How to reduce NSE data to I(Q,t)

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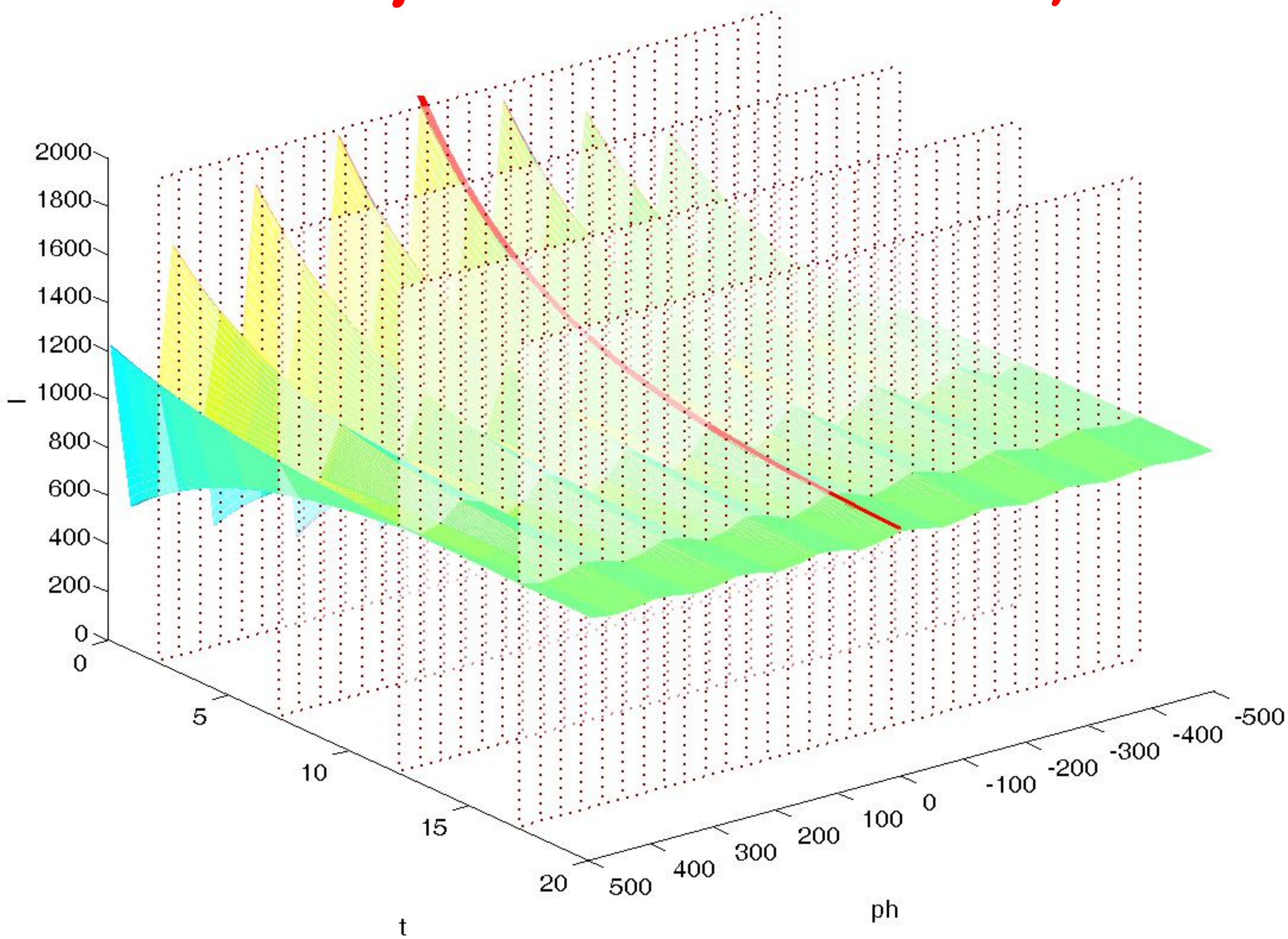
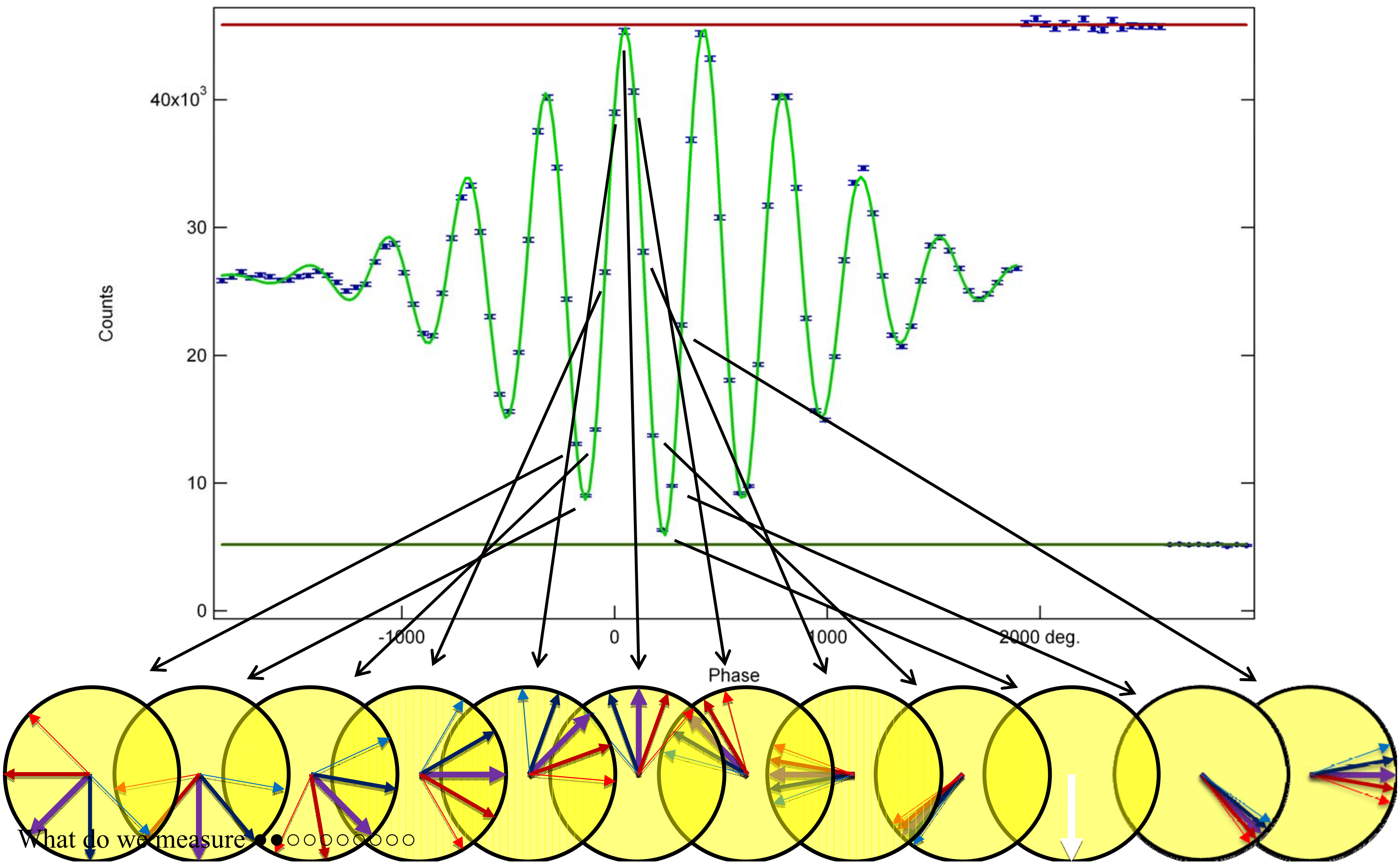
Outline

