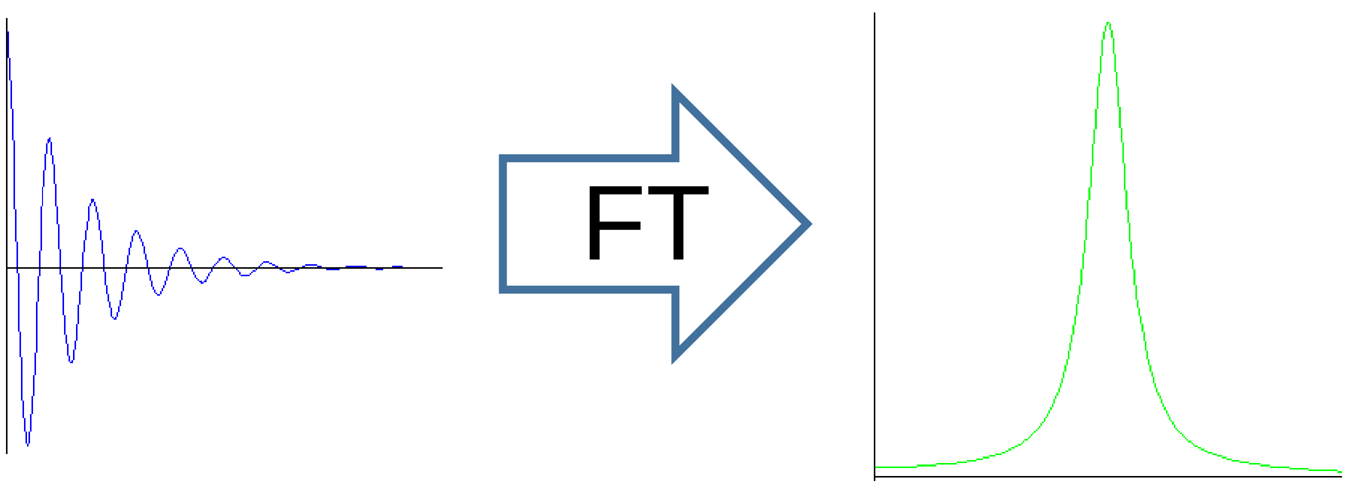
Quadrature detection and the FID

In order to obtain phase information detection along both x and y directions is required. Instead of using two coils to detect the radiofrequency signals one uses two detectors in which one has the phase of the reference frequency shifted by 90^{o}. These correspond to the real and imaginary components of the free induction decay (FID). The observed spectrum is the Fourier transform of the FID.



