DTI Atlas Building – Santa Fe

- Casey Goodlett, Guido Gerig

Overview

- Algorithm [1]

- Inputs

- Geometry of atlas fibers

- Diffusion statistics

- Results, conclusions, and thoughts

Inputs

- Larger data set

- Image data

  - Scanner resolution

  - No distortion correction

Preprocessing

- Tensor estimation – DTIProcess from NeuroLib

  - Weighted least squares (3 iterations)

  - Background threshold 350

  - Time: 3-4 minutes per

- FA/MD/Color FA computation using DTIProcess

- Maximum eigenvalue image (sigma = 4.5 mm)

- ~minutes per-image, Xeon dual-core w/ 2GB (Memory is limiting factor for processing)

Registration

- Average baseline image registered to T2 atlas

  - RView

  - Cross-Correlation

  - 3 resolution levels

- Affine registration used as initalization for fluid registration (Joshi, Davis) [2]

  - Multi-resolution (3 levels)

  - Runs in ~15 minutes on 8 core machine 64 GB RAM

Fiber Tracking

- Computed on atlas tensor image

- ROIs redrawn in atlas based on sample ROIs

  - InsightSNAP 1.5.4 with FA and/or Color FA images

  - Arcuate drawn based on Susumu Mori's atlas

- FiberTracking 2.3.1 used with default parameters

Collection of Diffusion Statistics

- FiberViewer 1.2.3 used for clustering/analysis

- Fiber process command line tool in DTIProcess

- For each point in atlas bundle lookup data from individual image

- For each bundle project collected data onto 1-d curve via arc-length parameterization. Median of data in cross-section

  - FA

  - MD

Analysis of Tract Statistics

- FiberViewer used to reduce each individual fiber bundle to 1-d function (median statistic)

- Population (N images) collected into spreadsheet NxM (m == # of samples along tract)

- Analysis done using scipy, numpy

- Functional Data Analysis [3]

  - Smoothing

  - PCA

  - point-wise tests (multiple comparison correction)

Internal Capsule
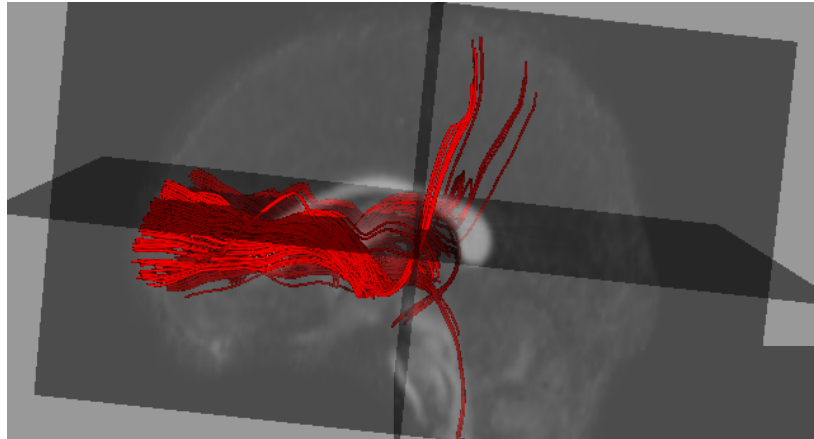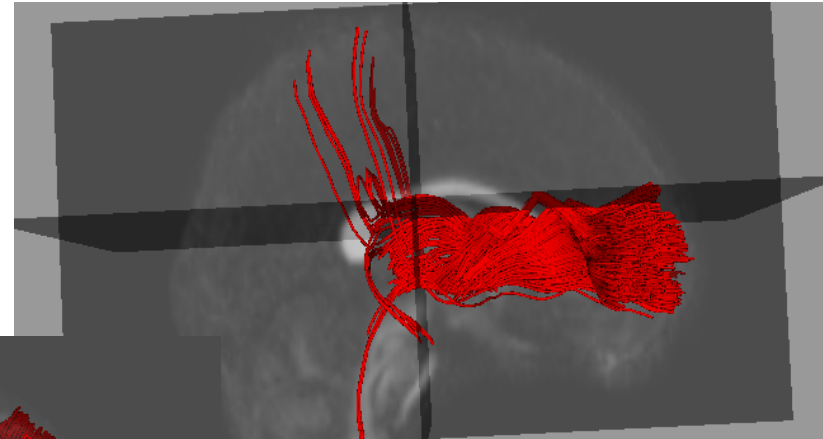
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right
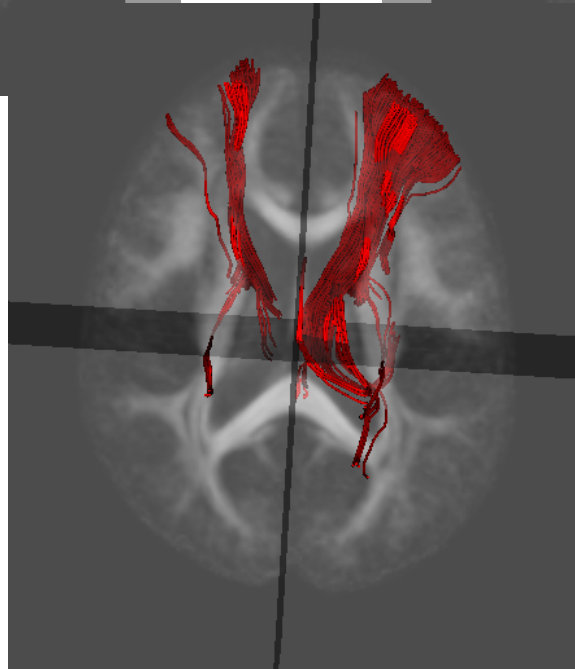
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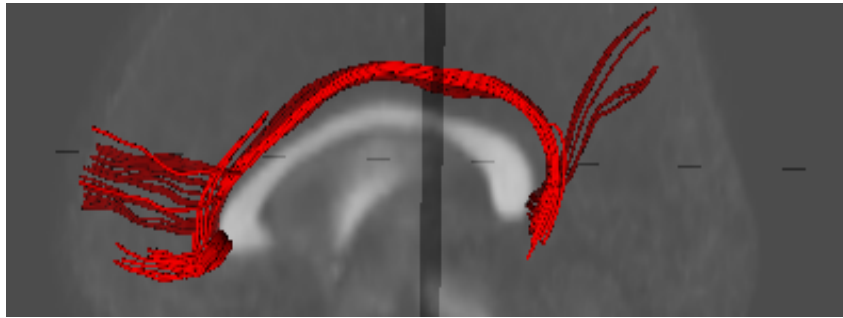
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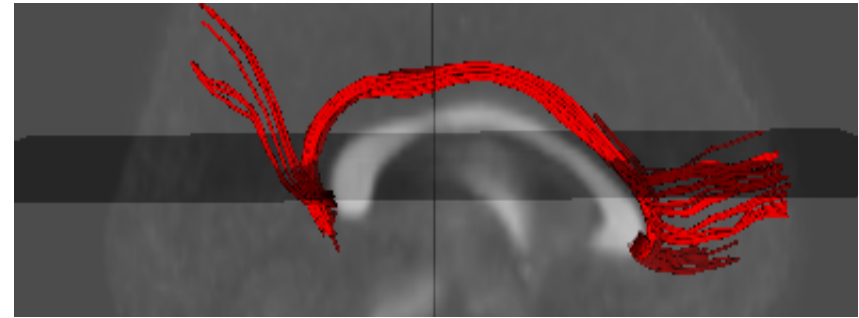
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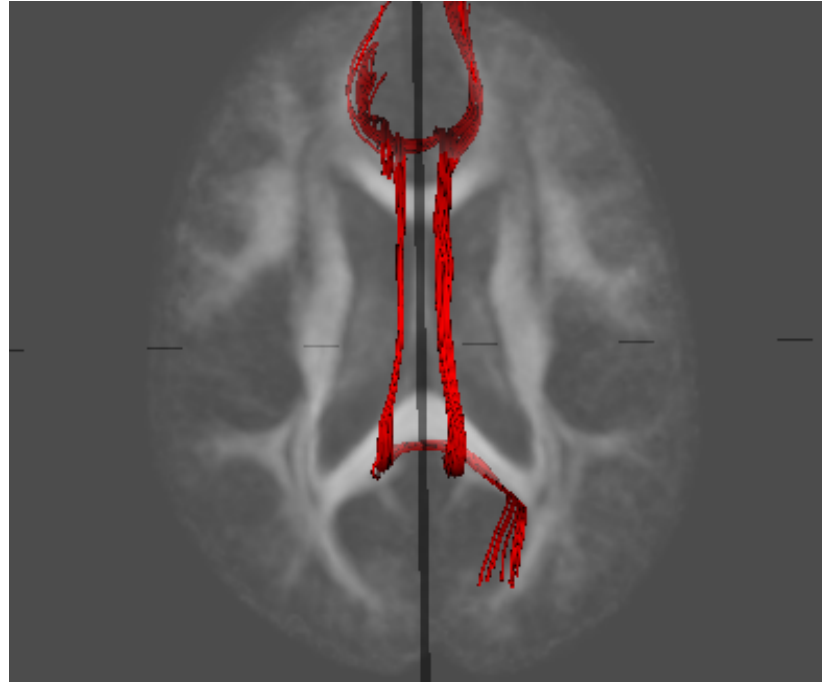
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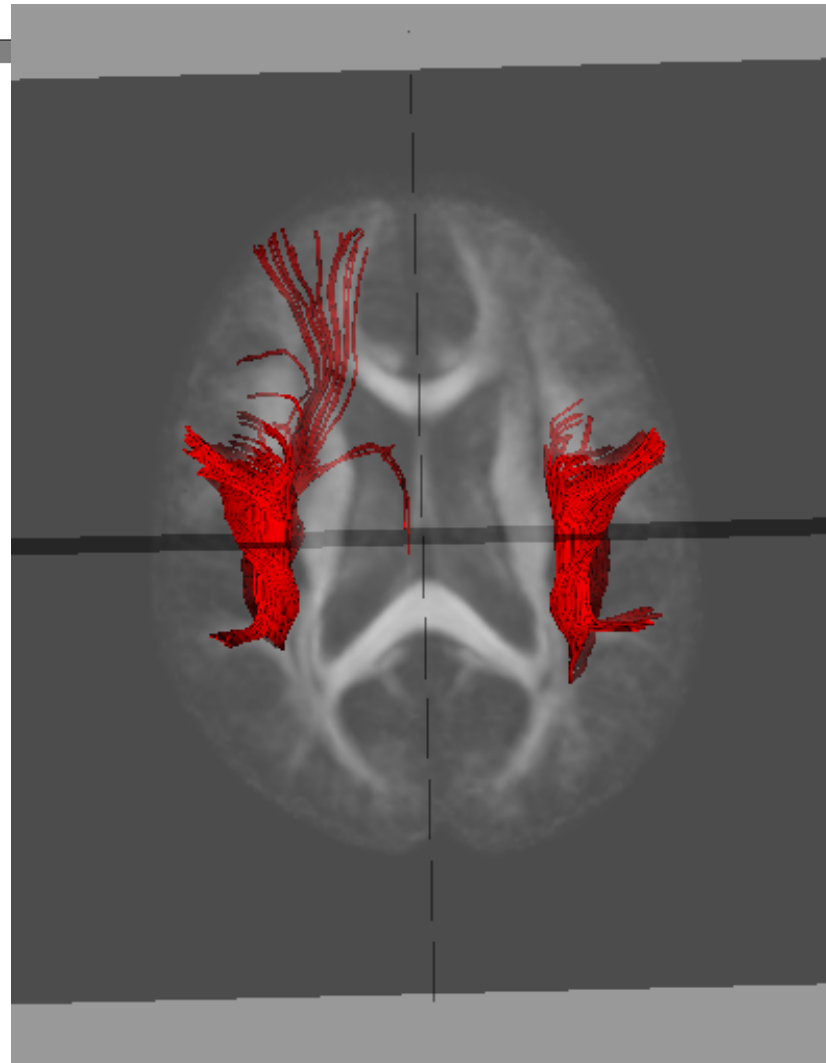
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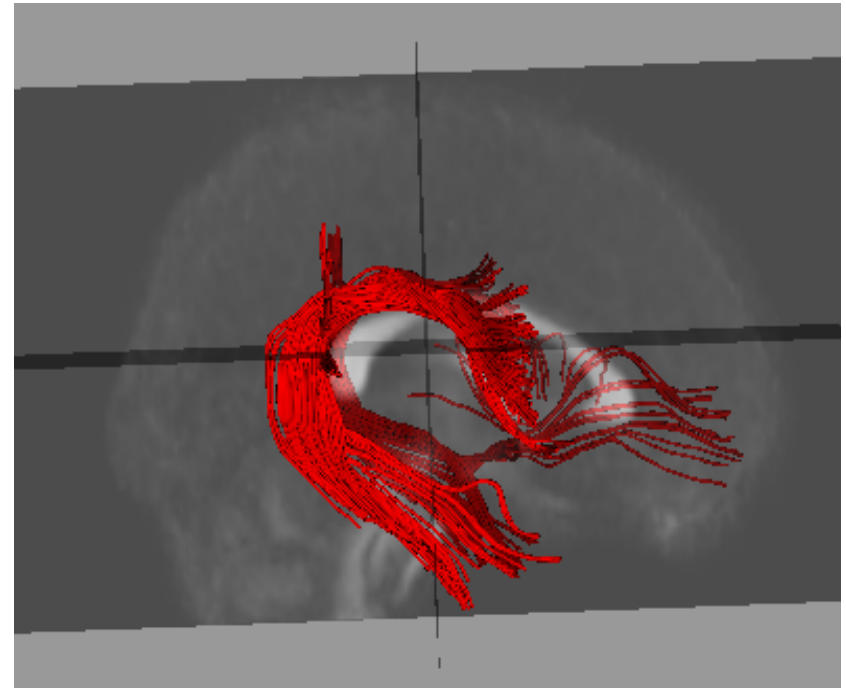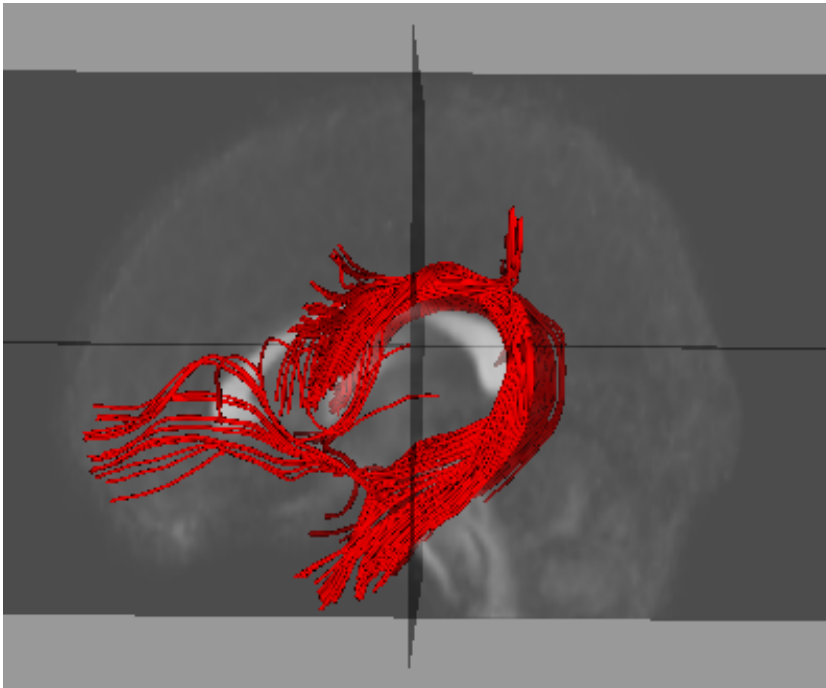
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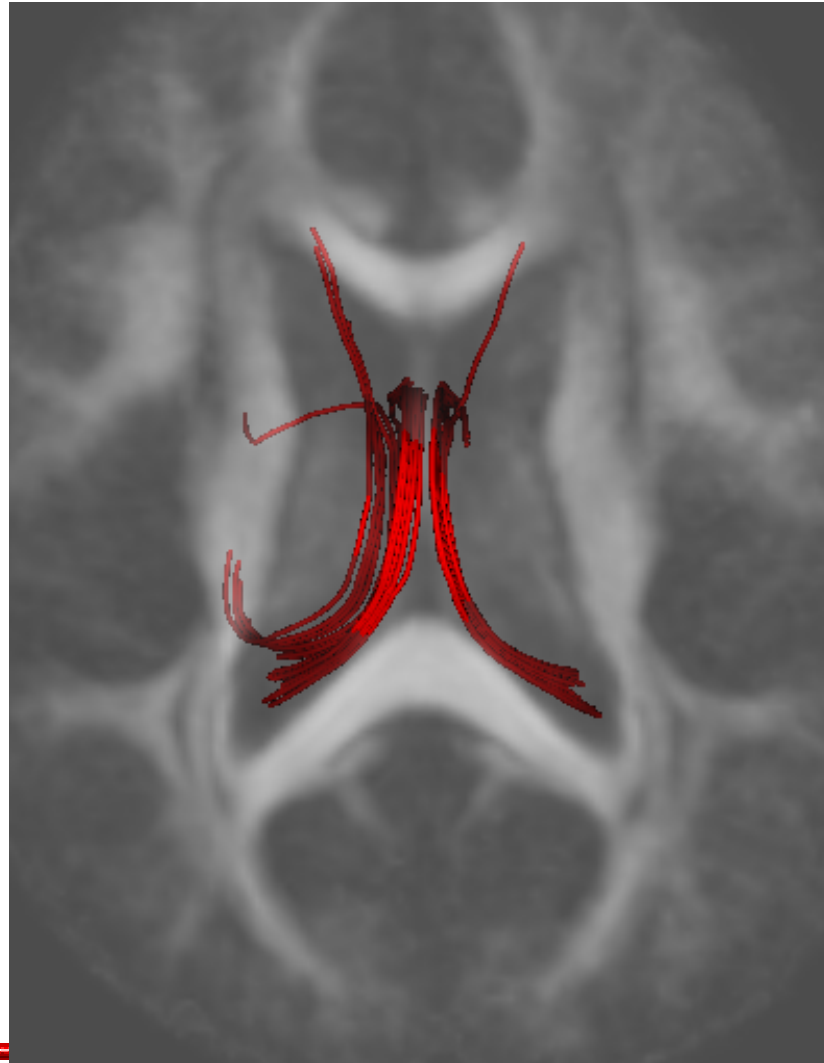
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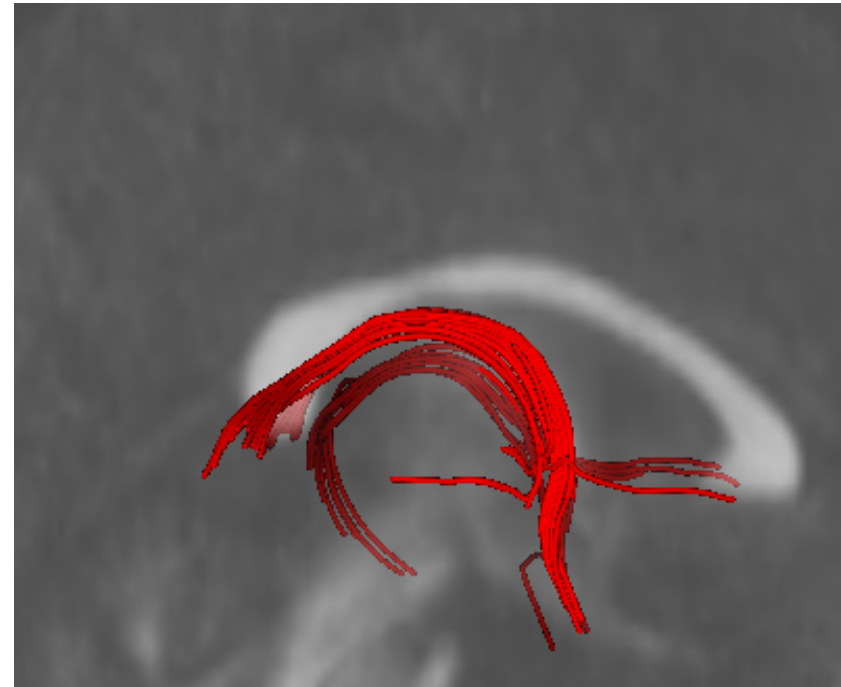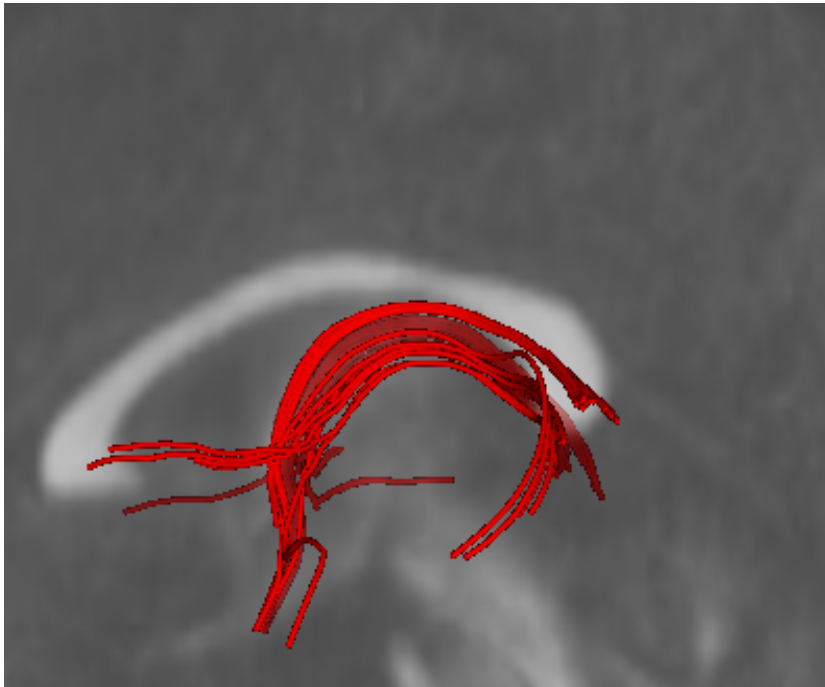
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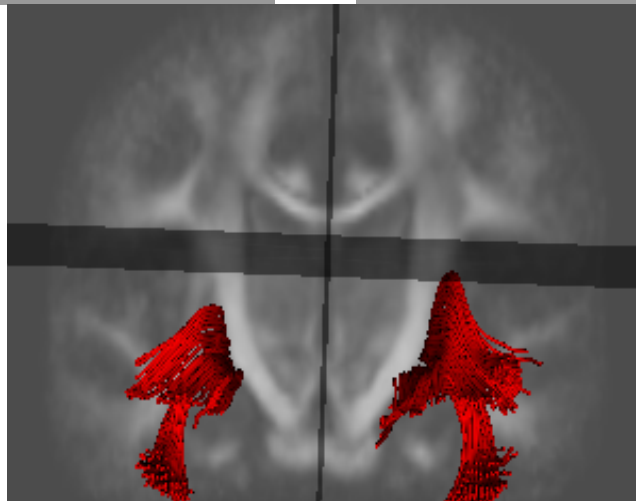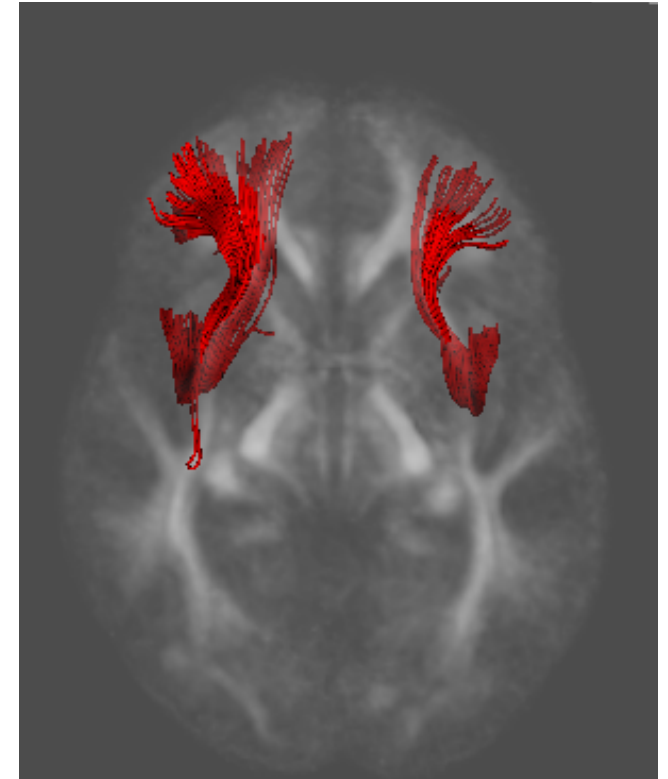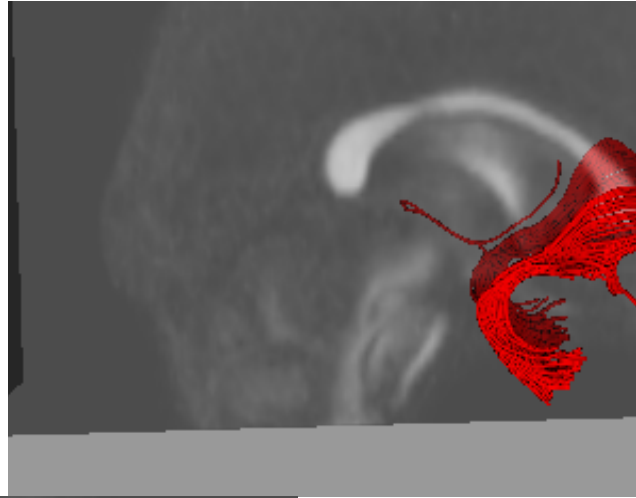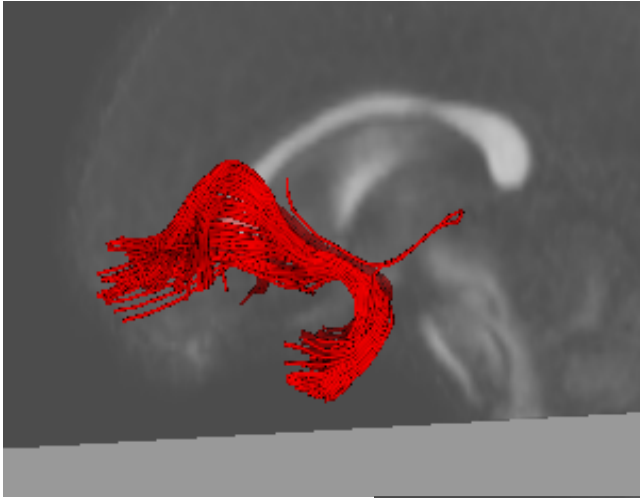
Super(fast|imprecise) Quality Check of Atlas

