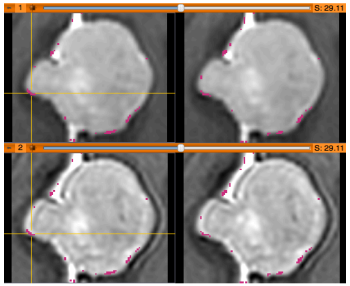
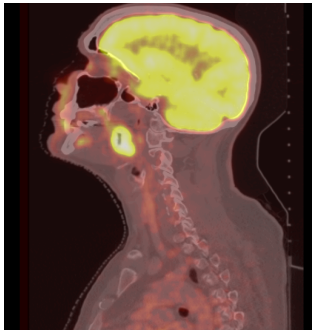
Surgical Planning Laboratory
Brigham and Women's Hospital
Boston, Massachusetts USA

a teaching affiliate of
Harvard Medical School

Quantitative Medical Imaging for Clinical Research and Practice



Sonia Pujol, PhD, Katarzyna Macura MD, PhD, Kitt Shaffer, MD, PhD, Hatsuho Mamata, MD, PhD, Andriy Fedorov, PhD, Wendy Plesniak, PhD, Ron Kikinis, MD



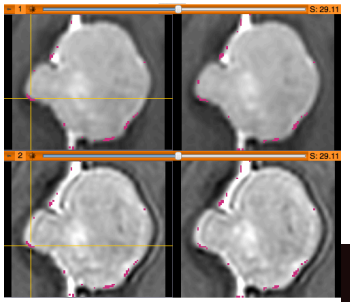
Quantitative Imaging Tutorial

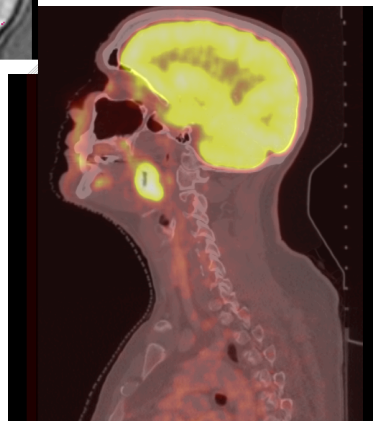
Quantitative imaging is the extraction of quantitative measurements from medical imaging.

This tutorial is built upon two examples of quantitative imaging:

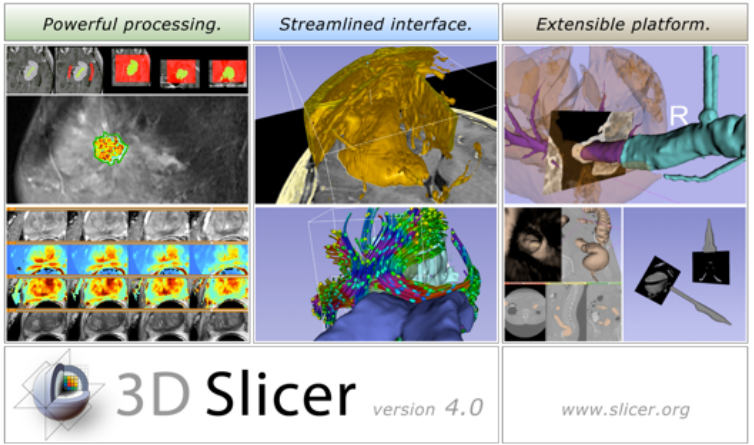
- **Morphology**: small volumetric changes in slow growing tumors

- **Function**: metabolic activity in squamous cell carcinoma





Quantitative Imaging: Software



www.slicer.org

- This hands-on tutorial will guide you step-by-step through the use of quantitative imaging modules of the 3DSlicer software.
- 3DSlicer is a freely available open-source platform for medical imaging research supported by the National Institutes of Health.

Course Overview

Part 1: Basics of 3D Data Loading and interactive visualization in 3DSlicer

Part 2: Measurement of small Volumetric Changes in meningioma using the Change Tracker module

Part 3: Measurement Metabolic Activity in squamous cell carcinoma using the PET Standard Uptake Value Computation module

Course Datasets

The course data is located in the directory:

C:/3DSlicerData/QuantitativeImaging_Tues_Dec3

- dataset1_MR_Head
- dataset2_ChangeTracker
- dataset3_PETCT

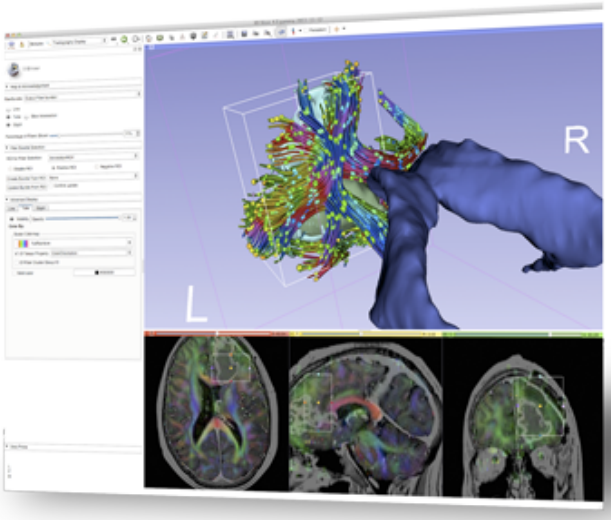
Each dataset is in Slicer **.mrb file format.**

Slicer mrb file format

A Slicer mrb file is an archive file that contains all data for loading into Slicer4.

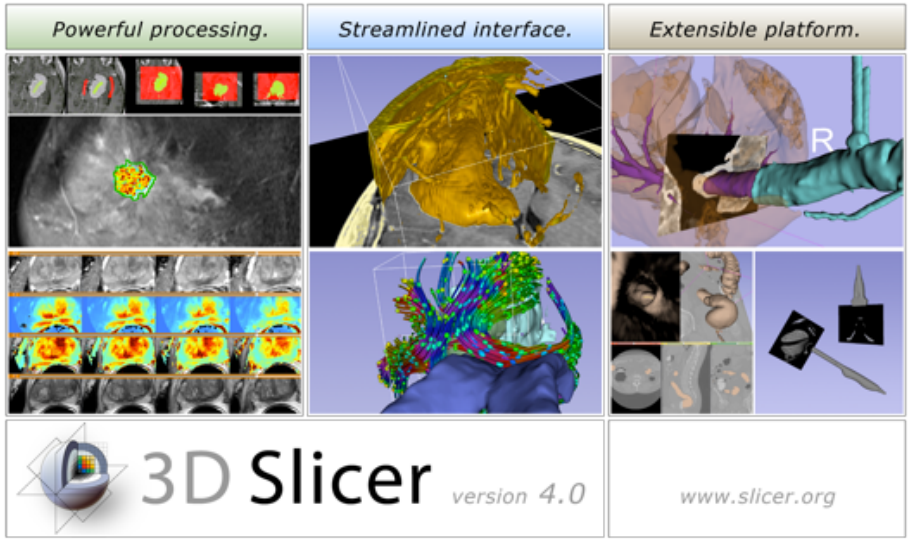
The .mrb file is a .zip file but with a different file extension.

Introduction to the 3DSlicer software



Sonia Pujol, PhD
Director of Training,
National Alliance for Medical Image Computing
Brigham and Women's Hospital, Boston, MA

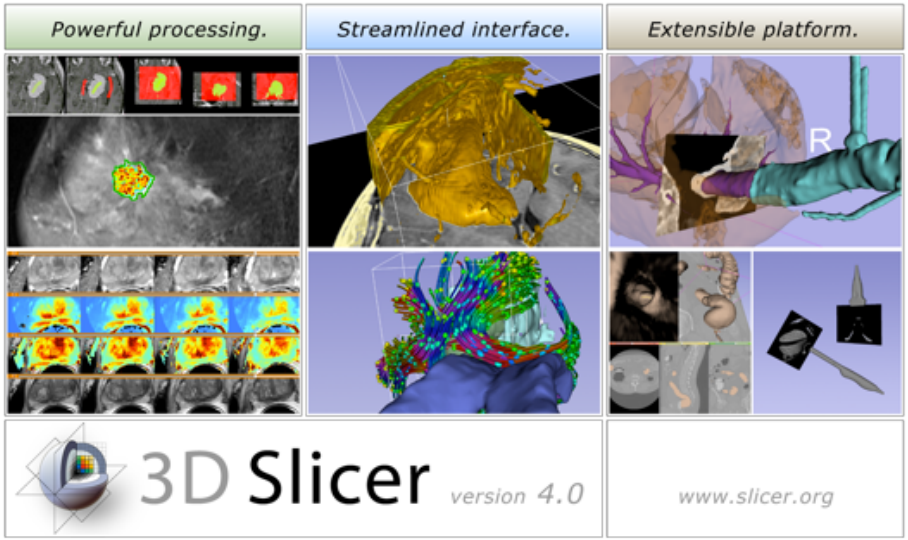
3DSlicer



3DSlicer is a freely available open-source platform for segmentation, registration and 3D visualization of medical imaging data.

3DSlicer is a multi-institutional effort supported by the National Institute of Health.

3DSlicer

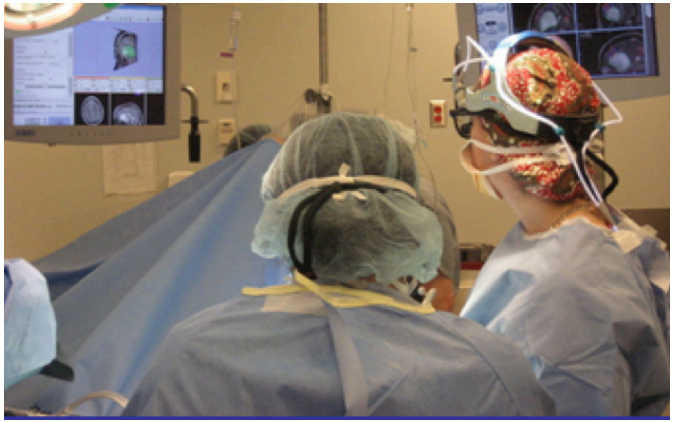


- 3DSlicer version 4.2 is a multi-platform software running on Windows, Linux, and Mac OSX
- Slicer is distributed under a BSD license with no restriction on use
- Slicer is a tool for research, and is not FDA approved

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.

An interdisciplinary platform

An open-source environment for software developers



An end-user application for clinical investigators and scientists

A software platform that is both easy to use for clinical researchers and easy to extend for programmers

3DSlicer History

- 1997: Slicer started as a research project between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)

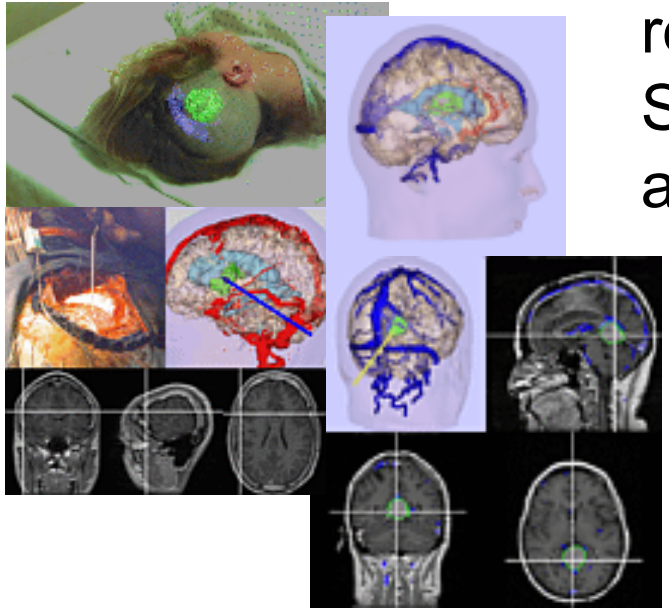
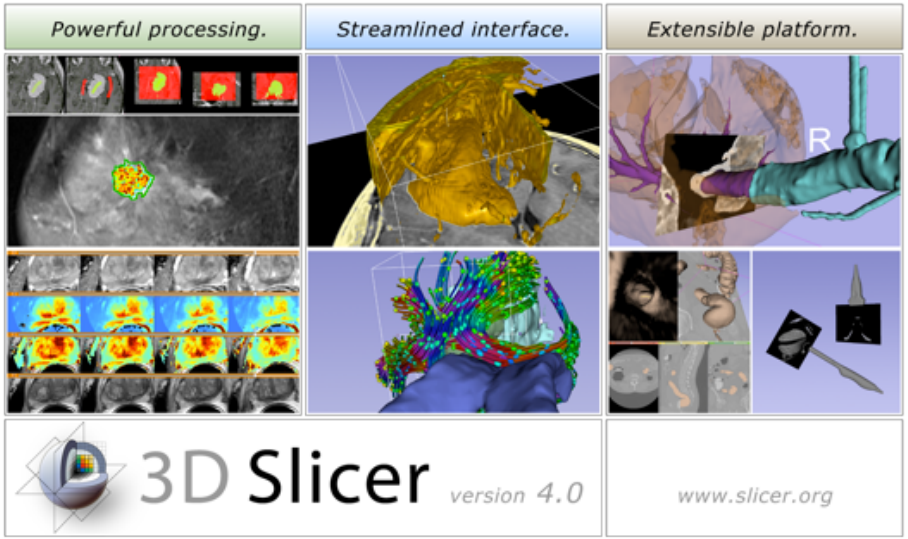


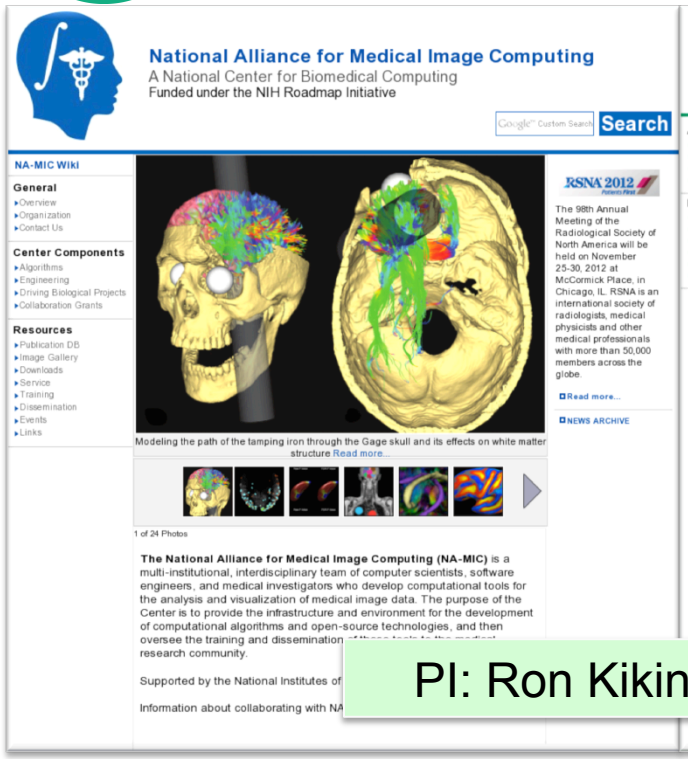
Image Courtesy of the CSAIL, MIT

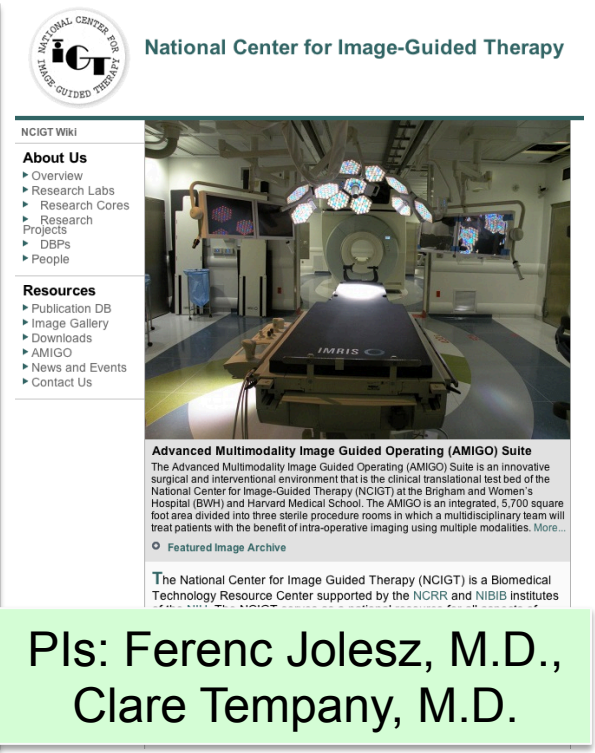
3DSlicer History



- 1997: Slicer started as a research project between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)
- 2012: Multi-institution effort to share the latest advances in image analysis with clinicians and scientists

A multi-institution: NA-MIC, NAC, NCIGT

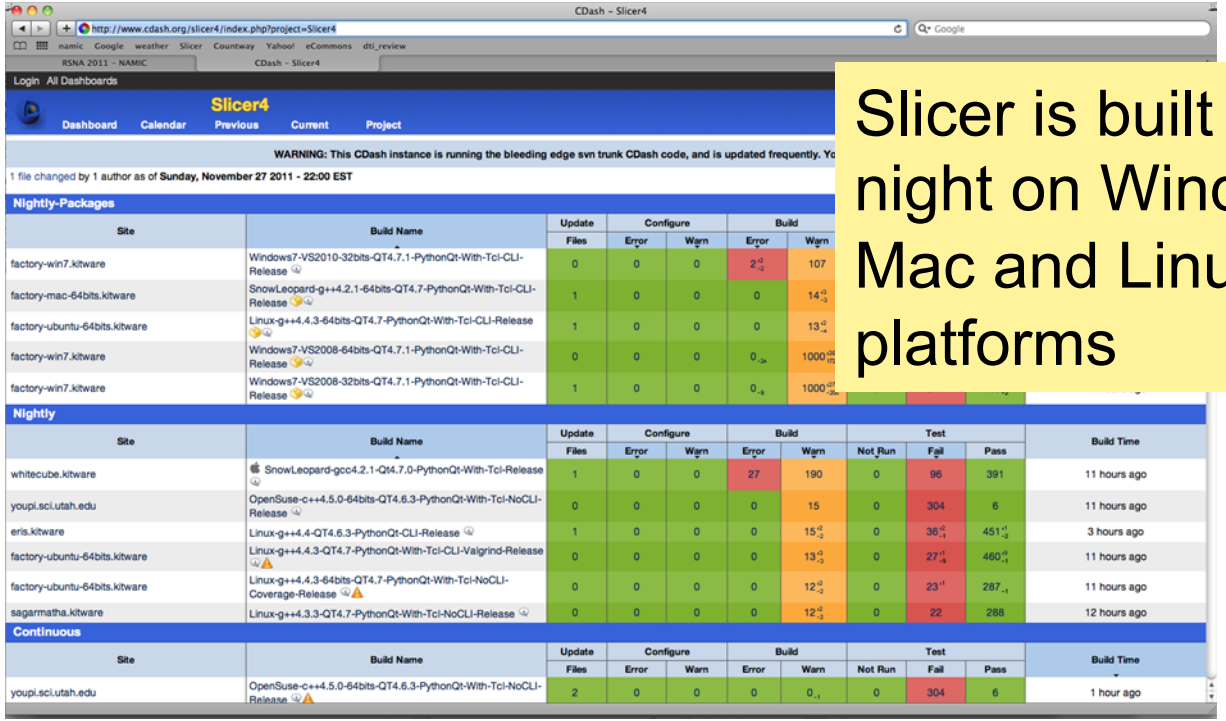




PI: Ron Kikinis, M.D.

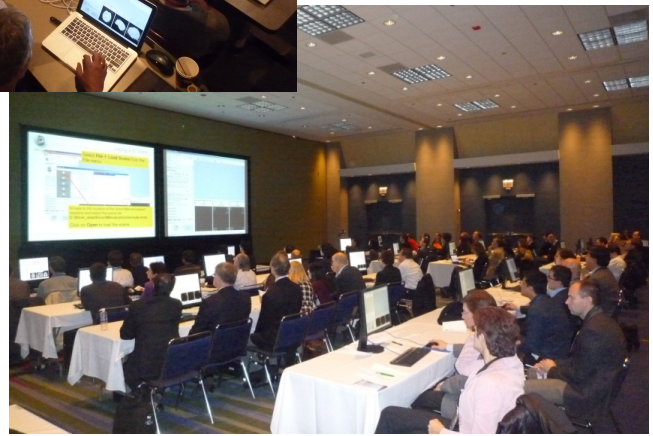
PIs: Ferenc Jolesz, M.D., Clare Tempany, M.D.

Slicer: Behind the scenes



Slicer is built every night on Windows, Mac and Linux platforms

Slicer Training



RSNA 2011

- Hands-on training workshops at national and international venues
- More than 2,000 clinicians, clinical researchers and scientists trained since 2005

Slicer Downloads

Slicer 4 download statistics

Total matching downloads:
46794

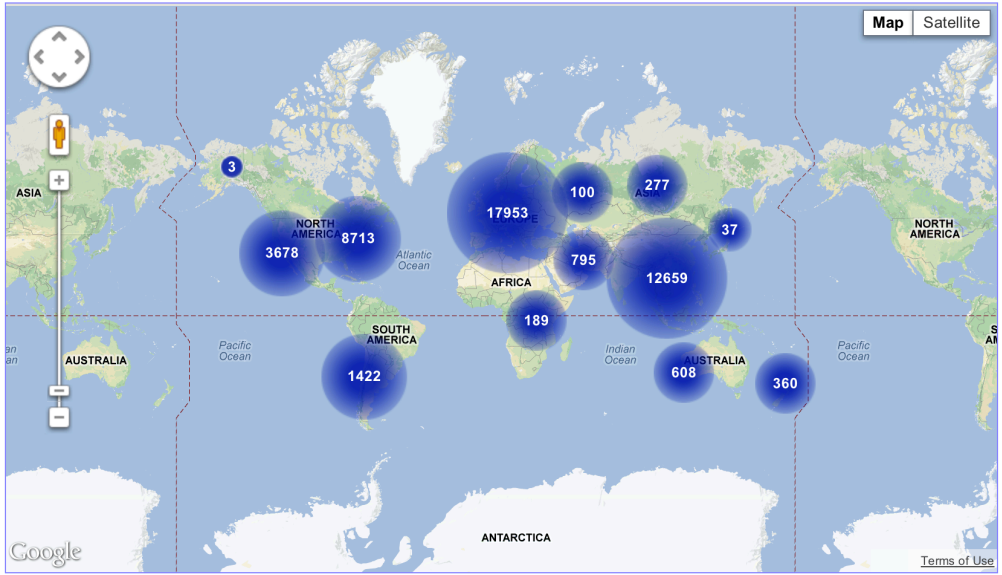
Date range: past year

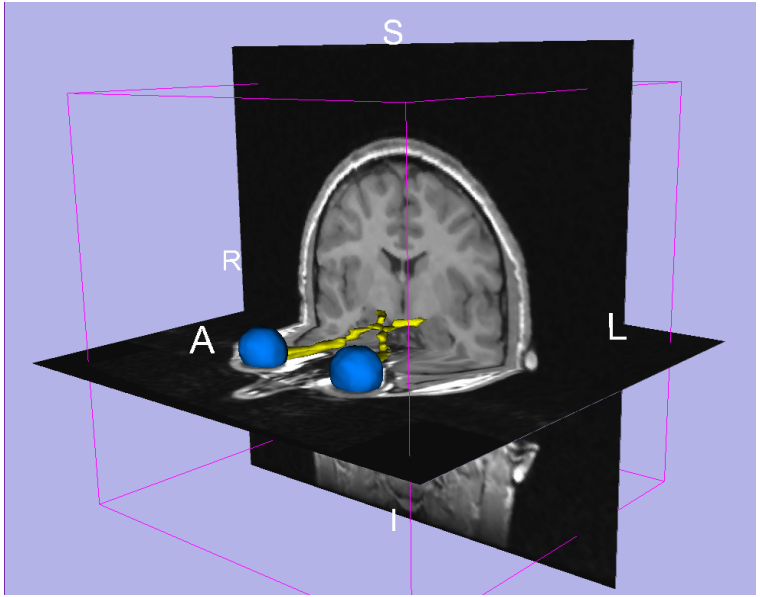
Release type: any

Browser type: desktop

Update

Download location | By Country | By Filename | By Month

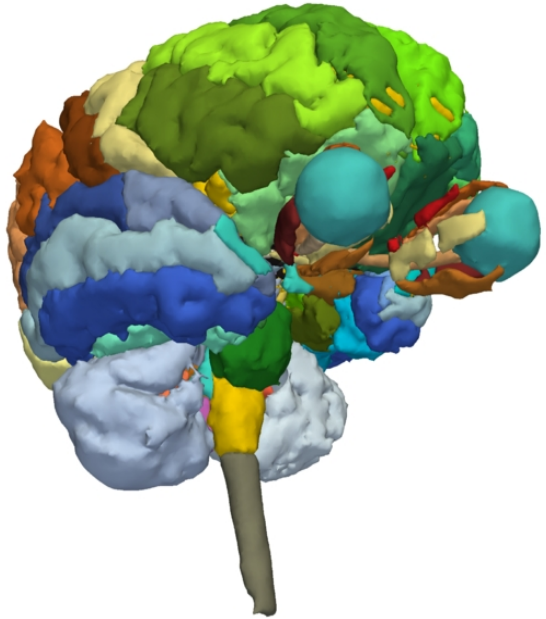




Part I: 3D Data Loading and Visualization

Sonia Pujol, PhD
Wendy Plesniak, PhD

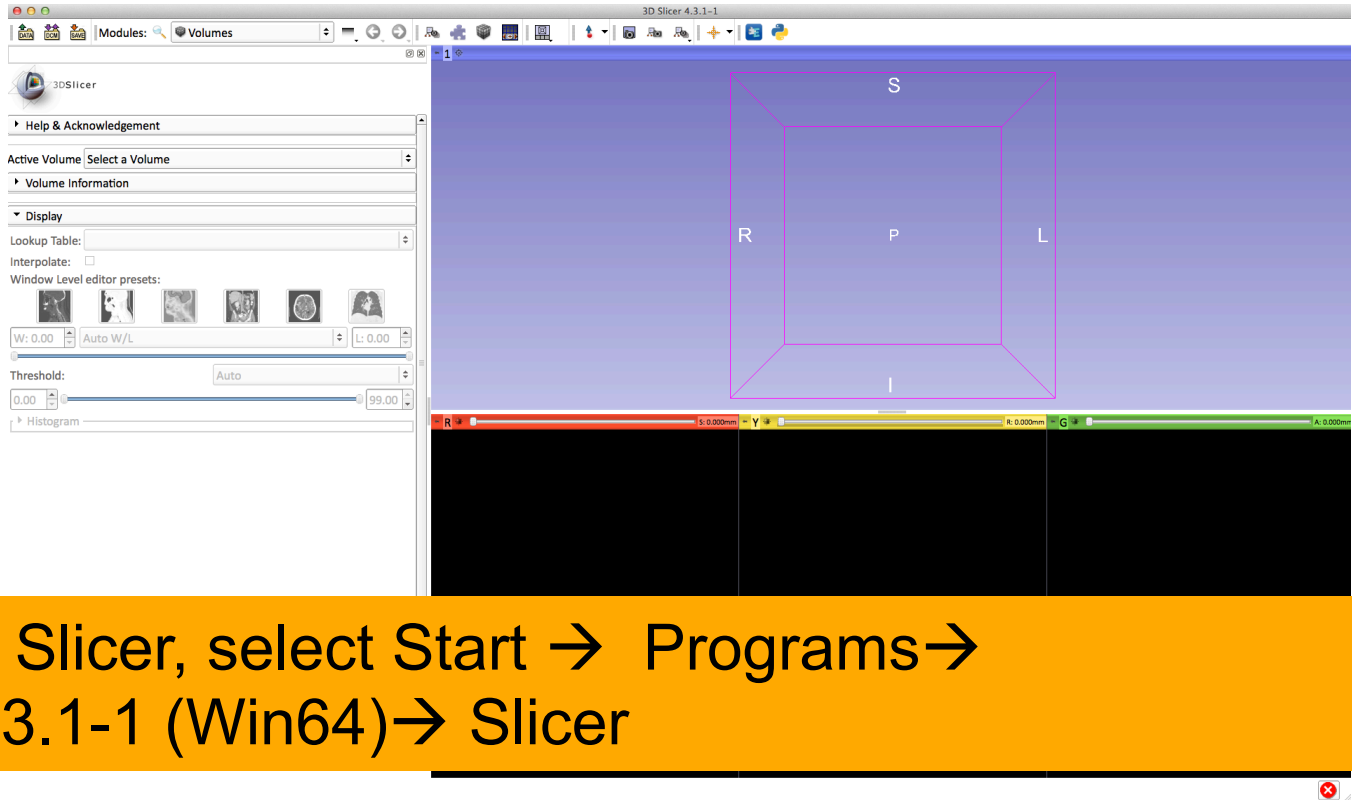
3D Data Loading and Visualization



- This tutorial is a short introduction to the advanced **3D visualization capabilities Slicer**
- The Slicer4 Minute dataset is composed of an MR scan of the brain and 3D surface reconstructions of anatomical structures.
- The data are part of the SPL-PNL Brain Atlas developed by Talos, Jakab, Kikinis *et al.* The atlas is available at:

http://www.spl.harvard.edu/publications/item/view/2037

Welcome to Slicer4

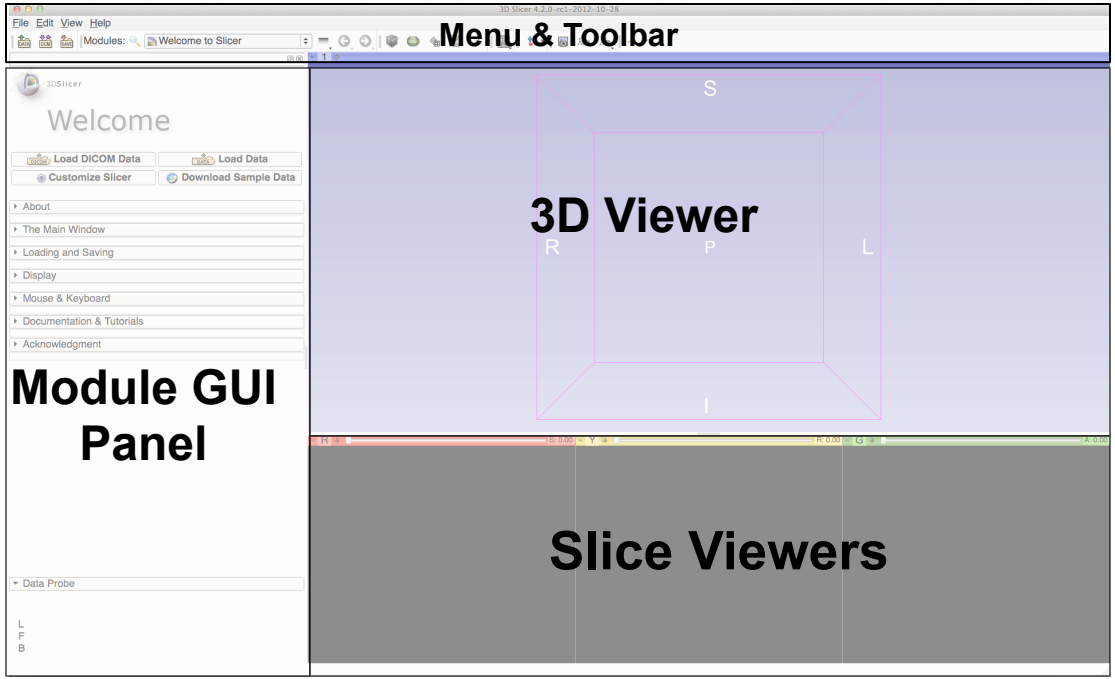


To start Slicer, select Start → Programs→ Slicer4.3.1-1 (Win64)→ Slicer

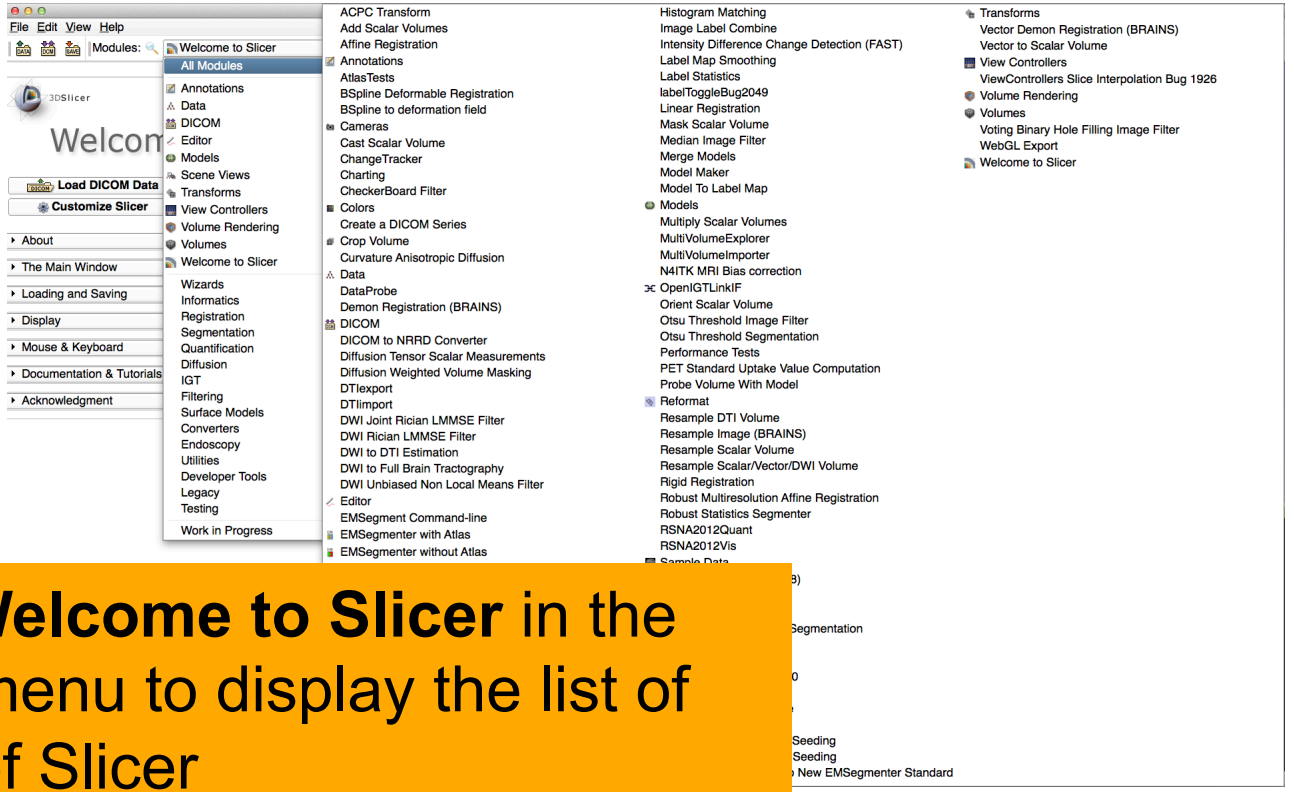
Slicer4 Minute Tutorial: Navigating the Application GUI

