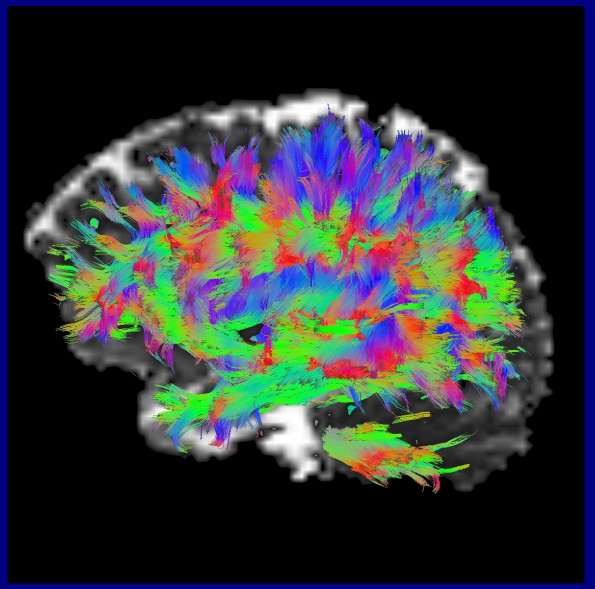
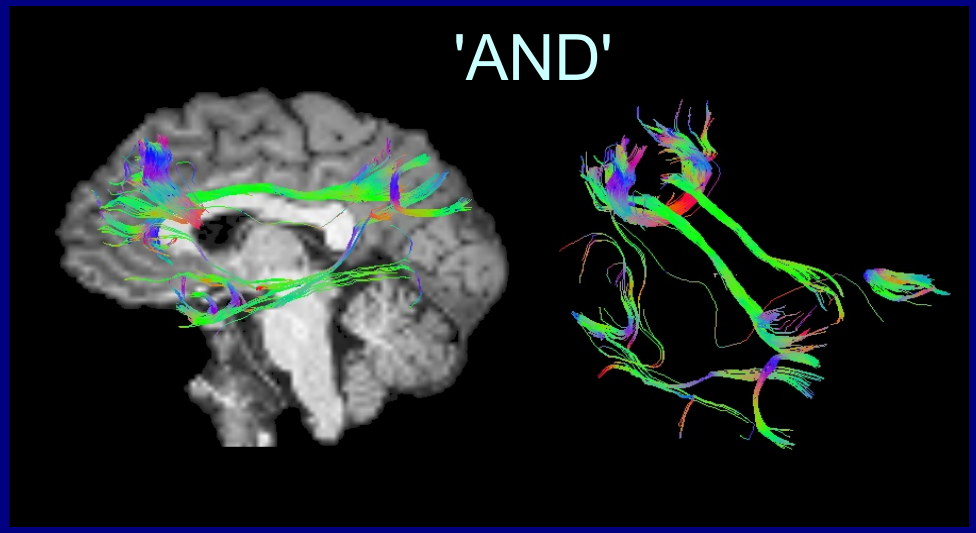
Supplementary notes:
Tracking modes and comparisons

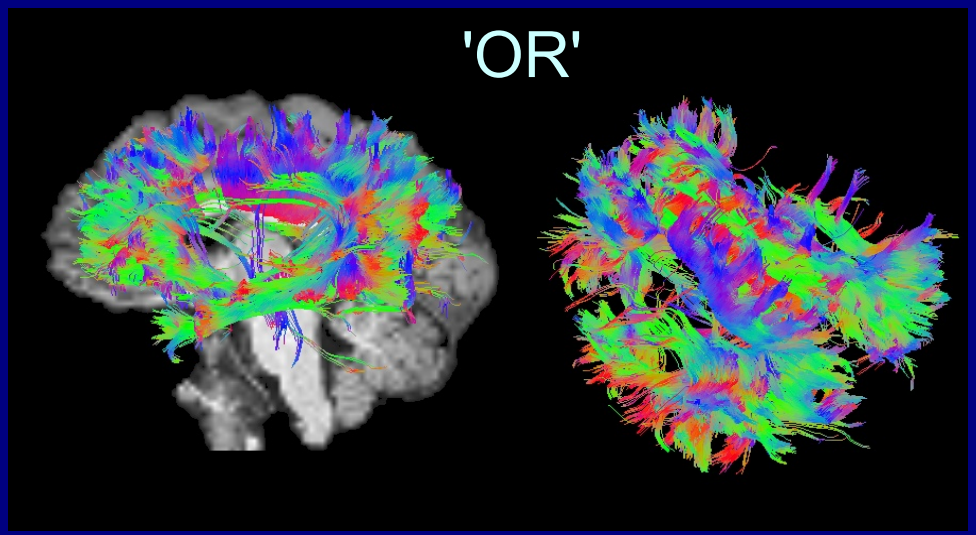
AFNI Bootcamp (SSCC, NIMH, NIH)

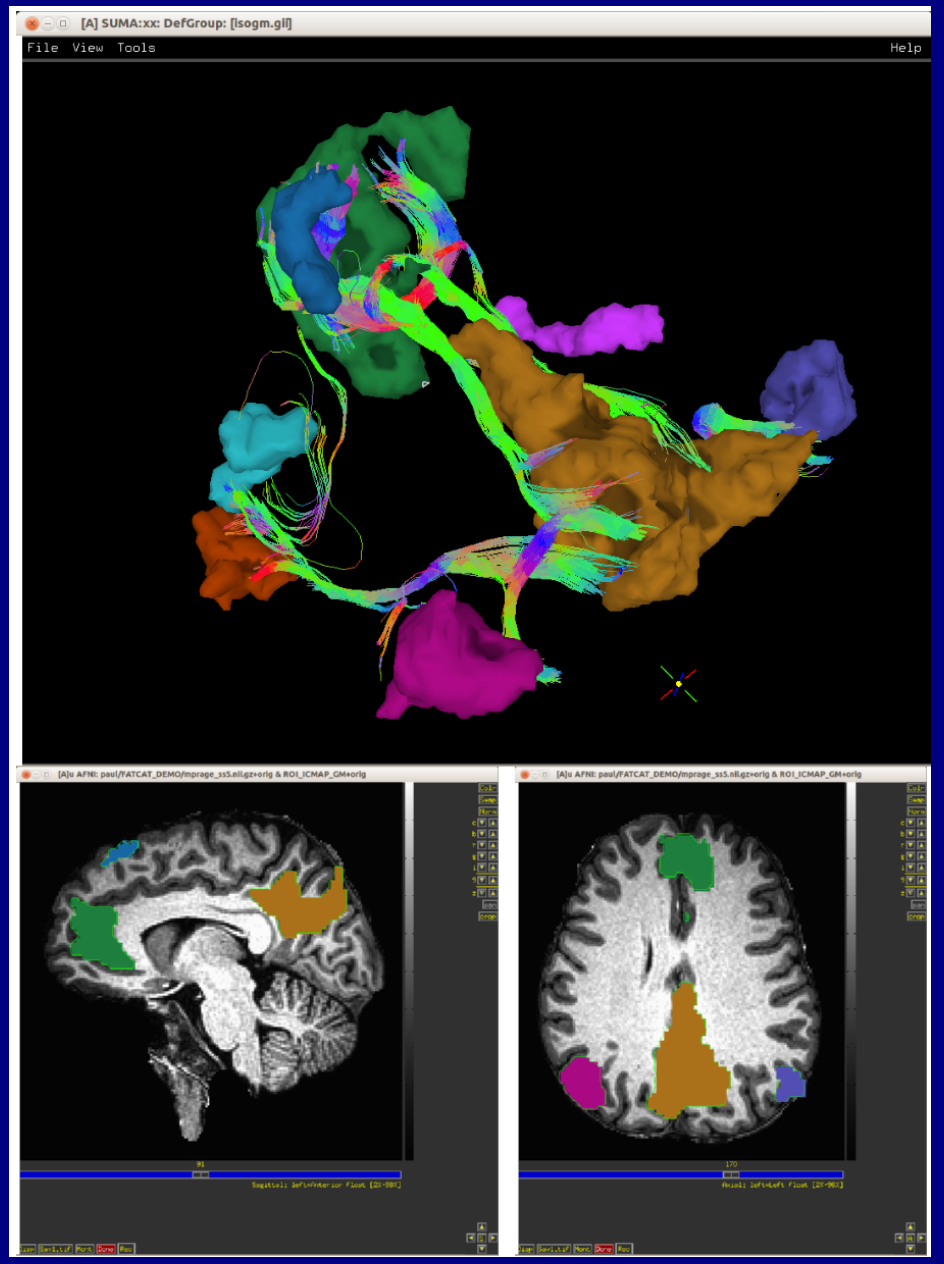


Example: Deterministic Tractography

Use DTI-tractography to
find likely location of WM
associated with these 'targets'



