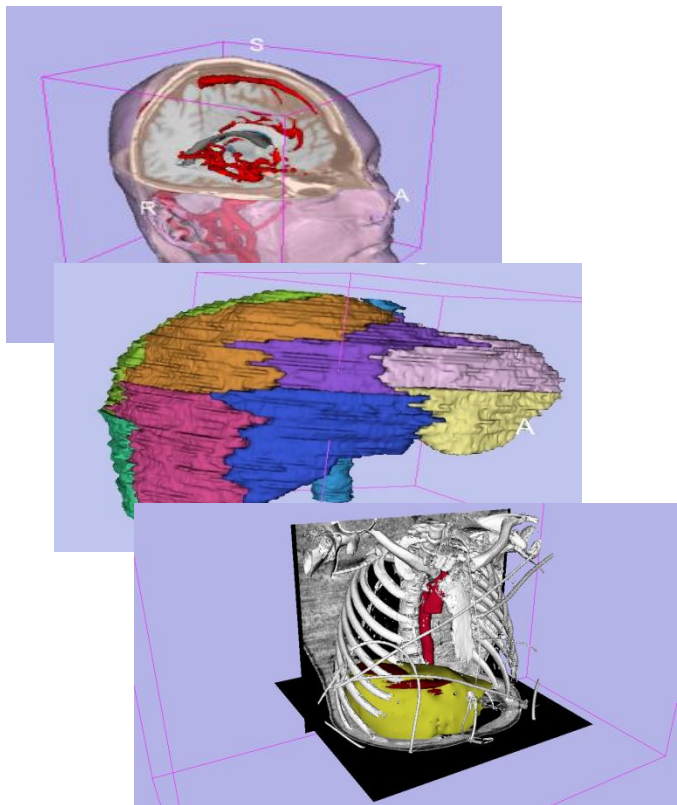


# 3D Interactive Visualization of DICOM Images for Radiology Applications

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

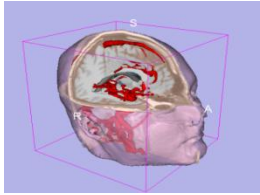
Kitt Shaffer MD, PhD, Boston Medical Center, Boston University



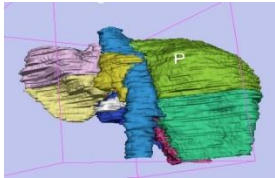
RSNA 2010, November 29, 2010

# Overview

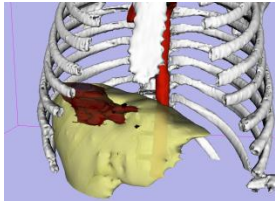
---



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

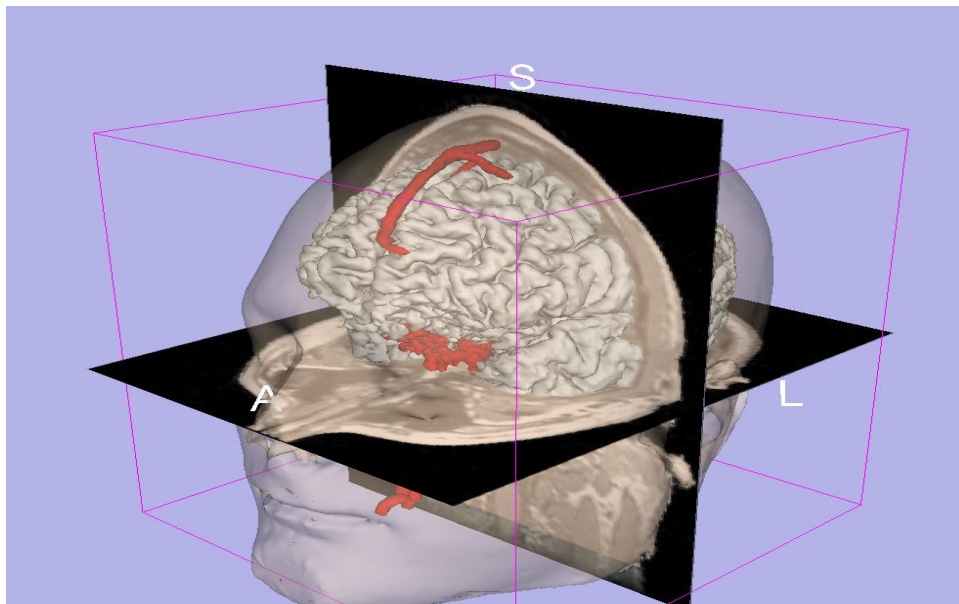


*Leonardo da Vinci (1452-1519), Virgin and Child  
Alte Pinakothek, München*

# An introduction to 3D Visualization

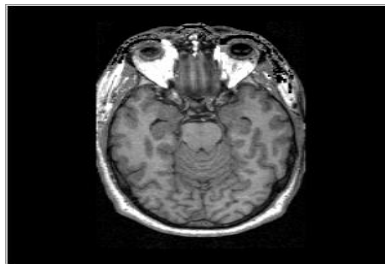
# *Learning objective*

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.

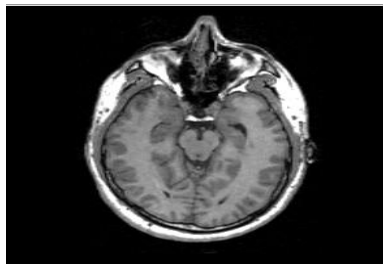




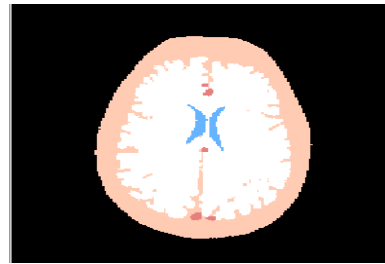
This course is built upon three datasets of a single healthy subject brain:



MR DICOM  
GRASS



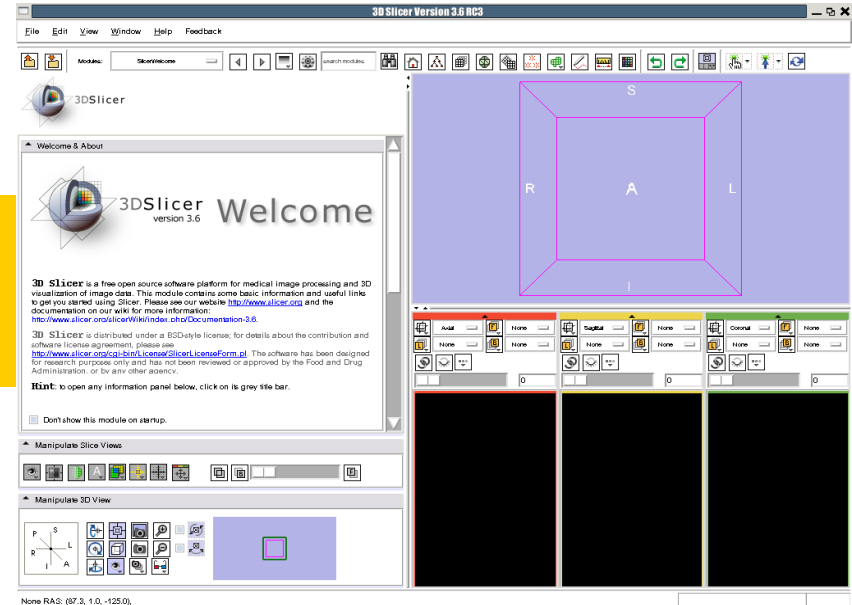
MR Nrrd  
SPGR



Pre-computed  
Label Map

# Launch Slicer3

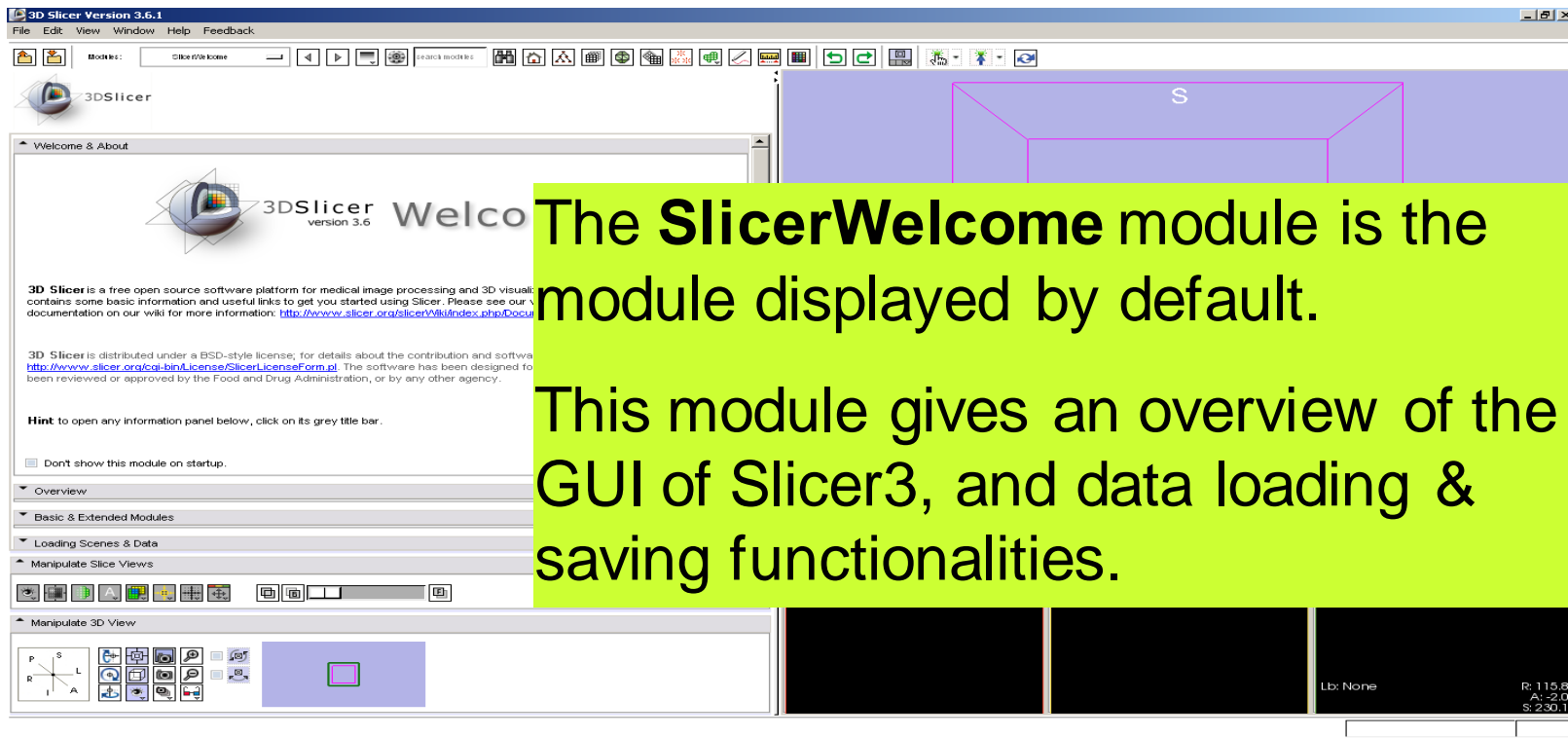
Select Start → Programs →  
Slicer3 3.6.2010-10-22 → Slicer



## ***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

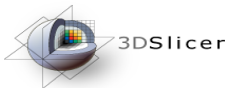


The screenshot shows the 3D Slicer Version 3.6.1 interface. The main window displays the SlicerWelcome module, which is a purple rectangular box with a white 'S' in the center. The interface includes a menu bar (File, Edit, View, Window, Help, Feedback), a toolbar, and a sidebar with various panels. The 'Welcome & About' panel is active, showing the 3DSlicer logo and version 3.6. The text in the panel reads: '3D Slicer is a free open source software platform for medical image processing and 3D visualization. It contains some basic information and useful links to get you started using Slicer. Please see our documentation on our wiki for more information: <http://www.slicer.org/SlicerWiki/index.php/Documentation>. 3D Slicer is distributed under a BSD-style license; for details about the contribution and software license, please see <http://www.slicer.org/cgi-bin/license/SlicerLicenseForm.pl>. The software has been designed to be reviewed or approved by the Food and Drug Administration, or by any other agency. Hint to open any information panel below, click on its grey title bar.  Don't show this module on startup. Overview Basic & Extended Modules Loading Scenes & Data Manipulate Slice Views Manipulate 3D View

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

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

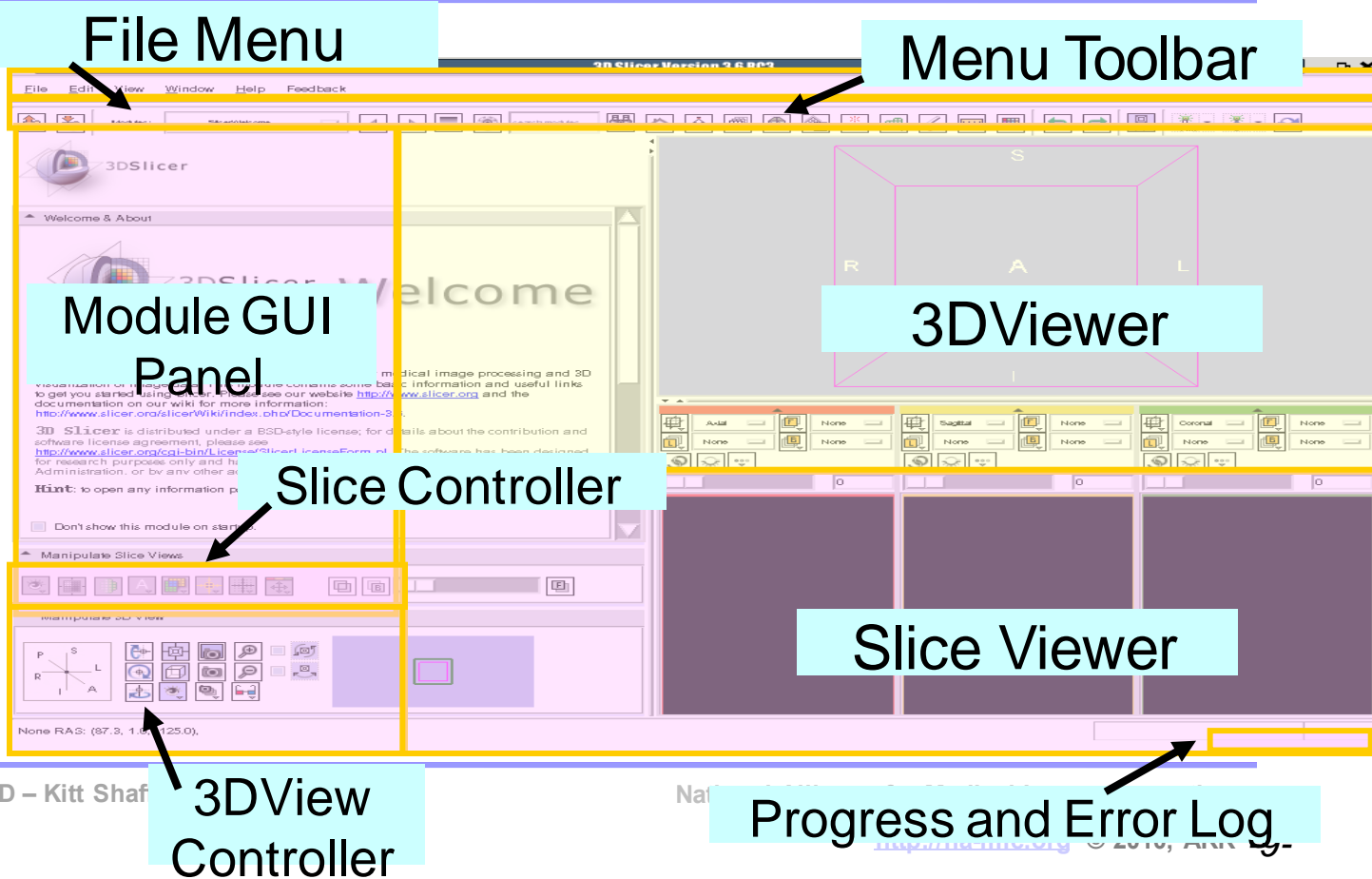


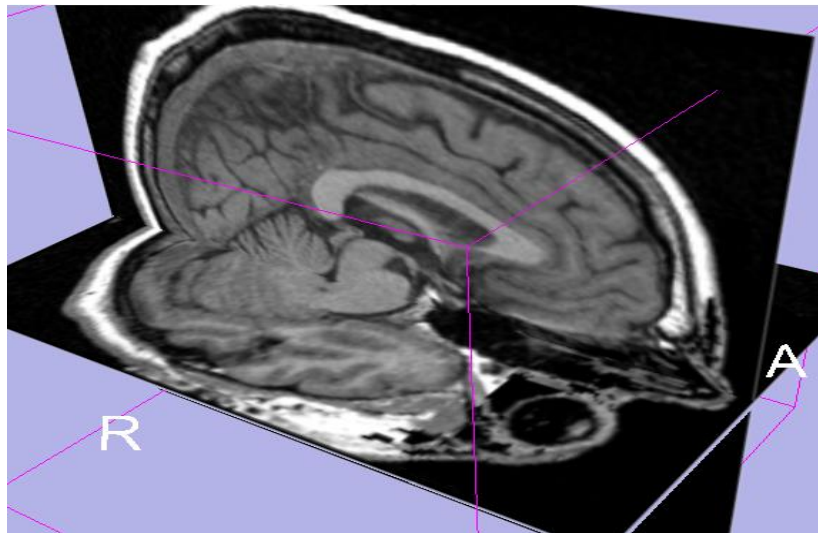


# Slicer3 GUI

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

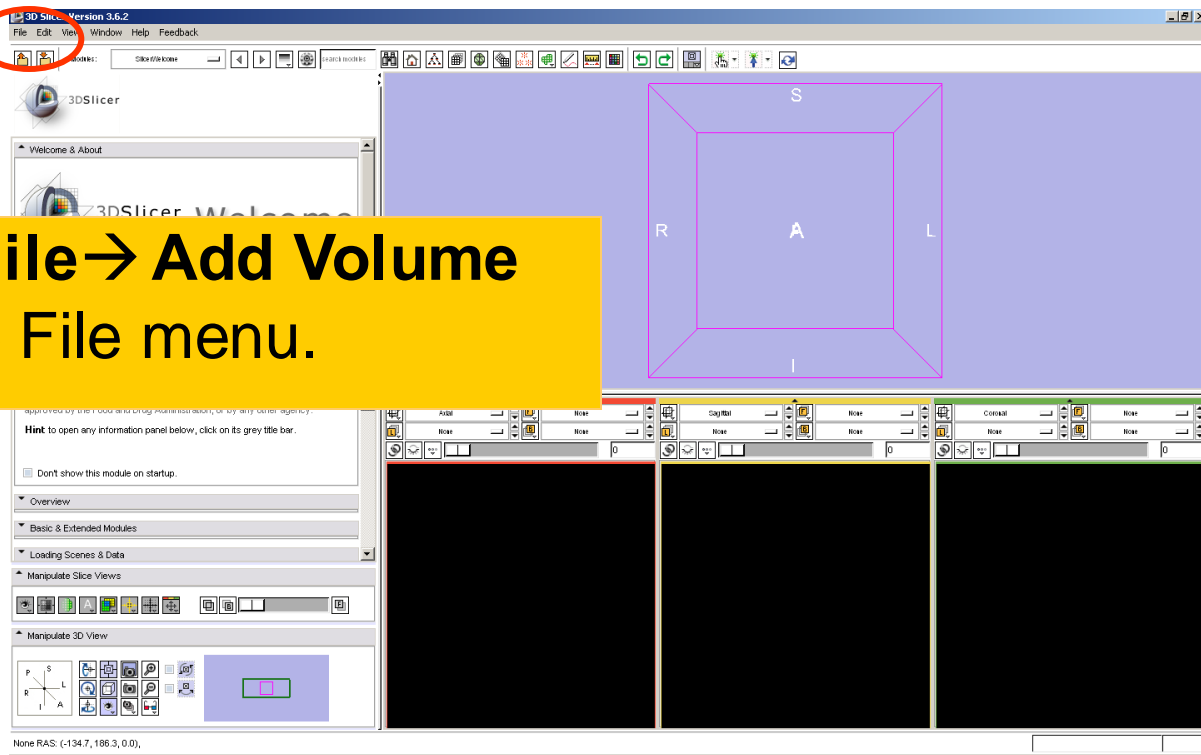




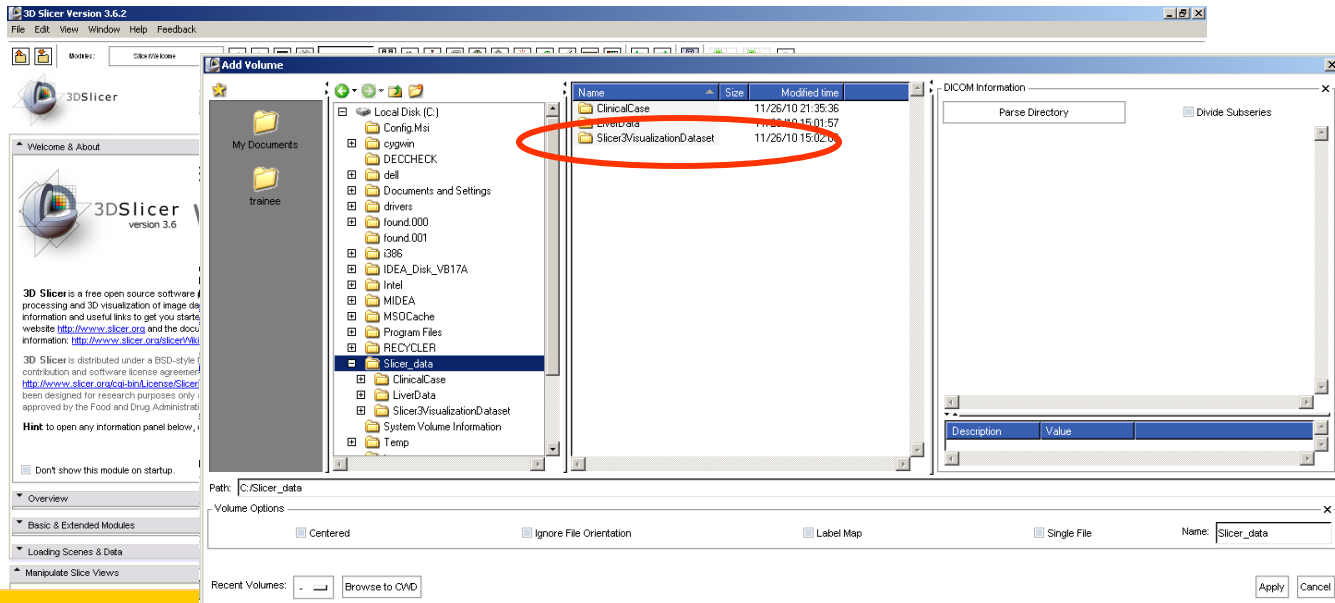
# Part 1: Loading and visualizing multiple volumes simultaneously

# Loading Volumes

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



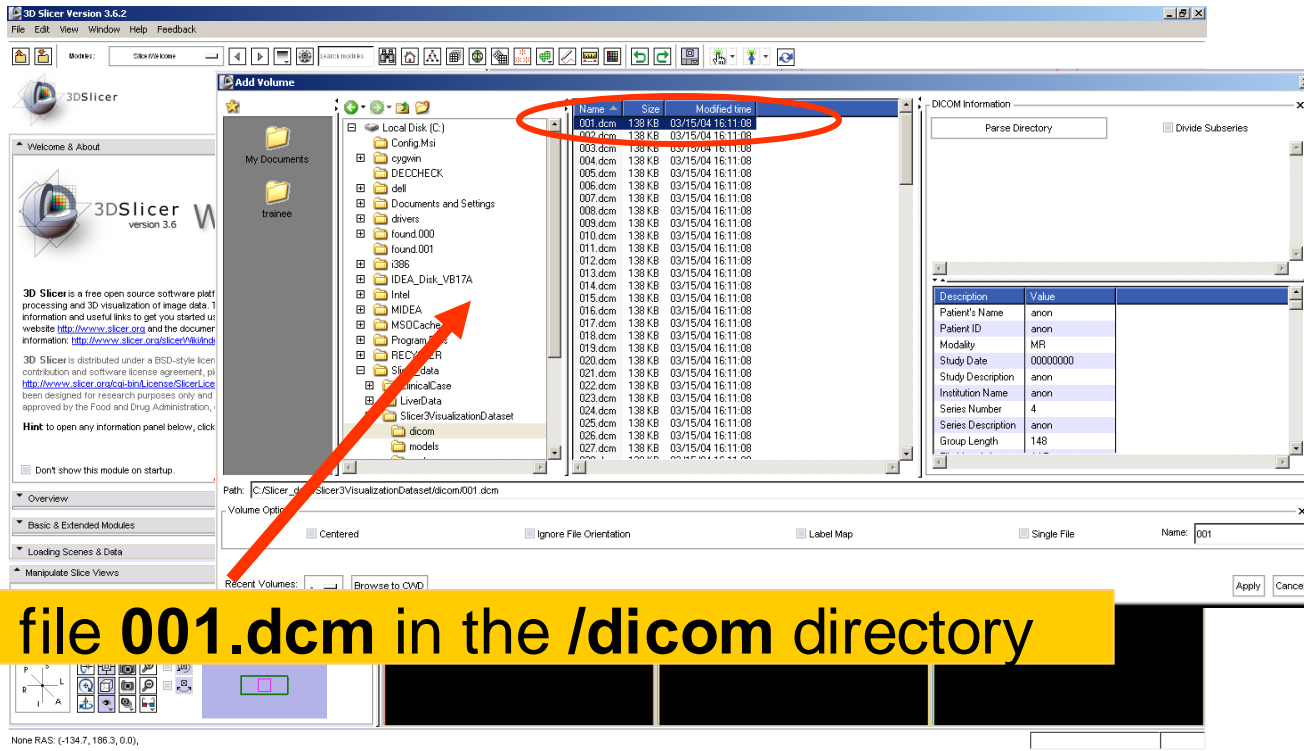
# Loading Volumes



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

**C:/SlicerData\_RSNA2010/Slicer3VisualizationDataset**

# Loading Volumes



3D Slicer Version 3.6.2

File Edit View Window Help Feedback

3DSlicer

Welcome & About

3D Slicer is a free open source software platform for processing and 3D visualization of image data. For information and useful links to get you started visit our website <http://www.slicer.org> and the document information <http://www.slicer.org/doc/3dslicer.html>

3D Slicer is distributed under a BSD-style license. See the contribution and software license agreement, <http://www.slicer.org/wiki/Contributing/SoftwareLicense> for more information.

Hint: to open any information panel below, click on the corresponding icon.

Don't show this module on startup.

Overview

Basic & Extended Modules

Loading Scenes & Data

Manipulate Slice Views

Add Volume

Name	Size	Modified time
001.dcm	138 KB	03/15/04 16:11:08
003.dcm	138 KB	03/15/04 16:11:08
004.dcm	138 KB	03/15/04 16:11:08
005.dcm	138 KB	03/15/04 16:11:08
006.dcm	138 KB	03/15/04 16:11:08
007.dcm	138 KB	03/15/04 16:11:08
008.dcm	138 KB	03/15/04 16:11:08
009.dcm	138 KB	03/15/04 16:11:08
010.dcm	138 KB	03/15/04 16:11:08
011.dcm	138 KB	03/15/04 16:11:08
012.dcm	138 KB	03/15/04 16:11:08
013.dcm	138 KB	03/15/04 16:11:08
014.dcm	138 KB	03/15/04 16:11:08
015.dcm	138 KB	03/15/04 16:11:08
016.dcm	138 KB	03/15/04 16:11:08
017.dcm	138 KB	03/15/04 16:11:08
018.dcm	138 KB	03/15/04 16:11:08
019.dcm	138 KB	03/15/04 16:11:08
020.dcm	138 KB	03/15/04 16:11:08
021.dcm	138 KB	03/15/04 16:11:08
022.dcm	138 KB	03/15/04 16:11:08
023.dcm	138 KB	03/15/04 16:11:08
024.dcm	138 KB	03/15/04 16:11:08
025.dcm	138 KB	03/15/04 16:11:08
026.dcm	138 KB	03/15/04 16:11:08
027.dcm	138 KB	03/15/04 16:11:08

DICOM Information

Parse Directory  Divide Subseries

Description	Value
Patient's Name	anon
Patient ID	anon
Modality	MR
Study Date	00000000
Study Description	anon
Institution Name	anon
Series Number	4
Series Description	anon
Group Length	148

Path: C:\Slicer\_data\Slicer3\visualizationDataset\dicom\001.dcm

Volume Options

Centered  Ignore File Orientation  Label Map  Single File Name: 001

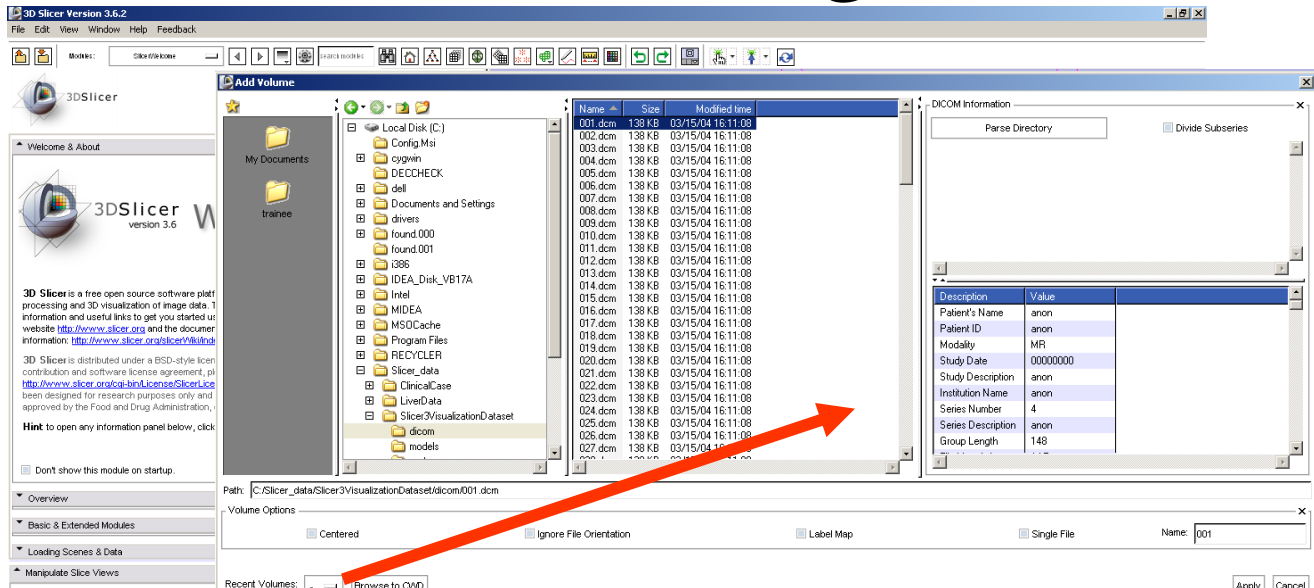
Recent Volumes:  Browse to CWD

Apply Cancel

None RAS: (-134.7, 166.3, 0.0),

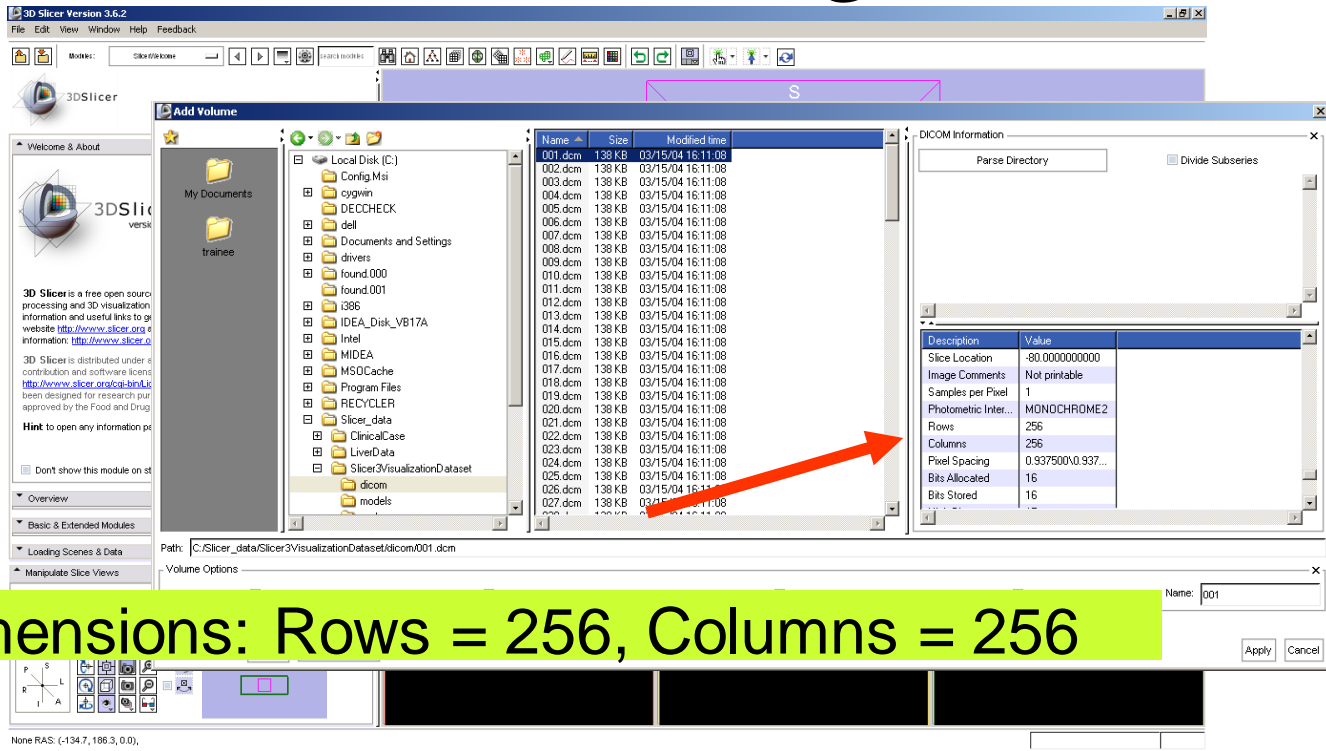
Select the file 001.dcm in the /dicom directory

# 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



3D Slicer Version 3.6.2

File Edit View Window Help Feedback

3DSlicer

**Add Volume**

Local Disk (C:)
 

- ConfigMsi
- cygwin
- DECCHECK
- dell
- Documents and Settings
- drivers
- found.000
- found.001
- l386
- IDEA\_Disk\_VB17A
- Intel
- MIDEA
- MSOCache
- Program Files
- RECYCLER
- Slicer\_data
  - ClinicalCase
  - LiverData
  - Slicer3VisualizationDataset
    - dcm
    - models

Name	Size	Modified time
001.dcm	138 KB	03/15/04 16:11:08
002.dcm	138 KB	03/15/04 16:11:08
003.dcm	138 KB	03/15/04 16:11:08
004.dcm	138 KB	03/15/04 16:11:08
005.dcm	138 KB	03/15/04 16:11:08
006.dcm	138 KB	03/15/04 16:11:08
007.dcm	138 KB	03/15/04 16:11:08
008.dcm	138 KB	03/15/04 16:11:08
009.dcm	138 KB	03/15/04 16:11:08
010.dcm	138 KB	03/15/04 16:11:08
011.dcm	138 KB	03/15/04 16:11:08
012.dcm	138 KB	03/15/04 16:11:08
013.dcm	138 KB	03/15/04 16:11:08
014.dcm	138 KB	03/15/04 16:11:08
015.dcm	138 KB	03/15/04 16:11:08
016.dcm	138 KB	03/15/04 16:11:08
017.dcm	138 KB	03/15/04 16:11:08
018.dcm	138 KB	03/15/04 16:11:08
019.dcm	138 KB	03/15/04 16:11:08
020.dcm	138 KB	03/15/04 16:11:08
021.dcm	138 KB	03/15/04 16:11:08
022.dcm	138 KB	03/15/04 16:11:08
023.dcm	138 KB	03/15/04 16:11:08
024.dcm	138 KB	03/15/04 16:11:08
025.dcm	138 KB	03/15/04 16:11:08
026.dcm	138 KB	03/15/04 16:11:08
027.dcm	138 KB	03/15/04 16:11:08

Path: C:\Slicer\_data\Slicer3VisualizationDataset\dicom\001.dcm

Volume Options

Path: C:\Slicer\_data\Slicer3VisualizationDataset\dicom\001.dcm

Name: 001

Apply Cancel

**DICOM Information**

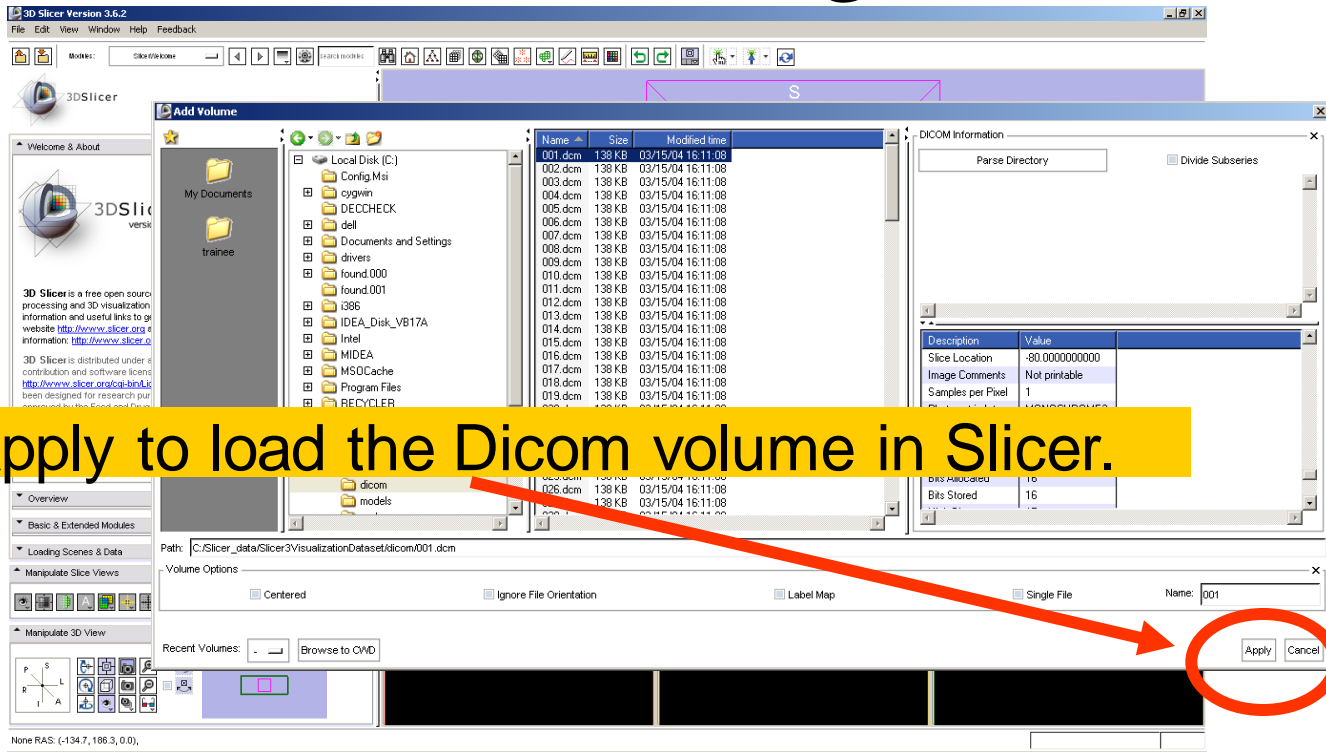
Parse Directory  Divide Subseries

Description	Value
Slice Location	-80.0000000000
Image Comments	Not printable
Samples per Pixel	1
Photometric Inter...	MONOCHROME2
Rows	256
Columns	256
Pixel Spacing	0.937500\0.937...
Bits Allocated	16
Bits Stored	16

None RAS: (-134.7, 166.3, 0.0)

**Image dimensions: Rows = 256, Columns = 256**

# Loading Volumes



3D Slicer Version 3.6.2

File Edit View Window Help Feedback

3DSlicer

**Add Volume**

Name	Size	Modified time
001.dcm	138 KB	03/15/04 16:11:08
002.dcm	138 KB	03/15/04 16:11:08
003.dcm	138 KB	03/15/04 16:11:08
004.dcm	138 KB	03/15/04 16:11:08
005.dcm	138 KB	03/15/04 16:11:08
006.dcm	138 KB	03/15/04 16:11:08
007.dcm	138 KB	03/15/04 16:11:08
008.dcm	138 KB	03/15/04 16:11:08
009.dcm	138 KB	03/15/04 16:11:08
010.dcm	138 KB	03/15/04 16:11:08
011.dcm	138 KB	03/15/04 16:11:08
012.dcm	138 KB	03/15/04 16:11:08
013.dcm	138 KB	03/15/04 16:11:08
014.dcm	138 KB	03/15/04 16:11:08
015.dcm	138 KB	03/15/04 16:11:08
016.dcm	138 KB	03/15/04 16:11:08
017.dcm	138 KB	03/15/04 16:11:08
018.dcm	138 KB	03/15/04 16:11:08
019.dcm	138 KB	03/15/04 16:11:08

DICOM Information

Parse Directory  Divide Subseries

Description	Value
Slice Location	-80.000000000
Image Comments	Not printable
Samples per Pixel	1

Path: C:\Slicer\_data\Slicer3VisualizationDataset\dicom\001.dcm

Volume Options

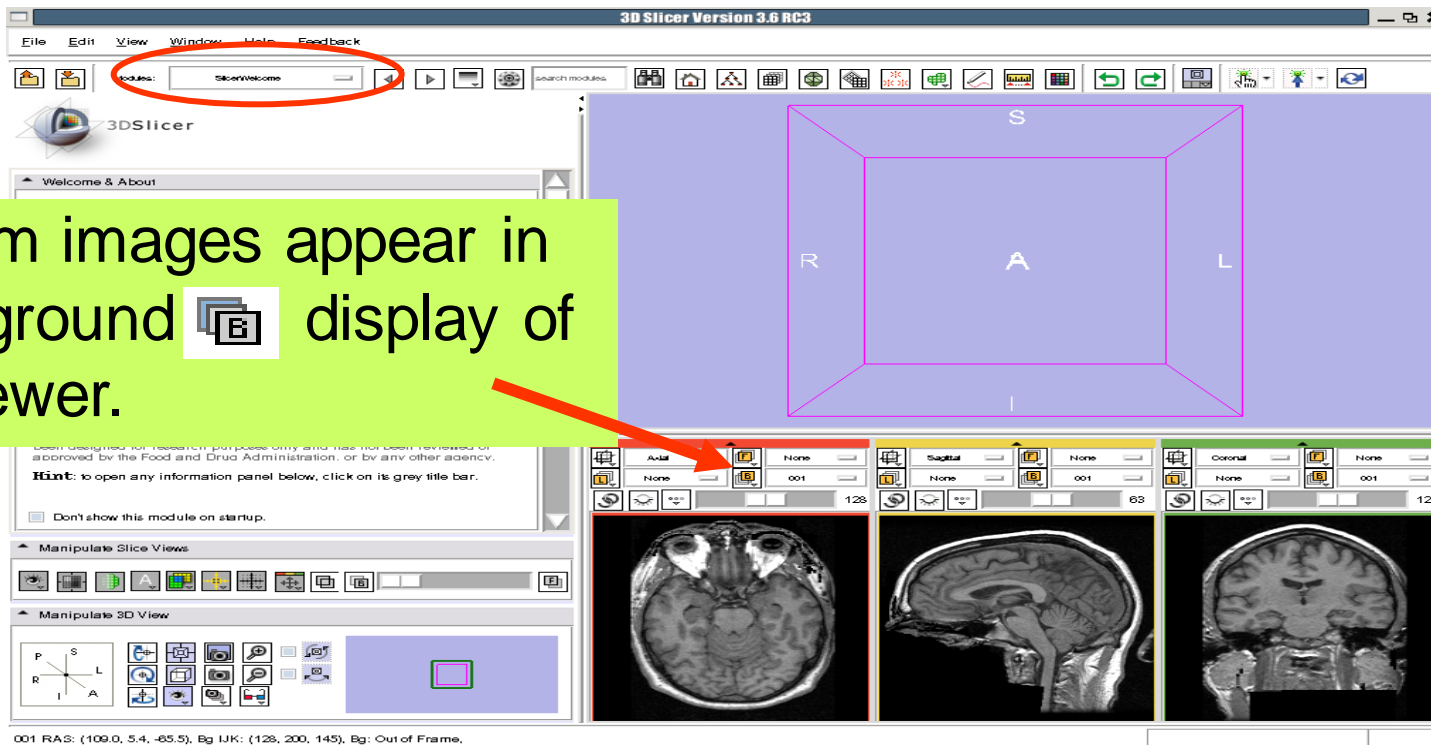
Centered  Ignore File Orientation  Label Map  Single File Name: 001


Recent Volumes:  Browse to CWD

Apply Cancel

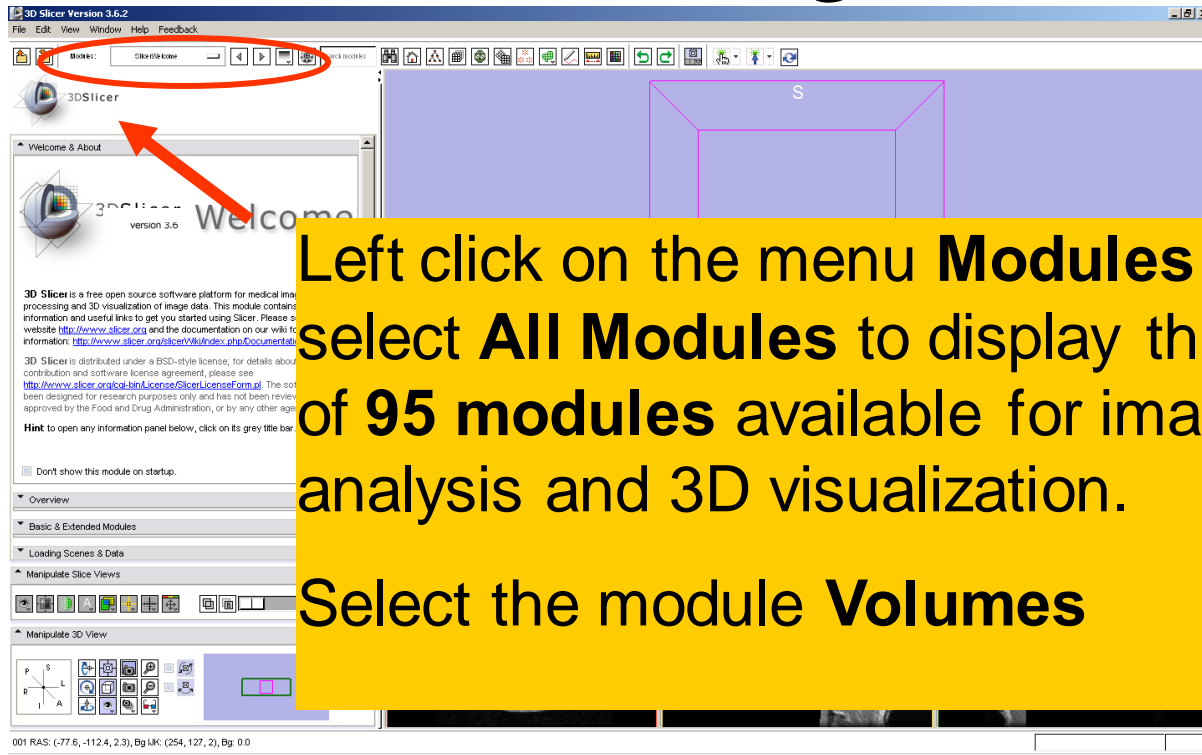


# Loading Volumes



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

# Loading Volumes



3D Slicer Version 3.6.2

File Edit View Window Help Feedback

Modules: Slicer@tkb.com

3DSlicer

Welcome & About

3DSlicer version 3.6 Welcome

3D Slicer is a free open source software platform for medical image processing and 3D visualization of image data. This module contains information and useful links to get you started using Slicer. Please see our website <http://www.slicer.org> and the documentation on our wiki for information: <http://www.slicer.org/slicerWiki/index.php/Documentation>

3D Slicer is distributed under a BSD-style license; for details about contribution and software license agreement, please see <http://www.slicer.org/ci-bin/license/SlicerLicenseForm.pl>. The software has been designed for research purposes only and has not been reviewed or approved by the Food and Drug Administration, or by any other agency.

Hint: to open any information panel below, click on its grey title bar

Don't show this module on startup.