The Graphic User Interface (GUI) of Slicer4 integrates **four components:**

- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer

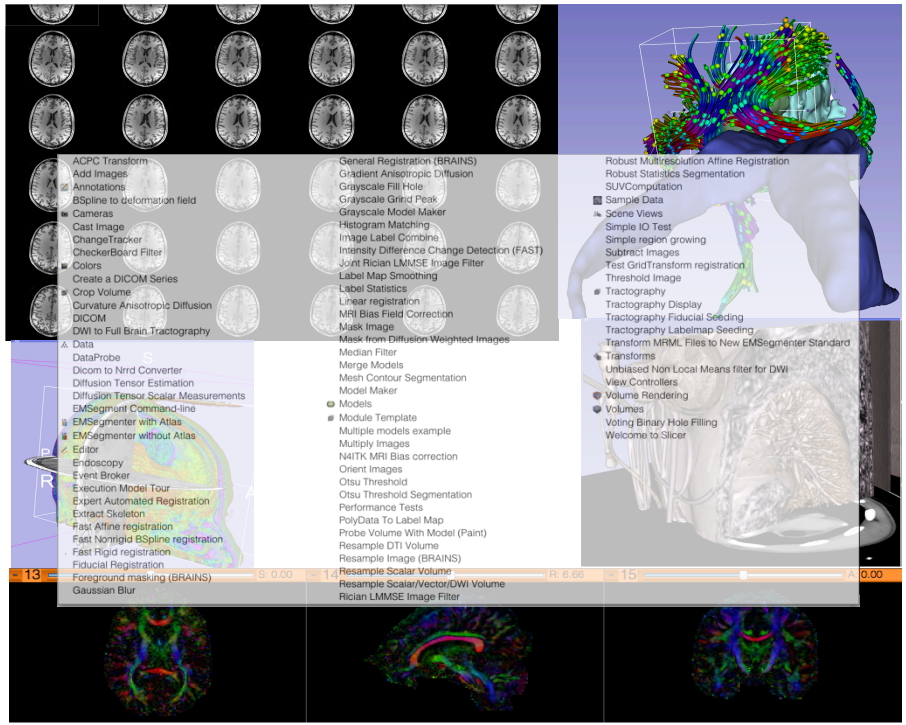


Welcome to Slicer4.3



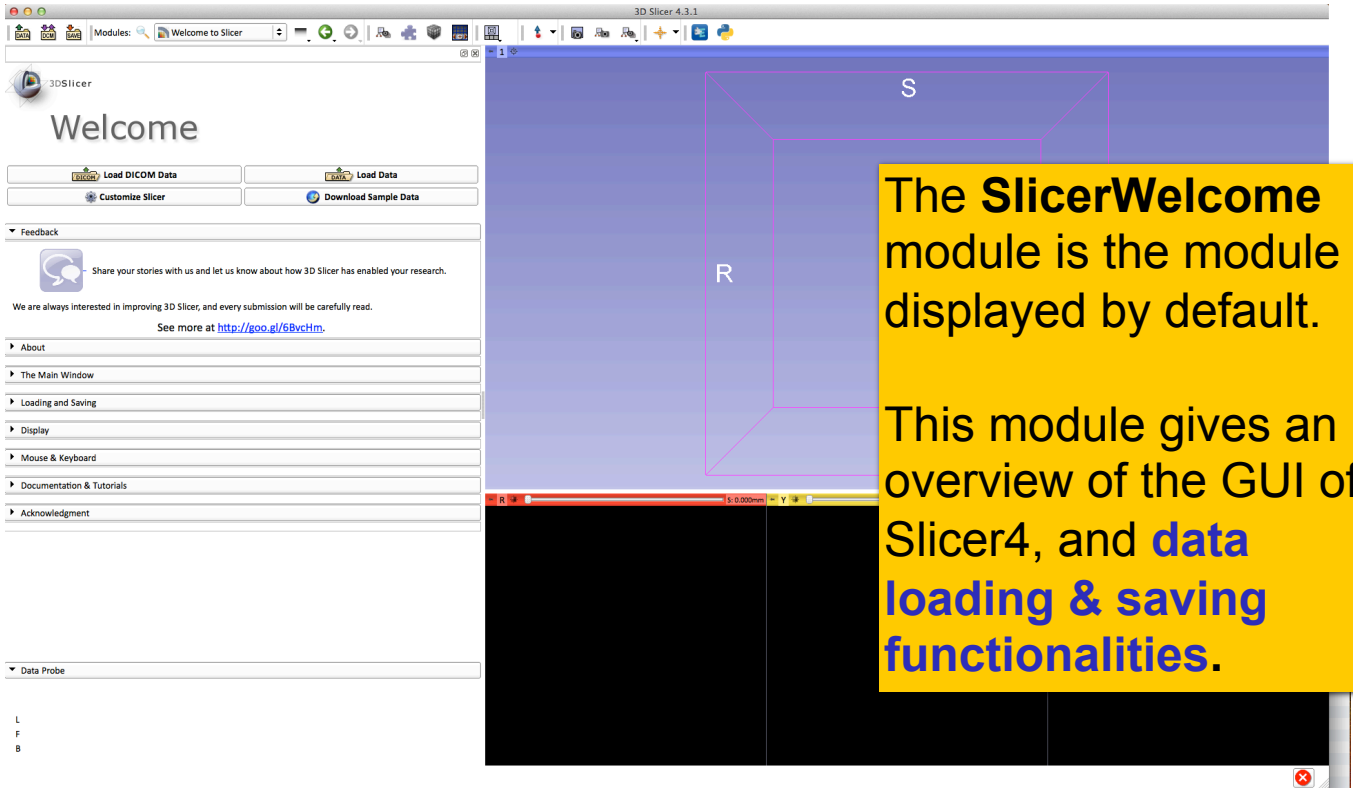
Click on **Welcome to Slicer** in the Modules menu to display the list of modules of Slicer

Welcome to Slicer4



Slicer4.3 contains more than 100 modules for image segmentation, registration and 3D visualization of medical imaging data

Slicer4 Minute Tutorial: Welcome Module

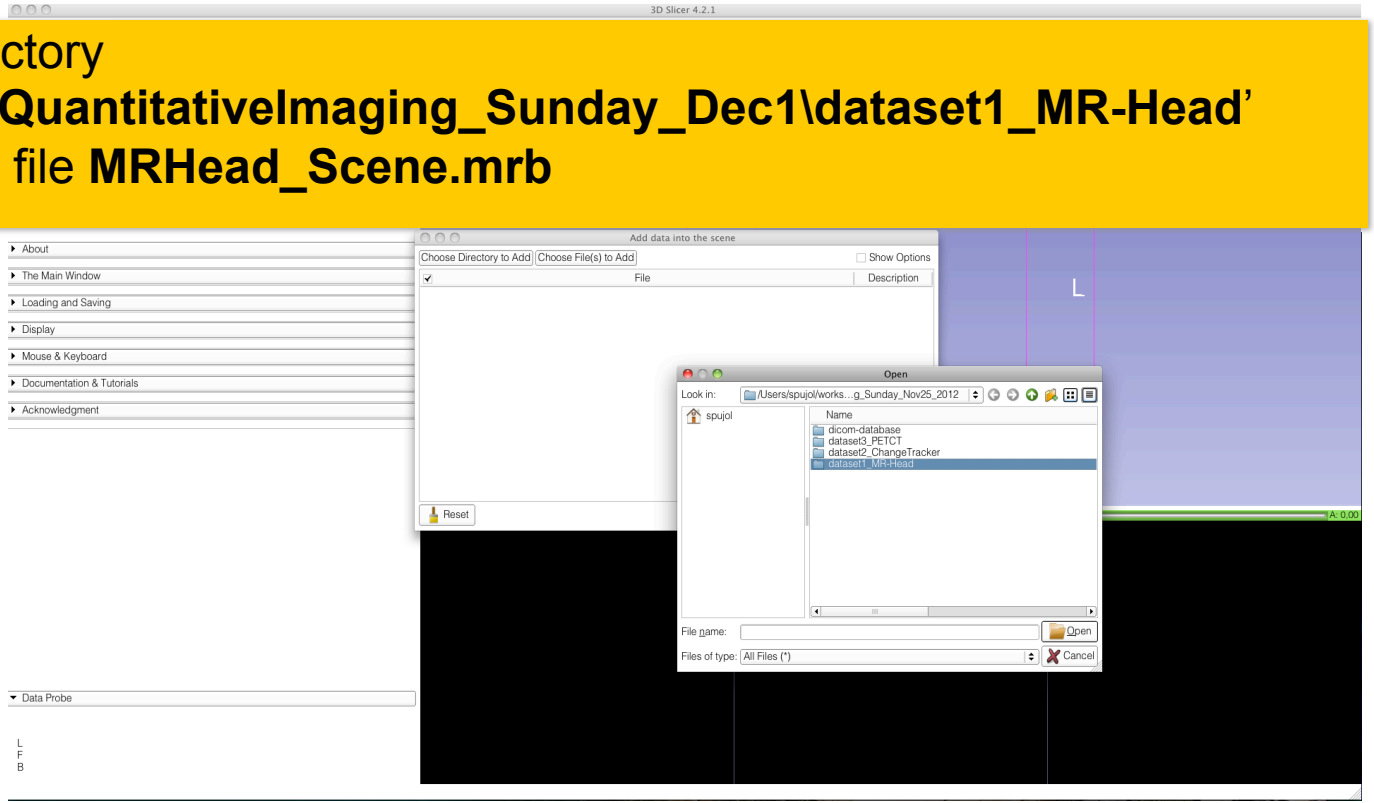


The **SlicerWelcome** module is the module displayed by default.

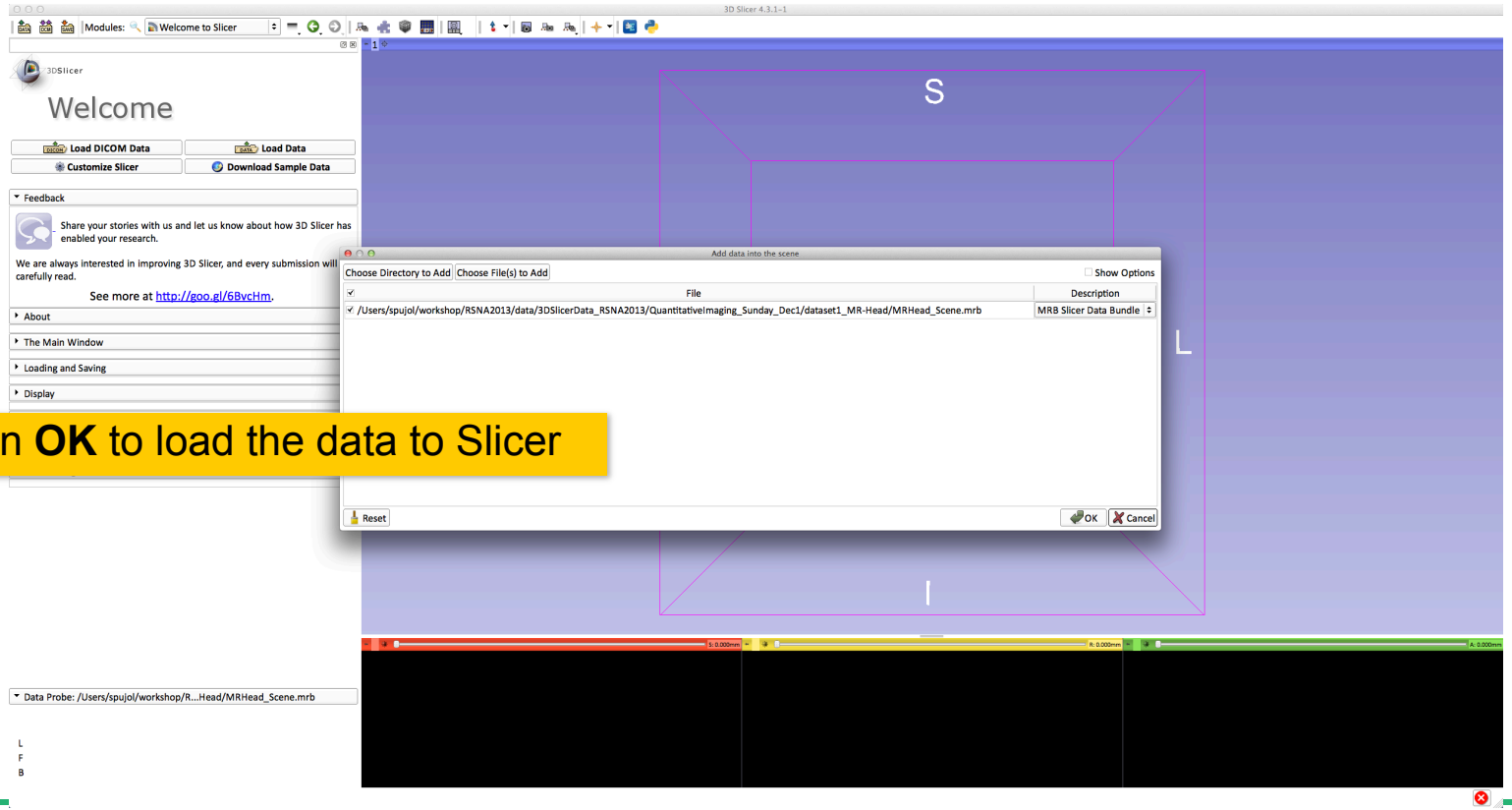
This module gives an overview of the GUI of Slicer4, and **data loading & saving functionalities**.

Slicer4 Minute Tutorial: Load a Scene

Browse to the directory
'**C:\3DSlicerData\QuantitativeImaging_Sunday_Dec1\dataset1_MR-Head**'
Drag and drop the file **MRHead_Scene.mrb**



Slicer4 Minute Tutorial: Load a Scene

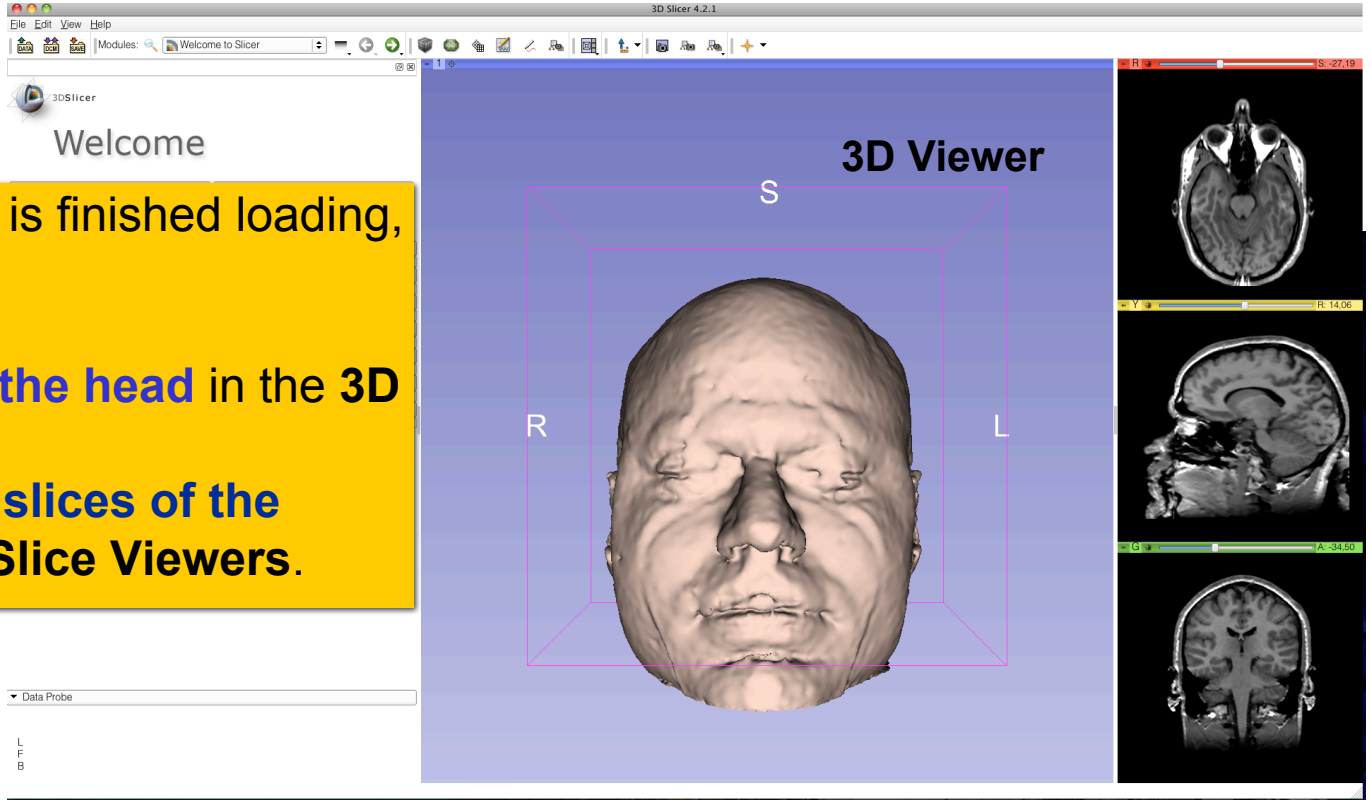


Click on **OK** to load the data to Slicer

Slicer4 Minute Tutorial: Viewing the Scene

When the scene is finished loading, Slicer displays:

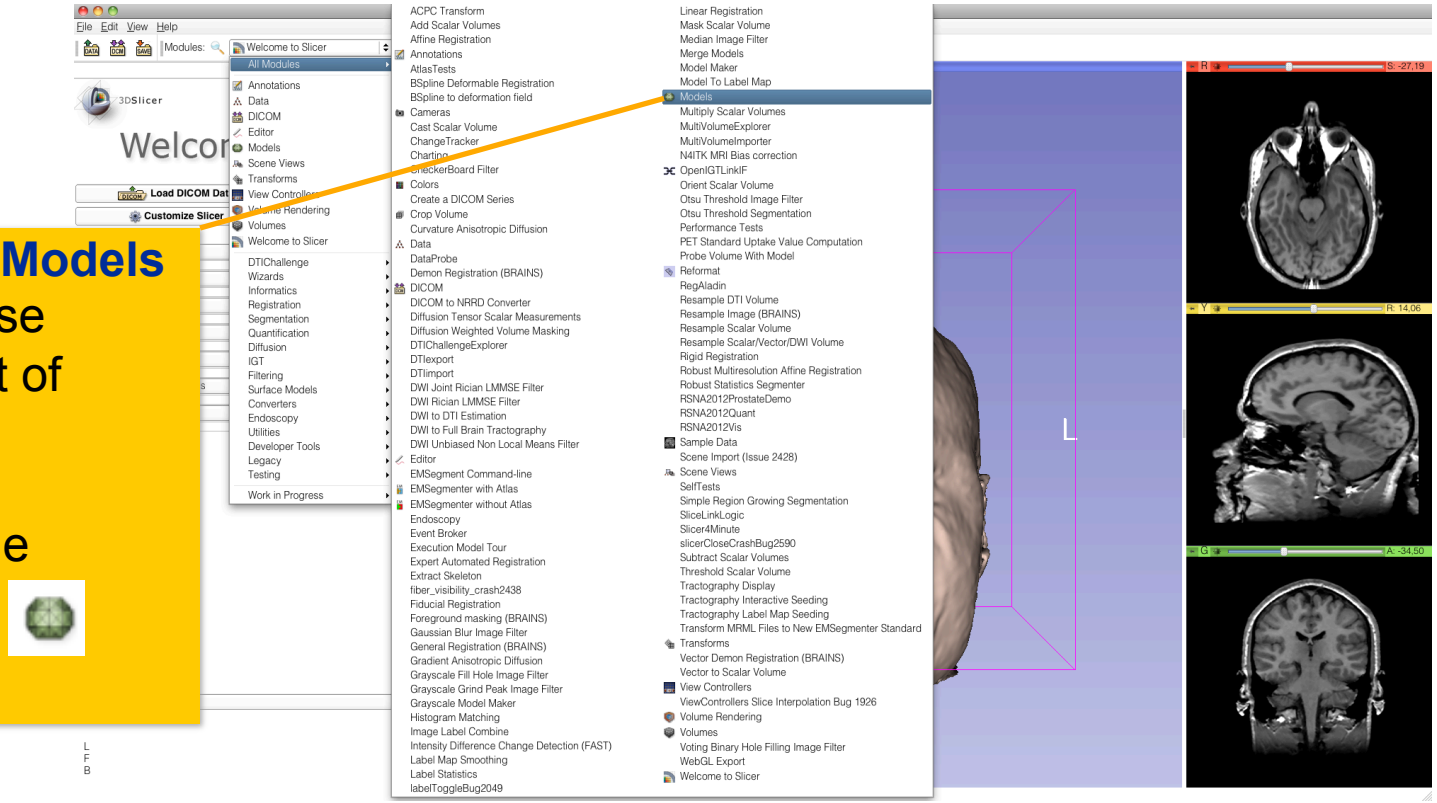
- a **3D model of the head** in the **3D Viewer**, and
- anatomical **MR slices of the brain** in the **2D Slice Viewers**.



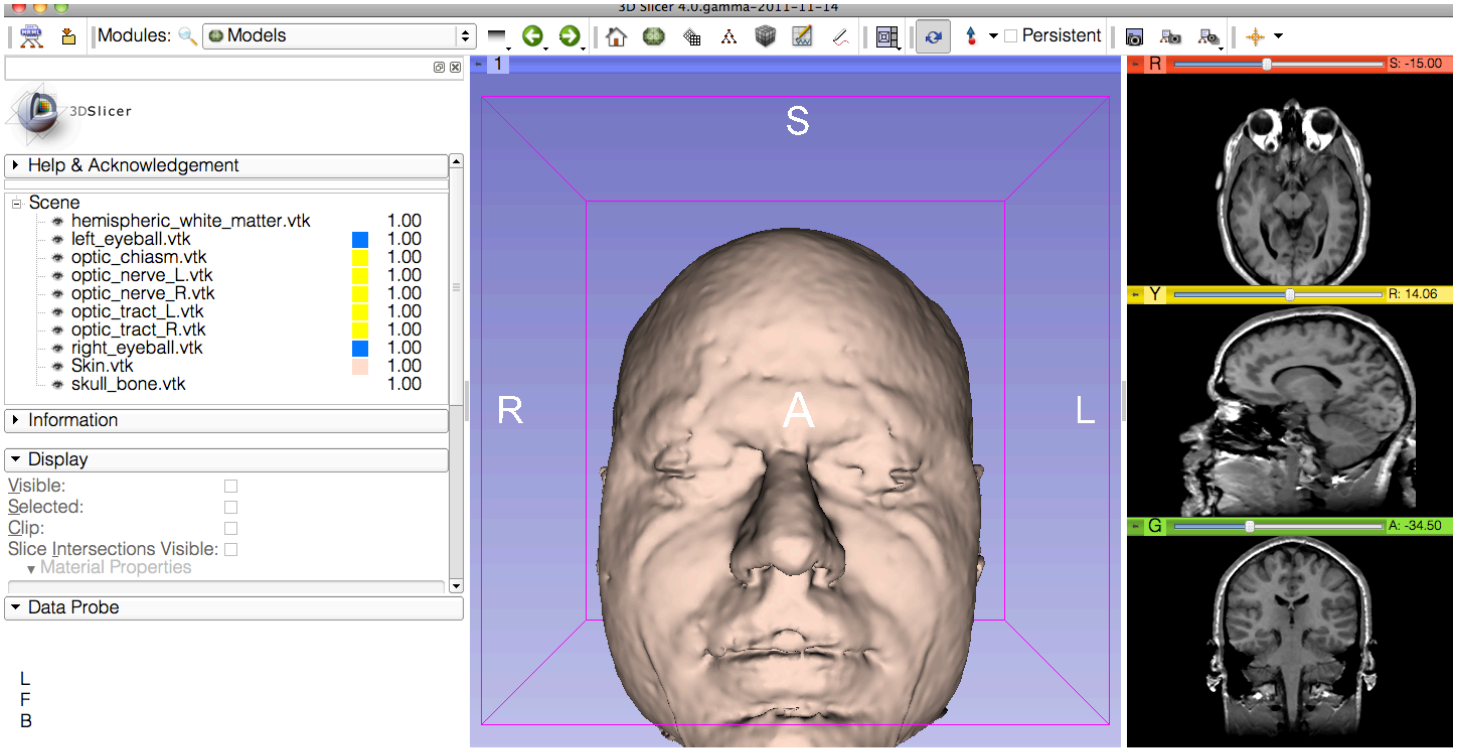
Slicer4 Minute Tutorial: Exploring Slicer's functionality

To access the **Models module**, browse through the list of modules...

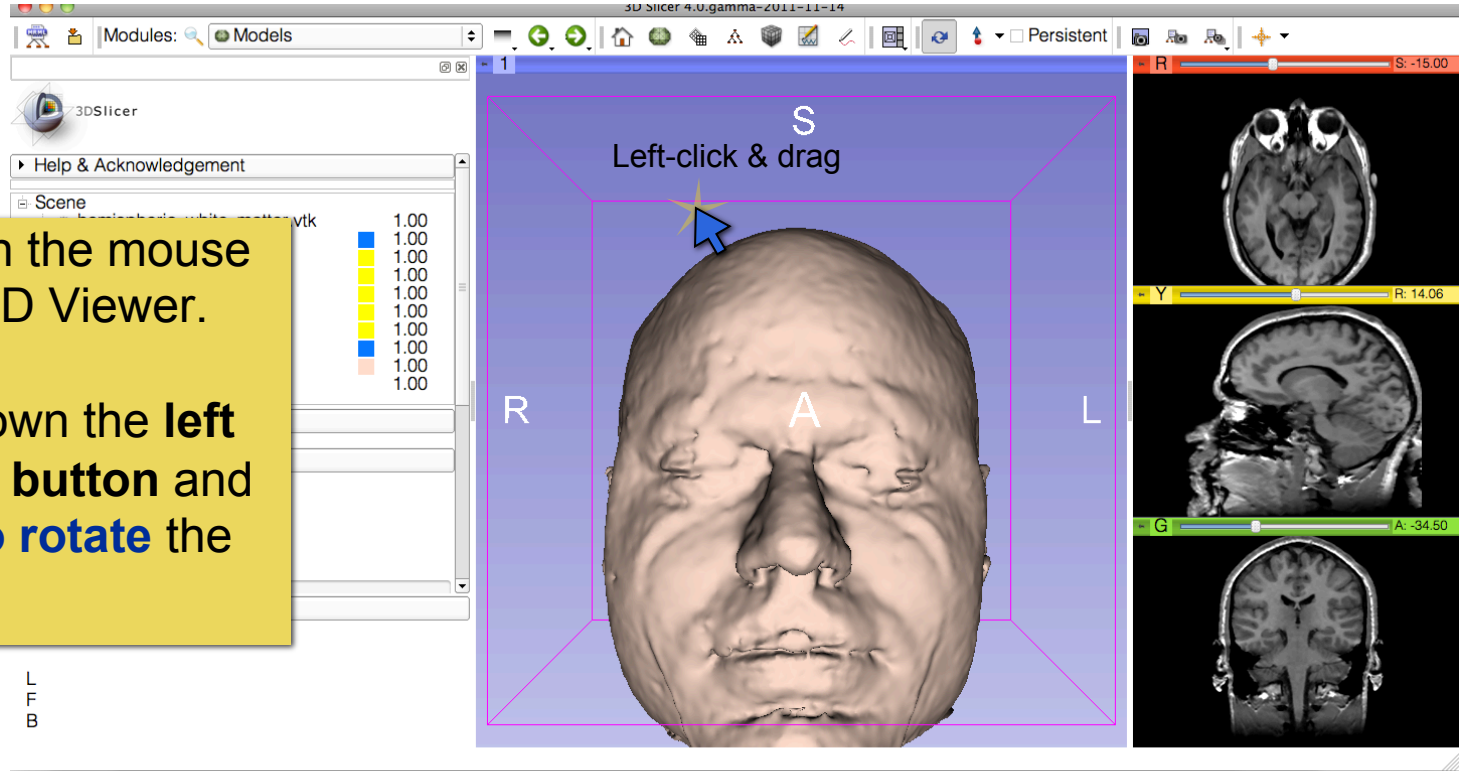
...or click on the **models icon** in the toolbar



Slicer4 Minute Tutorial: Switching to the Models Module



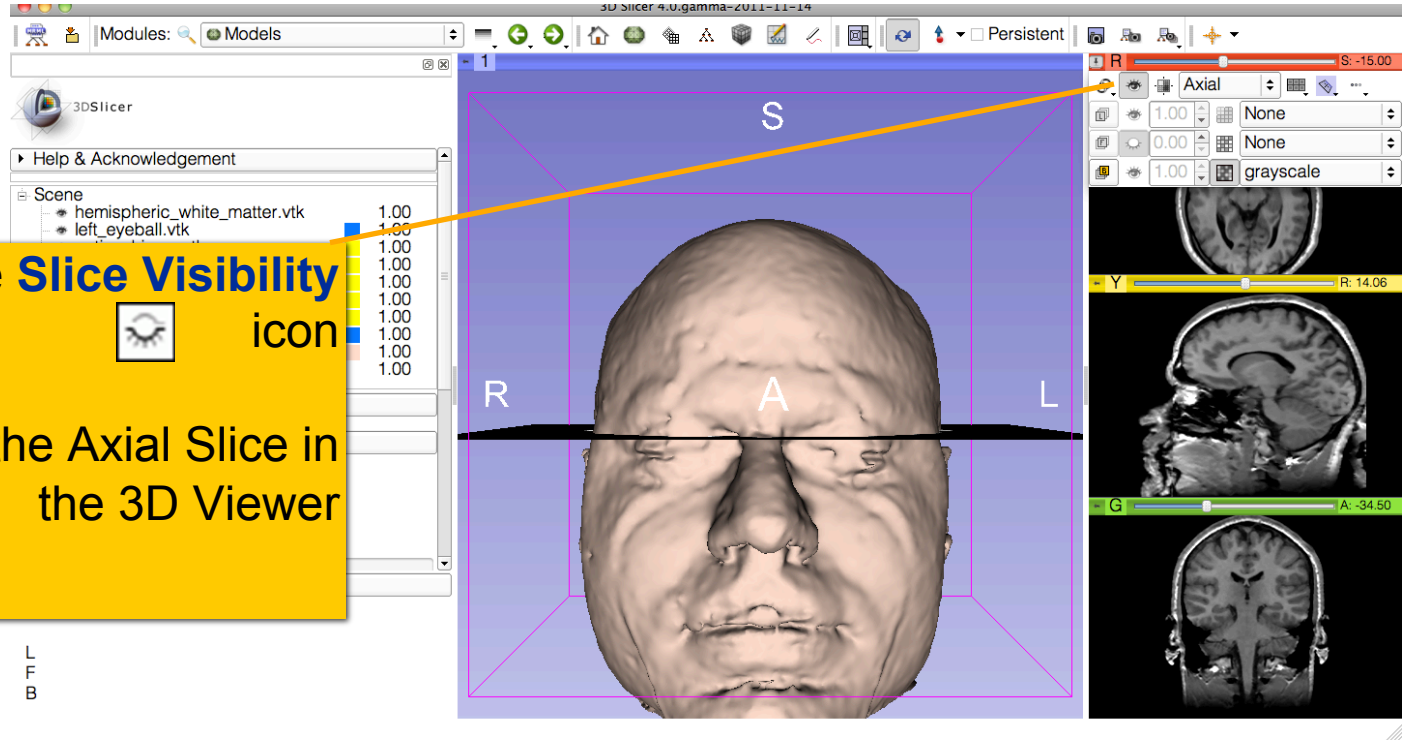
Slicer4 Minute Tutorial: Basic 3D Interaction



Position the mouse in the 3D Viewer.

Hold down the **left mouse button** and **drag to rotate** the model.

Slicer4 Minute Tutorial: Viewing Slices in the 3D Viewer

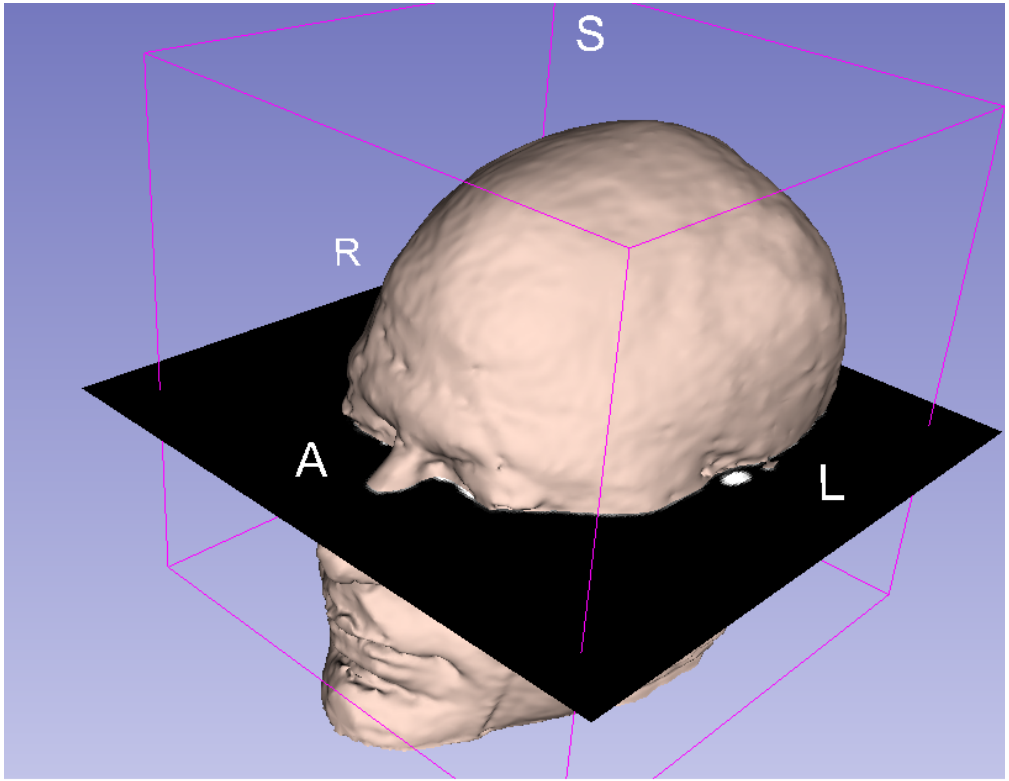


Click on the **Slice Visibility** icon

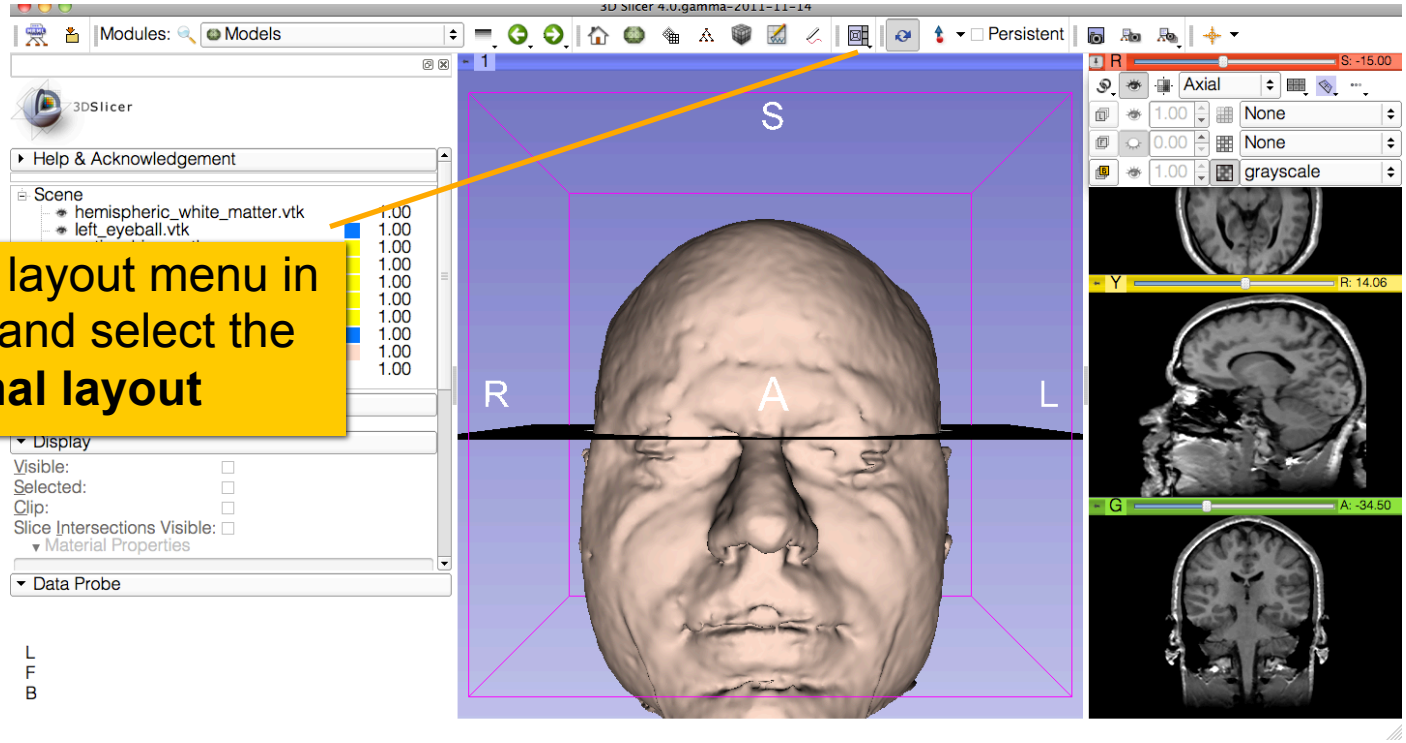
to display the Axial Slice in the 3D Viewer

Slicer4 Minute Tutorial: 3D Visualization

Slicer adds a view of the **Axial slice** in the 3D View.



