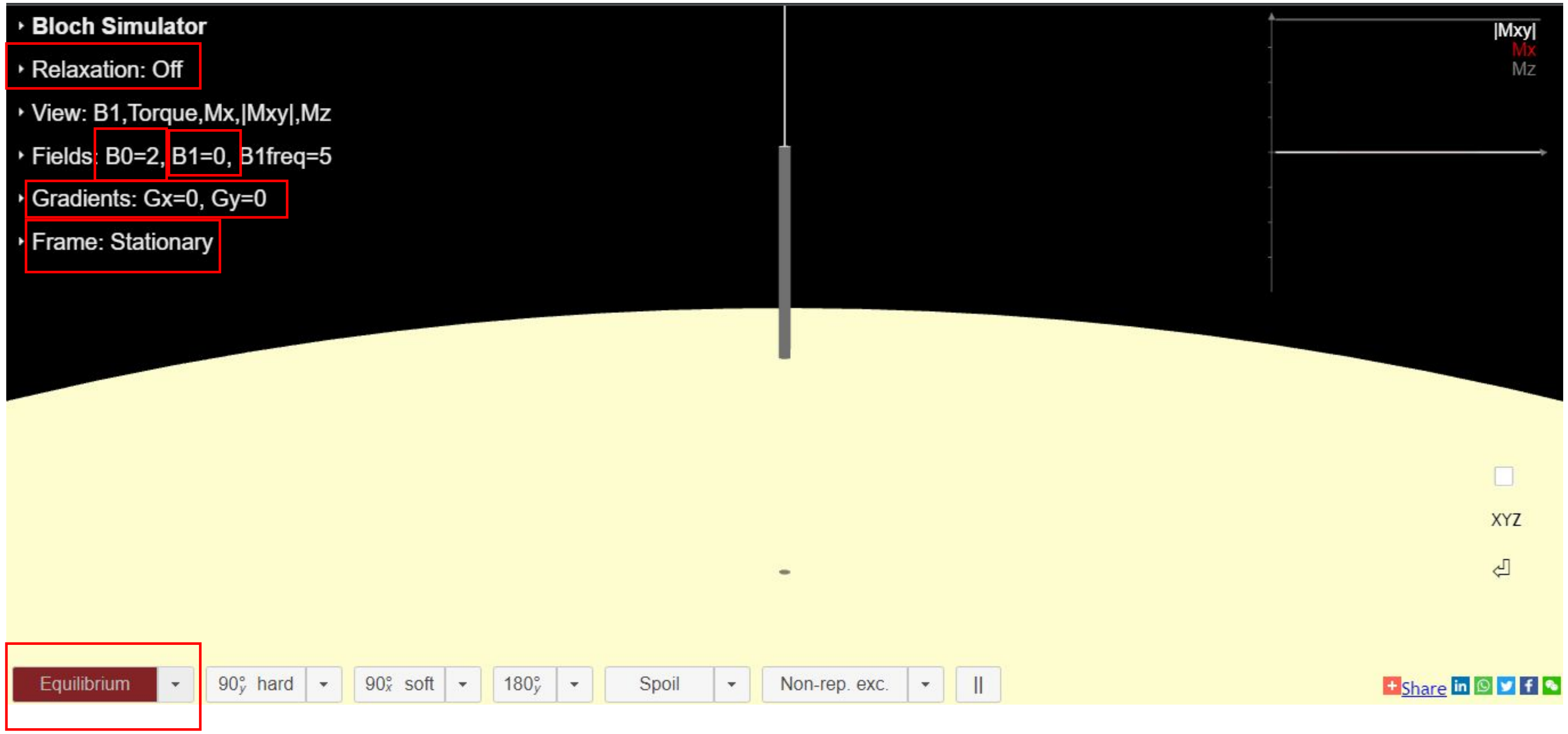
MRI Simulation

MSc Martha Rebeca Canales Fiscal.

Danya Rivera A01568331
Ariana Fragoso A00829129
Mariely Charles A00828348
Sebastian Mencias A00828056

RF effect

- You start by looking at the magnetization of a sample represented with a gray bar. To begin with the activity, be sure the specifications are as follows:



Mode: Equilibrium

Relaxation: off

B0: 2

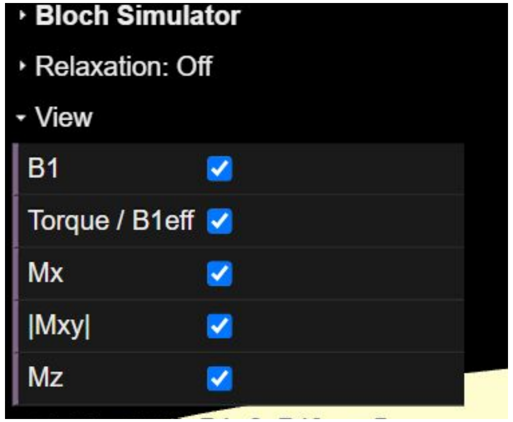
B1: 0

B1freq: not relevant at this point (it can have any value)

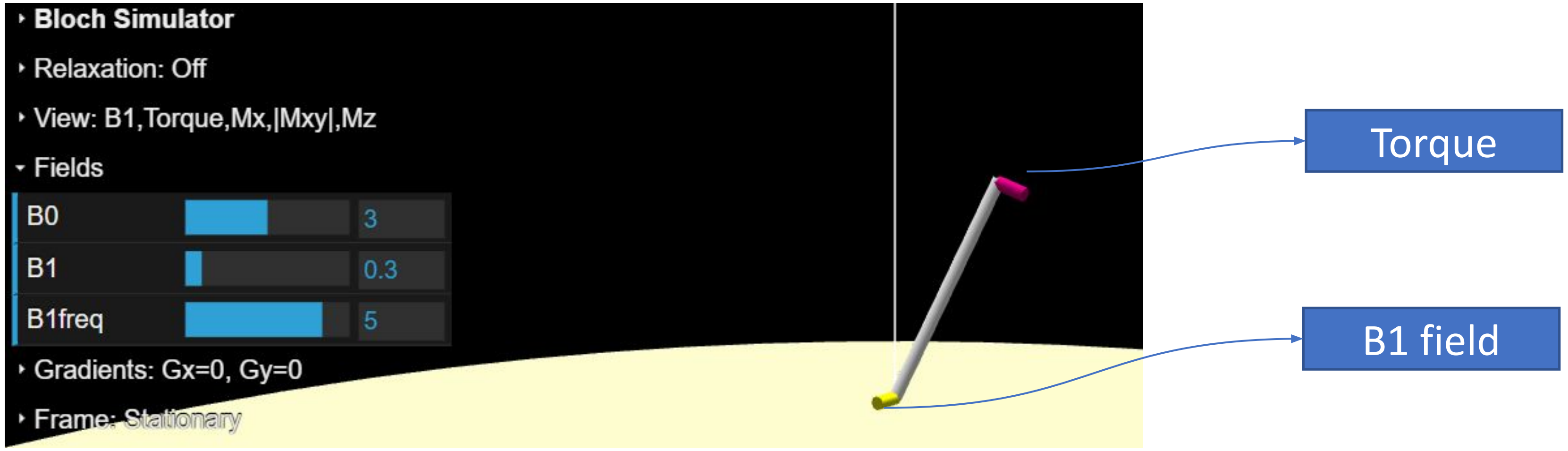
Gradients: both 0

Frame: Stationary.

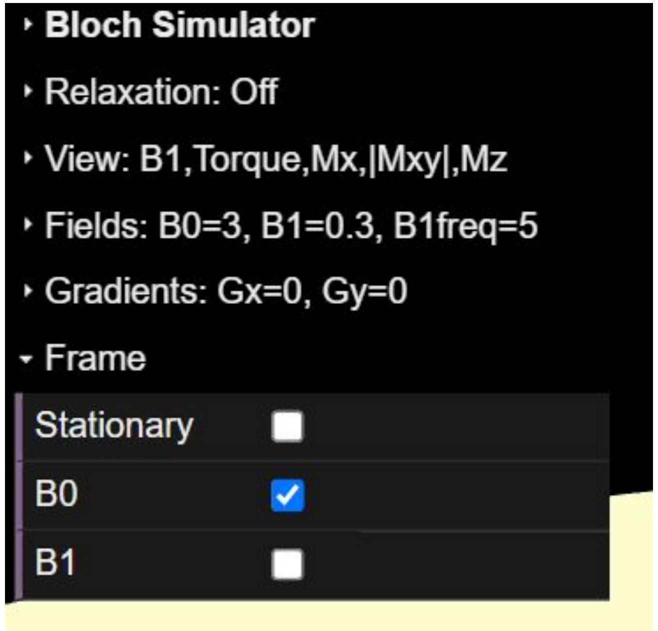
- You are going to look at the effect of applying an RF (B1 field).
- Click on View and be sure all the options are activated.



