BME 599: Advanced Topics in MRI
HW #2

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Problem 1: Extended phase graphs.

a. i. cf. Figure 1

ii. cf. Figure 2

iii. cf. Figure 3

b. An exemplary contour plot of the signal vs. T1 and T2 at the 6th echo when using 180° refocusing pulses is shown in Figure 4.

c. When using 180° pulses, the contrast solely depends on T2. With lower refocusing flip angles, the contrast starts to additionally depend on T1.

Problem 2: Single and Multiple Spin Echo Sequences.

a. **Single-echo spin echo.** Figures 5, 6, and 7 show the T1, T2 and PD weighted simulated SE images.

b. **Fast spin echo.**

ii. I choose a k-space filling order where I group phase encoding lines which have been acquired at the same point in the echo train. With $ETL = 32$, this results in 32 blocks of 8 k-space lines each. I fill k-space with these blocks and then shift them such that the block with $TE = TE_{eff}$ is in the center of k-space (cf. Figure 8). The resulting brain image with $ETL = 32$, $TE_{eff} = 80ms$ is shown in Figure 9.

iii.

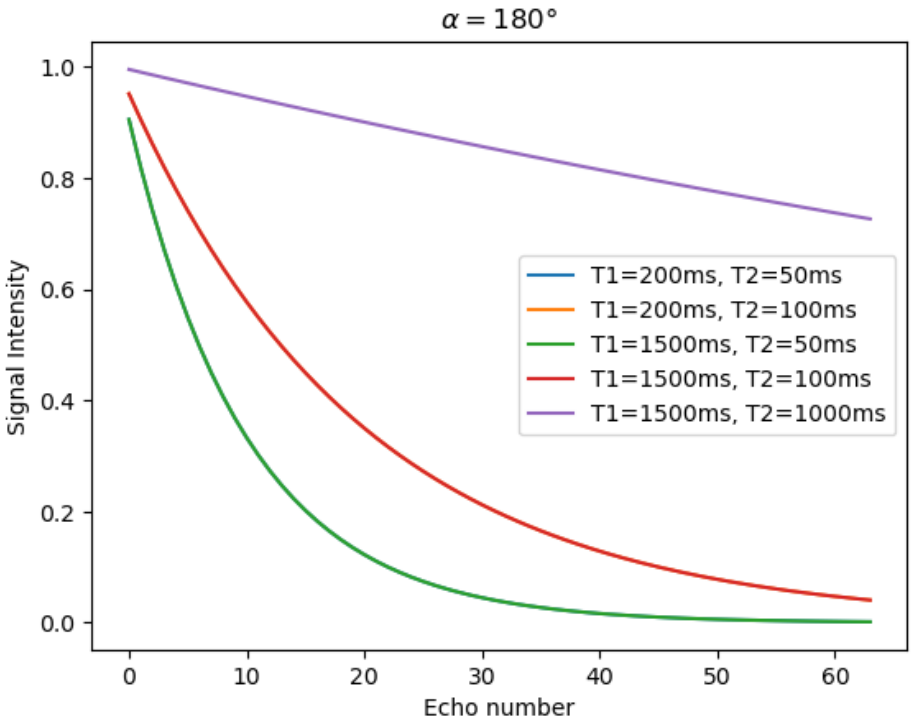

Figure 1: Echo amplitudes with $\alpha = 180°$.

