StimFit: A toolbox for robust T2 mapping with stimulated echo compensation

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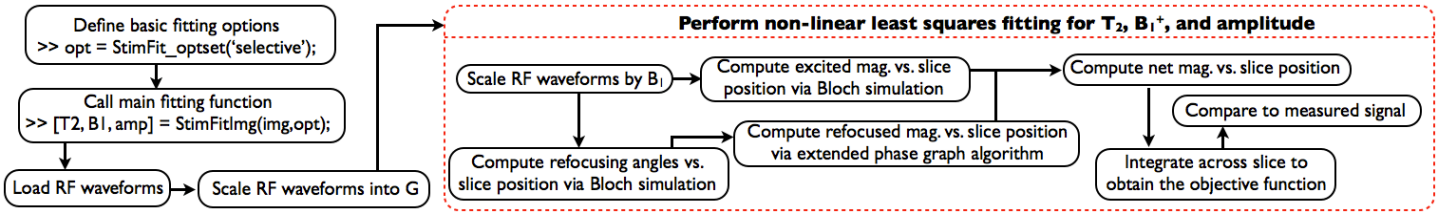
Introduction: Quantitative T_2 (or R_2) mapping provides an absolute measure of transverse relaxation that is independent of other confounding factors. It provides insight into tissue composition and pathology beyond that available with qualitative imaging. For example, myelin water imaging quantitates the relaxation of water bound within the myelin sheath, revealing the structural integrity of white matter; in neurodegenerative diseases, increased transverse relaxation rates are indicative of abnormally high tissue iron and T_2 may correlate with disease severity **[1]**. T_2 measurements are typically performed with a multi-echo spin echo sequence, but this is highly sensitive to transmit field heterogeneities (B_1^+), and in the case of slice selective imaging, to radio-frequency (RF) pulse shapes. In these cases, stimulated echoes confound the signal decay and preclude the use a mono- or multi-exponential fit. We recently proposed a fitting model to account for stimulated echoes, thus enabling accurate T_2 relaxometry despite B_1^+ heterogeneities and shaped RF pulses **[2]**. *In the spirit of collaborative research and to facilitate the implementation of this method, we present a freely available MATLAB toolbox, called* ***StimFit****, for robust quantitative T_2 mapping with stimulated echo compensation.*

Features: The toolbox is an easy to use package for T_2 quantitation from multi-echo spin echo images. The toolbox:

- fits slice-selective and non-selective images
- performs single component fits (non-linear least squares)
- performs multi-component fits (non-negative least squares)
- employs MEX functions to reduce computation time

The fitting procedure is summarized by the following flow chart:



Methods: Multi-echo spin echo images of a healthy volunteer and a postmortem MS patient were obtained on a 4.7 T Varian Inova scanner. Echo spacing was 10 ms, echo train length was either 20 or 32. Images from the MS patient were fit with a single component; images from the volunteer were fit with 150 discrete relaxation times ranging between 10 and 1000 ms to obtain the relaxation distribution. The multicomponent fit performs multiple fitting stages for both the optimal B_1^+ and for the relaxation distribution.

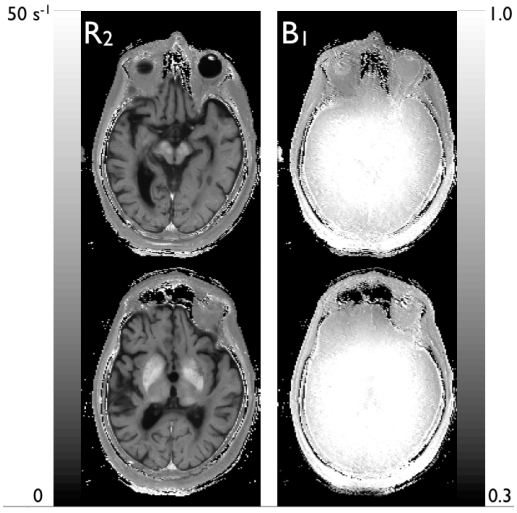
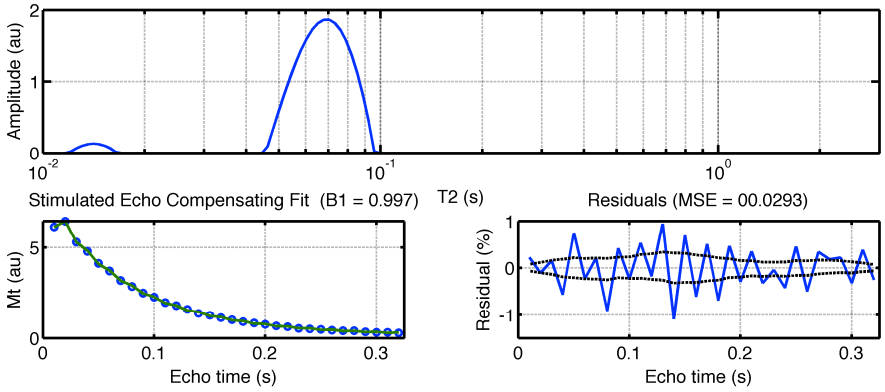


Figure 1 (left): Single component R_2 maps and relative B_1^+ fields of a postmortem MS patient obtained at 4.7 T and processed with the StimFit toolbox.

Figure 2 (below): Relaxation distribution from a single voxel from a multi-echo spin echo data set using a non-negative least squares fit.



Results: Figure 1 shows R_2 and B_1^+ maps from a two slice data set processed with a single relaxation time. Transmit heterogeneity is not visible in the relaxation maps and is properly attributed to the estimated B_1^+ field. Figure 2 shows a the relaxation distribution from a typical white matter voxel. The residual plot (difference between data points and fit) appears as noise and is free from structured information.

Conclusions: We present a package for transverse relaxometry with stimulated echo correction. This package fits both single and multiple components and is applicable to a wide range of studies. It is available for download from the "sharing" tab at http://mrel.usc.edu/.

References: **[1]** Schenck JF, NMR Biomed 2004. **[2]** Lebel RM, MRM 2010.