

FONT Meeting

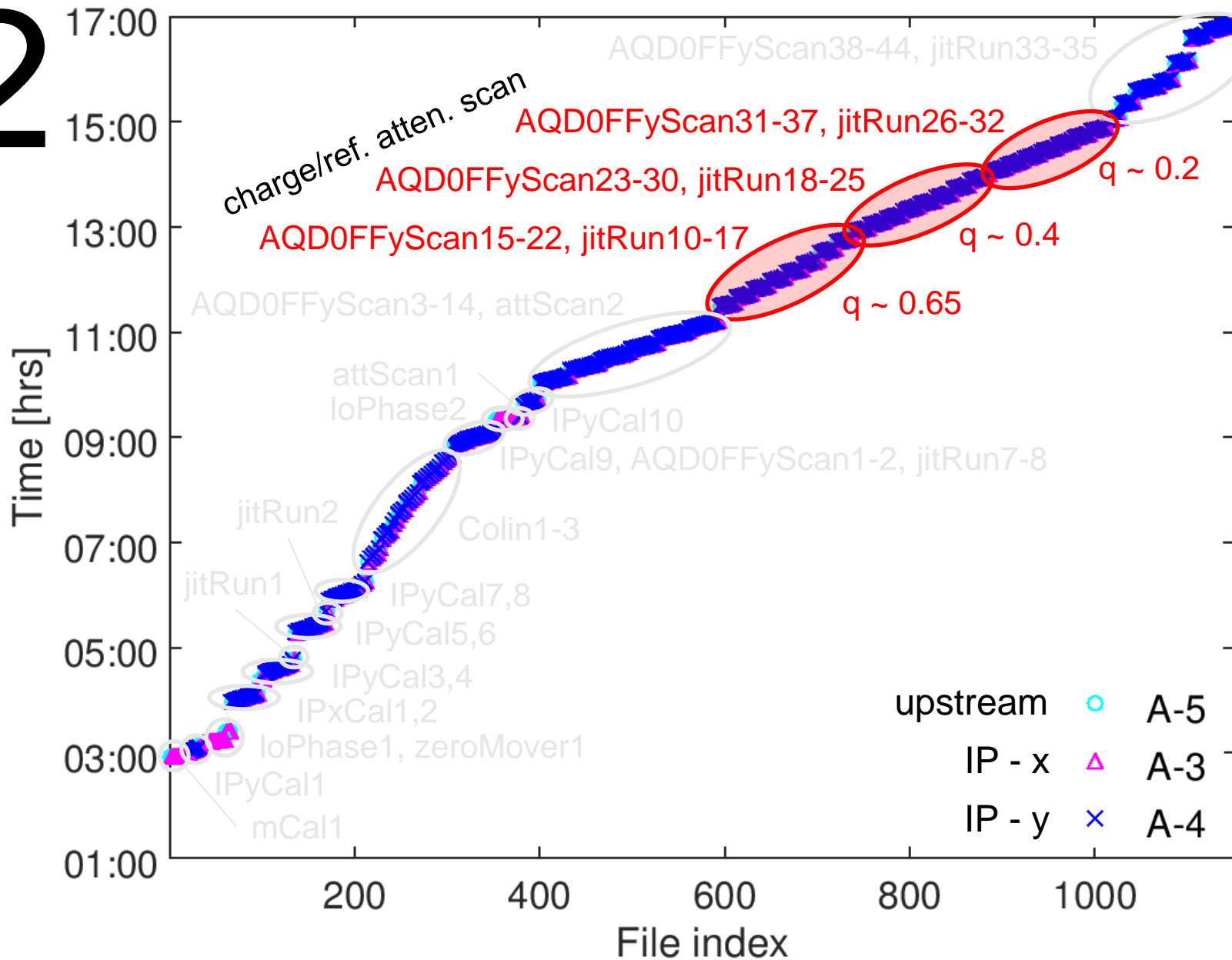
Friday 13 July 2018

Charge/reference attenuation scan: linearity of reference, calibrations

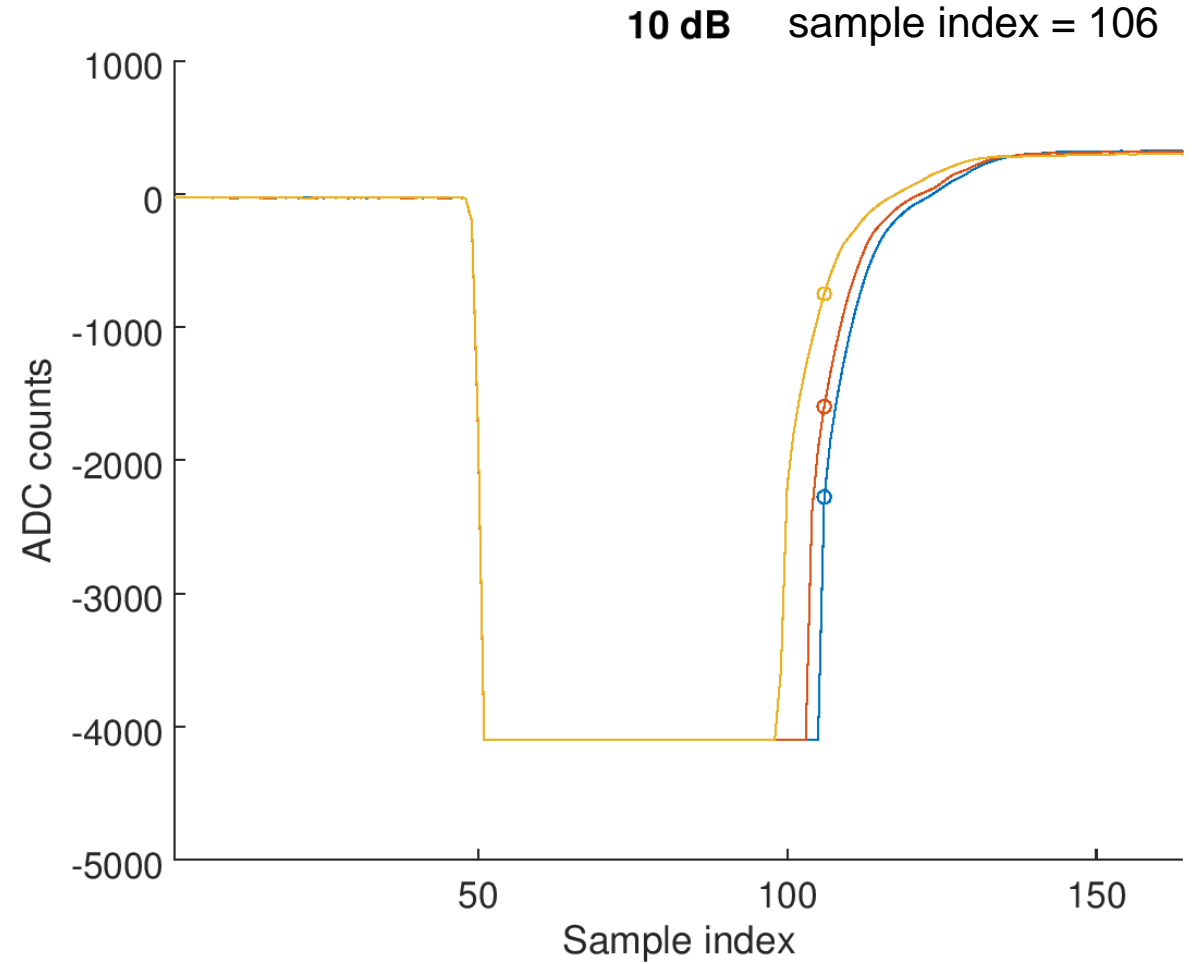
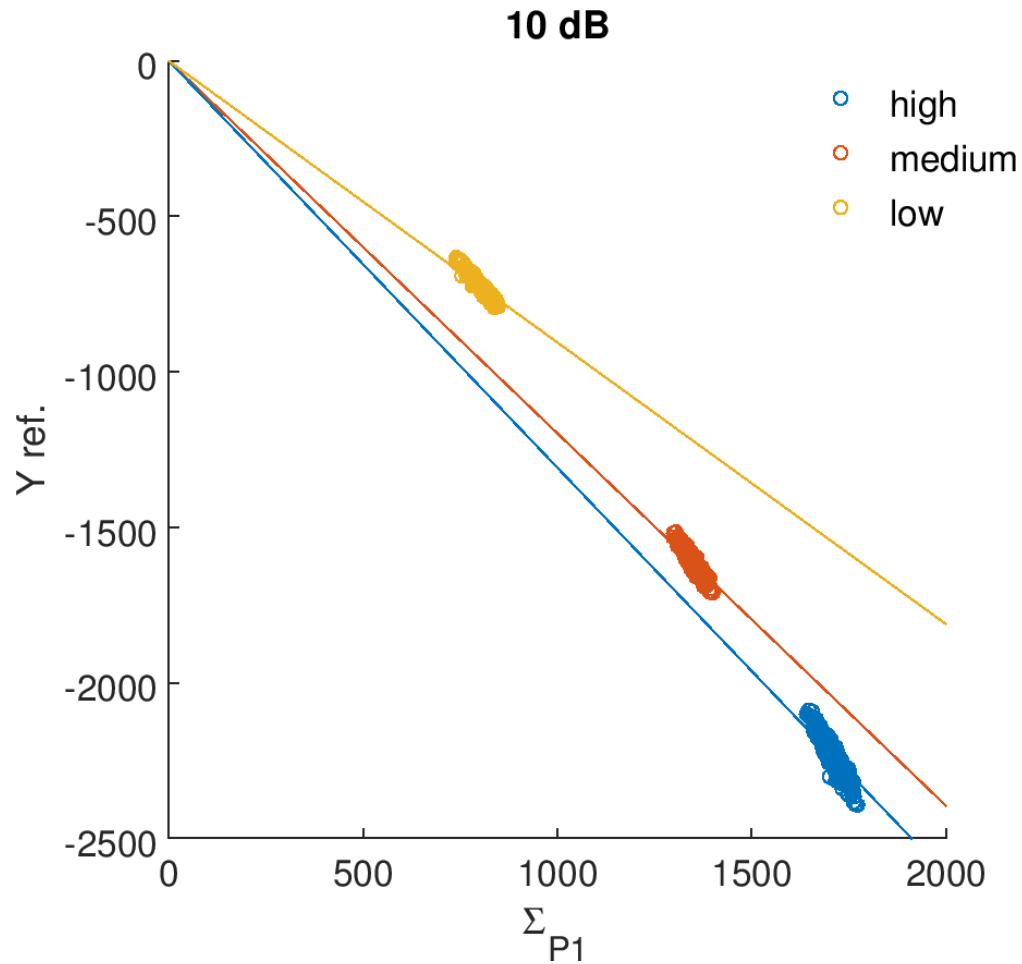
Douglas BETT

Revised Tuesday 17 July 2018

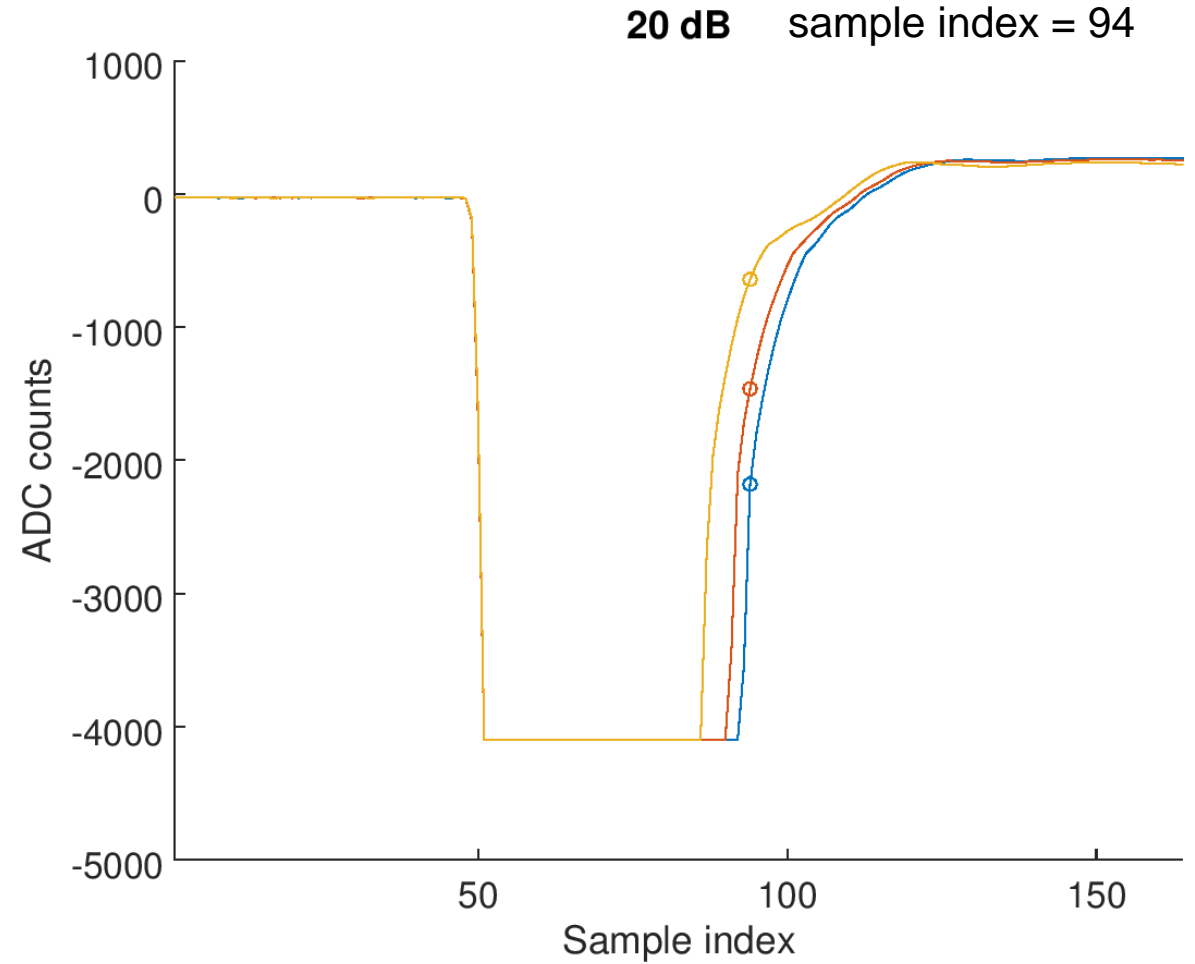
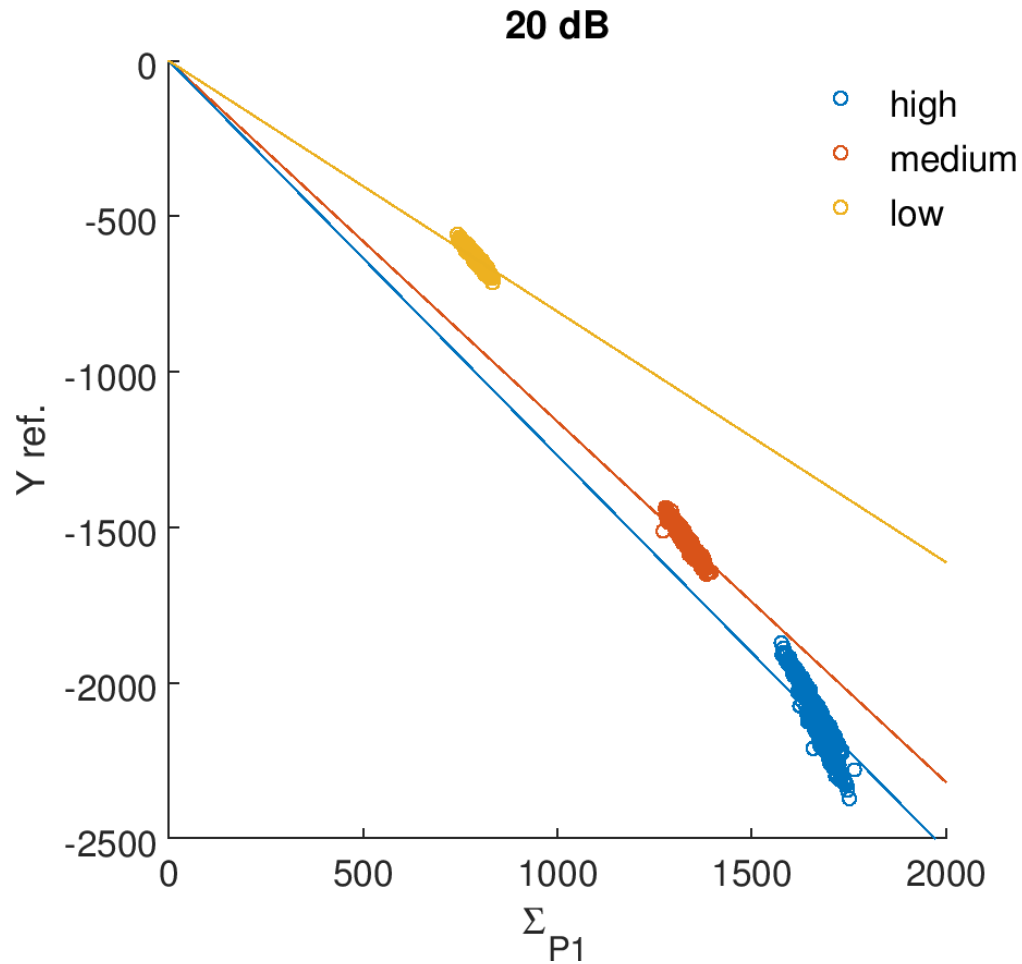
2



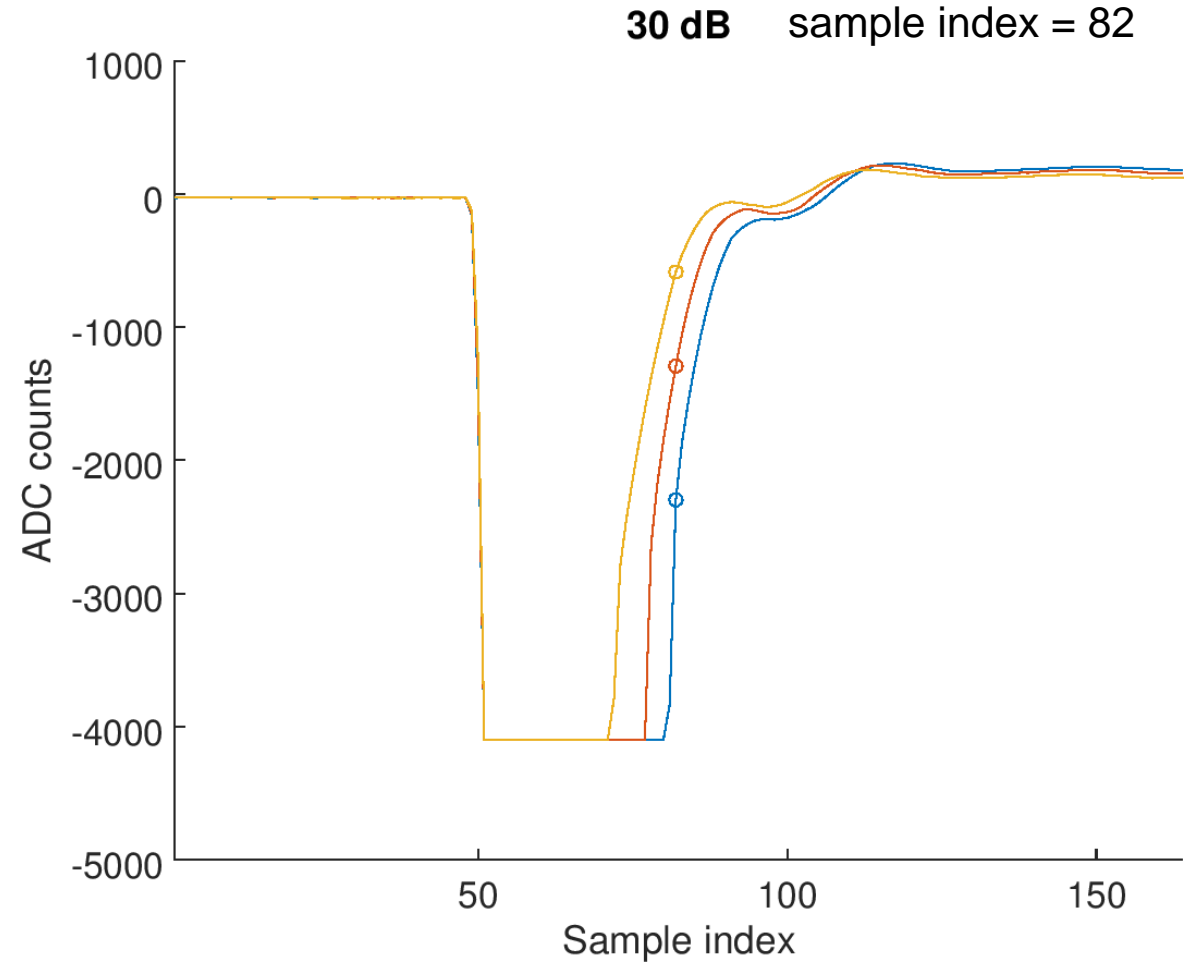
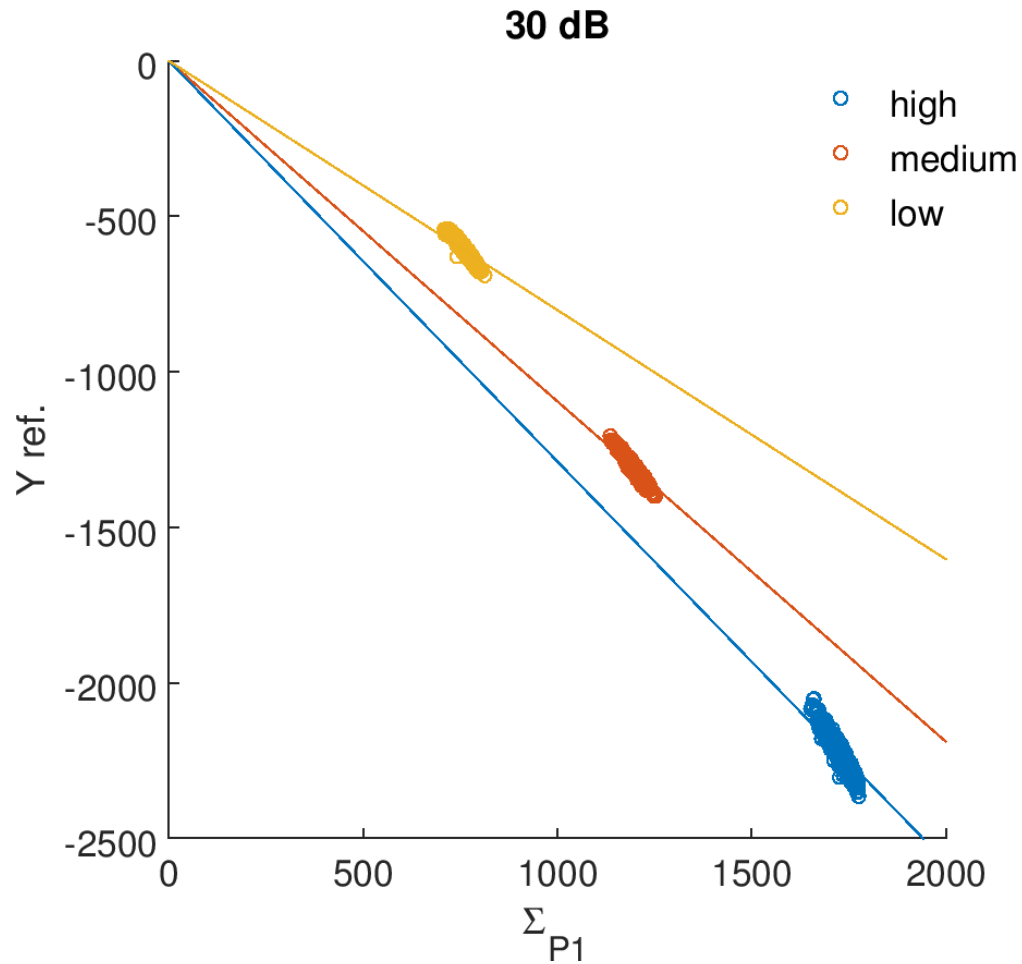
Upstream Σ vs. reference: 10 dB



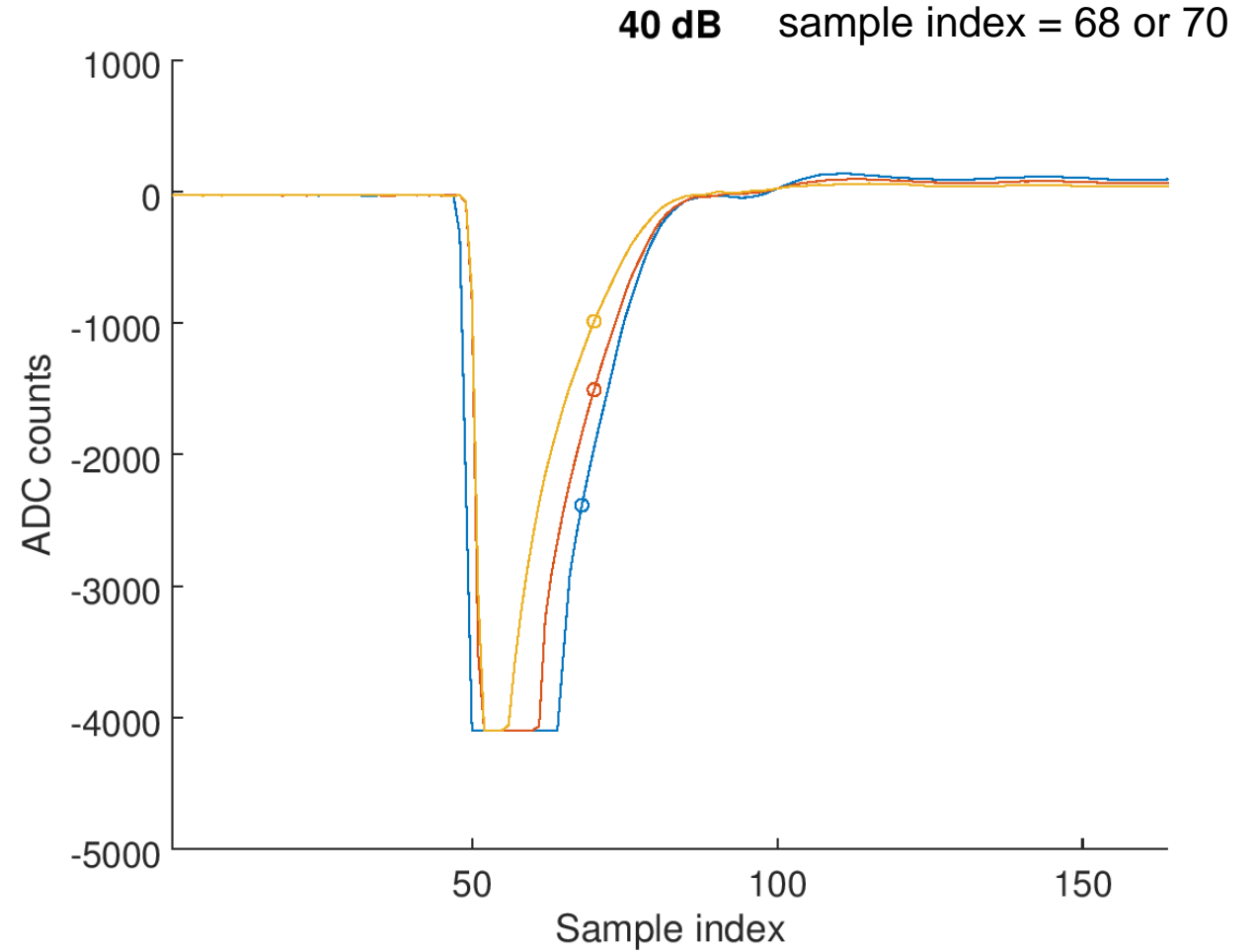
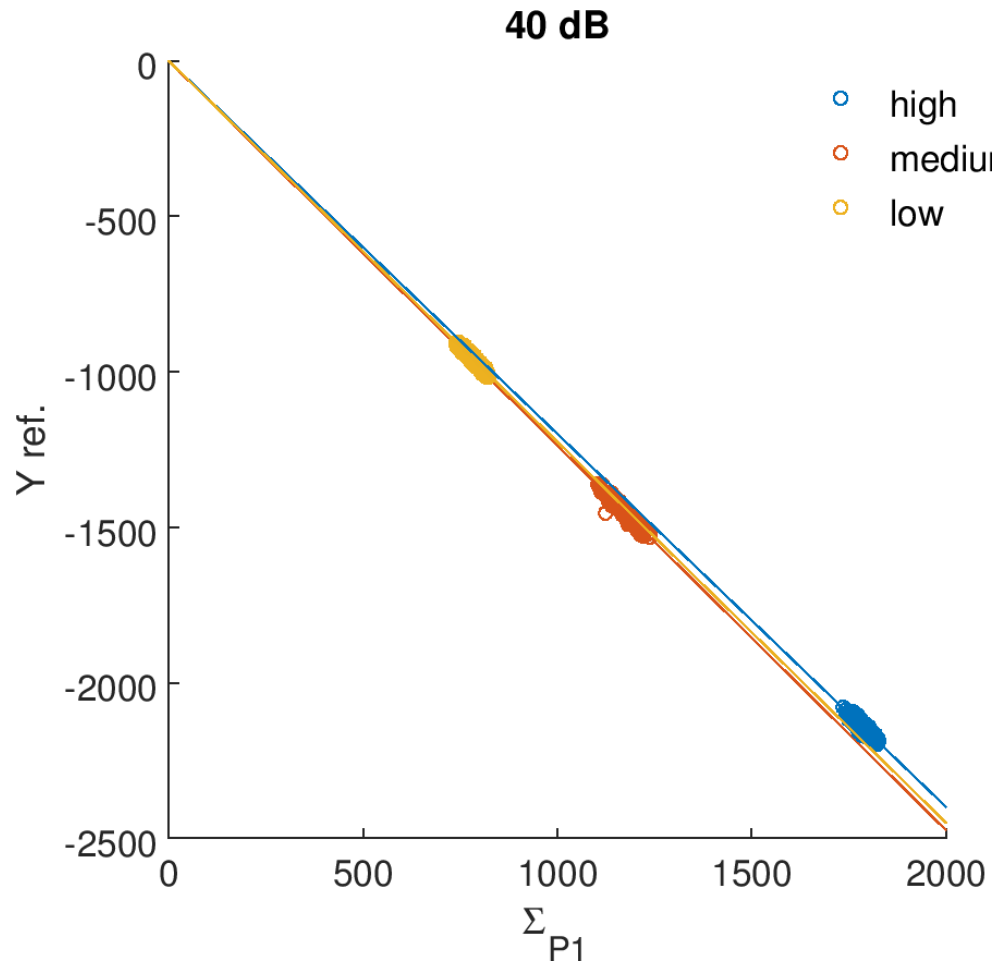
Upstream Σ vs. reference: 20 dB



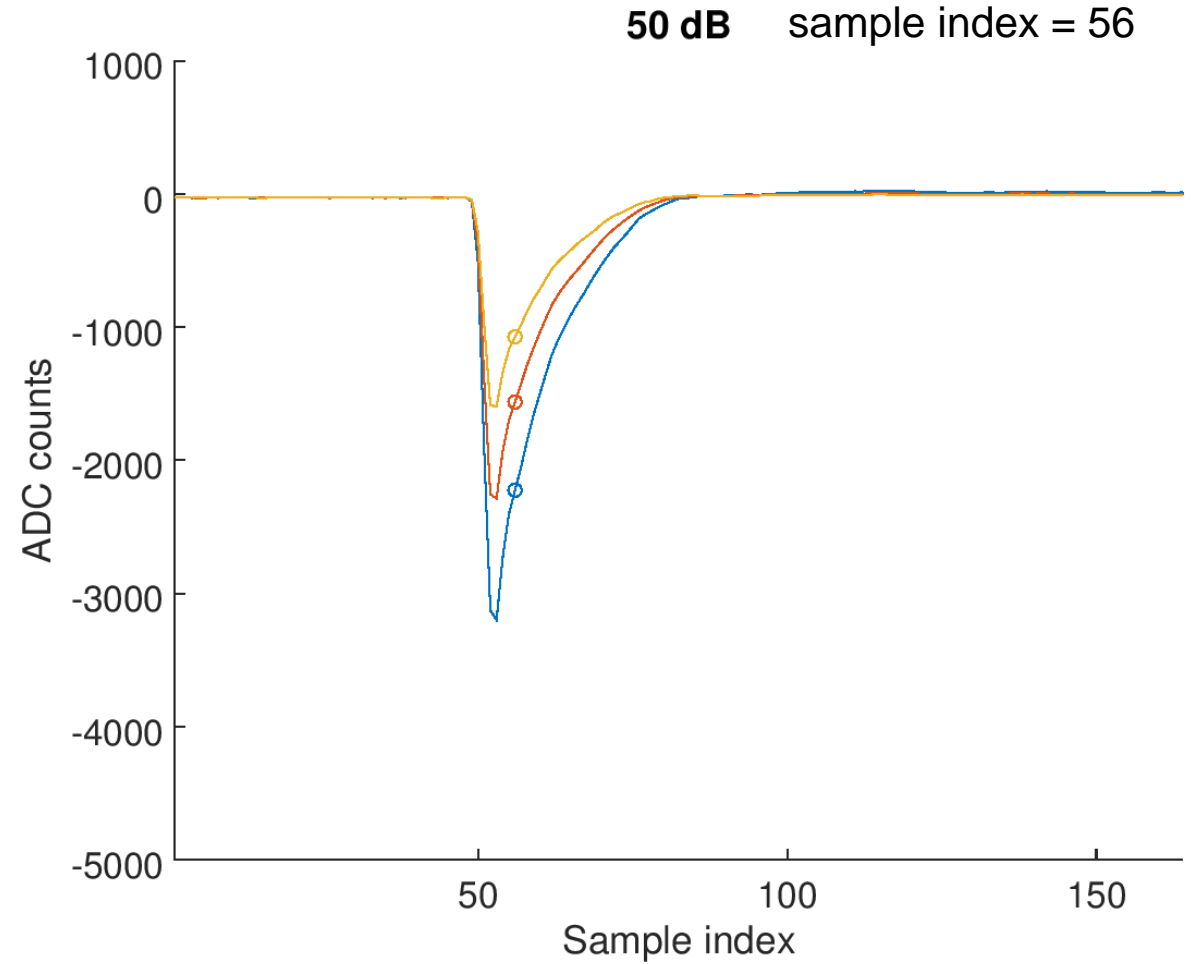
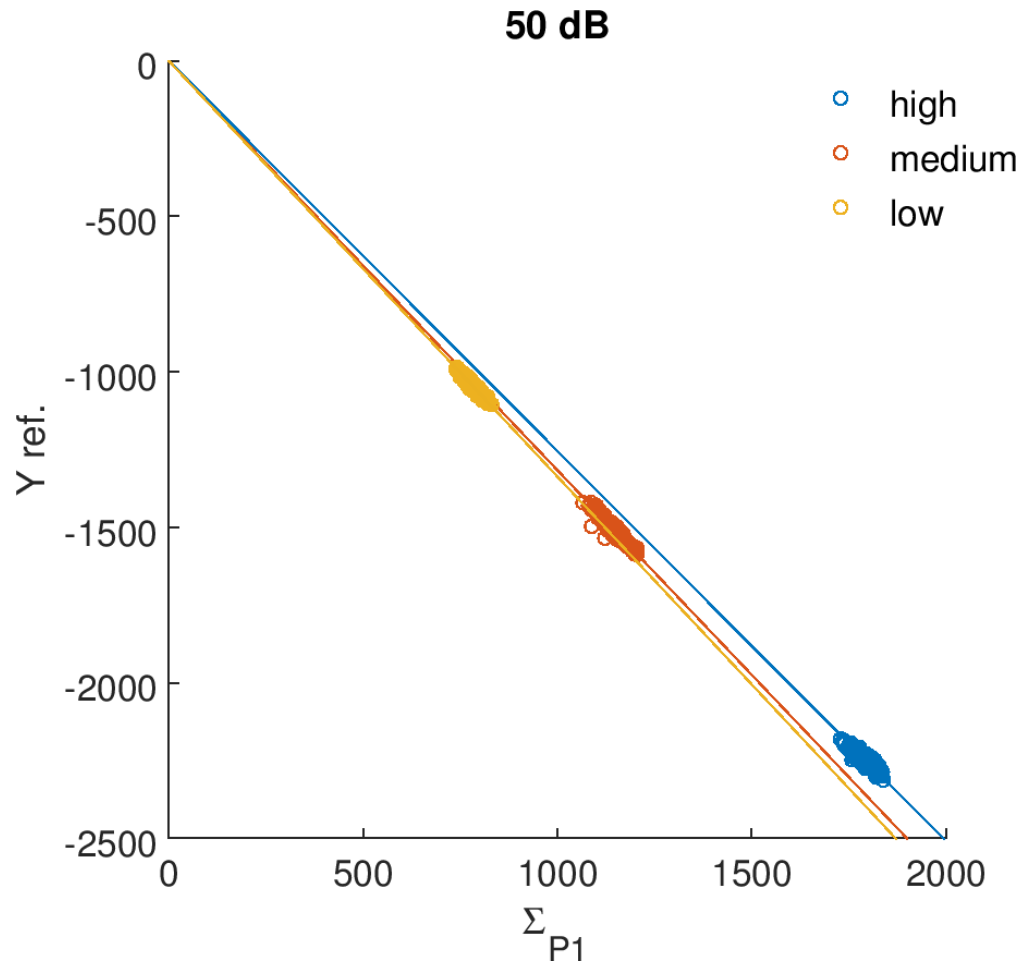
Upstream Σ vs. reference: 30 dB



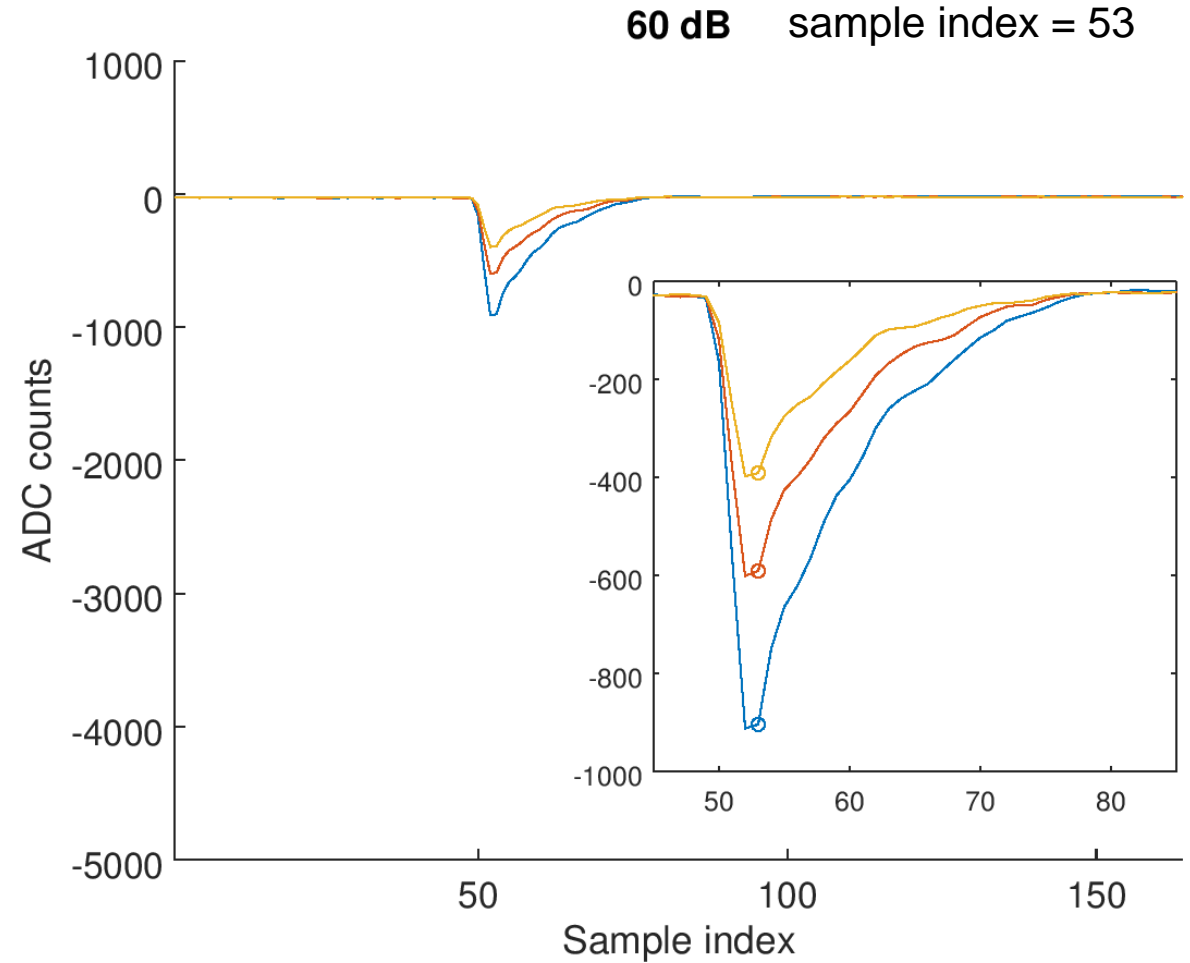
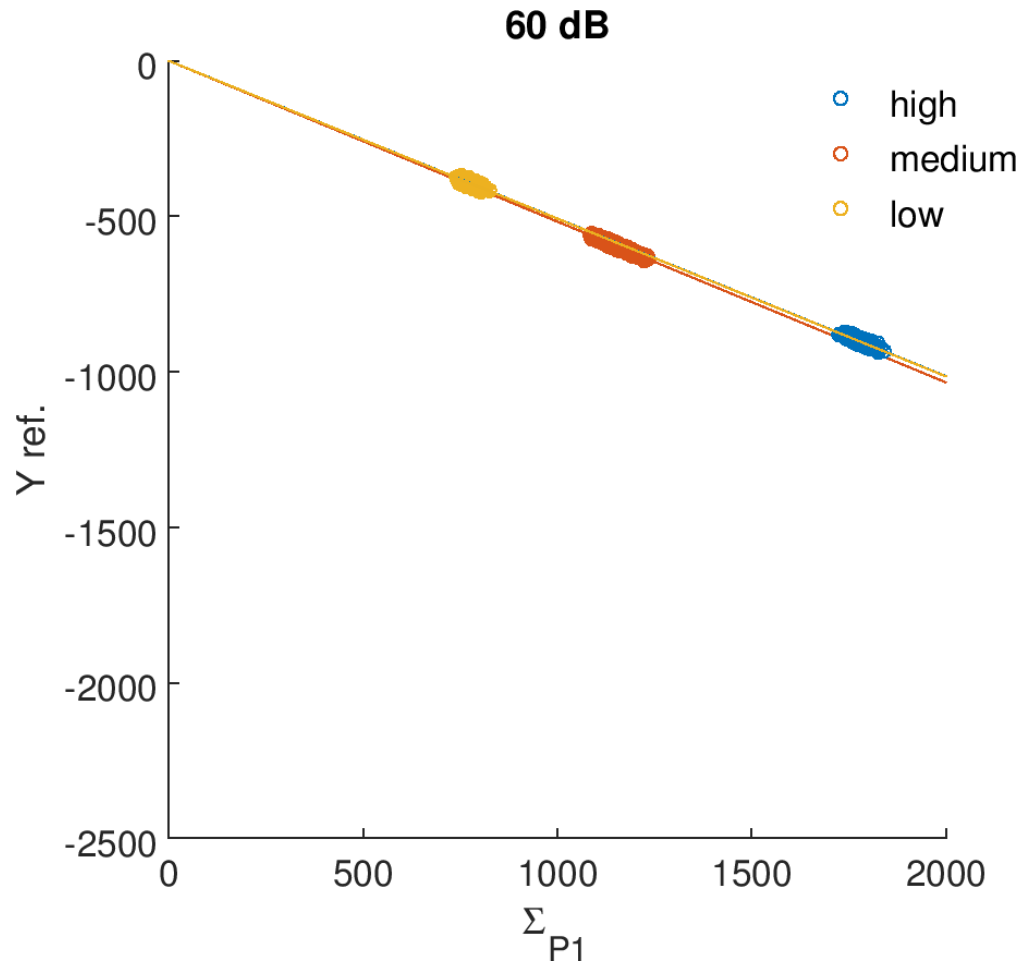
Upstream Σ vs. reference: 40 dB



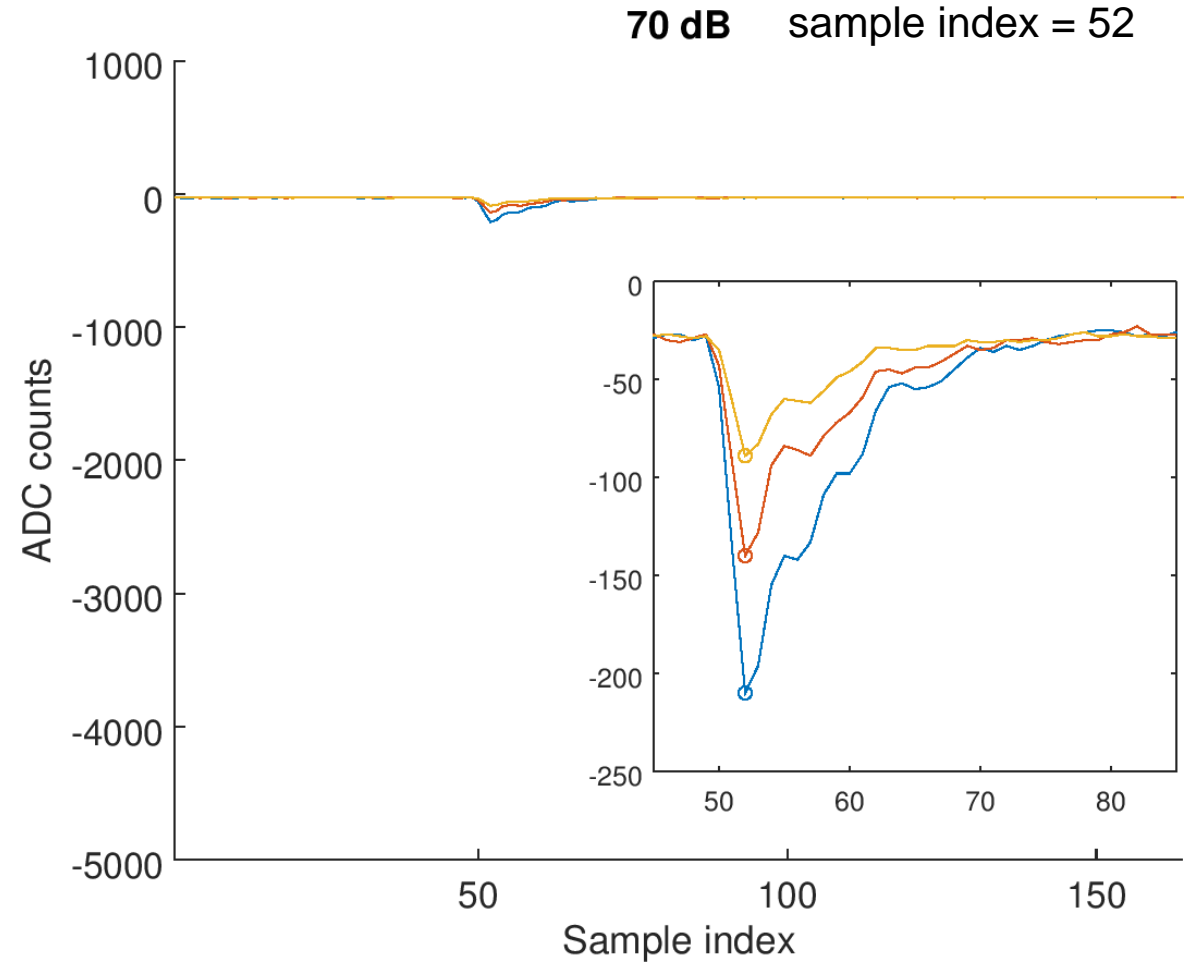
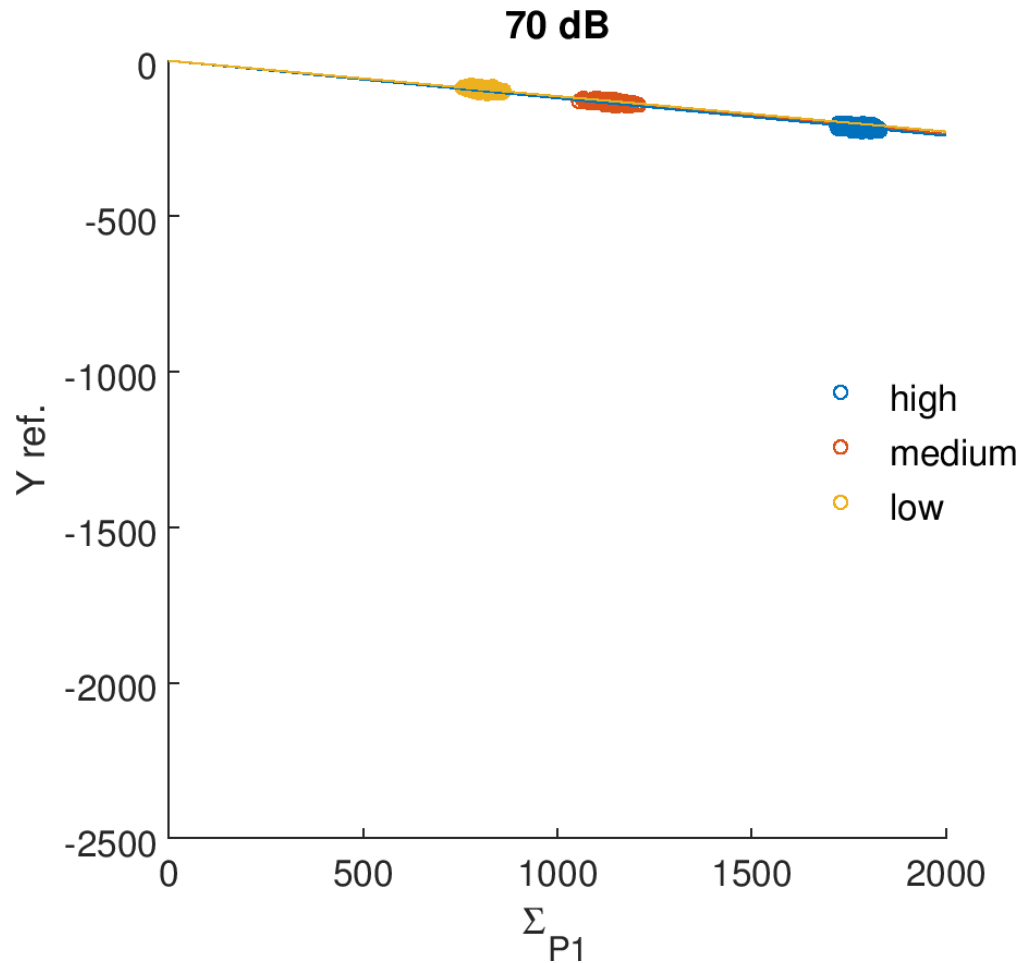
Upstream Σ vs. reference: 50 dB



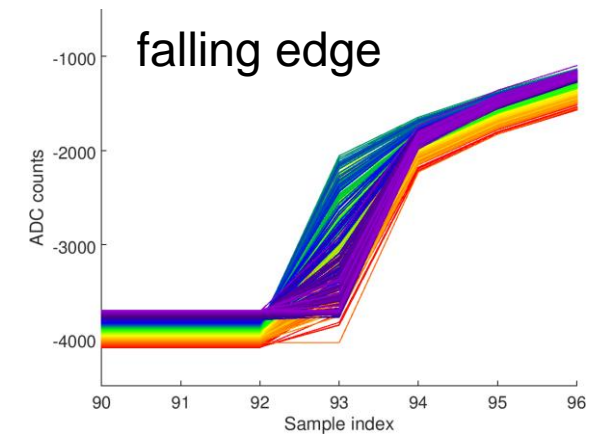
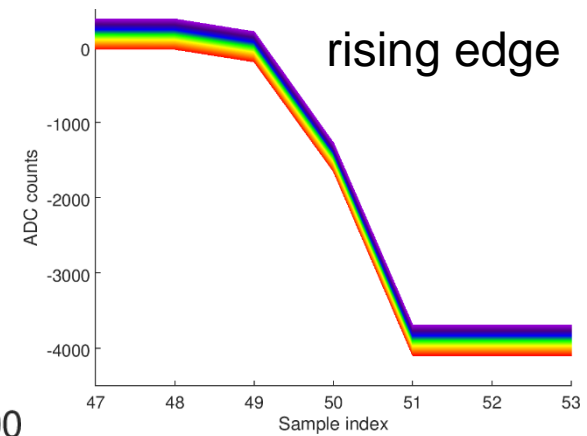
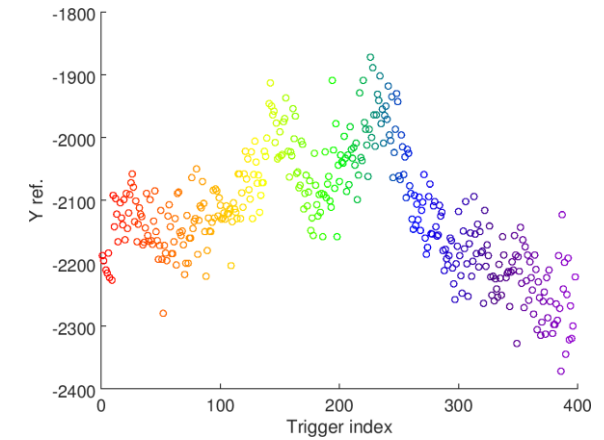
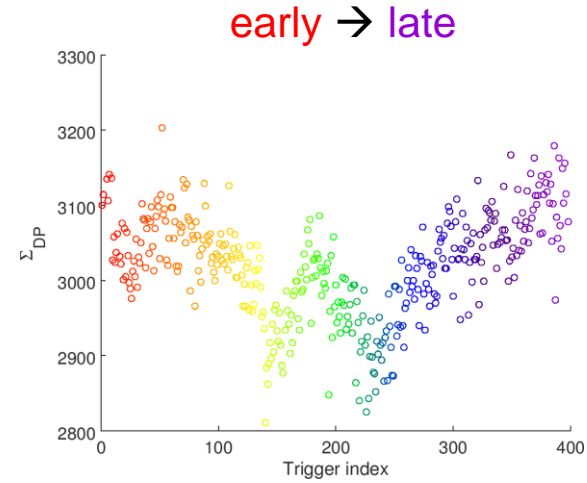
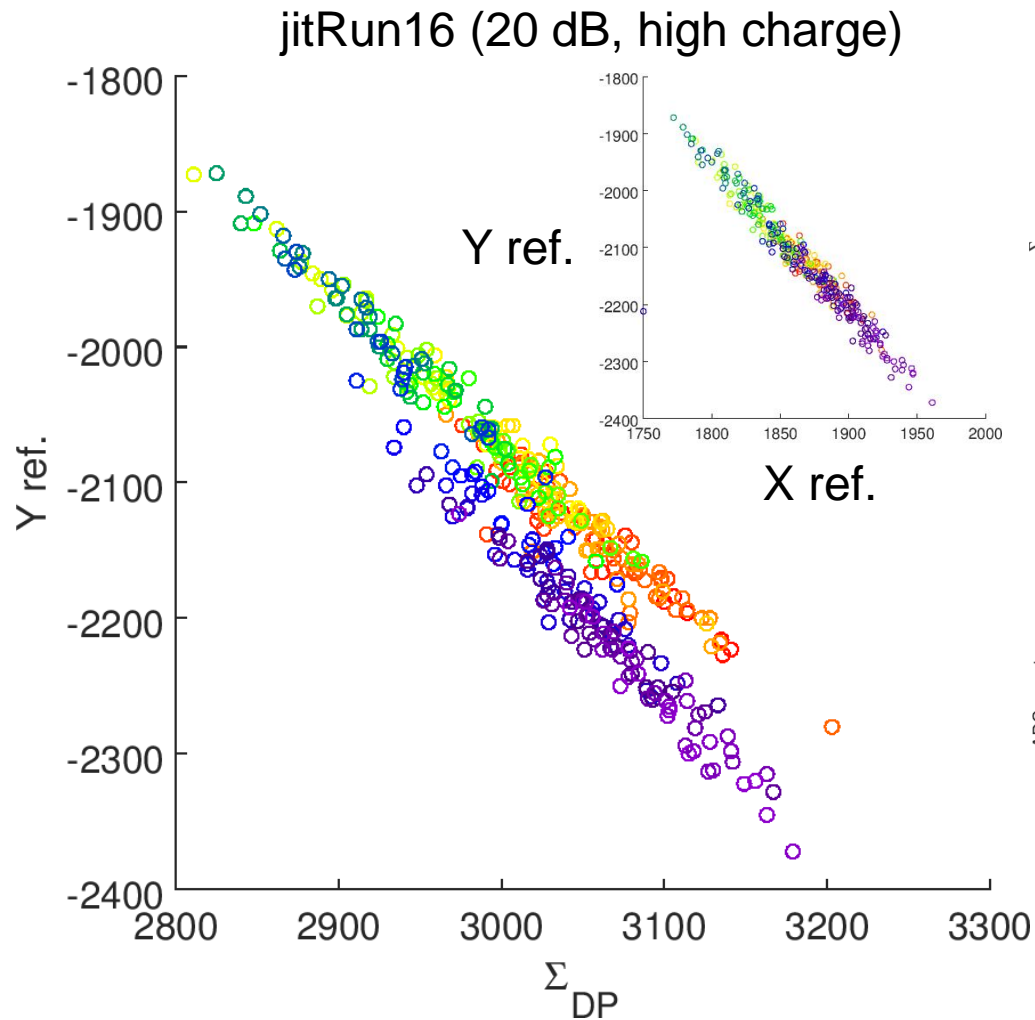
Upstream Σ vs. reference: 60 dB



