



Diffusion MRI Analysis

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Brain Anatomy



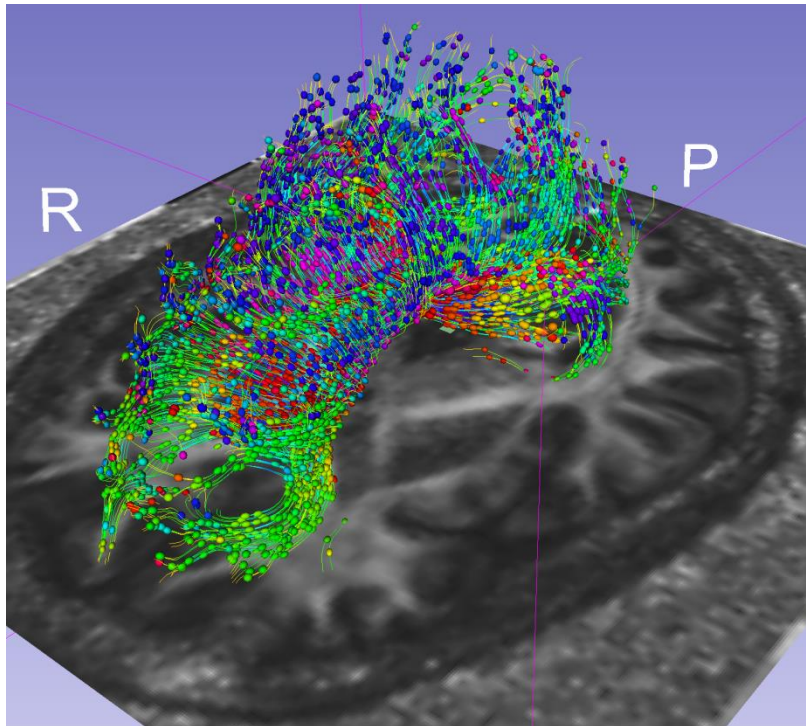
- White matter ~45% of the brain
- Myelinated nerve fibers (~ 10 μm axon diameter)

White Matter Exploration



Jules Joseph Dejerine
(*Anatomie des centres
nerveux* (Paris, 1890-1901):
Atlas of Neuroanatomy based
on myelin stained preparation

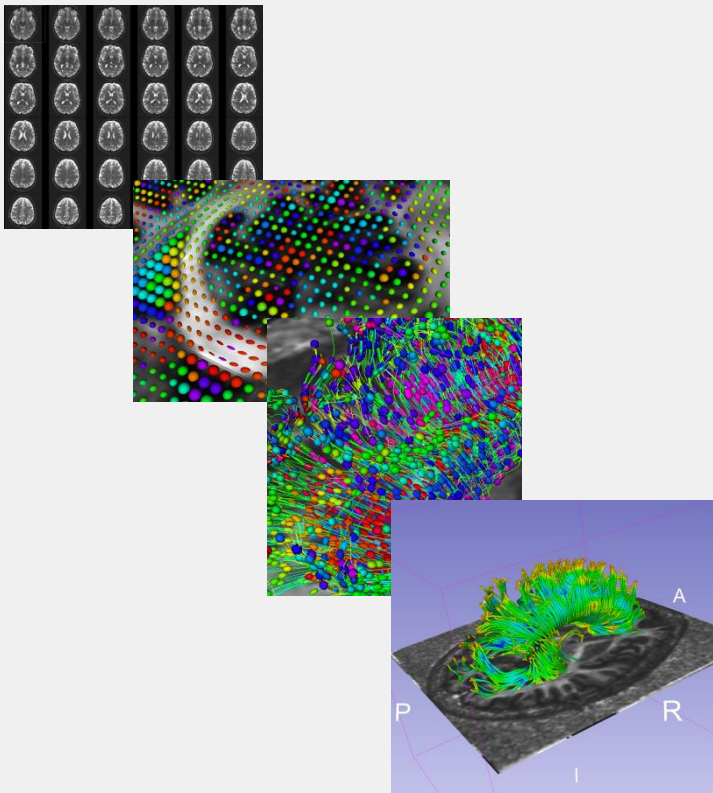
White Matter Exploration



First non-invasive window on the organization of brain white matter pathways *in-vivo*

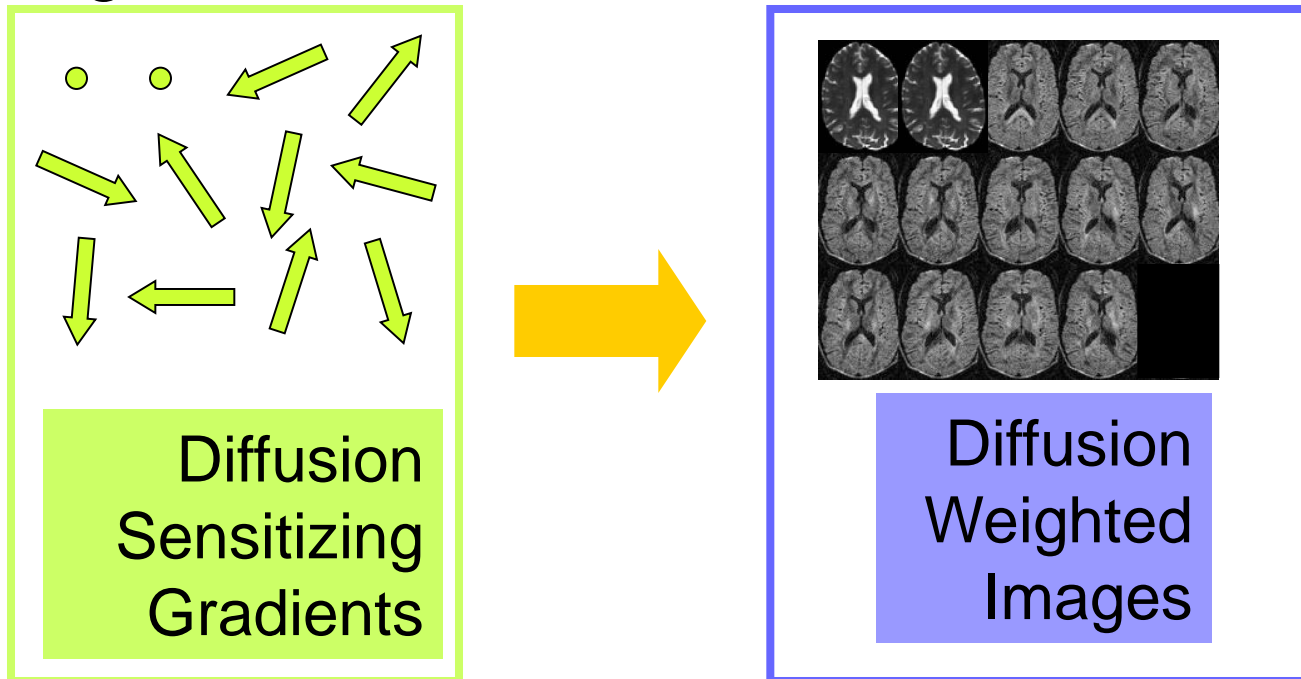
Tutorial Outline

This tutorial is an introduction to the fundamentals of Diffusion MRI analysis, from the estimation of diffusion tensors to the interactive 3D visualization of fiber tracts.



Tutorial Dataset

The tutorial dataset DiffusionMRI_tutorialData is a Diffusion Weighted MR scan of the brain acquired with 41 gradient directions and one baseline.



Tutorial Software

3DSlicer A multi-platform, **free and open source** software package for visualization and medical image computing

Download Tutorials Reference Feedback

Slicer Wiki

About Slicer

- ▶ Introduction
- ▶ Acknowledgments
- ▶ Contact Us

Resources

Download

- ▶ For Users
- ▶ For Developers
- ▶ Commercial Use
- ▶ NCIA
- ▶ Publication DB
- ▶ Image Gallery
- ▶ Slicer Community
- ▶ Source Code
- ▶ Licensing
- ▶ Mailing Lists
- ▶ Web Archive

Powerful processing.

Streamlined interface.

Extensible platform.

3D Slicer version 4.0

www.slicer.org

The community of Slicer developers is proud to announce the release of Slicer 4.0. Find out more...

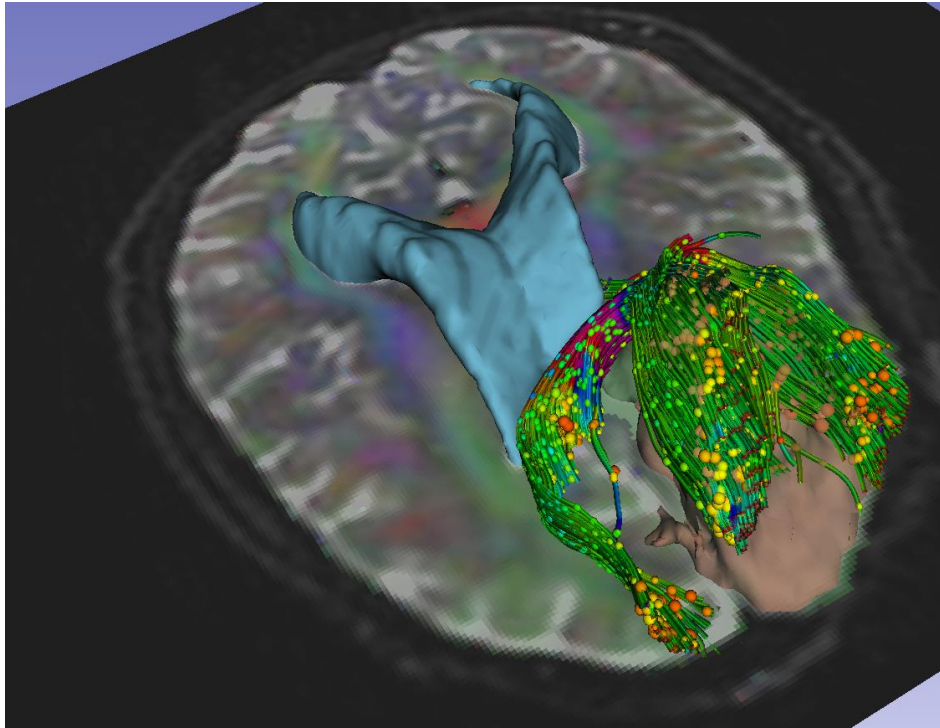
Content of this site is Copyright 2012 BWH and 3D Slicer contributors, unless otherwise noted.
Contact webmaster@bwh.harvard.edu for questions about the use of this site's content.
See [here](#) for more information about the web infrastructure.

The tutorial uses the 3DSlicer version 4.1 software available at www.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.

3DSlicer



3D Slicer is a multi-institution effort supported by the National Institutes of Health.

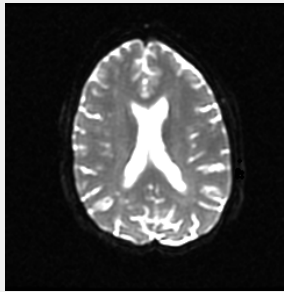
- An **end-user application** for image analysis
- An **open-source environment** for software development
- A software platform that is both **easy to use** for clinical researchers and **easy to extend** for programmers

Learning Objectives

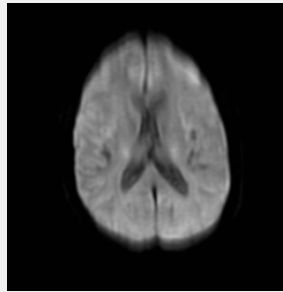
Following this tutorial, you'll be able to

- 1) Estimate a tensor volume from a set of Diffusion Weighted Images
- 2) Understand the shape and size of the diffusion ellipsoid
- 3) Reconstruct DTI tracts from a pre-defined region of interest
- 4) Interactively visualize DTI tracts seeded from a fiducial

