Obtaining your first spin-echo with a low-cost open-source MRI system

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Sponsor and organizer: LIBRE Hub

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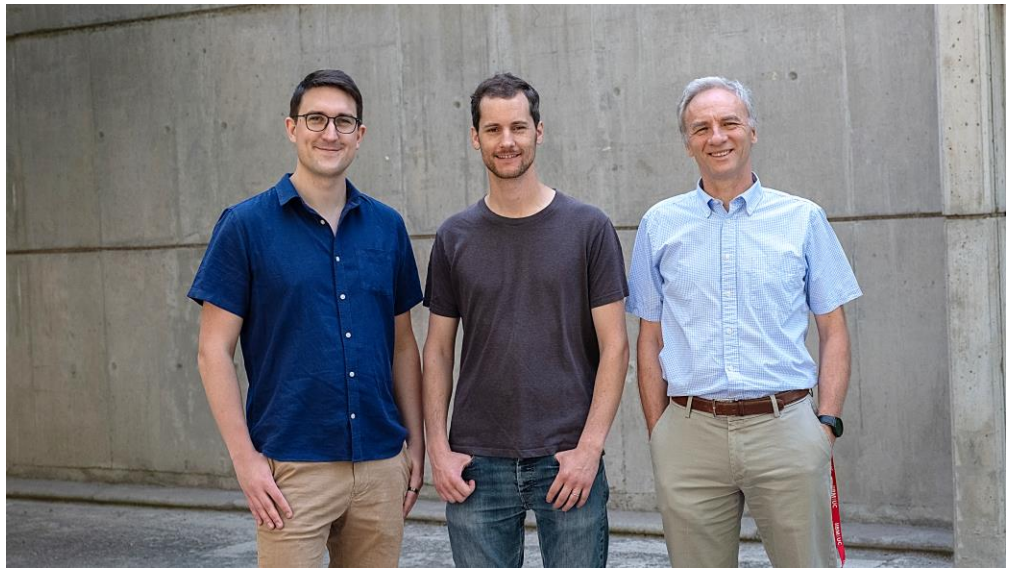
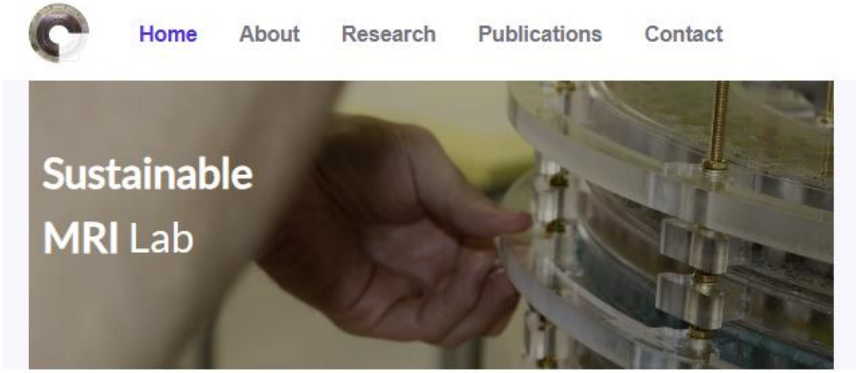
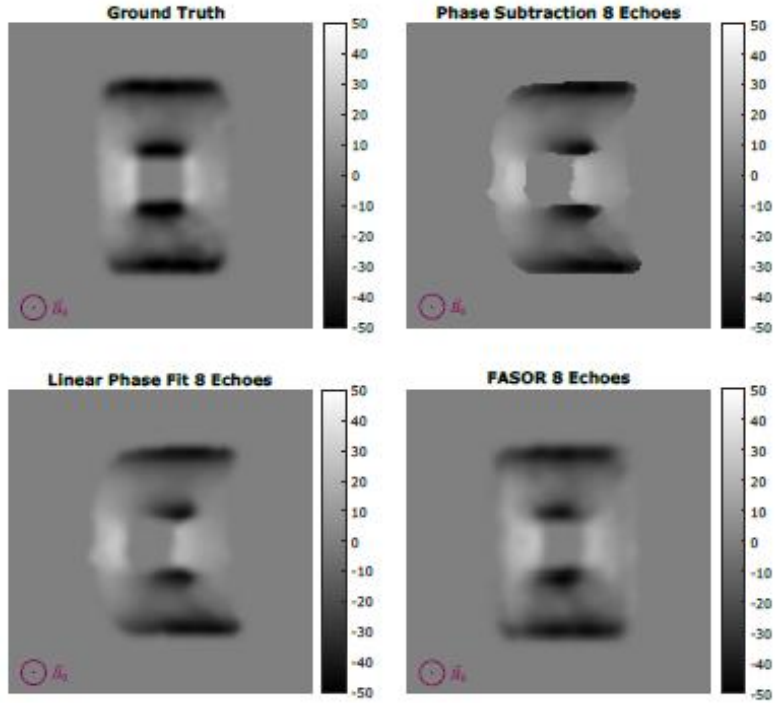
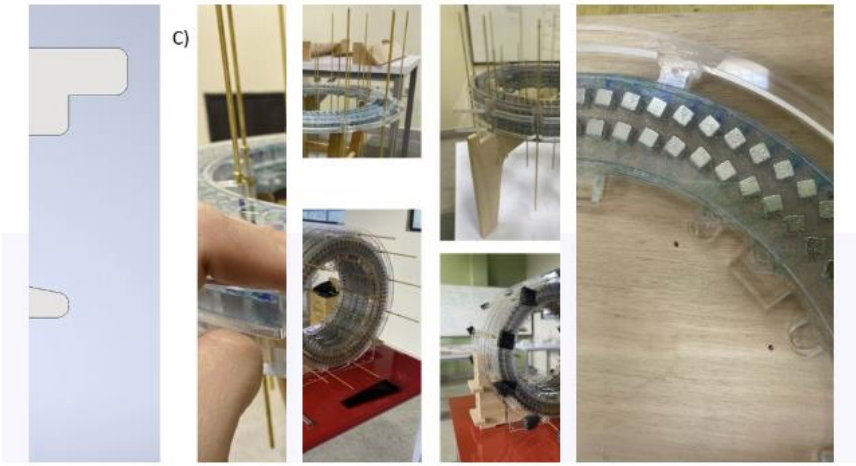
*The **Latin American Hub for Bioimaging Through Open Hardware (LIBRE Hub)** is a training network for open source bioimaging hardware in Latin America with the goal to empower regional researchers through practical workshops, seminars, networking, and online resources adapted to local needs and re-published in local languages.*



