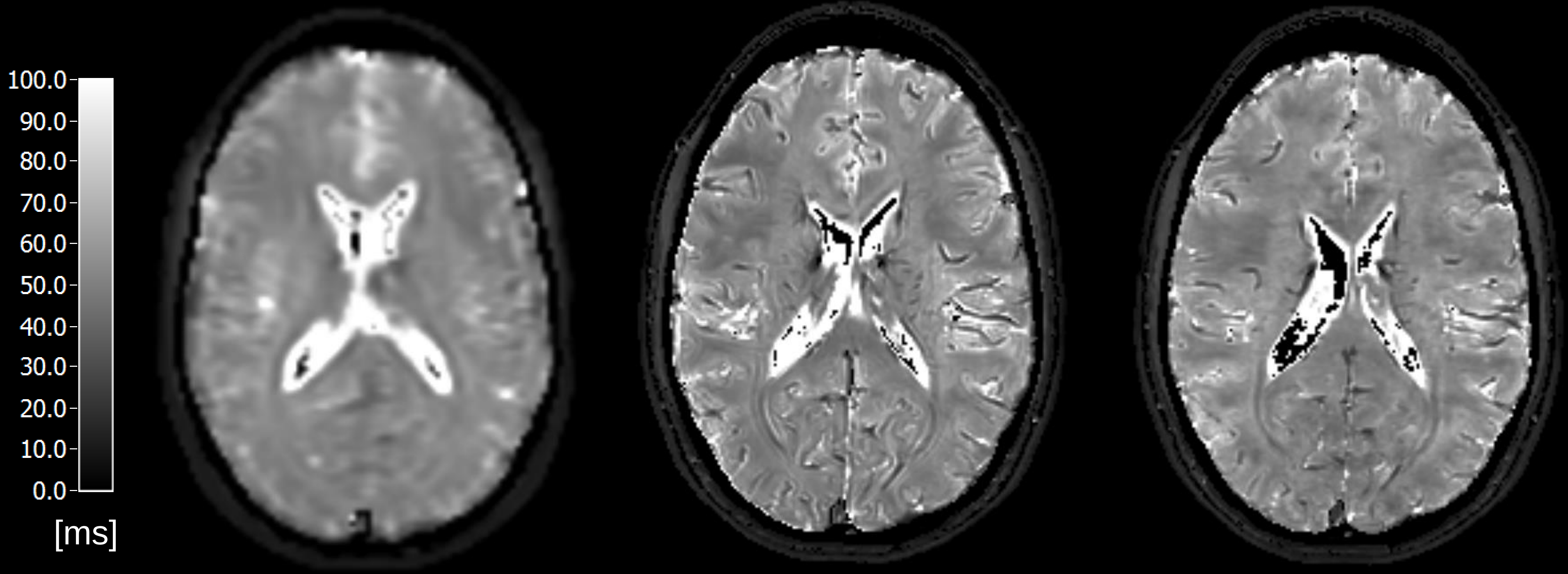
2D-GRE (2x2x3 mm^3)
no acceleration
03:39 min

3D-GRE (1x1x2 mm^3)
no acceleration
11:15 min

3D-GRE (1x1x2 mm^3)
CSAI $R = 6$
02:07 min



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Technische Universität München

Accelerated High-Resolution 3D Gradient Echo with DL-Based Reconstruction Improves T2* Mapping for Oxygenation-Sensitive MRI

Elisa Saks[1,2], Gabriel Hoffmann[1,2], Hannah Eichhorn[3,4], Kilian Weiss[5] , Stephan Kaczmarz[1,2,5], Claus Zimmer[1] , Christine Preibisch[1,2,6]

