

# Resolution Study -17<sup>th</sup> Feb 2017

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# Outline

## 17/02/17 Day shift

Resolution calculations for:

- Charge scans – measured resolutions compared with predicted scaling  $1/q$ .
- Attenuation scans – compared with predicted logarithmic scaling.

*Looking at improvements from adding X information to the fitting.*

*(With FONT 5A #4 as board 1 (IPY), and FONT 5 #1 as board 2 (IPX).)*

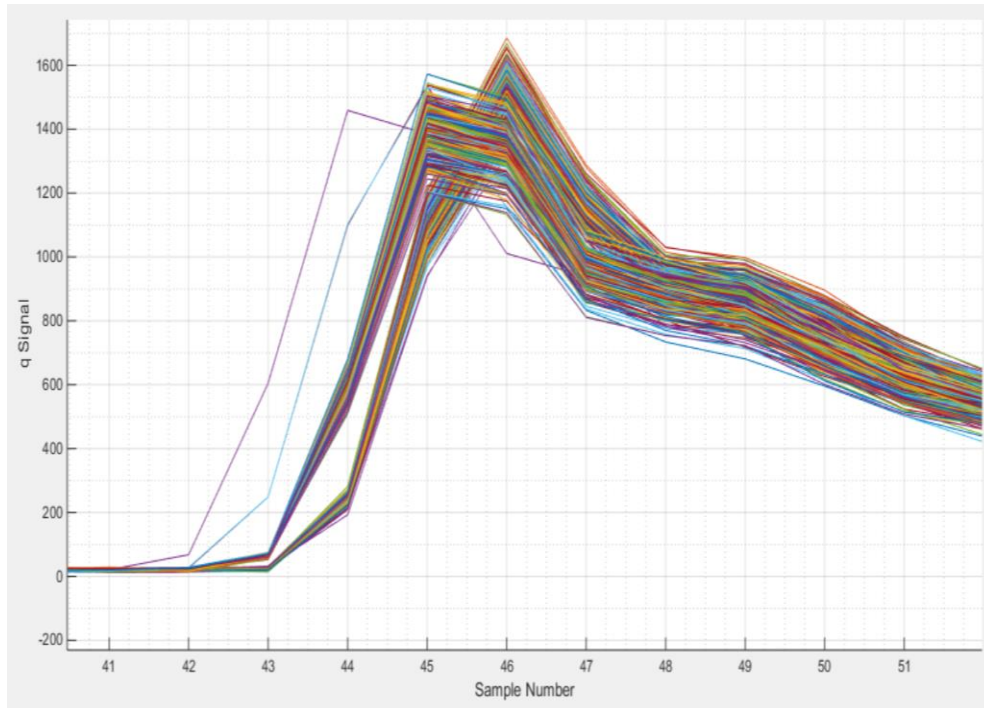
# Charge Scan

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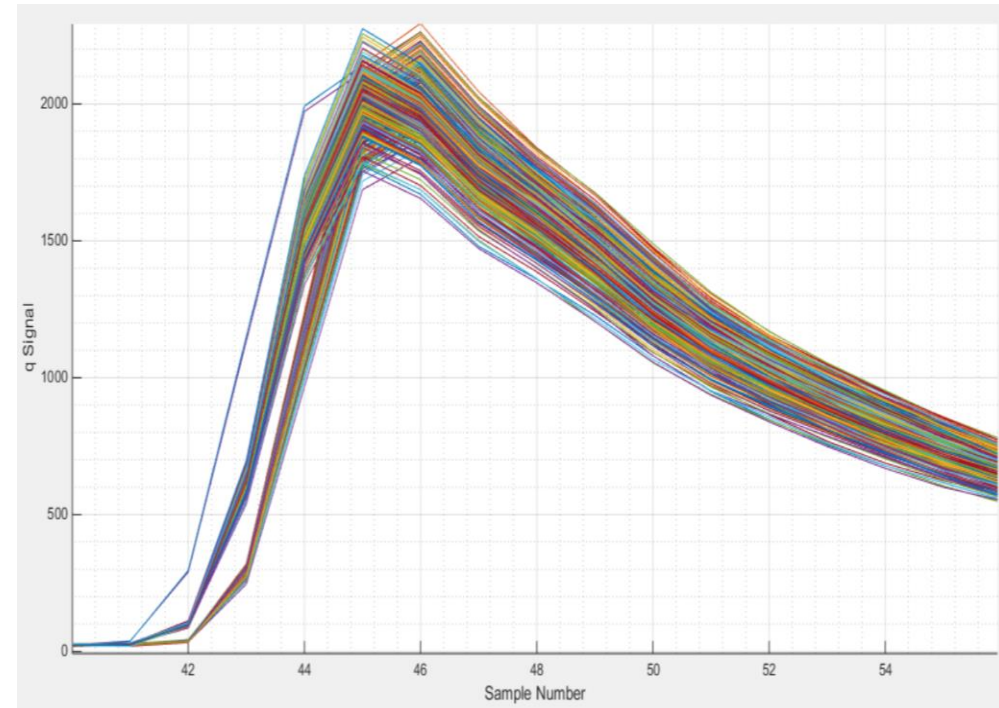
# Permanent Sample Jump

- Filename: jitRun17\_0dB\_0.55\_Board2\_170217
- Reference signal shows two families of peaks, peak permanently shifts after 194 triggers for both boards.
- Single-trigger sample jumps at triggers: (X) 20, 76 and (Y) 130, 183.

IP (X)



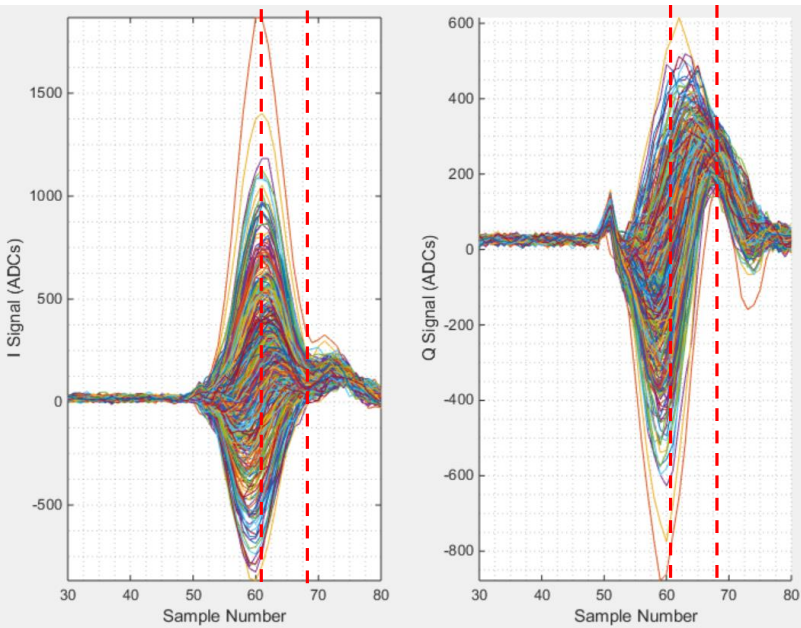
IP (Y)



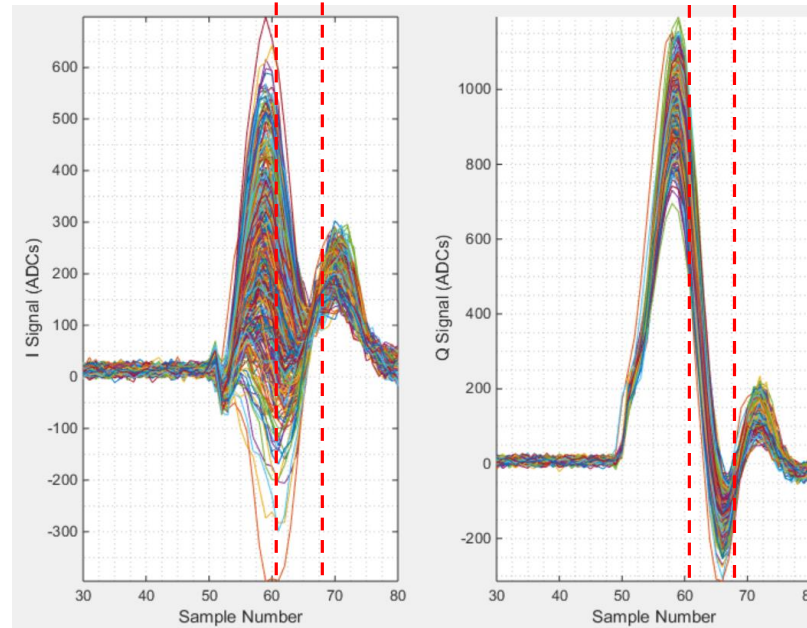
# Jitter Run Waveforms (X)

- jitRun4\_0dB\_0.55\_Board2\_170217, waveforms for X.
- Sample numbers used: 61:68.
- 9 triggers cut from 400 total triggers.

