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MRI DEMO SESSION: BASICS OF NMR

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CHUV
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DEMO SESSION

- Overview hardware, upstairs, downstairs
  - MRI Cabinet
  - Faraday Cage
  - Magnet
- Illustration of magnetic field and eddy current

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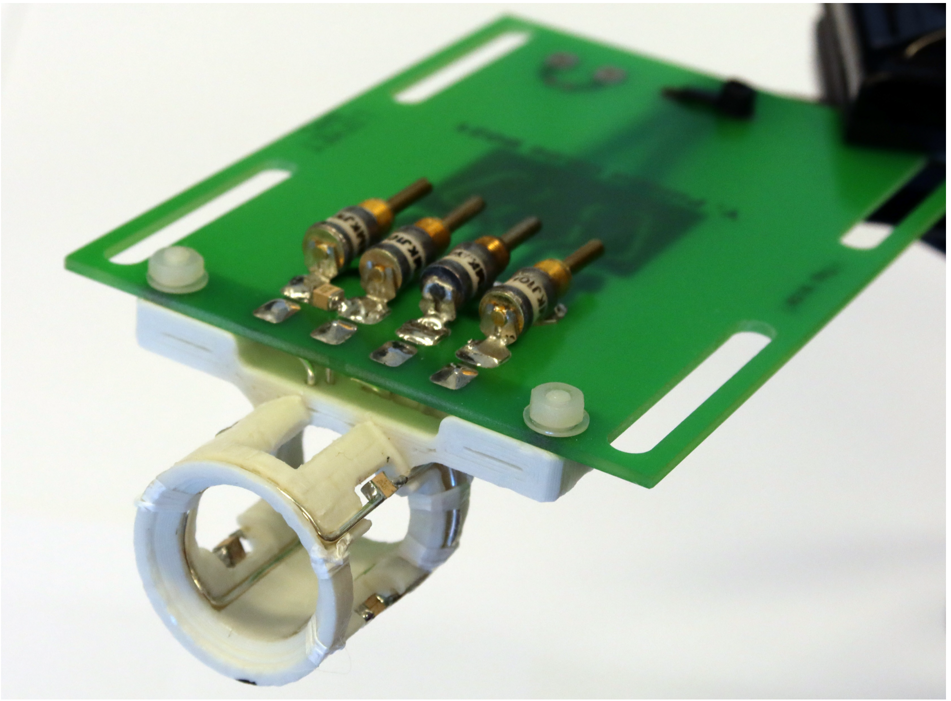
DEMO SESSION

- Sample: 1g/L $CuSO_4$ in H_2O.
- Coil: $^{1}H/^{13}C$ saddle coil (18mm ID)



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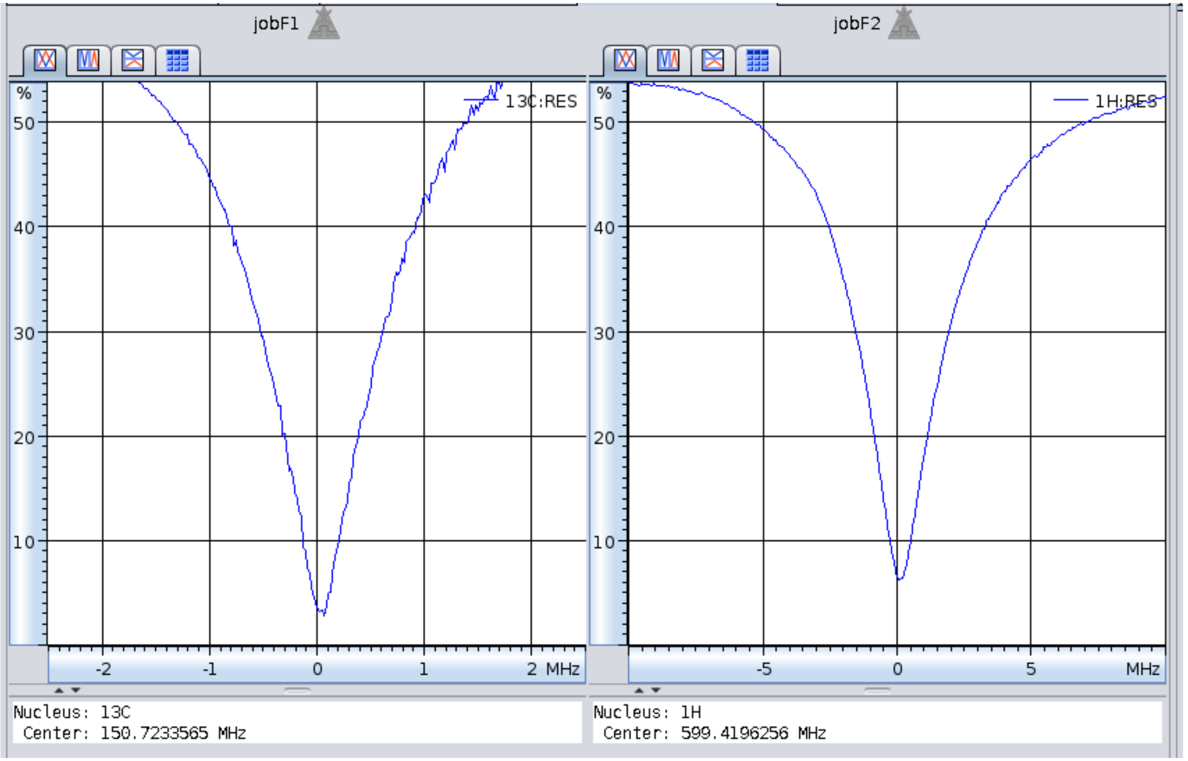
TUNING AND MATCHING

