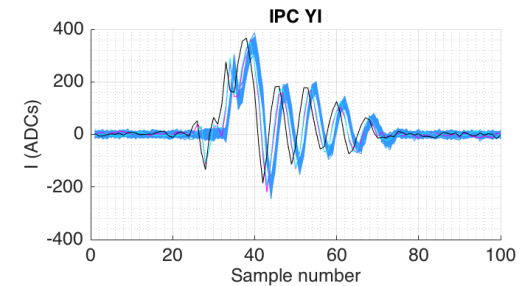
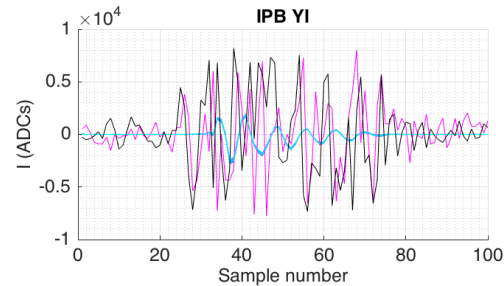
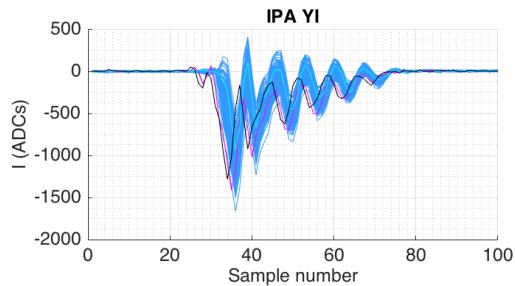


- One trigger removed on I'/Q' cuts.
- Four further removed from X cuts.

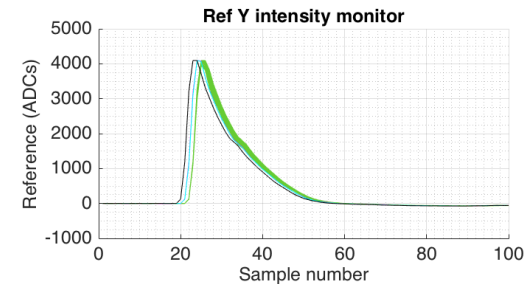
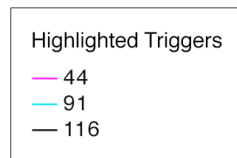


Study 1: examine cuts

- jitRun14(601:800) - Triggers 44, 91, 116 are problems

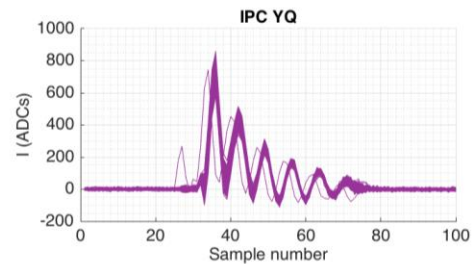
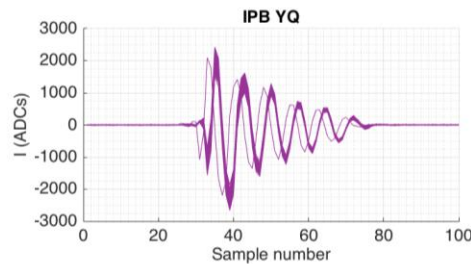
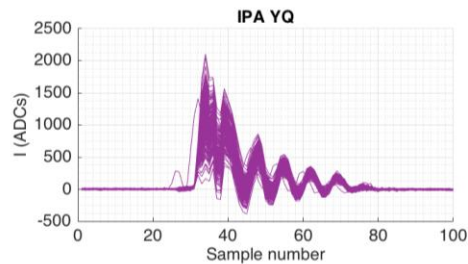
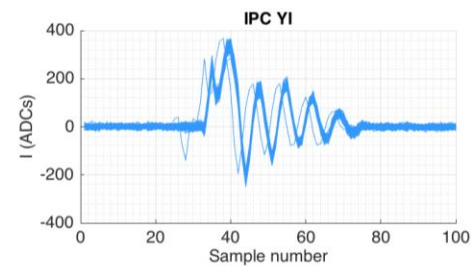
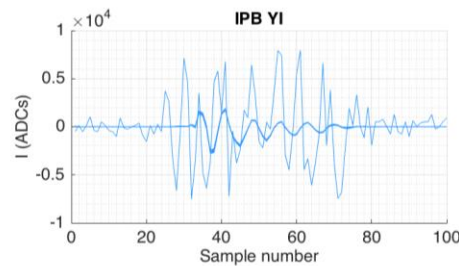
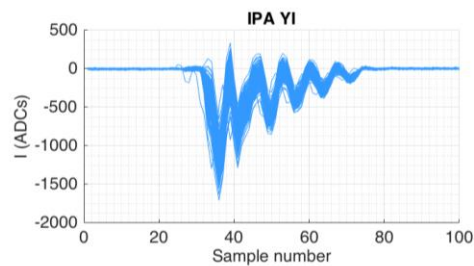


- For IPB triggers 44 and 116 get removed on saturation cuts. Trig 91 on ref 3-sigma cut.
- For IPA and IPC, all three are removed on ref 3-sigma cut.
- Two further triggers removed on I'/Q' cuts.
- Four further removed from X cuts.

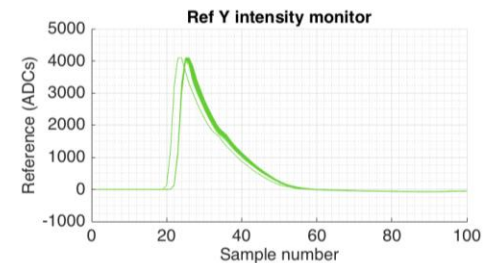


Study 1: examine cuts

- However, this is not unique to these files.
- Other files from this set show similar amounts of sample jumping and saturating triggers, which after cuts, still produce slightly lower resolution results

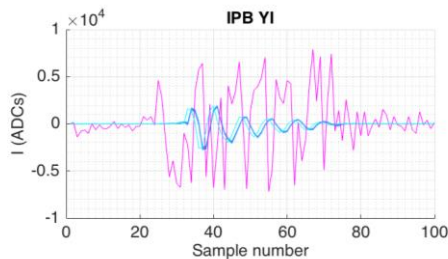


- Example: jitRun14(1:200)

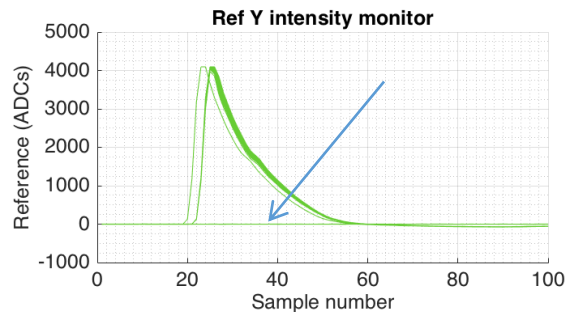


Current cutting process

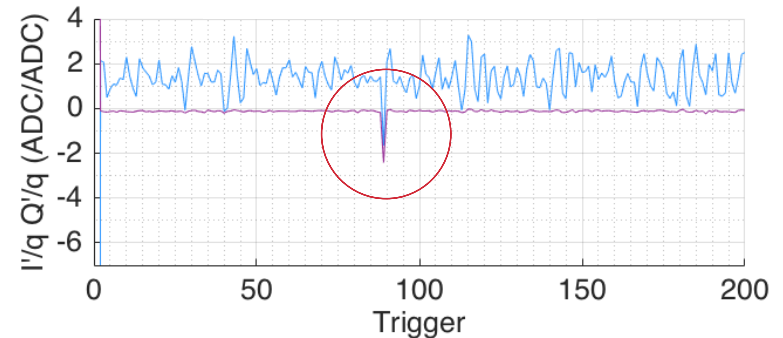
- Remove saturating triggers where data is lost or there are unphysical ADC counts. (Reference channel excluded, because often saturated intentionally)



- Remove empty triggers not above a certain threshold on the reference channel.



- 3 sigma cut on the reference, I' and Q' .



- Any triggers removed on any channels are also removed on other channels.
- Any triggers removed in Y or X, are also removed in their counterparts.
- All these processes combined typically results in the removal of about 10% of the total triggers in data set.