Overview

Basic & Extended Modules

Loading Scenes & Data

Manipulate Slice Views

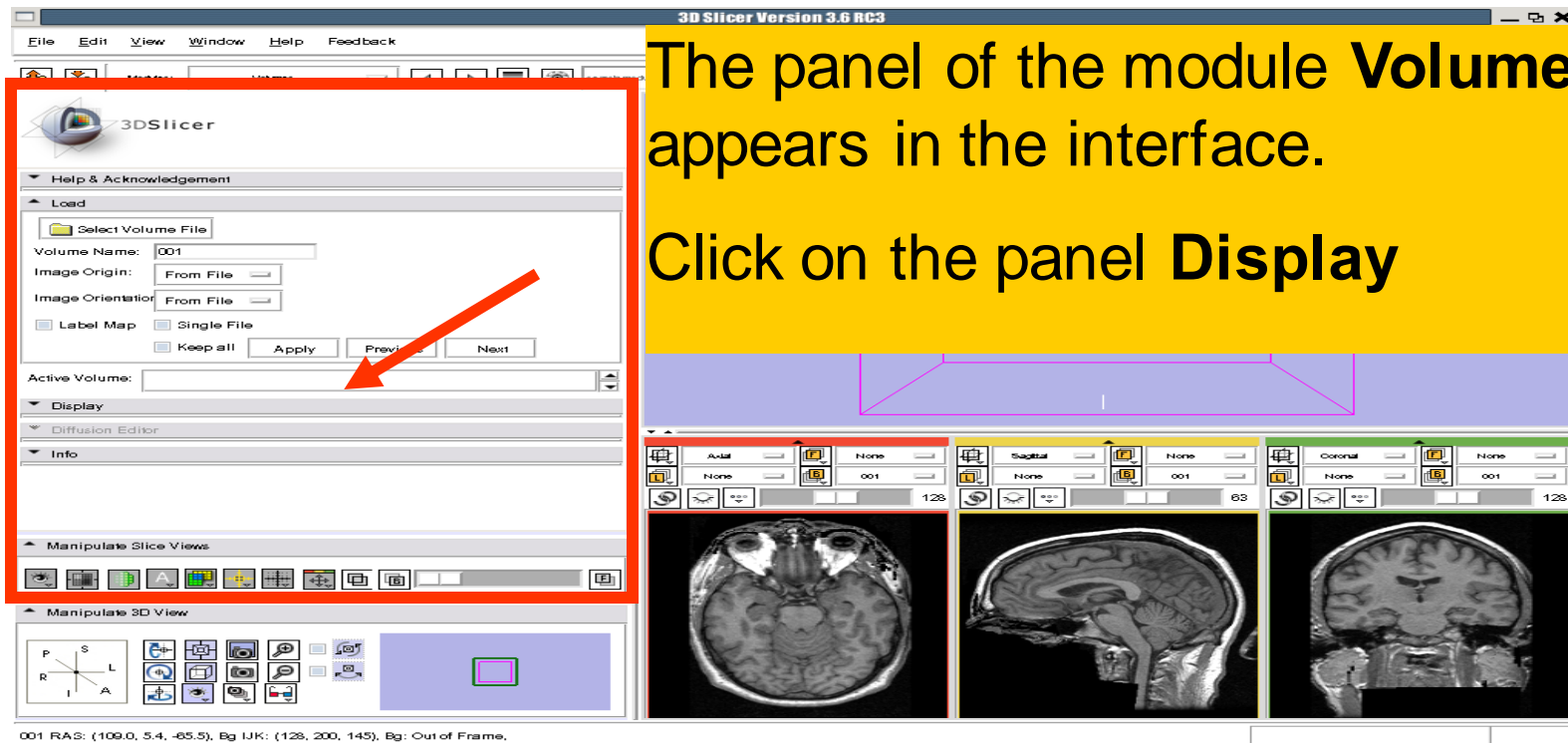
Manipulate 3D View

001 RAS: (-77.6, -112.4, 2.3), Bg Mk: (254, 127, 2), Bg: 0.0

**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

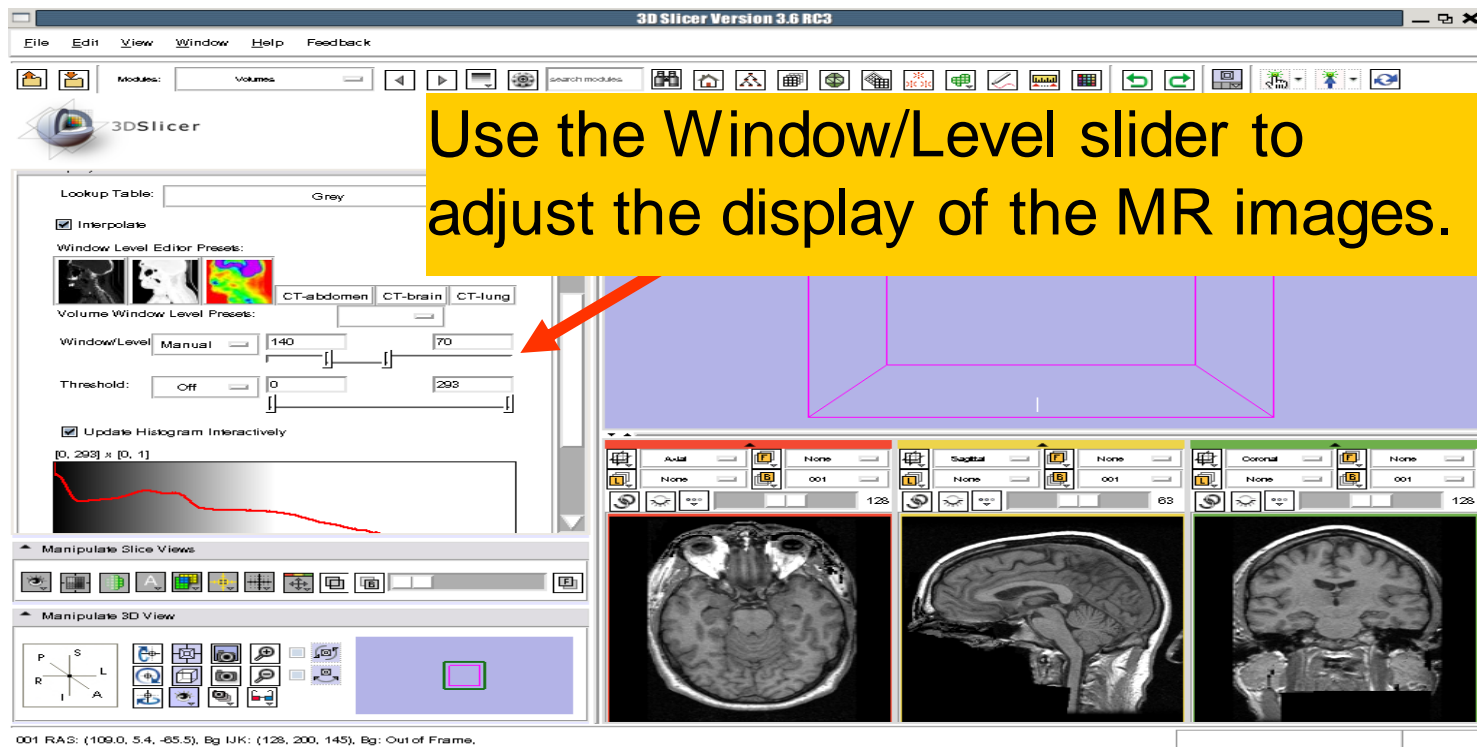


The panel of the module **Volumes** appears in the interface.

Click on the panel **Display**

001 RAS: (109.0, 5.4, -65.5), Bg IJK: (128, 200, 145), Bg: Out of Frame.

# Loading Volumes



3D Slicer Version 3.6 RC3

File Edit View Window Help Feedback

Modules: Volumes

Lookup Table: Grey

Interpolate

Window Level Editor Presets:

Volume Window Level Presets: CT-abdomen CT-brain CT-lung

Window/Level: Manual 140 70

Threshold: Off 0 293

Update Histogram Interactively

[D, 293] x [D, 1]

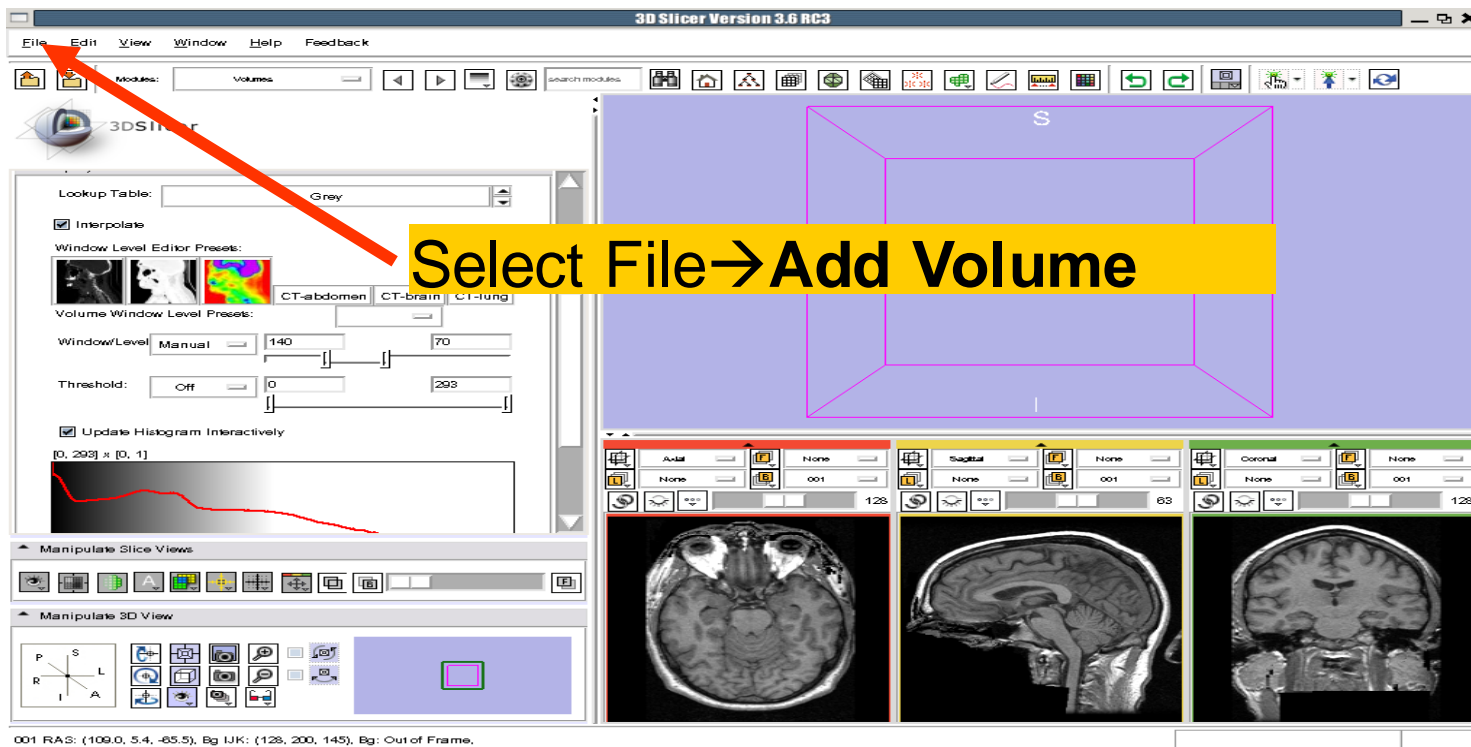
Manipulate Slice Views

Manipulate 3D View

001 RAS: (109.0, 5.4, -85.5), Bg IJK: (128, 200, 145), Bg: Out of Frame.

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

# Loading Volumes



3D Slicer Version 3.6 RC3

File Edit View Window Help Feedback

Modules: Volumes

Lookup Table: Grey

Interpolate

Window Level Editor Presets:

Volume Window Level Presets: CT-abdomen CT-brain CT-lung

Window Level: Manual 140 70

Threshold: Off 0 293

Update Histogram Interactively

[0, 293] x [0, 1]

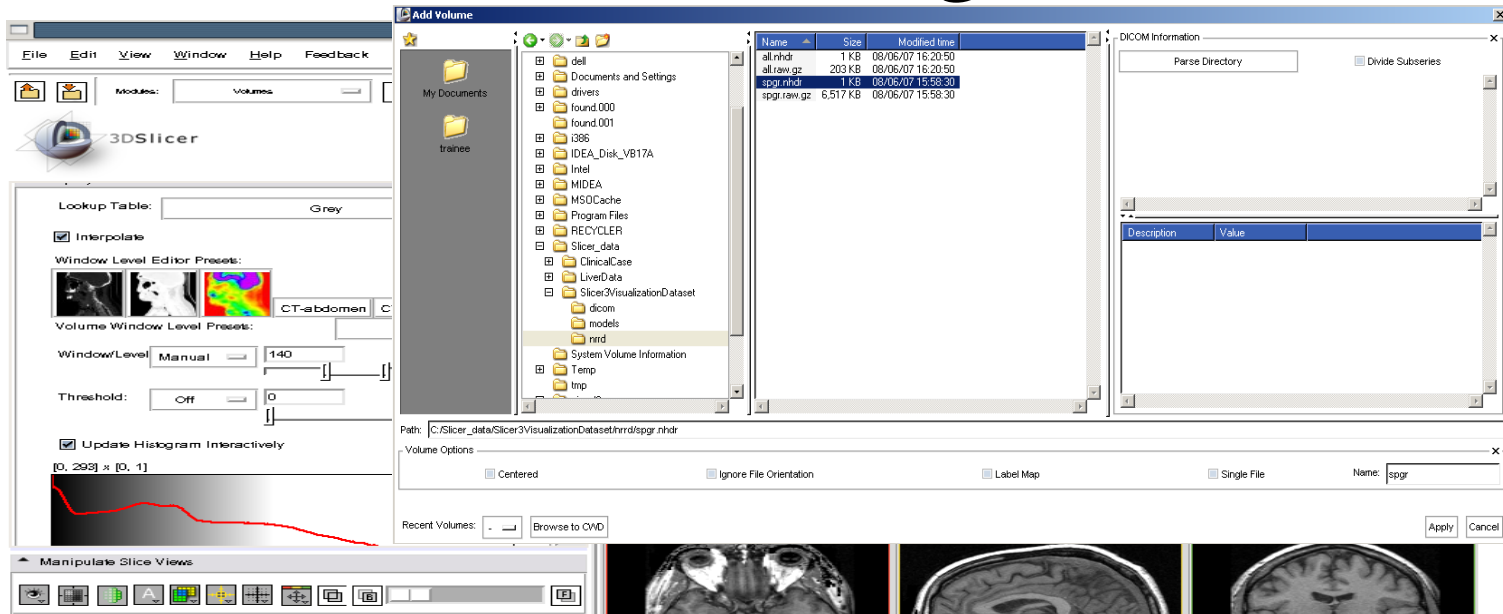
Manipulate Slice Views

Manipulate 3D View

001 RAS: (109.0, 5.4, -85.5), Bg IJK: (128, 200, 145), Bg: Out of Frame.

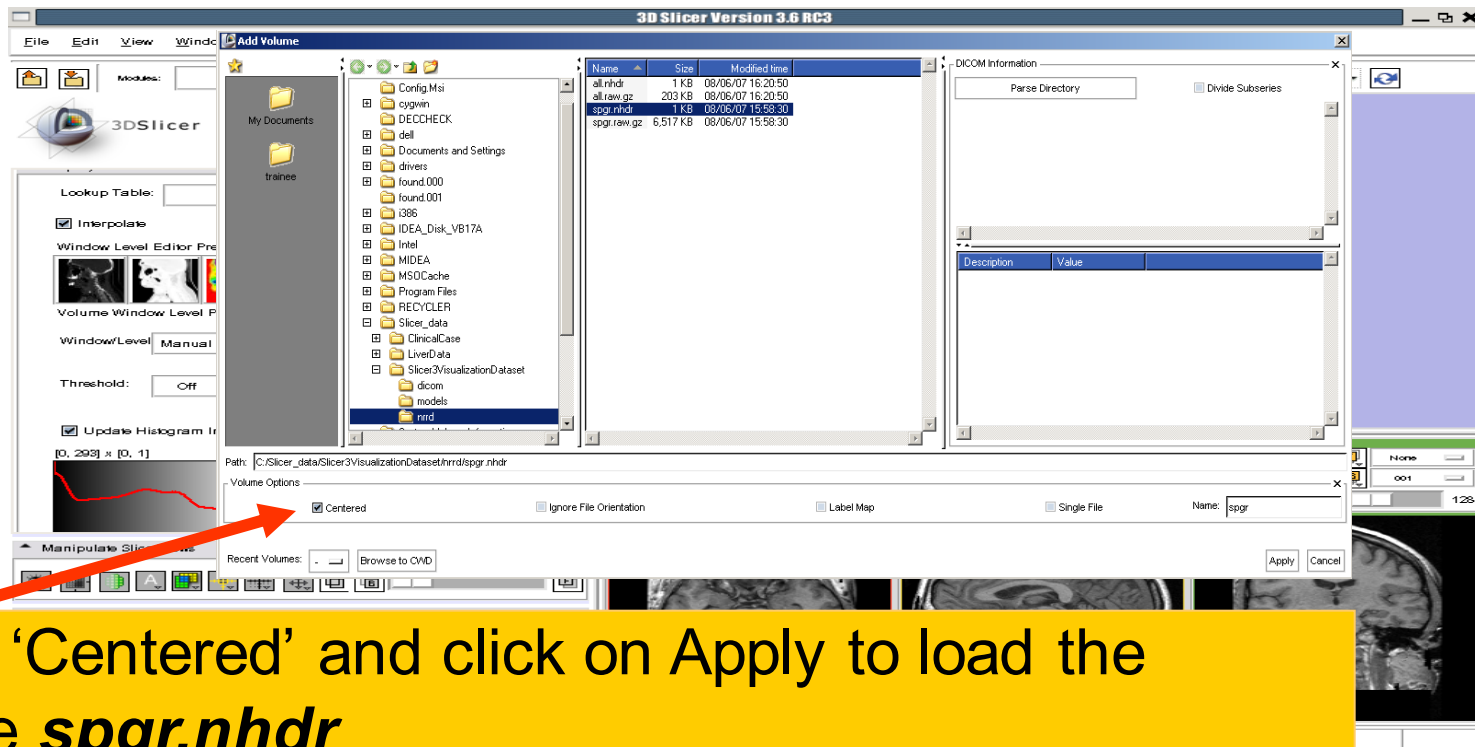
**Select File → Add Volume**

# Loading Volumes



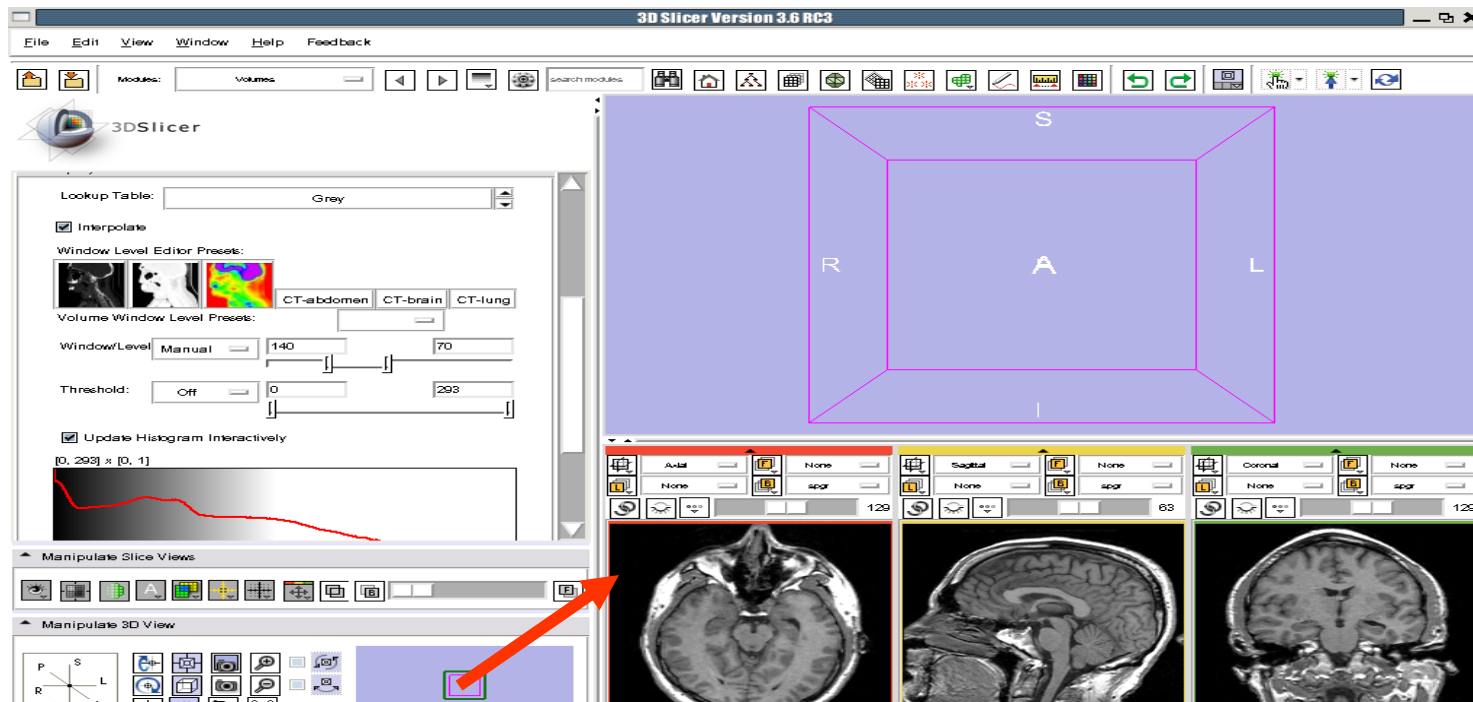
Browse to find the header file of the spgr volume *spgr.nhdr* located in the directory **`C:/SlicerData_RSNA2010/Slicer3VisualizationDataset/nrrd`**

# Loading Volumes



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

# Loading Volumes

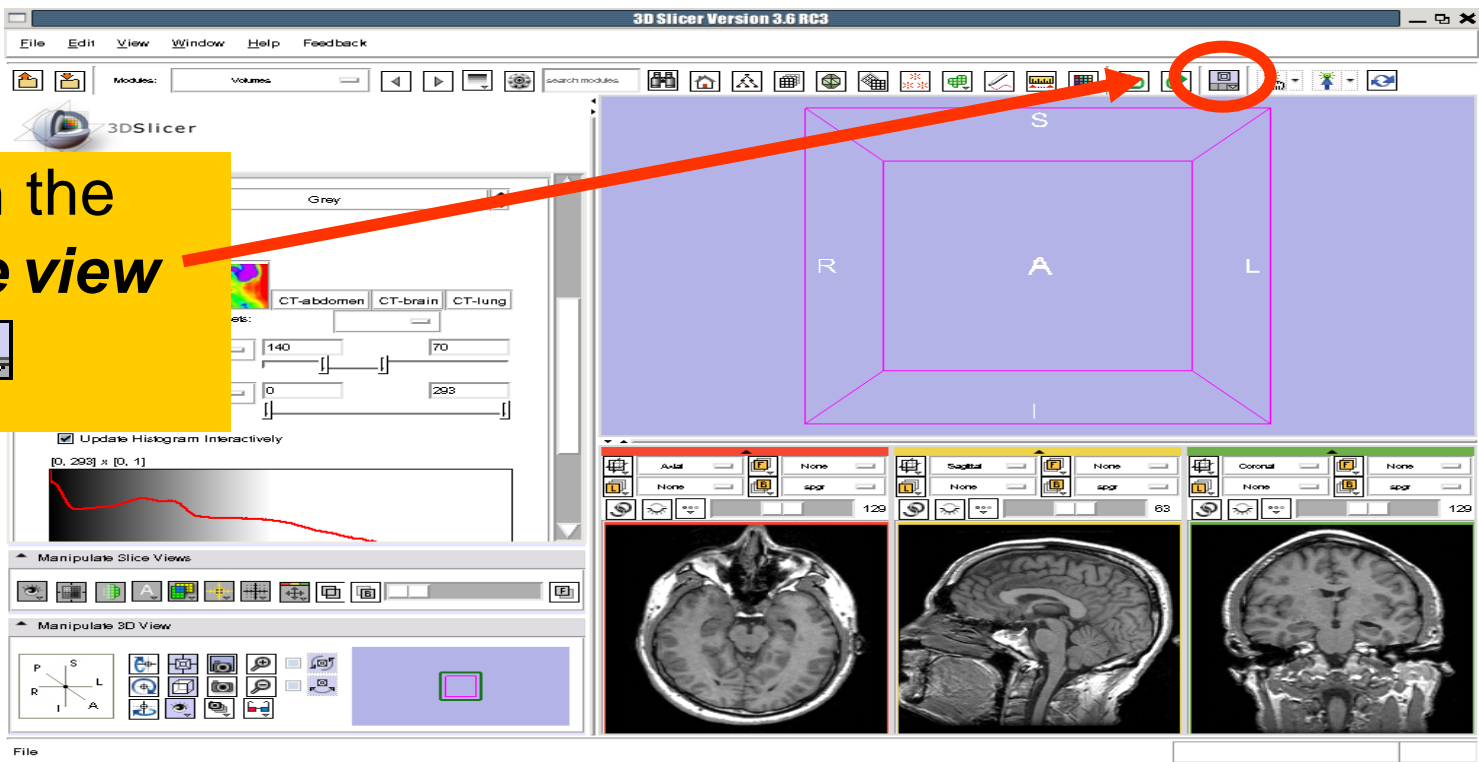


The spgr volume appears in the Background display  of the 2D Viewer.

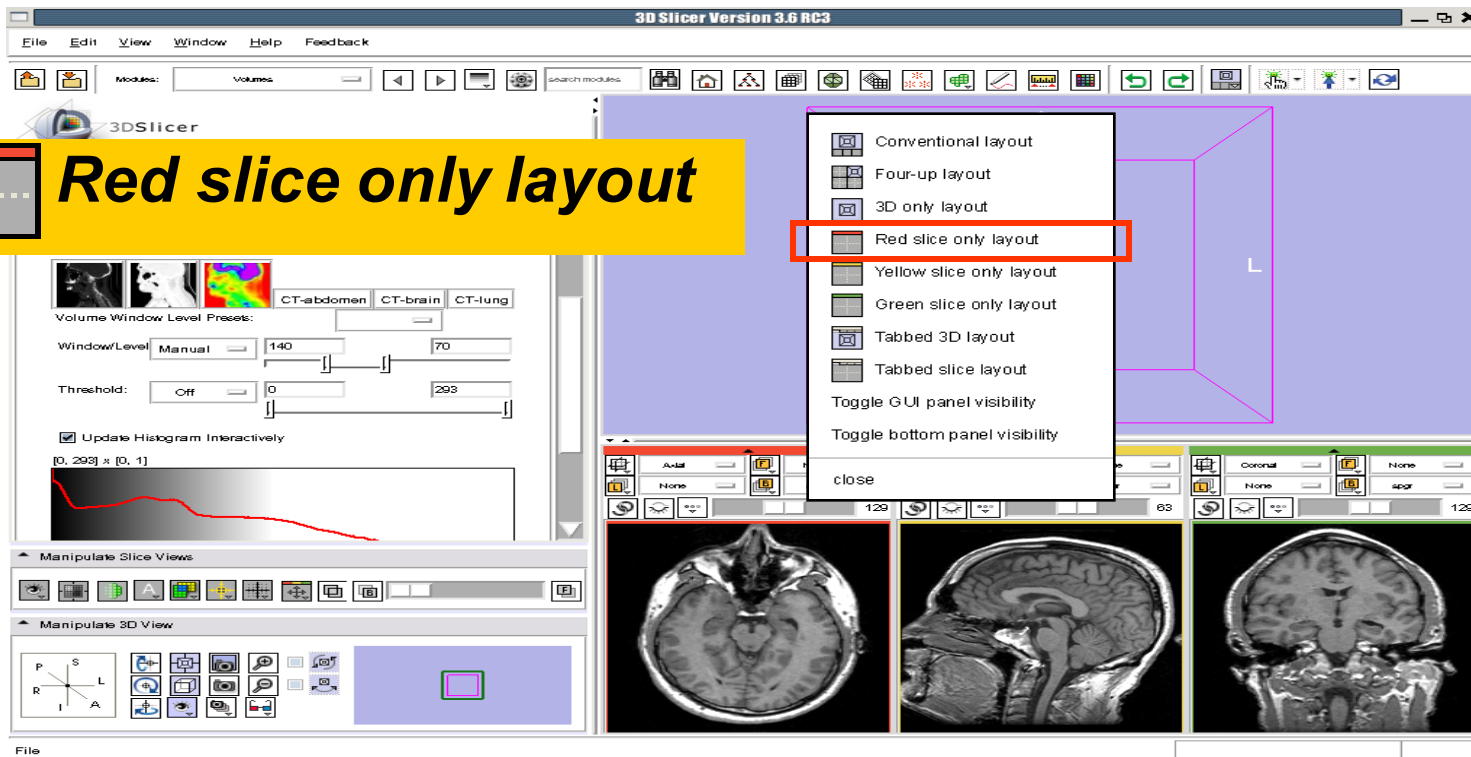


# Exploring the data

Click on the **choose view** icon



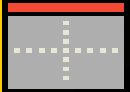
# Exploring the data



3D Slicer Version 3.6 RC3

File Edit View Window Help Feedback

Modules: Volumes

Select  **Red slice only layout**

- Conventional layout
- Four-up layout
- 3D only layout
- Red slice only layout**
- Yellow slice only layout
- Green slice only layout
- Tabbed 3D layout
- Tabbed slice layout
- Toggle GUI panel visibility
- Toggle bottom panel visibility
- close

Volume Window Level Presets: CT-abdomen CT-brain CT-lung

WindowLevel: Manual 140 70

Threshold: Off 0 293

Update Histogram Interactively

[D. 293] \* [D. 1]

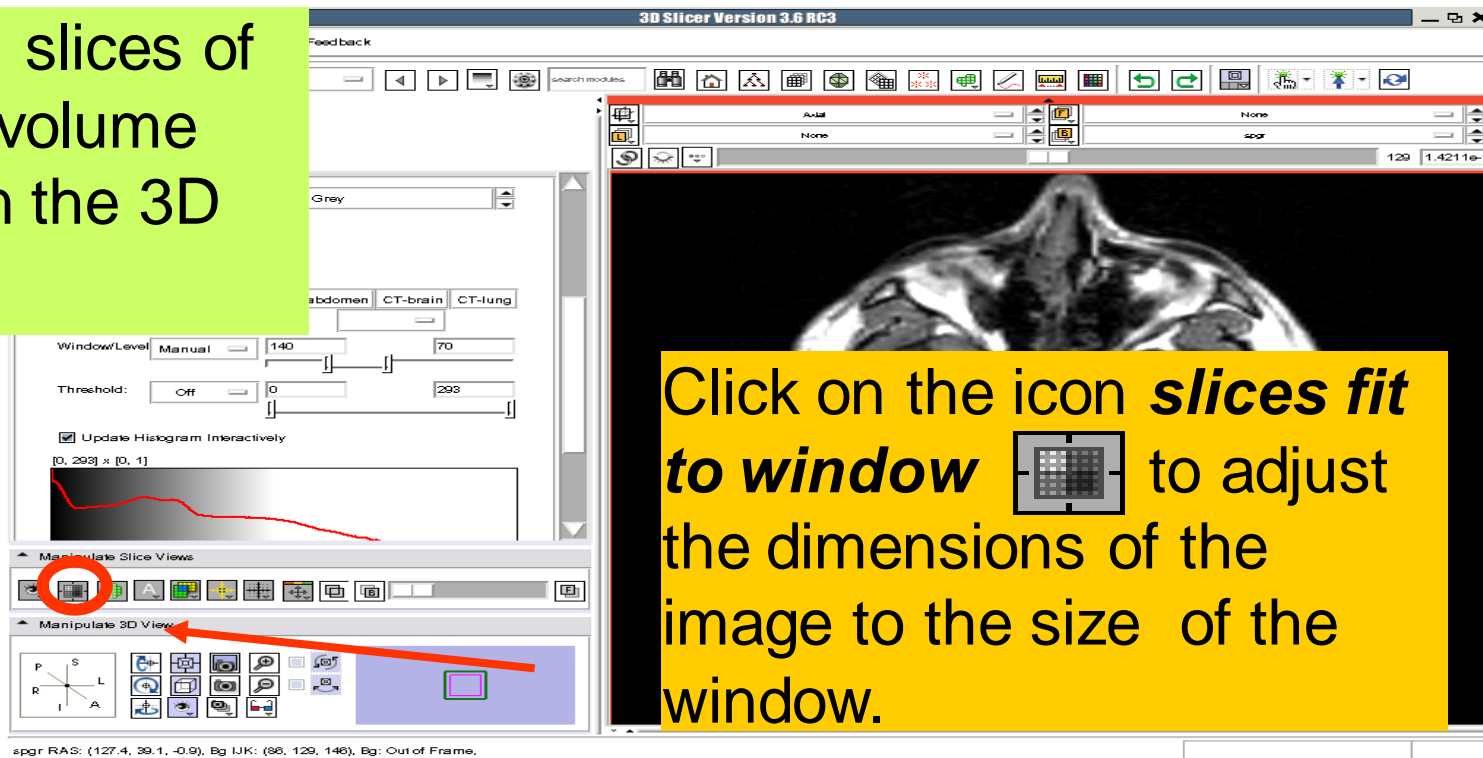
Manipulate Slice Views

Manipulate 3D View

File

# Exploring the data

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



3D Slicer Version 3.6 RC3

Feedback

Search modules

Window/Level: Manual | 140 | 70

Threshold: Off | 0 | 293

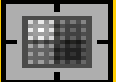
Update Histogram Interactively

[0, 293] x [0, 1]


Manipulate Slice Views

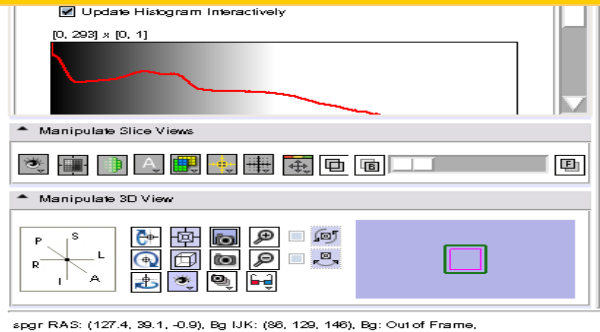
Manipulate 3D View

spgr RAS: (127.4, 39.1, -0.9), Bg IJK: (86, 129, 146), Bg: Out of Frame.



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

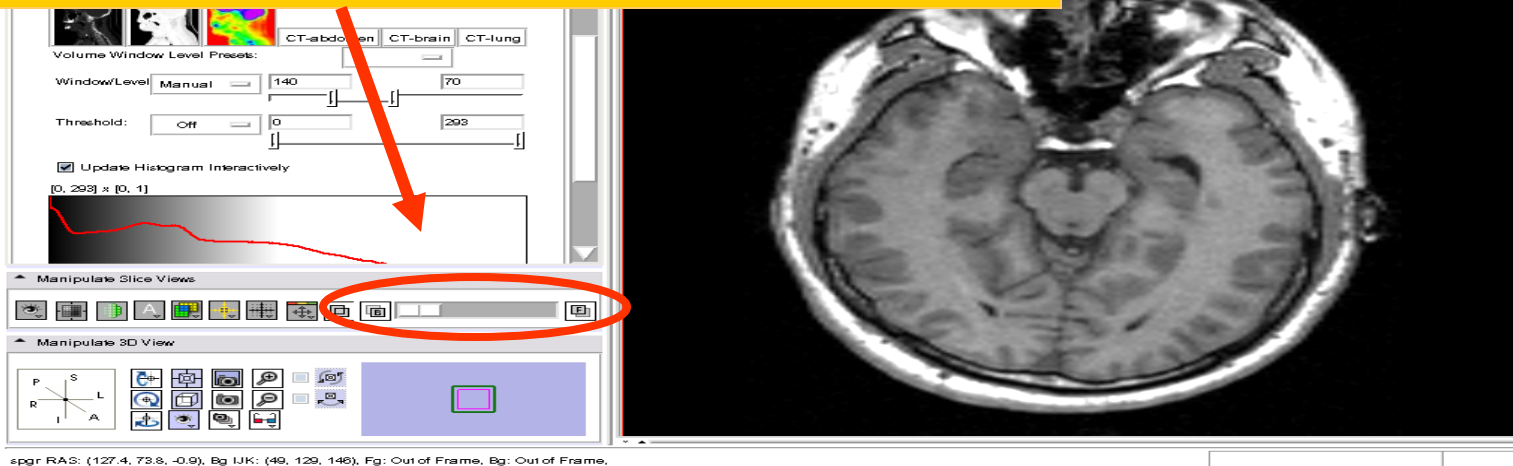
# Exploring the data

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



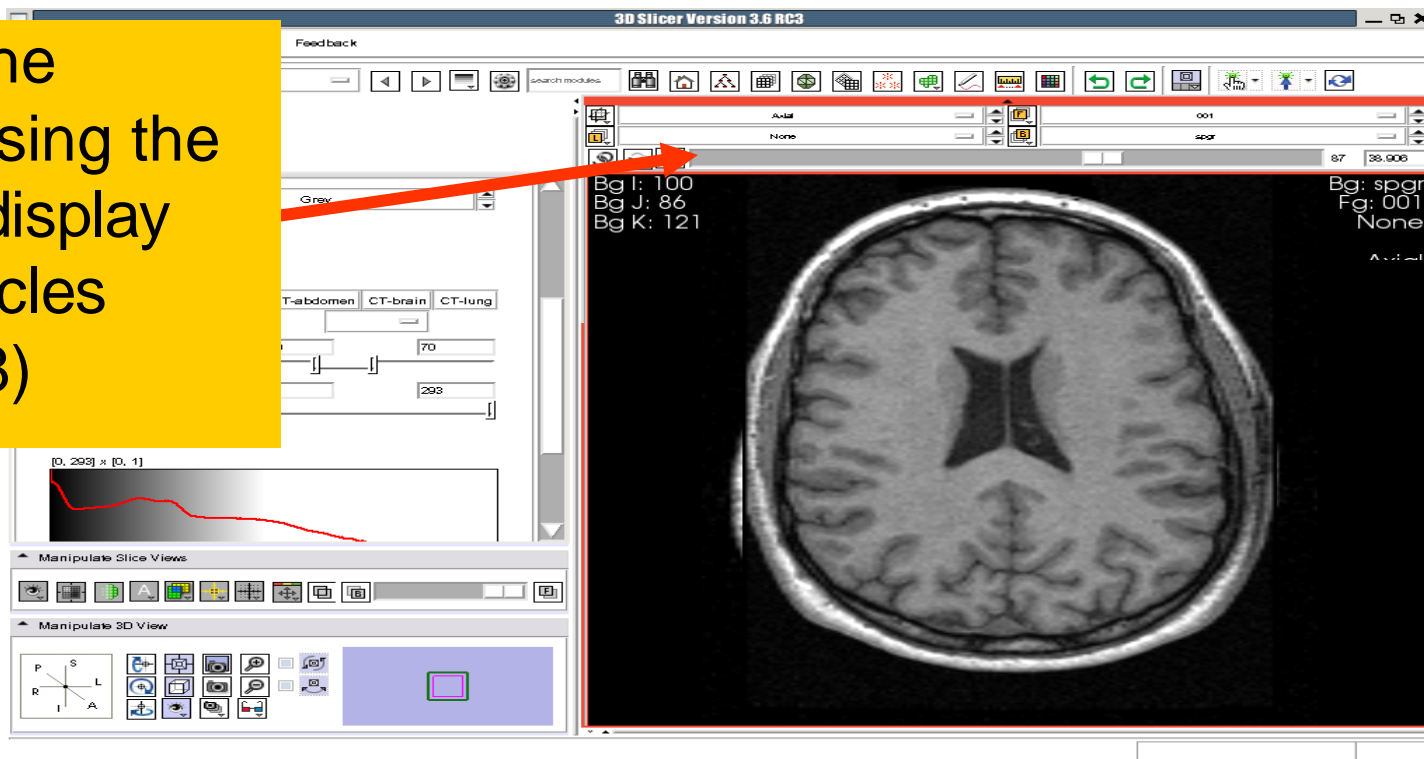
# Exploring the data

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



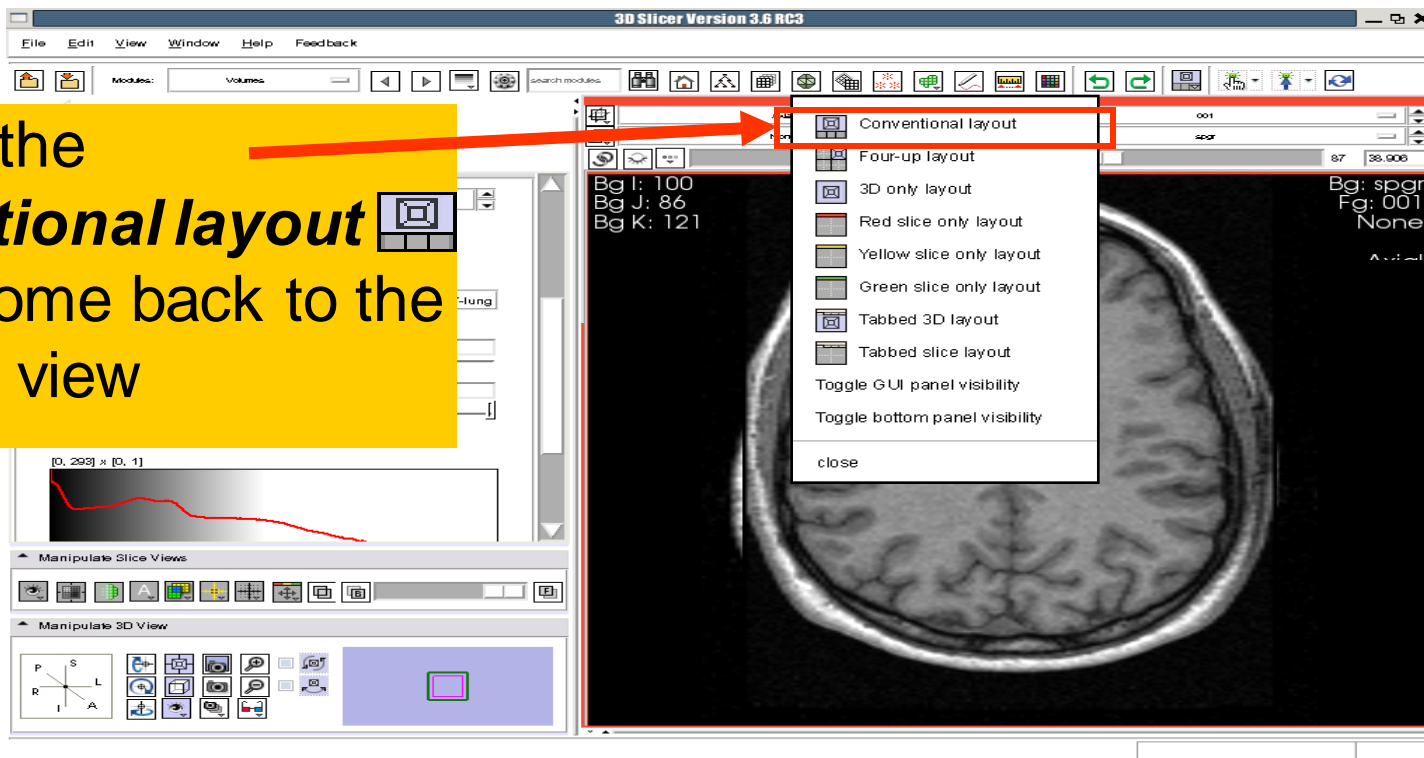
# Exploring the data

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




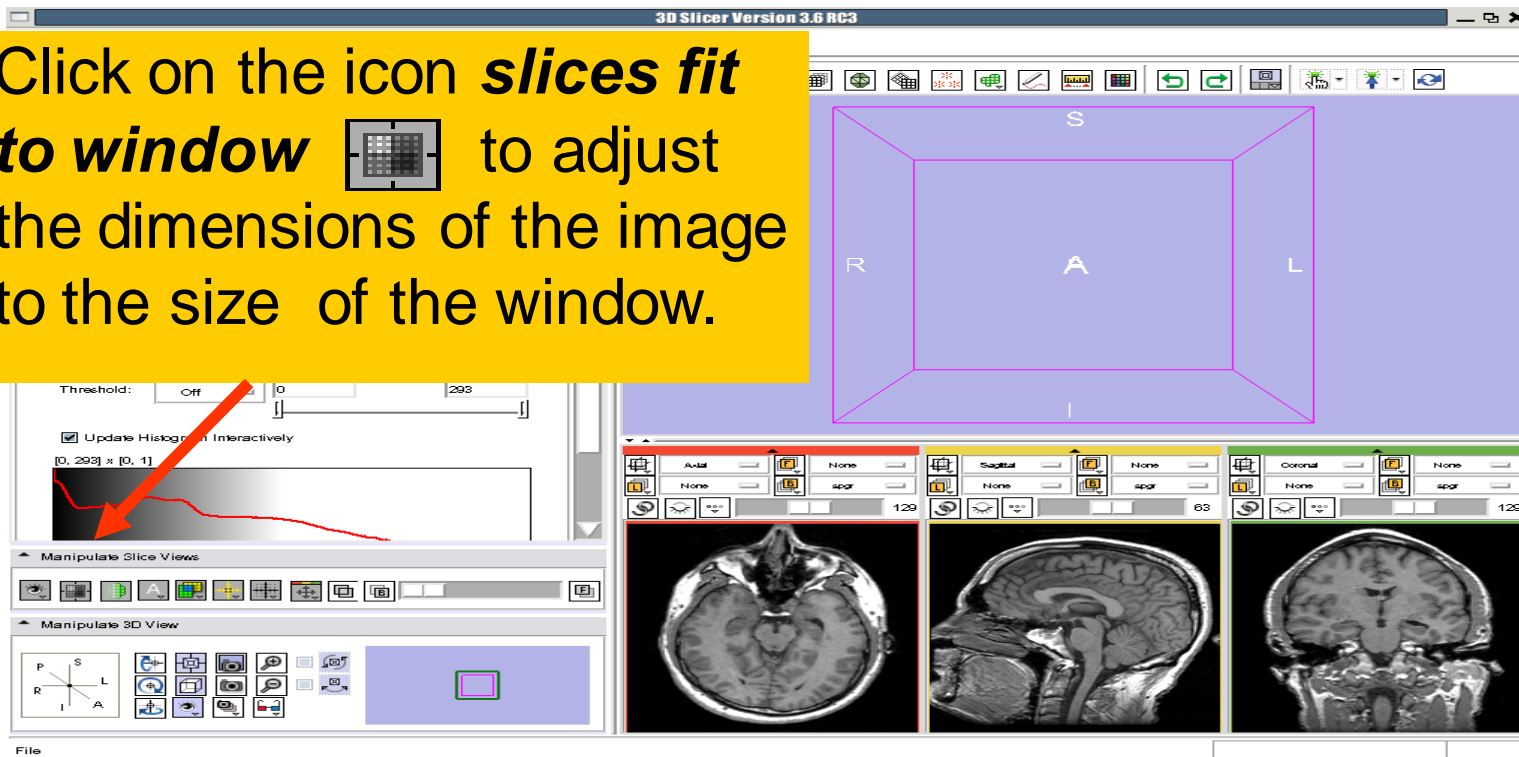
# Exploring the data

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.



