**Ronja Berg[1,2], Tobias Leutritz[3], Stephan Kaczmarz[1,2], Claus Zimmer[1,2], Nikolaus Weiskopf[3], Christine Preibisch[1,2]**

[1] Technical University of Munich, Department of Neuroradiology, School of Medicine, Munich, Germany, [2] Technical University of Munich, TUM Neuroimaging Center, Munich, Germany,
[3] Max Planck Institute for Human Cognitive and Brain Sciences, Department of Neurophysics, Leipzig, Germany

Klinikum München Rechts der Isar

Neuro Magnetic Resonance Munich

# Evaluating Compressed SENSE acceleration for multi-parametric quantitative mapping of R1, R2*, PD, and MTsat with the hMRI toolbox

Quantitative MRI

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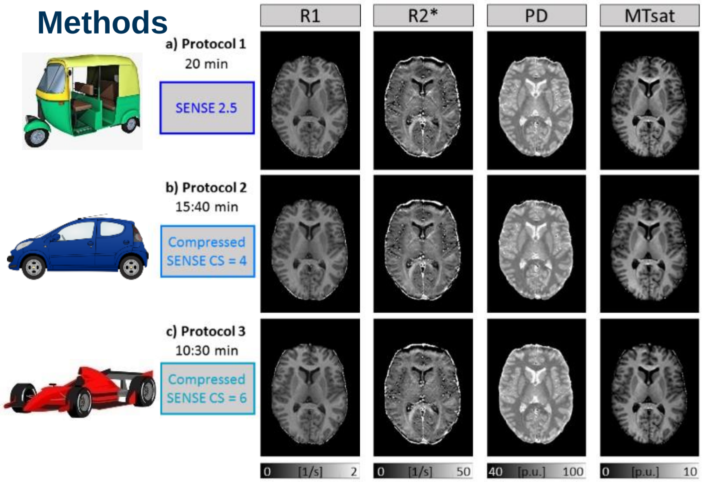
## Purpose

We compared measurements of the longitudinal relaxation rate R1 (=1/T1), transverse relaxation rate R2* (=1/T2*), proton density (PD), and magnetization transfer saturation (MTsat) between accelerations with standard SENSE and Compressed SENSE.

## Finding

Compressed SENSE[1] (CS), with acceleration factors up to at least 6, can be used for quantitative mapping of R1, R2*, PD, and MTsat without loss of fidelity.

## Methods




Imaging parameters

B1 map: α=60°, 3.5x3.5x5mm³, 70 slices, TE/TR=2.3/30ms

R1, R2*, PD: 2 x 3D FFE, α1=4°, α2=25°, TE/ΔTE/TR = 2.4/2.4/18ms

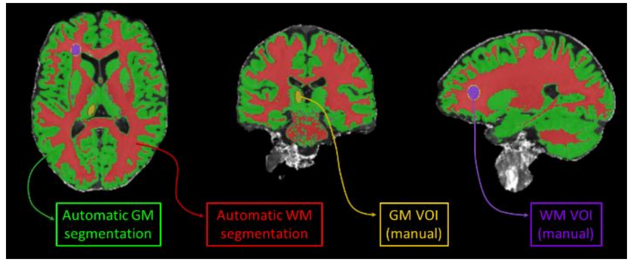
MTsat: 3D FFE, α=6°, TE/ΔTE/TR = 2.4/2.4/48ms

res:1x1x1mm³ 176 slices, 6 echoes

### Cohort

- n=5, 3w/2m
- aged 23-49
- healthy

### Exemplary brain regions for quantitative analysis




## Introduction

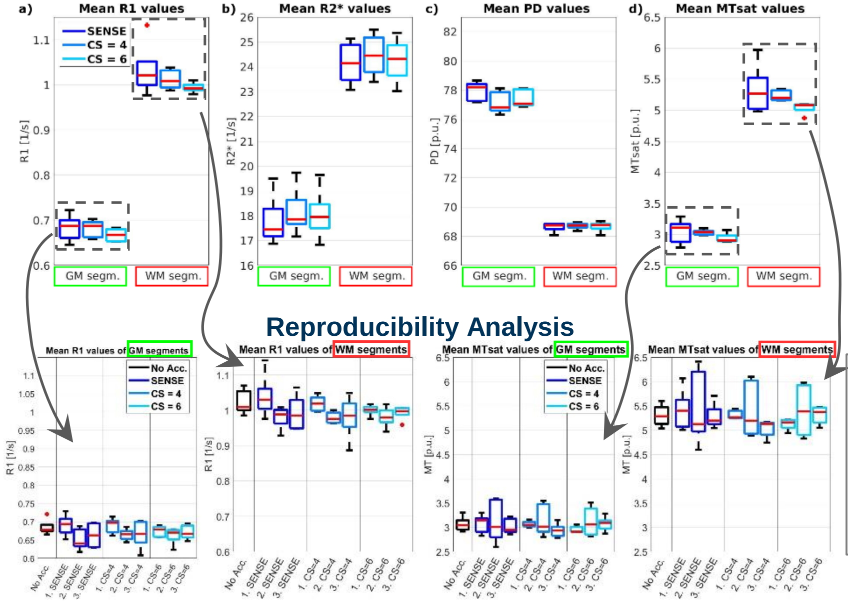
The measurement of quantitative parameters could be valuable for diagnostic applications as absolute values are assumed to be sequence and hardware independent.[2,3] Quantitative multi-parameter mapping techniques, such as the variable flip angle approach[2,3], increase the measurement time compared to conventional weighted (T1w, T2*w, PDw) MRI.