Lecturers







Joshua Harper, PhD (Penn State University)

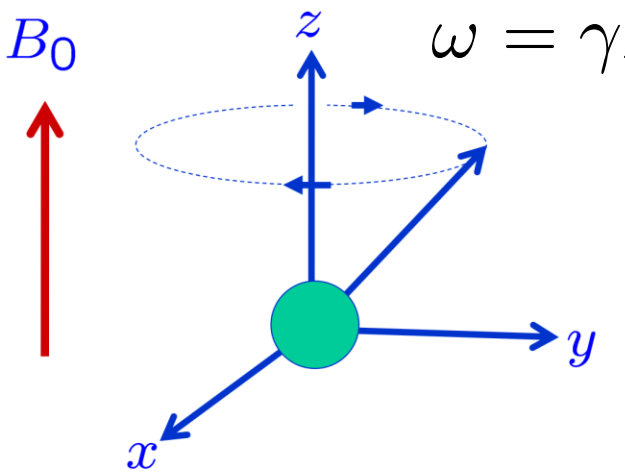
Belén Bravo, MSc (UC)

Program

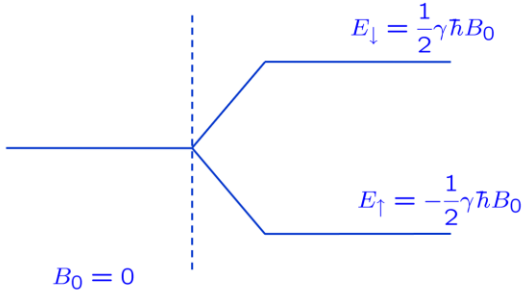
Time		Activity
16:00	16:25	1. Introduction to MRI, motivation, RF chain and spin-echo sequence
		Field mapping
		Center frequency (demonstration)
		Ppm in DSV
		Selecting an appropriate phantom
16:25	16:40	2. First RF coil (start small)
		Noise (measurements)
		50 ohm noise for baseline
		Noise level with coil attached
16:40	17:40	3. Tune and match
		Theoretical calculations to start
		Why only add capacitance and not inductance or resistance?
		VNA process flow
17:40	17:55	Break
17:55	19:00	4. Finding the echo
		Setting the initial 90 and 180 degree pulse (6 dB apart)
		Iterating through frequencies
		Identifying the echo
		Optimizing power
		Echo height characteristics