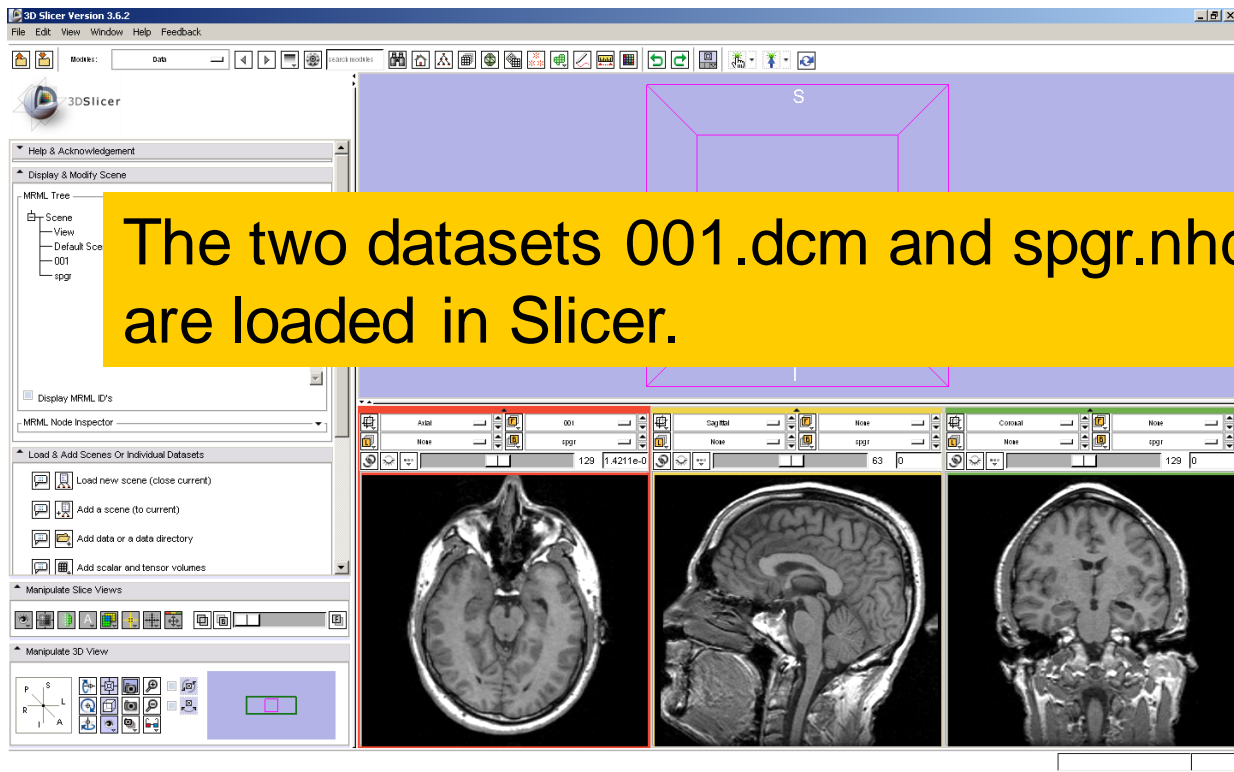


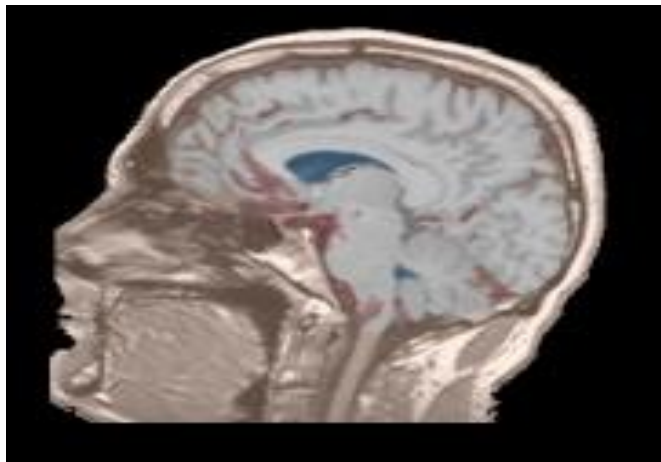
# Loading Volumes



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

# Loading Volumes

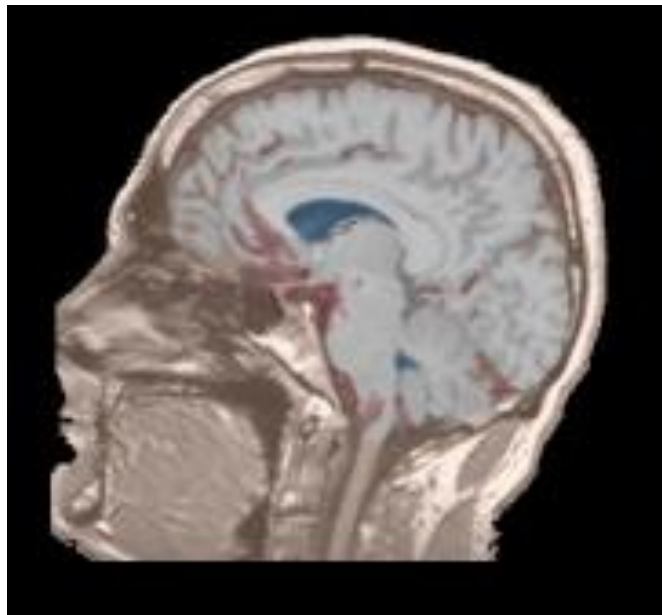




## Part 2: Loading and visualizing segmented structures overlaid on grayscale images

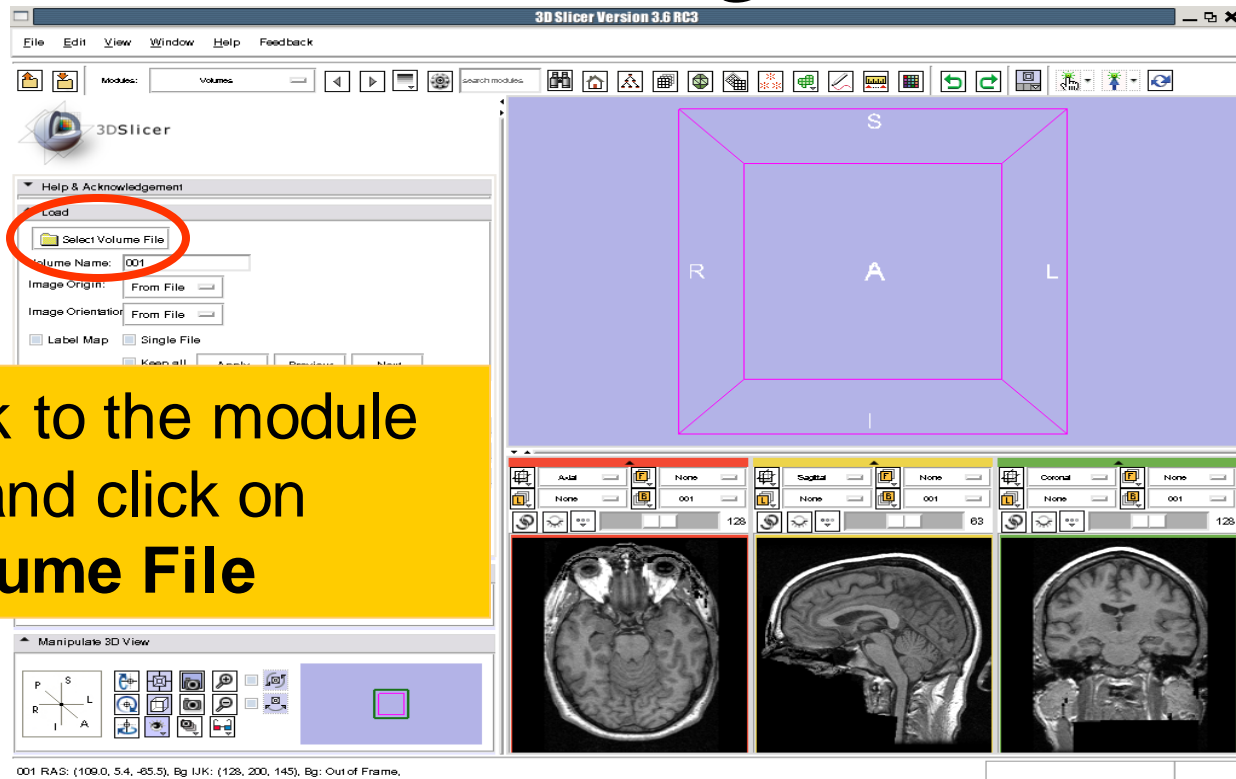
# *Label map*

---



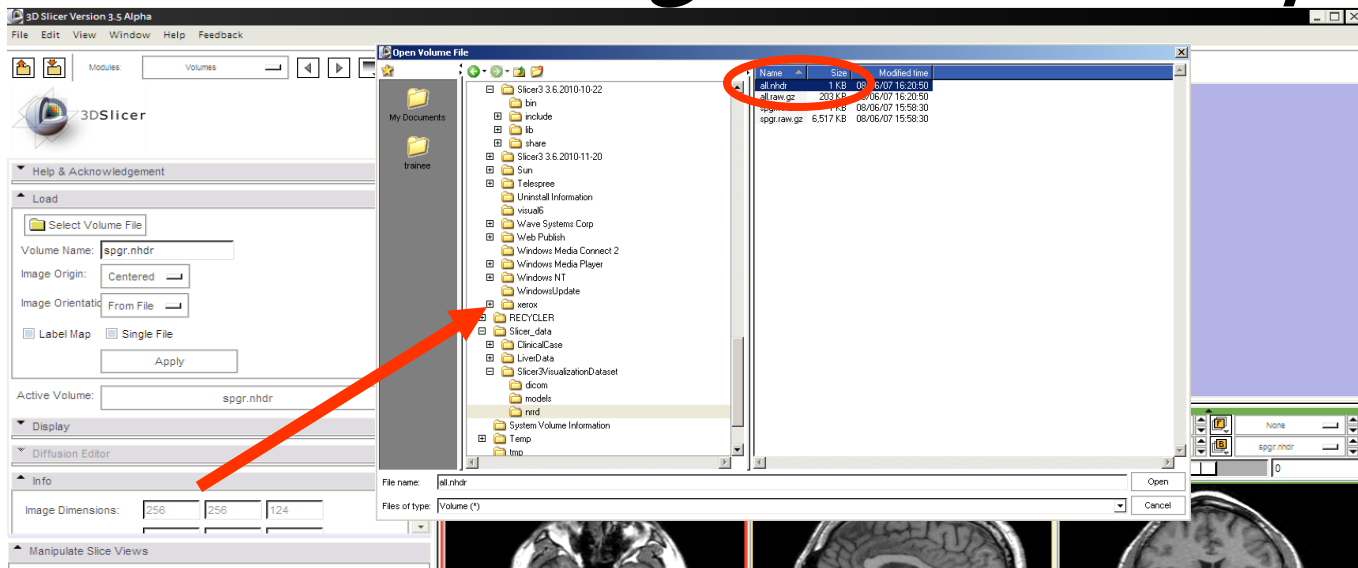
- **Image segmentation** is the extraction of structural information of particular interest from surrounding image.
- Each pixel is assigned a specific **label value** which corresponds to the anatomical structure that it belongs to.
- The three-dimensional result of the segmentation is a binary array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

# Loading a label map



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

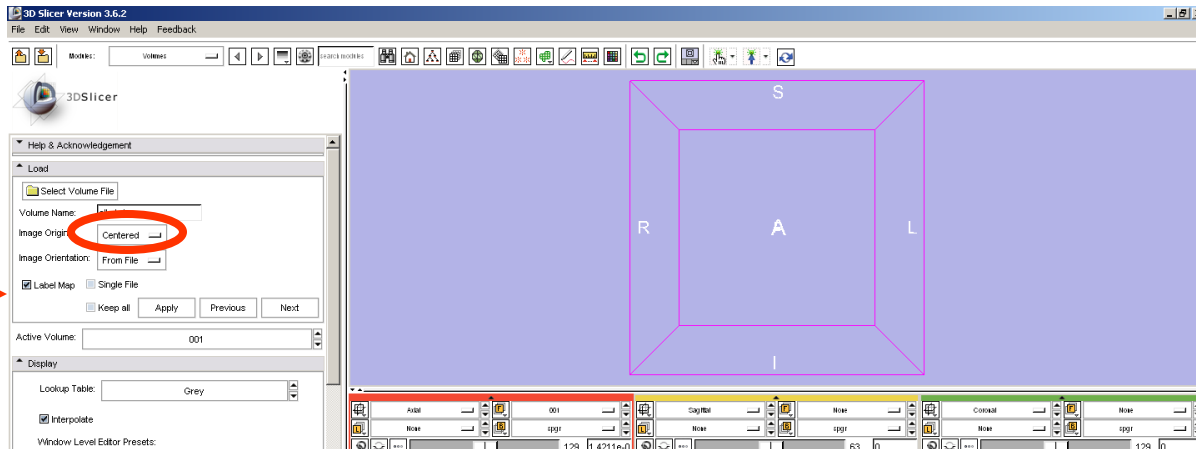
# Loading a label map



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

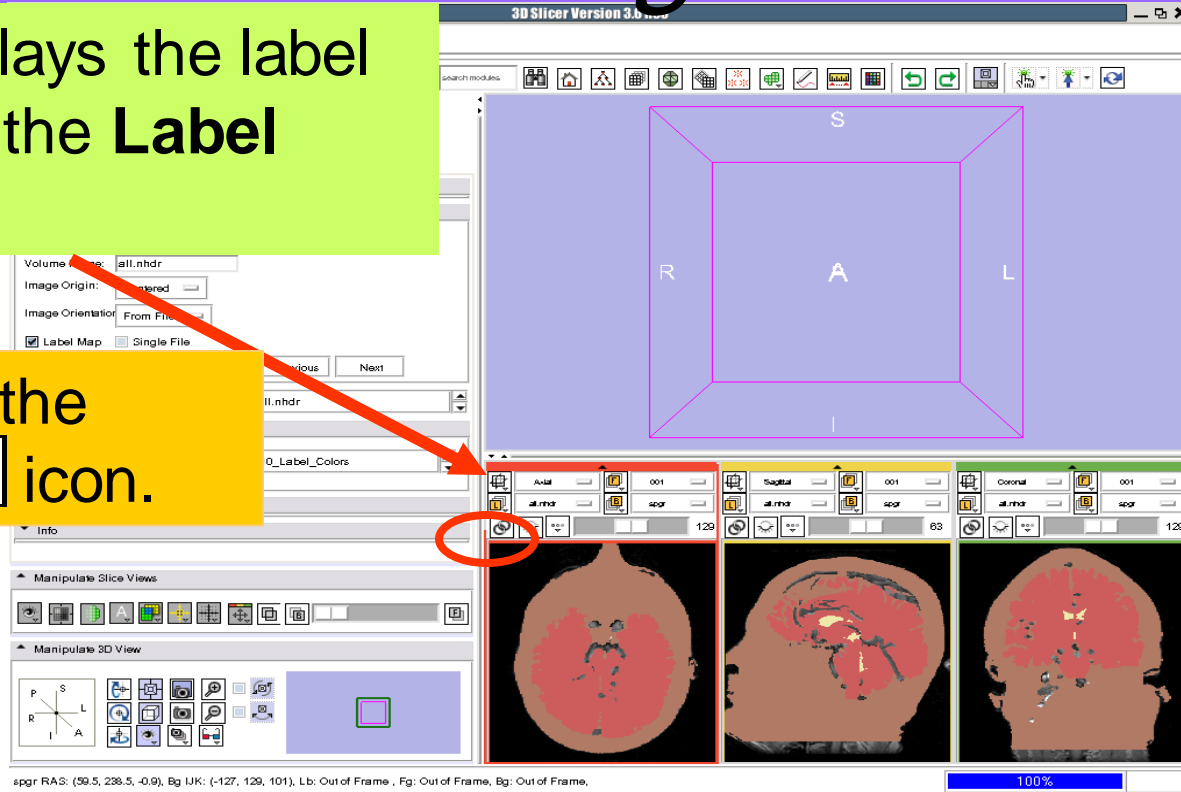


**Set Image Origin to **Centered****  
**Check the **Label Map** box and click on **Apply****

# Visualizing a label map

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

Click on the *links*  icon.

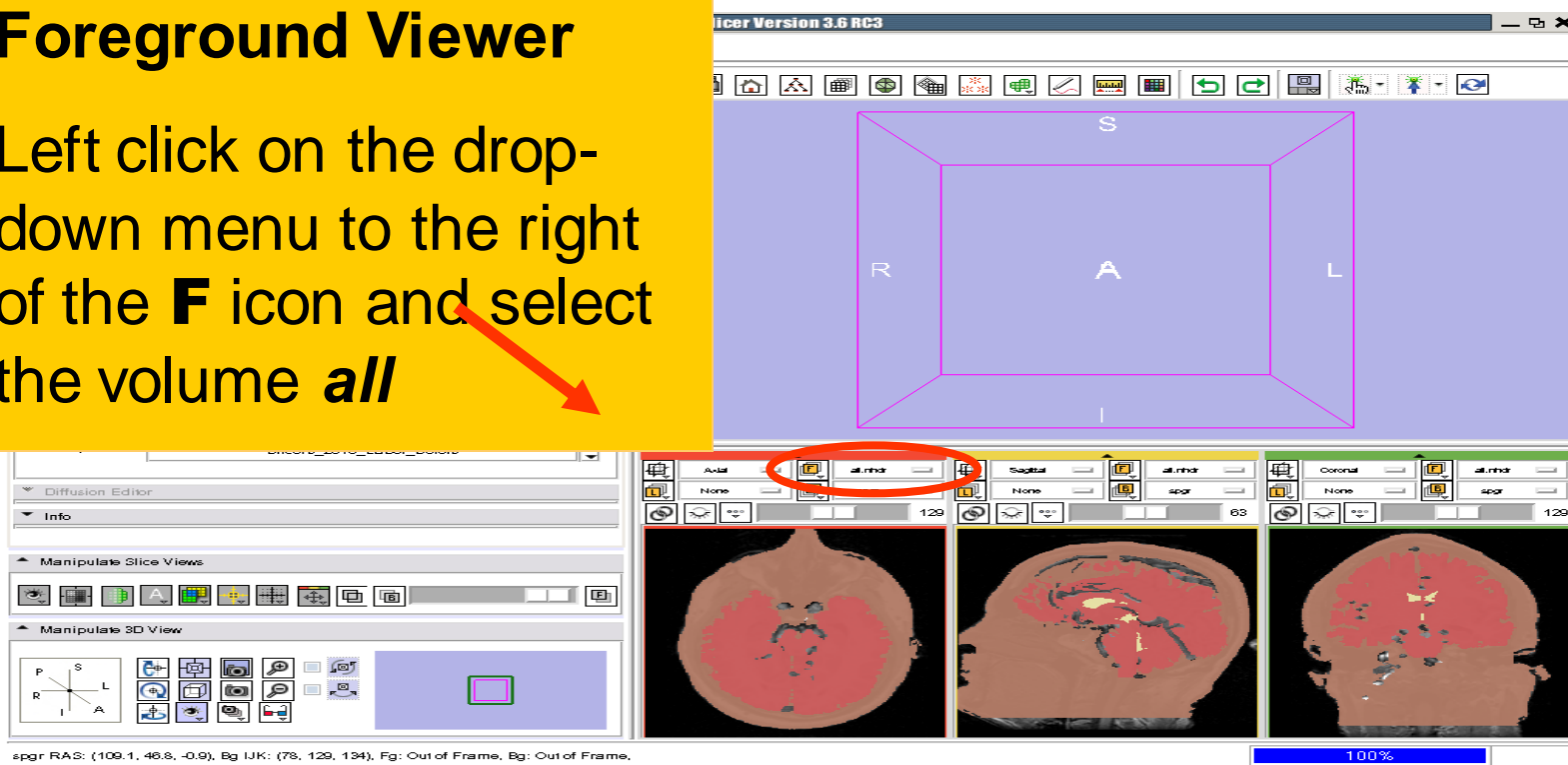




# Visualizing Multiple Volumes

## Foreground Viewer

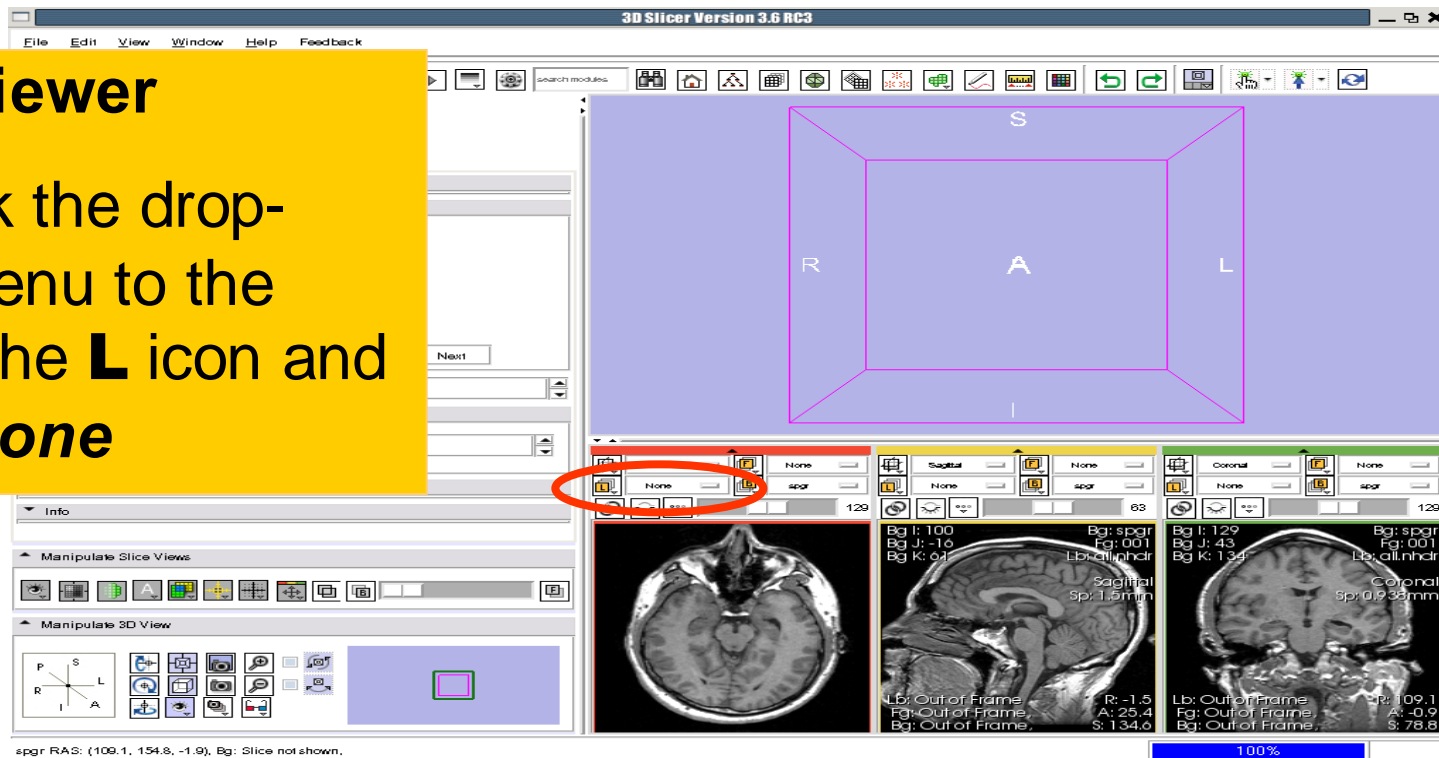
Left click on the drop-down menu to the right of the **F** icon and select the volume *all*



# Visualizing Multiple Volumes

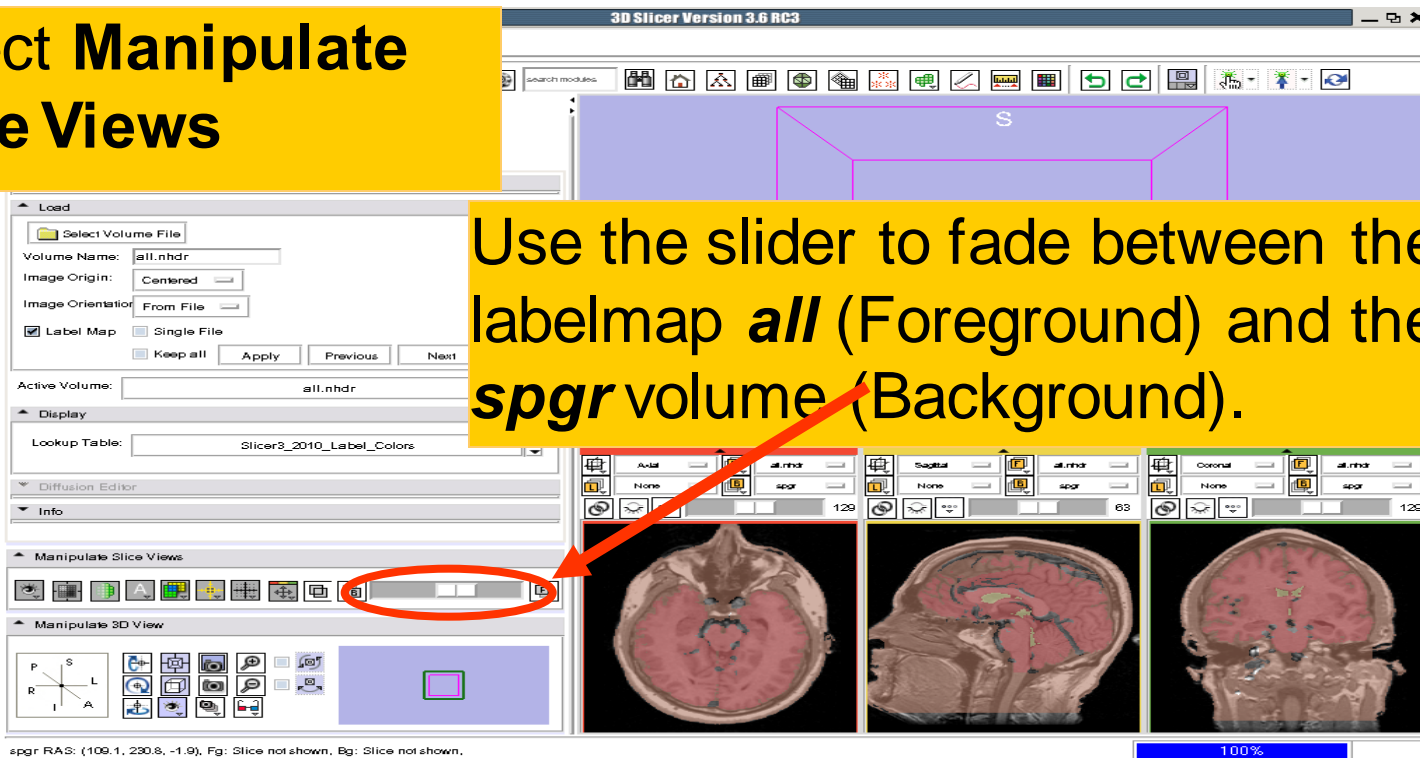
## Label Viewer

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



# Visualizing Multiple Volumes

Select Manipulate  
Slice Views



3D Slicer Version 3.6 RC3

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

Load

Select Volume File

Volume Name: all.nhdr

Image Origin: Centered

Image Orientation: From File

Label Map  Single File

Keep all Apply Previous Next

Active Volume: all.nhdr

Display

Lookup Table: Slicer3\_2010\_Label\_Colors

Diffusion Editor

Info

Manipulate Slice Views

Manipulate 3D View

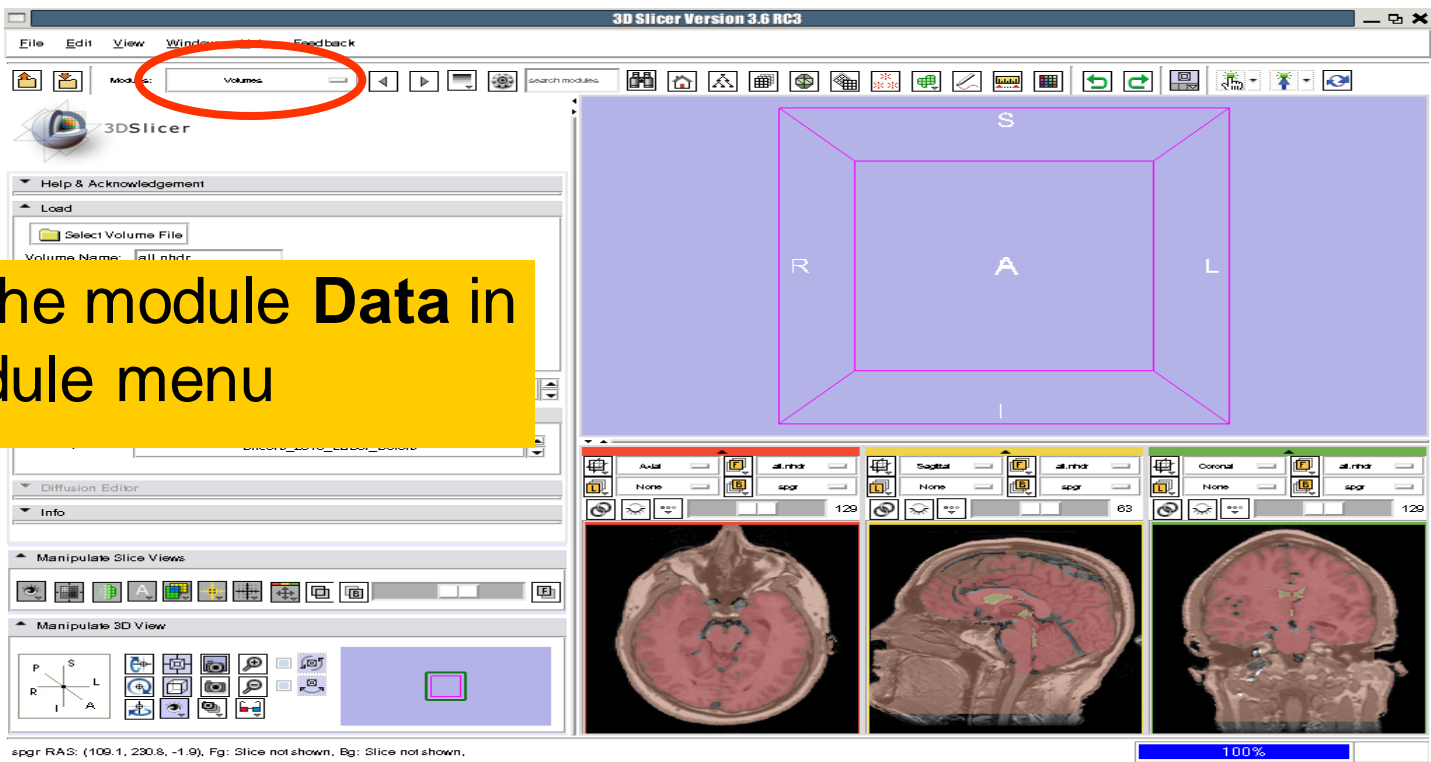
spgr RAS: (109.1, 230.8, -1.9), Fg: Slice not shown, Bg: Slice not shown.

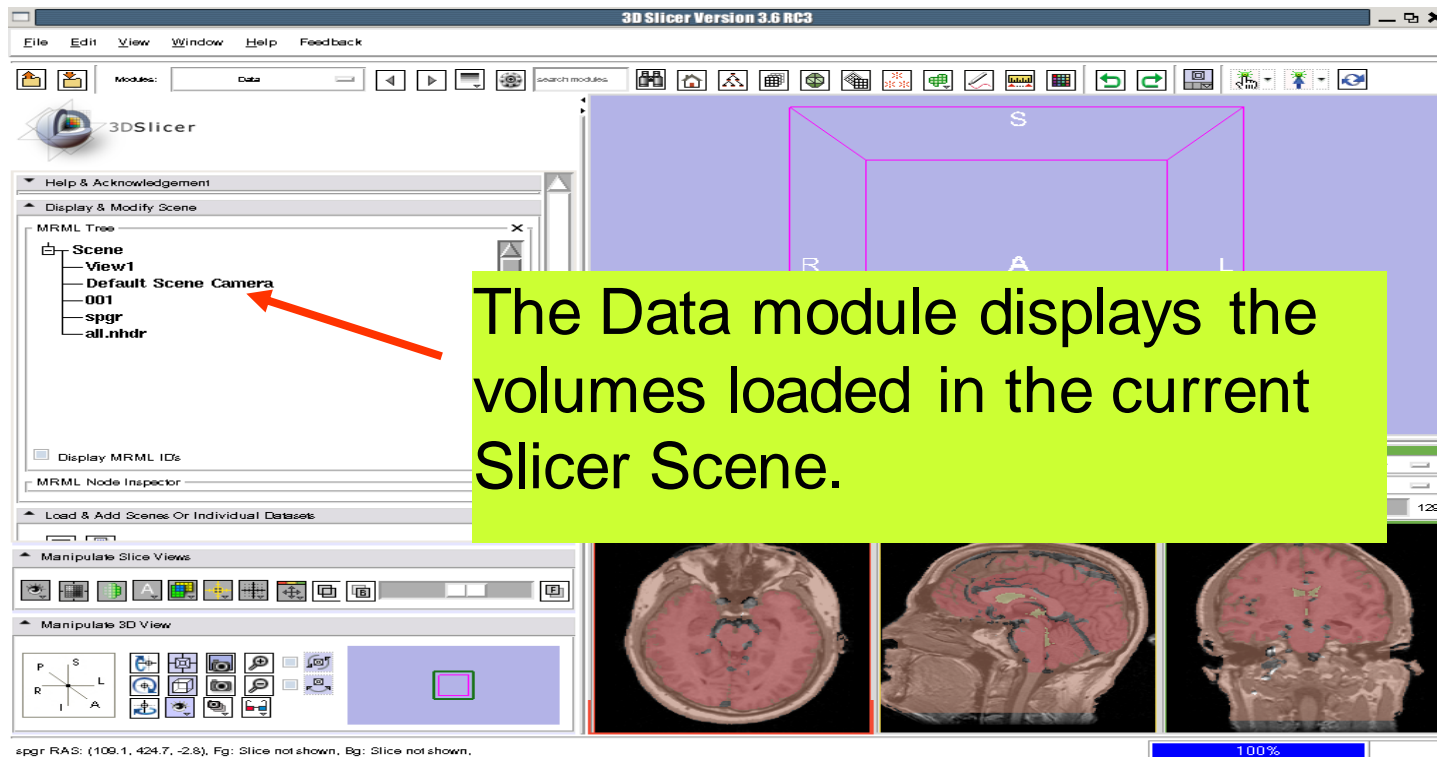
100%

The screenshot shows the 3D Slicer interface. A yellow box highlights the 'Manipulate Slice Views' panel, where a slider is circled in red. An arrow points from the text 'Use the slider to fade between the labelmap all (Foreground) and the spgr volume (Background)' to this slider. The main window displays three slice views: Axial, Sagittal, and Coronal. The 'all.nhdr' volume is selected in the foreground, and the 'spgr' volume is selected in the background. The status bar at the bottom shows 'spgr RAS: (109.1, 230.8, -1.9), Fg: Slice not shown, Bg: Slice not shown.' and a progress bar at 100%.

# 3D Visualization

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





The screenshot displays the 3D Slicer Version 3.6 RC3 interface. The main window shows a 3D volume with a purple bounding box. The MRML Tree on the left lists the scene structure: Scene, View1, Default Scene Camera, 001, spgr, and all.nhdr. A red arrow points to the '001' node. A yellow text box is overlaid on the scene, stating: "The Data module displays the volumes loaded in the current Slicer Scene." Below the main window, three slice views (axial, sagittal, and coronal) are shown, along with a status bar indicating the current slice position: spgr RAS: (109.1, 424.7, -2.8), Fg: Slice not shown, Bg: Slice not shown, and a 100% zoom level.

3D Slicer Version 3.6 RC3

File Edit View Window Help Feedback

Modules: Data

3DSlicer

Help & Acknowledgement

Display & Modify Scene

MRML Tree

- Scene
  - View1
    - Default Scene Camera
    - 001
    - spgr
    - all.nhdr

Display MRML IDs

MRML Node Inspector

Load & Add Scenes Or Individual Datasets

Manipulate Slice Views

Manipulate 3D View

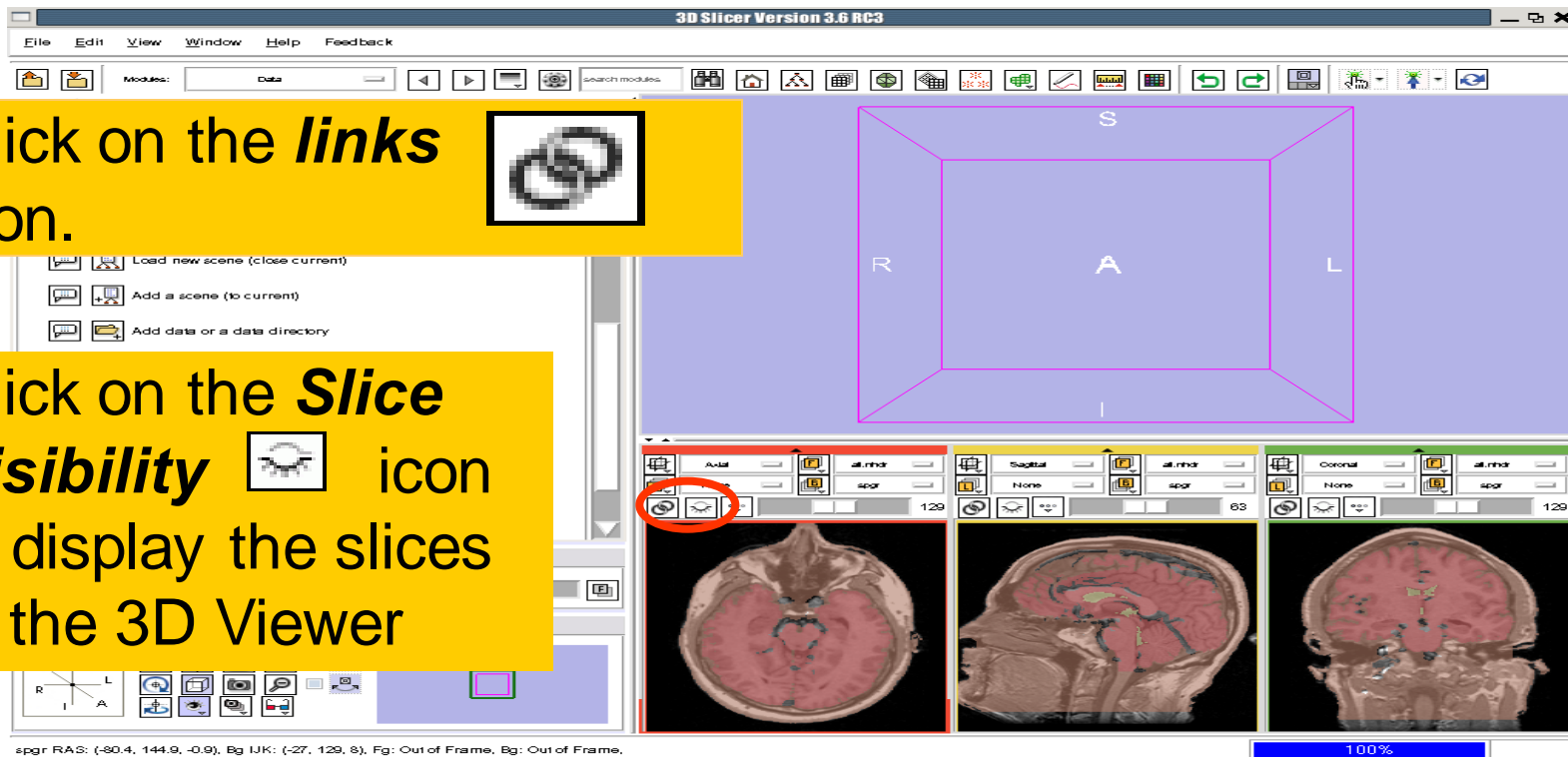
spgr RAS: (109.1, 424.7, -2.8), Fg: Slice not shown, Bg: Slice not shown.

100%

Click on the *links* icon.

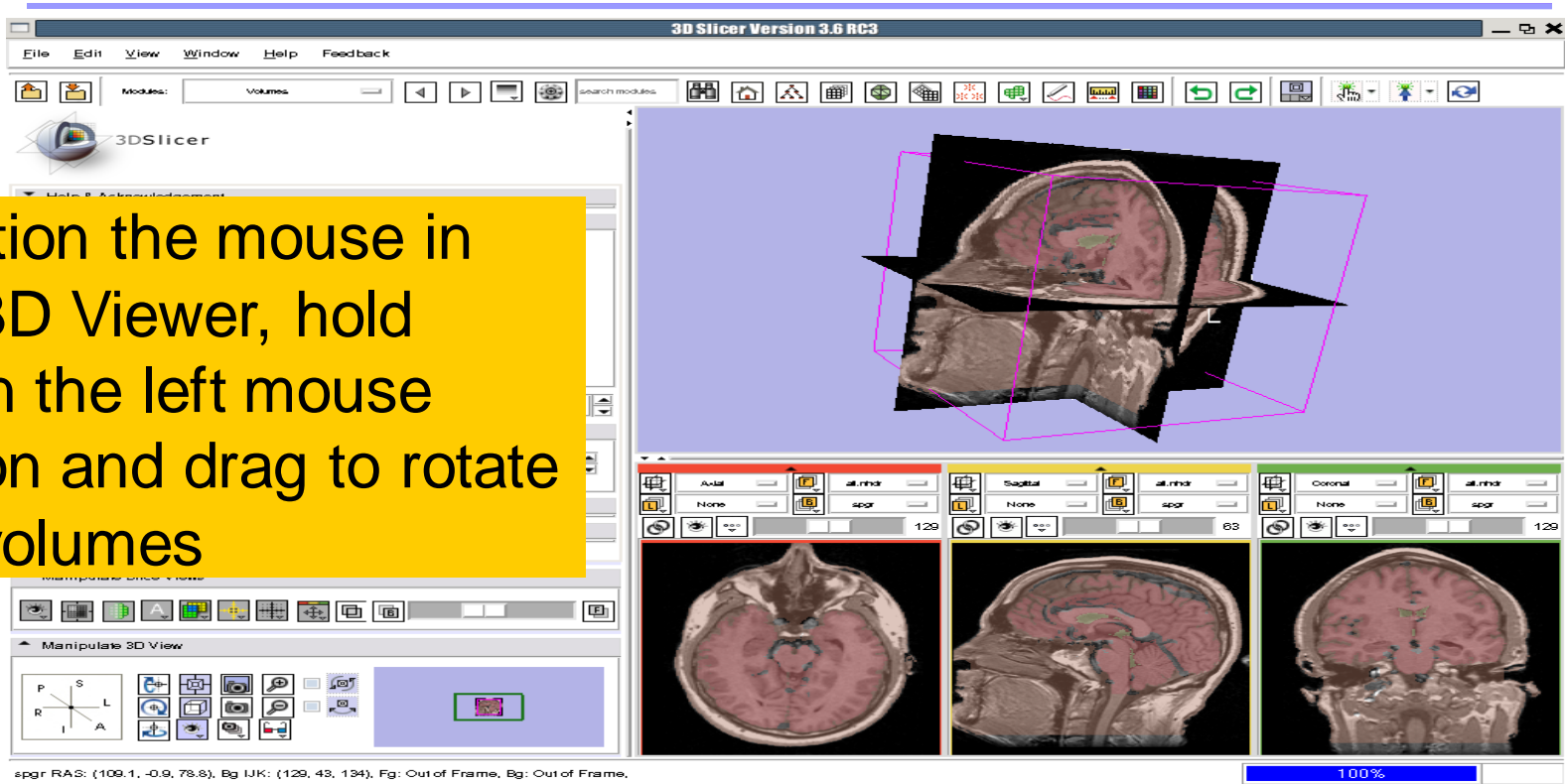


Click on the *Slice Visibility* icon to display the slices in the 3D Viewer



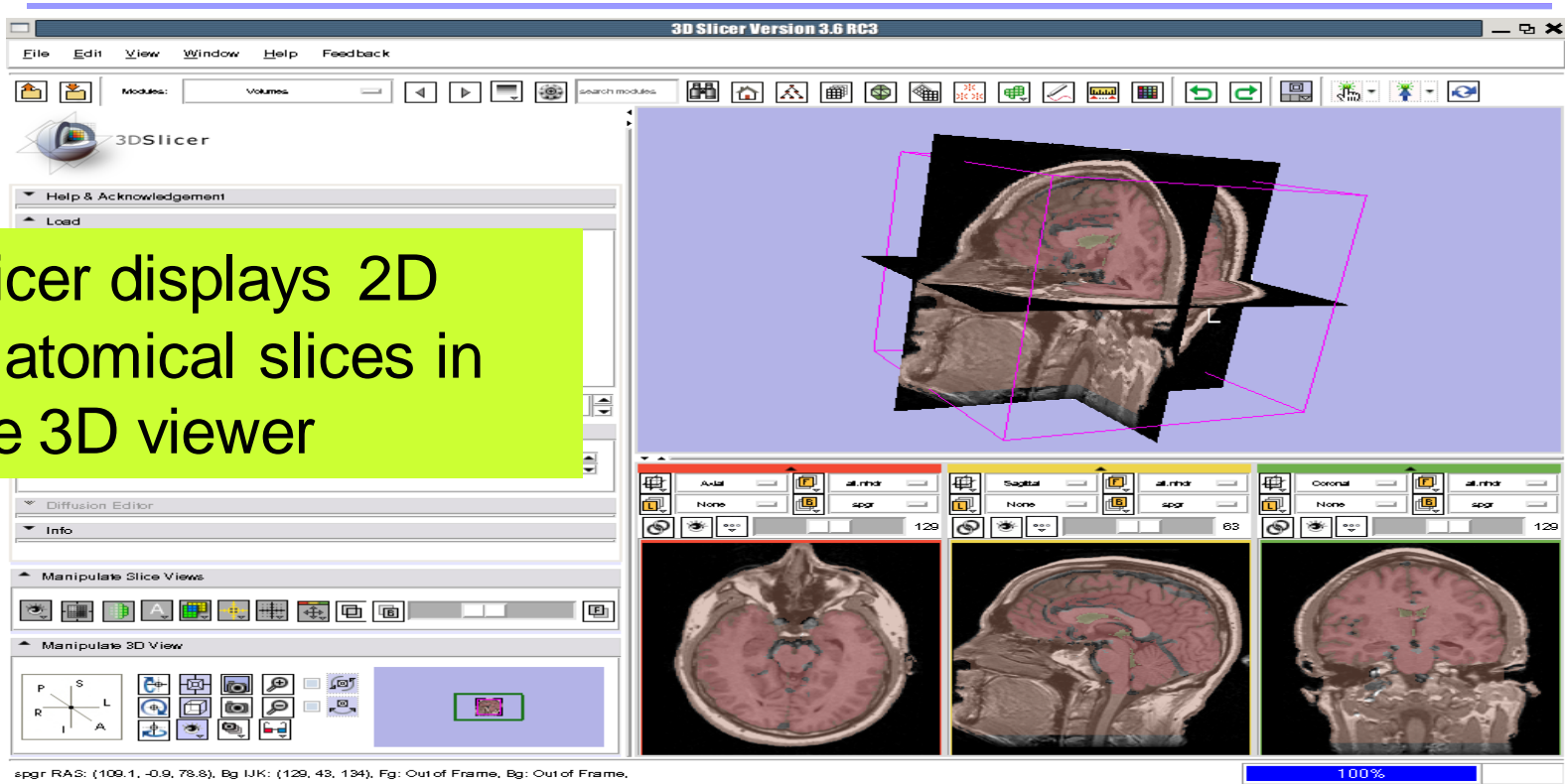
# 3D Visualization

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

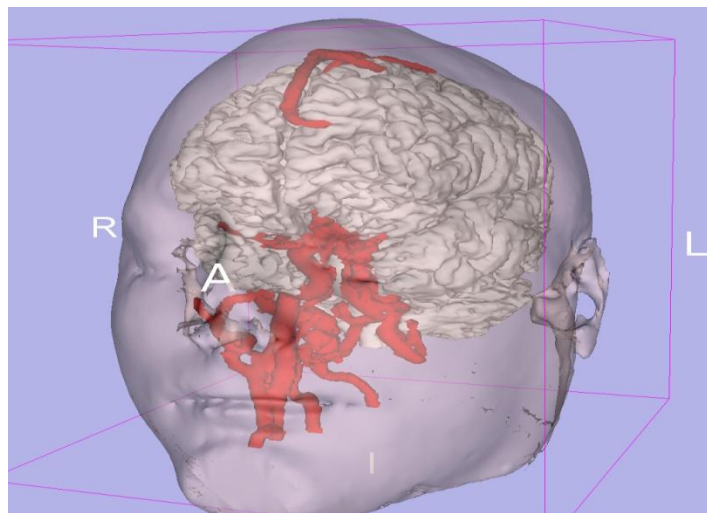


# 3D Visualization

Slicer displays 2D anatomical slices in the 3D viewer

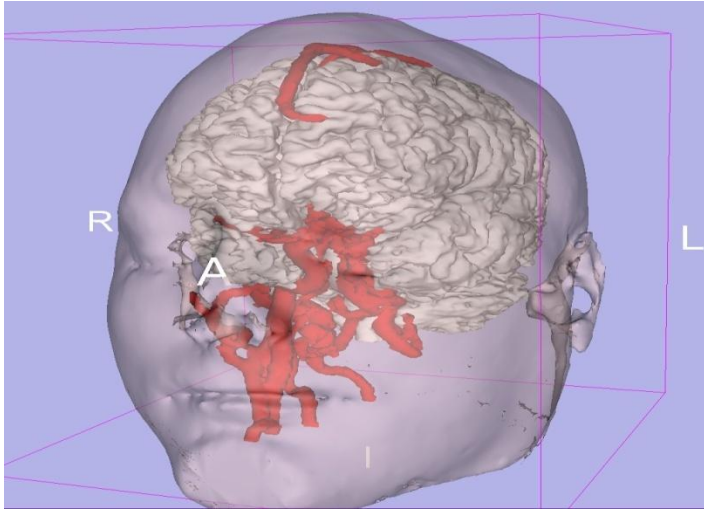




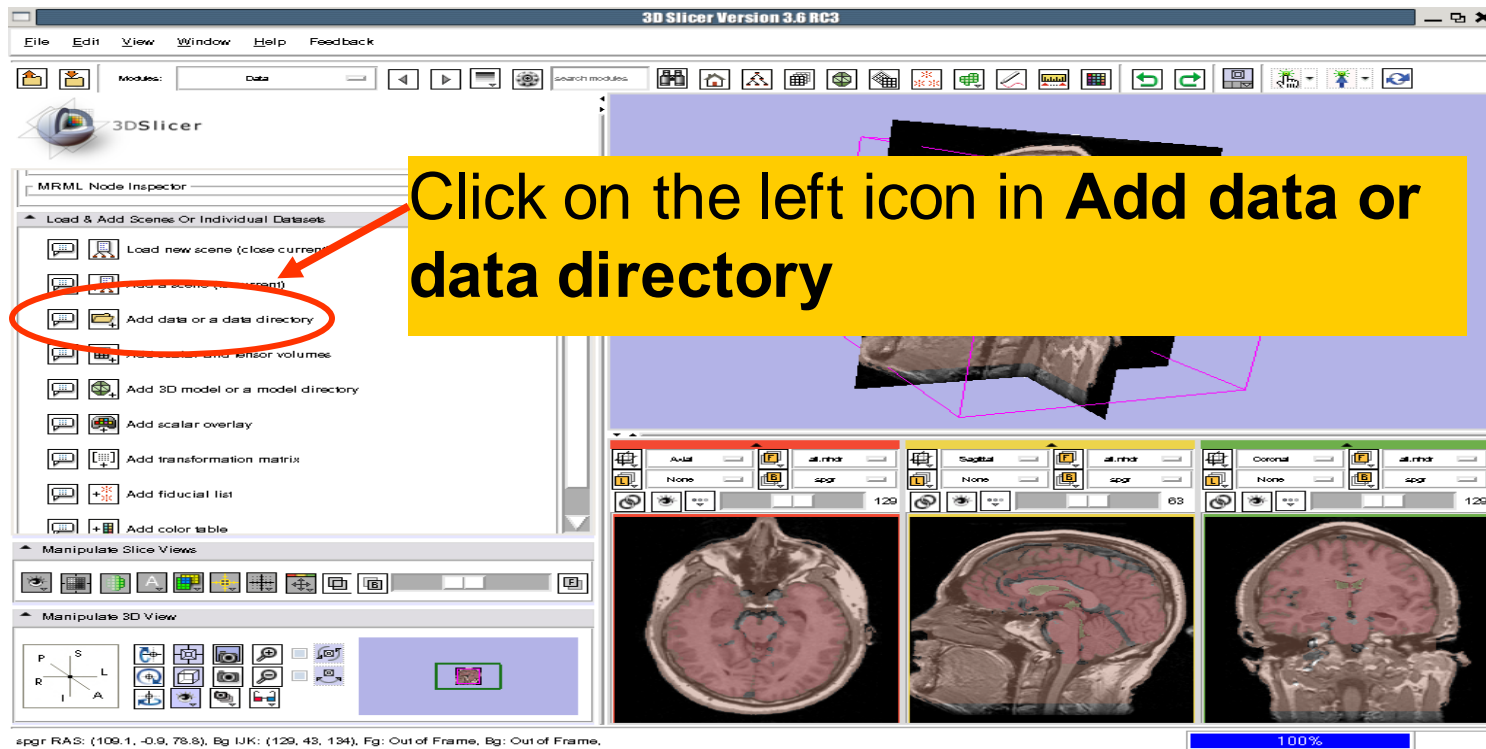


## *Part 3: Loading and visualizing 3D models of the anatomy*

# 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 Slicer Version 3.6 RC3

File Edit View Window Help Feedback

Modules: Data

MRML Node Inspector

Load & Add Scenes Or Individual Datasets

- Load new scene (close current)
- Load scene (current)
- Add data or a data directory**
- Add data or sensor volumes
- Add 3D model or a model directory
- Add scalar overlay
- Add transformation matrix
- Add fiducial list
- Add color table