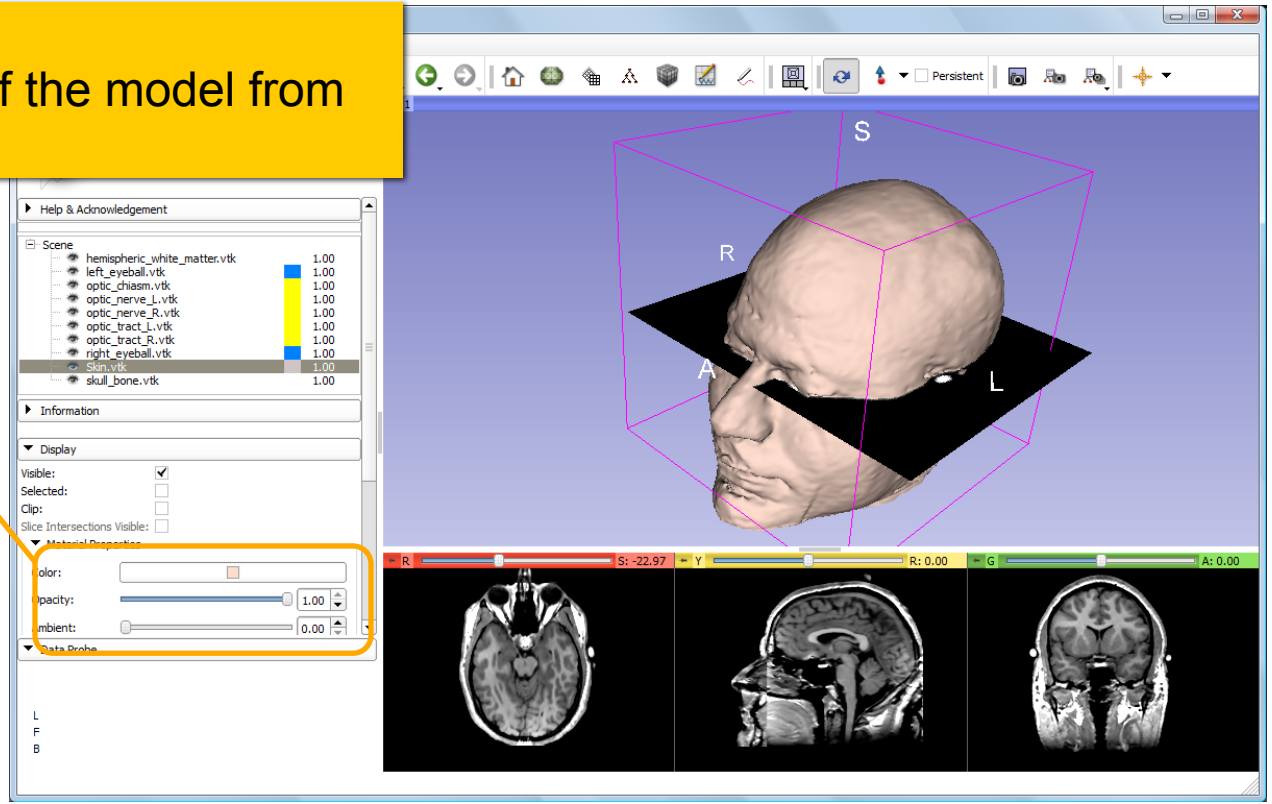
Slicer4 Minute Tutorial: Viewing Slices in the 3D Viewer



Click on the layout menu in the toolbar, and select the **Conventional layout**

Slicer4 Minute Tutorial: 3D Visualization

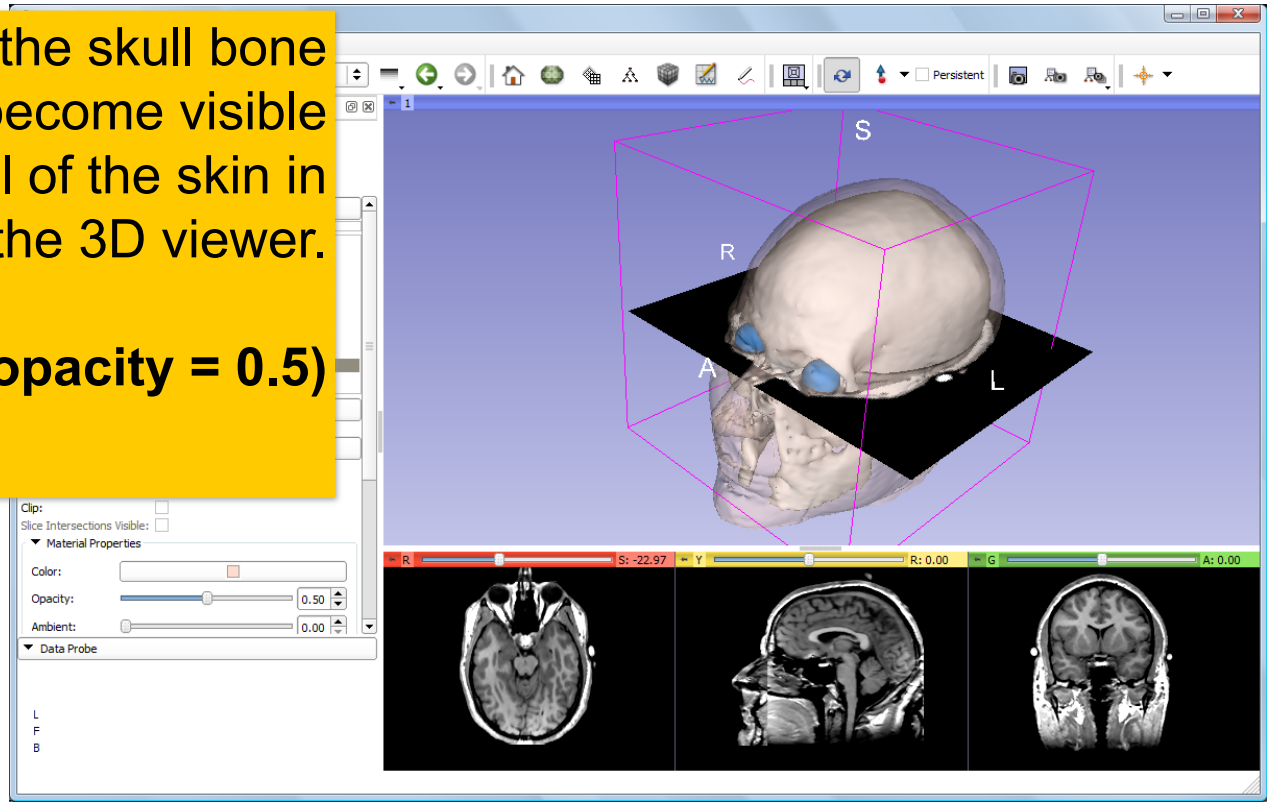
Select the **Skin.vtk**
Change the opacity of the model from **1.0** to **0.0**.



Slicer4 Minute Tutorial: 3D Visualization

The model of the skull bone and eyeballs become visible through the model of the skin in the 3D viewer.

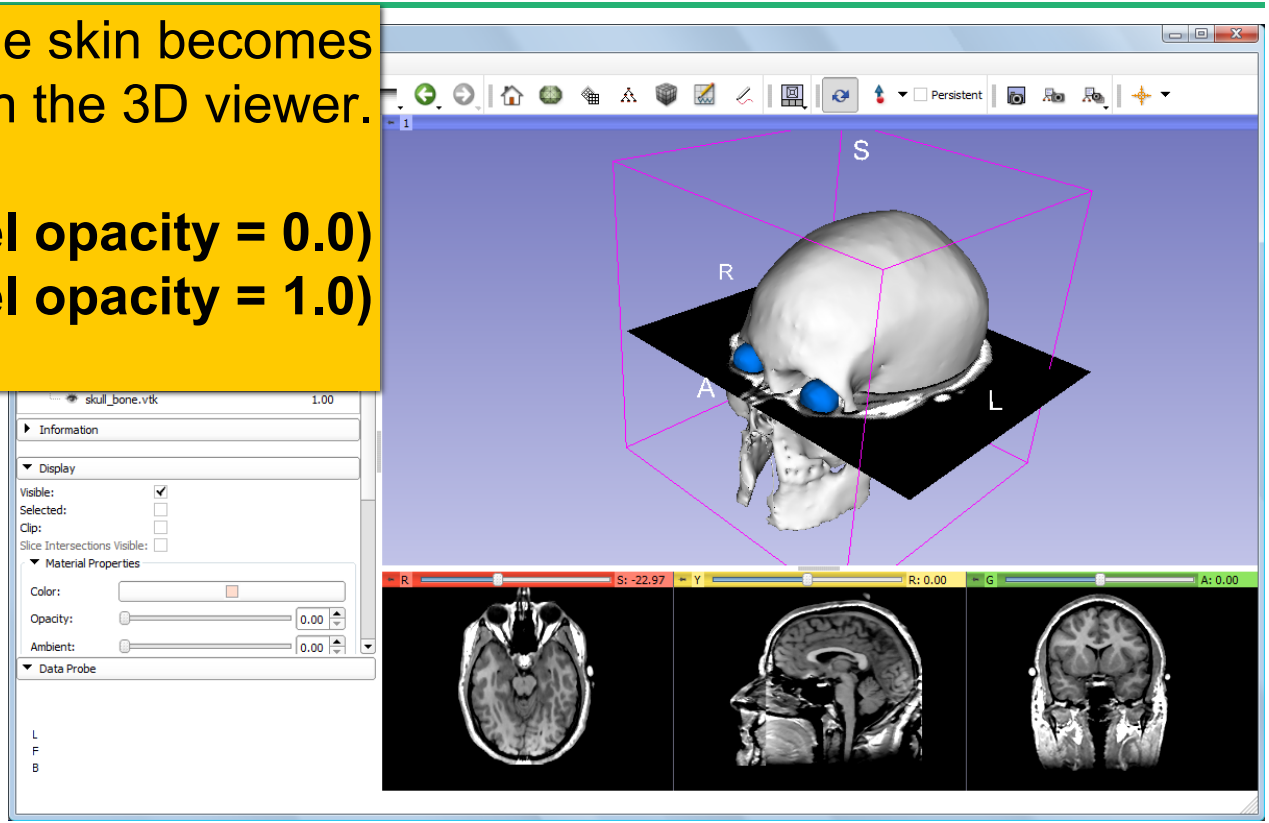
(skin model opacity = 0.5)



Slicer4 Minute Tutorial: 3D Visualization

The model of the skin becomes invisible in the 3D viewer.

(skin model opacity = 0.0)
(skull model opacity = 1.0)

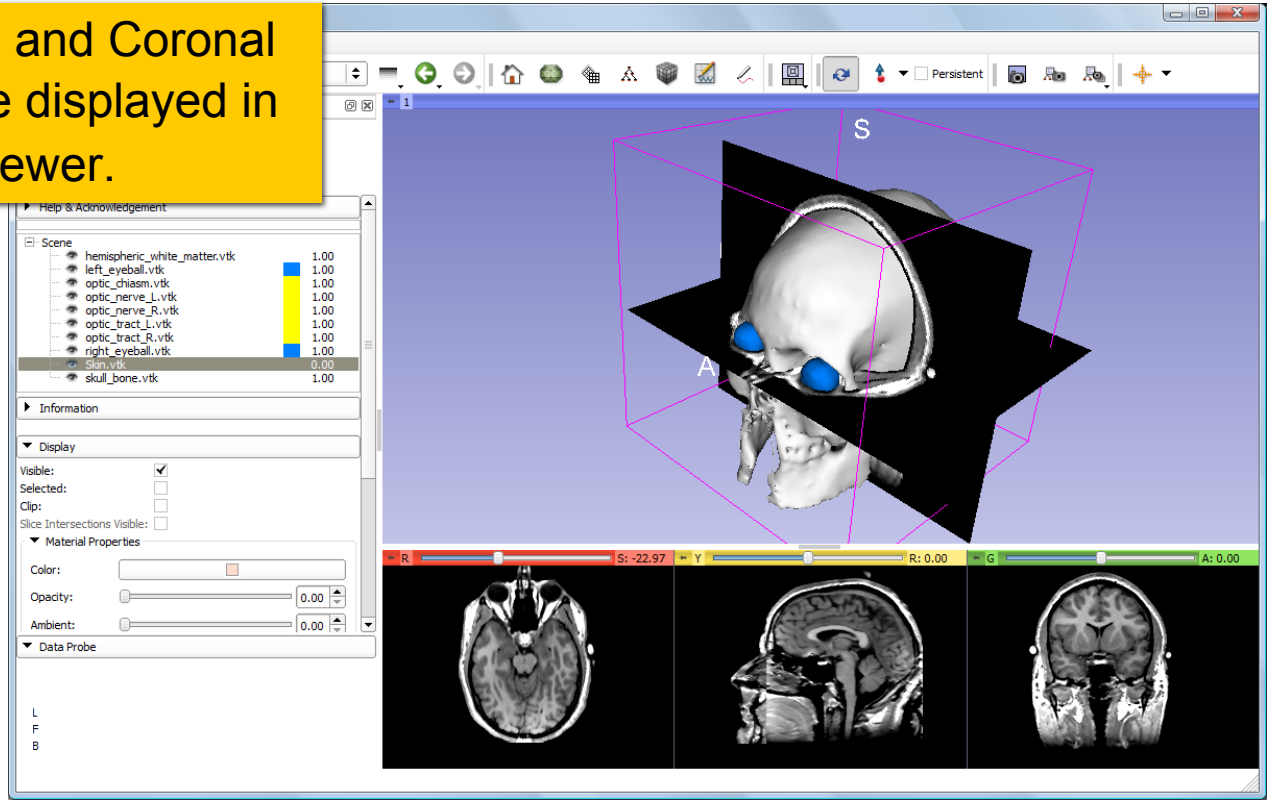


Slicer4 Minute Tutorial: 3D Visualization

Click on the **Slice Visibility icon** in the **Green Slice Viewer**  to display the Coronal Slice in the 3D Viewer.

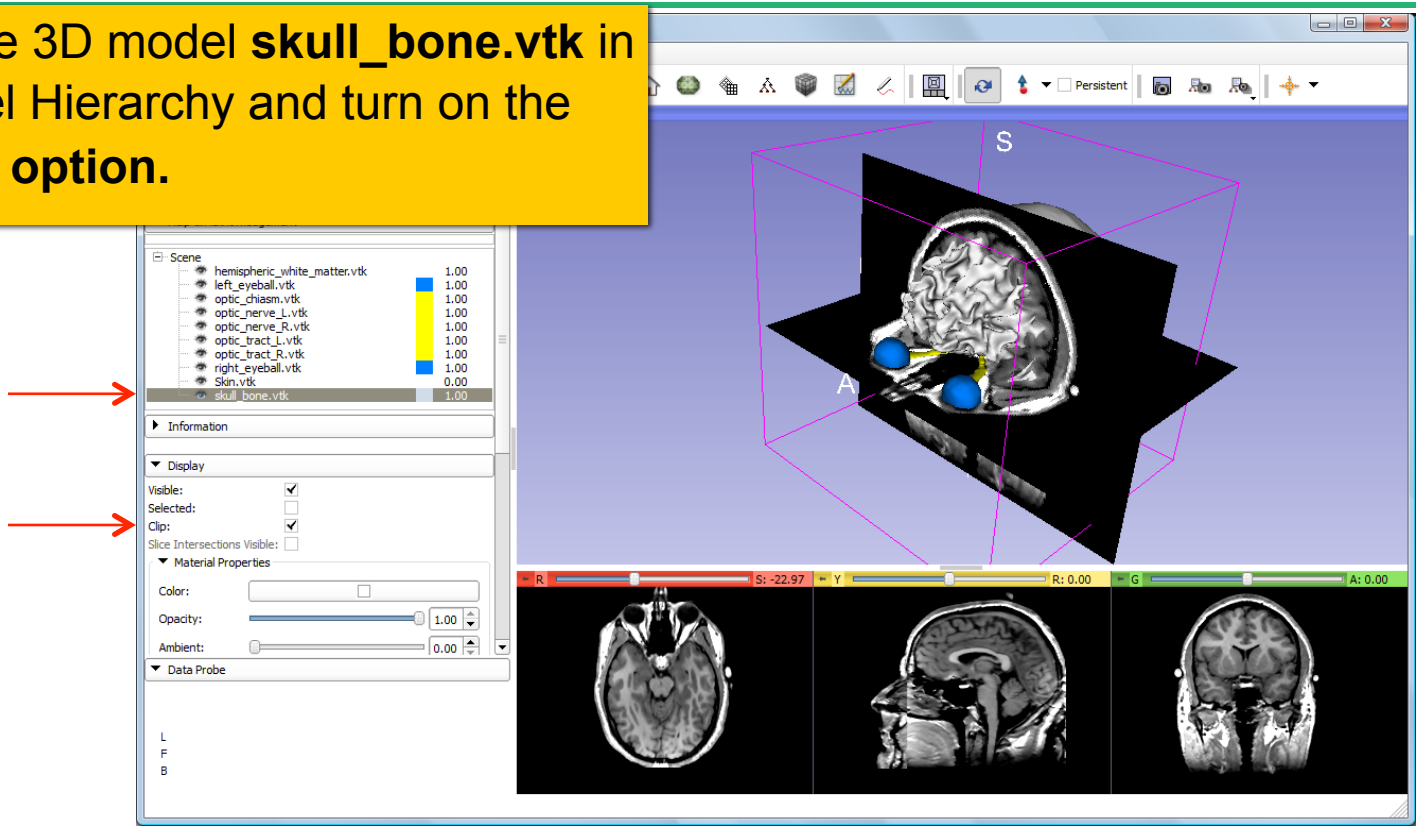
Slicer4 Minute Tutorial: 3D Visualization

The Axial and Coronal Slices are displayed in the 3D Viewer.



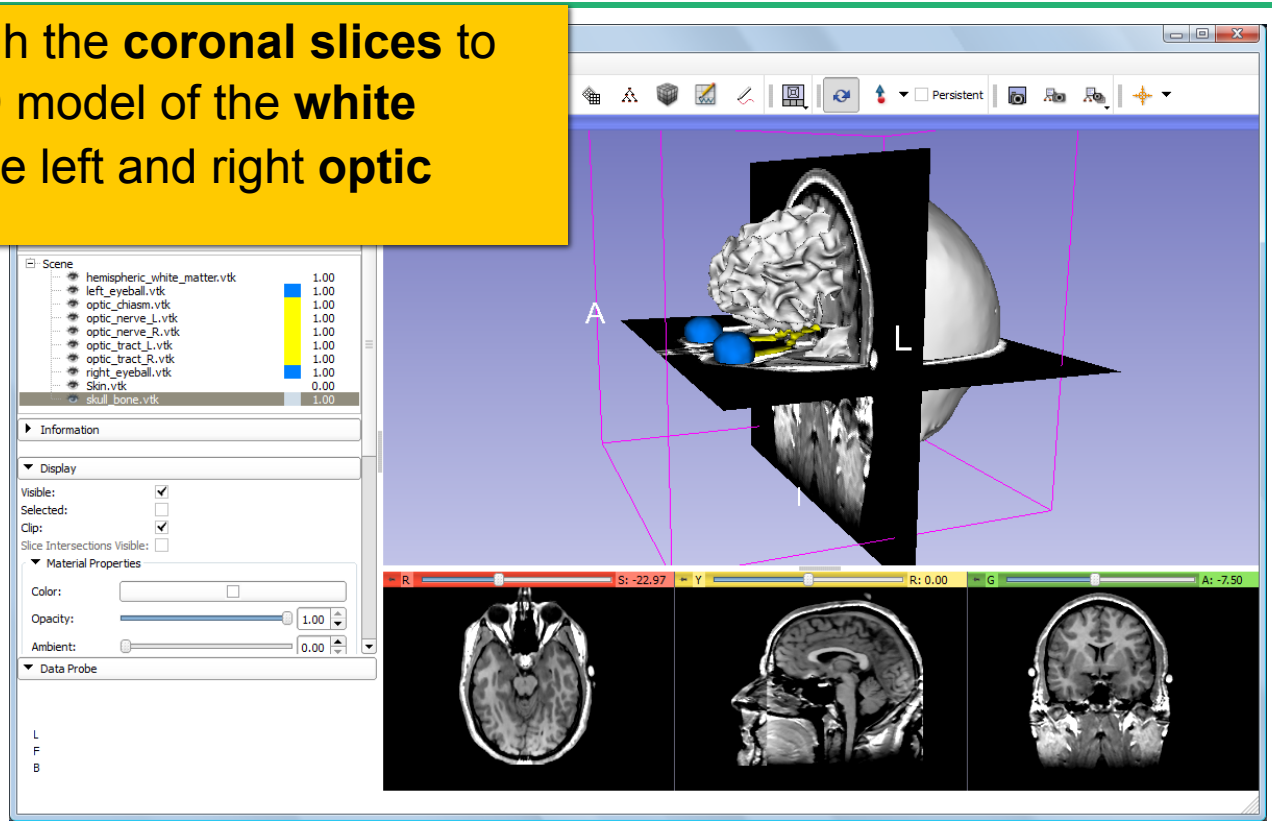
Slicer4 Minute Tutorial: 3D Visualization

Select the 3D model **skull_bone.vtk** in the Model Hierarchy and turn on the **Clipping option.**



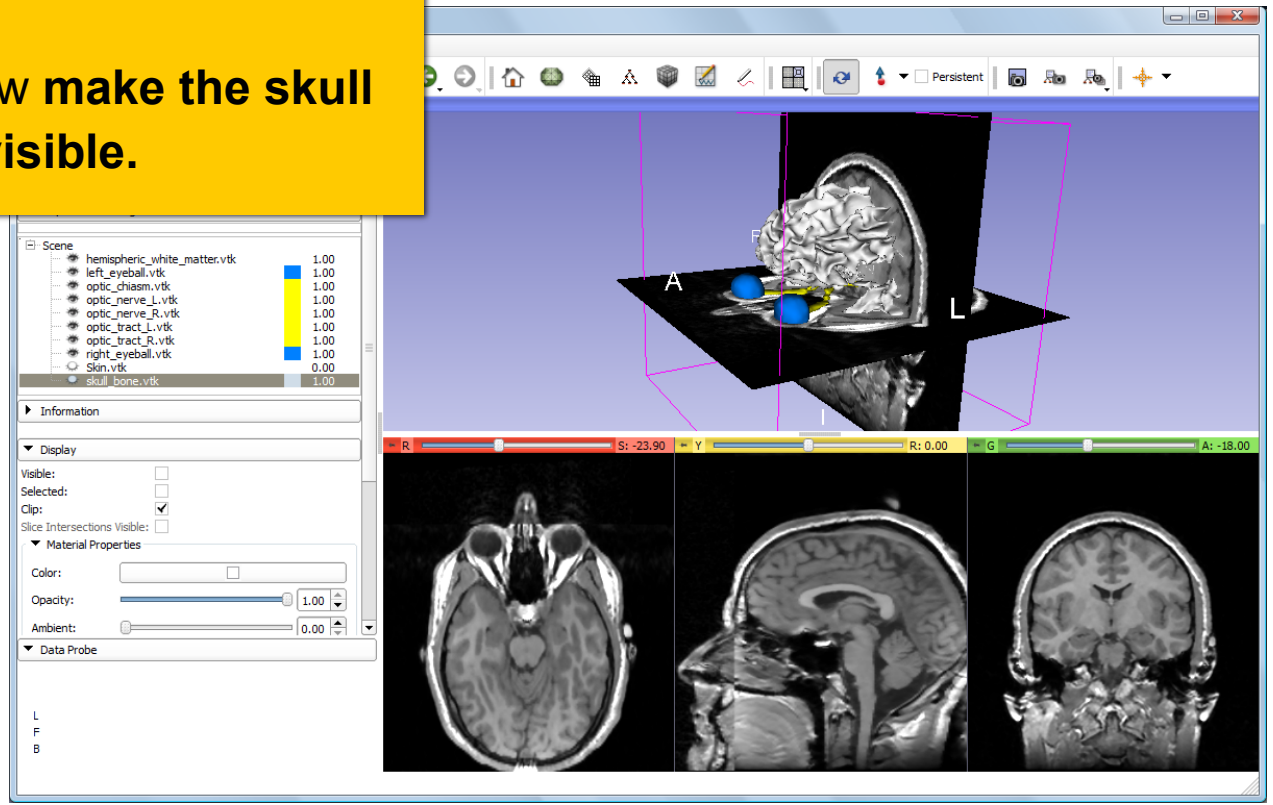
Slicer4 Minute Tutorial: 3D Visualization

Browse through the **coronal slices** to expose the 3D model of the **white matter**, and the left and right **optic nerves**.



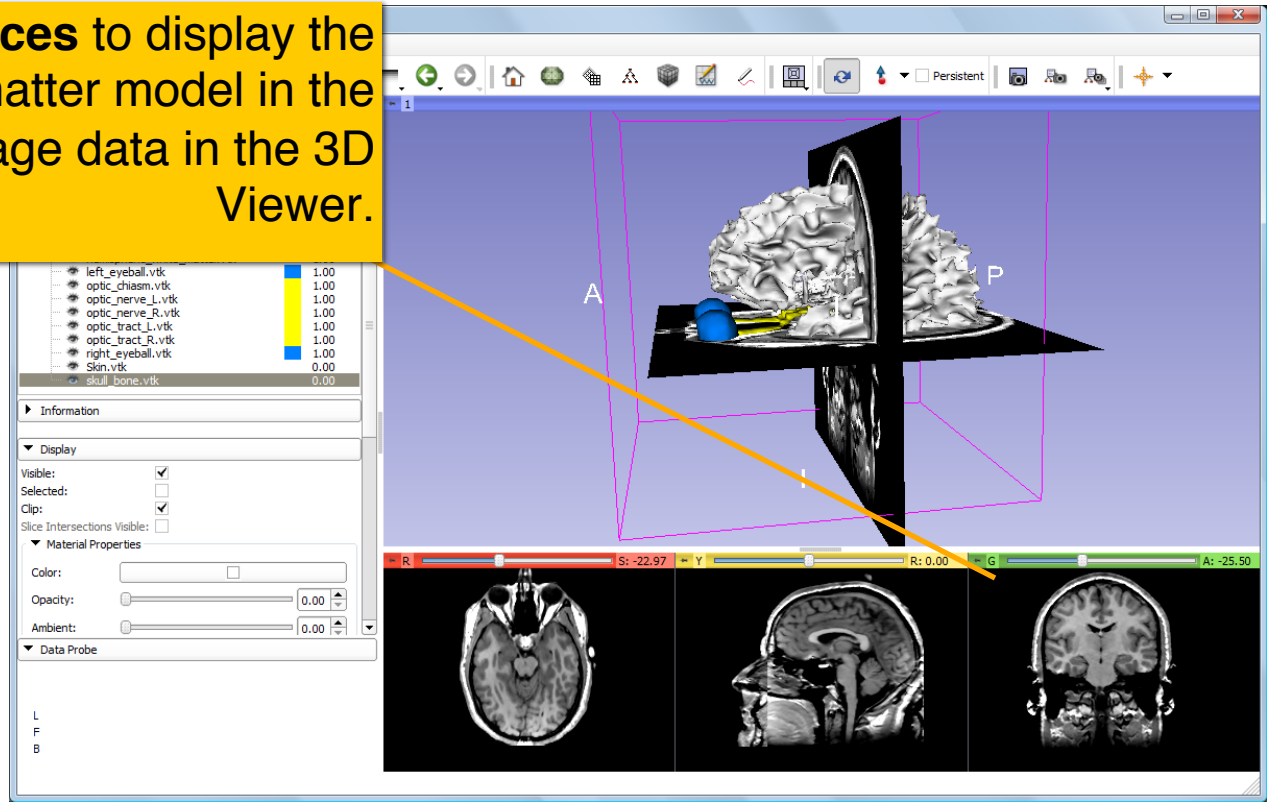
Slicer4 Minute Tutorial: 3D Visualization

Now **make the skull invisible.**



Slicer4 Minute Tutorial: 3D Visualization

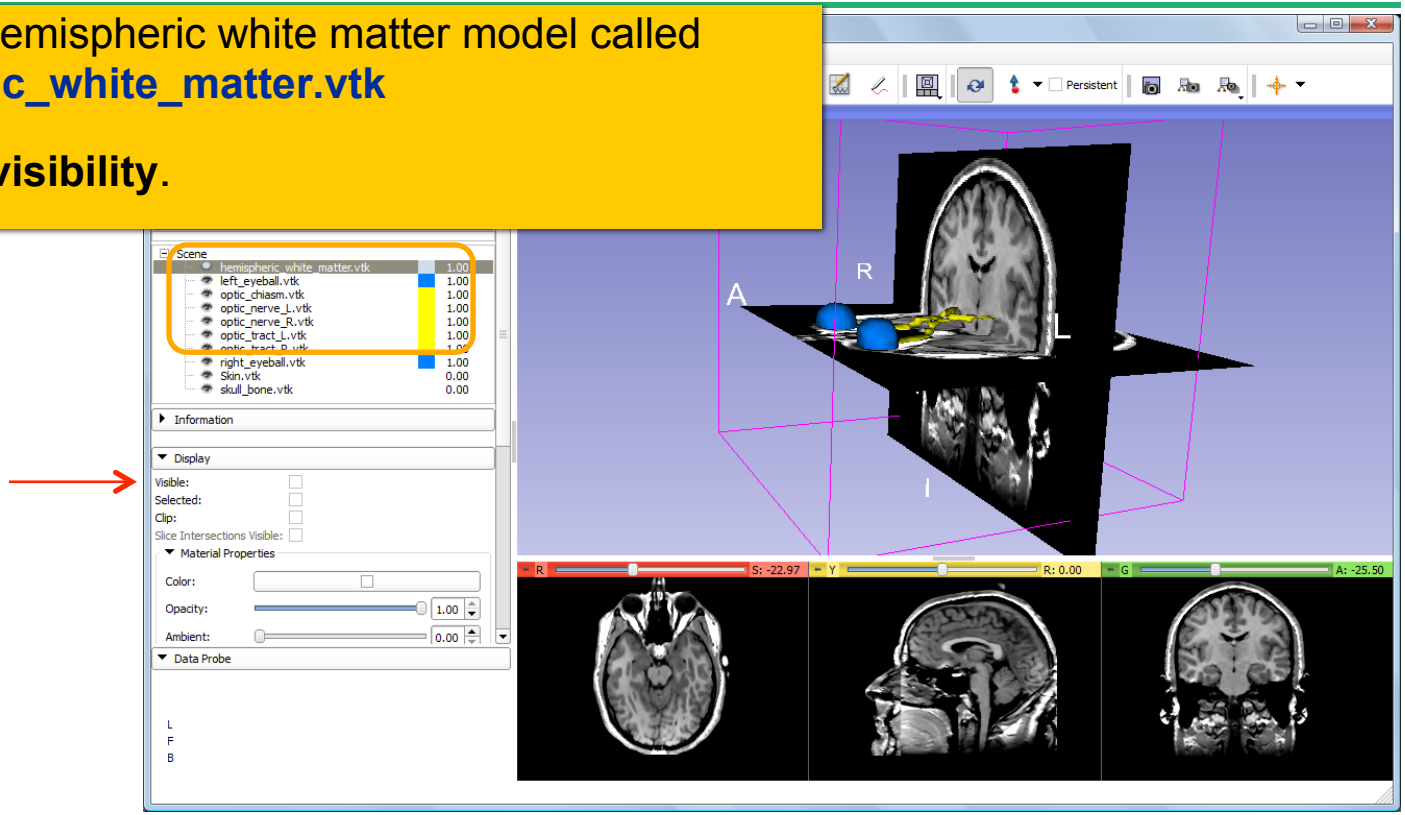
Scroll the **Coronal Slices** to display the hemispheric white matter model in the context of the image data in the 3D Viewer.



Slicer4 Minute Tutorial: 3D Visualization

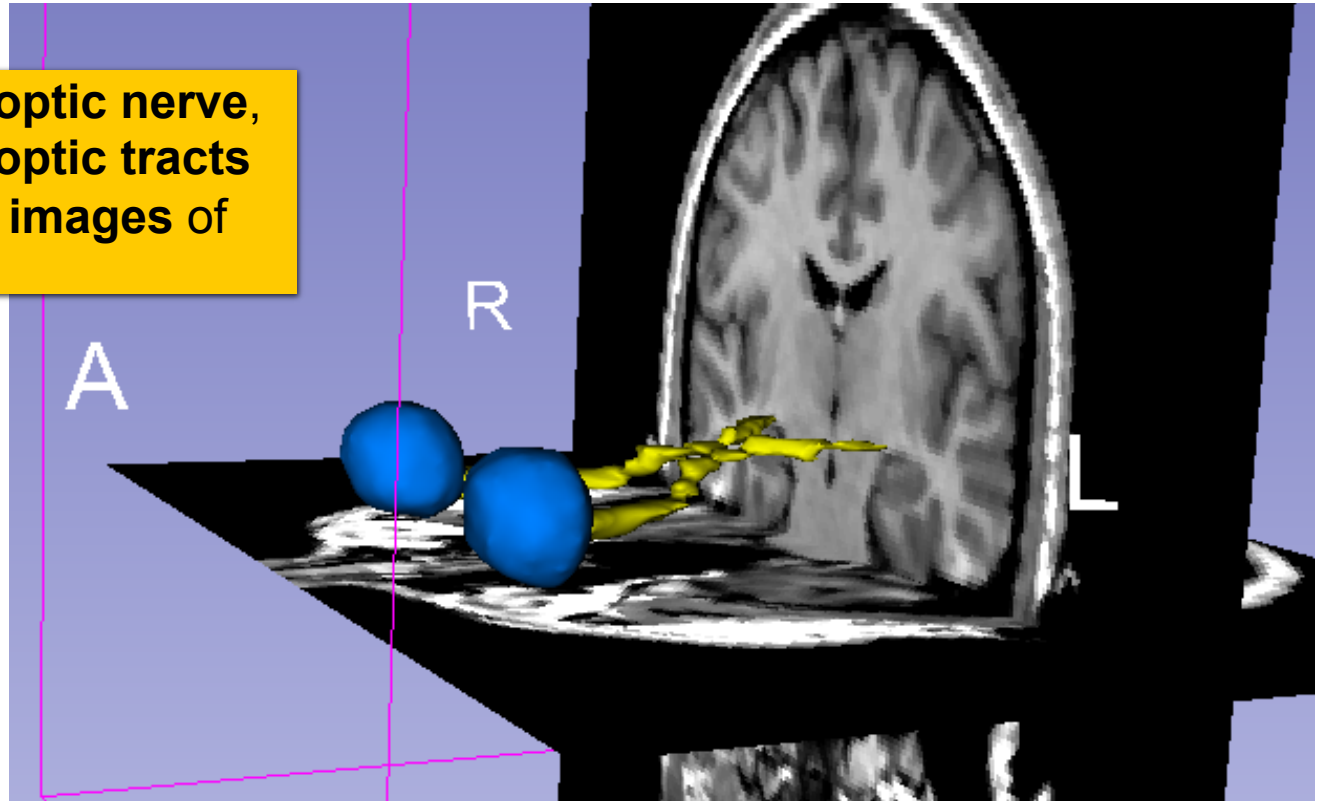
Select the hemispheric white matter model called **hemispheric_white_matter.vtk**

Turn off its **visibility**.



Slicer4 Minute Tutorial: 3D Visualization

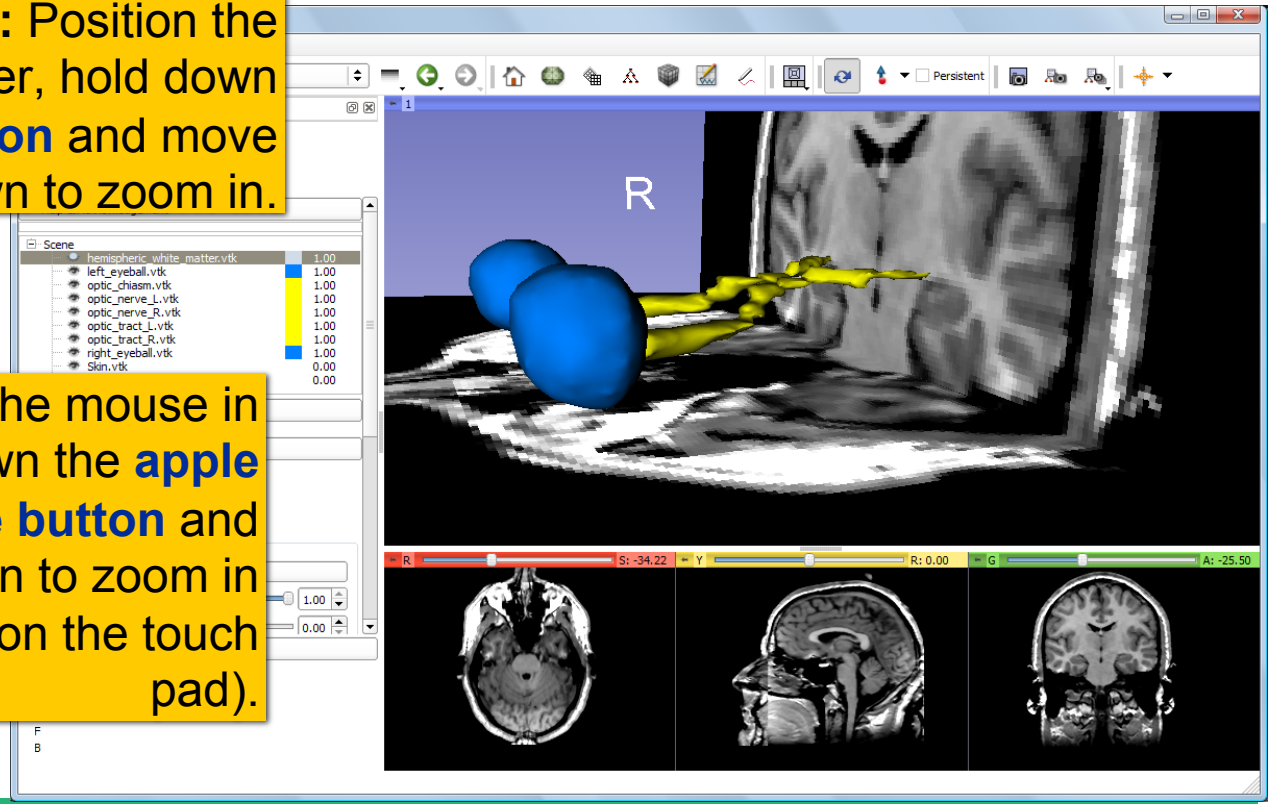
Slicer displays the **optic nerve**, **optic chiasm** and **optic tracts** overlaid on the **MR images** of the brain.



