MRI Simulation

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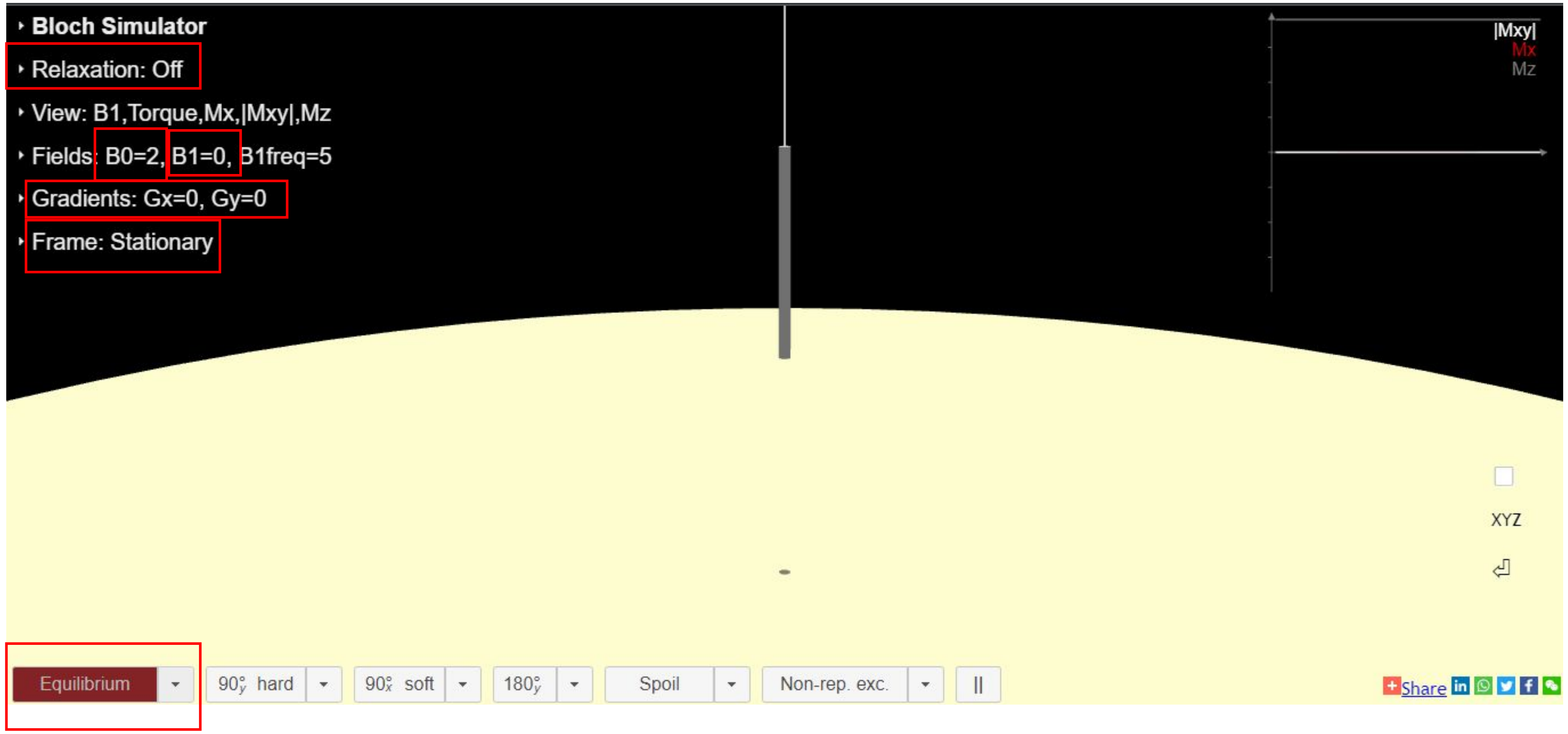
RF effect

- Open the simulator: https://www.drcmr.dk/BlochSimulator/
- 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

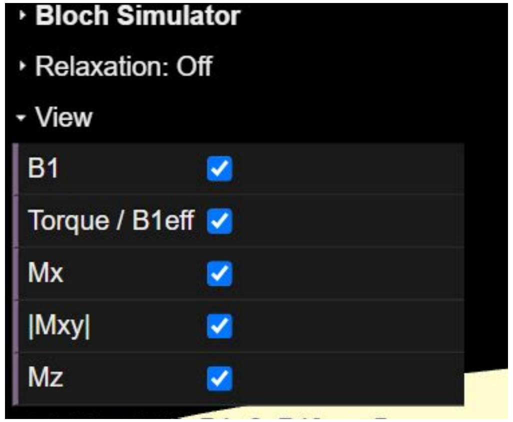
B1: 0

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

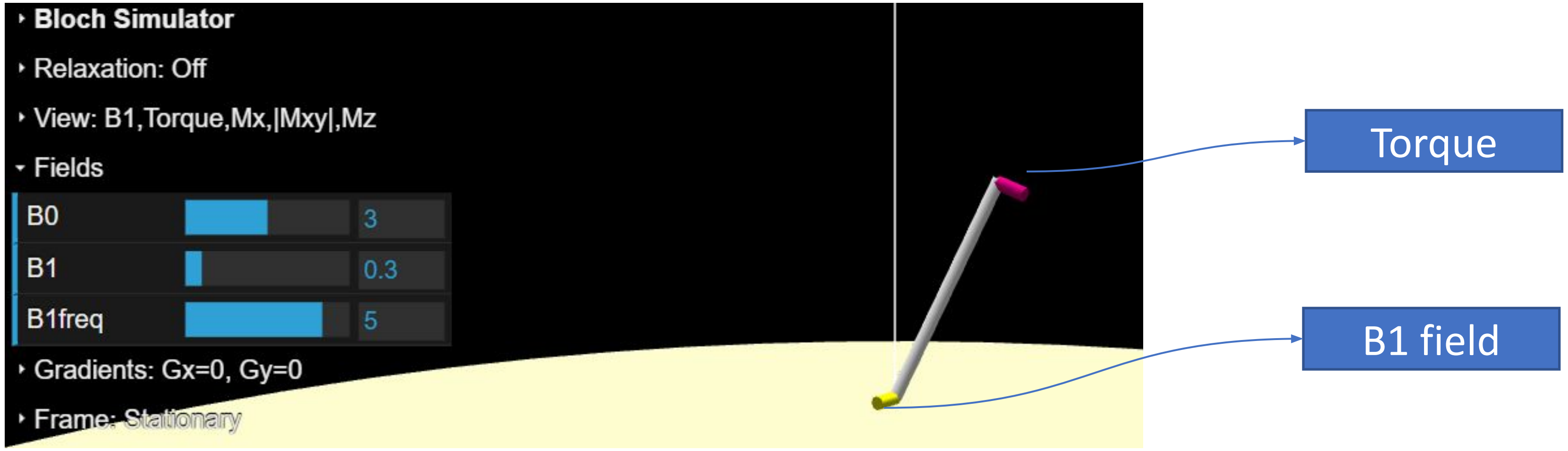
Gradients: both 0

Frame: Stationary.

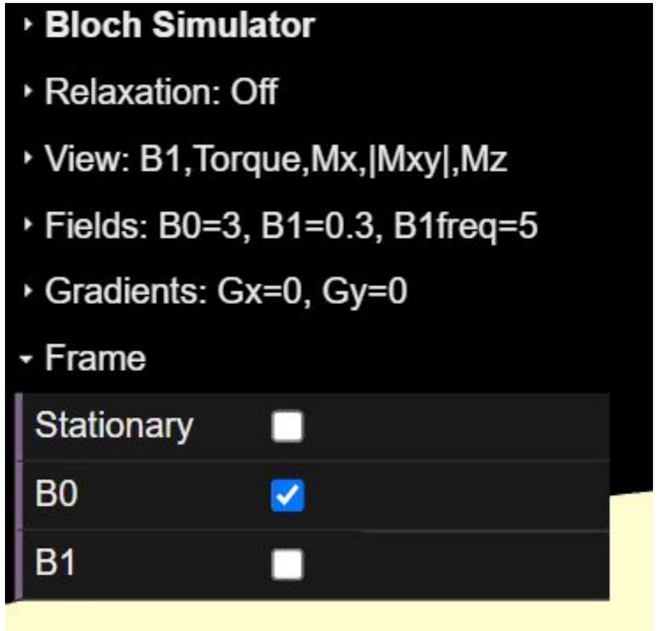
- You are going to look at the effect of applying an RF (B1 field).
- Click on View and be sure all the options are activated.



- 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).

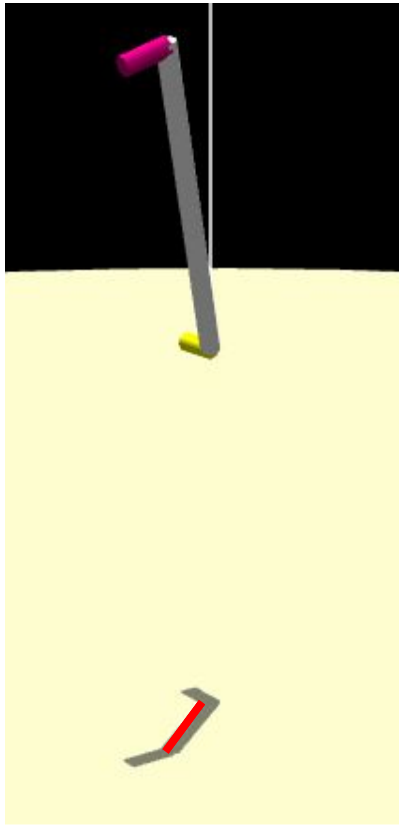


- You can see the magnetization precessing arbitrarily.
- To see more clearly the effect you should change the frame of reference. Observe how much and in which manner the magnetization moved away from the original direction.
- Click on Frame and choose the frame of reference of the field B0.

