

Common Artifacts in MRI

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National Institute
of Mental Health



Outline

- 1 Hardware artifacts, i.e. B_0 , B_1 , etc.
- 2 Reconstruction artifacts
- 3 Patient/sample artifacts
- 4 Misc. / grab-bag

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Hardware imperfections

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- Image shading/intensity problems usually come from B_1 issues.

Distortion issues

Larmor equation \Rightarrow

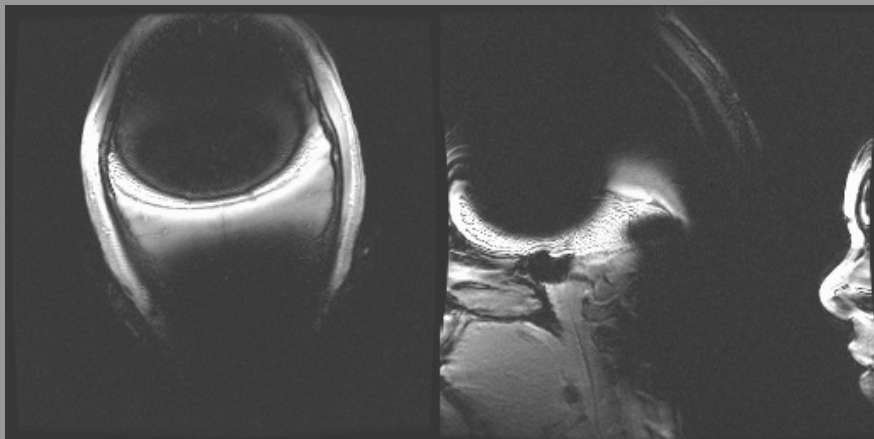
Distortion issues

Larmor equation \Rightarrow

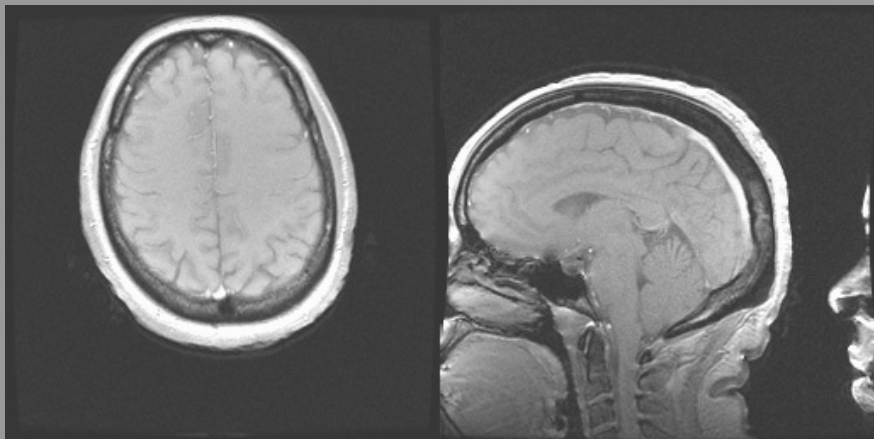
$$\omega_0 = \gamma B_0$$

Geometric distortion - Extreme example

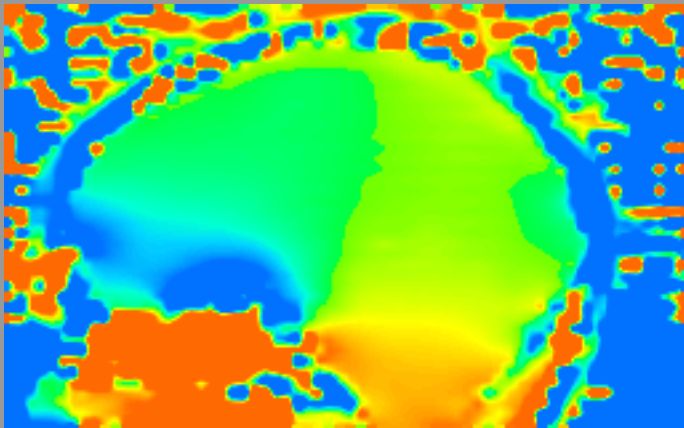
Geometric distortion - Extreme example



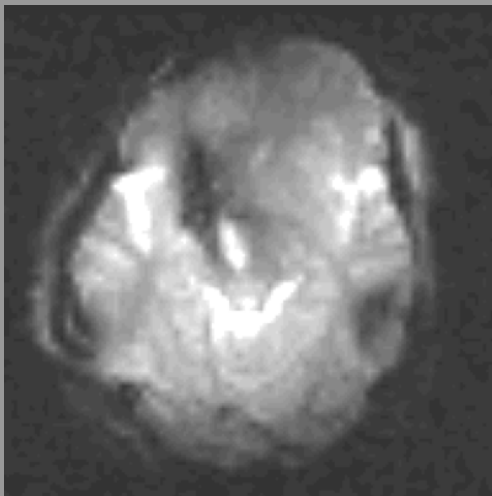
Geometric distortion - Extreme example



More common, less extreme, distortion examples



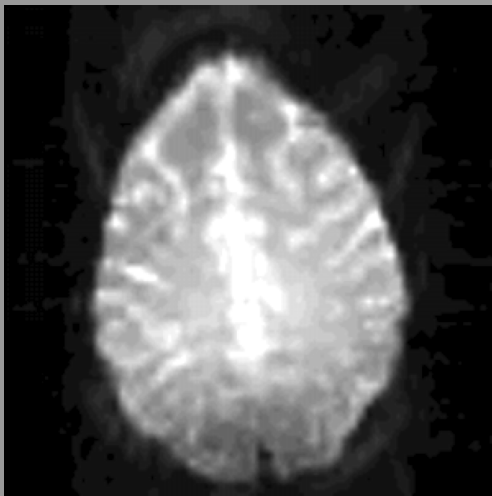
More common, less extreme, distortion examples



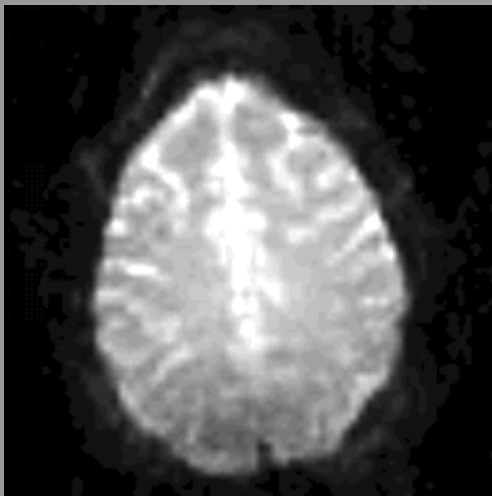
More common, less extreme, distortion examples