Overview of MRI

Polarization – Excitation – Readout – Reconstruction



$$\omega = \gamma B_o$$

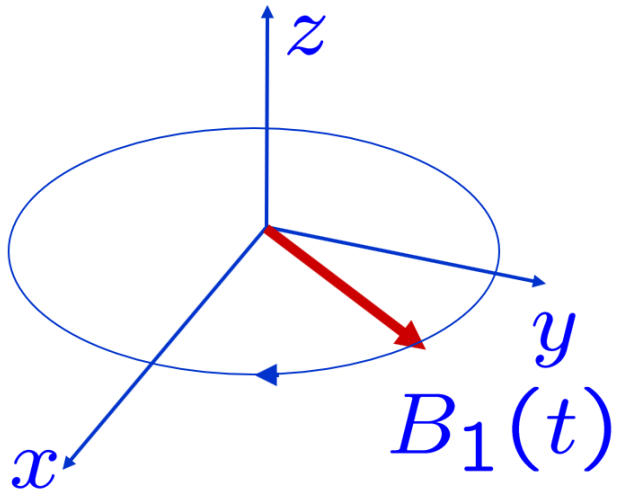


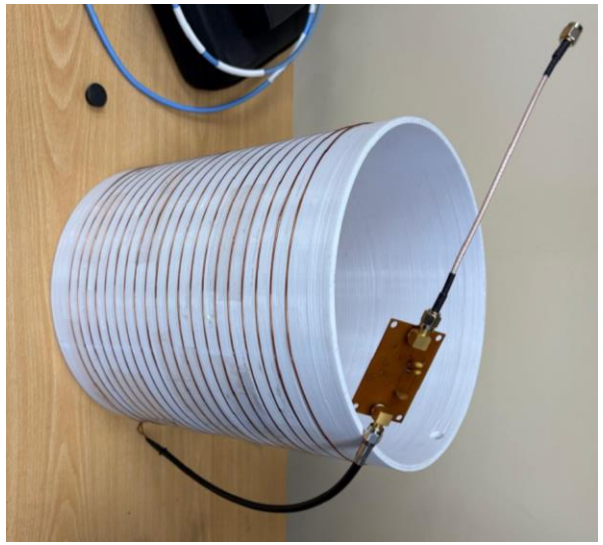
$$M_z^0 = |\vec{M}| = \frac{\gamma^2\hbar^2 B_0 N_s}{4KT_s}$$

Overview of MRI

Polarization – **Excitation** – Readout – Reconstruction

$$\vec{B}_1(t) = B_1^e(t)[\cos(\omega_{rf}\, t + \varphi)\hat{\imath} - \text{sen}(\omega_{rf}\, t + \varphi)\hat{\jmath}]$$