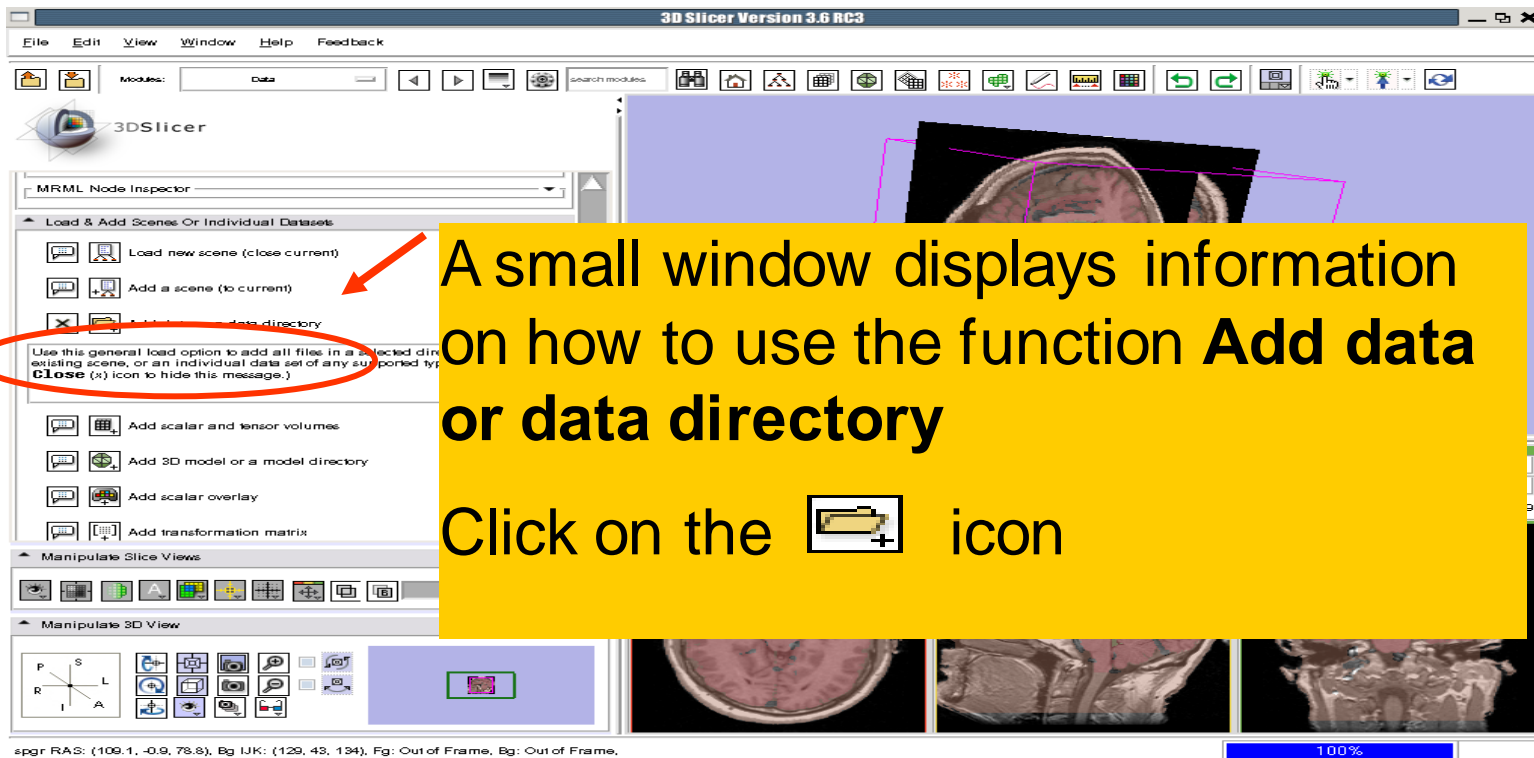
Manipulate Slice Views

Manipulate 3D View

spgr RAS: (109.1, -0.9, 78.8), Bg IJK: (129, 43, 134), Fg: Out of Frame, Bg: Out of Frame.

100%

**Click on the left icon in Add data or data directory**



3D Slicer Version 3.6 RC3

File Edit View Window Help Feedback

Modules: Data

3DSlicer

MRML Node Inspector

Load & Add Scenes Or Individual Datasets

- Load new scene (close current)
- Add a scene (to current)
- Add data directory**

Use this general load option to add all files in a selected directory to an existing scene, or an individual data set of any supported type. **Close** (x) icon to hide this message.

- Add scalar and tensor volumes
- Add 3D model or a model directory
- Add scalar overlay
- Add transformation matrix


Manipulate Slice Views

Manipulate 3D View

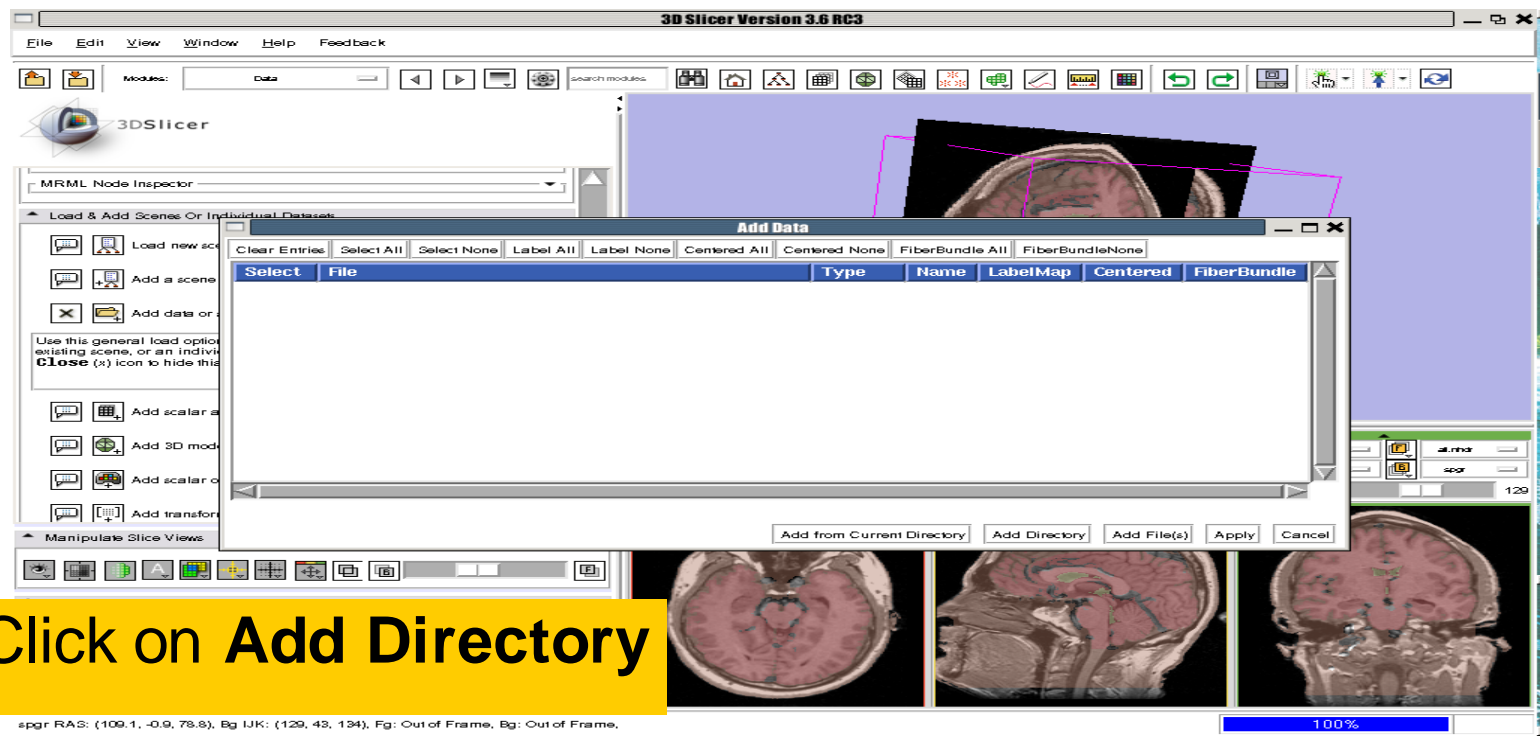
spgr RAS: (109.1, -0.9, 78.8), Bg IJK: (129, 43, 134), Fg: Out of Frame, Bg: Out of Frame.

100%

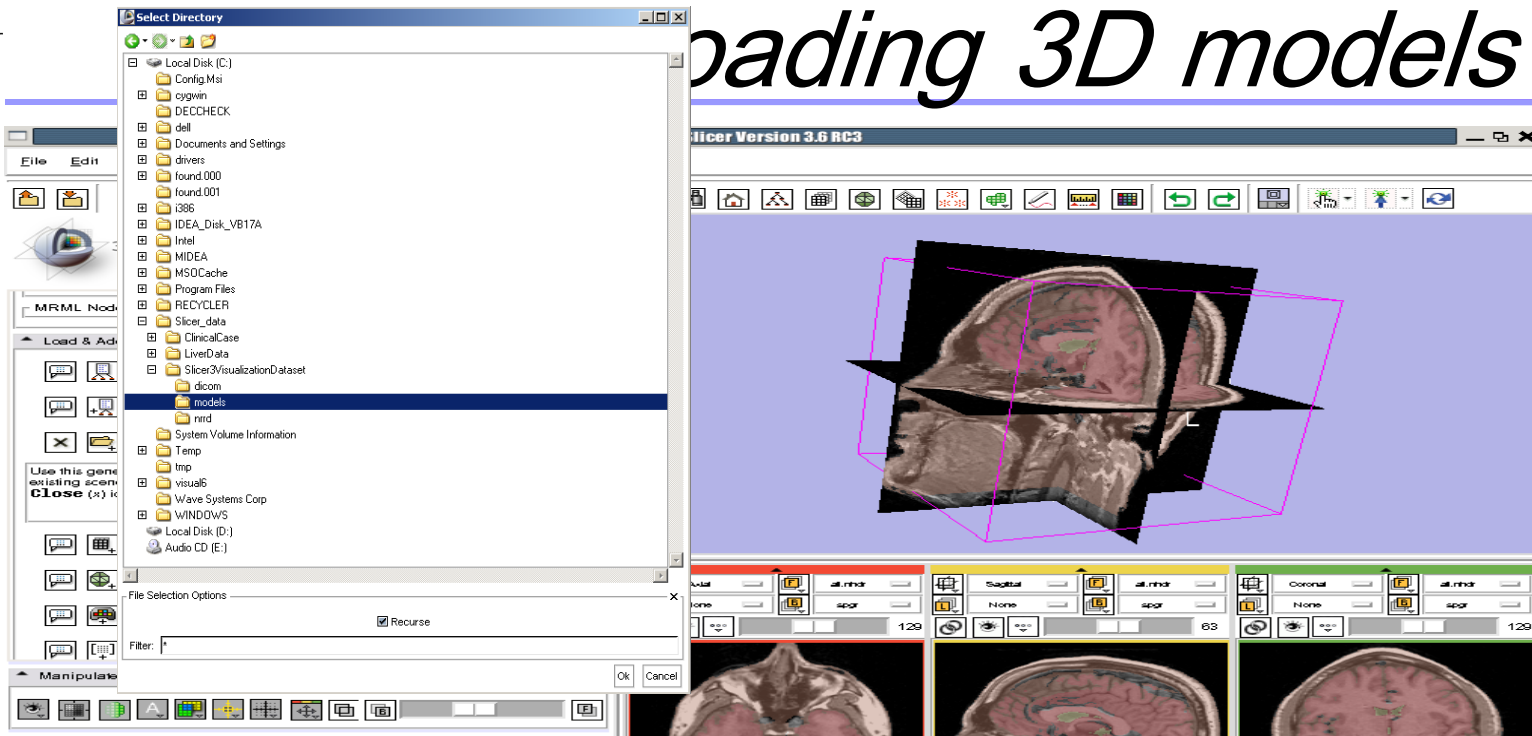
**A small window displays information on how to use the function **Add data or data directory****

Click on the  icon

# 3D Visualization

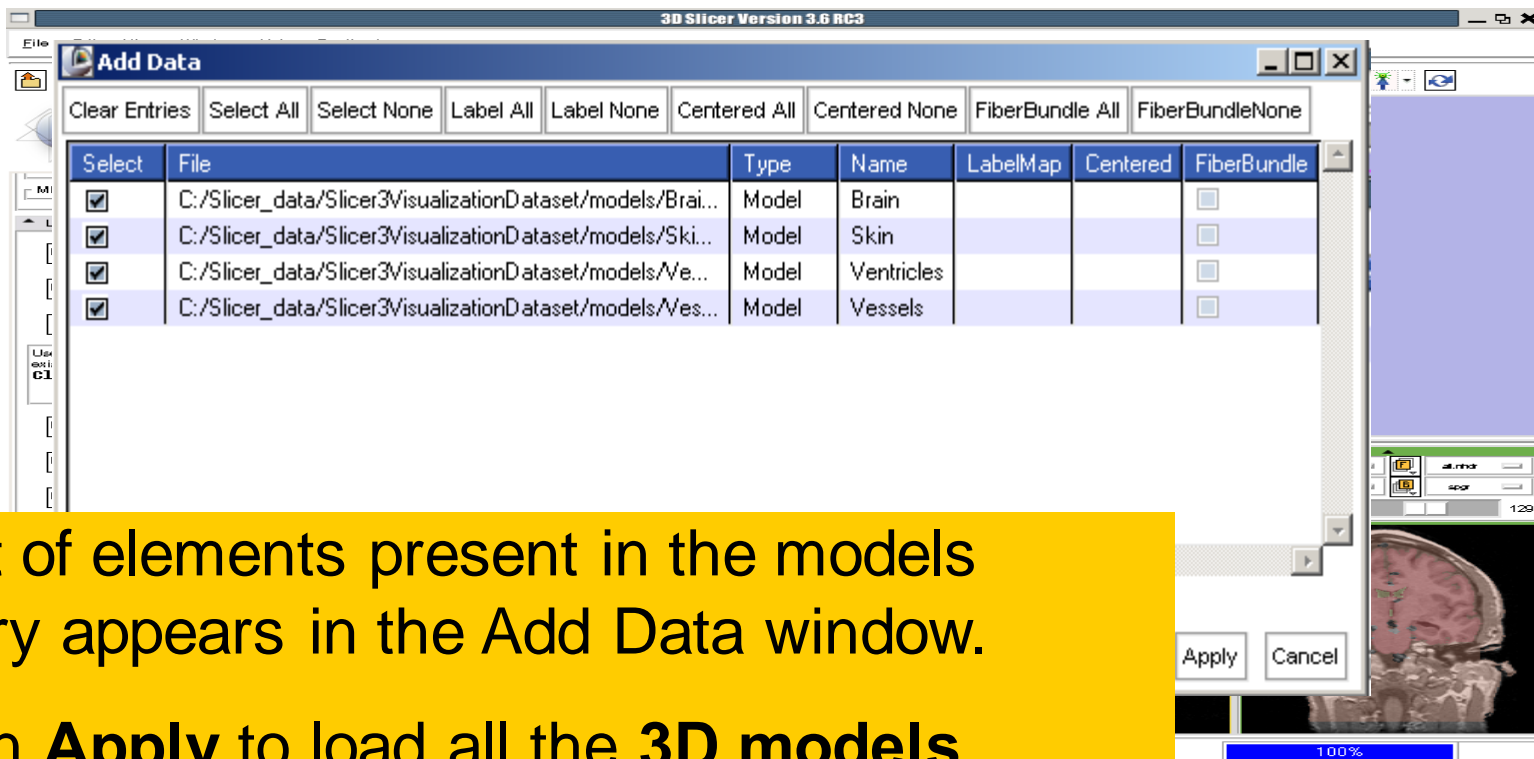


# loading 3D models



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.

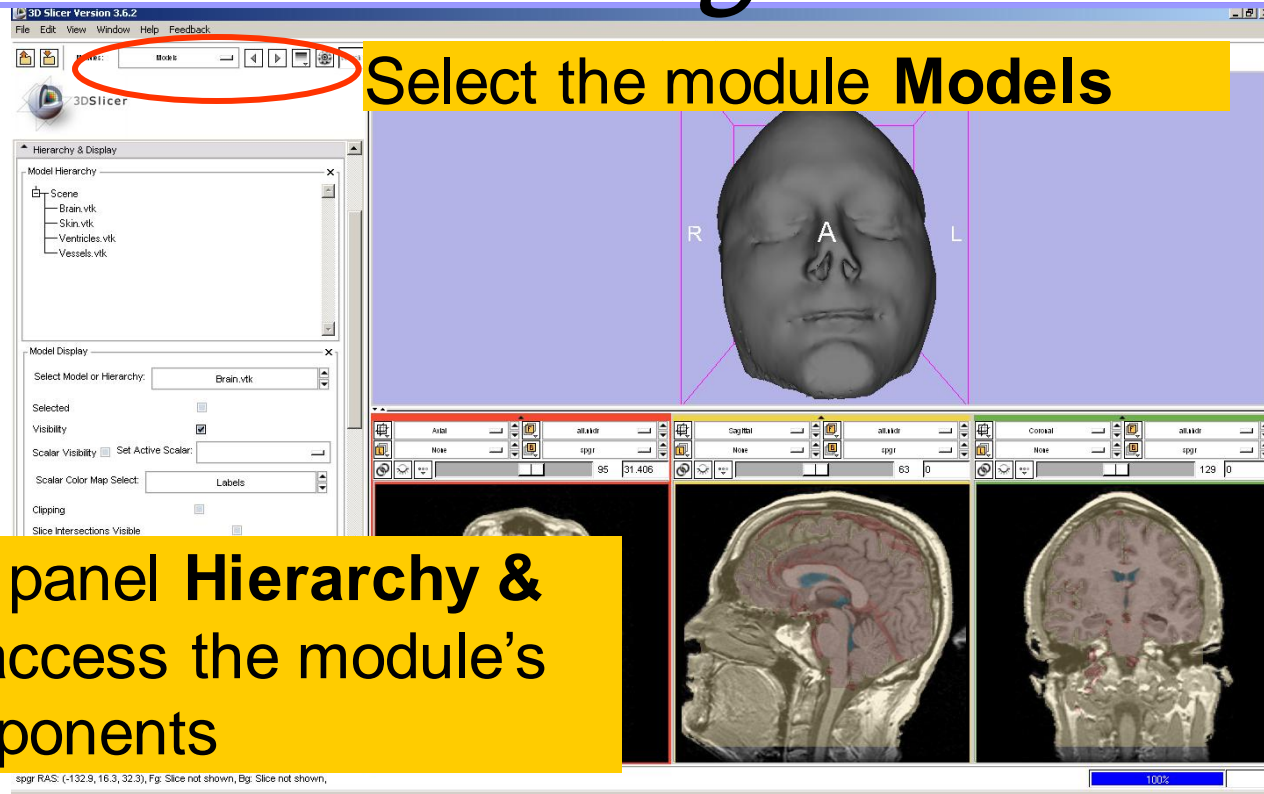
# Loading 3D models



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



# Loading a 3D model



The screenshot shows the 3D Slicer 3.6.2 interface. The top menu bar includes File, Edit, View, Window, Help, and Feedback. Below the menu is a toolbar with icons for file operations and navigation. A red circle highlights the 'Models' button in the toolbar. The main 3D view displays a 3D model of a human head with 'R', 'A', and 'L' labels. Below the 3D view are three 2D slice views: Axial, Sagittal, and Coronal. The 'Hierarchy & Display' panel on the left shows a tree view with 'Scene' expanded to show 'Brain.vtk', 'Skin.vtk', 'Ventricles.vtk', and 'Vessels.vtk'. The 'Model Display' panel below it shows 'Brain.vtk' selected. A red arrow points from the 'Hierarchy & Display' panel to a yellow text box.

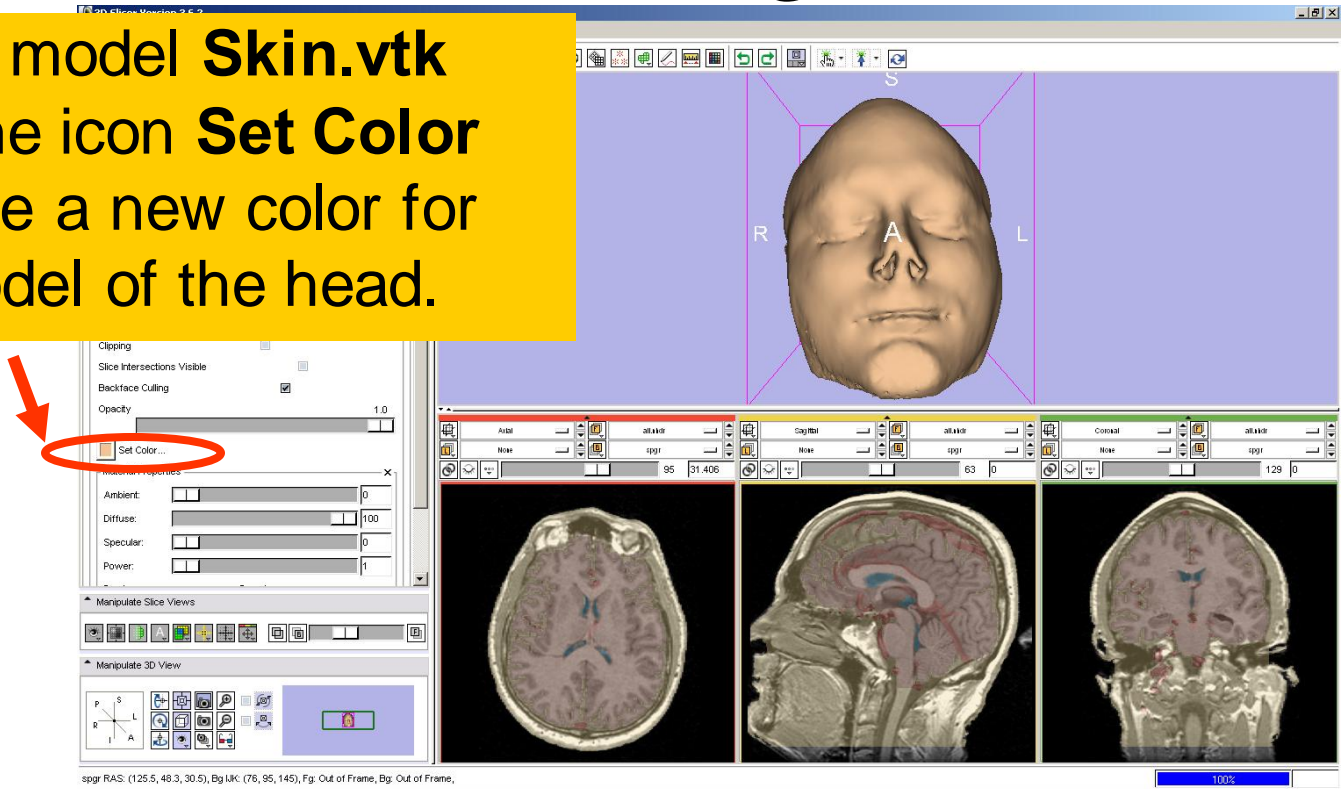
Select the module **Models**

Click on the panel **Hierarchy & Display** to access the module's display components

spgr RAS: (-132.9, 16.3, 32.3), Fg: Slice not shown, Bg: Slice not shown, 100%

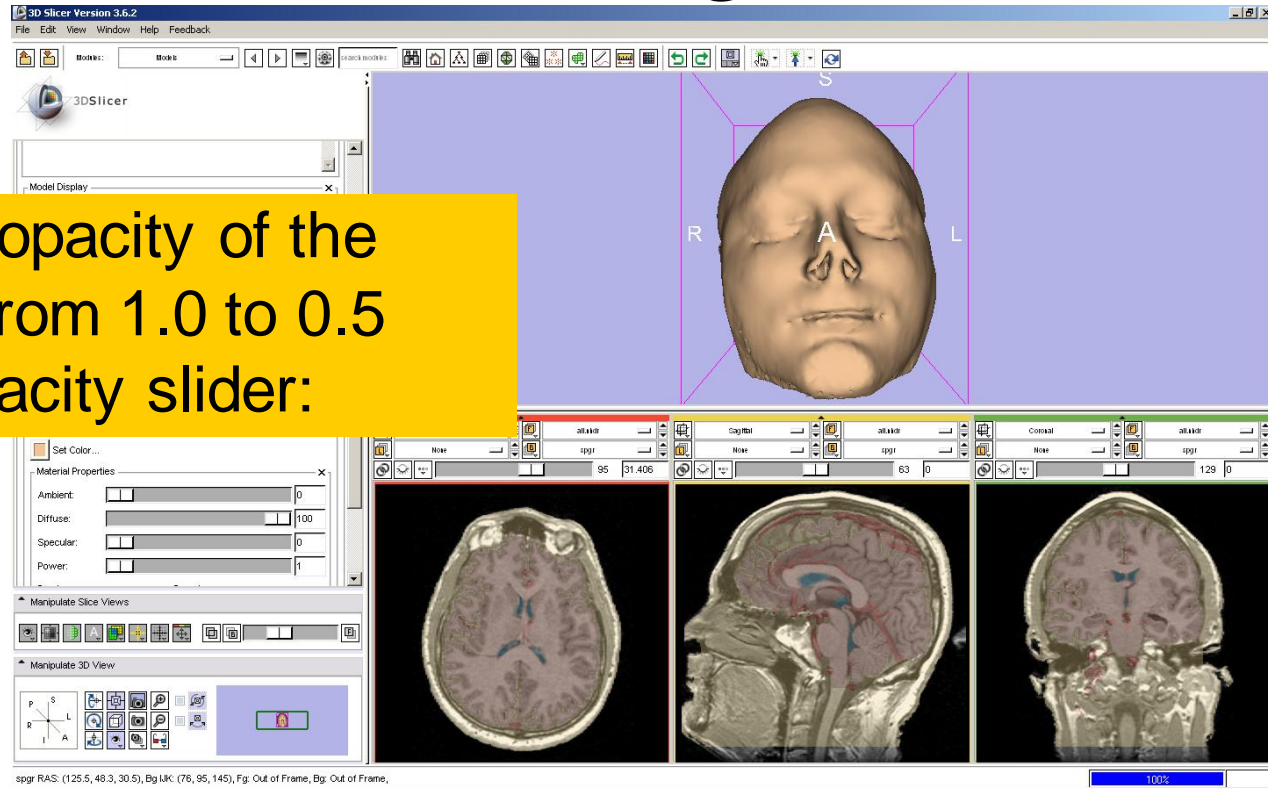
# Visualizing a 3D model

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



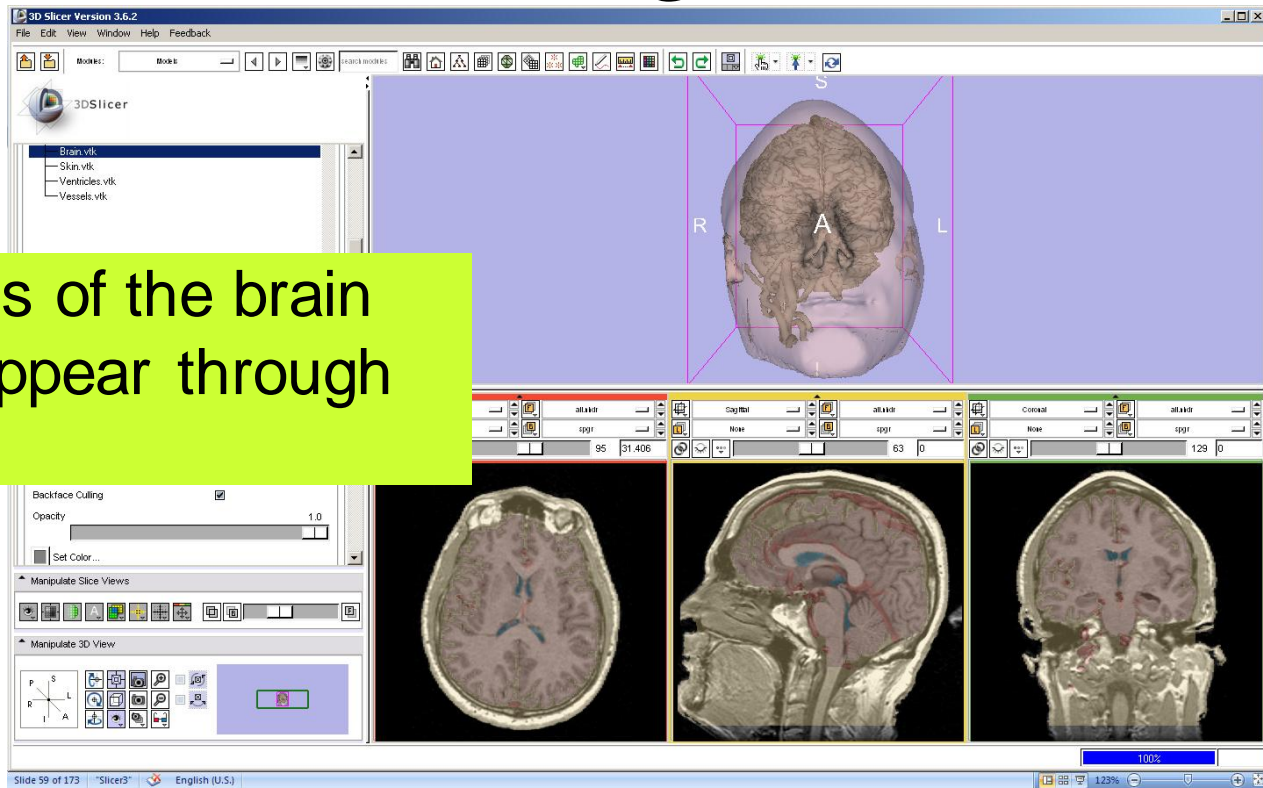
# Visualizing a 3D model

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

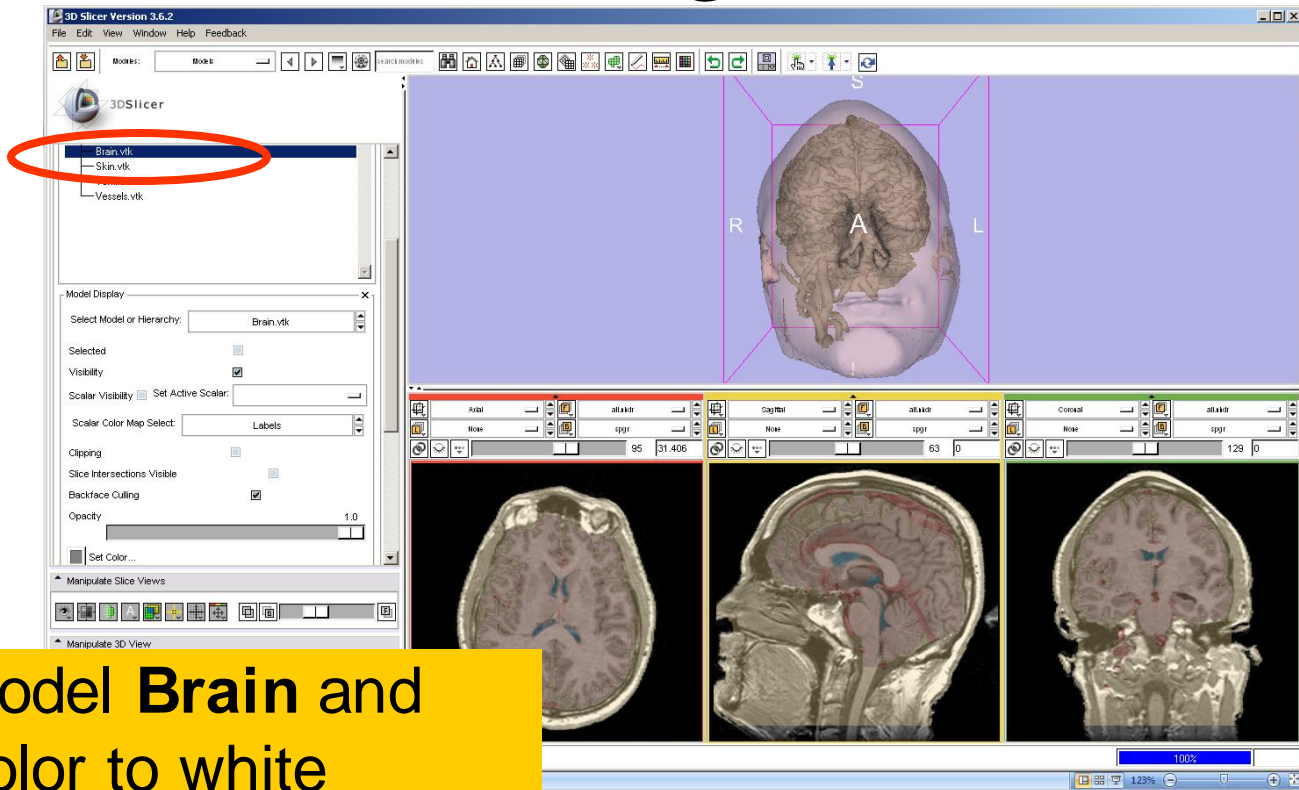


# Visualizing a 3D model

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

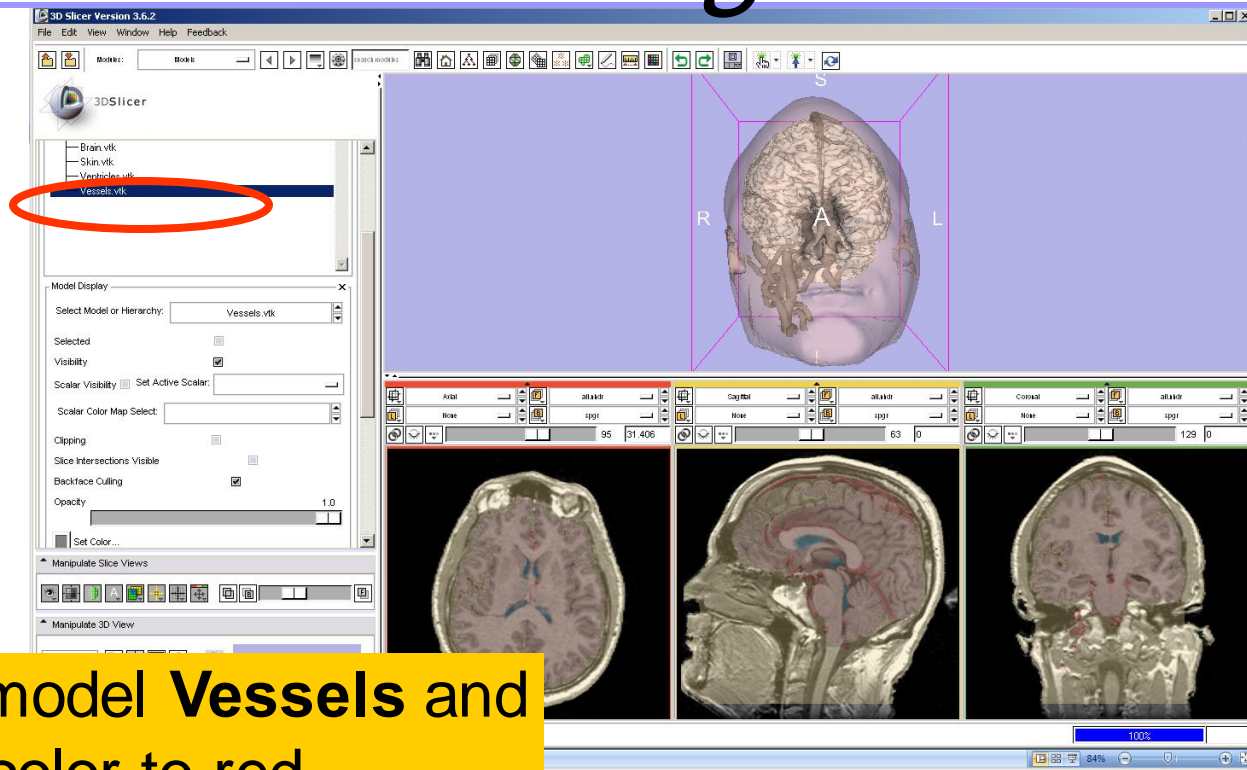


# Visualizing a 3D model



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

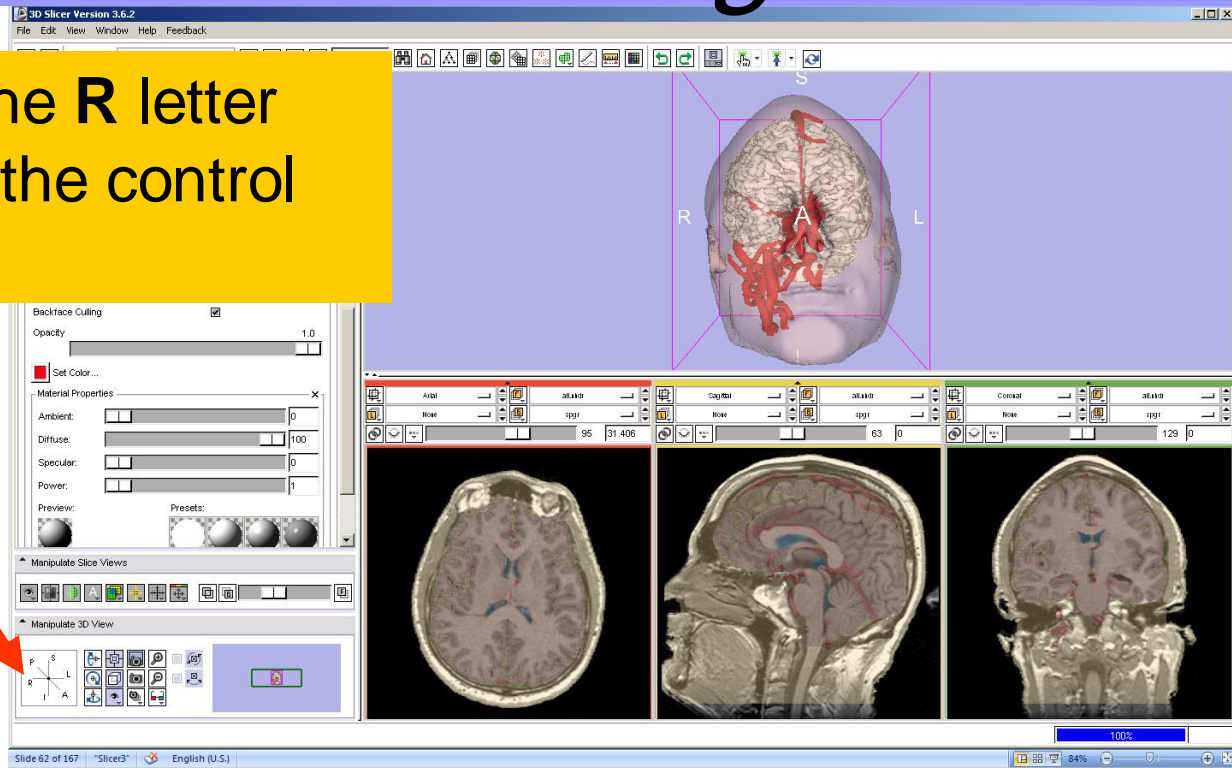
# Visualizing a 3D model



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

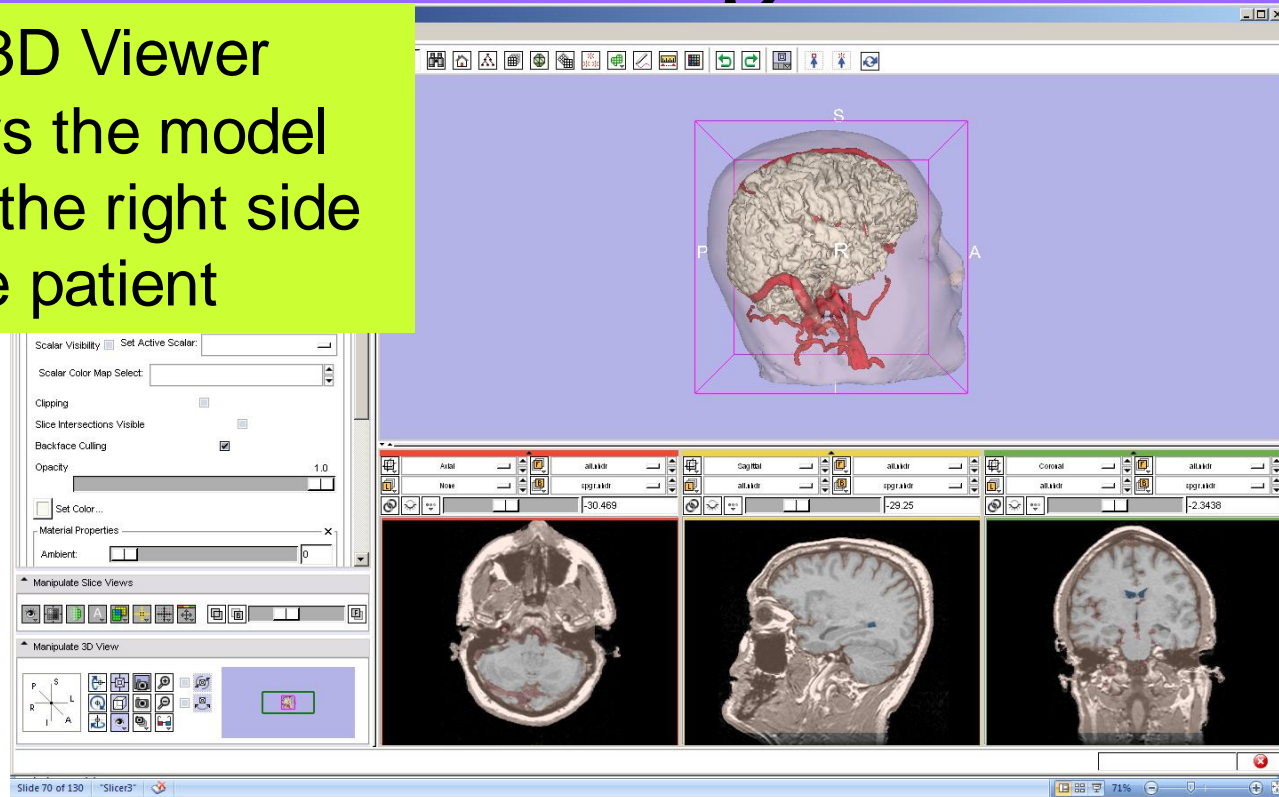
# Visualizing a 3D model

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



# Visualizing a 3D model

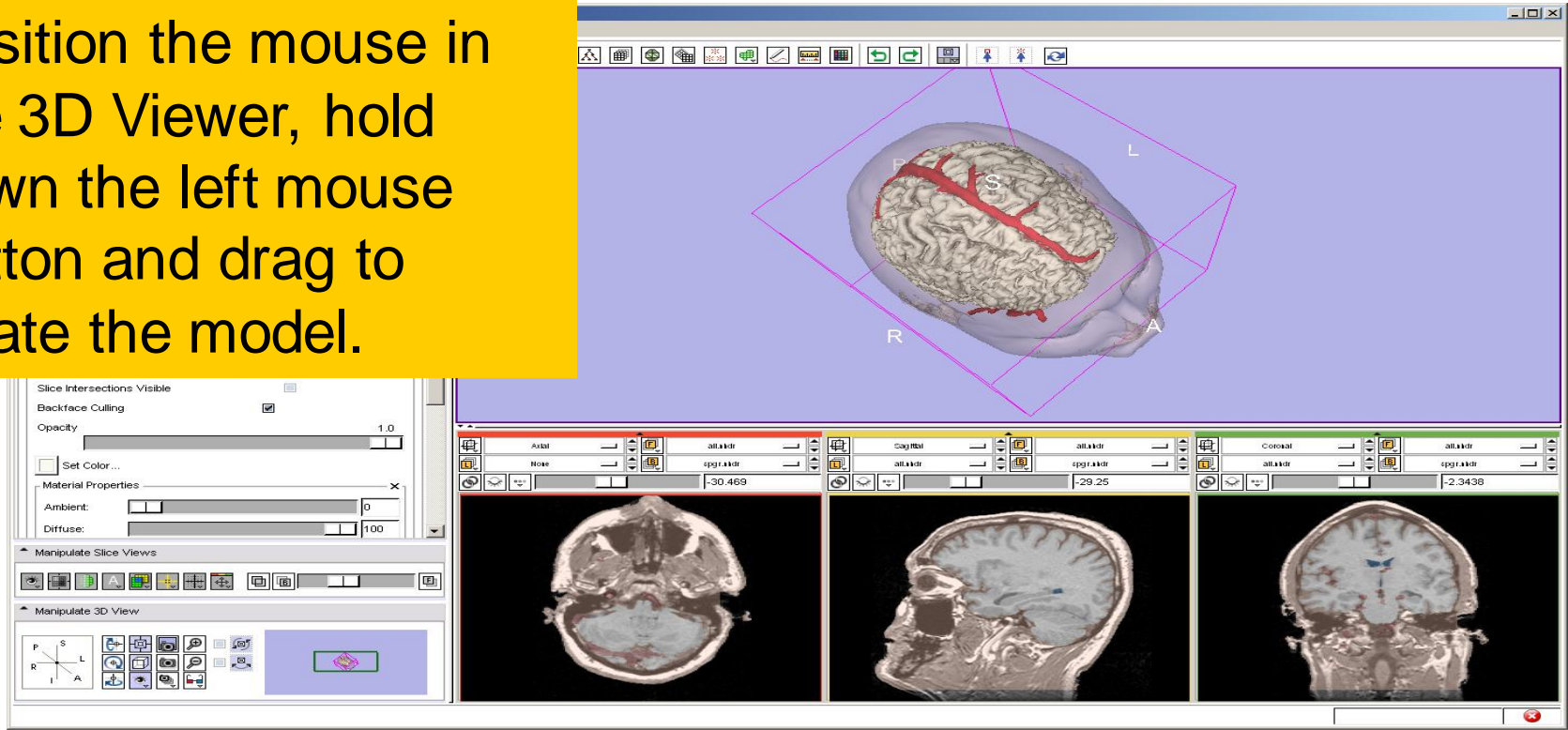
The 3D Viewer shows the model from the right side of the patient