Repeat study with minimal cuts

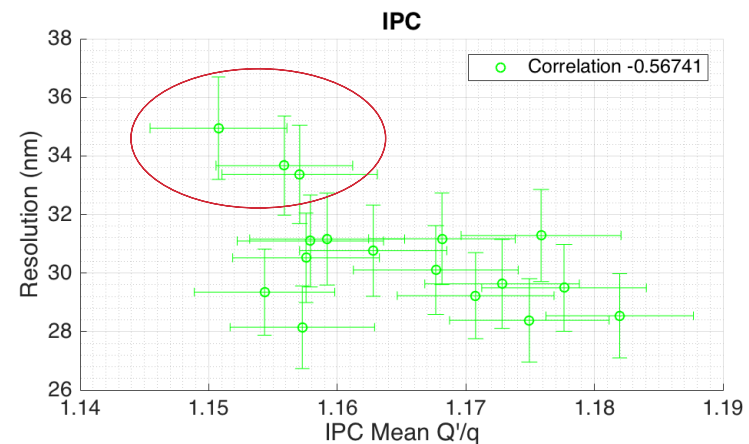
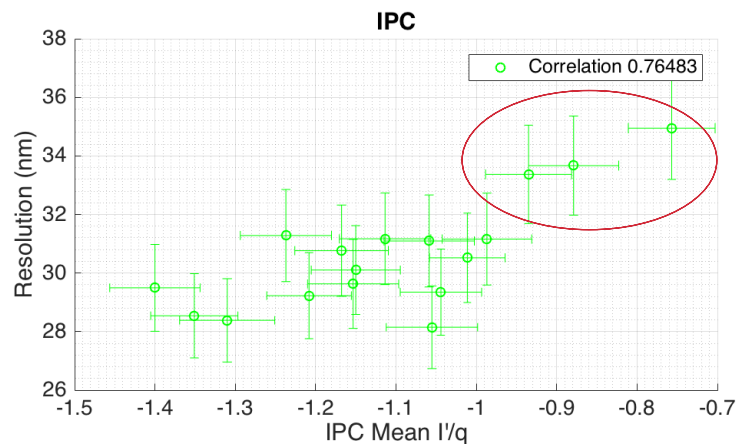
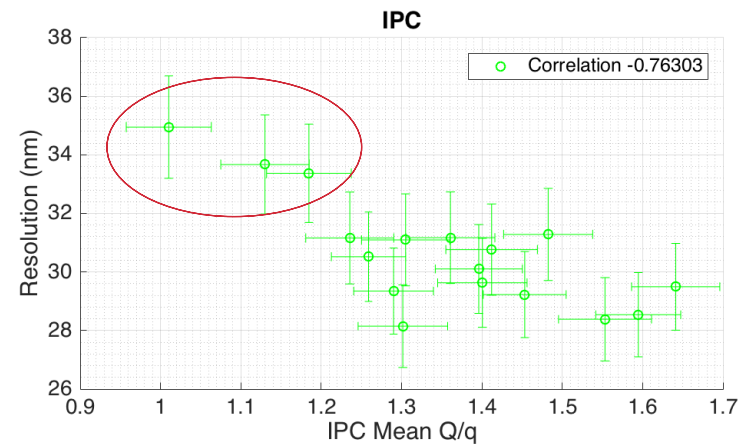
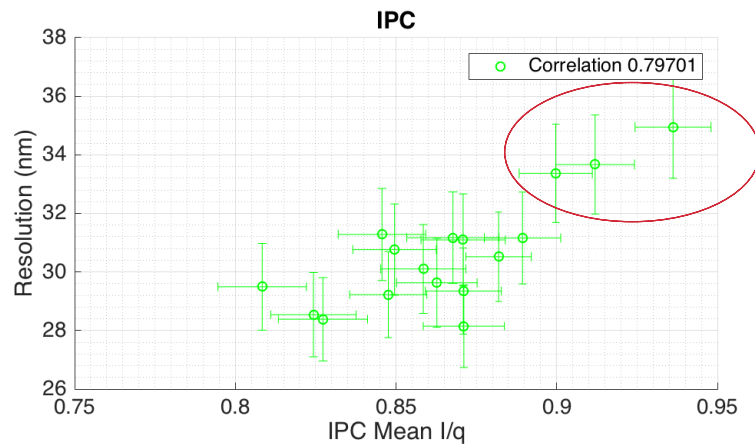
- Include saturation cut and reference threshold cut. No other cuts applied.
- Manual removal of sample jumps.
- Do not apply X cuts to Y data (as sample jumps apply in different places on different boards)
- Again look at the correlation between the geometric resolution and various parameters.
- Found almost identical result:
 - > 70% correlations between mean IPC I/q, Q/q, I'/q and geometric resolution.
 - > 60% correlations between mean IPA I/q, Q/q, I'/q and geometric resolution.

Std	A I'/q	-0.14
	A Q'/q	-0.62
	B I'/q	-0.28
	B Q'/q	-0.22
	C I'/q	-0.08
	C Q'/q	-0.39
	Ref Y	-0.25
	A I/q	-0.14
	A Q/q	-0.28
	B I/q	-0.08
	B Q/q	-0.20
	C I/q	-0.10
	C Q/q	-0.33

Mean	A I'/q	0.66
	A Q'/q	0.51
	B I'/q	0.44
	B Q'/q	0.07
	C I'/q	0.76
	C Q'/q	-0.57
	Ref Y	0.45
	A I/q	0.69
	A Q/q	-0.64
	B I/q	0.37
	B Q/q	-0.44
	C I/q	0.80
	C Q/q	-0.76

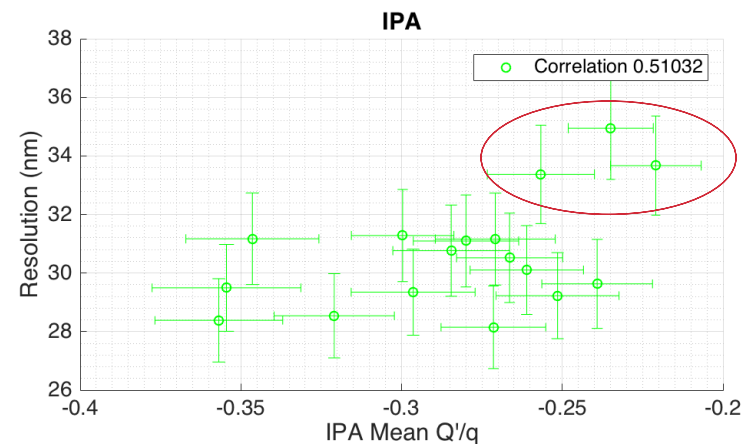
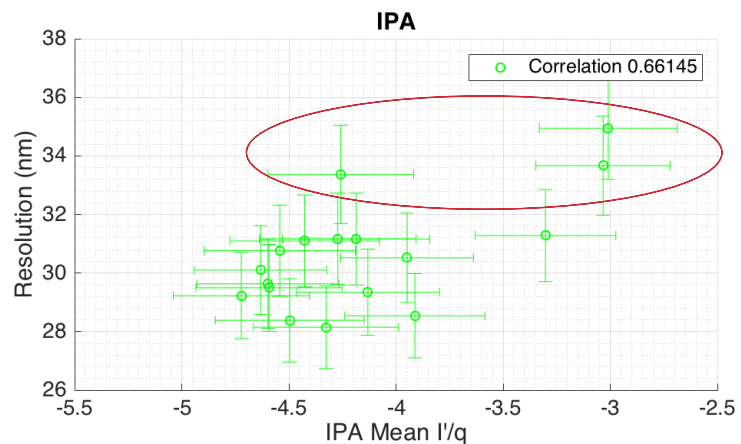
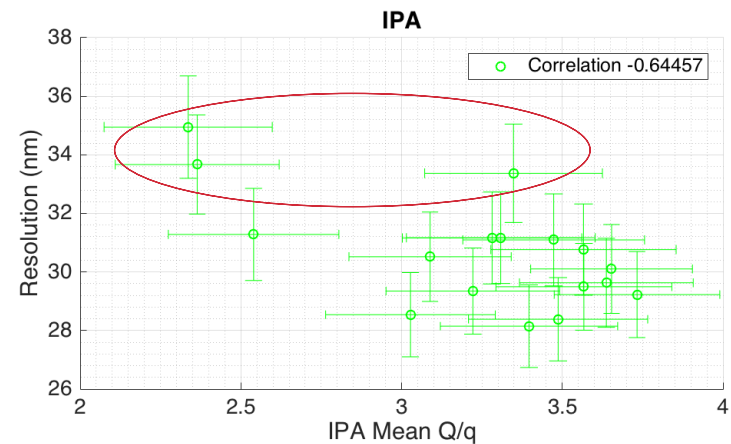
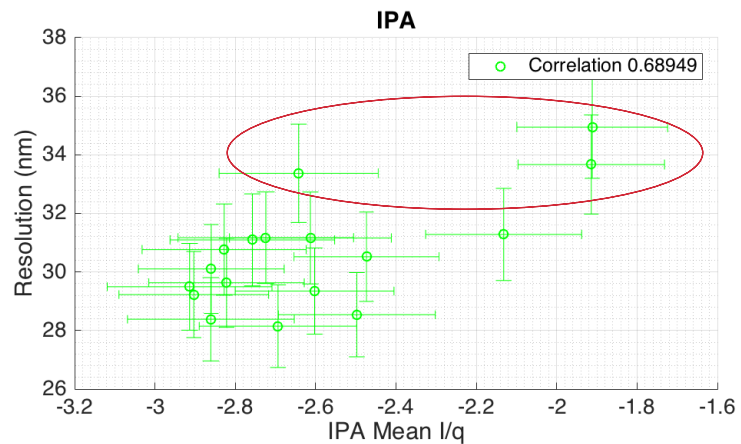
Study 1: results IPC

- Same three bad data points, so it does not appear to be a cuts-related phenomena.



