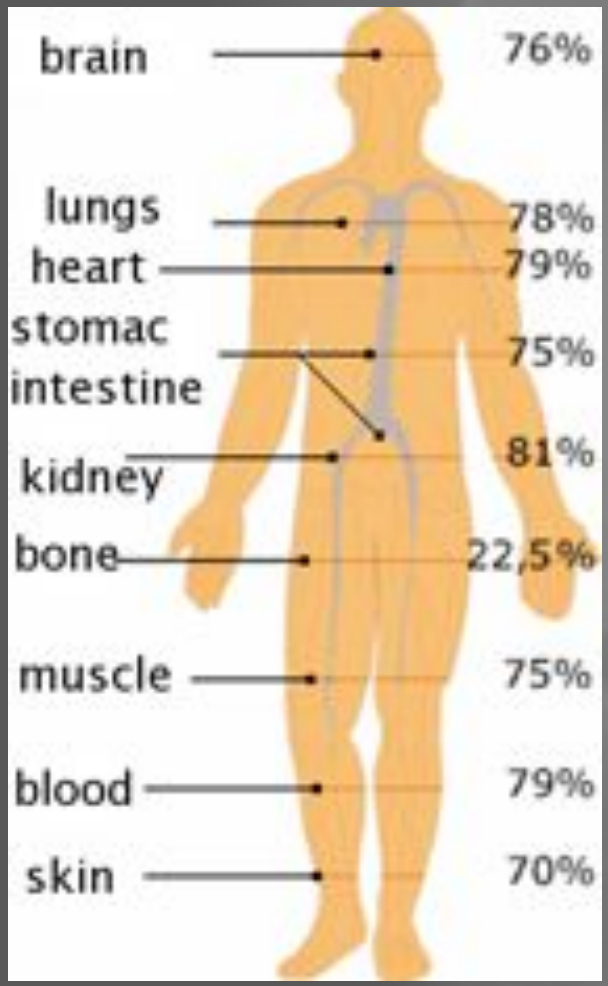
Overview

- Introduction
- Light & Endoscopy
- X-Rays
- Nuclear imaging
- Magnetic Resonance Imaging
- Ultrasound imaging

Magnetic Resonance Imaging (MRI)

- Based on the orientation of Hydrogen nuclei in the body.
- Properties differ according to several organs
- Mainly devoted to cortex and muscles/soft tissues imaging
- Non invasive !



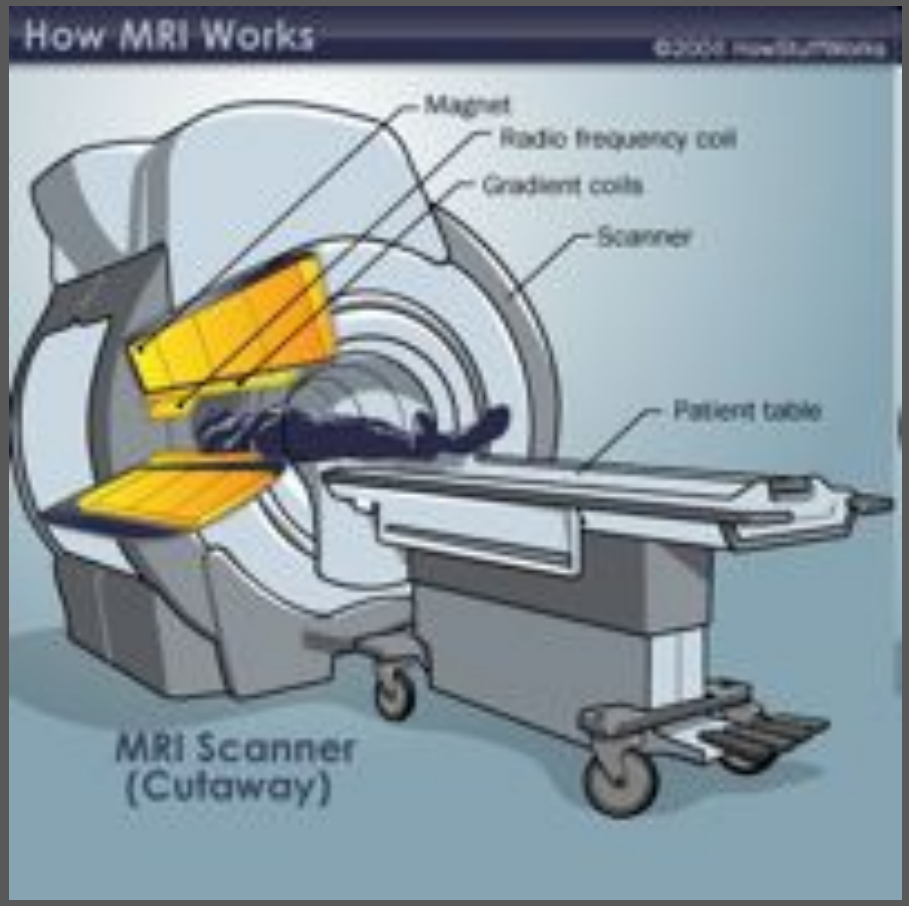
Magnetic Resonance Imaging (MRI)

Little History

- 1946 : Block (Stanford) and Purcell (Harvard) describe Nuclear Magnetic Resonance
- 1952 : Block et Purcell share Physics Nobel Price
- 1972 : Paul Lauterbur develops spatial information encoding principles, originally called zeugmatopgraphy
- 1977 : Firs MRImages of the human body

Magnetic Resonance Imaging (MRI)

- Nuclear Magnetic Resonance



–NMR involves nuclei (of an object to be imaged), magnetic fields (generated by an imager), and resonance phenomenon (arising from the interaction of the nuclei with the magnetic field)

Magnetic Resonance Imaging (MRI)

Nuc

Nuc er
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- Nu
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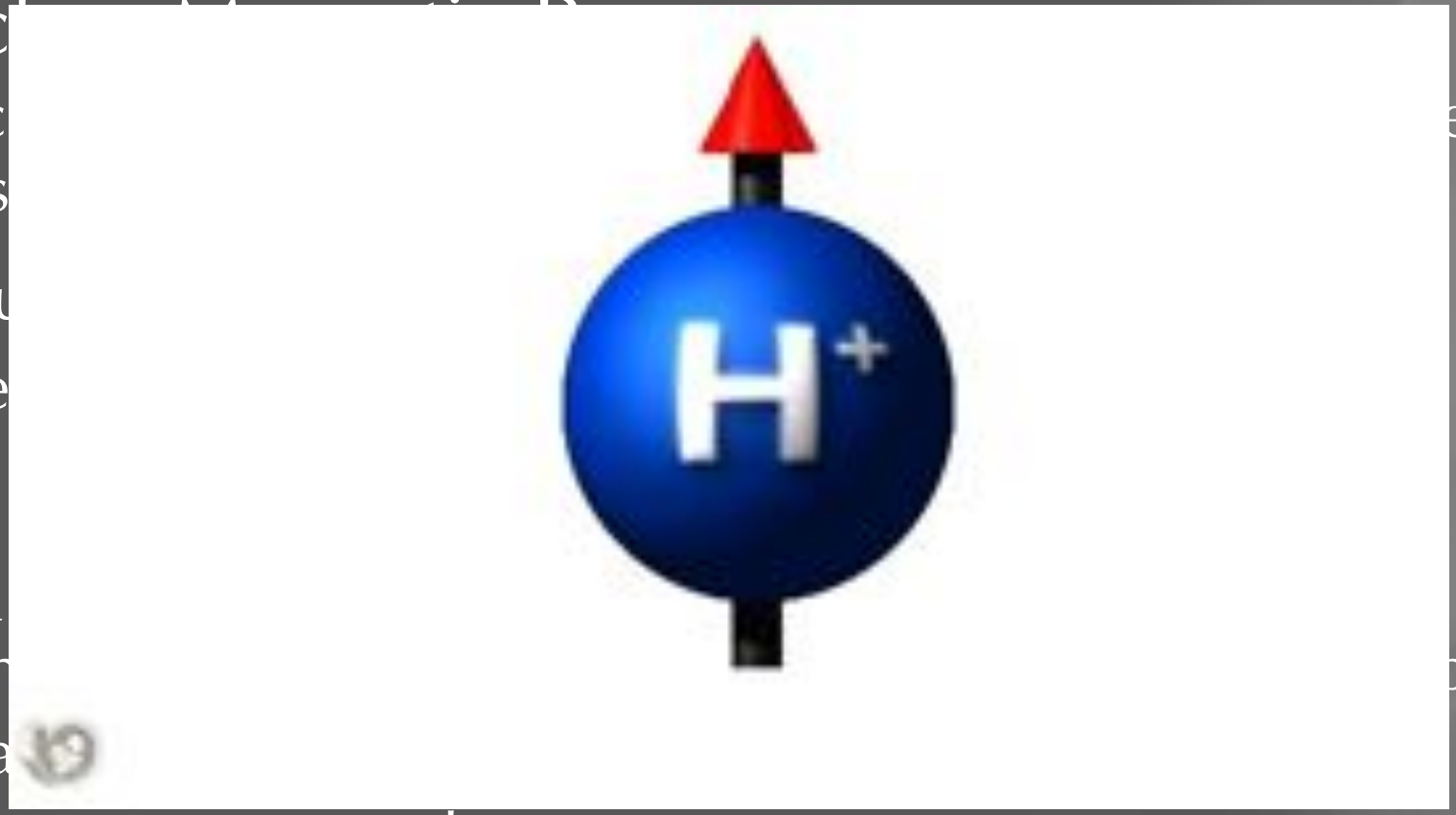
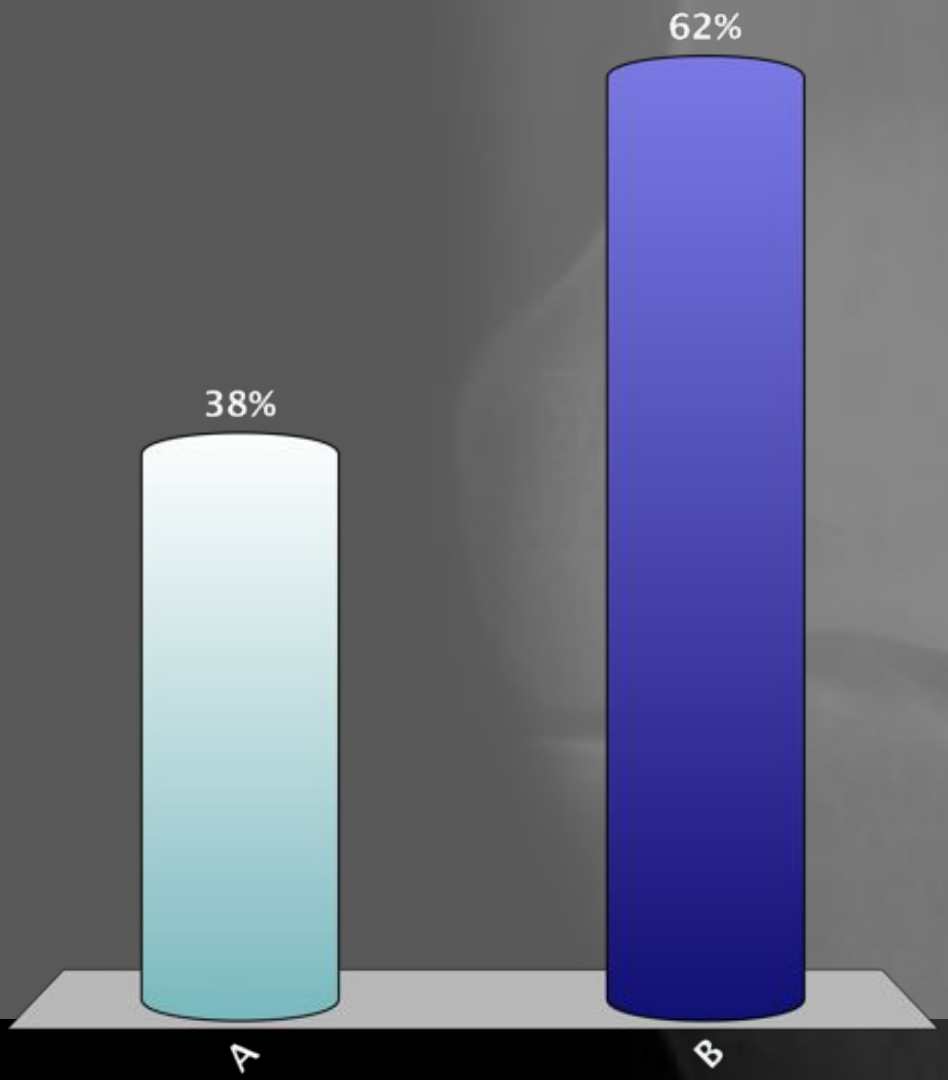
- Ch pace
- Ca
  - one proton and one neutron
  - Spin = 1/2 => is affected by magnetic field