- Click on Field and be sure B0 is on 3T, let B1freq in any value. Then put B1 in 0.3 and look at the effect on the magnetization (grey bar).

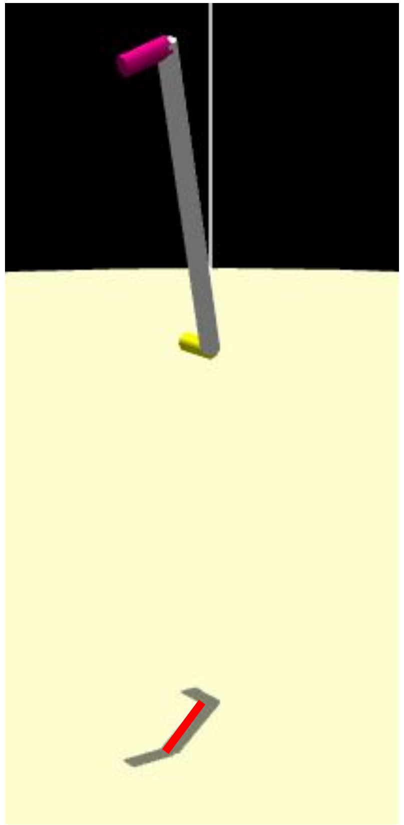


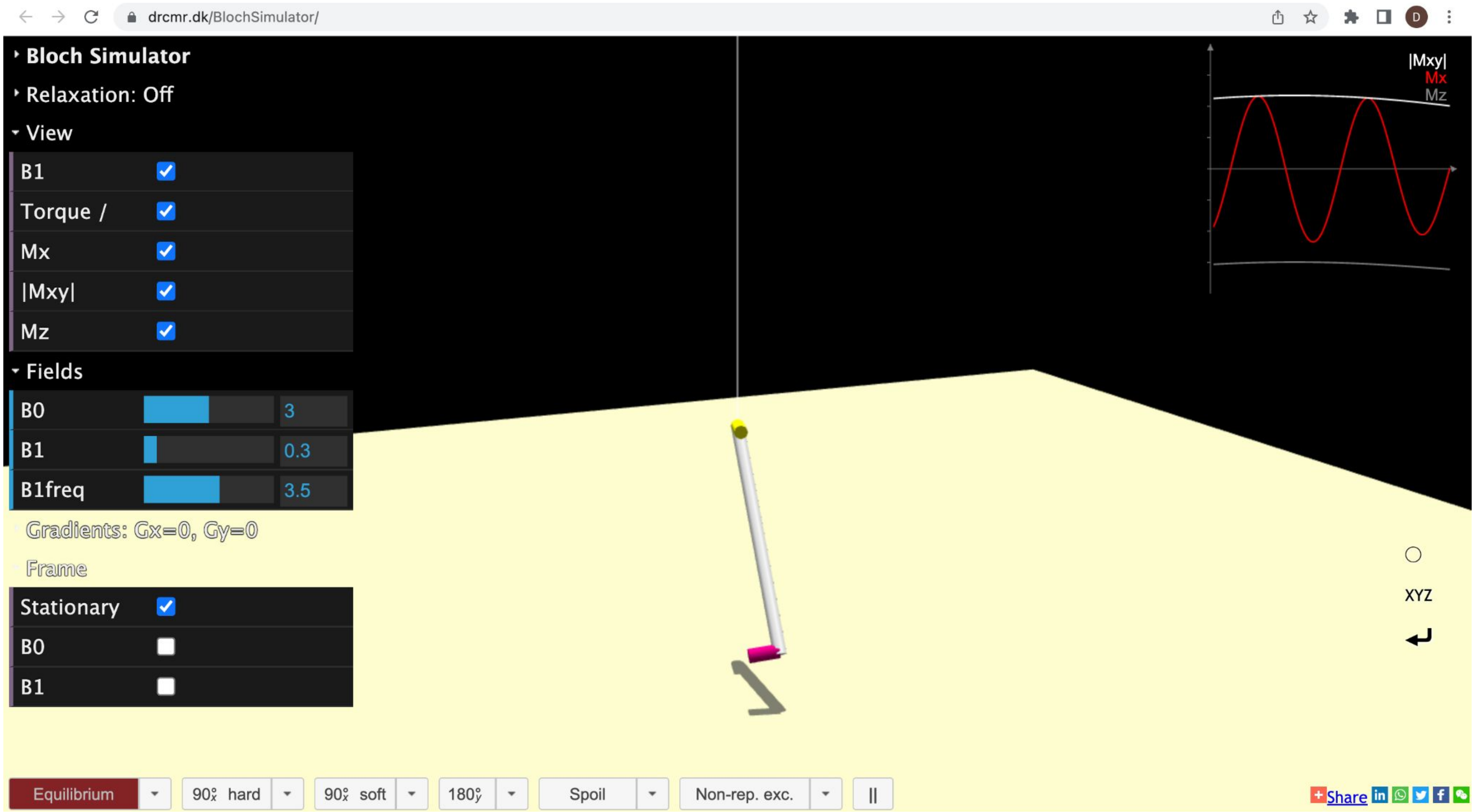
- You can see the magnetization precessing arbitrarily.
- To see more clearly the effect you should change the frame of reference. Observe how much and in which manner the magnetization moved away from the original direction.
- Click on Frame and choose the frame of reference of the field B0.



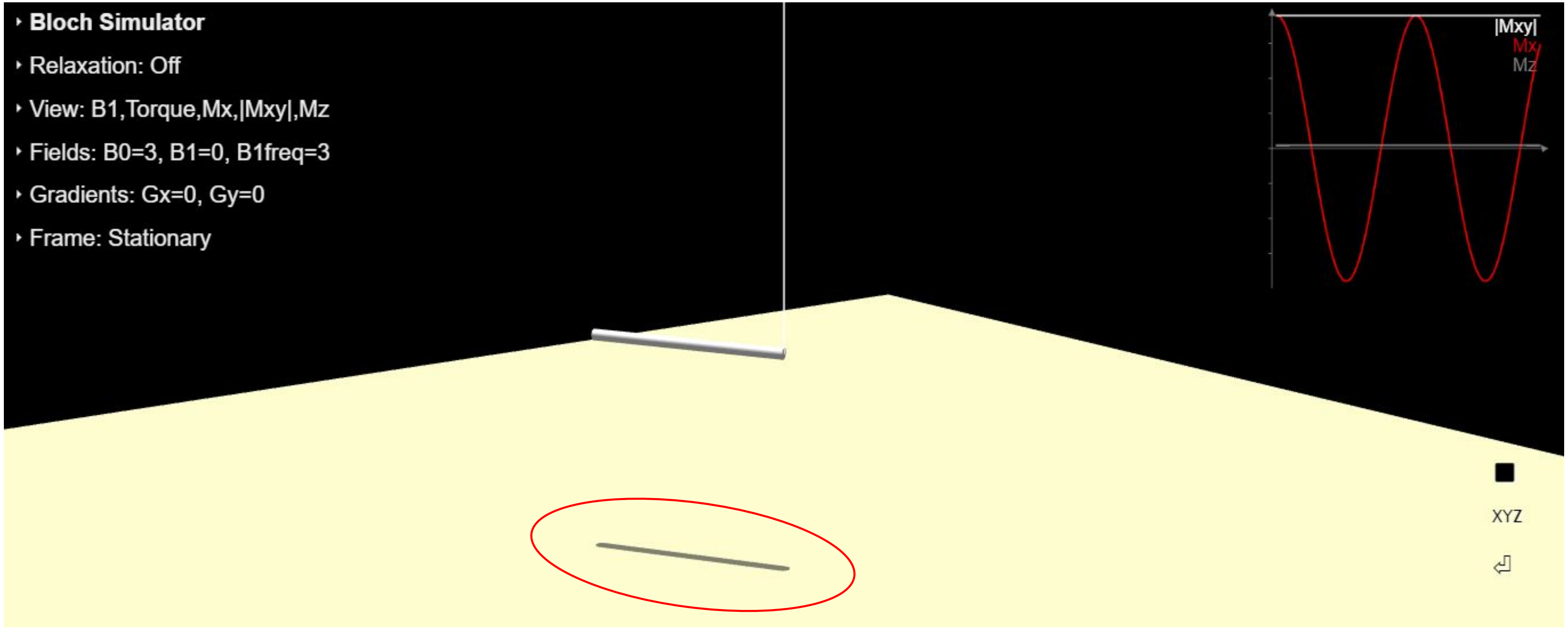
- The effect is not too strong because the frequency of B1 is not the resonant frequency. **Change the value of B1freq until the torque points towards only one direction**. **Once you find the appropriate frequency register it for your report =** **3.5**

The signal that we measure from the precessing magnetization is proportional to the size of the transversal magnetization (RF/B1). It can be seen in the length of the shadow (marked in red).



