Instituto Tecnológico y de Estudios Superiores de Monterrey

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23 de Mayo

MRI Activity

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Grupo 301

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19 de Mayo

Monterrey, Nuevo León

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MRI activity.

Open the simulator in https://phet.colorado.edu/en/simulations/mri

1. NMR

Place yourself in the tab *Simplified NMR*. Remember that the Larmour relationship relates the magnetic field to the resonant frequency:

where the resonant frequency is the gyromagnetic ratio and is the magnetic field.

Table1. Gyromagnetic ratios for different nuclei.

Nuclei	Gyromagnetic ratio	Nuclei	Gyromagnetic ratio
1H	42,58	65Cu	12,09
7Li	16,55	75As	7,291
9Be	5,984	77Se	8,118
11B	13,66	81Br	11,50
13C	10,71	87Rb	13,93
15N	4,314	93Nb	10,41
17O	5,772	117Sn	15,17

19F	40.05	121Sb	10,19
23Na	11,42	127I	8,518
27Al	11,09	133Cs	5,584
29Si	8,458	195Pt	9,153
31P	17,24	199Hg	7,590
35Cl	4,172	203Tl	24,33
51V	11,19	207Pb	8,907
55Mn	10,50	209Bi	6,841
59Co	10,05		

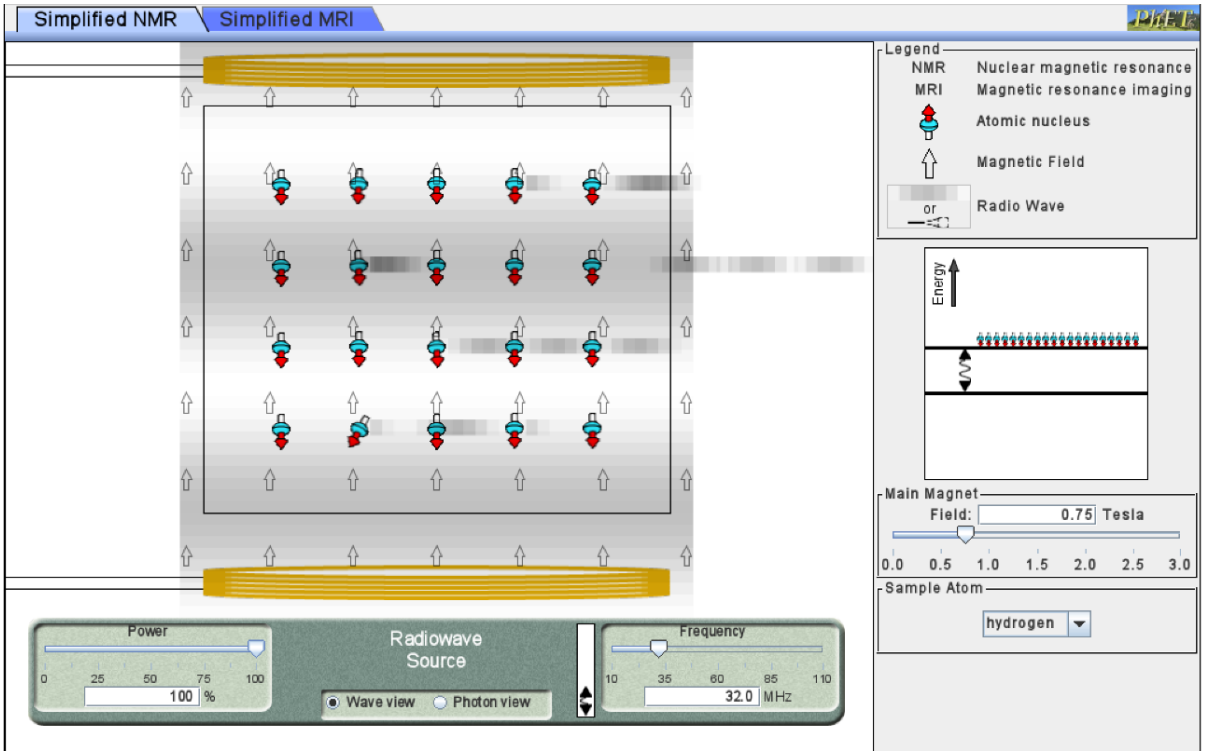
Use the Larmour relationship and the gyromagnetic ratios of various nuclei shown in table 1 to complete table 2. Check your results in the simulation by setting the appropriate frequencies and main magnet field, take a screenshot of the nuclei emitting energy to include in the report. Try to find the last nuclei (????) by playing with the simulation and register the frequency at two different magnetic fields.