caseD00922
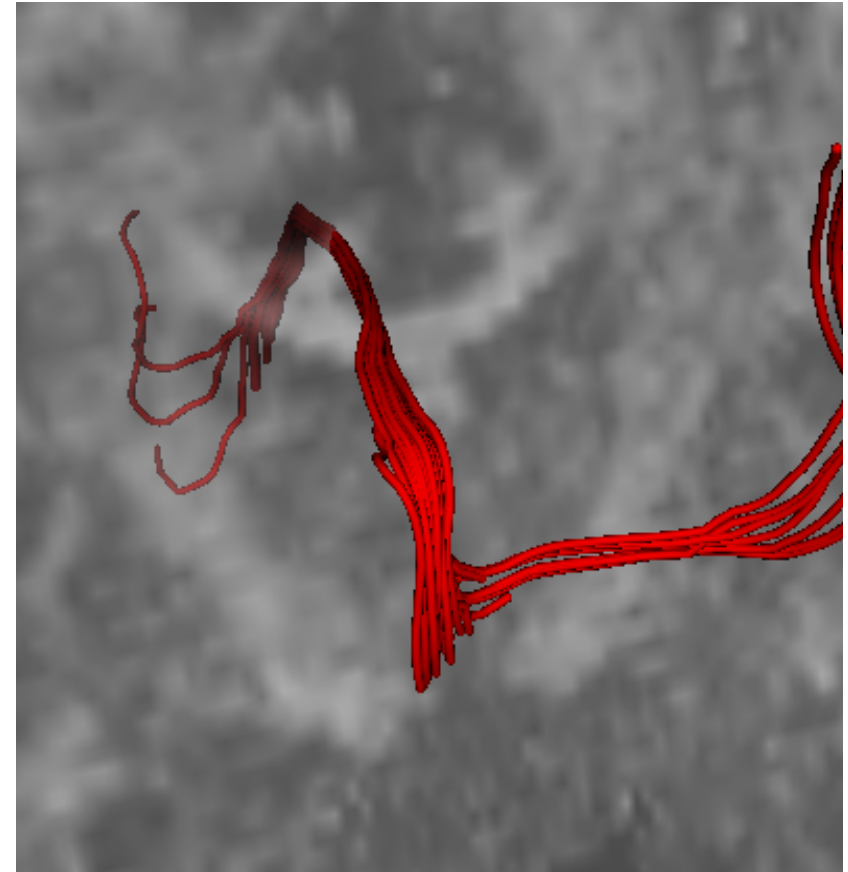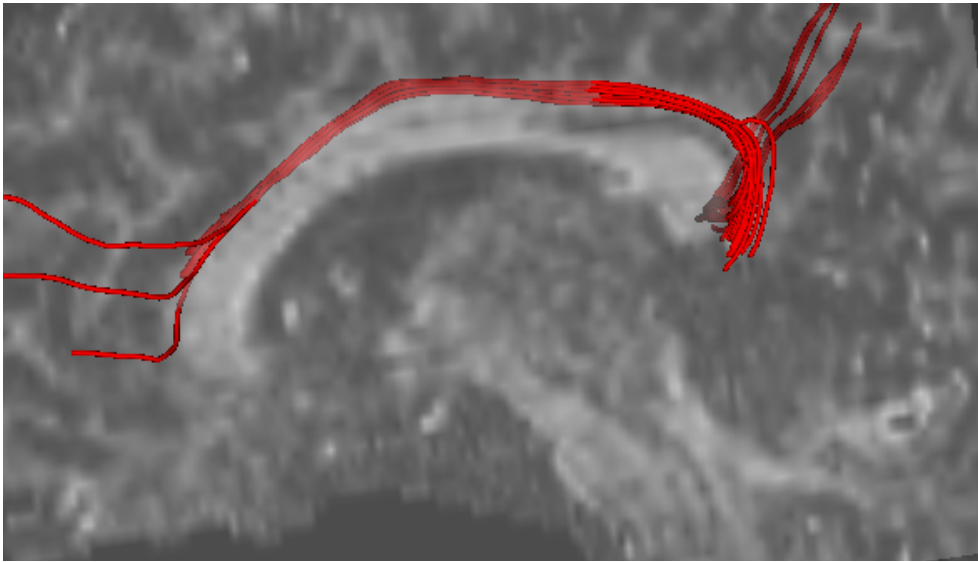
Top: Left cingulum bundle (Sagittal View)
Right: Left cingulum bundle (Coronal View)

Super(fast|imprecise) Quality Check of Atlas

caseD00939
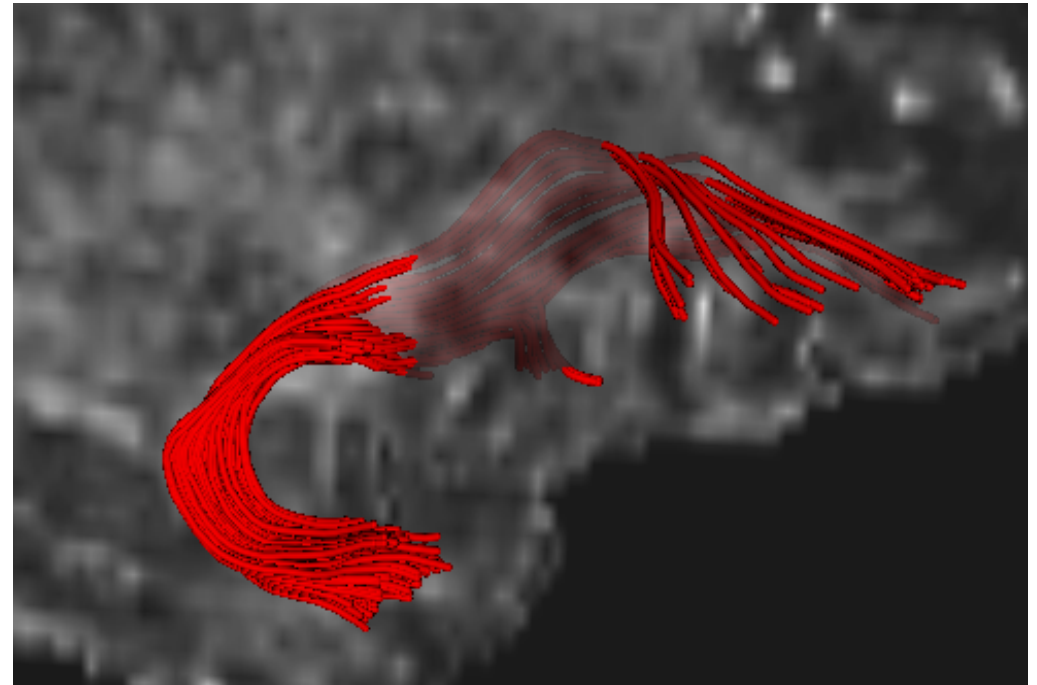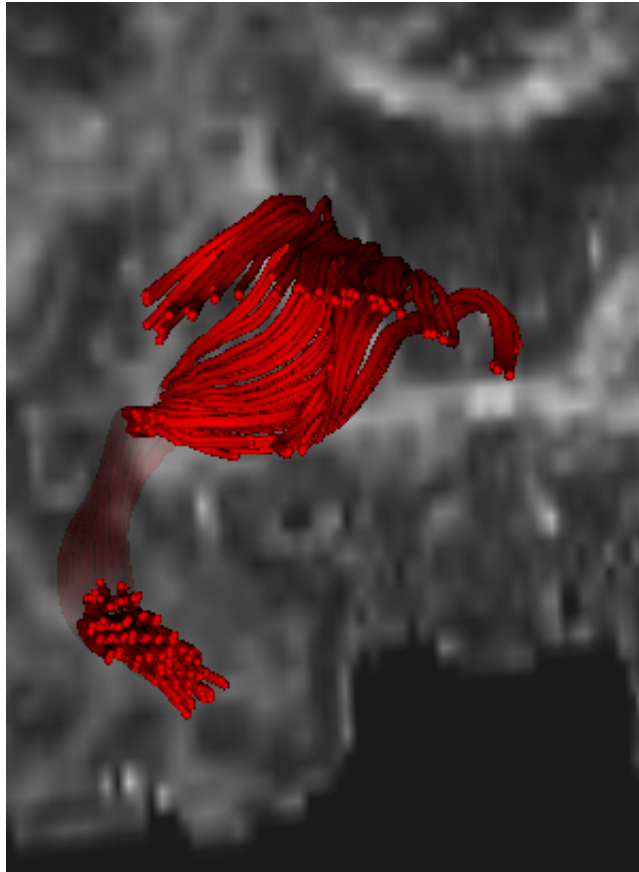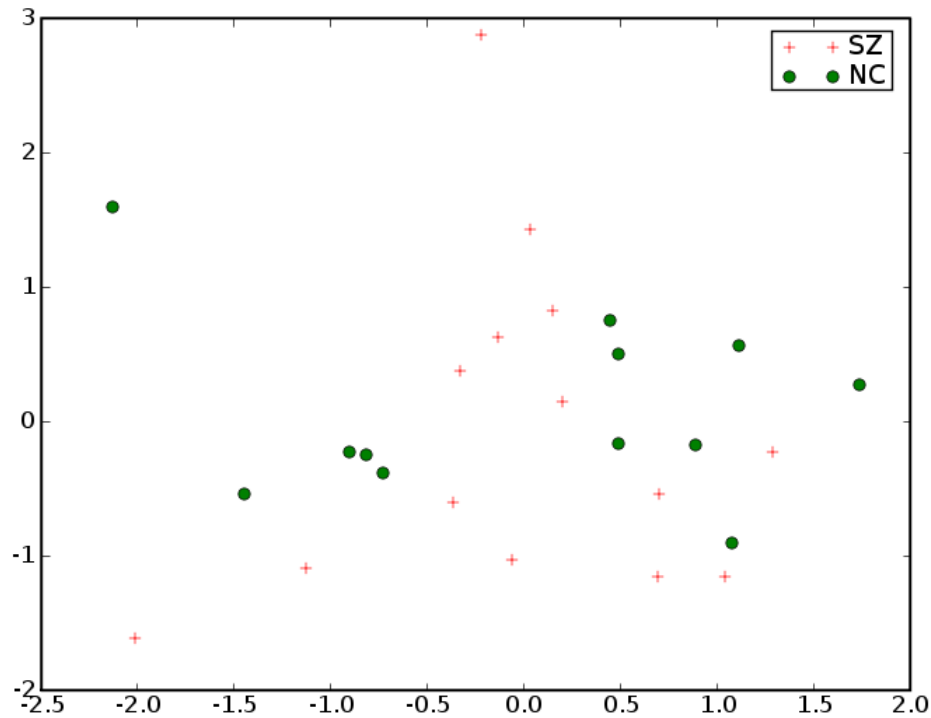

Left: Right Uncinate (from Anterior)
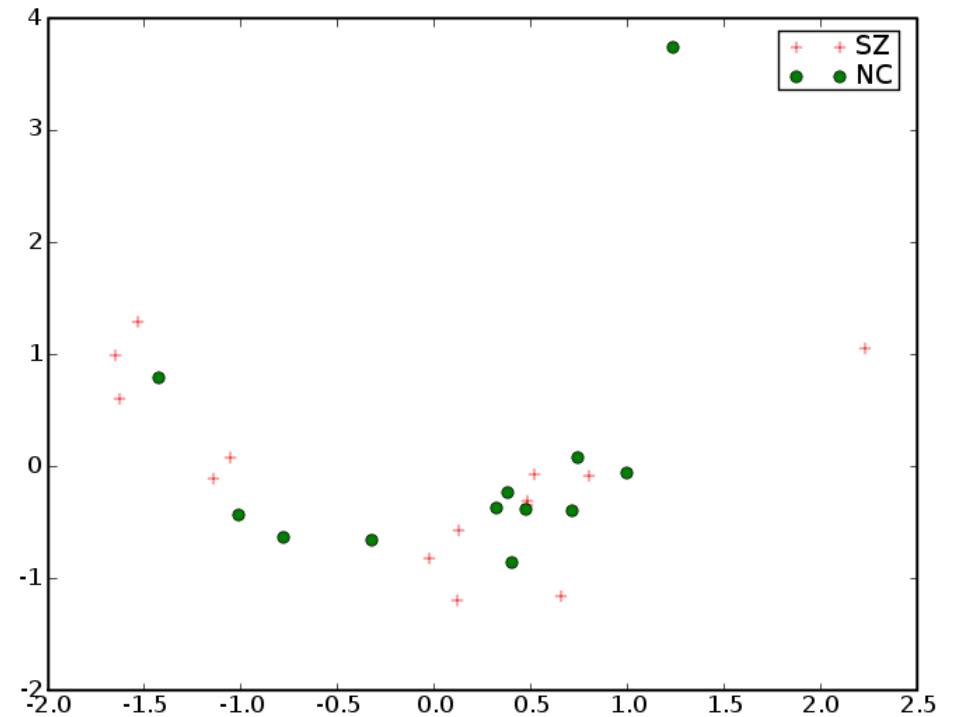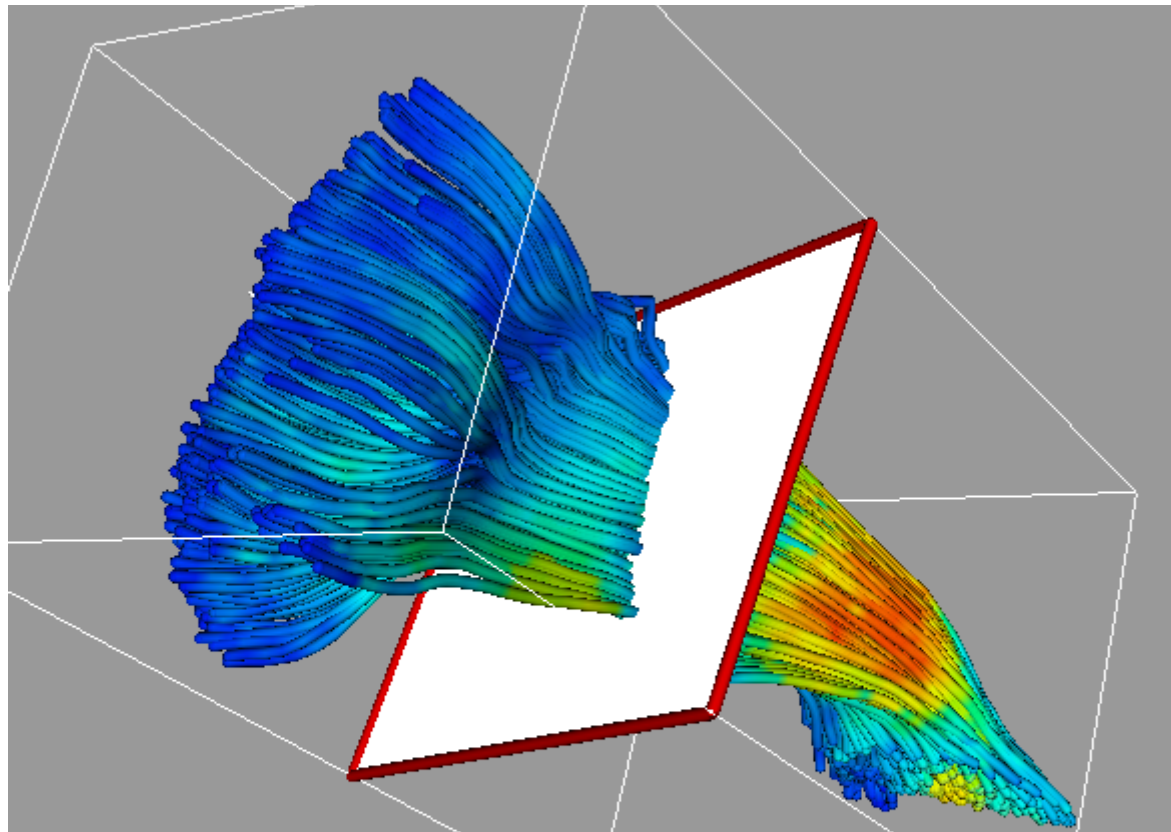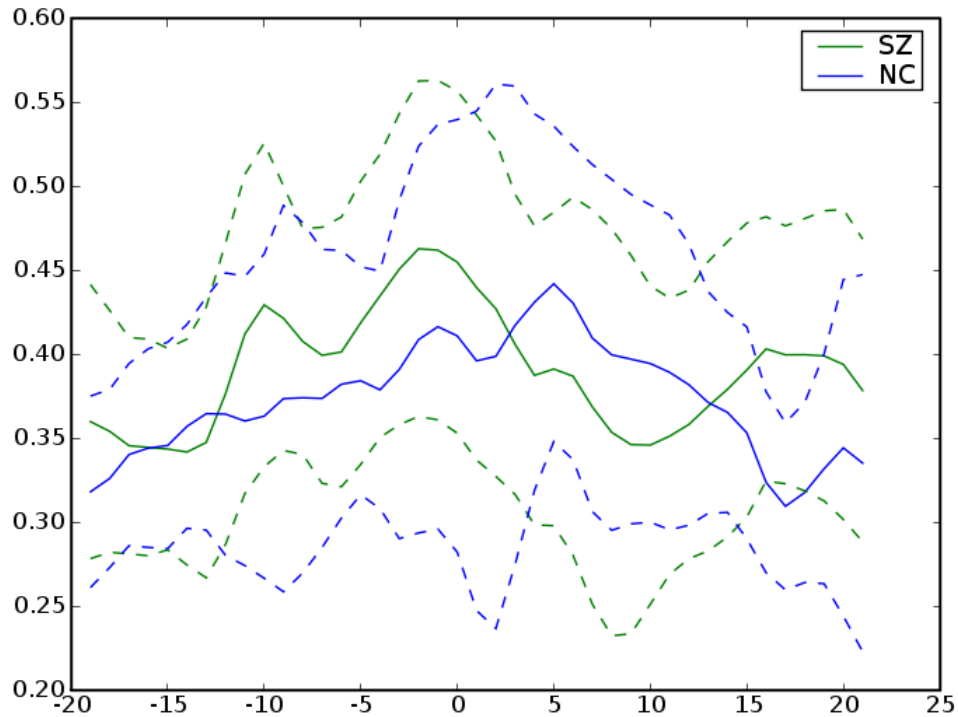Top: Right Uncinate (from Right)

