Ministry of Higher Education and Scientific Research
Al-Mustaqbal University College
Radiological Techniques Department

Radiological Equipment Techniques

Al-Mustaqbal University College

3rd Class

Radiological Techniques Department

By

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MS.C. Theoretical Physics

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Lecture 7: Slice Thickness and NEX

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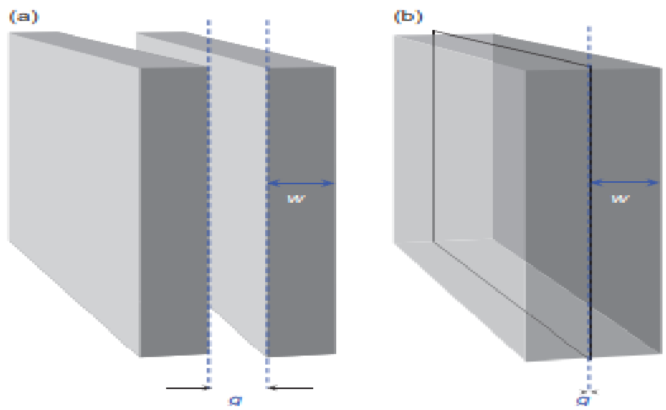
Inter-slice gap

Due to imperfections in the RF pulses we usually have to introduce a slice gap to separate the slices. This is measured as the distance between the slice edges. we generally try to keep the slice gap to a minimum, since tissues in the gap are not imaged at all.

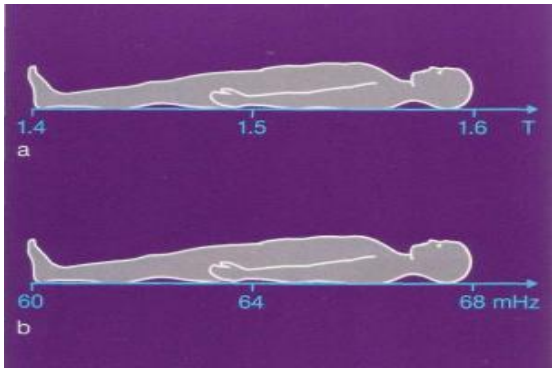


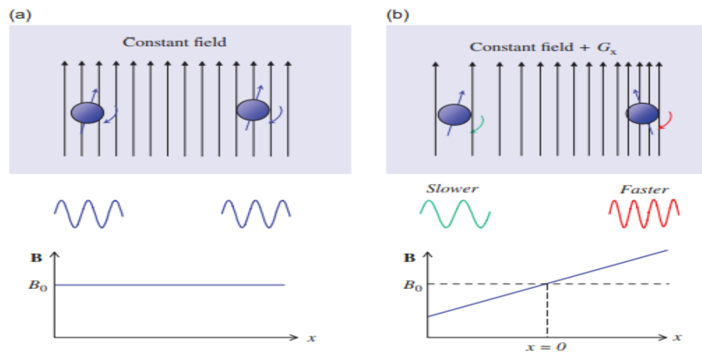
The RF pulse for one slice also excites protons in adjacent slices. Such interference is known as cross-talk. That is, when radio frequency pulse for one slice stimulates protons in the adjacent slices. This will lead to a reduction SNR.

Matrices are two types:

- Coarse matrices: a matrix that results in a low number of pixels in the field of view.
- Fine matrices: matrix that results in a large number of pixels in the field of view.

An example of a coarse matrix is 128 × 128, whereas a fine matrix is 512 × 512.



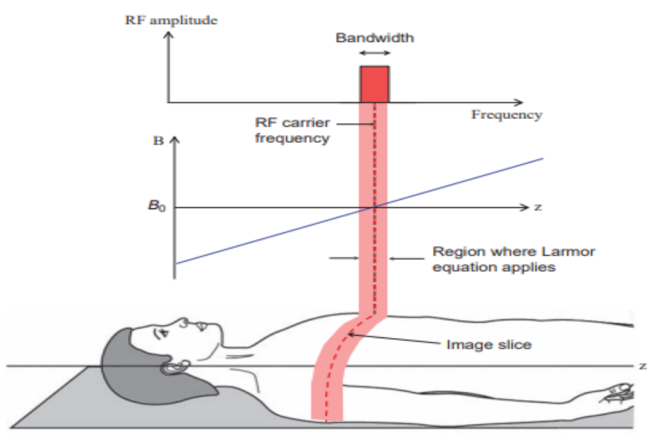


- ➢ The resulting magnetic field strength is increasing from 1.4 Tesla at the feet, to 1.6 Tesla at the head. As magnetic field strength and precessing/resonant frequency are directly correlated (Larmor equation), the resonant frequency at the feet is about 60 mHz,
- ➢ while it is about 68 mHz at the top of the head in our example. By selecting a certain RF pulse frequency we determine the location of the slice which we examine.