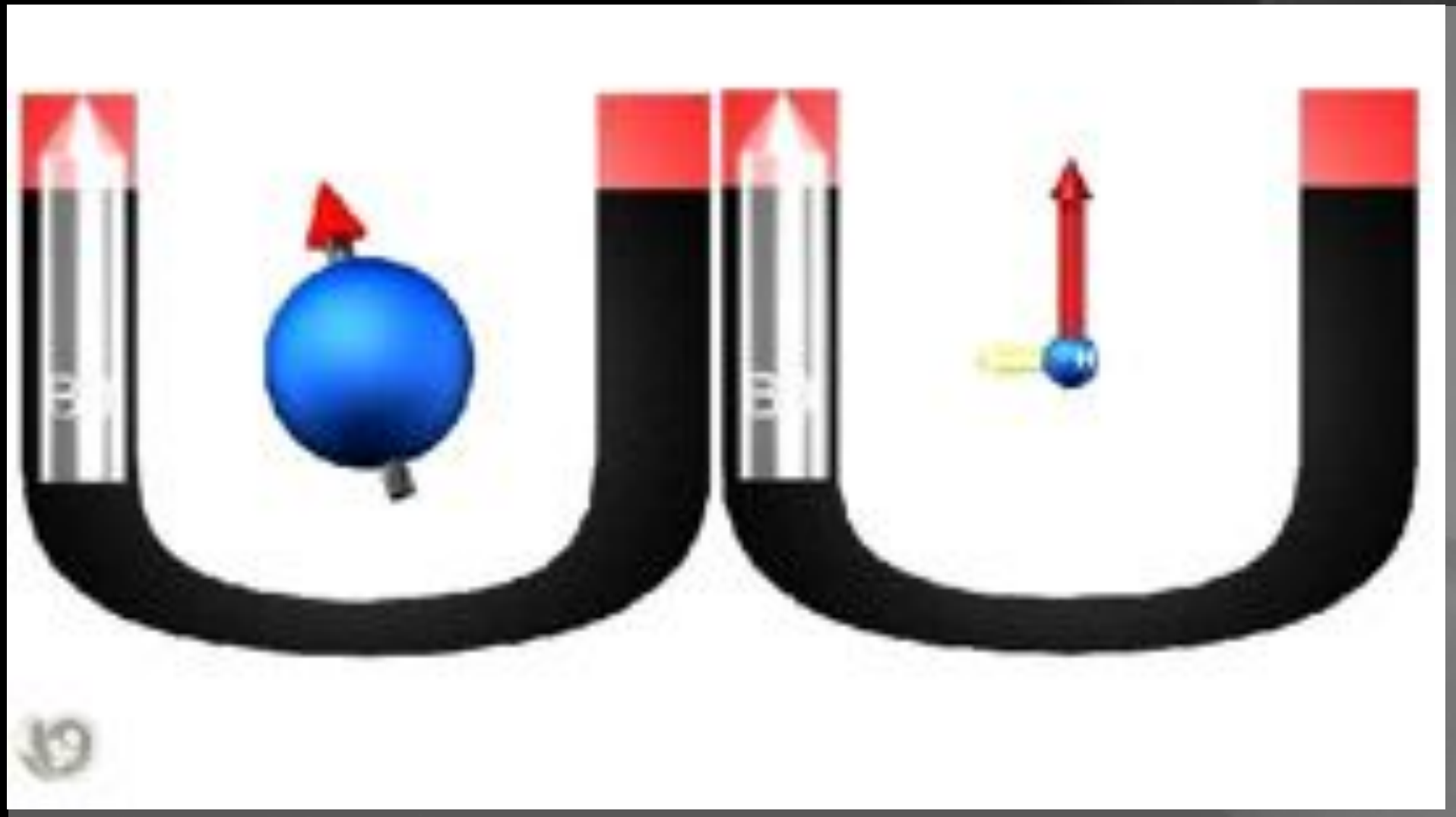
The water inside your body spontaneously creates a global magnetic field

A. True

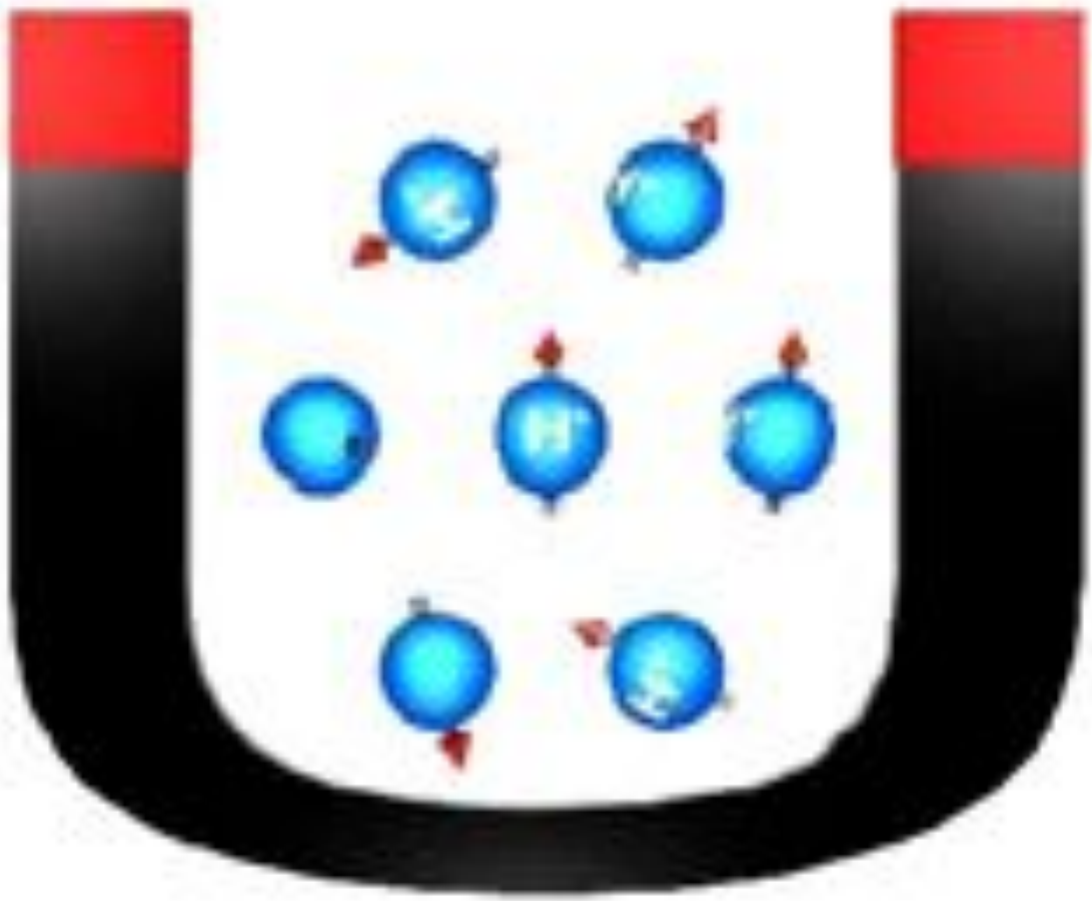
B. False



Inside a Magnetic Field B0

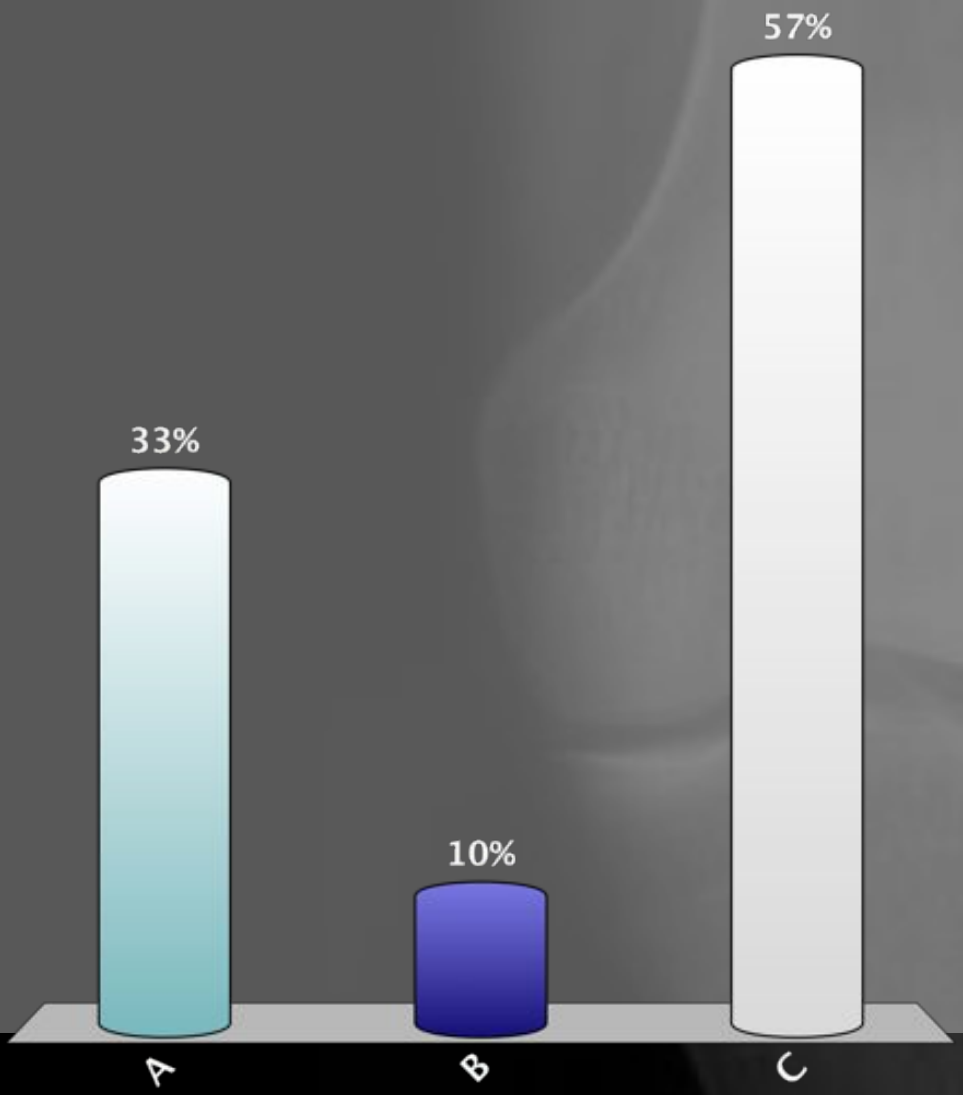


Inside a Magnetic Field B0

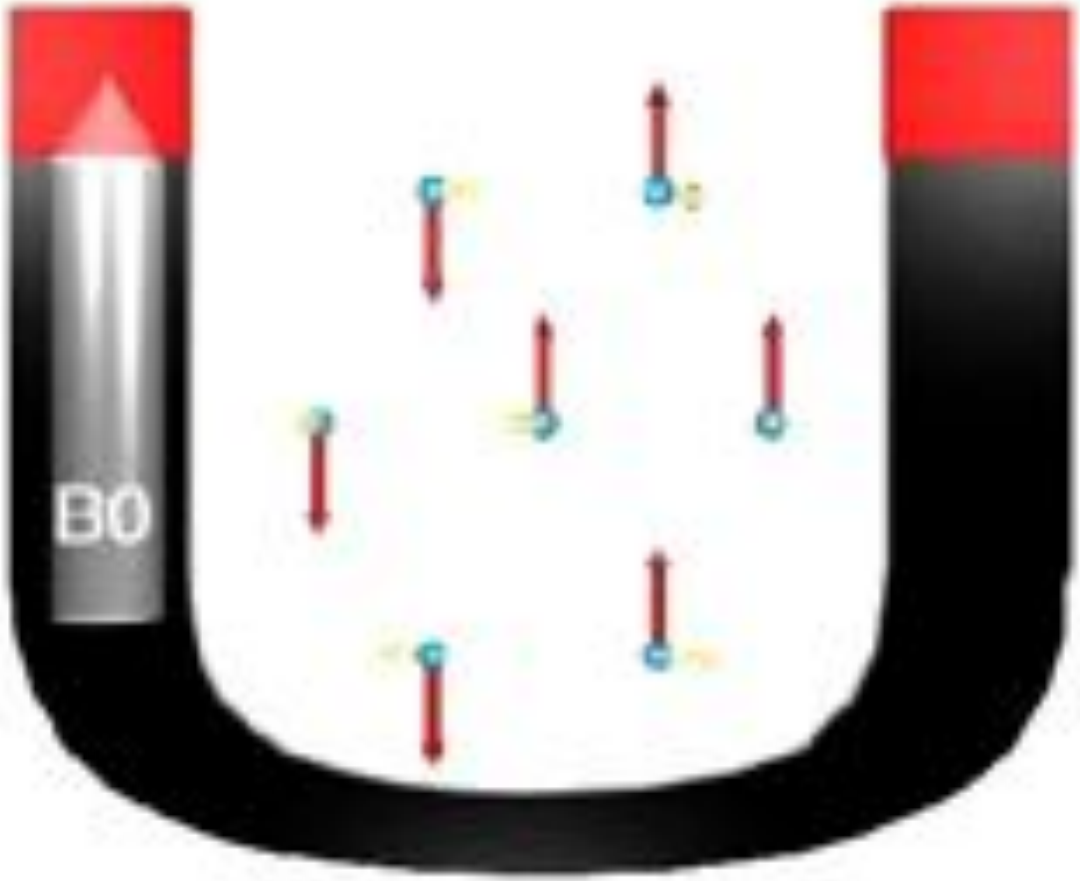


There will be more spins…

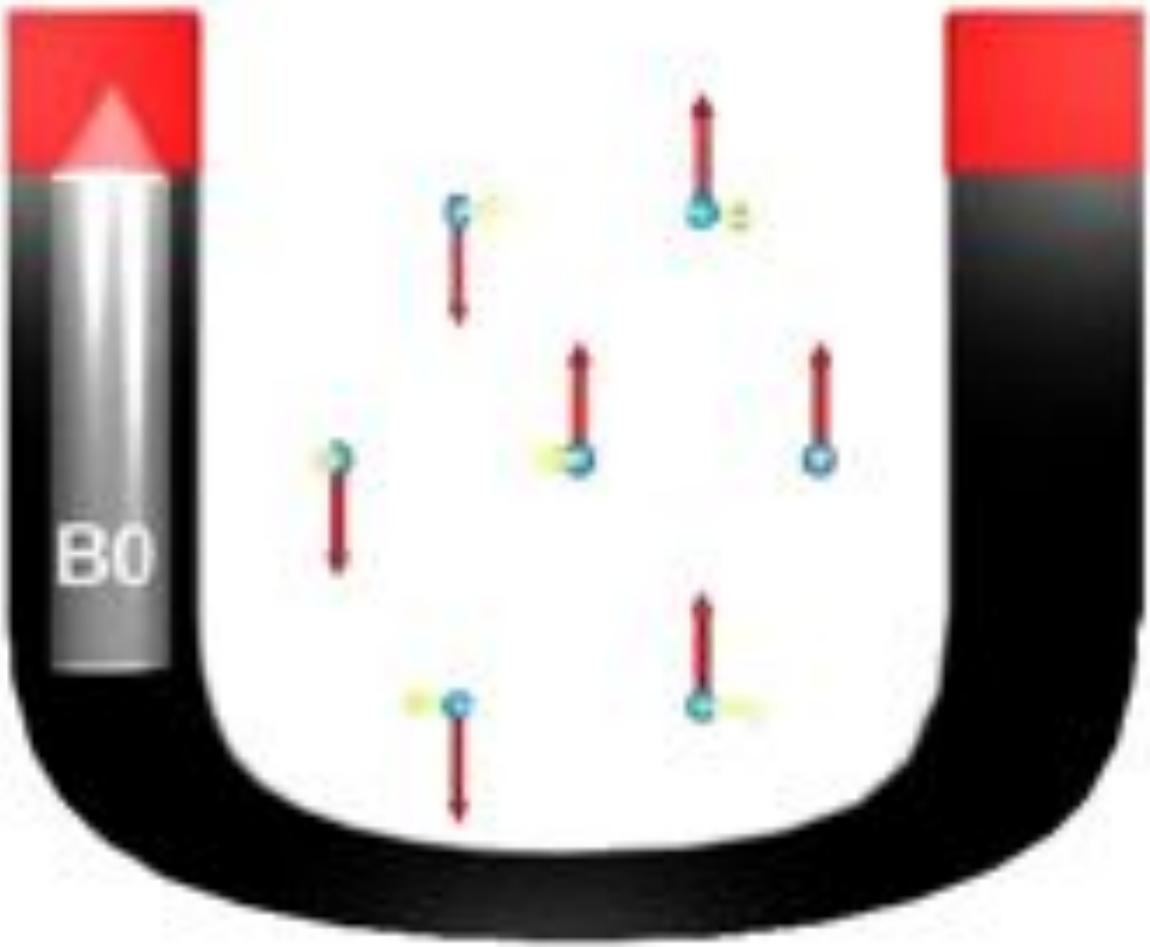
A. In the parallel direction
B. In the anti-parallel direction
C. The spins will be equally distributed



