

# **Understanding MRI Parameters: A Comprehensive Guide for Beginners**

***- Rajakumar Nagarajan***

Rajakumar Nagarajan, Ph.D.

MRI Physicist

Human Magnetic Resonance Center

Adjunct Associate Professor in Kinesiology

Institute for Applied Life Sciences (IALS)

240 Thatcher Way

University of Massachusetts Amherst, Massachusetts, 01003

Email: [rnagarajan@umass.edu](mailto:rnagarajan@umass.edu)

**Abstract:**

Acquiring a basic understanding of MRI parameters can help both patients and healthcare professionals optimize MRI image quality, improve diagnostic accuracy, and enhance patient outcomes. Furthermore, learning about MRI parameters can provide several advantages, such as:

(a) **Improved image quality:** Understanding how to adjust MRI parameters can help optimize image quality, resulting in clearer and more detailed images. (b) **Enhanced diagnostic accuracy:** By optimizing MRI parameters, radiologists and clinicians can better visualize and diagnose various conditions, leading to improved patient outcomes. (c) **Increased efficiency:** Knowledge of MRI parameters can help streamline the scanning process, reducing the need for repeat scans and minimizing the time patients spend in the MRI machine. (d) **Improved communication with radiologists and technologists:** Having a basic understanding of MRI parameters can help patients communicate with their radiologists and technologists more effectively, enabling them to ask questions and better understand their MRI scans. (e) **Better preparation for MRI exams:** Patients who understand the basics of MRI parameters can prepare more effectively for their exams, such as by wearing comfortable clothing, avoiding metal objects, and practicing relaxation techniques to reduce anxiety during the scan.

**Key Words:** MRI, Parameter, slice thickness, Slice gap, TR, TE, Field of view, Phase encoding, Bandwidth, Matrix, Flip Angle, Inversion Time

**Abbreviation:** MRI, magnetic resonance imaging; TR, Repetition Time; TE, Echo Time; TI, Inversion Time; FA, Flip Angle; FOV, Field of View; SNR, Signal to Noise Ratio; RF, Radio Frequency; PE, Phase Encoding; GRE, Gradient Echo; SE, Spin-Echo

## **Introduction:**

Magnetic resonance imaging (MRI) is a medical imaging technique that uses a powerful magnetic field, radio waves, and a computer to generate detailed images of the inside of the body. It is a non-invasive and painless way to visualize internal organs and structures and is commonly used to diagnose and monitor a variety of medical conditions. MRI can provide high-resolution images of the brain, spine, joints, abdomen, and other areas of the body, and is often preferred over other imaging methods because it does not use ionizing radiation.

MRI parameters refer to a set of various settings that can be adjusted during the acquisition of MRI images. These settings are adjusted to optimize image quality and obtain the most accurate diagnostic information possible. Some of the most commonly adjusted MRI parameters include TR (repetition time), TE (echo time), FA (flip angle), and TI (inversion time), as well as averages, matrix size, FOV (field of view), slice thickness, slice gap, phase encoding, bandwidth, and resolution.

To obtain high-quality MRI images, healthcare professionals can adjust these parameters based on the specific diagnostic purposes and patient populations.

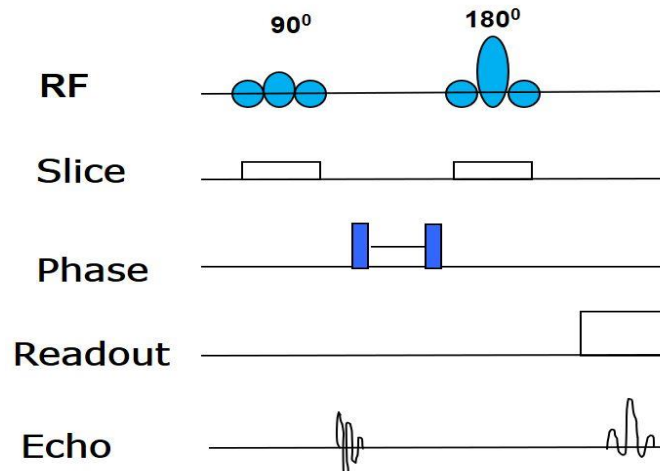
## **MRI Pulse sequence:**

In MRI, a pulse sequence refers to the specific timing and duration of the electromagnetic pulses and radio frequency (RF) signals used to create an image. Each pulse sequence is designed to produce a specific type of contrast between different types of tissues in the body.

A typical MRI pulse sequence involves four main stages: excitation, encoding, manipulation, and detection. During the excitation stage, a strong magnetic field is applied to align the protons in the body's tissues. In the encoding stage, a gradient magnetic field is applied, which causes each tissue to produce a slightly different signal based on its location. The manipulation stage involves applying RF pulses to alter the protons alignment, producing the desired contrast. Finally, the detection stage involves measuring the RF signals emitted by the protons and converting them into a digital image. There are many different types of pulse sequences used in MRI, each of which has specific advantages and limitations. Some of the most common MRI pulse sequences include T1-weighted, T2-weighted, proton density-weighted, and diffusion-weighted imaging. Each of these pulse sequences provides different types of contrast between tissues, making them useful for diagnosing different types of conditions.

