

Bioengineering 208 Magnetic Resonance Imaging

Winter 2007
Lecture 2

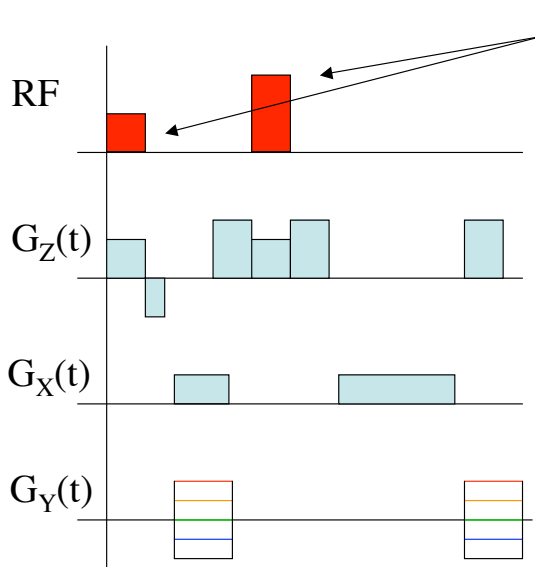
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Topics

- The basic spinwarp pulse sequence
 - Slice Selection
 - Frequency Encoding
 - Phase Encoding
 - Other pulses
- Basic image contrast
 - Proton Density
 - T_1
 - T_2

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Spin-Warp Pulse Sequence

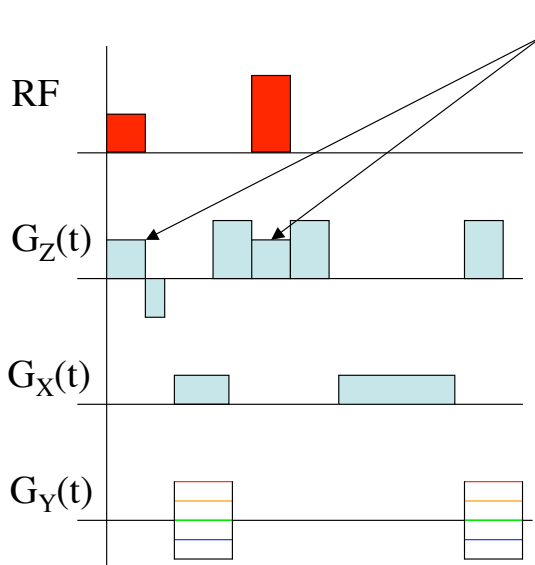


RF pulses

- What for?
 - 90°: Tip $M_Z \rightarrow M_{XY}$
 - 180°: Refocus resonance offsets
- How Big?
 - $\alpha = \gamma \int B_1 dt$
- What Shape?
 - $\sim \text{FT}(\gamma G_z \text{ slice profile})$

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Spin-Warp Pulse Sequence

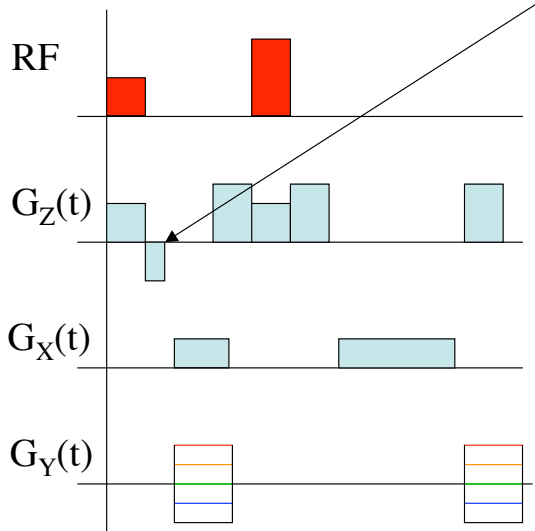


Slice Select Gradients

- What for?
 - Map space into frequency during RF pulses
- How Big?
 - $G_z = \frac{RF_bandwidth}{\gamma(slice_thickness)}$
- What Shape?
 - Typically flat during RF pulse

