



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

a teaching affiliate of  
Harvard Medical School

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# **3D VISUALIZATION OF DICOM IMAGES FOR RADIOLOGICAL APPLICATIONS**

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Vice-Chairman for Education, Boston University School of Medicine

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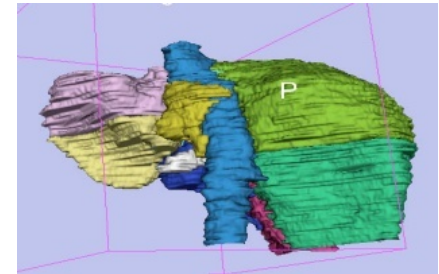
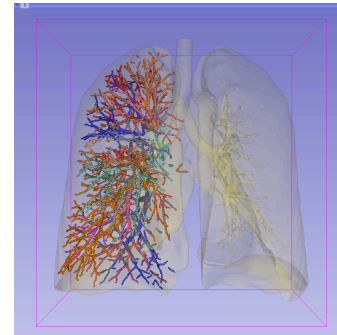
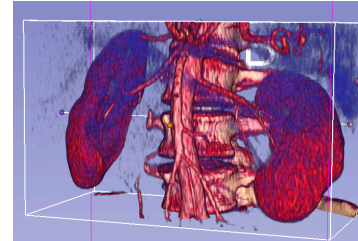
Surgical Planning Laboratory, Brigham and Women's Hospital



# 3D Visualization of DICOM images for Radiological applications

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Following this tutorial, you will be able to **load and visualize DICOM volumes** with 3D Slicer, and to **interact in 3D with structural images and models of the anatomy.**





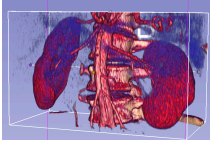


# Overview

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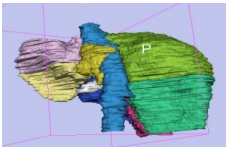
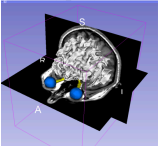


**Part I:** Introduction to the 3DSlicer software



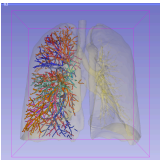
**Part II:** 3D Data Loading and visualization of DICOM images

- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data



**Part III:** 3D interactive exploration of the anatomy

- Exploration of the Segments of the liver
- Exploration of the Segments of the lung



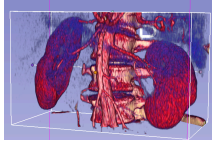


# Overview

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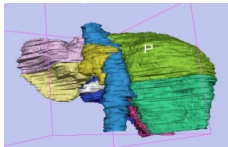
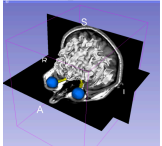


## Part I: Introduction to the 3DSlicer software



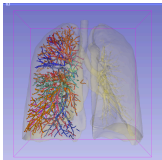
## Part II: 3D Data Loading and visualization of DICOM images

- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data



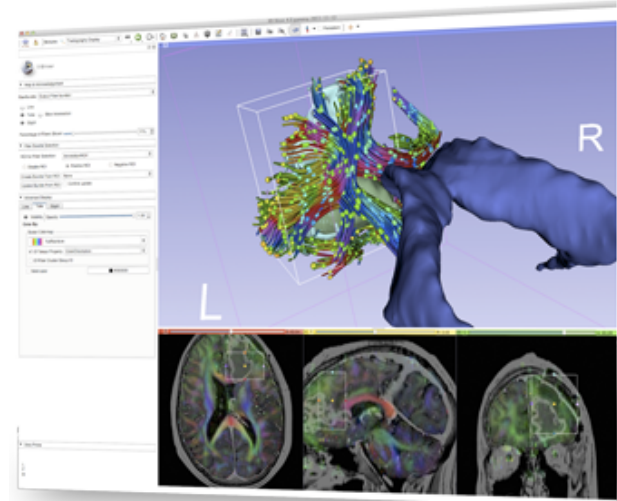
## Part III: 3D interactive exploration of the anatomy

- Exploration of the Segments of the liver
- Exploration of the Segments of the lung



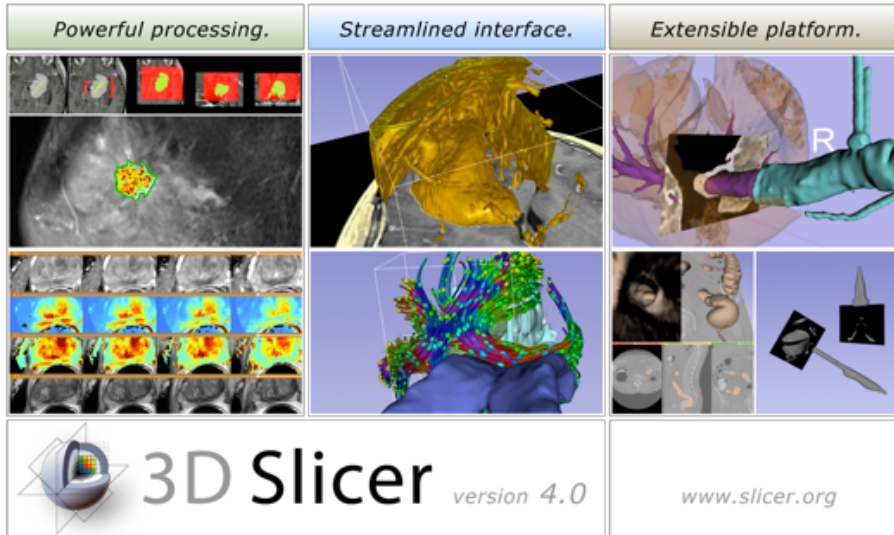


# ***Introduction to the 3DSlicer software***





# 3DSlicer

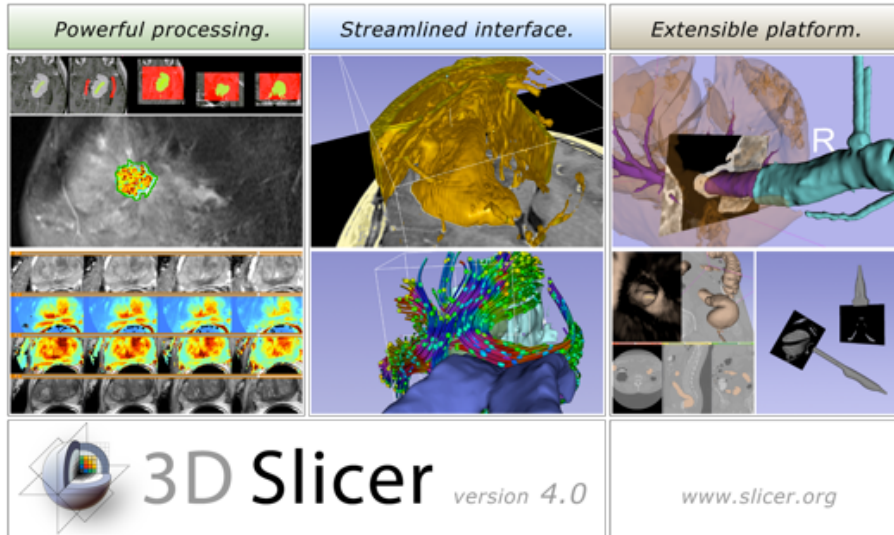


3DSlicer is a freely available **open-source** platform for segmentation, registration and 3D visualization of medical imaging data.

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



# 3DSlicer



- 3DSlicer version 4.3 is a **multi-platform software** running on Windows, Linux, and Mac OSX
- Slicer is distributed under a **BSD license** with no restriction on use
- Slicer is a tool for research, and is **not FDA** approved

## Disclaimer

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

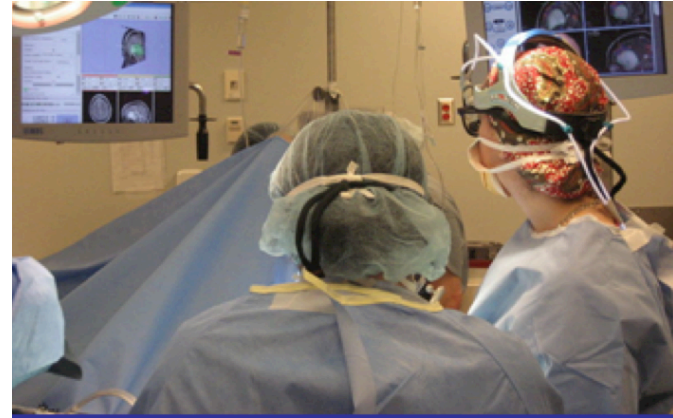


# An interdisciplinary platform

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



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

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



# 3DSlicer History

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

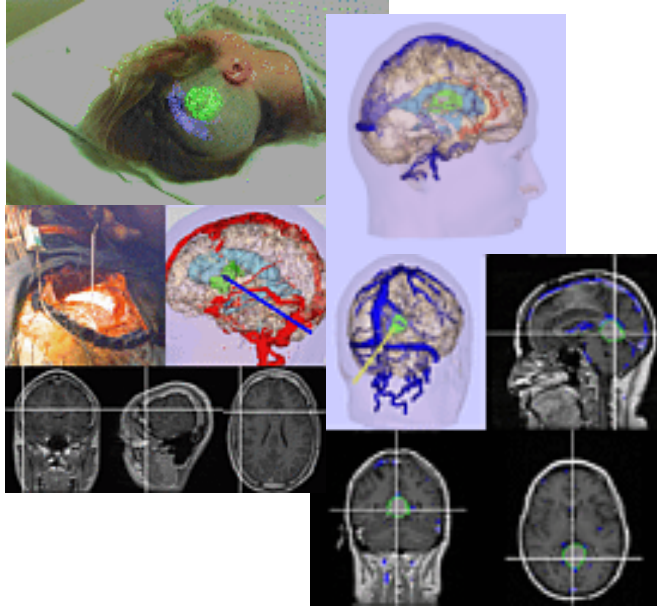
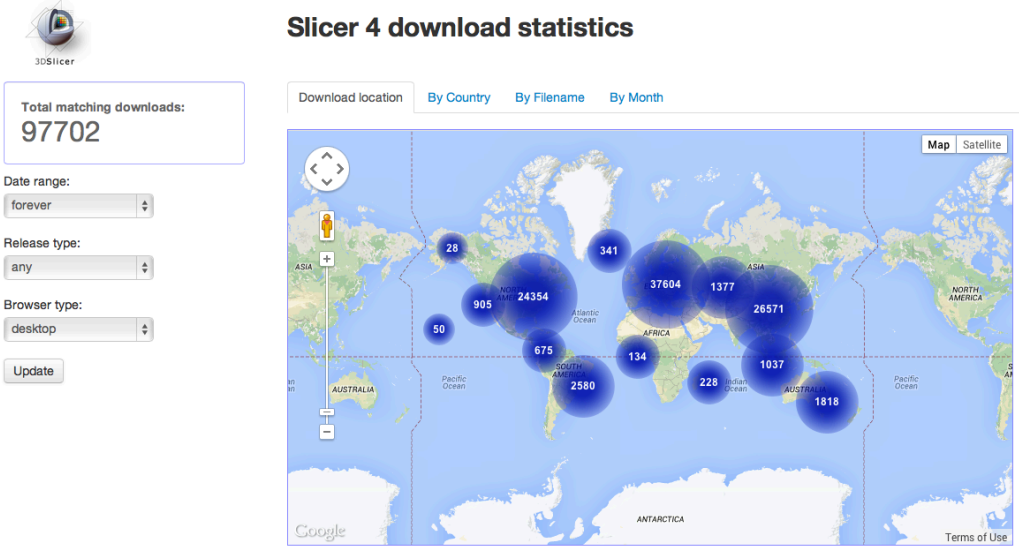


Image Courtesy of the CSAIL, MIT





# 3DSlicer History




- 1997: Slicer started as a research project between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)
- 2013: Multi-institution effort to share the latest advances in image analysis with the clinical and scientific community





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



## National Alliance for Medical Image Computing

A National Center for Biomedical Computing  
Funded under the NIH Roadmap Initiative

Google Custom Search  **Search**

### NA-MIC Wiki

**General**

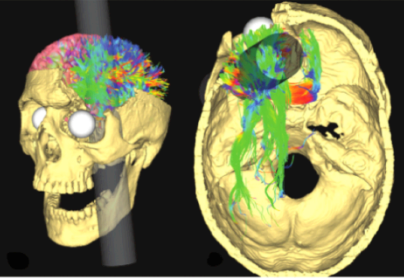
- Overview
- Organization
- Contact Us

**Center Components**

- Algorithms
- Engineering
- Driving Biological Projects
- Collaboration Grants

**Resources**

- Publication DB
- Image Gallery
- Downloads
- Service
- Training
- Dissemination
- Events
- Links



Modeling the path of the tamping iron through the Gage skull and its effects on white matter structure [Read more...](#)


1 of 24 Photos

**The National Alliance for Medical Image Computing (NA-MIC)** is a multi-institutional, interdisciplinary team of computer scientists, software engineers, and medical investigators who develop computational tools for the analysis and visualization of medical image data. The purpose of the Center is to provide the infrastructure and environment for the development of computational algorithms and open-source technologies, and then oversee the training and dissemination of these tools to the research community.

Supported by the National Institutes of Health (NIH) and the National Science Foundation (NSF).

Information about collaborating with NA-MIC

PI: Ron Kikinis, M.D.



## Neuroimage Analysis Center

"understanding the human brain through imaging"

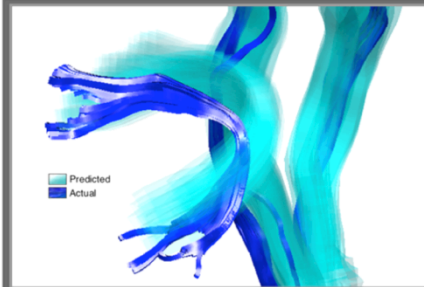
Google Custom Search  **GO**

### About the NAC

- Overview
- Organization
- Research Cores
- Collaborations

**Resources**

- Contact Us
- Publication DB
- Image Gallery
- Downloads
- Training
- Web Archive



IMRI-DTI Modeling via Landmark Distance Atlases for Prediction and Detection of Fiber Tracts


Leave-one-out prediction of tract location according to the landmark distance atlas (LDA). Each subject's MRI selection peaks and anatomical landmarks, plus the leave-one-out LDA from the other subjects, were used to predict the location of the AF, left CST, and right CST. The true dissections for each subject are shown in dark blue, and the 80% confidence interval for the predicted trajectory is shown in transparent cyan. These results provide an alternative visualization of the data in the learned landmark distance model and they demonstrate reasonable model generalization to novel subjects.

**More...**

**Featured Image Archive**

The Neuroimage Analysis Center (NAC) develops image processing and analysis techniques for basic and clinical neurosciences. The NAC research approach emphasizes both specific core technologies and collaborative application projects. The activities of the NAC are centered at the Harvard Medical School and the Surgical Planning Laboratory at the Brigham and Women's Hospital, with collaborators throughout the United States and the rest of the world.

Research supported by the National Center for Research Resources (NIH) and the Institute of Biomedical Imaging and Bioengineering (NIH).



## National Center for Image-Guided Therapy

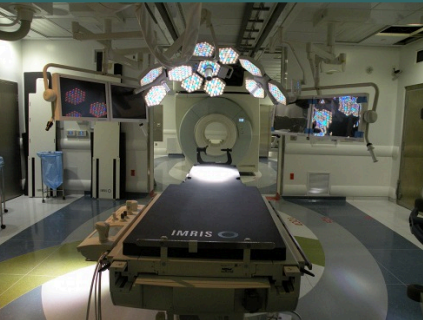
### NCIGT Wiki

**About Us**

- Overview
- Research Labs
- Research Cores
- Research Projects
- DBPs
- People

**Resources**

- Publication DB
- Image Gallery
- Downloads
- AMIGO
- News and Events
- Contact Us



**Advanced Multimodality Image Guided Operating (AMIGO) Suite**

The Advanced Multimodality Image Guided Operating (AMIGO) Suite is an innovative surgical and interventional environment that is the clinical translational test bed of the National Center for Image-Guided Therapy (NCIGT) at the Brigham and Women's Hospital (BWH) and Harvard Medical School. The AMIGO is an integrated, 5,700 square foot area divided into three sterile procedure rooms in which a multidisciplinary team will treat patients with the benefit of intra-operative imaging using multiple modalities. [More...](#)

[Featured Image Archive](#)

The National Center for Image Guided Therapy (NCIGT) is a Biomedical Technology Resource Center supported by the NCRR and NIBIB institutes.

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



# Slicer: Behind the scenes

CDash - Slicer4

http://www.cdash.org/slicer4/index.php?project=Slicer4

Dashboard Calendar Previous Current Project

WARNING: This CDash instance is running the bleeding edge svn trunk CDash code, and is updated frequently. You have 1 file changed by 1 author as of Sunday, November 27 2011 - 22:00 EST

### Nightly-Packages

Site	Build Name	Update	Configure			Build	
		Files	Error	Warn		Error	Warn
factory-win7.kitware	Windows7-VS2010-32bits-QT4.7.1-PythonQt-With-Tcl-CLI-Release	0	0	0		2 <sup>0</sup> <sub>0</sub>	107 <sup>0</sup> <sub>0</sub>
factory-mac-64bits.kitware	SnowLeopard-g++4.2.1-64bits-QT4.7-PythonQt-With-Tcl-CLI-Release	1	0	0		0	14 <sup>0</sup> <sub>0</sub>
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.7-PythonQt-With-Tcl-CLI-Release	1	0	0		0	13 <sup>0</sup> <sub>0</sub>
factory-win7.kitware	Windows7-VS2008-64bits-QT4.7.1-PythonQt-With-Tcl-CLI-Release	0	0	0		0 <sup>0</sup> <sub>0</sub>	1000 <sup>0</sup> <sub>0</sub>
factory-win7.kitware	Windows7-VS2008-32bits-QT4.7.1-PythonQt-With-Tcl-CLI-Release	1	0	0		0 <sup>0</sup> <sub>0</sub>	1000 <sup>0</sup> <sub>0</sub>

### Nightly

Site	Build Name	Update	Configure			Build		Test			Build Time
		Files	Error	Warn		Error	Warn	Not Run	Fail	Pass	
whitecube.kitware	SnowLeopard-gcc4.2.1-QT4.7.0-PythonQt-With-Tcl-Release	1	0	0		27 <sup>0</sup> <sub>0</sub>	190 <sup>0</sup> <sub>0</sub>	0	96 <sup>0</sup> <sub>0</sub>	391 <sup>0</sup> <sub>0</sub>	11 hours ago
youpi.sci.utah.edu	OpenSuse-c++4.5.0-64bits-QT4.6.3-PythonQt-With-Tcl-NoCLI-Release	0	0	0		0	15 <sup>0</sup> <sub>0</sub>	0	304 <sup>0</sup> <sub>0</sub>	6 <sup>0</sup> <sub>0</sub>	11 hours ago
eris.kitware	Linux-g++4.4-QT4.6.3-PythonQt-CLI-Release	1	0	0		0	15 <sup>0</sup> <sub>0</sub>	0	36 <sup>0</sup> <sub>0</sub>	451 <sup>0</sup> <sub>0</sub>	3 hours ago
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-QT4.7-PythonQt-With-Tcl-CLI-Vaigrind-Release	0	0	0		0	13 <sup>0</sup> <sub>0</sub>	0	27 <sup>0</sup> <sub>0</sub>	460 <sup>0</sup> <sub>0</sub>	11 hours ago
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.7-PythonQt-With-Tcl-NoCLI-Coverage-Release	0	0	0		0	12 <sup>0</sup> <sub>0</sub>	0	23 <sup>0</sup> <sub>0</sub>	287 <sup>0</sup> <sub>0</sub>	11 hours ago
sagarmatha.kitware	Linux-g++4.3.3-QT4.7-PythonQt-With-Tcl-NoCLI-Release	0	0	0		0	12 <sup>0</sup> <sub>0</sub>	0	22 <sup>0</sup> <sub>0</sub>	288 <sup>0</sup> <sub>0</sub>	12 hours ago

### Continuous

Site	Build Name	Update	Configure			Build		Test			Build Time
		Files	Error	Warn		Error	Warn	Not Run	Fail	Pass	
youpi.sci.utah.edu	OpenSuse-c++4.5.0-64bits-QT4.6.3-PythonQt-With-Tcl-NoCLI-Release	2	0	0		0	0 <sup>0</sup> <sub>0</sub>	0	304 <sup>0</sup> <sub>0</sub>	6 <sup>0</sup> <sub>0</sub>	1 hour ago

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



# Slicer Training events

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- Hands-on training workshops at national and international venues
- More than 2,700 clinicians, clinical researchers and scientists trained since 2005





# Slicer Training events

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RSNA 2011

## Major international conferences

- **RSNA** 2008, 2009, 2010, 2011, 2012, 2013
- **MICCAI** 2008, 2009, 2011, 2012, 2013
- **SfN** 2009, 2011
- **SPIE** 2012, 2013
- **CAOS** 2010
- **CARS** 2010, 2012, 2013



# RSNA Activities

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## Hands-on refresher courses

- 3D Visualization of DICOM images for Radiology Applications
- Quantitative Imaging for Clinical Research and Practice

## Quantitative Imaging Reading Room Exhibit

- 3DSlicer: An Open Source Platform for Segmentation, Registration, Quantitative Imaging, and 3D Visualization of Multi-Modal Image Data.



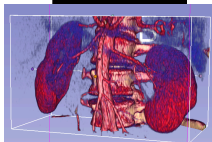


# Overview

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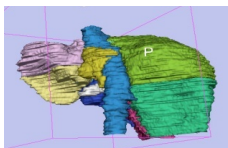
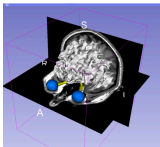


**Part I:** Introduction to the 3DSlicer software



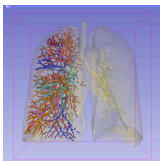
**Part II:** 3D Data Loading and visualization of DICOM images

- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data



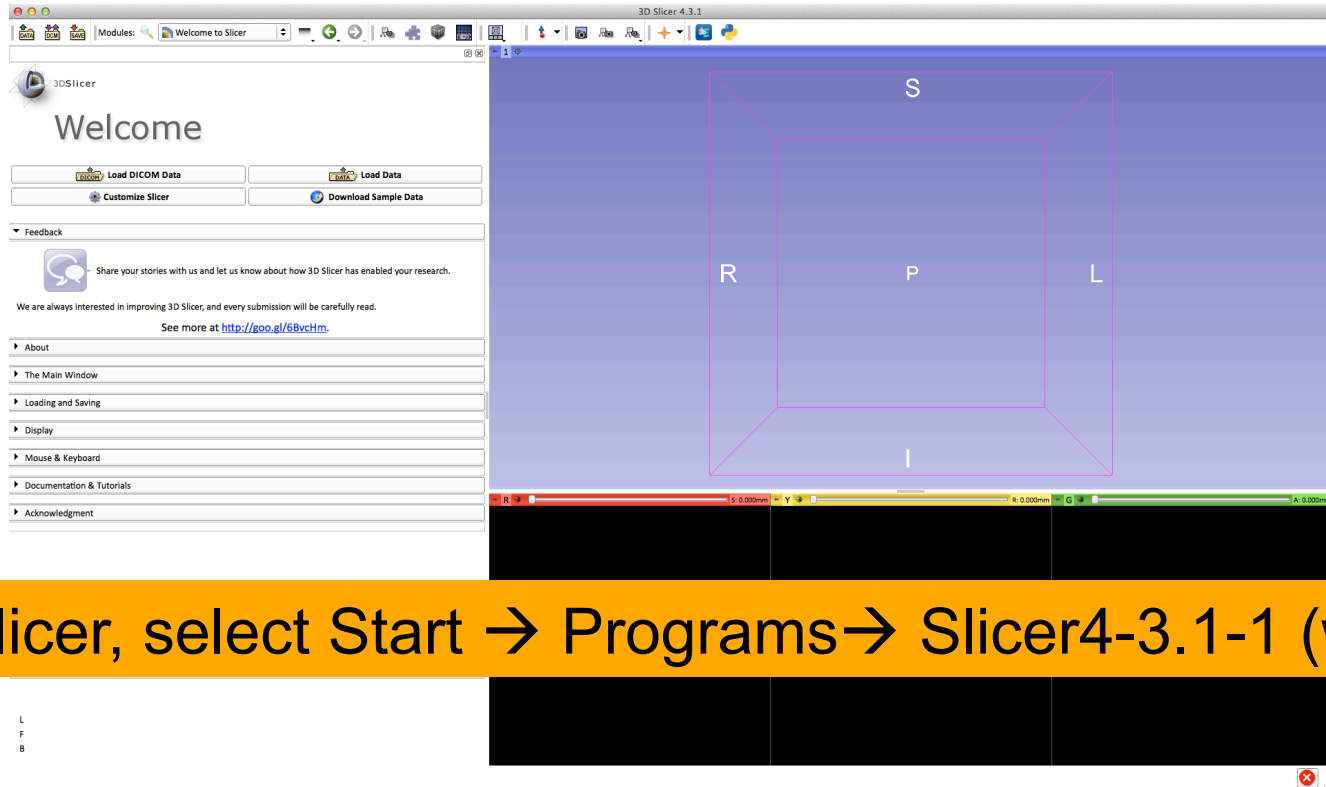
**Part III:** 3D interactive exploration of the anatomy

- Exploration of the Segments of the liver
- Exploration of the Segments of the lung





# Welcome to Slicer4



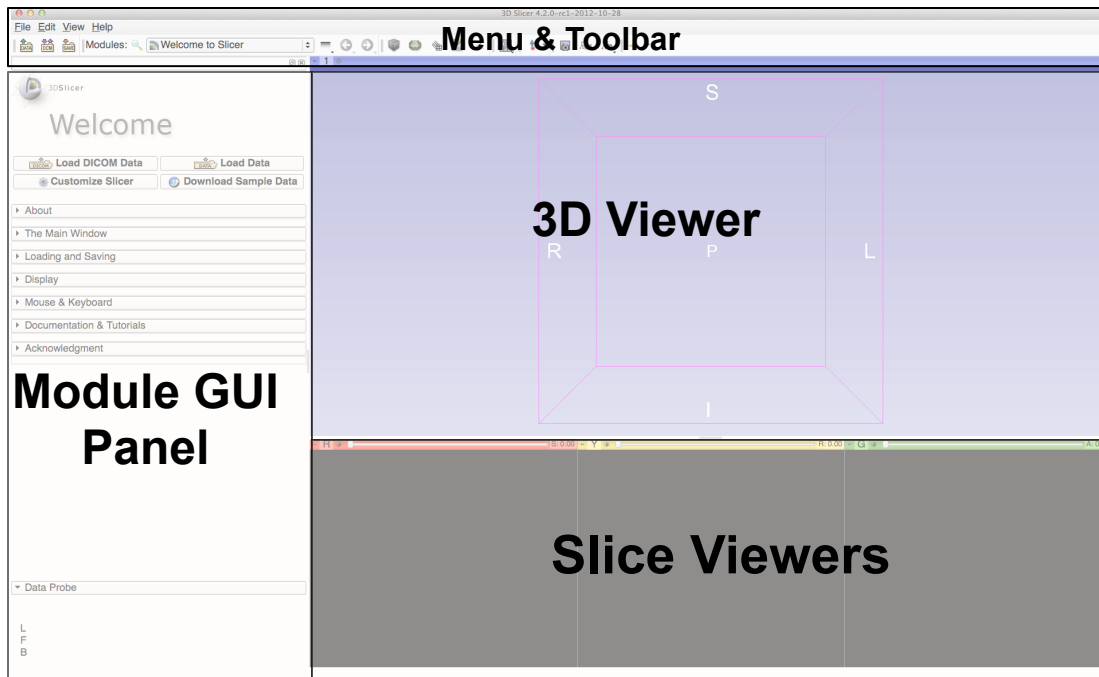
To start Slicer, select Start → Programs → Slicer4-3.1-1 (win64)



# Navigating the Application GUI

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

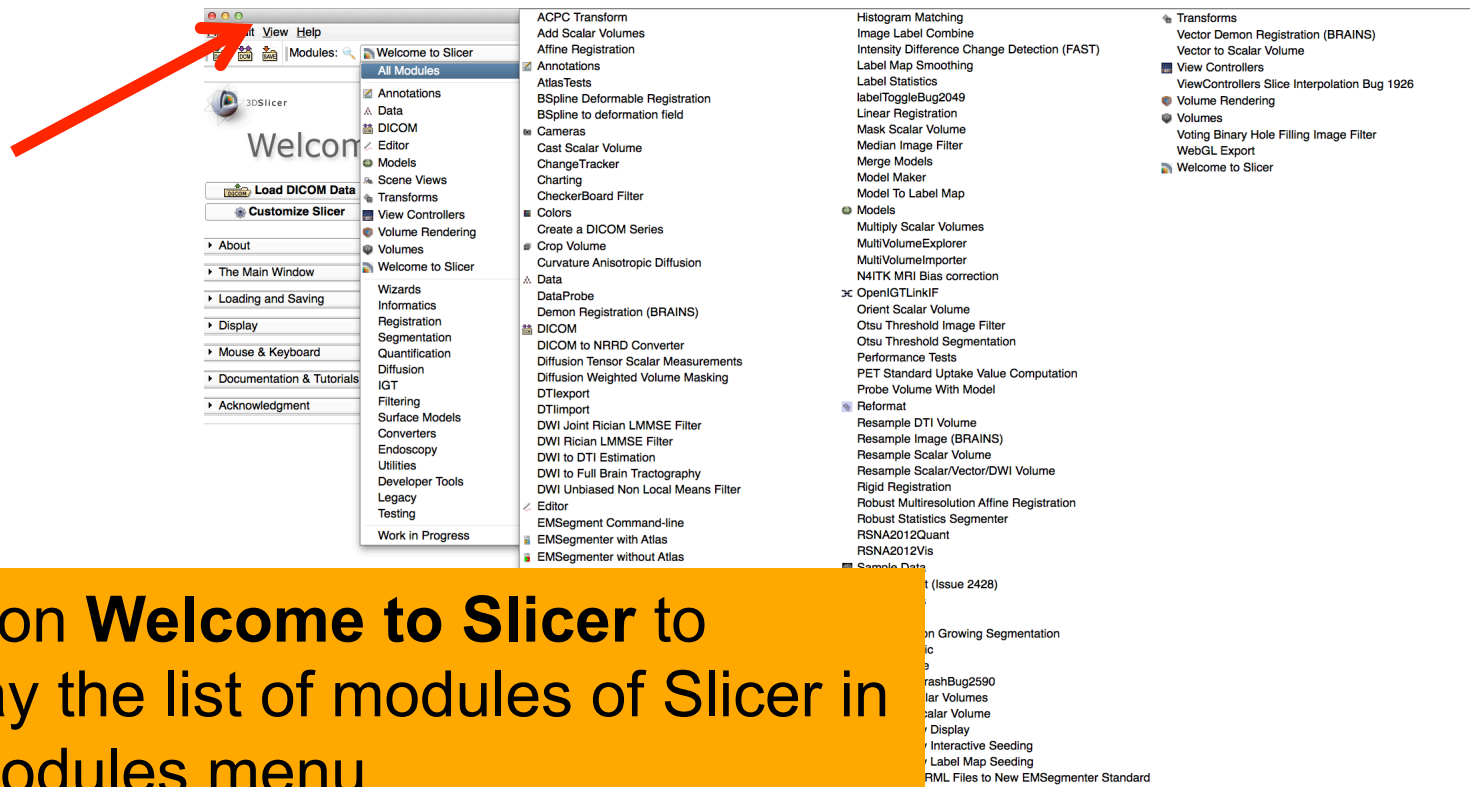
- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer







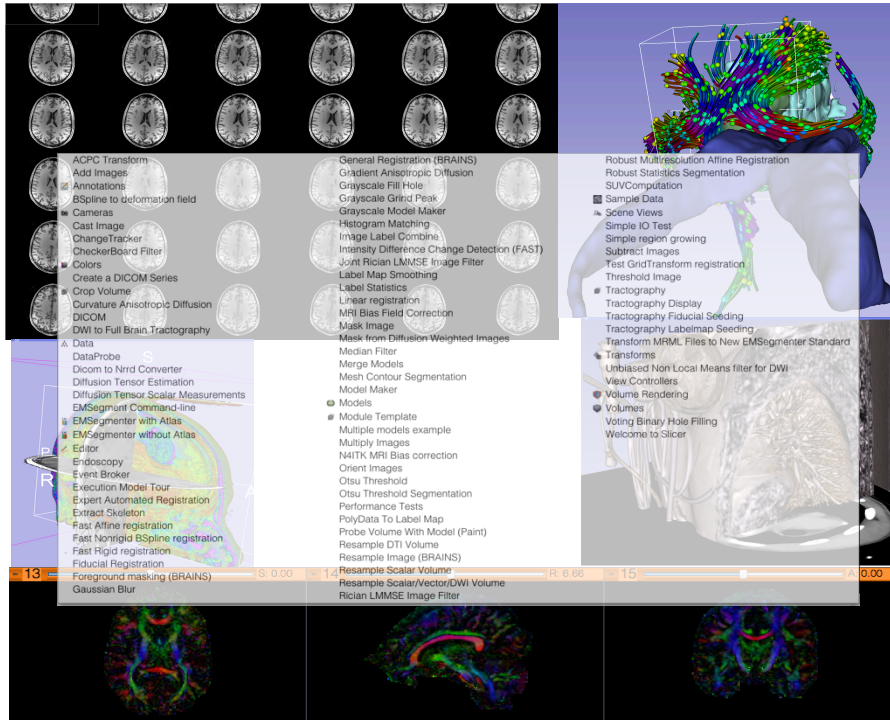
# Welcome to Slicer4.3.1.1



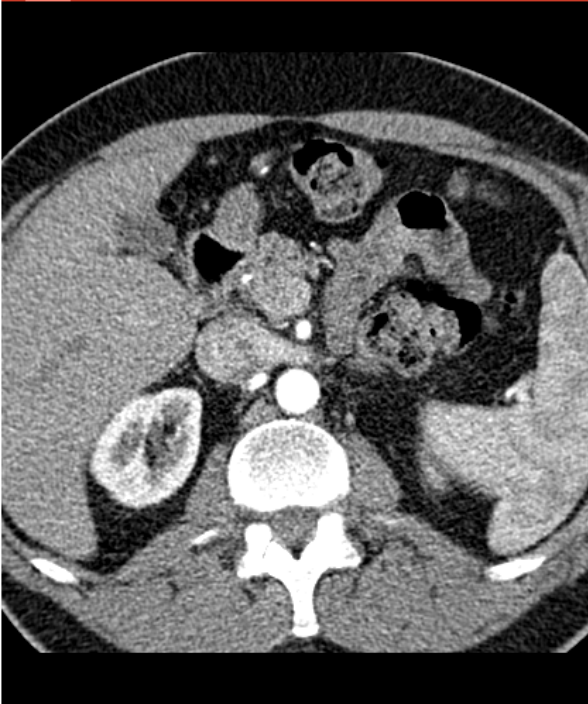
Click on **Welcome to Slicer** to display the list of modules of Slicer in the Modules menu