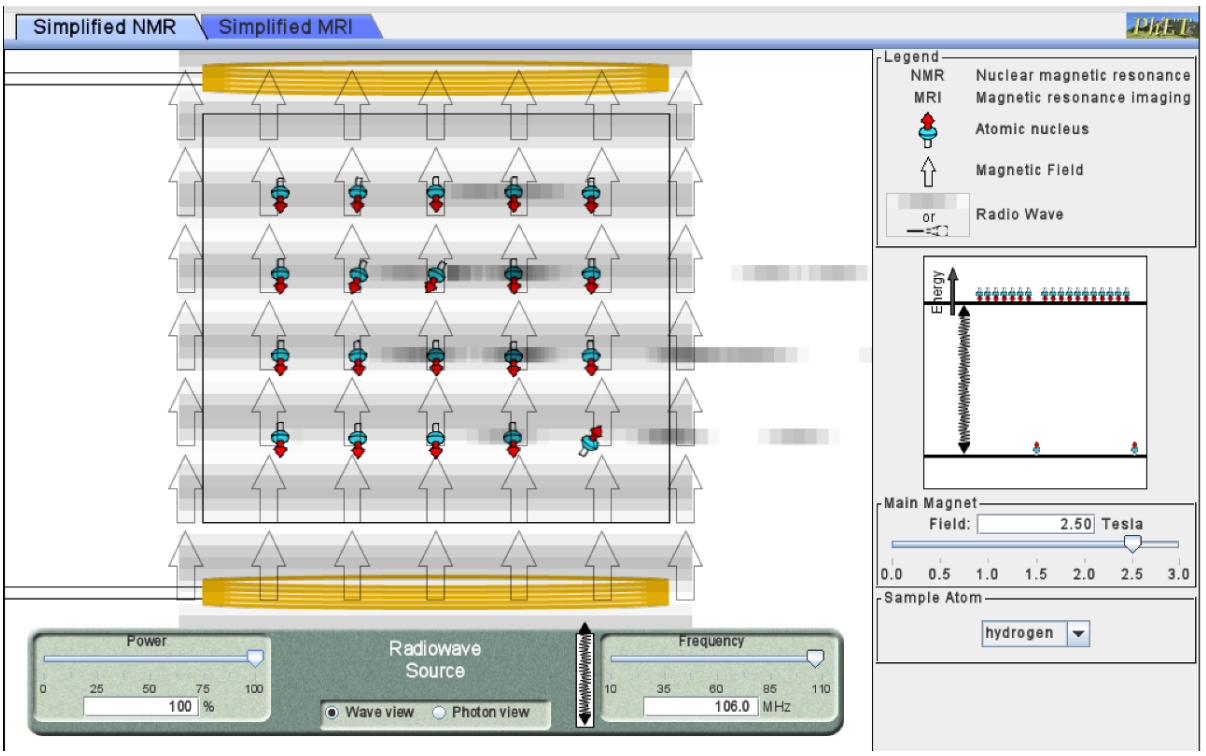
Table 2. Different settings to achieve energy emission.

Nuclei	Magnetic Field	Resonant Frequency	Magnetic Field	Resonant Frequency

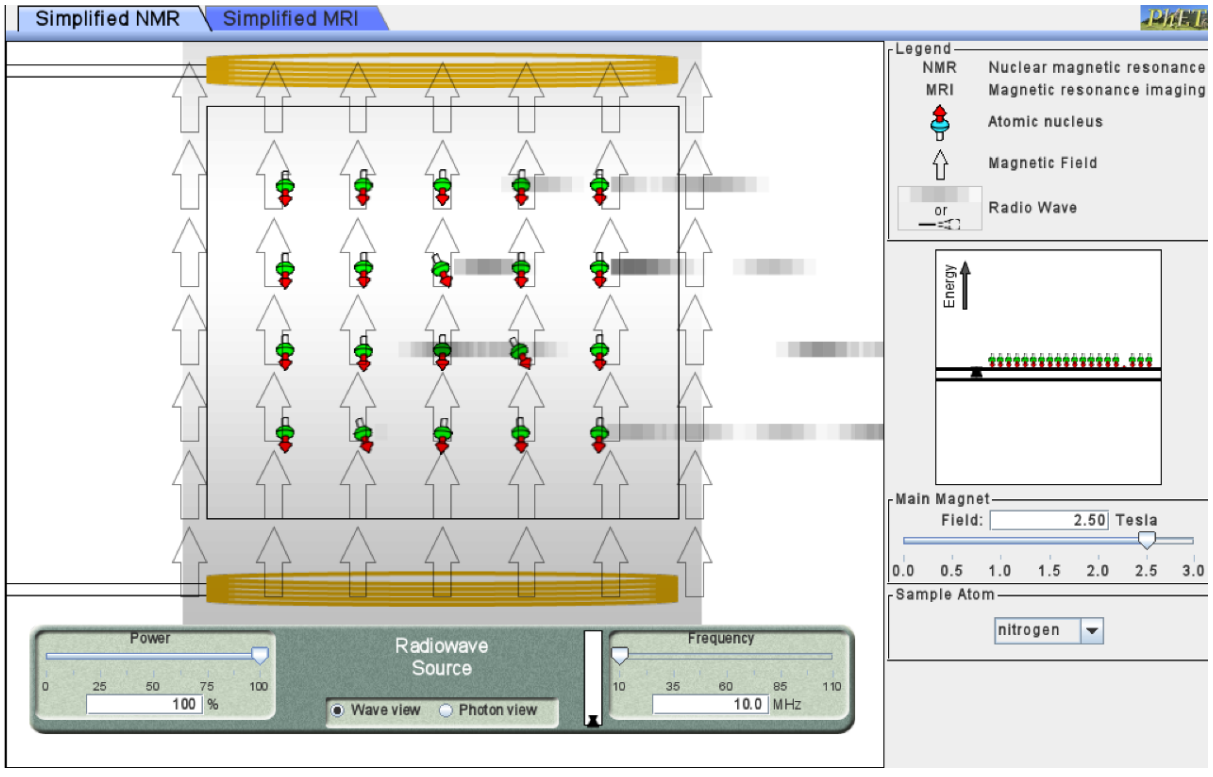
Hydrogen	0.75	32	2.5	106.45
Nitrogen	2.5	10	-	-
Sodium	1.5	17	2.75	31
Carbon-13	1.75	18	2.5	26
Oxygen	2.0	11	3.0	17
Sulfur	3.0	11	-	-
????	1.5	18.3	2.75	33.1

