Myelin Water Fraction (MWF) Imaging using Flip angle mapping and a Dual Channel Transmit Coil at 3T

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INTRODUCTION: The quality of MWF Images[1] is highly dependent on the precision and profile of the B1 transmit field, to minimize effects of diffusion and stimulated echoes[2,3]. The latter can be accounted for in the fitting algorithm, by choosing the flip angle that best matches the observed echo-to-echo signal variation[4]. On the other hand, the quality of the B1 field can be improved by the use of multi-channel excitation. In the present work we explored the suitability of different data analysis methods for MWF, while taking into account the actual flip angle (FA) using these techniques.

METHODS: *MRprotocol.* Ten healthy young subjects (13±3y) volunteered to participate in an ERB approved study and were scanned at 3T (Skyra, Siemens Erlangen, 2ch body Tx and 32 ch head Rx) with A) MPRAGE; B) CPMG multi-SE (32 echoes, TE: 10ms-320ms, TR=5s, voxel size = 1.5×1.5×5 mm3, 1 slice), modified to have shorter RF pulse durations and increased 180° RF profile[2,3]. C) B1 mapping for each transmit channel was performed and combined to obtain FA maps using the manufacter's standard approach. Smooth, relative FA maps in percent of the nominal flip angle were derived by scaling to 100 and fitting with an 8th order polynomial.

Data analysis. MWF was fitted voxel-wise in three different ways, based on a regularized non-linear least square fits (Chi2 regularization: 1.01) of the echo decay via the extended graph method[4]:
1) Standard evaluation based on voxel-wise selection of the flip-angle that best accounted for stimulated echoes;
2) scaled FA approach: from 1) the median value across the slice was used to scale the relative FA map prior to voxel-wise fitting, and 3) expected FA approach: a nominal flip angle of 180 was used to scale the relative FA map. For each subject, the T2spectra of each approach was assessed in the corticospinal tract (CST), and the MWF values evaluated in grey and white matter voxels identified in coregistered MPRAGE images by segmentation in SPM8.

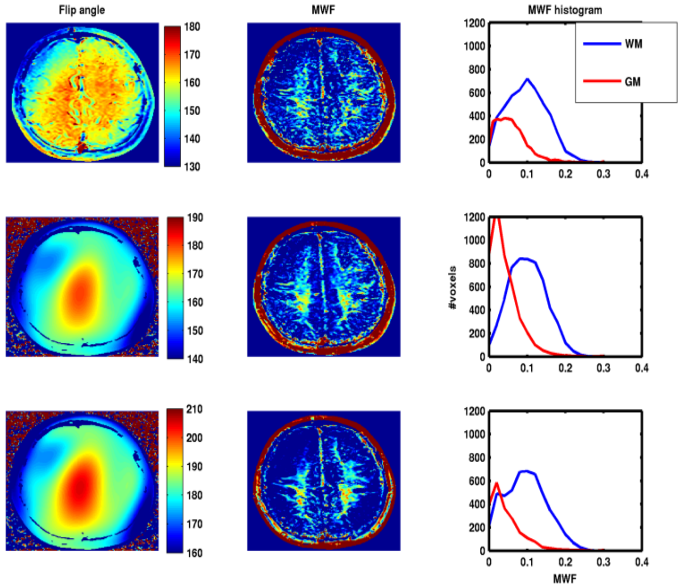

Fig. 1 Results from1) standard approach (first row);2) two-pass scaled FA (middle row) and 3) based on the expected 180° (last row). The two-pass approach yielded a more narrow MWF distribution in

RESULTS, DISCUSSION: The sum of the squared residuals of the fits for the CST was 106(range. 39-2100); 112(37-1574); and 404(56-1190) for approach 1), 2), and 3), respectively. The MWF distribution in WM voxels was slightly more peaked for approach 2. The mean(standard deviation) across the 10 subjects in the white matter voxels was not significantly different ($p<0.05$, paired ttest) for the three methods:.09(.02); .07(.03); and 07(.2); in contrast to grey matter voxels: .04(.01); .03(.01), and .03(.01).

The fitted B1 maps obtained by the standard approach have a similar profile to measured FA maps, but the observed local anatomical variation is unlikely. Fitting based on the expected 180° pulses lead to broadened spectra, and occasional difficulties to separate between components (Fig.2).

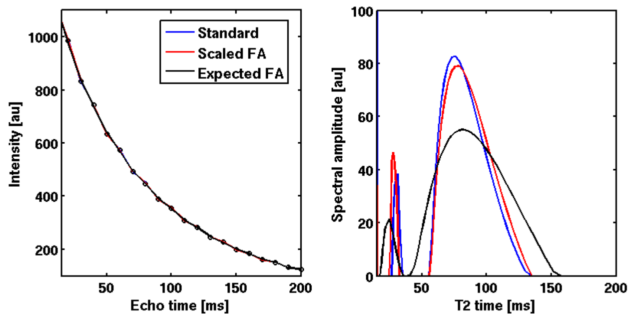

Fig. 2: T2 decay curves measured by CPMG averaged across the CST roi and fitted T2 spectra using three methods

CONCLUSION. Using a two-step approach based on measured FA maps scaled to the first pass fitted FA seems to be a viable approach to improve the MWF maps, without a too high cost in terms of goodness-of-fit or distinction between components.

References:
(1) Laule C, et al. *Mult. Scler.* 17:144(2011); (2) Pell G et al., JMRI 23:248(2006), (3) Gao et al., MRM *in press* (2012) (4) Prasloski T, et al; MRM 67:1803 (2012).