- Adjust resonant circuit such that:
  - It resonates at the Larmor frequency
  - Impedance matched to transmission line
- The dip must be at (or close to) 0 MHz.



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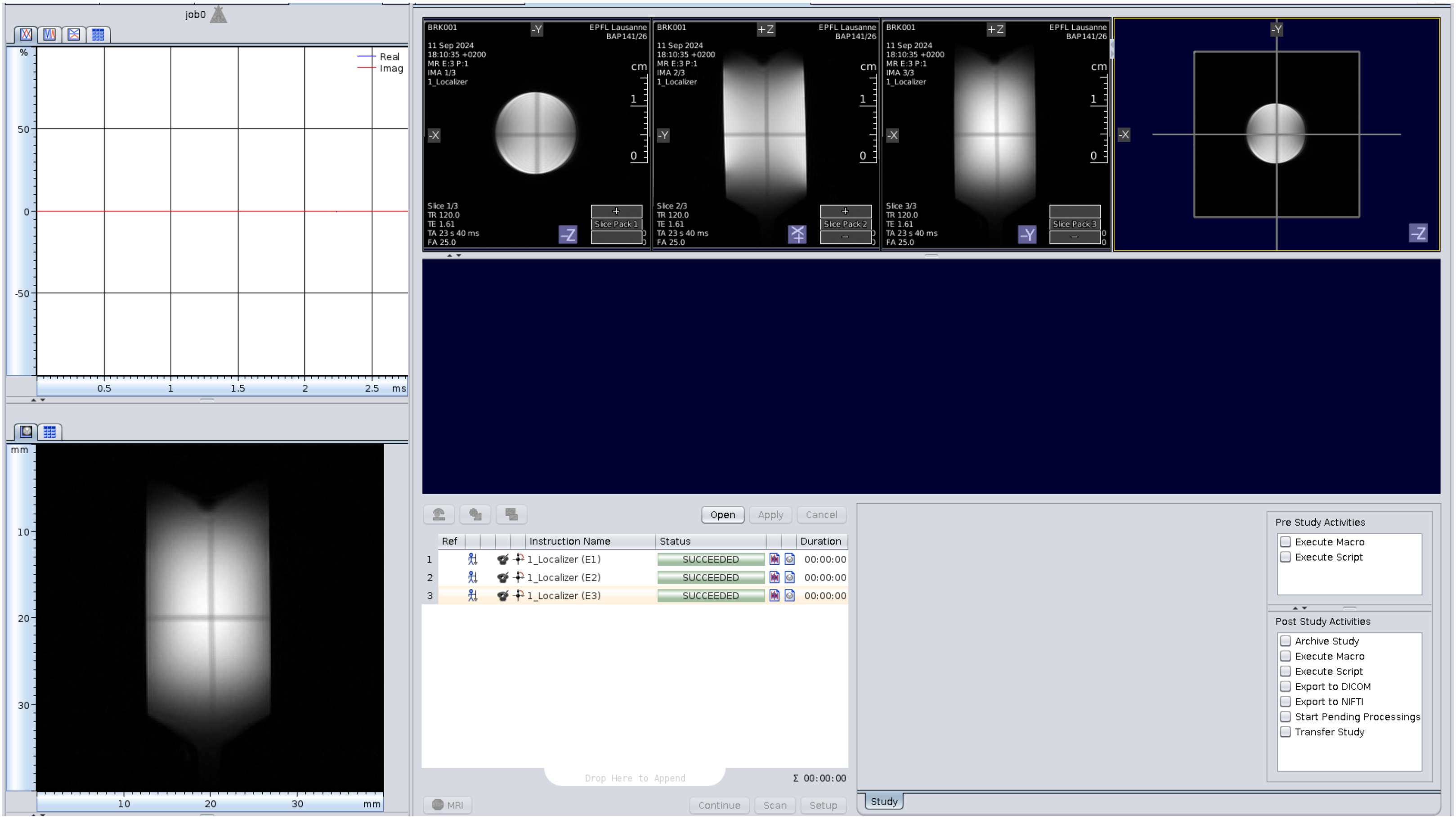
LOCALIZER

- We check that the sample is well centered.
- Otherwise we will need to move the slider.