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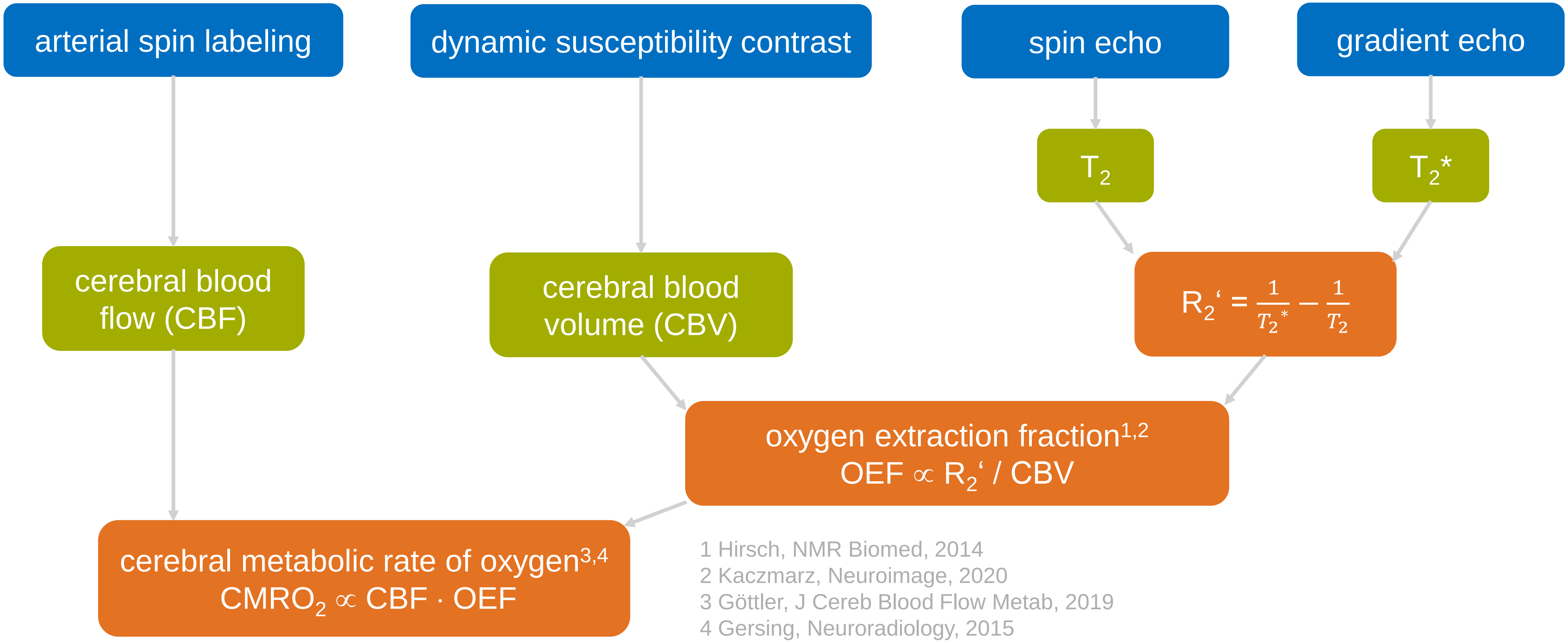
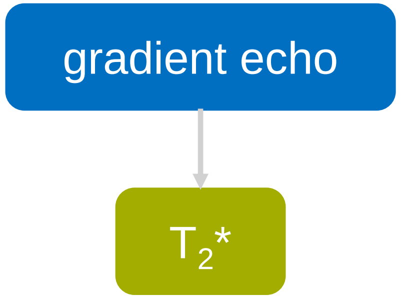
Background

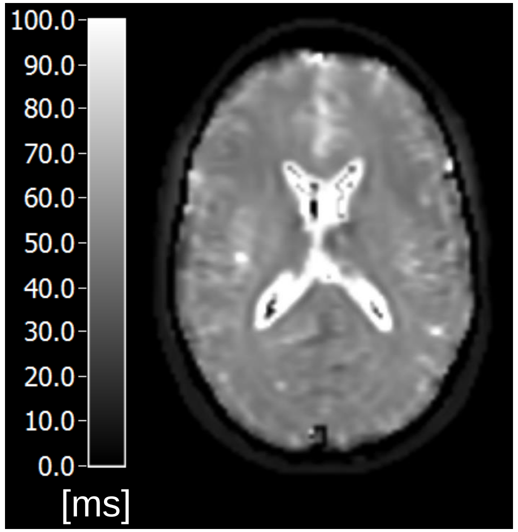
multi-parametric quantitative BOLD (mqBOLD):



1 Hirsch, NMR Biomed, 2014
2 Kaczmarz, Neuroimage, 2020
3 Göttler, J Cereb Blood Flow Metab, 2019
4 Gersing, Neuroradiology, 2015

Motivation and Goal





2D multi-slice multi-echo GRE sequence

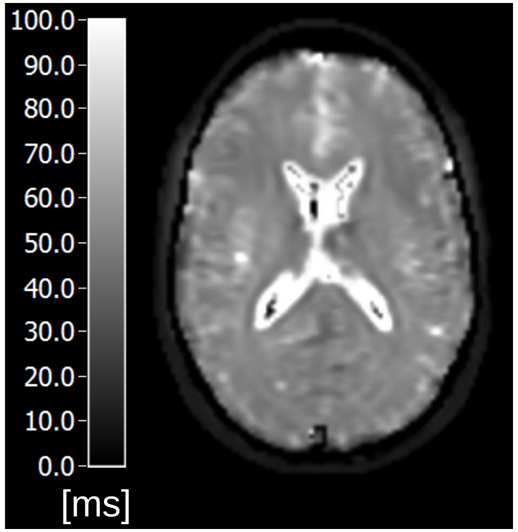
- voxel size: 2x2x3 mm^3
- acq. time: 3:39 min
- affected by magnetic background field gradients (mBFG)
  → correction algorithm in post-processing[5,6]

5 Baudrexel, Magn Reson Med, 2009 / 6 Hirsch, AJNR, 2013

Motivation and Goal

gradient echo

T_2^*



Goal: Improved T2* Mapping

- stable T2* values across mBFG strengths

→ reduced voxel size[7]

