



FACULTY OF  
NATURAL SCIENCES



# $T_1$ -weighted *in vivo* human whole brain MRI dataset with an ultrahigh isotropic resolution of 250 $\mu\text{m}$

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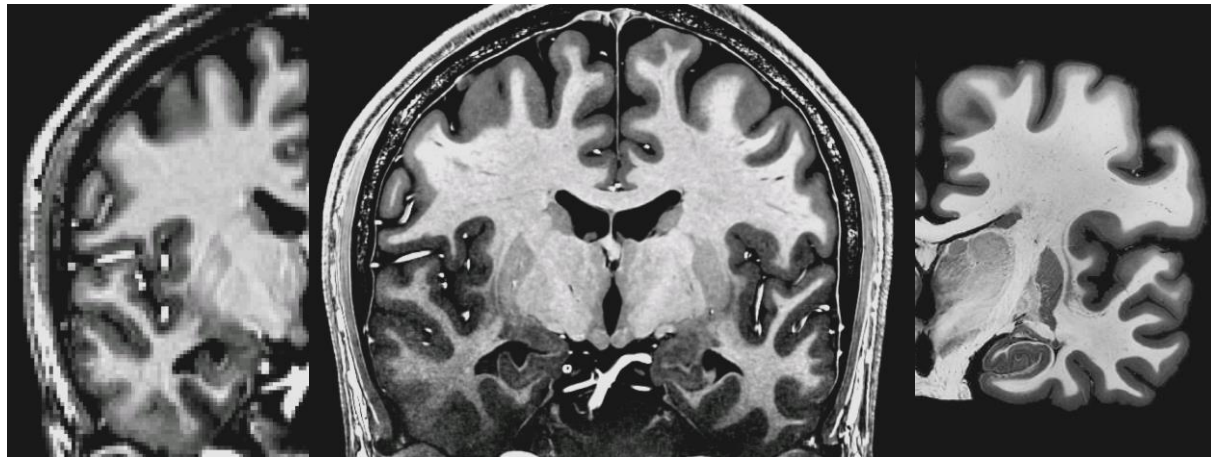
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<sup>4</sup> Leibniz Institute for Neurobiology, Magdeburg, Germany

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# Closing the gap between non-invasive imaging and histology



1 mm

250  $\mu\text{m}$  Histology (Heidenhain-  
Woelcke-Nissl stain)

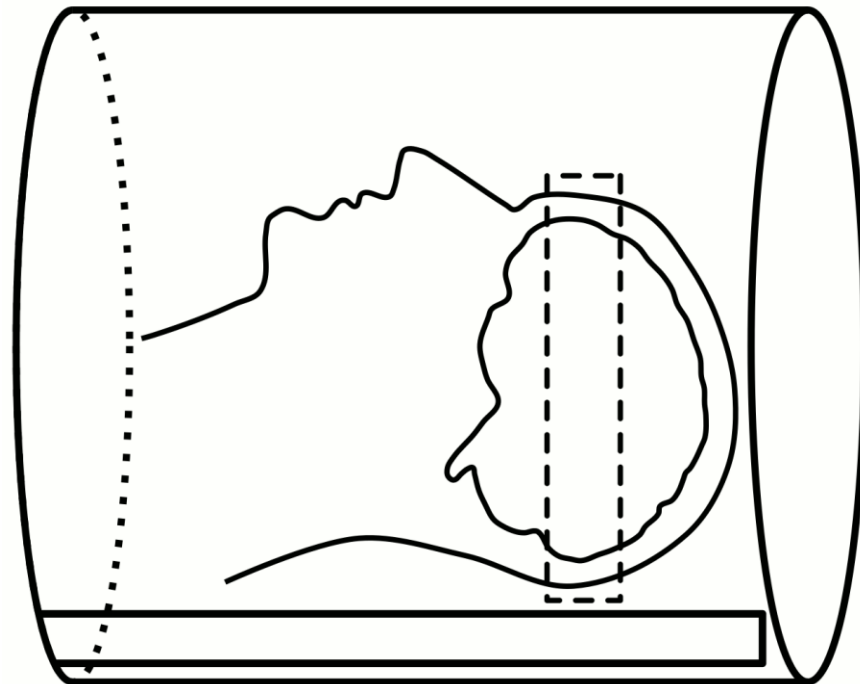
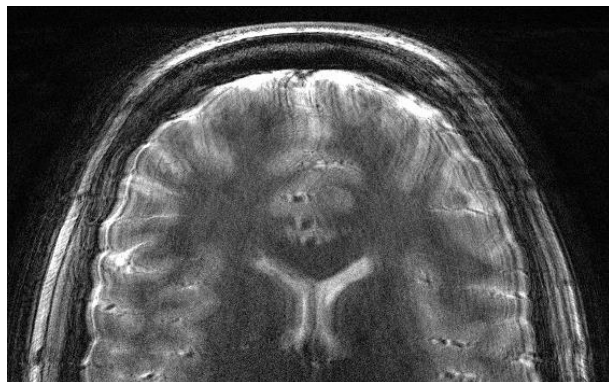
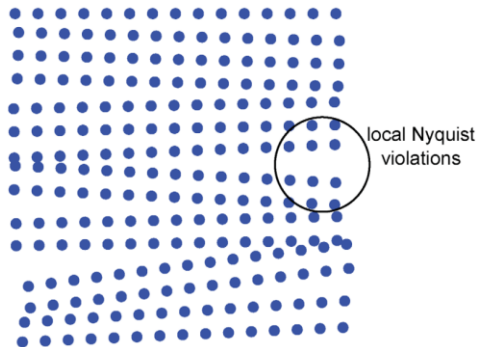
## MPRAGE parameters @ 7T

- 32-channel head coil (Nova Medical, Wilmington, MA, USA)
- Single subject

Voxel size [ $\mu\text{m}$ ]	TR [ms]	TE [ms]	TI [ms]	FA [ $^{\circ}$ ]	BW [Hz/px]	SPF	PPF	Matrix Size	ToA [min]
250	3580	2.41	1210	5	440	6/8	8/8	880x880x640	$\approx 53$
500	2740	3.24	1050	5	130	6/8	8/8	416x416x352	$\approx 19$
1000	2500	4.62	1050	5	130	8/8	8/8	256x256x192	$\approx 11$