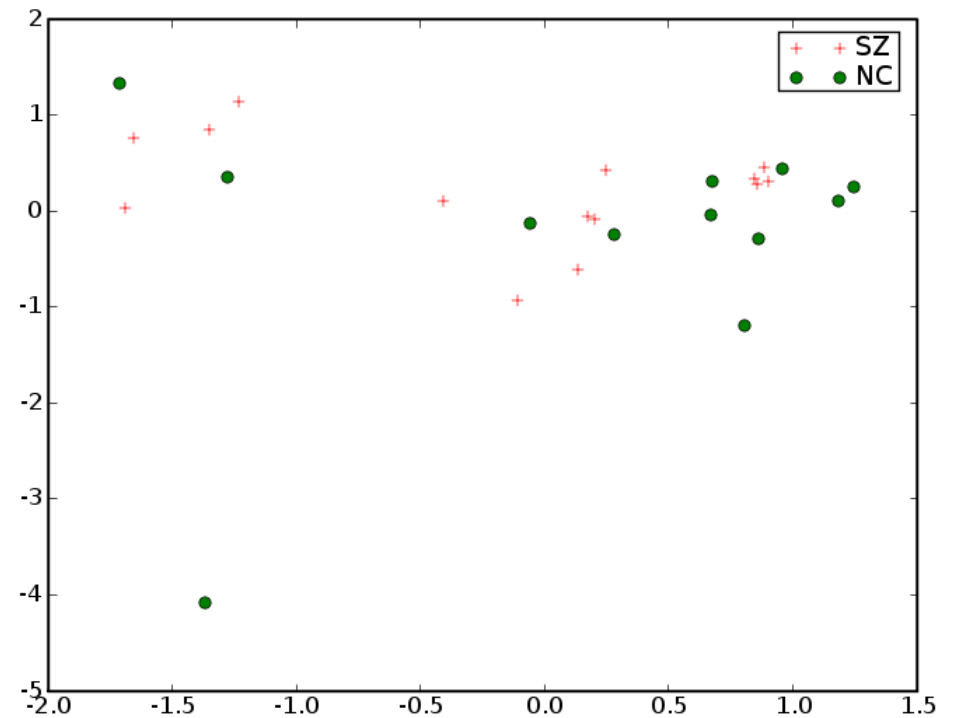# *Left Internal Capsule*
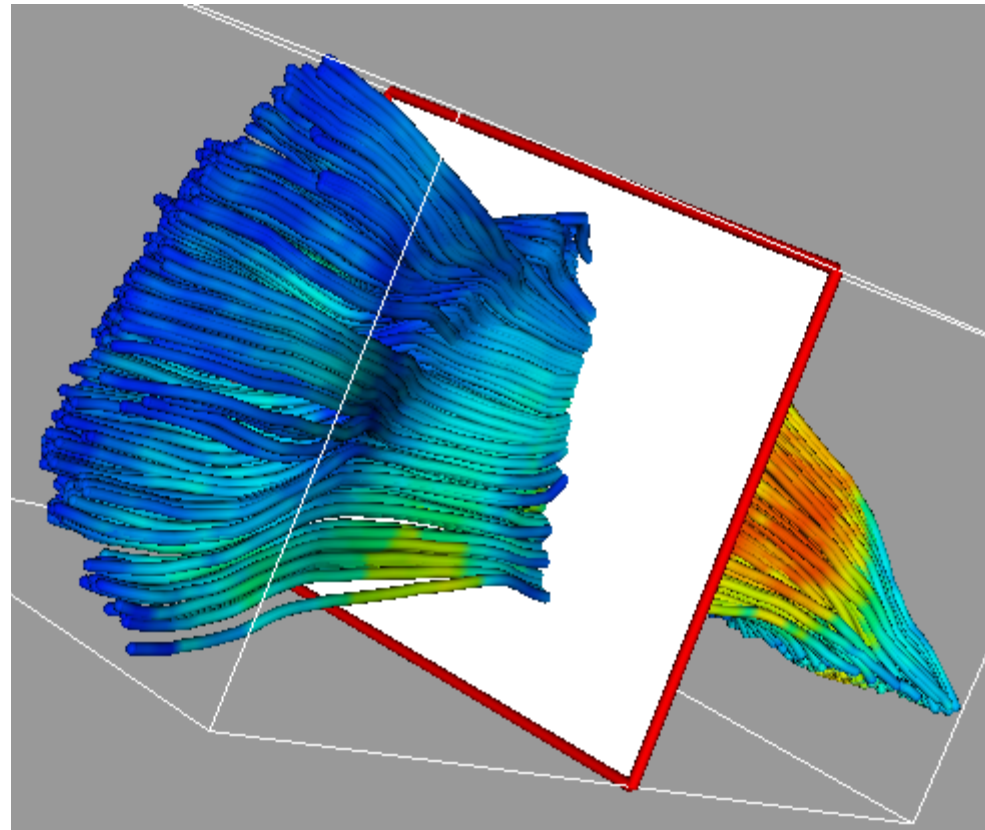
Left Internal Capsule

FA

MD

Left Internal Capsule
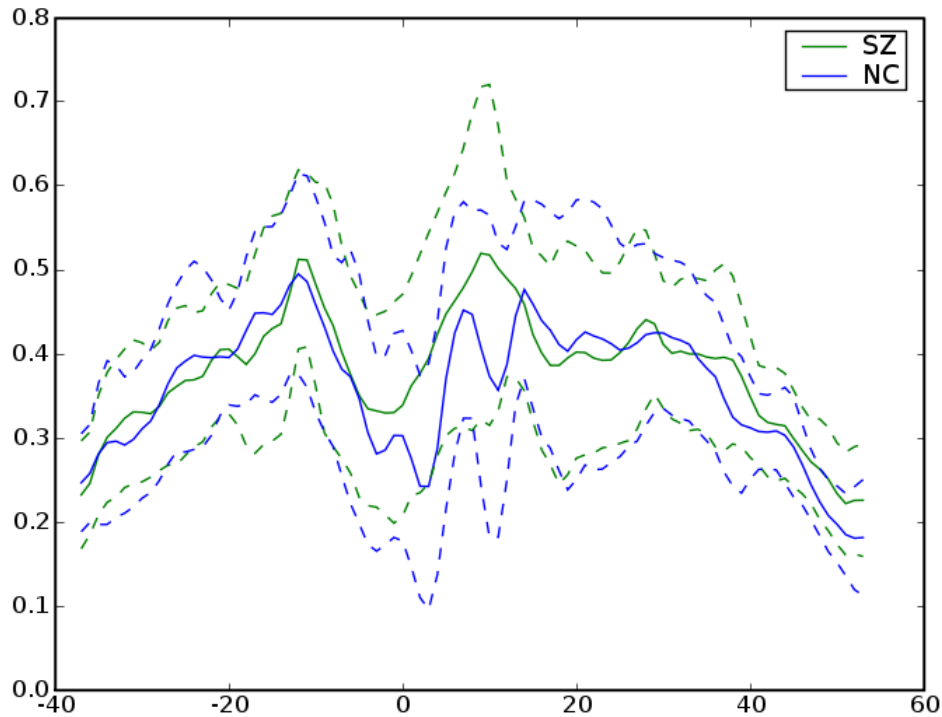

FA

MD

Left Internal Capsule

FA

MD
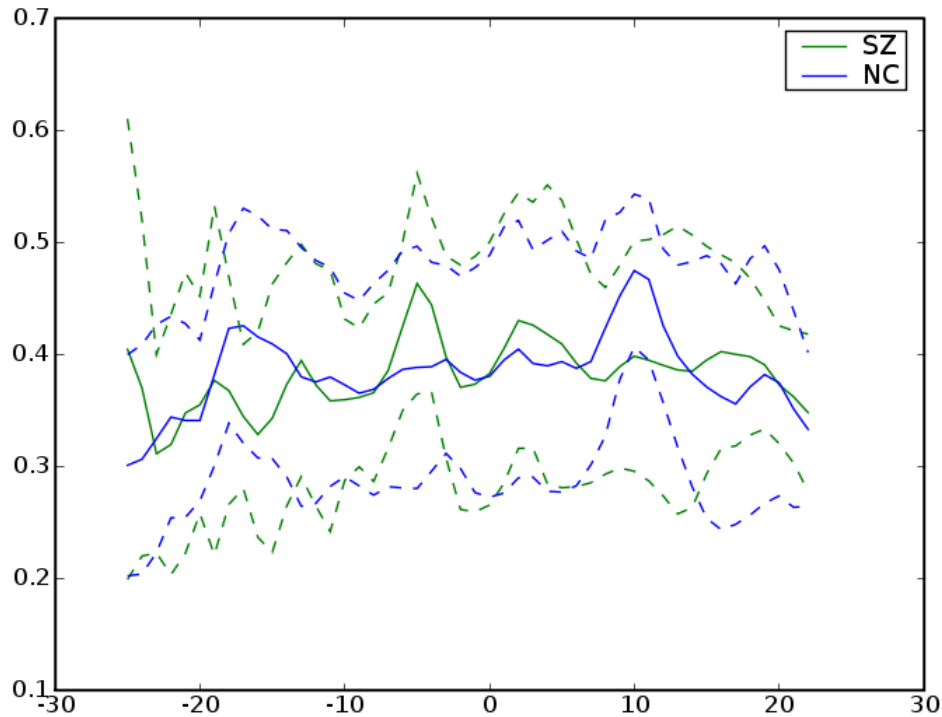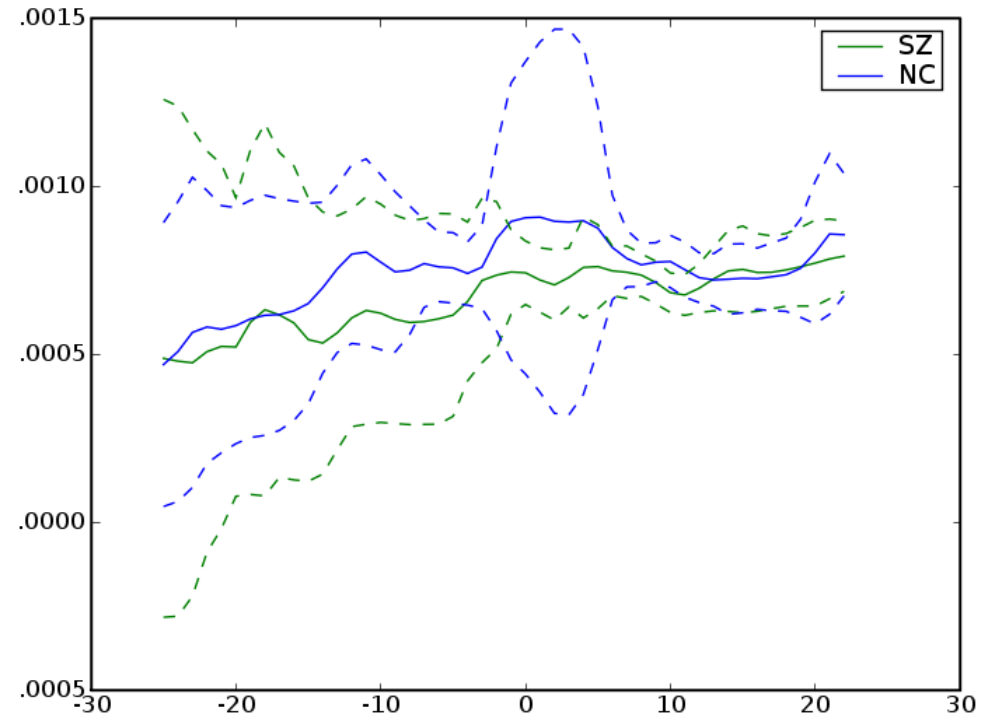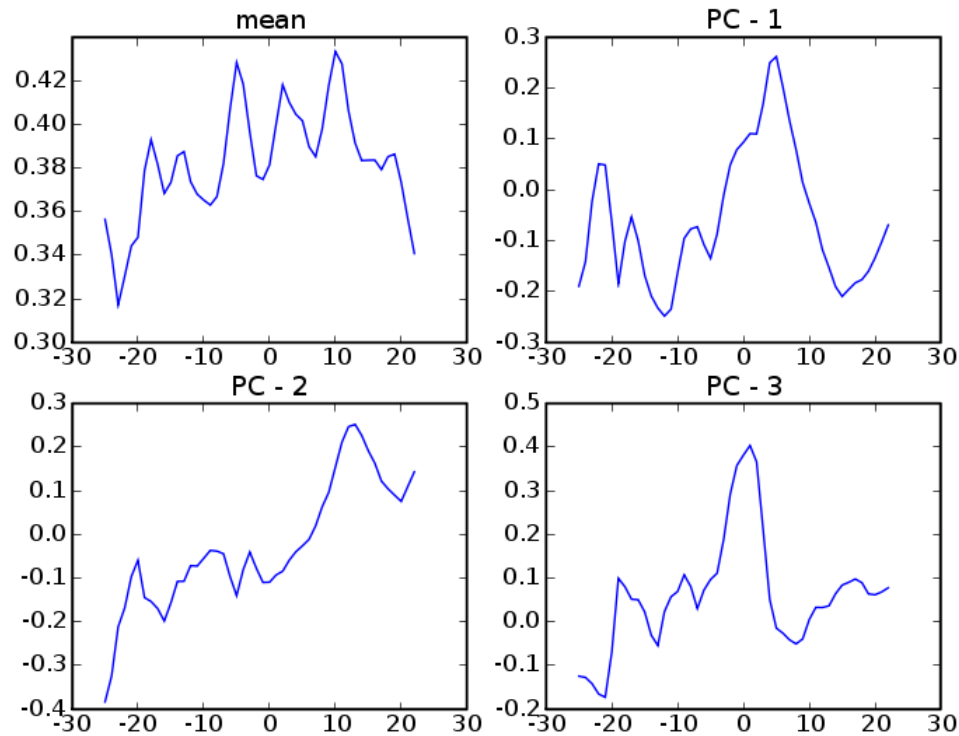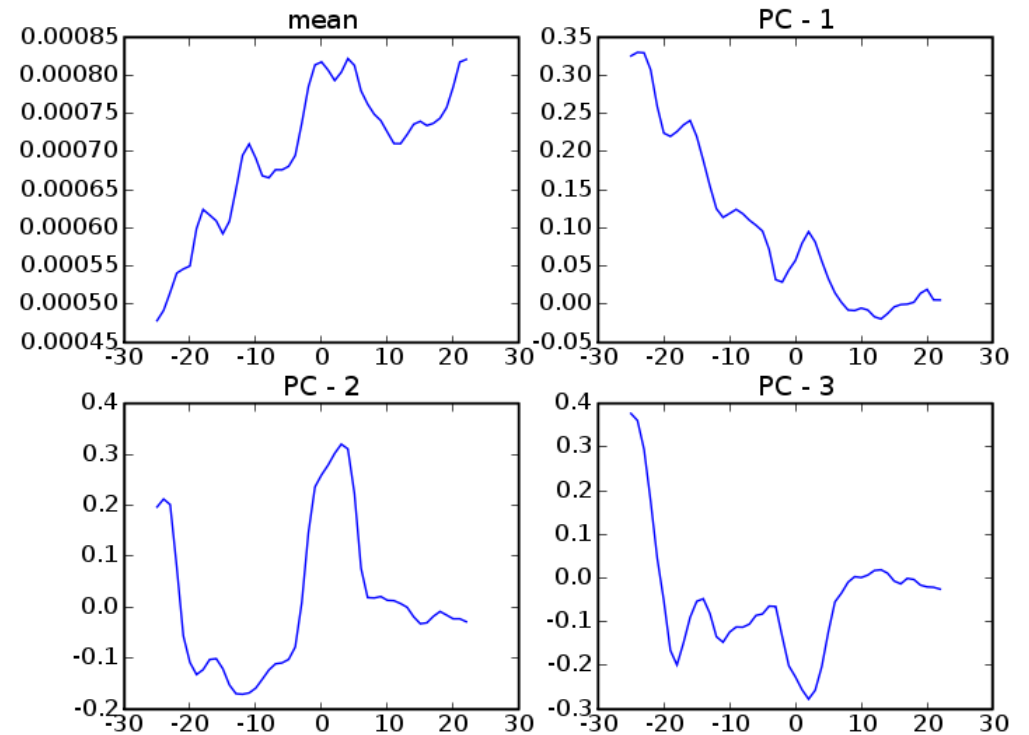
Right Internal Capsule

