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Merging T_1 weighted images with Quantitative Susceptibility Mapping provides a unique contrast for brain tissue segmentation in humans and non-human primates

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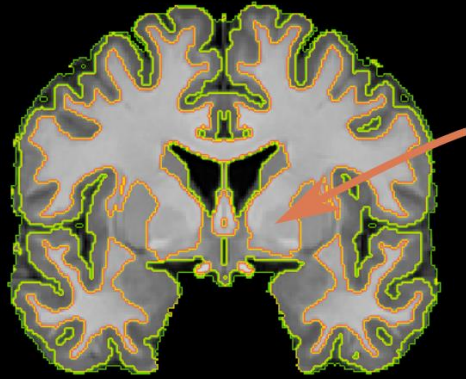rdadarwal@dpz.eu   @RakshitDadarwal

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Declaration of
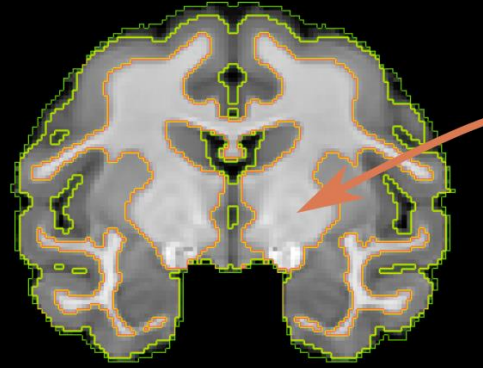# Financial Interests or Relationships

Speaker Name: Rakshit Dadarwal

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.
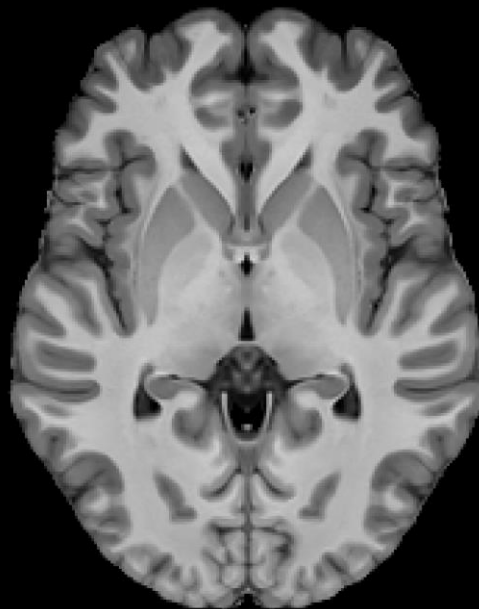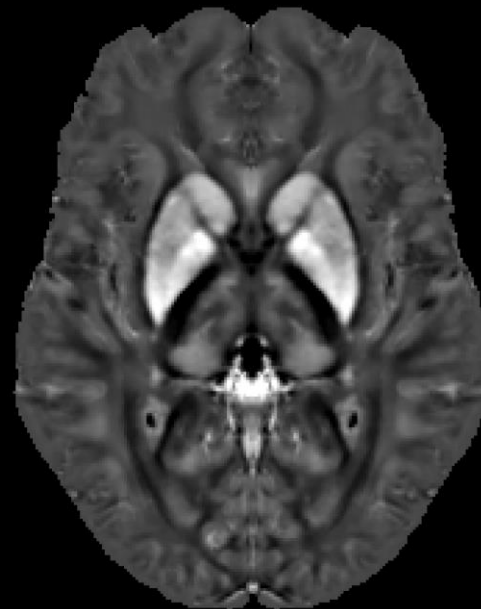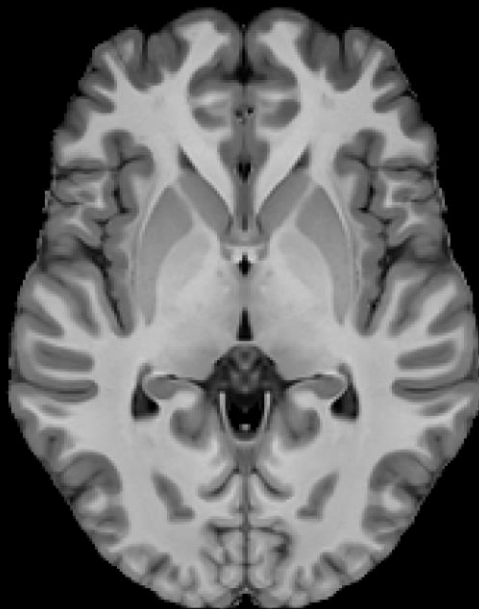
Human   Monkey

- T$_1$w contrast provides an excellent gray-white matter contrast

- However, minimal contrast to discern between the subcortical zone and the white matter