Study 1: results IPA

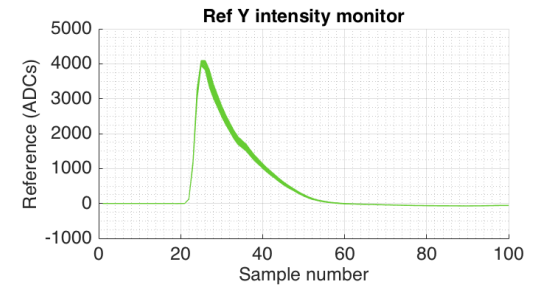
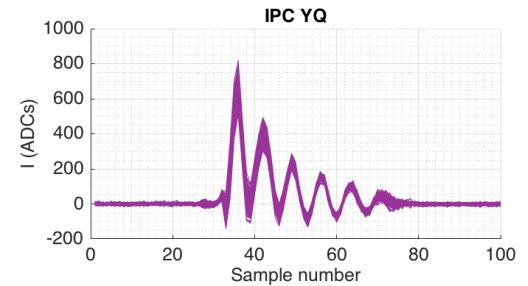
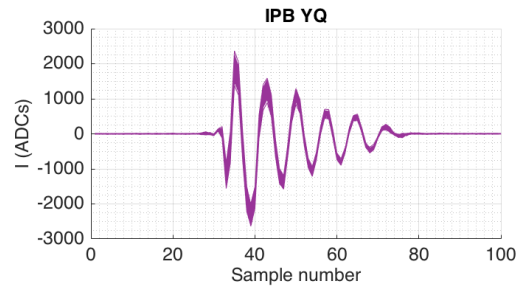
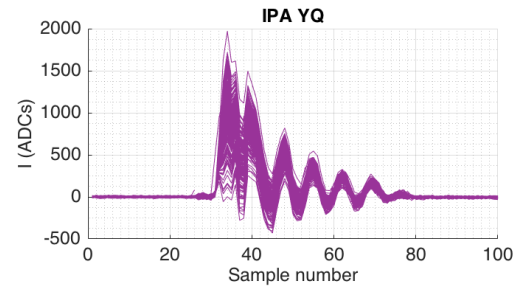
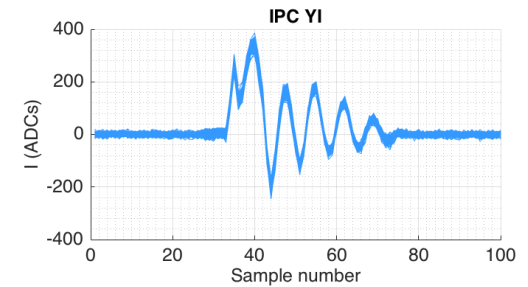
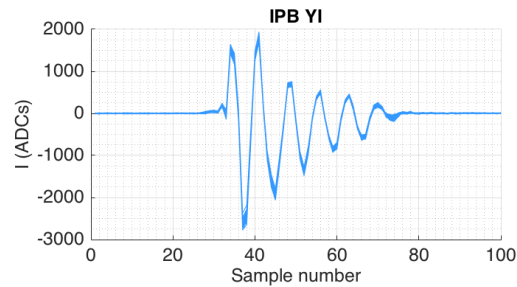
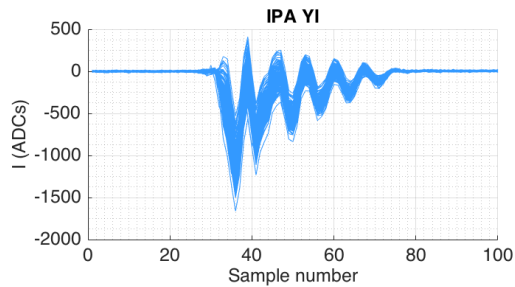
- Same three bad data points, so it does not appear to be a cuts-related issue.



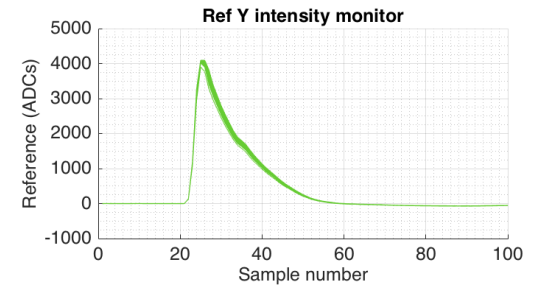
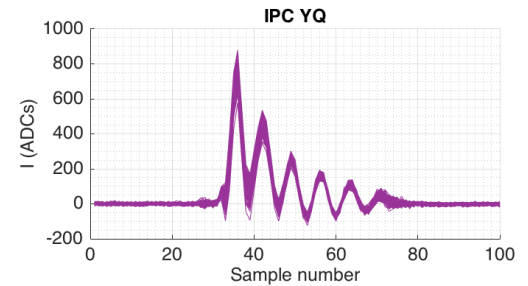
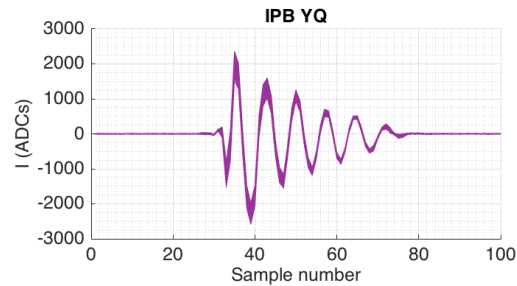
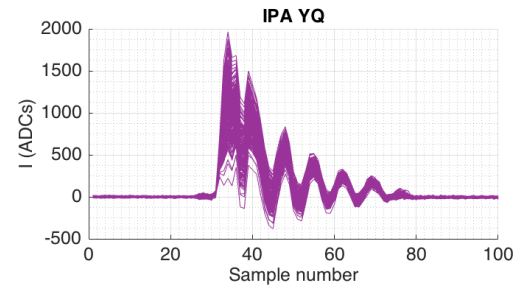
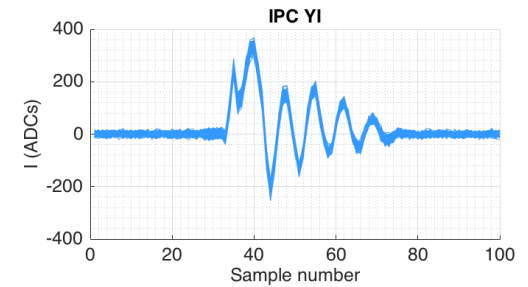
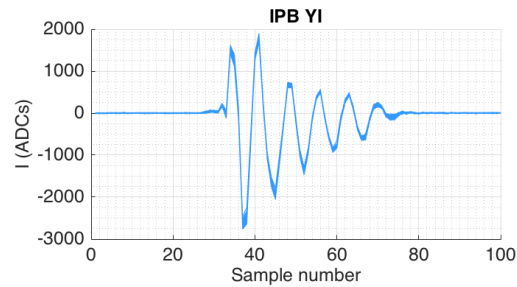
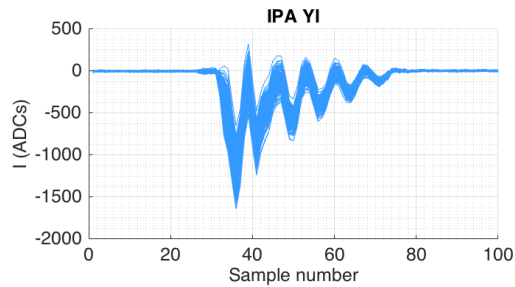
Examine the waveforms

