



# Brain Battery Imaging Protocol for Quantification

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## PURPOSE

- To quantify MR parameters of the brain in a timely fashion
- Target parameters include:  $B_0$  and  $B_1$  field inhomogeneity, coil sensitivity profiles,  $T_1$ ,  $T_2$ ,  $T_2^*$ , net magnetization ( $M_0$ ), and magnetic susceptibility ( $\chi$ )
- Whole brain coverage was achieved with 1 mm isotropic resolution in a scan time of <26 minutes

## METHODS

- Imaging was performed on a 3T MR Scanner (Discovery 750, GE Healthcare, WI) with an 8 channel head coil
- The brain of 26 year old healthy female was imaged with the sequence in Table 1
- From the image data brain extraction and mask erosion where applied
- Using sequence 1, the induced magnetic field ( $B_0$ ), was calculated by fitting the phase evolution to the echo time
- Using the magnetic field, background field removal was applied [1] to obtain the  $M_0$  estimate

Table 1: Summary of protocol and parameters.

#	Sequence	Parameters									
		FOV (cm)	TR (ms)	TE (ms)	Flip (degrees)	BW ( $\pm$ kHz)	Slice Thickness (mm)	Matrix Size	Aqu Time	Num Echos	PI Acceleration Factor
1	multi echo SPGR	$25.6 \times 25.6 \times 12.8$	2000	2.2-21.7 ms	15	62.5	2	$256 \times 256 \times 128$	4:12	8	2
2	B1 mapping	$25.6 \times 25.6 \times 12.8$	16-60 ms	1.7 ms	60	62.5	4	$128 \times 128 \times 32$	5:53	1	1
3	SPGR 1	$25.6 \times 25.6 \times 12.8$	7.0 ms	3.1 ms	4	31.25	1	$256 \times 256 \times 128$	3:58	1	1
4	SPGR 2	$25.6 \times 25.6 \times 12.8$	7.0 ms	3.1 ms	18	31.25	1	$256 \times 256 \times 128$	3:58	1	1
5	bSSFP 1	$25.6 \times 25.6 \times 12.8$	6.7 ms	3.3 ms	4	125	1	$256 \times 256 \times 128$	3:47	1	1
6	bSSFP 2	$25.6 \times 25.6 \times 12.8$	6.7 ms	3.3 ms	18	125	1	$256 \times 256 \times 128$	3:47	1	1
Total Time									25:35		

- Dipole inversion was used to calculate the magnetic susceptibility ( $\chi$ ) [2]
- $T_2^*$  was also calculated from sequence 1, by fitting the echo decay curve
- The  $B_1$  field map was calculated using sequence 2 and the method described by Voigt, et al. [3]
- Coil sensitivity profiles were estimated from sequence 3, which obtained images from each of the coils
- T1 and T2 maps were calculated using DESPOT1 and DESPOT2, respectively, as described by Deoni, et al. [4], with the B1 map and sequences 3 through 6

## RESULTS

- Figure 1 shows axial and sagittal slices of the desired parameters
- Images of similar quality to those found in the respective references were produced in this experiment
- The signal to noise ratio of the respective maps were of high quality

## DISCUSSION

- Here we selected methods and parameters that provide key MR parameters within a limited acquisition time
- The level of mask erosion required to calculate the volumes was undesirable; future work will need to limit the level of erosion
- Validating the accuracy of the measurements against other techniques could also improve the confidence in the measurements
- Data collected by this battery can be used for improved simulation of the Bloch equations with a Sum of Spin Vectors model [5]
- Production of a host of synthetic images would be possible from these data
- Quantifying additional parameters such as cerebral blood flow, diffusion and velocity would be an additional advancement to the model

## REFERENCES

- [1] Hongfu S, et al., MRM, 2013 (In Press)
- [2] Liu J, et al., Neuroimage, 2013;59(3):2560-2568
- [3] Voigt T, et al., MRM, 2010;64(3):725-733
- [4] Deoni, et al., MRM, 2005;53(1):237-241
- [5] Kwan RKS, et al., IEEE TMI, 1999;18(11):1085-1097

