Fiber Bundle Selection And Scalar Measurement

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Learning Objectives

Following this tutorial, you'll be able to:

1) select fiber bundles passing through region(s) of interest, and

1) calculate scalar measurements (such as FA and trace) from the fiber bundles.

Tutorial Outline

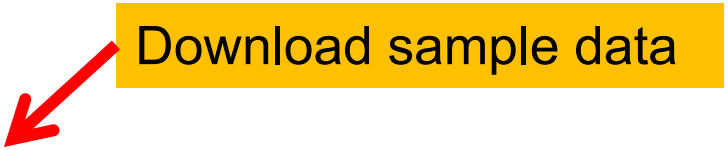
- Editing multiple labels
- Whole brain tractography
- Fiber bundle selection
- Fiber bundle scalar measurements

3D Slicer

The tutorial uses the 3D Slicer (Version 4.8.1, revision 26813, Stable Release) software available at:

http://download.slicer.org

Data used in this tutorial is available at:
https://na-mic.org/w/images/d/d6/FiberBundleSelectionAndScalarMeasurement_TutorialContestWinter2016.zip



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.

SlicerDMRI

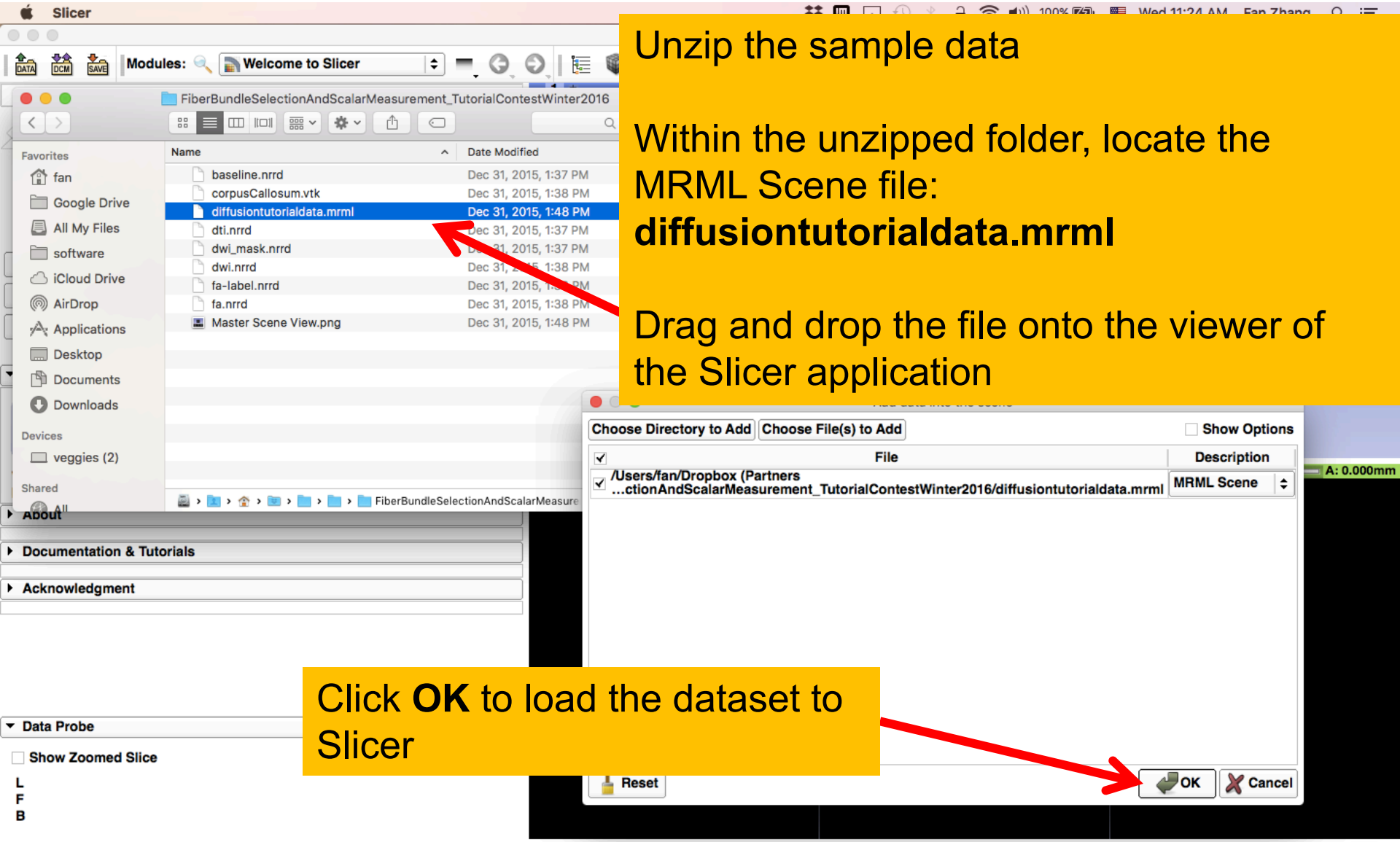
An open-source project to improve and extend diffusion magnetic resonance imaging software in 3D Slicer:

http://dmri.slicer.org

- Follow the “Diffusion MRI Analysis” to install SlicerDMRI :

  http://dmri.slicer.org/docs/tutorials/DiffusionMRIanalysis.pdf

Load MRML Data



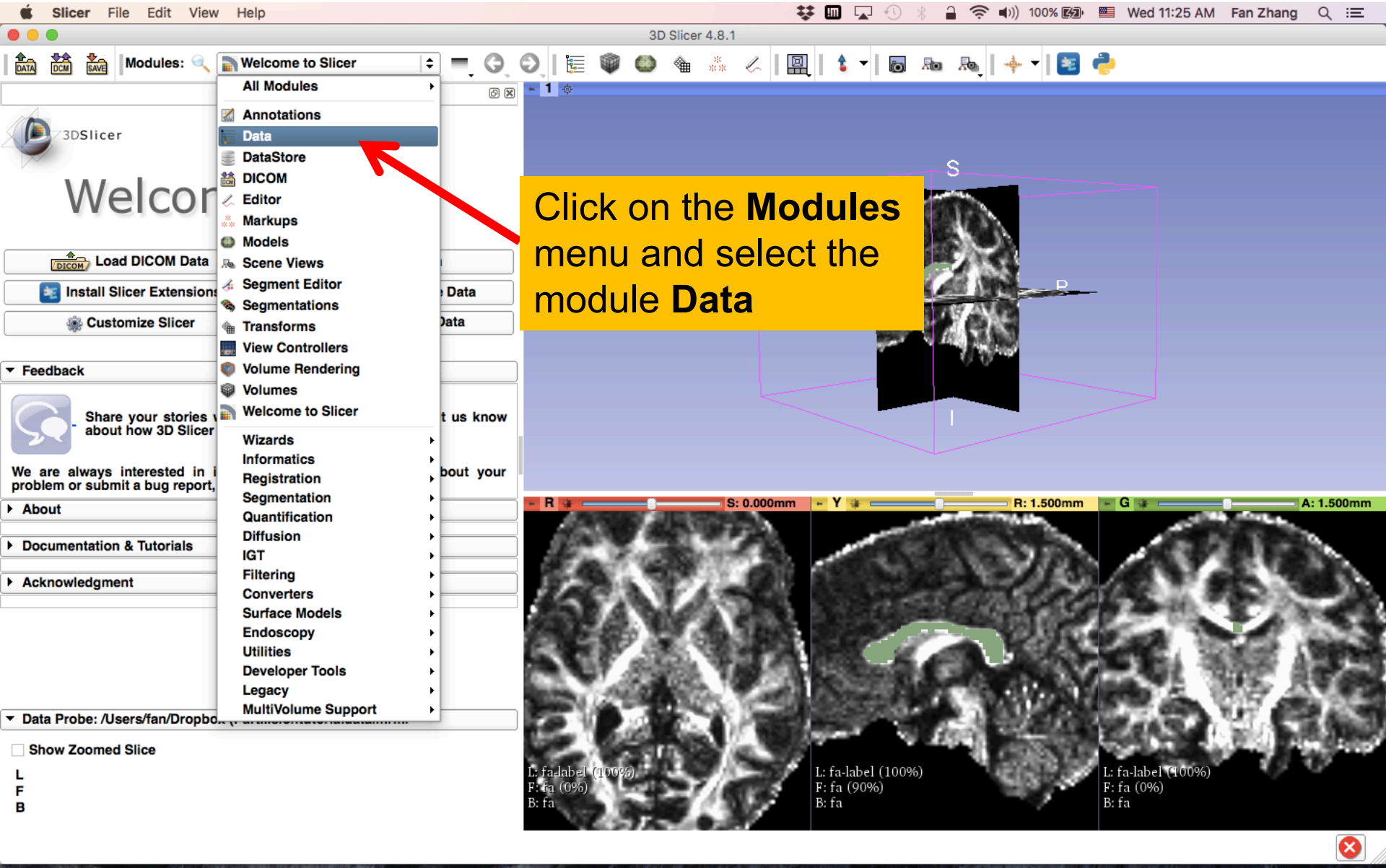
Unzip the sample data

Within the unzipped folder, locate the MRML Scene file: **diffusiontutorialdata.mrml**

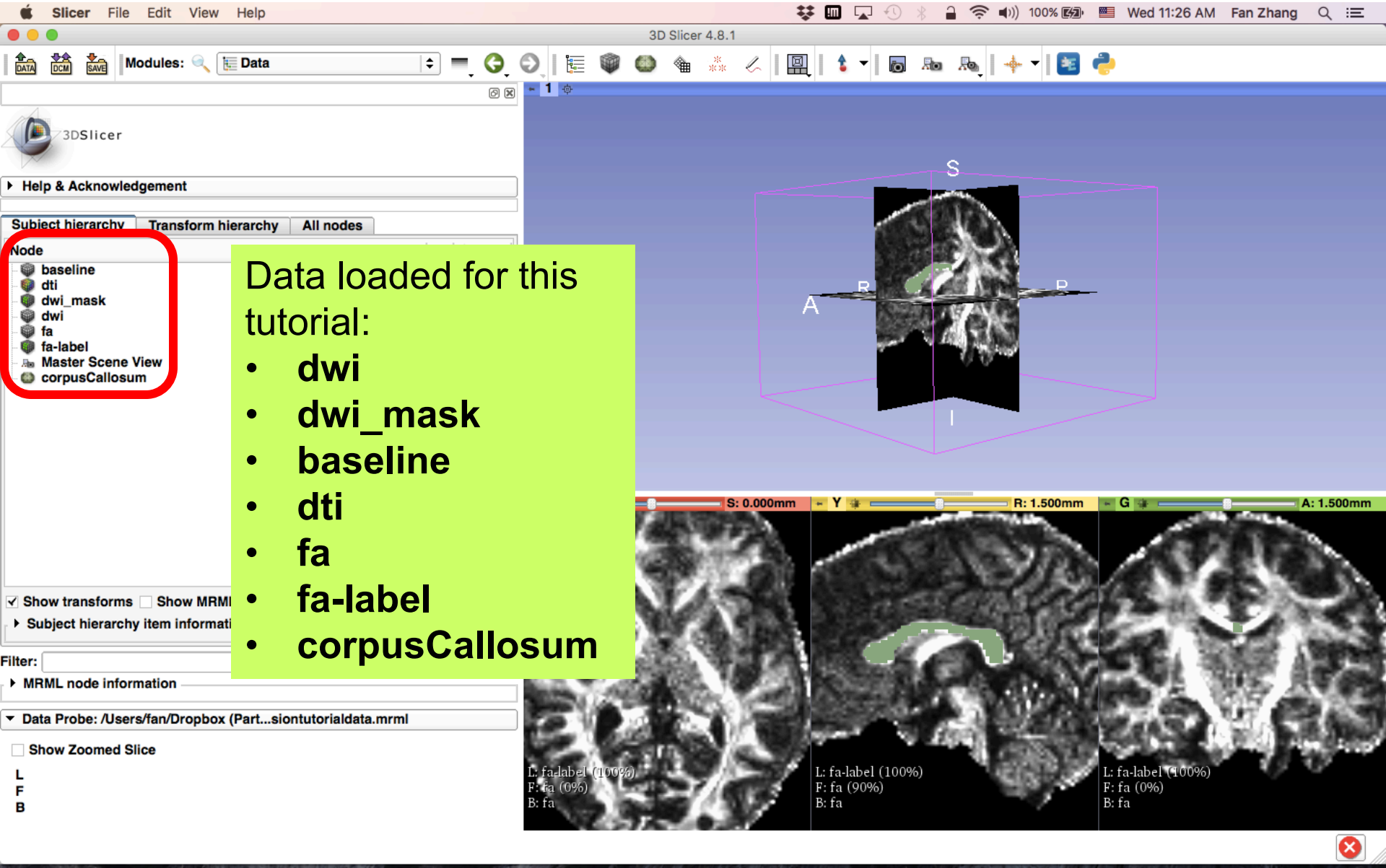
Drag and drop the file onto the viewer of the Slicer application