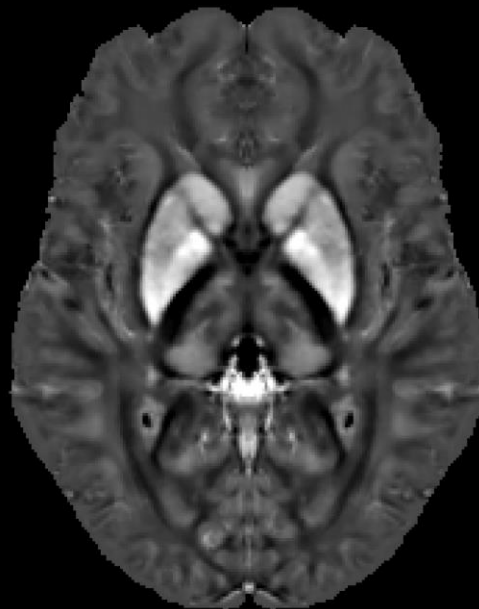- Major subcortical structures are incorrectly classified as white matter

T_1w QSM

$$T_1w \qquad\qquad QSM$$

Goal:

- Increase subcortical contrast while maintaining T_1w gray-white matter contrast

	Human (N = 3)		Monkey (N = 3)	
	T_1w	T_2^*w	T_1w	T_2^*w
sequence	3D MPRAGE	3D ME-GRE	3D MPRAGE	3D ME-GRE
resolution (mm)	0.8x0.8x0.8	0.75x0.75x0.75	0.5x0.5x0.5	0.31x0.31x0.31
repetition time (ms)	2400	41	2700	57
echo time (ms)	2.2	4.5/4.5/36	2.7	3.7/4.9/48
flip angle (deg)	8	20	8	20
acquisition time (min)	6.3	7	17	24
coil	20 channel head		7 cm single loop	

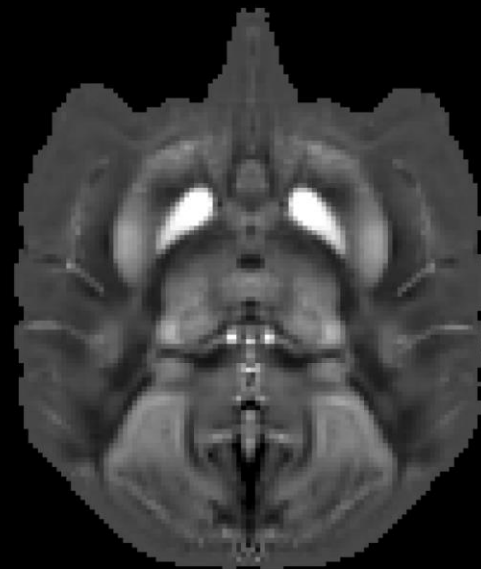3 T Siemens MAGNETOM Prisma

Human T_1w and T_2^*w data were acquired in 13 minutes.