- Nothing obviously different about these three compared to others on examination of waveforms once the necessary cuts have been applied.
- Examples on the next two slides:
 - jitRun14(601:800) -- geometric resolution 33nm
 - jitRun14(201:400) – geometric resolution 29 nm

jitRun14(601:800) → 33nm

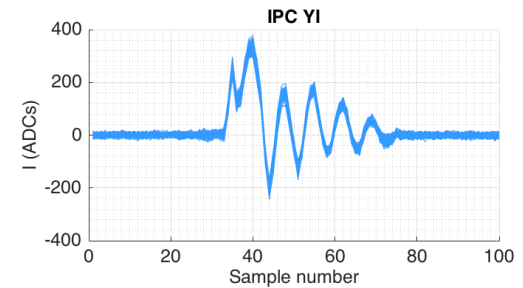
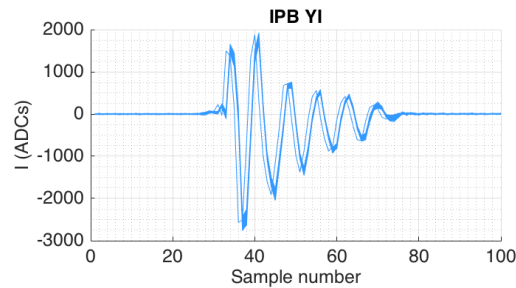
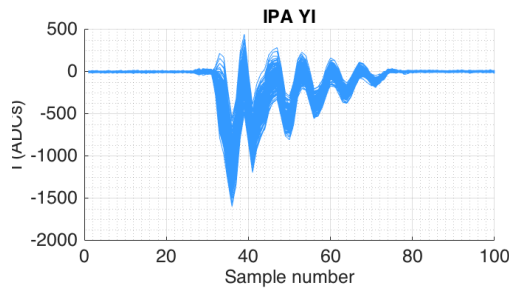


jitRun14(201:400) → 29nm



Introduce a new cut

- In order to calculate resolution on a rolling file, need some way of removing the sample jumps without reintroducing too many cuts.
- 5 sigma cut seems to successfully remove them without cutting anything else unnecessarily.

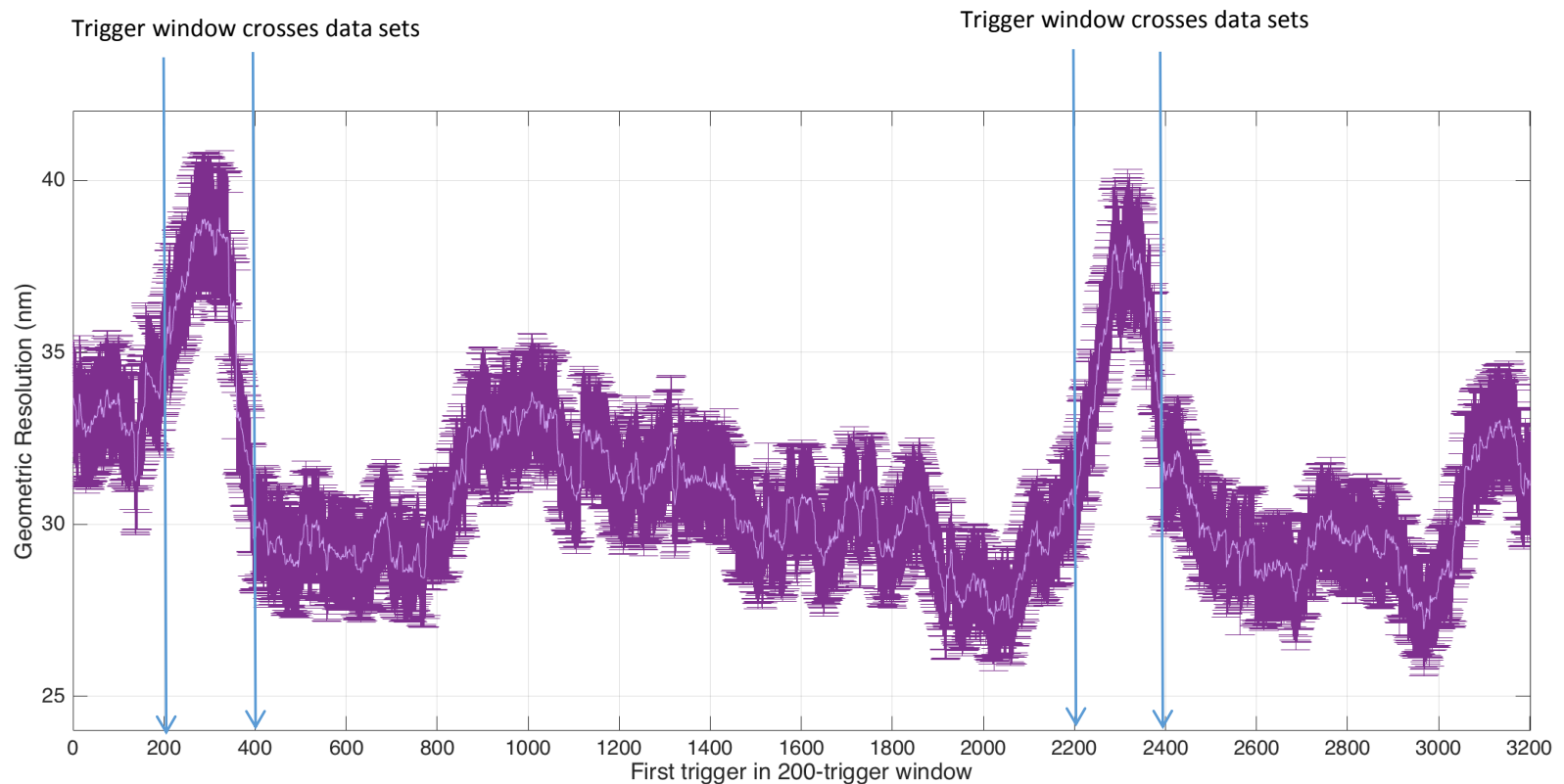


Necessary to apply to all channels because the jumps do not occur on all simultaneously.

- Leave out the I', Q' and reference cuts for now.

Study 1: Rolling resolution

- Combine all three data sets into one 3400-trigger data set.
- Break it up into 200 triggers i.e. 1:200, 2:201, 3:202, 4:203 to see what the geometric resolution does over time.

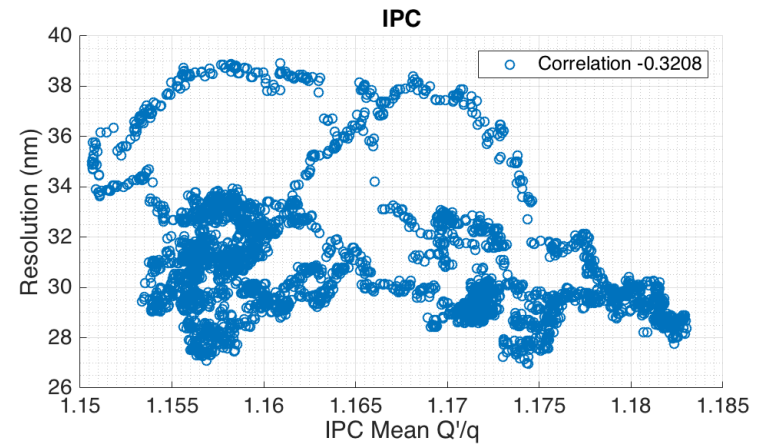
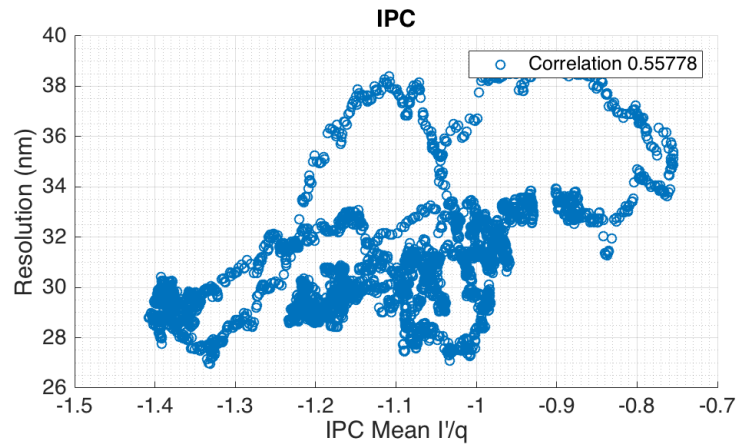
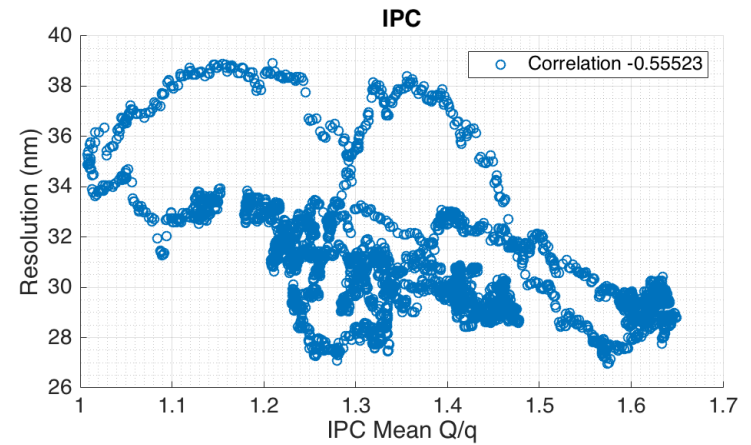
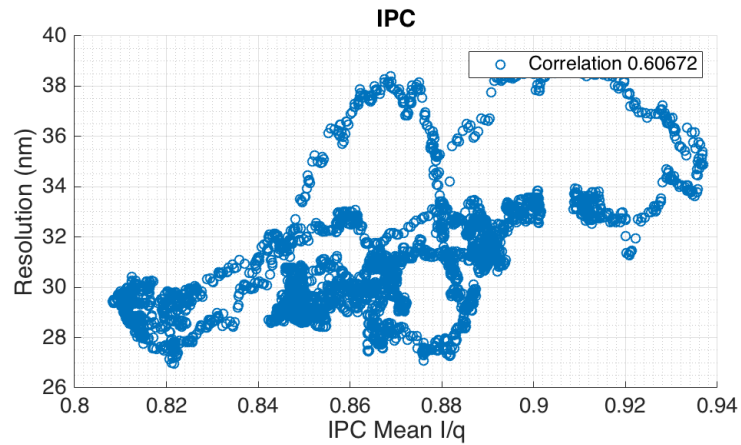