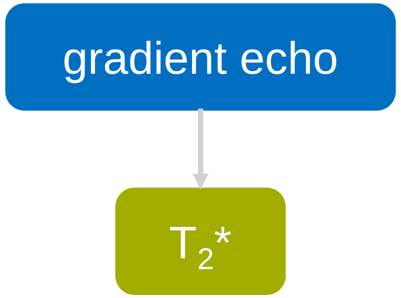
→ 3D acquisition[8]

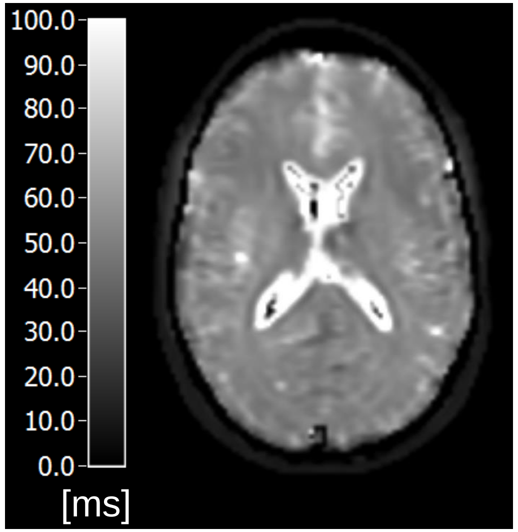
Comparison #1

low-resolution 2D-GRE vs. high-resolution 3D-GRE

7 Young, Magn Reson Imaging, 1988 / 8 Haacke, Radiology, 1989

Motivation and Goal





Goal: Improved T2* Mapping

- high-resolution 3D-GRE = long scan time

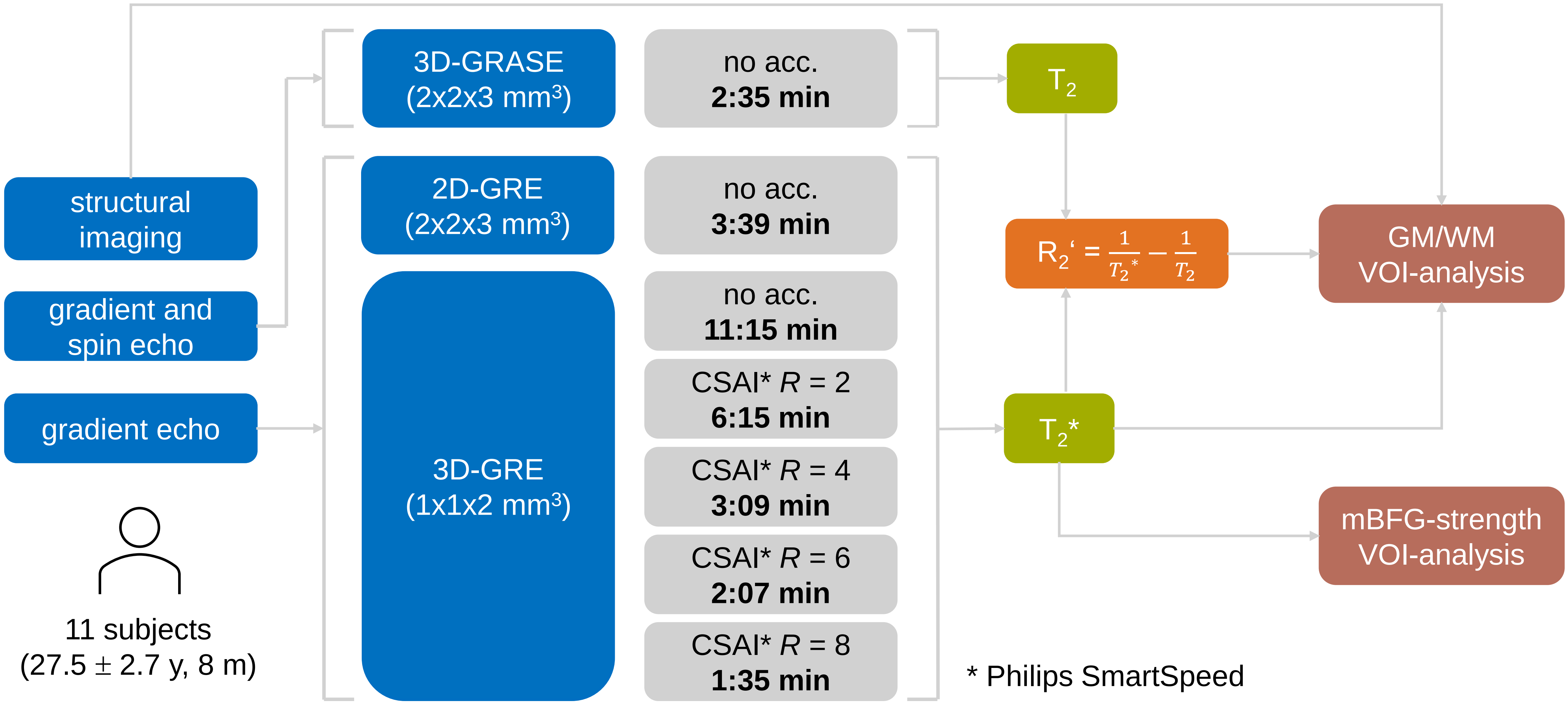
→ acceleration using a deep learning integrated compressed sensing approach[9] (CSAI)