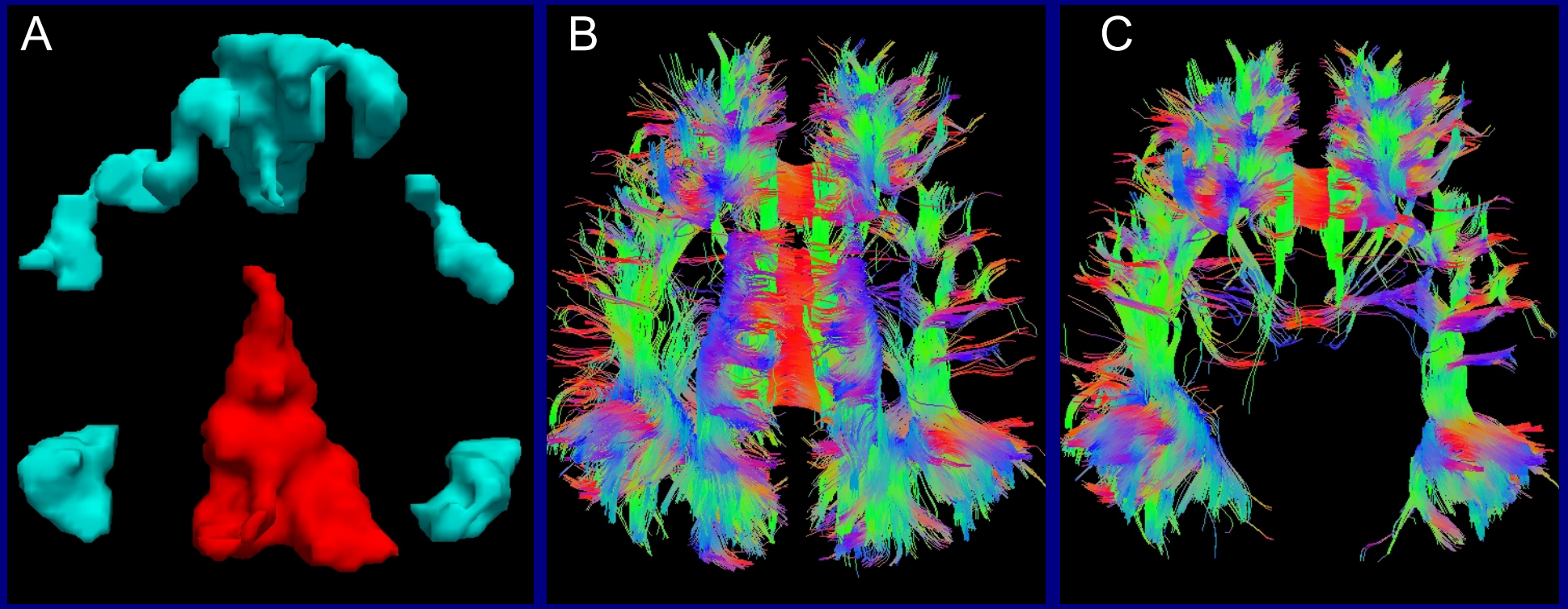




(Deterministic tracking using '3dTrackID -mode DET …'*)*

Sidenote: "anti-mask" (and "thru-mask")

Can control track propagation with `anti-mask' regions, simply defined by voxels = -1:



ROI values:
> 0, in network
< 0, anti-mask

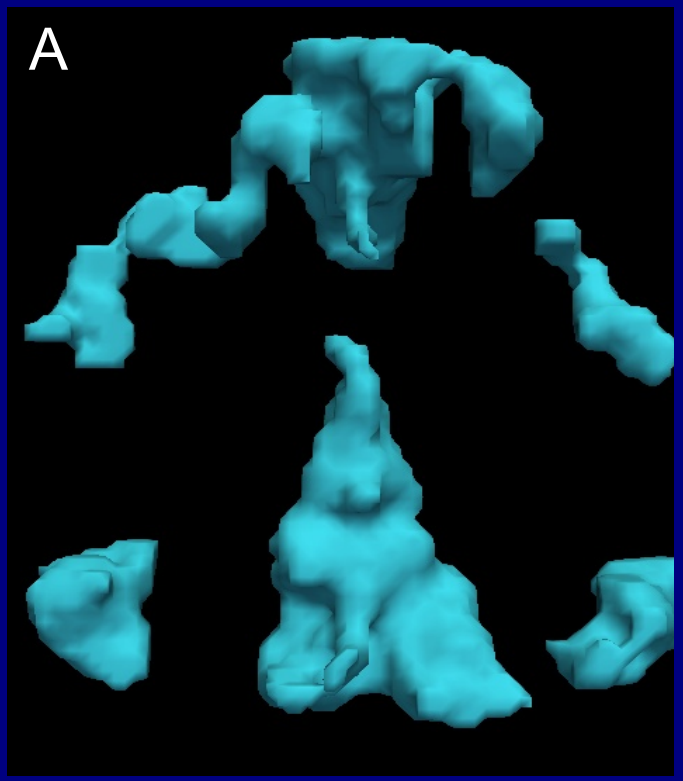
results when:
all ROI values > 0
(no anti-mask)

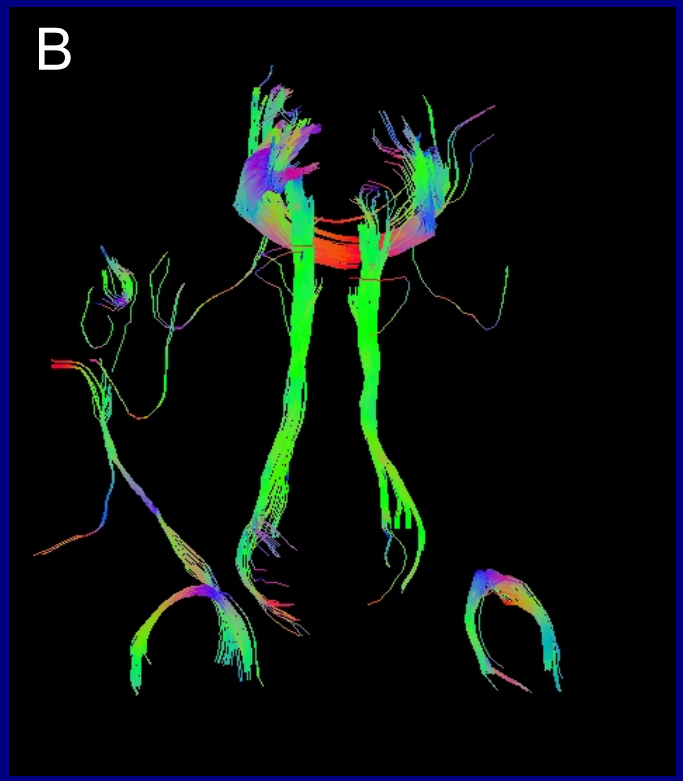
results when:
blue > 0, red < 0
(using anti-mask)

Can also include "-thru_mask ..", to restrict tract propagation.