Study 1: Rolling resolution

- Include saturation cut and reference threshold cut. No other cuts applied.
- Sample jumps removed by 5-sigma cut on all channels.
- Do not apply X cuts to Y data (as sample jumps apply in different places on different boards)
- Again look at the correlation between the geometric resolution and various parameters.
- Found:
 - > 50% correlations between mean IPA/B/C I/q, Q/q and I'/q and geometric resolution.

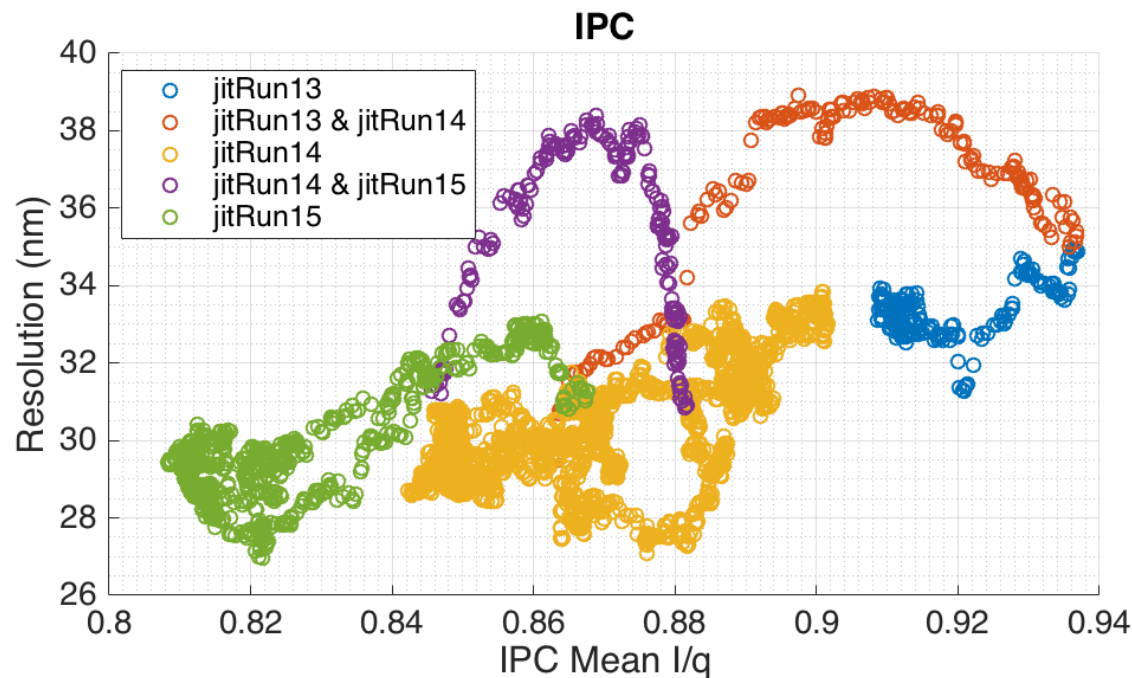
Std			Mean		
	A I'/q	0.28		A I'/q	0.58
	A Q'/q	-0.48		A Q'/q	0.39
	B I'/q	0.18		B I'/q	0.42
	B Q'/q	-0.03		B Q'/q	0.14
	C I'/q	0.43		C I'/q	0.56
	C Q'/q	0.06		C Q'/q	-0.32
	Ref Y	0.11		Ref Y	0.30
	A I/q	0.20		A I/q	0.61
	A Q/q	0.31		A Q/q	-0.57
	B I/q	0.08		B I/q	0.37
	B Q/q	0.18		B Q/q	-0.42
	C I/q	0.14		C I/q	0.61
	C Q/q	0.44		C Q/q	-0.56

Study 1: Rolling resolution



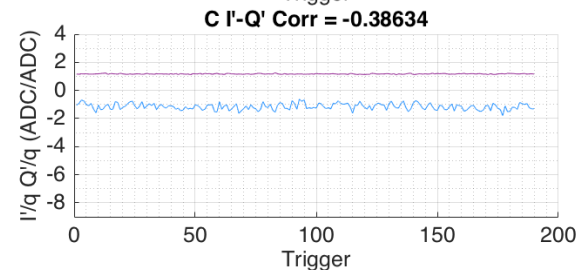
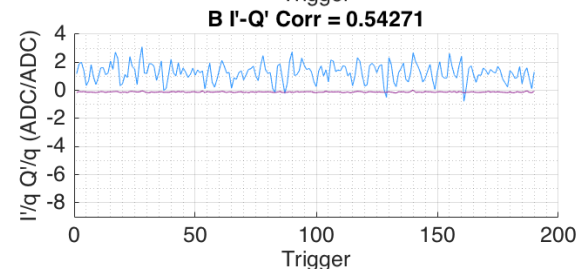
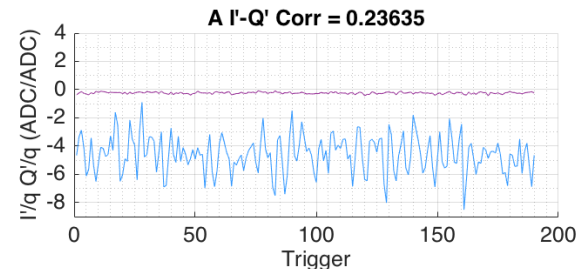
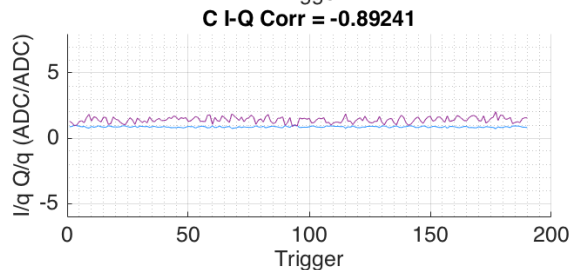
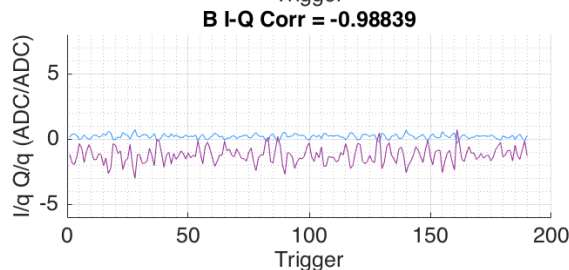
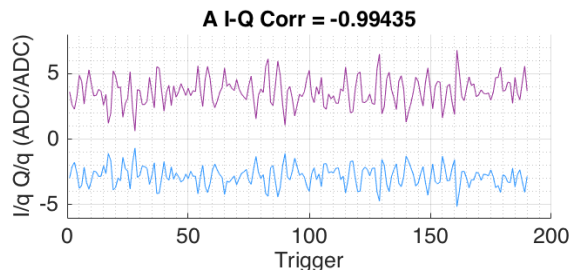
Study 1: Rolling resolution

- Correlations between, for example, the mean IPC I/q level and the geometric resolution can be clearly separated into distinct regions corresponding to temporal places in the data set.



