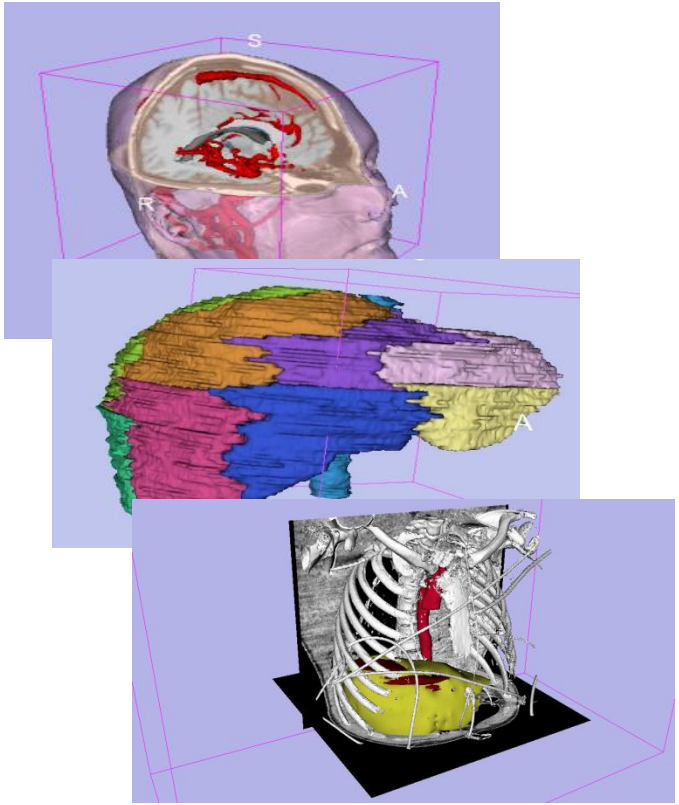


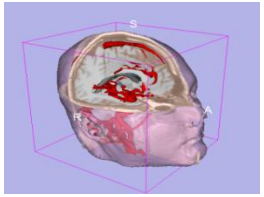
3D Interactive Visualization of DICOM Images for Radiology Applications

Sonia Pujol PhD, Brigham and Women's Hospital, Harvard University

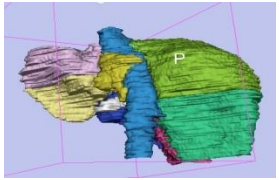
Kitt Shaffer MD, PhD, Boston Medical Center, Boston University

RSNA 2010, November 29, 2010

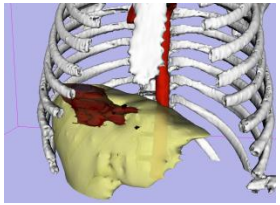
Overview



Part1: Introduction to data loading and 3D visualization of brain images



Part 2: 3D interactive exploration of the segments of the liver



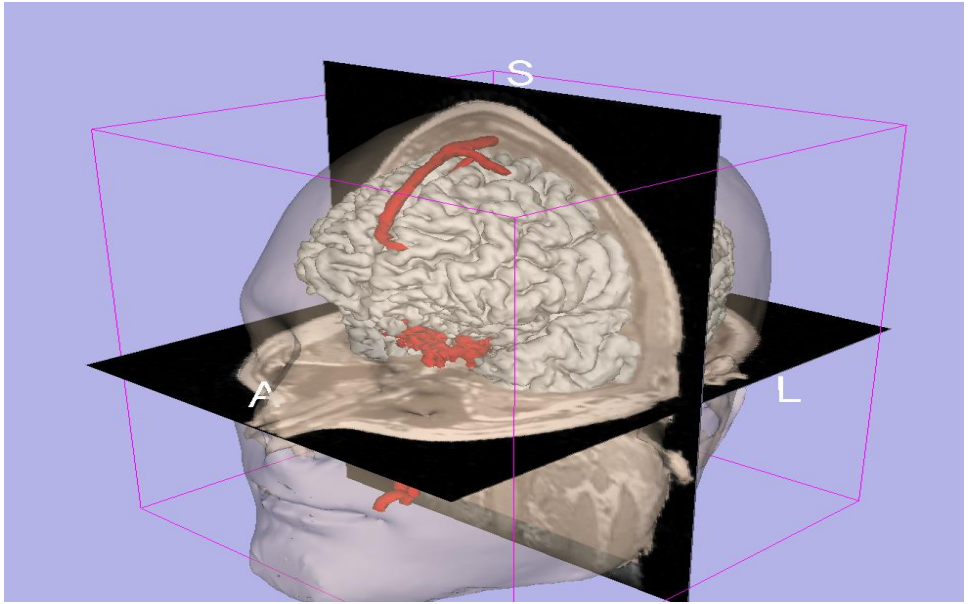
Part 3: Gunshot wound of the liver: a clinical case

Leonardo da Vinci (1452-1519), Virgin and Child
Alte Pinakothek, München

An introduction to 3D Visualization

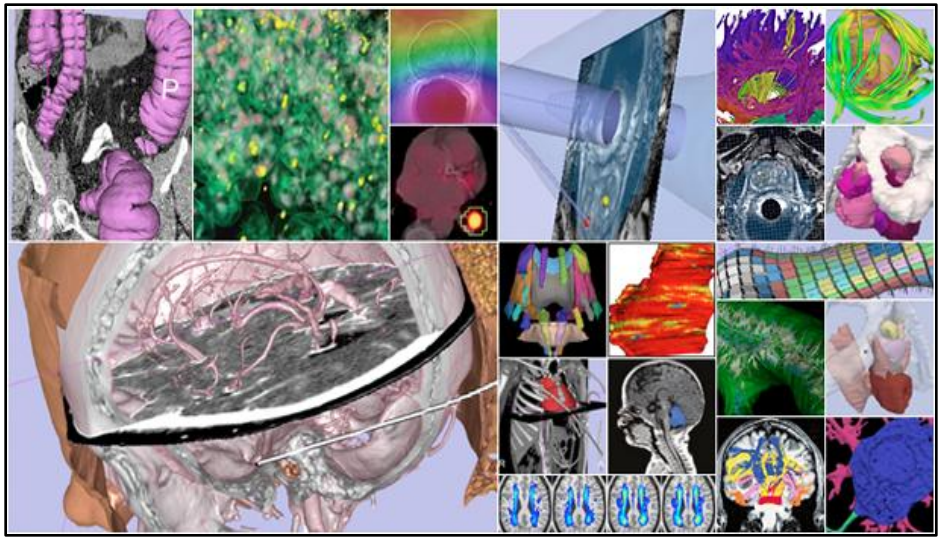
Learning objective

Following this tutorial, you'll be able to load and visualize volumes within Slicer3, and to interact in 3D with structural images and models of the brain.



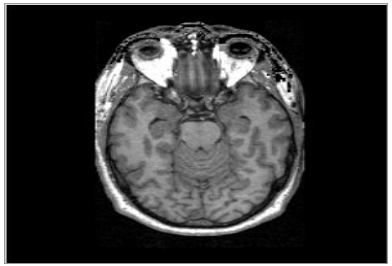
Slicer3

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

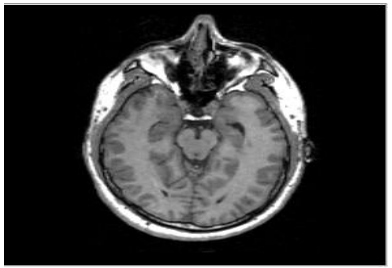


Data

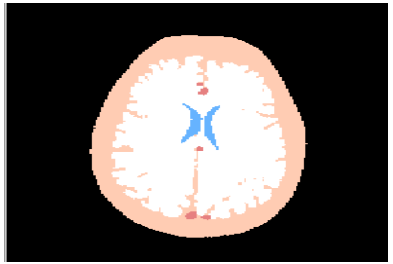
This course is built upon three datasets of a single healthy subject brain:



MR DICOM
GRASS



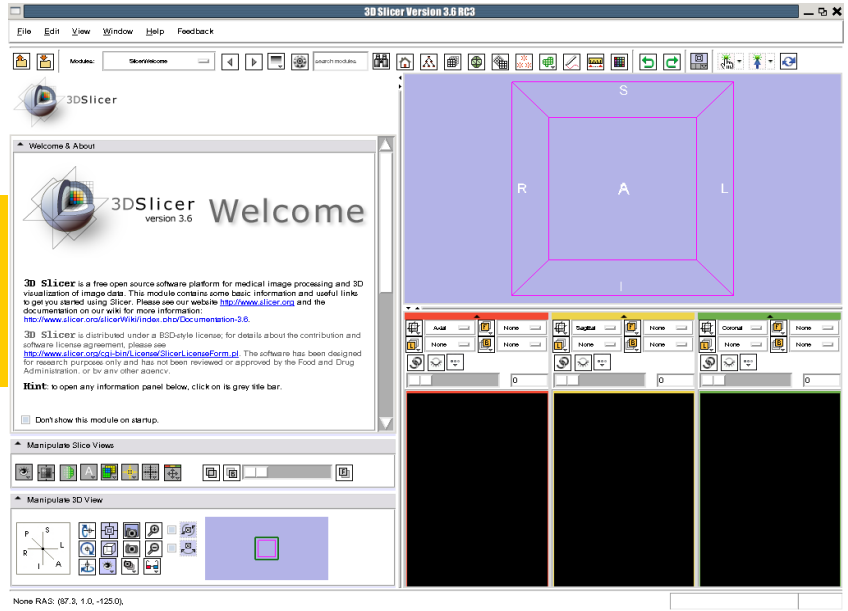
MR Nrrd
SPGR



Pre-computed
Label Map

Launch Slicer3

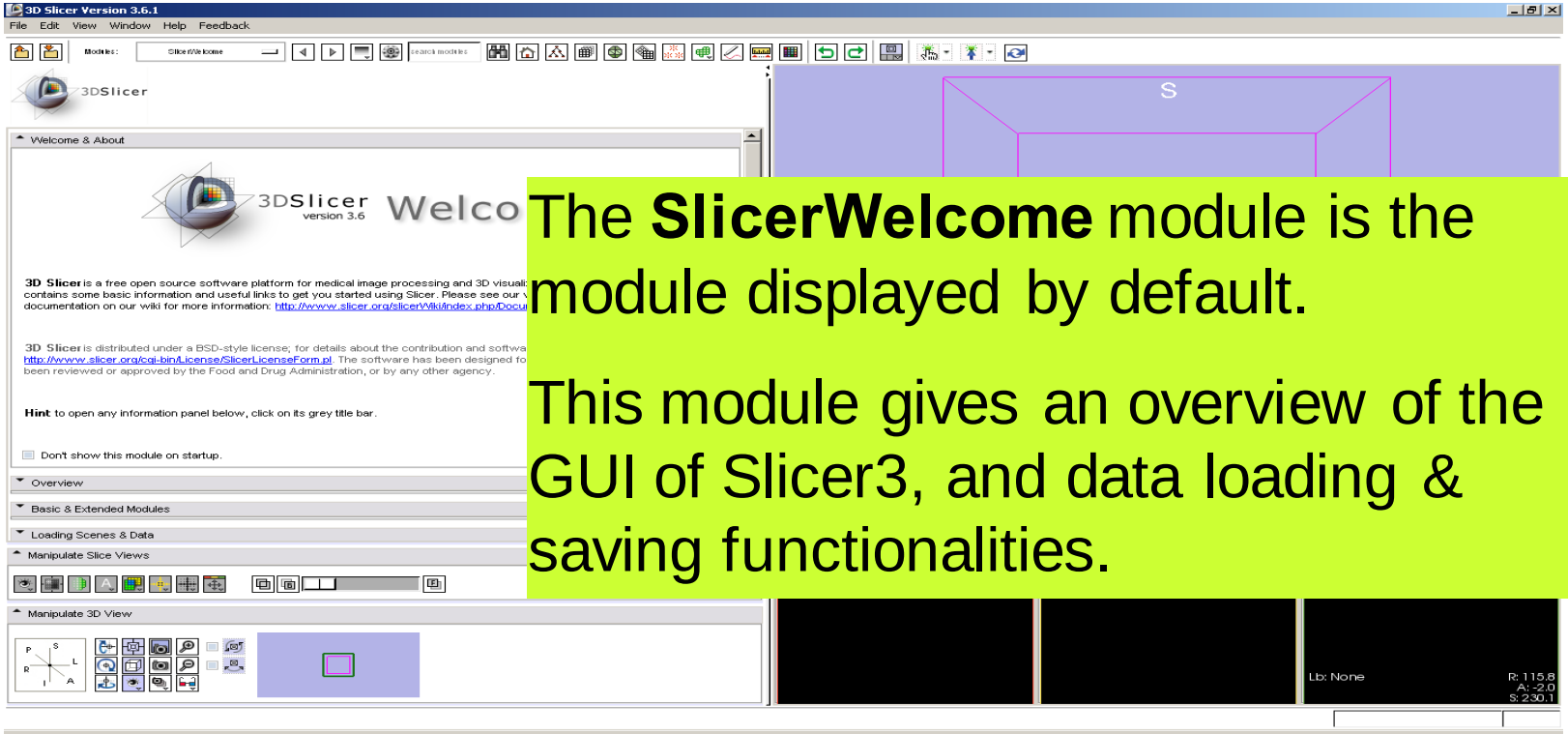
Select **Start → Programs → Slicer3 3.6.2010-10-22 →Slicer**



Disclaimer

It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules.

Slicer Welcome



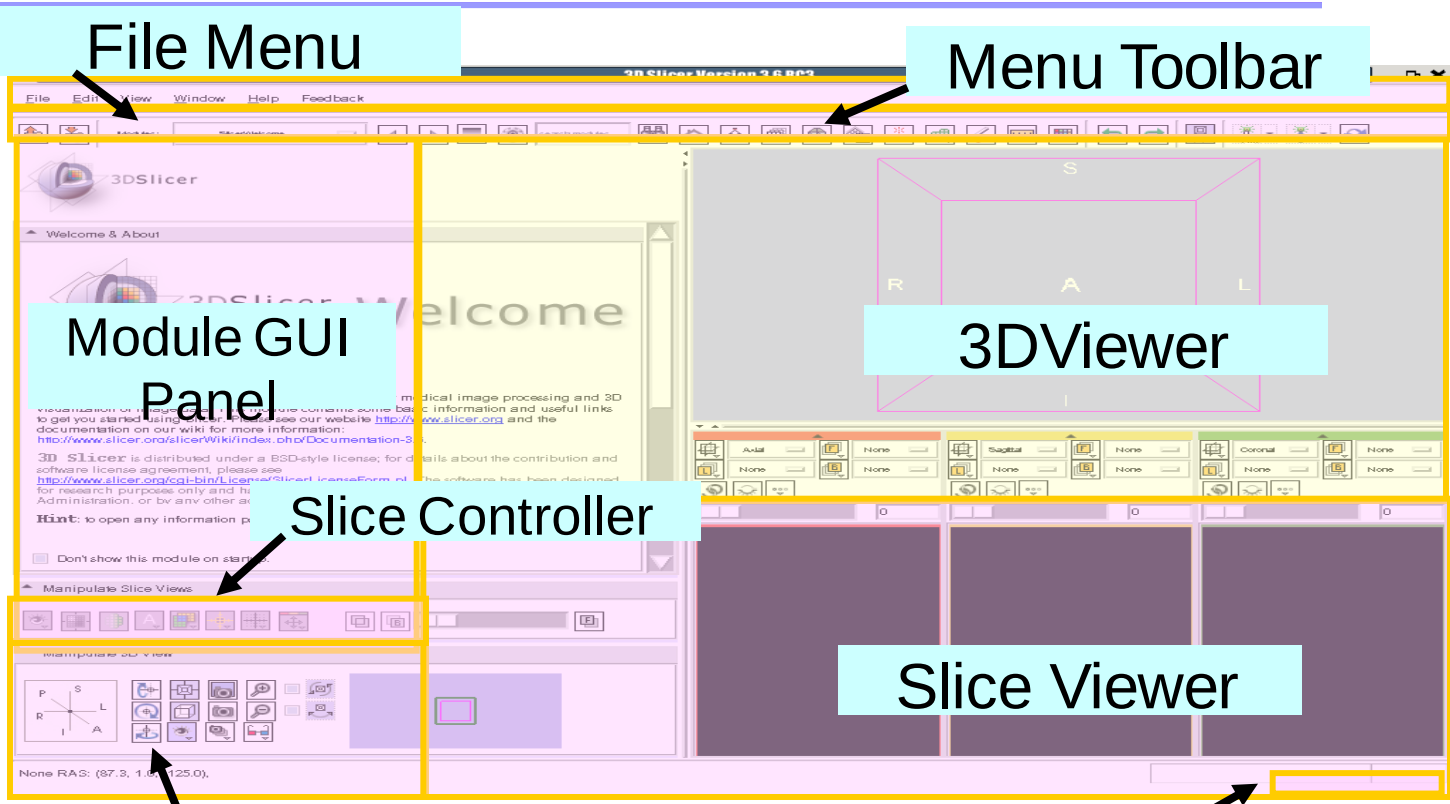
The **SlicerWelcome** module is the module displayed by default.

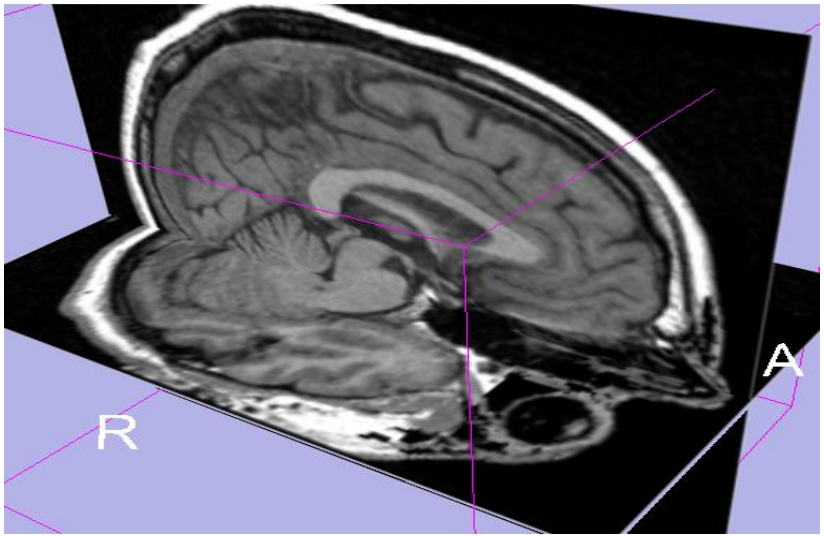
This module gives an overview of the GUI of Slicer3, and data loading & saving functionalities.

Slicer3 GUI

The Graphical User Interface (GUI) of Slicer3.6 integrates 8 main components:

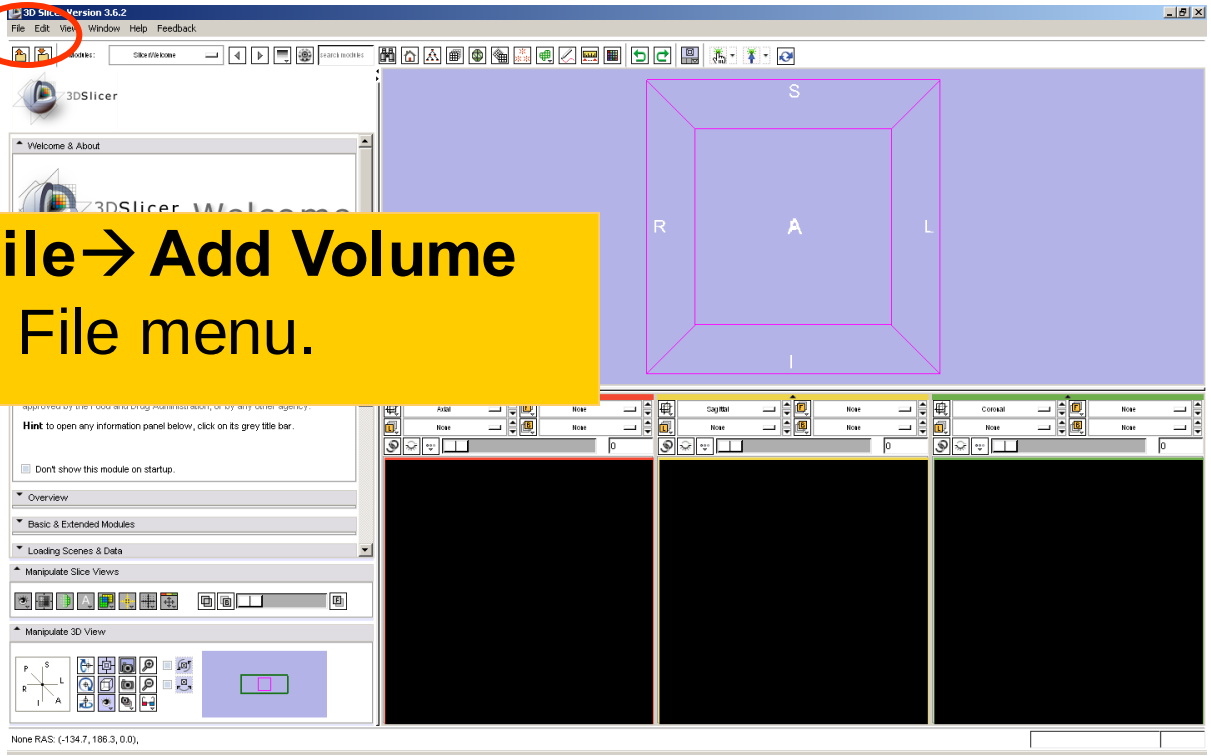
- the File Menu
- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer
- the Slice Controller
- the 3D View Controller





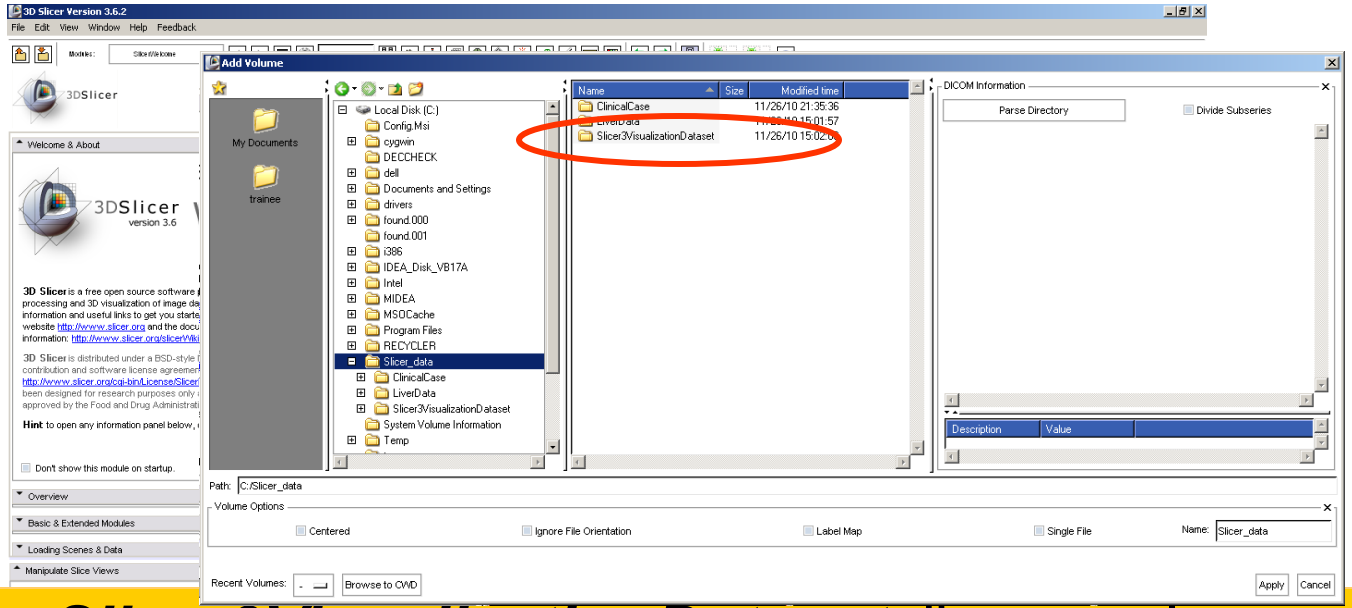
Part 1: Loading and visualizing multiple volumes simultaneously

Loading Volumes



Select **File→ Add Volume** from the File menu.

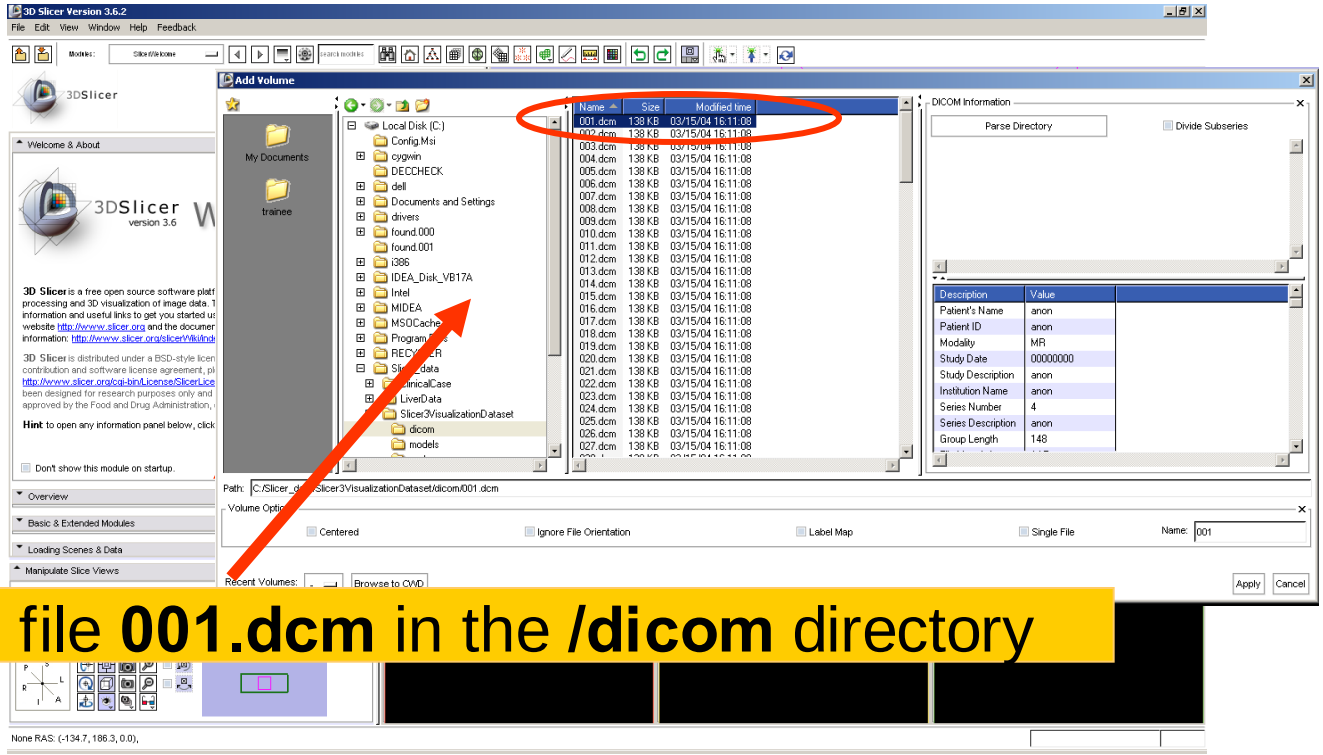
Loading Volumes



Browse to ***Slicer3VisualizationDataset*** directory located in

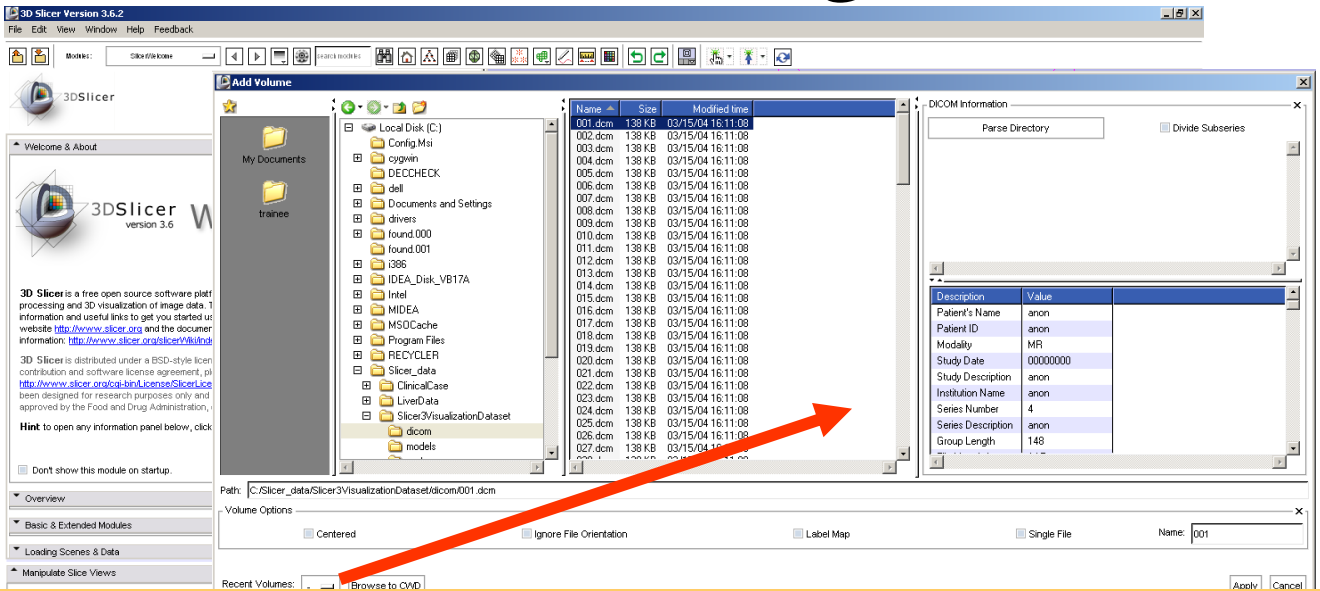
C:/SlicerData_RSNA2010/Slicer3VisualizationDataset

Loading Volumes



Select the file **001.dcm** in the **/dicom** directory

Loading Volumes



Slicer displays the **Dicom header information** of the images. Browse through the Dicom information panel to display the dimension of the images.

Loading Volumes

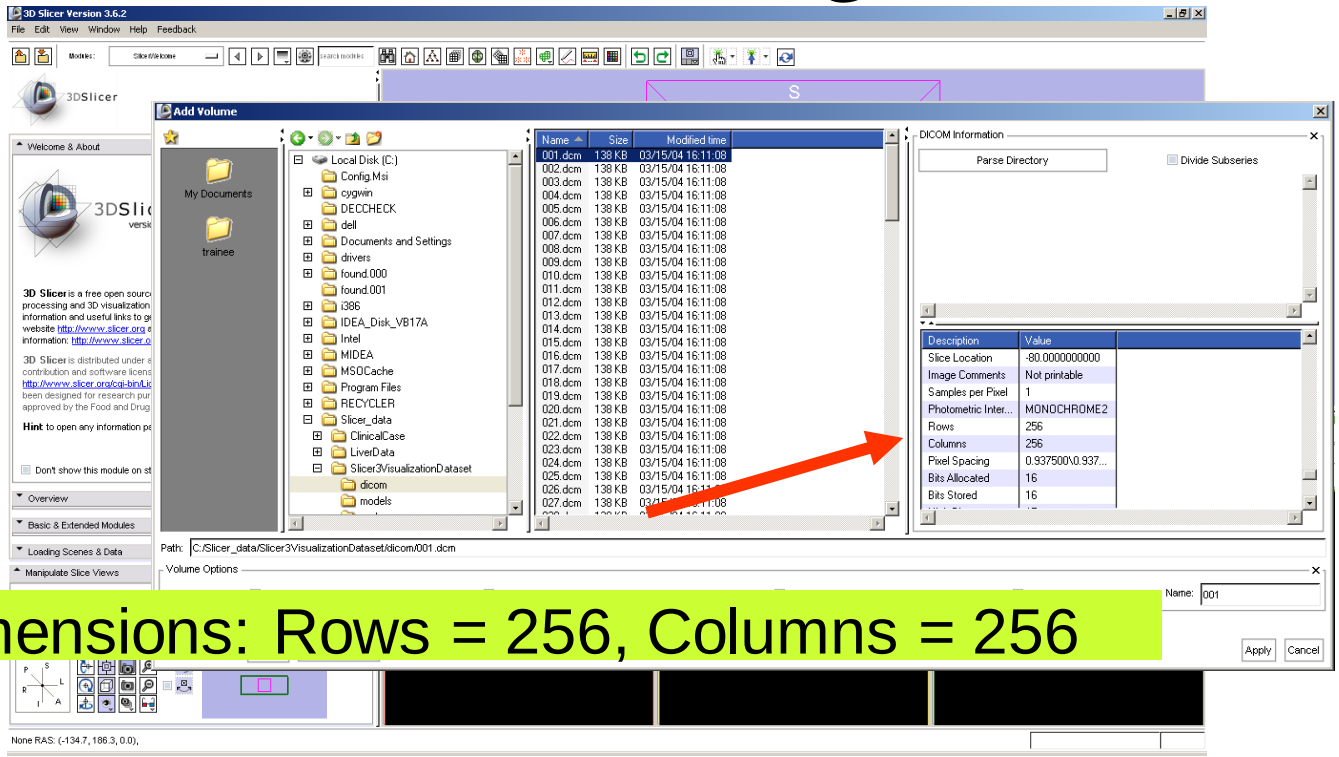
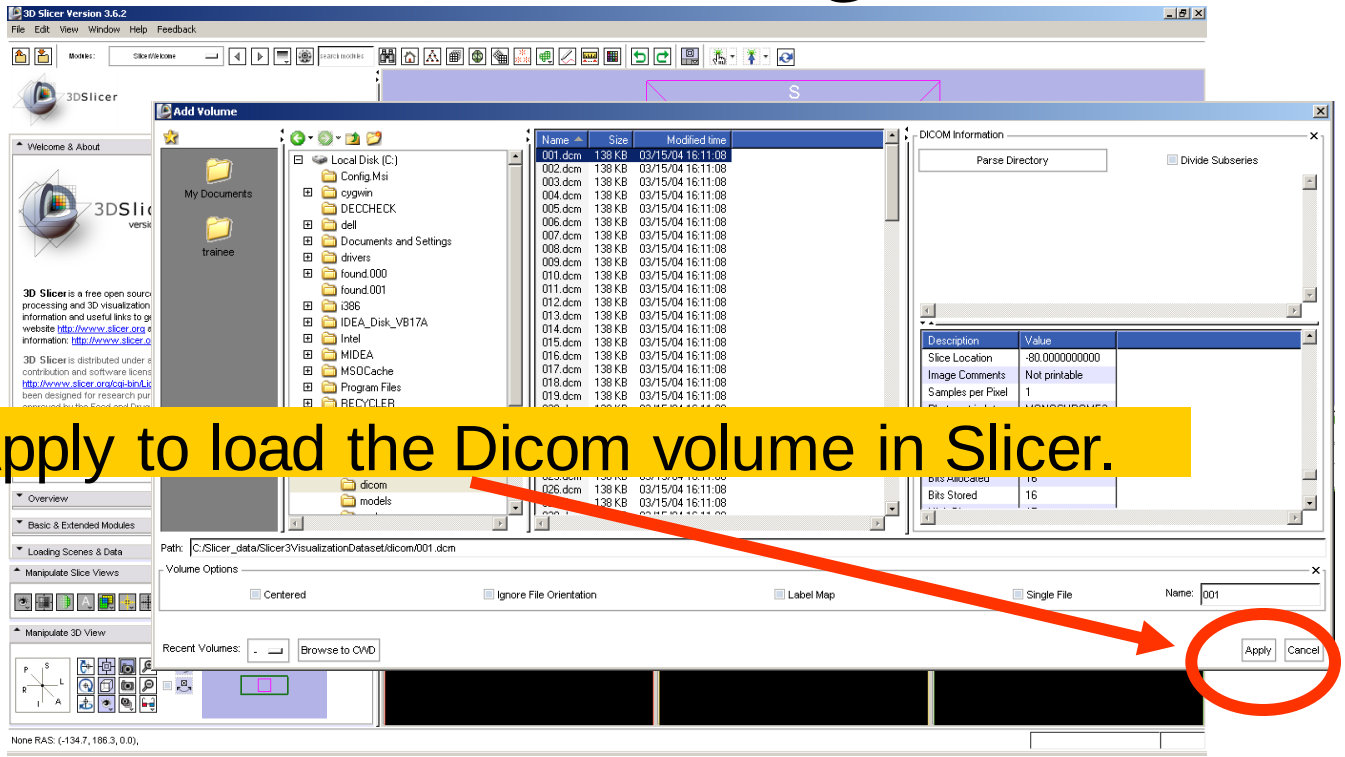


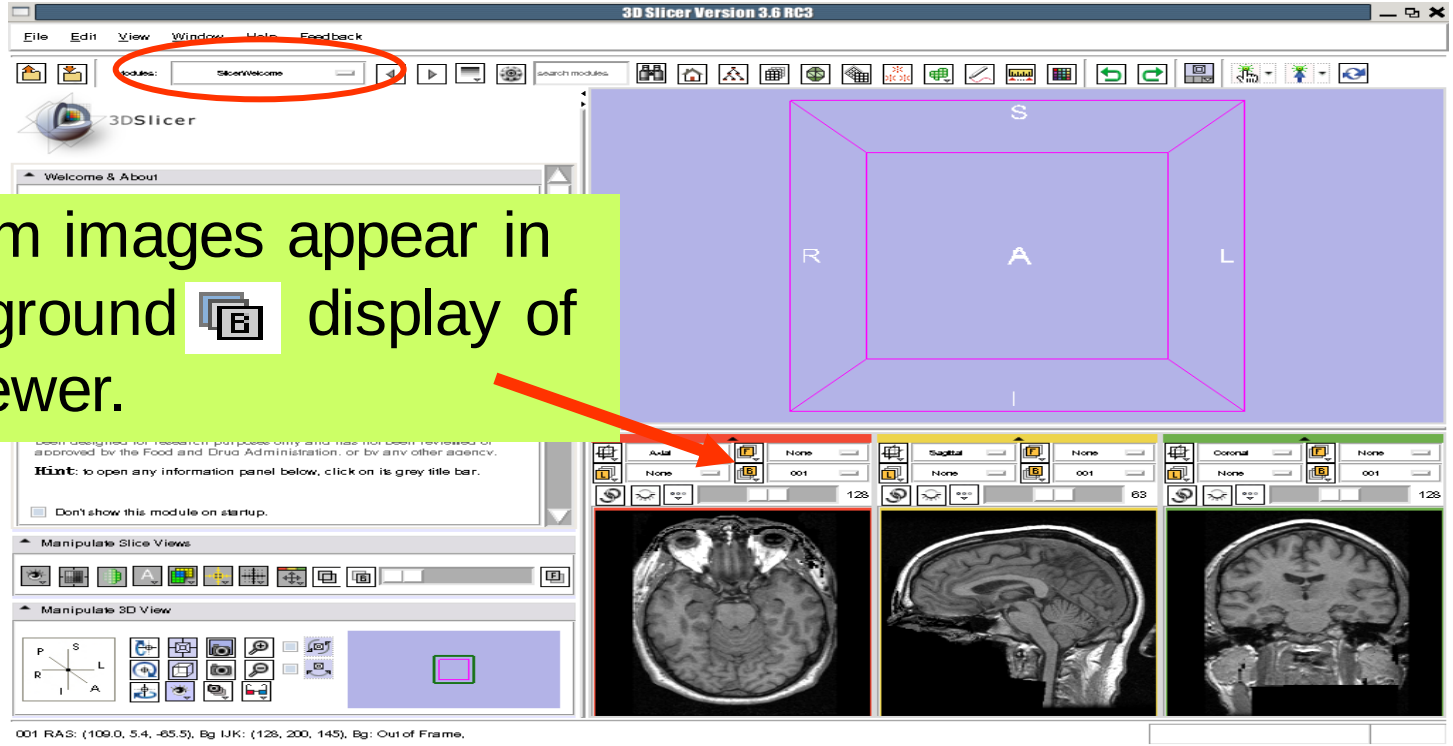
Image dimensions: Rows = 256, Columns = 256

Loading Volumes

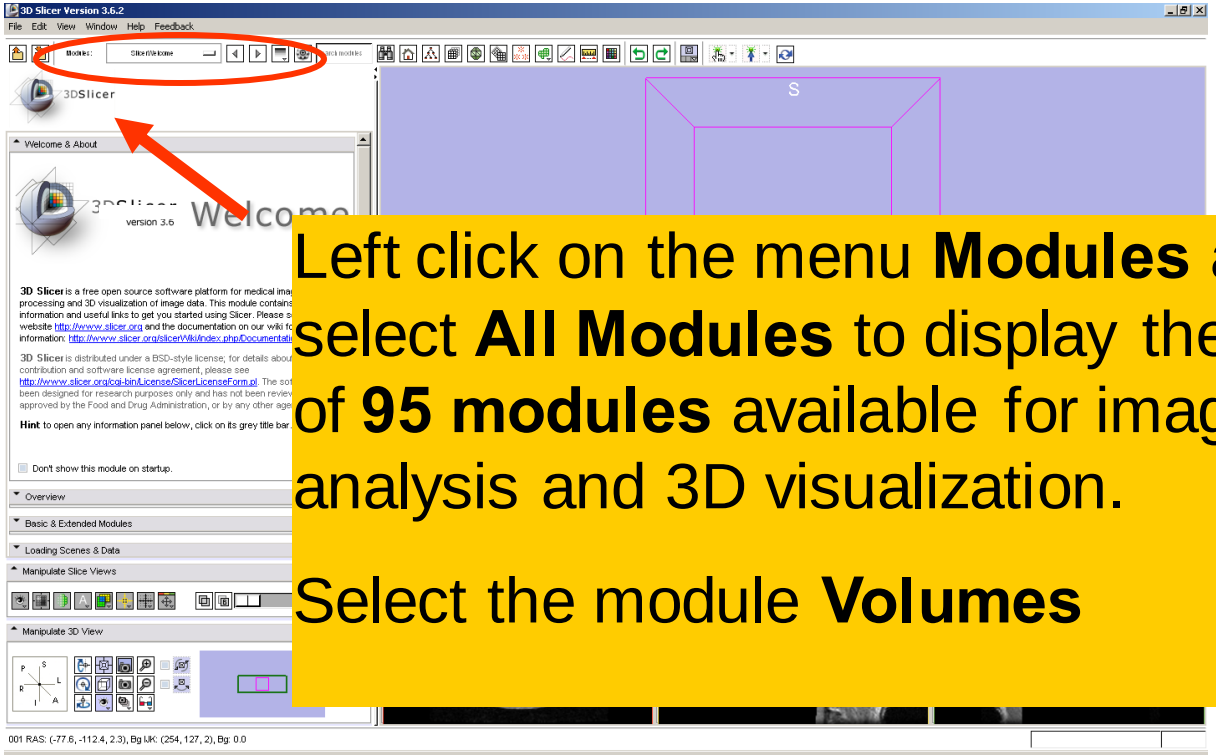


Loading Volumes

The Dicom images appear in the Background display of the 2DViewer.



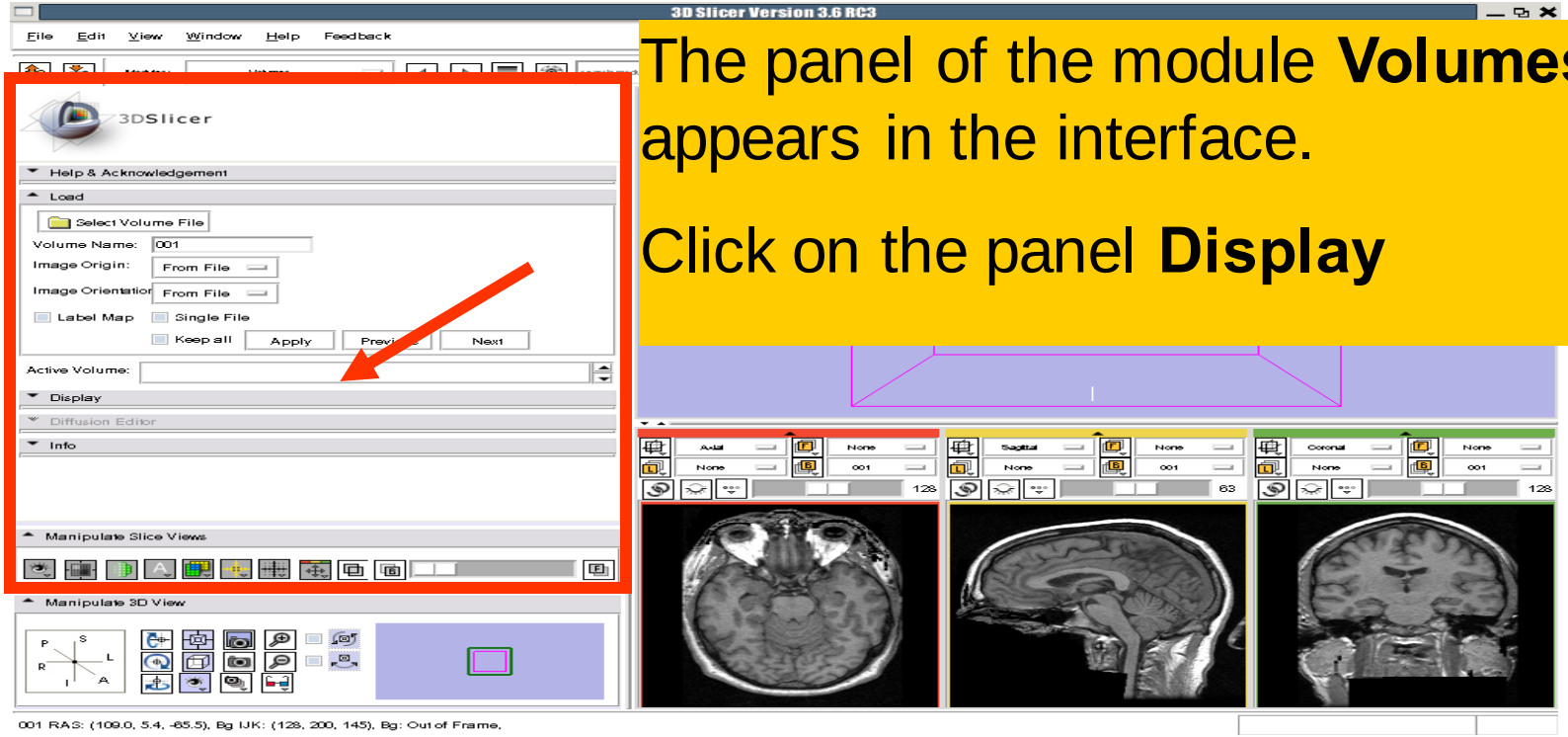
Loading Volumes



Left click on the menu **Modules** and select **All Modules** to display the list of **95 modules** available for image analysis and 3D visualization.