Right Internal Capsule

FA

MD

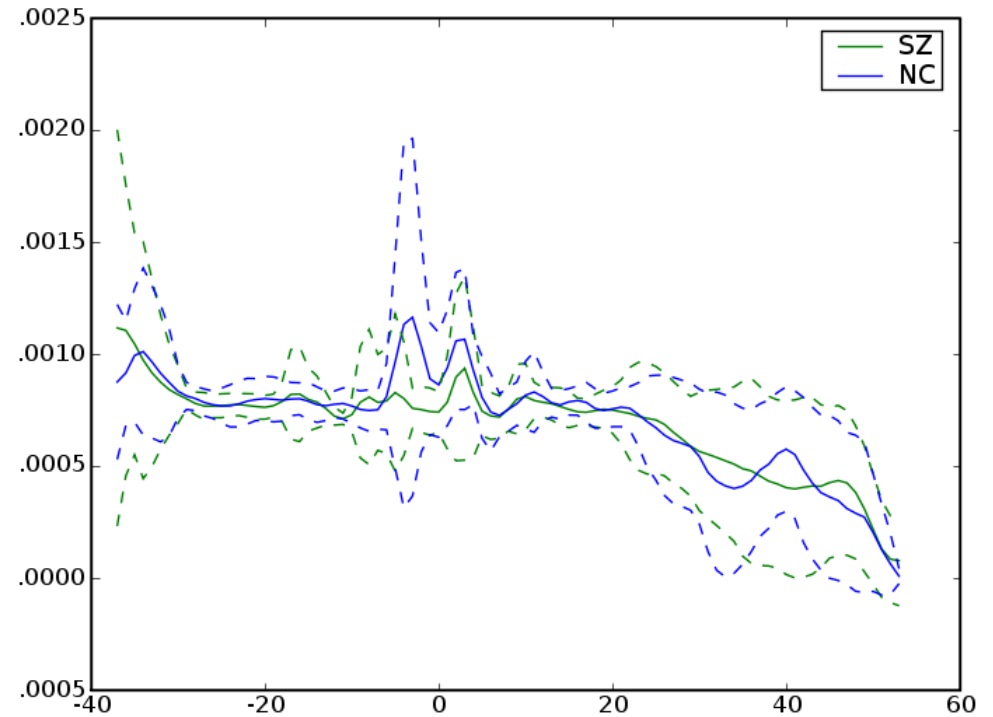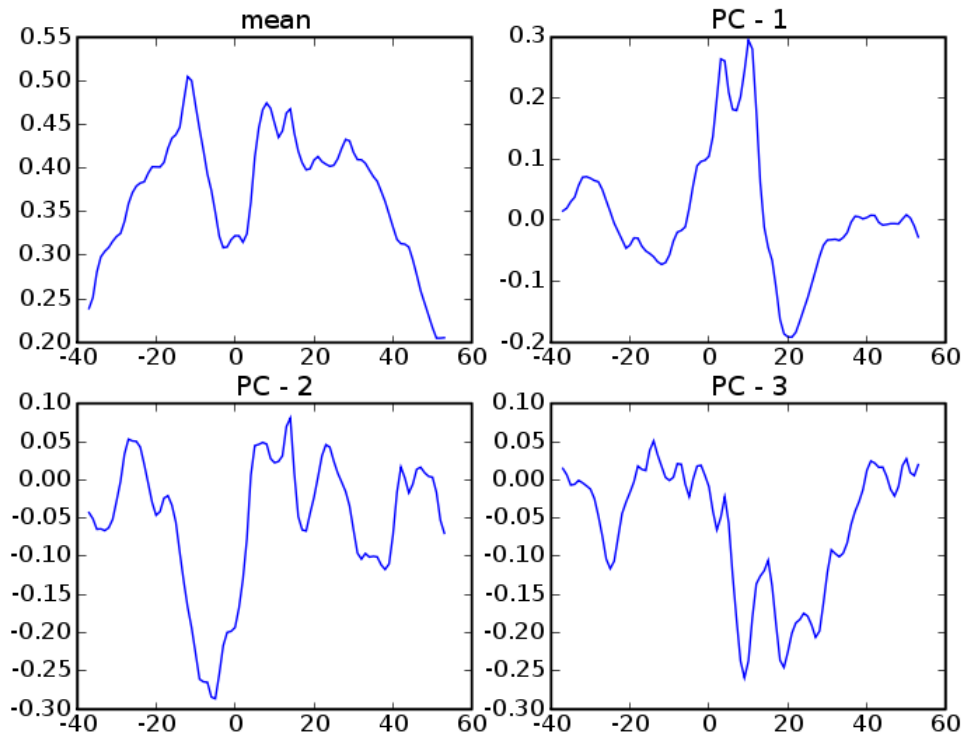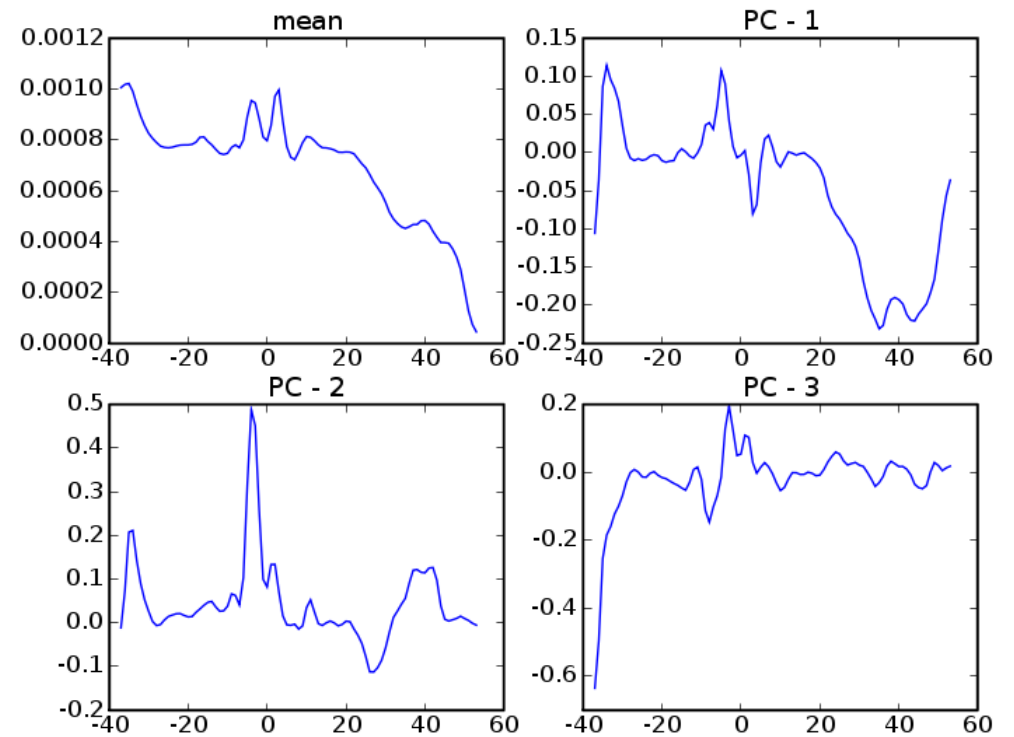# *Right Internal Capsule*

FA

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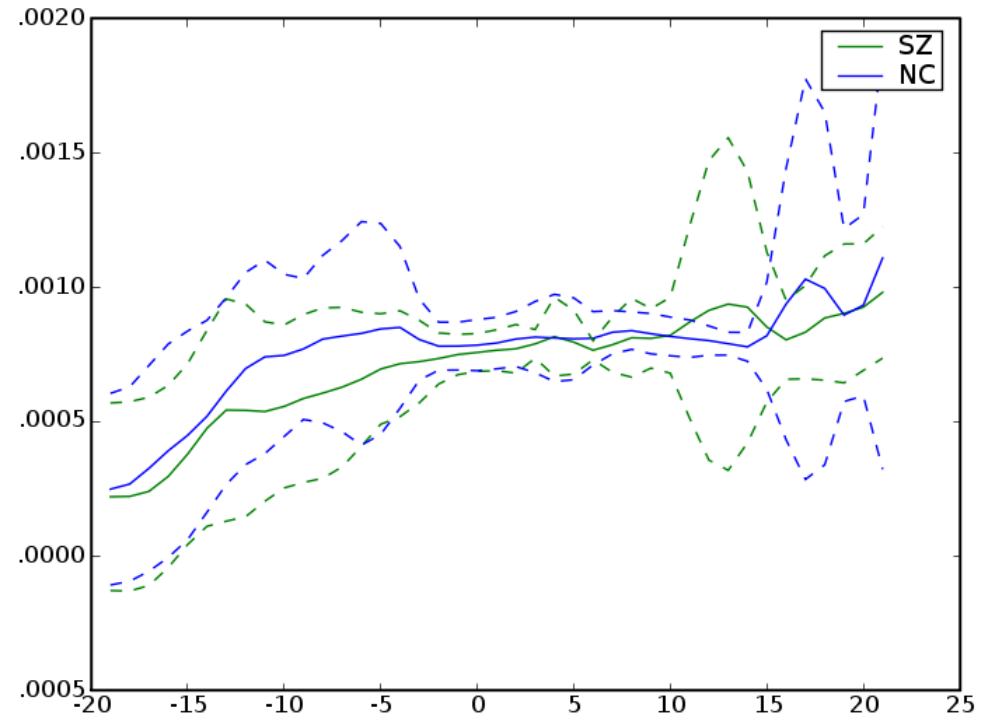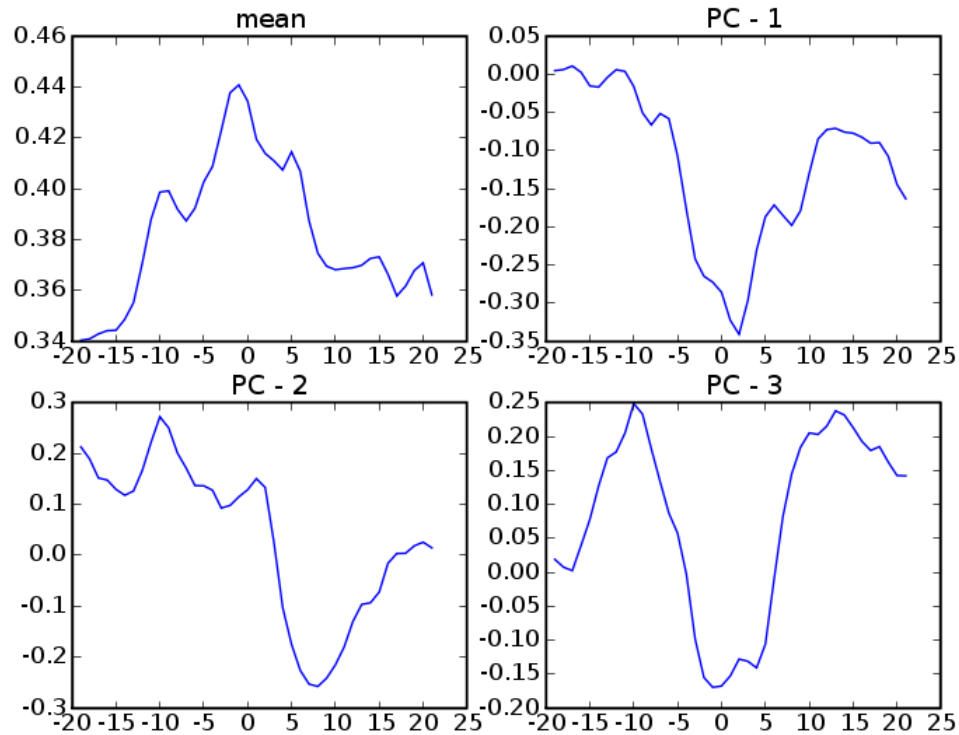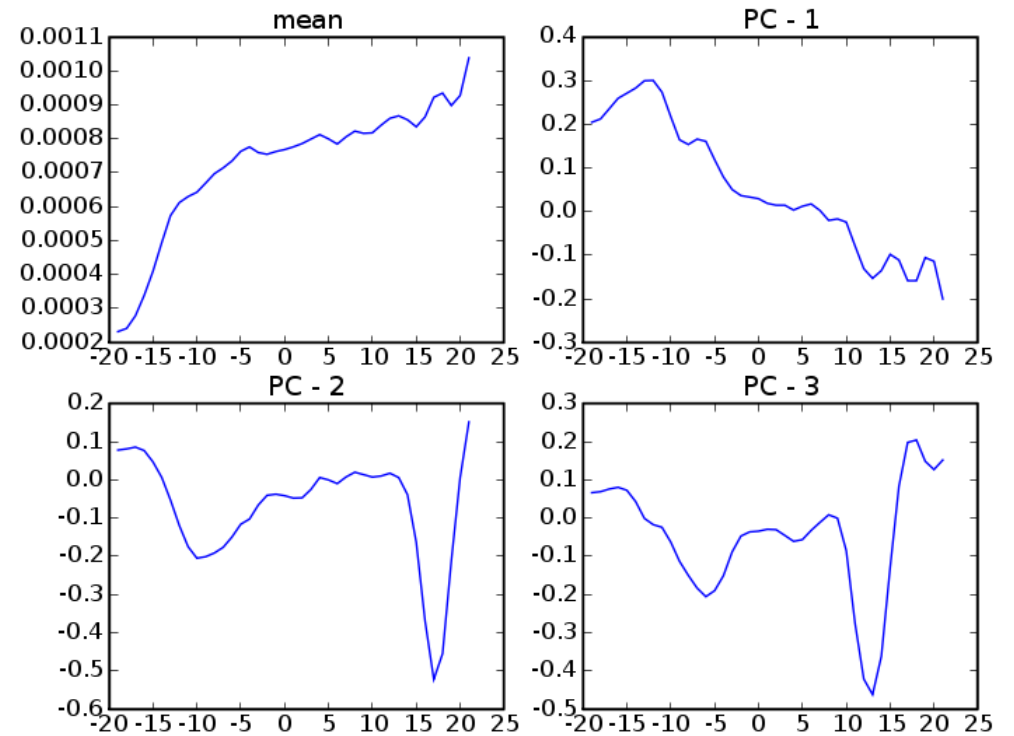
Right Internal Capsule
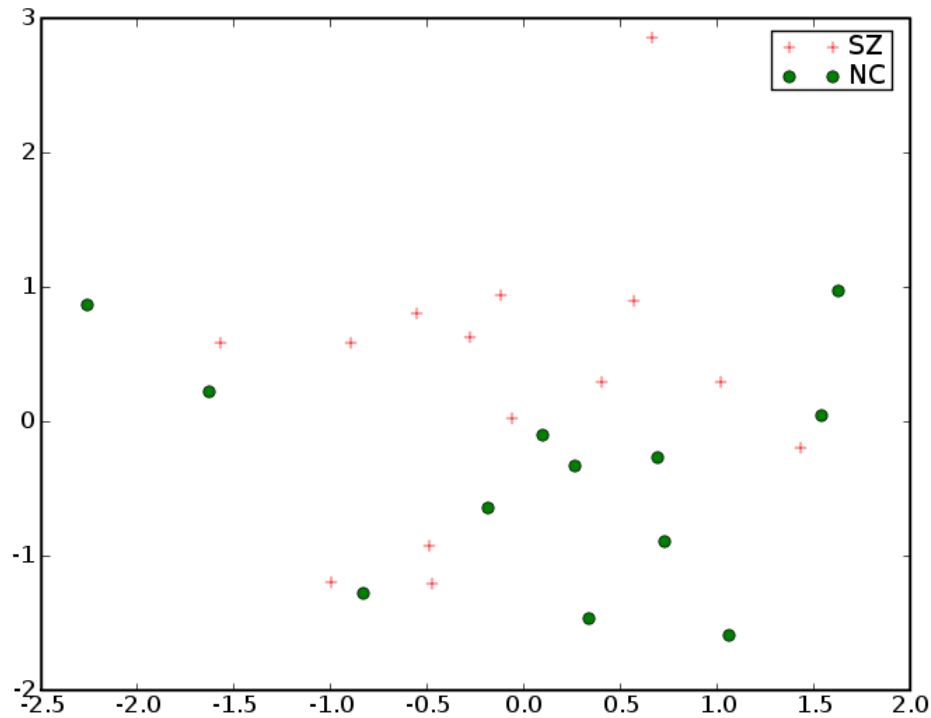
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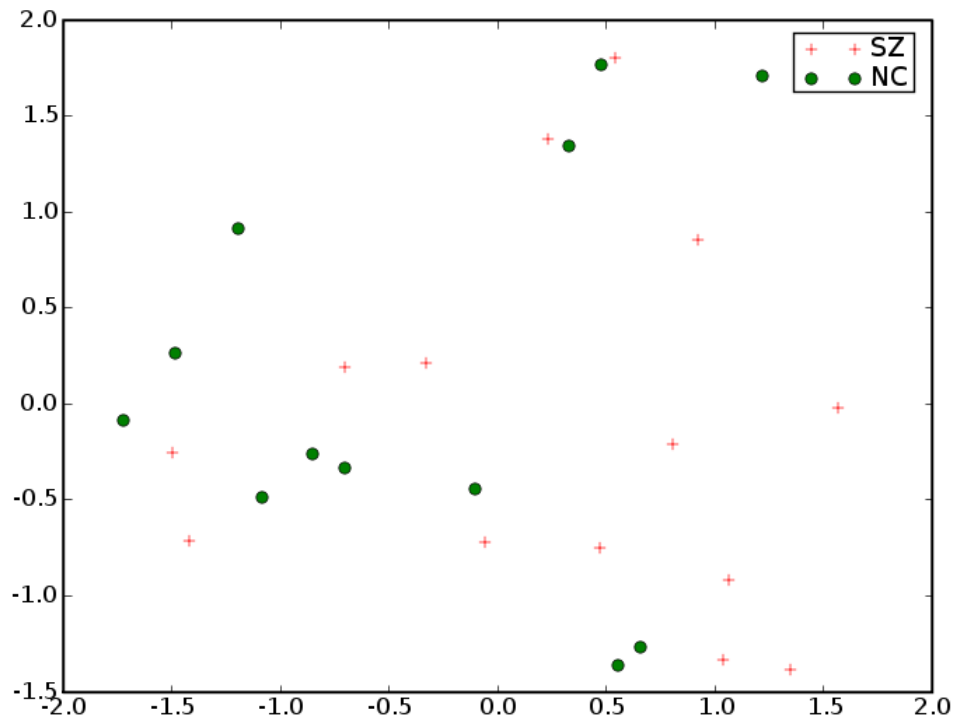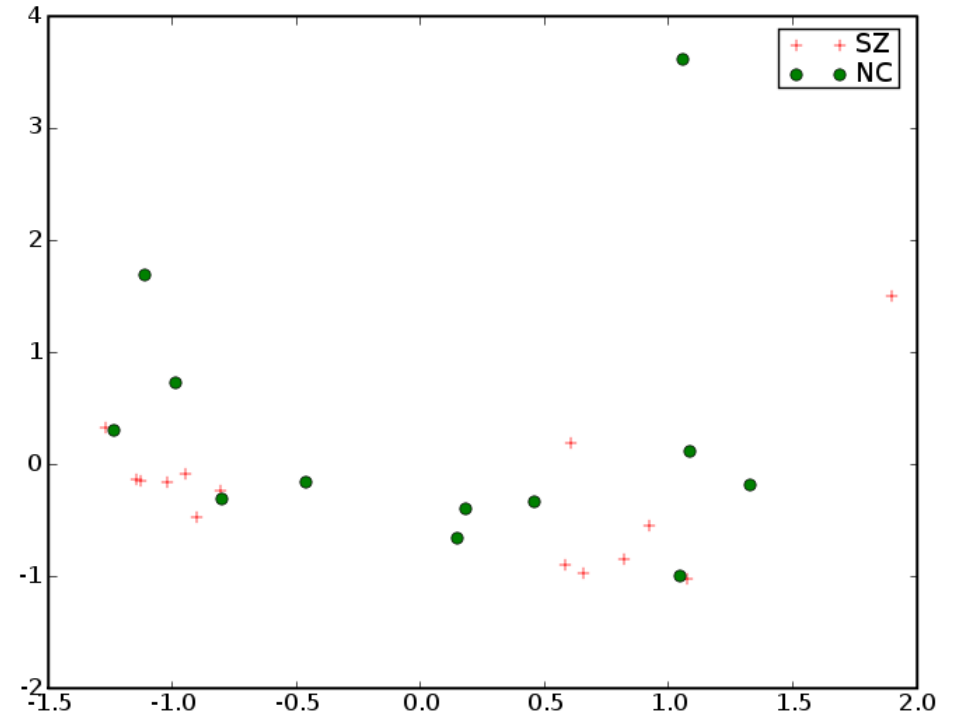MD