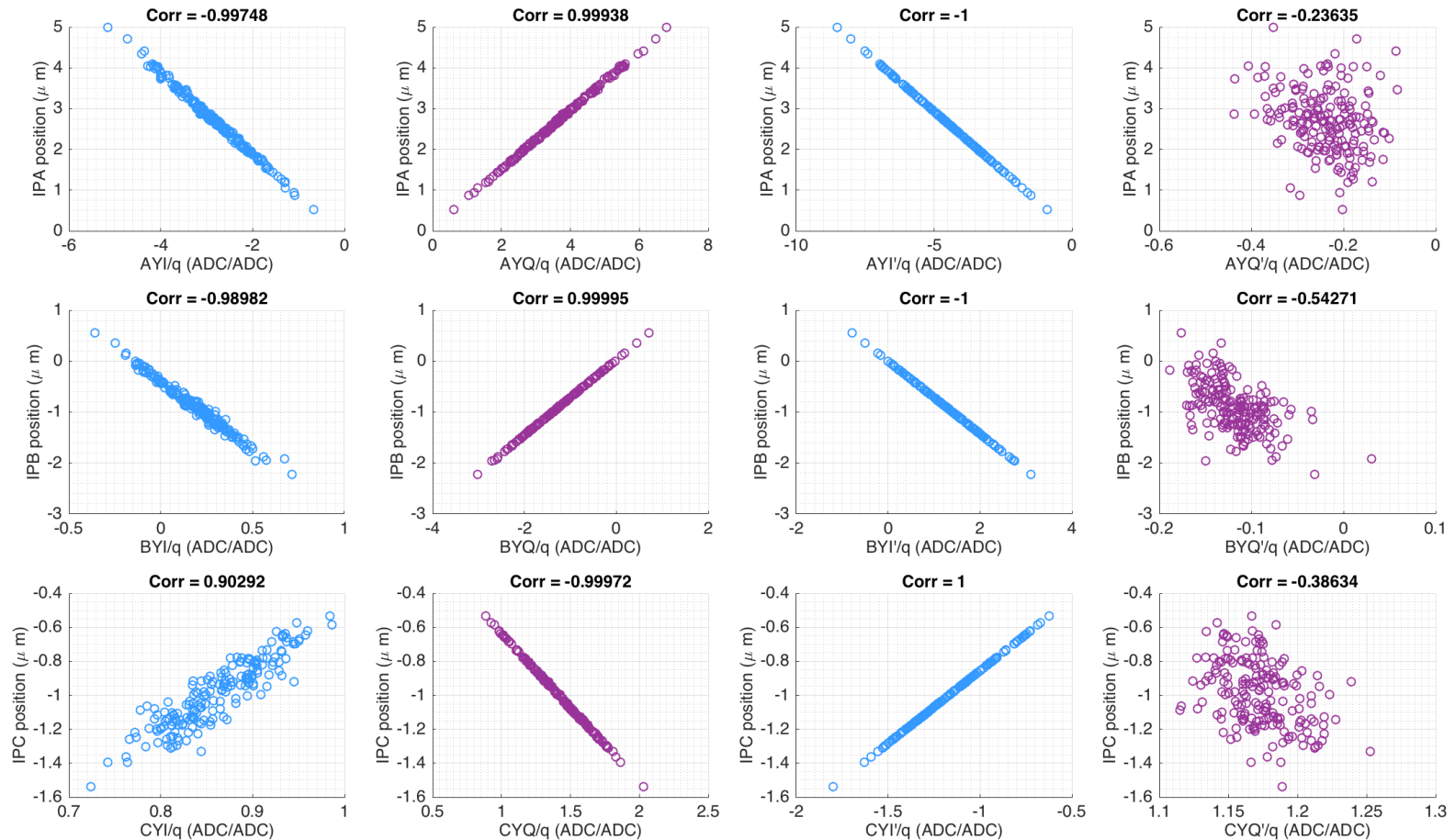
Study 1: Anti-correlation of I & Q

- Investigate the correlation between I/q and Q/q \rightarrow Appears on all of this data sets here.
- Example jitRun14(1:200)
- \sim 100% correlation on IPA and IPB, \sim 90% on IPC.



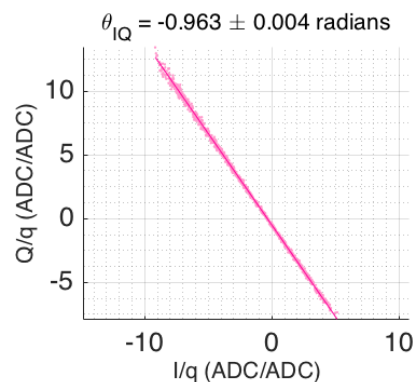
Study 1: Correlation with position

- I, Q and I' and Q' with position

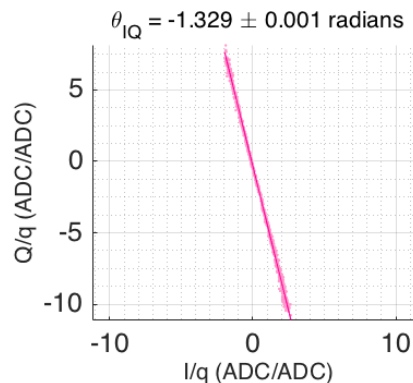


Study 1: Theta with time

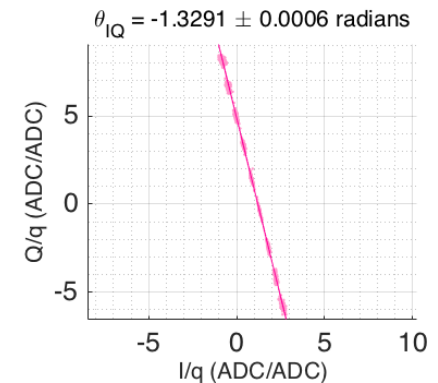
- Use the calibrations for IPA, IPB and IPC to determine the intercept.



IPA intercept
-0.52 ADCs



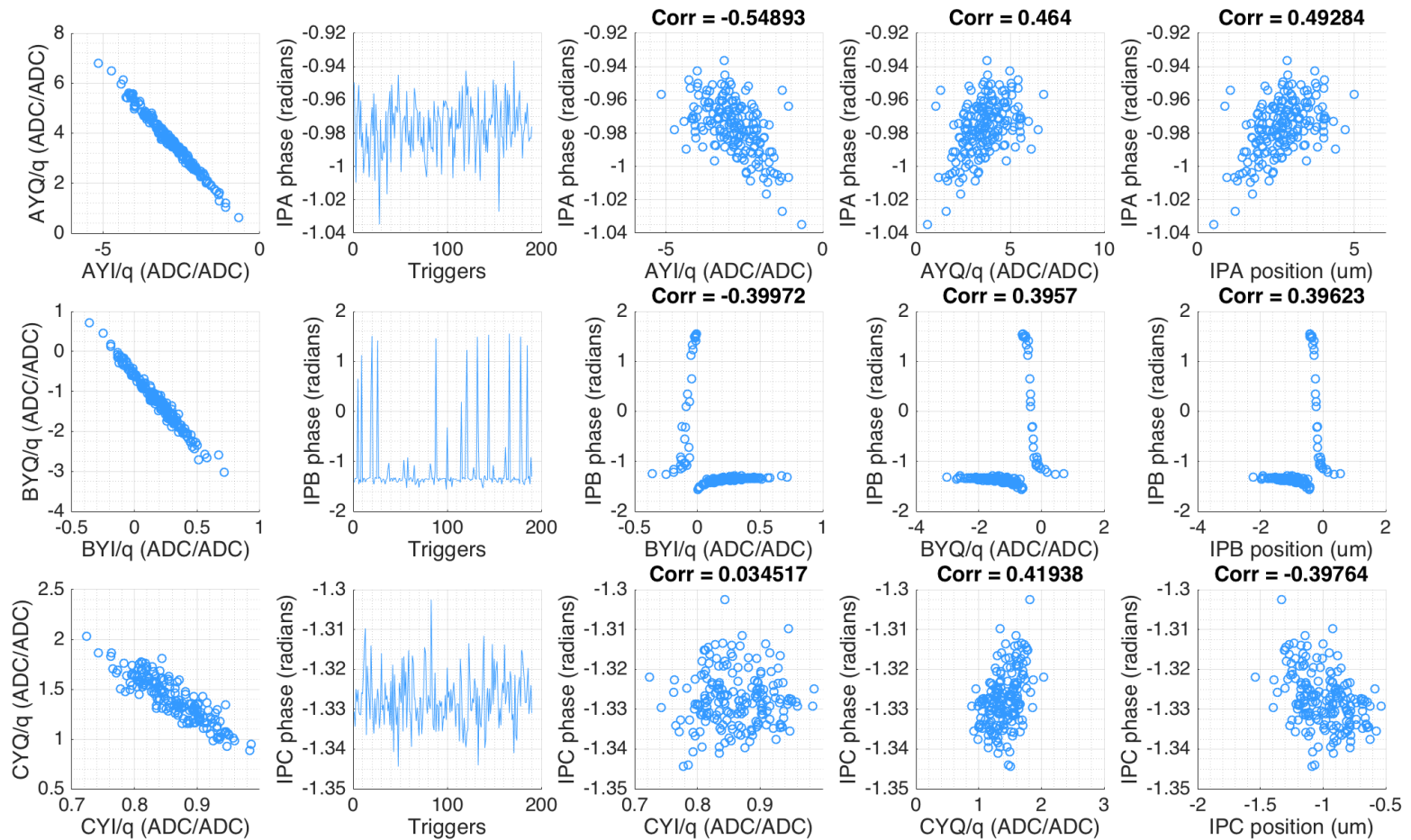
IPB intercept
-0.33 ADCs



IPC intercept
4.88 ADCs

Study 1: Correlation with theta

- Calculate theta for each trigger across the jitter run and look at correlations.



