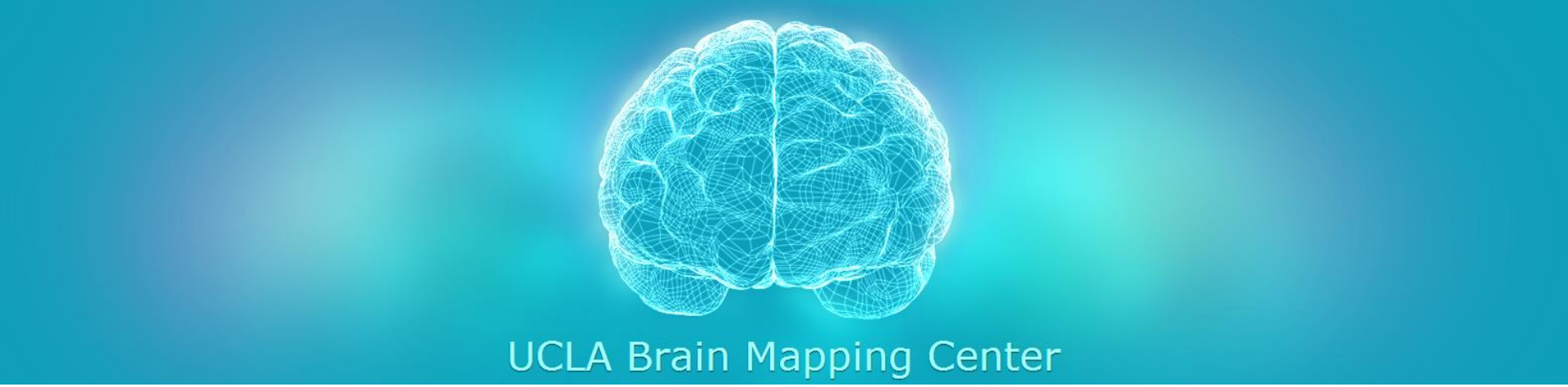

BrainSuite Workshop

Presented at the **UCLA Advanced Neuroimaging Summer Program**
12 August 2015

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Department of Neurology
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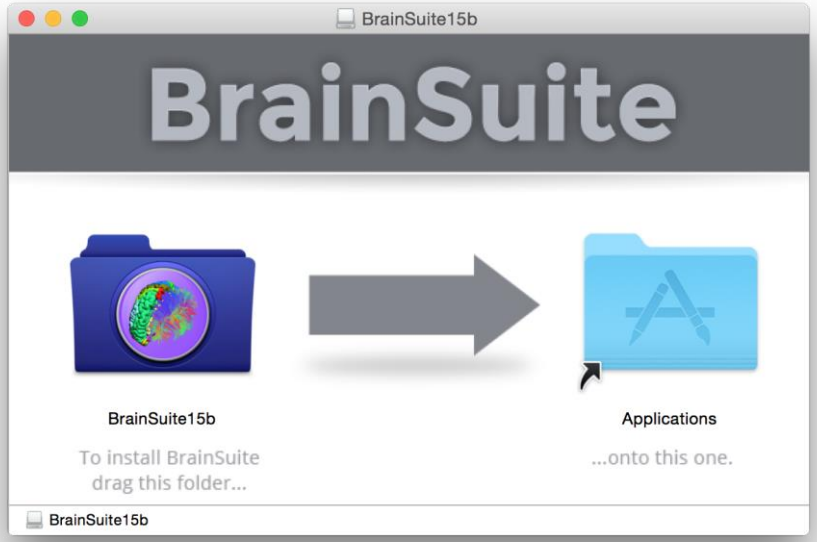
http://shattuck.bmap.ucla.edu

BrainSuite Resources

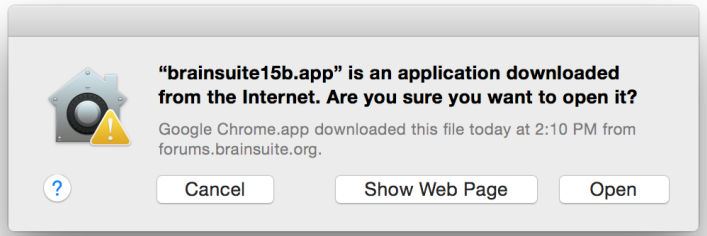
- e-mail support@brainsuite.org
- Main site http://brainsuite.org
- Registration (forum/download) http://brainsuite.org/register
- Download http://brainsuite.org/download
- User forums http://forums.brainsuite.org
- Tutorials http://brainsuite.org/tutorials
- Additional utilities
  http://brainsuite.org/processing/additional-tools

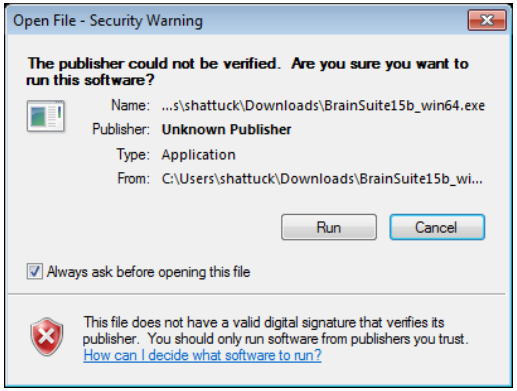
Installation



- Register and download at http://brainsuite.org
- Mac & Windows: open the installer
- Linux : gunzip/untar to your preferred install directory

Installation : Security





You may need to tell your OS that you trust BrainSuite.

- Mac
  - Navigate to /Applications/BrainSuite15b/brainsuite15b.app
  - Right-click and select "open".
  - Approve BrainSuite15b to run.
- Windows
  - Win7: approve it through the dialog box as above.
  - Other Windows versions may have different security procedures.

Installation : MCR

- SVReg and BDP require MATLAB Compiler Runtime (MCR) 2012a
  - **Important: must be the 2012a Version!!!**
  - http://www.mathworks.com/products/compiler/mcr/

	Windows	Linux	Mac
R2012a (7.17)	64-bit	64-bit	Intel 64-bit

  - Links are also on the BrainSuite website.

- To use MCR 2012a on Mac OS X 10.10 (Yosemite), you will need to also follow the instructions here:
  http://brainsuite.org/2014/10/configuring-mac-os-x-10-10-yosemite-to-work-with-svreg-and-bdp/

Sample Data

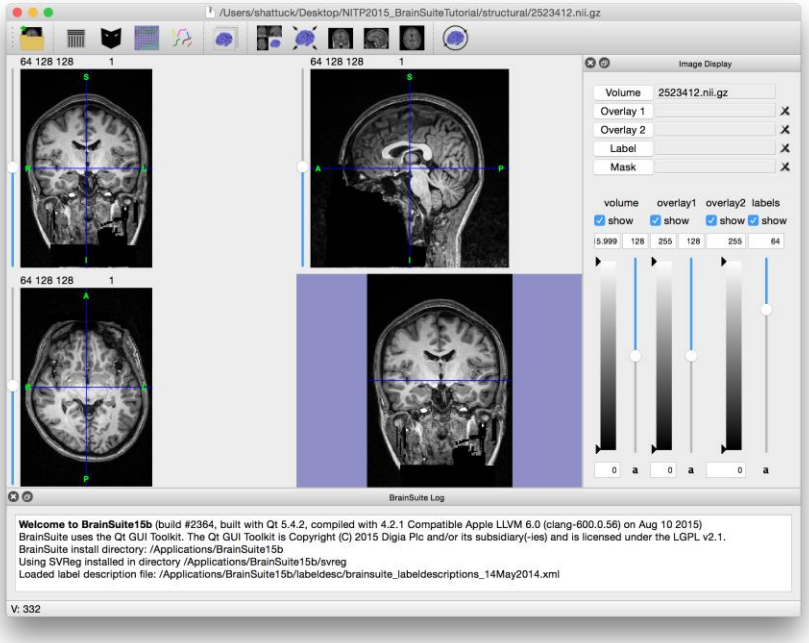
NITP2015_BrainSuite_Tutorial

- contains several .bst files for running the examples in this tutorial.
- **extraction** : MRI file for cortical surface extraction
- **structural** : contains SVReg outputs
- **diffusion** : contains output of the BDP commands
- **commandline** : scripts and data to run command line tools

1. Opening and Displaying an MRI

- Start BrainSuite
- Drag and drop the T1 image from the native space folder onto the interface

  structural/2523412.nii.gz
- Navigation:
  - Scrolling the sliders or click in the image windows
  - Click and drag the mouse in the 3D view to rotate the display
  - Ctrl+click/⌘+click to zoom*
- Press the 'I' key to open the Image Display Properties controller
  - Adjust the intensity ranges
  - Right-click to change colormaps