Upstream Σ vs. reference: 70 dB

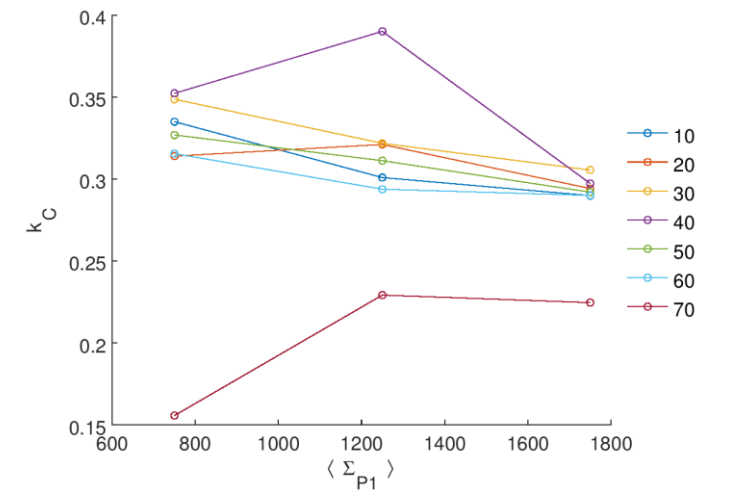
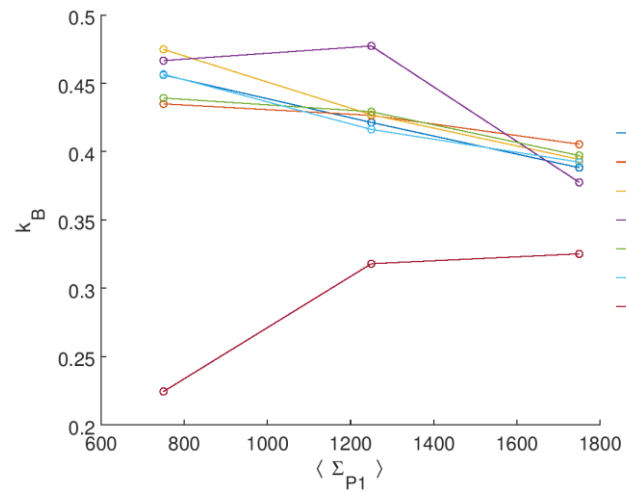
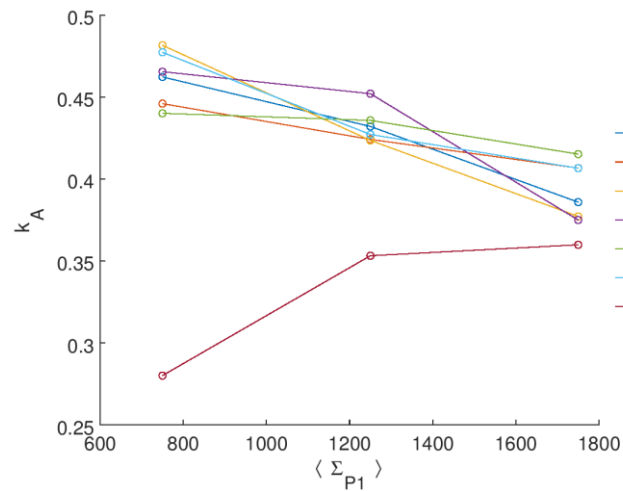
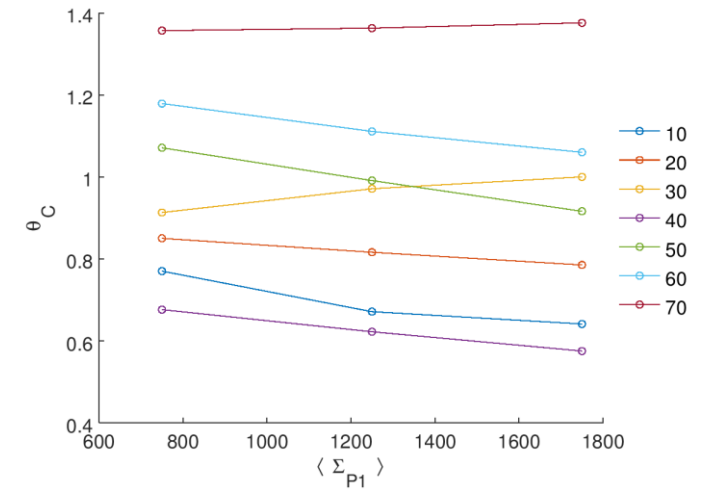
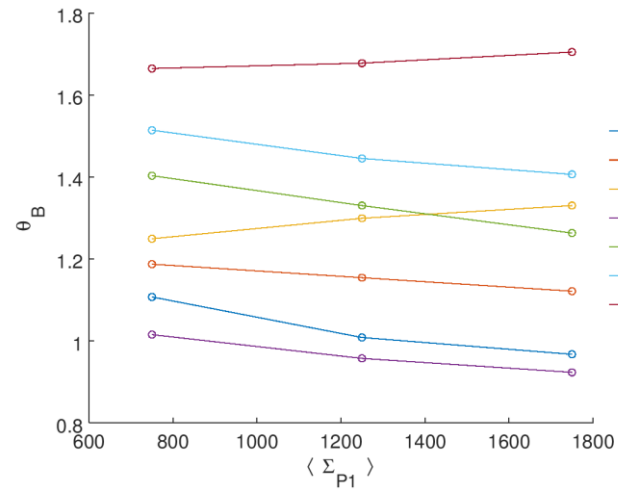
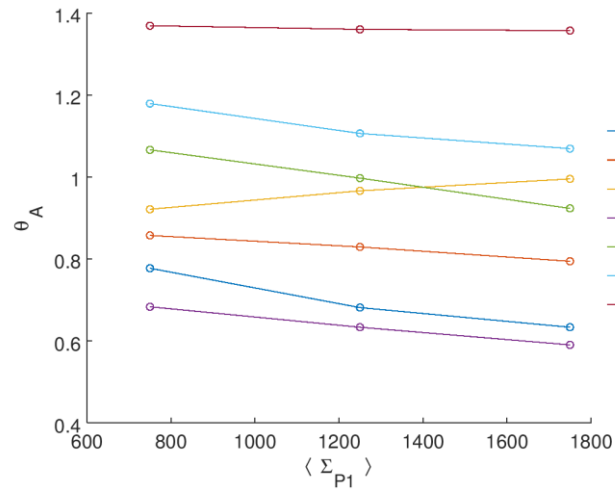


Observed phenomena – charge discrepancy

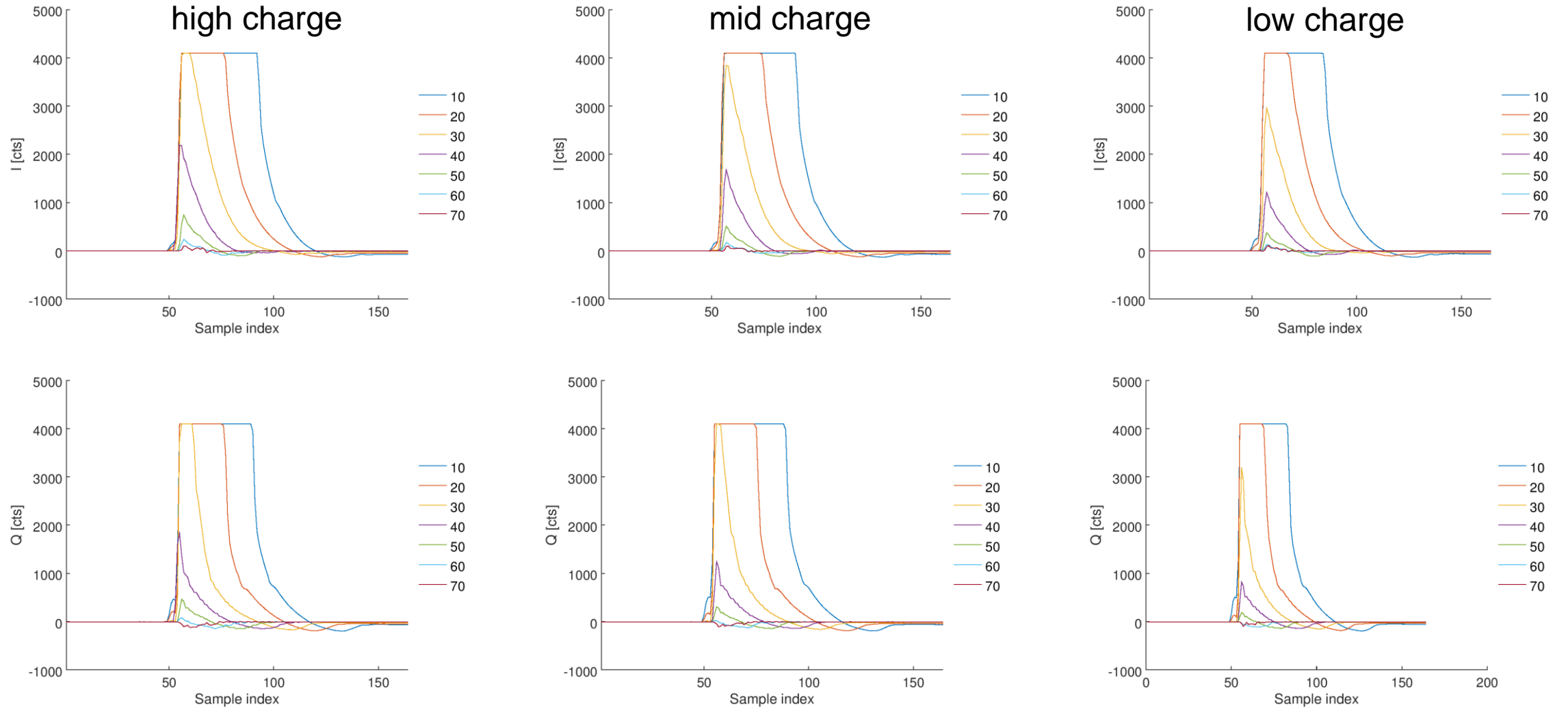


waveforms offset vertically for viewing purposes

θ_{IQ} , k as functions of charge & attenuation



Limiter phase – average waveforms

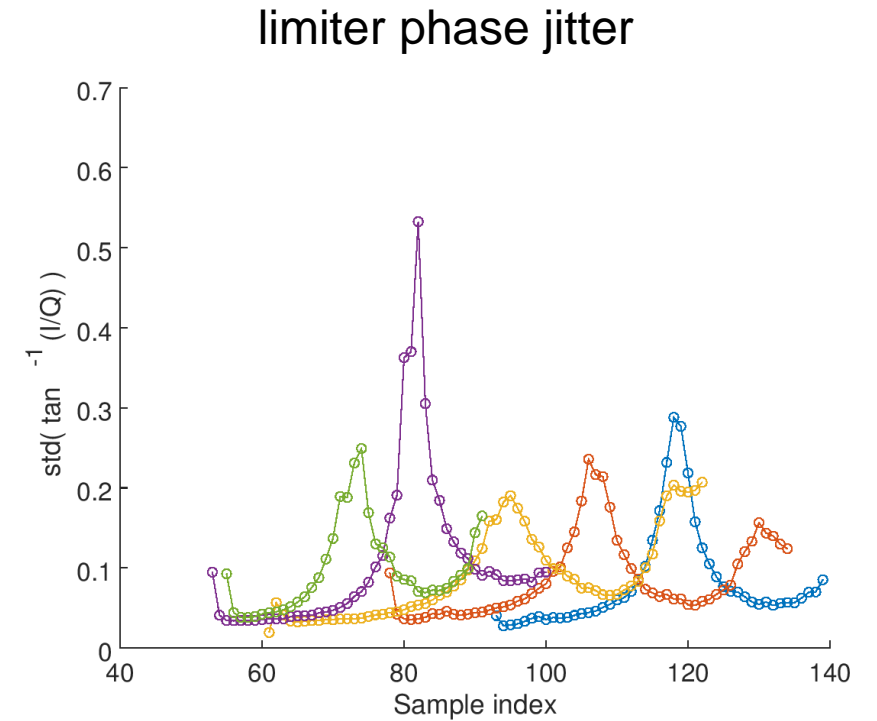
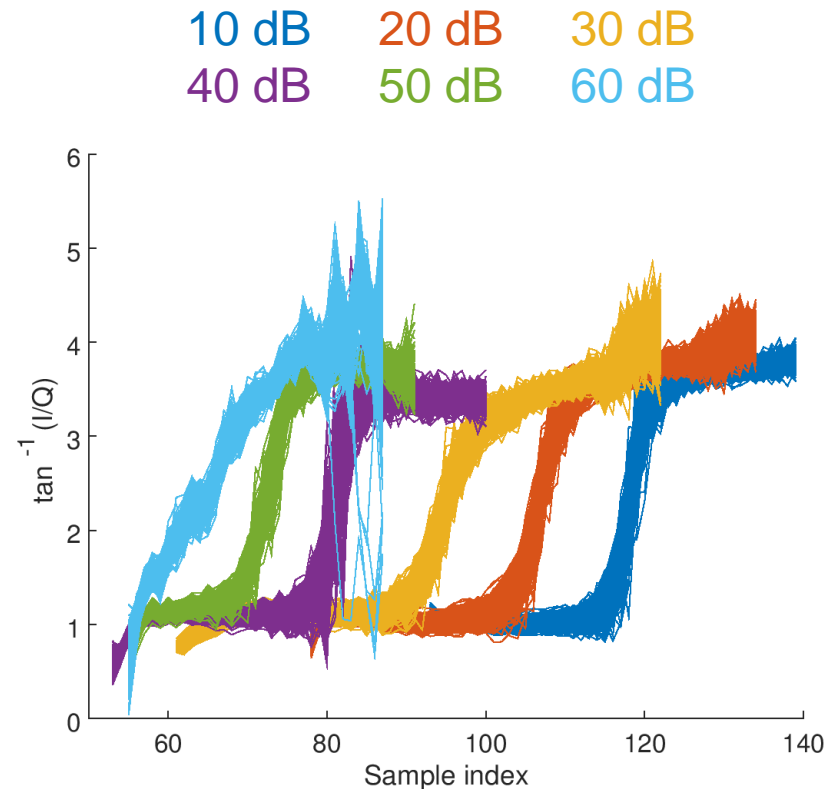


Limiter phase – sample-by-sample

Charge: high

phase calculated from:
arrival time of bunch
(low charge)
OR
end of saturation region
(high charge)

“unwrapping” algorithm
employed to suppress
discontinuity when
phase is close to $\pi/2$
(with limited success)

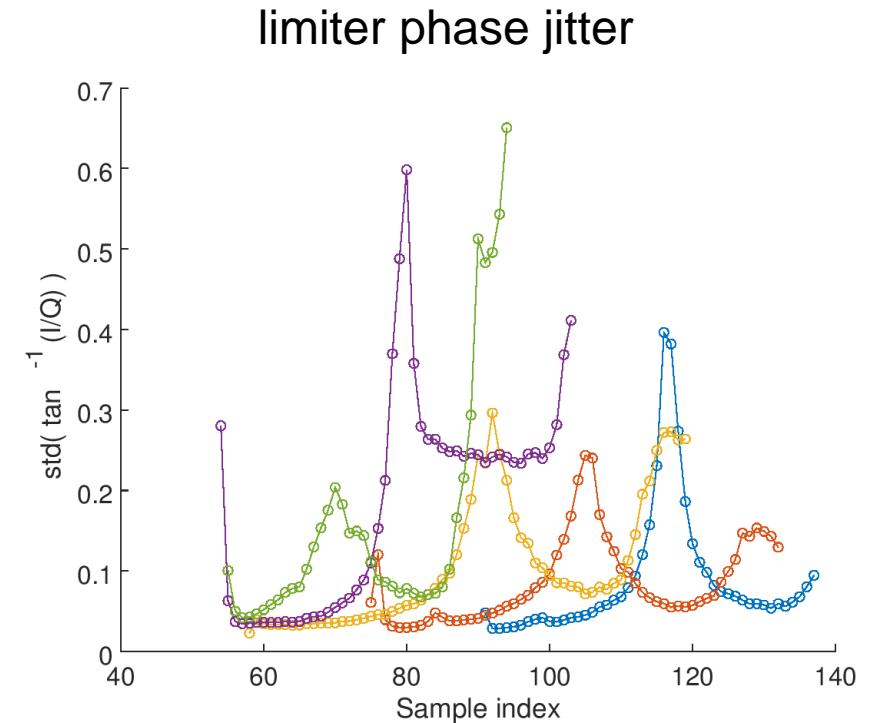
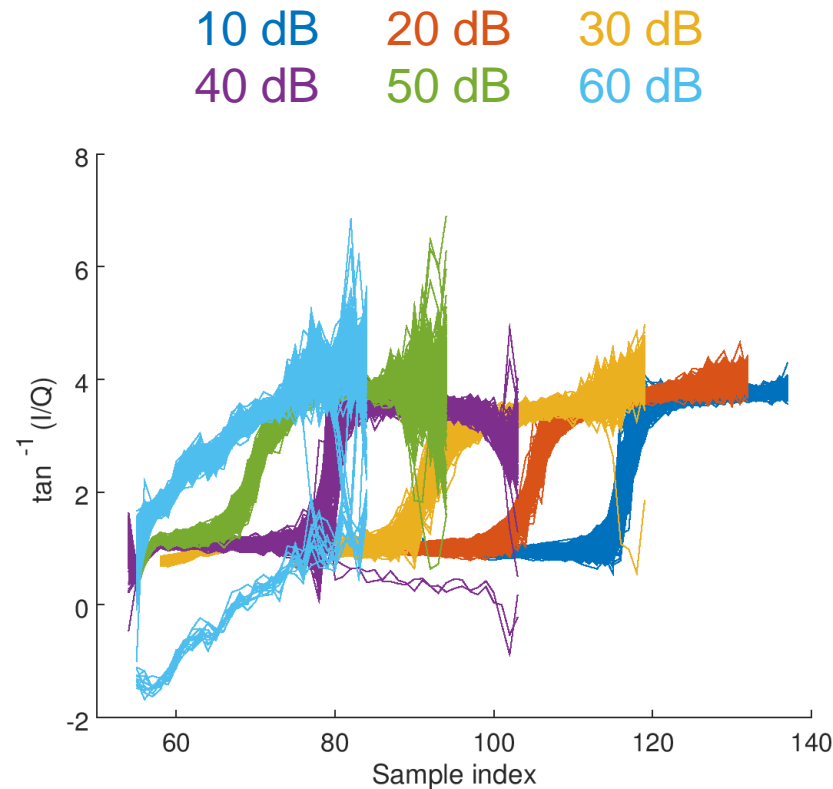


Limiter phase – sample-by-sample

Charge: mid

phase calculated from:
arrival time of bunch
(low charge)
OR
end of saturation region
(high charge)

“unwrapping” algorithm
employed to suppress
discontinuity when
phase is close to $\pi/2$
(with limited success)

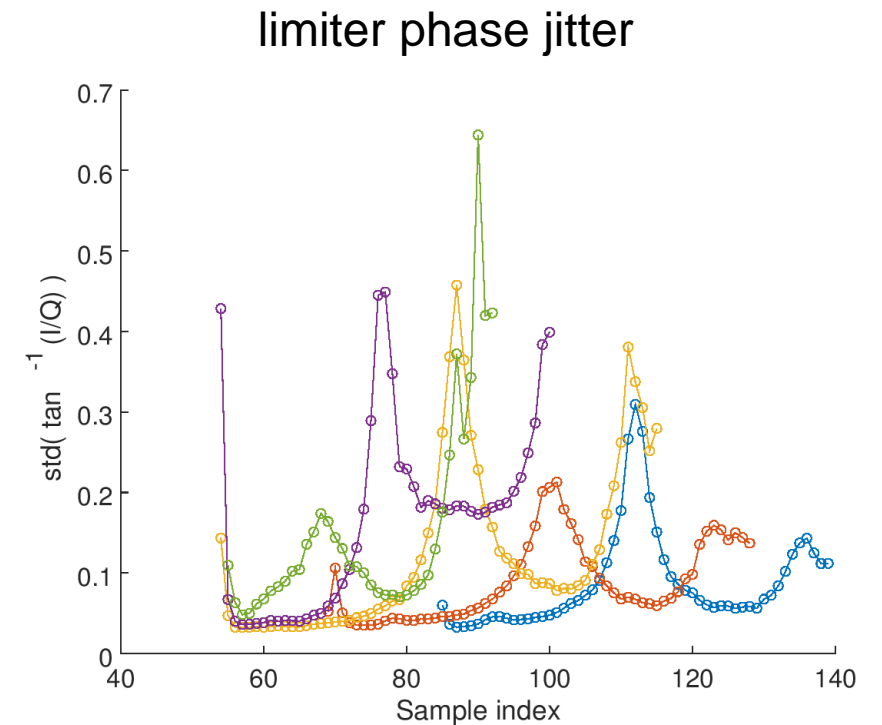
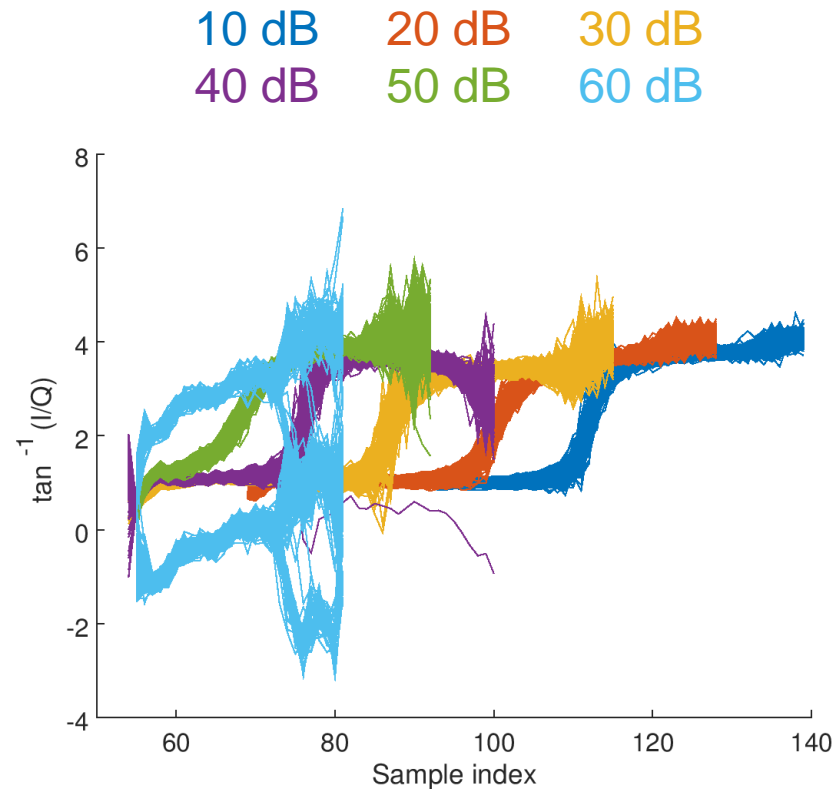


Limiter phase – sample-by-sample

Charge: low

phase calculated from:
arrival time of bunch
(low charge)
OR
end of saturation region
(high charge)

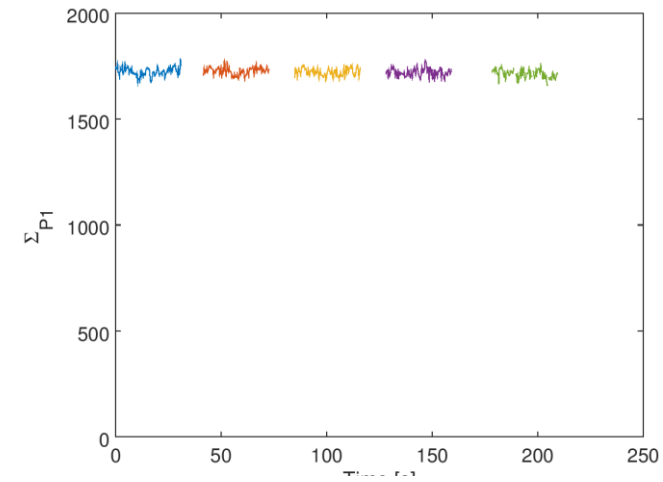
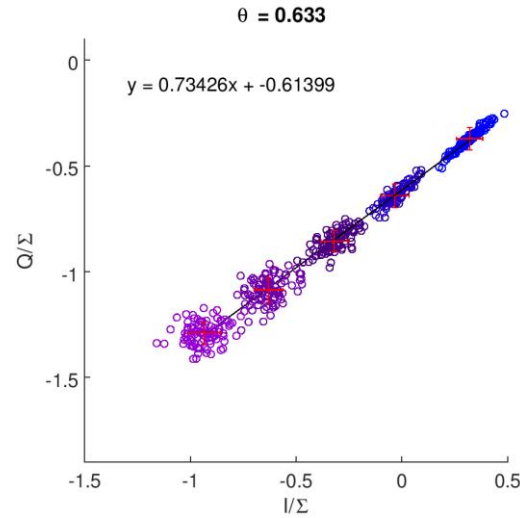
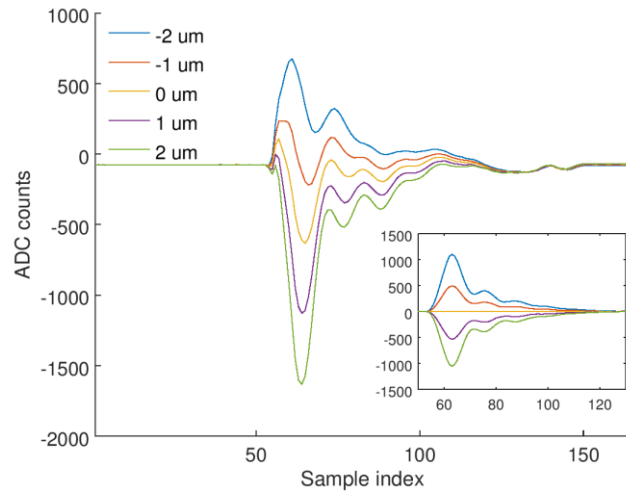
“unwrapping” algorithm
employed to suppress
discontinuity when
phase is close to $\pi/2$
(with limited success)



Conclusion

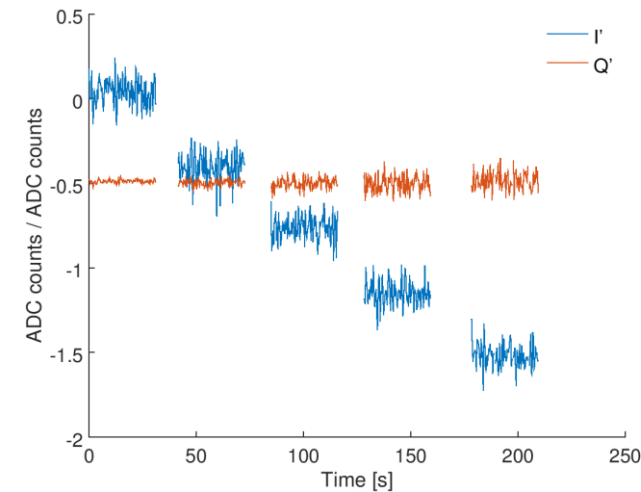
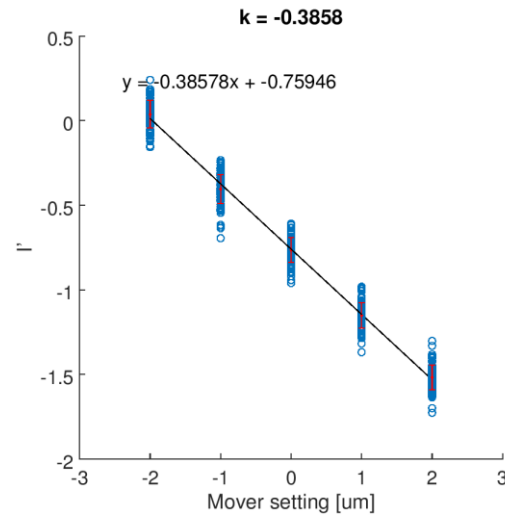
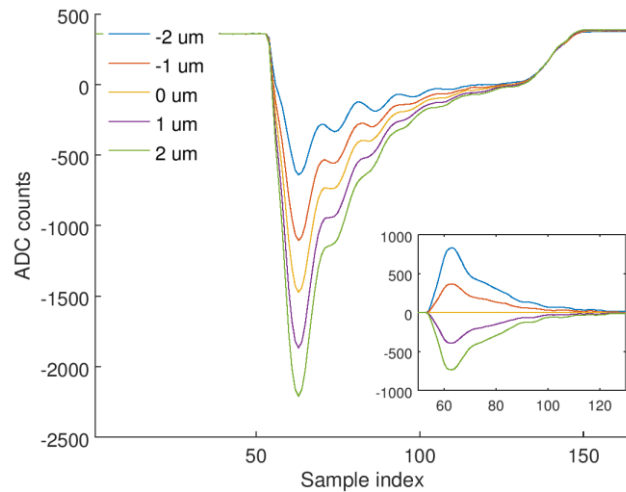
- Single-sample reference non-linear as a function of upstream Σ for low attenuation (<40 dB)
- Anomalous values of k obtained for 40 dB, mid-charge

AQD0FFyScan22 (10 dB, high charge)



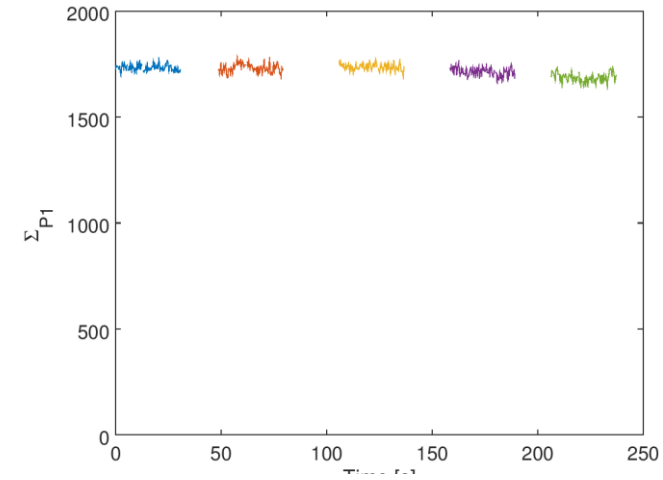
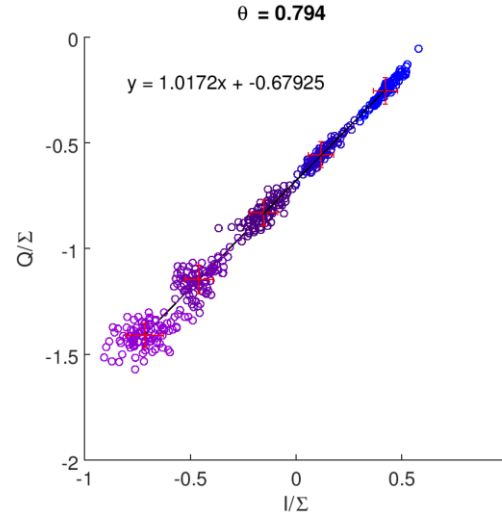
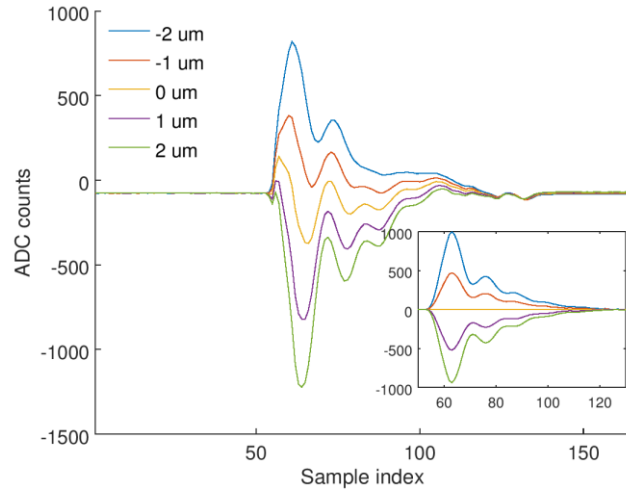
Sample index = 63

Charge normalization using Σ_{P1}



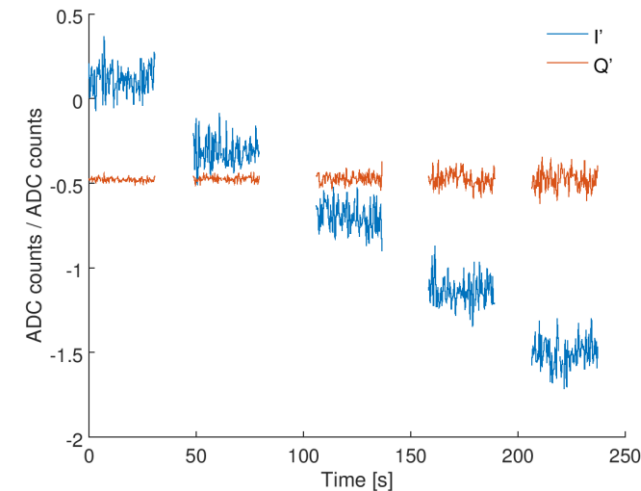
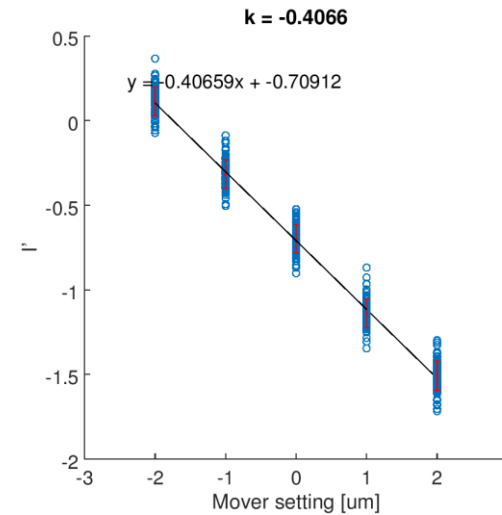
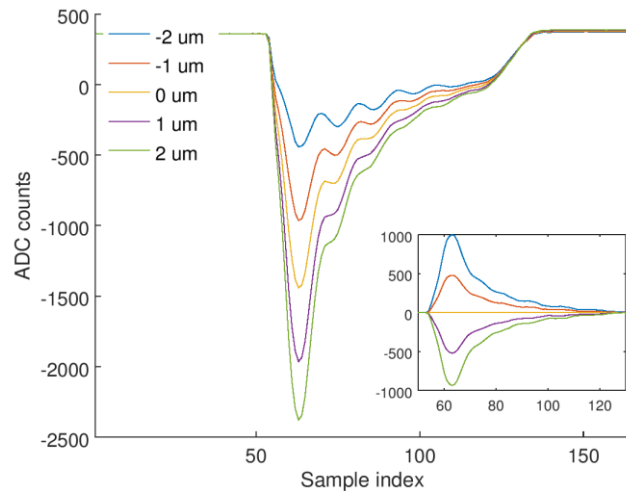
IPA

AQD0FFyScan21 (20 dB, high charge)



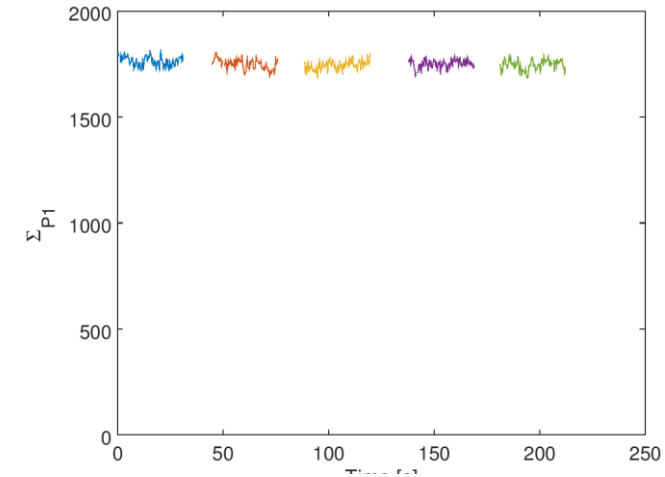
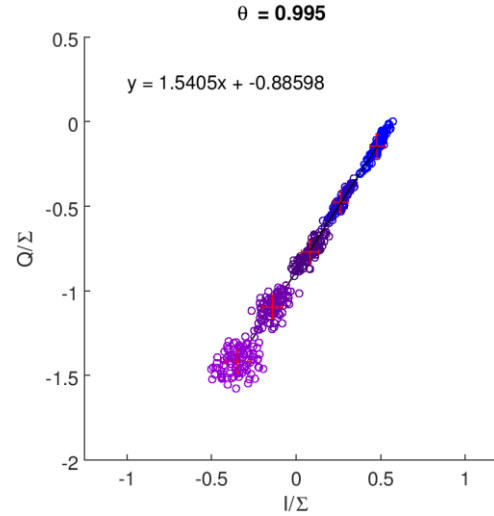
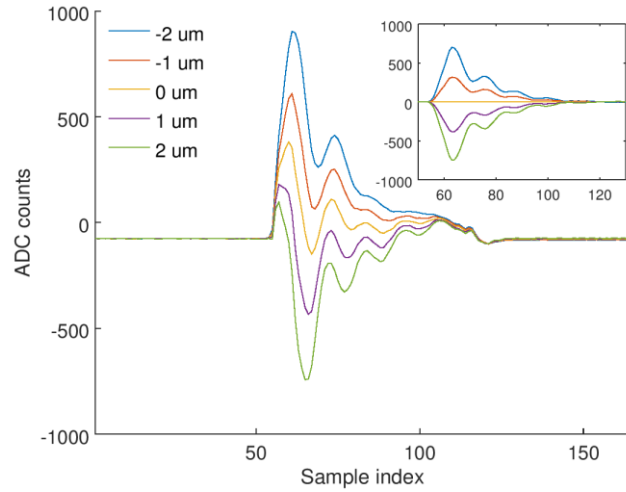
Sample index = 63

Charge normalization using Σ_{P1}



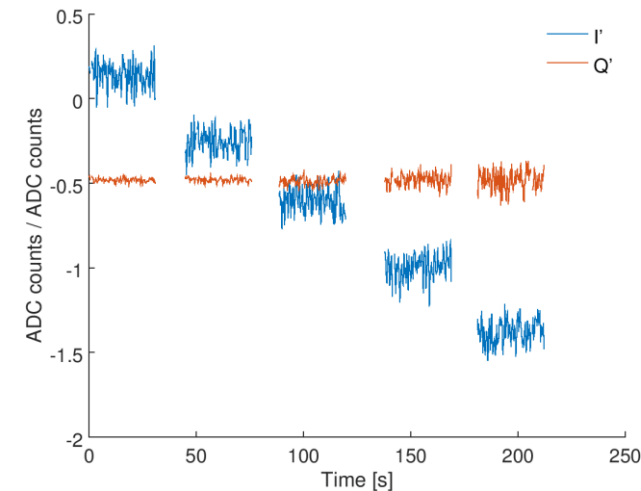
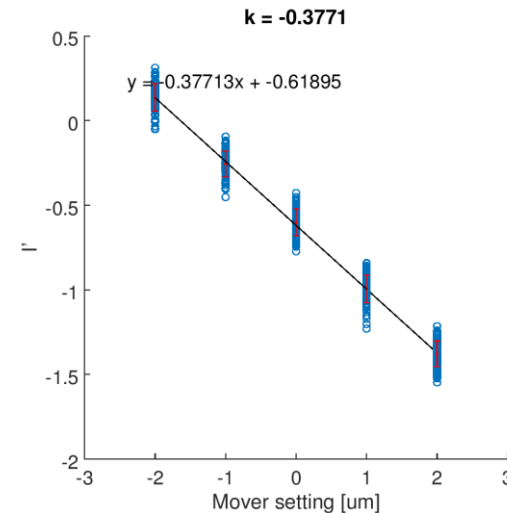
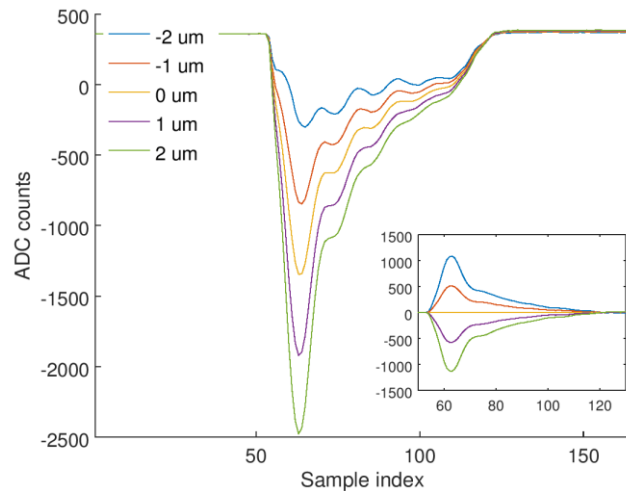
IPA

AQD0FFyScan19 (30 dB, high charge)



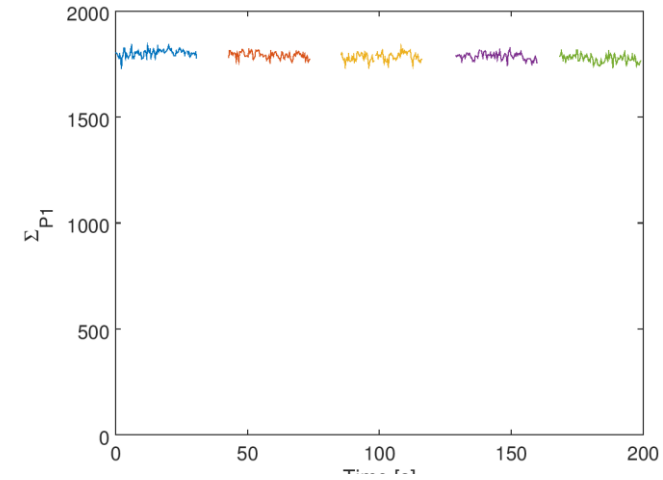
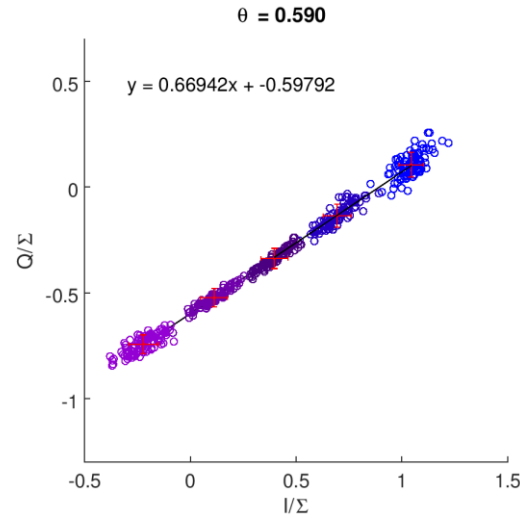
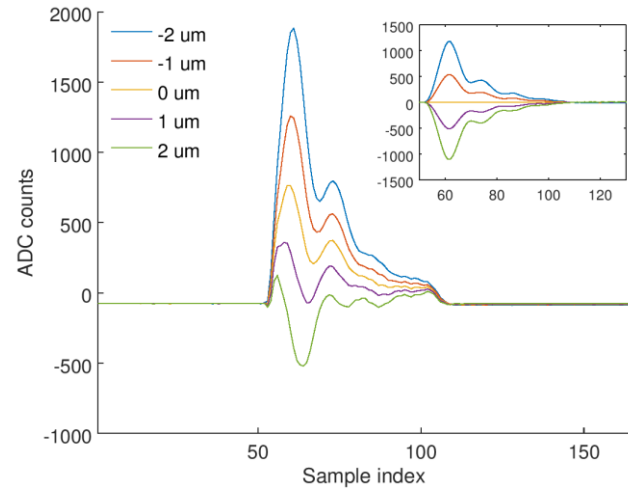
Sample index = 63

Charge normalization using Σ_{P1}



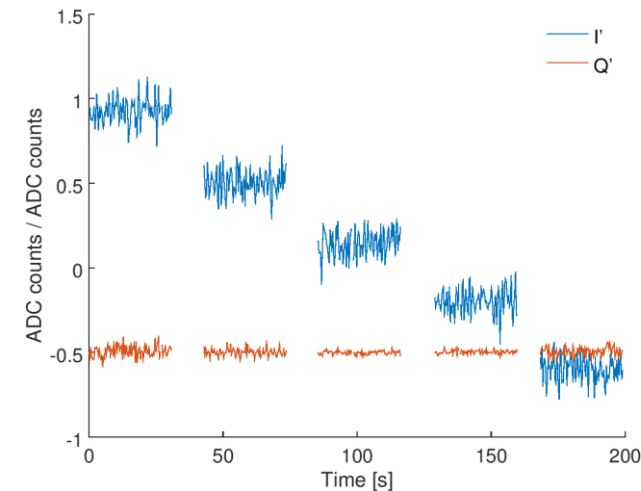
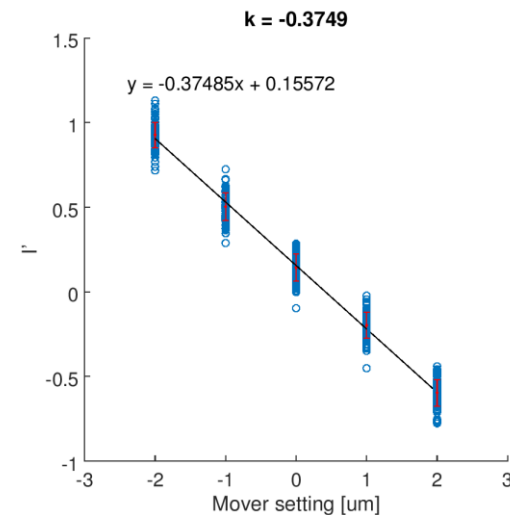
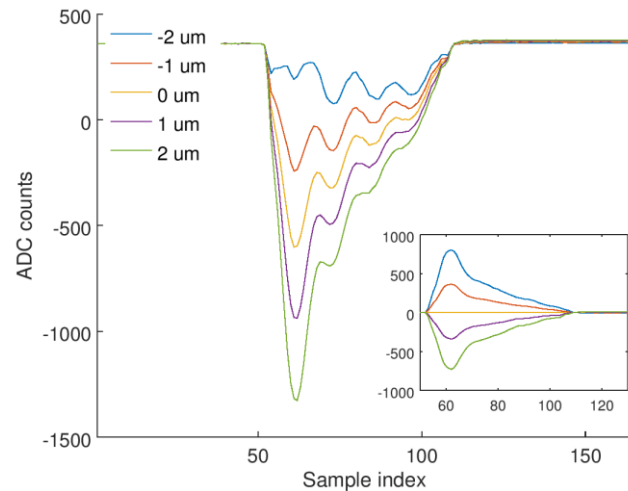
IPA

AQD0FFyScan15 (40 dB, high charge)



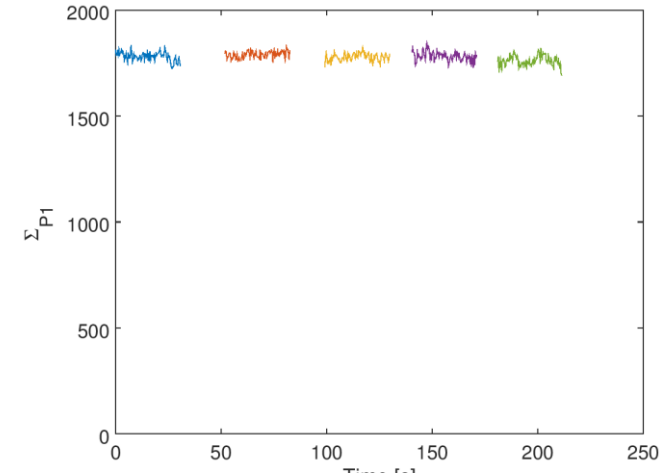
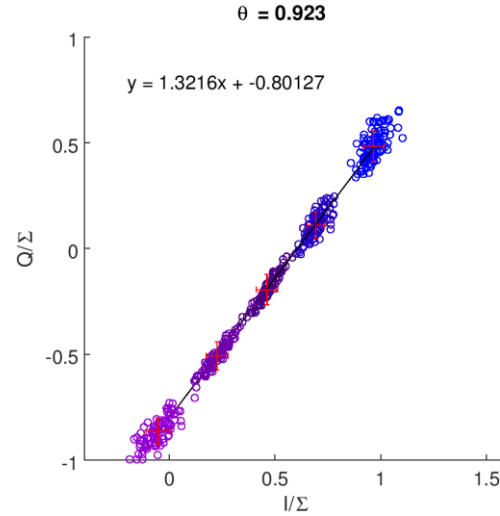
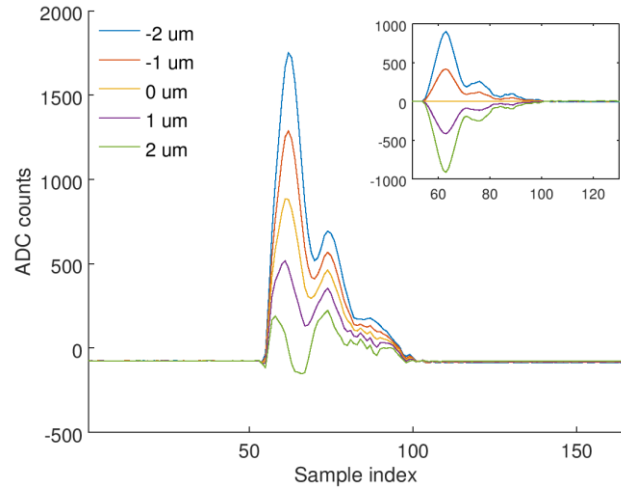
Sample index = 63

Charge normalization using Σ_{P1}



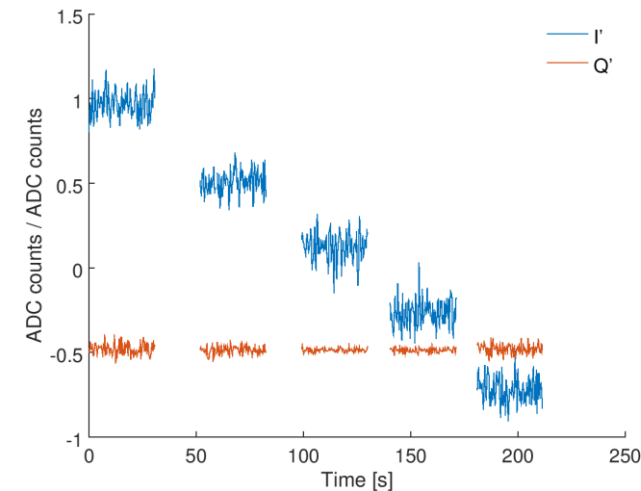
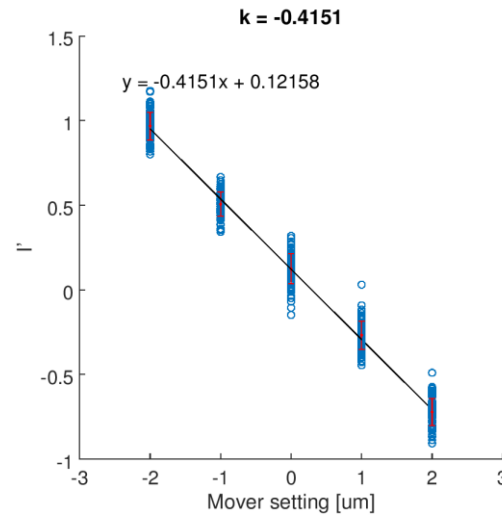
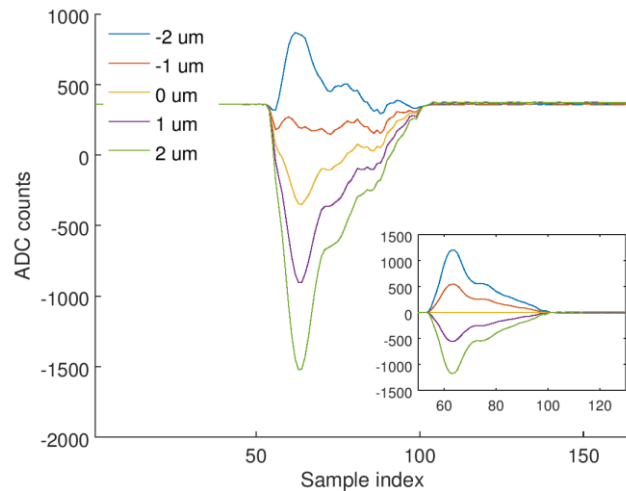
IPA

AQD0FFyScan16 (50 dB, high charge)