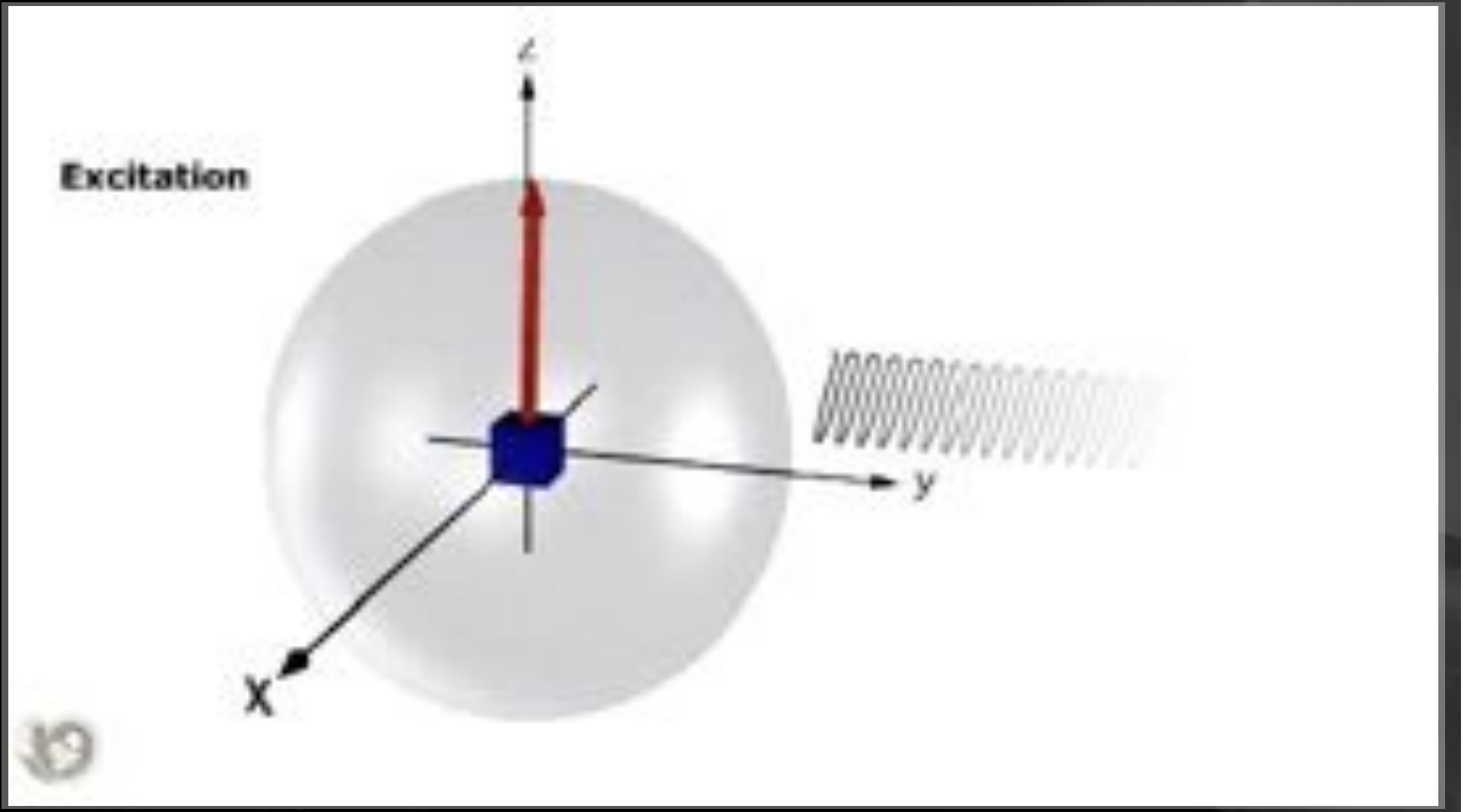
Inside a Magnetic Field B0



Inside a Magnetic Field B0



Adding a Radio Frequency Wawe

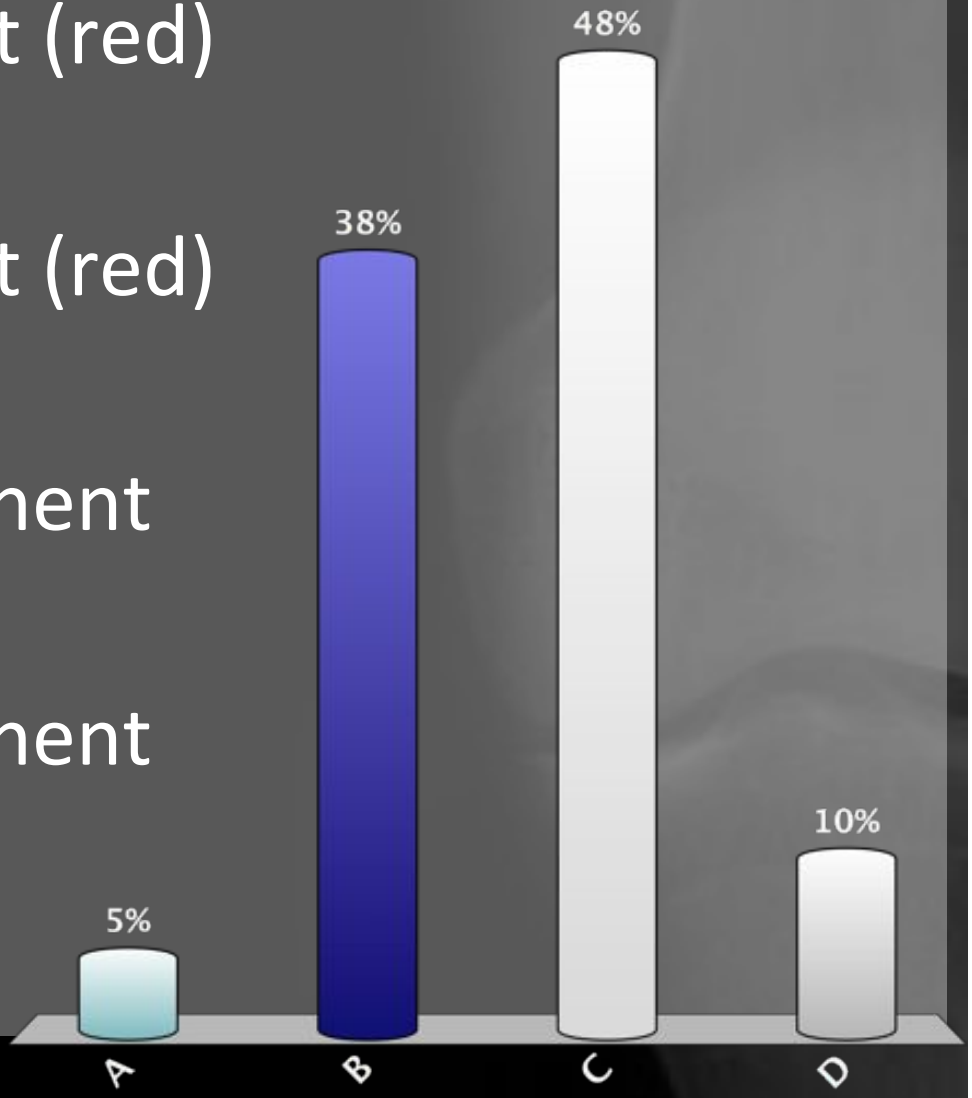


Adding a Radio Frequency Wawe

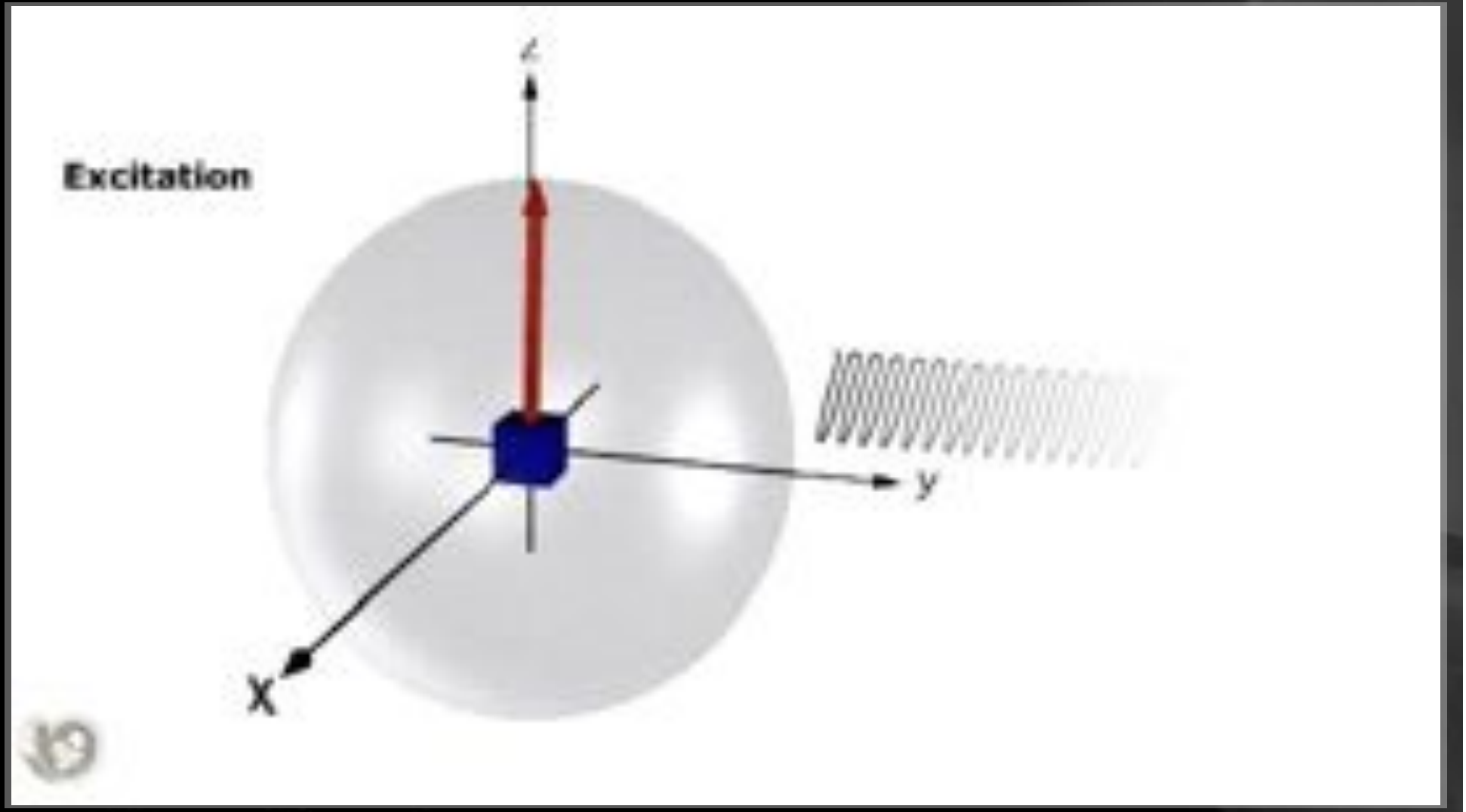
- Frequency w0
- Brings just enough energy to the system so that
  - Spins go into phase
  - Some spins in the parallel orientation (lower energy) go to anti-parallel orientation (higher energy)

The consequence of a Radio-Frequency Wave at F=w0 are

A. The parallel component (red) increases
B. The parallel component (red) decreases
C. The orthogonal component (yellow) increases
D. The orthogonal component (yellow) decreases