- What does NSE measure?
  - Polarization vs Phase and F_t.
  - How to Eliminate Instrument Dependent Signals.
- How using a 2D detector complicates things?
  - How DAVE helps us out.

Polarized Intensity vs phase and F_t



Polarized Intensity vs phase



Fitting the echo

I_0 Average Intensity

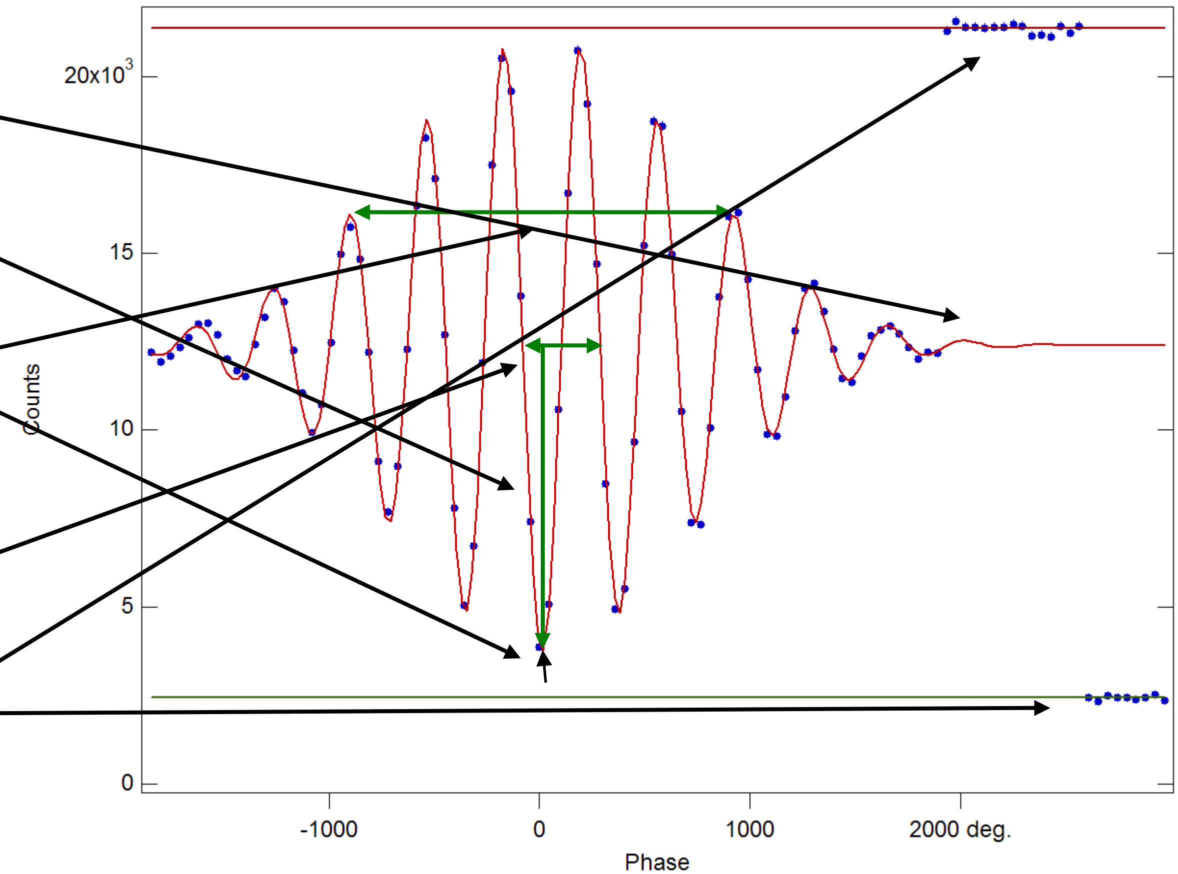
A Amplitude, related to I(Q,t)