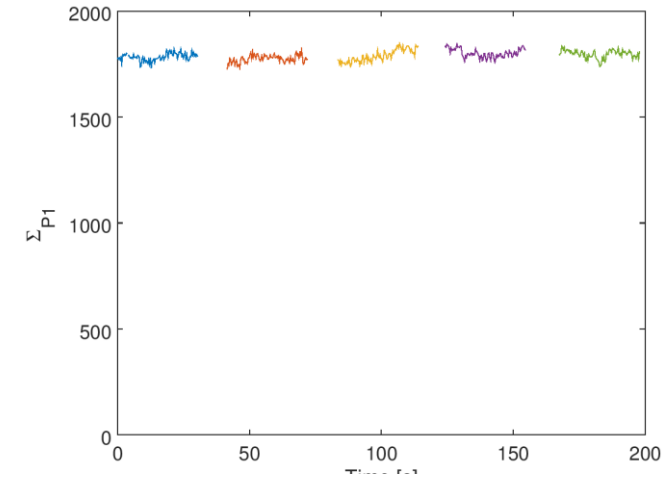
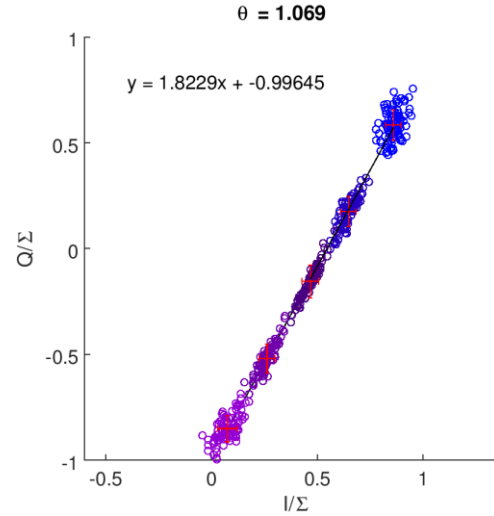
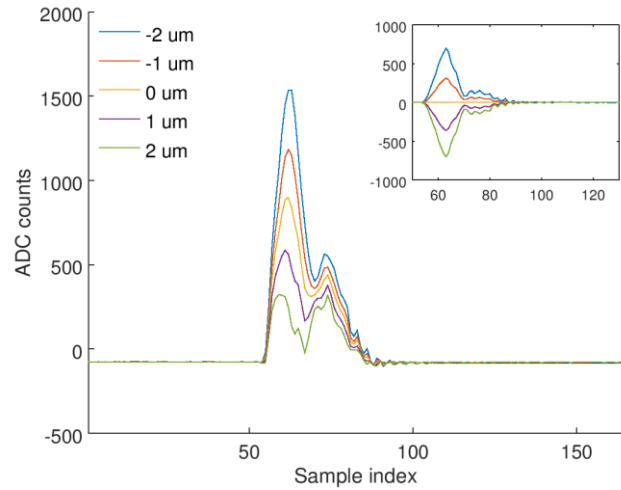
Sample index = 63

Charge normalization using Σ_{P1}



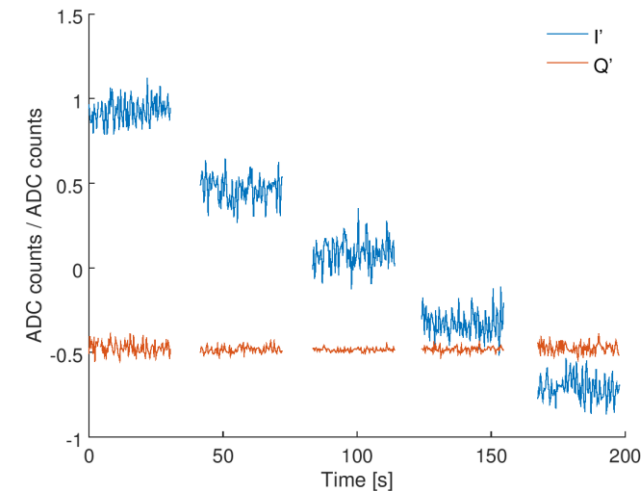
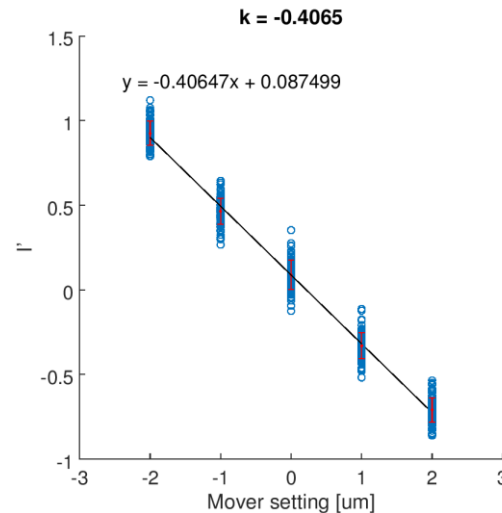
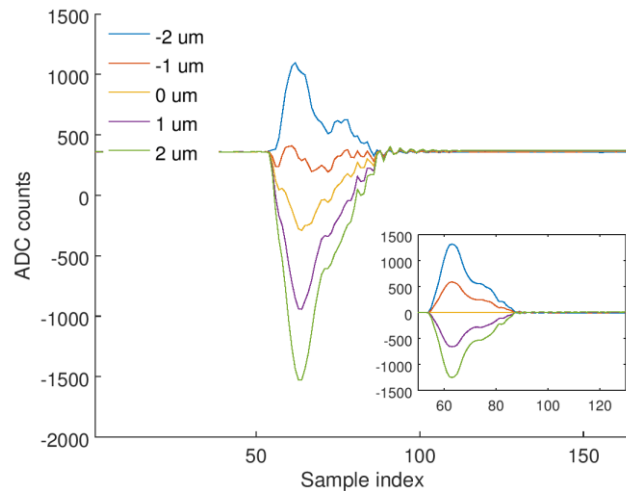
IPA

AQD0FFyScan17 (60 dB, high charge)



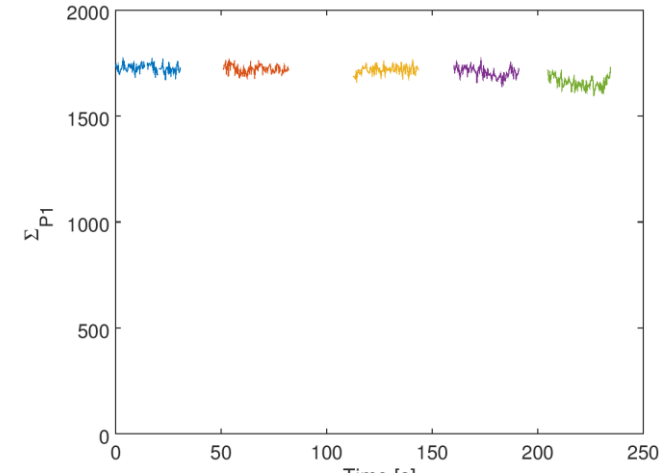
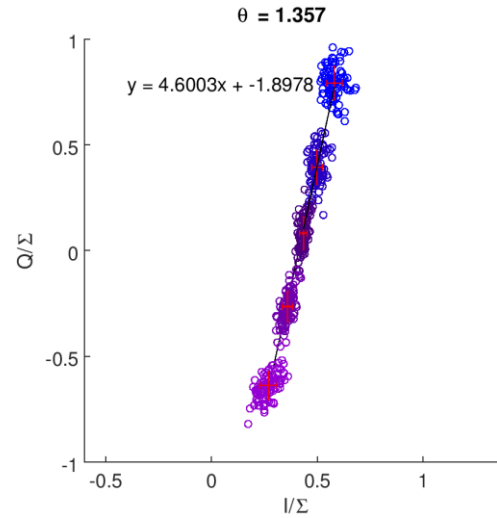
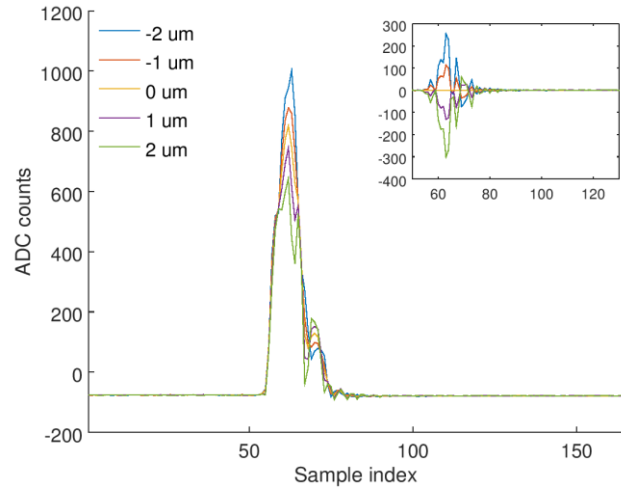
Sample index = 63

Charge normalization using Σ_{P1}



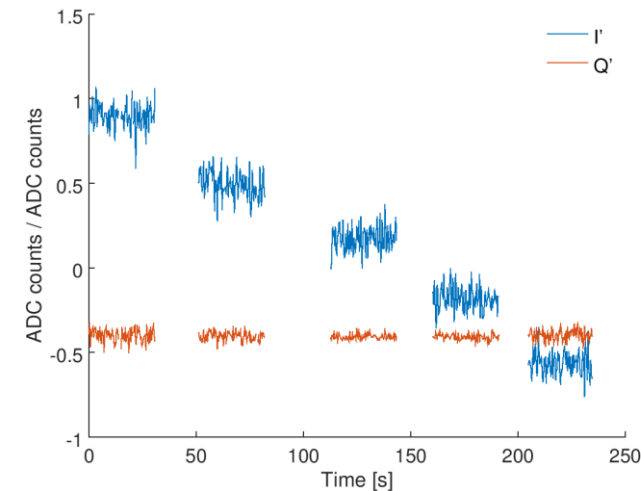
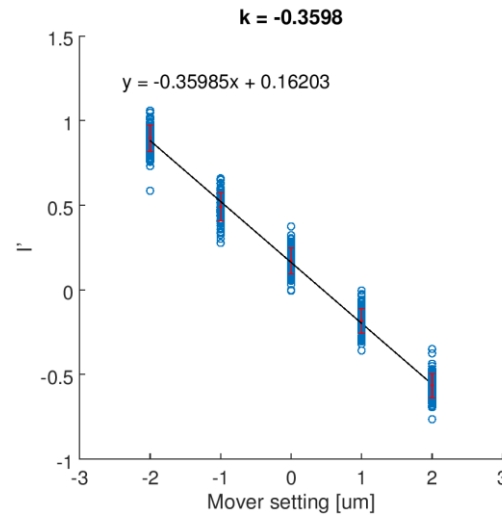
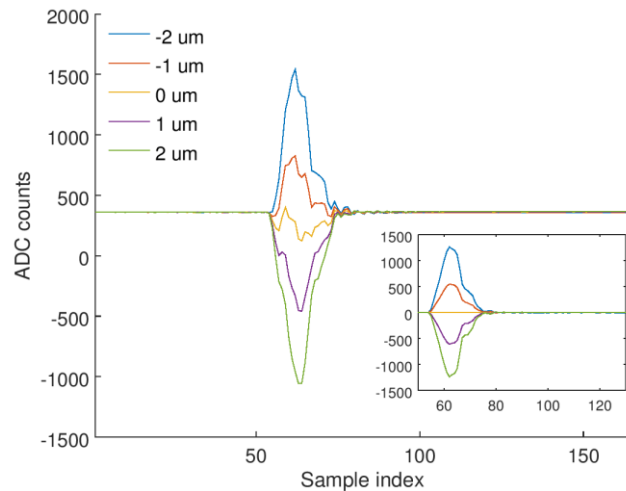
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AQD0FFyScan18 (70 dB, high charge)



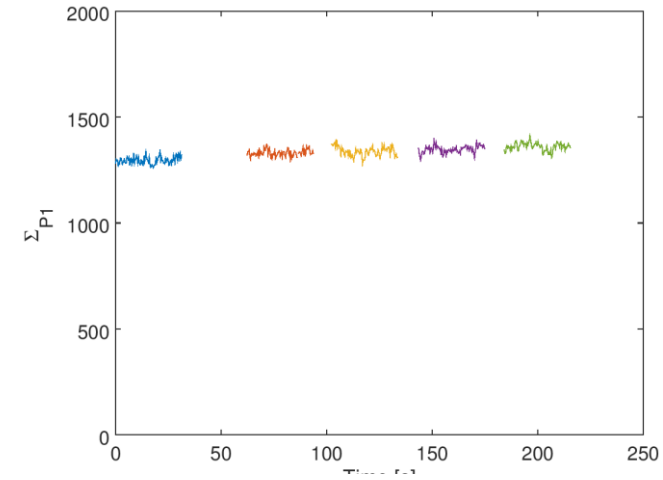
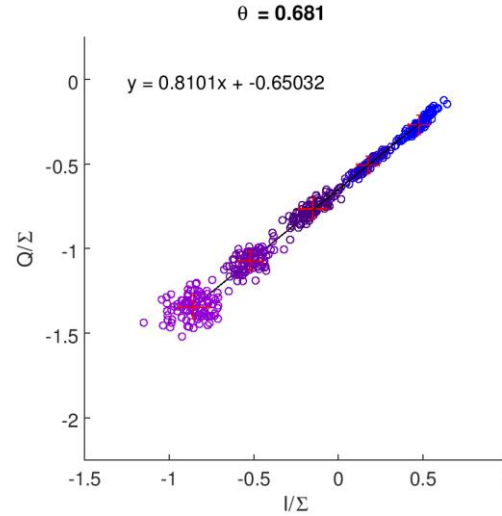
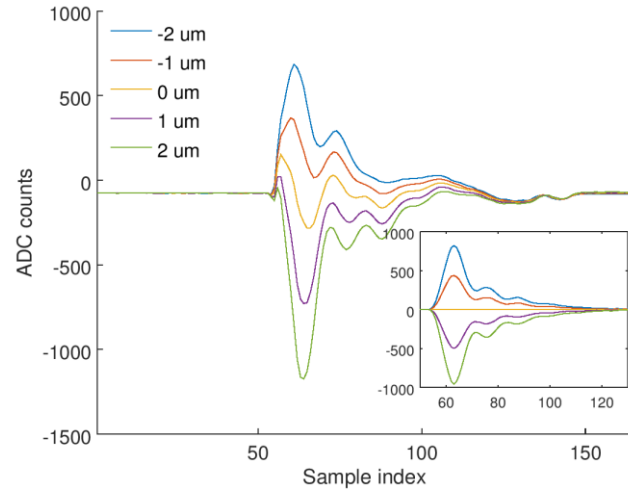
Sample index = 63

Charge normalization using Σ_{P1}



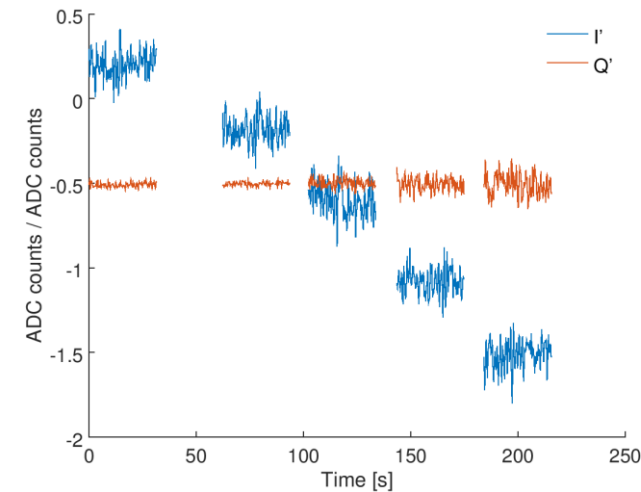
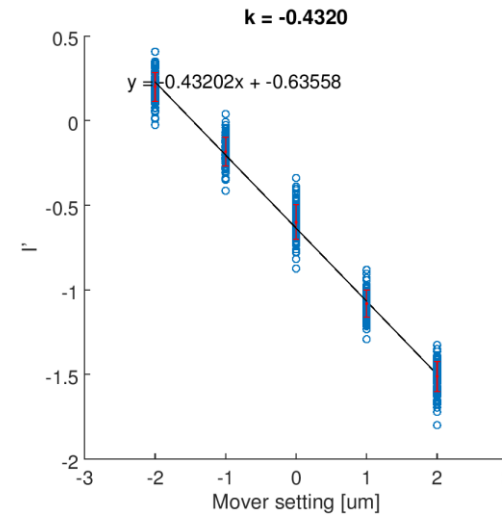
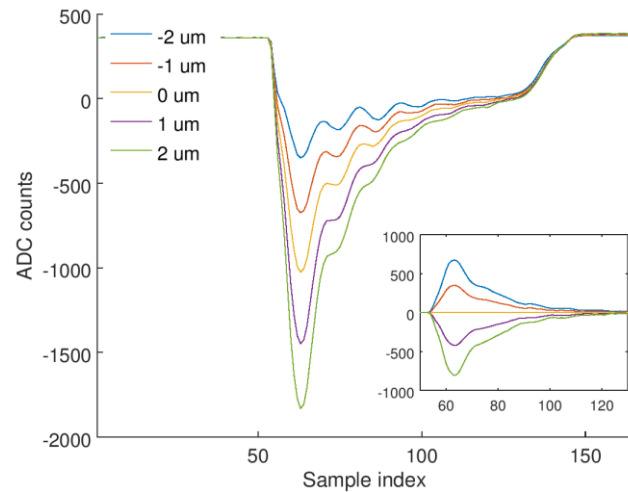
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AQD0FFyScan23 (10 dB, mid charge)



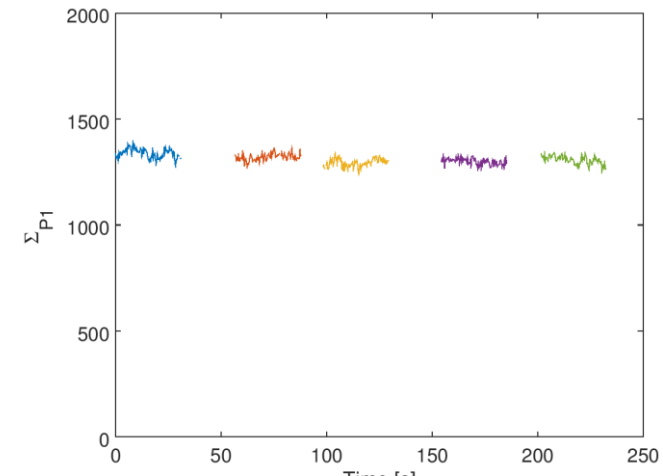
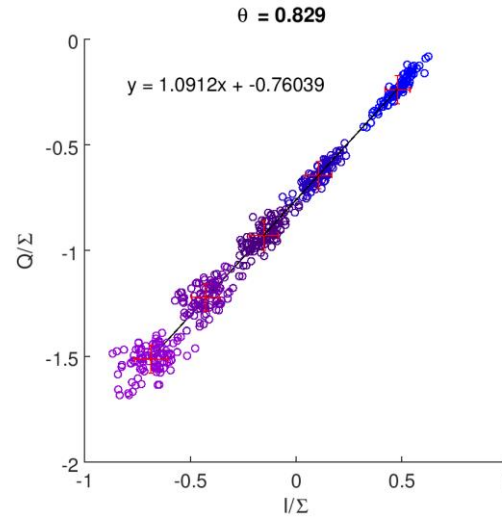
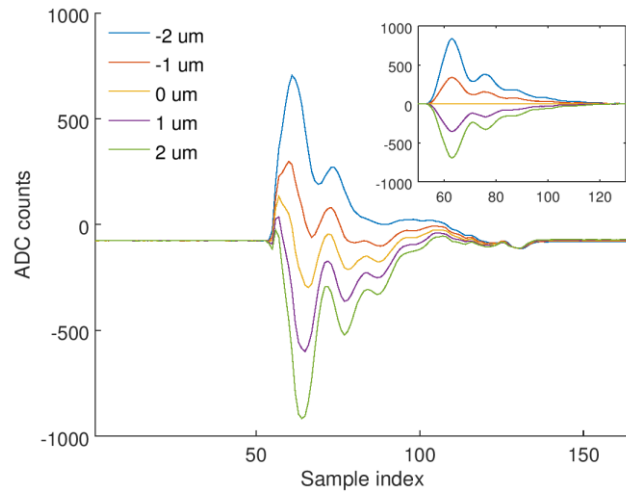
Sample index = 63

Charge normalization using Σ_{P1}



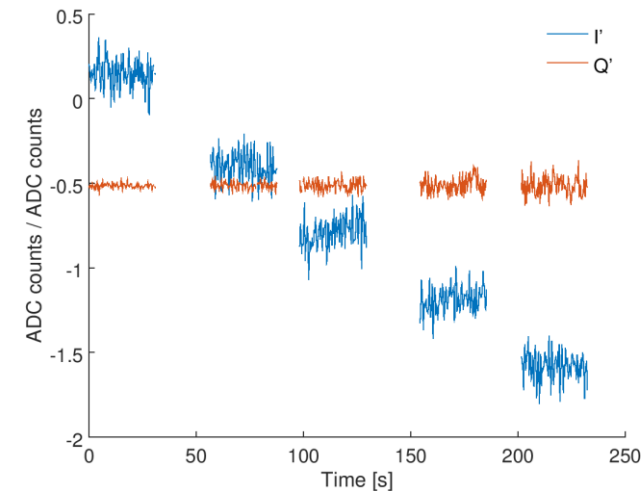
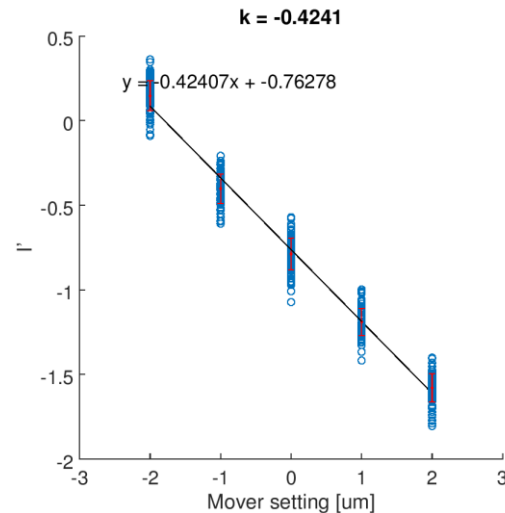
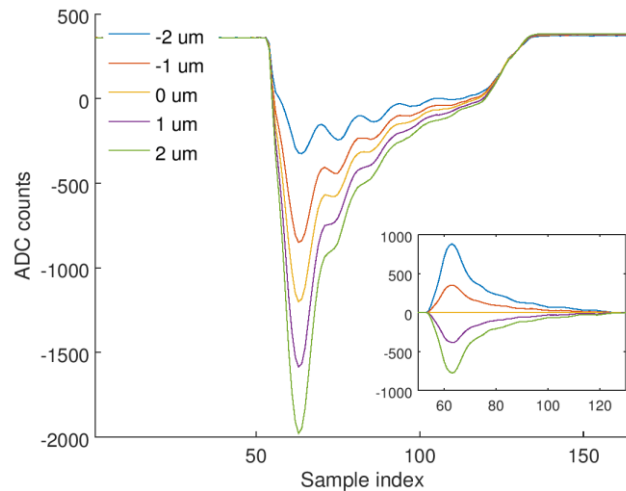
IPA

AQD0FFyScan24 (20 dB, mid charge)



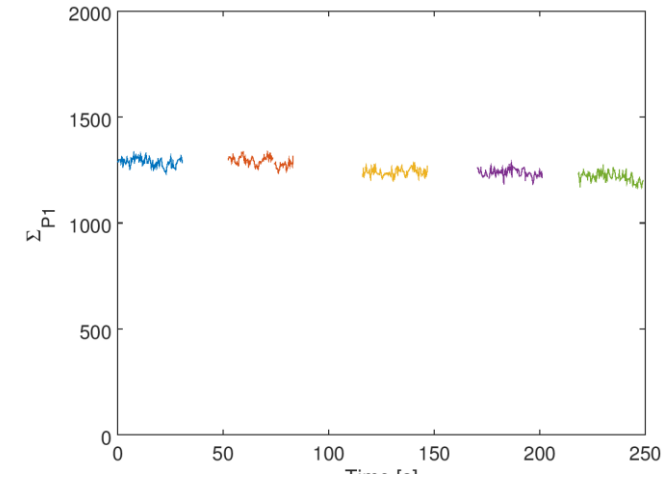
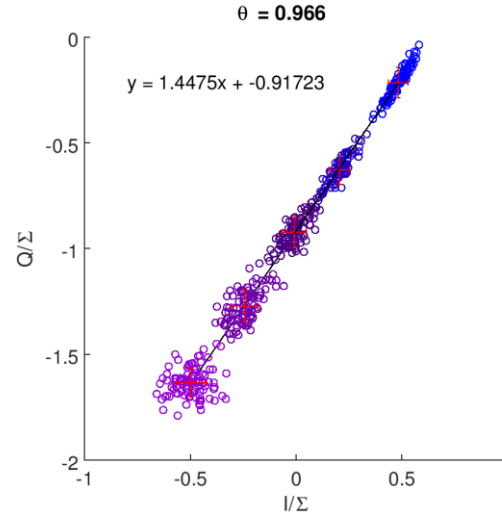
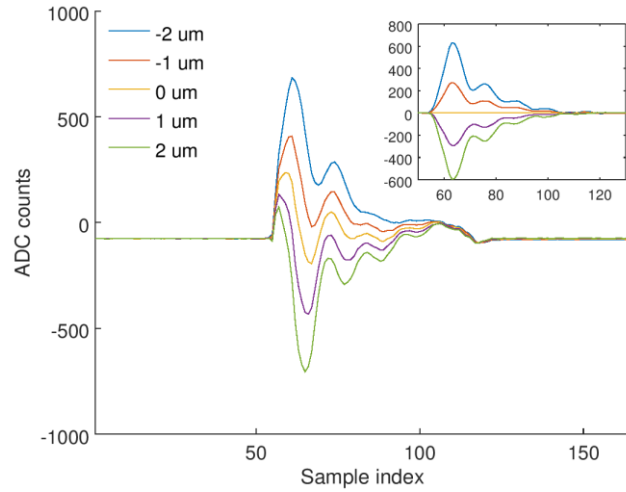
Sample index = 63

Charge normalization using Σ_{P1}



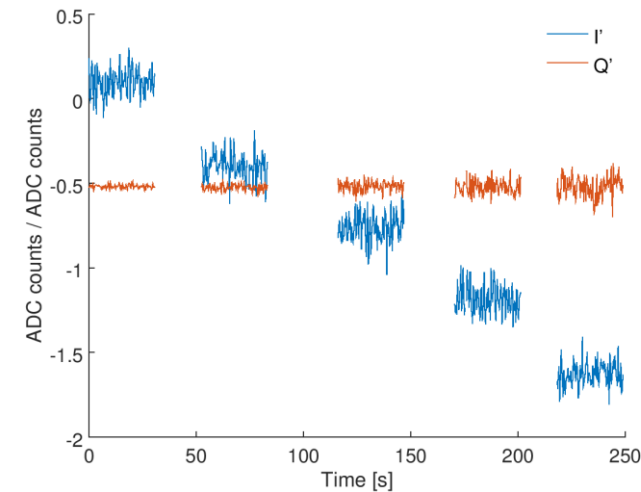
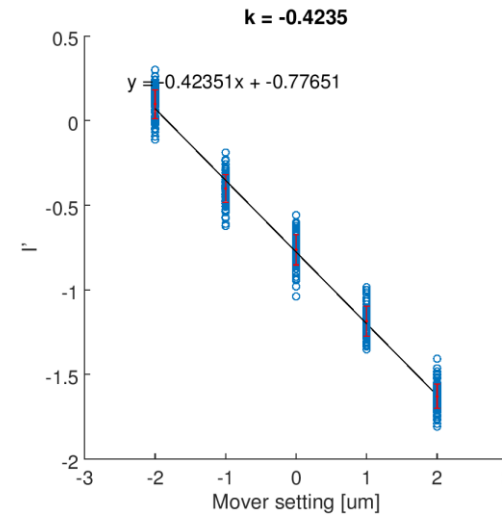
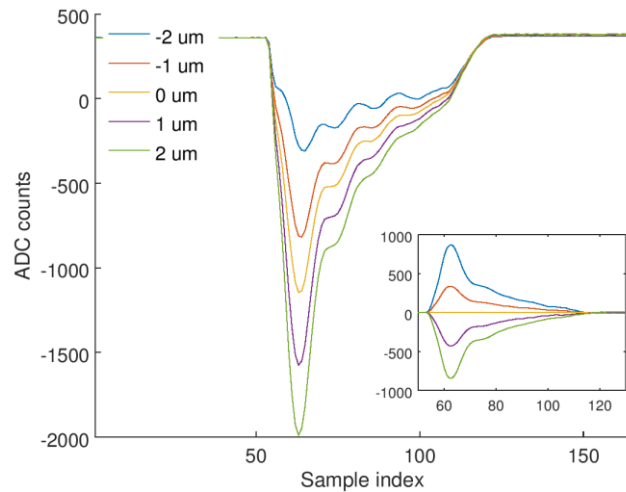
IPA

AQD0FFyScan25 (30 dB, mid charge)



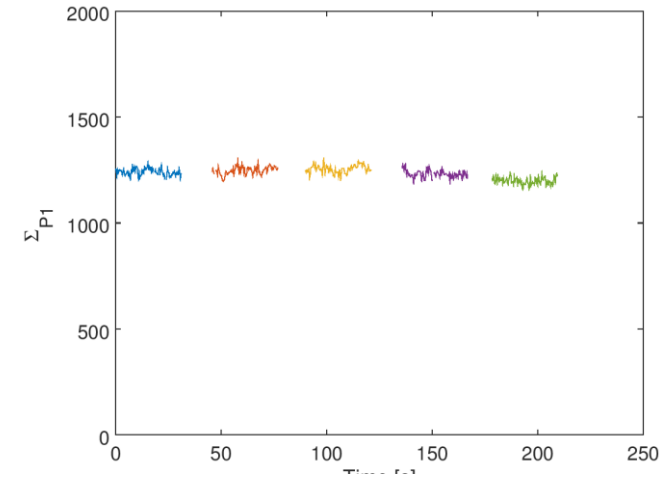
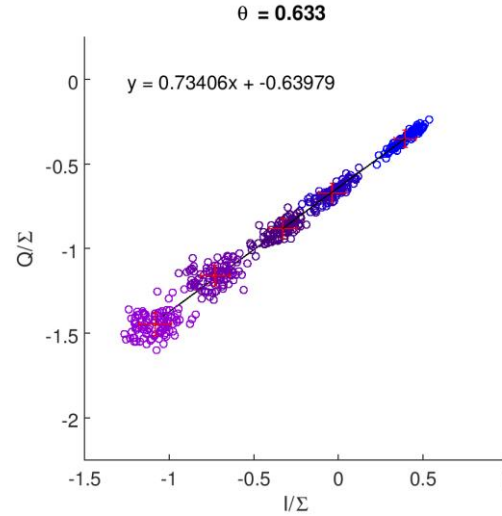
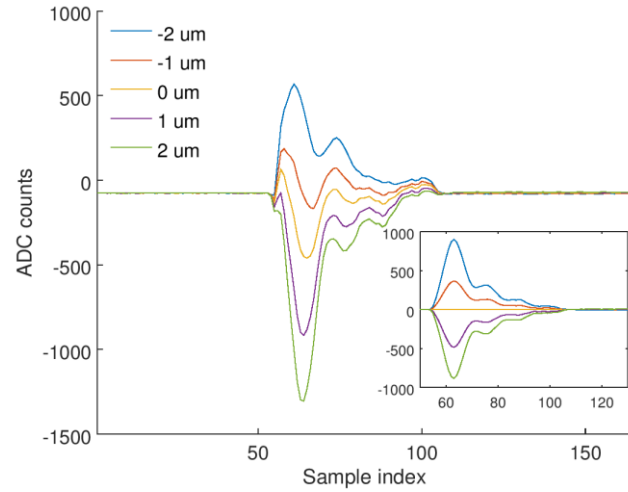
Sample index = 63

Charge normalization using Σ_{P1}



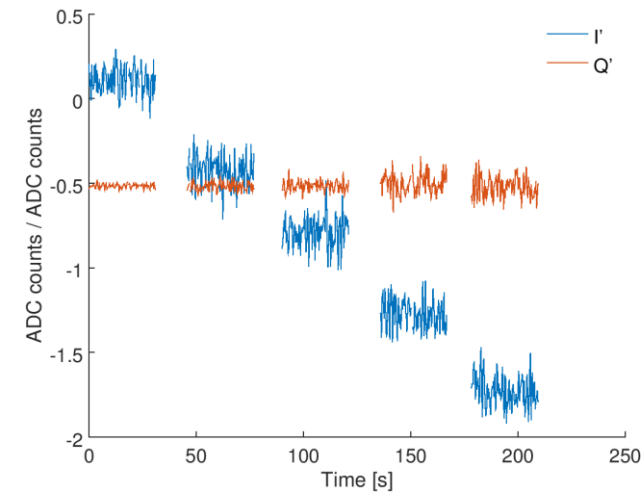
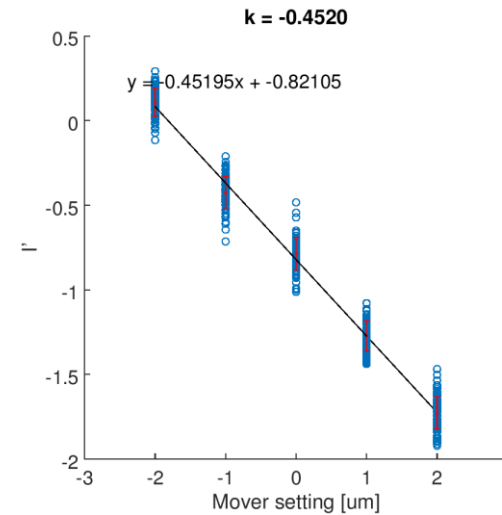
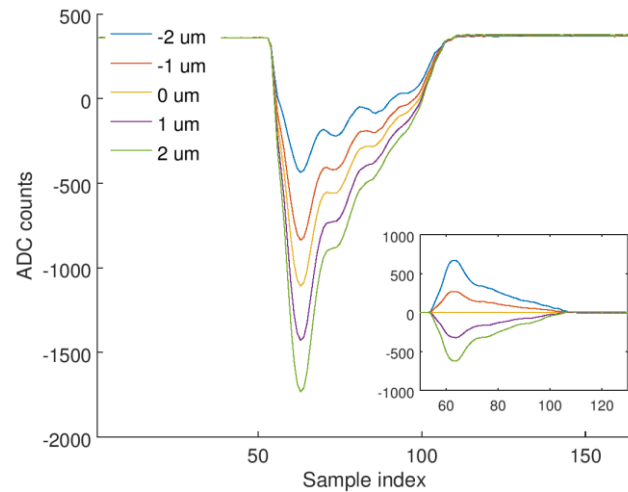
IPA

AQD0FFyScan27 (40 dB, mid charge)



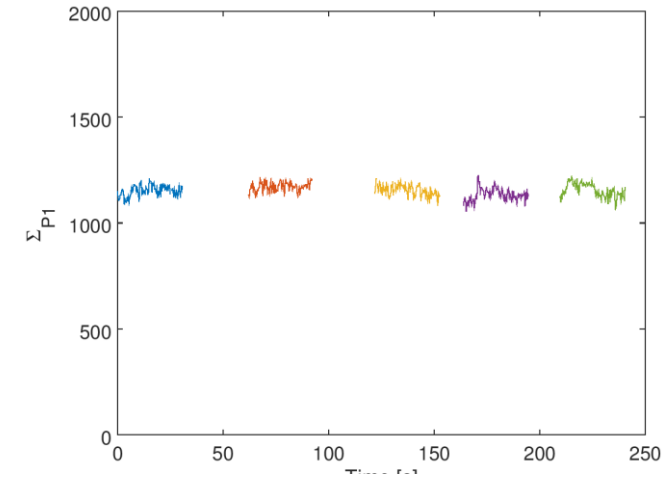
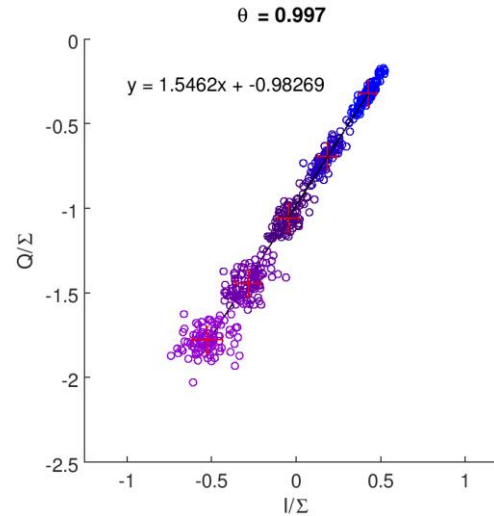
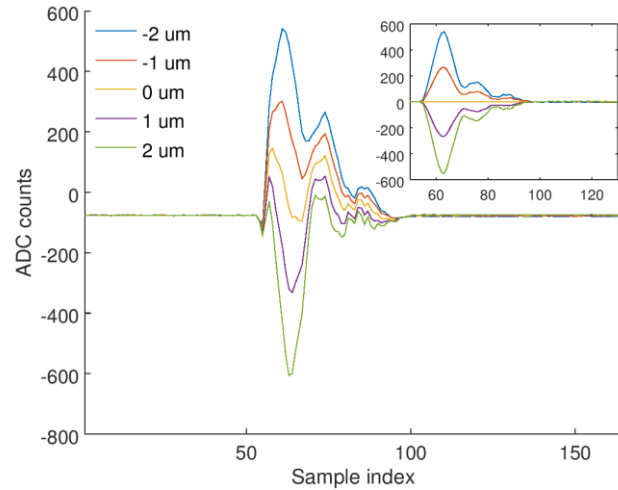
Sample index = 63

Charge normalization using Σ_{P1}



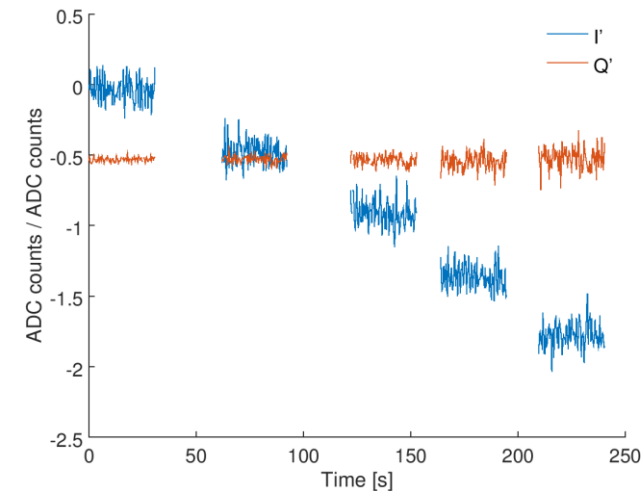
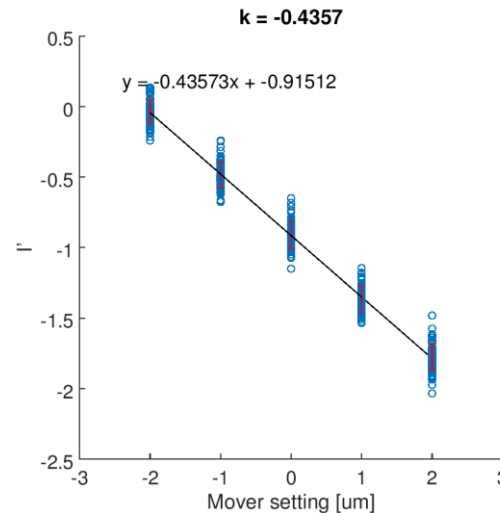
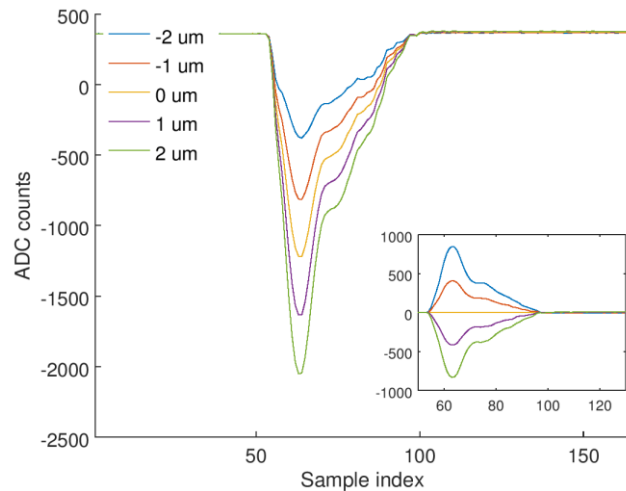
IPA

AQD0FFyScan28 (50 dB, mid charge)



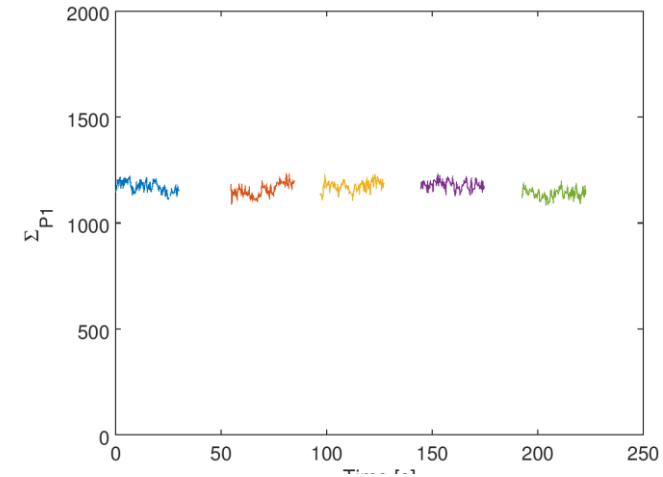
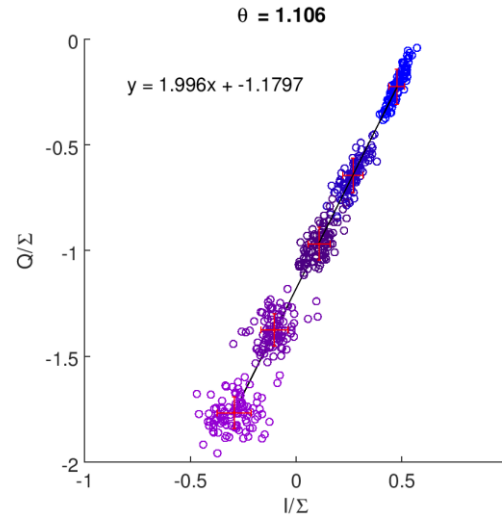
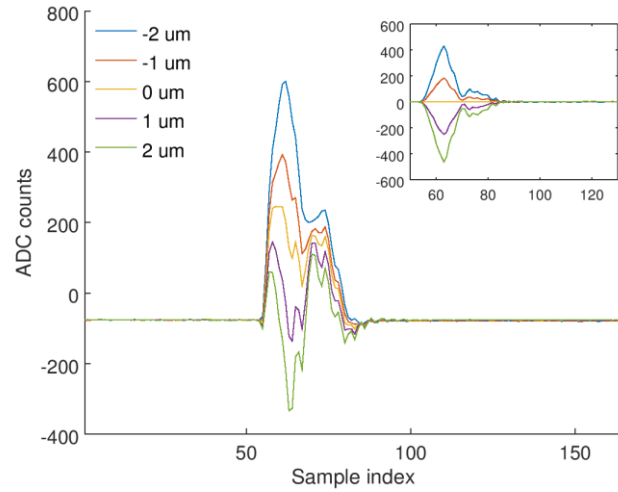
Sample index = 63

Charge normalization using Σ_{P1}



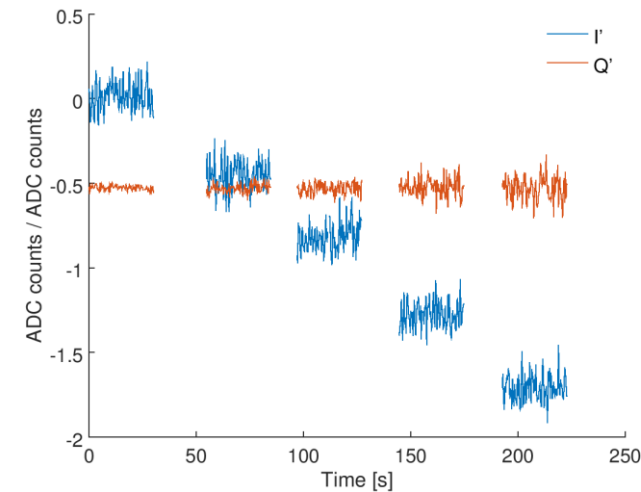
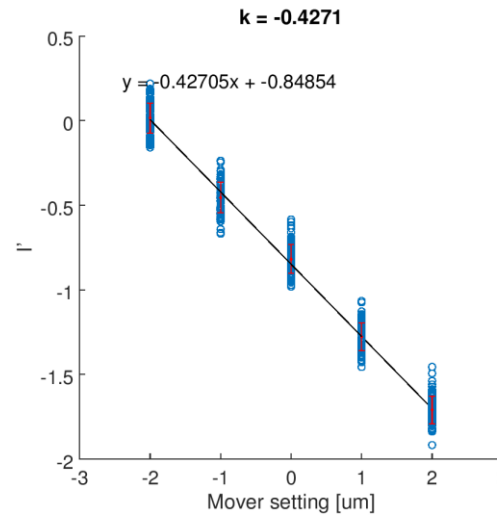
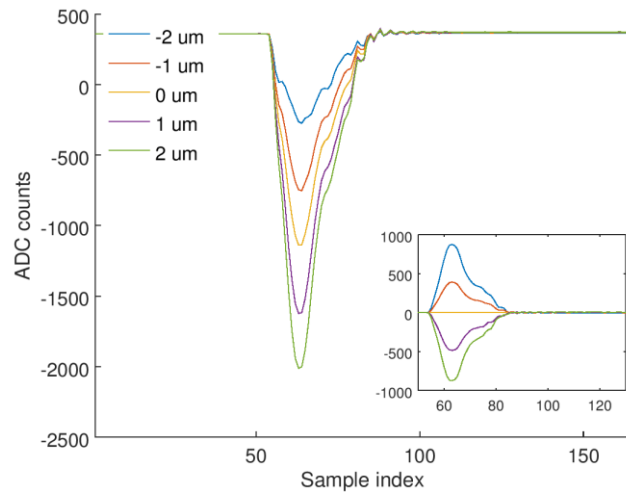
IPA

AQD0FFyScan29 (60 dB, mid charge)



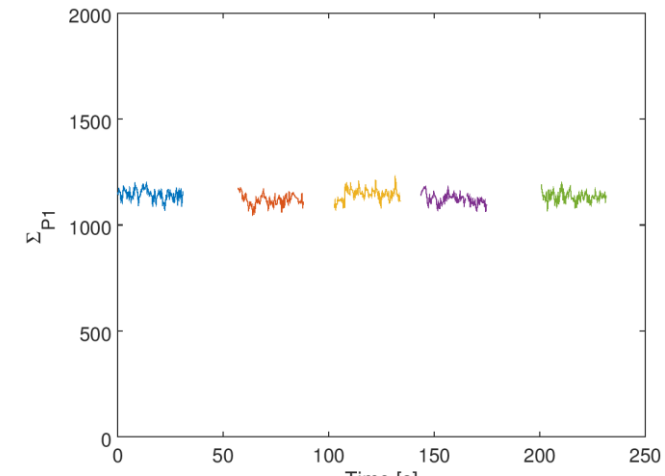
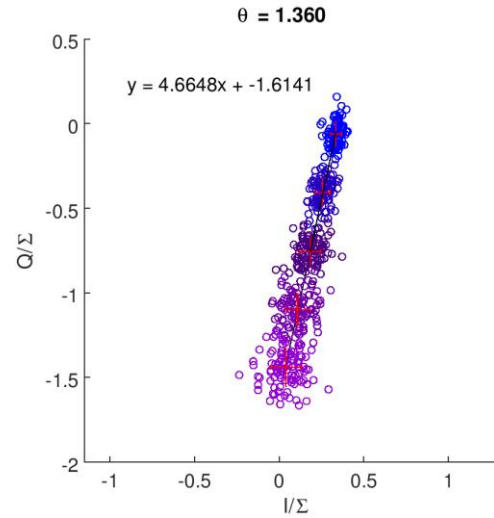
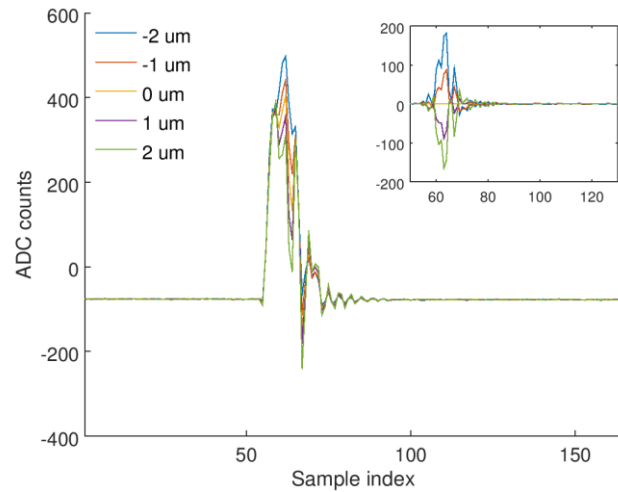
Sample index = 63

Charge normalization using Σ_{P1}



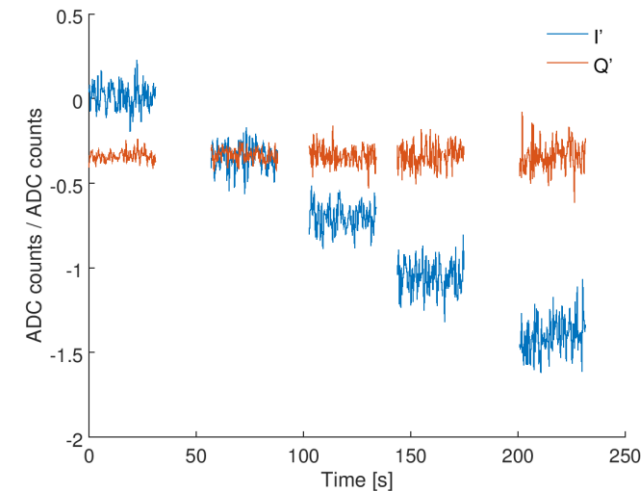
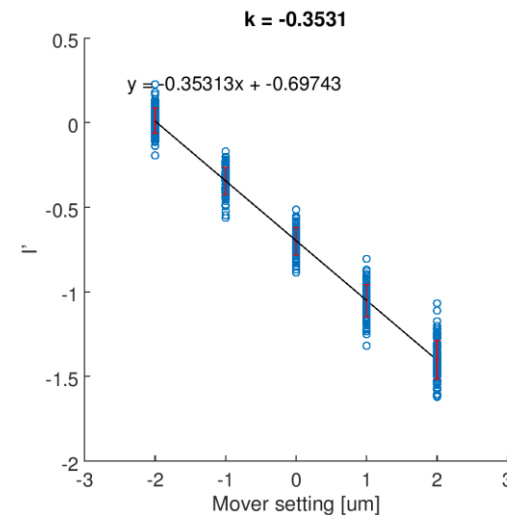
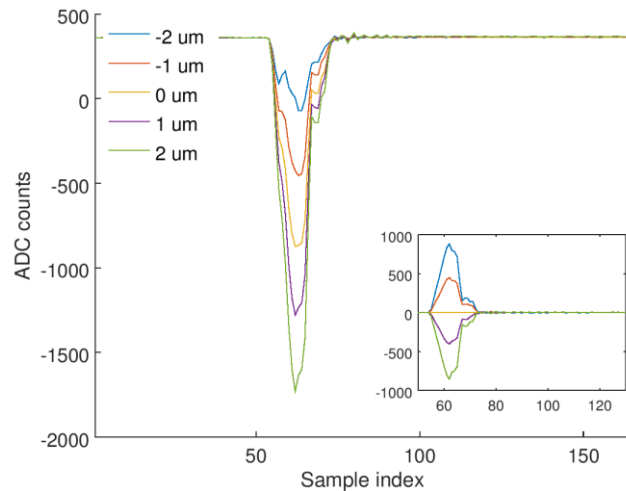
IPA

AQD0FFyScan30 (70 dB, mid charge)



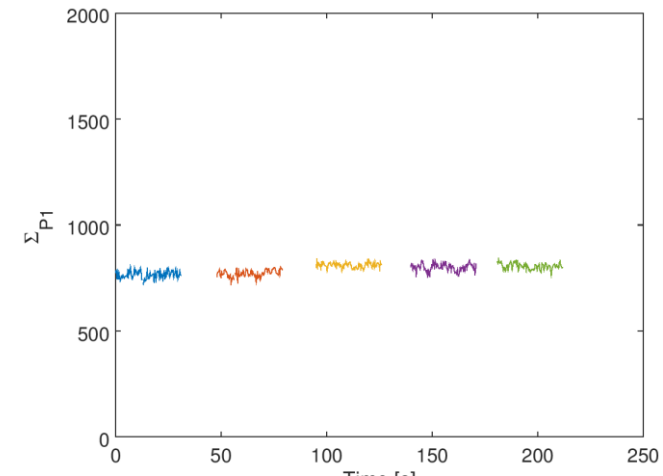
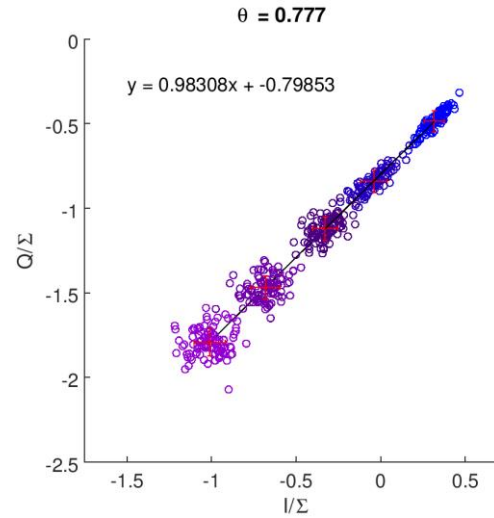
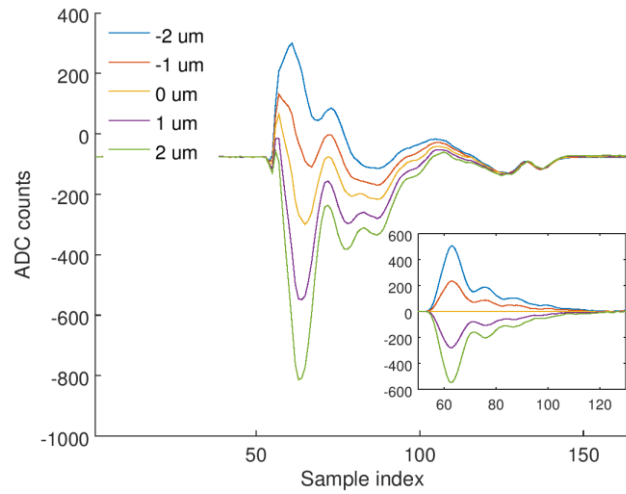
Sample index = 63

Charge normalization using Σ_{P1}



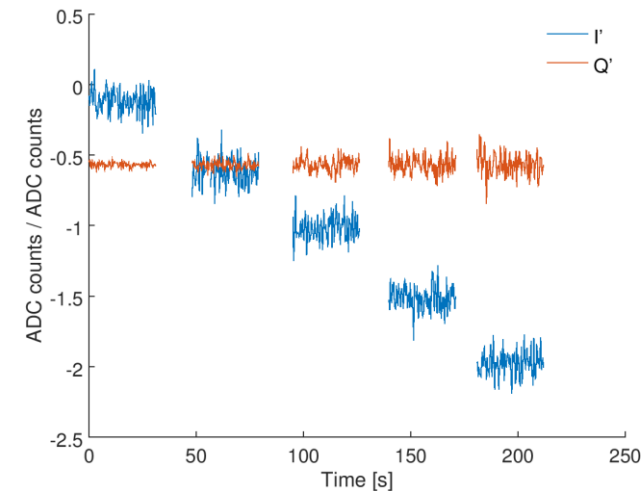
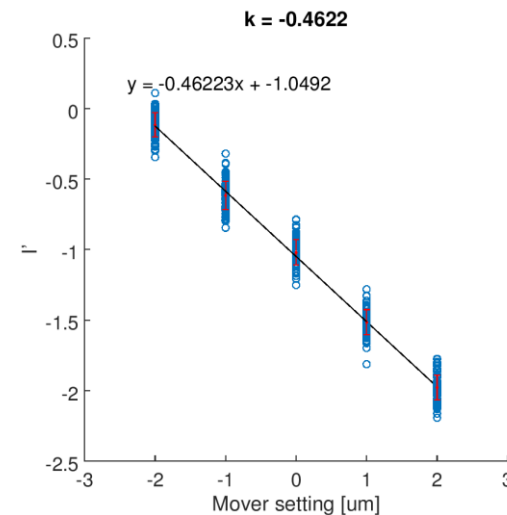
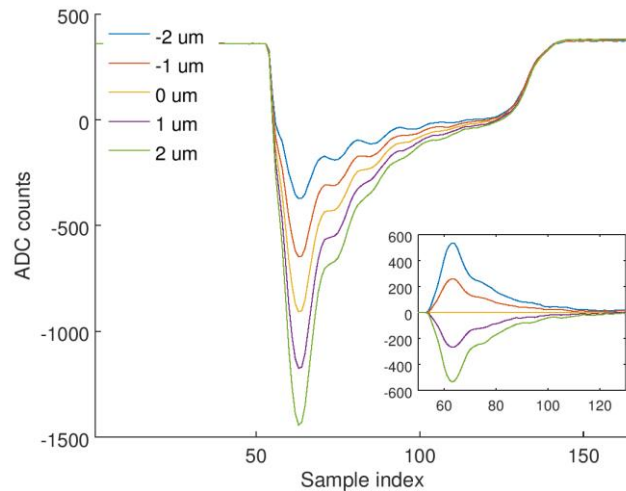
IPA

