



MRC Cognition  
and Brain  
Sciences Unit



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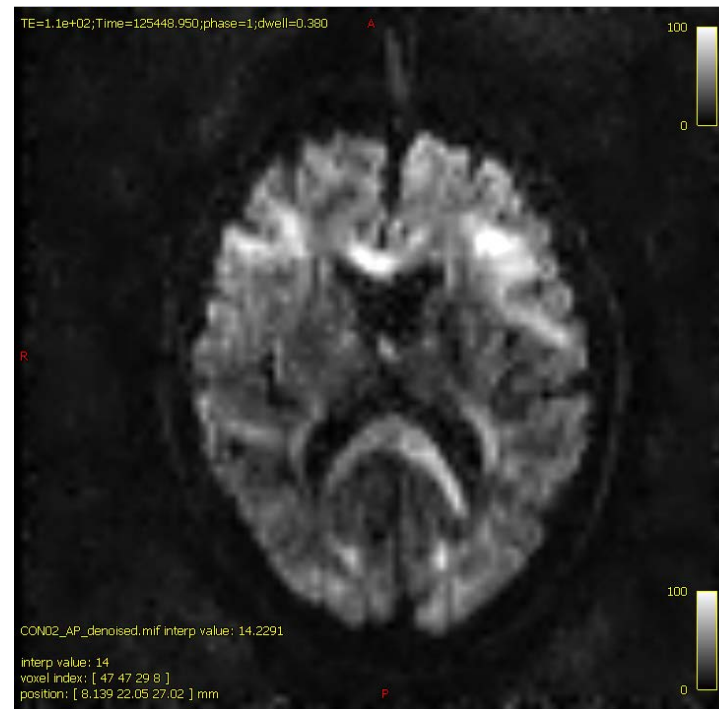
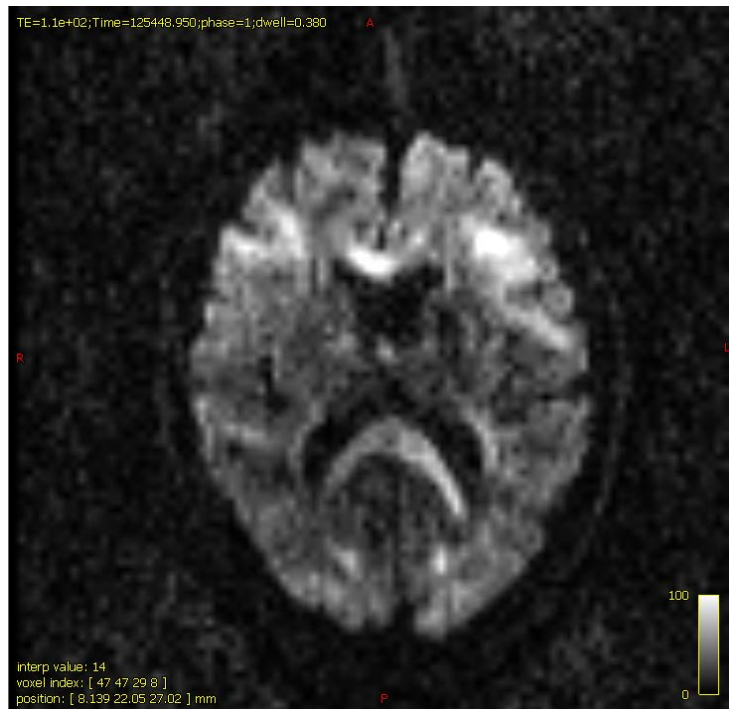
# Diffusion Tractography and Connectivity Analysis in MRTrix

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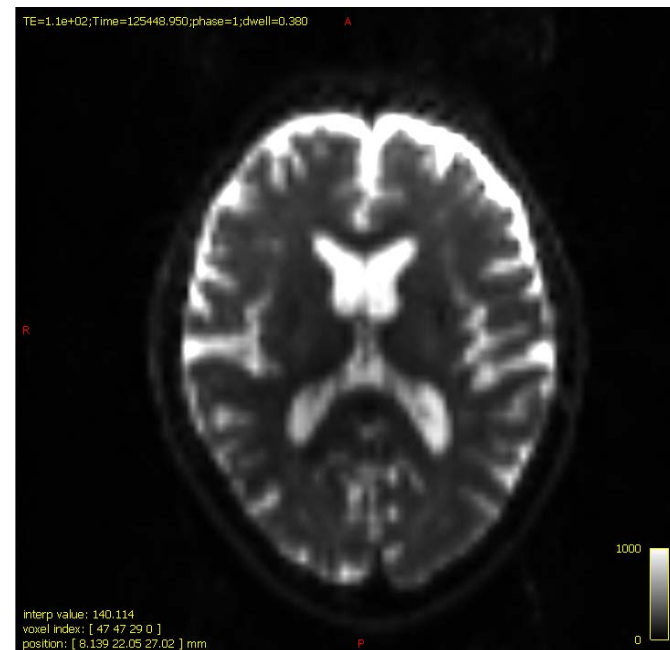
# DWI denoising