Comparison #2

fully-sampled vs. accelerated high-resolution 3D-GRE with different acceleration factors

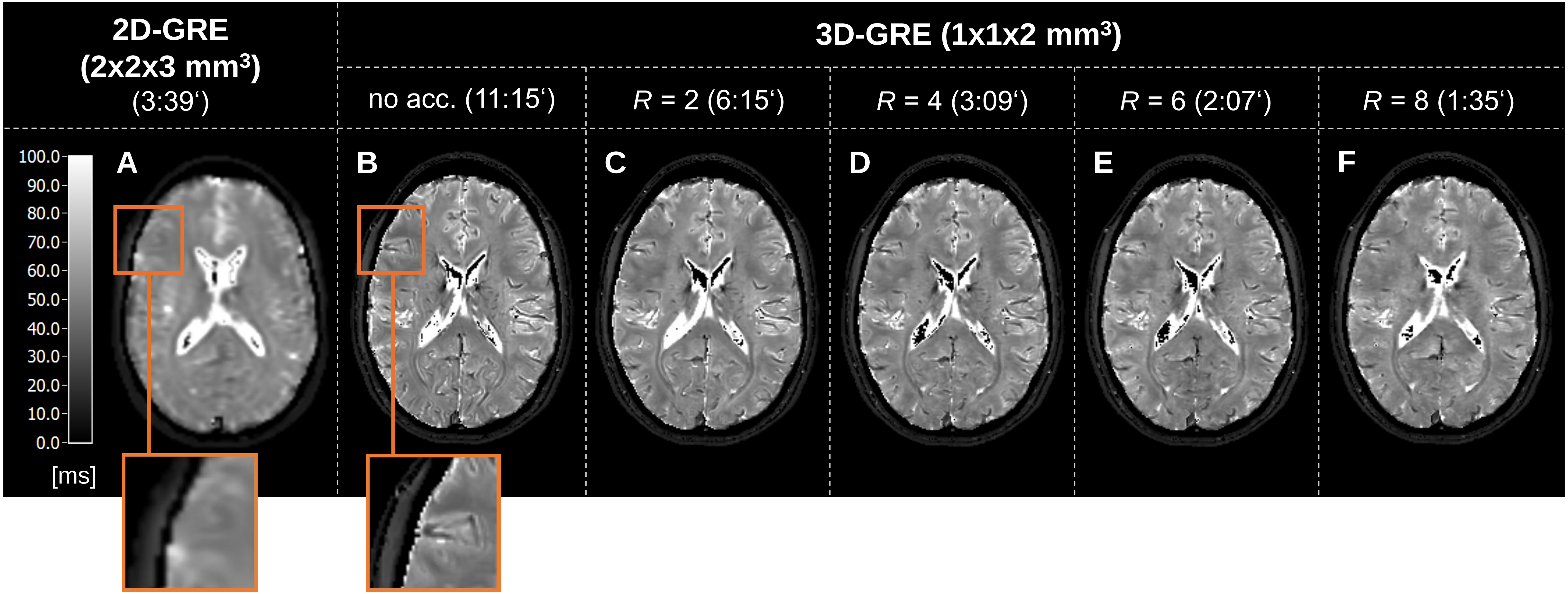
9 Pezzotti, IEEE Access, 2020

Methods


structural imaging
gradient and spin echo
gradient echo
11 subjects
(27.5 ± 2.7 y, 8 m)
3D-GRASE
(2x2x3 mm³)
no acc.
2:35 min
2D-GRE
(2x2x3 mm³)
no acc.
3:39 min
3D-GRE
(1x1x2 mm³)
no acc.
11:15 min
CSAI* R = 2
6:15 min
CSAI* R = 4
3:09 min
CSAI* R = 6
2:07 min
CSAI* R = 8
1:35 min
T_2
$R_2' = \frac{1}{T_2^*} - \frac{1}{T_2}$
T_2^*
GM/WM VOI-analysis
mBFG-strength VOI-analysis
* Philips SmartSpeed