Adding a Radio Frequency Wawe

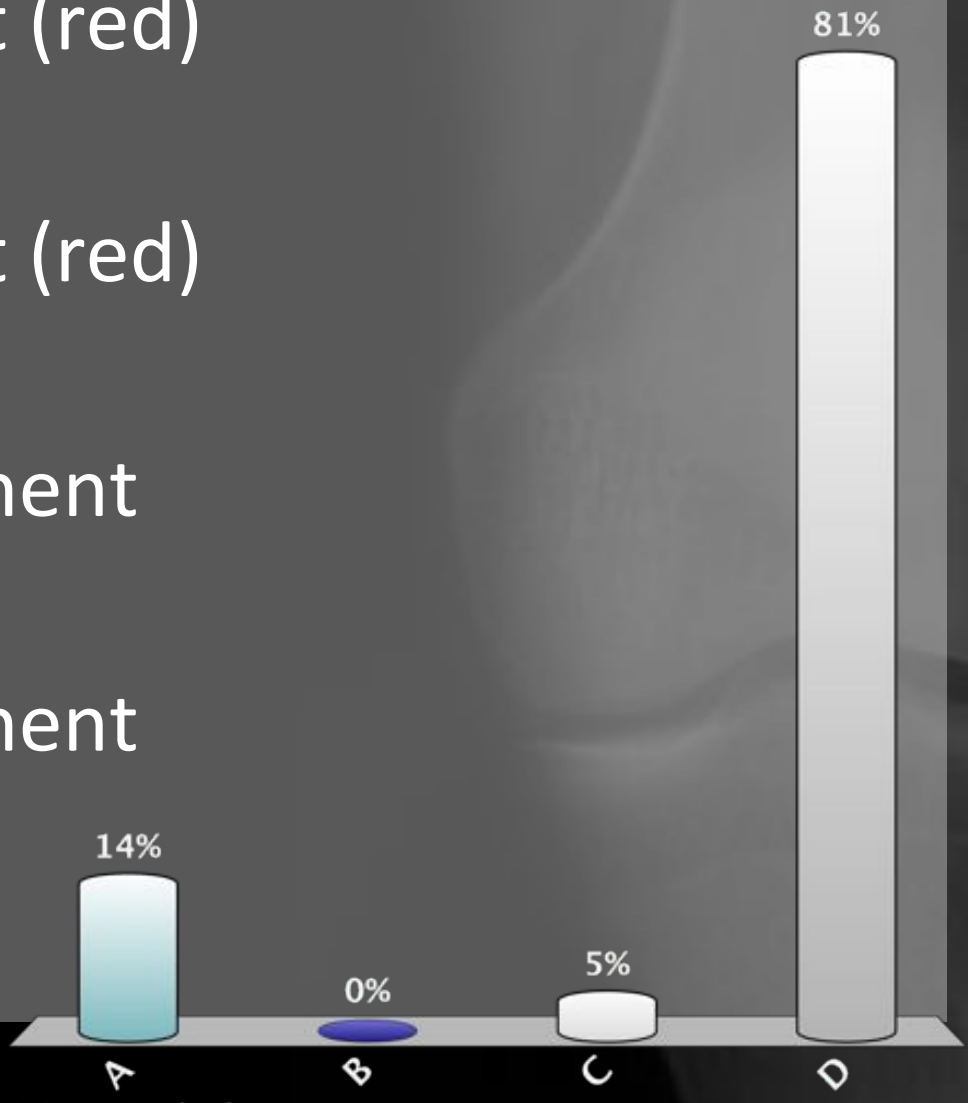


Relaxation

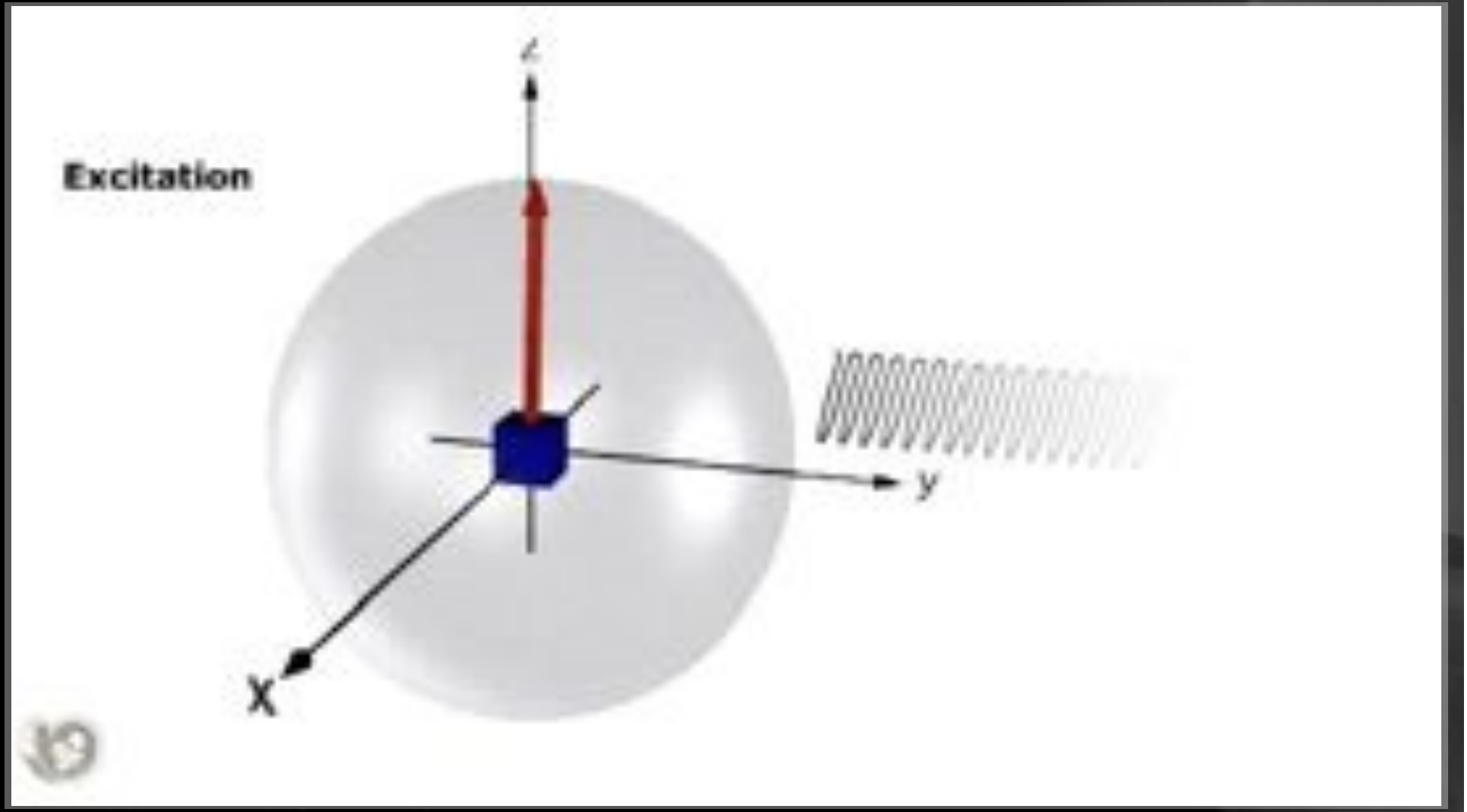
- Some spins in anti-parallel direction go back to parallel direction
  - Release energy (as Radio-Frequency wave)
- Spins un-phase

The consequence of Relaxation phase

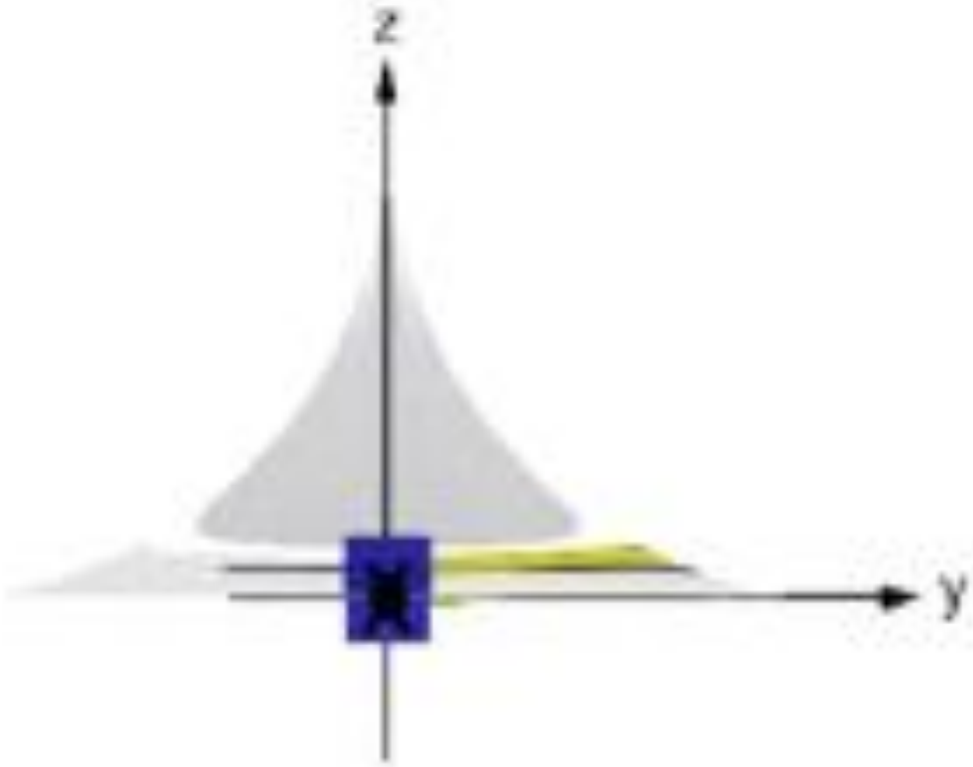
A. The parallel component (red) increases
B. The parallel component (red) decreases
C. The orthogonal component (yellow) increases
D. The orthogonal component (yellow) decreases