ph_0 Echo point

σ Echo width, function of f(λ) width distribution

T Period, function of ⟨λ⟩

Static measurements
(Up and Down)
t=0 (J=0): $\int S(Q,\omega)d\omega$



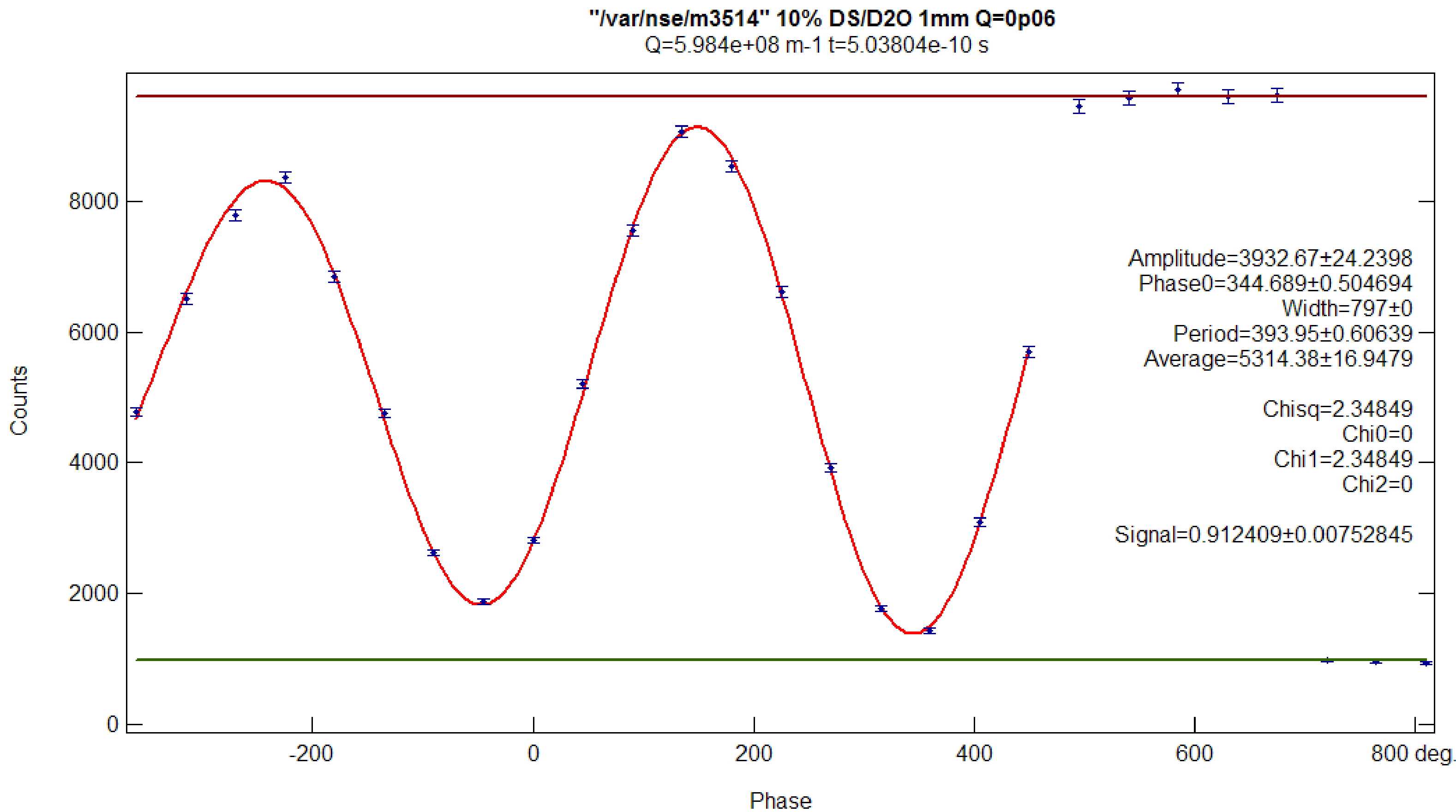
$$I^p = I_0 + A\exp\left[\frac{(ph-ph_0)^2}{2\sigma^2}\right]\cos\left[\frac{360}{T}(ph-ph_0)\right]$$

The Physical Information is All in the Amplitude

$$\frac{I(Q,t)}{I(Q)} \propto \frac{2A}{Up-Dwn}$$

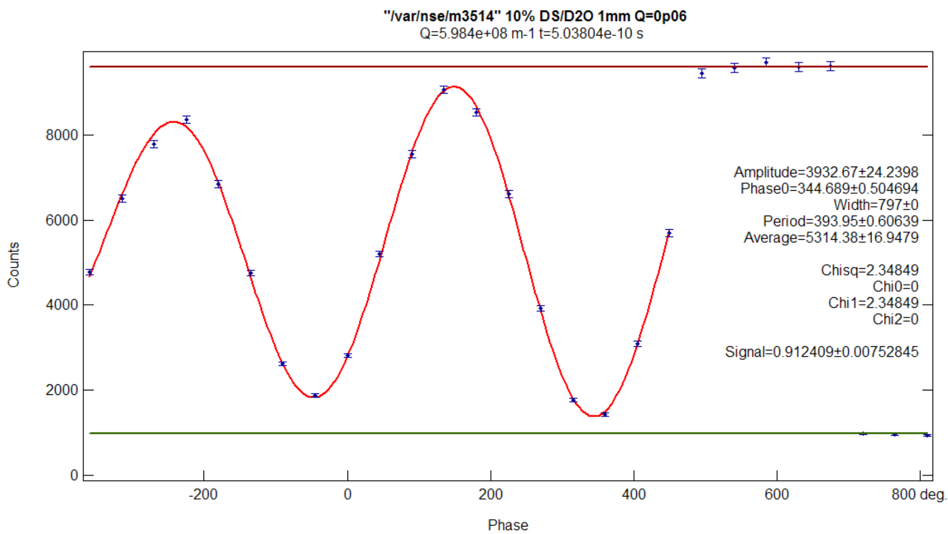
Incidentally, in this way, both polarization and detector efficiency effects are taken care off.

