

# Fiber Bundle Volume Measurement

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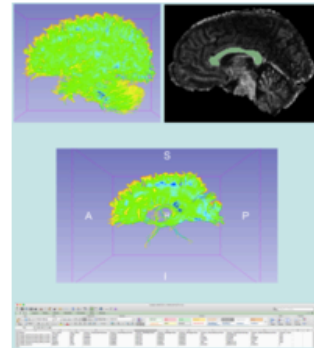
# Pre-requisite

- This tutorial is a follow-up tutorial of the “Fiber Bundle Selection And Scalar Measurement” by Fan Zhang, PhD. Please go through this ahead, which is available at:

<https://github.com/SlicerDMRI/slicerdmri.github.io/blob/master/docs/tutorials/FiberBundleSelectionAndScalarMeasurement.pptx>

**Fiber Bundle Selection and Scalar Measurements** [edit]

- The [Fiber Bundle Selection and Scalar Measurements Tutorial](#) guides through the use of the Diffusion Bundle Selection module and the Fiber Tract Scalar Measurement module for diffusion MRI tractography data analysis.
- Author: Fan Zhang, University of Sydney Australia, Brigham and Women's Hospital
- Dataset: [Fiber Bundle Selection And Scalar Measurement Tutorial Dataset](#)



# Learning Objectives

The aim is to calculate the volume of the fiber bundle that passes through the Corpus Callosum(CC). Following this tutorial, you'll be able to:

1) Fiber bundle to label map:

convert fiber bundles to label map;

2) Fiber bundle volume measurements:

calculate volume measurements from the fiber bundles.



3DSlicer

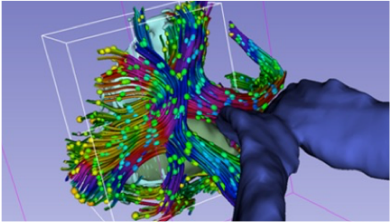
# 3D Slicer

The tutorial uses the 3DSlicer (Version 4.6.2 Stable Release) software available at

<http://download.slicer.org>

## *Disclaimer*

It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules. Slicer is a tool for research, and is not FDA approved.



# Slicer DMRI

An open-source project to improve and extend diffusion magnetic resonance imaging software in 3D Slicer:

<http://slicerdmri.github.io>

Please read the **Diffusion MRI Analysis** tutorial to install SlicerDMRI:

[https://github.com/SlicerDMRI/slicerdmri.github.io/blob/master/docs/tutorials/DiffusionMRI analysis.pdf](https://github.com/SlicerDMRI/slicerdmri.github.io/blob/master/docs/tutorials/DiffusionMRI%20analysis.pdf)