# Welcome to Slicer4



Slicer4.3.1 contains more than 100 modules for image segmentation, registration and 3D visualization of medical imaging data



Part 1:

Loading a DICOM Volume

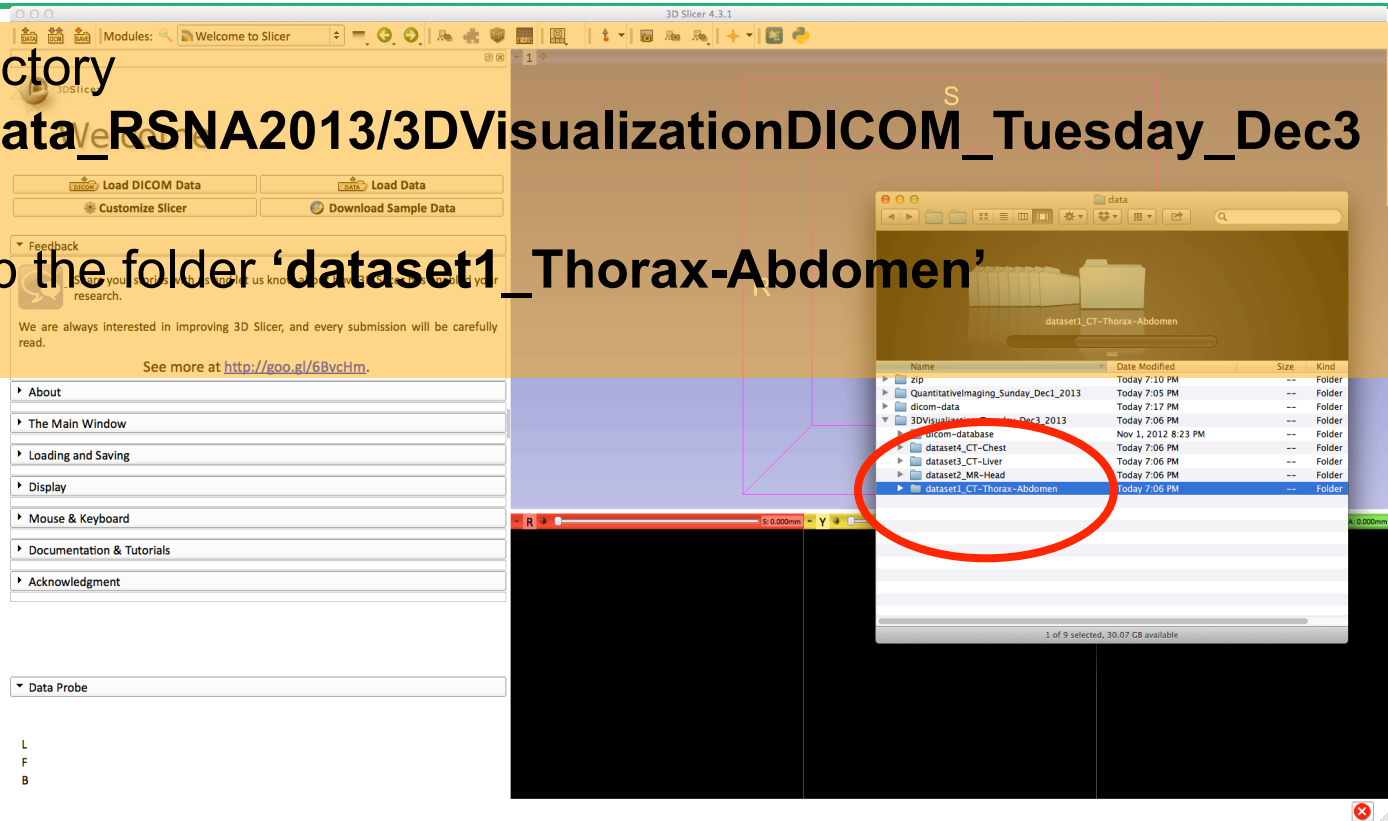


# Loading a DICOM volume

Open the directory

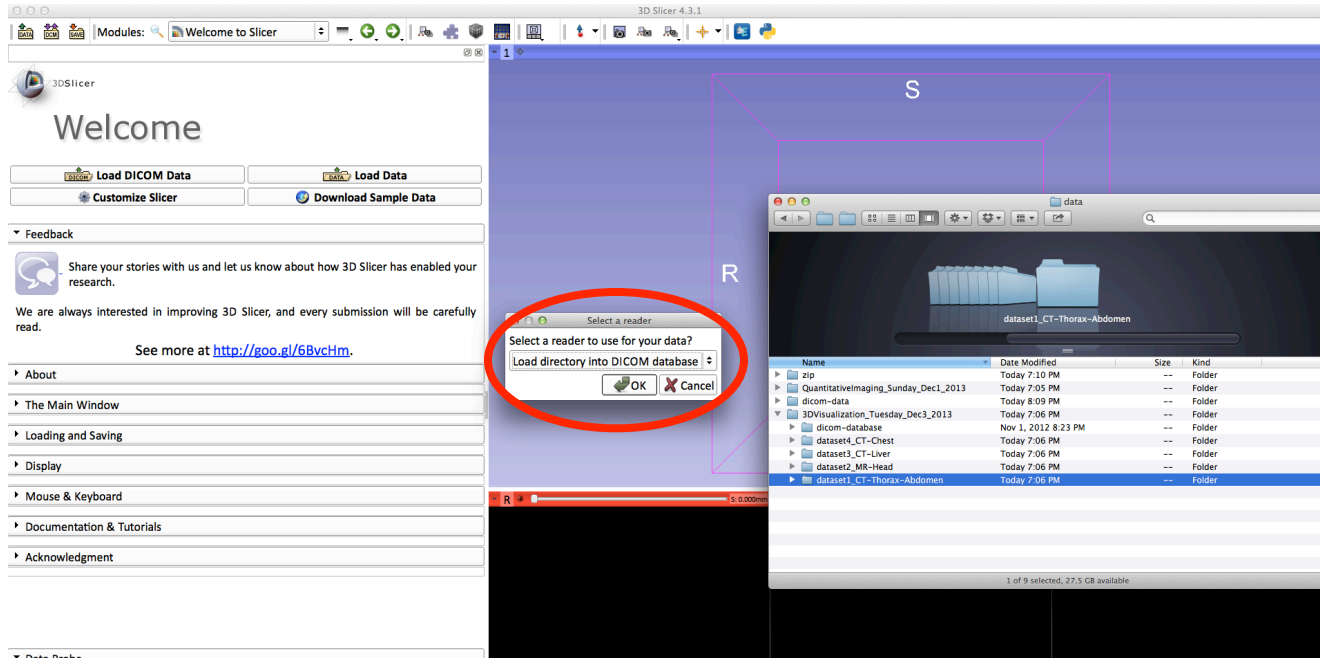
**C:/3DSlicerData\_RSNA2013/3DVisualizationDICOM\_Tuesday\_Dec3**

Drag and drop the folder **'dataset1\_Thorax-Abdomen'** into Slicer





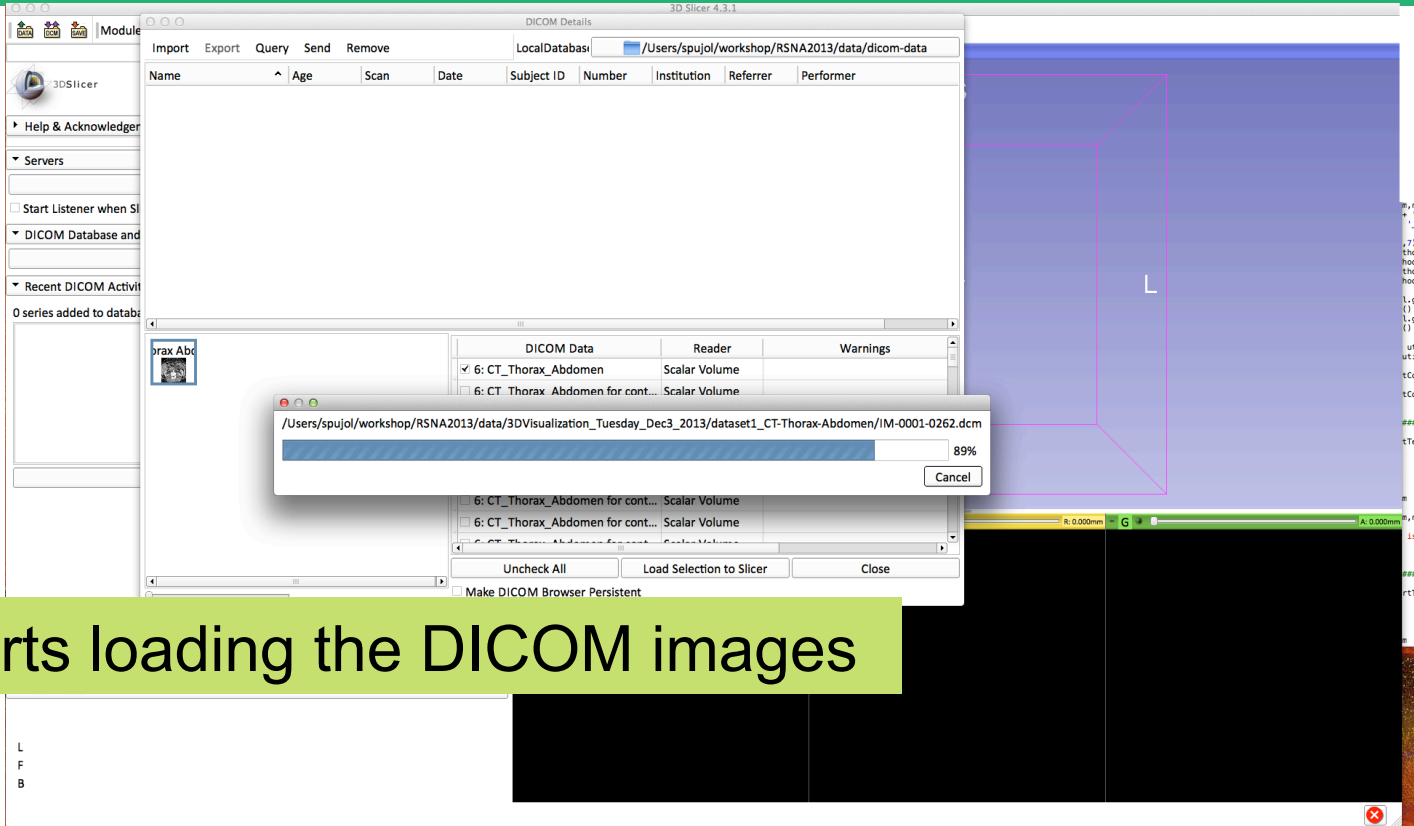
# Loading a DICOM volume



A pop-up window appears:  
Select **Load directory into DICOM database** and click on **OK**



# Loading a DICOM volume



Slicer starts loading the DICOM images



# Loading a DICOM volume

The screenshot shows the 3D Slicer 4.3.1 interface. The 'DICOM Details' window is open, displaying a table of DICOM data for 'patient1'. The table has columns: Name, Age, Scan, Date, Subject ID, Number, Institution, Referrer, and Performer. The 'Subject ID' column shows 'patient1\_ID'. A 'DICOM Data' dialog box is overlaid on the interface, showing a list of DICOM series with checkboxes. A message box is displayed in the center of the dialog, stating 'Directory import completed.' and listing the results: '1 New Patients', '1 New Studies', '1 New Series', and '291 New Instances'. An 'OK' button is at the bottom of the message box. In the background, a 3D volume is visible with a purple wireframe box indicating a region of interest. The volume is labeled with 'S', 'P', and 'L' on its sides. The 'Data Probe' window is also visible at the bottom left.

Click on OK once the directory import is completed



# Loading a DICOM volume

The **patient1** DICOM dataset appears in the DICOM browser. Click on 'patient1' to display the file hierarchy, select the DICOM volume **CT\_Thorax\_Abdomen\_CT**

Name	Age	Scan	Date	Subject ID	Number	Institution	Referrer	Performer
patient1				patient1_ID				
CT_Thorax_Abdomen			2005-06-01		6936864	oEFZQhRfY...		
CT_Thorax_Abdomen CT	6		2005-06-01	HEART	14			

Uncheck All   Load Selection to Slicer   Close

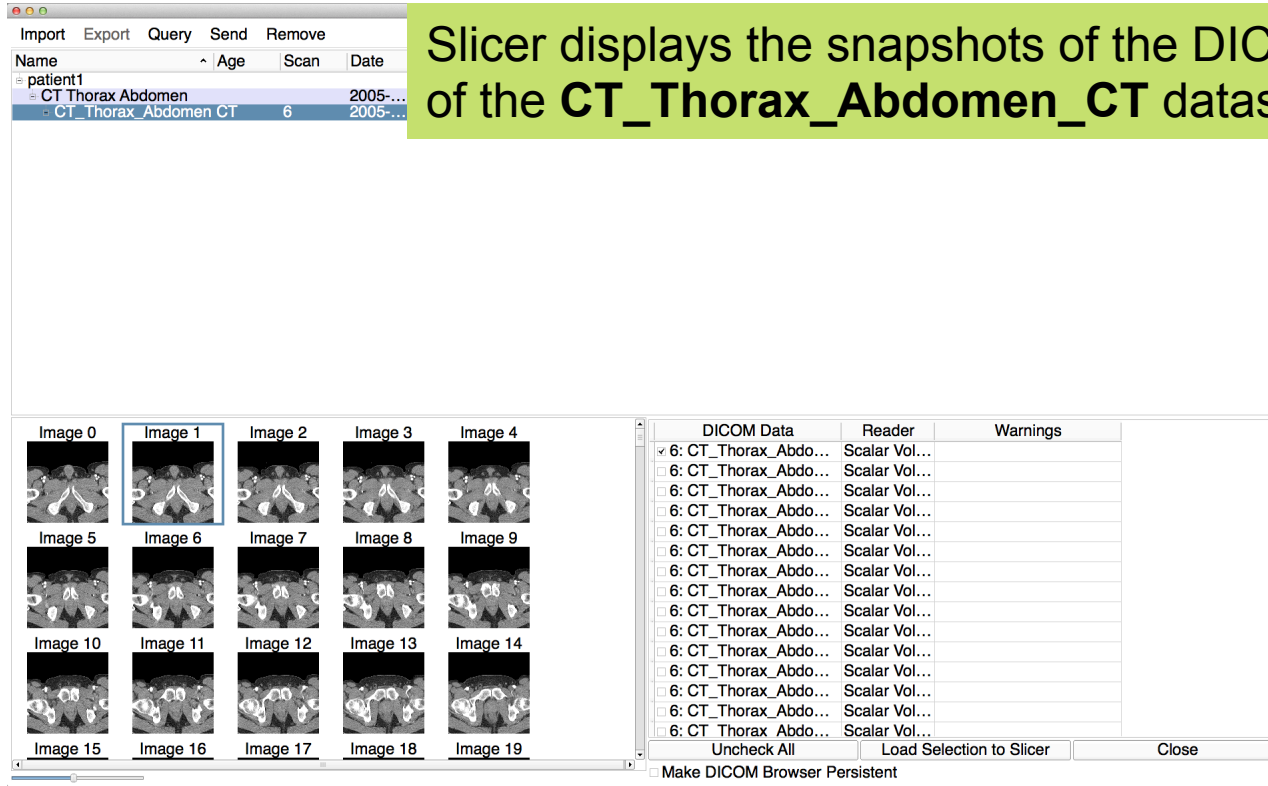
☐ Make DICOM Browser Persistent





# Loading a DICOM volume

Slicer displays the snapshots of the DICOM images of the **CT\_Thorax\_Abdomen\_CT** dataset

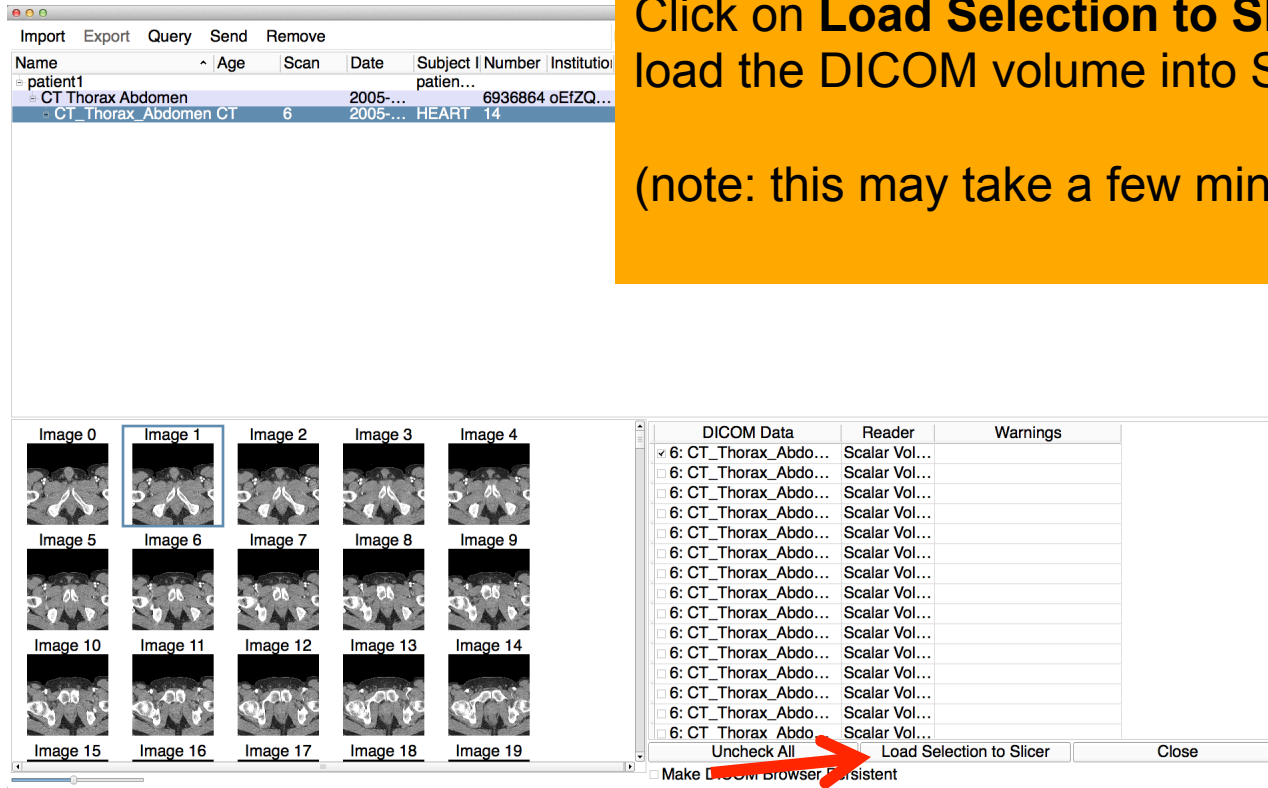




# Loading a DICOM volume

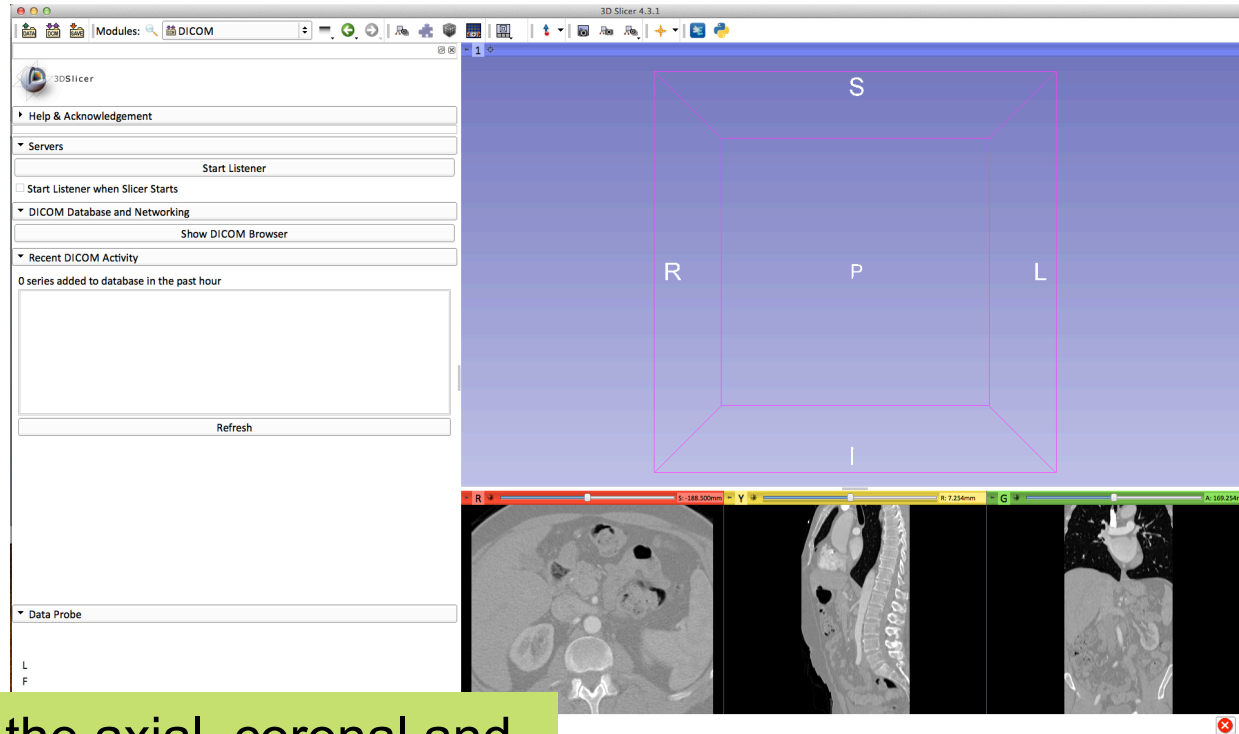
Click on **Load Selection to Slicer** to load the DICOM volume into Slicer

(note: this may take a few minutes)





# Loading a DICOM volume

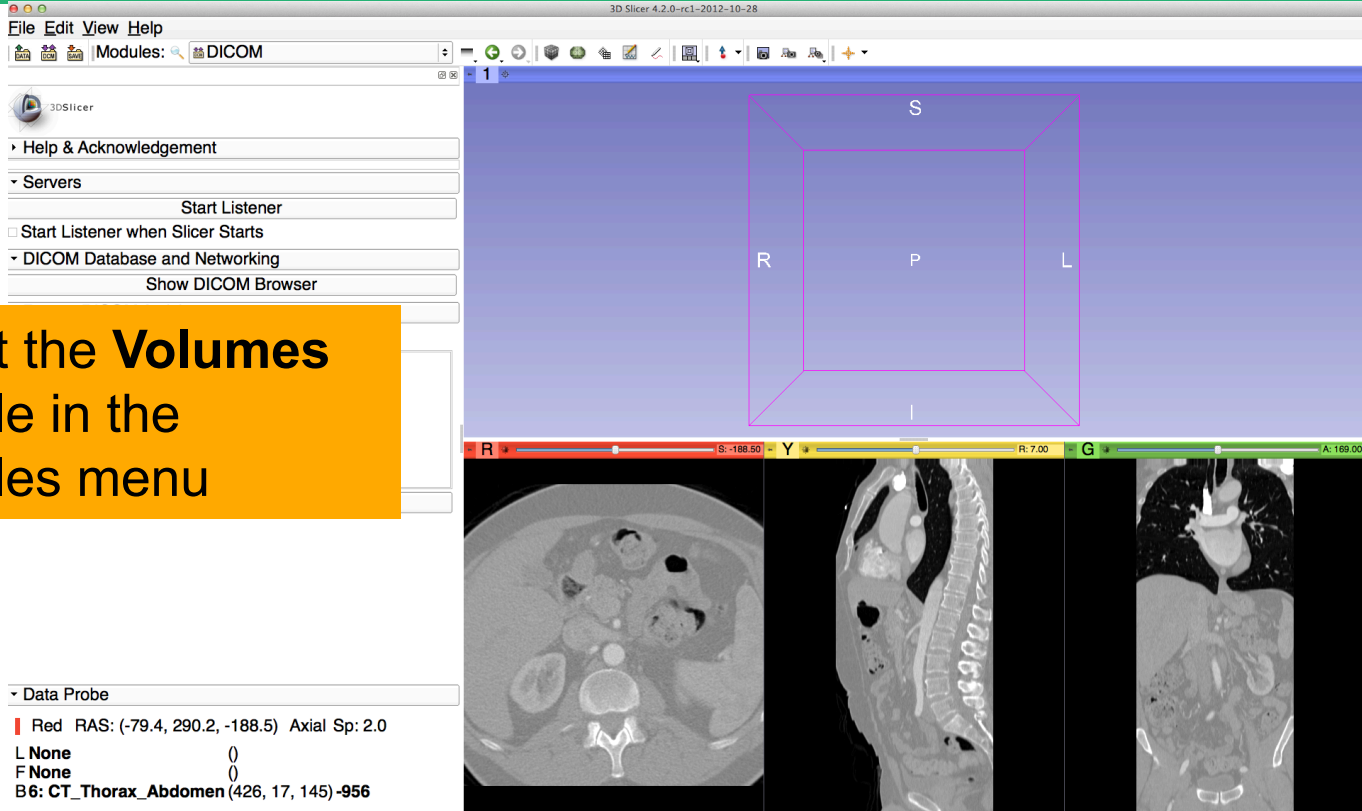


Slicer displays the axial, coronal and sagittal slices of the DICOM dataset



# Loading a DICOM volume

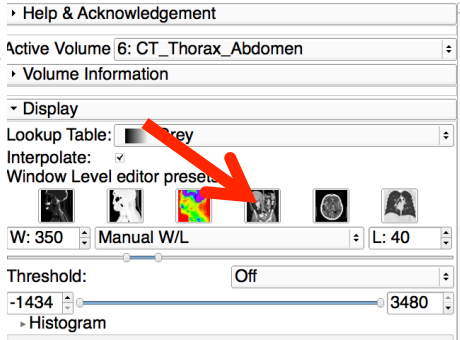
Select the **Volumes** module in the modules menu





# Loading a DICOM volume

Select the Active Volume  
**6:CT\_Thorax\_Abdomen**



Slicer has a series of  
window/level presets  
available


Click on the Window Level  
Preset **CT-abdomen**, or  
adjust manually the Window  
and Level using the Manual  
W/L slider



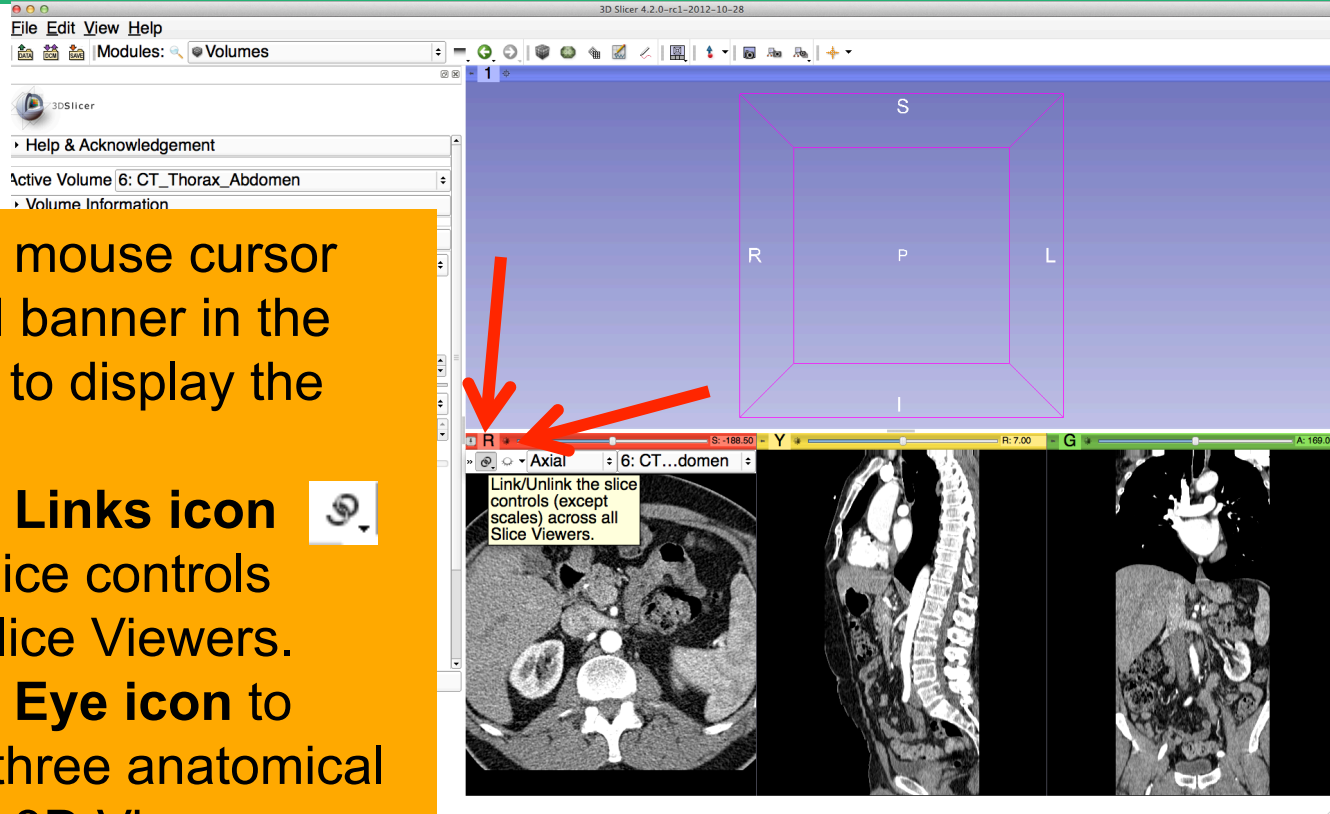


# Loading a DICOM volume

Position the mouse cursor over the red banner in the Red Viewer to display the slice menu.

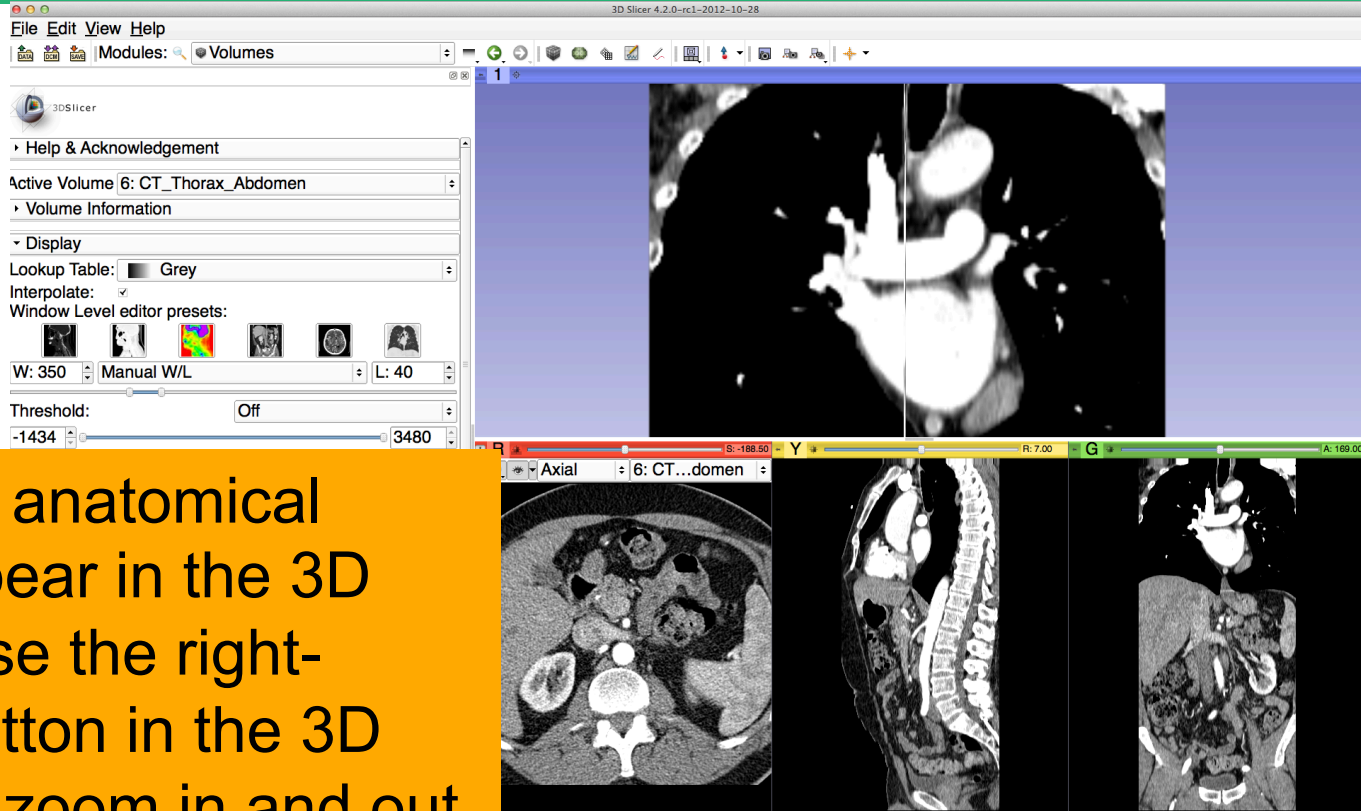
Click on the **Links icon**  to link the slice controls across all Slice Viewers.