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

Load MRML Data



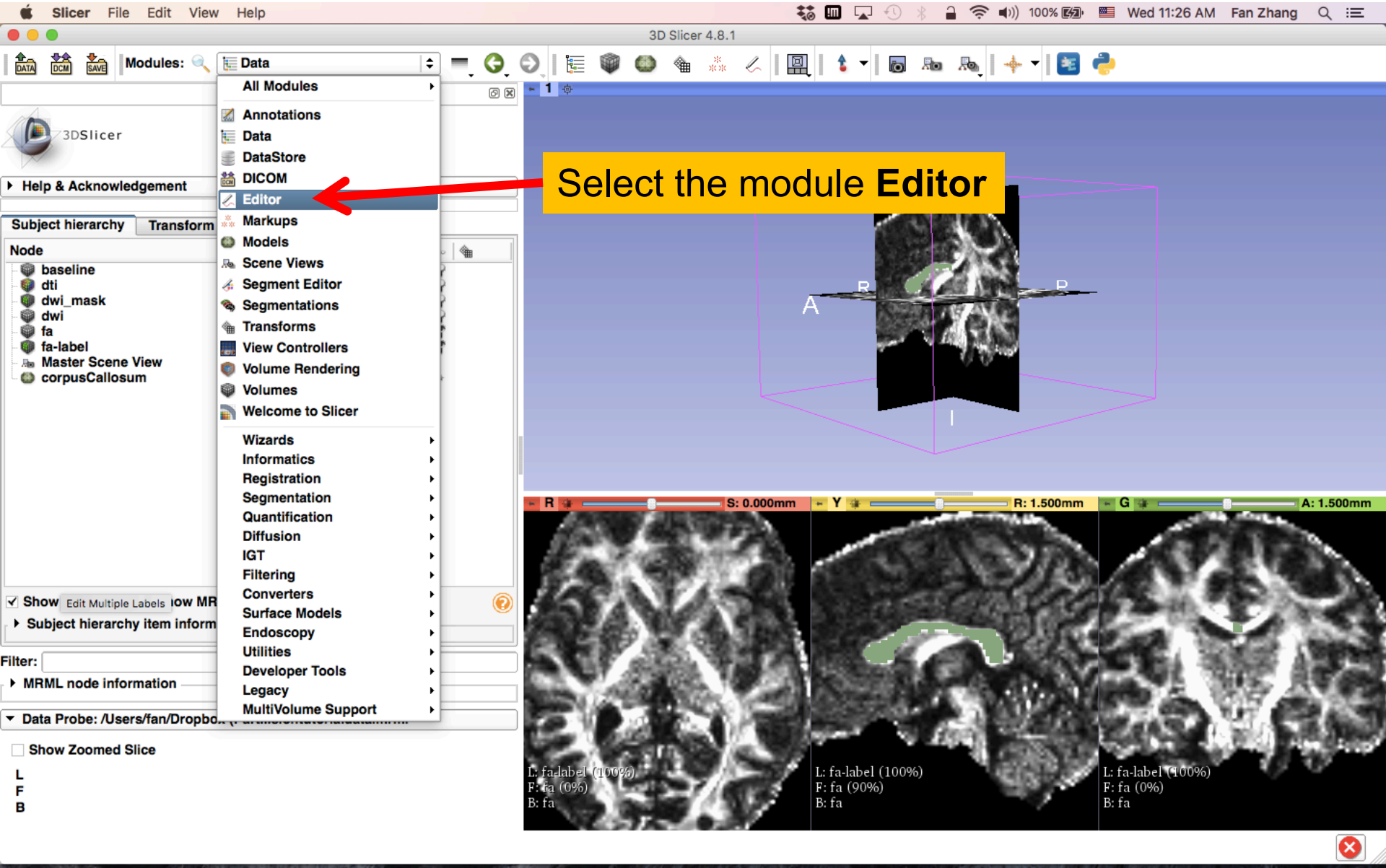
Load MRML Data



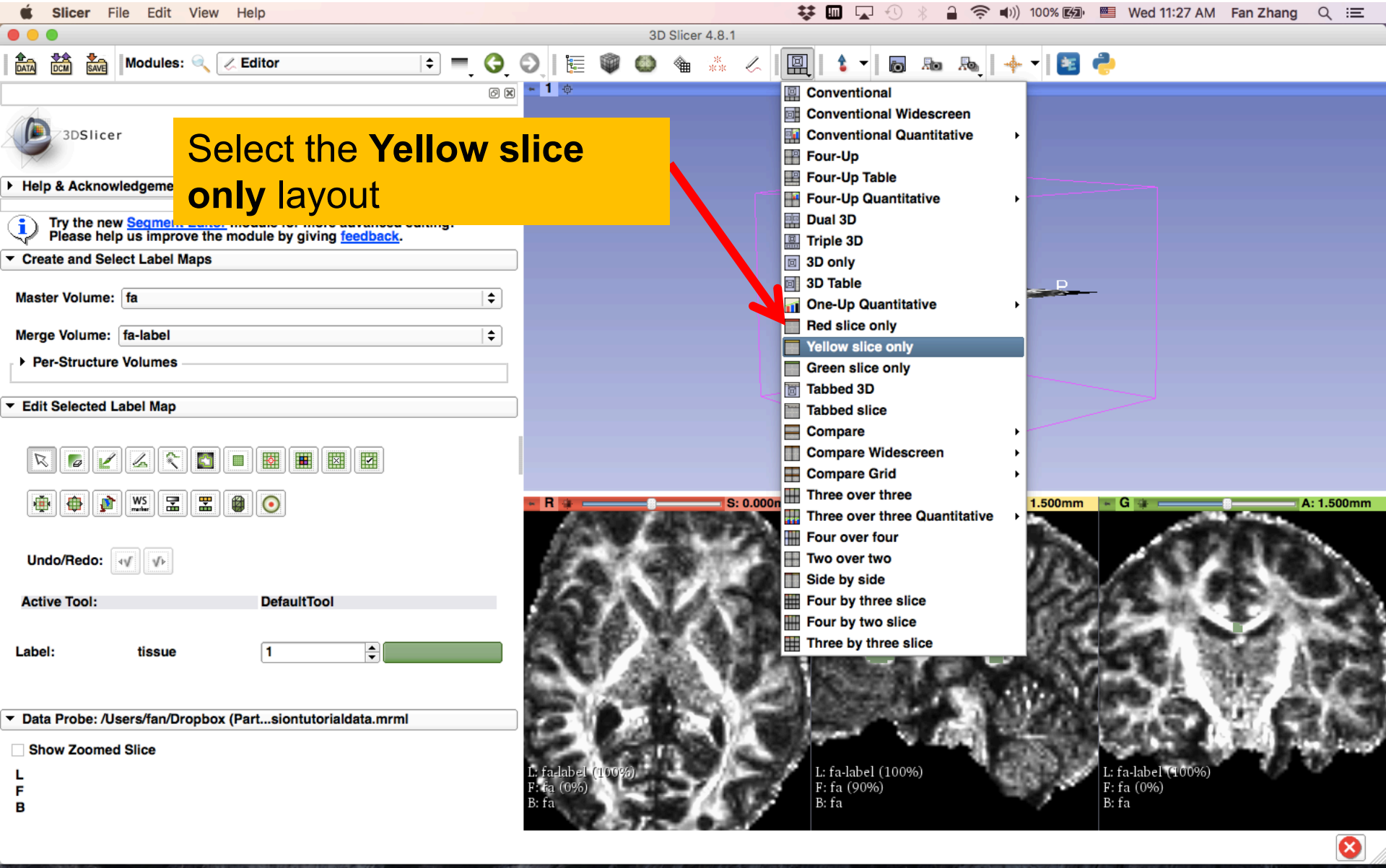
Data loaded for this tutorial:

- **dwi**
- **dwi_mask**
- **baseline**
- **dti**
- **fa**
- **fa-label**
- **corpusCallosum**