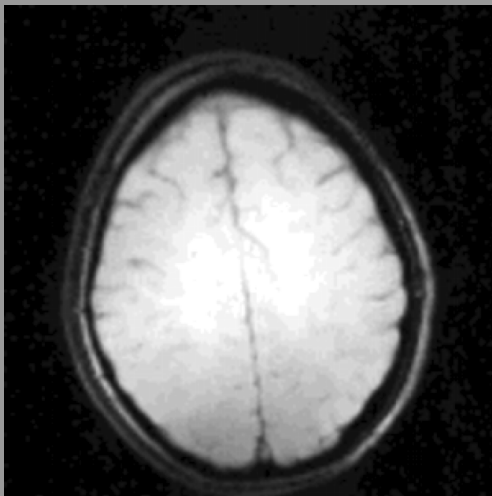
More common, less extreme, distortion examples



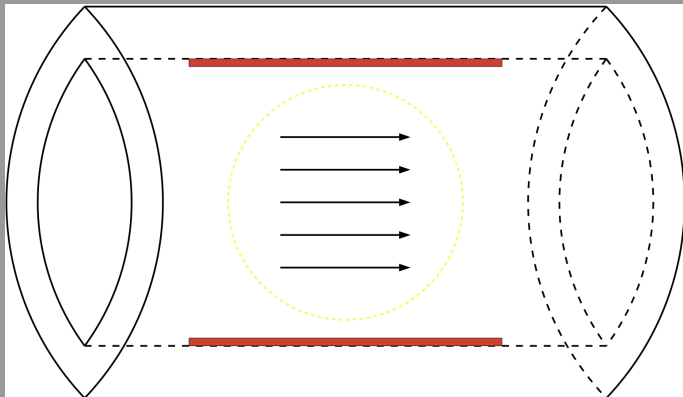
More common, less extreme, distortion examples



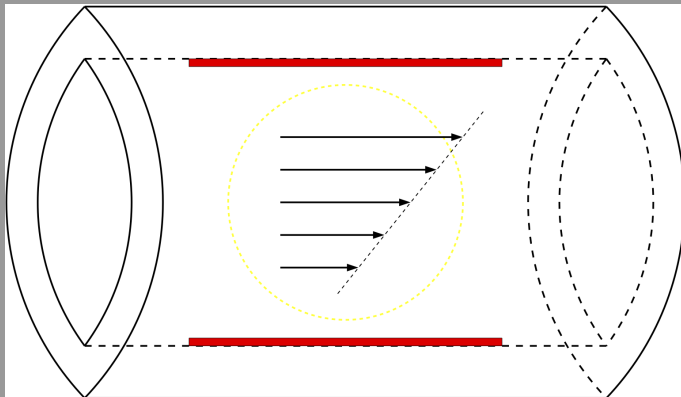
More common, less extreme, distortion examples



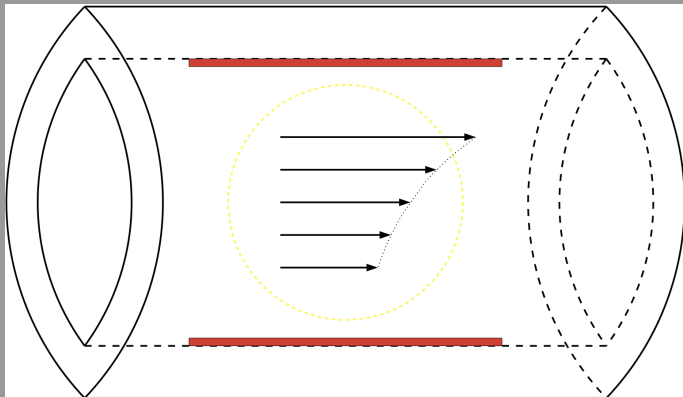
Even more subtle distortion issues



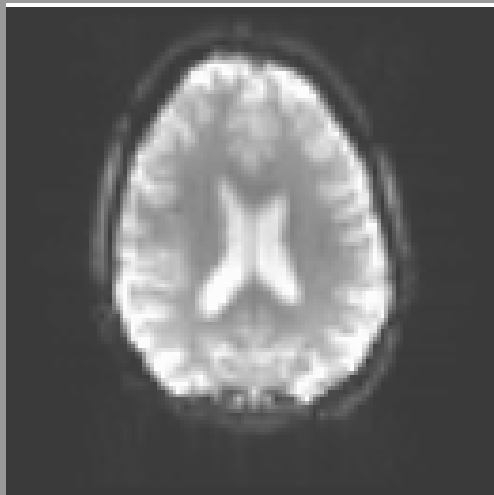
Even more subtle distortion issues



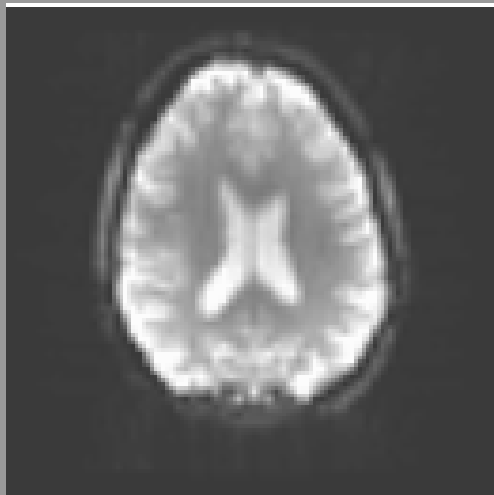
Even more subtle distortion issues



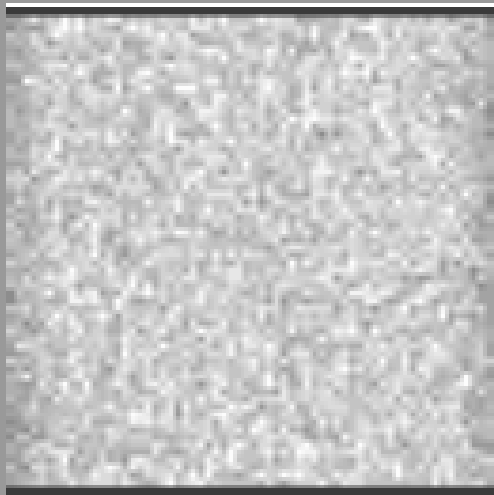
Even more subtle distortion issues



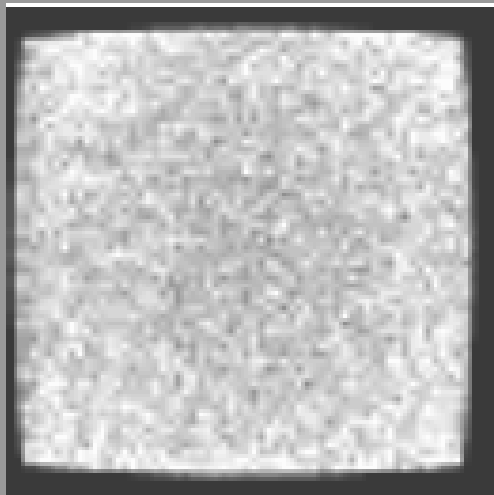
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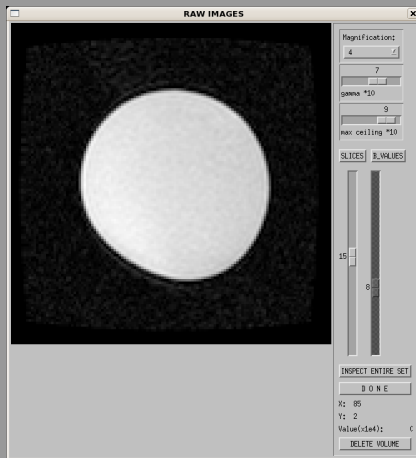
Very exotic, very troublesome, distortion issue

