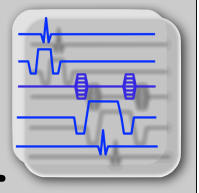


Principles of MRI

EE225E / BIO265

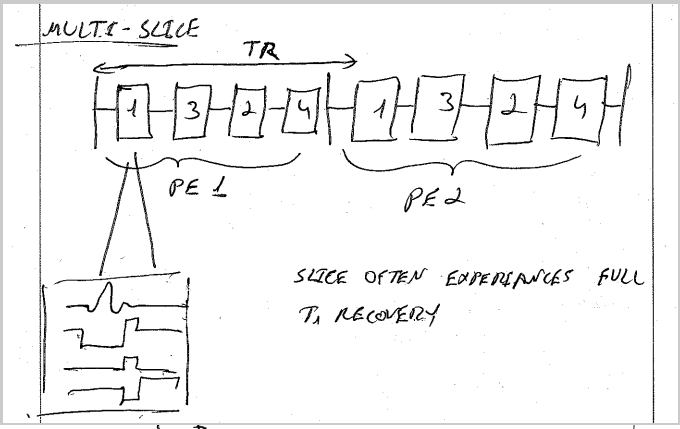
Lecture 20

Instructor: Miki Lustig
UC Berkeley, EECS

Chapter 8

- Volumetric Imaging
  - Multi-slice
  - RF-ecoding (Hadamard)
  - 3D Fourier Encoding

MULTI-SLICE



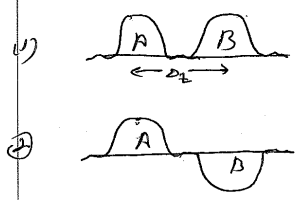
SLICE OFTEN EXPERIENCES FULL T_1 RECOVERY

- THROUGHPUT INCREASES
- ~~SNR~~ SNR EFFICIENCY ~~NOT~~ SAME
- M_0 RECOVERY ↑ SNR
- HARD TO CREATE VERY SELECTIVE SLICES → LOW SLICE RES.

RF HADAMARD ENCODING

① $B = 2B_1(t)\cos(2\pi\Delta f t)\hat{i}$

② $B = 2B_1(t)\sin(2\pi\Delta f t)\hat{j}$



① + ② = A

① − ② = B

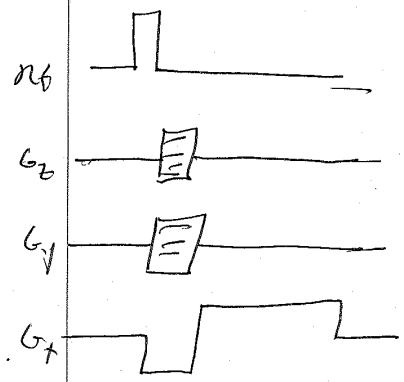
- SLICE SELECTIVITY AN ISSUE
- RF POWER.
- CROSS TALK.

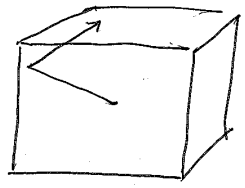
} ESPECIALLY FOR HIGHER ORDER HADAMARD.

LIKE 2 AVERAGES: $SNR = \sqrt{2}\,SNR_{single\ slice}$

3D

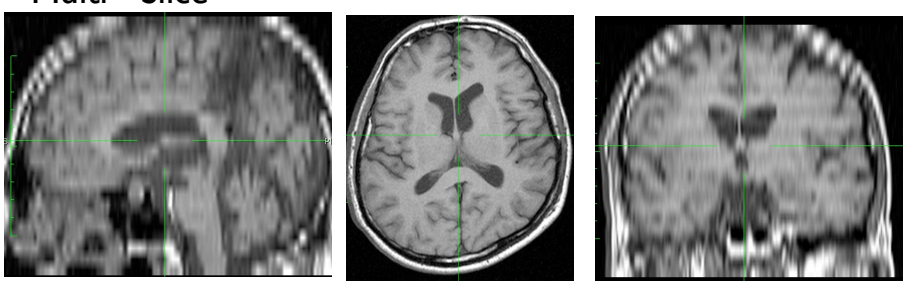
- ADD gradient in z (phase encode)
- POTENTIALLY DROP SLICE SELECT



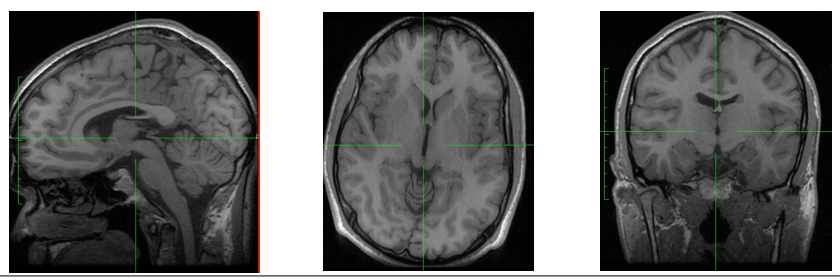


- PROVIDED THIN CONTIGUOUS SLICES
- SNR ~ $\sqrt{N_{PE} N_{PE}}$ compared to $\sqrt{N_{PE}}$ for 2D.
- MORE SUSCEPTIBLE TO MOTION
- LONG SCAN TIME
- OFTEN SHORT-TR! LONG TR → INEFFICIENT
- DYNAMIC RANGE CAN BE PROBLEM.