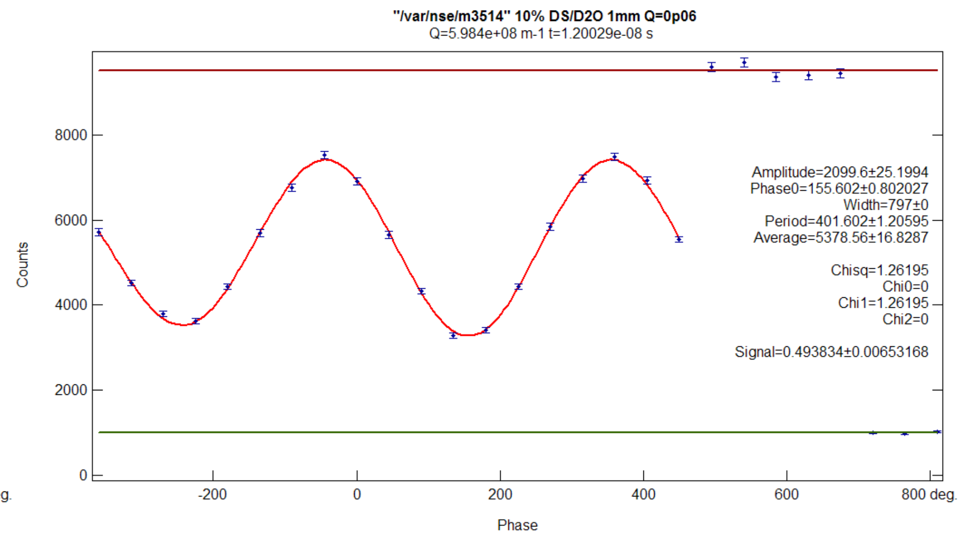
A Small Portion of the Echo will do

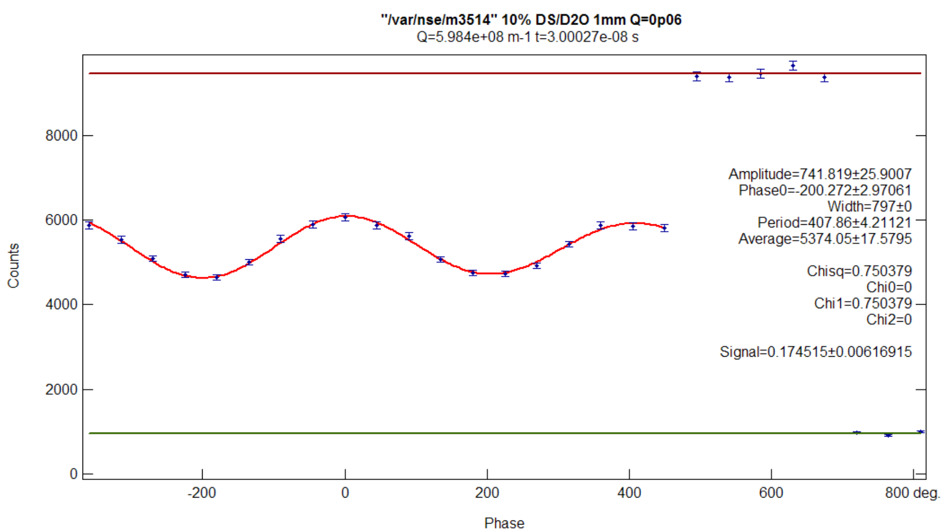


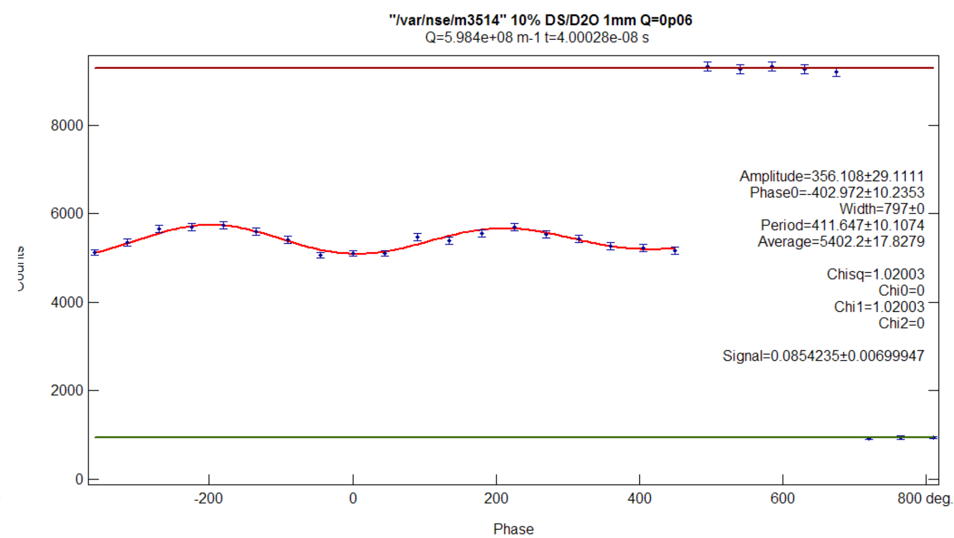
What do we measure ●●●●●○○○○○

Polarized Intensity vs F_t









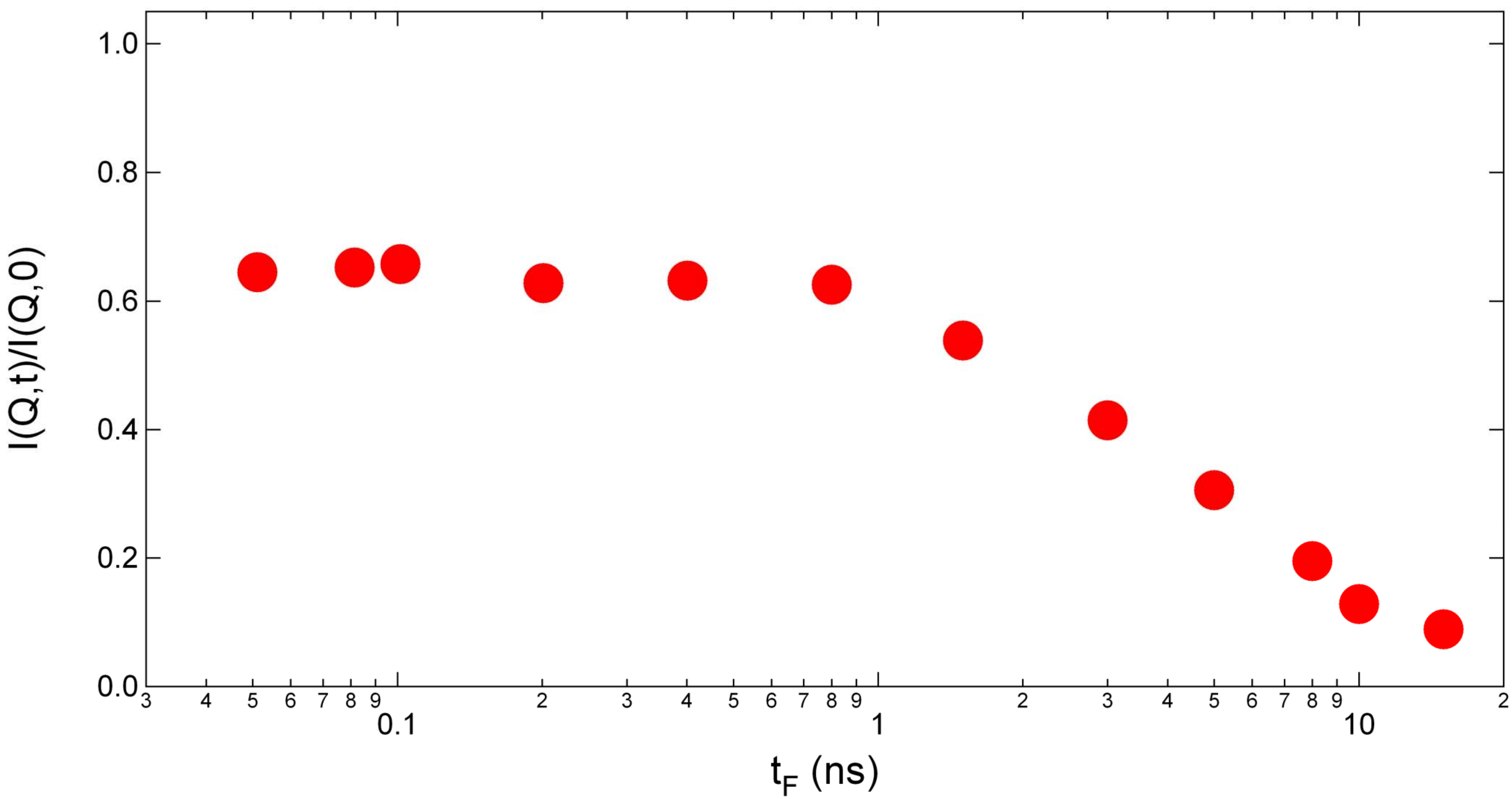
What do we measure ●●●●●●○○○○

Resolution

Even for an elastic scatterer the echo signal will decrease with the increase of the Fourier time.