AQD0FFyScan31 (10 dB, low charge)



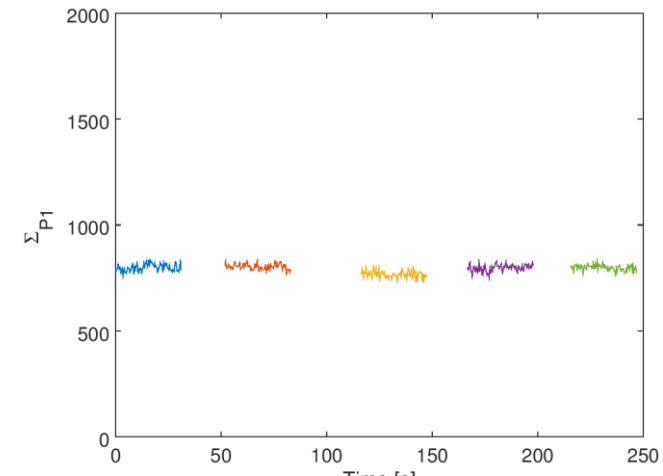
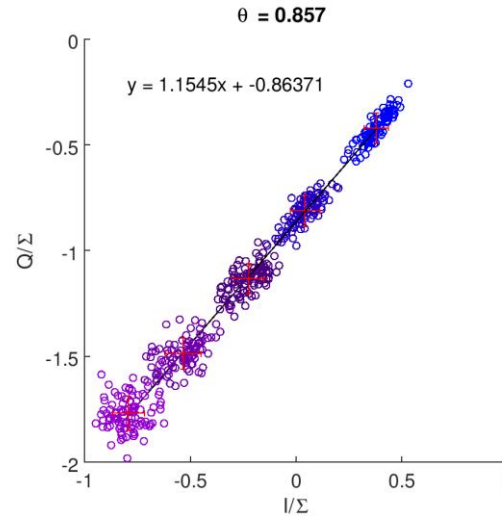
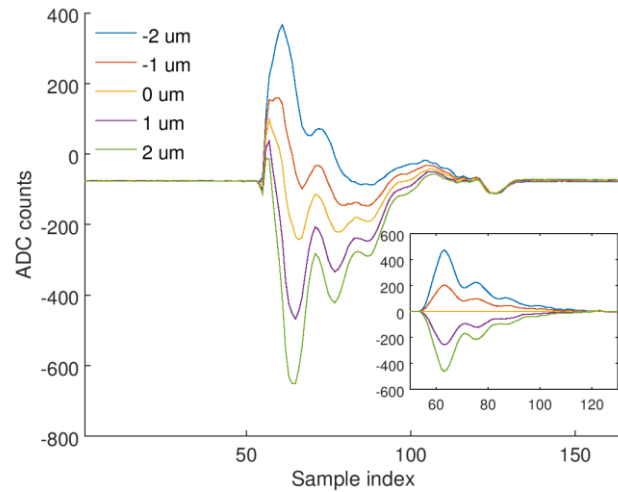
Sample index = 63

Charge normalization using Σ_{P1}



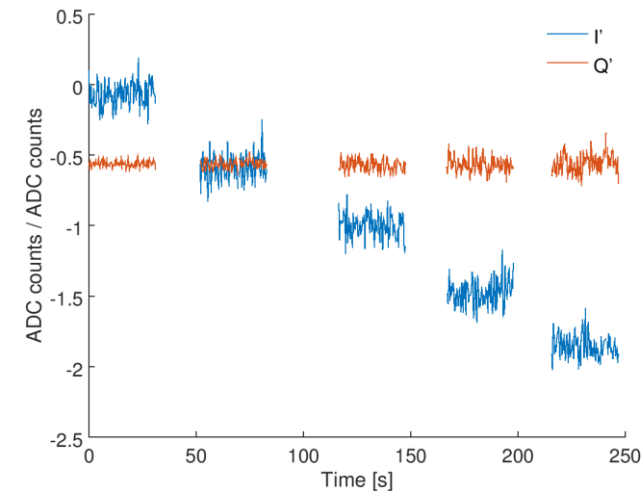
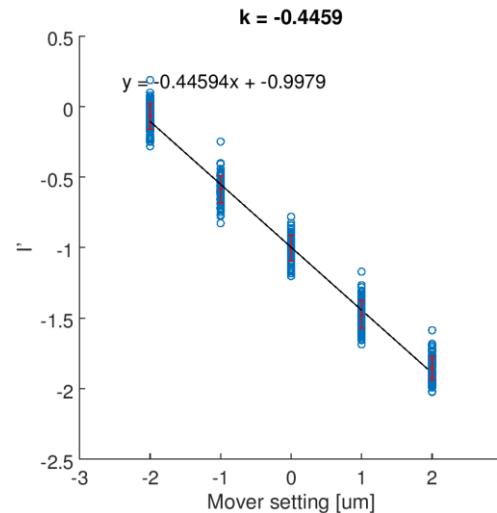
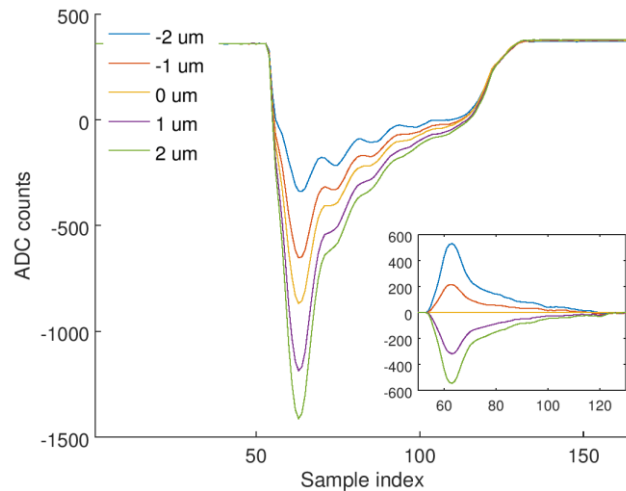
IPA

AQD0FFyScan32 (20 dB, low charge)



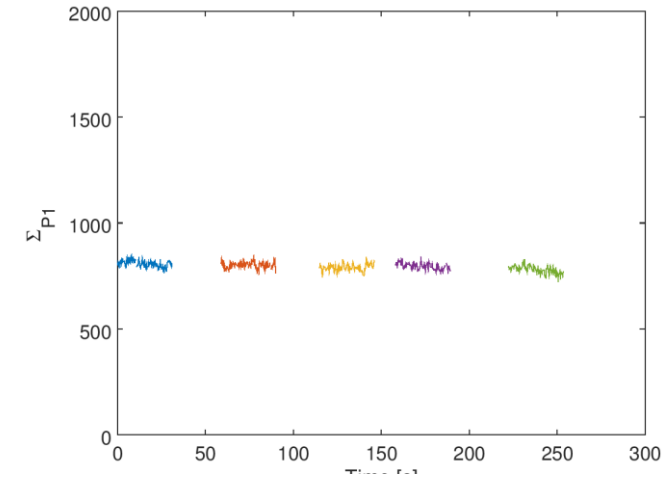
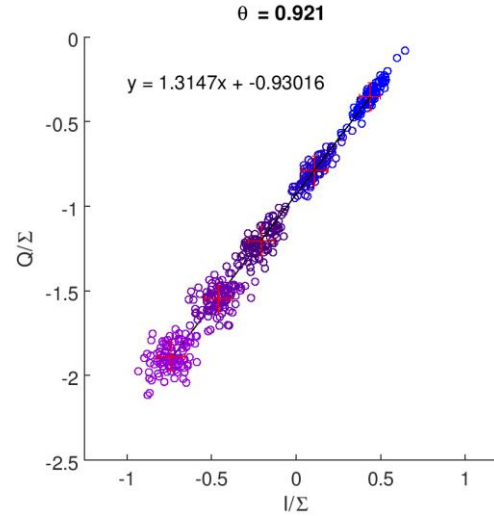
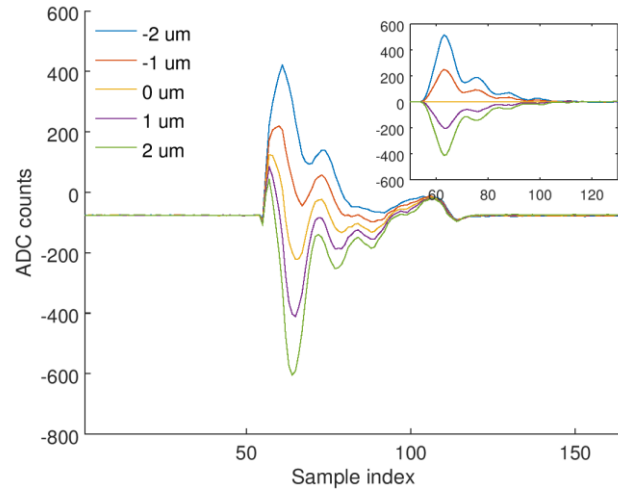
Sample index = 63

Charge normalization using Σ_{P1}



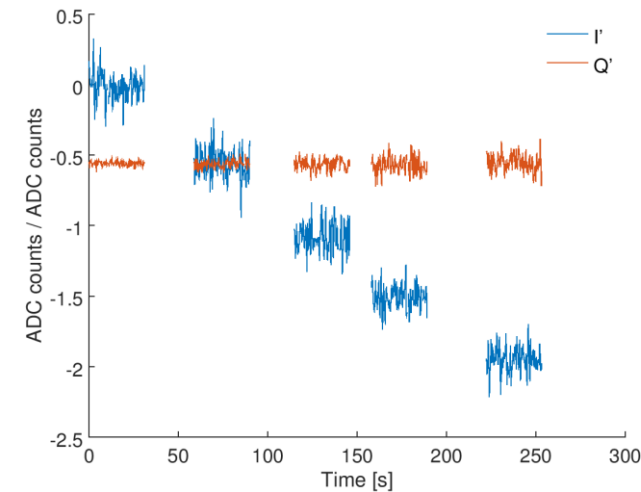
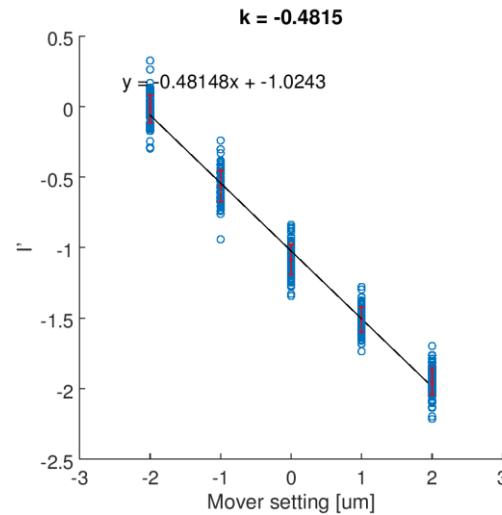
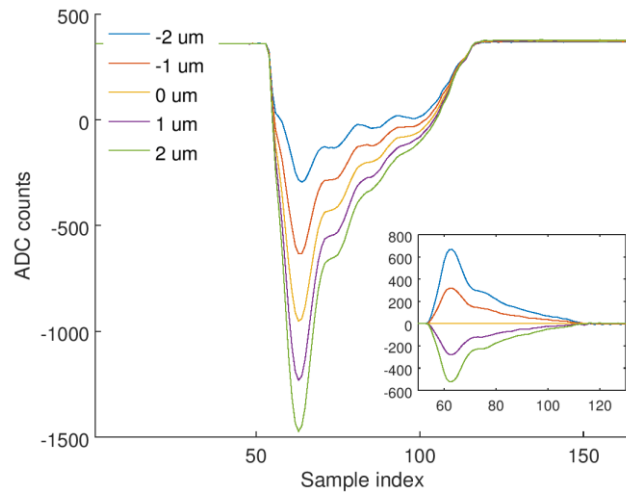
IPA

AQD0FFyScan33 (30 dB, low charge)



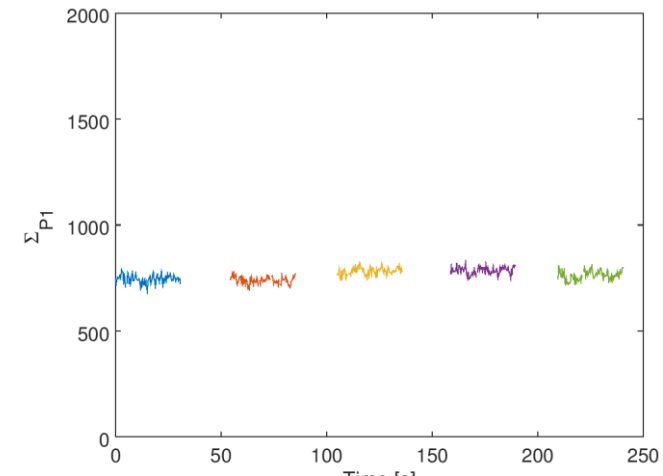
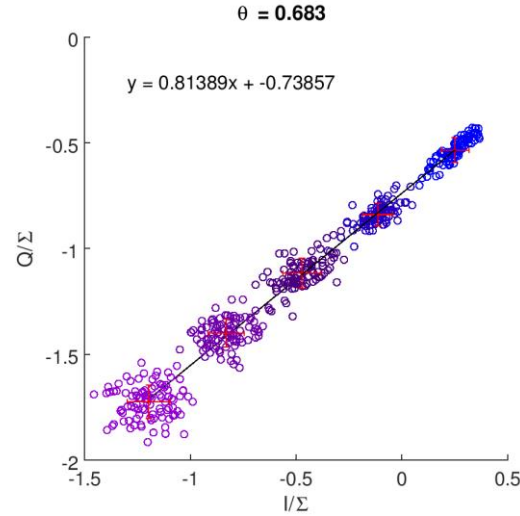
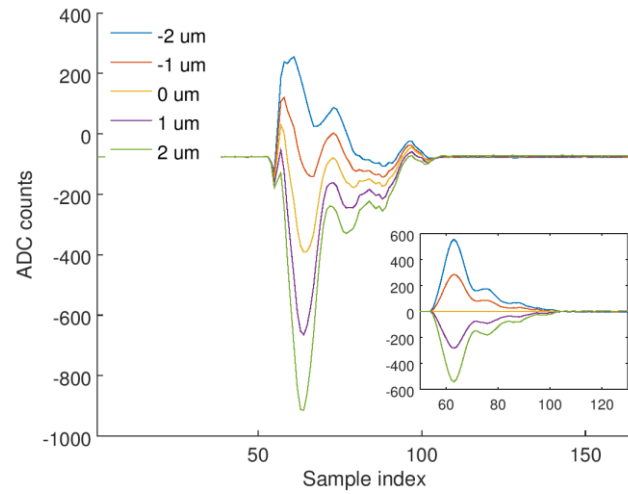
Sample index = 63

Charge normalization using Σ_{P1}



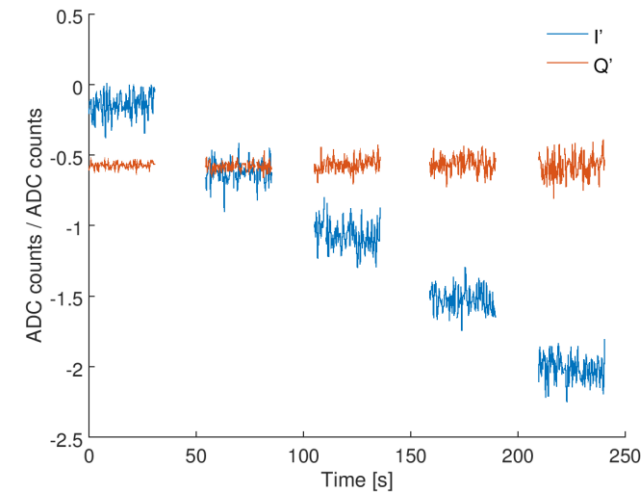
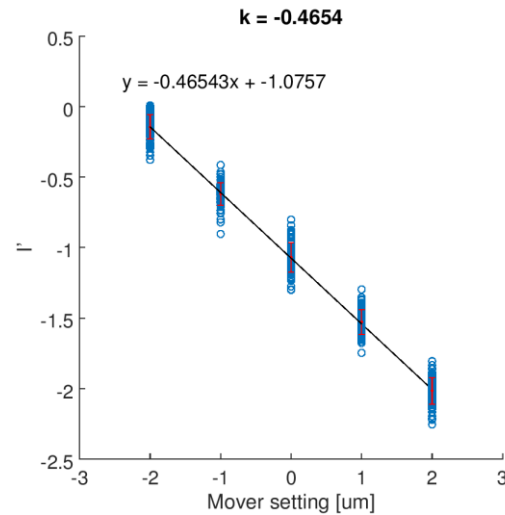
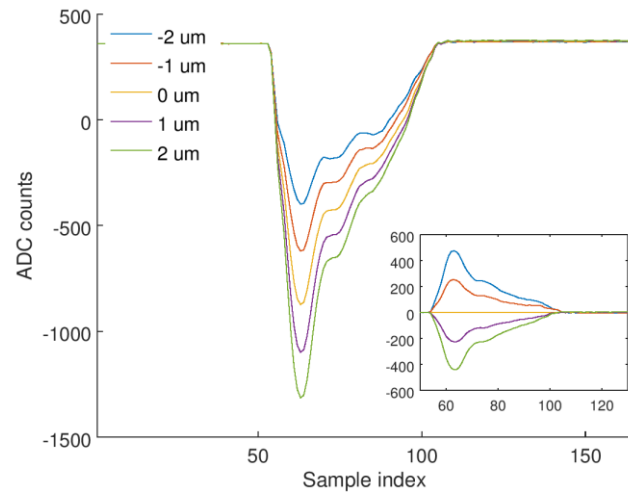
IPA

AQD0FFyScan34 (40 dB, low charge)



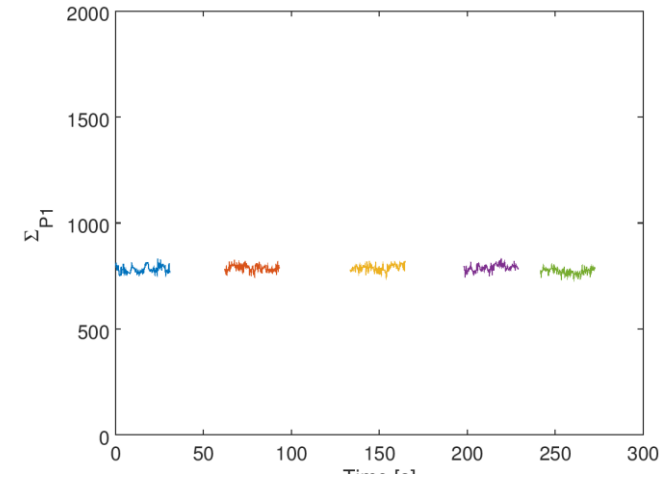
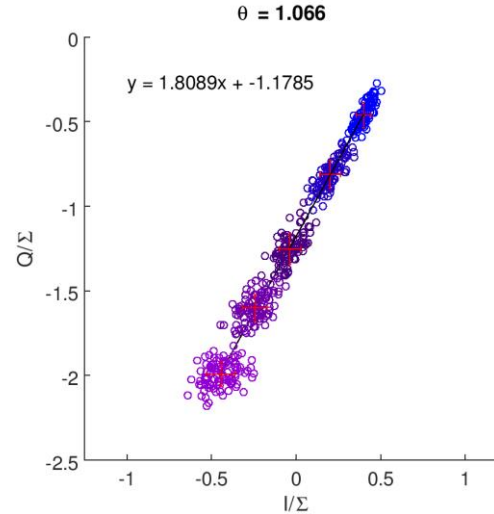
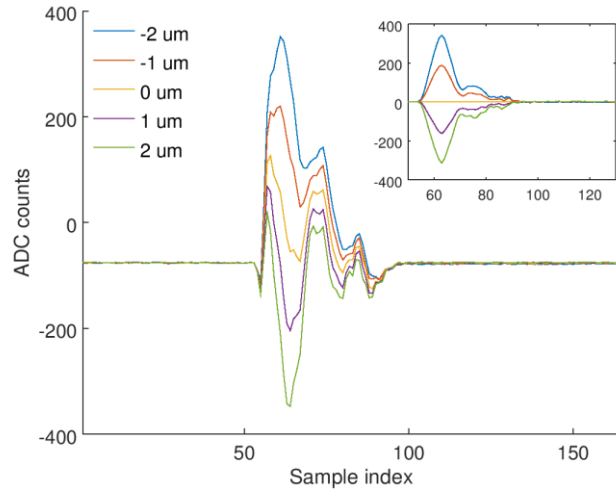
Sample index = 63

Charge normalization using Σ_{P1}



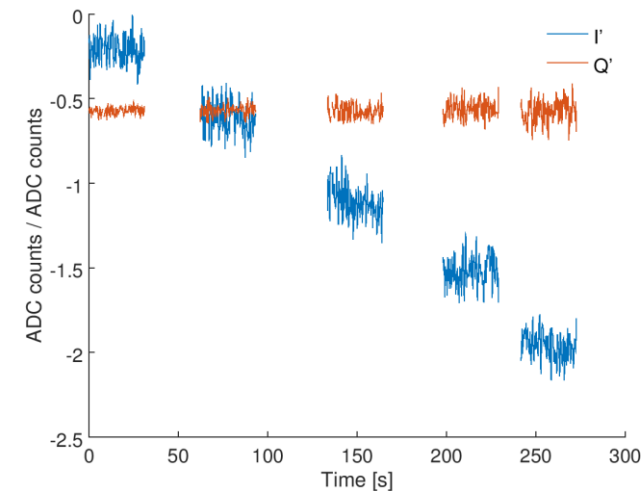
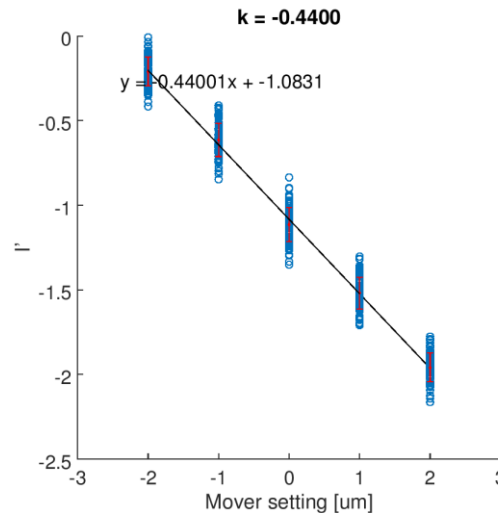
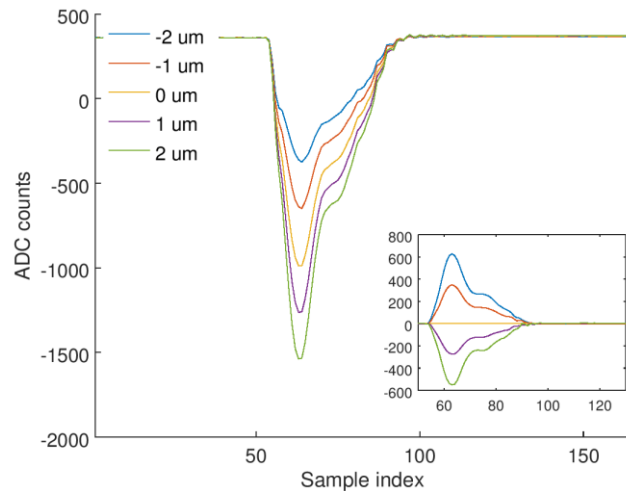
IPA

AQD0FFyScan35 (50 dB, low charge)



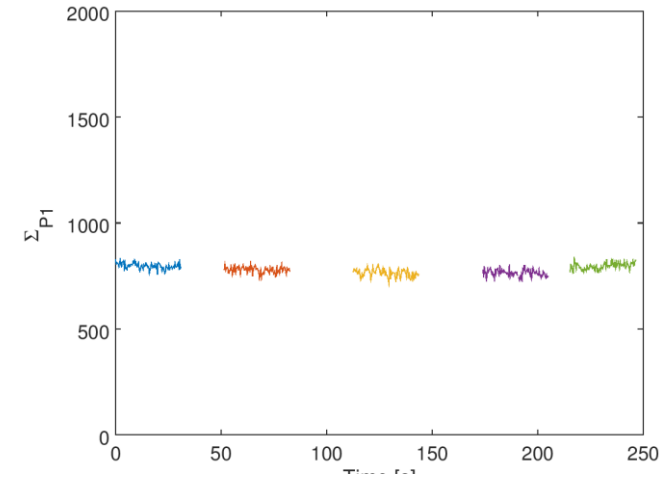
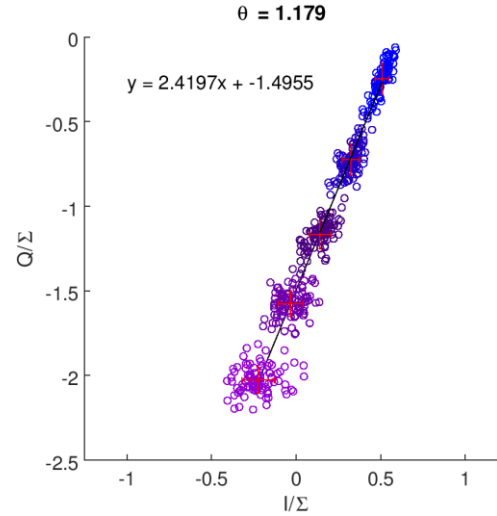
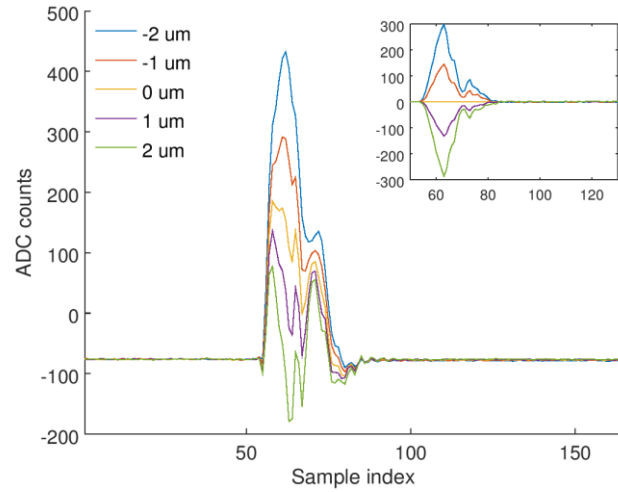
Sample index = 63

Charge normalization using Σ_{P1}



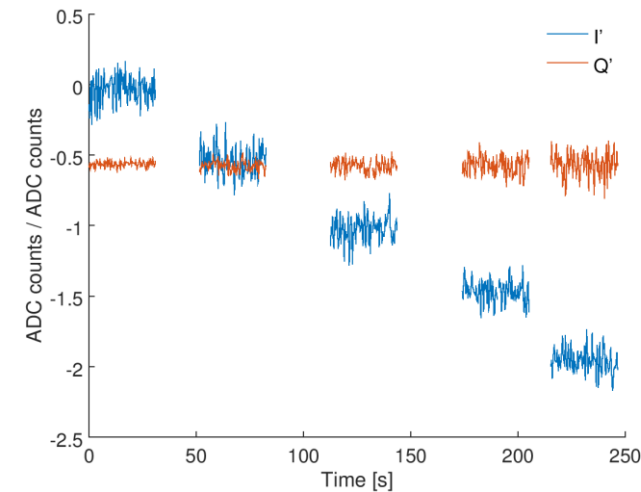
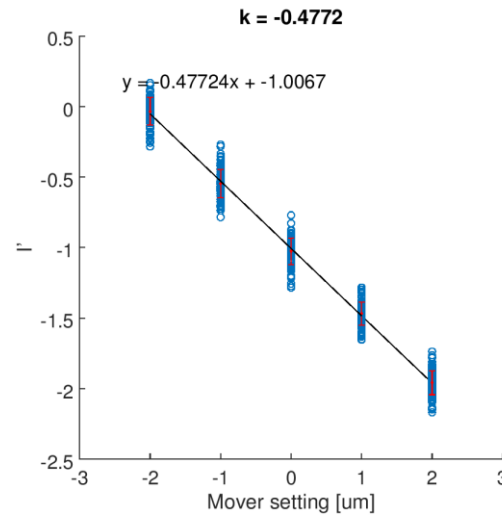
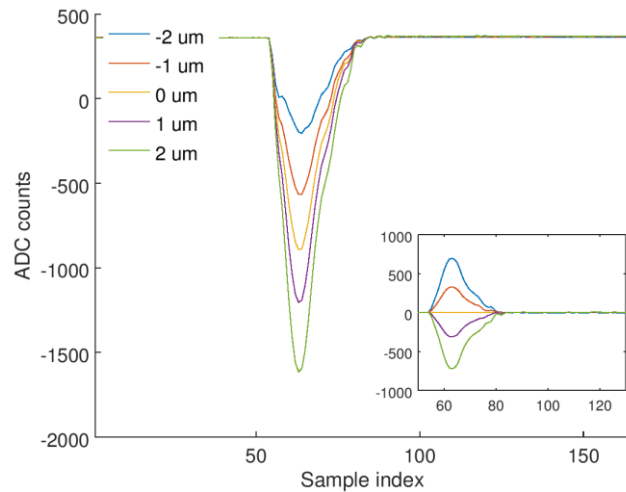
IPA

AQD0FFyScan35 (60 dB, low charge)



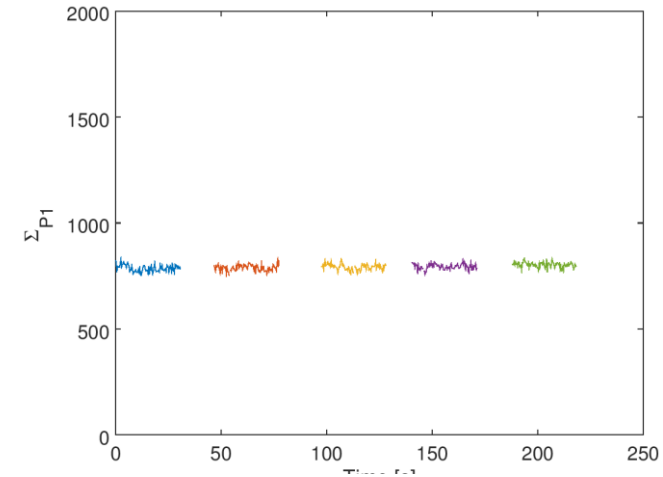
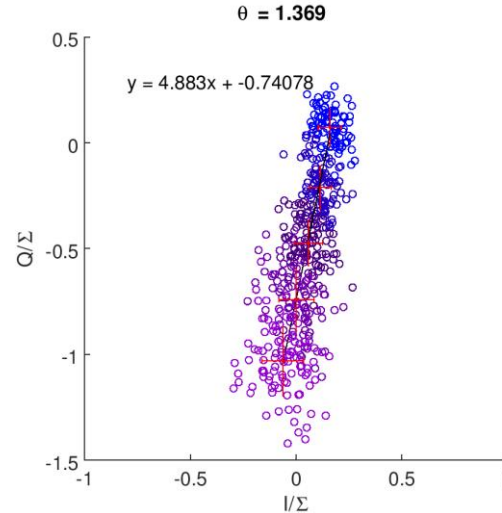
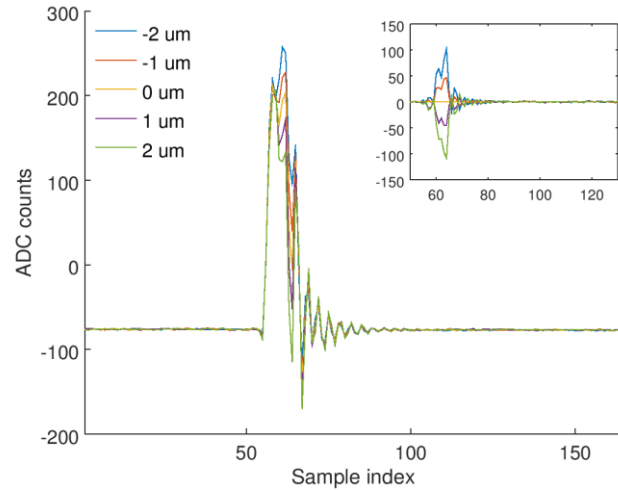
Sample index = 63

Charge normalization using Σ_{P1}



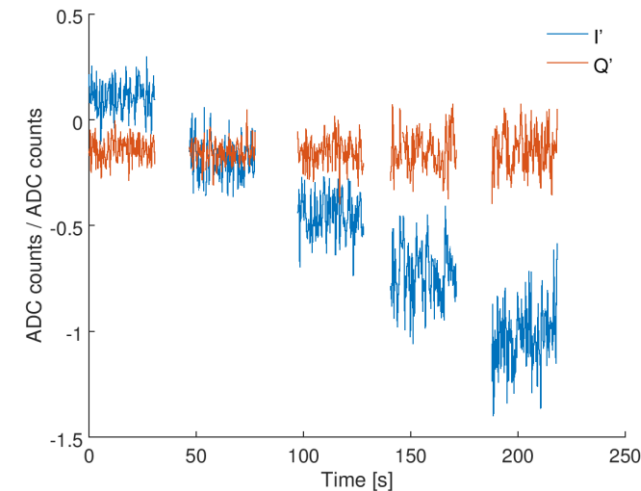
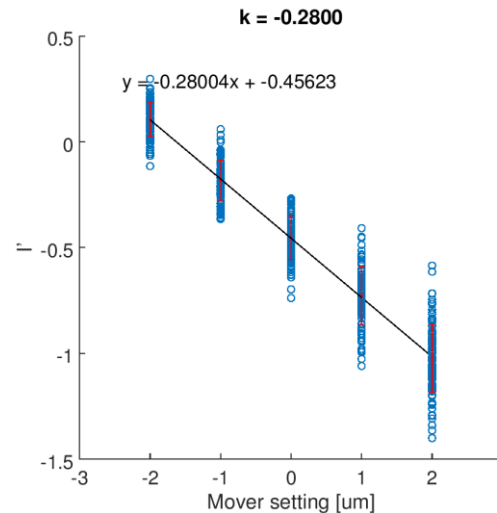
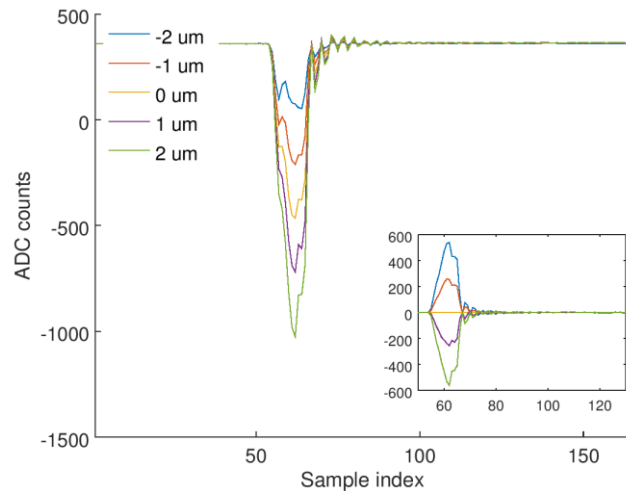
IPA

AQD0FFyScan37 (70 dB, low charge)



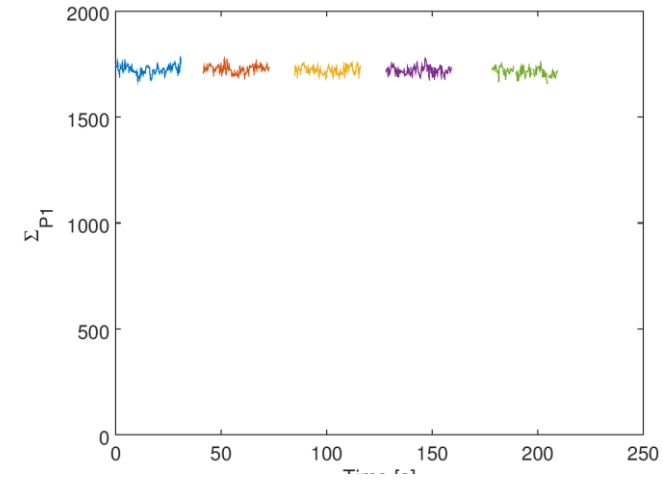
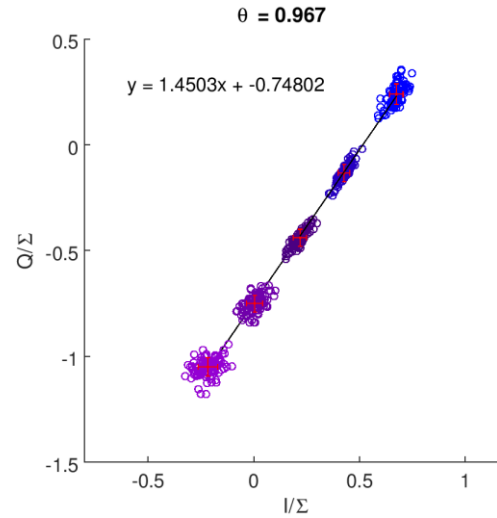
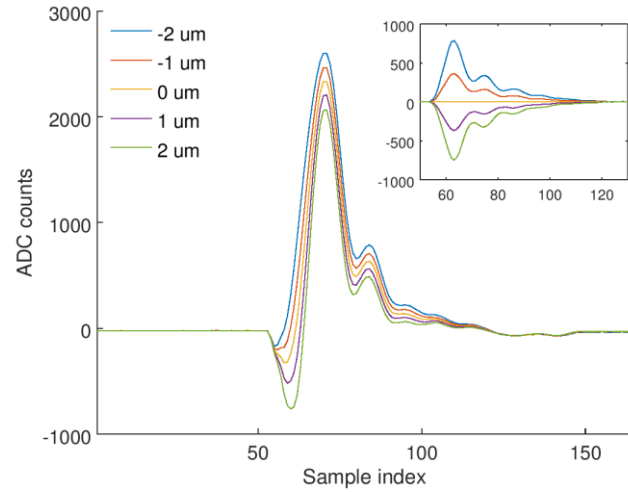
Sample index = 63

Charge normalization using Σ_{P1}



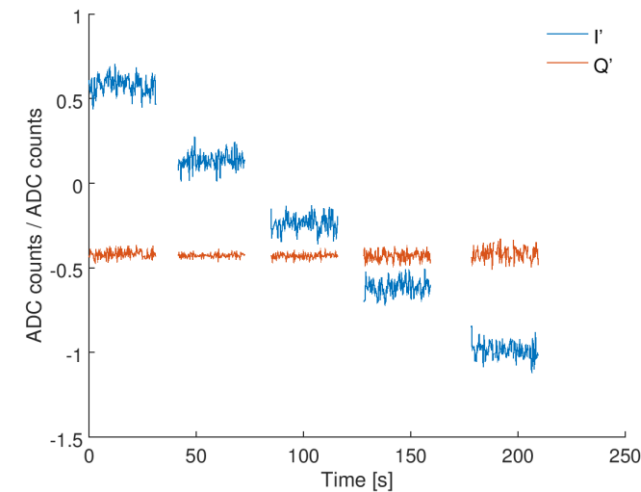
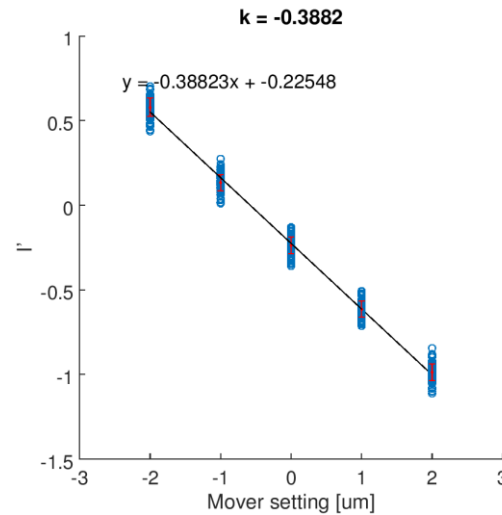
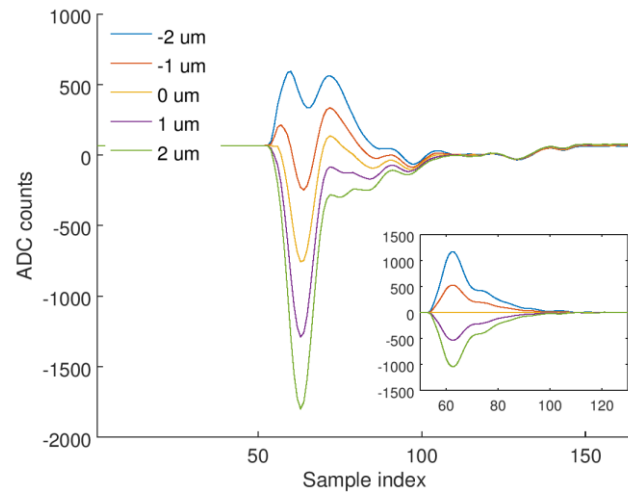
IPA

AQD0FFyScan22 (10 dB, high charge)



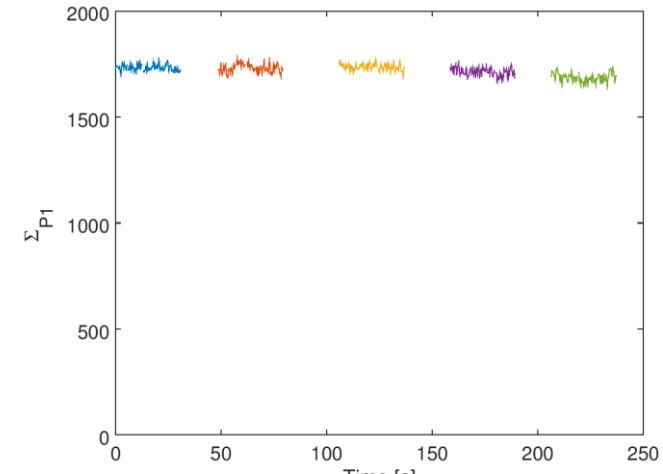
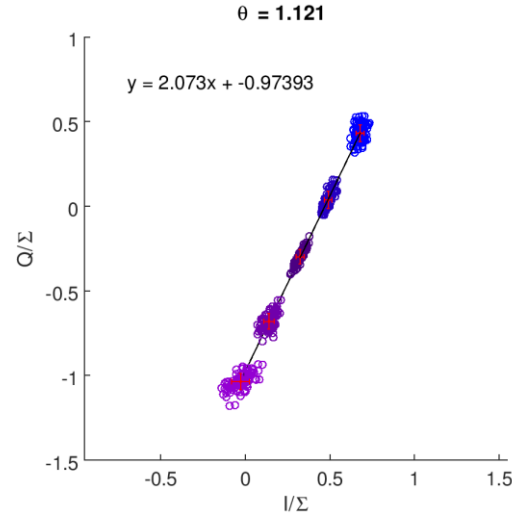
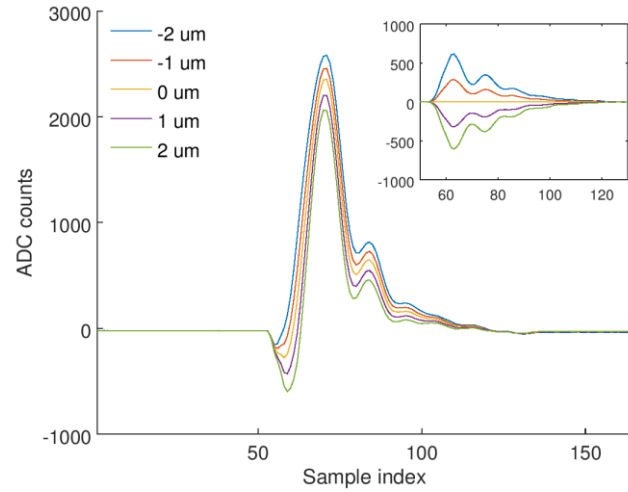
Sample index = 63

Charge normalization using Σ_{P1}



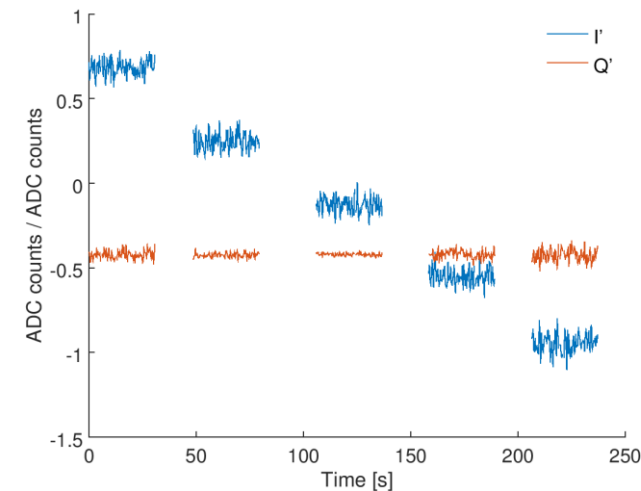
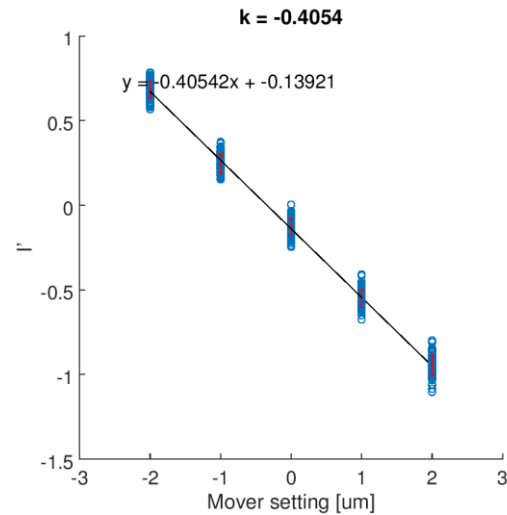
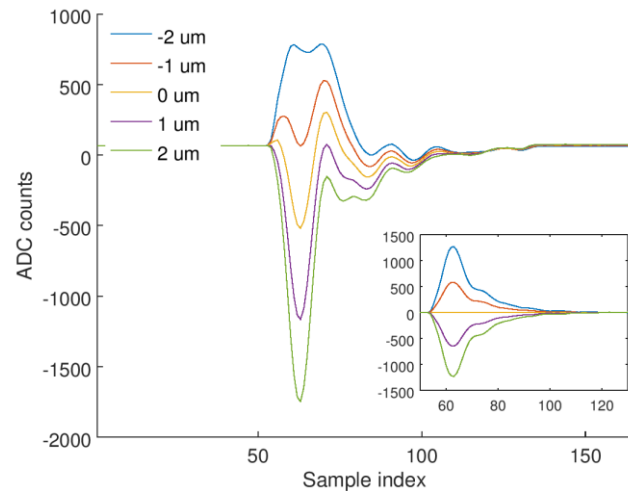
IPB

AQD0FFyScan21 (20 dB, high charge)



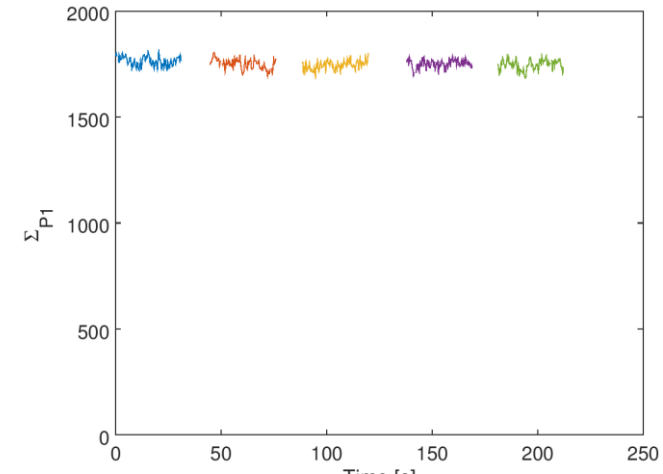
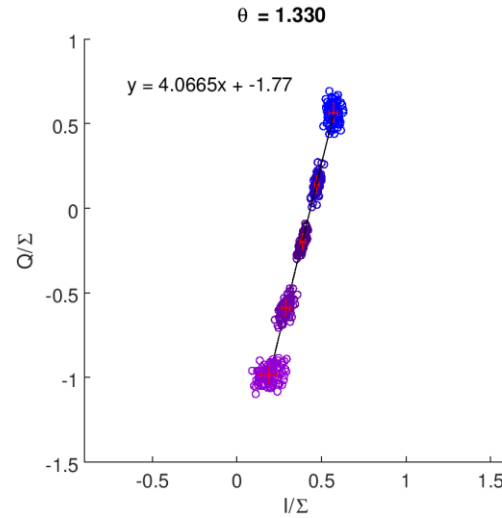
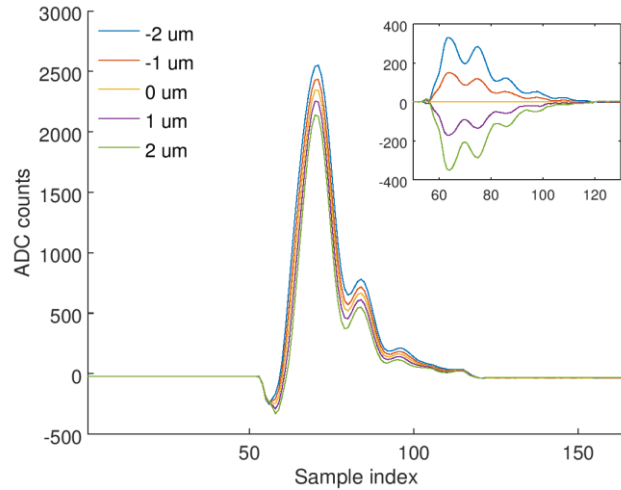
Sample index = 63

Charge normalization using Σ_{P1}



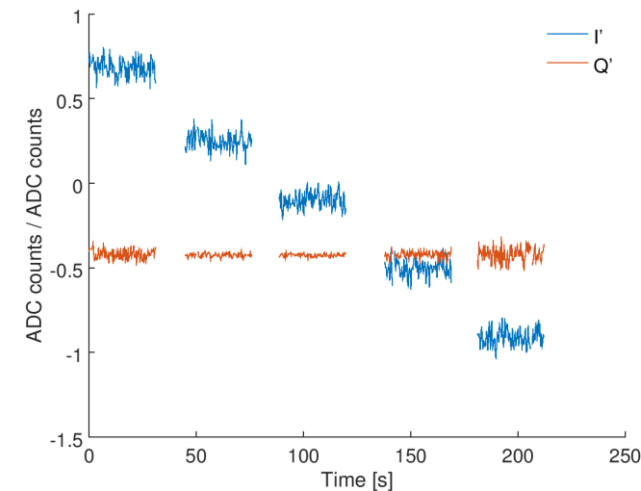
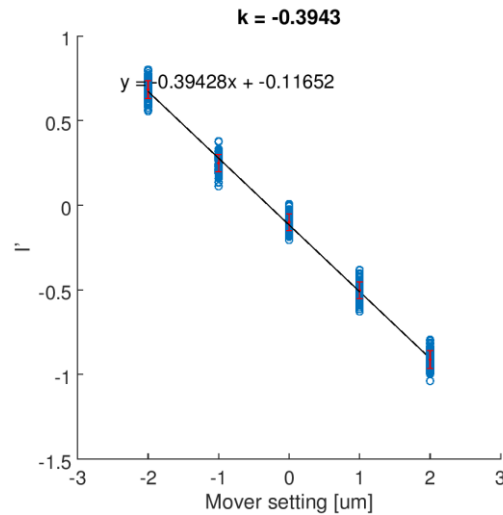
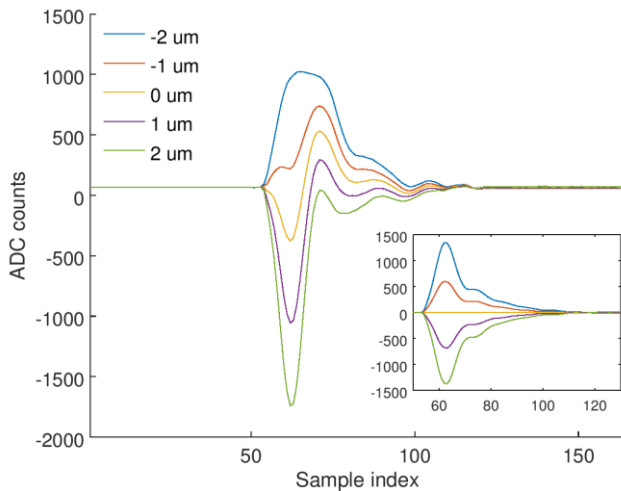
IPB

AQD0FFyScan19 (30 dB, high charge)



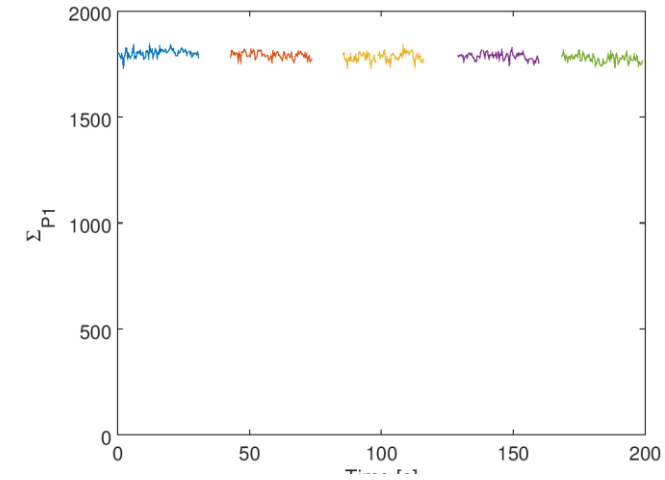
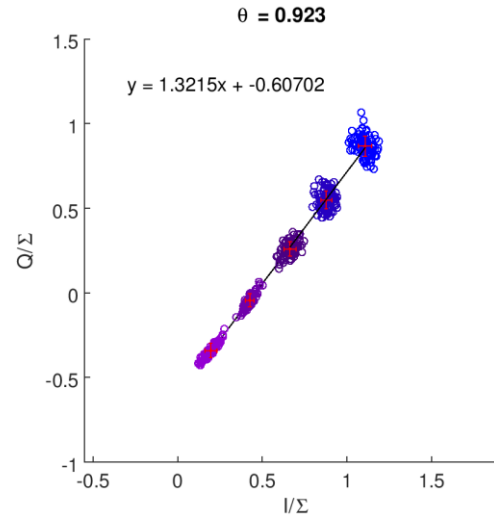
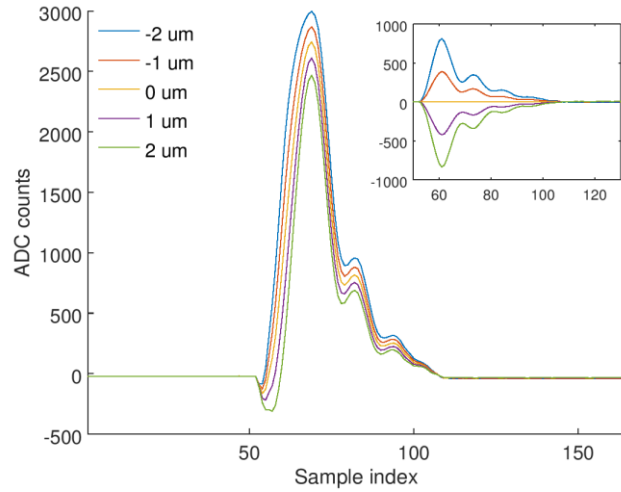
Sample index = 63