Click on the **Eye icon** to display the three anatomical slices in the 3D Viewer





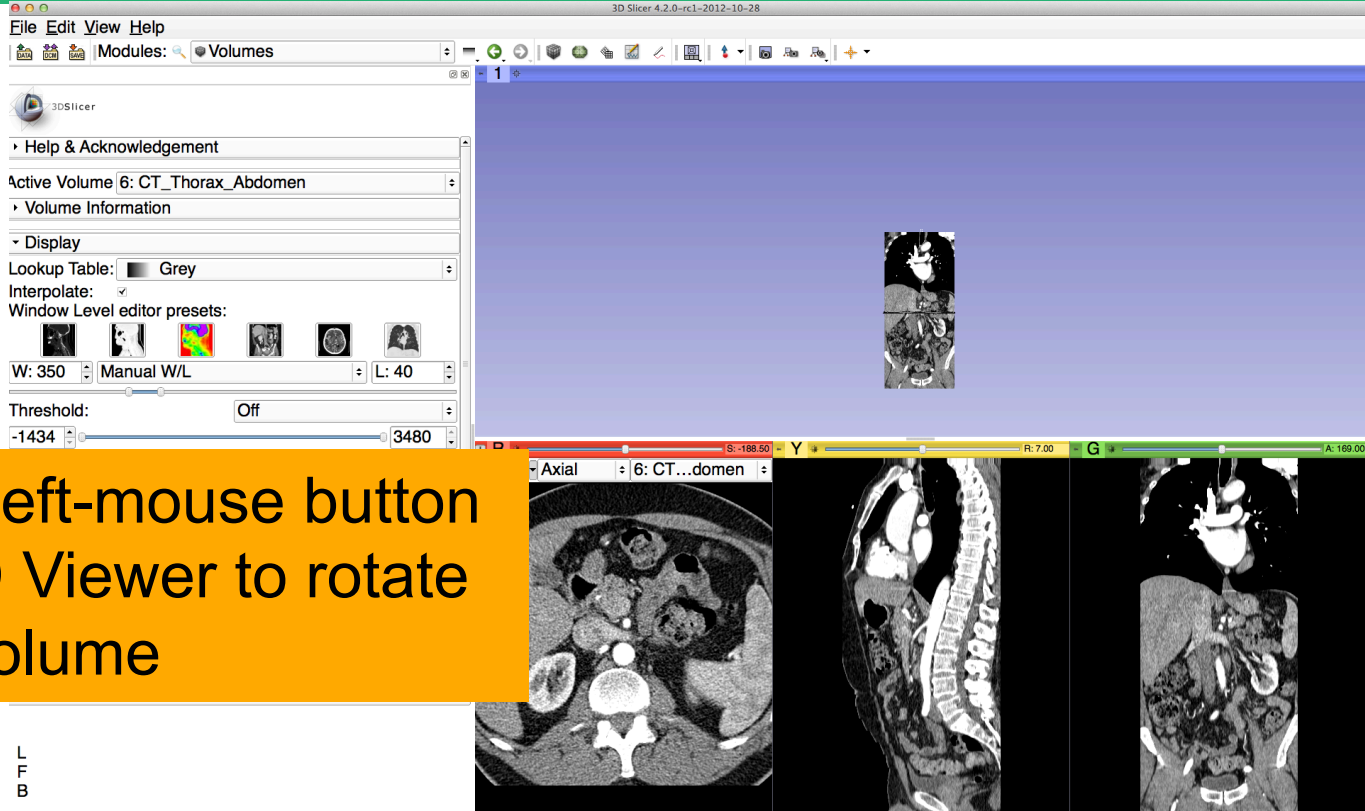
# Loading a DICOM volume



The three anatomical slices appear in the 3D viewer. Use the right-mouse button in the 3D Viewer to zoom in and out



# Loading a DICOM volume



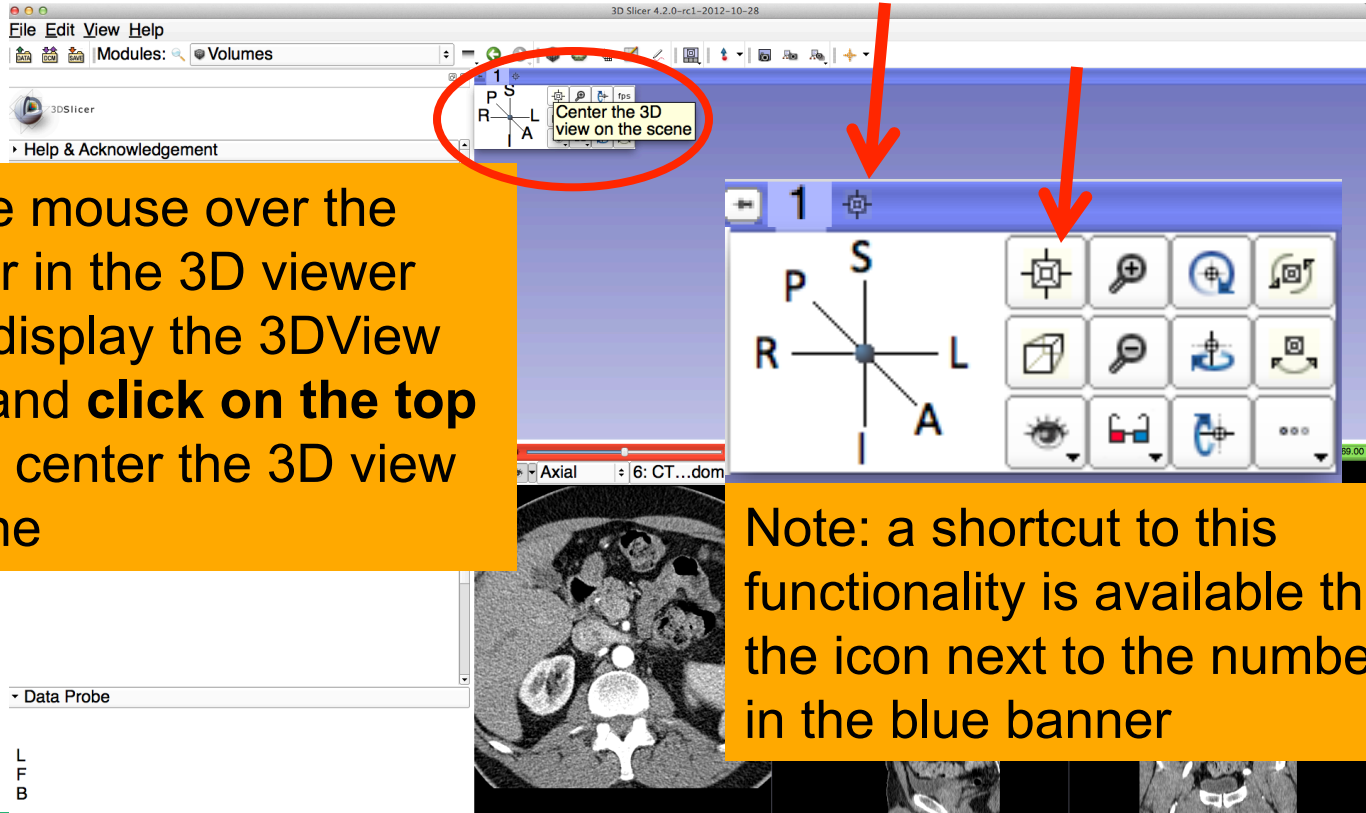
Use the left-mouse button  
in the 3D Viewer to rotate  
the 3D volume

L  
F  
B





# Loading a DICOM volume

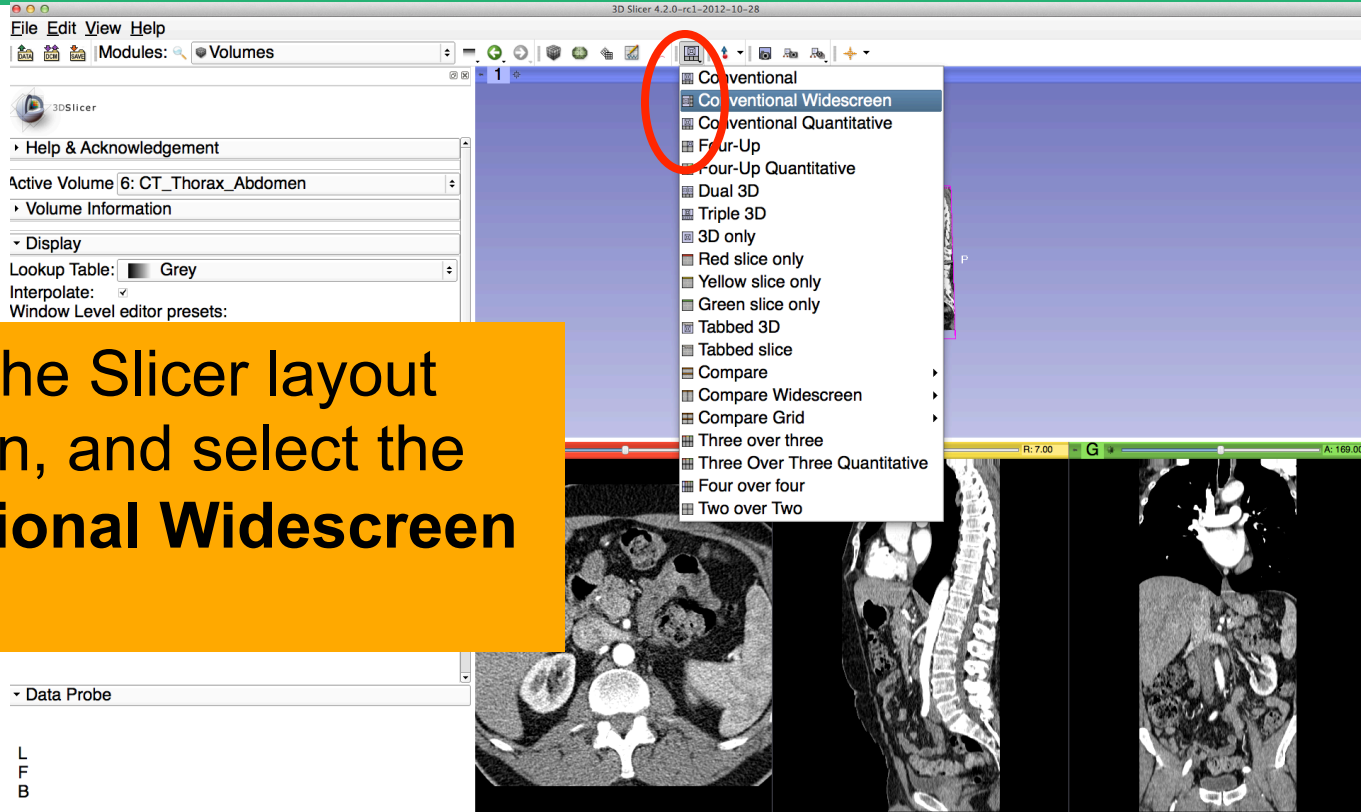


Position the mouse over the blue banner in the 3D viewer window to display the 3DView controller, and **click on the top left icon** to center the 3D view on the scene

Note: a shortcut to this functionality is available through the icon next to the number '1' in the blue banner



# Loading a DICOM volume

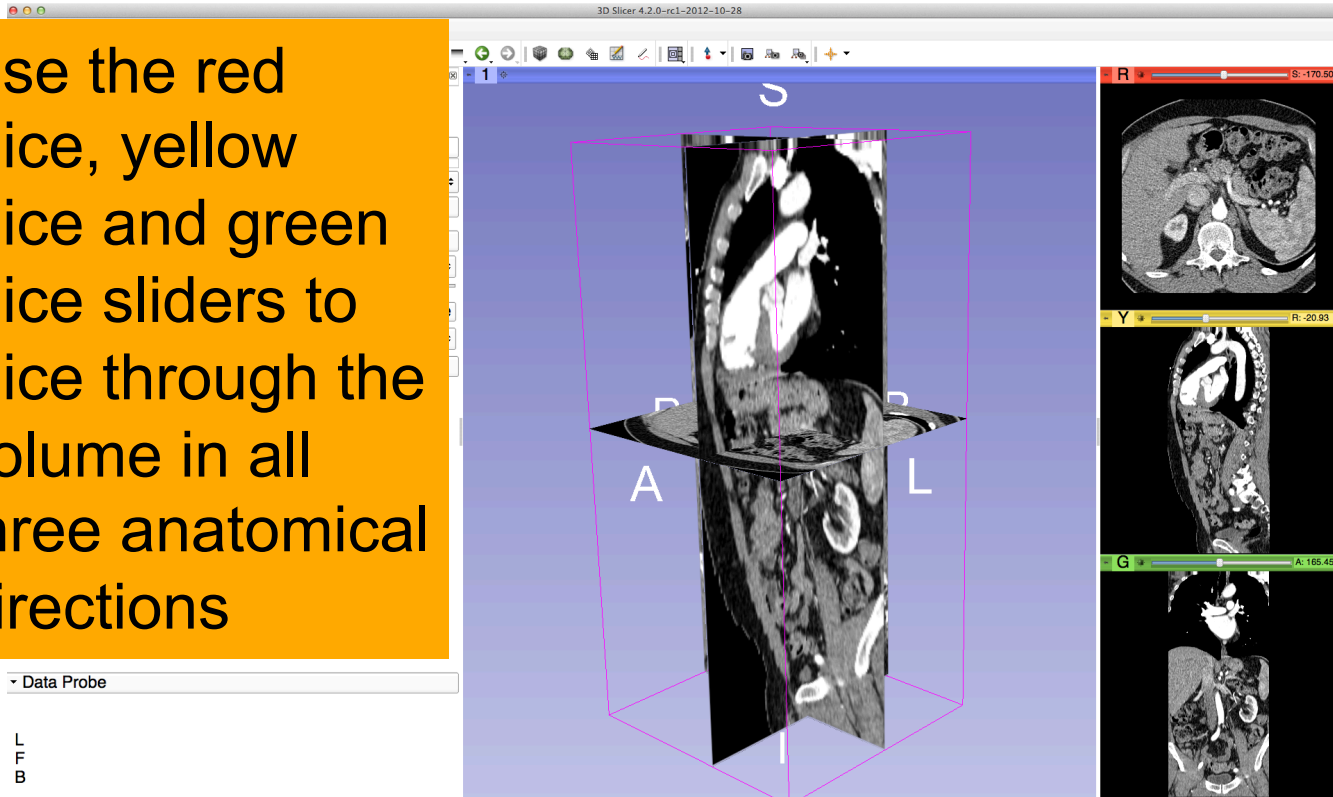


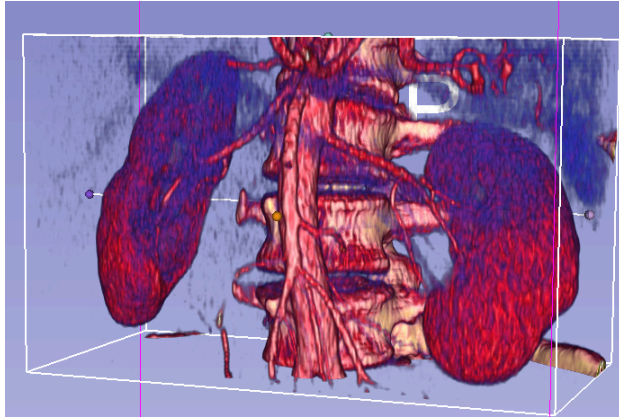
Click on the Slicer layout menu icon, and select the **Conventional Widescreen** layout



# Loading a DICOM volume

Use the red slice, yellow slice and green slice sliders to slice through the volume in all three anatomical directions



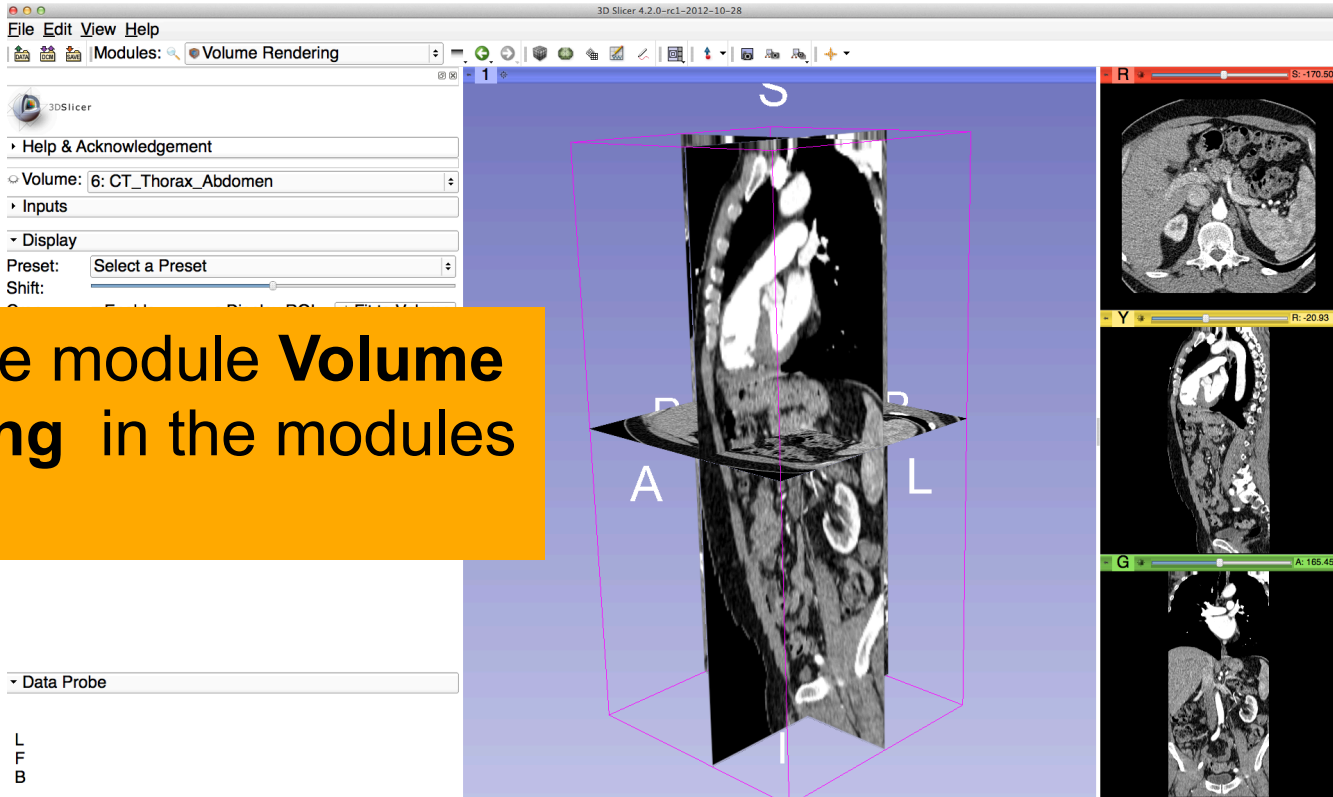


3D Interactive exploration of  
thoraco-abdominal CT data  
using Volume Rendering



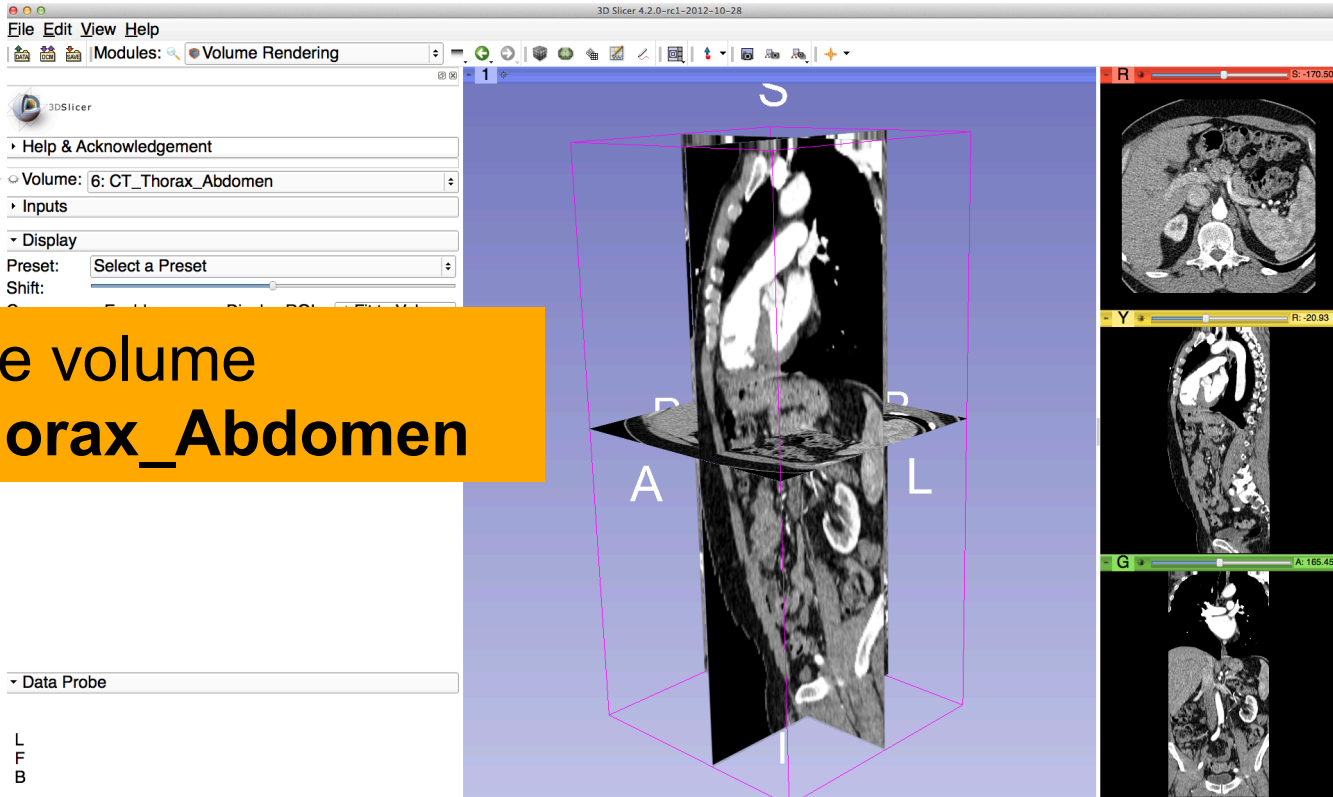
# Volume Rendering

Select the module **Volume Rendering** in the modules menu





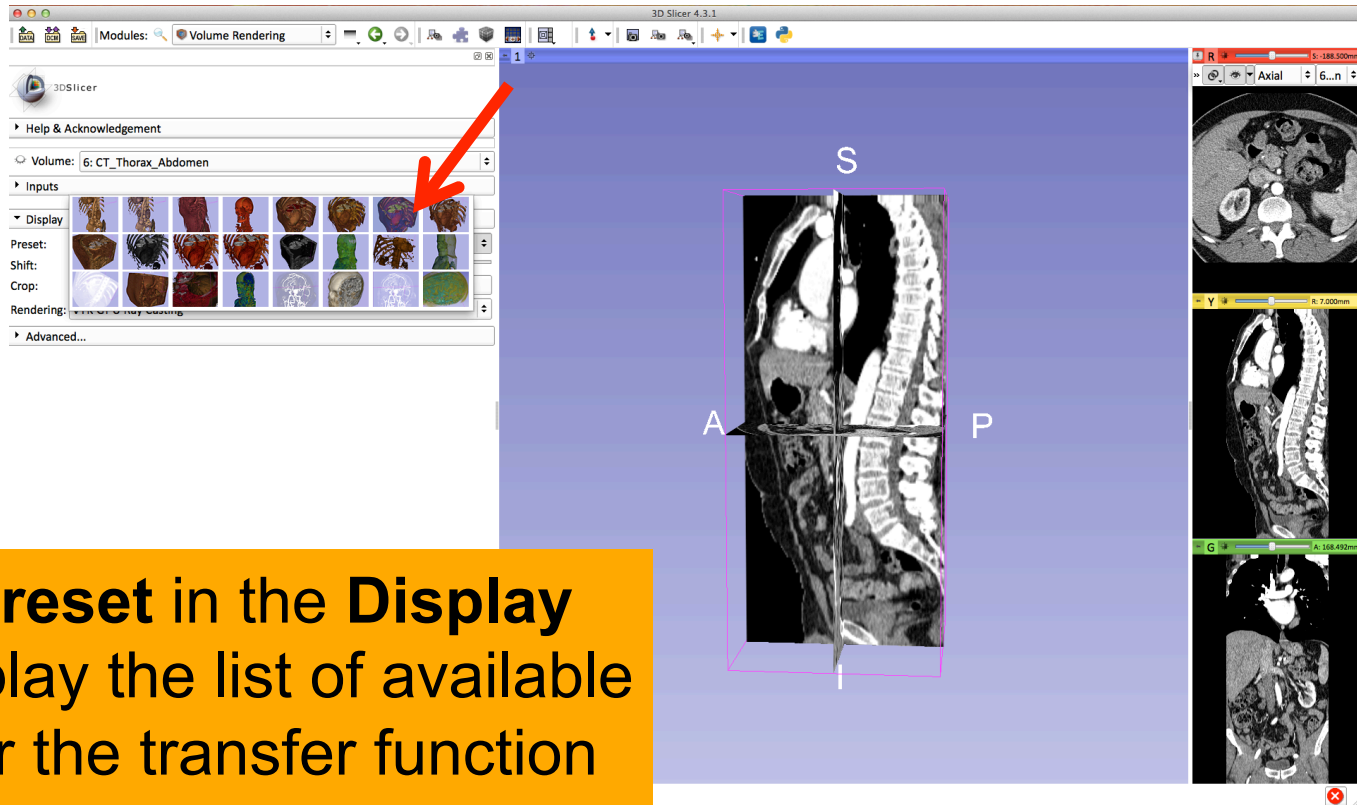
# Volume Rendering



Select the volume  
6:CT\_Thorax\_Abdomen



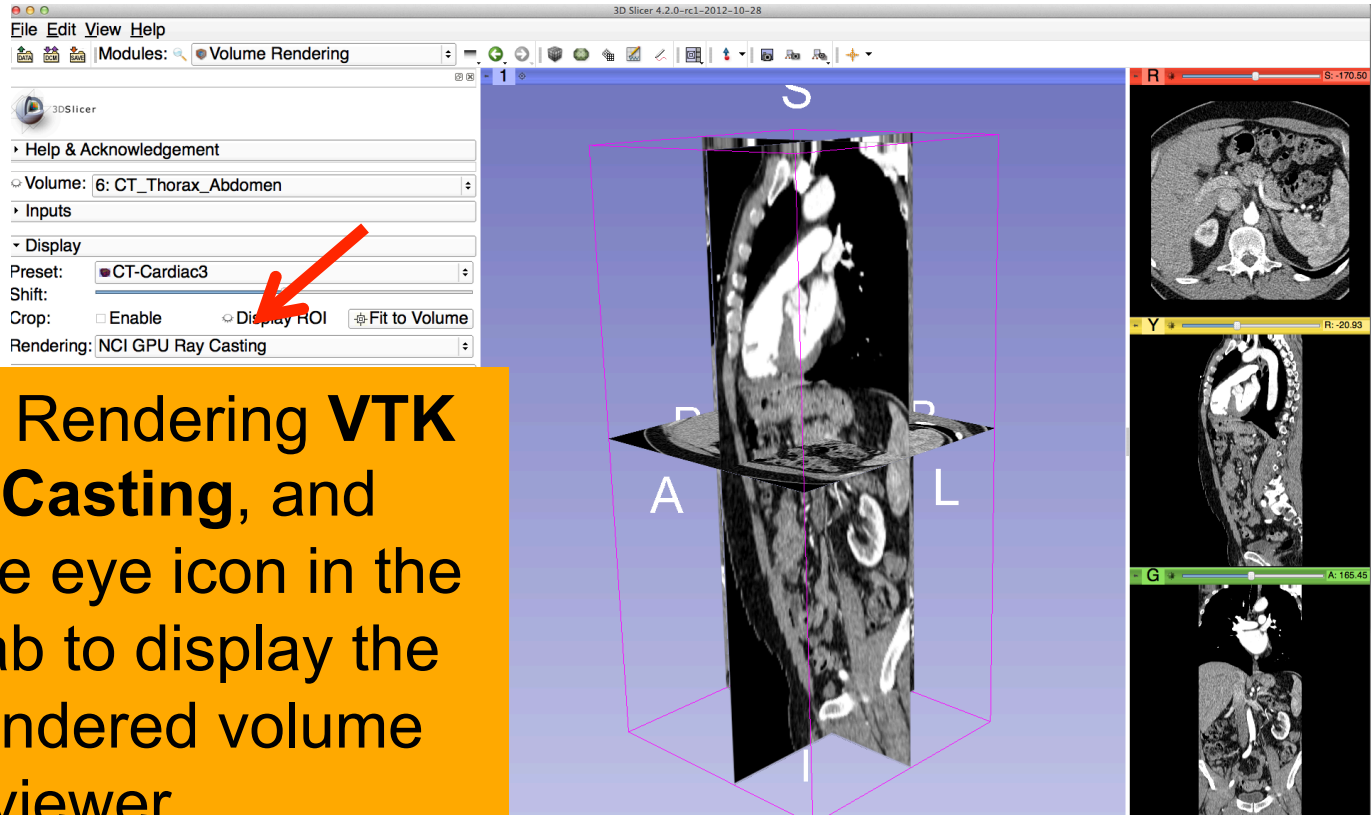
# Volume Rendering



Click on **Preset** in the **Display** tab to display the list of available presets for the transfer function  
Select the Preset **CT-Cardiac3**



# Volume Rendering

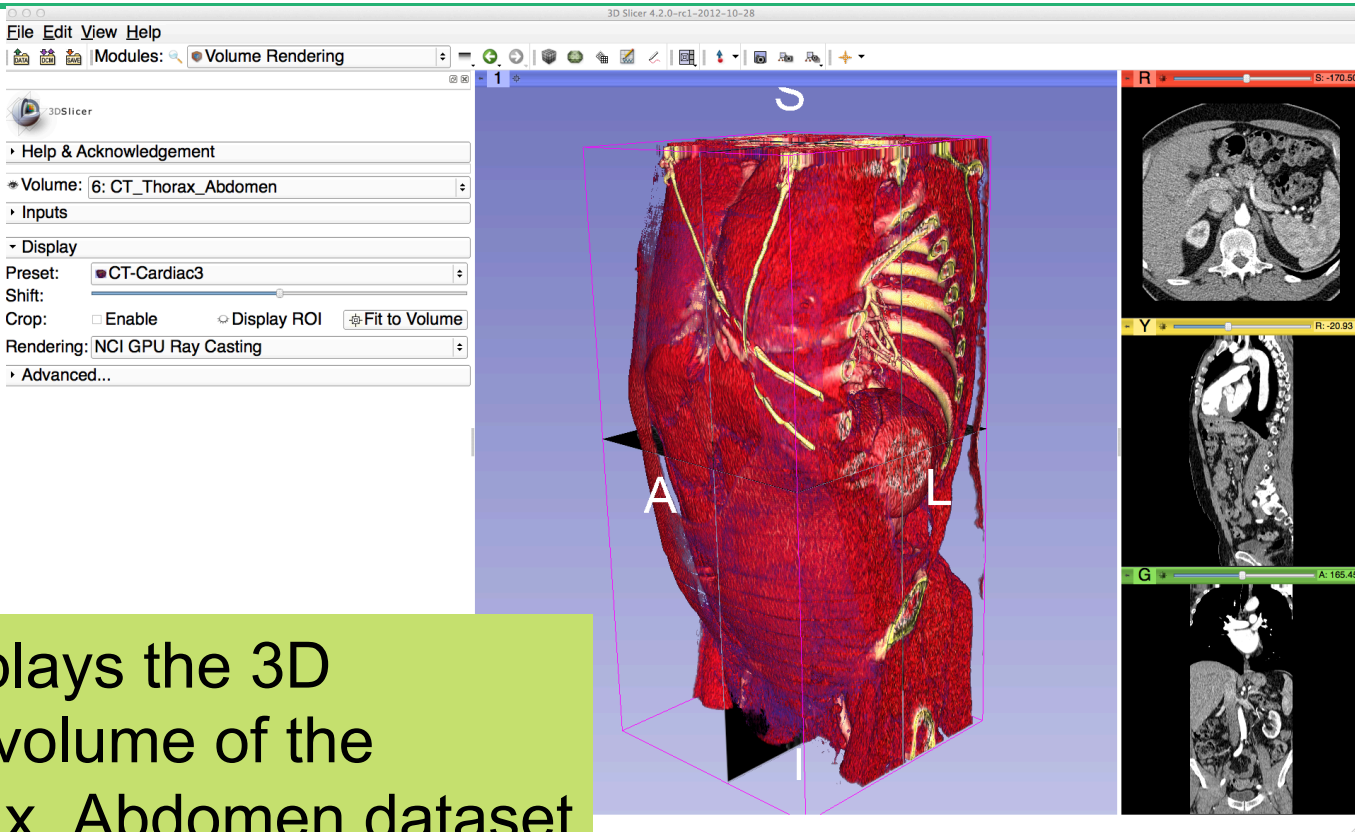


Select the Rendering **VTK CPU Ray Casting**, and click on the eye icon in the **Volume** tab to display the Volume rendered volume in the 3D viewer





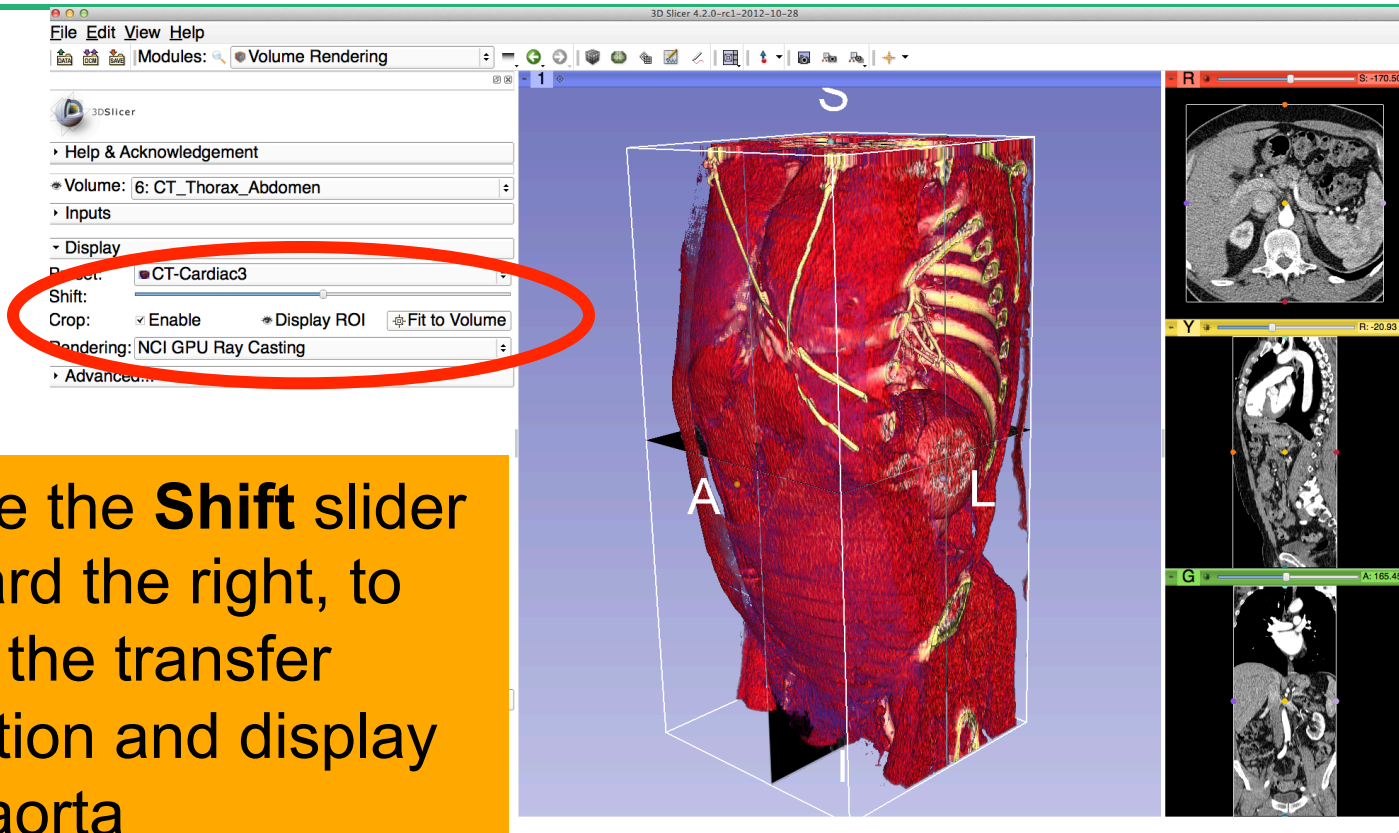
# Volume Rendering



Slicer displays the 3D rendered volume of the CT\_Thorax\_Abdomen dataset



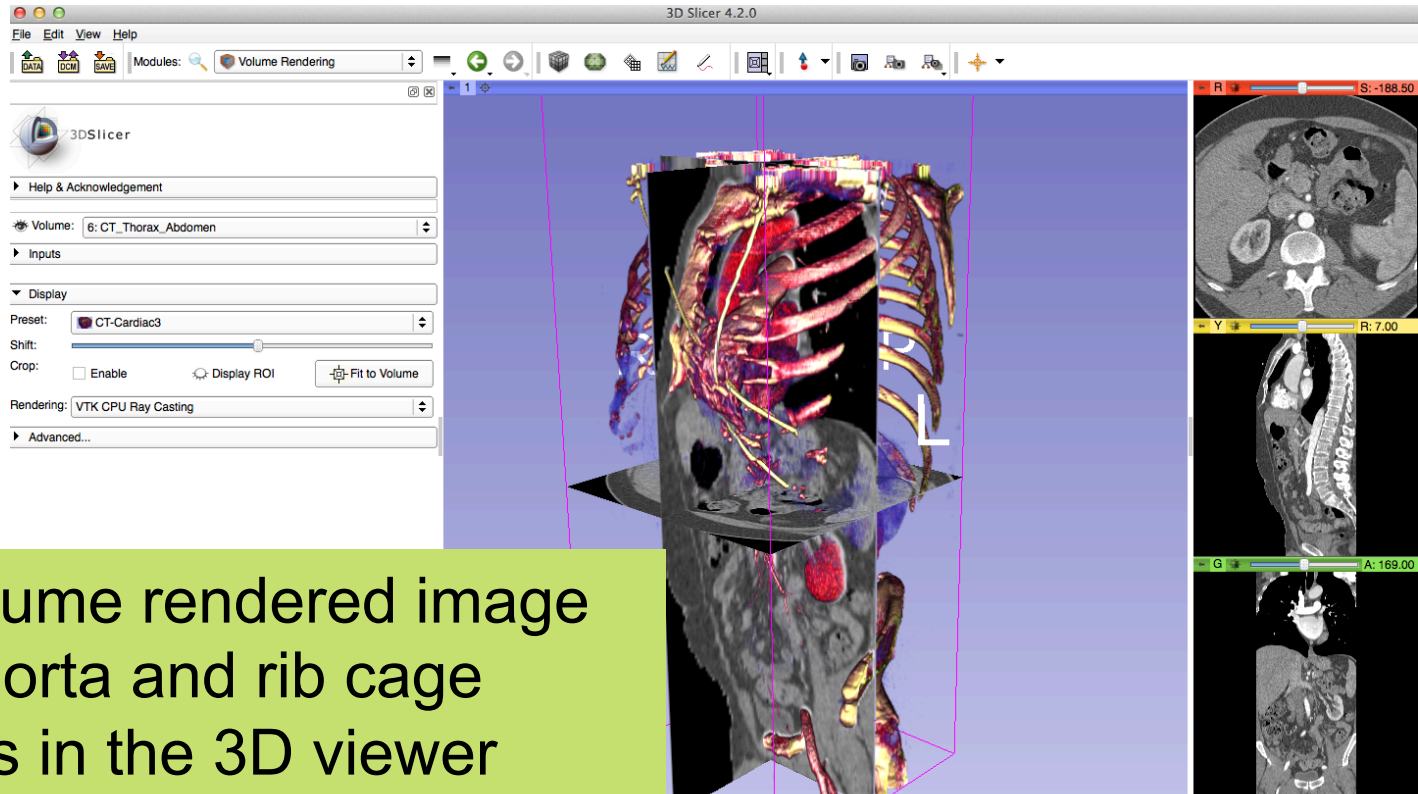
# Volume Rendering



Move the **Shift** slider toward the right, to shift the transfer function and display the aorta