QSM

Human
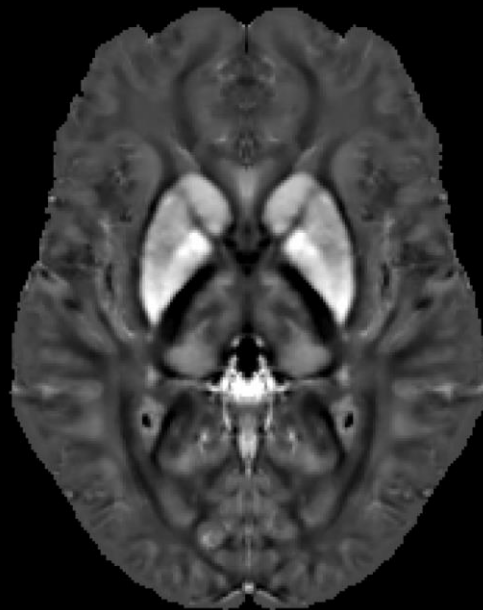
Monkey

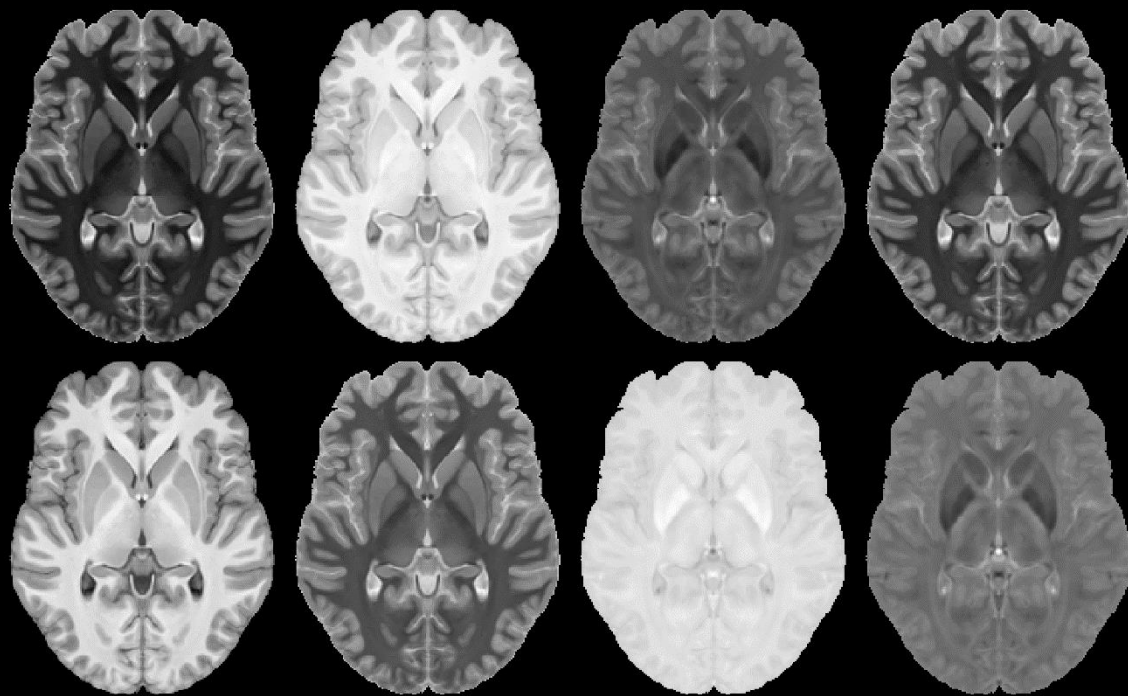TQ-SILiCON – T$_1$w - QSM Synthetic Images via a Linearly-weighted combination of CONtrasts

$$Y_i = \sum_{c=0}^{1} W_{ic} X_c$$

W (weights) = random(-1, 1)

X (T$_1$w & QSM intensities) = norm(0, 1)

i = number of generated images
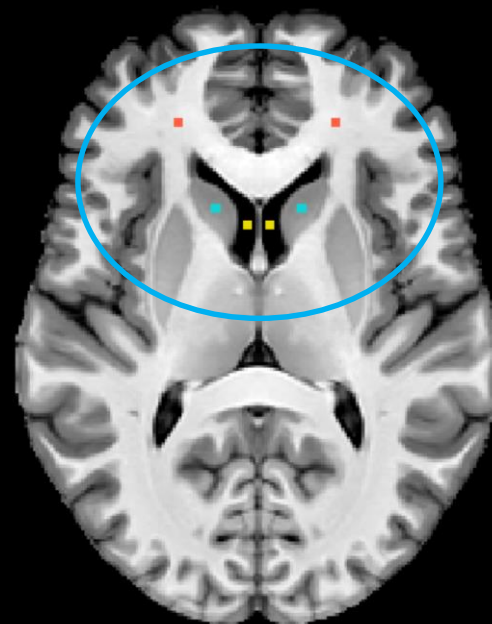
TQ-SILiCON images

Selection of best weights

- Contrast-to-noise ratio (CNR)
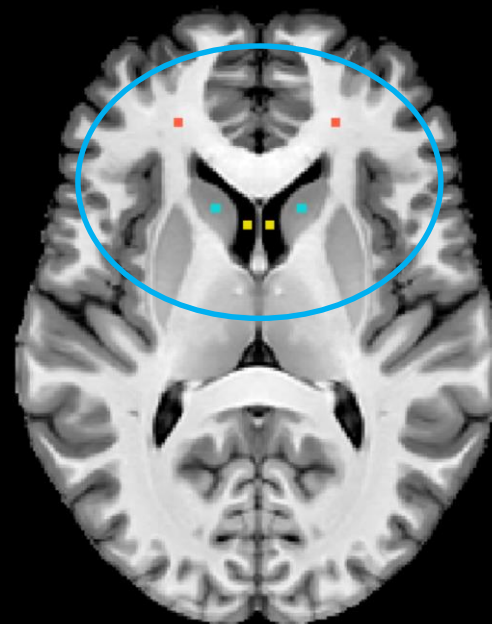
Selection of best weights