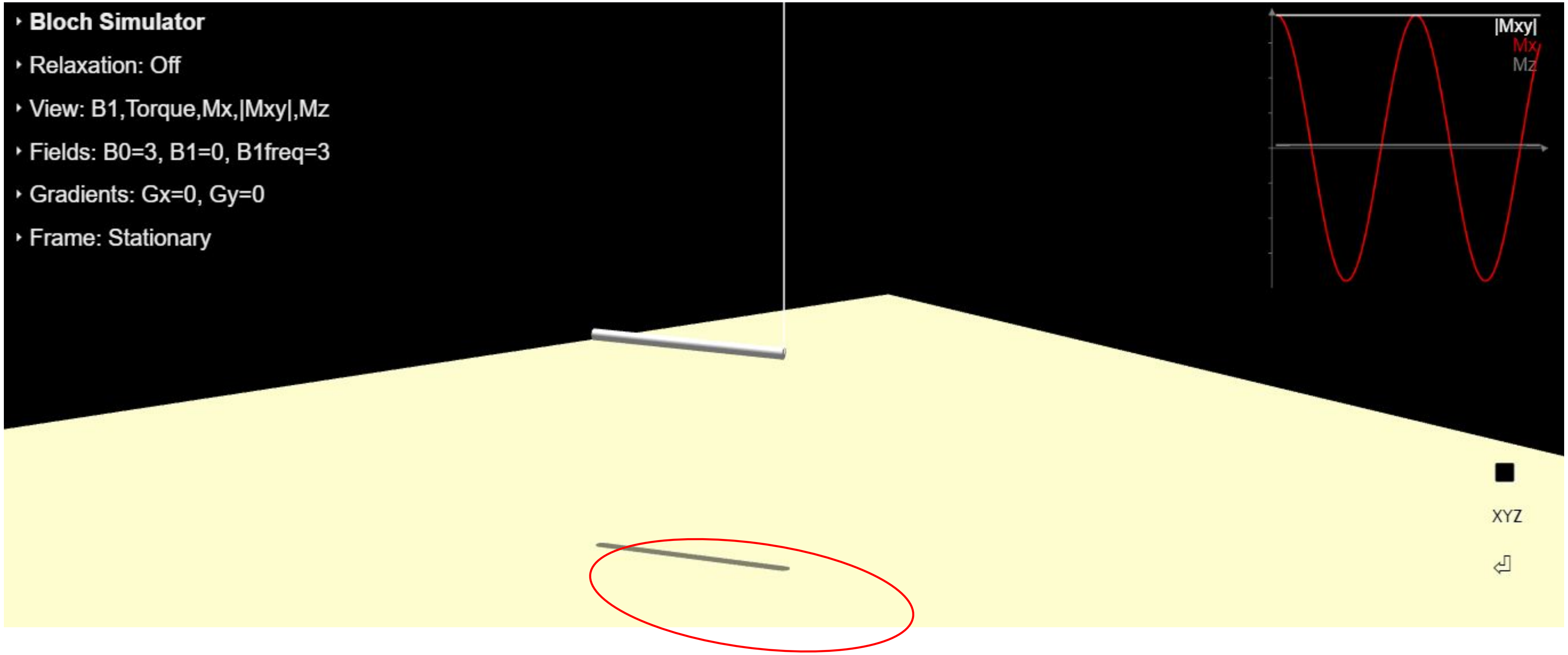


- The effect is not too strong because the frequency of B1 is not the resonant frequency. **Change the value of B1freq until the torque points towards only one direction**. **Once you find the appropriate frequency register it for your report**

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).

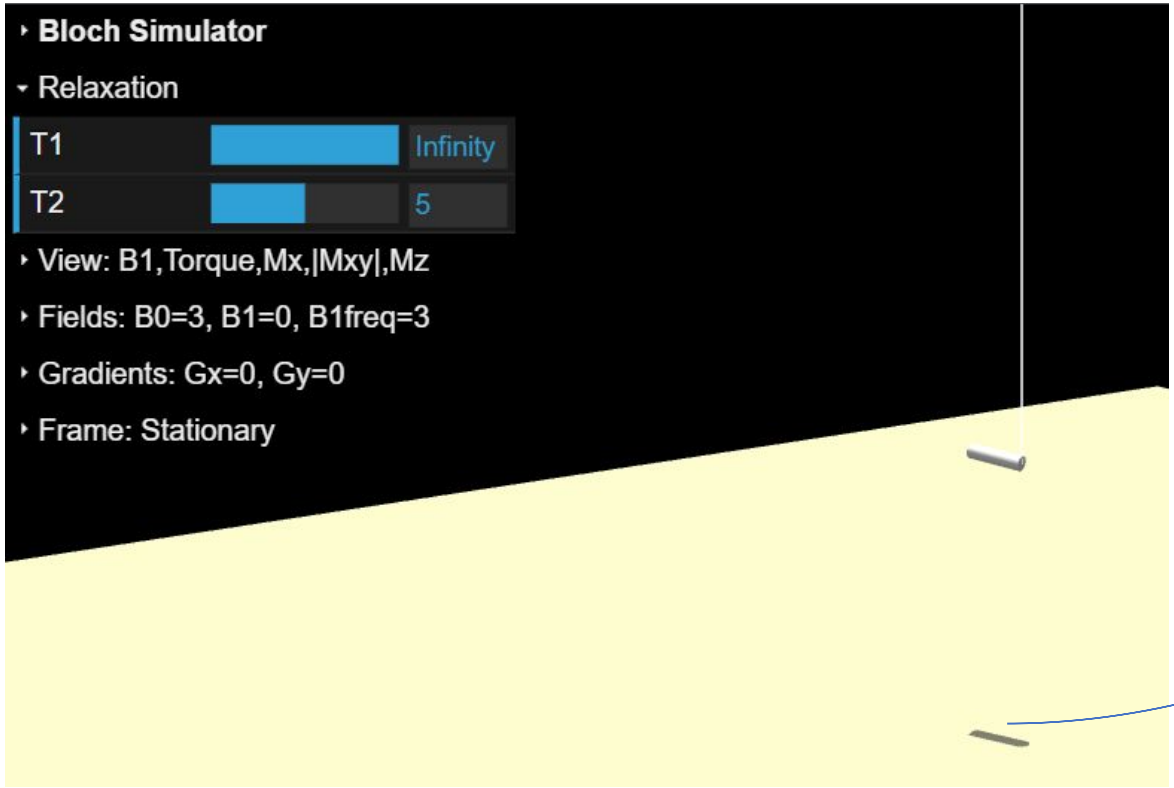


- Change between B0 and stationary frames of reference to observe by yourself and understand how the complete phenomenon is happening.
- Once you have a strong signal (the length of the shadow in large) turn off B1.



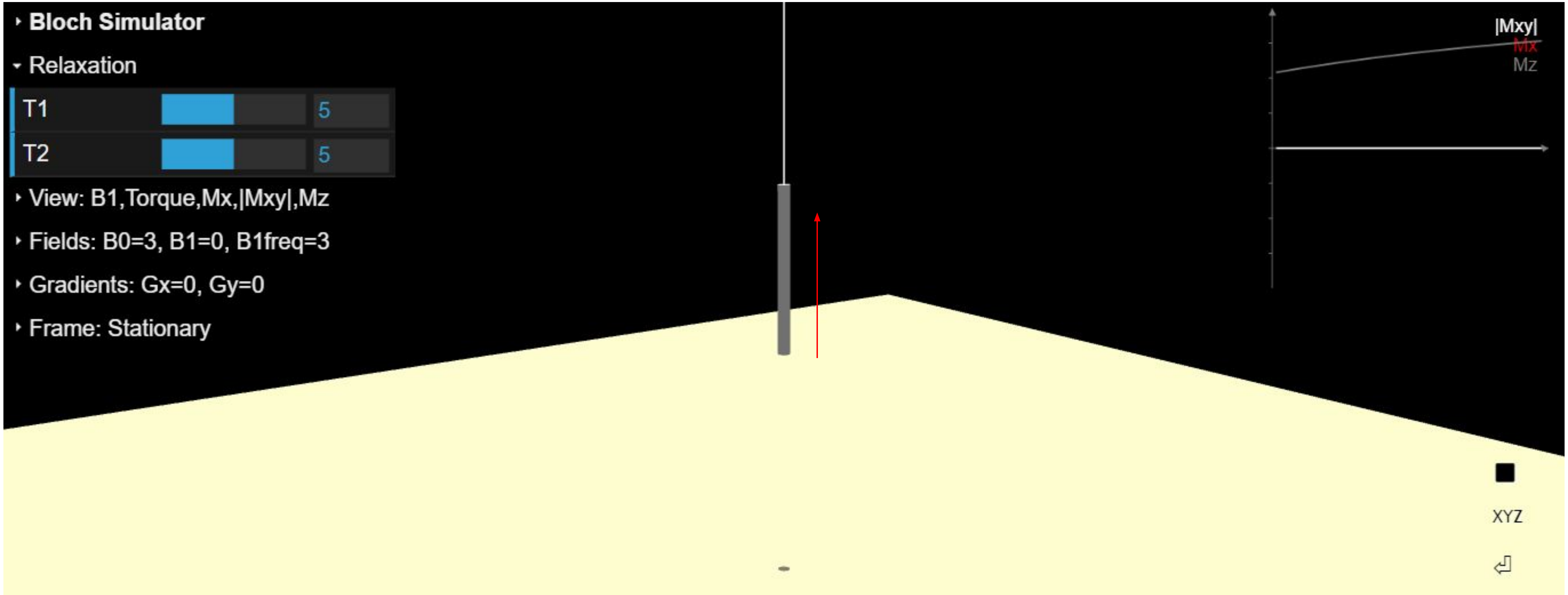
Relaxation times

- 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.



