



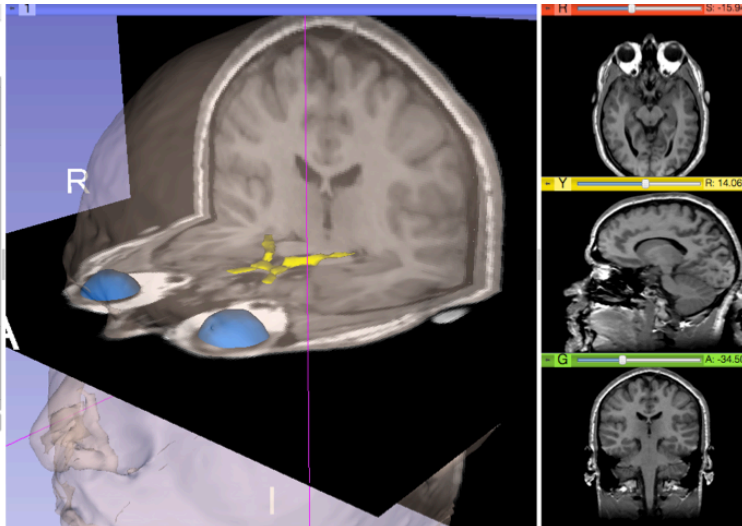
3DSlicer
Version 4.0

The 3D Slicer open-source platform for image analysis and 3D visualization

Junichi Tokuda, Ph.D., Nicole Aucoin, M.S. (Presenters)

Sonia Pujol, Ph.D.

Surgical Planning Laboratory,
Brigham and Women's Hospital, Harvard Medical School



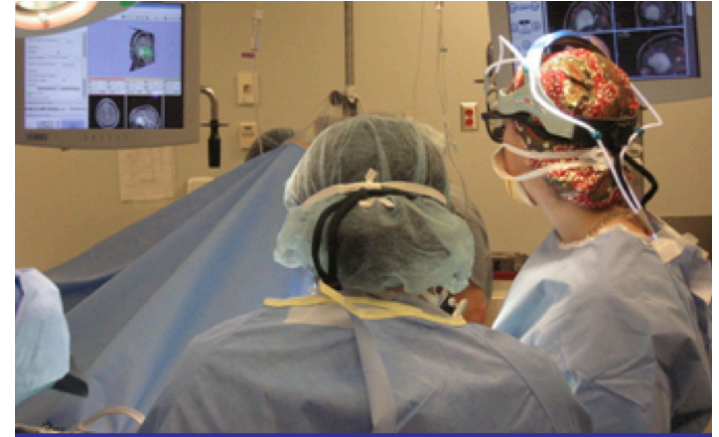
Part I – From algorithms to tools: the 3D Slicer software for translational research



Translational research



An **open-source environment**
for software developers



An **end-user application**
for clinical investigators
and scientists

3D Slicer: an open-source platform for
translating innovative algorithms into
clinical research applications



Slicer 16th year Anniversary

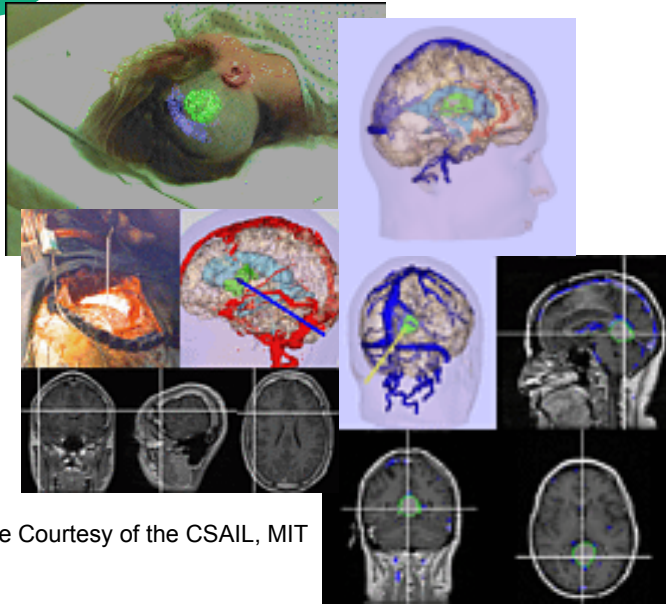
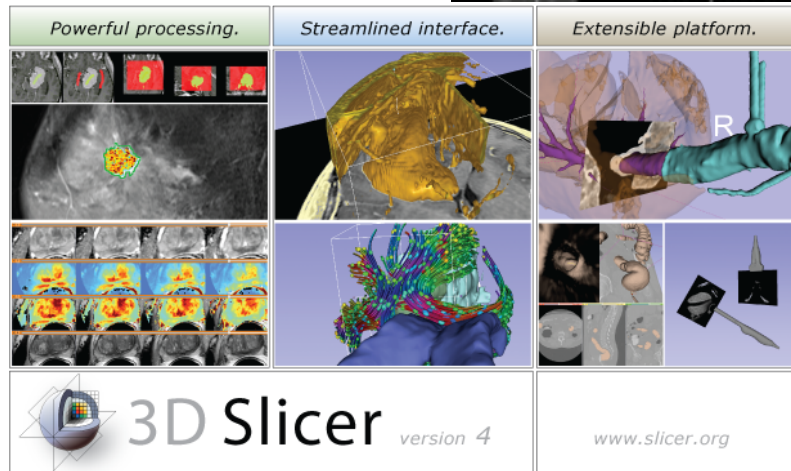


Image Courtesy of the CSAIL, MIT

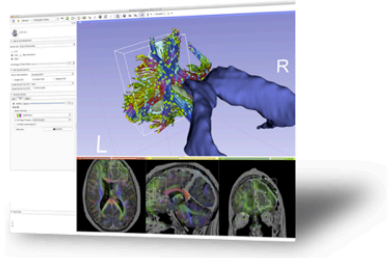
- 1997: Slicer started as a Master's thesis between the Surgical Planning Lab (Harvard) and the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL)
- 2013: International open-source platform developed through a multi-institution effort



P.I. Prof. Ron Kikinis, BWH, Harvard



3D Slicer in practice



Get Slicer 4.

Slicer 4 is the latest stable version of 3D Slicer, a free, comprehensive software platform for medical image analysis and visualization developed with NIH support.

3D Slicer is distributed under a permissive BSD-style open source license. It has a thriving user and developer community.

Pre-compiled binaries

	Windows	Mac OS X	Linux
stable release	64 bit 4.1.0 64 bit installer 2012-04-11 r19886 (159.6MB)	4.1.0 64 bit installer 2012-04-11 r19886 (236.9MB)	4.1.0 64 bit archive 2012-04-11 r19886 (251.5MB)
	32 bit 4.1.0 32 bit installer 2012-04-11 r19886 (153.3MB)		
nightly build	64 bit nightly 64 bit installer 2012-04-29 r19953 (160.4MB)	nightly 64 bit installer 2012-04-27 r19951 (237.4MB)	nightly 64 bit archive 2012-04-29 r19953 (252.0MB)
	32 bit nightly 32 bit installer 2012-04-29 r19953 (154.0MB)		

System requirements

Slicer requires 1GB of RAM absolute minimum, with more highly recommended. Common data sets may require 4GB or more RAM for processing. A fast graphics card or GPU that supports OpenGL is also recommended.

Slicer is built and tested on many hardware and software platforms. 3D Slicer runs on Microsoft Windows XP, Vista, and Windows 7; Mac OS X versions 10.5 (Leopard), 10.6 (Snow Leopard), and 10.7 (Lion); and a variety of Linux distributions.

- Slicer is free
- Slicer is open-source
- Slicer works on Windows, Linux, and Mac
- Slicer is distributed under a BSD-style license agreement with no restriction on use



Slicer Is Open

- Open Science
=
Open Source
+
Open Data
+
Open Community

Madrid 2012



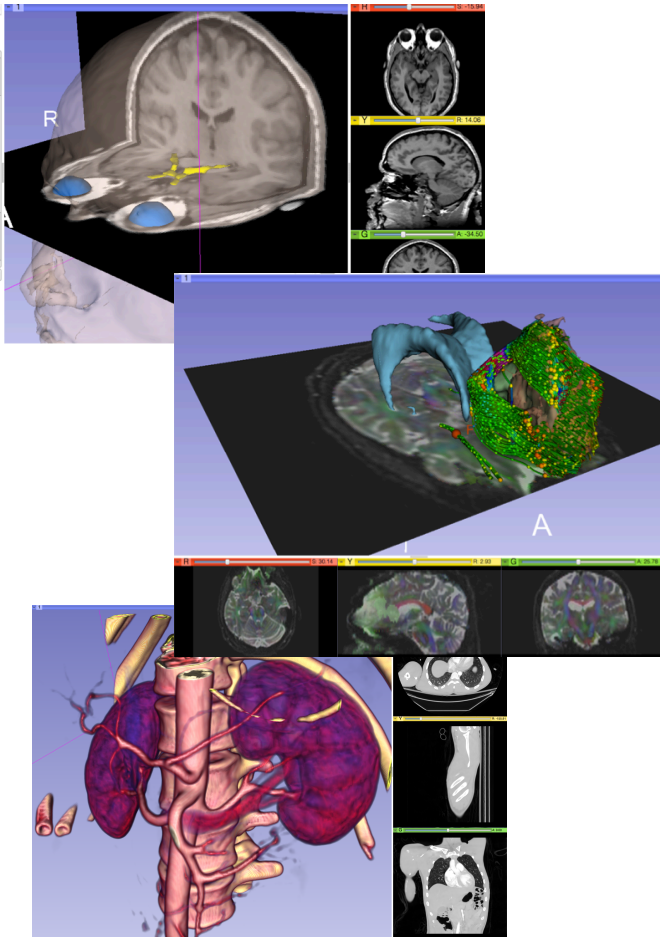
Iowa City, USA 2012



Courtesy R. Kikinis



Slicer Open Community



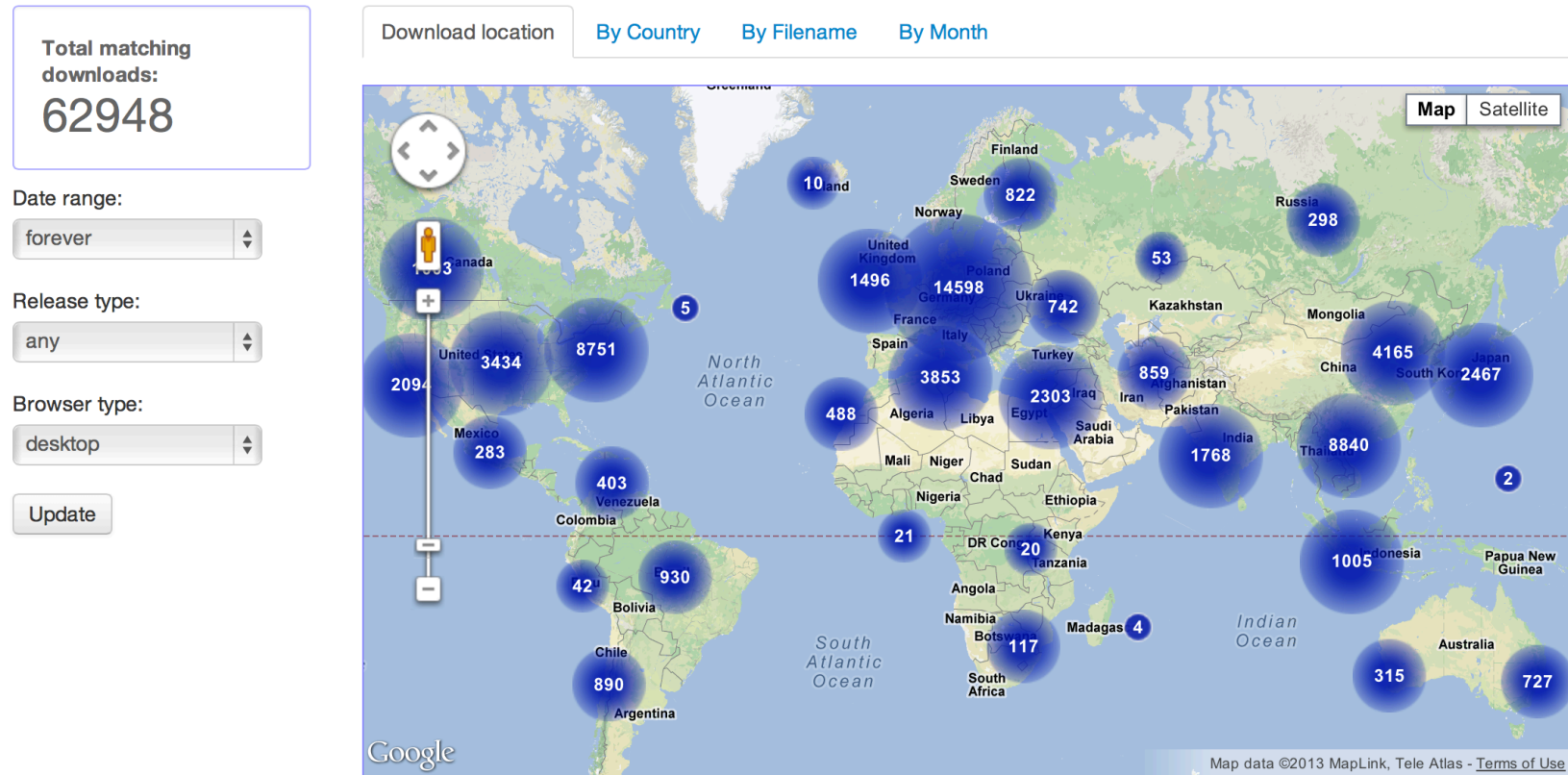
- 80 authorized developers contributing to the source code of Slicer
- Over 700 subscribers on Slicer user and Slicer developer mailing list



Nov.2011-March.2013 Downloads

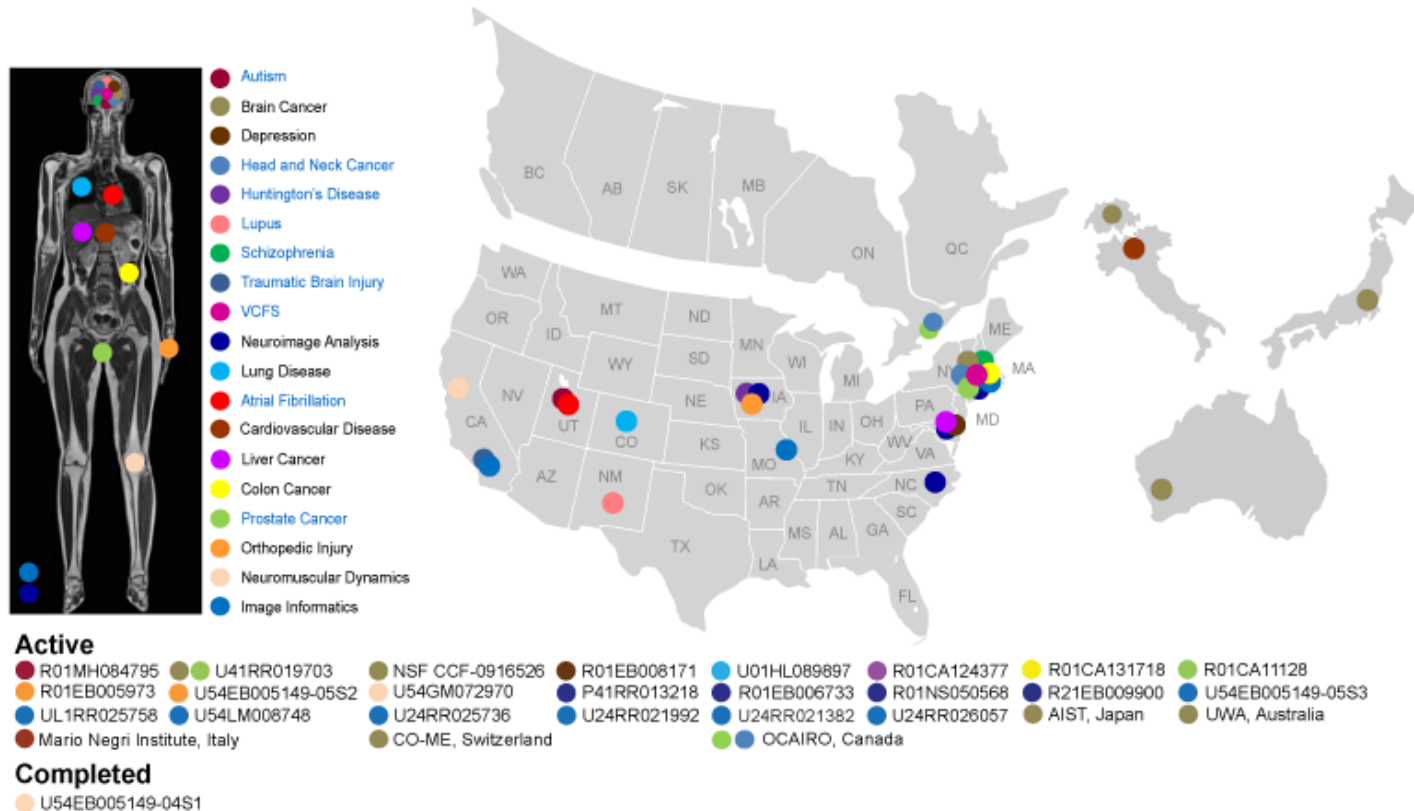


Slicer 4 download statistics





A Multi-institution Effort



- Infrastructure grants fund the platform
- Collaborative projects (e.g. Canada, Japan, Australia, Italy) fund the application packages



End-user Documentation

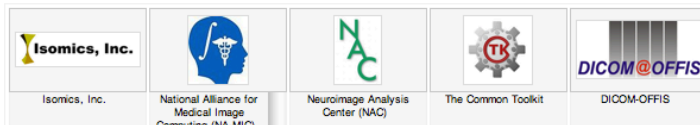
Documentation/4.1/Modules/DICOM

Home < Documentation < 4.1 < Modules < DICOM

Introduction and Acknowledgements

This work is part of the National Alliance for Medical Image Computing (NA-MIC), funded by the National Institutes of Health through the NIH Roadmap for Medical Research, Grant U54 EB005149. Information on NA-MIC can be obtained from the [NA-MIC website](#).

Author: Steve Pieper, Isomics, Inc.
Contributor1: Michael Onken, Offis
Contributor2: Marco Nolden, DFKZ
Contributor3: Julien Finet, Kitware
Contributor4: Stephen Aylward, Kitware
Contributors: Nicholas Hertlambang, AZE
Contact: Steve Pieper, pieper@bwh.harvard.edu

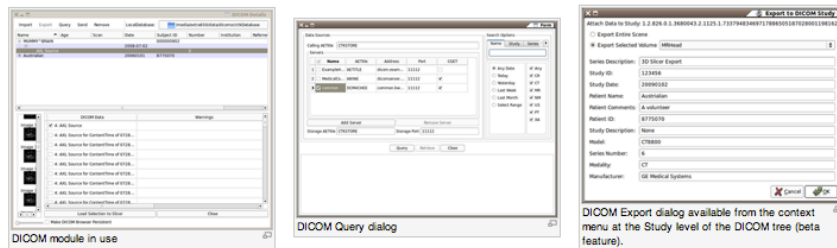


Module Description

Provides DICOM local database and networking support.

- A new DICOM infrastructure was put in place beginning with Slicer 4.0.
- DICOM data is stored in a local data base, which is based on SQLite.
- DICOM data can be imported from disk into this data base.
- DICOM data can be retrieved from a PACS system after proper configuration of Slicer.
- DICOM data can be loaded into Slicer from the local database. A graphical user interface with display of thumbnails is available for data selection.
- Plans for the near future, include support for storing data from slicer into the data base and uploading data from the data base into a PACS system.

Use Cases



Tutorials

Links to tutorials that use this module (not yet available)

Panels

Parameters:

Servers

- **Start/Stop Listener:** Control external process that listens for network connections to populate the local database. The listener port is controlled by the setting in the [Preferences](#) dialog.

- Wiki-based web pages accompany every module of Slicer and provide reference documentation of functionality and usage examples.



Developer Documentation

3DSlicer

search
Google Custom Search
GO

navigation
Slicer Website
Wiki Home
Slicer Downloads
Training
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Documentation/4.1/Developers/Tutorials/ModuleWriting

Home < Documentation < 4.1 < Developers < Tutorials < ModuleWriting

CONTENTS [hide]
1 Consider also reading
2 Initialization
2.1.1 Create the module directory

Slicer 4.1
Slicer is a multi-platform, free and open source software package for visualization and medical image computing

Main Page Related Pages Modules Namespaces **Classes** Files Directories Examples

Class List Class Index Class Hierarchy Class Members

Class Index

A B C D E F G H I J K L M N O P Q R S T U V W X Y _

A
qSlicerAboutDialog
qSlicerAbstractCoreModule
qSlicerAbstractModule
qSlicerAbstractModuleFactoryManager
qSlicerAbstractModulePanel
qSlicerAbstractModuleRepresentation
qSlicerAbstractModuleWidget
qSlicerActionsDialog
AffineImageToImageRegistrationMethod (itk)
AnisotropicSimilarity3DTransform (itk)
vtkAnnotation2DImageRepresentation
vtkAnnotation2DImageWidget
qMRMLAnnotationDisplayNodePropertyWidget
qMRMLAnnotationDisplayNodePropertyWidget
vtkAnnotationGlypSource2D
qSlicerAnnotationModulePropertyDialog
qSlicerAnnotationModuleReportDialog
qSlicerAnnotationModuleSnapShotDialog
qSlicerAnnotationModuleWidget
qSlicerAnnotationModuleWidgetsAbstractPlugin
qSlicerAnnotationModuleWidgetsPlugin
vtkAnnotationROIRepresentation
vtkAnnotationROIRepresentation2D
vtkAnnotationROIWidget
qMRMLAnnotationROIWidget
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qSlicerAnnotationsModule
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qSlicerApplication
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BoundMethodWeakref (safer)
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BSplineImageToImageRegistrationMethod (itk)
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TimeSeriesDatabaseCacheBlock (itk)

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IdentifyIslandsEffectOptions
(EditorLib:IdentifyIslandsEffect)
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(EditorLib:IdentifyIslandsEffect)
IdentifyIslandsOptions (EditorLib:EditOptions)
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vtkICTOpenTrackerStream
vtkICTP22imgRegistration
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vtkImageConnectivity
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vtkImageFillROI
vtkImageGetTensorComponents
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vtkImageLabelCombine
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vtkImageNeighborhoodFilter
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ImageRegistrationViewer
vtkImageResliceMask
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vtkImageSlicePush
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ImageToImageRegistrationMethod (itk)
ImageToImageRegistrationMethodTestingHelper (itk)
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ImplicitRectangularOptions (EditorLib:EditOptions)
InitialImageToImageRegistrationMethod (itk)
qSlicerIO
qSlicerIOManager
qSlicerIOOptions
qSlicerIOOptionsWidget
jDataUnion
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IslandEffectLogic (EditorLib:IslandEffect)
IslandEffectOptions (EditorLib:IslandEffect)
IslandEffectTool (EditorLib:IslandEffect)
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vtkITKArchetypeImageSeriesReader
vtkITKArchetypeImageSeriesScalarReader

vtkMRMLTransformNode
vtkMRMLTransformStorageNode
vtkMRMLUnstructuredGridDisplayNode
vtkMRMLUnstructuredGridNode
vtkMRMLUnstructuredGridStorageNode
vtkMRMLVectorVolumeDisplayNode
vtkMRMLVectorVolumeNode
vtkMRMLViewDisplayableManager
vtkMRMLViewNode
vtkMRMLVolumeArchetypeStorageNode
vtkMRMLVolumeDisplayNode
vtkMRMLVolumeGlyphSliceDisplayableManager
vtkMRMLVolumeHeaderlessStorageNode
vtkMRMLVolumeNode
vtkMRMLVolumePropertyNode
vtkMRMLVolumePropertyStorageNode
vtkMRMLVolumeRenderingDisplayableManager
vtkMRMLVolumeRenderingDisplayNode
vtkMRMLVolumeRenderingScenarioNode
vtkMRMLXYPivotManagerNode
qSlicerMultiVolumeRenderingModule
qSlicerMultiVolumeRenderingModuleWidget