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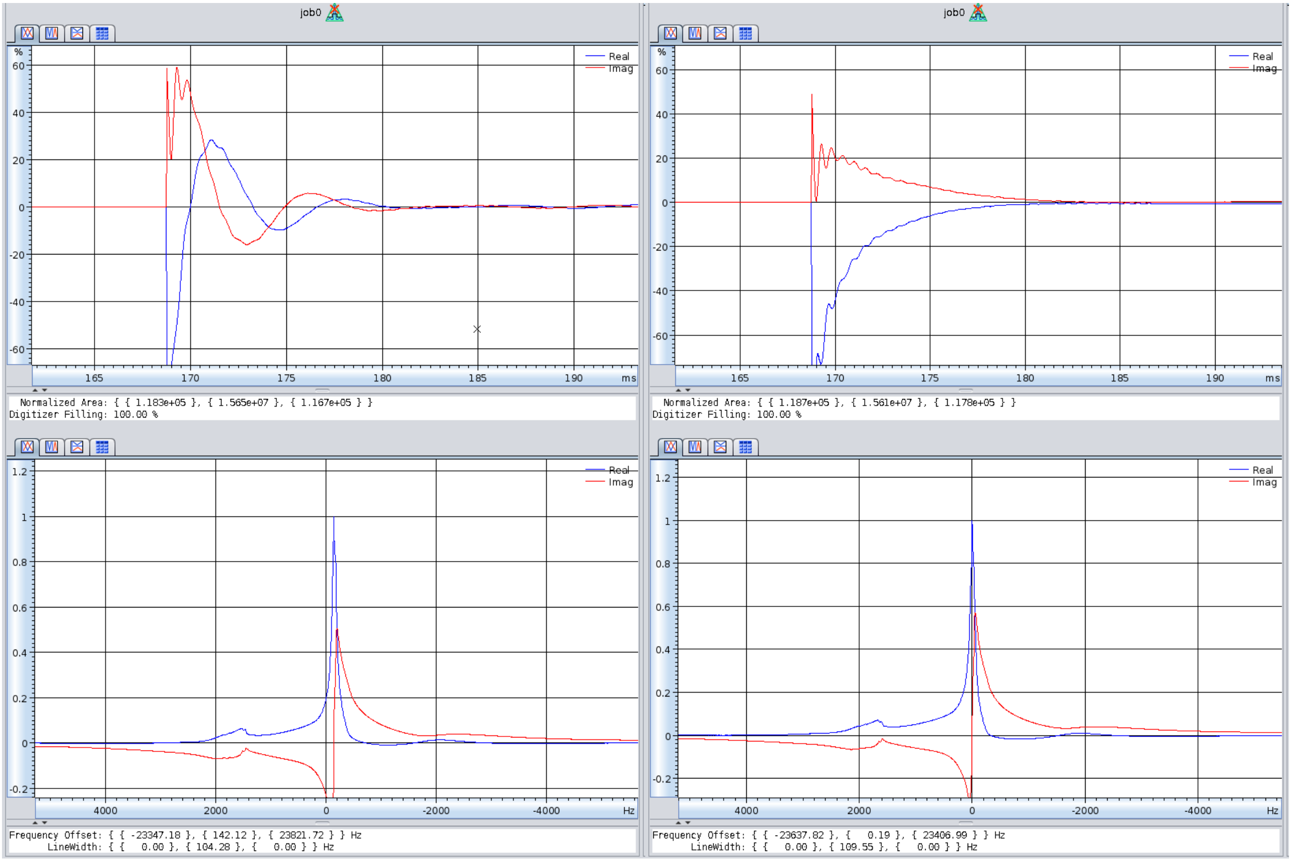
FREQUENCY ADJUSTMENT

- Adjust the scanner's transmission/reception frequency to match the Larmor frequency of the sample.
- This sample resonates at 599.419141 MHz.
- When we are on resonance, the FID seen on the window stops oscillating, because we demodulate the signal with the exact same frequency.