Slicer4 Minute Tutorial: 3D Visualization: Zoom the view

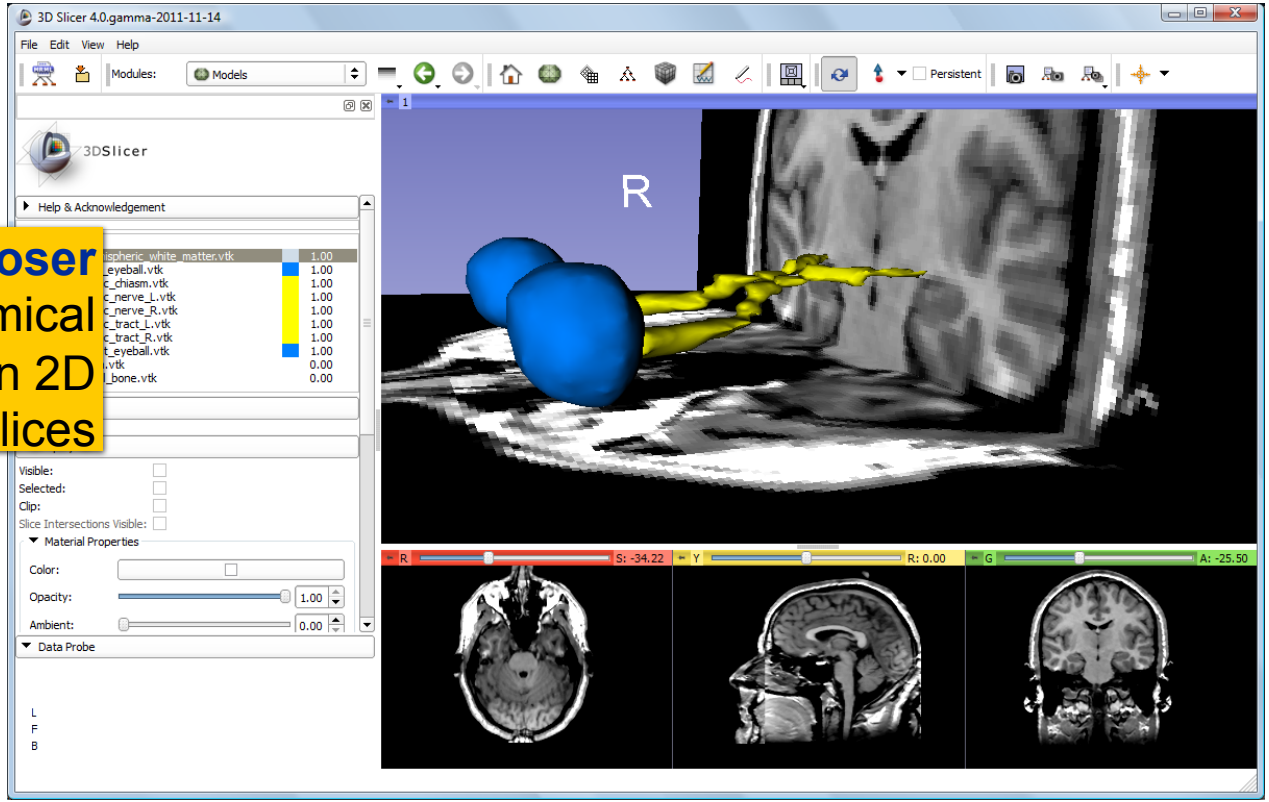
Windows/Linux users: Position the mouse in the 3D Viewer, hold down the **right mouse button** and move the mouse down to zoom in.

Mac users: Position the mouse in the 3D Viewer, hold down the **apple button and the mouse button** and move the mouse down to zoom in (or use two fingers on the touch pad).



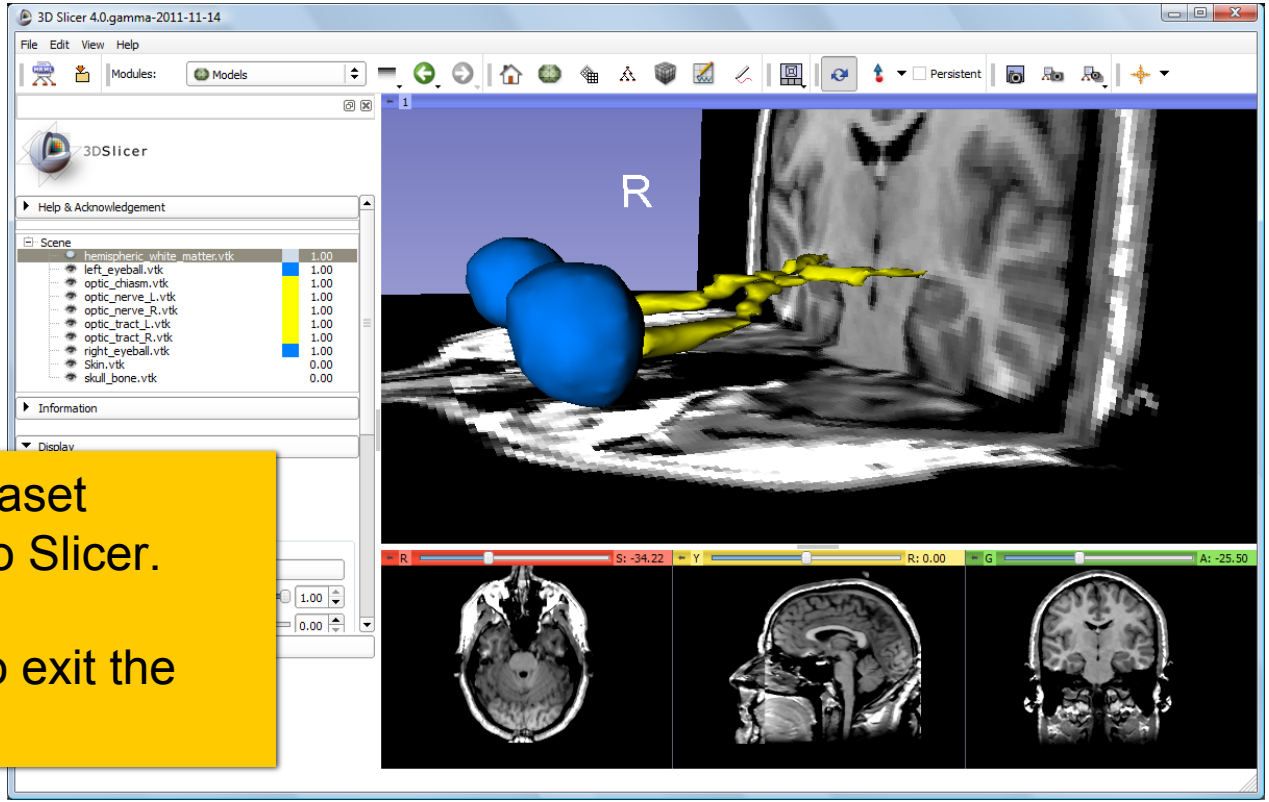
Slicer4 Minute Tutorial: 3D Visualization: Zoom the view

Slicer displays a **closer view** of 3D anatomical structures overlaid on 2D MR slices



Close the existing scene and all its data

Select **File->Close Scene**



This removes any dataset previously loaded into Slicer.

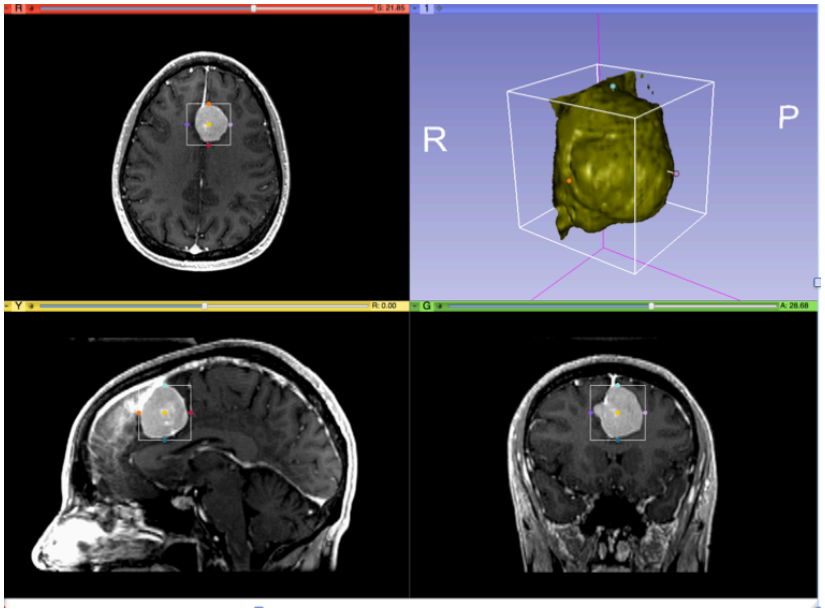
Select **Slicer->Quit** to exit the software

Part I: Summary

This first part of the tutorial has demonstrated:

- Basic description of the Slicer4 Application Interface
- How to load a scene containing volumes and models
- How to visualize these different datasets together

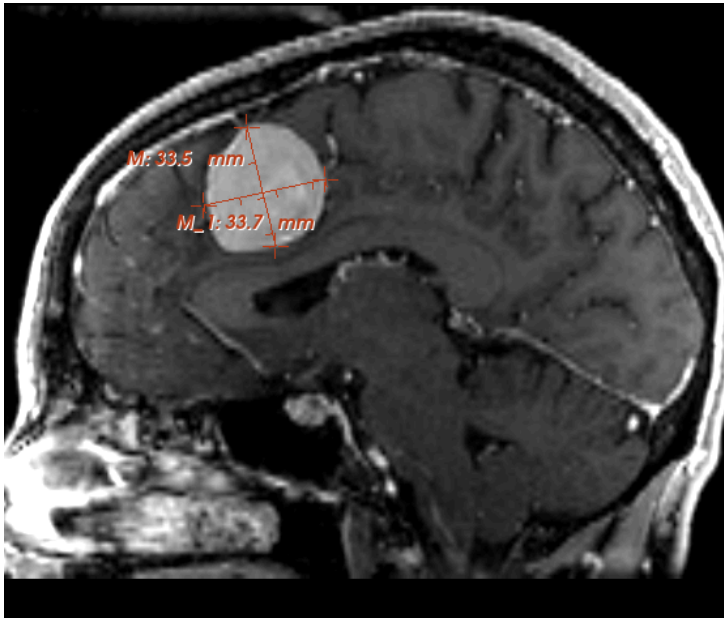
Next, we will use these building blocks to perform image analysis and visualize quantitative results.



Part II: Analyzing Small Volumetric Changes

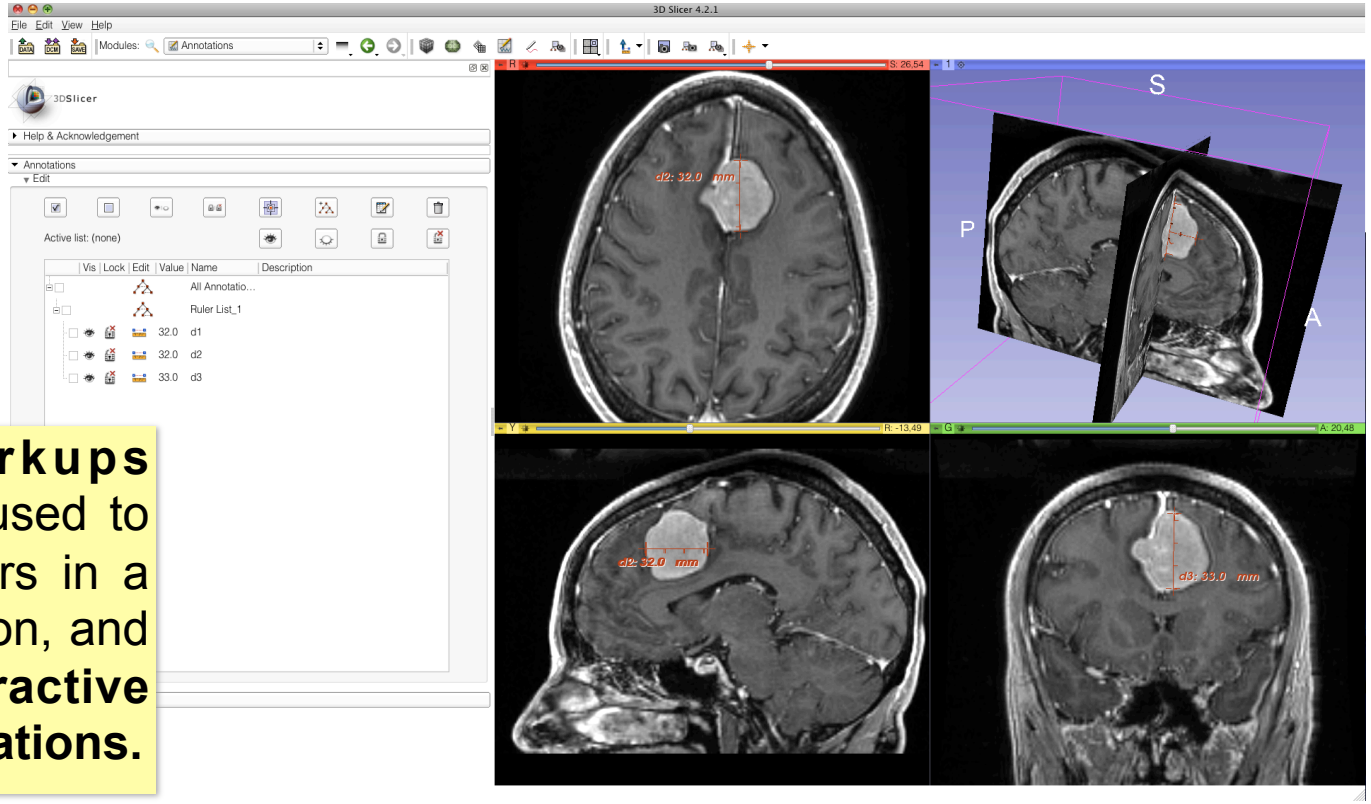
Sonia Pujol, PhD
Kilian M Pohl, PhD
Andriy Fedorov, PhD
Ender Konukoglu, PhD
Ron Kikinis, MD

Conventional measures of tumor response



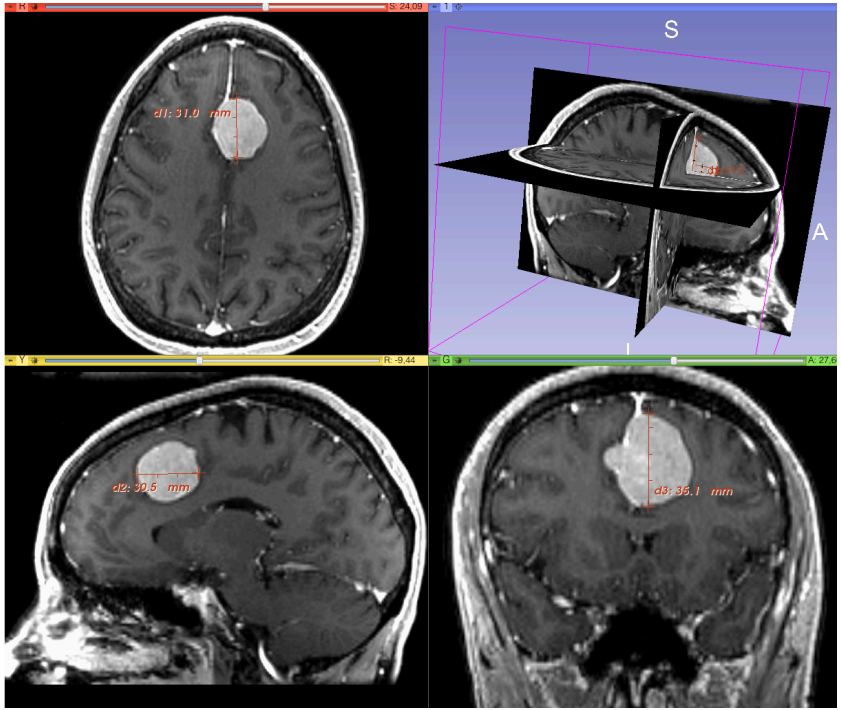
- Conventional anatomic imaging using CT or MRI are often used to evaluate tumor size and shape
- Most clinical trials that evaluate new chemotherapeutic drugs use changes in uni-dimensional or bi-dimensional measurements to assess response (*e.g.* RECIST)
- Slicer has several tools for applying RECIST methodologies

Conventional measures of tumor response



3D Slicer **Markups module** can be used to measure diameters in a tumor cross section, and to provide **interactive numerical annotations.**

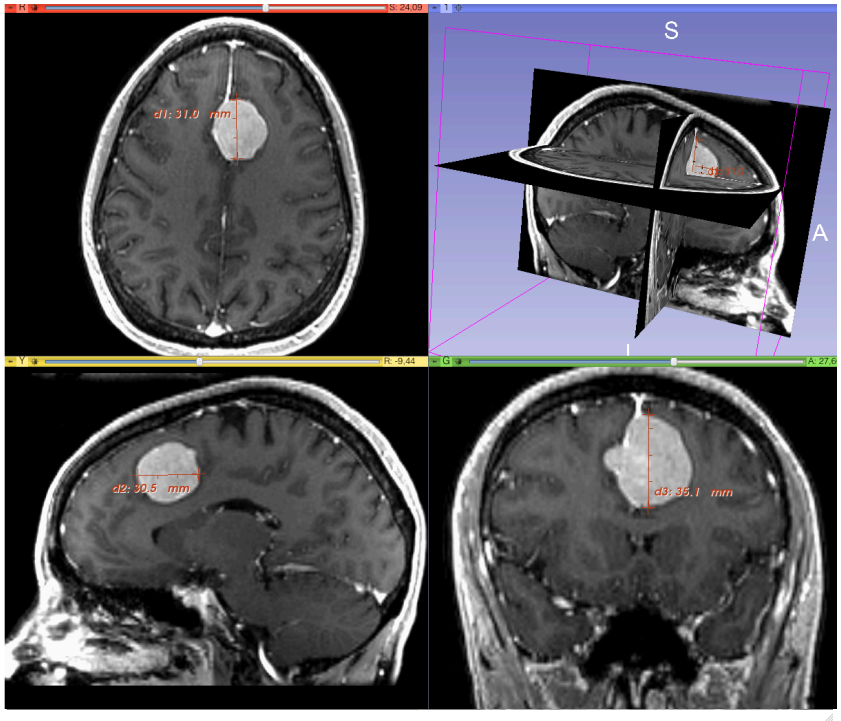
Clinical case: baseline scan



Baseline radiologist's clinical impression:

- large falcine lesion is identified.
- measures 3.10 cm anteroposteriorly and 3.51 cm in height.
- enhances moderately on post gadolinium imaging.

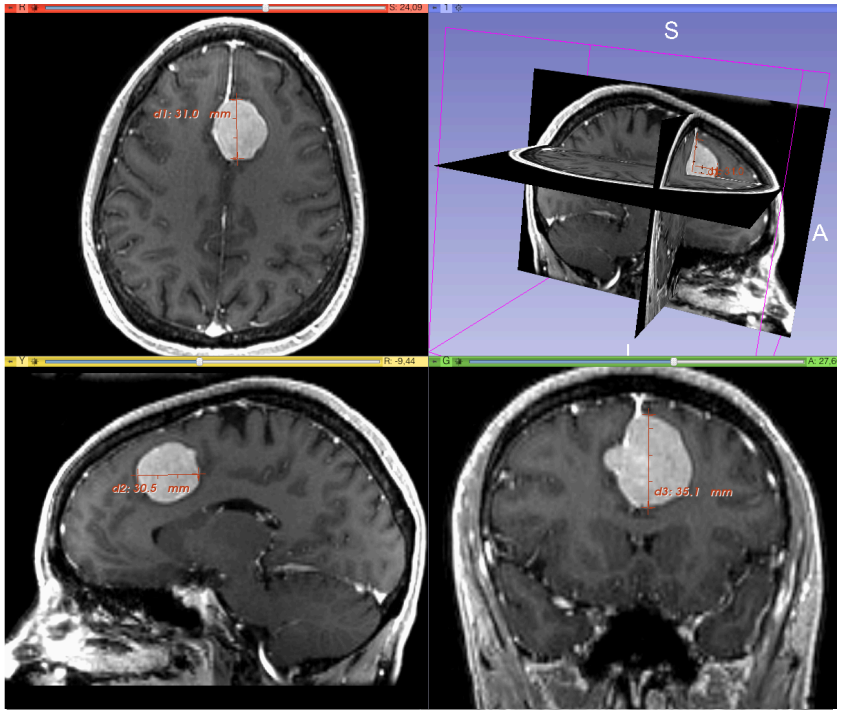
Clinical Case: follow-up scan



Follow-up radiologist's clinical impression:

- left frontal lobe mass appears unchanged on all series.
- measures 3.3 x 3.2 cm in maximum dimension.
- enhances moderately on post gadolinium imaging.

Clinical Case: follow-up scan



Follow-up radiologist's clinical impression:

- left frontal lobe mass appears unchanged on all series.
- measures 3.3 x 3.2 cm in maximum dimension.
- enhances moderately on post gadolinium imaging.

→ How has the tumor changed?

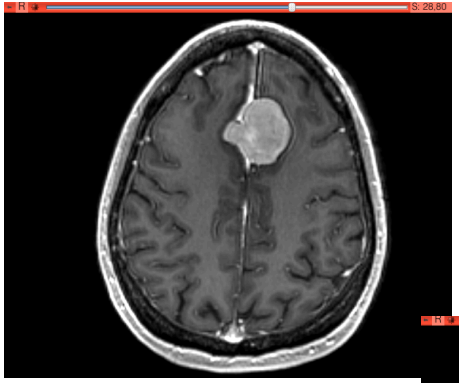
ChangeTracker: rationale for new approaches

More accurate and precise methods for understanding volume changes may be useful when:

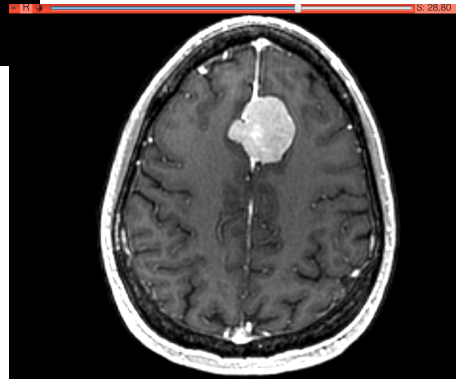
- **benign tumor change** is being monitored, or
- where **small changes may be clinically significant** but difficult to assess with RECIST

Goal of the tutorial

MR Scan1 June 2006



MR Scan2 June 2007



(Voxel dimension: 0.94mm x 0.94mm x 1.20mm, FOV: 240mm, Matrix: 256 x 256)

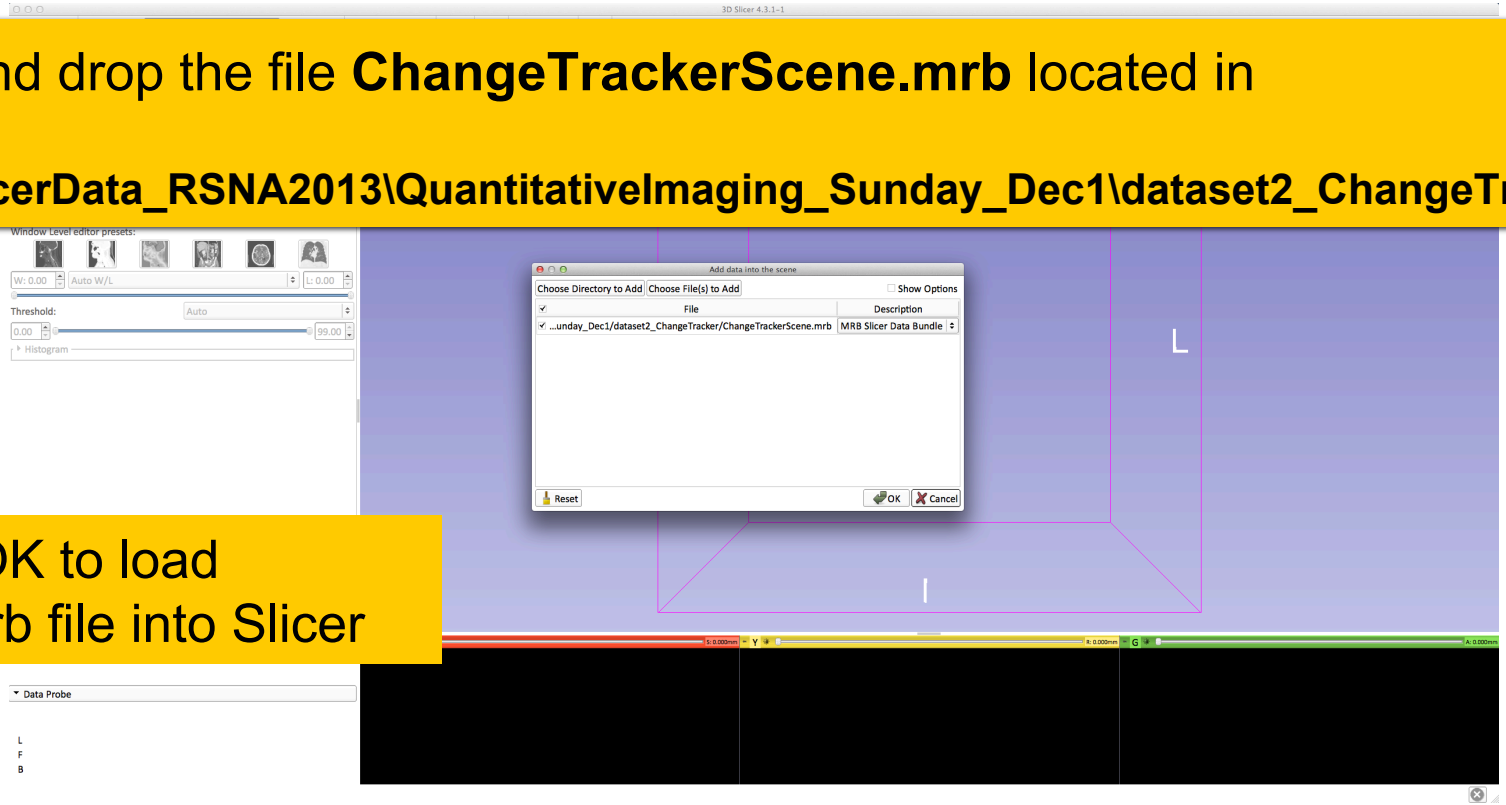
The following section will guide you step-by-step through the computation of small volumetric changes in a slow growing tumor.

This tutorial is built upon two scans (Axial 3D SPGR T1 post Gadolinium) of a patient with meningioma, and uses the Change Tracker module of Slicer.

ChangeTracker: Load the dataset

Drag and drop the file **ChangeTrackerScene.mrb** located in

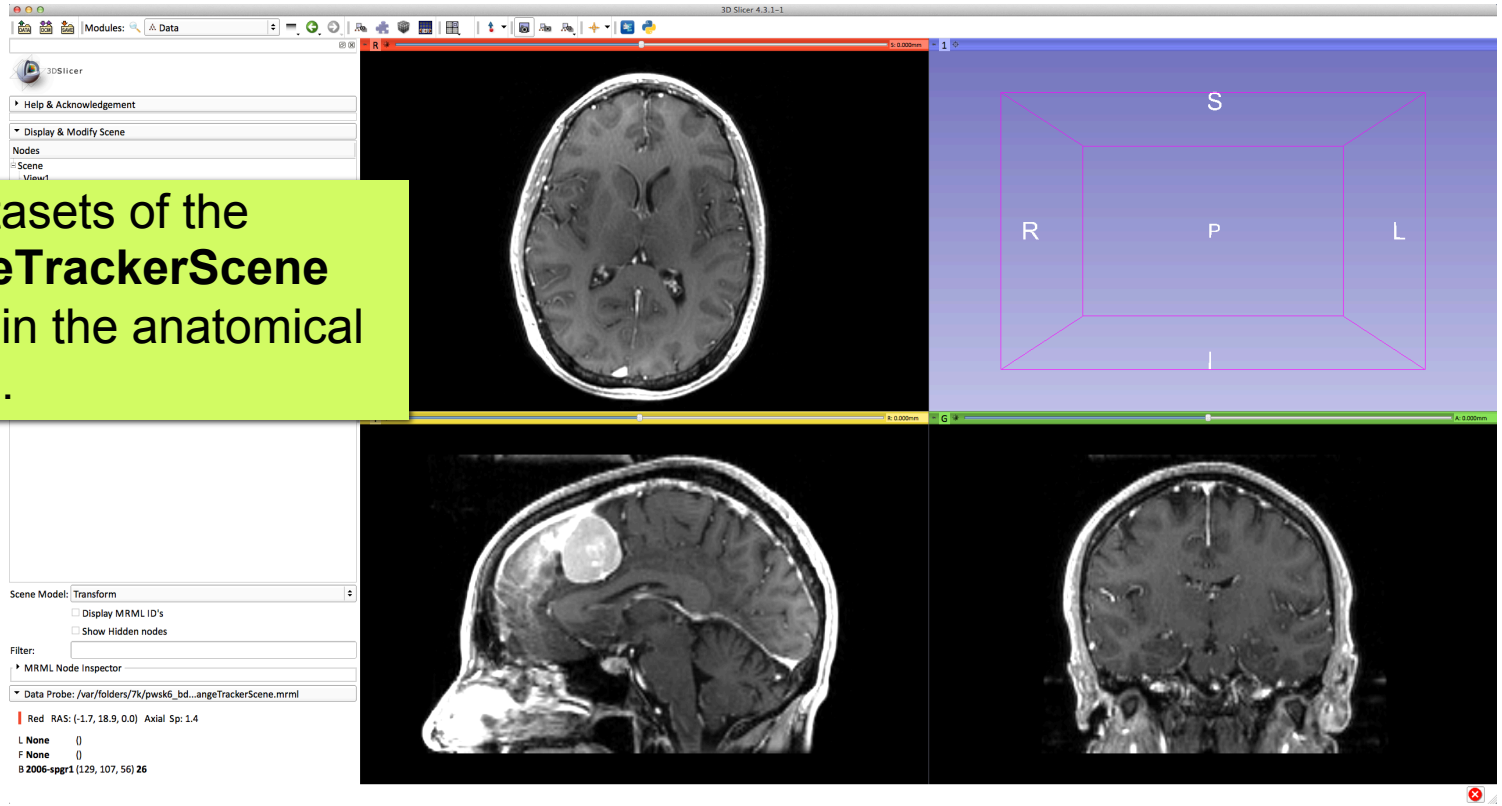
C:\3DSlicerData_RSNA2013\QuantitativeImaging_Sunday_Dec1\dataset2_ChangeTracker



Click OK to load
the .mrb file into Slicer

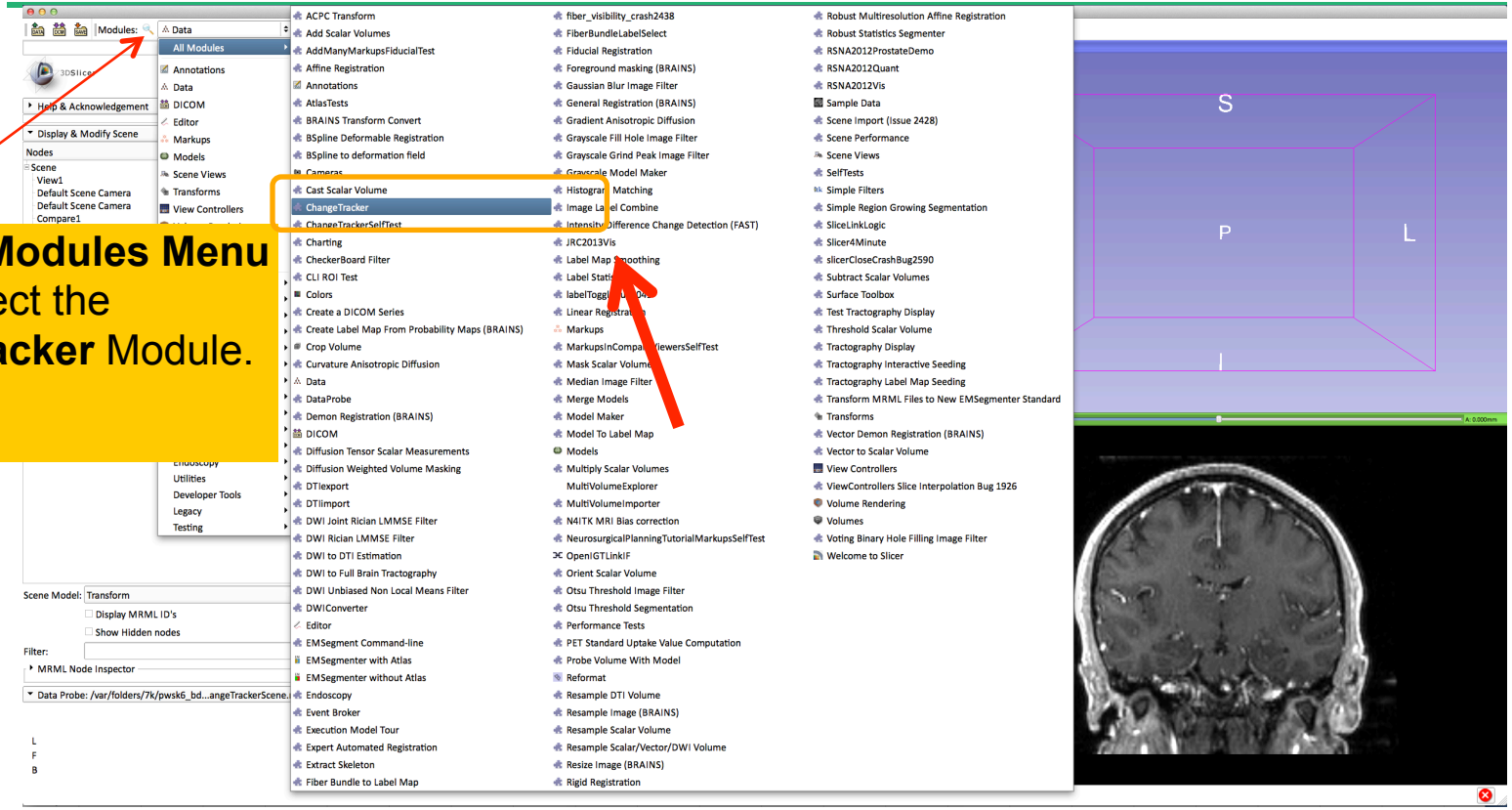
Loading the data

The datasets of the **ChangeTrackerScene** appear in the anatomical viewers.



ChangeTracker: exploring small volumetric changes

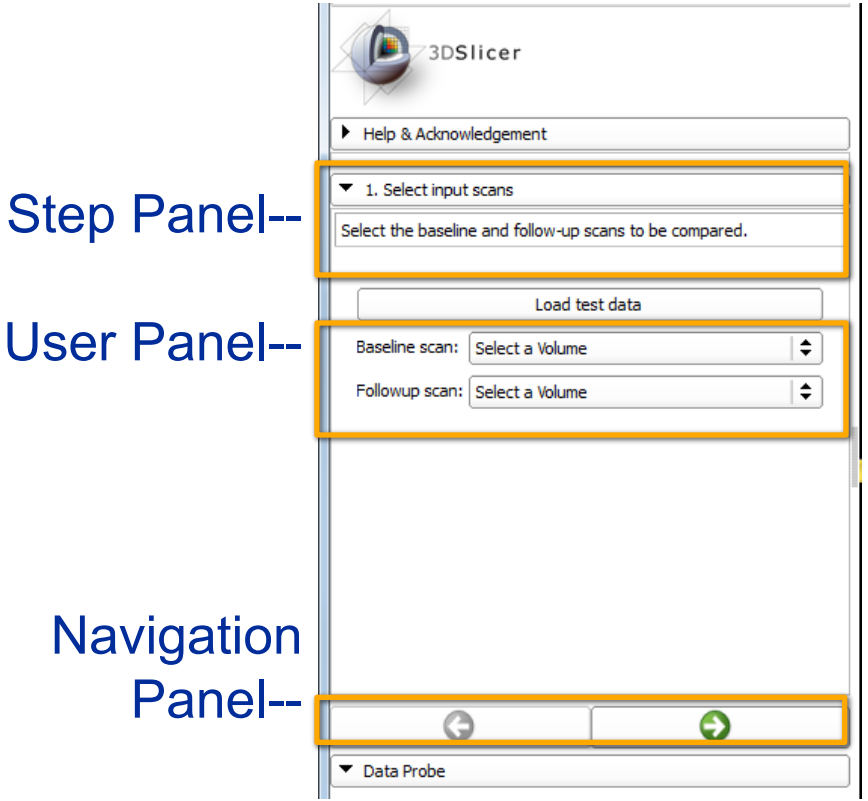
Using the **Modules Menu** button, select the **ChangeTracker** Module.



