Improving SNR in high b-value diffusion imaging using G_{max}=300 mT/m human gradients

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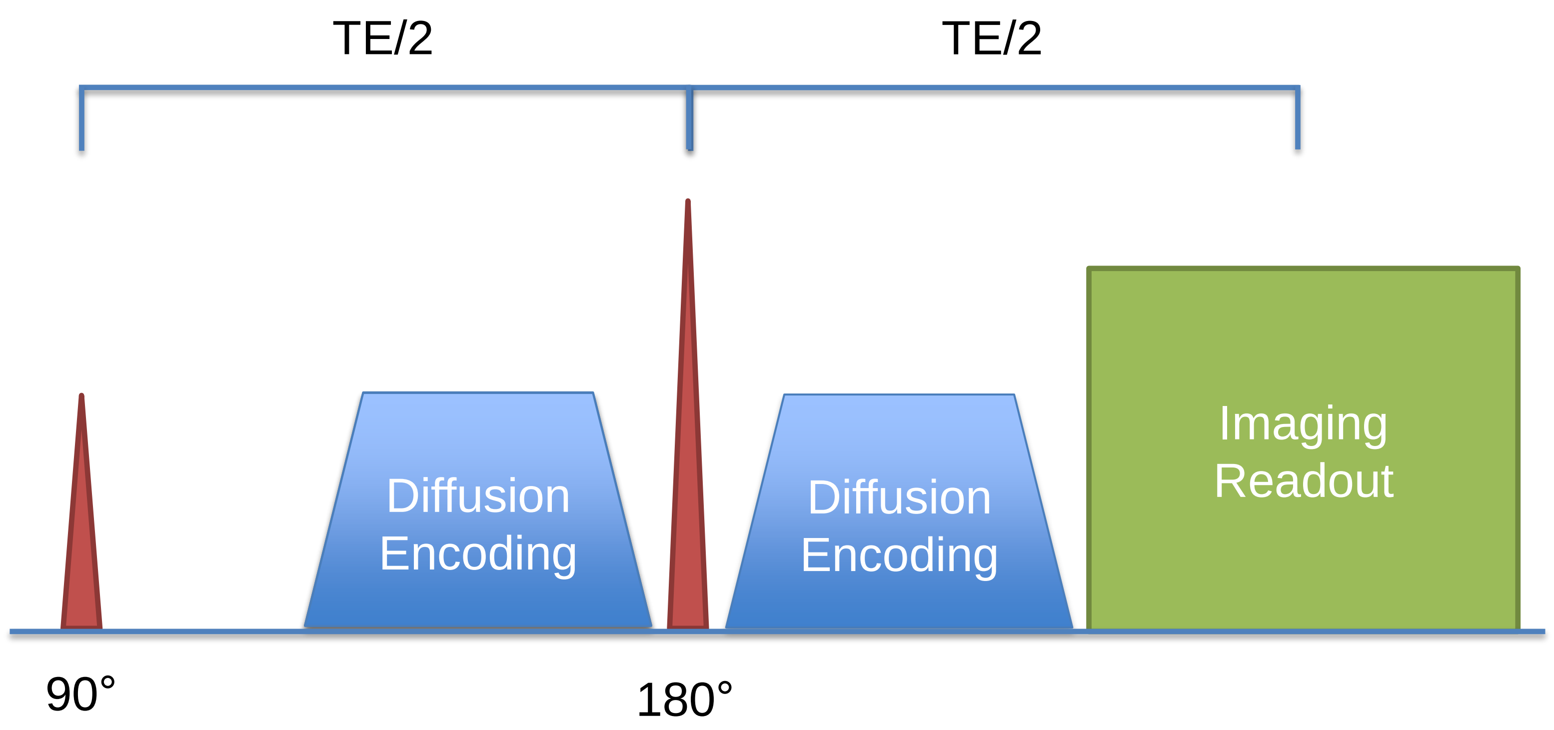
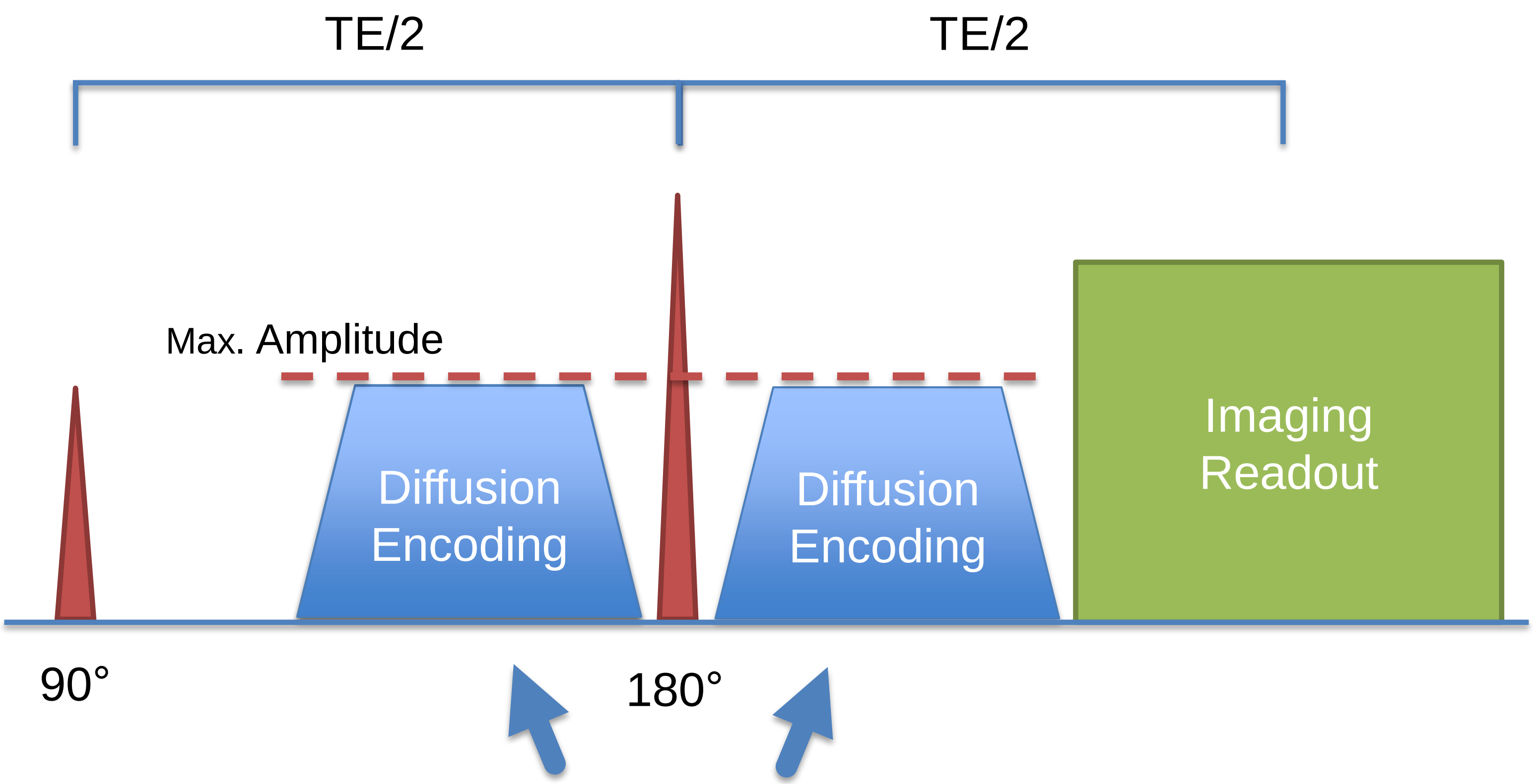
Stejskal-Tanner Diffusion-Weighted Imaging