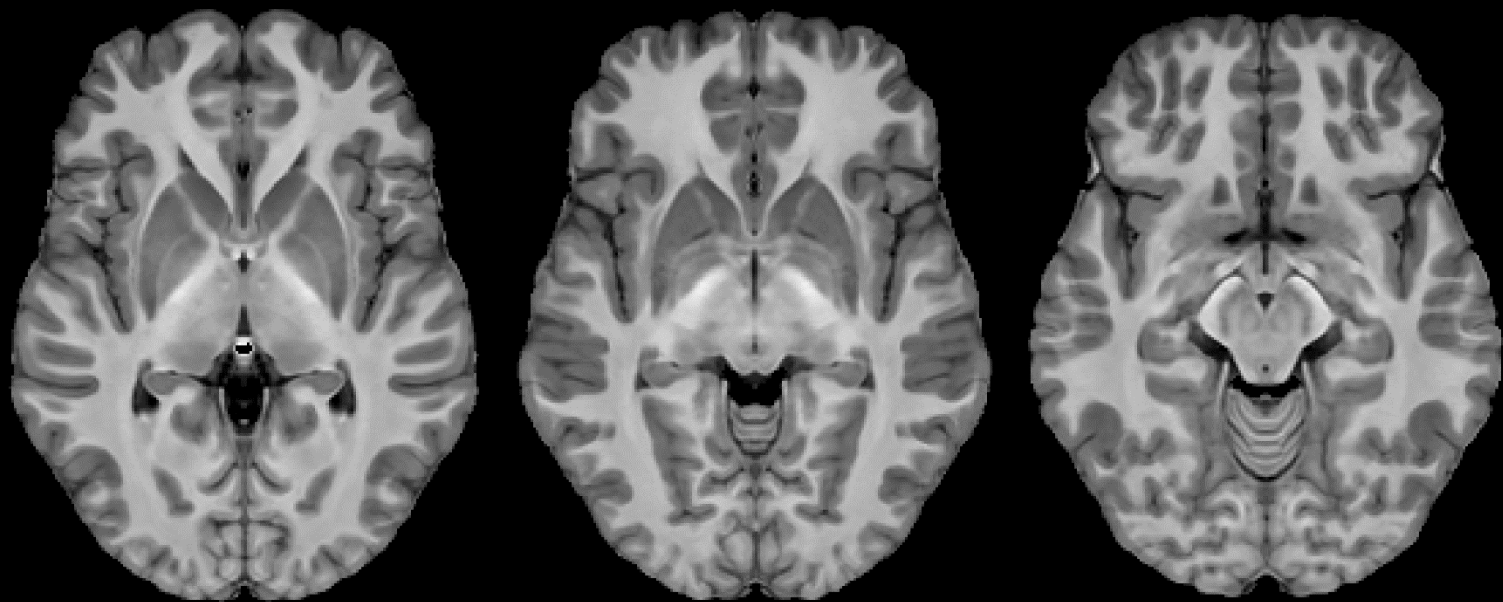3-tissue priors

- Contrast-to-noise ratio (CNR)