Left Arcuate

Left Arcuate

FA

MD
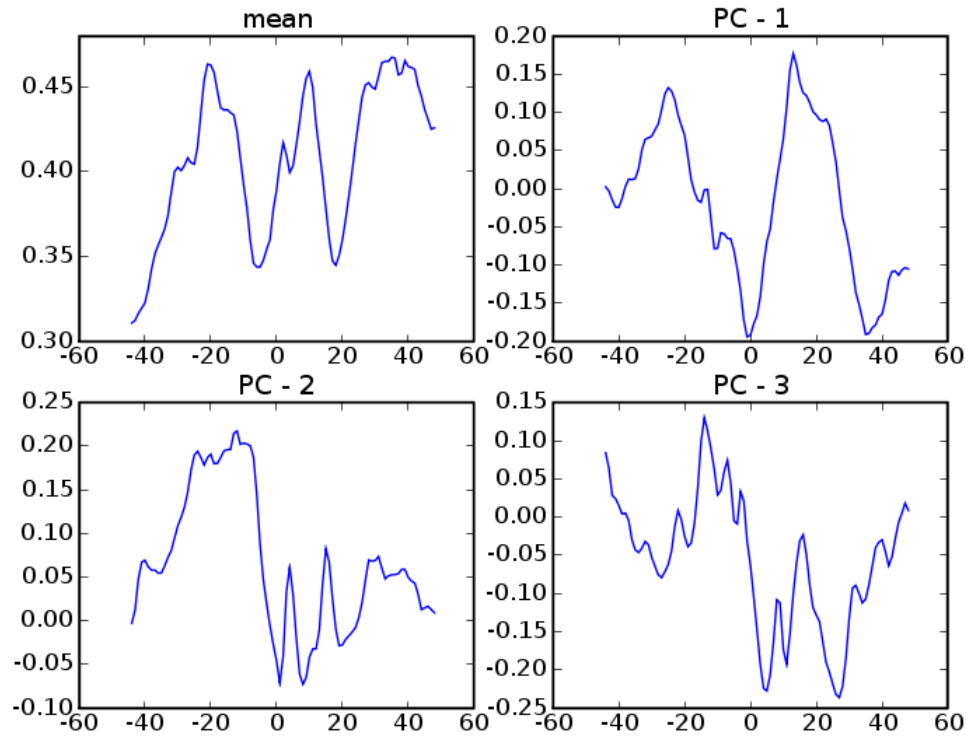
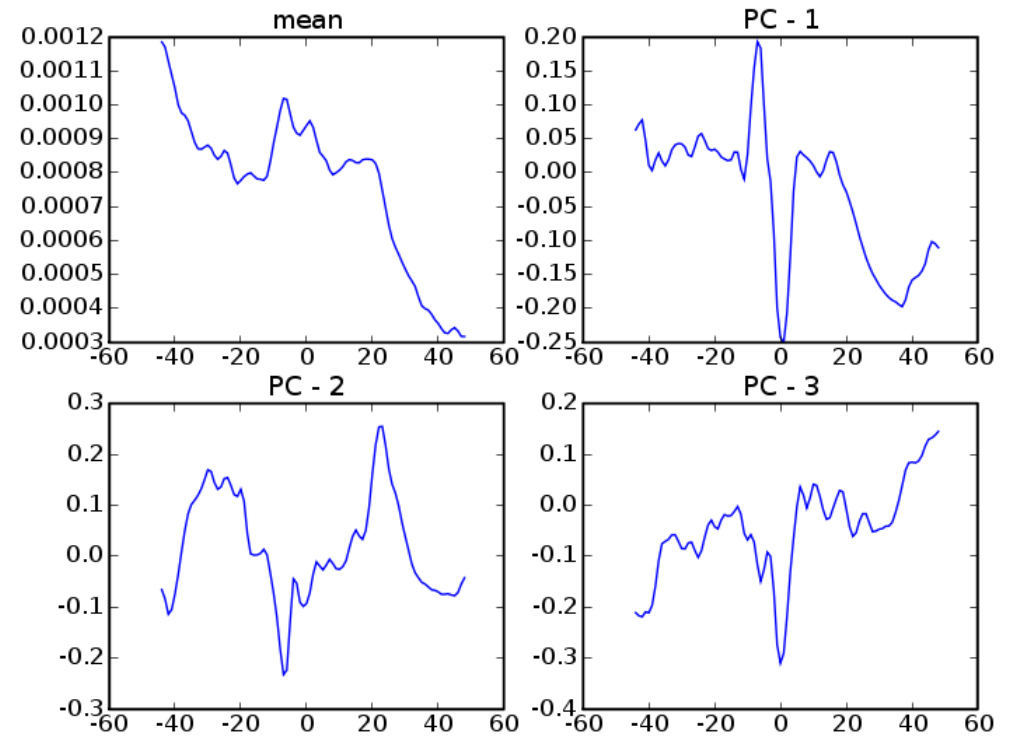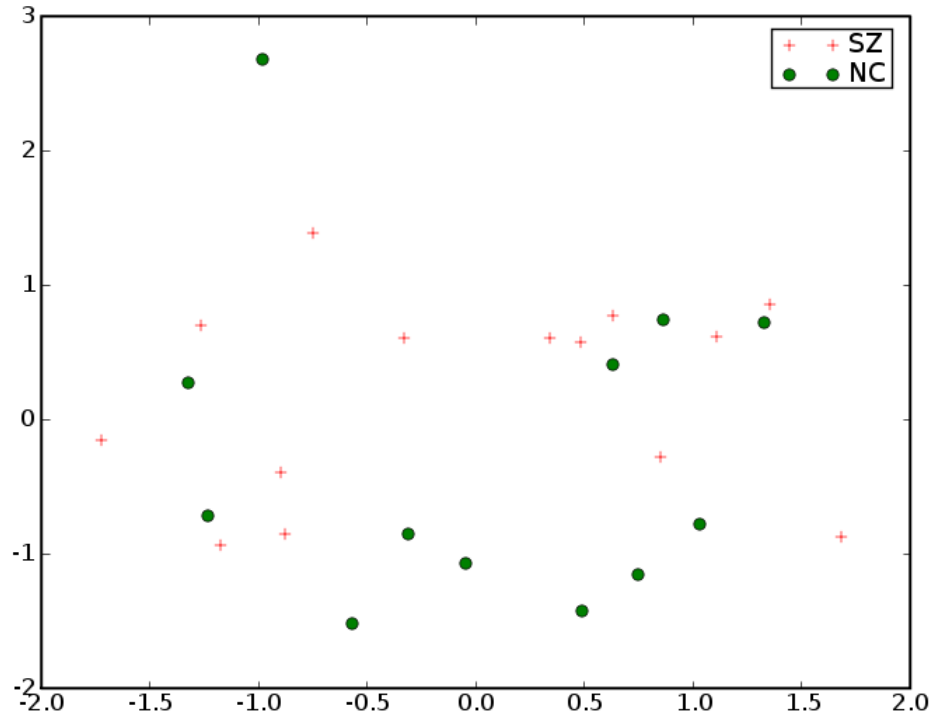# Left Arcuate

FA

MD
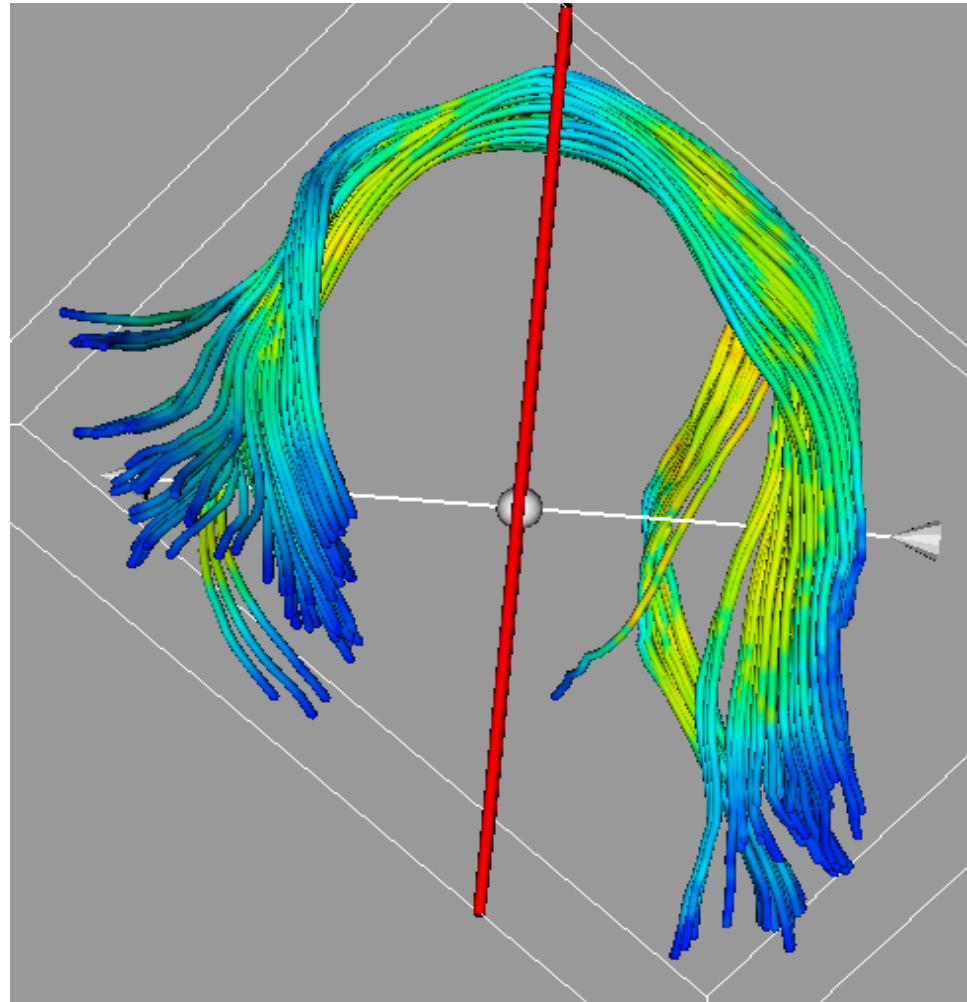
Left Arcuate

FA

MD

Right Arcuate
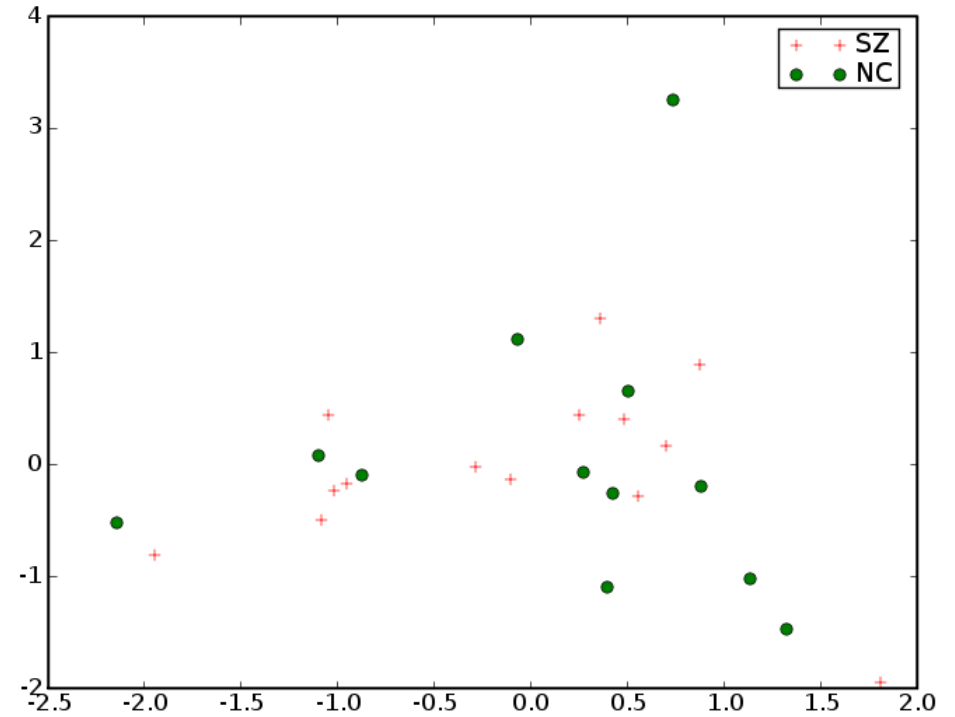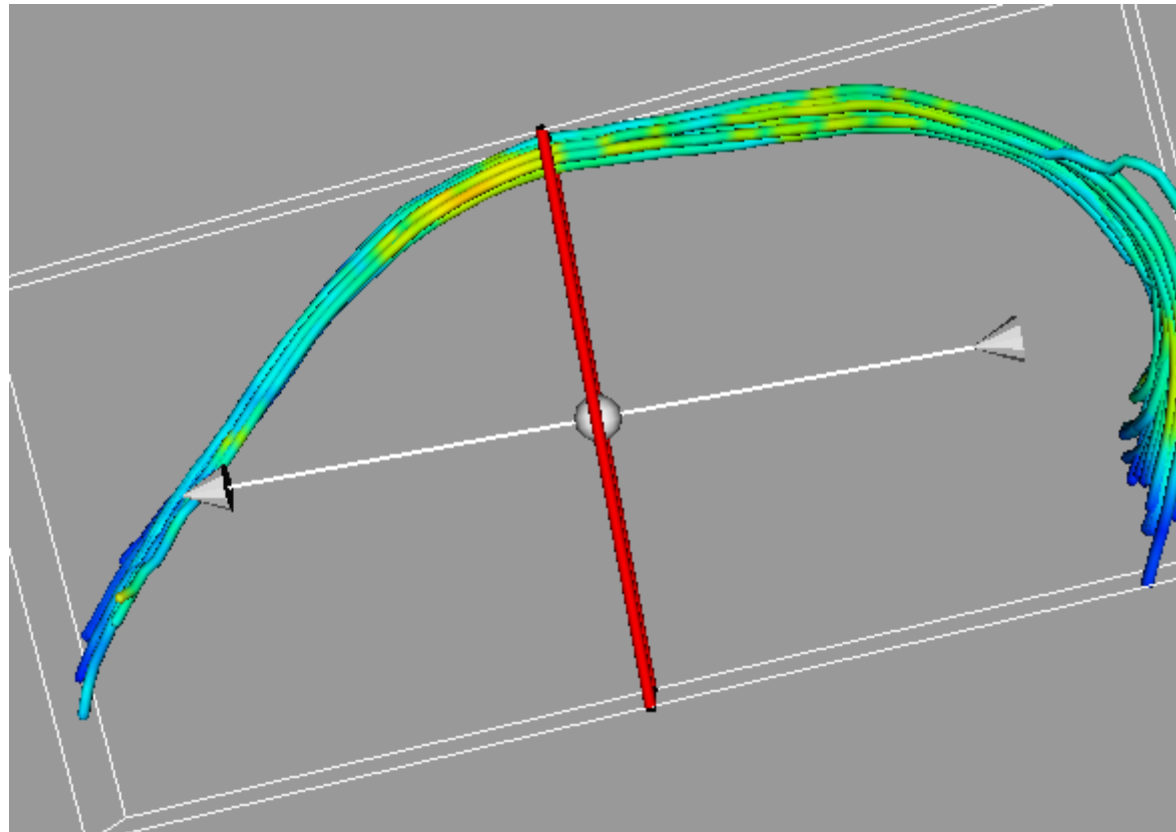
Right Arcuate

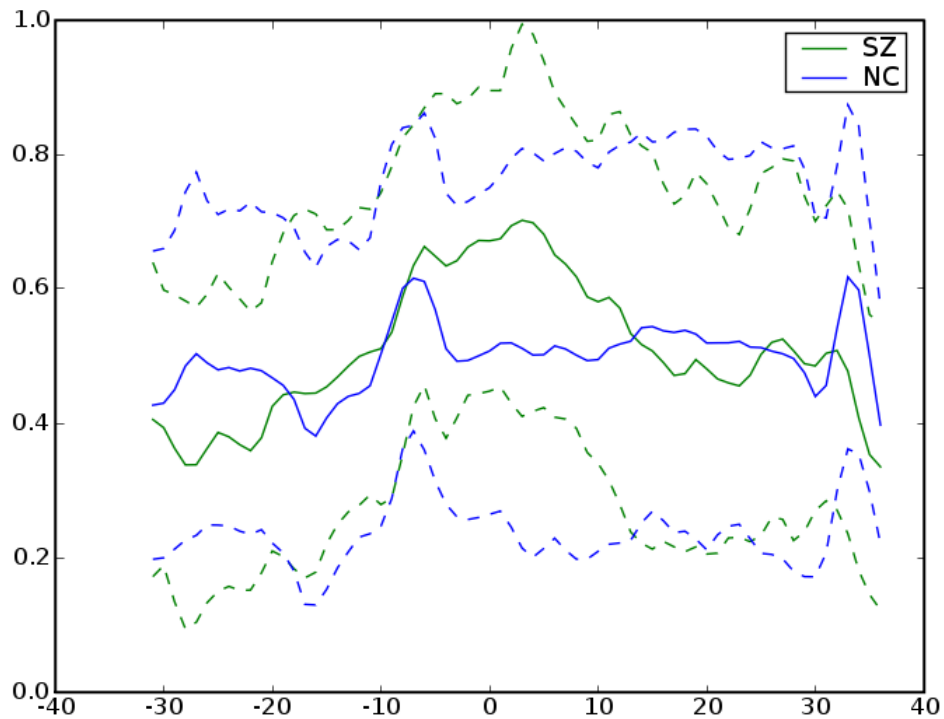FA

MD

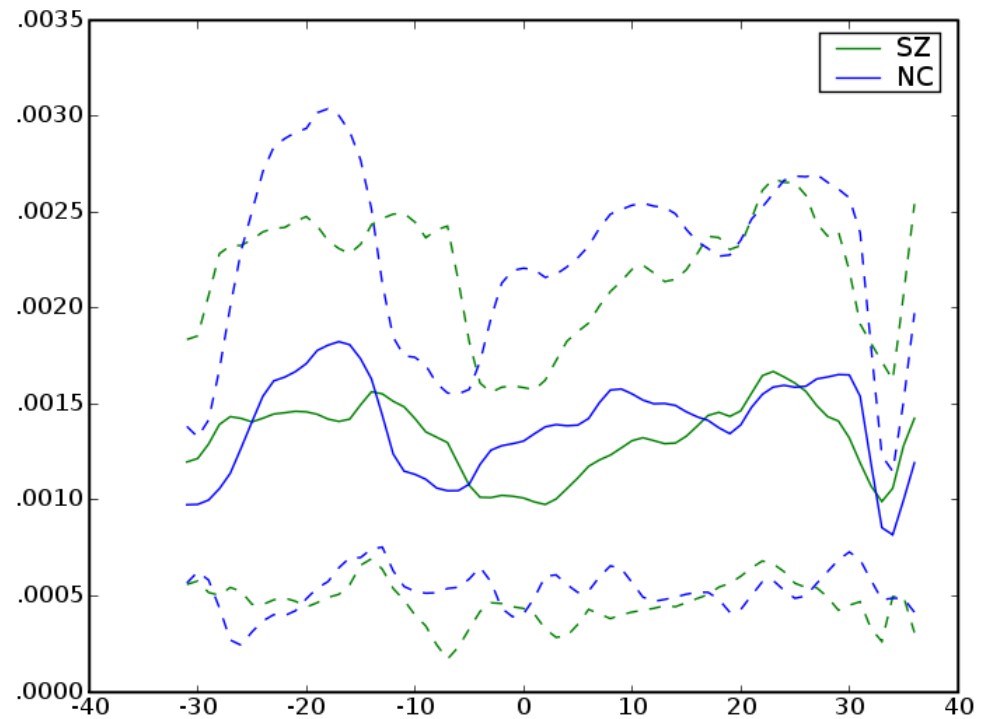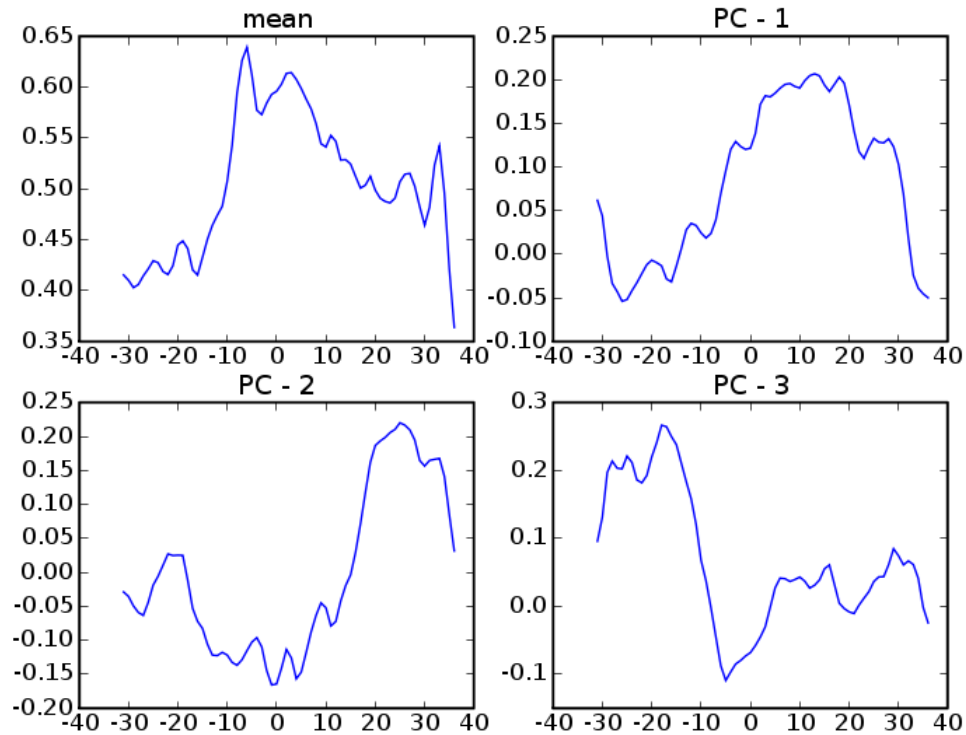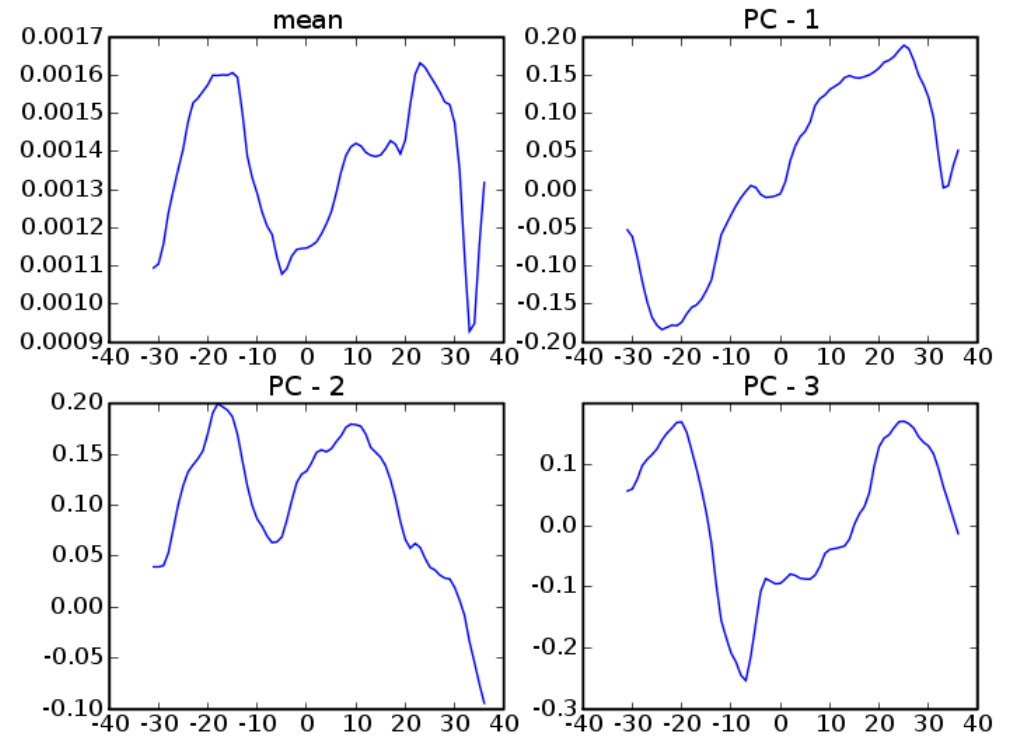# *Right Arcuate*