Experimental quadrature detection

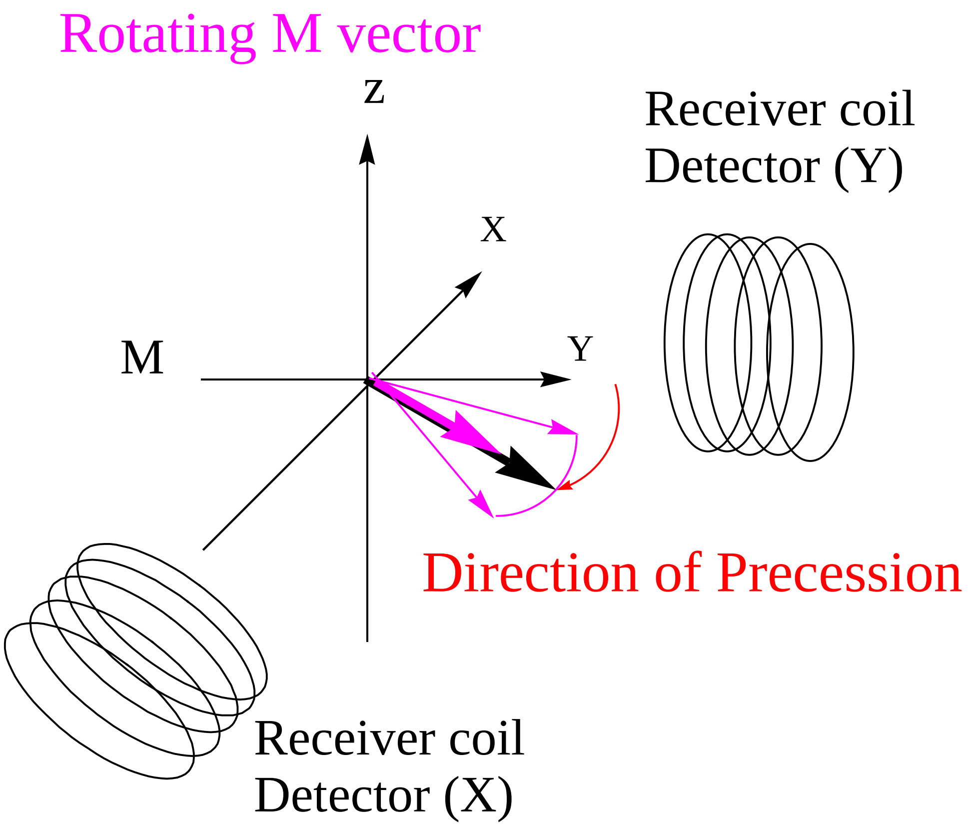
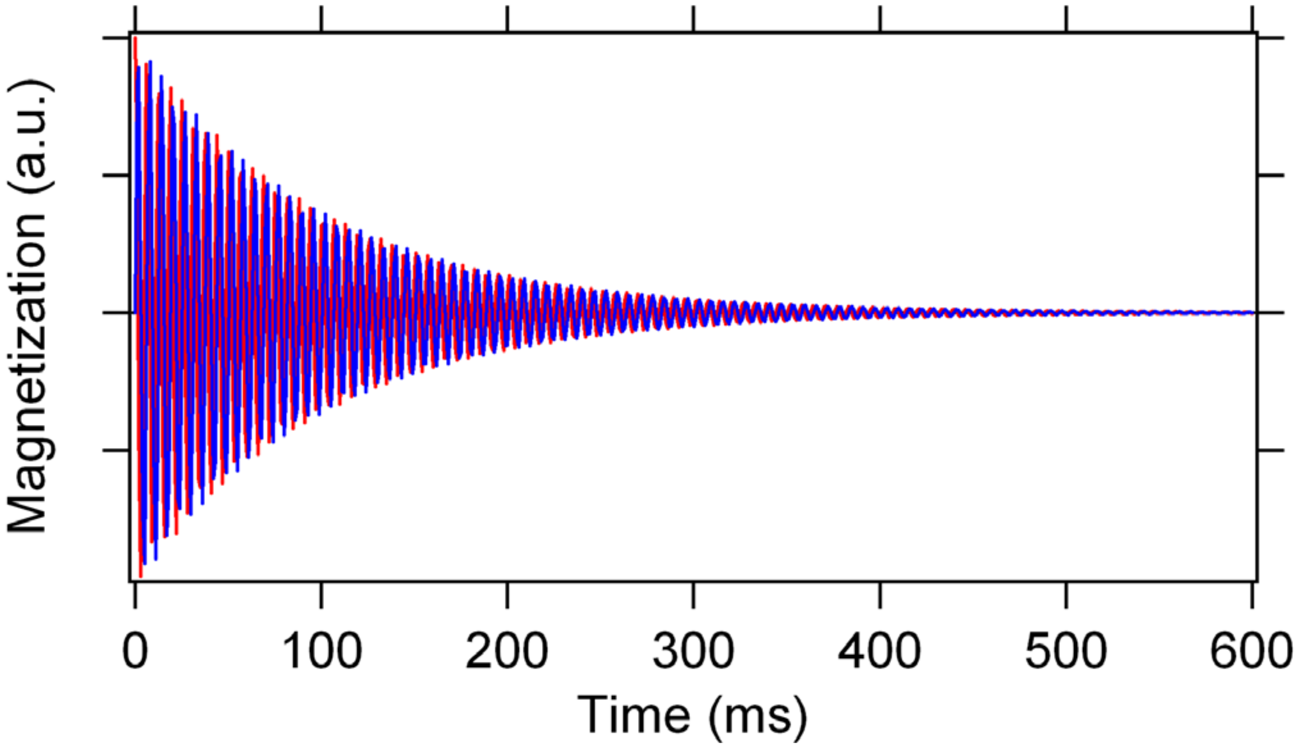


Illustration of receiver coils at 90º to one another.