N
N3BiasFieldScaleCostFunction (itk)
N3MRIBiasFieldCorrectionImageFilter (itk)
N4MRIBiasFieldCorrectionImageFilter (itk)
qMRMLNavigationView
qMRMLNavigationViewPlugin
NewOtsuThresholdImageCalculator (itk)
NewOtsuThresholdImageFilter (itk)
qMRMLNodeComboBox
qMRMLNodeComboBoxDelegate
qMRMLNodeComboBoxMenuDelegate
qMRMLNodeComboBoxPlugin
qMRMLNodeFactory
qMRMLNodeSelectorPlugin
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vtkNRDWriter

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vtkObserverManager
OptimizedImageToImageRegistrationMethod (itk)
OtsuStatistics (itk)
OtsuThreshold (itk)

P
PaintEffect (EditorLib:PaintEffect)
PaintEffectLogic (EditorLib:PaintEffect)
PaintEffectOptions (EditorLib:PaintEffect)

Code examples
and Doxygen
source code
API
documentation



Slicer Bug Tracker

My View - Mantis

http://www.na-mic.org/Bug/my_view_page.php

Google

Logged in as: *spujol* (Sonia Pujol - reporter)

2012-04-28 05:35 EDT

Project: Slicer4 Switch 133

[Main](#) | [My View](#) | [View Issues](#) | [Report Issue](#) | [Change Log](#) | [Roadmap](#) | [Docs](#) | [My Account](#) | [Logout](#)

Issue # Jump

Unassigned [^] (1 - 10 / 29)

0001951

Resample Scalar/Vector/DWI module does not accept DWI input
Command Line Modules (Modules/CLI) - 2012-04-26 15:09

0001938

Volume rendering volume received from OpenIGTLink
Base Code - 2012-04-24 16:53

0001930

Scrolling volume slices past the last slice
Usability - 2012-04-23 19:23

0001929

Texts in 3D are hard to see
Usability - 2012-04-23 15:36

0001918

Color scale
Usability - 2012-04-18 11:58

0001915

Effect of matrix bottom row in Transforms module
Base Code - 2012-04-18 10:12

0001910

Problem with fiducial registration
Command Line Modules (Modules/CLI) - 2012-04-17 03:11

0001899

Saving and reopening .nrrd problem
Usability - 2012-04-12 12:43

0001887

sceneview roundtrip problem with LUT and with VR
MRML - 2012-04-11 22:56

0001888

Ensure Capitalization rule is respected all over Slicer
GUI - 2012-04-10 10:55

Reported by Me [^] (1 - 10 / 37)

0001894

EM Segmenter labelmap opacity
EMSegmenter - 2012-04-25 20:59

0001389

Tract Visibility
Diffusion - 2012-04-18 10:27

0001893

Download of Sample MR head data failed
Base Code - 2012-04-11 16:33

0001845

GUI issue in red slicer viewer mode on Mac
GUI - 2012-04-11 09:17

0001892

Colors Module GUI: LUT label values issue
Base Code - 2012-04-10 20:29

0001873

Saving a scene with a new LUT
Base Code - 2012-04-10 15:23

0001844

Maximum path length - Fiducial seeding
Diffusion - 2012-04-07 12:23

0001867

Restoring a scene view with tract intersection
Diffusion - 2012-04-07 12:21

0001866

Saving Scene: path update issue
Base Code - 2012-04-06 12:06

0001778

Tractography Display module
Diffusion - 2012-04-06 11:37

Resolved [^] (1 - 10 / 130)

0001204

Centralize revision/version/name of Slicer
Packaging - 2012-04-26 18:53

0001167

Fix warning related to SlicerFunctionGenerateExtensionDescription
Building (CMake, Superbuild) - 2012-04-26 17:24

0001677

SVN download of loadable extension modules does not work
Base Code - 2012-04-26 16:51

0001747

windows build/run issues as of svn 19350
Building (CMake, Superbuild) - 2012-04-26 16:06

0001863

To avoid _RegisterApplication / _CGSDefaultConnection error, create a template of launchd file for dashboard
Building (CMake, Superbuild) - 2012-04-26 12:38

0001940

No version in mac bundle
Packaging - 2012-04-26 10:31

0001645

update of the mouse mode toolbar
GUI - 2012-04-25 16:22

0001593

Untoggle "Place a fiducial" on click
Annotations - 2012-04-25 16:22

0001936

make RAS box axis labels visibility camera dependent
Usability - 2012-04-24 11:35

0001923

{{documentation/({documentation/version})/module-category}} doesn't support extra newline spacing in XML
Documentation - 2012-04-23 13:47

Recently Modified [^] (1 - 10 / 776)

0001855

Link errors during CTK build
Building (CMake, Superbuild) - 2012-04-27 17:03

0001868

crash on exit and other issues
Scripting (Wrapping, Python) - 2012-04-27 17:00

0001850

Found PythonLibs: ... get_filename_component unknown component optimized
Building (CMake, Superbuild) - 2012-04-27 16:59

0001955

EMSegmenter shows up red in Modules Setting but works fine
Base Code - 2012-04-27 16:44

0001954

drag & drop: option to lock view settings
GUI - 2012-04-27 10:04

0001942

Model to Label Map not working
Diffusion - 2012-04-27 07:46

0001941

Extensions download from SVN repository fails
Extensions - 2012-04-26 21:52

0001952

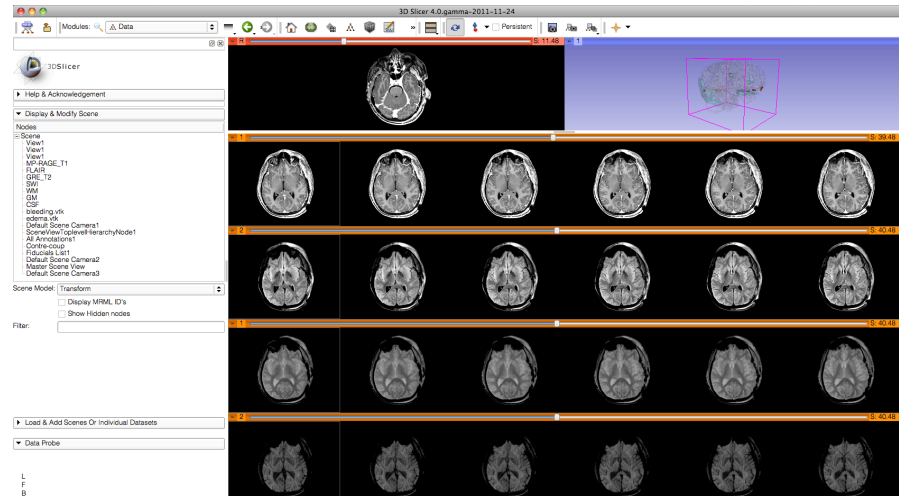
camera position after loading scene
GUI - 2012-04-26 20:13

0001486

VTK Qt designer plugins are missing
Packaging - 2012-04-26 19:26

0001145

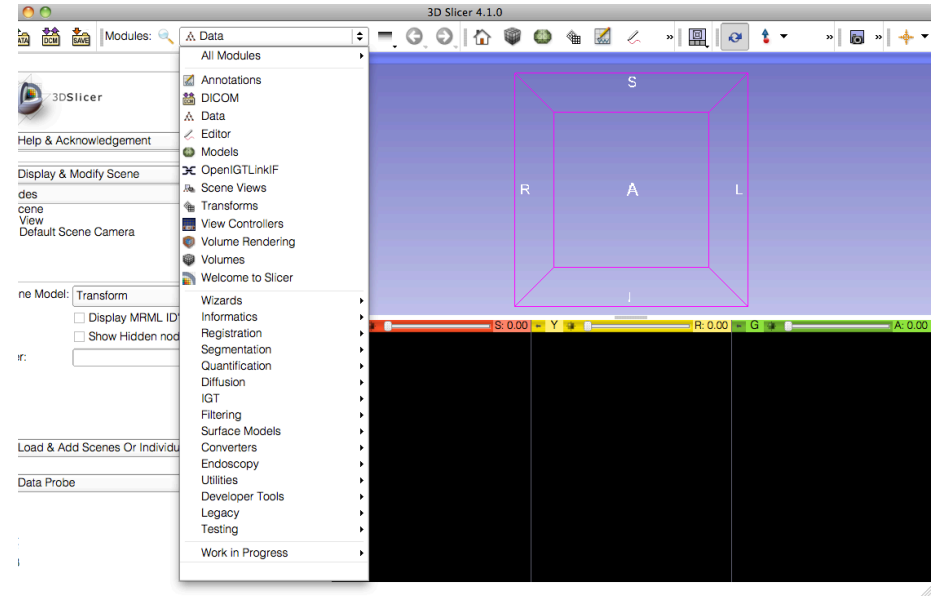
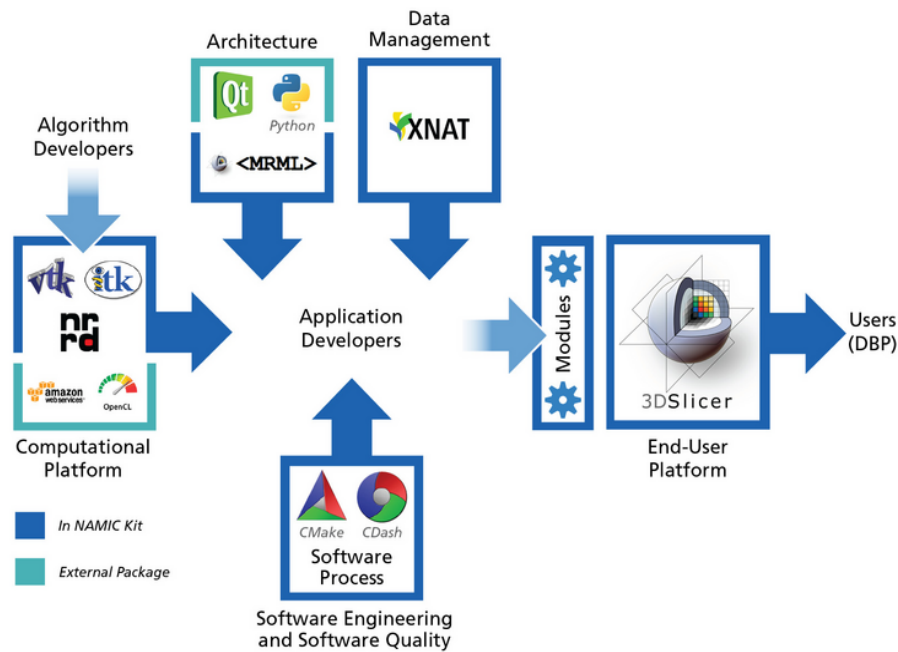
Add Test to make slicer starts
Base Code - 2012-04-26 19:04



SLICER FUNCTIONALITIES

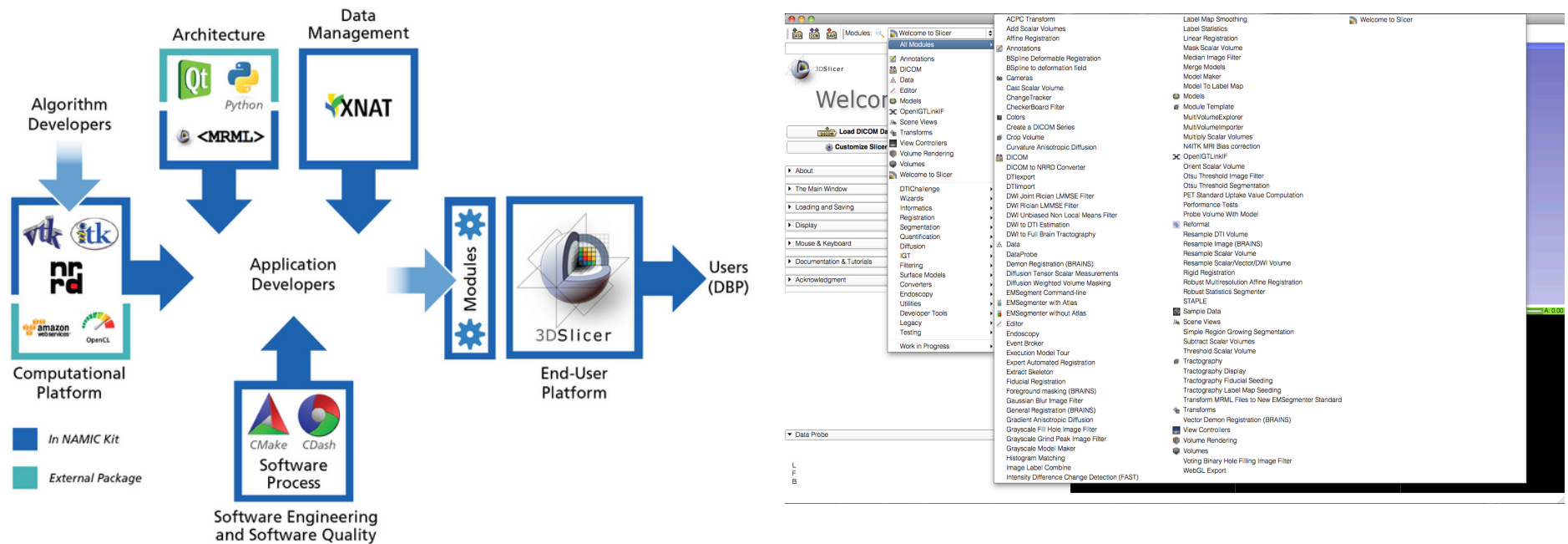


Core Functionalities





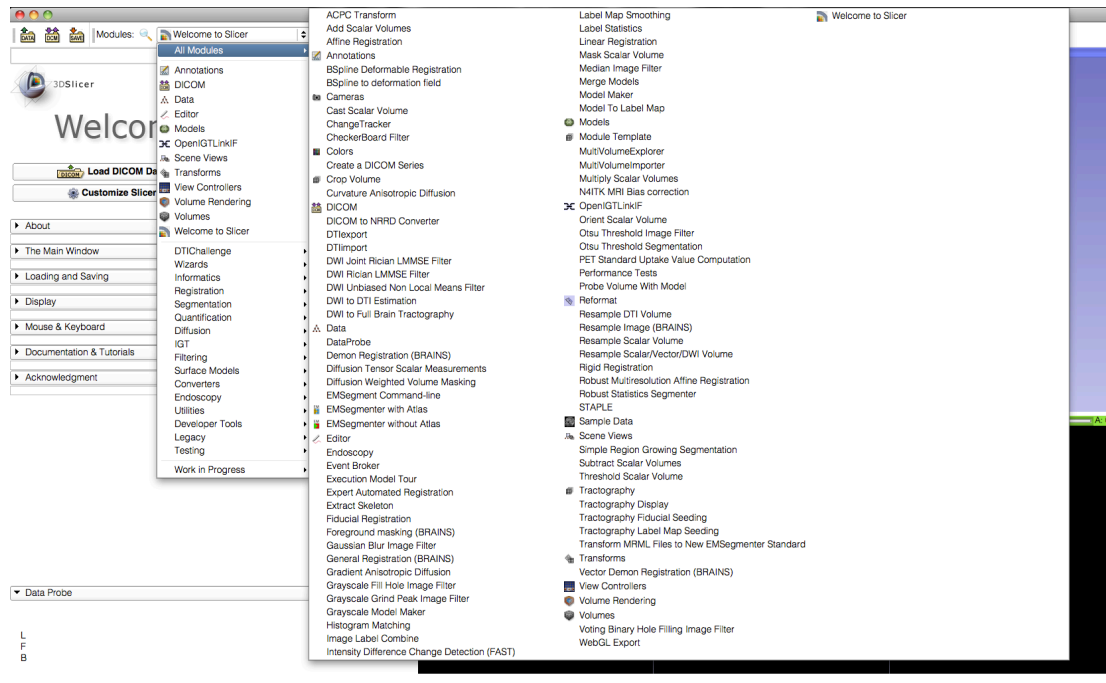
Core Functionalities



Slicer4 core functionalities include 108 modules, and represent 700,000 lines of code



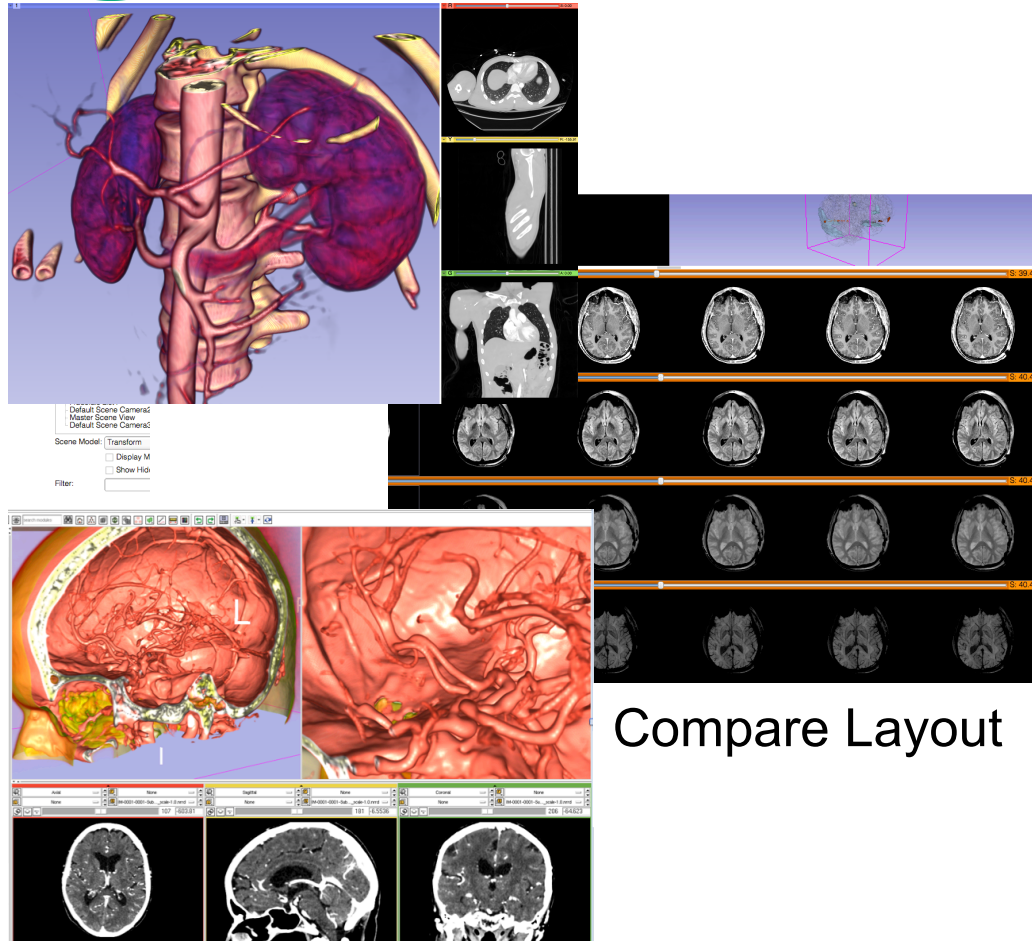
Core Functionalities



- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification
- Reporting



Core Functionalities



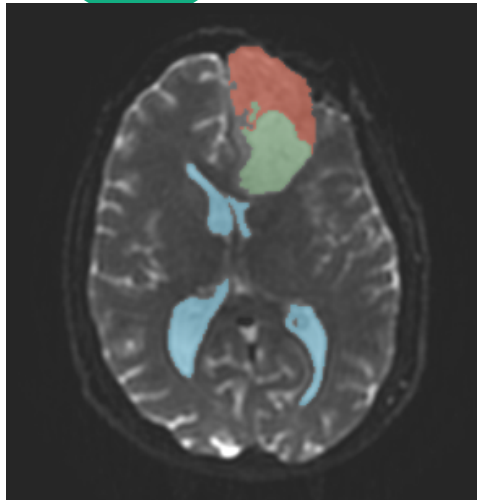
- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification

Compare Layout

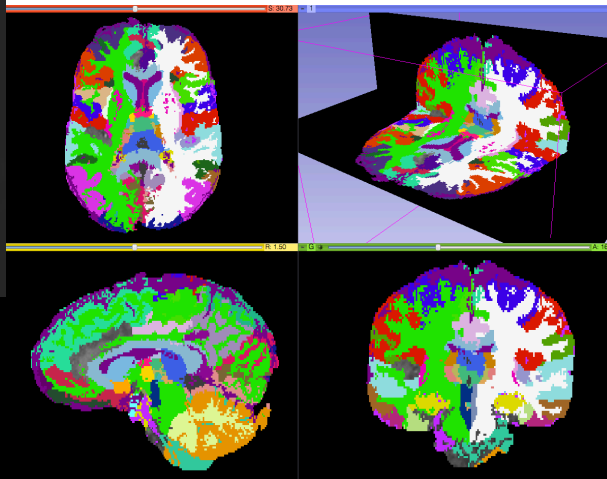
Volume Rendering



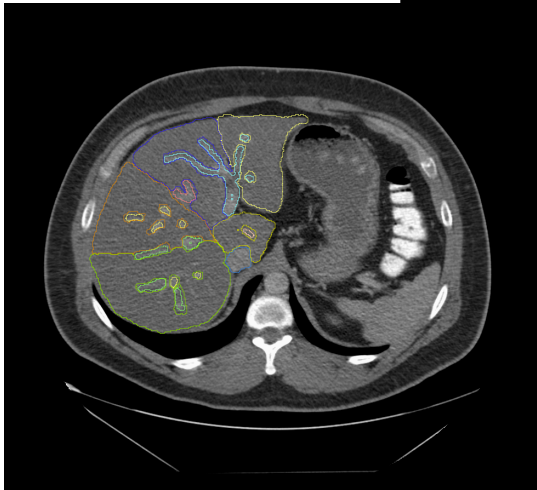
Core Functionalities



Editor



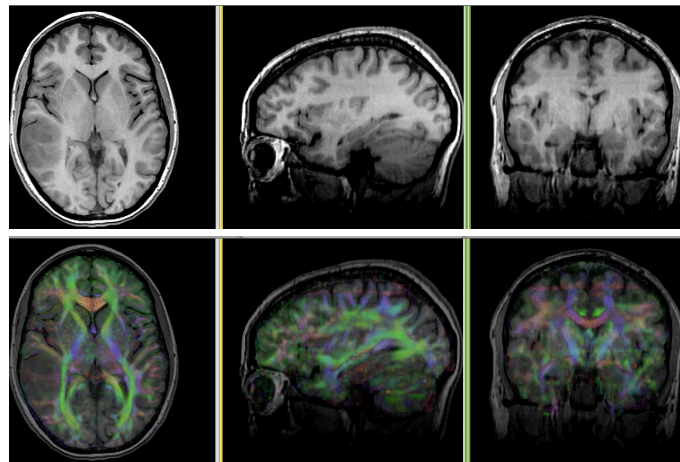
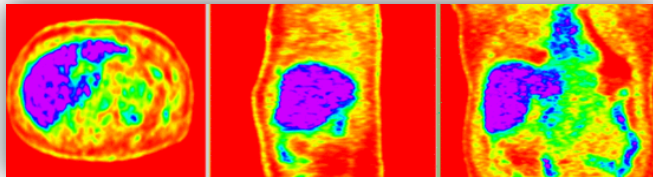
EMSegmenter



- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification



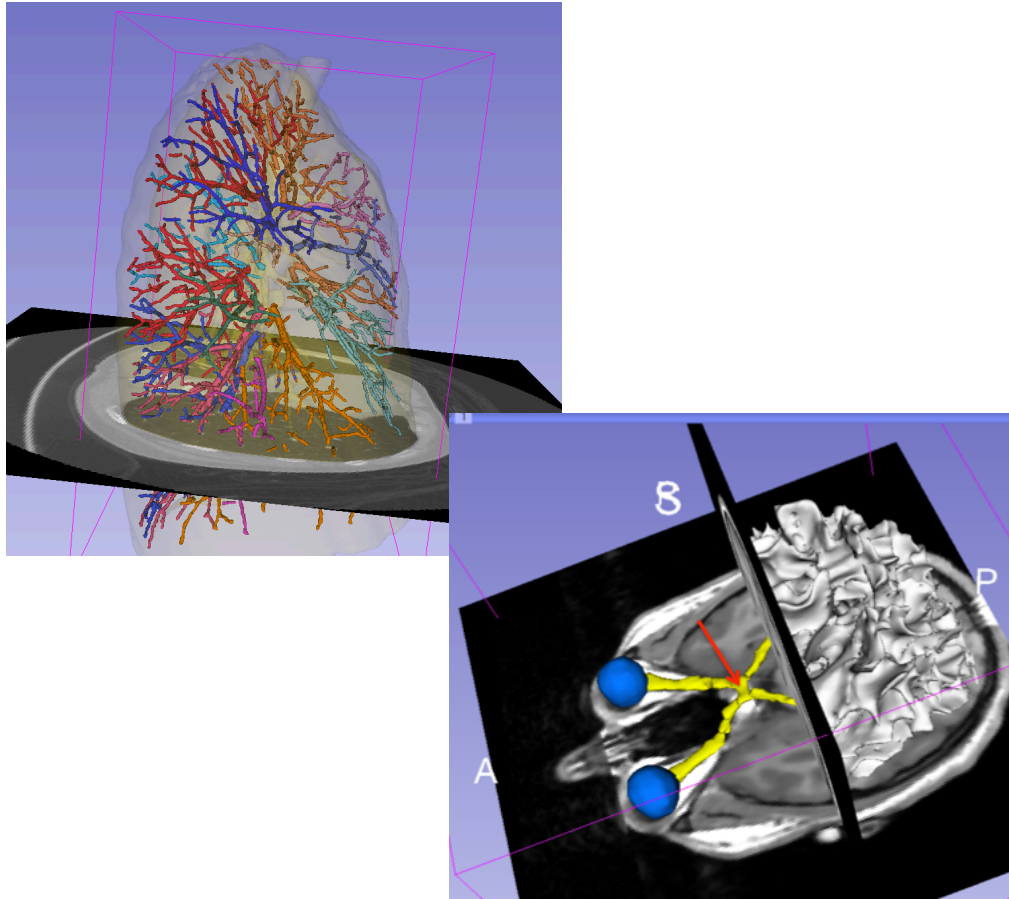
Core Functionalities



- Visualization
- Segmentation
- **Registration**
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification



Core Functionalities

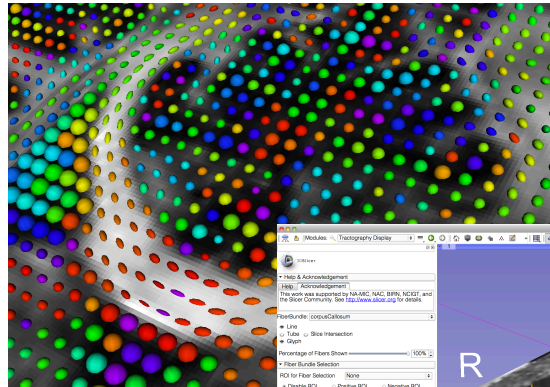


- Visualization
- Segmentation
- Registration
- **Surface Reconstruction**
- Diffusion
- Image Guided Therapy
- Quantification

Model Maker

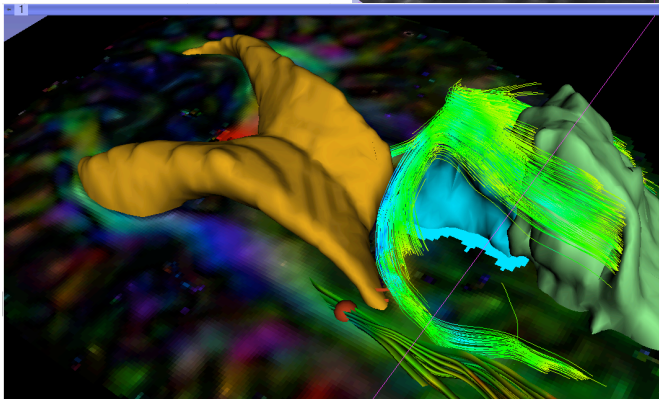
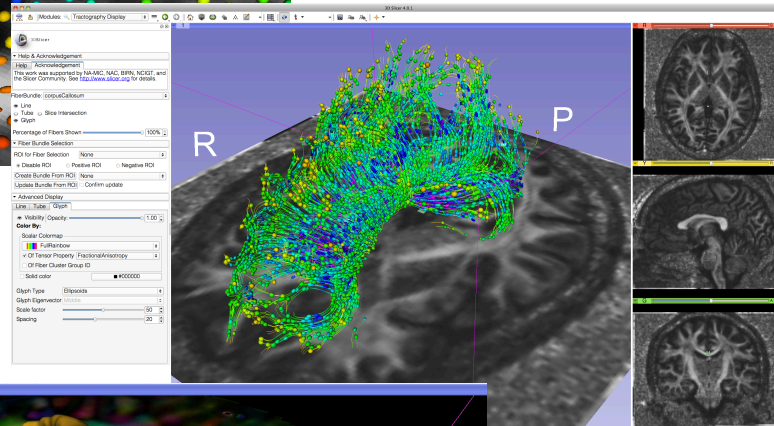


Core Functionalities



DWI To DTI
Estimation

Labelmap
Seeding

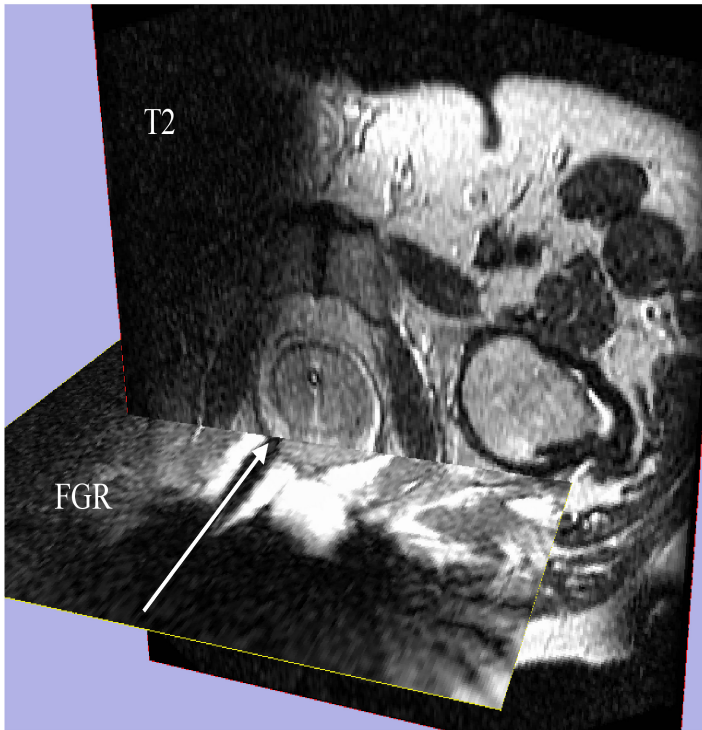


Interactive
Seeding

- Visualization
- Segmentation
- Registration
- Reconstruction
- **Diffusion MRI**
- Image Guided Therapy
- Quantification



Core Functionalities



- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Filtering
- Image Guided Therapy
- Quantification

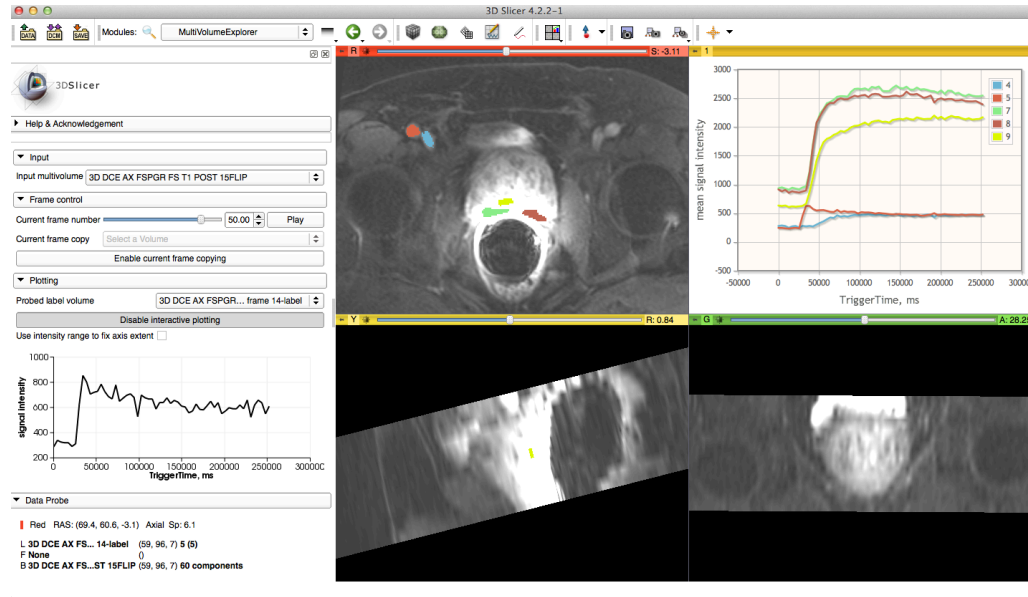
Image Courtesy of Steven Haker, PhD and Clare Tempany, MD

Image-guided therapy for prostate interventions:

- Brachytherapy Planning
- Navigation for Biopsy



Core Functionalities



- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Filtering
- Image Guided Therapy
- Quantification

Prostate DCE-MRI analysis.

MutiVolumeExplorer



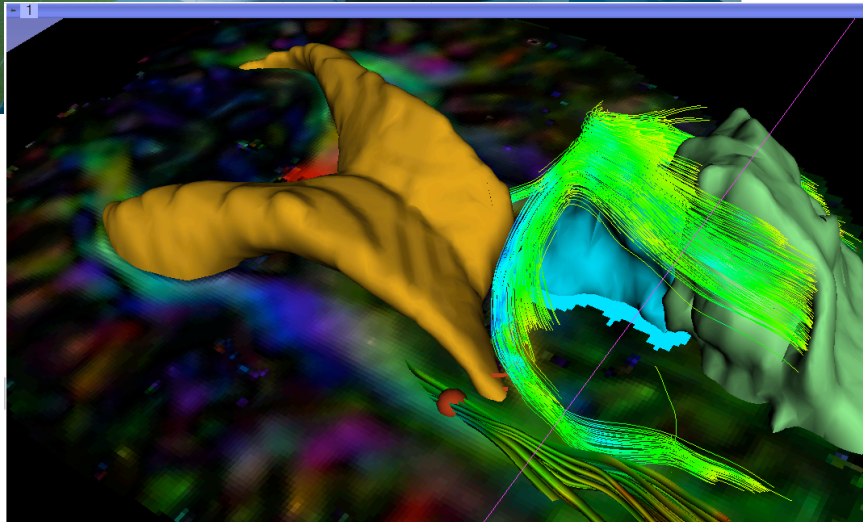
Slicer use in clinical research environment



- AMIGO, BWH, Boston



Neurosurgery applications



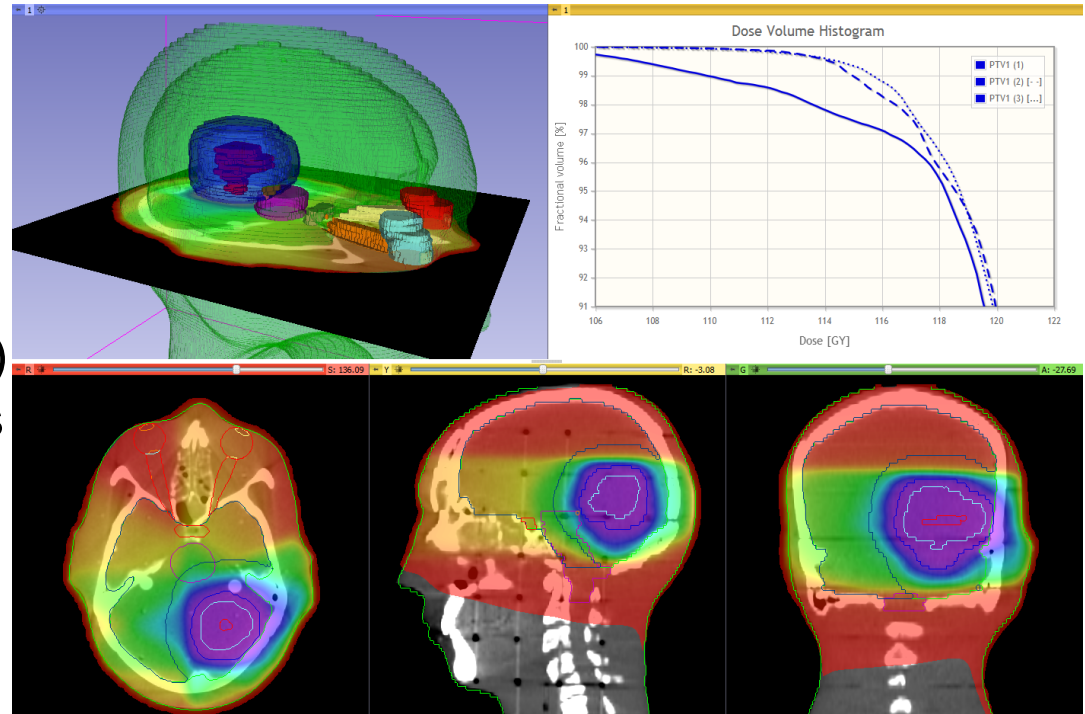
Interactive exploration
of peritumoral white
matter anatomy
neurosurgical planning
using DTI tractography



SlicerRT for radiation therapy

SlicerRT extension

- DICOM-RT import
- RT-specific analysis:
 - Dose Accumulation
 - Dose Comparison (gamma)
 - Isodose contours / surfaces
 - Contour Comparison
 - Contour Morphology
- Plastimatch
 - BSpline registration
 - Landwarp registration
- Project homepage: <https://www.assembla.com/spaces/slicerrt/>



Slide courtesy
G.Fichtinger and
C.Pinter



3DSLICER: TRAINING



Slicer Trainees





- Clinical investigators
- Senior scientists
- Postdoctoral fellows
- Programmers
- Undergraduate and graduate students
- Staff researchers



Slicer Tutorials: for Users

- Clinically driven goal
- Pre-computed anonymized datasets
- Image-analysis pipeline with step-by-step instructions

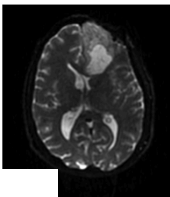
Exploring Peritumoral White Matter Fibers for Neurosurgical Planning

Sonia Pujol, Ph.D.
Ron Kikinis, M.D.

Surgical Planning Laboratory
Harvard University

Clinical Case

- 35 year-old male diagnosed with Glioblastoma multiforme (GBM)
- Diffusion Weighted Imaging (DWI) acquisition for neurosurgical planning

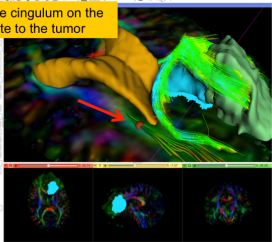


Overview of the analysis pipeline

- Part 1: Loading & Visualization of Diffusion Data
- Part 2: Segmentation of the ventricles, and solid and cystic parts of the tumor
- Part 3: Tractography reconstruction of the white matter fibers in the peri-tumoral volume
- Part 4: Tractography exploration of the ipsilateral and contralateral side

Fiducial Seeding

Position the fiducial in the cingulum on the contralateral side opposite to the tumor



White Matter Exploration for Neurosurgical Planning

Sonia Pujol, Ph.D. – Ron Kikinis, M.D. NA-MIC ARR 2012-2014



Slicer Tutorials: for developers

- Slicer Module development
- Pre-computed exemplar source code
- Programming pipeline with step-by-step instructions



Paul Cézanne, Moulin sur la Couleuvre à Pontoise, 1881, Staatliche Museum zu Berlin, Nationalgalerie

Programming in Slicer4

Sonia Pujol, Ph.D.
Surgical Planning Laboratory,
Harvard Medical School

Steve Pieper, Ph.D.
Isomics Inc.

Course Material

Unzip the HelloPython.zip archive

spgr.nhdr spgr.raw.gz
(124 SPGR images)



HelloPython.py
HelloLaplace.py
HelloSharpen.py

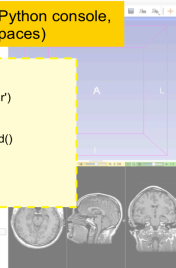
Course Overview

- Part A: Exploring Slicer via Python
- Part B: Integration of the HelloPython.py program into Slicer4
- Part C: Implementation of the Laplace operator in the HelloPython module
- Part D: Image Sharpening using the Laplace operator

Manipulating Arrays

Run the following code in the Python console,
(indent each new line with 2 spaces)

```
Welcome  
def toggle():  
    n = slicer.util.getNode('spgr')  
    a = slicer.util.array('spgr')  
    a[1] = a.max()/2 - a  
    n.GetImageData().Modified()  
    print('Toggled')  
toggle()
```





Slicer Training Workshops

Hands-on courses at major international conferences (e.g. RSNA, SfN, SPIE, CARS, etc..)

Invited workshops at international universities (April 2013: Iwate Medical Center, Japan)

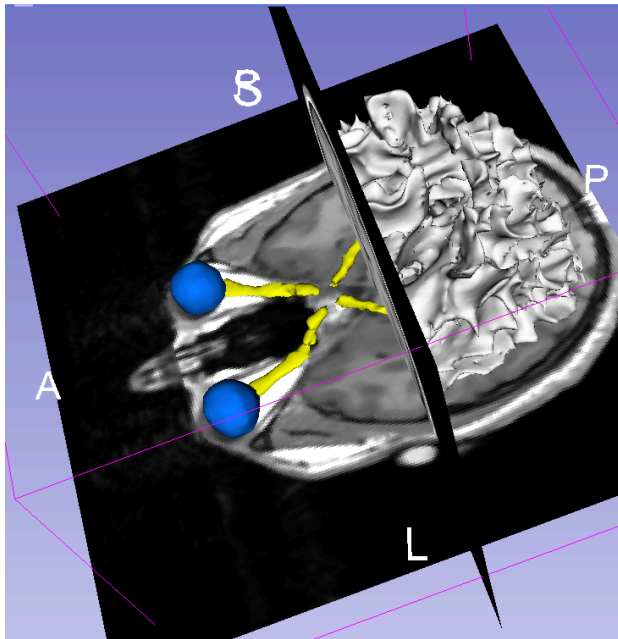




Slicer Project Weeks



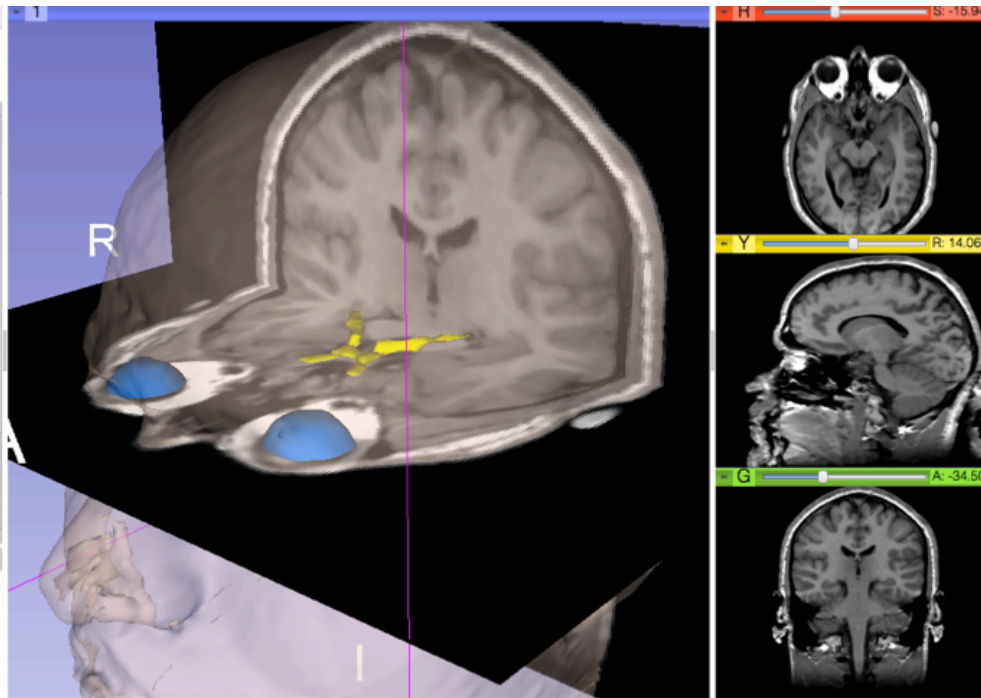
- Bi-annual week of hands-on programming (Winter: Salt Lake City, Summer: MIT)
- Practical exchange of idea and experience
- 17 project weeks since 2005
- Next Project Week:
June 17-21, 2013, MIT



Part II – Hands-on session: Slicer4 Minute tutorial on data loading and 3D Visualization



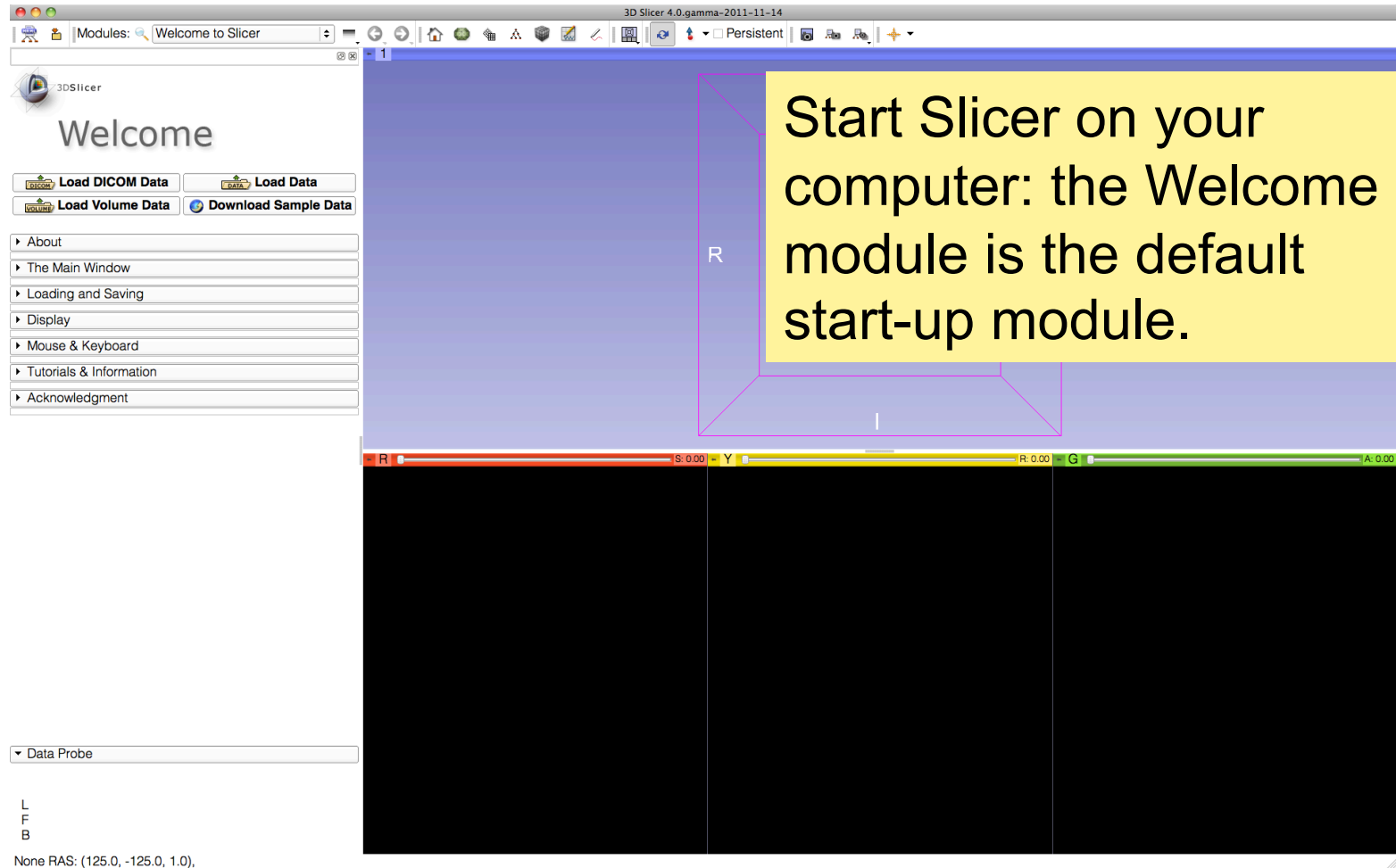
Slicer4 minute tutorial



This tutorial is an introduction to the 3D visualization capabilities of the Slicer4 software for medical image analysis.