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Spin-Warp Pulse Sequence

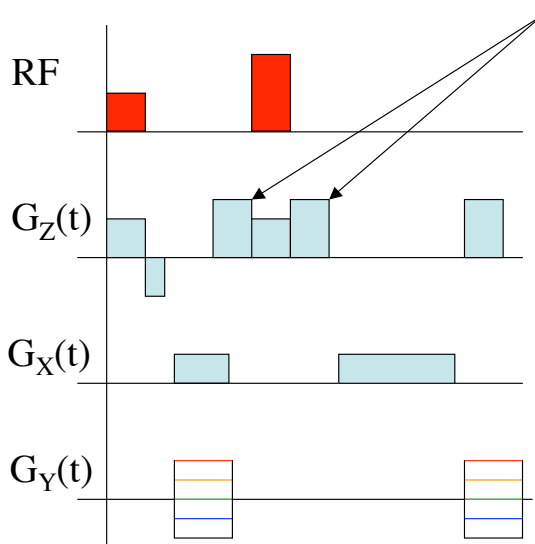


Slice Refocussing Gradient

- What for?
 - Rewind magnetization that was dephased by the second half of the slice select gradient
- How Big?
 - Half the area of the slice select gradient
- What Shape?
 - Only the area matters

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Spin-Warp Pulse Sequence

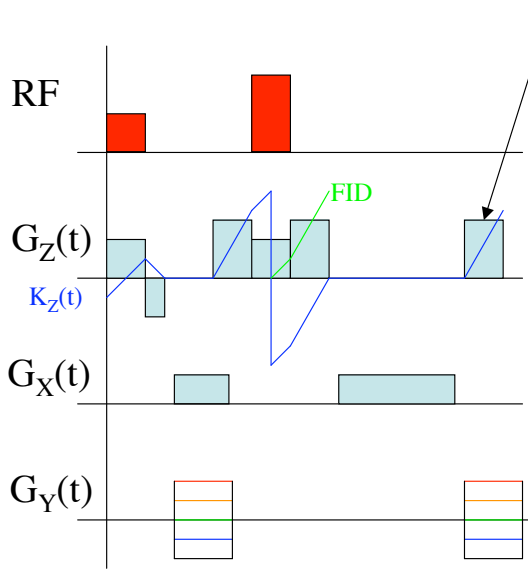


Crusher Gradients

- What for?
 - Right one destroys FID from imperfect 180°
 - Left one required to balance right one
- How Big?
 - $FID \propto \int M_z(z) e^{i\gamma z \int G_z dt} dz$
 - Want several phase wraps across slice
- What Shape?
 - Only the area matters

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Spin-Warp Pulse Sequence

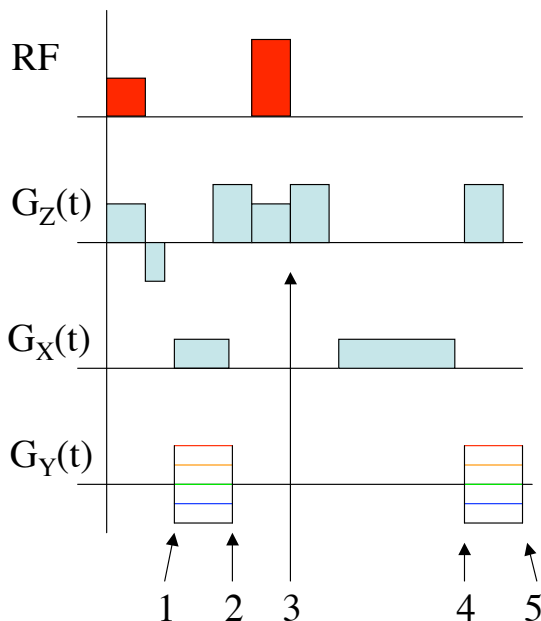


Killer Gradient

- What for?
 - Destroy residual transverse magnetization prior to next TR
- How Big?
 - Same criteria as Crushers:
 - Want several phase wraps across voxel
- What Shape?
 - Only the area matters

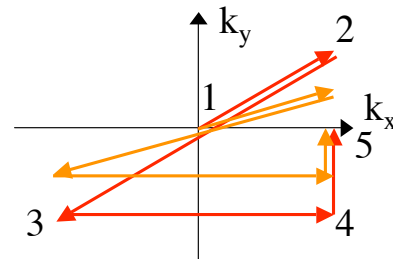
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Spin-Warp Pulse Sequence