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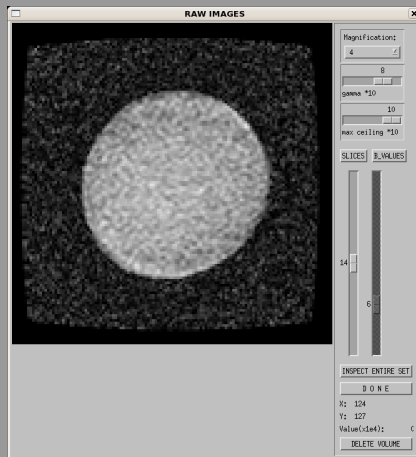
Data provided by J. Sarlls

Very exotic, very troublesome, distortion issue



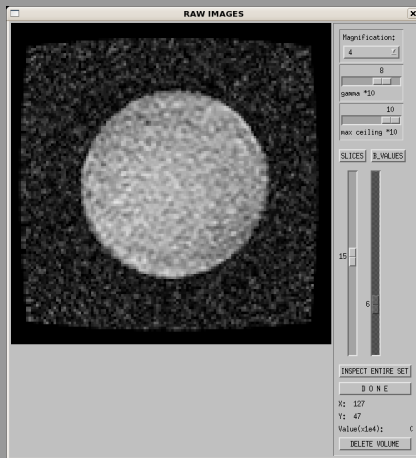
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Issues with image intensity, shading, noise

Problems with image intensity variation, noise, etc

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⇒ problems along the RF chain

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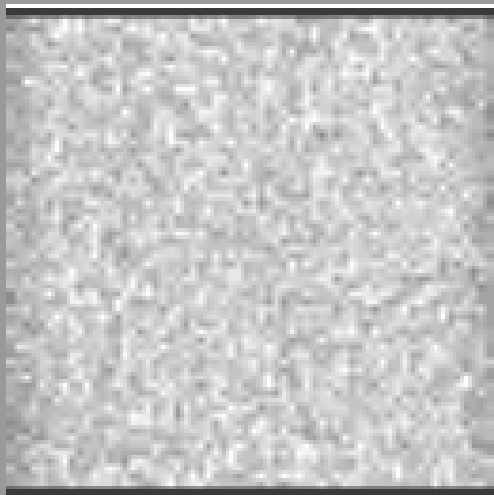
Problems with image intensity variation, noise, etc

⇒ problems along the RF chain

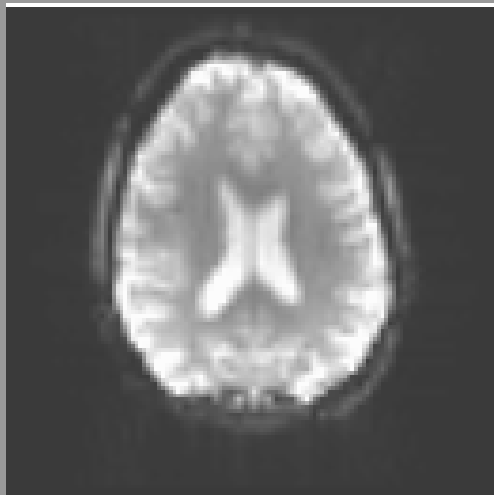
⇒ limitations imposed by physics (geometry, sensitivity).

e.g. RF Coils, RF amplifiers, etc.

