Module 6: Slice Selection
Slice Selection

Objectives

...Draw a PSD that illustrates the relationship between the slice selective gradient and application of RF.

…Identify the scan timing parameters of TE and TR on an SE PSD.

...Identify the effects cross-talk has on image quality.
Gradients

- slice selection
- phase encoding
- frequency encoding
Spin Echo PSD

RF

Gz

Gy

Gx

90

180

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Training in Partnership
Slice selection

RF

Gz

Slice Planes

Z=axial  Y=Coronal  X=Sagital
Transmit Bandwidth

- Transmit bandwidth along with gradient slope control slice thickness
- We can only acquire one slice thickness during an acquisition
Slice selection

- .49995 T, 21.263715 mHz
- .5000 T, 21.285000 mHz
- .5004 T, 21.302028 mHz

ISOCENTER
Slice selection

Gz
Cross Talk

- Slice interval or gap is the distance between each slice measured from the center of one slice to the center of the next slice.
- Cross-talk occurs when protons bordering a slice become excited during slice excitation. As a result of this cross-excitation, the transverse magnetization is saturated when the protons in the bordering slice are excited.
- There is a SNR and contrast loss resulting from cross talk.
Cross Talk

Two ways to minimize cross talk:

1. Multiple acquisitions

Order of excitation

2. Use an interscan spacing

Order of excitation
1. Describe how the system selectively excites protons at unique locations.

2. What determines the thickness of the slice?

3. Describe what causes cross talk.

4. What image quality characteristic is affected by cross talk?

5. How can cross talk be minimized?
Progress Check

Slice Spacing change

Image A: Spacing = 0

Image B: Spacing = 2 mm

Image C: Spacing = 5 mm

SNR:
Contrast:
Spatial resolution:
Time:
Gradients: Slice Selection

11. X-talk SNR

Solutions:
- Interleave
- Gap
- 3D

12. Thinner slices can potentially:

- FOV minimum
- Minimum TE
- # of slices
Module 7: Spatial Encoding
Spatial Encoding

Objectives

... Describe the order the gradients are applied in a pulse sequence.

... Identify the change in scan time that will occur when phase steps or NEX are changed.

... Identify the change in spatial resolution that occurs when the frequency axis changes.
Gradients

- slice selection
- phase encoding
- frequency encoding
Spin Echo PSD

RF

Gz

Gy

Gx
Phase Encoding

prior to phase encode

phase encode

post phase encode
Phase Encoding

- Maximum positive amplitudes
- Minimum positive amplitudes
- Minimum negative amplitudes
- Maximum negative amplitudes

Amplitude and/or polarity vary with every TR
K-space
9 K-space / Gradient amplitude

High amplitude gradient

Edge detail

Outer edges of k-space

Low amplitude gradient

Highest SNR

Middle of k-space
Spatial Encoding

Slice

Gz

Phase

Gy
Gradients

- slice selection
- phase encoding
- frequency encoding
9 Frequency Encoding

X gradient
spin coherence
in phase
echo
Spatial Encoding

Slice

Gz

Gy

Frequency

Phase

Gx

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Gradient Slope

- Both the FOV and the slice thickness affect the gradient slope. A steeper slope results when the gradients have more current flowing through them. More current results in more heat and increased minimum TE.
- Smaller FOV’s, thinner slices, and higher matrix values stress the gradient system.

Fourier Transform

- Used to reconstruct an image from the set of encoded MRI signals.
- It changes the signal from a frequency/time domain to a frequency/amplitude domain.
Spin Echo PSD

RF

Gz

Gy

Gx
1. When is the phase encoding gradient applied relative to the slice gradient?

2. A steep slope to the phase gradient produces a signal with __________ signal and __________ spatial information.

3. A steep slope to the frequency gradient produces a __________ FOV.

4. The center lines of k-space represent signals that primarily contribute to the image __________.

5. As the frequency matrix increases, the SNR __________ and the spatial resolution __________.

6. As the NEX increases, the SNR __________ and the spatial resolution ________.
Progress Check

Order the sequence of events for a SE pulse sequence:

- Second slice selective gradient within the TR period
- 90 RF excitation pulse
- Slice selective gradient
- Raw data to K-space
- 180 RF refocusing pulse
- Spin echo forms sampled
- Readout window begins
- Phase encoding gradient applied

Let’s review the Take-Away before film activity
Progress Check

Frequency Matrix Change

Image A: Frequency = 256

Image B: Frequency = 512

SNR:
Spatial resolution:

Contrast:
Time:
# of slices:
Progress Check

Phase Matrix Change

Image A: Phase = 160
Image B: Phase = 192
Image C: Phase = 256

SNR:

Spatial resolution:

Contrast:

Time:
Phase FOV (PFOV) Change

Image A: PFOV = 0.5

Image B: PFOV = 0.75

Image C: PFOV = 1

SNR:
Contrast:
Spatial resolution:
Time:
Gradients: Spatial Encoding

13. Scan Parameter tradeoffs

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Conditional: It is dependent on Square Pixel selection.

14. Phase matrix considerations

1. Anatomy outside FOV wraps

2. Motion projected in phase

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