•Inhomogeneities in the magnetic field will depolarize the beam.

Resolution Normalization



What do we measure ●●●●●●●●●○○

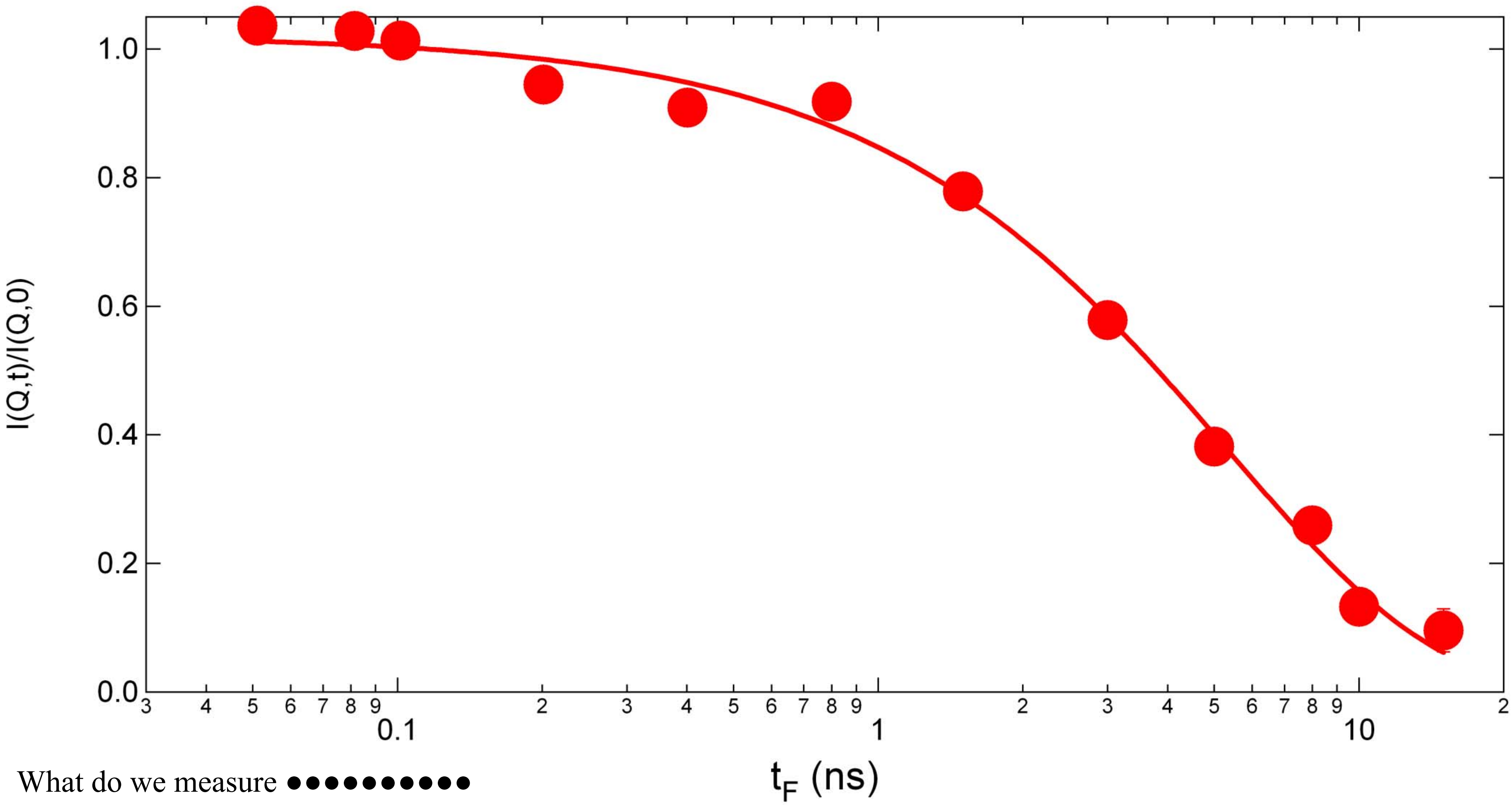
$$\frac{I(Q,t)}{I(Q,0)} = \frac{2A/(Up - Dwn)}{2A^R/(Up^R - Dwn^R)}$$

Resolution Normalization

In Neutron Spin-Echo the resolution can be simply divided out from the data.