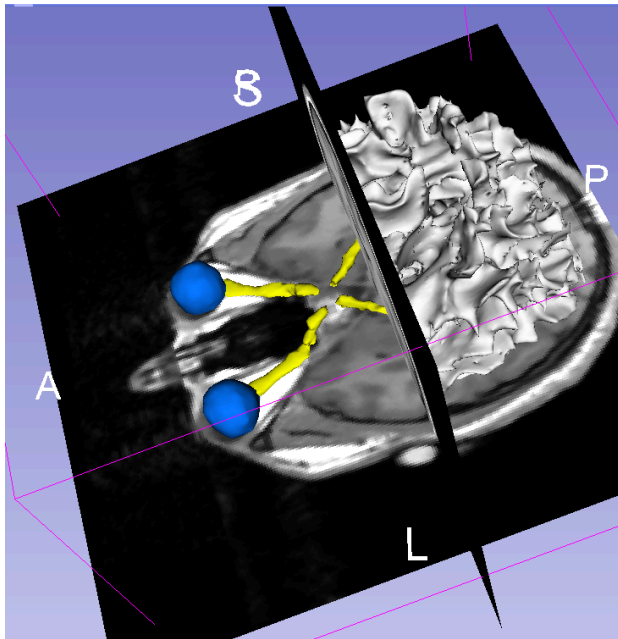


3DSlicer version 4





3D Slicer Scene

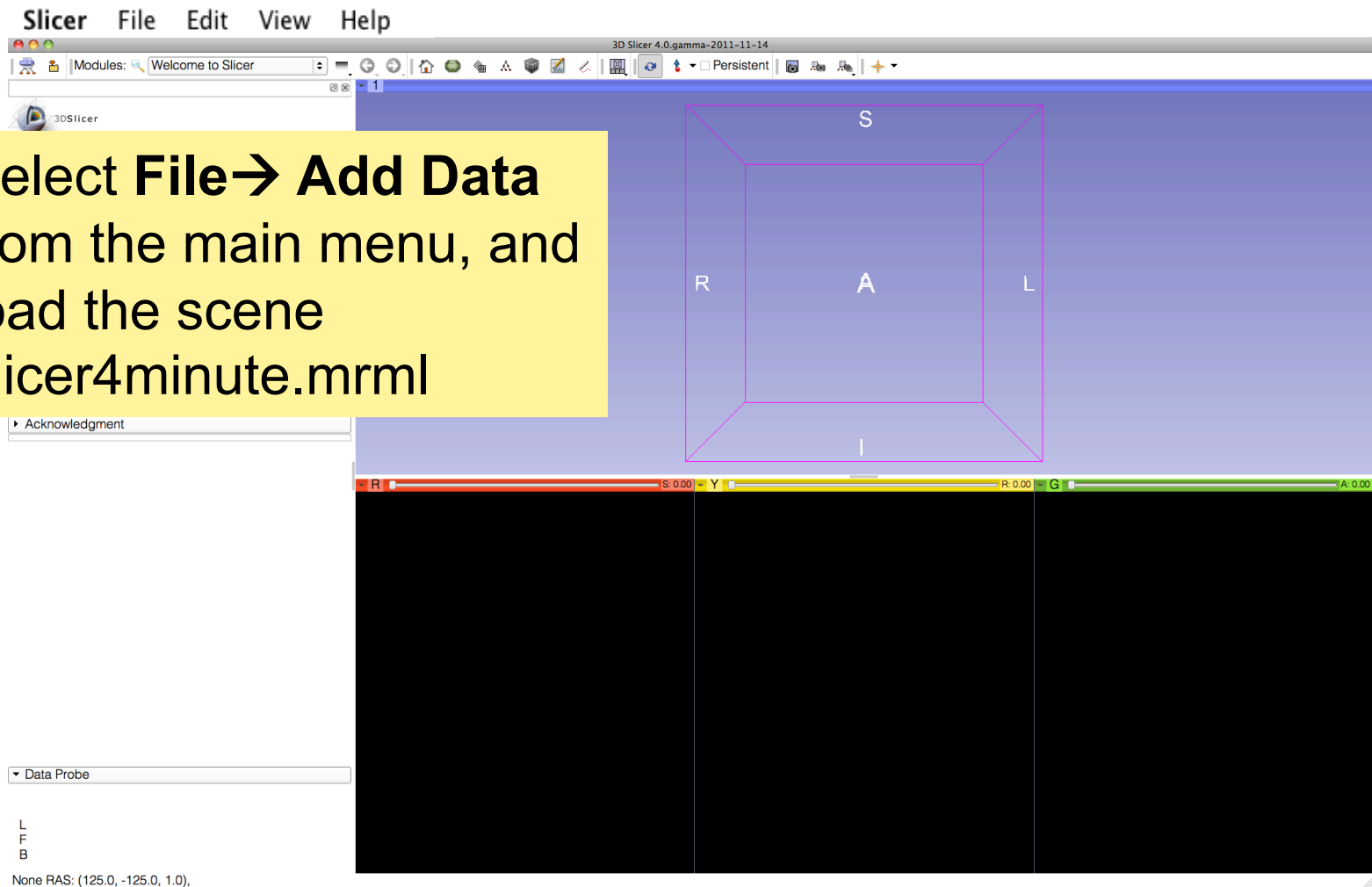


- A Slicer scene is a MRML file which contains the list of elements loaded into Slicer (volumes, models, fiducials...)
- The following example uses a 3D Scene which contains images and 3D surface models of the head from the SPL-PNL Brain Atlas.



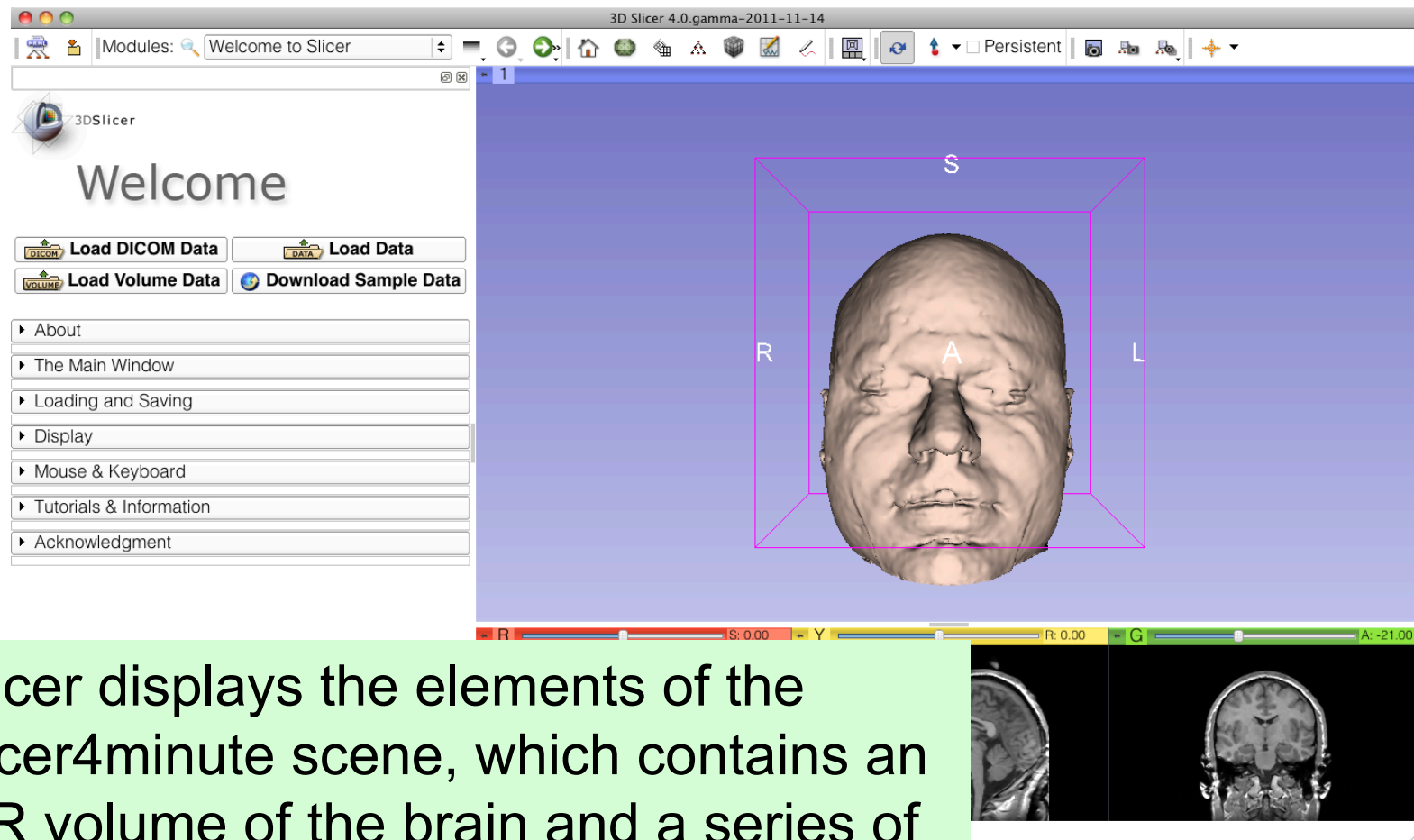
3DSlicer version 4

Select **File** → **Add Data**
from the main menu, and
load the scene
slicer4minute.mrml





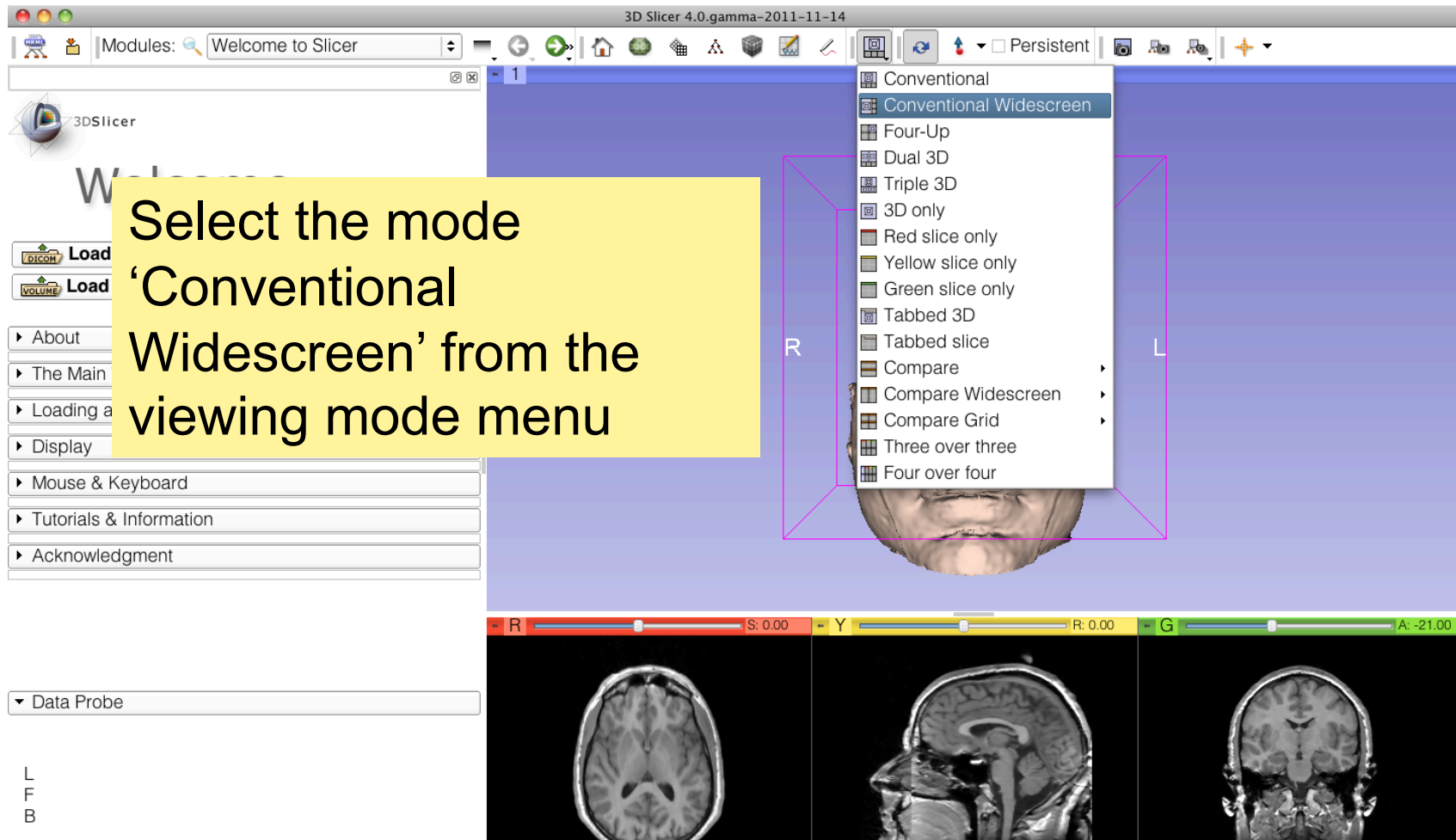
Slicer4 minute Scene



Slicer displays the elements of the slicer4minute scene, which contains an MR volume of the brain and a series of 3D surface models.

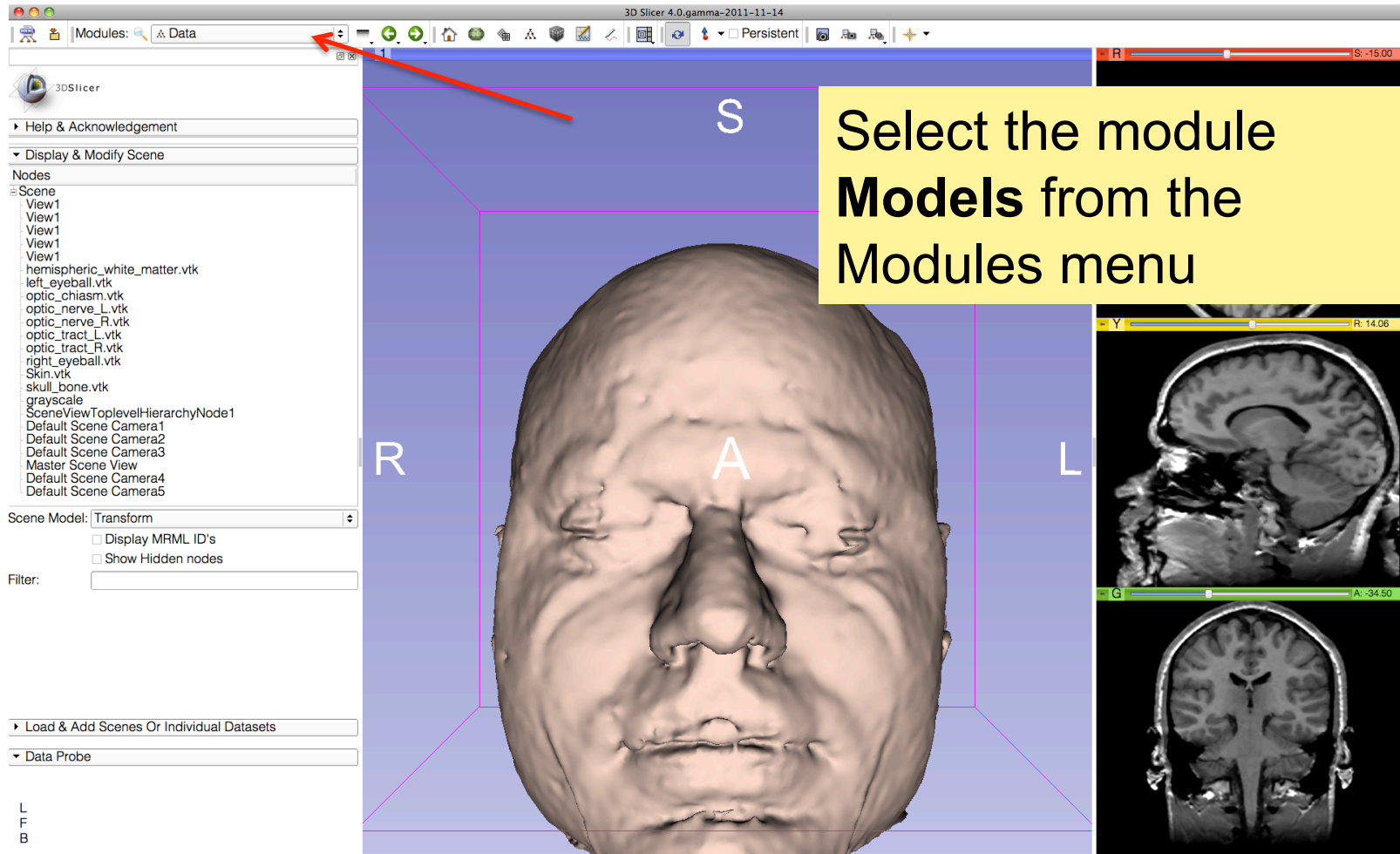


Slice4 minute scene





Slicer4minute Scene





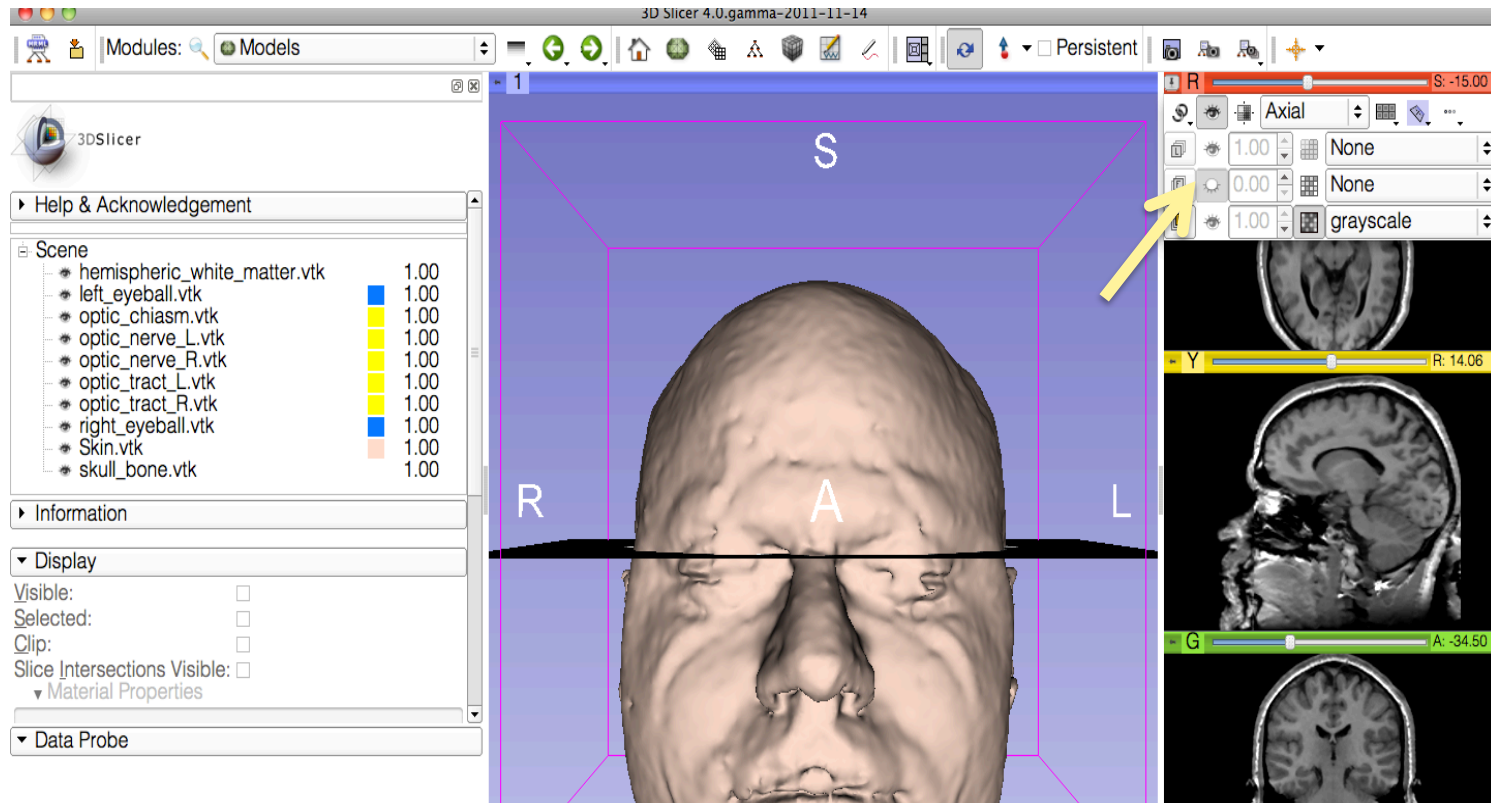
3D Visualization



The Models module GUI displays the list of models loaded in the slicer4minute scene, their color and the value of their opacity (between 0.0 and 1.0)



3D Visualization



Click on the pin icon on the top left corner of the red slice to display the slice viewer menu.