Multi - Slice

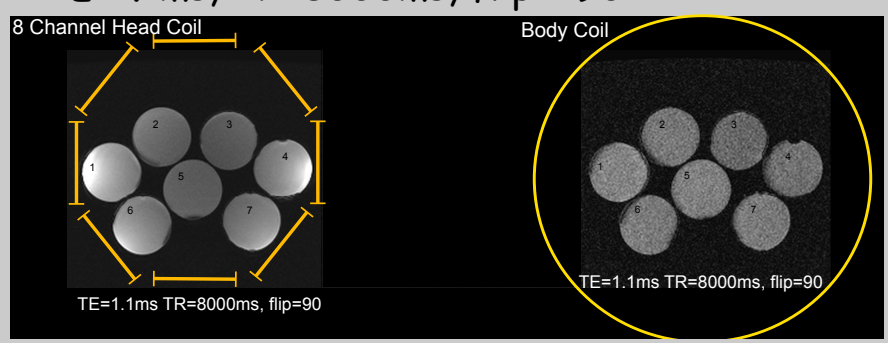


3D



From 2nd midterm 2011

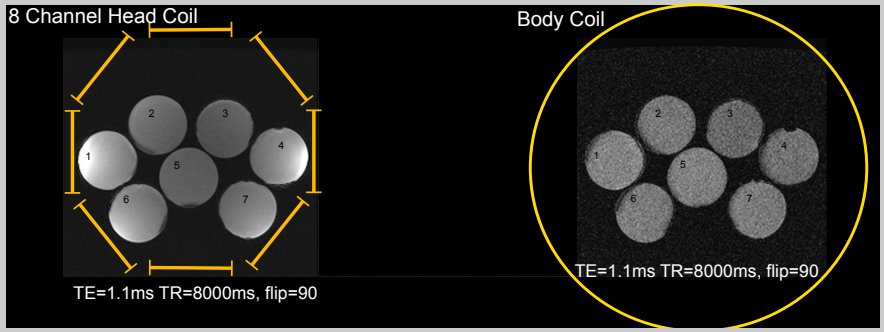
- TE=1.1ms, TR=8000ms, flip = 90



- What is the dominant source of contrast in the body coil image?

From 2nd midterm 2011

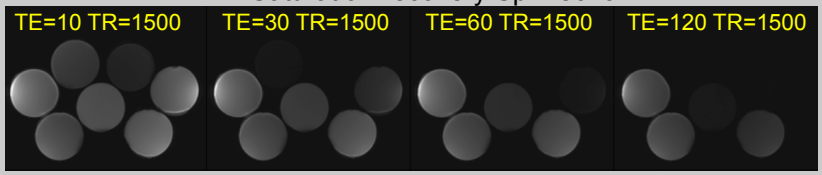
- TE=1.1ms, TR=8000ms, flip = 90



- What are the differences between the images, and what are the sources?

Saturation Recovery Spin-Echo

Saturation-recovery Spin-echo



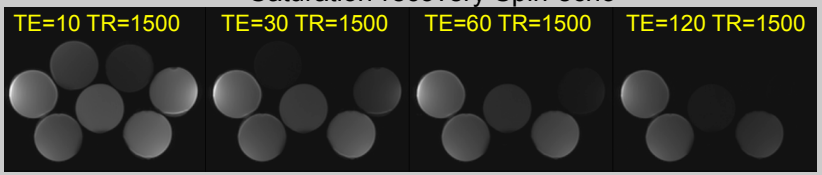
What are the T2's ?

6ms
12ms
30ms
50ms
100ms
250ms
600ms

1 T1 = T2 = 250
2 T1 = T2 =
3 T1 = T2 =
4 T1 = T2 =
5 T1 = 700 T2 =
6 T1 = T2 = 600
7 T1 = 1000 T2 =

Saturation Recovery Spin-Echo

Saturation-recovery Spin-echo



What are the T2's ?

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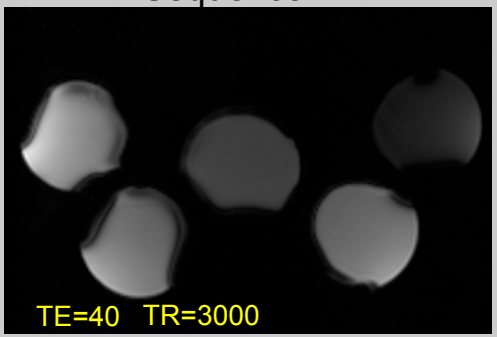
1 T1 = T2 = 250
2 T1 = T2 = 12
3 T1 = T2 = 6
4 T1 = T2 = 30
5 T1 = 700 T2 = 50
6 T1 = T2 = 600
7 T1 = 1000 T2 = 100

What is this sequence?

Sequence = ?



What is this sequence?

Sequence = ?