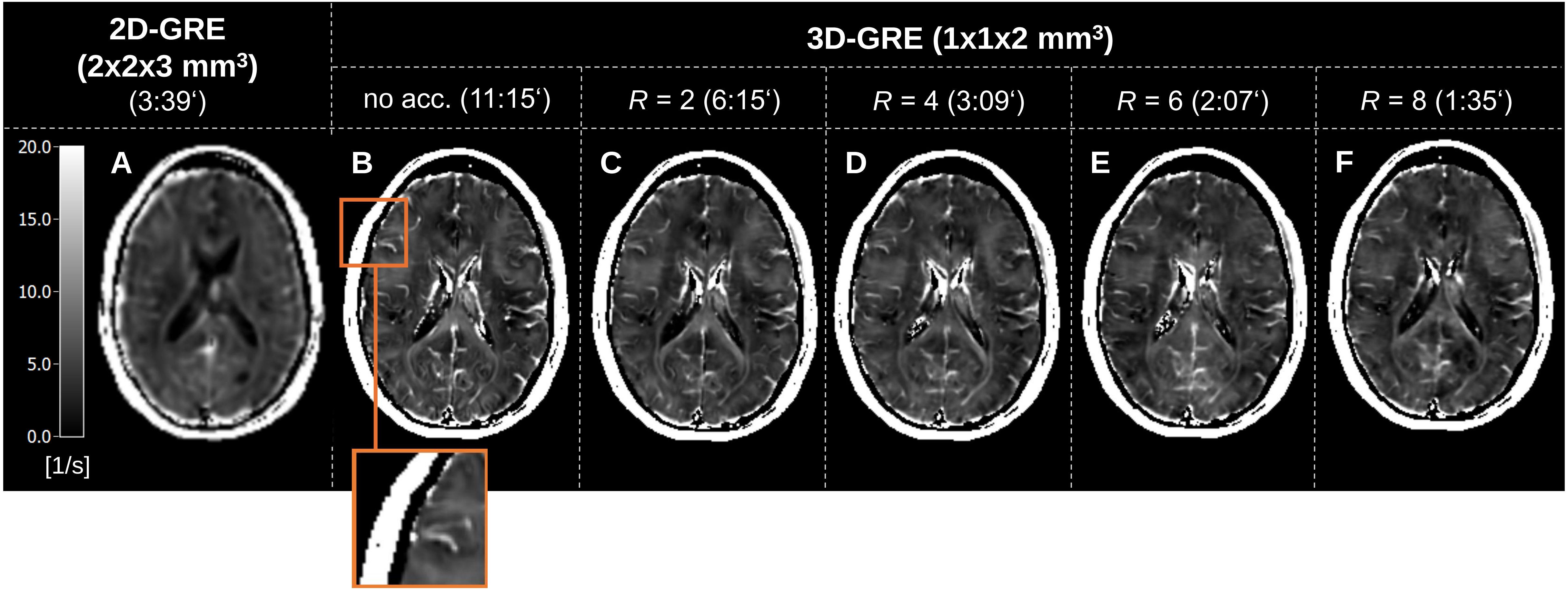
Results

visual inspection: T_2* parameter maps



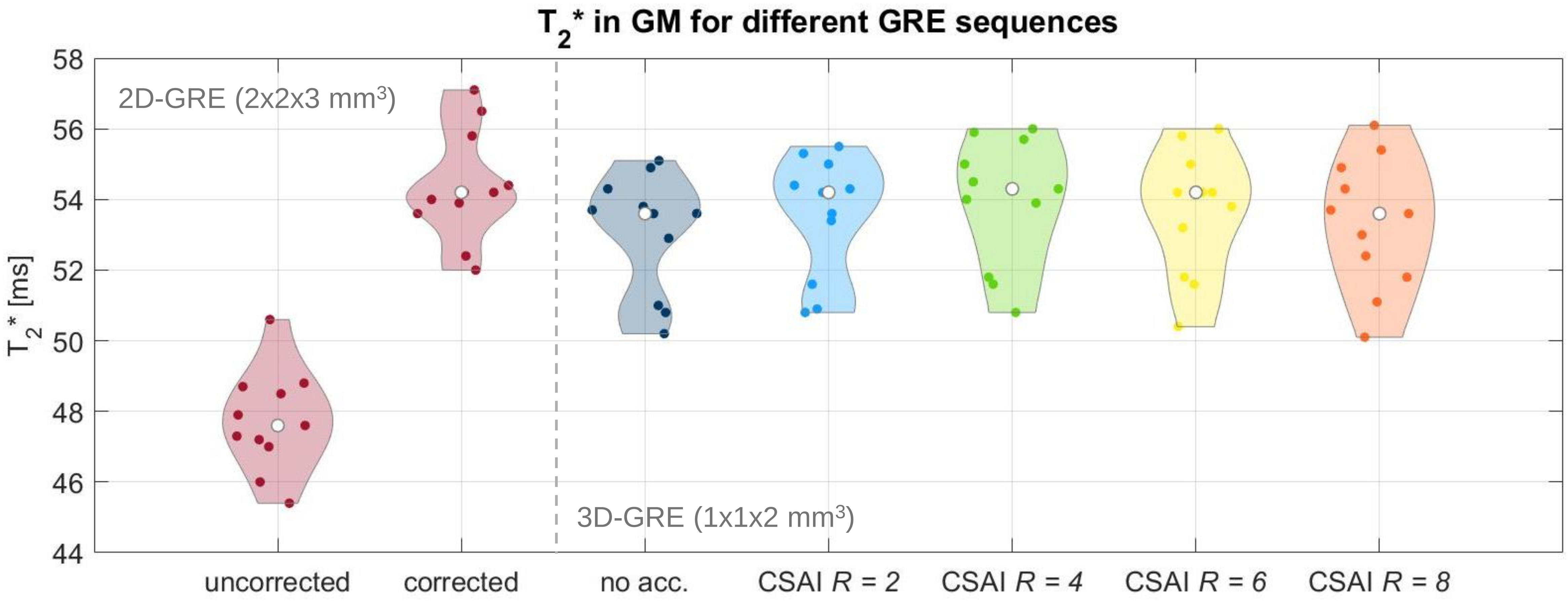
Results