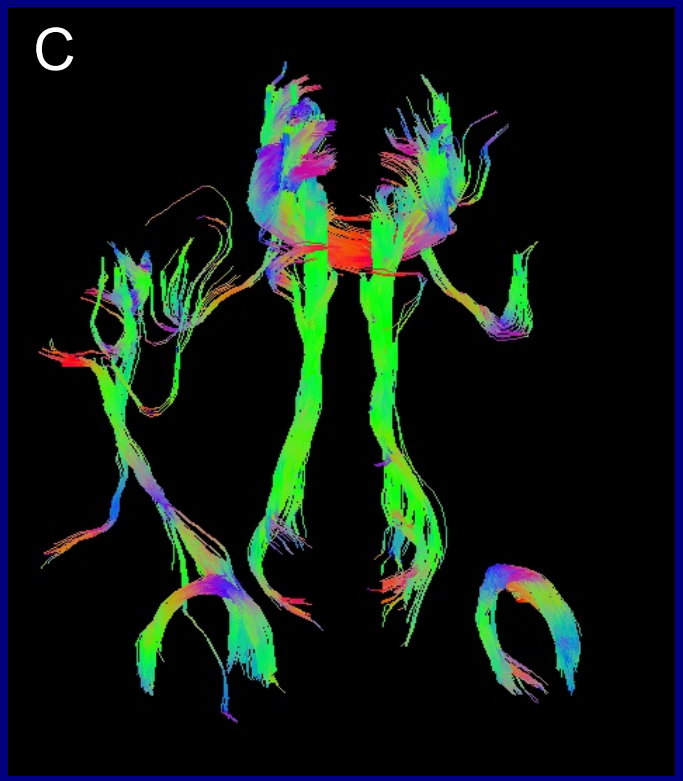
Mini-Probabilistic Tracking

+ Full probabilistic methods generate voxelwise brain maps without linear track structure
+ 'Mini-probabilistic' tracking performs a few extra iterations of 'deterministic' tracking on uncertainty-perturbed data sets
  - track structure is retained,
  - results generally exhibit more robust tracks and fewer false negatives than deterministic tracking alone
  - false positives tend to be isolated and visually apparent.





Deterministic (AND)

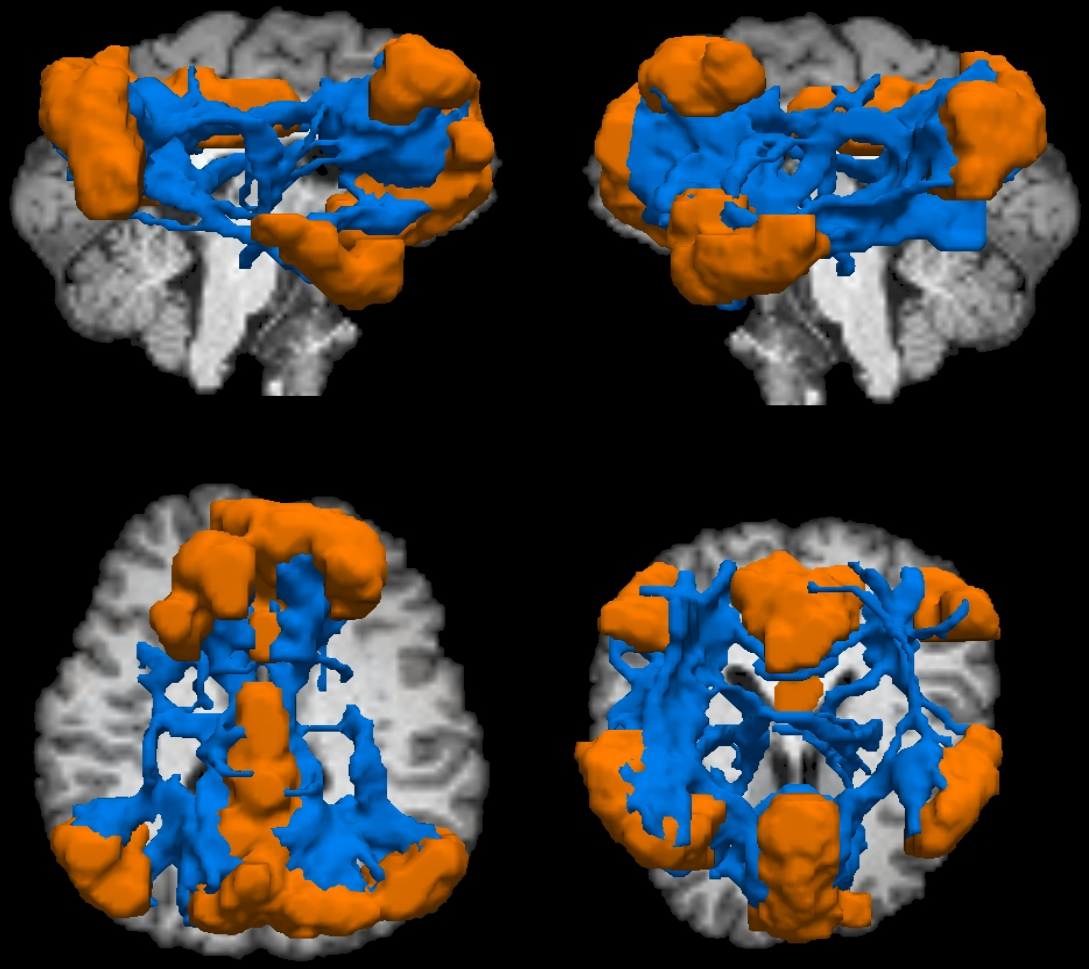


with `-mini_prob 7'

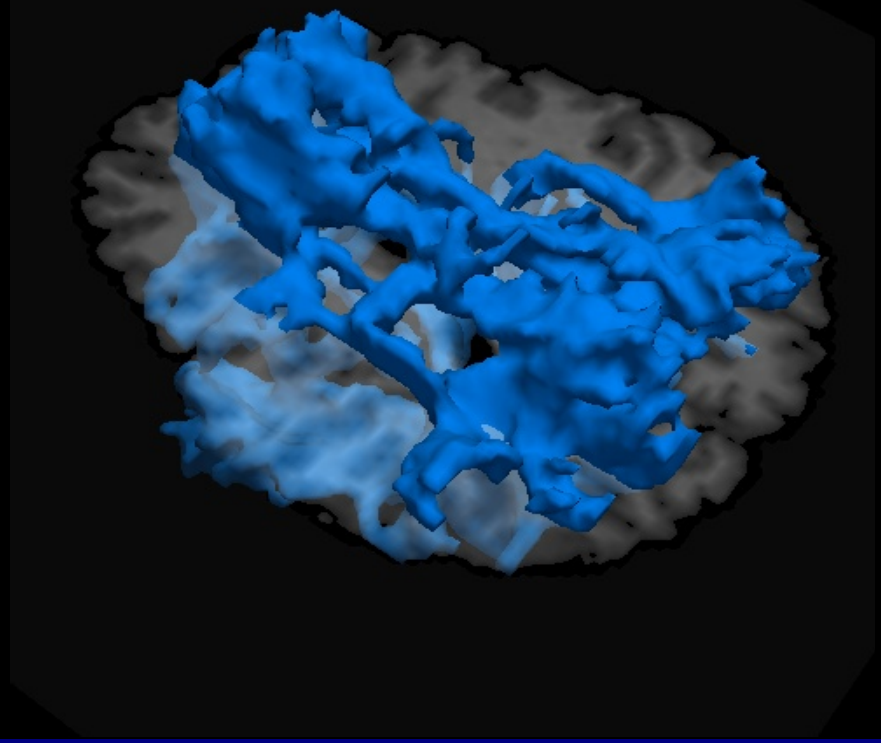
Example: Probabilistic tractography

More robust tracking method (many Monte Carlo iterations)