Select the module **Volumes**

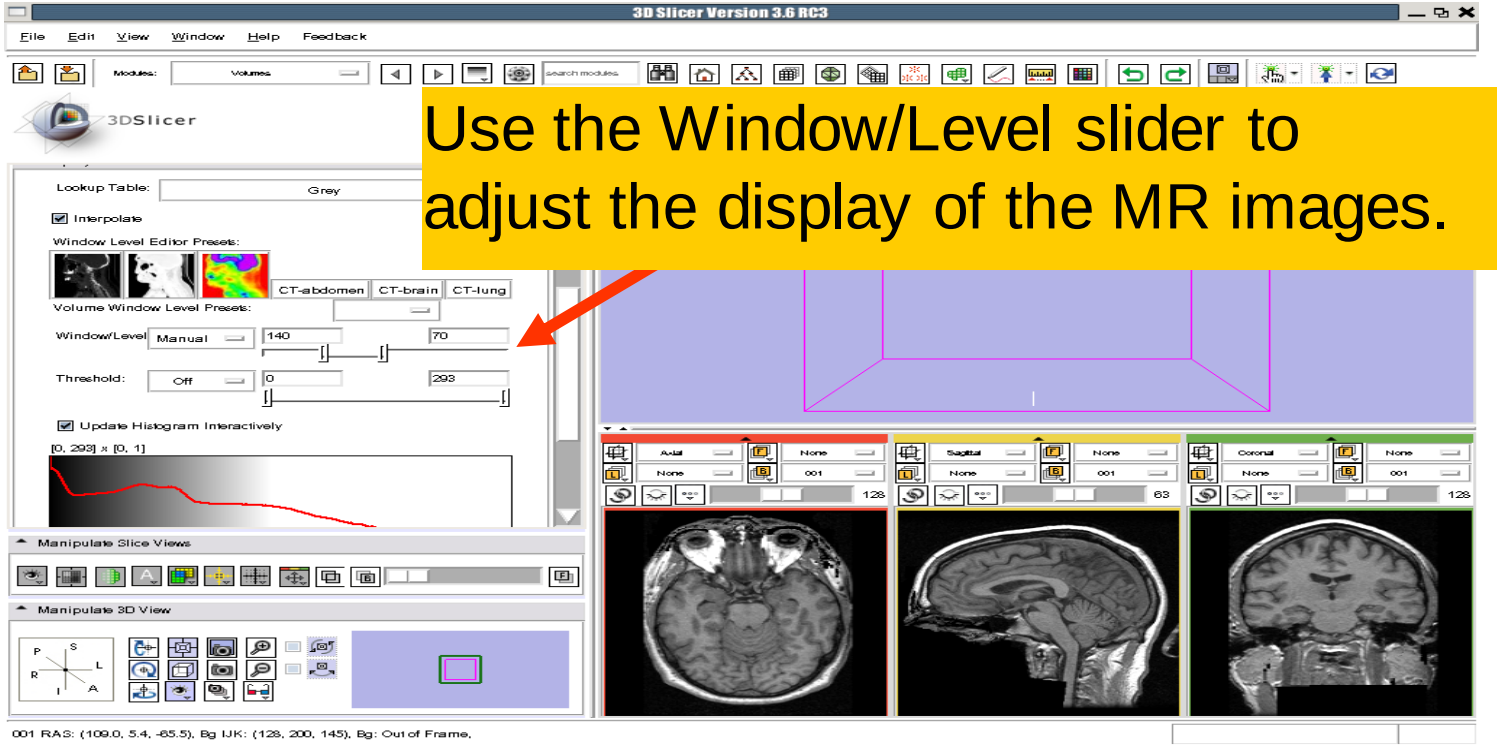
Loading Volumes



The panel of the module **Volumes** appears in the interface.

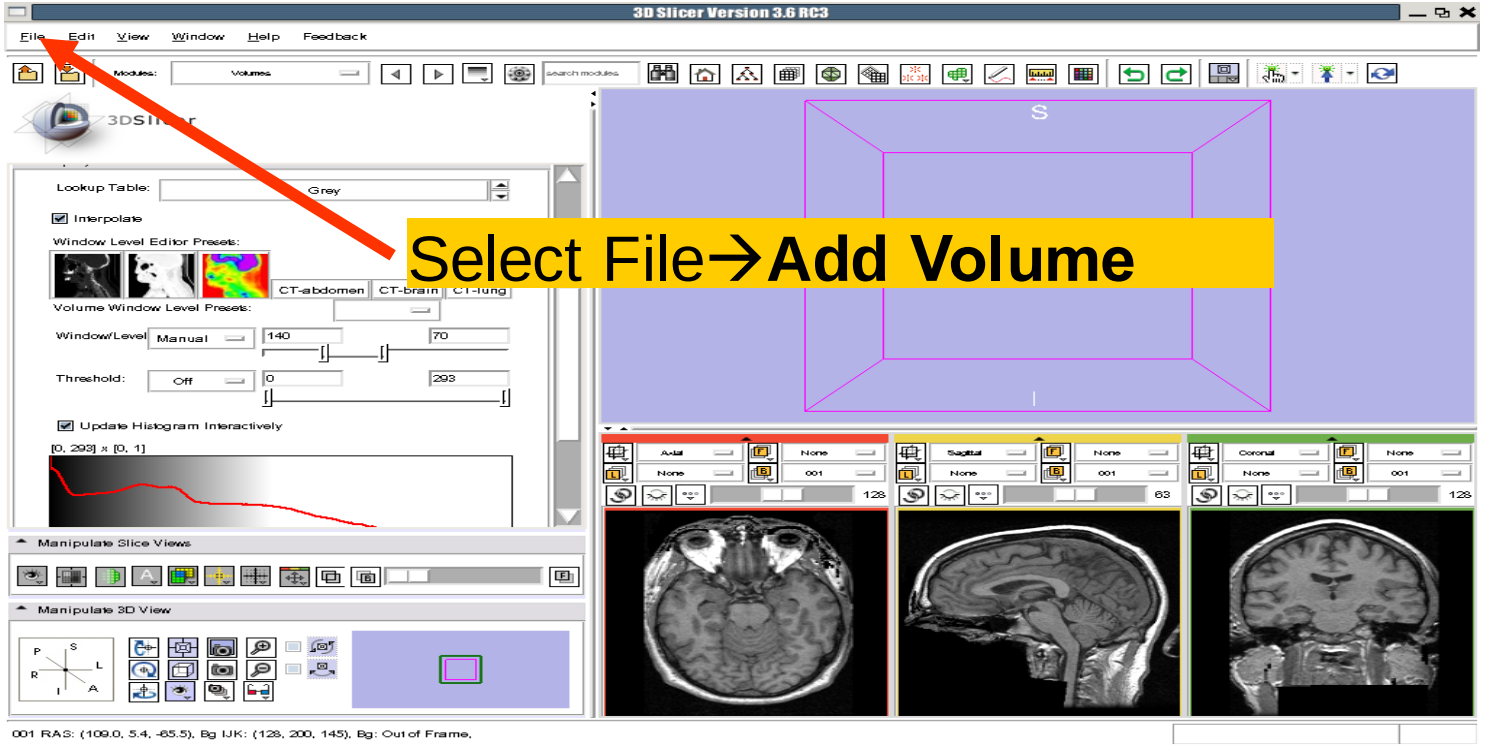
Click on the panel **Display**

Loading Volumes

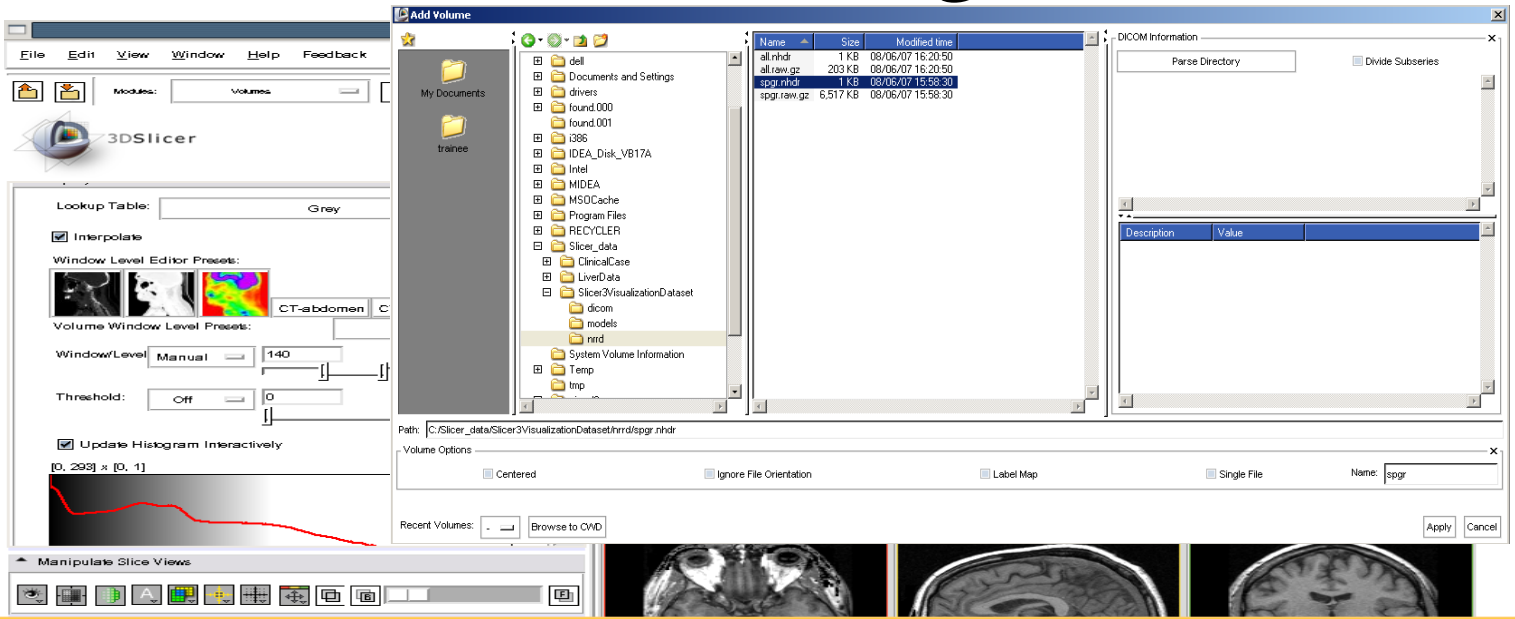


Use the Window/Level slider to adjust the display of the MR images.

Loading Volumes

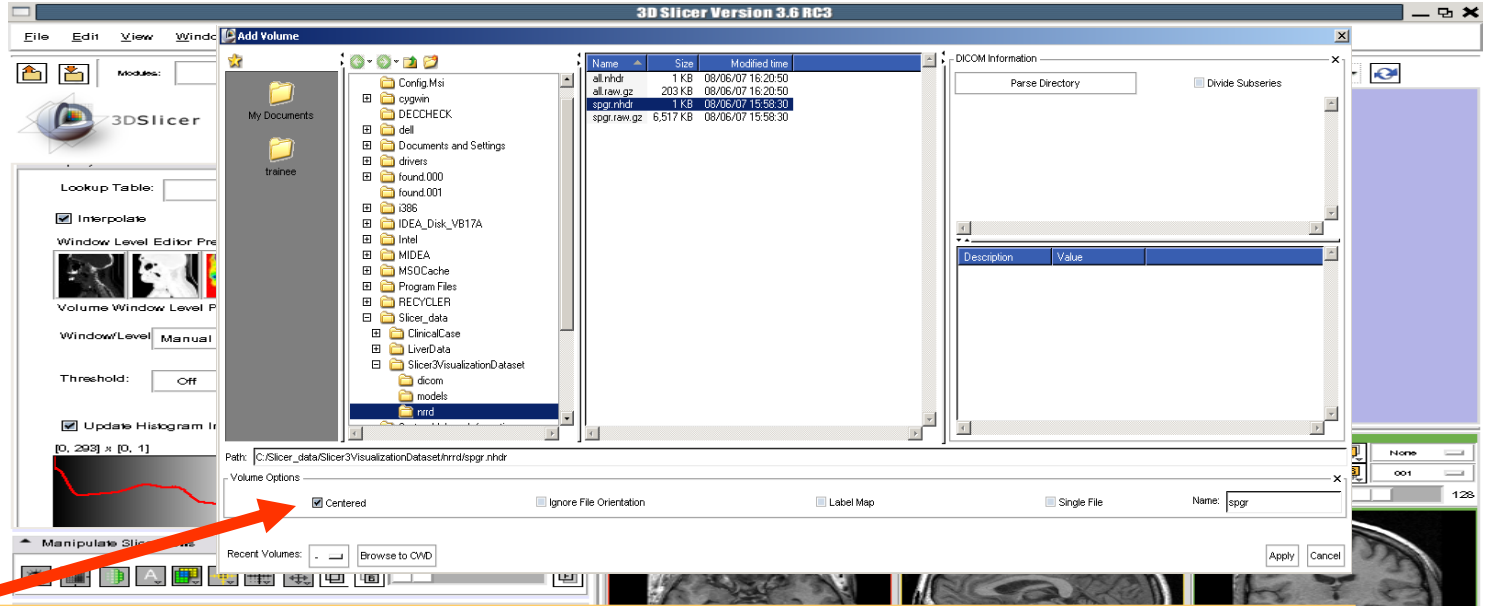


Loading Volumes



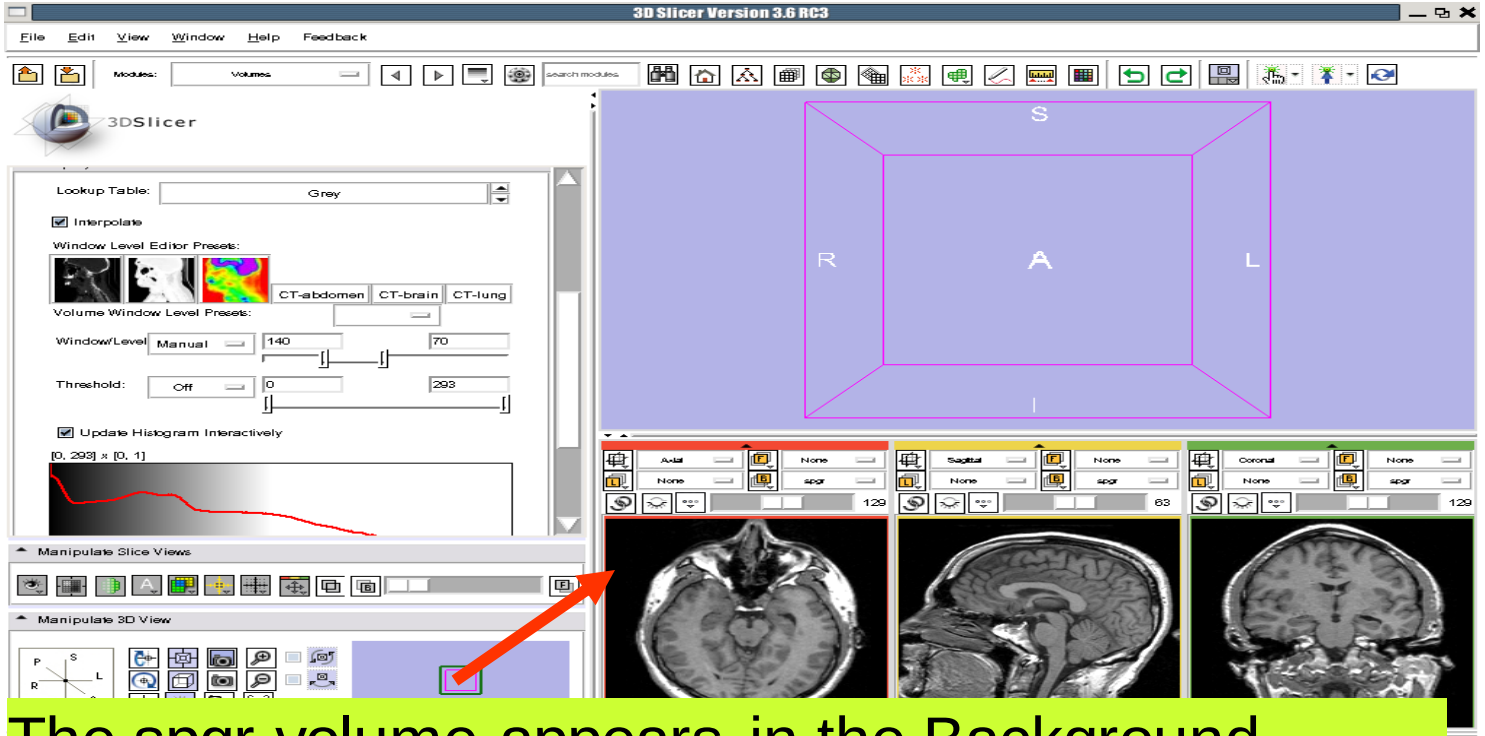
Browse to find the header file of the spgr volume ***spgr.nhdr*** located in the directory ***C:/SlicerData_RSNA2010/Slicer3VisualizationDataset/nrrd***

Loading Volumes



Select ‘Centered’ and click on Apply to load the volume ***spgr.nhdr***

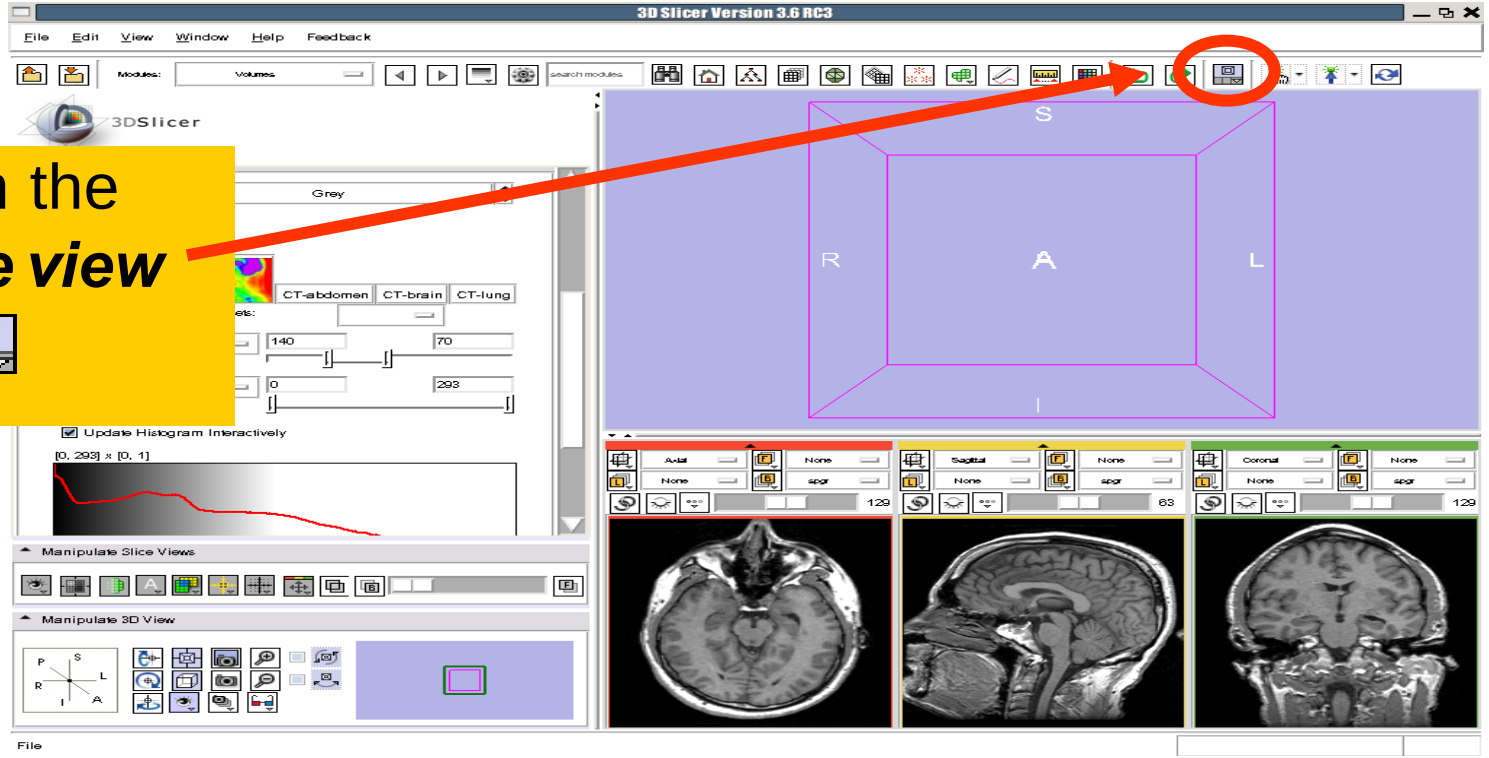
Loading Volumes



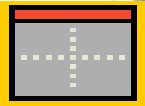
The spgr volume appears in the Background display  of the 2D Viewer.

Exploring the data

Click on the ***choose view*** icon 

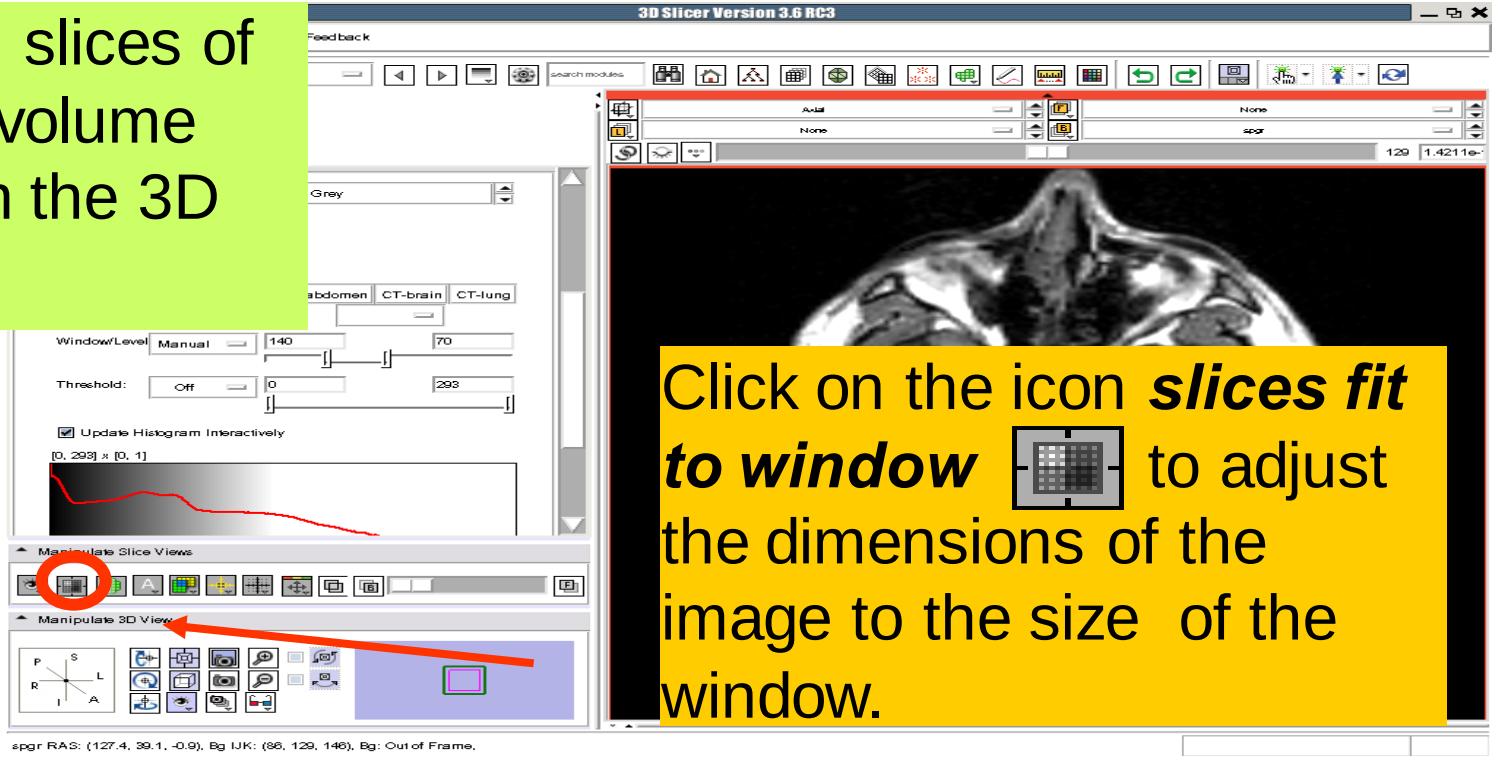


Exploring the data

Select  ***Red slice only layout***

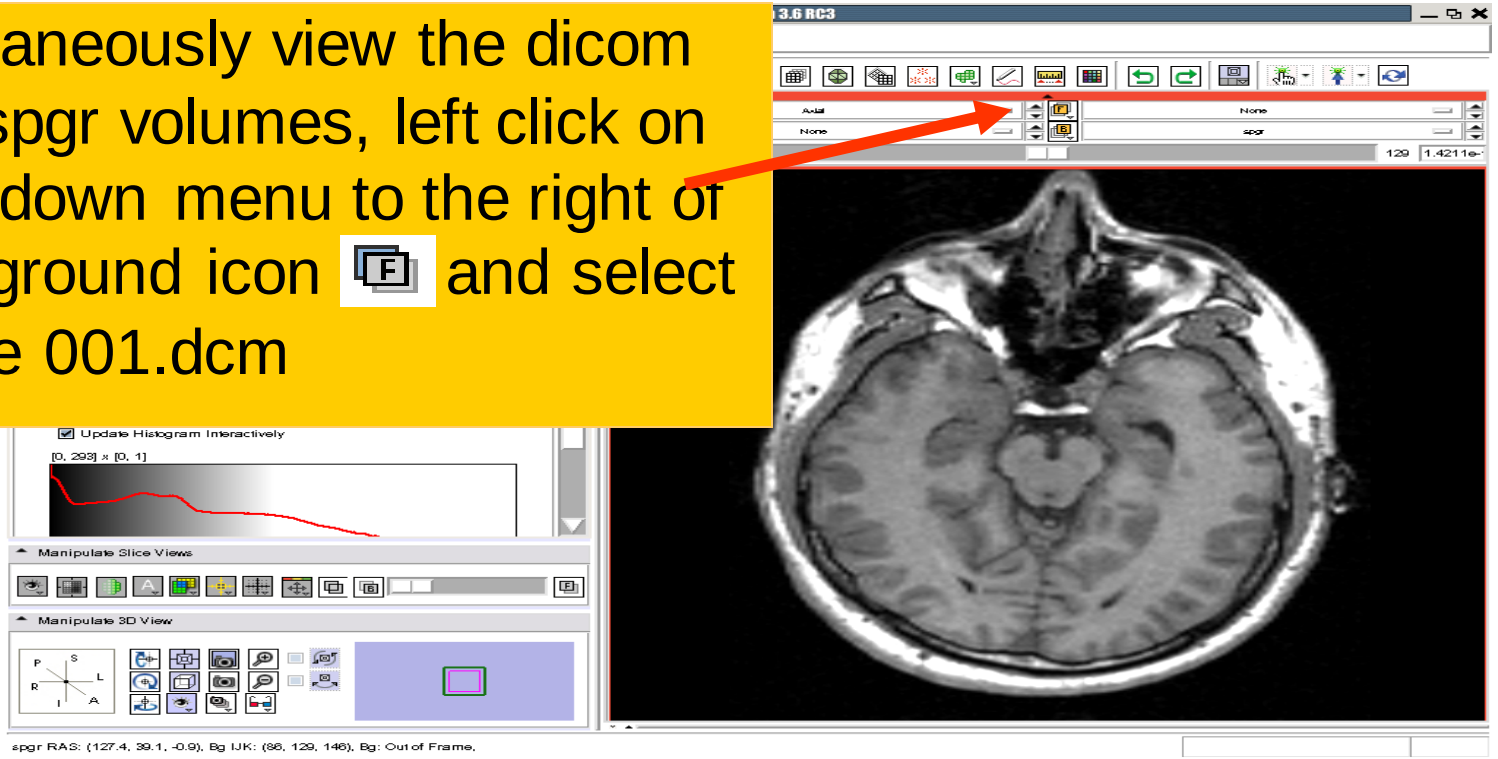
Exploring the data

The axial slices of the spgr volume appear in the 3D viewer.



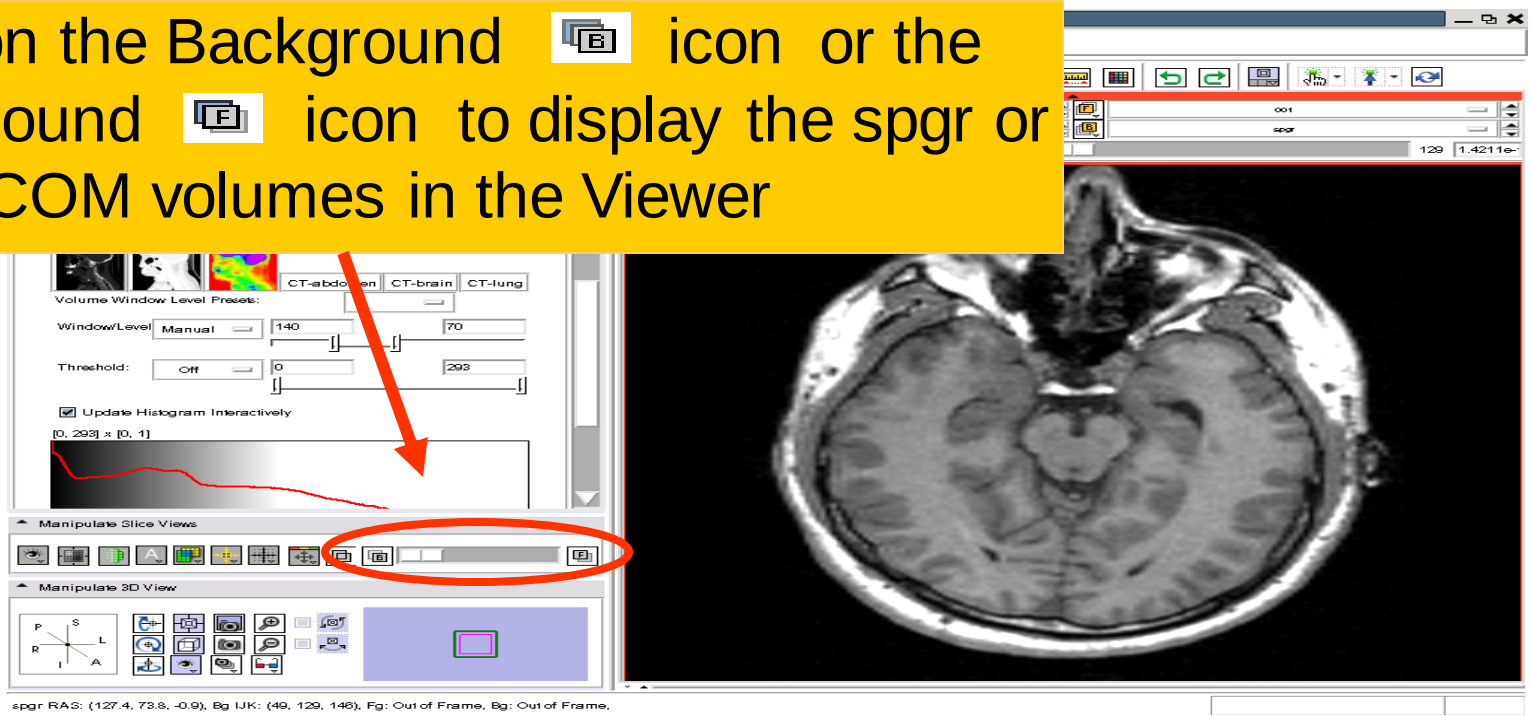
Exploring the data

To simultaneously view the dicom and the spgr volumes, left click on the drop-down menu to the right of the Foreground icon and select the image 001.dcm



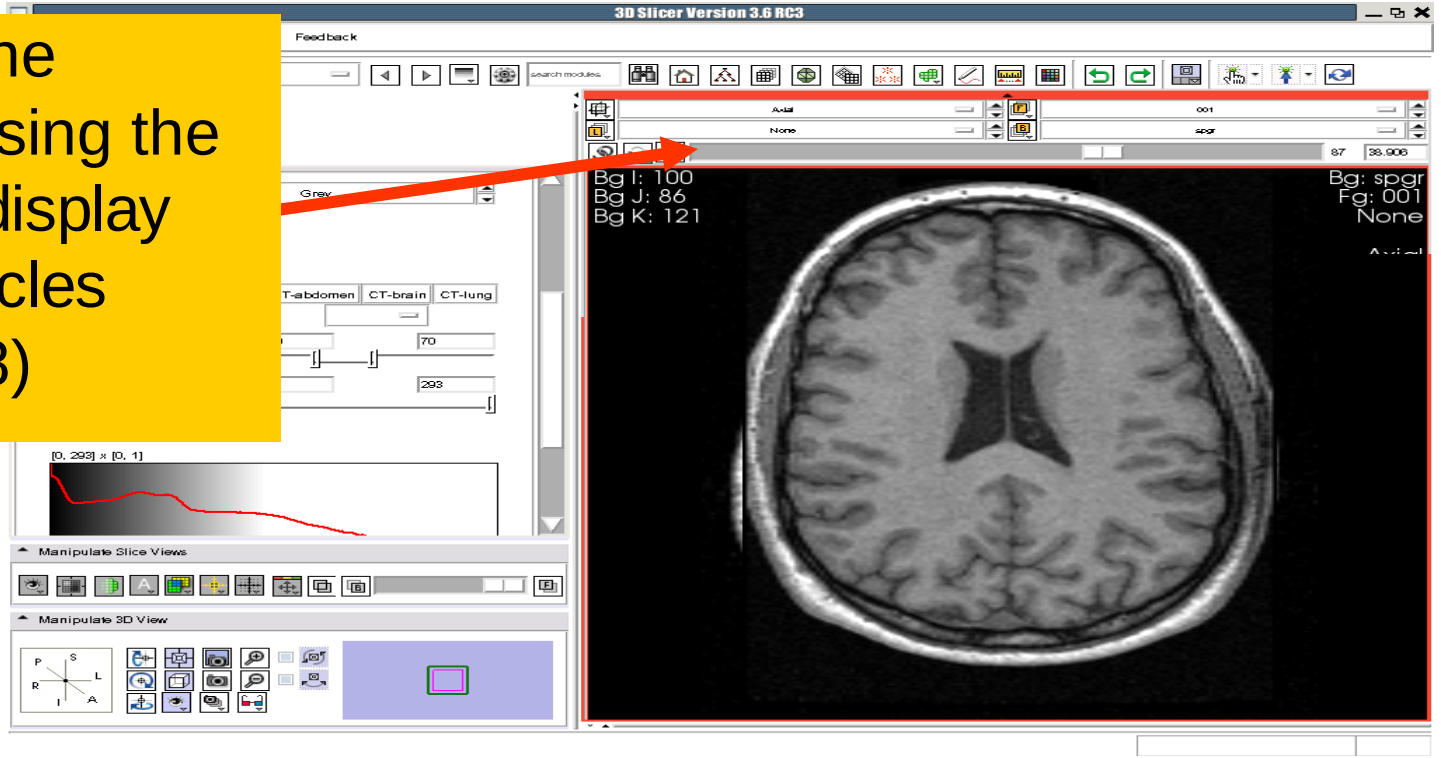
Exploring the data

Click on the Background icon or the Foreground icon to display the spgr or the DICOM volumes in the Viewer



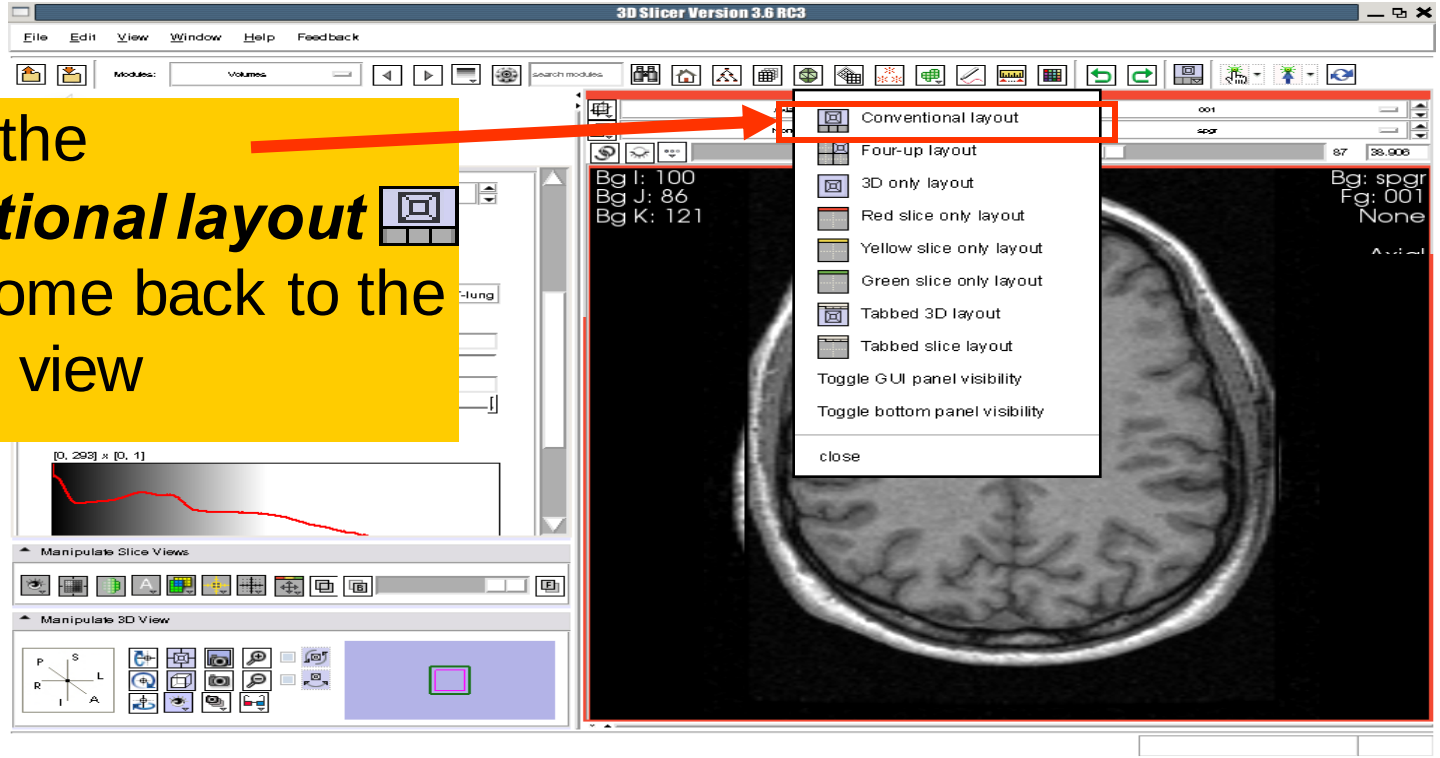
Exploring the data

Browse the images using the slider to display the ventricles (~slice 38)

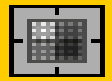


Exploring the data

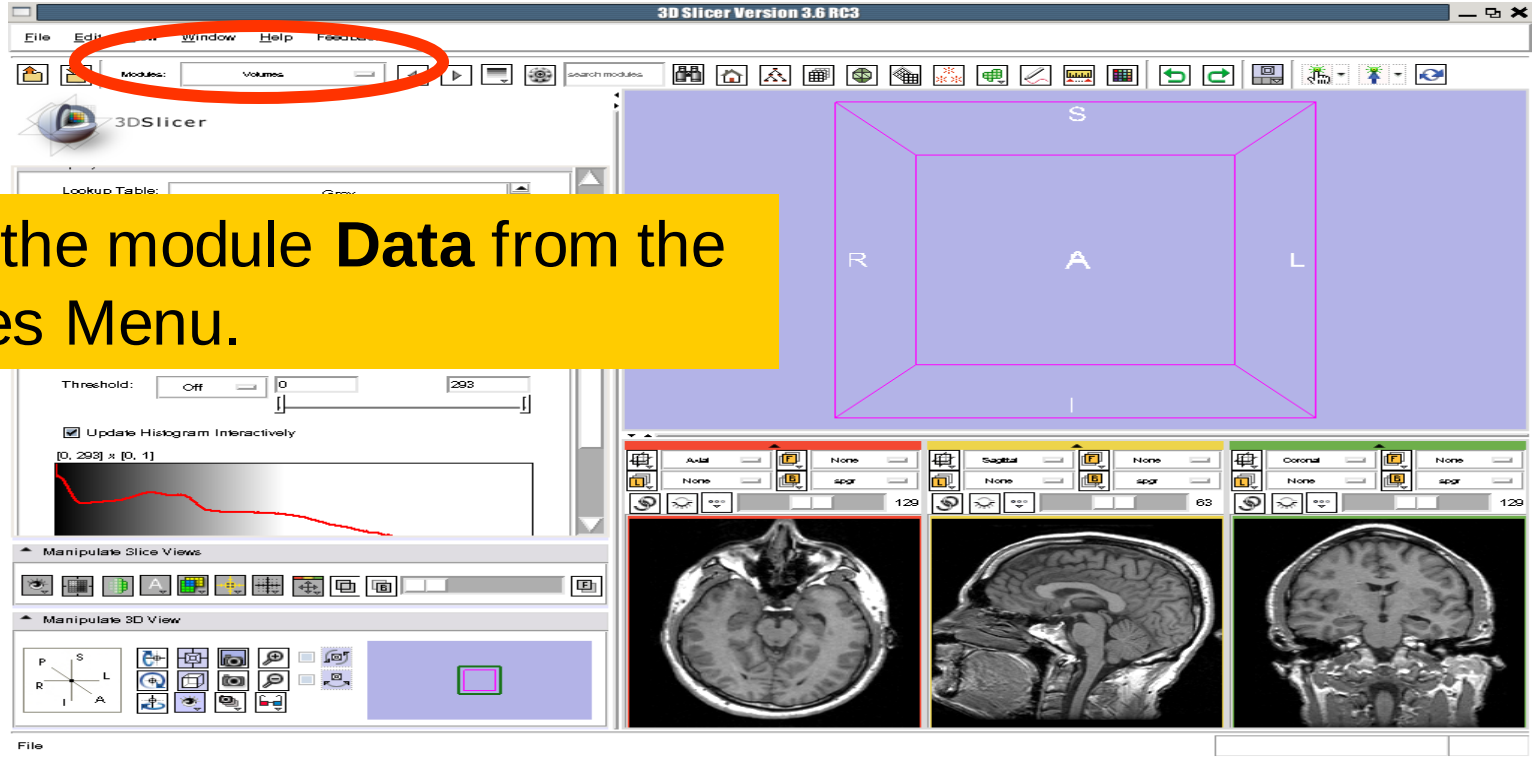
Click on the ***Conventional layout*** *icon to* come back to the standard view



Loading Volumes

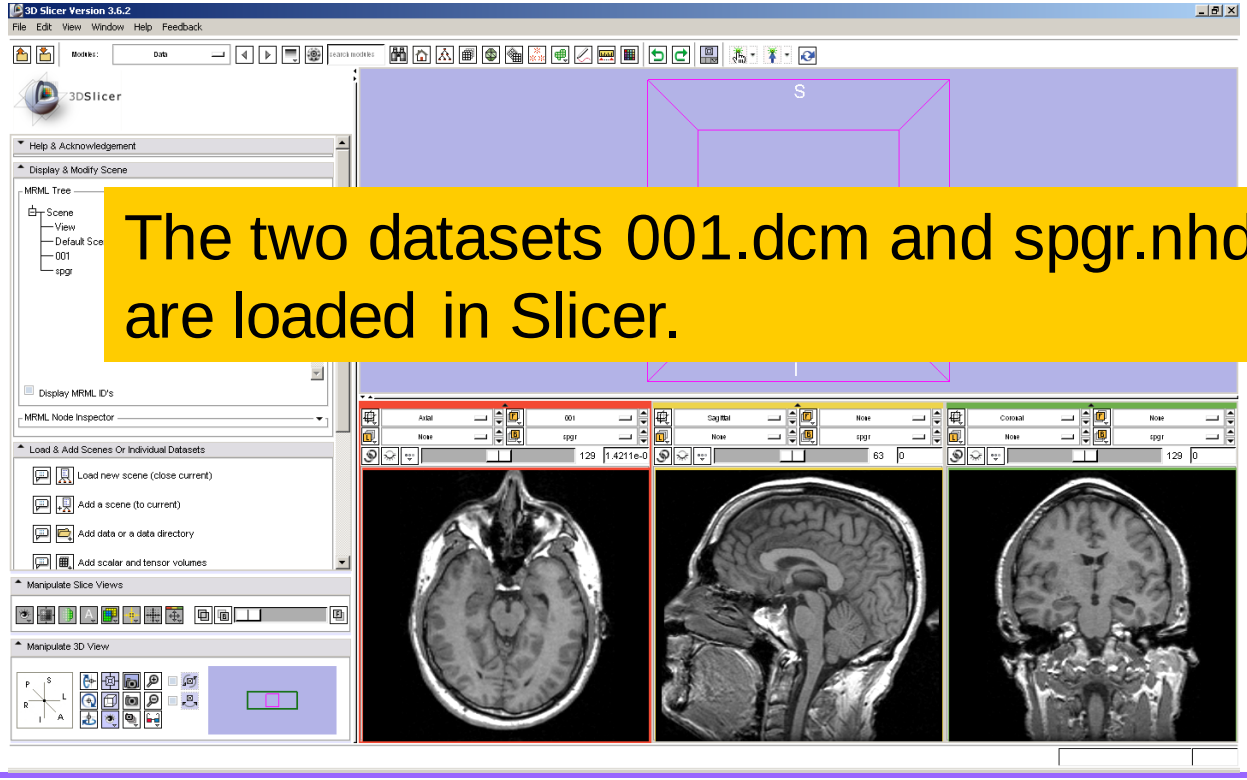
Click on the icon ***slices fit to window***  to adjust the dimensions of the image to the size of the window.

Loading Volumes



Select the module **Data** from the Modules Menu.

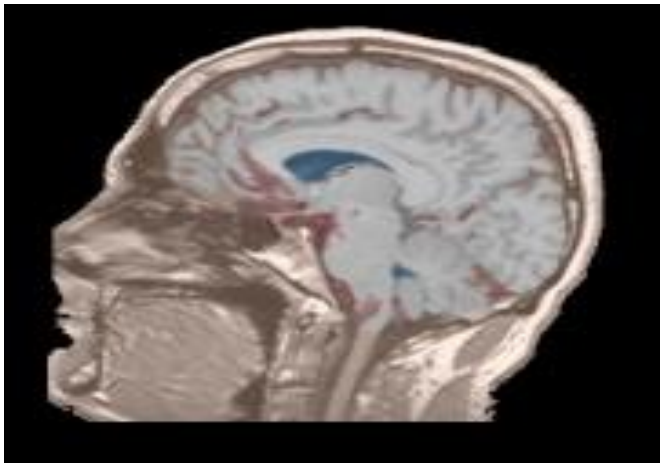
Loading Volumes



The two datasets 001.dcm and spgr.nhdr are loaded in Slicer.