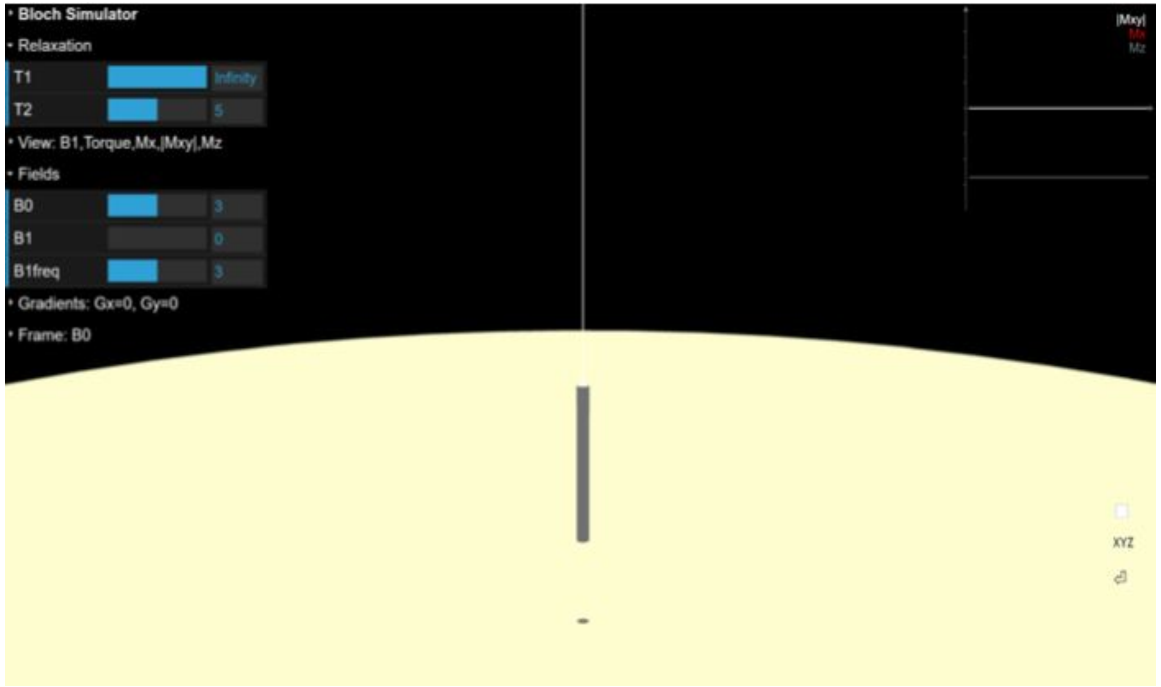

drcmr.dk/BlochSimulator/
Bloch Simulator
Relaxation: Off
View
B1
Torque /
Mx
|Mxy|
Mz
Fields
B0
3
B1
0.3
B1freq
3.5
Gradients: Gx=0, Gy=0
Frame
Stationary
B0
B1
|Mxy|
Mx
Mz
XYZ
Equilibrium
90° hard
90° soft
180°
Spoil
Non-rep. exc.
||
Share

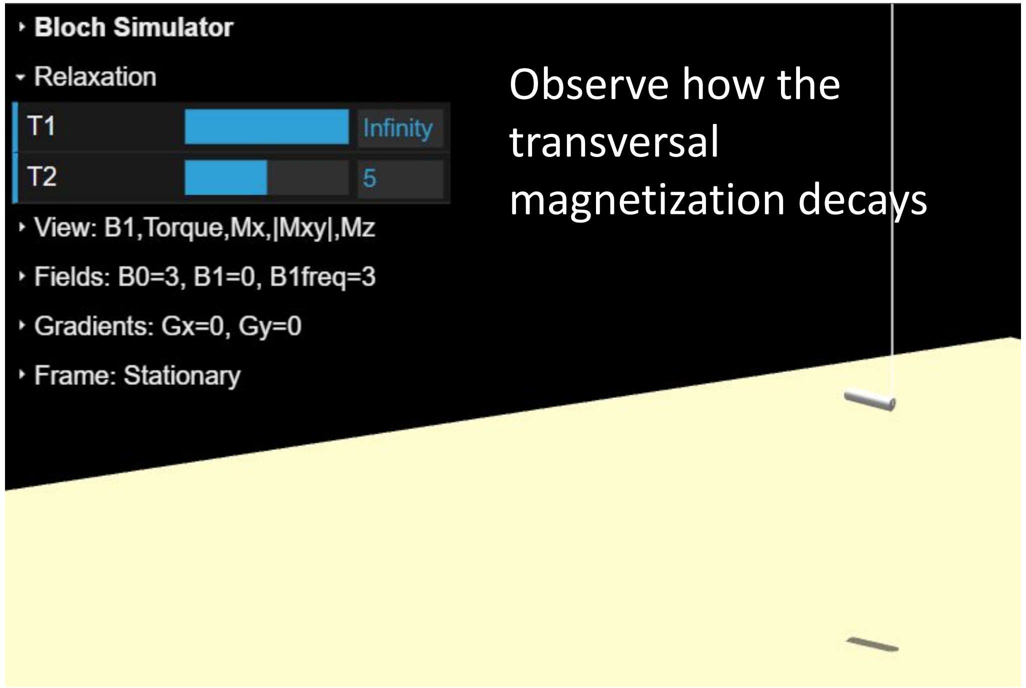
- Change between B0 and stationary frames of reference to observe by yourself and understand how the complete phenomenon is happening.
- Once you have a strong signal (the length of the shadow in large) turn off B1.



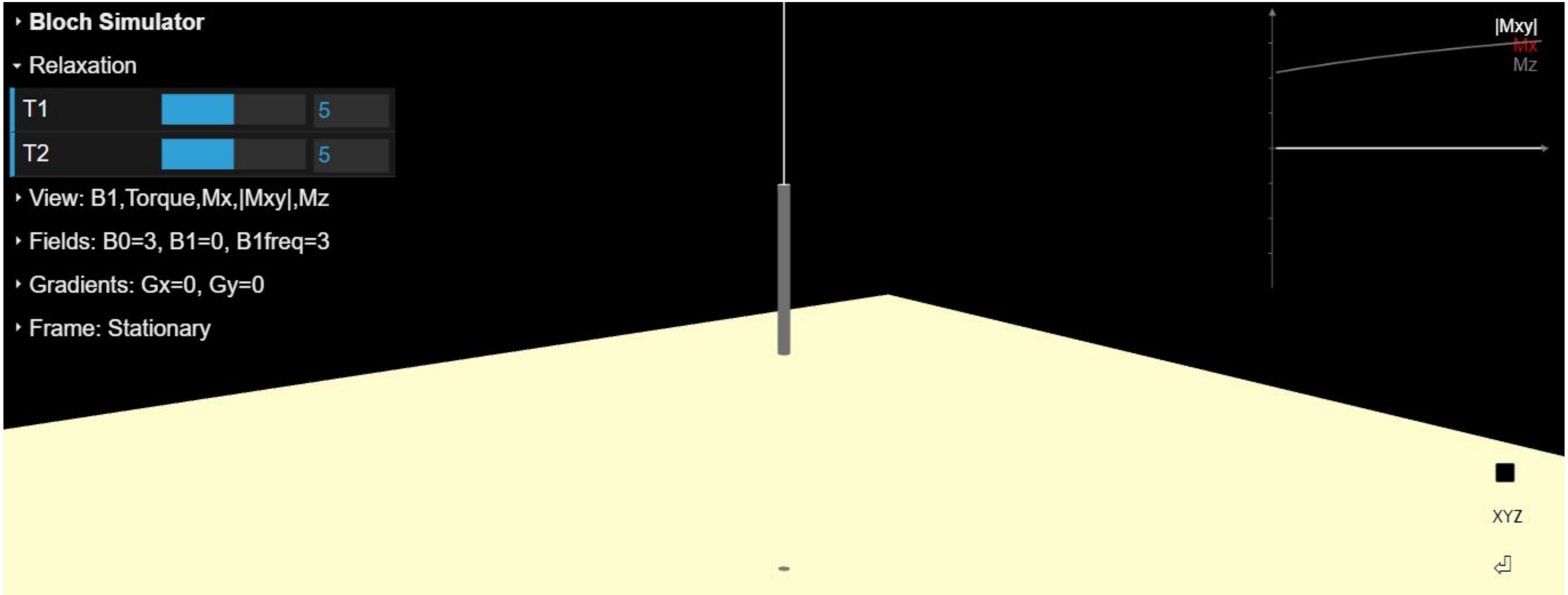
Relaxation times

- Until now, you explored the effect that the transversal field has on the magnetization. Now you should return it to the equilibrium. For doing so, you need to change the relaxation times.
- First look at the effect of the T2 relaxation time.
- Click on Relaxation and change T2 to 5 seconds.