Hydrogen

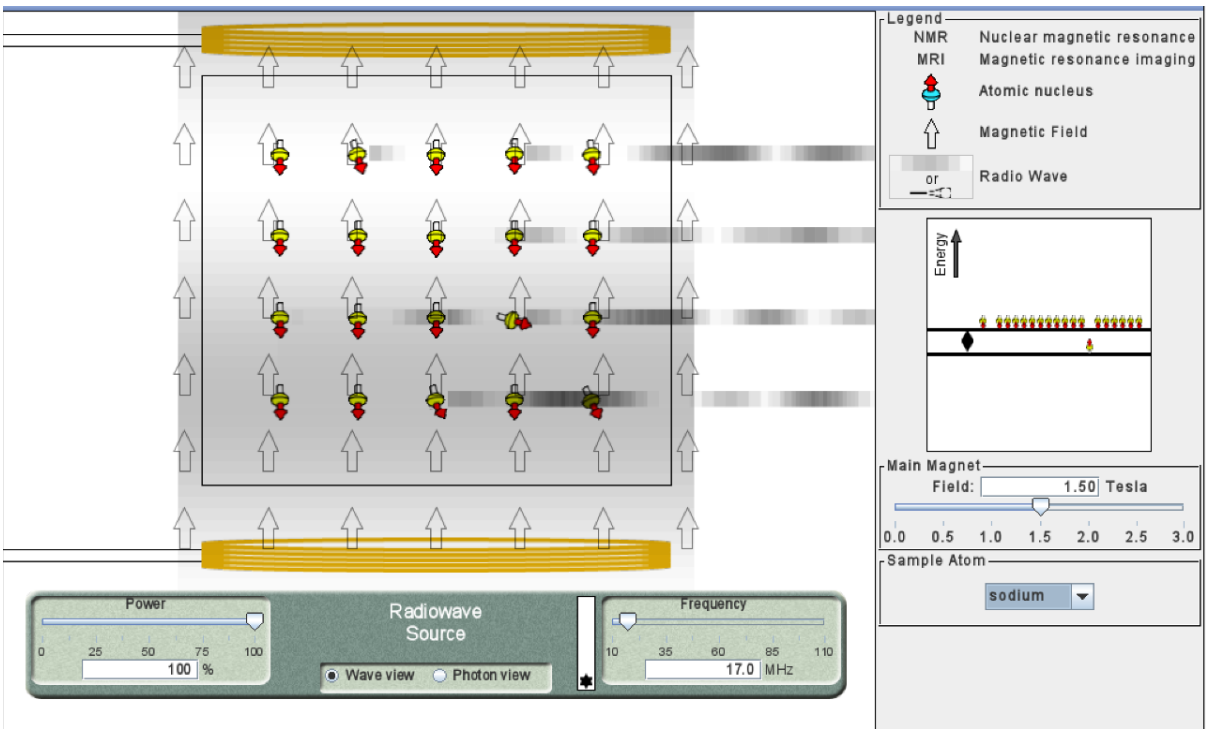


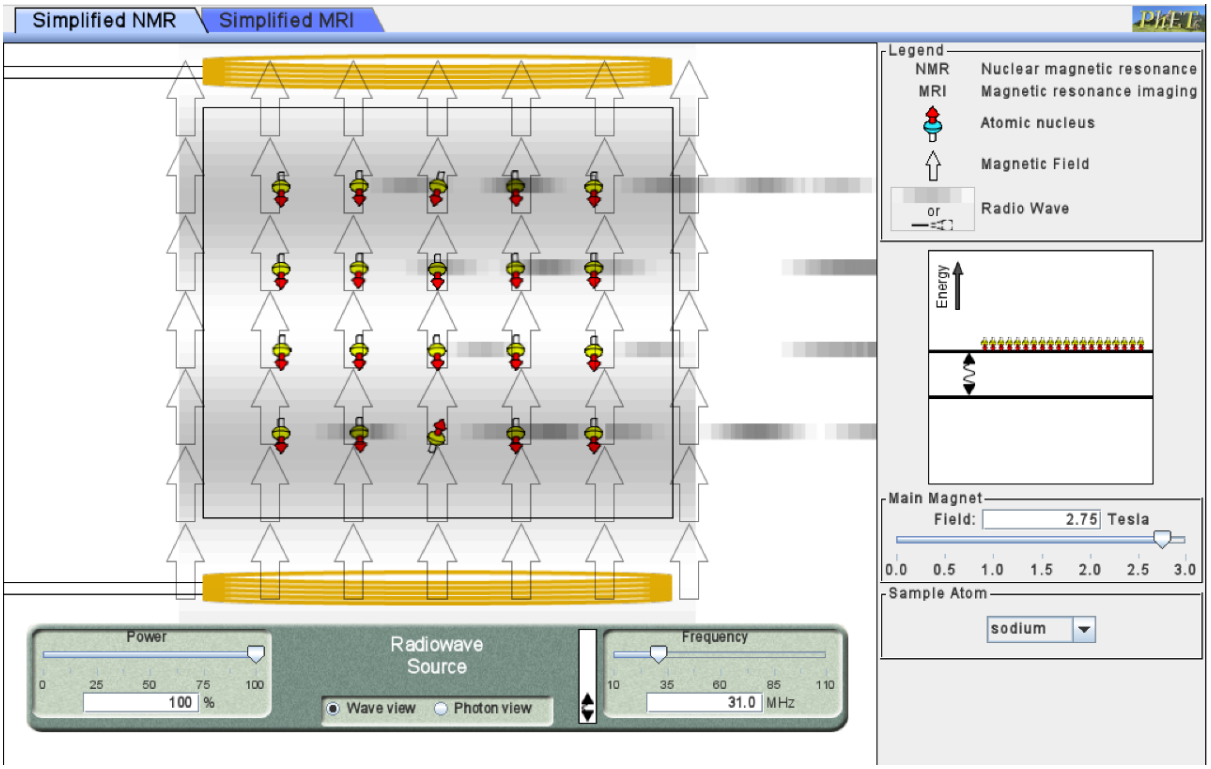


Nitrogen

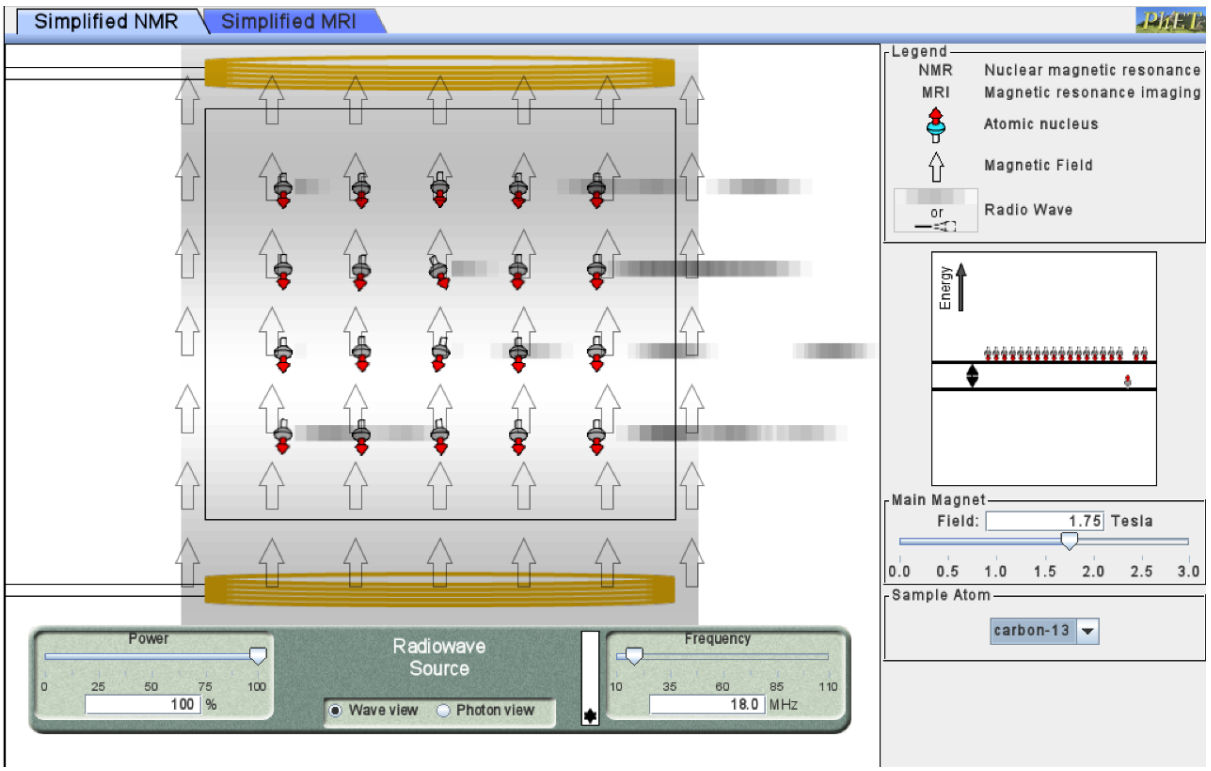


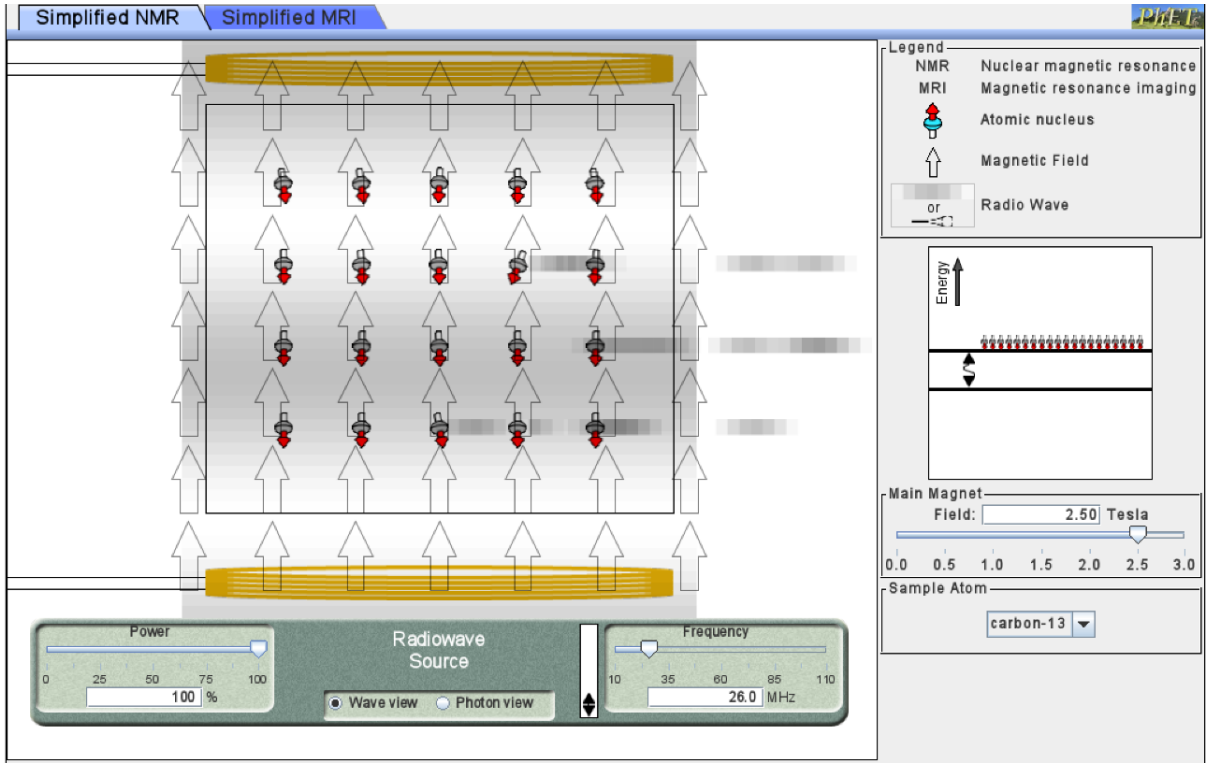
Sodium


Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Energy