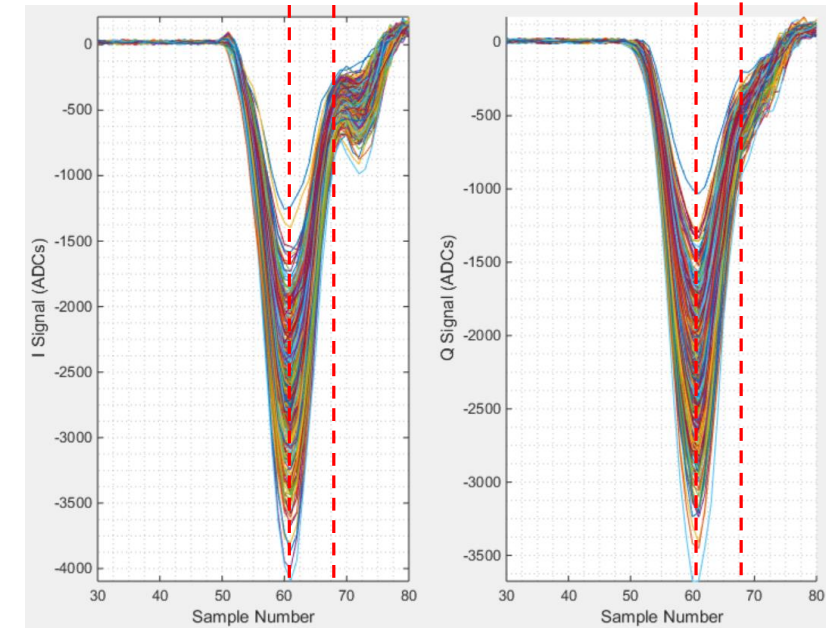
IPA(X)



IPB(X)



IPC(X)

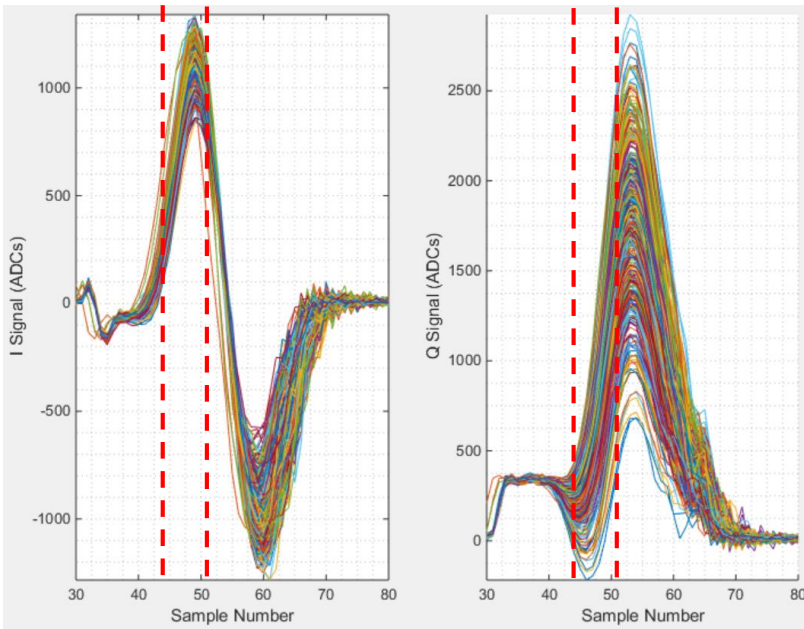




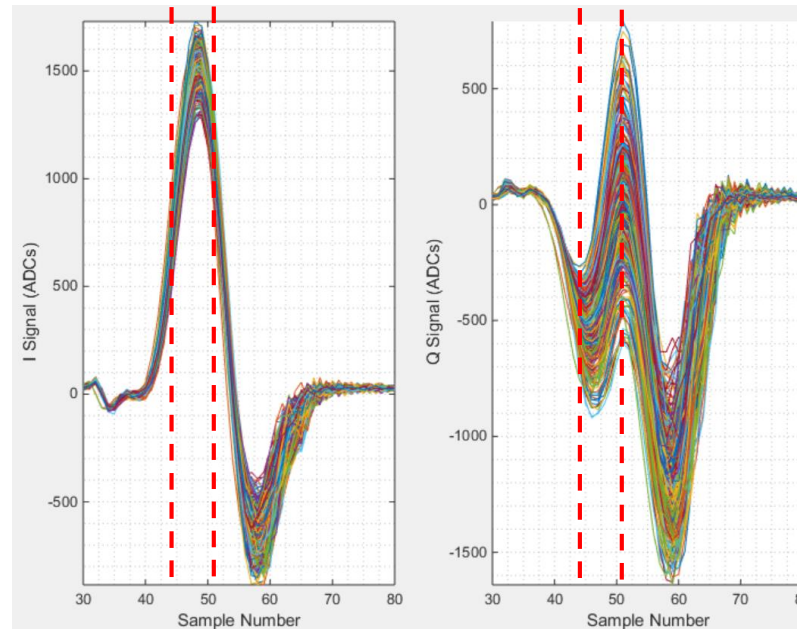
# Jitter Run Waveforms (Y)

- jitRun4\_0dB\_0.55\_Board2\_170217, waveforms for Y.
- Sample numbers used: 44:51. Sample early in the waveform as BPF.
- 8 triggers cut from 400 total triggers.

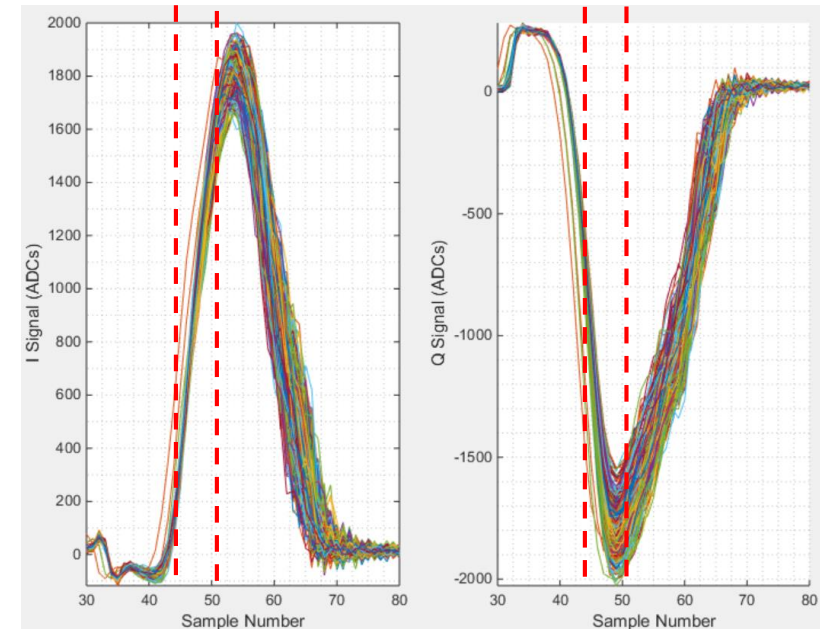
IPA(Y)



IPB(Y)

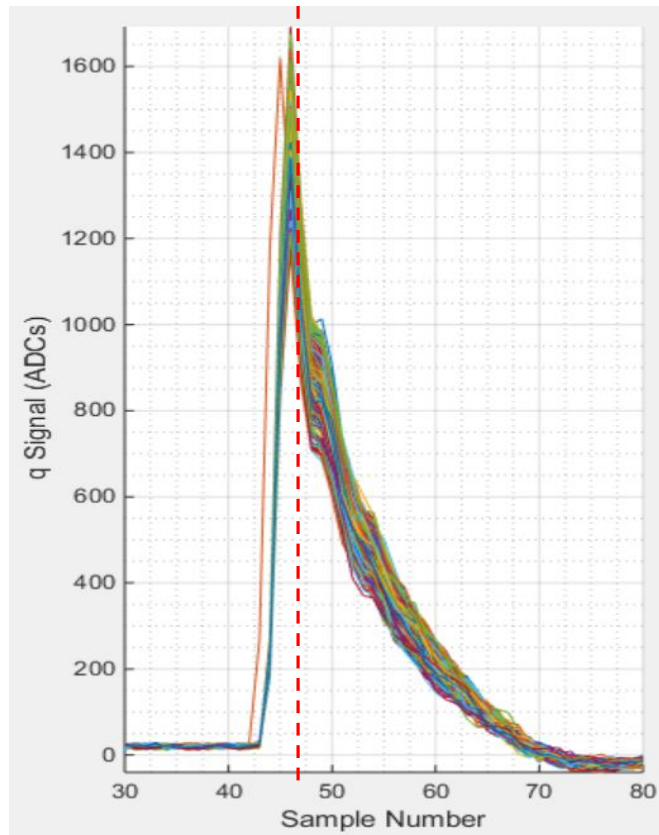


IPC(Y)



# Jitter Run Waveforms: Reference Signal

Ref(X)

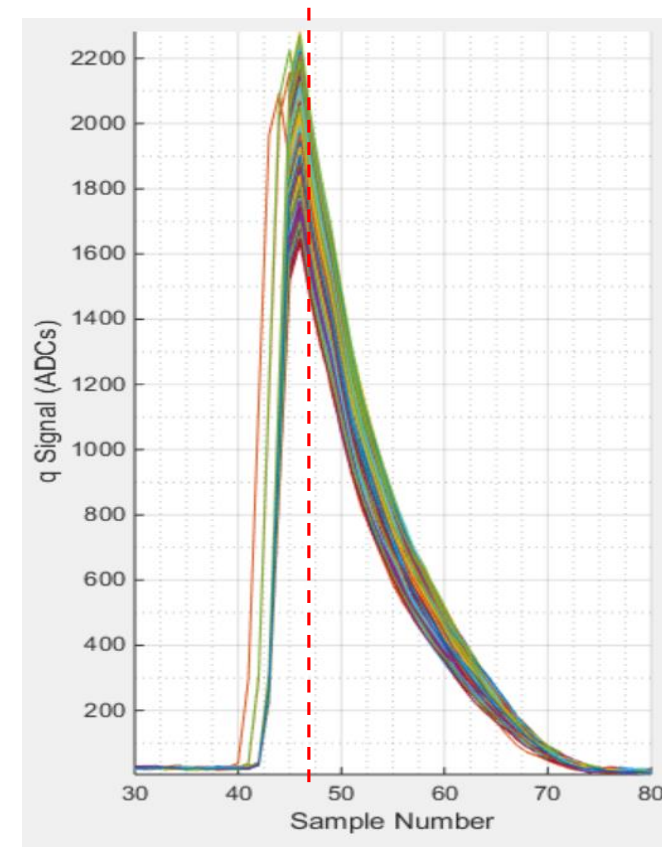


Reference signal sampled at 47.