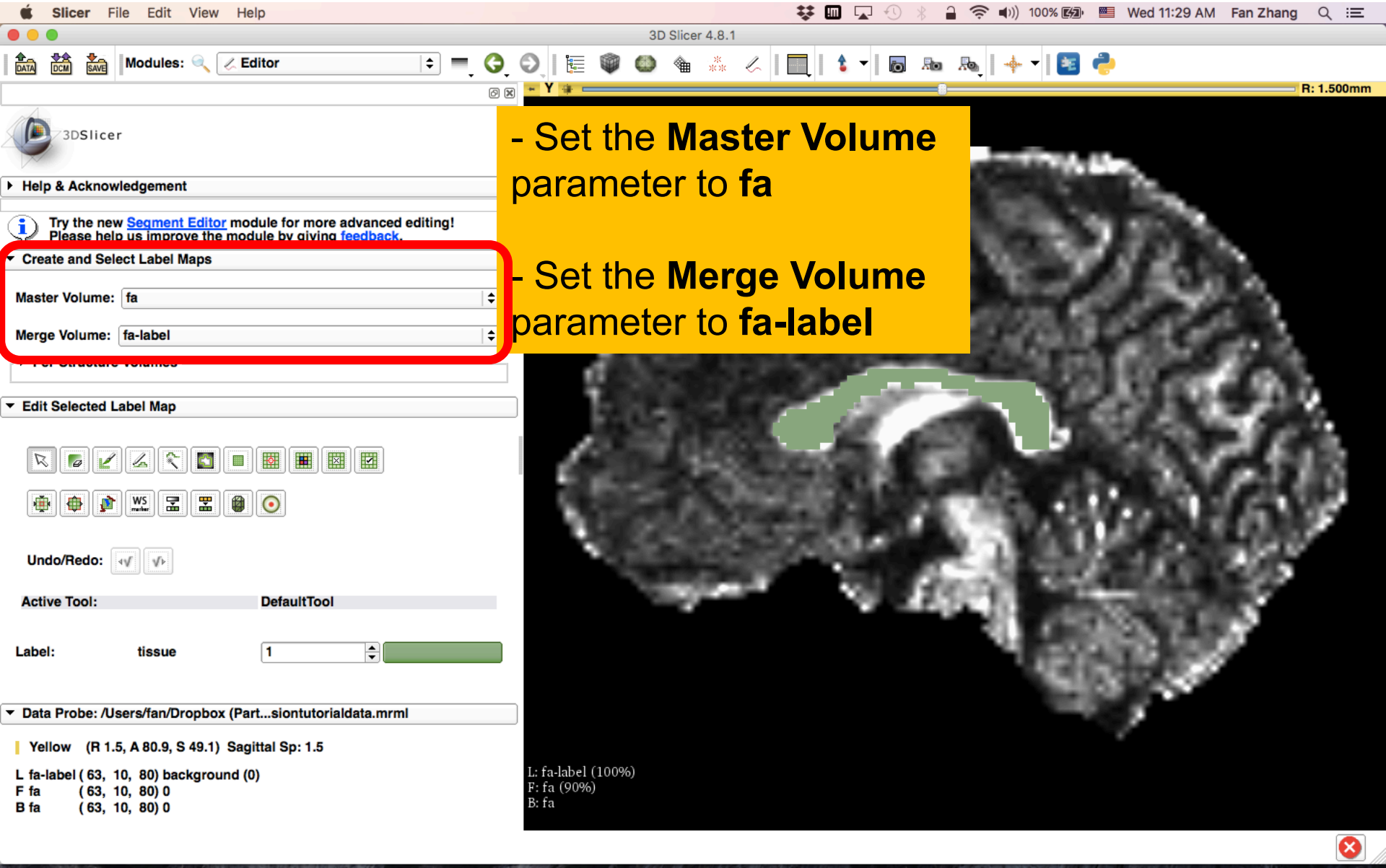
Edit Multiple Labels



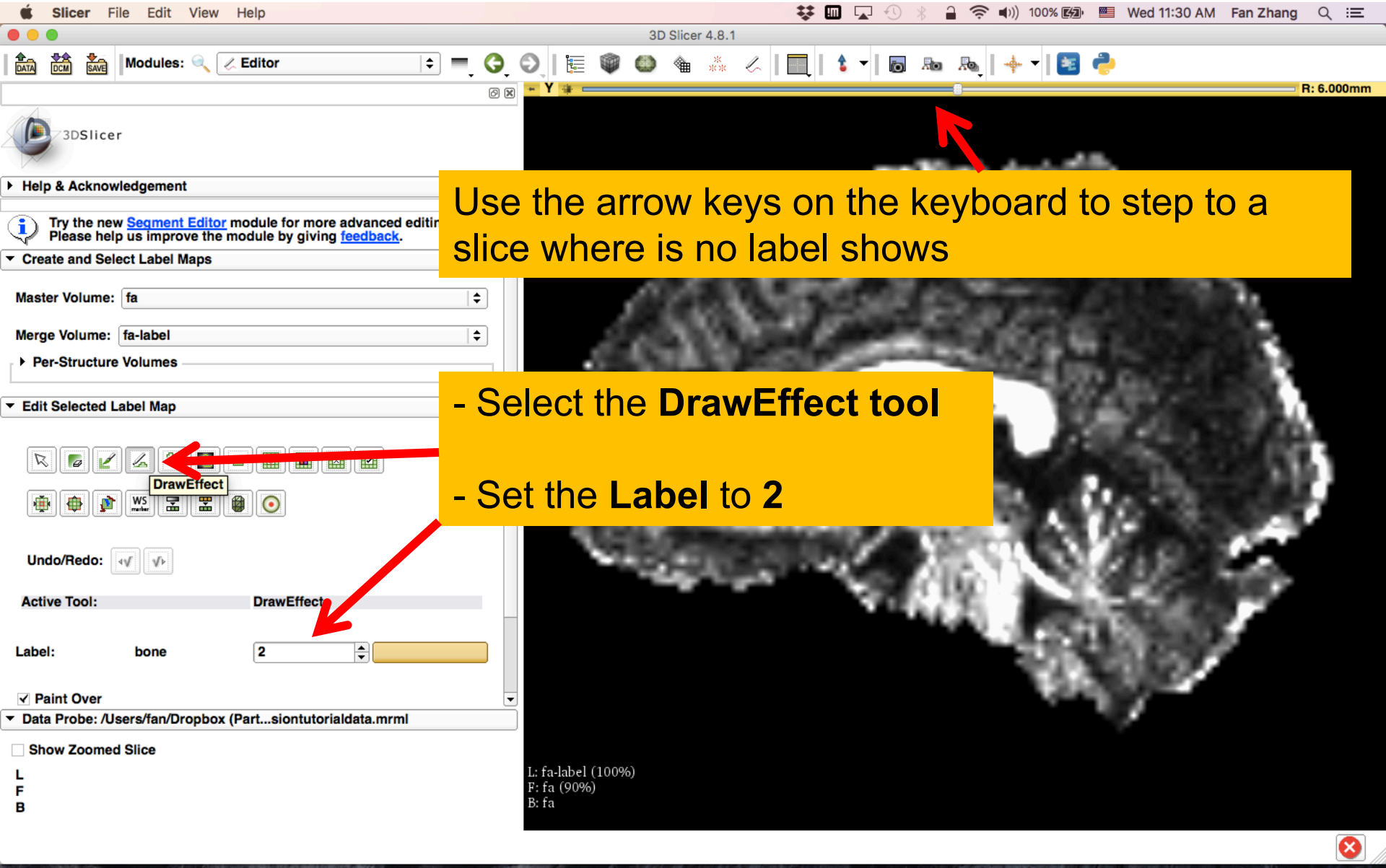
Edit Multiple Labels



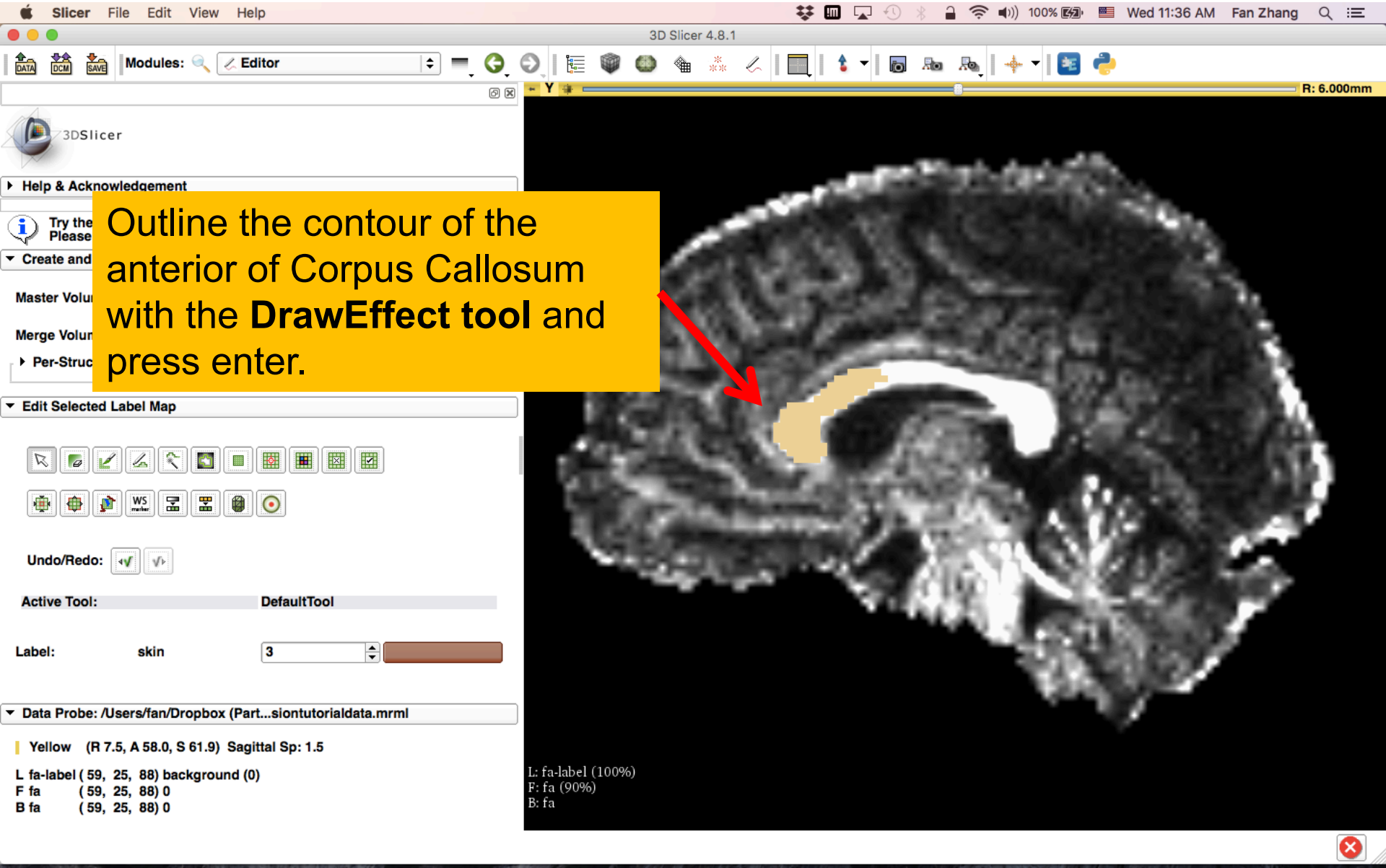
Edit Multiple Labels



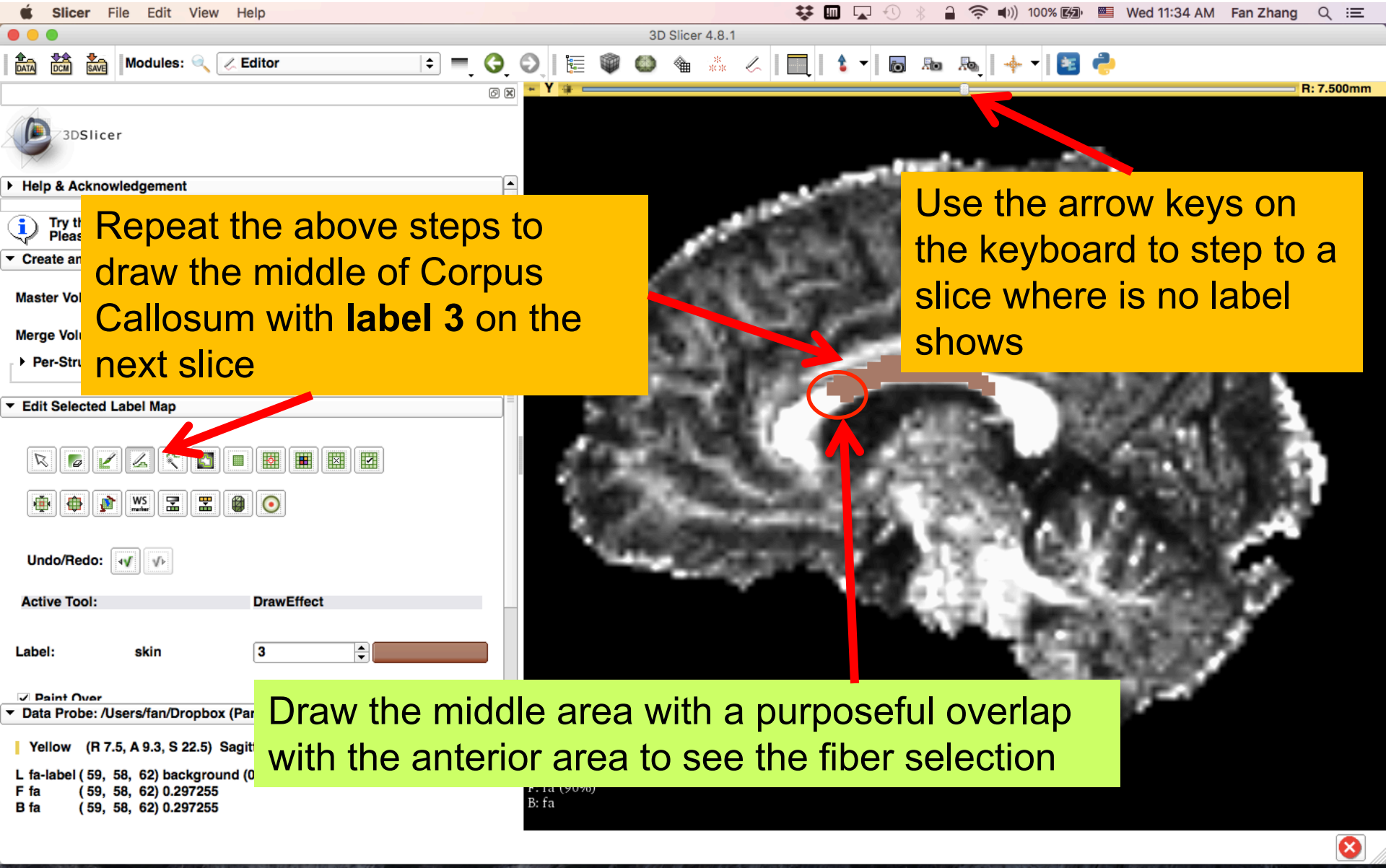
Edit Multiple Labels



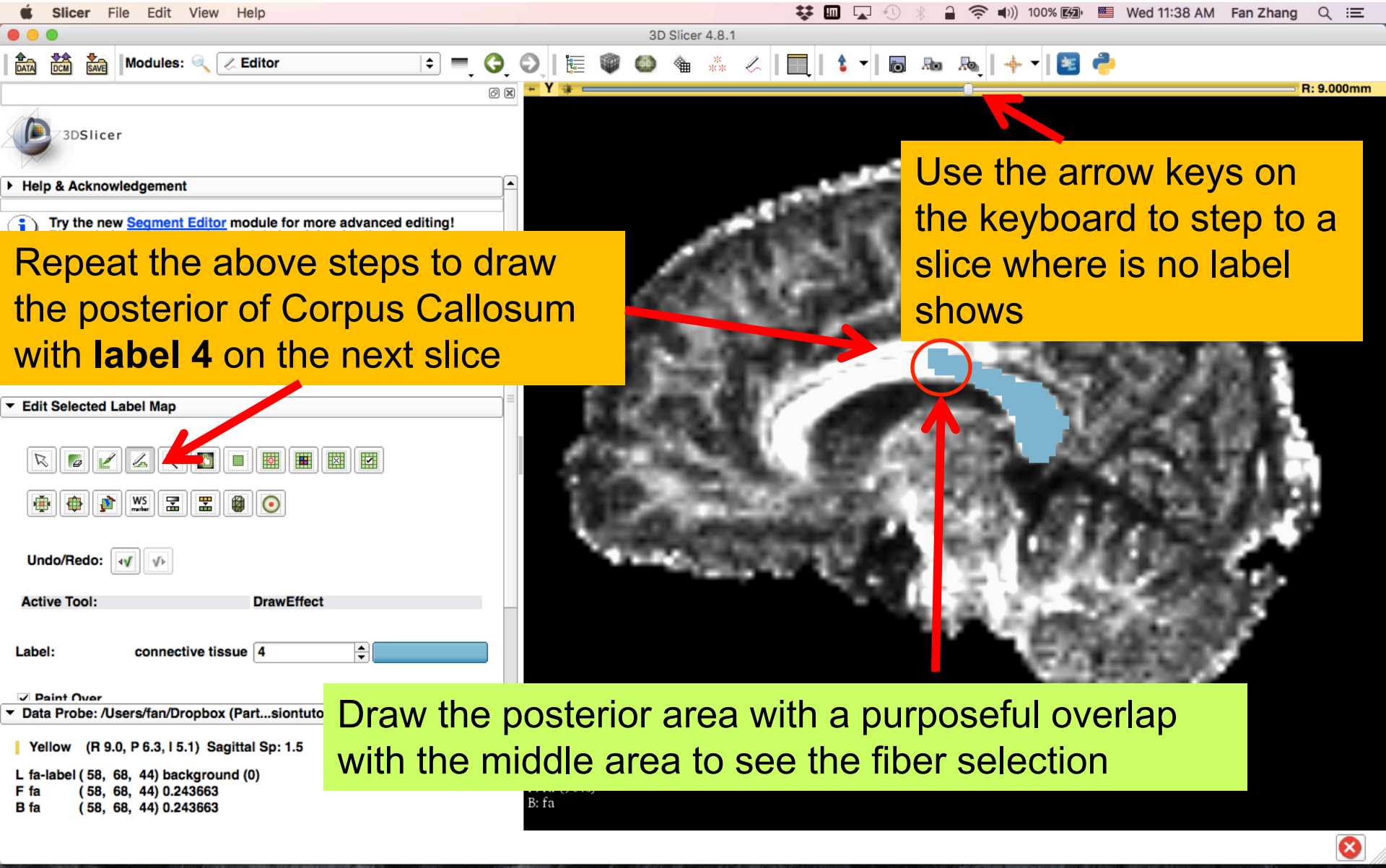
Edit Multiple Labels



Edit Multiple Labels



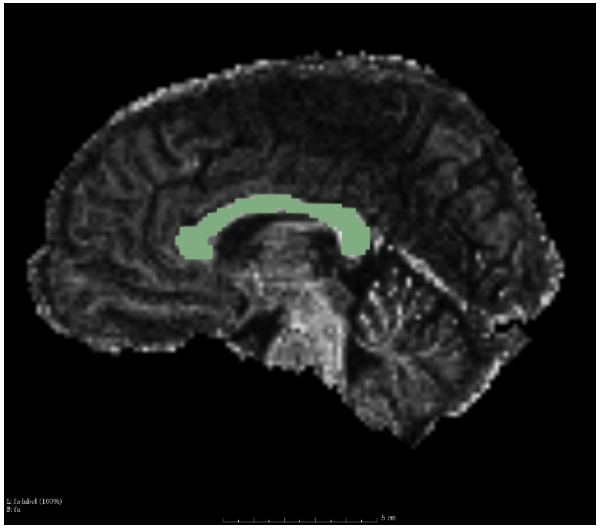
Edit Multiple Labels



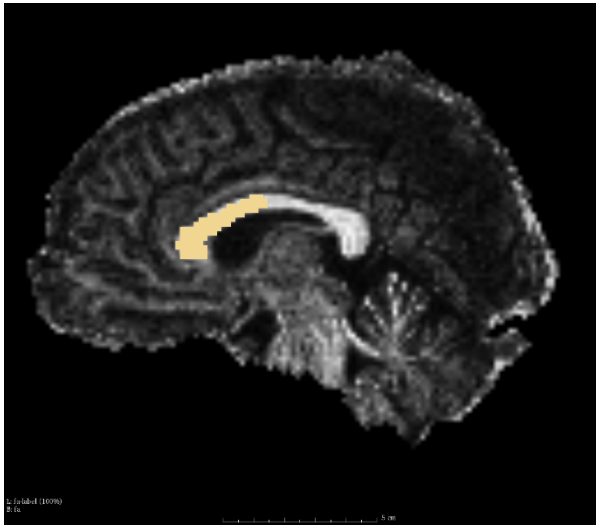
Edit Multiple Labels

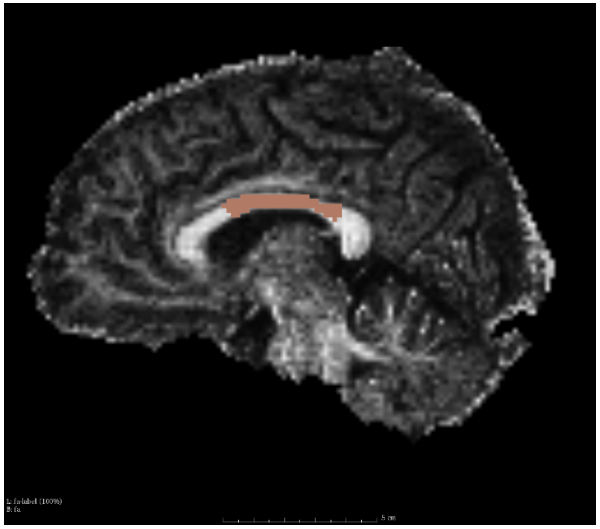
Label map on individual slice, with :

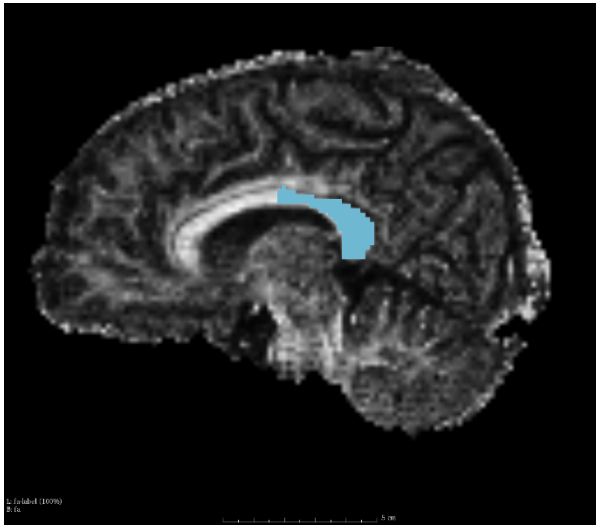
- **1 - entire CC**
- **2 - anterior CC**
- **3 - middle CC**
- **4 - posterior CC**



Notice that there are overlaps between different labeled regions*, which will be used to investigate the fiber bundle selection.