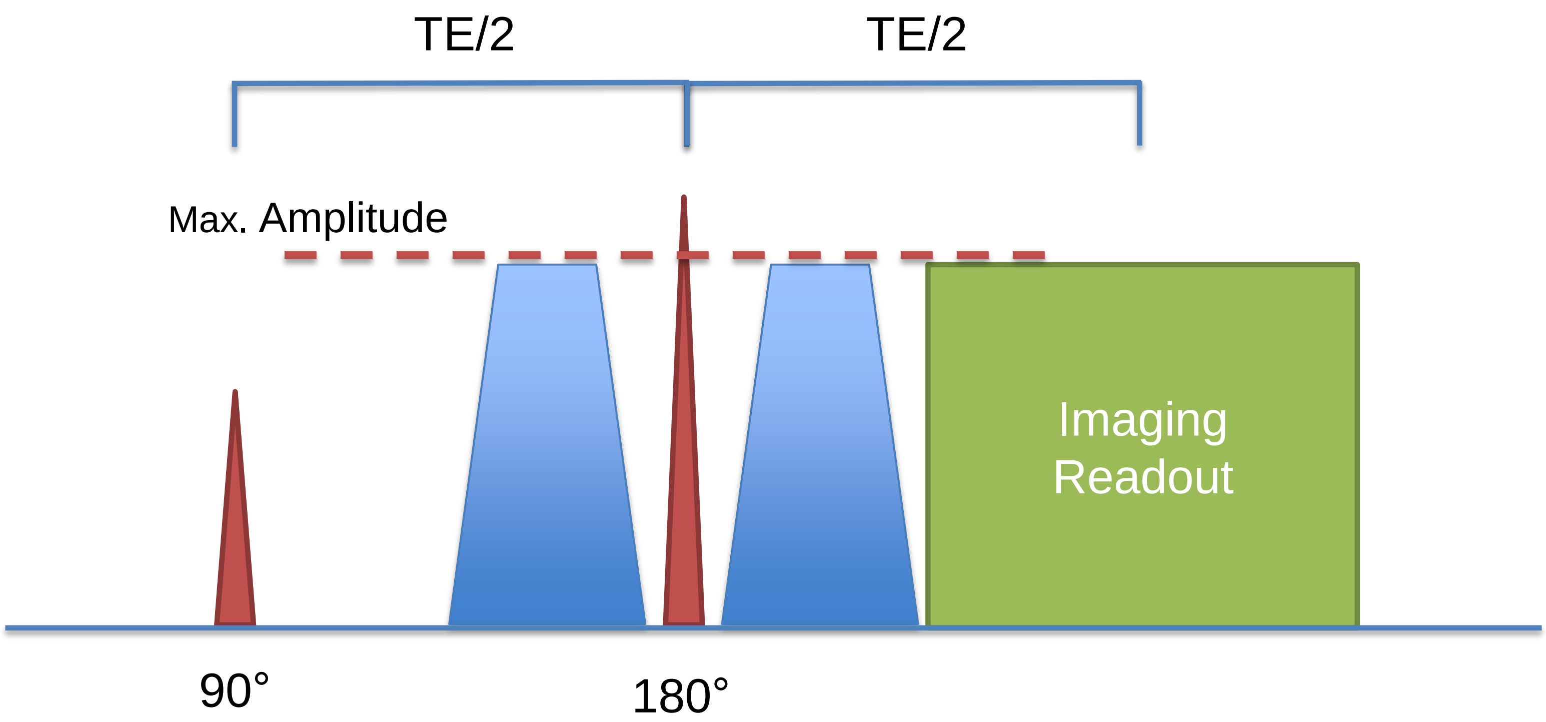


Stejskal-Tanner Diffusion-Weighted Imaging



Minimum duration of diffusion encoding gradients is limited by their **maximum amplitude.**

Stejskal-Tanner Diffusion-Weighted Imaging



If the max **gradient amplitude increases**, we can **shorten the gradients** while keeping the same area and, in turn, **reduce TE.**

