#1221

White matter abnormalities in Parkinson's disease illuminated via TDI

Ziegler E.[1], Rouillard M.[1], André E.[1], Coolen T.[1], Stender J.[1], Balteau E.[1], Garraux G.[1,2], **Phillips C.**[1,3]

[1] Cyclotron Research Centre, [2] Department of Neurology, CHU Sart Tilman, [3] Department of Electrical Engineering & Computer Science; University of Liège, Belgium

Background

TRACK DENSITY IMAGING

- Artificial contrast created by tractography streamlines **[1,2,3]**
- Resolution above original scan ("super-resolution") is possible **[1,2,3]**
- White matter accuracy validated histologically in mice **[3]**

DIFFUSION-WEIGHTED IMAGING & PARKINSON'S DISEASE

- Previous studies have found fractional anisotropy and mean diffusivity changes in Parkinson's disease **[4]**
- Novel MRI Biomarkers of PD are required for animal studies and drug development

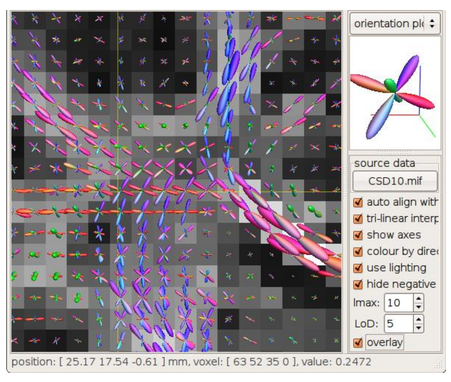
EXPERIMENTAL DESIGN

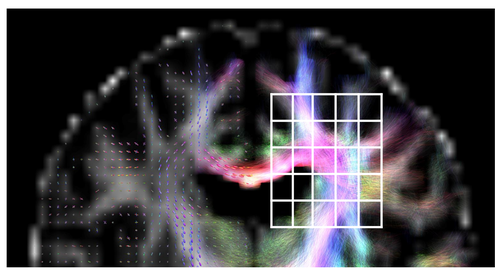
- Population (n = 53, 26 healthy controls, 27 with Parkinson's disease)
- Age, sex, and education-matched groups
- Magnetization Transfer volume for segmentation (1 x 1 x 1 mm^3 voxels)
- Diffusion-weighted MRI (2.4 x 2.4 x 2.4 mm^3 voxels)
  - 120 directions with two b-values (b=1000, b=2500)
  - 22 interleaved b=0 volumes

Track Density Mapping Pipeline

PROCESSING PIPELINE

- Noise & motion correction, b-vecs rotated **[5]**
- Constrained spherical deconvolution to obtain orientation distribution functions **[6,7]**
- Probabilistic fiber tractography
  - 2 million tracks
- Total streamlines counted within each voxel of 1 x 1 x 1 mm^3 grid **[1,2,3]**
- TDI maps normalized to MNI space
  - Initial affine transformation
  - Secondary non-linear warping
- Basic SPM two-sample t-test
- No intensity normalization

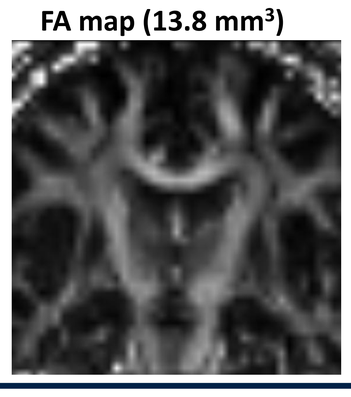




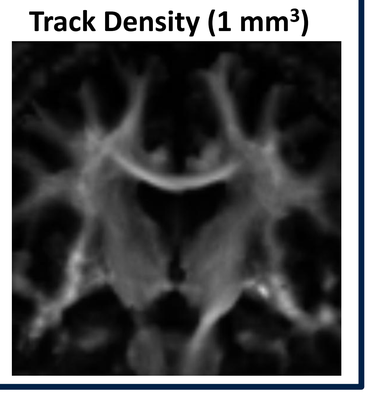
TDI vs. Fractional Anisotropy

- Intensity is dependent on processing steps taken
- More quantitative value
- **Increased resolution**

FA map (13.8 mm^3)