Not adjusted Adjusted

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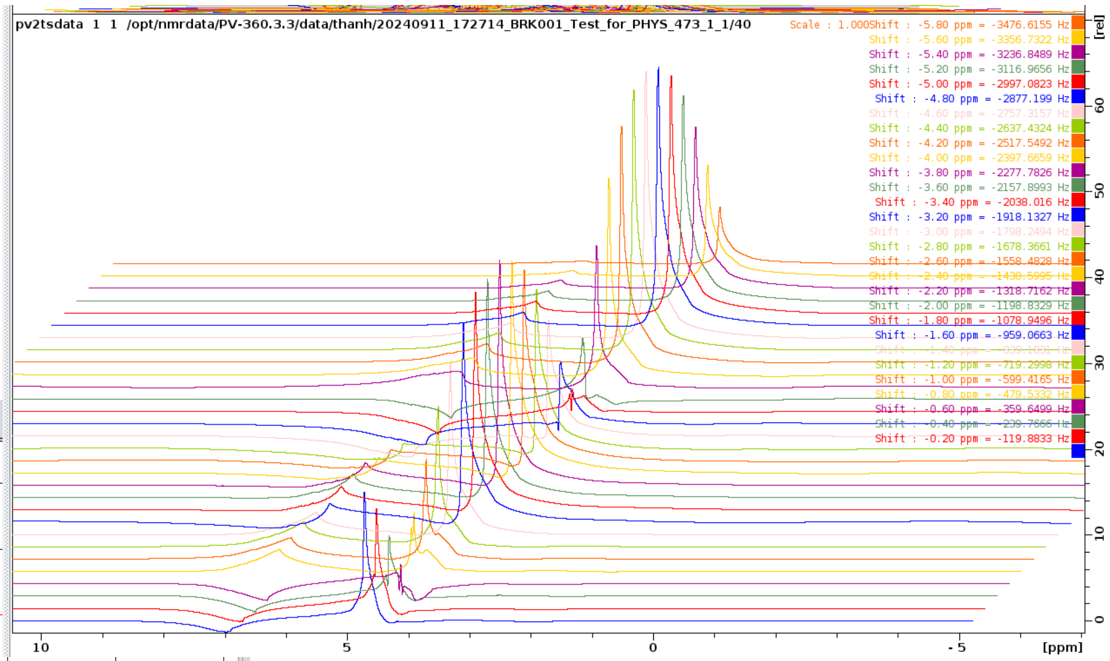
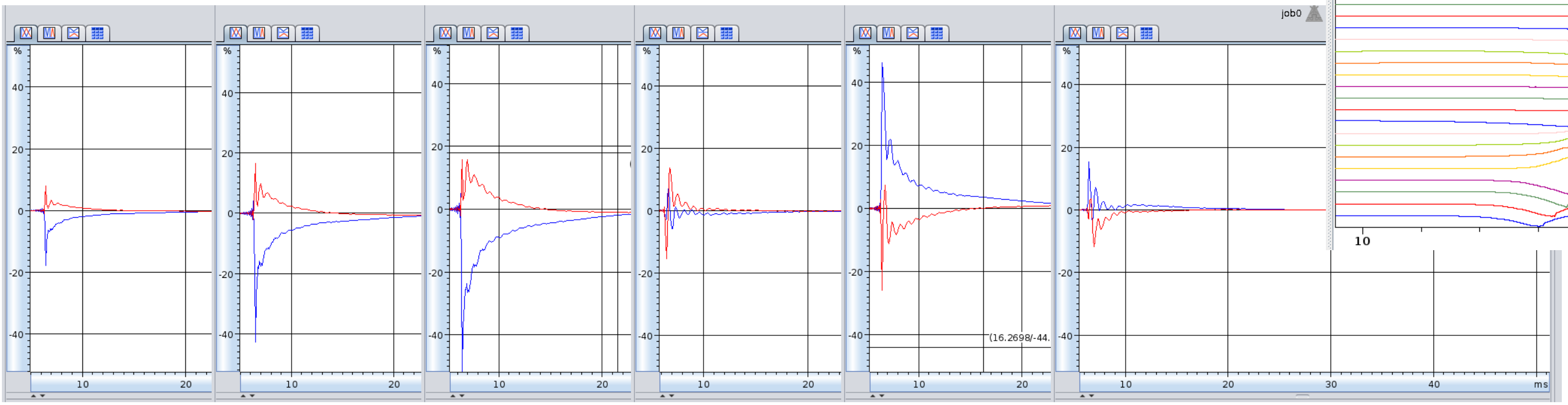
PULSE CALIBRATION

- Fixed power (10W), hard pulse
- Flip angle proportional to pulse length τ:

$$\alpha = \gamma \cdot B_1^+ \cdot \tau$$

- The maximum with 60us





τ =0.01ms 0.03ms 0.06ms 0.12ms 0.18ms 0.24ms

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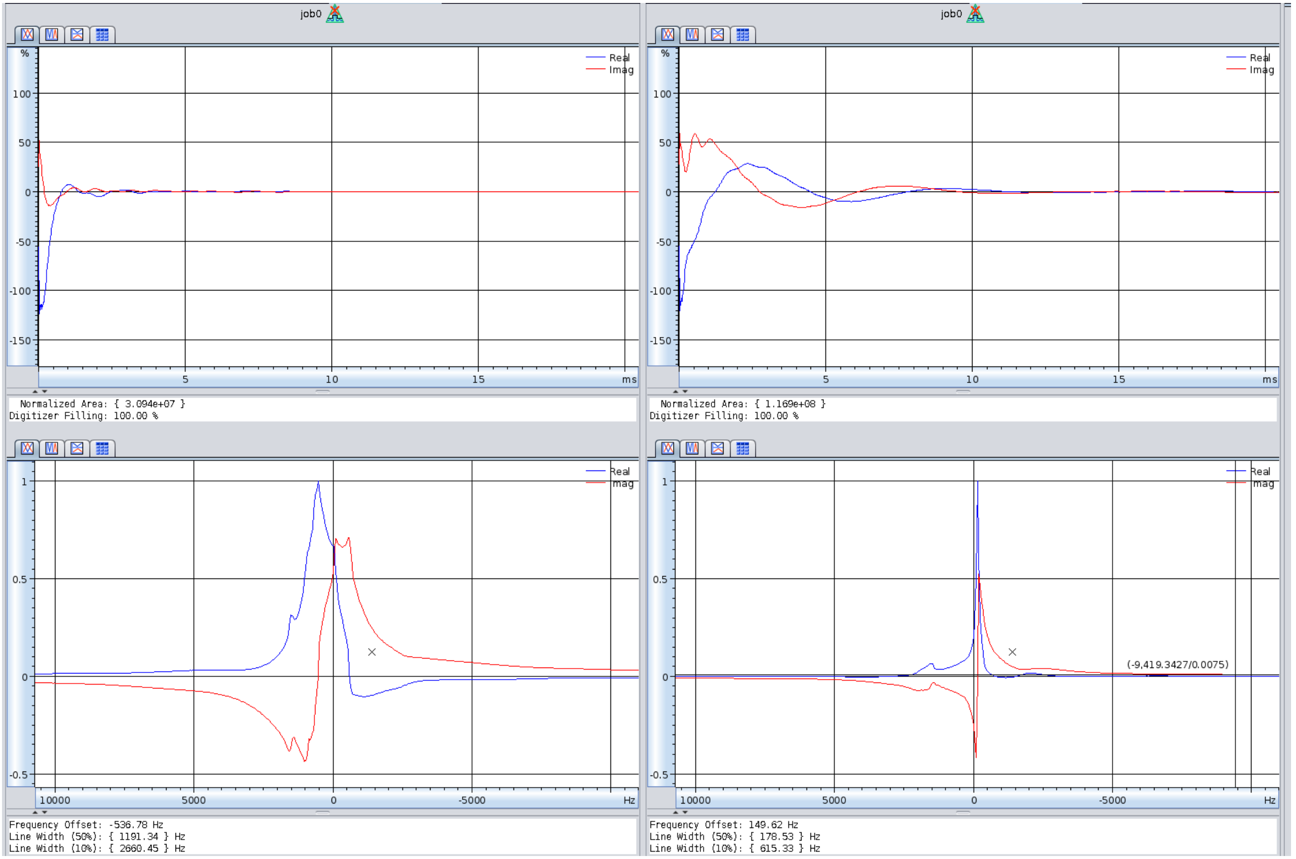
B_0 SHIMMING

- Compensate B_0 inhomogeneities by adjusting the current in the shim coils.
- The peak gets narrower, and FID decays more slowly.



Unshimmed

Linear shim

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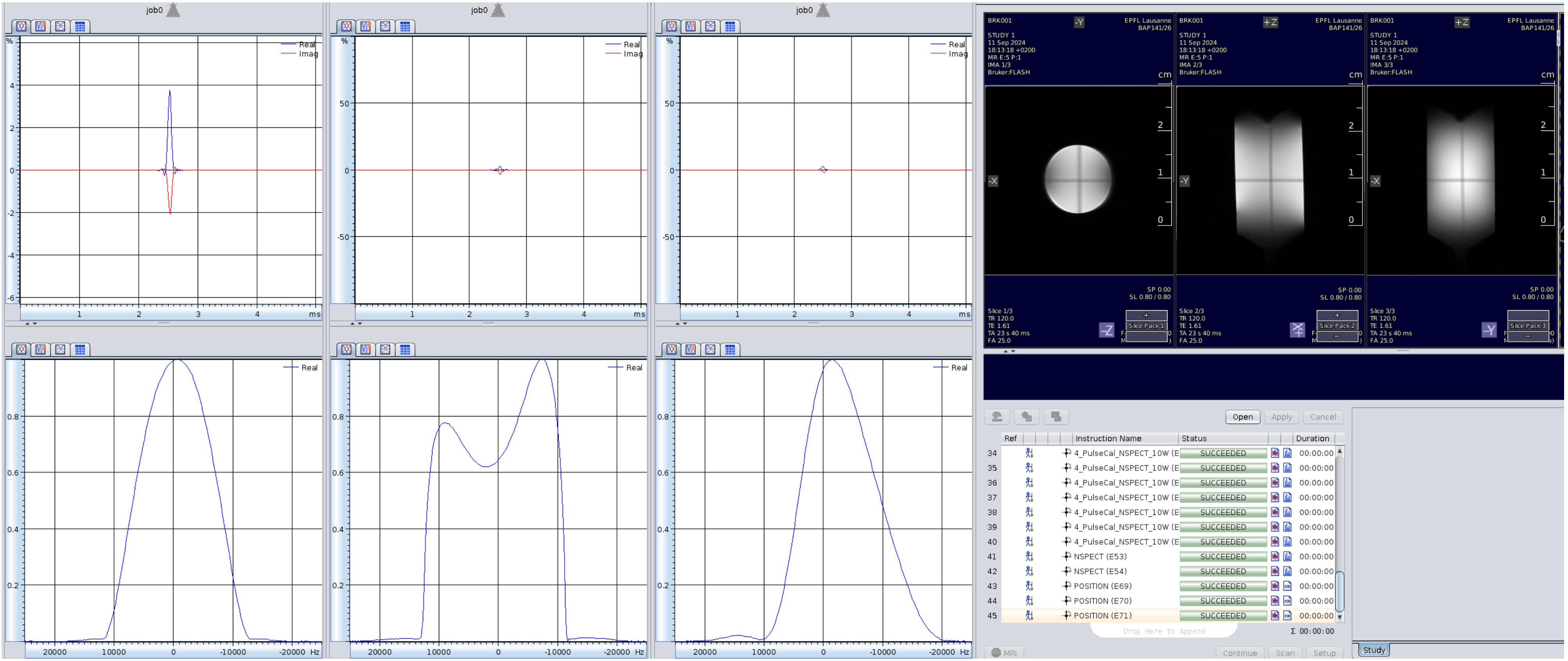
PROFILE 1D