Overall, the pulse sequence used in an MRI scan plays a crucial role in determining the quality and type of image produced, making it an essential factor in the MRI imaging process. Below is the schematic diagram of the conventional spin-echo sequence.

## Spin-Echo Pulse Sequence



### Repetition Time (TR):

Repetition time (TR) is one of the fundamental MRI parameters used in the acquisition of MRI images. TR refers to the time interval between successive excitations of the tissues being imaged.

A strong magnetic field is used to align the spins of the hydrogen atoms in the body. Then, a RF pulse is applied to excite the spins and cause them to emit a detectable signal. After the signal is detected, the magnetic field is again applied to realign the spins, and the process is repeated.

TR is the time interval between two successive RF pulses. It is determined by the characteristics of the tissue being imaged and the desired image contrast. Longer TR values can improve the signal-to-noise ratio (SNR), as more time is allowed for the relaxation of spins between excitation pulses, resulting in a stronger signal.

However, longer TR values also increase the time required to acquire an image. Shorter TR values can improve temporal resolution, allowing more images to be acquired in a shorter period of time, but may result in lower SNR and poorer image quality. The optimal TR value depends on the specific imaging needs and the characteristics of the tissues being imaged.

$$TR = n \times \Delta t$$

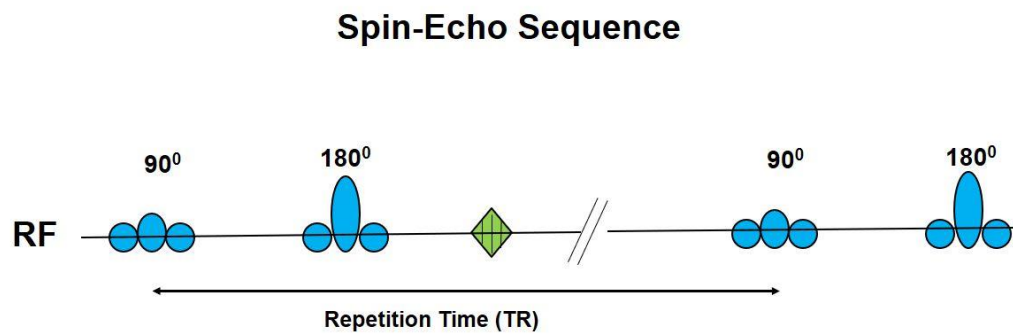
where  $n$  is an integer (usually 1 or 2), and  $\Delta t$  is the time between the start of one RF excitation pulse and the start of the next RF excitation pulse. The repetition time is used in pulse sequences where the MRI signal is measured repeatedly over time, such as in a

T1-weighted or T2-weighted sequence. In these sequences, a series of RF pulses and gradients are applied, and the MRI signal is measured at each time point.

For example, if the time between the start of one RF excitation pulse and the start of the next RF excitation pulse is 500 ms, and  $n$  is 1, then the repetition time would be:

$$TR = 1 \times 500 \text{ ms} = 500 \text{ ms}$$

This means that the RF excitation pulse would be repeated every 500 ms, and the MRI signal would be measured at each time point. The repetition time can be adjusted by changing the pulse sequence parameters, such as the timing of the RF pulses and gradients, depending on the specific imaging protocol and the clinical question being addressed. Below is the schematic diagram of the conventional spin-echo sequence with TR.



### Echo Time (TE):

Echo time (TE) is another important MRI parameter that is used to control the timing of the MRI signal acquisition. TE refers to the time between the excitation pulse and the peak of the MRI signal generated by the hydrogen atoms in the body.

After the RF excitation pulse is applied, the hydrogen atoms in the body produce a detectable signal that decays over time due to various factors such as T1 and T2 relaxation times. TE is the time interval between the excitation pulse and the time when the MRI signal is at its peak.

The TE value can be adjusted to control the image contrast and the visualization of different tissues. Tissues with short T2 relaxation times, such as fluid or fat, have a faster decay of the MRI signal, and thus require a shorter TE value to produce a maximum signal. Conversely, tissues with longer T2 relaxation times, such as muscle or bone, have a slower decay of the MRI signal and require a longer TE value to produce a maximum signal.

Therefore, the TE value is adjusted to optimize the image contrast and visualization of the specific tissues of interest. A shorter TE value can increase the contrast between tissues with different T2 relaxation times, while a longer TE value can reduce image noise and improve the visualization of structures with longer T2 relaxation times. The optimal

TE value depends on the specific imaging needs and the characteristics of the tissues being imaged.