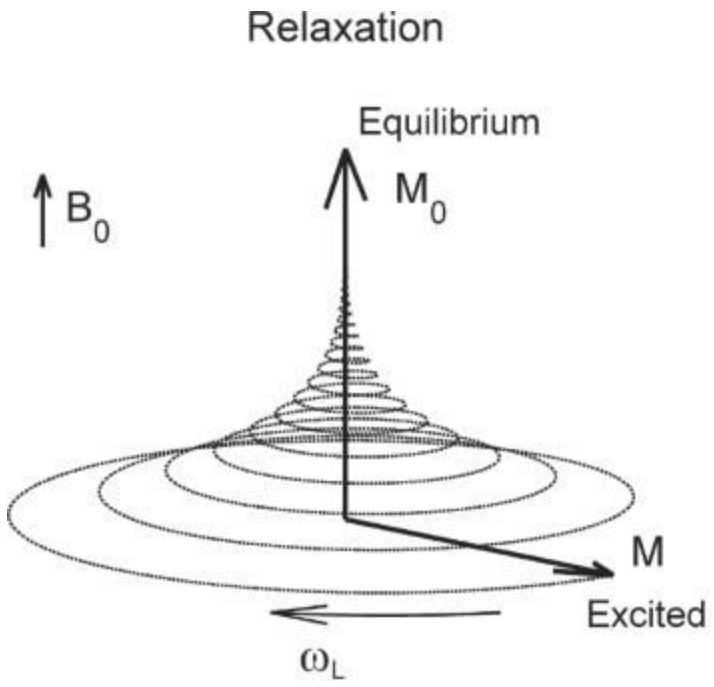


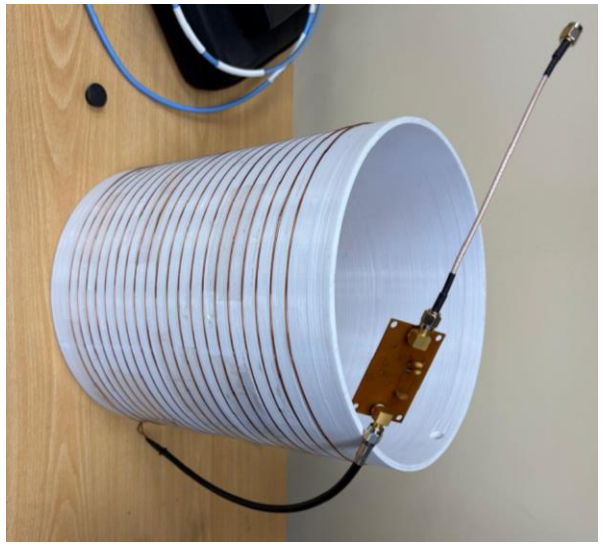


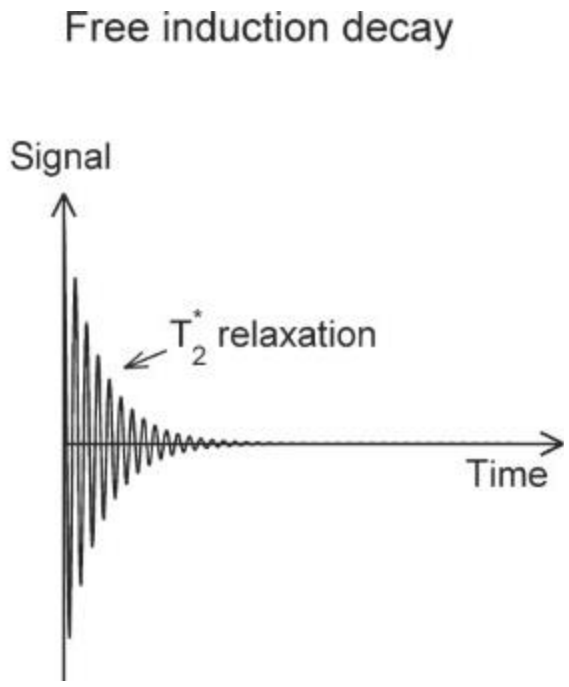
Overview of MRI

Polarization – Excitation – **Readout** – Reconstruction

$$S(t) = \int M_{xy}(\vec{r}, 0) e^{-i\gamma \int_0^t \Delta B(\vec{r},\xi) d\xi} d\vec{r}$$