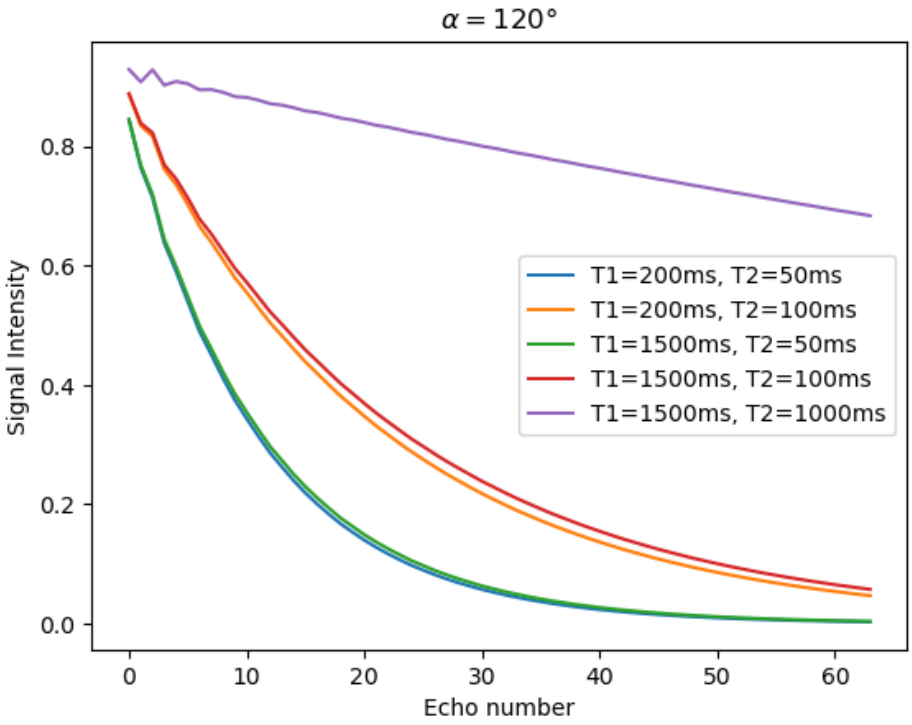

Figure 2: Echo amplitudes with $\alpha = 120°$.

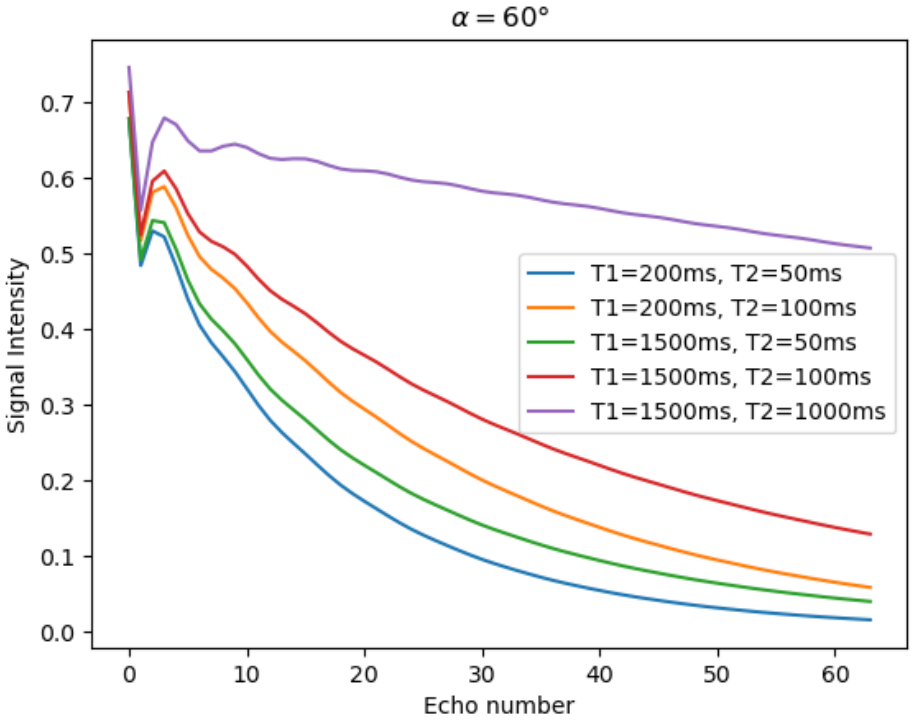

Figure 3: Echo amplitudes with $\alpha = 60°$.