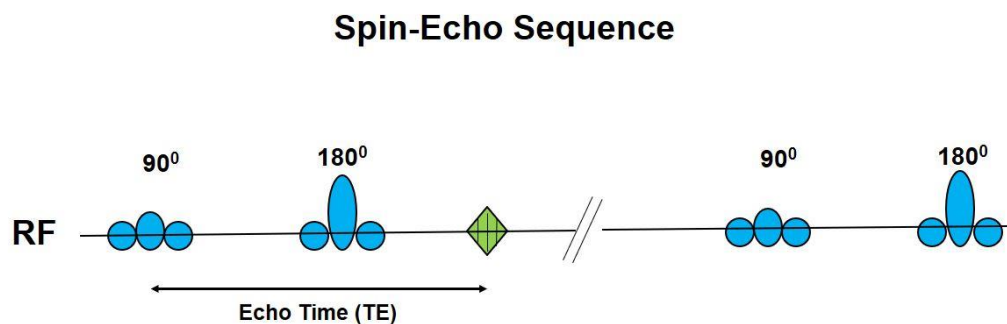
$$TE = n \times \Delta TE$$

where  $n$  is an integer (usually 1 or 2), and  $\Delta TE$  is the time between the initial RF excitation pulse and the peak of the MRI signal. The echo time is used in pulse sequences where the MRI signal is measured after the application of a gradient echo (GRE) or spin echo (SE) pulse sequence. In GRE sequences, the MRI signal is measured after a single RF pulse and a gradient is applied to generate the echo. In SE sequences, two RF pulses are applied, and the MRI signal is measured after the second pulse.

For example, if the time between the initial RF pulse and the peak of the MRI signal is 15 ms, and  $n$  is 1, then the echo time would be:

$$TE = 1 \times 15 \text{ ms} = 15 \text{ ms}$$

This means that the MRI signal would be measured 15 ms after the initial RF pulse. The echo time can be adjusted by changing the pulse sequence parameters, such as the timing of the RF pulses and gradients, depending on the specific imaging protocol and the clinical question being addressed. Below is the schematic diagram of the conventional spin-echo sequence with TE.



### Flip angle (FA):

Flip angle (FA) is an important MRI parameter that determines the angle at which the magnetic field is applied to the hydrogen atoms in the body. In MRI, a strong magnetic field is used to align the spins of the hydrogen atoms in the body. Then, a RF pulse is applied to excite the spins and cause them to emit a detectable signal. The angle at which the magnetic field is applied during the RF pulse is referred to as the flip angle.

The FA is measured in degrees and can be adjusted to control the amount of energy transferred to the hydrogen atoms during the RF pulse, which affects the strength of the MRI signal. A small FA results in a weak MRI signal, while a large flip angle results in a strong MRI signal.

A larger flip angle can improve the SNR and result in a stronger MRI signal. However, it can also cause unwanted effects such as tissue heating or saturation, which can lead to image artifacts or decreased image quality.

A smaller FA can reduce these unwanted effects but may result in a weaker MRI signal and lower SNR. The optimal flip angle depends on the specific imaging needs and the characteristics of the tissues being imaged. It is typically chosen based on factors such as the desired image contrast, the sequence type, and the magnet strength.

$$\alpha = \cos^{-1}(M_z / M_0)$$

where  $M_z$  is the longitudinal magnetization of the tissue after excitation and  $M_0$  is the equilibrium longitudinal magnetization. The FA is used in pulse sequences where the tissue magnetization is tipped away from the longitudinal axis (z-axis) using an RF pulse. The FA determines the amount of magnetization that is tipped away from the longitudinal axis, which affects the strength of the MRI signal.

For example, if the equilibrium longitudinal magnetization is 1, and the longitudinal magnetization of the tissue after excitation is 0.8, then the flip angle would be:

$$\alpha = \cos^{-1}(0.8 / 1) = 36.87 \text{ degrees}$$

This means that the RF pulse would need to have a flip angle of 36.87 degrees to achieve a longitudinal magnetization of 0.8 after excitation. The flip angle can be adjusted by changing the properties of the RF pulse, depending on the specific imaging protocol and the clinical question being addressed.

### **Inversion time (TI):**

Inversion time (TI) is another important MRI parameter that is used in some MRI sequences to selectively suppress the signal from certain tissues.

In MRI, a strong magnetic field is used to align the spins of the hydrogen atoms in the body. Then, a RF pulse is applied to excite the spins and cause them to emit a detectable signal. In some MRI sequences, a second RF pulse called an inversion pulse is applied before the excitation pulse. The inversion pulse inverts the magnetization of certain tissues, such as fat or cerebrospinal fluid, which can then be selectively suppressed in the resulting image.

TI is the time interval between the inversion pulse and the excitation pulse. It can be adjusted to selectively suppress the signal from specific tissues, based on the T1 relaxation time of the tissue. Tissues with shorter T1 relaxation times, such as white matter, require a shorter TI to achieve maximum suppression, while tissues with longer T1 relaxation times, such as gray matter or cerebrospinal fluid, require a longer TI to achieve maximum suppression.

The optimal TI value depends on the specific imaging needs and the characteristics of the tissues being imaged. It is typically chosen based on factors such as the desired image contrast and the sequence type.