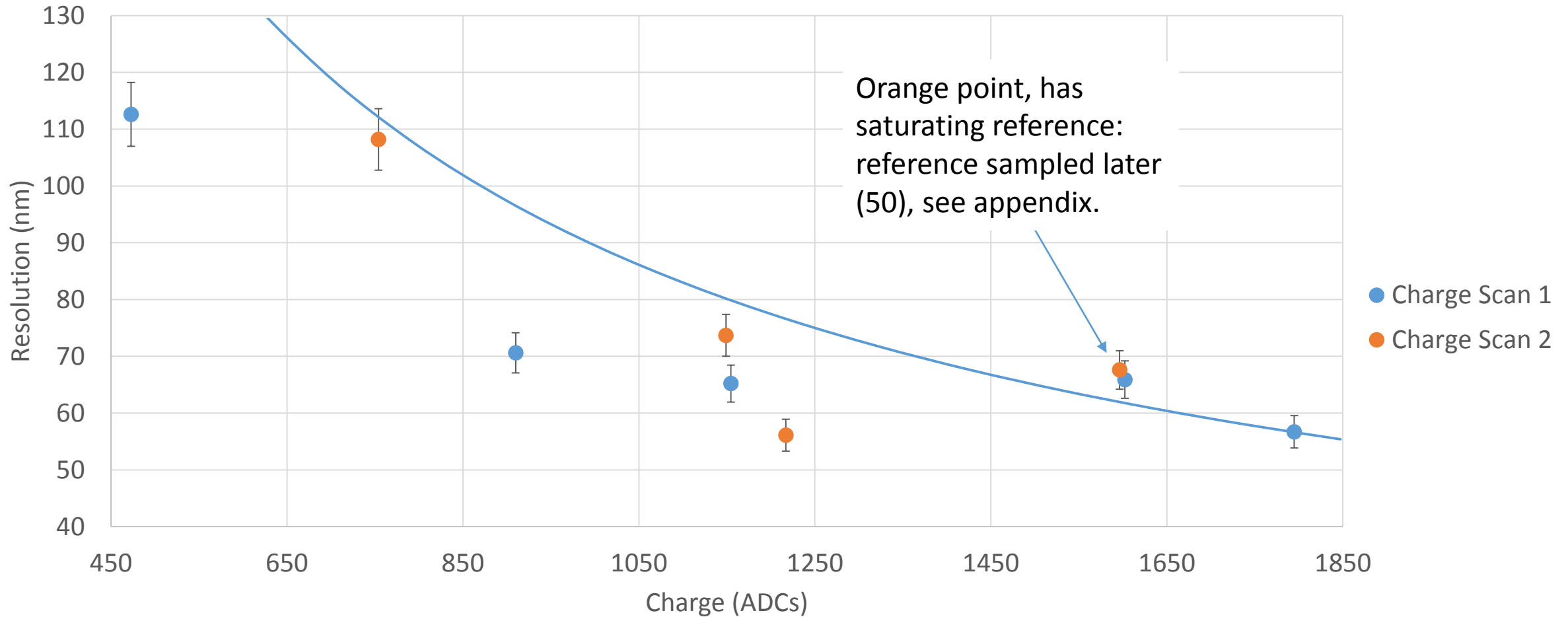
Reference peak at sample 46.

Can see single trigger sample jumps, removed during analysis.

Ref(Y)



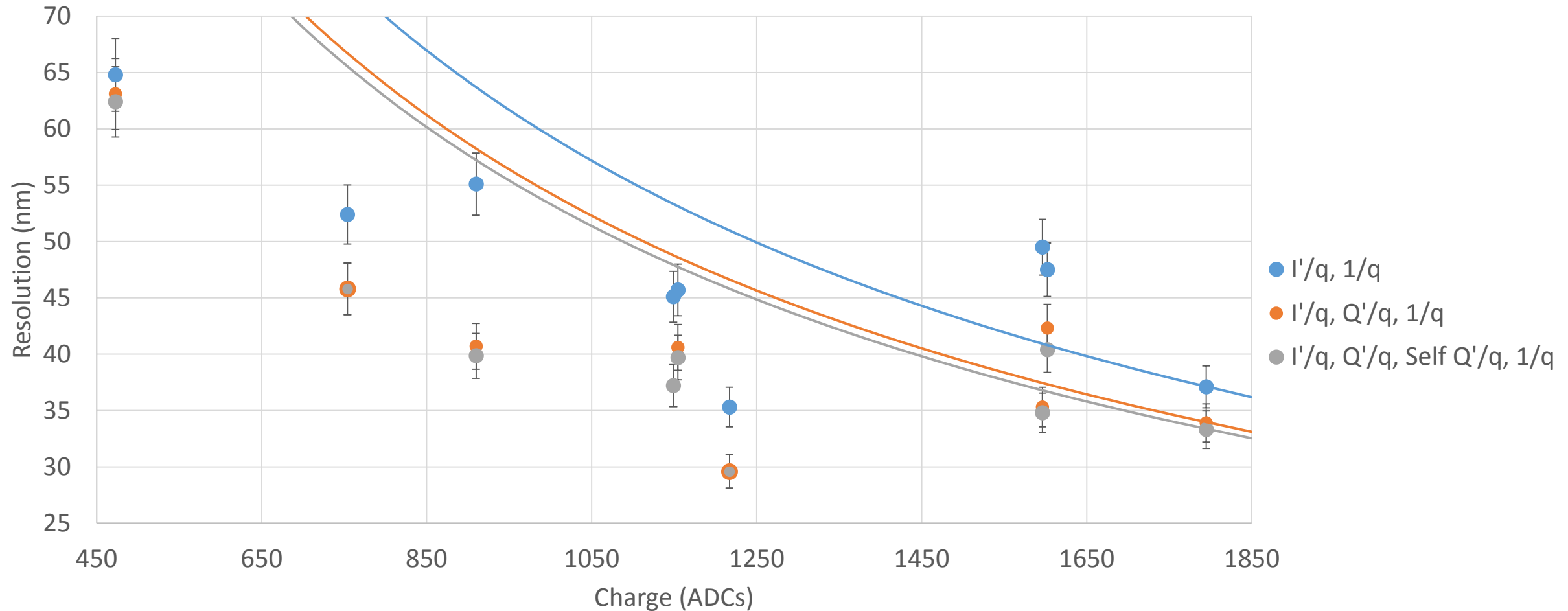
# Geometric Resolution Charge Scan





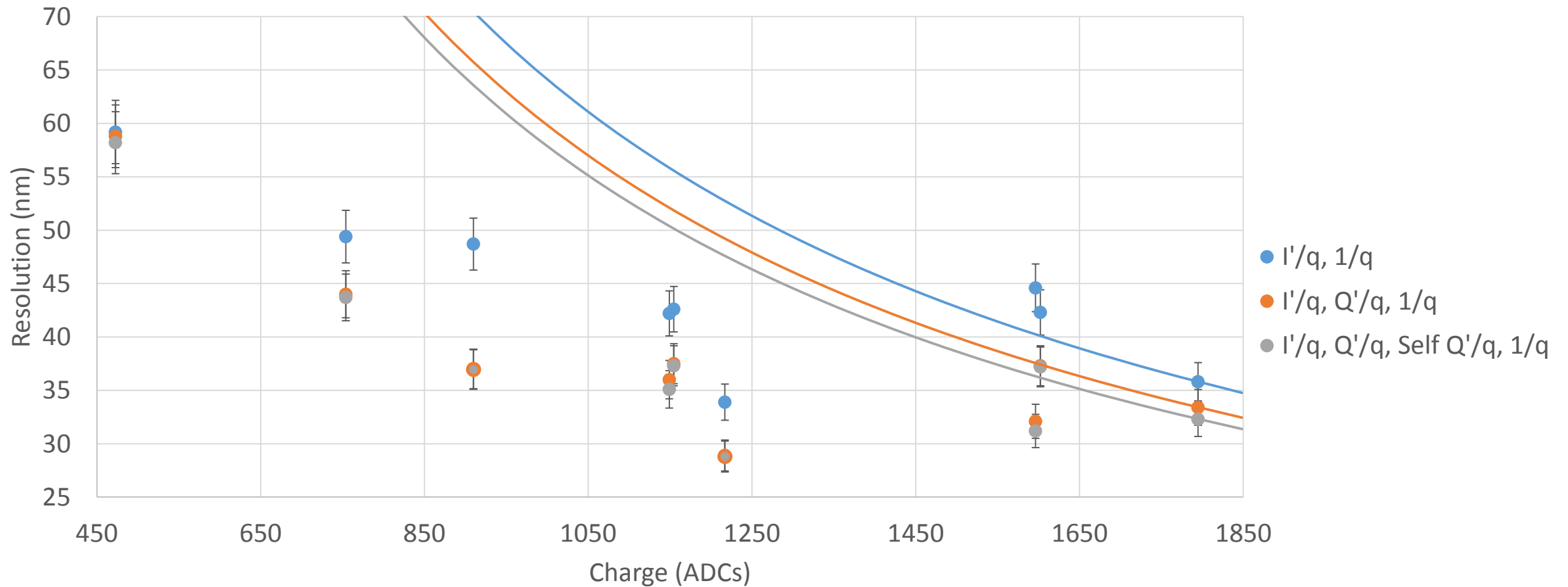
# IPA Resolution Fitting to Y information