*ctrl for Windows, ⌘ for Mac

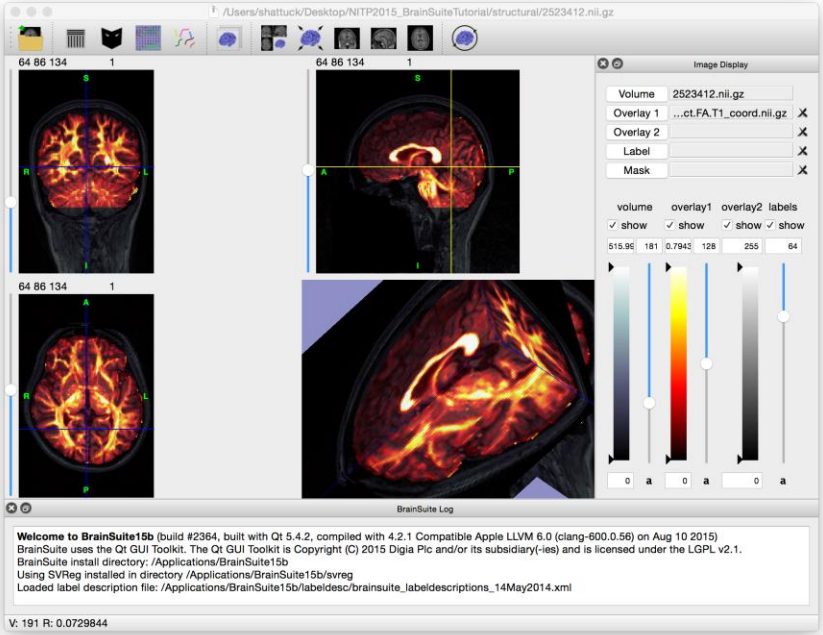
2. Opening an Overlay

Load an overlay image

- Press the Overlay1 button
- Select the FA file:

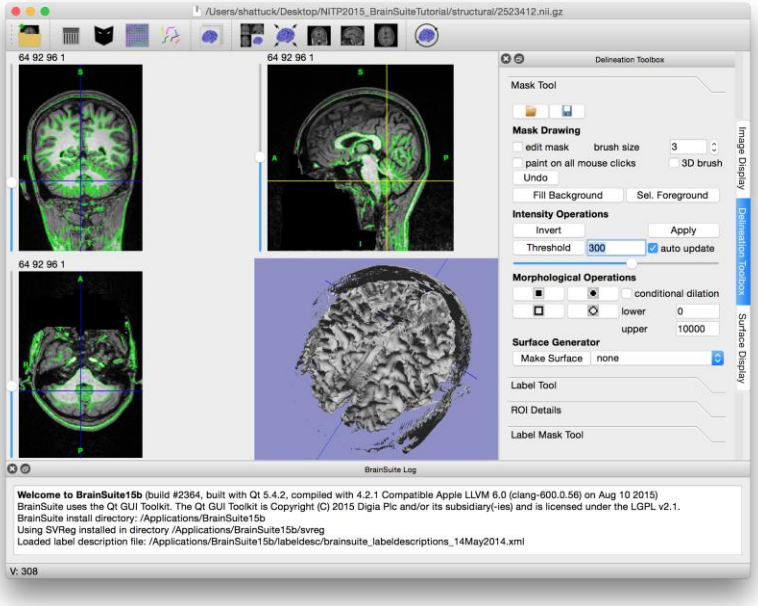
diffusion/DTI/2523412.dwi.RAS.correct.FA.T1_coord.nii.gz

- Adjust the first alpha slider to change the blending of the two images
- Change the colormap of the overlay



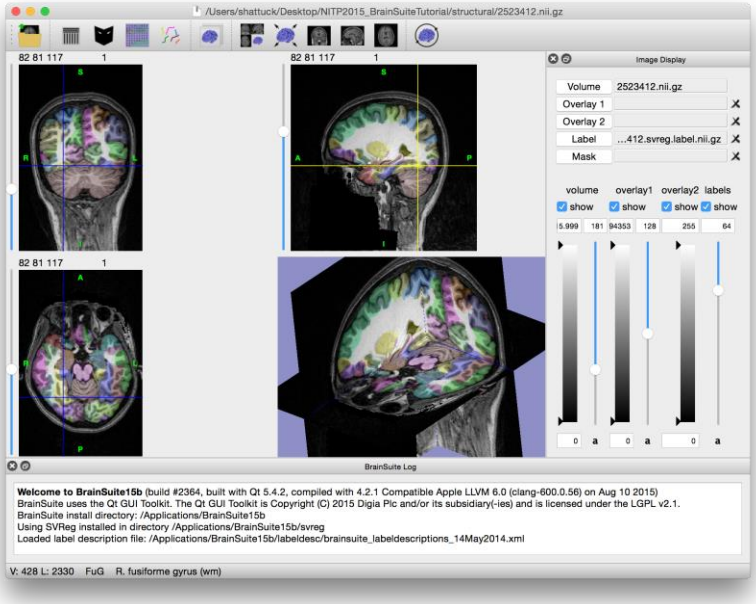
3. Mask and Surface Tools

- Open the T1 image as the primary volume
- Open the display properties and adjust the lower intensity range
- Press ‘M’ to open the mask tool
- Adjust the slider under Threshold, and see the mask boundary change.
- This will create a new mask as the slider moves.
- Set the value to 256.
- Press the ‘Make Surface’ button (you may need to enlarge the BrainSuite window to see this button)
- Press ctrl+V/⌘+V to hide the slices in the 3D view



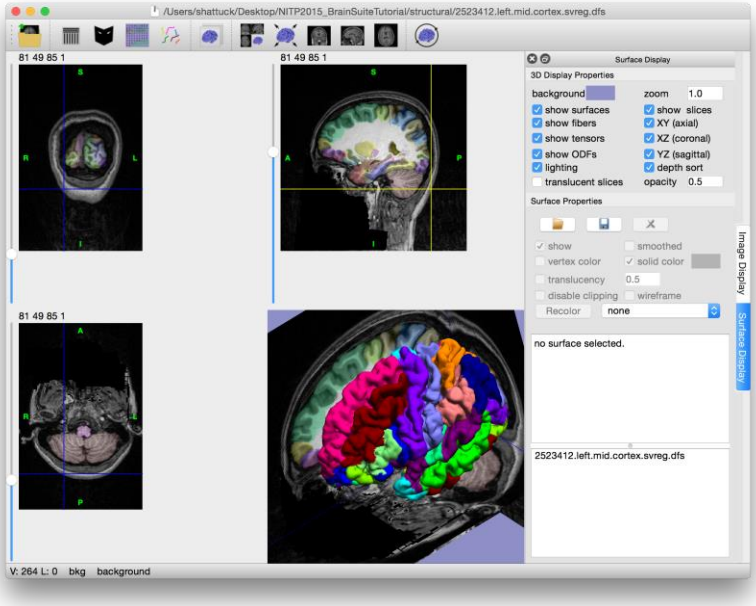
4. Working with Labels

- Load data from the structural directory
  - Load 2523412.nii.gz
  - Load 2523412.svreg.label.nii.gz as a Label image
- Each color corresponds to a different anatomical area as defined by BrainSuite
- Click the mouse on a labeled area, and the label is shown in the status bar.



5. Working with Surfaces

- From the structural folder, drag and drop the file 2523412.left.mid.cortex.svreg.dfs onto BrainSuite
- Properties of the different surfaces can be adjusted
  - Show or hide
  - Wireframe mode
  - Translucency
- Recolor based on different properties
  - Volumetric labeling
  - Curvature

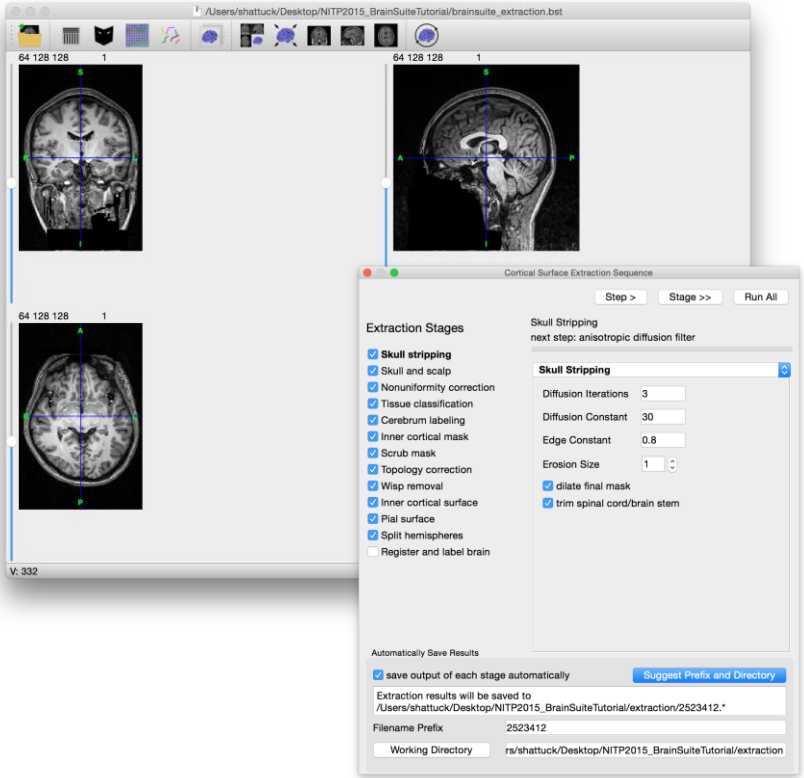


6. Extracting a Brain Surface

- Load the T1 image from the **extraction** folder* or drag brainsuite_extraction.bst onto BrainSuite.