visual inspection: R_2' parameter maps



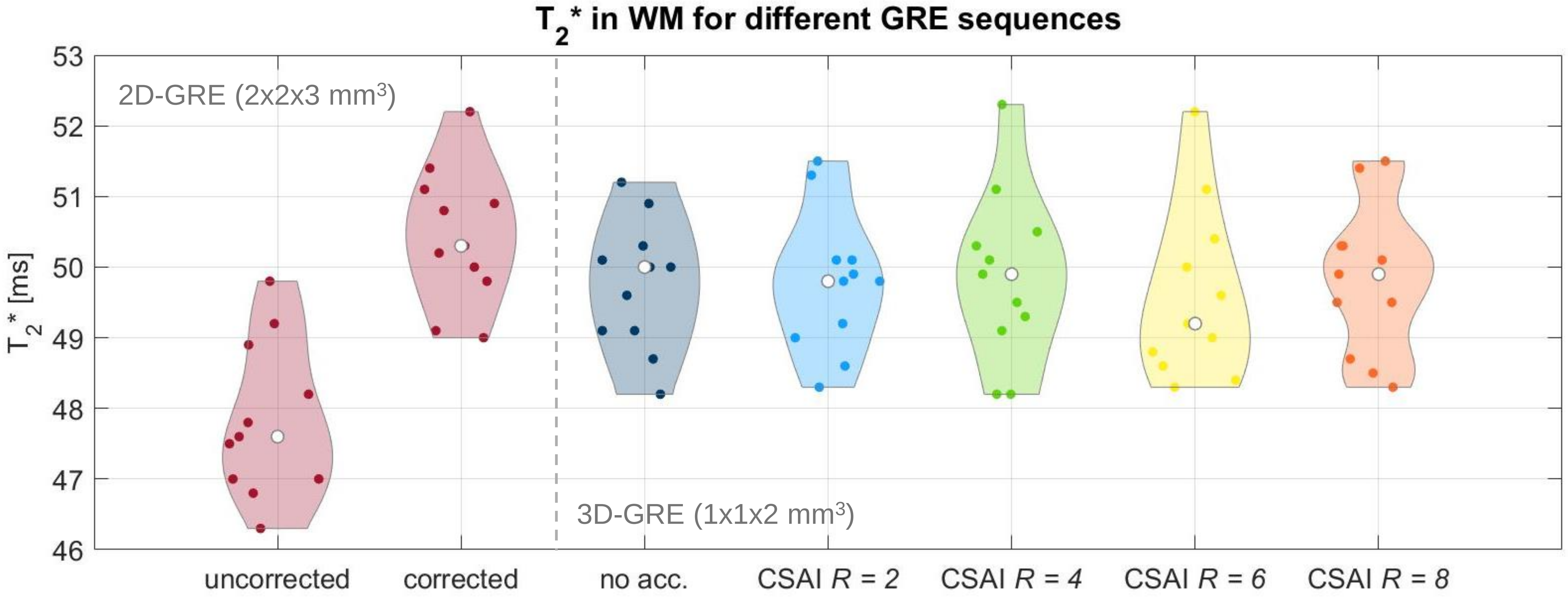
Results

T_2* VOI analysis in gray matter (GM)



Results

T_2* VOI analysis in gray matter (GM)