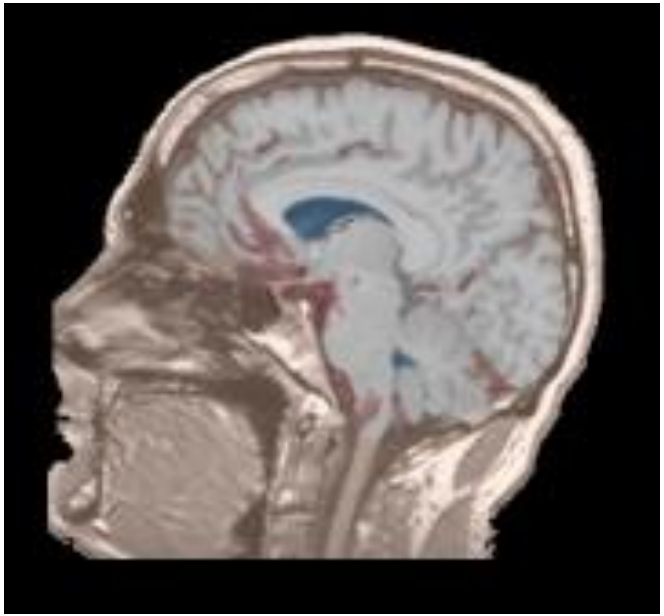
National Alliance for Medical Image Computing

http://na-mic.org © 2010, ARR



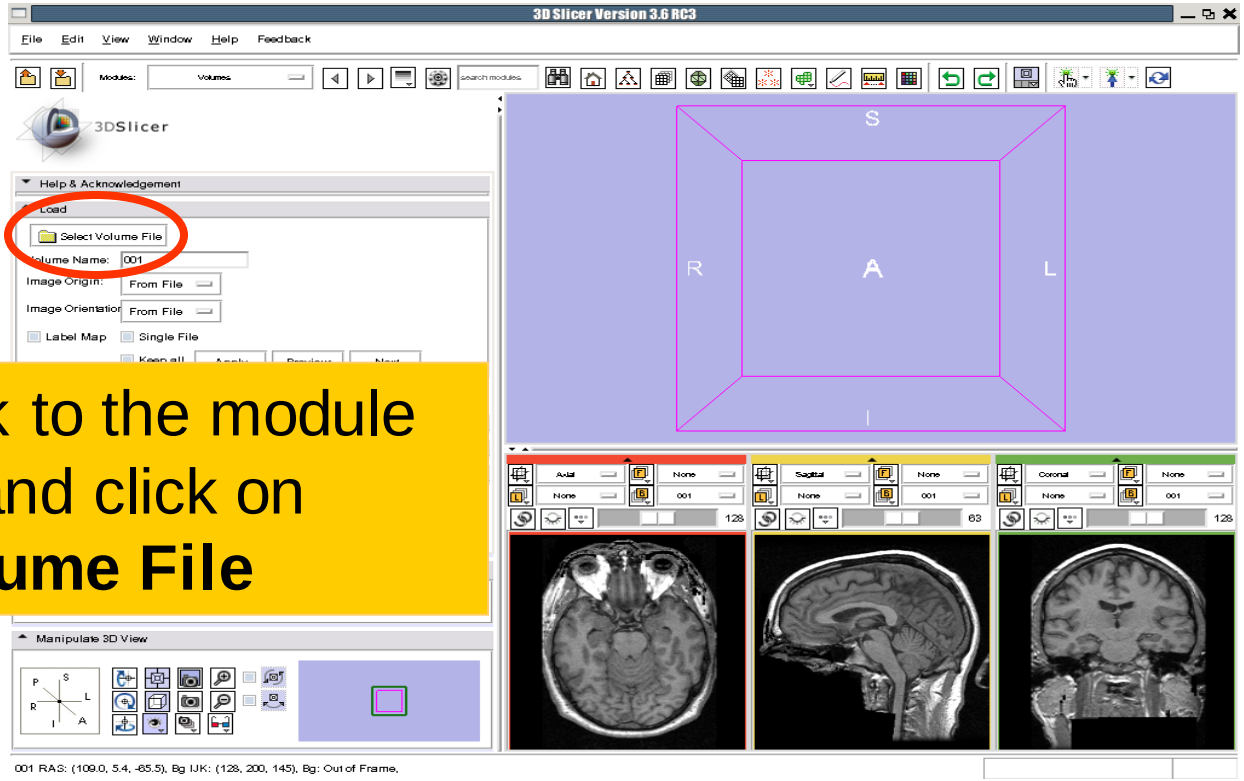
Part 2: Loading and visualizing segmented structures overlaid on grayscale images

Label map



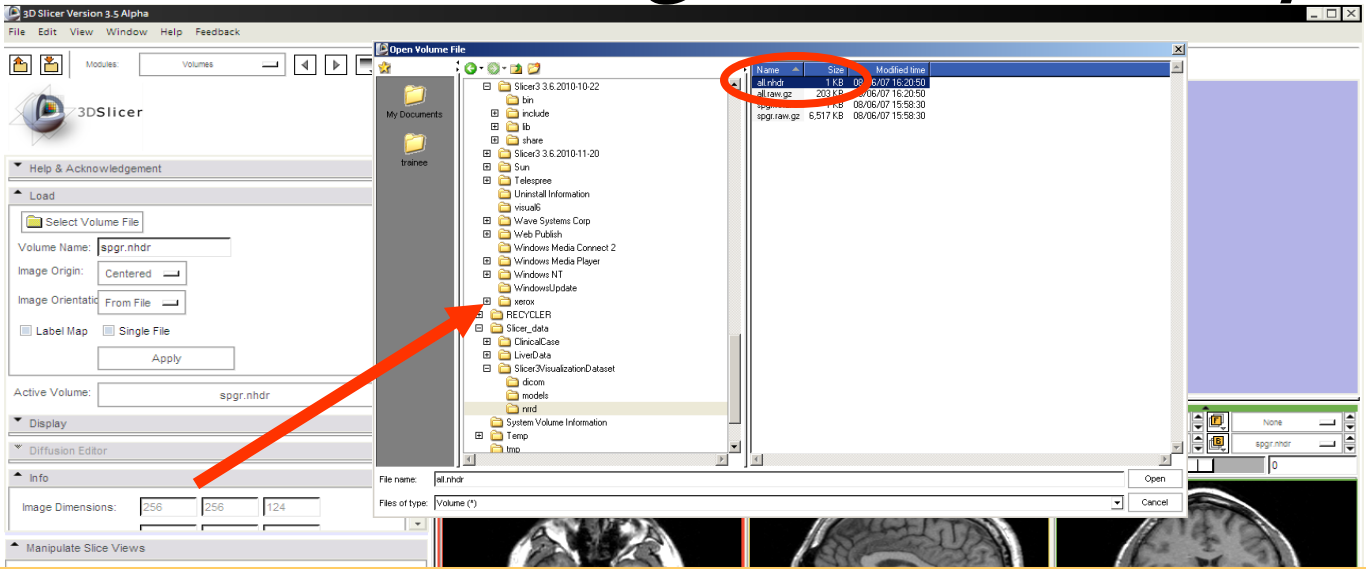
- Image segmentation is the extraction of structural information of particular interest from surrounding image.
- Each pixel is assigned a specific label value which corresponds to the anatomical structure that it belongs to.
- The three-dimensional result of the segmentation is a binary array called a label map.

Loading a label map



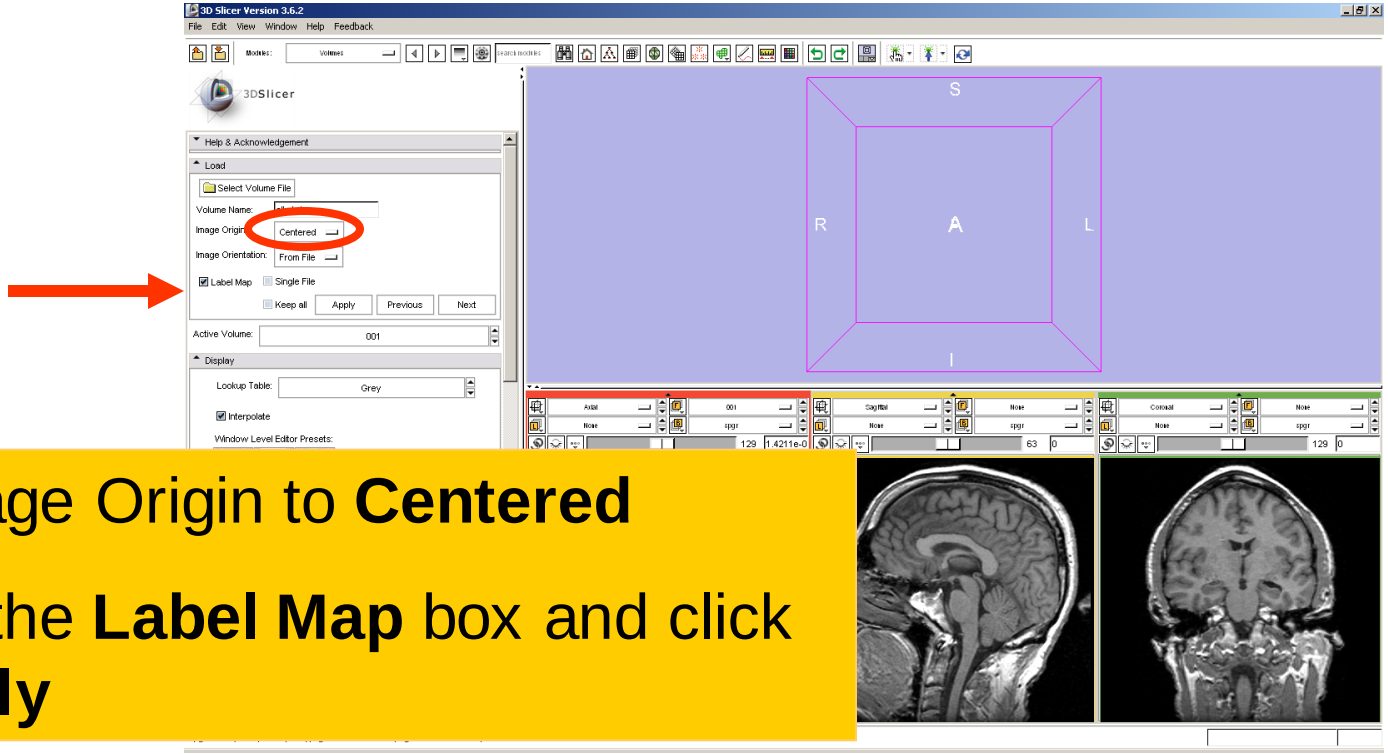
Come back to the module **Volumes** and click on **Select Volume File**

Loading a label map



Browse to find the header file ***all.nhdr*** of the label map dataset located in the directory ***C:/SlicerData_RSNA2010/Slicer3VisualizationDataset/nrrd*** and click on **Open**

Visualizing a label map



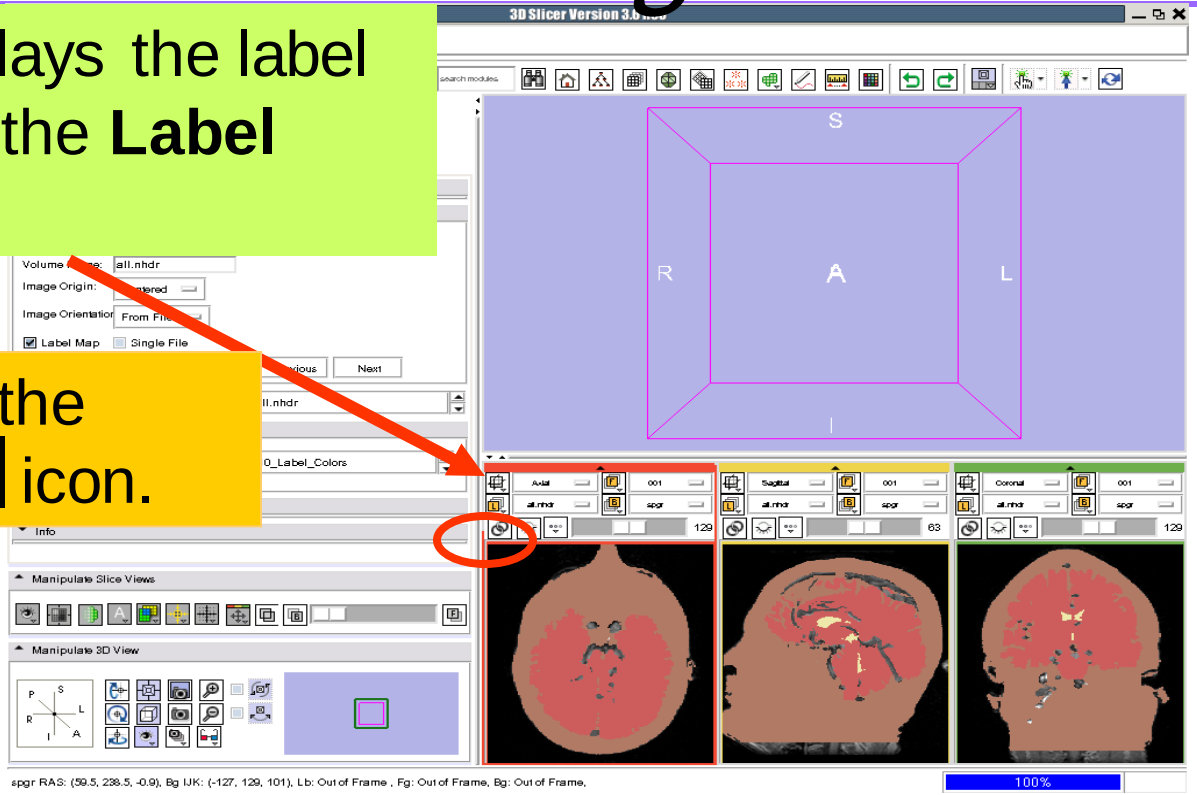
Set Image Origin to **Centered**

Check the **Label Map** box and click on **Apply**

Visualizing a label map

Slicer displays the label map ***all*** in the **Label layer** 

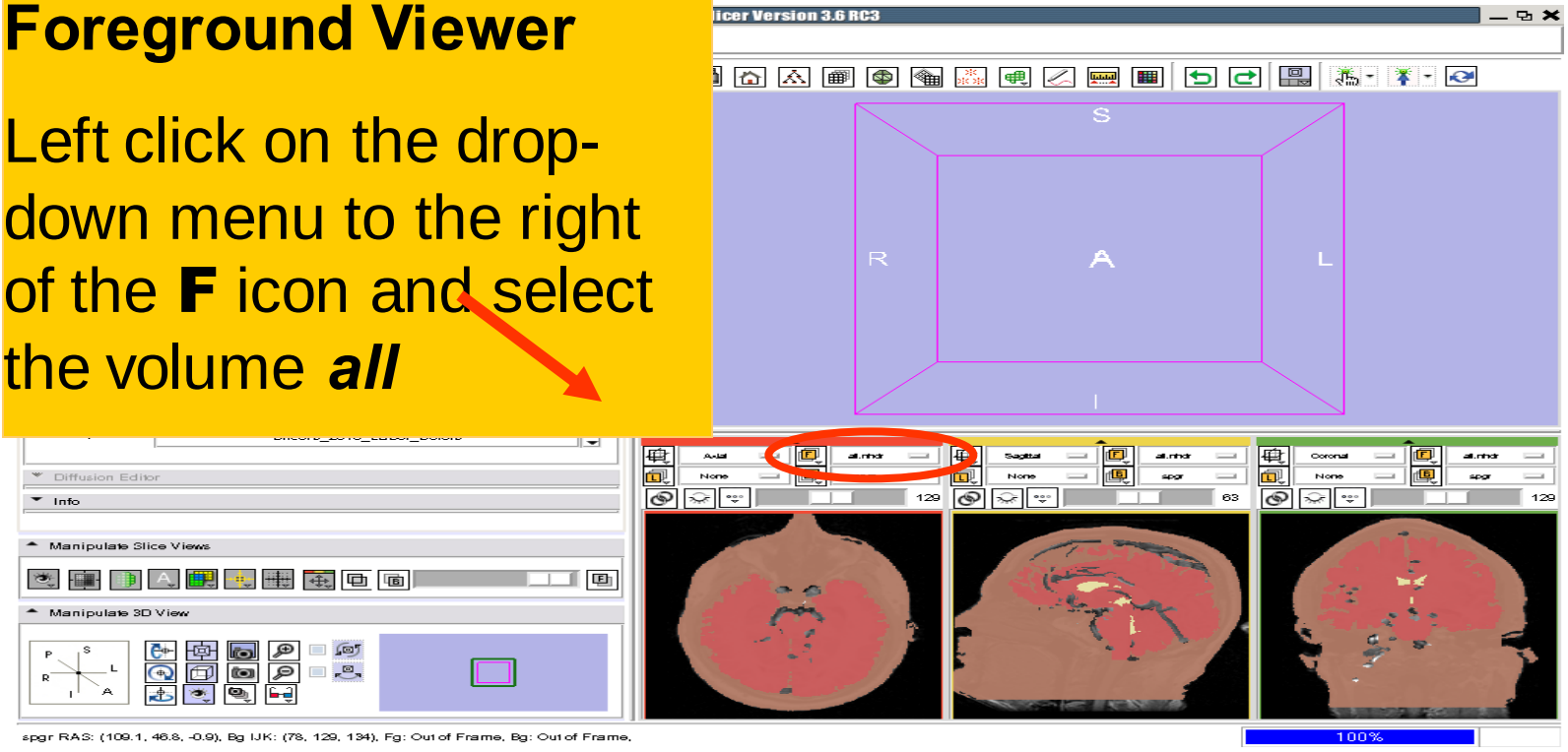
Click on the ***links***  icon.



Visualizing Multiple Volumes

Foreground Viewer

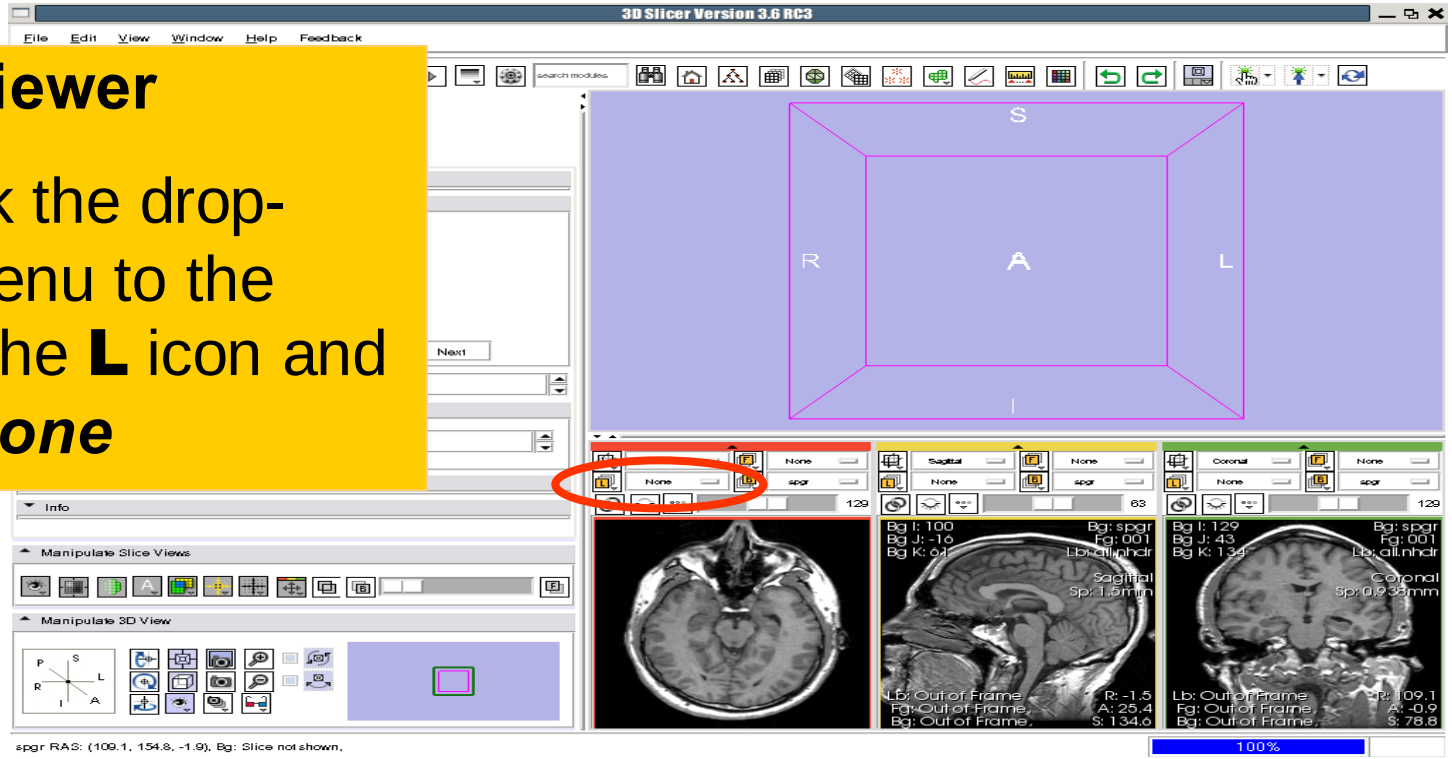
Left click on the drop-down menu to the right of the **F** icon and select the volume ***all***



Visualizing Multiple Volumes

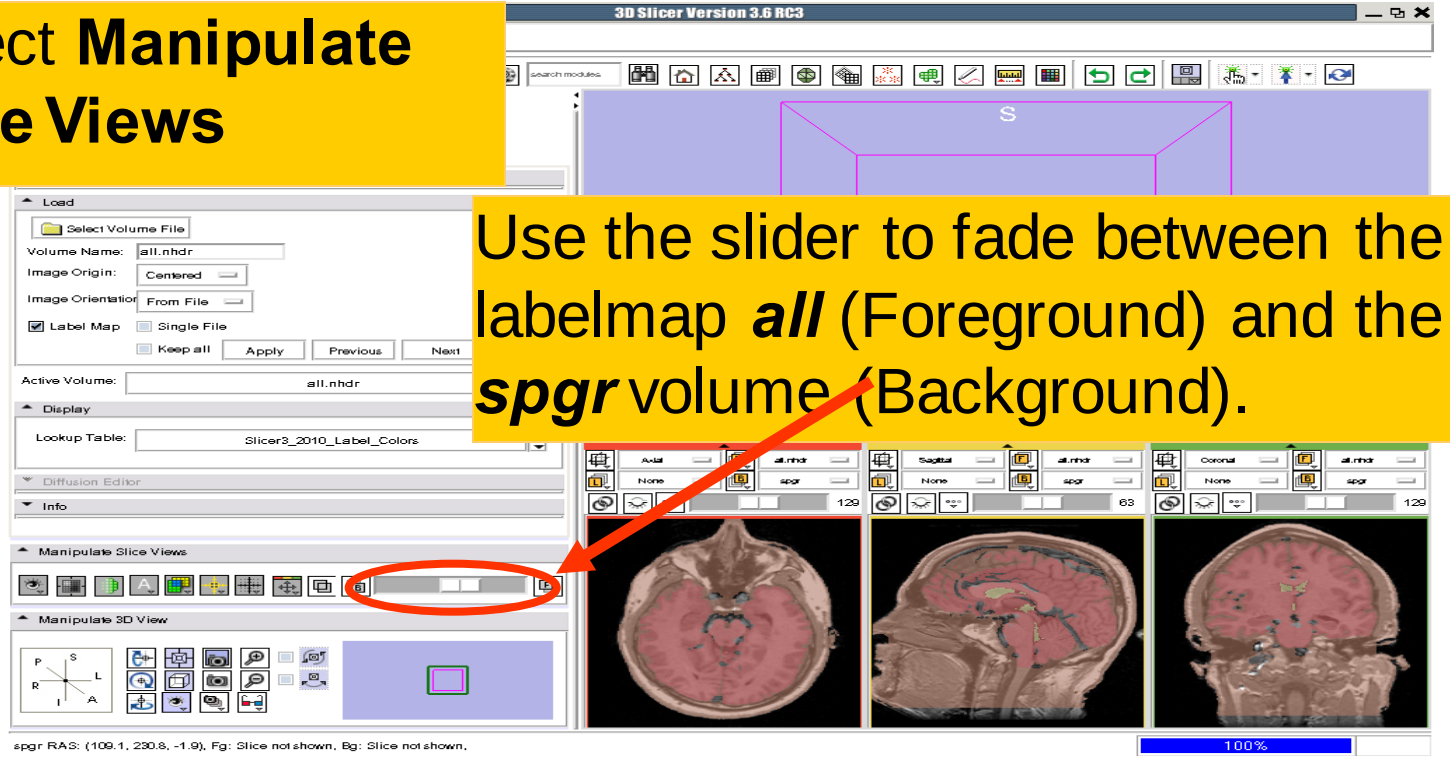
Label Viewer

Left click the drop-down menu to the right of the **L** icon and select ***None***



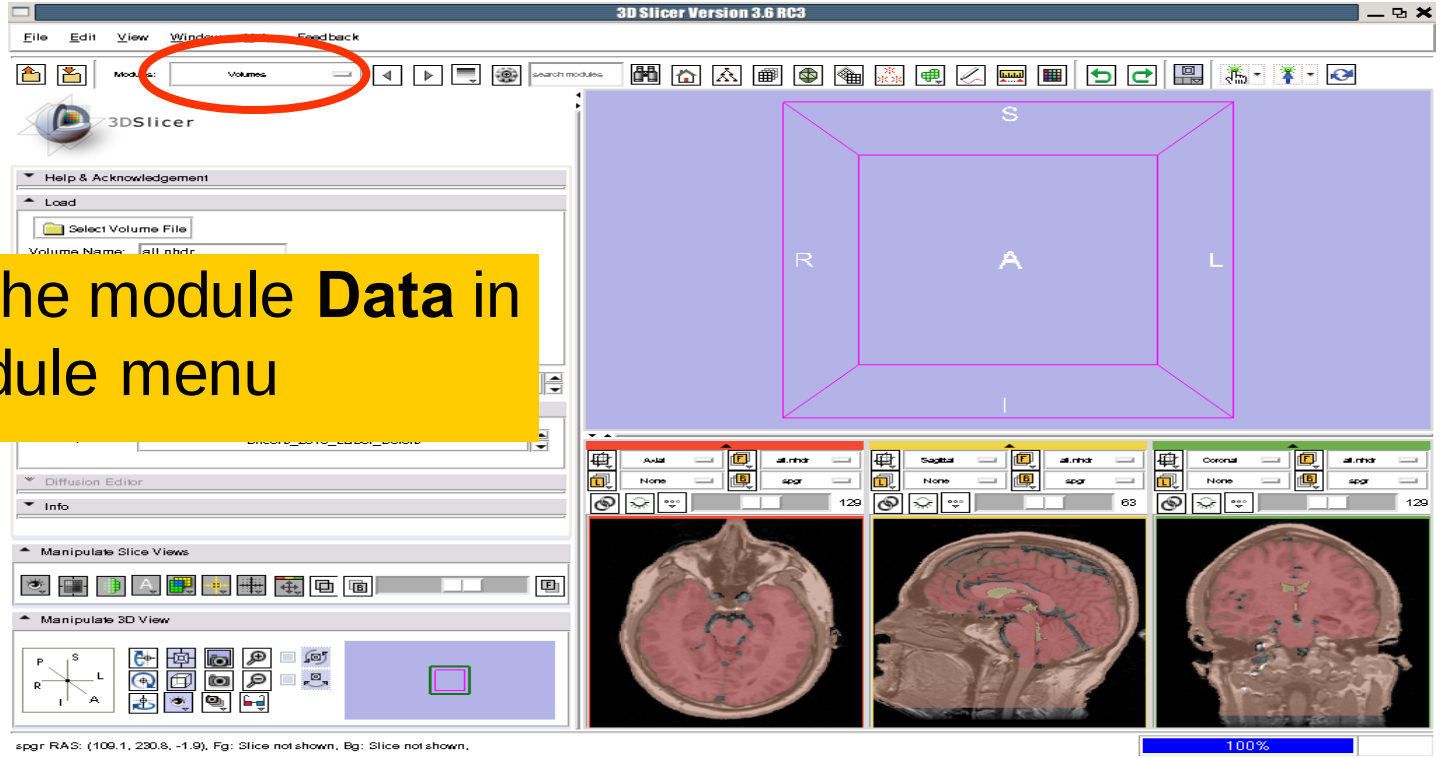
Visualizing Multiple Volumes

Select **Manipulate Slice Views**



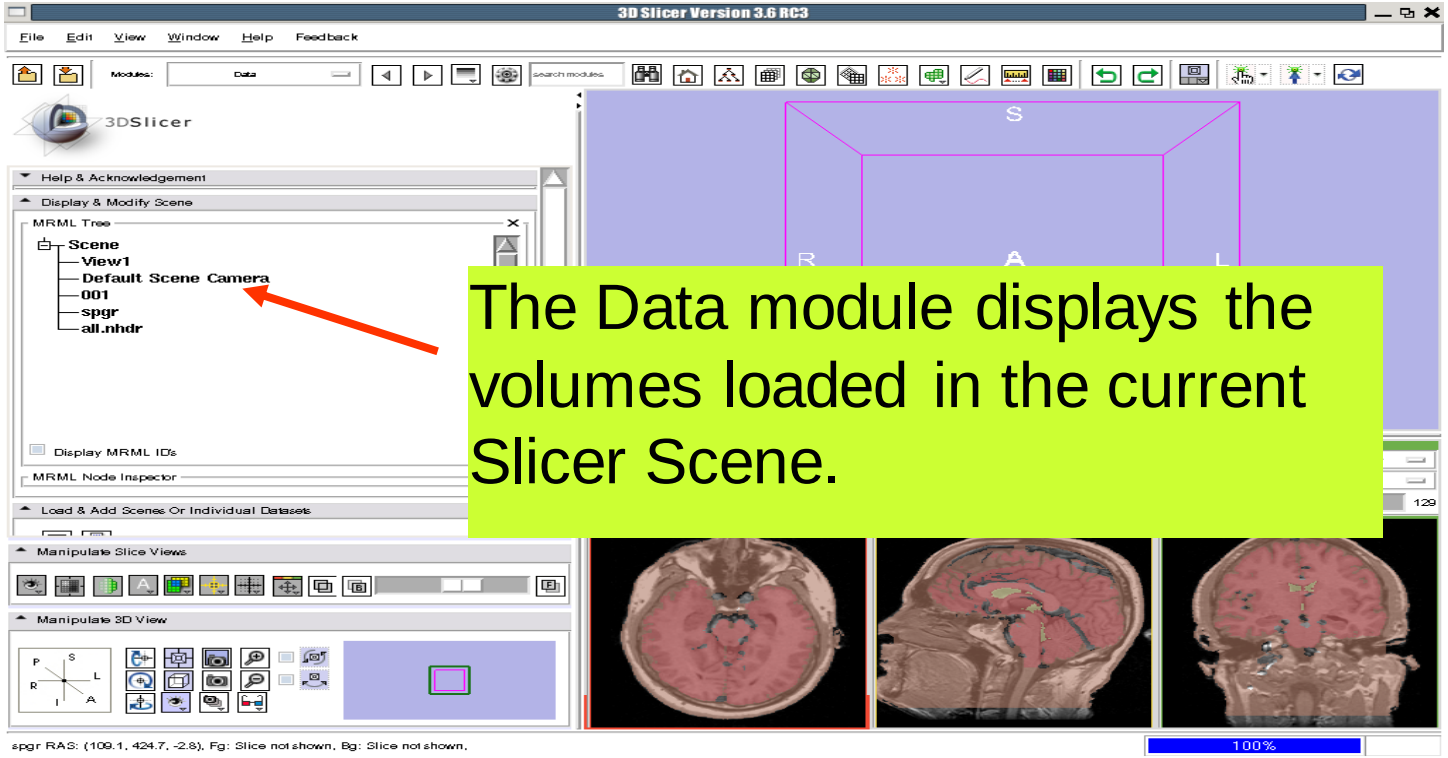
Use the slider to fade between the labelmap ***all*** (Foreground) and the ***spgr*** volume (Background).

3D Visualization



Select the module **Data** in the module menu

3D Visualization

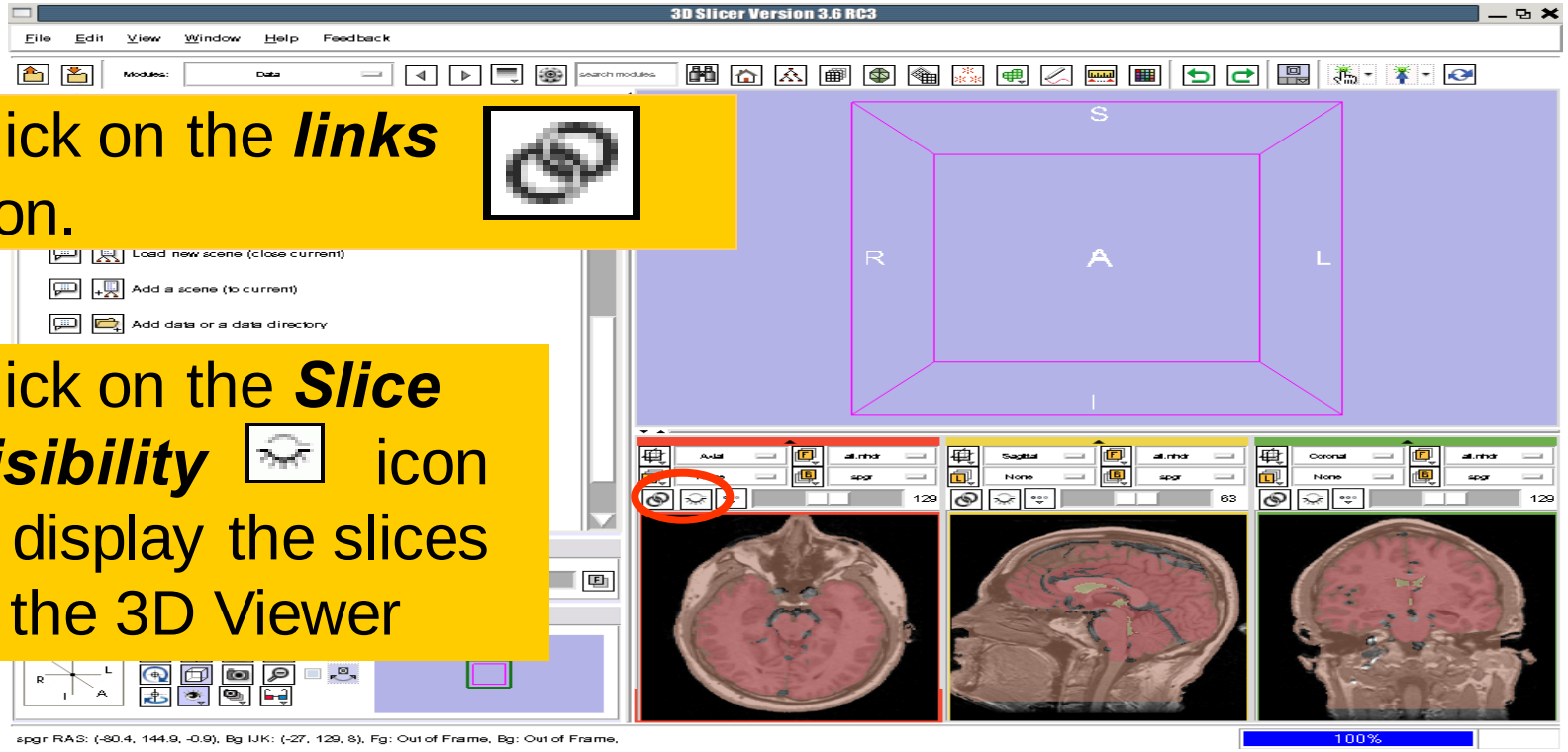


The Data module displays the volumes loaded in the current Slicer Scene.

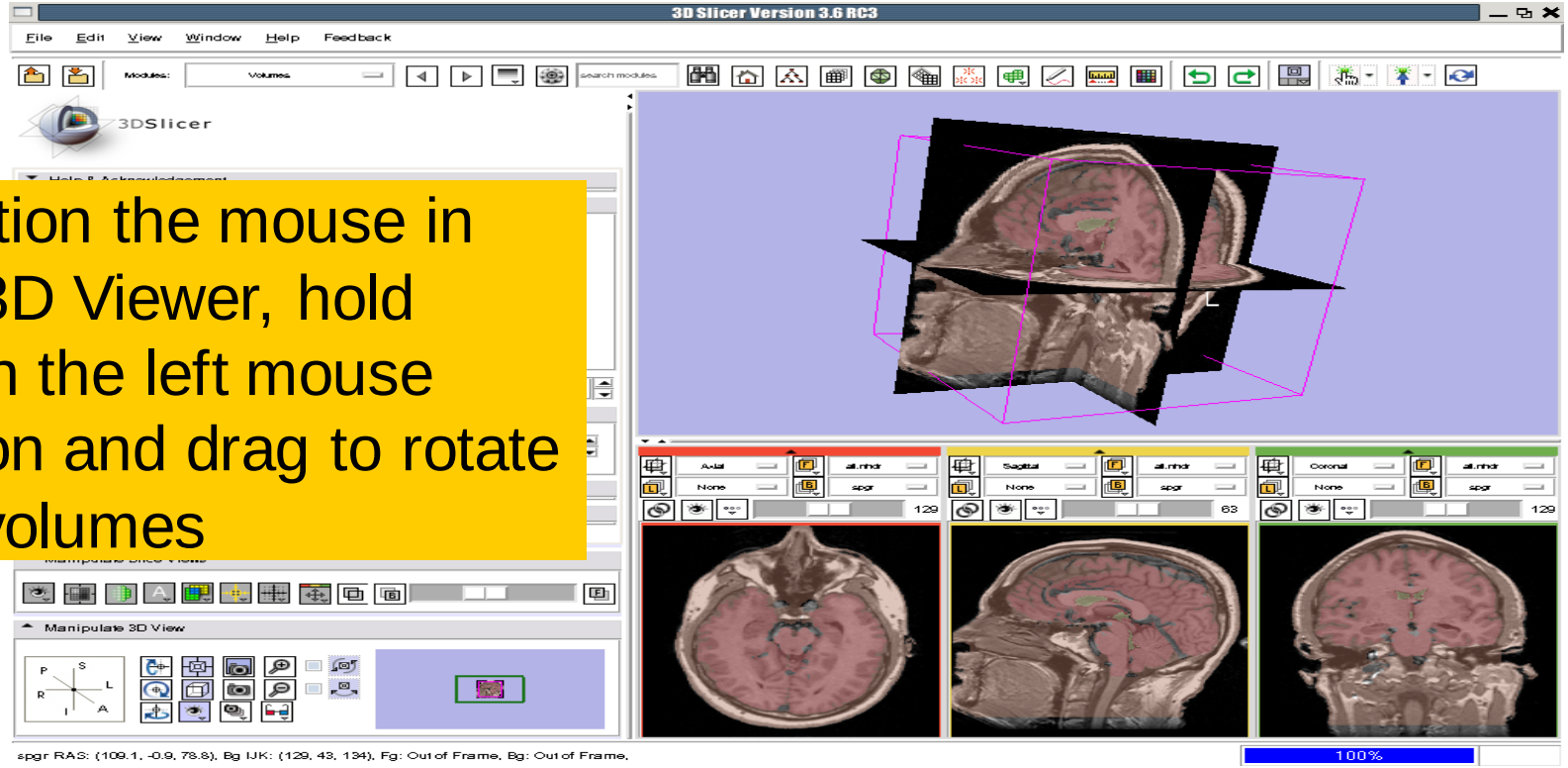
3D Visualization

Click on the ***links*** icon.

Click on the ***Slice Visibility*** icon to display the slices in the 3D Viewer

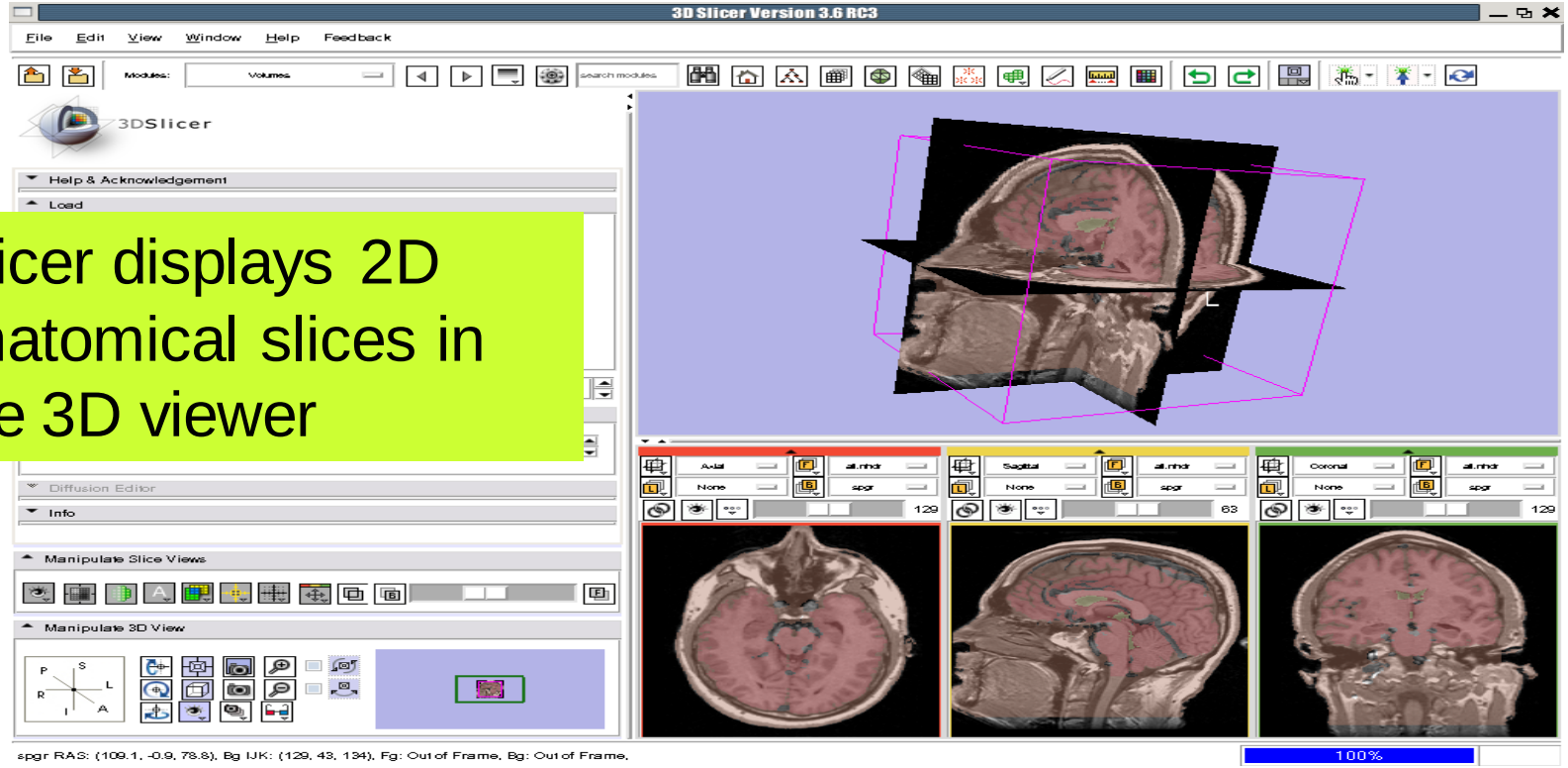


3D Visualization

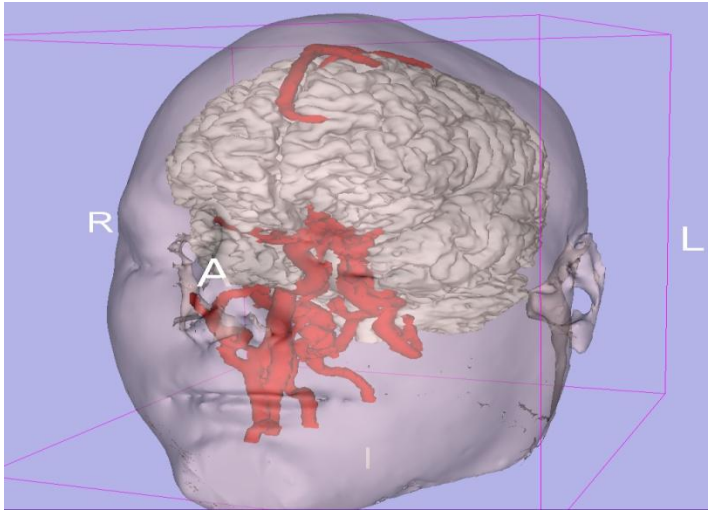


Position the mouse in the 3D Viewer, hold down the left mouse button and drag to rotate the volumes

3D Visualization

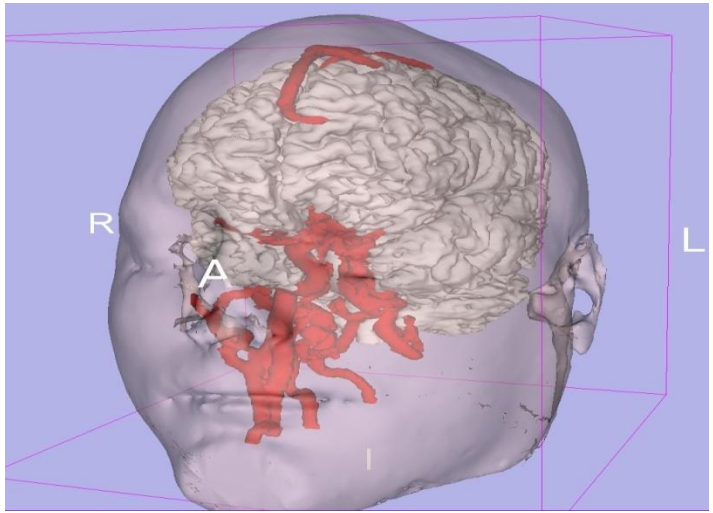


Slicer displays 2D anatomical slices in the 3D viewer



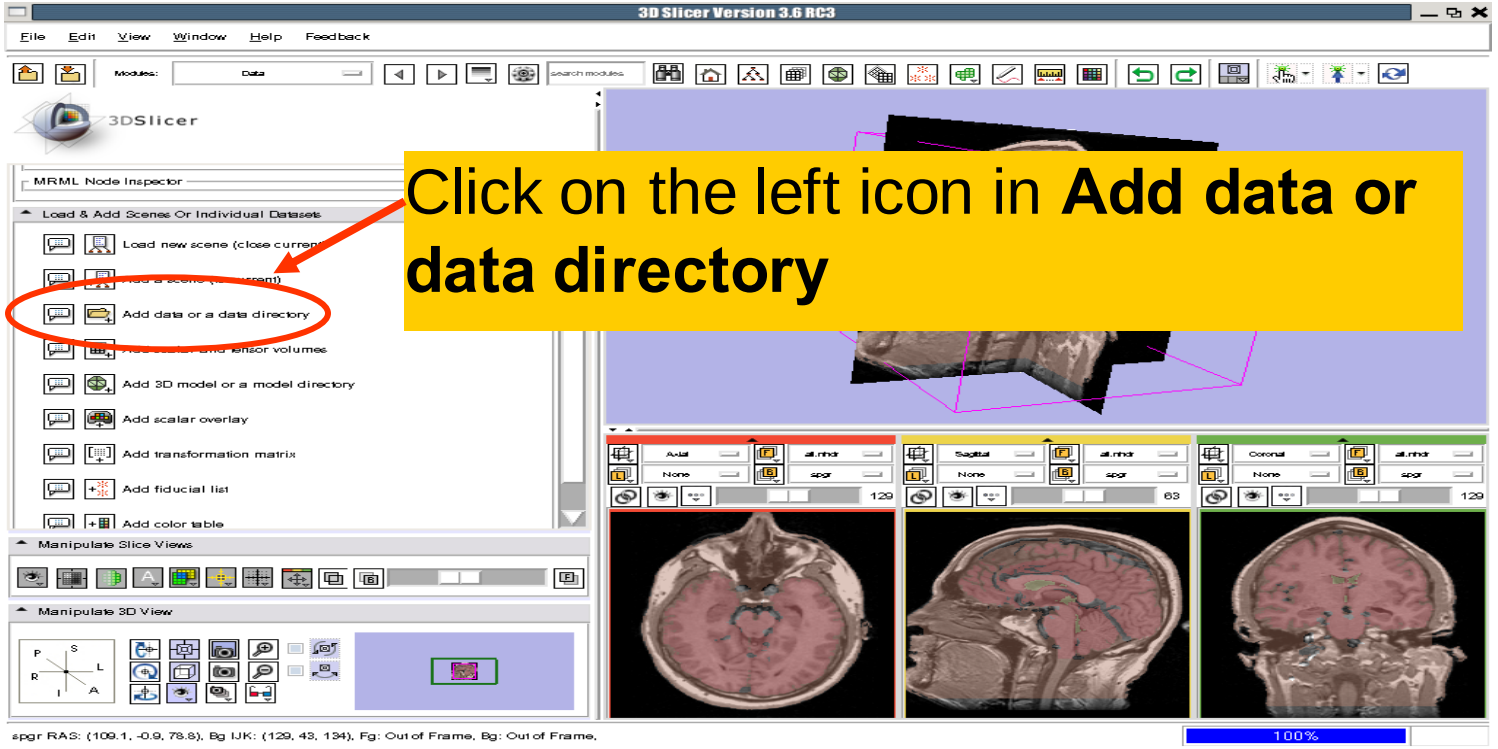
Part 3: Loading and visualizing 3D models of the anatomy

3D models

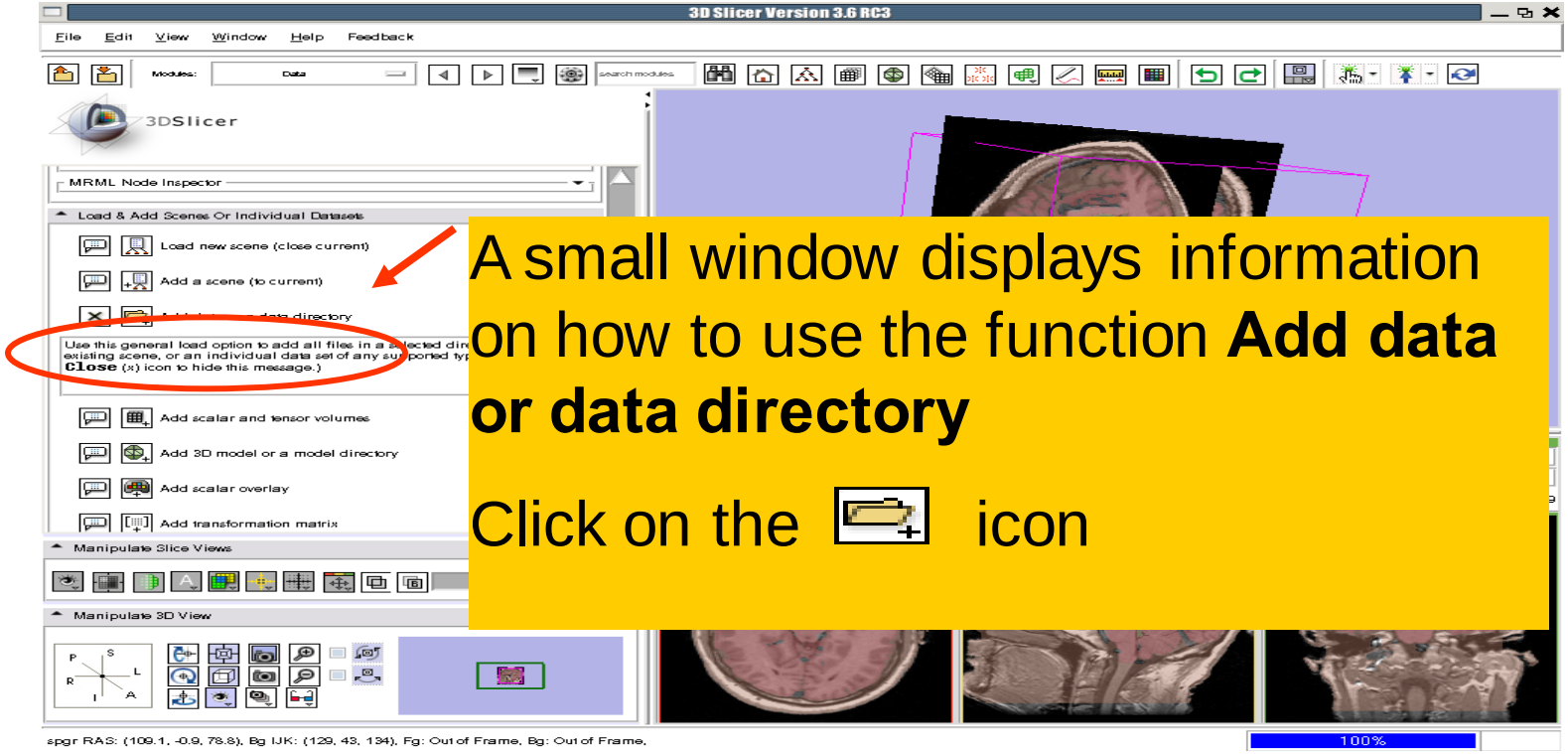


- A 3D model is a surface reconstruction of an anatomical structure.
- The model is a triangular mesh that approximates a surface from a 3D label map.
- The scalar values for surface models are integers which correspond to the label that had been assigned in the segmentation process.