- Frequency encoding using gradient on one axis at a time



X gradient Y gradient Z gradient

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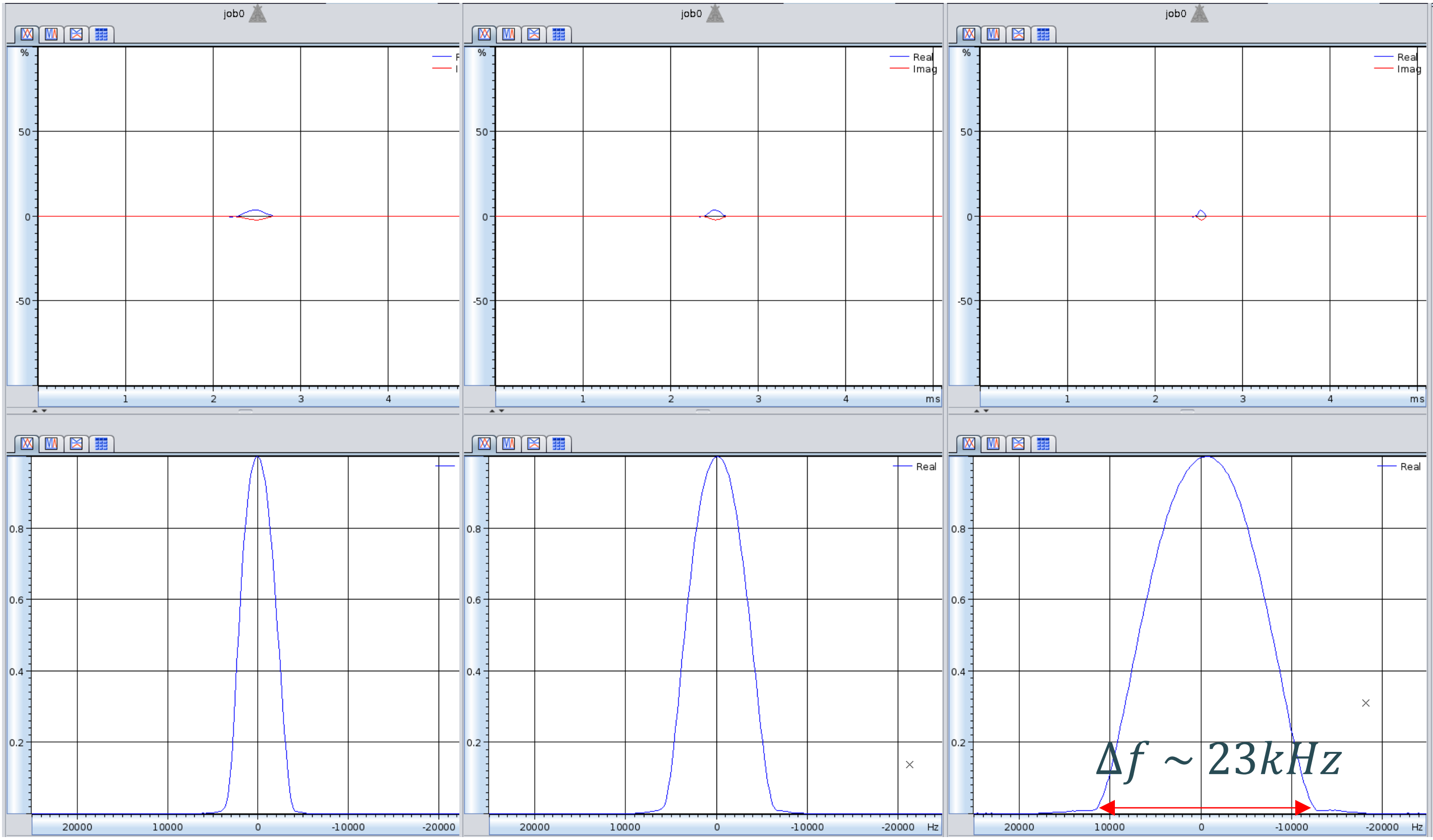
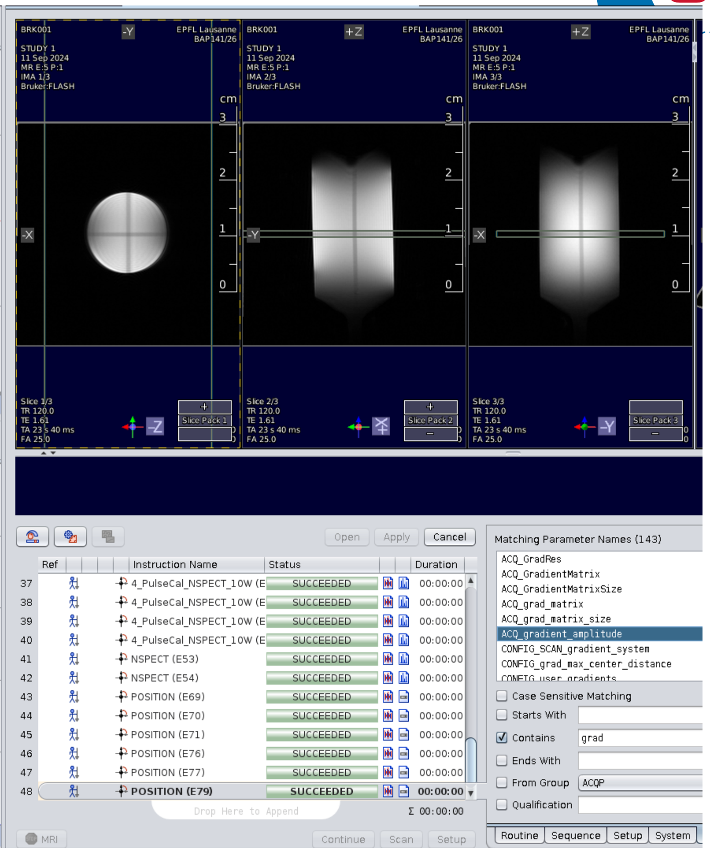
PROFILE 1D (Y AXIS)