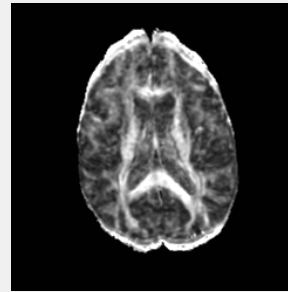
MR Diffusion Analysis Pipeline



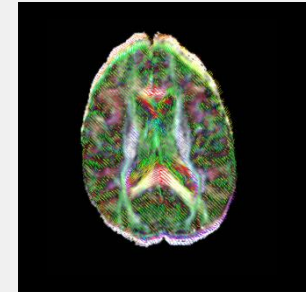
DWI
Acquisition



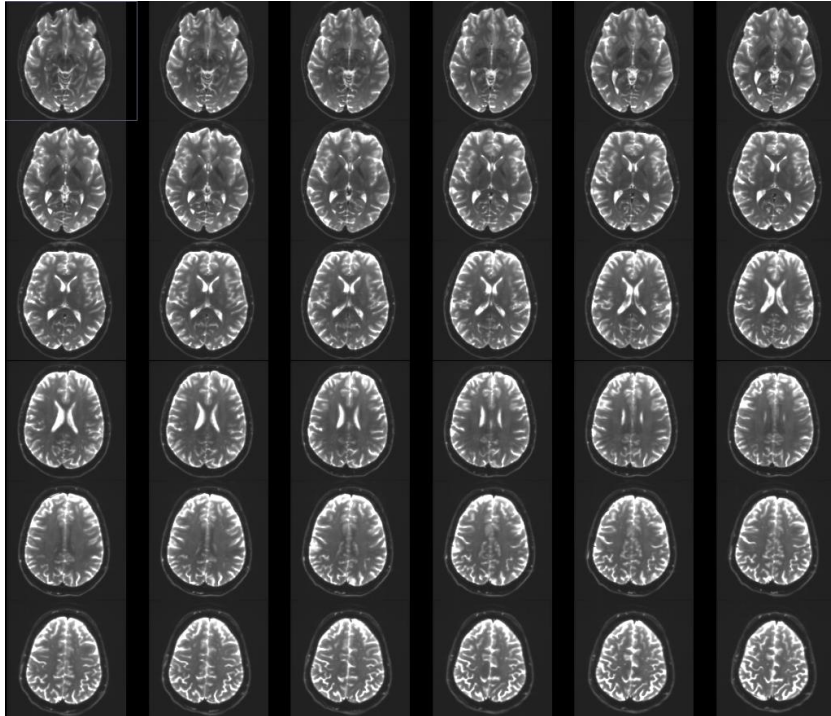
Tensor
Calculation



Scalar
Maps

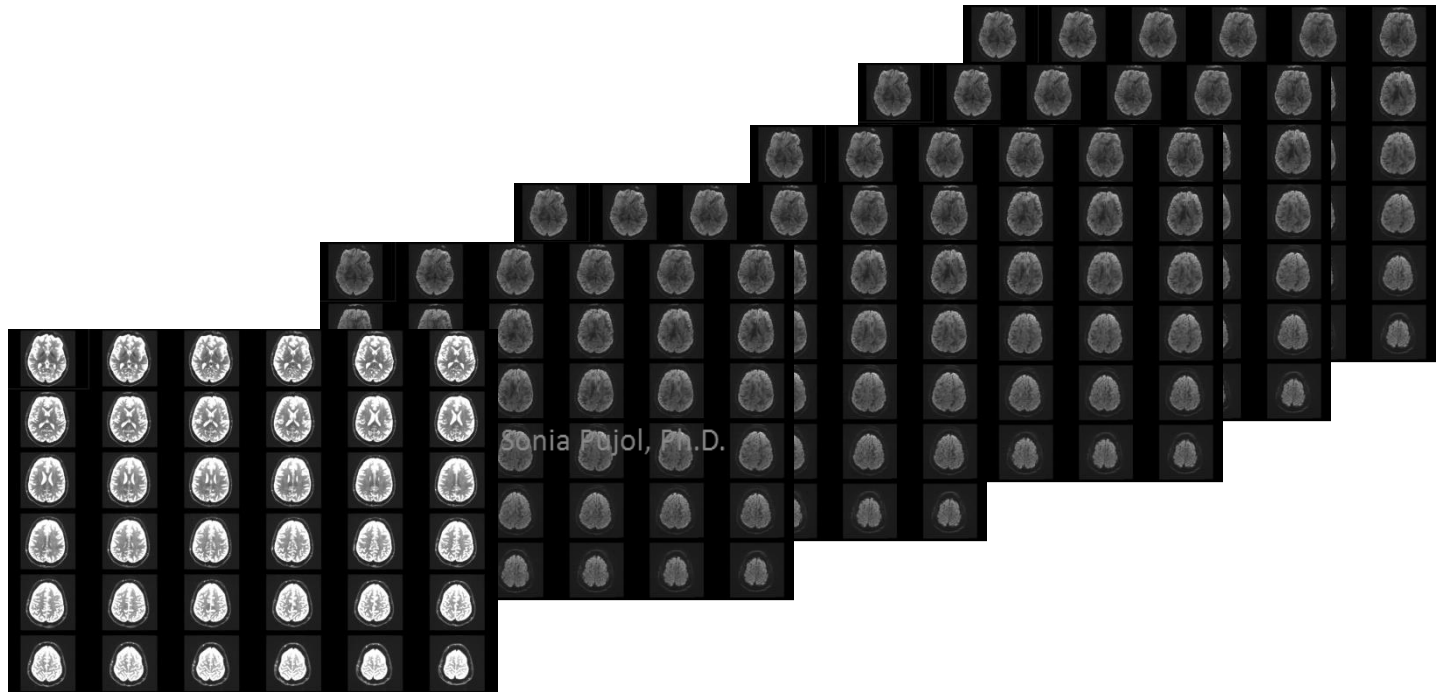


3D
Visualization



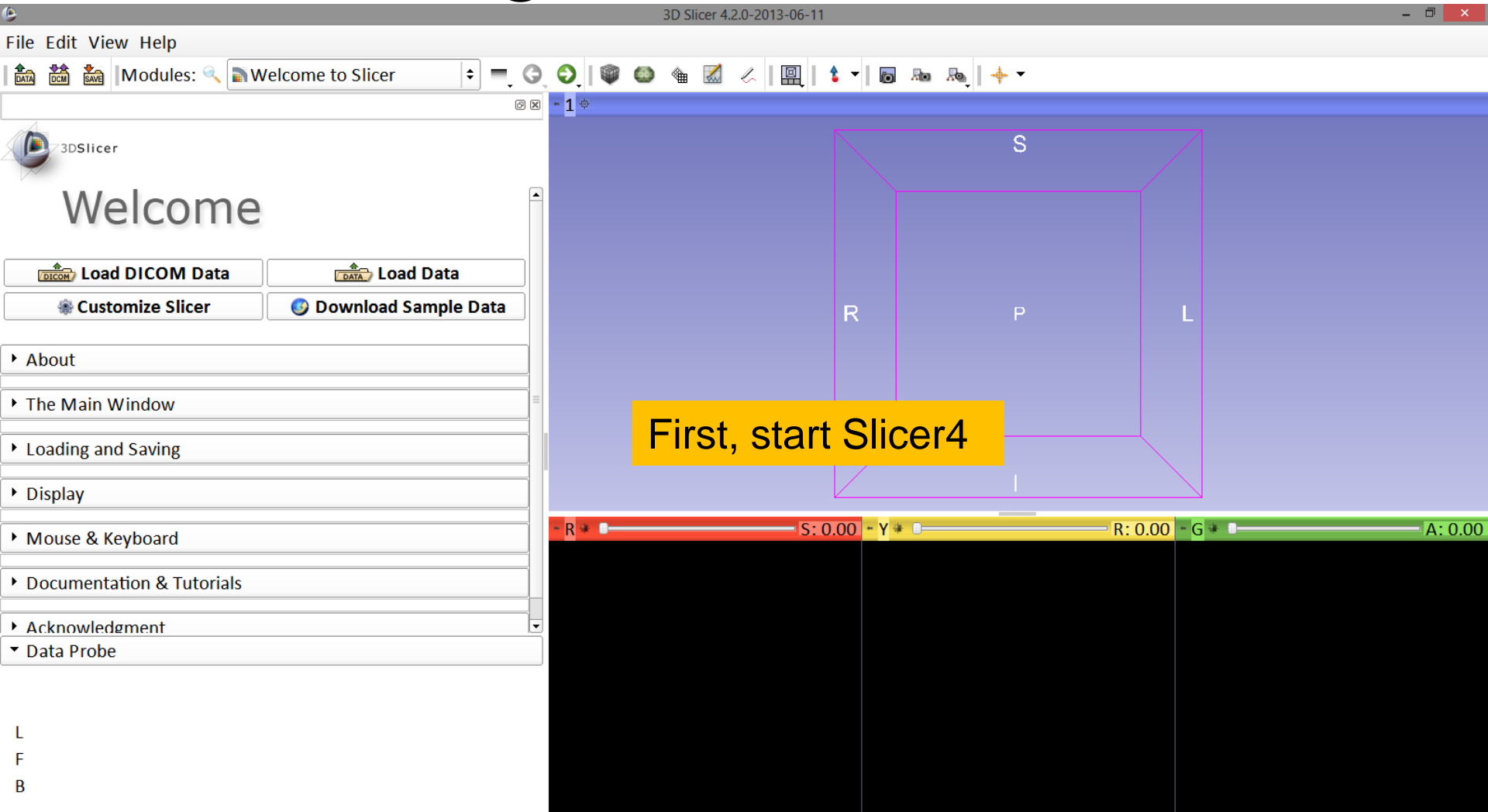
Part 1: From DWI images to Tensors

Understanding the DWI Dataset



The Diffusion Weighted Imaging (DWI) dataset is composed of 1 volume acquired without diffusion-sensitizing gradient, and 41 volumes acquired with 41 different diffusion-sensitizing gradient directions.

Loading the DWI Dataset



Loading the DWI Dataset

The screenshot shows the 3D Slicer 4.2.0-2013-07-27 interface. The main window displays a 'Welcome' message and a sidebar with navigation options. A file explorer window titled 'DiffusionMRI_tutorialData' is open, showing the path 'Libraries > Documents > Slicer4 > datasets > DiffusionMRI_tutorialData'. The file explorer displays two files:

Name	Date modified	Type	Size
dwi.nhdr	1/30/2012 3:52 PM	NHDR File	3 KB
dwi.raw.gz	1/30/2012 3:52 PM	GZ File	66,150 KB

A red arrow points to the 'dwi.nhdr' file. A yellow text box with black text is overlaid on the image, stating: 'In your files archive, locate the file **dwi.nhdr** in the dataset folder for this tutorial'.

L
F
B

Loading the DWI Dataset

The screenshot shows the 3D Slicer application interface. The top menu bar includes File, Edit, View, and Help. Below it is a toolbar with various icons. The left sidebar contains a 'Welcome' message and several buttons: 'Load DICOM Data', 'Customize Slicer', and a list of help topics including 'About', 'The Main Window', 'Loading and Saving', 'Display', 'Mouse & Keyboard', 'Documentation & Tutorials', 'Acknowledgment', and 'Data Probe'. The main window displays a file explorer for 'DiffusionMRI_tutorialData'. The file list shows two items: 'dwi.nhdr' (3 KB, NHDR File) and 'dwi.raw.gz' (66,150 KB, GZ File). A yellow callout box with a red arrow points to the file viewer area, containing the text: 'Drag and drop the file **dwi.nhdr** onto the viewer of the Slicer4 application'. The status bar at the bottom left shows 'L', 'F', and 'B'.

3D Slicer 4.2.0-2013-07-27

File Edit View Help

Modules: Welcome to Slicer

3DSlicer

Welcome

Load DICOM Data

Customize Slicer

About

The Main Window

Loading and Saving

Display

Mouse & Keyboard

Documentation & Tutorials

Acknowledgment

Data Probe

DiffusionMRI_tutorialData

File Home Share View

Libraries Documents Slicer4 datasets DiffusionMRI_tutorialData

Search DiffusionMRI_tutorialData

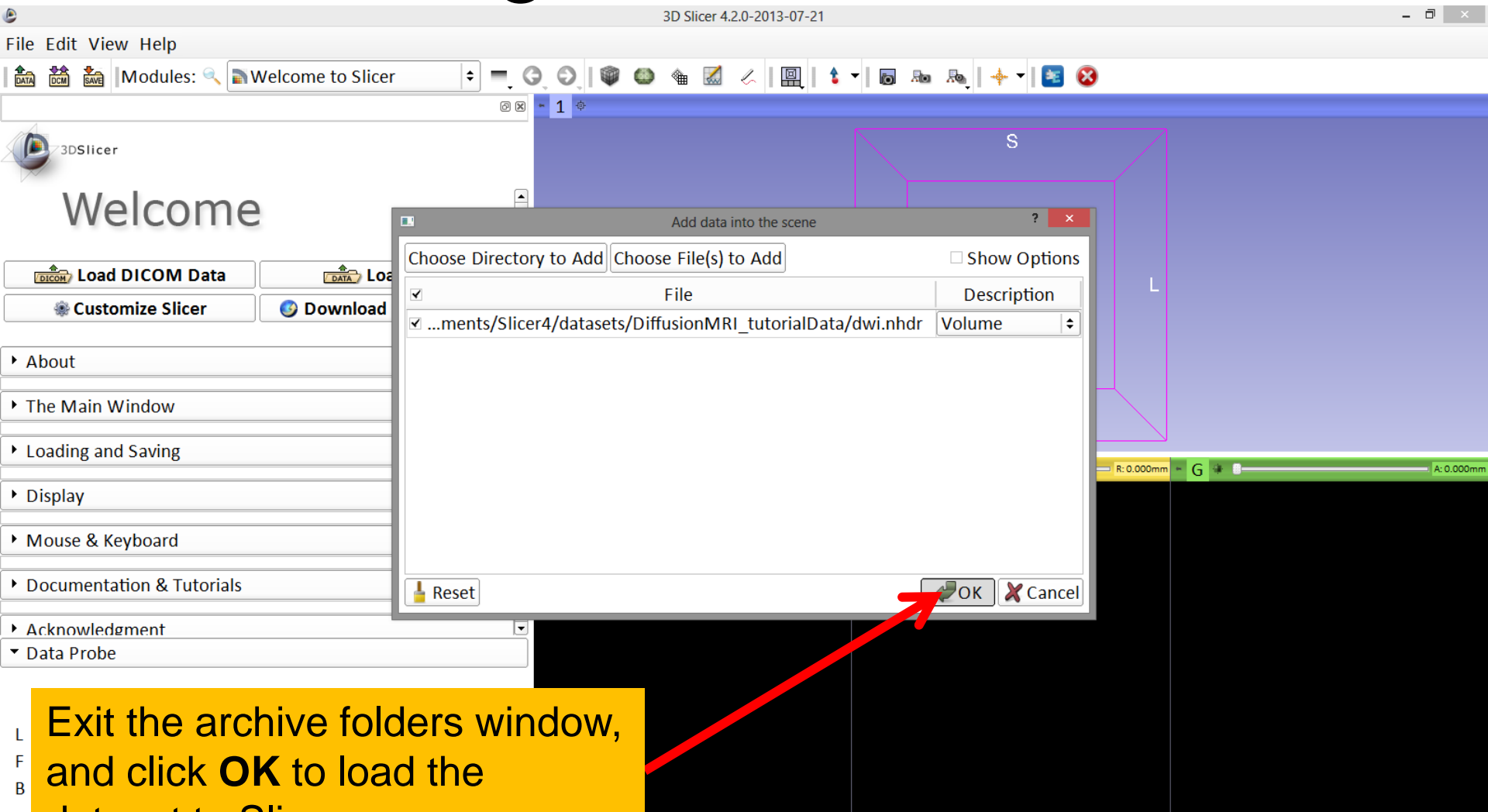
Name	Date modified	Type	Size
dwi.nhdr	1/30/2012 3:52 PM	NHDR File	3 KB
dwi.raw.gz	1/30/2012 3:52 PM	GZ File	66,150 KB