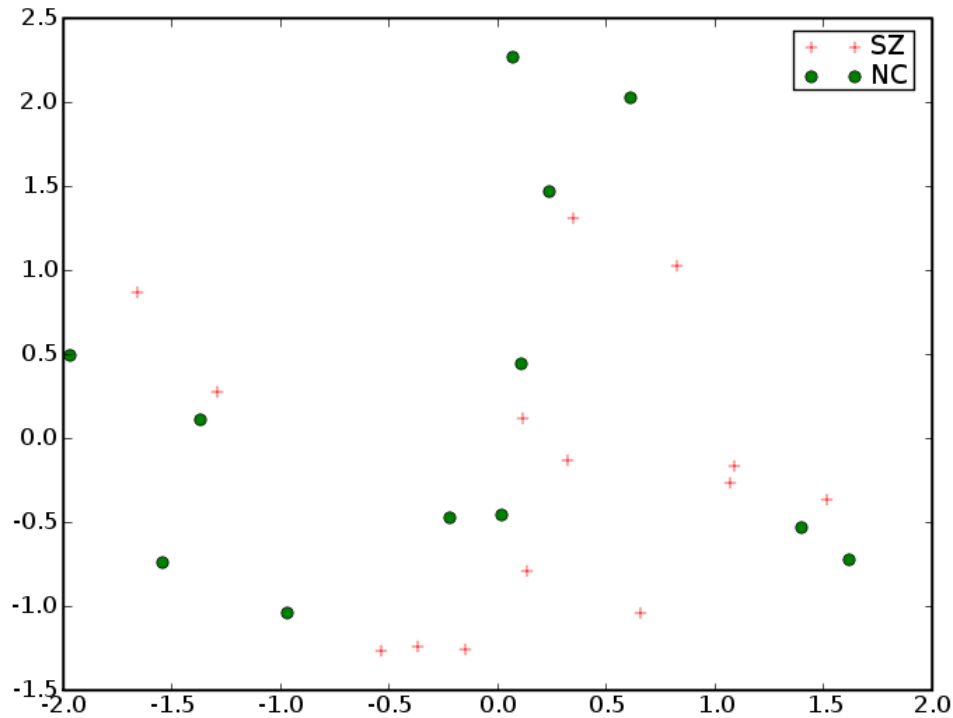
FA

MD
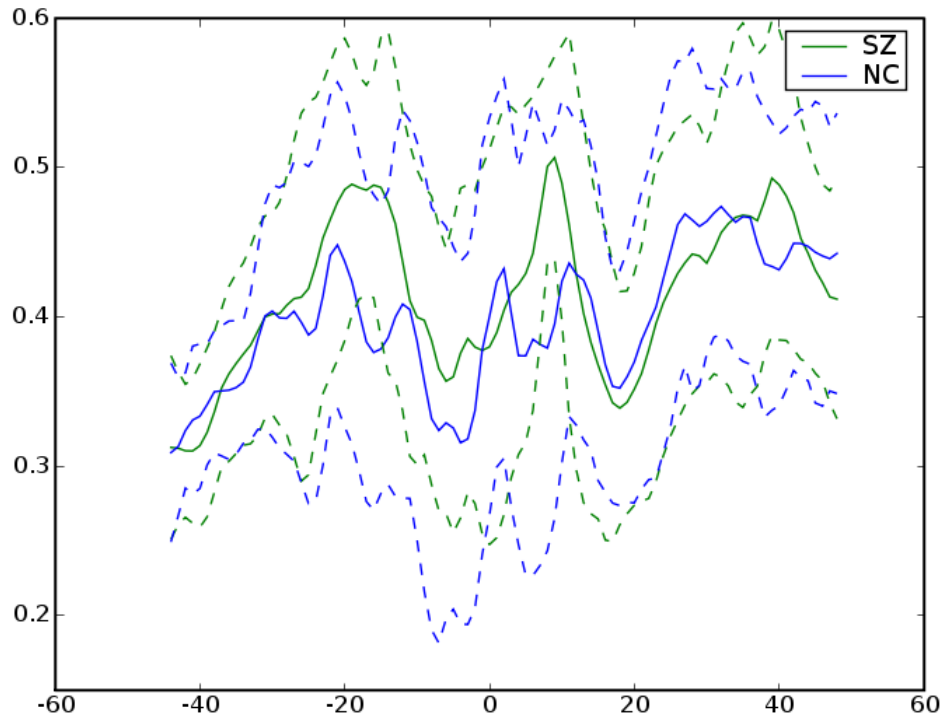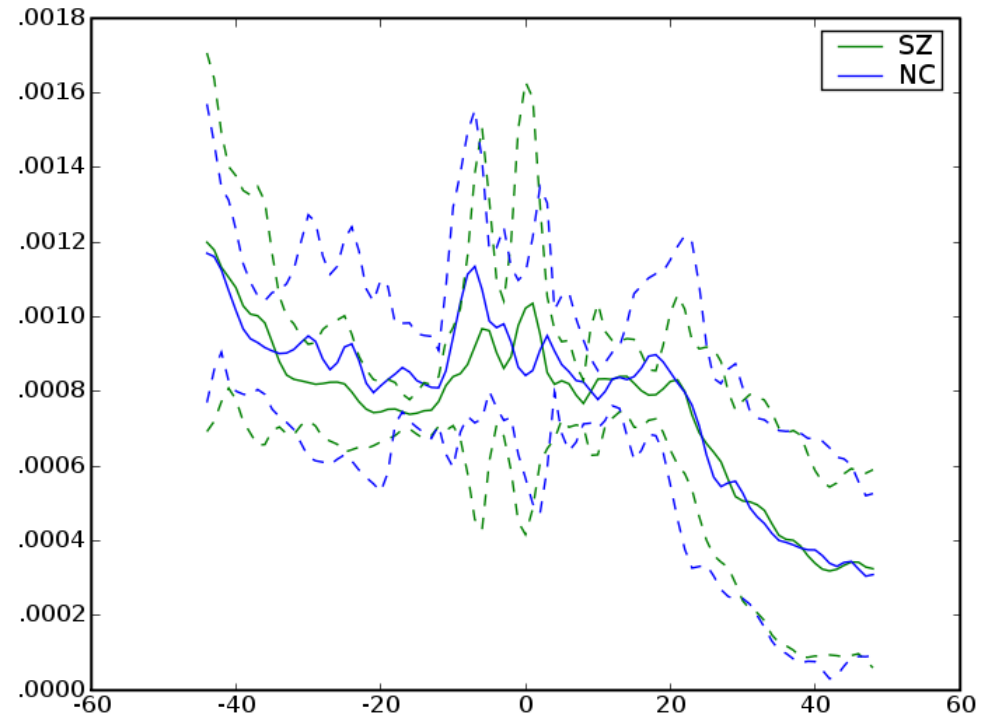
Right Arcuate

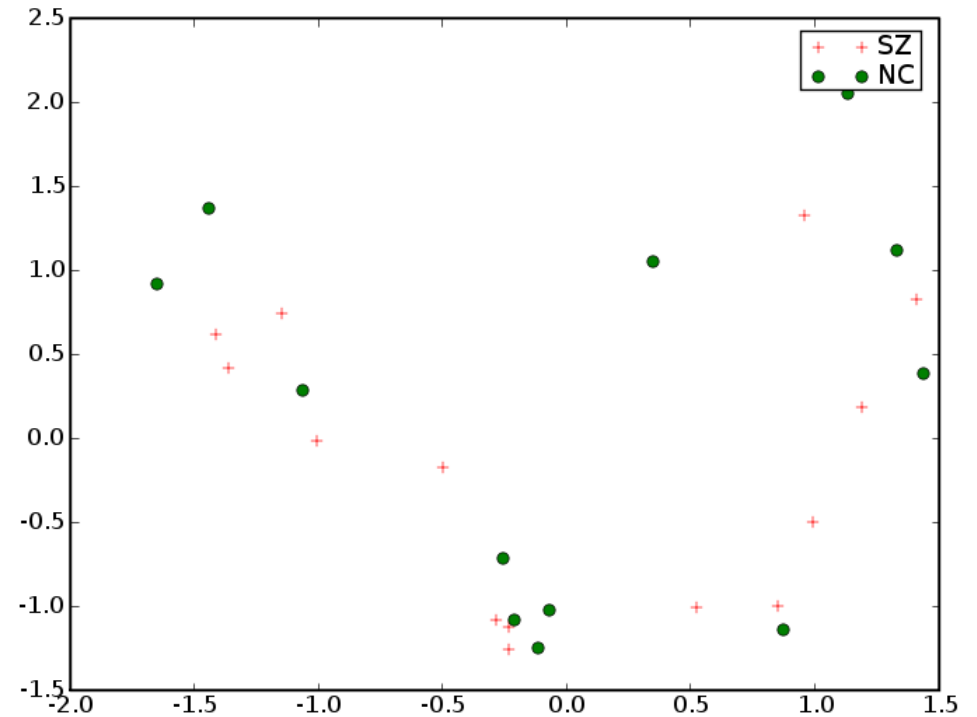

FA

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Left Cingulum

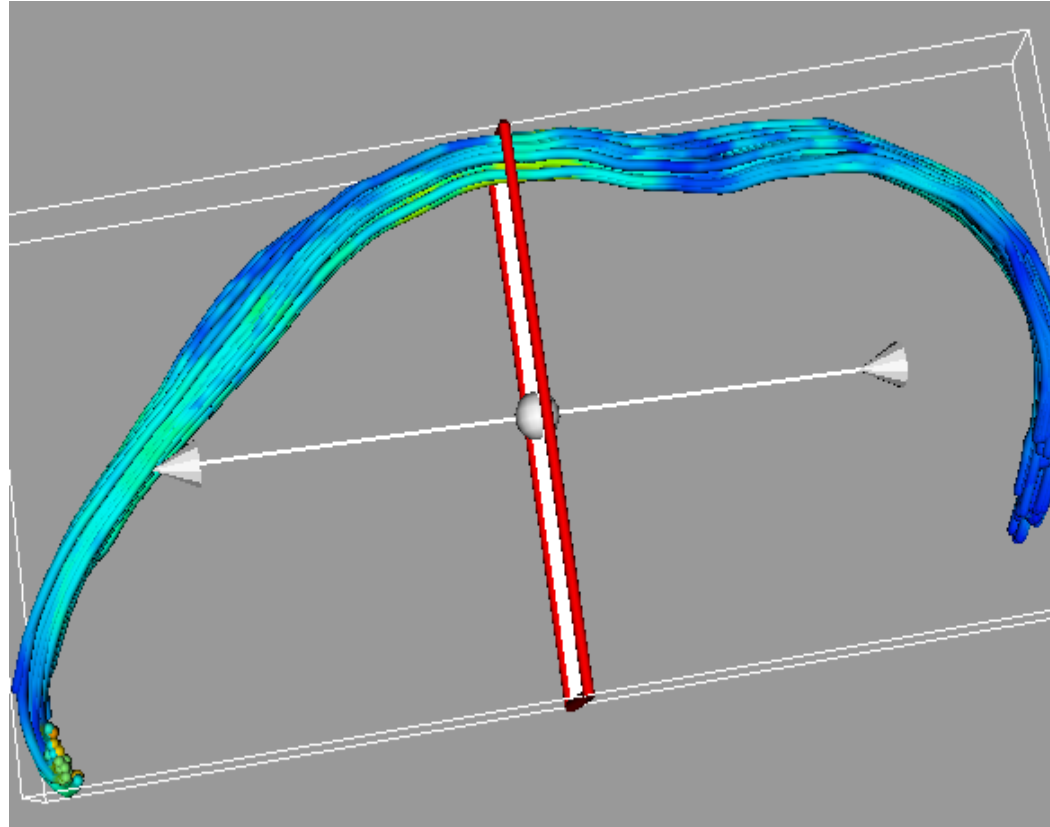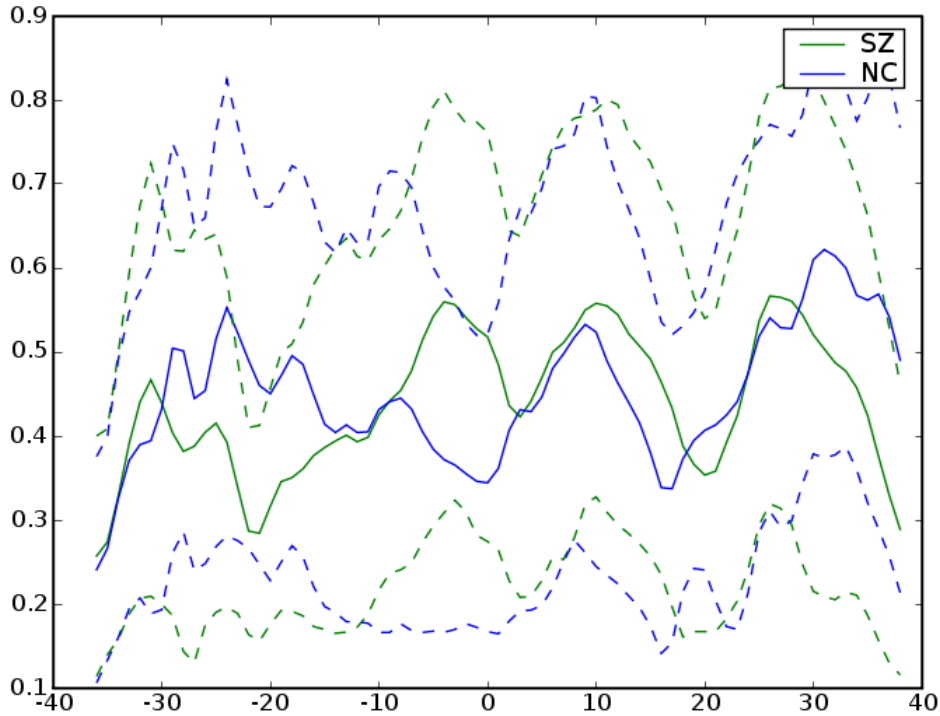# Left Cingulum

FA

MD

Left Cingulum
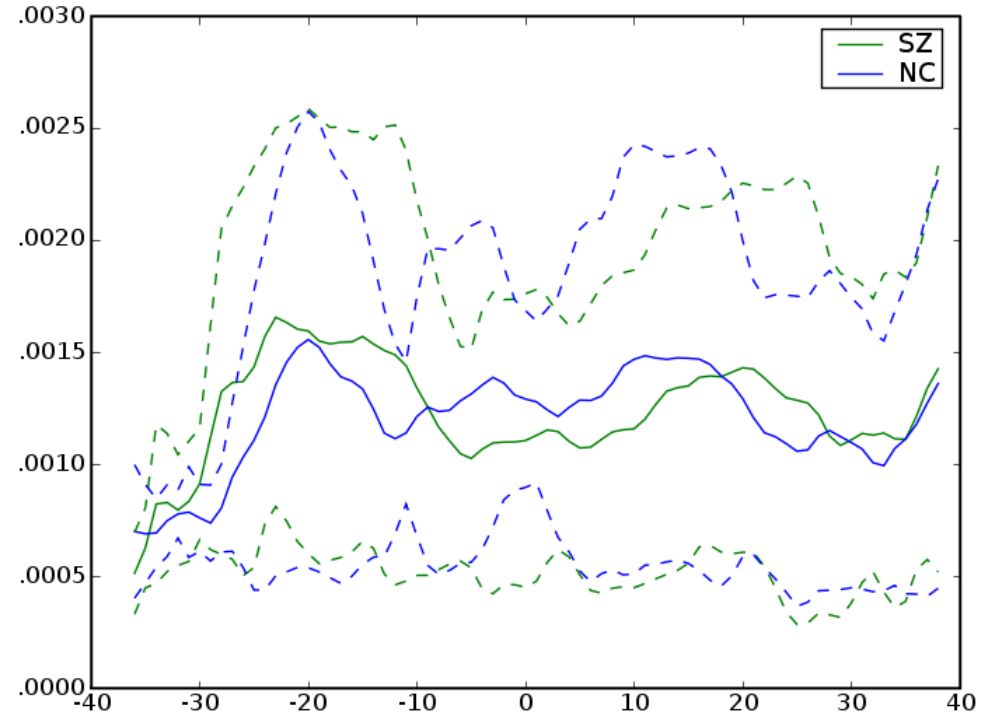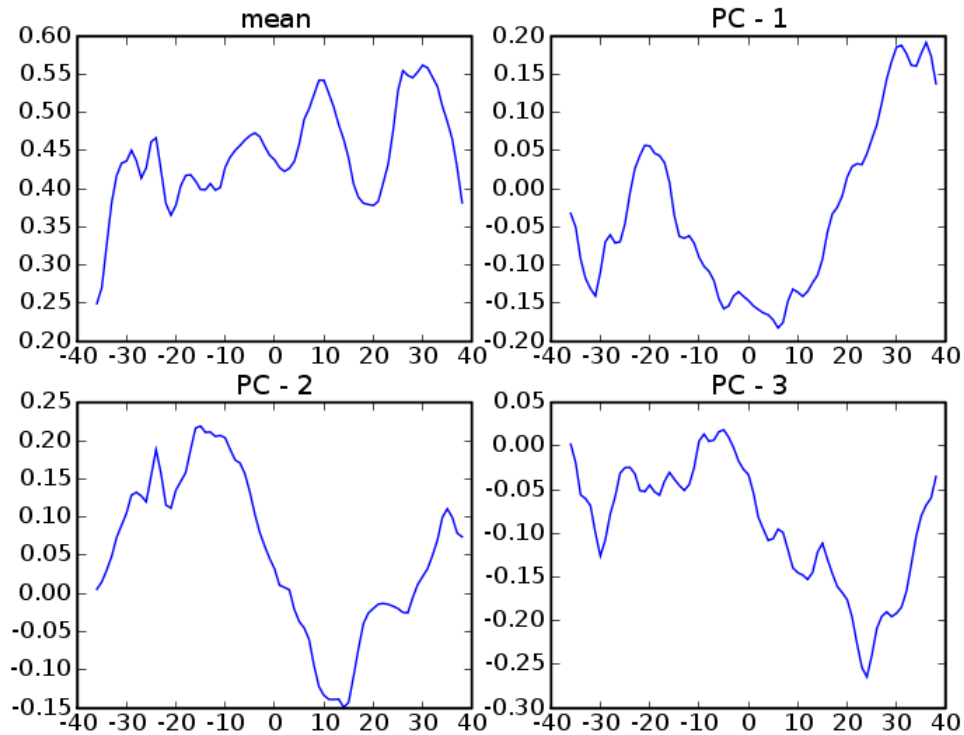