ChangeTracker: a note about the Workflow wizard

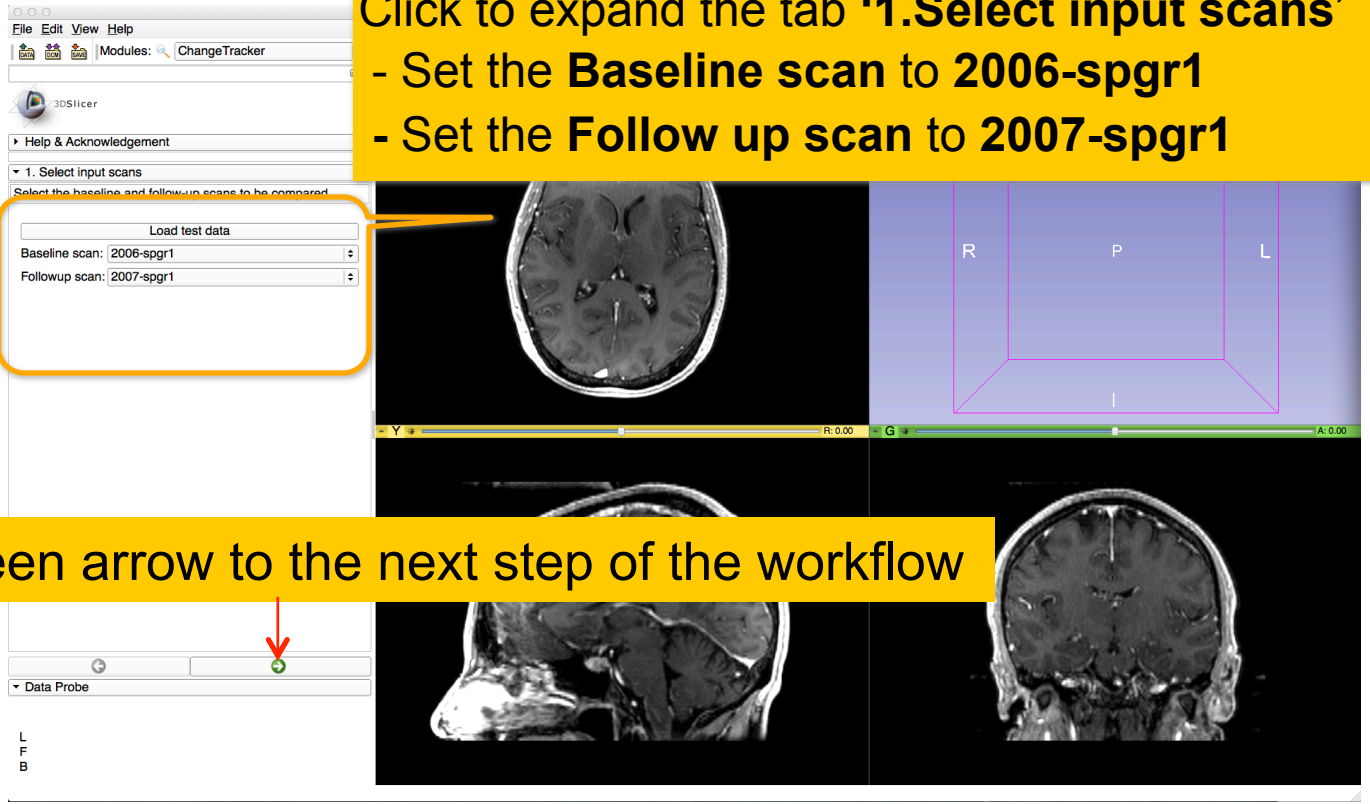
The **Workflow Wizard** guides the user through a sequence of steps and has the following components:

- the Step Panel
- the User Panel
- the Navigation Panel



Step1: Select input scans

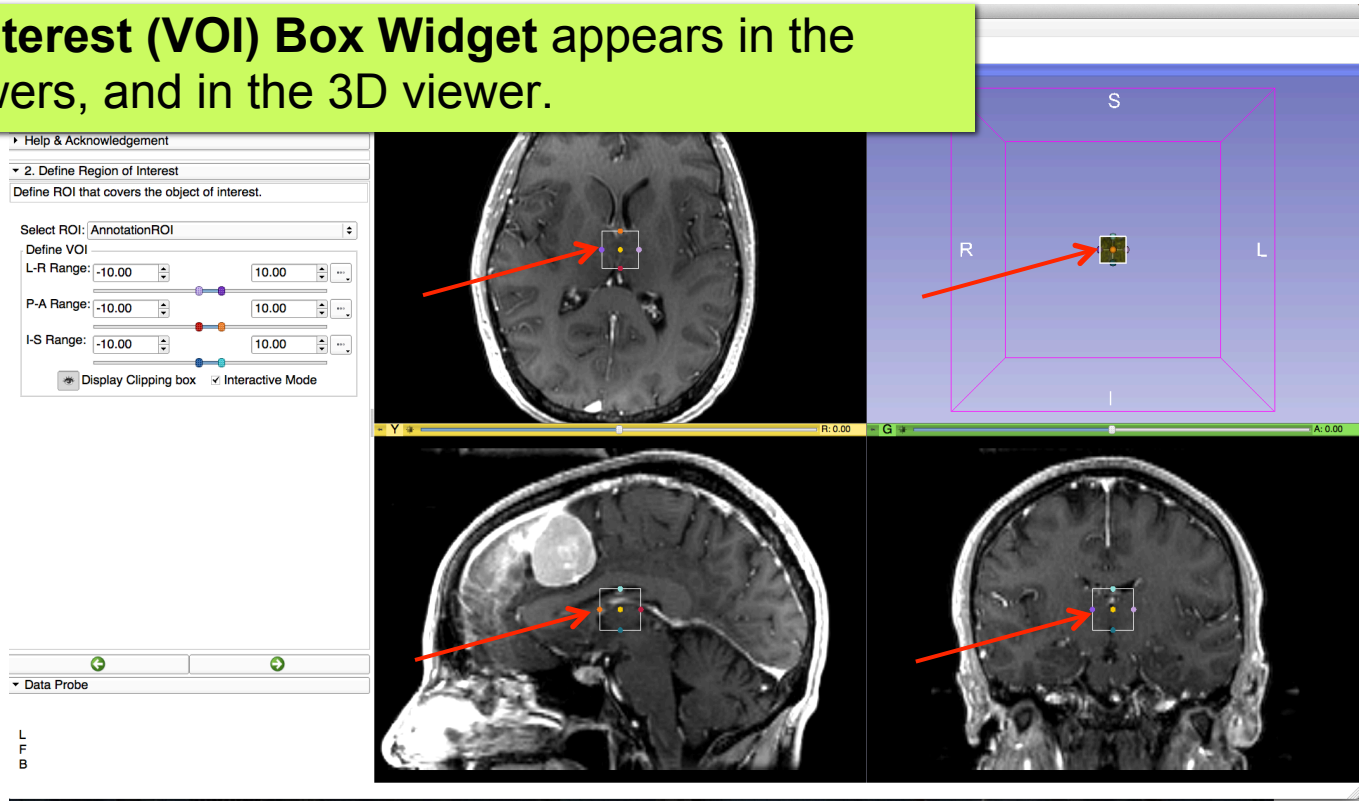
Click to expand the tab **‘1.Select input scans’**
- Set the **Baseline scan** to **2006-spgr1**
- Set the **Follow up scan** to **2007-spgr1**



Click on the green arrow to the next step of the workflow

Step2: Define Region of interest

A **Volume of Interest (VOI) Box Widget** appears in the anatomical viewers, and in the 3D viewer.

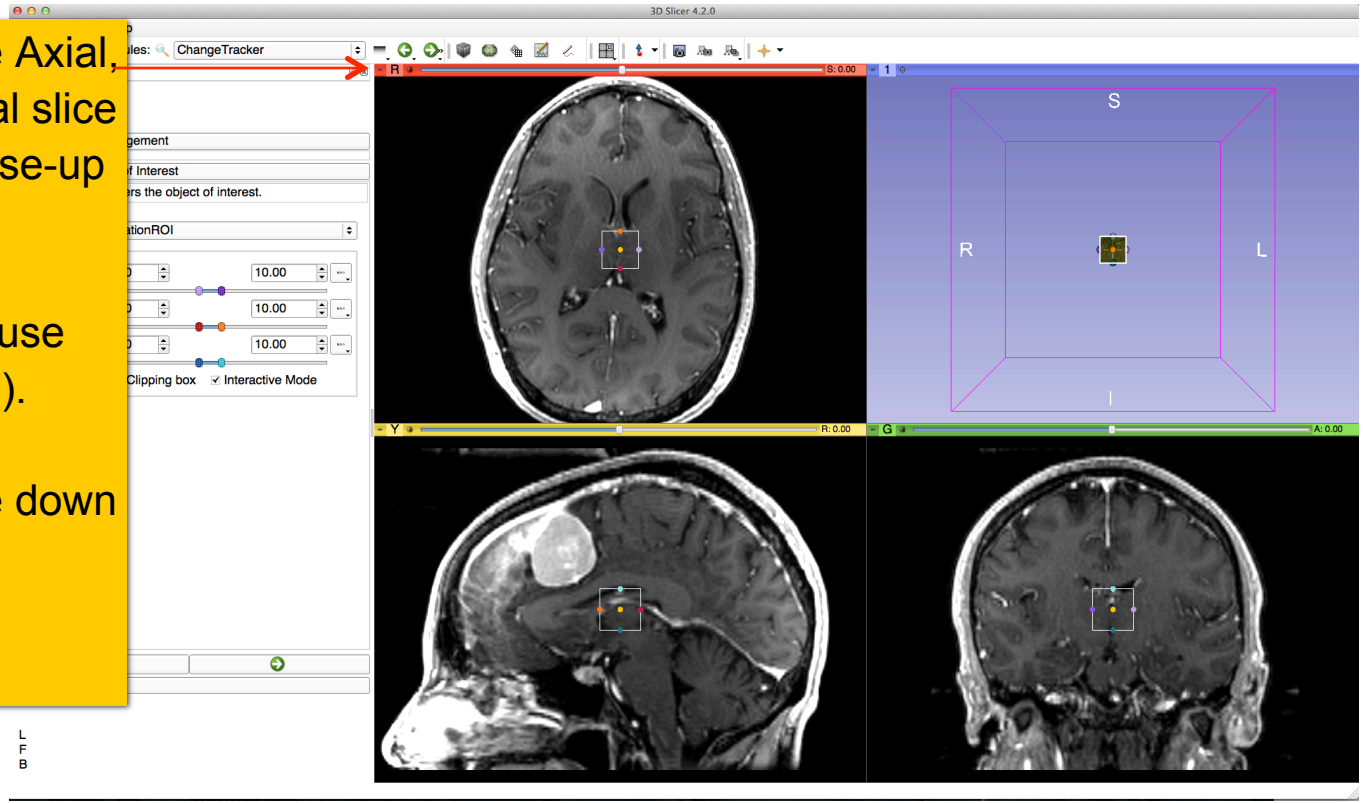


Step2: Define Region of interest

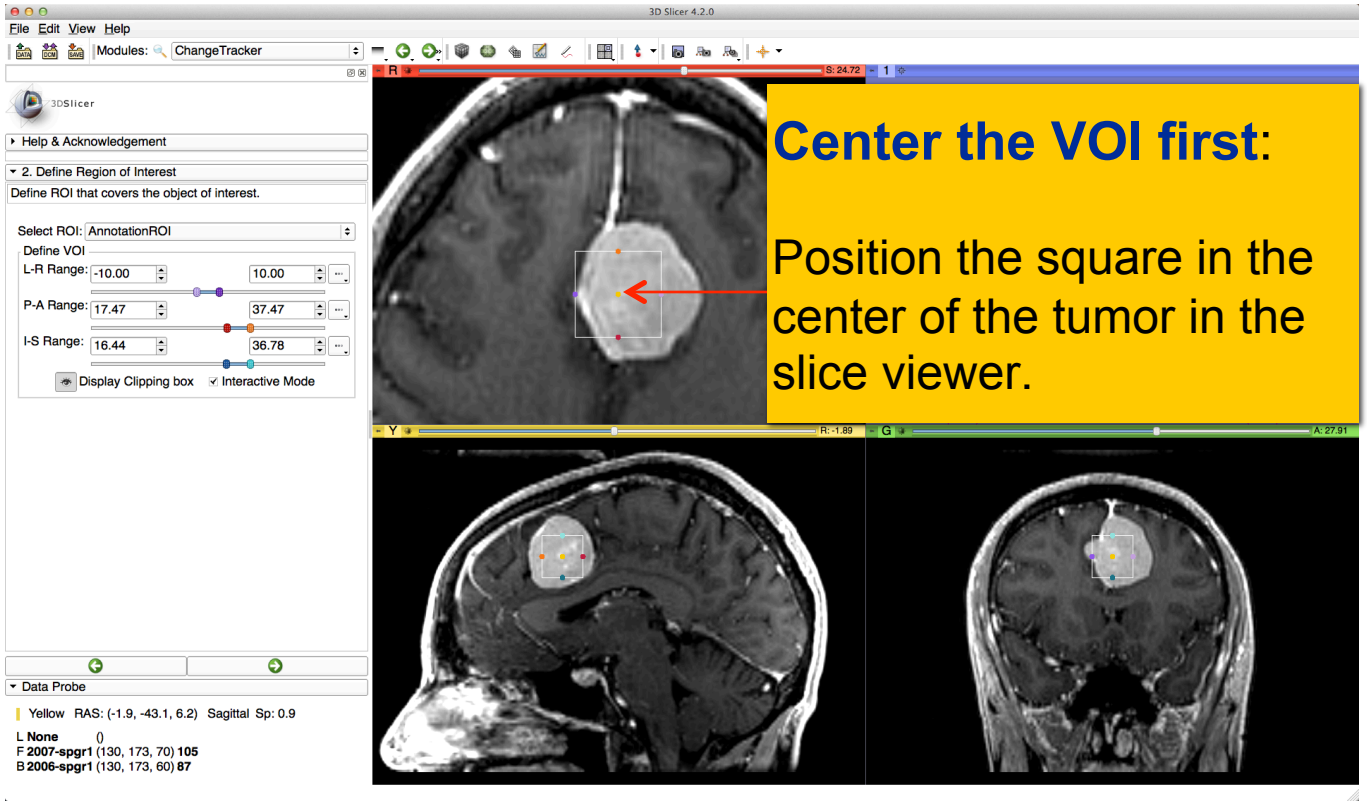
Browse through the Axial, Sagittal and Coronal slice viewers to get a close-up view of the tumor

Zoom in (Right mouse down and push/pull).

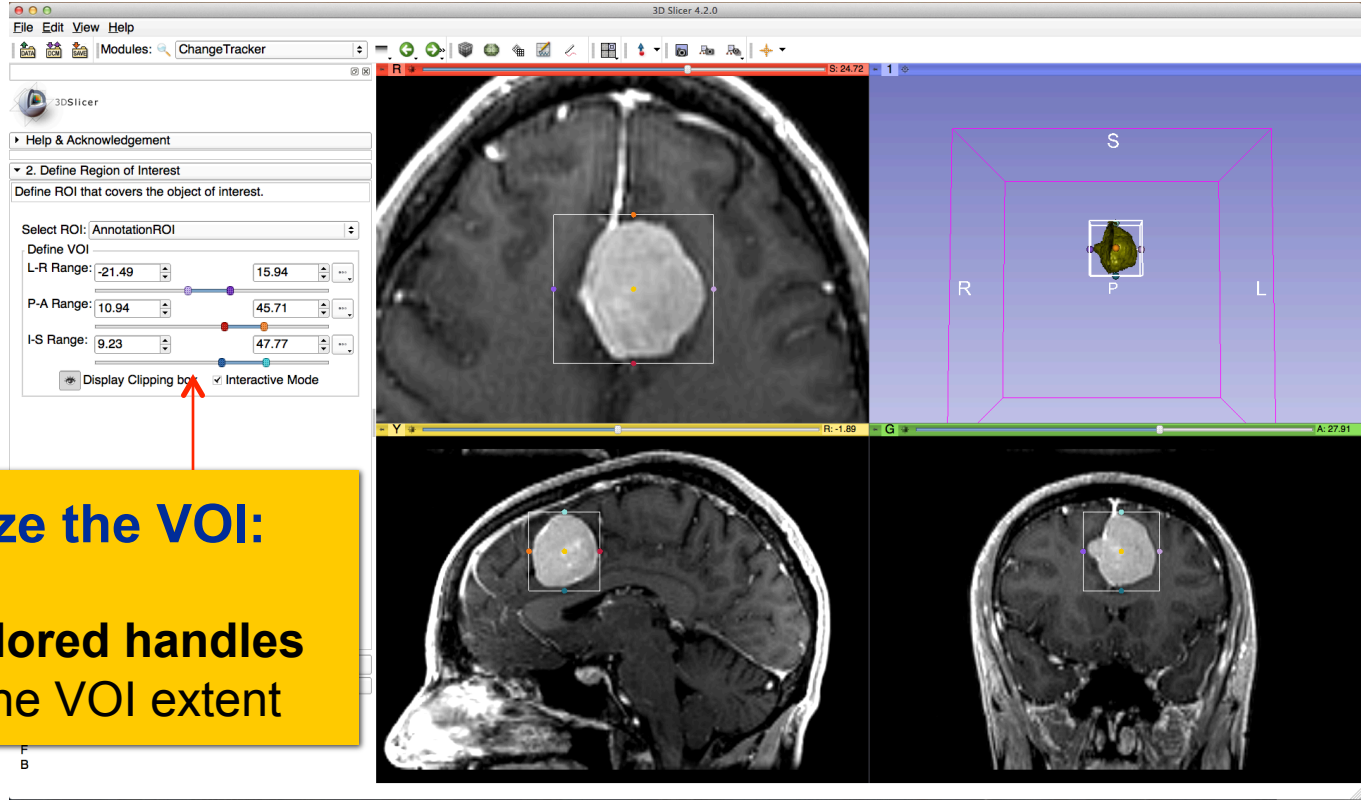
Pan (Middle mouse down and move)



Step2: Define Region of interest



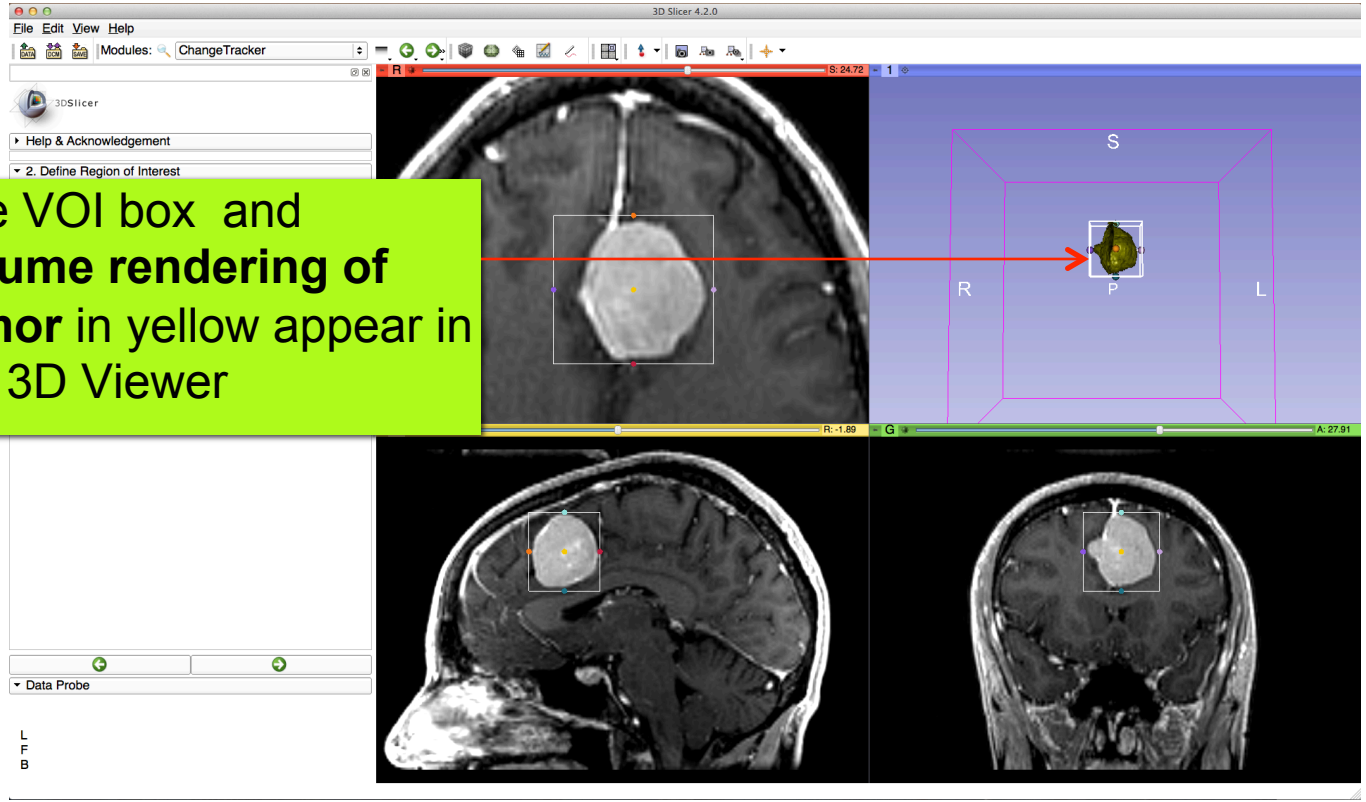
Step2: Define Region of interest



Next, resize the VOI:

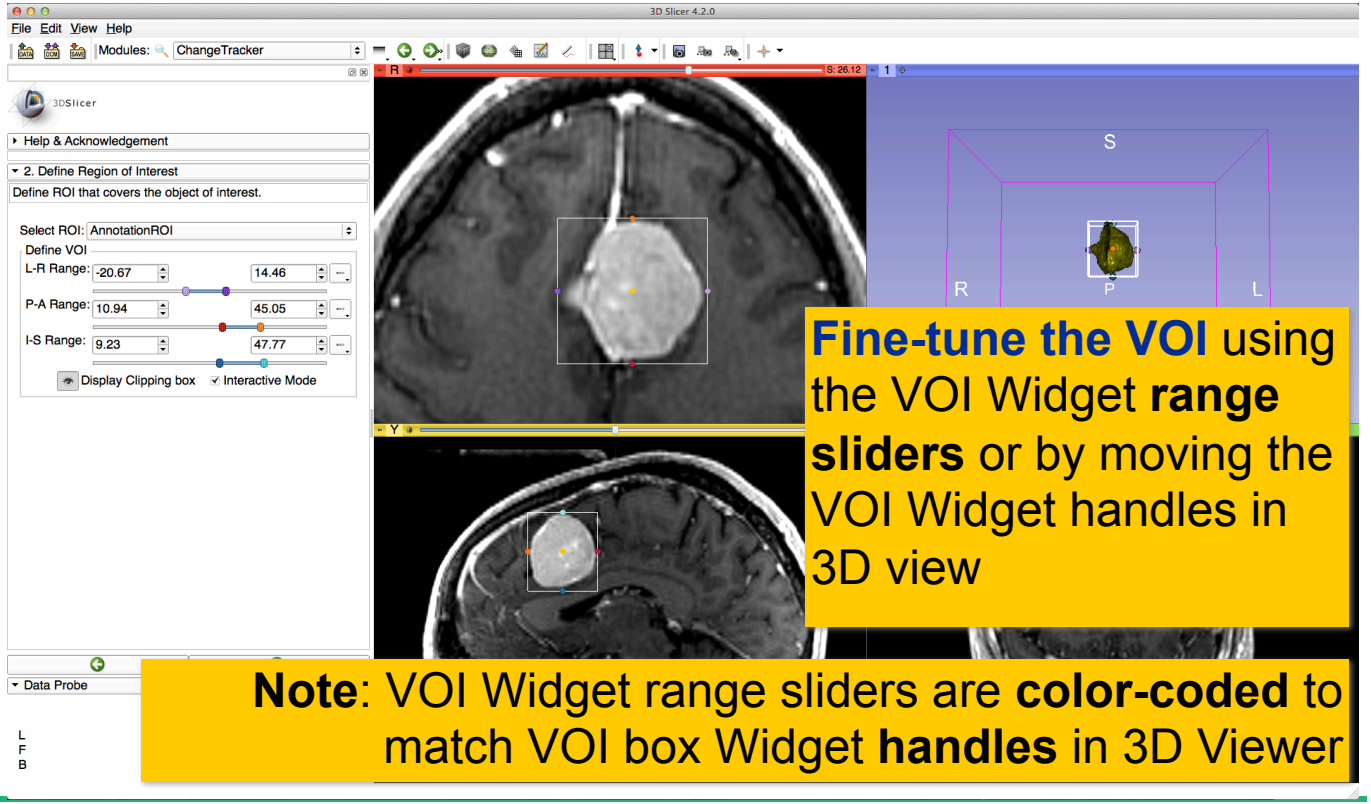
Use the colored handles to change the VOI extent

Step2: Define Region of interest



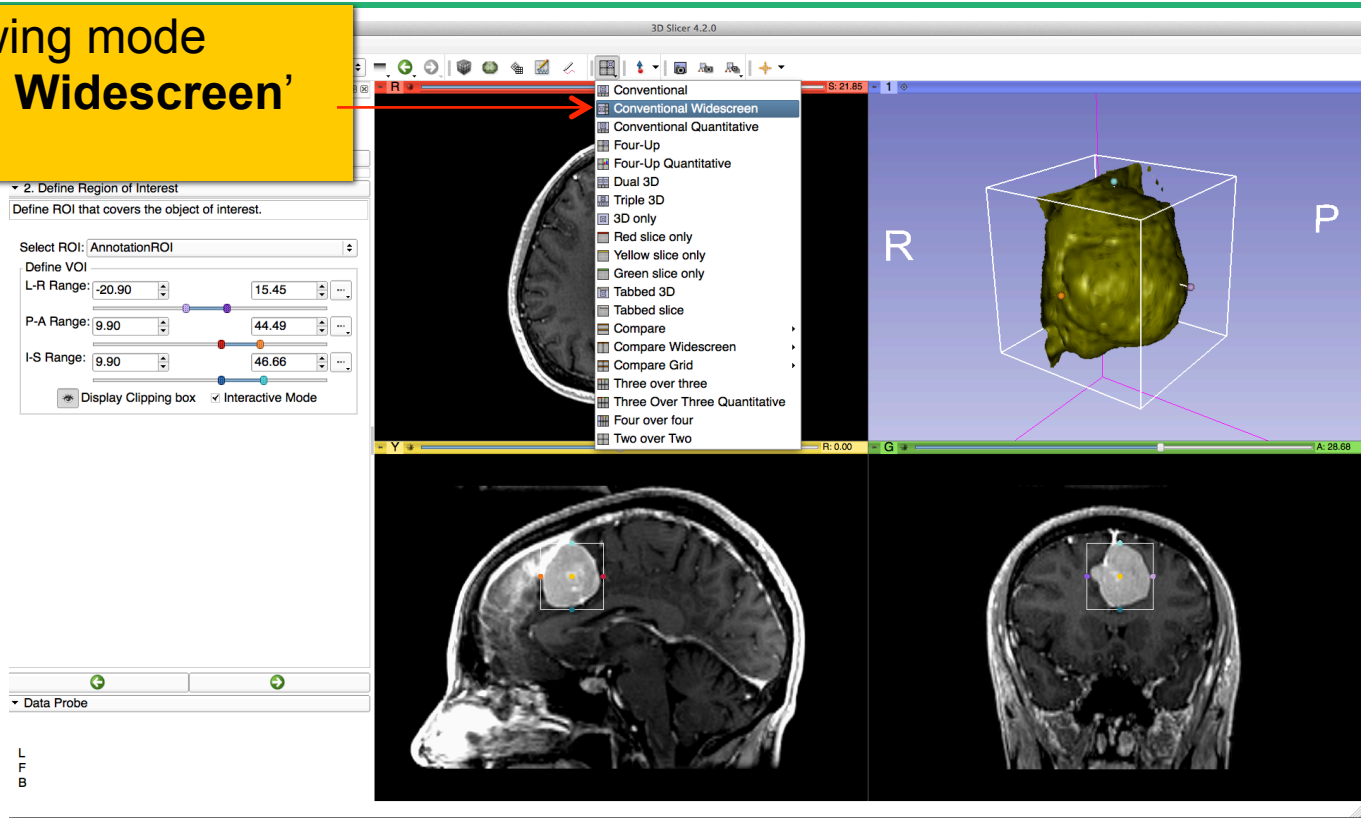
The VOI box and **volume rendering of tumor** in yellow appear in the 3D Viewer

Step2: Define Region of interest

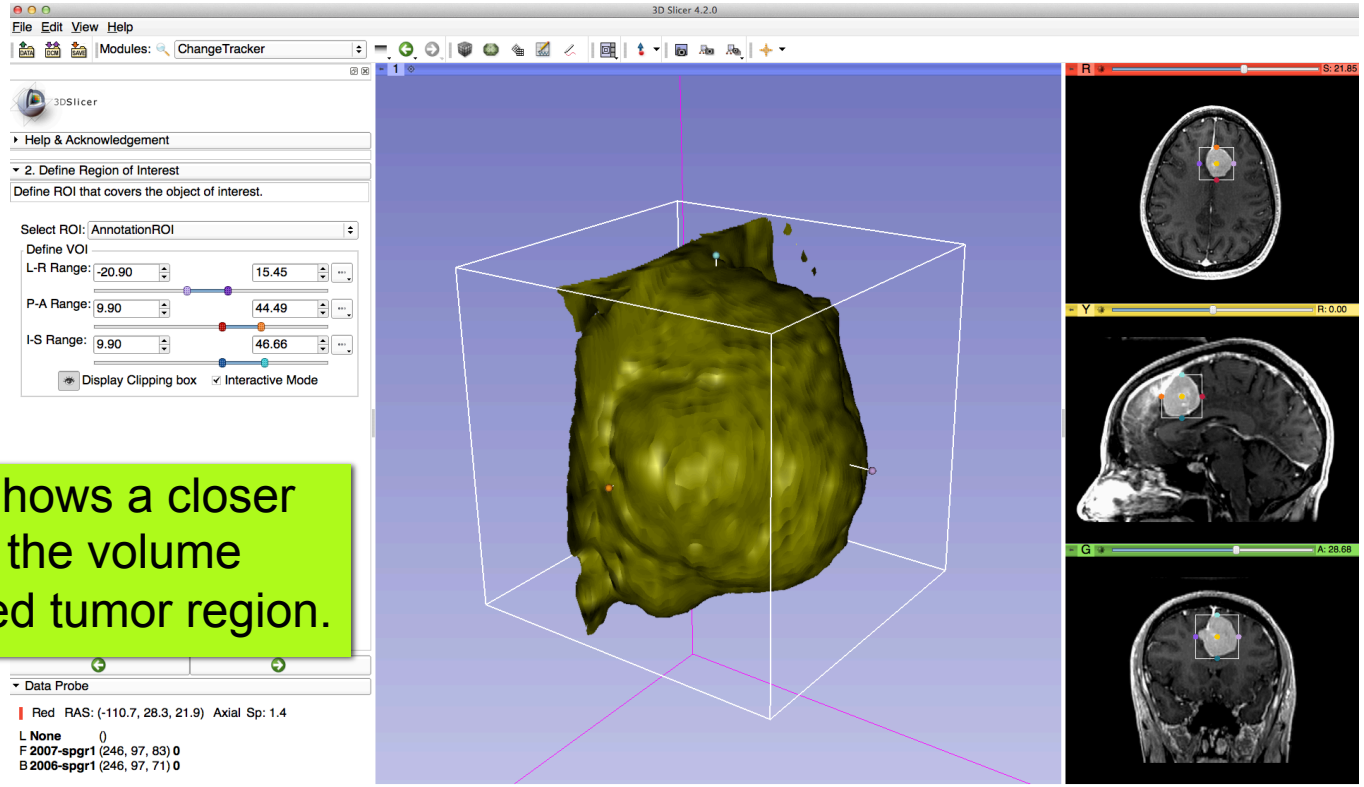


Step2: Define Region of interest

Select the viewing mode
‘**Conventional Widescreen**’

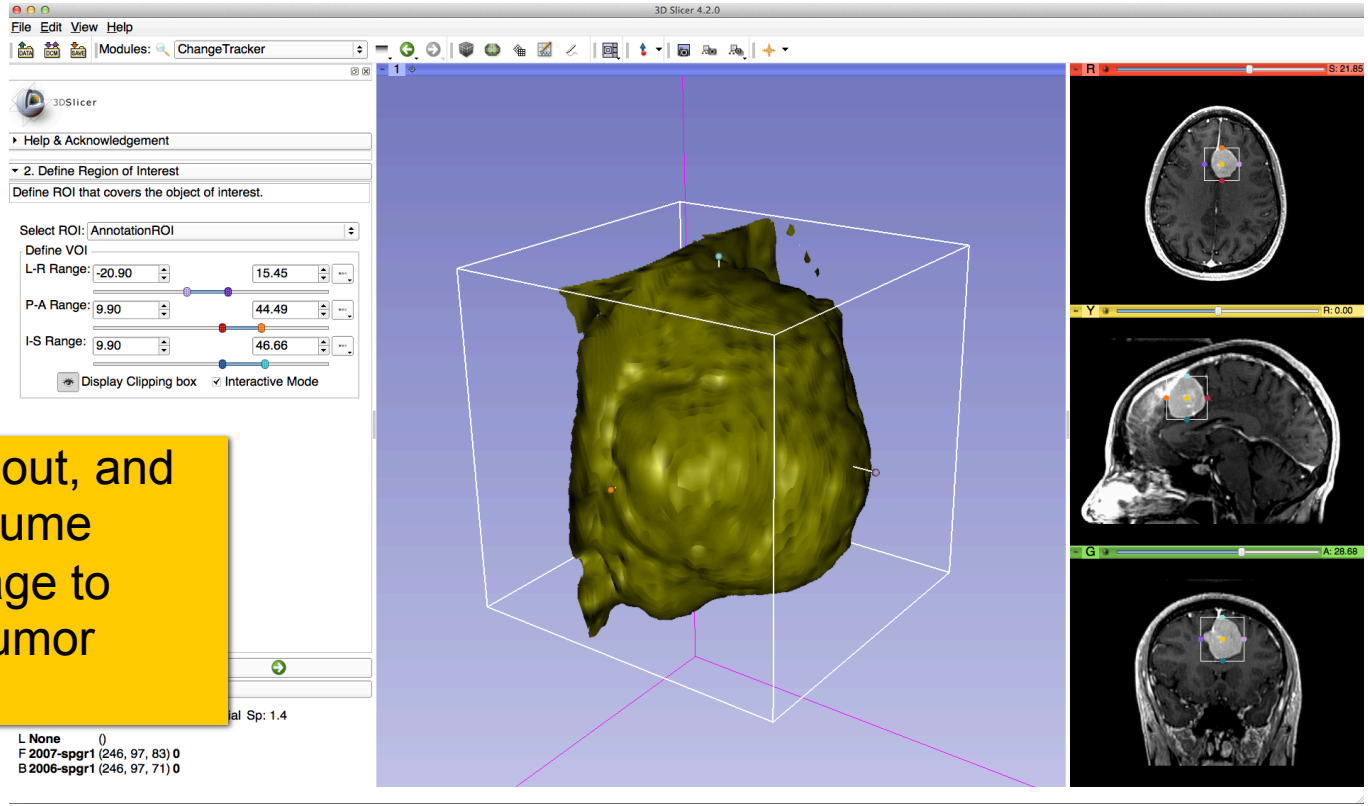


Step2: Define Region of interest



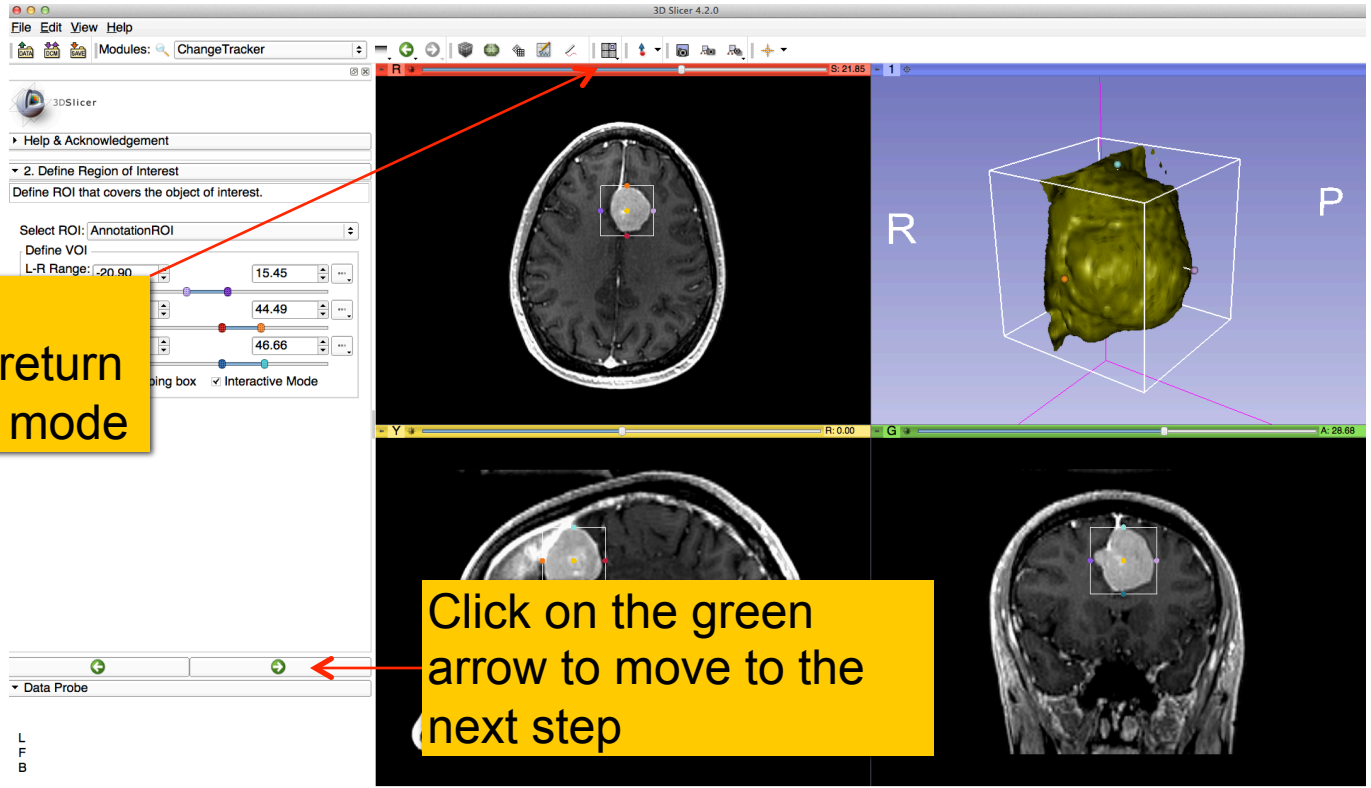
Slicer shows a closer view of the volume rendered tumor region.

Step2: Define Region of interest



Zoom in and out, and rotate the volume rendered image to explore the tumor region in 3D.