2 items 1 item selected 2.52 KB

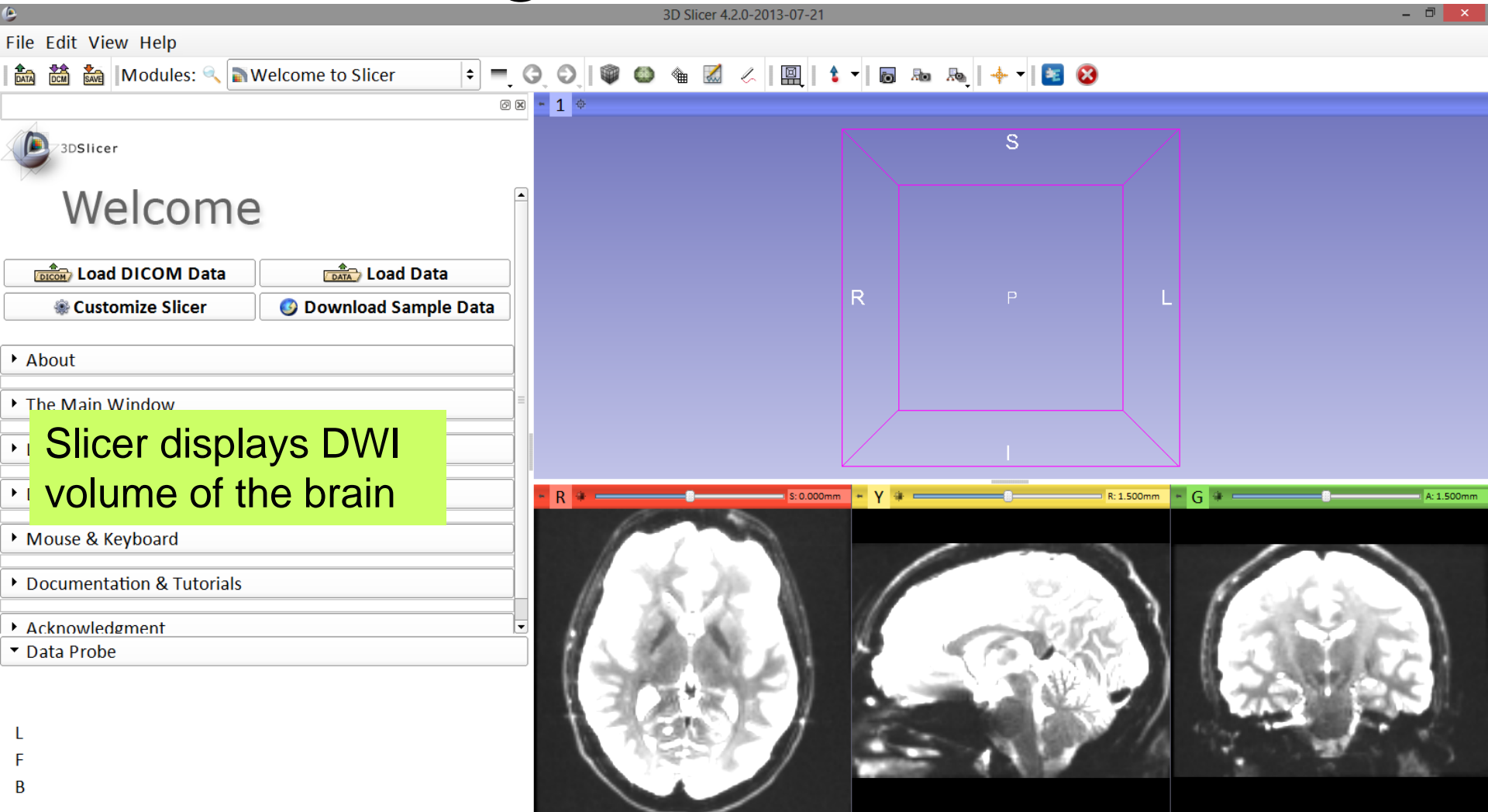
L
F
B

Drag and drop the file **dwi.nhdr** onto the viewer of the Slicer4 application

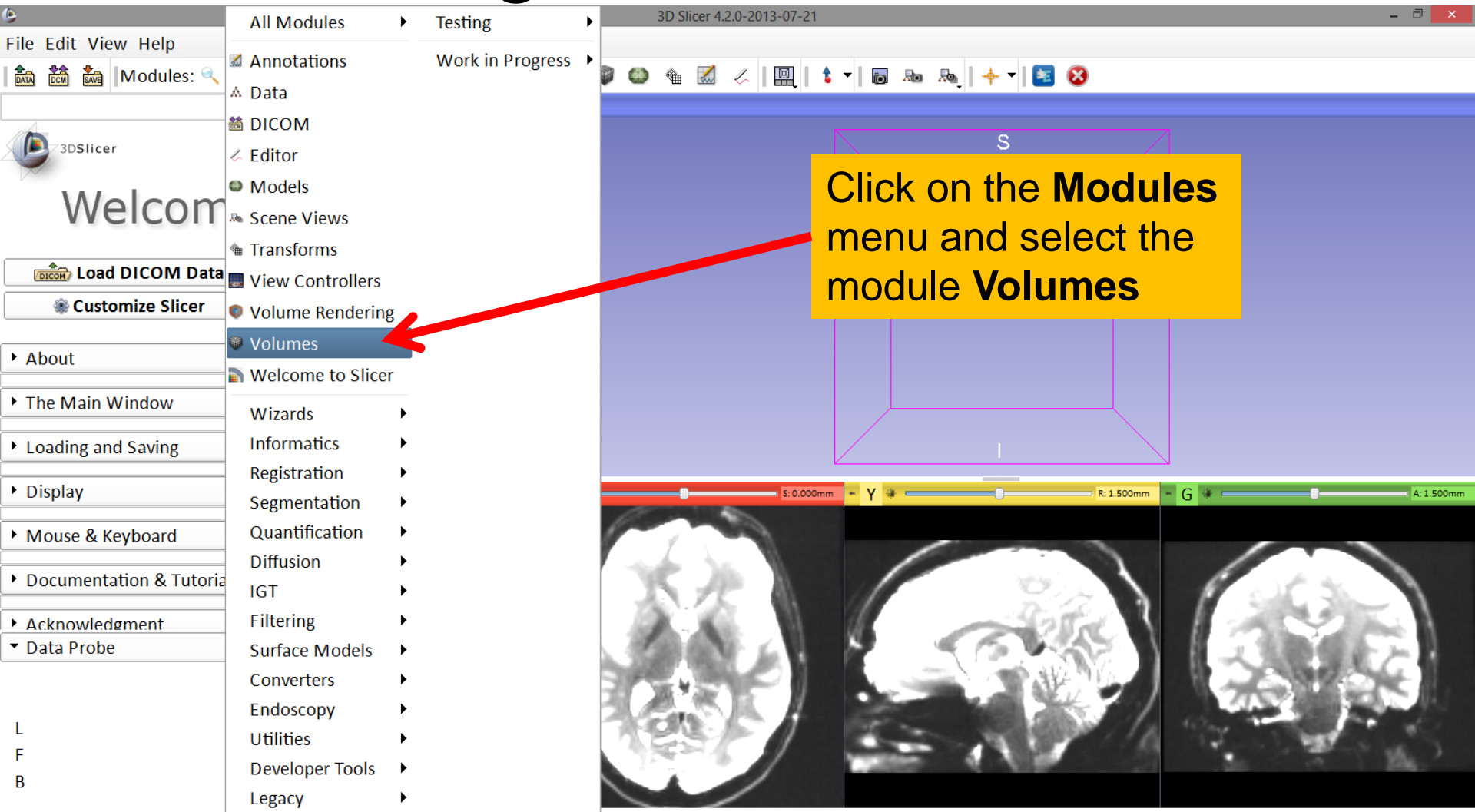
Loading the DWI Dataset



Loading the DWI Dataset



Loading the DWI Dataset



Loading the DWI Dataset

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Volumes

3DSlicer

Help & Acknowledgement

Active Volume: dwi

Volume Information

Display

Scalar Display

DWI Component: 10

LookUp Table: Grey

Interpolate:

Window Level editor presets:

W: 771 Manual W/L L: 454

Threshold: Off

Data Probe

L
F
B

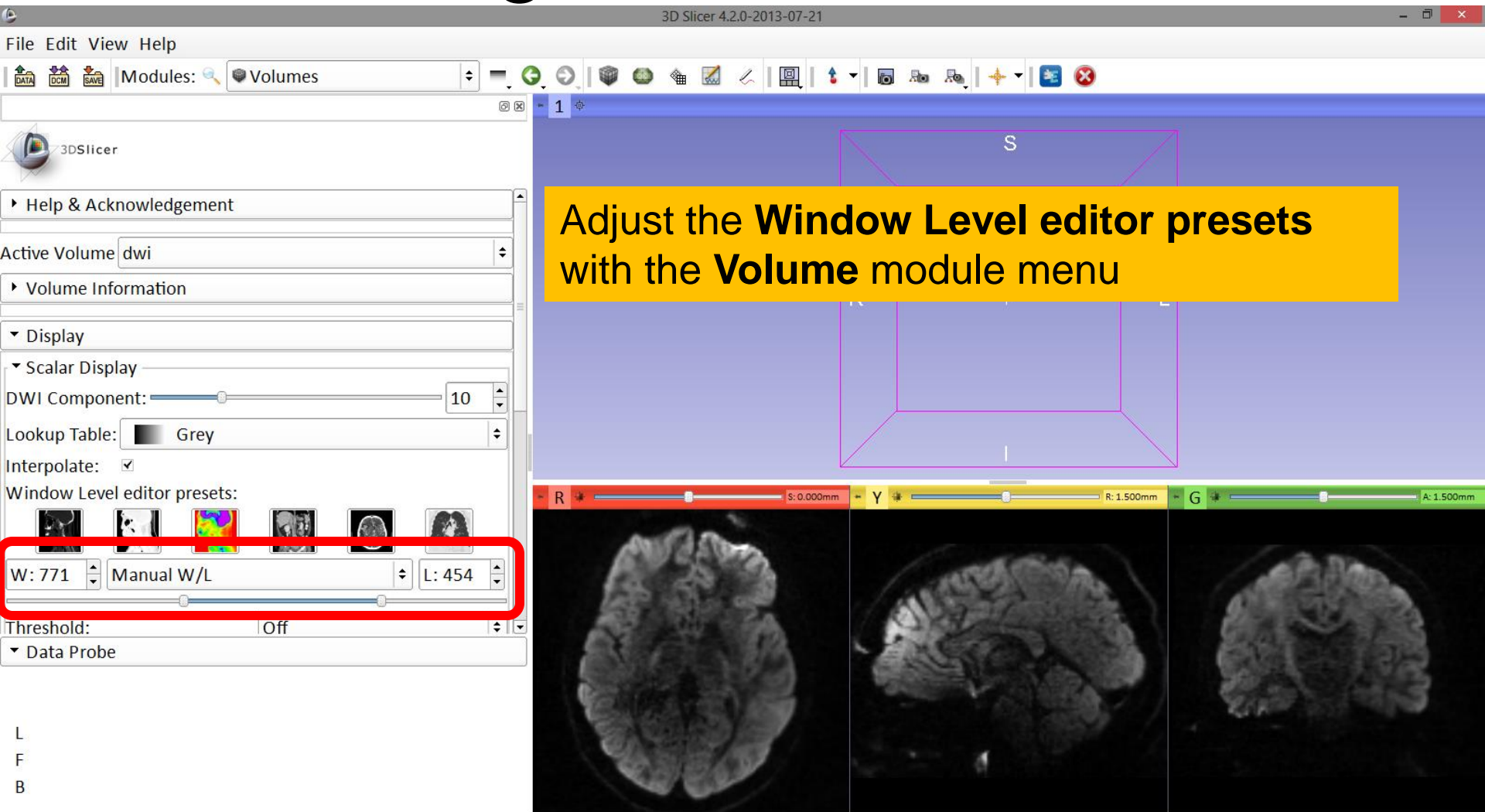
S

R

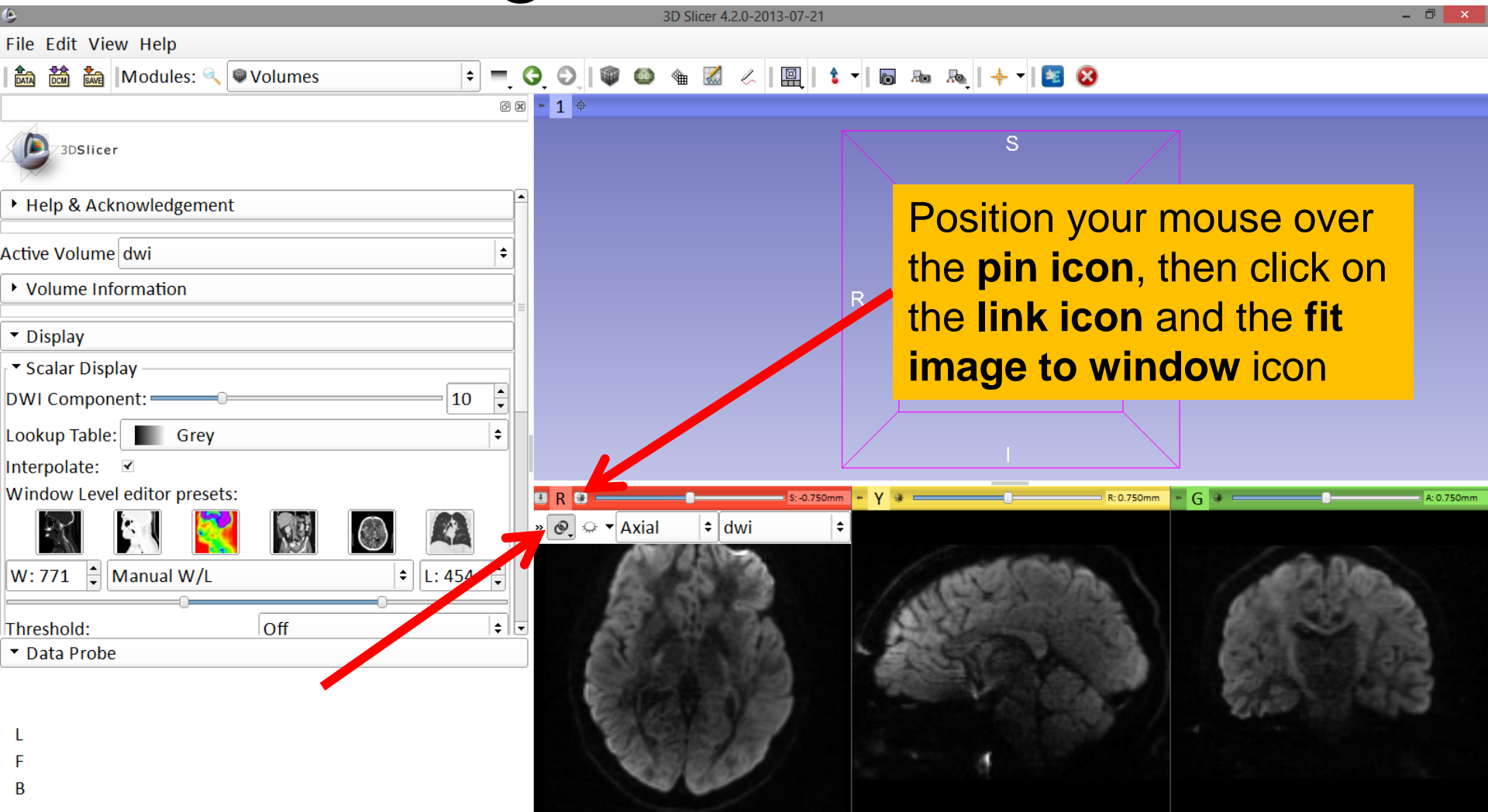
A: 1.500mm

The baseline image corresponds to the DWI Component #0. Select the **DWI Component #10**, which corresponds to the 10th diffusion sensitizing gradient

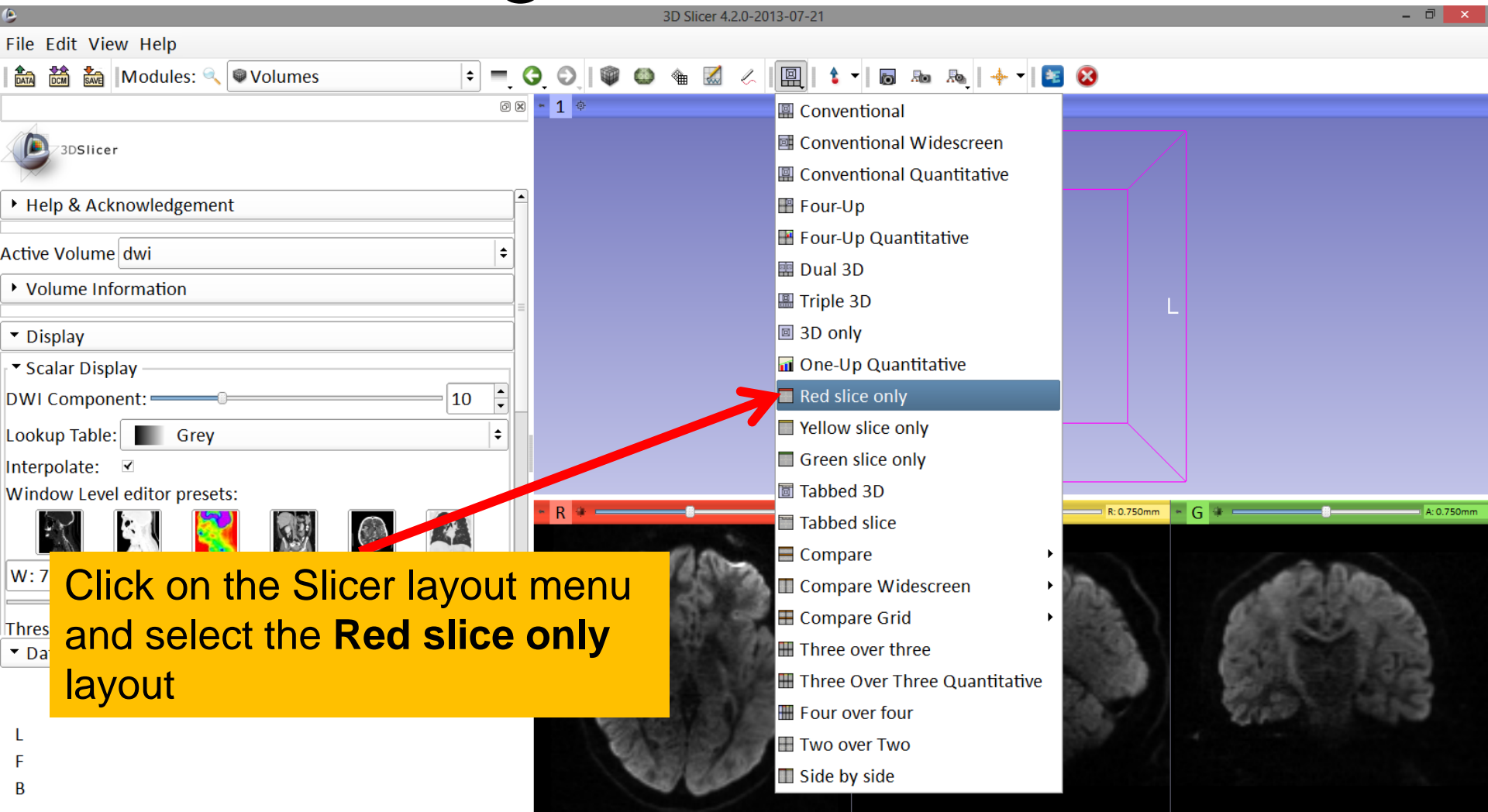
Loading the DWI Dataset



Loading the DWI Dataset



Loading the DWI Dataset



Click on the Slicer layout menu and select the **Red slice only** layout

Loading the DWI Dataset

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Volumes

3DSlicer

► Help & Acknowledgement

Active Volume dwi

► Volume Information

▼ Display

▼ Scaling

DWI C

Lookup

Interp

Window Level editor presets:

W: 771 Manual W/L L: 454

Threshold: Off

▼ Data Probe

Red RAS: (97.3, 35.7, -0.8) Axial Sp: 1.5

L None ()

F None ()

B dwi (-1, 40, 47) Out of Frame

Slicer displays only the Axial anatomical slice in the Viewer

R S: -0.750mm

Exploring the DWI Dataset

The image shows the 3D Slicer 4.2.0-2013-07-21 interface. The 'Modules' menu is open, showing a tree structure of categories. The 'Diffusion' category is expanded, and the 'DWI to DTI Estimation' option is highlighted. A yellow callout box with a red arrow points to this option. The background shows a brain MRI slice.