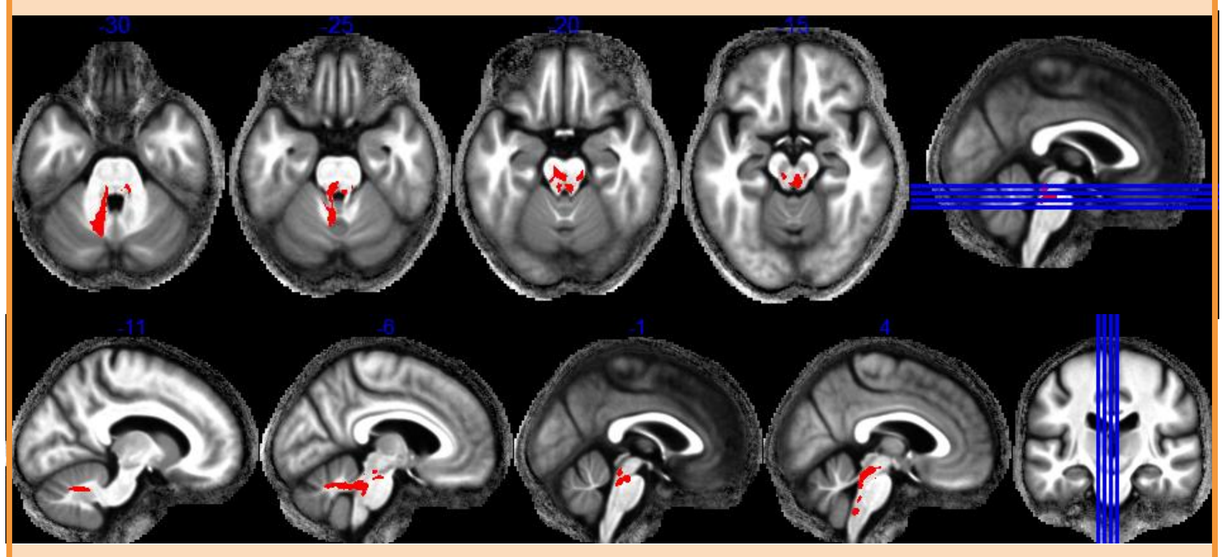
Track Density (1 mm^3)



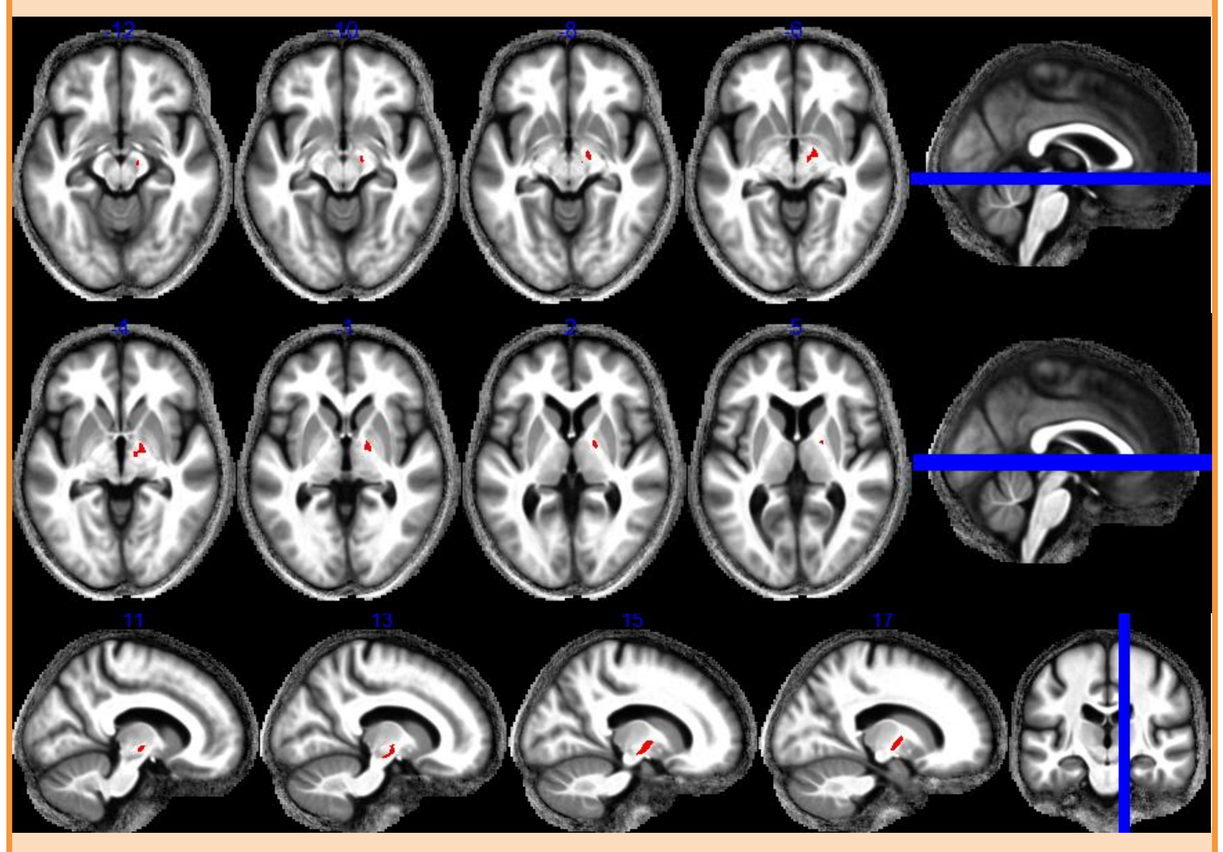
Results (significant at FWER p<.05 cluster level)