# Volume Rendering

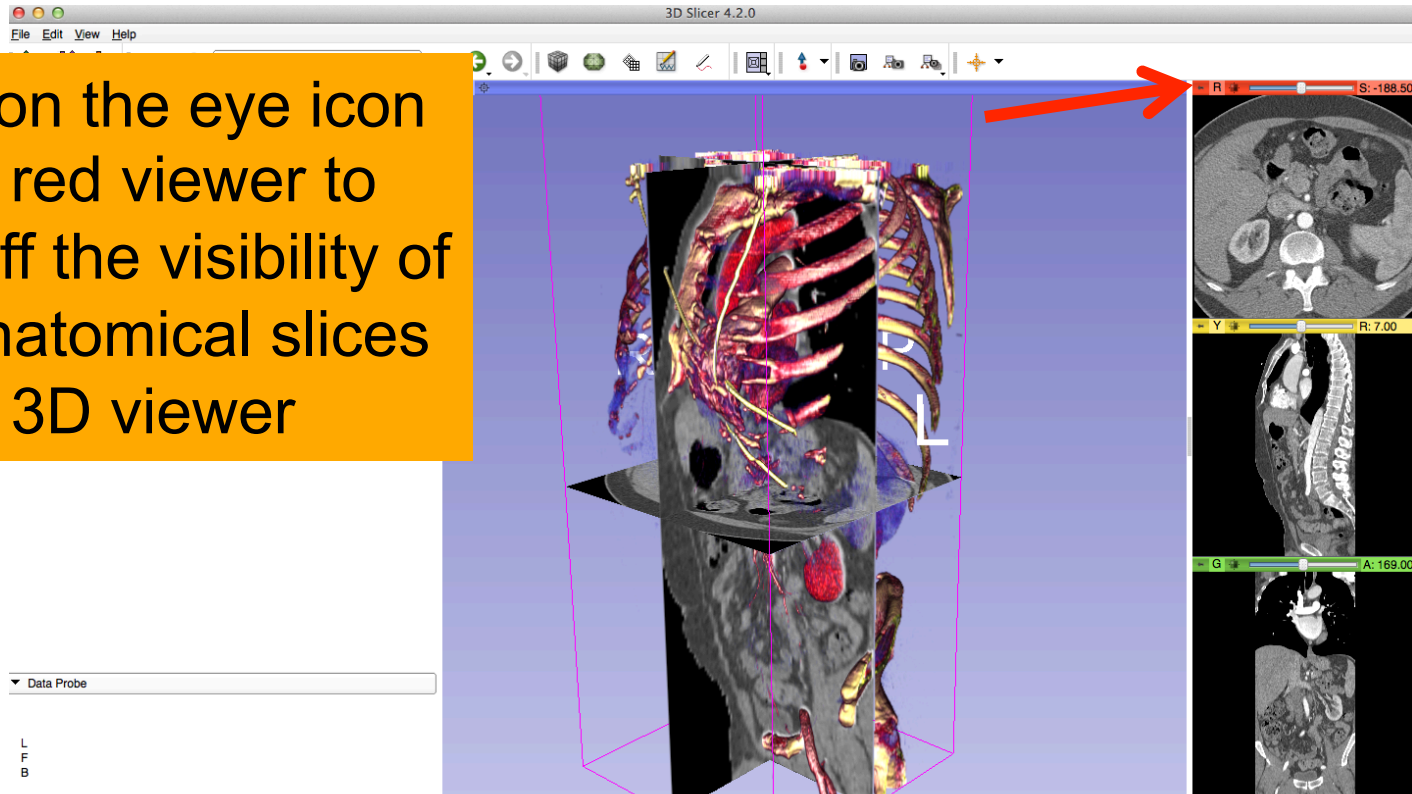


The volume rendered image of the aorta and rib cage appears in the 3D viewer



# Volume Rendering

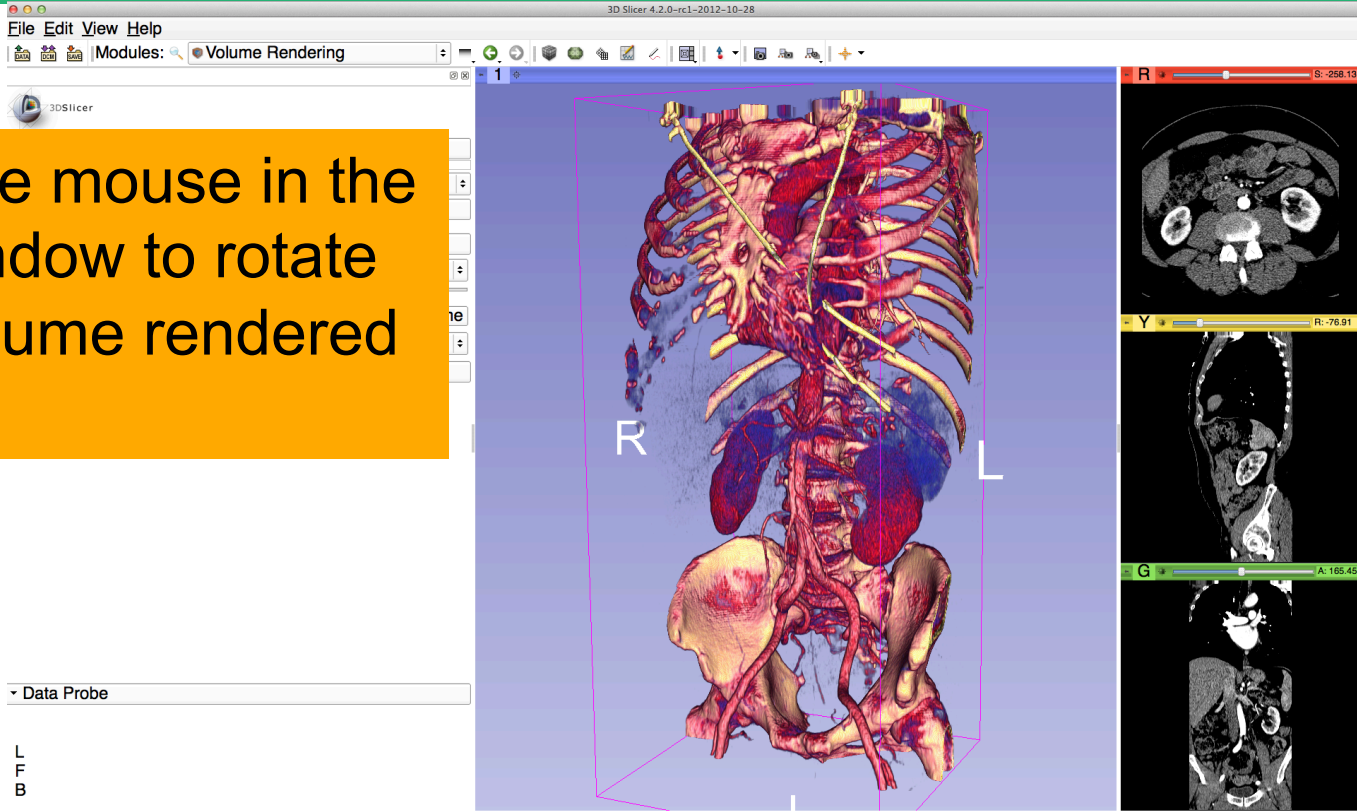
Click on the eye icon in the red viewer to turn off the visibility of the anatomical slices in the 3D viewer





# Volume Rendering

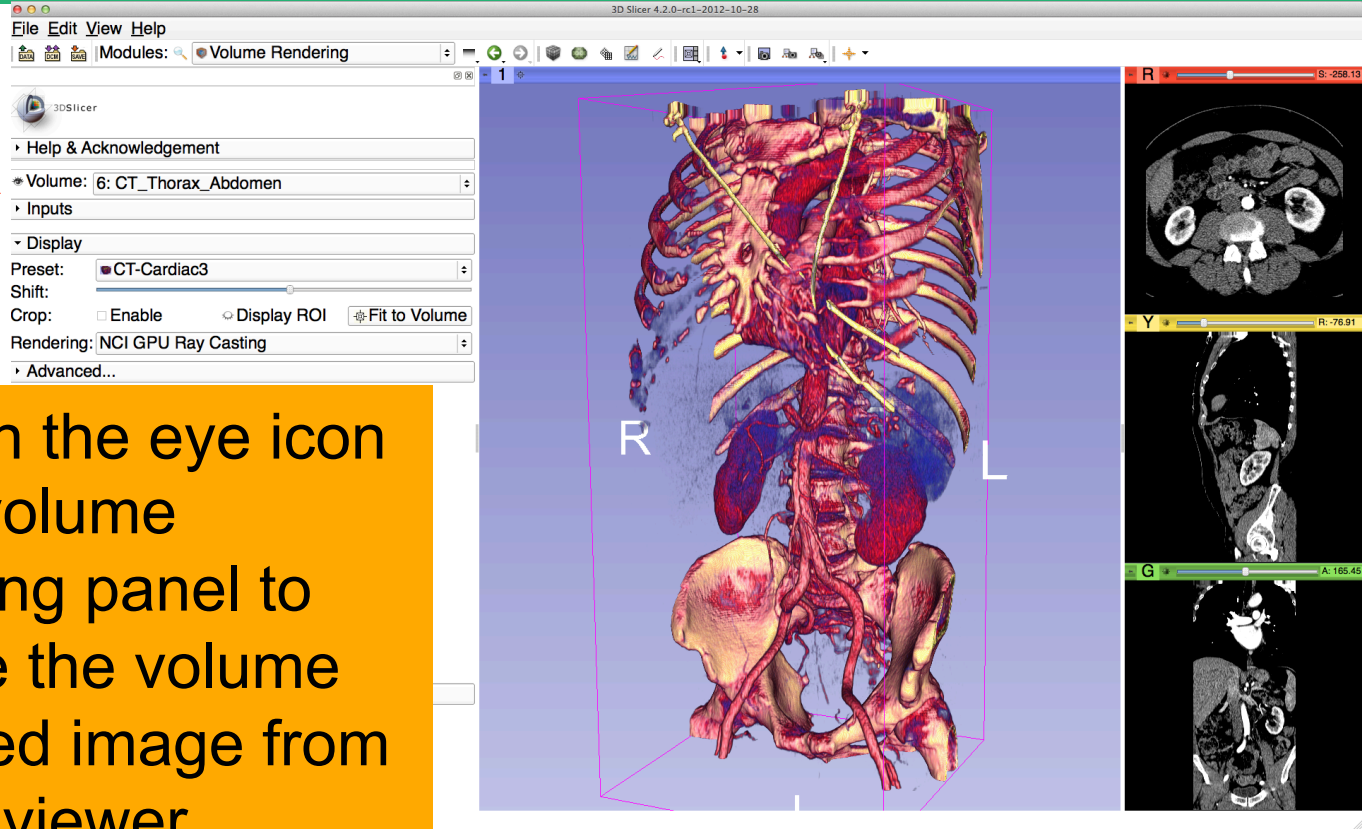
Use the mouse in the 3D window to rotate the volume rendered image







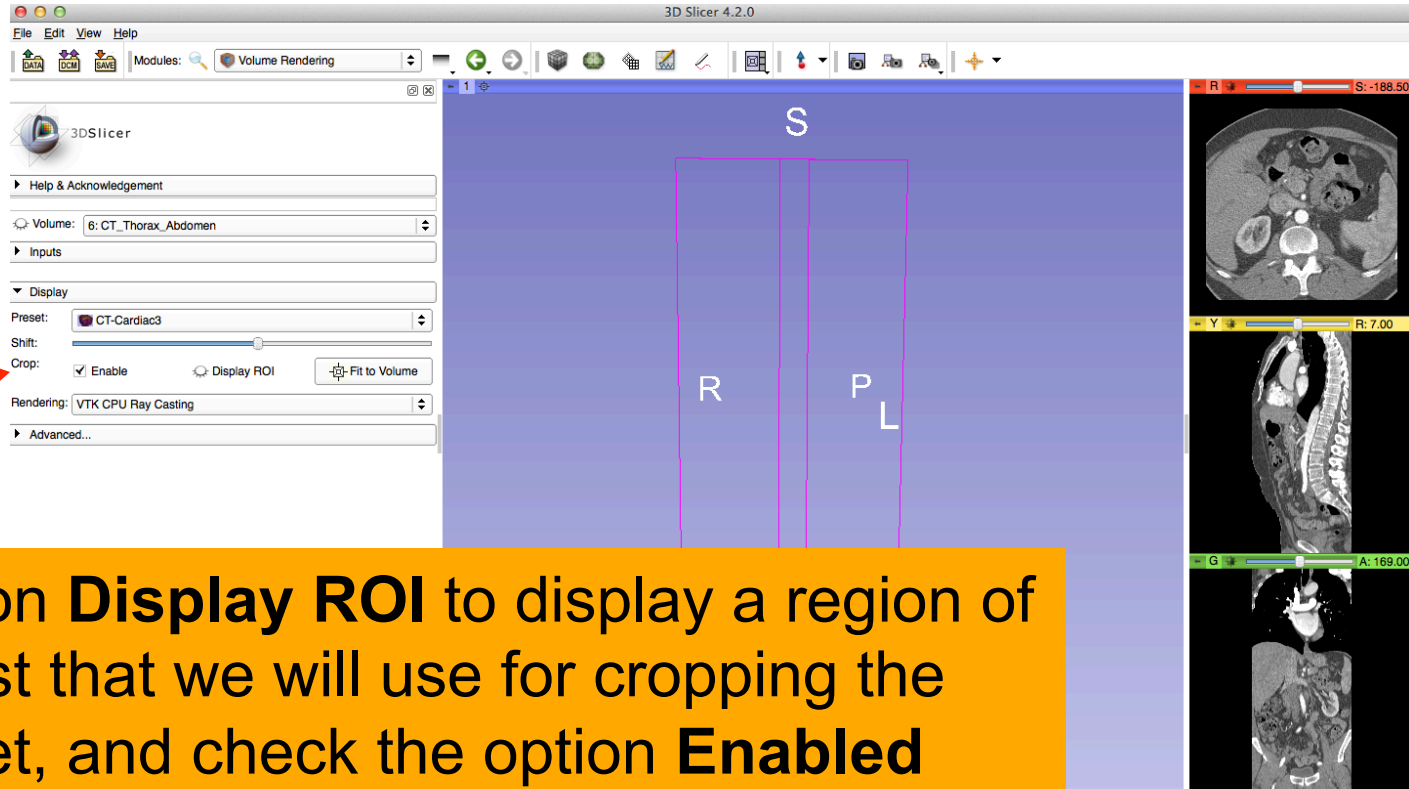
# Volume Rendering



Click on the eye icon in the volume rendering panel to remove the volume rendered image from the 3D viewer



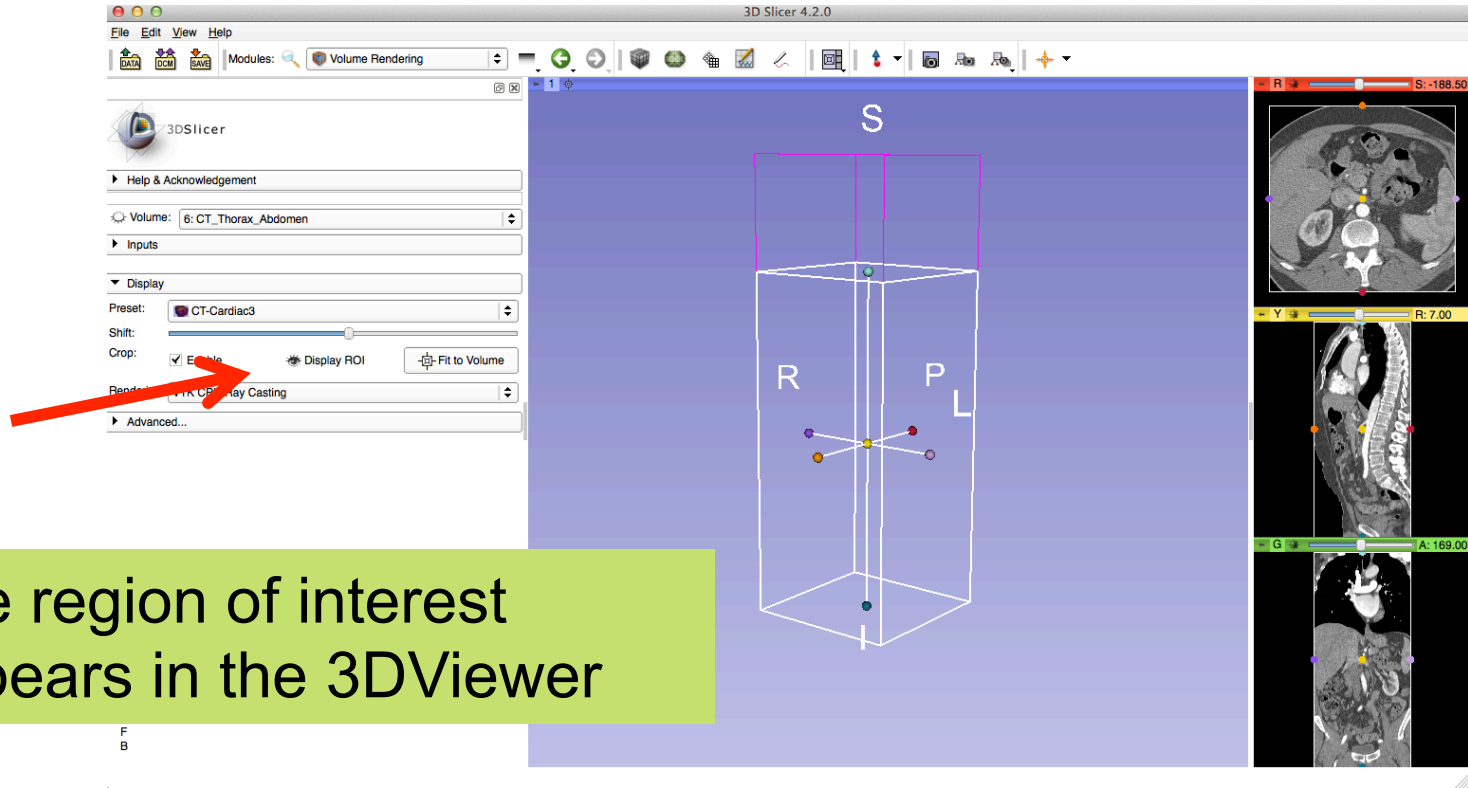
# Volume Rendering



Click on **Display ROI** to display a region of interest that we will use for cropping the dataset, and check the option **Enabled**



# Volume Rendering

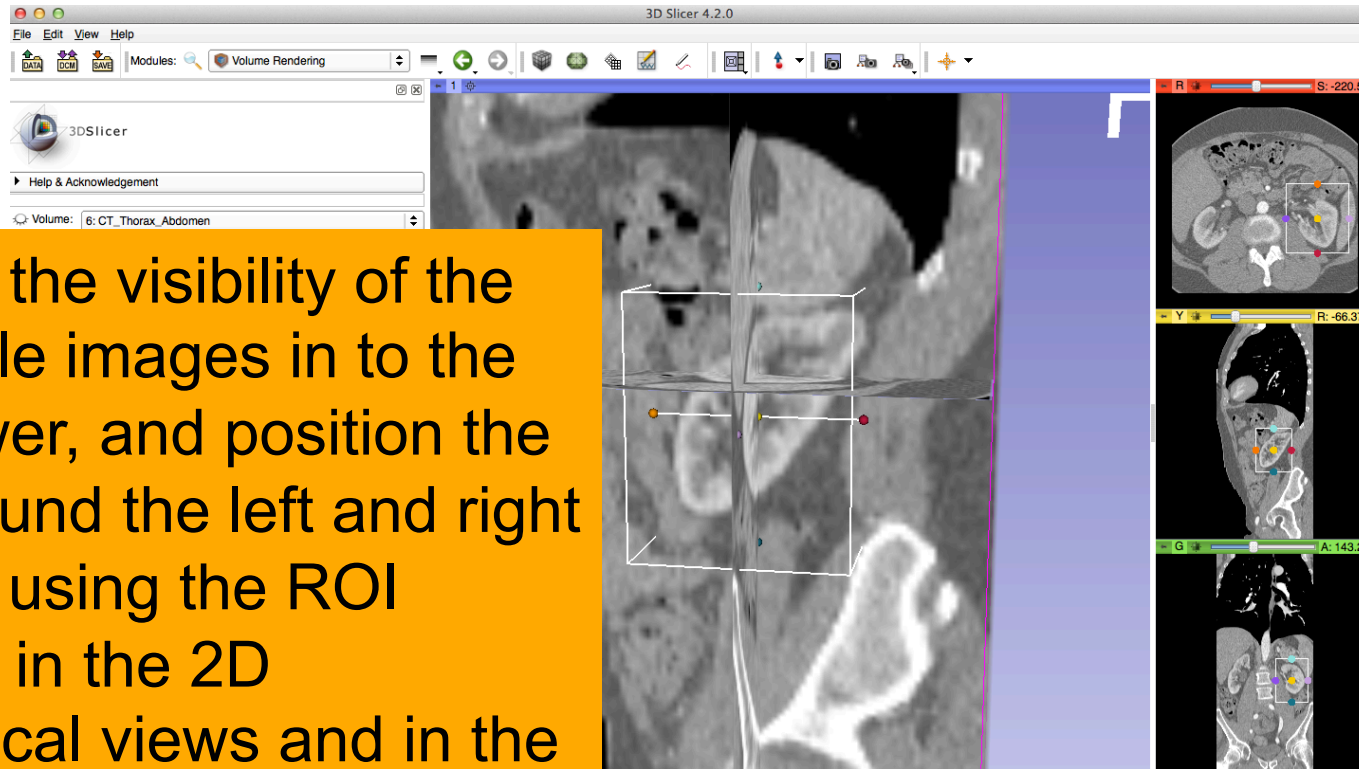


The region of interest  
appears in the 3DViewer





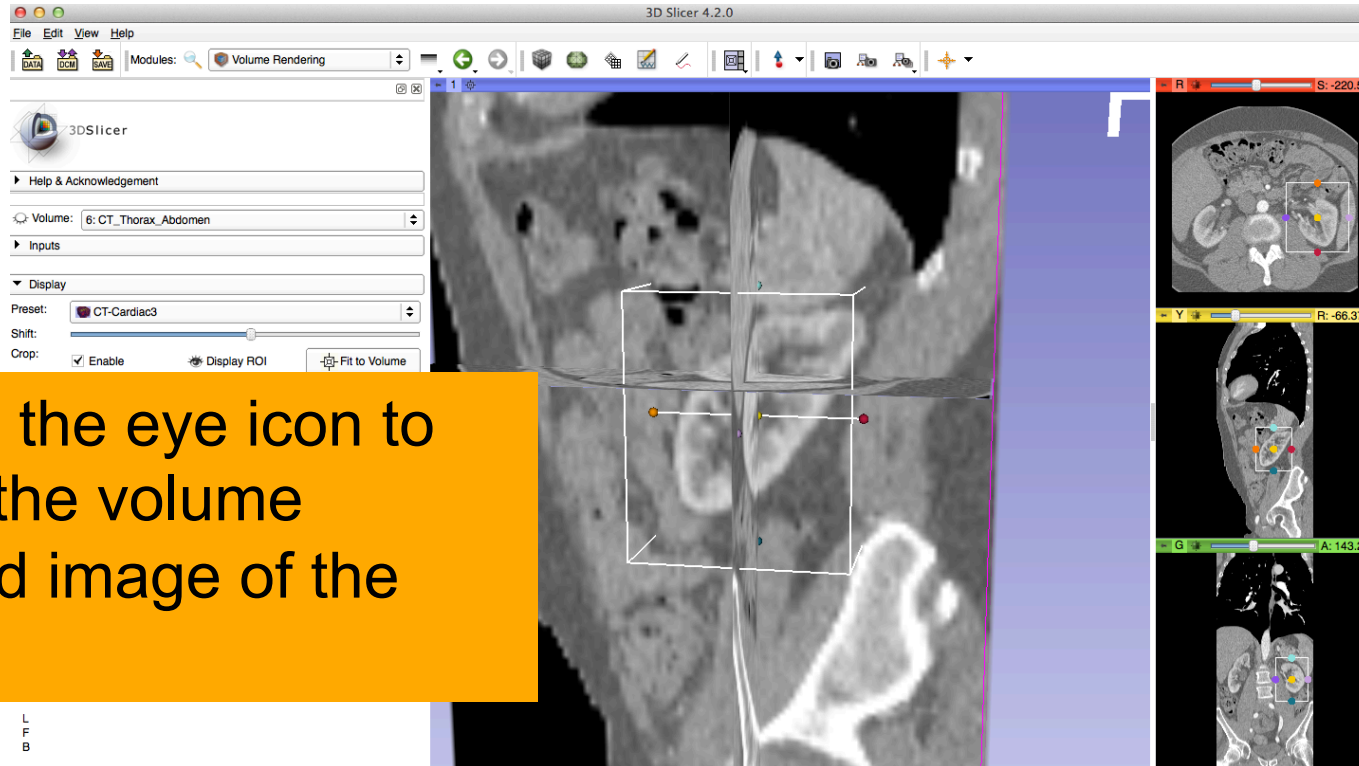
# Volume Rendering



Turn on the visibility of the grayscale images in to the 3D Viewer, and position the ROI around the left and right kidneys using the ROI controls in the 2D anatomical views and in the 3D viewer