# Tutorial Data

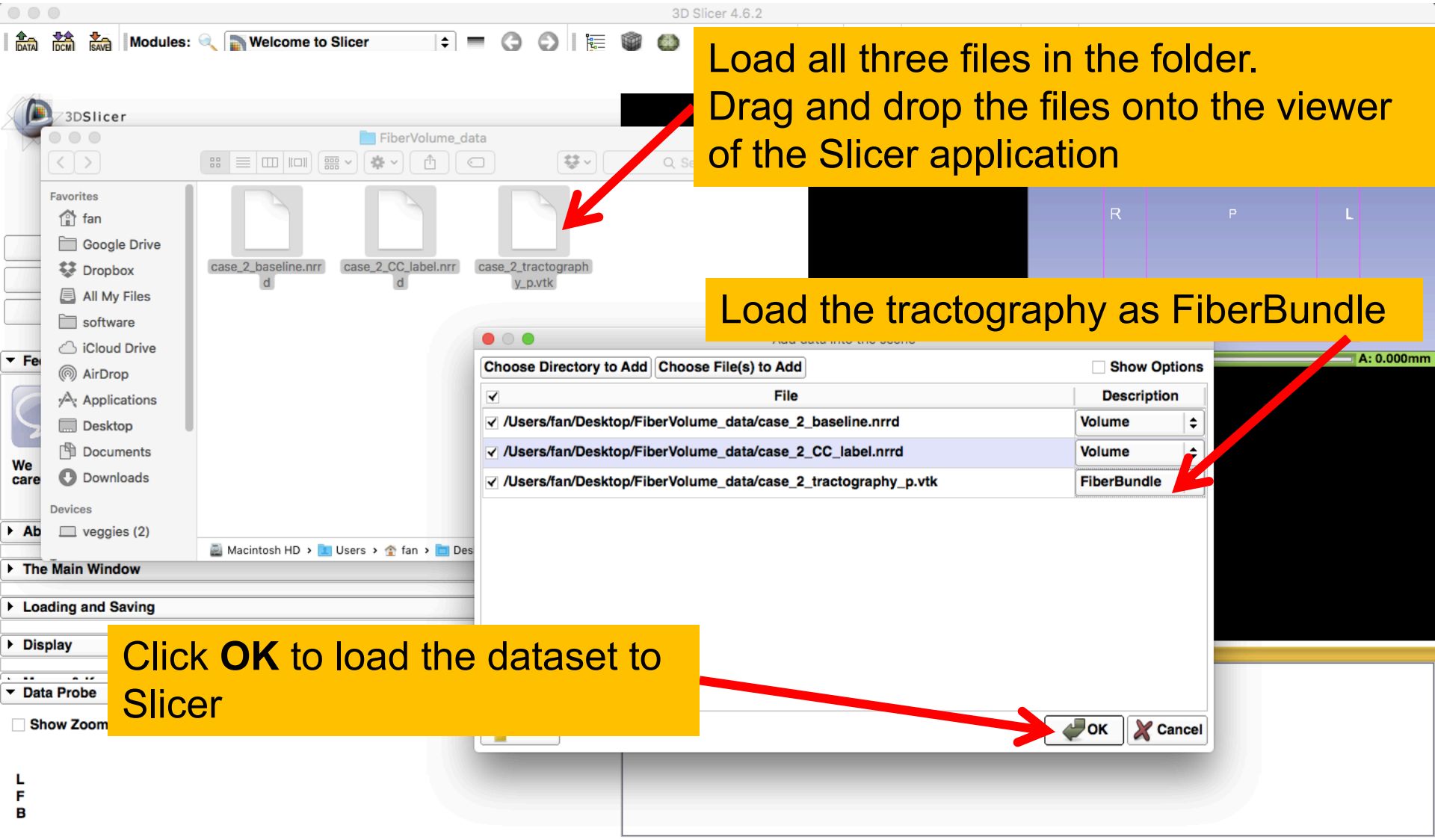
Download sample data, at

[http://www.na-mic.org/Wiki/images/4/4c/FiberVolume\\_data.zip](http://www.na-mic.org/Wiki/images/4/4c/FiberVolume_data.zip)

The following data are provided:

- Baseline image
- Down sampled whole brain tractography (conducted as in the DWI tutorial and down-sampled to about 10000 fibers using Tractography Display module)
- Corpus callosum label map (drawn as in the DWI tutorial)

# Load Data



Load all three files in the folder.  
Drag and drop the files onto the viewer  
of the Slicer application

Load the tractography as FiberBundle

Click **OK** to load the dataset to  
Slicer

# Tractography ROI Selection

The screenshot displays the 3D Slicer 4.6.2 software interface. The main window shows a brain scan with a purple bounding box labeled 'S' at the top, 'R' on the left, and 'L' on the right. A yellow text box with a red arrow points to the 'Tractography ROI Selection' option in the menu. The menu path is: Modules -> Diffusion -> Region-based -> Tractography ROI Selection. The interface also shows a 'Welcome to Slicer' sidebar on the left and a bottom panel with three axial brain slices.

3D Slicer 4.6.2

Modules: Welcome to Slicer

- All Modules
- Annotations
- Data
- DataStore
- DICOM
- Editor
- Markups
- Models
- Scene Views
- Segmentations
- Subject Hierarchy
- Transforms
- View Controllers
- Volume Rendering
- Volumes
- Welcome to Slicer
- Wizards
- Informatics
- Registration
- Segmentation
- Quantification
- Diffusion**
  - Diffusion Data Conversion
  - Diffusion Weighted Images
  - Process
  - Quantify
  - Tractography**
    - Tractography Display
    - Tractography Seeding
    - UKF Tractography
    - Region-based**
      - Tractography ROI Seeding**
      - Tractography ROI Selection**
  - Utilities
- Surface Models
- Endoscopy
- Utilities
- Developer Tools
- Legacy
- Filter
- MultiVolume Support

- About
- The Main Window
- Loading and Saving
- Display
- Mouse & Keyboard
- Data Probe