Observe how the transversal magnetization decays

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



Complete process

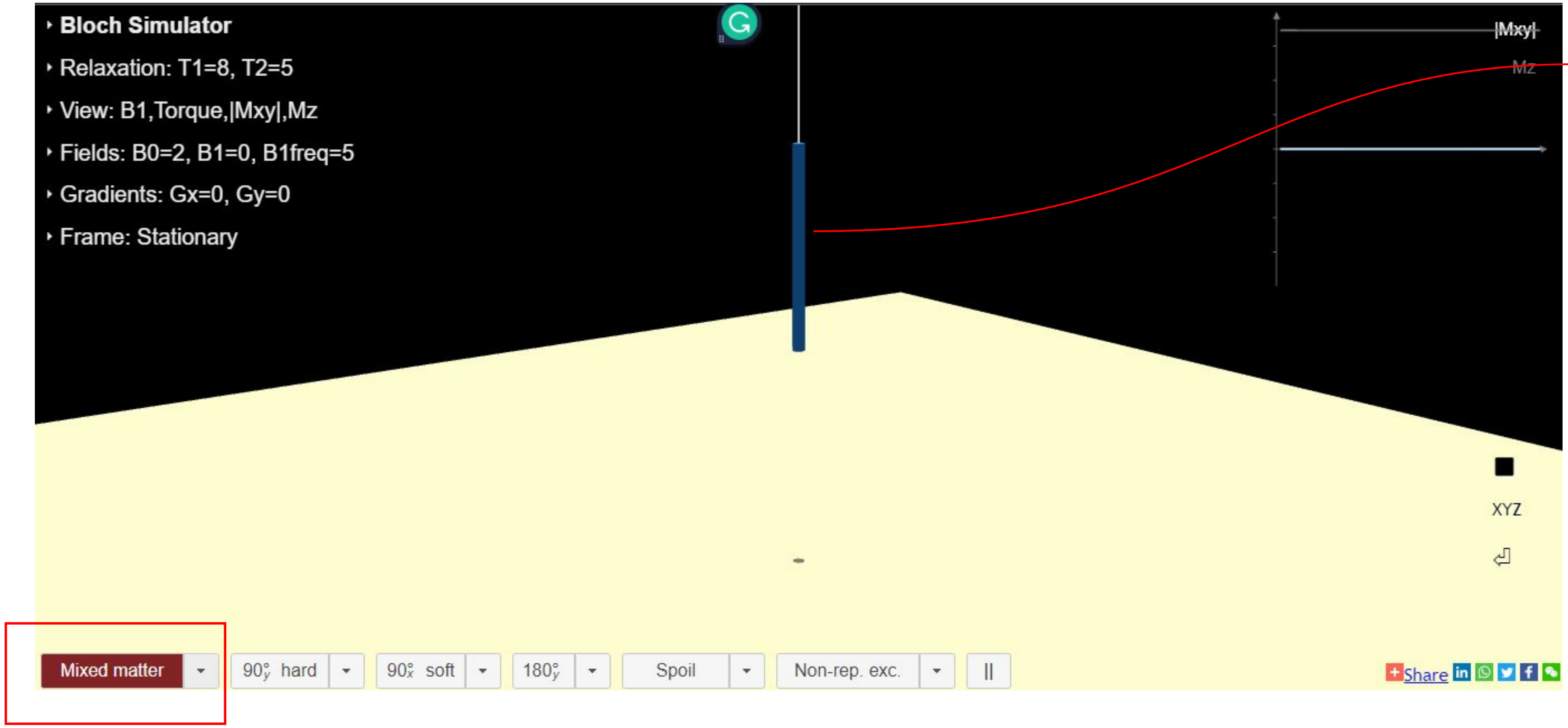
- Now repeat the entire process by yourself using different relaxation times combinations.

1) Start in the equilibrium.
2) Turn on B1.
3) Set the resonant frequency.
4) When you obtain a strong signal, turn off B1.
5) 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).

Remember to take ss during convenient times for your report.

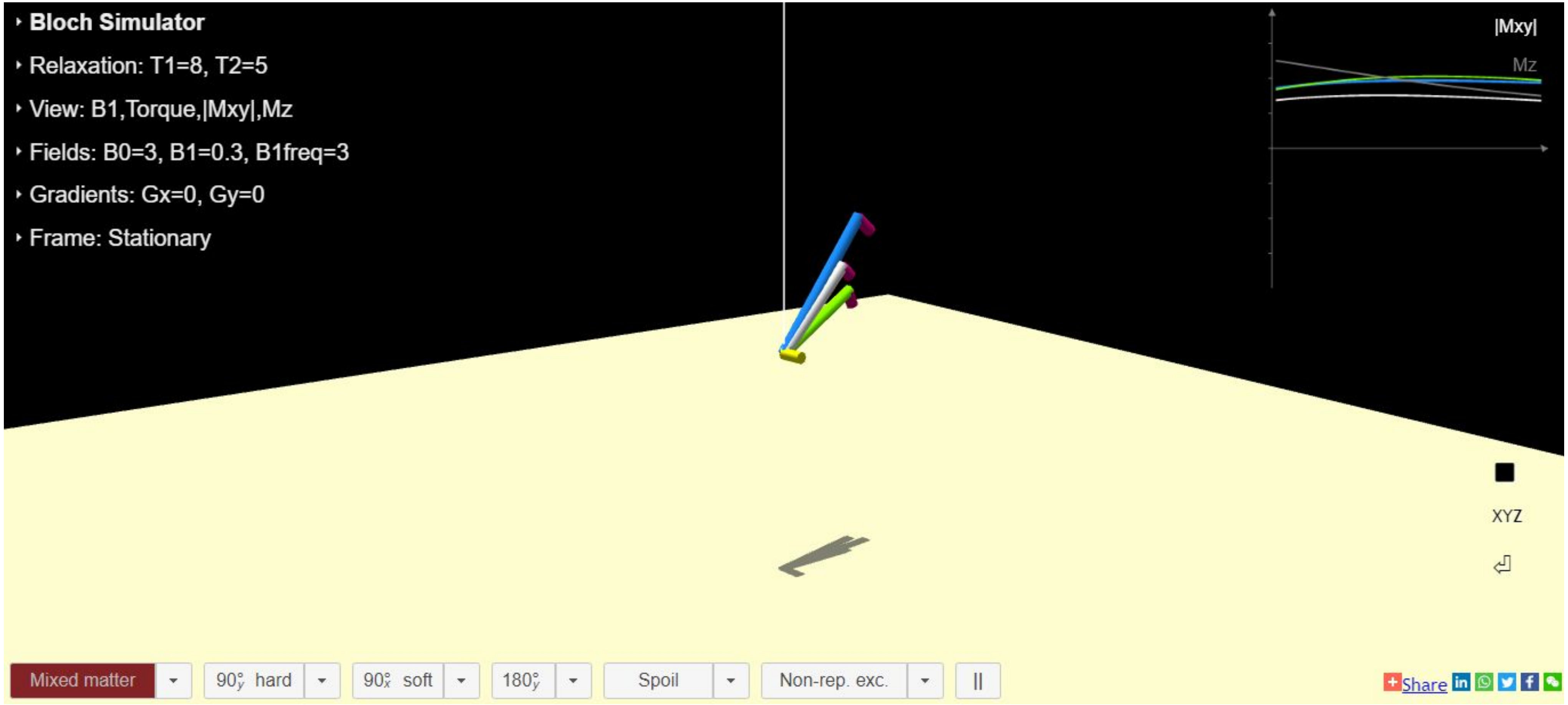
Different tissues

- 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.