3D Visualization



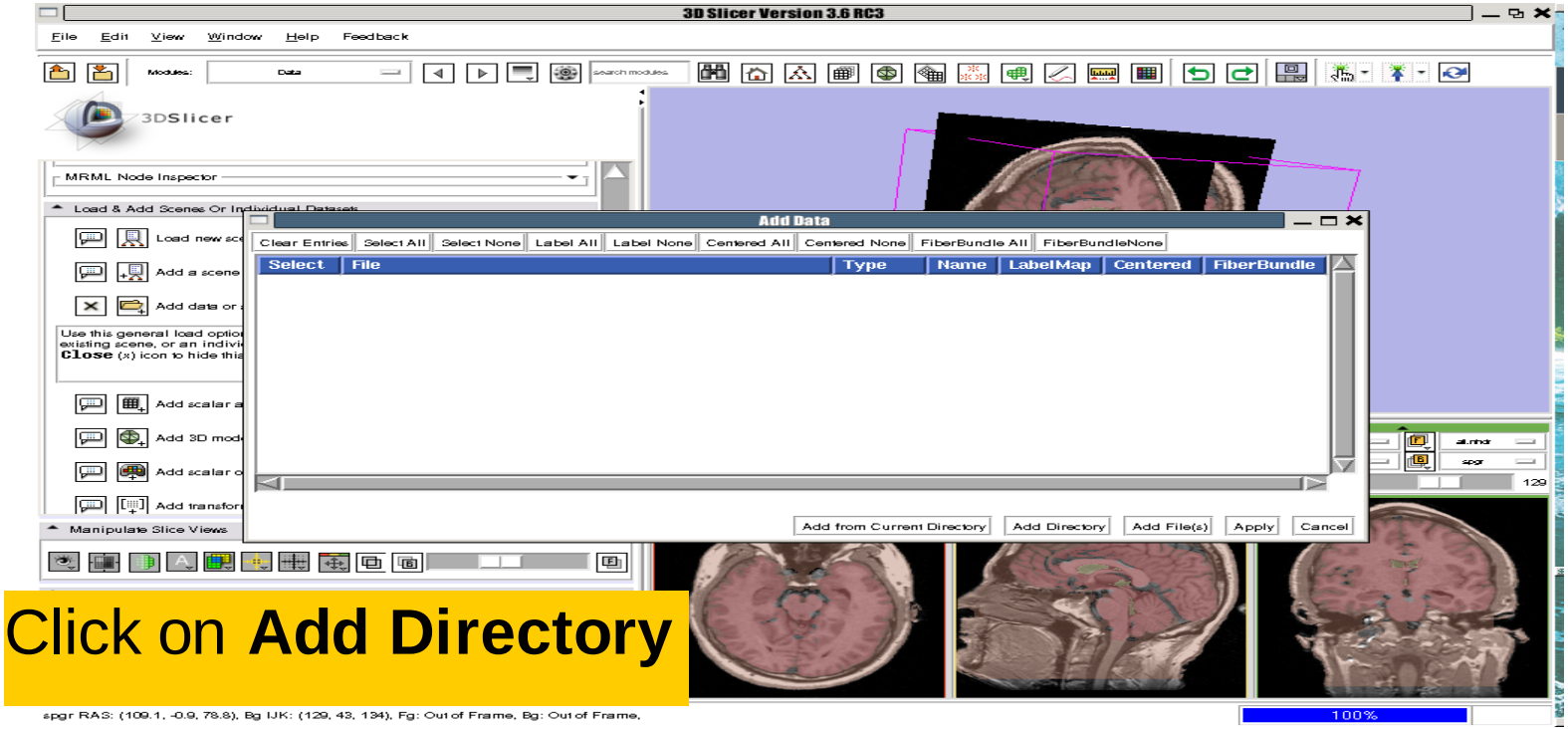
3D Visualization



A small window displays information on how to use the function **Add data or data directory**

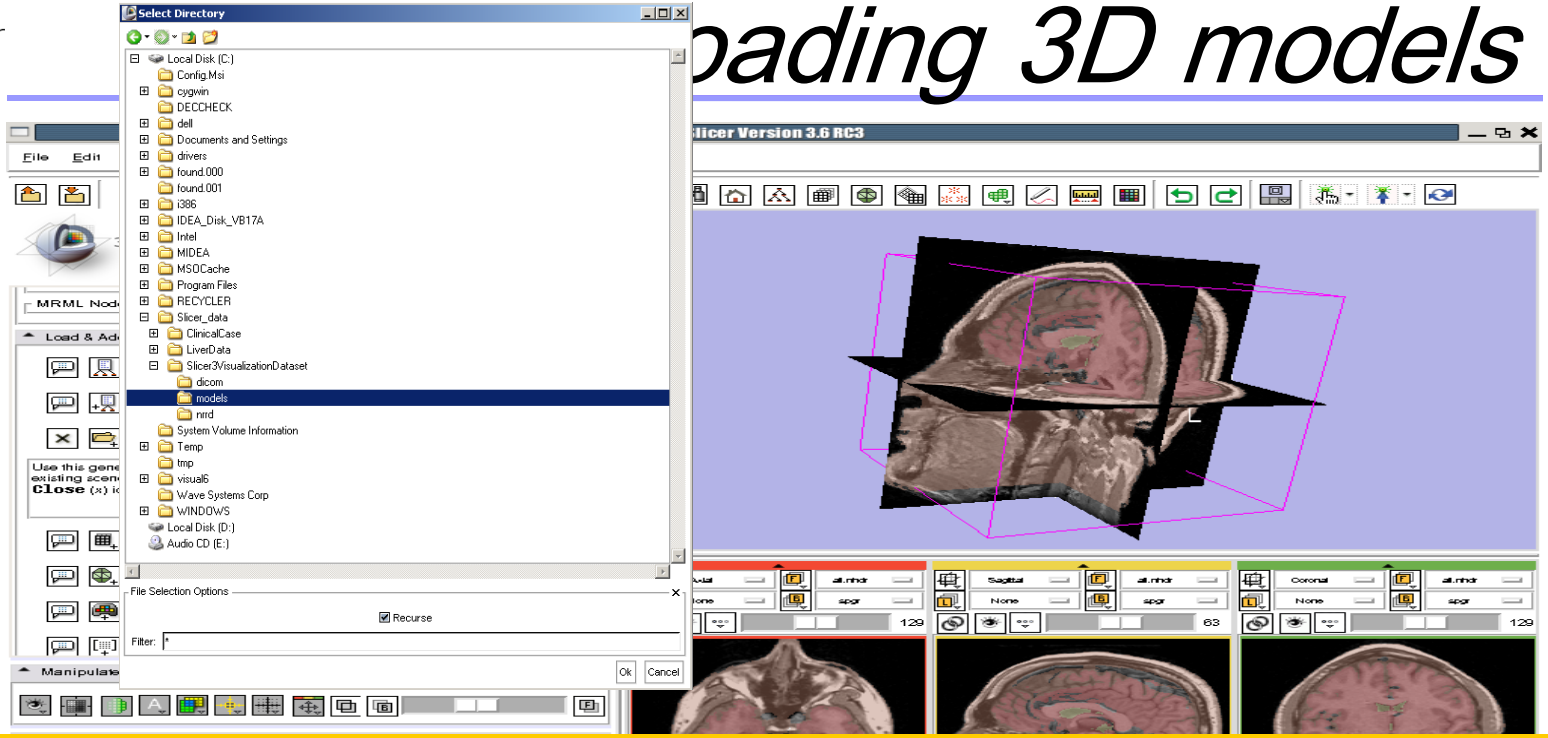
Click on the icon

3D Visualization



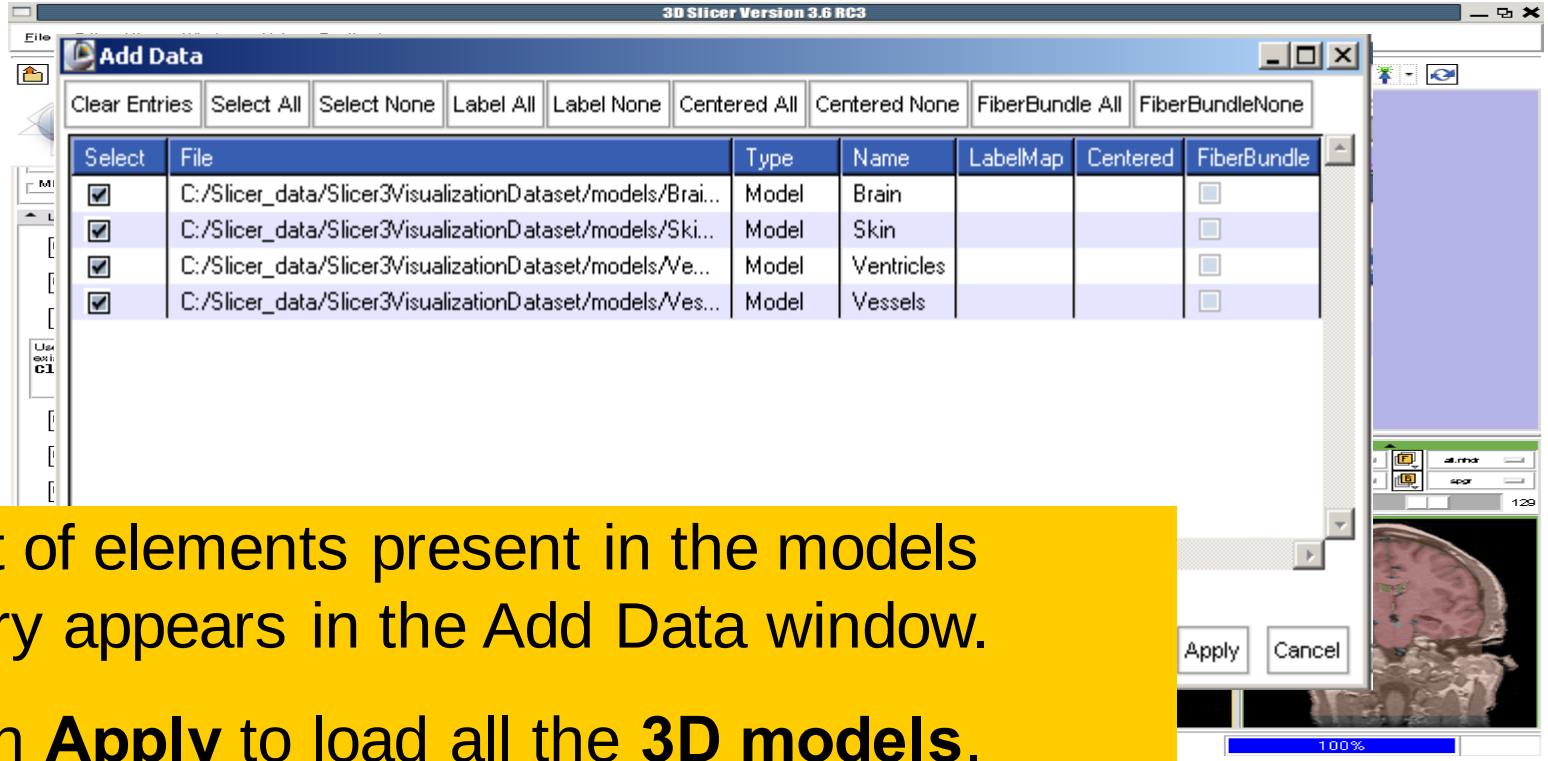
Click on **Add Directory**

oading 3D models



Select the directory **Slicer3VisualizationDataset/models** and click on OK

Loading 3D models



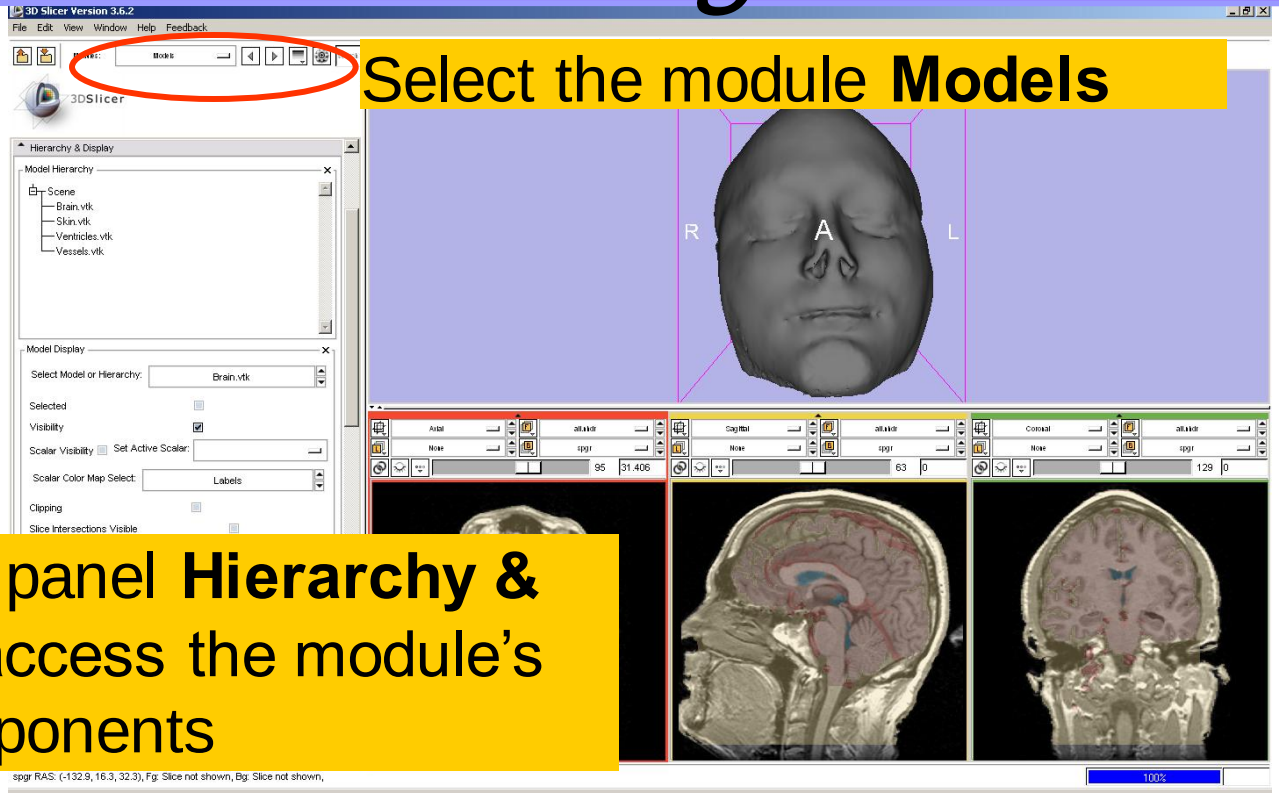
The list of elements present in the models directory appears in the Add Data window.

Click on **Apply** to load all the **3D models**.

Loading 3D models

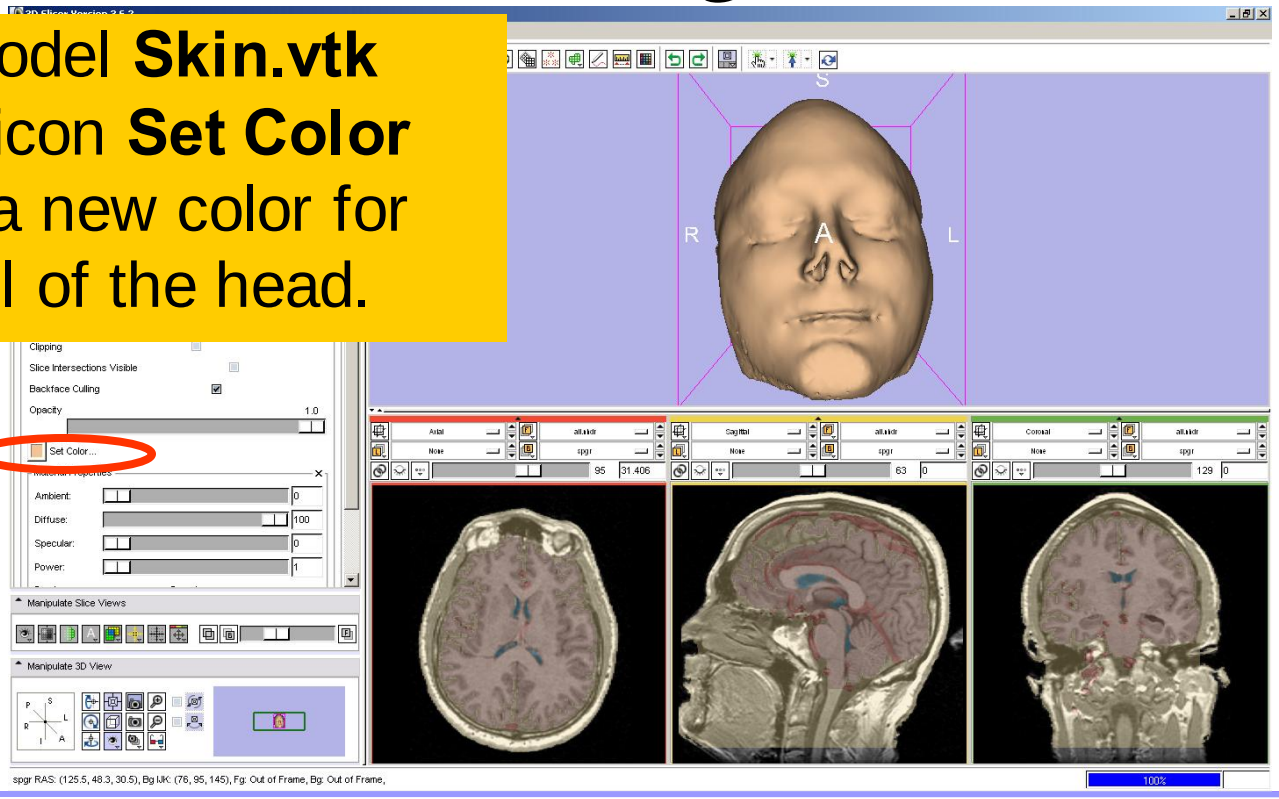
Slicer loads the 3D models in the 3D Viewer. The models have been added to the MRML scene.

Loading a 3D model



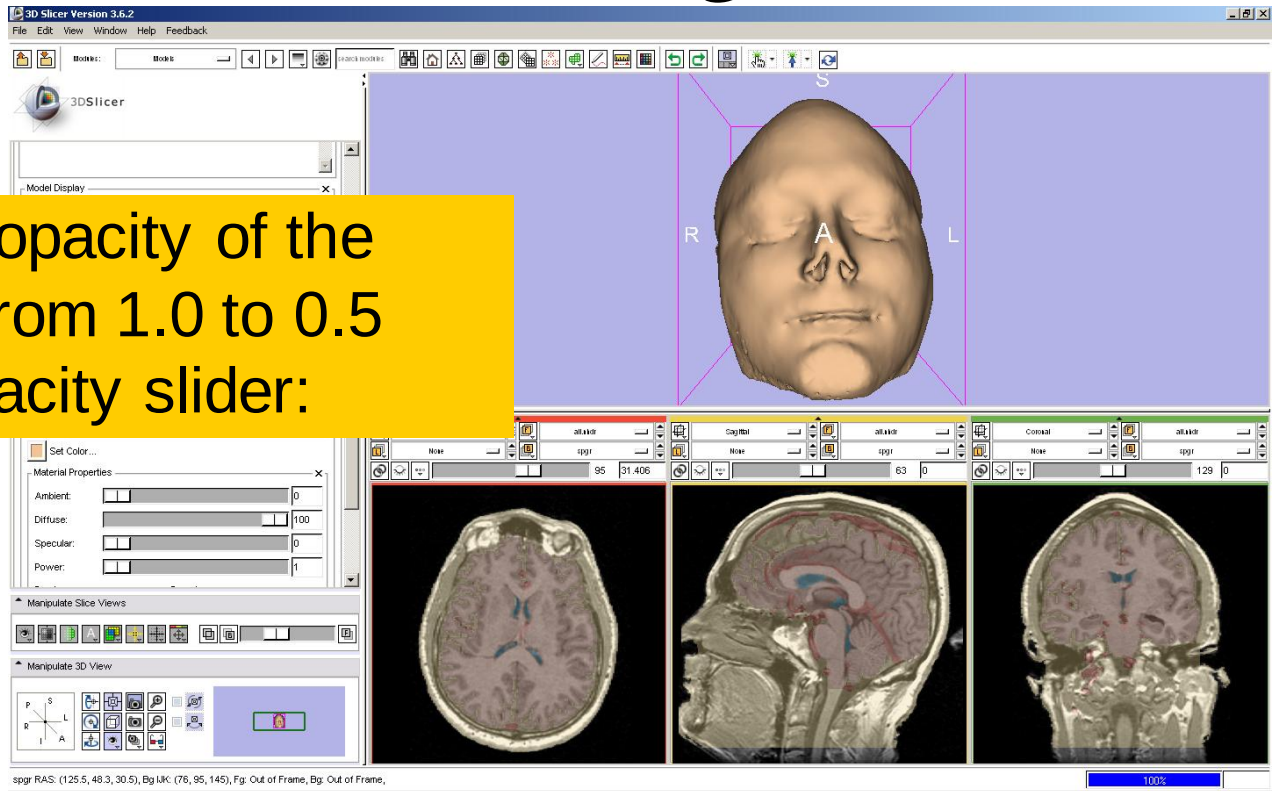
Visualizing a 3D model

Select the model **Skin.vtk**
Click on the icon **Set Color** and choose a new color for the 3D model of the head.



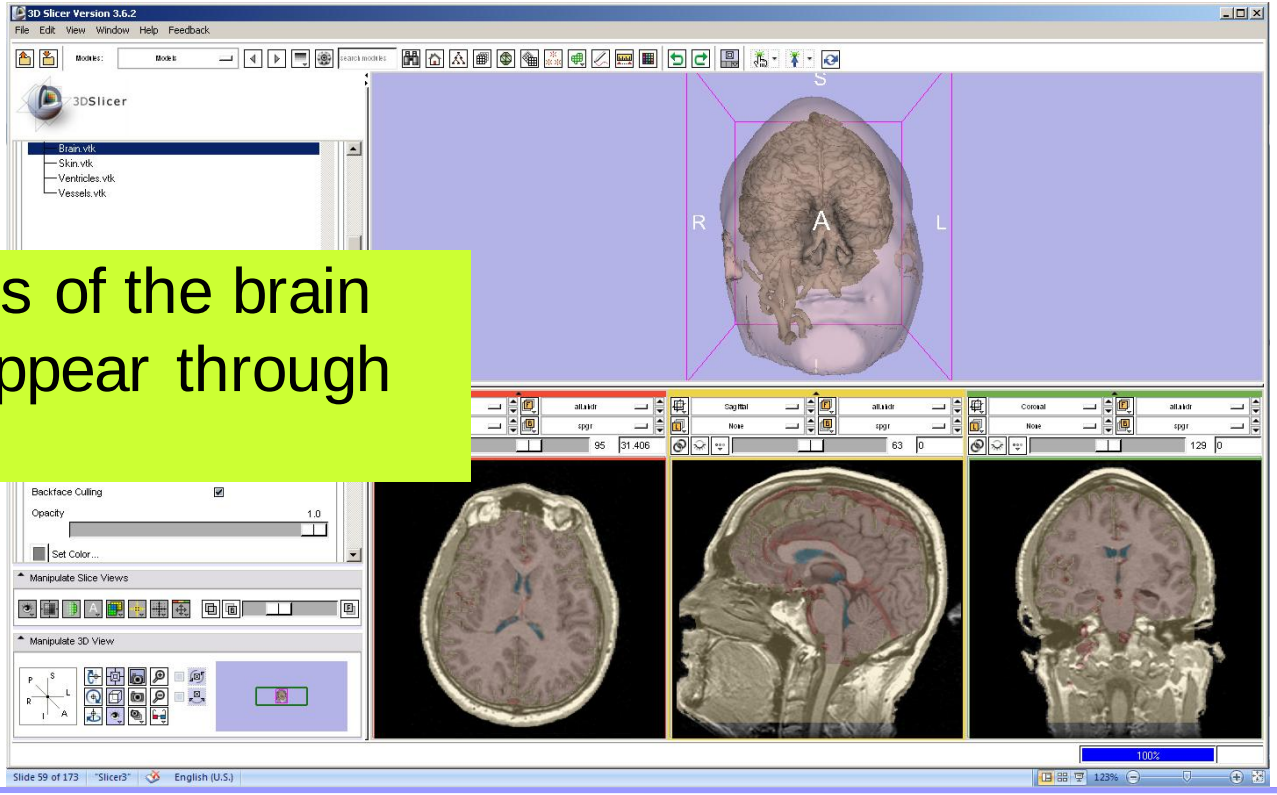
Visualizing a 3D model

Change the opacity of the skin model from 1.0 to 0.5 using the opacity slider:

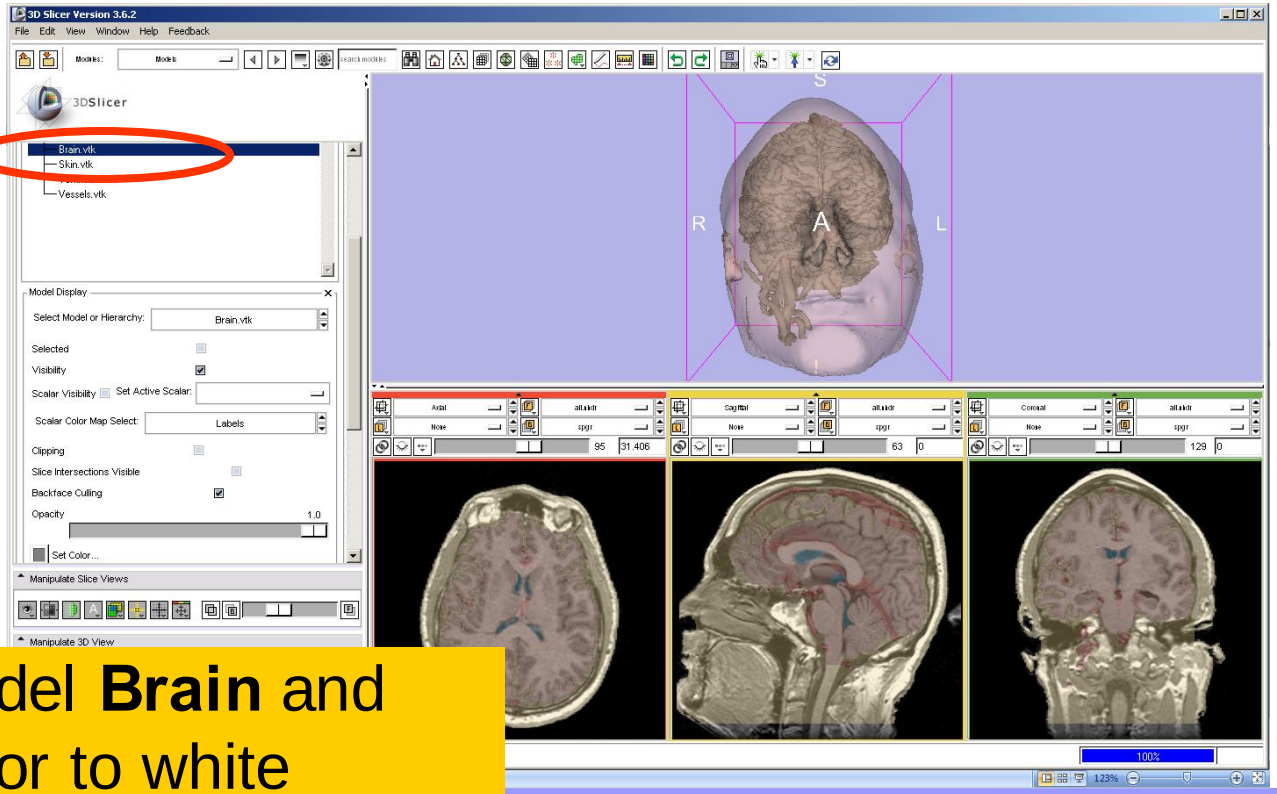


Visualizing a 3D model

The 3D models of the brain and vessels appear through the skin

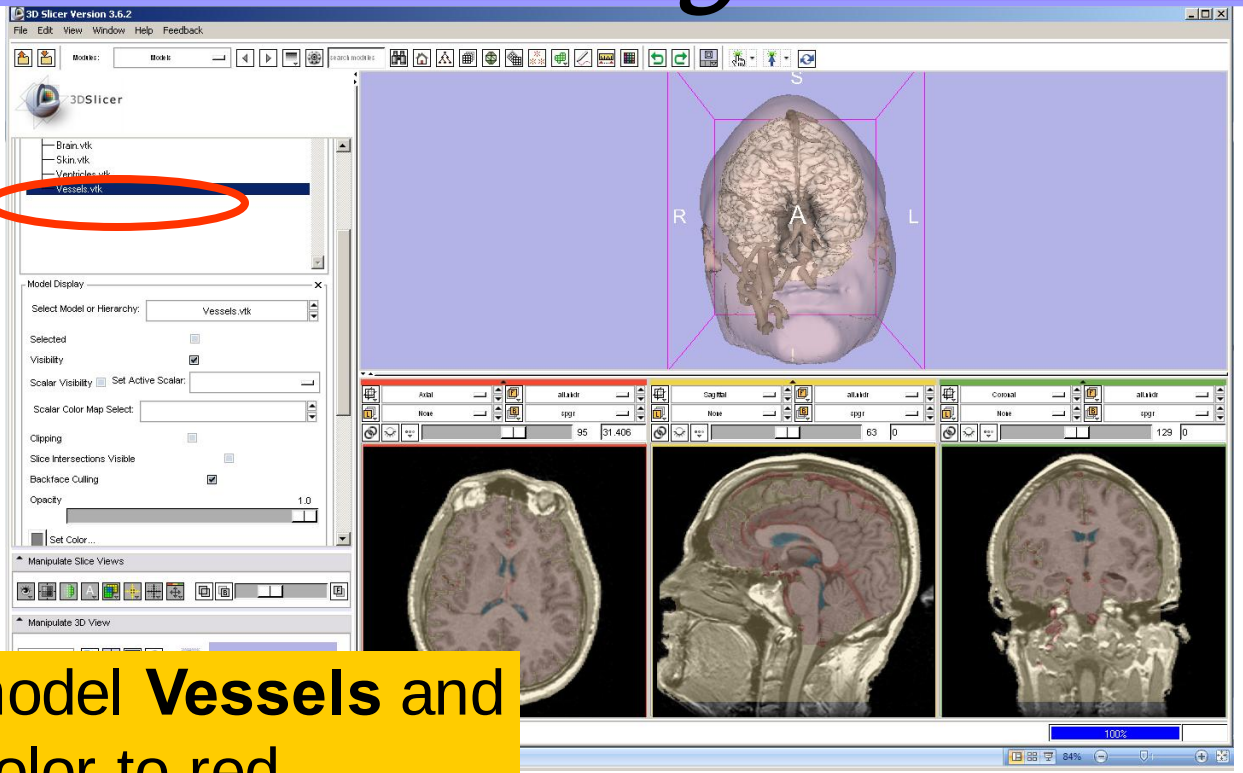


Visualizing a 3D model



Select the model **Brain** and change its color to white

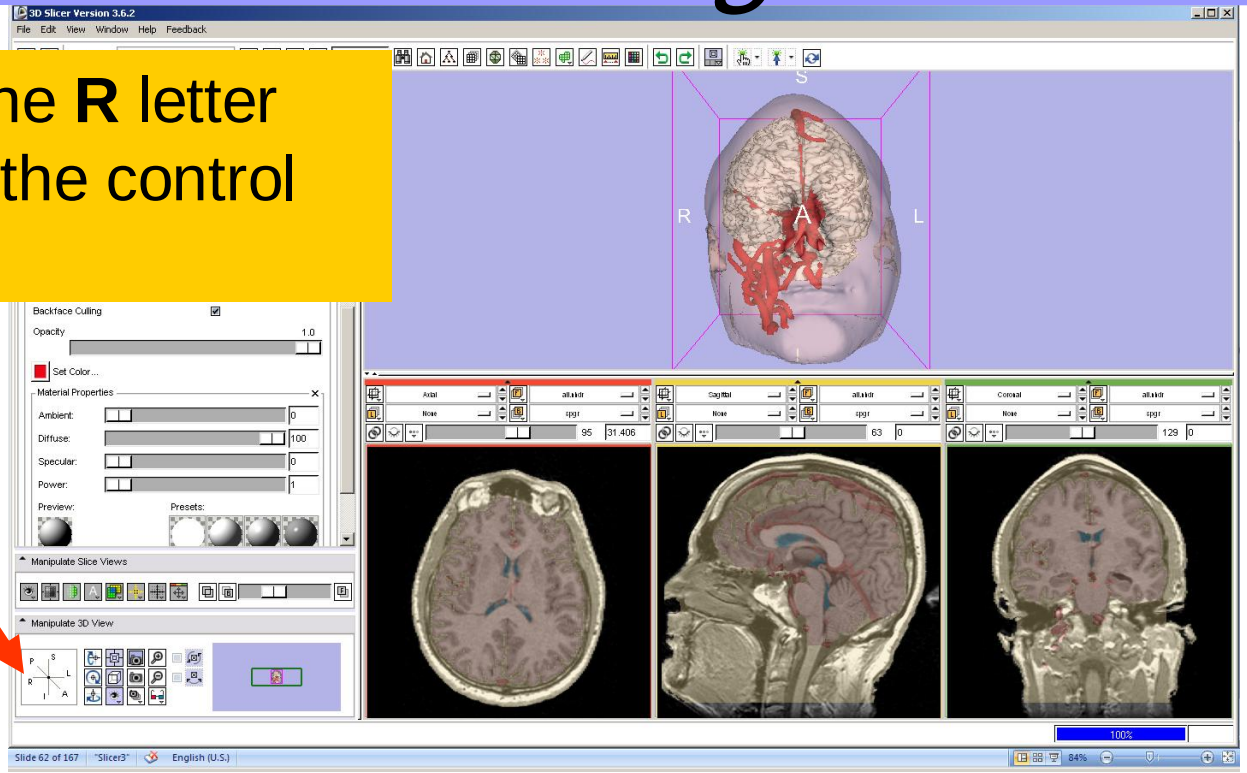
Visualizing a 3D model



Select the model **Vessels** and change its color to red

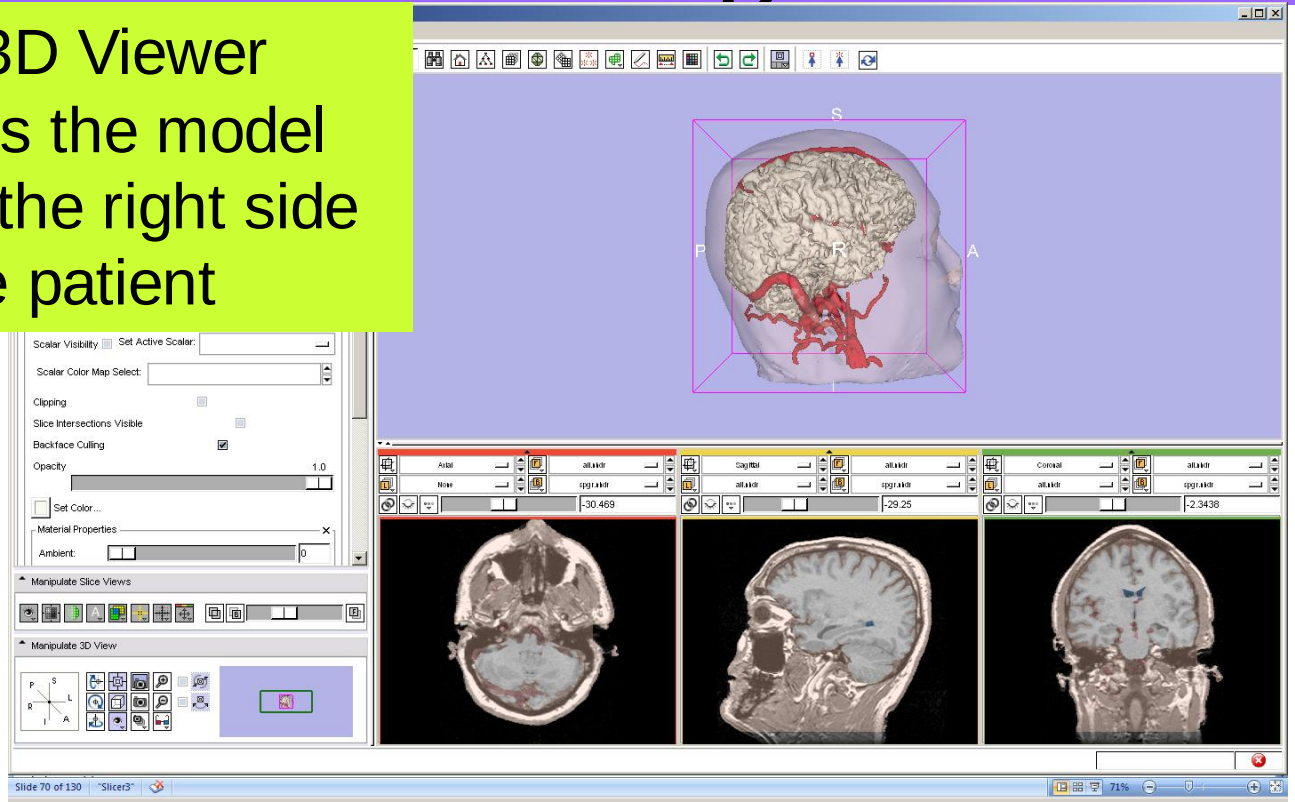
Visualizing a 3D model

Click on the **R** letter (Right) in the control window



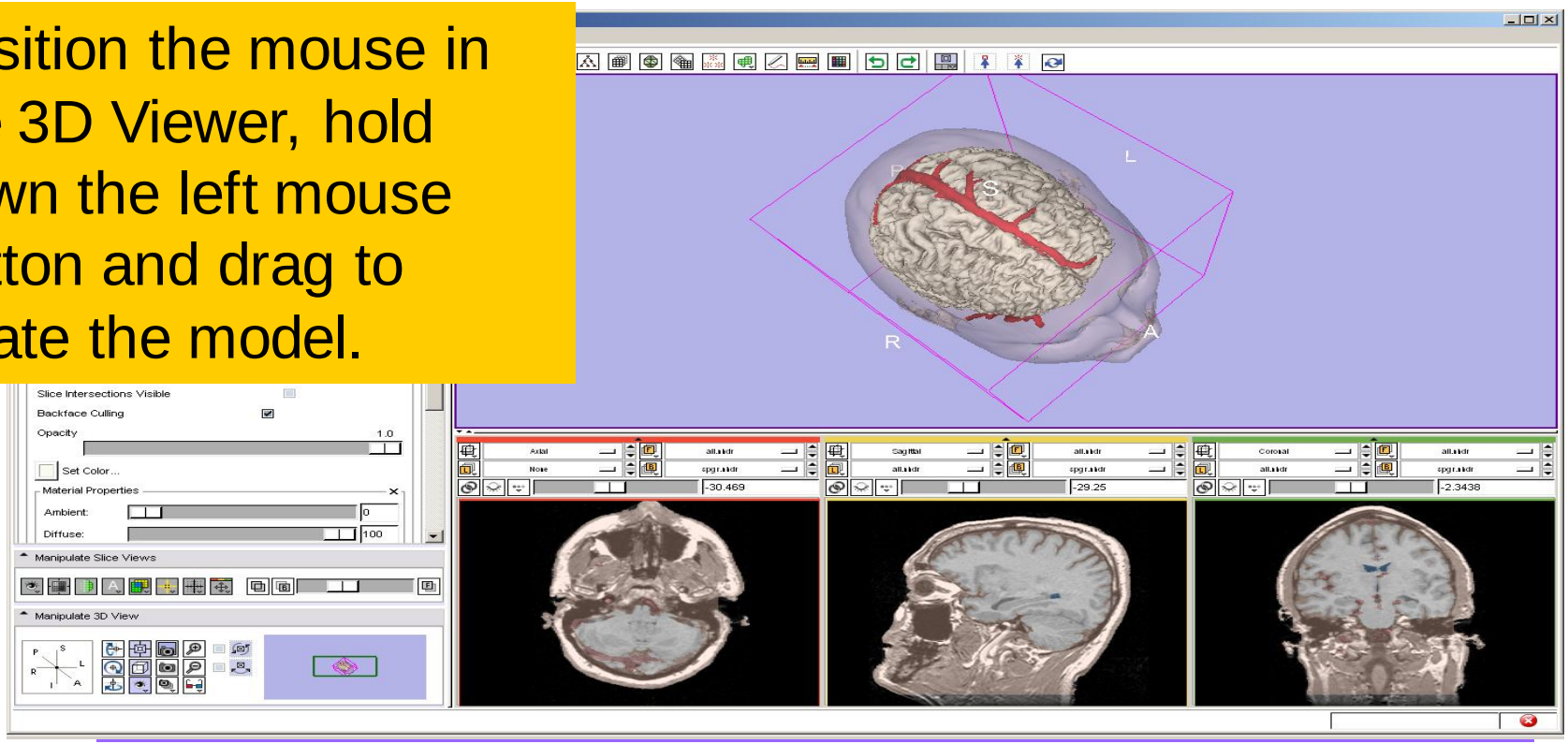
Visualizing a 3D model

The 3D Viewer shows the model from the right side of the patient



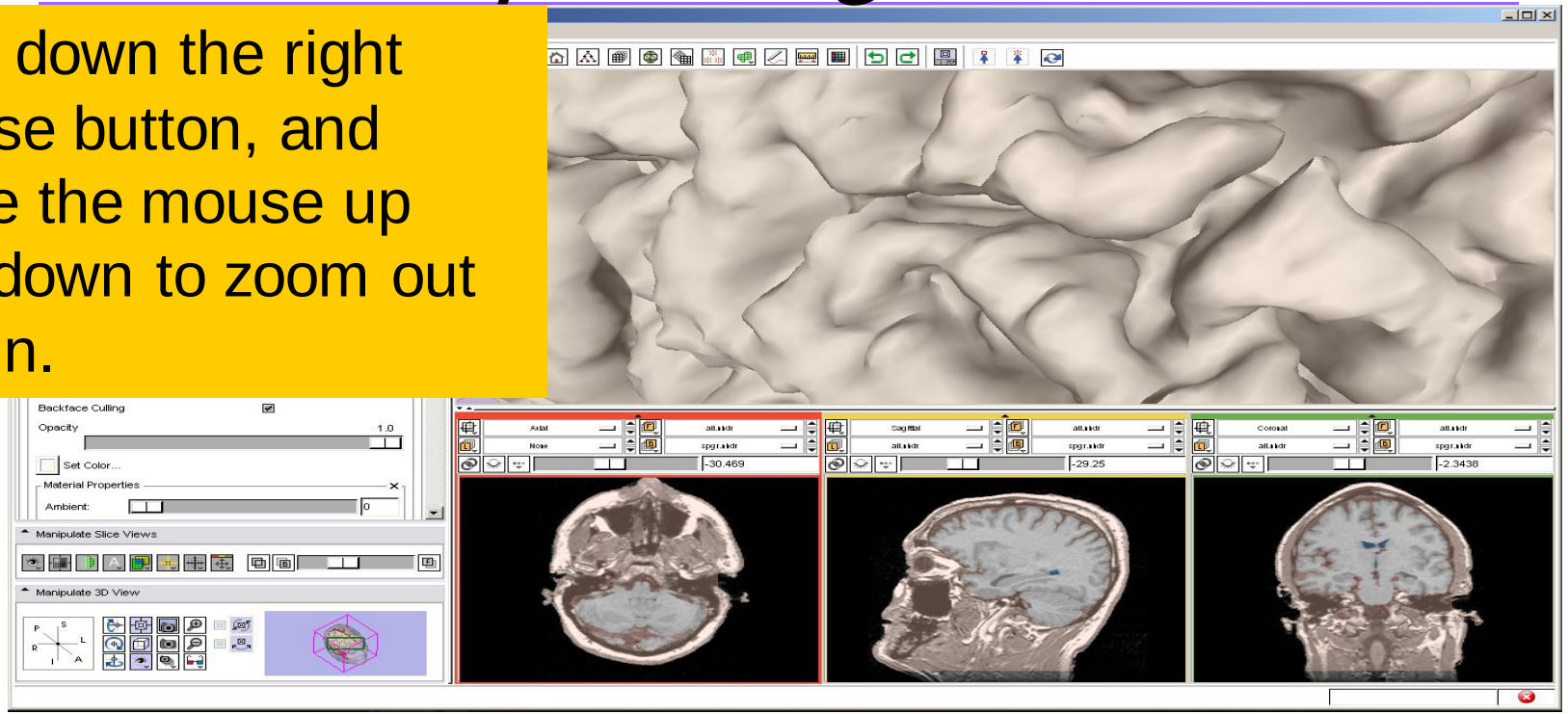
Manipulating a 3D model

Position the mouse in the 3D Viewer, hold down the left mouse button and drag to rotate the model.