- Denoising must be performed as the first step of the pipeline
- Exploits data redundancy in the patch-level PCA domain



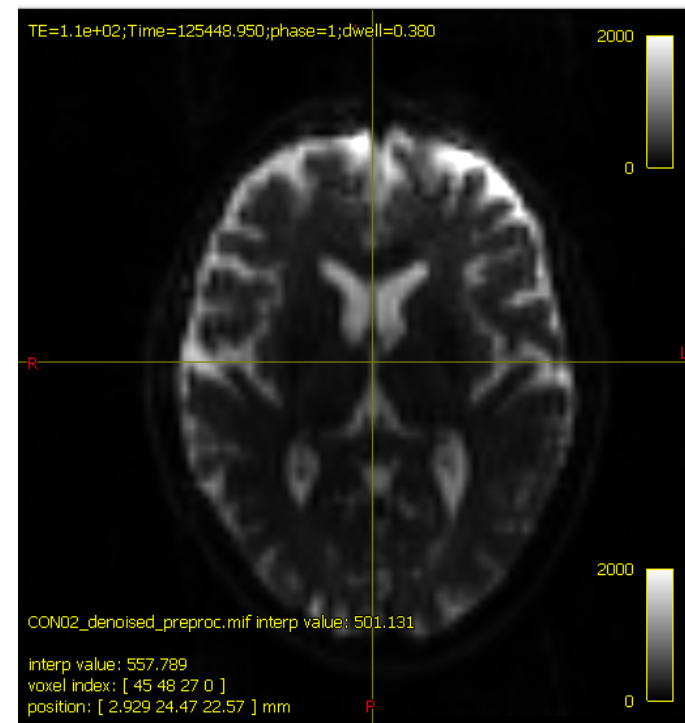
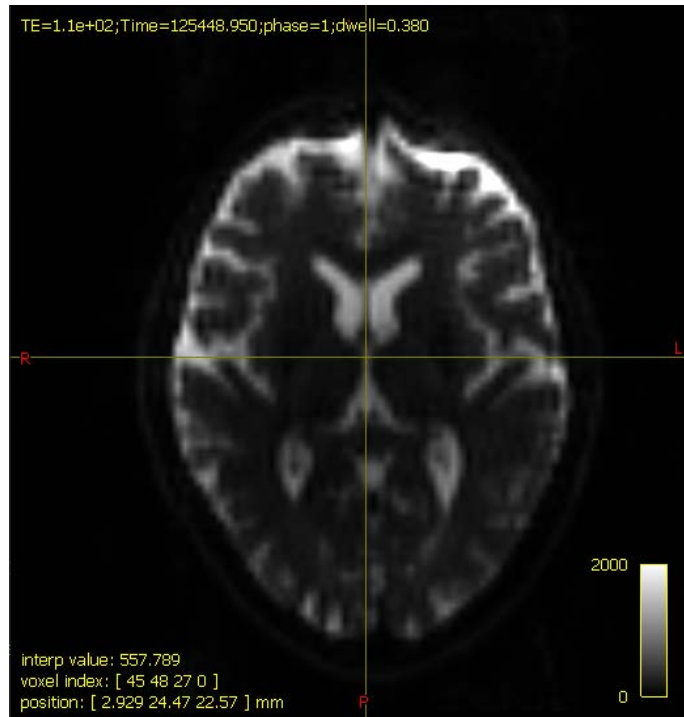
# Removal of Gibbs artefacts (optional)

- Removes Gibbs ringing artefacts from DWI images
- Designed for data acquired with full k-space
- May fail for data acquired with Partial Fourier – always inspect the output