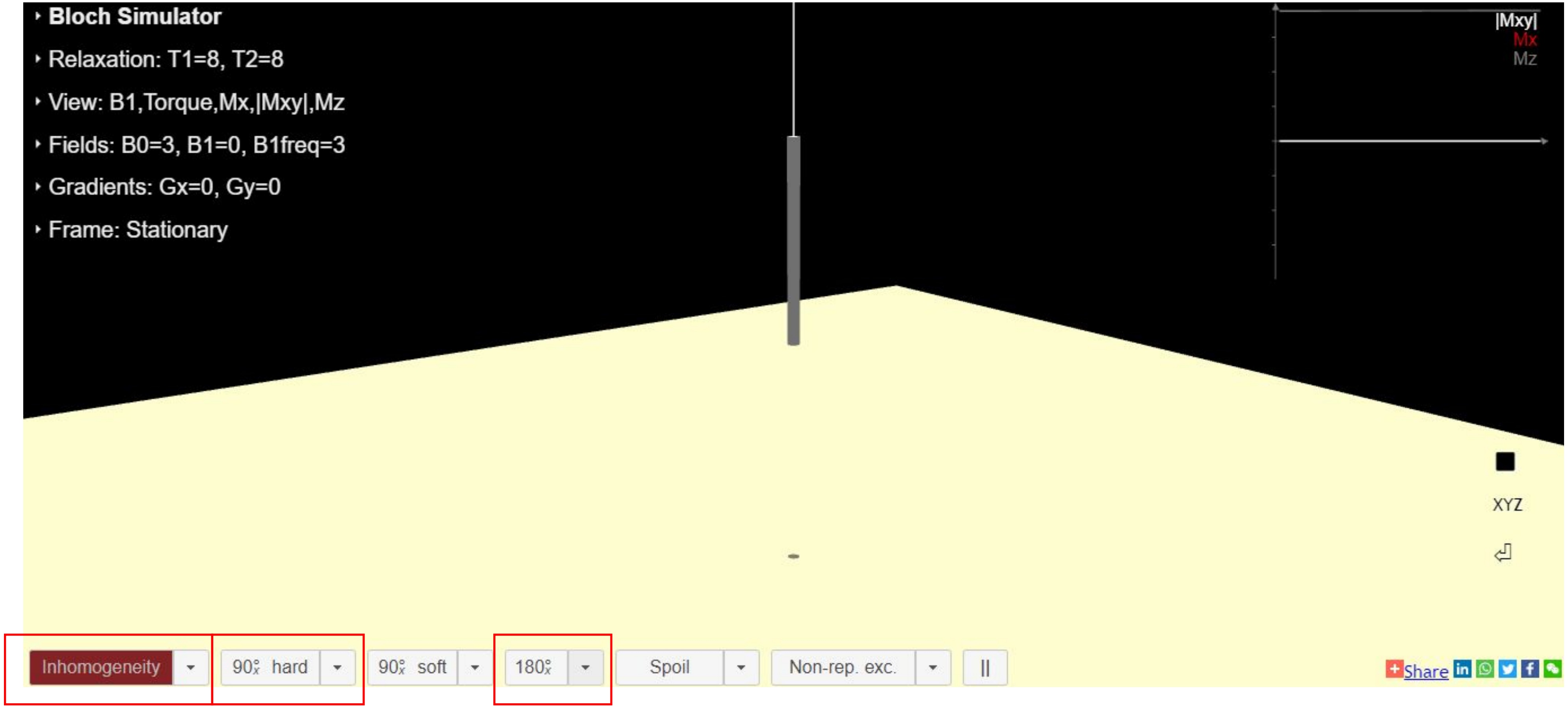
The magnetizations of all the tissues are here all together.

- 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.**



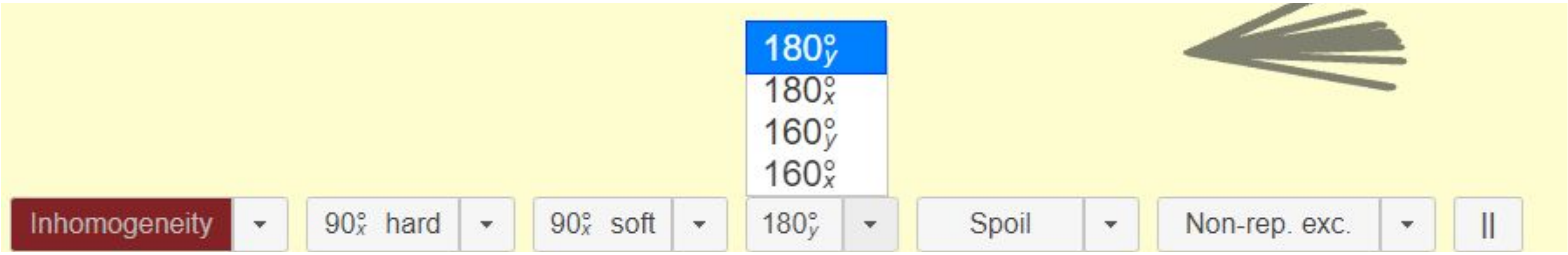
Spin Echo

- 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.

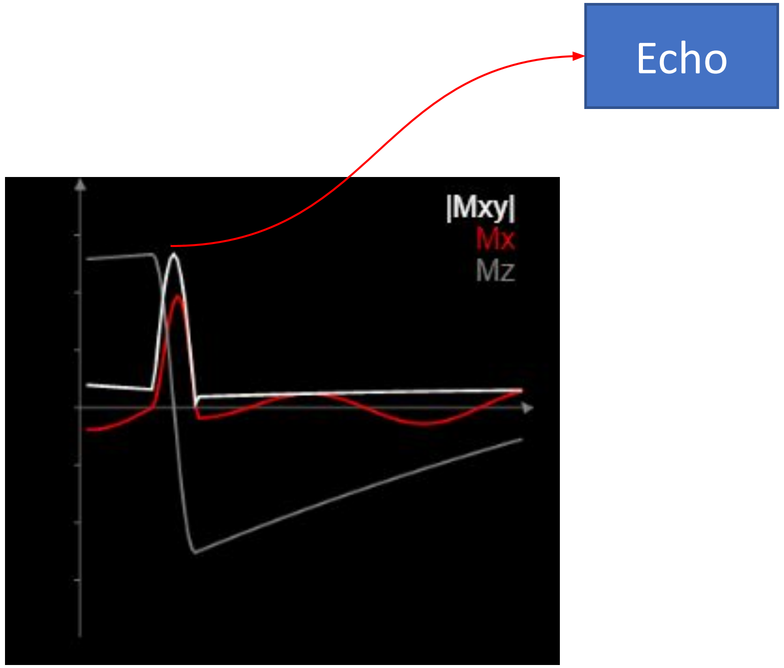


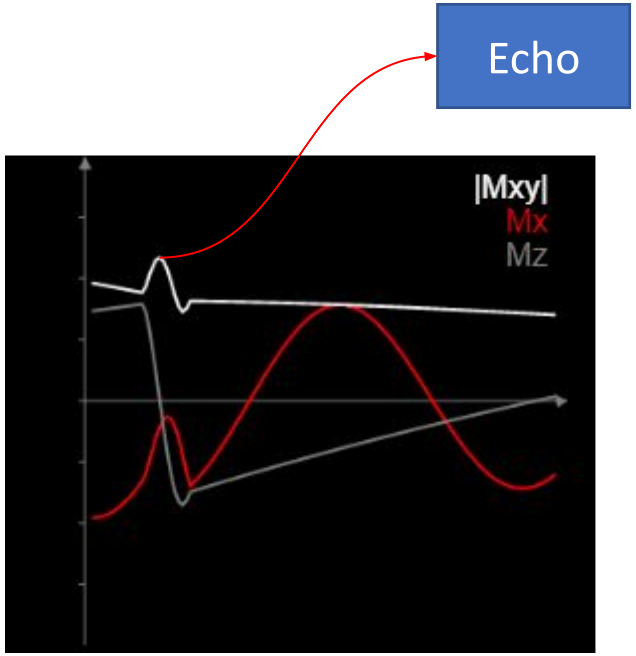
- Apply a 90°x hard pulse.

- As the sample is not homogeneous you can see how the magnetizations are depahsing. **Take an ss of this effect**.
- After the magnetizations are dephased and they start to return to the equilibrium state apply a 180°y pulse.



- 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.).