Click on the **Modules** menu, then select **Diffusion** -> **Tractography** -> **Region-based** -> **Tractography ROI Selection**

S: 0.000mm Y R: 1.500mm G A: 1.500mm

L: case\_2\_... (100%)  
B: case\_2\_baseline

L: case\_2\_... (100%)  
B: case\_2\_baseline

L: case\_2\_... (100%)  
B: case\_2\_baseline



# Single Label Selection

3D Slicer 4.6.2

Modules: Tractography ROI Selection

Tractography ROI Selection

Parameter set: Tractography ROI Selection

IO

Selection Region Label Map: case\_2\_CC\_label

Input Fiber Bundle: case\_2\_tractography\_p

Output Fiber Bundle: CC\_fiber

Tract selection region labels

Inclusion labels (comma-separated): 1

Inclusion label combination logic:  OR  AND

Exclusion labels (comma-separated):

Exclusion label combination logic:  OR  AND

Advanced Settings

Restore Defaults AutoRun

Status: Idle

Cancel Apply

Data Probe

Show Zoomed Slice

L  
F  
B

L: case\_2...(100%)  
B: case\_2\_baseline

L: case\_2...(100%)  
B: case\_2\_baseline

L: case\_2...(100%)  
B: case\_2\_baseline

A: 1.500mm

Click the button Apply

- Selection Region Label Map: **case\_2\_CC\_label**
- Input Fiber Bundle: **case\_2\_tractography\_p**
- Create and rename Output Fiber Bundle: **CC\_fiber**
- Inclusion labels: **1**

# Single Label Selection

The image shows the 3D Slicer 4.6.2 interface. The top toolbar contains various icons, with a red arrow pointing to the 'Models' icon. The left sidebar shows the 'Scene' panel with a tree view containing 'case\_2\_tractography\_p' and 'CC\_fiber'. A red arrow points to the 'Include Fibers' checkbox, which is checked. Another red arrow points to the 'CC\_fiber' entry. The main 3D view shows a brain with a fiber bundle highlighted in green and yellow, enclosed in a purple wireframe box. The bottom panel shows three axial brain slices with a green box highlighting the fiber bundle passing through the corpus callosum.

Select the module **Models**

Check **Include Fibers**

Check the visibility of **CC\_fiber** only

The fiber bundle from the whole brain tractography that passes through **Corpus Callosum(CC)** is displayed

# Fiber bundle to label map

3D Slicer 4.6.2

Modules: Models

3DSlicer

Help & Acknowled

Try the new [Segment Editor](#) module for more advanced editing! Please help us improve the module by giving [feedback](#).

Create and Select Label Maps

Master Volume: case\_2\_baseline

Merge Volume: Select a LabelMapVolume

Per-Structure Volumes

Edit Selected Label Map

Create a merge label map or a segmentation for selected master volume case\_2\_baseline. New volume will be case\_2\_baseline-label. Select the color table node that will be used for segmentation labels.

GenericAnatomyColors

OK Cancel

R: 1.500mm G A: 1.500mm

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

Show Zoomed Slice

L  
F  
B

Select the module **Editor**

The 'SlicerApp-real' window appears. Select the label map **GenericAnatomyColors** and click **OK**.

# Fiber bundle to label map

3D Slicer 4.6.2

Modules: Editor

3DSlicer

Help & Acknowledgement

Try the new [Segment Editor](#) module for more advanced editing! Please help us improve the module by giving [feedback](#).

Create and Select Label Maps

Master Volume: case\_2\_baseline

Merge Volume: case\_2\_baseline-label

Per-Structure Volumes

Undo/Redo: [Undo] [Redo]

Active Tool: DefaultTool

Label: tissue 1

Terminology

Data Probe

Show Zoomed Slice

L  
F  
B

S

Create and Select Label Maps:

- Master Volume: **case\_2\_baseline**
- Merge Volume: **case\_2\_baseline-label**

R S: 0.000mm Y R: 1.500mm G A: 1.500mm

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

# Fiber bundle to label map

The image shows the 3D Slicer 4.6.2 interface. The main window displays a brain slice with a fiber bundle visualization. A yellow text box with a black border contains the instruction: "Click on the **Modules** menu, then select **Diffusion** -> **Tractography** -> **Utilities**-> **Tractography to Mask Image**". A red arrow points from this text box to the "Tractography to Mask Image" option in the menu. The menu path is: **Modules** > **Diffusion** > **Utilities** > **Tractography to Mask Image**. The interface also shows a "Scene" panel with "case\_2\_tractography\_p" and "CC\_fiber" selected, and a "Data Probe" panel with "Show Zoomed Slice" checked. The bottom of the interface shows three brain slices with labels "L: case\_...100%" and "B: case\_...eline".