File Edit View Help

Modules:

- All Modules
 - Testing
 - Work in Progress
 - Annotations
 - Data
 - DICOM
 - Editor
 - Models
 - Scene Views
 - Transforms
 - View Controllers
 - Volume Rendering
 - Volumes
 - Welcome to Slicer
 - Wizards
 - Informatics
 - Registration
 - Segmentation
 - Quantification
 - Diffusion**
 - DWI to Full Brain Tractography
 - Tractography Display
 - Diffusion Data Conversion
 - Diffusion Tensor Images
 - Diffusion Weighted Images**
 - Diffusion Weighted Volume Masking
 - DWI Joint Rician LMMSF Filter
 - DWI Rician LMMSE Filter
 - DWI to DTI Estimation**
 - Resample Scalar/Vector/DWI Volume
 - Tractography
 - IGT
 - Filtering
 - Surface Models
 - Converters
 - Endoscopy
 - Utilities
 - Developer Tools
 - Legacy

3DSlicer

Help & Acknowledgements

Active Volume: dwi

Volume Information

Display

Scalar Display

DWI Component:

Lookup Table: Grey

Interpolate:

Window Level editor preset:

W: 771 Manual W/L

Threshold:

Data Probe

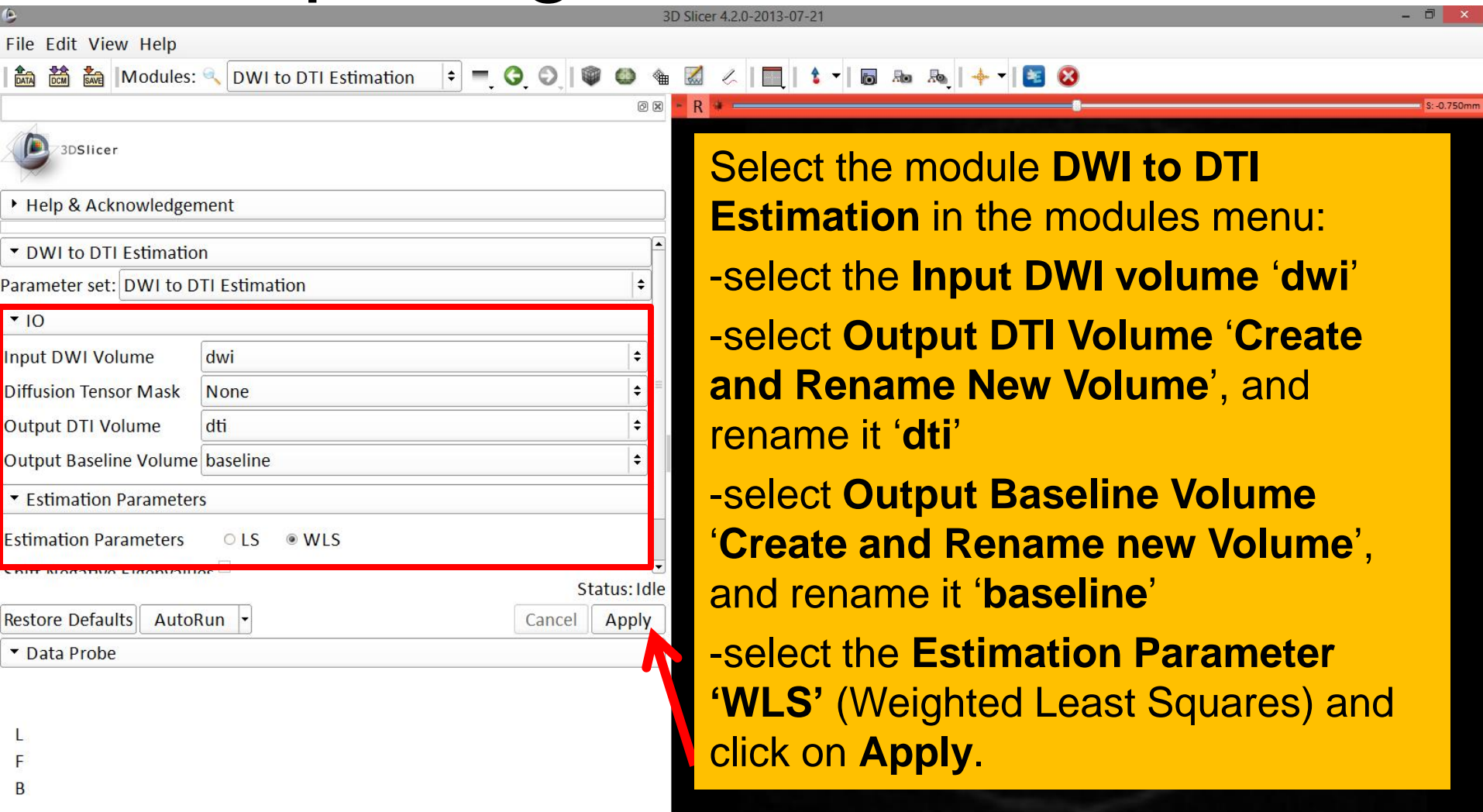
L
F
B

3D Slicer 4.2.0-2013-07-21

S: -0.750mm

Click on the Modules menu and select the module **DWI to DTI Estimation**

Exploring the DWI Dataset



3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: DWI to DTI Estimation

3DSlicer

Help & Acknowledgement

DWI to DTI Estimation

Parameter set: DWI to DTI Estimation

IO

Input DWI Volume: dwi

Diffusion Tensor Mask: None

Output DTI Volume: dti

Output Baseline Volume: baseline

Estimation Parameters

Estimation Parameters: LS WLS

Status: Idle

Restore Defaults AutoRun Cancel Apply

Data Probe

L
F
B

Select the module **DWI to DTI Estimation in the modules menu:**

- select the **Input DWI volume 'dwi'**
- select **Output DTI Volume 'Create and Rename New Volume'**, and rename it **'dti'**
- select **Output Baseline Volume 'Create and Rename new Volume'**, and rename it **'baseline'**
- select the **Estimation Parameter 'WLS'** (Weighted Least Squares) and click on **Apply**.

Exploring the DWI Dataset

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: DWI to DTI Estimation

None
dwi
dti
baseline
Rename current Volume

Position your mouse over the **pin icon** and select the volume **dti**

Input DWI Volume: dwi
Diffusion Tensor Mask: None
Output DTI Volume: dti
Output Baseline Volume: baseline

Status: Completed
100%

Restore Defaults AutoRun Cancel Apply

L
F
B

Exploring the DWI Dataset

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: DWI to DTI Estimation

3DSlicer

Help & Acknowledgement

DWI to DTI Estimation

Parameter set

IO

Input DWI Volume

Diffusion Tensor

Output DTI Volume

Output Base

Estimation Method

Estimation Parameters

Restored 100%

Restore Defaults AutoRun Cancel Apply

Data Probe

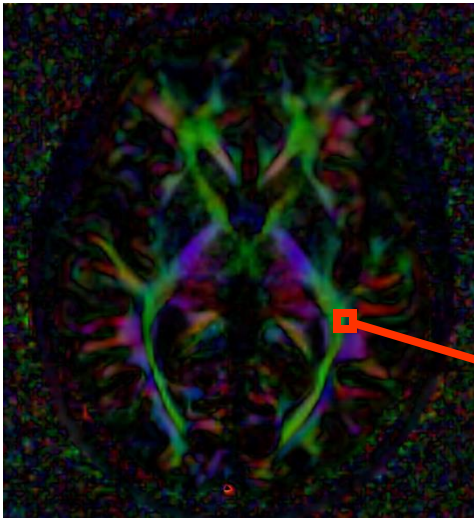
L
F
B

Slicer displays the DTI volume in color by orientation mode:
Red: right-left
Green: anterior-posterior
Blue: inferior-superior

R

S: 0.000mm

Diffusion Tensor Data



$$S_i = S_0 e^{-b \hat{g}_i^T \underline{D} \hat{g}_i}$$

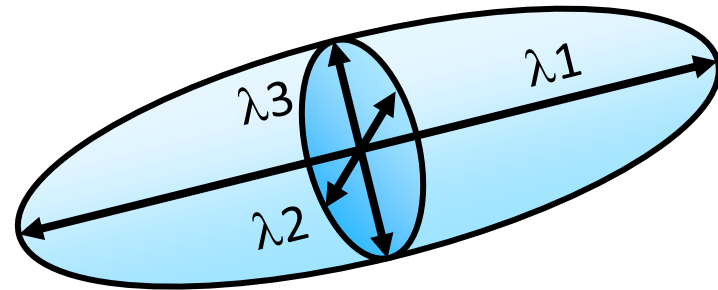
Stejskal-Tanner equation (1965)

$$\underline{\mathbf{D}} = \begin{bmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{zx} & D_{zy} & D_{zz} \end{bmatrix}$$

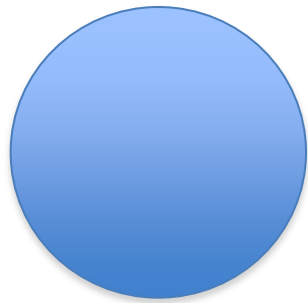
The diffusion tensor $\underline{\mathbf{D}}$ in the voxel (I,J,K) is a 3x3 symmetric matrix.

Diffusion Tensor

- The diffusion tensor \underline{D} in the voxel (I,J,K) can be visualized as an ellipsoid, with the eigenvectors indicating the directions of the principal axes, and the square root of the eigenvalues defining the ellipsoidal radii.
- Scalar maps can be derived from the rotationally invariant eigenvalues λ_1 , λ_2 , λ_3 to characterize the size and shape of the diffusion tensor.

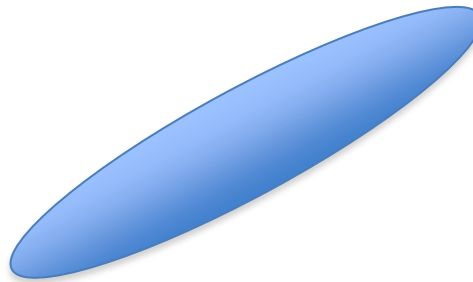


Diffusion Tensor Shape



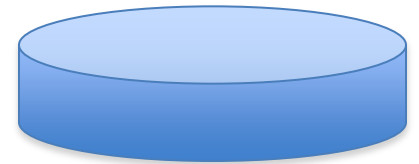
$$\lambda_1 = \lambda_2 = \lambda_3$$

Isotropic media
(CSF, gray matter)



$$\lambda_1 \gg \lambda_2, \lambda_3$$

Anisotropic media
(white matter)



$$\lambda_1 \sim \lambda_2 \gg \lambda_3$$

Exploring the DWI Dataset

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: DWI to DTI Estimation

3DSlicer

Help & Acknowledgement

DWI to DTI Estimation

Parameter set: DWI to DTI Estimation

IO

Input DWI Volume: dwi

Diffusion Tensor Mask: None

Output DTI Volume: dti

Output Baseline Volume: baseline

Estimation Parameters

Status: Completed

100%

Restore Defaults AutoRun Cancel Apply

Data Probe

Red RAS: (26.4, -3.6, 0.0) Axial Sp: 1.5

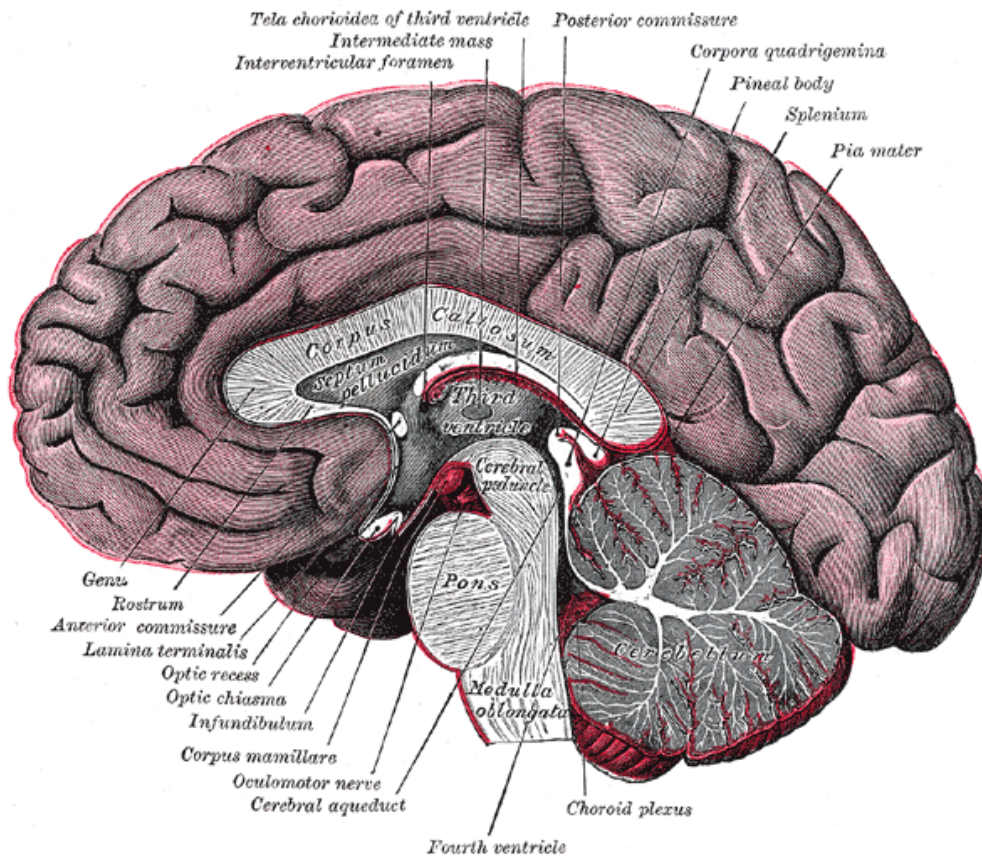
L None ()

F None ()

B dti (46, 66, 47) ColorOrientation 0

Use the slider to browse through the dti volume, and try to locate the **Corpus Callosum**

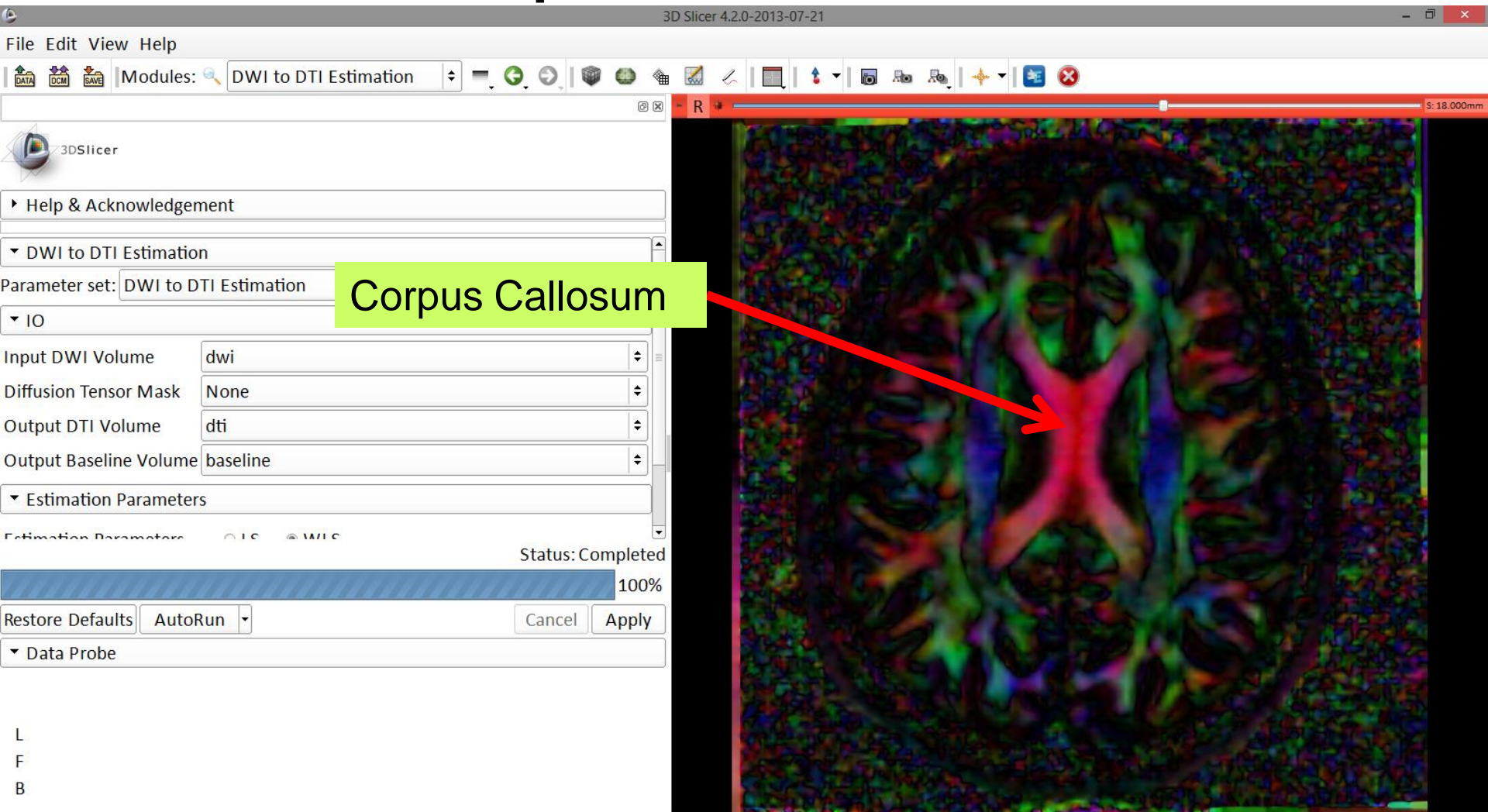
Corpus Callosum



The corpus callosum is a broad thick bundle of dense myelinated fibers that connect the left and right hemisphere. It is the largest white matter structure in the brain