The free induction decay



Real part

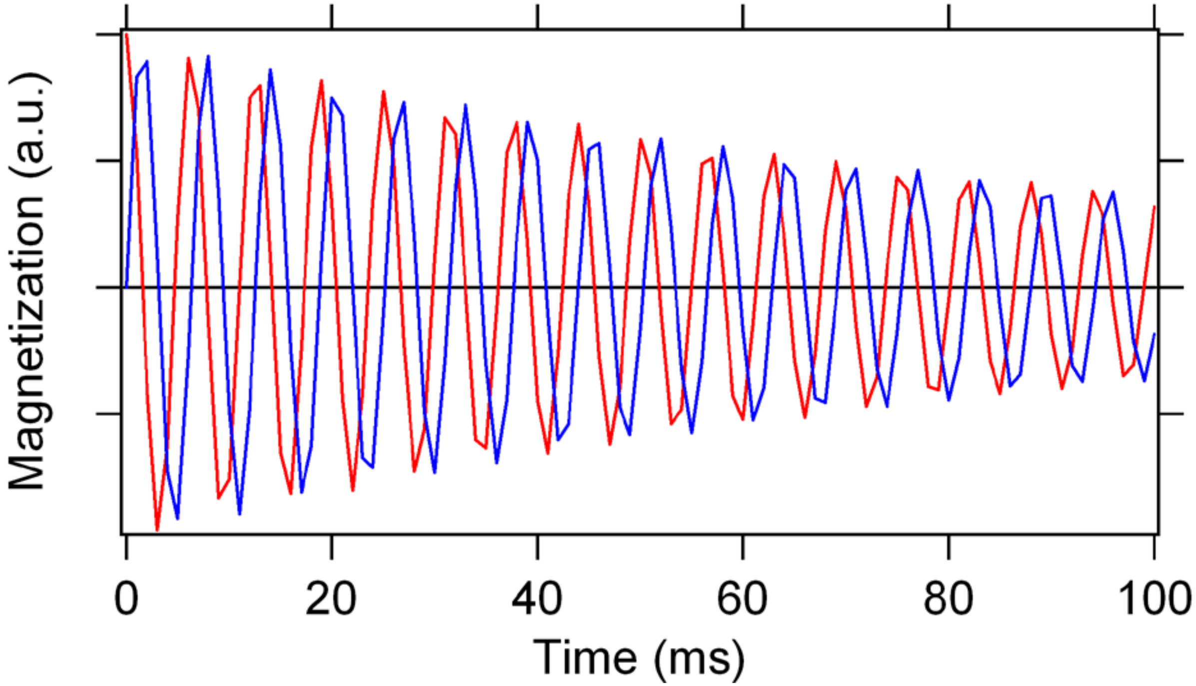
$$FID(t) = \exp(-t/T_2)\cos(\omega t)$$

Imaginary part

$$FID(t) = \exp(-t/T_2)\sin(\omega t)$$

Here w = p

The free induction decay



Note that in this modeling the sample rate is one point per millisecond. The period is $1/\pi$ so there are approximately 3 points per period. Note that the sampling does capture the sinusoidal character.

Nyquist Theorem
("Fundamental Theorem of DSP")

If f(t) is bandlimited to $[-\Omega_B, \Omega_B]$, we can reconstruct it *perfectly* from its samples for $\Omega_s = 2\pi T > 2\Omega_B$

$\Omega_N = 2\ \Omega_B$ is called the "Nyquist frequency" for f(t).

For perfect reconstruction to be possible $\Omega_s \geq 2\Omega_B$ where Ωs is the sampling frequency and Ω_B is the highest frequency in the signal. Below is the same "data set" with 4 times the sampling rate.