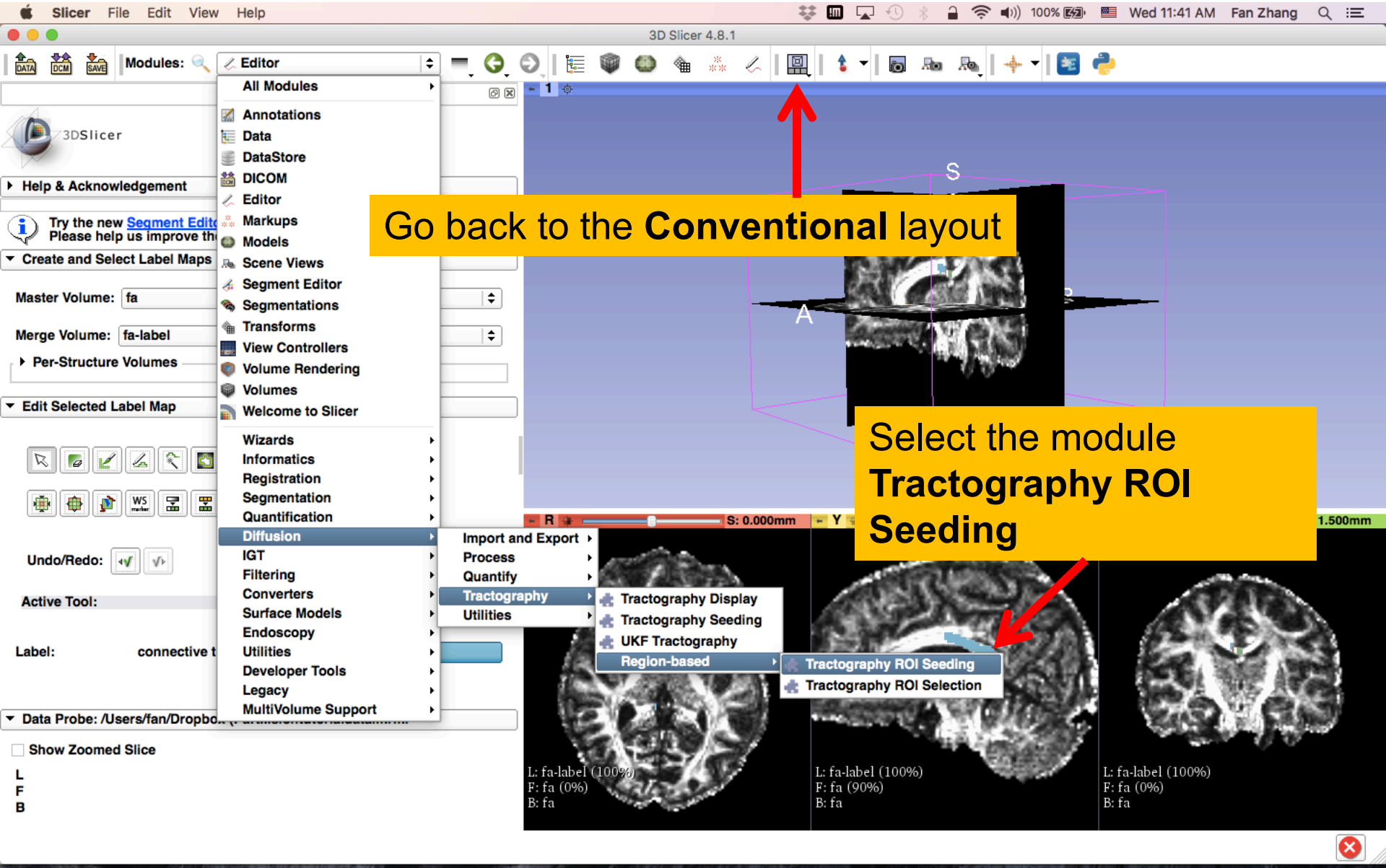




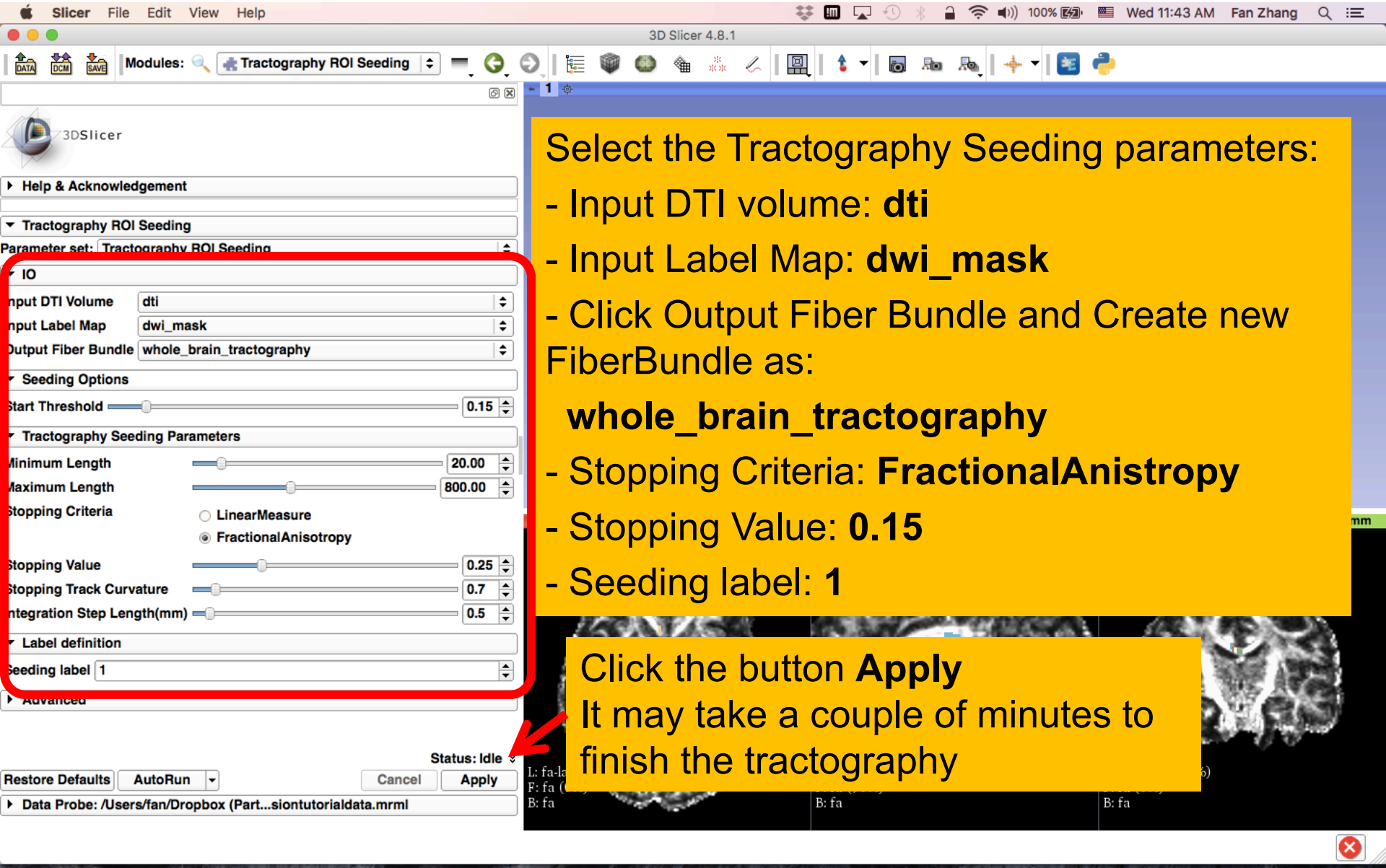


*** For details of CC segments: http://adessowiki.fee.unicamp.br/adesso/wiki/DTI/proj_cc/view/**

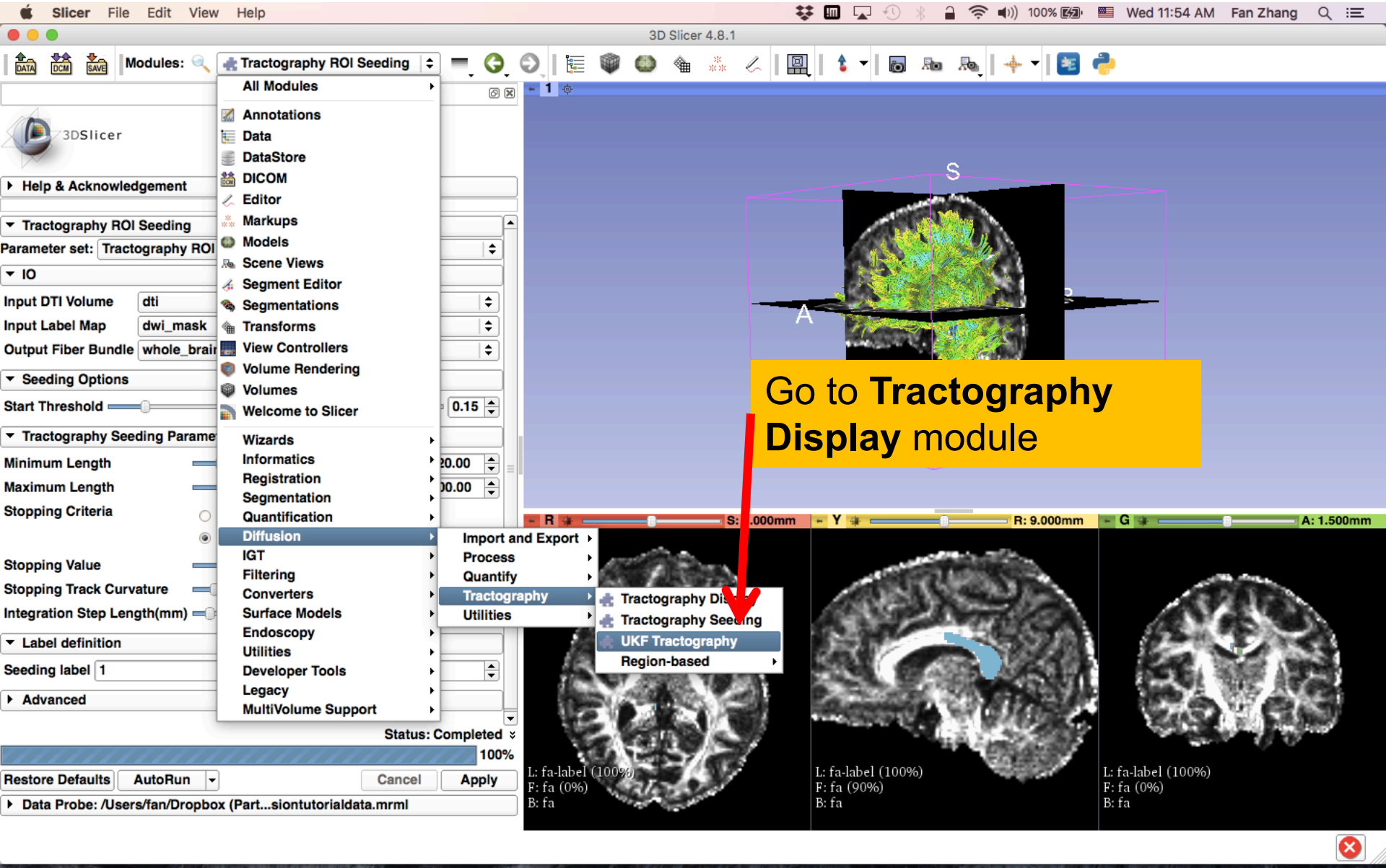
Whole Brain Tractography



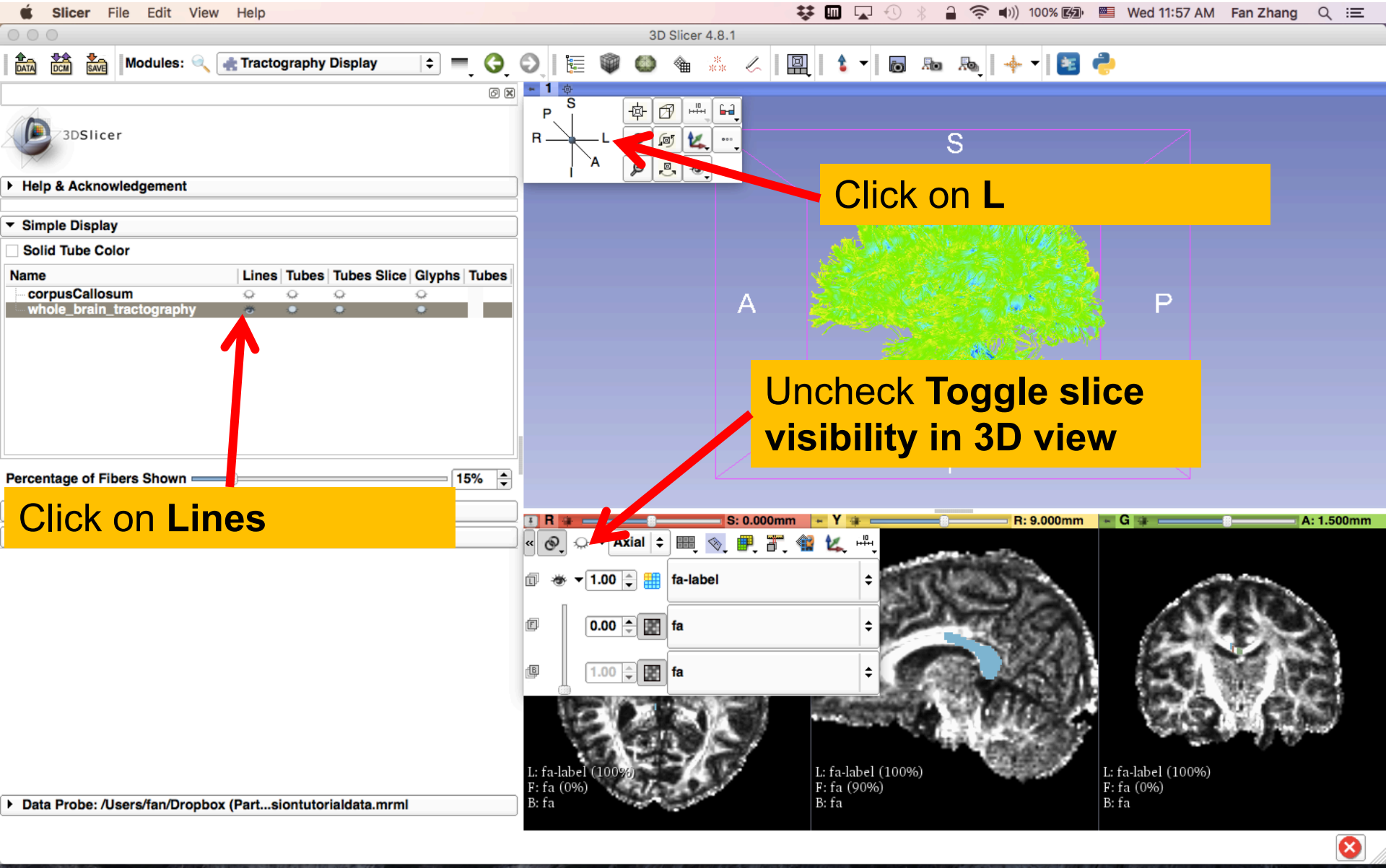
Whole Brain Tractography



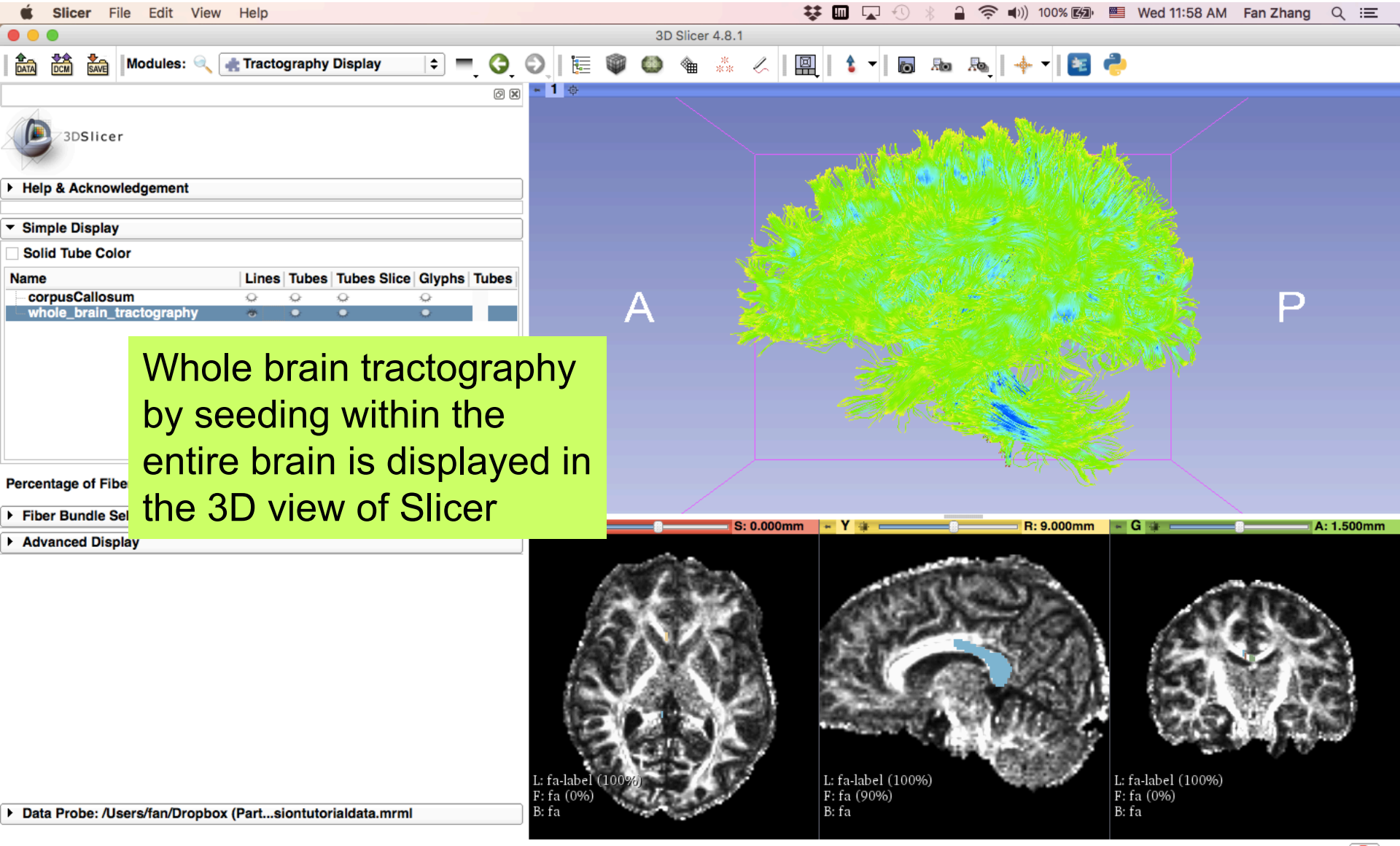
Whole Brain Tractography



Whole Brain Tractography

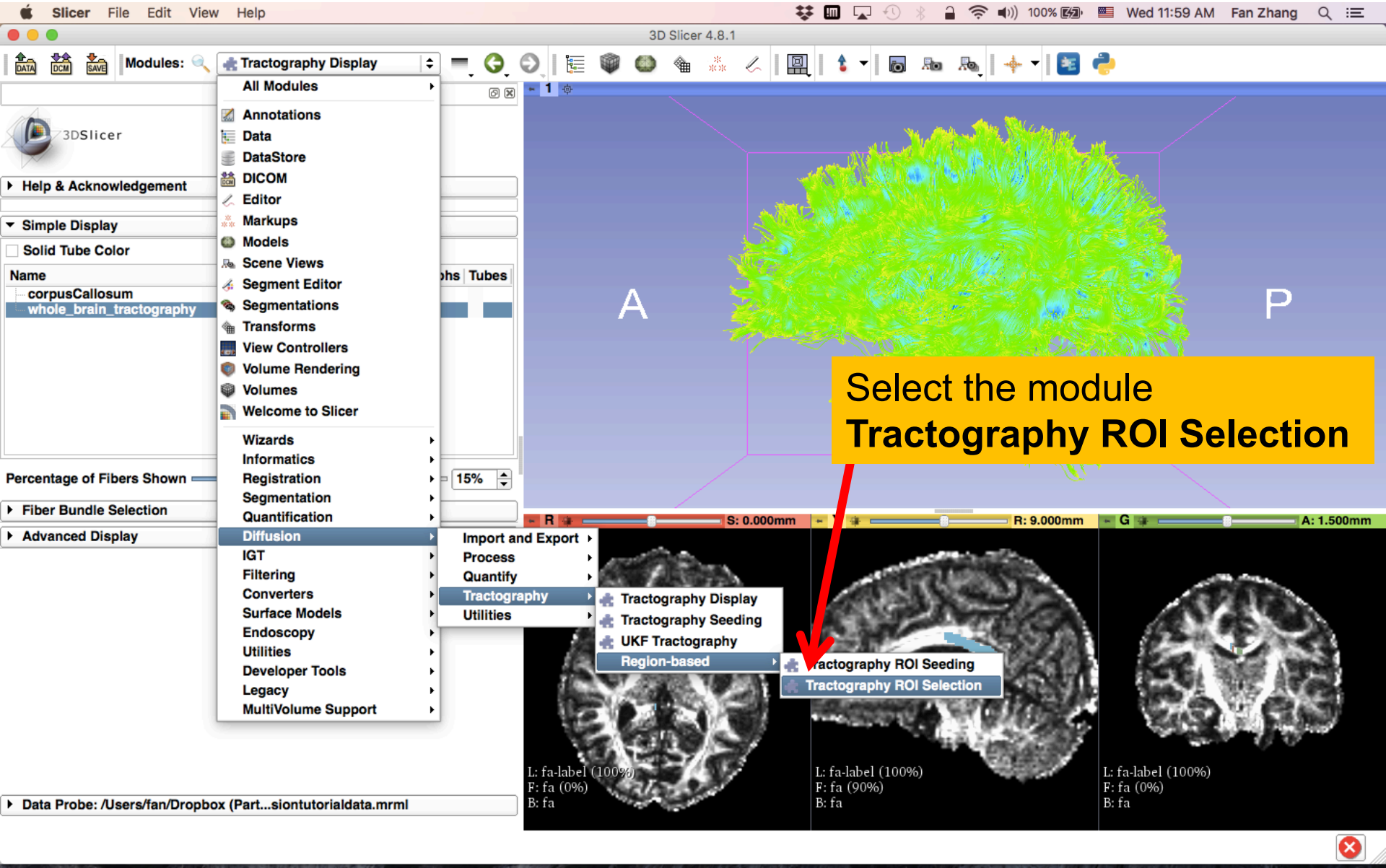


Whole Brain Tractography