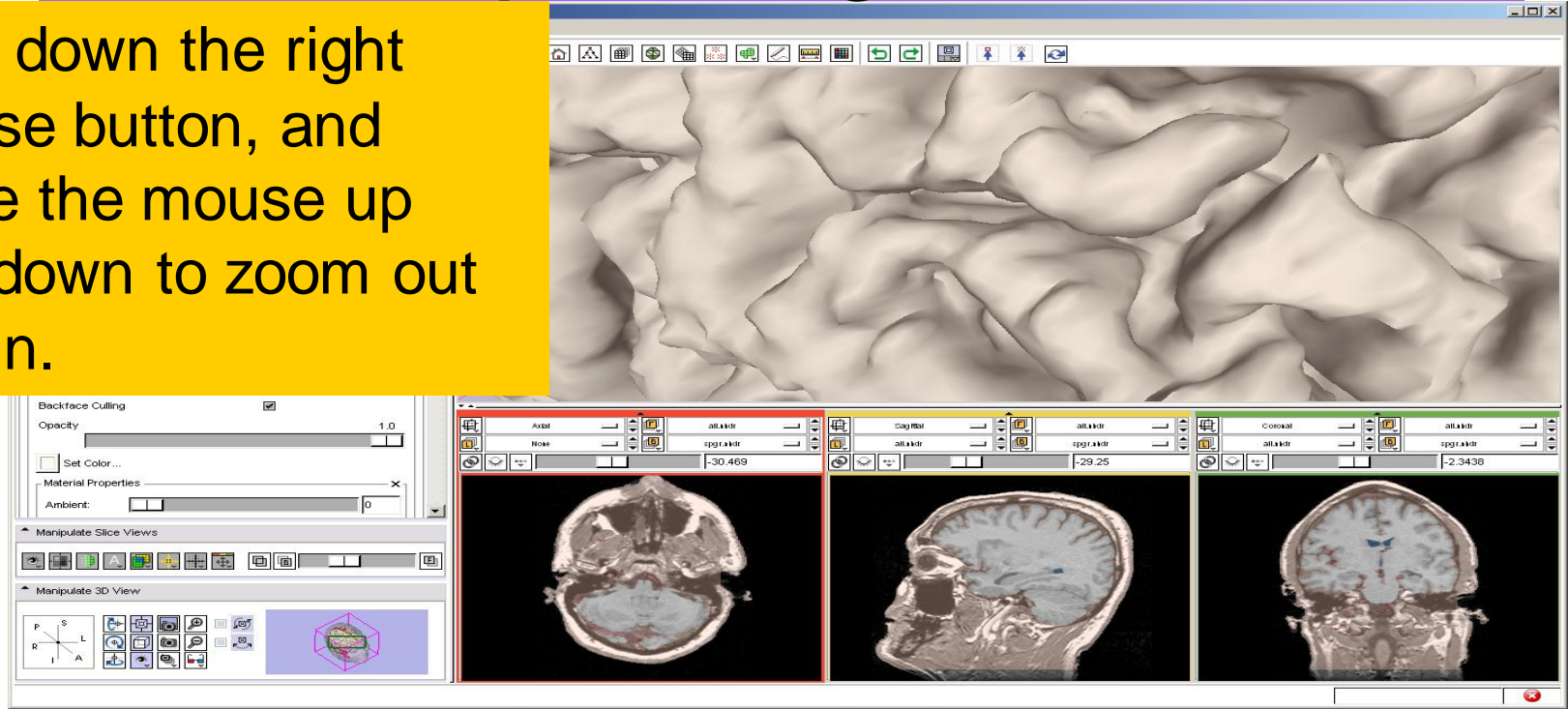
# Manipulating a 3D model

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



# Manipulating a 3D model

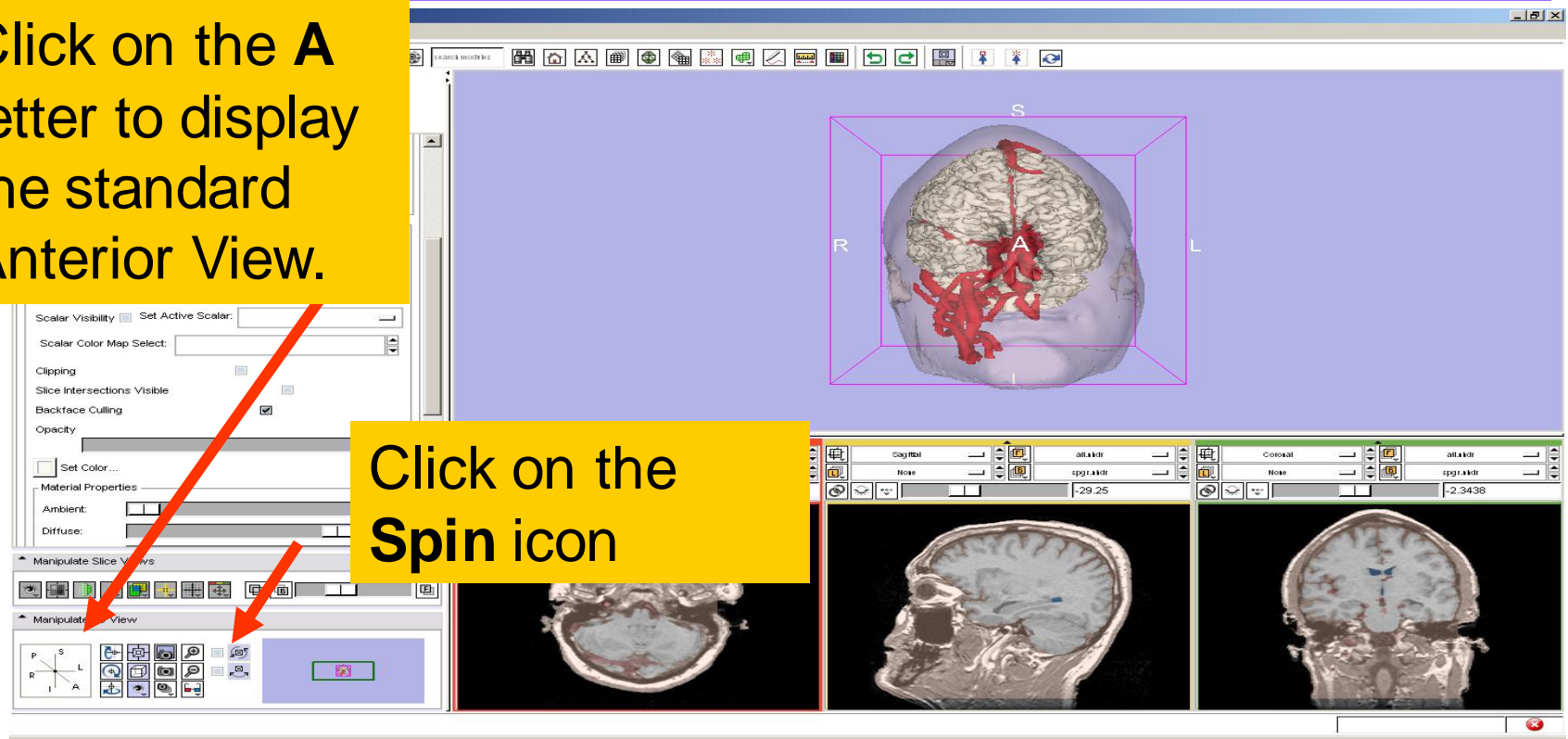
Hold down the right mouse button, and move the mouse up and down to zoom out and in.



# Manipulating a 3D model

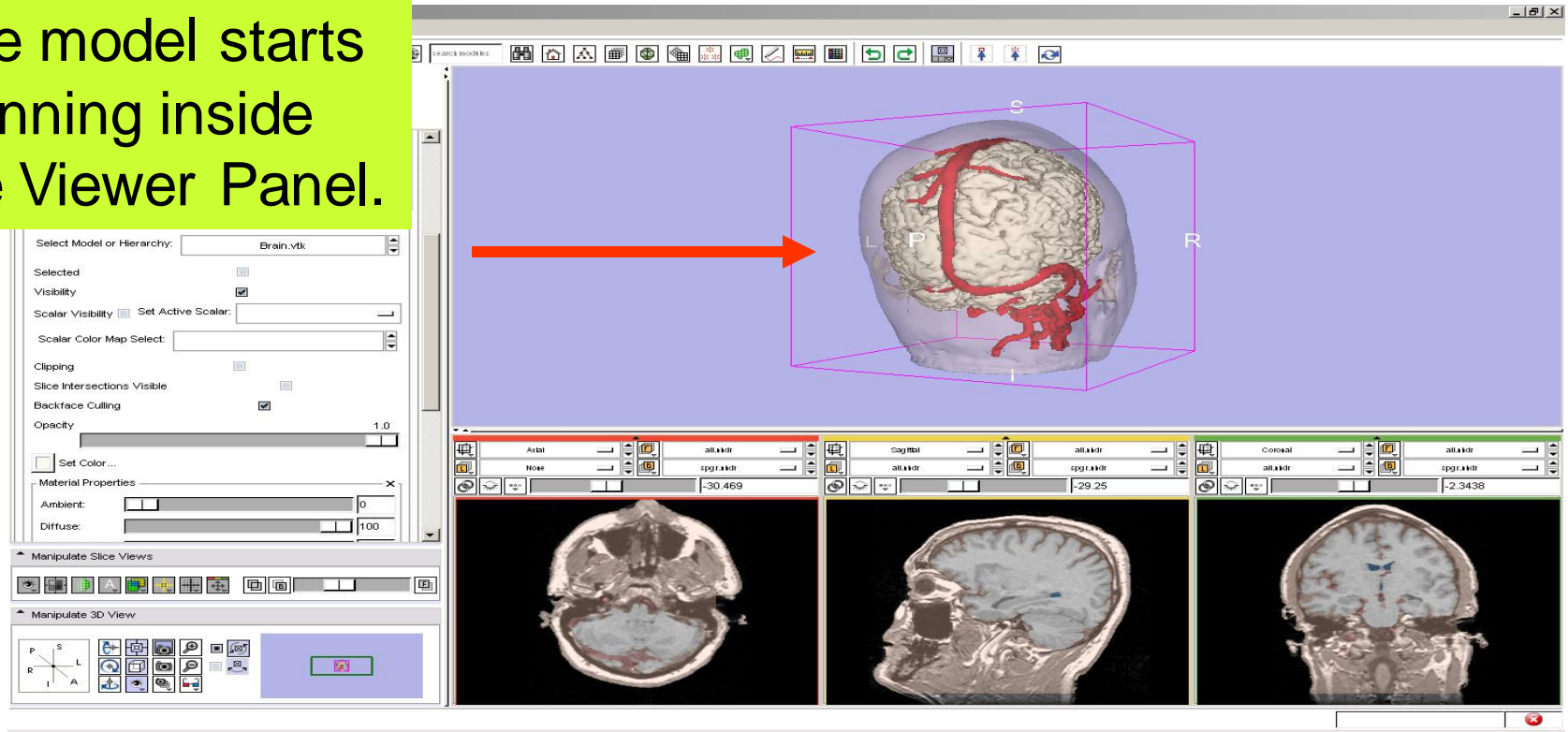
Click on the **A** letter to display the standard Anterior View.

Click on the **Spin** icon



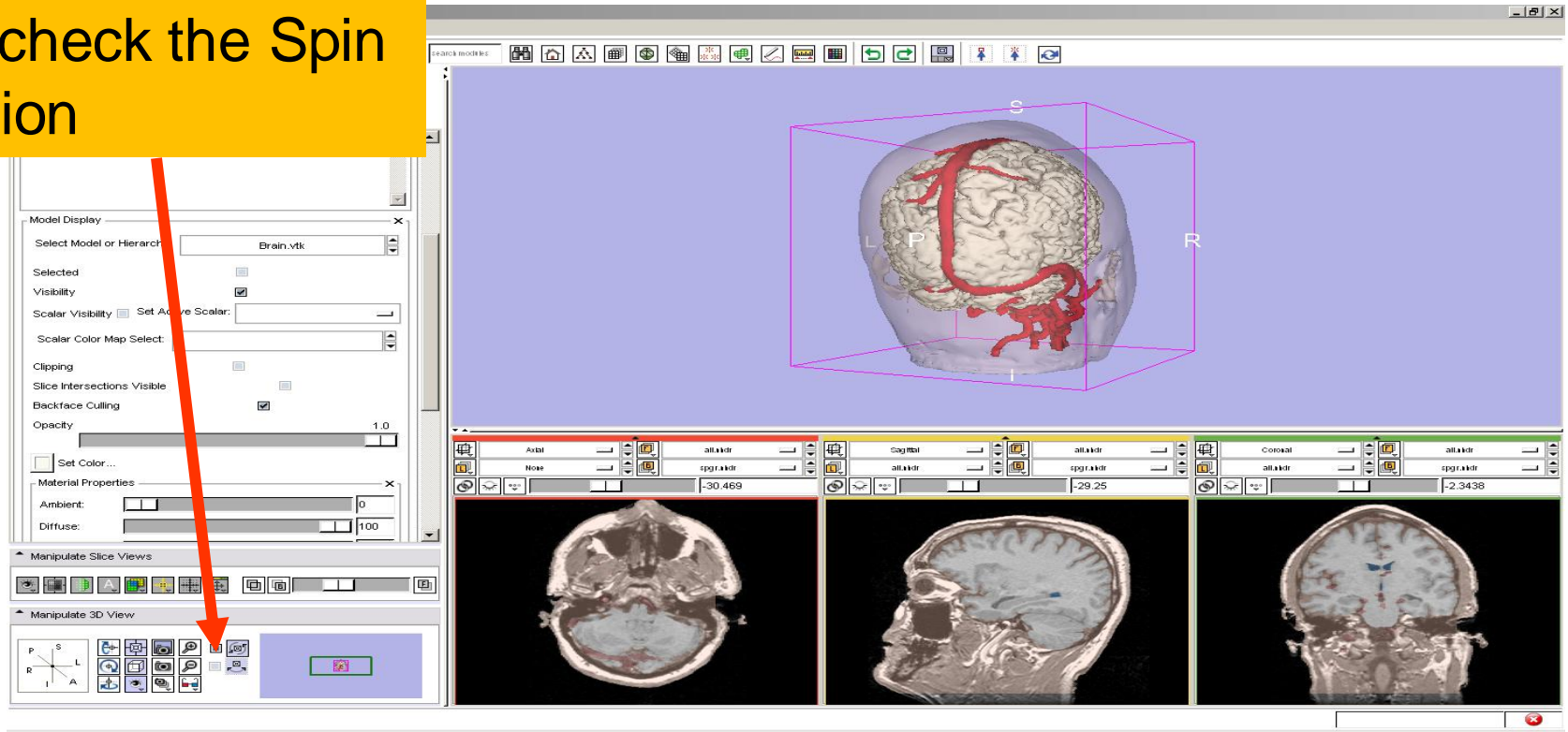
# Manipulating a 3D model

The model starts spinning inside the Viewer Panel.





# Manipulating a 3D model

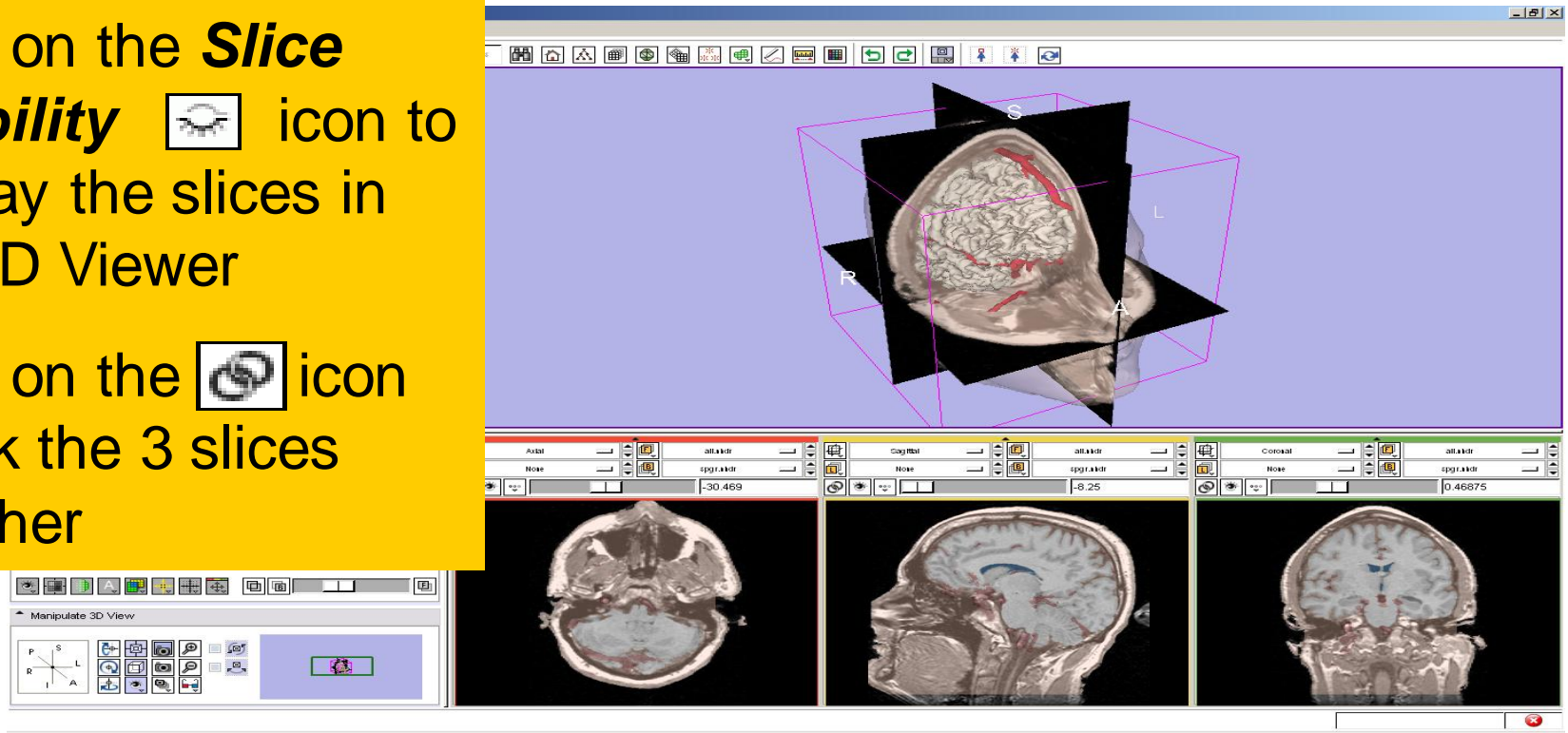
Uncheck the Spin option



# Manipulating a 3D model

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

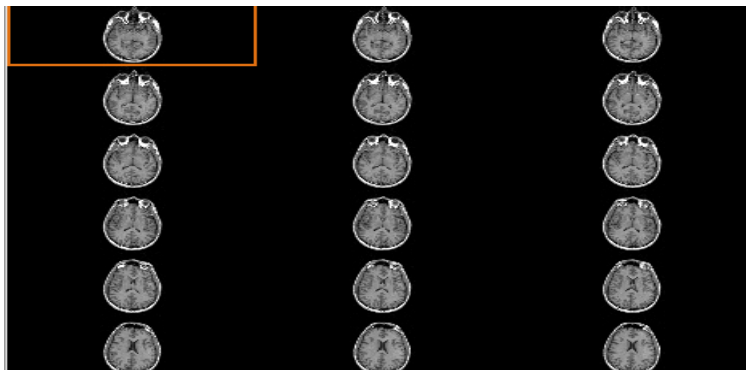
Click on the  icon to link the 3 slices together



# *Manipulating the images*

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



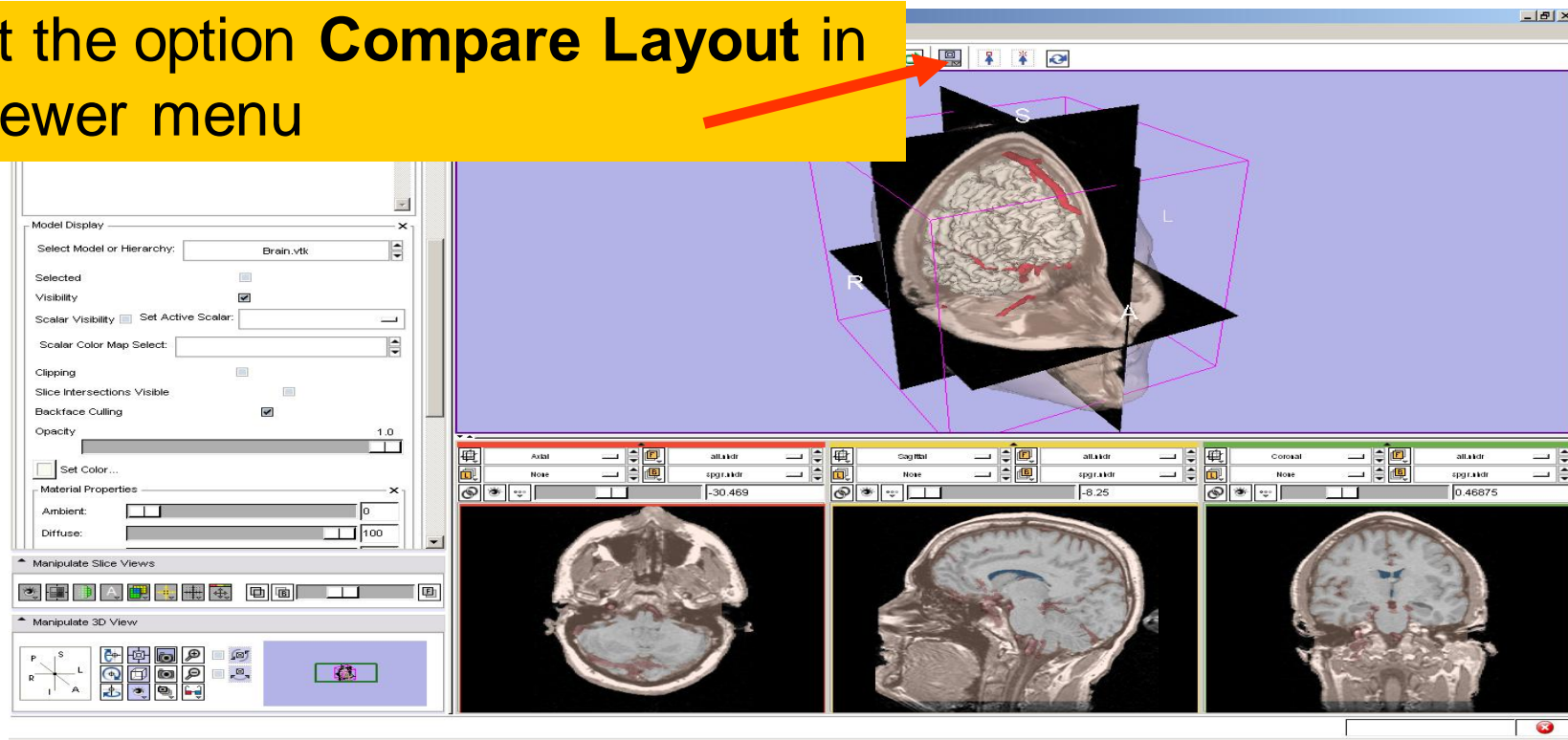


## *Part 4: Lightbox viewer*



# Visualizing a 3D model

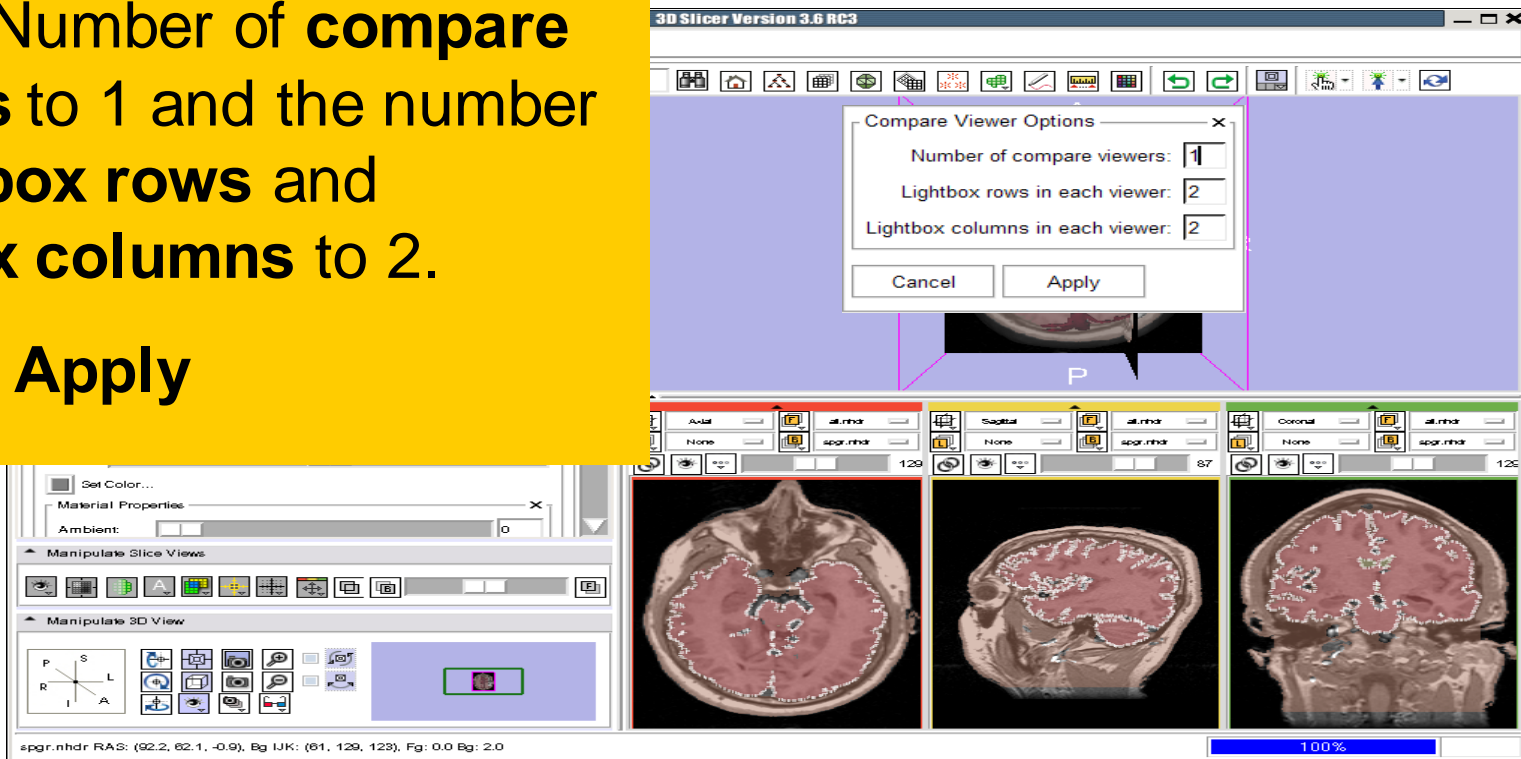
Select the option **Compare Layout** in the Viewer menu

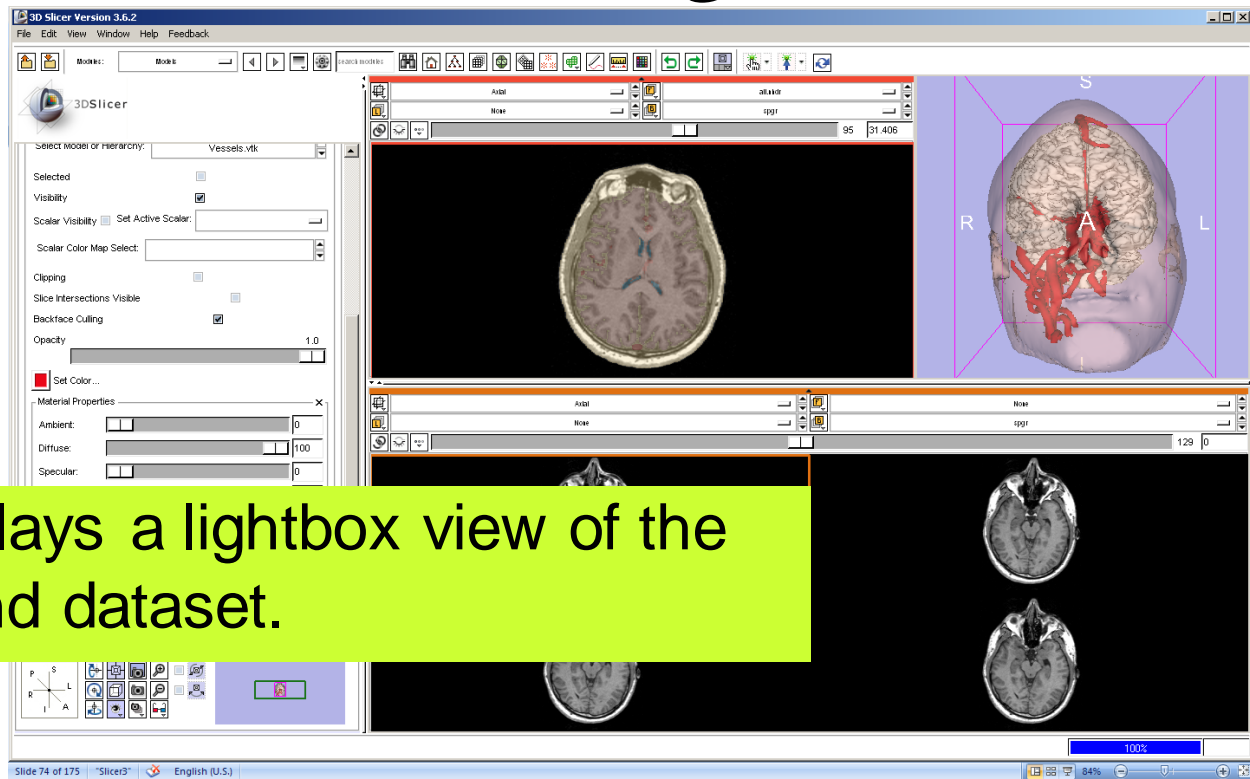


# Visualizing a 3D model

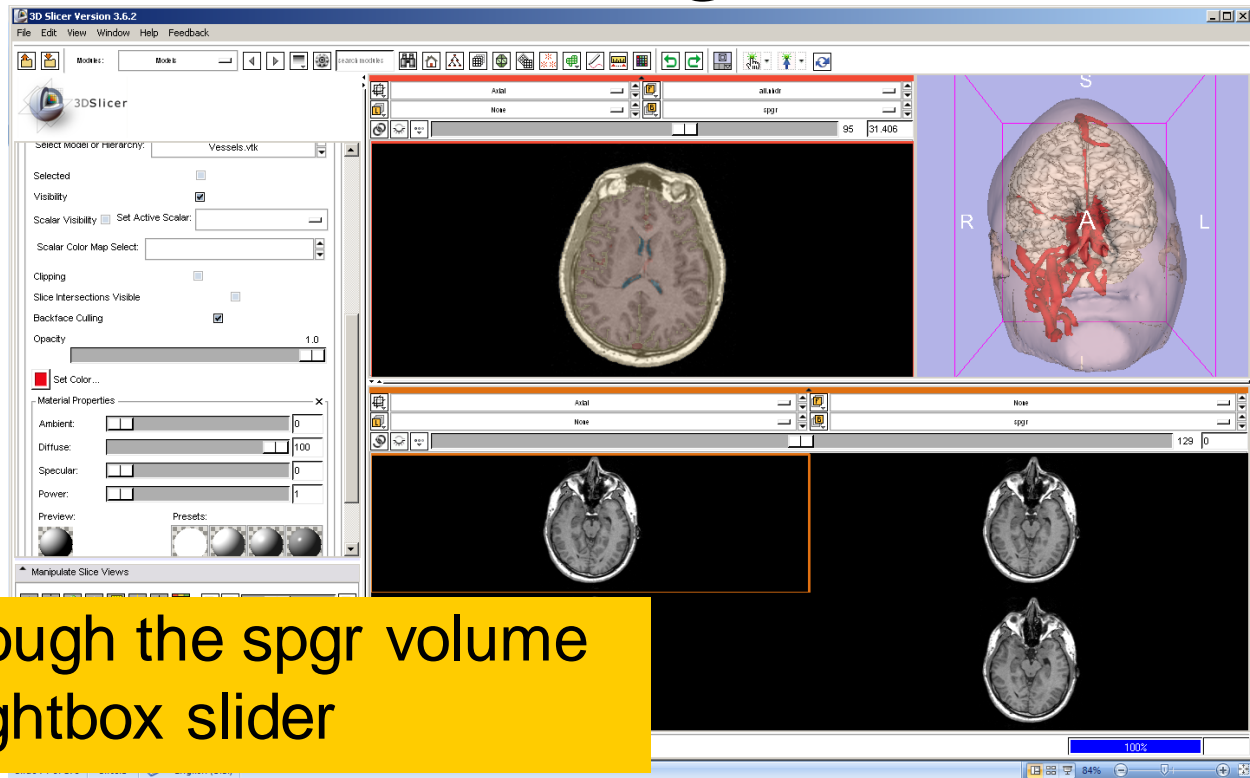
Set the Number of **compare Viewers** to 1 and the number of **lightbox rows** and **lightbox columns** to 2.

Click on **Apply**

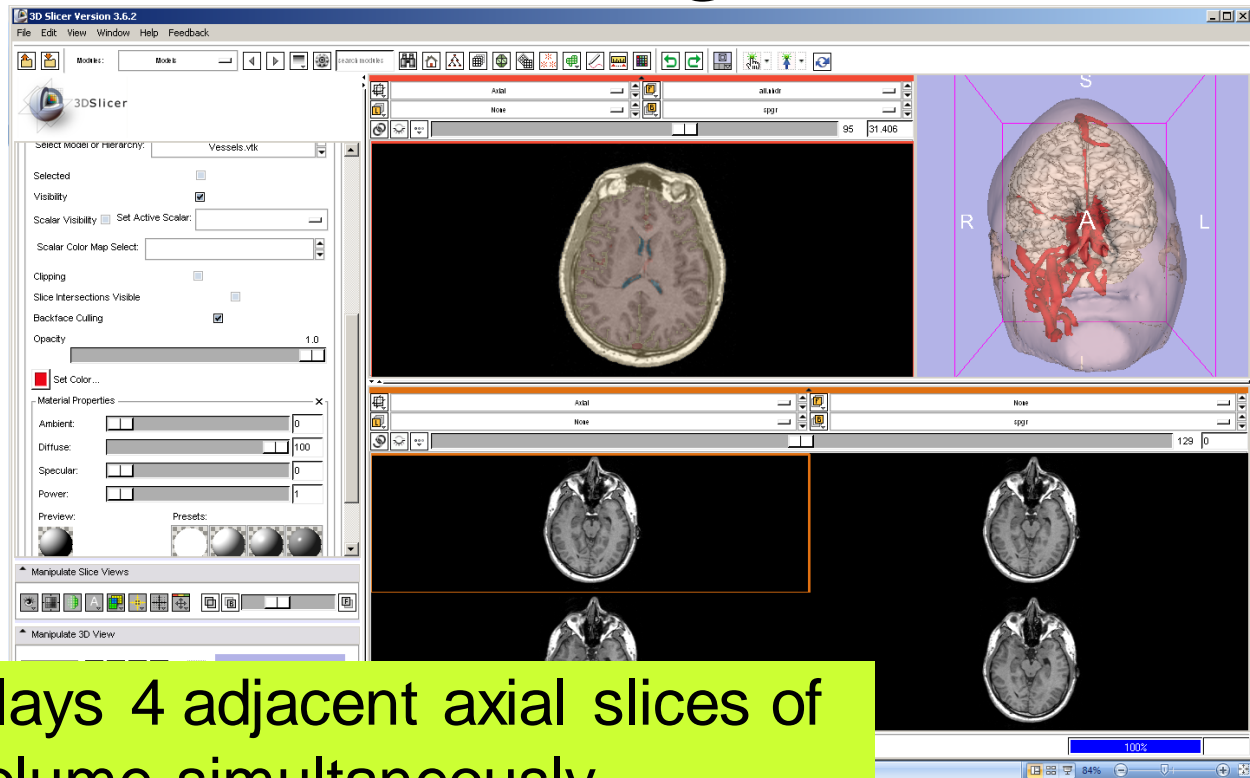




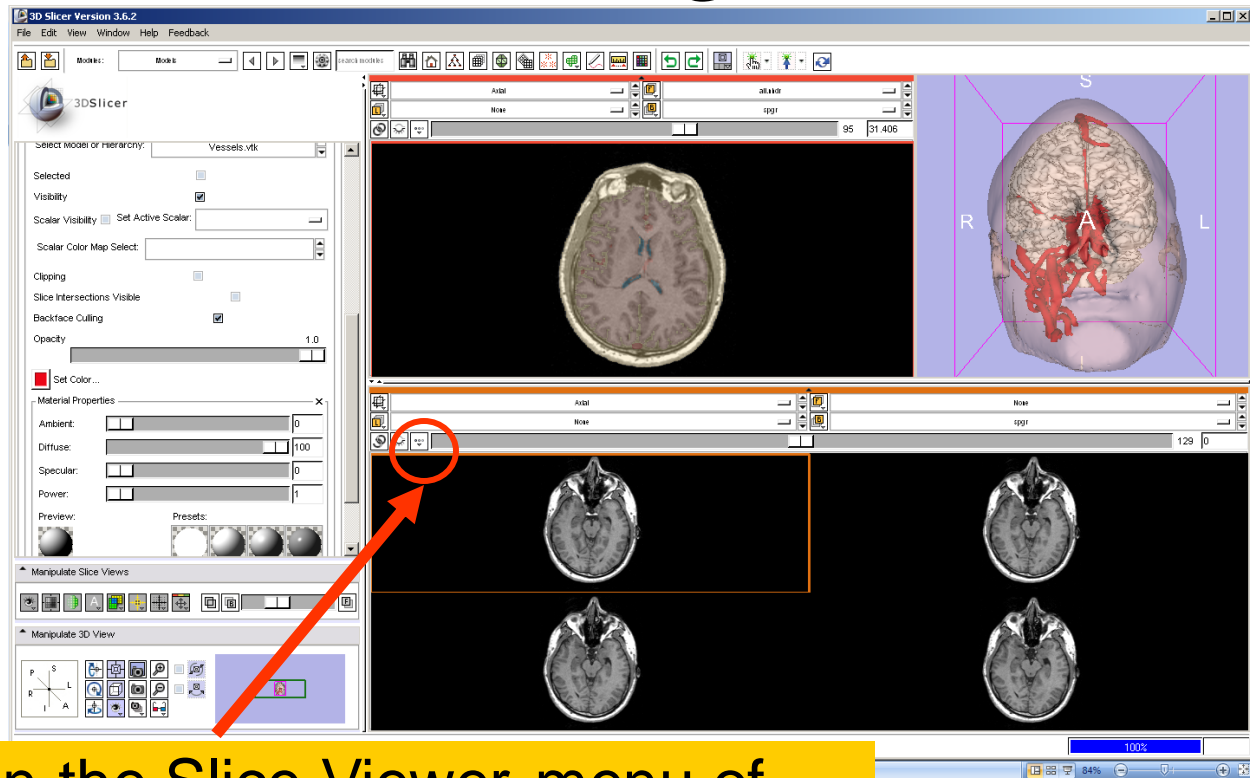
Slicer displays a lightbox view of the Background dataset.



Browse through the spgr volume using the lightbox slider

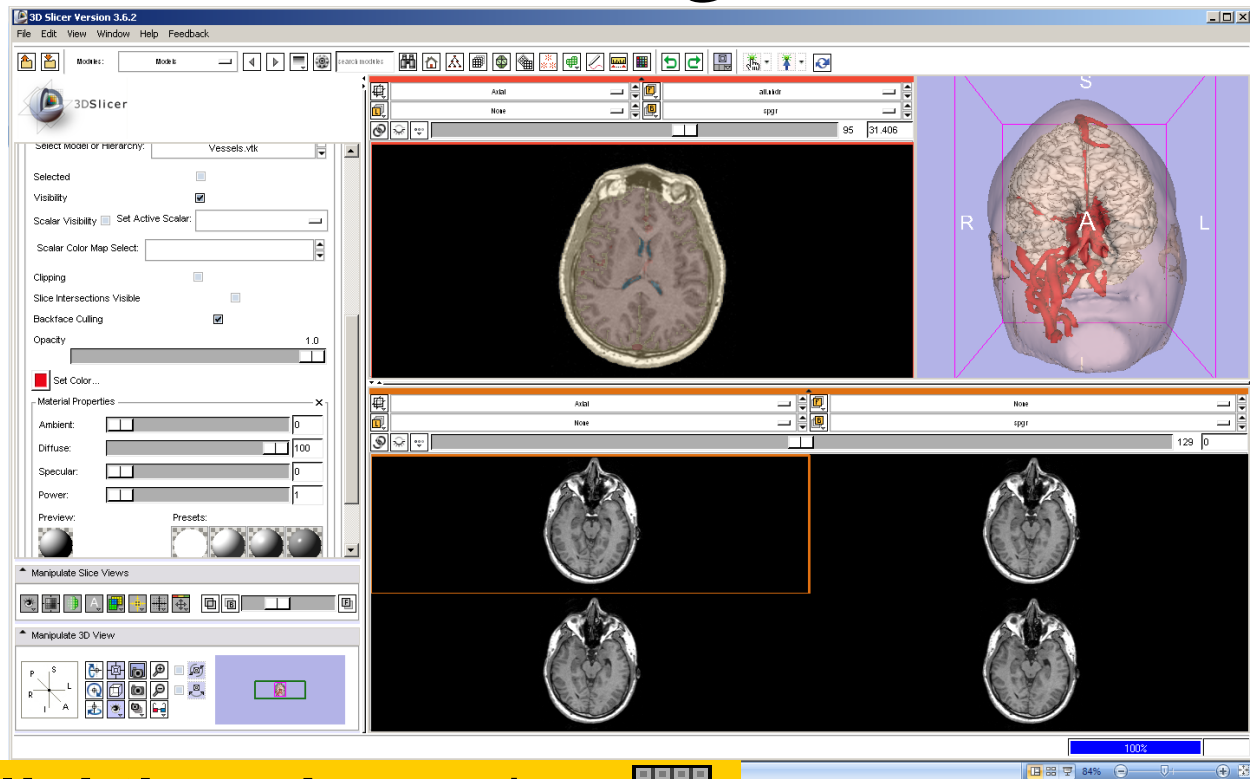


Slicer displays 4 adjacent axial slices of the spgr volume simultaneously



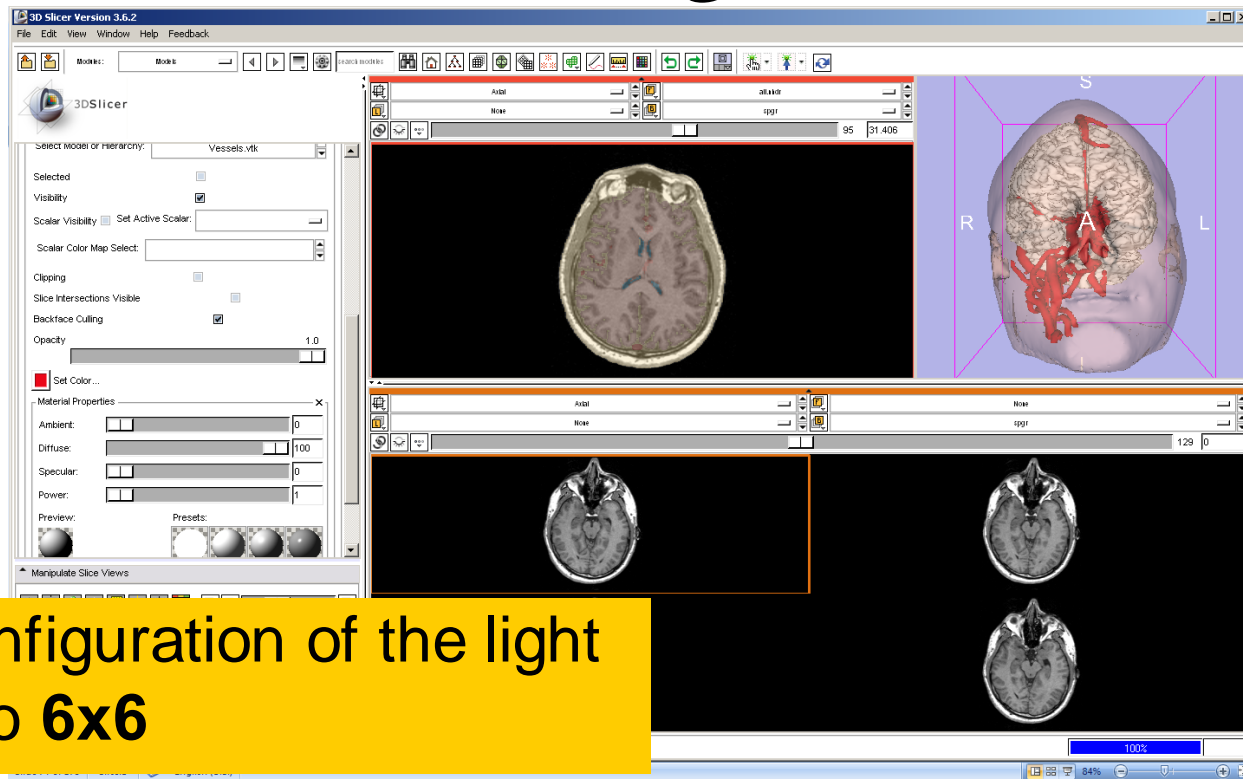
Left click on the Slice Viewer menu of  
the Compare Layout viewer

# Lightbox viewer



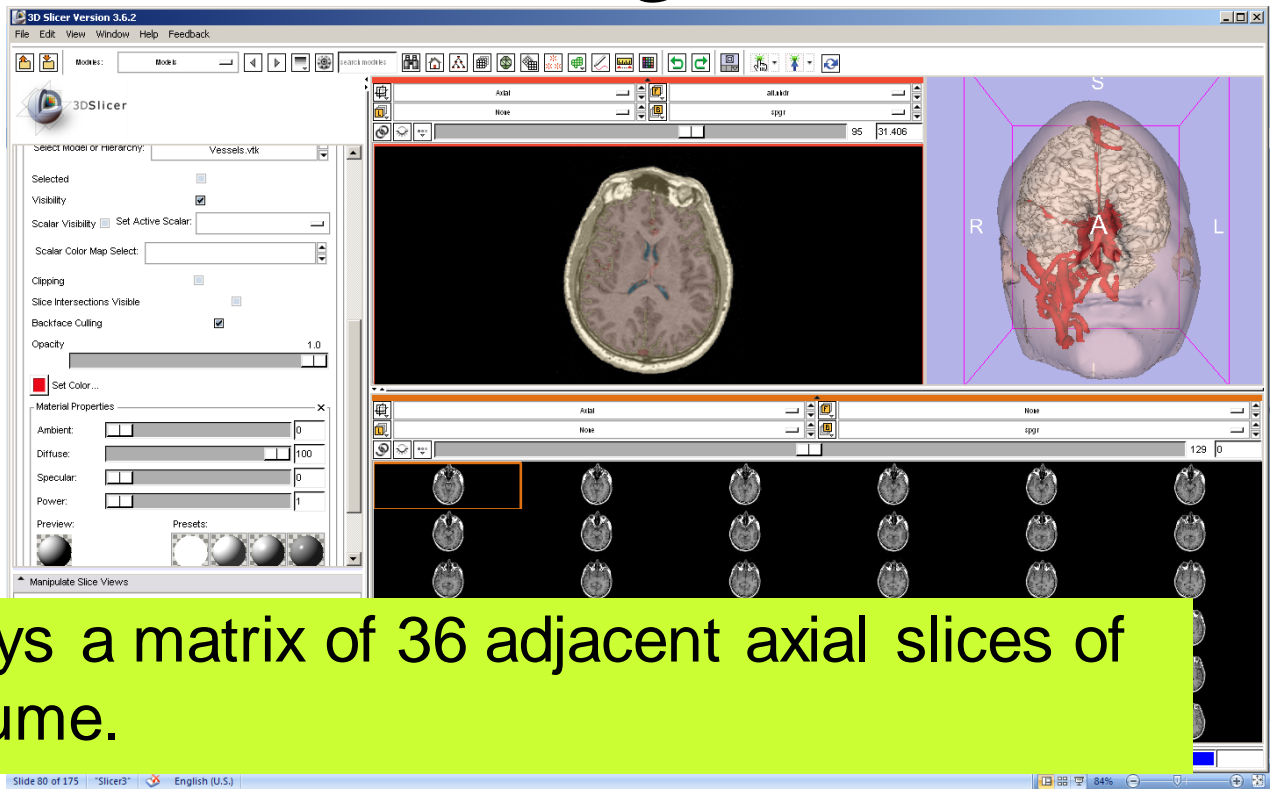
Select the **lightbox** view option





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

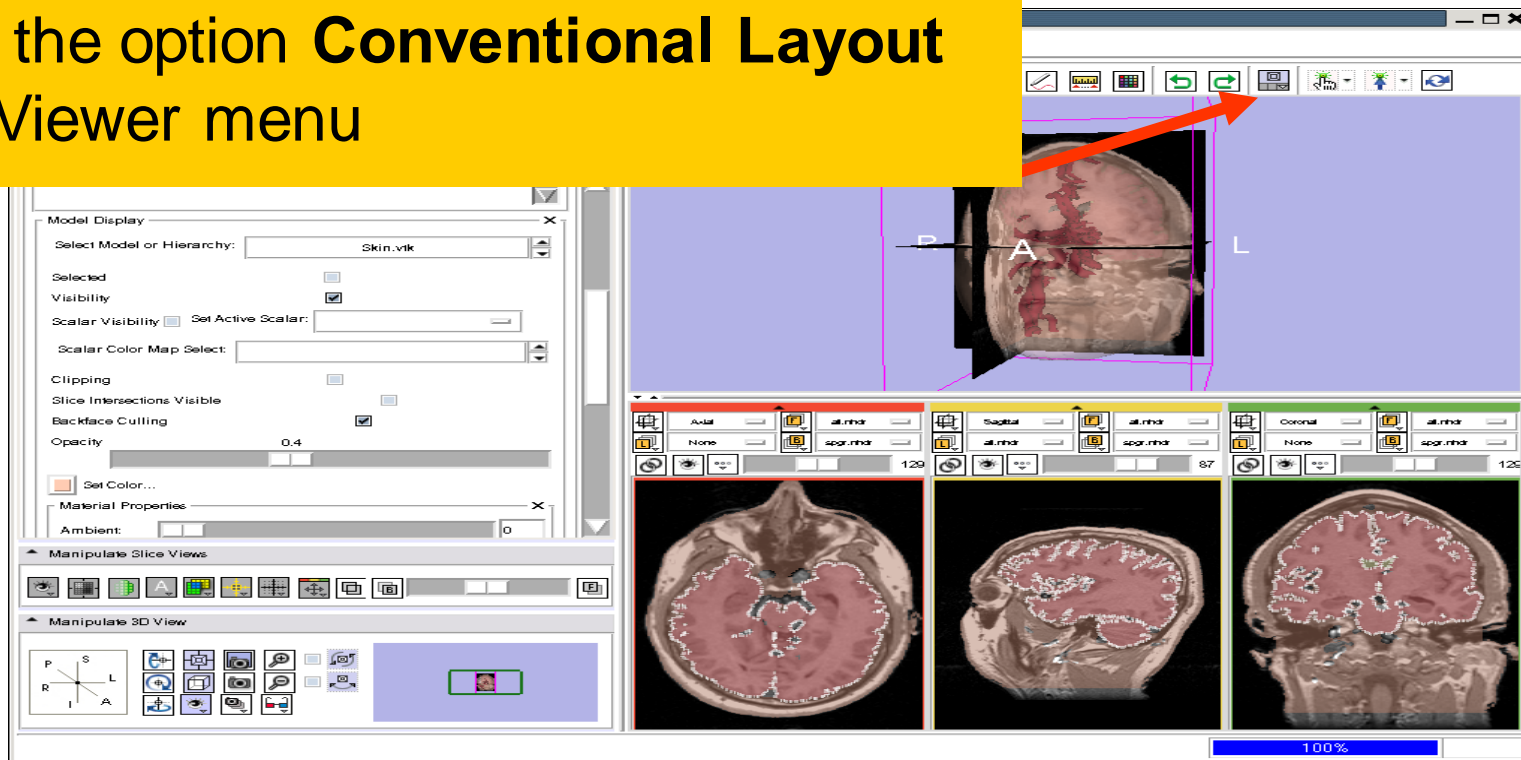


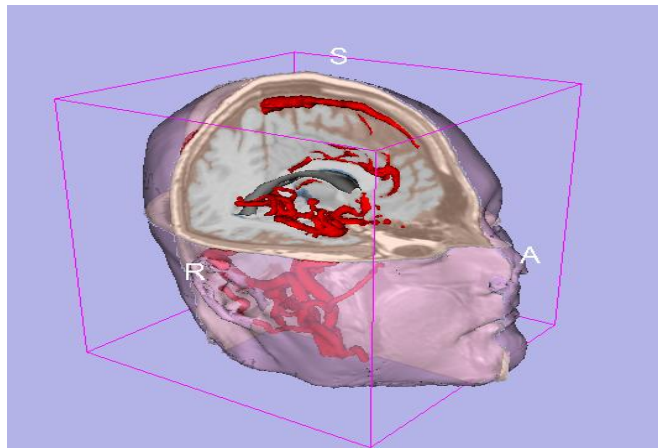


Slicer displays a matrix of 36 adjacent axial slices of the spgr volume.