MRI 2nd Activity
Team SPECT

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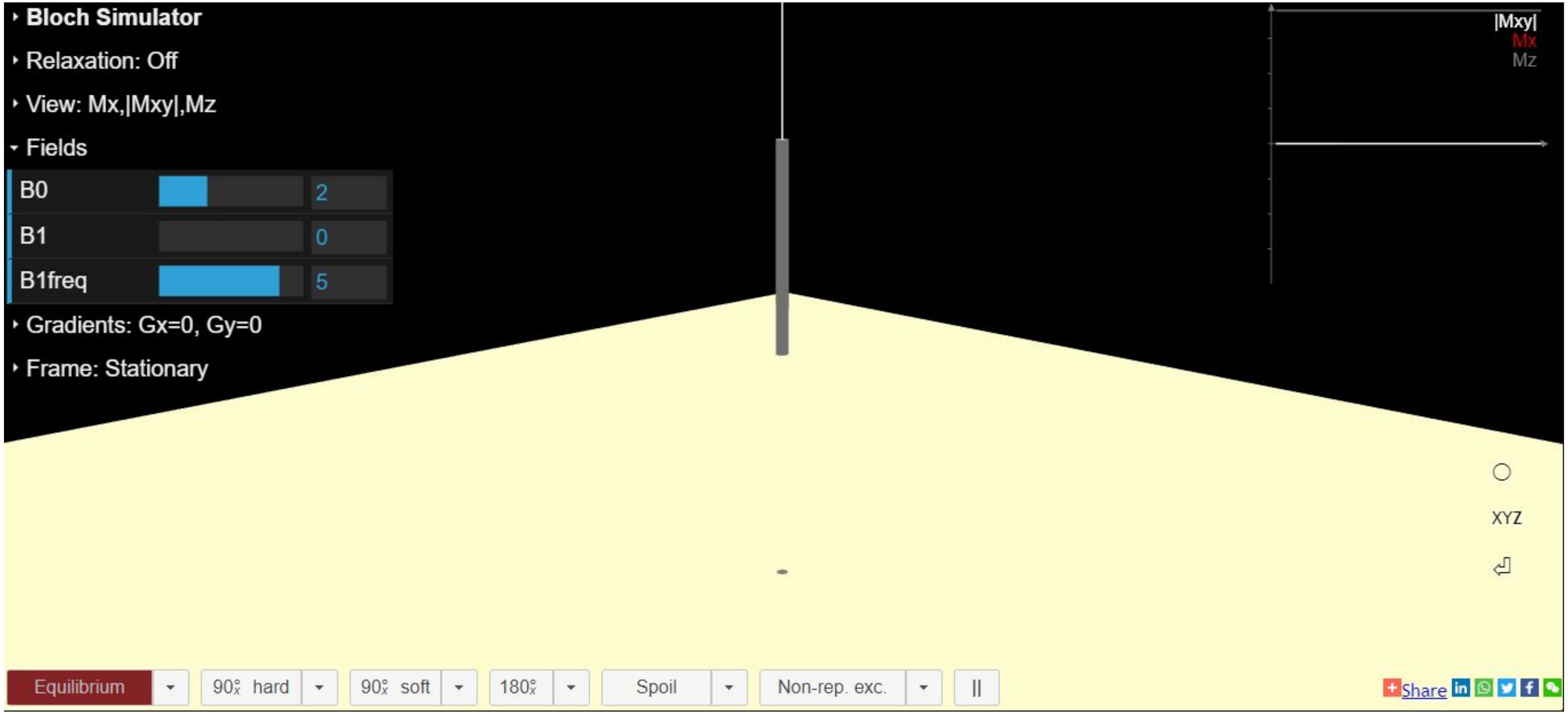
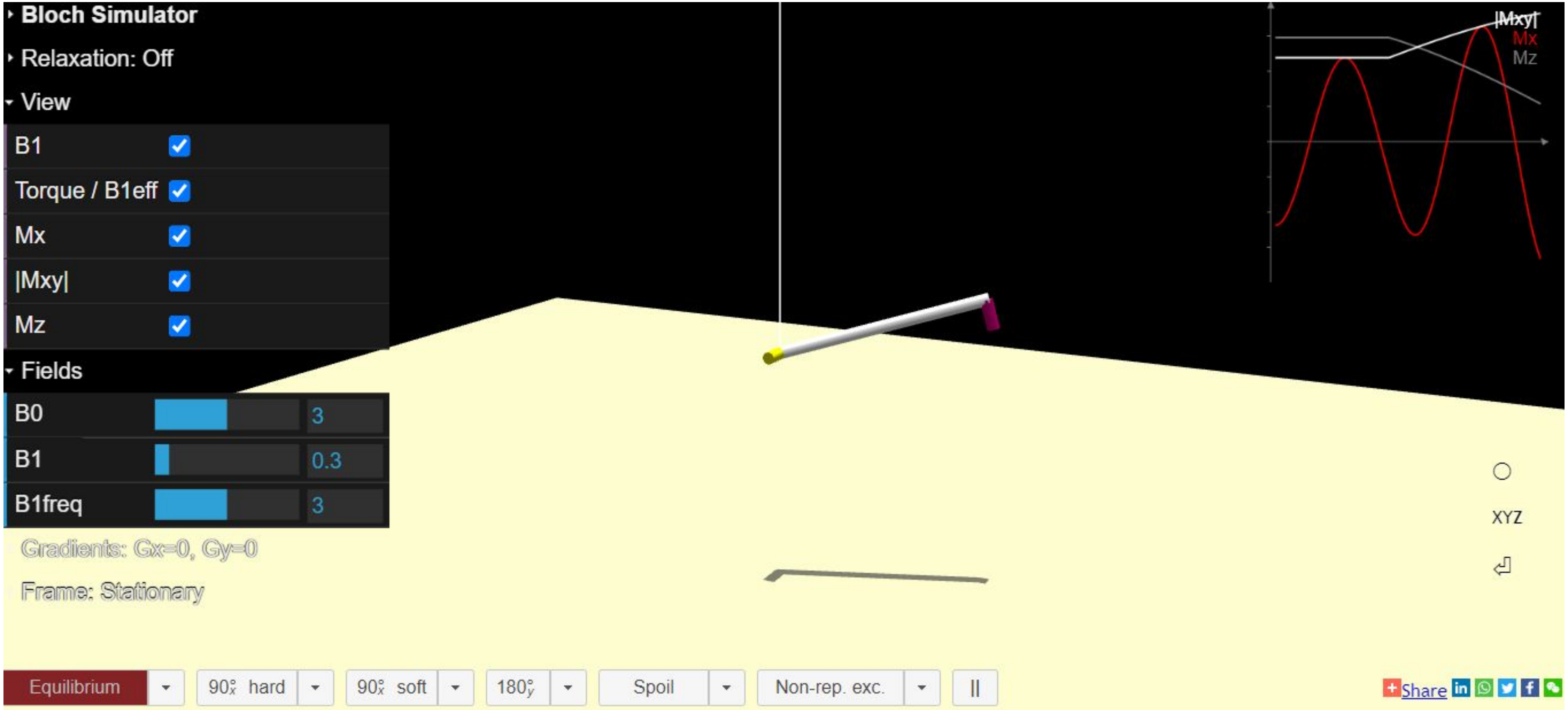
step 1

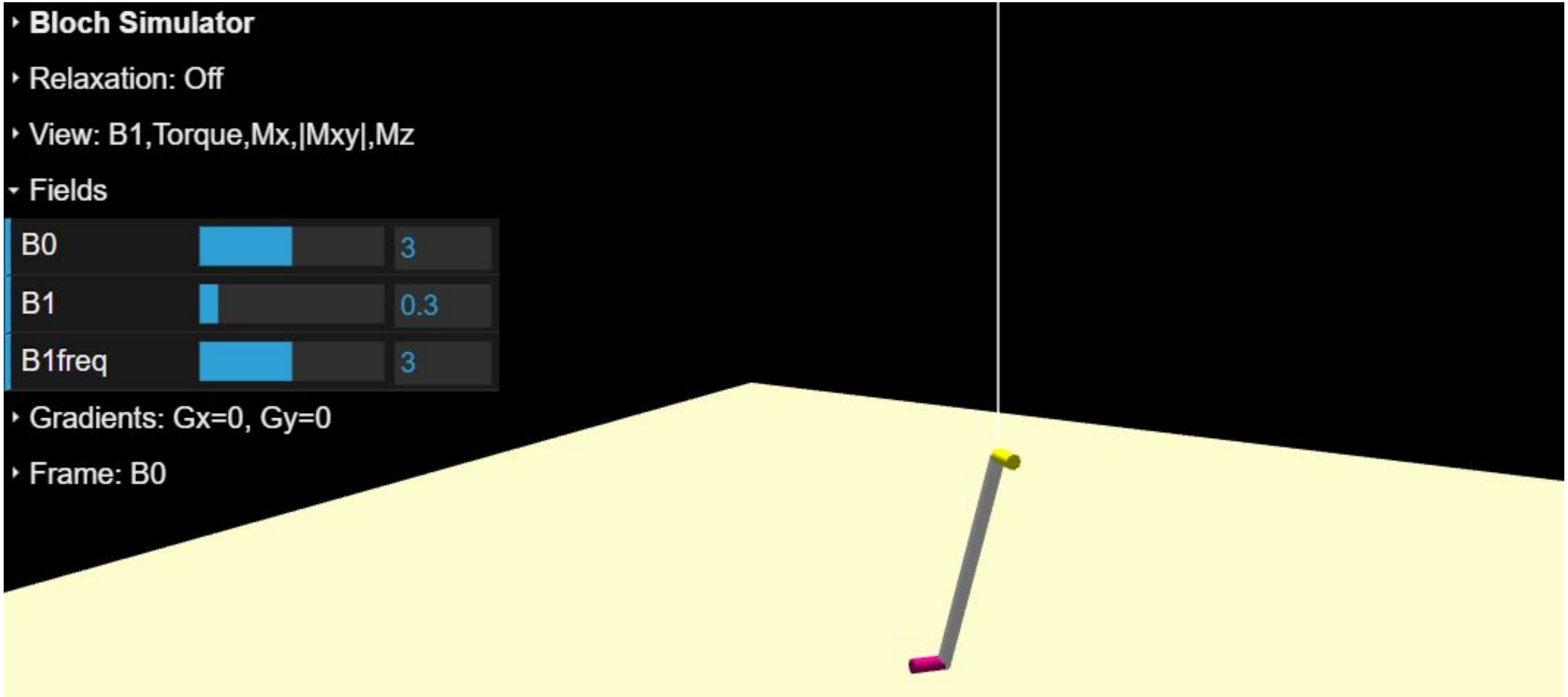

Bloch Simulator
Relaxation: Off
View: Mx,|Mxy|,Mz
Fields
B0 2
B1 0
B1freq 5
Gradients: Gx=0, Gy=0
Frame: Stationary
|Mxy|
Mx
Mz
XYZ
Equilibrium
90° hard
90° soft
180°
Spoil
Non-rep. exc.
Share