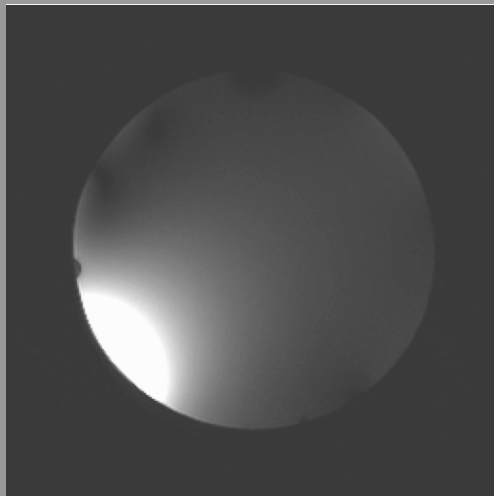
Failing hardware - single-channel coil



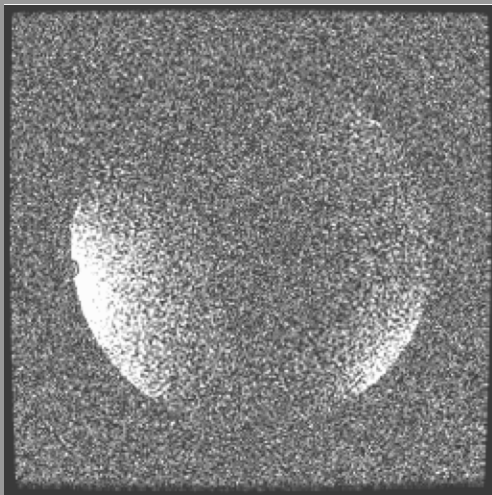
Failing hardware - single-channel coil



Failing hardware - multi-channel array coils

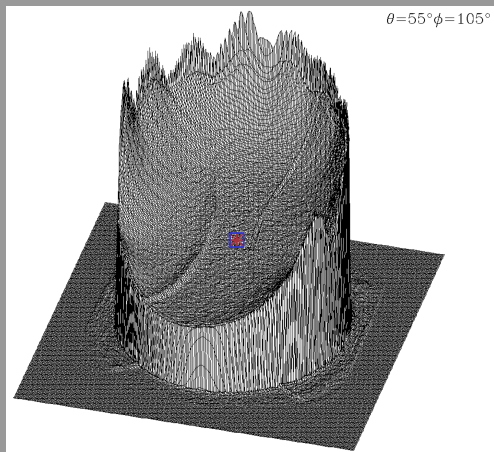


Failing hardware - multi-channel array coils

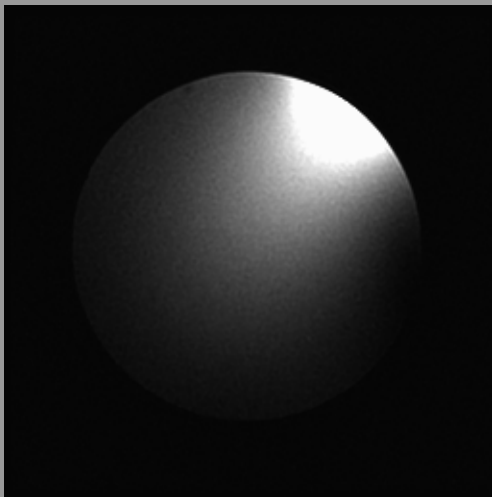


Coil Sensitivity

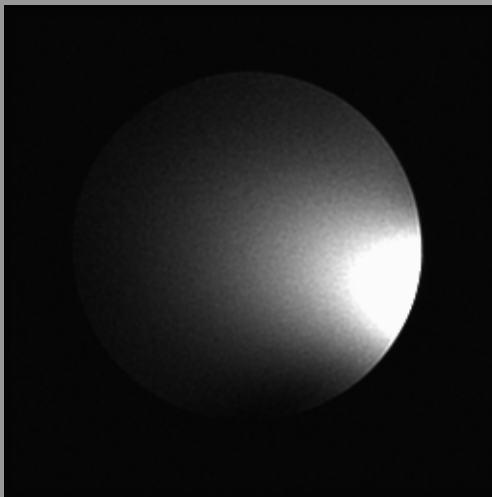
Coil Sensitivity



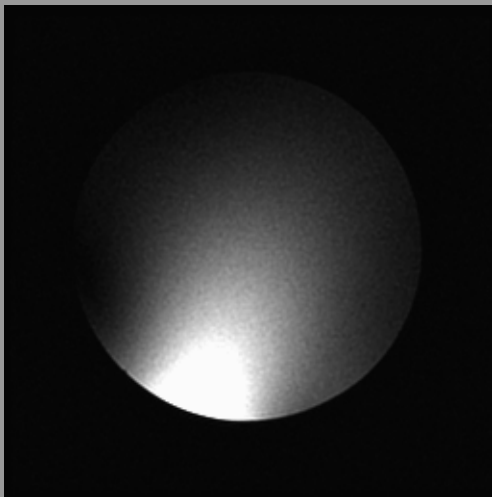
Coil Sensitivity



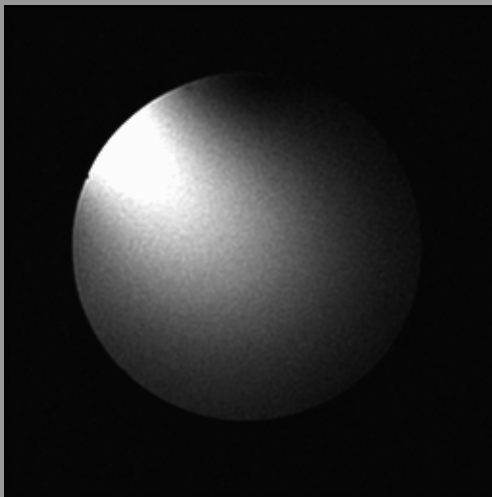
Coil Sensitivity



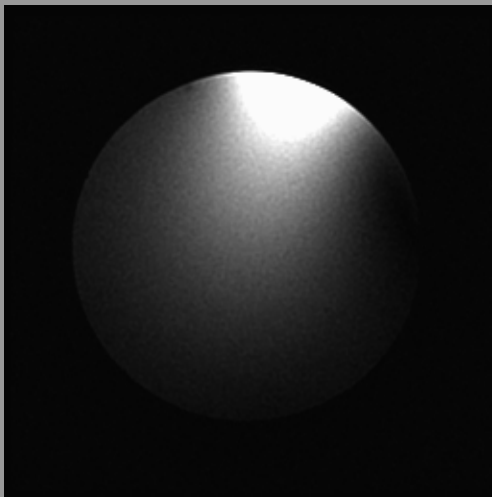
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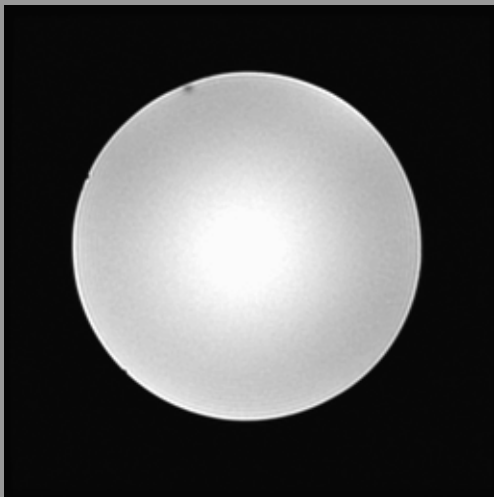
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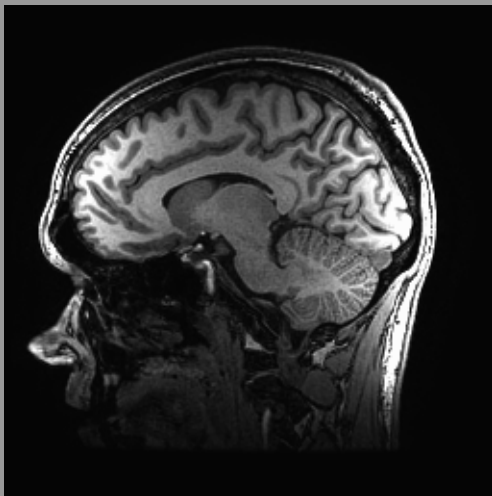


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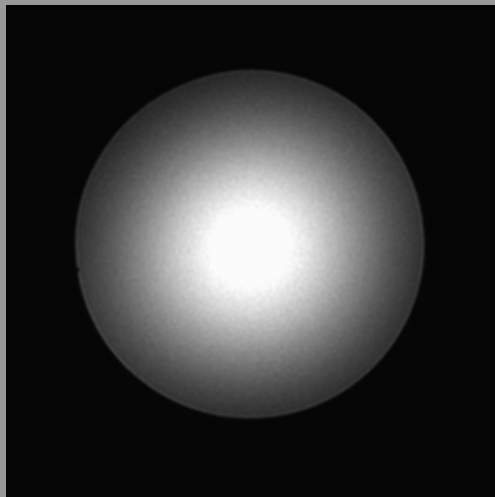
Coil Sensitivity

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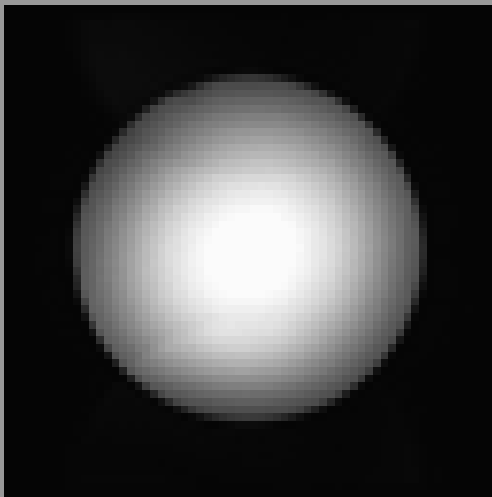