- Open “Cortex -> Cortical Surface Extraction Sequence”

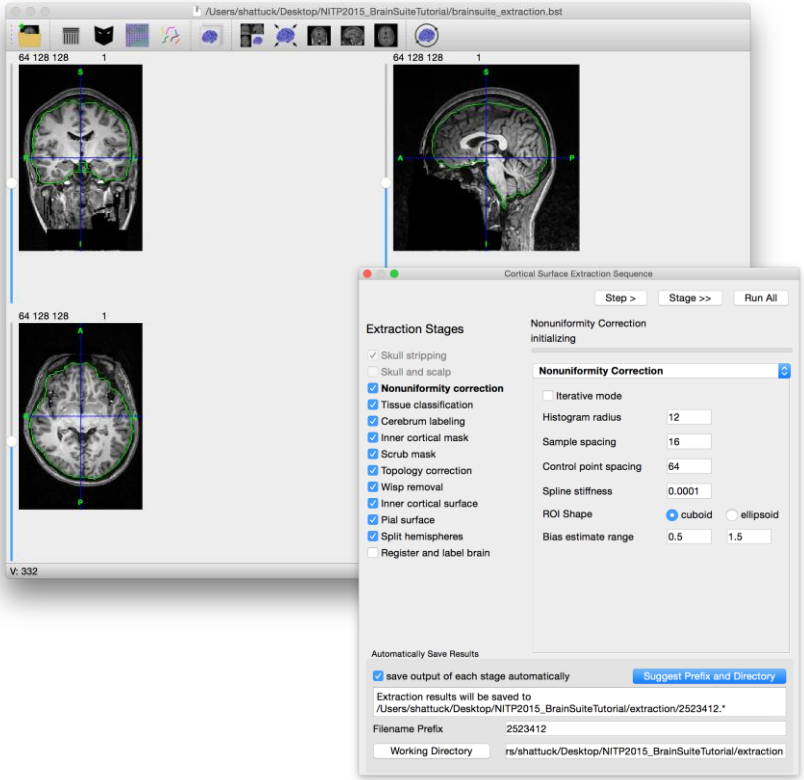
- Change the Skull Stripping parameters as follows:
  - Diffusion constant: 30
  - Edge constant: 0.80
  - These values will be automatically loaded if you use the .bst file



*By default, BrainSuite’s extraction dialog will write files to the same directory as the input image, so be sure to use the extraction folder rather than the structural folder, which contains pre-processed data.

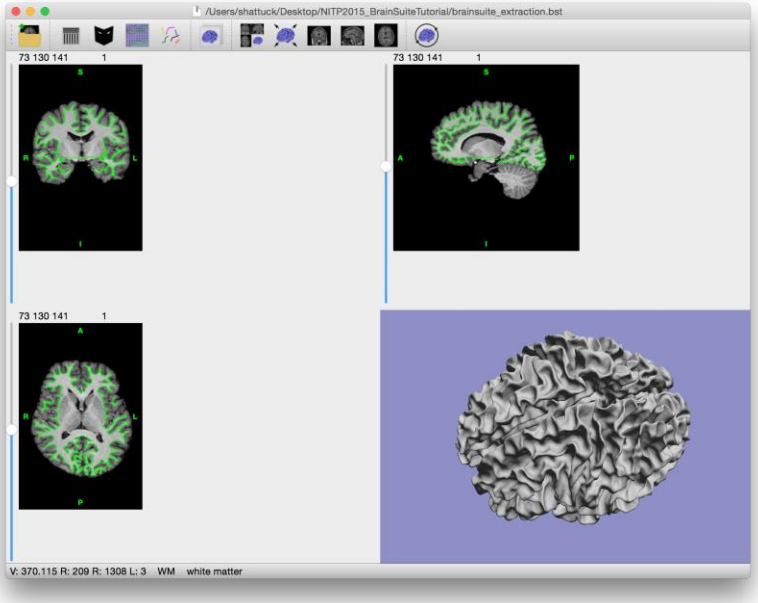
6. Extracting a Brain Surface

- Step through the Skull Stripping Stage
- Uncheck “Skull and Scalp”
- Continue stepping through each stage, observing the outputs
- **Stop after you’ve finished producing the inner cortical surface**



6. Extracting a Brain Surface

- At this point, you have produced an inner cortical surface mesh.
- The next step will produce the pial surface, which can take 5-10 minutes.



7. Automated SVReg Labeling

- **Drop brainsuite_labeling.bst onto BrainSuite**
- Hide one of the surfaces
- Scroll to different positions in the volume and observe the boundaries of the labels
- Open the Label Painter tool (press ‘P’)
  - Can be used to edit the labels
  - Can calculate total volume of different labeled structures

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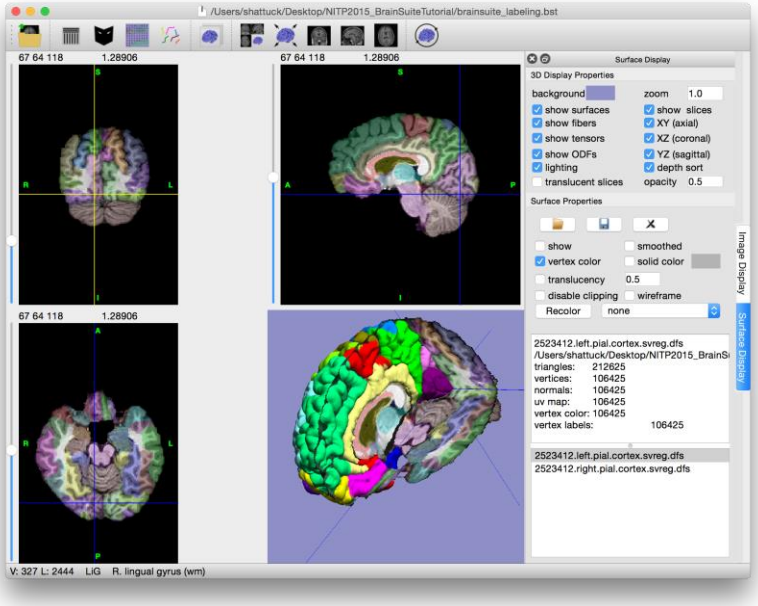
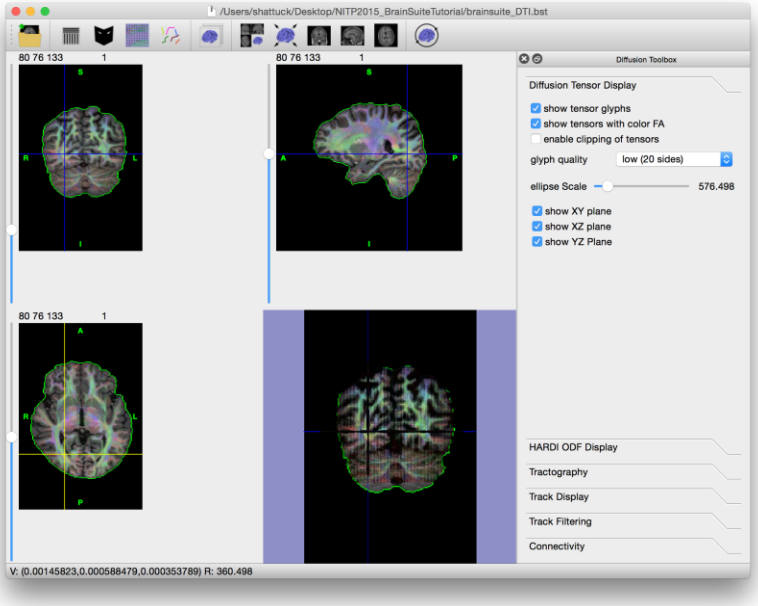


8. DTI Data

- **Drop brainsuite_DTI.bst onto BrainSuite**
- Adjust the image display parameters ('I') to increase the brightness.
- Scroll through the volume and observe some of the structure that is made visible by the DTI
  - Hide the volume slices (ctrl+V/⌘+V)
  - Make the surface display full view
  - Zoom into the image
  - In the diffusion toolbox ('D'), adjust the size of the diffusion glyphs
- You can also load the structural scan as an overlay to observe the different modalities.



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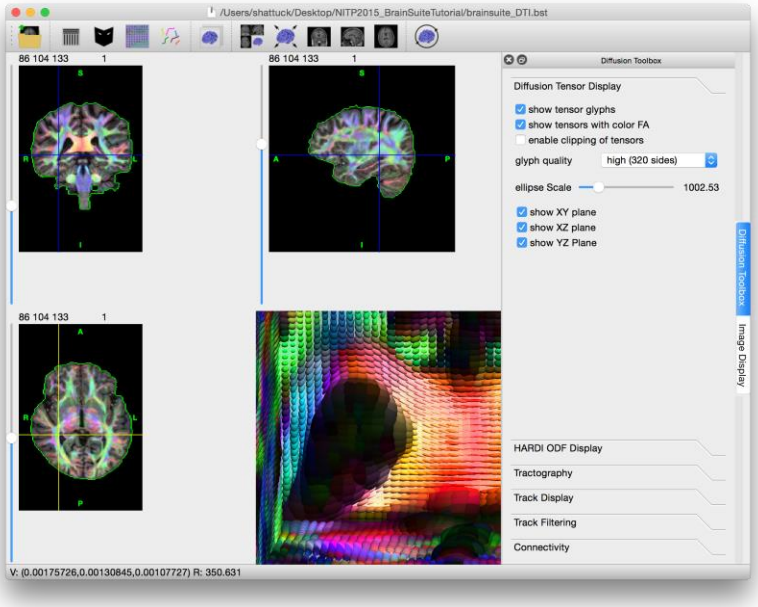