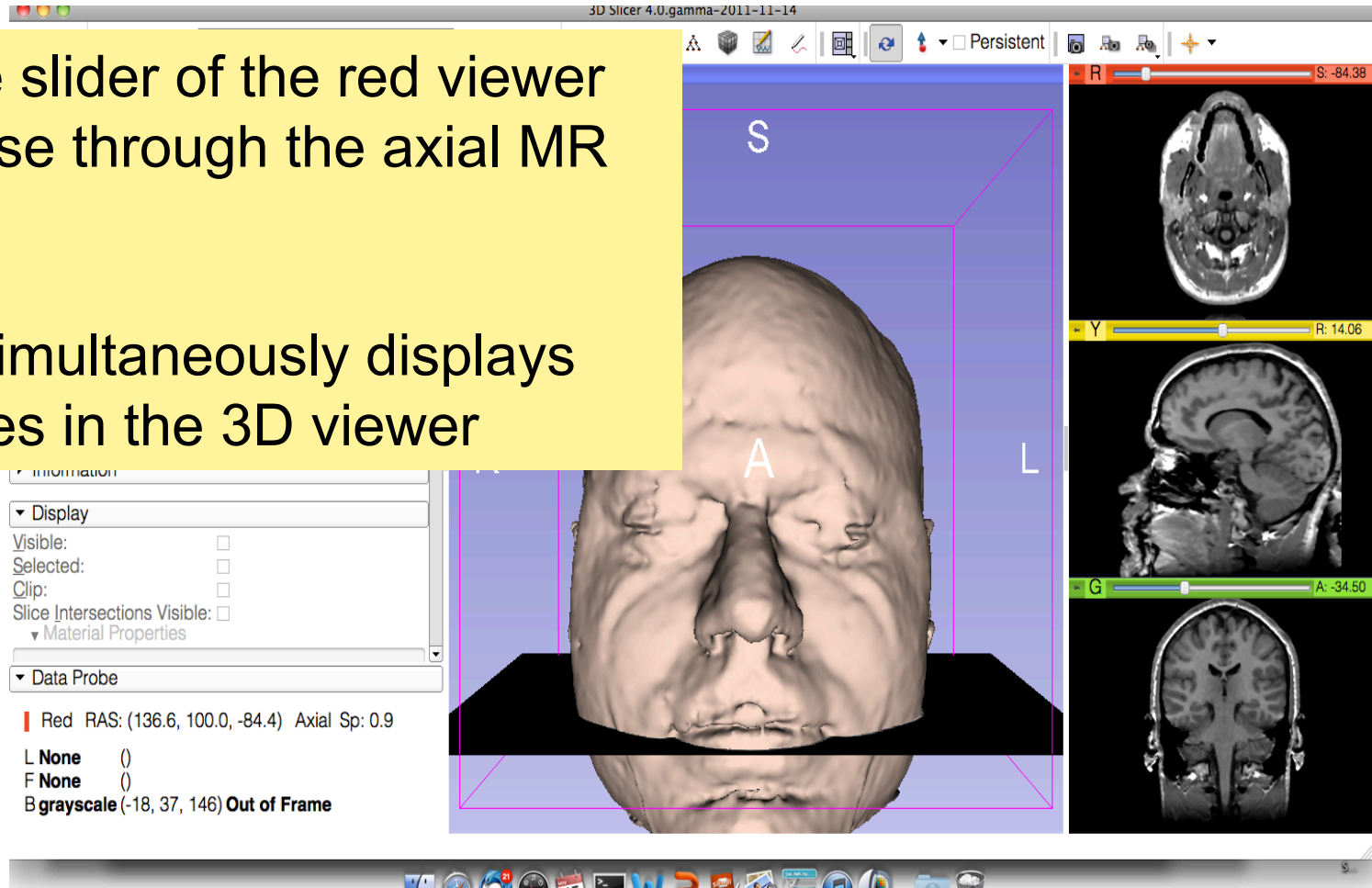
Click on the eye icon to display the axial slice in the 3D Viewer



3D Visualization

Use the slider of the red viewer to browse through the axial MR slices.

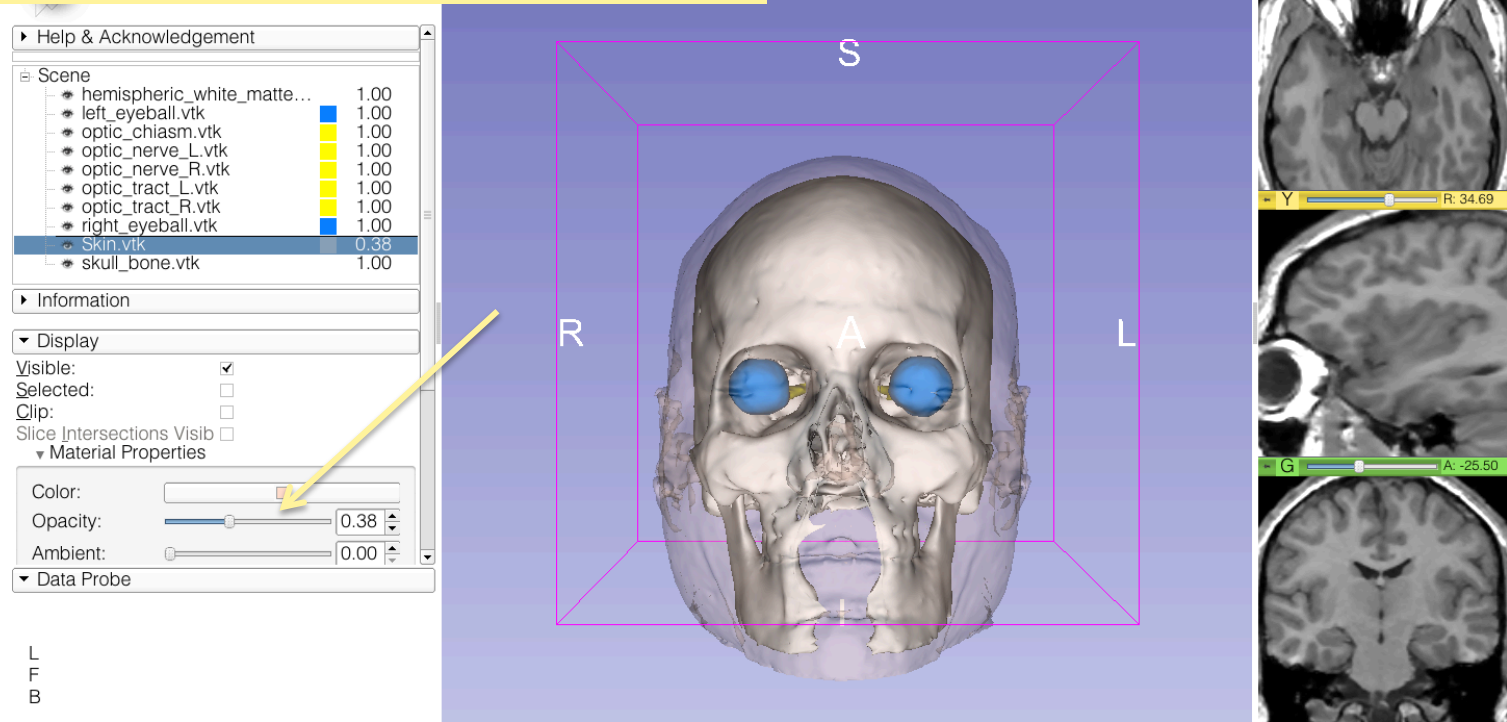
Slicer simultaneously displays the slices in the 3D viewer





3D Visualization

Lower the opacity of the Skin.vtk model in the Display tab



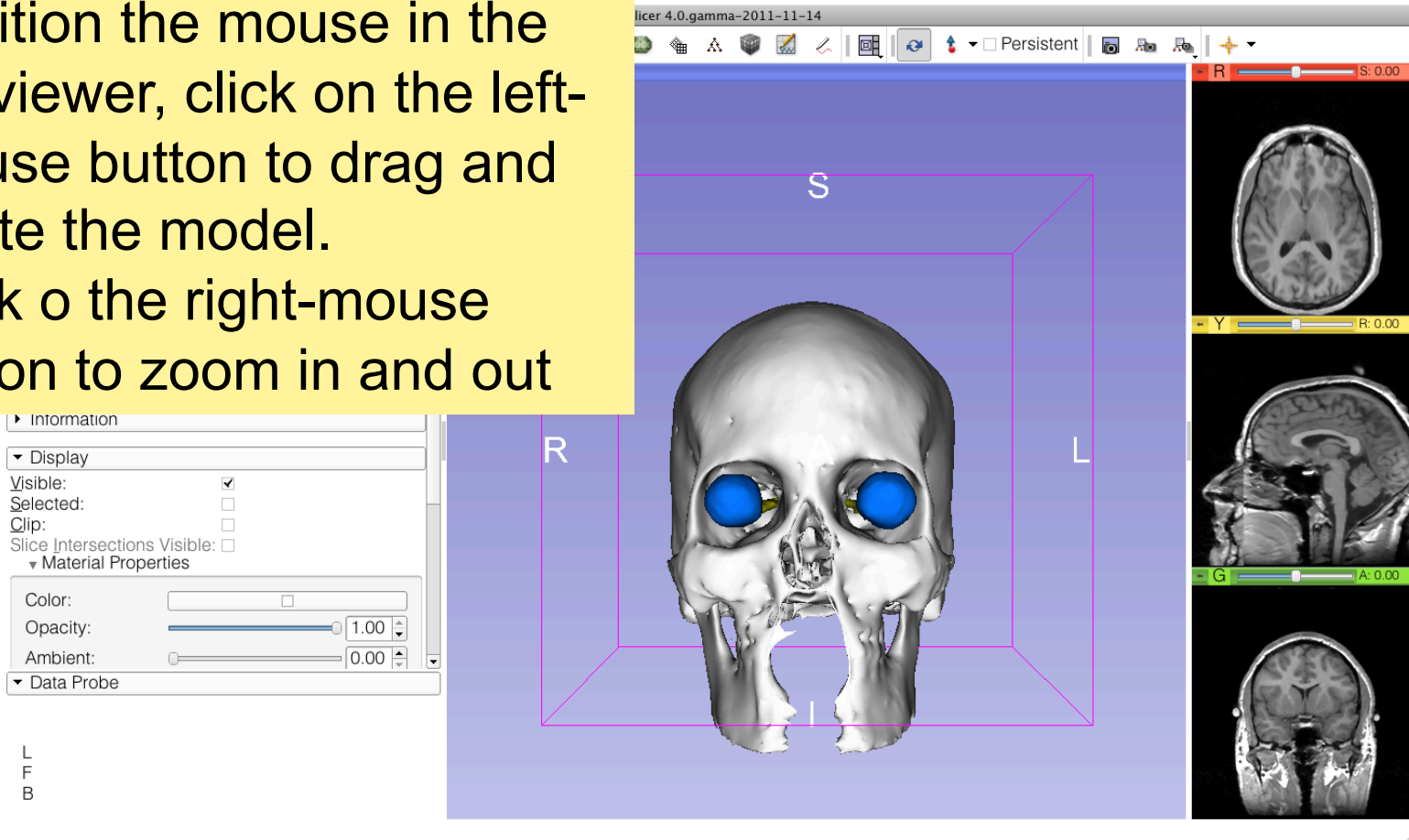
The skull_bone.vtk model appears through the skin.



3D Visualization

Position the mouse in the 3D viewer, click on the left-mouse button to drag and rotate the model.

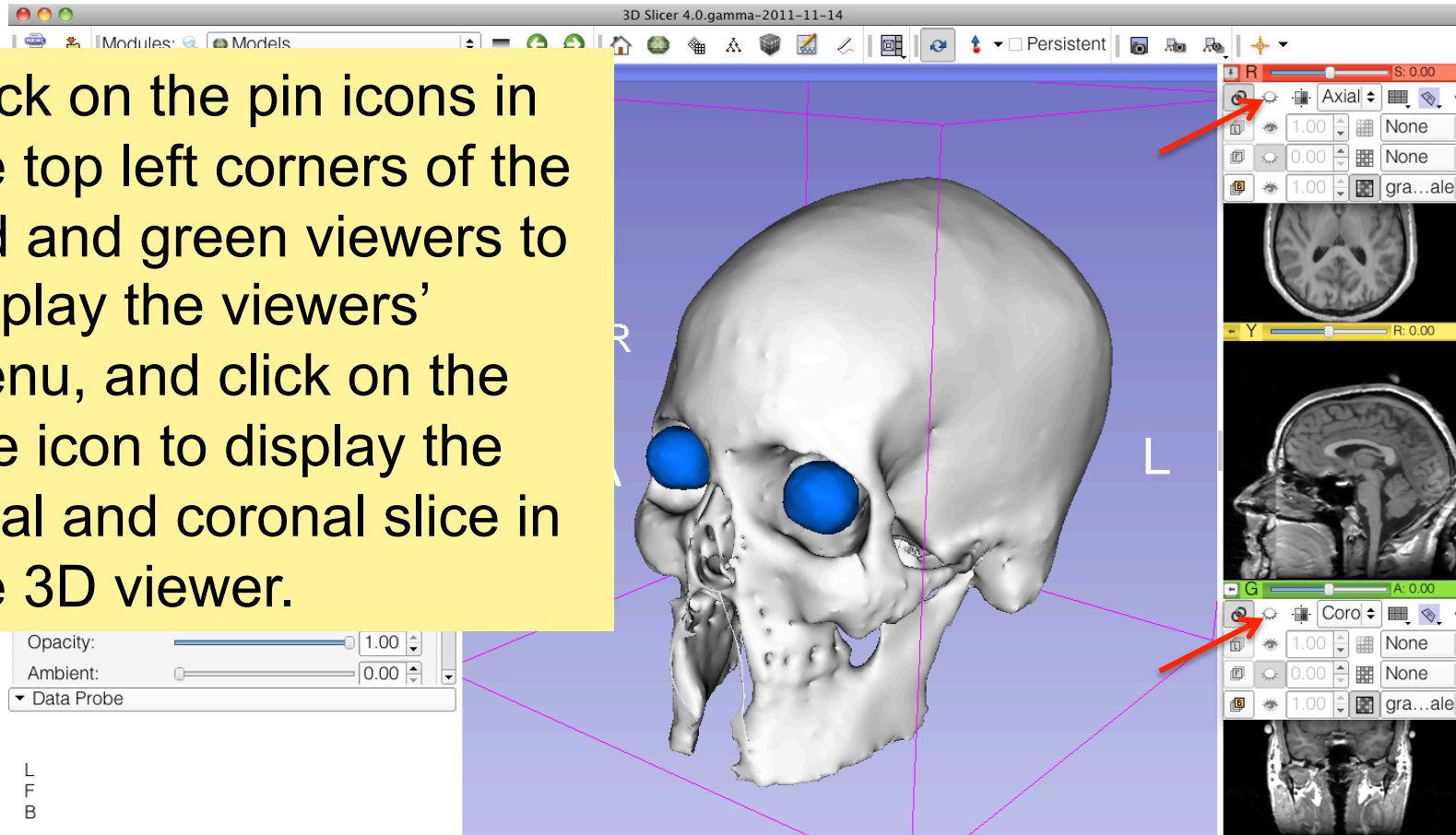
Click on the right-mouse button to zoom in and out





Anatomical Views

Click on the pin icons in the top left corners of the red and green viewers to display the viewers' menu, and click on the eye icon to display the axial and coronal slice in the 3D viewer.



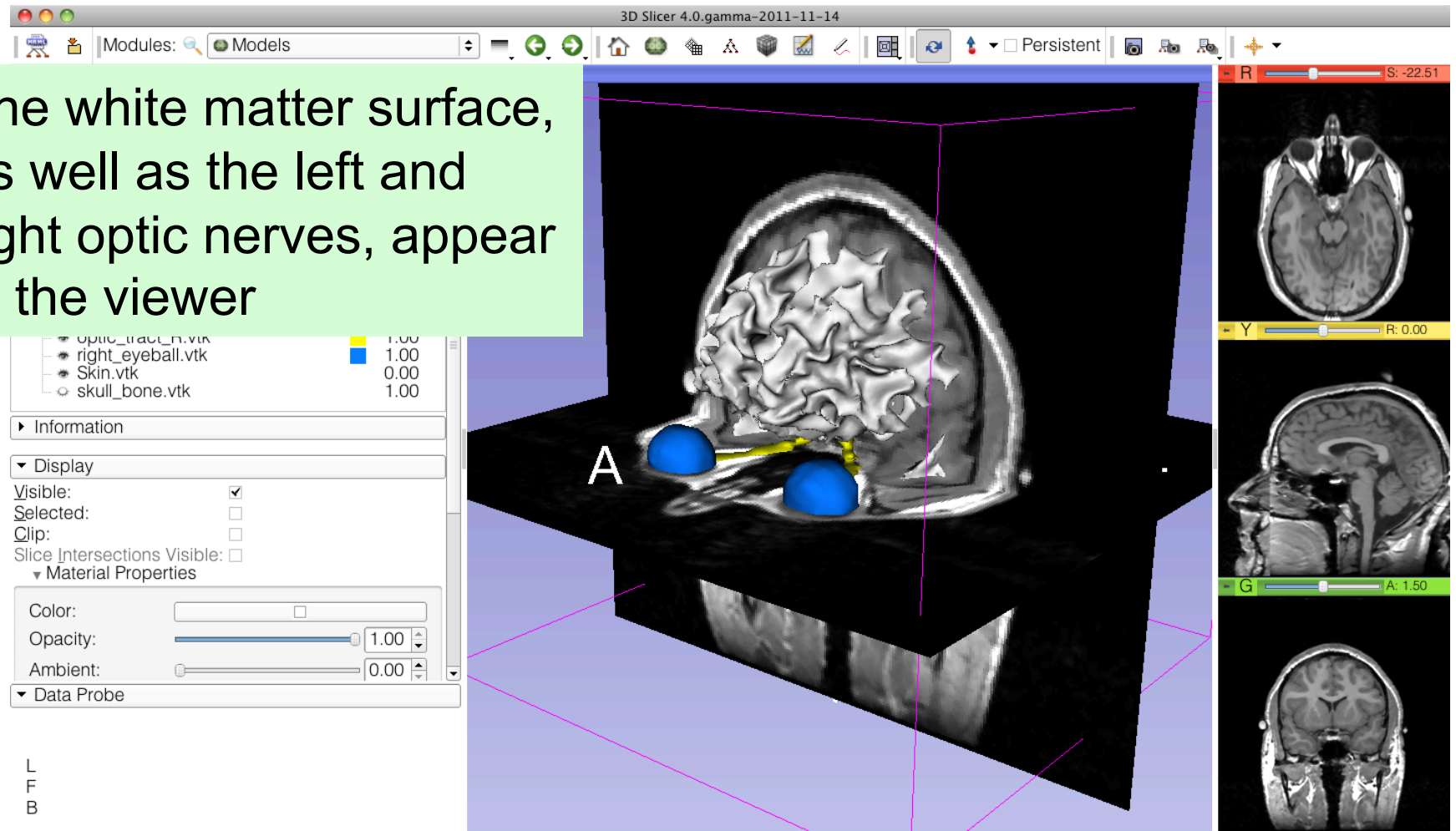


The screenshot shows the 3D Slicer 4.0 interface. On the left, the 'Models' panel lists several models: optic_nerve_n.vtk, optic_tract_L.vtk, optic_tract_R.vtk, right_eyeball.vtk, Skin.vtk, and skull_bone.vtk. The 'skull_bone.vtk' model is selected, and its 'Display' section shows 'Visible' checked. Below this, the 'Material Properties' section has sliders for Color, Opacity (set to 1.00), and Ambient (set to 0.00). The main 3D view displays a brain model with two blue spheres representing eyes. The skull bone is visible as a white mesh. A yellow text box at the top left contains the instruction: 'Turn off the visibility of the skull to display the brain white matter model'. On the right side, there are three axial MRI slices with corresponding navigation controls.



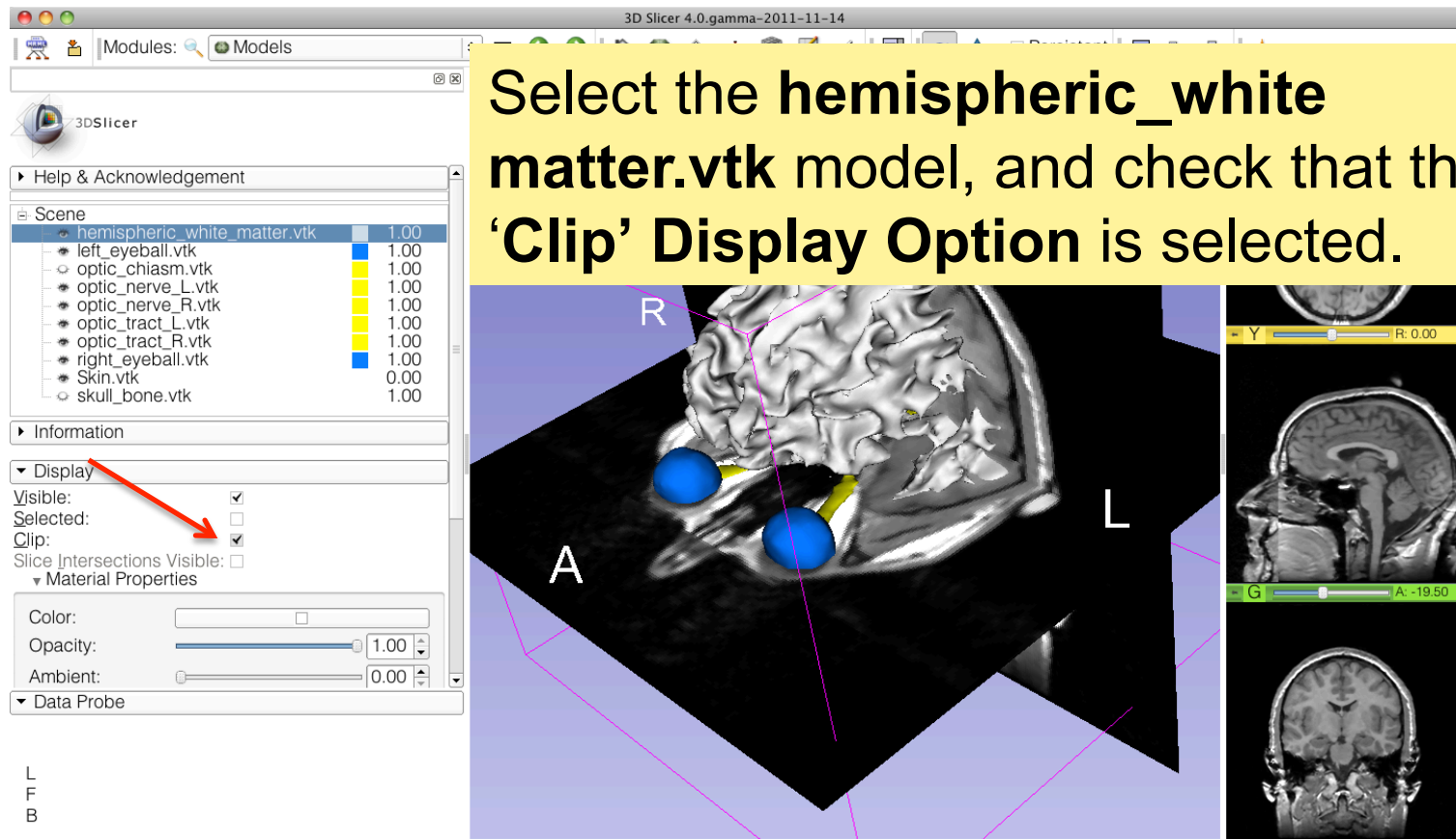
3D Visualization

The white matter surface, as well as the left and right optic nerves, appear in the viewer