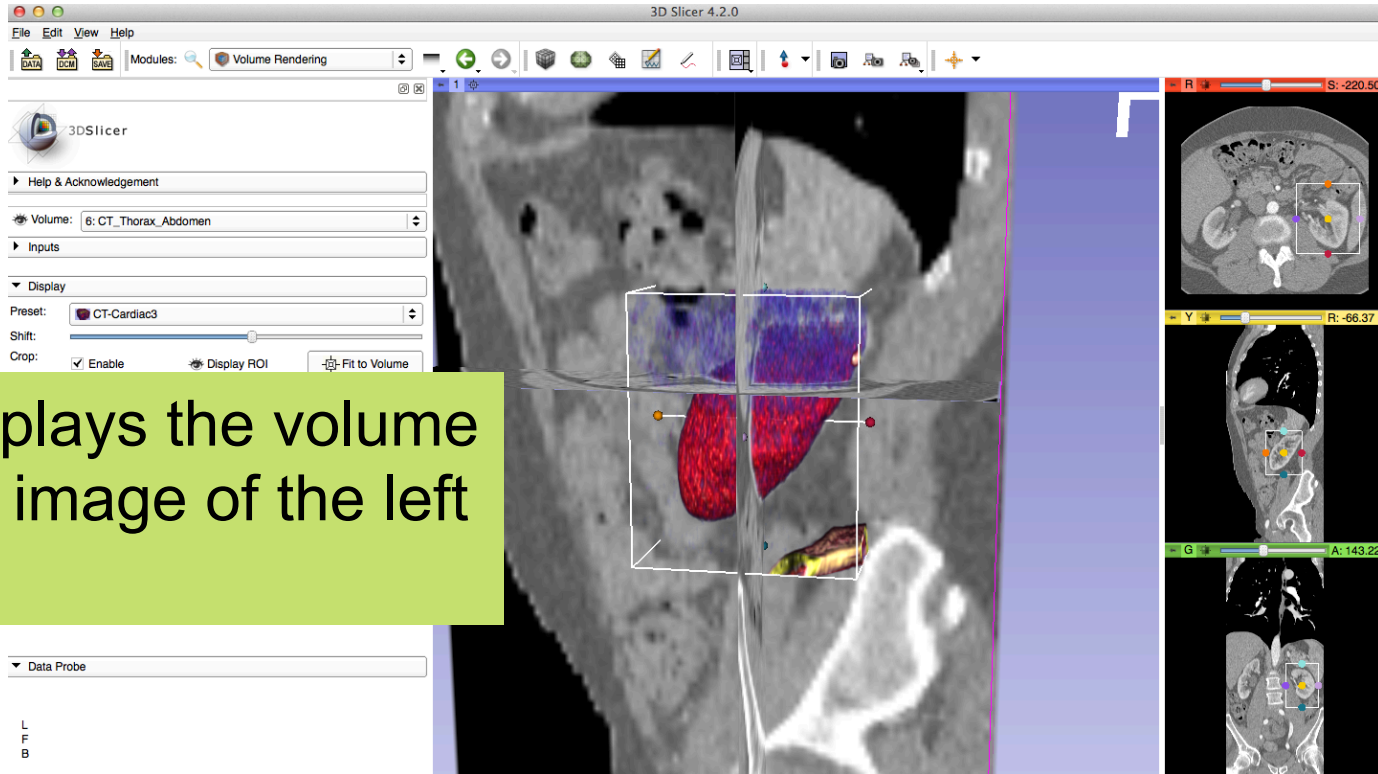
# Volume Rendering



Click on the eye icon to display the volume rendered image of the kidney



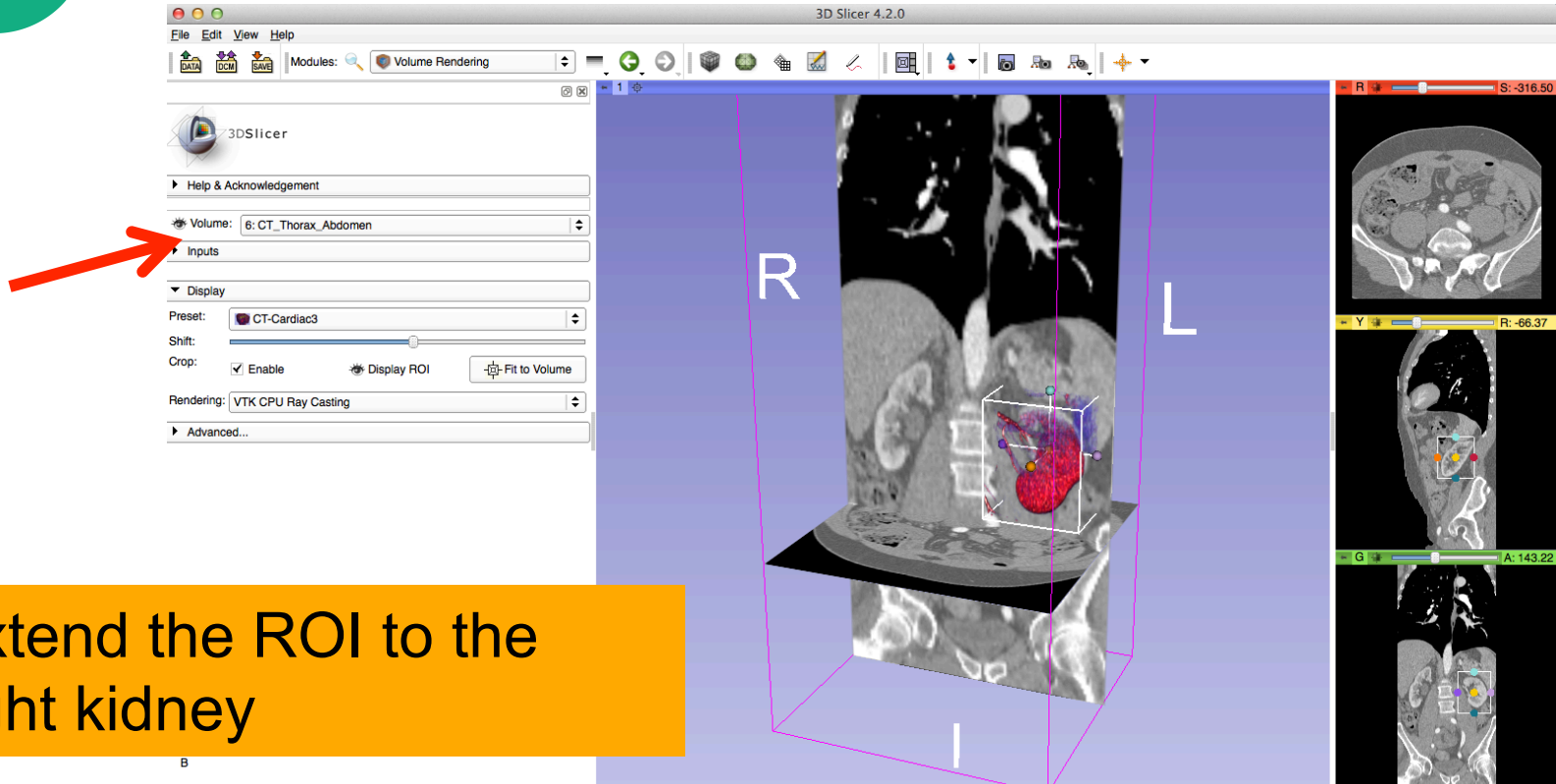
# Volume Rendering



Slicer displays the volume rendered image of the left kidney



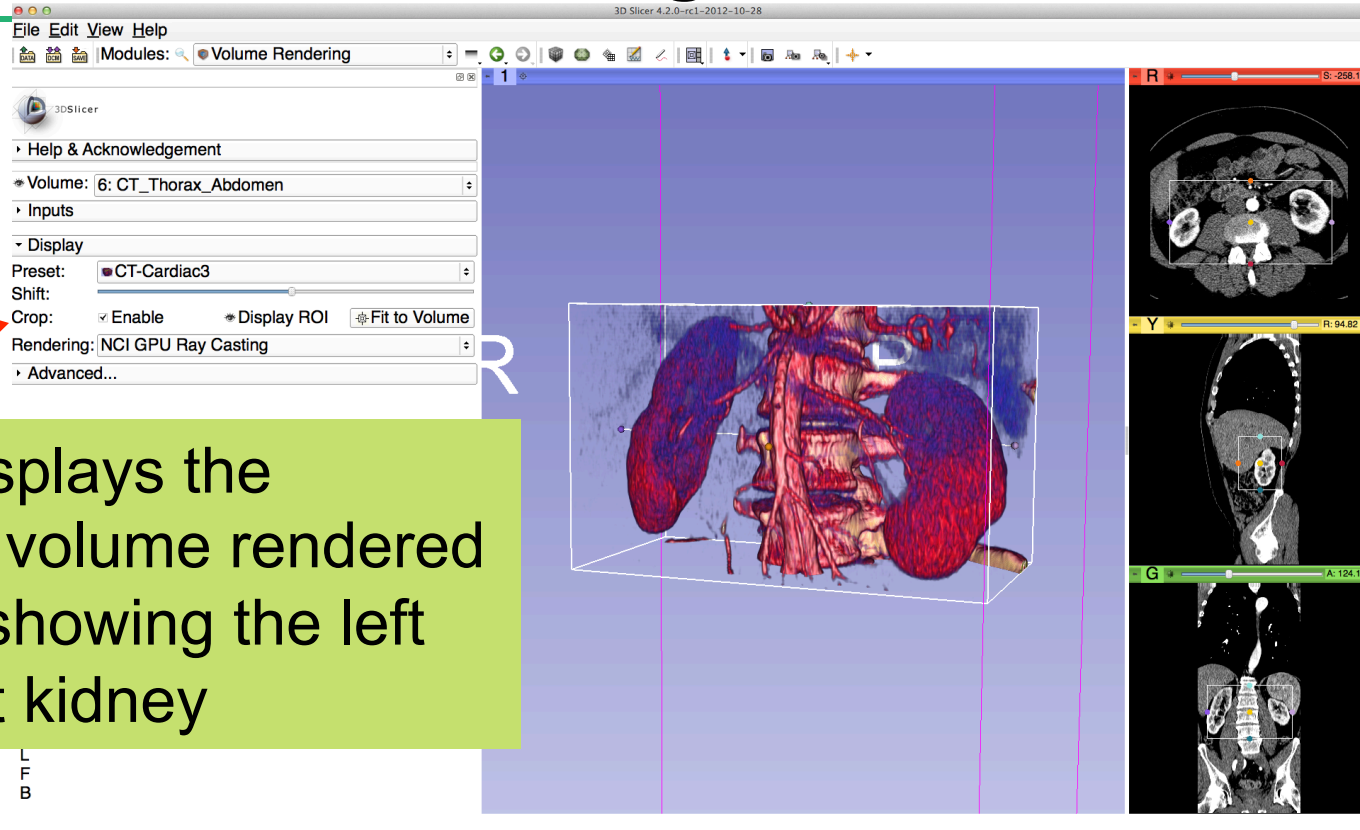
# Volume Rendering



Extend the ROI to the right kidney



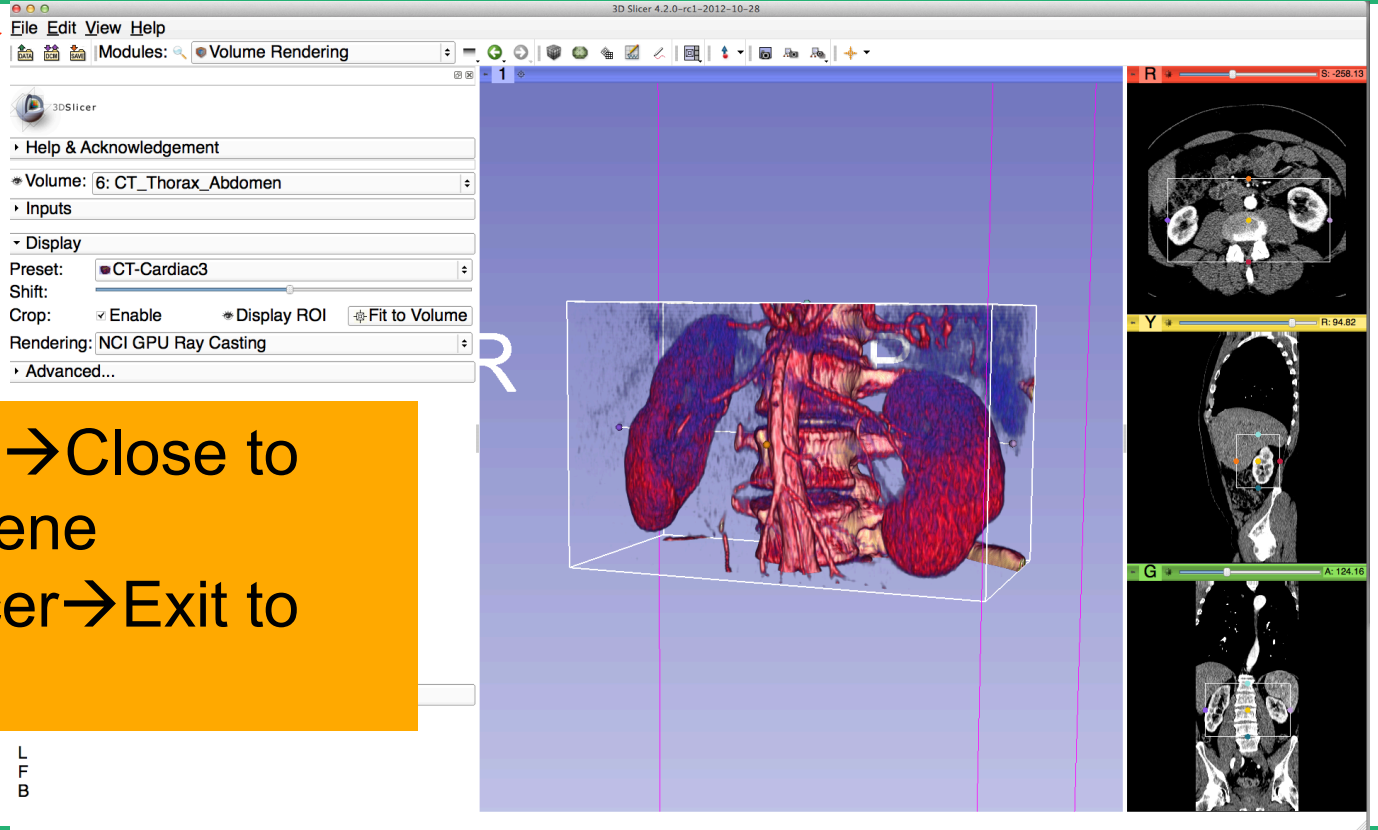
# Volume Rendering



Slicer displays the cropped volume rendered images showing the left and right kidney



# Volume Rendering

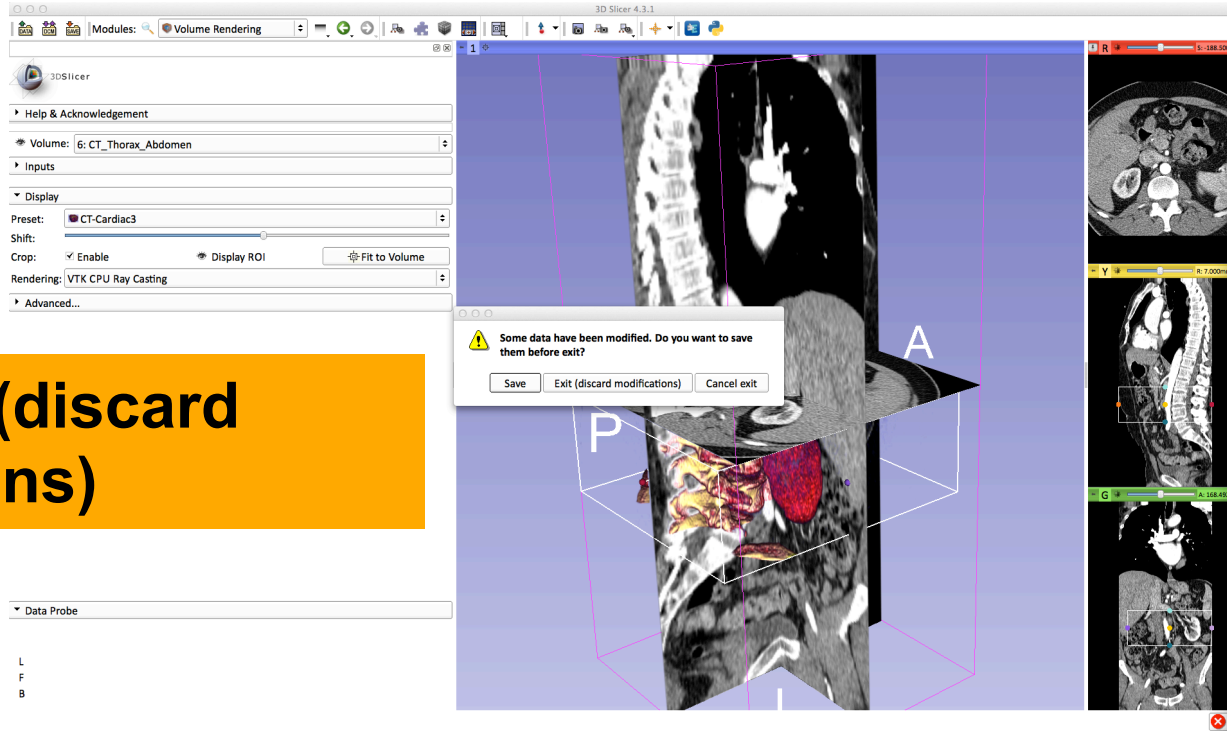


Click on File→Close to  
close the scene  
Click on Slicer→Exit to  
quit Slicer

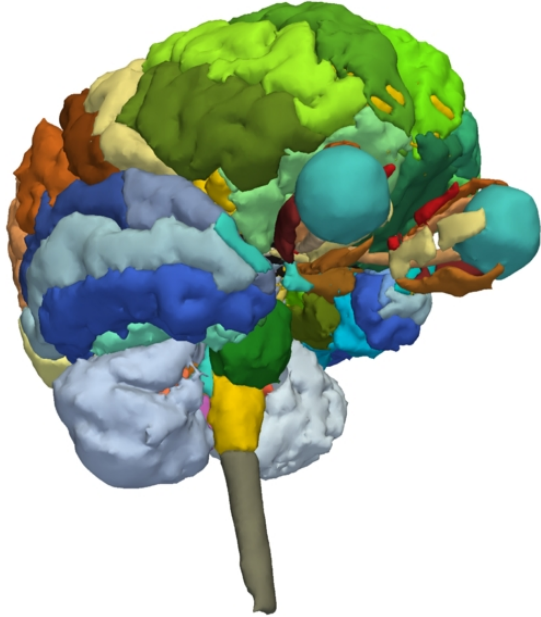
L  
F  
B



# Volume Rendering



**Select Exit (discard modifications)**



3D visualization of surface models of the brain





# 3D Data Loading and Visualization

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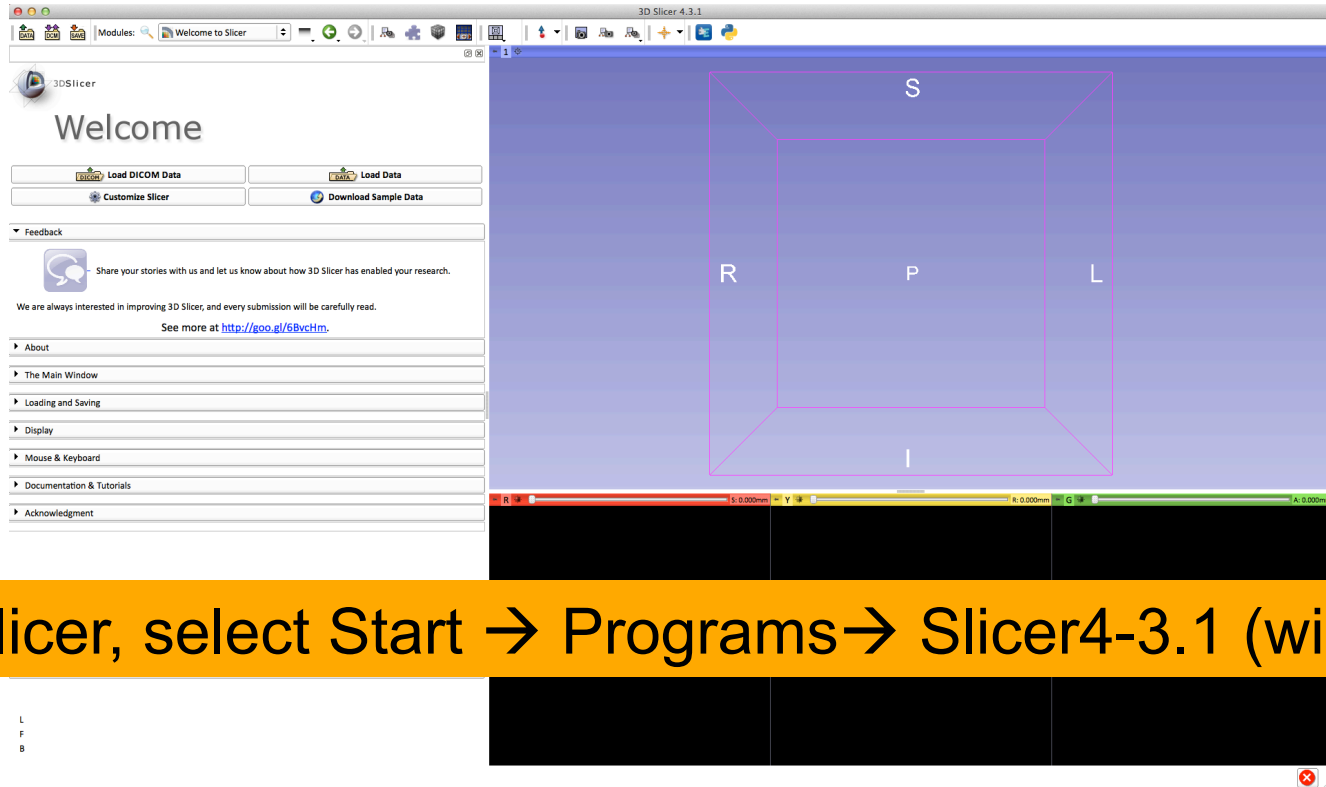


- This tutorial is a short introduction to the advanced **3D visualization capabilities Slicer**
- The Slicer4 Minute dataset is composed of an MR scan of the brain and 3D surface reconstructions of anatomical structures.
- The data are part of the SPL-PNL Brain Atlas developed by Talos, Jakab, Kikinis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

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



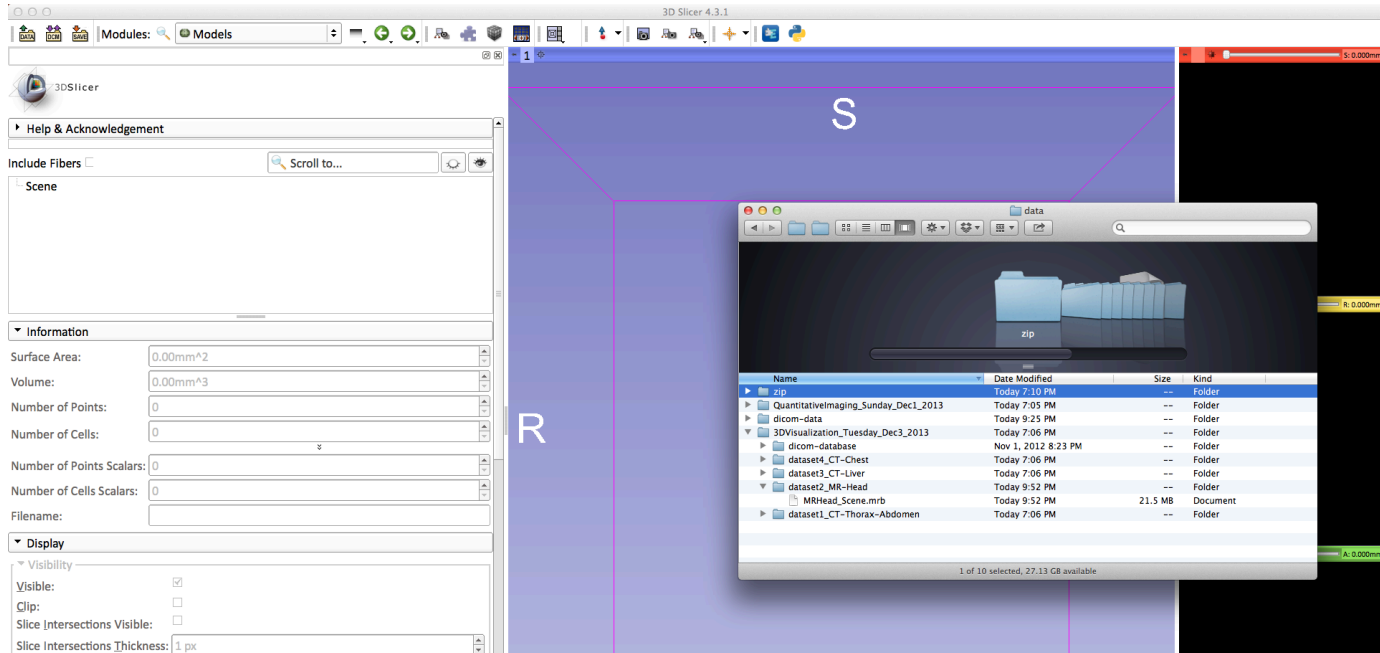
# Welcome to Slicer4



To start Slicer, select Start → Programs → Slicer4-3.1 (win64)



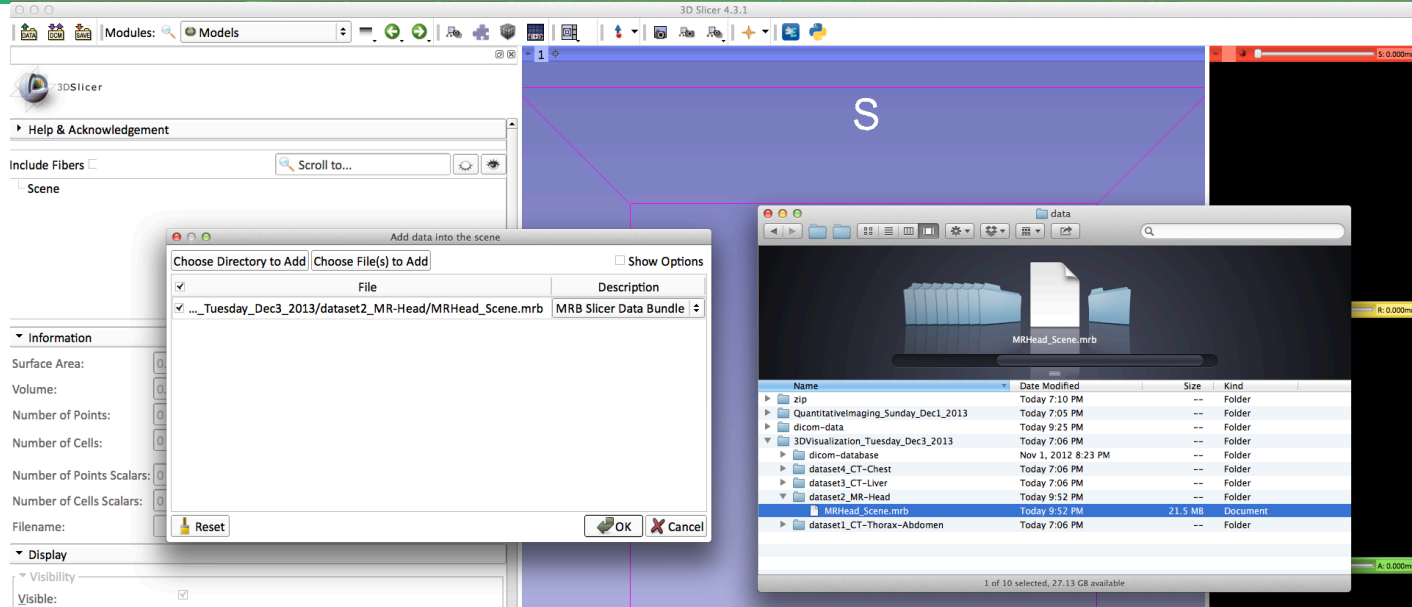
# Slicer4 Minute Tutorial: Viewing the Scene



Open the directory **dataset2\_Head** located in  
**C:/3DSlicerData\_RSNA2013/3DVisualizationDICOM\_Tuesday\_Dec3**  
Drag and drop the file **Head\_Scene.mrb** into Slicer



# Slicer4 Minute Tutorial: Viewing the Scene



Click on **OK** to load the file **MRHead\_Scene.mrb** into Slicer

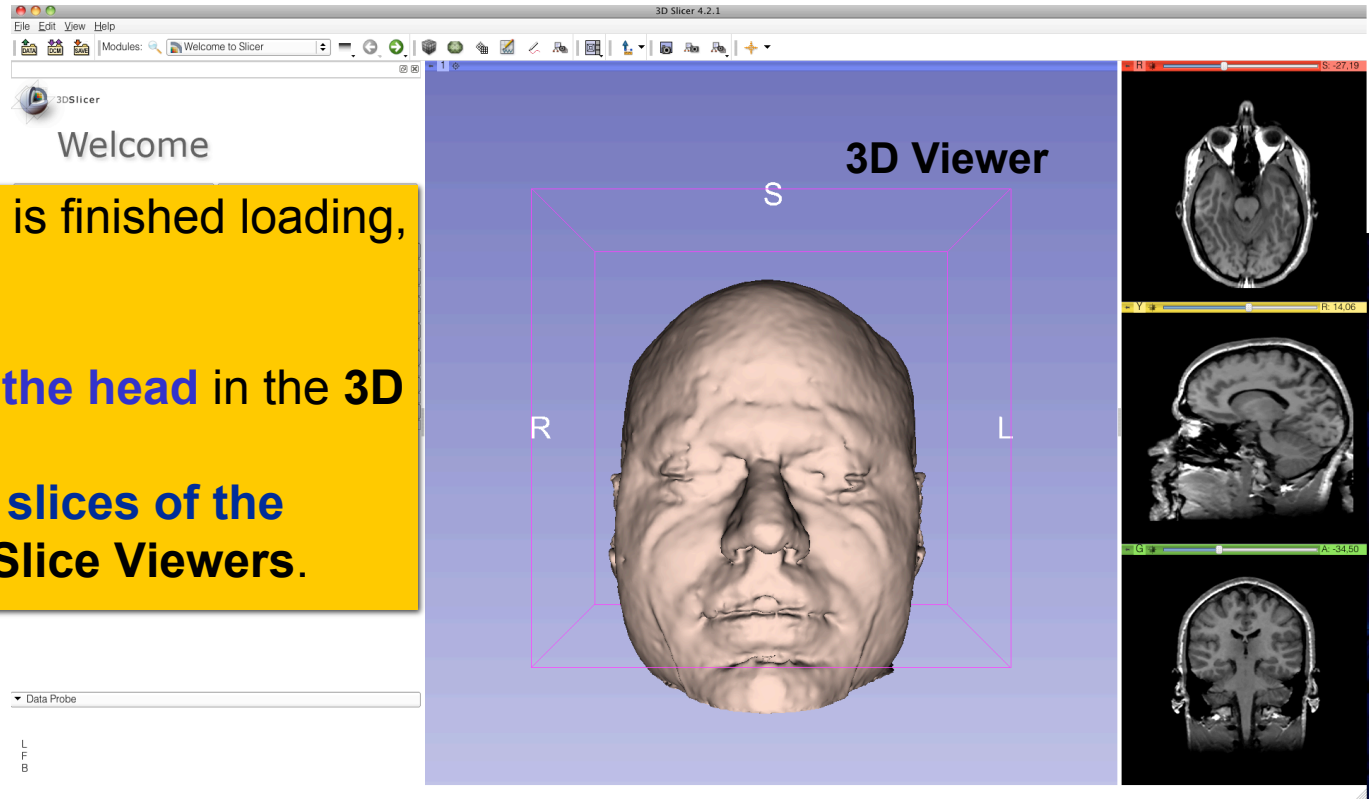
L  
F  
B



# Slicer4 Minute Tutorial: Viewing the Scene

When the scene is finished loading, Slicer displays:

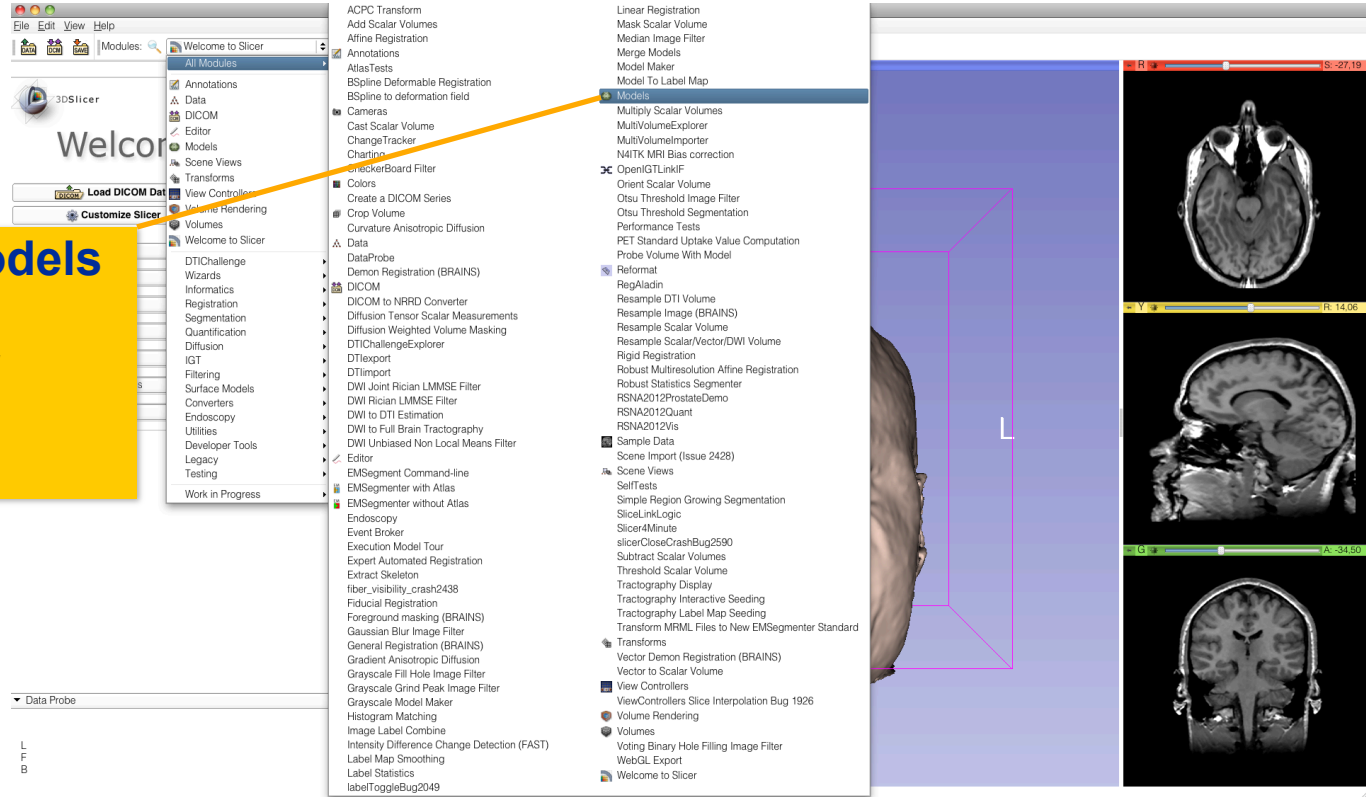
- a **3D model of the head** in the **3D Viewer**, and
- anatomical **MR slices of the brain** in the **2D Slice Viewers**.





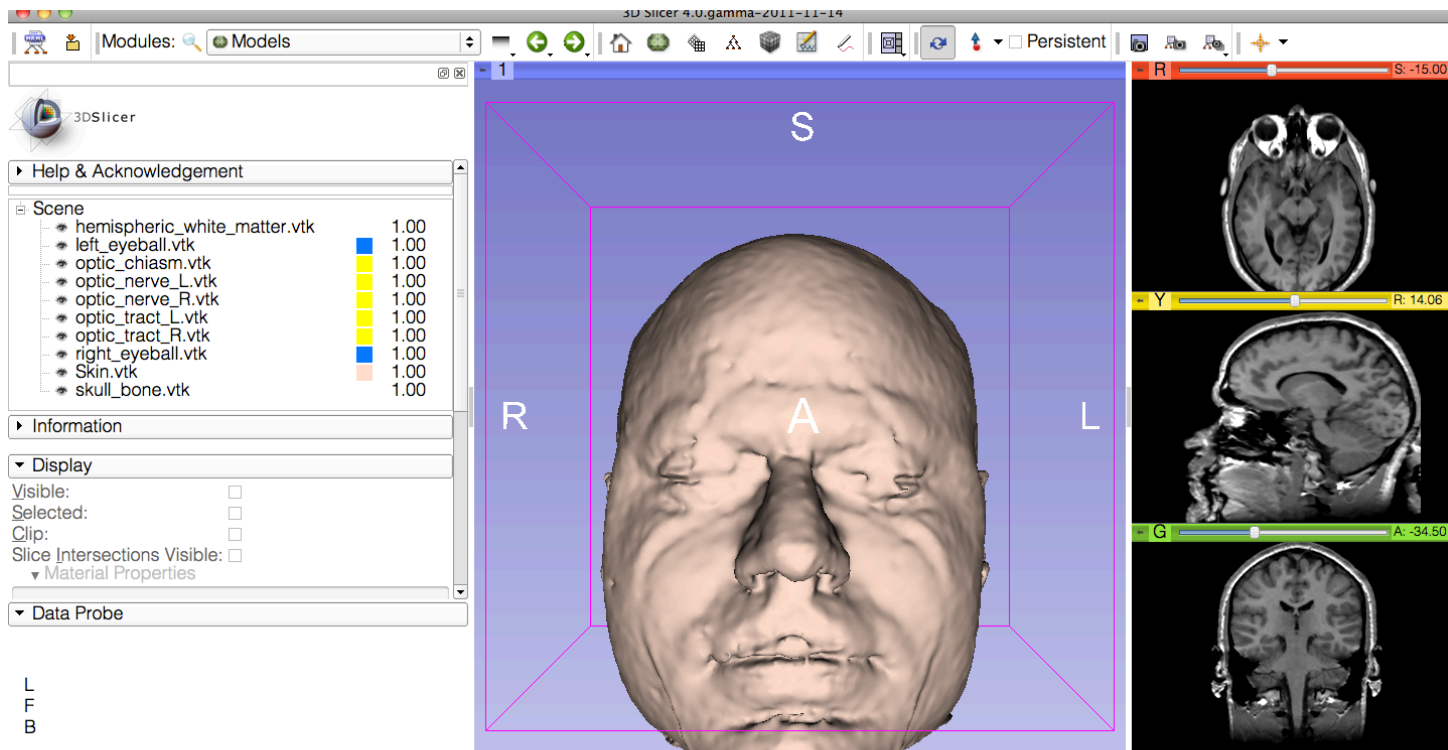
# Slicer4 Minute Tutorial: Exploring Slicer's functionality

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





# Slicer4 Minute Tutorial: Switching to the Models Module

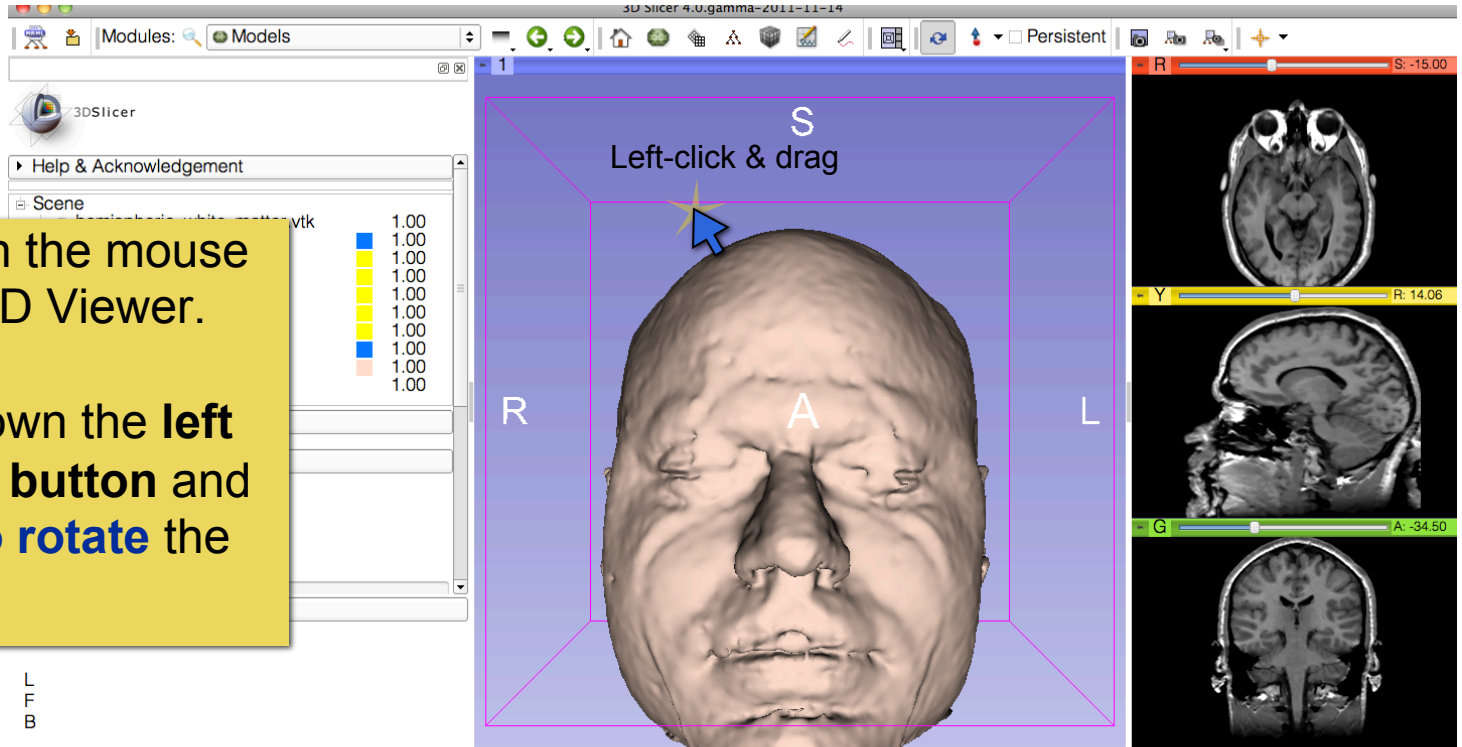




# Slicer4 Minute Tutorial: Basic 3D Interaction

Position the mouse  
in the 3D Viewer.