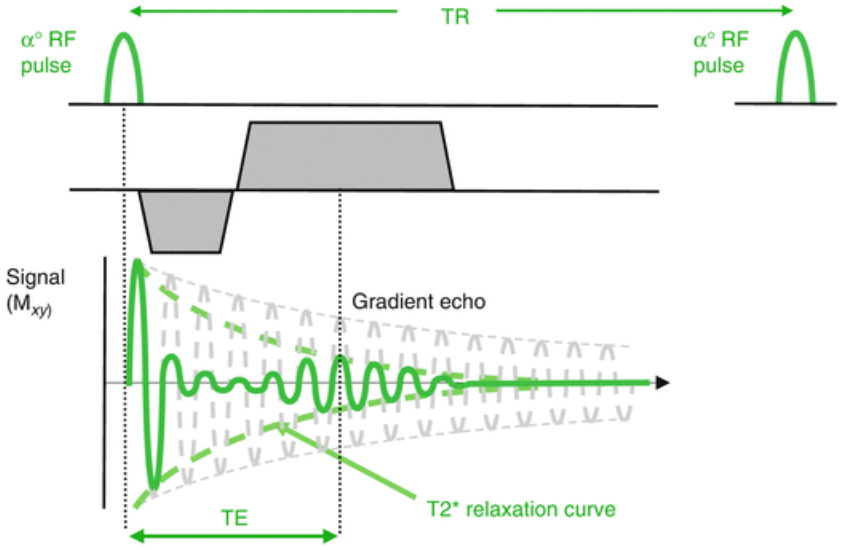


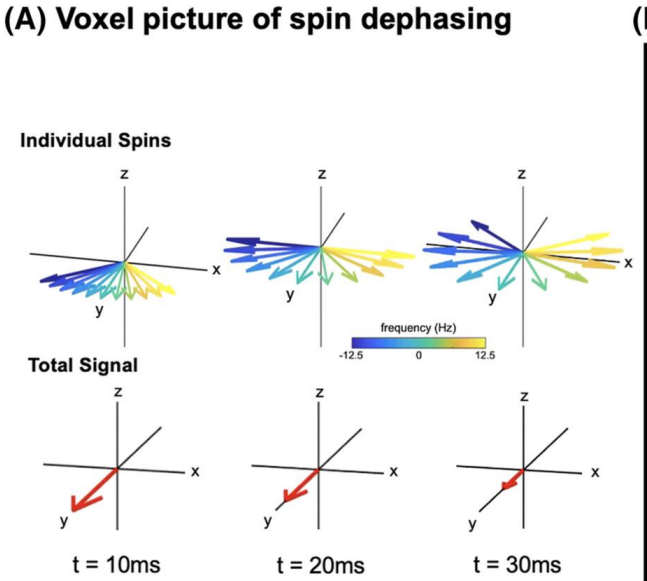


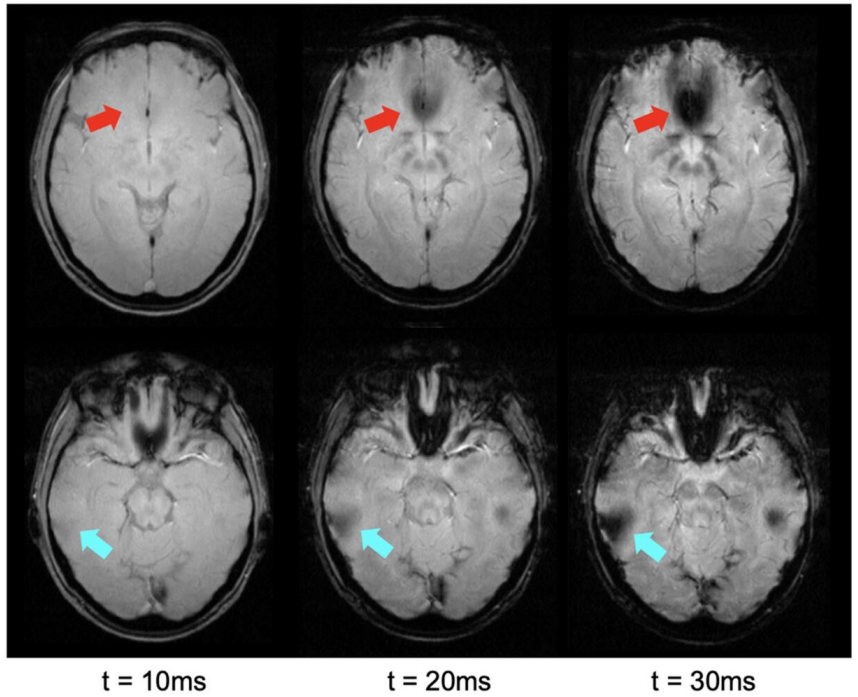
Overview of MRI: off-resonance in Gradient Echo