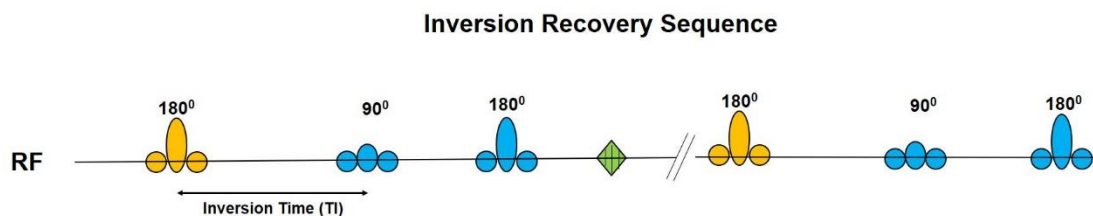
$$TI = n \times TR - T1$$

where  $n$  is an integer (usually 1 or 2),  $TR$  is the repetition time, and  $T1$  is the longitudinal relaxation time of the tissue being imaged. The inversion time is used in inversion recovery sequences, where the magnetization of the tissue is inverted and then allowed to recover before the MRI signal is measured. The inversion time determines the amount of time that the magnetization is allowed to recover before the signal is measured.

For example, if the repetition time is 2 seconds, the tissue  $T1$  is 1000 ms, and  $n$  is 1, then the inversion time would be:

$$TI = 1 \times 2 \text{ seconds} - 1000 \text{ ms} = 1000 \text{ ms}$$

This means that the magnetization is inverted and allowed to recover for 1000 ms before the MRI signal is measured. The inversion time can be adjusted by changing the repetition time, the tissue  $T1$ , or the value of  $n$ , depending on the specific imaging protocol and the clinical question being addressed. Below is the schematic diagram of the inversion recovery sequence with TI.



### Averages:

Averages or number of excitation (NEX) is an MRI parameter that refers to the number of times an MRI sequence is repeated to obtain the final image. In MRI, multiple repetitions of the same sequence can be acquired and averaged together to improve the signal-to-noise ratio (SNR) of the image. Averaging involves adding together the signals from each repetition and dividing by the number of averages to produce a final image with improved SNR. Increasing the number of averages can improve the quality of the final image, but it also increases the imaging time. The number of averages is typically adjusted based on the desired image quality and the available imaging time.

A higher number of averages can be useful in cases where there is low signal or high noise, such as in imaging small structures or in patients with metal implants. However, in



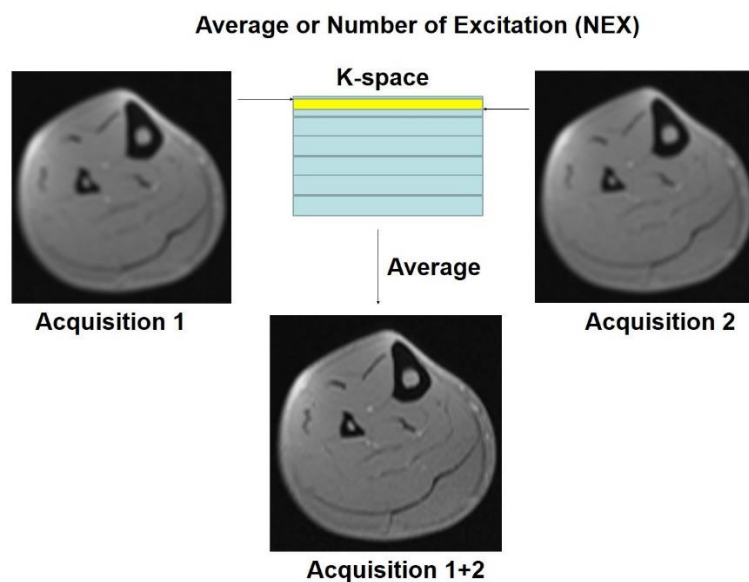
some cases, a lower number of averages may be sufficient to obtain a good quality image, especially if imaging time is limited or if the SNR is already high.

$$\text{Number of Averages} = \text{Total Acquisition Time} / \text{Repetition Time}$$

where Total Acquisition Time is the length of time required to acquire all of the MRI images in the protocol, and Repetition Time is the time between successive RF pulses. For example, if the total acquisition time is 10 minutes (600 seconds) and the repetition time is 2 seconds, then the number of averages would be:

$$\text{Number of Averages} = 600 \text{ seconds} / 2 \text{ seconds} = 300$$

This means that each MRI image in the protocol would be acquired 300 times to obtain the final image, which helps to reduce noise and improve image quality. The number of averages can be adjusted by changing the total acquisition time or the repetition time, depending on the specific imaging protocol and the clinical question being addressed.



### **Field of view (FOV):**

Field of view (FOV) is an MRI parameter that determines the size of the area being imaged. In MRI, the scanner generates a magnetic field that covers a certain area of the body. The FOV is the area within this magnetic field that is being imaged. The FOV is defined by two parameters: the readout FOV and the phase FOV. The readout FOV determines the size of the image in the direction of the frequency encoding gradient. The phase FOV determines the size of the image in the direction of the phase encoding gradient.