Main Magnet
Field:
1.50
Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Sample Atom
sodium
Power
0 25 50 75 100
100 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
17.0 MHz

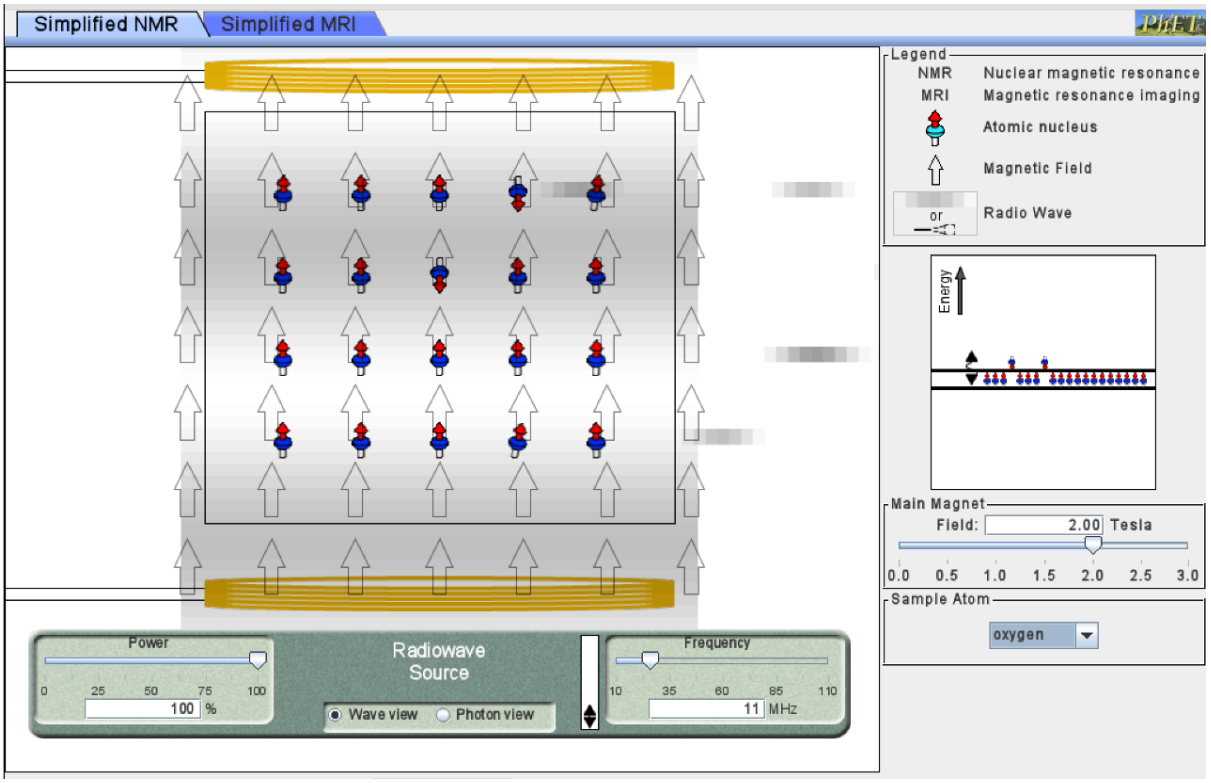

Simplified NMR
Simplified MRI
PhET
Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Energy
Main Magnet
Field:
2.75
Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Sample Atom
sodium
Power
0 25 50 75 100
100 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
31.0 MHz