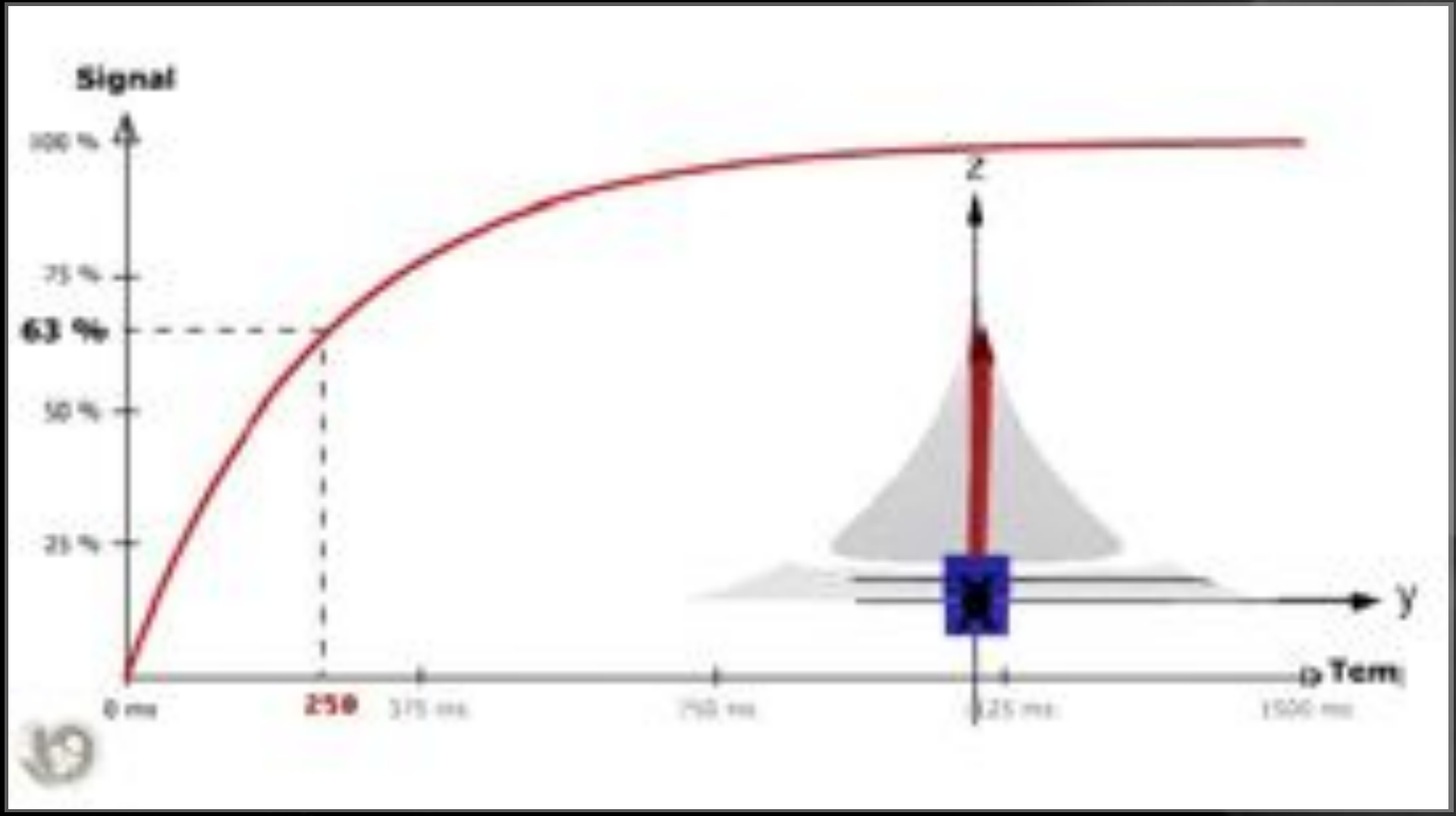
Adding a Radio Frequency Wawe



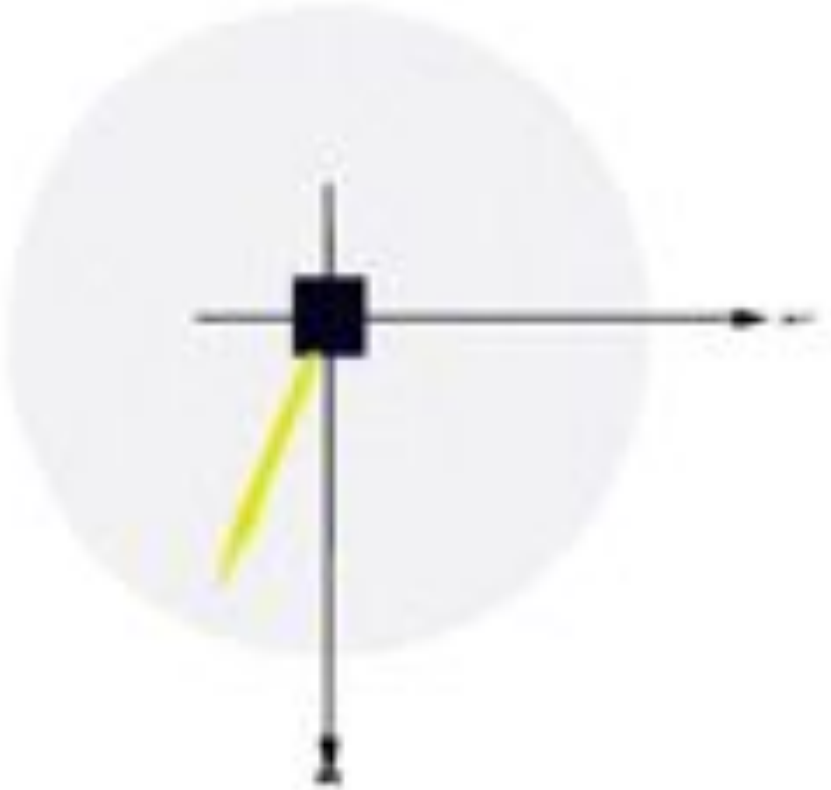
Signal Measurment



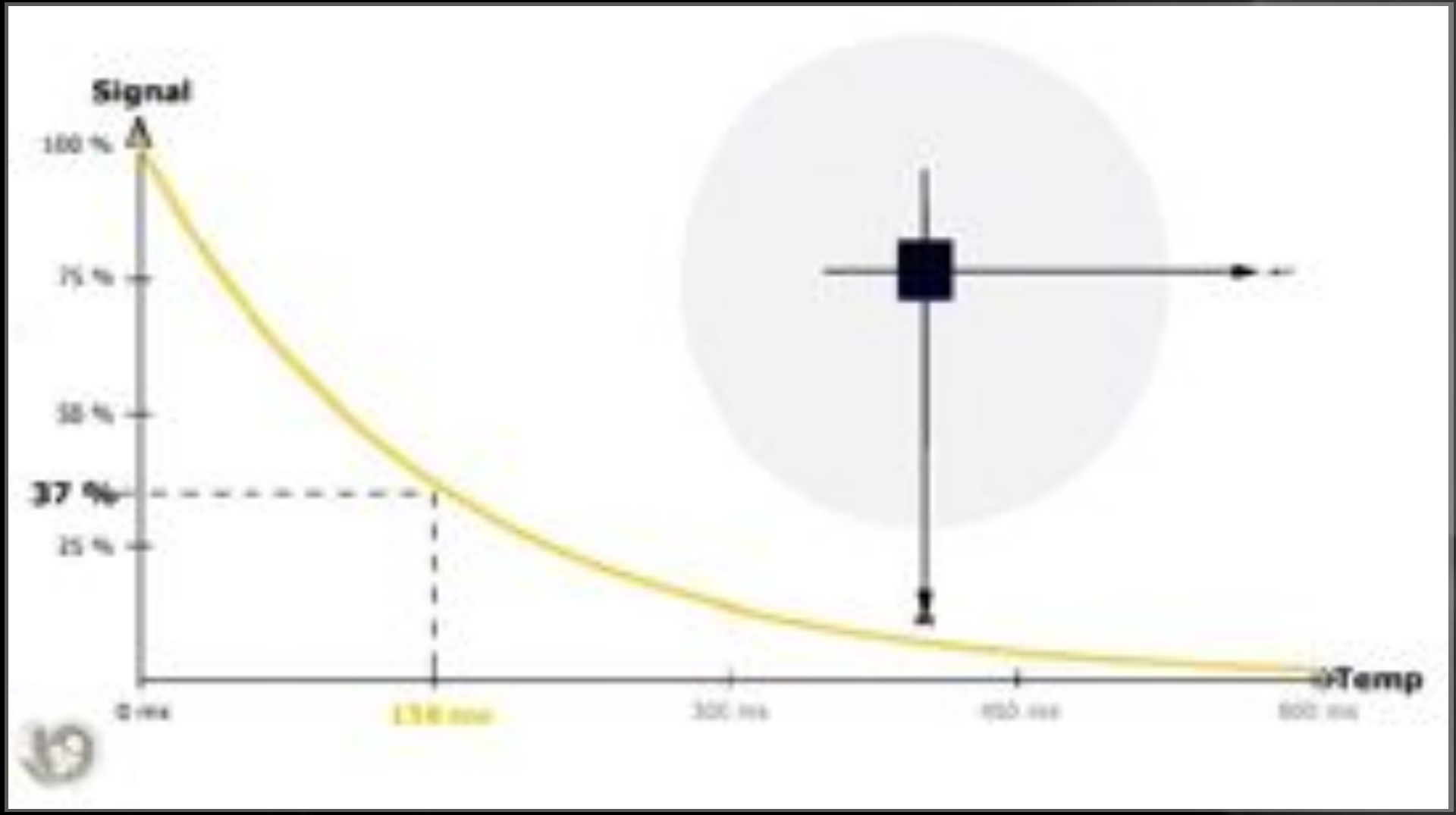
T1 Weighting



Signal Measurment



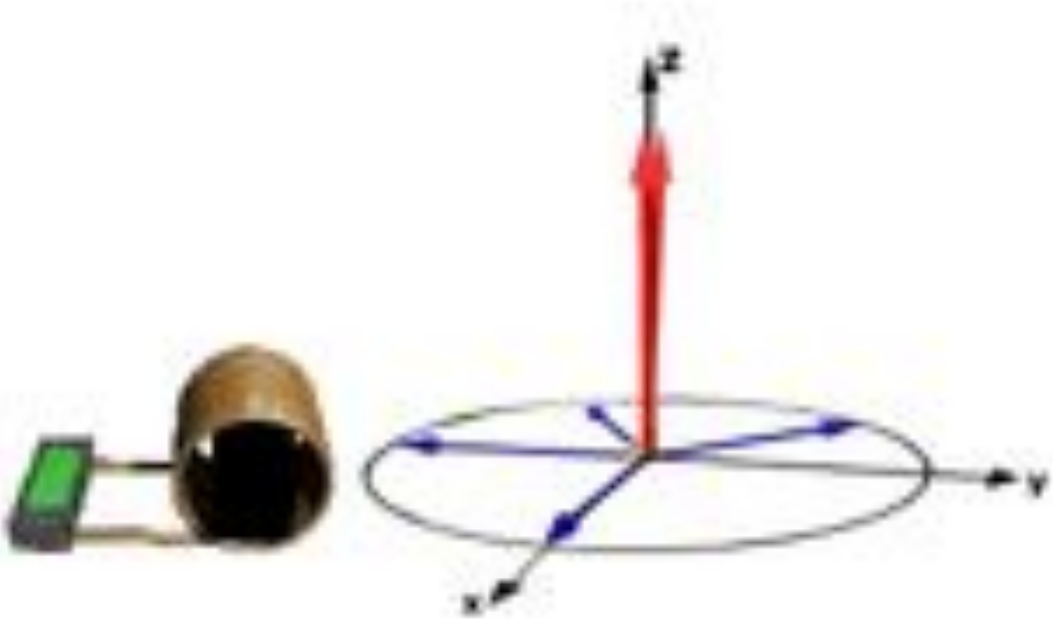
T1 Weighting



Signal Measurement

Signal Measurement

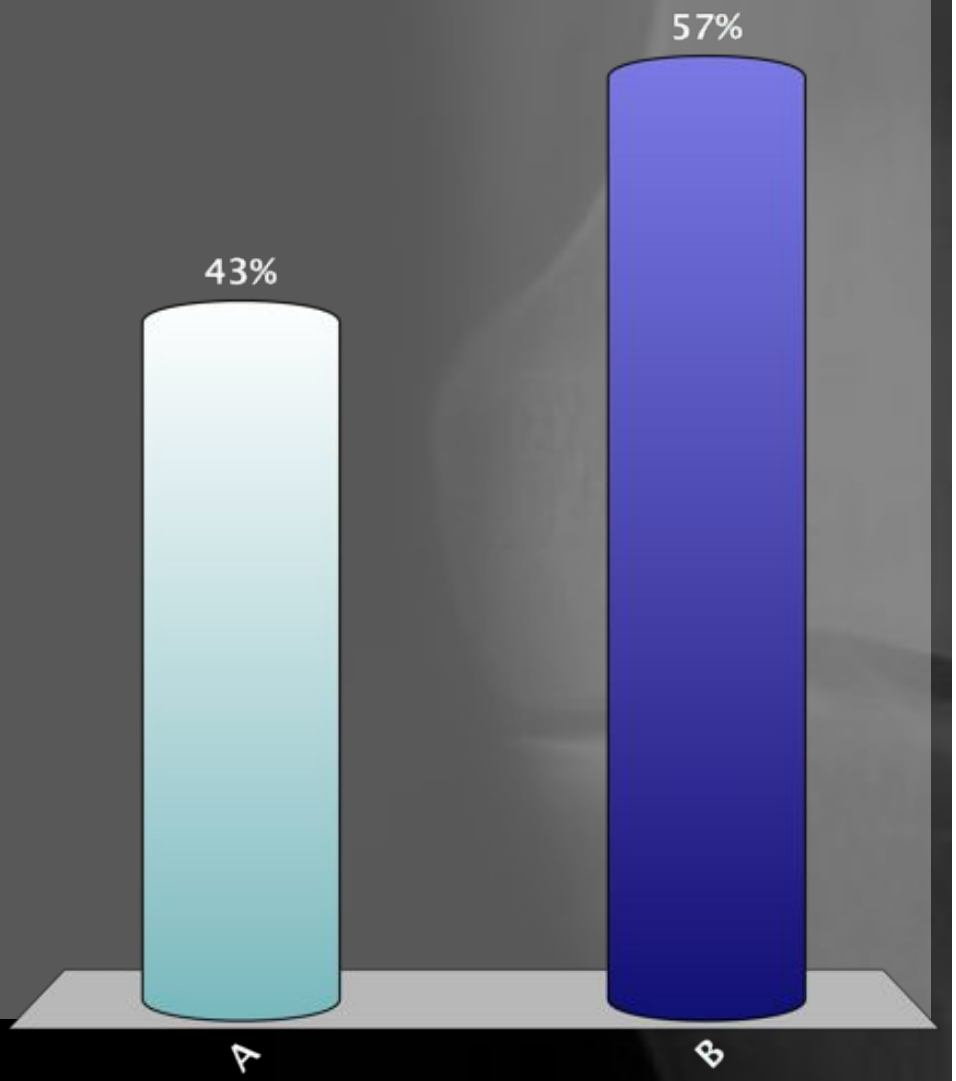
Signal Measurement



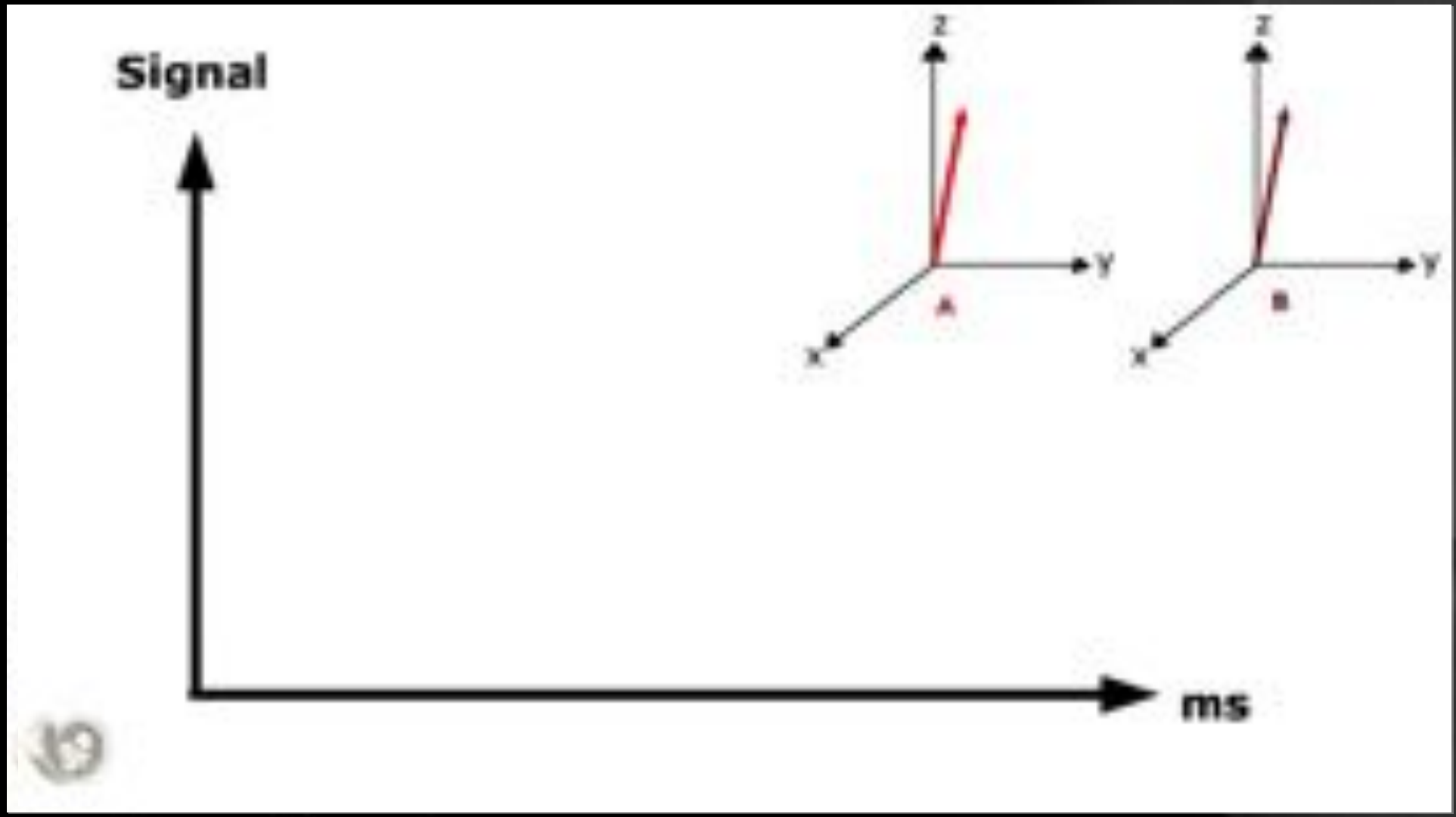
This technique measures only the orthogonal component