→ '***most likely***' locations of WM



orange = GM ROIs
blue = WM estimates
(via AFNI-FATCAT)

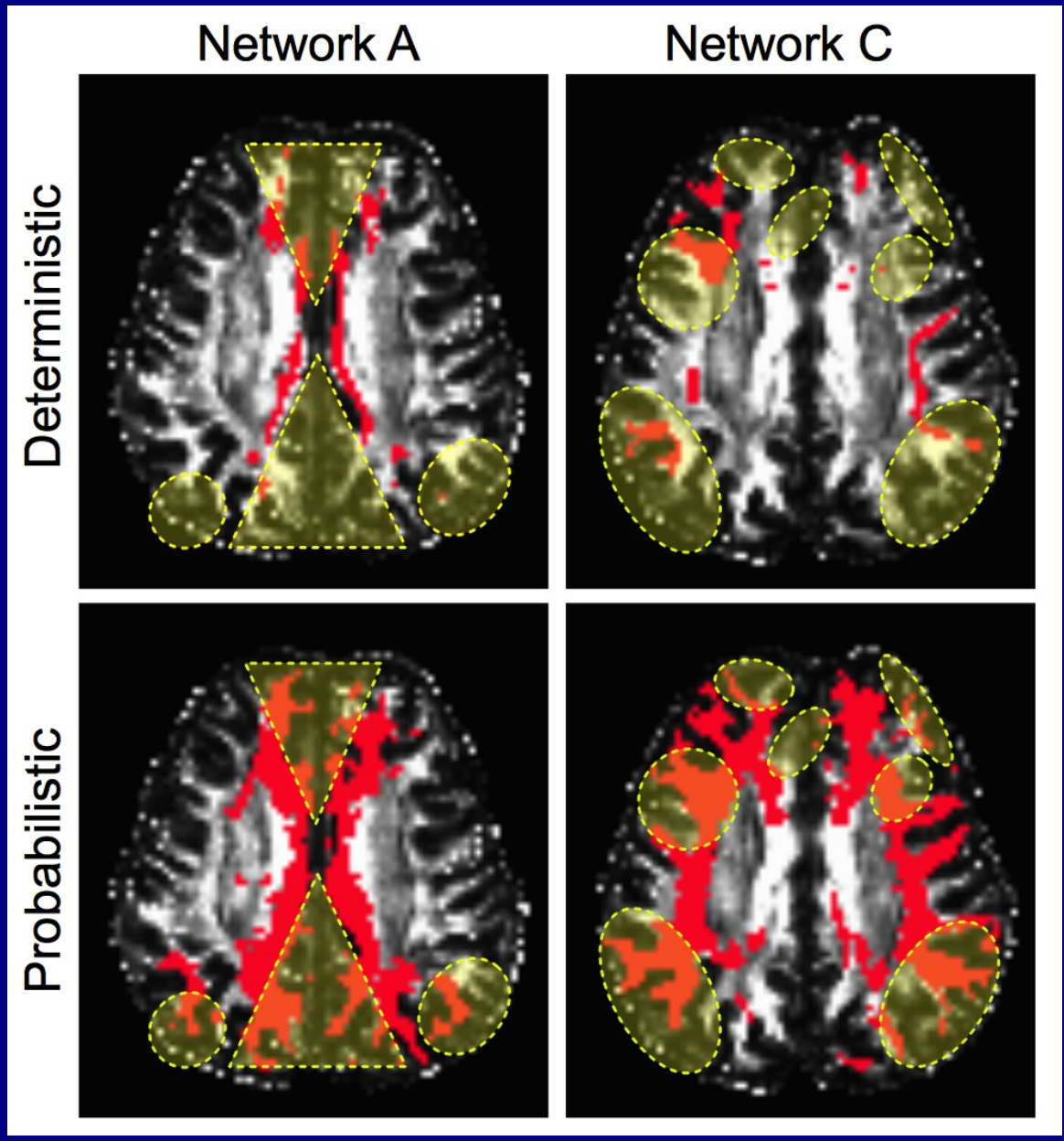


(Fully probabilistic tracking using '3dTrackID -mode PROB …')

Deterministic vs Probabilistic

+ NB: coverage and connectivity differences between tractography types

+ Deterministic can be useful for initial investigations, but is more susceptible to noise/errors and truncation



Probabilistic tractography

+ with networks of ROIs from 3dROIMaker and uncertainty from 3dDWUncert (as well as tensor estimates from, e.g., 3dDWItoDT), can finally do probabilistic tractography
+ 3dTrackID -mode PROB
  - does lots of Monte Carlo simulations: wholebrain tractography -> perturb FA & e1 based on uncertainty -> wholebrain tracking -> perturb -> wholebrain tracking -> etc.

Probabilistic tractography

+ with networks of ROIs from 3dROIMaker and uncertainty from 3dDWUncert (as well as tensor estimates from, e.g., 3dDWItoDT), can finally do probabilistic tractography
+ 3dTrackID -mode PROB
  - does lots of Monte Carlo simulations: wholebrain tractography -> perturb FA & e1 based on uncertainty -> wholebrain tracking -> perturb -> wholebrain tracking -> etc.
  - at each iteration, checks for connections between any pair of ROIs
  - can trim saved tracts to only keep voxels *between* 2 ROIs (i.e., no overrunners in the 'connection' ROIs)