step 2

Selección de las view y se establecieron los rangos de B0, B1 y B1freq



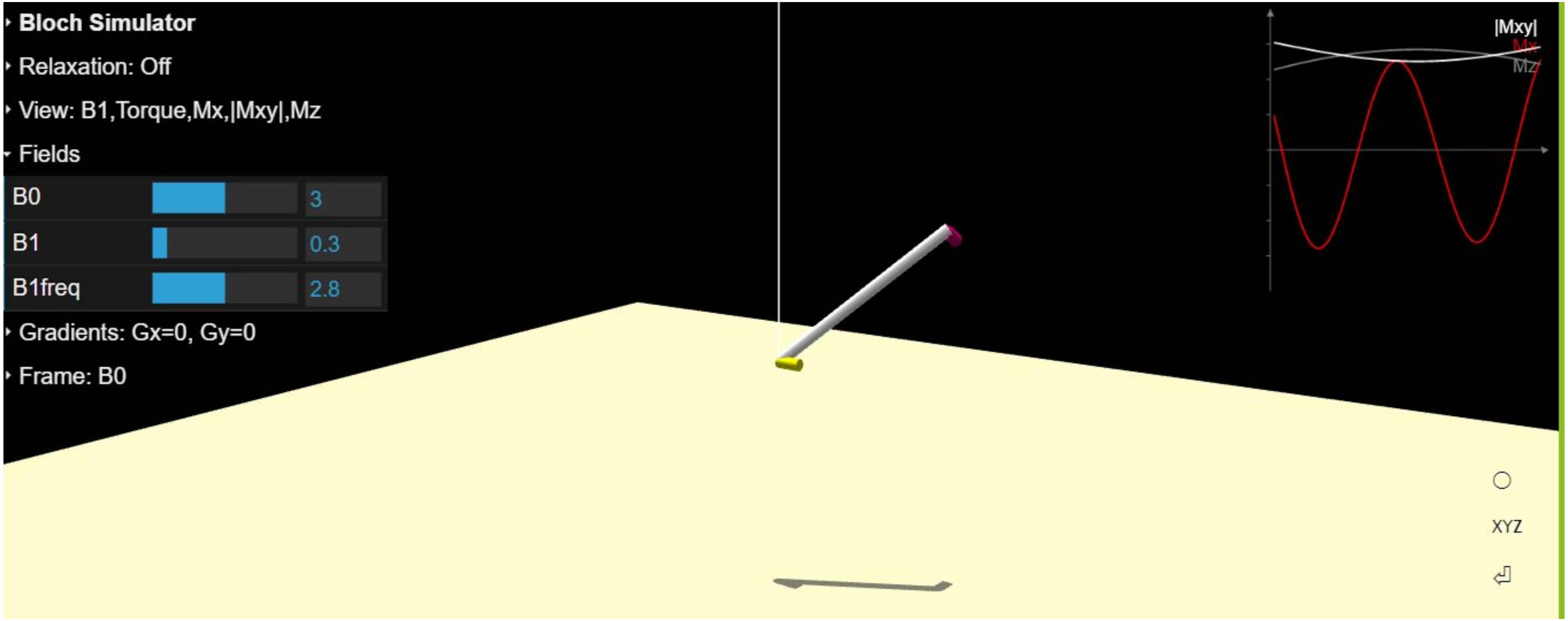
step 3


Bloch Simulator
Relaxation: Off
View: B1,Torque,Mx,|Mxy|,Mz
Fields
B0
3
B1
0.3
B1freq
3
Gradients: Gx=0, Gy=0
Frame: B0