Step2: Define Region of interest

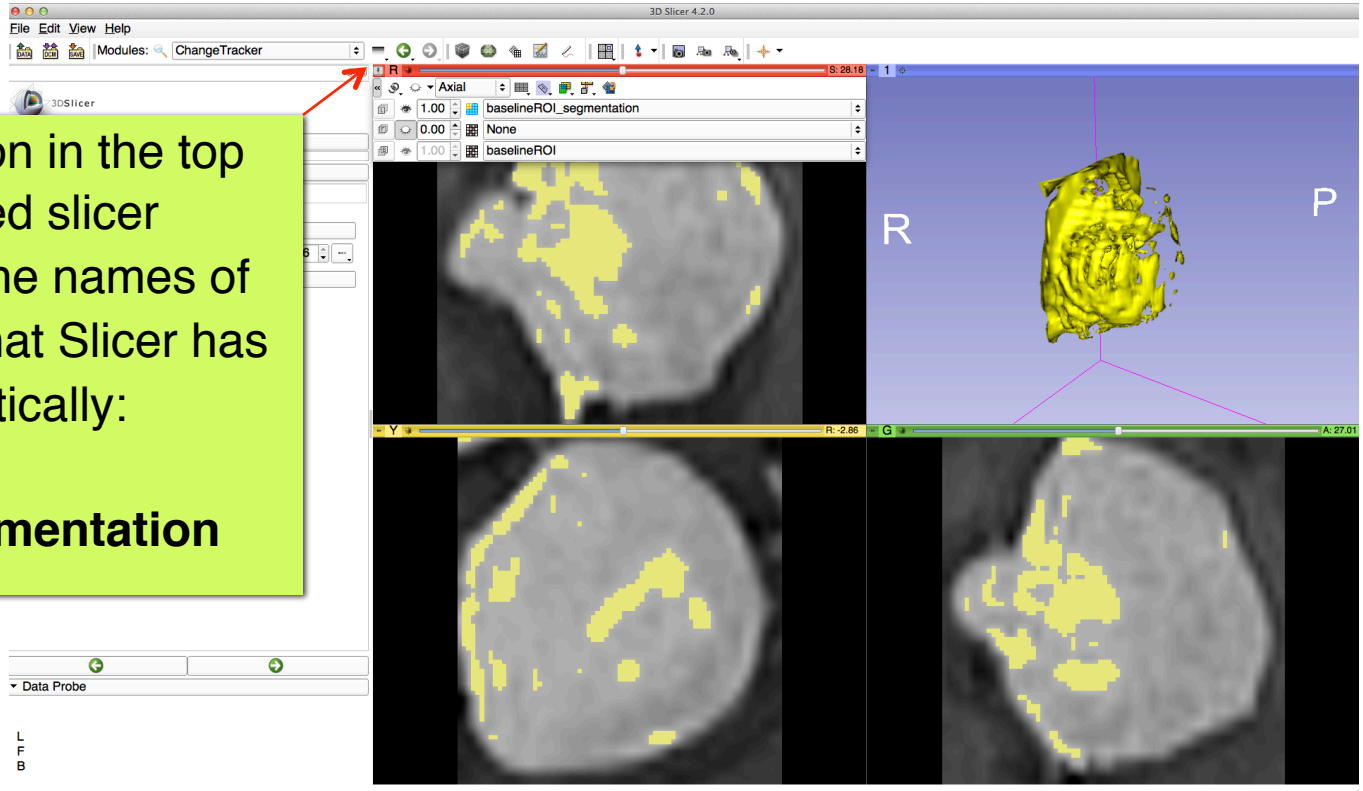


Select '**Four-Up Quantitative**' to return to the initial view mode

Click on the green arrow to move to the next step

Step3: Segment the tumor

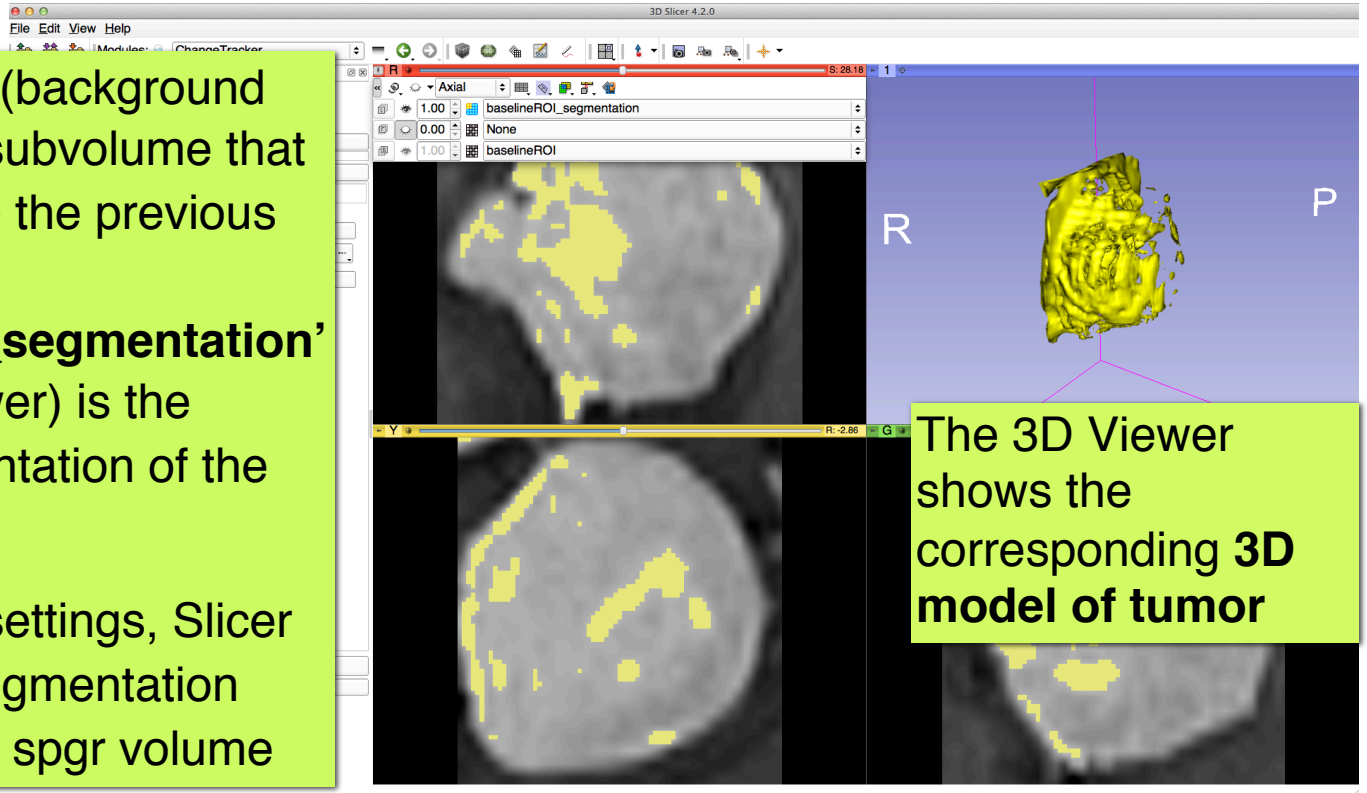
Click on the pin icon in the top left corner of the red slicer viewer to display the names of the two volumes that Slicer has generated automatically: **baselineROI** and **baselineROI_segmentation**



Step3: Segment the tumor

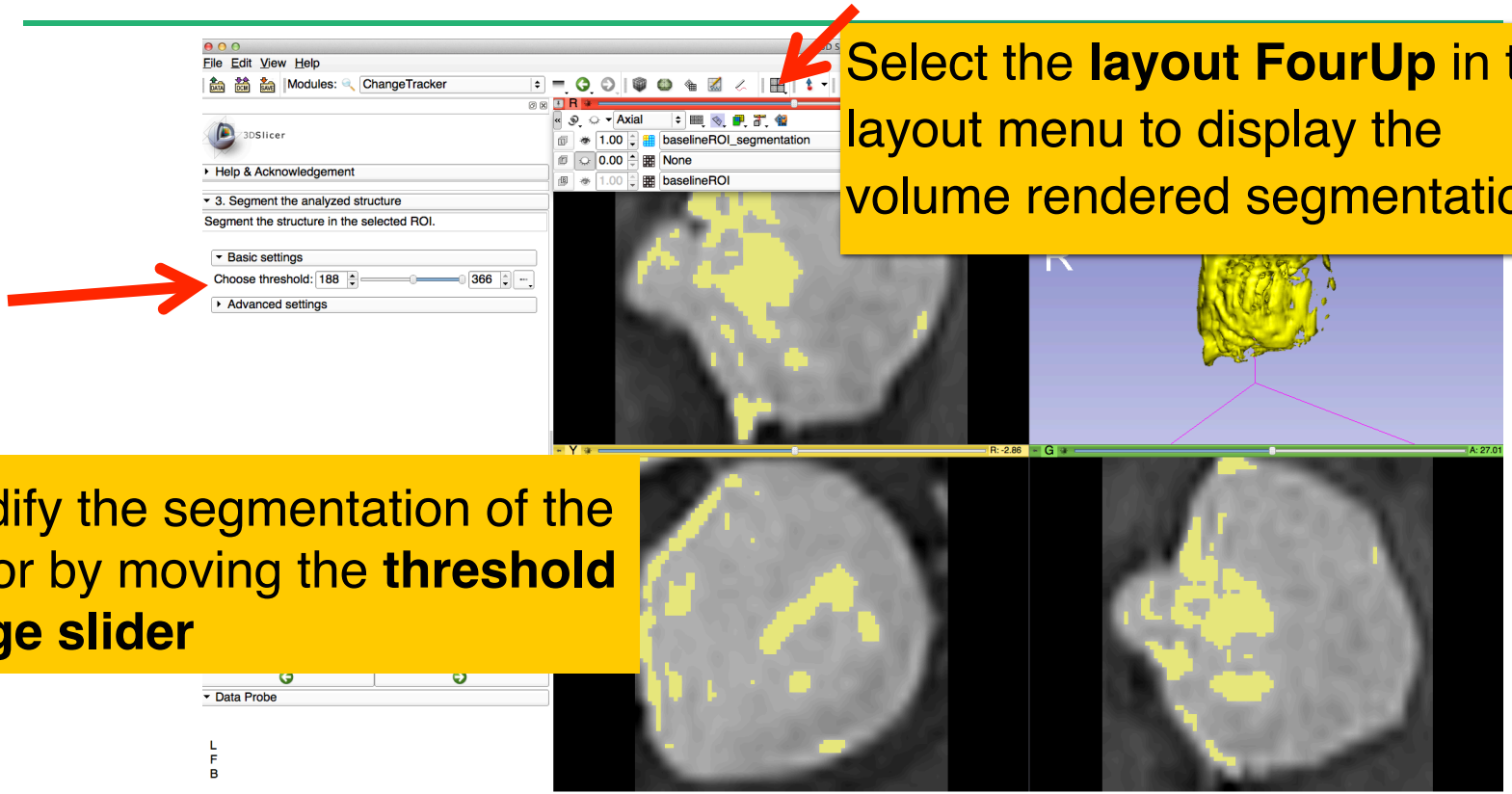
‘**baselineROI** ‘(background viewer) is the subvolume that corresponds to the previous VOI ‘**baselineROI_segmentation**’ (labelmap viewer) is the current segmentation of the tumor.

In the current settings, Slicer displays the segmentation overlaid on the spgr volume



The 3D Viewer shows the corresponding **3D model of tumor**

Step3: Segment the tumor

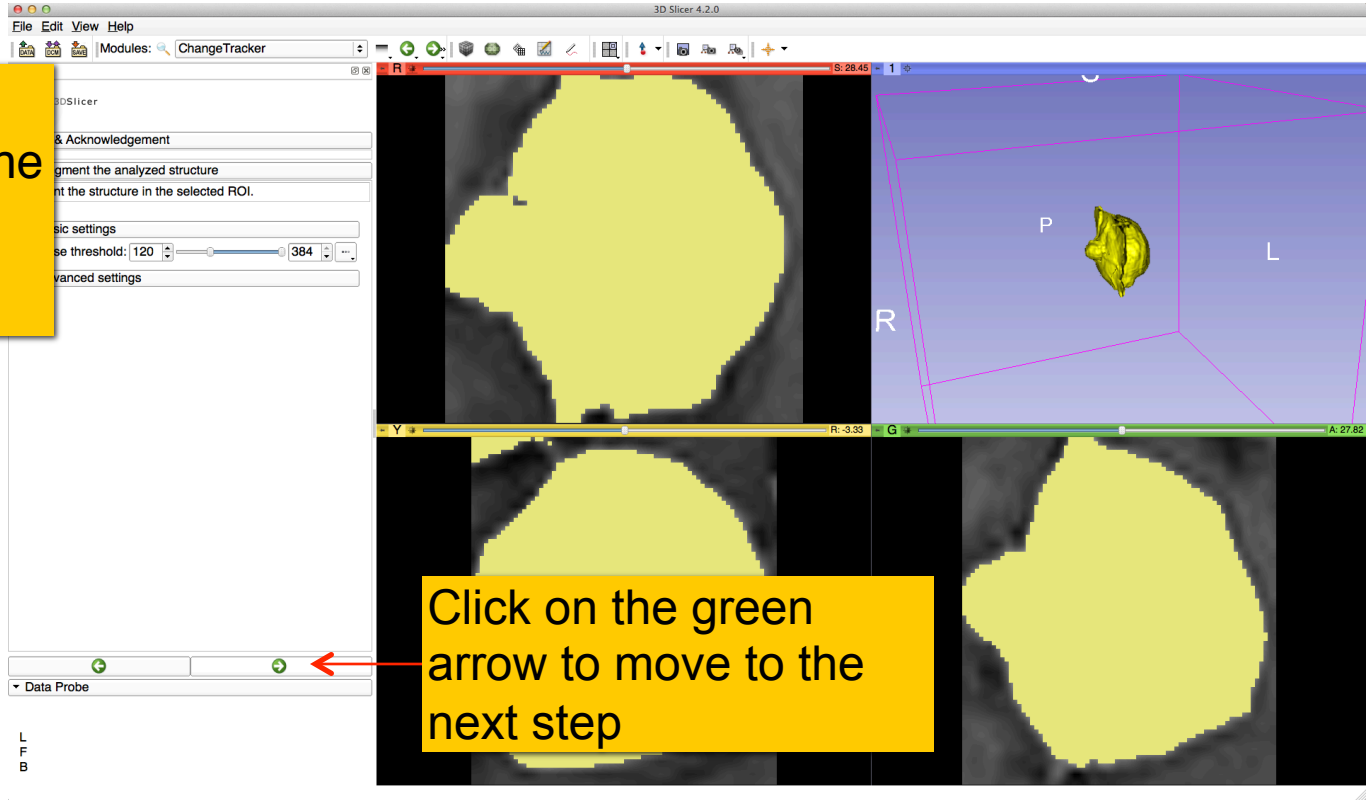


Select the **layout FourUp** in the layout menu to display the volume rendered segmentation

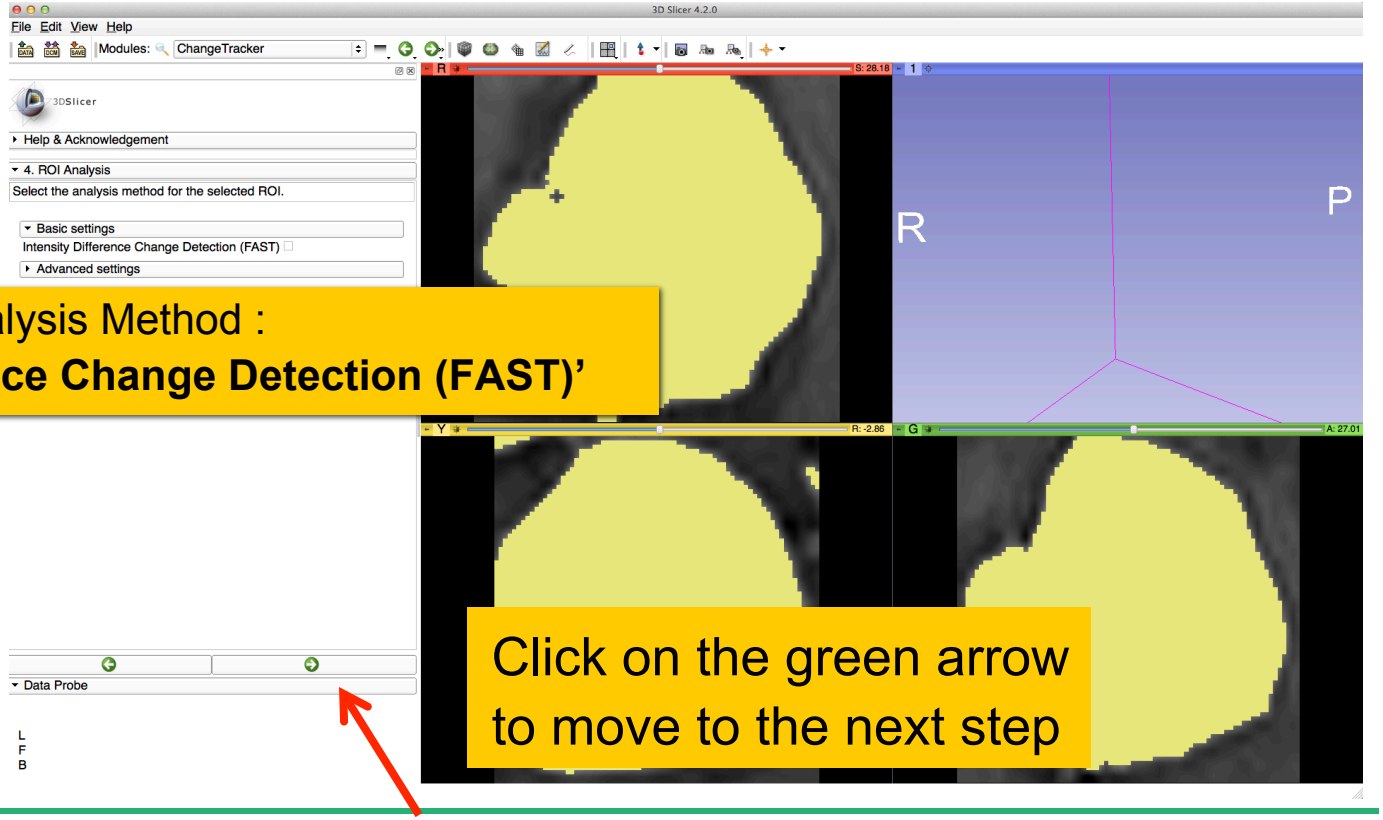
Modify the segmentation of the tumor by moving the **threshold range slider**

Step3: Segment the tumor

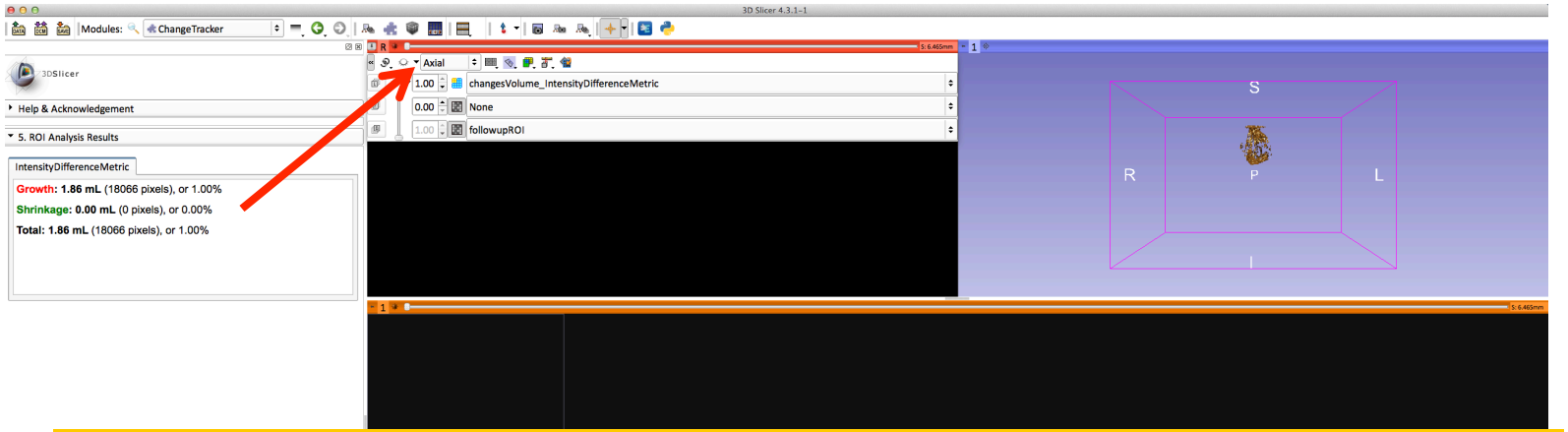
Scroll through the slices until the segmentation appears optimal.



Step4: Select the Analysis Method



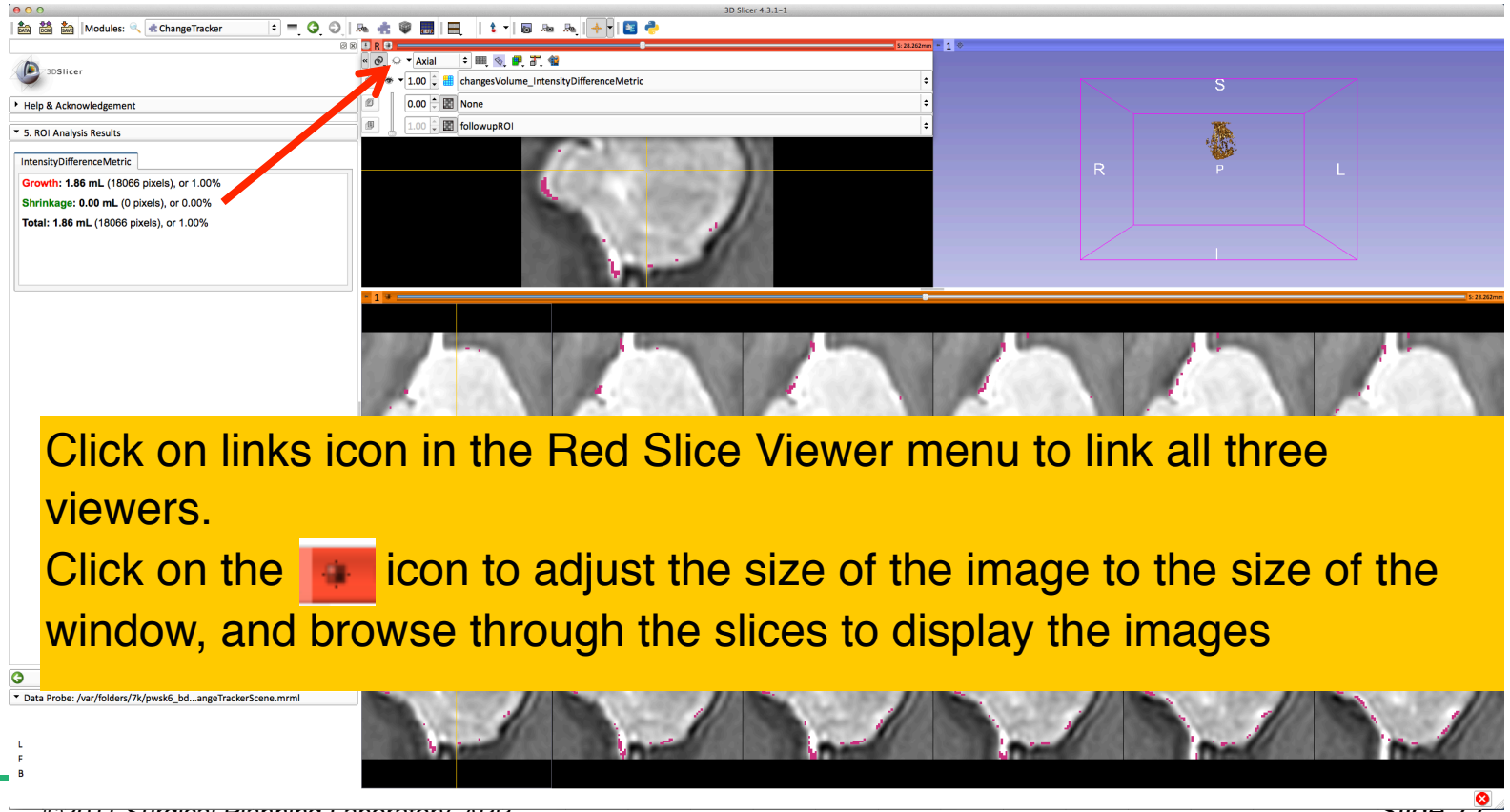
Step4: Select the Analysis Method



Left click on the slice menu to display the volumes that have been generated:

- **followupROI** correspond to the subvolume that has been extracted around the tumor in the 2007-spgr_1 dataset
- **changesVolume_IntensityDifferenceMetric** corresponds to the change between the 2006 and 2007 scans

Step4: Select the Analysis Method



Click on links icon in the Red Slice Viewer menu to link all three viewers.

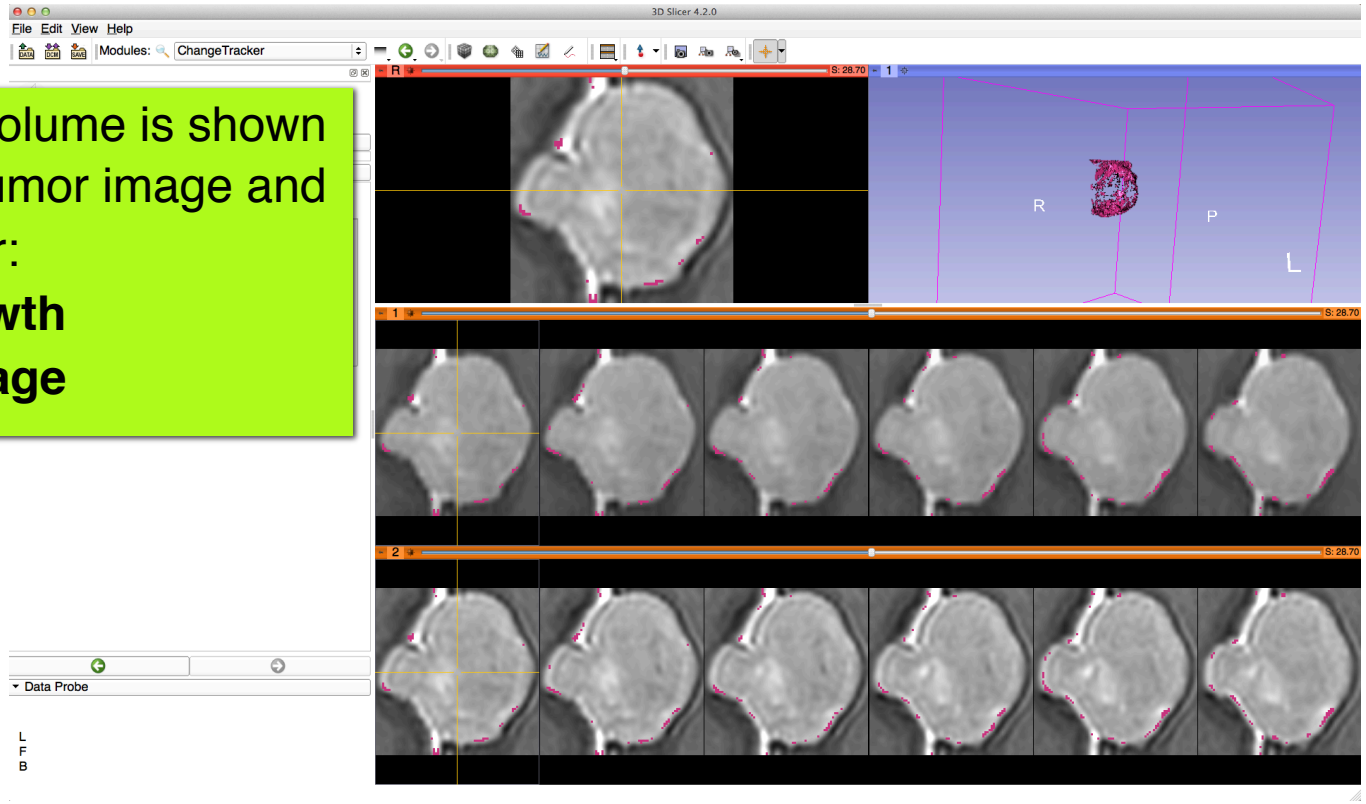
Click on the icon to adjust the size of the image to the size of the window, and browse through the slices to display the images

Final Step: Change Tracker Results

The change in volume is shown overlaying the tumor image and in the 3D Viewer:

magenta = growth

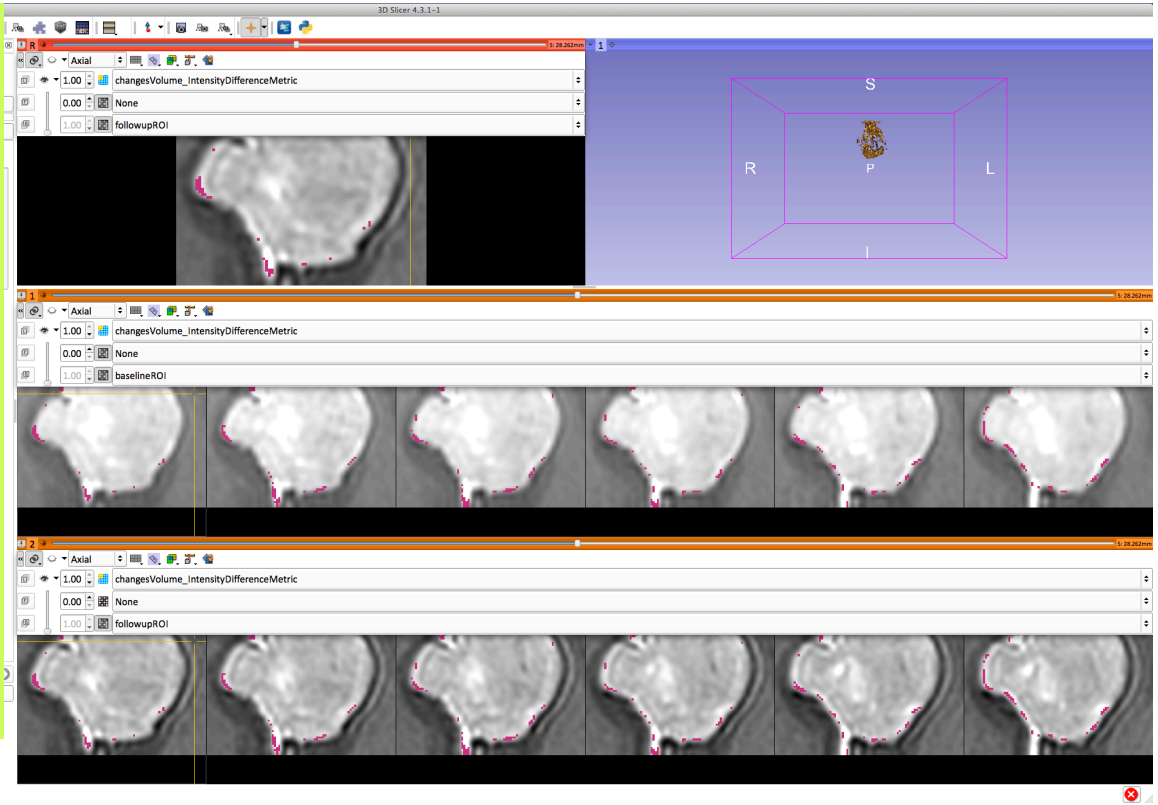
green = shrinkage



Visualization of the change in pathology

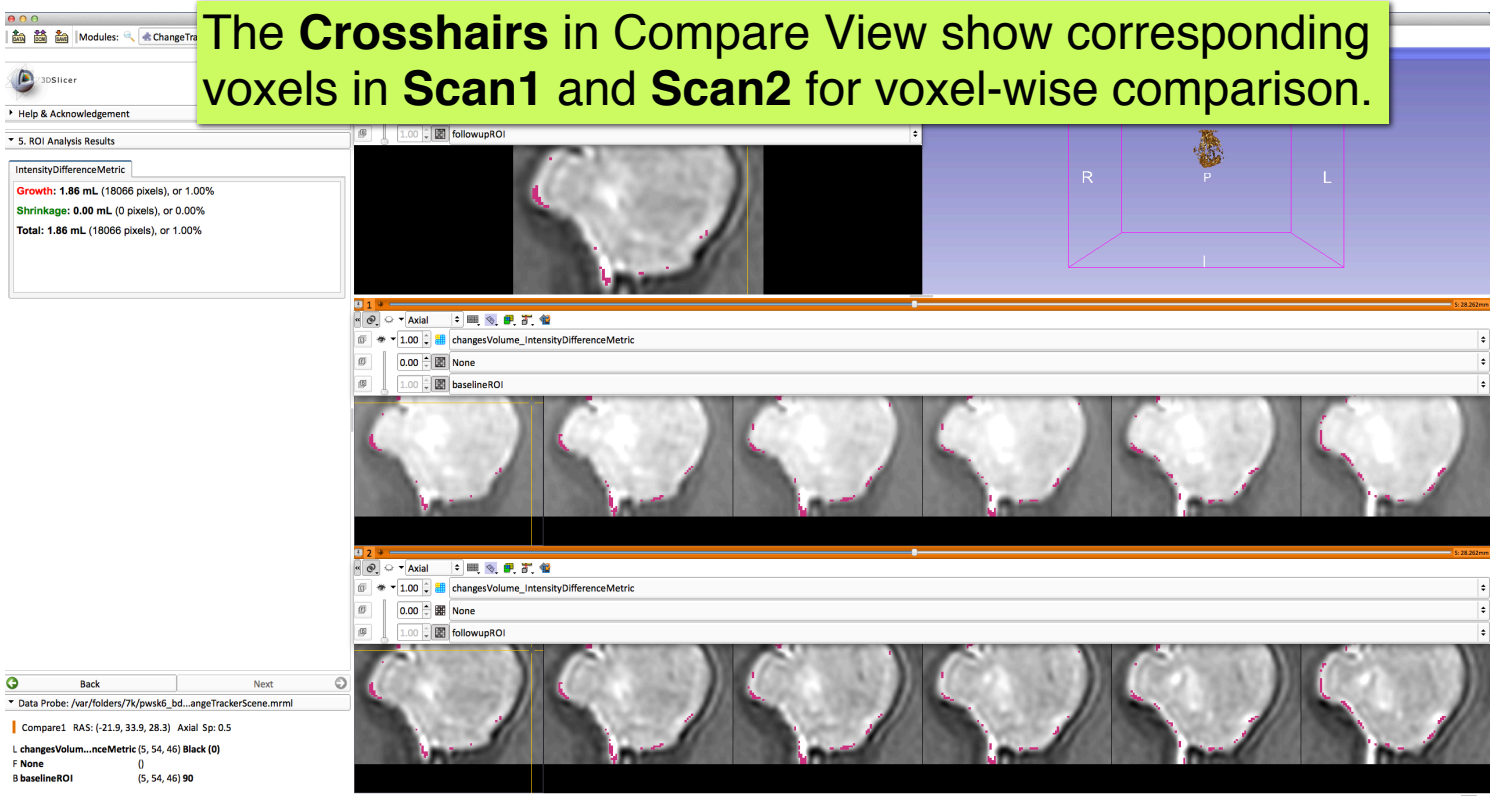
The results of the analysis are displayed in the **“Compare View” layout**

- Six consecutive slices for the VOI in Scan1 **(top row)**, and
- Six corresponding consecutive slices for the VOI in Scan2 **(bottom row).**
- A zoomed view of the axial slice in the red slicer viewer

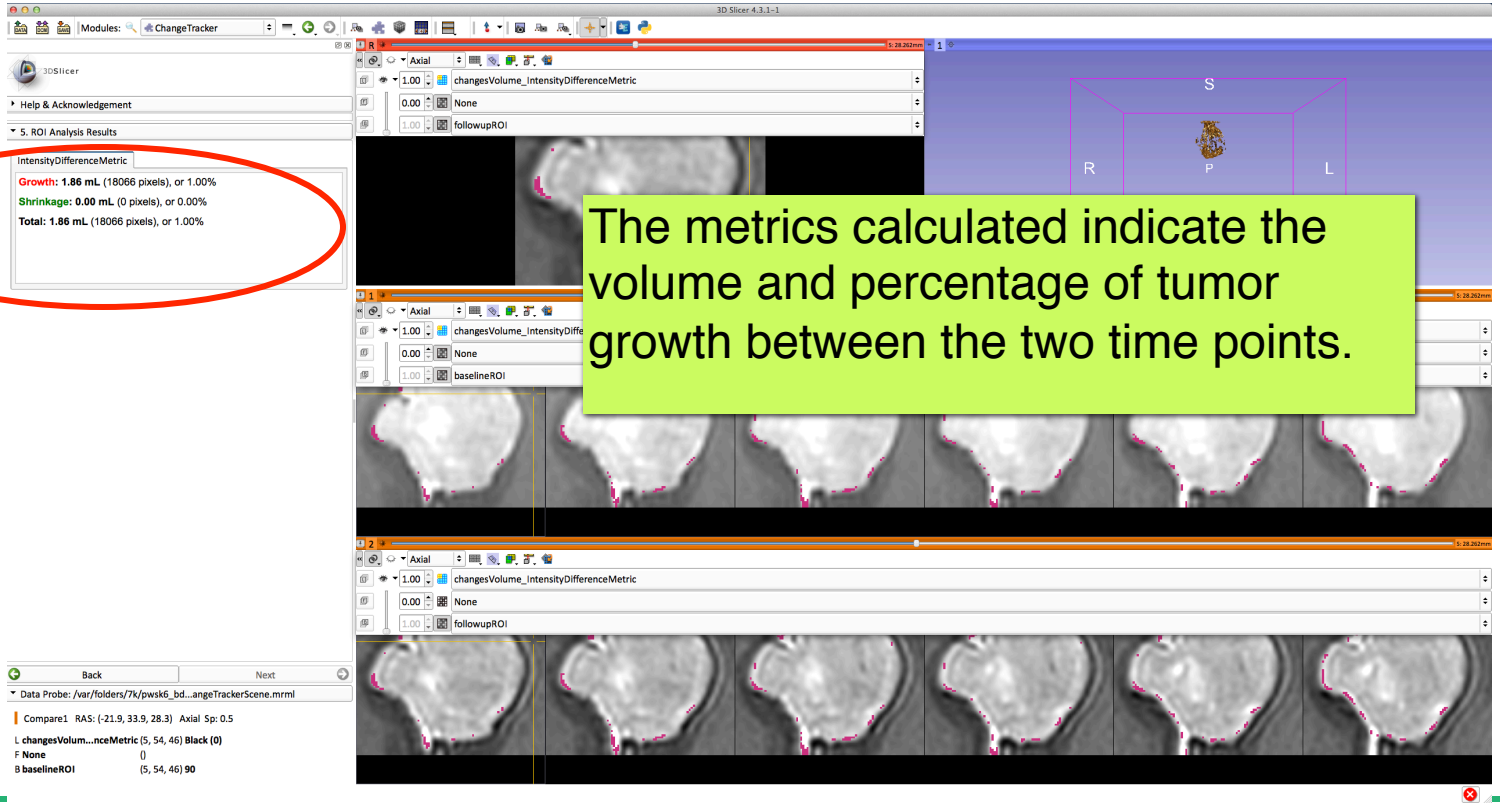


Visualization of the change in pathology

The **Crosshairs** in Compare View show corresponding voxels in **Scan1** and **Scan2** for voxel-wise comparison.