Dielectric Effects / a.k.a. B_1 Inhomogeneities

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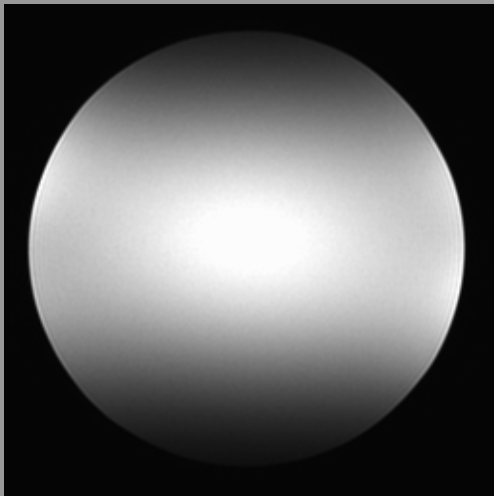


Outline

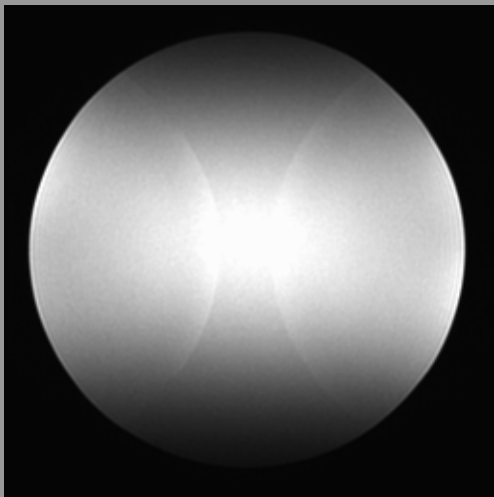
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Accelerated Reconstruction artifacts

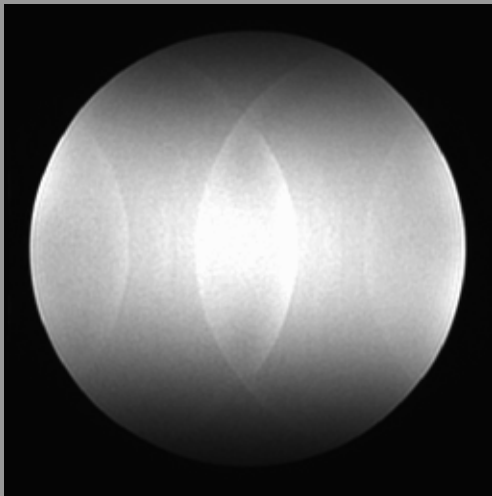
Accelerated Reconstruction artifacts



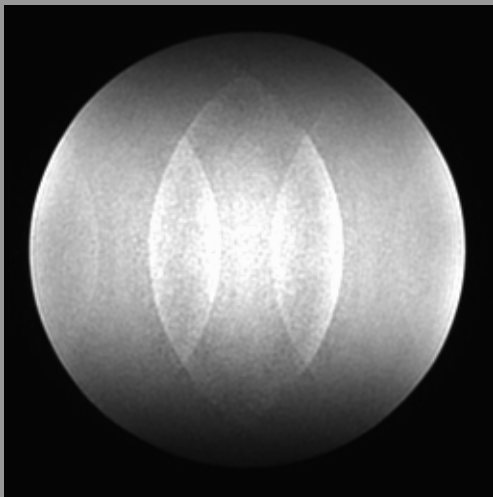
Accelerated Reconstruction artifacts



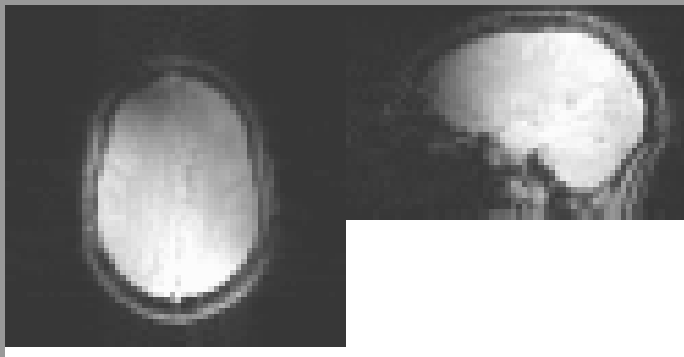
Accelerated Reconstruction artifacts



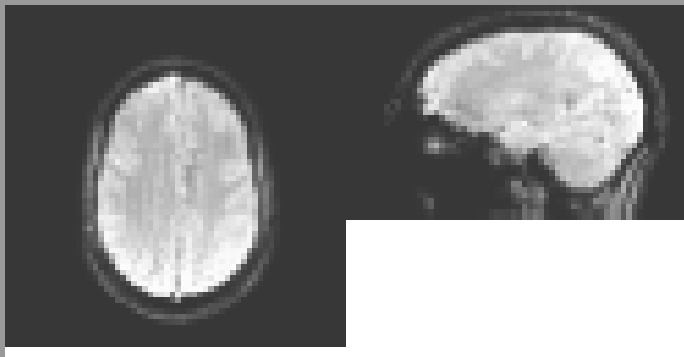
Accelerated Reconstruction artifacts



Error combining data



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Patient/sample artifacts

Probably hardest class of artifacts to deal with.

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- Ethical responsibility toward your patients, volunteers, and animals.

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- Ethical responsibility toward your patients, volunteers, and animals.
- Experimental validity - not supposed to change the state of the thing you are measuring.

B_0 uniformity

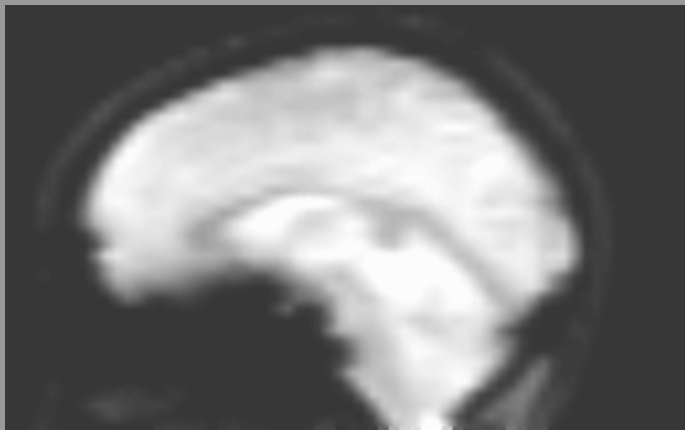
Basic premise of MRI - *VERY* uniform magnetic field, distorted in a controlled fashion to provide spatial information.

B_0 uniformity

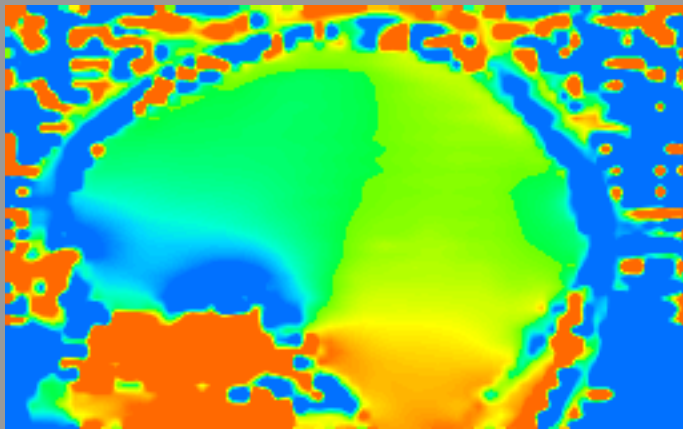
Basic premise of MRI - *VERY* uniform magnetic field, distorted in a controlled fashion to provide spatial information.