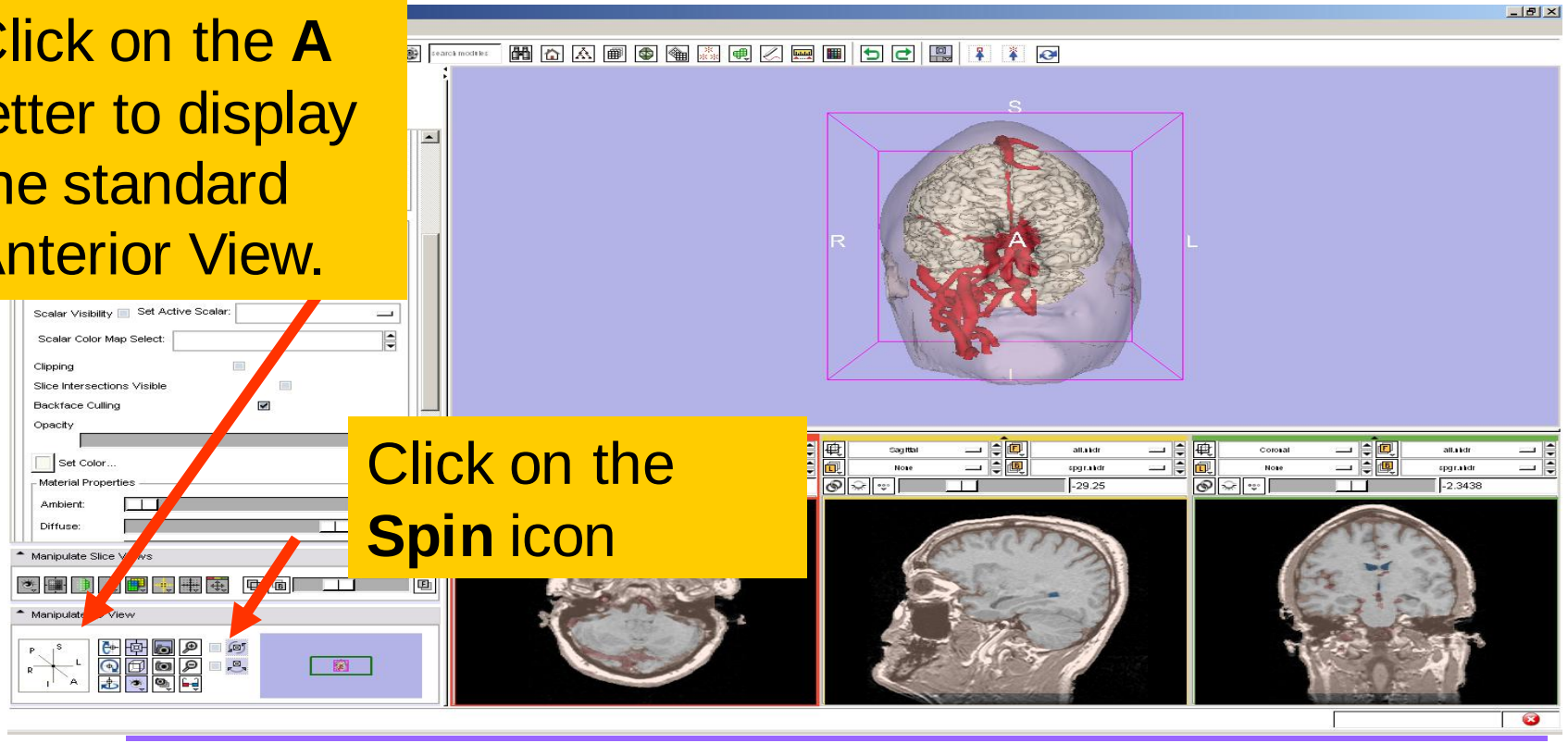
Manipulating a 3D model

Hold down the right mouse button, and move the mouse up and down to zoom out and in.



Manipulating a 3D model

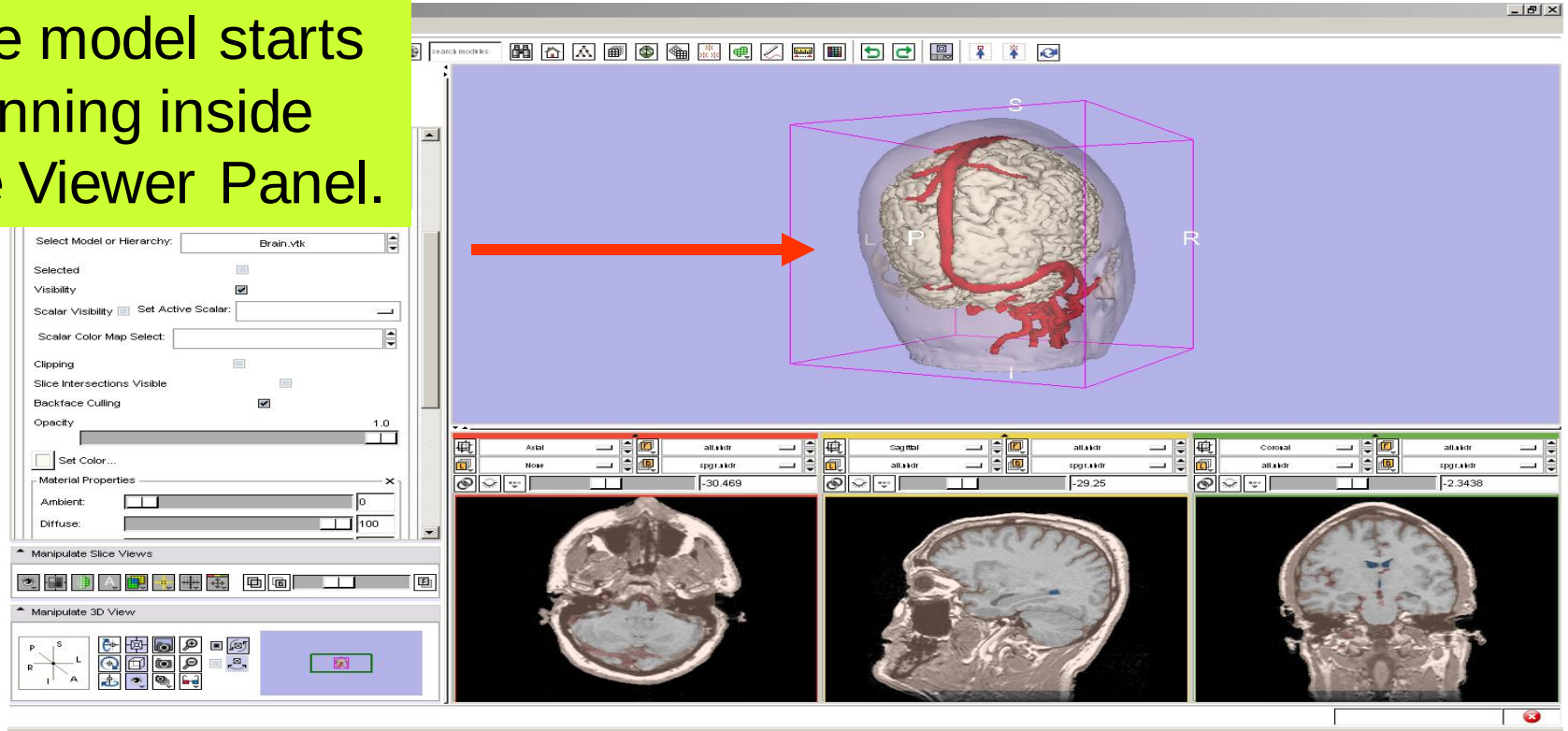
Click on the **A** letter to display the standard Anterior View.



Click on the **Spin** icon

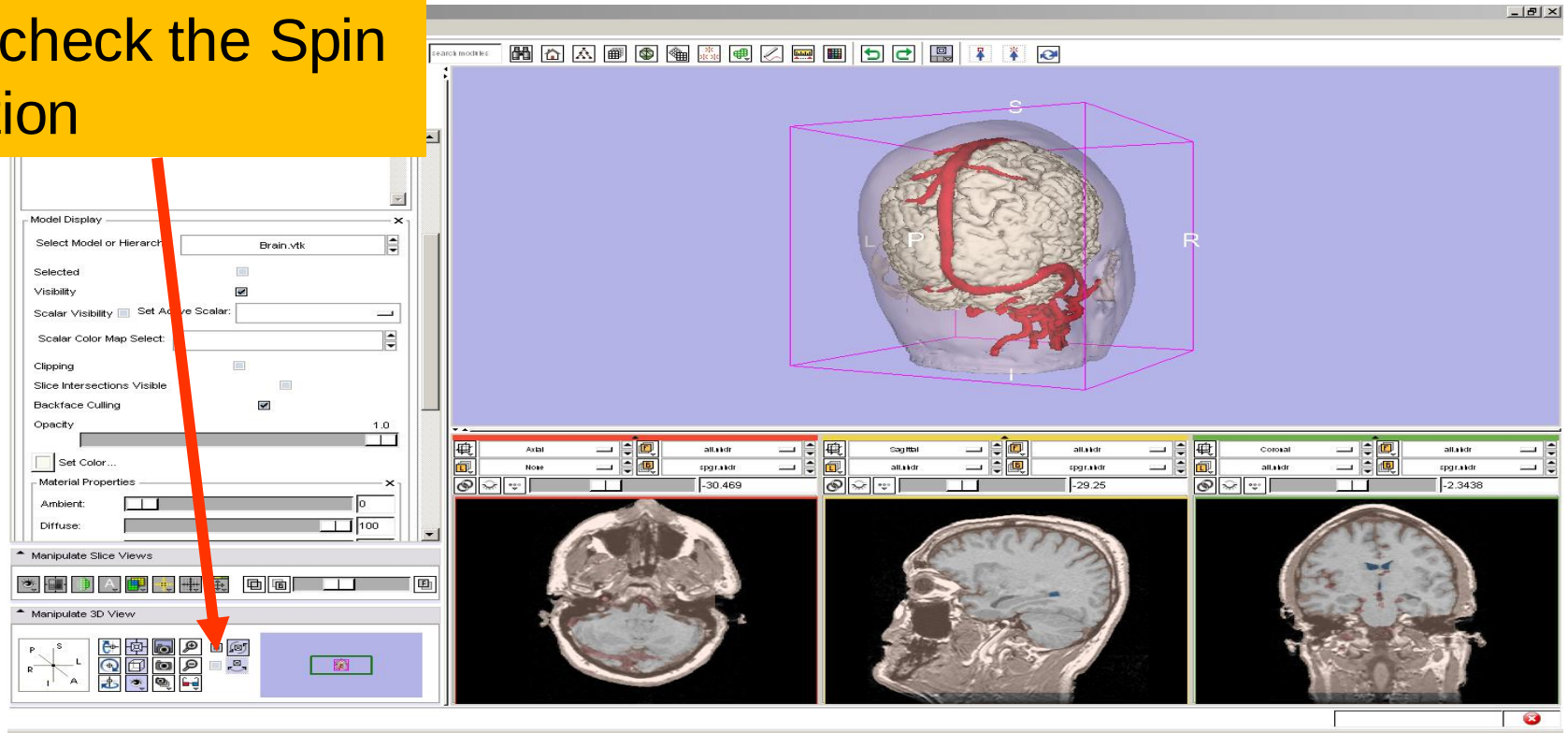
Manipulating a 3D model

The model starts spinning inside the Viewer Panel.



Manipulating a 3D model

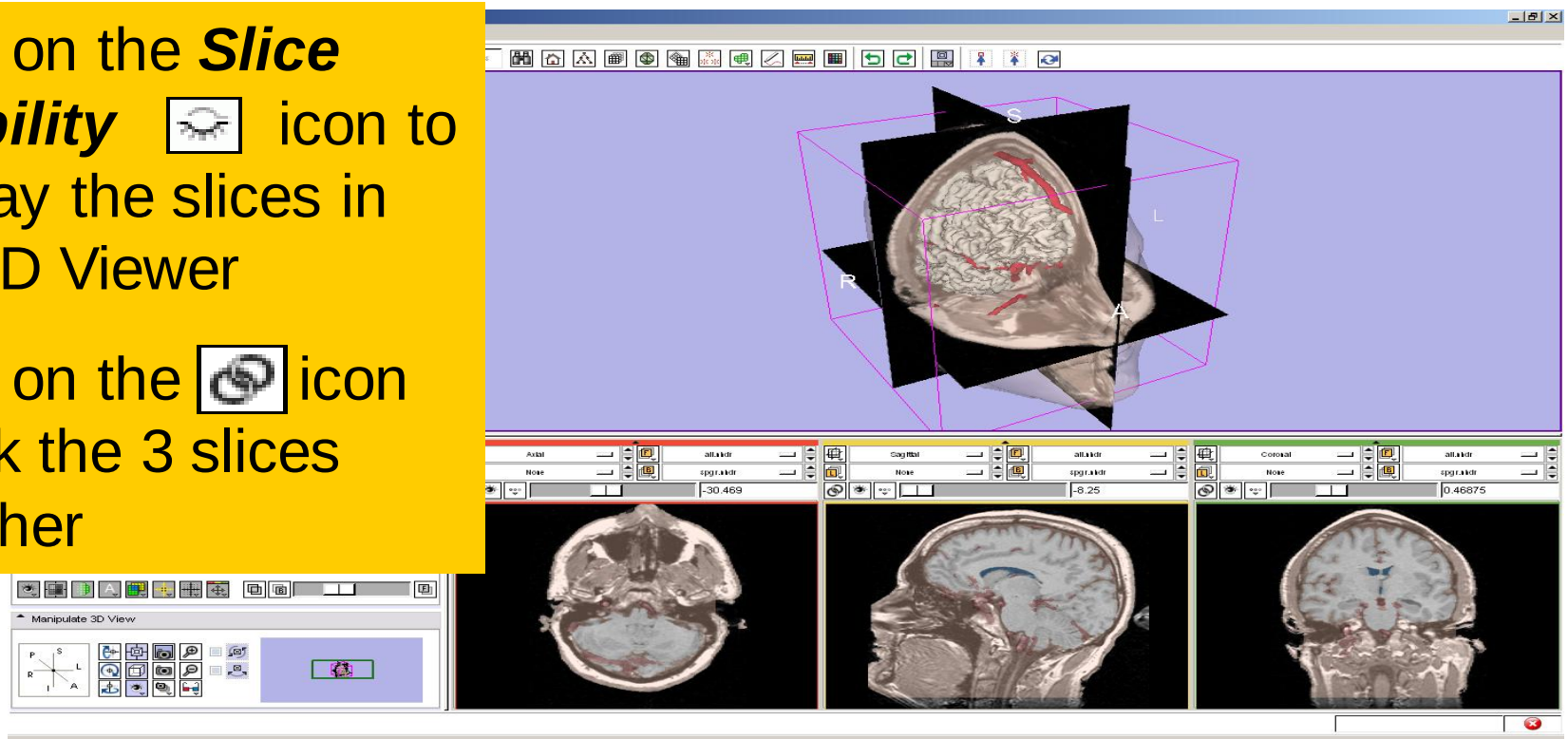
Uncheck the Spin option



Manipulating a 3D model

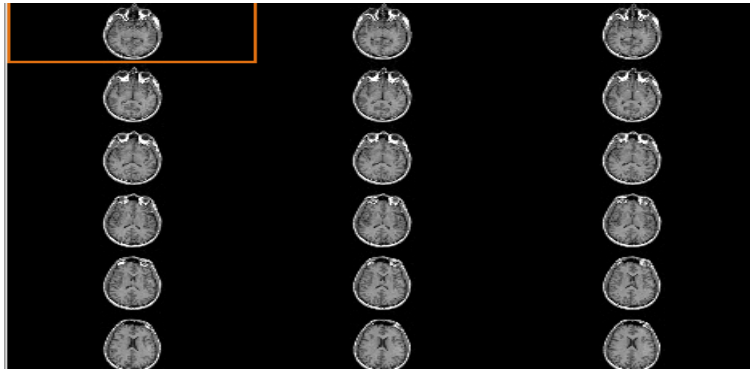
Click on the ***Slice Visibility*** icon to display the slices in the 3D Viewer

Click on the icon to link the 3 slices together



Manipulating the images

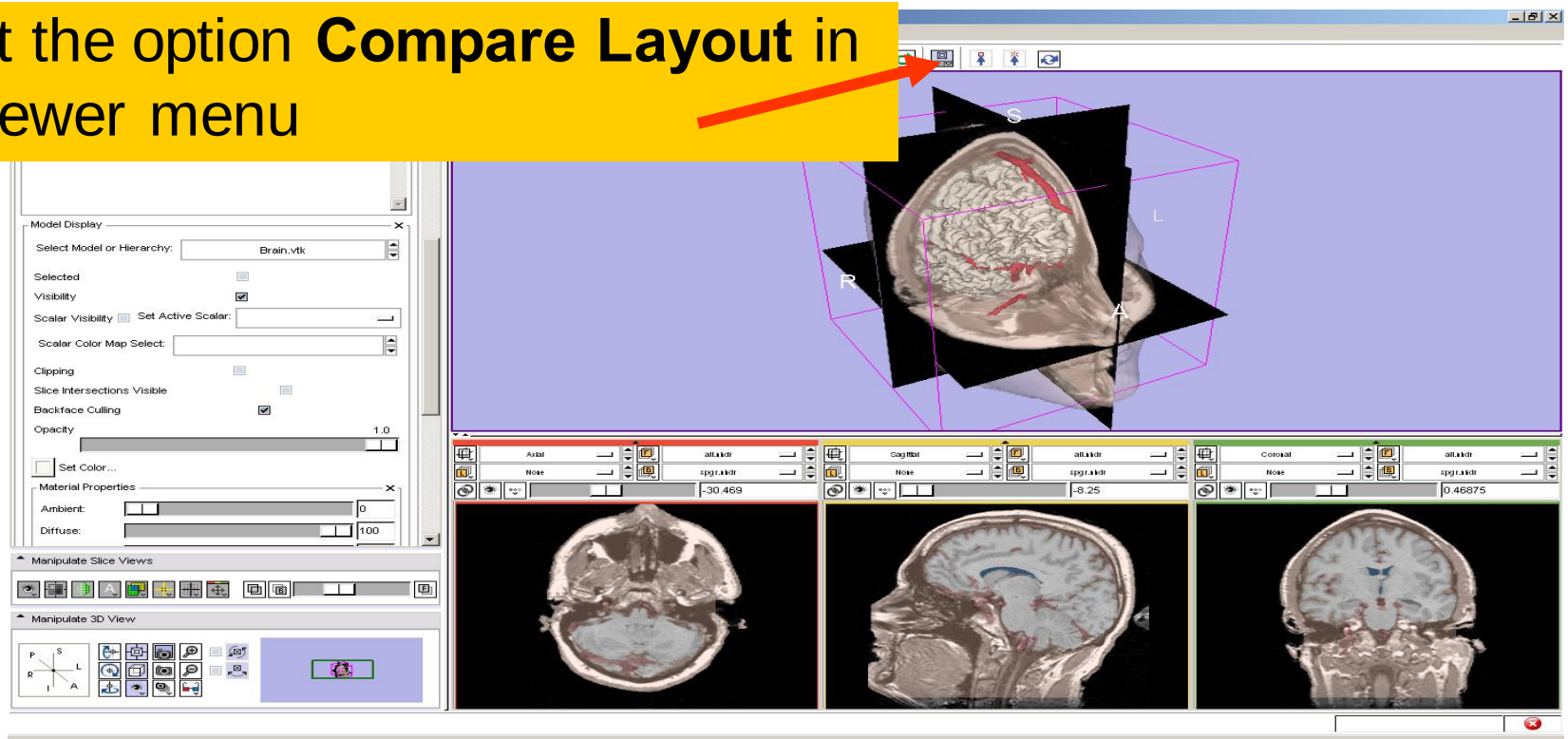
Use the sliders to slice through the volume in all three directions



Part 4: Lightbox viewer

Visualizing a 3D model

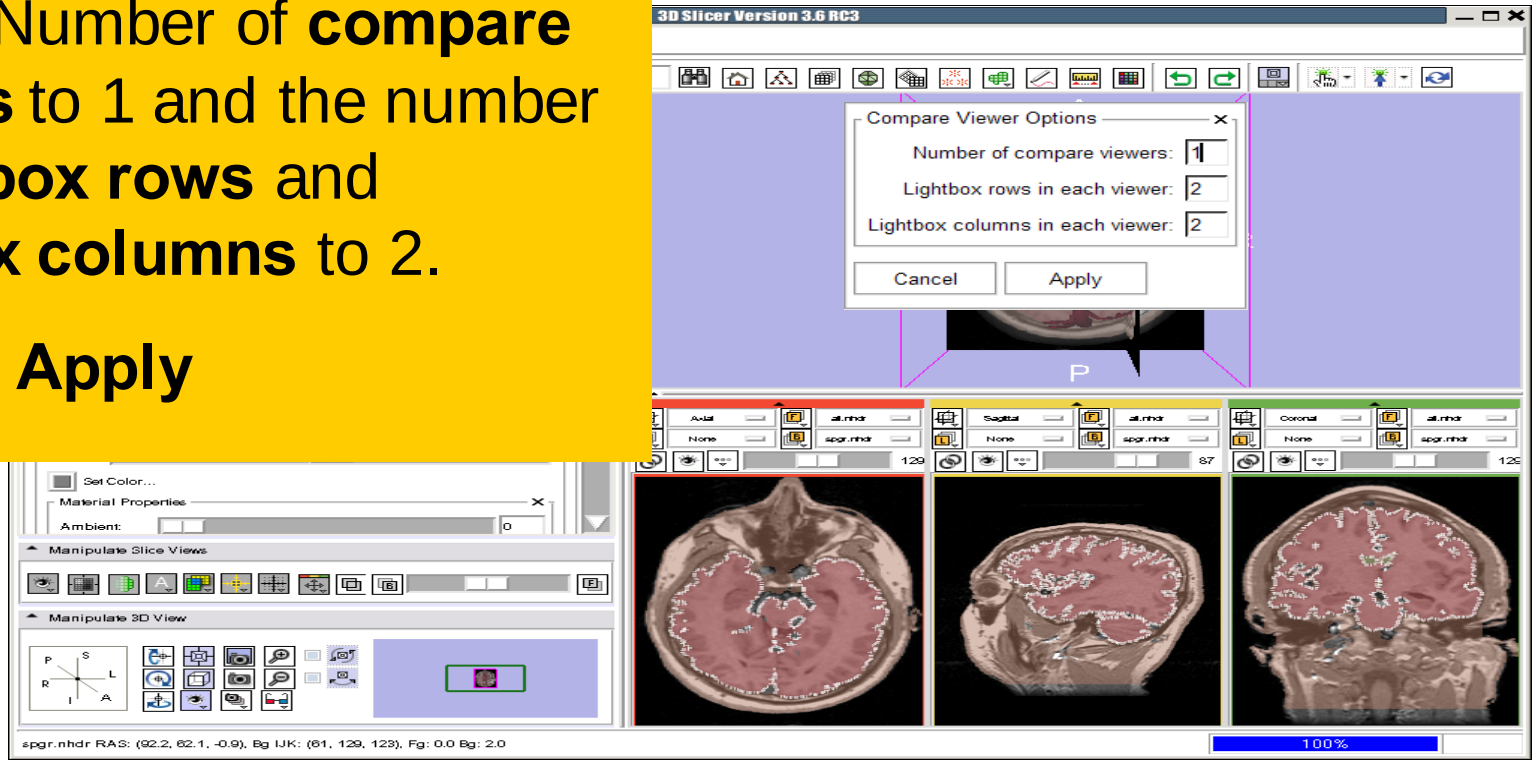
Select the option **Compare Layout** in the Viewer menu



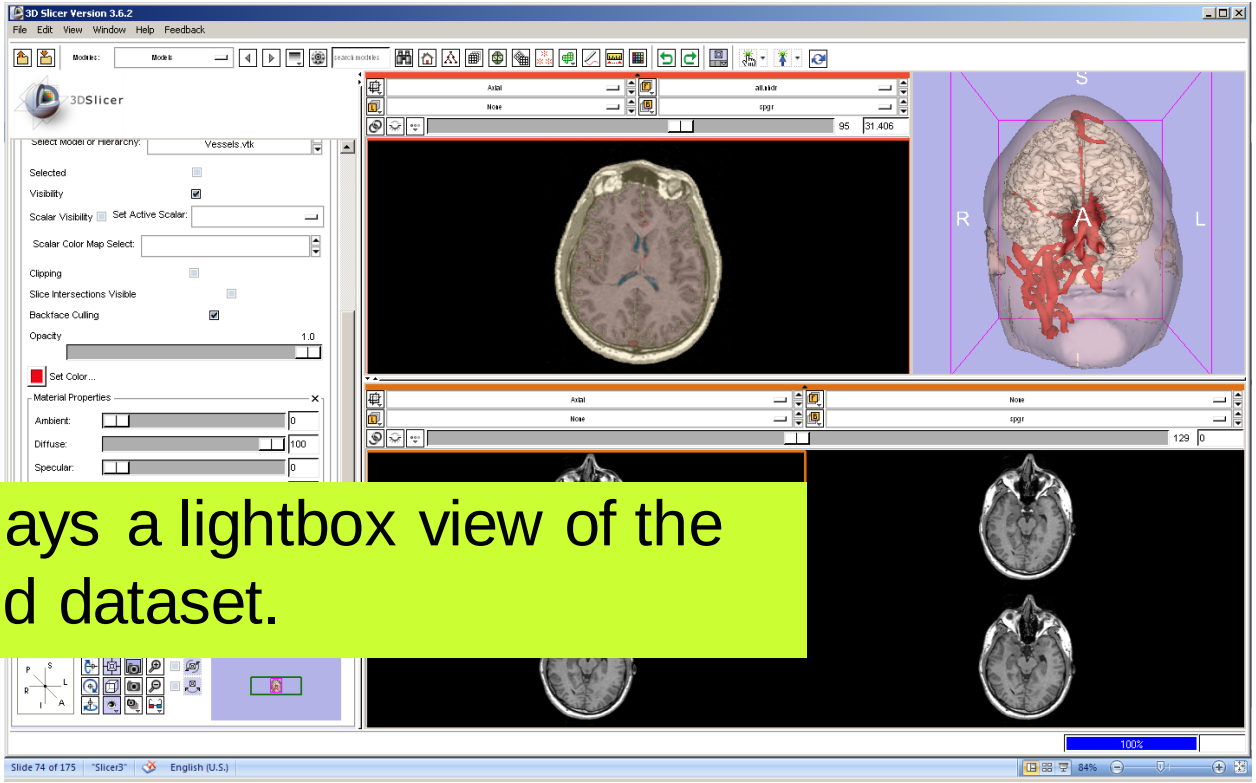
Visualizing a 3D model

Set the Number of **compare Viewers** to 1 and the number of **lightbox rows** and **lightbox columns** to 2.

Click on **Apply**

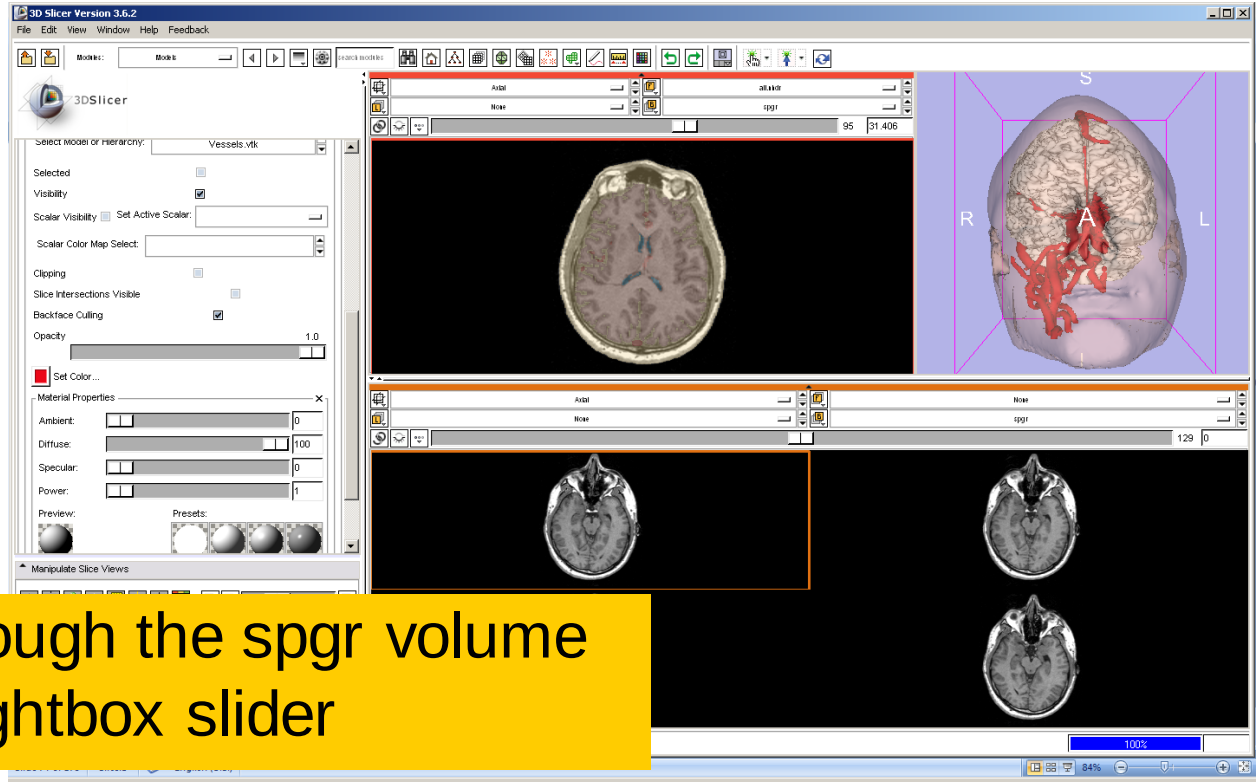


Lightbox viewer



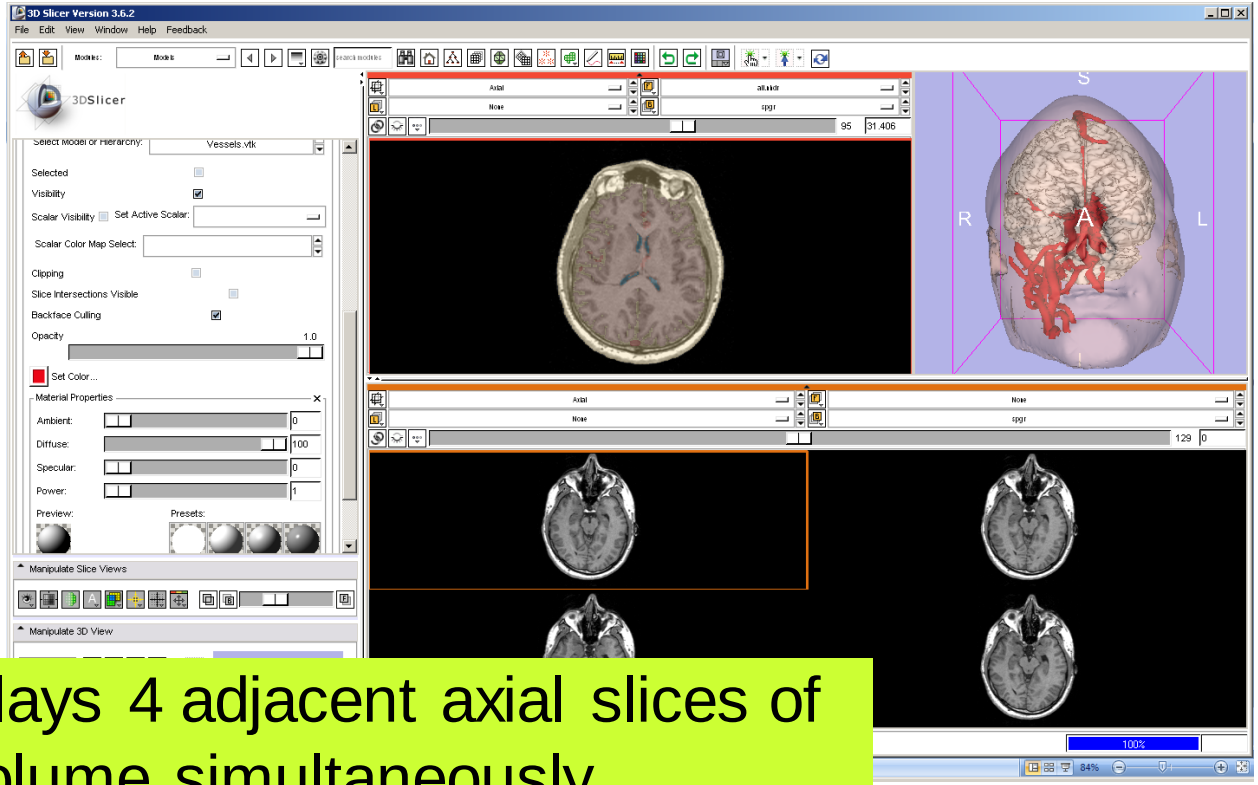
Slicer displays a lightbox view of the Background dataset.

Lightbox viewer



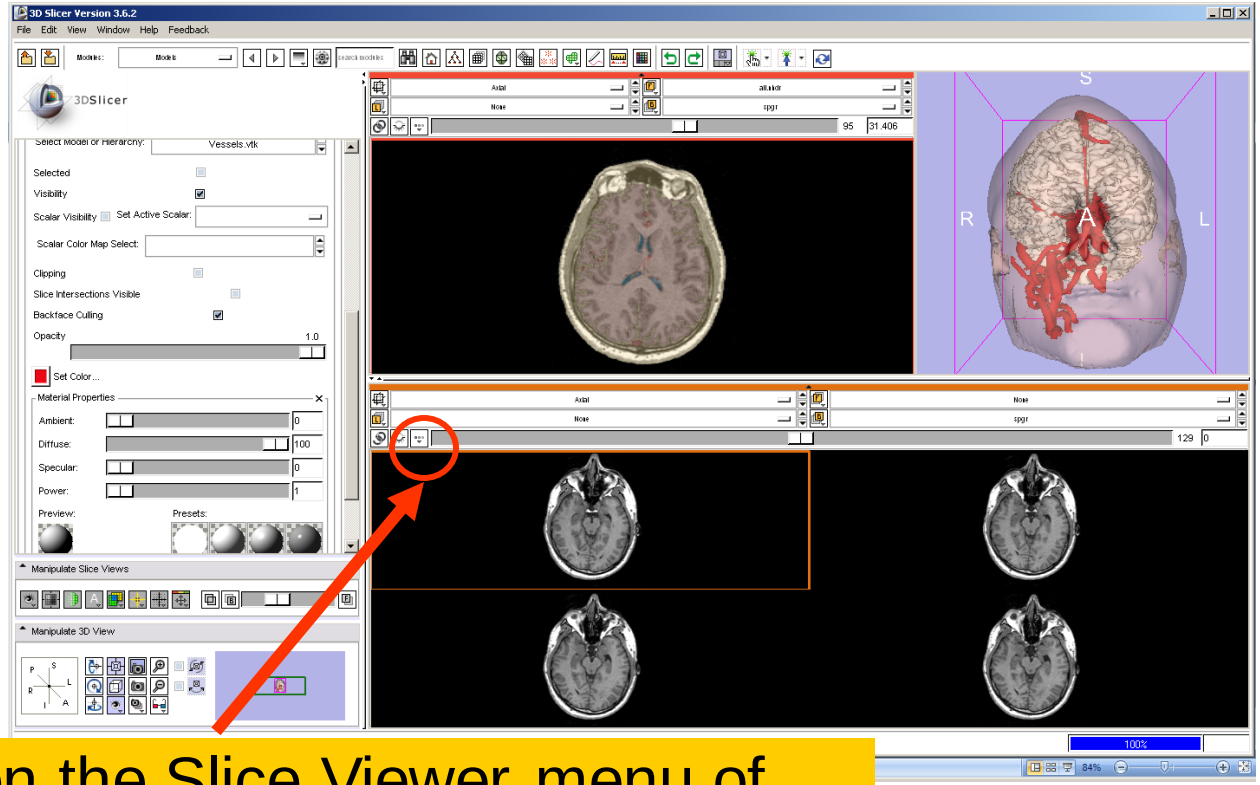
Browse through the spgr volume using the lightbox slider

Lightbox viewer



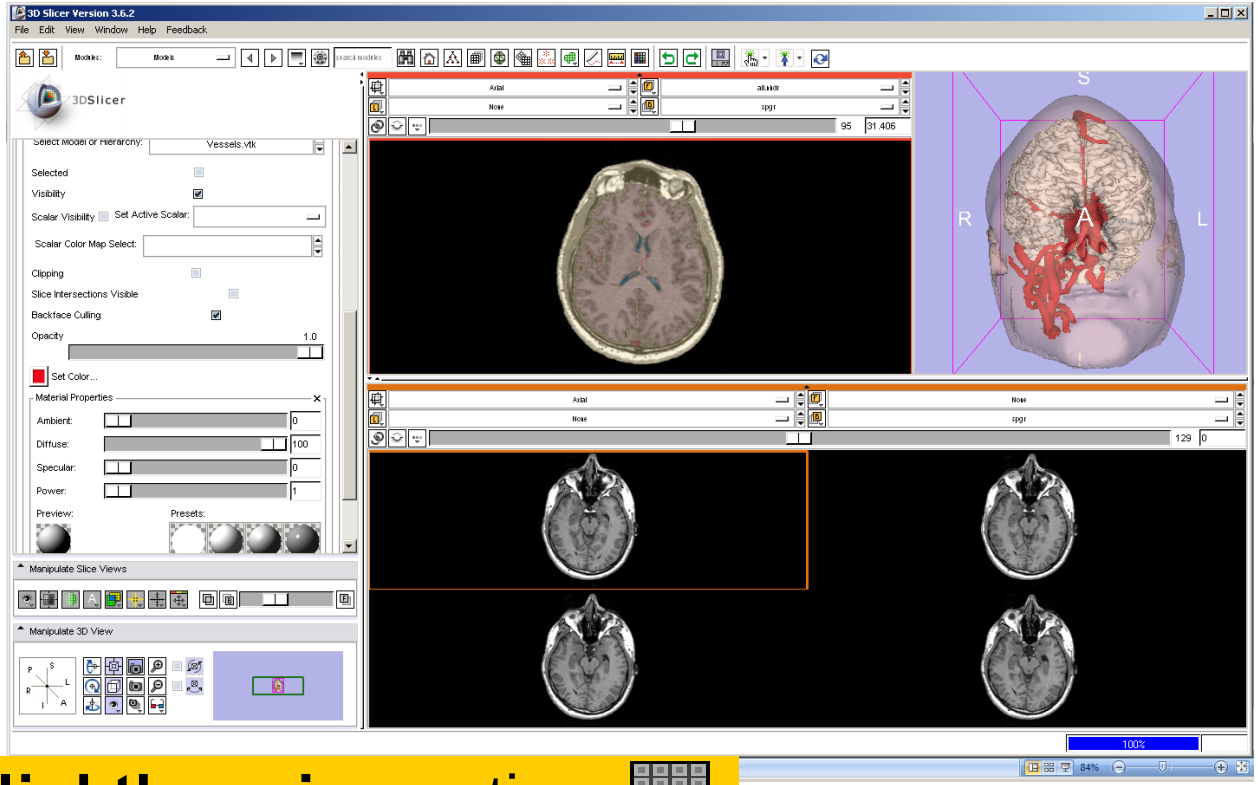
Slicer displays 4 adjacent axial slices of the spgr volume simultaneously

Lightbox viewer



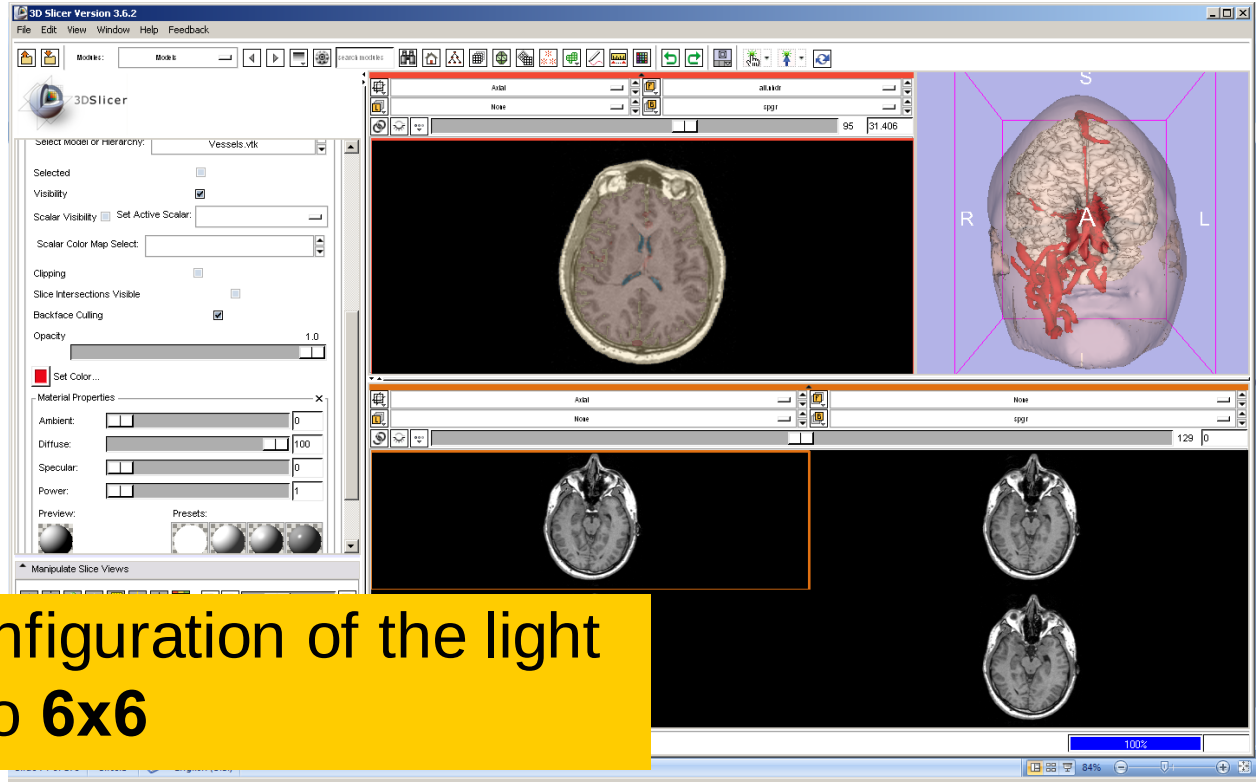
Left click on the Slice Viewer menu of the Compare Layout viewer

Lightbox viewer



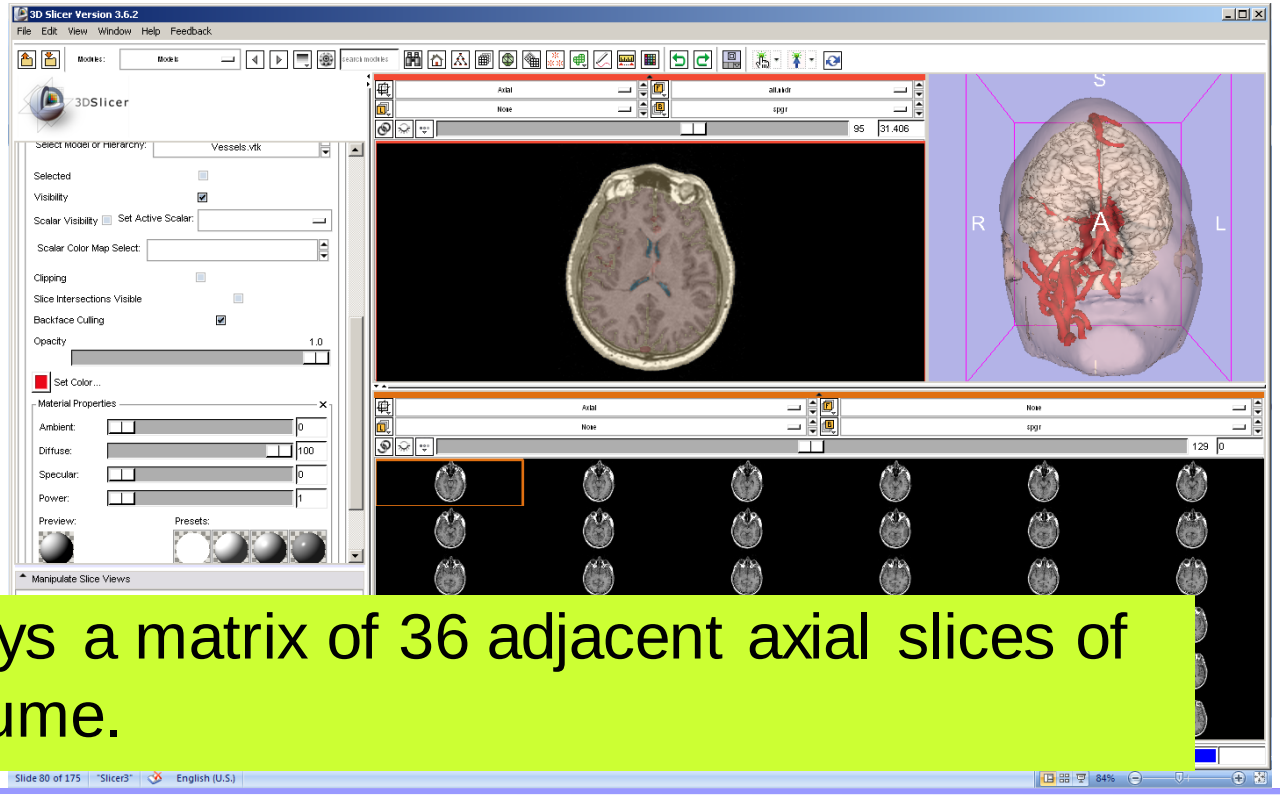
Select the **lightbox view** option 

Lightbox viewer



Set the configuration of the light box view to **6x6**

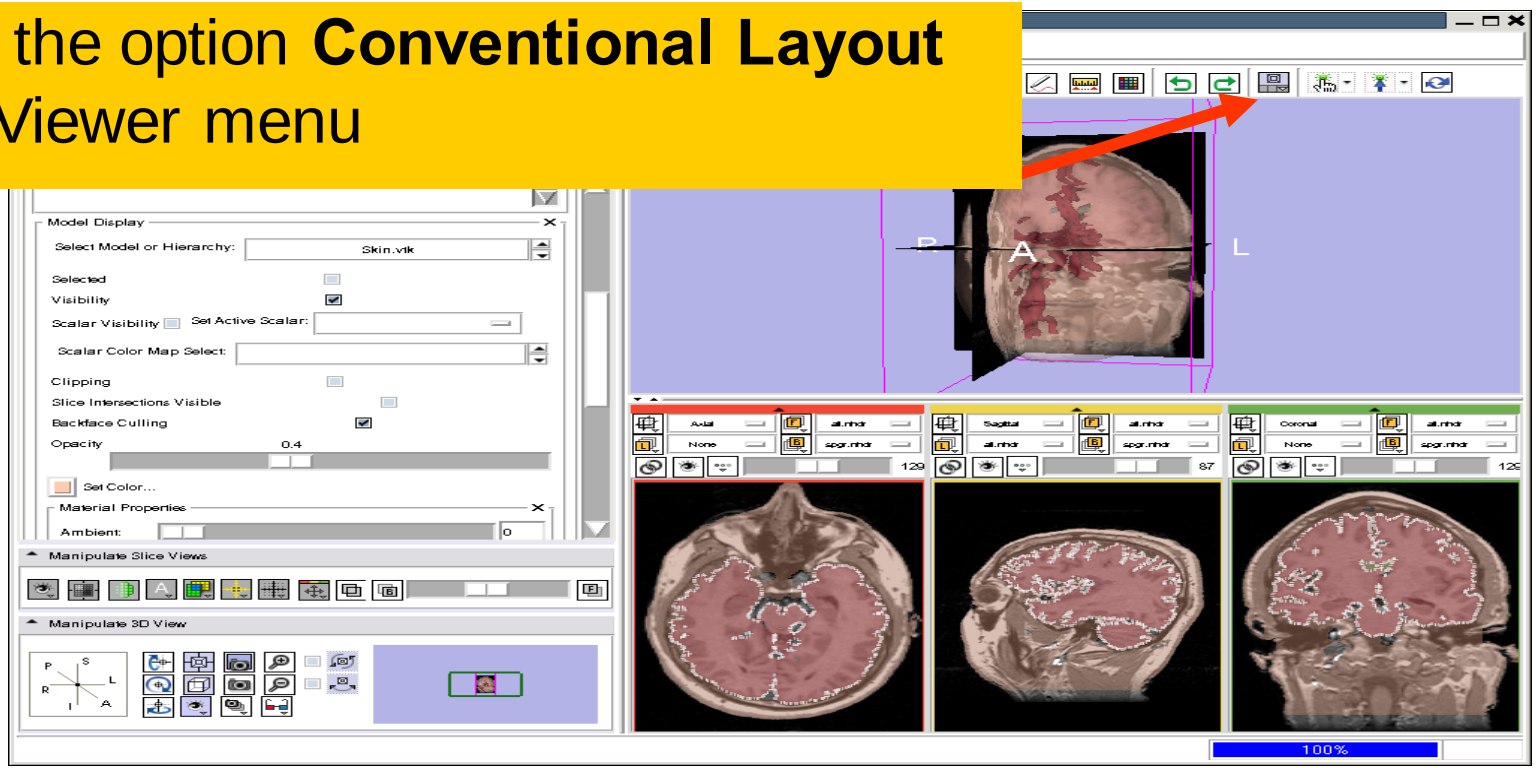
Lightbox viewer

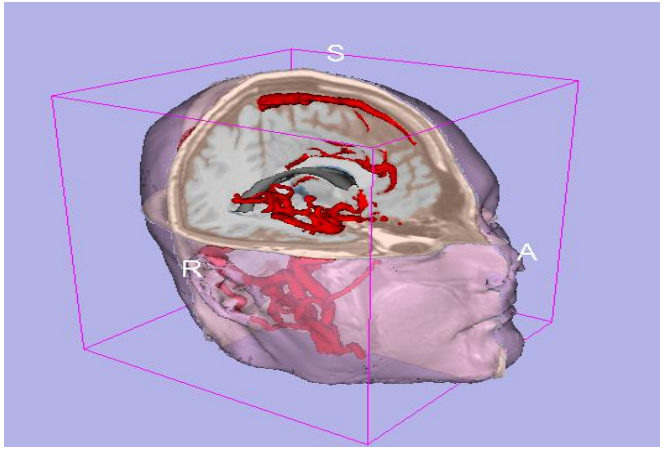


Slicer displays a matrix of 36 adjacent axial slices of the spgr volume.