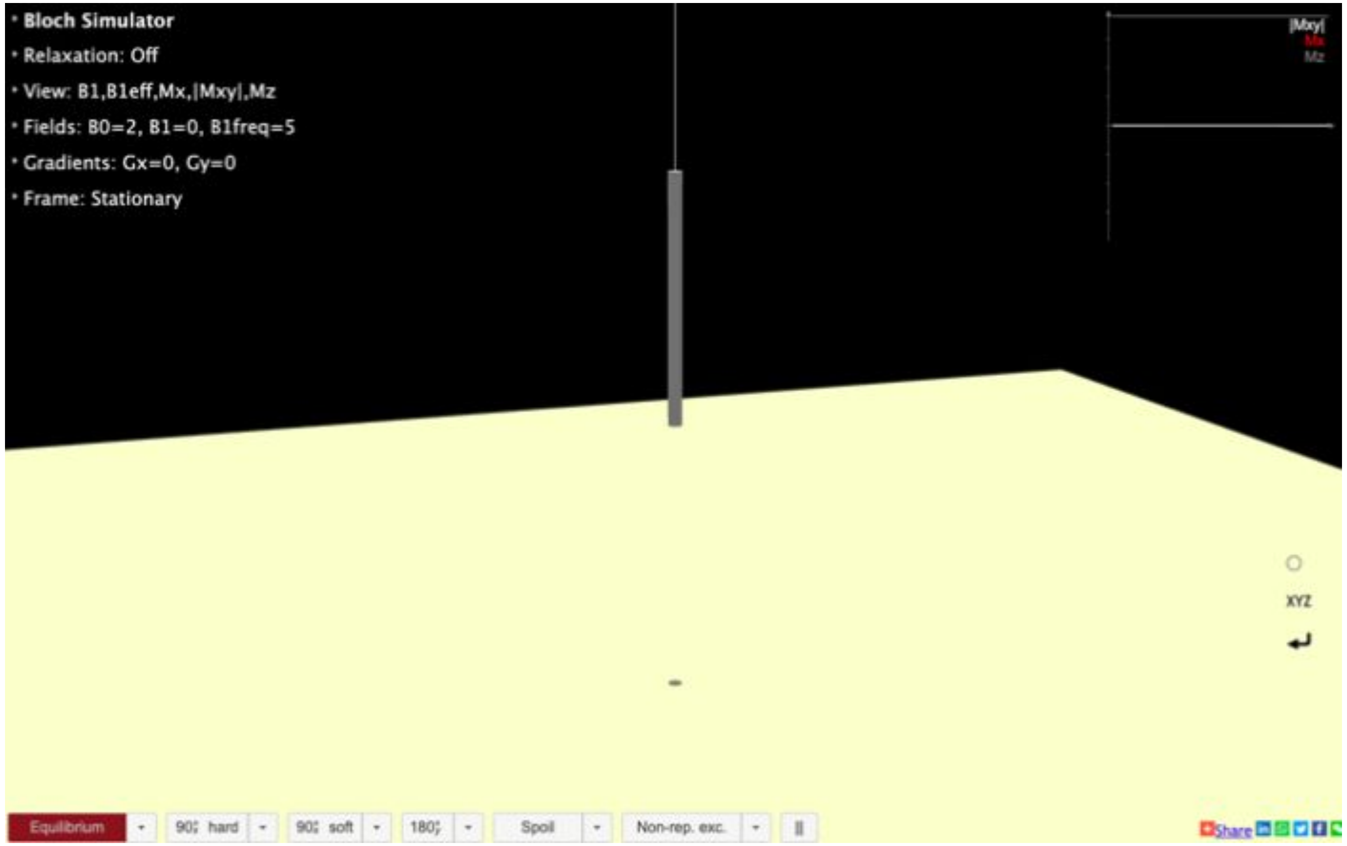
- Now change T1 to 5 seconds.
- Observe how it returns to the equilibrium state.



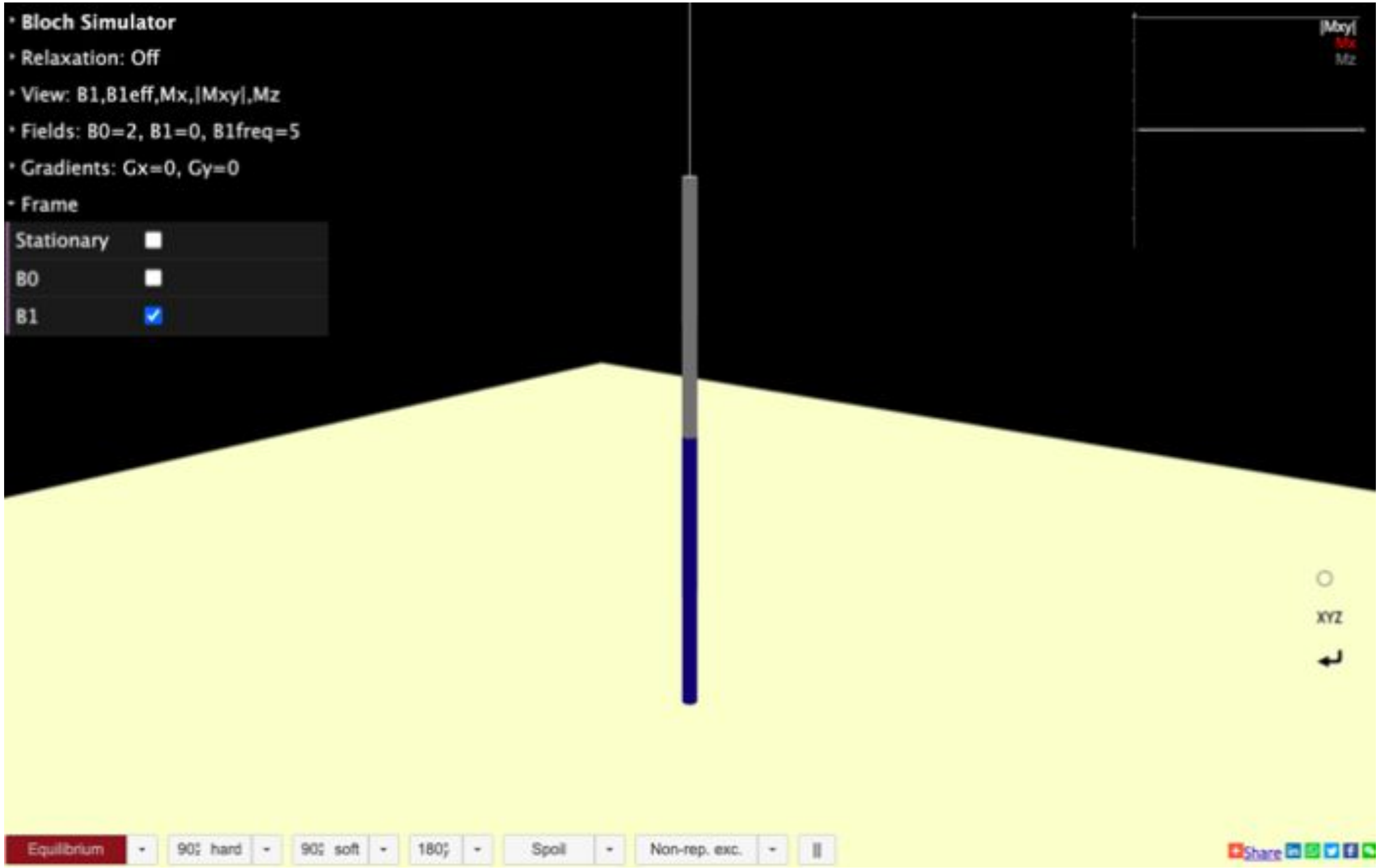
Complete process

- Now repeat the entire process by yourself using different relaxation times combinations.

1) Start in the equilibrium.