➤ Exceptionally long time of acquisition requires motion correction

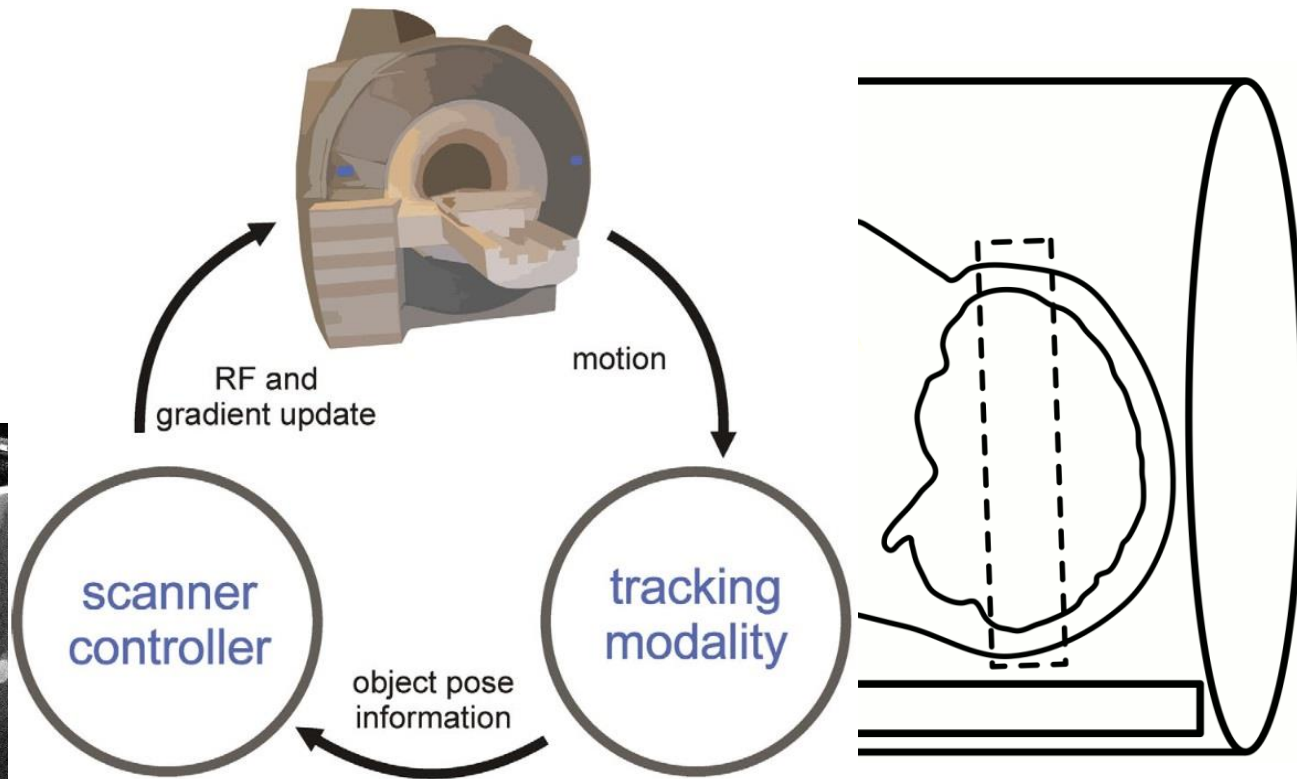
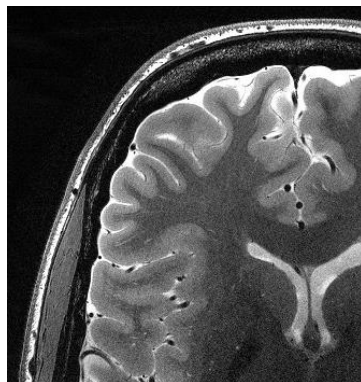
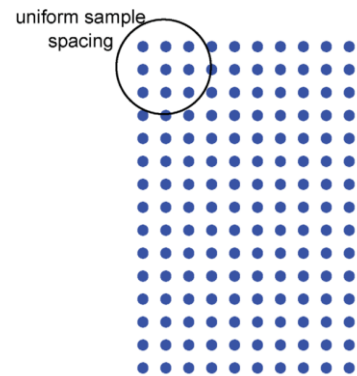
# Without motion correction



[1] Maclaren et al. (2012)

[2] Maclaren et al. (2013)