⇒ Have to revise this assumption when imaging.

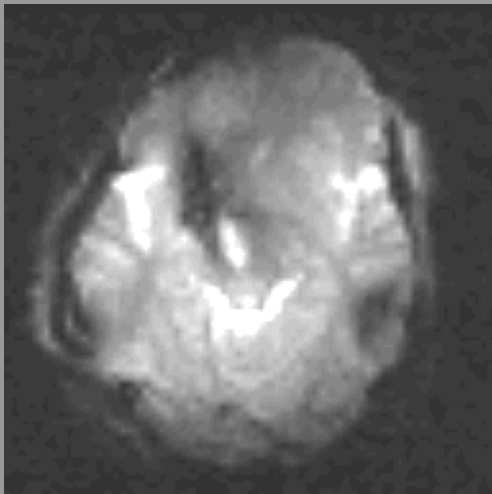
B_0 uniformity in the human brain



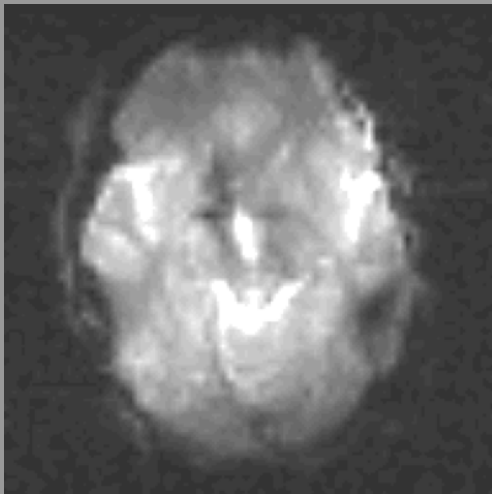
B_0 uniformity in the human brain



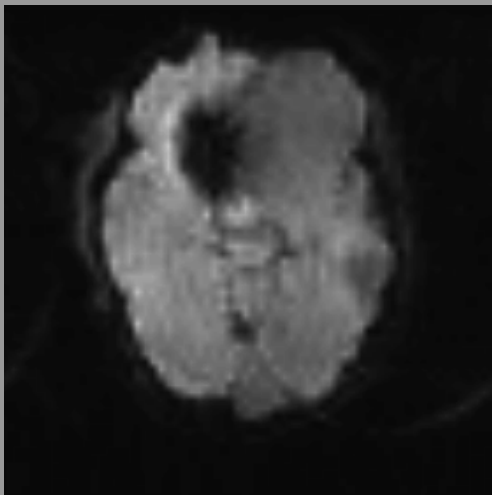
B_0 uniformity in the human brain



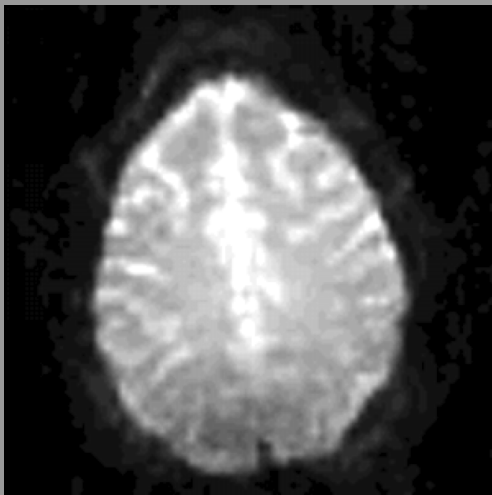
B_0 uniformity in the human brain



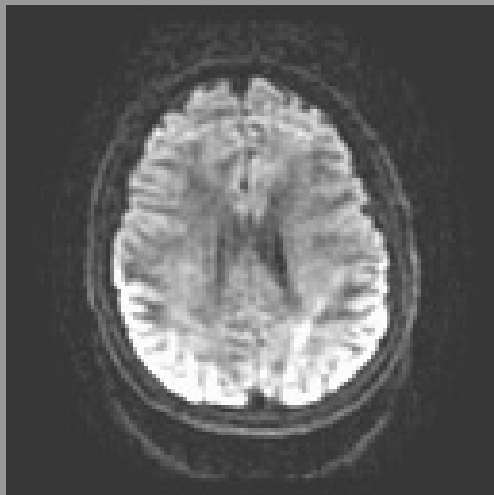
B_0 uniformity in the human brain



Different tissue types, namely fat



Different tissue types, namely fat



Physiology

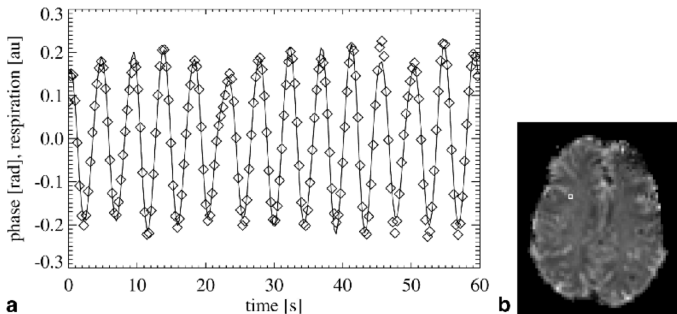
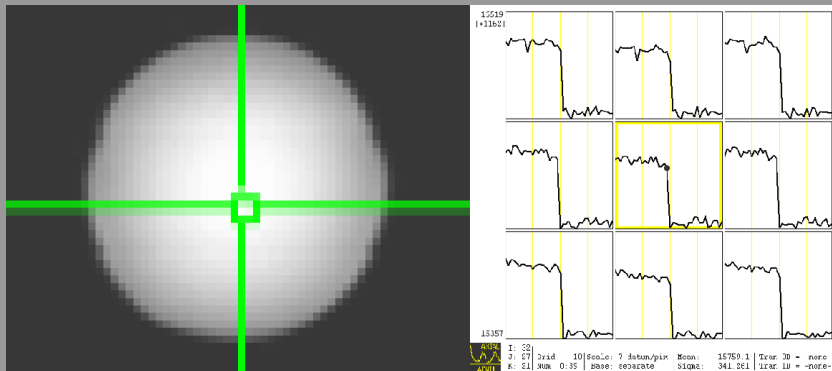


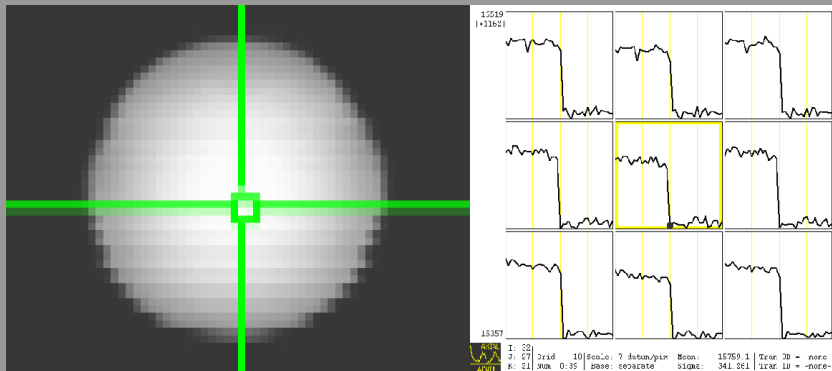
FIG. 3. **a:** Correlation between the phase of one voxel (diamonds) and the (scaled) respiratory signal (solid line), both of which were filtered between 0.11 and 0.49 Hz, for 1 min of data. **b:** Location of the voxel used for the plot in a, indicated on a slice from the first EPI volume in the series.

van Gelderen: Magnetic Resonance In Medicine (57:2), 362-368, Feb 2007.