Image from Gray's Anatomy

Corpus Callosum



Characterizing the Size of the tensor: Trace

$$\text{Trace}(D) = \lambda_1 + \lambda_2 + \lambda_3$$

- Trace(D) is intrinsic to the tissue and is independent of fiber orientation, and diffusion sensitizing gradient directions
- Trace(D) is a clinically relevant parameter for monitoring stroke and neurological condition (degree of structural coherence in tissue)
- Trace(D) is useful to characterize the size of the diffusion ellipsoid

Trace

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Annotations

Data

DICOM

Editor

Models

Scene Views

Transforms

View Controllers

Volume Rendering

Volumes

Welcome to Slicer

Wizards

Informatics

Registration

Segmentation

Quantification

Diffusion

- DWI to Full Brain Tractography
- Tractography Display
- Diffusion Data Conversion
- Diffusion Tensor Images**
- Diffusion Weighted Images
- Tractography

- Diffusion Tensor Scalar Measurements**
- Resample DTI Volume
- Tractography Interactive Seeding
- Tractography Label Map Seeding

Click on the Modules menu and select the module **Diffusion Tensor Scalar Measurements**

Input DWI Volume: dwi
Diffusion Tensor Mask: No
Output DTI Volume: dti
Output Baseline Volume: ba

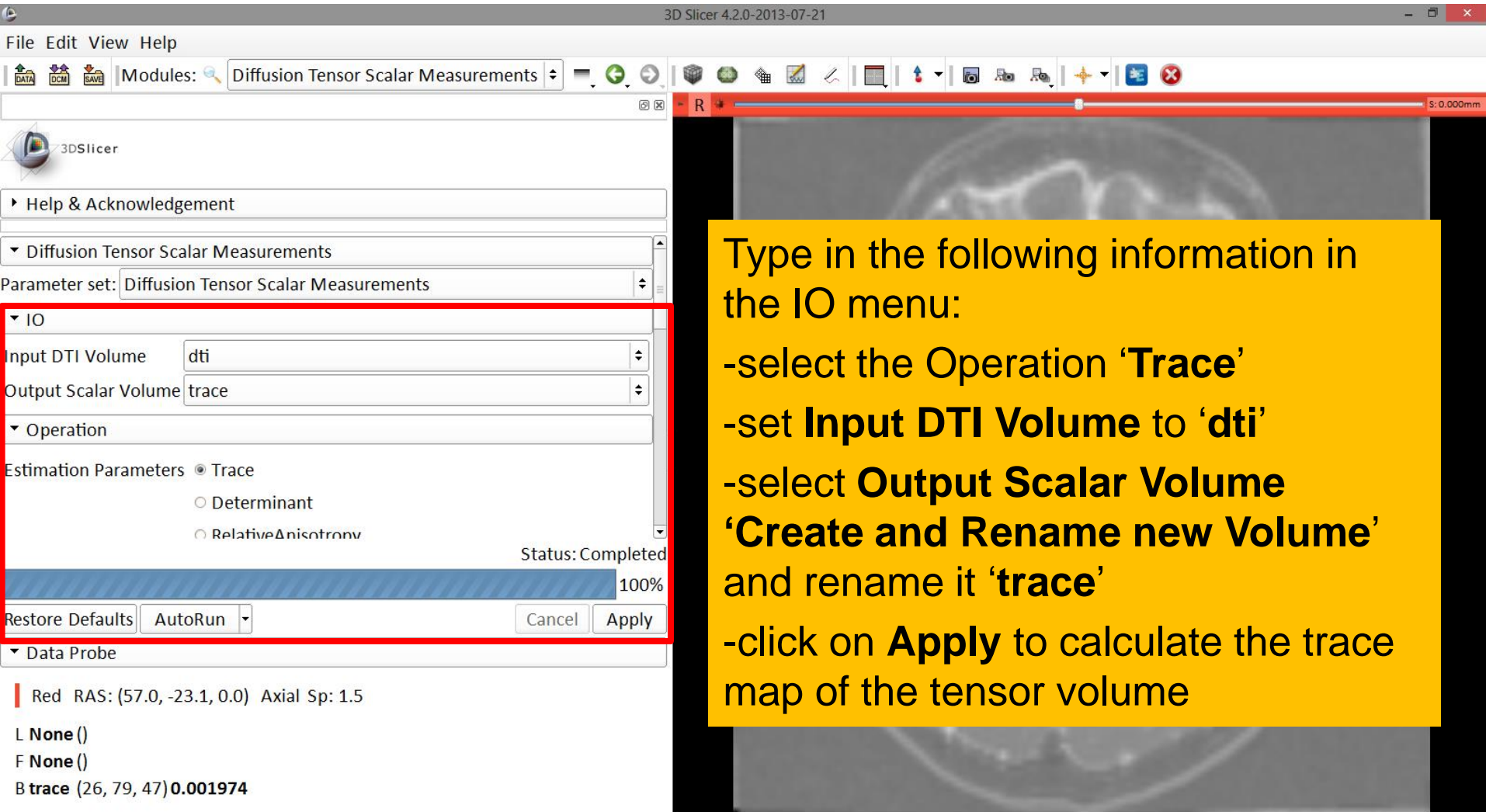
Estimation Parameters

Restore Defaults AutoRun

Data Probe

L
F
B

Trace



File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

3DSlicer

Help & Acknowledgement

Diffusion Tensor Scalar Measurements

Parameter set: Diffusion Tensor Scalar Measurements

IO

Input DTI Volume dti

Output Scalar Volume trace

Operation

Estimation Parameters

Trace

Determinant

Relative Anisotropy

Status: Completed

100%

Restore Defaults AutoRun Cancel Apply

Data Probe

Red RAS: (57.0, -23.1, 0.0) Axial Sp: 1.5

L None ()

F None ()

B trace (26, 79, 47) 0.001974

3D Slicer 4.2.0-2013-07-21

S: 0.000mm

Type in the following information in the IO menu:

- select the Operation **'Trace'**
- set **Input DTI Volume** to **'dti'**
- select **Output Scalar Volume** **'Create and Rename new Volume'** and rename it **'trace'**
- click on **Apply** to calculate the trace map of the tensor volume

Trace

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

3DSlicer

Help & Acknowledgement

Diffusion Tensor Scalar Measurements

Parameters

IO

Input Data

Output Scalar Volume: trace

Operation

Estimation Parameters

- Trace
- Determinant
- Relative Anisotropy

Status: Completed

100%

Restore Defaults AutoRun Cancel Apply

Data Probe

L
F
B

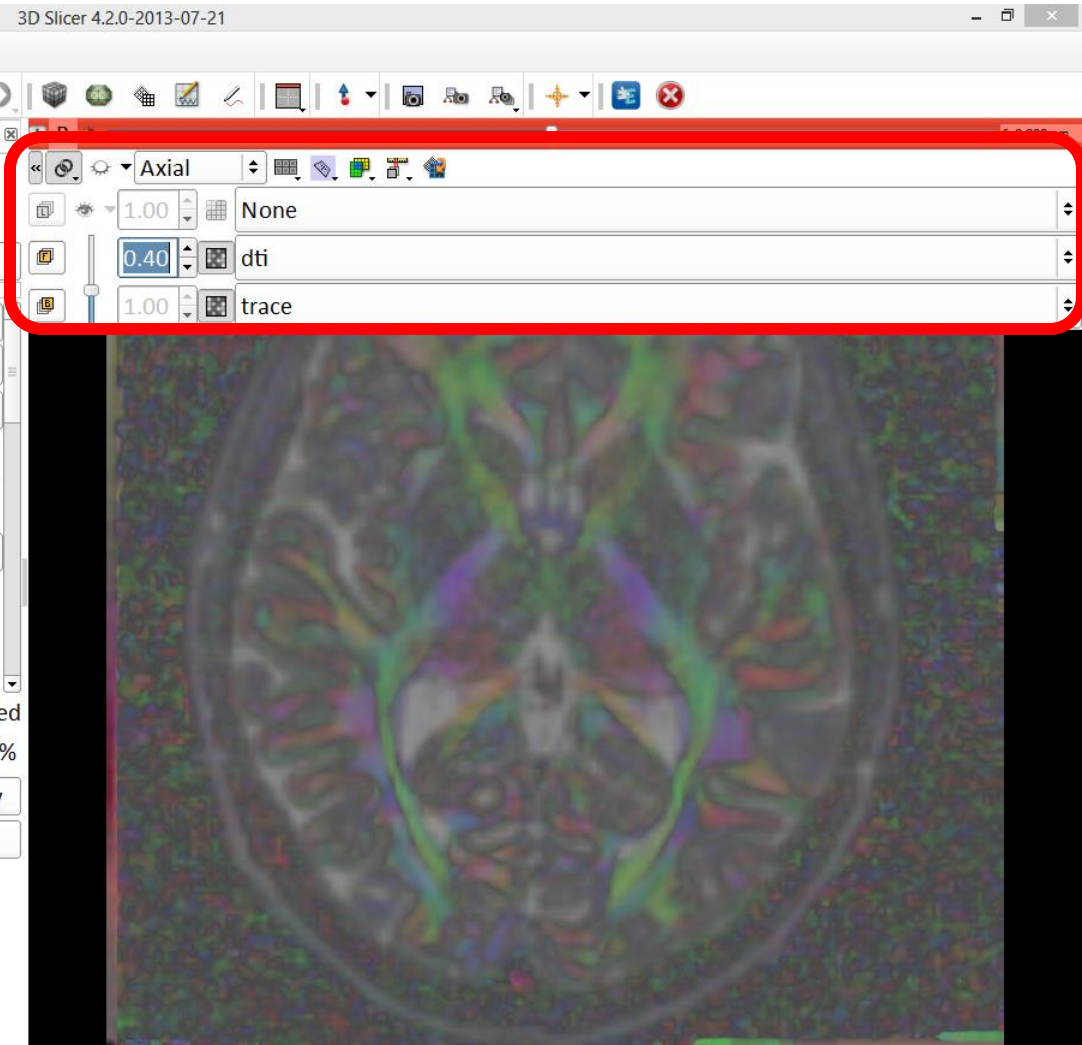
The trace image appears in the red viewer

Trace

Position your mouse over the **pin icon** and then select the '>>' icon to display this table and fill in the following information:

- Select the volume '**trace**' in the Background viewer
- Select the volume '**dti**' in the Foreground viewer

Set the **opacity** of the **dti** volume to **0.40**



Trace

Position your mouse within the region of the Corpus Callosum and observe the trace values in the **Data Probe**

The screenshot shows the 3D Slicer interface. The top menu bar includes File, Edit, View, and Help. The main window displays a brain MRI slice with a red arrow pointing to the Corpus Callosum. The left sidebar contains the Diffusion Tensor Scalar Measurements panel, which is currently set to 'Trace' estimation. A red box highlights the Data Probe section, which displays the following information:

Parameter set: Diffusion Tensor Scalar Measurements
IO
Input DTI Volume: dti
Output Scalar Volume: trace
Operation
Estimation Parameters: Trace, Determinant, Relative Anisotropy
Status: Completed
Progress: 100%
Data Probe:
Red RAS: (-2.1, 17.4, 18.0) Axial Sp: 1.5
L None ()
F dti (65, 52, 59) ColorOrientation 0
B trace (65, 52, 59) 0.001942




Trace

Note how the Trace values are fairly uniform in both white and gray matter, even if the tissues are different in structure.

Input DTI Volume: dti
Output Scalar Volume: trace
Operation: [Dropdown]
Estimation Parameters: Trace, Determinant, Relative Anisotropy
Status: Completed
Progress: 100%
Buttons: Restore Defaults, AutoRun, Cancel, Apply
Data Probe:
Red RAS: (17.4, -2.8, 18.0) Axial Sp: 1.5
L None ()
F dti (52, 66, 59) ColorOrientation 0
B trace (52, 66, 59) 0.008211

Scalar Maps: Fractional Anisotropy

$$FA(D) = \frac{\sqrt{(\lambda_1 - \lambda_2)^2 + (\lambda_1 - \lambda_3)^2 + (\lambda_2 - \lambda_3)^2}}{\sqrt{2}\sqrt{\lambda_1^2 + \lambda_2^2 + \lambda_3^2}}$$

- FA(D) is intrinsic to the tissue and is independent of fiber orientation, and diffusion sensitizing gradient directions
- FA(D) is useful to characterize the shape (degree of 'out-of-roundness') of the diffusion ellipsoid'
- Low FA:   High FA: 

Fractional Anisotropy

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

3DSlicer

Help & Acknowledgement

IO

Input DTI Volume dti

Output Scalar Volume fa

Operation

Estimation Parameters

Trace

Determinant

RelativeAnisotropy

FractionalAnisotropy

Status: Completed

100%

Restore Defaults AutoRun Cancel Apply

Data Probe

L

F

B

R

5: 18.000mm

Fill in the following information:

- Set **Input DTI Volume** to 'dti'
- Select **Output Scalar Volume** 'Create new Volume' and rename it 'fa'
- Select the Operation '**Fractional Anisotropy**'
- Click on **Apply** to calculate the Fractional Anisotropy map of the tensor volume