IPA Resolution Fitting to Y



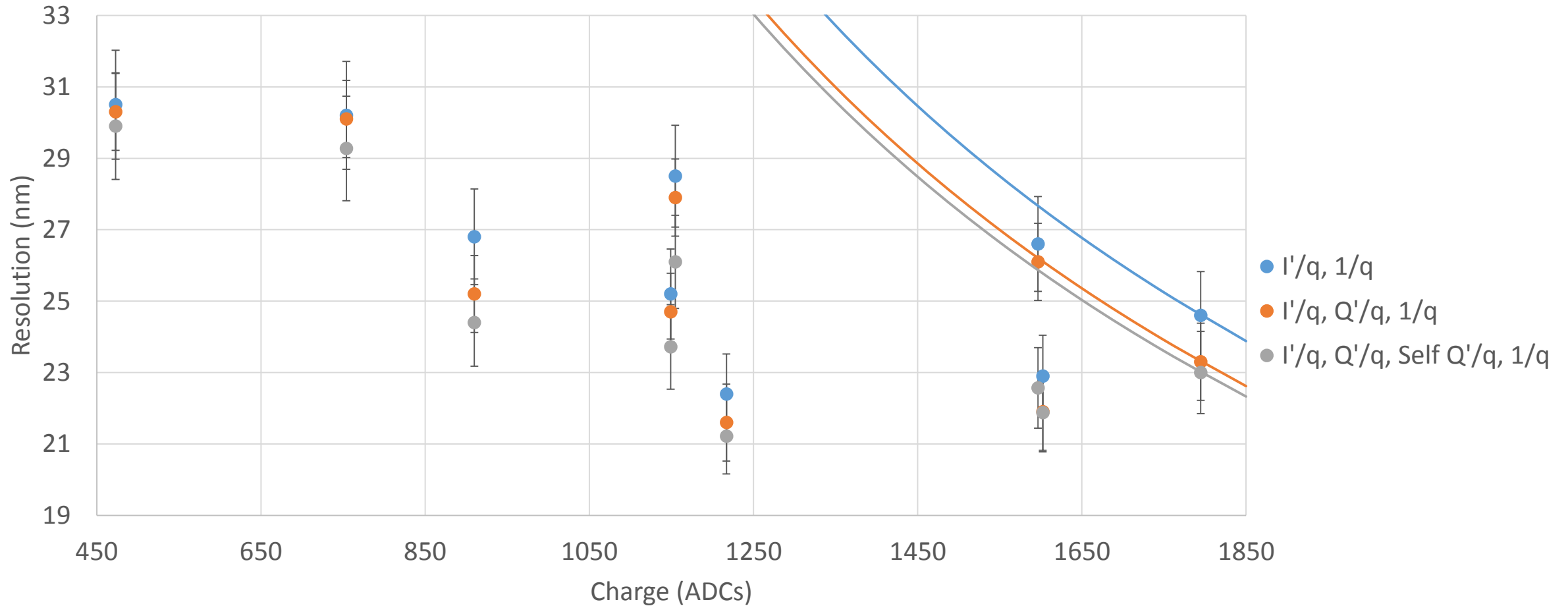
# IPB Resolution Fitting to Y information

IPB Resolution Fitting to Y



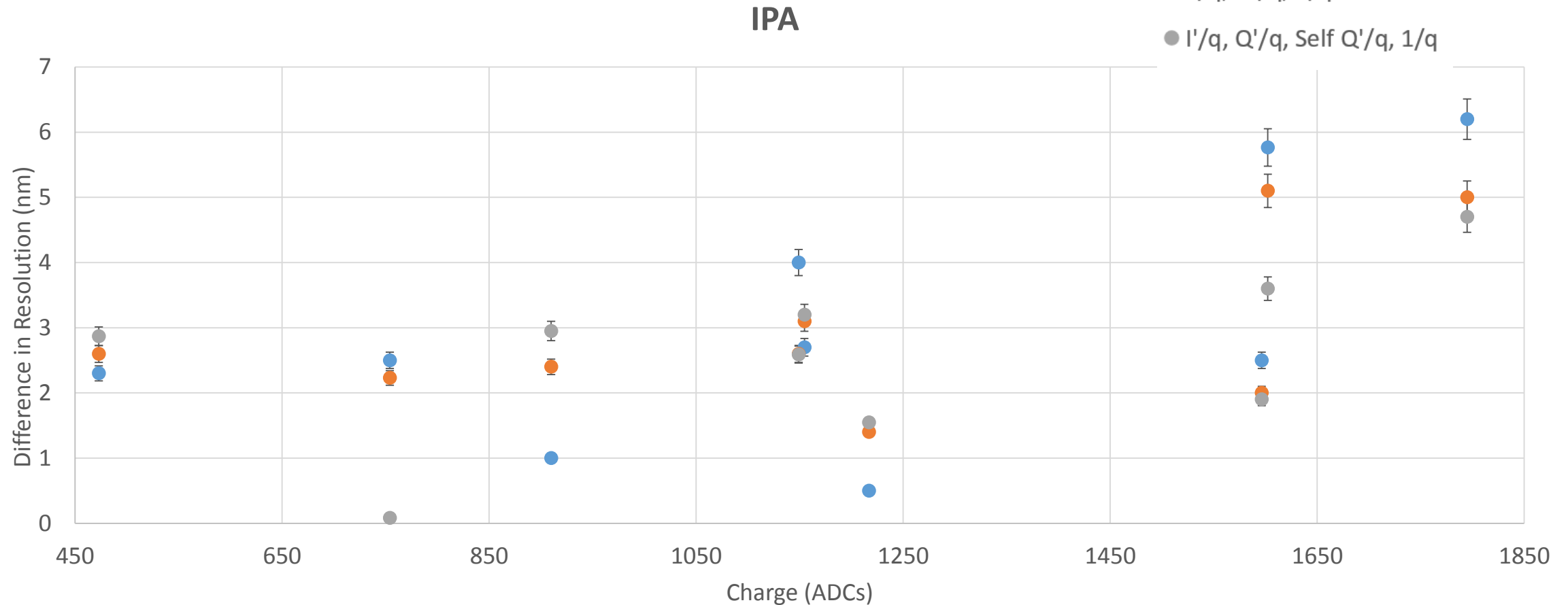
# IPC Resolution Fitting to Y information

IPC Resolution Fitting to Y



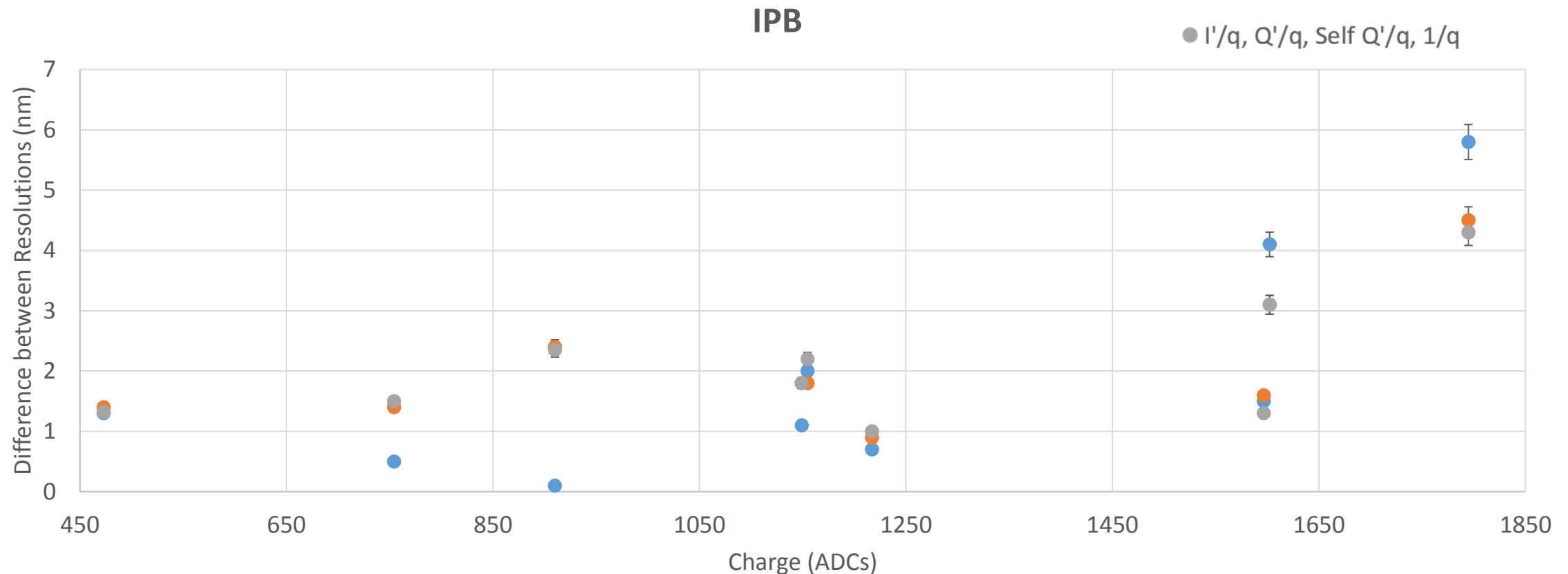
# Improvement to Resolution by also Fitting to X

- Difference in resolution = resolution (fitting to Y) – resolution (fitting to X and Y) in nm.
- Plots of resolution (fitting to X and Y) in appendix.
- Improvements to resolution from X appear to scale with charge.