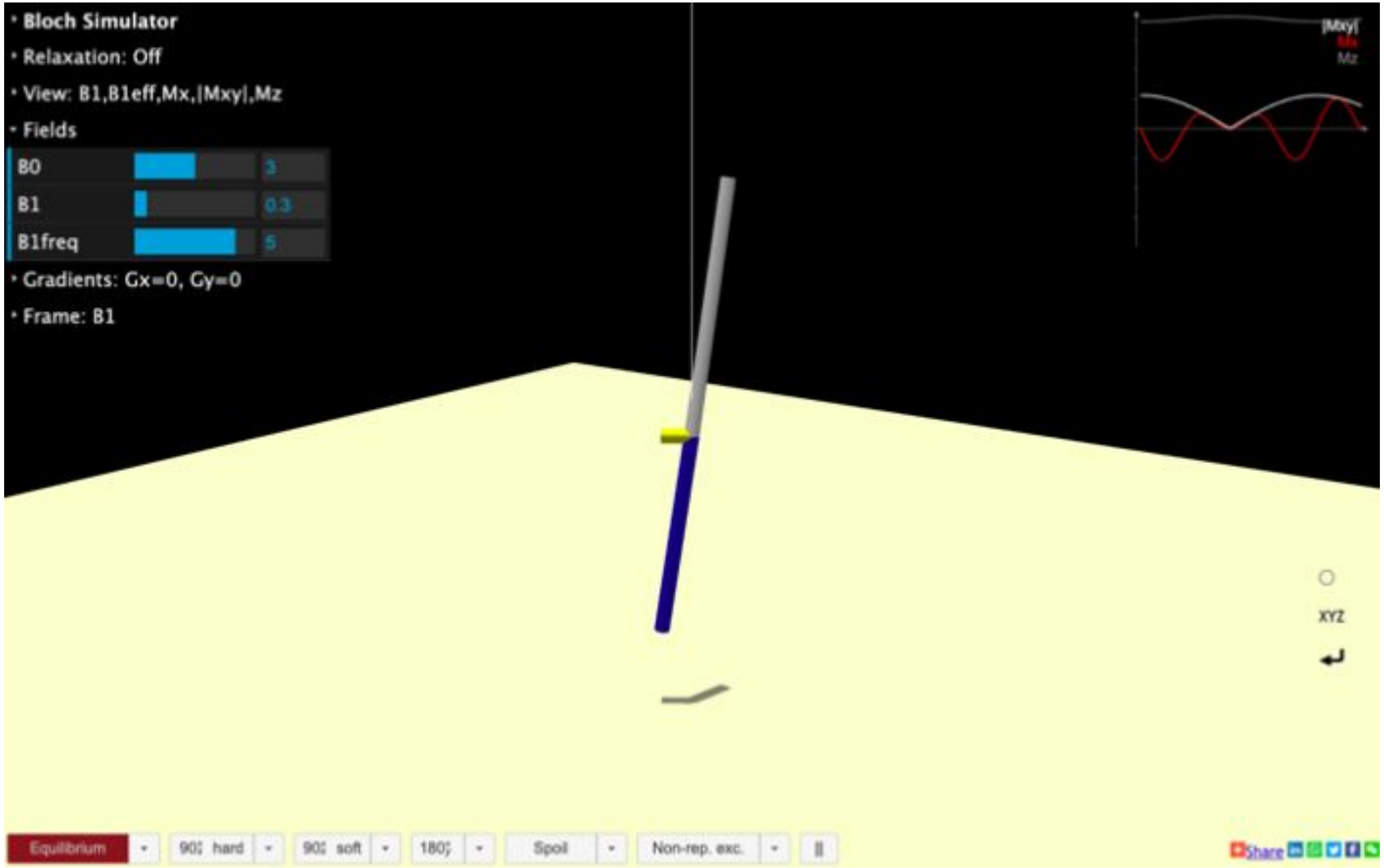


1) Turn on B1.

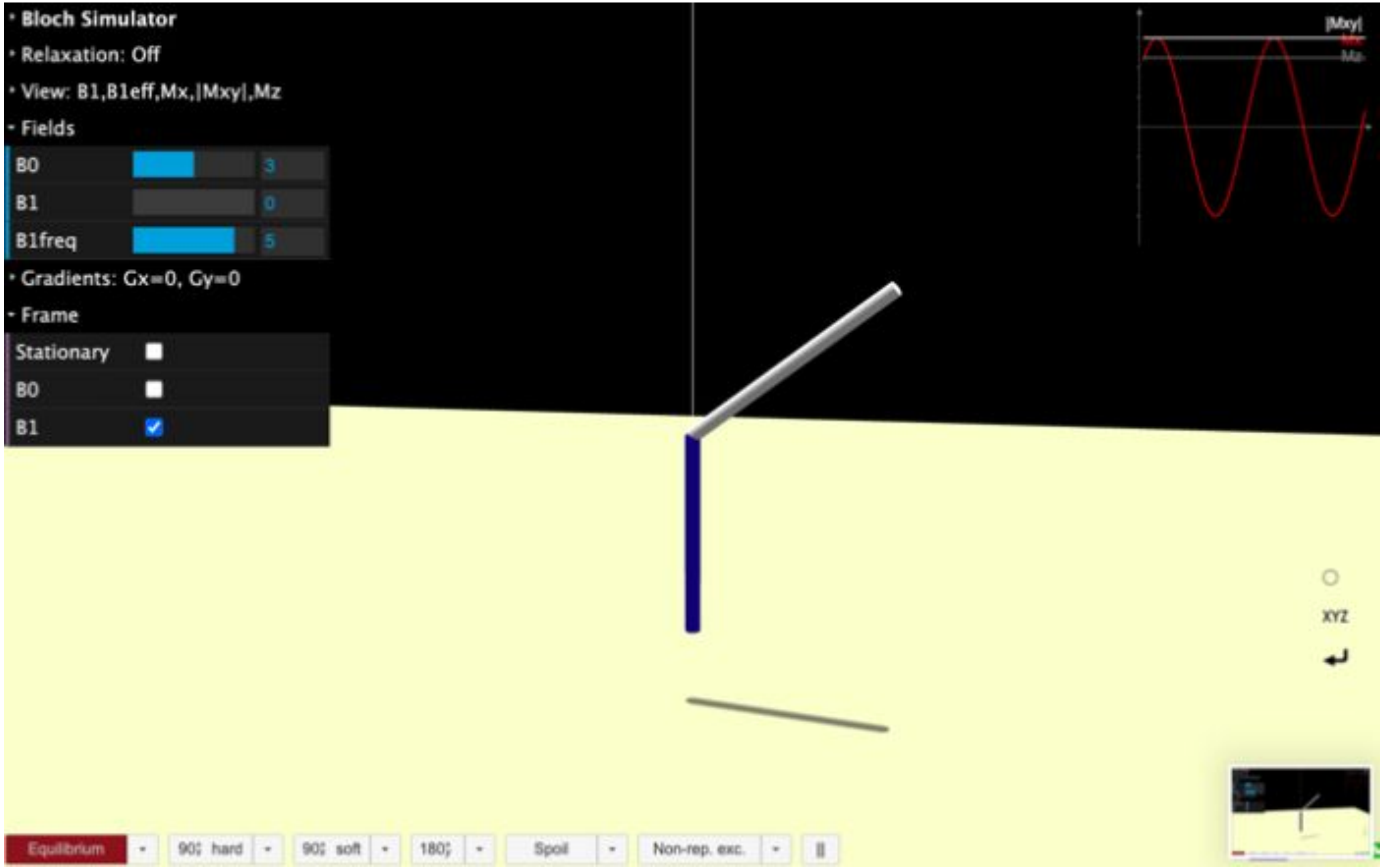


Bloch Simulator
Relaxation: Off
View: B1,B1eff,Mx,|Mxy|,Mz
Fields: B0=2, B1=0, B1freq=5
Gradients: Gx=0, Gy=0
Frame
Stationary
B0
B1
|Mxy|
Mz
XYZ
Equilibrium
90: hard
90: soft
180;
Spoil
Non-rep. exc.
Share

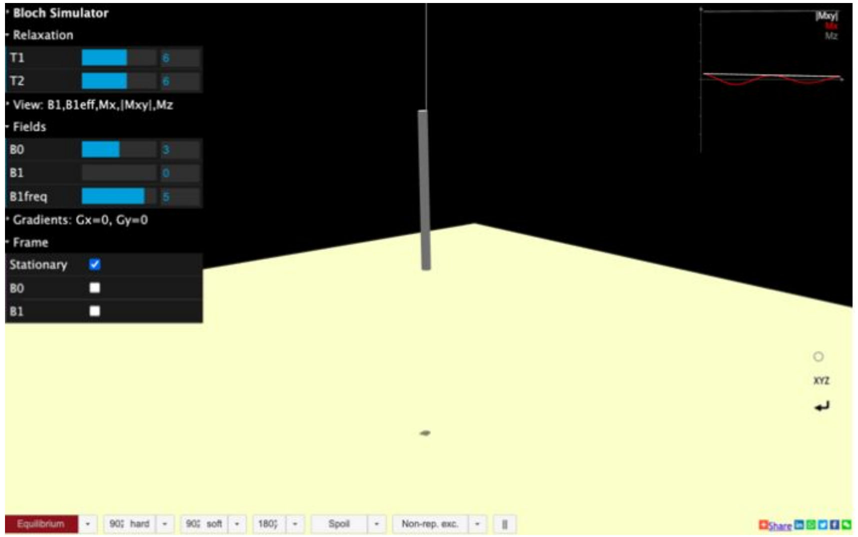
1) Set the resonant frequency.