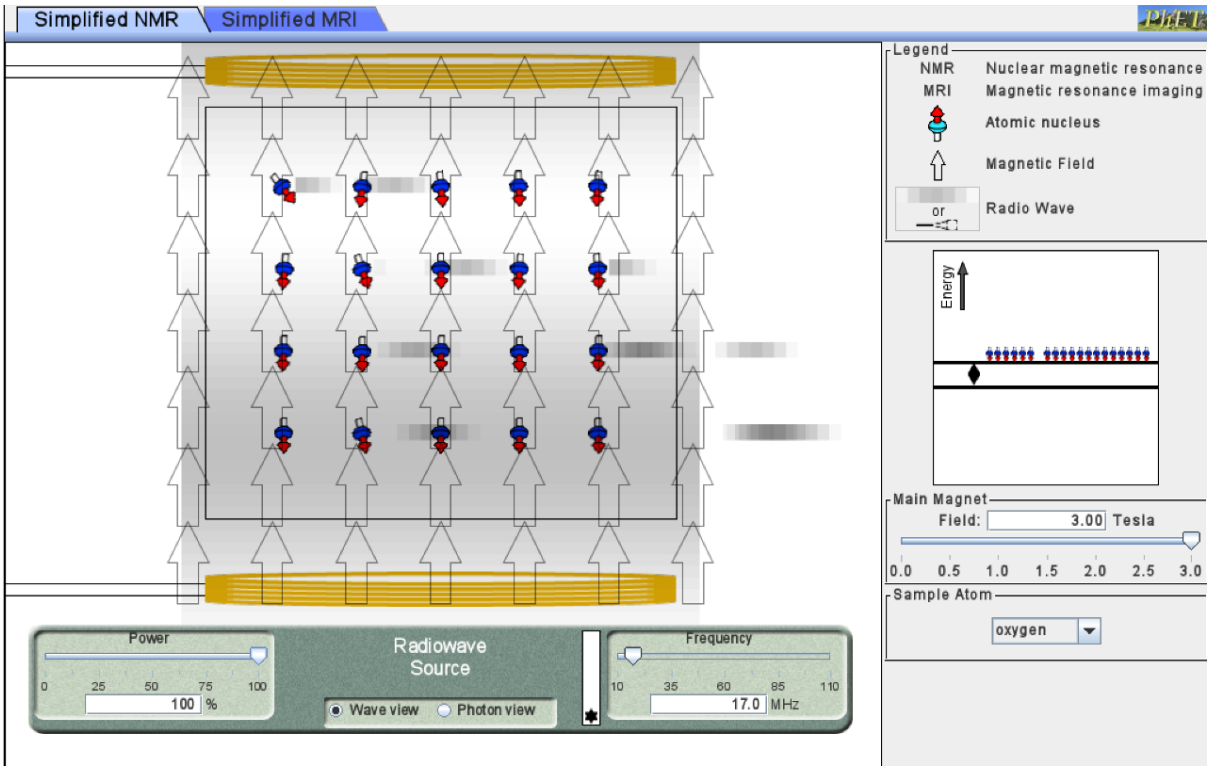
Carbon-13


Simplified NMR
Simplified MRI
Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Energy
Main Magnet
Field:
1.75
Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Sample Atom
carbon-13
Power
0 25 50 75 100
100 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
18.0 MHz

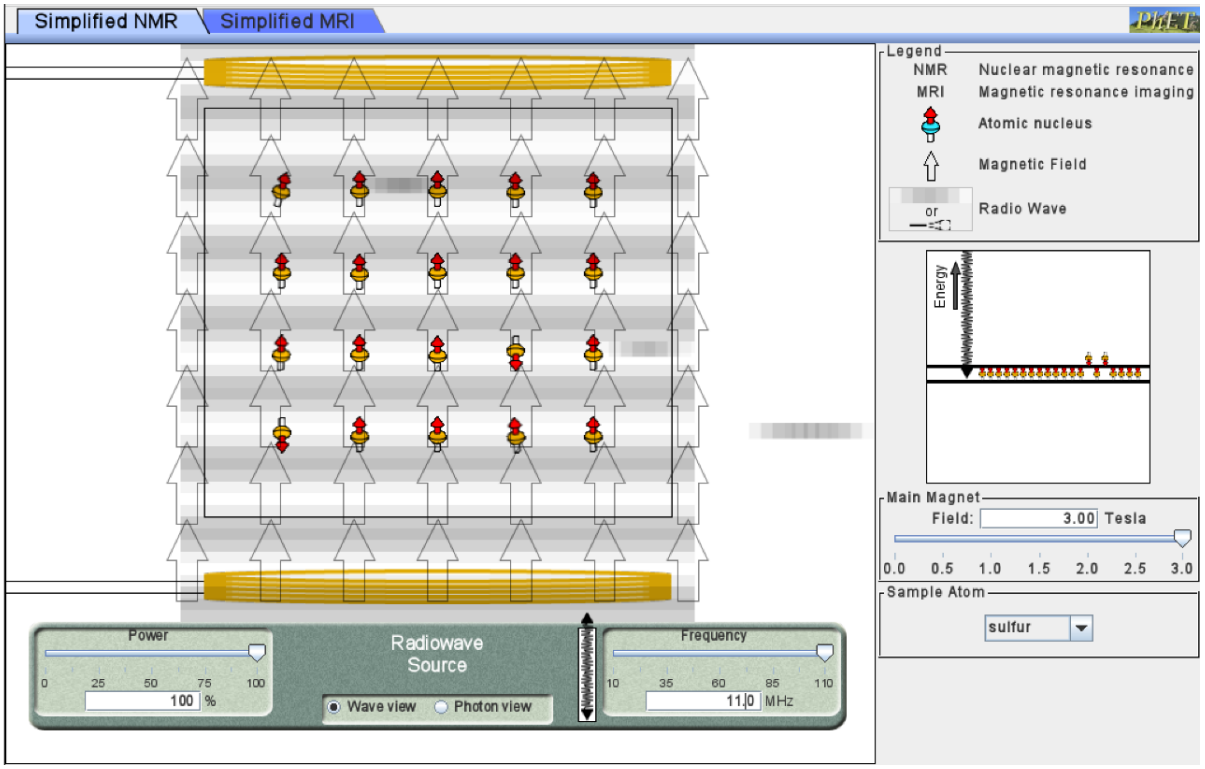

Simplified NMR
Simplified MRI
Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Energy
Main Magnet
Field:
2.50
Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Sample Atom
carbon-13
Power
0 25 50 75 100
100 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
26.0 MHz

Oxigen


Simplified NMR
Simplified MRI
Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Energy
Main Magnet
Field:
2.00
Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Sample Atom
oxygen
Power
0 25 50 75 100
100 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
11 MHz