Selection of best weights

3-tissue priors

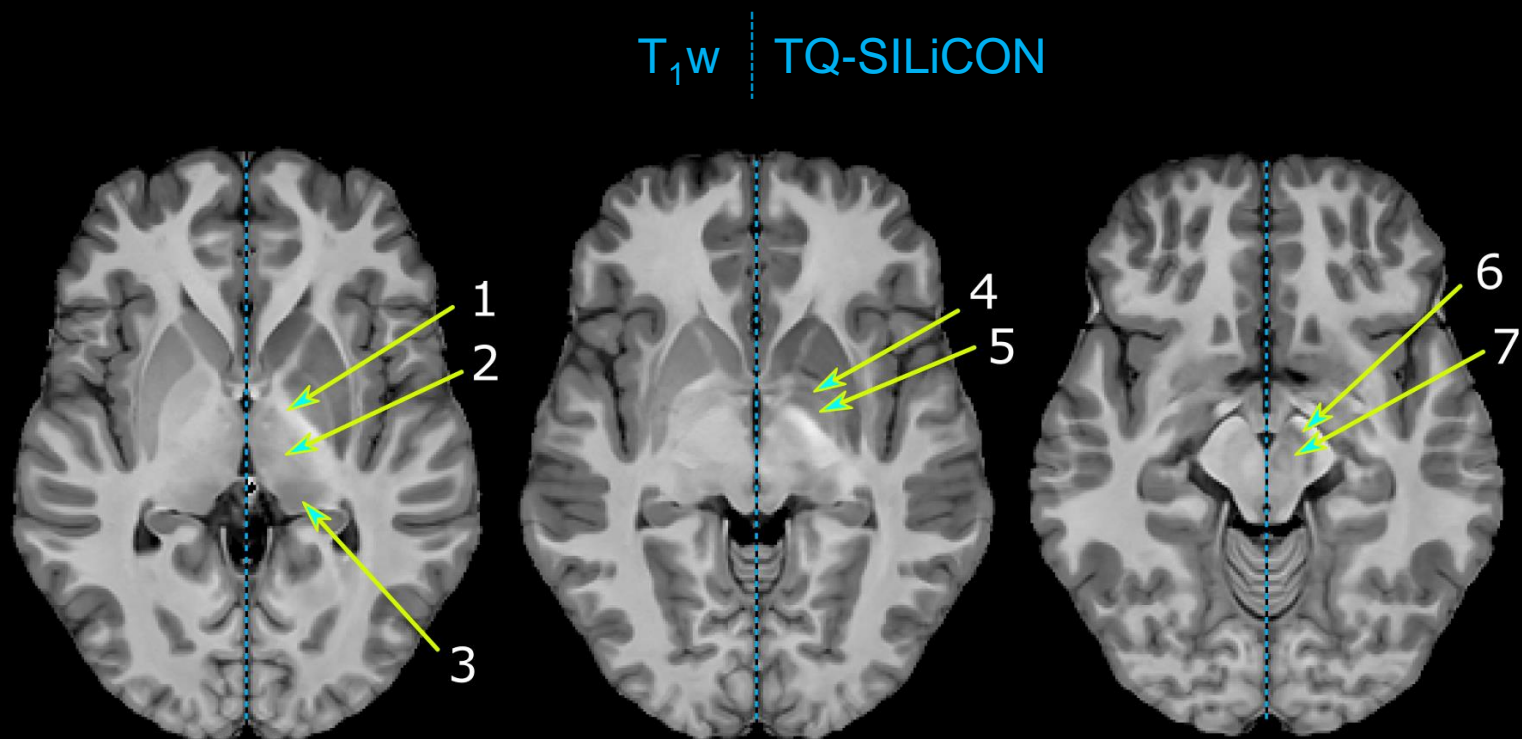- Contrast-to-noise ratio (CNR)
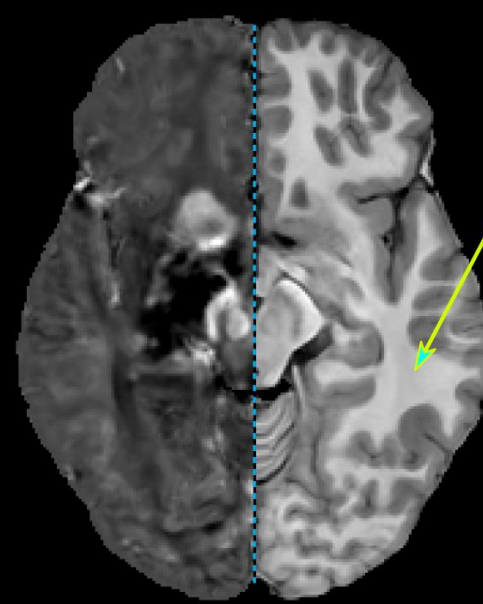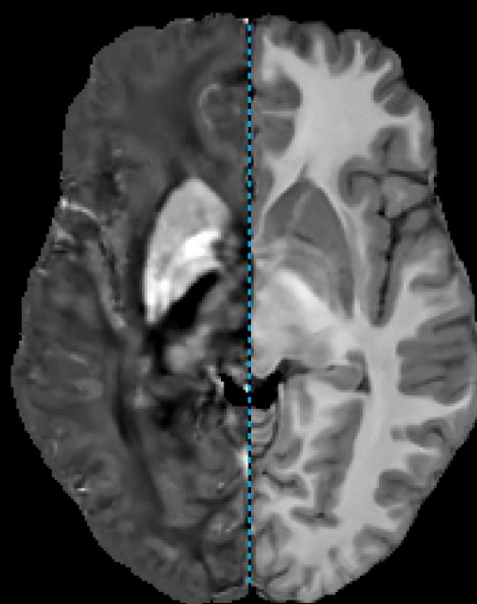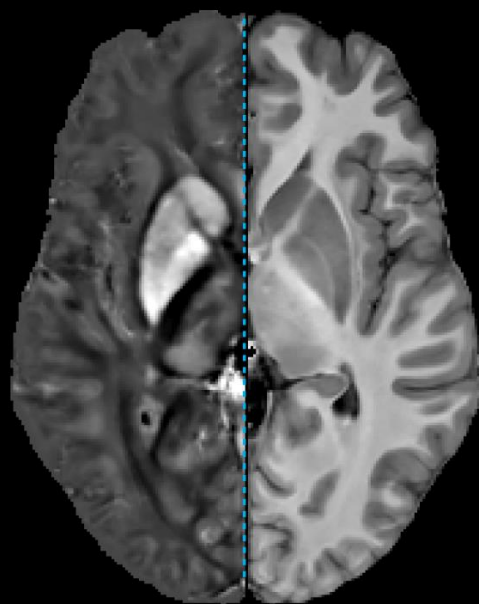
- Linear discriminant analysis (LDA)