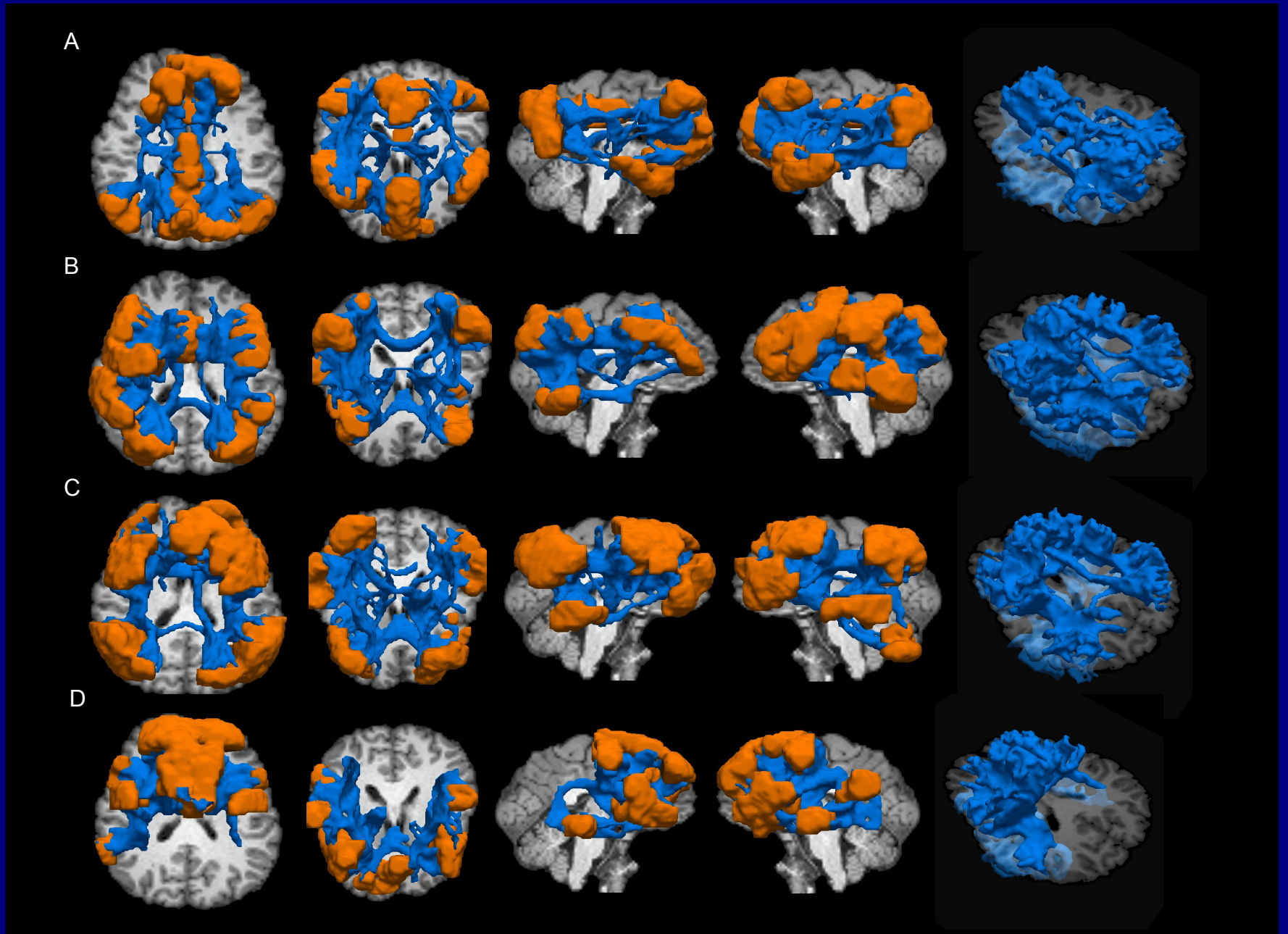
Probabilistic tractography

+ with networks of ROIs from 3dROIMaker and uncertainty from 3dDWUncert (as well as tensor estimates from, e.g., 3dDWItoDT), can finally do probabilistic tractography
+ 3dTrackID -mode PROB
  - does lots of Monte Carlo simulations: wholebrain tractography -> perturb FA & e1 based on uncertainty -> wholebrain tracking -> perturb -> wholebrain tracking -> etc.
  - at each iteration, checks for connections between any pair of ROIs
  - can trim saved tracts to only keep voxels *between* 2 ROIs (i.e., no overrunners in the 'connection' ROIs)
  - also finds tracts through each individual ROI
  - to find WM region connecting, say, ROI 1 and 2: keep voxels through which Ntracks which intersected both ROI1 and ROI2 is greater than a user-defined threshold

Probabilistic tractography

+ with networks of ROIs from 3dROIMaker and uncertainty from 3dDWUncert (as well as tensor estimates from, e.g., 3dDWItoDT), can finally do probabilistic tractography
+ 3dTrackID -mode PROB
  - does lots of Monte Carlo simulations: wholebrain tractography -> perturb FA & e1 based on uncertainty -> wholebrain tracking -> perturb -> wholebrain tracking -> etc.
  - at each iteration, checks for connections between any pair of ROIs
  - can trim saved tracts to only keep voxels *between* 2 ROIs (i.e., no overrunners in the 'connection' ROIs)
  - also finds tracts through each individual ROI
  - to find WM region connecting, say, ROI 1 and 2: keep voxels through which Ntracks which intersected both ROI1 and ROI2 is greater than a user-defined threshold
  - calculate stats on final WM ROIs found
  - analyze multiple networks **simultaneously** for efficiency (i.e., very little extra cost)

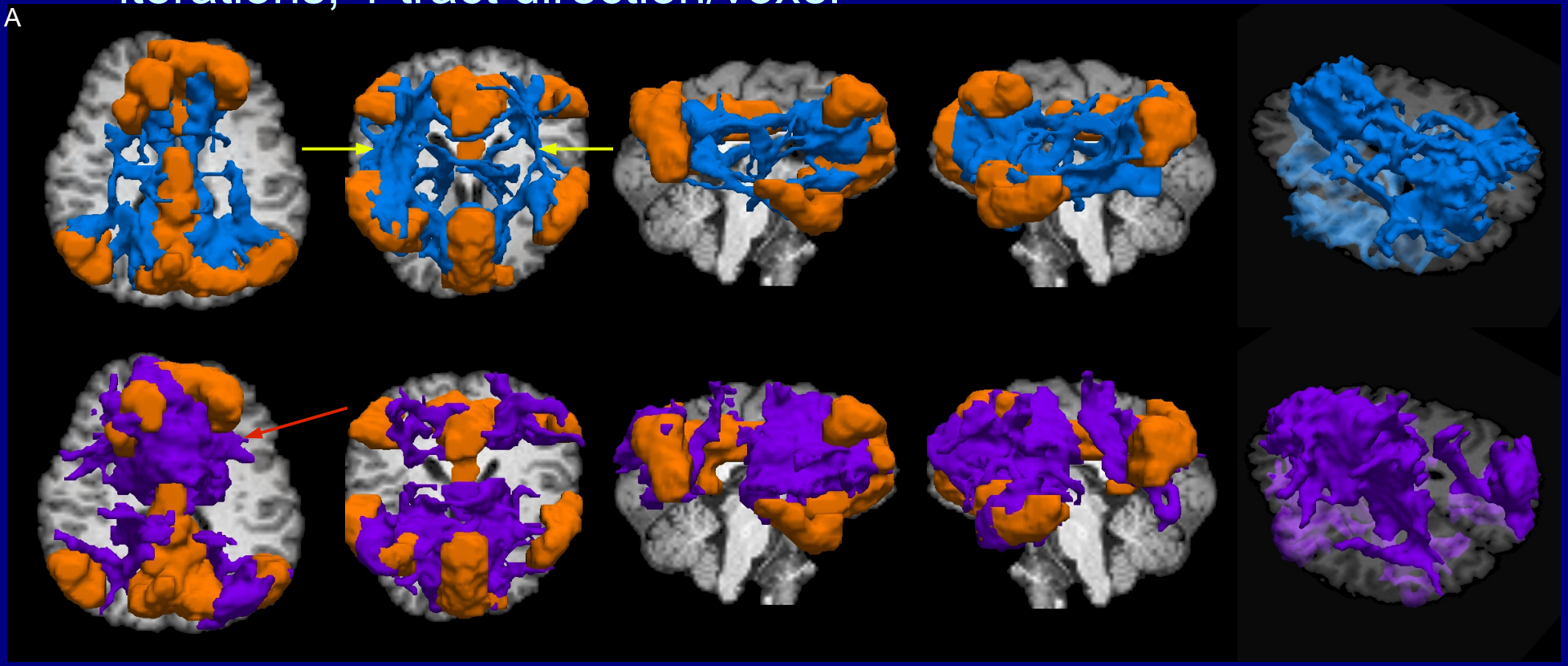
3dTrackID: Probabilistic tractography



(orange is ROI; blue is set of WM regions with tracts connecting)