FA

MD

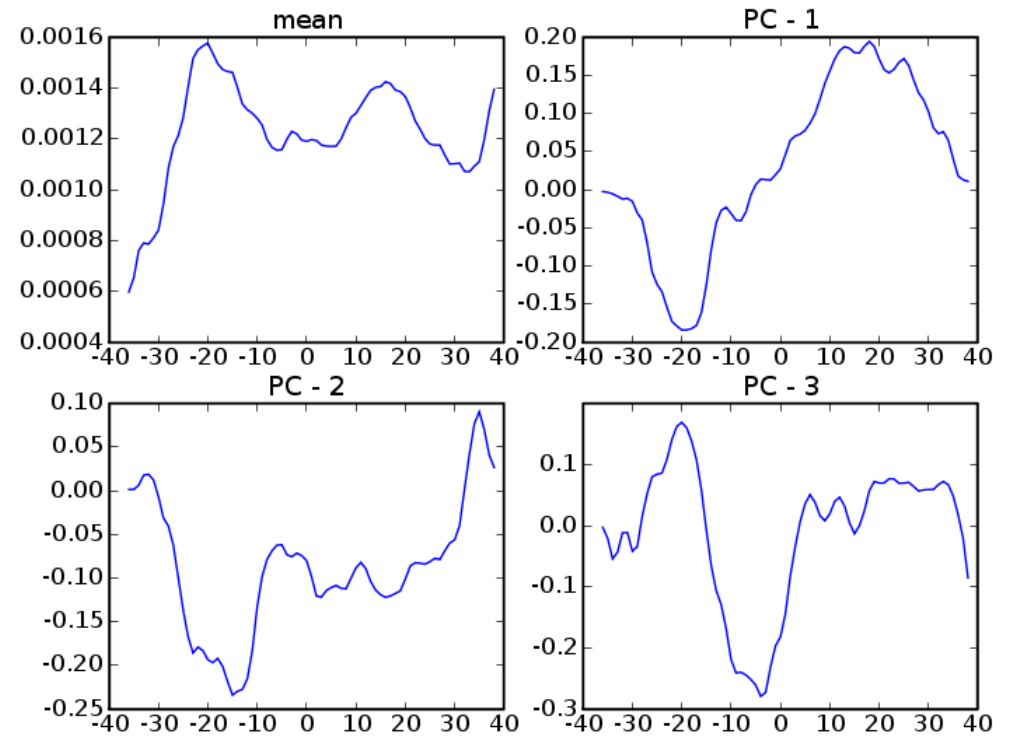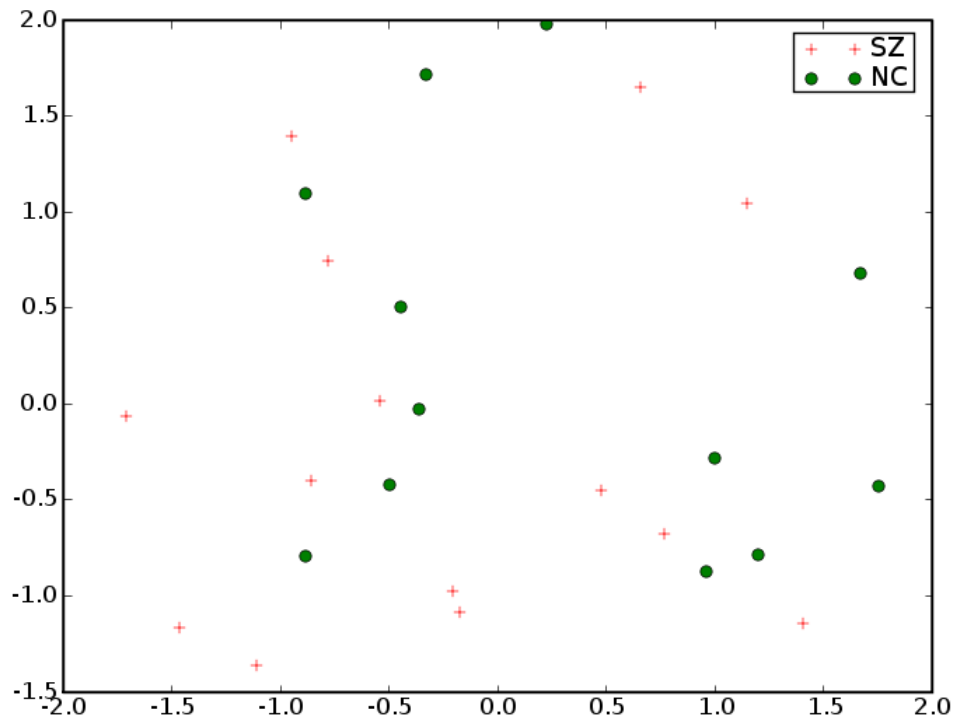# *Left Cingulum*

FA

MD

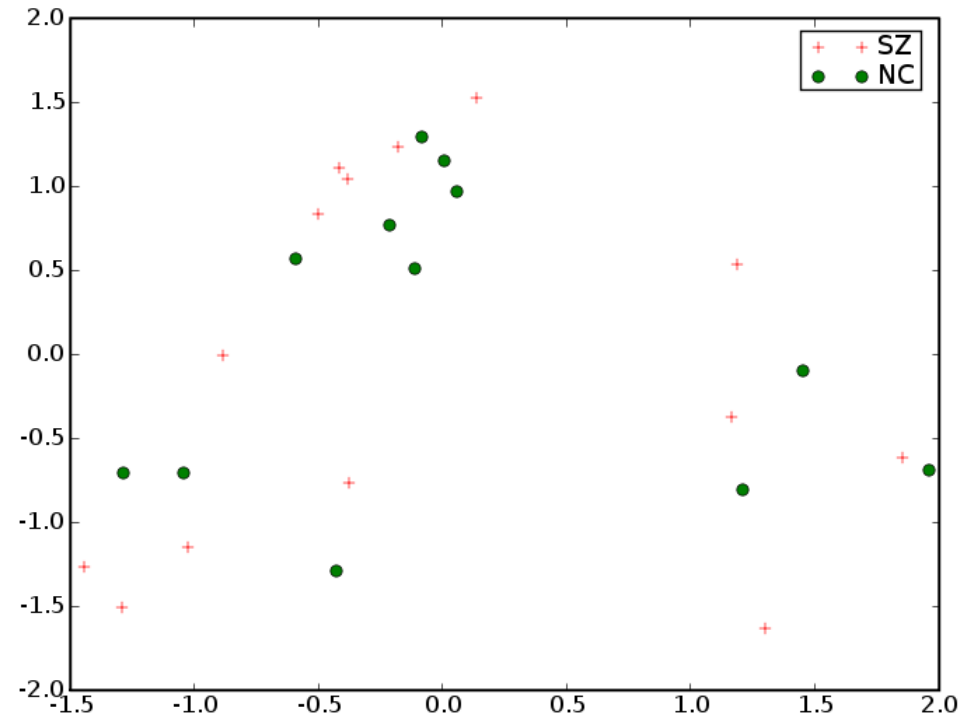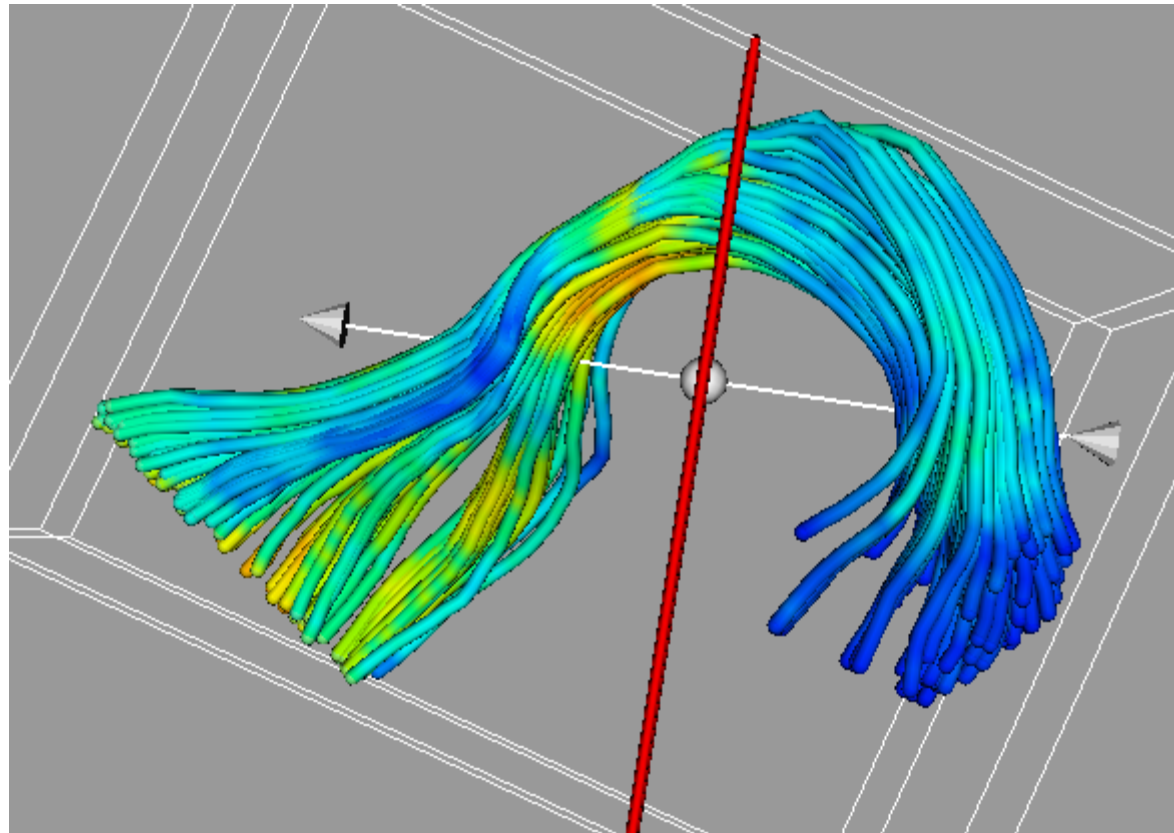# *Right Cingulum*

Right Cingulum
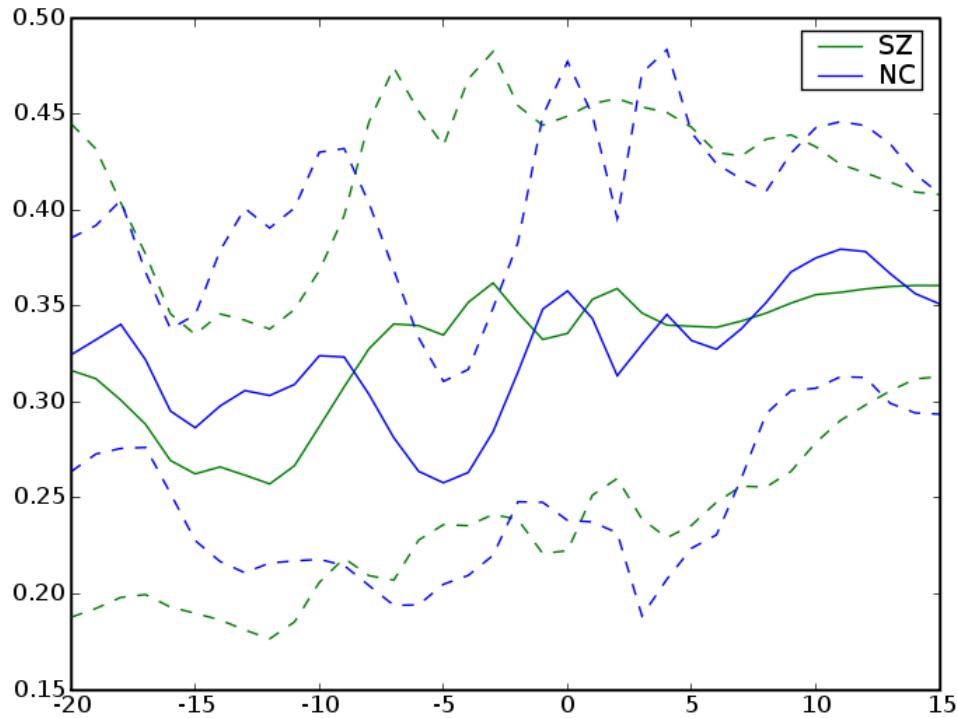

FA

MD

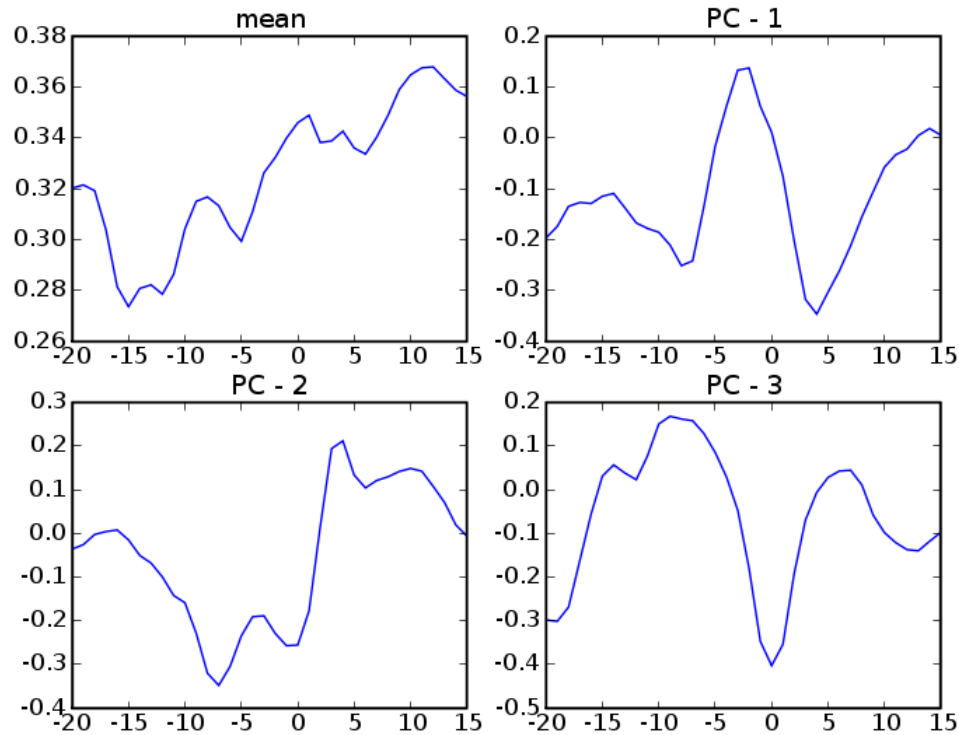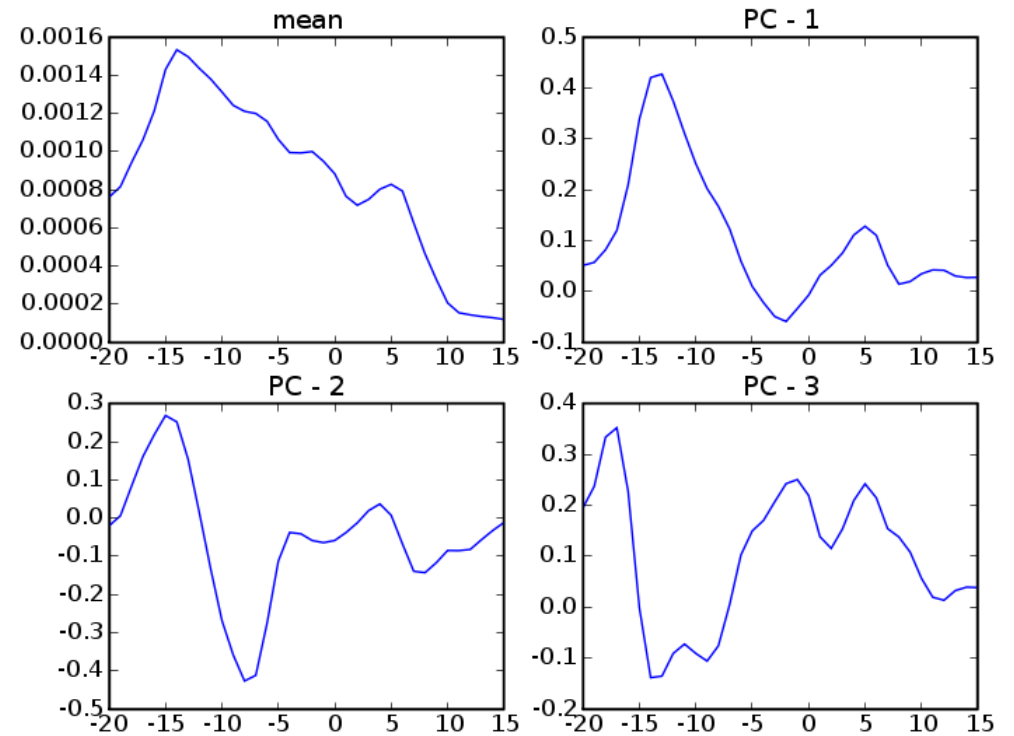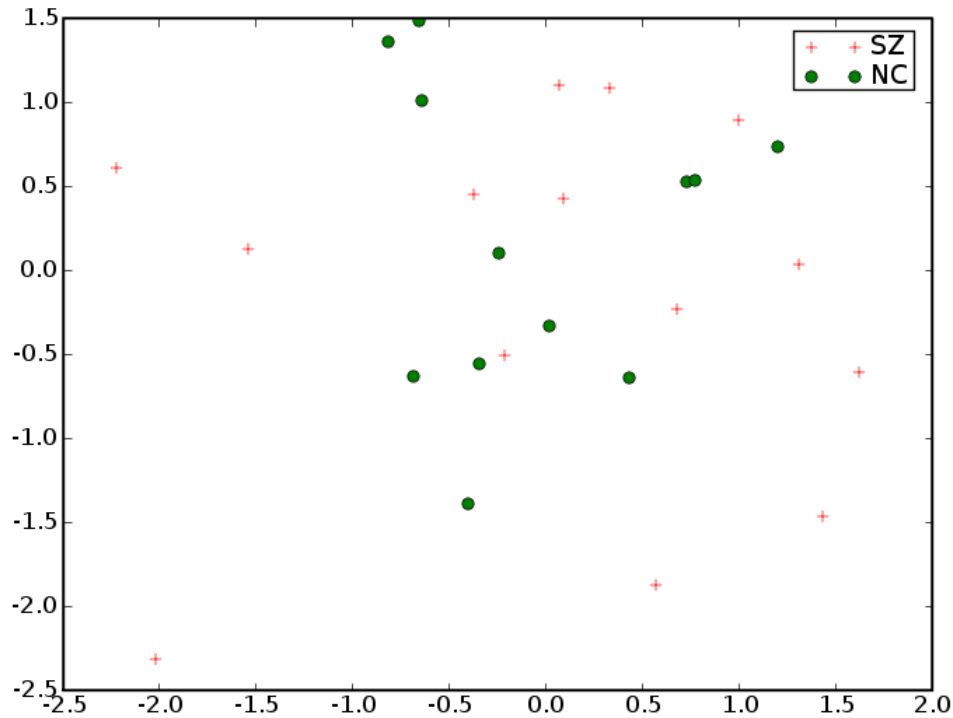# *Right Cingulum*