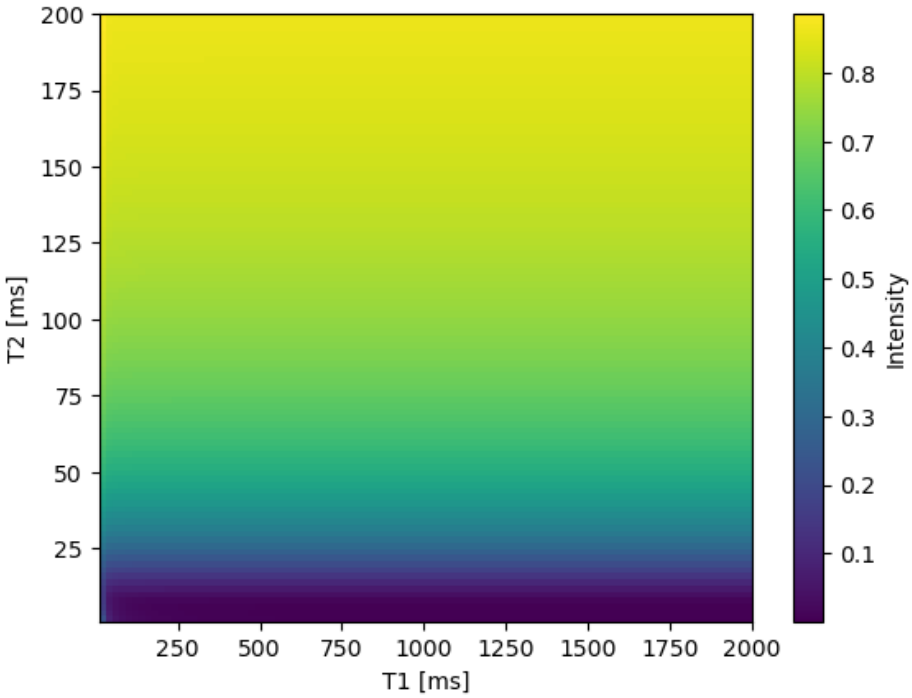

Figure 4: Contour plot of the signal intensity at the 6th echo when using 180° refocusing pulses.

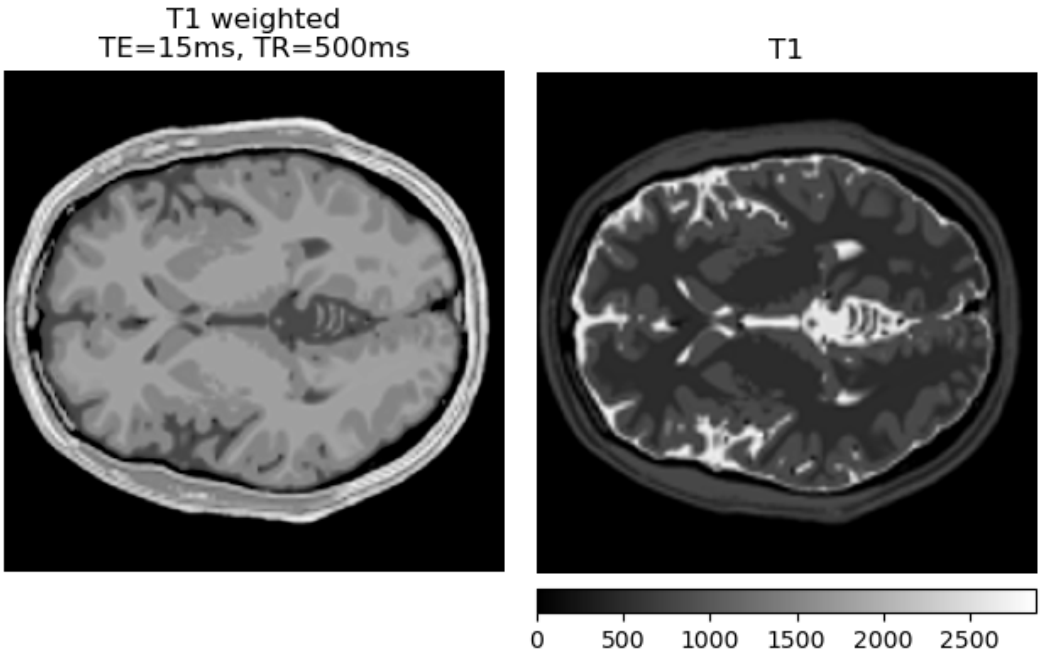

Figure 5: Simulated T1 weighted SE image (left) compared to T1 map (right).