Polarization – Excitation – **Readout** – Reconstruction

$$S(t) = \int M_{xy}(\vec{r}, 0) e^{-i\gamma \int_0^t \vec{G}(\xi)\cdot\vec{r}\, d\xi - i\gamma t \Delta B(\vec{r})} d\vec{r}$$



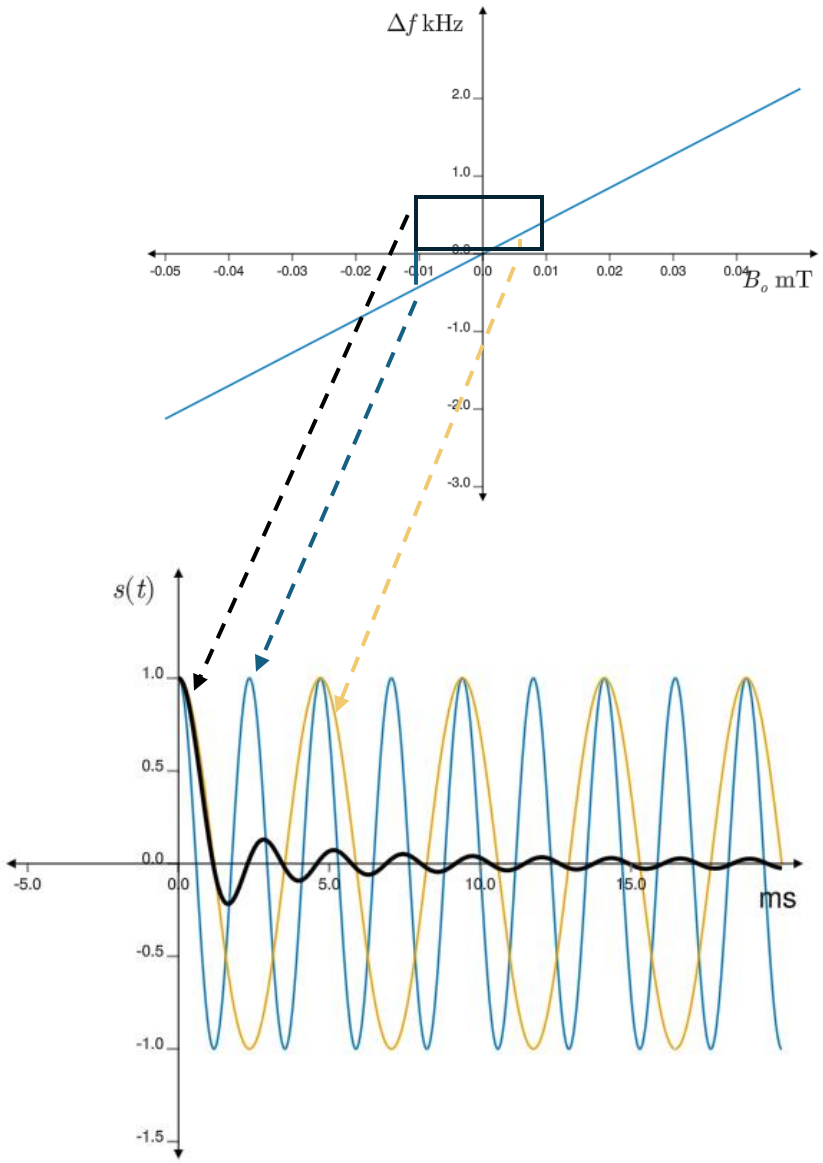




Overview of MRI: measuring the field

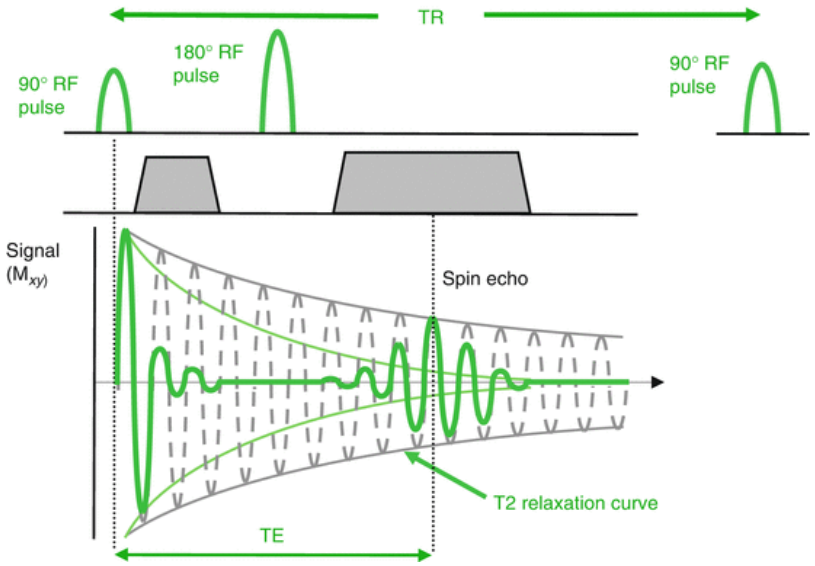