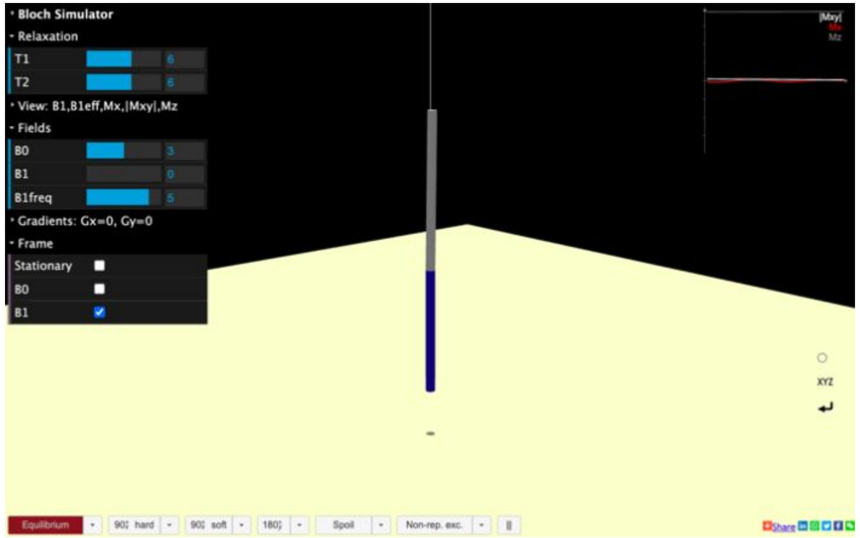


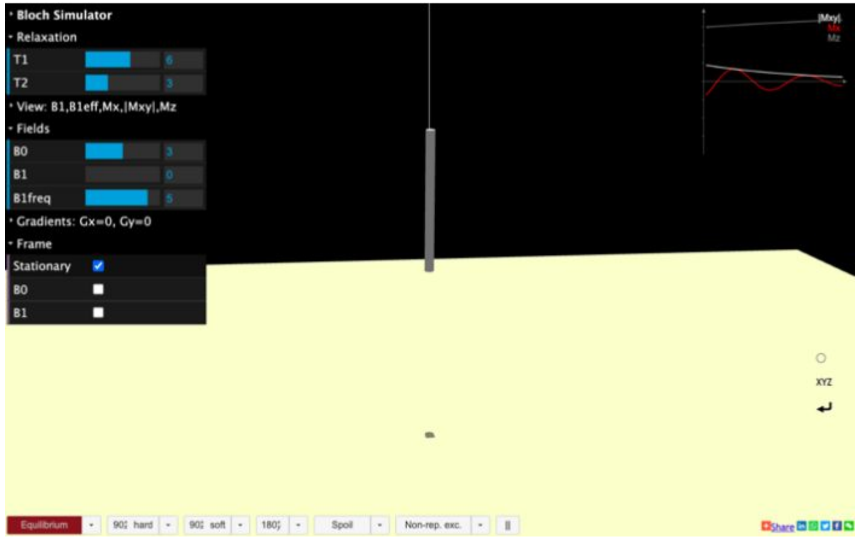
1) When you obtain a strong signal, turn off B1.



1) Use different relaxation times and observe the effect when changing the frames of reference from Stationary to B0 and again to Stationary as many times as you need to understand the process (at least once).