TQ-SILiCON

$W_{T1} = 0.31; W_{QSM} = -0.79$

1 – Internal capsule; 2 – Thalamus; 3 – Pulvinar nucleus; 4 – External GP; 5 – Internal GP;
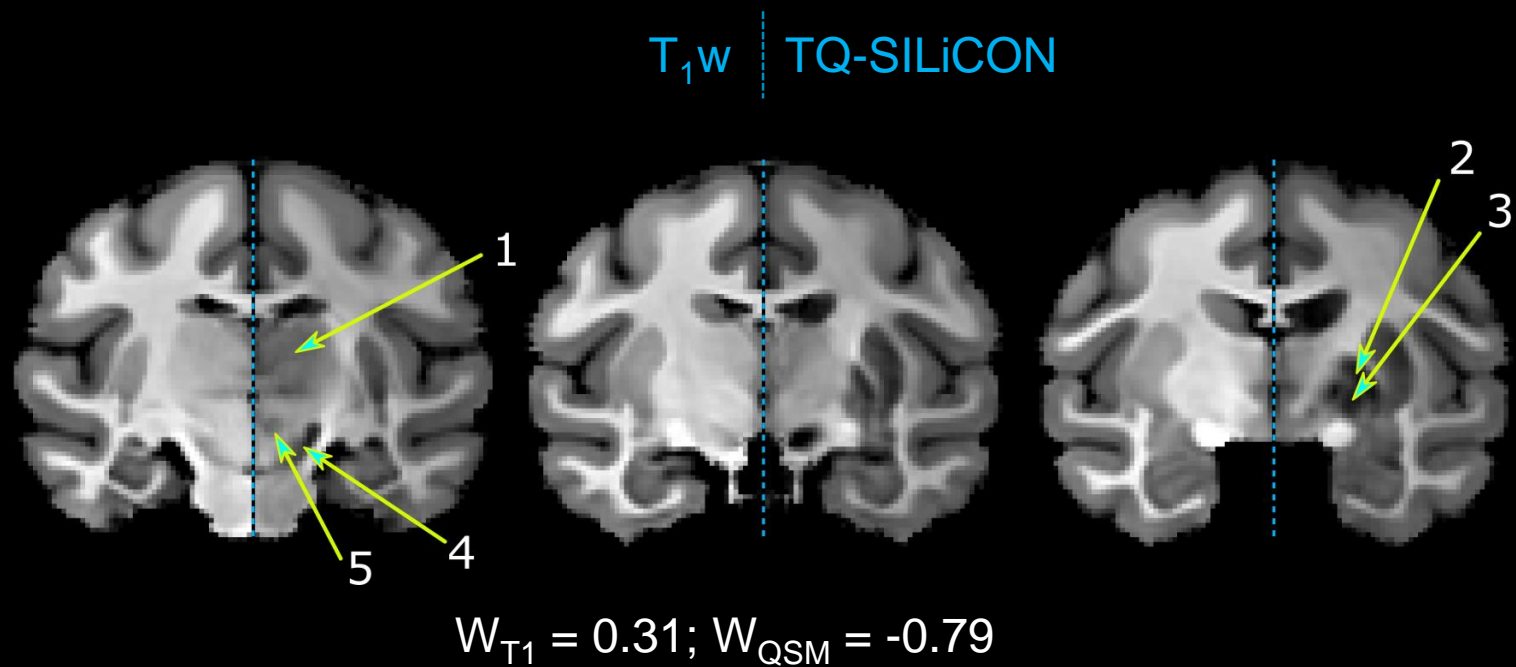6 – Substantia nigra; 7 – Red nucleus
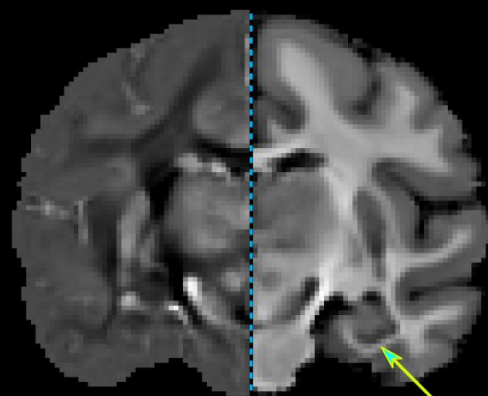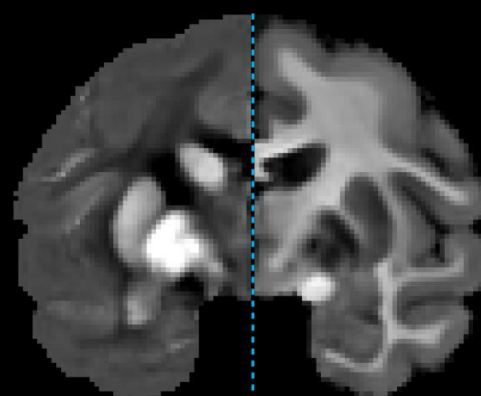
QSM | TQ-SILiCON