The choice of FOV depends on the imaging needs and the specific imaging protocol. A larger FOV can cover a larger area of the body and provide more anatomical information, but it can also result in a lower spatial resolution and longer imaging times. A smaller FOV

can provide higher spatial resolution and faster imaging times, but it may not cover the entire area of interest.

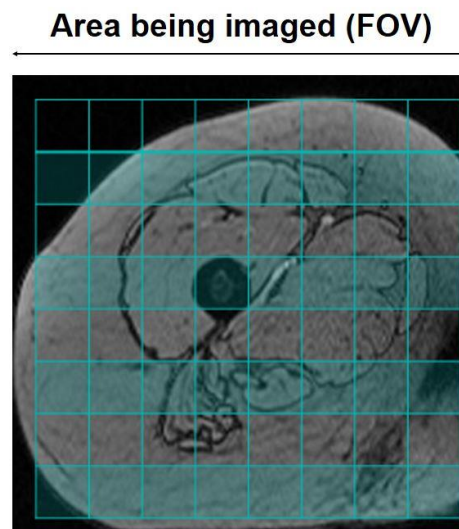
The FOV is often adjusted based on the body part being imaged, the desired spatial resolution, and the specific imaging protocol.

$$\text{FOV} = \text{Matrix} \times \text{Pixel Size}$$

where Matrix is the number of pixels in each direction, and pixel size is the size of each pixel in the image. For example, if the matrix size is 256 x 256 and the pixel size is 0.9375 mm, then the FOV would be:

$$\text{FOV} = 256 \times 0.9375 \text{ mm} = 240 \text{ mm}$$

This means that the field of view for the MRI acquisition would be 240 mm in each direction. The FOV can be adjusted by changing the matrix size or the pixel size, depending on the specific imaging protocol and the clinical question being addressed.



### **Matrix:**

Matrix is an MRI parameter that determines the number of pixels in the final image. In MRI, the signals received from the body are digitized and used to create an image matrix, which is a rectangular grid of picture elements, or pixels. The matrix is defined by two parameters: the number of rows and the number of columns. The matrix size determines the spatial resolution of the image, with higher matrix sizes corresponding to higher spatial resolution.

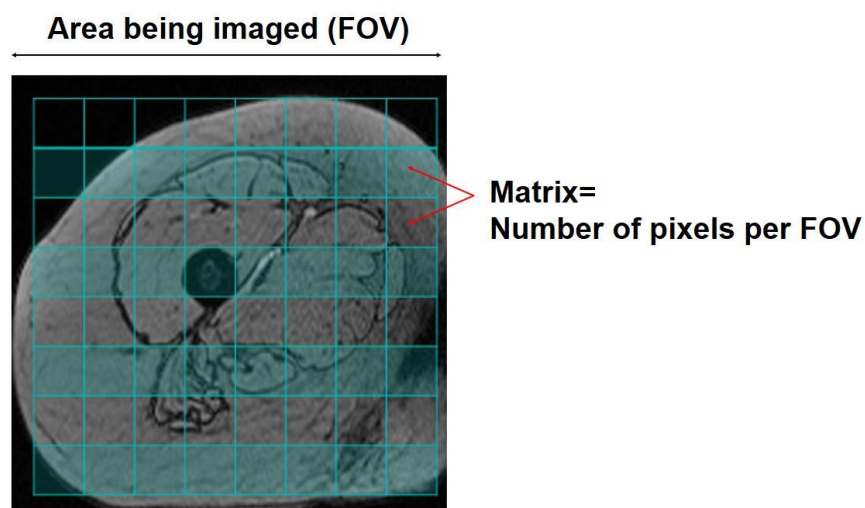
$$\text{Matrix Size} = \text{FOV} / \text{Pixel Size}$$

where FOV is the field of view, and Pixel Size is the size of each pixel in the image. For example, if the FOV is 240 mm and the pixel size is 0.9375 mm, then the matrix size would be:

$$\text{Matrix Size} = 240 \text{ mm} / 0.9375 \text{ mm} = 256 \text{ pixels}$$

This means that the MRI acquisition would have a matrix size of 256 x 256 pixels. The matrix size can be adjusted by changing the FOV or the pixel size, depending on the specific imaging protocol and the clinical question being addressed. The choice of matrix size depends on the imaging needs and the available imaging time. Higher matrix sizes can produce images with better spatial resolution, but they also require longer imaging times and may have lower SNR. Lower matrix sizes may have faster imaging times and higher SNR, but the resulting image may have lower spatial resolution.

The matrix size is often adjusted based on the body part being imaged, the desired spatial resolution, and the specific imaging protocol.