Change Tracker Results



The metrics calculated indicate the volume and percentage of tumor growth between the two time points.

Change Tracker module

- This tutorial demonstrated the use of the change tracker module in Slicer on axial 3D SPGR T1 post Gadolinium scans

  - **Tumor boundary should be clear**
  - **Only for contrast enhanced images**
  - **Need homogenous enhancement across timepoints.**

- The Change Tracker module has not been tested for tumors with changing necrosis.

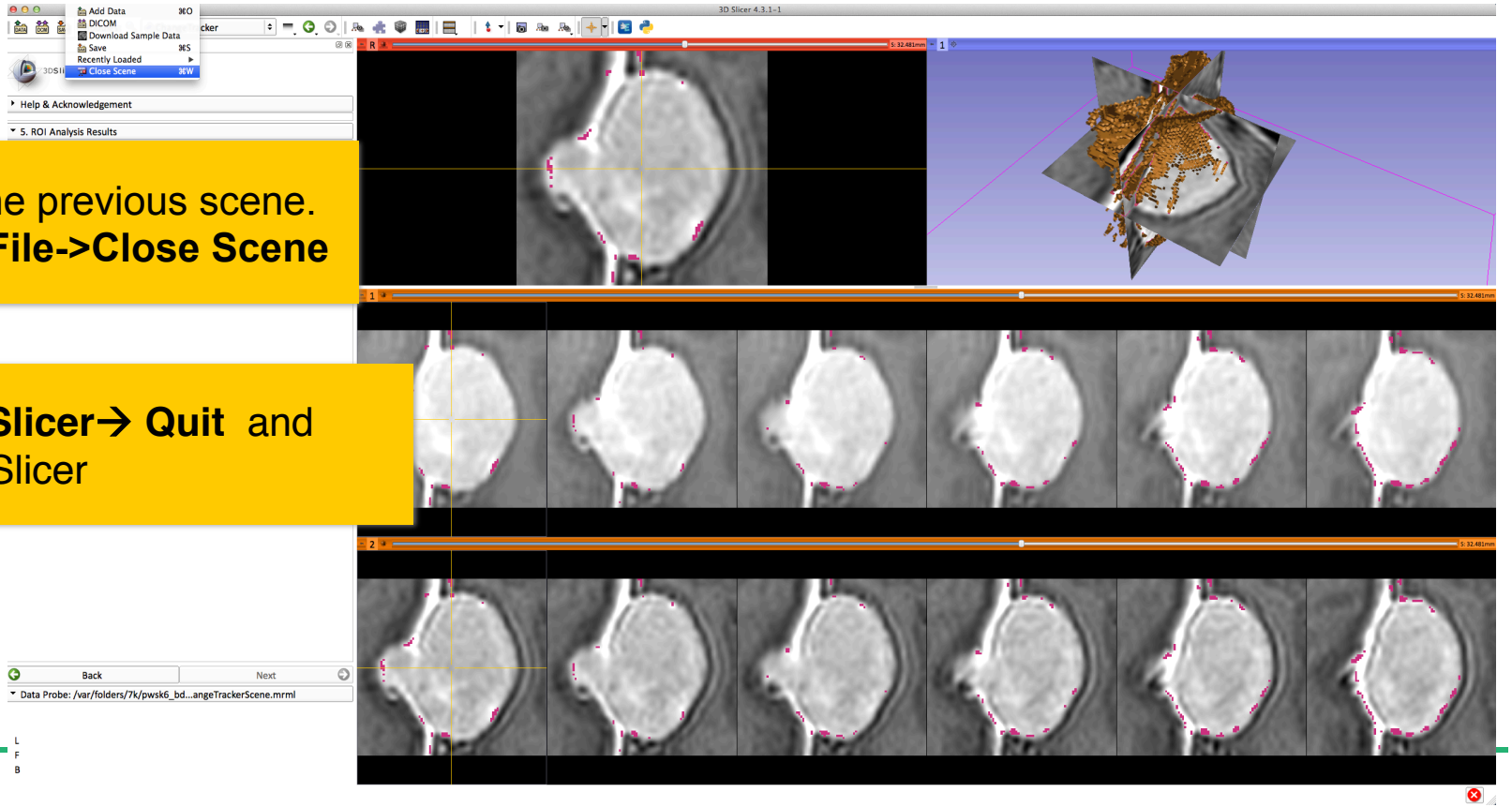
ChangeTracker: Exploring small volumetric changes

This tutorial demonstrated:

- a method to quantify small volumetric changes in pathology.
- visualization of these changes in the anatomical context
- use of Slicer's "**Compare Viewer**" to simultaneously explore baseline and followup studies.

Next, we will demonstrate combined visualization of PET/CT studies and SUV computation.

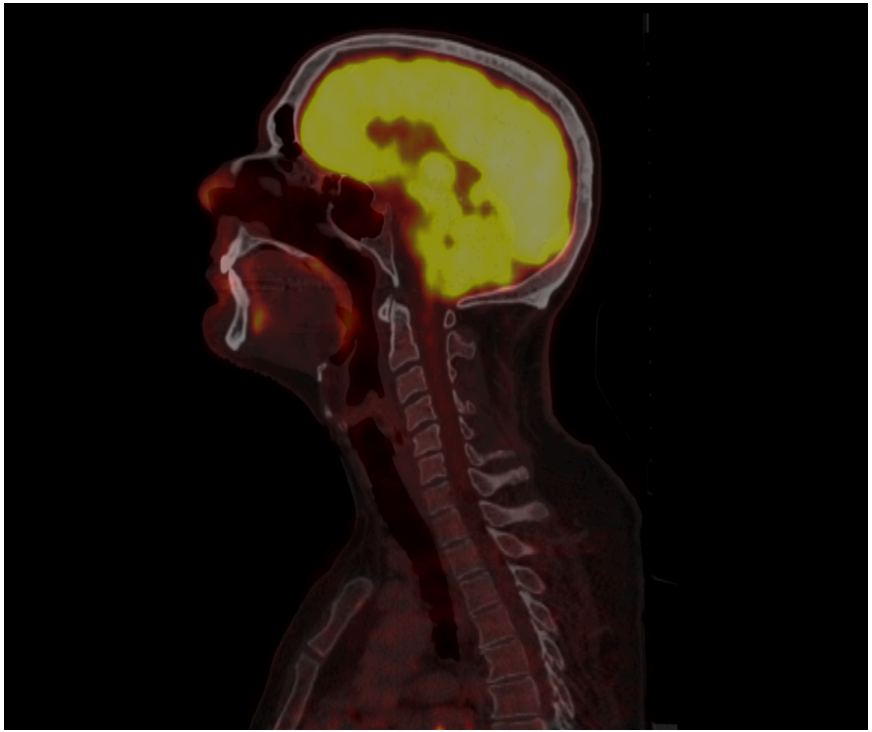
Clear the scene and its data



Clear the previous scene.
Select **File->Close Scene**

Select **Slicer→ Quit** and restart Slicer

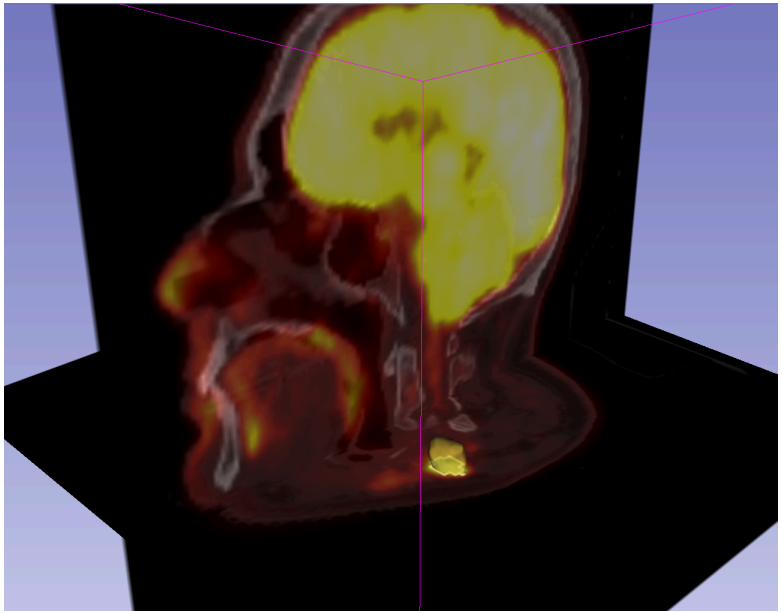
PET/CT Visualization and Analysis



Part III: PET/CT Analysis

Sonia Pujol, PhD
Kitt Shaffer, MD, PhD
Hatsuho Mamata, MD, PhD
Ron Kikinis, MD

Goal of the tutorial



The goal of this tutorial is to guide you step-by-step through the SUV computation of PETCT data of a squamous cell carcinoma case pre- and post- treatment

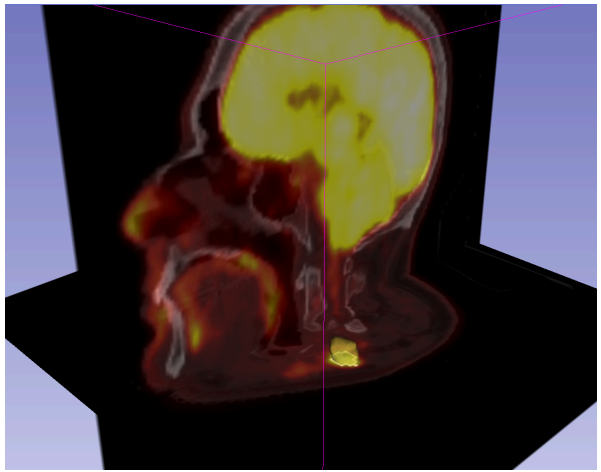
FDG-PET SUV

- Standardized Uptake Value (SUV) is a semi-quantitative measure derived from the determination of tissue activity obtained from a clinical PET study

SUV = Tissue Concentration of Radioactive Tracer x
Patient Weight / Injected Dose

- Under certain circumstances, 18-F Fluorodeoxyglucose (FDG) SUV correlates with metabolic rate of glucose and/or the number of viable tumor cells

Tutorial Case



- Pathology: poorly differentiated squamous cell carcinoma
- Treatment: radiotherapy and chemotherapy (weekly cis-platin)
- Two 18F-FDG PET and CT scans acquired within a 5-month interval.

PETCT tutorial: Clinical Case and Data

The datasets are located in

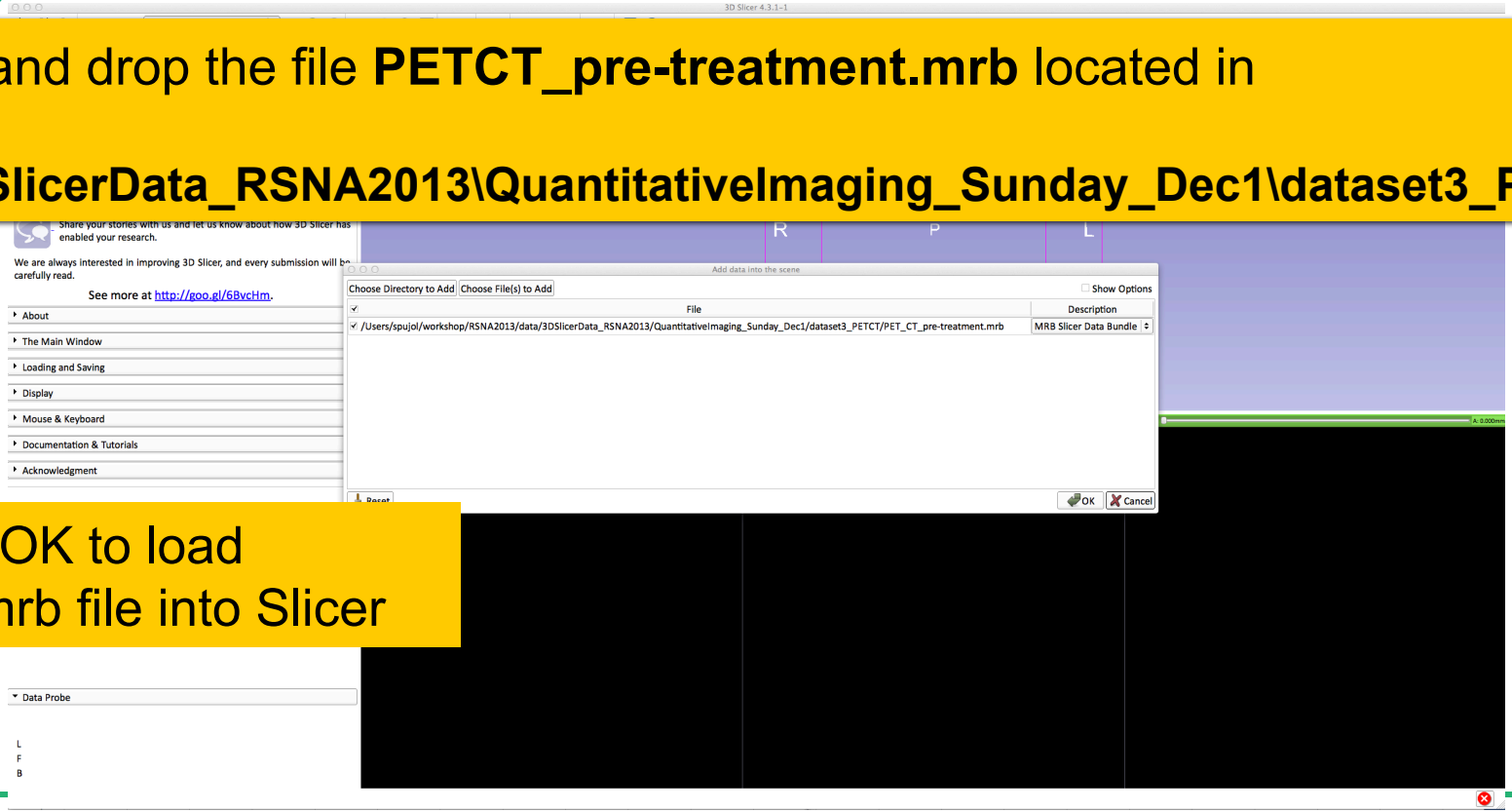
C:\3DSlicerData_RSNA2013\QuantitativeImagingSunday_Dec1\dataset3_PETCT

- **PETCT1 dataset** is located in the **pre-treatment directory** corresponds to the baseline
- **PETCT2 dataset** is located in the **post-treatment directory** corresponds to the follow-up scan.

Loading the PETCT scene

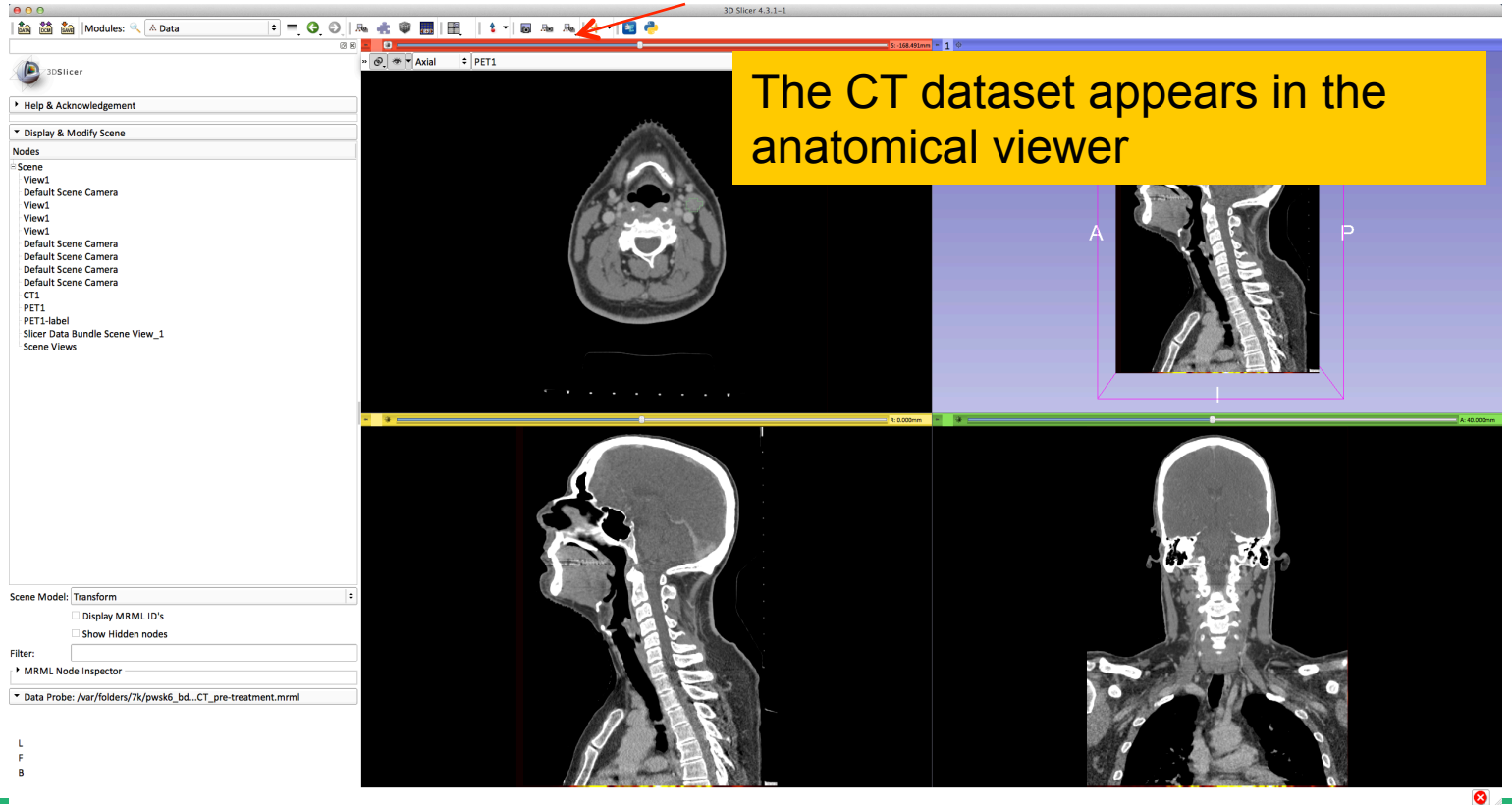
Drag and drop the file **PETCT_pre-treatment.mrb** located in

C:\3DSlicerData_RSNA2013\QuantitativeImaging_Sunday_Dec1\dataset3_PETCT

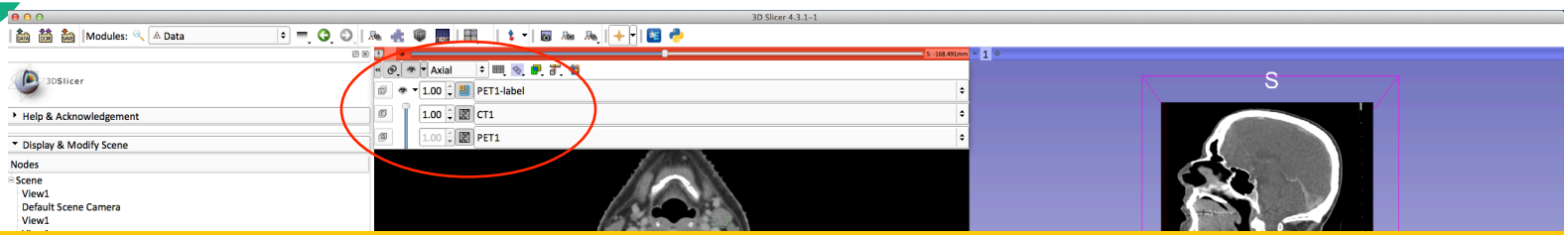


Click OK to load
the .mrb file into Slicer

Loading the PETCT scene



Loading a PETCT dataset



Left click on the pin icon in the top left corner to display the red slice viewer menu.

The **CT1** volume is displayed in the Foreground viewer

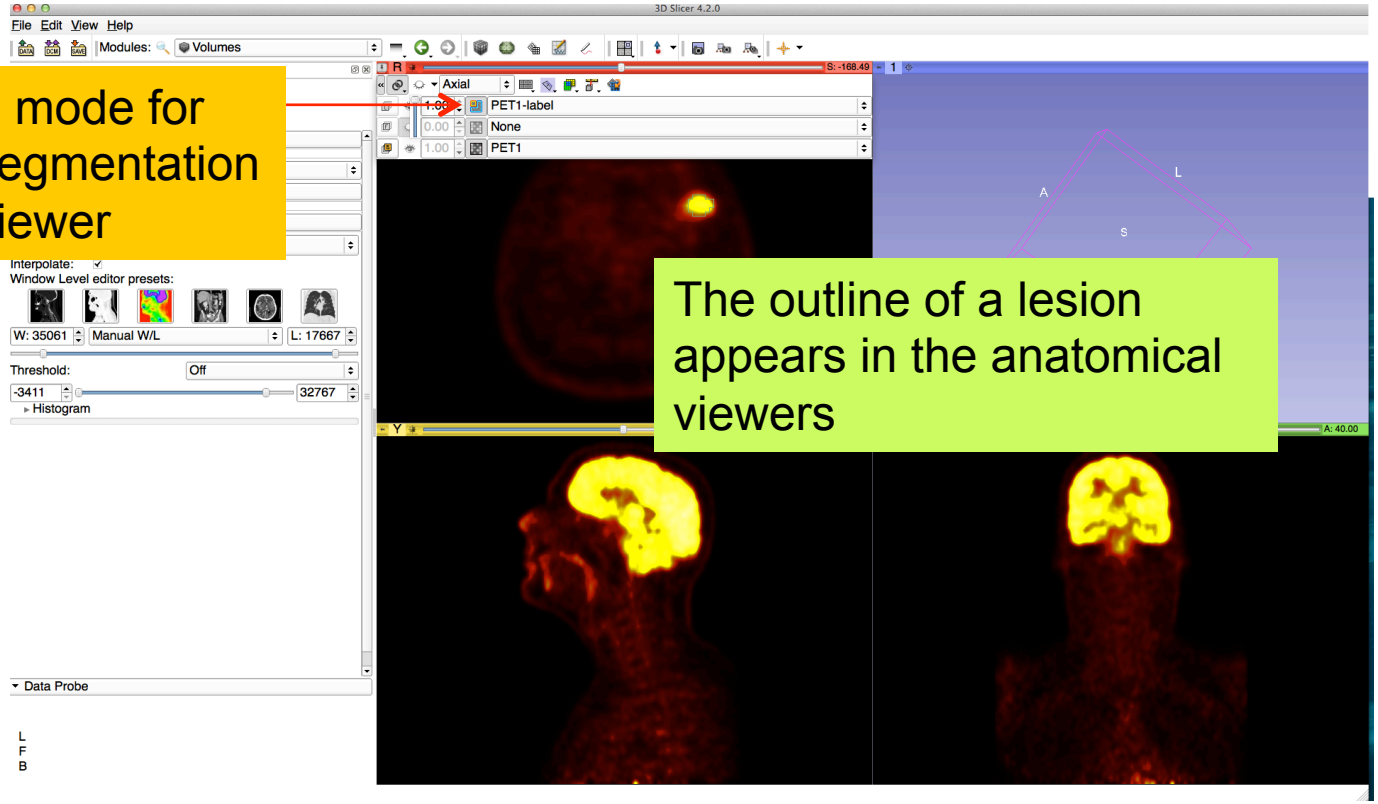
The **PET1** volume is displayed in the Background viewer

The **PET1-Label** is displayed in the Labelmap viewer

Use the slider to fade between the Bg viewer and the Fg viewer to display the PET volume overlaid on the CT volume

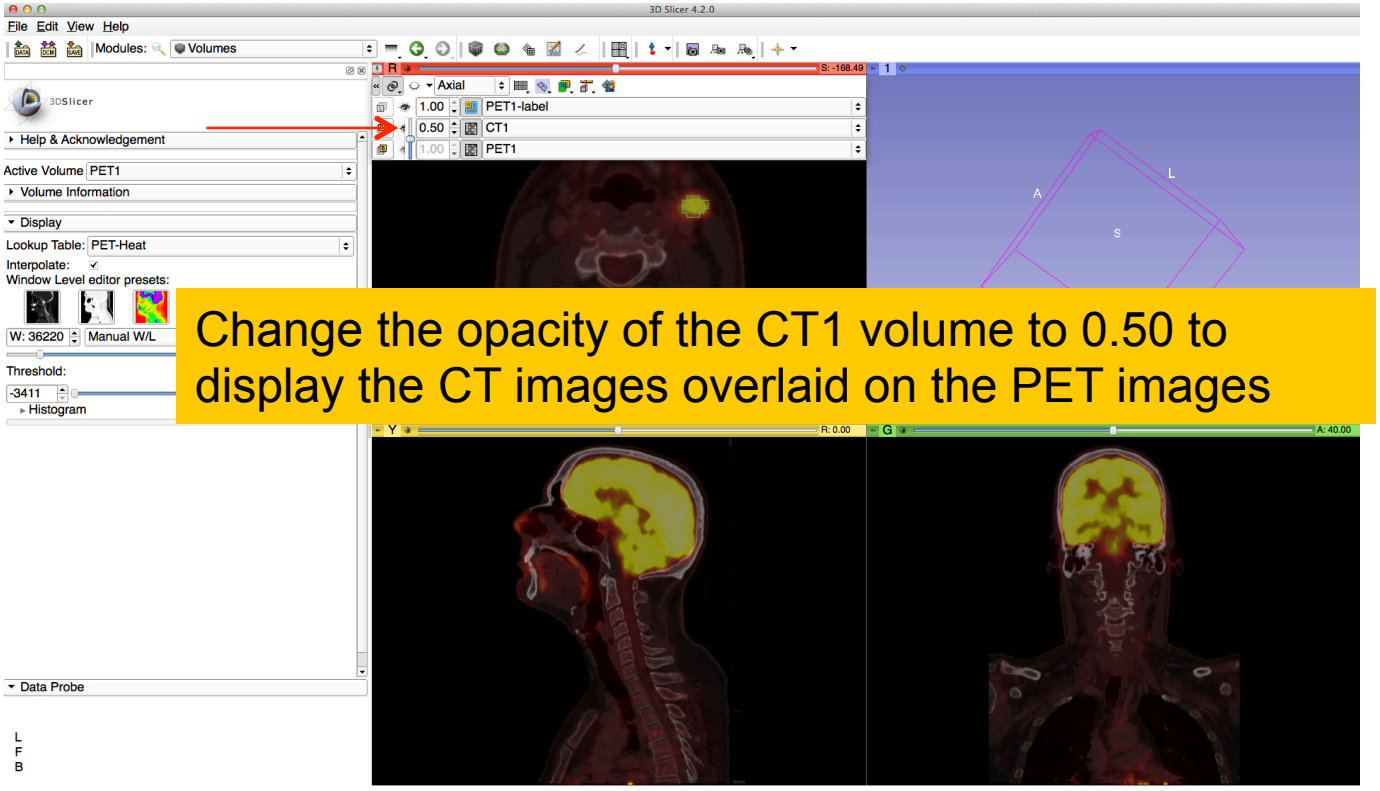
Visualization of PETCT data

Select the outline mode for the **PET1-label** segmentation in the labelmap viewer

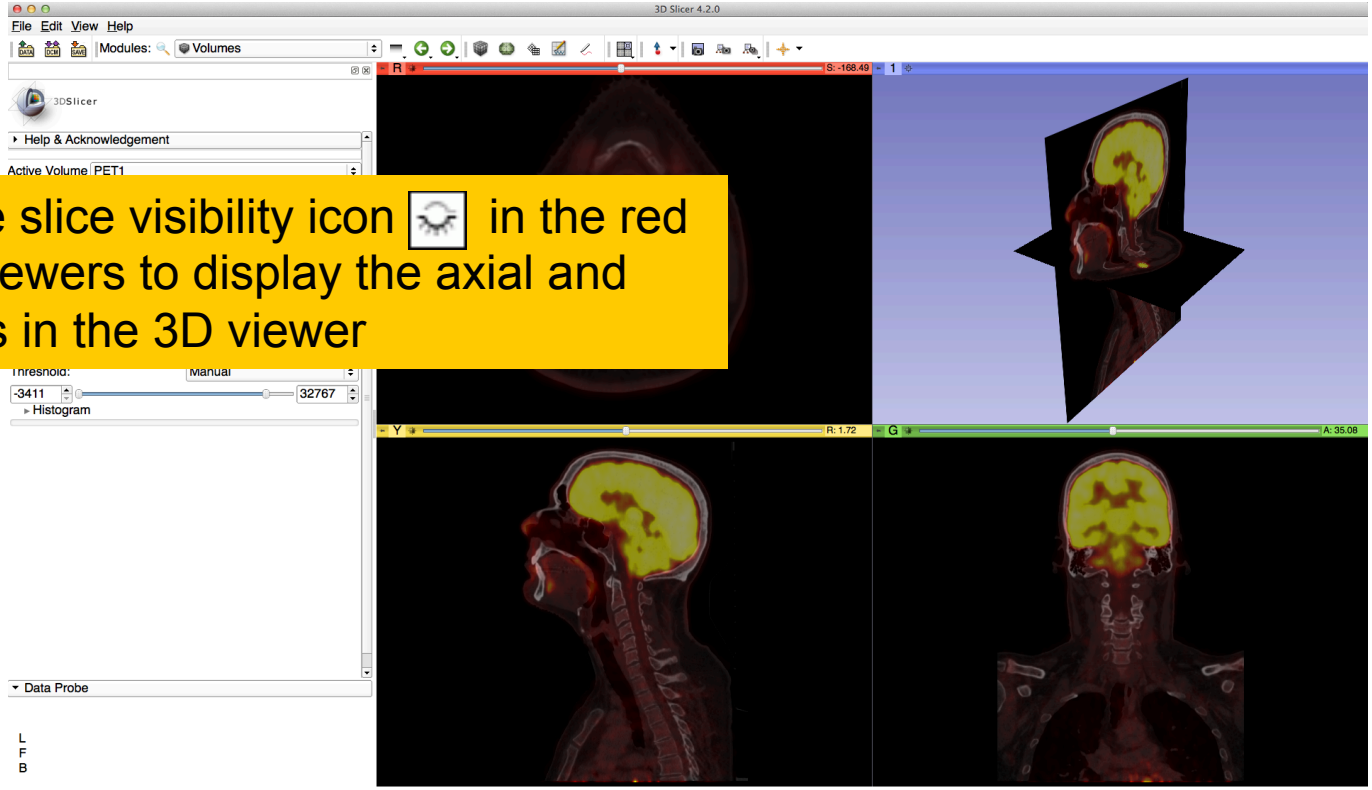


The outline of a lesion appears in the anatomical viewers

Visualization of PETCT data



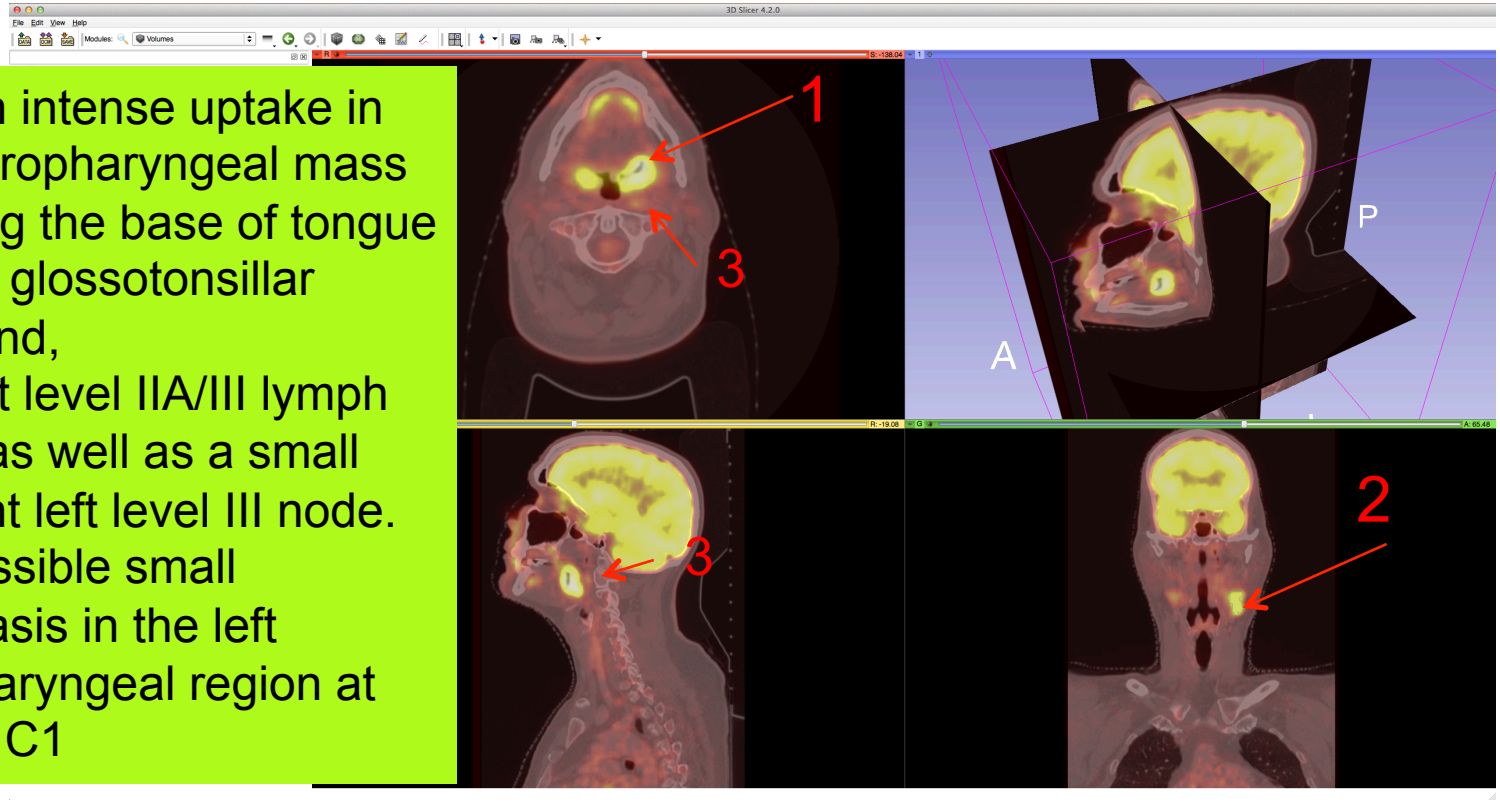
Visualization of PETCT data



Check on the slice visibility icon in the red and yellow viewers to display the axial and sagittal slices in the 3D viewer

PET uptake findings

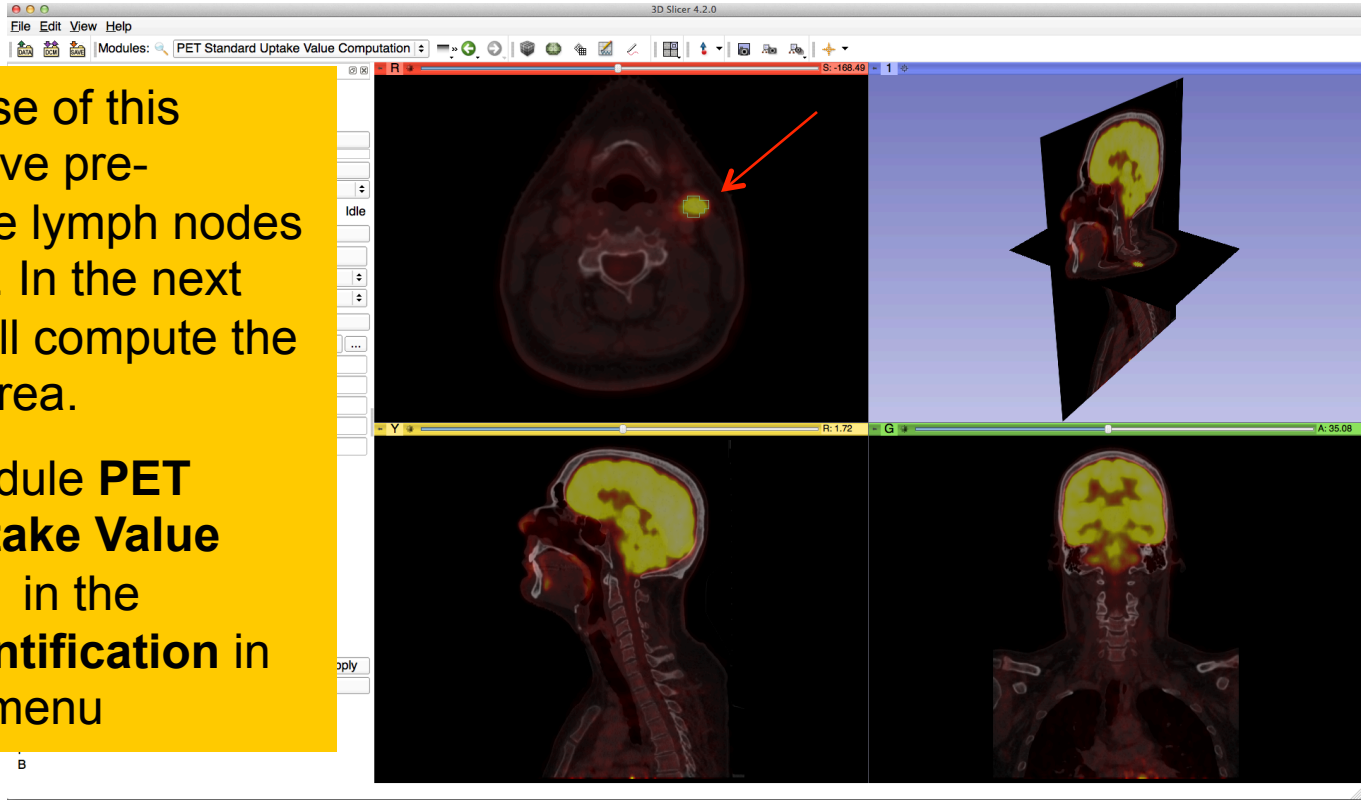
Note an intense uptake in
1) left oropharyngeal mass involving the base of tongue and left glossotonsillar fossa and,
2) in left level IIA/III lymph nodes as well as a small adjacent left level III node.
3) a possible small metastasis in the left retropharyngeal region at level of C1



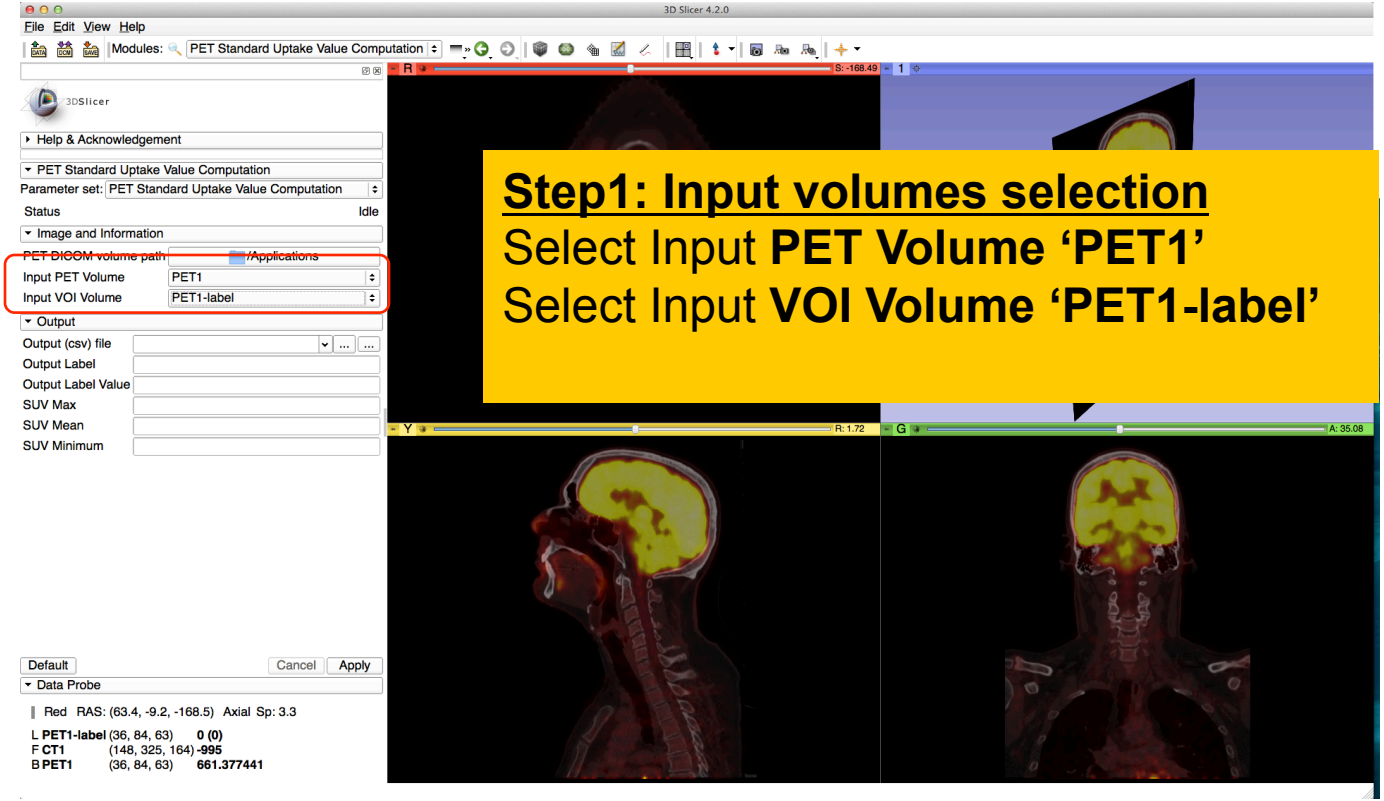
PET SUV Computation

For the purpose of this tutorial, we have pre-segmented the lymph nodes uptake region. In the next section, we will compute the SUV for this area.