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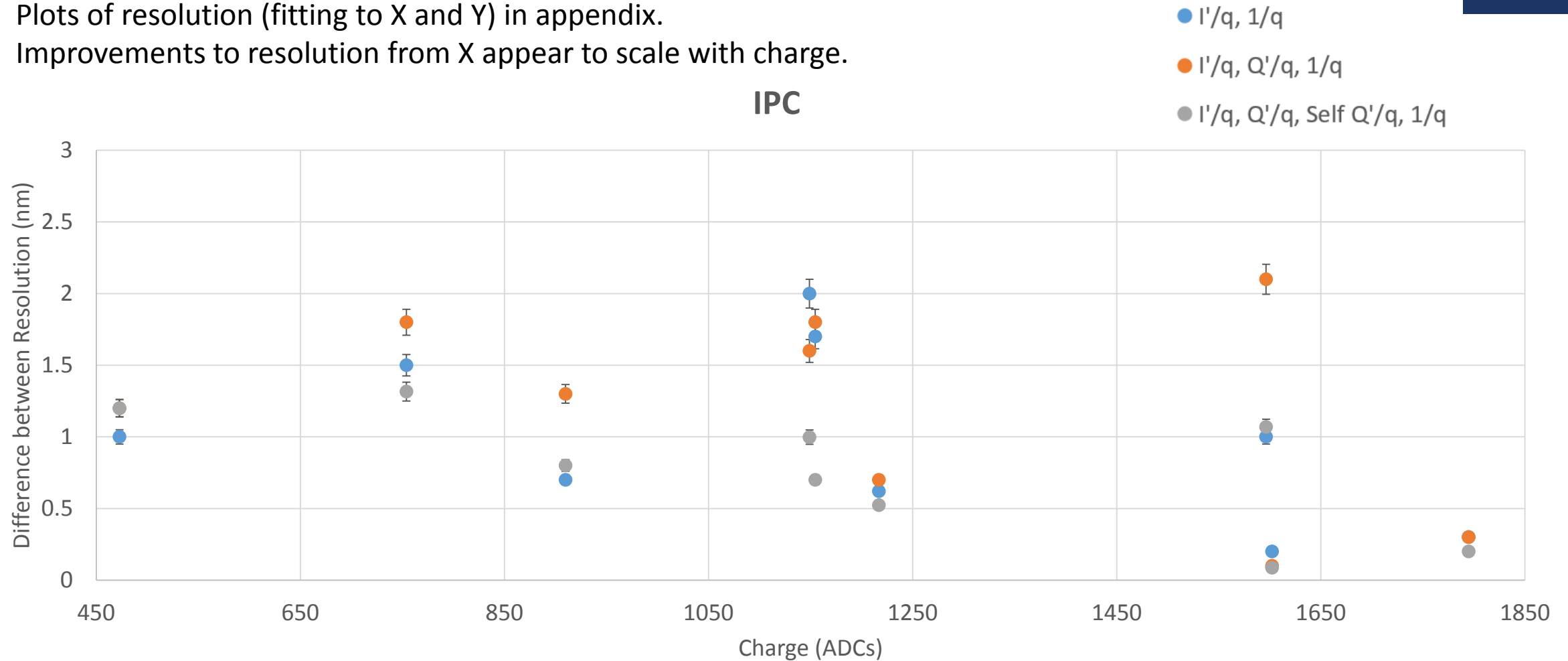
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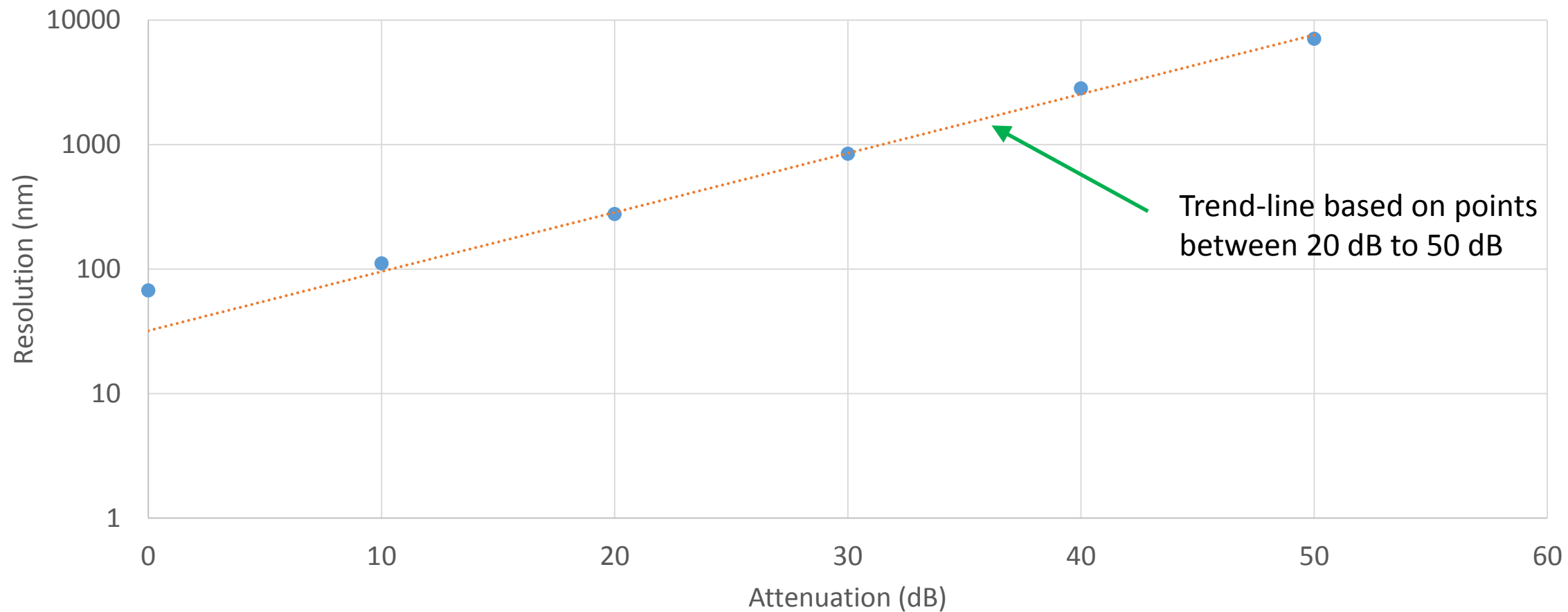


# Attenuation Scan

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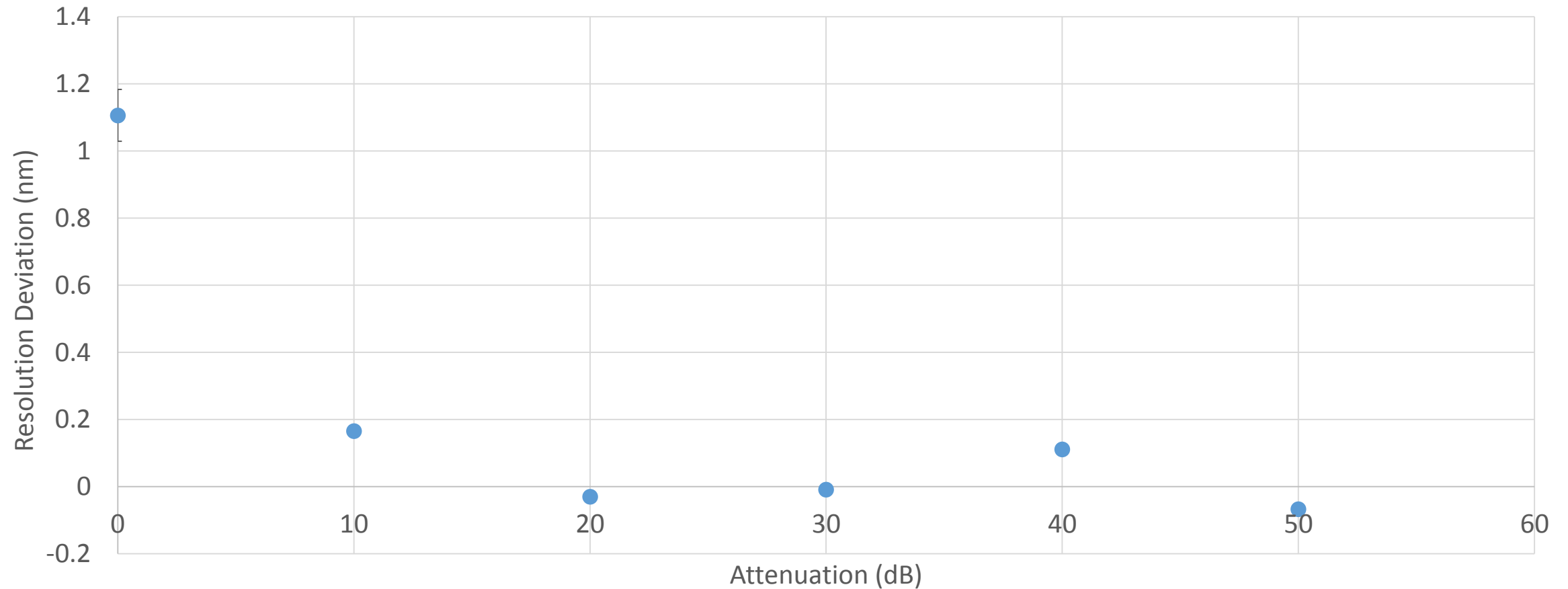
# Attenuation Scan