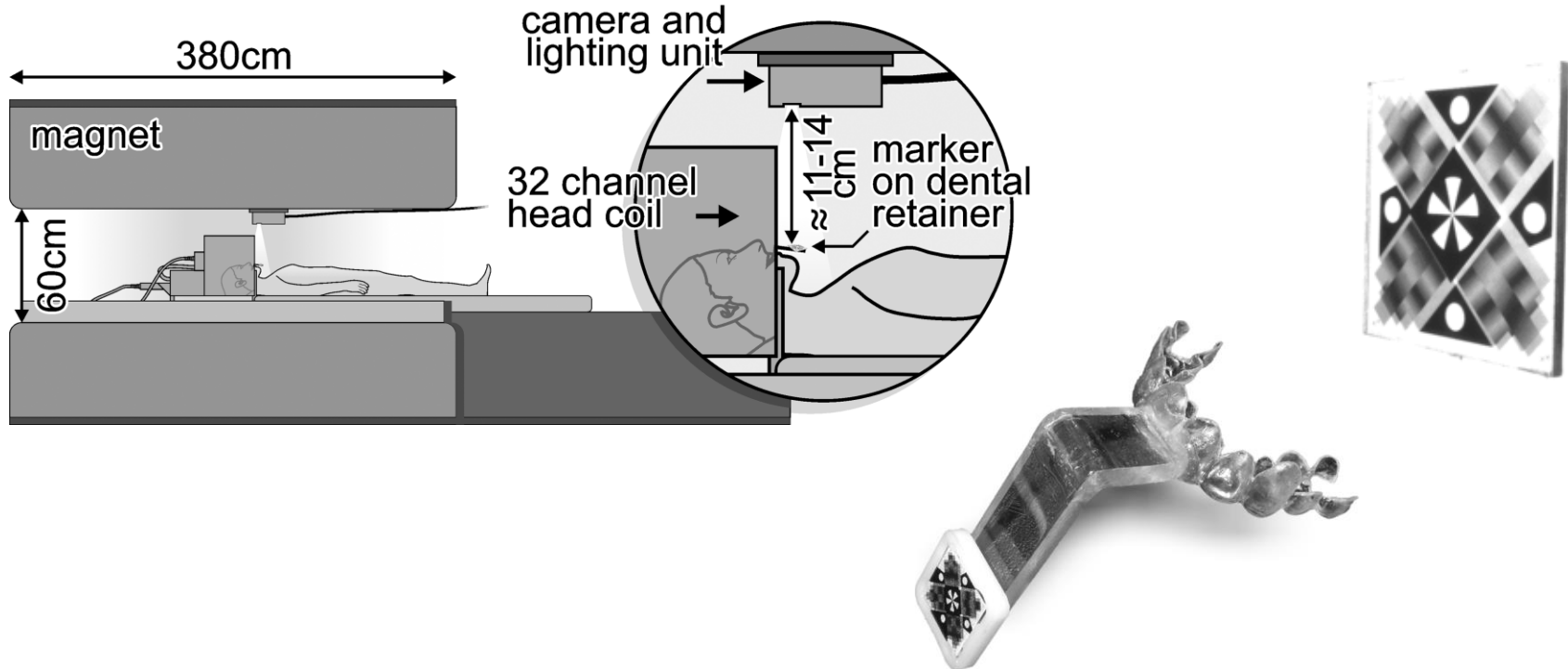
# Prospective motion correction



[1] Maclaren et al. (2012)

[2] Maclaren et al. (2013)

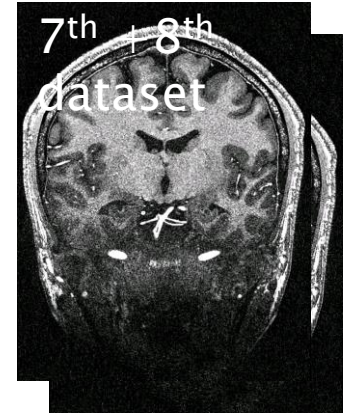
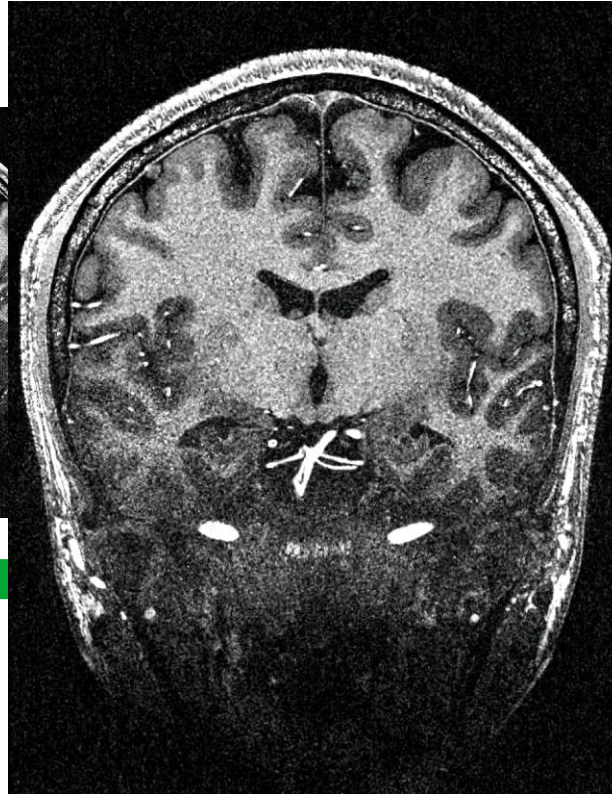
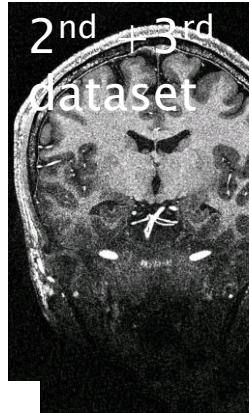
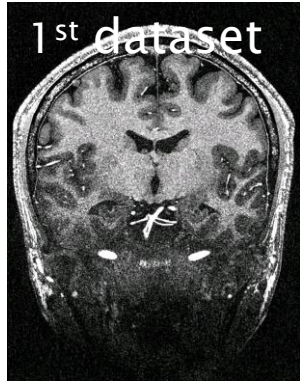
# Prospective motion correction setup @ 7T



[3] Stucht et al. (2015)