3D Slicer 4.6.2

Modules: Models

All Modules

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- Welcome to Slicer

Wizards

- Informatics
- Registration
- Segmentation
- Quantification

**Diffusion**

- IGT
- Filtering
- Converters
- Surface Models
- Endoscopy
- Utilities
- Developer Tools
- Legacy
- Filter
- MultiVolume Support

Diffusion Data Conversion

Diffusion Weighted Images

Process

Quantify

Tractography

**Utilities**

- DWI to Full Brain Tractography
- Resample DTI Volume
- Resample Scalar/Vector/DWI Volume
- Tractography to Mask Image**

Click on the **Modules** menu, then select **Diffusion** -> **Tractography** -> **Utilities**-> **Tractography to Mask Image**

case\_2\_tractography\_p

CC\_fiber

1.00

1.00

S

P

L

A

R

S: 0.000mm

Y

R: 1.500mm

G

A: 1.500mm

L: case\_...100%)

B: case\_...eline

L: case\_...100%)

B: case\_...eline

L: case\_...100%)

B: case\_...eline

# Fiber bundle to label map

3D Slicer 4.6.2

Modules: Tractography to Mask Image

3DSlicer

Help & Acknowledgement

Parameters

Fiber Bundle: CC\_fiber

Target LabelMap: case\_2\_baseline-label

Label Value: 15

Apply

Advanced

Click the button **Apply**

Set the Parameters:

- Fiber Bundle: **CC\_fiber**
- Target LabelMap: **case\_2\_baseline-label**
- Label Value: 15

R: 0.000mm Y: R: 1.500mm G: A: 1.500mm

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline



# Fiber bundle to label map

3D Slicer 4.6.2

Modules: Tractography to Mask Image

3DSlicer

Help & Acknowledgement

Parameters

Fiber Bundle: CC\_fiber

Target LabelMap: case\_2\_baseline-label

Label Value: 15

Apply

Advanced

Data Probe

Show Zoomed Slice

L  
F  
B

The fiber bundle that passes through **Corpus Callosum(CC)** to label map is displayed

S  
P  
L  
A  
I

R: 0.000mm Y: R: 1.500mm G: A: 1.500mm

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

# Fiber bundle volume measurements

3D Slicer 4.6.2

Modules: Tractography to Mask Image

All Modules

- Annotations
- Data
- DataStore
- DICOM
- Editor
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- Segmentations
- Subject Hierarchy
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- View Controllers
- Volume Rendering
- Volumes
- Welcome to Slicer

Wizards

- Informatics
- Registration
- Segmentation
- Quantification**
- Diffusion
- IGT
- Filtering
- Converters
- Surface Models
- Endoscopy
- Utilities
- Developer Tools
- Legacy
- Filter
- MultiVolume Support

Quantification

- DataProbe
- Label Statistics**
- Label Statistics (BRAINS)
- PET Standard Uptake Value Computation

Click on the **Modules** menu, then select **Quantification** > **Label Statistics**

Fiber Bundle: CC\_fiber  
Target LabelMap: case\_2\_baseline  
Label Value: 15

Advanced

Show Zoomed Slice

L  
F  
B

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline



# Fiber bundle volume measurements

3D Slicer 4.6.2

Modules: Label Statistics

Grayscale Volume: case\_2\_baseline

Label Map: case\_2\_baseline-label

Apply

Chart Count Ignore Zero

▼ Data Probe

Show Zoomed Slice

L  
F  
B

S

Set the Parameters:

- Grayscale Volume: **case\_2\_baseline**
- Label Map: **case\_2\_baseline-label**

Click the button Apply

R S: 0.000mm Y R: 1.500mm G A: 1.500mm

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

L: case\_...100%)  
B: case\_...eline

# Fiber bundle volume measurements

3D Slicer 4.6.2

Modules: Label Statistics

Grayscale Volume: case\_2\_baseline

Label Map: case\_2\_baseline-label

Type	Index	Count	Volume mm <sup>3</sup>	Volume cc	Min
background	0	1.50843...	5.09096e+06	5090.96	1
nerve	15	31663	106863	106.863	116