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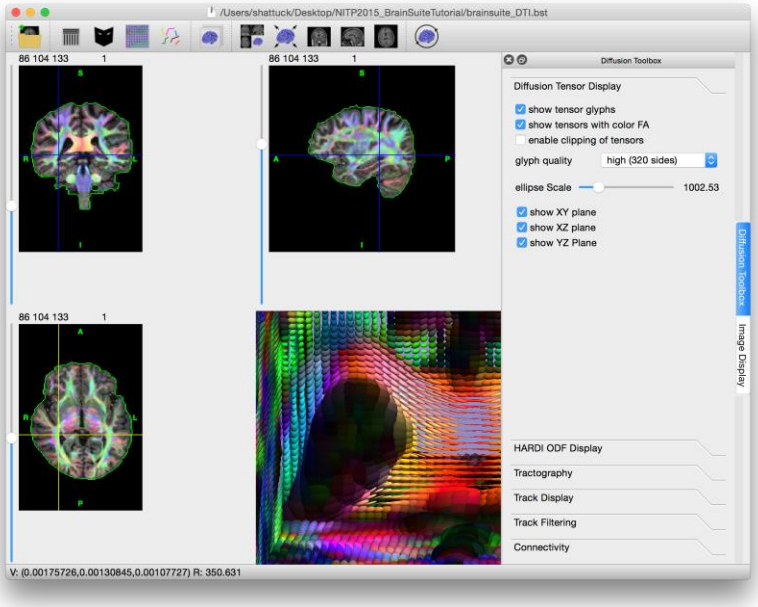

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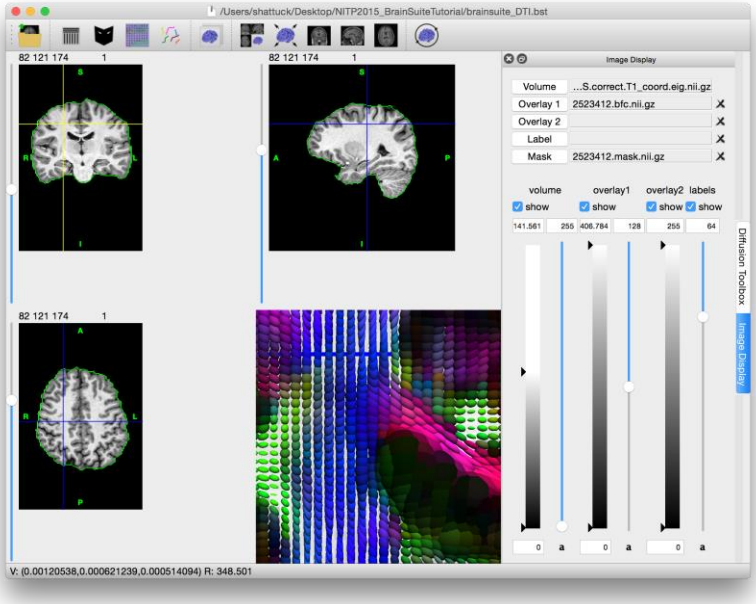
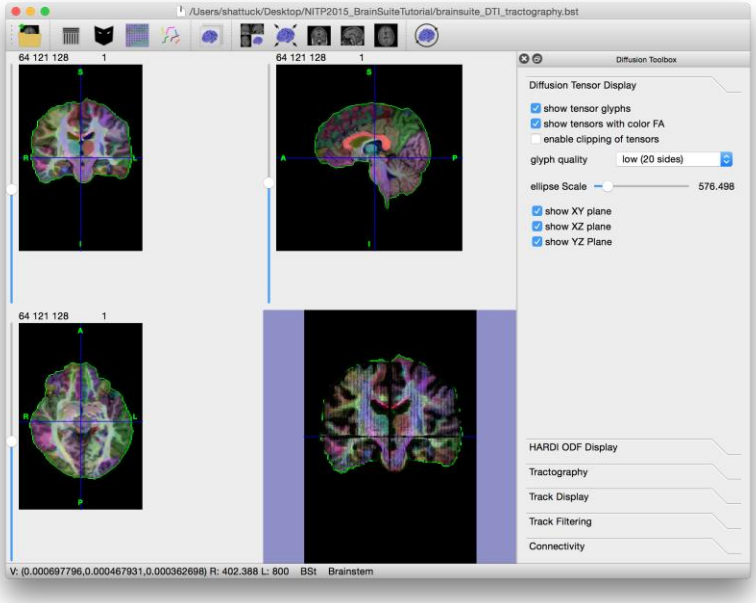


9. DTI Tractography

- **Drop brainsuite_DTI_tractography.bst onto BrainSuite**
- Adjust the display
  - Hide the labels (ctrl+L/⌘+L)
  - Zoom in on the 3D view
- In the diffusion toolbox ('D'):
  - Open the tractography tab
  - Change FA threshold to 0.25
  - Change track seeding to 0.5
  - Change angle threshold to 30
  - Press 'Compute Tracks'
- Explore the tracks using the interface
  - Cut planes (x/y/z keys)
  - Fibers on/off ('F')
  - Tensors glyphs on/off ('G')



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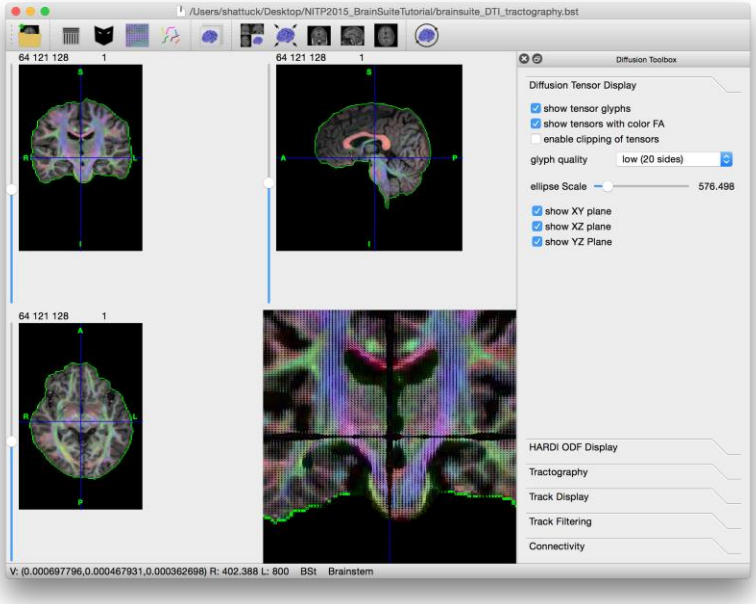

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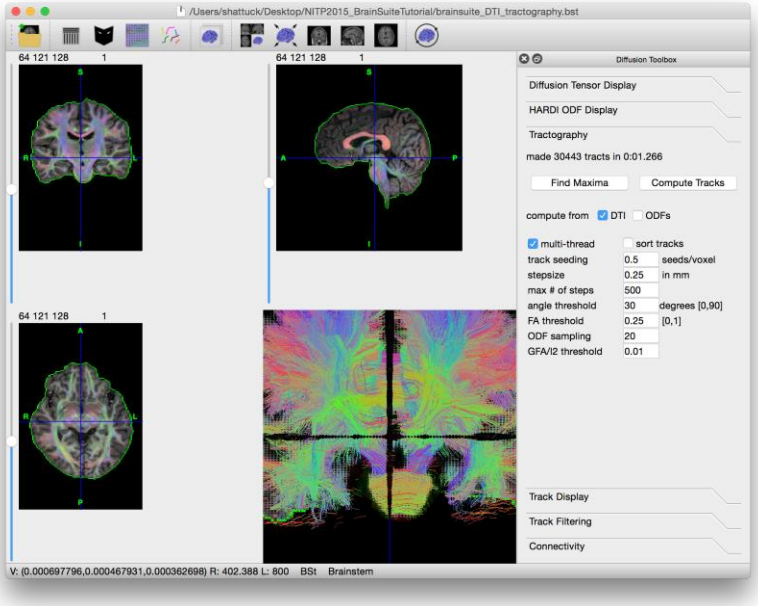

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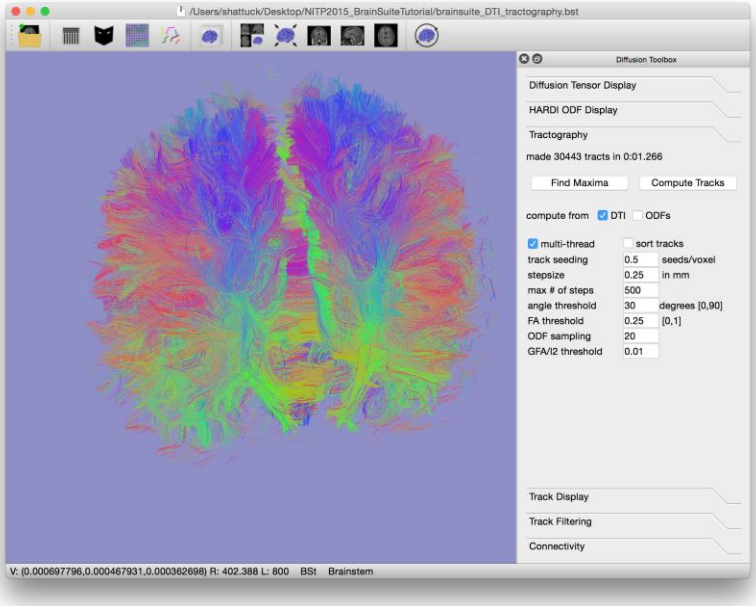
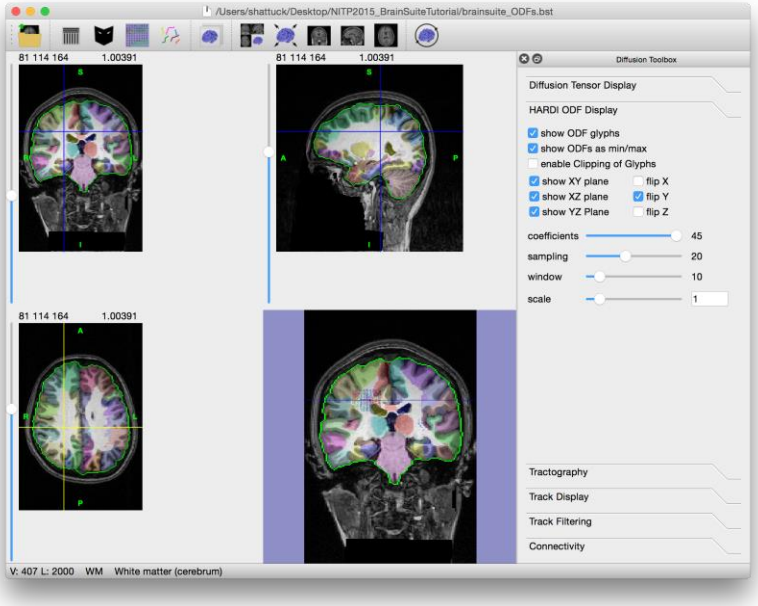


10. ODF Data

This exercise requires a computer with a 64-bit operating system and at least 4GB of RAM

- **Drop brainsuite_ODFs.bst onto BrainSuite**
- Zoom in on the 3D view
- In the diffusion toolbox (press ‘D’):
  - Show only the X-Z plane
  - Increase the window size to cover more of the slice
  - Scroll through the image and observe the ODF glyphs, particularly in the region of crossing fibers.