## Conclusion

Compressed SENSE is highly promising for establishing quantitative R1, R2*, PD and MT mapping within clinically feasible scan times.

## Results

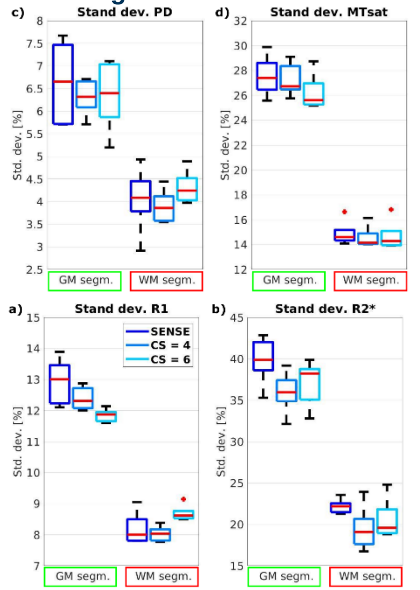
### Whole brain GM & WM segments



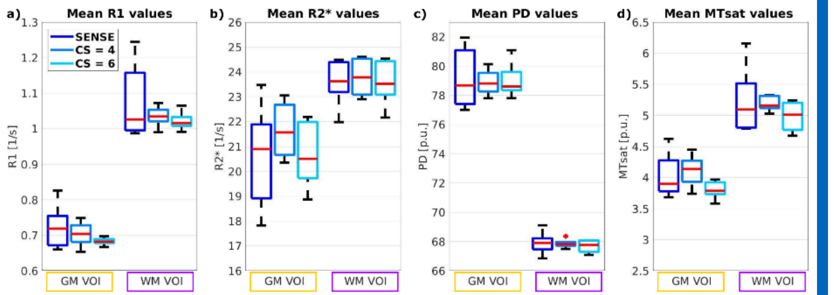

Boxplots of subject-mean quantitative R1, R2*, PD, and MTsat parameters of whole brain GM and WM segments (5 subjects)

- Rescanning each accelerated sequence twice (3 scans) to investigate reproducibility of SENSE and CS outcomes
- Inclusion of scans with no acceleration (as reference)

### Average Standard Deviation




### Manual elliptical GM & WM VOIS




## Discussion

- Quantitative values of R1, R2*, PD, and MTsat in GM and WM segments agreed well between scan protocols and depend neither on acceleration technique nor factor
- The reduced VOI-average variation across subjects by CS, especially for R1 and MTsat values (dashed boxes), could not be verified in the reproducibility analysis
- Standard deviations of parameter values within GM and WM segments were very similar across accelerations

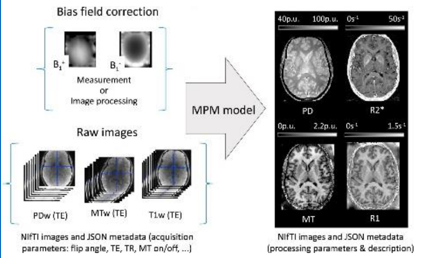
### Materials & Methods

- 3T Elition (Philips Healthcare) with release R5.5
- 32-channel head-coil
- R1, R2*, and MTsat maps were computed using the hMRI toolbox[4,5], correcting for B1-inhomogeneities (via B1 mapping[6]) & insufficient RF spoiling[2,3]
- Segmentation of GM and WM with SPM12[7]
- Threshold for defining GM & WM segments: 0.75
- GM Mask: R2* < 40 $s^{-1}$ (T2* > 25 ms) for single measurements and R2* < 25 $s^{-1}$ (T2* > 40 ms) for reproducibility analysis
- Analysis of VOIs: Vinci 4.43.[8]
- VOIs: GM: thalamus, WM: fronto-subcortical

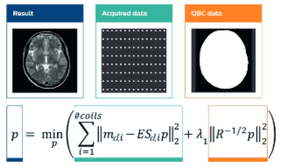
### Box plots

- Mean values of all five subjects
- Red line: median of mean values of each subject
- Edges of box: 25th and 75th percentiles

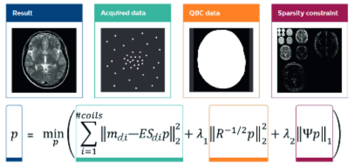
### Map creation (hMRI toolbox)[4]




### Standard SENSE[1]




### Compressed SENSE[1]




Contact: ronja.berg@tum.de

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[3] Baudrexel, S., Nöth, U., Schüre, J. R., & Deichmann, R. (2018). T1 mapping with the variable flip angle technique: A simple correction for insufficient spoiling of transverse magnetization. Magnetic resonance in medicine, 79(6), 3082-3092. [4] Tabelow, K., Balteau, E., Ashburner, J., Callaghan, M. F., Draganski, B., Helms, G., ... & Reimer, E. (2019). hMRI–A toolbox for quantitative MRI in neuroscience and clinical research. Neuroimage, 194, 191-210. [5] Weiskopf, N., Mohammadi, S., Lutti, A., & Callaghan, M. F. (2015). Advances in MRI-based computational neuroanatomy: from morphometry to in-vivo histology. Current opinion in neurology, 28(4), 313-322.
[6] Yarnykh, V. L. (2007). Actual flip-angle imaging in the pulsed steady state: a method for rapid three-dimensional mapping of the transmitted radiofrequency field. Magnetic Resonance in Medicine, 57(1), 192-200. [7] www.fil.ion.ucl.ac.uk/spm. [8] VINCI: Volume Imaging in Neurological Research Co-Registration and ROIs Included: http://vinci.sf.mpg.de.

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