Blank correction

$$\frac{I(Q,t)}{I(Q)} = \frac{2\left[A-(1-\phi)\frac{T}{T^{BKG}}A^{BKG}\right] \Big/ \left[(Up-Dwn)-(1-\phi)\frac{T}{T^{BKG}}\left(Up^{BKG}-Dwn^{BKG}\right)\right]}{2A^{R}\Big/\left(Up^{R}-Dwn^{R}\right)}$$



What do we measure ●●●●●●●●●●●●

Take Home Messages

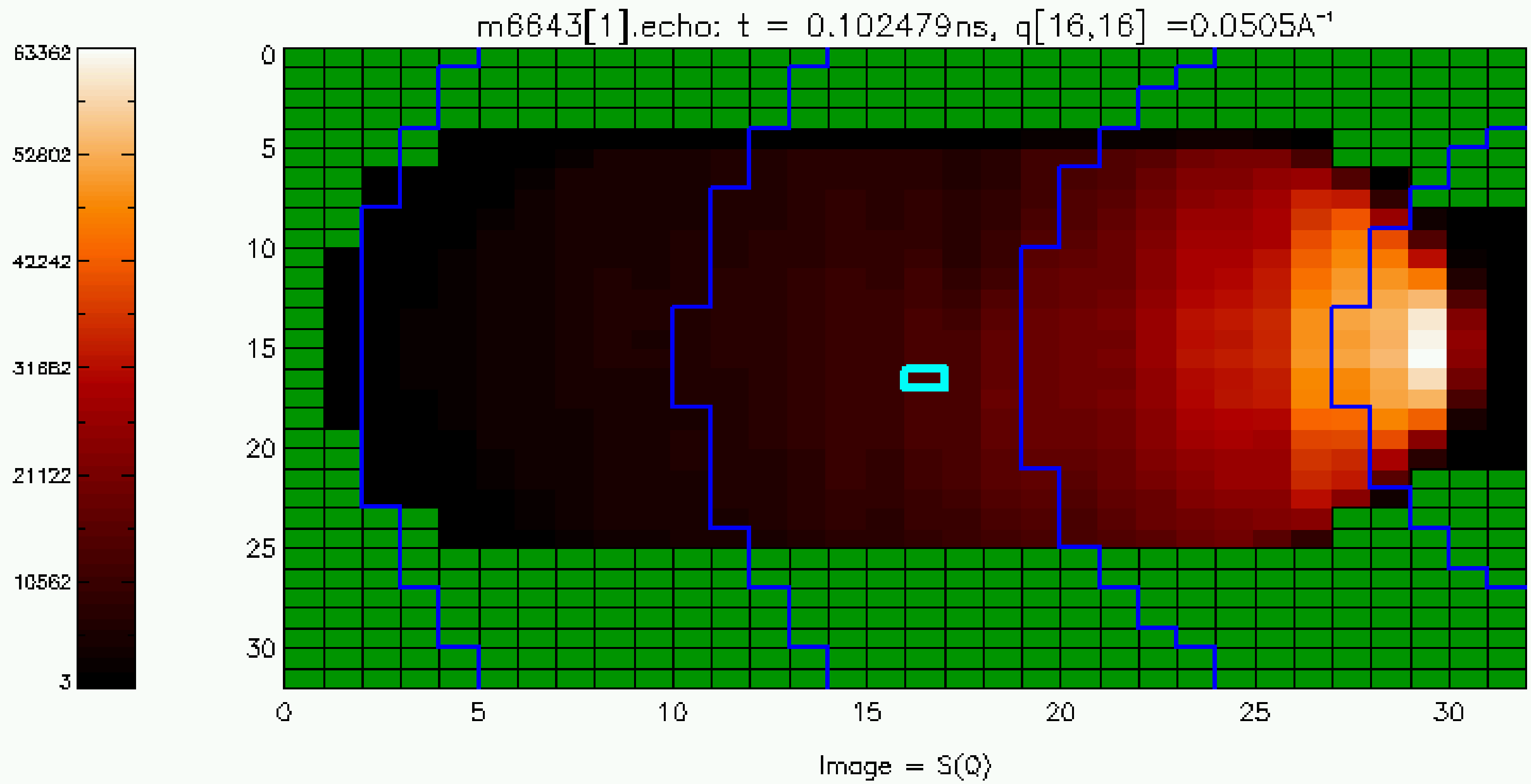
- The Physical Information is in the Echo Amplitude.
- But… You Have to Accurately Fit the Echo to get the Amplitude right.
- The Resolution can be simply divided out.

Using a Big Detector Makes Things Harder

Questions:

- What are the advantages of using a 2D detector?
- What are the problems that a 2D detector gives for the reduction of NSE data?