Clusters of increased track density in Parkinson's disease

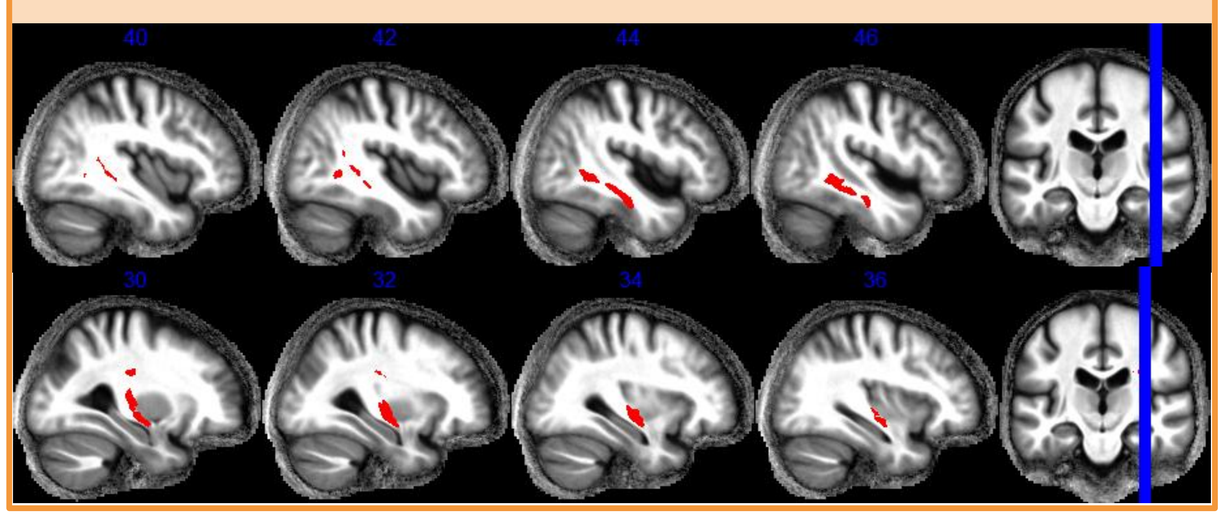
- **Cerebellum, cerebellar peduncle cluster**



- **Tract superior to substantia nigra**



- **Lateral temporal lobe tracts**



Conclusions

- Track-weighted imaging has potential for wide use **[1,2,3,8,9]**
- Guidelines need to be developed and validated
  - Fiber count and voxel-sizes, length-scaling
  - Spatial and intensity normalization
  - Statistical testing (e.g. covariates, follow VBM best practices?)
- Track density imaging can detect white matter changes in Parkinson's disease
- Significantly **increased TDI** clusters in patients with Parkinson's disease
  - Cluster locations appear biologically plausible
- No clear trend with time since disease onset
- More quantitative than FA but unclear what exactly is being resolved

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CYCLOTRON RESEARCH CENTRE | http://www.cyclotron.ulg.ac.be | c.phillips@ulg.ac.be & erik.ziegler@ulg.ac.be