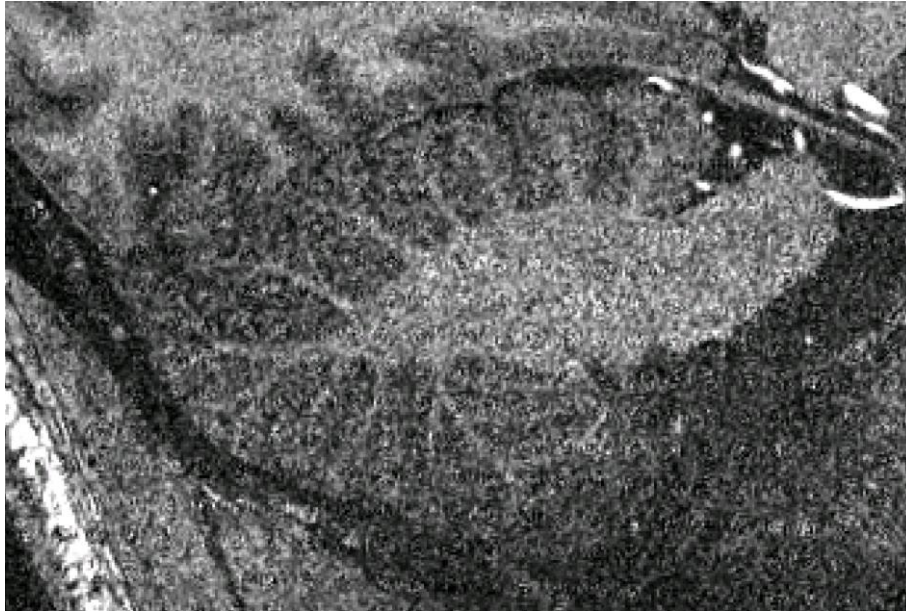


# Acquisition of motion corrected low SNR volumes

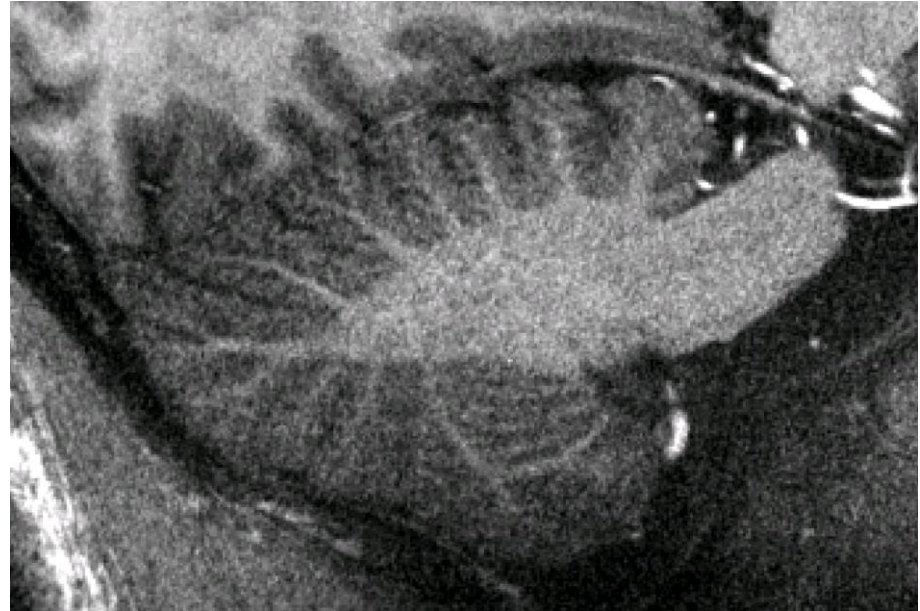


3 months

# Mean volume after registration of distant time points



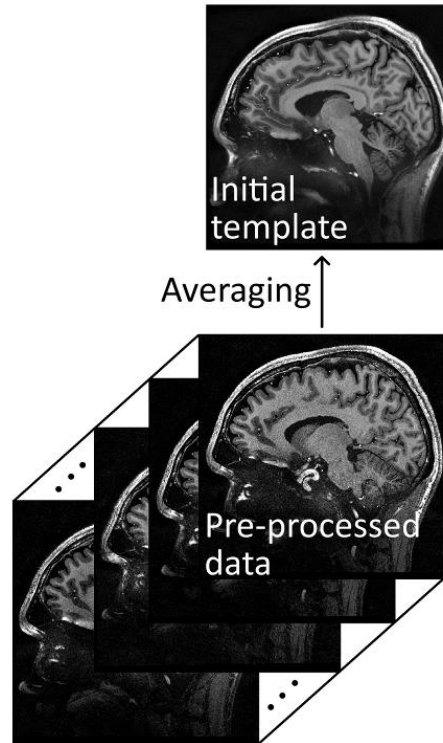
8 averages (non-linear)



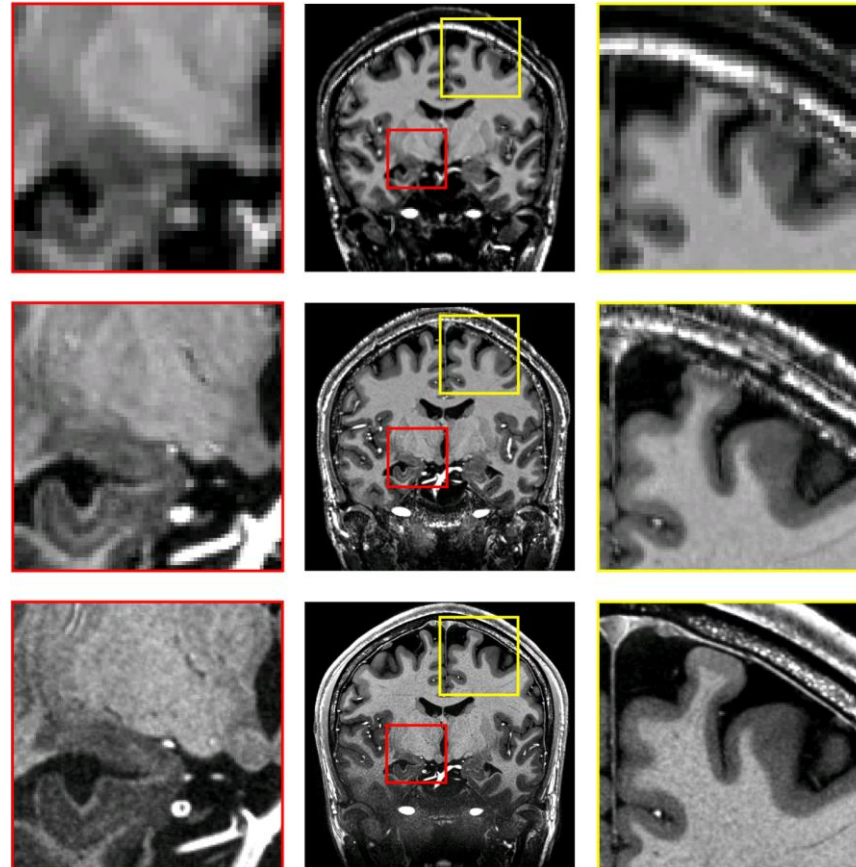
8 averages (rigid only)