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

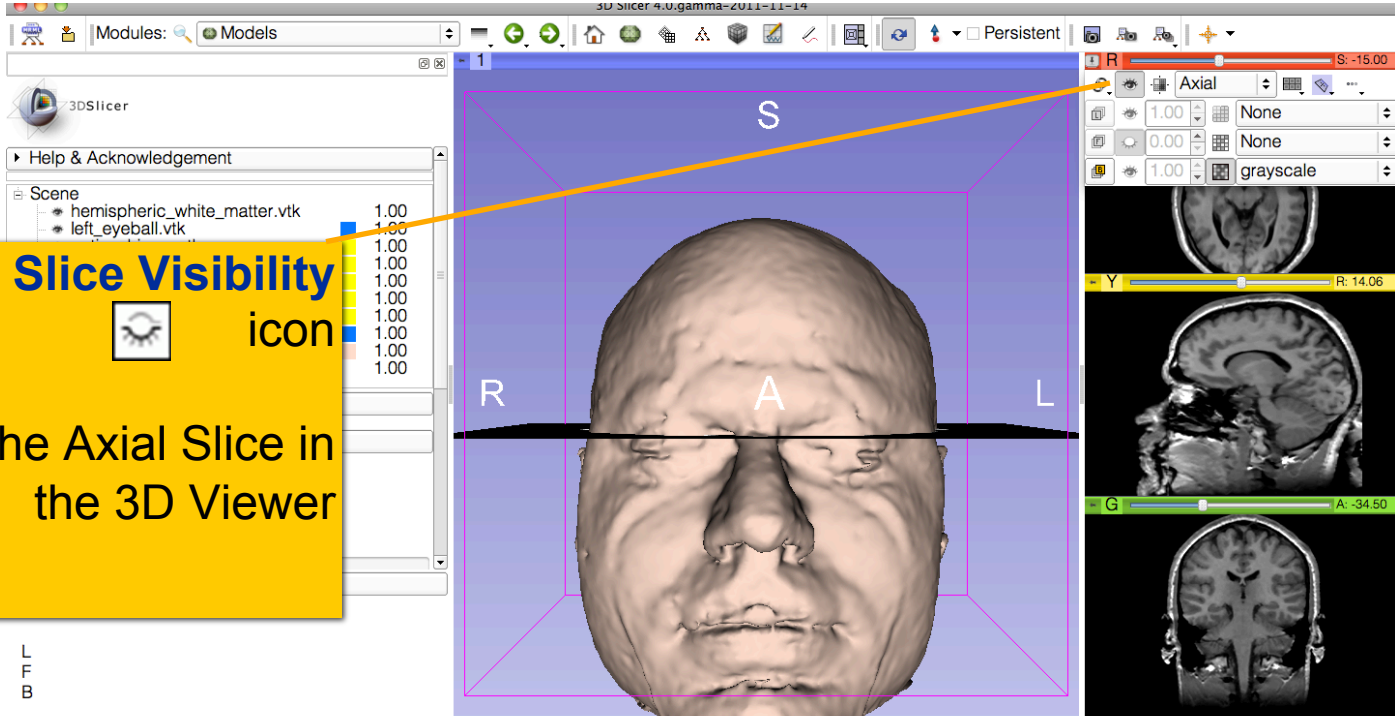






# Slicer4 Minute Tutorial: Viewing Slices in the 3D Viewer

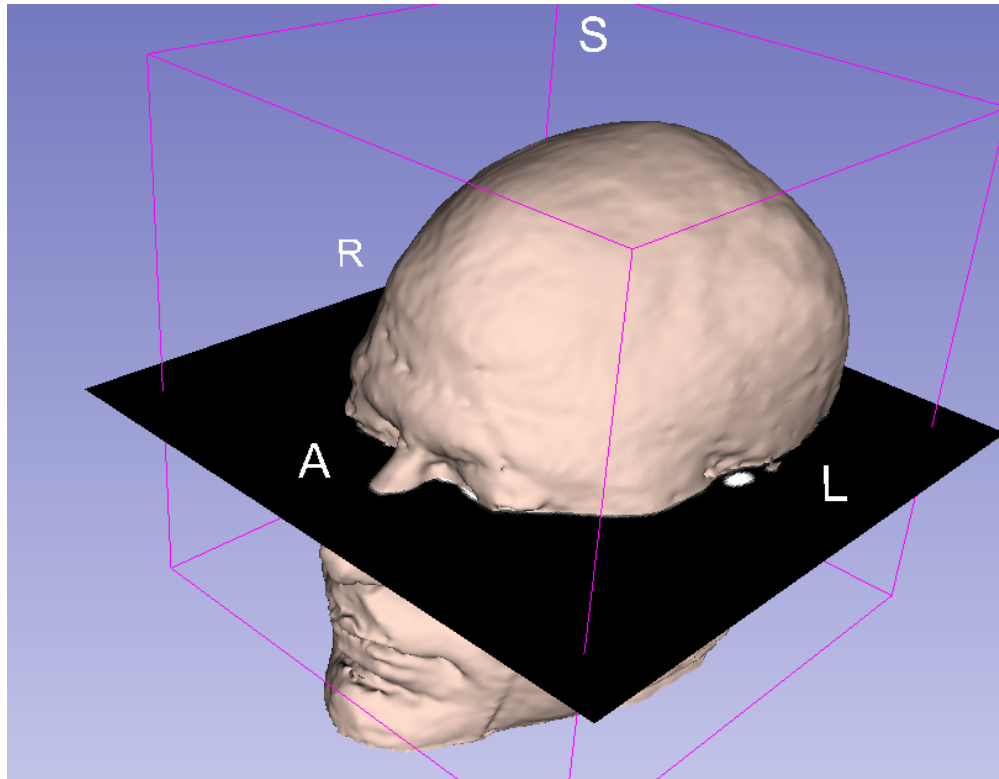
Click on the **Slice Visibility** icon  
to display the Axial Slice in  
the 3D Viewer





## Slicer4 Minute Tutorial: 3D Visualization

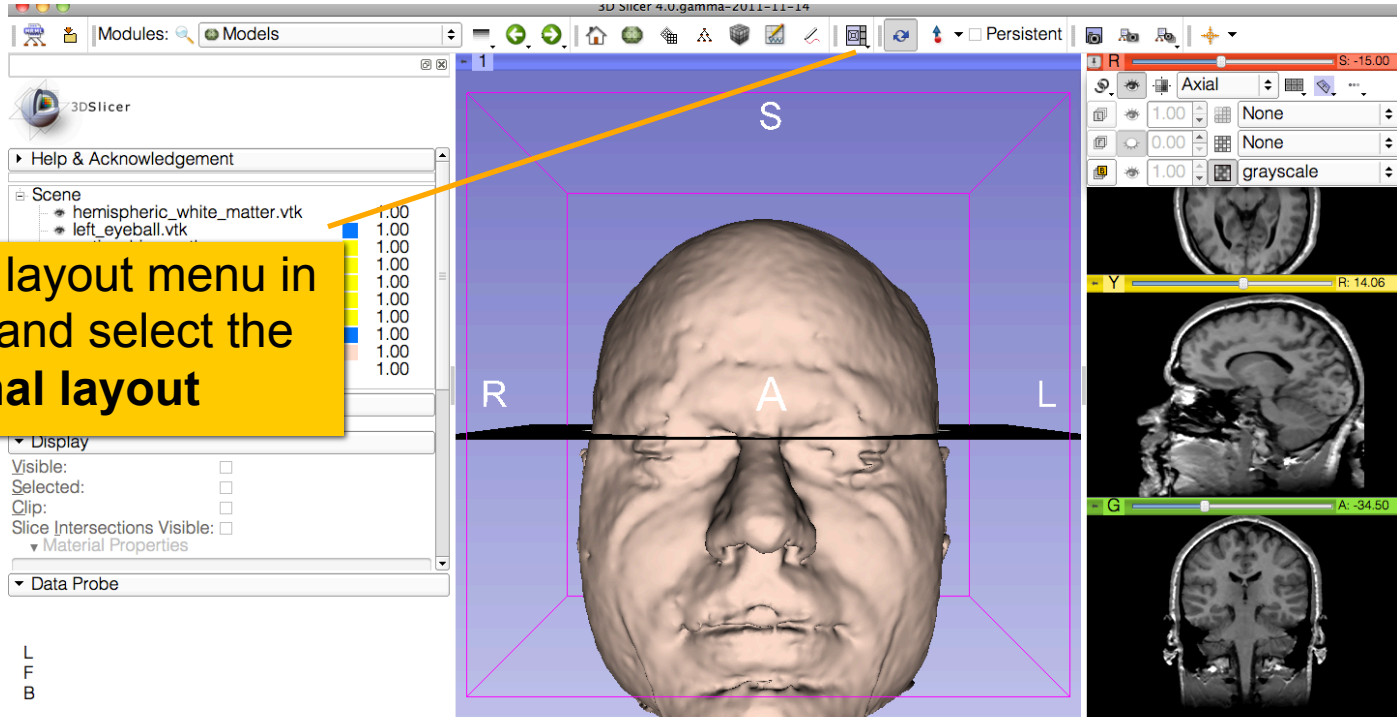
Slicer adds a view of the **Axial slice** in the 3D View.





# Slicer4 Minute Tutorial: Viewing Slices in the 3D Viewer

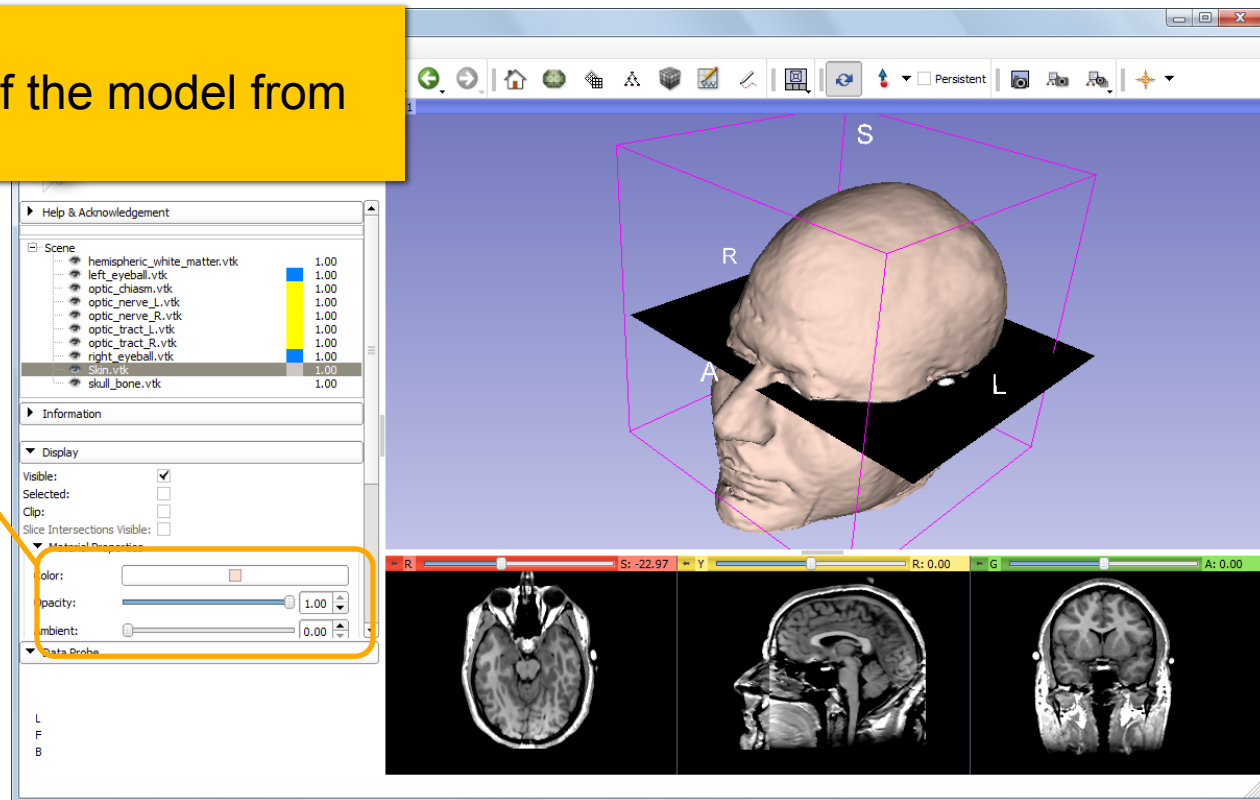
Click on the layout menu in the toolbar, and select the **Conventional layout**





## Slicer4 Minute Tutorial: 3D Visualization

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

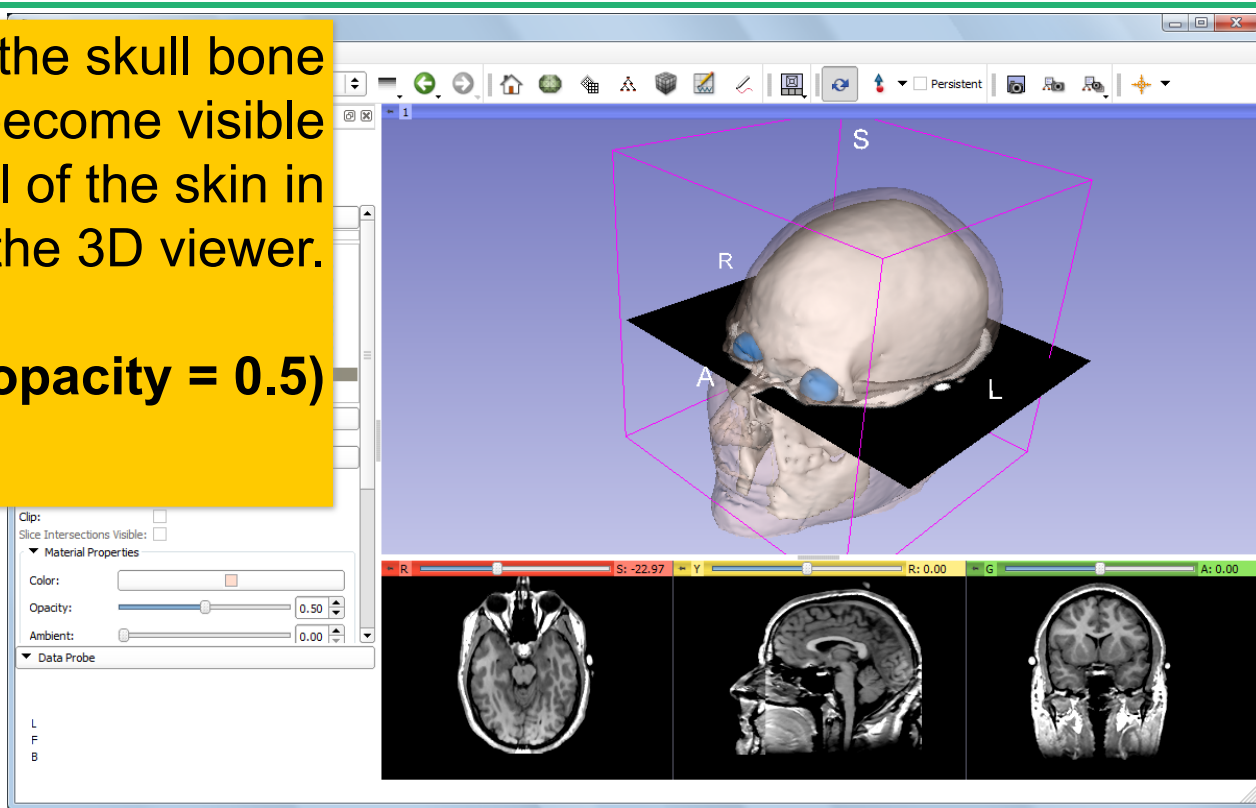




## Slicer4 Minute Tutorial: 3D Visualization

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

**(skin model opacity = 0.5)**

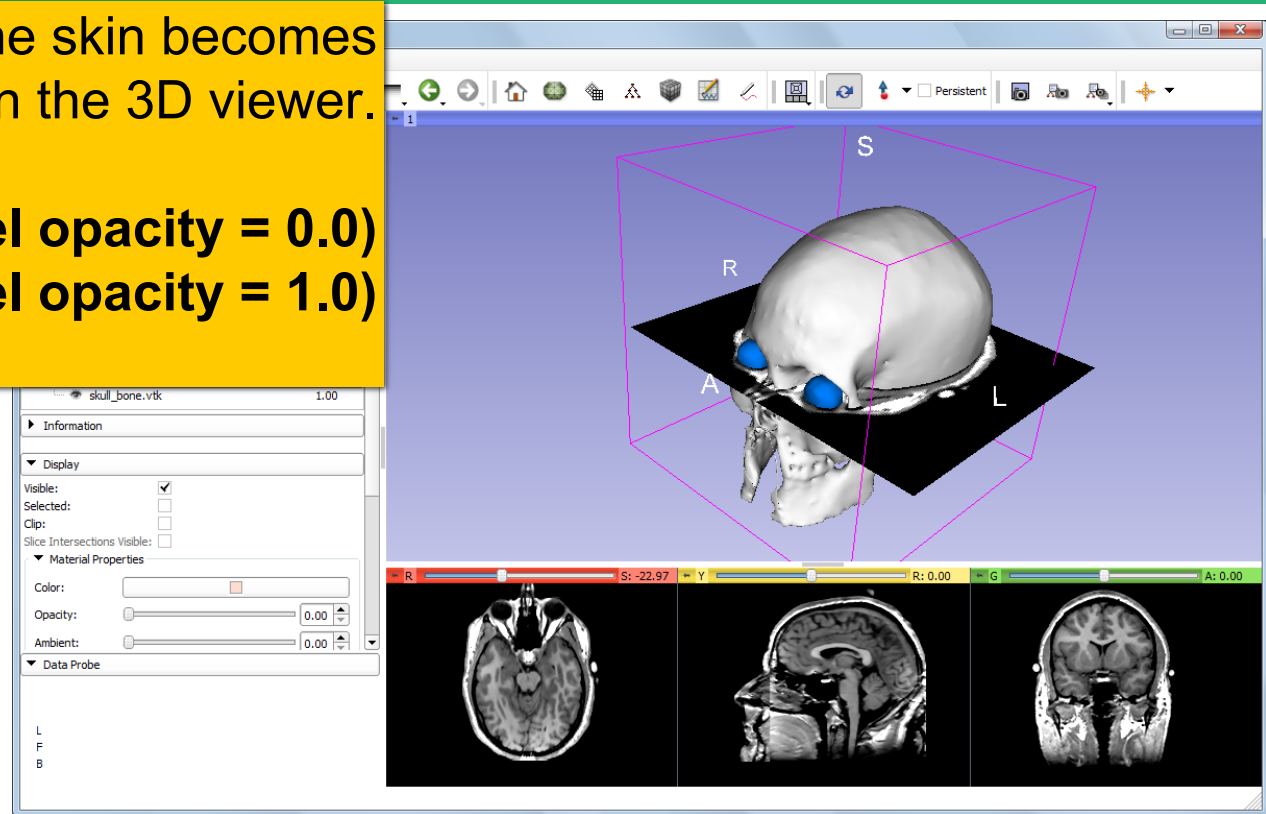




## Slicer4 Minute Tutorial: 3D Visualization

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

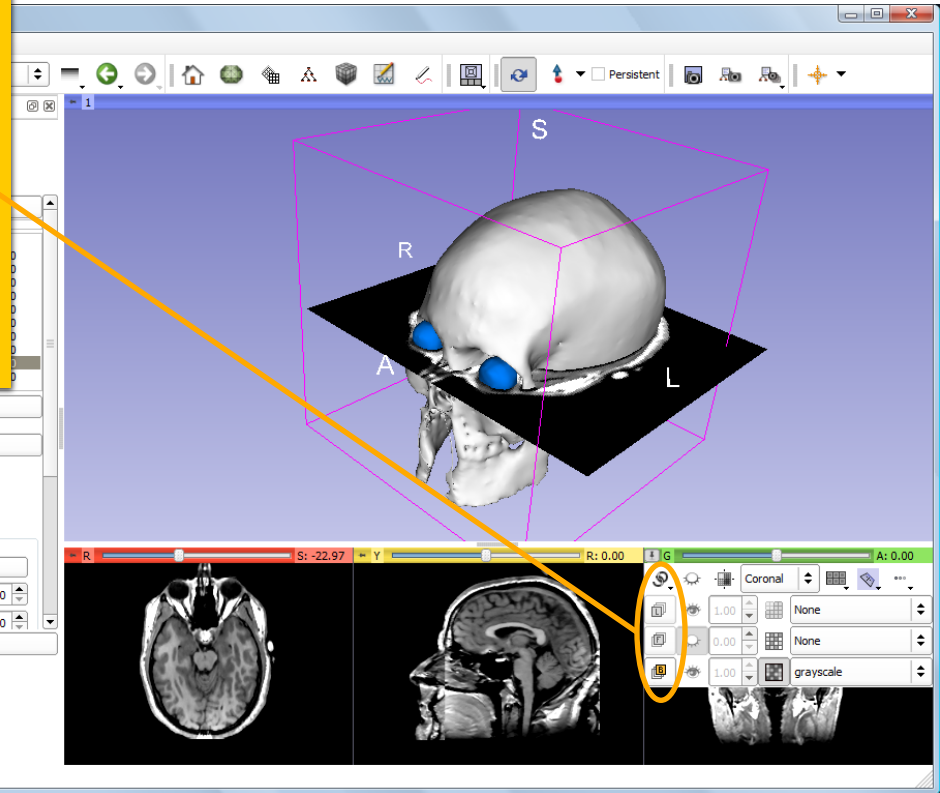
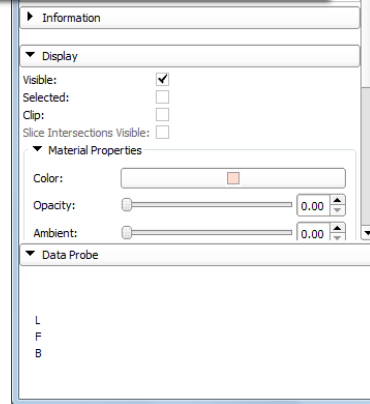
**(skin model opacity = 0.0)**  
**(skull model opacity = 1.0)**





## Slicer4 Minute Tutorial: 3D Visualization

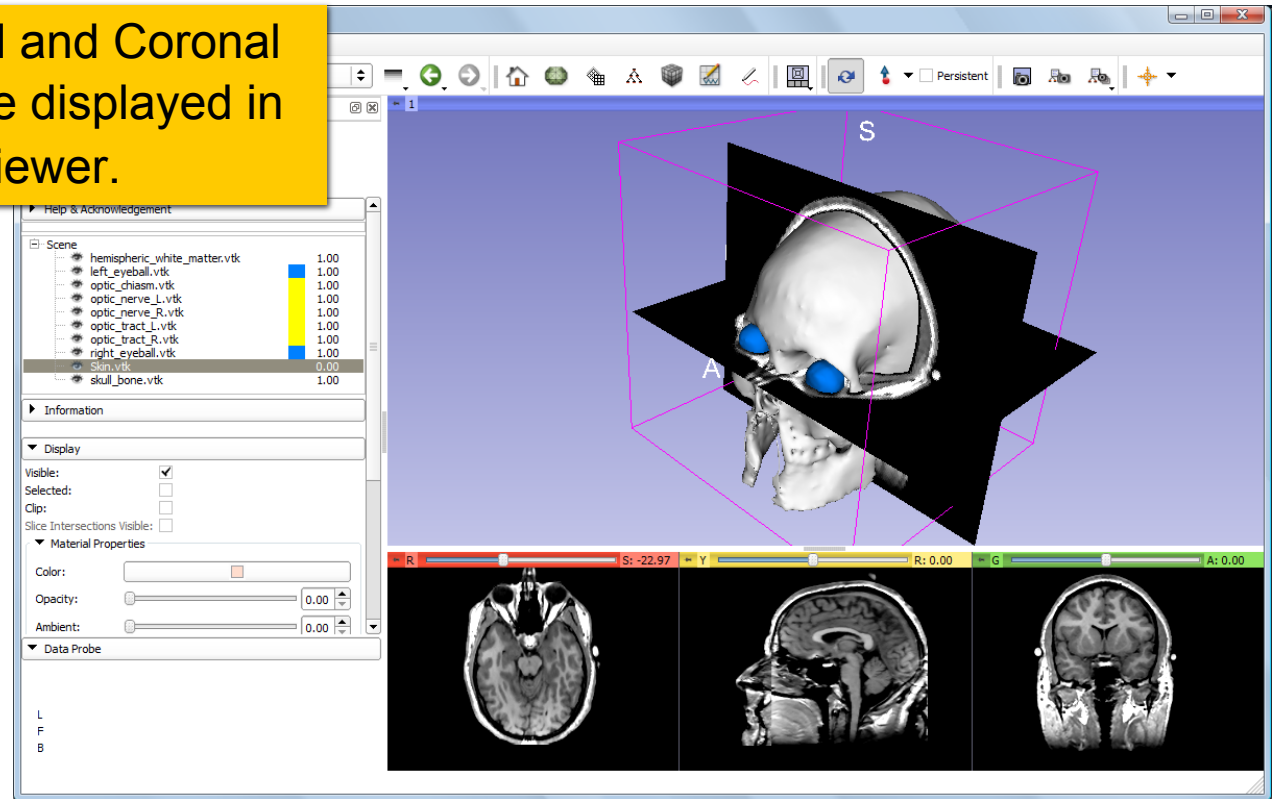
Click on the **Slice Visibility** icon in the **Green Slice Viewer** to display the Coronal Slice in the 3D Viewer.





## Slicer4 Minute Tutorial: 3D Visualization

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

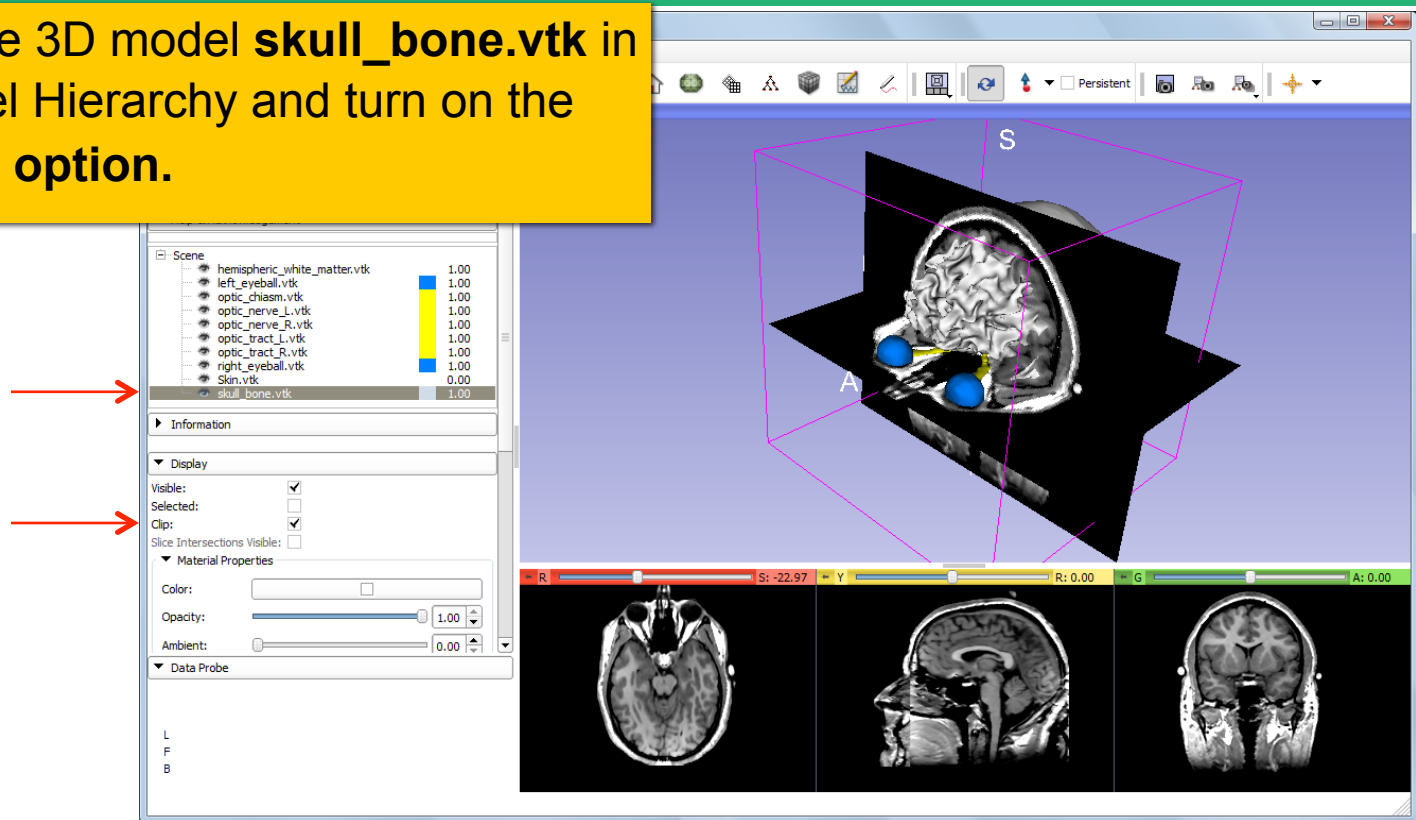






## Slicer4 Minute Tutorial: 3D Visualization

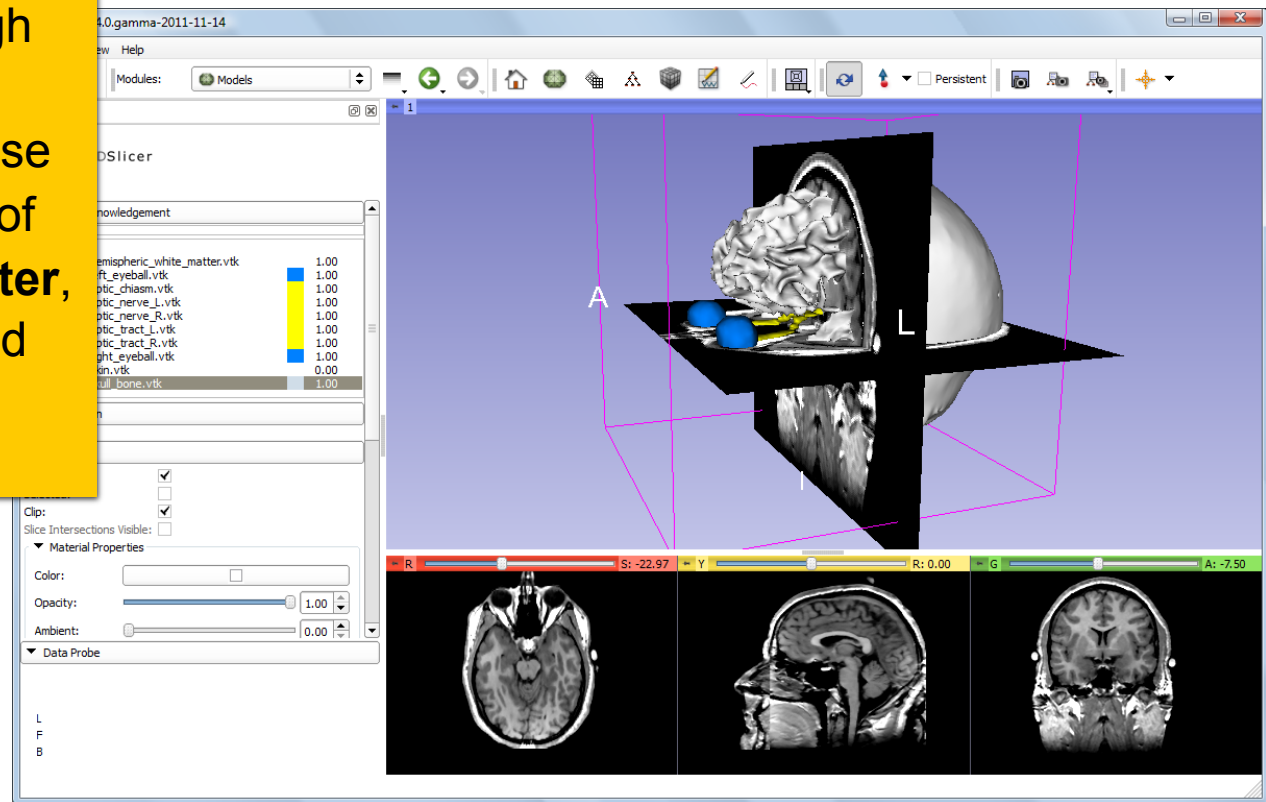
Select the 3D model **skull\_bone.vtk** in the Model Hierarchy and turn on the **Clipping** option.