Charge normalization using Σ_{P1}



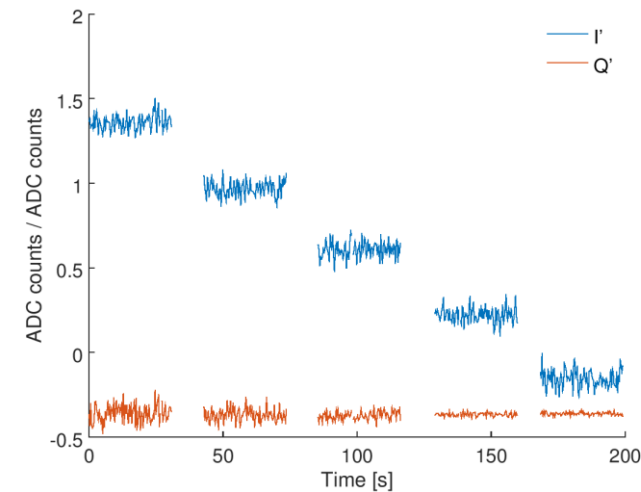
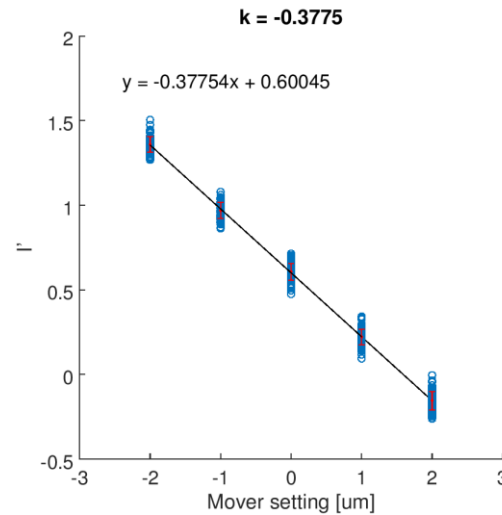
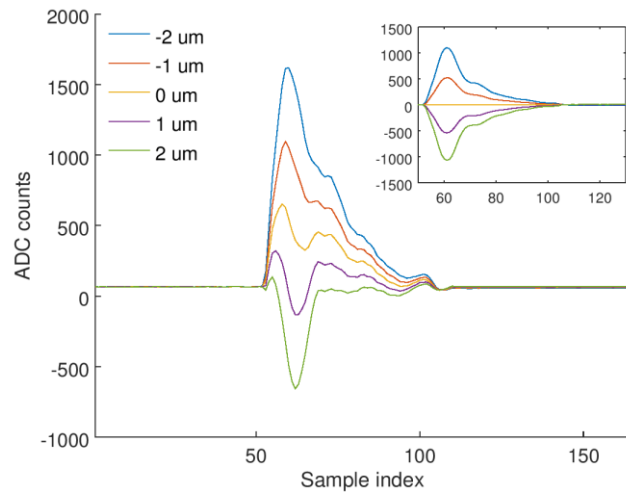
IPB

AQD0FFyScan15 (40 dB, high charge)



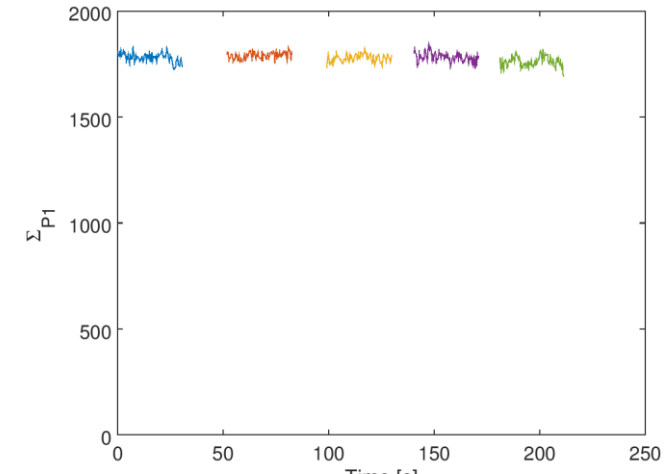
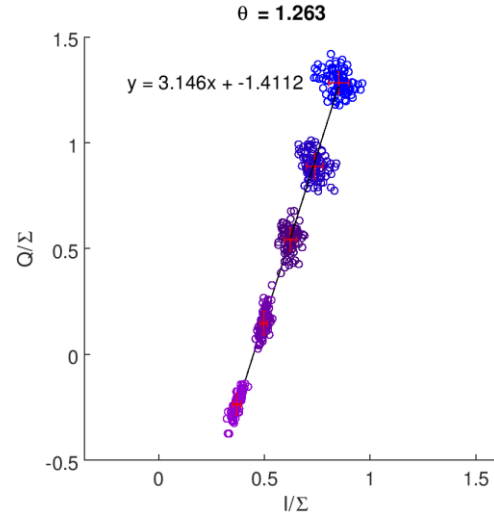
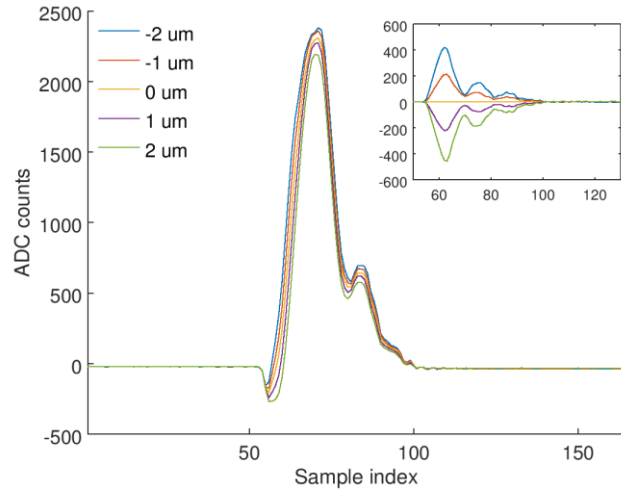
Sample index = 63

Charge normalization using Σ_{P1}



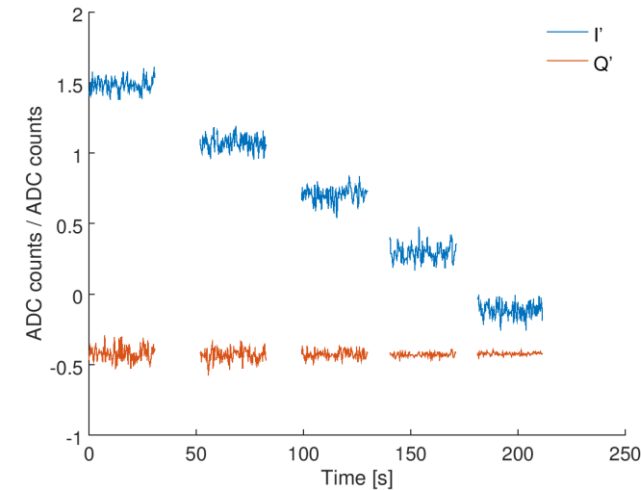
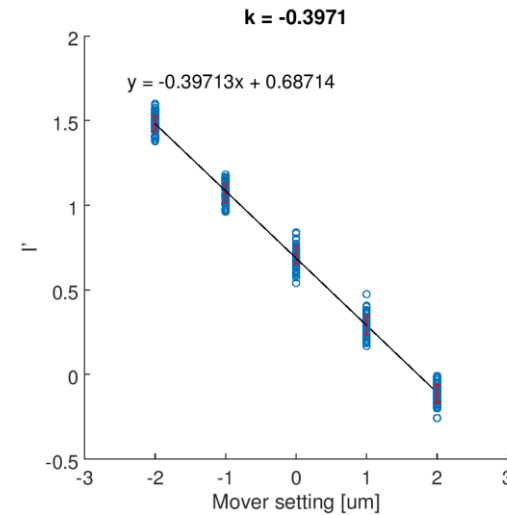
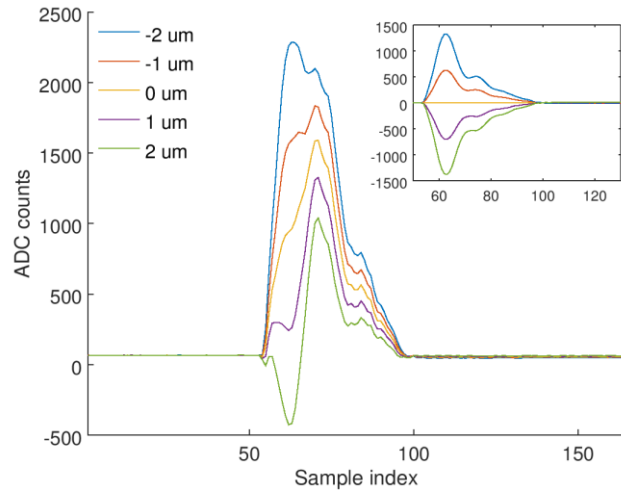
IPB

AQD0FFyScan16 (50 dB, high charge)



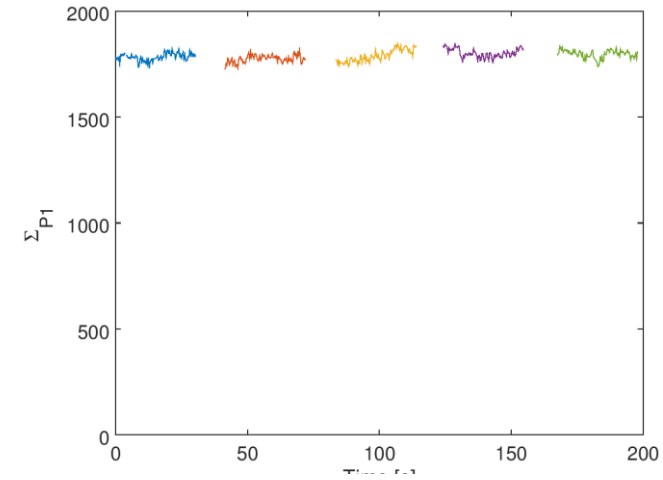
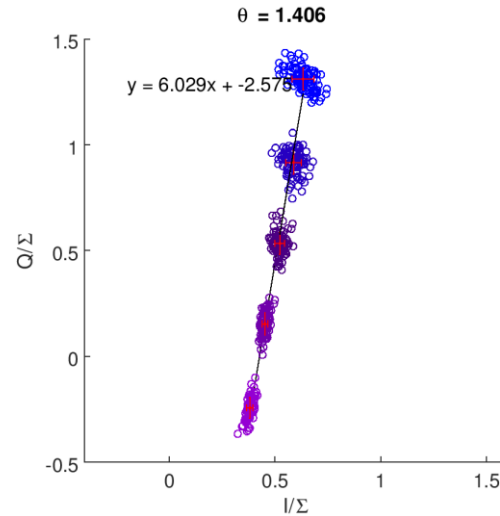
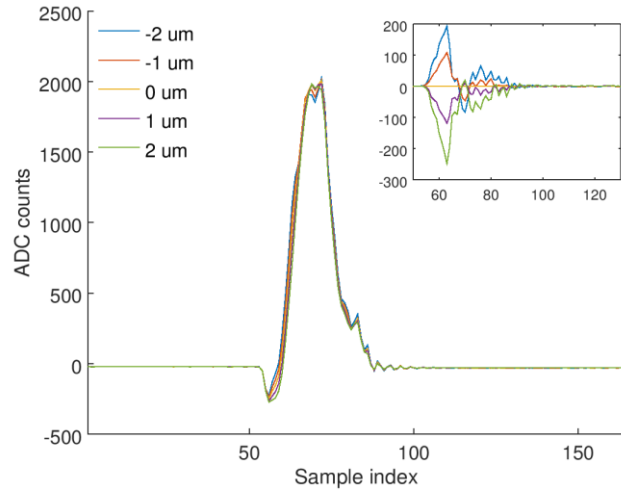
Sample index = 63

Charge normalization using Σ_{P1}



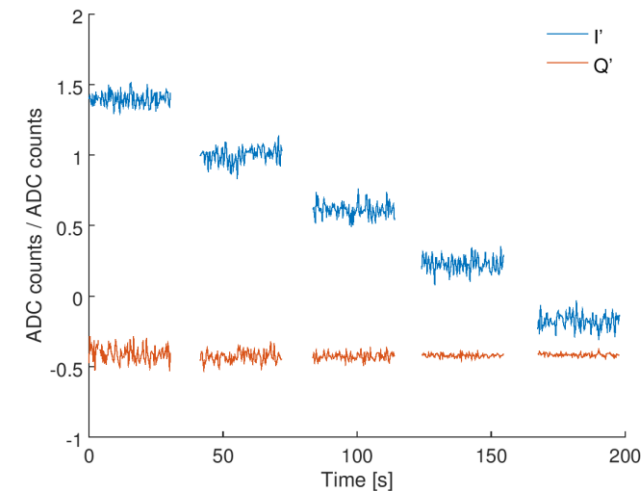
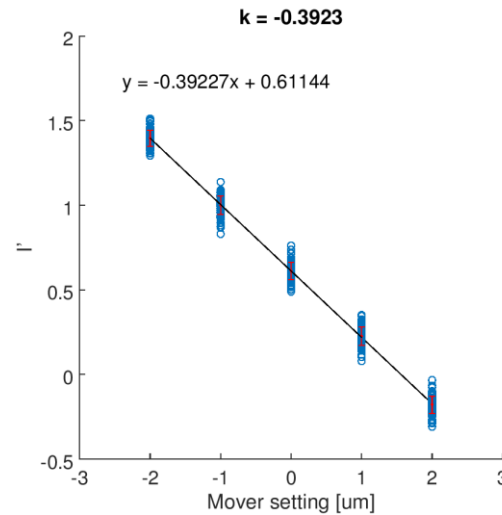
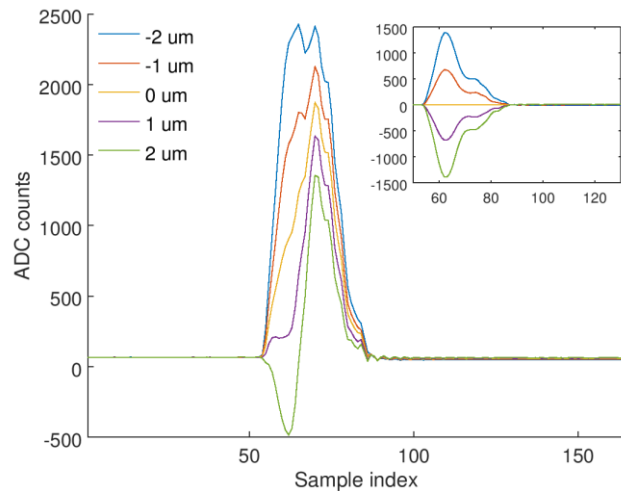
IPB

AQD0FFyScan17 (60 dB, high charge)



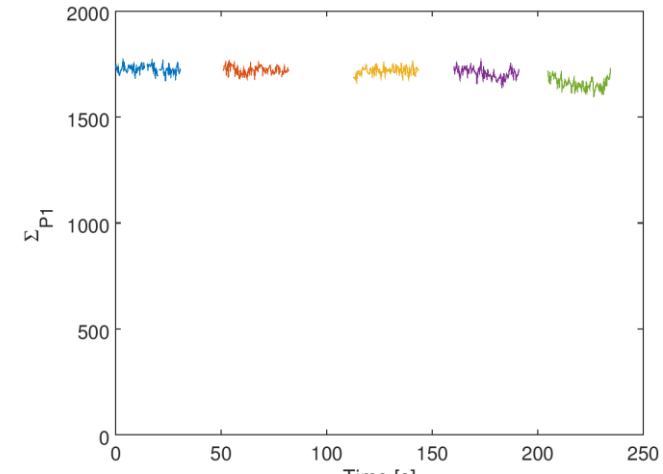
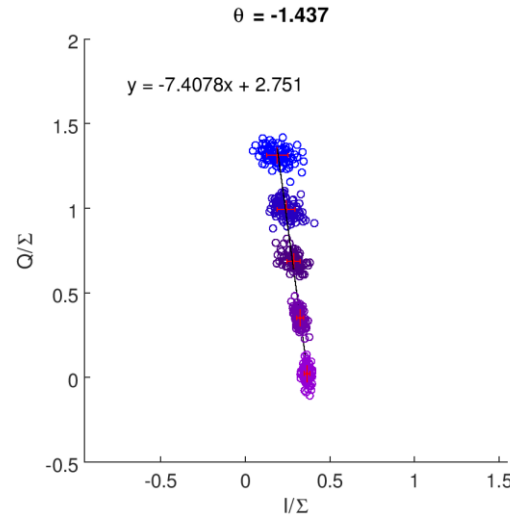
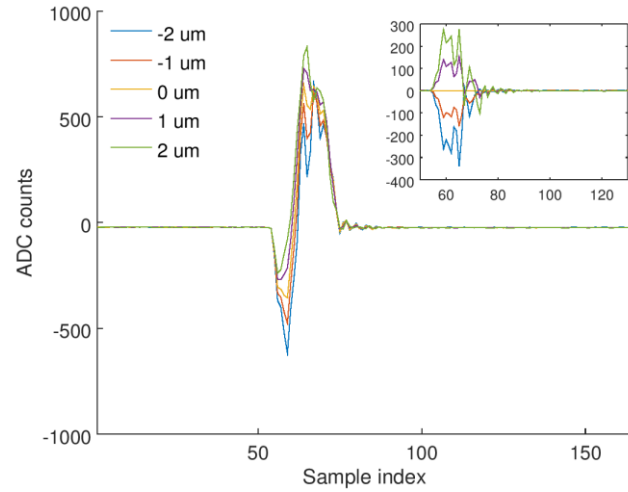
Sample index = 63

Charge normalization using Σ_{P1}



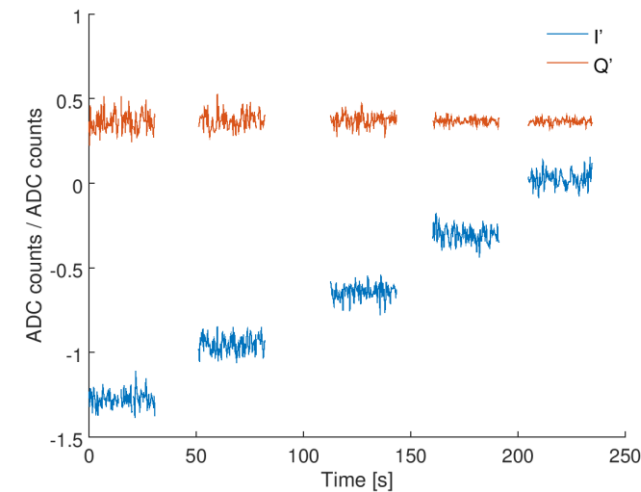
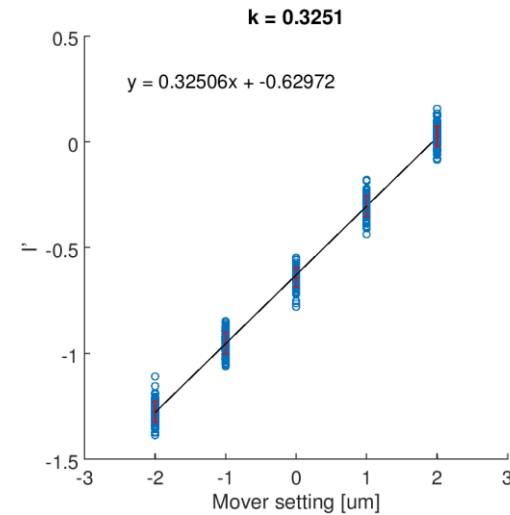
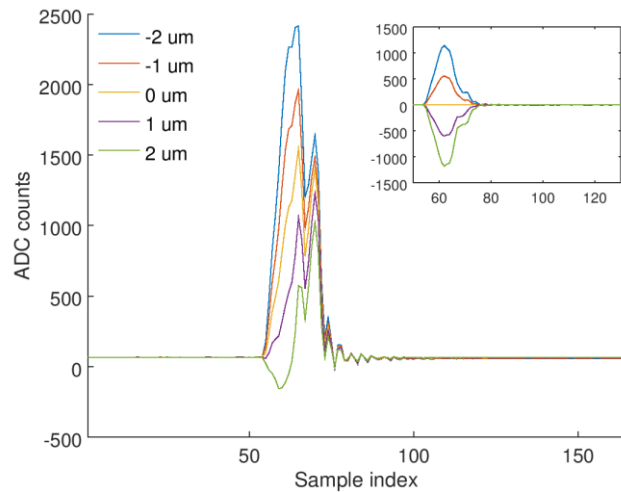
IPB

AQD0FFyScan18 (70 dB, high charge)



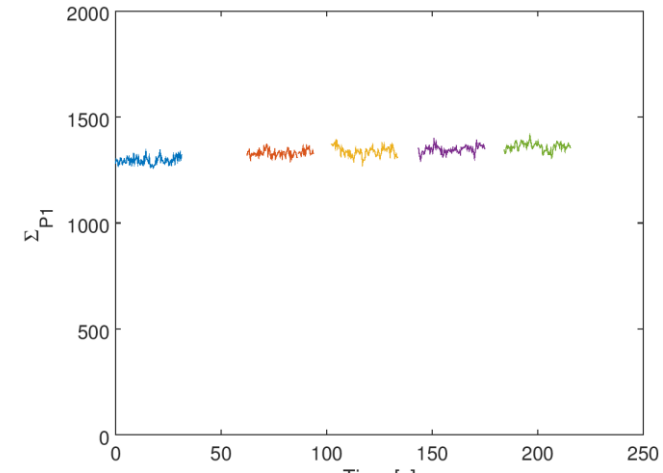
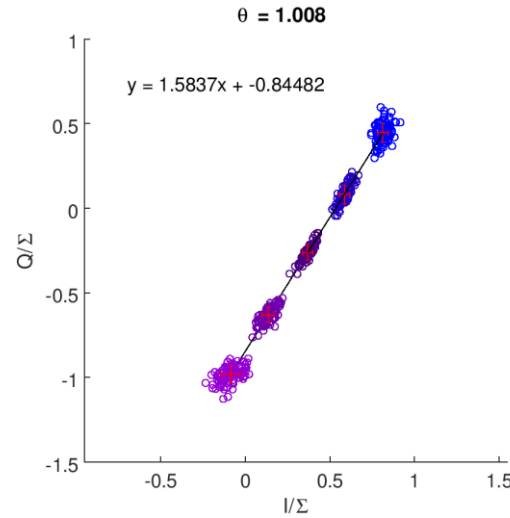
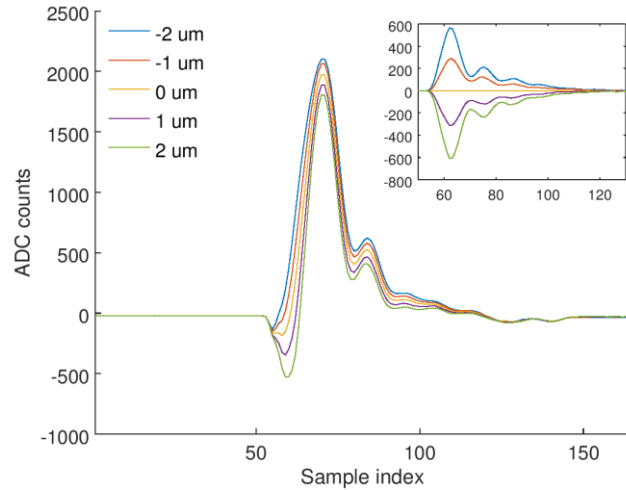
Sample index = 63

Charge normalization using Σ_{P1}



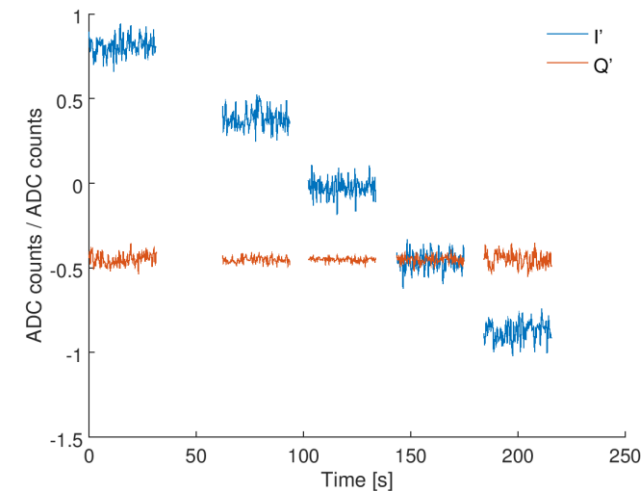
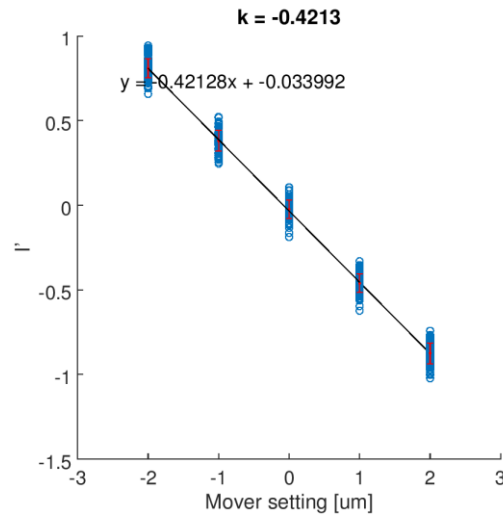
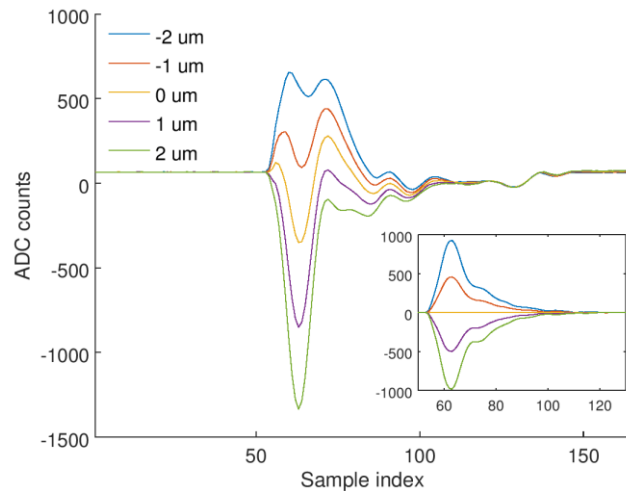
IPB

AQD0FFyScan23 (10 dB, mid charge)



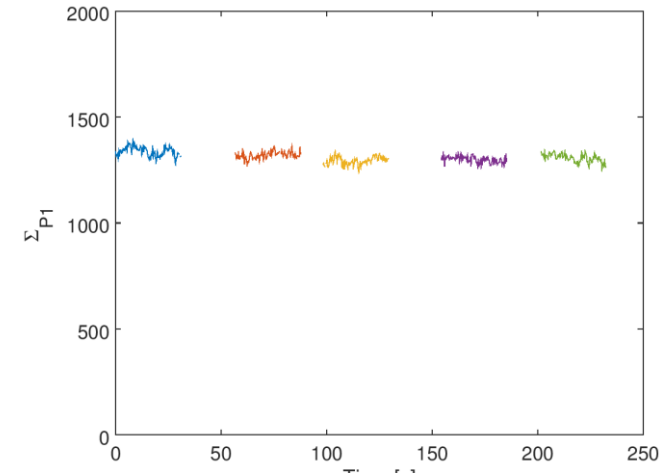
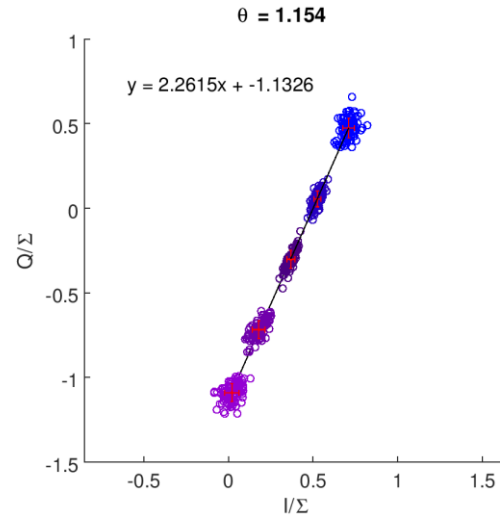
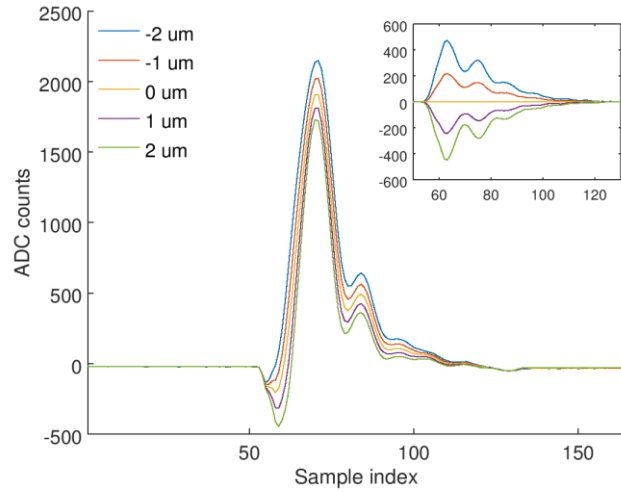
Sample index = 63

Charge normalization using Σ_{P1}



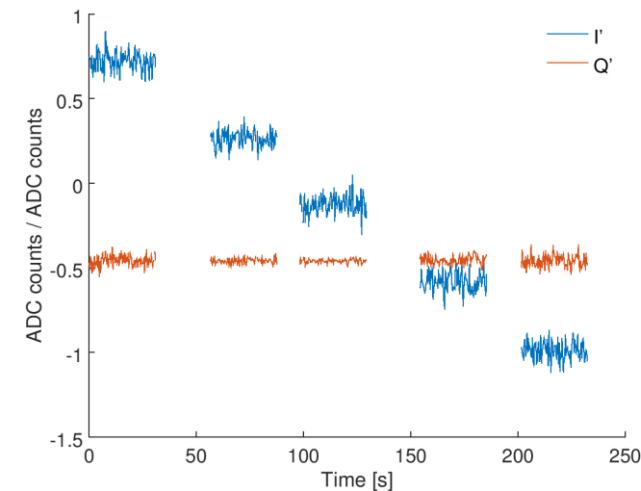
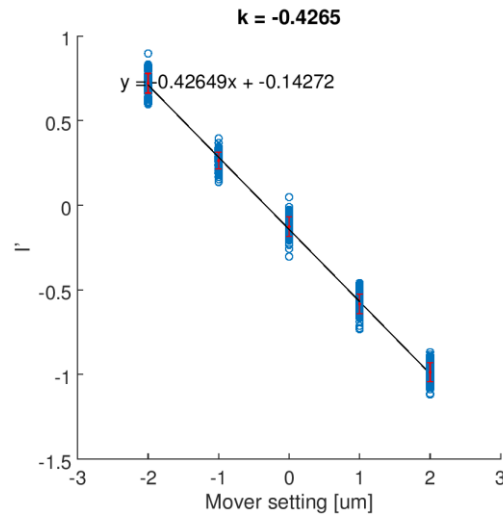
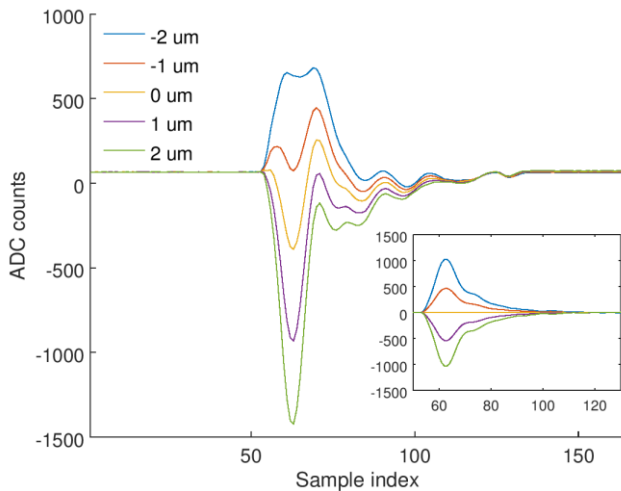
IPB

AQD0FFyScan24 (20 dB, mid charge)



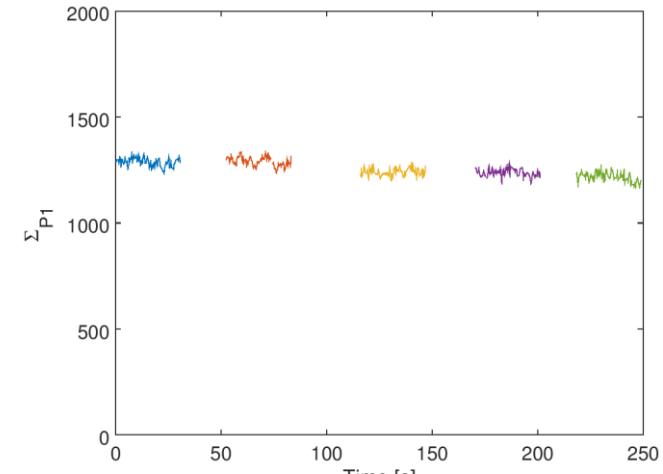
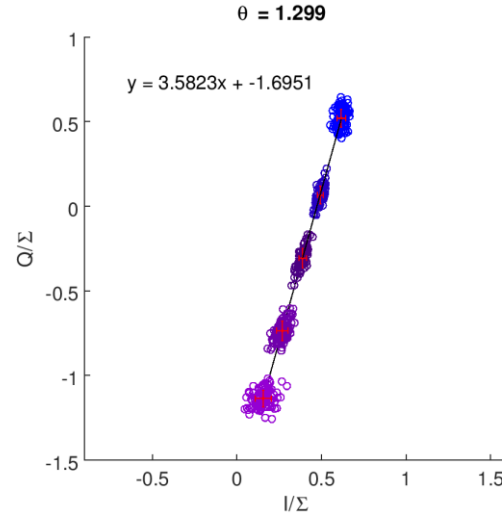
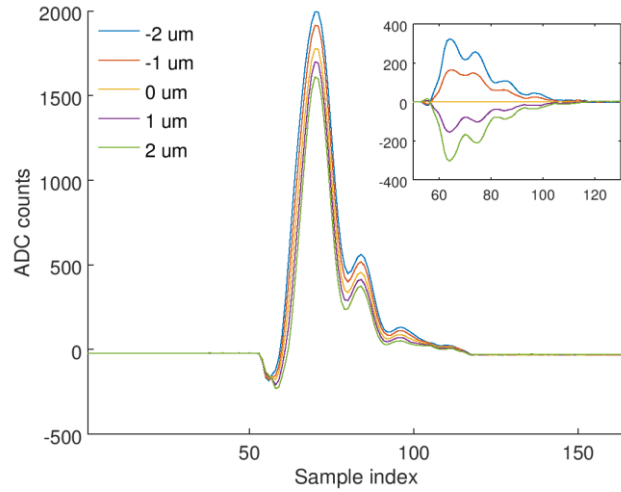
Sample index = 63

Charge normalization using Σ_{P1}



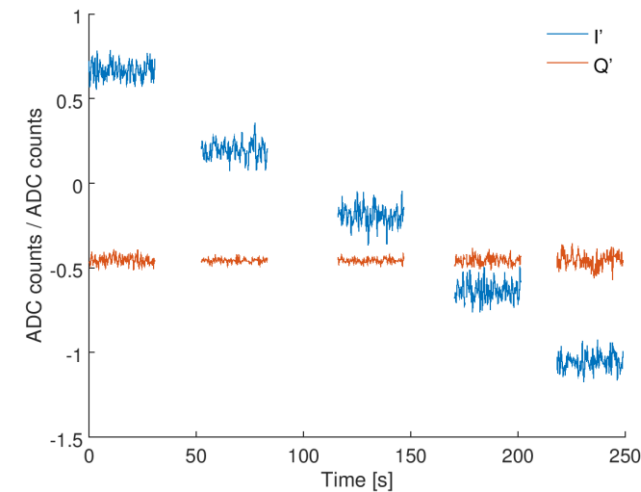
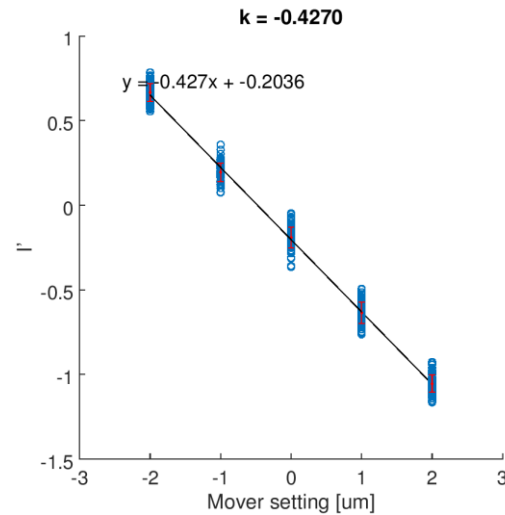
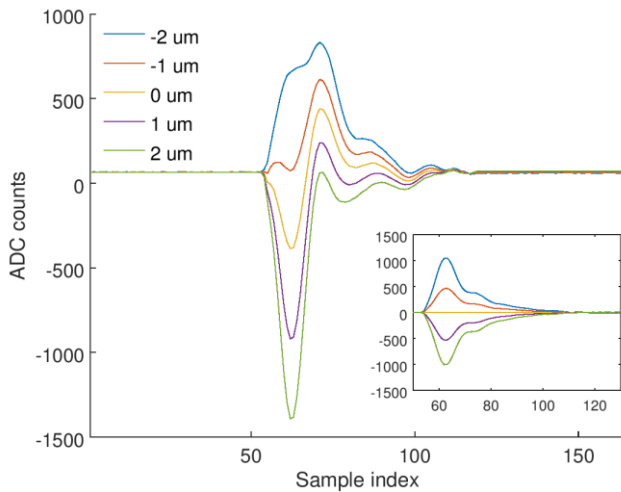
IPB

AQD0FFyScan25 (30 dB, mid charge)



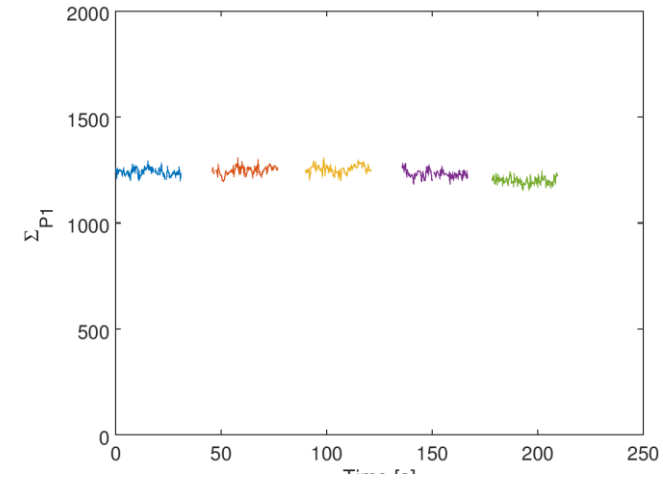
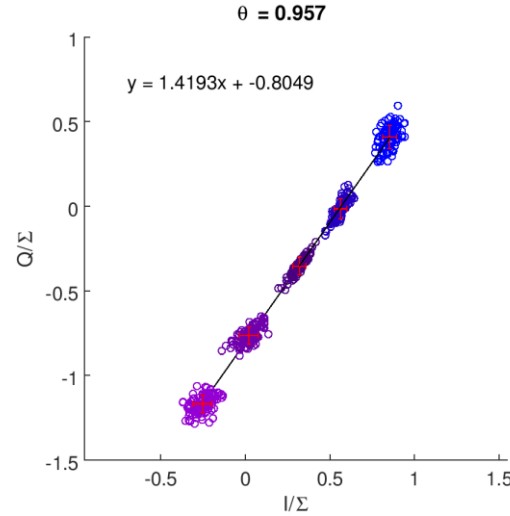
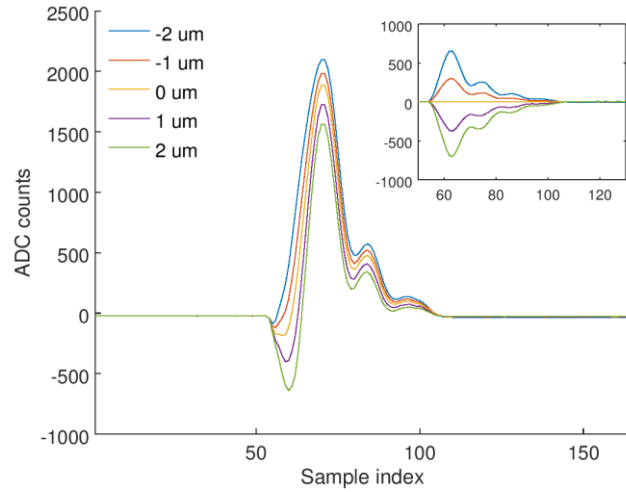
Sample index = 63

Charge normalization using Σ_{P1}



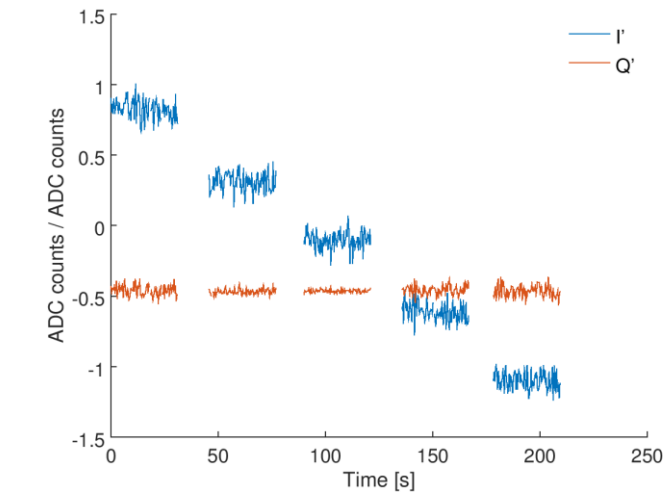
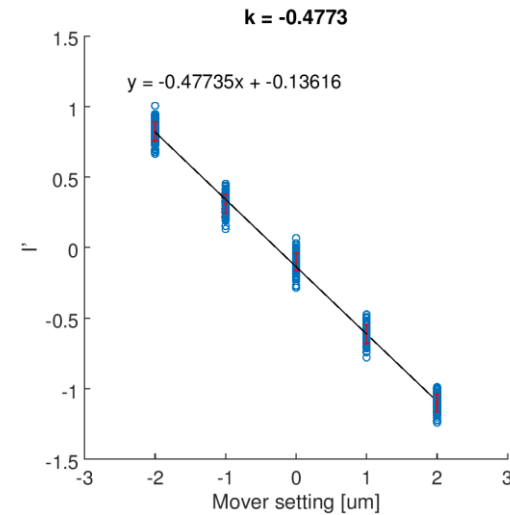
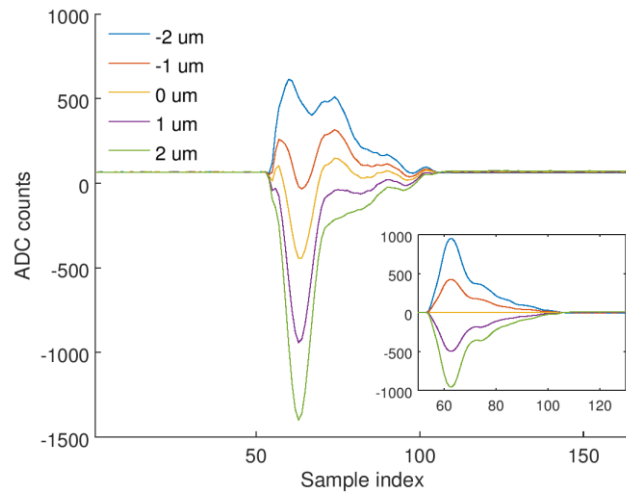
IPB

AQD0FFyScan27 (40 dB, mid charge)



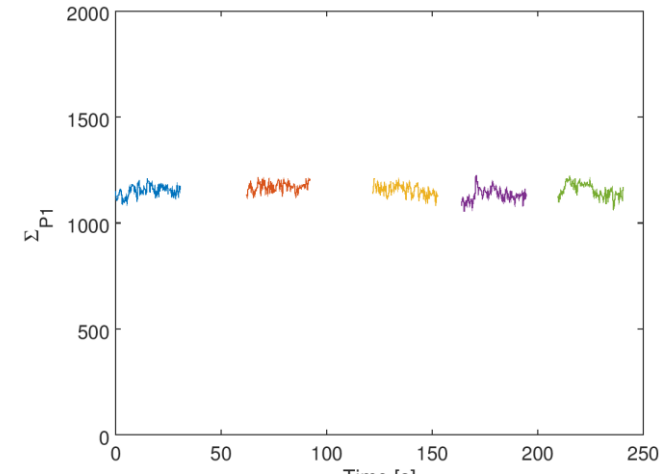
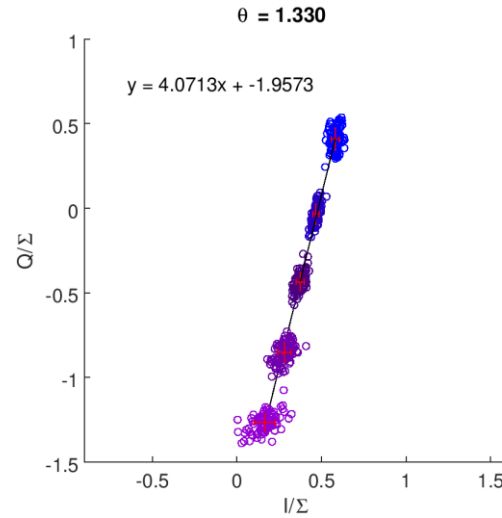
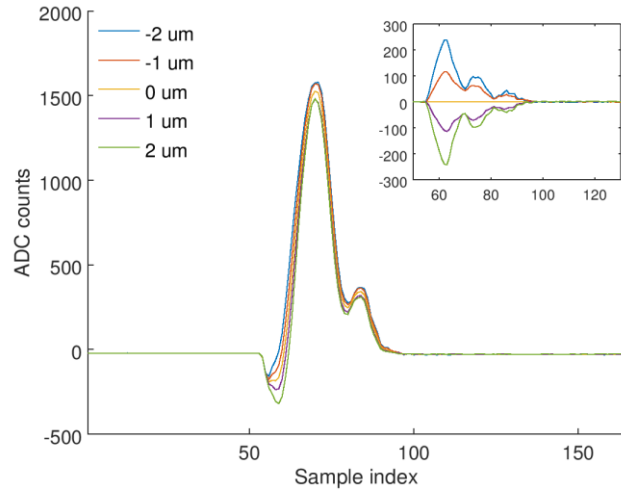
Sample index = 63

Charge normalization using Σ_{P1}



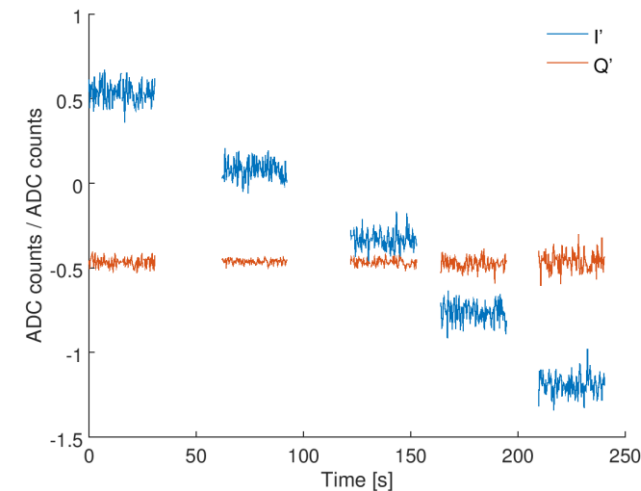
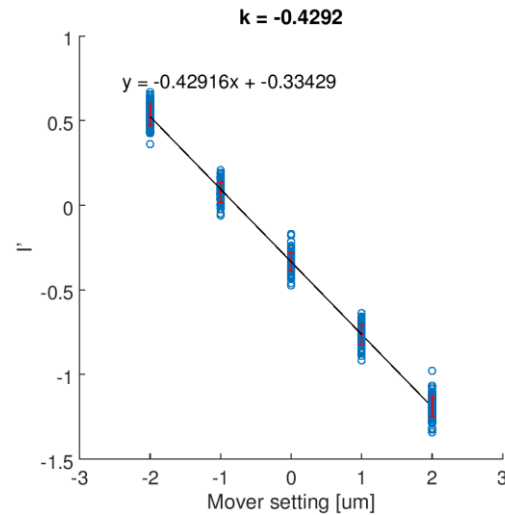
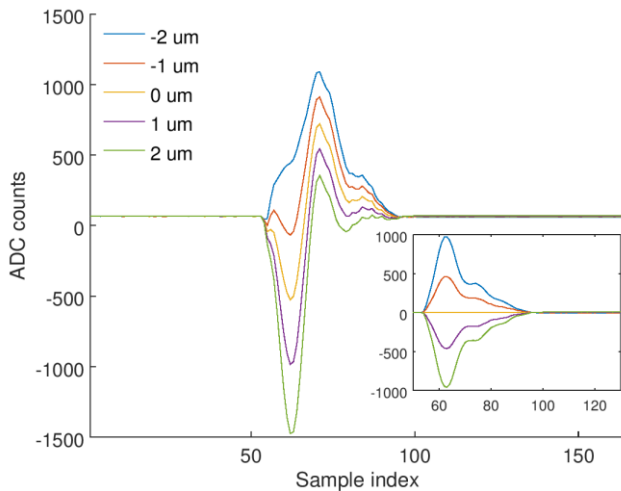
IPB

AQD0FFyScan28 (50 dB, mid charge)



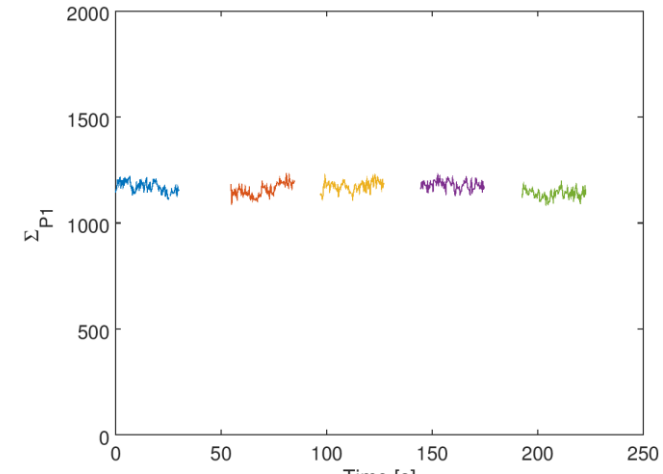
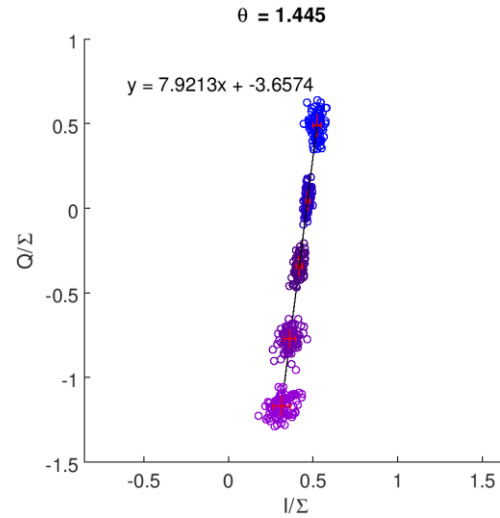
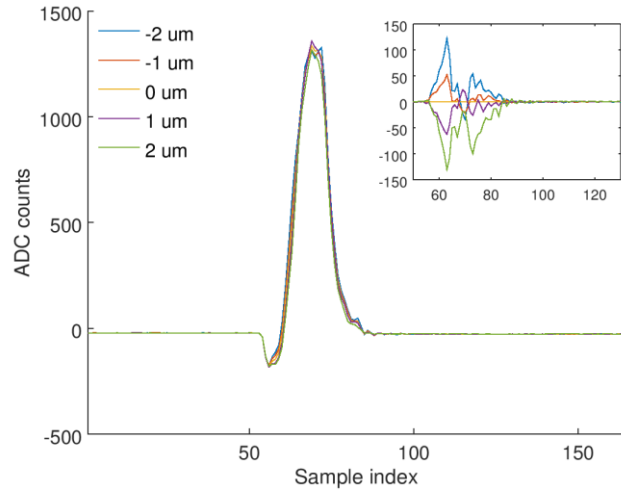
Sample index = 63

Charge normalization using Σ_{P1}



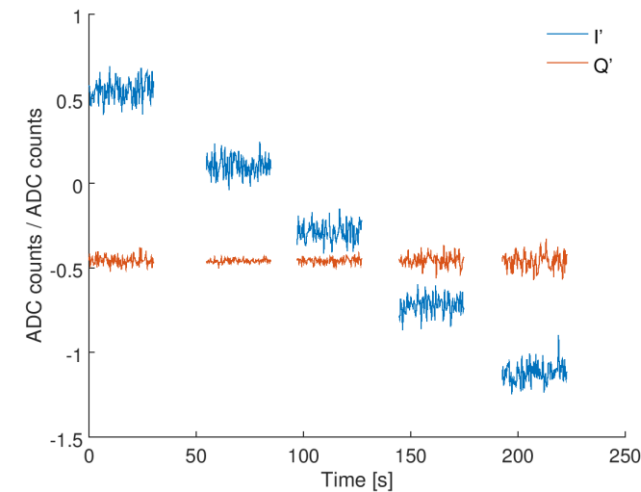
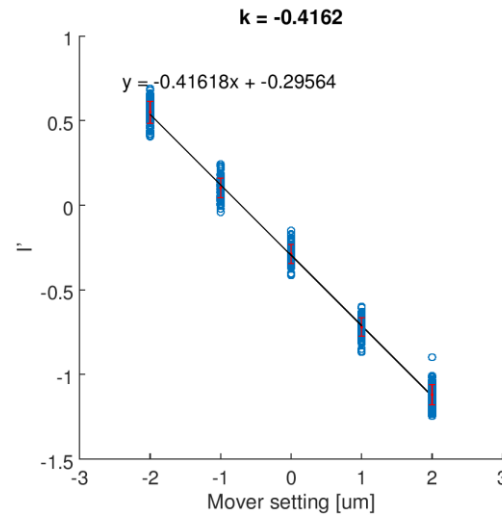
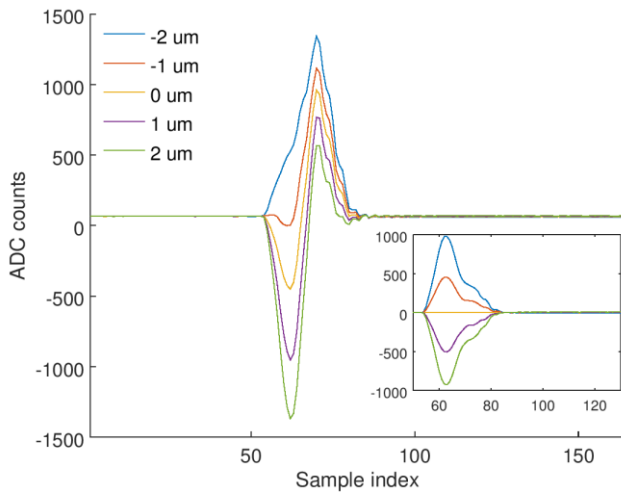
IPB

AQD0FFyScan29 (60 dB, mid charge)