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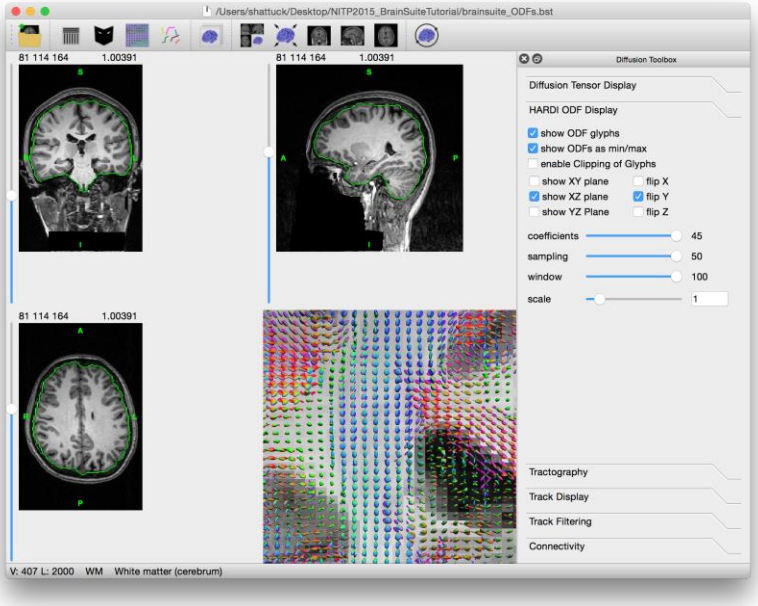

11. ODF Tracks

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- **Drop brainsuite_ODF_tractography.bst onto BrainSuite**
- Zoom in on the 3D view
- Hide the labels (ctrl+L/⌘+L)
- Open the Mask Tool ('M'):
  - Change the threshold to 0.25
  - Press the threshold button
- Open Diffusion Toolbox ('D'):
  - Open the tractography tab
  - Change track seeding to 0.5
  - Press 'Compute Tracks'
- Explore the tracks using the interface
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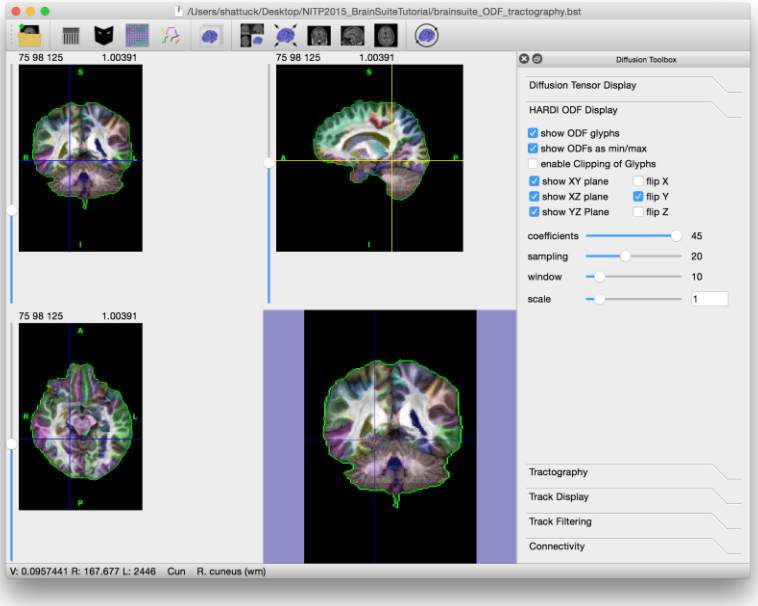
  - Toggle the labels (ctrl+L/⌘+L)



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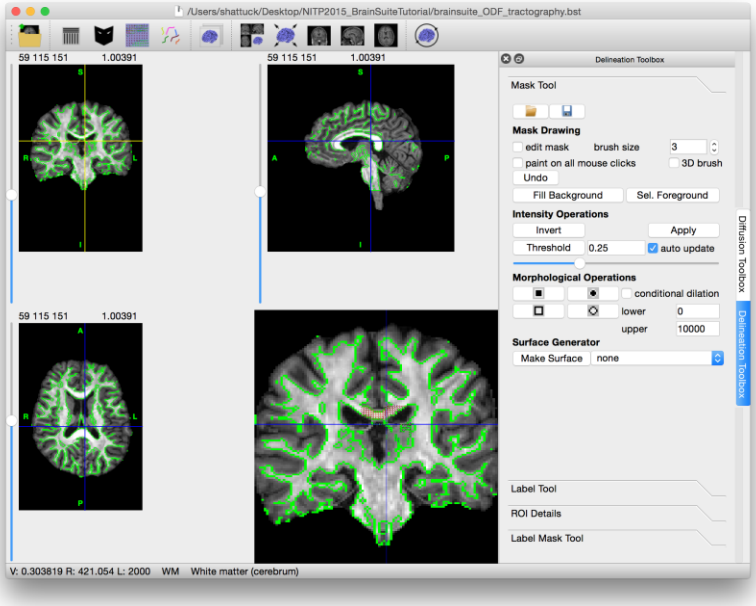

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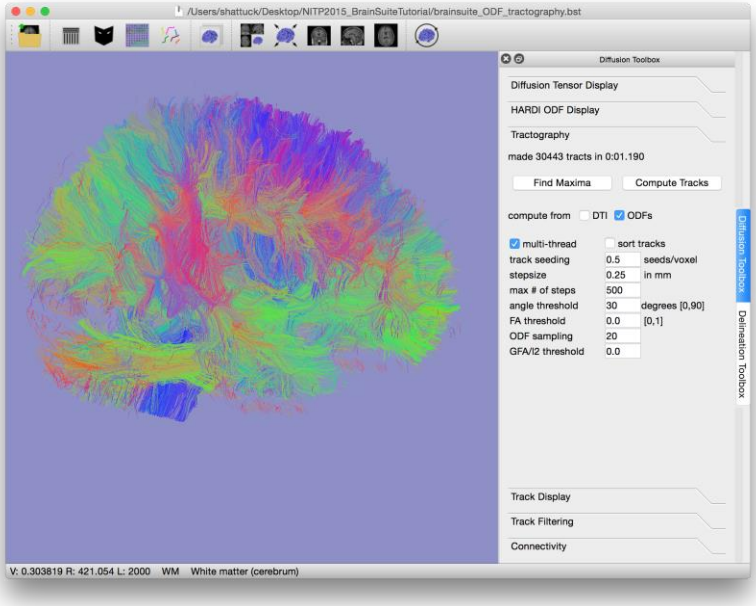
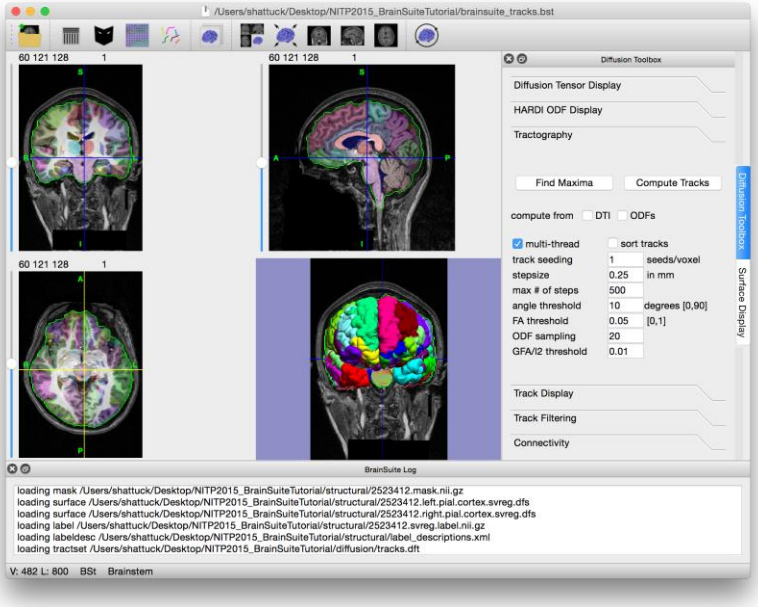