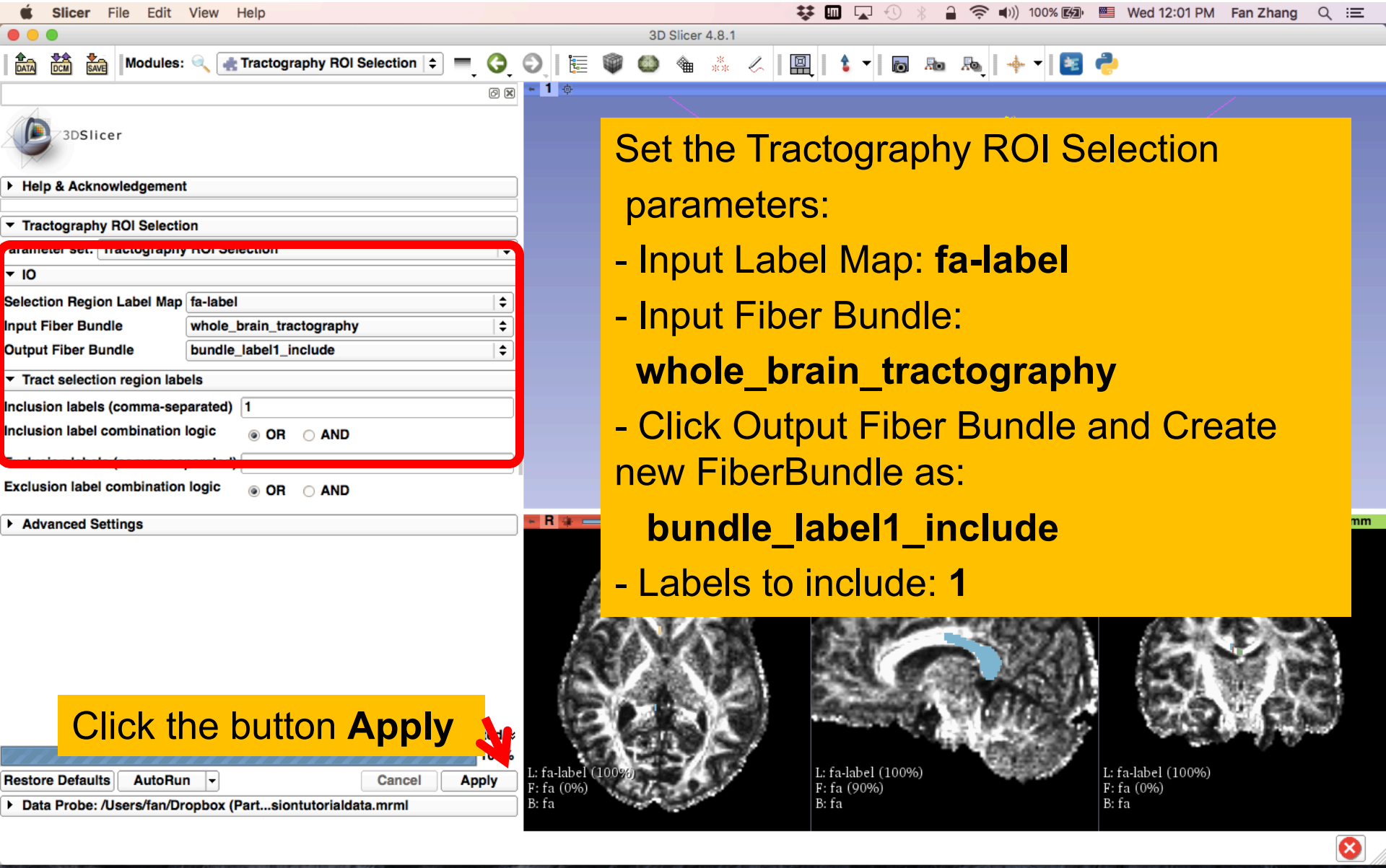


Whole brain tractography by seeding within the entire brain is displayed in the 3D view of Slicer

Tractography ROI Selection



Single Label Selection

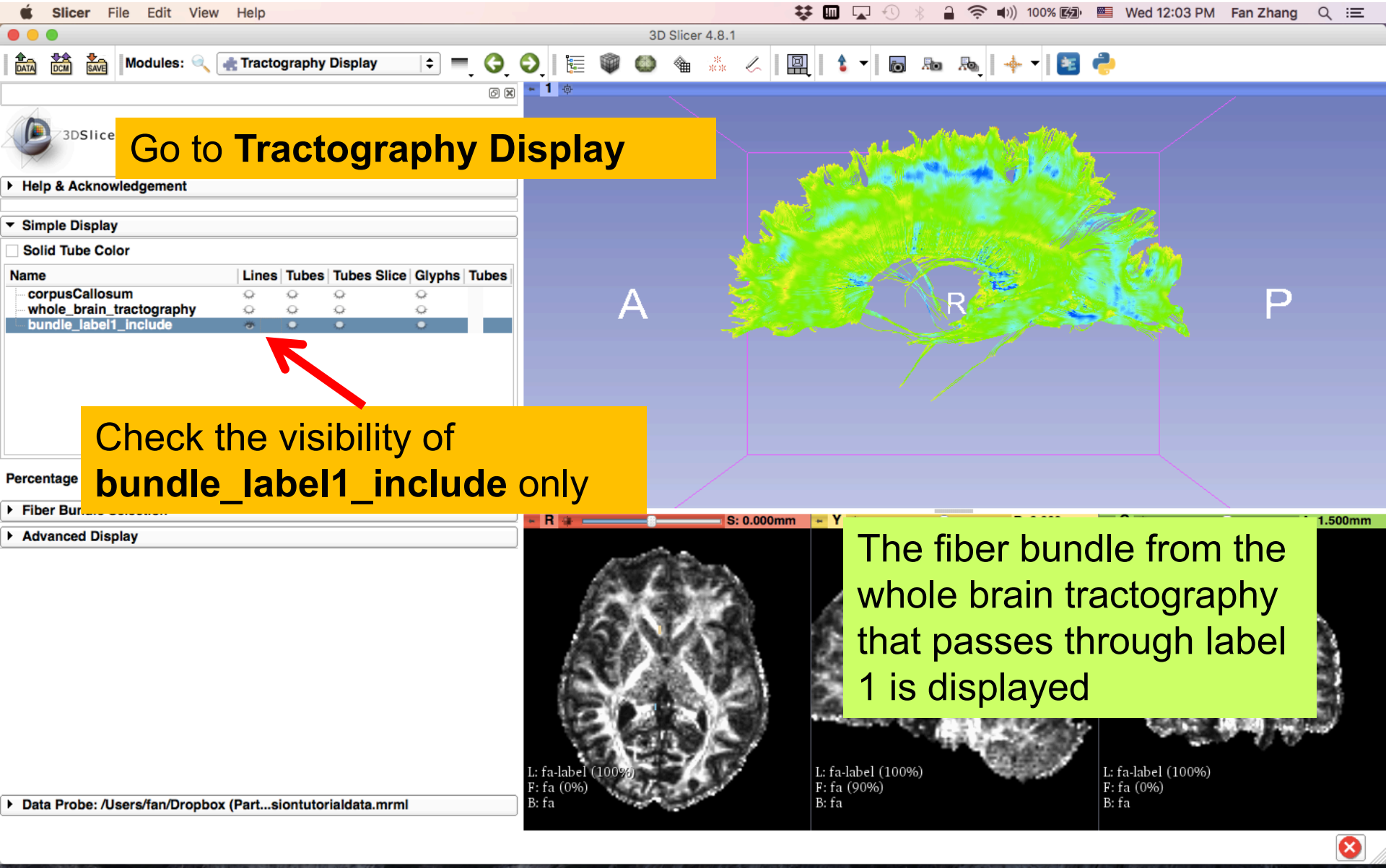


Set the Tractography ROI Selection parameters:

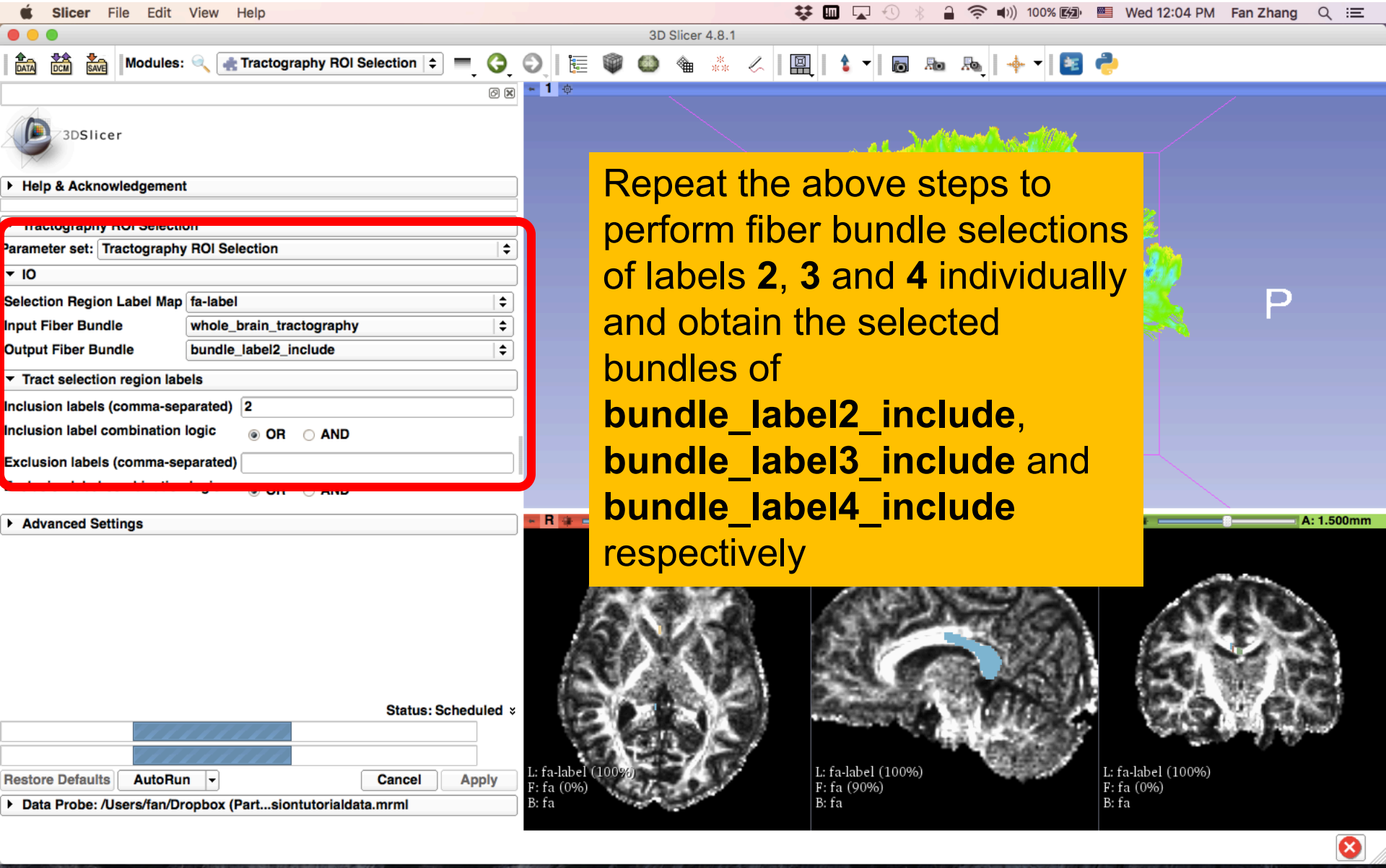
- Input Label Map: **fa-label**
- Input Fiber Bundle: **whole_brain_tractography**
- Click Output Fiber Bundle and Create new FiberBundle as: **bundle_label1_include**
- Labels to include: **1**