Slice Thickness

To give each slice a thickness, a “band” of nuclei are excited by the RF excitation pulse (and rephased by the RF rephasing pulse in spin-echo pulse sequences).

- Selective excitation of an image slice by applying a shaped RF pulse and a field gradient at the same time



The slice thickness is governed by the following equation:

$$thk = \frac{BW_{trans}}{\gamma_0 . G_s}$$

Where;

thk is the slice thickness,

BW_{trans} is the transmitted RF bandwidth (the range of frequencies it covers),

is the gyromagnetic ratio and

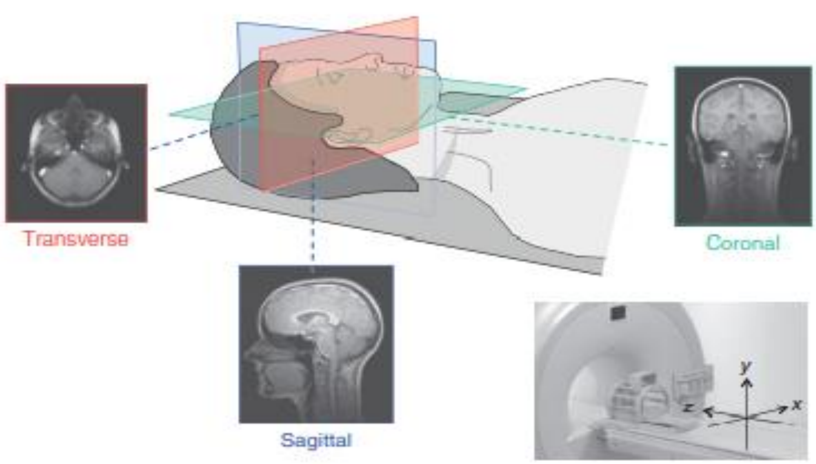
G_s is the magnitude of the slice selection magnetic field gradient.

For example: using a gradient magnetic field strength of ($10mTm^{-1}$), the transmitted RF pulse bandwidth would be about 4.3 kHz (using γ_0 = 42.58 MHz T^{-1}).

<u>The slice thickness can be determined by:</u>

1. the steepness of the slope of the gradient field (Gs) and
2. the bandwidth of the 90o RF-pulse

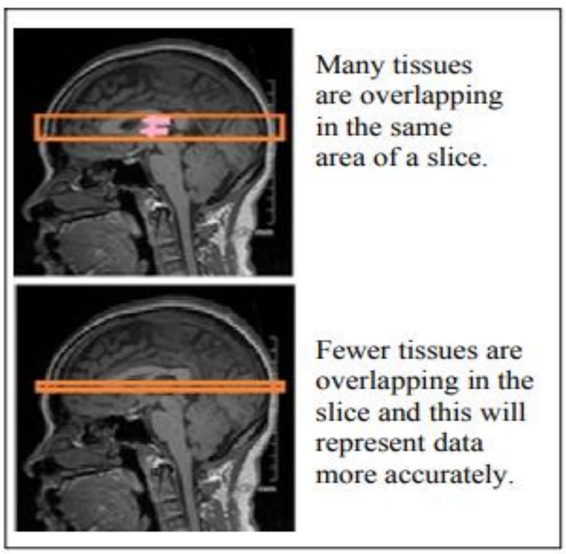
The slice select gradient (Gs) is a magnetic field gradient applied to select the slice position in the direction of this gradient.



- If we increase our slice thickness, we will be including many more types of tissues in to our slice. This may cause an image blurring artifact called partial voluming artifact.

For example, if we were to have tissue associated with cerebral spinal fluid (CSF) and brain tissue within one slice, areas where these structures overlap will be blurred because each will produce different signal intensity.

- By decreasing our slice thickness, we will be creating a more detail and better representation of the anatomy that we are sampling.
- Thinner slices will decrease the size of our voxel size. Smaller voxels will increase our resolution.