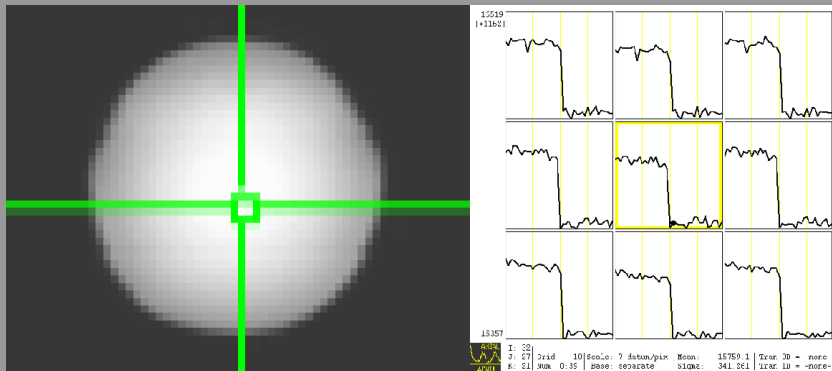
Motion



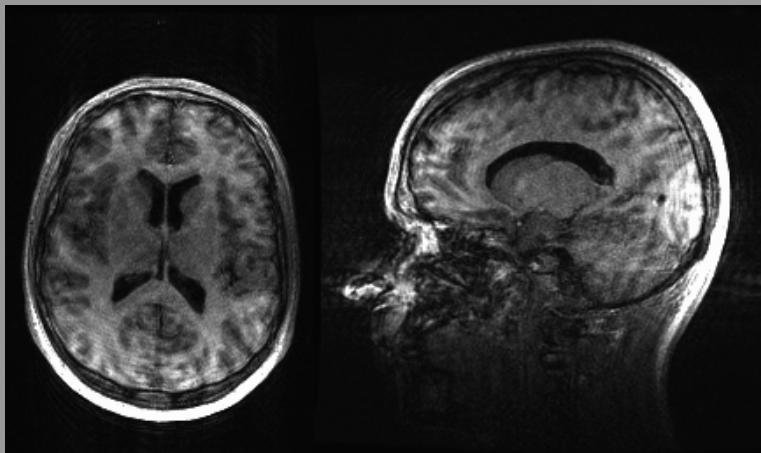
Motion



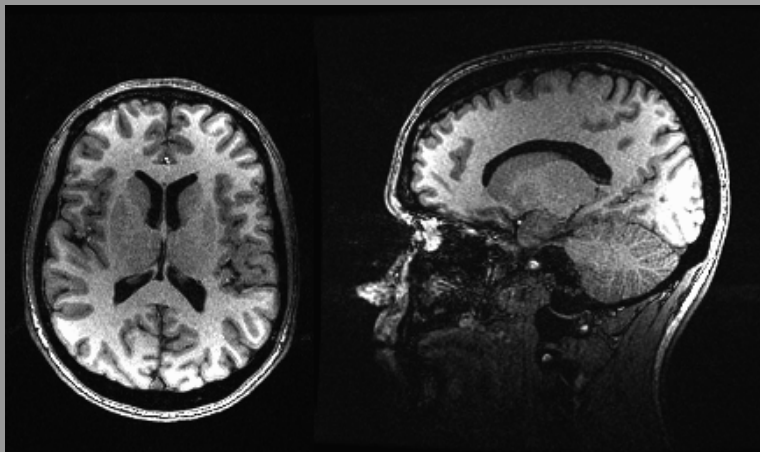
Motion



Motion



Motion

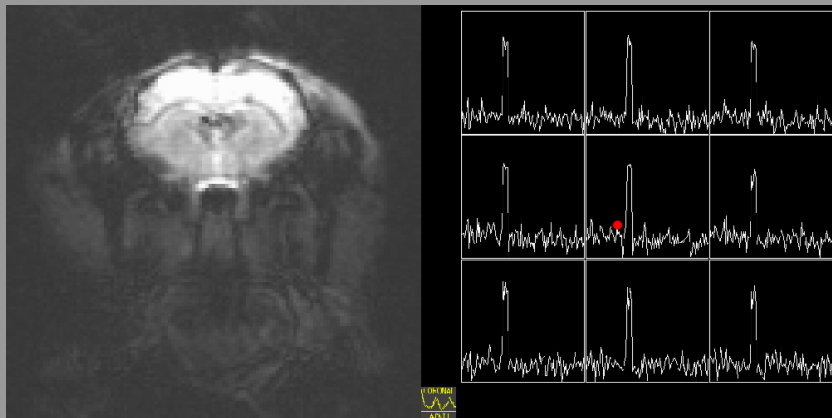


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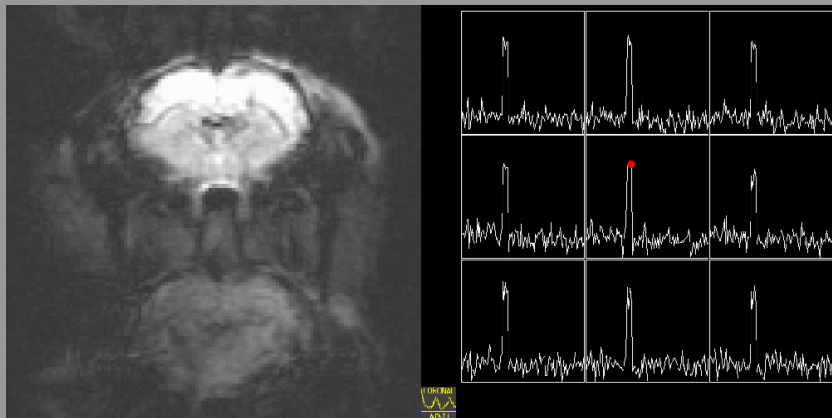
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EPI Nyquist Ghosting