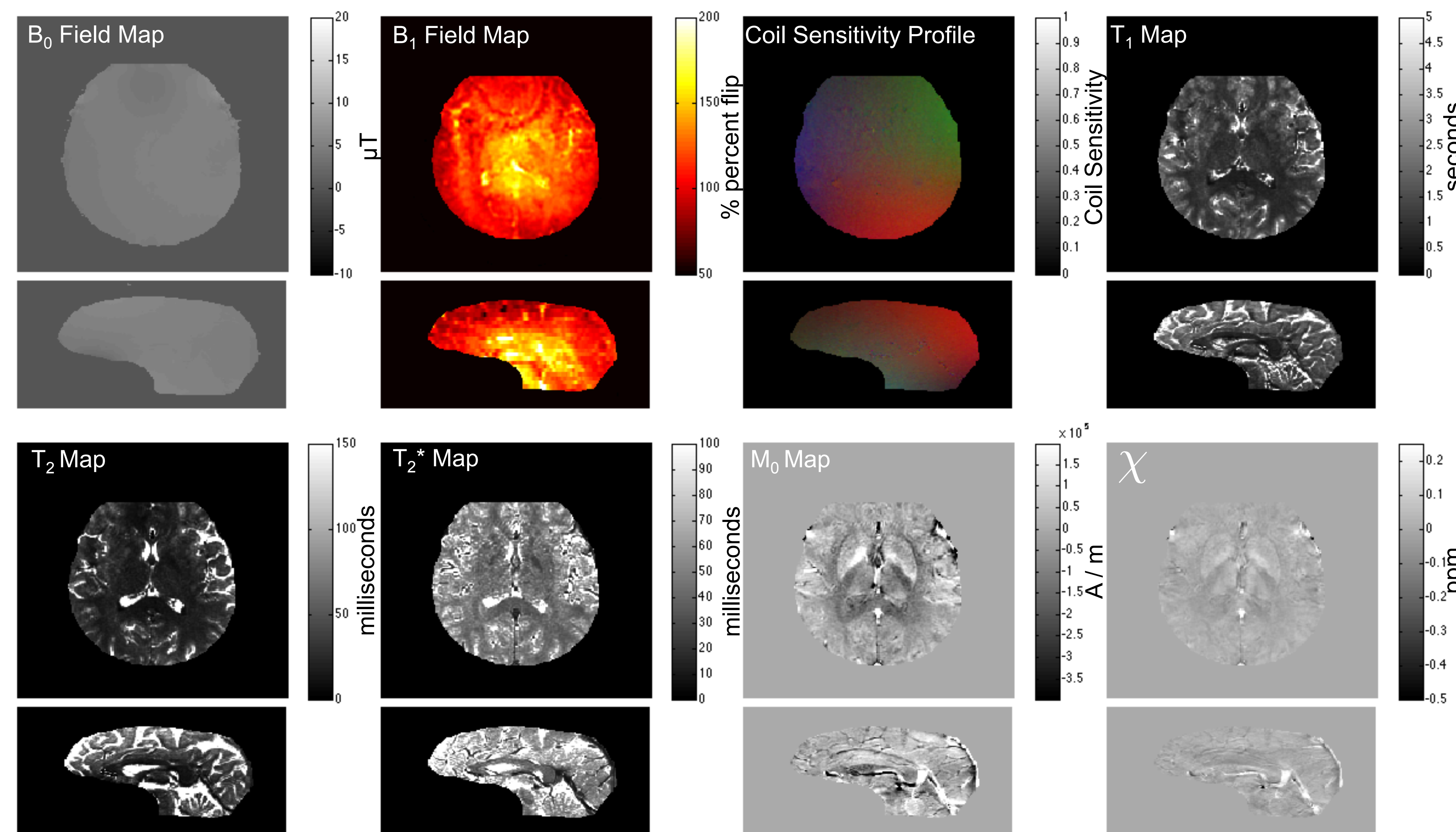


Figure 1: Parameter maps obtained from the protocol.

