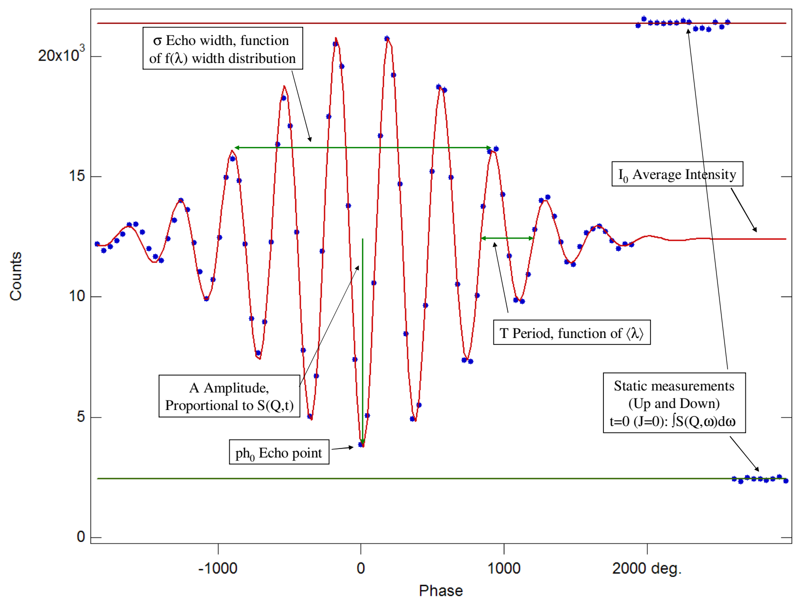
The Neutron Spin-Echo Experiment

CHRNS Center for High Resolution Neutron Scattering NSF NIST

Fitting the Echo



In a NSE experiment the measured intensity at the detector, after the polarizer, takes the typical oscillating shape, the echo, as a function of the phase, the difference of the field path between the two arms of the spectrometer. The data can be described by the product of a cosine with a Gaussian, this latter being the Fourier transform of the incoming neutron wavelength distribution function. The minimum (maximum) of the curve is the echo point, occurring when the field paths in the two arms are exactly balanced.

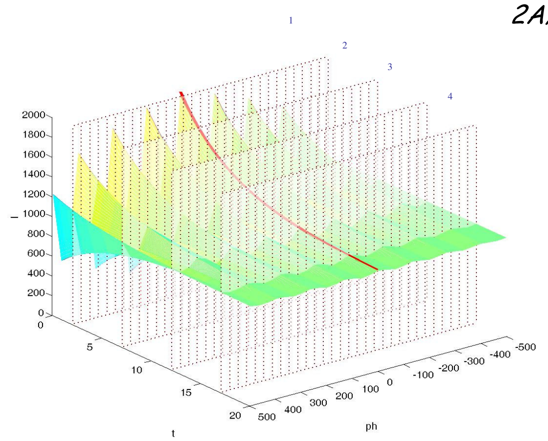
$$I = I_0 + A\exp\left[\frac{(ph-ph_0)^2}{2\sigma^2}\right]\cos\left[\frac{360}{T}(ph-ph_0)\right]$$

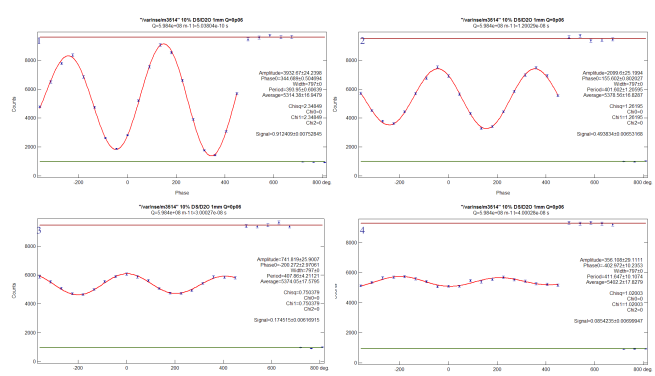
The Up and Down measurements are taken without any precession of the neutron spin. They represent a static measurement (t=0). Their determination is a measurement of the polarization of the scattered beam.

Measuring the Intermediate Scattering Function

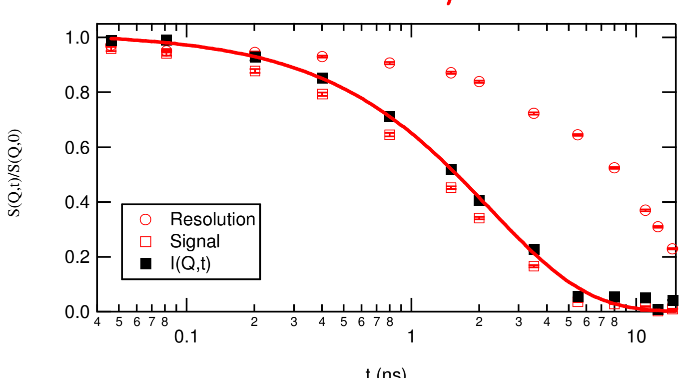
A three dimensional image of the echo signal, as a function of the phase (ph~[J_0-J_1]) and the Fourier time (t~J_0), would look like in the figure below. The echo signal amplitude, A, decreases with the increase of the Fourier time, proportionally to the ISF, S(Q,t). To precisely determine S(Q,t) it is then necessary to measure the echo signal, as a function of the phase, at different values of the Fourier time. A fit of each echo to a damped cosine will allow to determine A. The Up-Down difference is the normalization factor. The signal prior of resolution correction is then

2A/(Up-down)





Spin-Echo Resolution function



Inhomogeneities in the magnetic field may further reduce the polarization. Since they are not correlated with S(Q,ω) or f(λ), their effect may be divided out by measuring the polarization from a purely elastic scatterer.

$$\frac{S(Q,t)}{S(Q,0)} = \frac{I^*(Q,t)}{R(Q,t)}$$

In the time domain the resolution is simply divided out