2D Detector



$$\text{Total Data}=32\times32\times N_{phase}\times N_{Ft}\approx500000$$

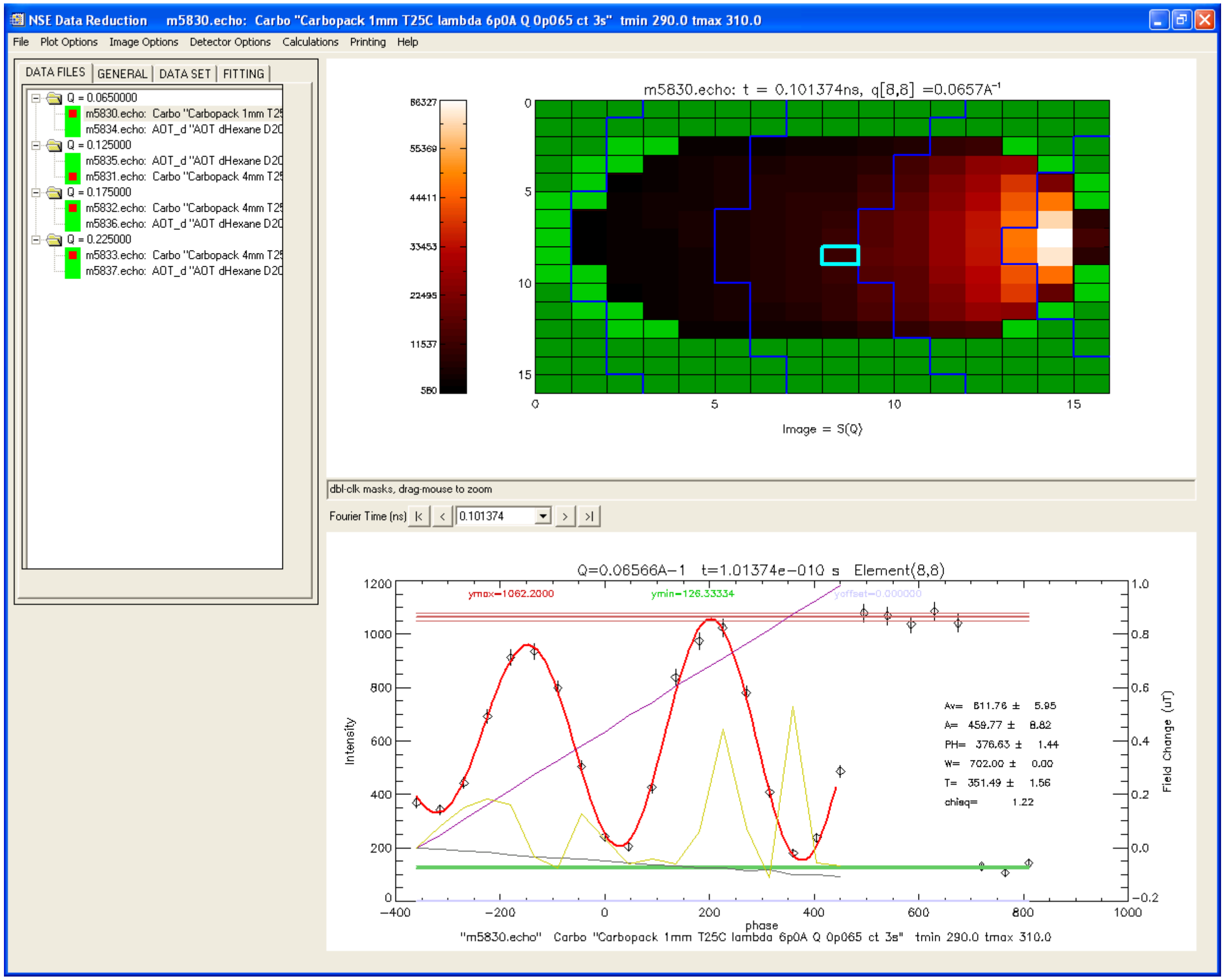
Questions II

- What are those thin blue lines?
- Does the polarized intensity change with the pixel position? Why?

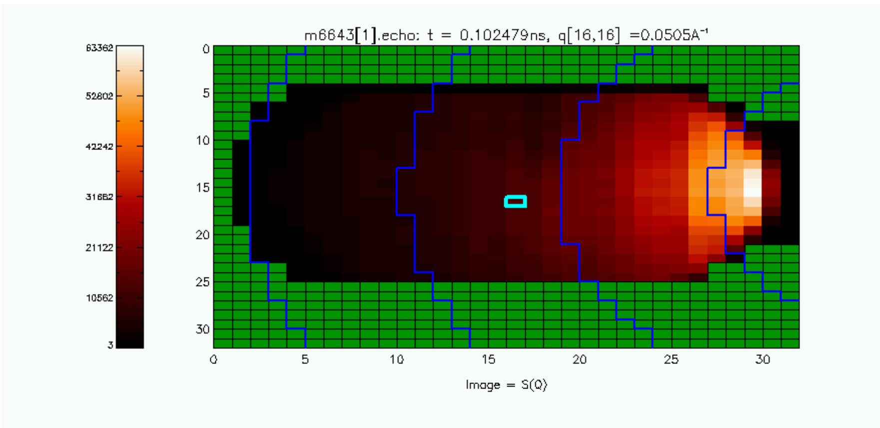
Up and Down	• Yes. Efficiency, Polarization.
I_0	• Yes.
A	• Yes. Q-dependence.
T	• No.
σ	• No.
Ph_0	• Yes. Field Integral: $\int Bdl$.

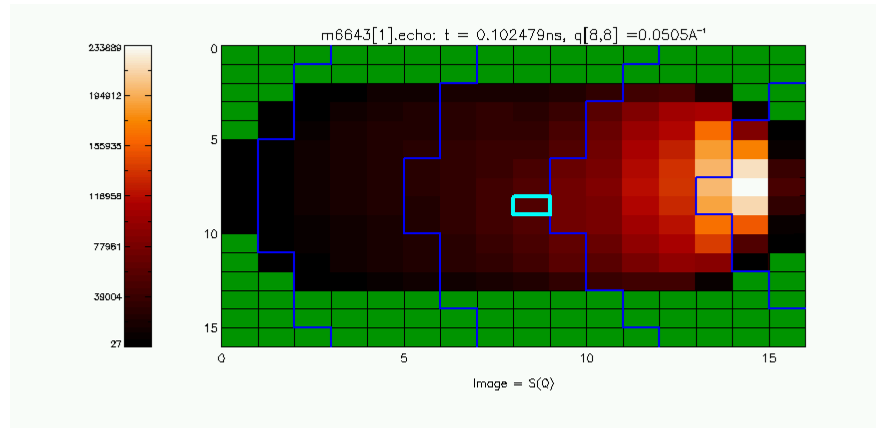
2D Detector Analysis

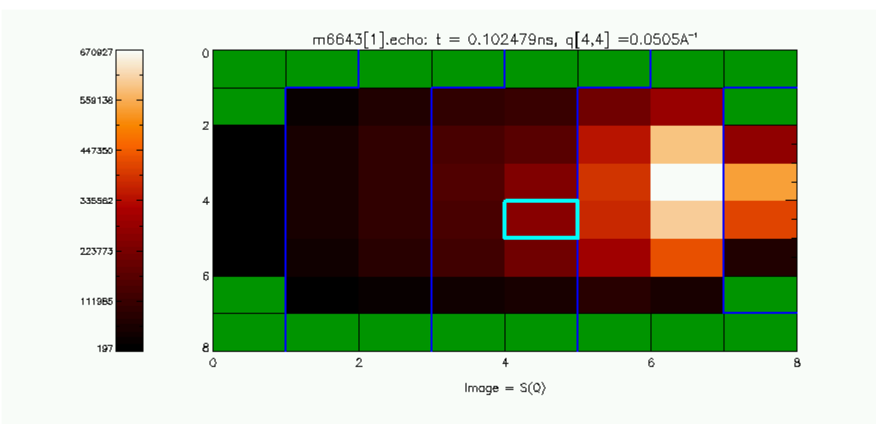
The echoes at each detector pixel have to be fitted individually.