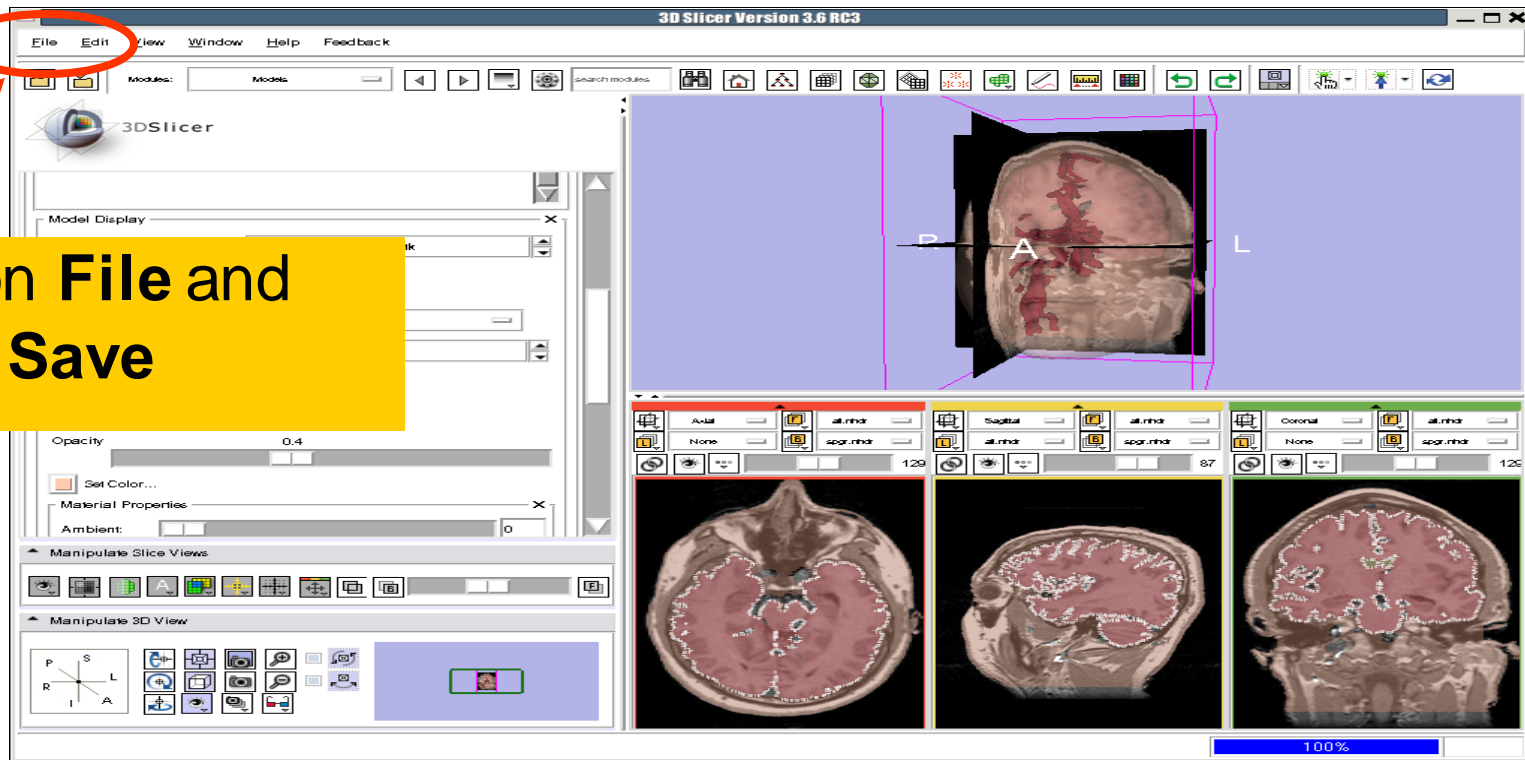
# Lightbox viewer

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



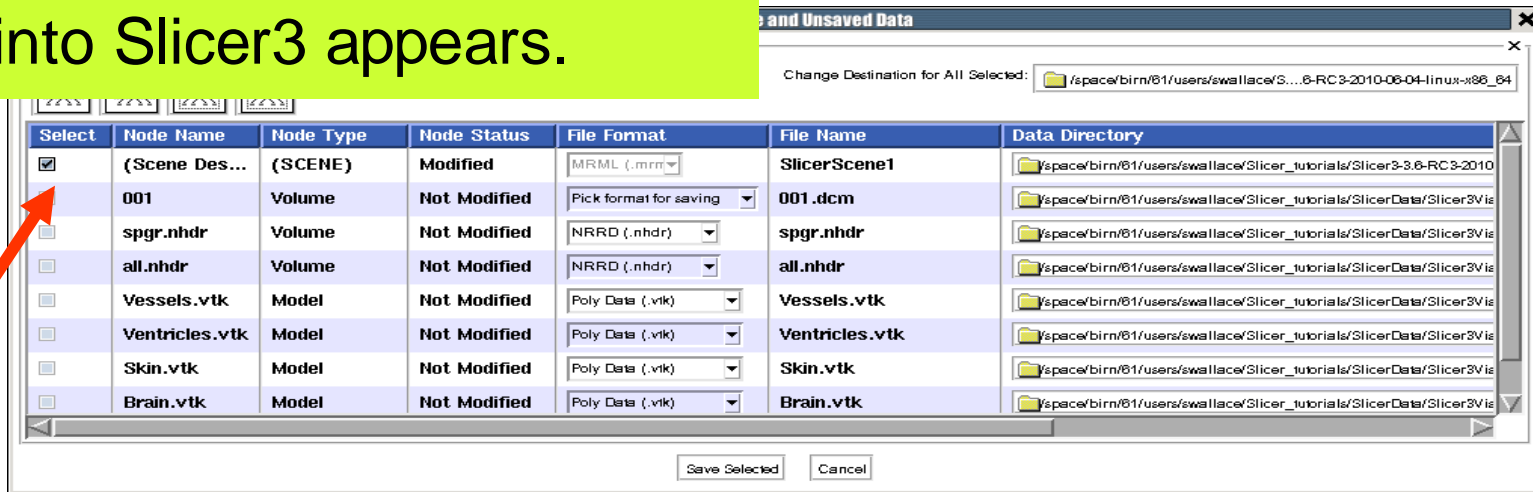


## *Part 5: Loading and saving a Scene*



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

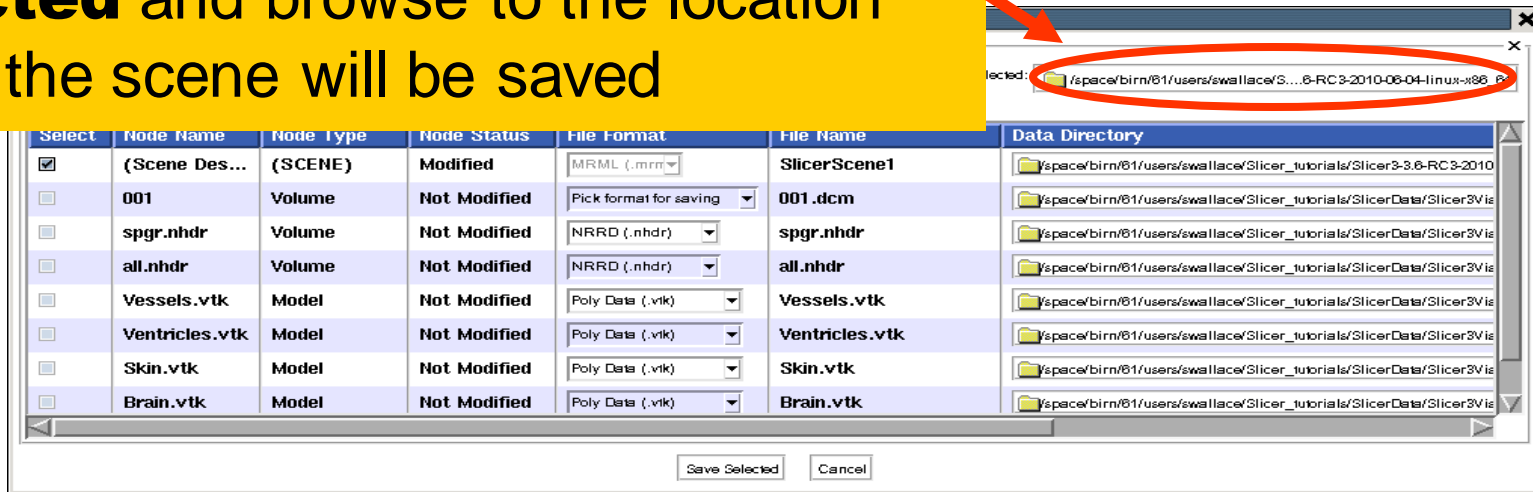
The list of elements currently loaded into Slicer3 appears.



Select	Node Name	Node Type	Node Status	File Format	File Name	Data Directory
<input checked="" type="checkbox"/>	(Scene Des...)	(SCENE)	Modified	MRML (.mrml)	SlicerScene1	/space/birn/81/users/swallace/Slicer_tutorials/Slicer3-3.6-RC3-2010
<input type="checkbox"/>	001	Volume	Not Modified	Pick format for saving	001.dcm	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	spgr.nhdr	Volume	Not Modified	NRRD (.nhdr)	spgr.nhdr	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	all.nhdr	Volume	Not Modified	NRRD (.nhdr)	all.nhdr	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Vessels.vtk	Model	Not Modified	Poly Data (.vtk)	Vessels.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Ventricles.vtk	Model	Not Modified	Poly Data (.vtk)	Ventricles.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Skin.vtk	Model	Not Modified	Poly Data (.vtk)	Skin.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Brain.vtk	Model	Not Modified	Poly Data (.vtk)	Brain.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis

Make sure only the first check box is selected

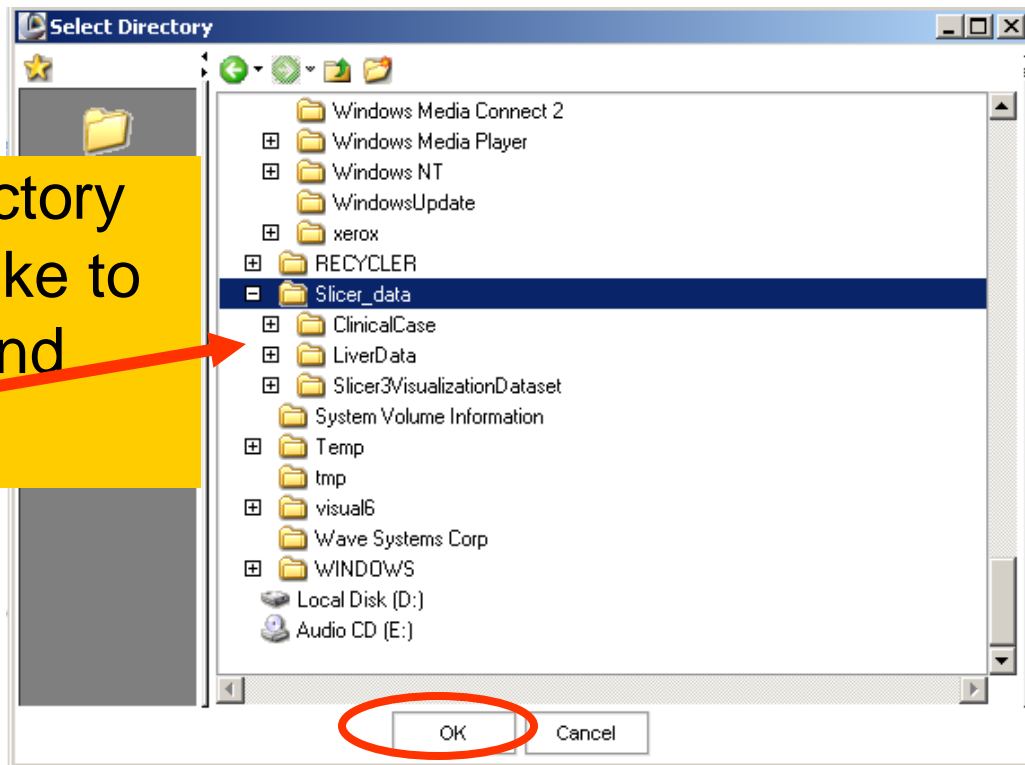
Click on **Change Destination for All Selected** and browse to the location where the scene will be saved



Select	Node Name	Node Type	Node Status	File Format	File Name	Data Directory
<input checked="" type="checkbox"/>	(Scene Des...)	(SCENE)	Modified	MRML (.mrm)	SlicerScene1	/space/birn/81/users/swallace/Slicer_tutorials/Slicer3-3.6-RC3-2010
<input type="checkbox"/>	001	Volume	Not Modified	Pick format for saving	001.dcm	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	spgr.nhdr	Volume	Not Modified	NRRD (.nhdr)	spgr.nhdr	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	all.nhdr	Volume	Not Modified	NRRD (.nhdr)	all.nhdr	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Vessels.vtk	Model	Not Modified	Poly Data (.vtk)	Vessels.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Ventricles.vtk	Model	Not Modified	Poly Data (.vtk)	Ventricles.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Skin.vtk	Model	Not Modified	Poly Data (.vtk)	Skin.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis
<input type="checkbox"/>	Brain.vtk	Model	Not Modified	Poly Data (.vtk)	Brain.vtk	/space/birn/81/users/swallace/Slicer_tutorials/SlicerData/Slicer3Vis

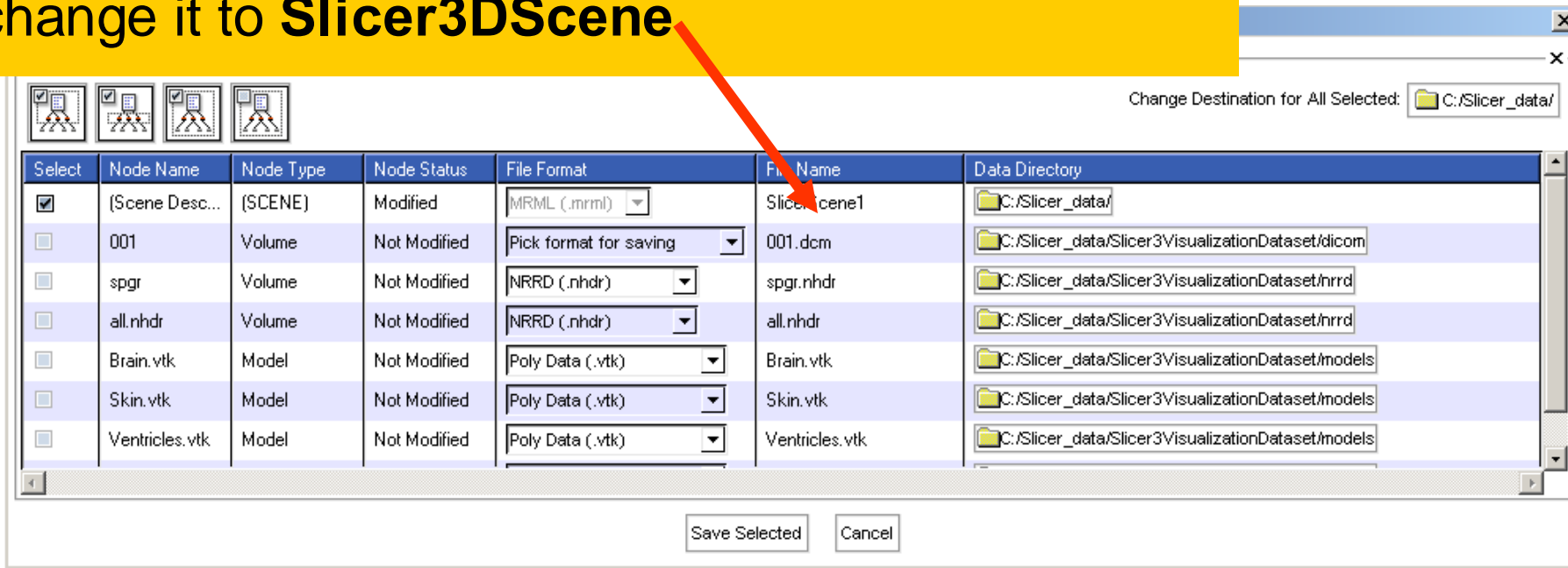
Save Selected    Cancel

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**



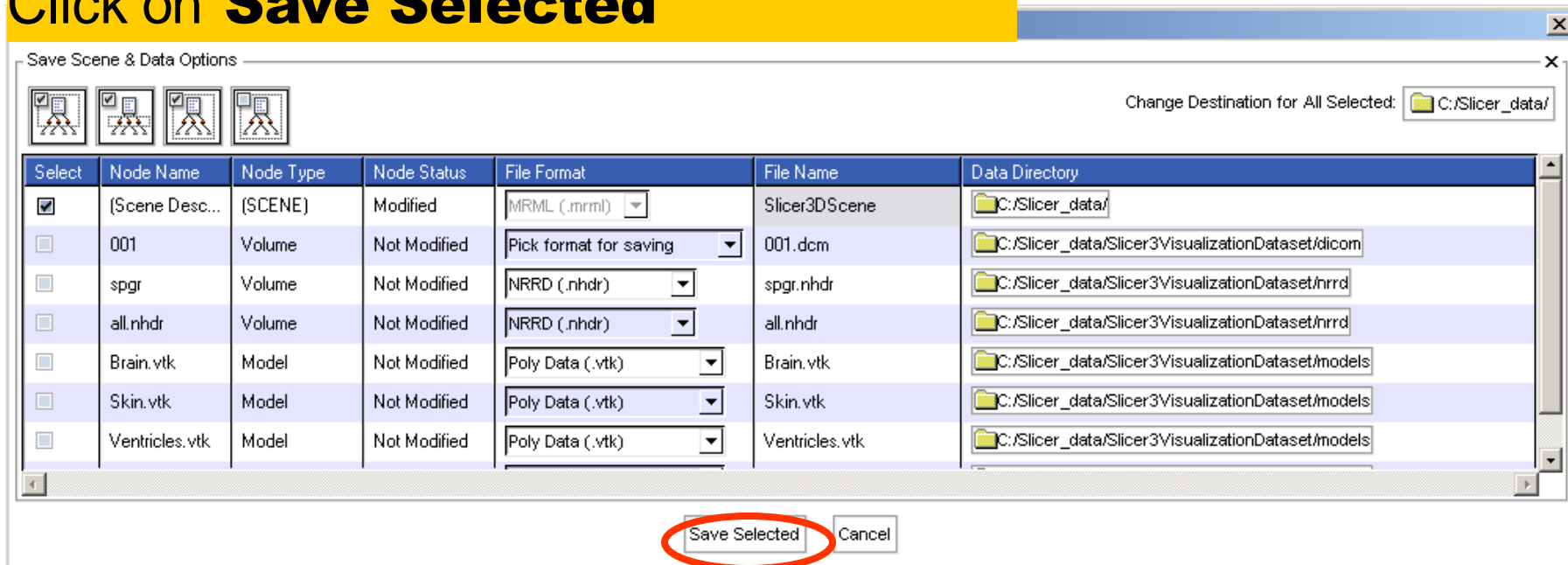
Change Destination for All Selected: C:/Slicer\_data/

Select	Node Name	Node Type	Node Status	File Format	File Name	Data Directory
<input checked="" type="checkbox"/>	(Scene Desc...	(SCENE)	Modified	MRML (.mrm)	SlicerScene1	C:/Slicer_data/
<input type="checkbox"/>	001	Volume	Not Modified	Pick format for saving	001.dcm	C:/Slicer_data/Slicer3VisualizationDataset/dicom
<input type="checkbox"/>	spgr	Volume	Not Modified	NRRD (.nhdr)	spgr.nhdr	C:/Slicer_data/Slicer3VisualizationDataset/nrrd
<input type="checkbox"/>	all.nhdr	Volume	Not Modified	NRRD (.nhdr)	all.nhdr	C:/Slicer_data/Slicer3VisualizationDataset/nrrd
<input type="checkbox"/>	Brain.vtk	Model	Not Modified	Poly Data (.vtk)	Brain.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models
<input type="checkbox"/>	Skin.vtk	Model	Not Modified	Poly Data (.vtk)	Skin.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models
<input type="checkbox"/>	Ventricles.vtk	Model	Not Modified	Poly Data (.vtk)	Ventricles.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models

Save Selected    Cancel



## Click on **Save Selected**



Save Scene & Data Options

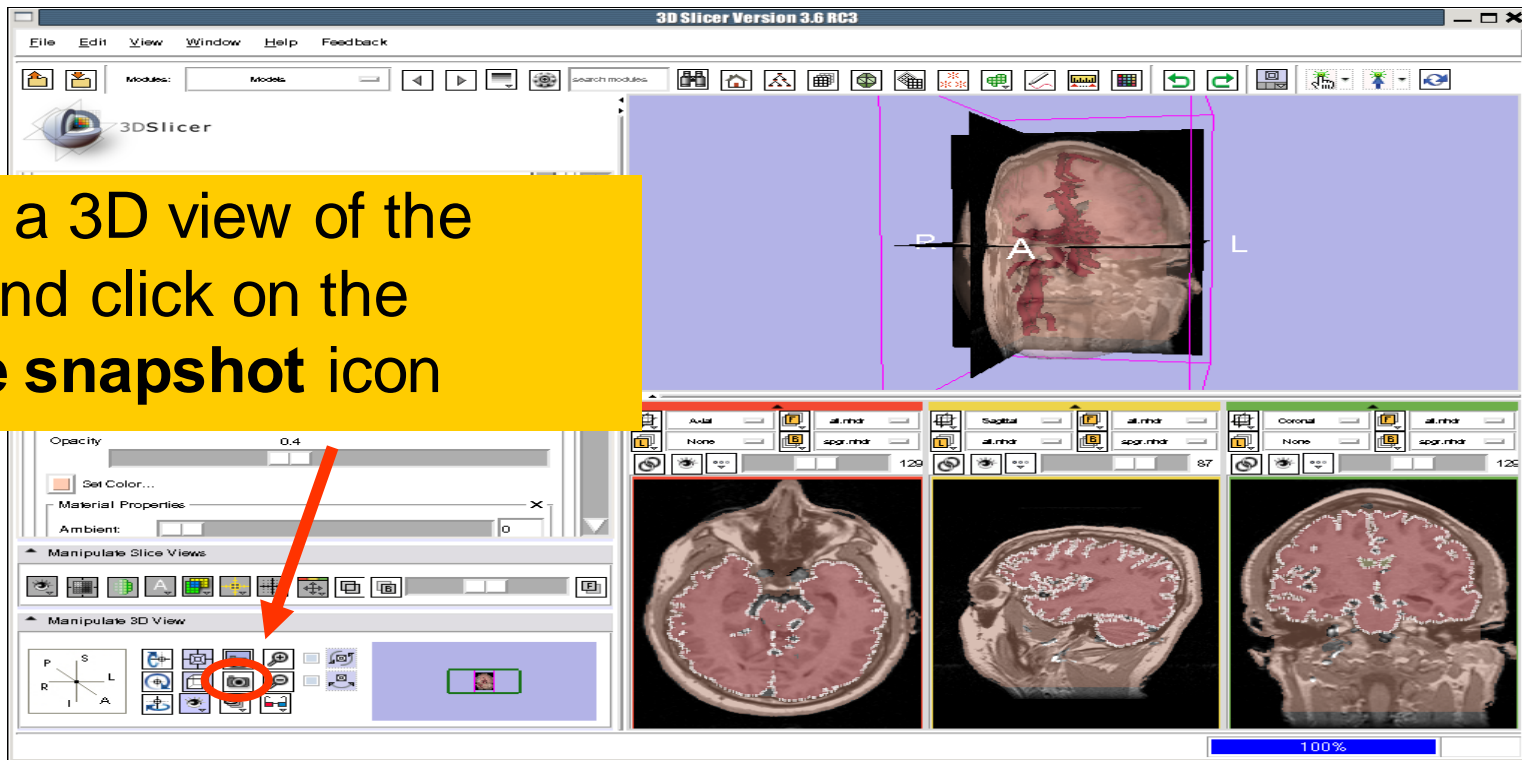
Change Destination for All Selected:

Select	Node Name	Node Type	Node Status	File Format	File Name	Data Directory
<input checked="" type="checkbox"/>	(Scene Desc...)	(SCENE)	Modified	MRML (.mrm)	Slicer3DScene	C:/Slicer_data/
<input type="checkbox"/>	001	Volume	Not Modified	Pick format for saving	001.dcm	C:/Slicer_data/Slicer3VisualizationDataset/dicom
<input type="checkbox"/>	spgr	Volume	Not Modified	NRRD (.nhdr)	spgr.nhdr	C:/Slicer_data/Slicer3VisualizationDataset/nrrd
<input type="checkbox"/>	all.nhdr	Volume	Not Modified	NRRD (.nhdr)	all.nhdr	C:/Slicer_data/Slicer3VisualizationDataset/nrrd
<input type="checkbox"/>	Brain.vtk	Model	Not Modified	Poly Data (.vtk)	Brain.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models
<input type="checkbox"/>	Skin.vtk	Model	Not Modified	Poly Data (.vtk)	Skin.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models
<input type="checkbox"/>	Ventricles.vtk	Model	Not Modified	Poly Data (.vtk)	Ventricles.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models

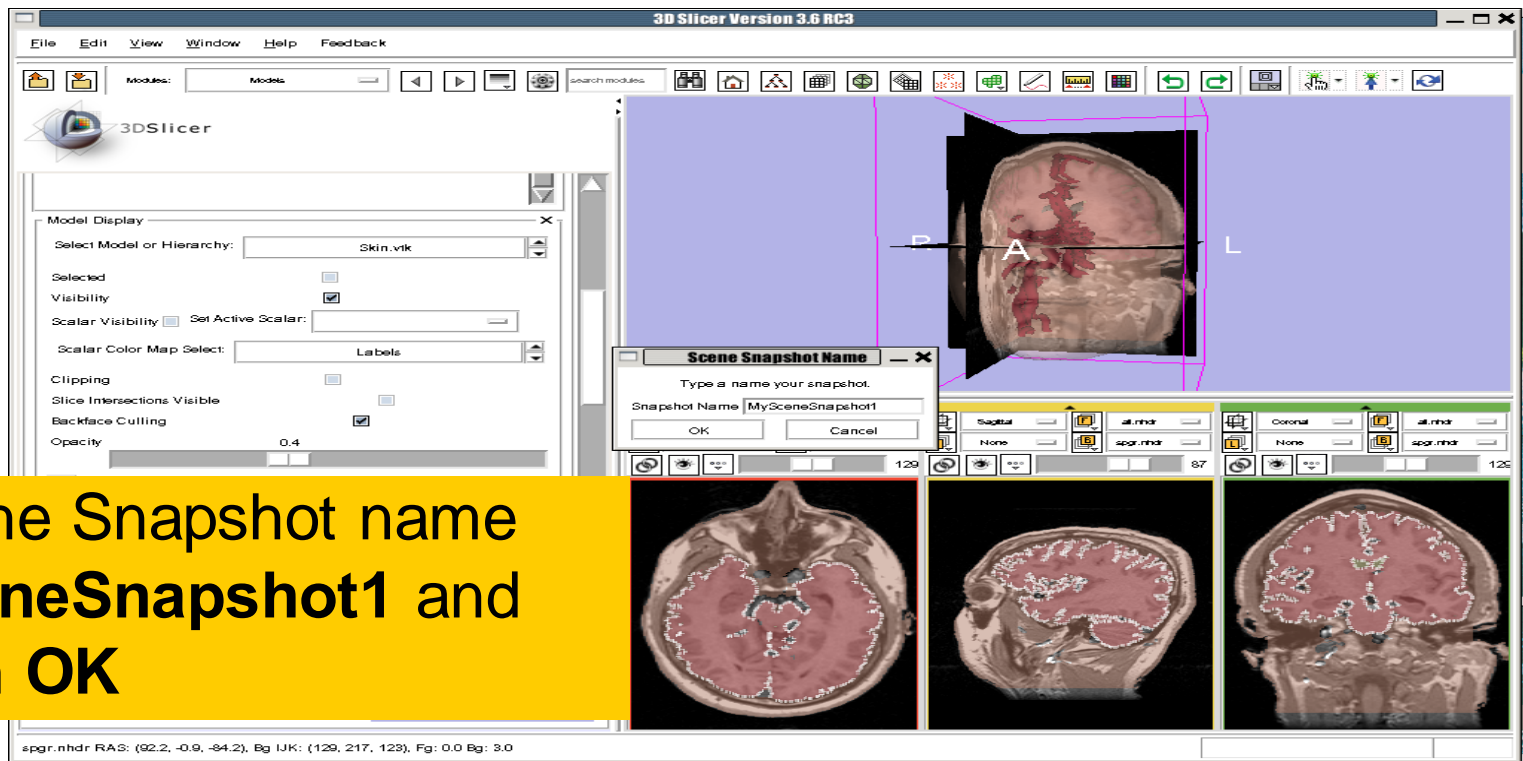
Save Selected Cancel

# Creating Scene Snapshots

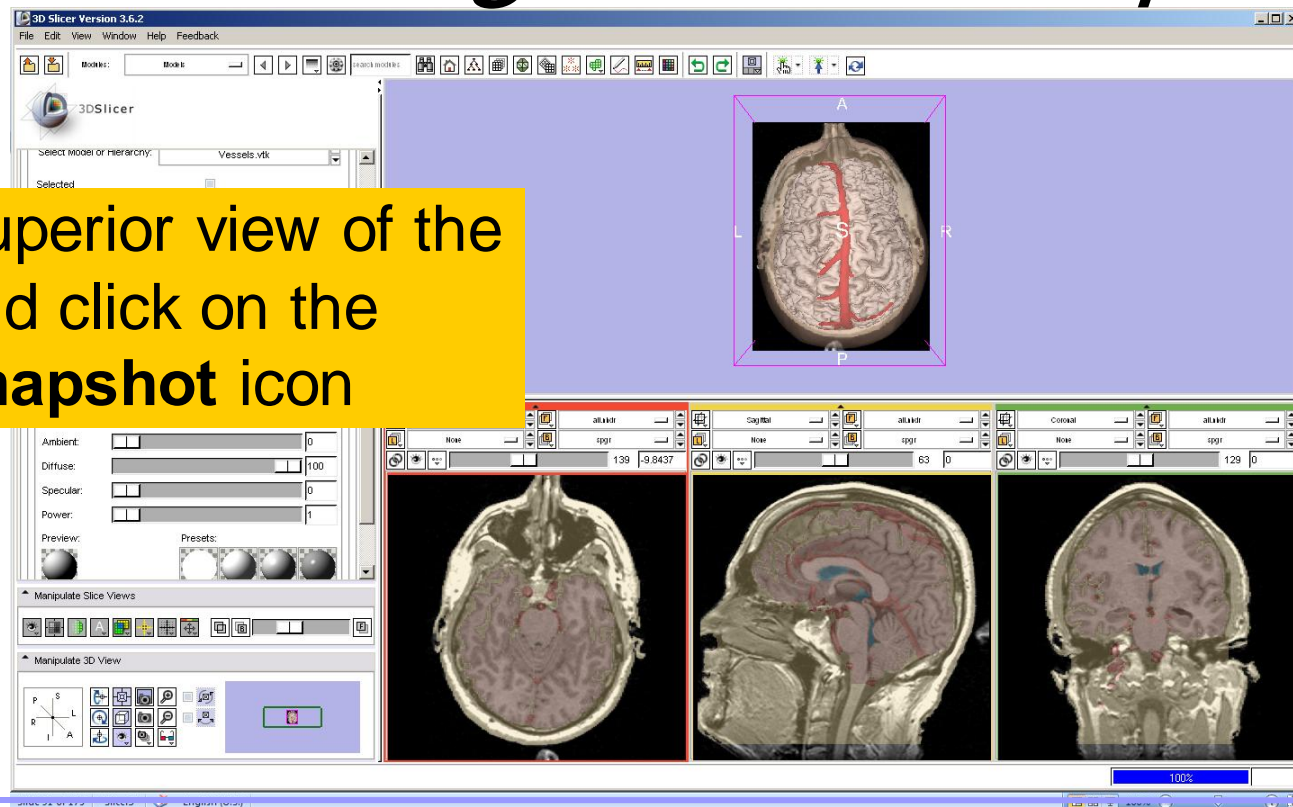
Choose a 3D view of the scene and click on the capture snapshot icon



# Creating Scene Snapshots

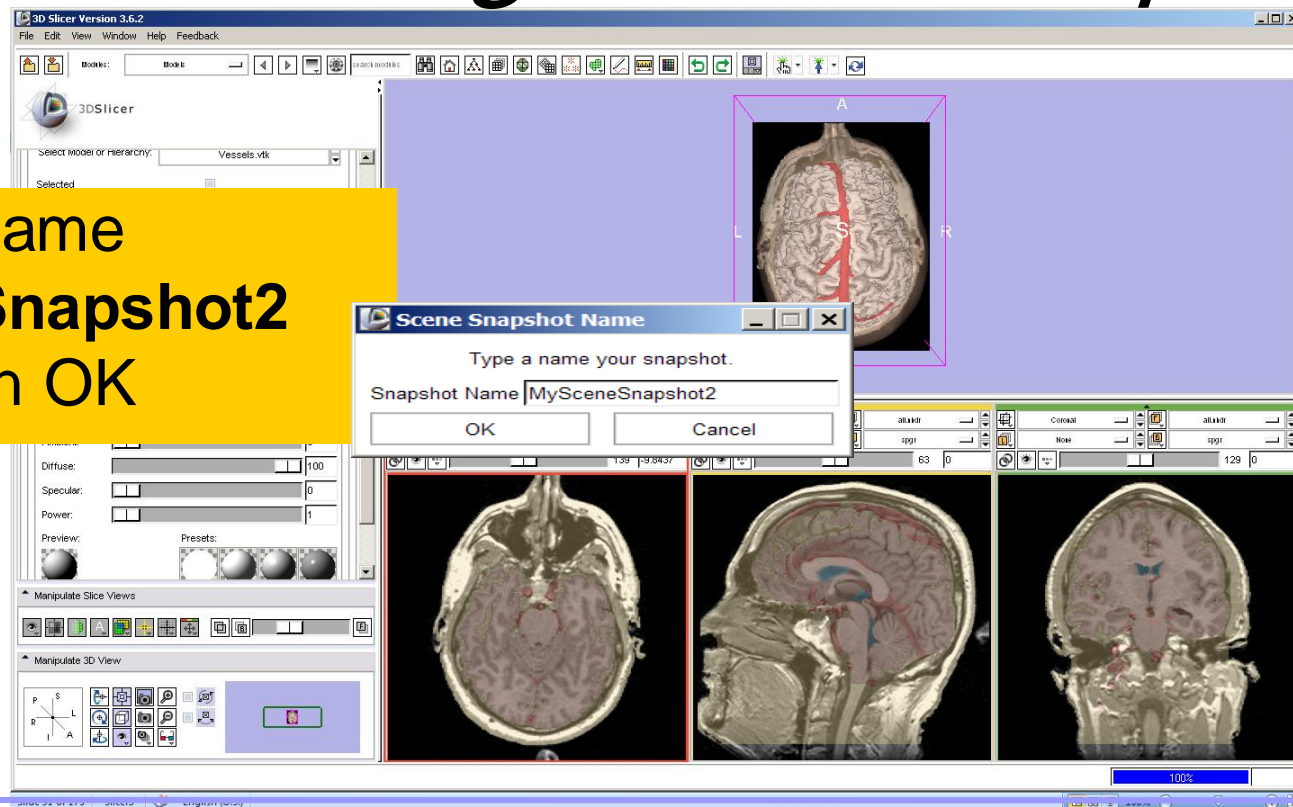


# Creating Scene Snapshots



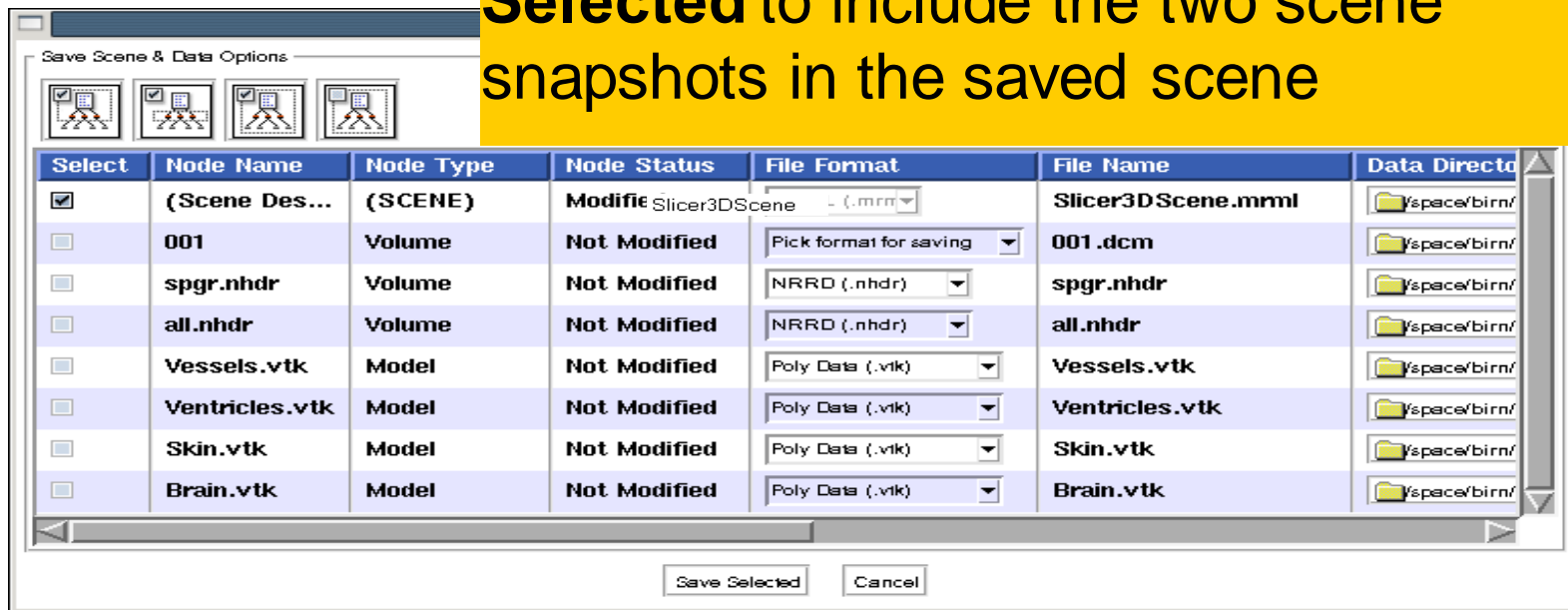
# Creating Scene Snapshots

Enter the name  
**MySceneSnapshot2**  
and click on OK



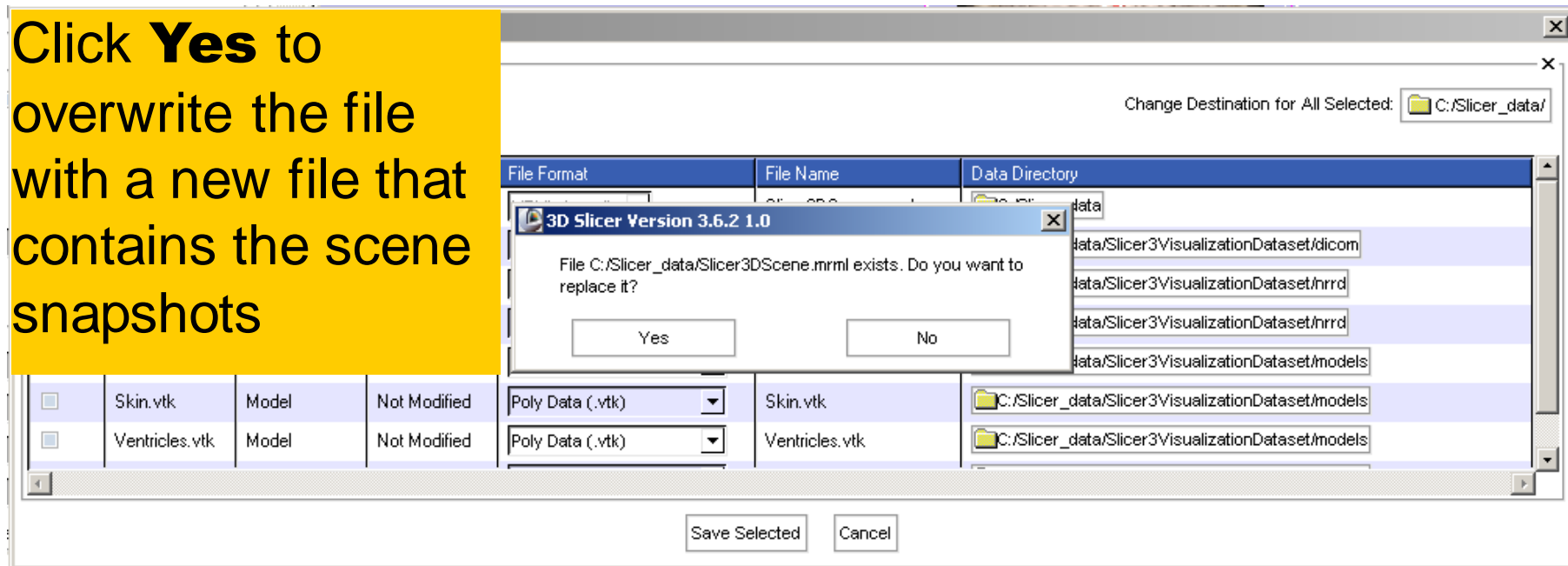
# Creating Scene Snapshots

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



The screenshot shows the 3D Slicer interface with a file save dialog open. The dialog has a table with the following columns: File Format, File Name, and Data Directory. Two files are listed: 'Skin.vtk' and 'Ventricles.vtk', both in 'Poly Data (.vtk)' format. A confirmation dialog is overlaid on top, asking 'File C:/Slicer\_data/Slicer3DScene.mrml exists. Do you want to replace it?' with 'Yes' and 'No' buttons. The 'Yes' button is highlighted, indicating the user's choice.