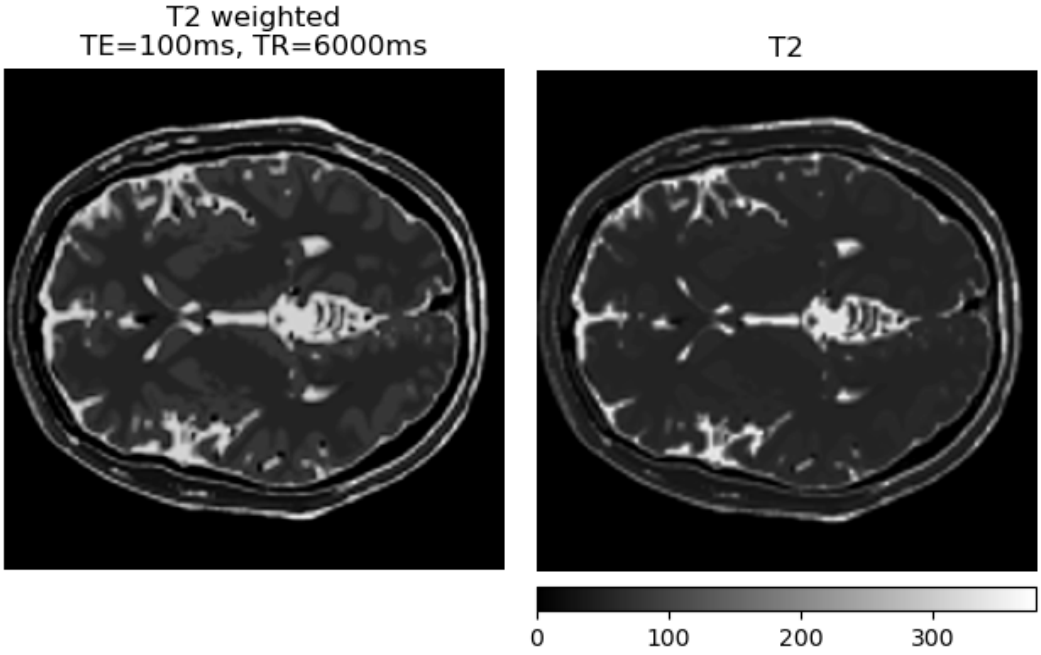

Figure 6: Simulated T2 weighted SE image (left) compared to T2 map (right).

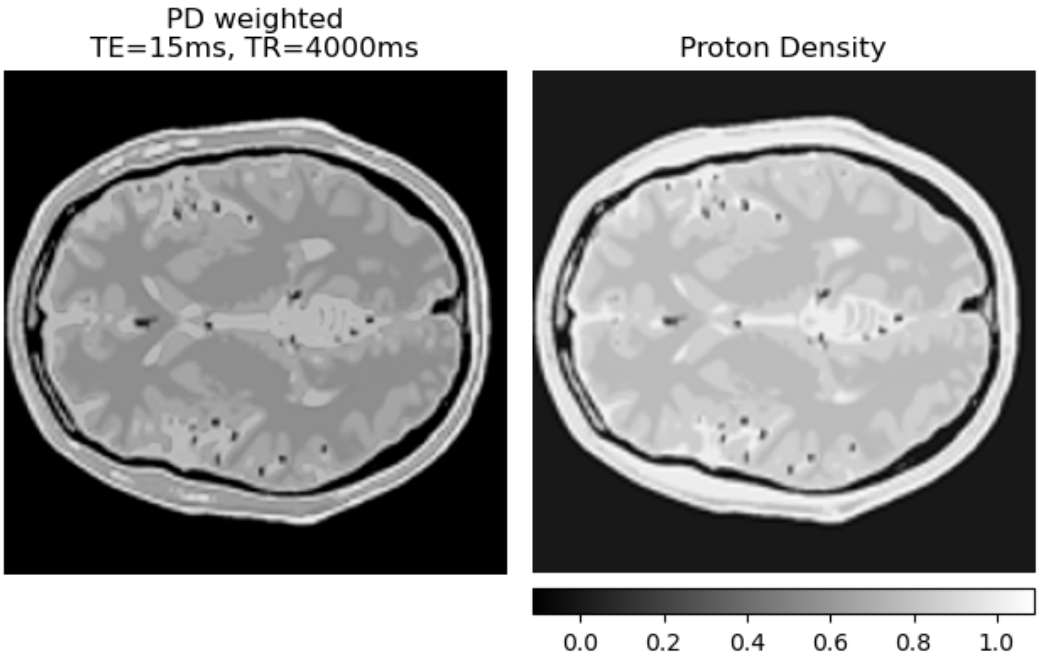

Figure 7: Simulated PD weighted SE image (left) compared to PD map (right).