$$\gamma = 42.51 \quad \mathrm{MHz/T}$$

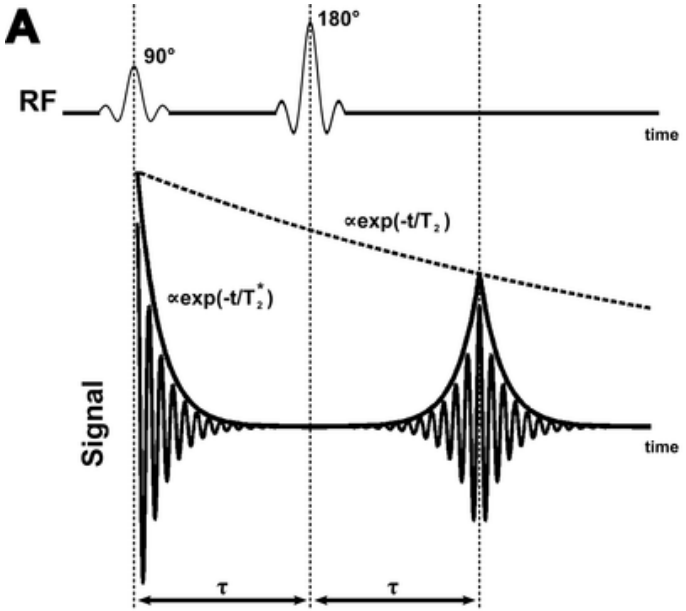
$$f_o = \gamma B_o \quad \mathrm{Hz}$$

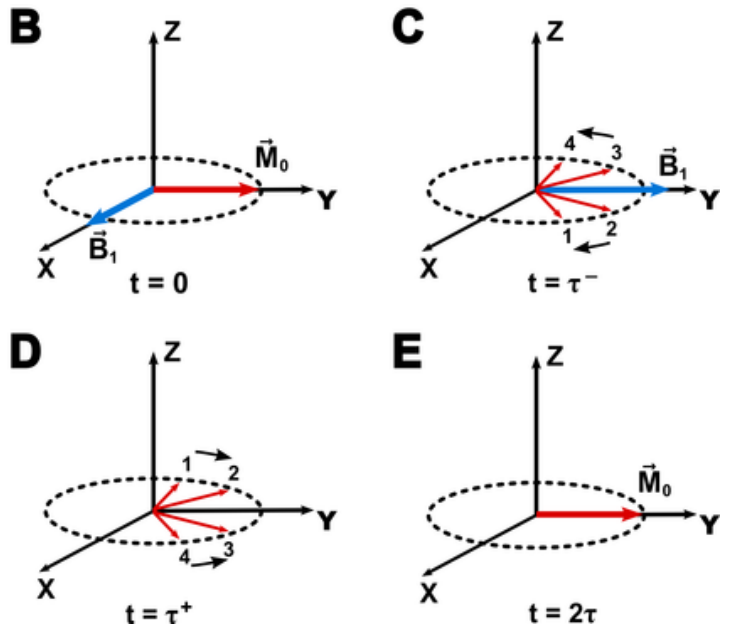


Overview of MRI: off-resonance in Spin Echo

Polarization – Excitation – **Readout** – Reconstruction







RF excitation + readout