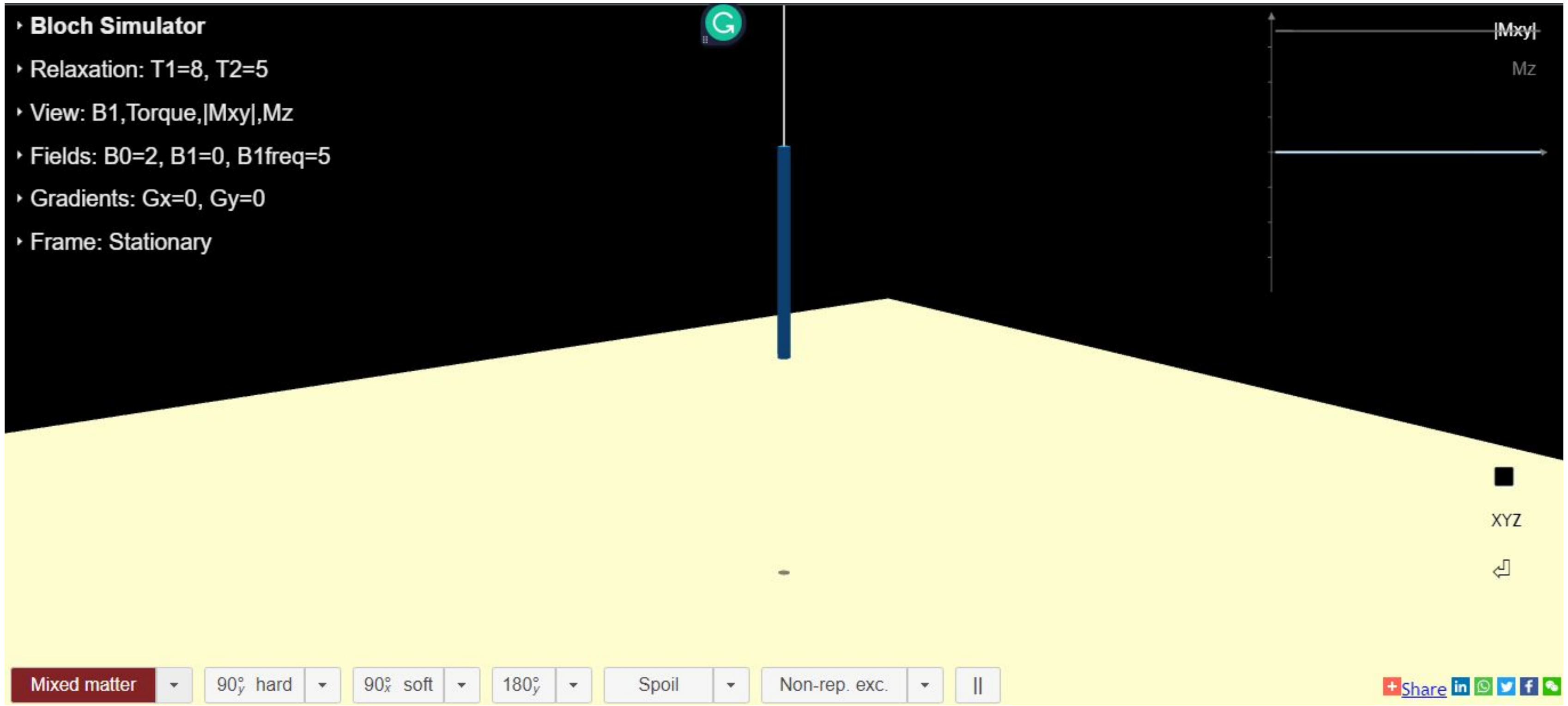






Different tissues

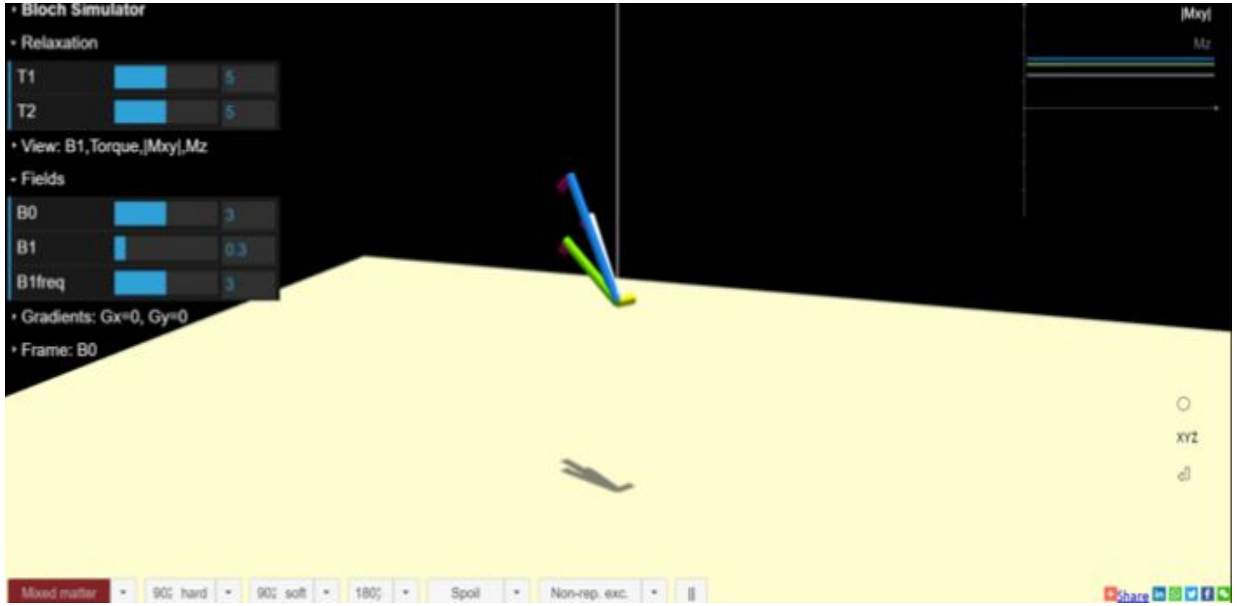
- Change the mode to Mixed matter. You are going to see the magnetizations corresponding to samples of different tissues with different colors. At the beginning all of them are together so you can't differentiate them.

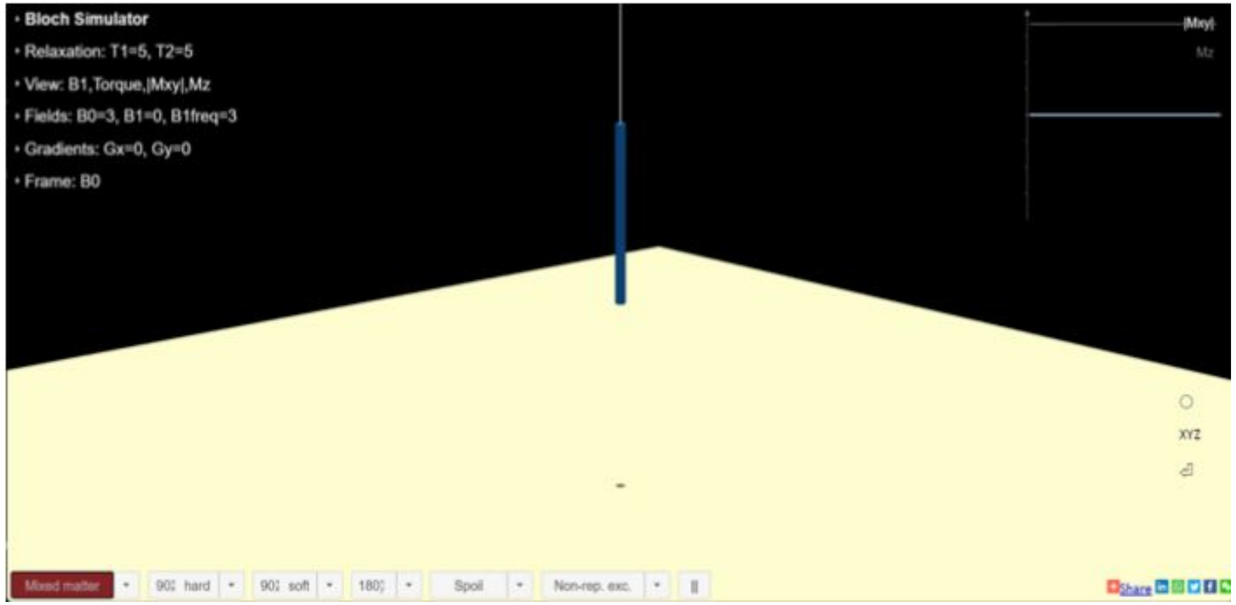


The magnetizations of all the tissues are here all together.

- Now repeat the process that you previously learned and observe how the magnetizations of the different tissues respond differently (**Take evidence with ss**). **Explain in your report the differences (signal's strength and time) between the magnetizations referring to them by colors.**

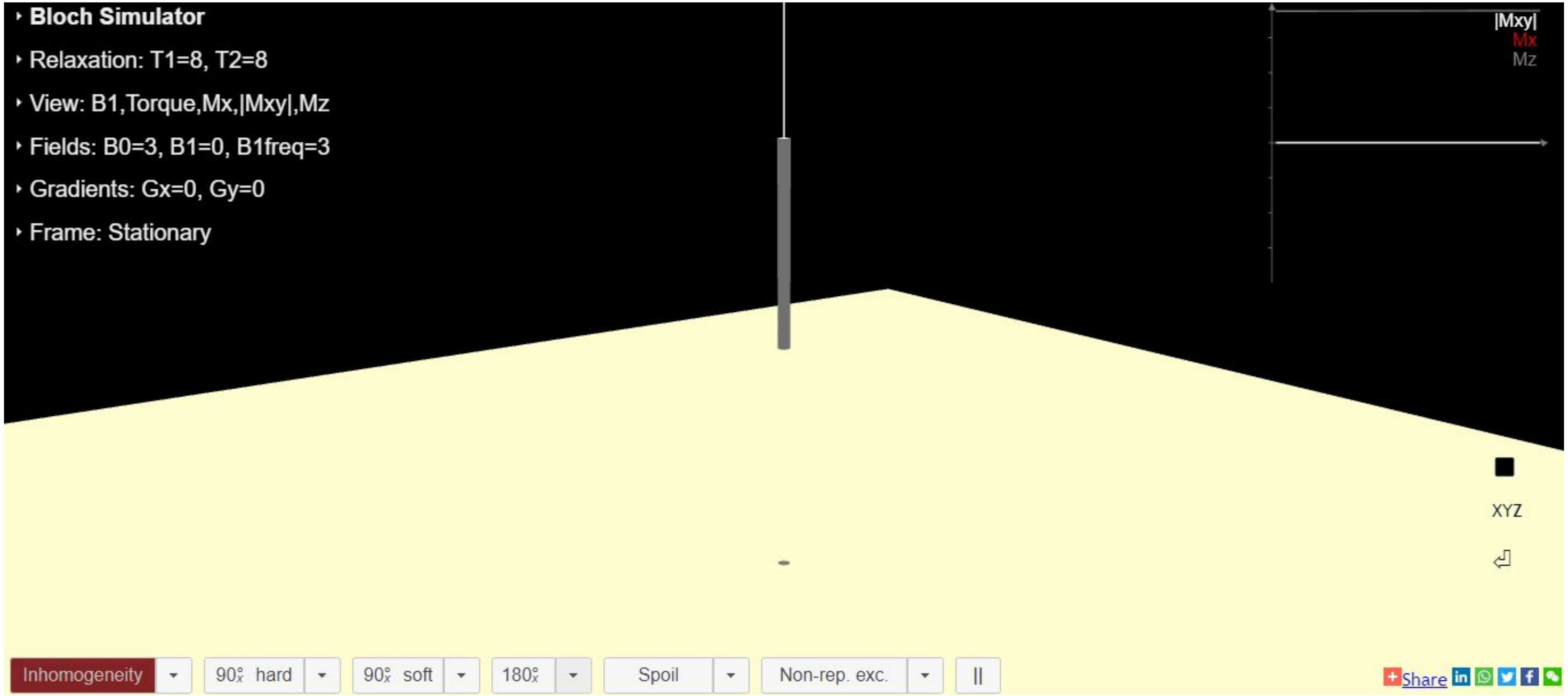
La barra verde alcanza su posición final más rápido que la barra azul y la barra gris. Cuando apagas el campo B1, la barra azul alcanza primero el equilibrio, luego el gris y le sigue el verde. La diferencia entre las señales es que el azul es más grande que el verde y este otro es más grande que el gris. El significado de esta comparación es que la barra azul sería más brillante, seguido de la barra gris y la barra verde.