Click the button **Apply**

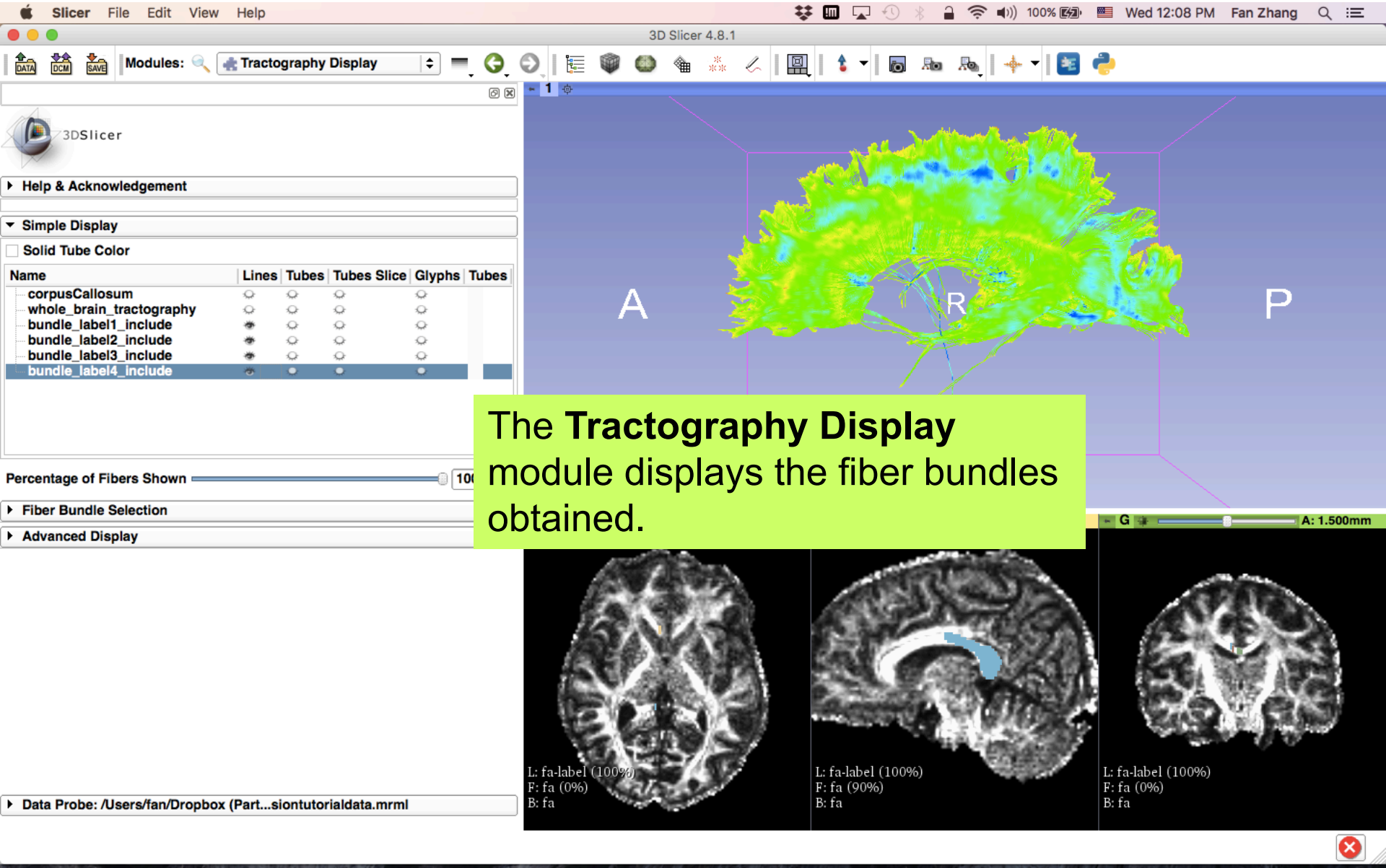
Single Label Selection



Single Label Selection

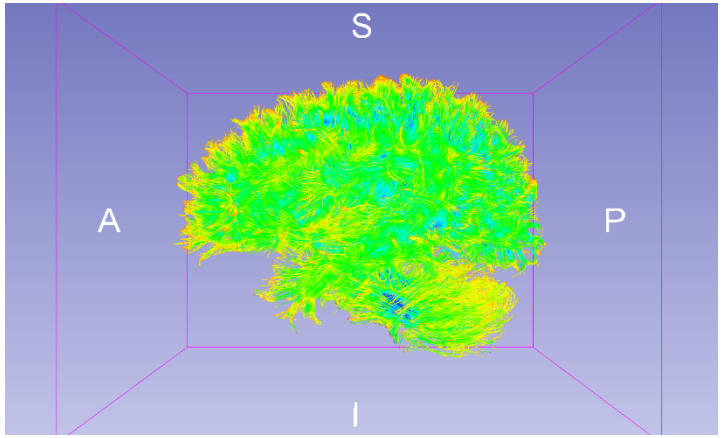


Single Label Selection

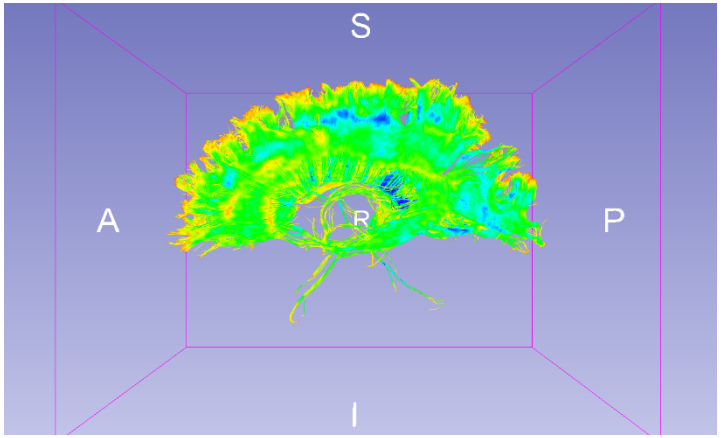


Single Label Selection

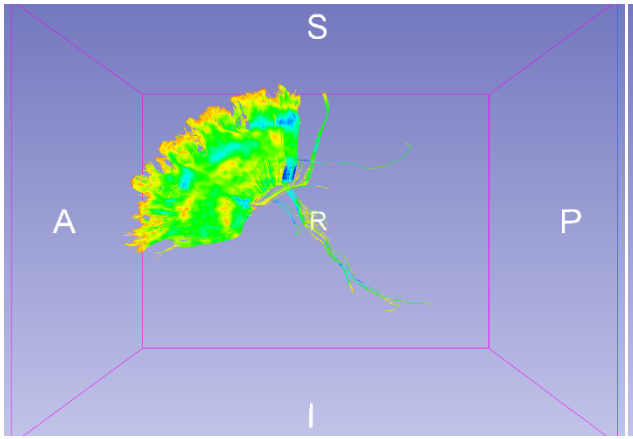
Whole Brain



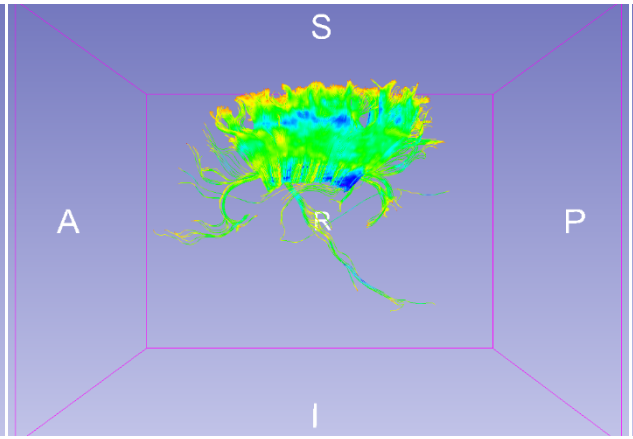
Label 1



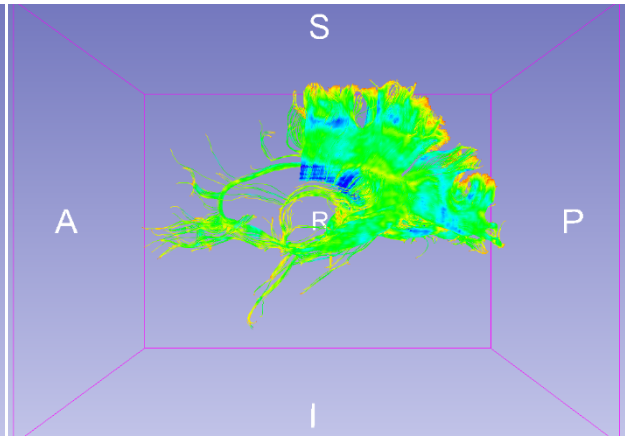
Label 2



Label 3



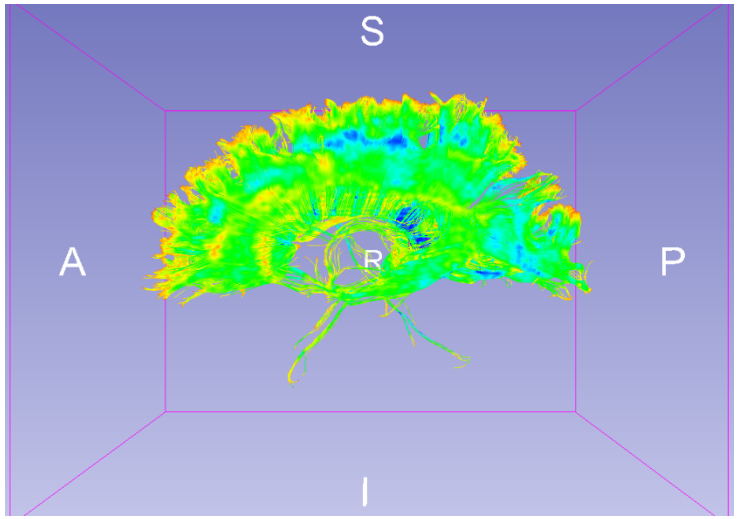
Label 4



Single Label Selection

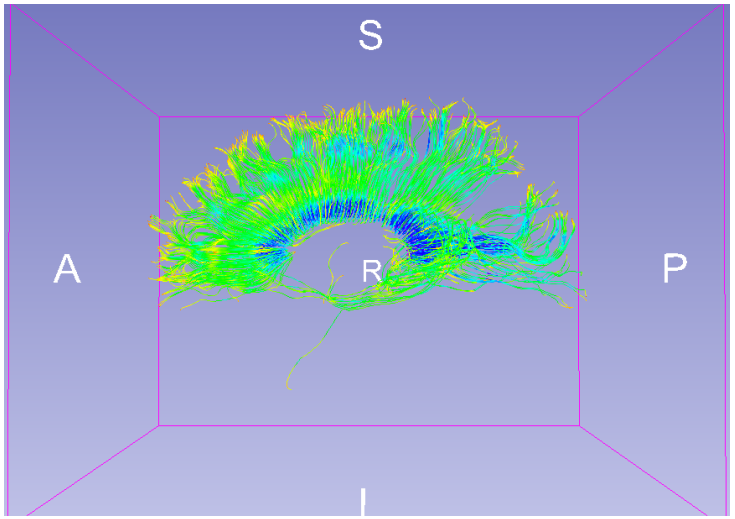
Notice that whole brain seeding creates a denser fiber bundle than seeding from the label 1.

Fiber Bundle Selection of Label 1 from the Whole Brain Tractography



V.S.

Fiber Bundle Obtained by Seeding within Label 1



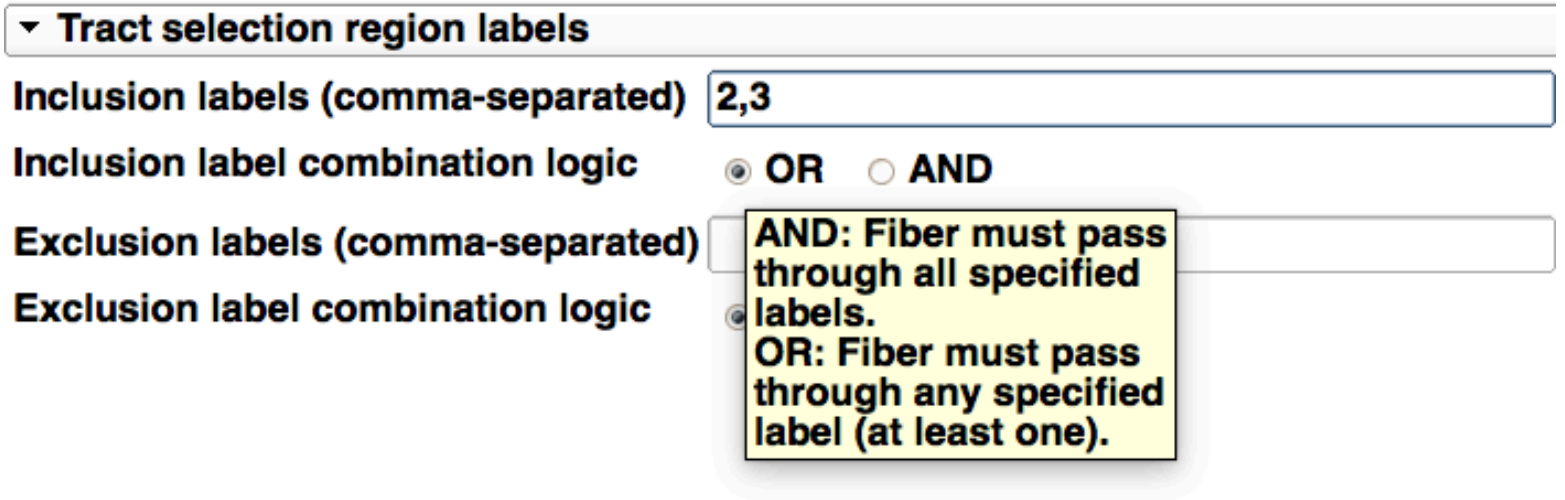
By viewing **corpusCallosum** loaded in the MRML file

Multiple Labels Selection

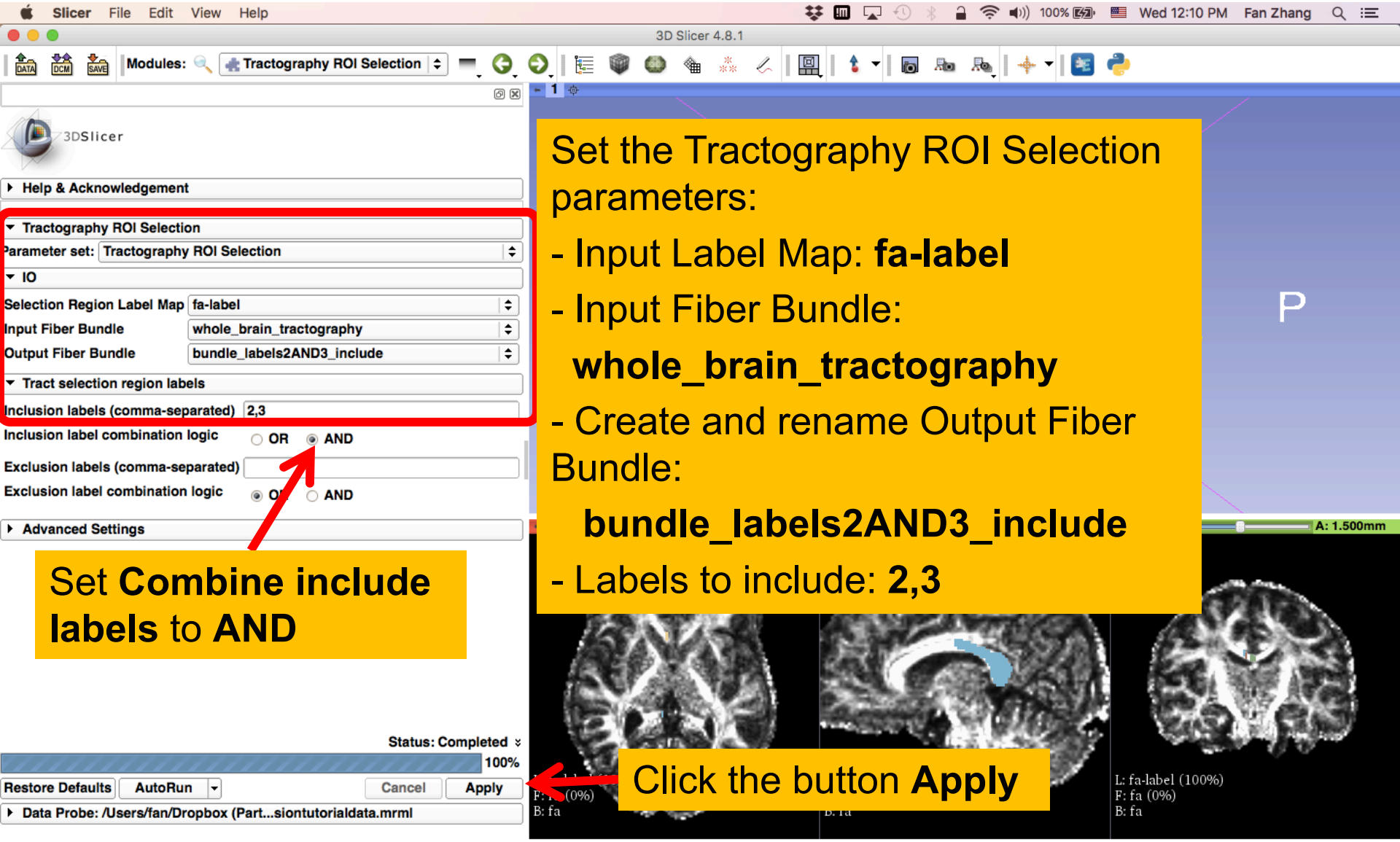
FiberBundleLabelSelect allows users to perform multiple labels selection by providing a list of labels and selecting one logical operation:

- **OR**: fiber bundles that pass through **any label** in the list

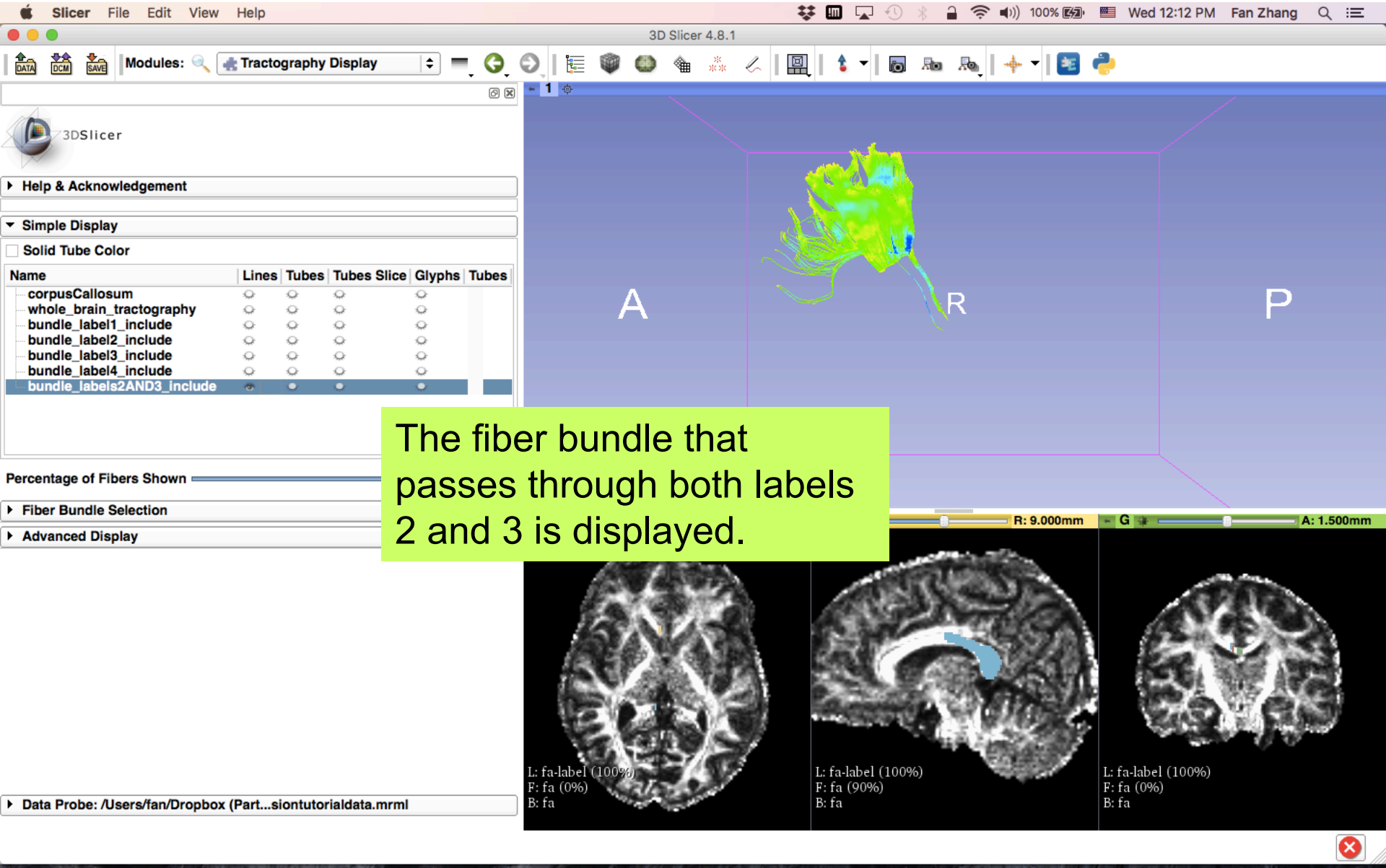
- **AND**: fiber bundles that pass through **all labels** in the list



Multiple Labels Selection (AND)

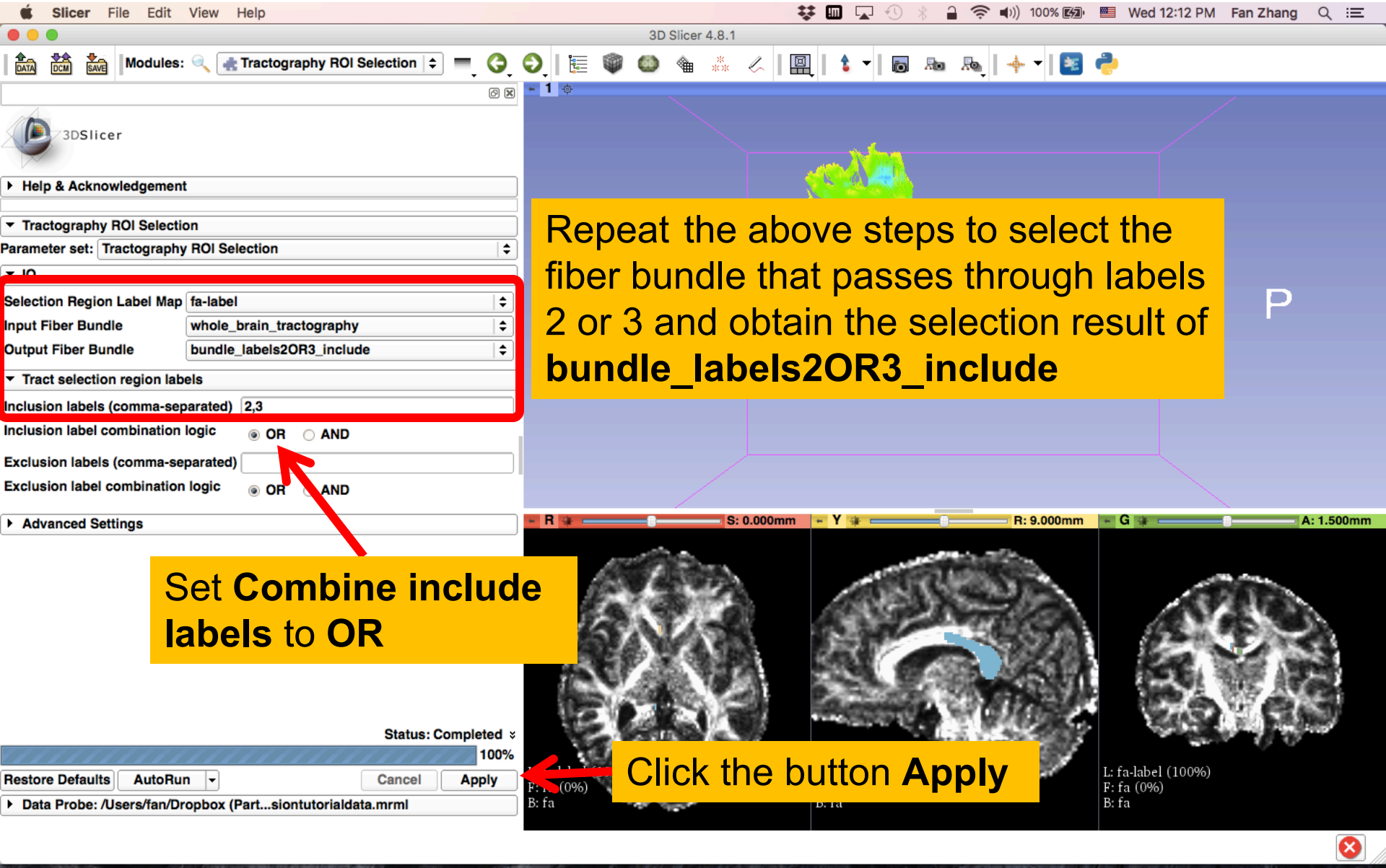


Multiple Labels Selection (AND)

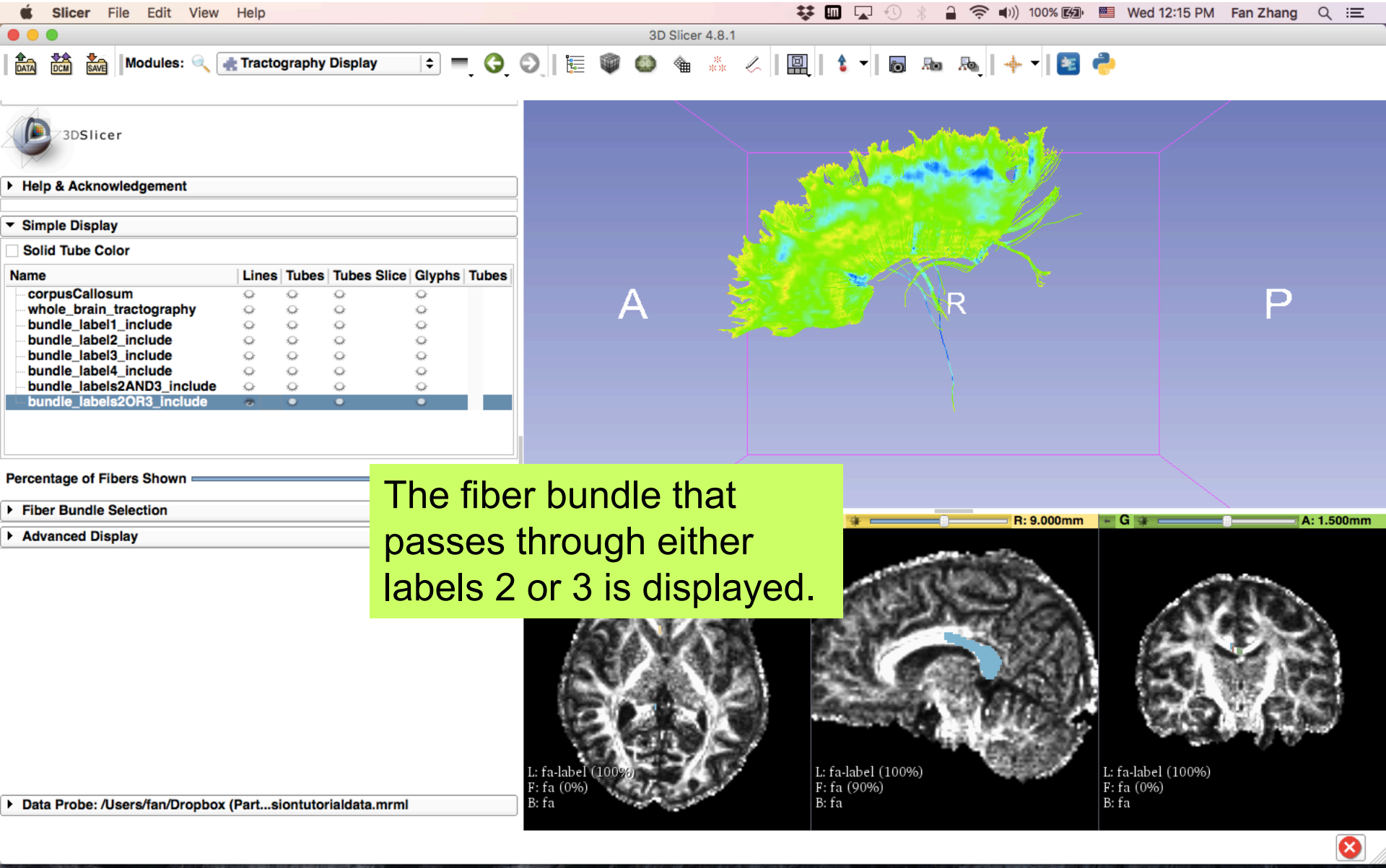


The fiber bundle that passes through both labels 2 and 3 is displayed.

Multiple Labels Selection (OR)



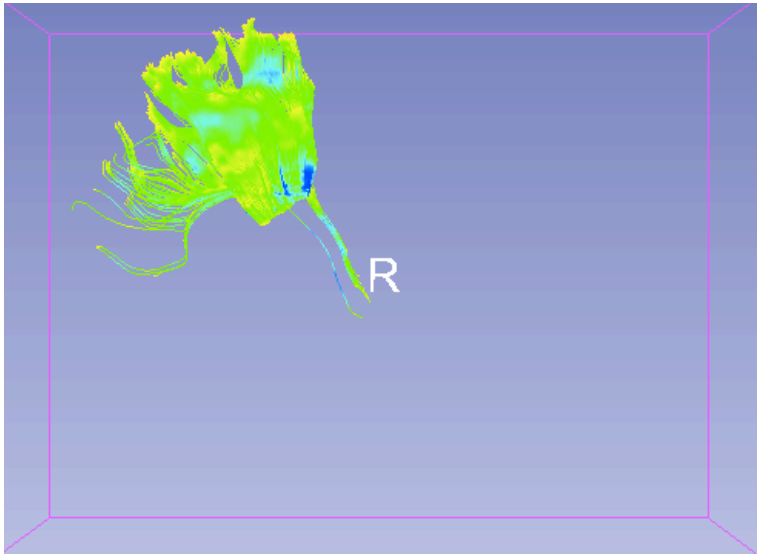
Multiple Labels Selection (OR)



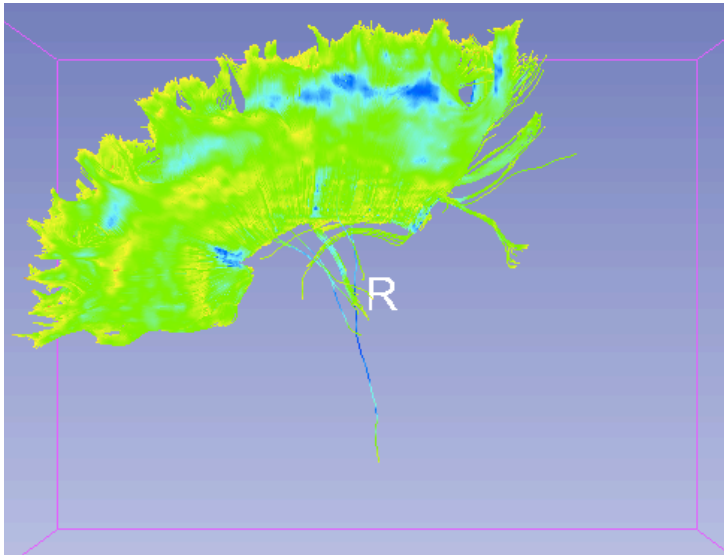
The fiber bundle that passes through either labels 2 or 3 is displayed.