12. Track Filtering

- **Drop brainsuite_tracks.bst onto BrainSuite**
- Adjust the display
  - Hide the surfaces (ctrl+S/⌘+S)
  - Hide the slices (ctrl+V/⌘+V)
  - Zoom in on the 3D view
- In the diffusion toolbox ('D'):
  - Open the Track Filtering tab
  - Adjust the length threshold to 10 and observe the spurious tracks disappear
- Explore the tracks using spherical ROIs
  - Press + to add a sphere at the current cursor position
  - Scroll through the image to see tracks connected to the sphere
  - Adjust the sphere radius to see larger regions
  - Adjust other parameters (e.g., wireframe)



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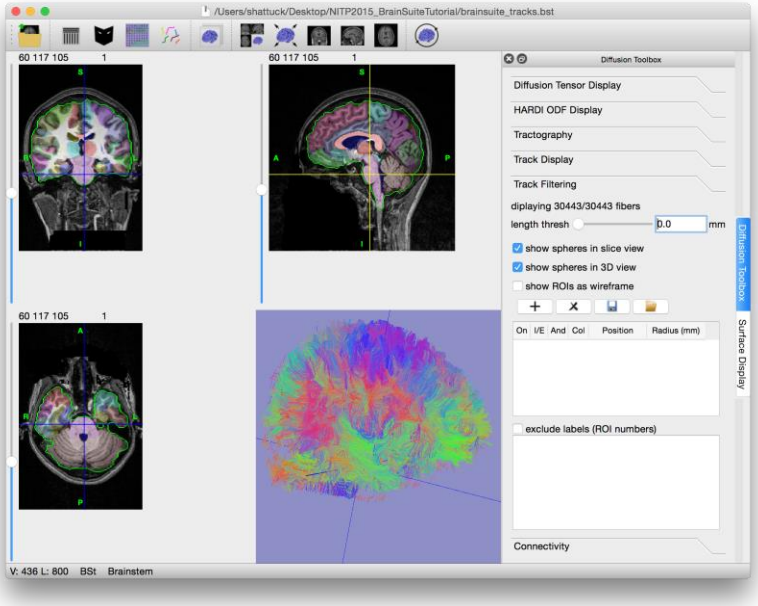

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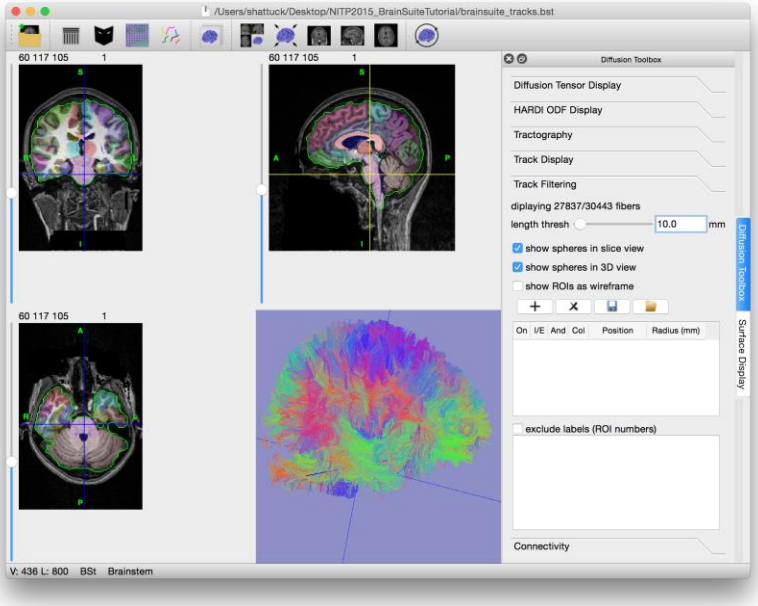
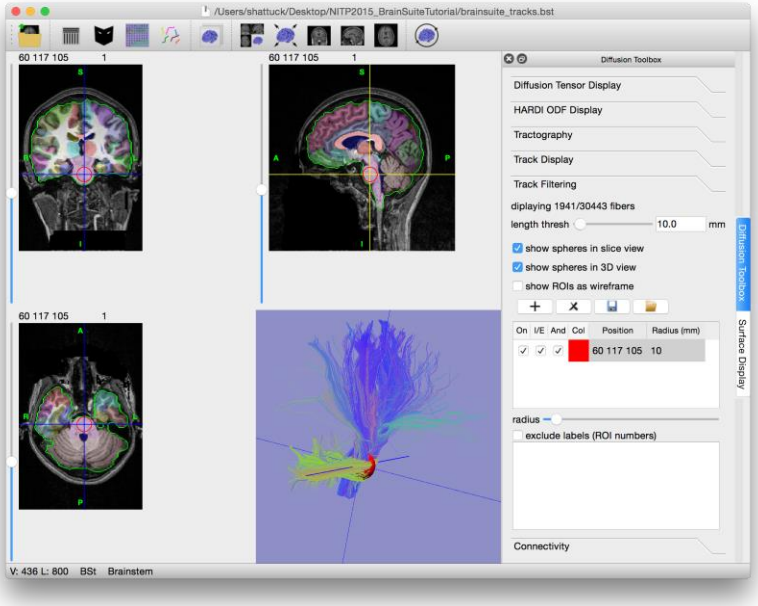


12. Track Filtering

- Drop brainsuite_tracks.bst onto BrainSuite
- Adjust the display
  - Hide the surfaces (ctrl+S/⌘+S)
  - Hide the slices (ctrl+V/⌘+V)
  - Zoom in on the 3D view
- In the diffusion toolbox ('D'):
  - Open the Track Filtering tab
  - Adjust the length threshold to 10 and observe the spurious tracks disappear
- **Explore the tracks using spherical ROIs**
  - Press + to add a sphere at the current cursor position
  - Scroll through the image to see tracks connected to the sphere
  - Adjust the sphere radius to see larger regions
  - Adjust other parameters (e.g., wireframe)



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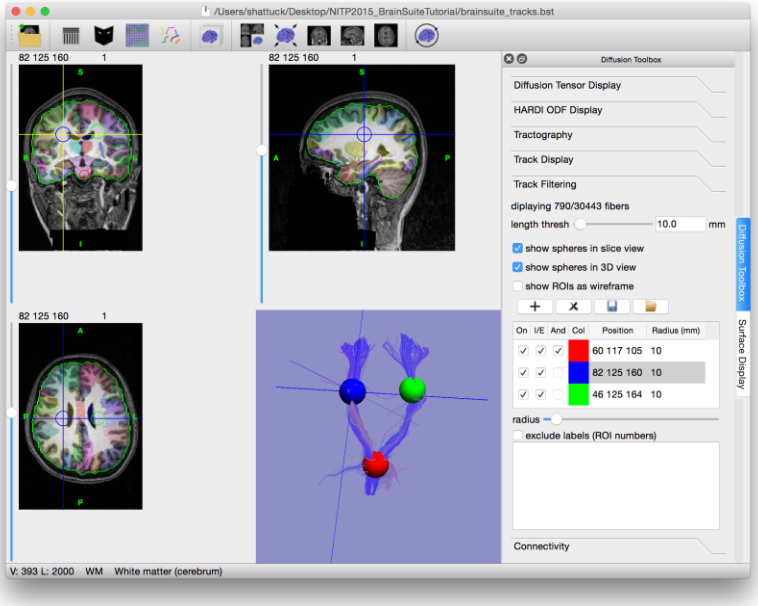
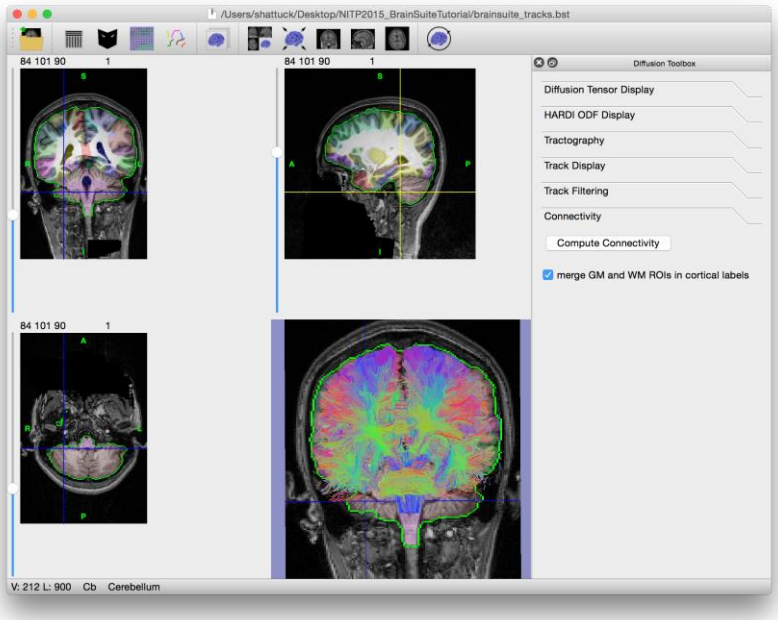
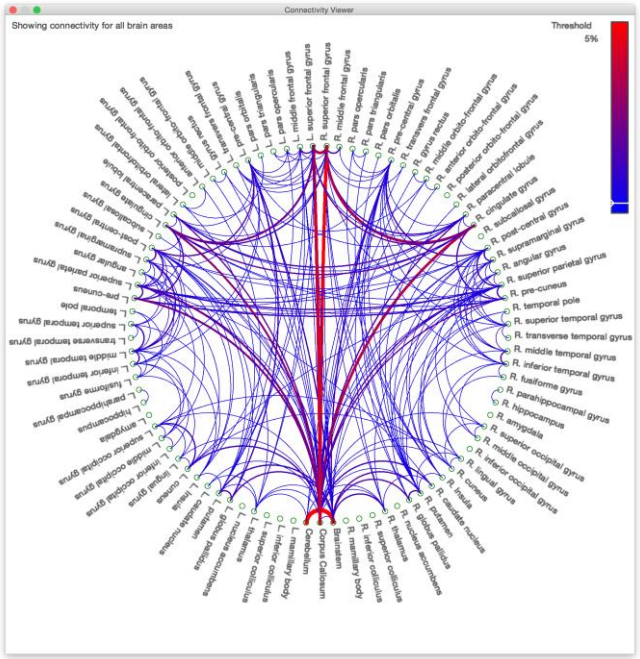