Study 2: Compare jitRun8 and 9

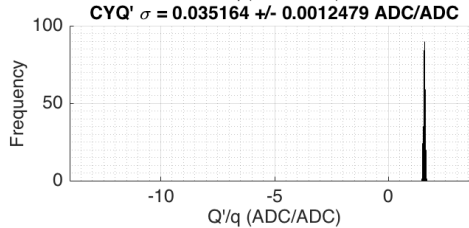
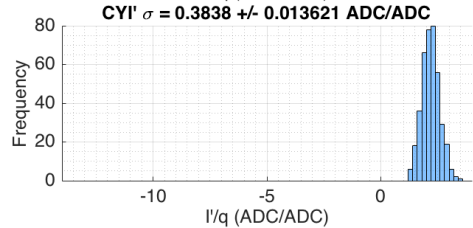
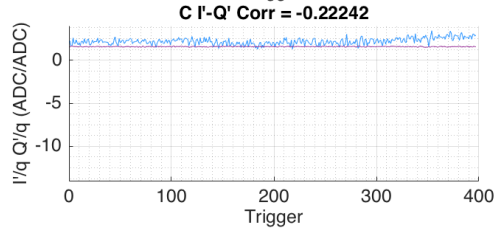
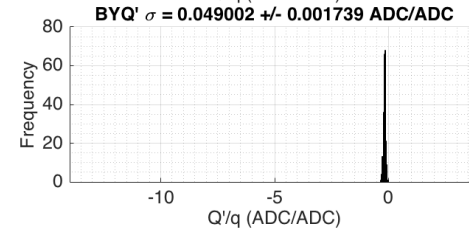
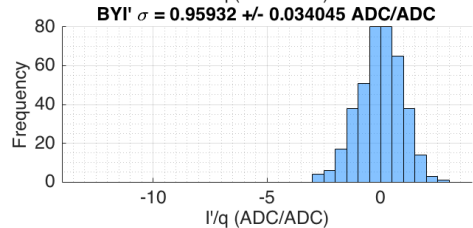
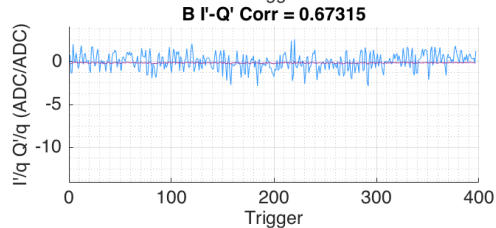
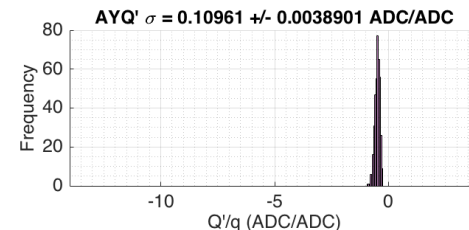
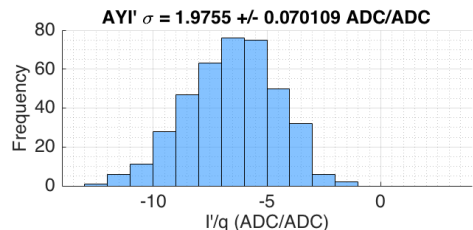
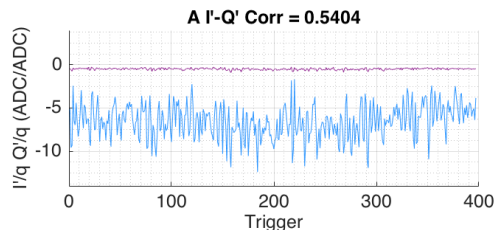
Compare the two most extreme cases:

jitRun8_10dB_Board1_260517	20 nm
jitRun9_10dB_Board1_260517	40 nm

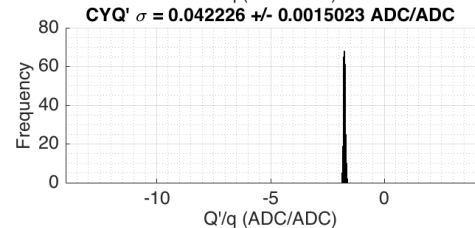
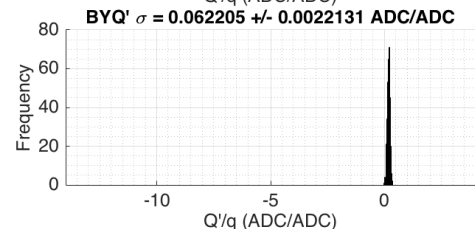
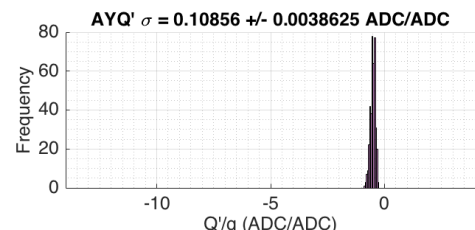
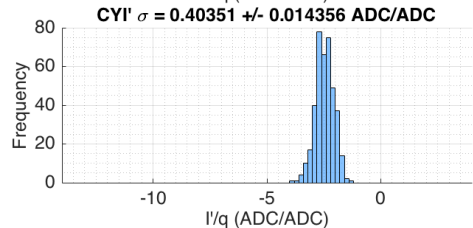
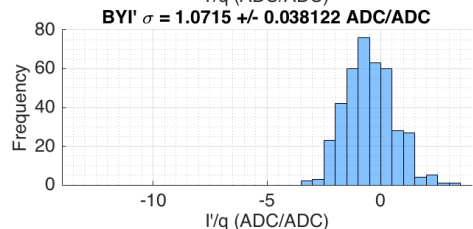
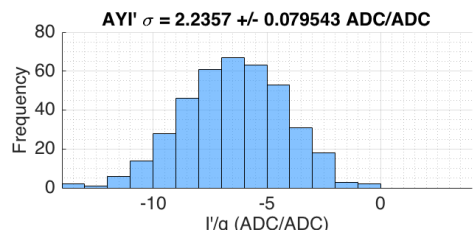
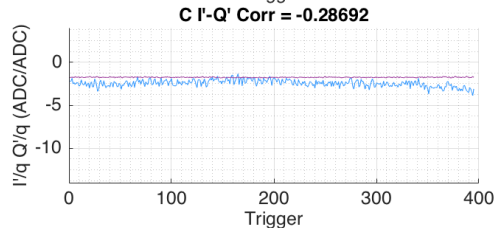
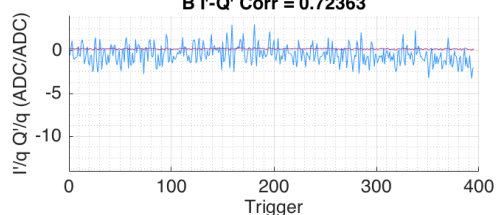
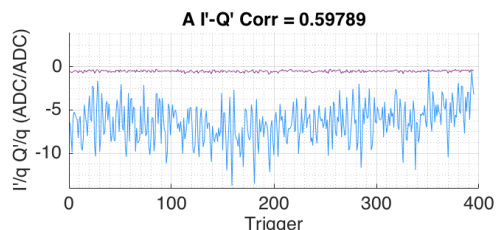
Differences between these two files:

- Slight change in the attenuation on the reference signal (6dB) are accounted for by scaling the diode reference signal to 50dB to make all comparable.
- New calibrations. New background subtractions.
- Plot I' and Q' rather than I and Q.
- How theta is changing across the jitter runs.