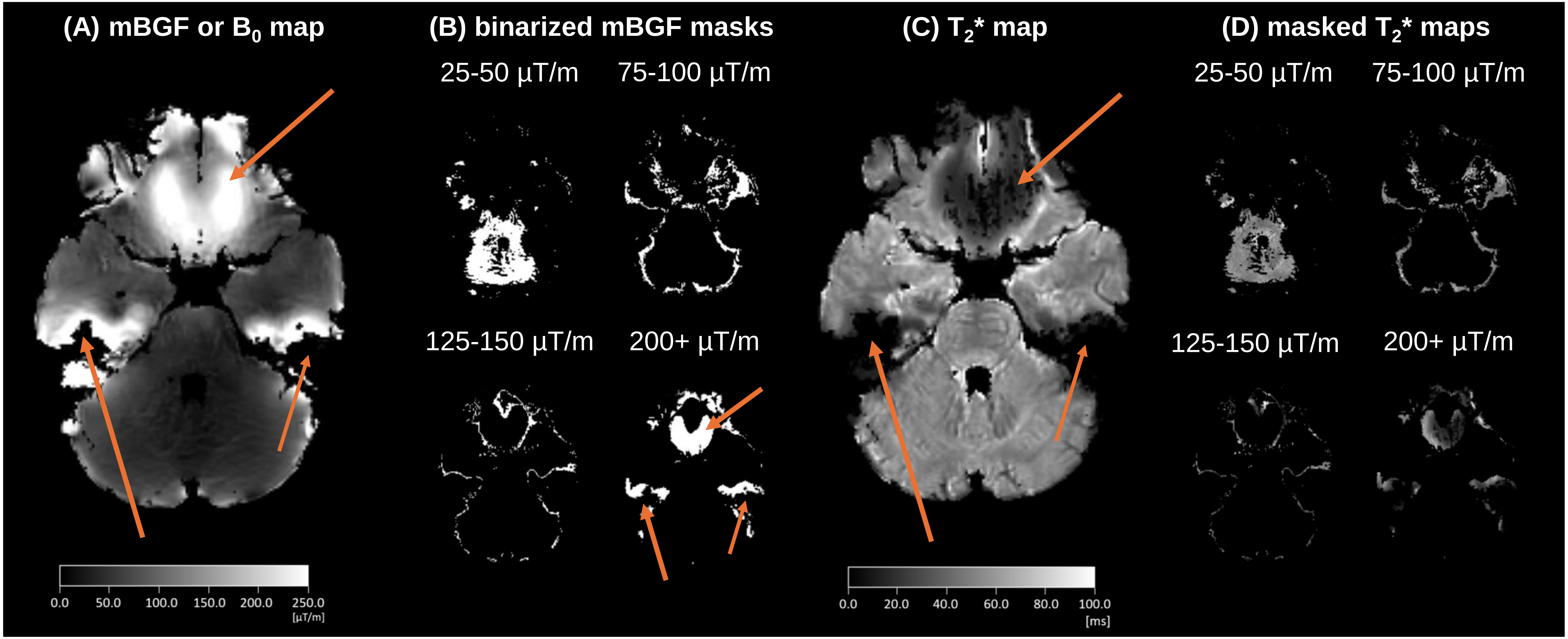
Results

VOI analysis in gray and white matter (GM/WM)

	VOI (tissue type)	T_2 3D-GRASE ($2x2x3\ mm^3$)	2D-GRE T_2* ($2x2x3\ mm^3$) uncorr.	3D-GRE T_2* ($1x1x2\ mm^3$)				
				no acc.	*R* = 2	*R* = 4	*R* = 6	*R* = 8
T_2/T_2* [ms]	GM	80.3 ± 1.8	47.7 ± 1.2	**53.1 ± 1.7 ***	**53.5 ± 1.7 ***	**54.0 ± 1.8 ***	**53.7 ± 1.8 ***	**53.3 ± 1.9 ***
	WM	68.1 ± 1.2	47.8 ± 1.1	**49.7 ± 0.9 ***	**49.8 ± 1.0 ***	**49.9 ± 1.2 ***	**49.6 ± 1.2 ***	**49.8 ± 1.1 ***
R_2‘ [Hz]	GM	-	7.7 ± 0.6	7.9 ± 0.9	7.3 ± 0.8	7.0 ± 0.7	7.2 ± 1.0	7.2 ± 0.8
	WM	-	5.8 ± 0.5	6.0 ± 0.5	5.8 ± 0.5	5.7 ± 0.5	5.9 ± 0.7	5.7 ± 0.5