A. True

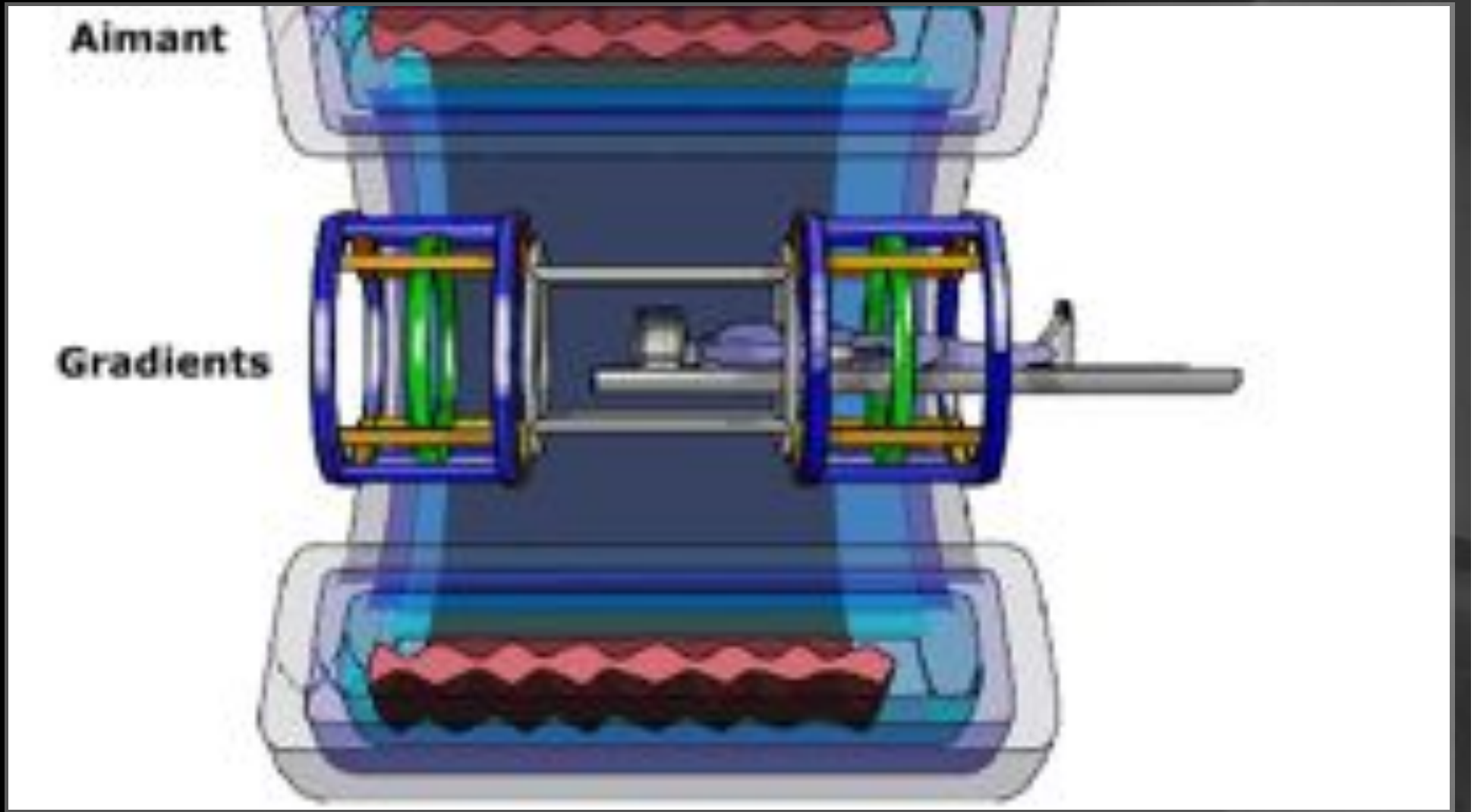
B. False



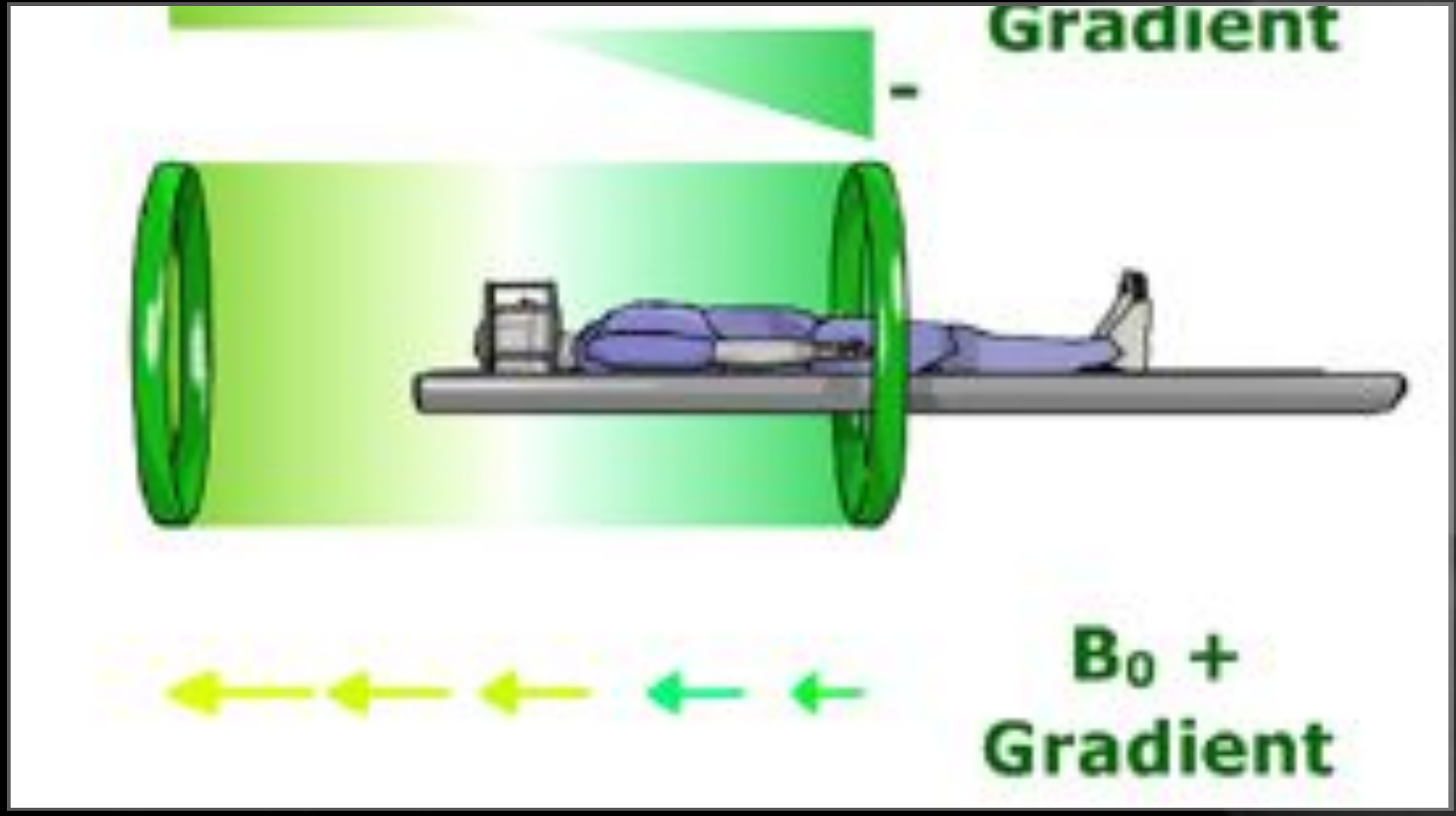
Signal Measurement



Signal Localization

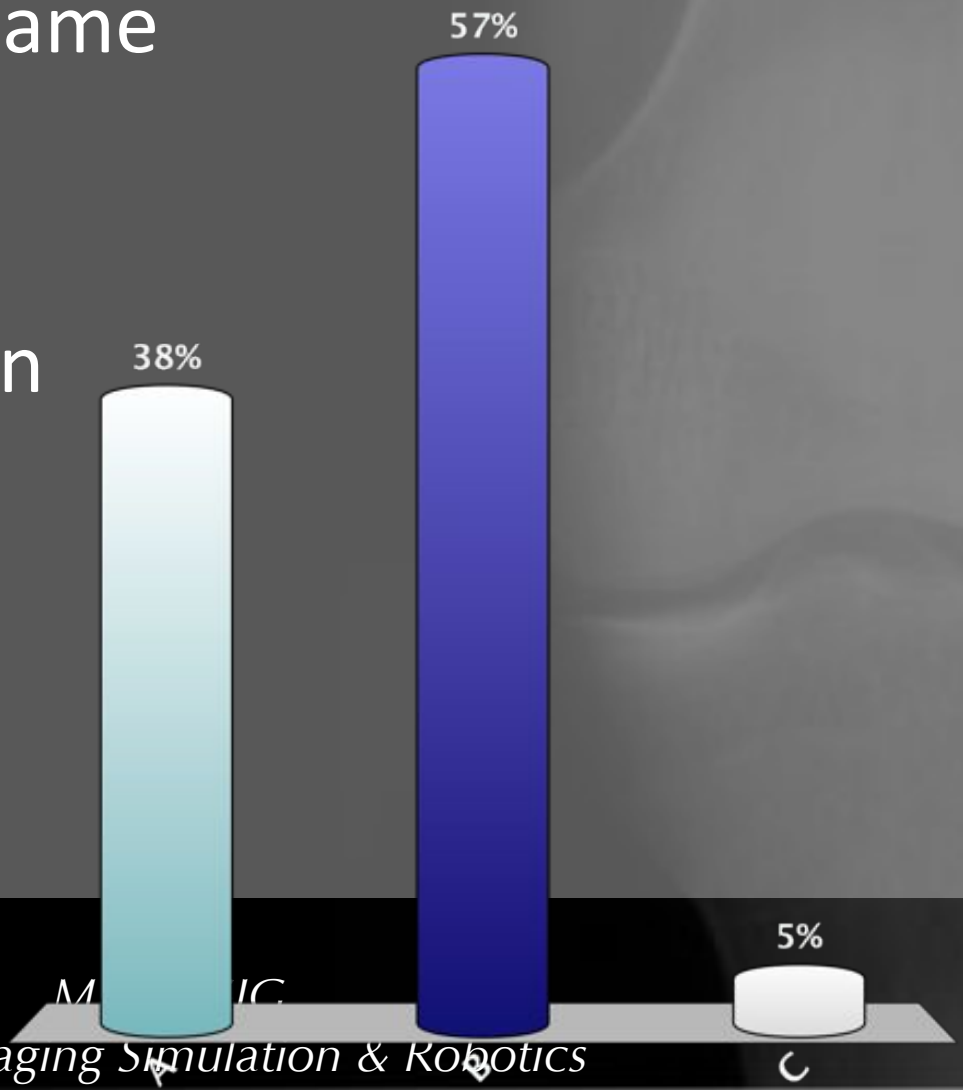


Signal Localization (Z)

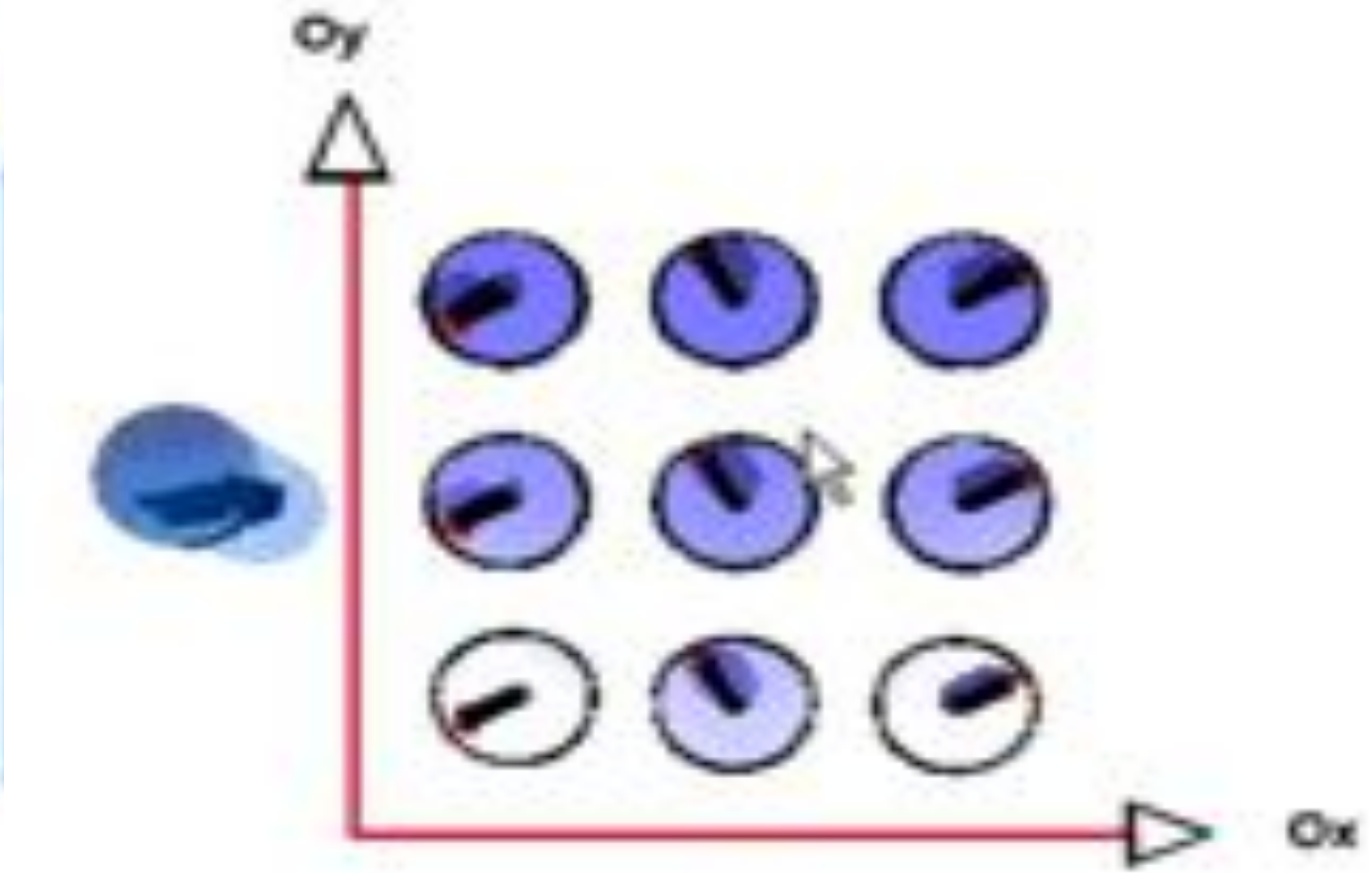


What will a Gradient on B0 do on Spins that are in B0+G space (not exactly B0)?