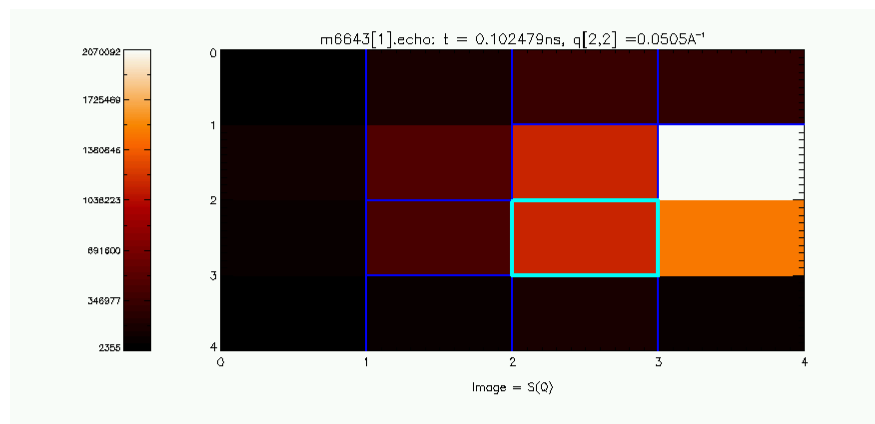


Binning

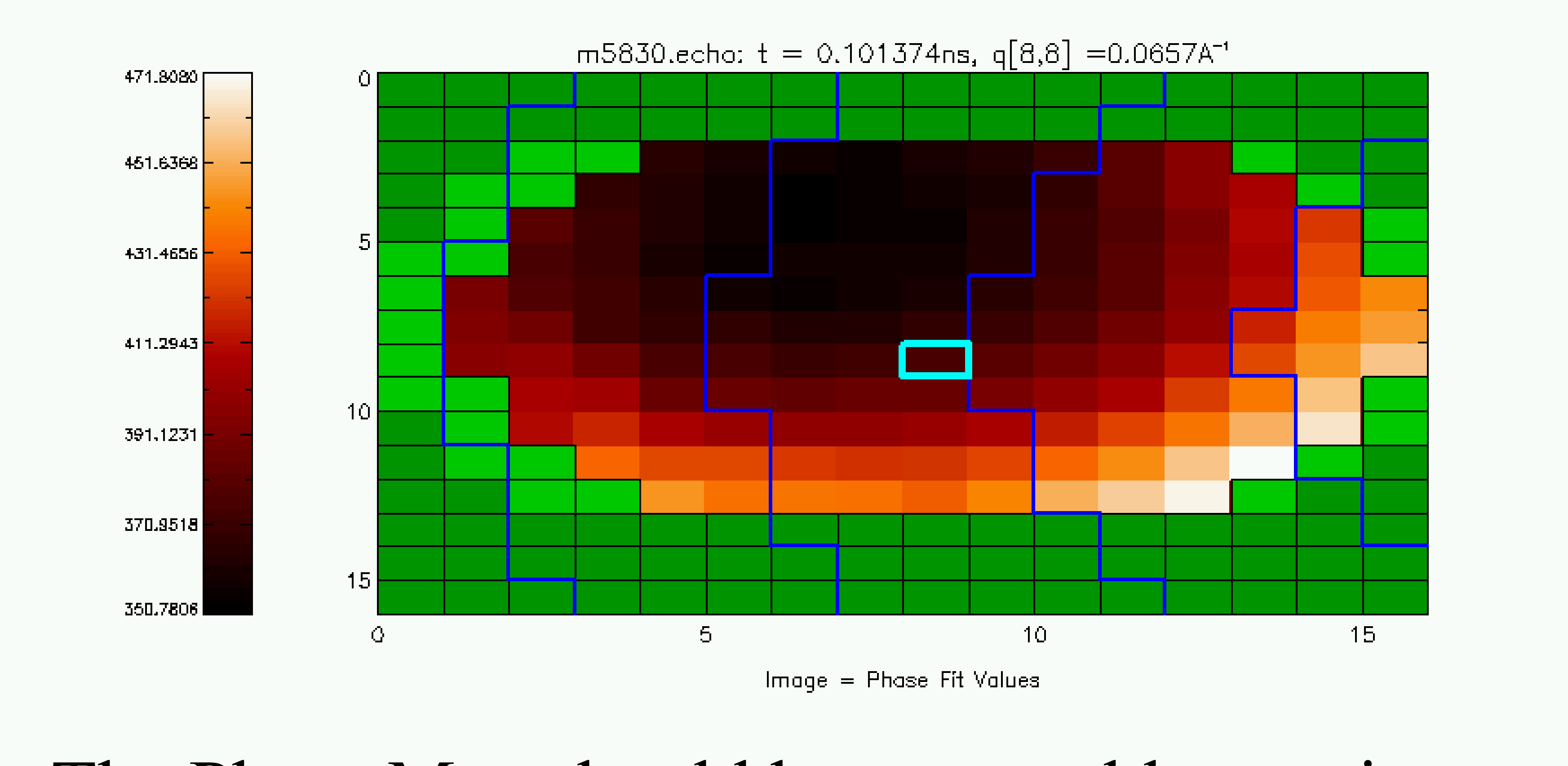

m6643[1].echo: t = 0.102479ns, q[16,16] =0.0505A⁻¹
Image = S(Q)


m6643[1].echo: t = 0.102479ns, q[8,8] =0.0505A⁻¹
Image = S(Q)


m6643[1].echo: t = 0.102479ns, q[4,4] =0.0505A⁻¹
Image = S(Q)


m6643[1].echo: t = 0.102479ns, q[2,2] =0.0505A⁻¹
Image = S(Q)

Phase Map



The Phase Map should be a smoothly varying function of the position on the detector and of the Fourier time.

Reducing NSE data with DAVE

1. Mask low intensity areas.
2. Fit the resolution.
3. Make sure the phase map is correct.
4. Remove poor resolution points.
5. Check the χ^2.

Importing the phase map

The phase map is sample independent. To fit your sample and background data just…

1. Import the phase map from the resolution.
2. Check the χ^2.

Calculate I(Q,t)

$$\frac{I(Q,t)}{I(Q)} = \frac{2\left[A-(1-\phi)\frac{T}{T^{BKG}}A^{BKG}\right] \Big/ \left[(Up-Dwn)-(1-\phi)\frac{T}{T^{BKG}}\left(Up^{BKG}-Dwn^{BKG}\right)\right]}{2A^{R} \Big/ \left(Up^{R}-Dwn^{R}\right)}$$

The Intermediate Scattering function values are calculated pixel by pixel and averaged, according to their weight, by Q areas.

Conclusion

At the end of the reduction process the I(Q,t) contains information about your sample only.