Geometric Method



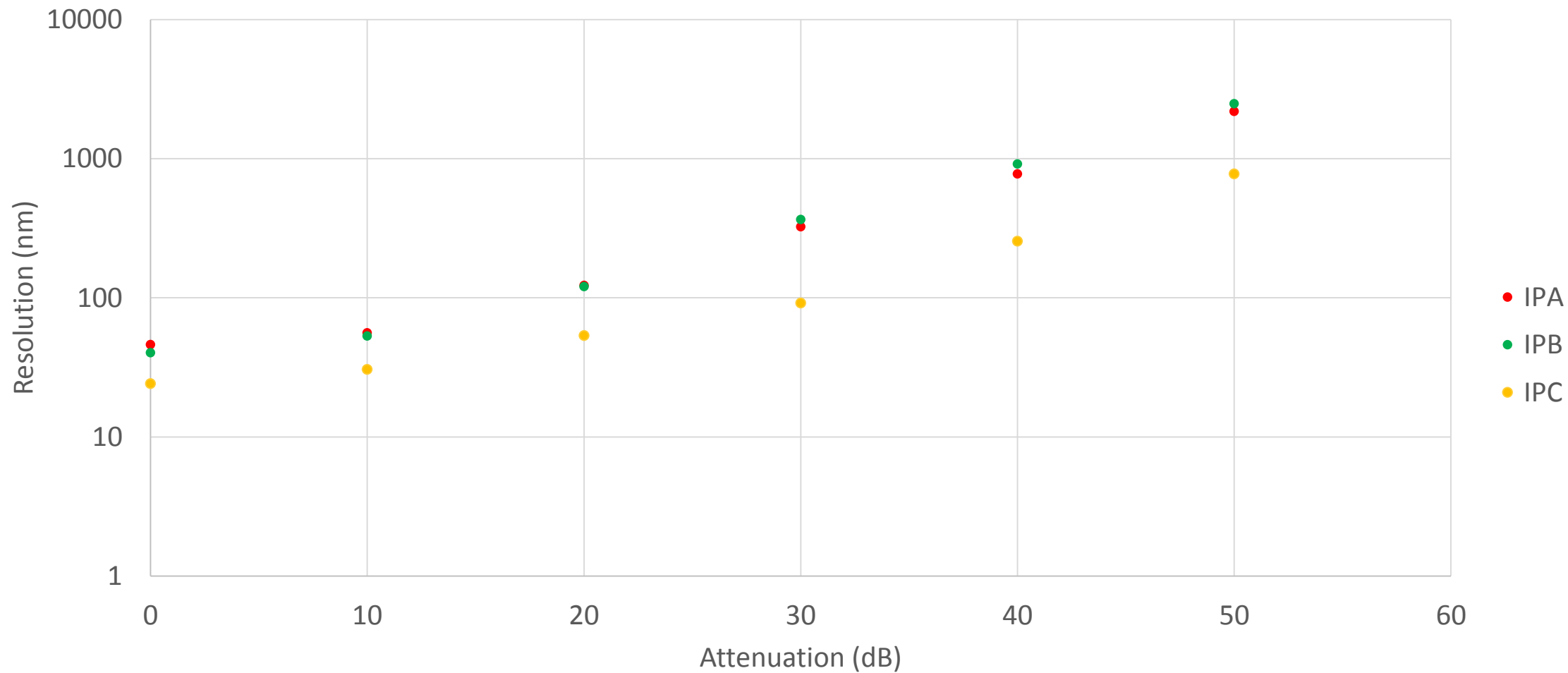
# Deviation from trend-line Geometric

Fractional Deviation from Resolution Prediction based on 20 – 50 dB



# Attenuation Scan (Y)

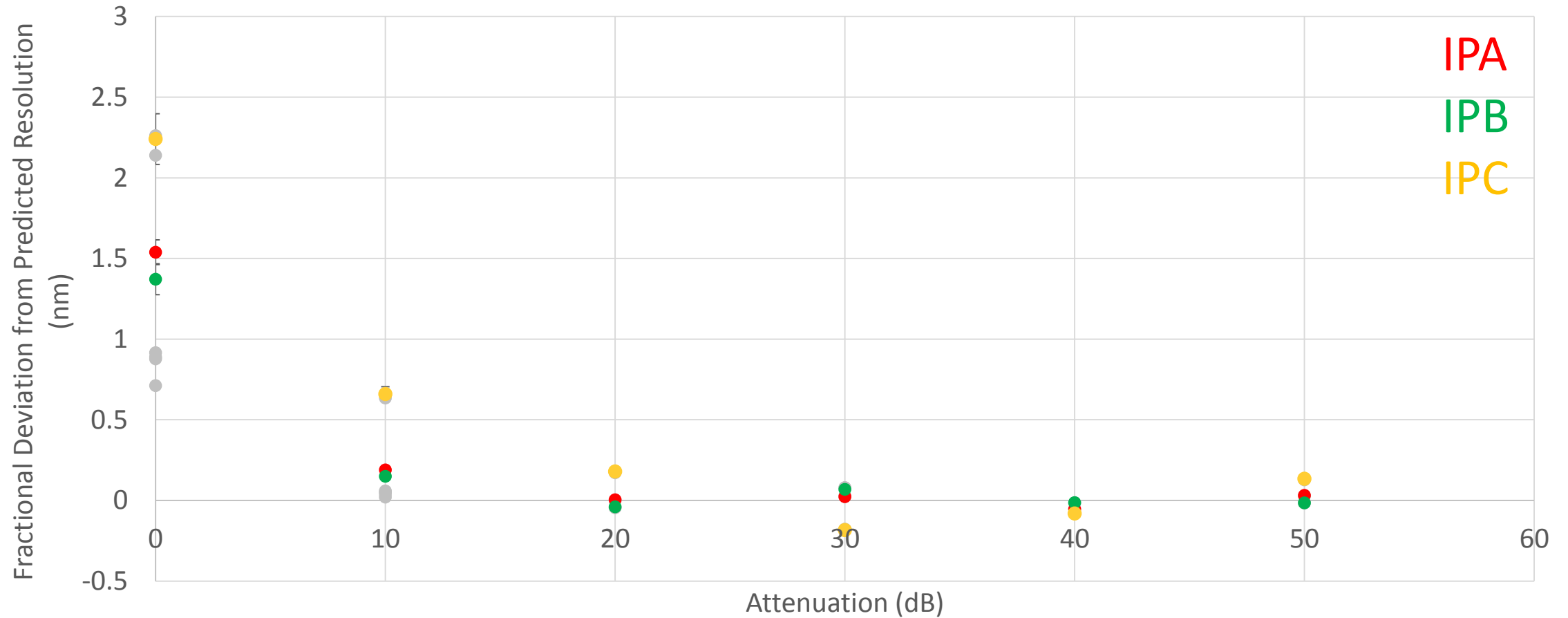
Fitting to  $I'/q$ ,  $1/q$





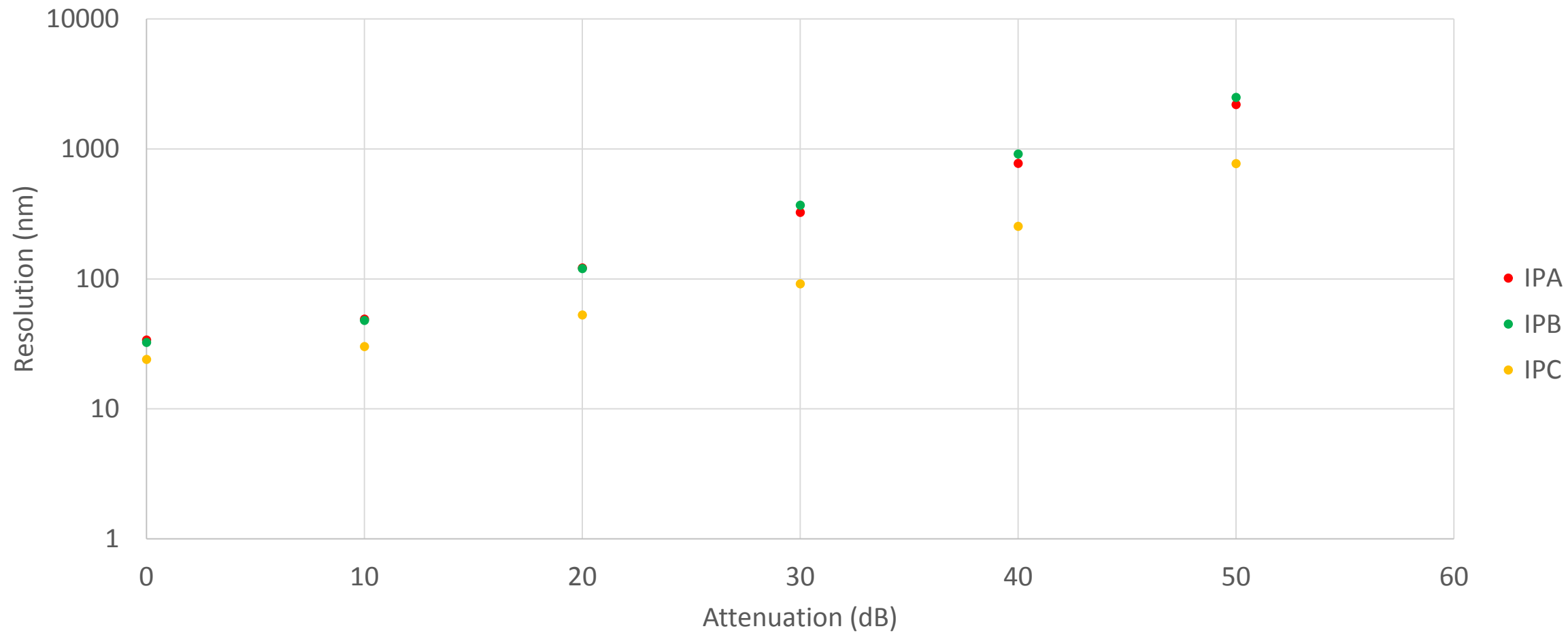
# Fitting to $l'/q$ , $1/q$

Fractional Deviation from Resolution Prediction based on 20 – 50 dB



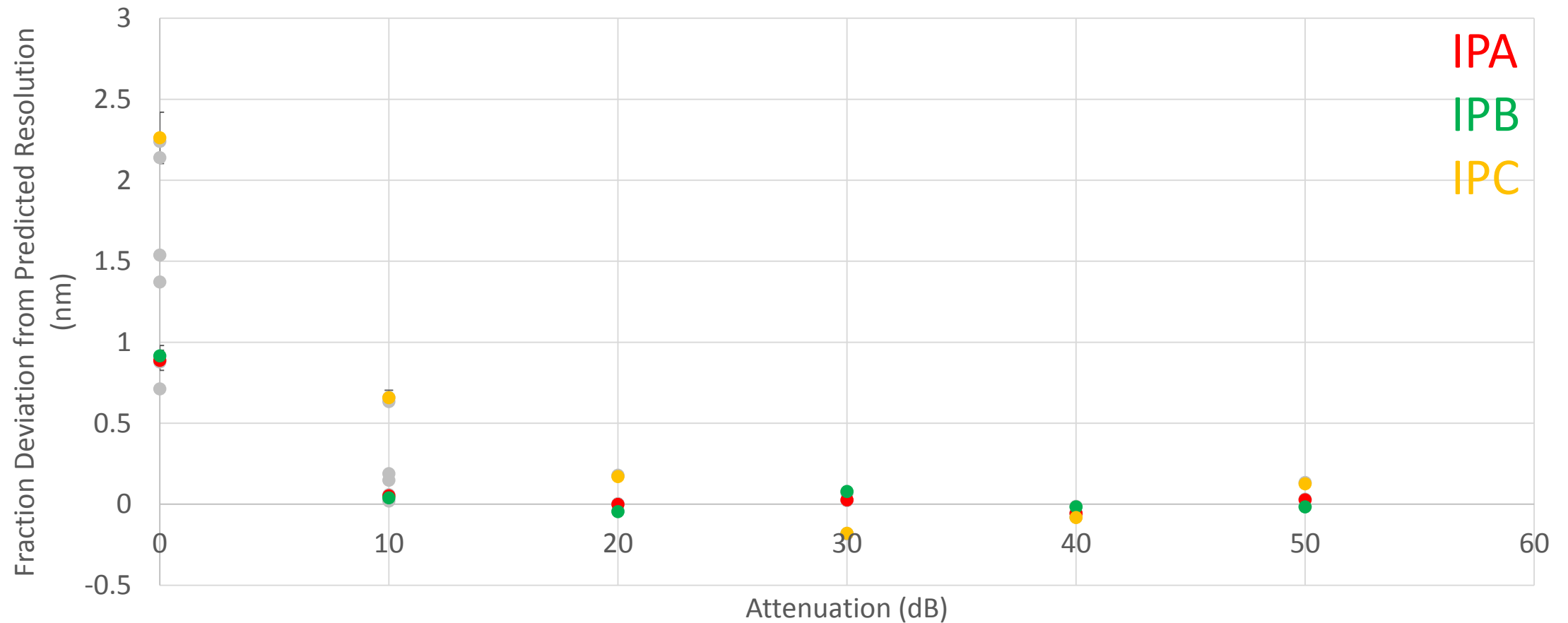
# Attenuation Scan (Y)