Simplified NMR
Simplified MRI
Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Energy
Main Magnet
Field:
3.00
Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Sample Atom
oxygen
Power
0 25 50 75 100
100 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
17.0 MHz

Sulfur

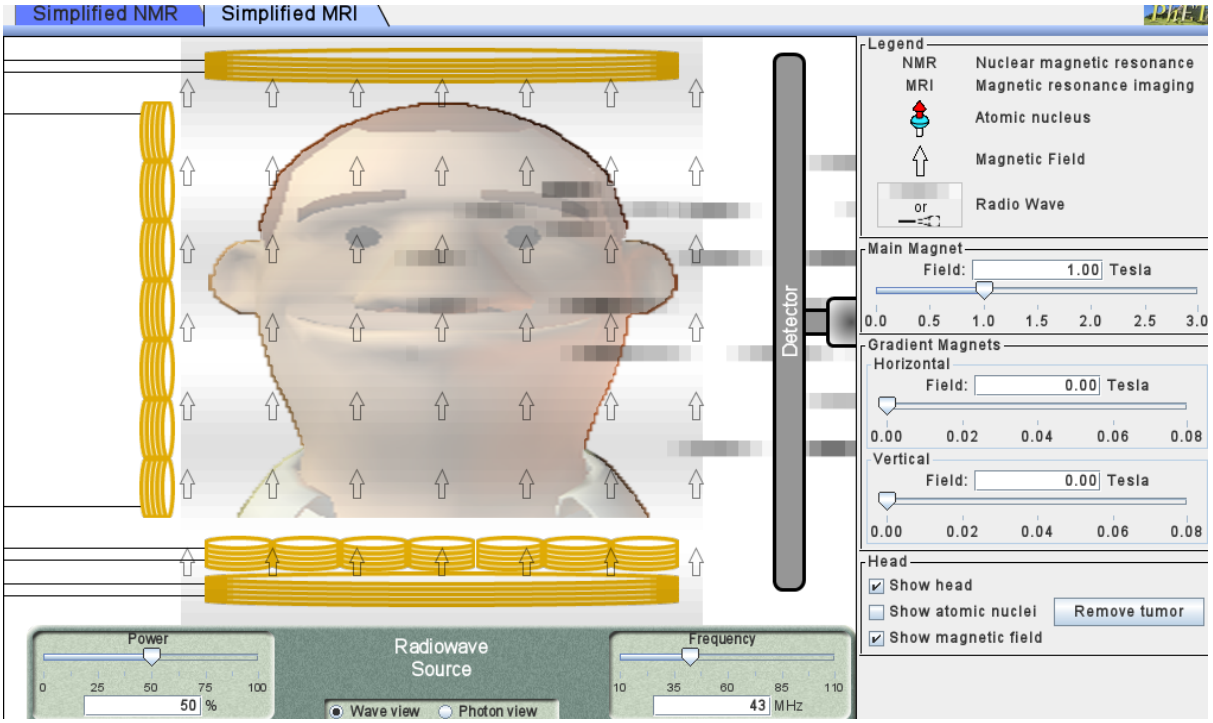


2. MRI

Move to the *Simplified MRI* tab

1. Set the *main magnet field* to 1.0 Tesla, leave the *gradient magnets* in zeros, activate only *show head*, and *show magnetic field* (be sure that *show atomic nuclei* is deactivated), set the frequency in 43 MHz. Finally set the *power* to 50% and observe the flow and distribution of the emissions. After a while observing the emissions, click on *add tumor*, wait for around 7 seconds so the flow distribution stabilizes, look at how the emission changed and try to guess where the tumor is located.

Explain how the emission allowed you to find the correct location: La mayoría de las ondas nacían del lado derecho de la cara del paciente sobre todo en el área del ojo y ceja derecha



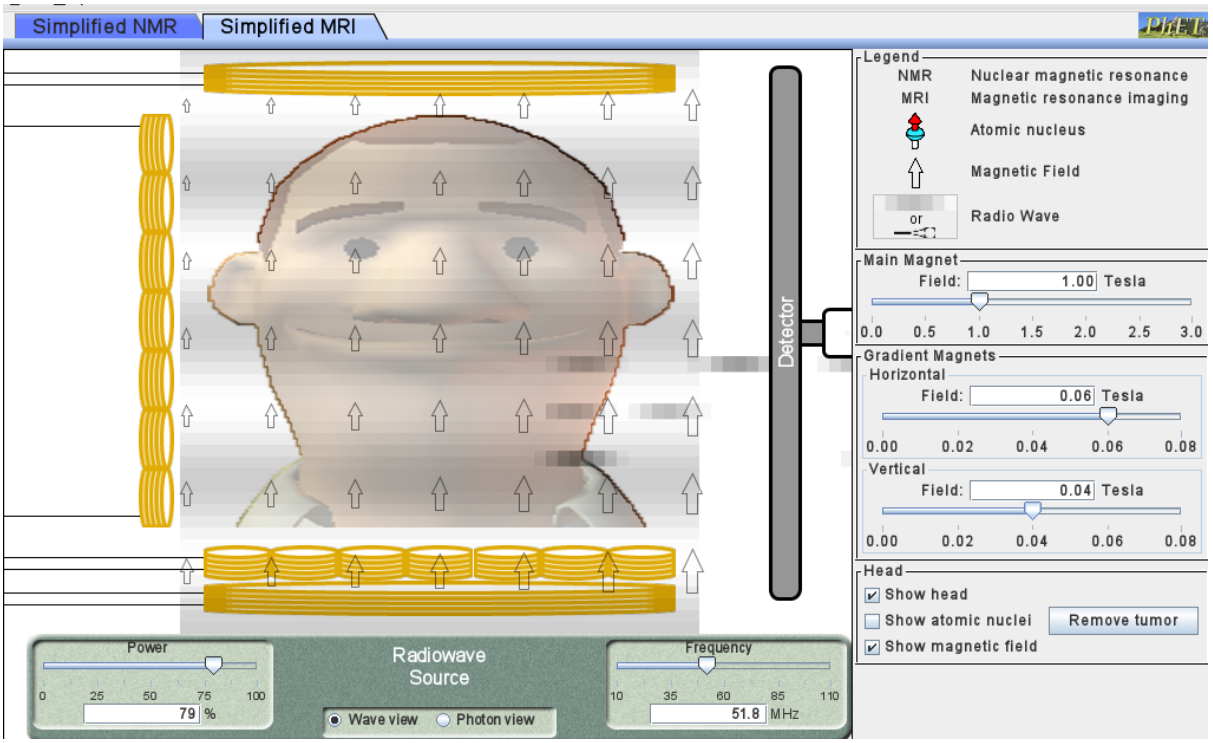
2. Play with the main magnet field, frequency, and gradient magnets (both, horizontal and vertical) to try to obtain an emission focused mainly in the zone of the tumor (register your best guess, it doesn't need to be perfect). Answer the following questions.