White matter

T_1w | TQ-SILiCON

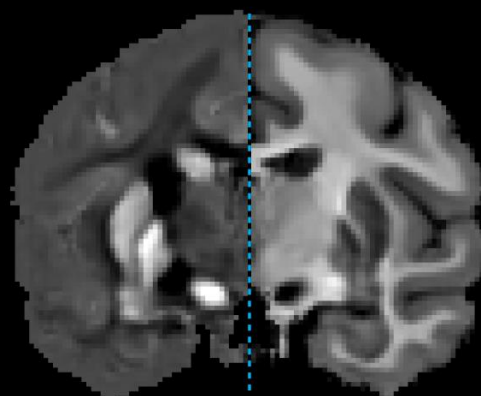

$W_{T1} = 0.31$; $W_{QSM} = -0.79$

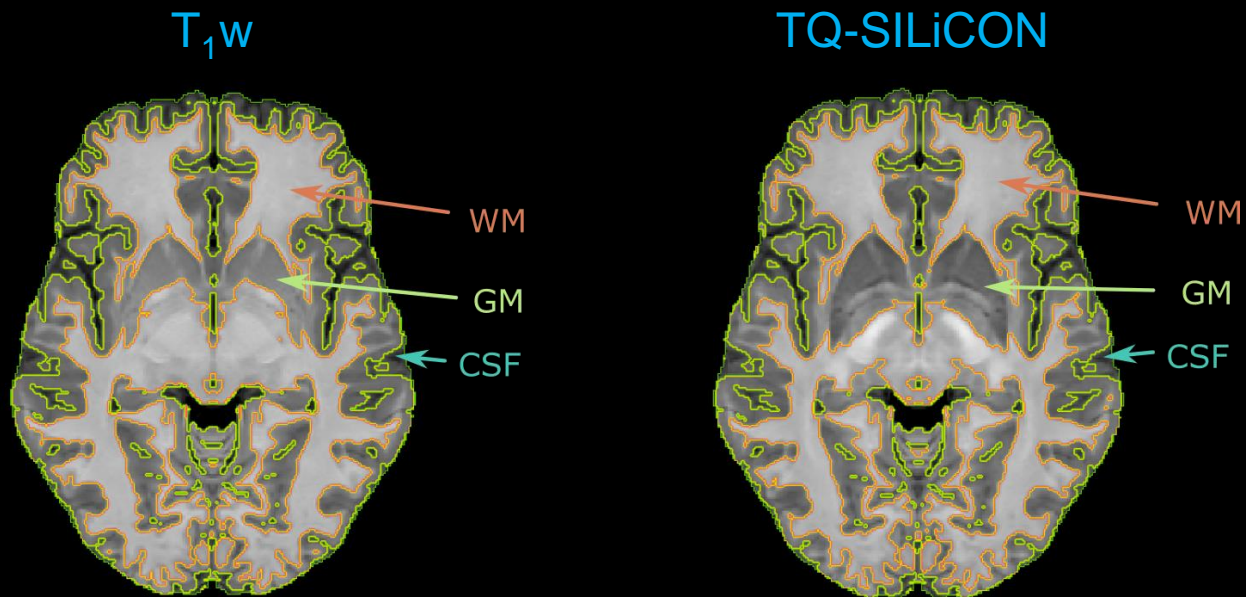1 – Thalamus; 2 – External GP; 3 – Internal GP; 4 – Substantia nigra; 5 – Red nucleus
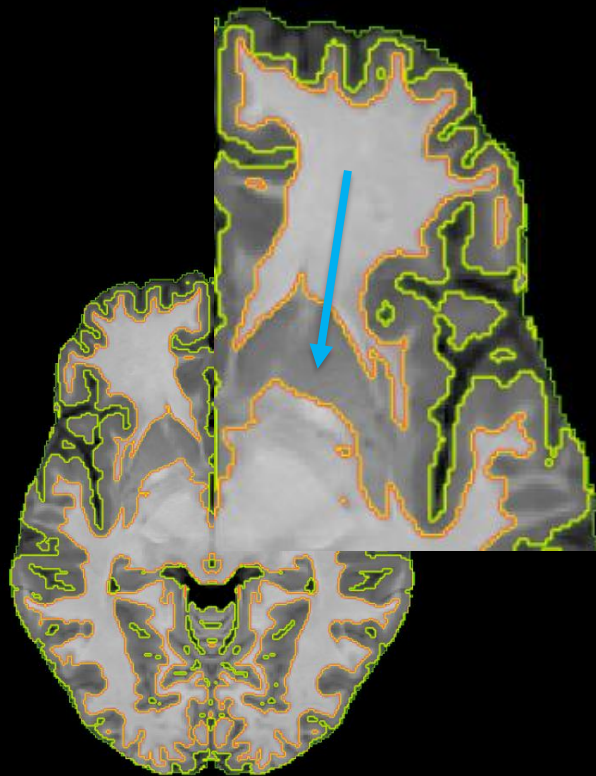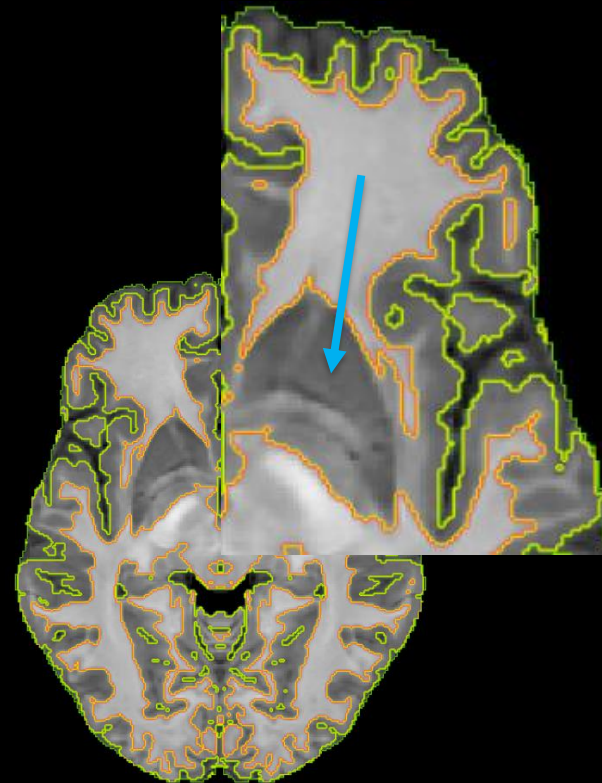
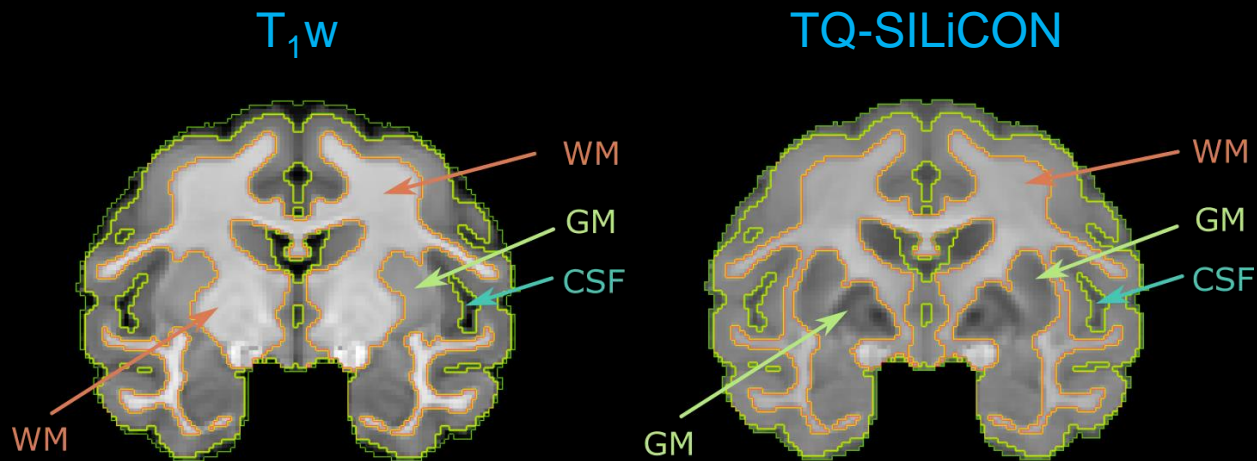QSM | TQ-SILiCON

White matter

Automatic tissue segmentation

T$_1$w

TQ-SILiCON

T_1w TQ-SILiCON

Automatic tissue segmentation

T$_1$w

TQ-SILiCON

WM

GM

CSF

WM

WM

GM

CSF

GM

- The best of two contrasts are combined in TQ-SILiCON images.

- TQ-SILiCON images revealed excellent grey-white matter contrast as well as a distinct delineation of subcortical structures from white matter.

- TQ-SILiCON images resulted in an improved grey and white matter tissue classification.

- 13 minutes TQ-SILiCON data acquisition has the potential to be used in human clinical routine scans.