Fitting to  $I'/q$ ,  $Q'/q$ ,  $1/q$



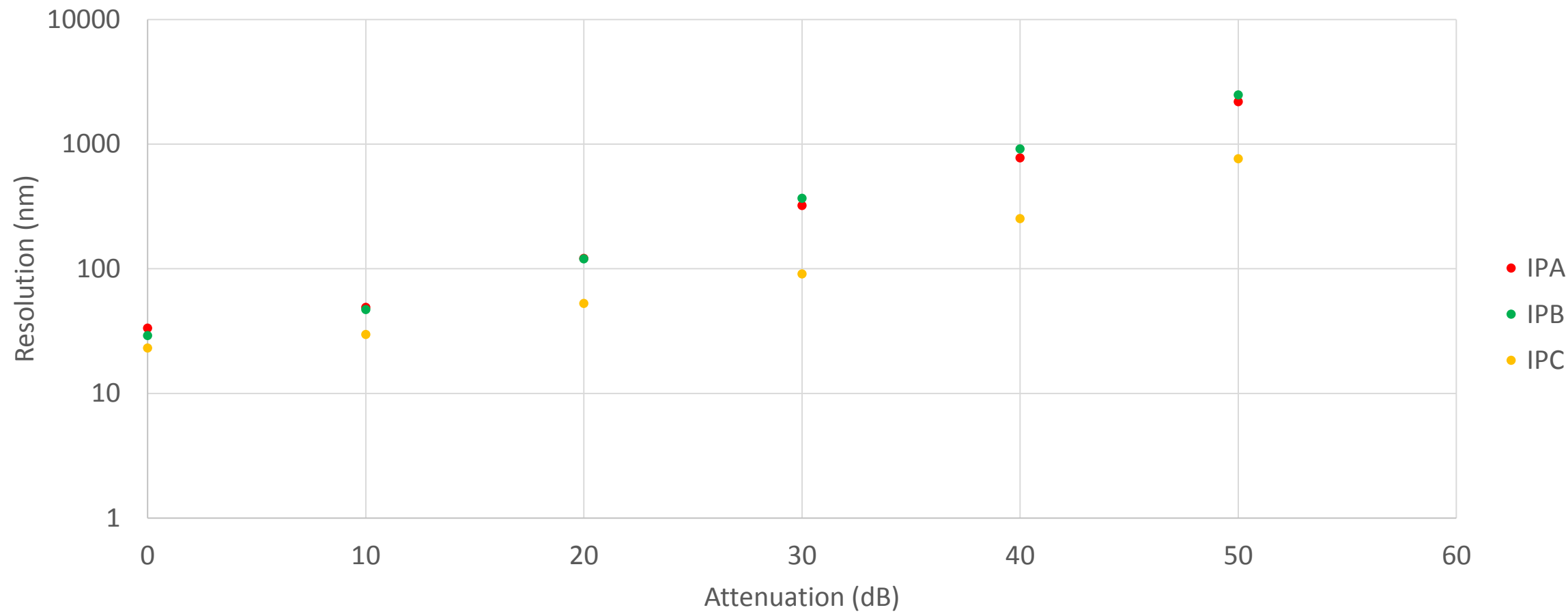
# Fitting to $I'/q$ , $Q'/q$ , $1/q$

Fractional Deviation from Resolution (Prediction based on 20 – 50 dB)



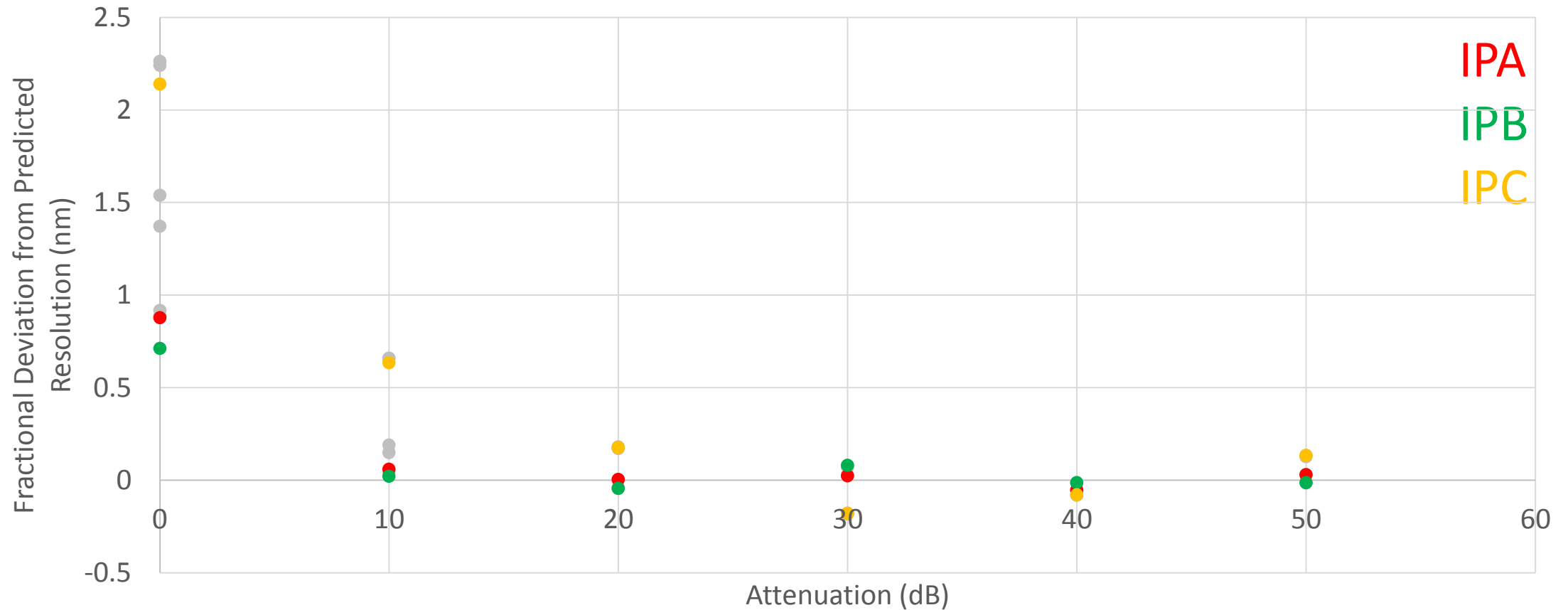
# Attenuation Scan (Y)

Fitting to  $l'/q$ ,  $Q'/q$ ,  $1/q$ , Self  $Q'/q$



# Fitting to $I'/q$ , $Q'/q$ , Self $Q'/q$ , $1/q$

Fractional Deviation from Resolution (Prediction based on 20 – 50 dB)





# jitRun2 – AQD0FF Scan1

Fitting method: best resolution calculation at  $0.55 \times 10^{10}$  charge. Samples used: (Y) 44:51, (X) 61:68, Ref 47.  
14 triggers out of 400 cut (31, 93, 138, 139, 168, 201, 210, 226, 301, 302, 321, 326, 334, 351)

## Fitting to: X and Y (6,10,11 parameters)

**I'/q and 1/q:** IPA =  $0.0448 \pm 0.0022 \mu\text{m}$   
: IPB =  $0.0399 \pm 0.0020 \mu\text{m}$   
: IPC =  $0.0215 \pm 0.0011 \mu\text{m}$

**I'/q, Q'/q and 1/q:** IPA =  $0.0366 \pm 0.0018 \mu\text{m}$   
: IPB =  $0.0316 \pm 0.0016 \mu\text{m}$   
: IPC =  $0.0184 \pm 0.0009 \mu\text{m}$

**I'/q, Q'/q, Self Q'/q, 1/q:** IPA =  $0.0330 \pm 0.0017 \mu\text{m}$   
: IPB =  $0.0307 \pm 0.0015 \mu\text{m}$   
: IPC =  $0.0179 \pm 0.0009 \mu\text{m}$

## Fitting to: Y (4,6,7 parameters)

**I'/q and 1/q:** IPA =  $0.0454 \pm 0.0023 \mu\text{m}$   
: IPB =  $0.0404 \pm 0.0020 \mu\text{m}$   
: IPC =  $0.0220 \pm 0.0011 \mu\text{m}$

**I'/q, Q'/q and 1/q:** IPA =  $0.0373 \pm 0.0019 \mu\text{m}$   
: IPB =  $0.0331 \pm 0.0017 \mu\text{m}$   
: IPC =  $0.0192 \pm 0.0010 \mu\text{m}$

**I'/q, Q'/q, Self Q'/q, 1/q:** IPA =  $0.0343 \pm 0.0017 \mu\text{m}$   
: IPB =  $0.0322 \pm 0.0016 \mu\text{m}$   
: IPC =  $0.0188 \pm 0.0009 \mu\text{m}$

# Summary

## **Geometric fitting –**

- Scaled approximately as predicted with charge
- Didn't scale with attenuation as predicted down to 0 dB

## **Fitting method –**

- IPA and IPB resolution showed increasing resolution with decreasing charge (but not scaling as  $\propto 1/q$ ).
- IPC resolution showed much less sensitivity to charge.
- IPC shows especially bad scaling of resolution with attenuation – measured resolution approximately twice predicted resolution at 0 dB.