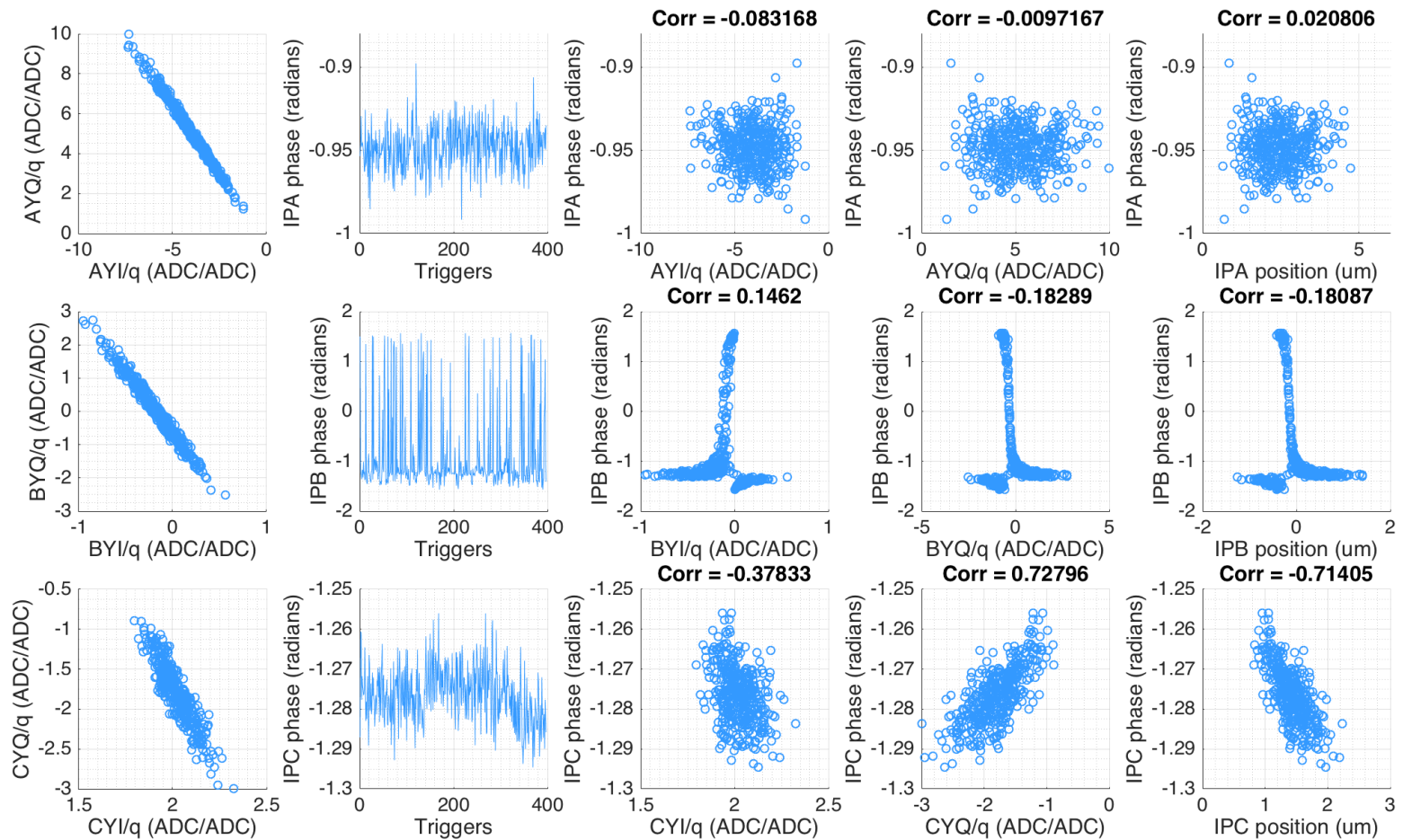
Study 2: jitRun8 (20nm)



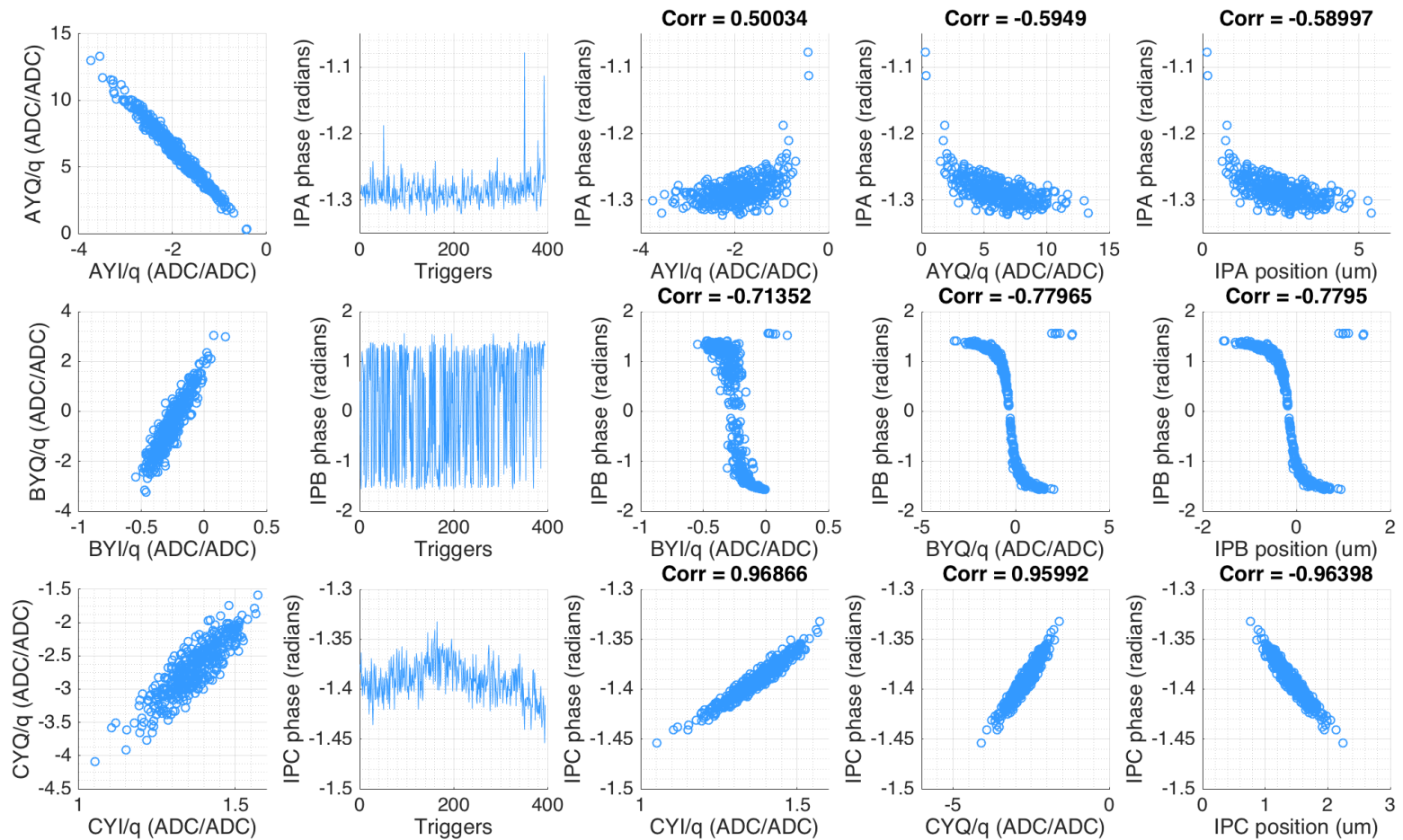
Study 2: jitRun9 (40nm)



Study 2: jitRun8 (20nm) theta



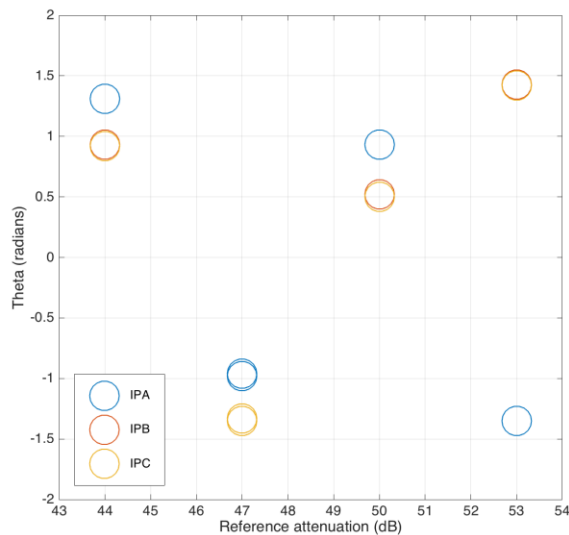
Study 2: jitRun9 (40nm) theta



Study 2: Theta and Ref atten.

Look at how theta from the calibration changes with the reference attenuation setting.

Ref attenuation (dB)	44	47	47	50	53
theta A	1.31	-0.98	-0.96	0.93	-1.35
theta B	0.93	-1.35	-1.33	0.52	1.43
theta C	0.92	-1.35	-1.33	0.50	1.42
Associated resolutions (nm)	30	20	33, 30,30	28	40



Add pi to the negative theta results.