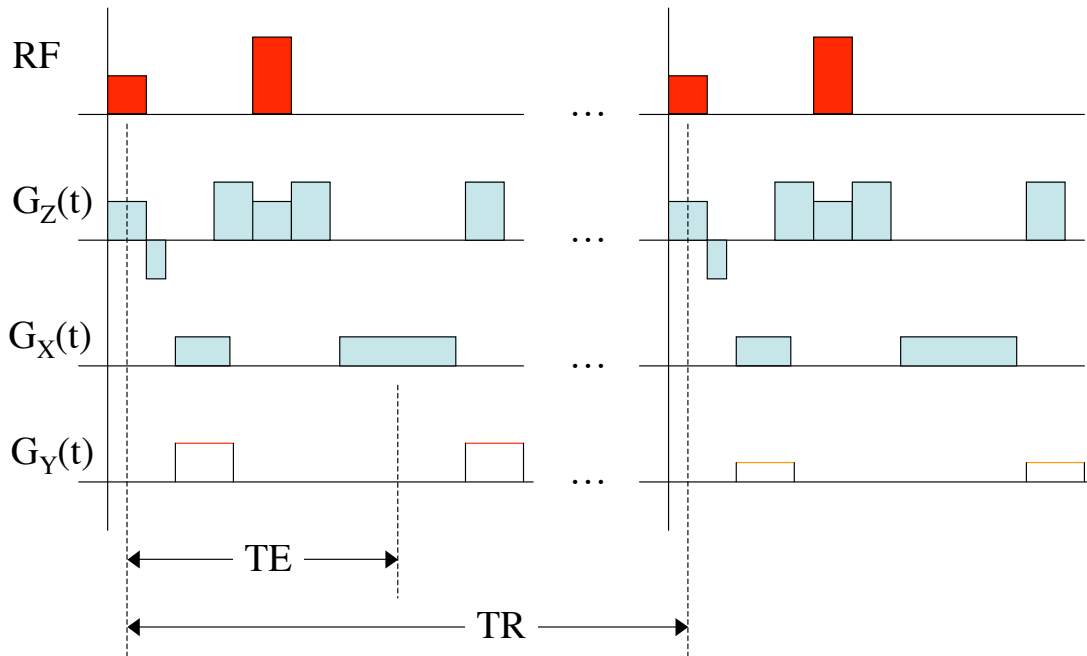
XY Imaging Gradients

- What for?
 - Sample $K(= \gamma \int Gdt)$ space
- Frequency encode:
 - $G_x = \frac{\text{Acquisition_Bandwidth}}{\gamma(\text{FOV})}$
- Phase encode:
 - Only the area matters
 - Phase rewinder leaves phase consistent across phase encodes



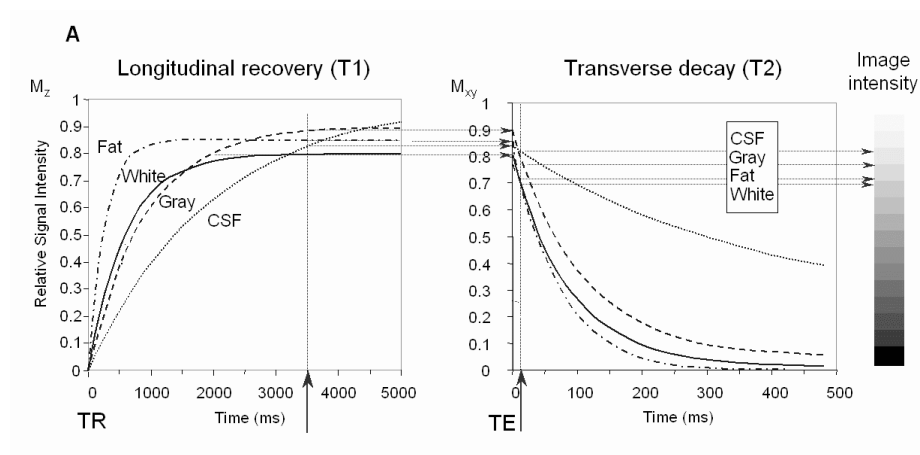
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Spin-Warp Pulse Sequence

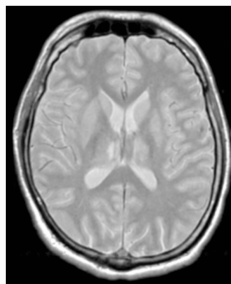


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Image Contrast - Proton Density