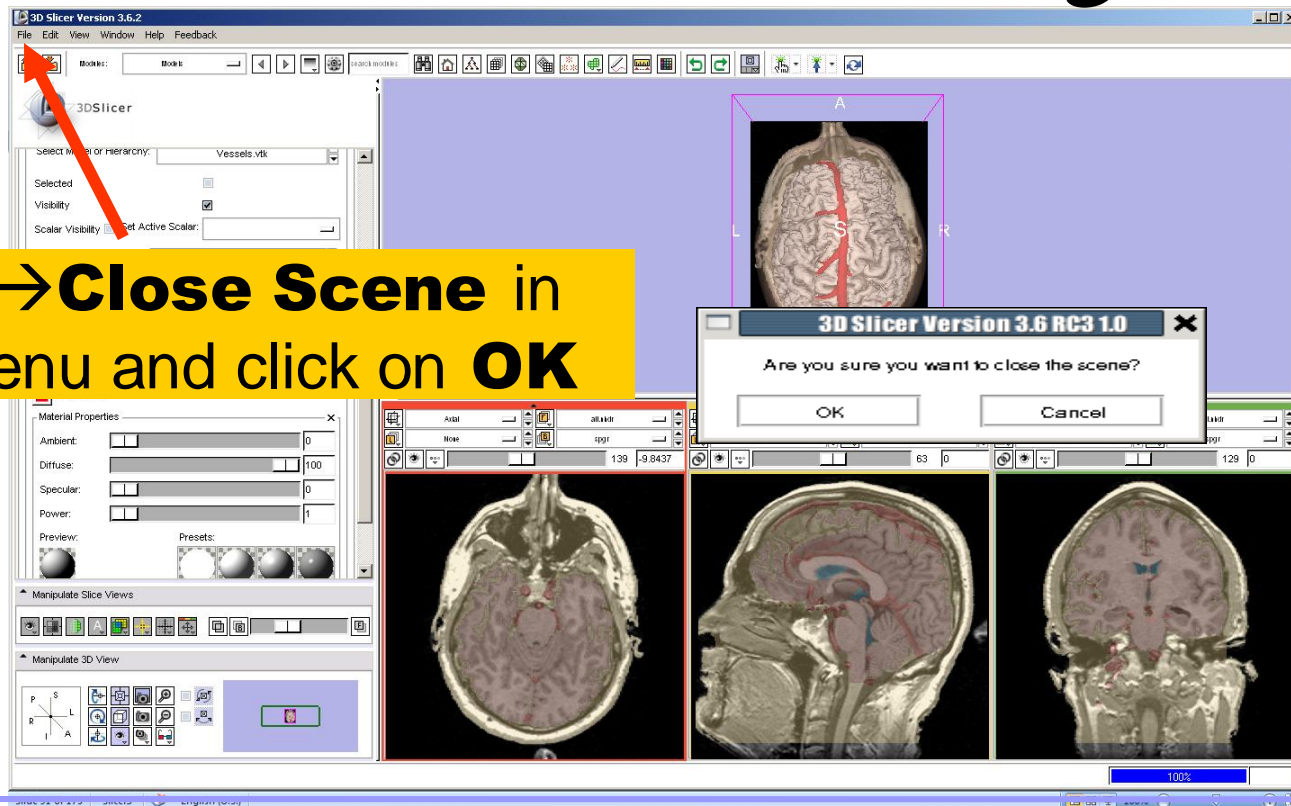
File Format	File Name	Data Directory
Poly Data (.vtk)	Skin.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models
Poly Data (.vtk)	Ventricles.vtk	C:/Slicer_data/Slicer3VisualizationDataset/models

3D Slicer Version 3.6.2 1.0

File C:/Slicer\_data/Slicer3DScene.mrml exists. Do you want to replace it?

Yes No

Save Selected Cancel

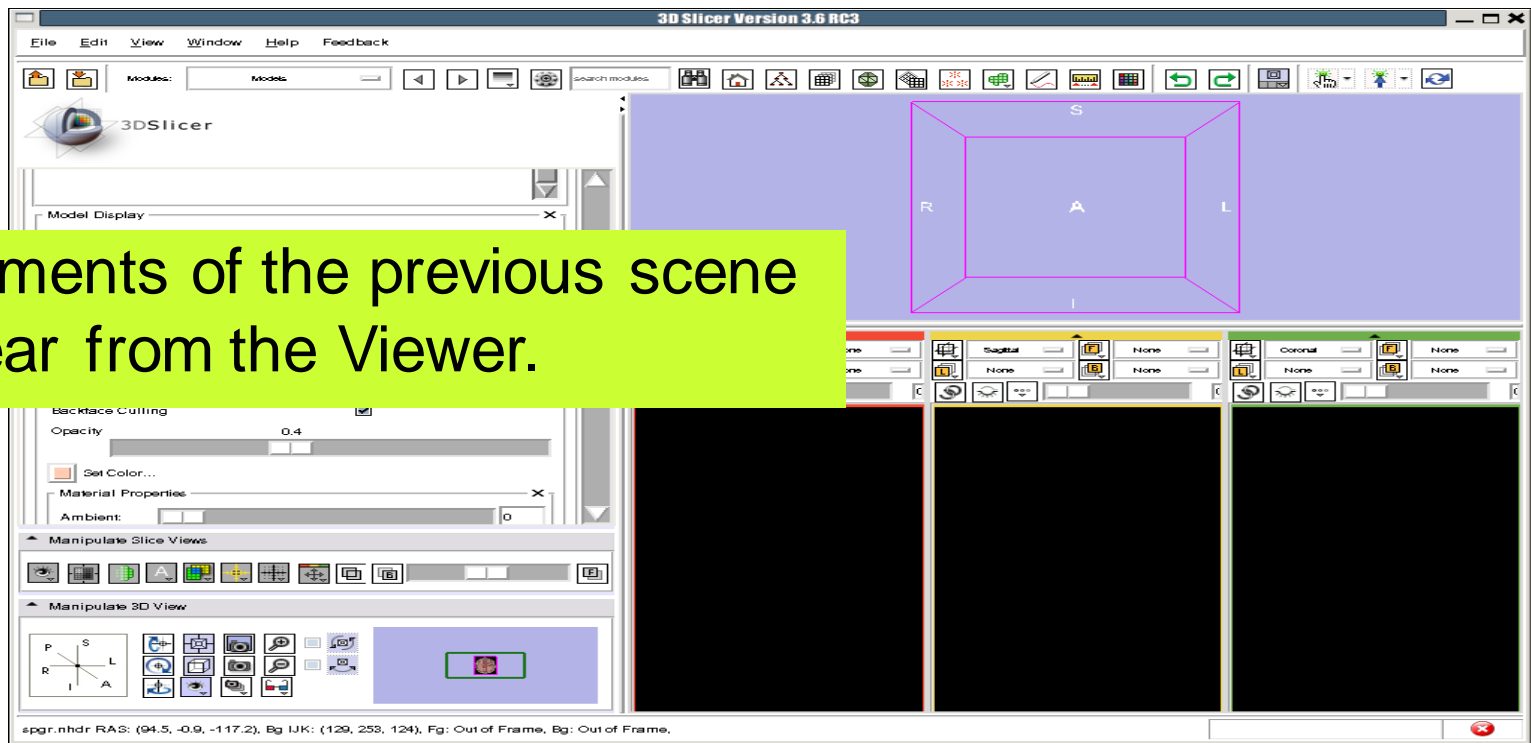


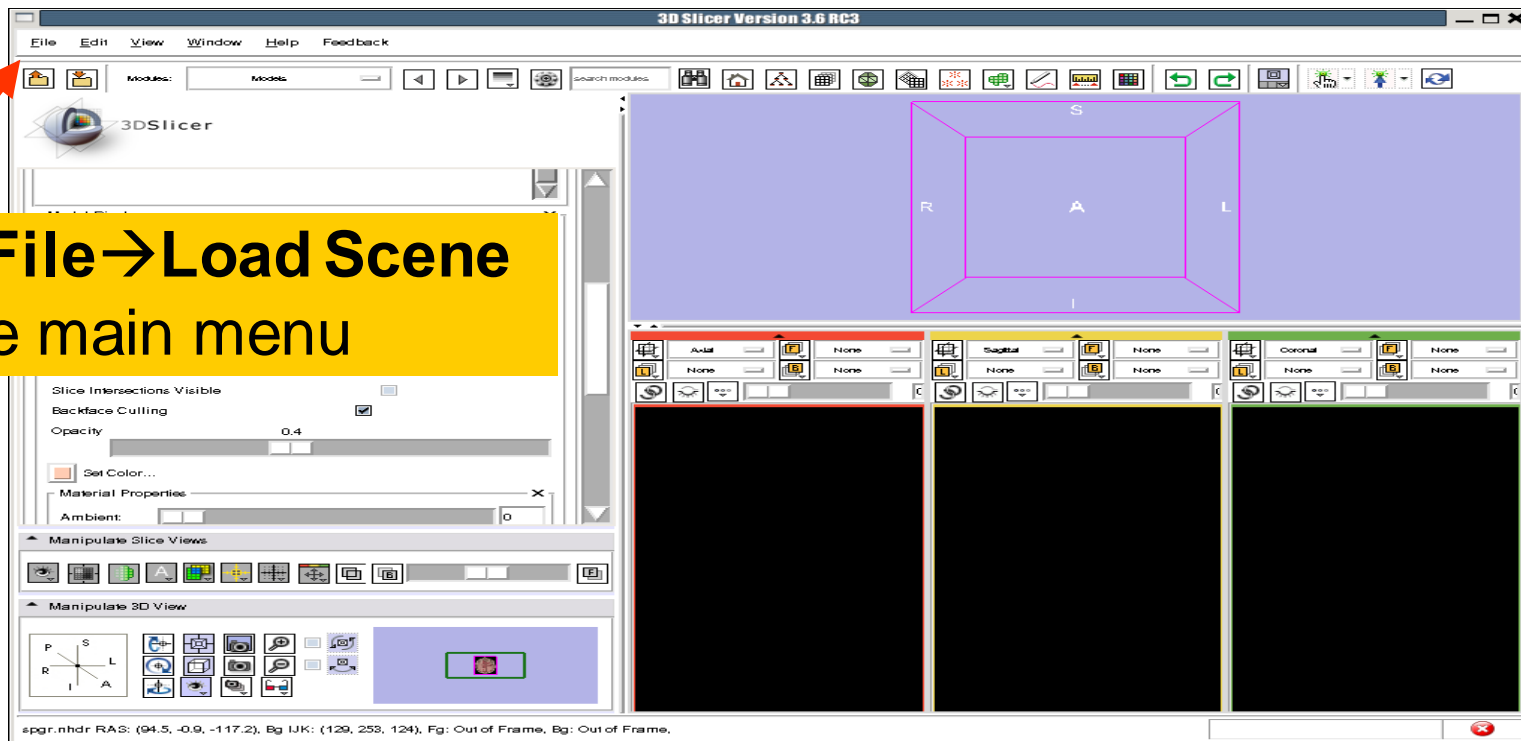
Select **File**→**Close Scene** in the main menu and click on **OK**



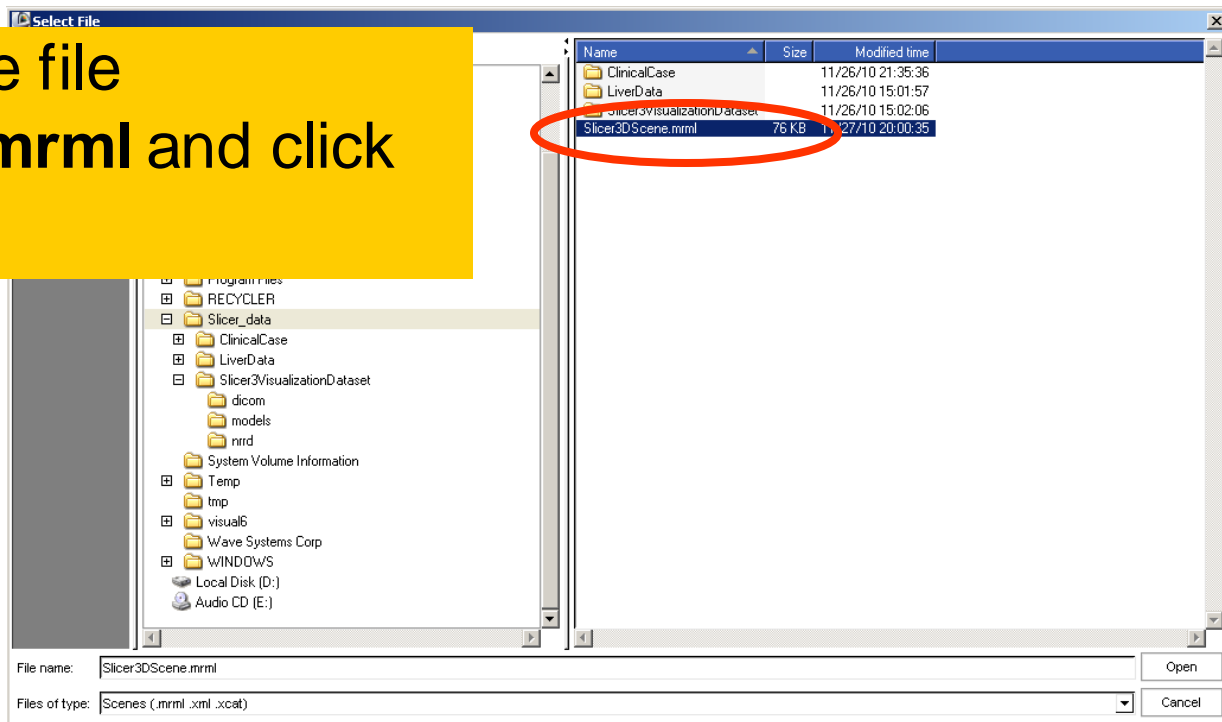
# *Saving Data*

The elements of the previous scene disappear from the Viewer.

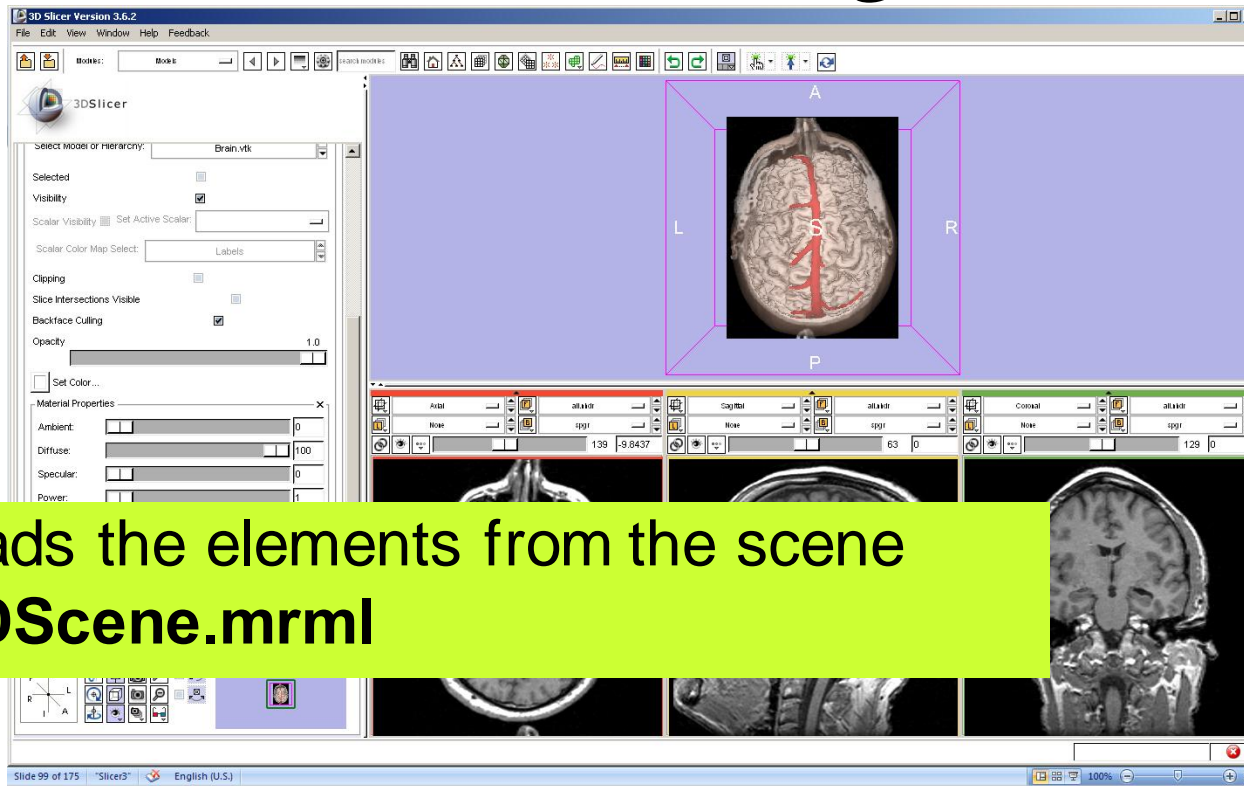




Browse to find the file  
**Slicer3DScene.mrml** and click  
on **Open**



# Loading a Scene

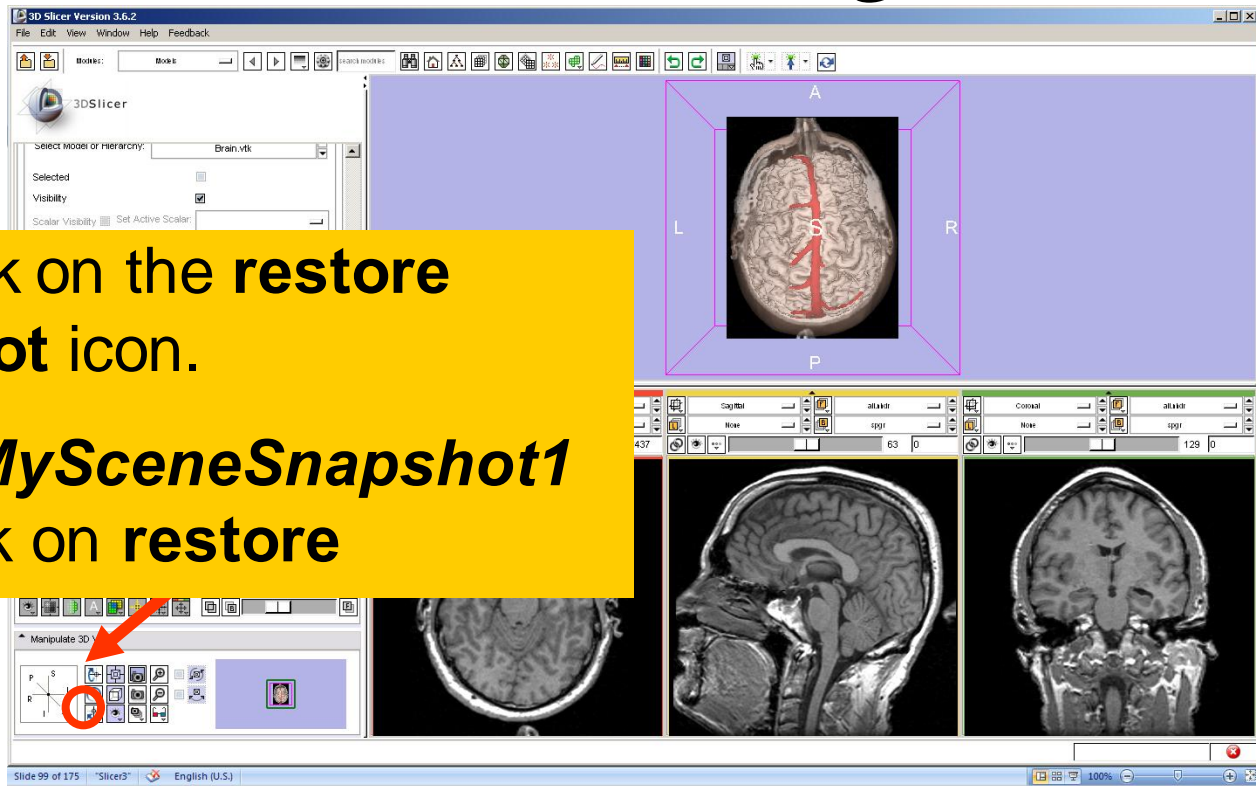


Slicer loads the elements from the scene  
**Slicer3DScene.mrml**

# Loading a Scene

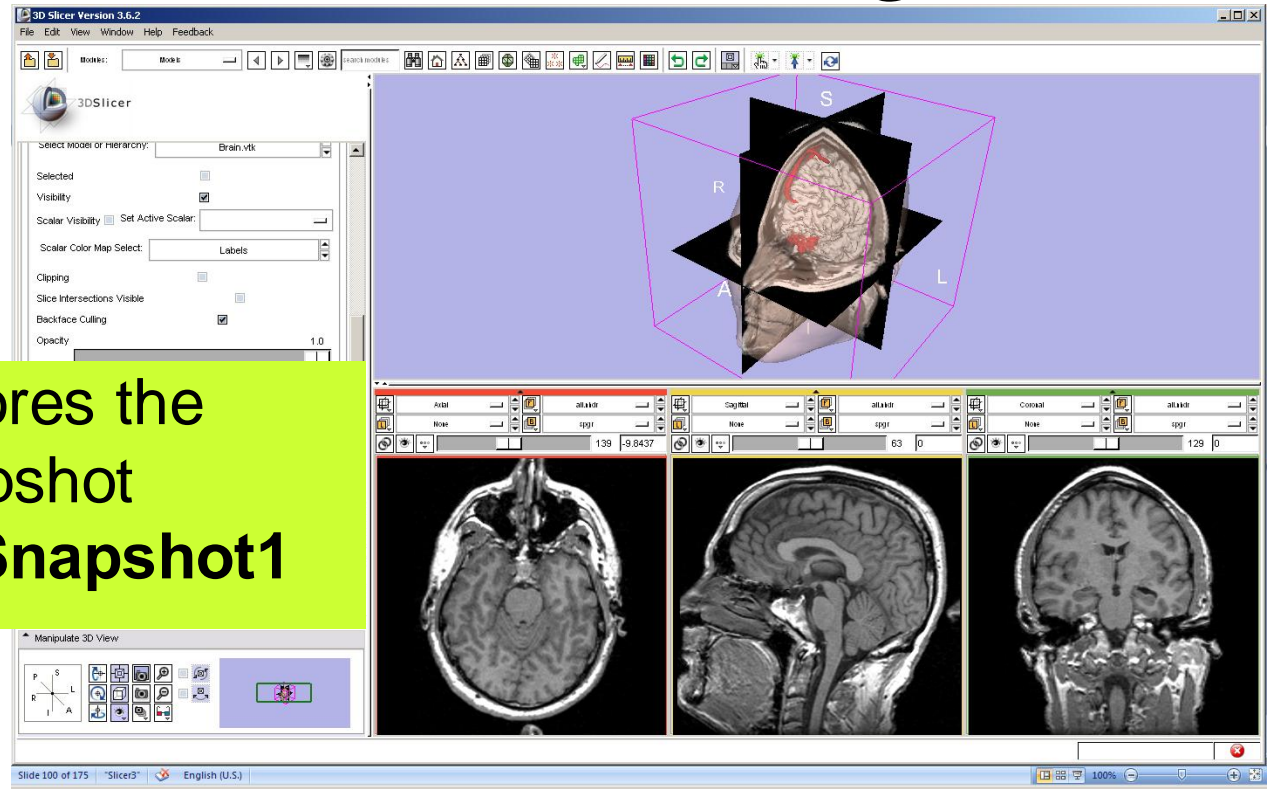
Left-click on the **restore** snapshot icon.

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

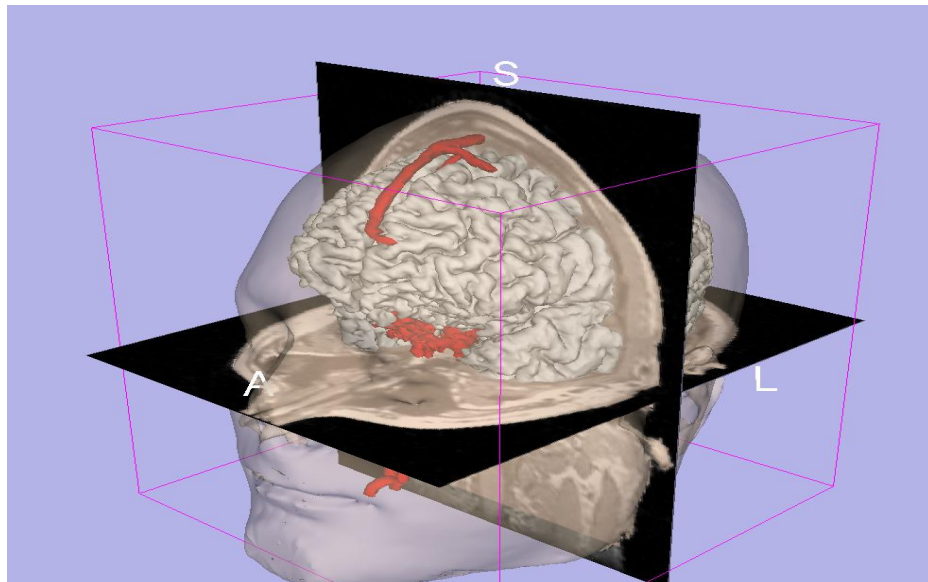


# Loading a Scene

Slicer restores the scene snapshot  
**MySceneSnapshot1**

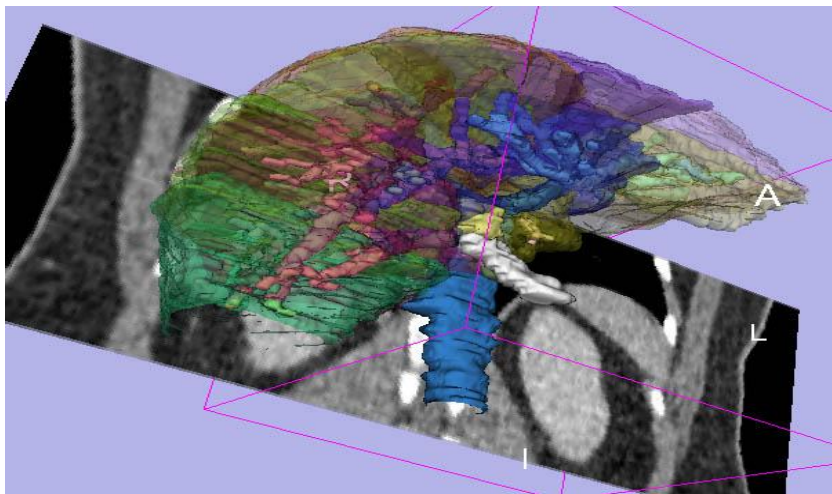


# Conclusion



- 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

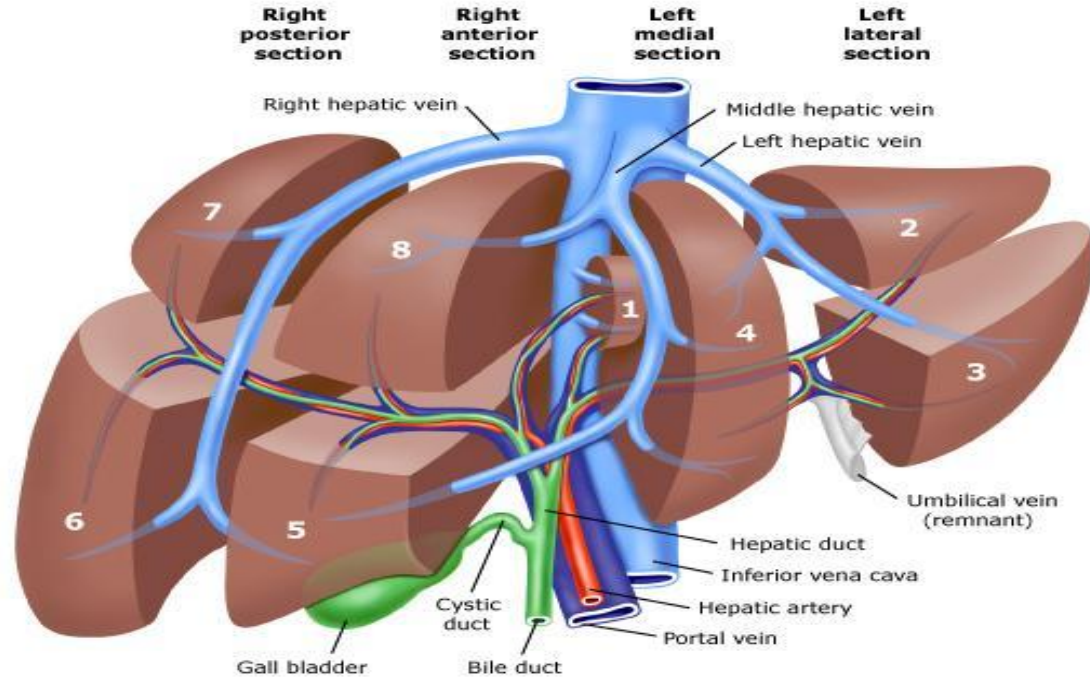
3D Slicer Course for Radiologists, November 29, 2010  
RSNA 2010

National Alliance for Medical Image Computing

<http://na-mic.org> © 2010, ARR

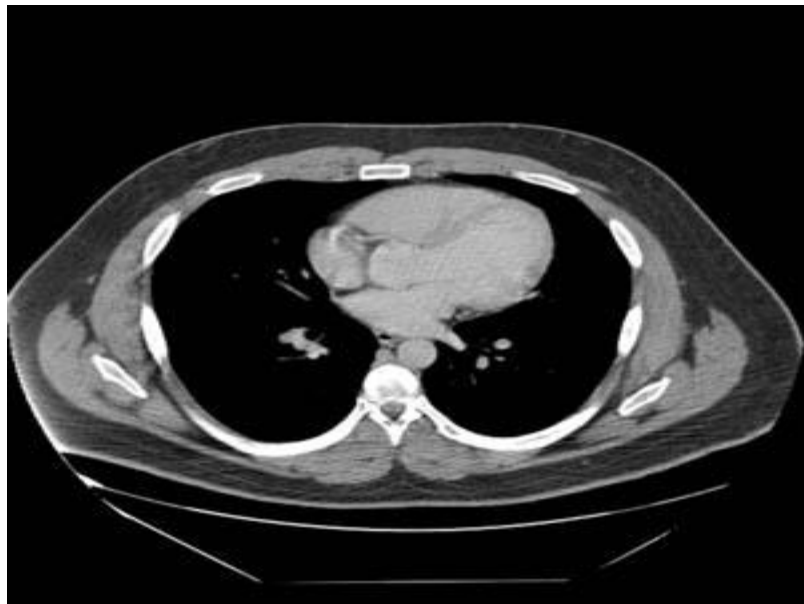


# *Anatomy of the liver*



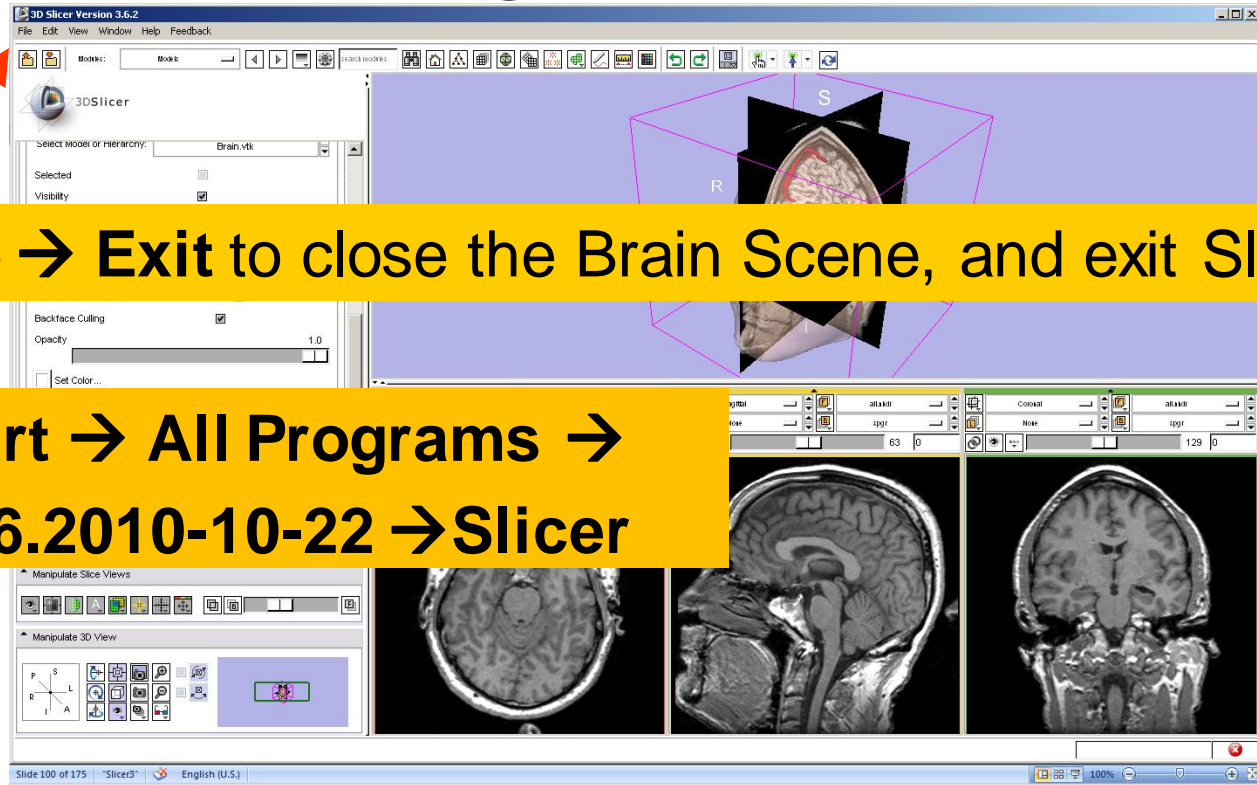
# *Dataset*

---



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

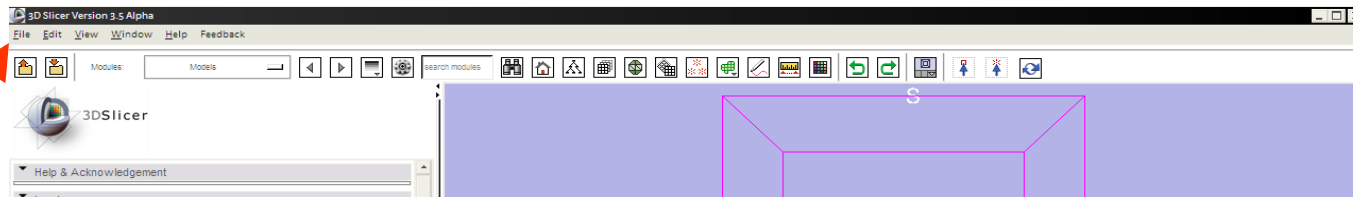
# *Loading the Liver Scene*



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

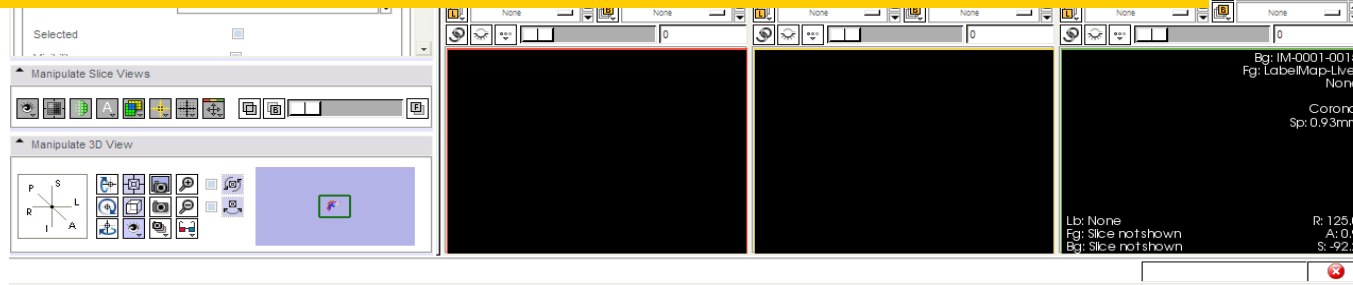
Select **Start** → **All Programs** →  
**Slicer3 3.6.2.010-10-22** → **Slicer**

# Loading the Liver Scene



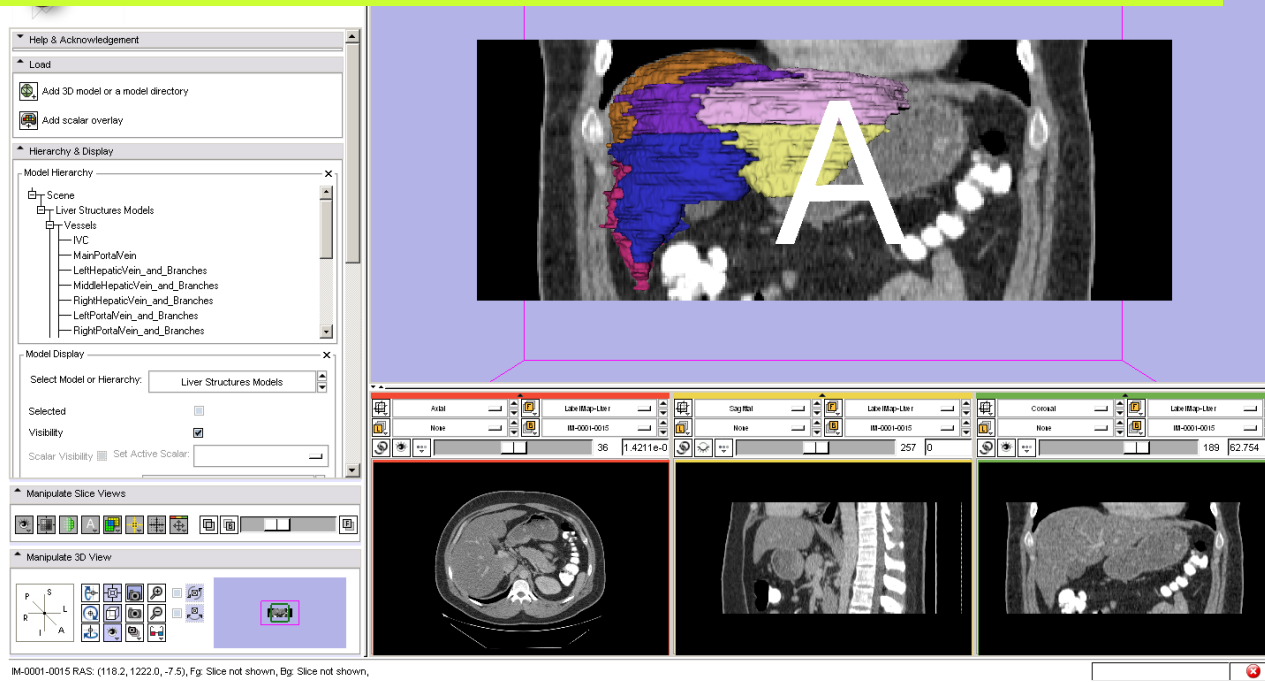
Select **File** → **Load Scene** from the main menu

Load the scene **Scene-Liver.mrml** located in the directory **C:/SlicerData\_RSNA2010/LiverData**

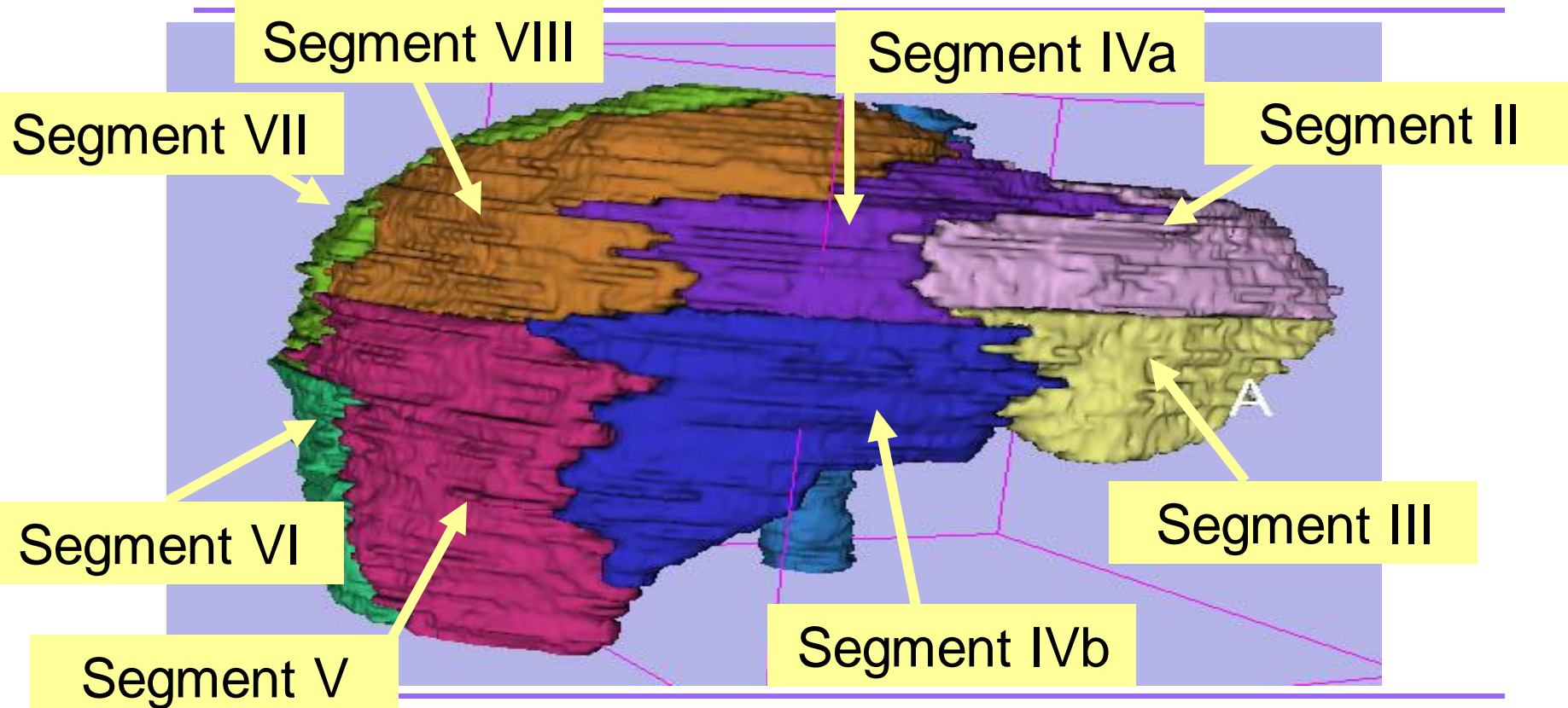


# Liver Segments Scene

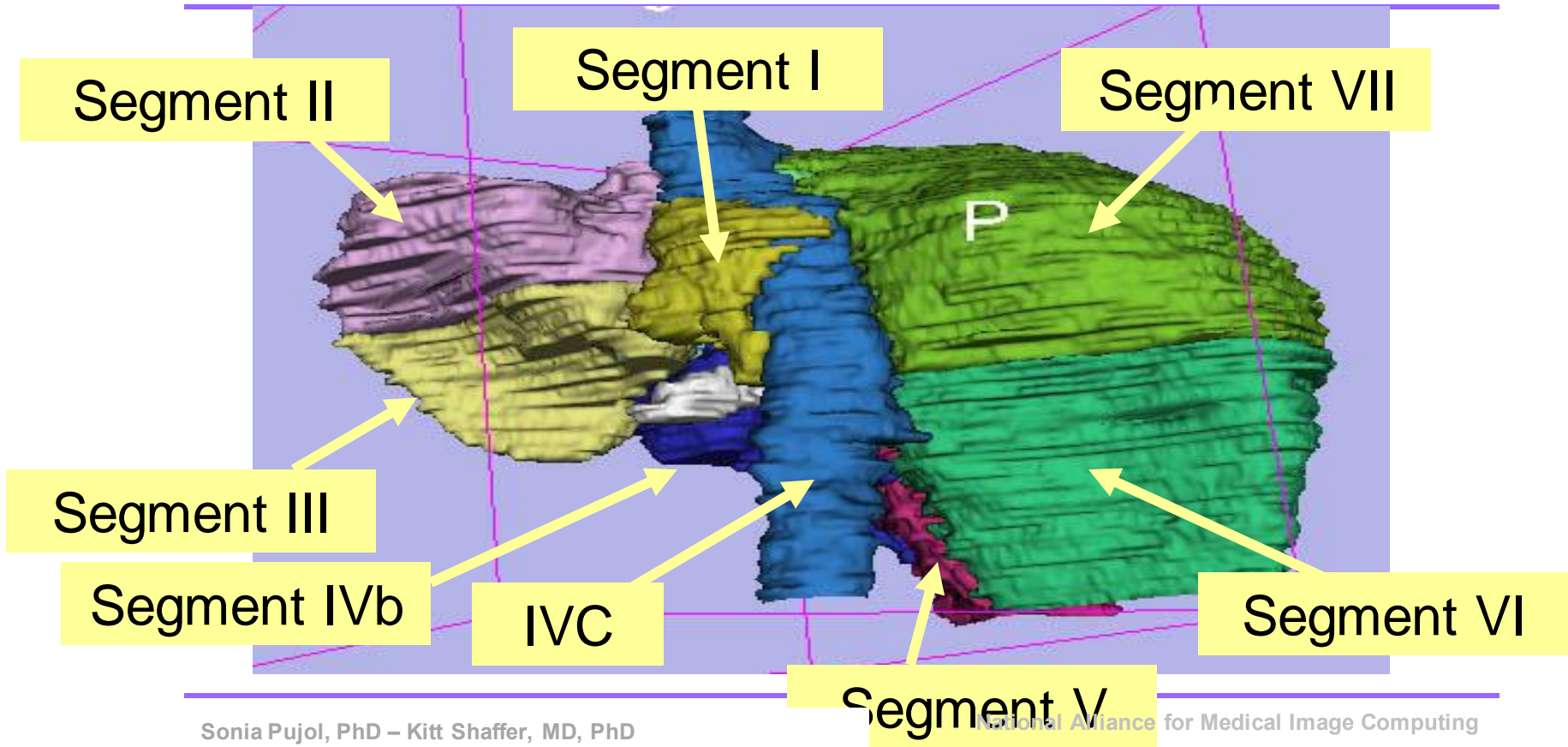
The elements of the scene appear in the Viewer