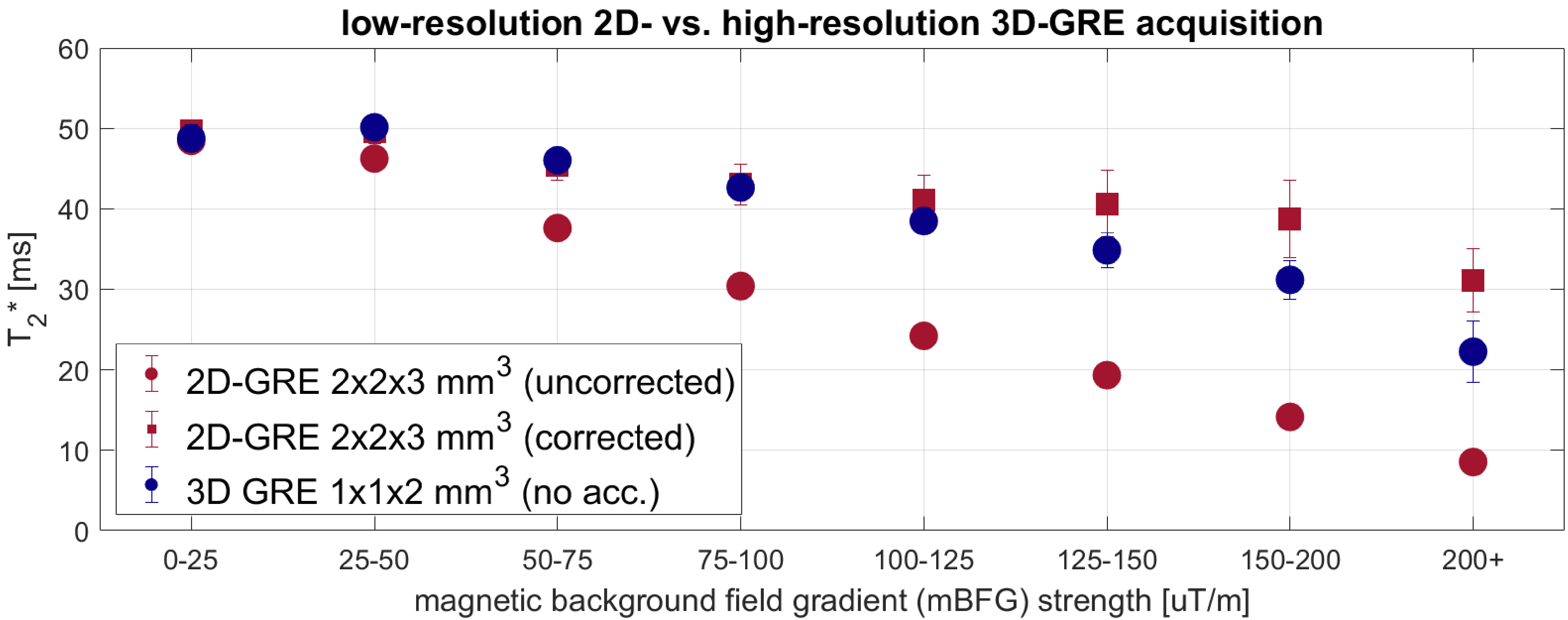
Results

magnetic background field correction VOI analysis



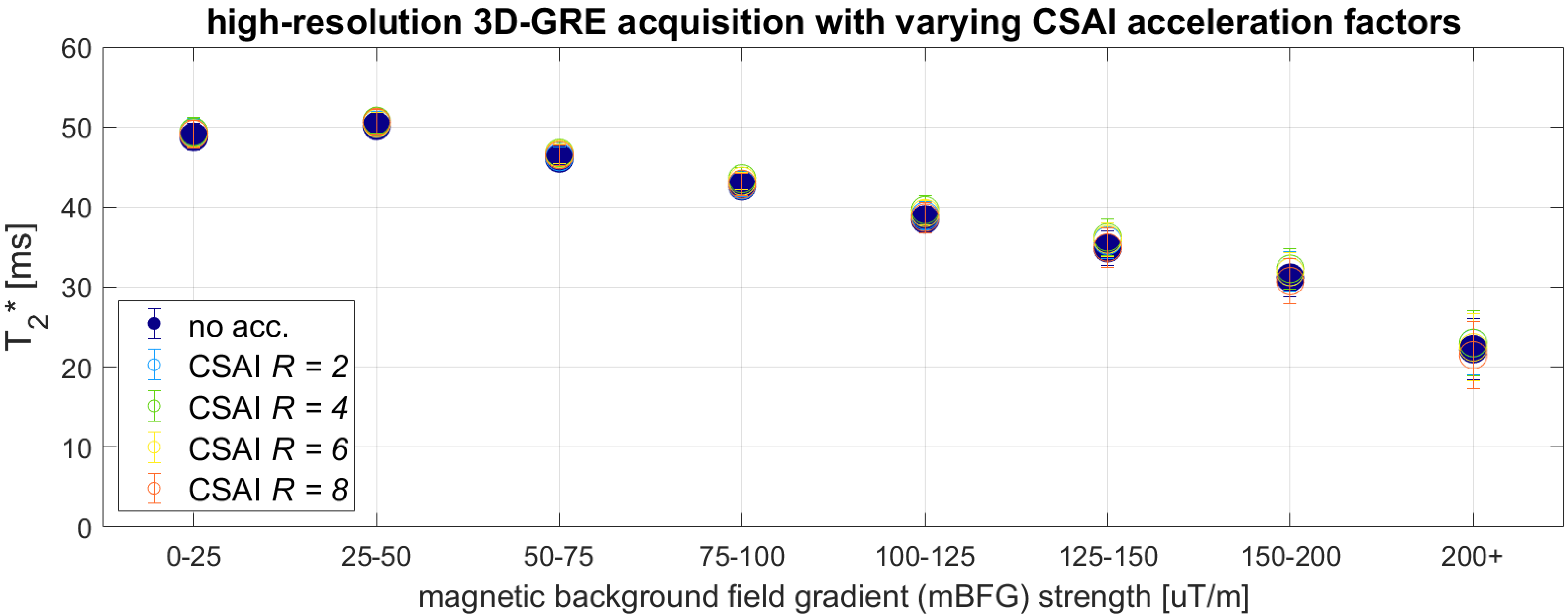
Results

magnetic background field correction VOI analysis



Results

magnetic background field correction VOI analysis



Conclusion and Outlook

2D-GRE → high-resolution 3D-GRE with CSAI acceleration

✓ higher spatial resolution leading to improved T2* mapping

✓ reduced intrinsic susceptibility to magnetic background field gradients

✓ faster acquisition possible

in the future

- mBFG corretion algorithm for 3D-GRE
- correction for subject motion

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Thank you for your attention!