step 4

Frequency at which the torque only moves at one direction. B1Freq= 2.8

B1Freq= 2.8



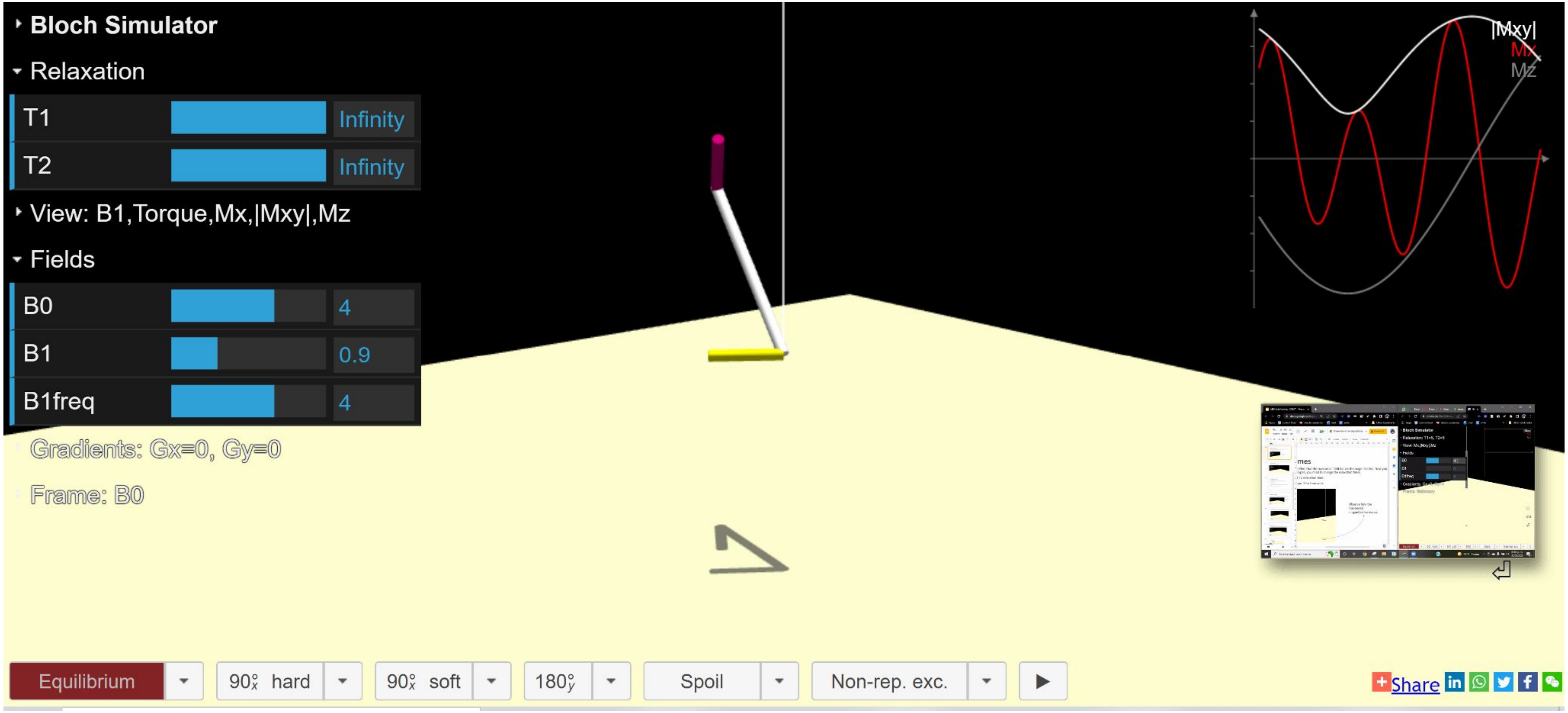
Our example

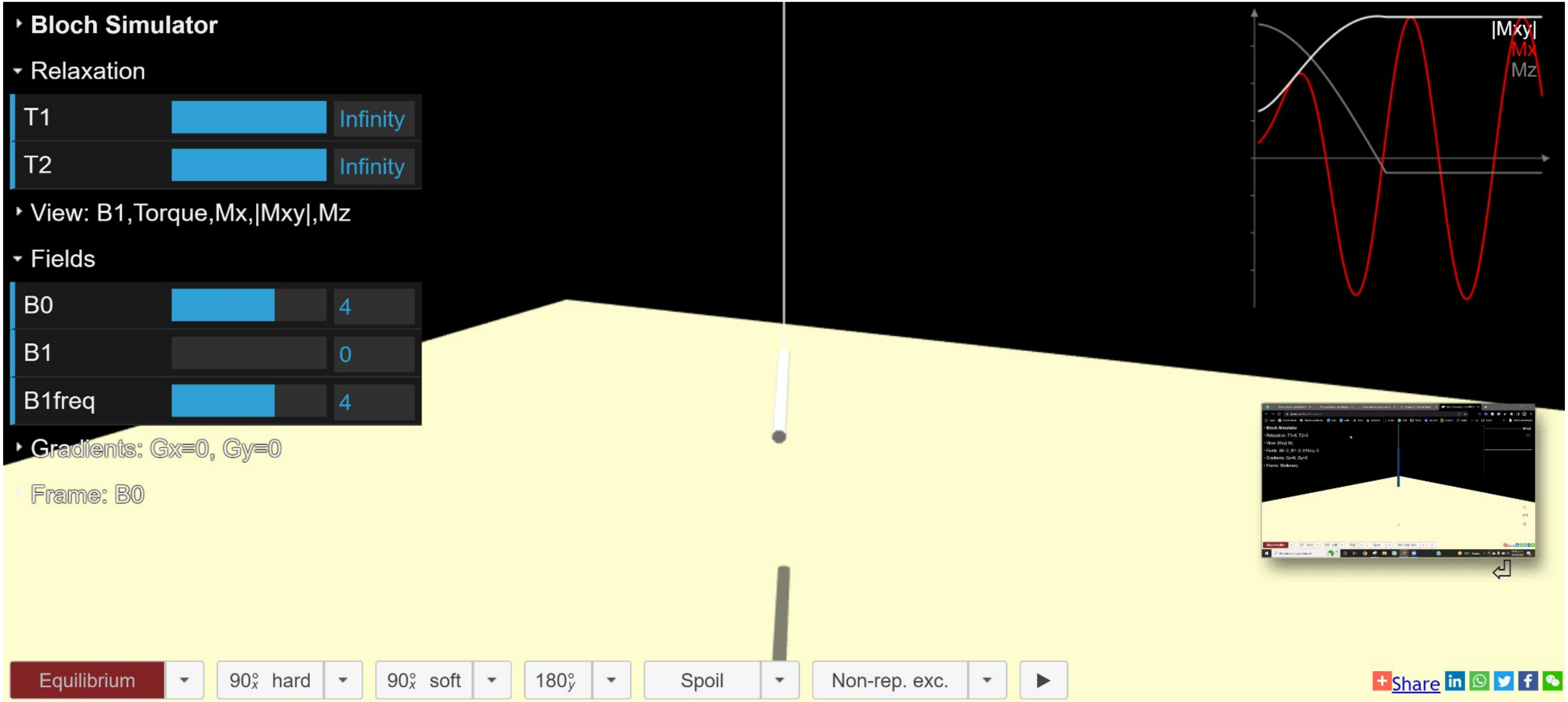
BO = 4

B1 = 0.9

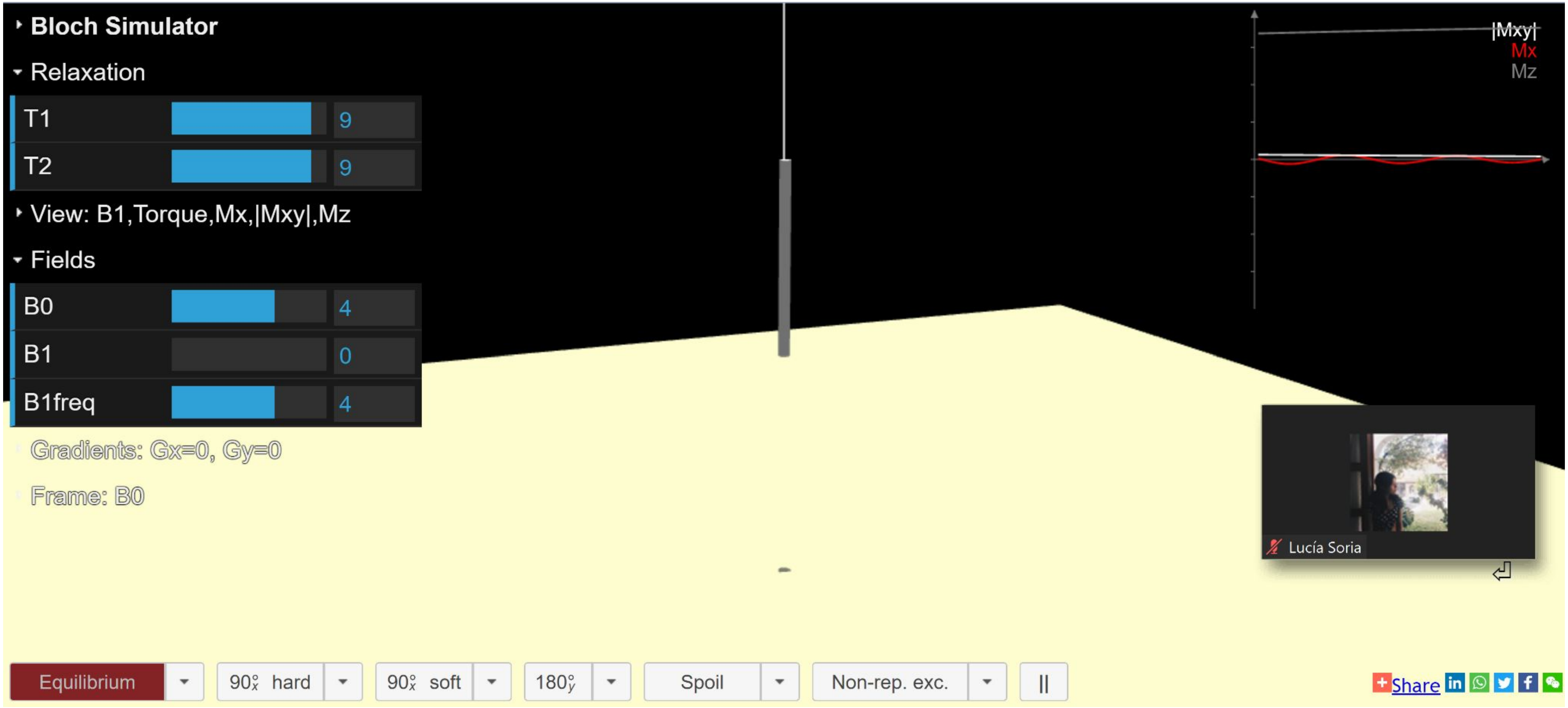
B1Freq = 4

Case

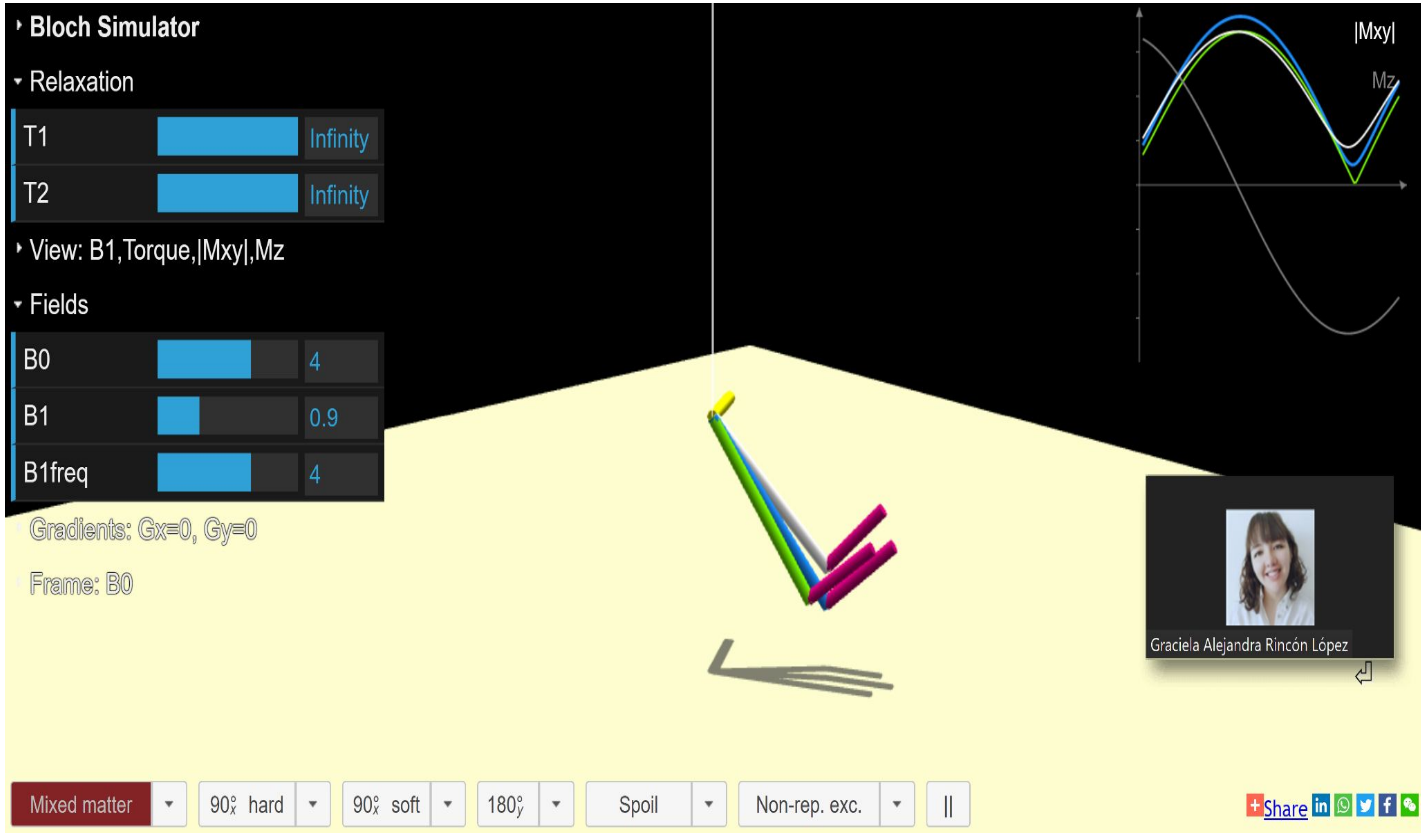

Bloch Simulator
Relaxation
T1
Infinity
T2
Infinity
View: B1,Torque,Mx,|Mxy|,Mz
Fields
B0
4
B1
0.9
B1freq
4
Gradients: Gx=0, Gy=0
Frame: B0
|Mxy|
Mx
Mz
Equilibrium
90°x hard
90°x soft
180°y
Spoil
Non-rep. exc.
Share