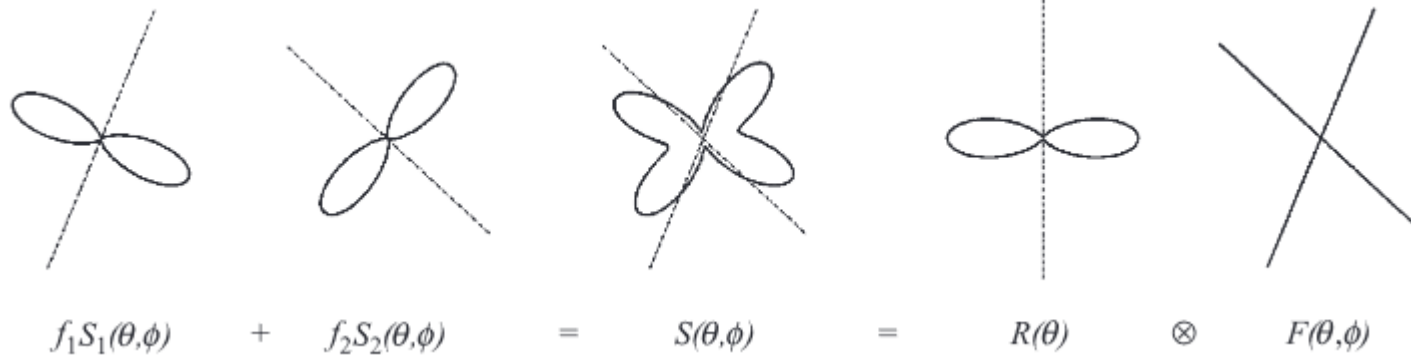


# DWI distortion correction

- Pre-processing of DWI images using TOPUP and EDDY



# Constrained Spherical Deconvolution (CSD)



Tournier et al. 2007

- Two distinct fibre orientations
- $S_1(\theta, \phi), S_2(\theta, \phi)$  – diffusion weighted signal attenuation
- $f_1, f_2$  – volume fractions

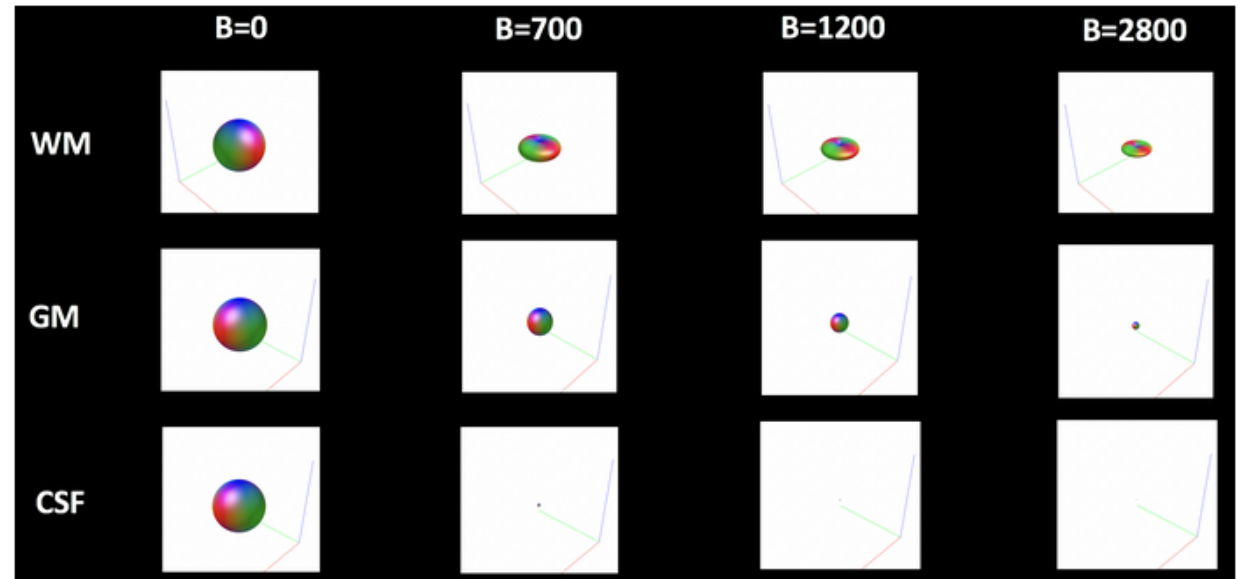
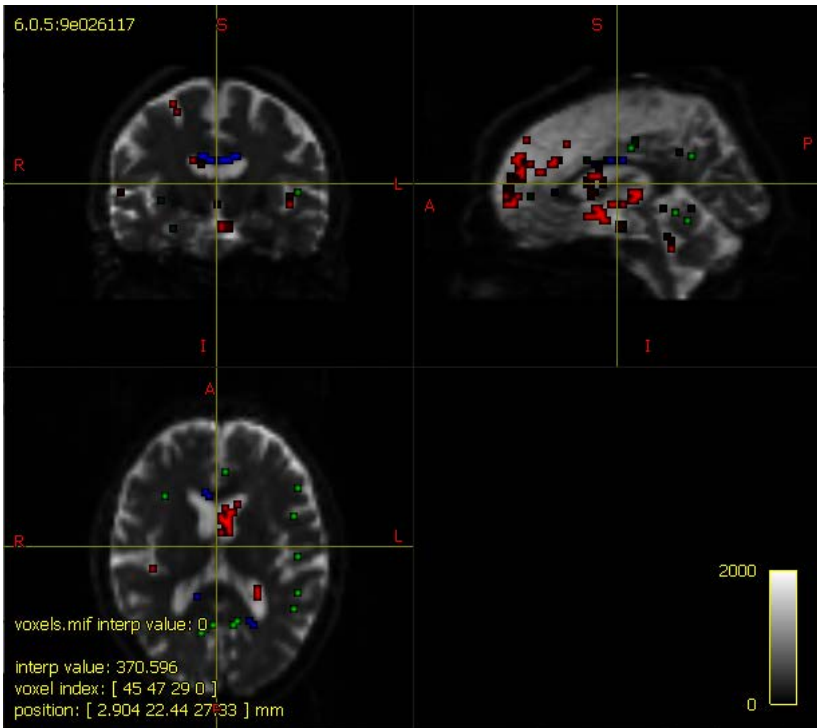
- Overall diffusion weighted signal attenuation