The Siemens MAGNETOM Skyra CONNECTOM with AS302 whole-body gradients

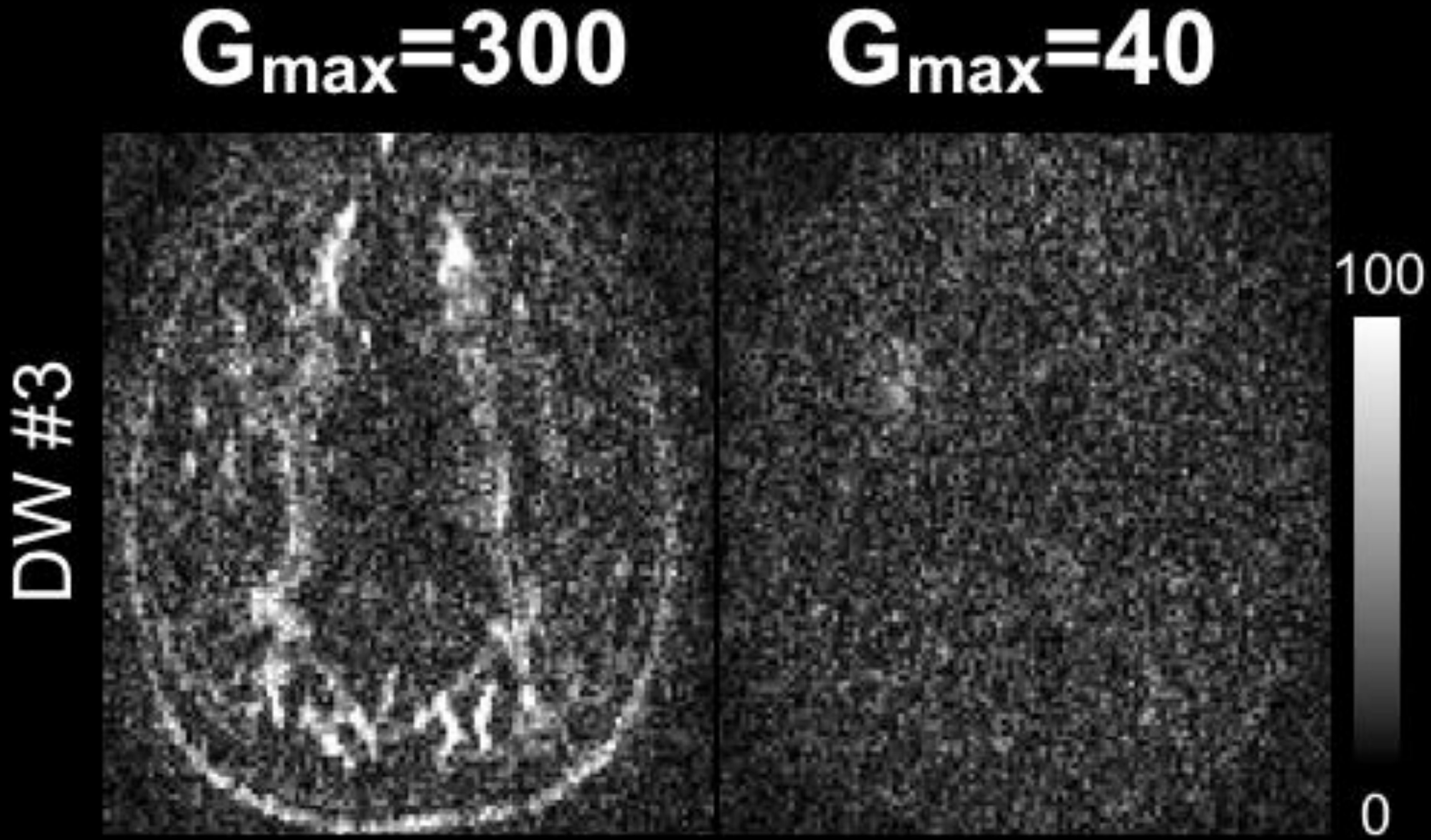
The system has 300 mT/m peak gradient amplitude; 200 T/m/s slew rate. We use the full gradient amplitude only for the diffusion lobes; EPI is capped at 40 mT/m.

Achievable TEs on our system as a function of b-value. Test protocol was a 220 mm FOV scan with 2mm isotropic resolution, ¾ partial Fourier, and 2x GRAPPA acceleration.

For system info, see talk 696, Kimmlingen *et al.*

Expected signal gain at T2 = 70 ms, given TE shortening with increased gradient amplitude

Single slice acquired at b=10k with two peak gradient amplitudes shows large SNR gain in real data.



Quantifying SNR gain as a function of gradient amplitude with a polyethylene glycol phantom

Single 10mm slice of PEG phantom (T2 ~ 85 ms) was imaged with a 208 mm FOV, 2 mm in-plane resolution, and ¾ partial Fourier. Siemens' 20-channel head coil was used. Thick slice reduces noise bias.

SNR gain was estimated via median ratio of signal in an ROI measured with increased peak gradients compared to the same ROI at 40 mT/m.

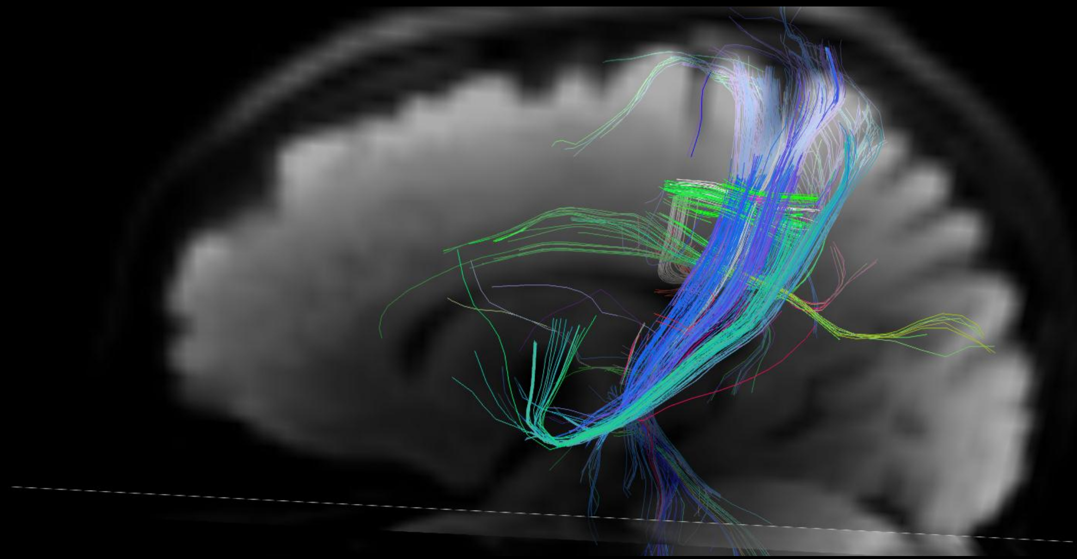
Quantifying SNR gain as a function of gradient amplitude with a human subject