Bloch Simulator
Relaxation
T1
Infinity
T2
Infinity
View: B1,Torque,Mx,|Mxy|,Mz
Fields
B0
4
B1
0
B1freq
4
Gradients: Gx=0, Gy=0
Frame: B0
|Mxy|
Mx
Mz
Equilibrium
90°x hard
90°x soft
180°y
Spoil
Non-rep. exc.
Share


Bloch Simulator
Relaxation
T1
9
T2
9
View: B1,Torque,Mx,|Mxy|,Mz
Fields
B0
4
B1
0
B1freq
4
Gradients: Gx=0, Gy=0
Frame: B0
|Mxy|
Mx
Mz
Lucía Soria
Equilibrium
90°x hard
90°x soft
180°y
Spoil
Non-rep. exc.
||
Share

Mixed matter

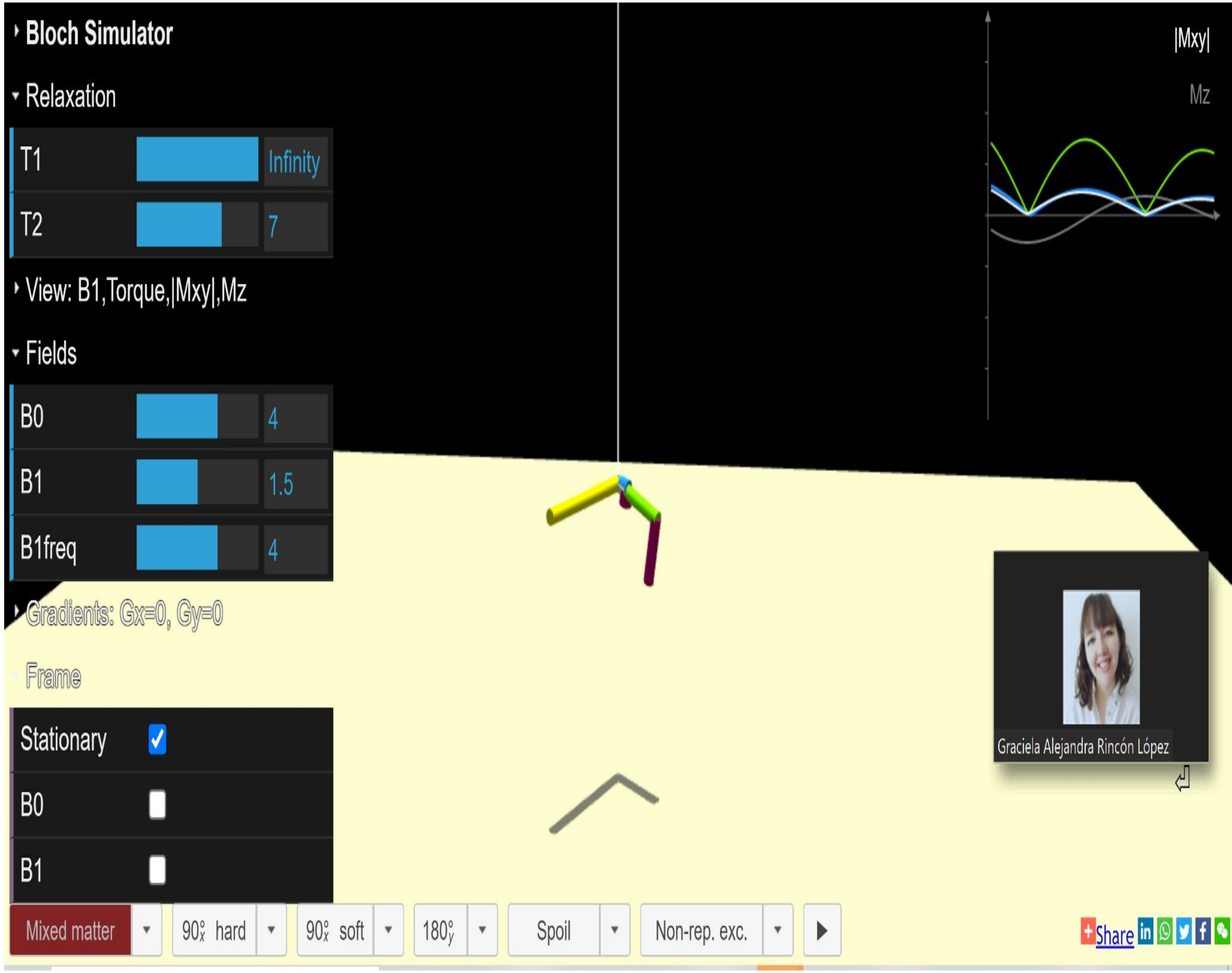


With the B1 frame, all the components are moving in the same direction.
Due to the different properties found in the simulation there are affected in different ways by the ultramagnetic field. This is seen as in the simulation the pieces move towards the same direction, yet they move at a different speed.

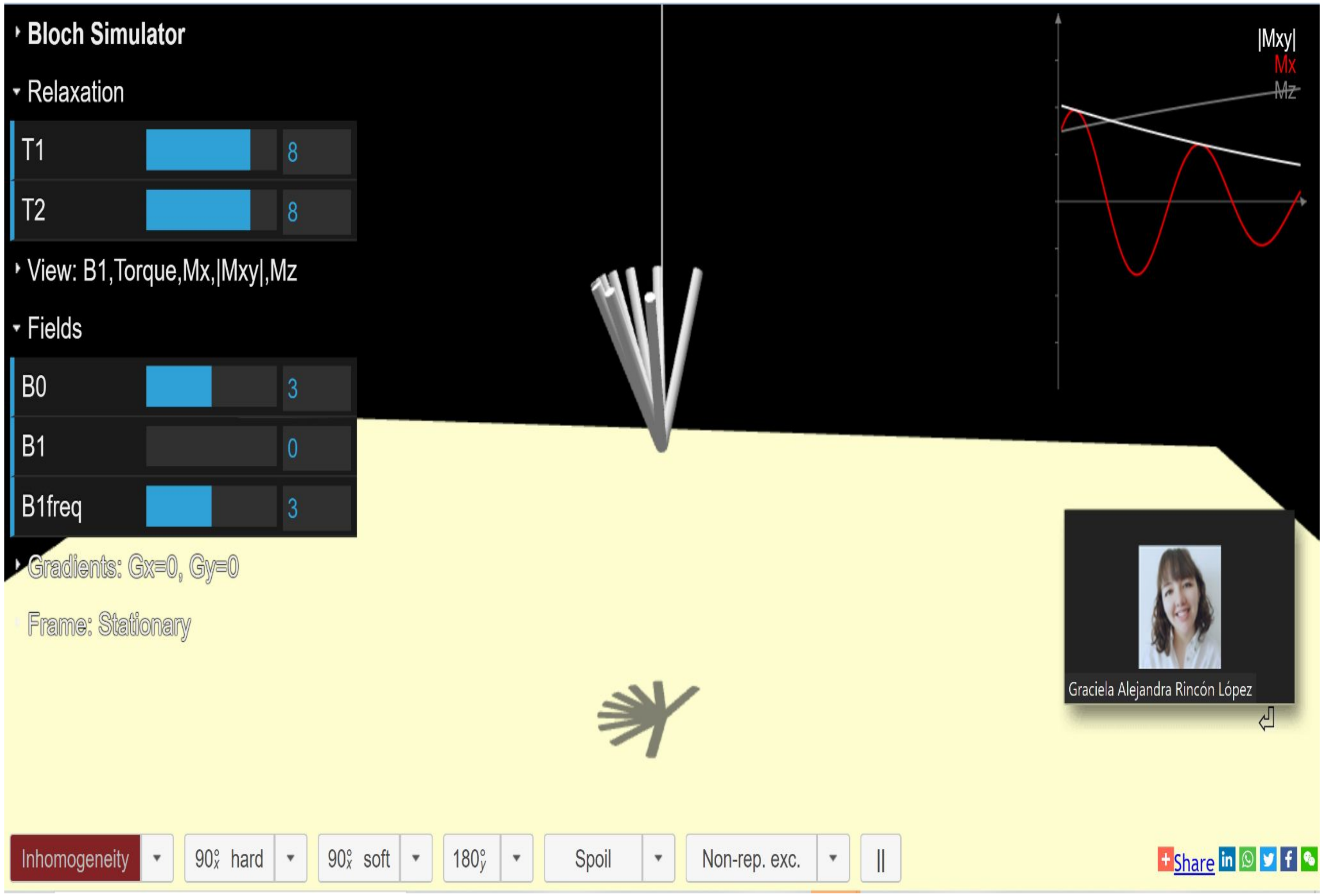
Looking at the different colors of pieces we can observe delays on the rotation of them, it can be seen how the green piece is moving at a faster rate than the blue piece.

Mixed matter

When editing the B1 and the relaxation, a faster decrease was noted by the white and blue bars, while the green one kept a relatively good size and rotation time.



90° hard angle



In the 90º hard angle the magnetizations are dephasing and we can appreciate that the echo is greater than mx but is not strong enough to be greater than mz.

180°y angle

When the magnetizations are returning to the equilibrium state the 180ºy angle is applied and we can observe that the echo is stronger than both mx and mz.