Fractional Anisotropy

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

3DSlicer

Help & Acknowledgement

IO

Input Data

Output Data

Operation

Estimation Parameters

- Trace
- Determinant
- RelativeAnisotropy
- FractionalAnisotropy

Status: Completed

100%

Restore Defaults AutoRun

Cancel Apply

Data Probe

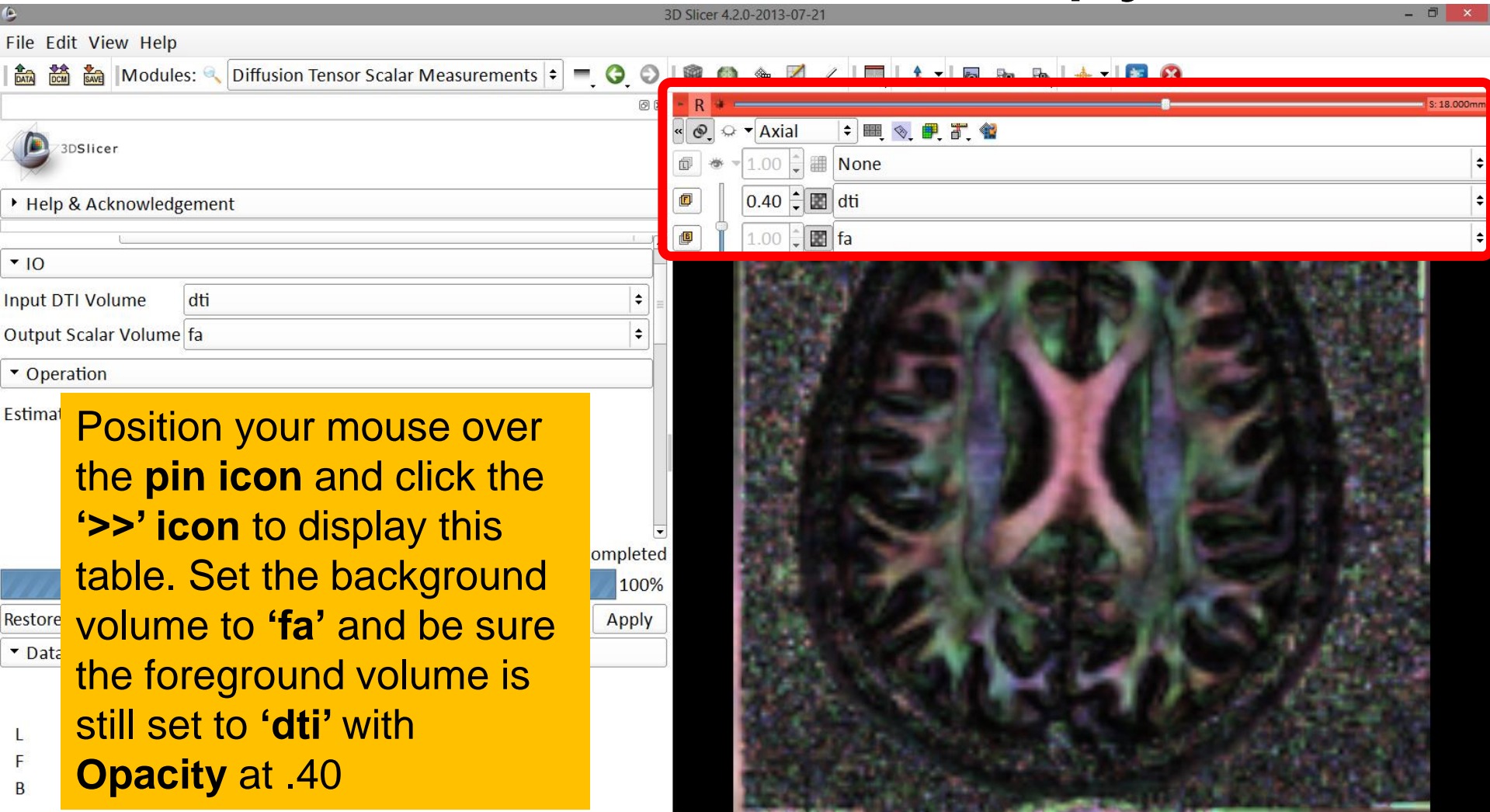
L
F
B

R

S: 0.000mm

The FA image appears in the red viewer

Fractional Anisotropy



3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

3DSlicer

Help & Acknowledgement

IO

Input DTI Volume dti

Output Scalar Volume fa

Operation

Estimate

completed 100%

Apply

Restored

Data

L
F
B

Position your mouse over the **pin icon** and click the **'>>'** icon to display this table. Set the background volume to **'fa'** and be sure the foreground volume is still set to **'dti'** with **Opacity at .40**

R

Axial

1.00 None

0.40 dti

1.00 fa

S: 18.000mm

Fractional Anisotropy

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

Explore the FA values in the Corpus Callosum and in adjacent gray matter areas. Note how the FA values are high in the white matter areas, and low in gray matter regions

Operation

Estimation Parameters

- Trace
- Determinant
- RelativeAnisotropy
- FractionalAnisotropy

Status: Completed

100%

Restore Defaults AutoRun Cancel Apply


Data Probe

Red RAS: (11.3, 24.9, 18.0) Axial Sp: 1.5

None ()

F dti (56, 47, 59) ColorOrientation 0

B fa (56, 47, 59) **0.832488**



Fractional Anisotropy

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

3DSlicer

Help & Acknowledgement

IO

Input DTI Volume dti

Output Scalar Volume fa

Operation

Estimation

completed 100%

Restore Defaults Apply

Data Probe

L
F
B

Go back to the Red slice menu and change the foreground volume to **'None'** and the background volume to **'dti'**

R Axial 5: 18.000mm

1.00 None

0.40 None

1.00 dti

Fractional Anisotropy

3D Slicer 4.2.0-2013-07-21

File Edit View Help

Modules: Diffusion Tensor Scalar Measurements

3DSlicer

Help & Acknowledgement

IO

Input DTI Volume dti

Output Scalar Volume fa

Operation

Estimation Parameters

Trace

Determinant

RelativeAnisotropy

Conventional

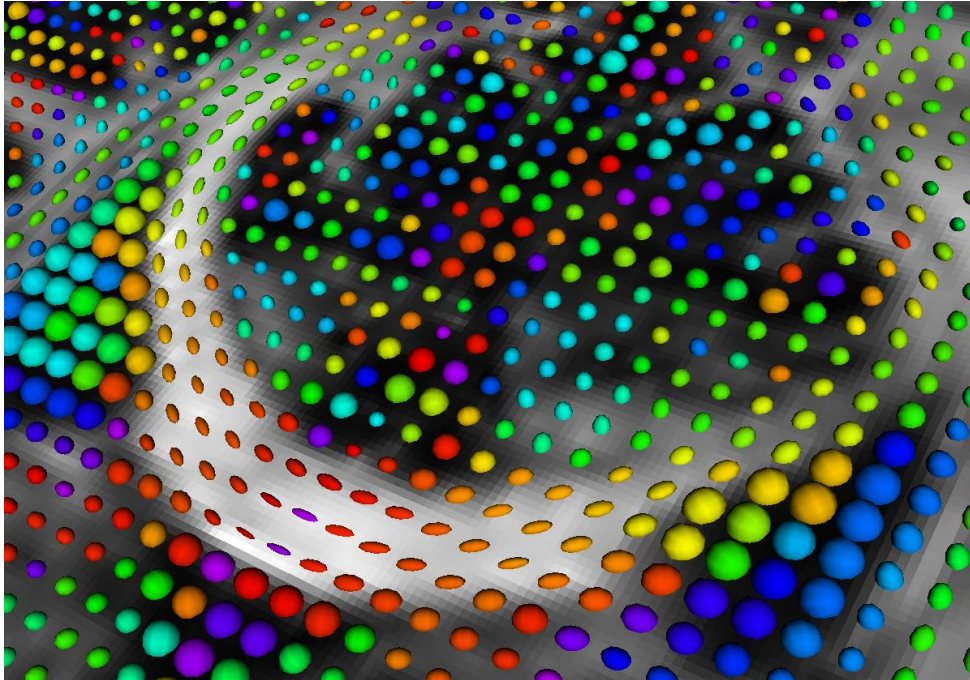
- Conventional Widescreen
- Conventional Quantitative
- Four-Up
- Four-Up Quantitative
- Dual 3D
- Triple 3D
- 3D only
- One-Up Quantitative
- Red slice only
- Yellow slice only
- Green slice only
- Tabbed 3D
- Tabbed slice
- Compare
- Compare Widescreen
- Compare Grid
- Three over three
- Three Over Three Quantitative
- Four over four
- Two over Two
- Side by side

Click on the Slicer layout menu and select **Conventional** layout

L

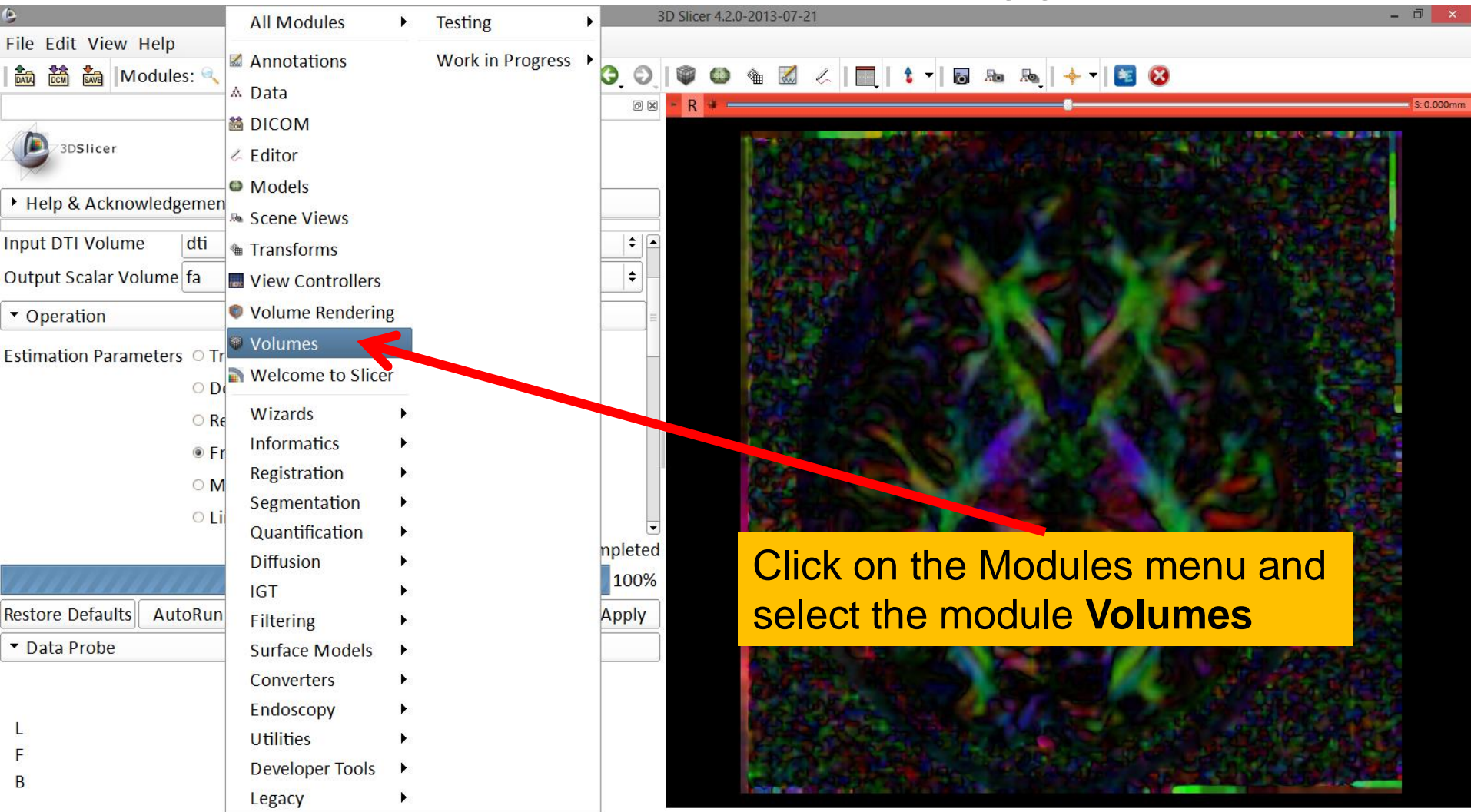
F

B



Part 2: Visualizing the tensor data

3D Visualization: Glyphs

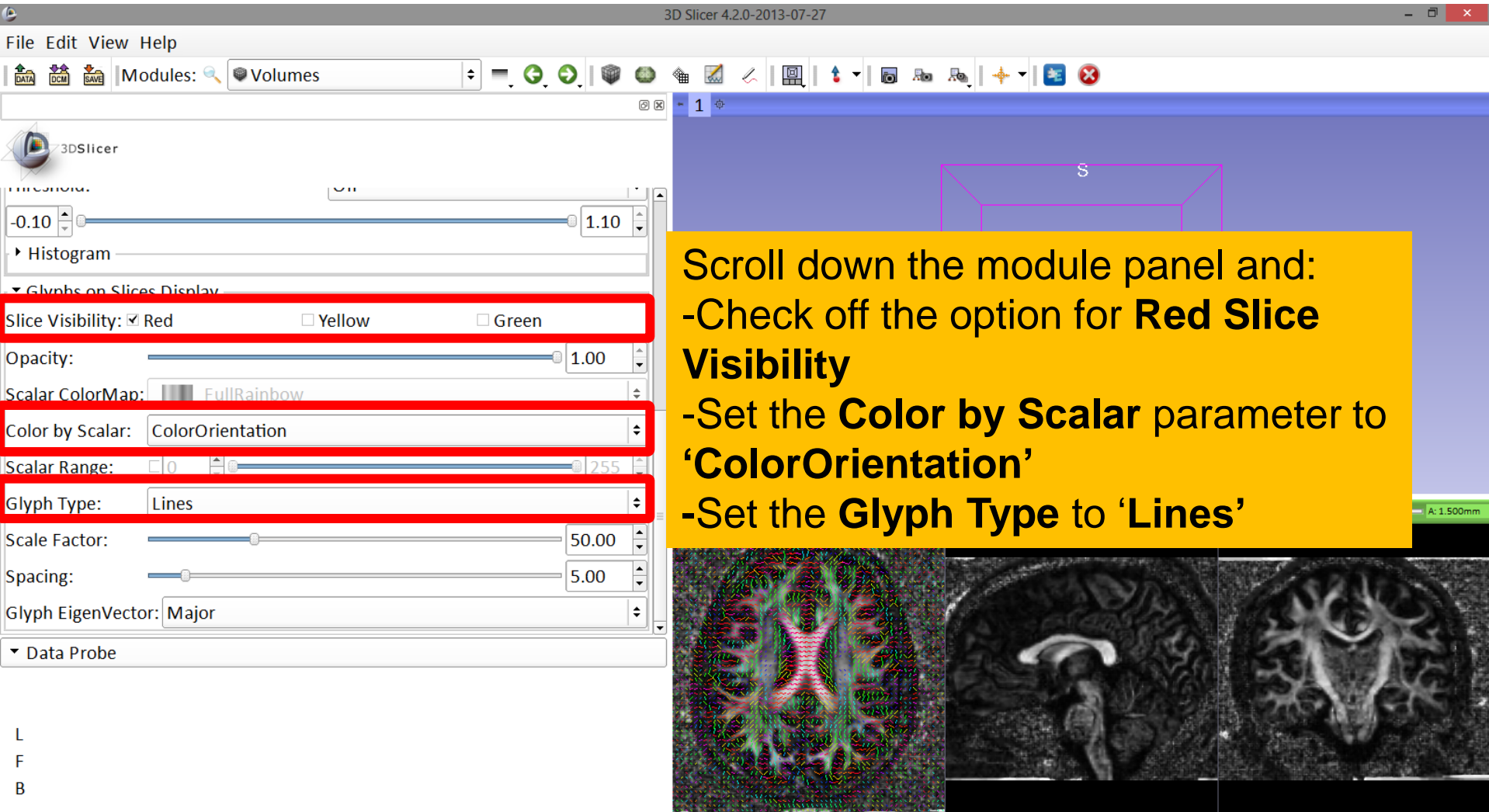


The screenshot shows the 3D Slicer 4.2.0-2013-07-21 interface. The 'Modules' menu is open, and the 'Volumes' option is highlighted with a red arrow. A yellow callout box with black text reads: 'Click on the Modules menu and select the module **Volumes**'. The main 3D view shows a brain with colorful glyphs representing diffusion tensor information. The interface includes a menu bar (File, Edit, View, Help), a toolbar, and a sidebar with various modules like Annotations, Data, DICOM, Editor, Models, Scene Views, Transforms, View Controllers, Volume Rendering, and Volumes. The 'Volumes' module is currently selected.

3D Visualization: Glyphs

The screenshot displays the 3D Slicer 4.2.0-2013-07-21 interface. The left sidebar contains the 'Volumes' panel, where the 'Active Volume' is set to 'dti' and the 'Scalar Mode' is set to 'FractionalAnisotropy'. The 'Display' section shows a 'Lookup Table' of 'Grey' and 'Interpolate' checked. Below these are 'Window Level editor presets' and a 'Threshold' slider set to 'Off'. The main 3D view shows a brain slice with a purple wireframe box and a yellow text box that reads: 'Set the Active Volume to 'dti' and the Scalar Mode to FractionalAnisotropy'. The bottom of the interface features three orthogonal viewports (axial, sagittal, and coronal) and a toolbar with sliders for 'R' (S: 0.000mm), 'Y' (R: 1.500mm), and 'G' (A: 1.500mm).

3D Visualization: Glyphs



The screenshot shows the 3D Slicer interface. The 'Glyphs' module panel is visible on the left, with several settings highlighted in red boxes:

- Slice Visibility:** Red, Yellow, Green
- Color by Scalar:** ColorOrientation
- Glyph Type:** Lines

The 3D visualization area shows a brain slice with a purple wireframe box labeled 'S'. Below the main visualization, there are three smaller images: a 3D visualization of glyphs on a brain slice, a 2D axial MRI slice, and a 2D coronal MRI slice.