Lightbox viewer

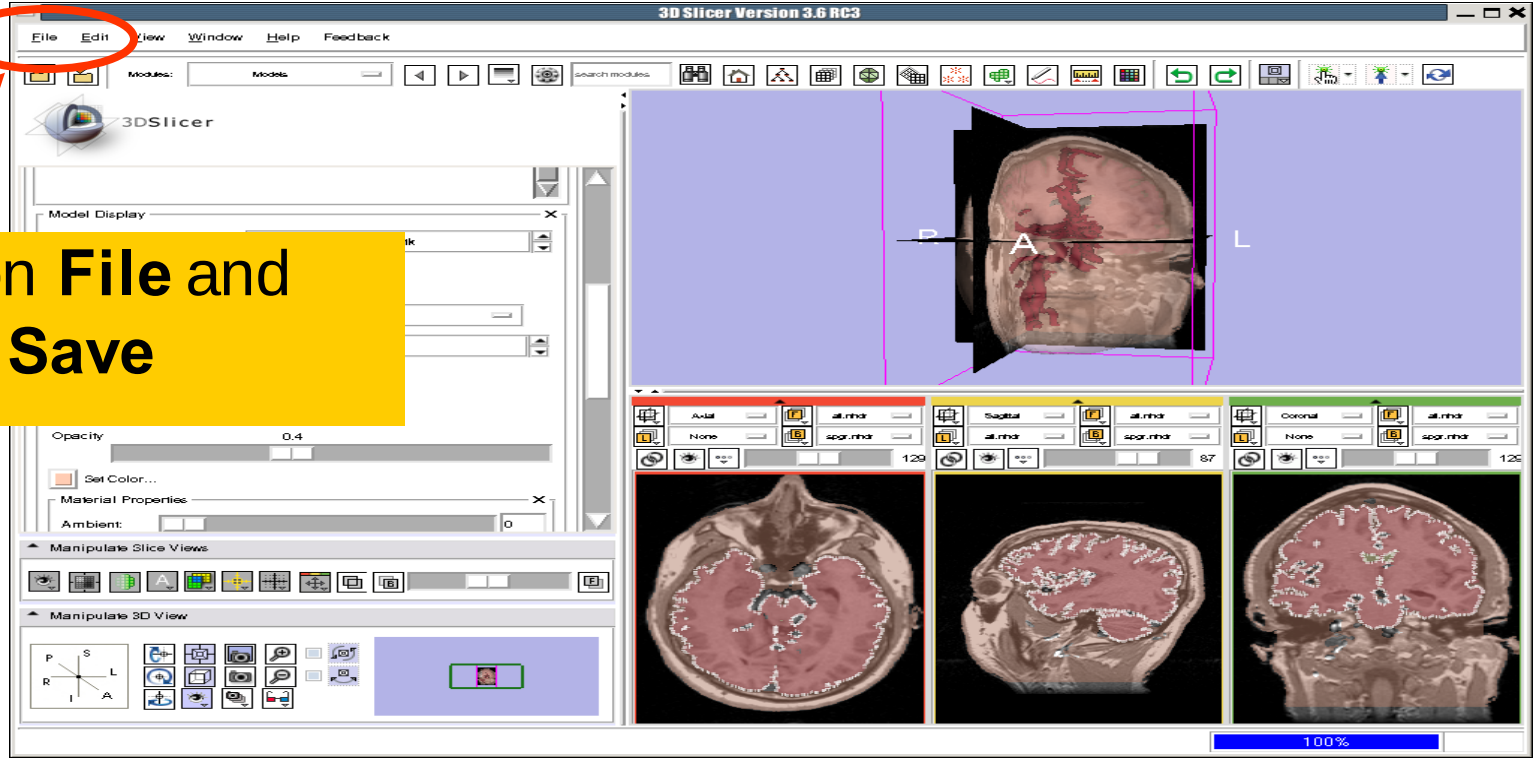
Select the option **Conventional Layout** in the Viewer menu





Part 5: Loading and saving a Scene

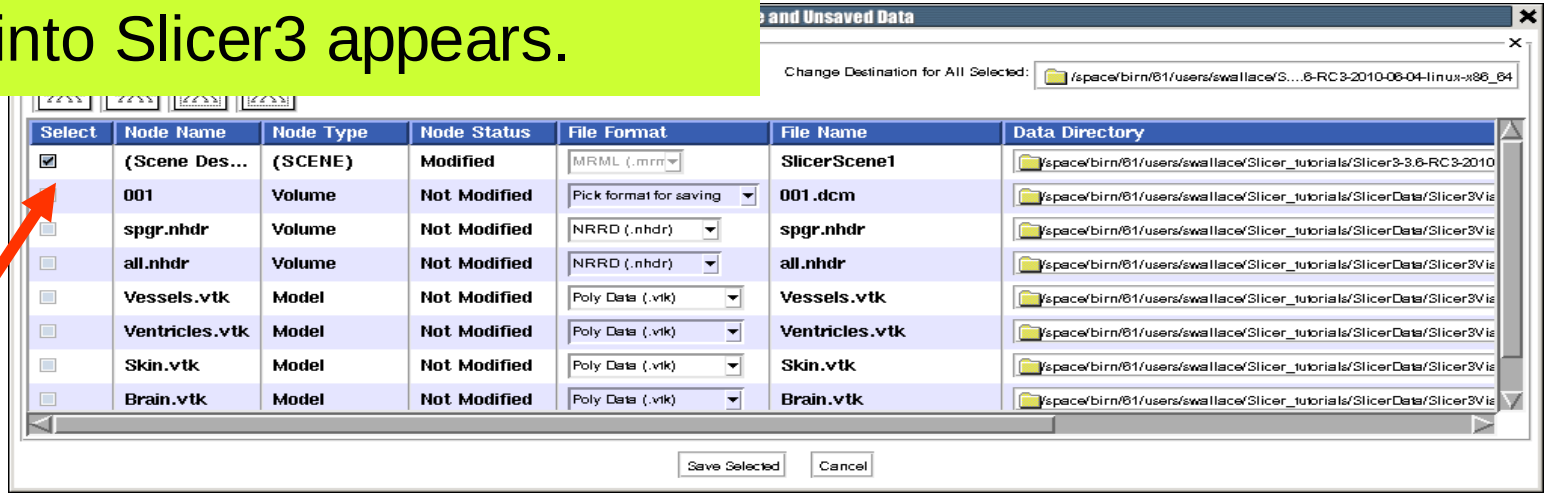
Saving Data



Click on **File** and Select **Save**

Saving Data

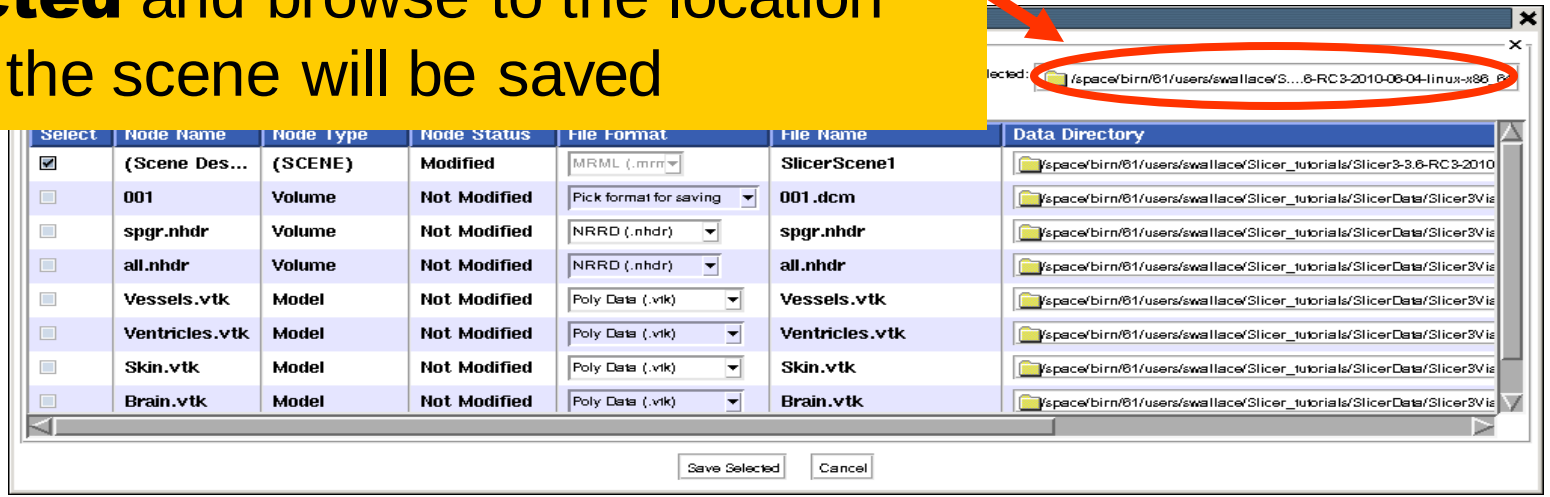
The list of elements currently loaded into Slicer3 appears.



Make sure only the first check box is selected

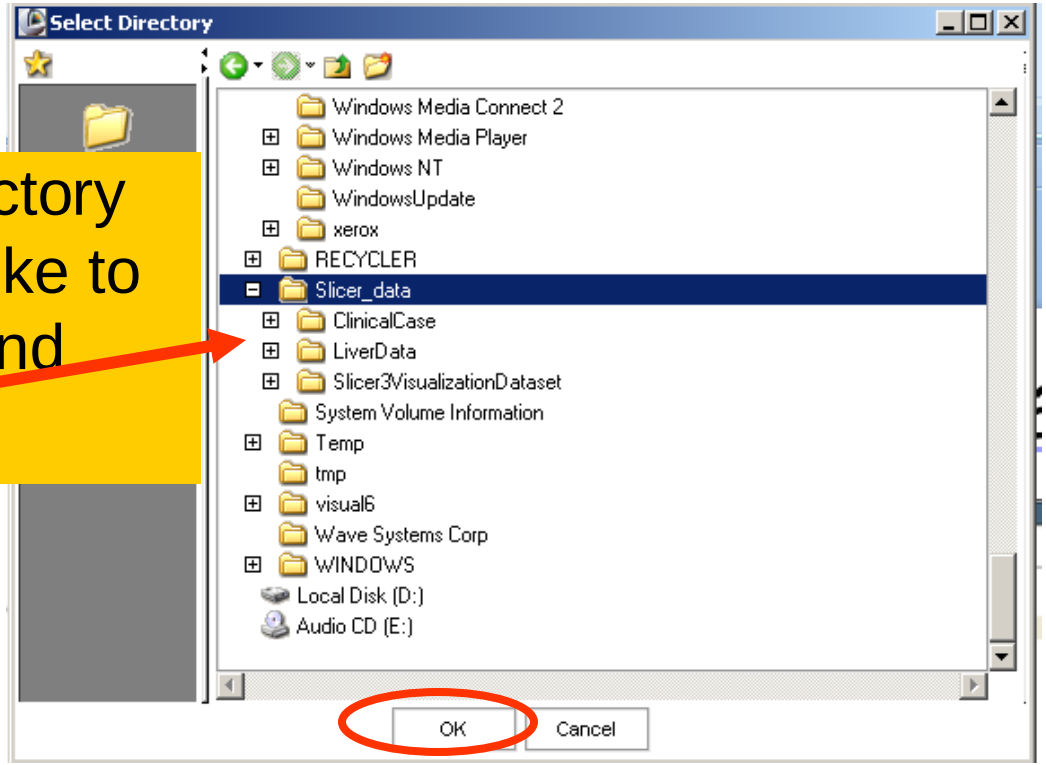
Saving Data

Click on **Change Destination for All Selected** and browse to the location where the scene will be saved



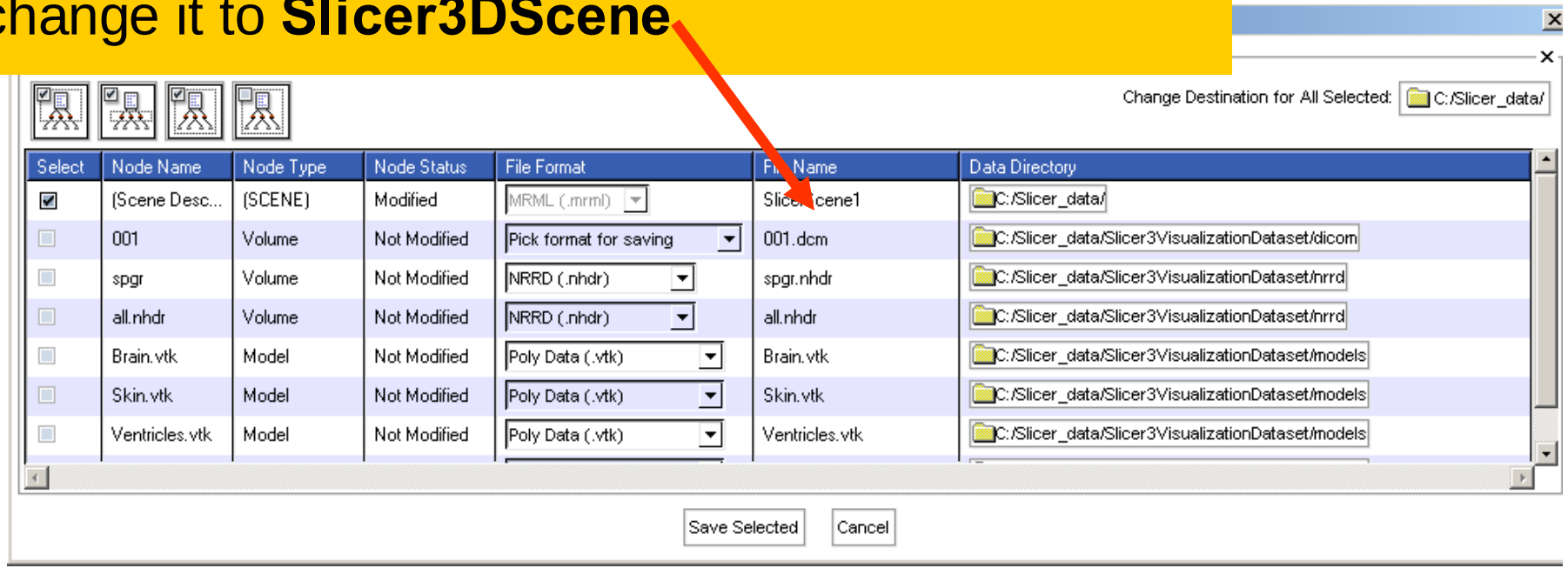
Saving Data

Browse to the directory where you would like to save your scene and click OK



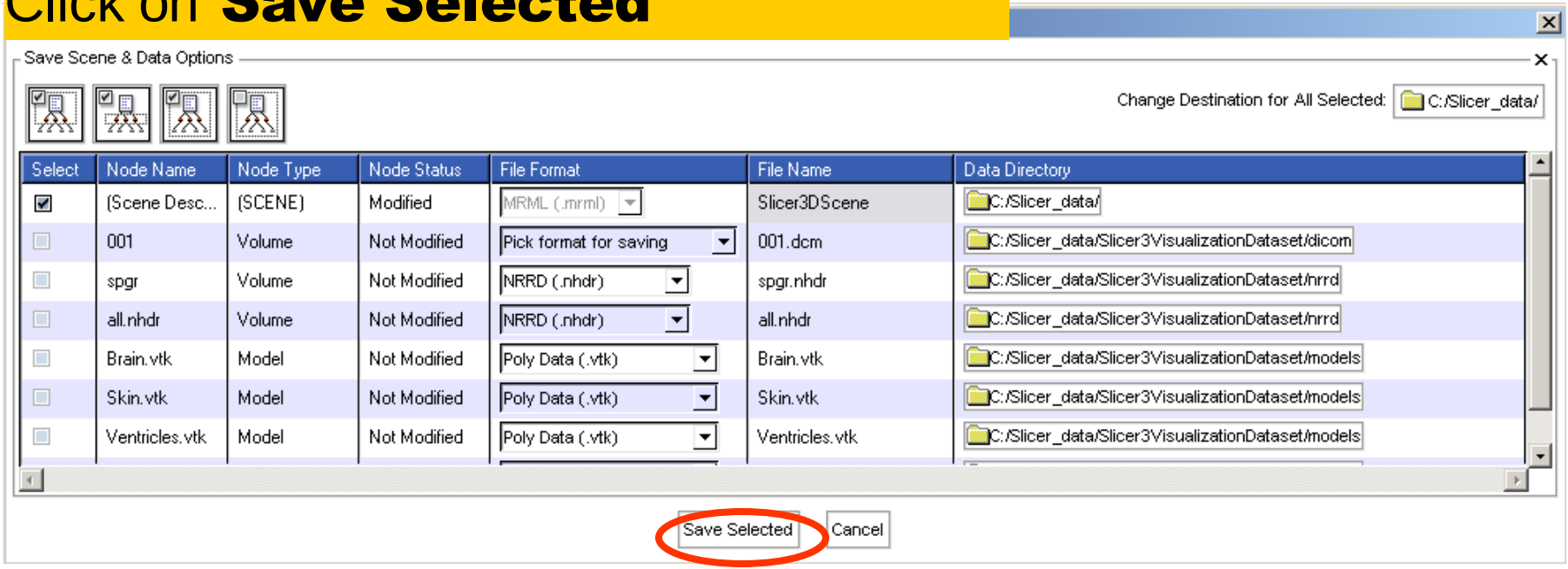
Saving Data

Double click on the file name **SlicerScene1** and change it to **Slicer3DScene**

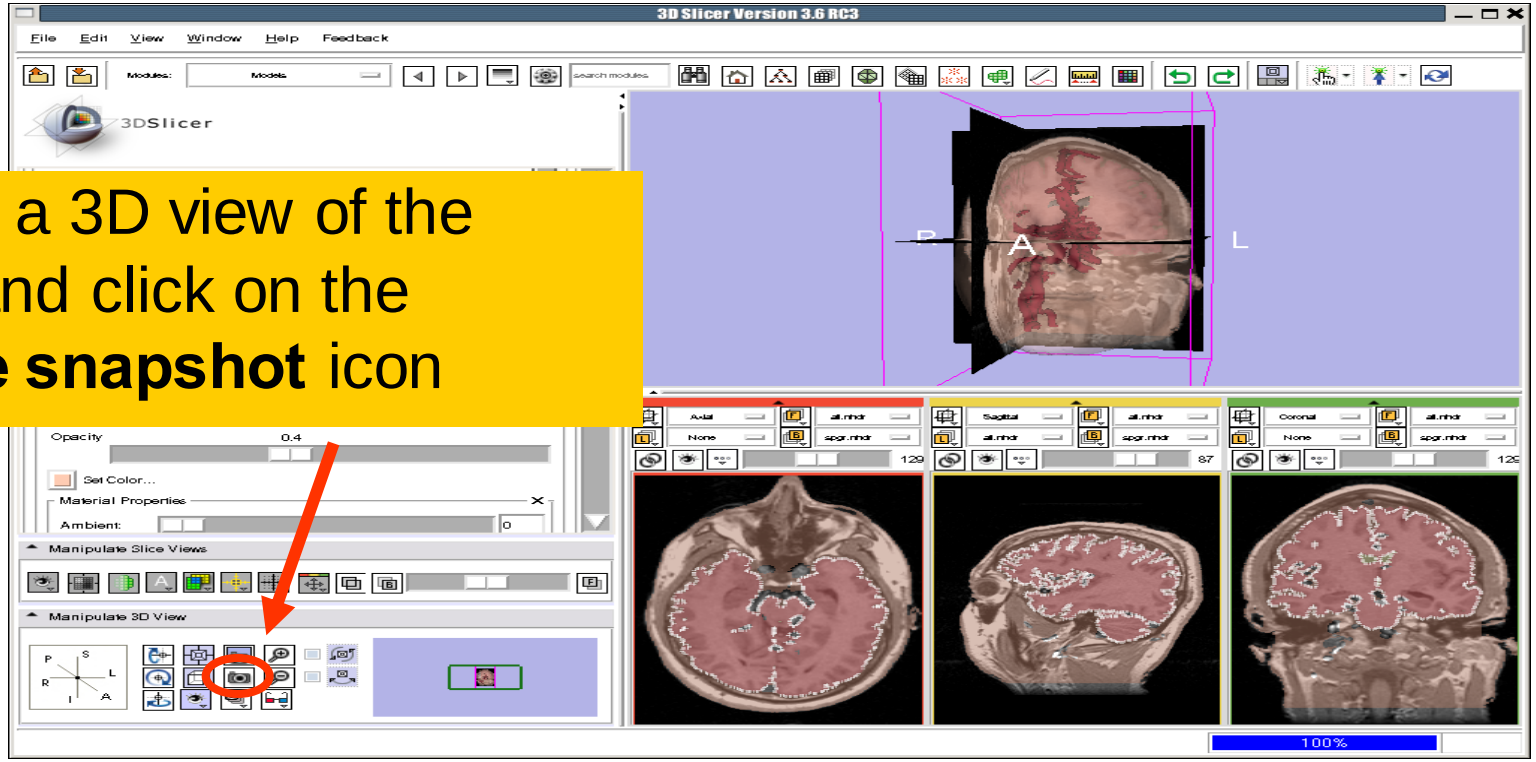


Saving Data

Click on **Save Selected**

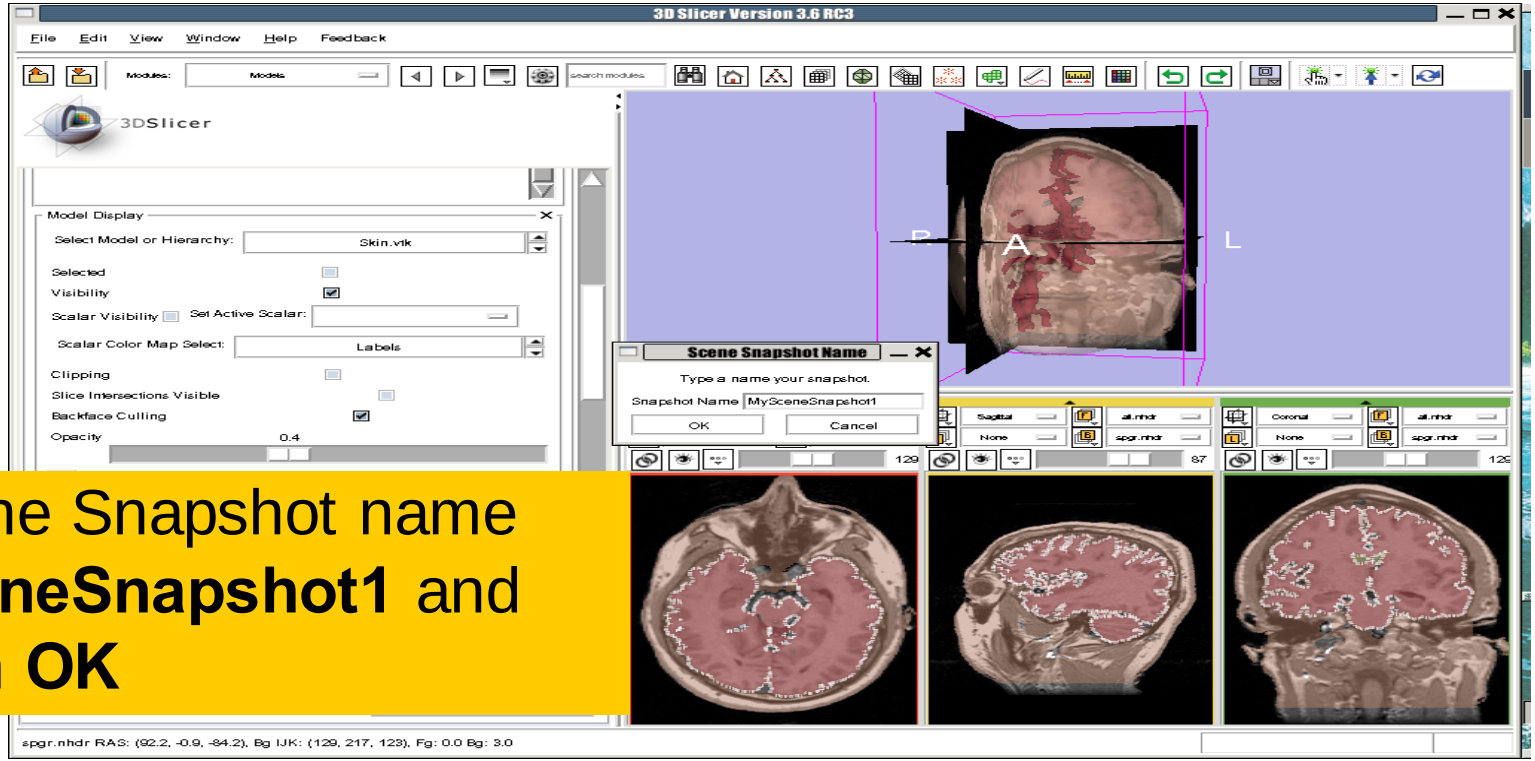


Creating Scene Snapshots



Choose a 3D view of the scene and click on the **capture snapshot** icon

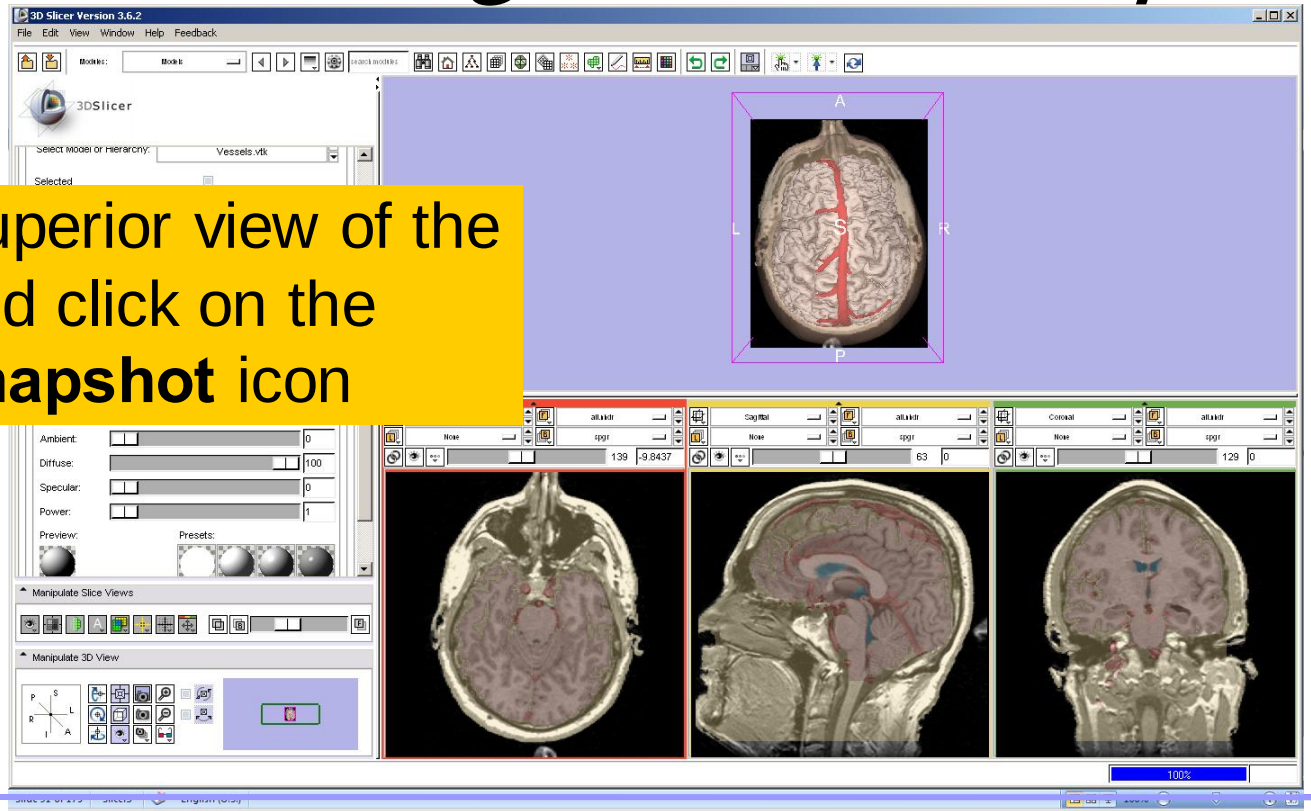
Creating Scene Snapshots



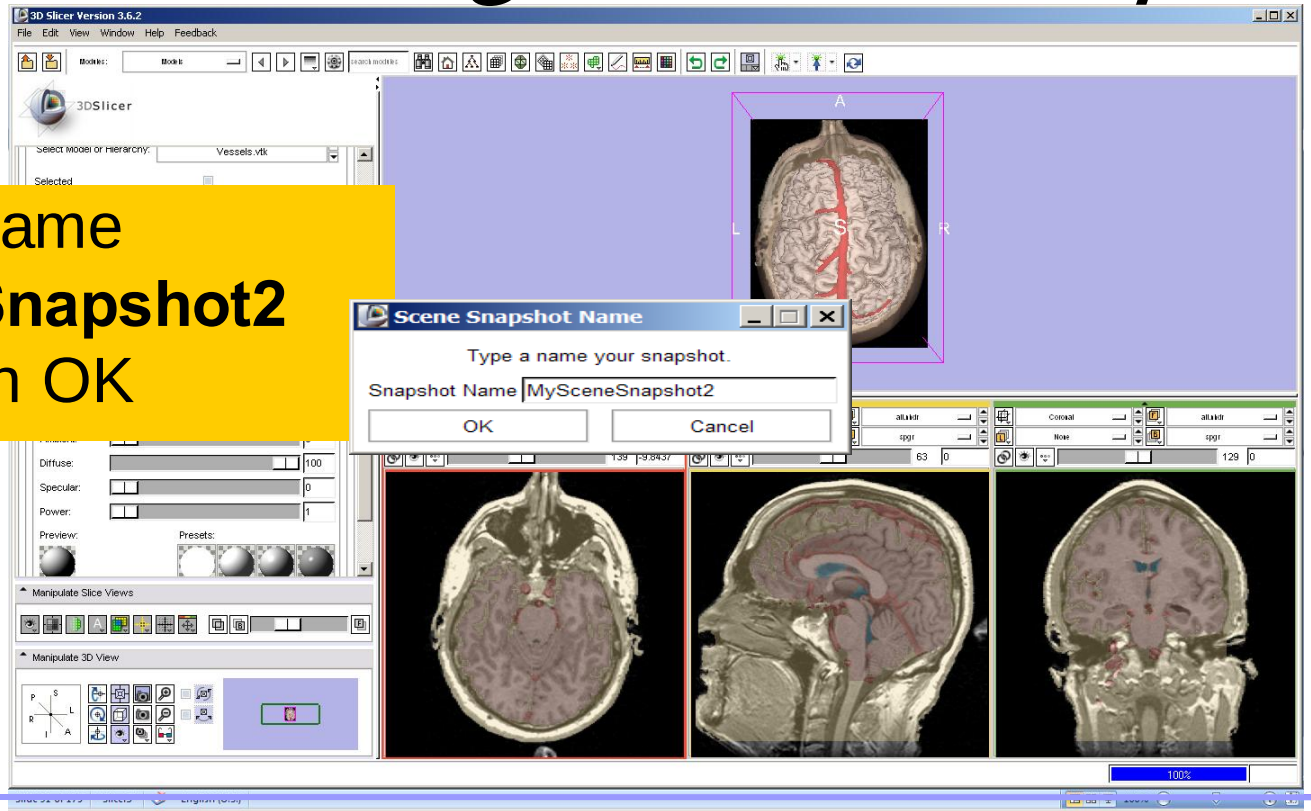
Enter the Snapshot name **MySceneSnapshot1** and click on **OK**

Creating Scene Snapshots

Select a Superior view of the dataset, and click on the **capture snapshot** icon



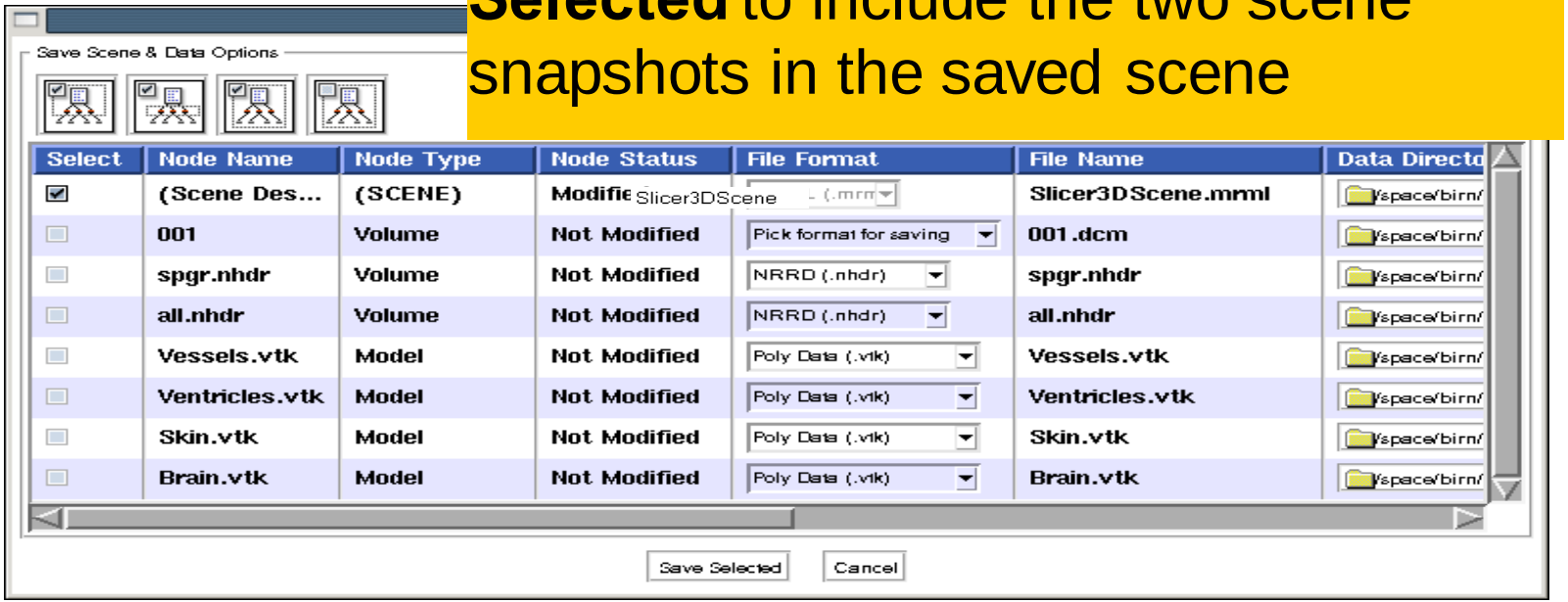
Creating Scene Snapshots



Enter the name
MySceneSnapshot2
and click on OK

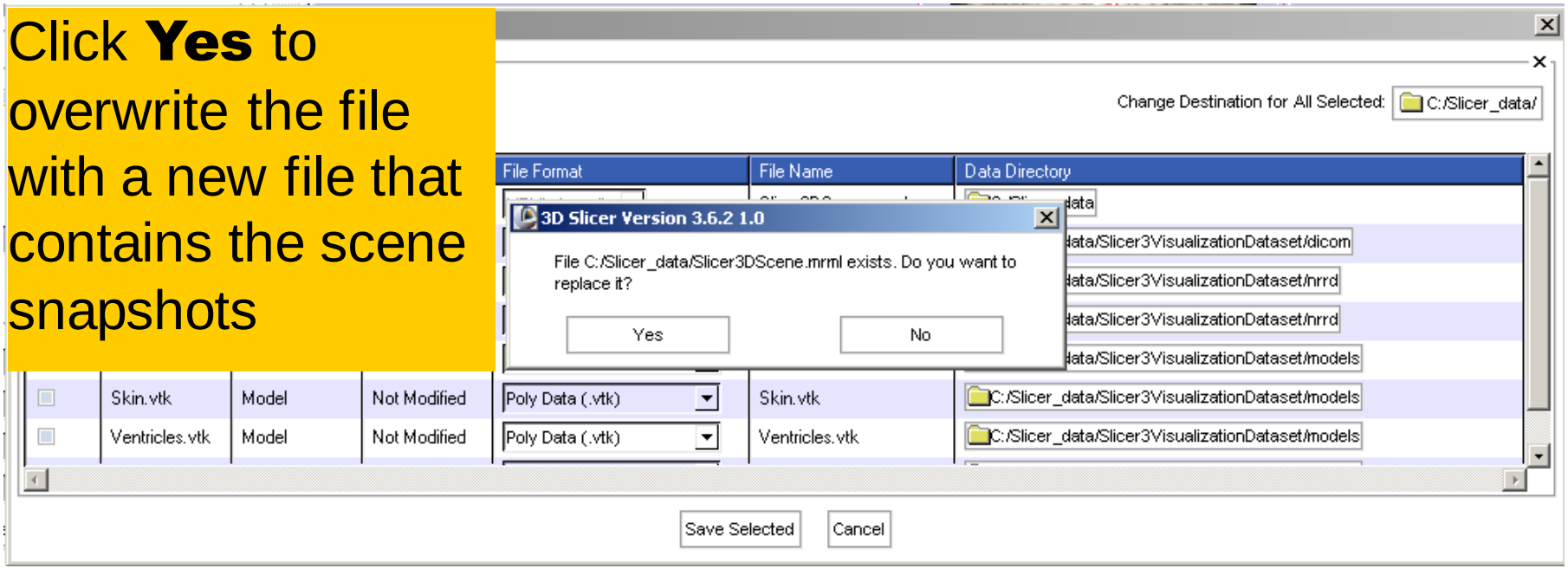
Creating Scene Snapshots

Select **File→ Save** and click on **Save Selected** to include the two scene snapshots in the saved scene

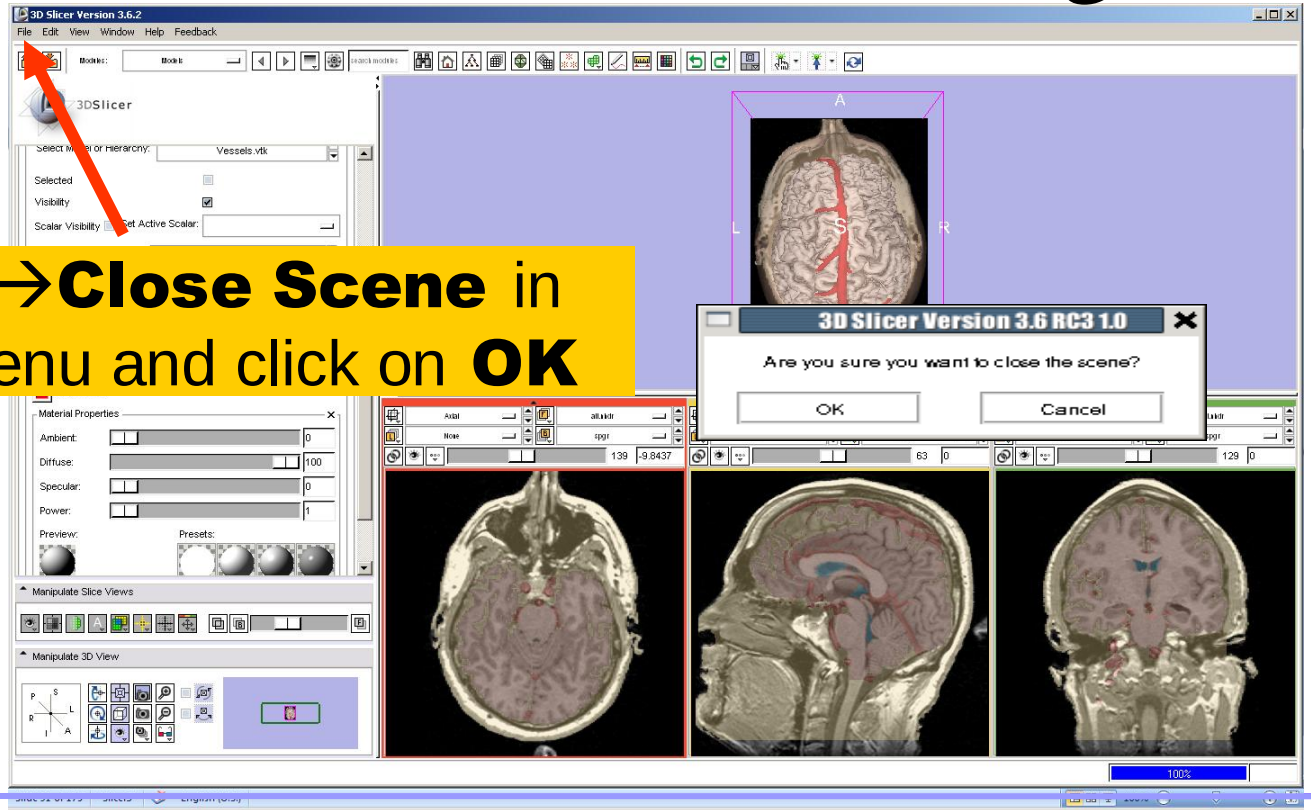


Creating Scene Snapshots

Click **Yes** to overwrite the file with a new file that contains the scene snapshots

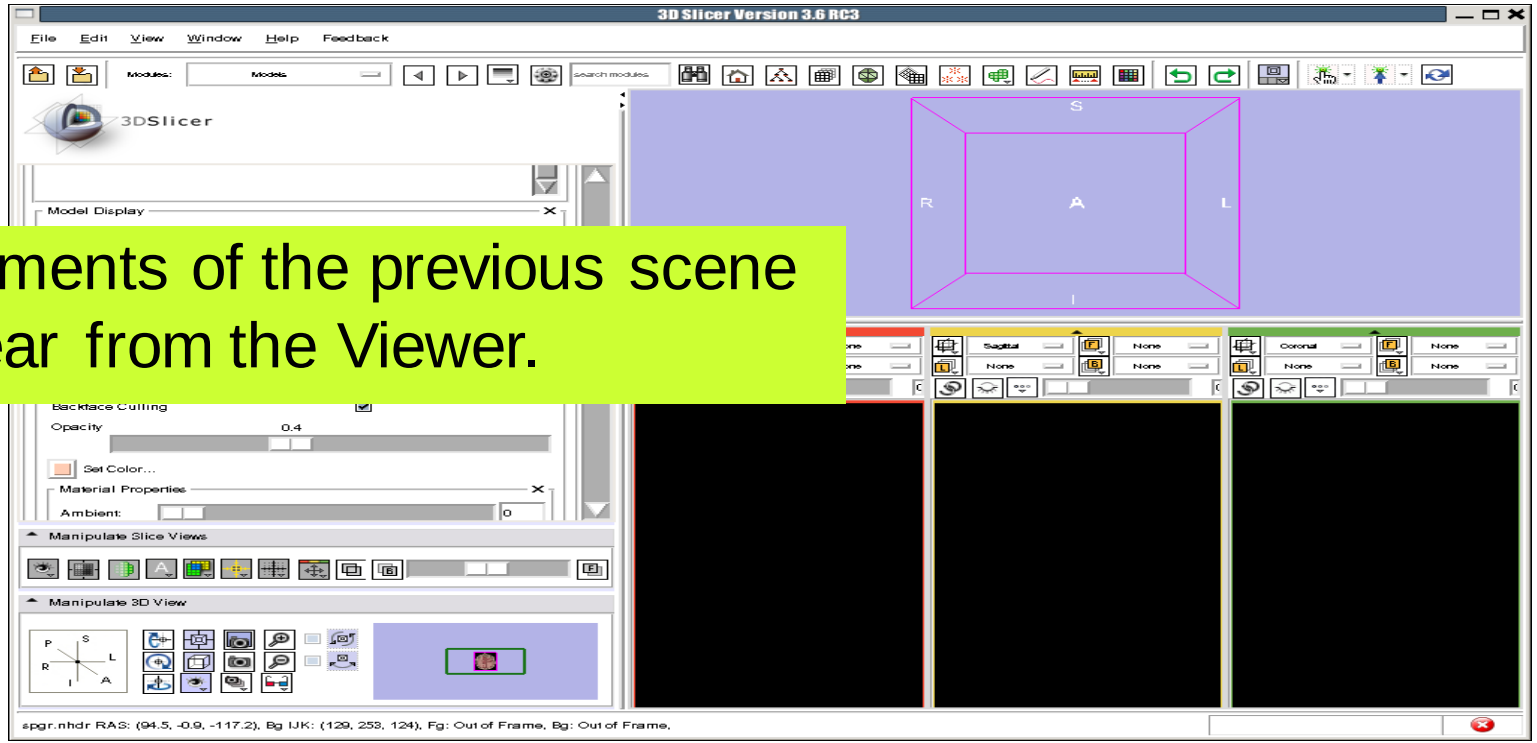


Saving Data



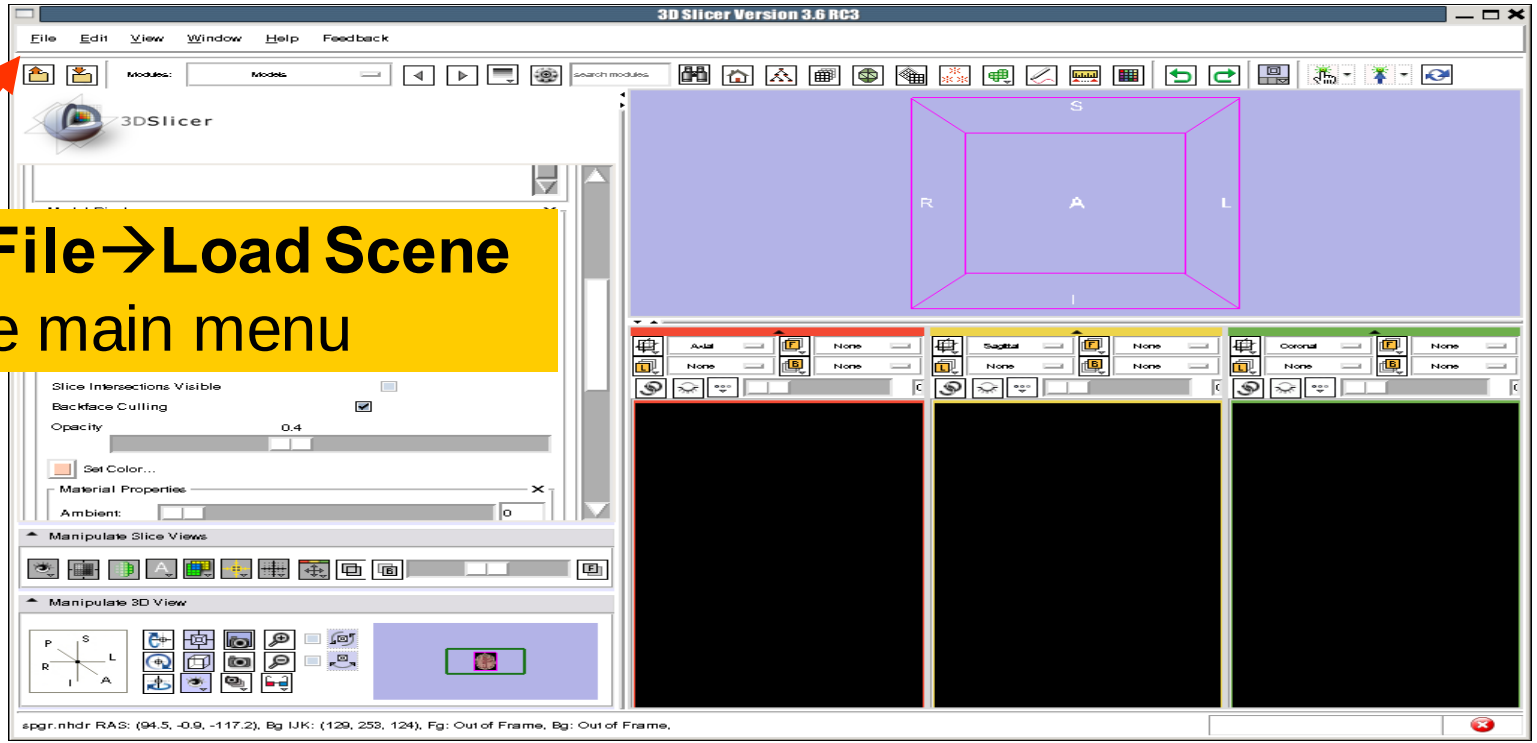
Select **File→Close Scene** in the main menu and click on **OK**

Saving Data



The elements of the previous scene disappear from the Viewer.