### Resolution:

Resolution is an MRI parameter that refers to the level of detail that can be seen in an MRI image. In MRI, resolution is determined by the number of pixels in the image and the size of the pixel, which is determined by the field of view (FOV) and the matrix size. A larger matrix size and a smaller FOV result in a higher resolution image, while a smaller matrix size and a larger FOV result in a lower resolution image. The choice of resolution depends on the imaging needs and the specific imaging protocol. Higher resolution images are useful for identifying small structures and subtle changes, while lower resolution images are useful for visualizing larger structures and providing a broader overview.

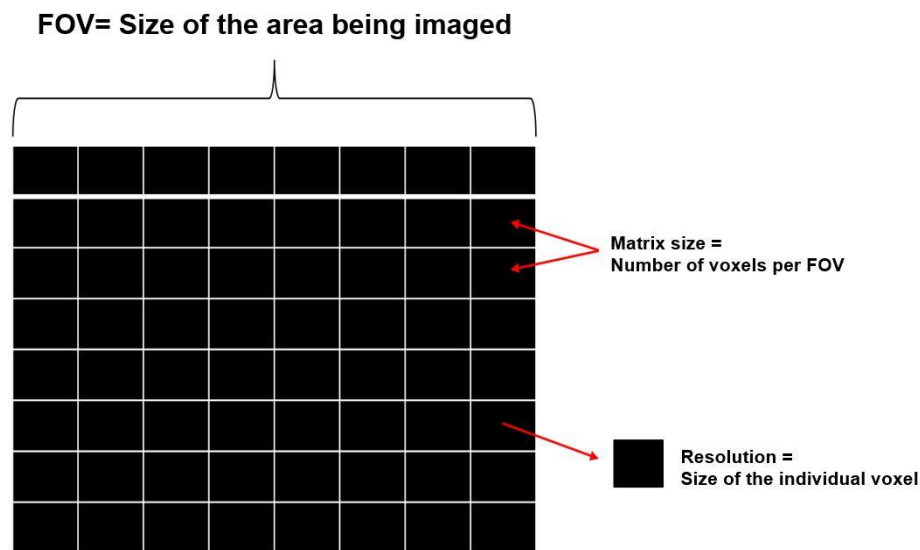
The resolution is often adjusted based on the body part being imaged, the desired spatial resolution, and the specific imaging protocol. The resolution can be adjusted during the MRI sequence to optimize the image quality. The resolution is typically measured in units of distance per pixel, such as millimeters per pixel or micrometers per pixel.

$$\text{Resolution} = \text{FOV} / \text{Matrix Size}$$

where FOV is the field of view, which is the size of the region being imaged and Matrix Size is the number of pixels in the image. For example, if the FOV is 20 cm and the matrix size is 256 x 256, then the resolution would be:

$$\text{Resolution} = 20 \text{ cm} / 256 = 0.078 \text{ cm per pixel}$$

This means that each pixel in the image represents an area of 0.078 square centimeters, which determines the level of detail that can be seen in the image.



### **Slice Thickness:**

Slice thickness is an MRI parameter that determines the thickness of each slice in the volume of the imaged tissue. In MRI, images are acquired in slices, with each slice representing a thin section of the imaged tissue. The thickness of the slice is determined by the slice selection gradient applied during the MRI sequence.

The choice of slice thickness depends on the imaging needs and the specific imaging protocol. A thinner slice thickness can provide higher spatial resolution and more detailed images, but it may also result in longer imaging times and lower SNR. A thicker slice thickness can provide faster imaging times and higher SNR, but it may also result in lower spatial resolution and less detailed images. The slice thickness is often adjusted based on the body part being imaged, the desired spatial resolution, and the specific imaging protocol. For example, brain imaging typically uses slice thicknesses in the range of 1-5mm, while imaging of the spine or joints may use thicker slices of 3-6mm or more.

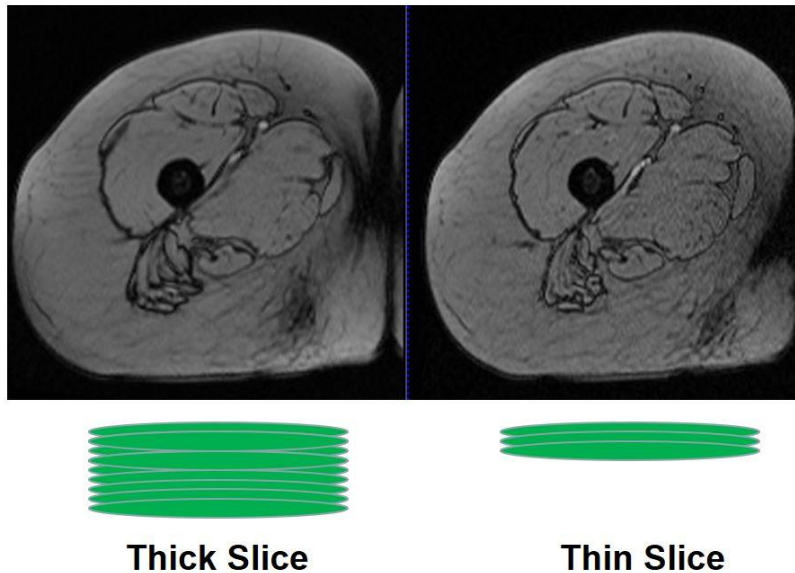
$$\text{Slice Thickness} = \text{FOV} / \text{Matrix} * (\text{Percentage of field of view})$$

where FOV is the field of view, Matrix is the number of pixels in each direction, and Percentage of field of view is the percentage of the FOV that is covered by the slice. For example, if the FOV is 200 mm, the matrix size is 256 x 256, and the percentage of field of view covered by the slice is 100%, then the slice thickness would be:

$$\text{Slice Thickness} = 200 \text{ mm} / 256 \text{ pixels} * 1 = 0.78 \text{ mm}$$