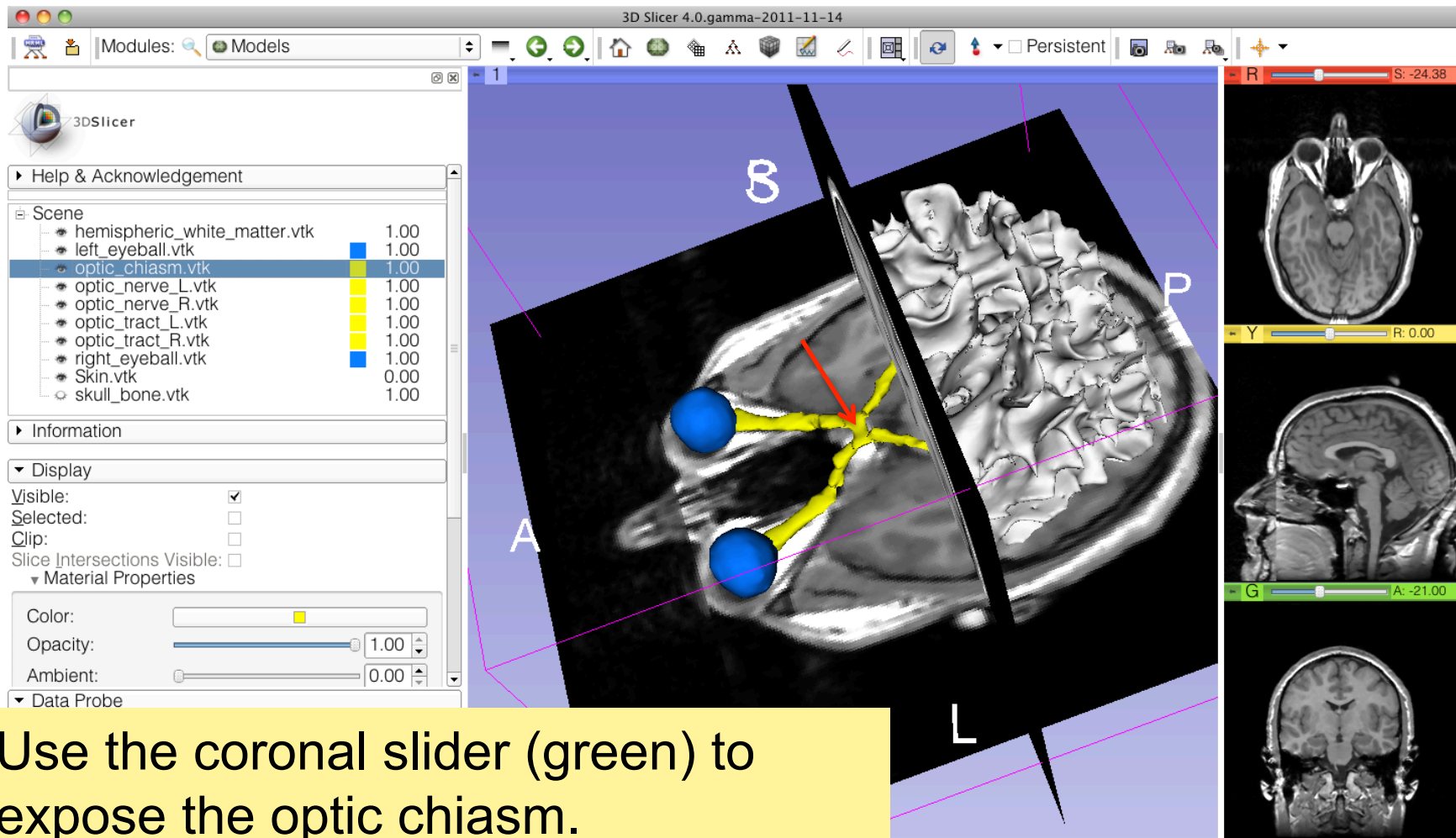


3D Visualization



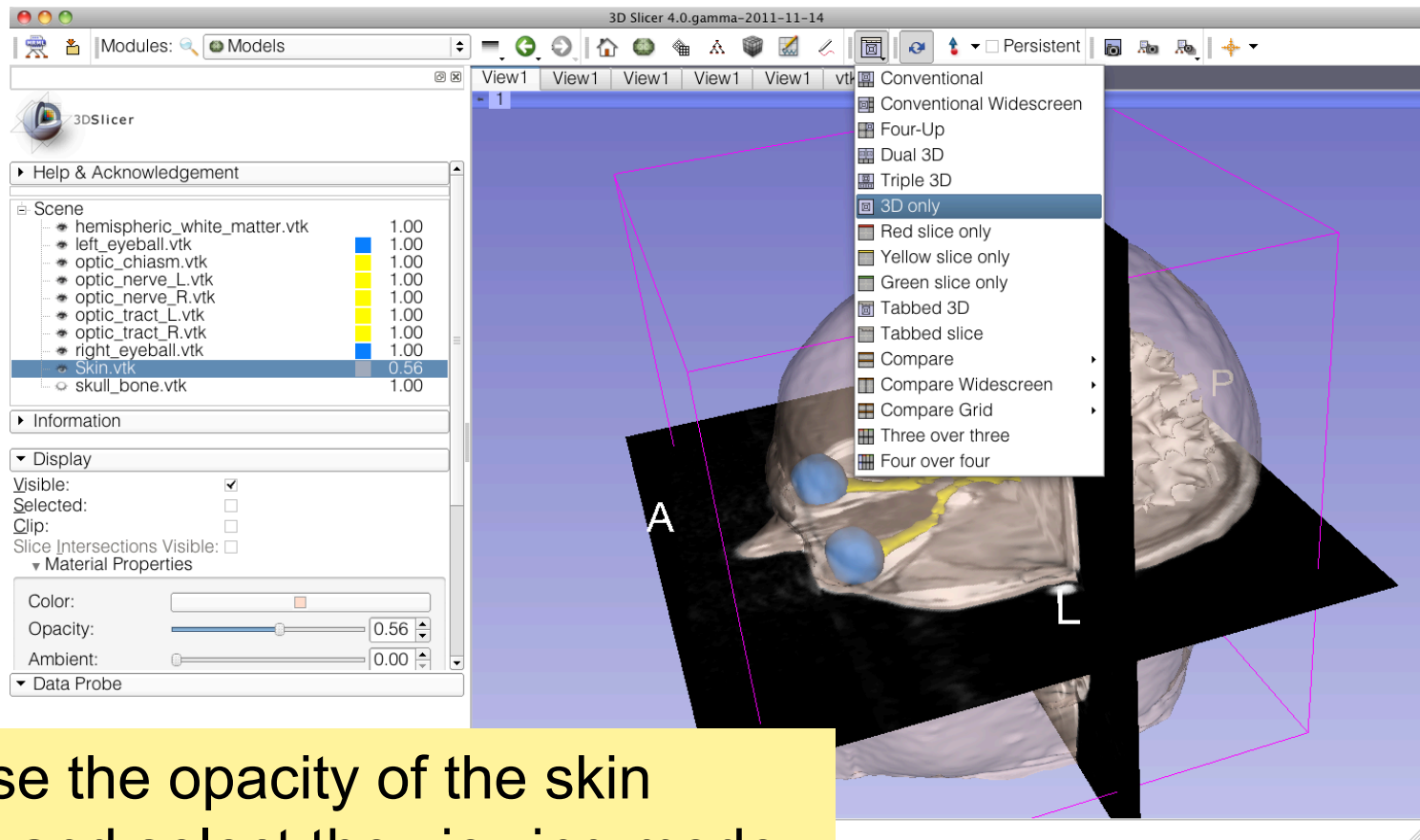


3D Visualization





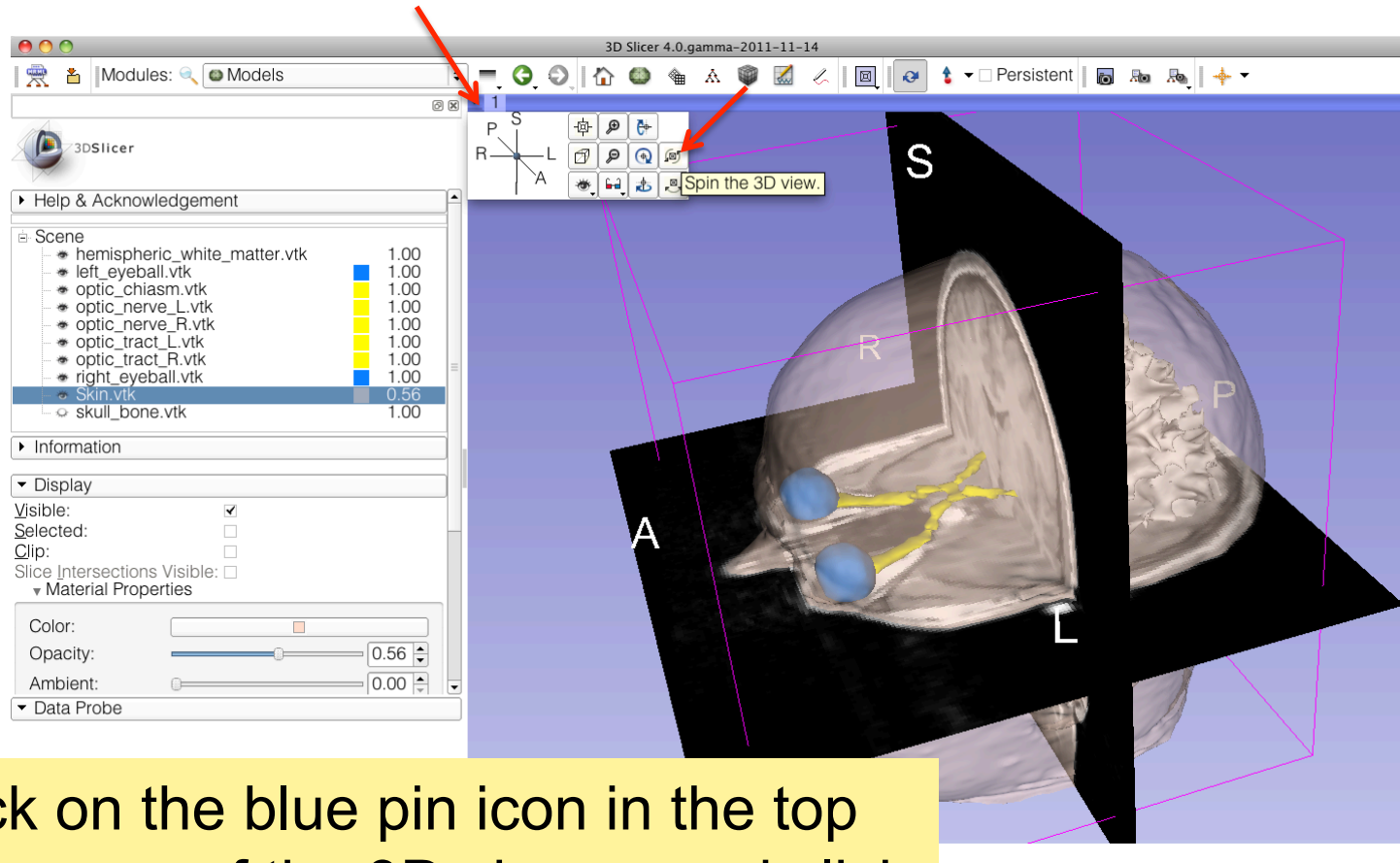
3D Visualization



Increase the opacity of the skin model, and select the viewing mode '3D only'



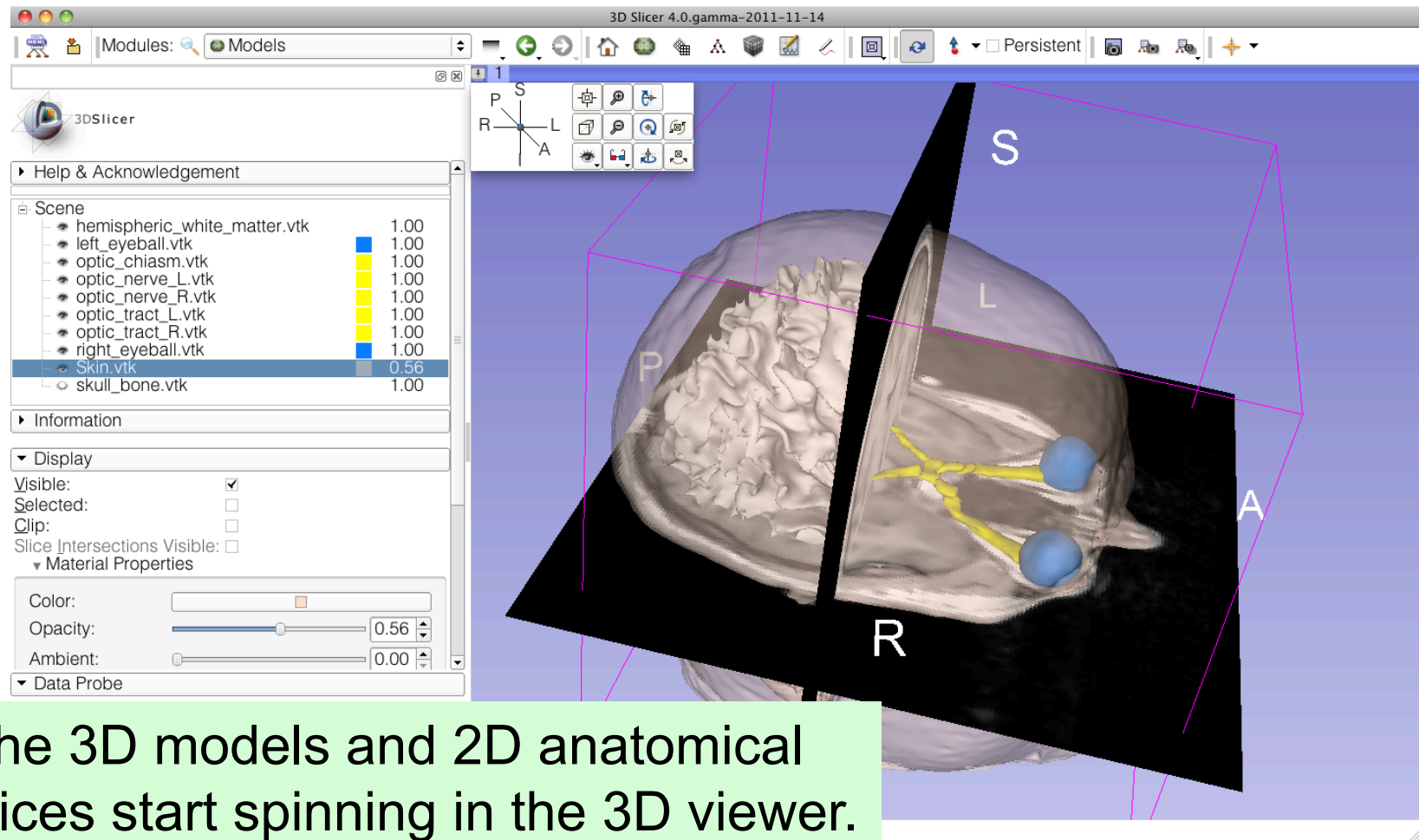
3D Visualization



Click on the blue pin icon in the top left corner of the 3D viewer, and click on the Spin icon.



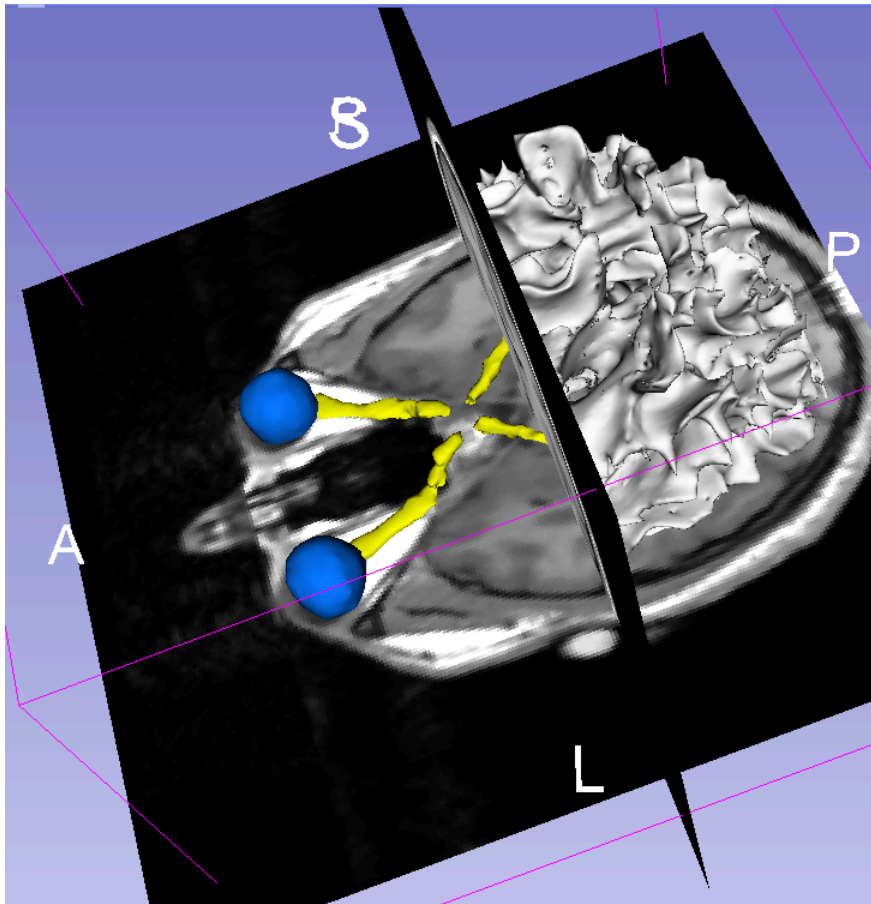
3D Visualization



The 3D models and 2D anatomical slices start spinning in the 3D viewer. Click a second time on the spin icon to stop the models from spinning.

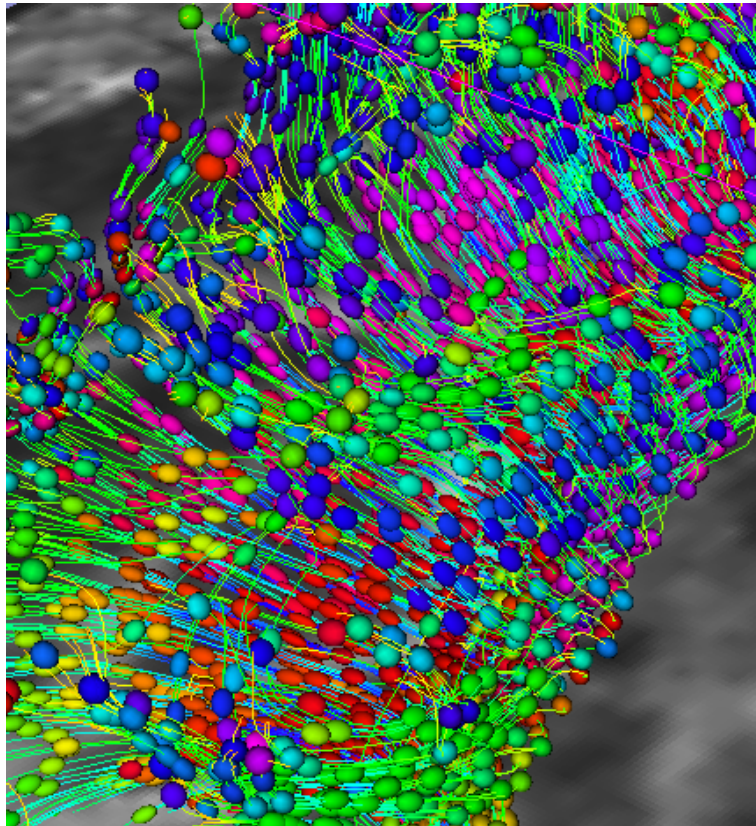


Slicer4 minute tutorial



This tutorial was a short introduction to the 3D visualization capabilities of Slicer.

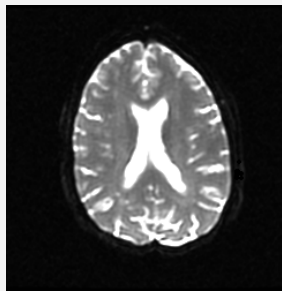
Please visit the Slicer4 training compendium for more information on the software
www.slicer.org