G=11mT/m G= 20mT/m G= 40mT/m

γ_{1H} = 42.58 MHz/T

- Could you calculate the syringe's diameter?

$$D = \frac{\Delta f}{\gamma_{1H} G}$$

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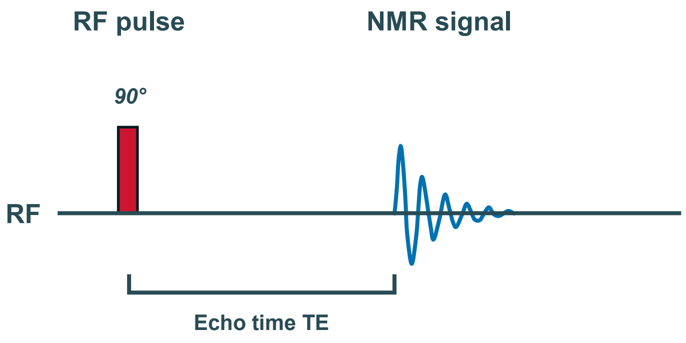
PULSE-ACQUIRE (NON-LOCALIZED GRADIENT-ECHO)

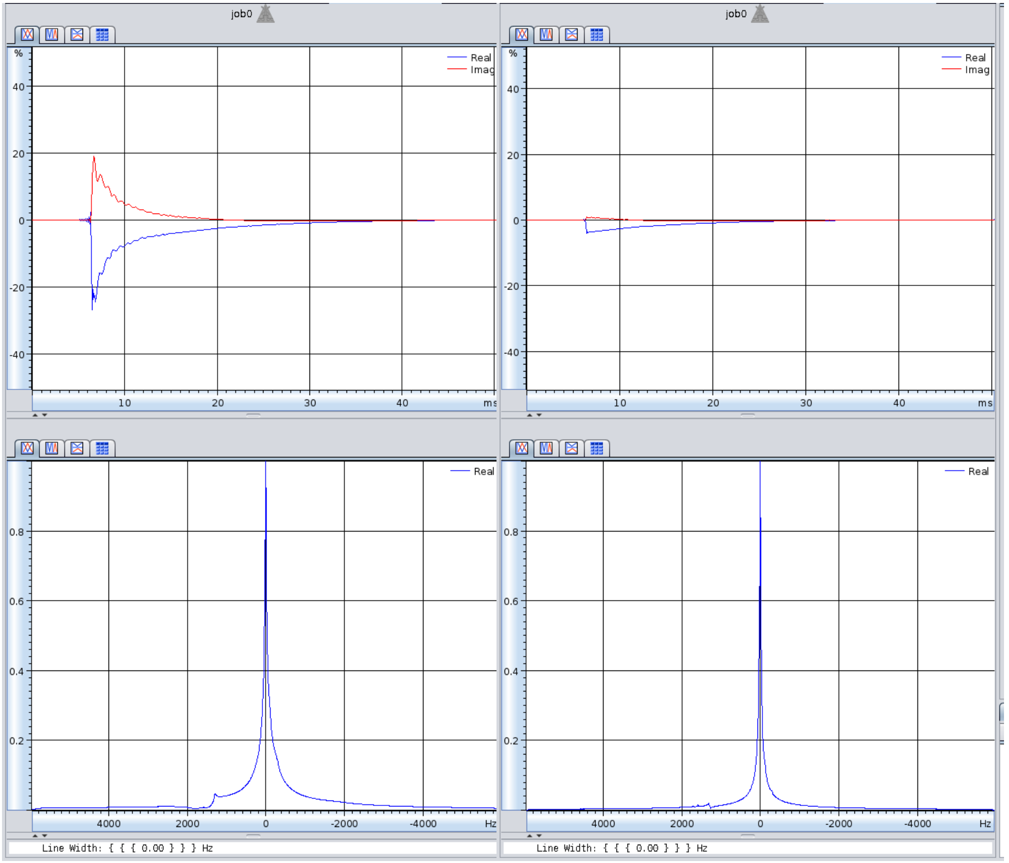


- Transverse magnetization evolves as:

$$M_{xy}(t) = M_0\left(e^{-t/T_2^*}\right)$$

- The echo time has a huge influence on the signal amplitude.
- To measure T_2^*, the experiment is repeated with different values of TE. The signal amplitude exponentially decays as a function of TE:

$$S \propto e^{-\frac{TE}{T_2^*}}$$



TE = 0.36ms TE = 10ms

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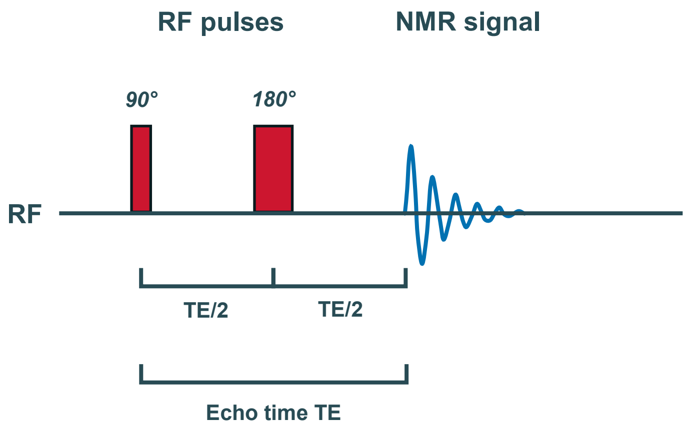
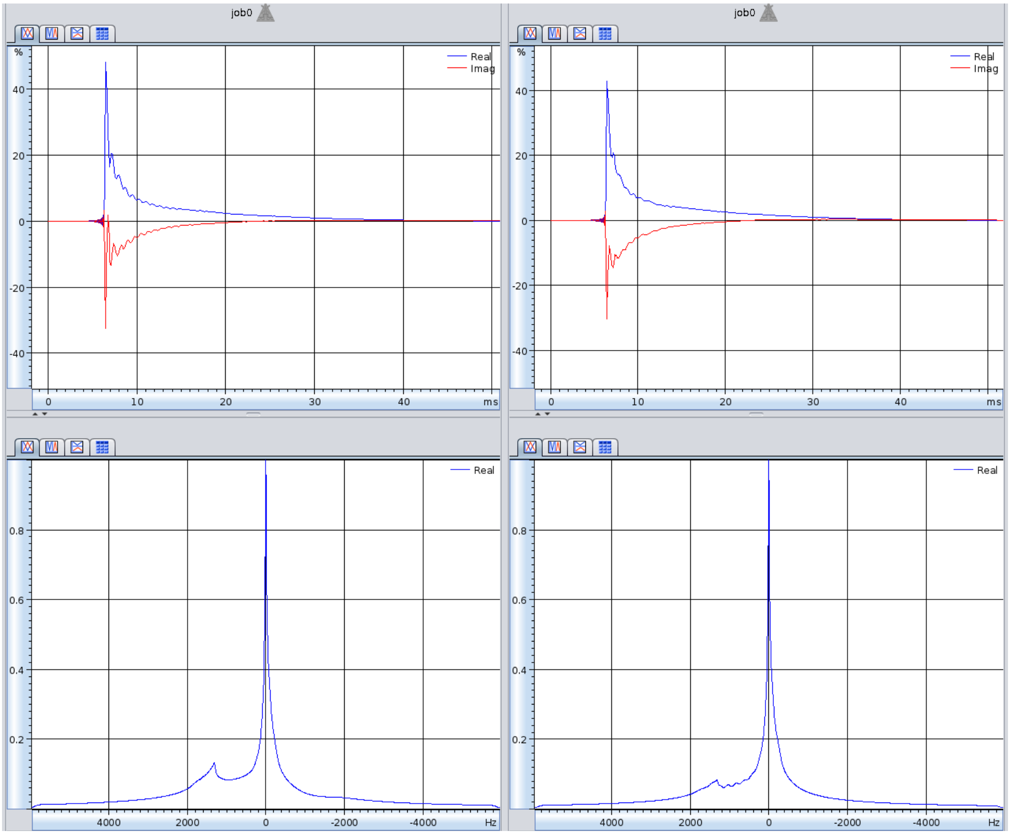
SPIN-ECHO (NON-LOCALIZED)





TE = 0.36ms

TE = 10ms

Transverse magnetization evolves as:

$$M_{xy}(t) = M_0 \left(e^{-t/T_2}\right)$$

- The echo time has a little influence on the signal amplitude.
- To measure T_2 , repeat with different values of TE. The signal amplitude decays as

$$S \propto e^{-\frac{TE}{T_2}}$$

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