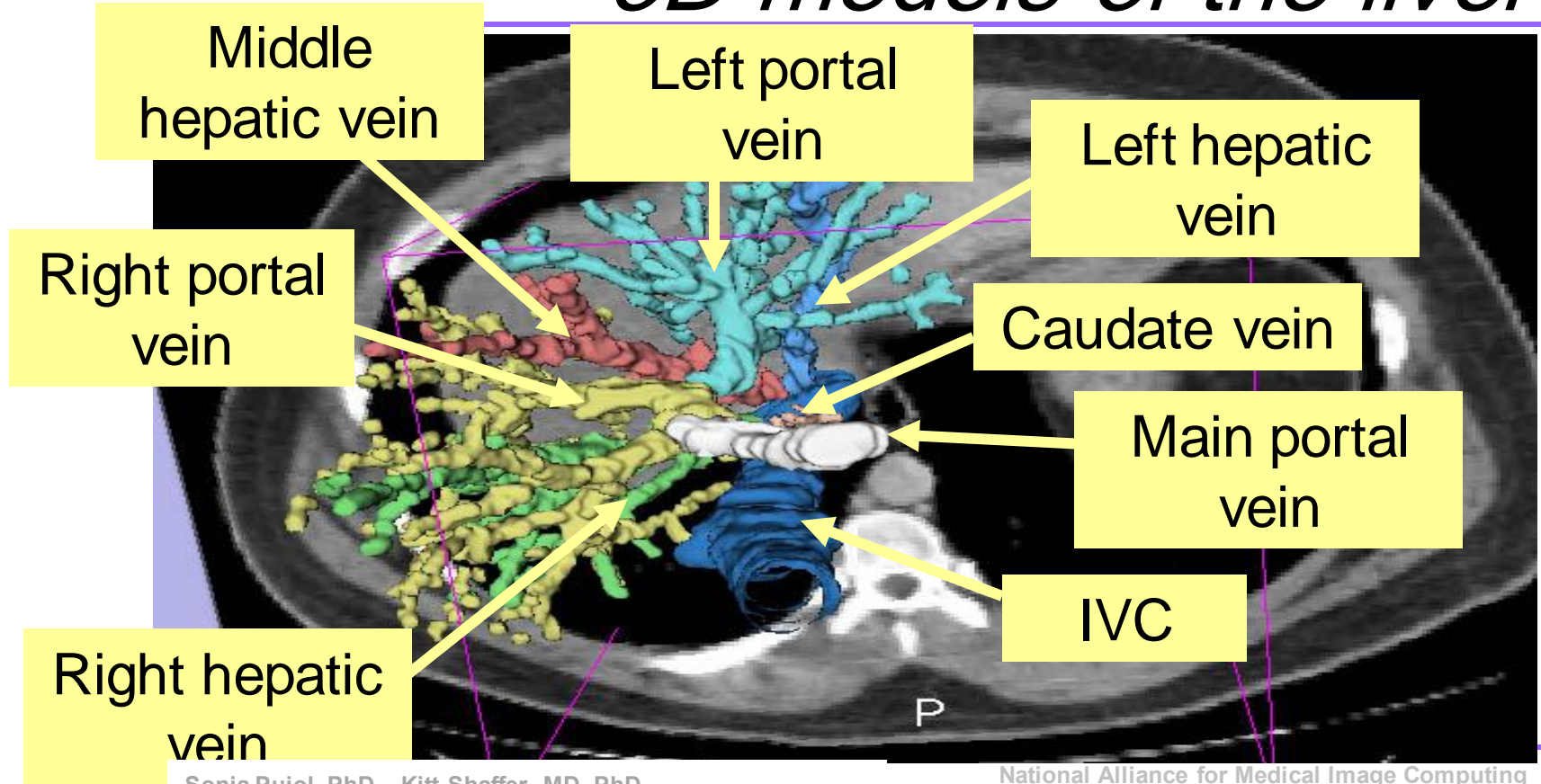
# *3D models of the liver*



# 3D models of the liver

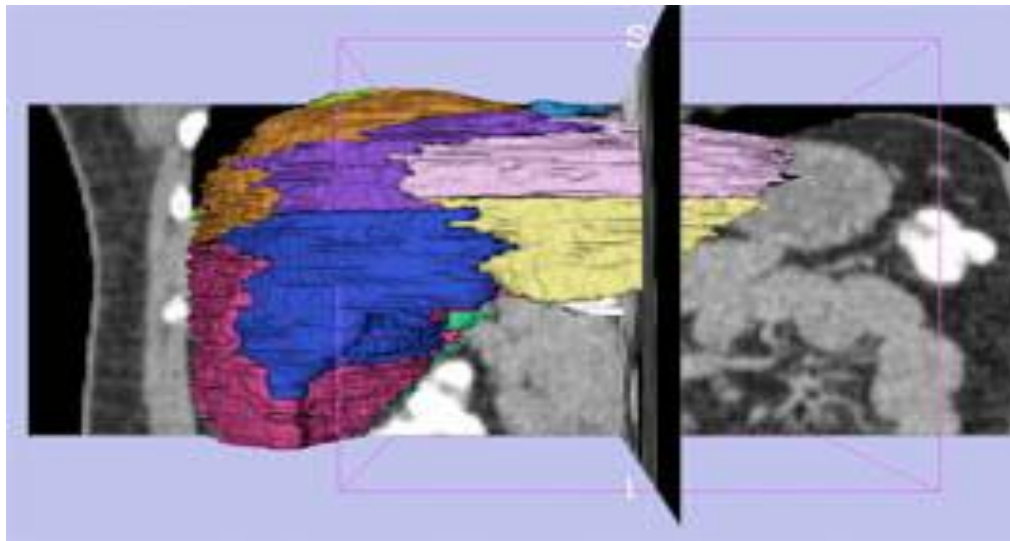


# 3D models of the liver





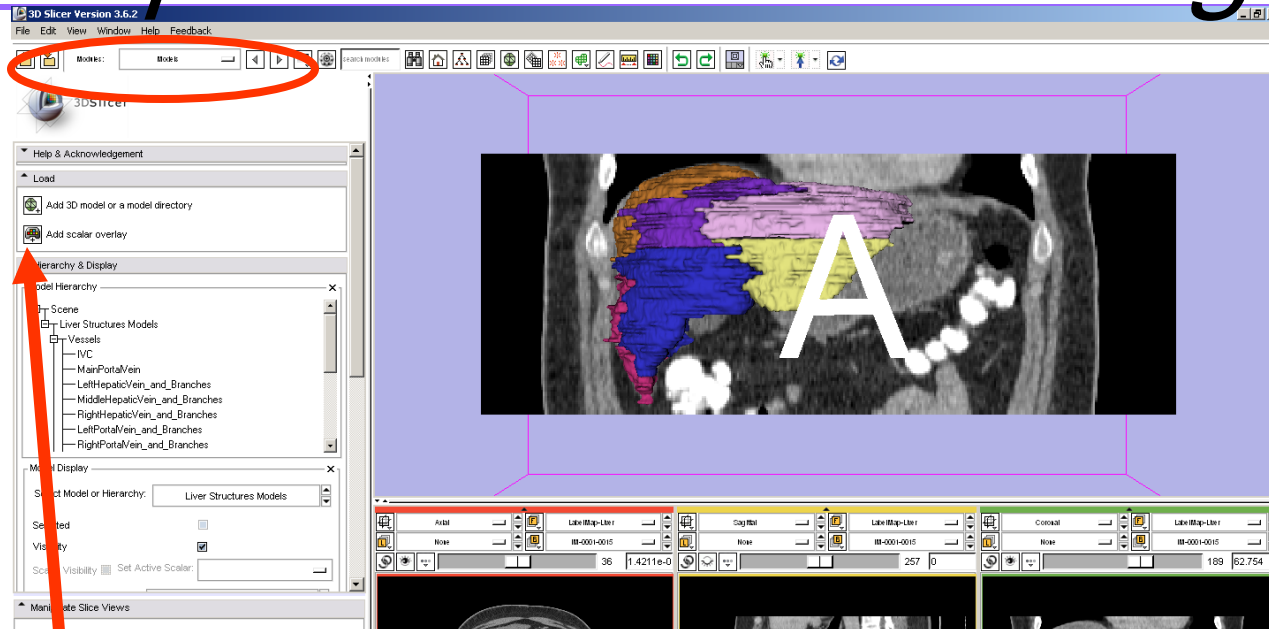
# 3D Exploration of Liver Segments



## **Example:**

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

# 3D Exploration of Liver Segments



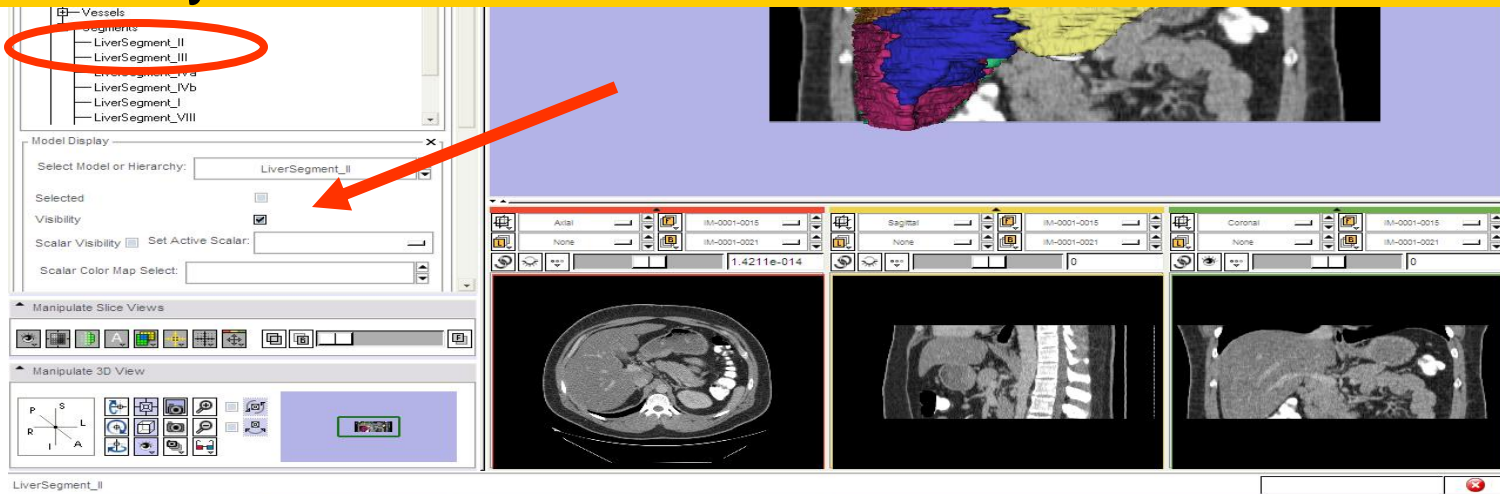
Select the module **Models**

Click on the panel **Hierarchy and Display**

# 3D Exploration of Liver Segments

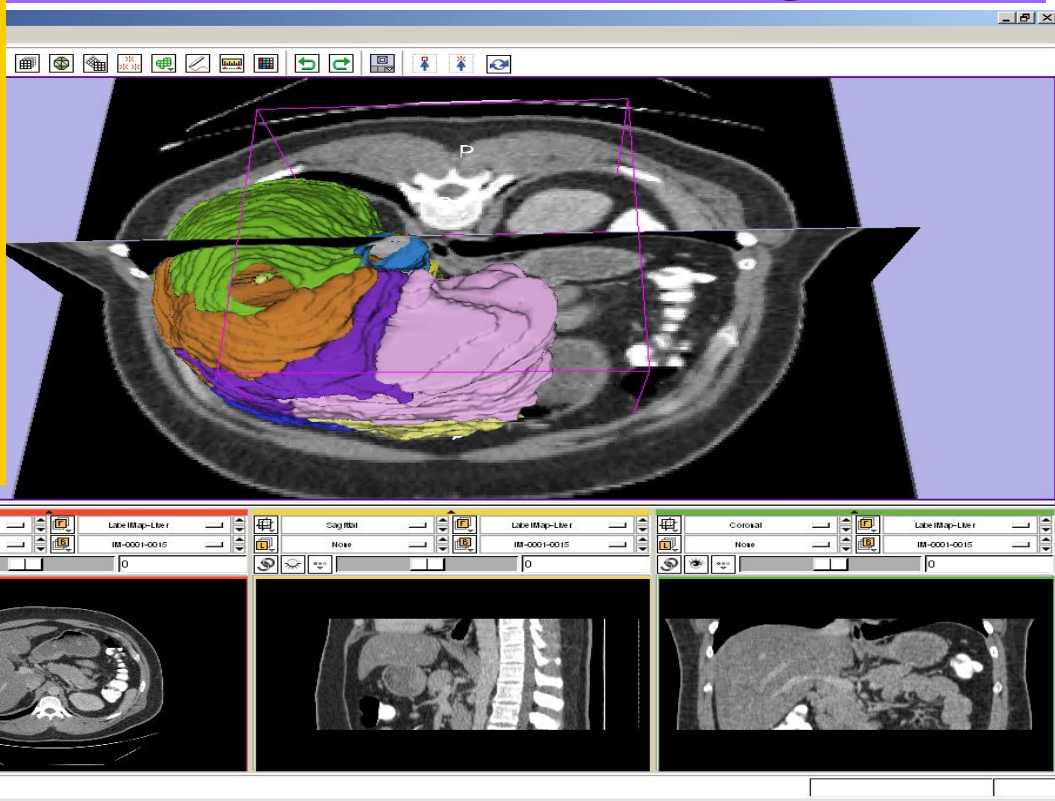
Select the model **Liver\_Segment II**

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?



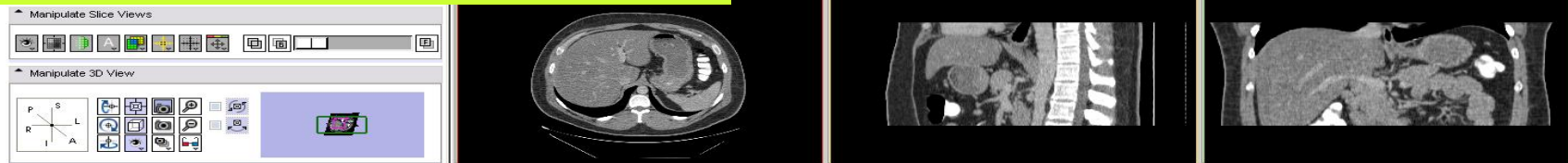
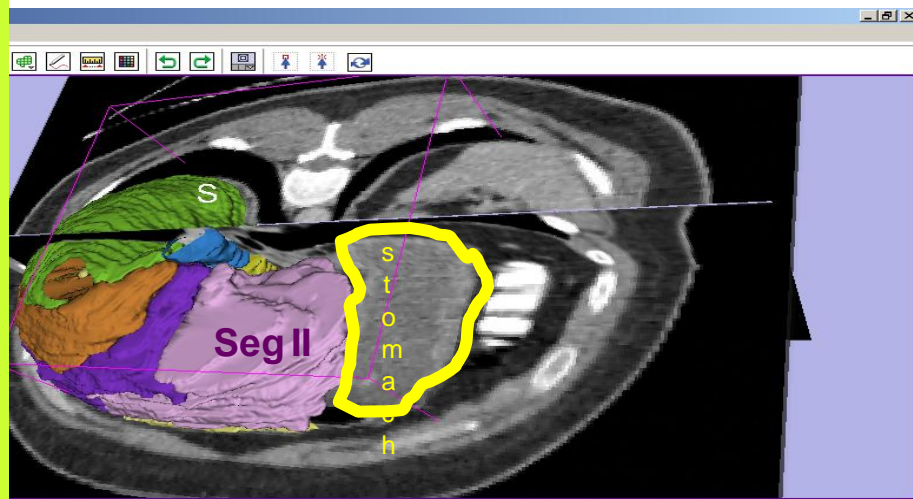
# 3D Exploration of Liver Segments

## Question 1:

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

## Answer 1:

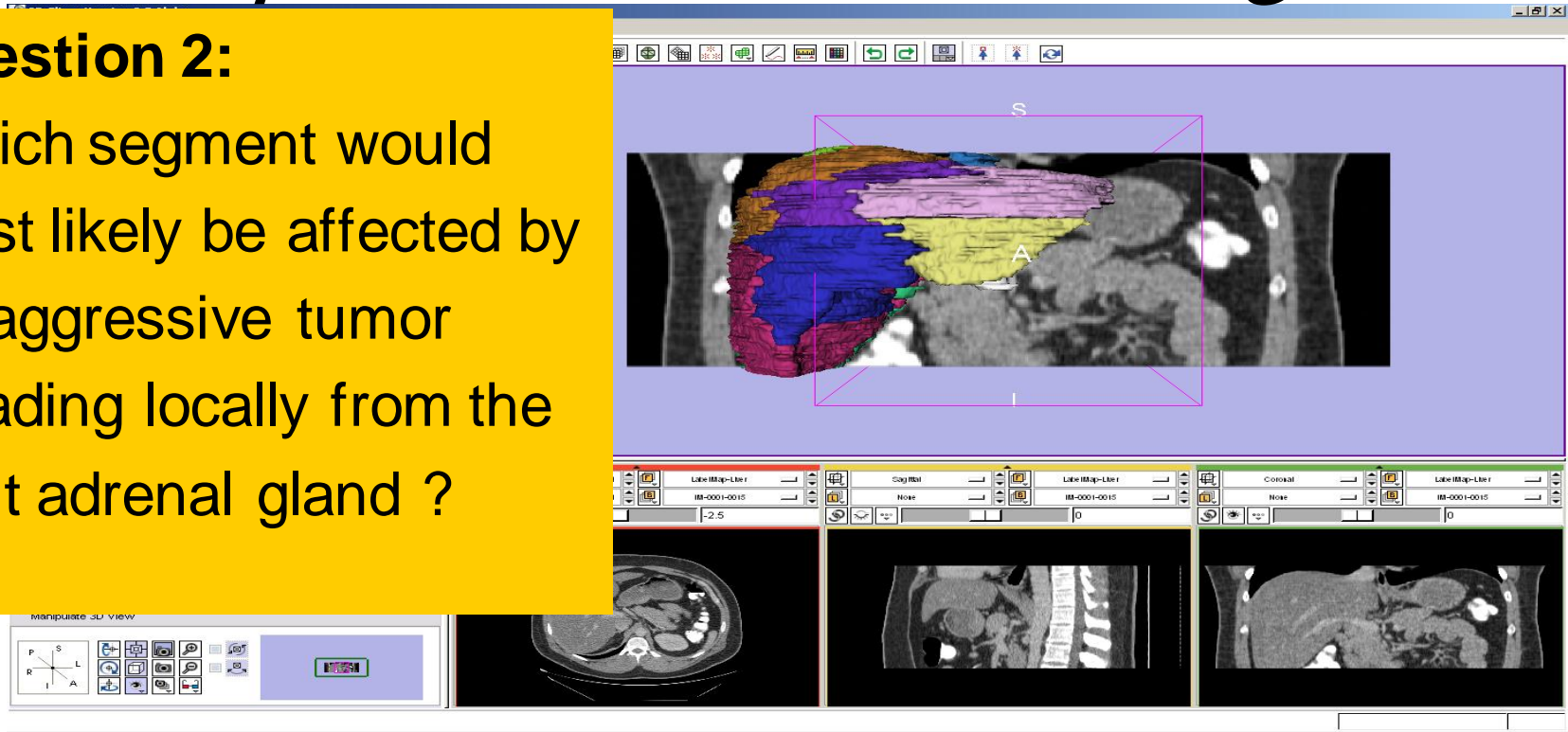
Stomach



# 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 ?



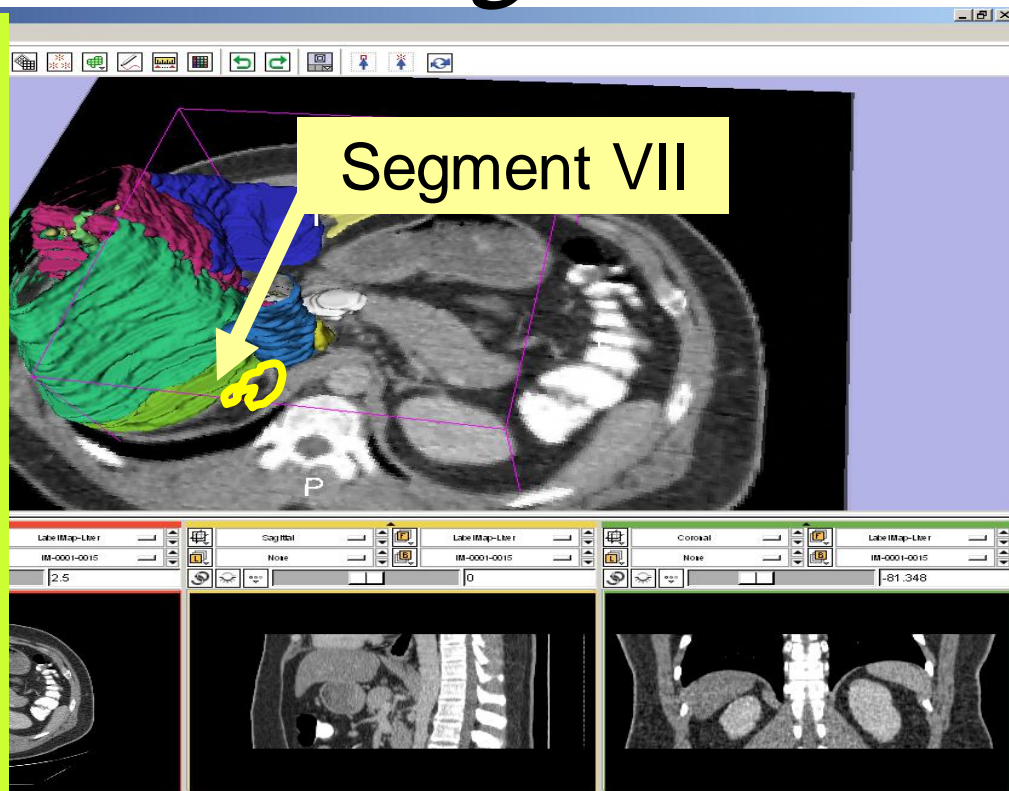
# Segment VII

## 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:

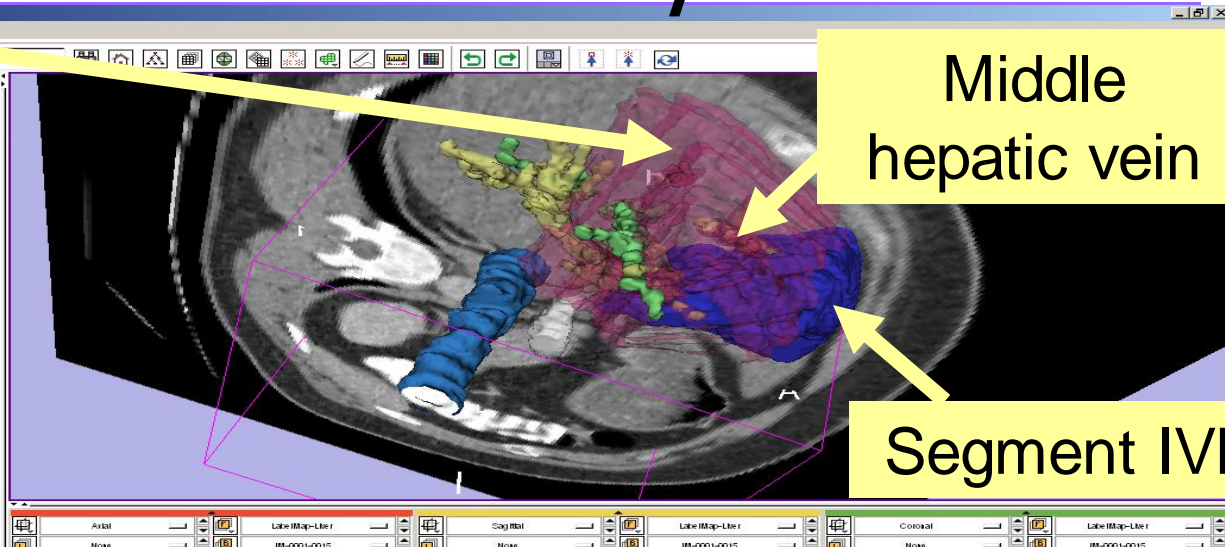
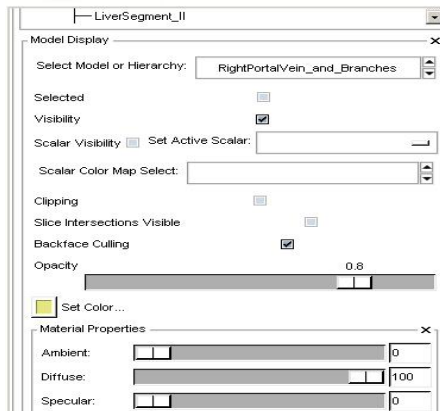
Which vessel separates Segment IVb and Segment V?

# Middle Hepatic Vein

Segment V

Middle hepatic vein

Segment IVb



**Question 3:**

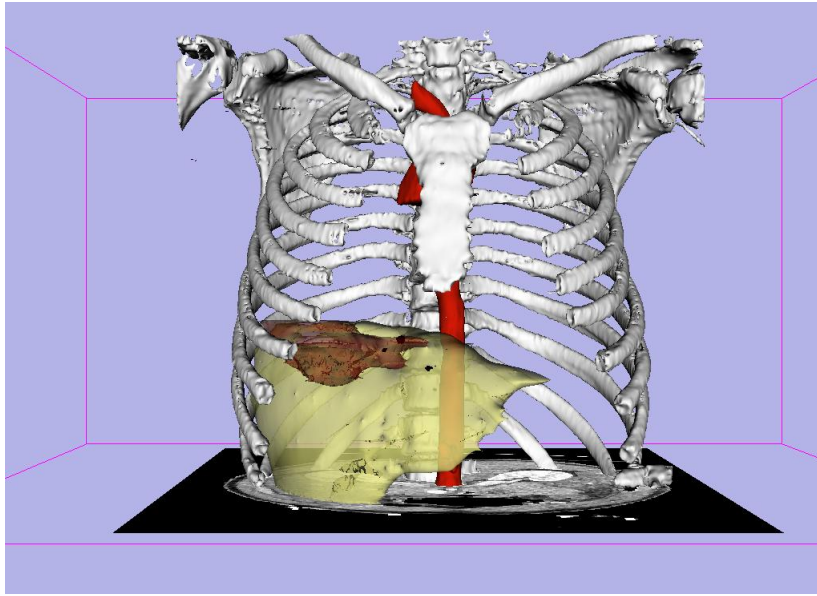
Which vessel separates Segment IVb and Segment V?

**Answer 3:**

The middle hepatic vein

# *Closing the Liver Scene*



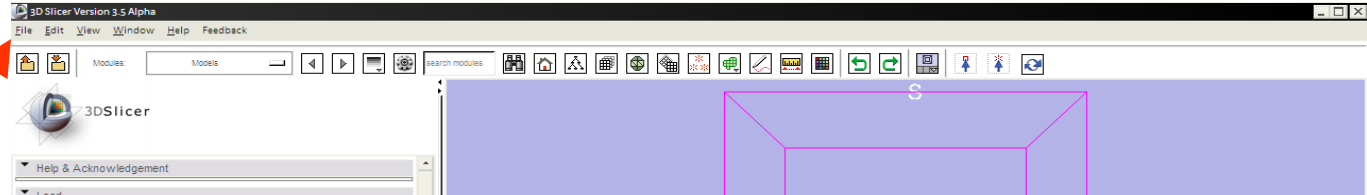


# Gunshot wound of the liver: A Clinical Case

Sonia Pujol, PhD - Kitt Shaffer, MD, PhD

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

# Loading the Clinical Case



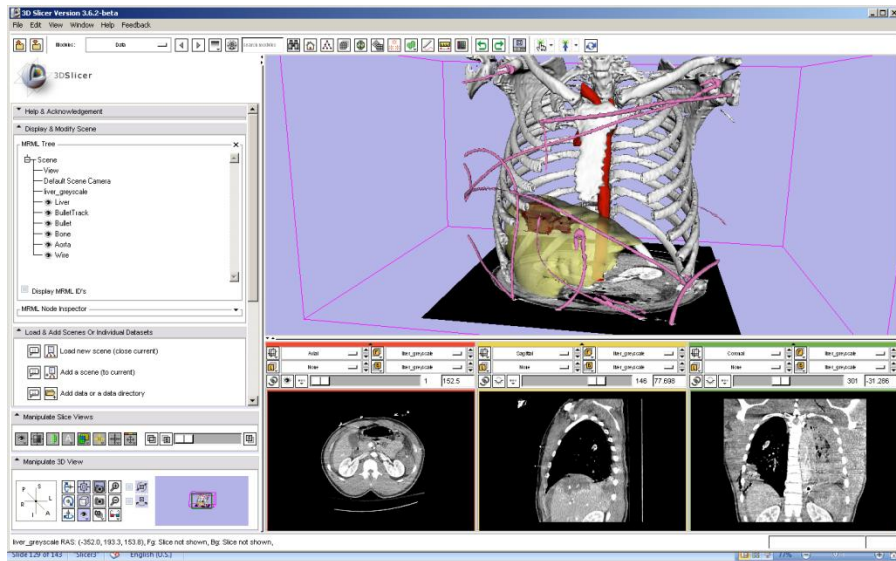
Select Start → All Programs → Slicer3.3.6-2010-22-10 → Slicer3

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

Load the scene **ClinicalCase.mrml** located in the directory  
**C:/SlicerData\_RSNA2010/ClinicalCase**

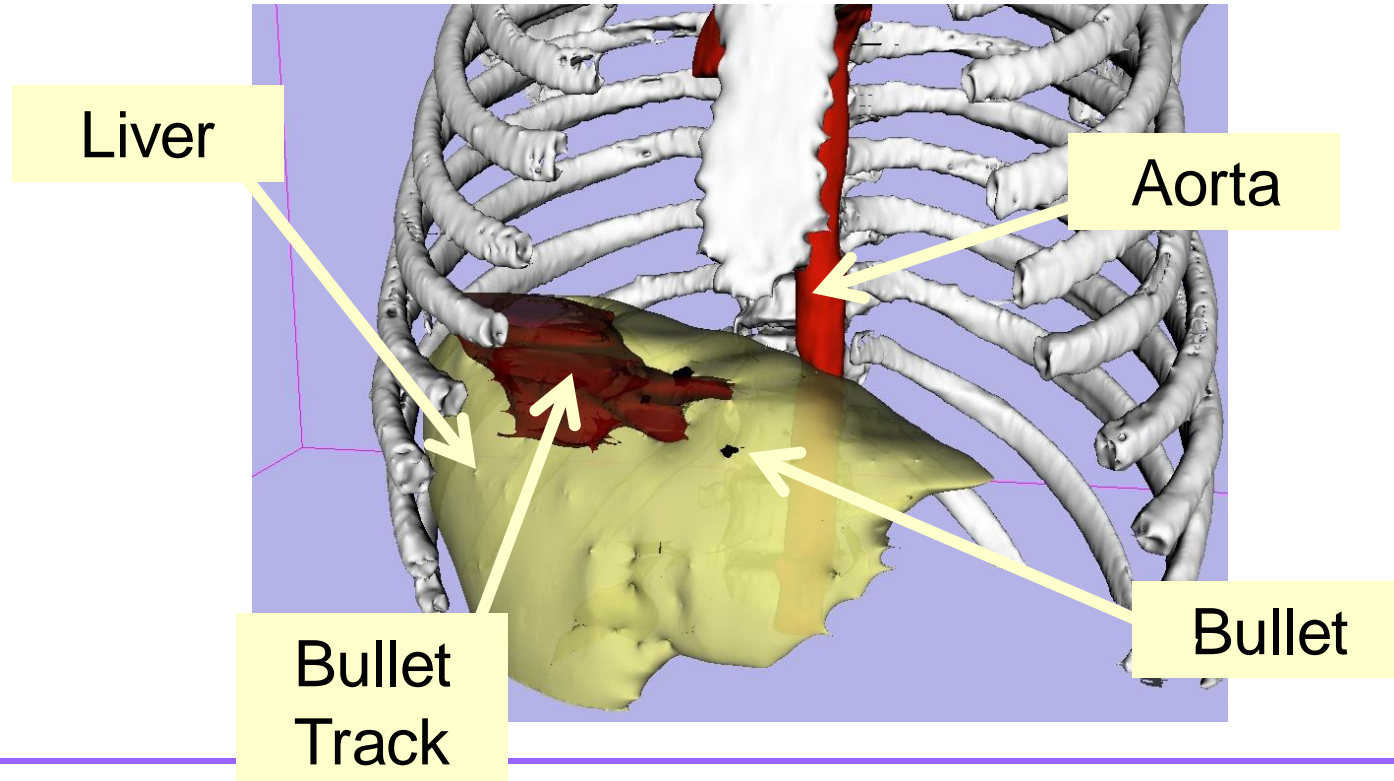


# *Loading the Clinical Case*



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

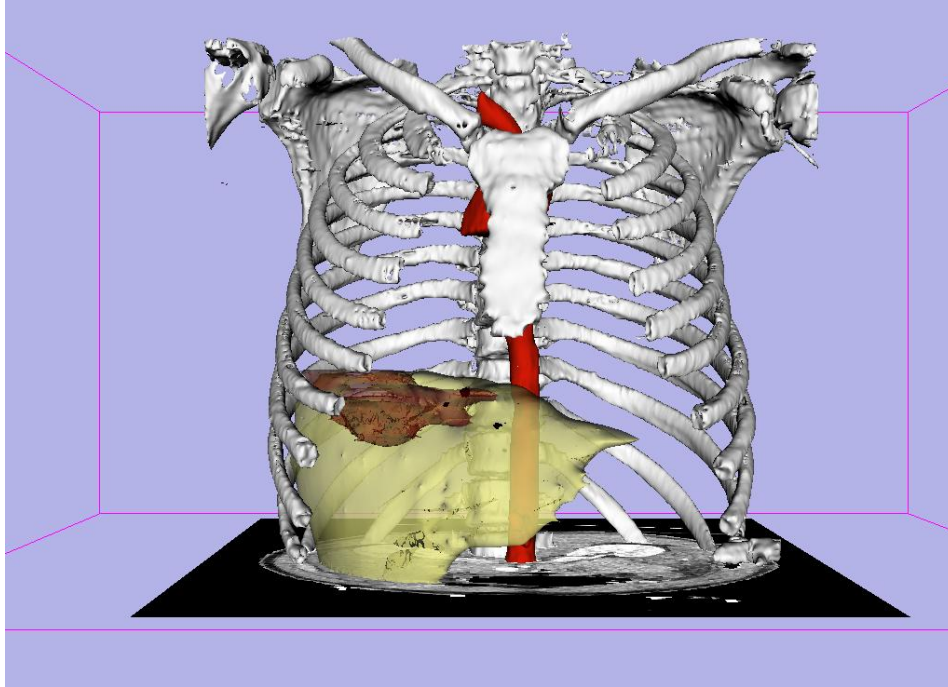
# *Clinical Case*



Sonia Pujol, Ph.D. – Kitt Shaffer, M.D., Ph.D.

National Alliance for Medical Image Computing

# *Clinical Case*

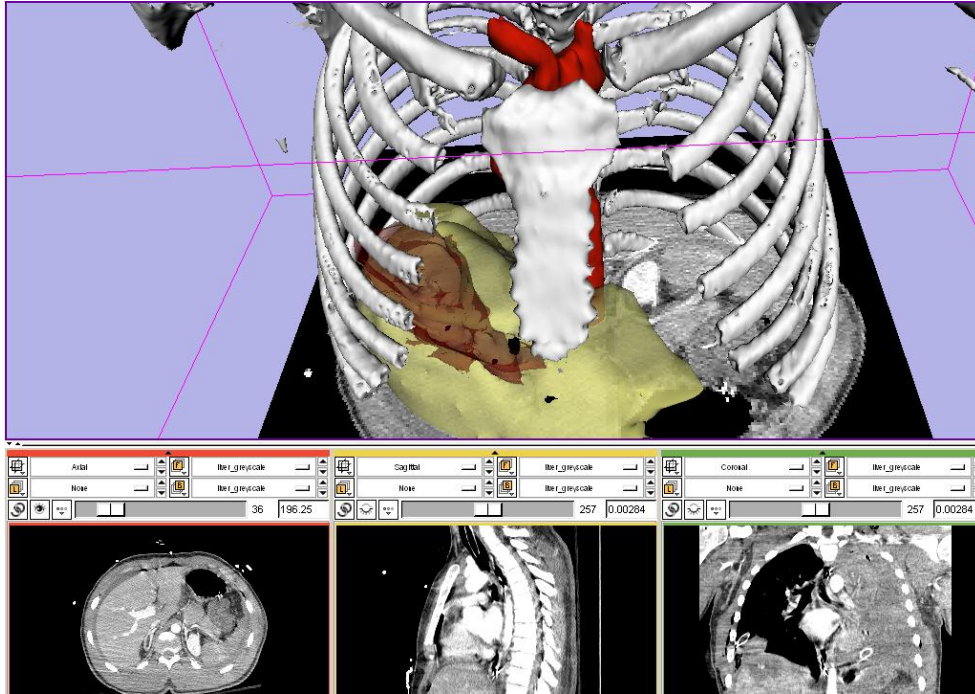


## **Question 1:**

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



# *Clinical Case*

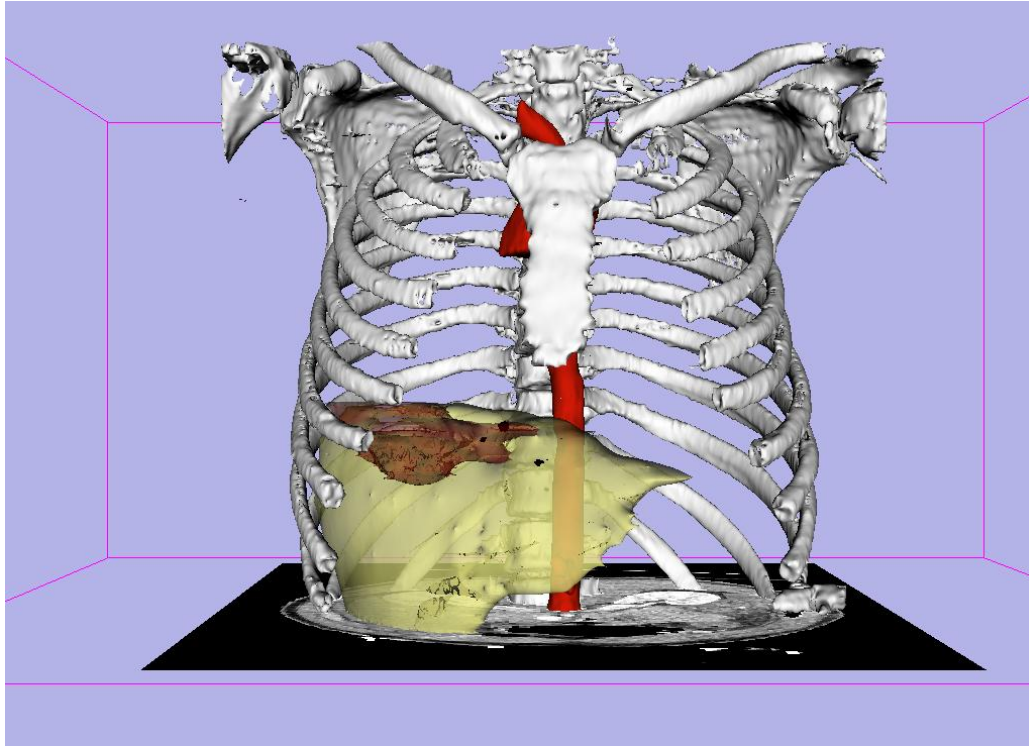


## **Question 1:**

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

**Answer 1:** The bullet likely entered anteriorly.

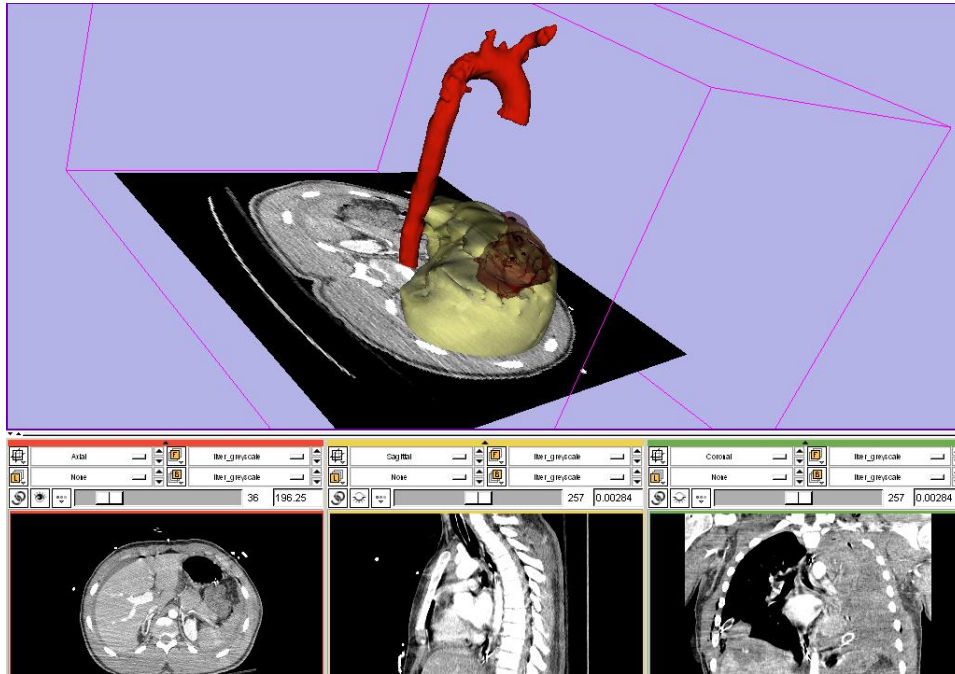
# *Clinical Case*



## **Question 2:**

Did the bullet pass near the aorta ?

# Clinical Case

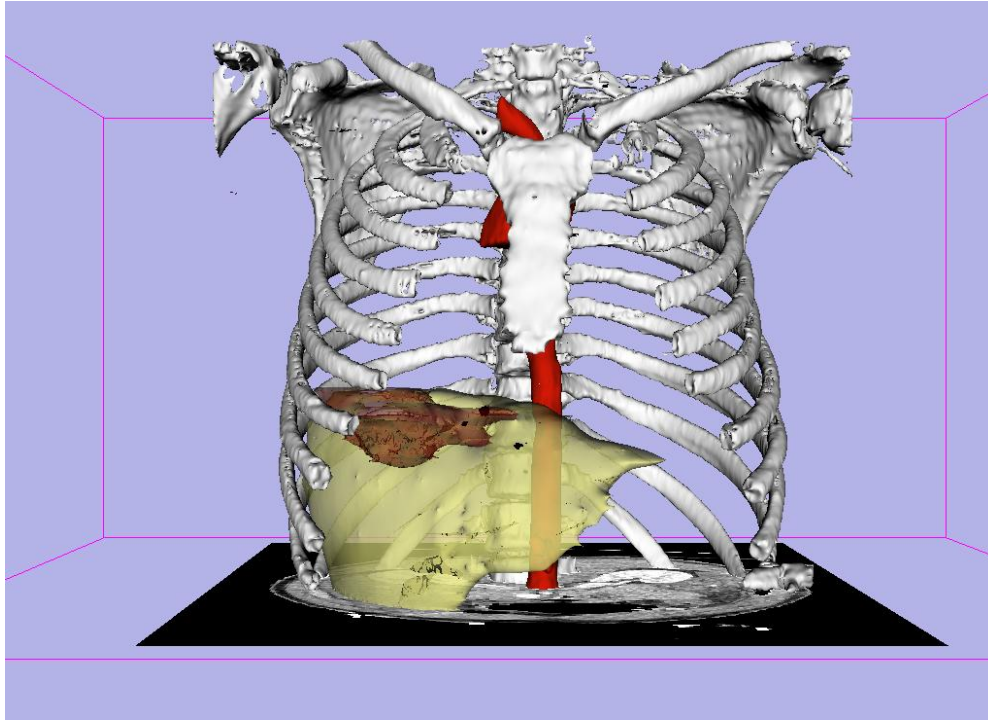


## Question 2:

Did the bullet pass near the aorta ?

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

# *Clinical Case*

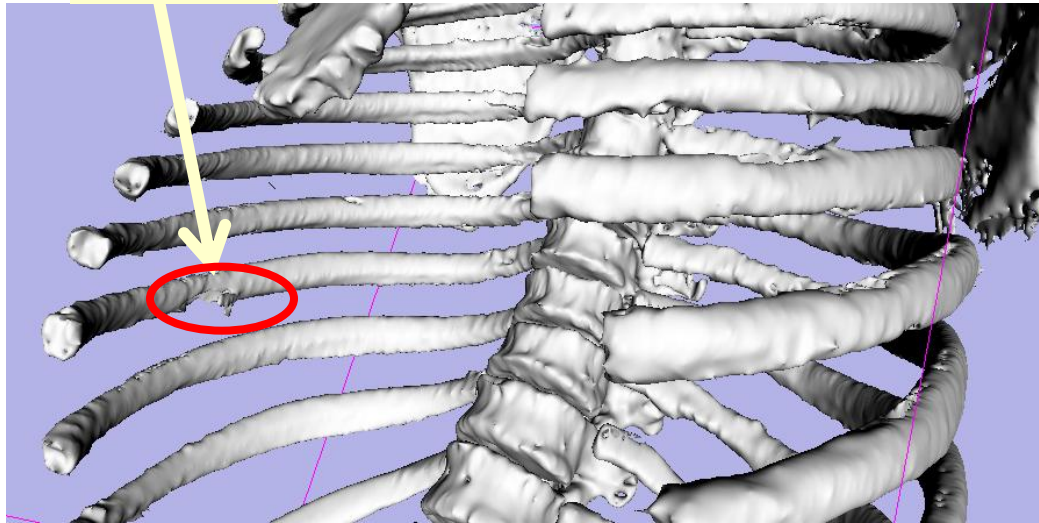


## **Question 3:**

Which rib was damaged by the bullet?

# Clinical Case

8<sup>th</sup> rib



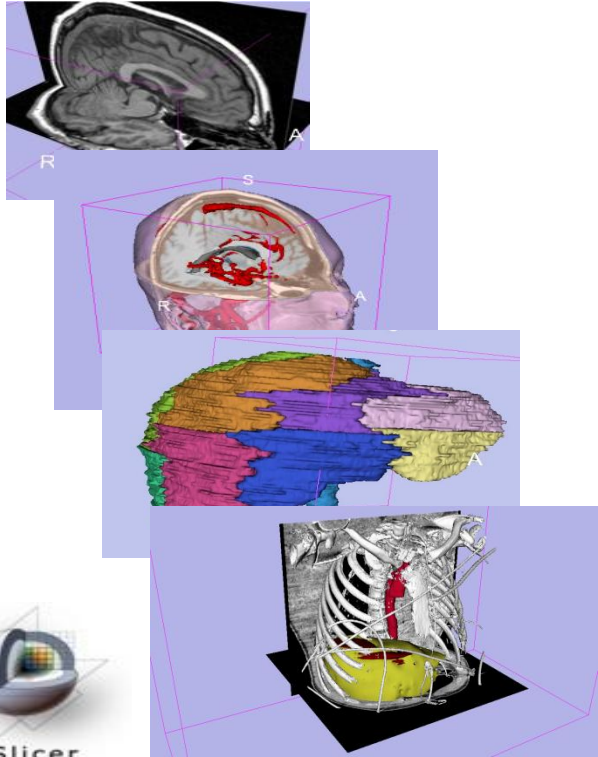
**Question 3:**

Which rib was damaged by the bullet?

**Answer 3:**

The bullet damaged the 8<sup>th</sup> 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*

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**National Alliance for Medical Image Computing**

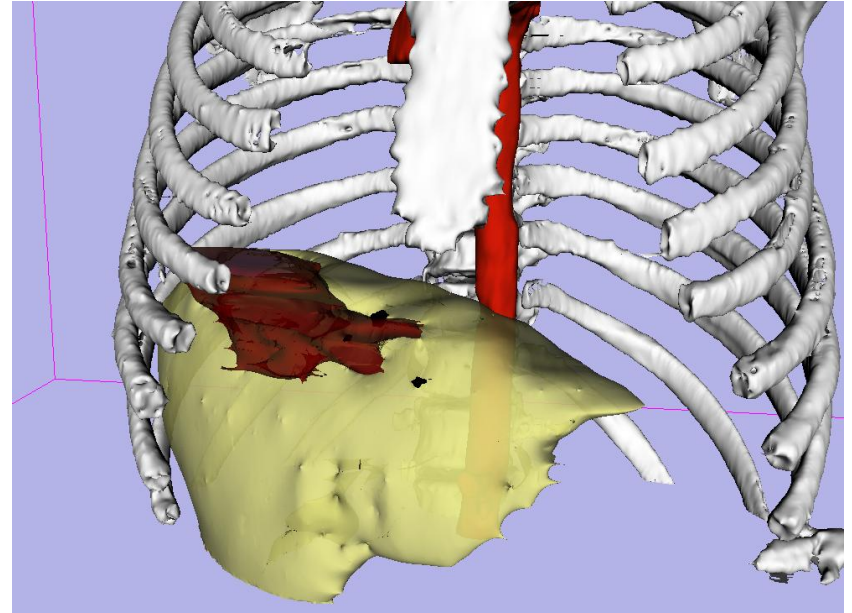
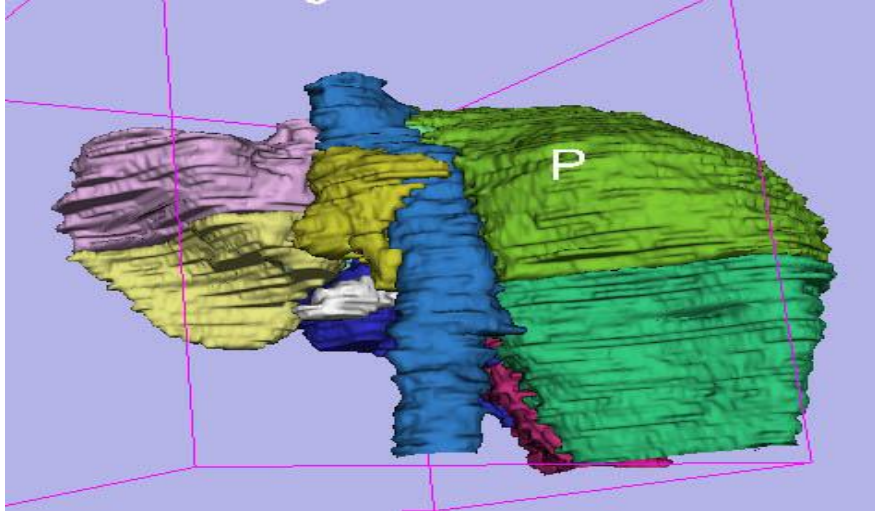
NIH U54EB005149



**Neuroimage Analysis Center**

NIH P41RR013218

# Questions



[spujol@bwh.harvard.edu](mailto:spujol@bwh.harvard.edu)

[slicer-users@bwh.harvard.edu](mailto:slicer-users@bwh.harvard.edu)



# *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