- Axially symmetric response function describing the signal attenuation measured for a single fibre population.

- Fibre orientation density function describing the fibre orientations present in the voxel

# Constrained Spherical Deconvolution (CSD)

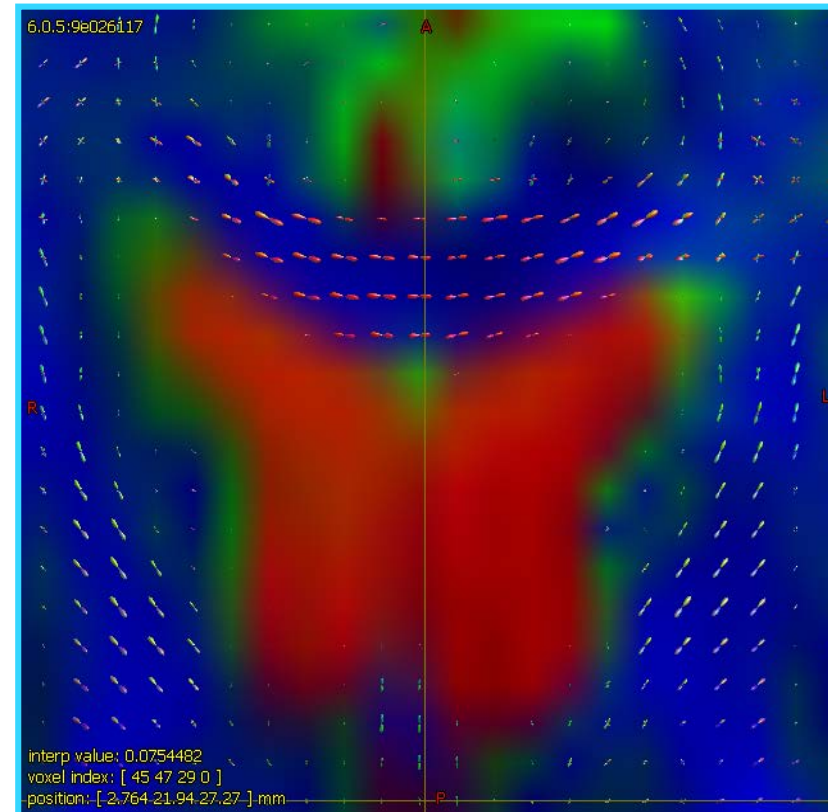
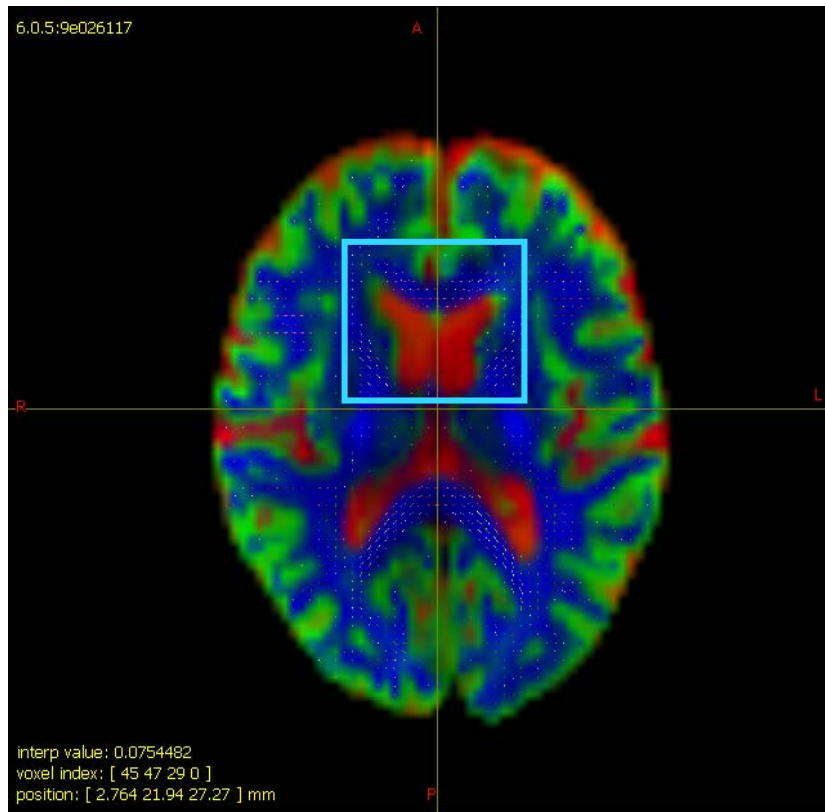
- Estimate the response function per tissue type