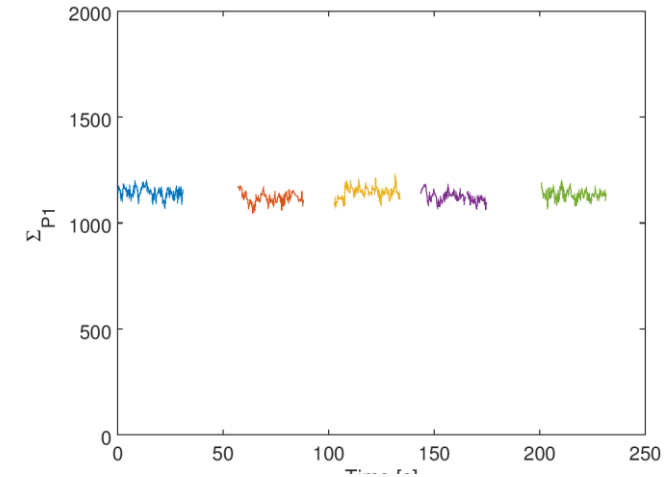
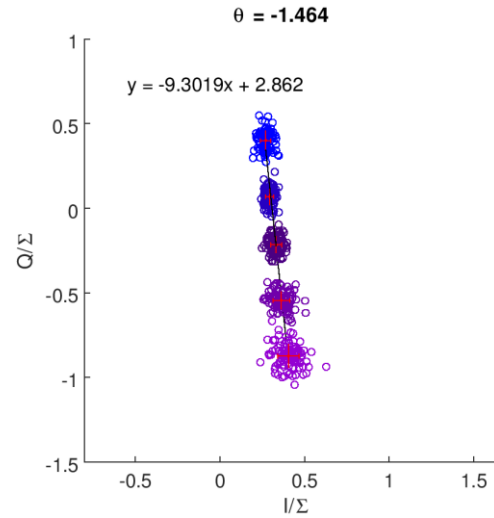
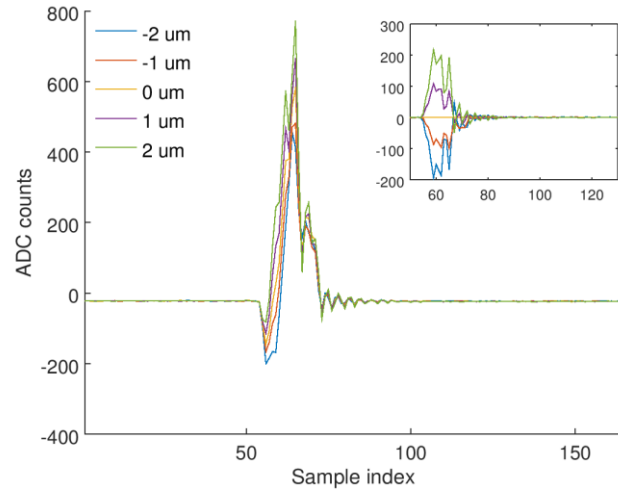
Sample index = 63

Charge normalization using Σ_{P1}



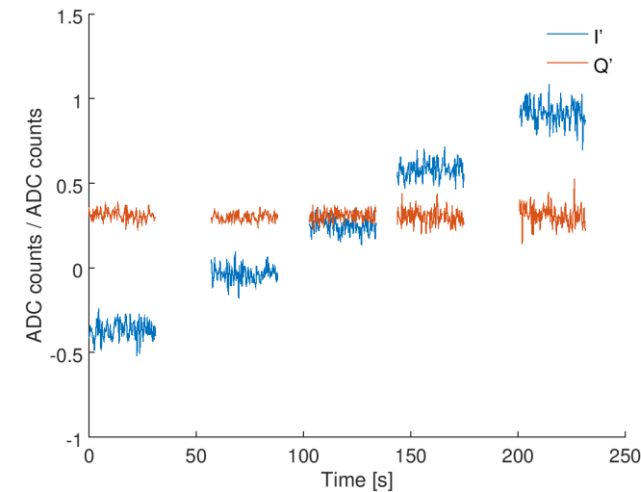
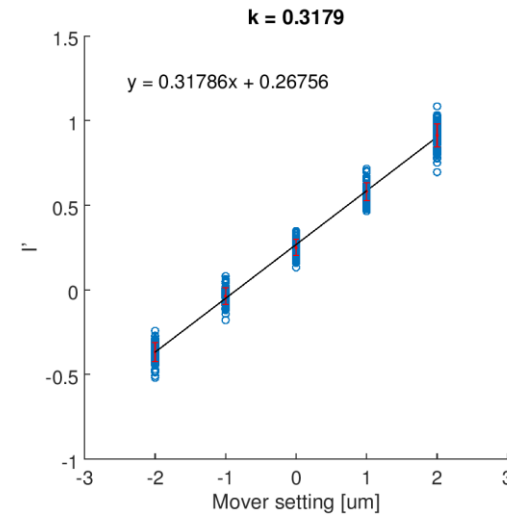
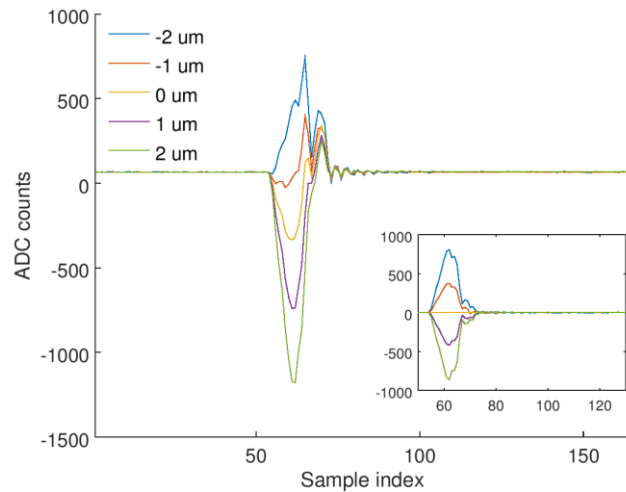
IPB

AQD0FFyScan30 (70 dB, mid charge)



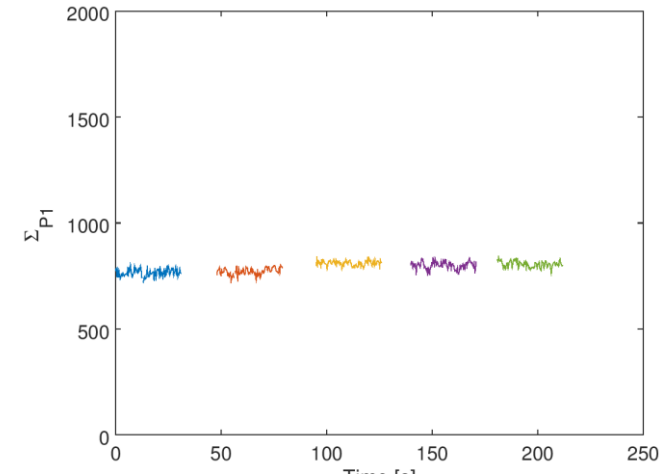
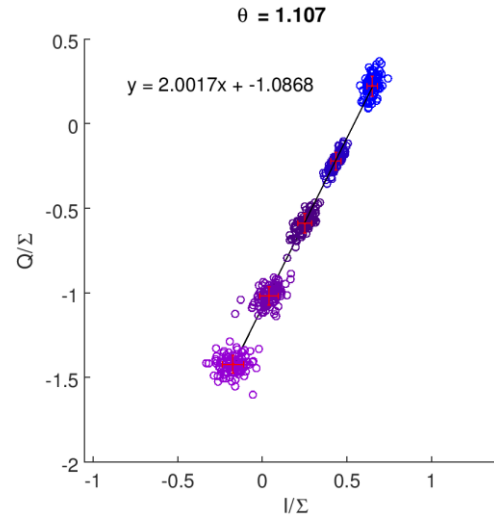
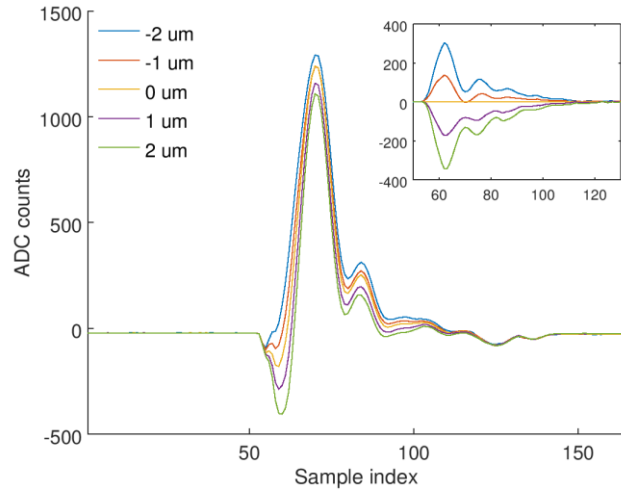
Sample index = 63

Charge normalization using Σ_{P1}



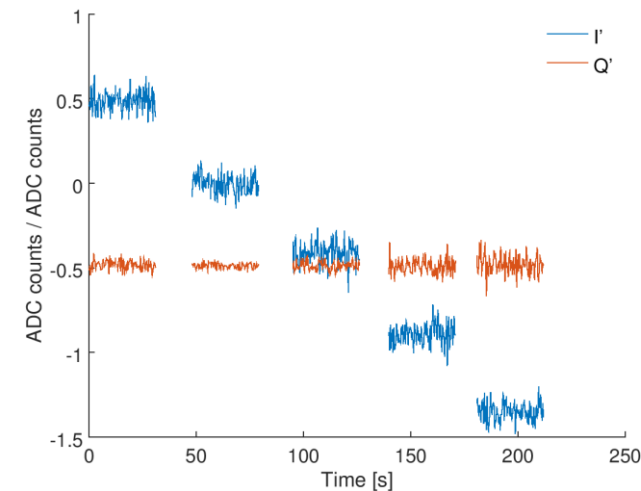
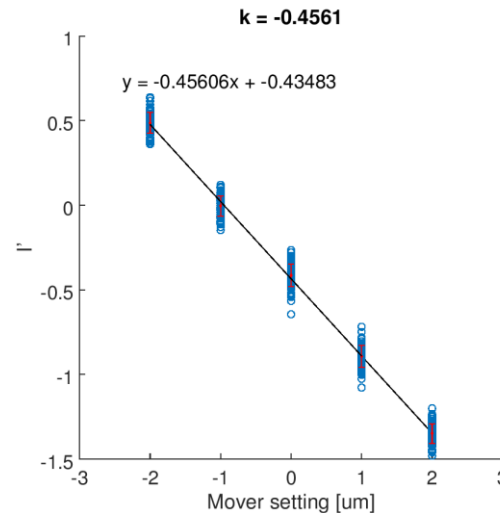
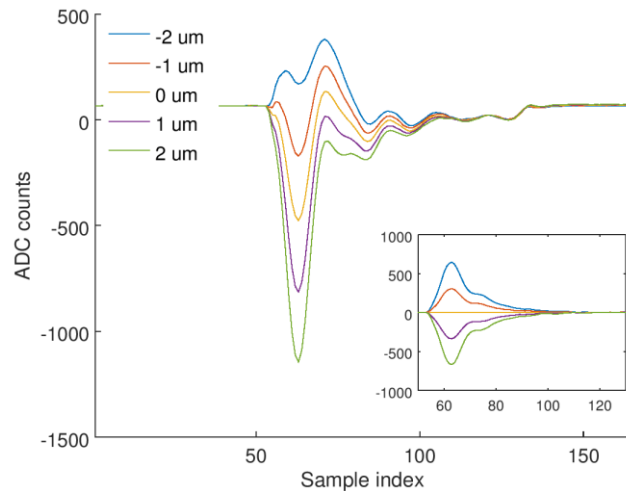
IPB

AQD0FFyScan31 (10 dB, low charge)



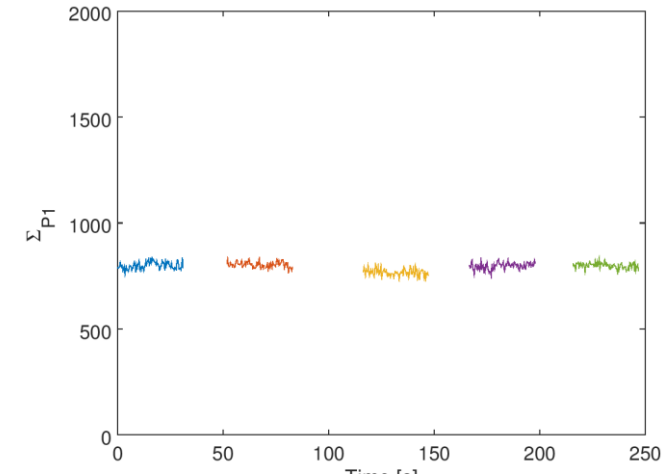
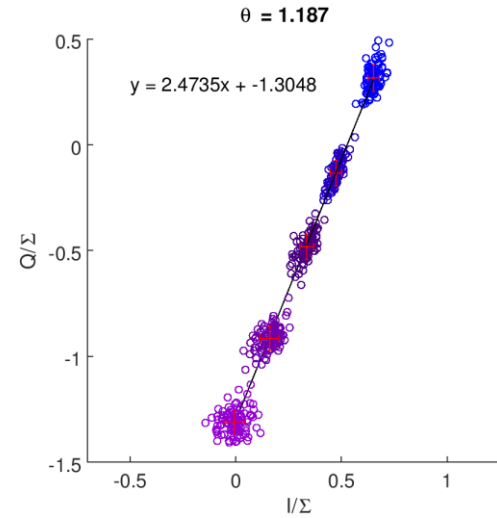
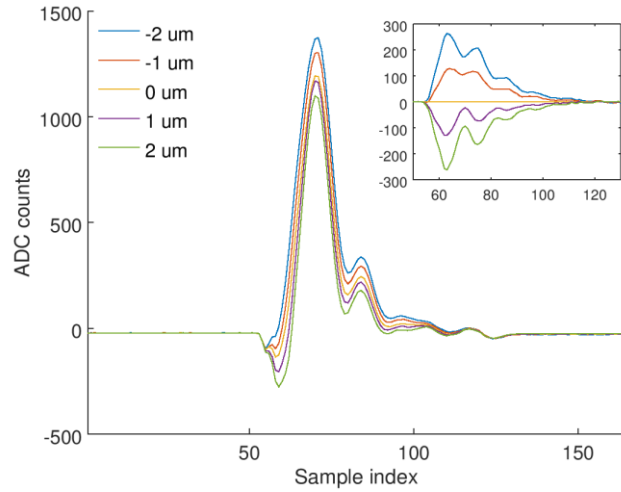
Sample index = 63

Charge normalization using Σ_{P1}



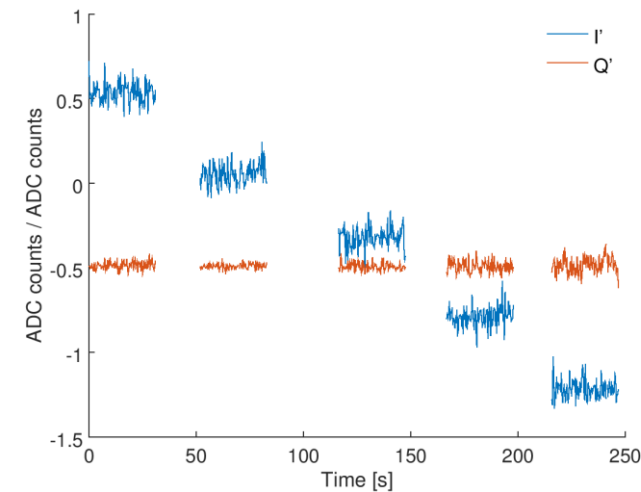
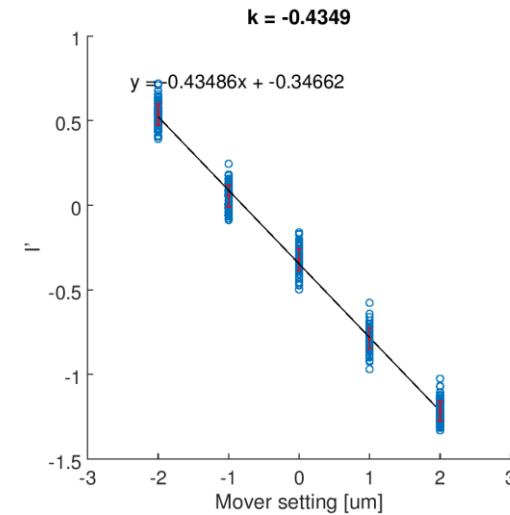
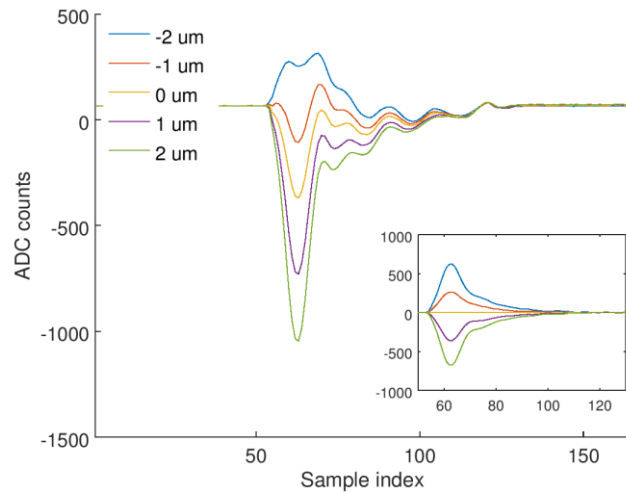
IPB

AQD0FFyScan32 (20 dB, low charge)



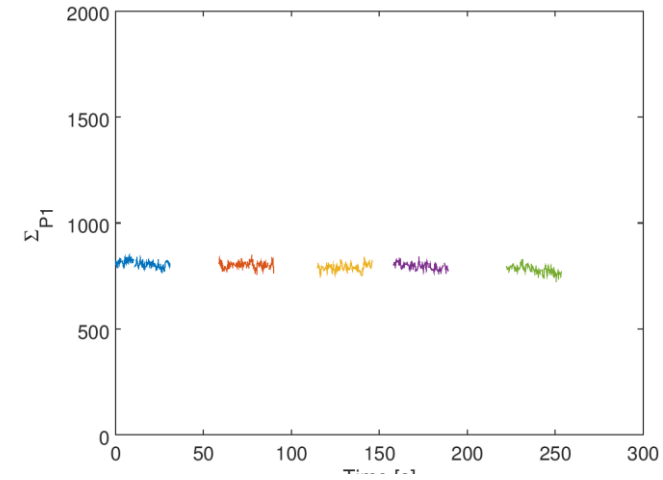
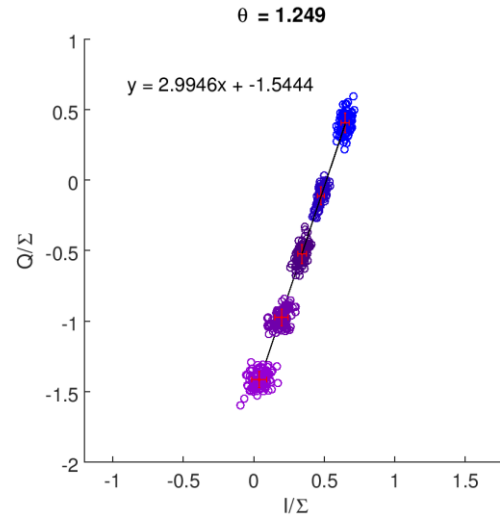
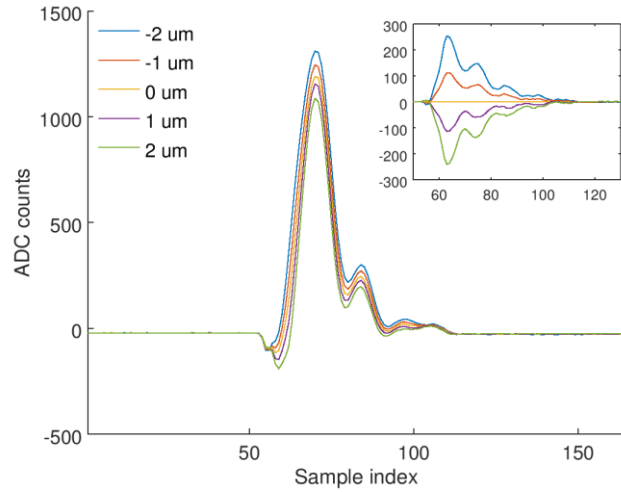
Sample index = 63

Charge normalization using Σ_{P1}



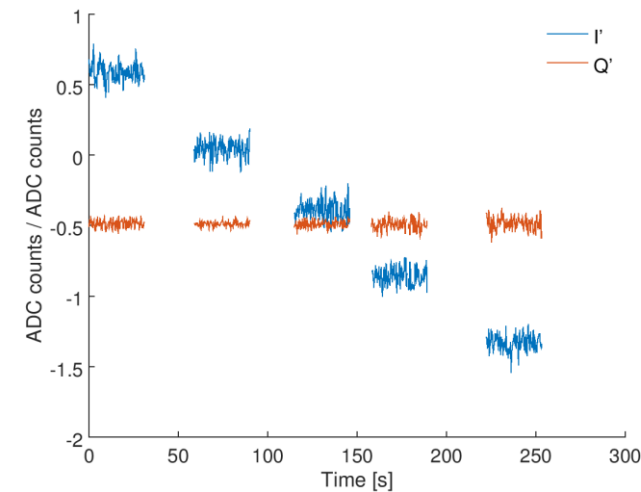
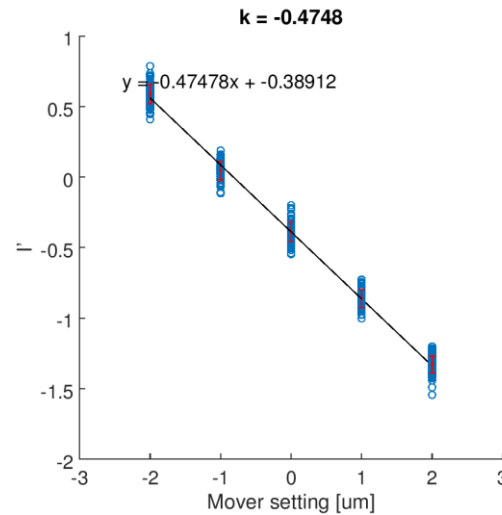
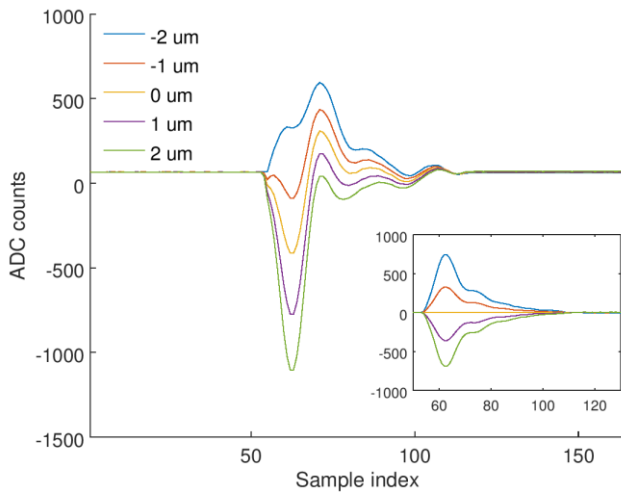
IPB

AQD0FFyScan33 (30 dB, low charge)



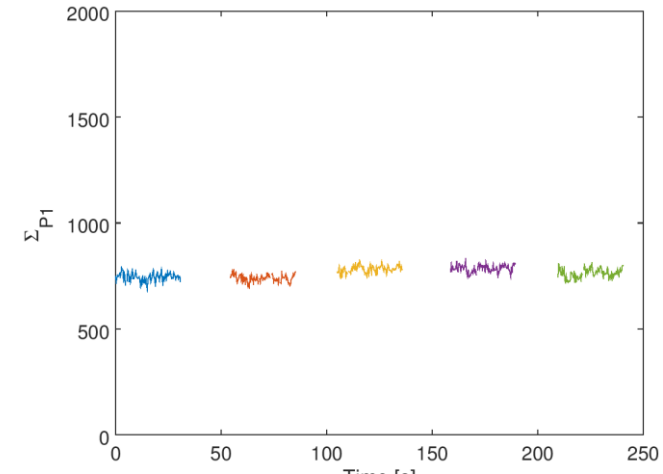
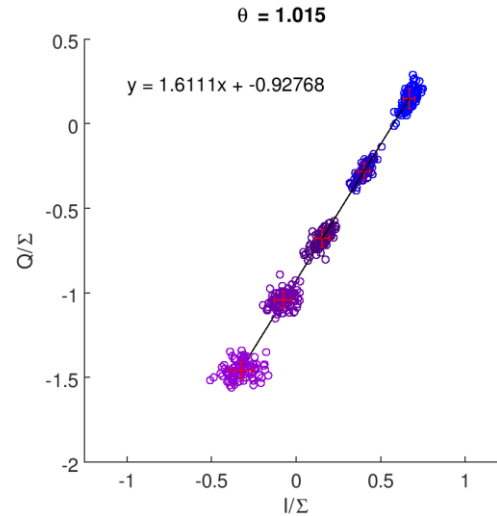
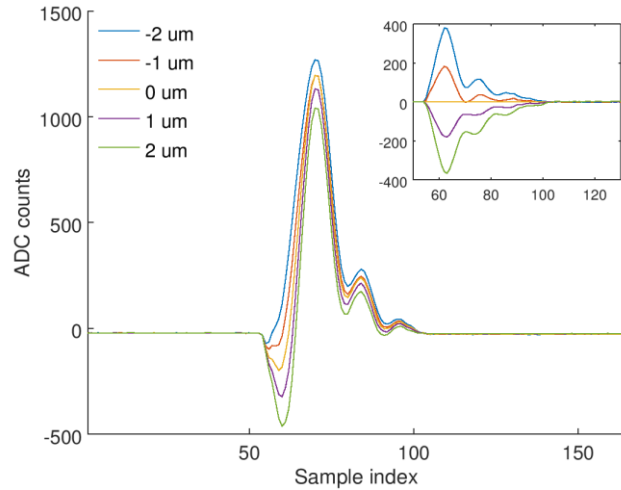
Sample index = 63

Charge normalization using Σ_{P1}



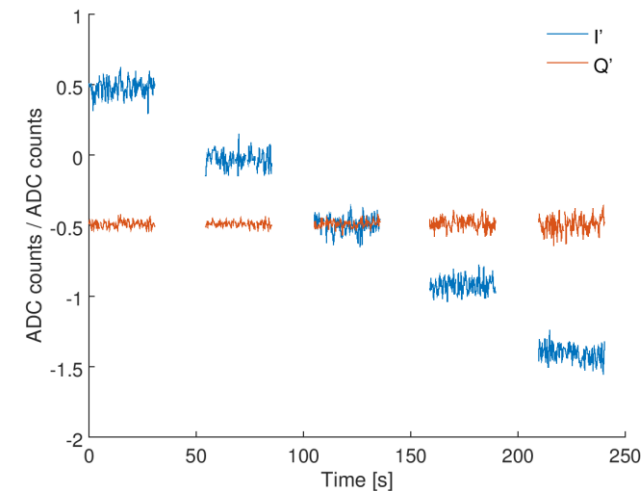
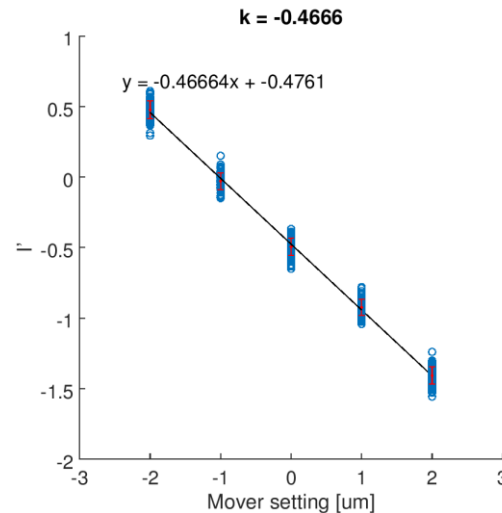
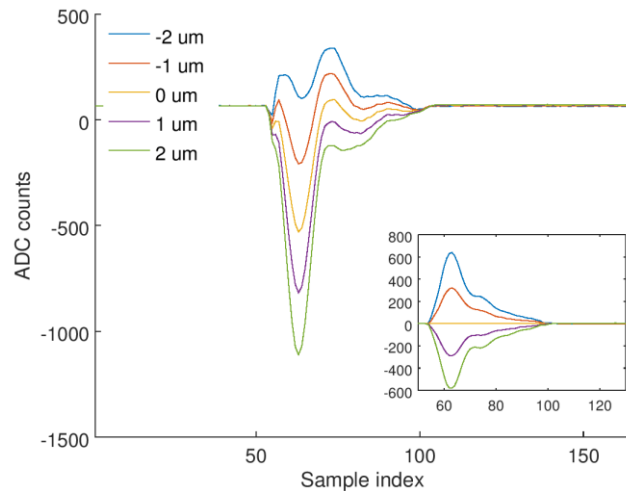
IPB

AQD0FFyScan34 (40 dB, low charge)



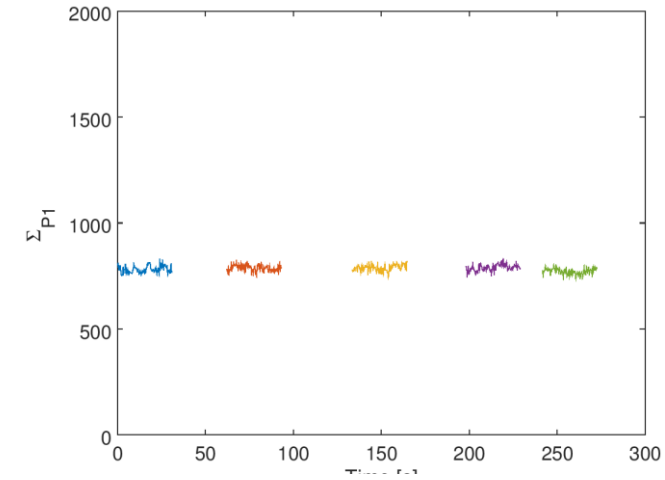
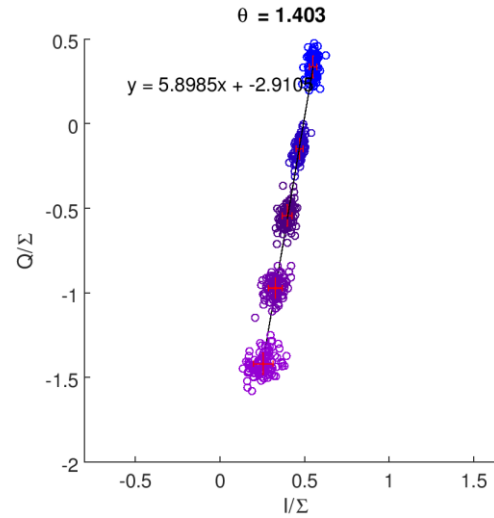
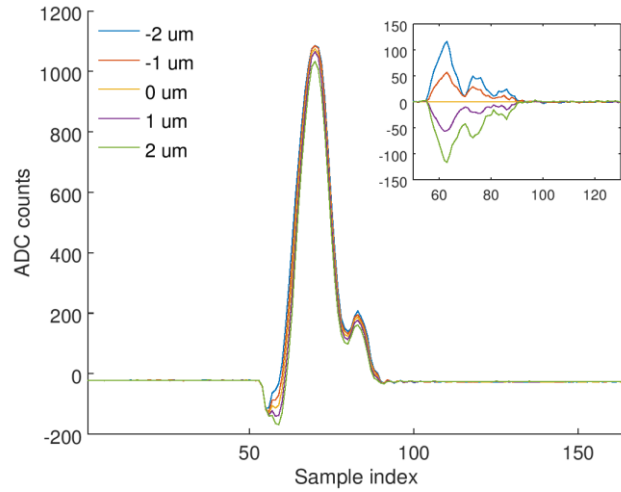
Sample index = 63

Charge normalization using Σ_{P1}



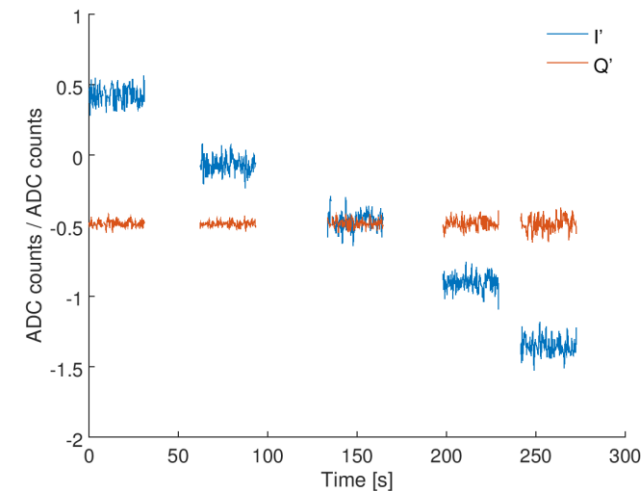
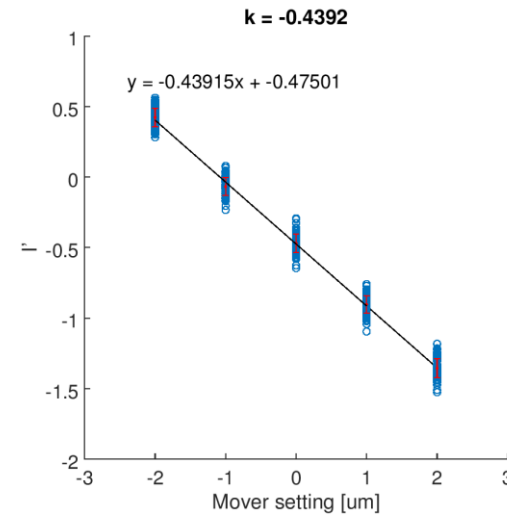
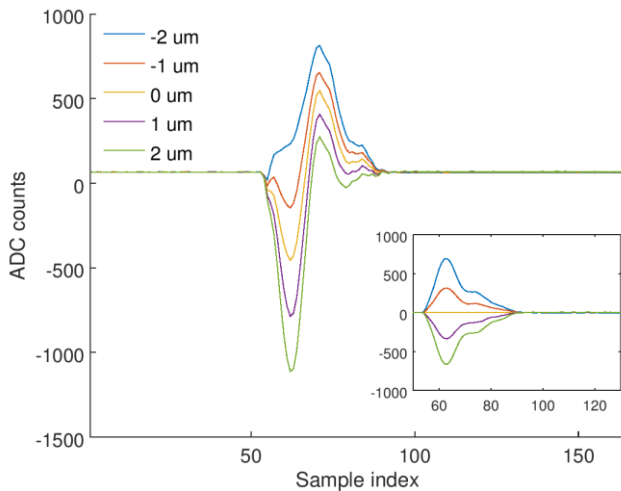
IPB

AQD0FFyScan35 (50 dB, low charge)



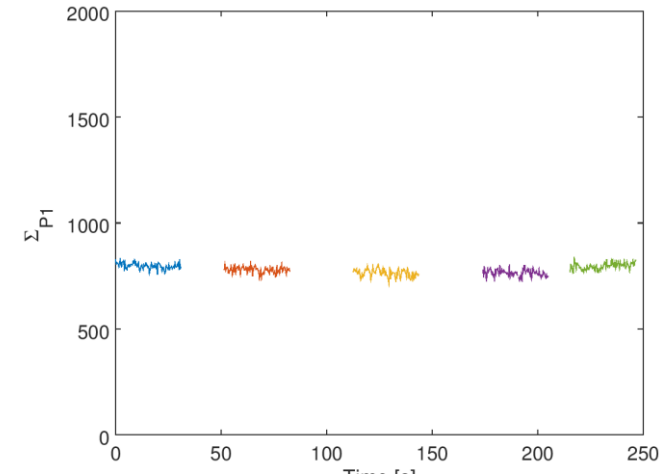
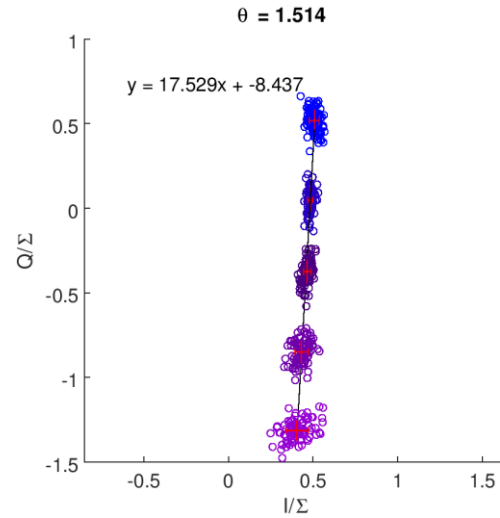
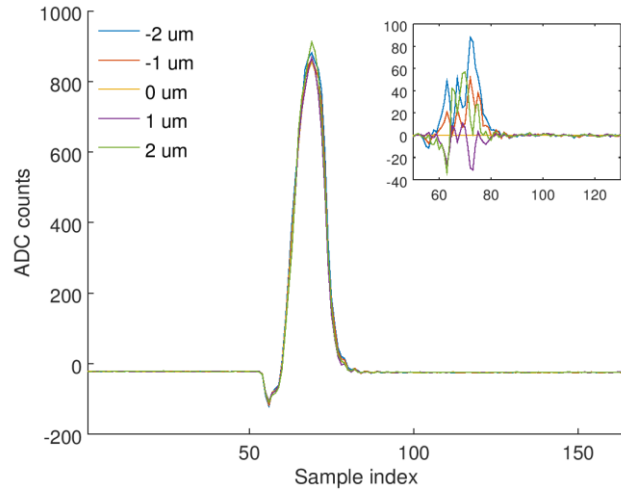
Sample index = 63

Charge normalization using Σ_{P1}



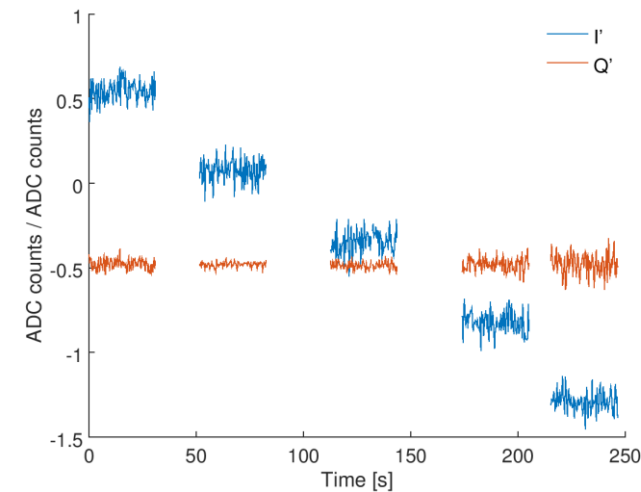
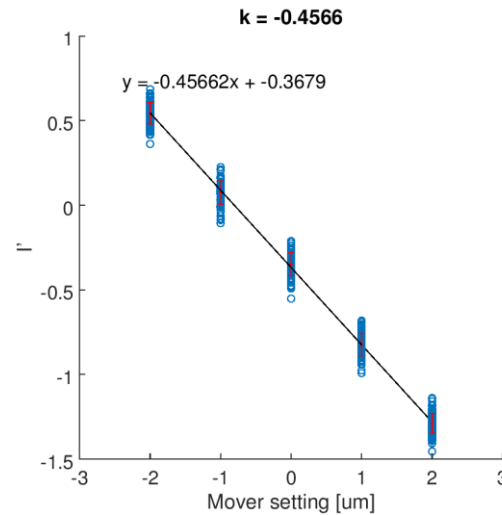
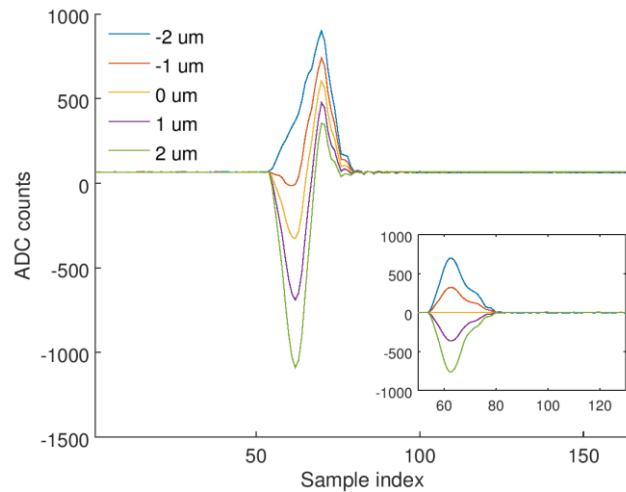
IPB

AQD0FFyScan35 (60 dB, low charge)



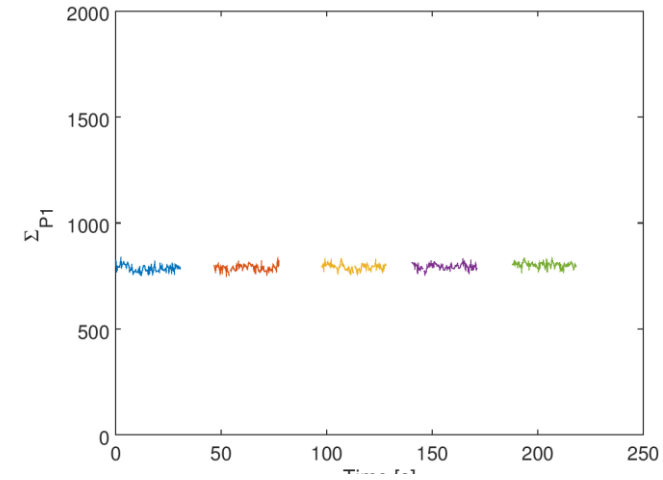
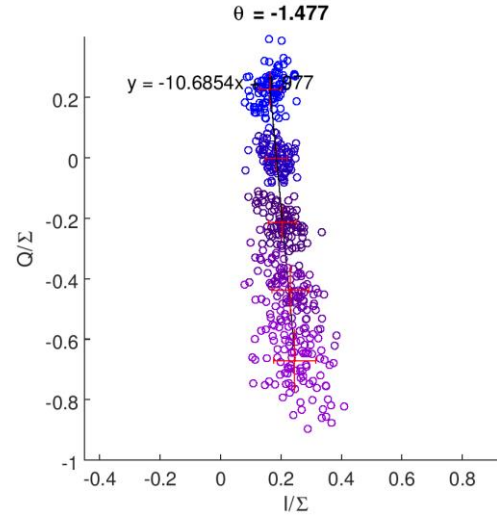
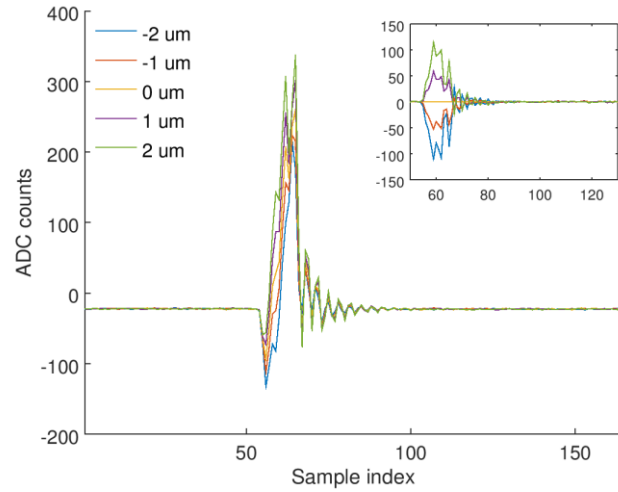
Sample index = 63

Charge normalization using Σ_{P1}



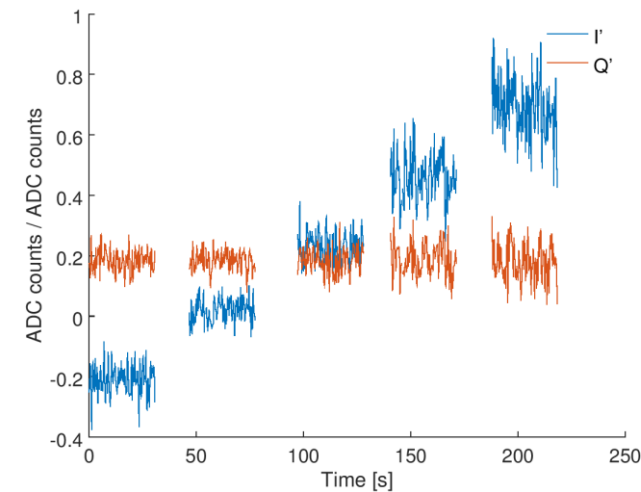
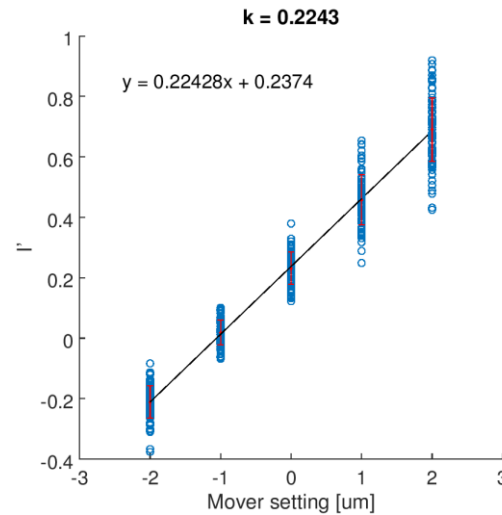
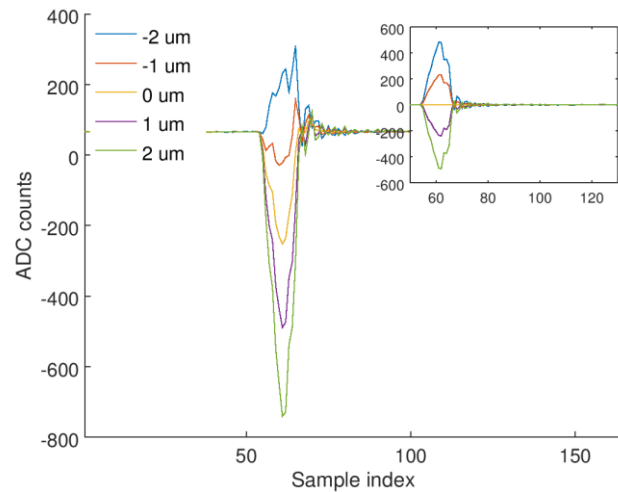
IPB

AQD0FFyScan37 (70 dB, low charge)



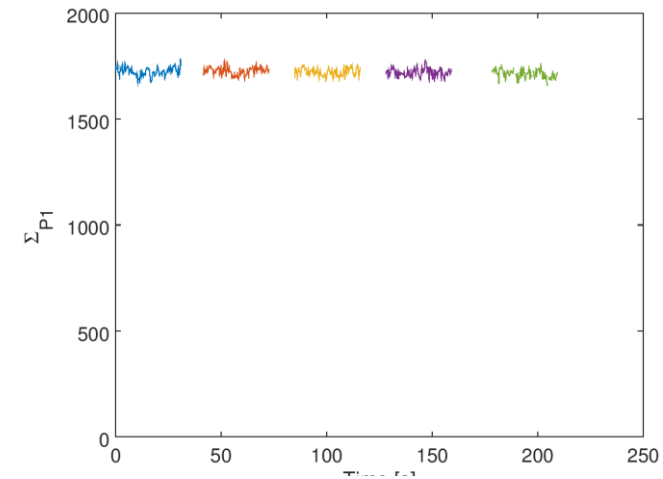
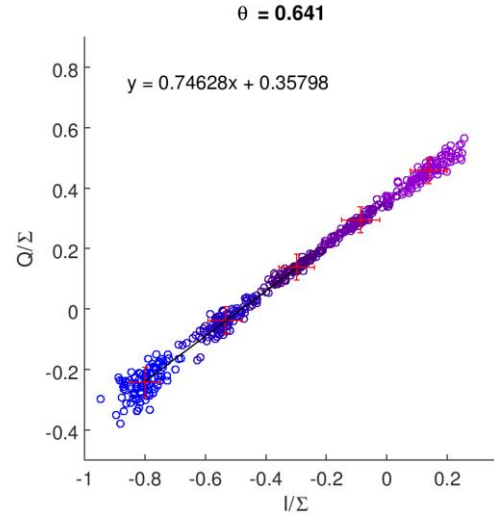
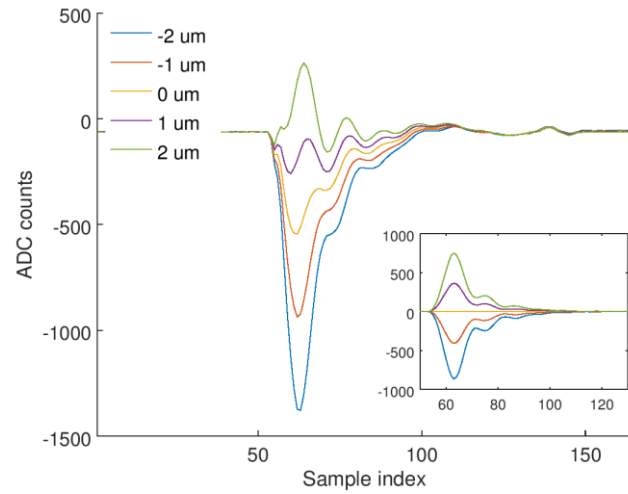
Sample index = 63

Charge normalization using Σ_{P1}



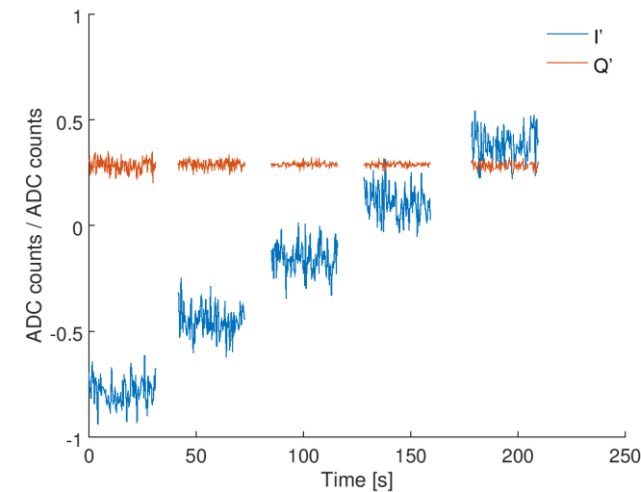
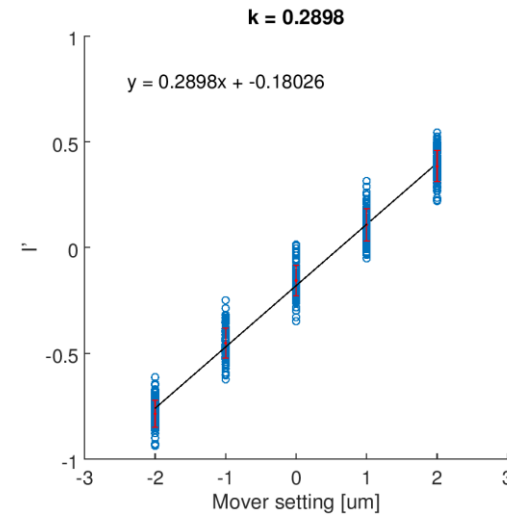
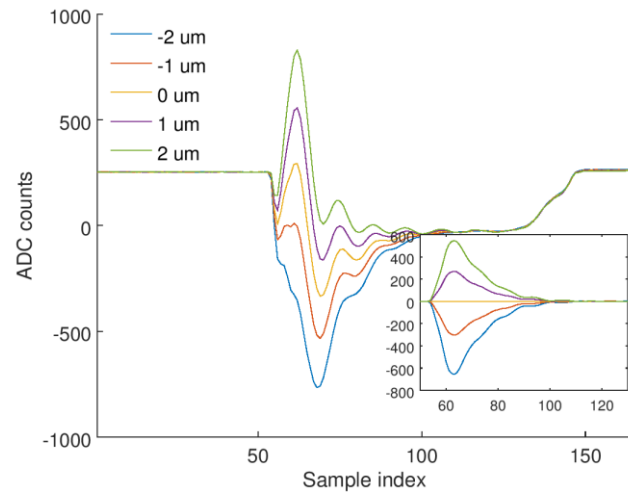
IPB

AQD0FFyScan22 (10 dB, high charge)



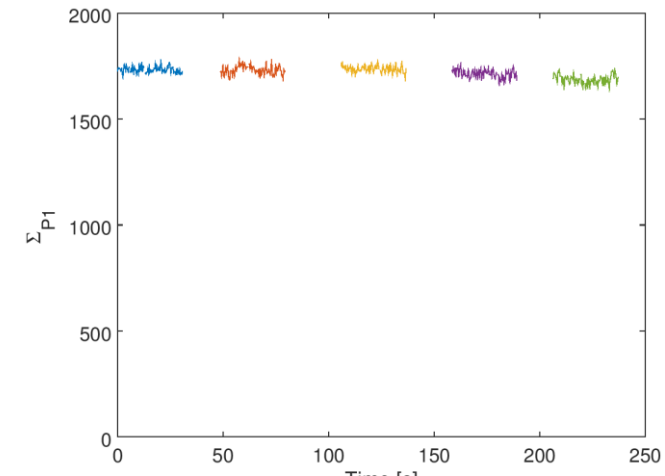
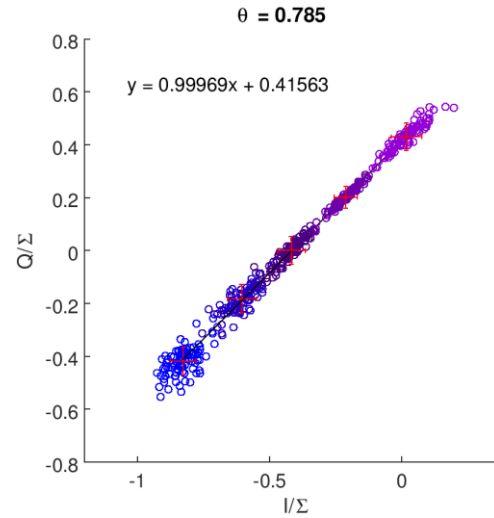
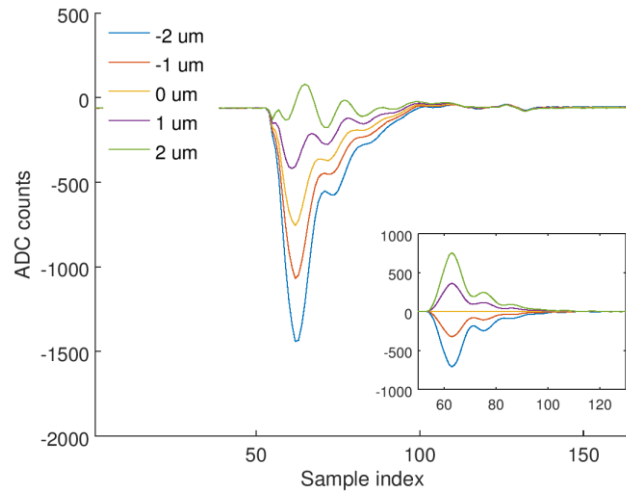
Sample index = 63