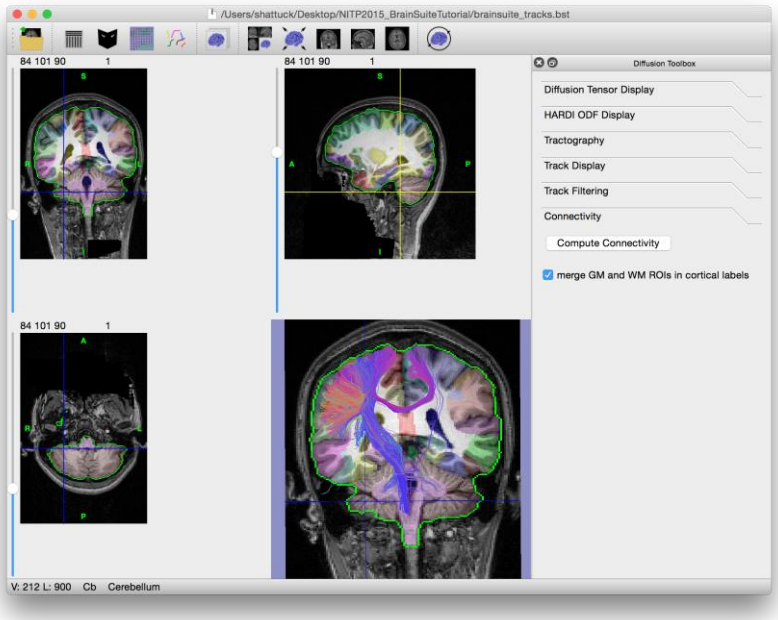
13. Connectivity

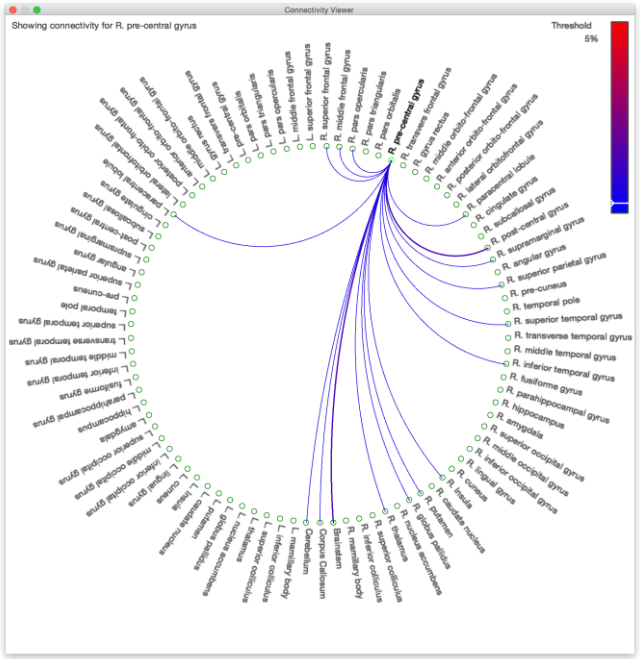




- **Load brainsuite_tracks.bst**
- **In the diffusion toolbox ('D'):**
  - Open the Connectivity tab
  - Press the 'Compute Connectivity' button
- The Connectivity Viewer allows you to explore connections between different ROIs
  - Select nodes along the wheel
  - ctrl+select to view connections between only 2 ROIs
  - shift+select to view multiple connections
  - Press 1,2,3,4 to observe different subsets (e.g., lobes)

13. Connectivity





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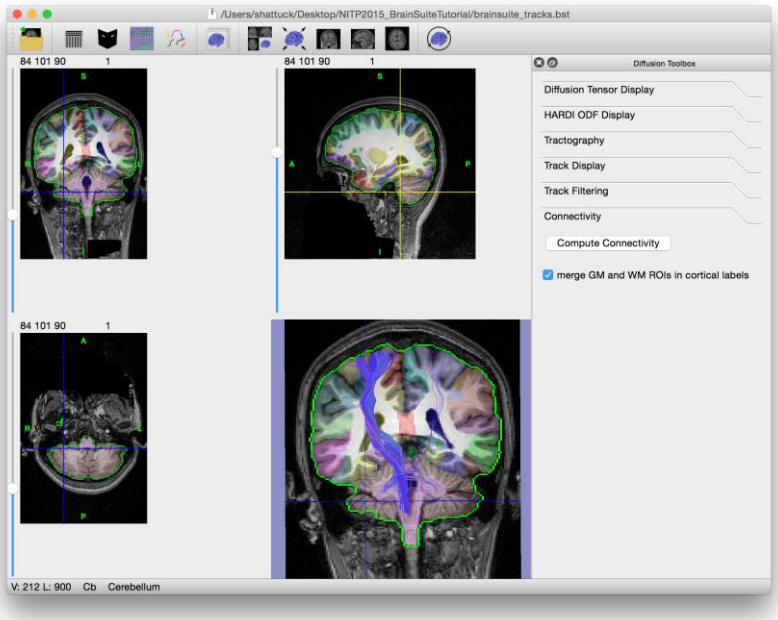

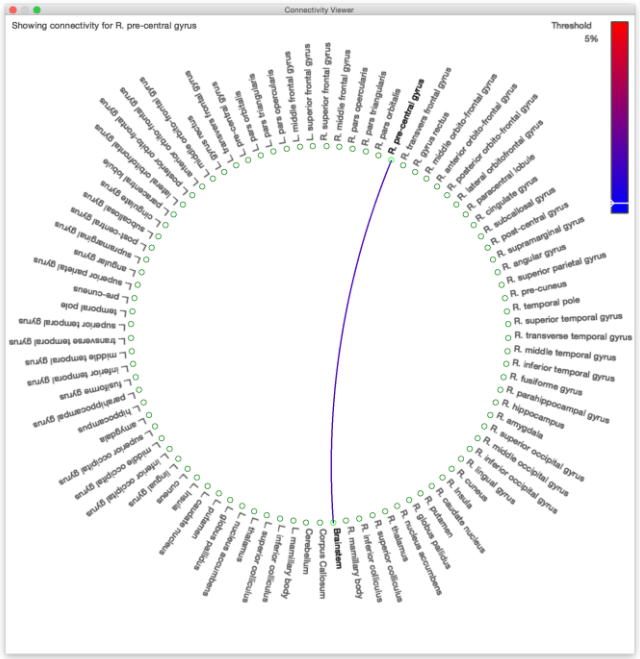

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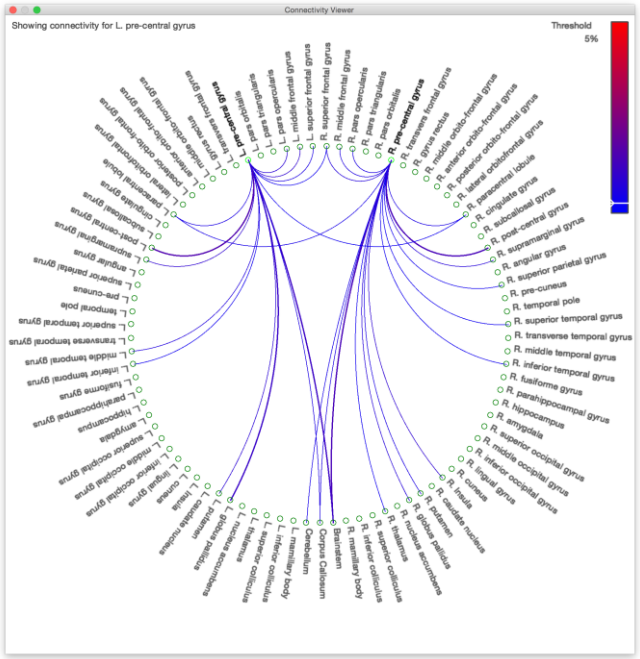