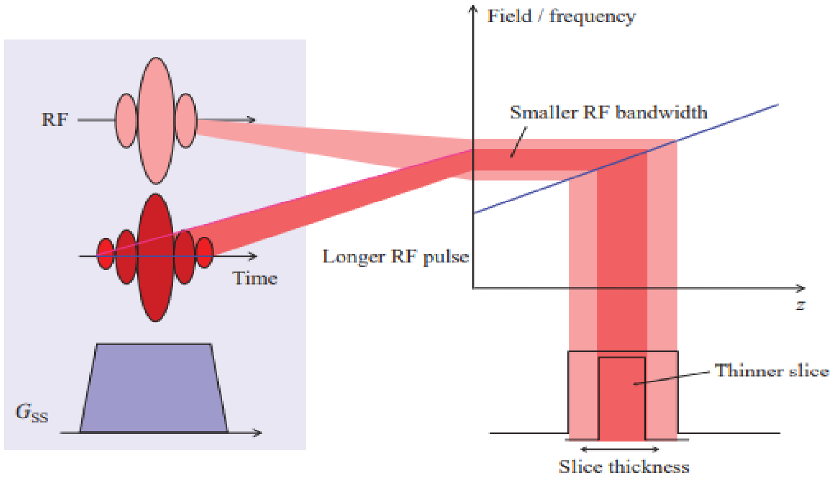


- Therefore, as mentioned previously, a typical slice thickness is 2-10 mm

Bandwidth

The RF excitation pulse contains the same range of frequencies to match the difference in precessional frequency.

Large bandwidth = large range of frequencies = larger slice

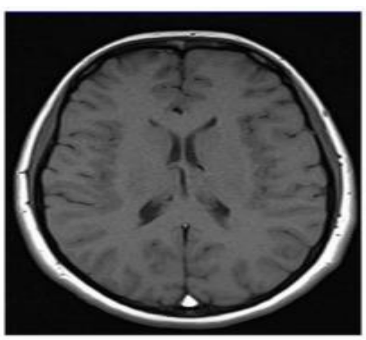


we can use a narrower RF pulse bandwidth. According to Fourier theory, this means using a longer duration RF pulse. can have a thinner slice but it will take longer to excite

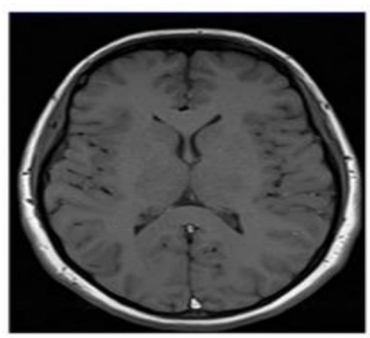
Receive Bandwidth

A range of frequencies is mapped across the FOV in the frequency direction.

Increasing receiver bandwidth reduces the SNR.



Receiver bandwidth 260
TR 350
TE 14
Good SNR

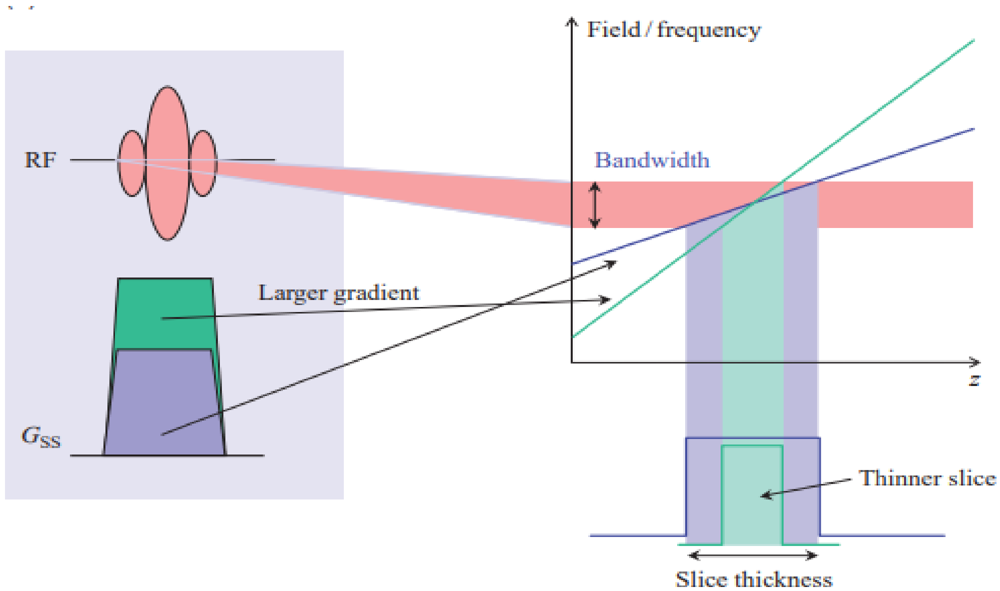


Receiver bandwidth 130
TR 350
TE 14
Very high SNR

Gradient Strength

if we use the same range of radio frequencies, the same band width as it is called, slice thickness can be modified by the slope of the gradient field

A **stronger gradient** will result in **a thinner slice**



Number of Acquisitions

The number of excitations (NEX) or number of signal averages (NSA) denotes how many times a signal from a given slice is measured.

- As there are more data in each line, the resultant image has a higher signal-to-noise ratio
- Increasing the NEX also increases the scan time and allow motion artifacts to appear on the images.