[https://andysbrainbook.readthedocs.io/en/latest/MRtrix/MRtrix\\_Course/MRtrix\\_05\\_BasisFunctions.html](https://andysbrainbook.readthedocs.io/en/latest/MRtrix/MRtrix_Course/MRtrix_05_BasisFunctions.html)

# Constrained Spherical Deconvolution (CSD)

- Estimate the fiber orientation distribution function (ODF) per tissue per voxel



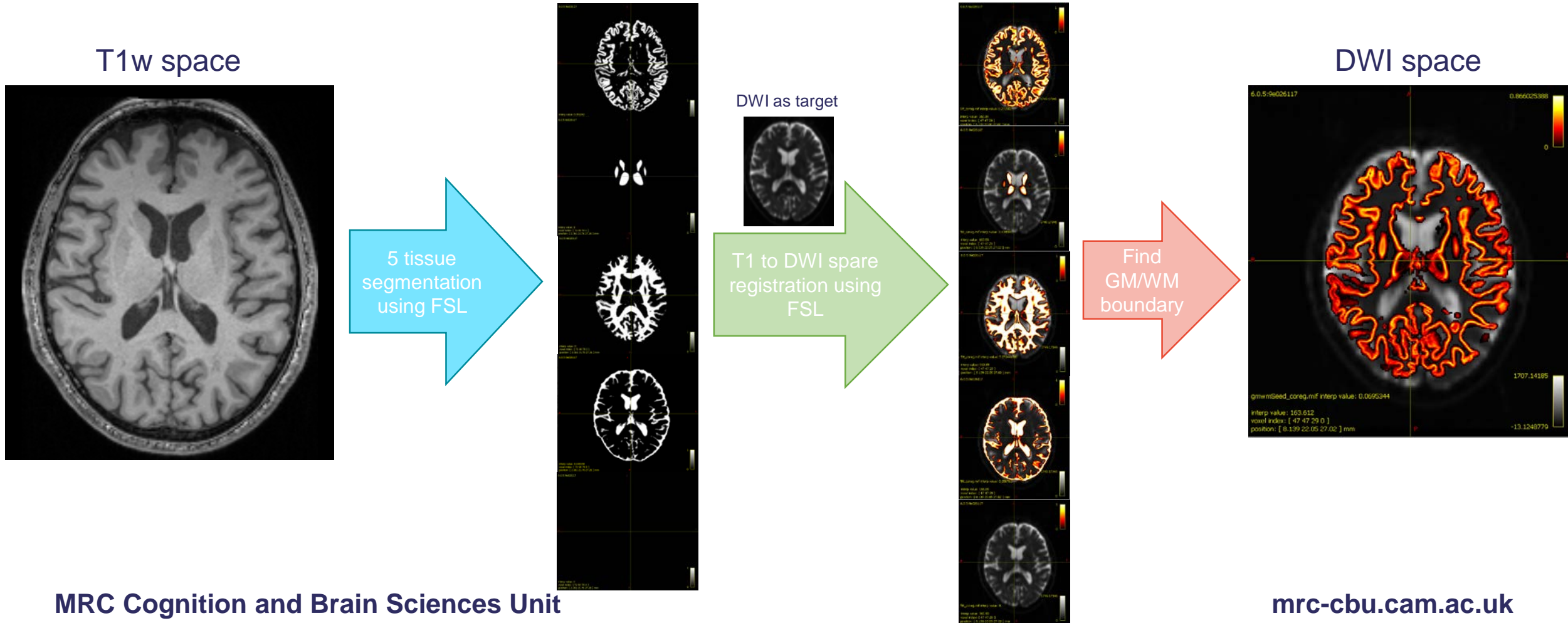
# Anatomically Constrained Tractography (ACT)