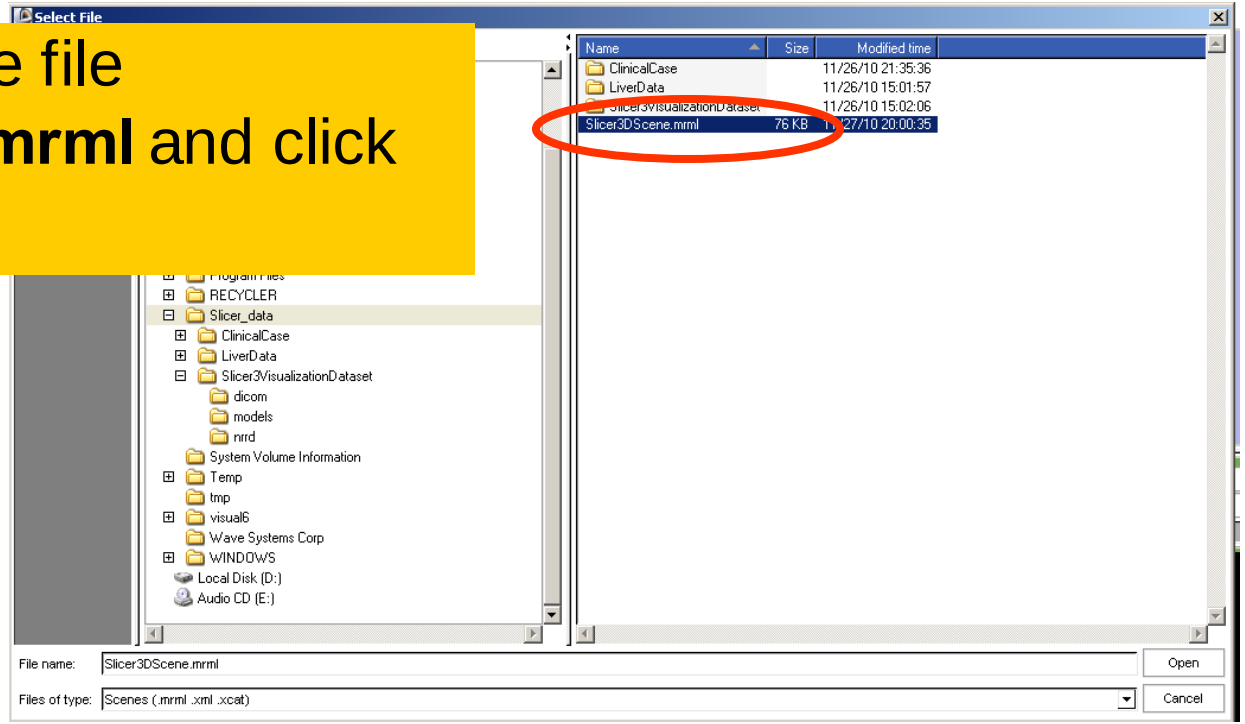
Saving Data



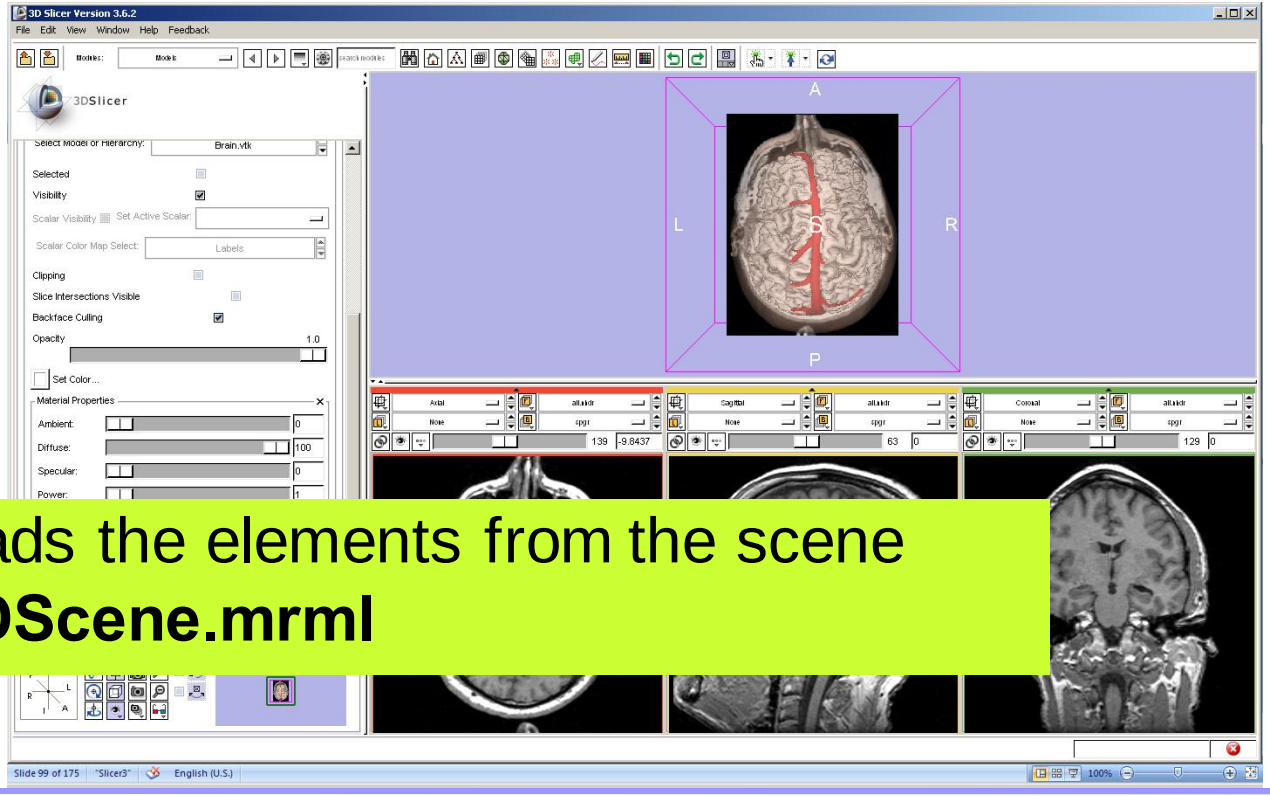
Select **File→Load Scene** from the main menu

Saving Data

Browse to find the file **Slicer3DScene.mrml** and click on **Open**

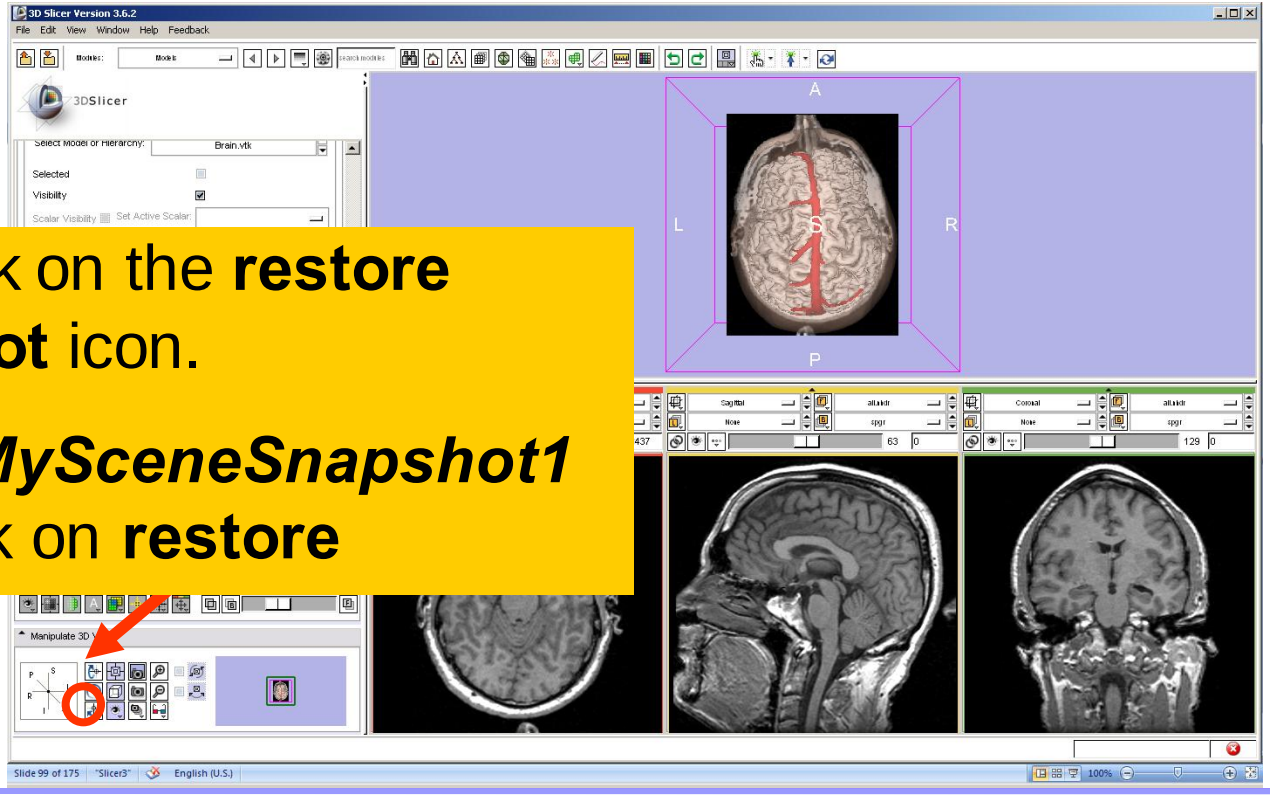


Loading a Scene



Slicer loads the elements from the scene **Slicer3DScene.mrml**

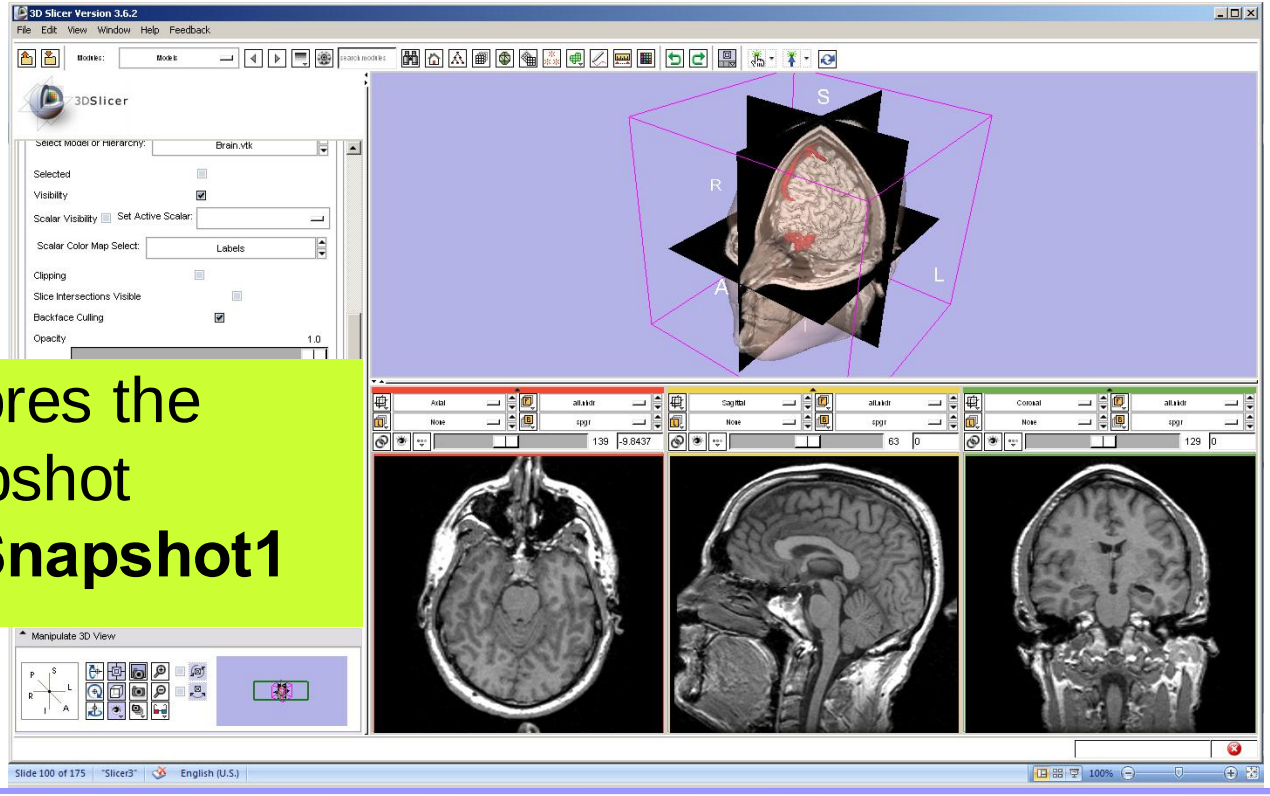
Loading a Scene



Left-click on the **restore snapshot** icon.

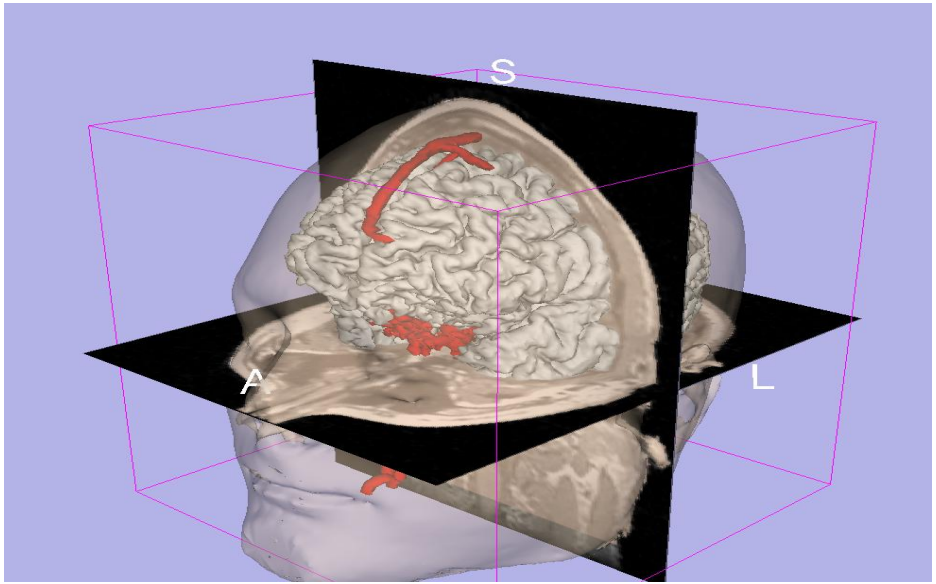
Select ***MySceneSnapshot1*** and click on **restore**

Loading a Scene

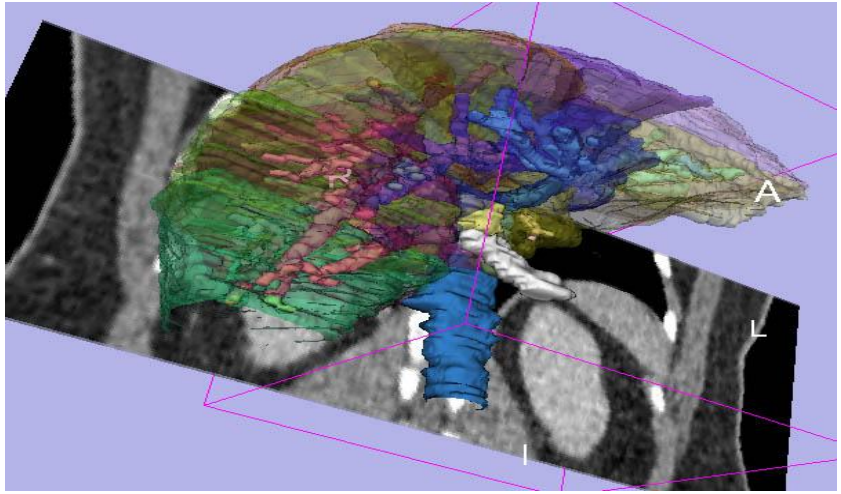


Slicer restores the scene snapshot **MySceneSnapshot1**

Conclusion



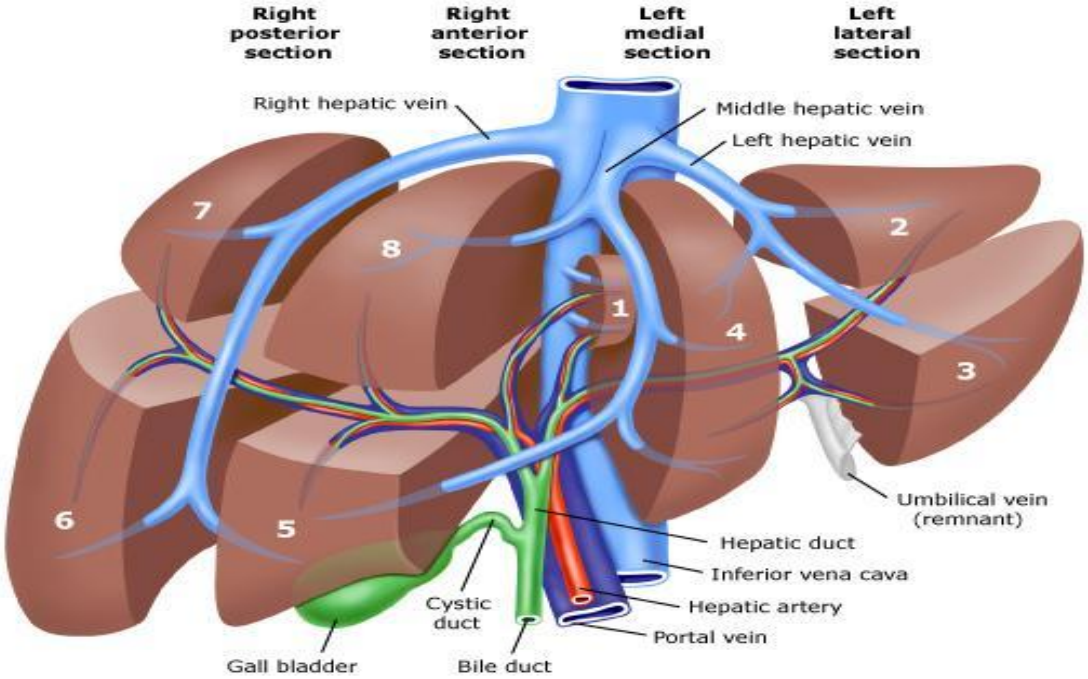
- 3D visualization of anatomical surface reconstructions
- 3D interaction with volumes and models
- Open-source platform



Part2: Exploring liver segments in 3D

Sonia Pujol, PhD - Kitt Shaffer, MD, PhD

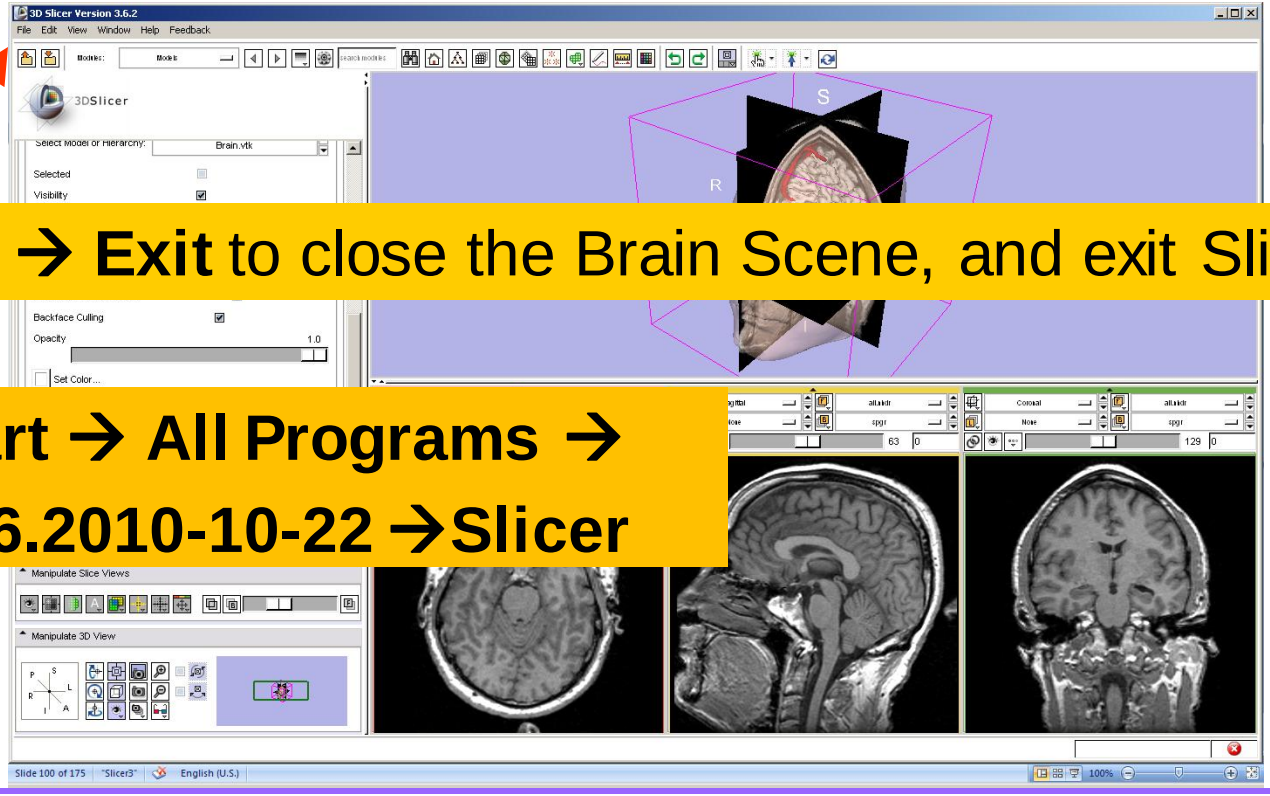
Anatomy of the liver



Dataset

The patient1 dataset is a contrast-enhanced CT abdominal scan of a healthy 36 year old male.

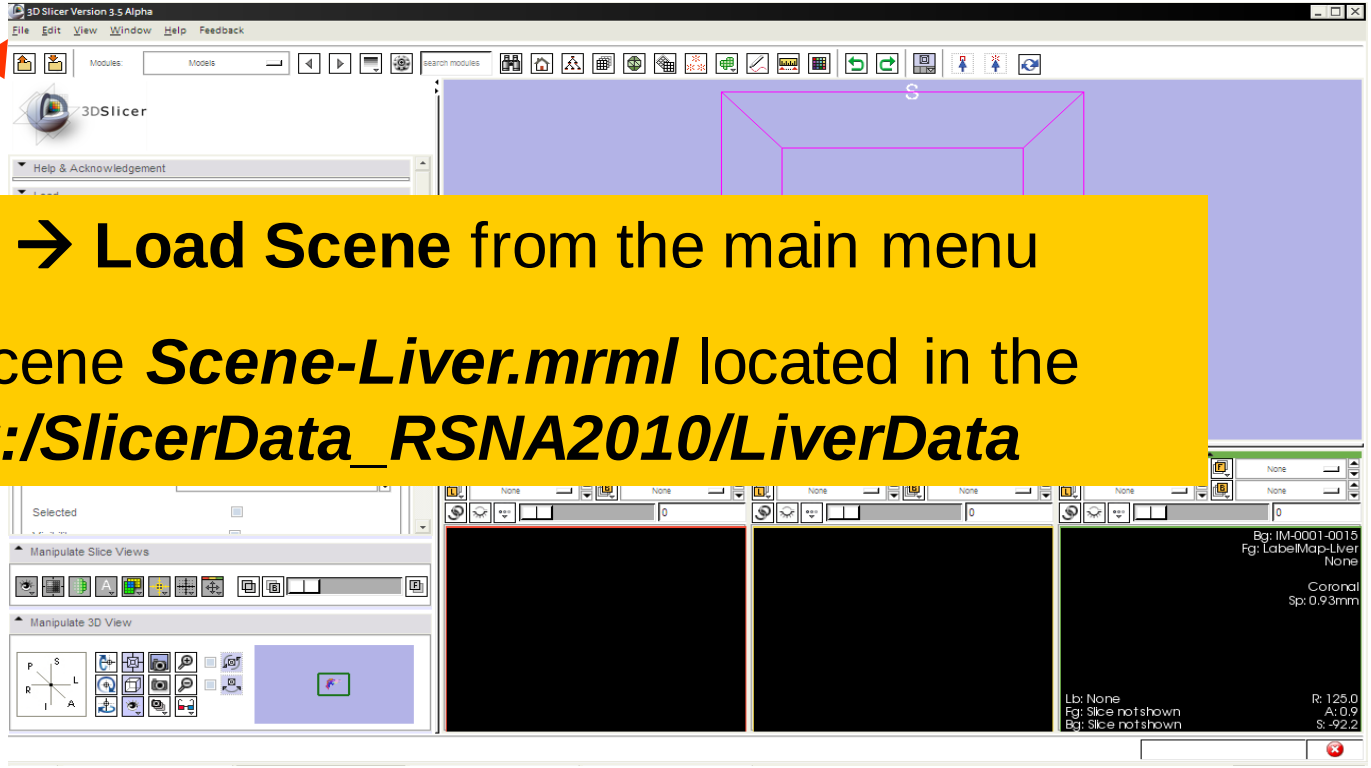
Loading the Liver Scene



Select **File → Exit** to close the Brain Scene, and exit Slicer

Select **Start → All Programs → Slicer3 3.6.2010-10-22 →Slicer**

Loading the Liver Scene

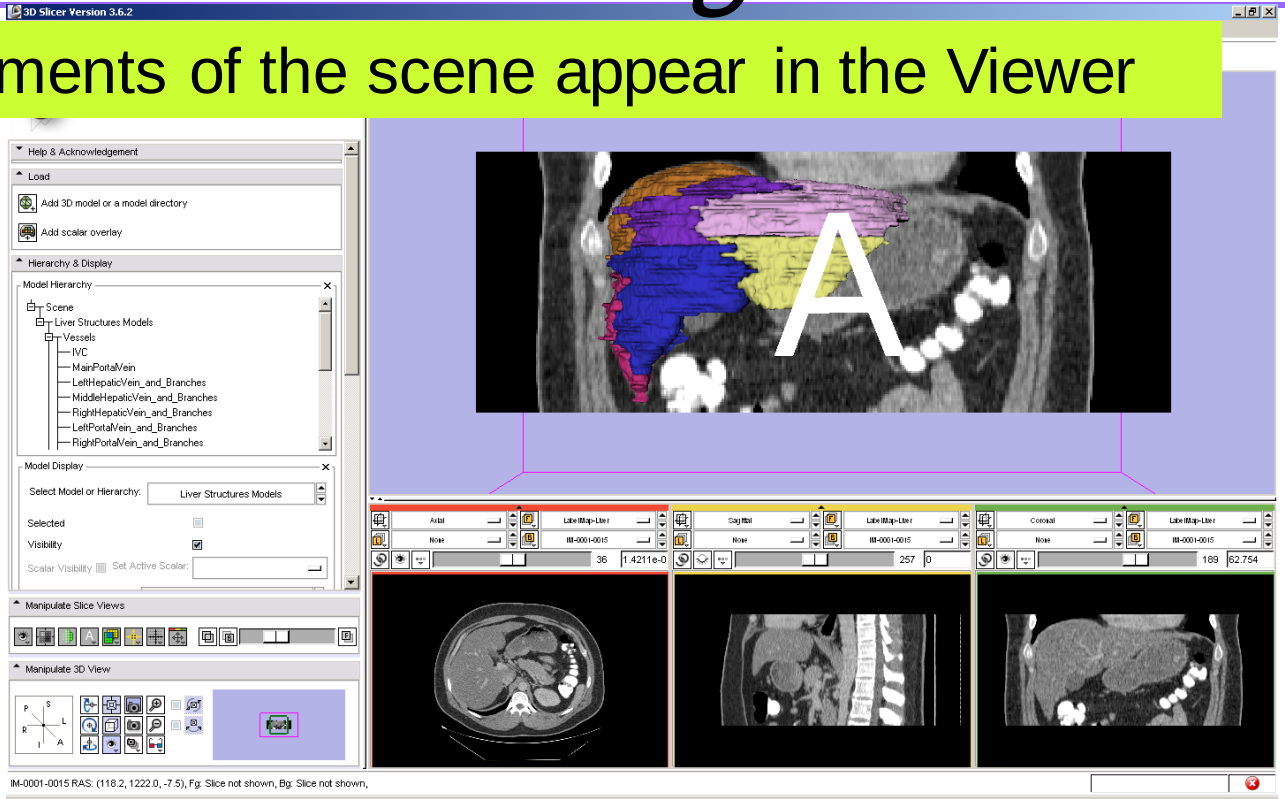


Select **File → Load Scene** from the main menu

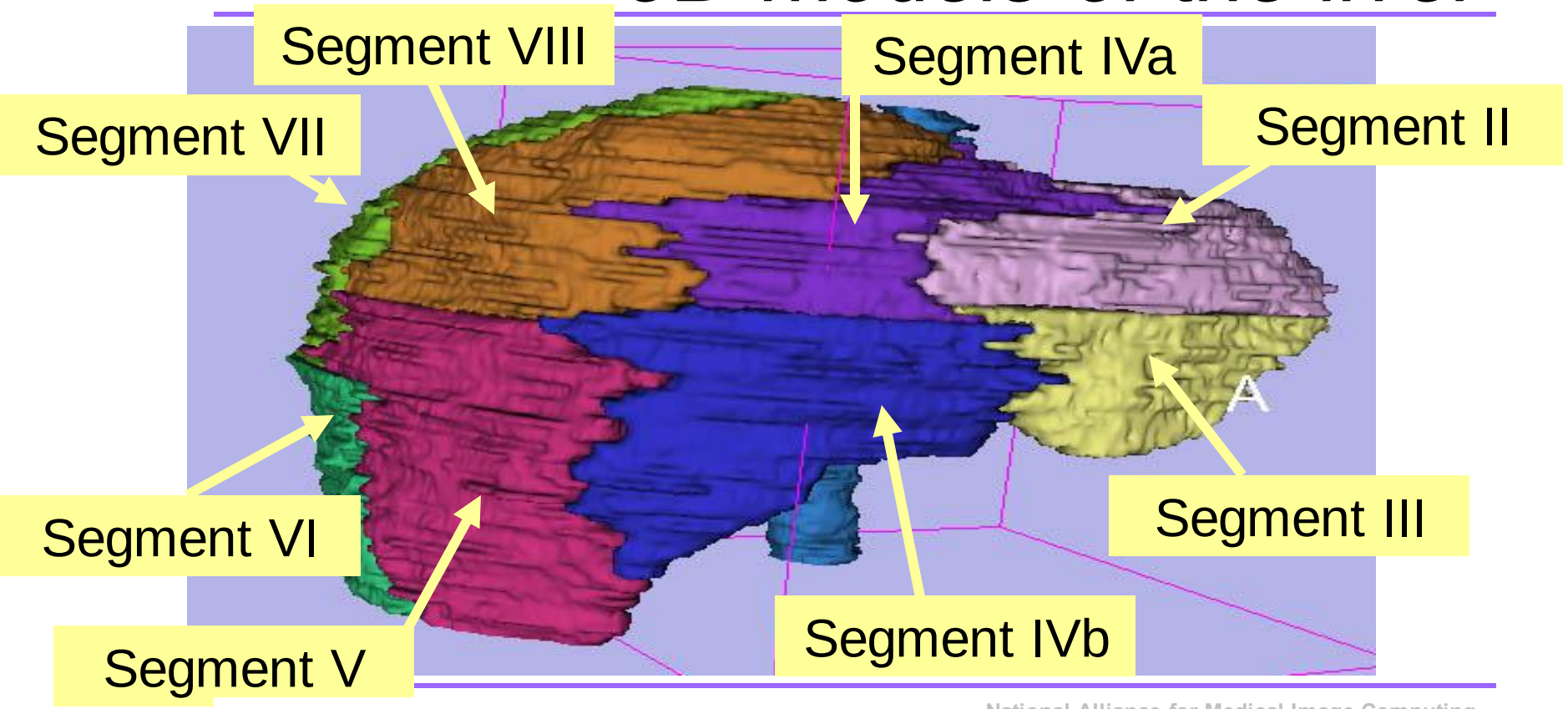
Load the scene ***Scene-Liver.mrml*** located in the directory ***C:/SlicerData_RSNA2010/LiverData***

Liver Segments Scene

The elements of the scene appear in the Viewer



3D models of the liver



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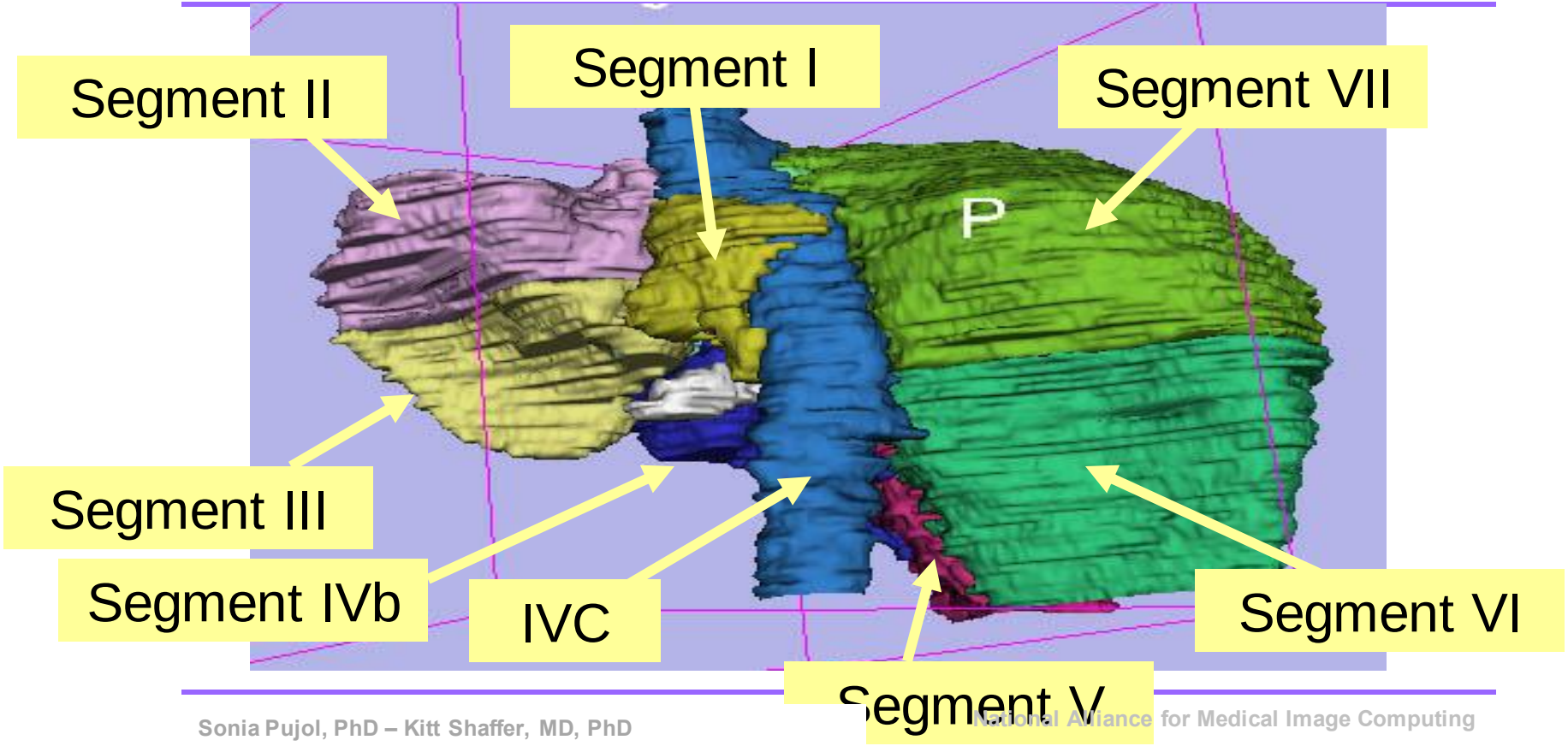
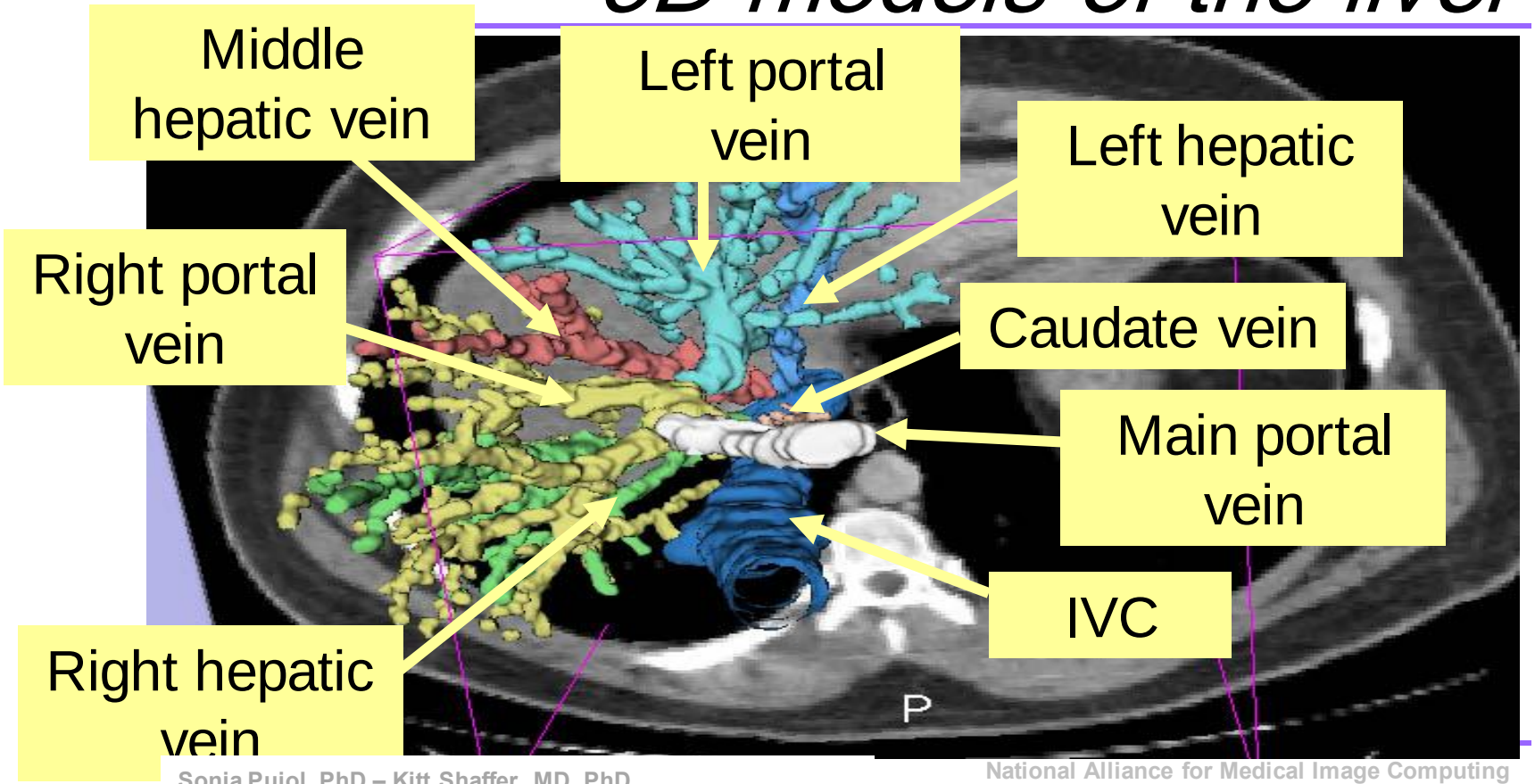
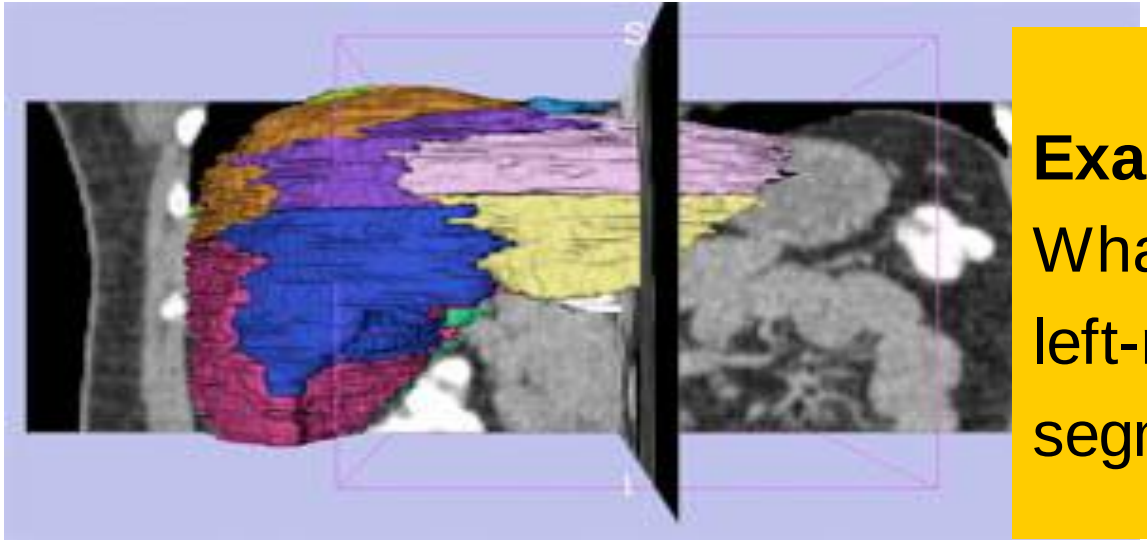
3D models of the liver



3D models of the liver



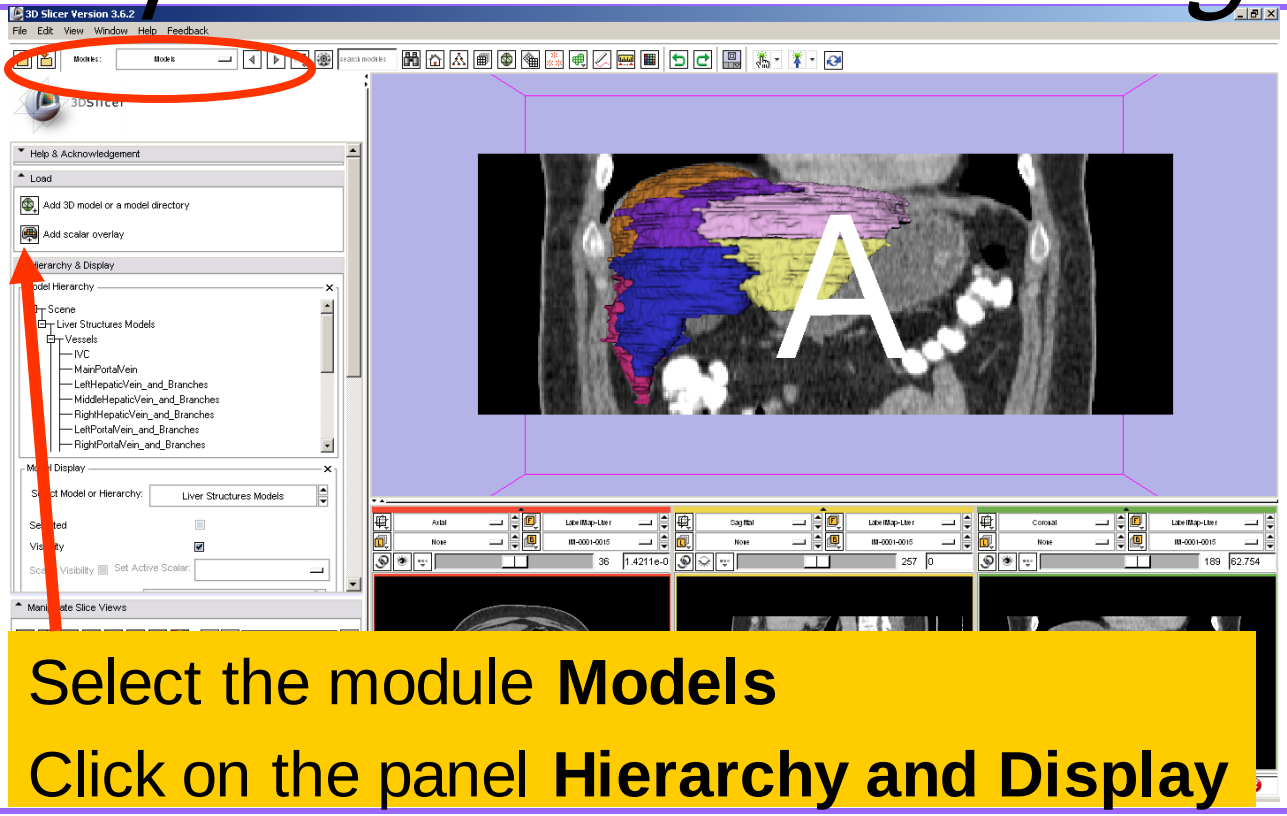
3D Exploration of Liver Segments



Example:

What organ abuts the left-most margin of segment II in Patient 1?