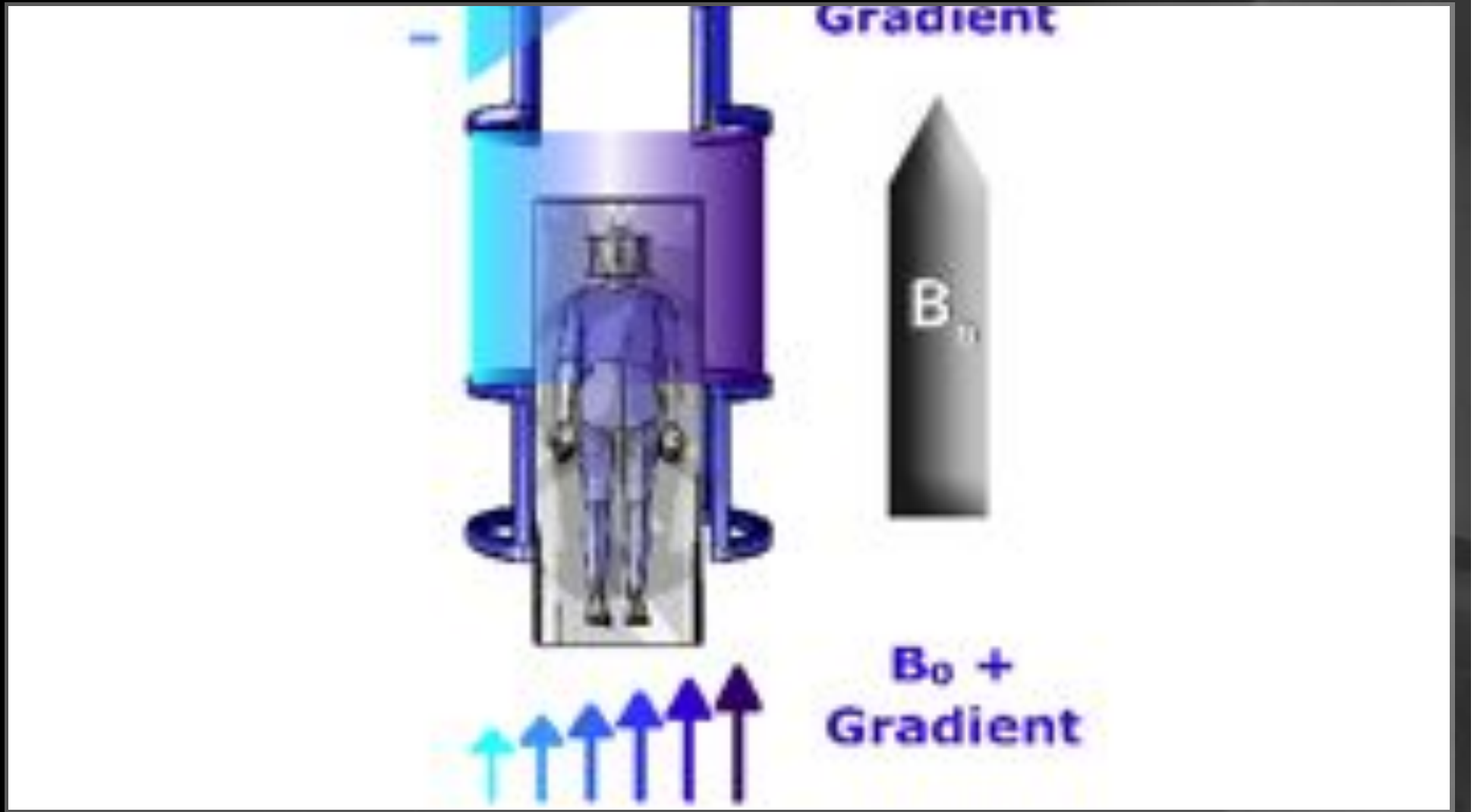
A. Spins will un-phase
B. Spins won't have the same Larmor Freqency
C. There will be no more resulting magnetization



Signal Localization (Z)



Space Encoding (X)



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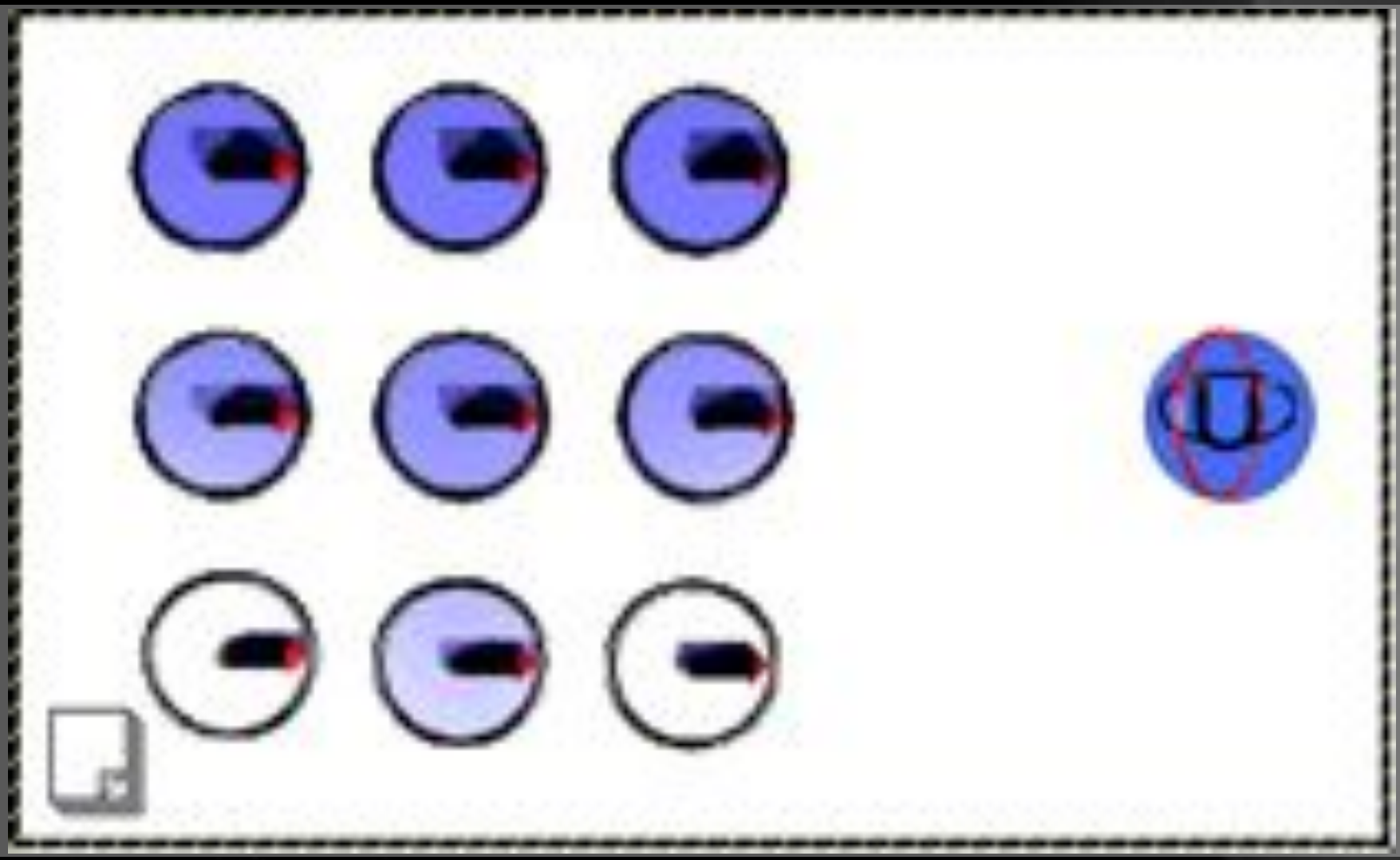
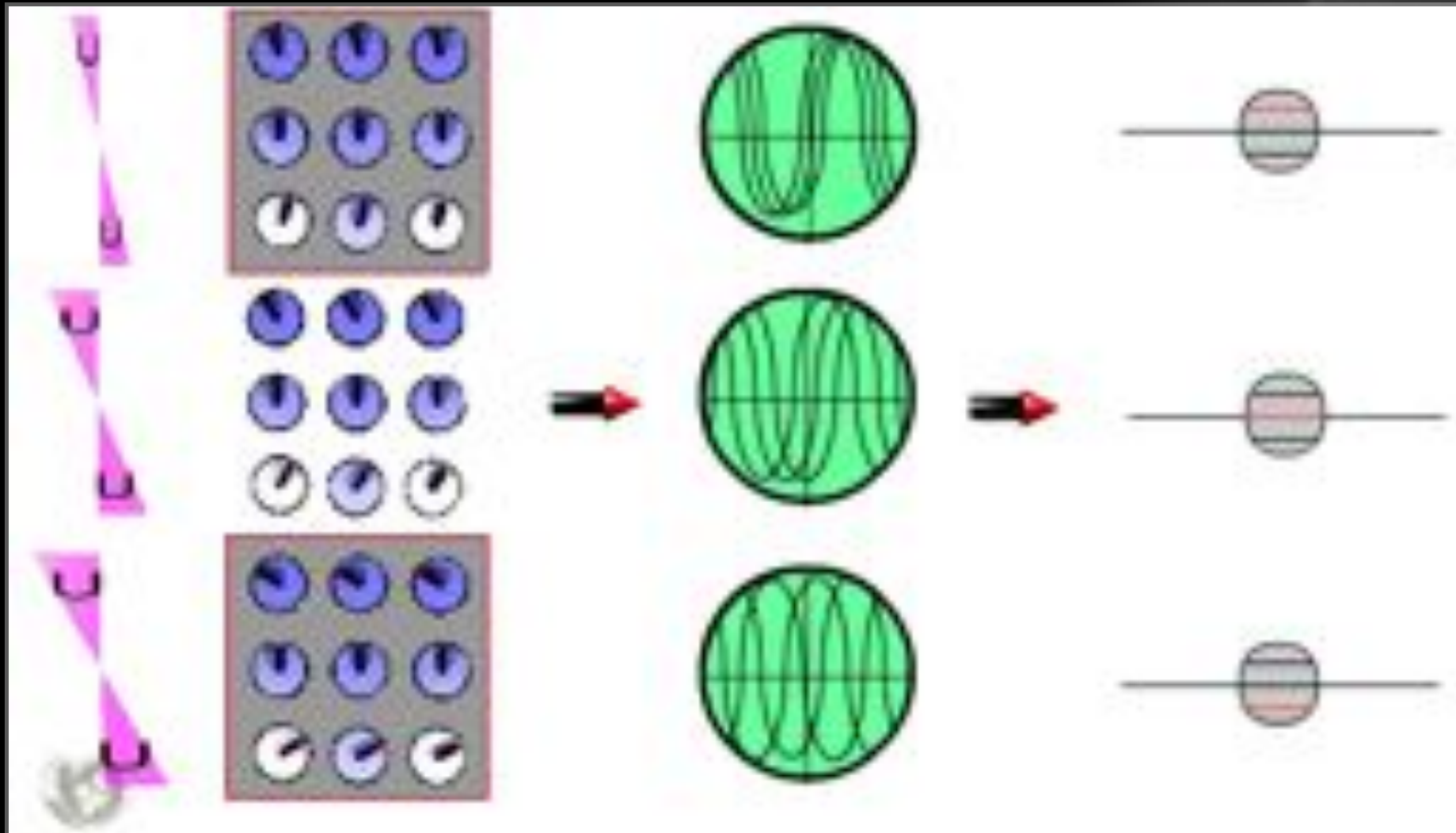
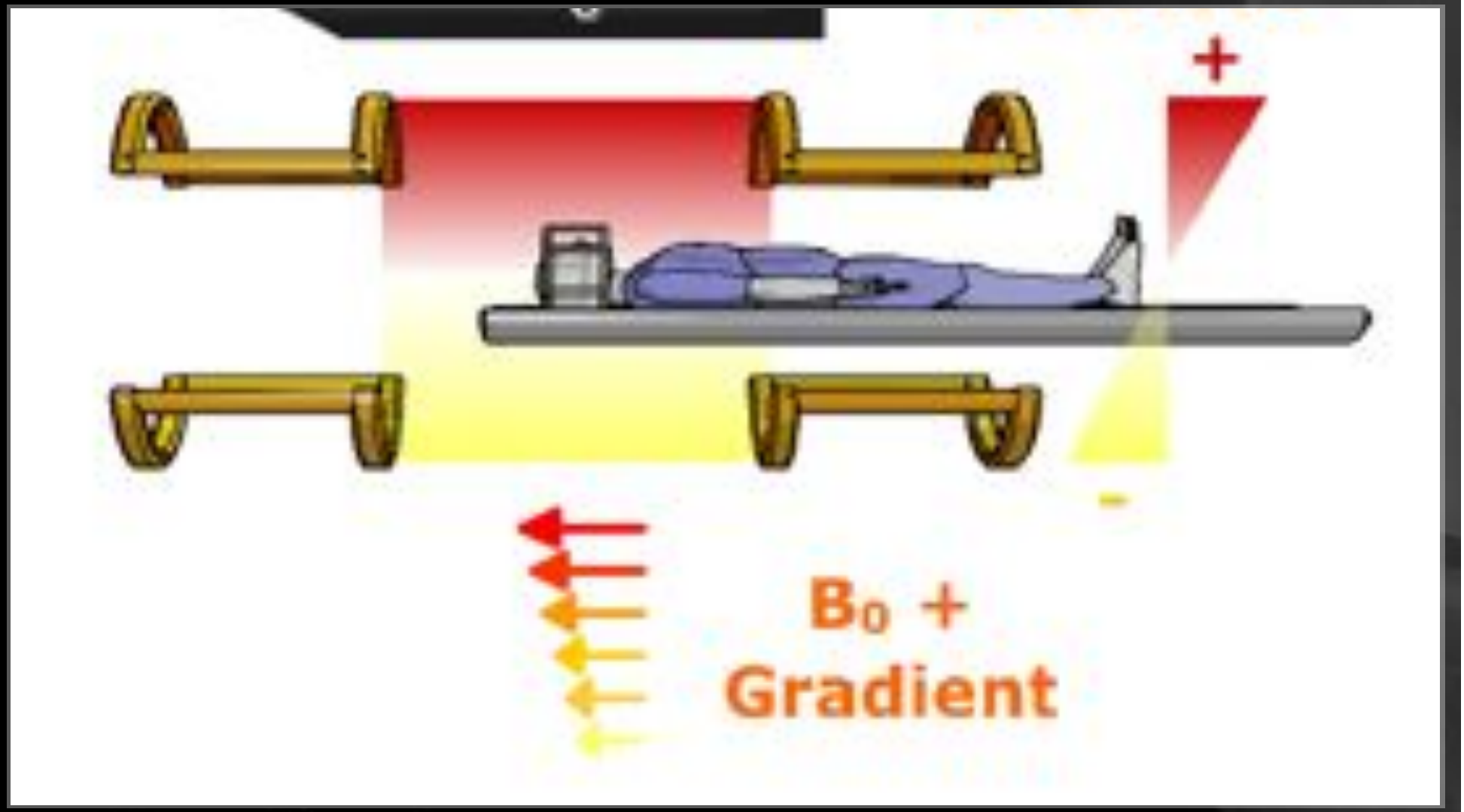