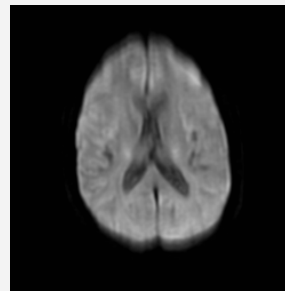
Part III: 3D Slicer DTI demo



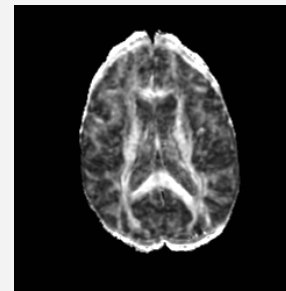
MR Diffusion Analysis Pipeline



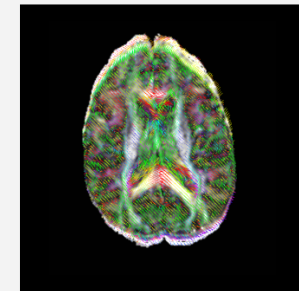
DWI
Acquisition



Tensor
Calculation



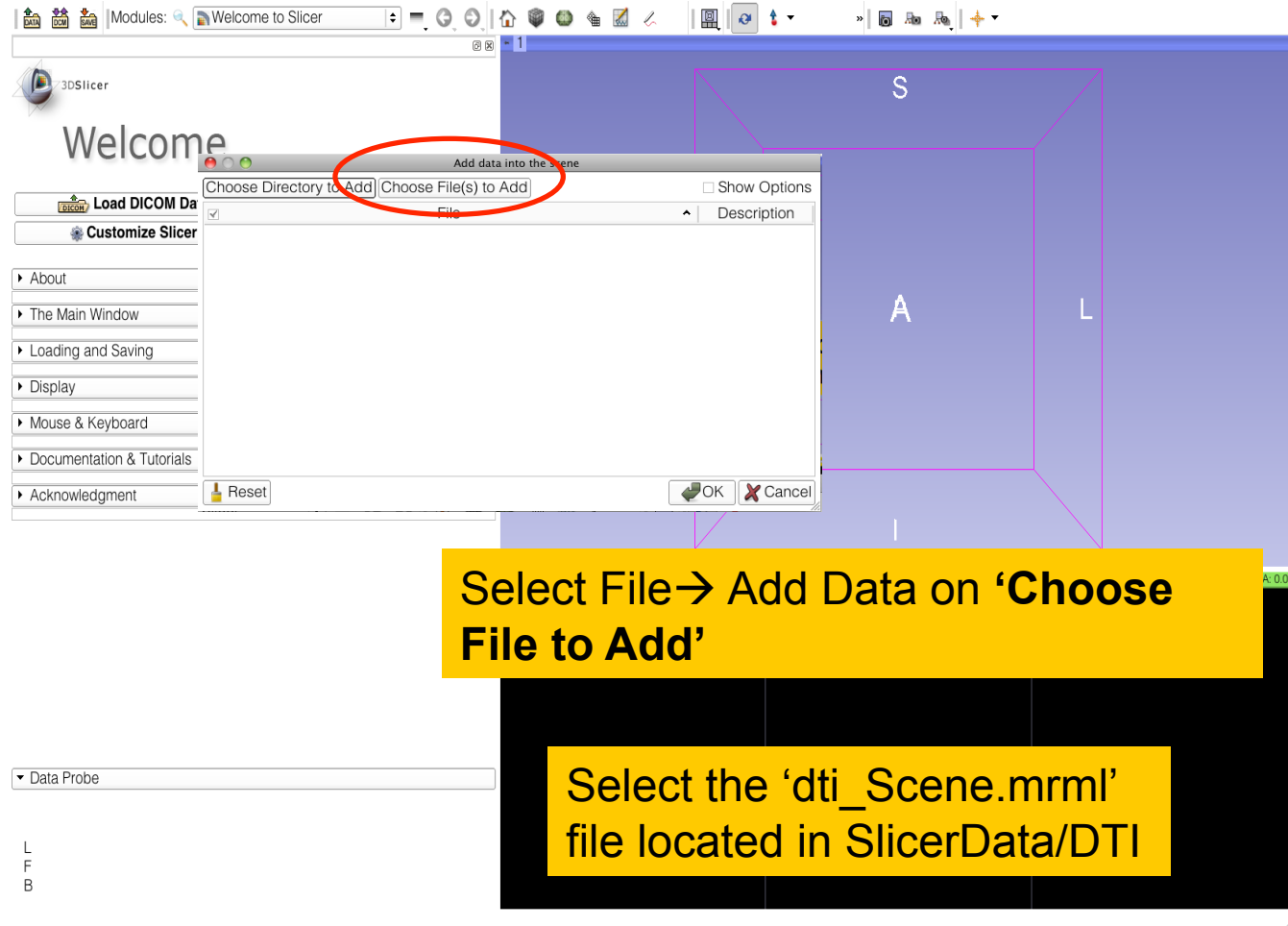
Scalar
Maps



3D
Visualization

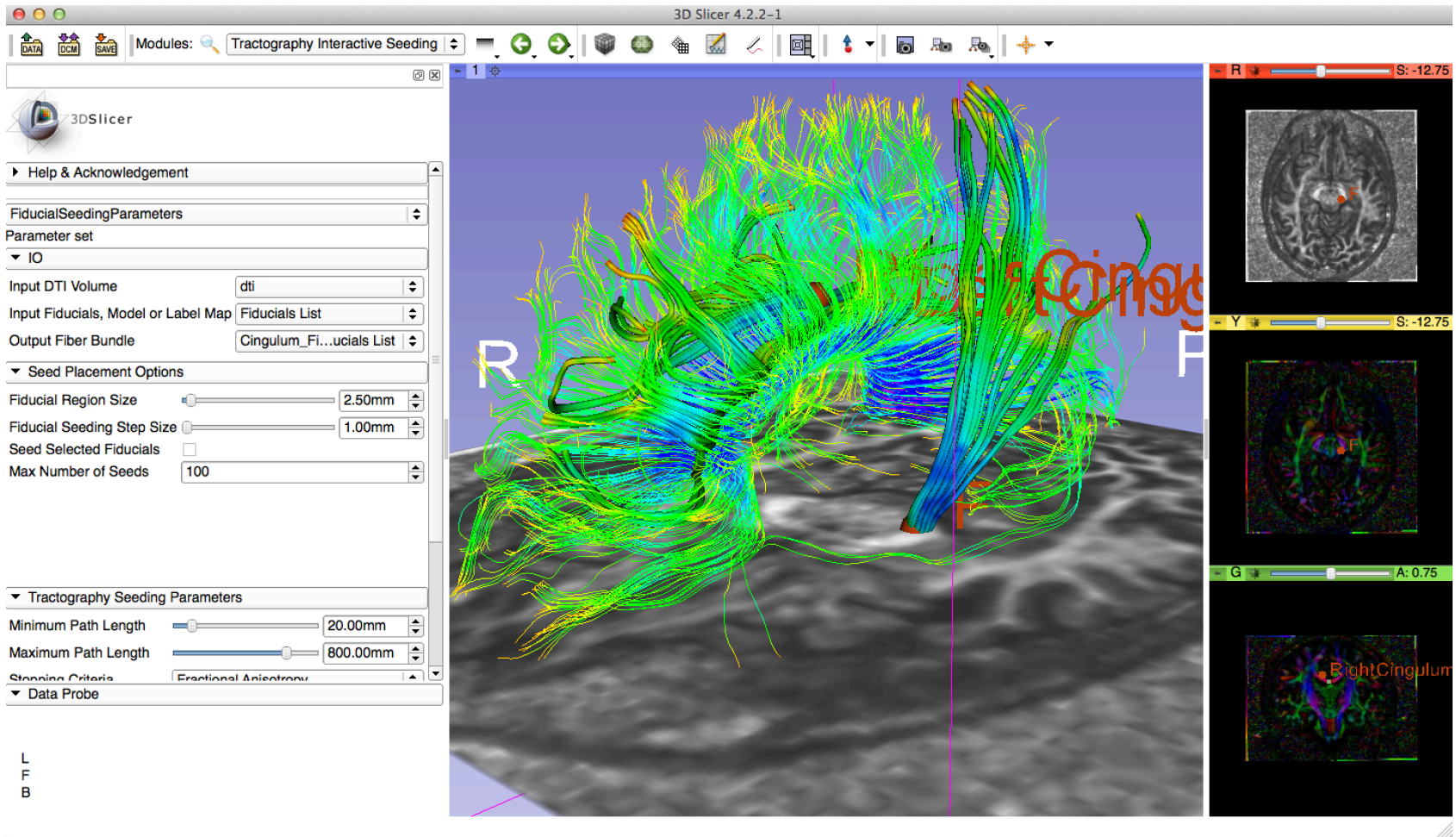


Loading the DTI Scene



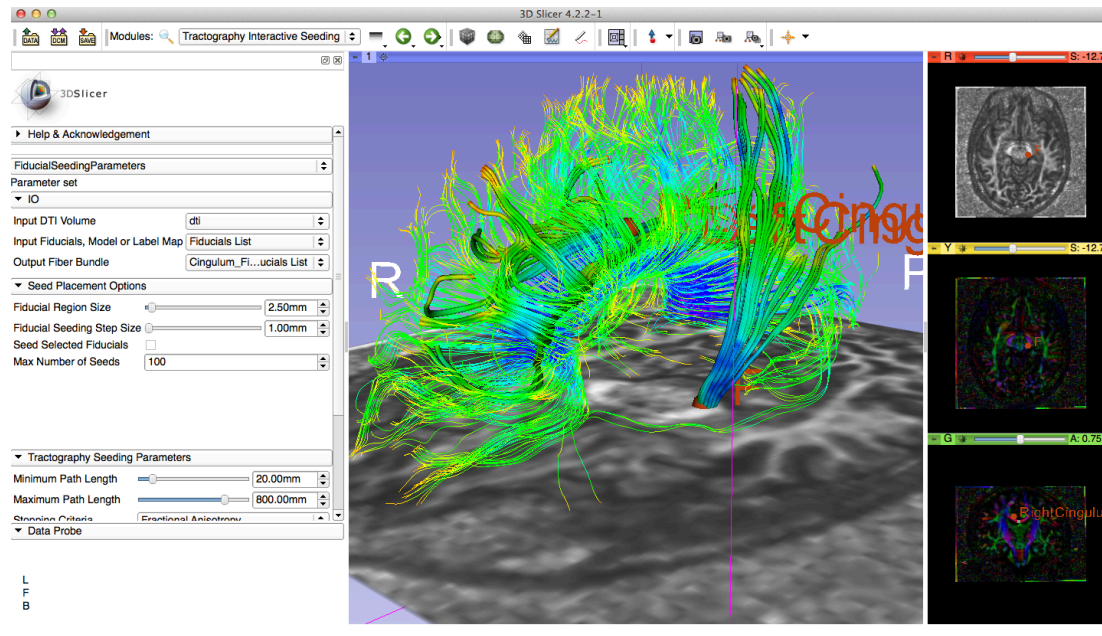


DTI Scene





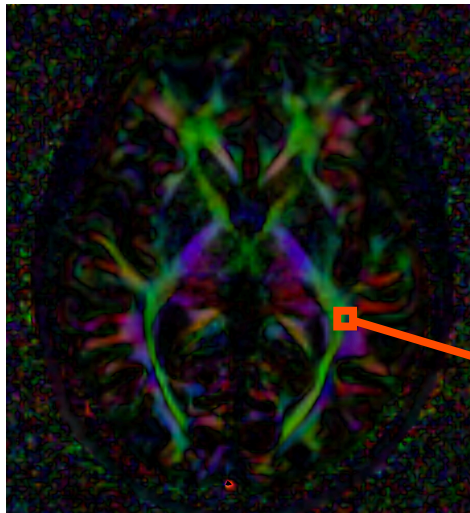
DTI Scene



The DTI Scene contains a pre-computed DTI volume and corresponding FA map. Slicer displays the tractography reconstructions of part of the corpus callosum, left and right cingulum.



Diffusion Tensor Data



Stejskal-Tanner equation (1965)

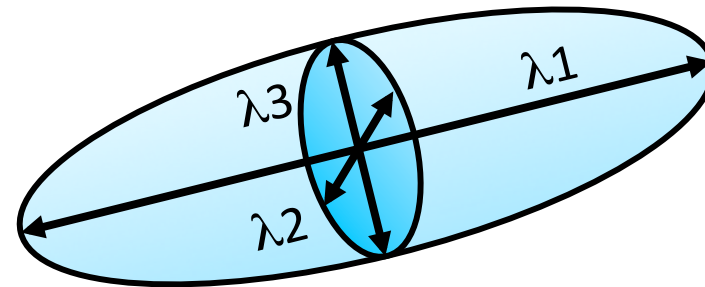
$$\underline{\mathbf{D}} = \begin{bmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{zx} & D_{zy} & D_{zz} \end{bmatrix}$$

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



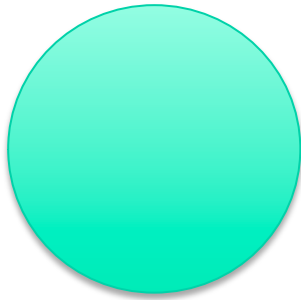
Diffusion Tensor

- 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.



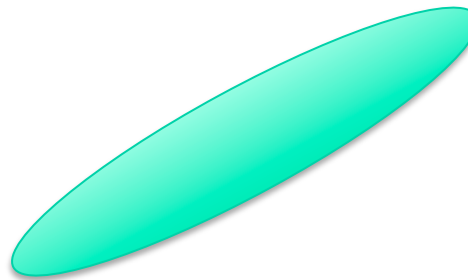


Diffusion Tensor Shape



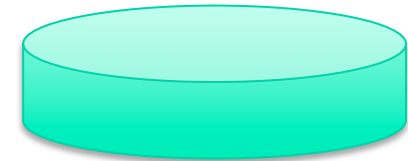
$$\lambda_1 = \lambda_2 = \lambda_3$$

Isotropic media
(CSF, gray matter)



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

Anisotropic media
(white matter)



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



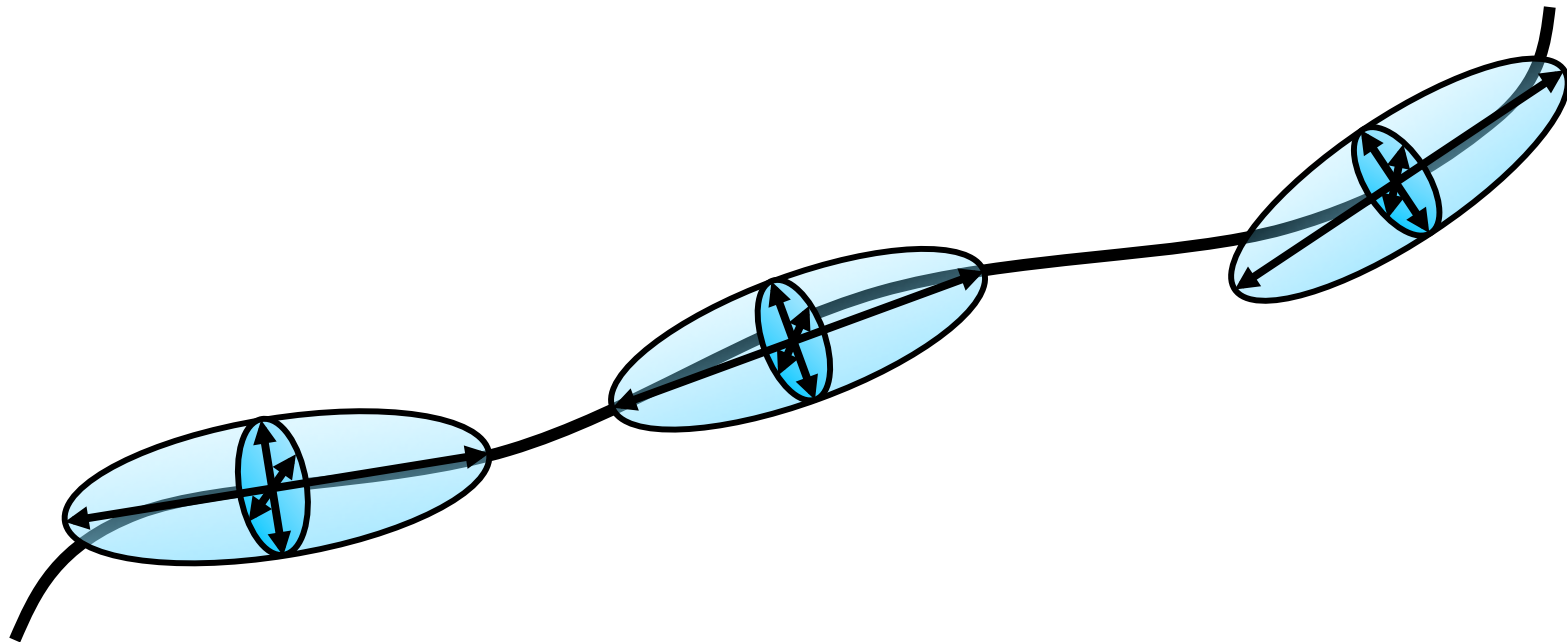
Diffusion MRI tractography

- Tractography can be defined as the virtual reconstruction of the trajectory of water molecules along white matter bundles.
 - DTI tracts provide a mathematical representation of the underlying white matter anatomy.
 - Each voxel contains hundreds of thousands of axon fibers: size of a voxel $\sim 1\text{-}5\text{ mm}$; diameter of an axon $\sim 0.1\text{-}10\text{ }\mu\text{m}$
- A DTI tract is not equivalent to a real fiber.



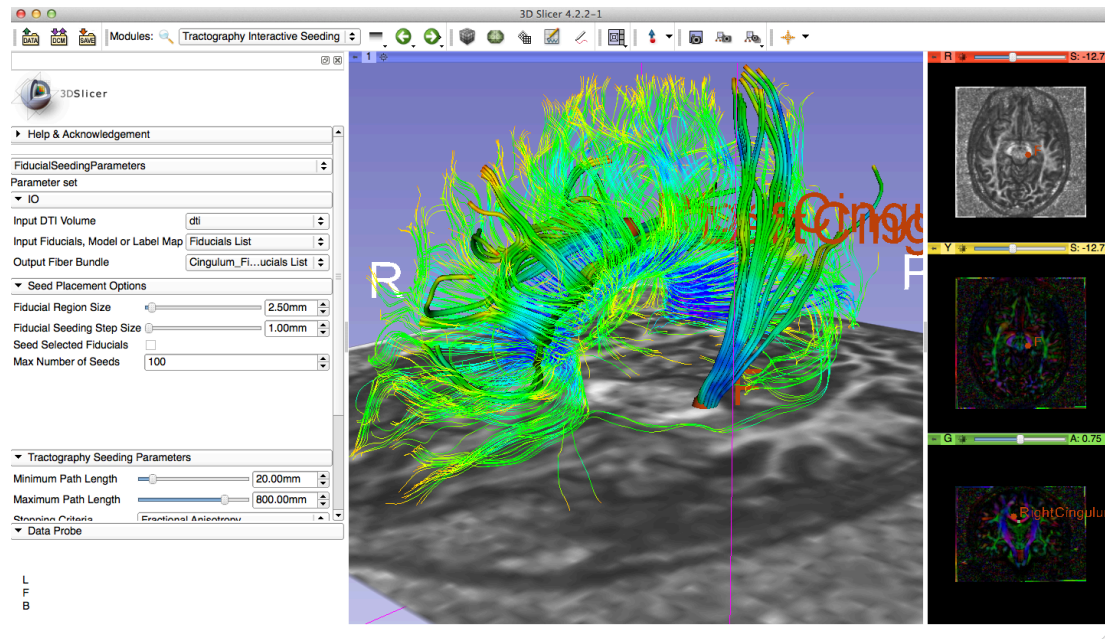
Streamline tractography

Underlying Assumption: the orientation of the fibers is collinear with the direction of the principal eigenvector





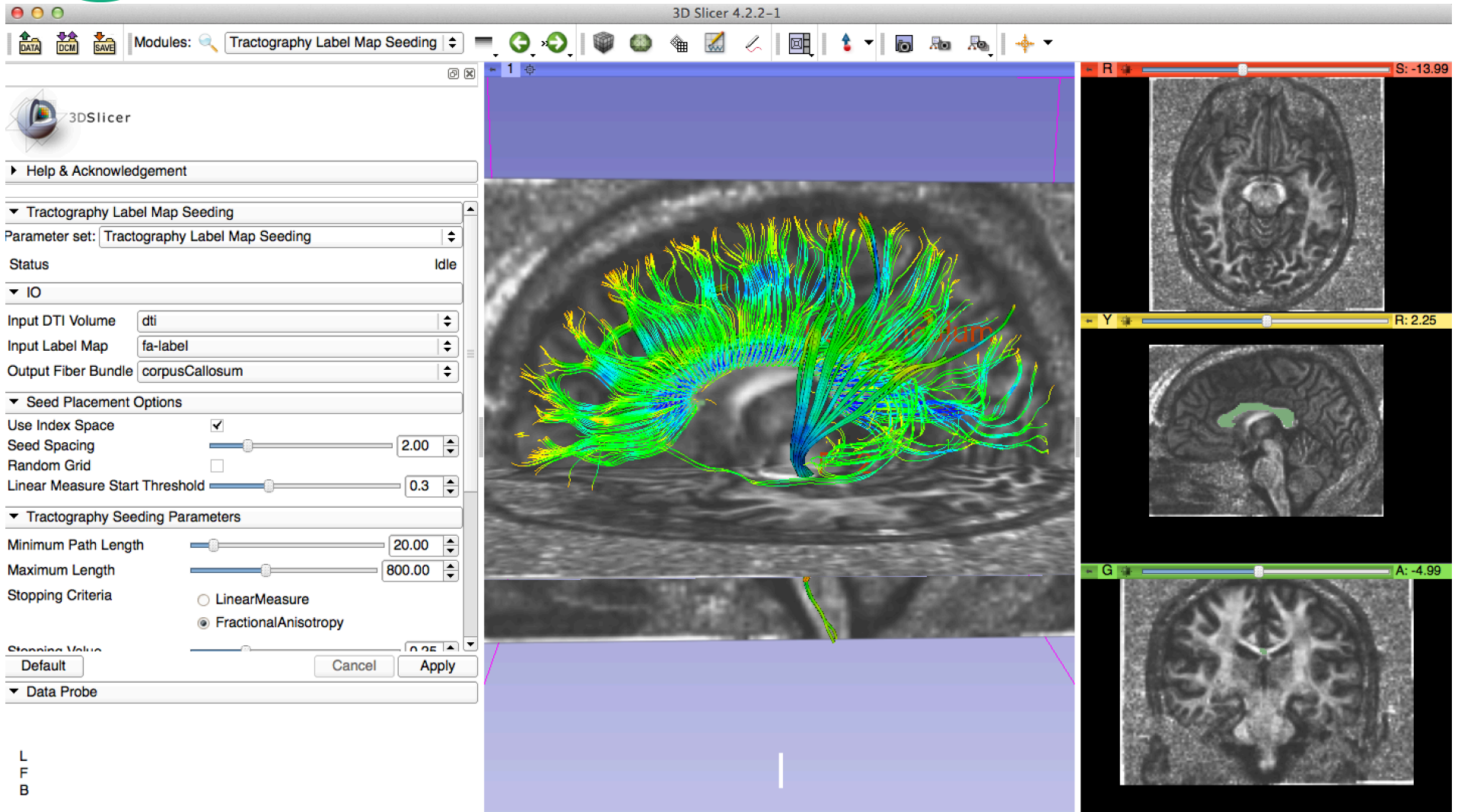
DTI Scene



In this example, the tractography reconstruction of the corpus callosum has been generated using the **LabelMap Seeding module**;

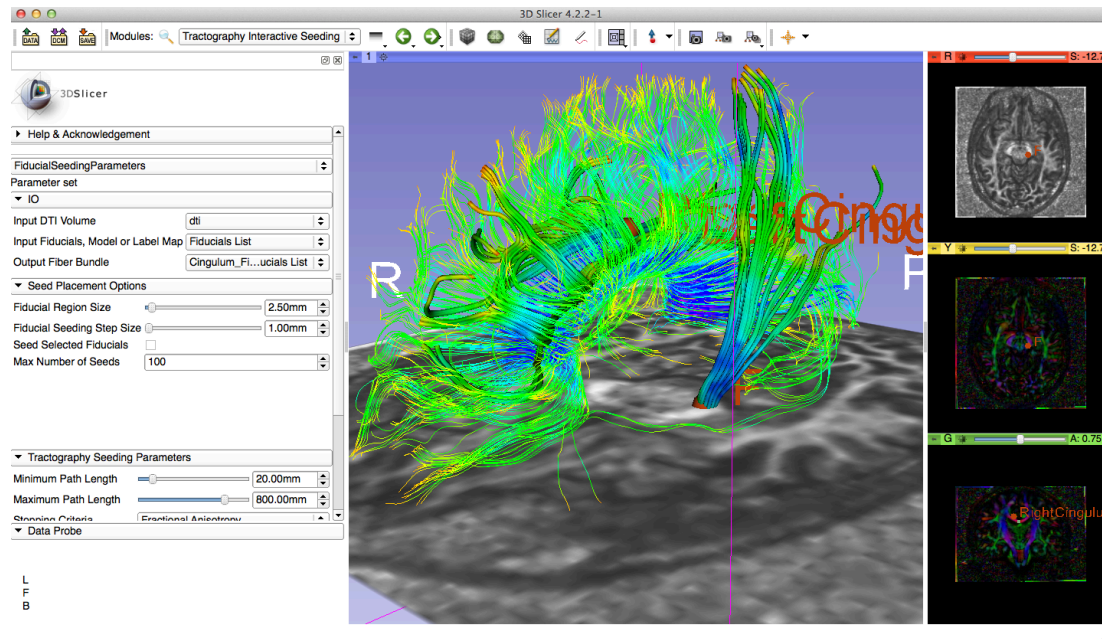


LabelMap Seeding Module





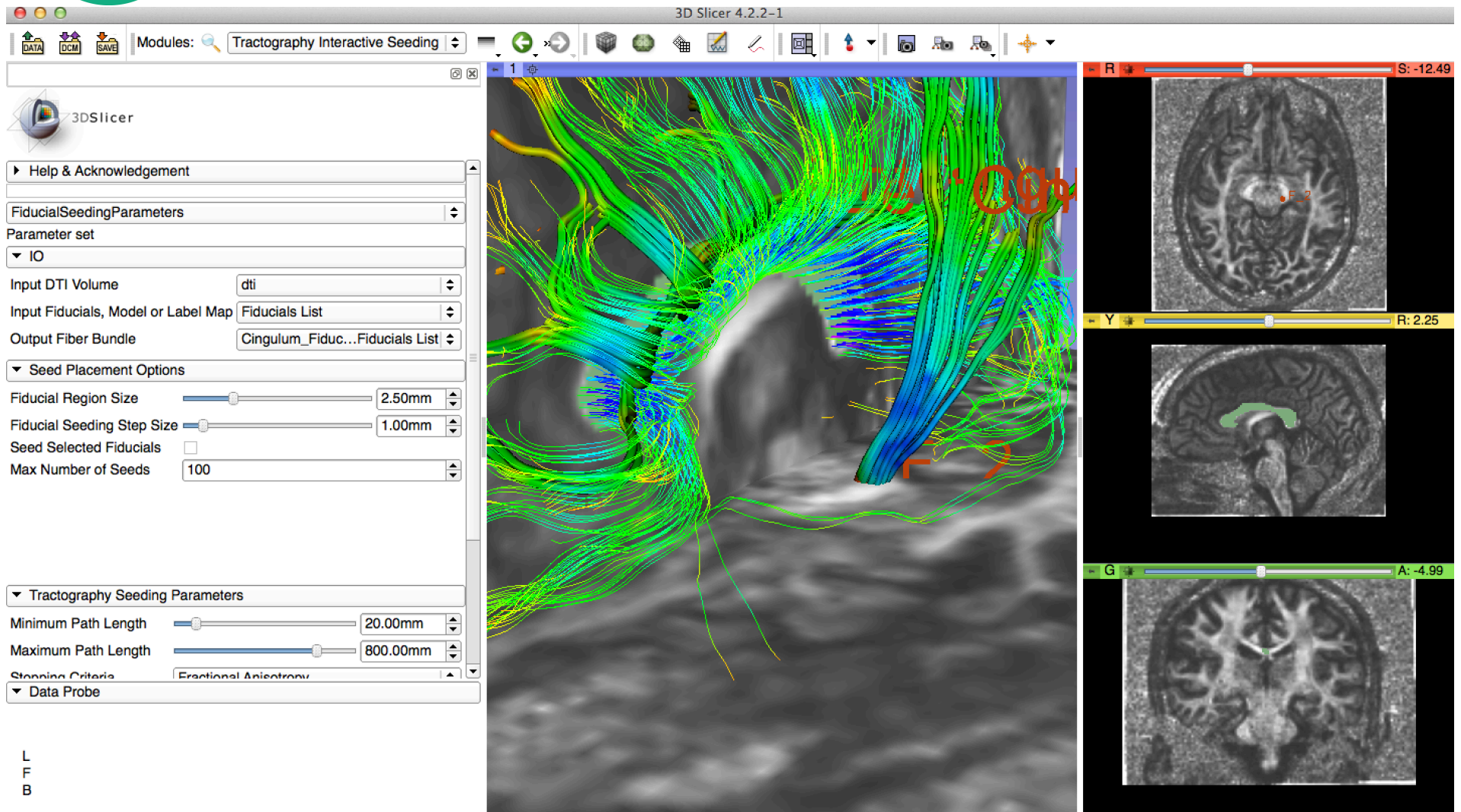
DTI Scene



In this example, the tractography reconstruction of the the cingulum has been generated using the **Interactive Tractography Seeding** module.