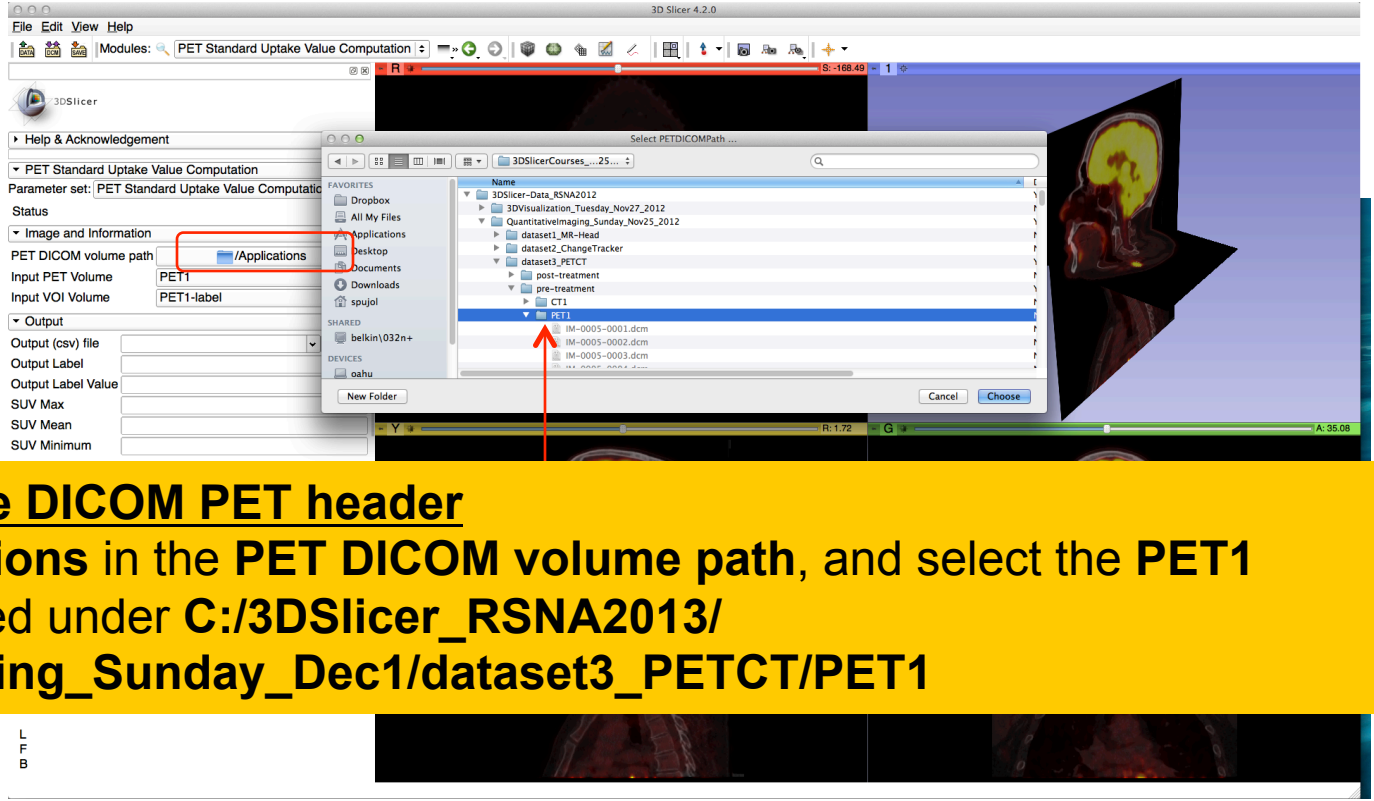
Select the module **PET Standard Uptake Value Computation** in the category **Quantification** in the modules' menu



PET SUV Computation



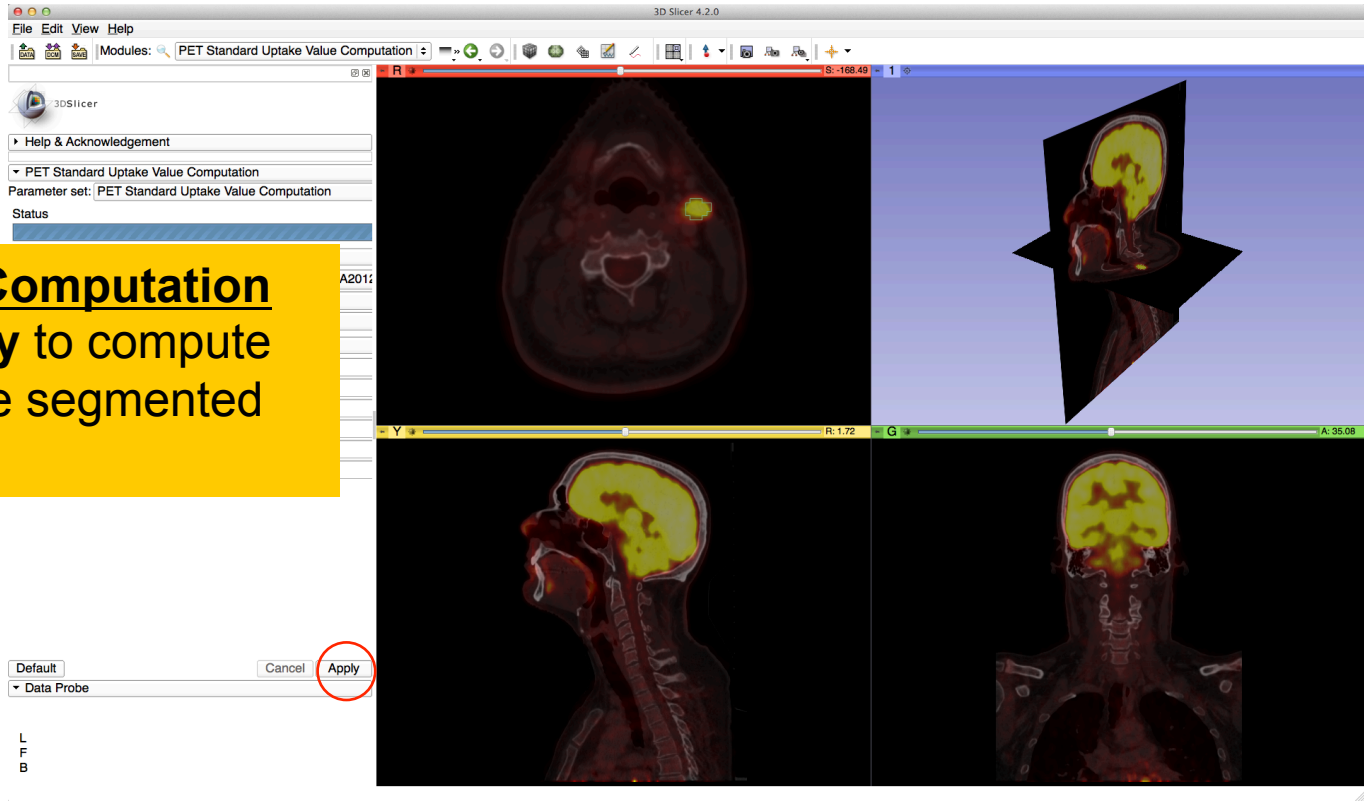
PET SUV Computation



Step2: Path to the DICOM PET header

Click on **/Applications** in the **PET DICOM volume path**, and select the **PET1** subdirectory located under **C:/3DSlicer_RSNA2013/QuantitativeImaging_Sunday_Dec1/dataset3_PETCT/PET1**

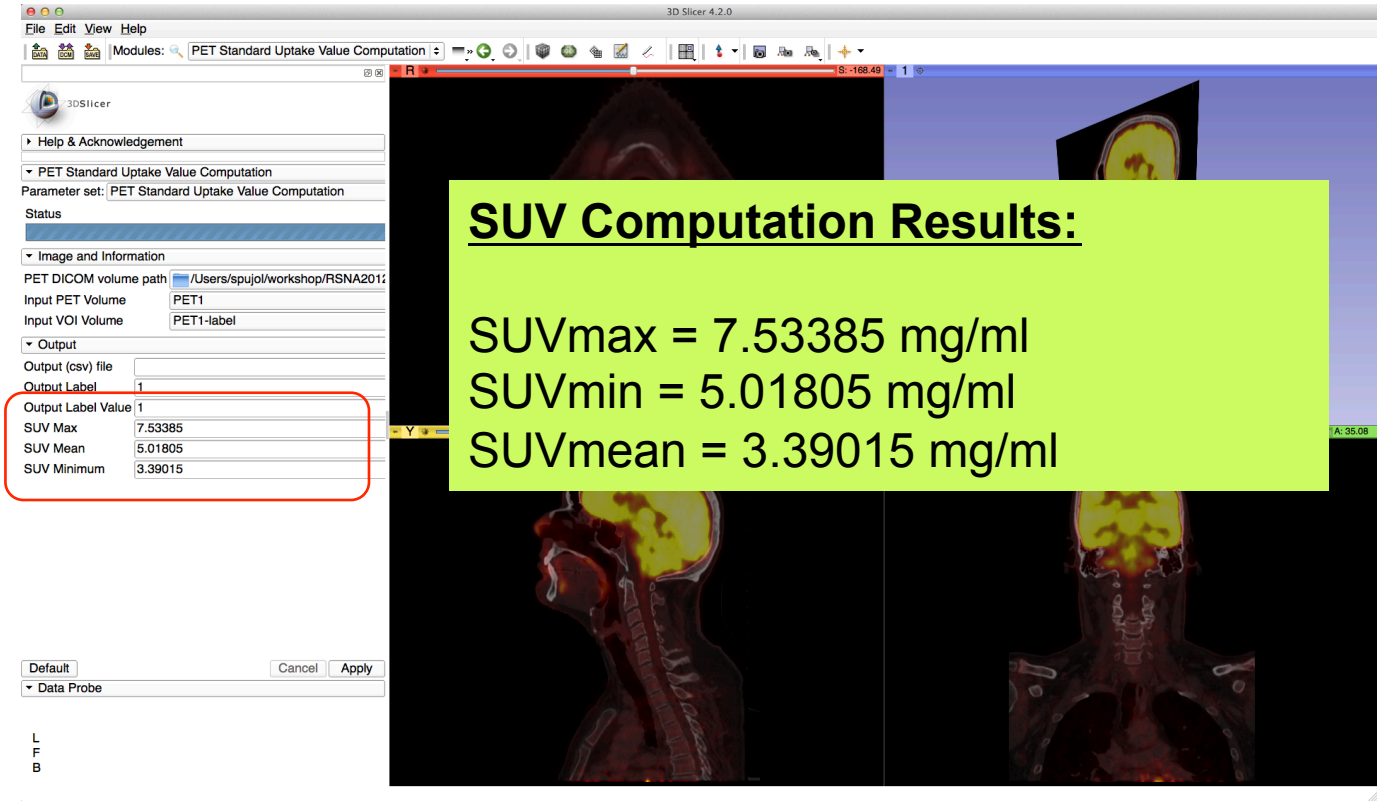
PET SUV Computation



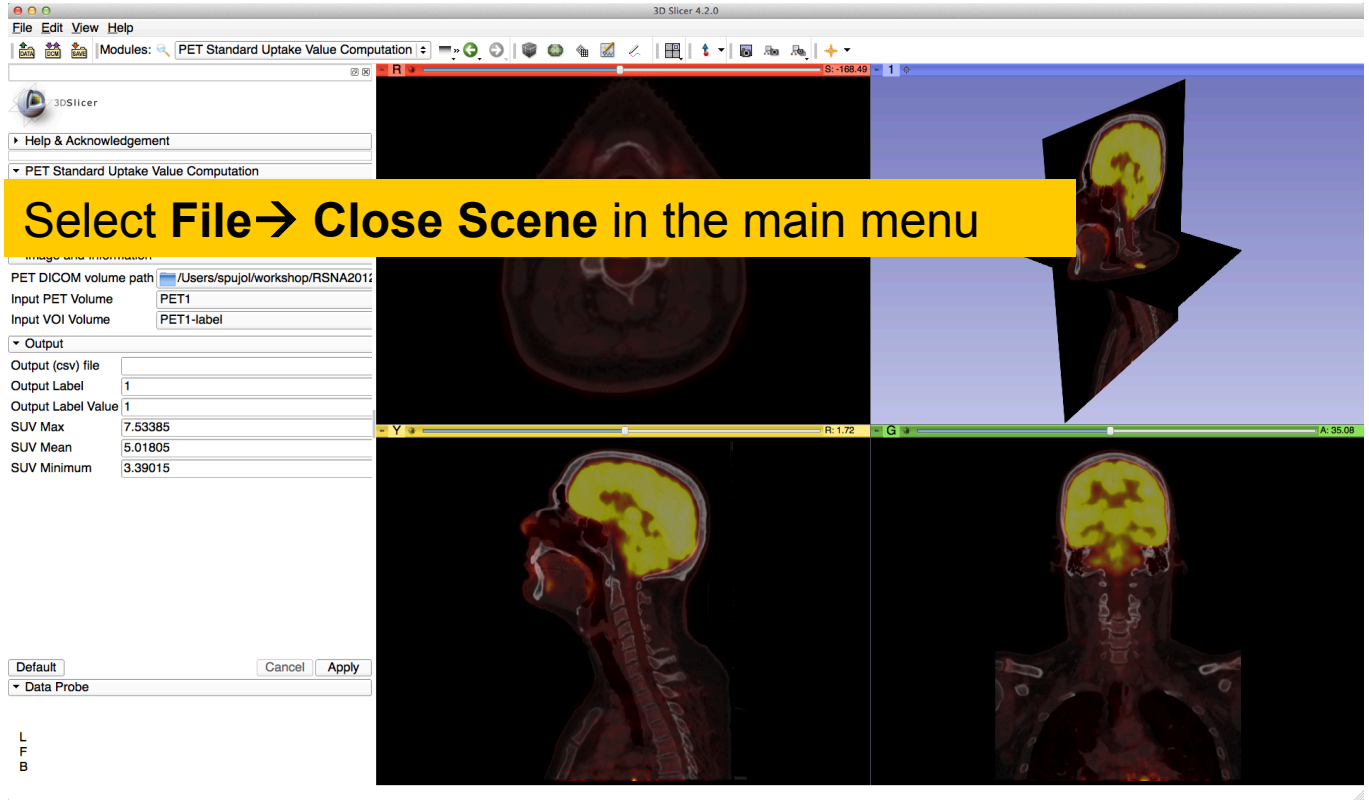
Step3: SUV Computation

Click on **Apply** to compute the SUV in the segmented region

PET SUV Computation



PET SUV Computation

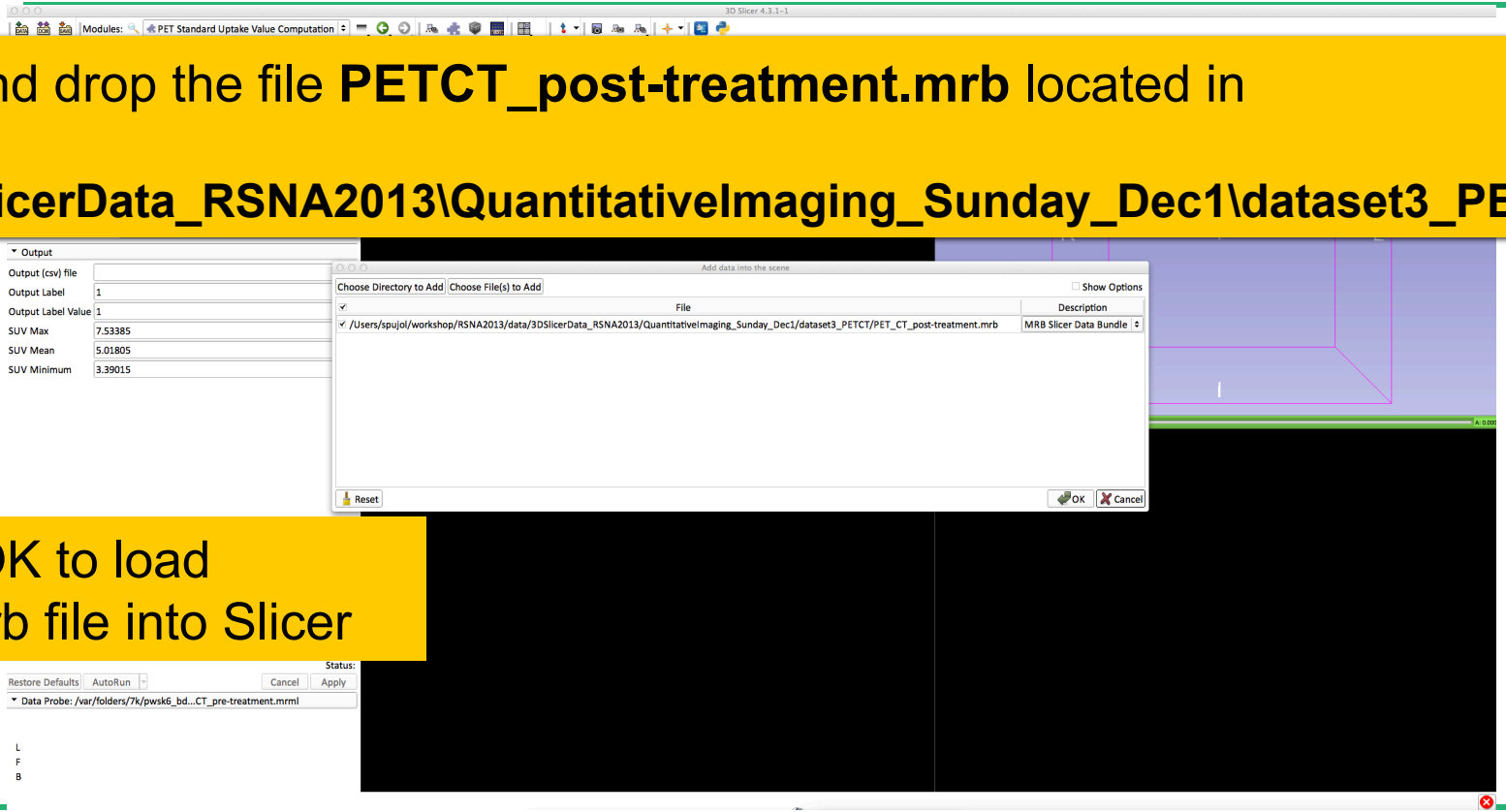


Select **File→ Close Scene** in the main menu

Loading the PETCT scene

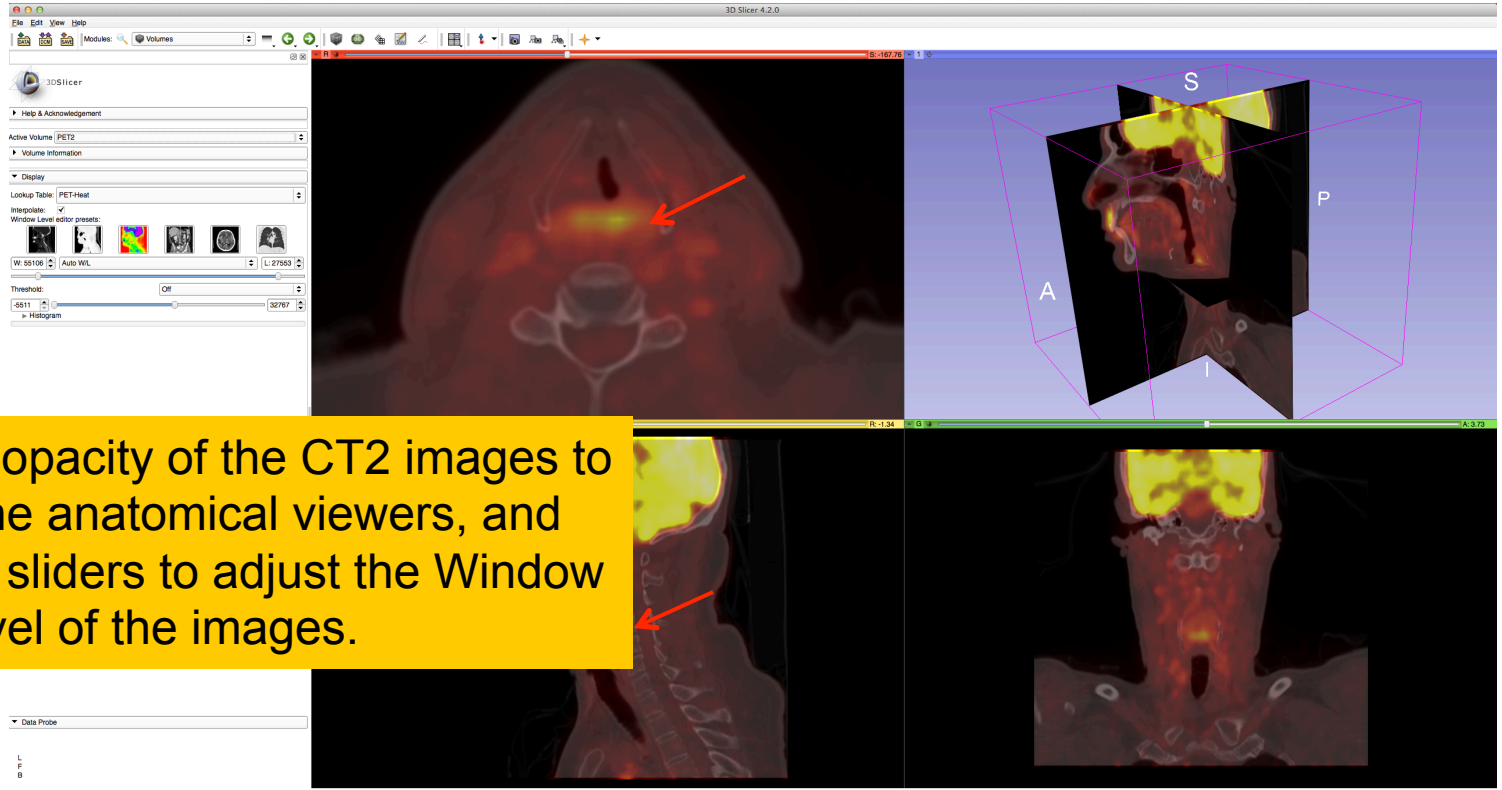
Drag and drop the file **PETCT_post-treatment.mrb** located in

C:\3DSlicerData_RSNA2013\QuantitativeImaging_Sunday_Dec1\dataset3_PETCT



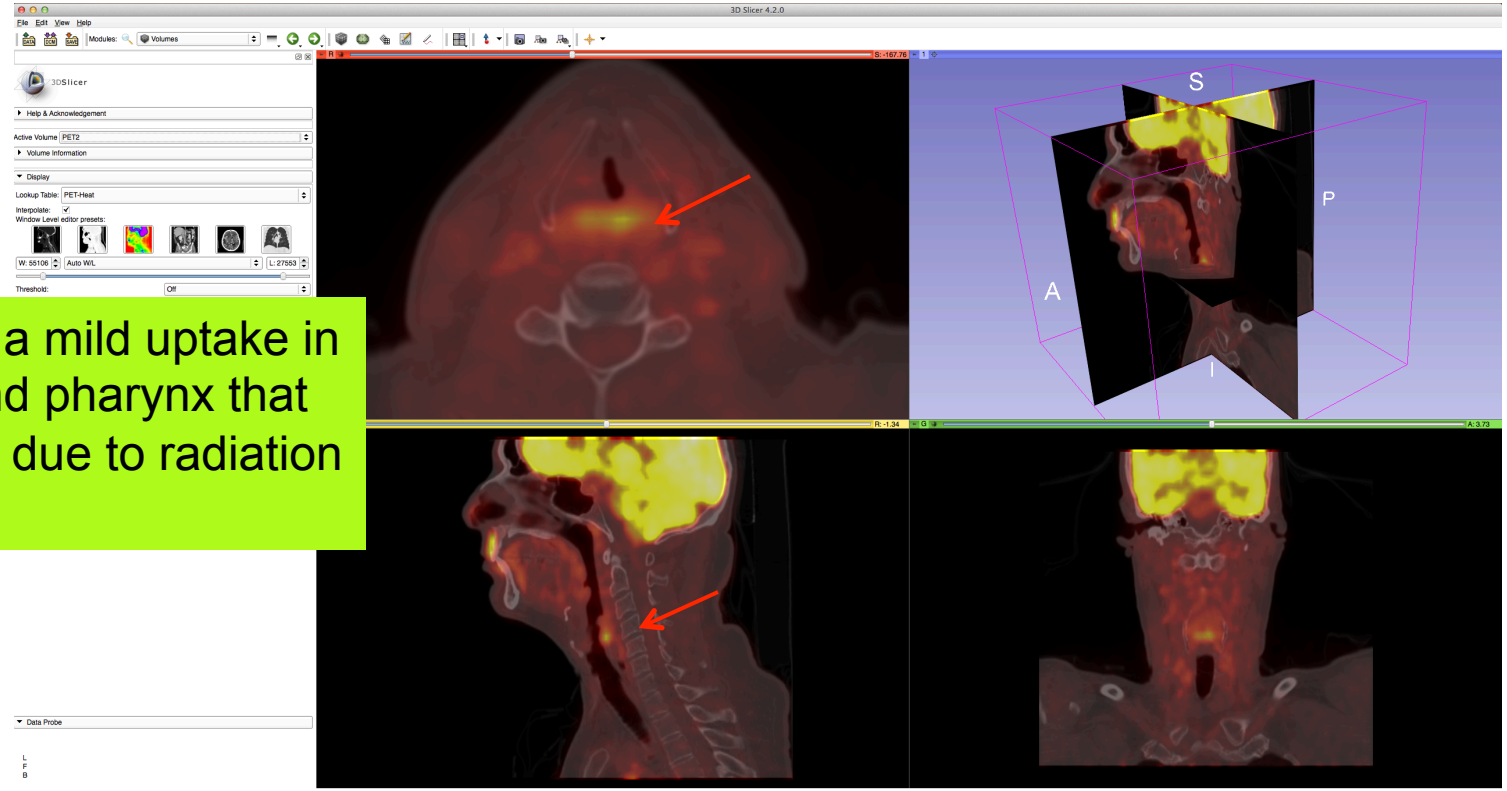
Click OK to load
the .mrb file into Slicer

PET uptake findings



Set the opacity of the CT2 images to 0.5 in the anatomical viewers, and use the sliders to adjust the Window and Level of the images.

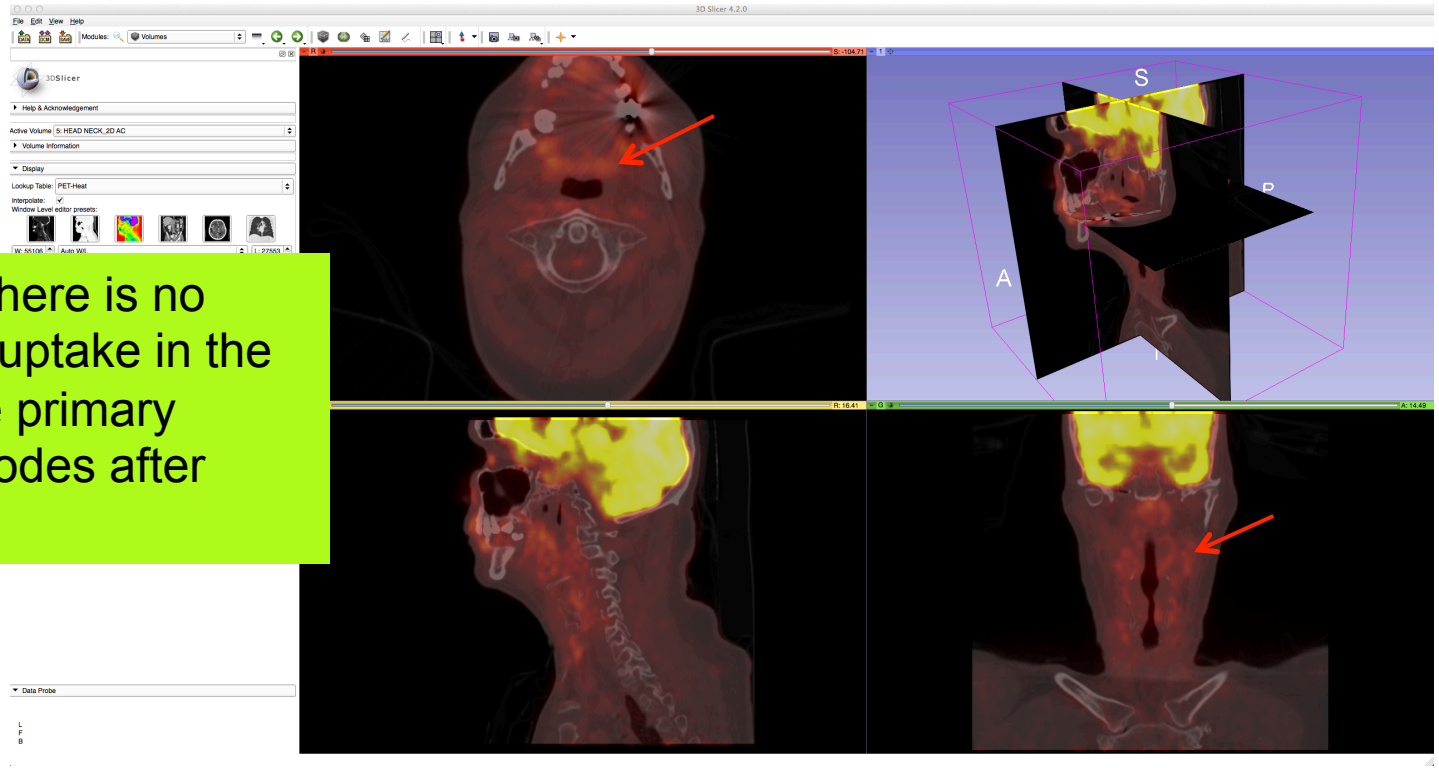
PET uptake findings



Observe a mild uptake in larynx and pharynx that are likely due to radiation effect.

PET uptake findings

Note that there is no remaining uptake in the area of the primary tumor or nodes after treatment



Conclusion

- This tutorial has demonstrated how to do 3D data visualization, quantitative measurement of small changes in tumor size, and PET CT SUV computation in Slicer
- 3DSlicer is for research use only, and is not FDA approved
- 3DSlicer is a free open-source software for medical image computing and supported by the NIH

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3DSlicer at RSNA 2013

Quantitative Imaging Reading Room Exhibit QIRR 1028

- Sun. Dec.1-Fri. Dec.6, 8:00-6:00
- 3DSlicer: An Open Source Platform for Segmentation, Registration, Quantitative Imaging, and 3D Visualization of Multi-Modal Image Data.
- Sonia Pujol, PhD, Steve Pieper, PhD, Andriy Fedorov, PhD, Ron Kikinis, MD,

Additional Related Hands-on courses

All courses are in this Advanced Imaging Classroom: S401CD (except Monday when it is in S401AB)

Sunday 4:00 pm – Structured Annotation and Image Markup (AIM) Template and Toolsets (ICIW12)

Monday 4:30 pm – Clinical Trials Software for Clinical Trials and Research (ICIW24)

Wed 10:30 am – Open Access Imaging Data Resources: NIH Cancer Imaging Archive (ICIA41)

Wed 12:30 pm – Correlating Imaging with Human Genomics (ICIA42)

3DSlicer at RSNA

Sunday, December 1	Monday, December 2	Tuesday, December 3	Wednesday, December 4	Thursday, December 5	Friday, December 6
8:00am-11:00am: 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-11:00am:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-11:00am:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-12:15pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-12:15pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-12:45pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.
11:00am-12:30pm: RSNA Refresher Course: **"Quantitative Medical Imaging for Clinical Research and Practice: Hands-on Workshop."** **Sonia Pujol, Katarzyna Macura, Ron Kikinis** Room S401CD.	**12:30pm-1:30pm:** Meet-The-Experts Session, 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**12:30pm-2:00pm:** RSNA Refresher Course: **"3D Interactive Visualization of DICOM Images for Radiology Applications: Hands-on Workshop."** **Sonia Pujol, Kitt Shaffer, Ron Kikinis** Room S401CD.	**1:30pm-6:00pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center, Hall E, Exhibit LL-QRR3007.	**12:30pm-1:30pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	
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