This means that each slice would have a thickness of 0.78 mm. The slice thickness can be adjusted by changing the FOV, matrix size, or percentage of field of view covered by the slice, depending on the specific imaging protocol and the clinical question being addressed. Please find below the figure that compares the thick and thin slices.

### **Slice Thickness**



### **Slice gap:**

A slice gap is an MRI parameter that determines the distance between adjacent slices in a volume of the imaged tissue. In MRI, images are acquired in slices, with each slice representing a thin section of the imaged tissue. The slice gap is the distance between the top of one slice and the bottom of the next slice. The choice of slice gap depends on the imaging needs and the specific imaging protocol. A larger slice gap can result in faster imaging times, but it may also result in missed or incomplete image information between adjacent slices. A smaller slice gap can provide more complete image information, but it may also result in longer imaging times.

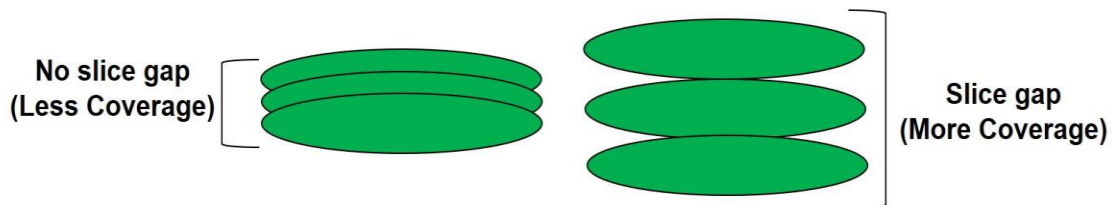
The slice gap is often adjusted based on the body part being imaged, the desired spatial resolution, and the specific imaging protocol. For example, a slice gap of 0-2mm may be used in brain imaging to ensure that there is no missing information between slices, while a larger slice gap of 5-10mm may be used in body imaging to reduce the imaging time.

$$\text{Slice Gap} = \text{Slice Thickness} + \text{Gap between slices}$$

where slice thickness is the thickness of the slices being acquired, and gap between slices is the distance between the centers of adjacent slices. For example, if the slice thickness is 5 mm and the gap between slices is 1 mm, then the Slice Gap would be:

$$\text{Slice Gap} = 5 \text{ mm} + 1 \text{ mm} = 6 \text{ mm}$$

This means that there would be a 6 mm distance between the centers of adjacent slices during the scan. The slice gap can affect the accuracy of the resulting MRI images, as well as the amount of time required to acquire the data. A smaller slice gap may result in higher accuracy but a longer scan time, while a larger slice gap may result in lower accuracy but a shorter scan time. The optimal slice gap depends on the specific imaging protocol and the clinical question being addressed.



### Phase encoding:

Phase encoding is an MRI parameter that determines the position of each pixel in the phase-encoding direction of an MRI image. In MRI, images are constructed from a series of signals that are acquired through multiple steps. During the phase encoding step, the magnetic field gradients are applied to the tissue being imaged in a direction perpendicular to the frequency encoding direction. This results in each pixel having a unique phase shift that corresponds to its position in the phase-encoding direction.

The choice of phase encoding parameters depends on the imaging needs and the specific imaging protocol. The number of phase encoding steps determines the resolution of the image in the phase-encoding direction, with more steps resulting in higher resolution but also longer imaging times. The direction and orientation of the phase encoding gradient also affects the image quality and should be chosen carefully based on the body part being imaged and the desired spatial resolution.

The phase encoding is often adjusted based on the body part being imaged, the desired spatial resolution, and the specific imaging protocol. During the imaging process, the phase encoding is varied for each slice, resulting in a series of images that can be combined to produce a full 3D volume of the imaged tissue.

$$PE = Gy * t$$

where PE is the phase encoding gradient, Gy is the strength of the gradient in the phase encoding direction, and t is the duration of the gradient pulse. The phase encoding