FA

MD

Right Cingulum

FA

MD

Left Uncinate

Left Uncinate
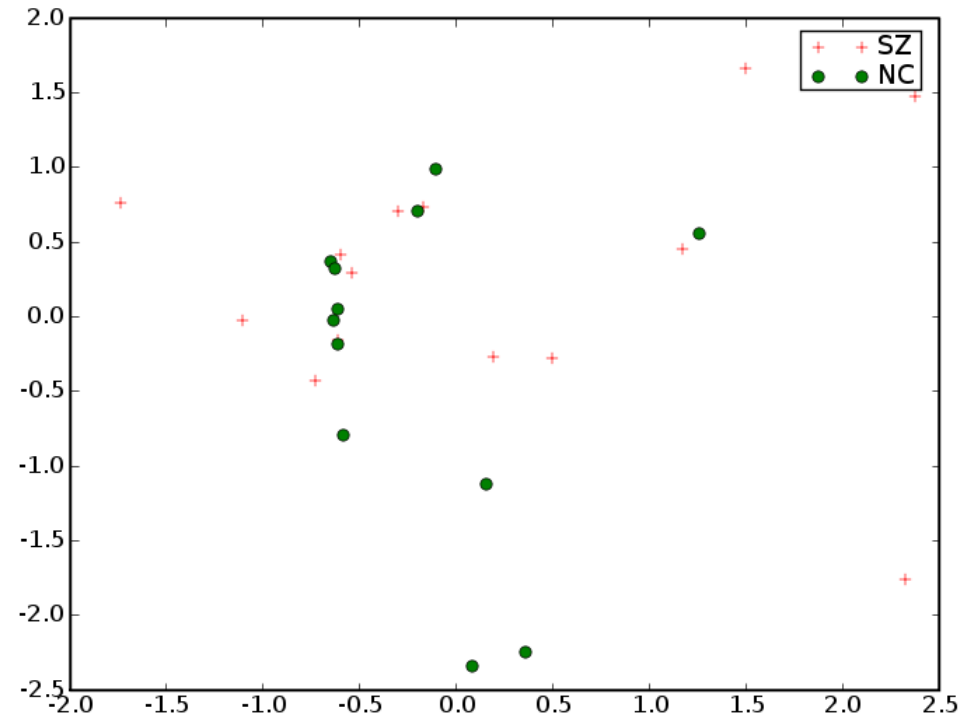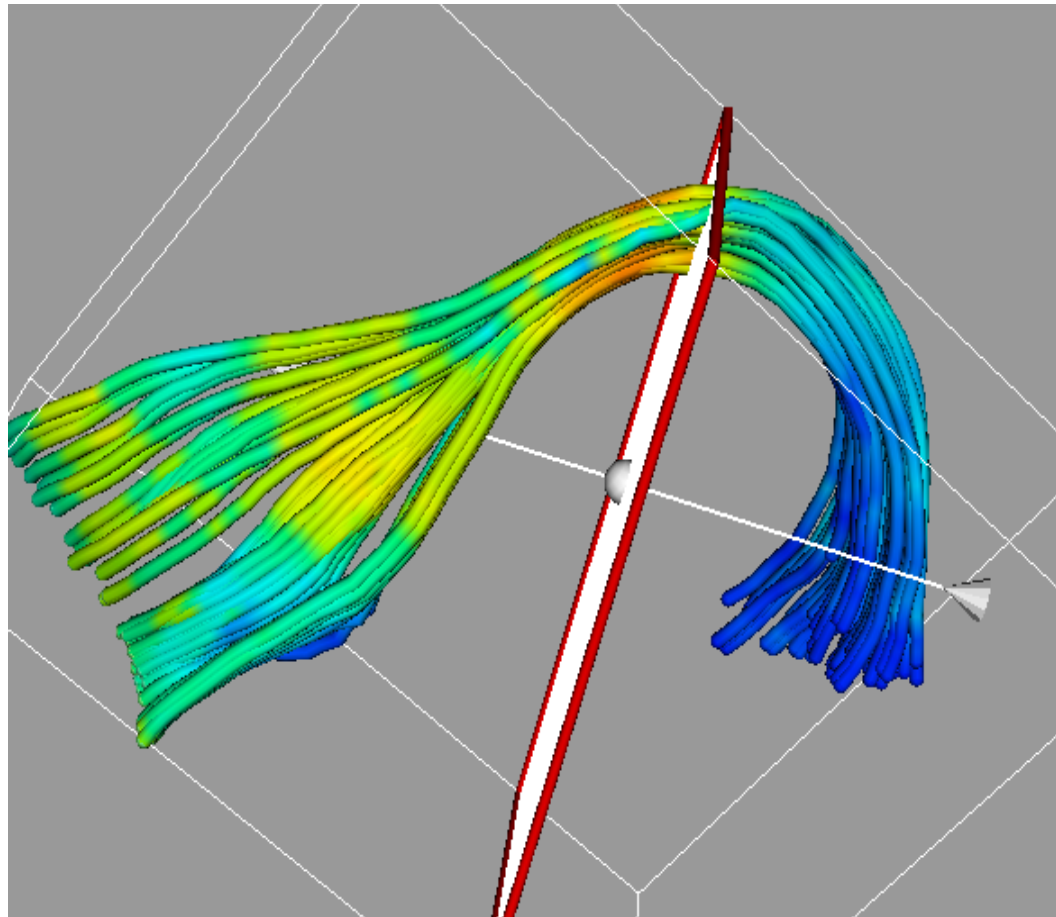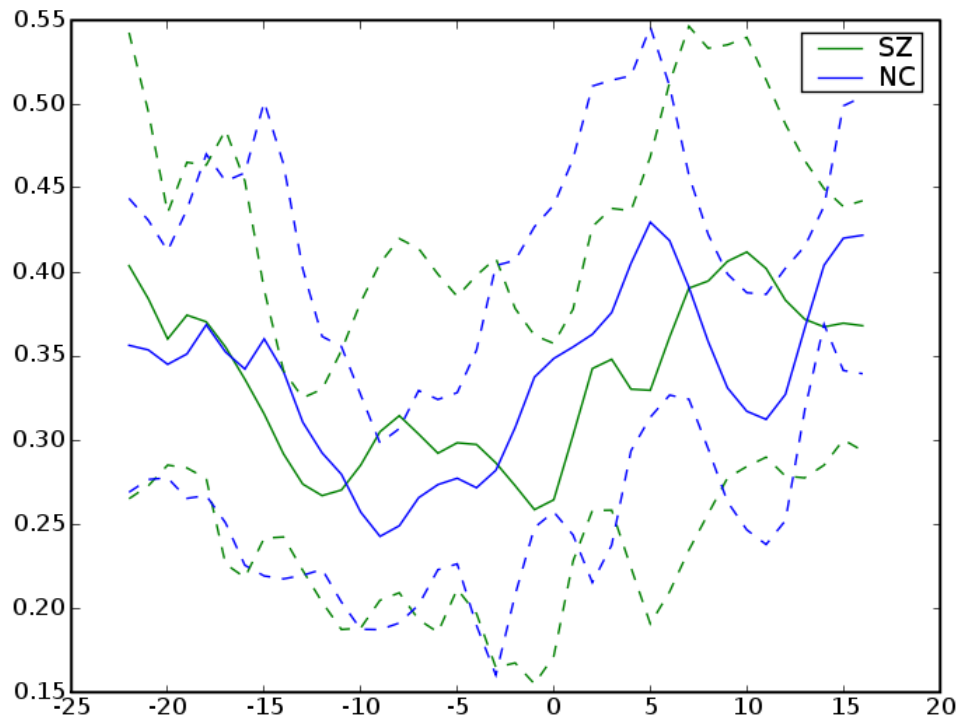

FA

MD

Left Uncinate

FA

MD
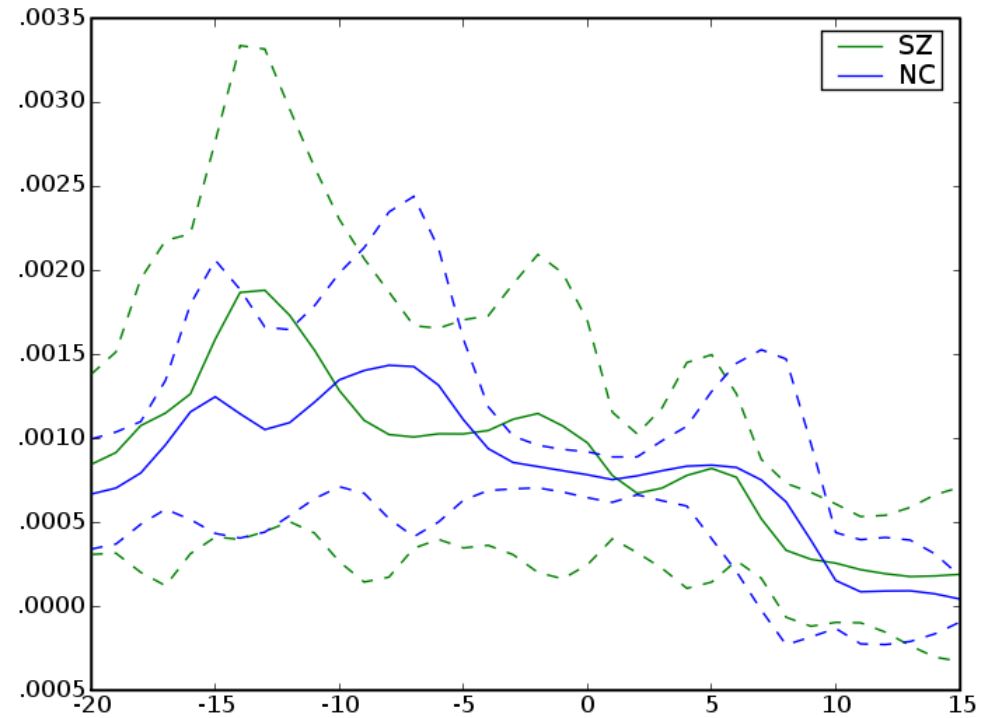
Left Uncinate

FA

MD

Right Uncinate

Right Uncinate

FA

MD
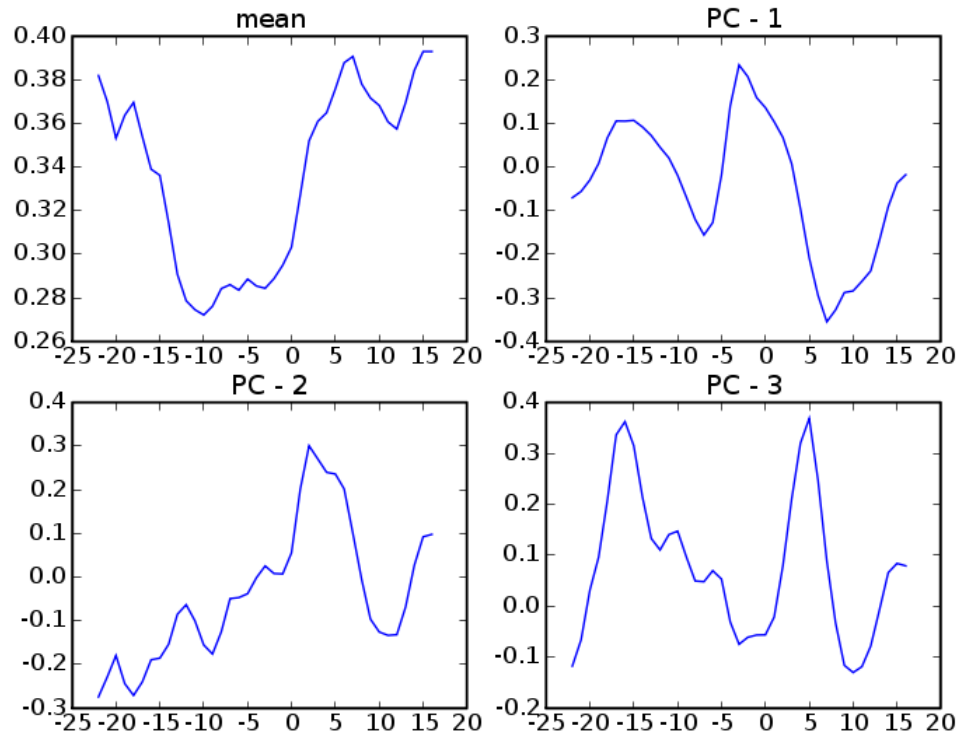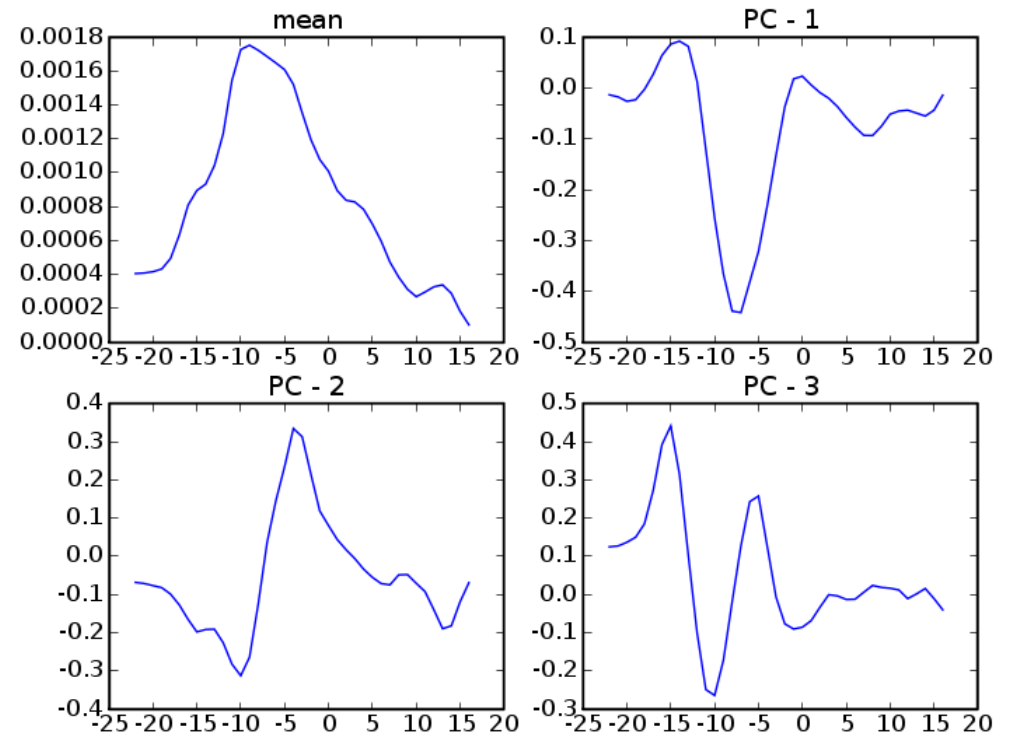
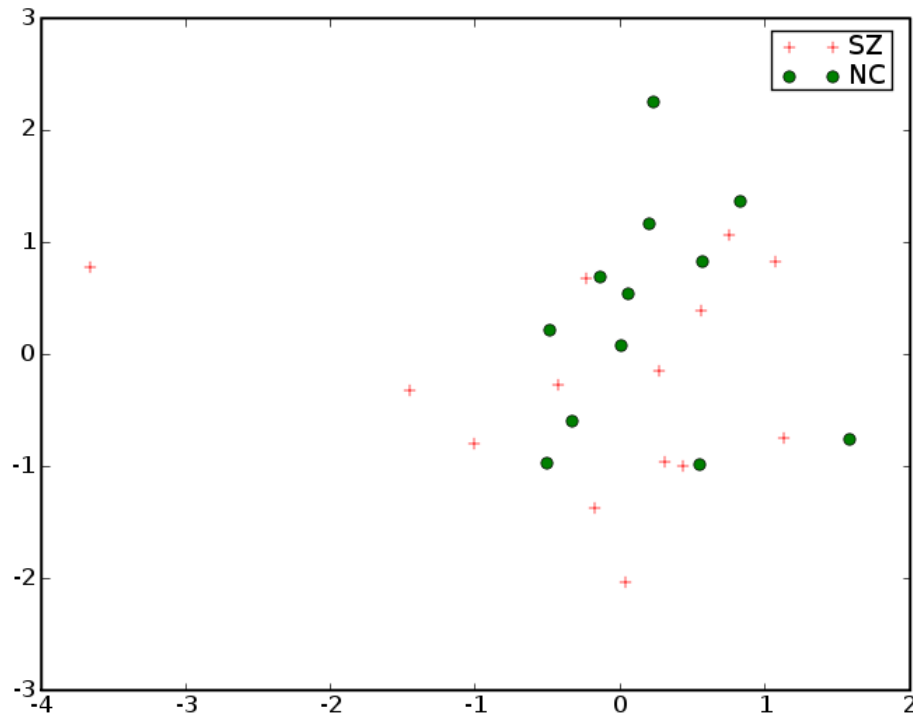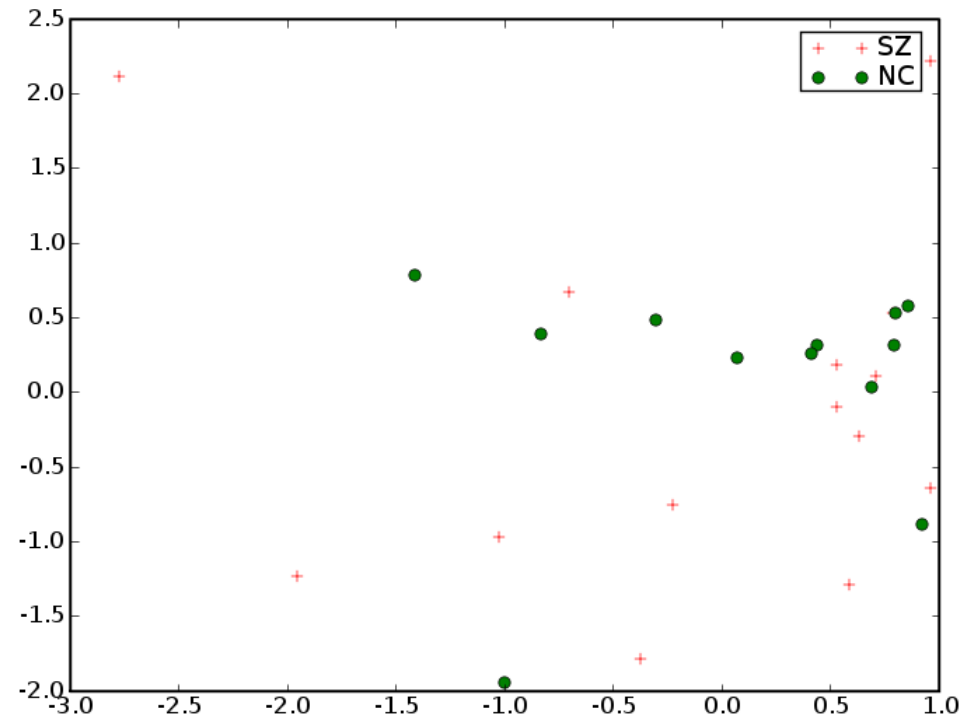# *Right Uncinate*

FA

MD
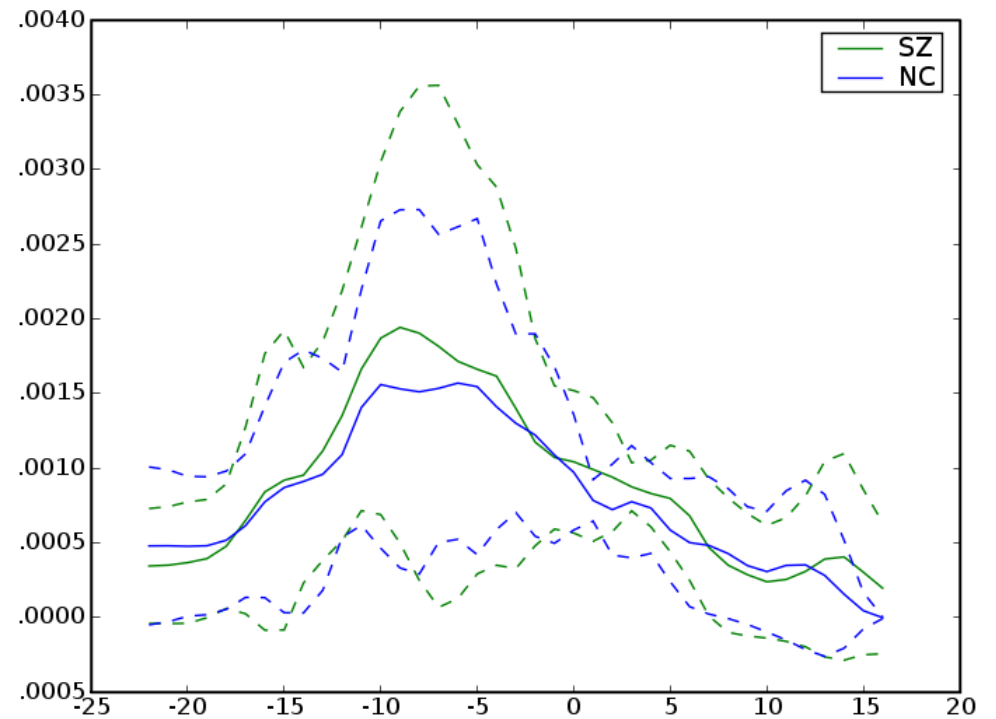
Right Uncinate

FA

MD

Results

- Lateralization in Internal Capsule, Cingulum,

    - Possibly due to atlas procedure especially in cingulum

    - Possibly in original data especially in internal capsule

- No statistically significant diffusion differences

- We want to compare the atlas results with individual manual processing

References

[1] Improved correspondance for DTI population studies via unbiased atlas building. Casey Goodlett, Brad Davis, Remi Jean, Guido Gerig. MICCAI 2006.

[2] Unbiased diffeomorphic atlas construction for computational anatomy. Sarang Joshi, Brad Davis, Matthieu Jomier, Guido Gerig. NeuroImage vol. 23 Supplement. pgs 151-160. 11/2004

[3] Functional Data Analysis. Ramsay, J.O.; Silverman, B.W.