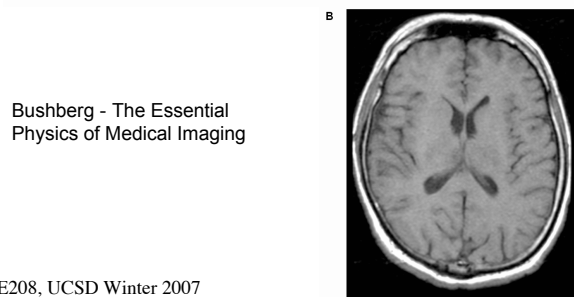
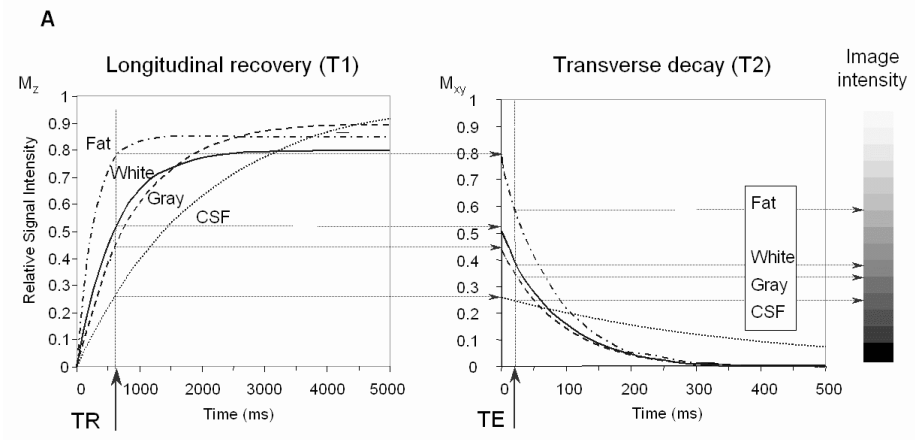


Bushberg - The Essential
Physics of Medical Imaging



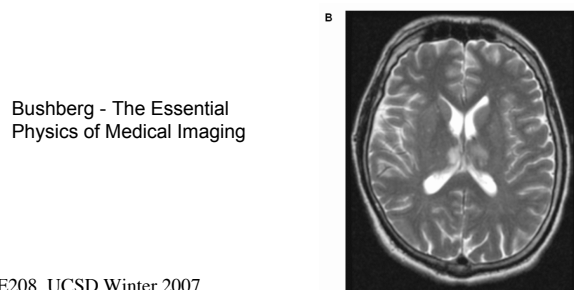
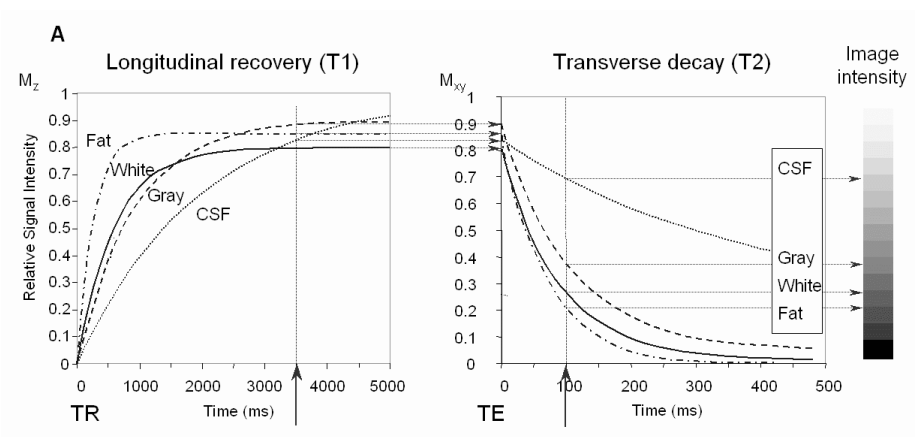
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Image Contrast - T_1

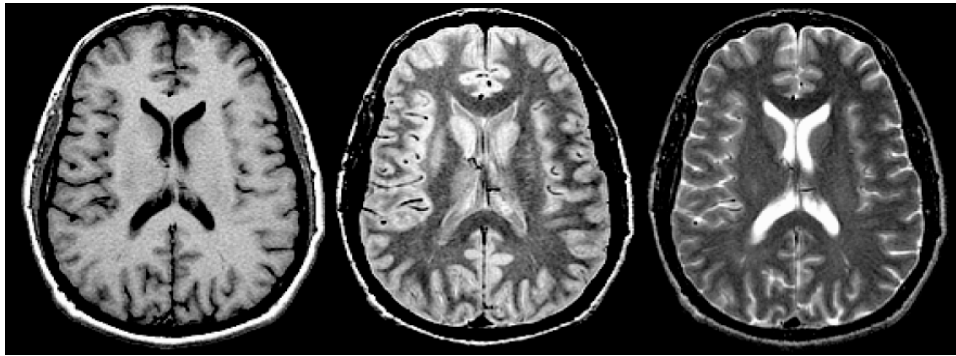


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Image Contrast - T_2



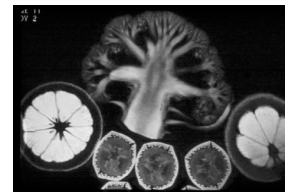
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T₁-weighted

Density-weighted

T₂-weighted



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Slide Credit: T.T. Liu

http://cal.man.ac.uk/student_projects/2000/mmmr7gjw/technique5.htm