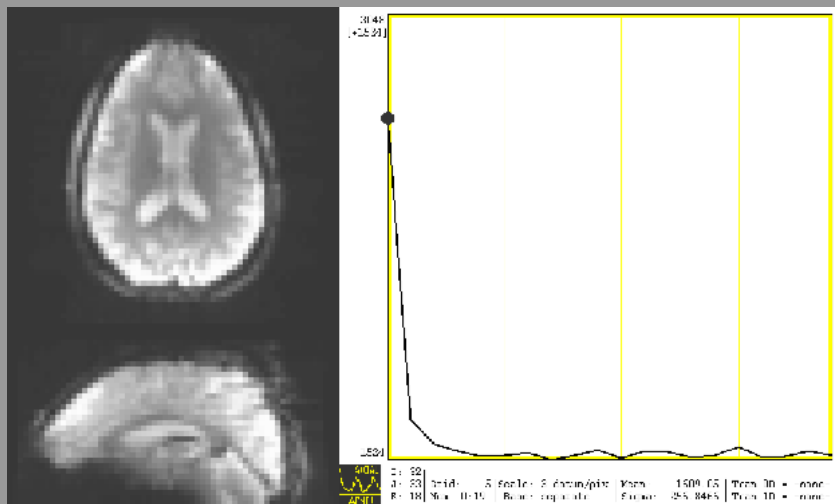
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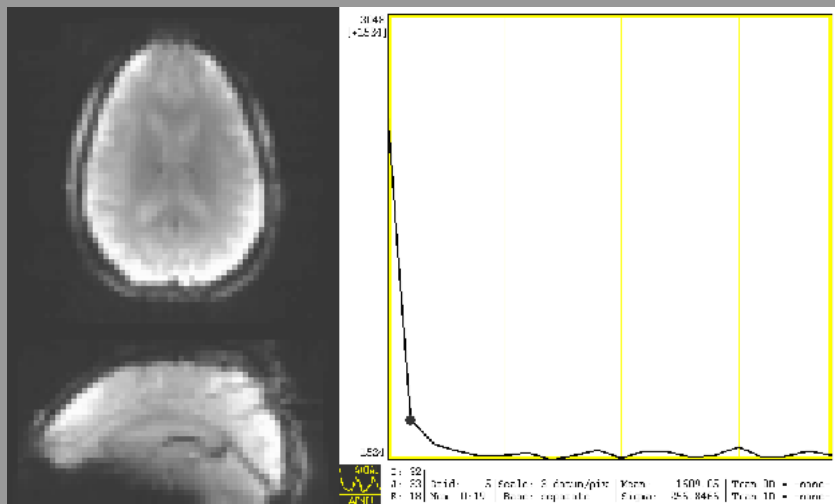
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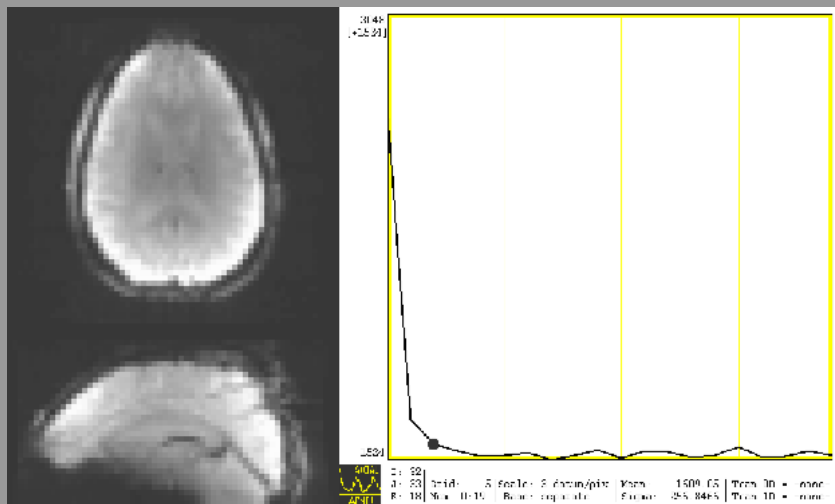
Saturation effects



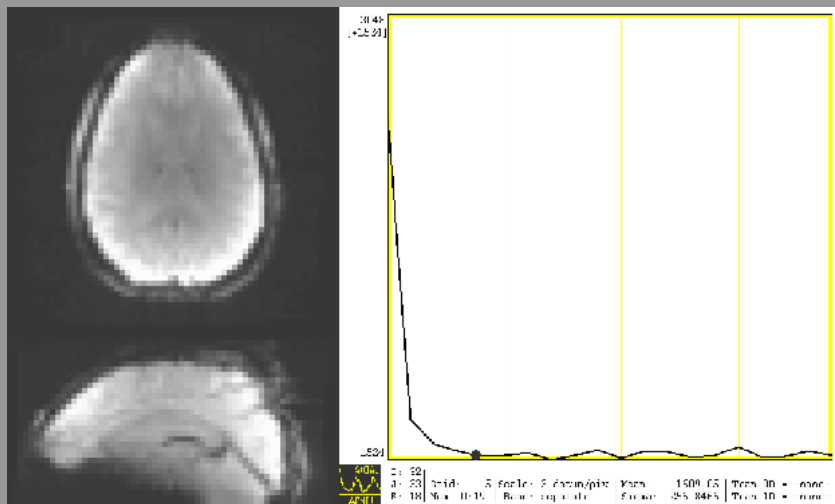
Saturation effects



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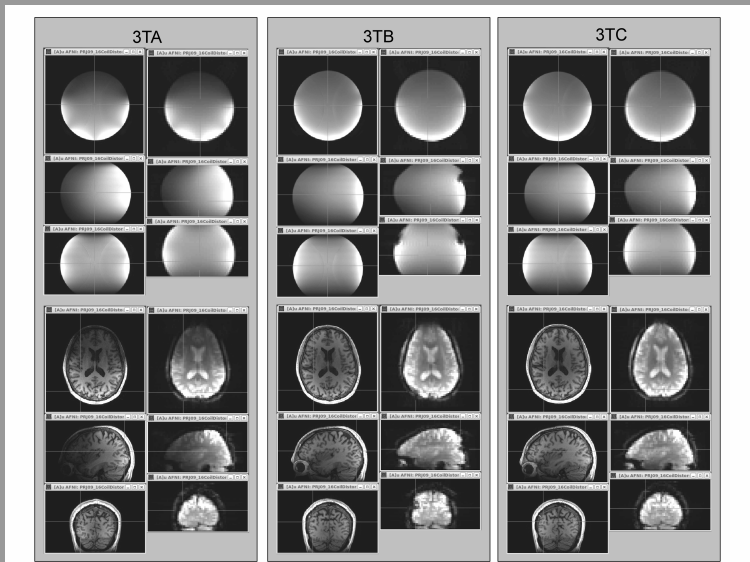
Saturation effects



Pop-quiz

- How to differentiate fat shift artifact from Nyquist ghost shift ?

Pop-quiz



Acknowledgments

- J. Sarlls (NMRF-NINDS)
- R. M. Birn (MCW/FIM-NIMH/UW)
- S. Wei and S. Kippenhan (SIN-NIMH)
- J. Gonzalez-Castillo (FIM-NIMH)
- D. Handwerker (FIM-NIMH)