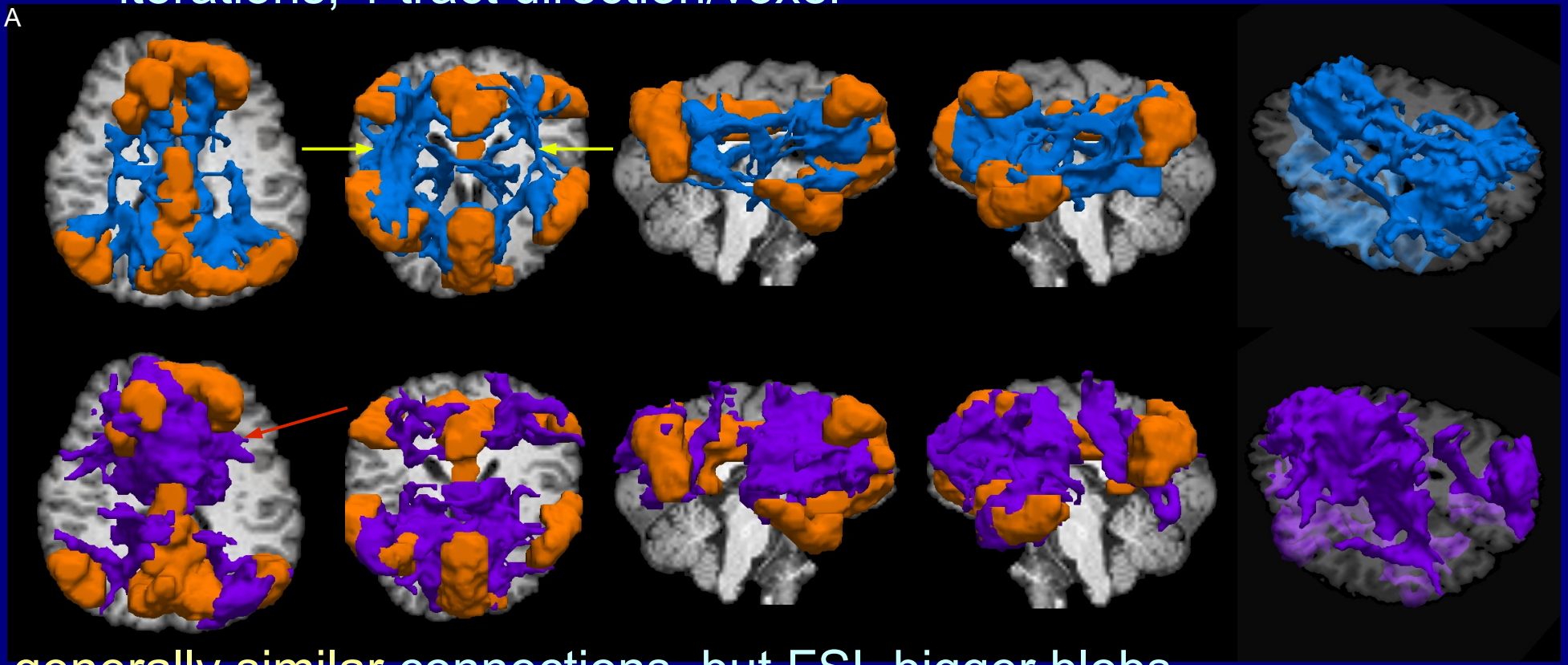
3dTrackID: Probabilistic tractography

+ compare with existing algorithms:
  - purple: FSL-probtrackX (and FSL-bedpostX for uncertainty)
  - same parameters: FA>0.2, max angle 60deg, 5000 Monte Carlo iterations; 1 tract direction/voxel



3dTrackID: Probabilistic tractography

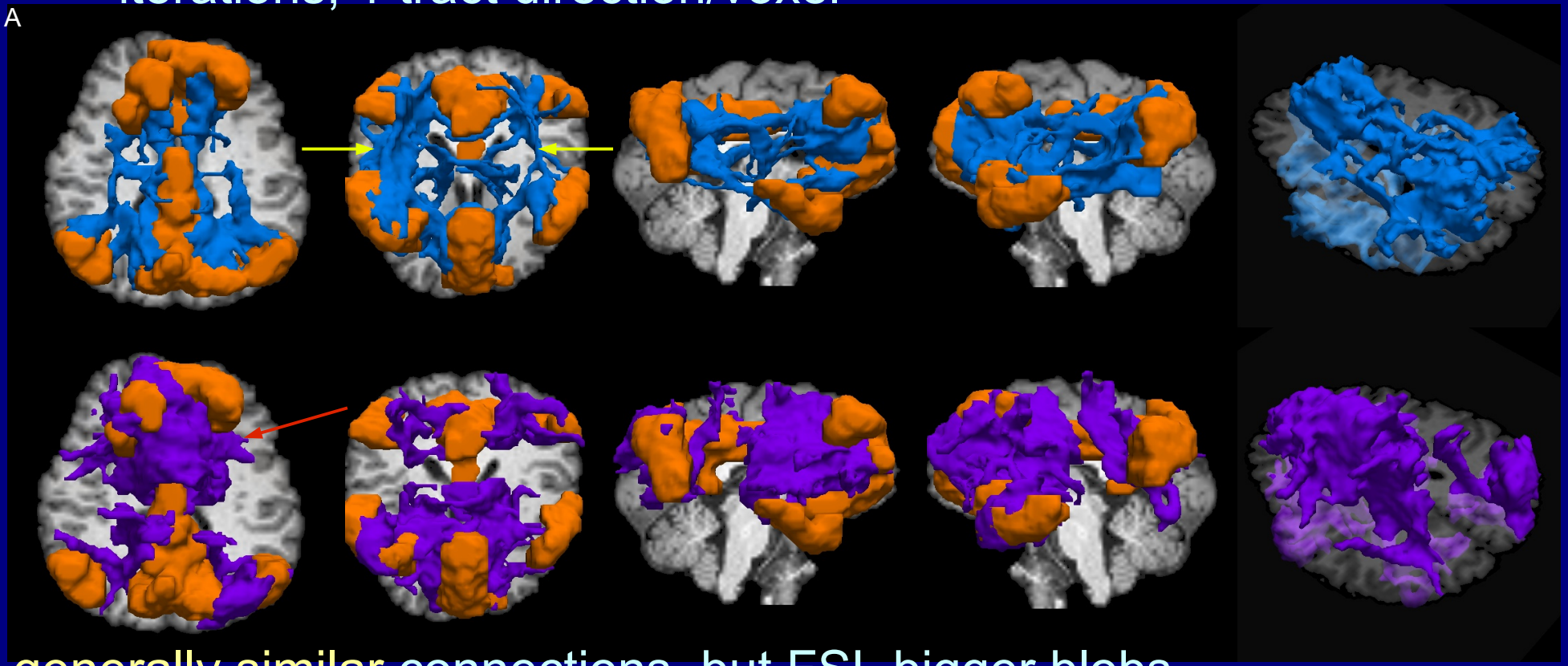
+ compare with existing algorithms:
  - purple: FSL-probtrackX (and FSL-bedpostX for uncertainty)
  - same parameters: FA>0.2, max angle 60deg, 5000 Monte Carlo iterations; 1 tract direction/voxel