# Iterative registration pipeline



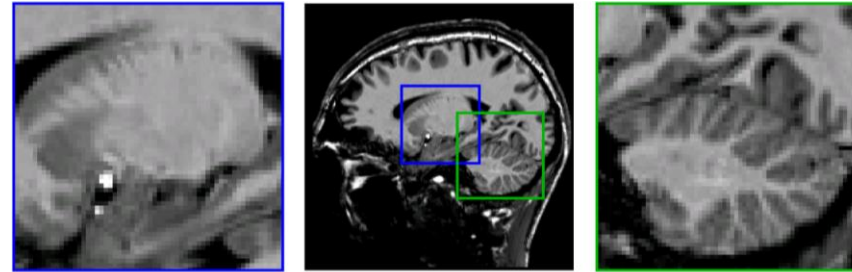




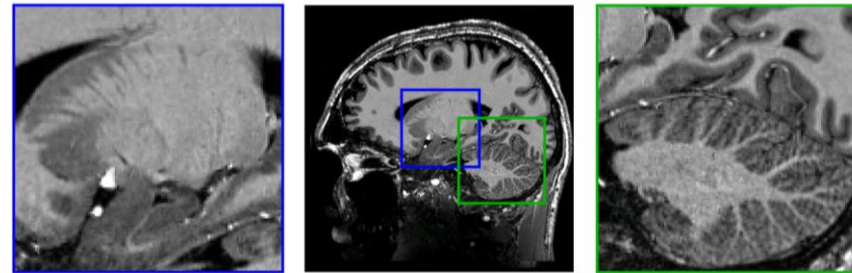
1 mm

500  $\mu\text{m}$

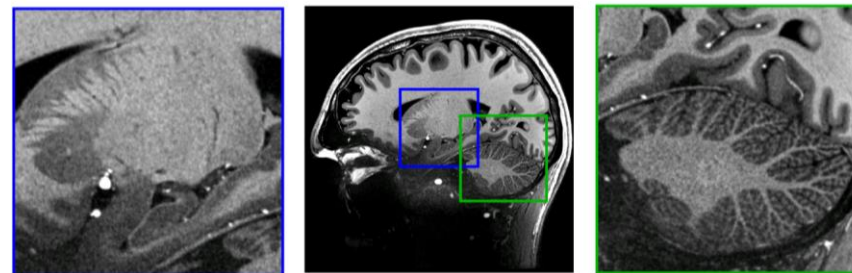
250  $\mu\text{m}$



1 mm



500 µm



250 µm

# Data are openly available

	File format	File size
Scanner's raw data	ISMRM raw data	≈ 1.2 TB
Reconstructed data	Compressed NiftI	≈ 5.9 GB
Pre-processed data	Compressed NiftI	≈ 6.6 GB
Averaged data	Compressed NiftI	≈ 1.6 GB
Motion data	Plain text and mat-Files	≈ 0.8 GB

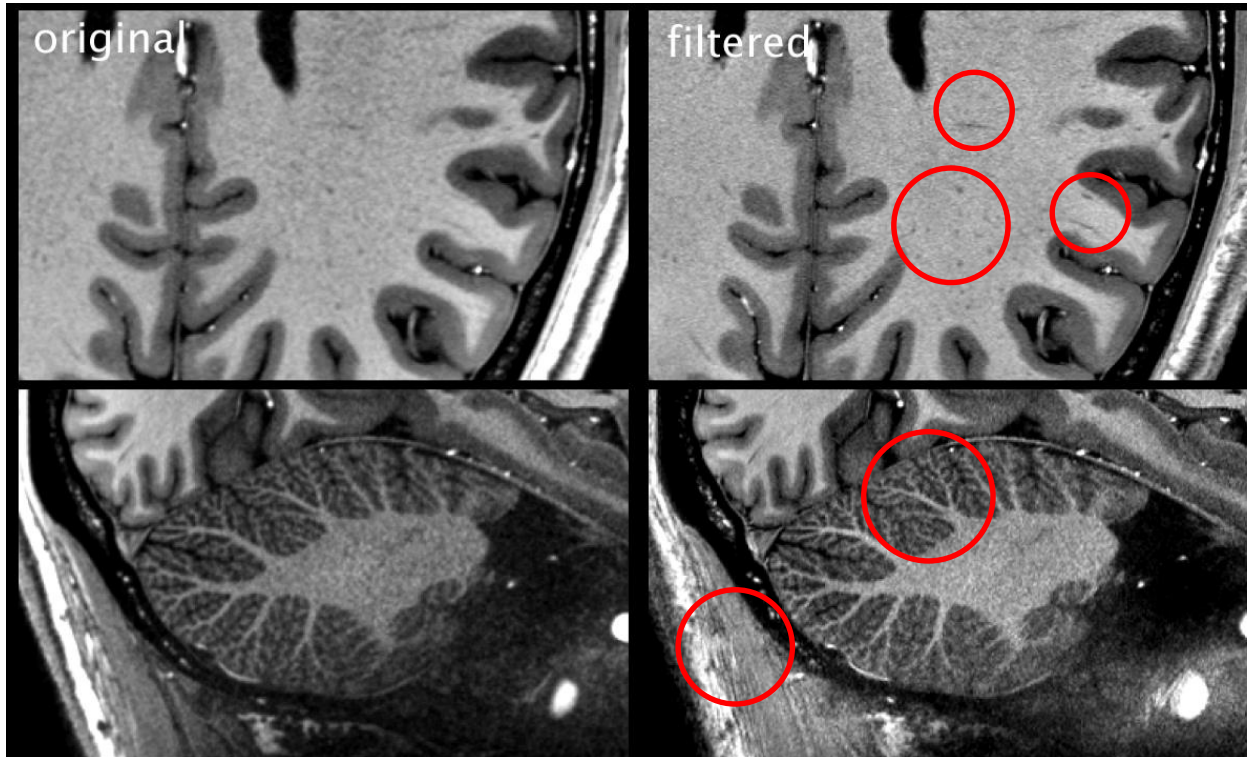
<http://www.nature.com/articles/sdata201732>