Instructions:

- Scroll down the module panel and:
 - Check off the option for **Red Slice Visibility**
 - Set the **Color by Scalar** parameter to **'ColorOrientation'**
 - Set the **Glyph Type** to **'Lines'**

3D Visualization: Glyphs

The screenshot displays the 3D Slicer interface. On the left, the 'Volumes' panel shows various settings for the active volume. The 'Glyphs on Slices Display' section is expanded, showing 'Slice Visibility' with 'Red' checked, and 'Opacity' set to 1.00. The 'Scalar ColorMap' is set to 'FullRainbow', 'Color by Scalar' is 'ColorOrientation', and 'Glyph Type' is 'Lines'. The 'Data Probe' is also visible. The main 3D view shows a brain slice with a red slice viewer. A yellow text box with the text 'The glyphs appear in the Red slice viewer' is overlaid on the 3D view. A red box highlights the glyphs in the red slice viewer, which are colorful lines representing the orientation of the diffusion tensor. The bottom of the interface shows the 'R', 'Y', and 'G' slice viewers, with the 'R' slice viewer showing the glyphs.

File Edit View Help

Modules: Volumes

3DSlicer

W: 1.00 Auto W/L L: 0.50

Threshold: Off

-0.10 1.10

Histogram

Glyphs on Slices Display

Slice Visibility: Red Yellow Green

Opacity: 1.00

Scalar ColorMap: FullRainbow

Color by Scalar: ColorOrientation

Scalar Range: 0 255

Glyph Type: Lines

Data Probe

L
F
B

The glyphs appear in the Red slice viewer

R S: 18.000mm Y R: 1.500mm G A: 1.500mm

3D Visualization: Glyphs

The screenshot shows the 3D Slicer 4.2.0 interface. On the left, the 'Glyphs on Slices Display' panel is open, showing settings for 'Slice Visibility' (Red checked, Yellow and Green unchecked), 'Opacity' (1.00), 'Scalar ColorMap' (FullRainbow), 'Color by Scalar' (ColorOrientation), 'Scalar Range' (0 to 255), 'Glyph Type' (Lines), 'Scale Factor' (50.00), and 'Spacing' (5.00). The main 3D view shows a brain slice with a purple wireframe box and a red arrow pointing to the 'eye' icon in the bottom toolbar. Below the 3D view are three smaller views: a color-coded glyph visualization, an axial MRI slice, and another MRI slice.

Position your mouse over the **pin icon** and deselect the **link icon**, then select the **eye icon** to display the axial slice in the 3D viewer

L
F
B

3D Visualization: Glyphs

3D Slicer 4.2.0-2013-07-27

File Edit View Help

Modules: Volumes

Slicer displays the axial slice in the 3D viewer

-0.10

Histogram

Glyphs on Slices Display

Slice Visibility: Red Yellow Green

Opacity: 1.00

Scalar ColorMap: FullRainbow

Color by Scalar: ColorOrientation

Scalar Range: 0 255

Glyph Type: Lines

Scale Factor: 50.00

Spacing: 5.00

Glyph Eigenvector: Major

Data Probe

L
F
B

R S: 18.00mm Y R: 1.500mm G A: 1.500mm

3D Visualization: Glyphs

File Edit View Help

Modules: Volumes

1

Zoom in to observe the glyphs.
The lines represent the principal direction of diffusion (main eigenvector)

Opacity: 1.00

Scalar ColorMap: FullRainbow

Color by Scalar: ColorOrientation

Scalar Range: 0 255

Glyph Type: Lines

Scale Factor: 50.00

Spacing: 5.00

Glyph Eigenvector: Major

Data Probe

L
F
B

R S: 18.000mm Y R: 1.500mm G A: 1.500mm

Diffusion MRI tractography

The image shows the 3D Slicer software interface. On the left is the 'Volumes' panel with various settings for the selected volume. A red box highlights the 'Slice Visibility' section, where the 'Red' checkbox is unchecked. Other settings include Opacity (1.00), Scalar ColorMap (FullRainbow), Color by Scalar (ColorOrientation), Scalar Range (0 to 100), Glyph Type (Lines), Scale Factor (50.00), Spacing (5.00), and Glyph EigenVector (Major). On the right is the 3D view of a brain slice, with a yellow callout box containing the text: 'Deselect the option for Red Slice Visibility, and deselect the eye icon in the red slice viewer'. A red arrow points from the callout box to the eye icon in the red slice viewer. The 3D view shows a brain slice with a purple wireframe box around it. Below the 3D view are three smaller views: a red slice viewer (R), a yellow slice viewer (Y), and a green slice viewer (G). The red slice viewer is currently selected and shows an axial slice of the brain with white fiber-like structures. The yellow and green slice viewers show sagittal and coronal slices respectively.

3D Slicer 4.2.0-2013-07-27

File Edit View Help

Modules: Volumes

3DSlicer

0.10 1.10

Histogram

Slice Visibility: Red Yellow Green

Opacity: 1.00

Scalar ColorMap: FullRainbow

Color by Scalar: ColorOrientation

Scalar Range: 0 100

Glyph Type: Lines

Scale Factor: 50.00

Spacing: 5.00

Glyph EigenVector: Major

Data Probe

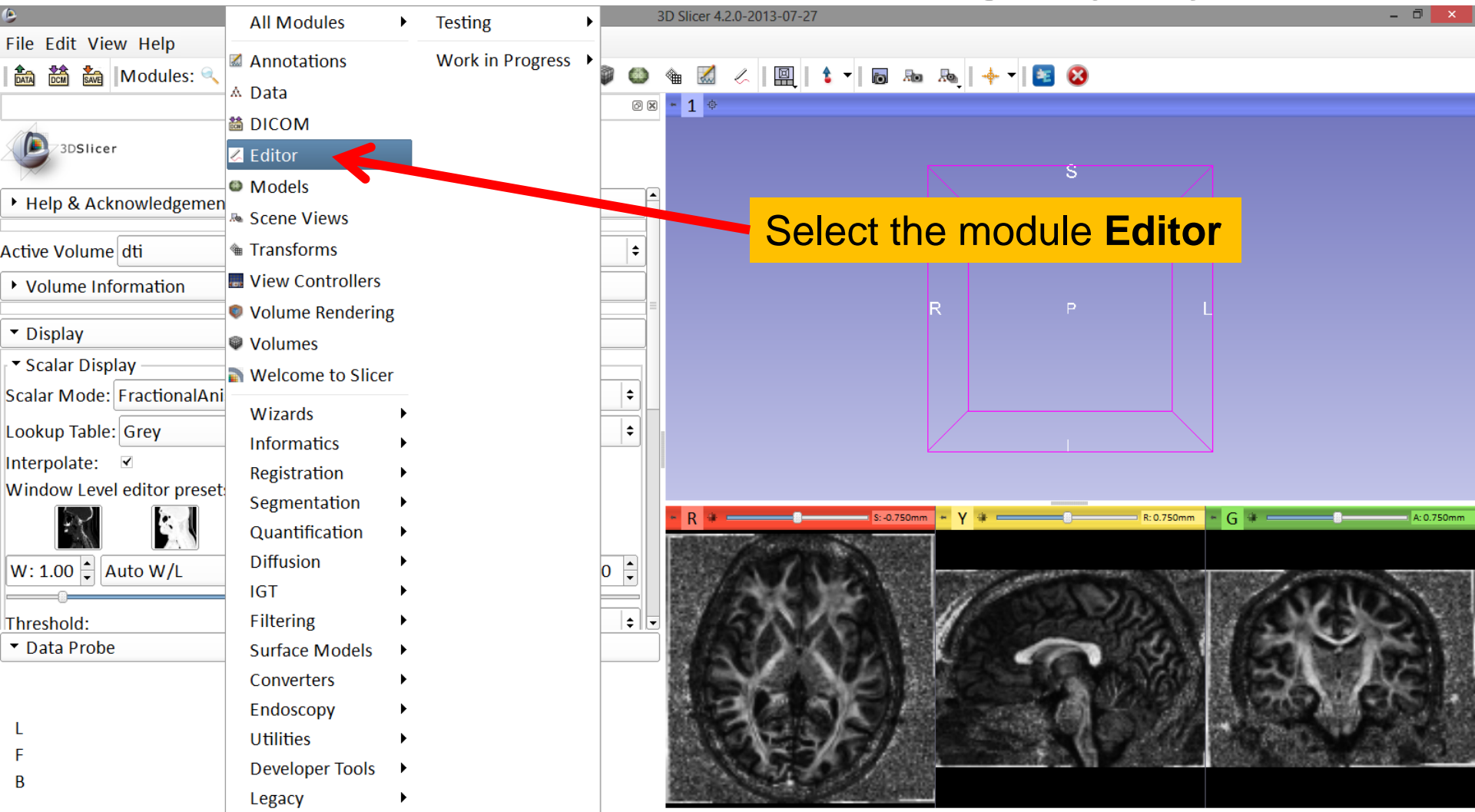
L
F
B

Deselect the option for **Red Slice Visibility**, and deselect the **eye icon** in the red slice viewer

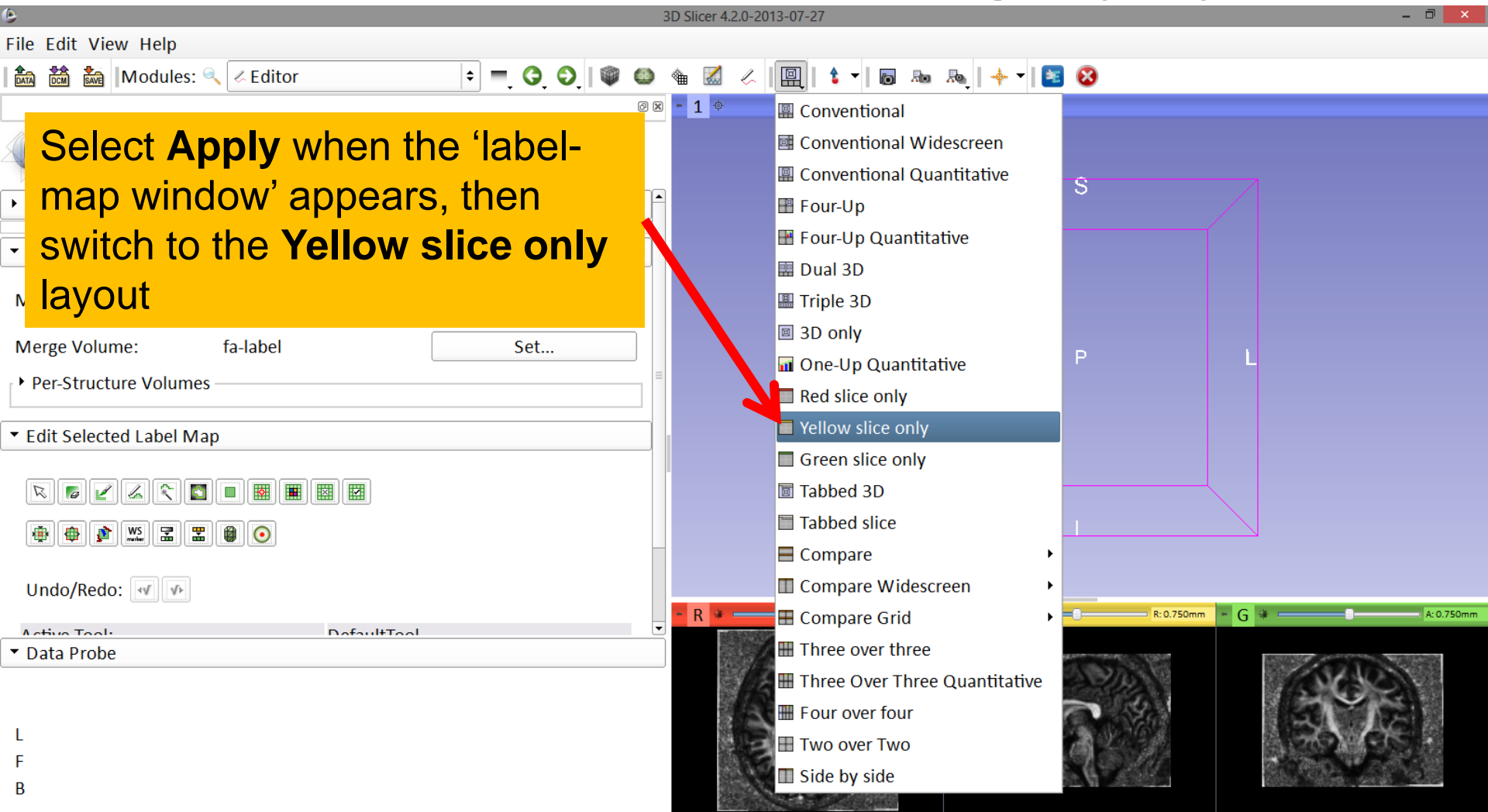
R S: 0.000mm Y R: 1.500mm G A: 1.500mm

Axial fa

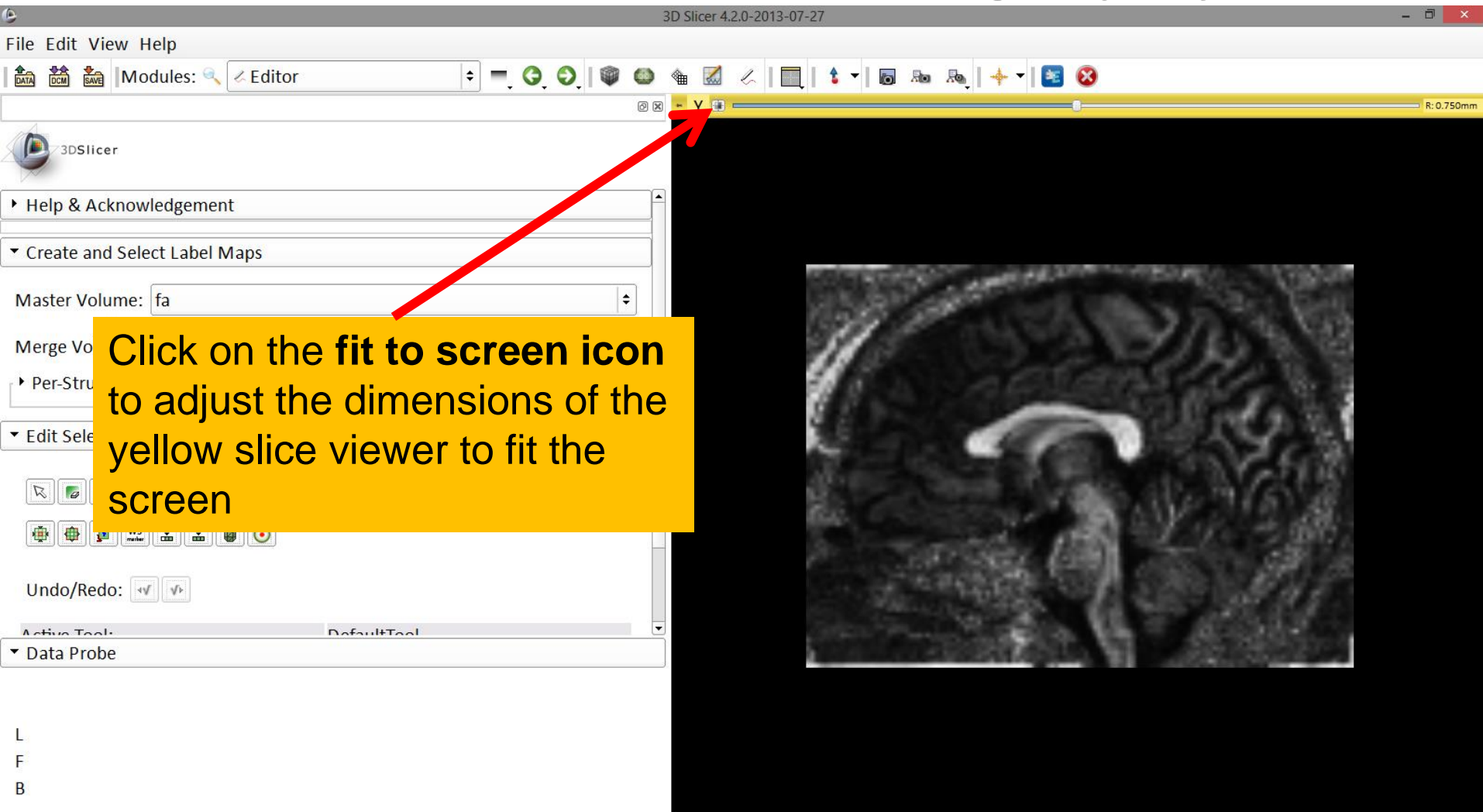
Diffusion MRI tractography



Diffusion MRI tractography



Diffusion MRI tractography



File Edit View Help

3D Slicer 4.2.0-2013-07-27

Modules: Editor

3DSlicer

Help & Acknowledgement

Create and Select Label Maps

Master Volume: fa

Merge Volume

Per-Structure

Edit Selection

Undo/Redo: [Undo] [Redo]