Charge normalization using Σ_{P1}



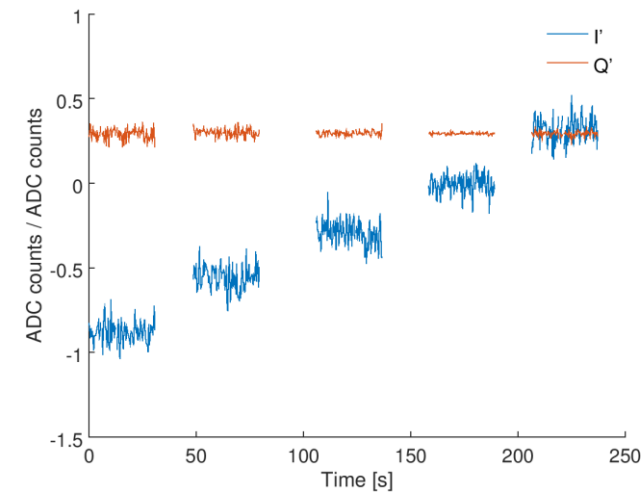
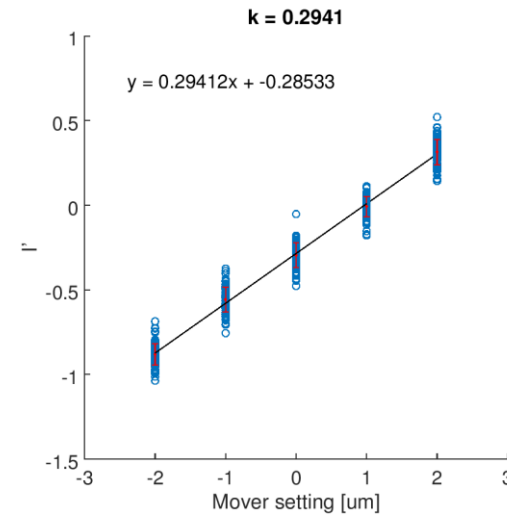
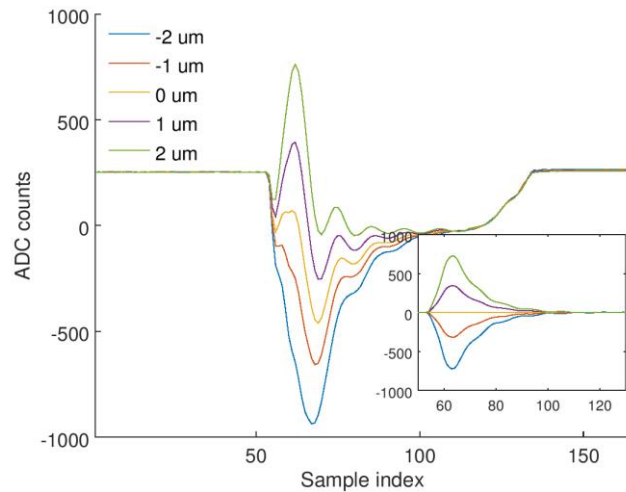
IPC

AQD0FFyScan21 (20 dB, high charge)



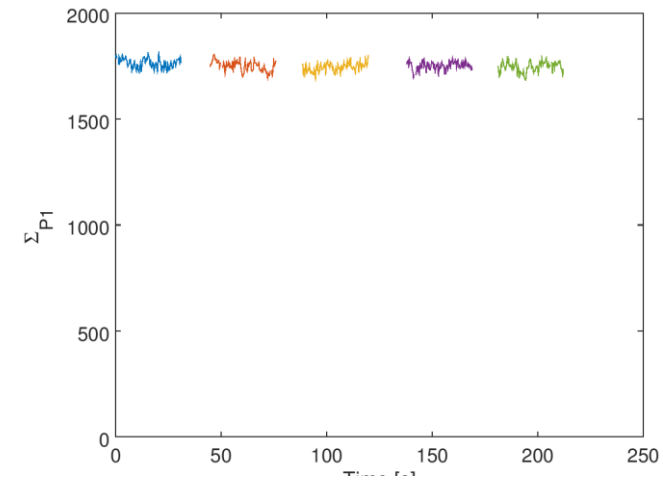
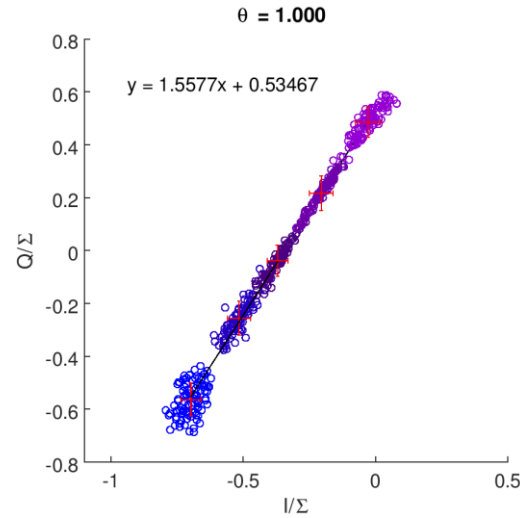
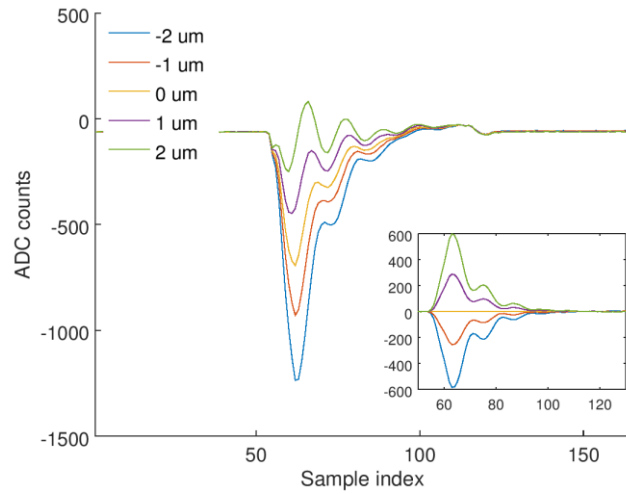
Sample index = 63

Charge normalization using Σ_{P1}



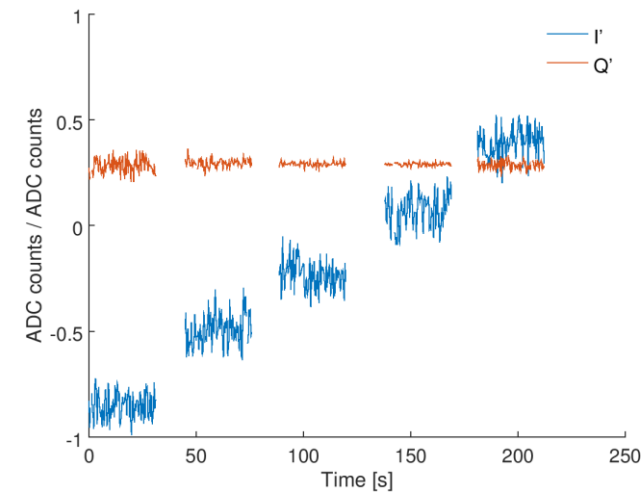
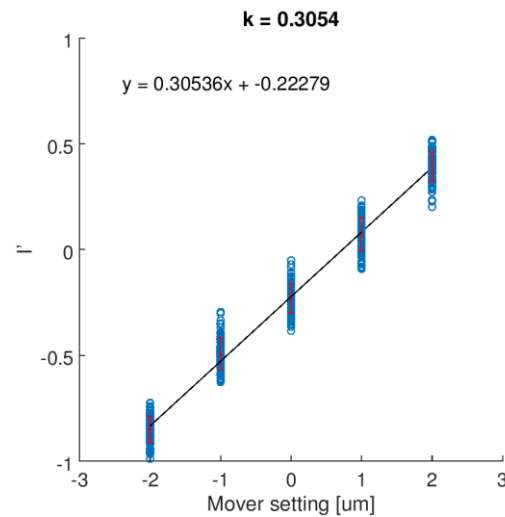
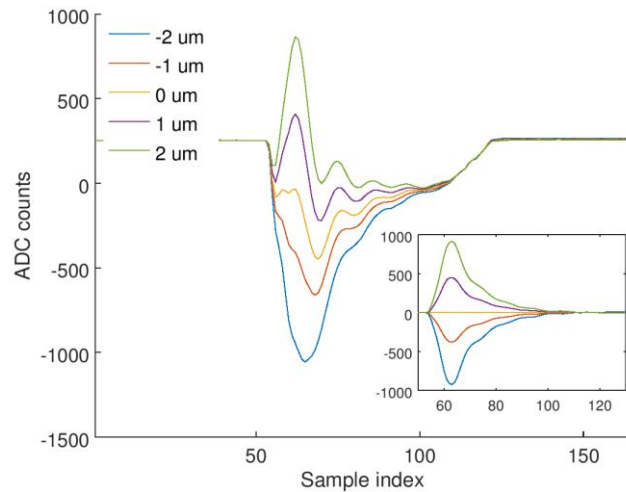
IPC

AQD0FFyScan19 (30 dB, high charge)



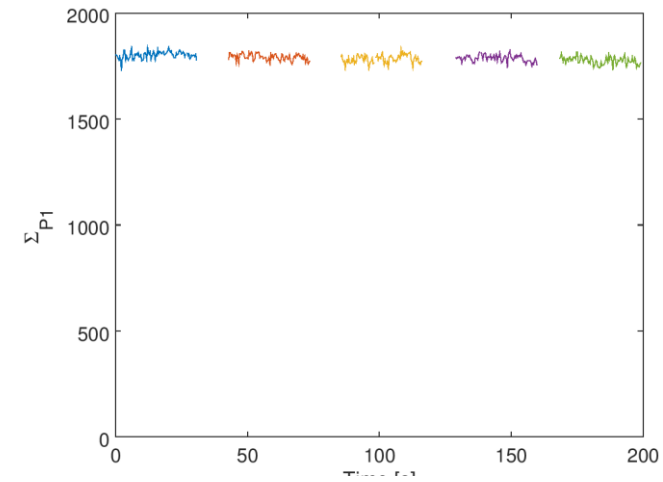
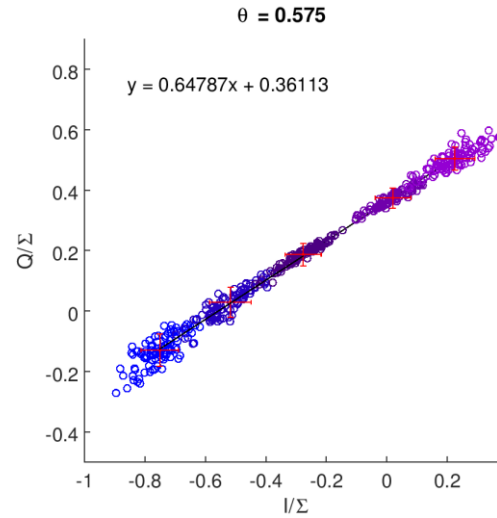
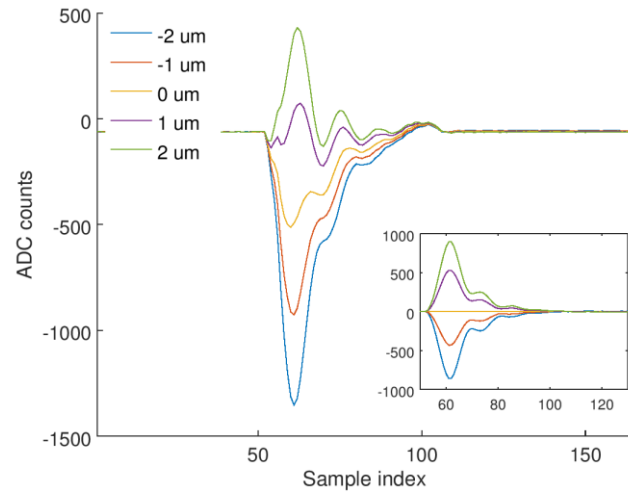
Sample index = 63

Charge normalization using Σ_{P1}



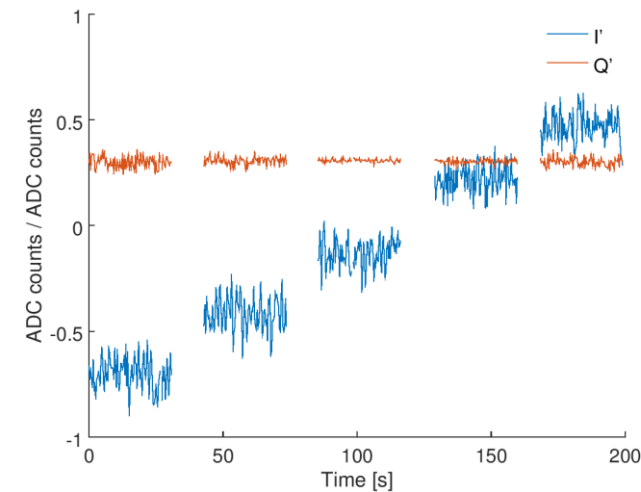
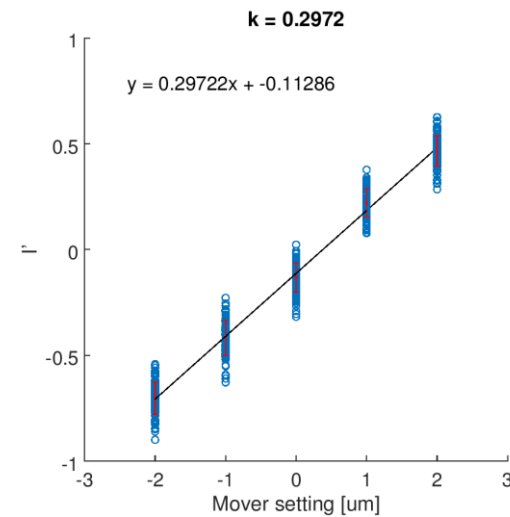
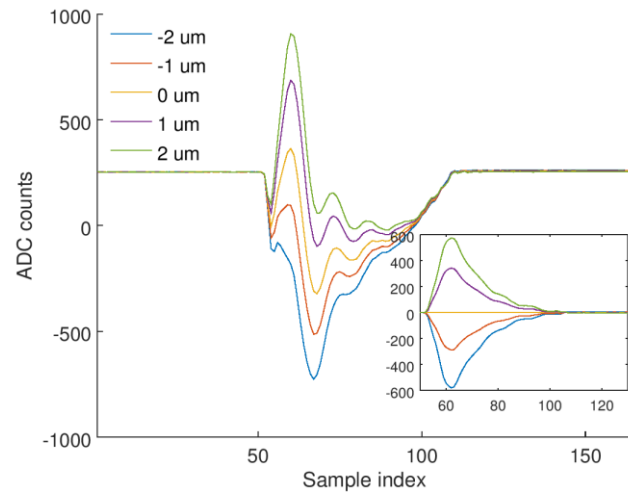
IPC

AQD0FFyScan15 (40 dB, high charge)



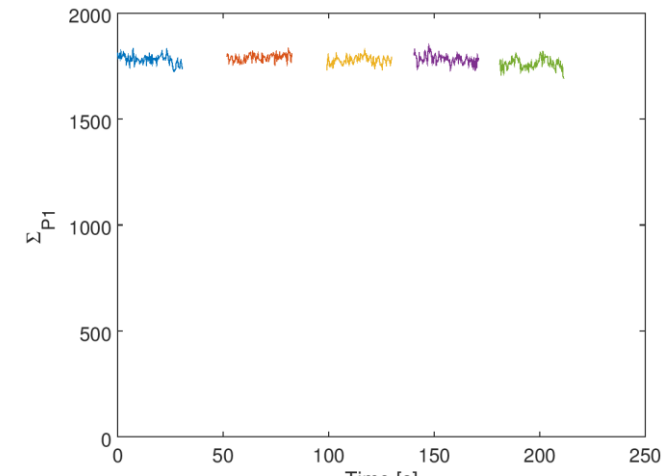
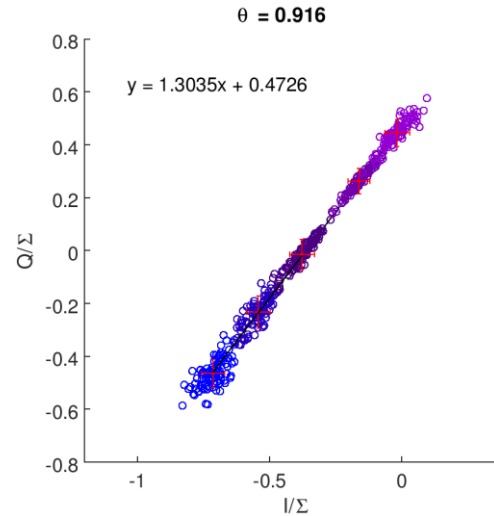
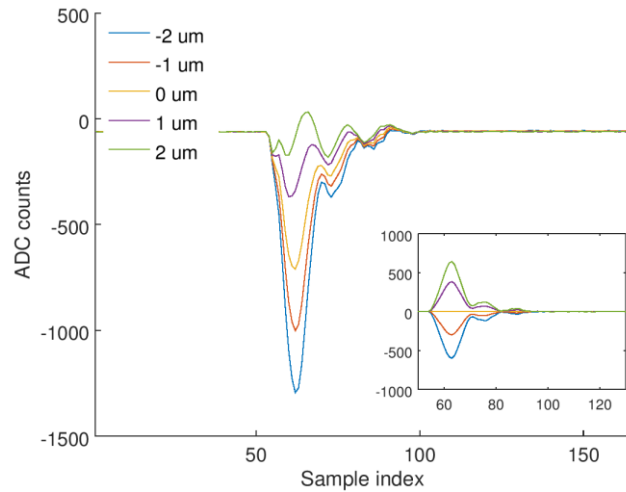
Sample index = 63

Charge normalization using Σ_{P1}



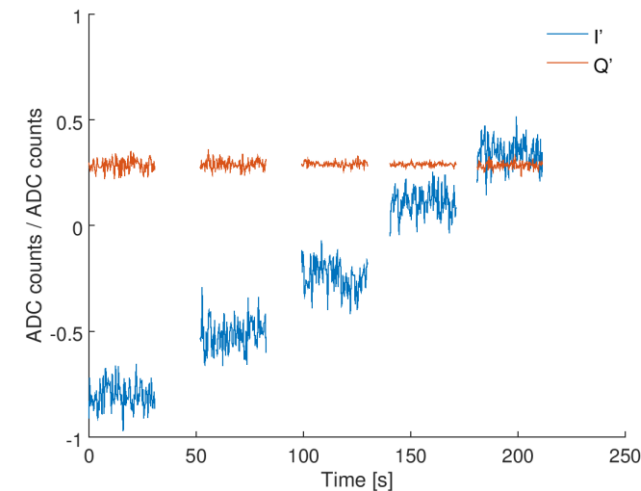
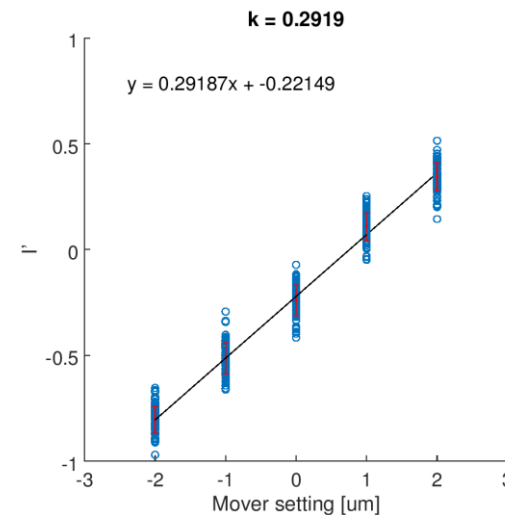
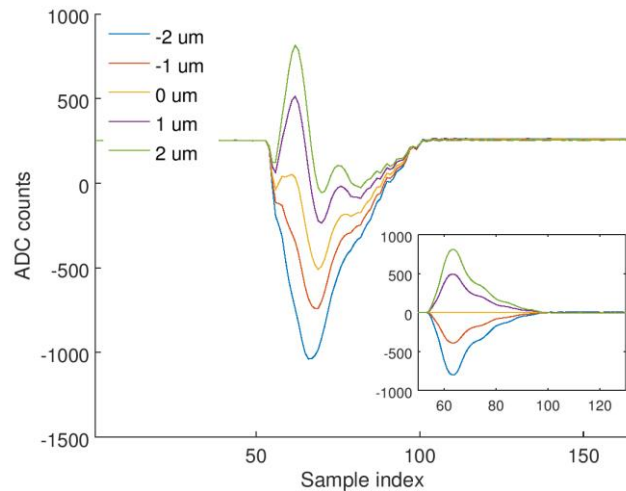
IPC

AQD0FFyScan16 (50 dB, high charge)



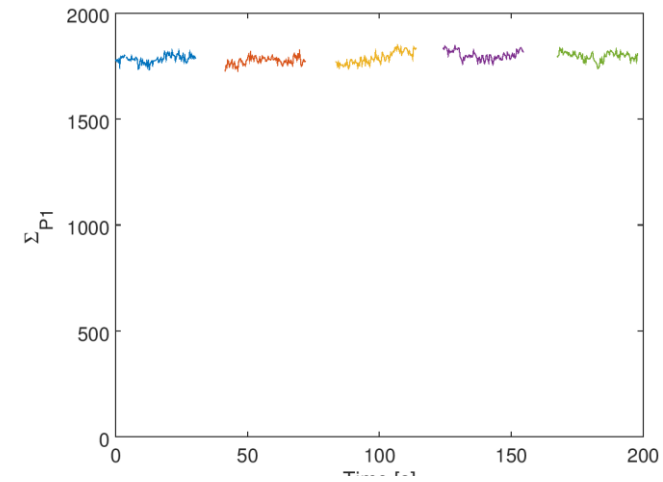
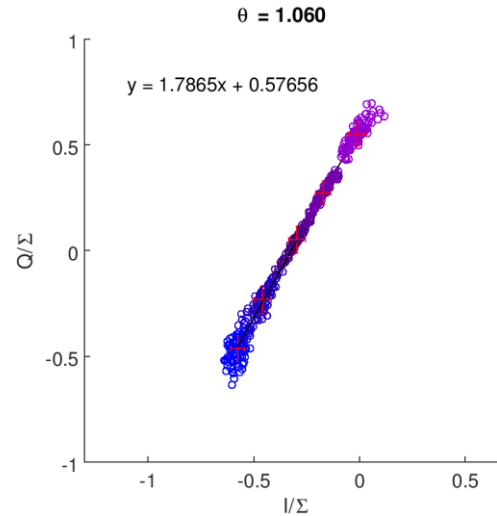
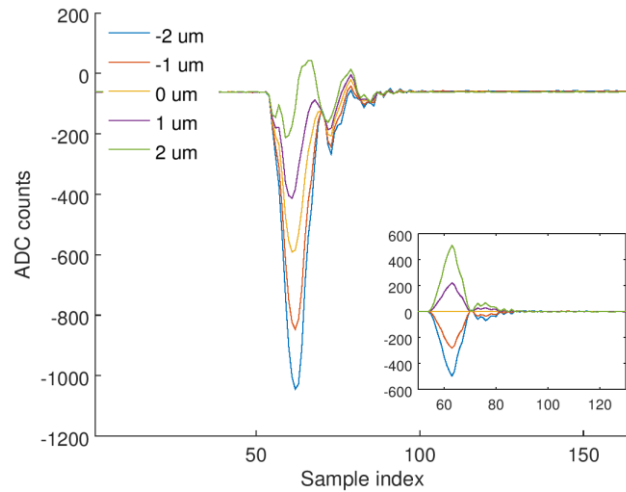
Sample index = 63

Charge normalization using Σ_{P1}



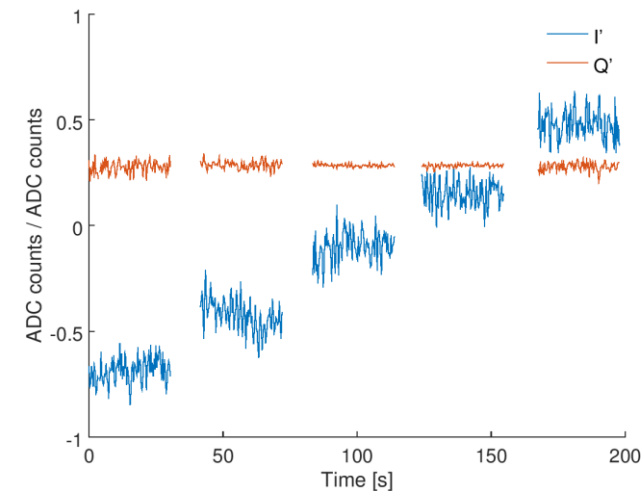
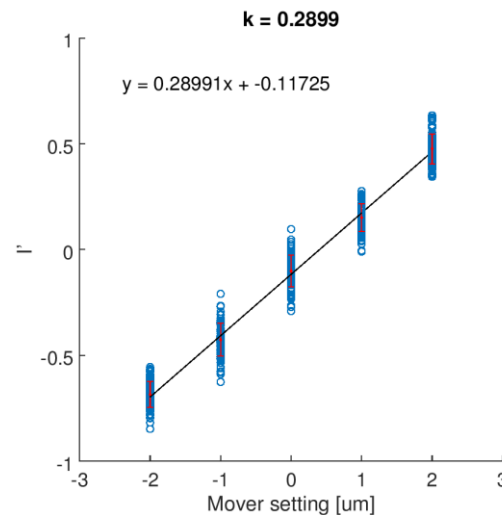
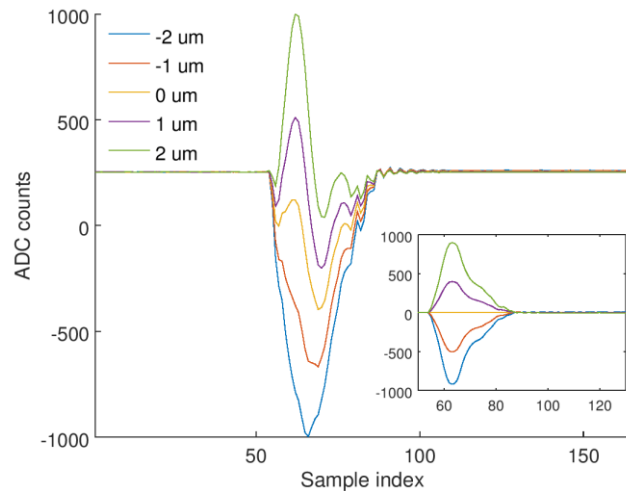
IPC

AQD0FFyScan17 (60 dB, high charge)



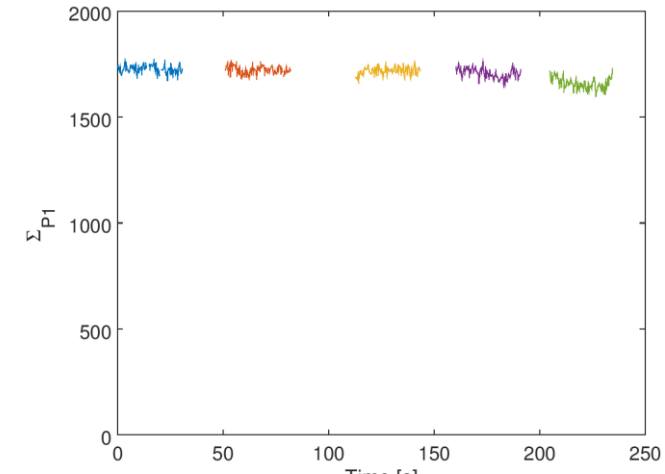
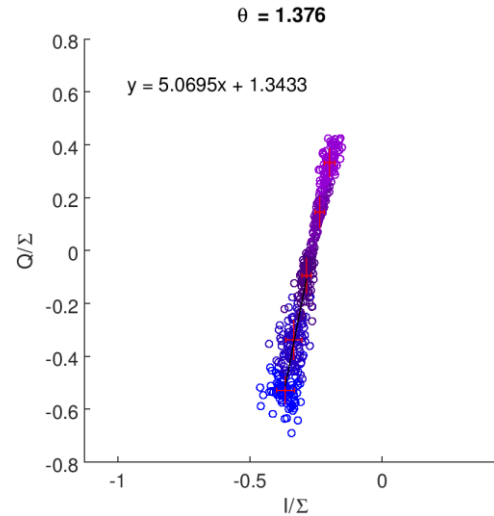
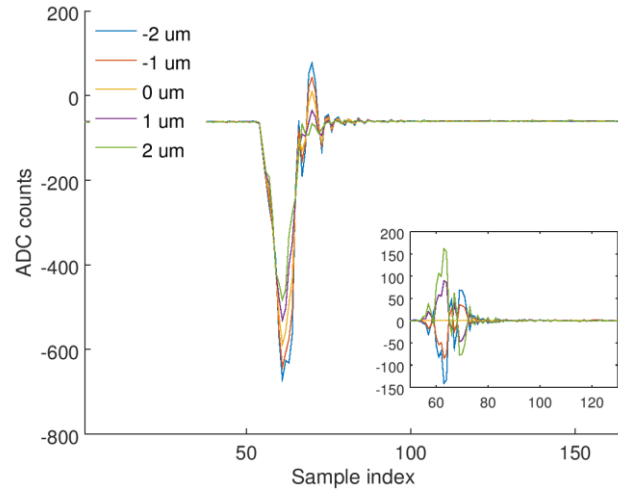
Sample index = 63

Charge normalization using Σ_{P1}



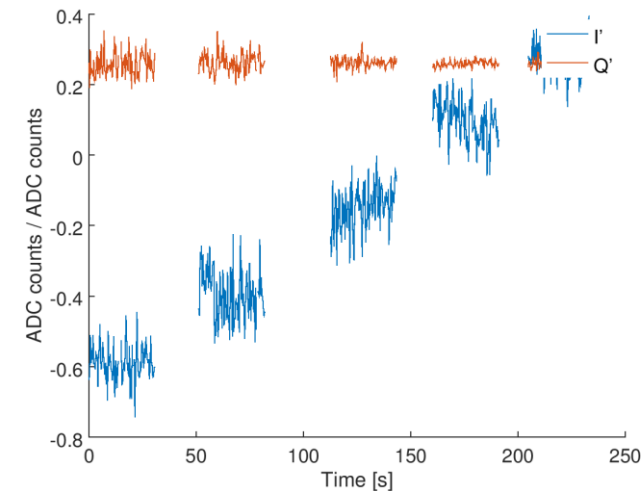
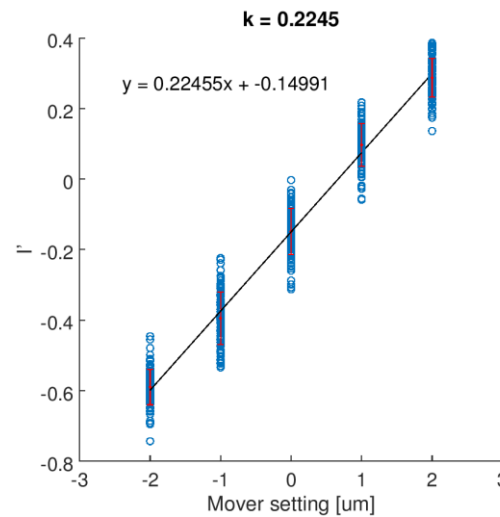
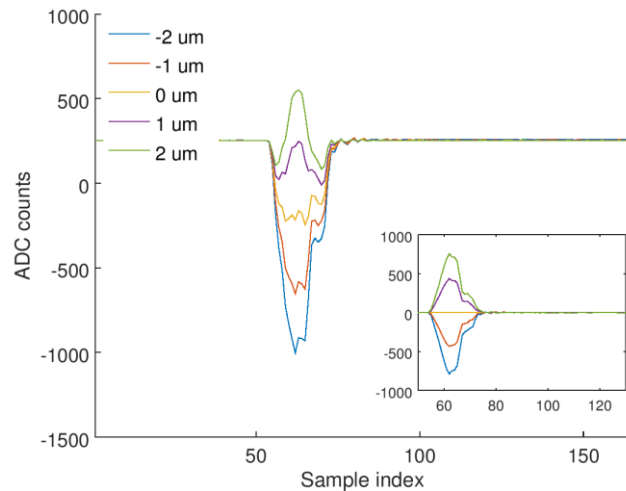
IPC

AQD0FFyScan18 (70 dB, high charge)



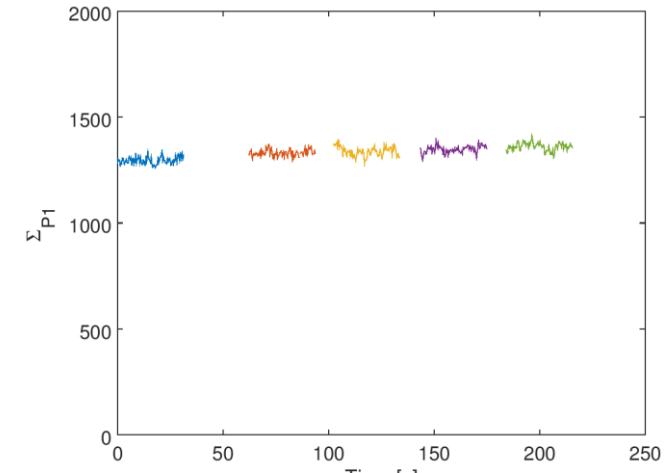
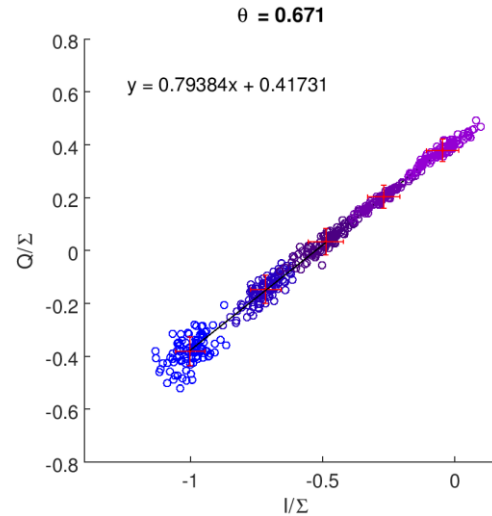
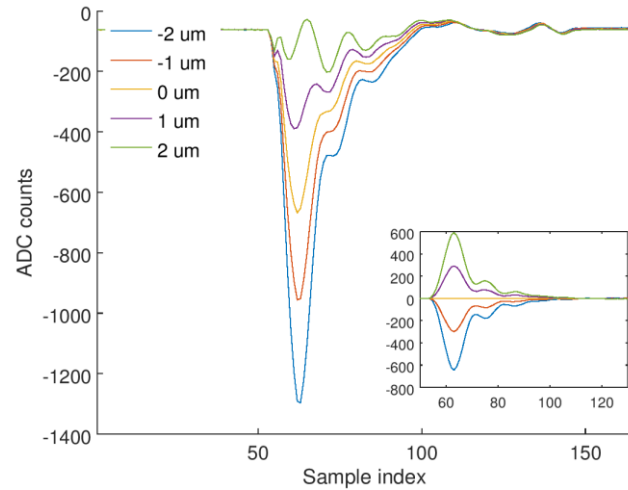
Sample index = 63

Charge normalization using Σ_{P1}



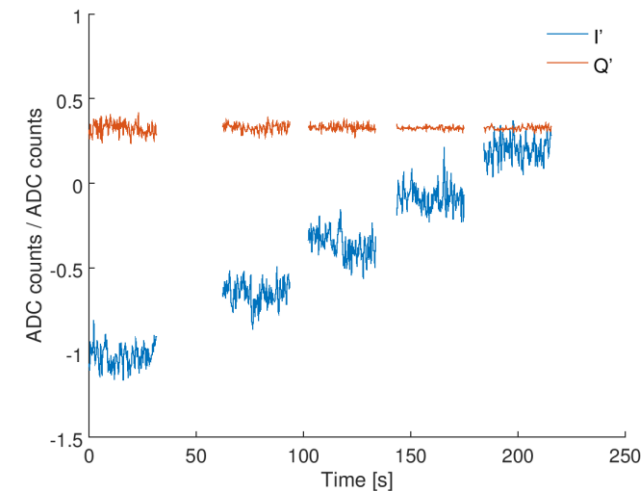
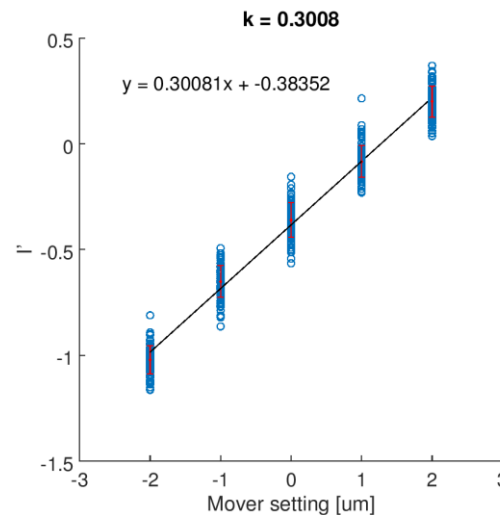
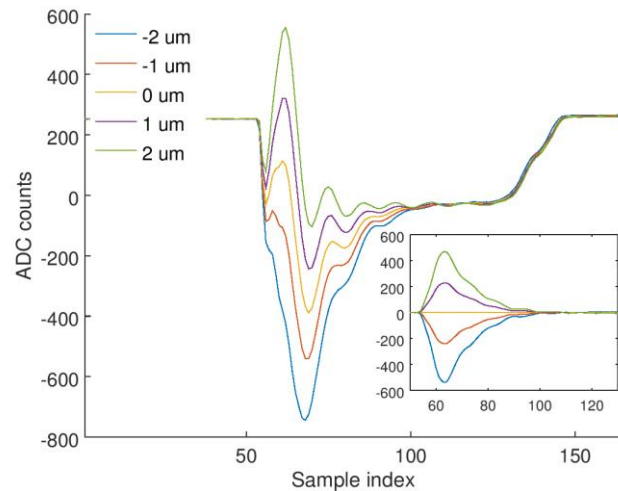
IPC

AQD0FFyScan23 (10 dB, mid charge)



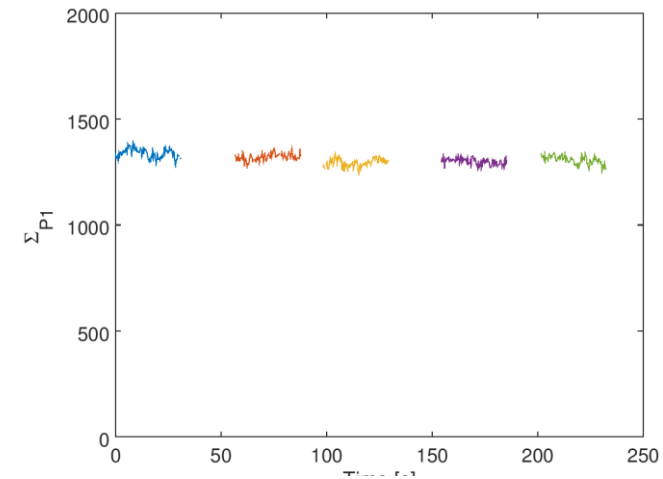
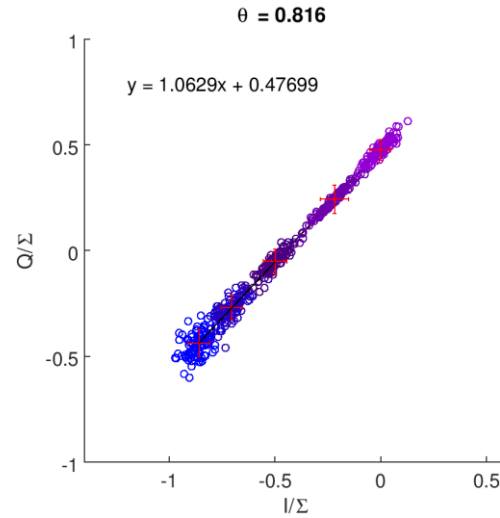
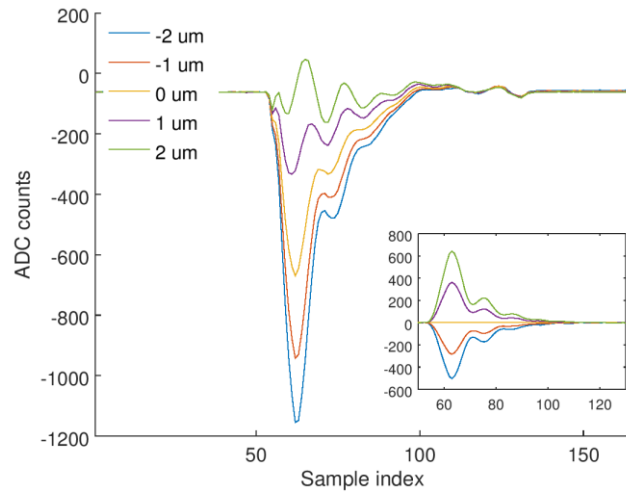
Sample index = 63

Charge normalization using Σ_{P1}



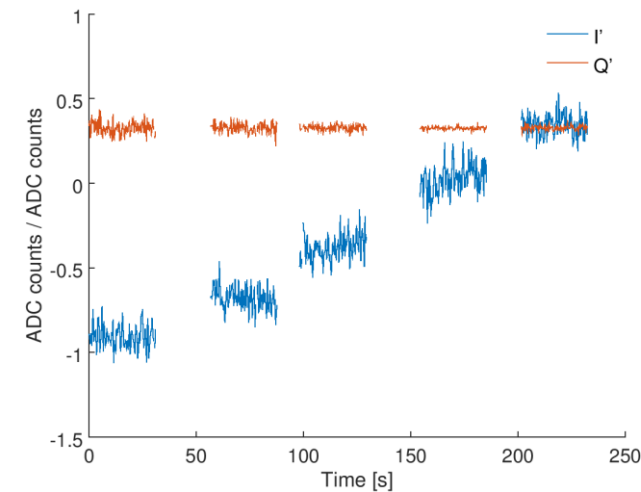
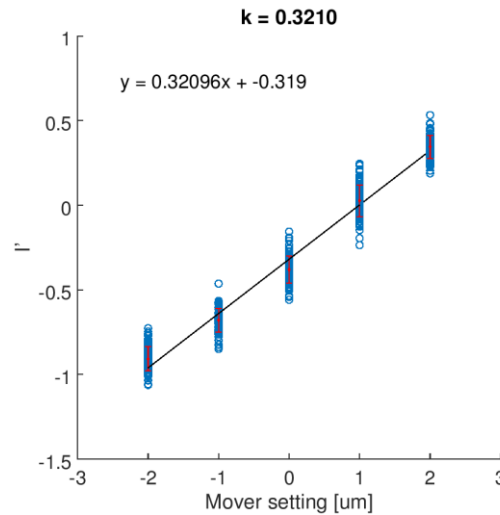
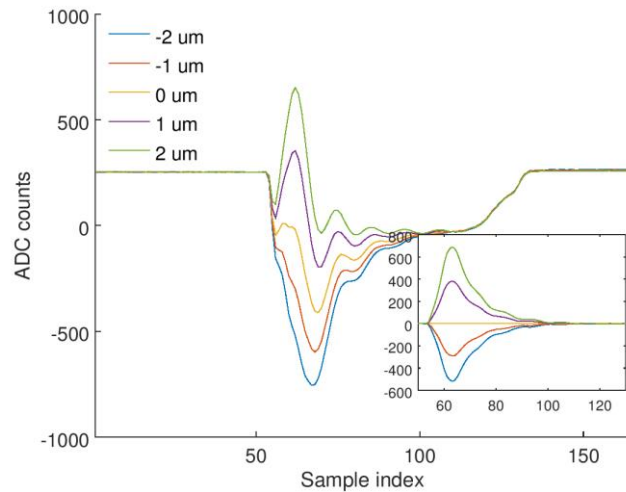
IPC

AQD0FFyScan24 (20 dB, mid charge)



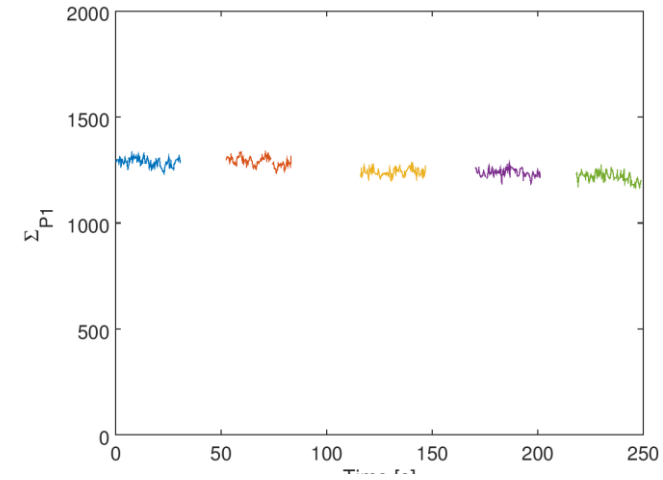
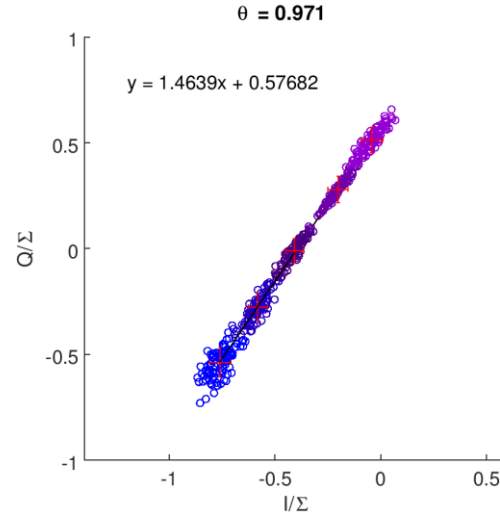
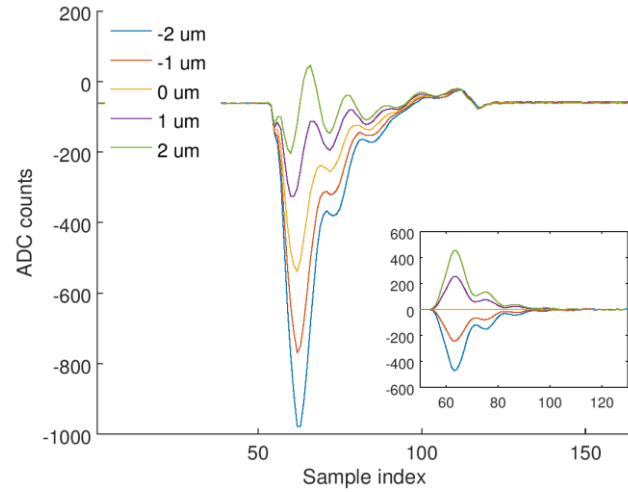
Sample index = 63

Charge normalization using Σ_{P1}



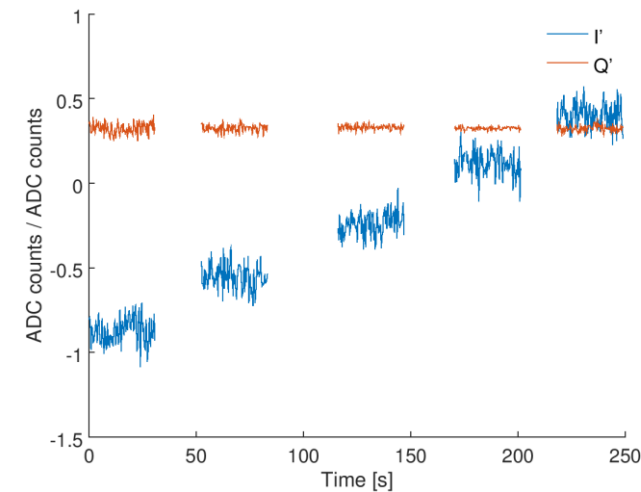
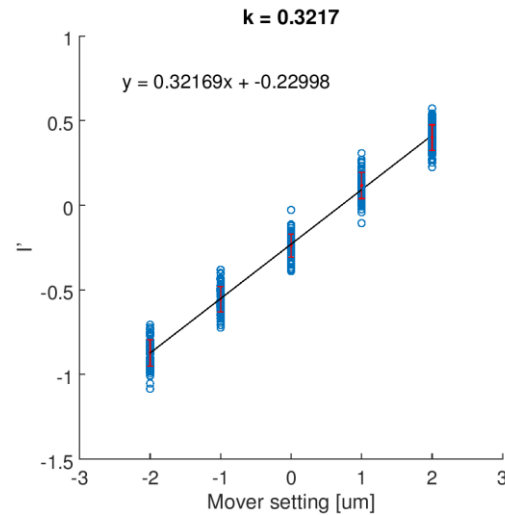
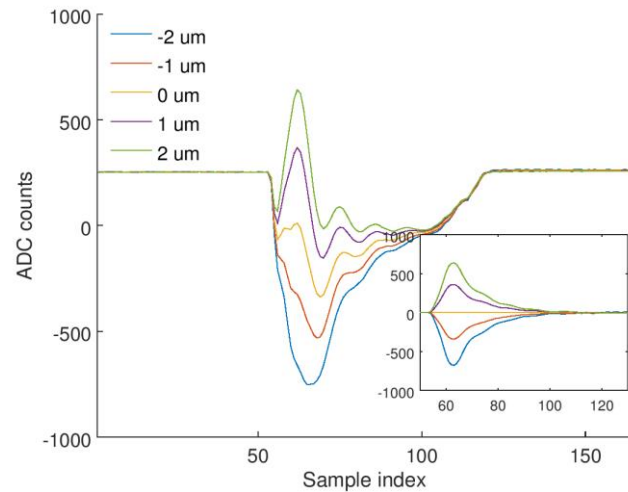
IPC

AQD0FFyScan25 (30 dB, mid charge)



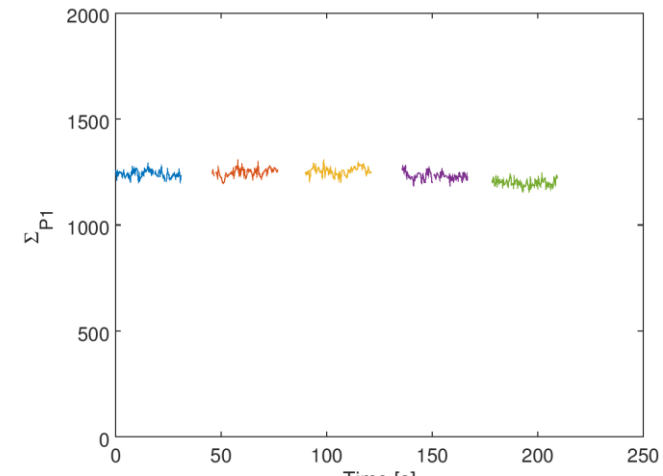
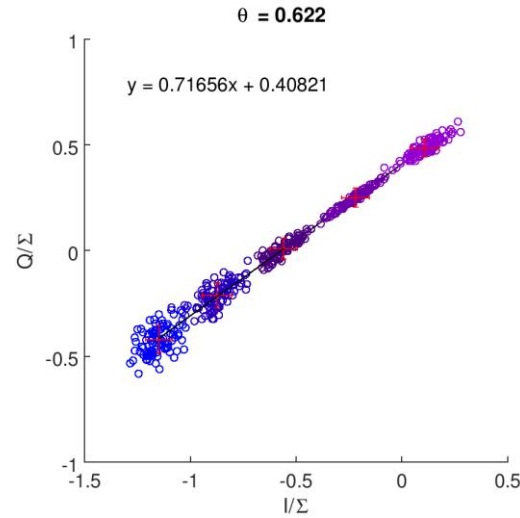
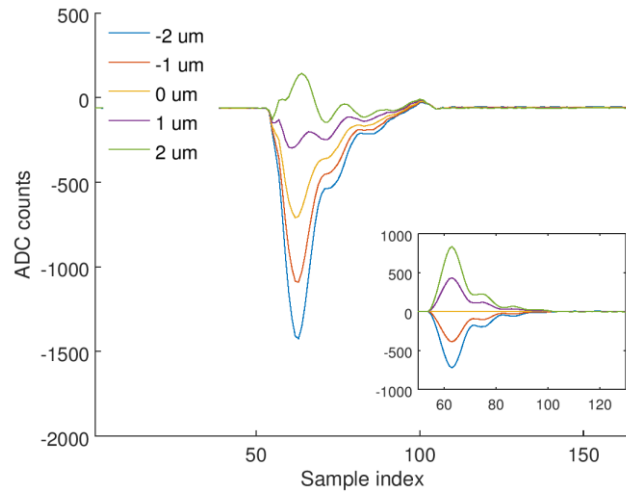
Sample index = 63

Charge normalization using Σ_{P1}



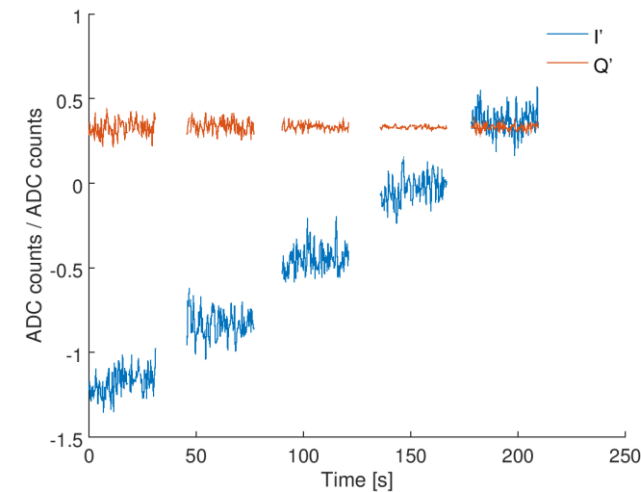
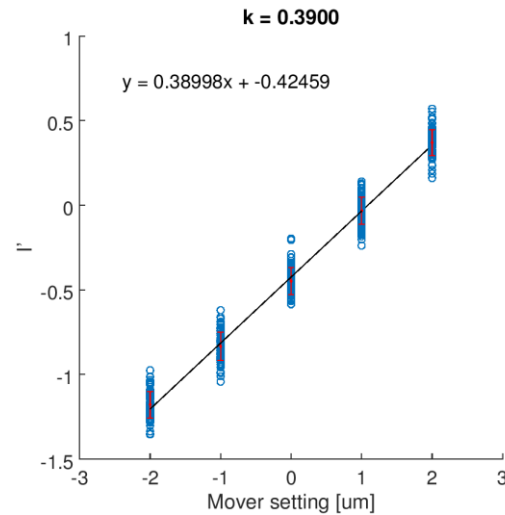
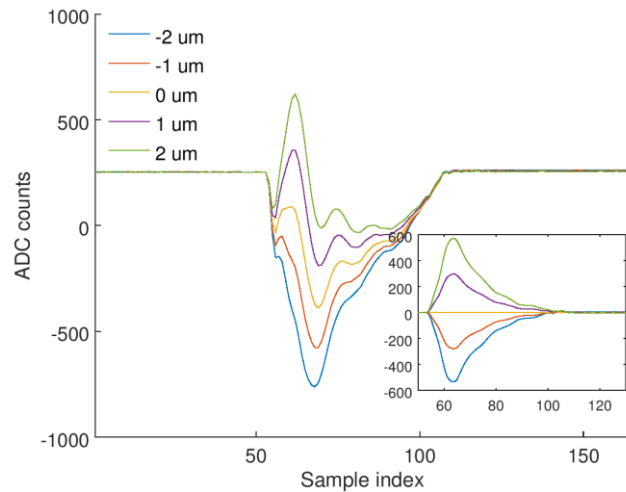
IPC

AQD0FFyScan27 (40 dB, mid charge)



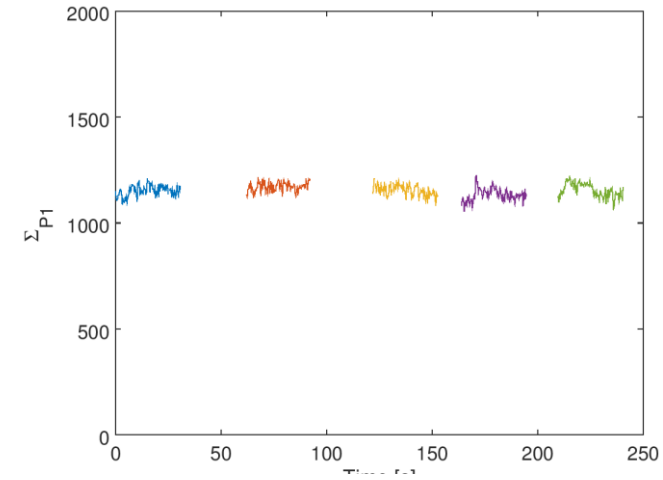
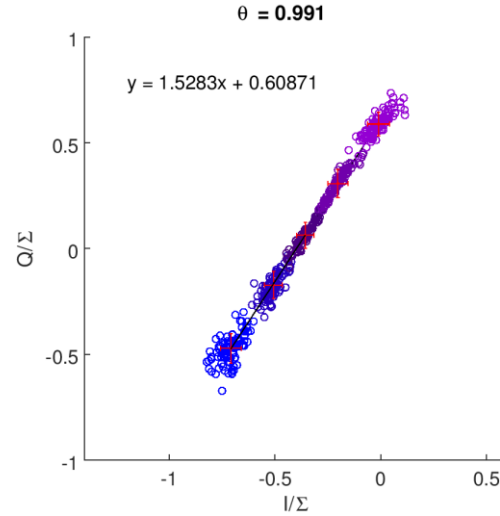
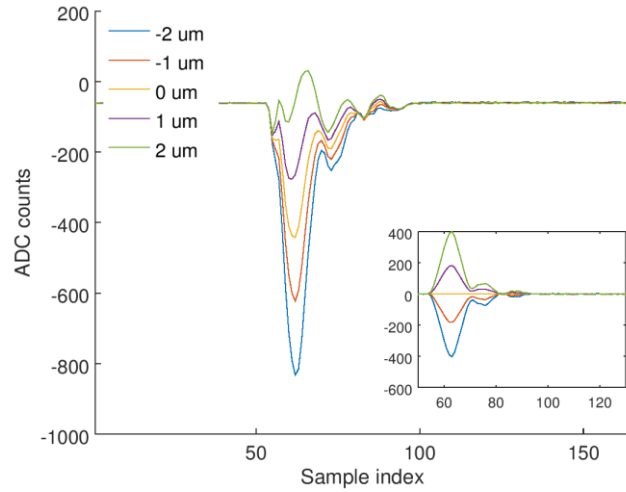
Sample index = 63