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- In the diffusion toolbox ('D'):
  - Open the Connectivity tab
  - Press the 'Compute Connectivity' button
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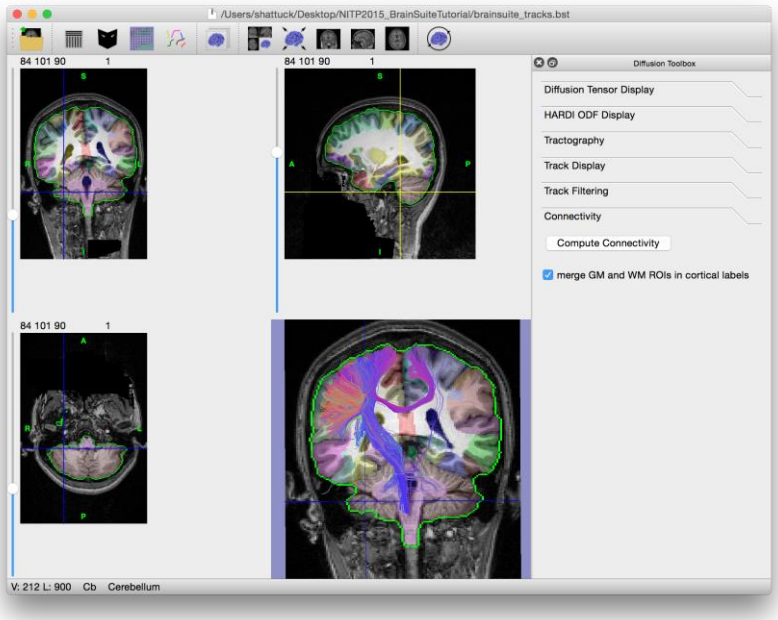
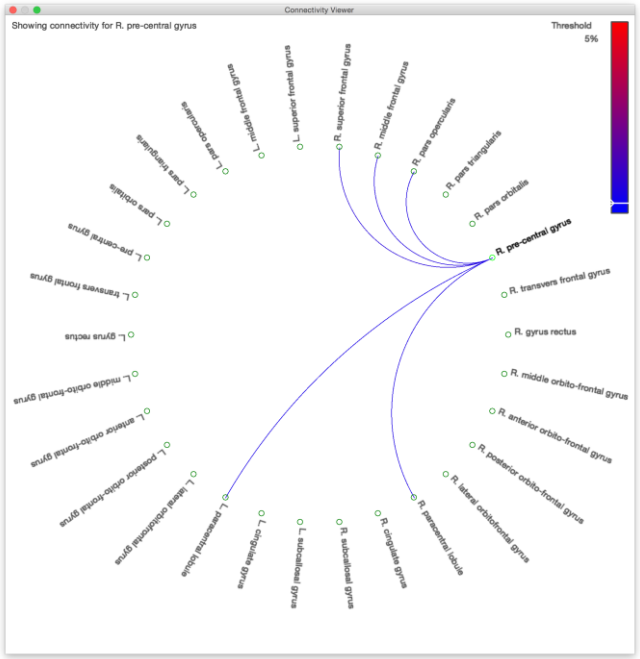
  - ctrl+select to view connections between only 2 ROIs
  - **shift-select to view multiple connections**
  - Press 1,2,3,4 to observe different subsets (e.g., lobes)

13. Connectivity





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  - Select nodes along the wheel
  - ctrl+select to view connections between only 2 ROIs
  - shift-select to view multiple connections
  - **Press 1,2,3,4 to observe different subsets (e.g., lobes)**

Command Line Extraction

Cortical Surface Extraction can also be run from the command line

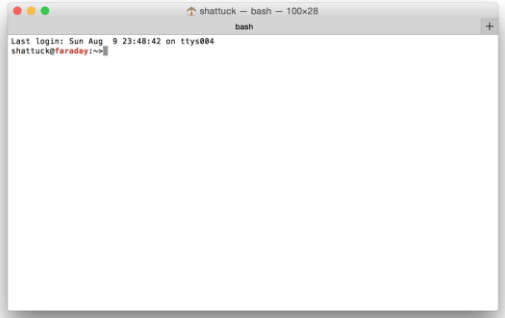
Mac (similar for Linux):

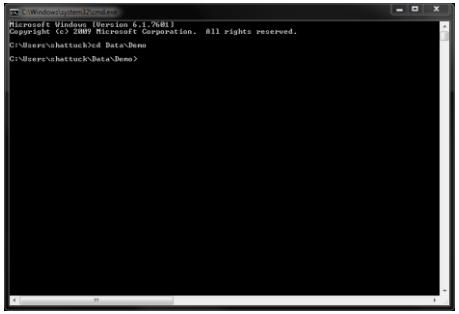
```
/Applications/BrainSuite15b/bin/cortical_extraction.sh 2523412.nii.gz
```

Windows:

```
"C:\Program Files\BrainSuite15b\bin\cortical_extraction.cmd" 2523412.nii.gz
```

- The scripts will automatically read a file named BrainSuiteOptions if it exists in the current directory.
- The demo includes settings for the skull-stripping command.
- These commands are included as demo scripts in the extraction folder.
- Approximate run time on a 3.5GHz i7-3770k is **6 minutes**.





Command Line SVReg

Surface/Volume Registration can be run from the command line:

Mac (similar for Linux):

```
/Applications/BrainSuite15b/svreg/bin/svreg.sh 2523412 \
        /Applications/BrainSuite15b/svreg/BCI-DNI_brain_atlas/BCI-DNI_brain
```

Windows:

```
"C:\Program Files\BrainSuite15b\svreg\bin\svreg.exe" 2523412.nii.gz ^
         "C:\Program Files\BrainSuite15b\svreg\BCI-DNI_brain_atlas\BCI-DNI_brain"
```

n.b.: \ and ^ are line continuation characters for Mac/Linux and Windows, respectively.

- These commands are included as demo scripts in the extraction folder.
- Approximate run time on a 3.5GHz i7-3770k is **120 minutes**.

For additional usage flags, please see: http://brainsuite.org/processing/svreg/usage/

Command Line BDP

The BrainSuite Diffusion Pipeline is run from the command line:

Mac (similar for Linux):

```
/Applications/BrainSuite15b/bdp/bdp.sh 2523412.bfc.nii.gz --tensor --odf --nii \
        2523412.dwi.nii.gz -g 2523412.dwi.bvec -b 2523412.dwi.bval
```

Windows:

```
"C:\Program Files\BrainSuite15b\bdp\bdp.exe" 2523412.bfc.nii.gz --tensor --odf --nii ^
        2523412.dwi.nii.gz -g 2523412.dwi.bvec -b 2523412.dwi.bval
```

n.b.: \ and ^ are line continuation characters for Mac/Linux and Windows, respectively.

- These commands are included as demo scripts in the DWI folder.
- Approximate run time on a 3.5GHz i7-3770k is **22 minutes**.

For additional command line options, please see:
http://brainsuite.org/processing/diffusion/flags/

Command Line Thickness

Cortical Surface Thickness is run from the command line:

Mac (similar for Linux):

```
/Applications/BrainSuite15b/svreg/bin/thicknessPVC.sh 2523412
```

Windows:

```
"C:\Program Files\BrainSuite15b\svreg\bin\thicknessPVC.exe" 2523412
```

- These commands are included as demo scripts in the extraction folder.
- Approximate run time on an i7-3770k is **20 minutes**.

BrainSuite Keyboard Shortcuts

Main Window	
Ctrl Key Combos	**Action**
Ctrl + A	Autoscale images
Ctrl + B	Show previous surface (back)
Ctrl + F	Show next surface (forward)
Ctrl + G	Toggle Debug Keys
Ctrl + L [upper case L]	Toggle ROI Labels
Ctrl + l [lower case L]	Toggle ROI Label Outlines
Ctrl + R	Toggle first overlay volume on/off
Ctrl + M [case sensitive]	Cycle mask mode
Ctrl + m [case sensitive]	Toggle Mask on/off
Ctrl + S	Toggle show surfaces
Ctrl + V	Toggle show volume slices in 3D view
Ctrl + X	Toggle show cursors
Ctrl + Z	Undo last paint action

Note that on a Mac you use the ⌘ key instead of Ctrl http://brainsuite.org/keyboard-shortcuts/

BrainSuite Keyboard Shortcuts

Surface Display	
Key	**Action**
L	Toggle lighting for 3D view
G	Toggle tensor glyphs on/off
O	Toggle ODF glyphs on/off
F	Toggle fibers on/off
W	Toggle wire frame mode for surfaces
X	Cycle X-plane clipping (off, positive, negative)
Y	Cycle Y-plane clipping (off, positive, negative)
Z	Cycle Z-plane clipping (off, positive, negative)
h [case sensitive]	Reset clipping mode and position

http://brainsuite.org/keyboard-shortcuts/

BrainSuite Keyboard Shortcuts

Toolboxes	
Key	**Action**
I	Show Image Display Toolbox
S	Show Surface Display Toolbox
M	Show masking tool (Delineation Toolbox)
P	Show painter tool (Delineation Toolbox)
C	Show Curve Toolbox
D	Show Diffusion Toolbox

http://brainsuite.org/keyboard-shortcuts/

BrainSuite Keyboard Shortcuts

Image Display	
Key	**Action**
+	Zoom In
-	Zoom Out
*	Zoom Best Fit
/	Zoom to 1:1 (in smallest pixel dimension)

http://brainsuite.org/keyboard-shortcuts/

BrainSuite Keyboard Shortcuts

Connectivity Viewer	
Key	**Action**
1	Show Connectivity for Cortical Areas
2	Show Connectivity for Frontal Lobe
3	Show Connectivity for Parietal Lobe
4	Show Connectivity for Temporal Lobe
5	Show Connectivity for Occipital Lobe
6	Show Connectivity for Subcortical Areas
7	Show Connectivity for Brain Areas
8	Show Connectivity for All Labeled Regions (includes white matter, ventricles, etc).

http://brainsuite.org/keyboard-shortcuts/

BrainSuite Keyboard Shortcuts

Orthogonal Views	
Alt Key Combos	**Action**
Alt + 1	Rotate 3D view to xy view (axial, from superior)
Alt + 2	Rotate 3D view to xy view (axial, from inferior)
Alt + 3	Rotate 3D view to xz view (coronal, from posterior
Alt + 4	Rotate 3D view to xz view (coronal, from anterior)
Alt + 5	Rotate 3D view to yz view (sagittal, from right)
Alt + 6	Rotate 3D view to yz view (sagittal, from left)

http://brainsuite.org/keyboard-shortcuts/