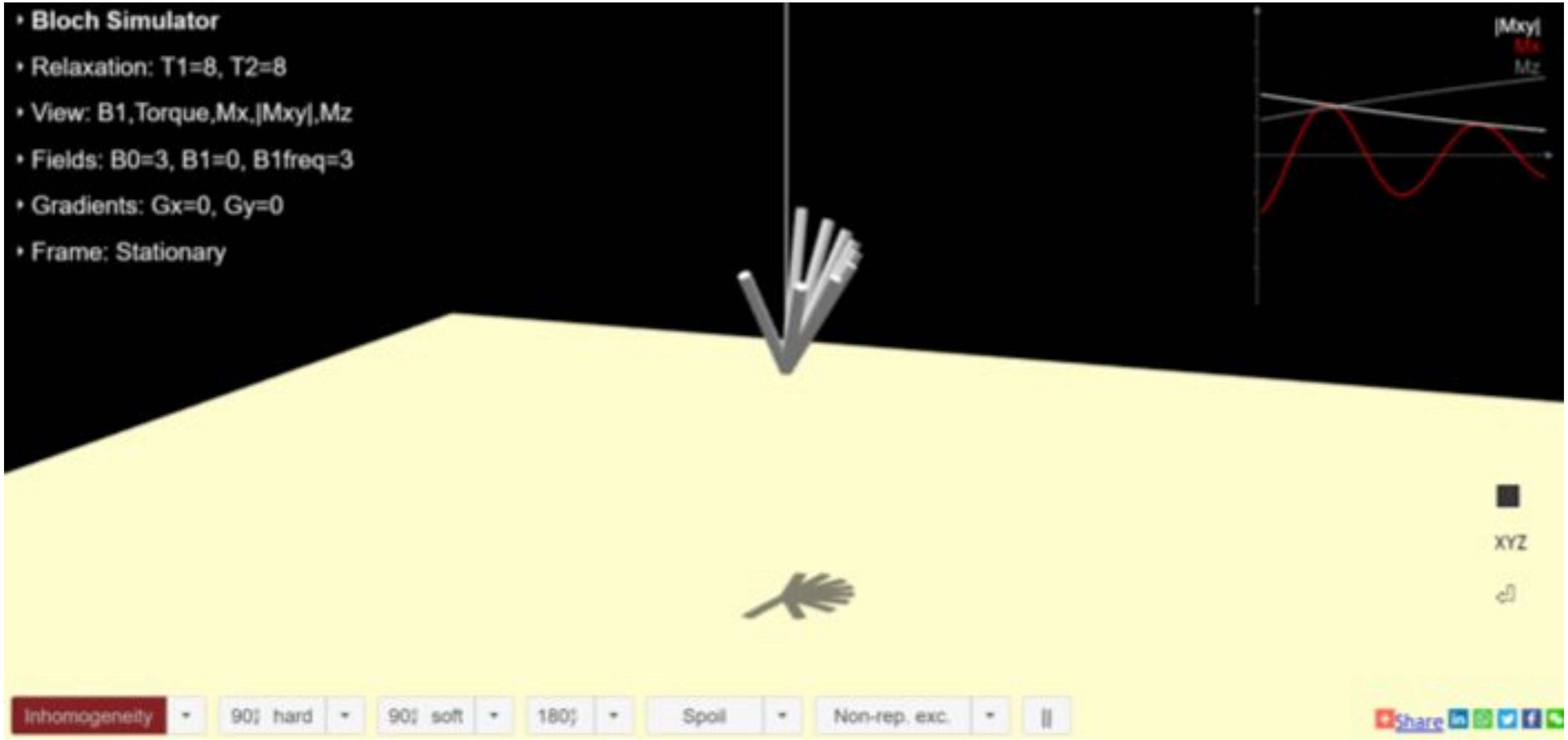




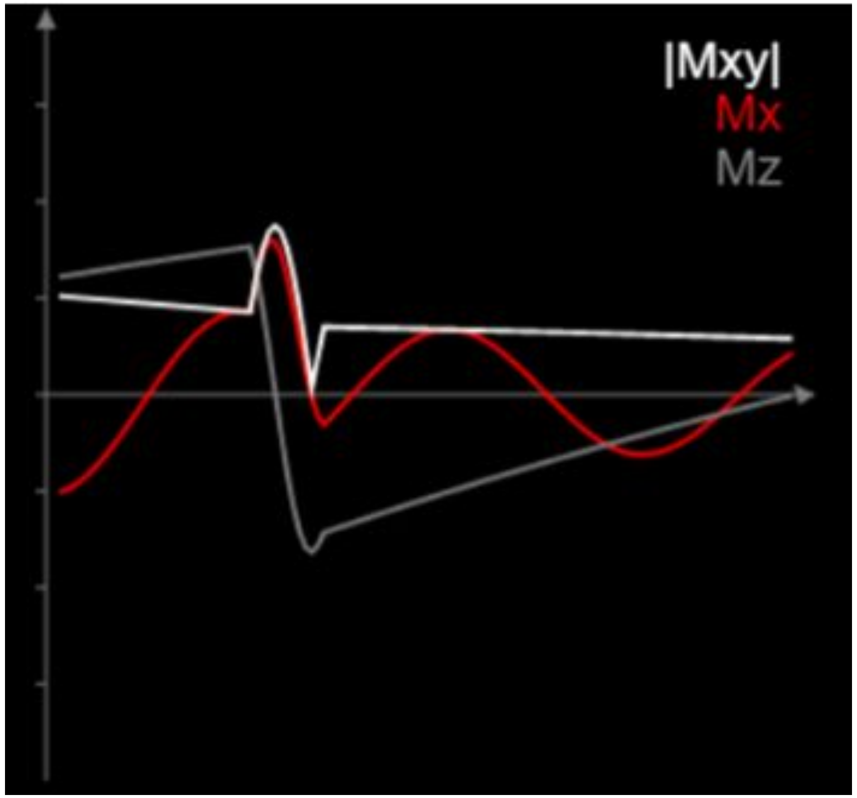
Spin Echo

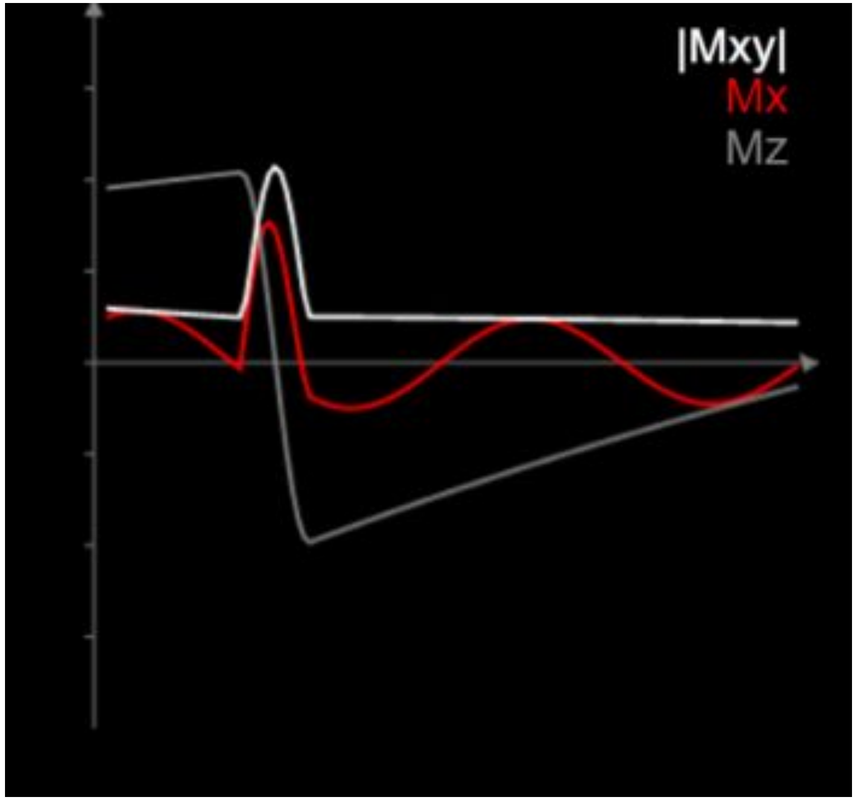
- Now you are going to explore spin-echo and with it the dephasing effect.
- Start with the specifications of the image. Note that Inhomogeneity mode was chosen. The commands in the bottom allow you to apply a quick pulse of 90° in the x-direction and 180° in the y-direction.




Bloch Simulator
Relaxation: T1=8, T2=8
View: B1,Torque,Mx,|Mxy|,Mz
Fields: B0=3, B1=0, B1freq=3
Gradients: Gx=0, Gy=0
Frame: Stationary
|Mxy|
Mx
Mz
XYZ
Inhomogeneity
90° hard
90° soft
180°
Spoil
Non-rep. exc.
Share

- Note how you obtain an echo with this process. If you do it at the correct timing the echo is going to be strong. **Try to obtain your best result and take an ss of the graph**. Play with different specifications (B0, T1, T2, etc.).





El pulso de 90° genera el cambio de fase, mientras que el pulso de 180° invierte el cambio de fase, generando el pulso observado. La diferencia en la magnitud del pulso depende del tiempo transcurrido entre el pulso de 90° y el pulso de 180°.