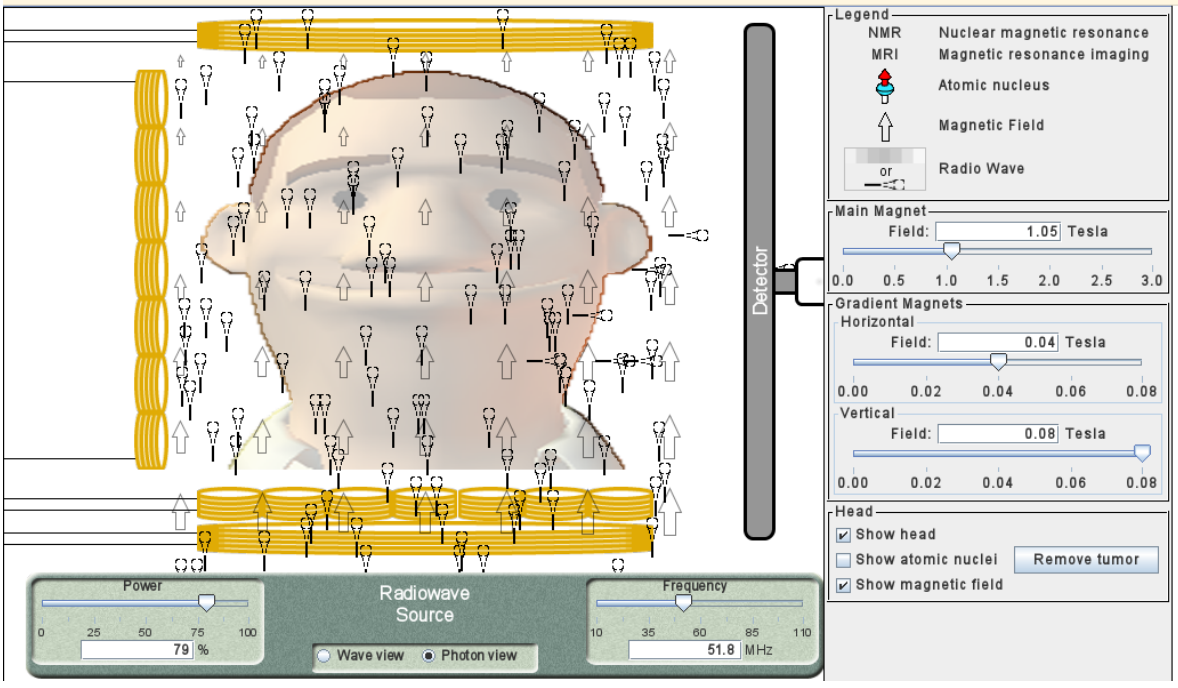
El tumor se encuentra en la parte derecha de la cara del paciente a la altura de la mandíbula y la comisura del labio.

Best guess: main magnet: 1.05 horizontal gradient: 0.06 vertical gradient: 0.04 frequency: 51.8

What happens when the horizontal gradient increases its magnitude? How does it affect the emissions? las emisiones se hacen mas constantes y son lanzadas con un poco mas de velocidad

What about vertical gradient? No se miran muy afectadas las ondas emitidas, sin embargo al aumentar el grandiente más fotones som emitidos a través del paciente


Simplified NMR
Simplified MRI
Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Main Magnet
Field: 1.00 Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Gradient Magnets
Horizontal
Field: 0.06 Tesla
0.00 0.02 0.04 0.06 0.08
Vertical
Field: 0.04 Tesla
0.00 0.02 0.04 0.06 0.08
Head
Show head
Show atomic nuclei
Remove tumor
Show magnetic field
Detector
Power
0 25 50 75 100
79 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
51.8 MHz


Legend
NMR
Nuclear magnetic resonance
MRI
Magnetic resonance imaging
Atomic nucleus
Magnetic Field
or
Radio Wave
Main Magnet
Field: 1.05 Tesla
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Gradient Magnets
Horizontal
Field: 0.04 Tesla
0.00 0.02 0.04 0.06 0.08
Vertical
Field: 0.08 Tesla
0.00 0.02 0.04 0.06 0.08
Head
Show head
Show atomic nuclei
Remove tumor
Show magnetic field
Detector
Power
0 25 50 75 100
79 %
Radiowave Source
Wave view
Photon view
Frequency
10 35 60 85 110
51.8 MHz