<http://dx.doi.org/10.5061/dryad.38s74>

<http://dx.doi.org/10.24352/ub.ovgu-2017-001>

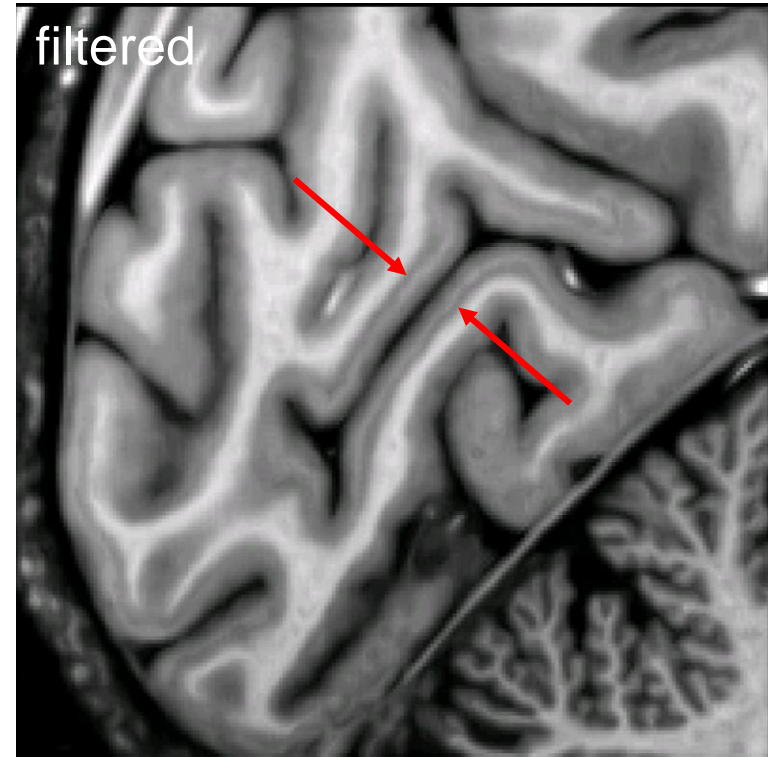


# Enhancement of image quality by noise filtering<sup>4</sup>



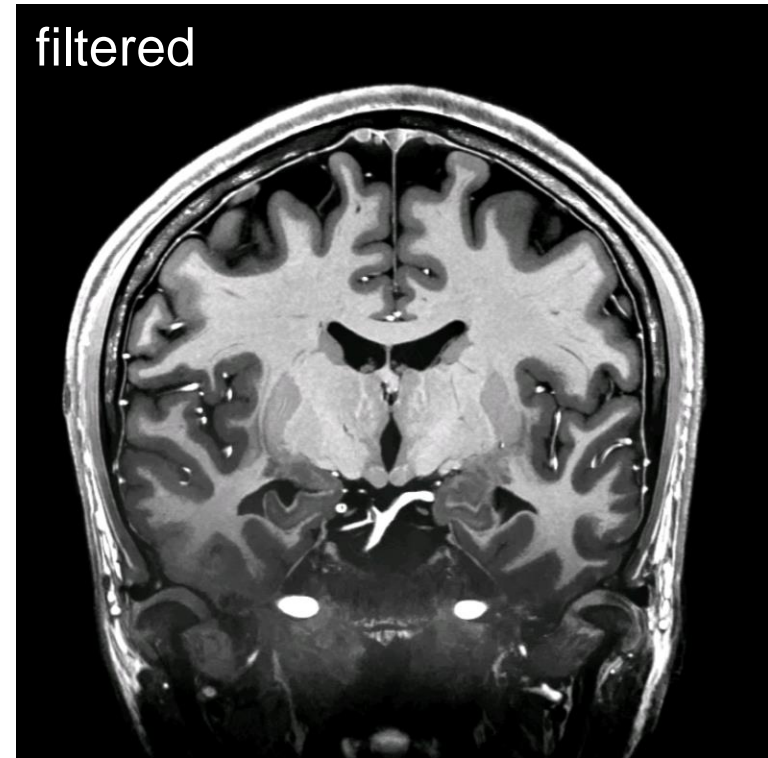
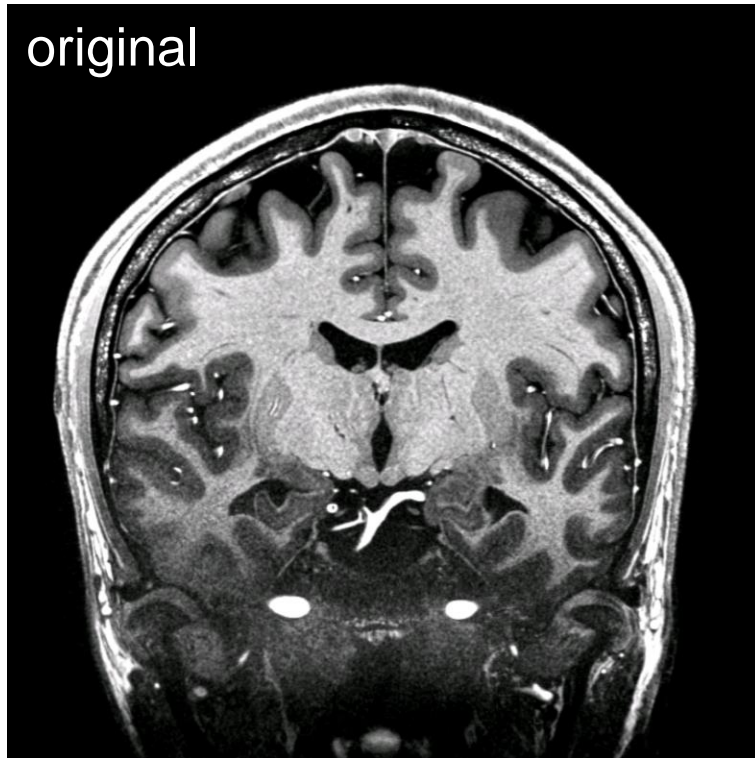
[4] Coupé et al. (2011)