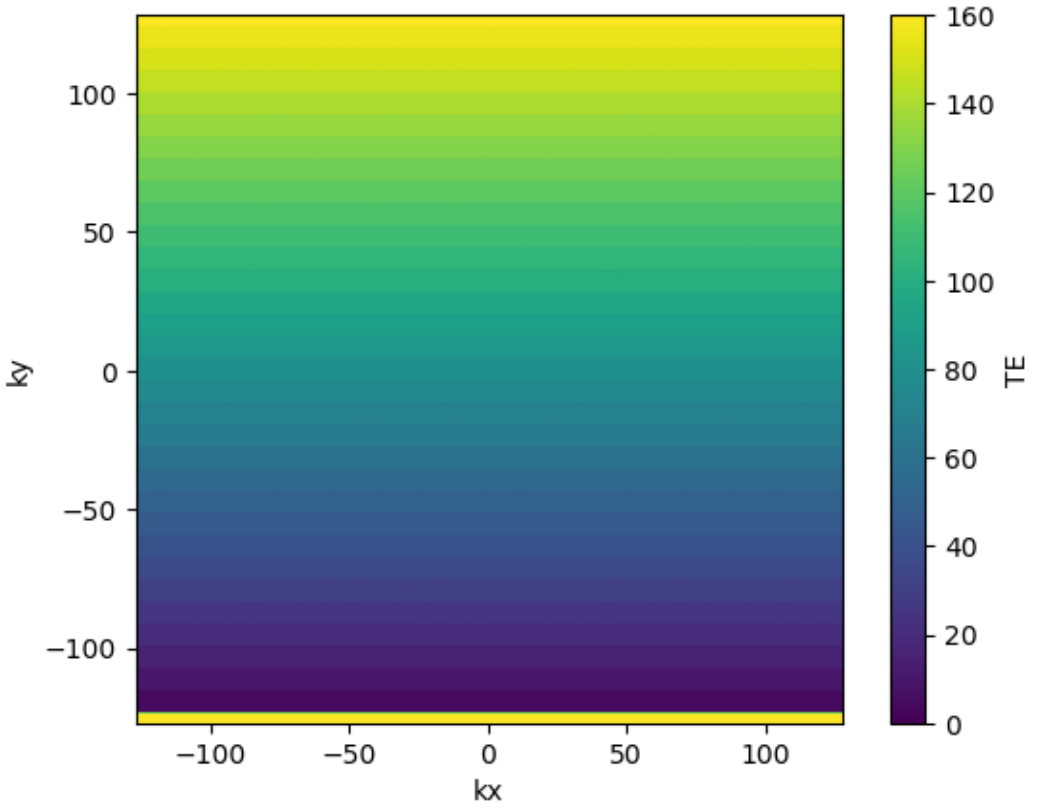

Figure 8: k-space filling order for $ETL = 32$, $TE_{eff} = 80ms$.

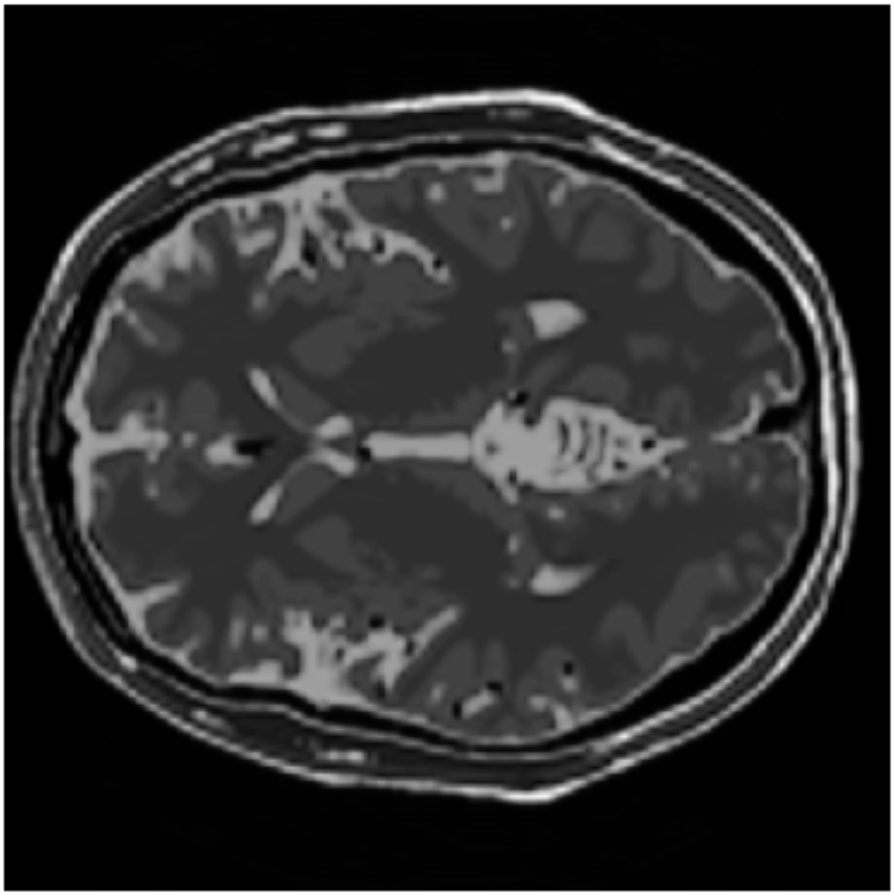

Figure 9: Simulated FSE image for $ETL = 32$, $TE_{eff} = 80ms$.