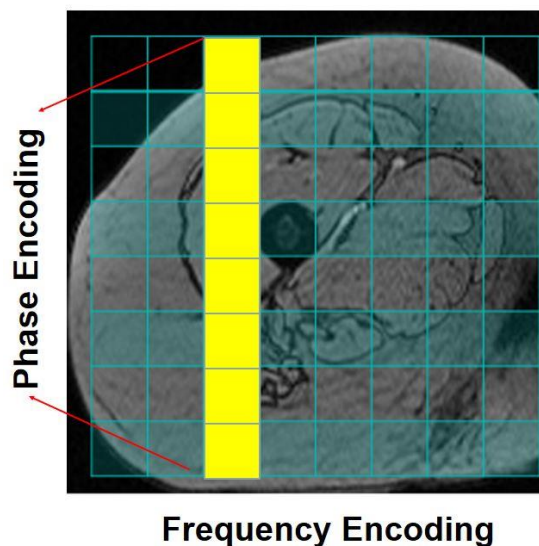
gradient is one of the three magnetic field gradients used in MRI to encode spatial information into the MRI signal. The strength and duration of the gradient determine the position of the signal along the phase encoding direction, which is perpendicular to the frequency encoding direction and the slice selection direction.

The phase encoding gradient is typically applied multiple times during an MRI sequence to acquire data from different positions along the phase encoding direction. The total number of phase encoding steps is determined by the resolution in the phase encoding direction and the size of the field of view.

The formula for the total duration of the phase encoding gradient is:

$$TE = PE \text{ steps} * PE \text{ dwell time}$$

where TE is the total duration of the phase encoding gradient, PE steps is the number of phase encoding steps, and PE dwell time is the time between phase encoding gradient pulses. The duration of the phase encoding gradient affects the scan time and image quality of the MRI, and it can be adjusted to optimize the balance between these factors for a given imaging protocol.



### **Bandwidth:**

Bandwidth is an MRI parameter that determines the range of frequencies that can be detected during the imaging process.

In MRI, the magnetic field gradients are used to encode spatial information into the MRI signal. The bandwidth of the MRI sequence determines the range of frequencies that can be encoded into the signal, which affects the spatial resolution and SNR of the resulting images. A higher bandwidth allows more frequencies to be detected, resulting in higher spatial resolution and lower SNR. Conversely, a lower bandwidth allows fewer frequencies to be detected, resulting in lower spatial resolution and higher SNR. The

choice of bandwidth depends on the imaging needs and the specific imaging protocol. For example, a higher bandwidth may be used for imaging small structures with high spatial resolution, while a lower bandwidth may be used for imaging large structures with lower spatial resolution but higher SNR.

The bandwidth is often adjusted based on the body part being imaged, the desired spatial resolution, and the specific imaging protocol. It is typically measured in Hertz (Hz) and can be adjusted during the MRI sequence to optimize the image quality.

$$\text{Bandwidth} = \text{Frequency Range} / \text{Number of Frequency Bins}$$

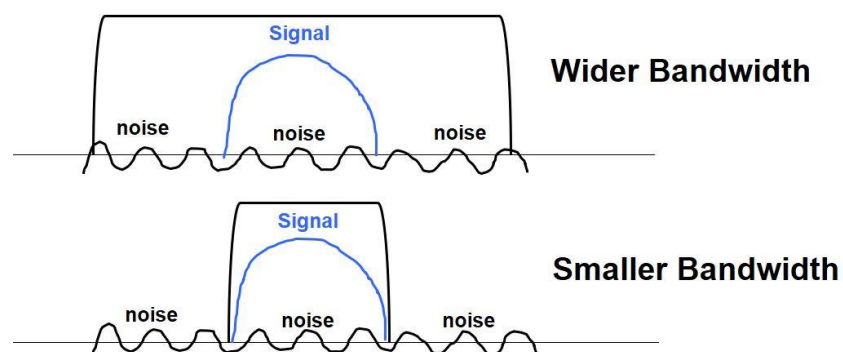
where the frequency range is the range of frequencies being measured by the MRI scanner and the number of frequency bins is the number of digital samples used to represent the frequency range. The frequency range is determined by the strength of the magnetic field used in the MRI and the type of imaging sequence being used. The number of frequency bins is determined by the receiver bandwidth, which is a parameter that can be set by the MRI operator.

For example, if the frequency range is 100 kHz and the number of frequency bins is 512, then the bandwidth would be:

$$\text{Bandwidth} = 100 \text{ kHz} / 512 = 195.3 \text{ Hz per frequency bin}$$

This means that each frequency bin represents a range of 195.3 Hz, which determines the level of frequency detail that can be detected in the MRI signal. The bandwidth can be adjusted to optimize the SNR and spatial resolution of the resulting MRI images.

### SNR Vs. Bandwidth



### Conclusion:

MRI parameters play a critical role in optimizing MRI scans to achieve the best possible image quality, tissue contrast, and functional information, while also ensuring patient safety. MRI scanners can adjust various parameters, such as echo time (TE), repetition



time (TR), flip angle, and inversion time (TI), among others, to optimize the image acquisition process. These adjustments can improve the image quality, make it easier to interpret the images, and allow for the detection of smaller abnormalities. Moreover, different MRI sequences can be combined to achieve optimal imaging results for specific tissues, organs, or pathologies. Ultimately, proper selection and optimization of MRI parameters can significantly improve the diagnostic accuracy and safety of MRI examinations.

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