# Enhancement of image quality by noise filtering<sup>5</sup>



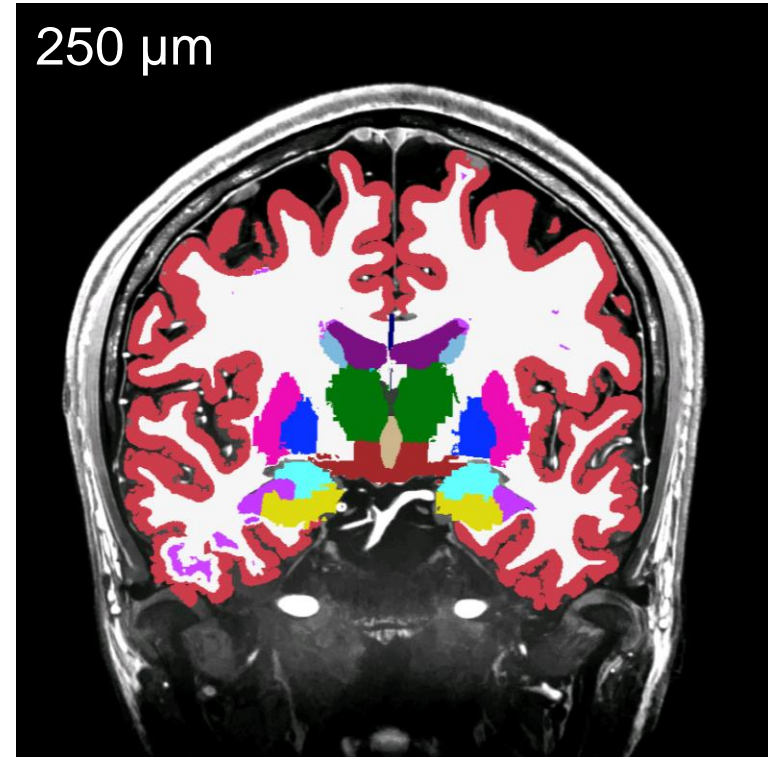
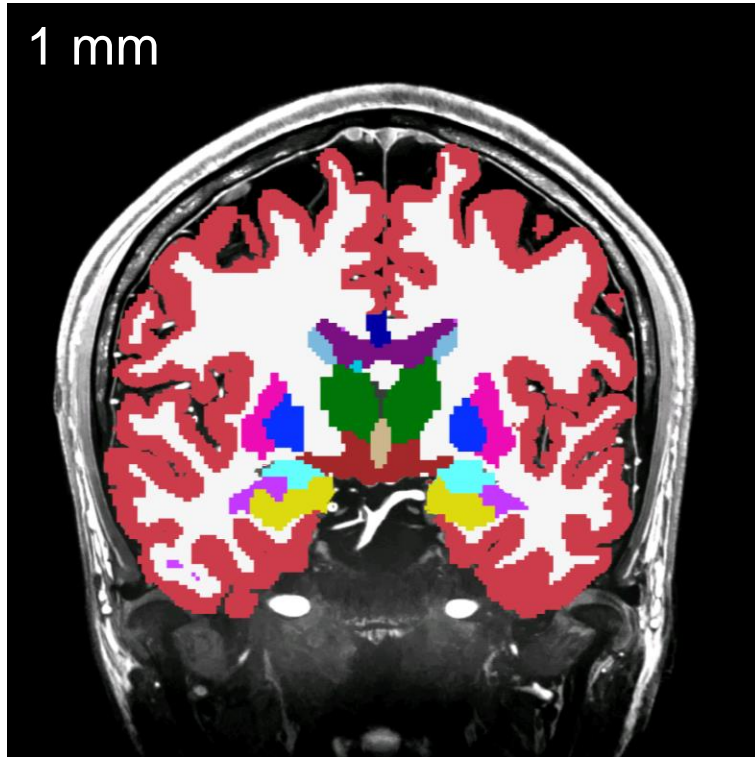
[5] Gulban et al. (2018)

# Enhancement of image quality by noise filtering<sup>6</sup>



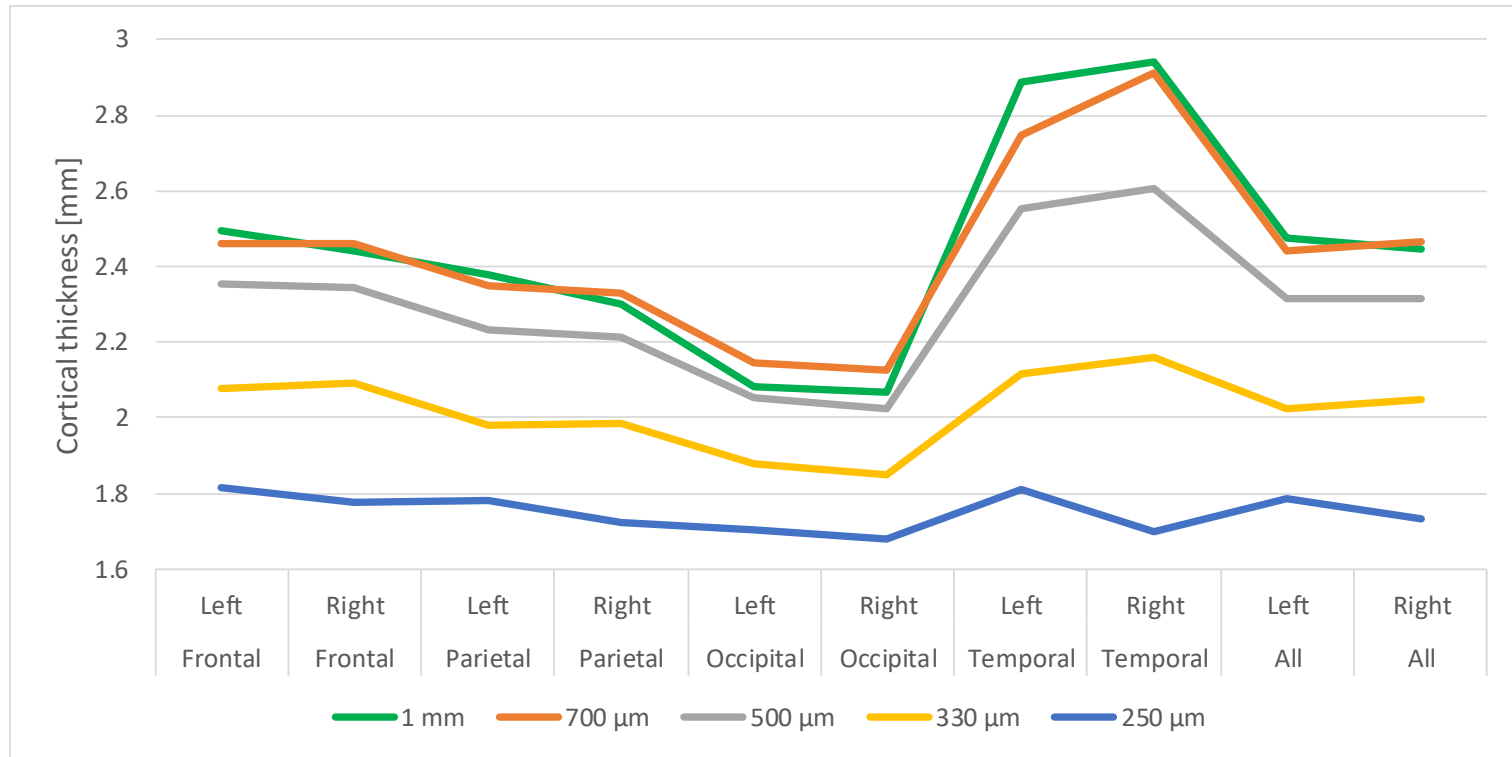
[6] Gaser & Dahnke (2016)