Human subject imaged in one diffusion direction with 240 mm FOV, 2.5 mm isotropic resolution, 5 slices, ¾ partial Fourier, 2x GRAPPA acceleration. A custom-built 64-channel coil was used.

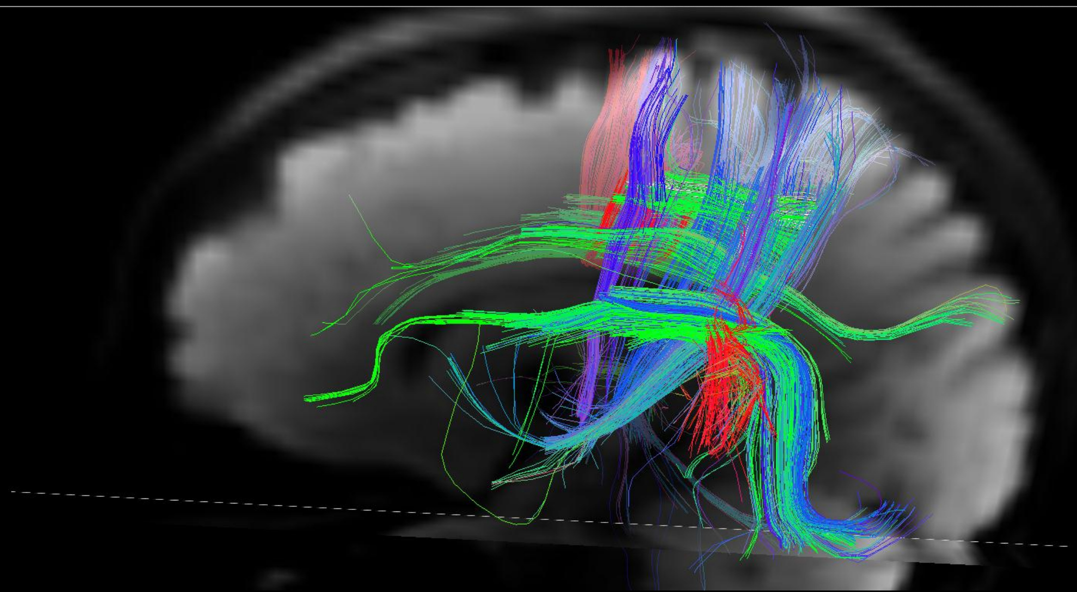
SNR gain was estimated via median ratio of signal in an ROI measured with increased peak gradients compared to the same ROI at 40 mT/m. To minimize noise bias, ROI was chosen to include only regions that were bright at 300 mT/m.

Human in vivo tractography, existing vs Connectome Scanner – Interaction of SLF and external capsule

G 40 mT/m
b 5000



G 300 mT/m
b 15000



Courtesy V. Wedeen

Conclusions

- Our experiments show that **using the novel gradients to shorten TE does produce a gain in SNR** consistent with the T2 range (60-90 ms) of the directionally sensitive water pool in white matter.

- We have shown that, although further work (see talk 701 “A 64 channel receive-only field camera for eddy current and trajectory calibration”, Tountcheva *et al.*) is being performed to more precisely correct for eddy currents, we have demonstrated that **we can successfully measure at high-b with full gradient power and achieve significant SNR gains**.

- For further analysis related to specific diffusion metrics, see talk 4055 “Improved Q-ball imaging using a 300 mT/m human gradient” Cohen-Adad *et al.*

Acknowledgements

- Kawin Setsompop
- Steve Cauley
- Boris Keil
- Himanshu Bhat

- NIH Blueprint for Neuroscience Grant U01MH093765 The Human Connectome Project
- NIH P41RR014075

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