- Find the GM/WM boundary to seed the streamlines
  - Tissue segmentation of T1w data using FSL tools
  - Image registration using FSL
  - Generate boundary mask in DWI space



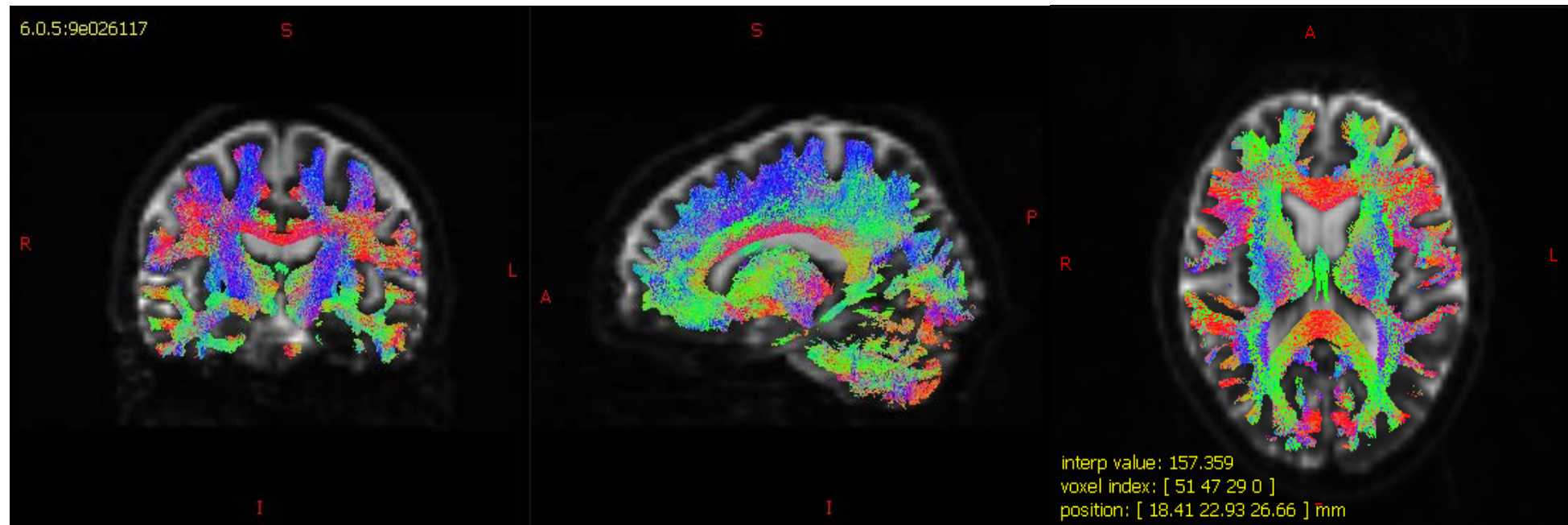
# Anatomically Constrained Tractography (ACT)

- Find the GM/WM boundary to seed the streamlines



# Anatomically Constrained Tractography (ACT)

- Find the GM/WM boundary to seed the streamlines
- Generate streamlines





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**Thank you**

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