3D Exploration of Liver Segments



Select the module **Models**

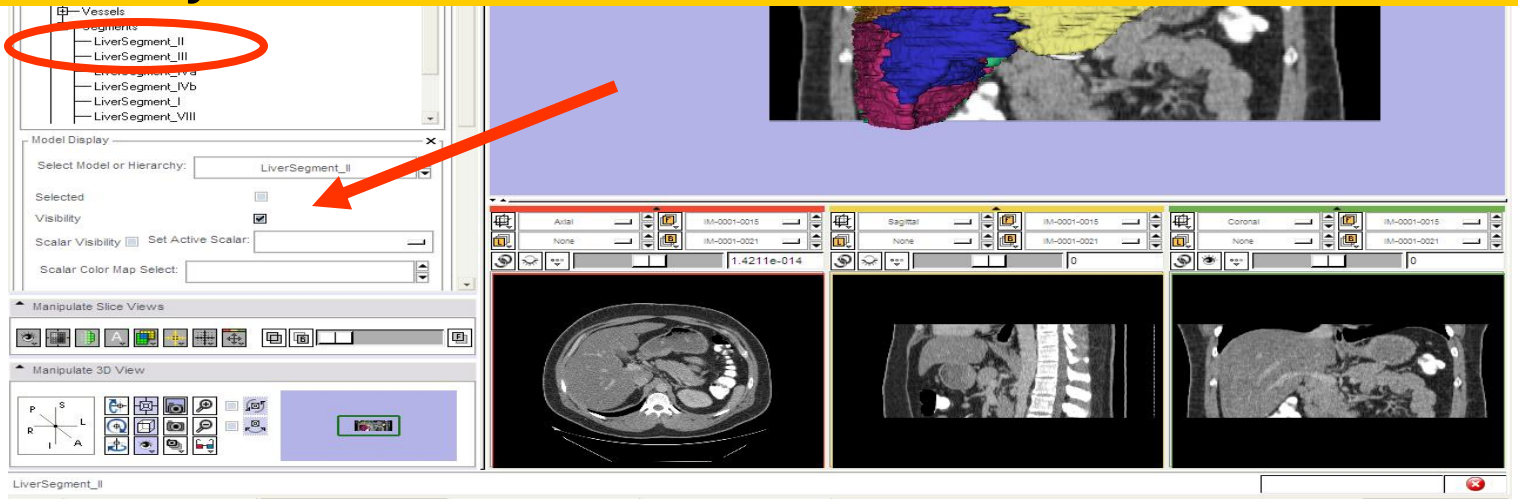
Click on the panel **Hierarchy and Display**

3D Exploration of Liver Segments

Select the model **Liver_Segment II**

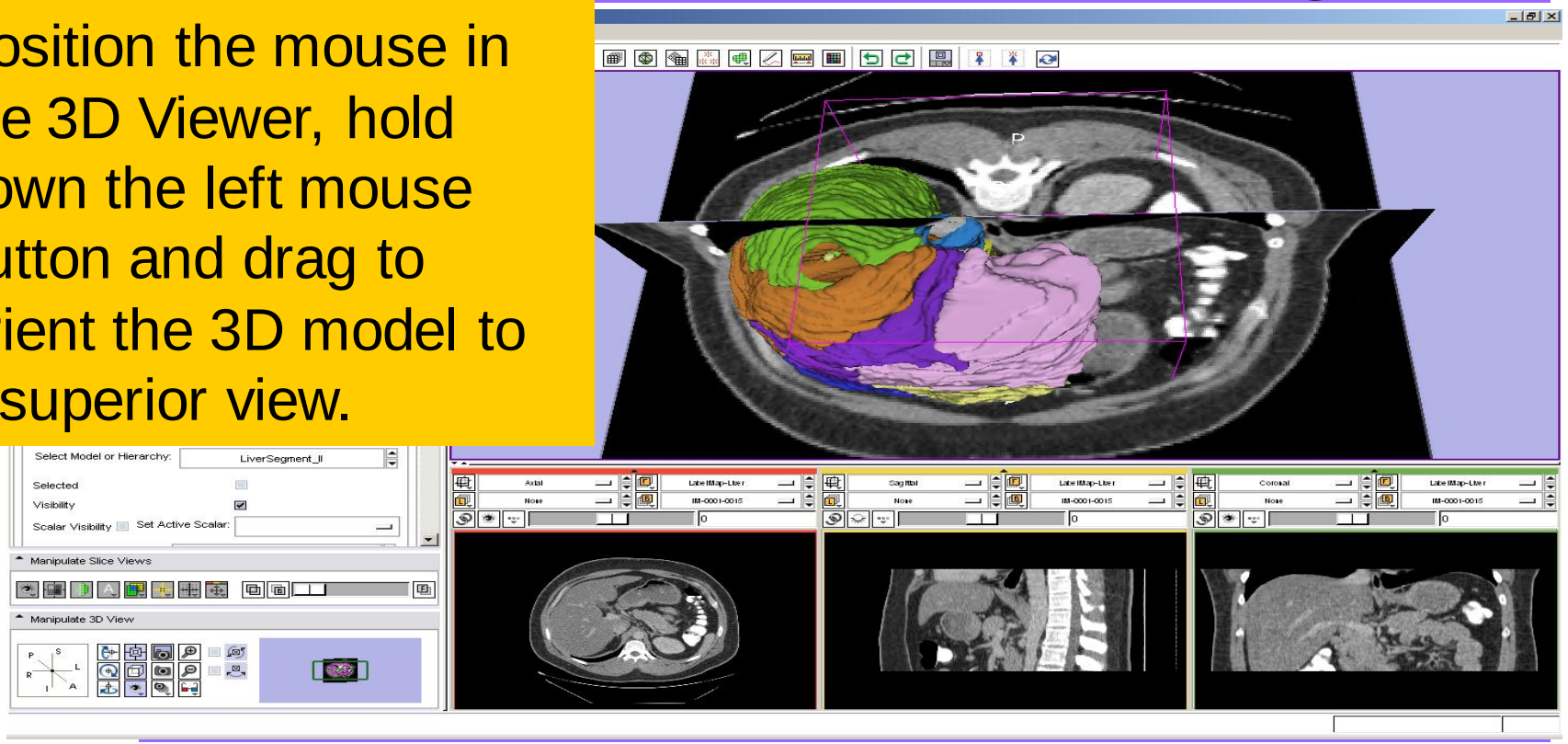
Turn on/off the visibility of Segment II

to identify its location.



3D Exploration of Liver Segments

Position the mouse in the 3D Viewer, hold down the left mouse button and drag to orient the 3D model to a superior view.



3D Exploration of Liver Segments

Question 1:

What organ abuts the left-most margin of segment II in Patient 1?

3D Exploration of Liver Segments

Question 1:

What organ abuts the left-most margin of segment II in Patient 1?

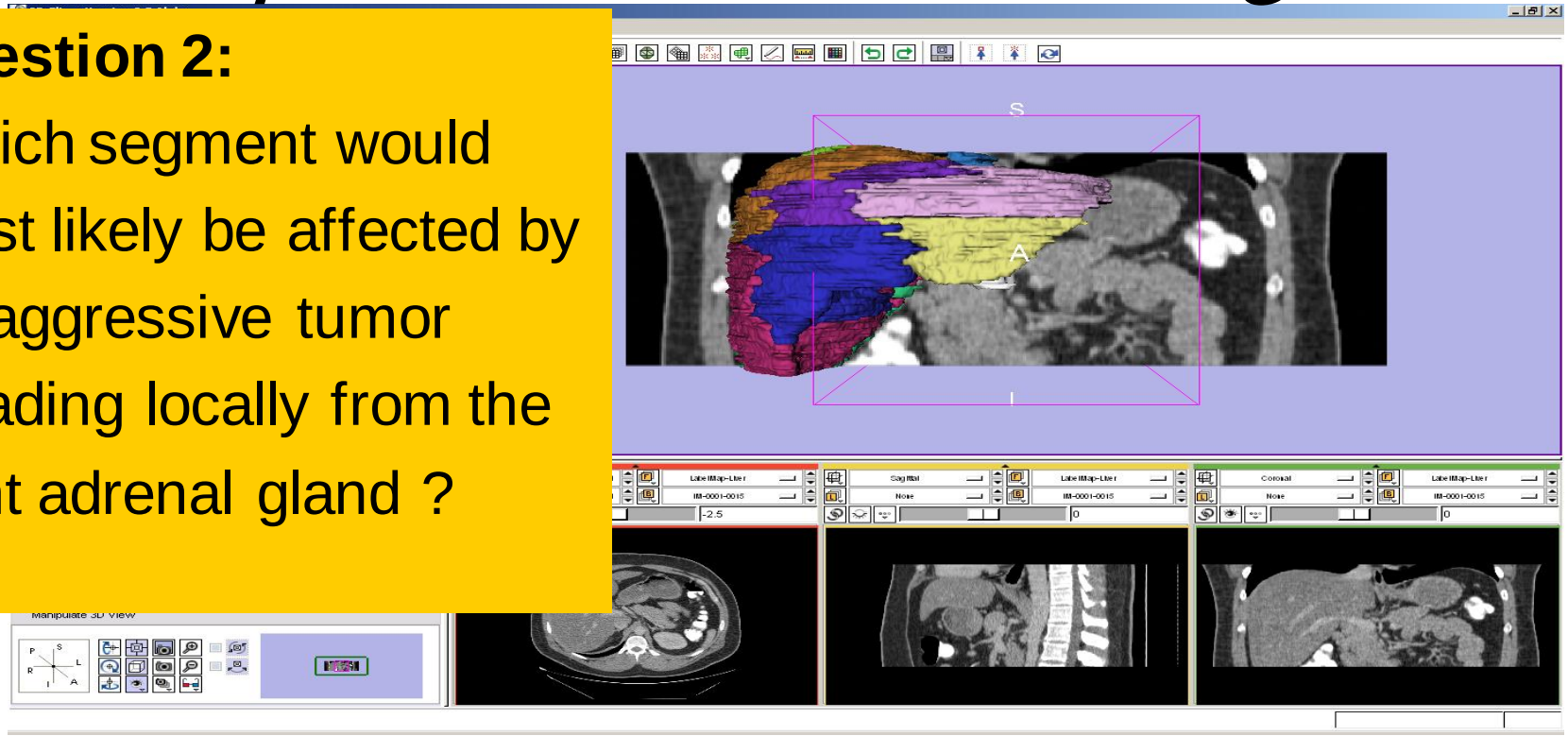
Answer 1:

Stomach

3D Exploration of Liver Segments

Question 2:

Which segment would most likely be affected by an aggressive tumor invading locally from the right adrenal gland ?



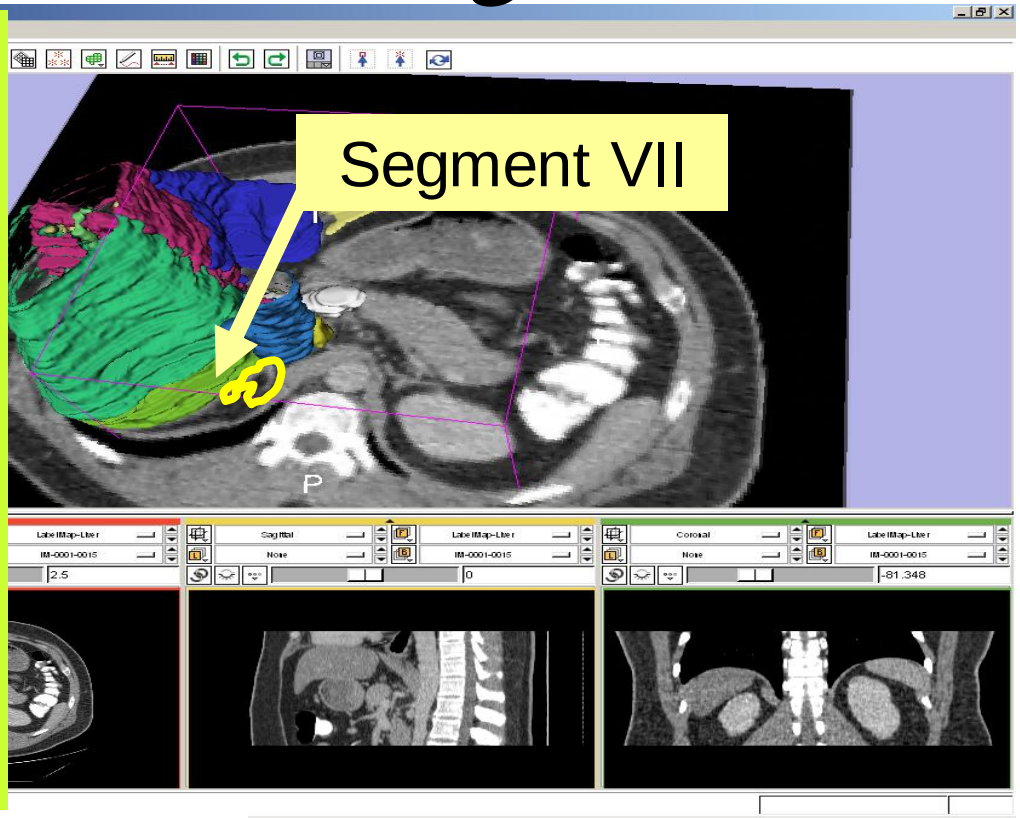
Segment VII

Question 2:

Which segment would most likely be affected by an aggressive tumor invading locally from the right adrenal gland ?

Answer 2:

Segment VII

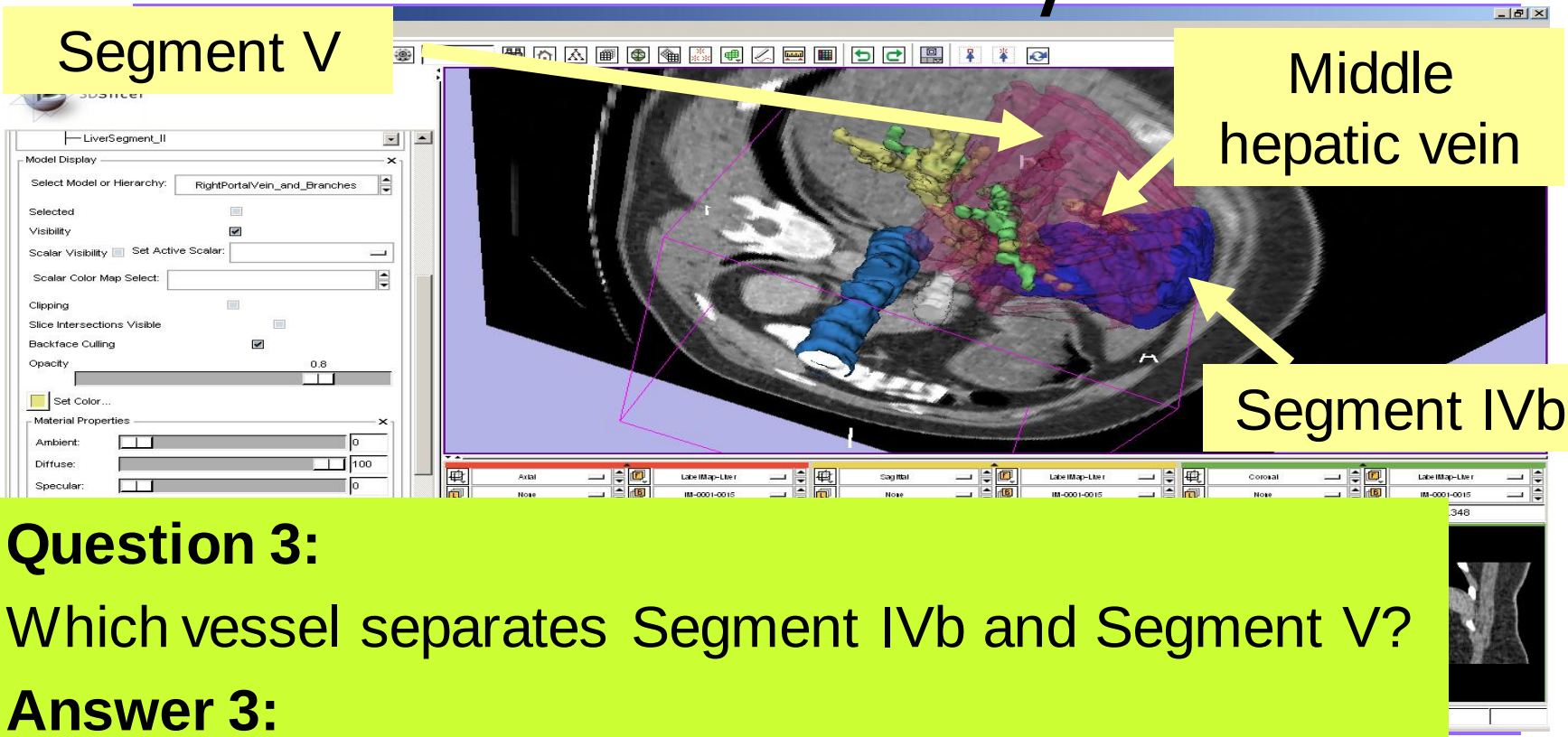


3D Exploration of Liver Segments

Question 3:

Which vessel separates Segment IVb and Segment V?

Middle Hepatic Vein



Question 3:

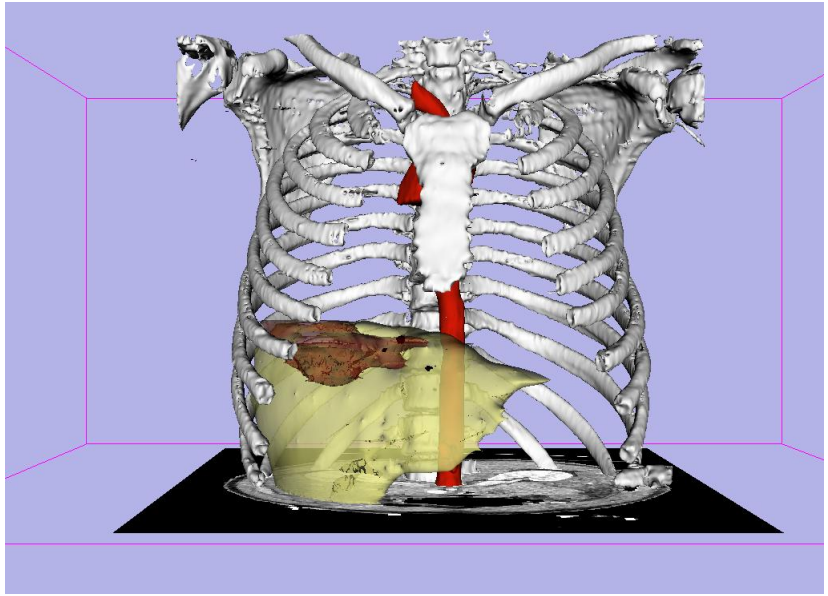
Which vessel separates Segment IVb and Segment V?

Answer 3:

The middle hepatic vein

Closing the Liver Scene

Select **File → Exit** to close the Liver Scene and exit Slicer

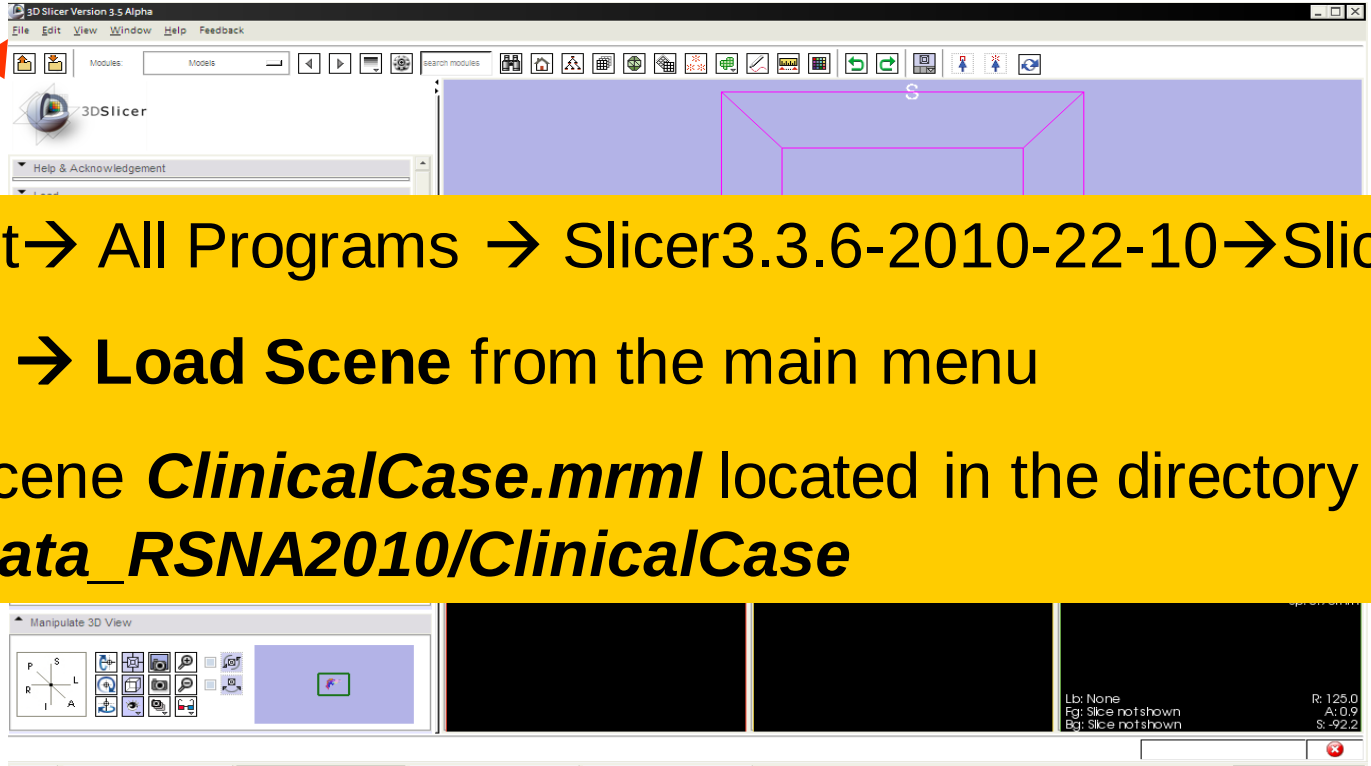


Gunshot wound of the liver: A Clinical Case

Sonia Pujol, PhD - Kitt Shaffer, MD, PhD

3D Slicer Course for Radiologists, November 29, 2010
RSNA 2010

Loading the Clinical Case

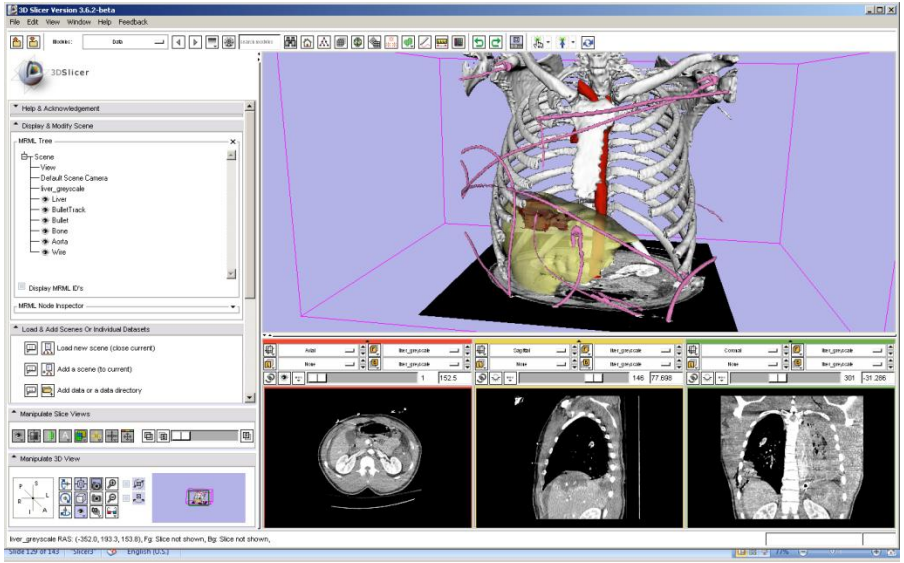


Select Start→ All Programs → Slicer3.3.6-2010-22-10→Slicer3

Select **File → Load Scene** from the main menu

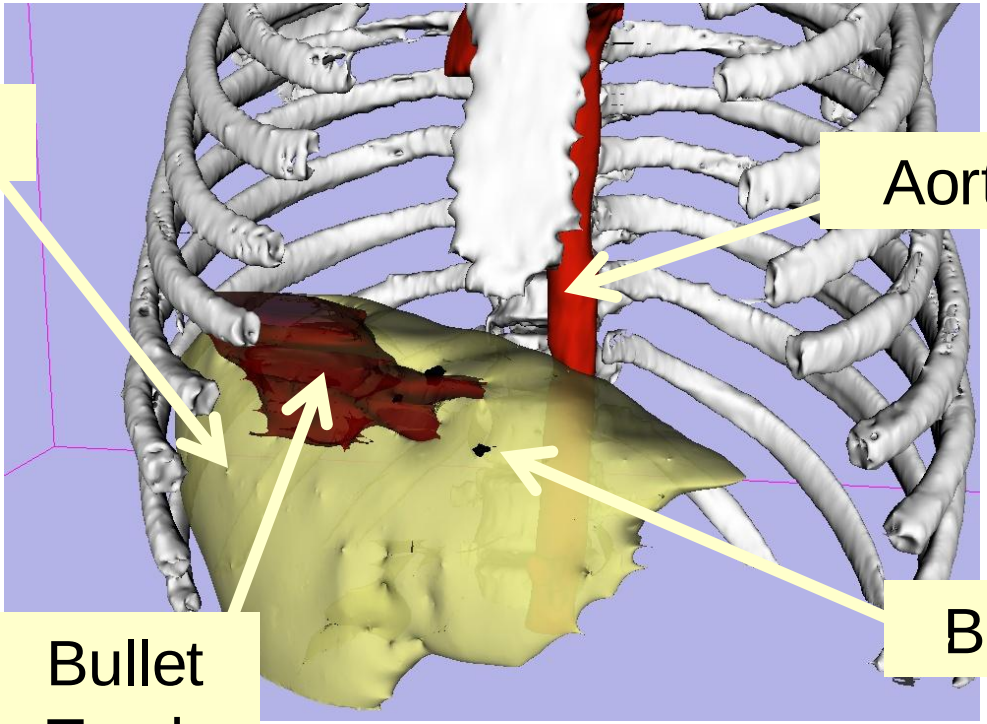
Load the scene ***ClinicalCase.mrml*** located in the directory ***C:/SlicerData_RSNA2010/ClinicalCase***

Loading the Clinical Case

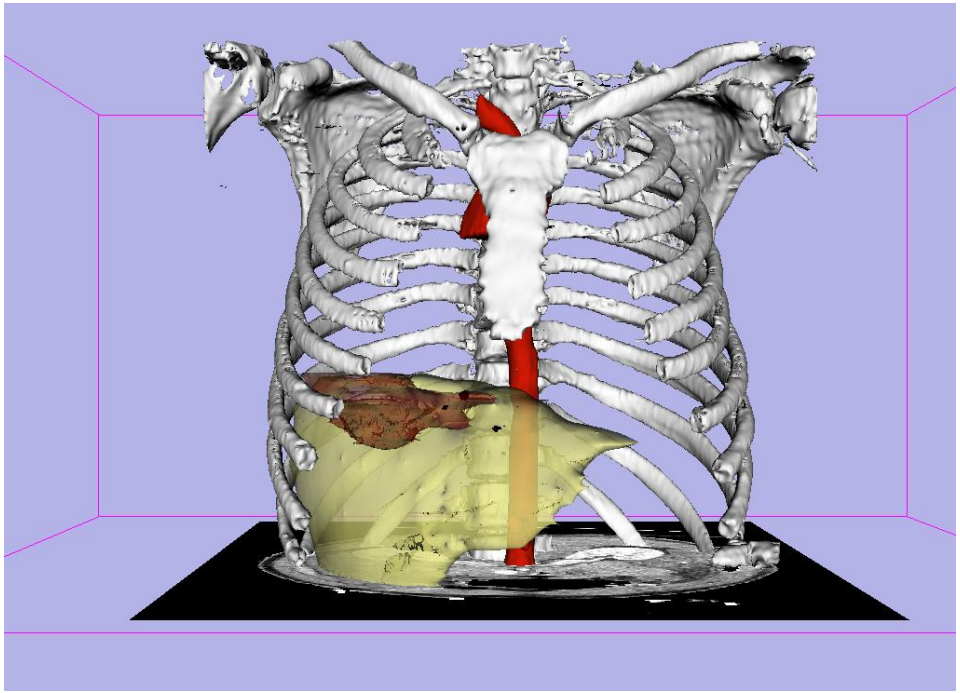


The patient dataset is a contrast-enhanced CT abdominal scan of a 16 year old male involved in gun battle related to drugs

Clinical Case



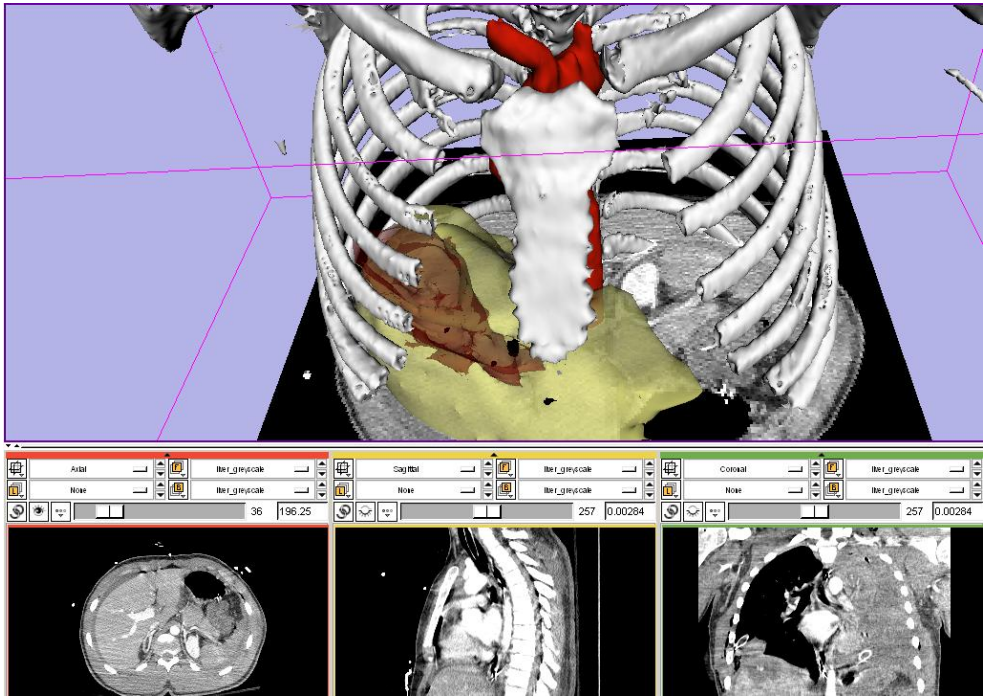
Clinical Case



Question 1:

Based on the pattern of injury, where is the likely entry point of the bullet ?

Clinical Case

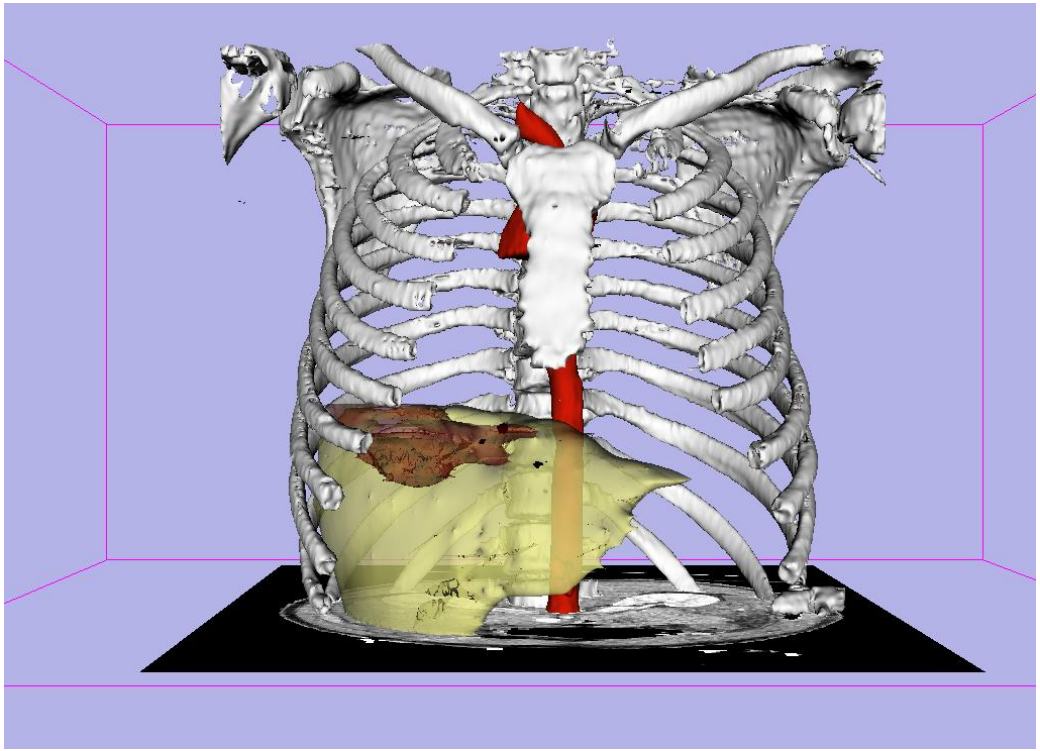


Question 1:

Based on the pattern of injury, where is the likely entry point of the bullet?

Answer 1: The bullet likely entered anteriorly.

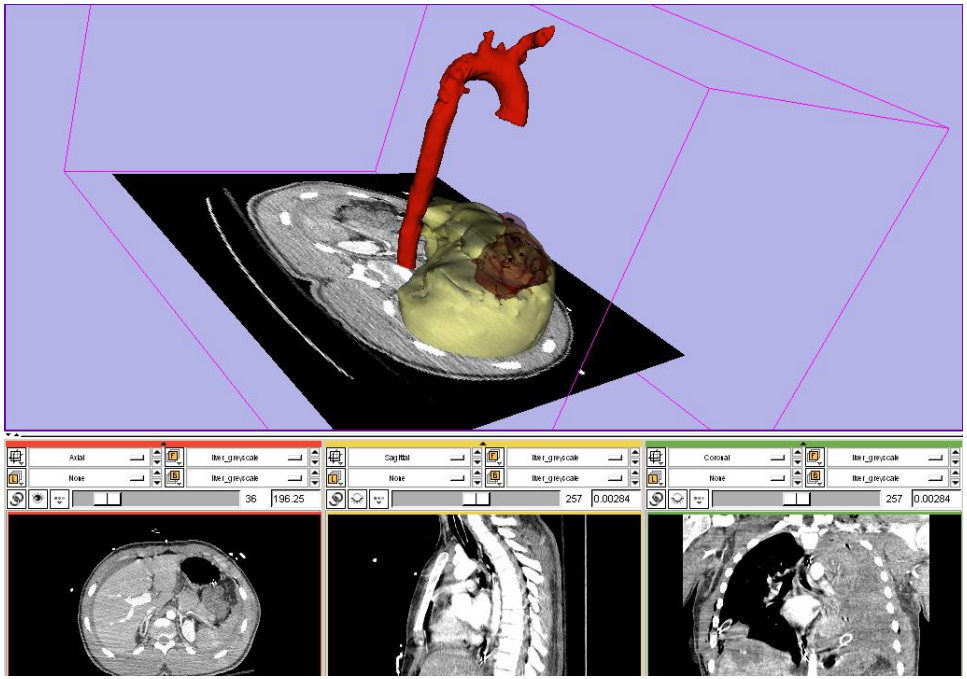
Clinical Case



Question 2:

Did the bullet pass near the aorta ?

Clinical Case

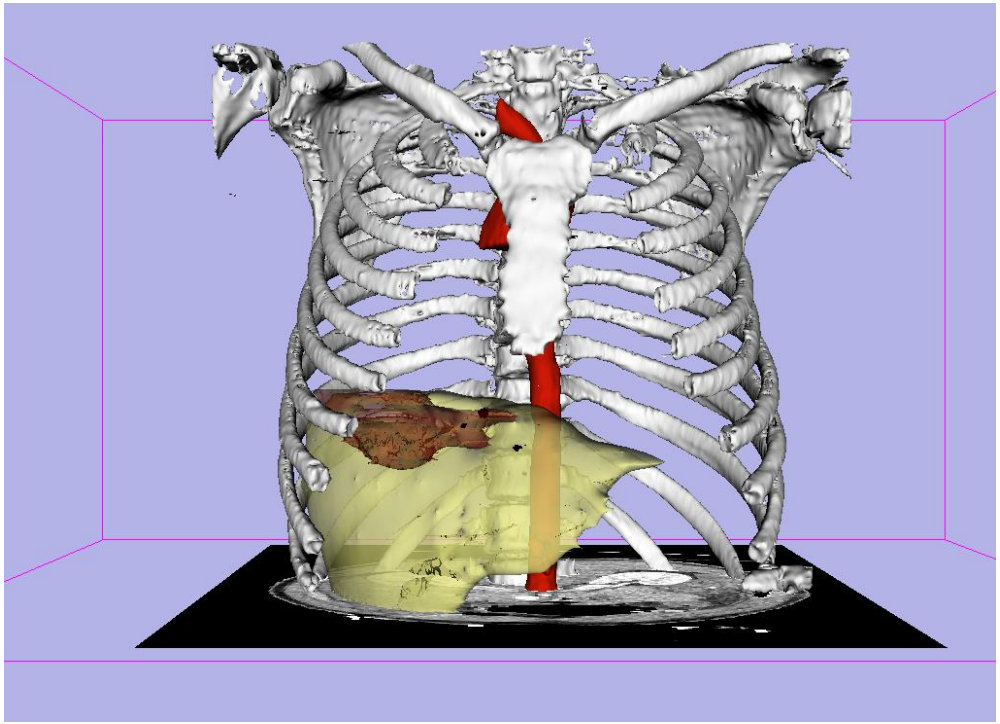


Question 2:

Did the bullet pass near the aorta ?

Answer 2: The bullet passes through the liver anteriorly, far from the aorta.

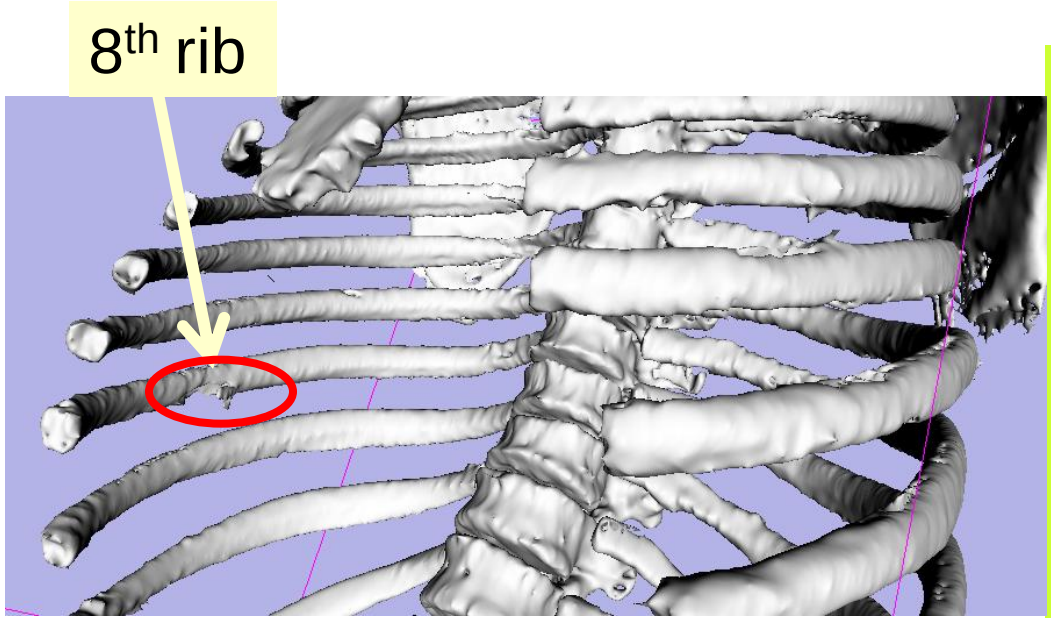
Clinical Case



Question 3:

Which rib was damaged by the bullet?

Clinical Case



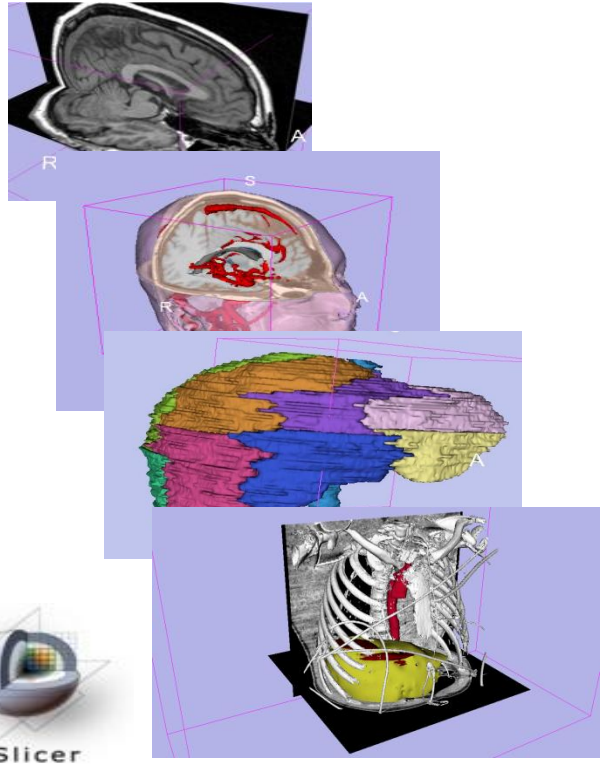
Question 3:

Which rib was damaged by the bullet?

Answer 3:

The bullet damaged the 8th rib.

Conclusion



- Interactive interface to load and manipulate greyscale volumes, labelmaps and 3D models.
- 3D interaction with anatomical view
- Open-source platform for Linux, Mac and Windows

Acknowledgments

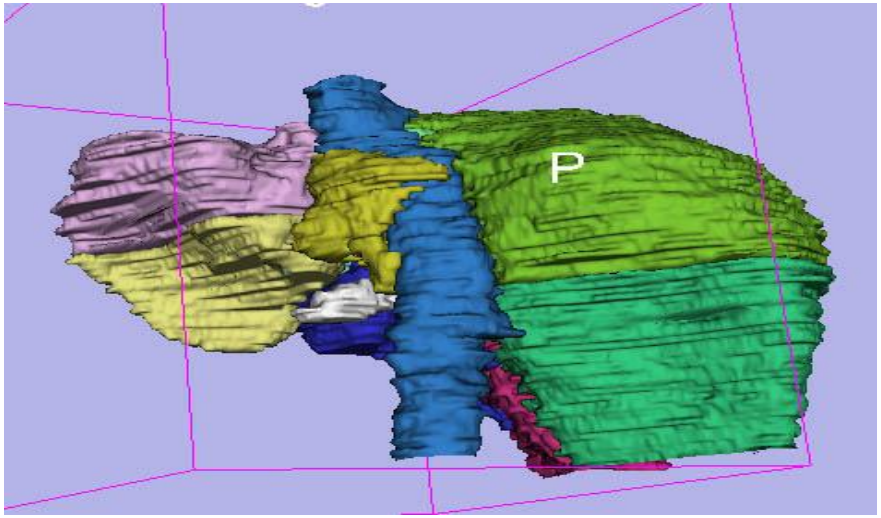
National Alliance for Medical Image Computing

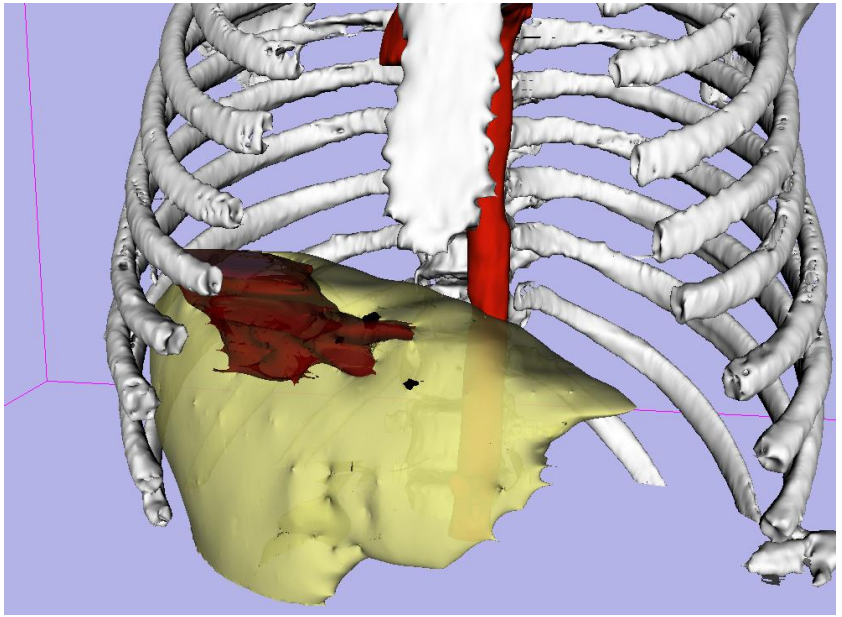
NIH U54EB005149

Neuroimage Analysis Center

NIH P41RR013218

Questions





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Slicer courses at RSNA 2010

- **Quantitative Medical Imaging for Clinical Research and Practice**

Tuesday November 30, 10:30 AM - 12:00 PM

Room S401CD, McCormick Place

- **Slicer Booth - Quantitative Imaging Reading Room**

Monday November 29, 12:15-1:15pm

Wednesday December 1, 12:15-1:15pm

Thursday December 2, 12:15 - 1:15pm