+ generally similar connections, but FSL bigger blobs

3dTrackID: Probabilistic tractography

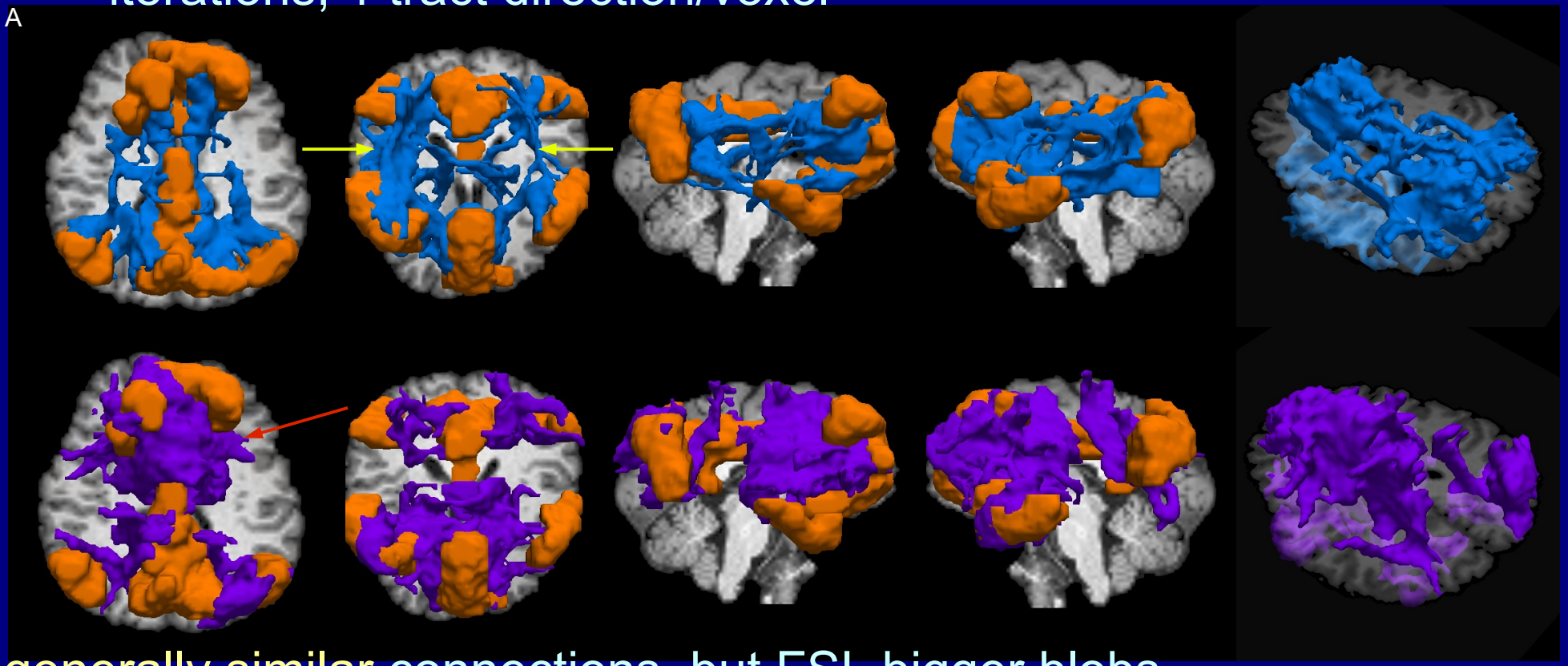
+ compare with existing algorithms:
  - purple: FSL-probtrackX (and FSL-bedpostX for uncertainty)
  - same parameters: FA>0.2, max angle 60deg, 5000 Monte Carlo iterations; 1 tract direction/voxel



+ generally similar connections, but FSL bigger blobs
+ FSL took several hours for uncertainty, and then >24 hours for tracking this single network (and had to run 4 for this study)

3dTrackID: Probabilistic tractography

+ compare with existing algorithms:
  - purple: FSL-probtrackX (and FSL-bedpostX for uncertainty)
  - same parameters: FA>0.2, max angle 60deg, 5000 Monte Carlo iterations; 1 tract direction/voxel

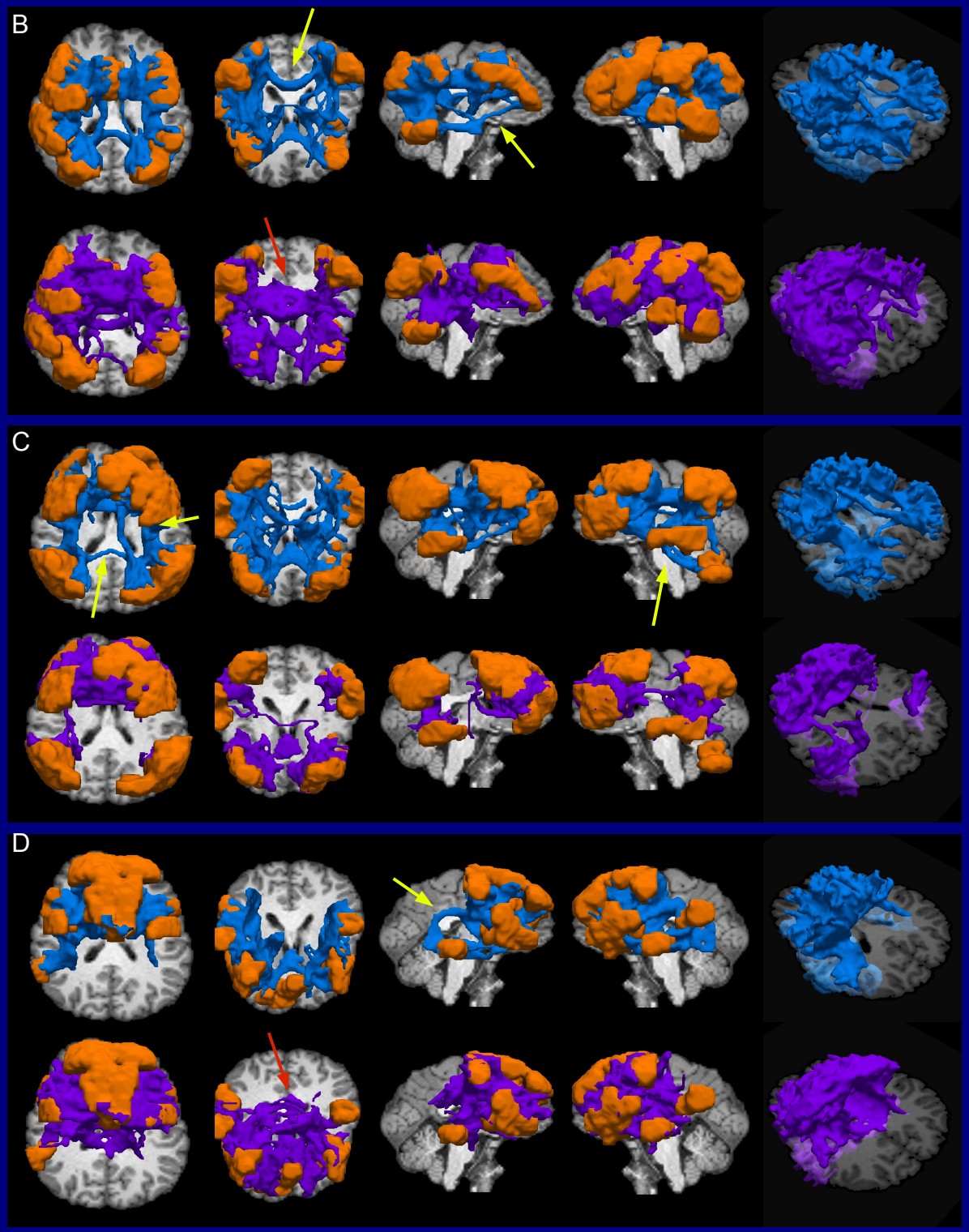


+ generally similar connections, but FSL bigger blobs
+ FSL took several hours for uncertainty, and then >24 hours for tracking this single network (and had to run 4 for this study)
+ 3dDWUncert took 7***min***; 3dTrackID took 25***mins*** total for 4 netw.