Charge normalization using Σ_{P1}



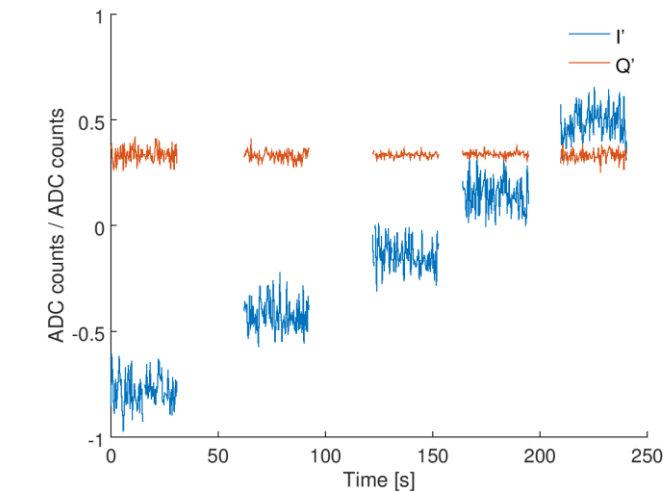
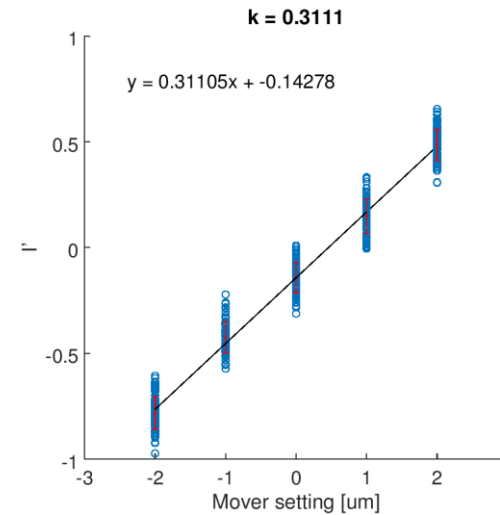
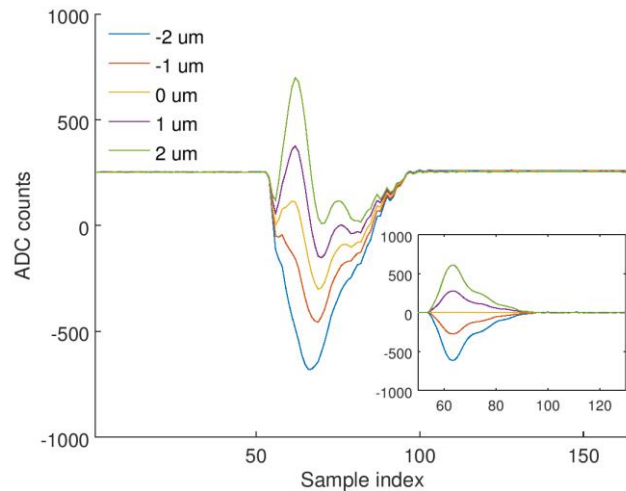
IPC

AQD0FFyScan28 (50 dB, mid charge)

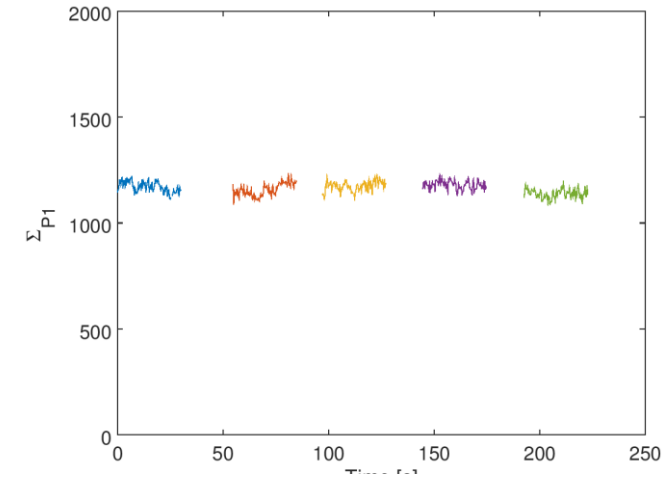
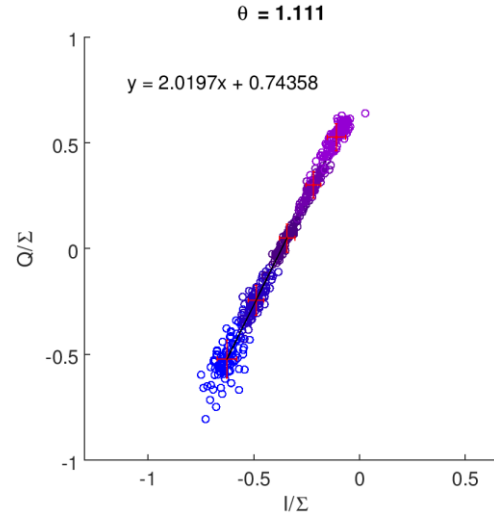
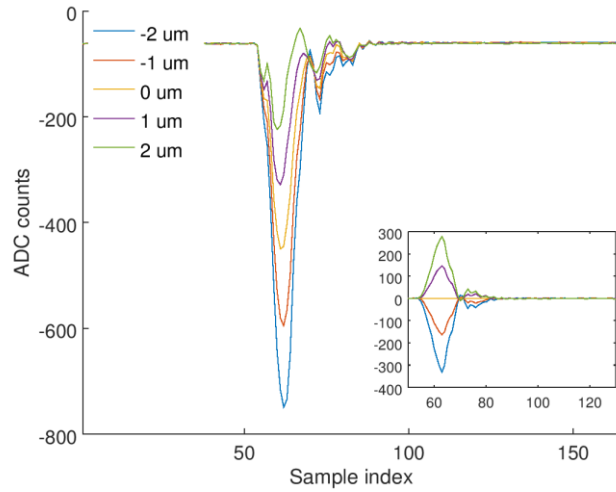


Sample index = 63

Charge normalization using Σ_{P1}

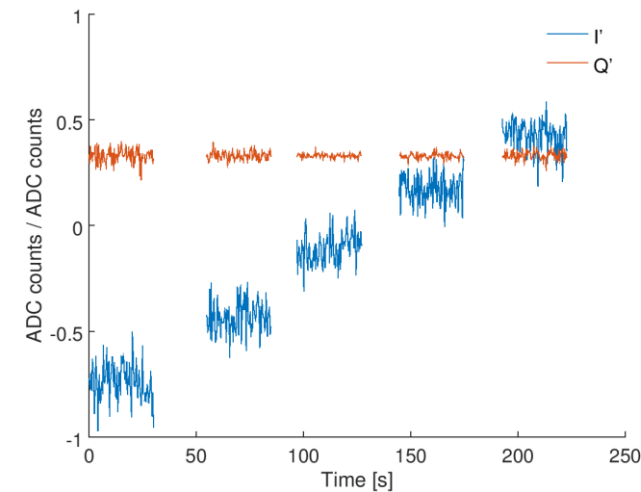
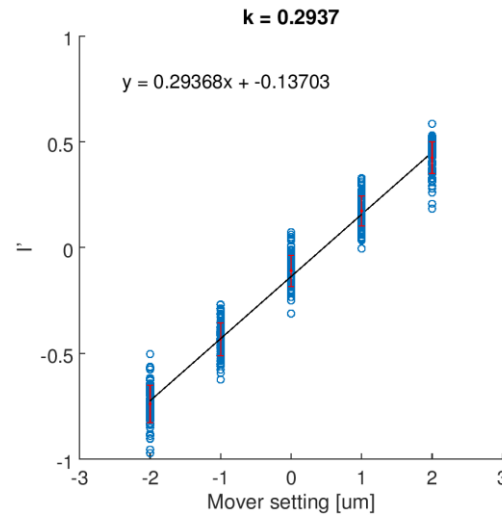
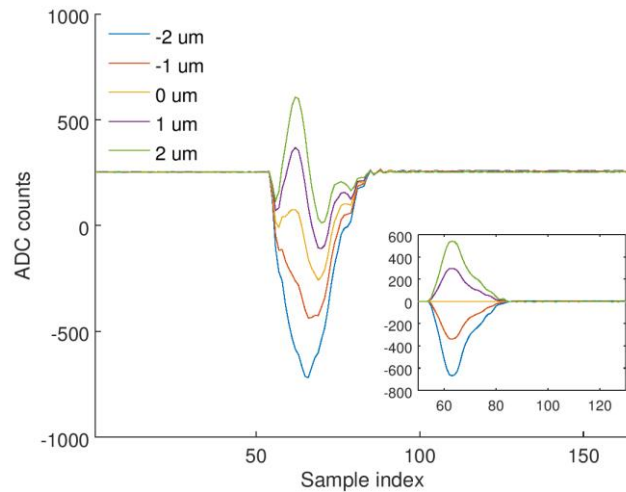


AQD0FFyScan29 (60 dB, mid charge)



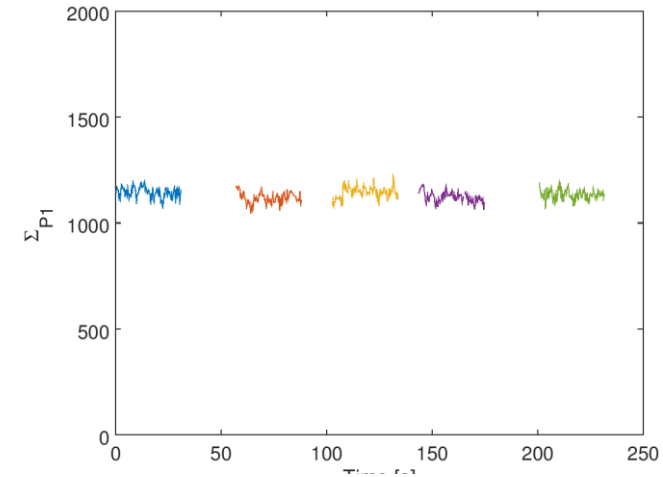
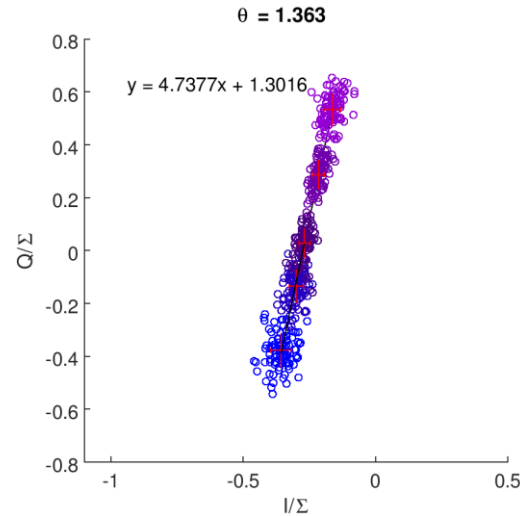
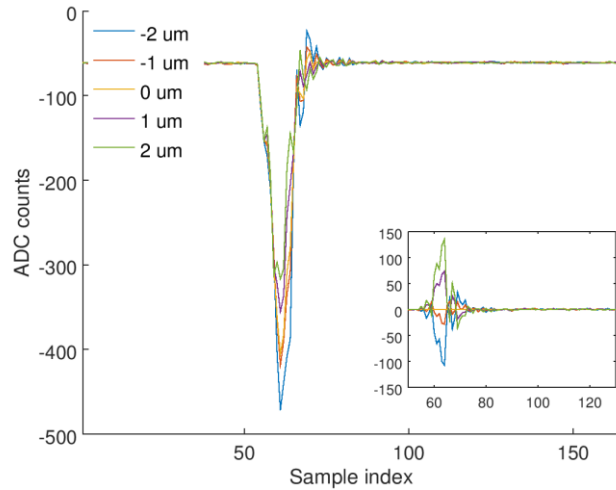
Sample index = 63

Charge normalization using Σ_{P1}



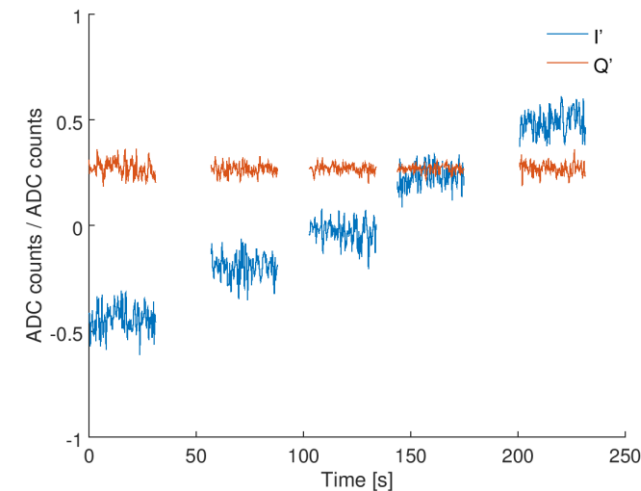
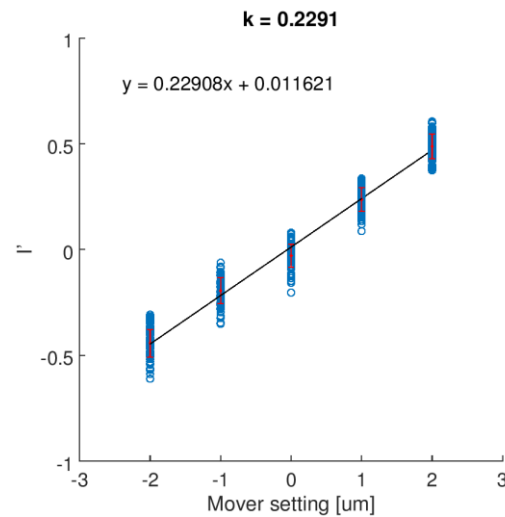
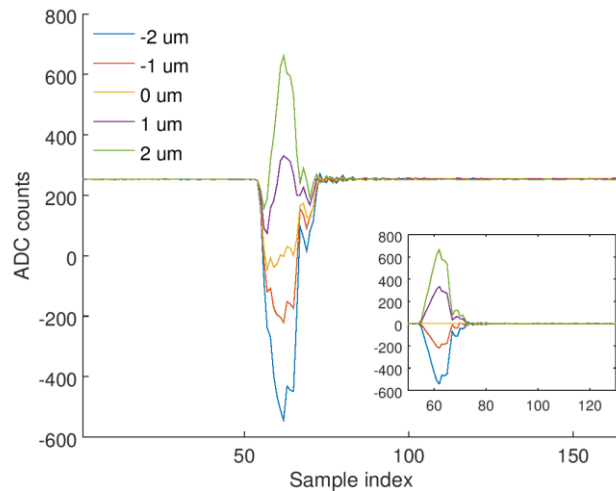
IPC

AQD0FFyScan30 (70 dB, mid charge)



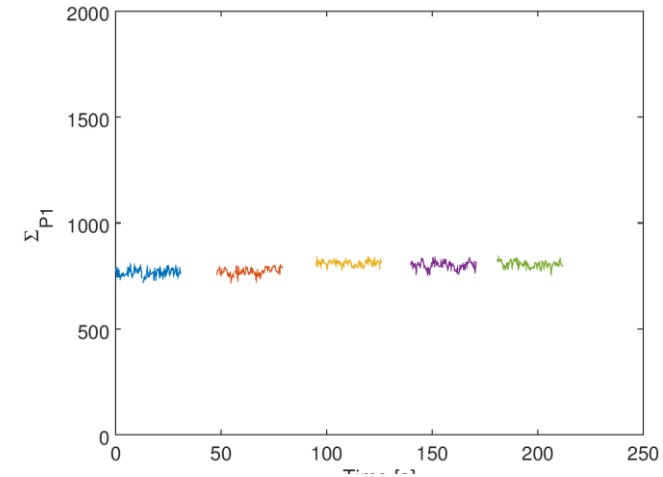
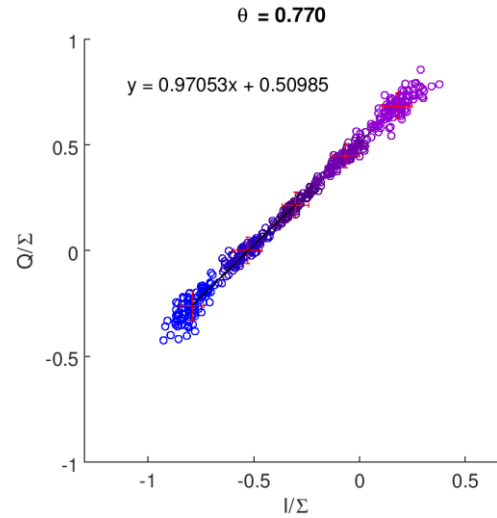
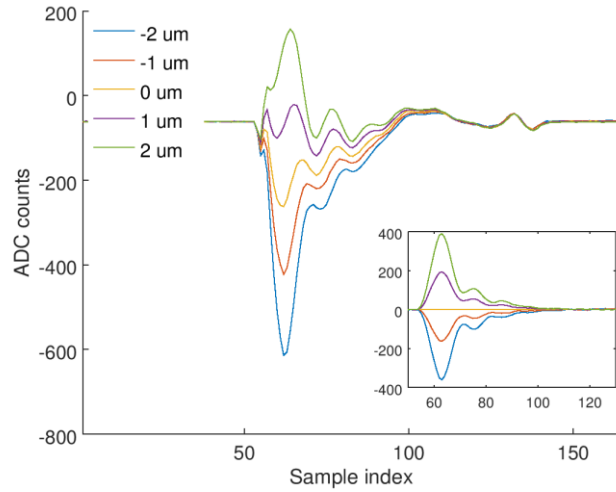
Sample index = 63

Charge normalization using Σ_{P1}



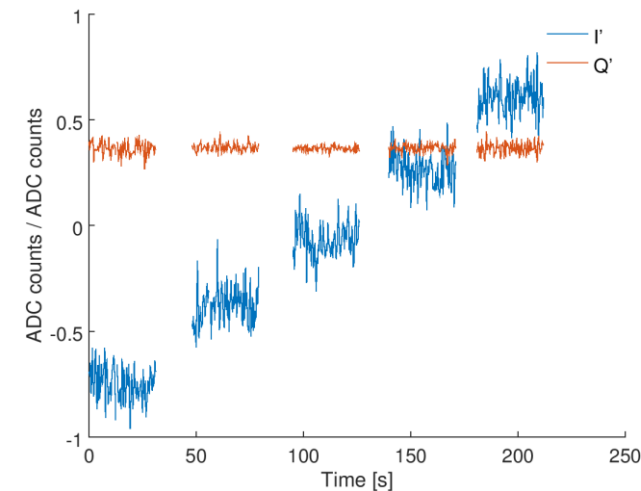
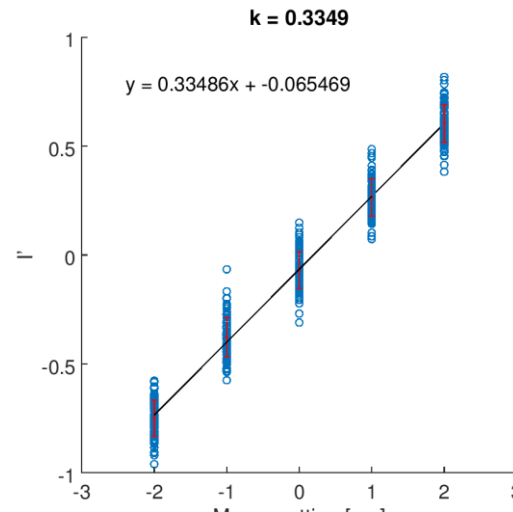
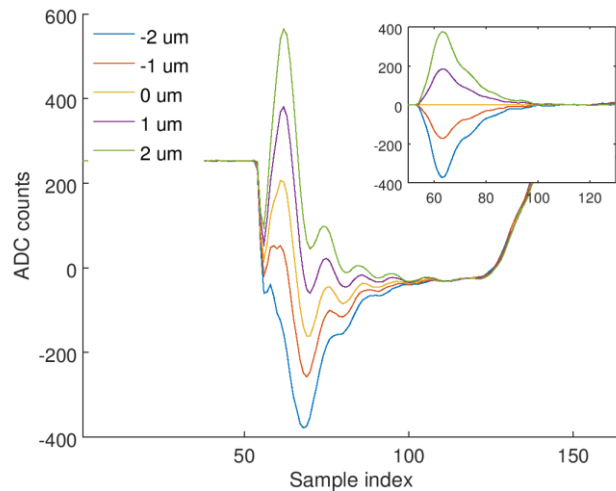
IPC

AQD0FFyScan31 (10 dB, low charge)



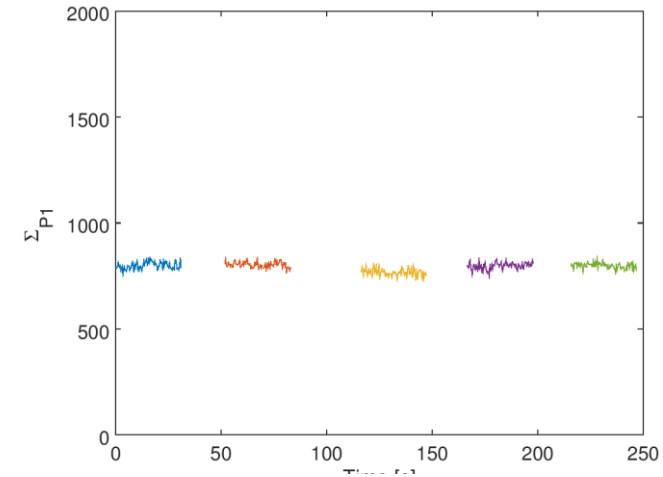
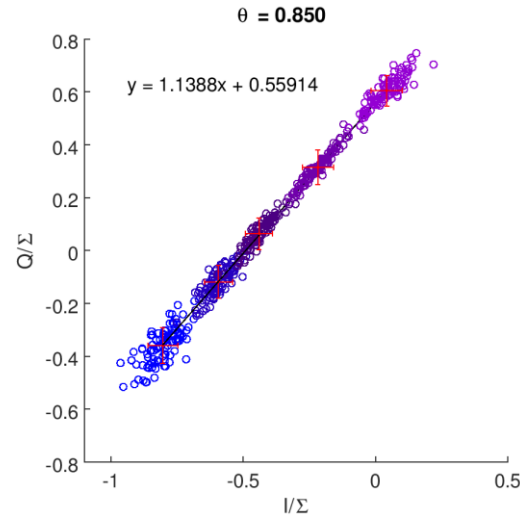
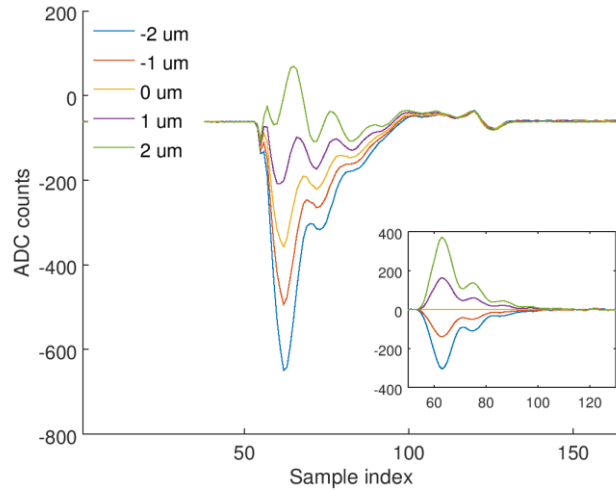
Sample index = 63

Charge normalization using Σ_{P1}



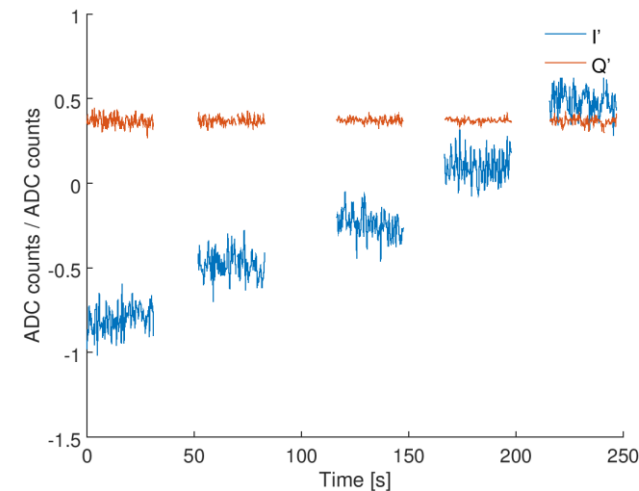
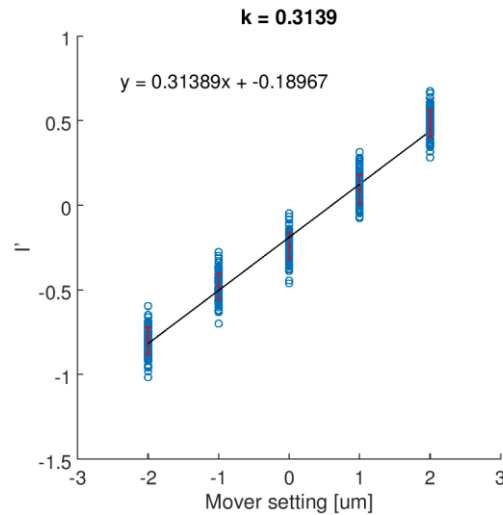
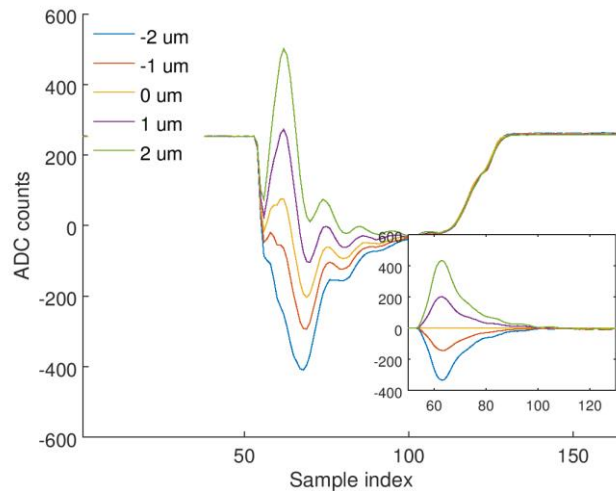
IPC

AQD0FFyScan32 (20 dB, low charge)



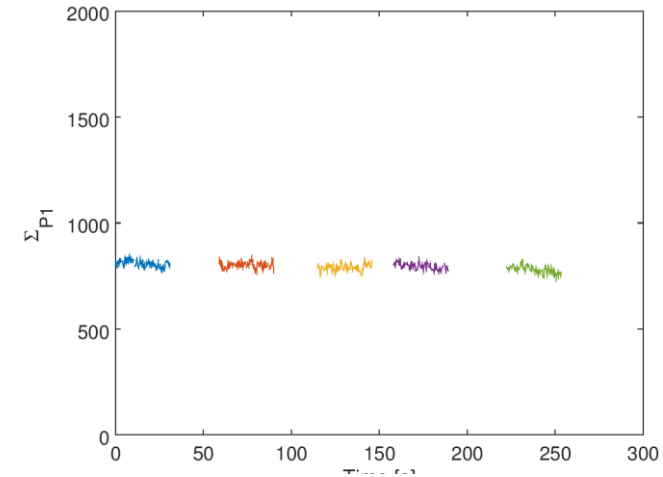
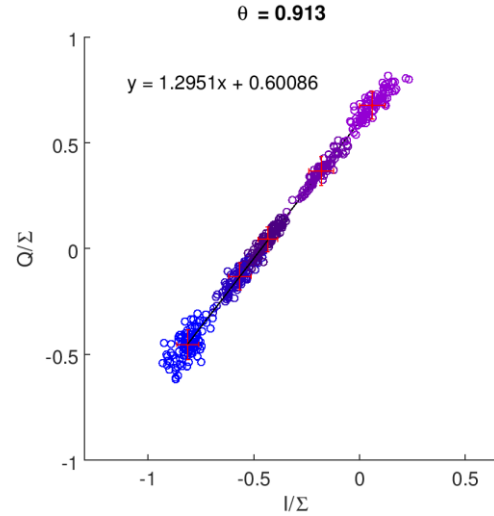
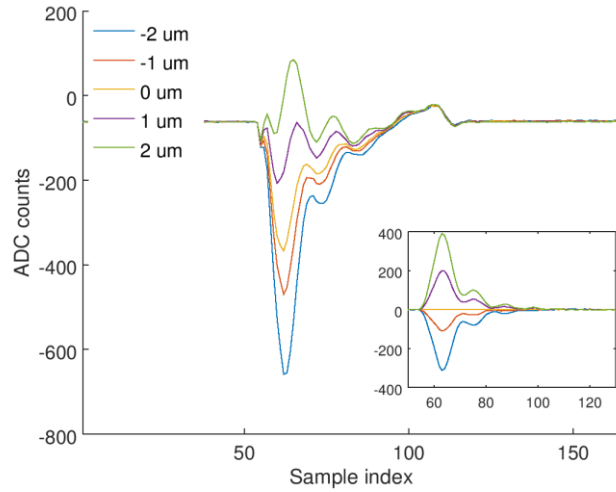
Sample index = 63

Charge normalization using Σ_{P1}



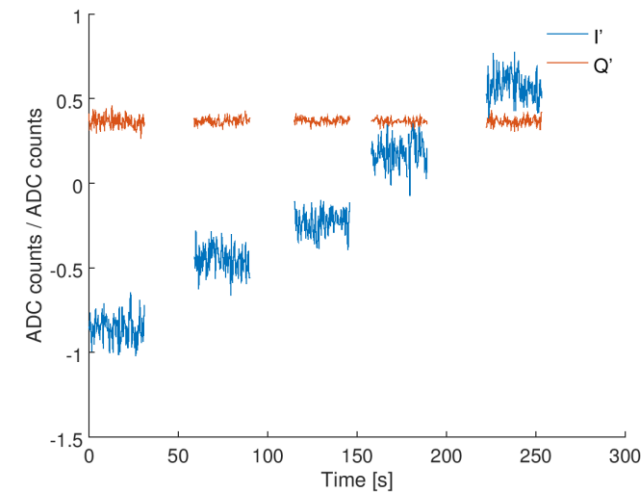
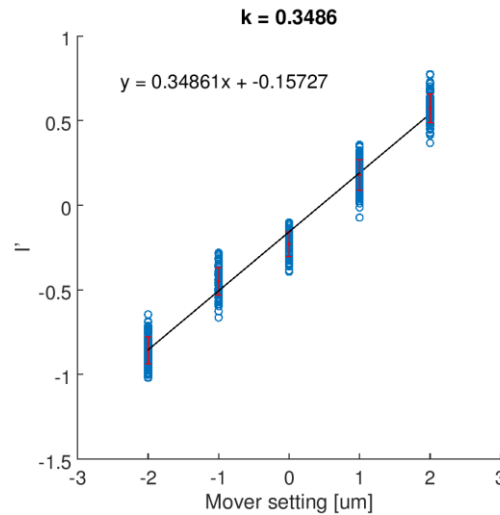
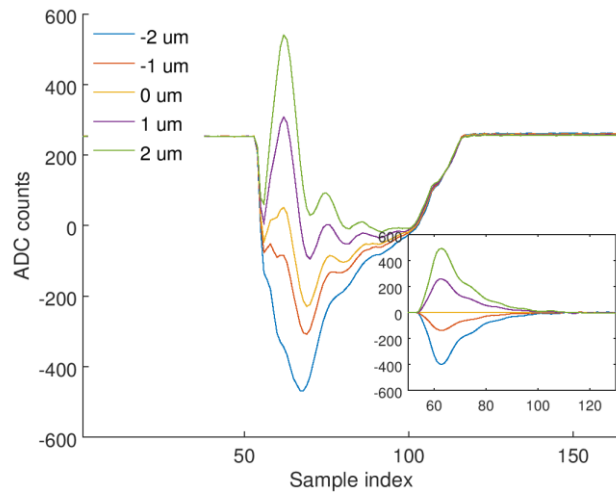
IPC

AQD0FFyScan33 (30 dB, low charge)



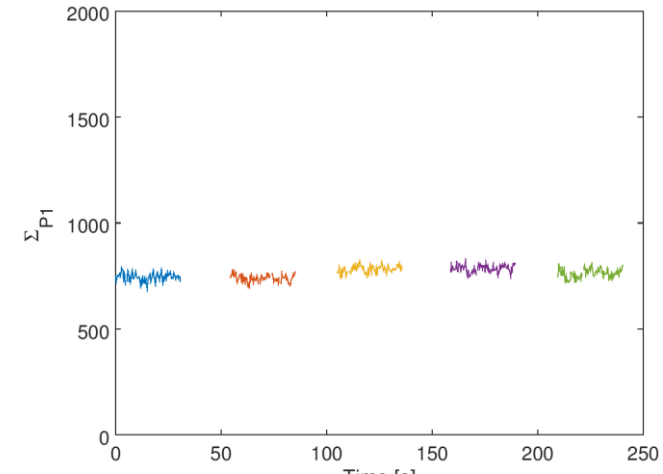
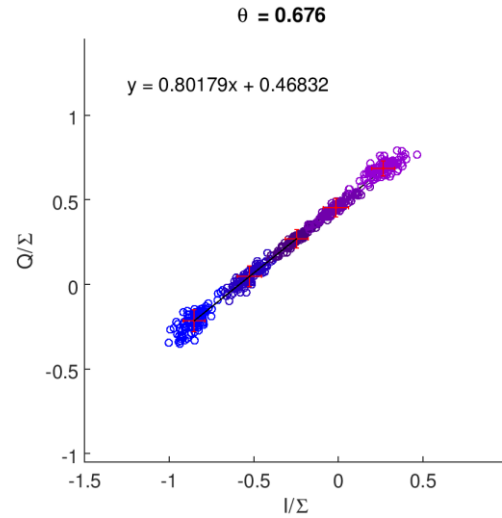
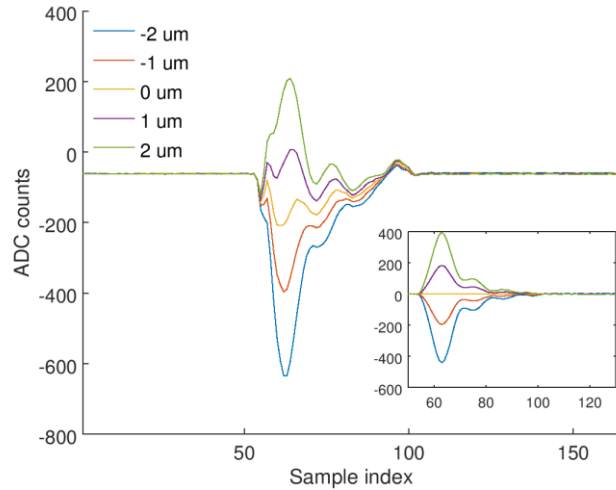
Sample index = 63

Charge normalization using Σ_{P1}



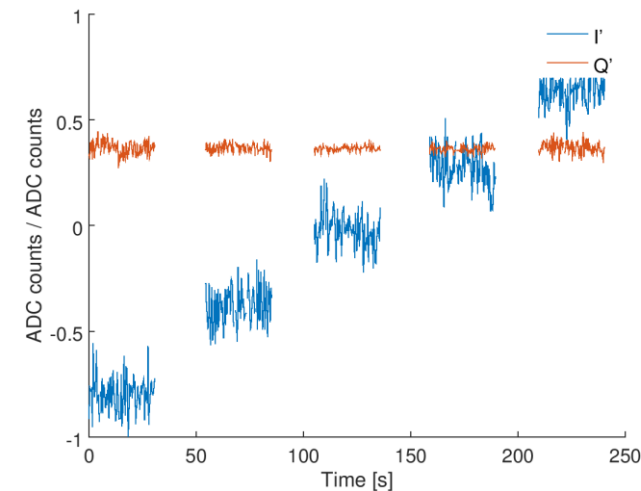
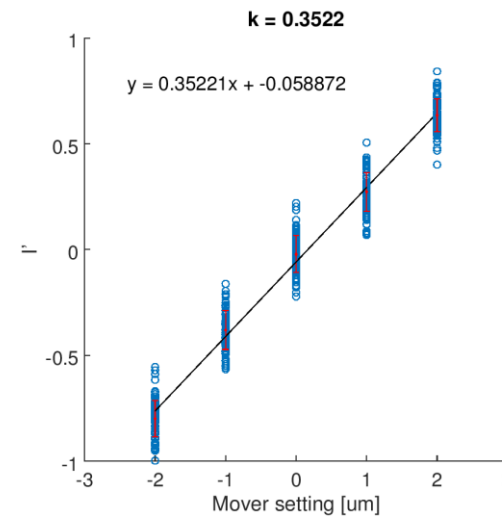
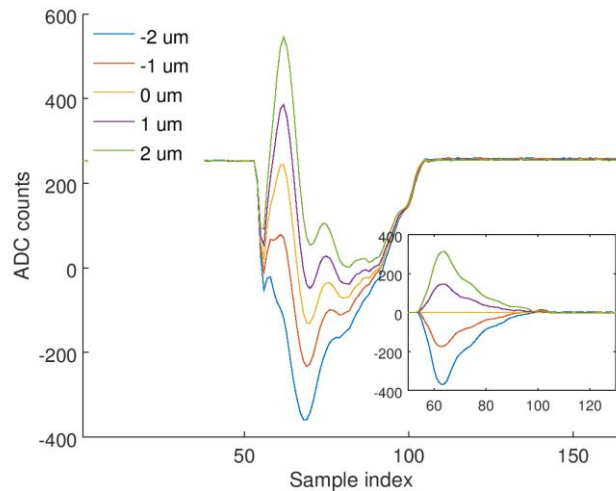
IPC

AQD0FFyScan34 (40 dB, low charge)



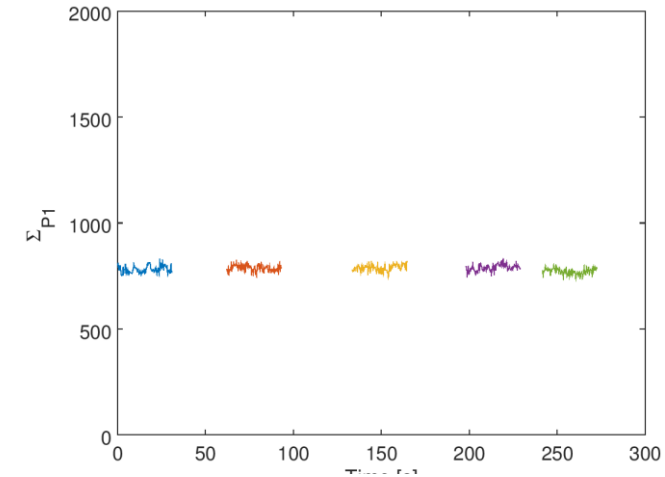
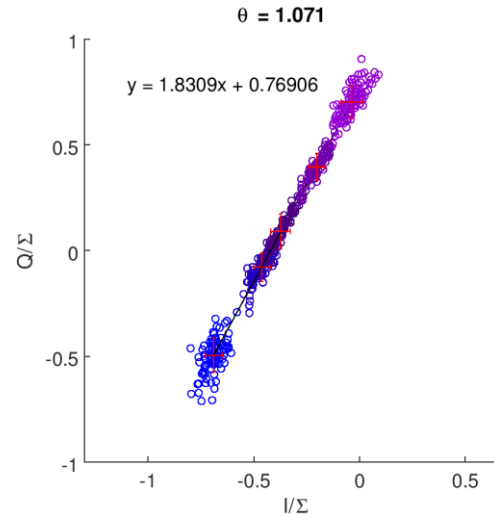
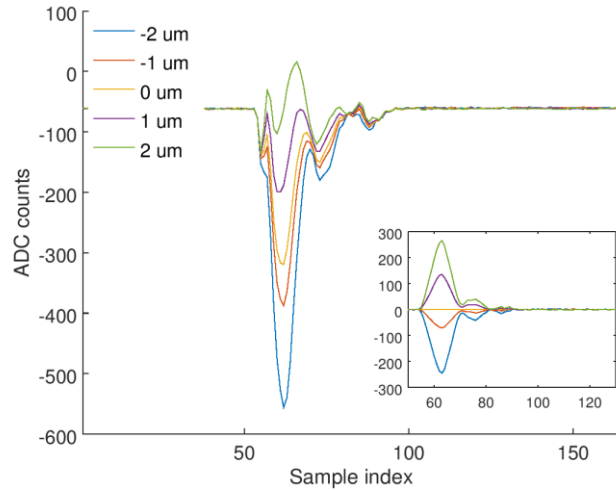
Sample index = 63

Charge normalization using Σ_{P1}



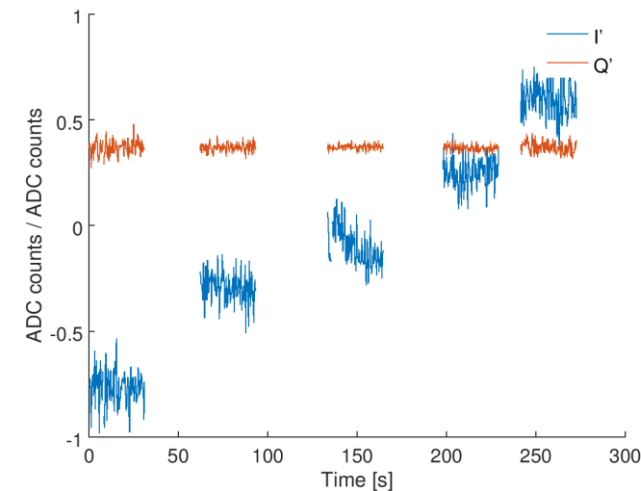
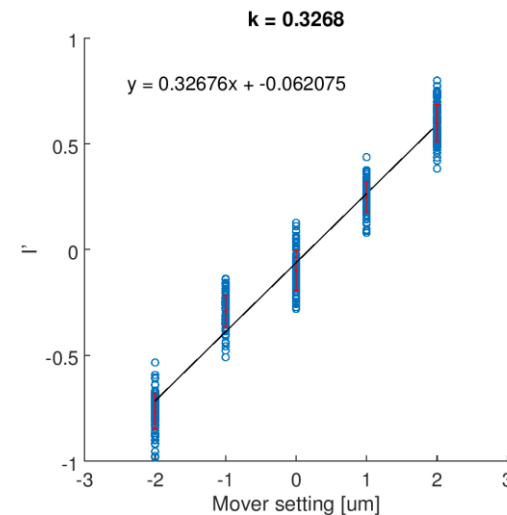
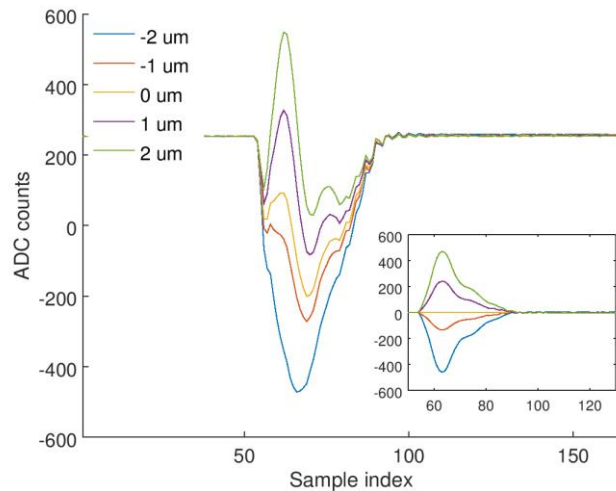
IPC

AQD0FFyScan35 (50 dB, low charge)



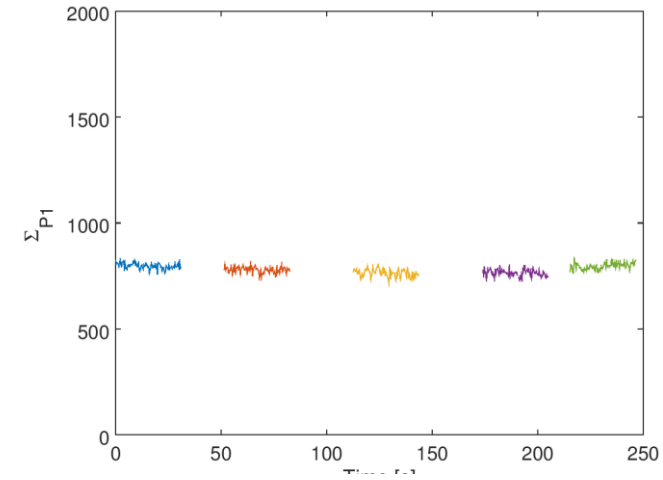
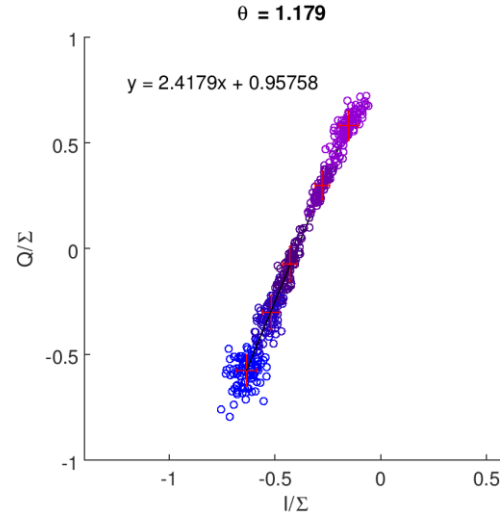
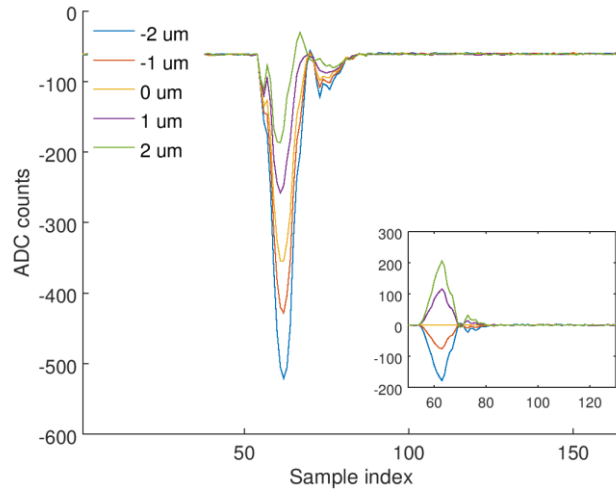
Sample index = 63

Charge normalization using Σ_{P1}



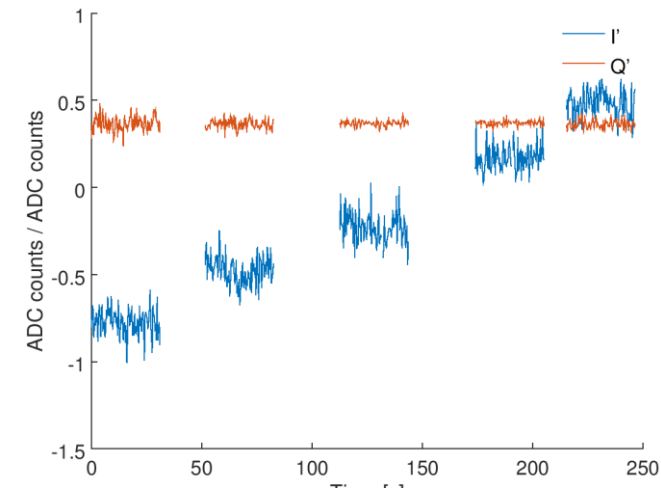
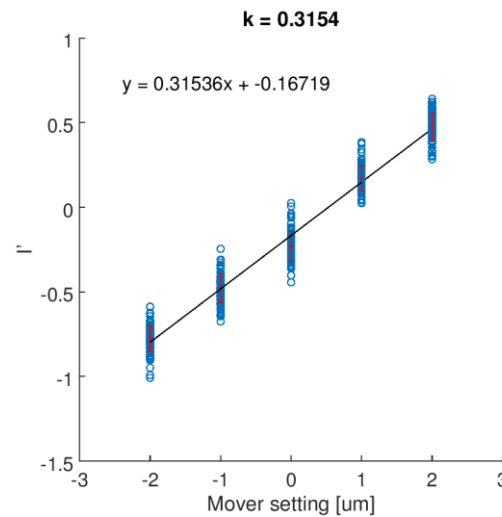
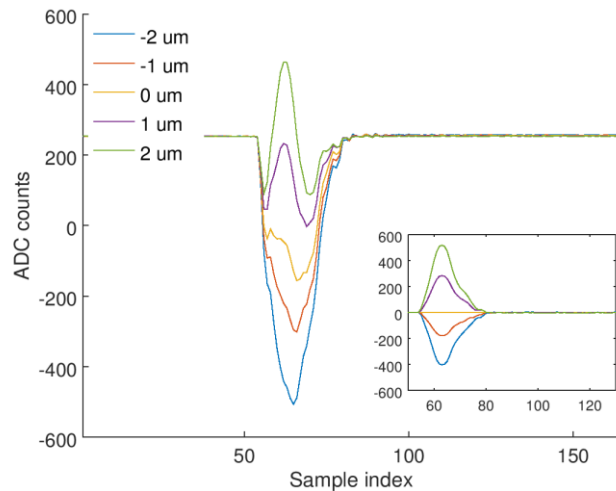
IPC

AQD0FFyScan35 (60 dB, low charge)



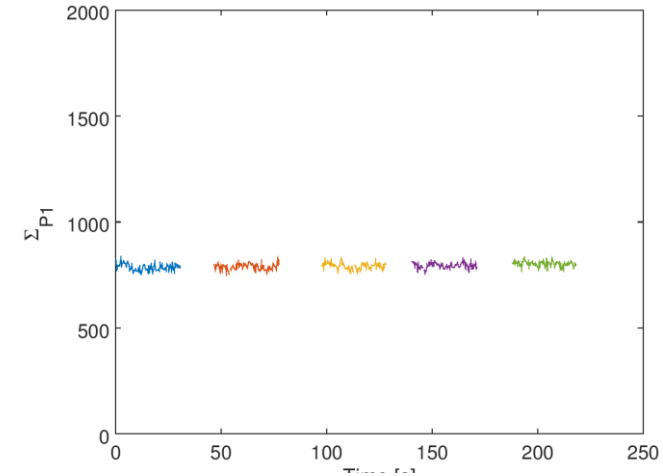
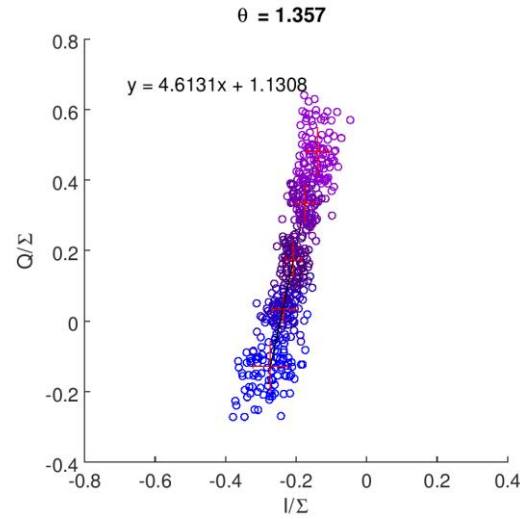
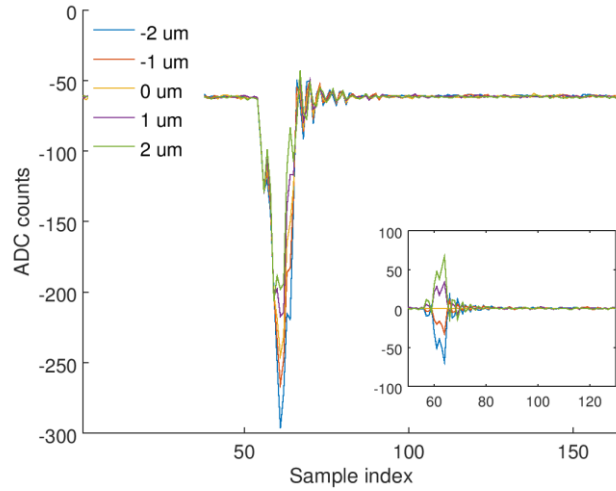
Sample index = 63

Charge normalization using Σ_{P1}



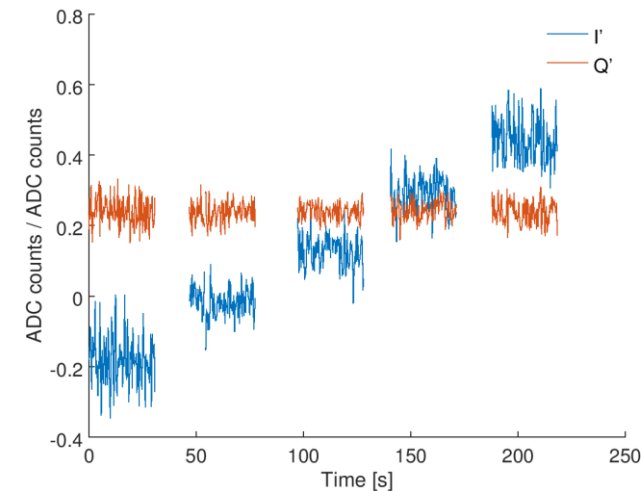
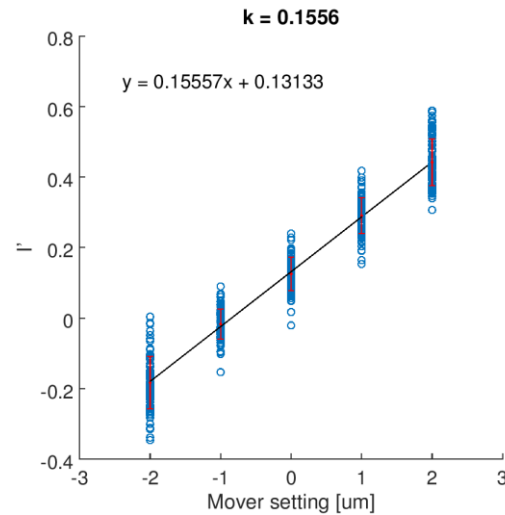
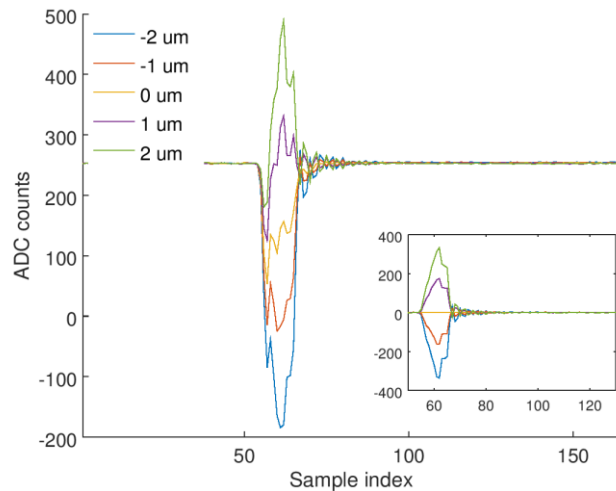
IPC

AQD0FFyScan37 (70 dB, low charge)



Sample index = 63

Charge normalization using Σ_{P1}



IPC