Active Tool: DefaultTool

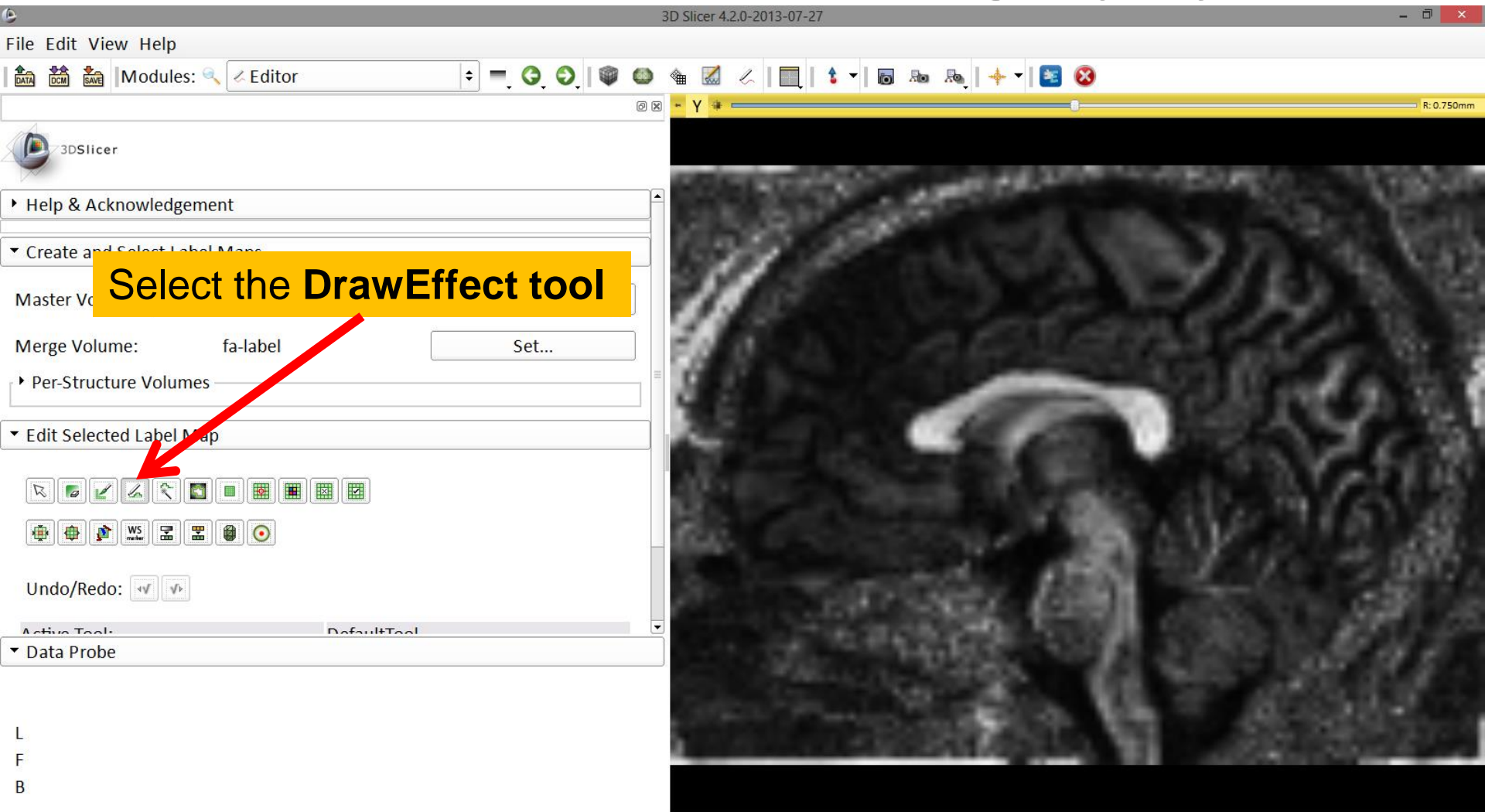
Data Probe

L
F
B

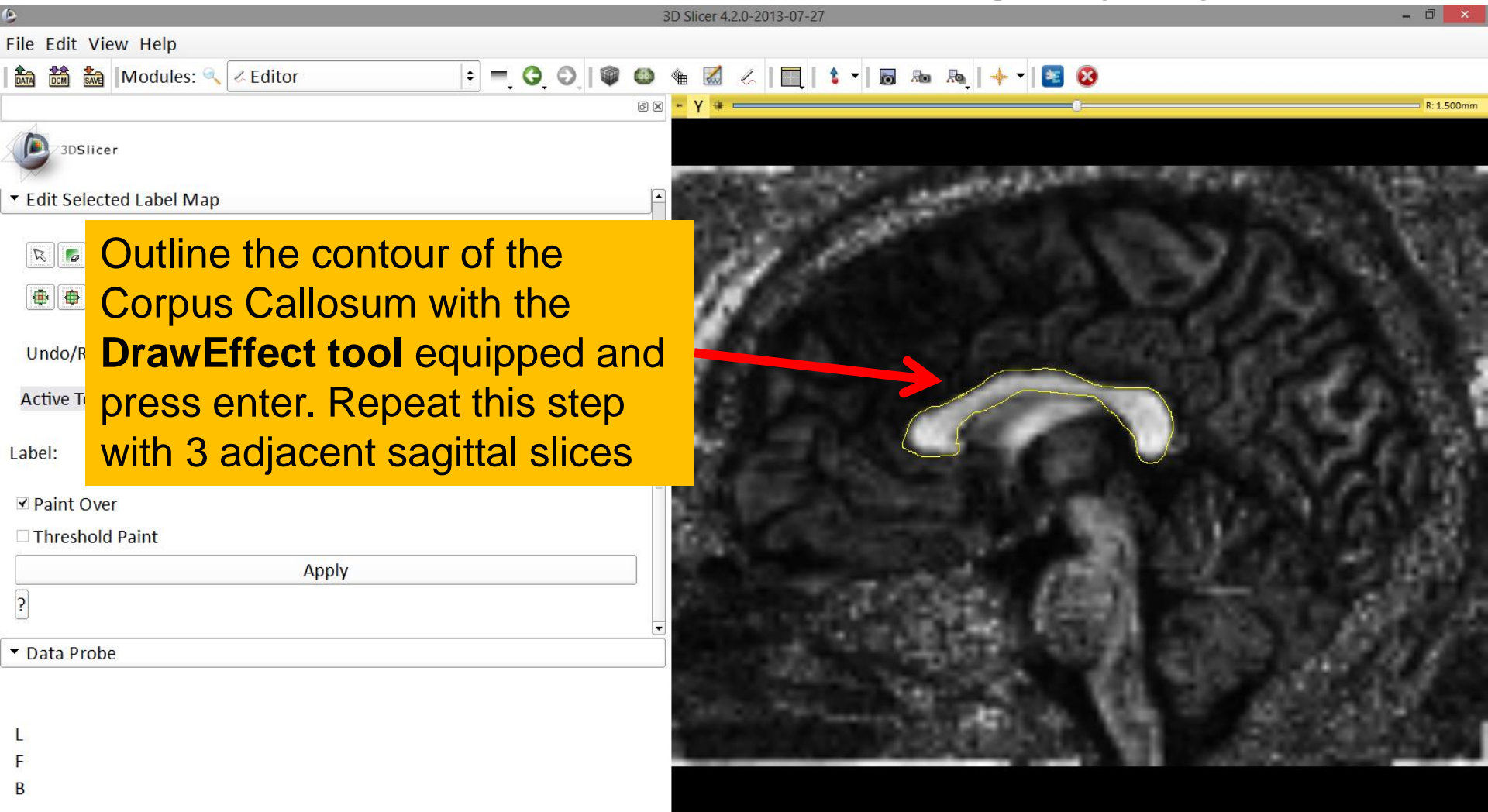
R: 0.750mm

Click on the **fit to screen** icon to adjust the dimensions of the yellow slice viewer to fit the screen

Diffusion MRI tractography



Diffusion MRI tractography



Diffusion MRI tractography

3D Slicer 4.2.0-2013-07-27

File Edit View Help

Modules: Editor

3DSlicer

Help & Acknowledgement

Create and Select Label Maps

Master Volume: fa

Merge

Per-

Edit

Undo/Redo:

Active Tool: DrawEffect

Data Probe

Yellow RAS: (3.0, 38.4, -9.3) Sagittal Sp: 1.5

L fa-label (62, 38, 41) background (0)

F None ()

B fa (62, 38, 41) 0.22537

R: 4.500mm

The tracts will be seeded from the region of interest defined in the Corpus Callosum area.

Diffusion MRI tractography

The screenshot shows the 3D Slicer 4.2.0-2013-07-27 interface. The left sidebar contains various module categories: Annotations, Data, DICOM, Editor, Models, Scene Views, Transforms, View Controllers, Volume Rendering, Volumes, Welcome to Slicer, Wizards, Informatics, Registration, Segmentation, Quantification, Diffusion, IGT, Filtering, Surface Models, Converters, Endoscopy, Utilities, Developer Tools, and Legacy. The 'Diffusion' module is selected, and its sub-menu is open, showing 'DWI to Full Brain Tractography', 'Tractography Display', 'Diffusion Data Conversion', 'Diffusion Tensor Images', 'Diffusion Weighted Images', and 'Tractography'. The 'Diffusion Tensor Images' sub-menu is also open, showing 'Diffusion Tensor Scalar Measurements', 'Resample DTI Volume', 'Tractography Interactive Seeding', and 'Tractography Label Map Seeding'. A red arrow points from a yellow text box to the 'Tractography Label Map Seeding' option. The main window displays a brain scan with a green seed region.

File Edit View Help
Modules:
3DSlicer
Help & Acknowledgements
FiducialSeedingParameters
Parameter set
IO
Input DTI Volume
Input Fiducials, Model or La
Output Fiber Bundle
Enable Seeding Tracts
Seed Placement Options
Fiducial Region Size
Fiducial Seeding Step Size
Seed Selected Fiducials
Max Number of Seeds
Data Probe

All Modules ▶ Testing ▶
Work in Progress ▶
Annotations
Data
DICOM
Editor
Models
Scene Views
Transforms
View Controllers
Volume Rendering
Volumes
Welcome to Slicer
Wizards ▶
Informatics ▶
Registration ▶
Segmentation ▶
Quantification ▶
Diffusion ▶
IGT ▶
Filtering ▶
Surface Models ▶
Converters ▶
Endoscopy ▶
Utilities ▶
Developer Tools ▶
Legacy ▶

DWI to Full Brain Tractography
Tractography Display
Diffusion Data Conversion ▶
Diffusion Tensor Images ▶
Diffusion Weighted Images ▶
Tractography ▶
Diffusion Tensor Scalar Measurements
Resample DTI Volume
Tractography Interactive Seeding
Tractography Label Map Seeding

Select the module
Tractography Label Map Seeding

3D Slicer 4.2.0-2013-07-27
R: 4.500mm

Diffusion MRI tractography

3D Slicer 4.2.0-2013-07-27

File Edit View Help

Modules: Tractography Label Map Seeding

3DSlicer

Help & Acknowledgement

Tractography Label Map Seeding

Parameter set: Tractography Label Map Seeding

IO

Input DTI Volume: dti

Input Label Map: fa-label

Output Fiber Bundle: corpusCallosum

Seed Placement Options

Use Index Space:

Seed Spacing: 2.00

Random Grid:

Status: Idle

Restore Defaults AutoRun Cancel Apply

Data Probe

L
F
B

-Set the Input DTI Volume to 'dti'
-Set the Input Label Map to 'fa-label'
-Set Output Fiber Bundle to 'Create and Rename New Fiber Bundle' and rename it 'corpusCallosum'

3D Visualization: Glyphs

3D Slicer 4.2.0-2013-07-27

File Edit View Help

Modules: Tractography Label Map Seeding

3DSlicer

Help & Acknowledgement

Tractography Label Map Seeding

Parameter set: Tractography Label Map Seeding

IO

Input DTI Volume dti

Input Label Map fa-label

Output Fiber Bundle corpusCallosum

Seed Placement Options

Use Index Space

Seed Spacing 2.00

Random Grid

Status: Idle

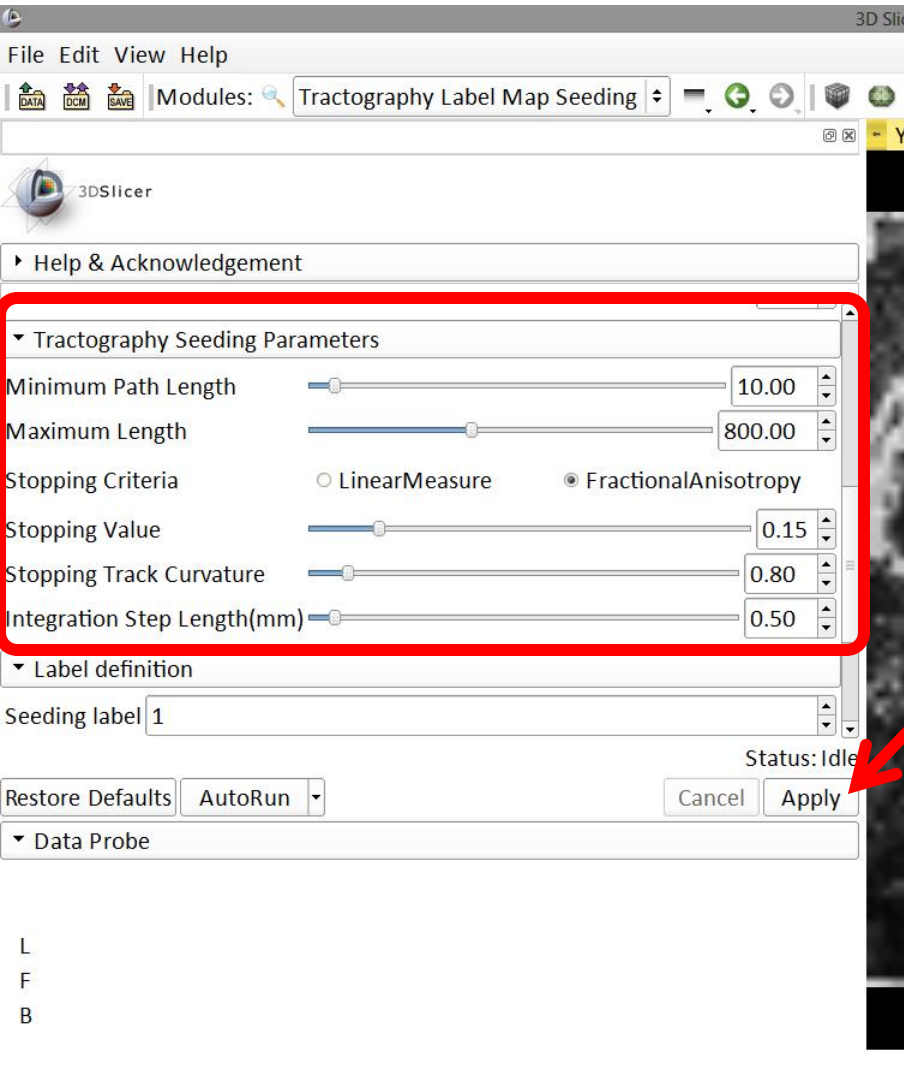
Restore Defaults AutoRun Cancel Apply

Data Probe

L
F
B

Under **Seed Placement Options**, check off the option for **'Use Index Space'**

3D Visualization: Glyphs



Select the default Tractography Seeding parameters:

- Minimum Path Length: 10 mm
 - Maximum Length: 800 mm
 - Stopping Criteria: FractionalAnisotropy
 - Stopping Value: 0.15
 - Stopping Track Curvature: 0.8
 - Integration Step Length: 0.5 mm
- Click on **Apply**

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