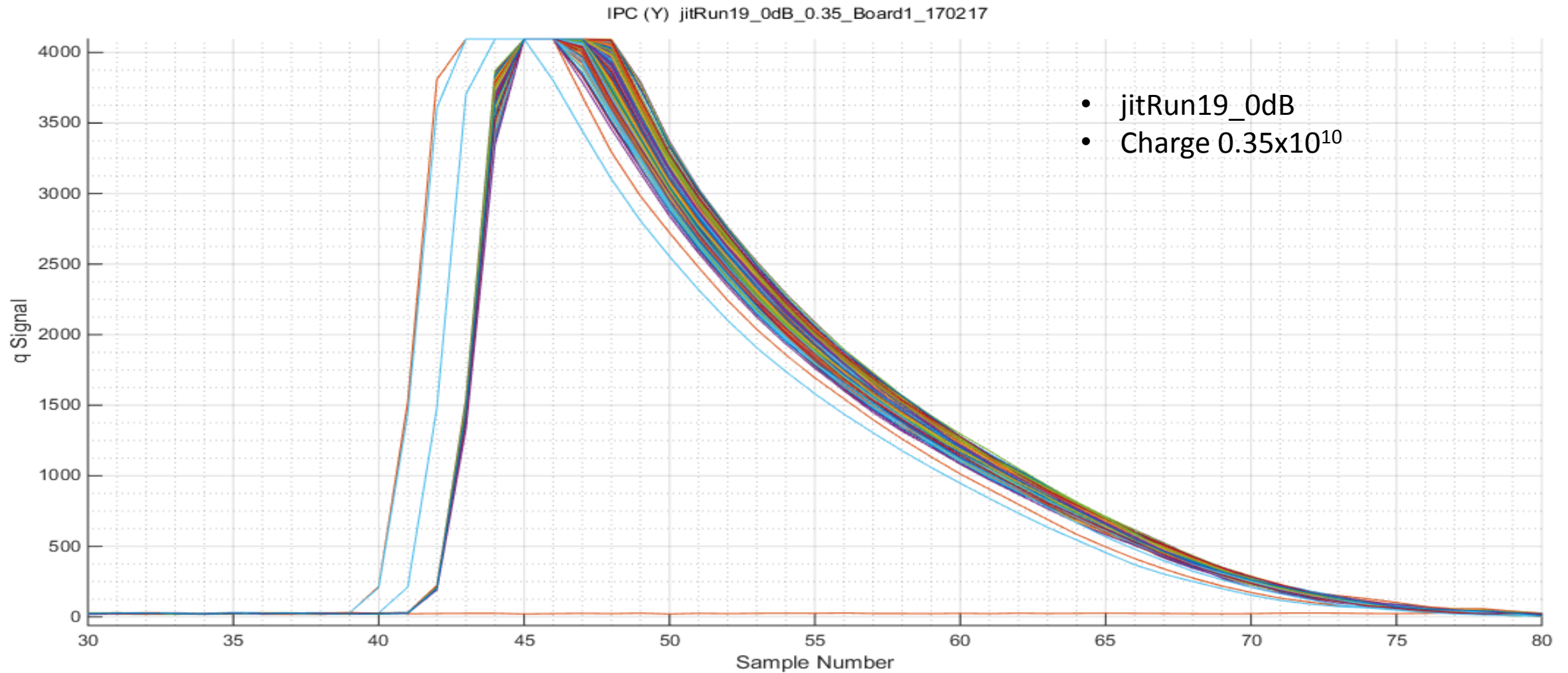
## **Fitting to X, Y resolution –**

- Improvement to resolution (for fitting to X as well) appears to scale with charge for IPA and IPB, but offers little improvement in IPC (as already has much lower resolution?).

# Appendix

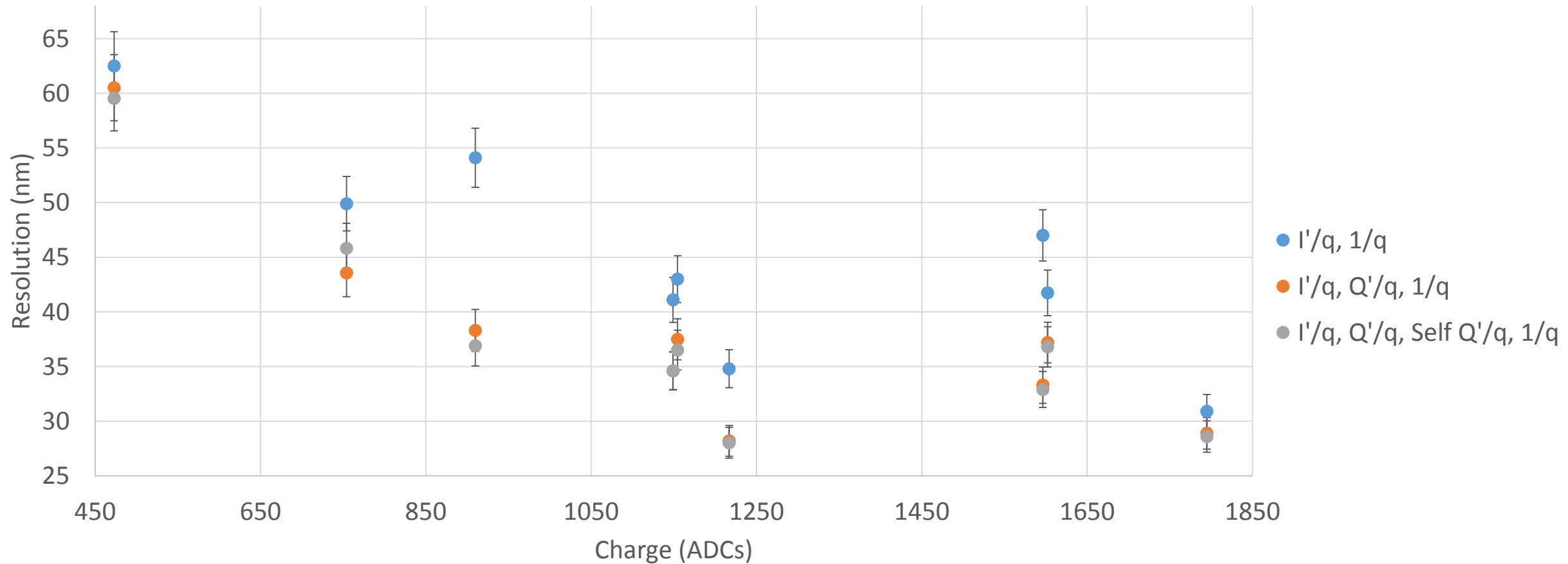
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# Saturating Reference



# IPA Resolution Fitting to X and Y information

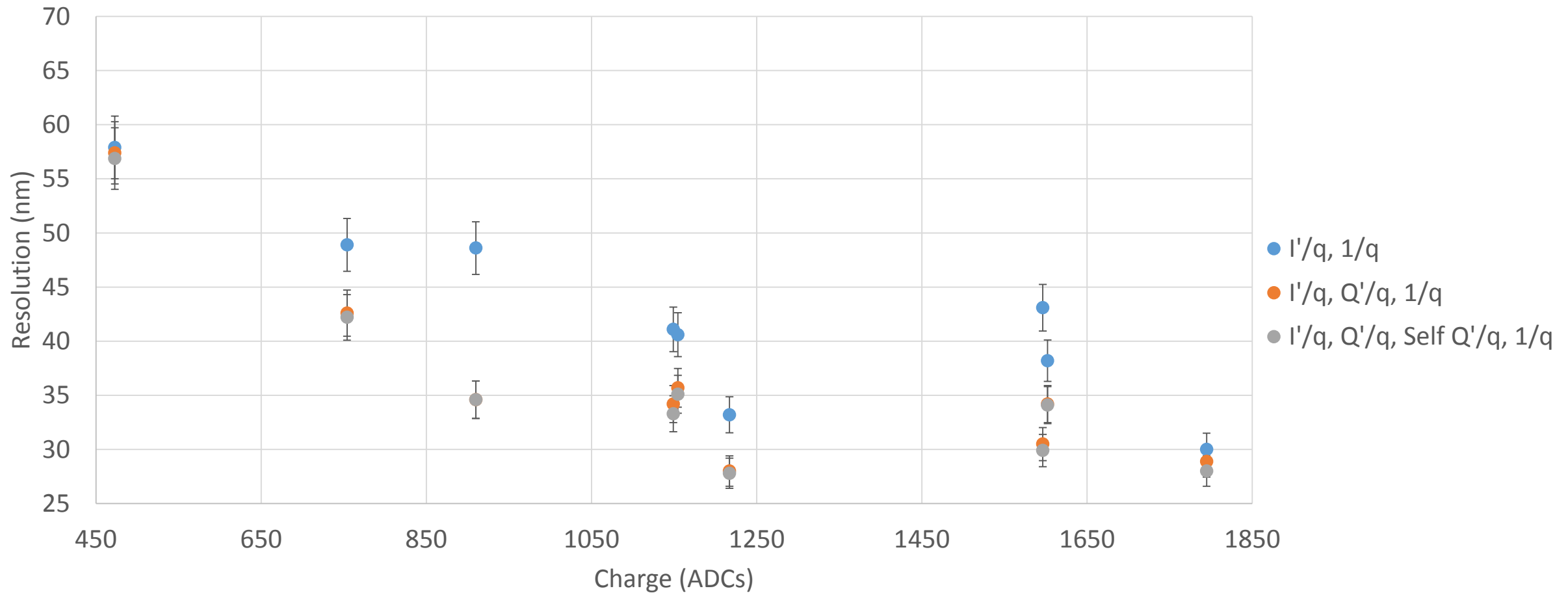
IPA Resolution Fitting with X and Y





# IPB Resolution Fitting to X and Y information

IPB Resolution Fitting to X and Y



# IPC Resolution Fitting to X and Y information

IPCY Resolution Fitting to X and Y