3dTrackID:

(other networks show similar results in terms of:

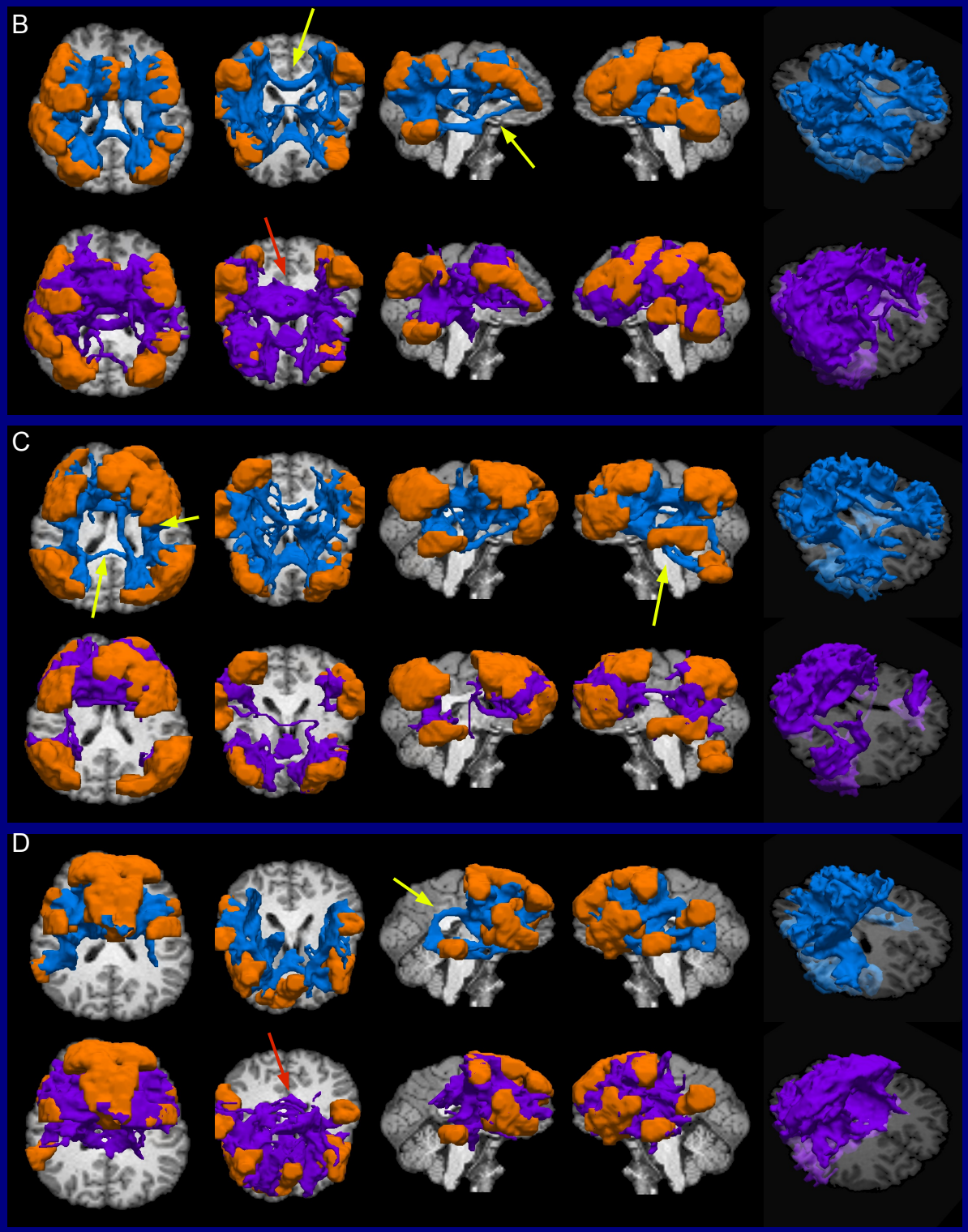
- narrow/wide regions of tracts;
- broadly similar locations;
- each program shows some tracks which the other doesn't)

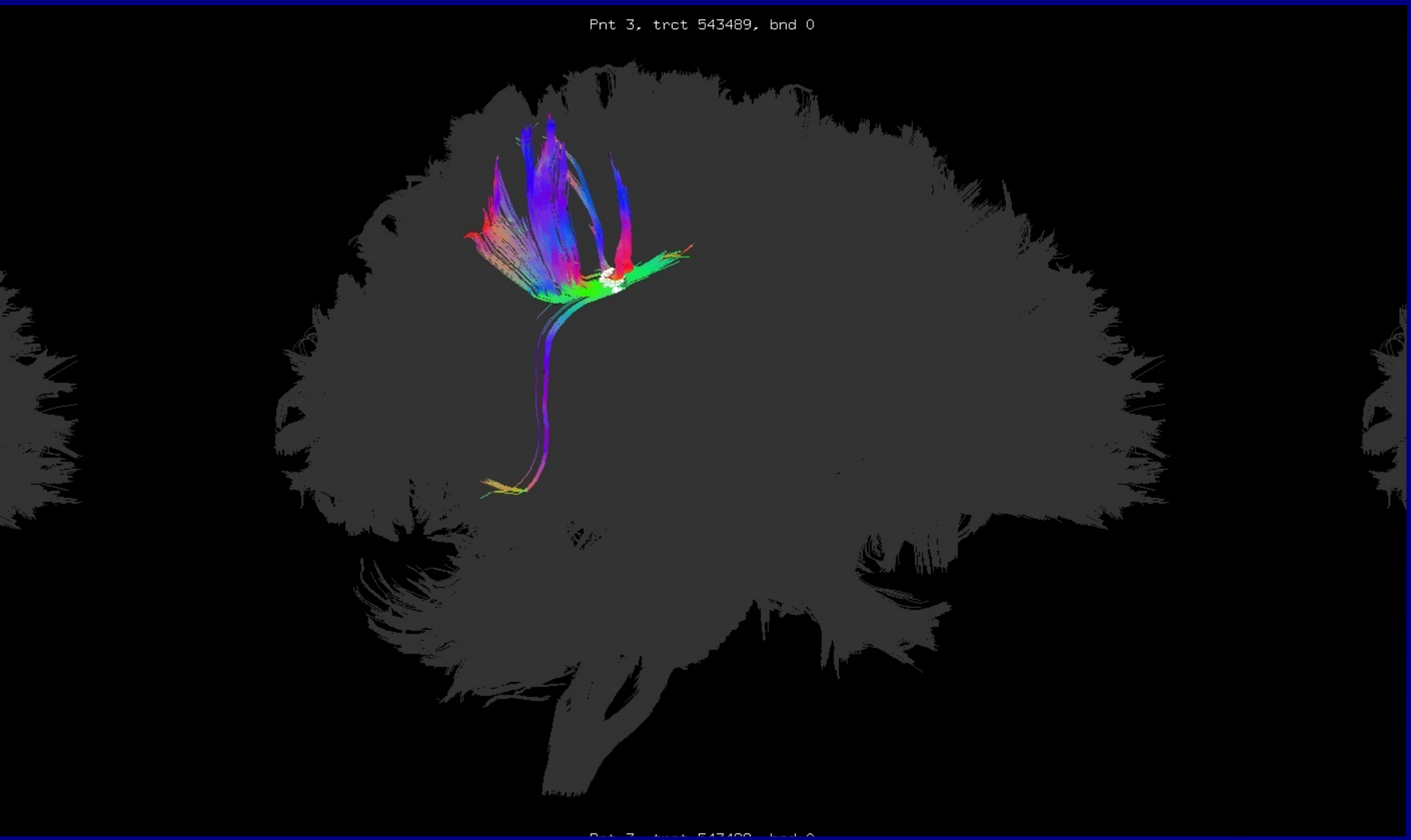


3dTrackID:

(other networks show similar results in terms of:
- narrow/wide regions of tracts;
- broadly similar locations;
- each program shows some tracks which the other doesn't)

(3dTrackID automatically creates *.grid files for probabilistic files, as well.)




Pnt 3, trct 543489, bnd 0