Export to table

Click the button **Export to table**

The Volume of the fiber bundle that passes through **Corpus Callosum(CC)** to label map is displayed

Type	Index	Count	Volume mm <sup>3</sup>	Volume cc	Min	Max	Mean	StdDev
background	0	1508433	5090961.375	5090.961375	1.0	4094.0	257.836712668	343.559924496
nerve	15	31663	106862.625	106.862625	116.0	2741.0	509.631083599	199.902570047

# Save the Results

3D Slicer 4.6.2

Modules: Label Statistics

Grayscale Volume: case\_2\_baseline

Label Map: case\_2\_baseline-label

Apply

Type	Index	Count	Volume mm <sup>3</sup>
background	0	1.50843...	5.09096e+06
nerve	15	31663	106863

Chart: Count

Export to table

Save Scene and Unsaved Data

File Name	File Format
<input type="checkbox"/> case_2_CC_label.nrrd	NRRD (.nrrd)
<input checked="" type="checkbox"/> case_2_tractography_p.vtk	Poly Data (.vtk)
<input checked="" type="checkbox"/> CC_fiber.vtk	Poly Data (.vtk)
<input checked="" type="checkbox"/> case_2_baseline-label.nrrd	NRRD (.nrrd)
<input checked="" type="checkbox"/> case_2_baseline-label statistics.tsv	Tab-separated values (.tsv)

Change directory for selected files

Save Cancel

Check the results obtained above

Type	Index	Count	Volume mm <sup>3</sup>	Volume c
background	0	1508433	5090961.375	5090.9613
nerve	15	31663	106862.625	106.862625

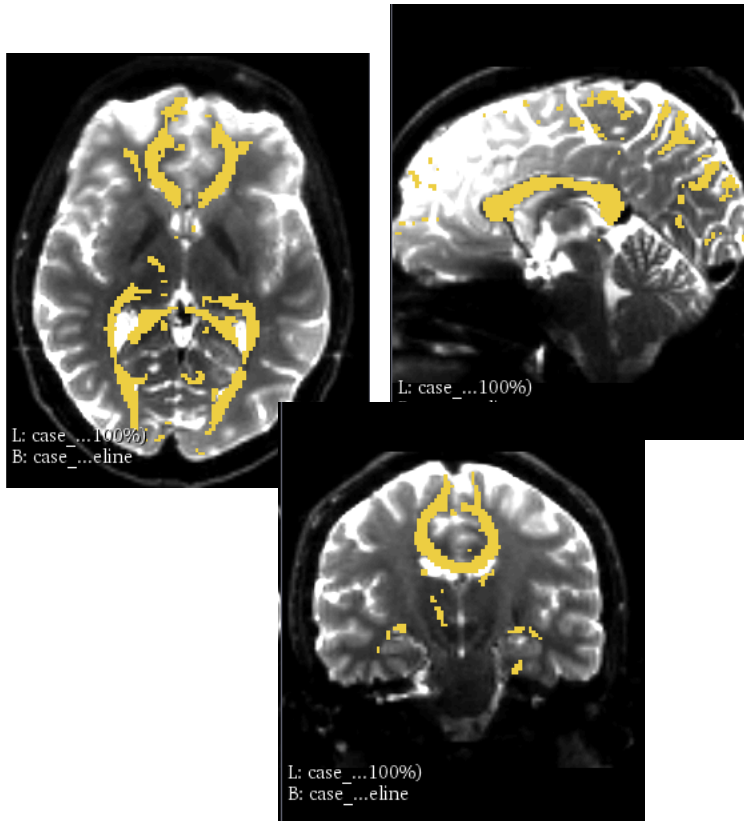
Click the button **SAVE**

Click **Change directory for selected files** and select a folder to store the results

Click the button **Save**

# Conclusion

This tutorial guided you through converting fiber bundle to label map and measuring fiber bundle volume for conducting further tractography processing.



	A	B	C	D	E	F	G	H	I
1 Type	Index	Count	Volume mm <sup>3</sup>	Volume cc	Min	Max	Mean	StdDev	
2 background	0	1508433	5090961.375	5090.961375	1.0	4094.0	257.836712668	343.559924496	
3 nerve	15	31663	106862.625	106.862625	116.0	2741.0	509.631083599	199.902570047	

# Acknowledgments

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**Neuroimage Analysis Center (NAC)**

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