Space encoding (X)



Space Encoding (Y)



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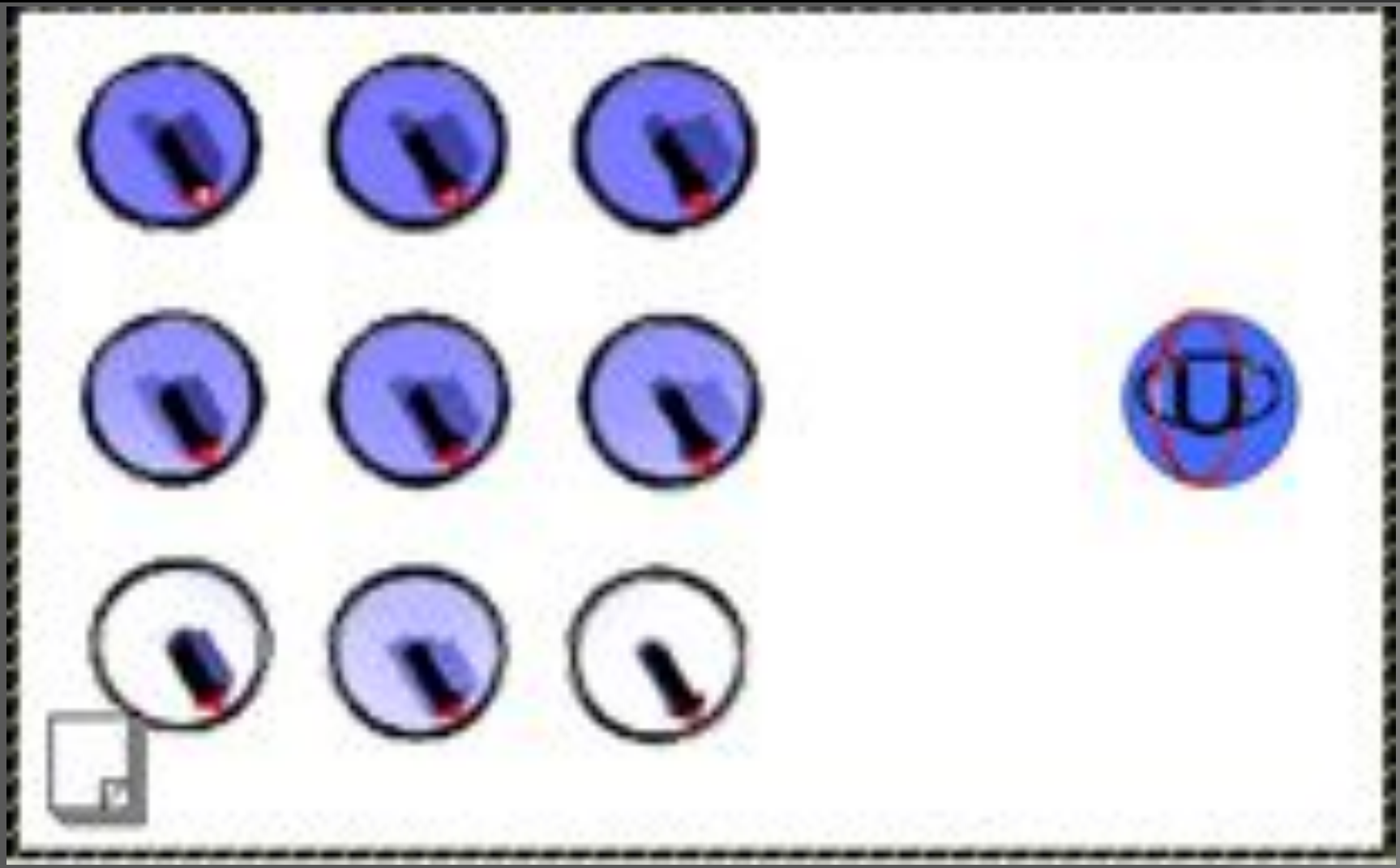



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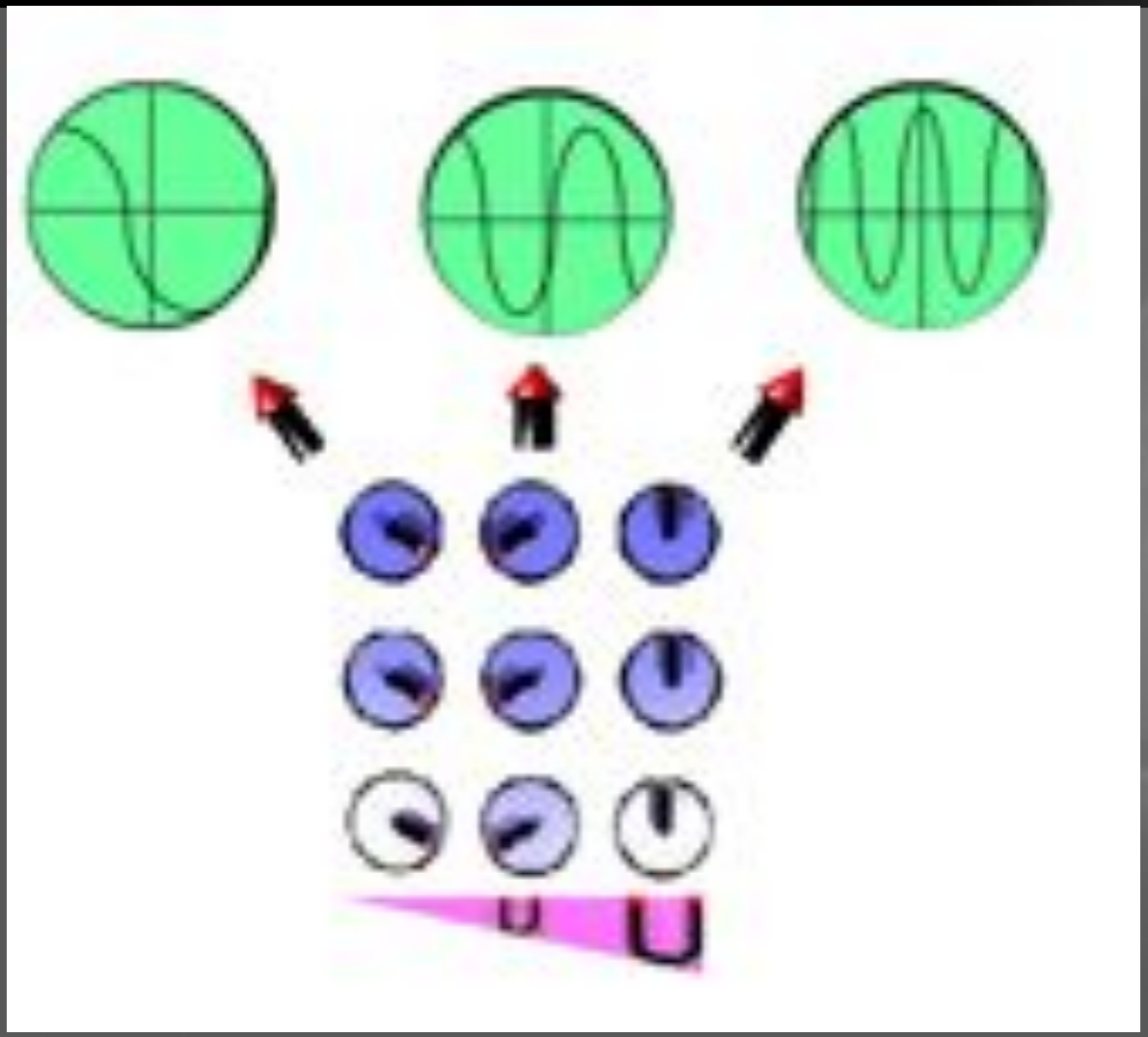




Image Encoding

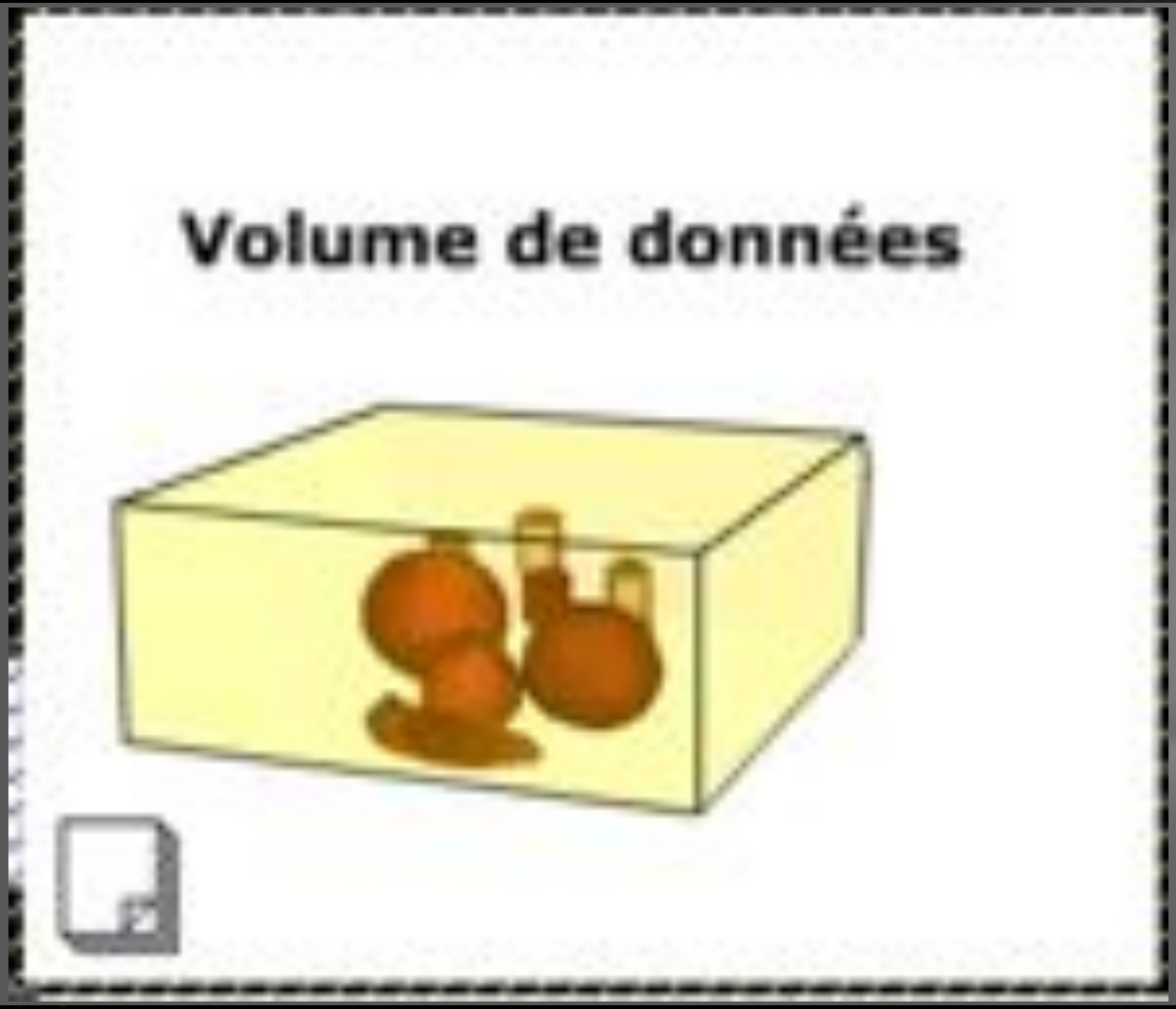
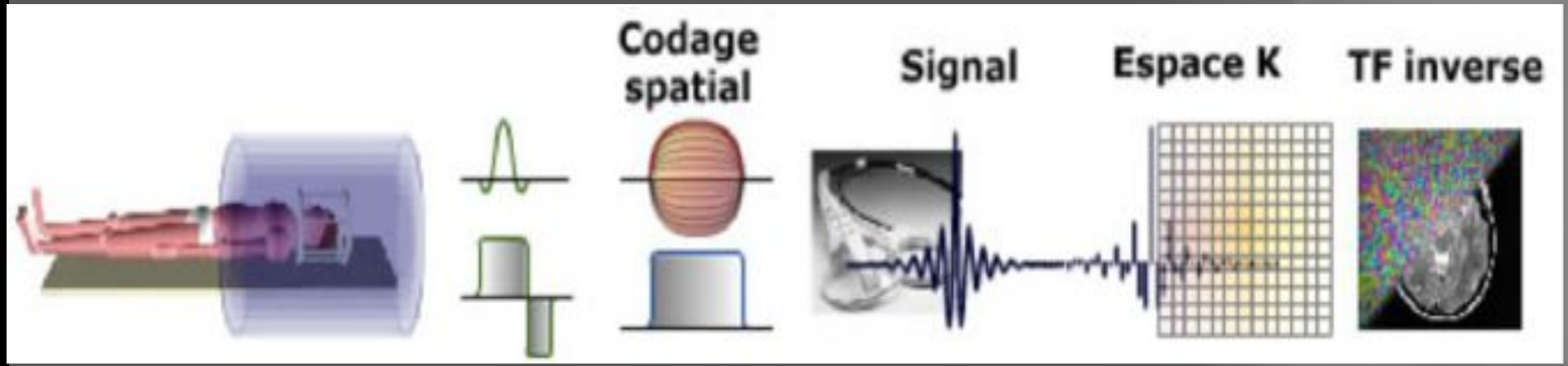


Image Encoding



Magnetic Resonance Imaging

- Visualization of
  - soft tissues
  - flows
- Expensive
- Real 3D view (images can be acquired along any orientation)
- T1 / T2, PD weighting

Functional MRI