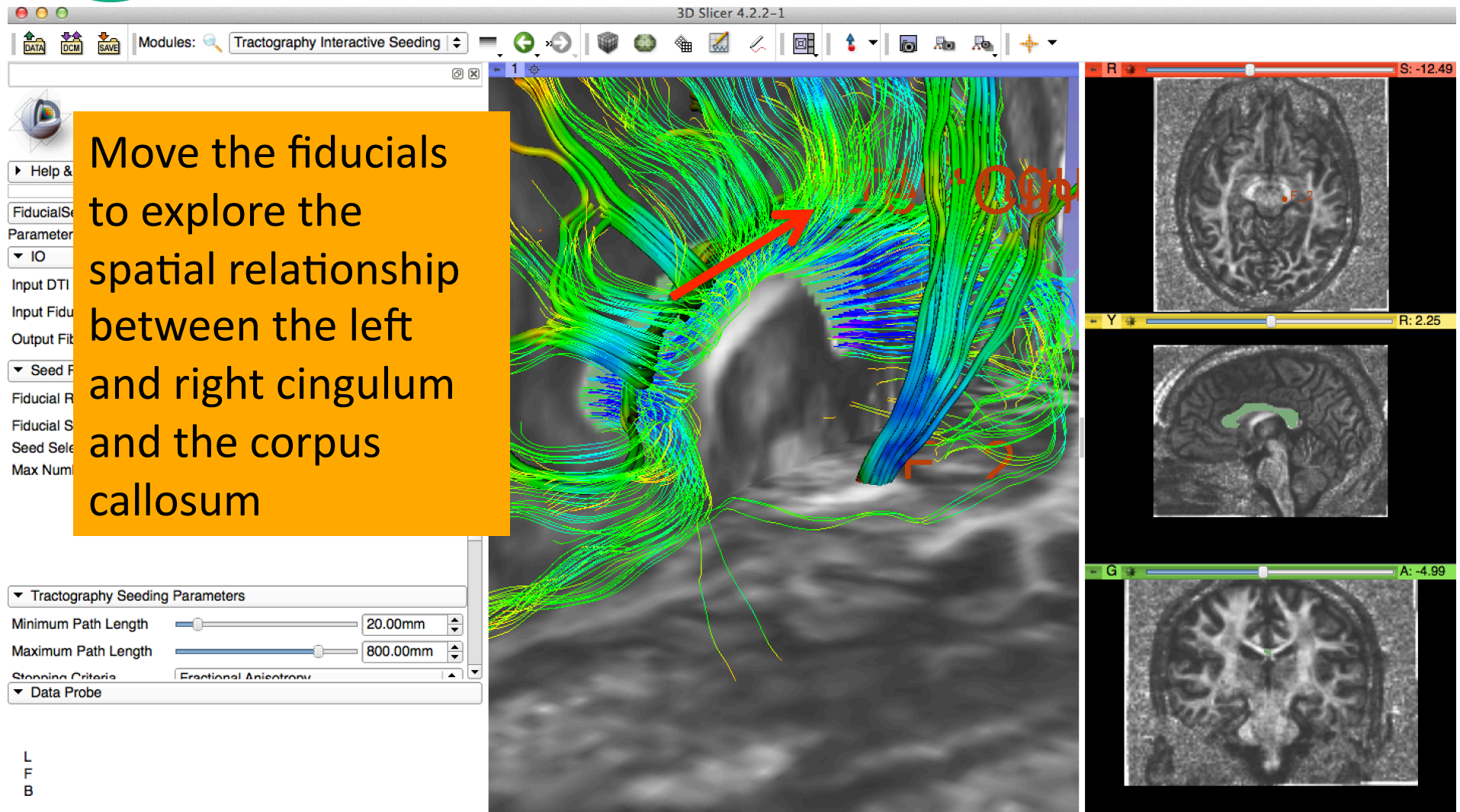


Interactive Tractography Seeding





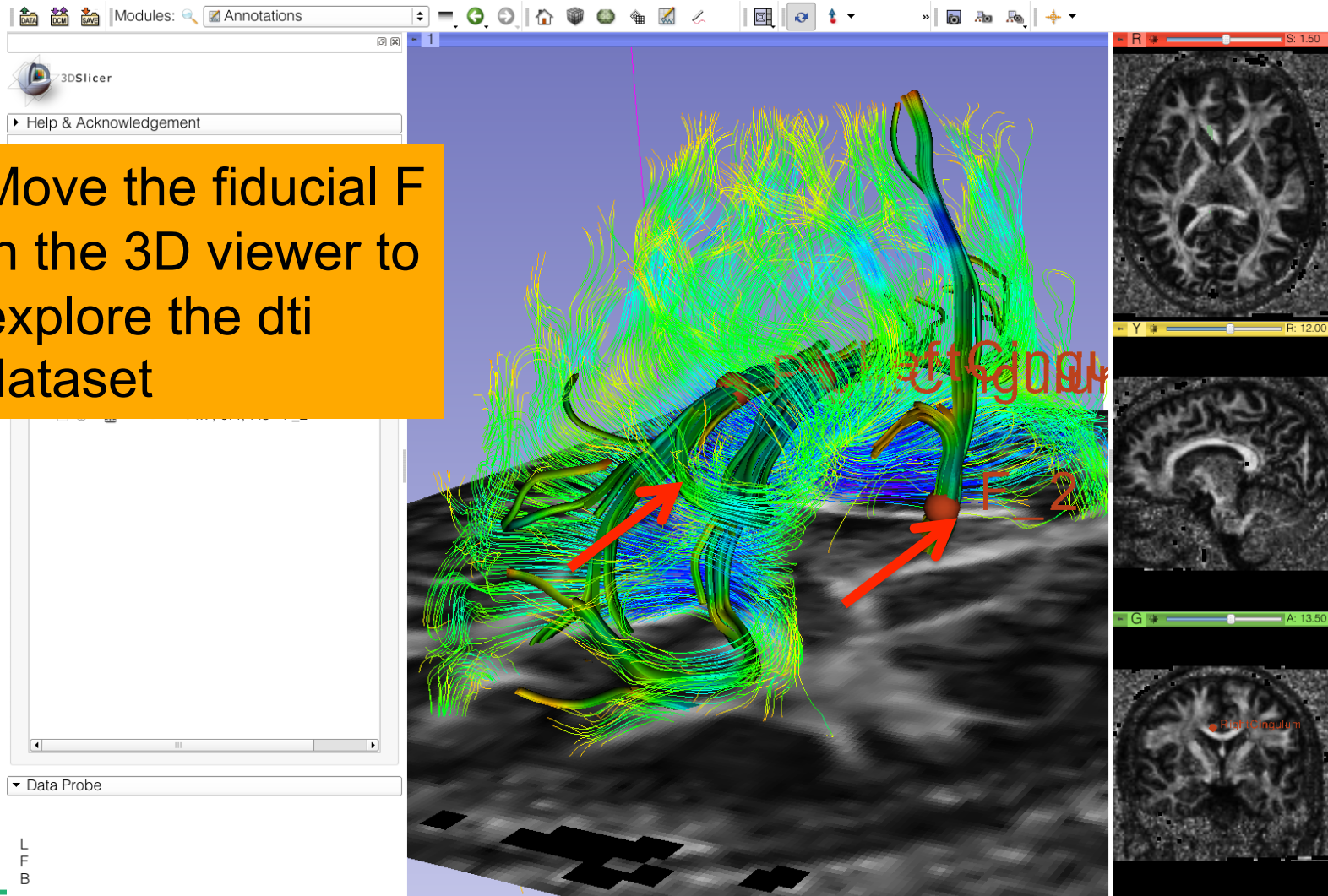
Interactive Tractography Seeding





Fiducial Seeding

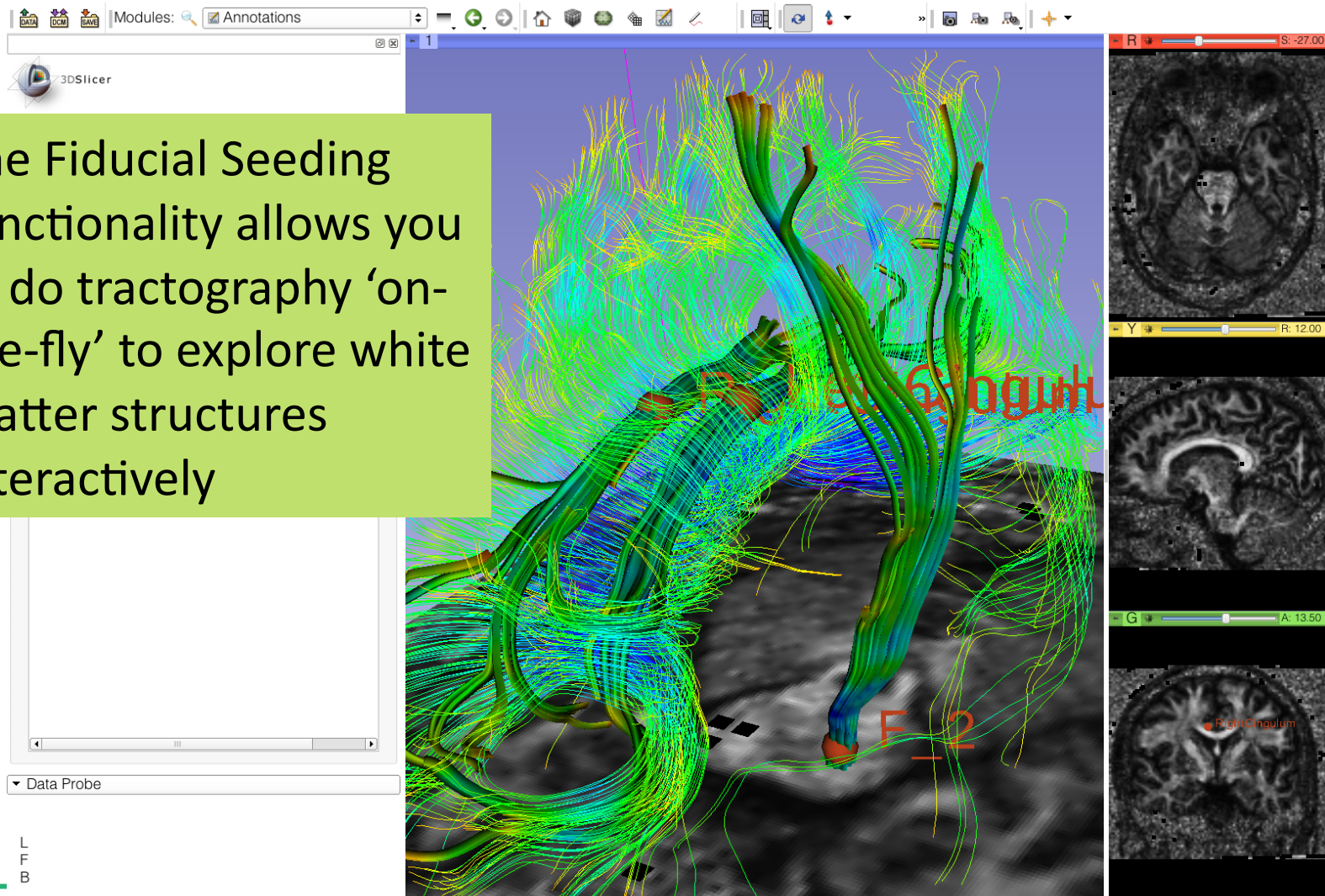
Move the fiducial F in the 3D viewer to explore the dti dataset





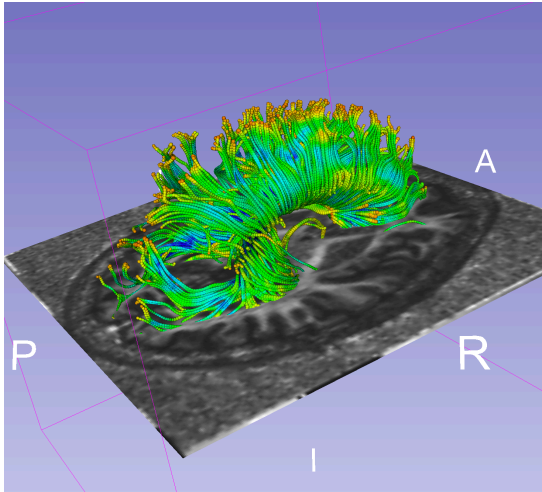
Tractography 'on-the-fly'

The Fiducial Seeding functionality allows you to do tractography 'on-the-fly' to explore white matter structures interactively

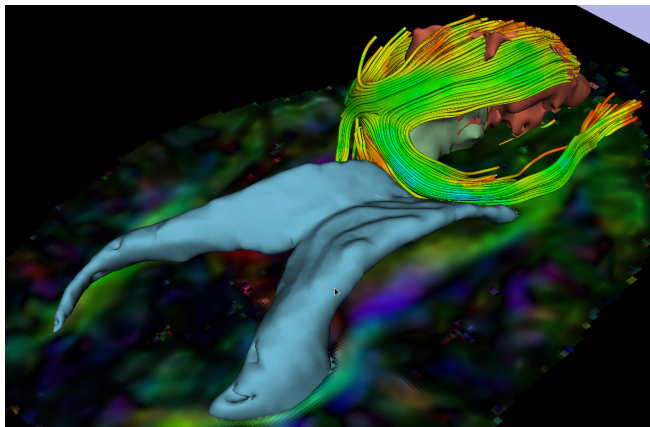




DTI training tutorials in Slicer4:

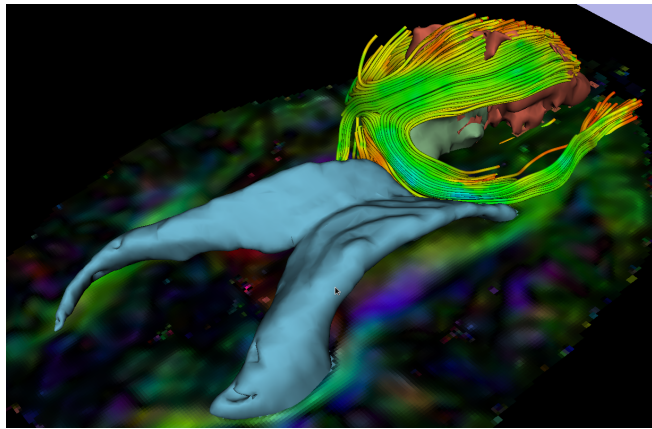


- Diffusion MR Imaging tutorial
- Exploring White Matter peritumoral fibers for exploration for neurosurgical planning
- Tutorials and datasets available at www.slicer.org





Going Further



- DTI tractography can be used to guide resection of tumor located in eloquent areas
- However, validation of DTI findings in clinical settings has yet to be establish



MICCAI DTI Challenge

14th International Conference on Medical Image Computing and Computer Assisted Intervention

18-22 September
MICCAI 2011
Toronto, CANADA

DTI Tractography for Neurosurgical Planning: A Grand Challenge

MICCAI 2011 Workshop
Sunday September 18, 9am-6pm
Westin Harbour Castle
Toronto, Canada

Workshop Faculty
Soma Puri, PhD, Surgical Planning Laboratory, Harvard Medical School
Ron Kikinis, MD, Surgical Planning Laboratory, Harvard Medical School
Alexandra Golby, MD, Brigham and Women's Hospital, Harvard Medical School
Guido Gerig, PhD, The Scientific Computing and Imaging Institute, University of Utah
Martin Styner, PhD, NeuroImage Research and Analysis Laboratory, University of North Carolina
William Wells, PhD, Surgical Planning Laboratory, Harvard Medical School
Carl-Friedrik Westin, PhD, Laboratory of Mathematics in Imaging, Harvard Medical School
Sylvain Goutard, MSc, The Scientific Computing and Imaging Institute, University of Utah

National Alliance for Medical Image Computing
http://www.na-mic.org/Workshops/Workshops_DTITractography_Challenge_MICCAI_2011

MICCAI 2012 DTI Tractography Challenge
Second Edition

INTRODUCTION THE CHALLENGE FACULTY KEYNOTE SPEAKER DATA REGISTRATION CONTACT

Welcome to the 2nd edition of the MICCAI DTI Tractography Challenge. The workshop will be held on Monday October 1st, 2012 as part of the 15th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2012).

The 15th International Conference on Medical Image Computing and Computer Assisted Intervention
1-5 October 2012 - Acropolis Convention Center - Nice, France

MICCAI

- International collaborative effort on the validation of DTI tractography for neurosurgical planning
- Standardized comparison of tractography methods on patient data
- Working group of DTI Experts, Practising neurosurgeons, tractography algorithms developers and neuroradiologists
- <http://dti-challenge.org>



Third edition: Sept 22, 2013, Nagoya, Japan

MICCAI 2013 DTI Challenge

[Introduction](#)

[Datasets](#)

[Faculty](#)

[Program](#)

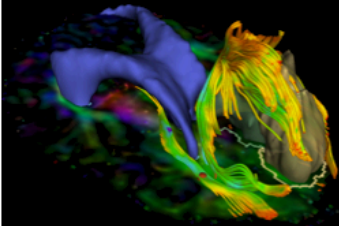
[Submission](#)

[Contact](#)

MICCAI 2013 DTI Tractography Challenge

Sunday September 22, 2013, Nagoya, Japan

[Learn more »](#)



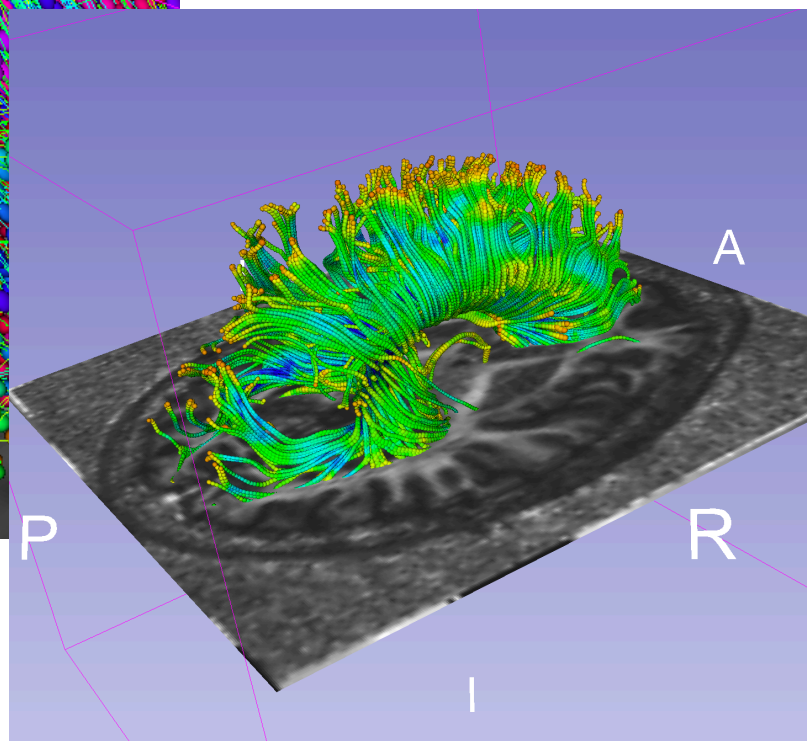
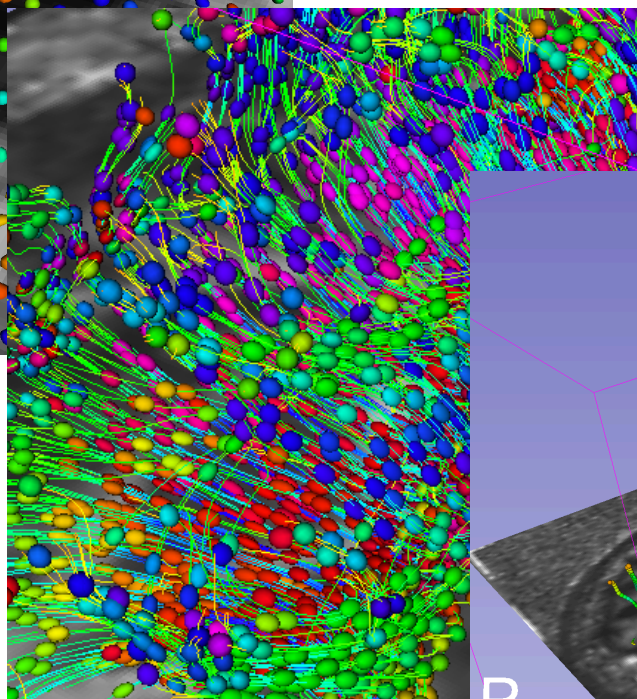
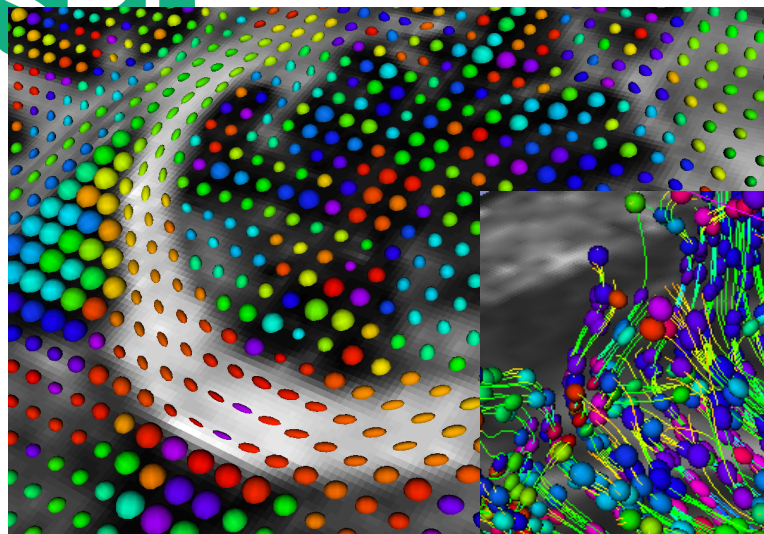
DTI Tractography Challenge on Peritumoral White Matter Anatomy for Neurosurgical Decision-Making





Slicer Community

- www.slicer.org
- Mailing lists:
slicer-user@bwh.harvard.edu
slicer-devel@bwh.harvard.edu



Contact:
spujol@bwh.harvard.edu



Conclusion

- Slicer is an open-source research platform for the rapid development of biomedical image analysis tools.
- Slicer community is open with contributors from all over the world
- Slicer is a versatile platform for translational research and subject specific analysis of biomedical image data





Acknowledgments



National Alliance for Medical Image Computing

NIH U54EB005149



Neuroimage Analysis Center

NIH P41RR013218