# Processing with FreeSurfer





# Cortical thickness as a function of spatial resolution



[7] Lüsebrink et al. (2013)

[8] Zaretskaya et al. (2018)



# Outlook

- Further improvement of image quality
  - Better reconstruction
  - Denoising of complex data channel-wise
  - Averaging of complex data
- Acquisition of more data
  - More subjects
  - More contrasts
  - More efficiently

# Acknowledgements



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funded by the FP7 Marie Curie  
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National Institutes  
of Health

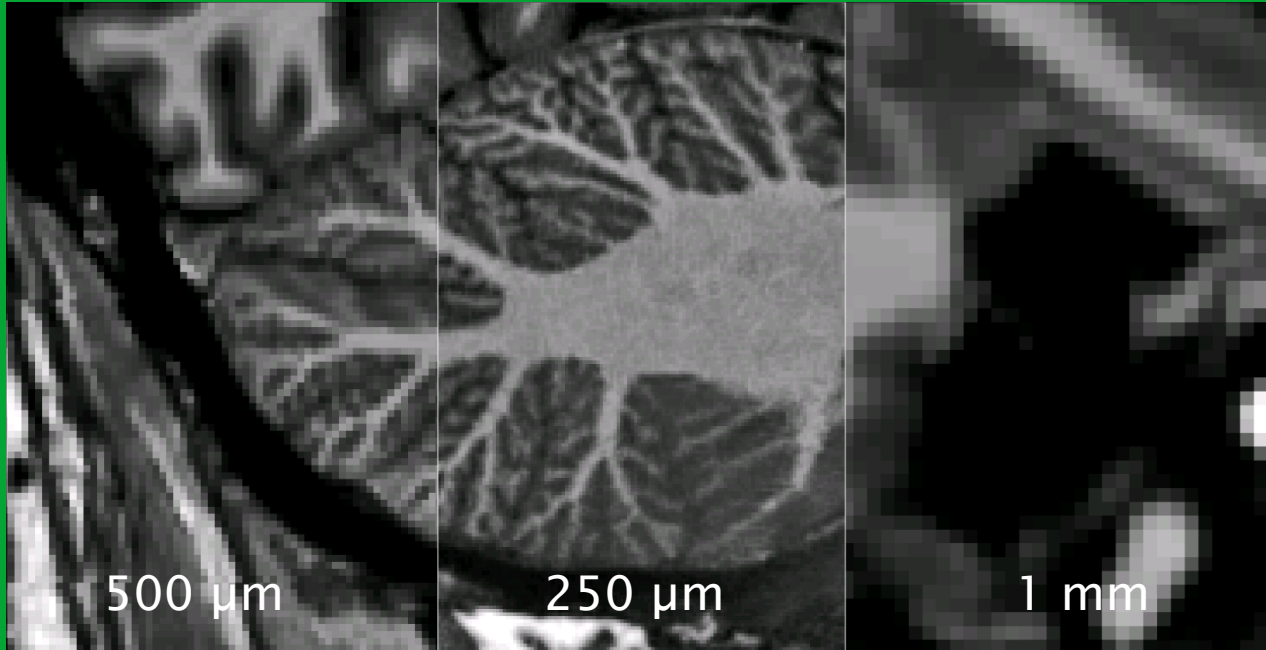
NIH (1R01-DA021146)

# References

1. Maclaren et al. (2012), [10.1371/journal.pone.0048088](https://doi.org/10.1371/journal.pone.0048088)
2. Maclaren et al. (2013), [10.1002/mrm.24314](https://doi.org/10.1002/mrm.24314)
3. Stucht et al. (2015), [10.1371/journal.pone.0133921](https://doi.org/10.1371/journal.pone.0133921)
4. Coupé et al (2011), [10.1049/iet-ipr.2011.0161](https://doi.org/10.1049/iet-ipr.2011.0161)
5. Gulban et al. (2018), [10.1101/245738](https://doi.org/10.1101/245738)
6. Gaser & Dahnke (2016), [hbm2016](https://doi.org/10.1002/hbm.2016)
7. Lüsebrink et al. (2013), [10.1016/j.neuroimage.2012.12.016](https://doi.org/10.1016/j.neuroimage.2012.12.016)
8. Zaretskaya et al. (2018), [10.1016/j.neuroimage.2017.09.060](https://doi.org/10.1016/j.neuroimage.2017.09.060)



Thank you for your attention.



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