Multiple Labels Selection

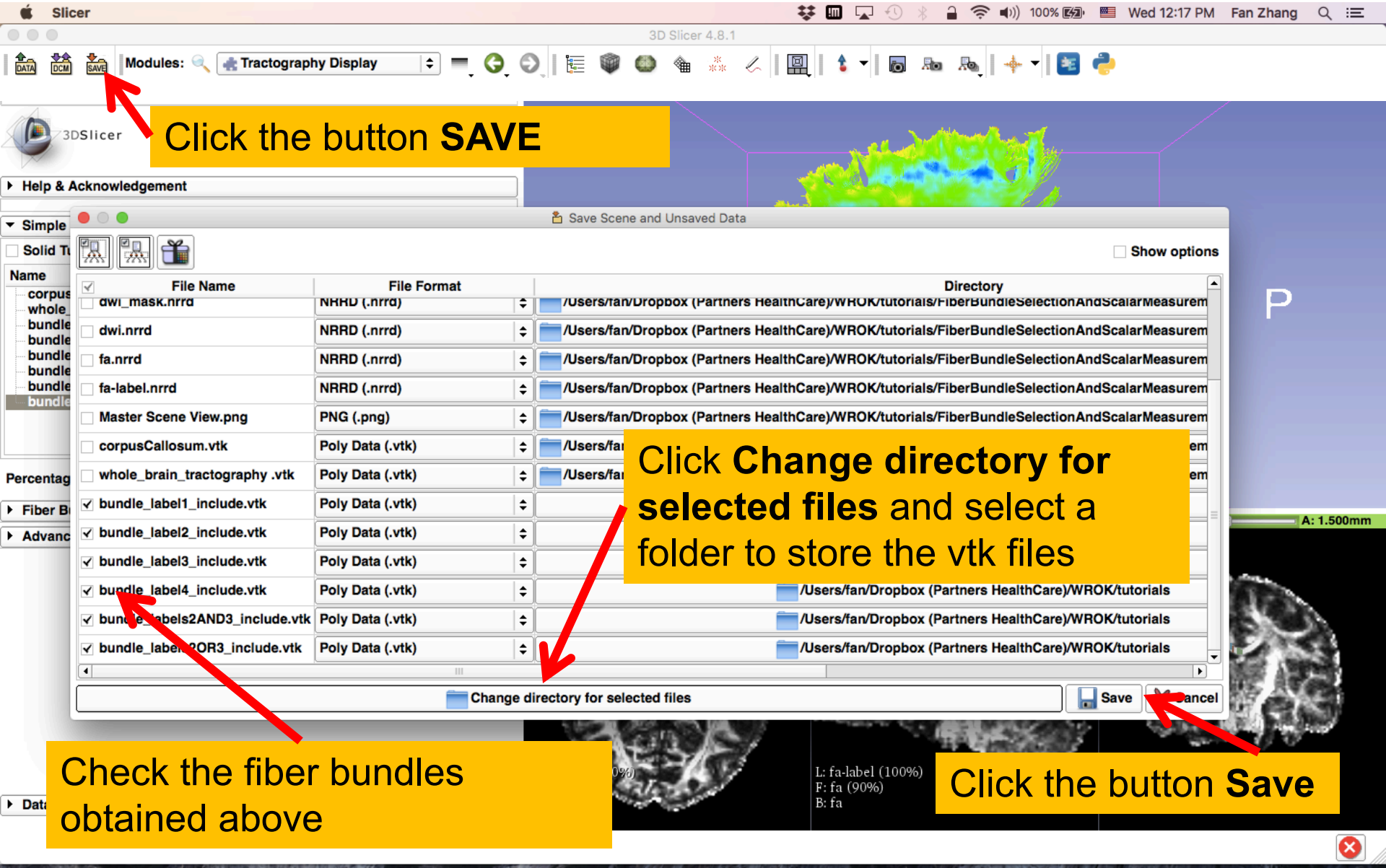
Labels 2 **and** 3



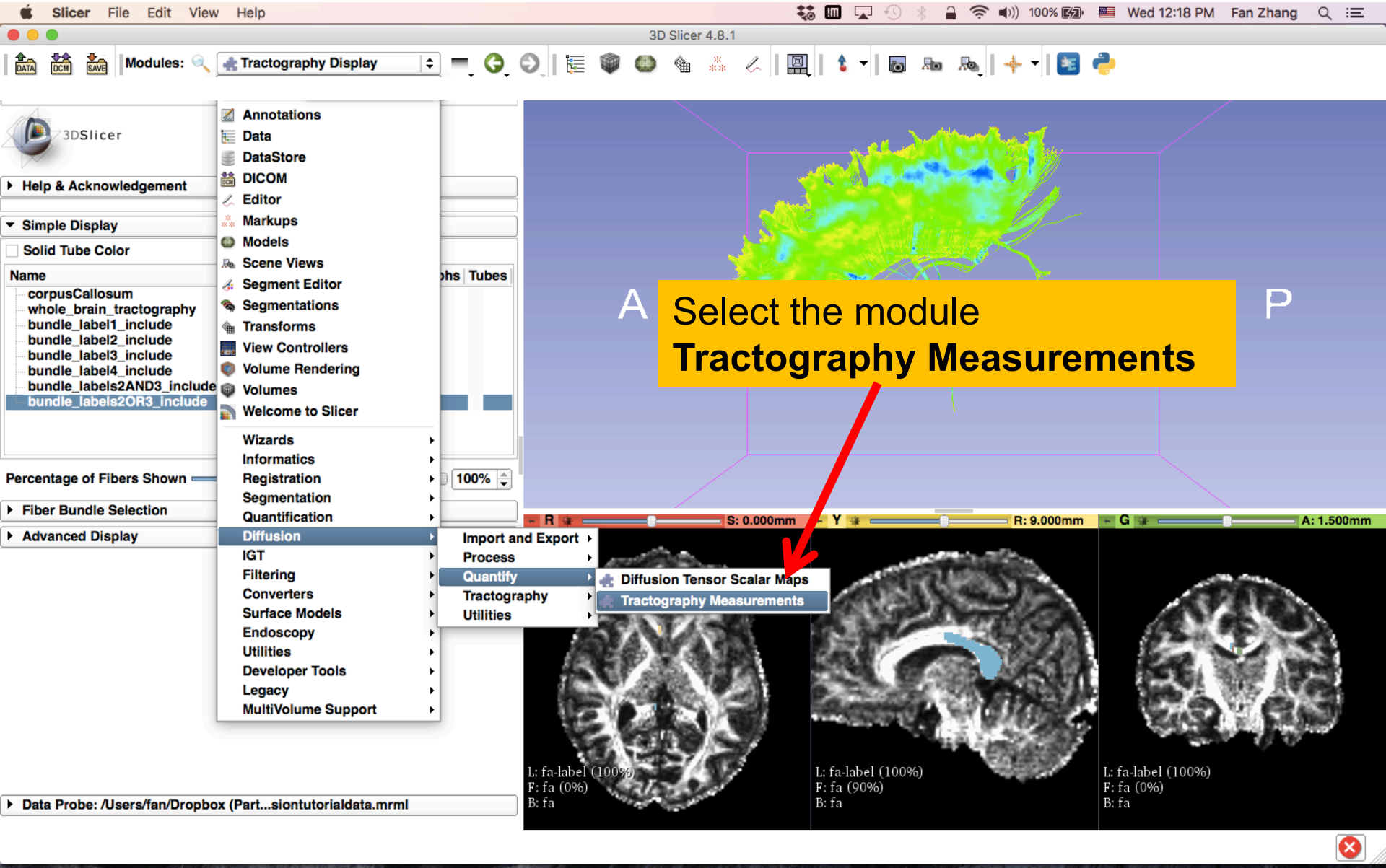
Labels 2 **or** 3



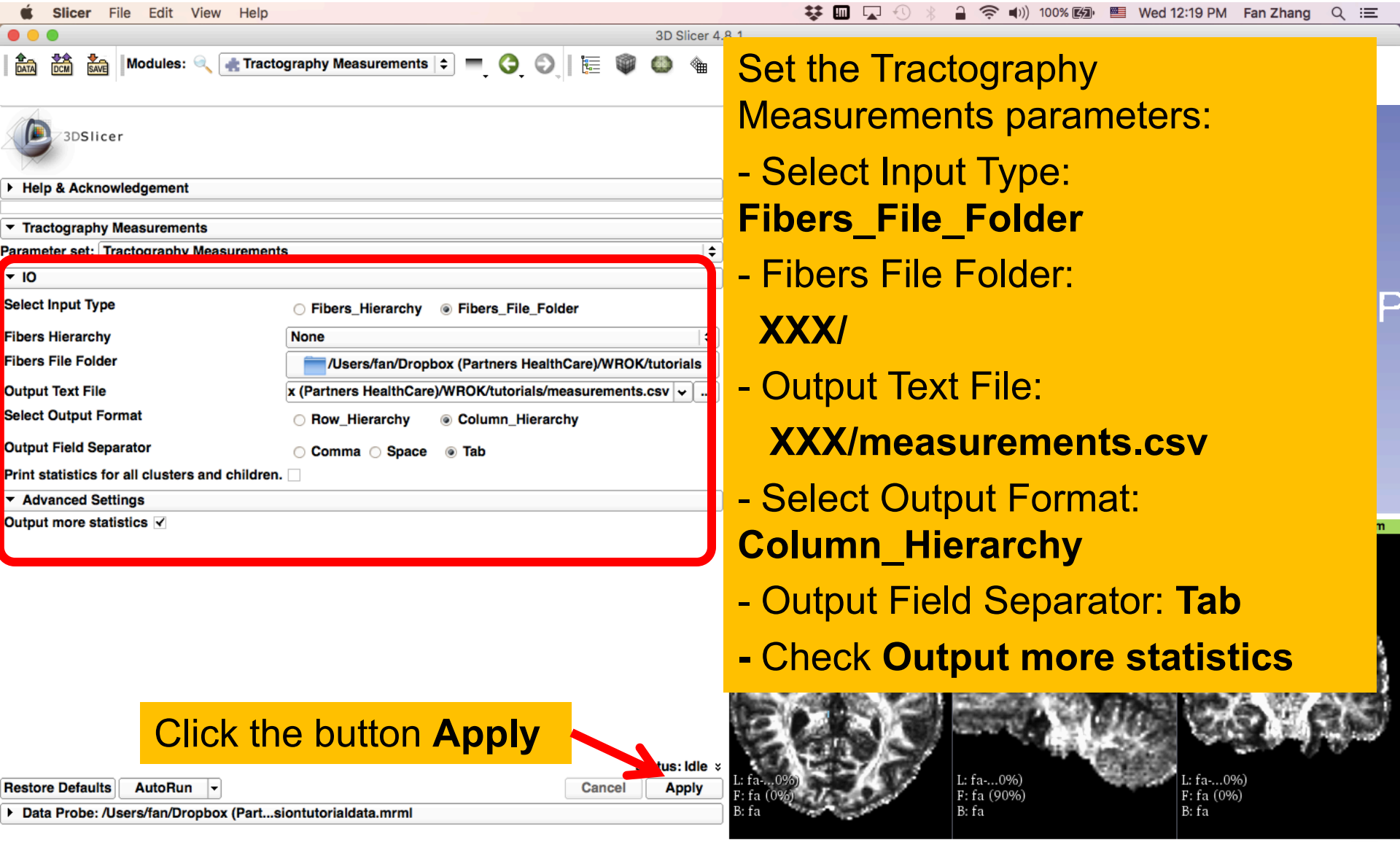
Save Fiber Bundles



Tractography Measurements



Tractography Measurements



Set the Tractography Measurements parameters:

- Select Input Type: **Fibers_File_Folder**
- Fibers File Folder: **XXX/**
- Output Text File: **XXX/measurements.csv**
- Select Output Format: **Column_Hierarchy**
- Output Field Separator: **Tab**
- Check **Output more statistics**

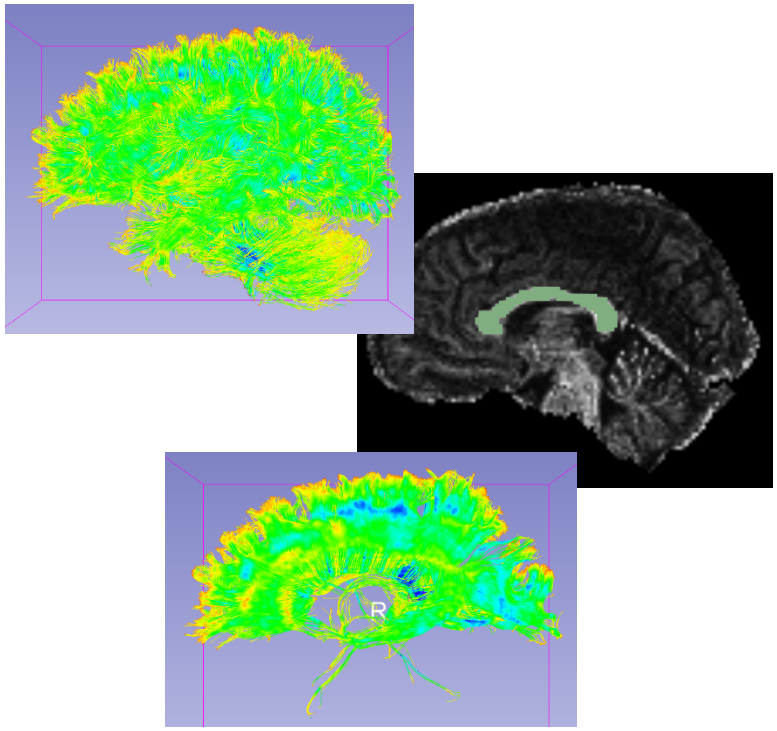
Click the button **Apply**

Tractography Measurements

The module outputted a CSV file listing the mean scalar value (such as FA and Trace) of each fiber bundle in the folder

	A	B	C	D	E	F	G	H
1	Name	Num_Points	Num_Fibers	Mean_Length	Num_Clamp_Excluded	Tensors_.FractionalAnisotropy.Max	Tensors_.FractionalAnisotropy.Mean	Tensors_.FractionalAnisotropy.Median
2	bundle_label1_include.vtk	2151800	16140	99.185761	1955	1	0.552109	0.529033
3	bundle_label2_include.vtk	617185	5483	83.621564	0	0.997704	0.512498	0.479581
4	bundle_label3_include.vtk	651843	5598	86.535613	0	0.997704	0.528475	0.512219
5	bundle_label4_include.vtk	1346359	8972	111.736367	1957	1	0.57416	0.55411
6	bundle_labels2AND3_include.vtk	171716	1630	78.215332	0	0.997704	0.518245	0.487751
7	bundle_labels2OR3_include.vtk	1097312	9451	86.280013	0	0.997704	0.521089	0.498575

Conclusion



This tutorial guided you through the fiber bundle label selection and fiber tract scalar measurements for conducting further tractography processing.

	A	B	C	D	E	F	G	H
1	Name	Num_Points	Num_Fibers	Mean_Length	Num_Clamp_Excluded	Tensors_.FractionalAnisotropy.Max	Tensors_.FractionalAnisotropy.Mean	Tensors_.FractionalAnisotropy.Median
2	bundle_label1_include.vtk	2151800	16140	99.185761	1955	1	0.552109	0.529033
3	bundle_label2_include.vtk	617185	5483	83.621564	0	0.997704	0.512498	0.479581
4	bundle_label3_include.vtk	651843	5598	86.535613	0	0.997704	0.528475	0.512219
5	bundle_label4_include.vtk	1346359	8972	111.736367	1957	1	0.57416	0.55411
6	bundle_labels2AND3_include.vtk	171716	1630	78.215332	0	0.997704	0.518245	0.487751
7	bundle_labels2OR3_include.vtk	1097312	9451	86.280013	0	0.997704	0.521089	0.498575

Acknowledgments

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Australian Research Council