## Slicer4 Minute Tutorial: 3D Visualization

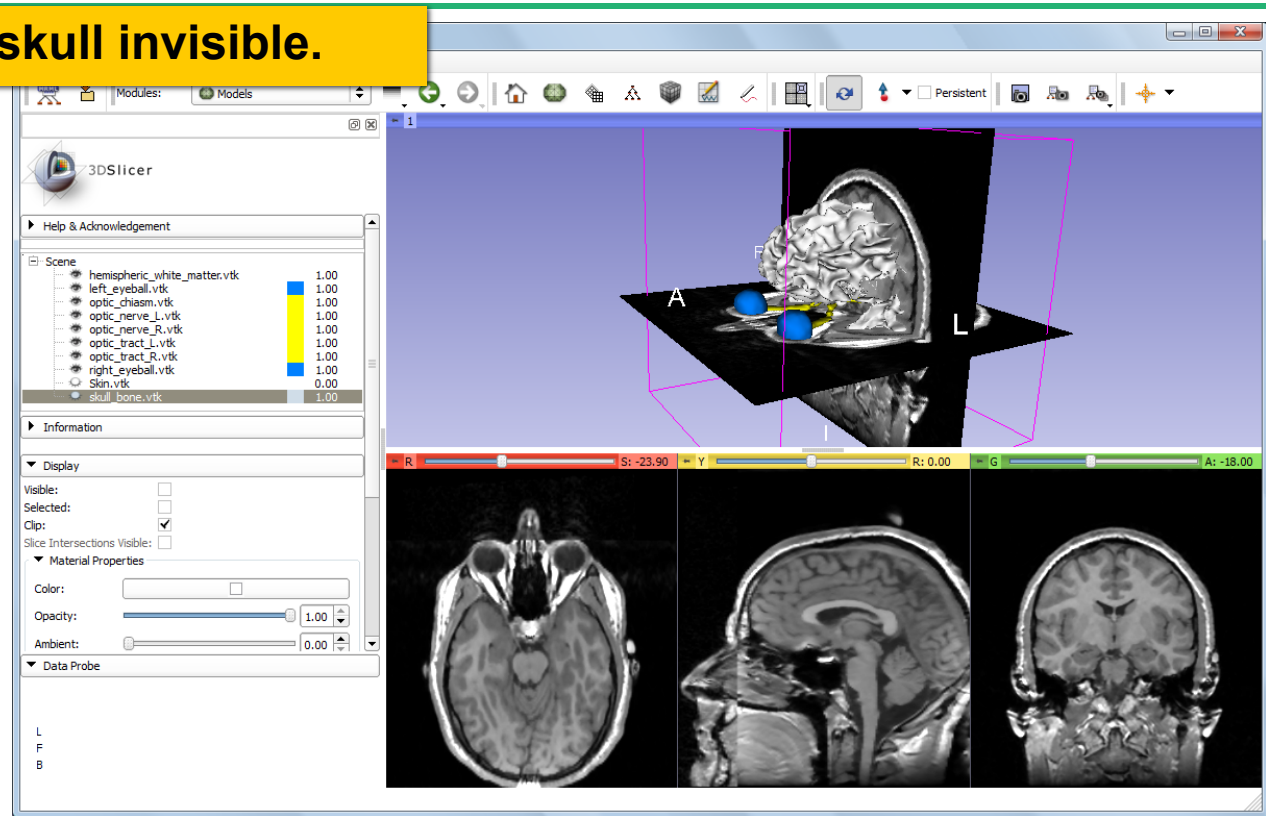
Browse through the **coronal slices** to expose the 3D model of the **white matter**, and the left and right **optic nerves**.





# Slicer4 Minute Tutorial: 3D Visualization

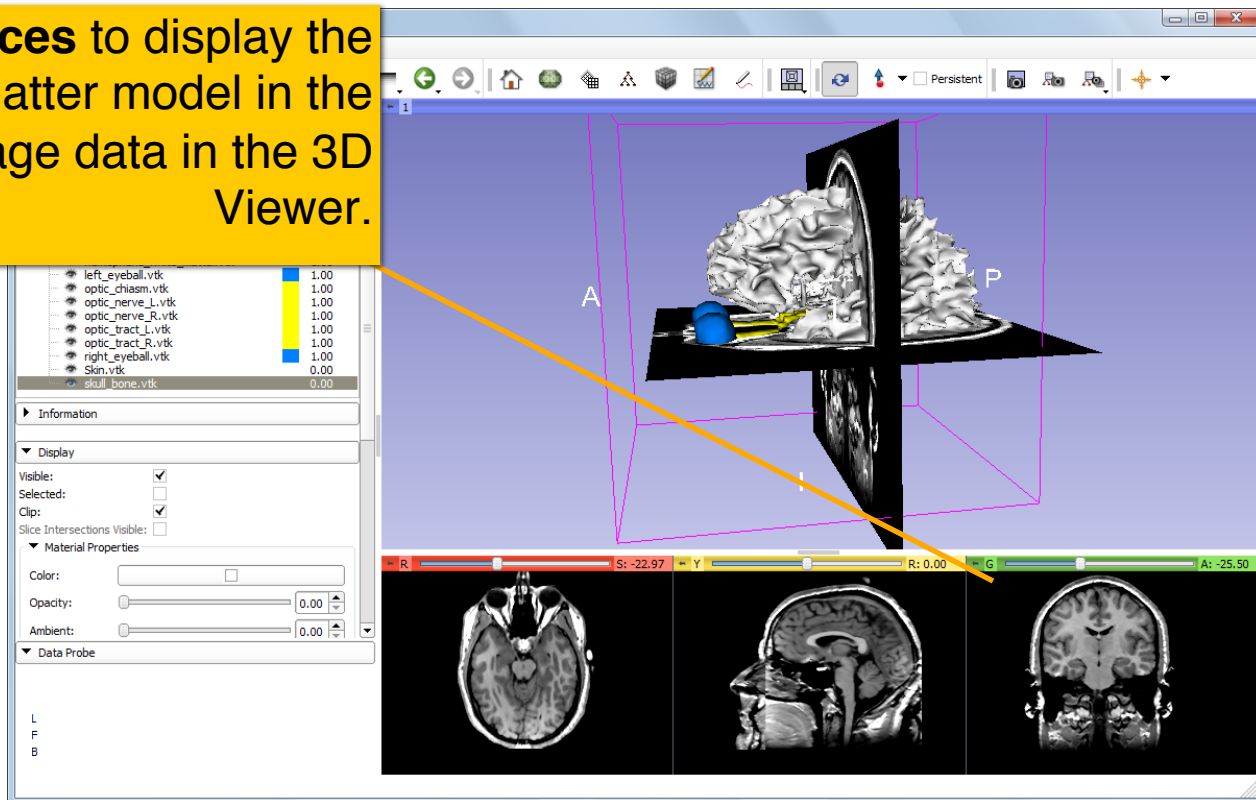
Now make the skull invisible.





## Slicer4 Minute Tutorial: 3D Visualization

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

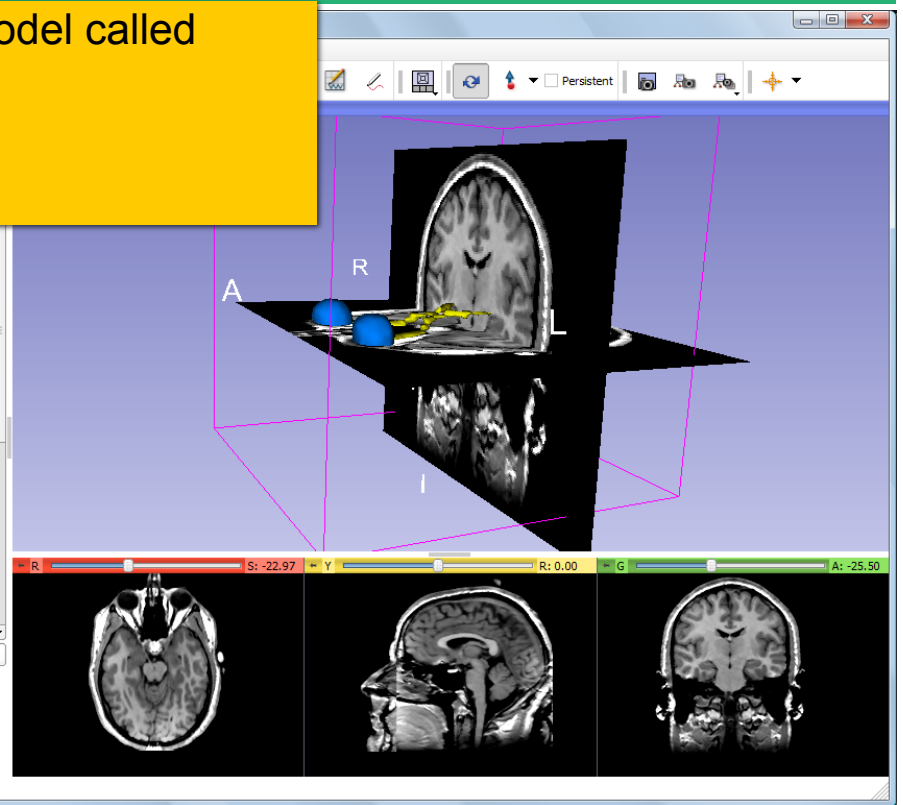
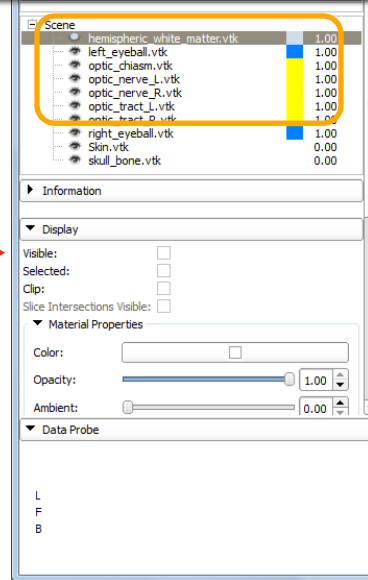




## Slicer4 Minute Tutorial: 3D Visualization

Select the hemispheric white matter model called **hemispheric\_white\_matter.vtk**

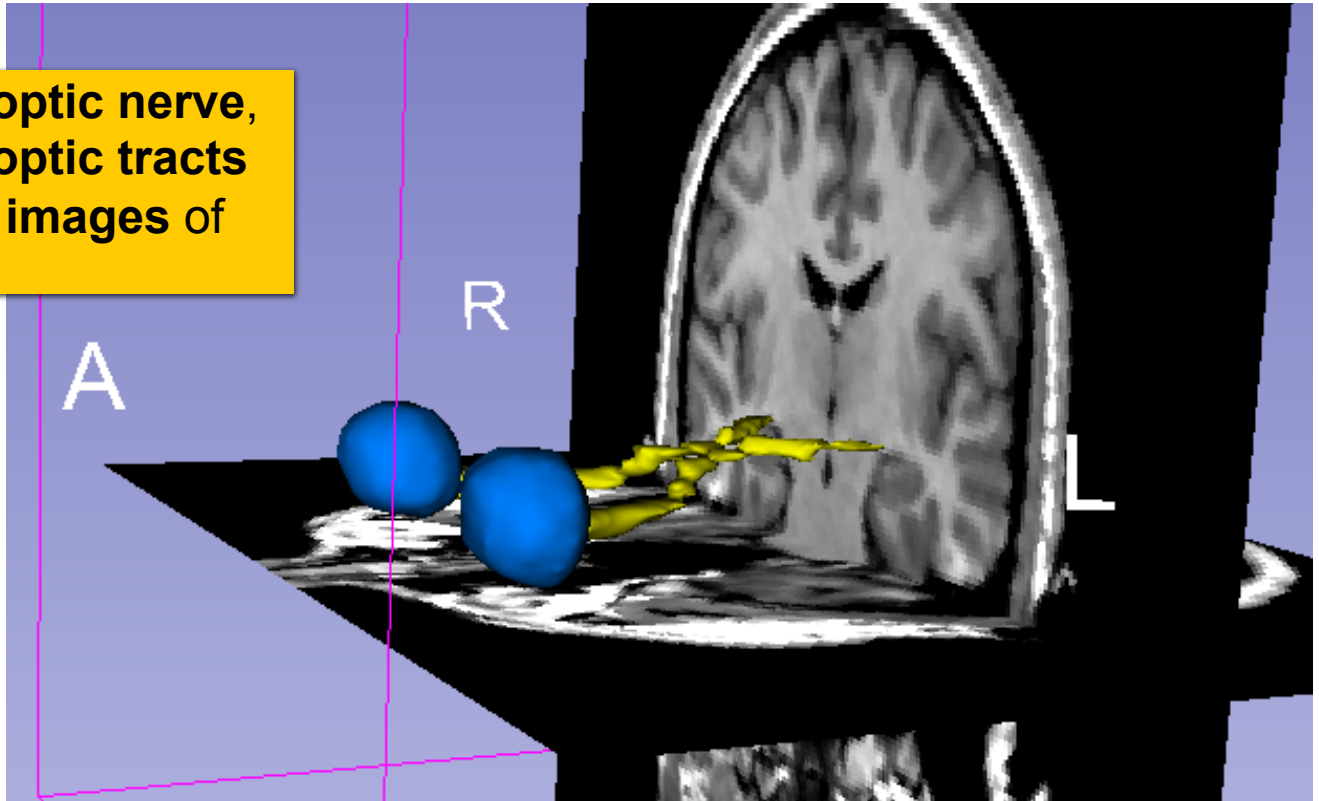
Turn off its **visibility**.





## Slicer4 Minute Tutorial: 3D Visualization

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

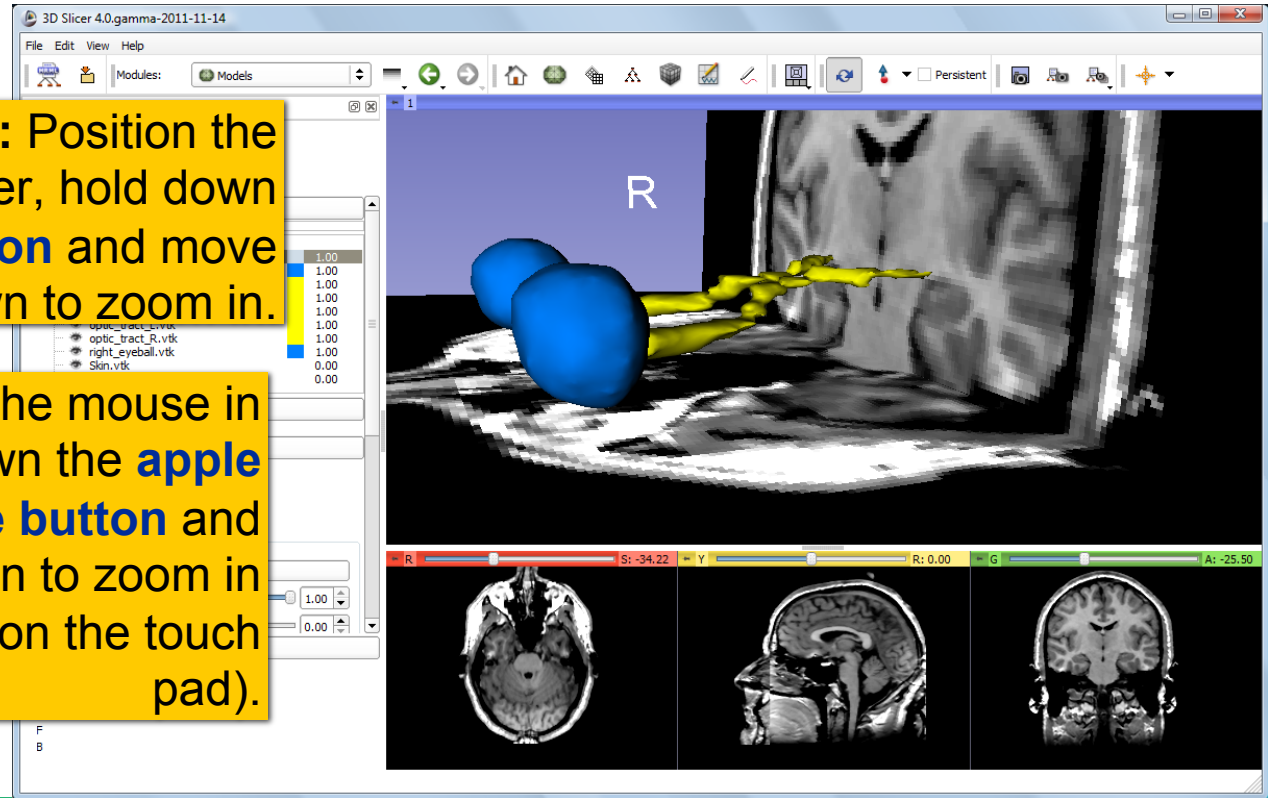




## Slicer4 Minute Tutorial: 3D Visualization: Zoom the view

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

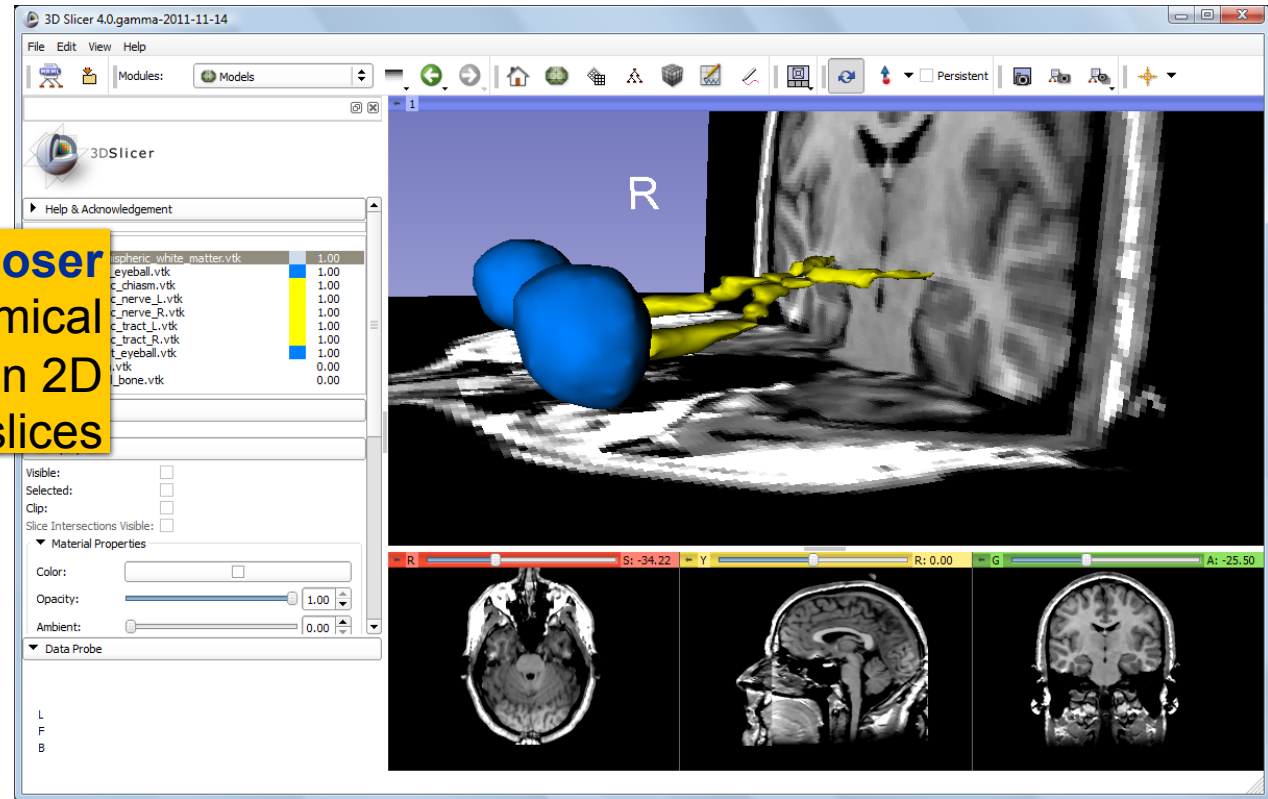
**Mac users:** Position the mouse in the 3D Viewer, hold down the **apple button and the mouse button** and move the mouse down to zoom in (or use two fingers on the touch pad).





# Slicer4 Minute Tutorial: 3D Visualization: Zoom the view

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

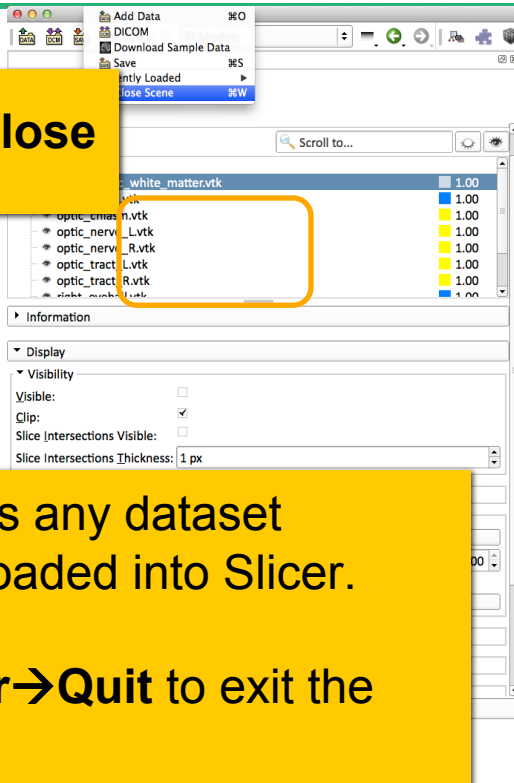






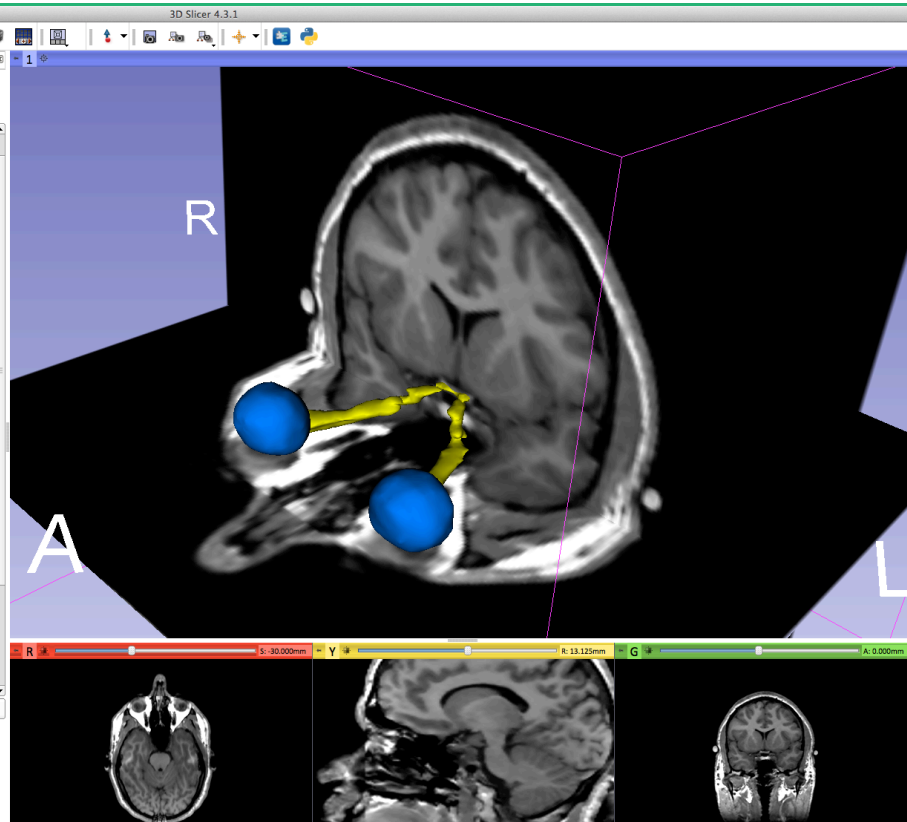
# Close the existing scene and all its data

Select **File->Close Scene**



This removes any dataset previously loaded into Slicer.

Select **Slicer→Quit** to exit the software



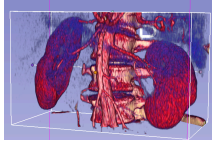


# Overview

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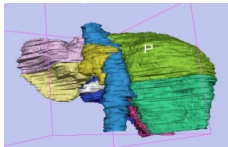
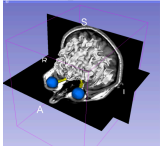


**Part I:** Introduction to the 3DSlicer software



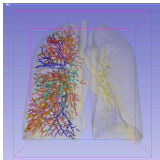
**Part II:** 3D Data Loading and visualization of DICOM images

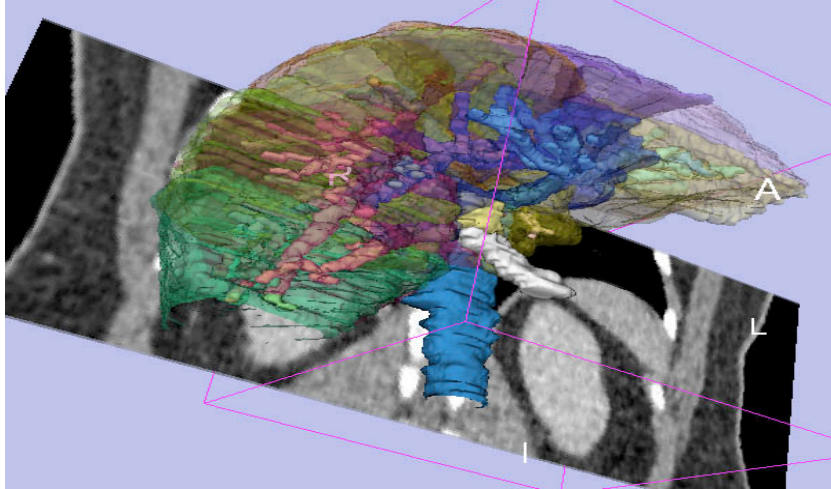
- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data



**Part III:** 3D interactive exploration of the anatomy

- Exploration of the Segments of the liver
- Exploration of the Segments of the lung

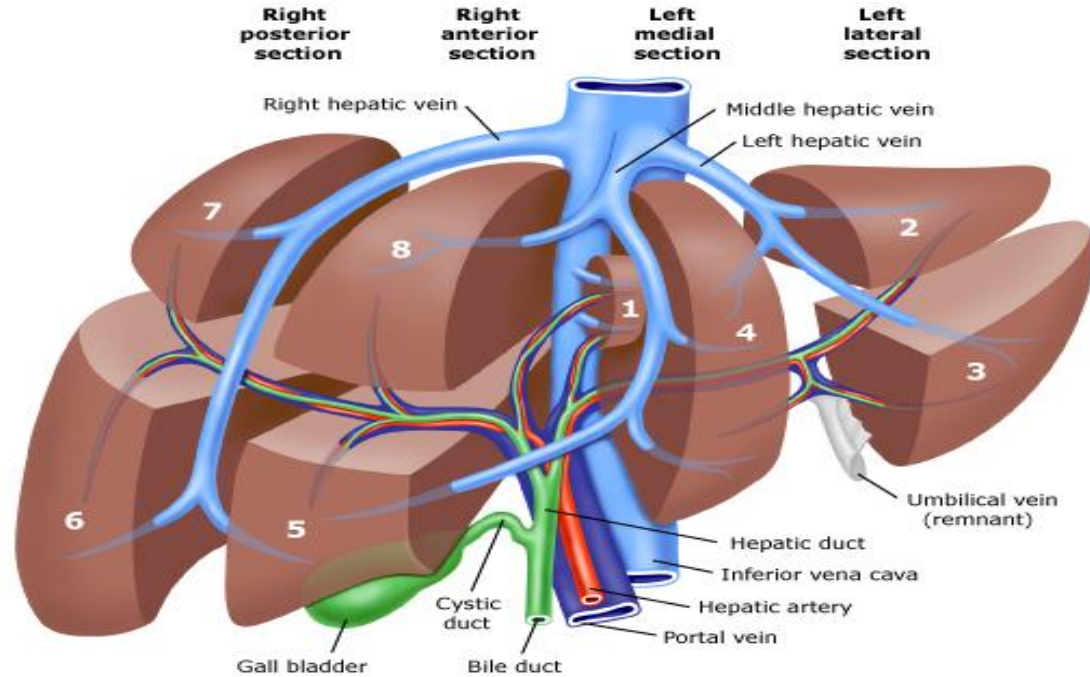




Part II:

Interactive 3D Visualization  
of the segments of the liver

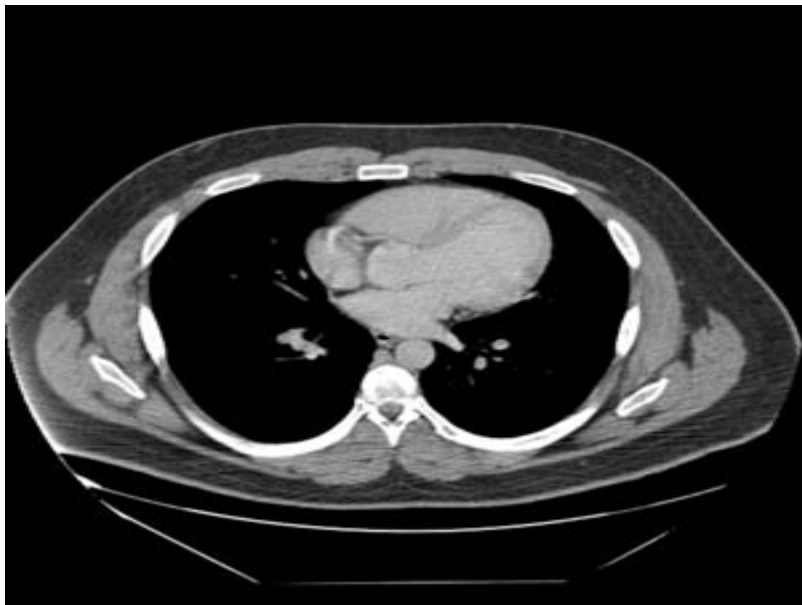
# Anatomy of the liver





# Liver dataset

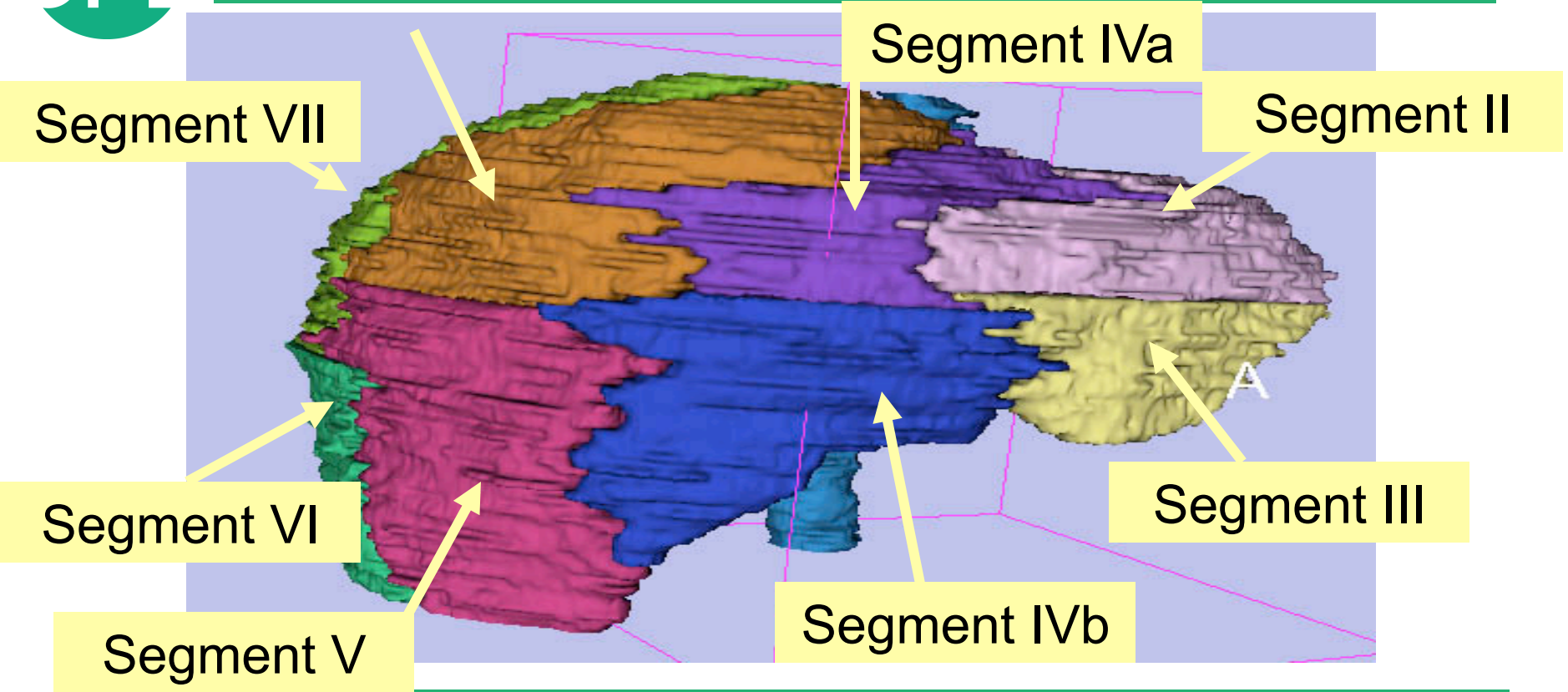
---



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



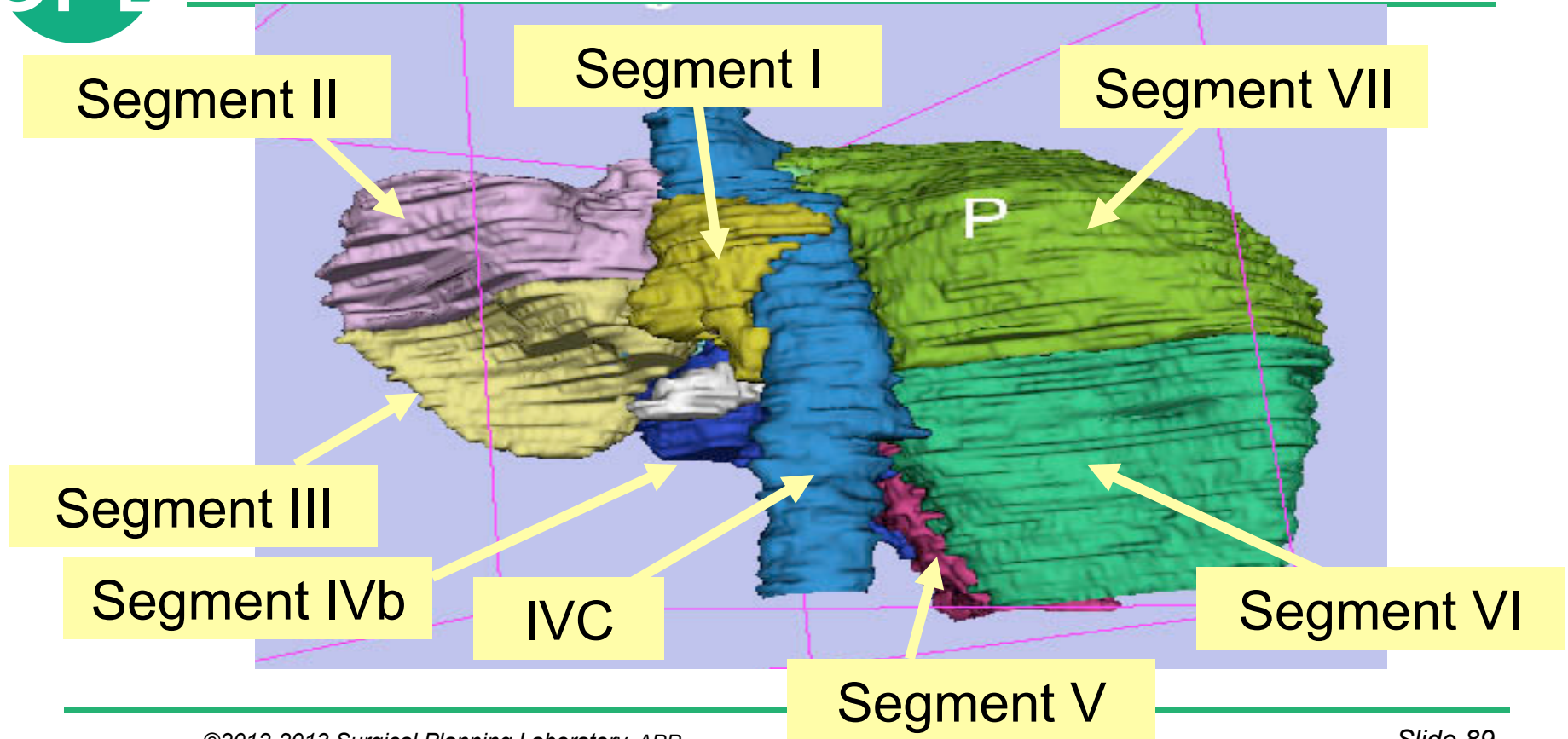
# 3D segments of the liver





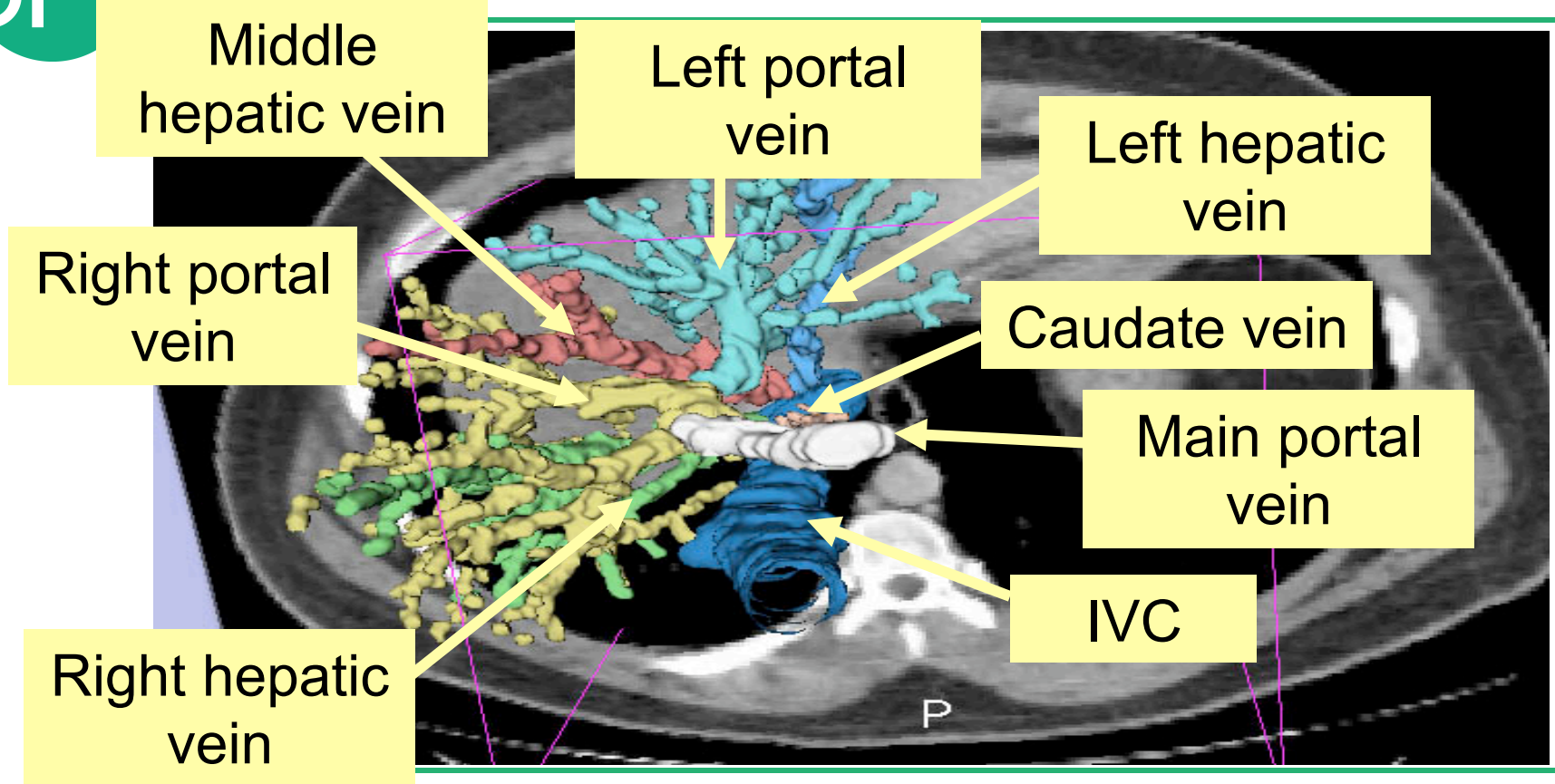


# 3D segments of the liver





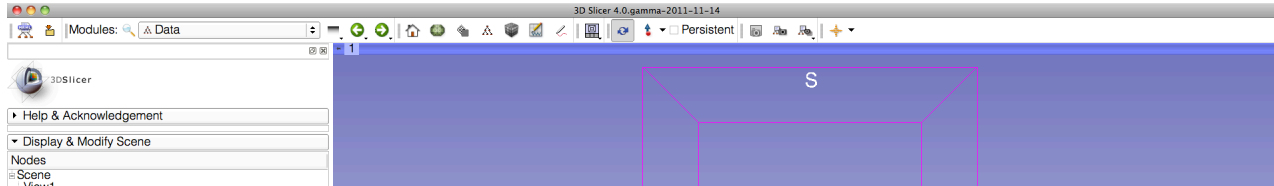
# Liver vasculature







# Loading the Liver Scene



Browse to the directory

**C:\3DSlicerData\_RSNA2013\3DVisualizationDICOM\_Tuesday\_Dec3**

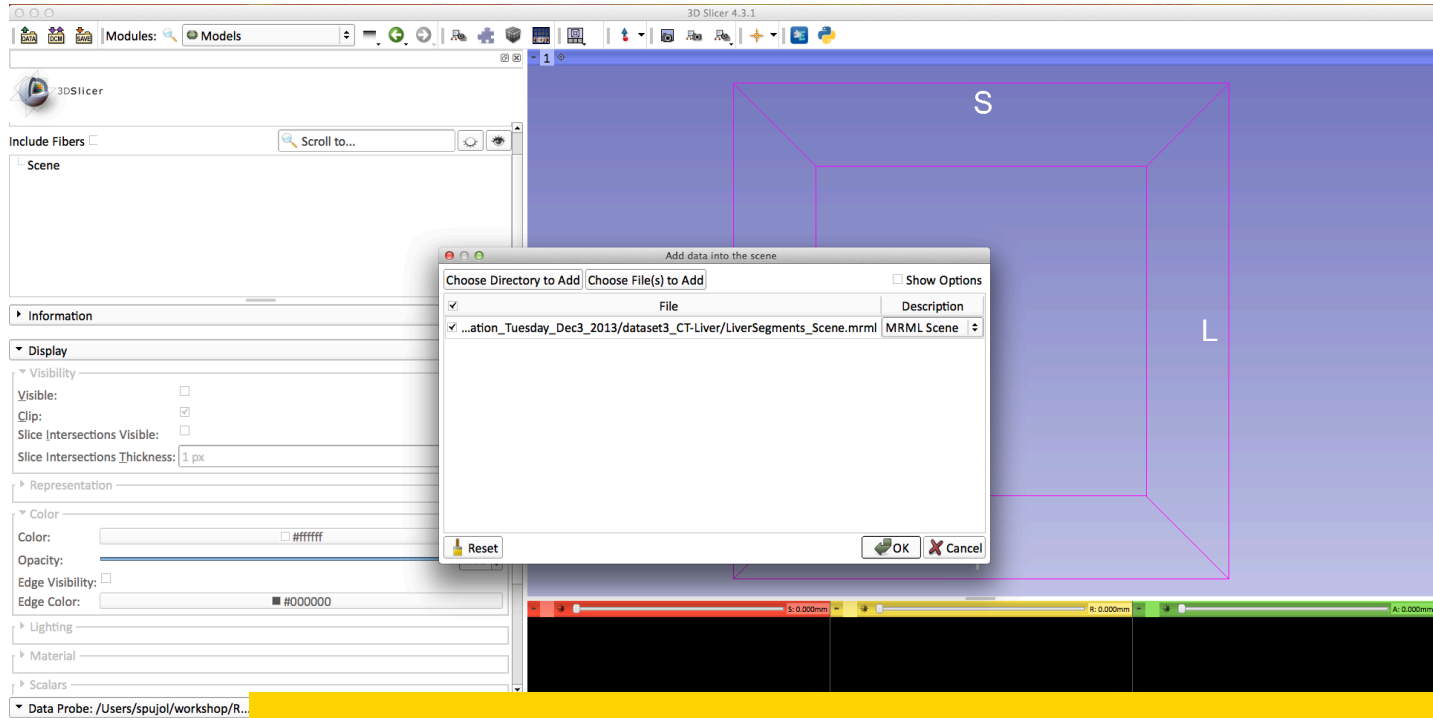
Select the directory **dataset3\_Liver**

Drag and drop the file **LiverSegments\_Scene.mrb** into Slicer

Click on OK to load the scene into Slicer



# Loading the Liver Scene



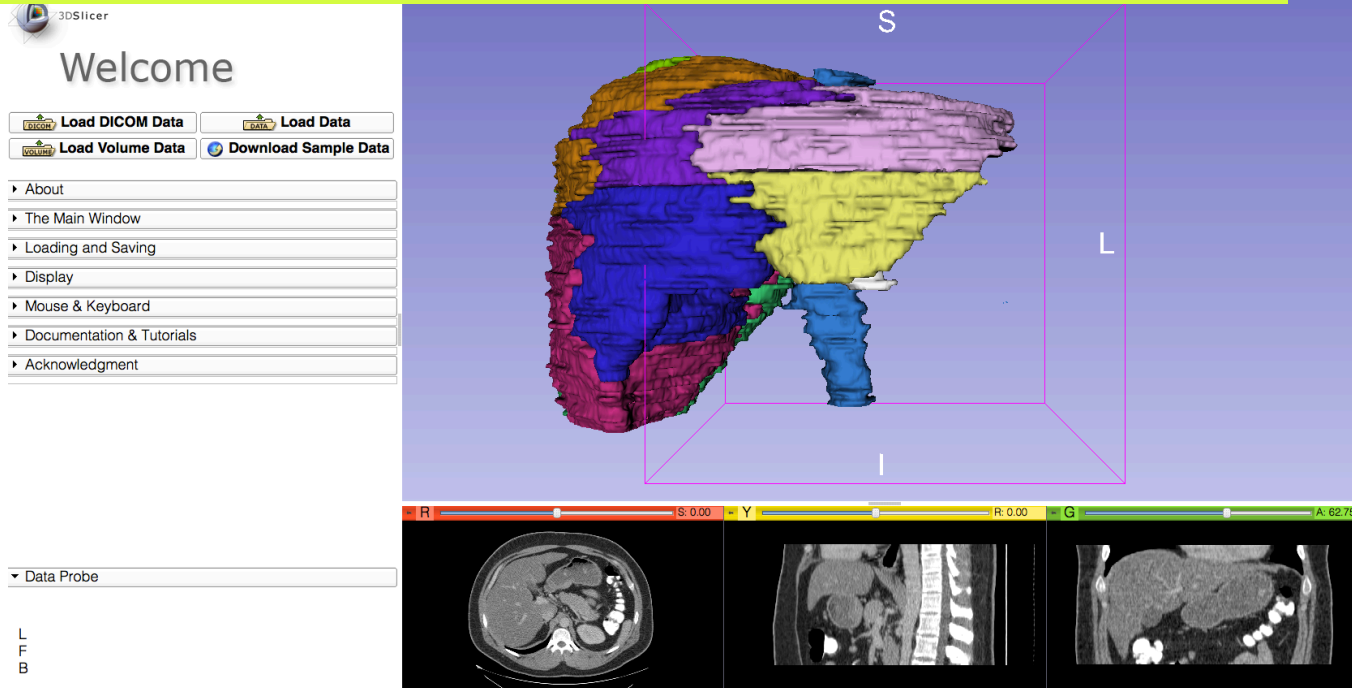
Click on OK to load the scene into Slicer

L  
F  
B



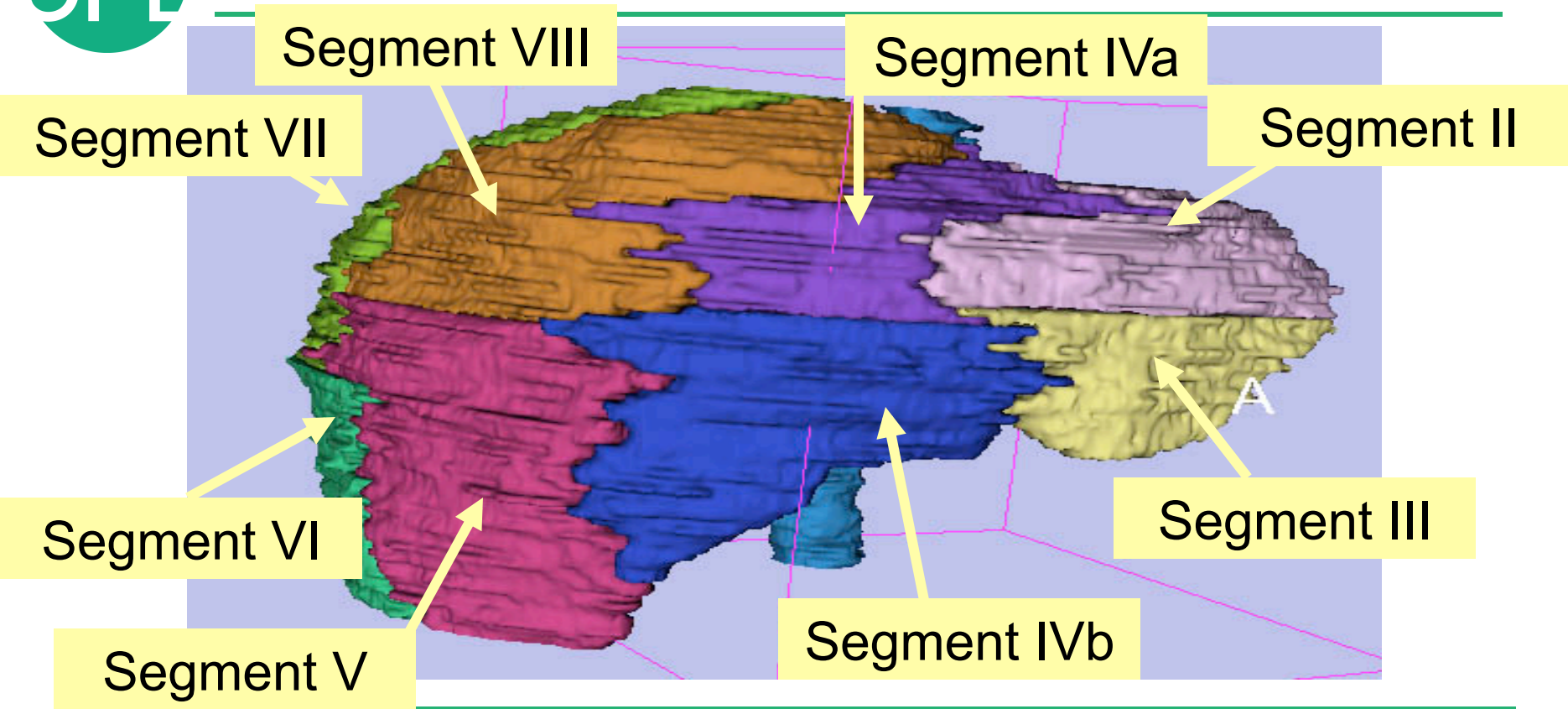
# Liver Segments Scene

The elements of the scene appear in the Viewer



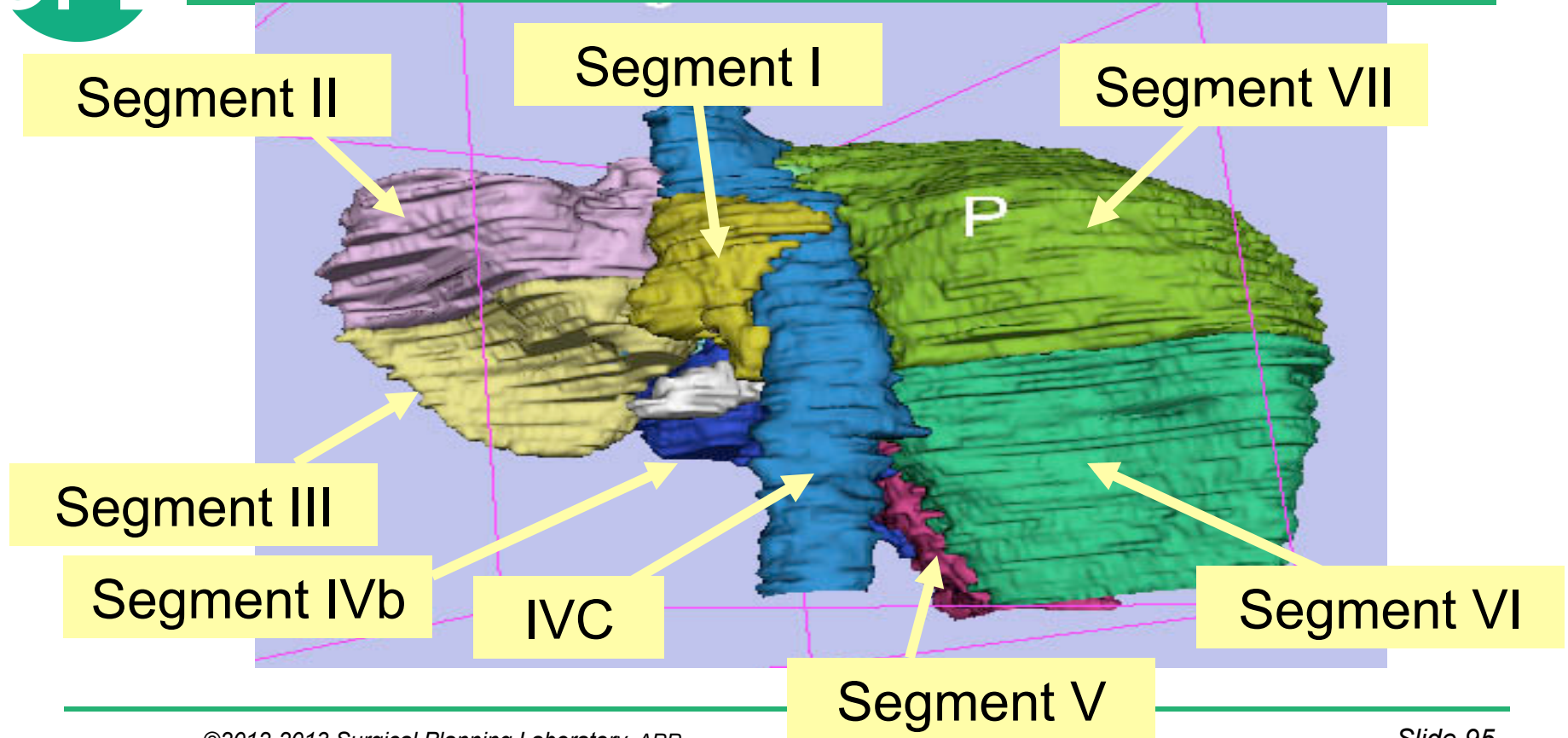


# 3D models of the liver



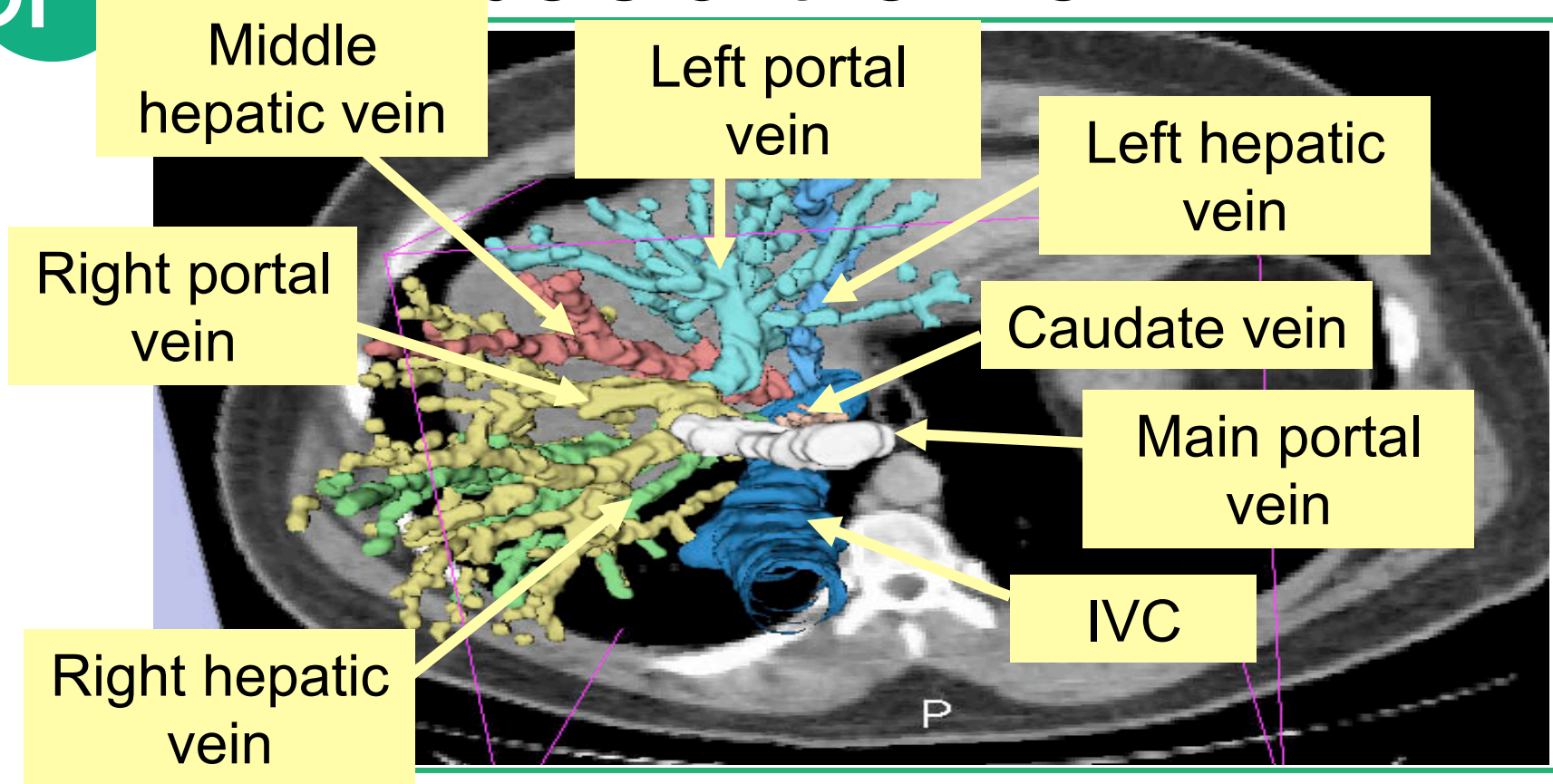


# 3D models of the liver



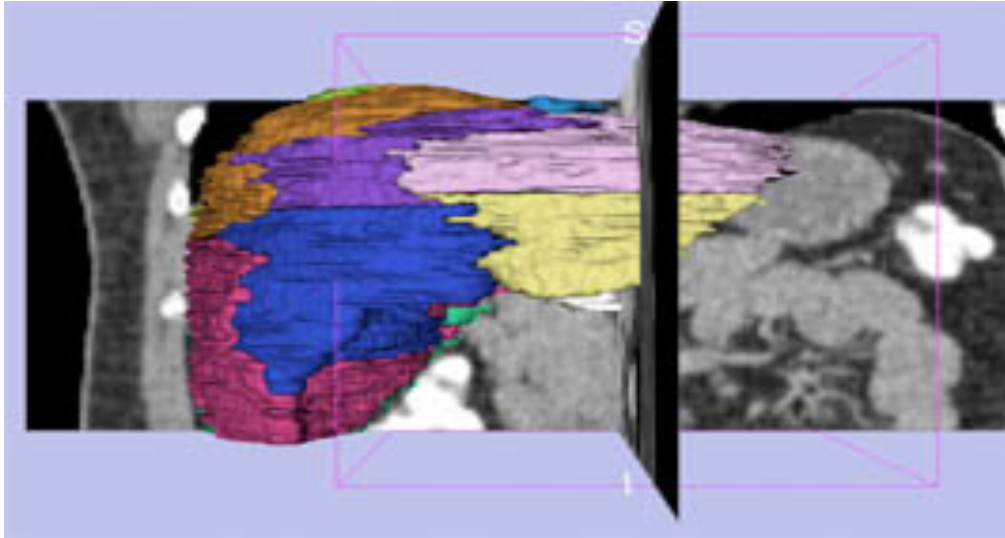


# 3D models of the liver





# 3D Exploration of Liver Segments



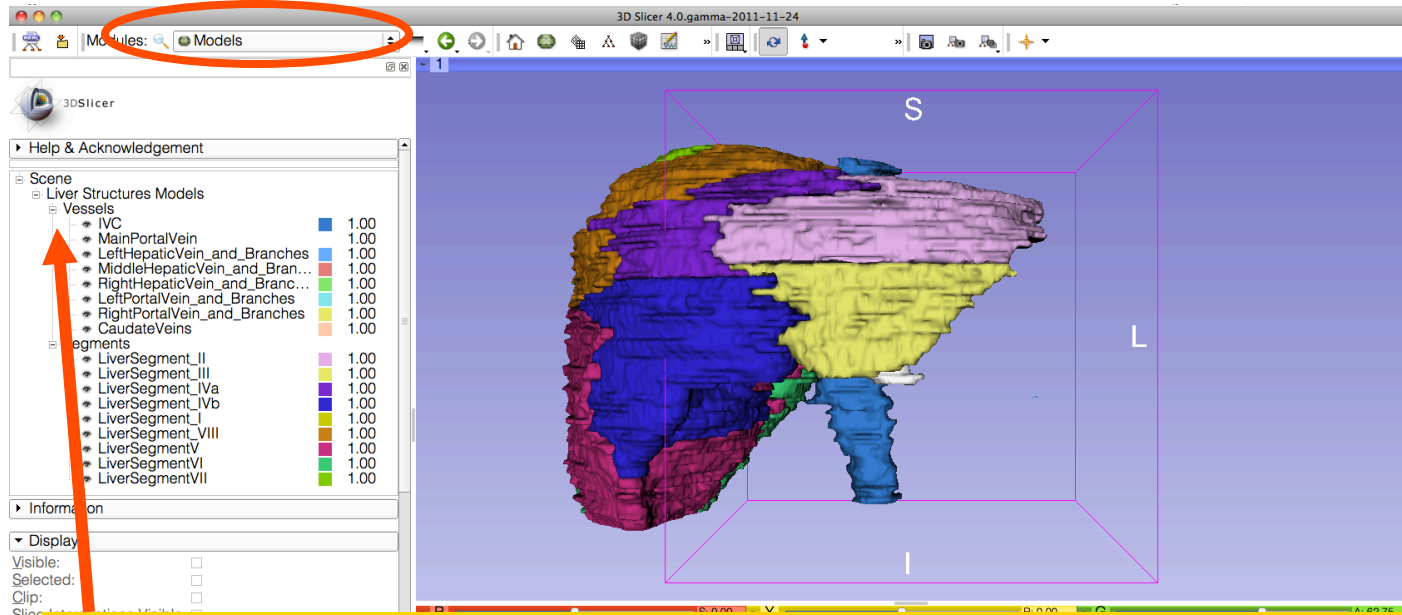
## **Example:**

What organ abuts the left-most margin of segment II in this patient ?





# 3D Exploration of Liver Segments



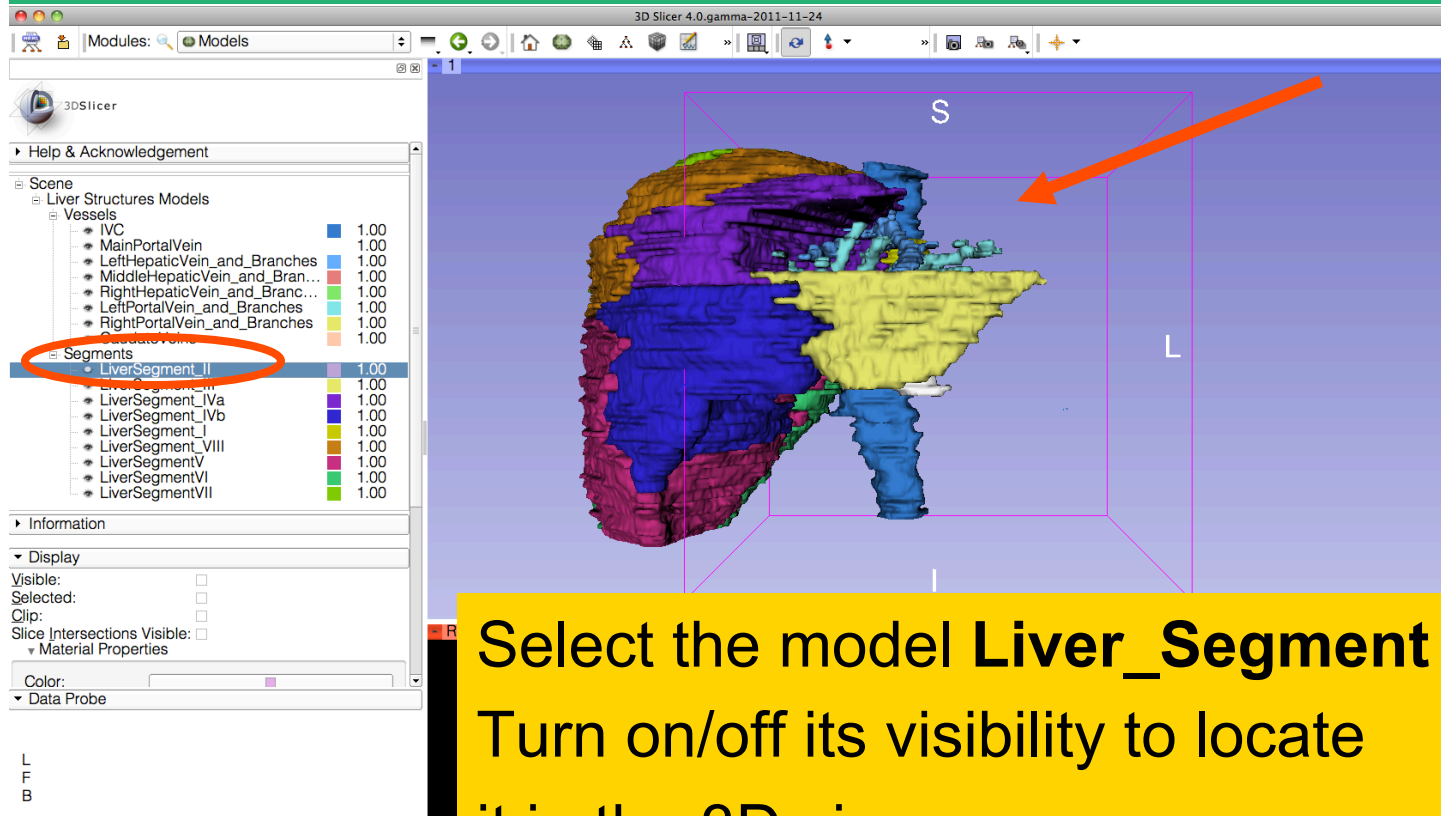
**Select the module **Models****

**Click on the Liver Structures Models Hierarchy**





# 3D Exploration of Liver Segments

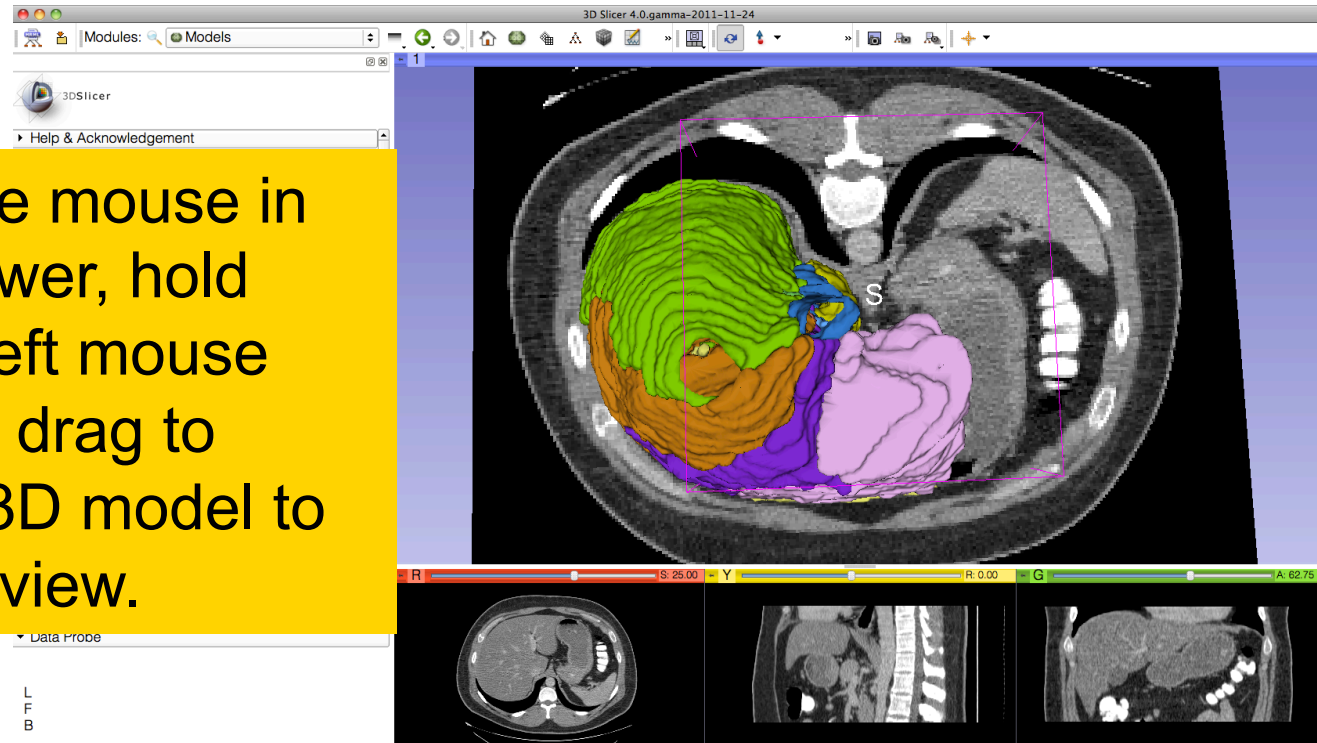


Select the model **Liver\_Segment II**  
Turn on/off its visibility to locate  
it in the 3D viewer.



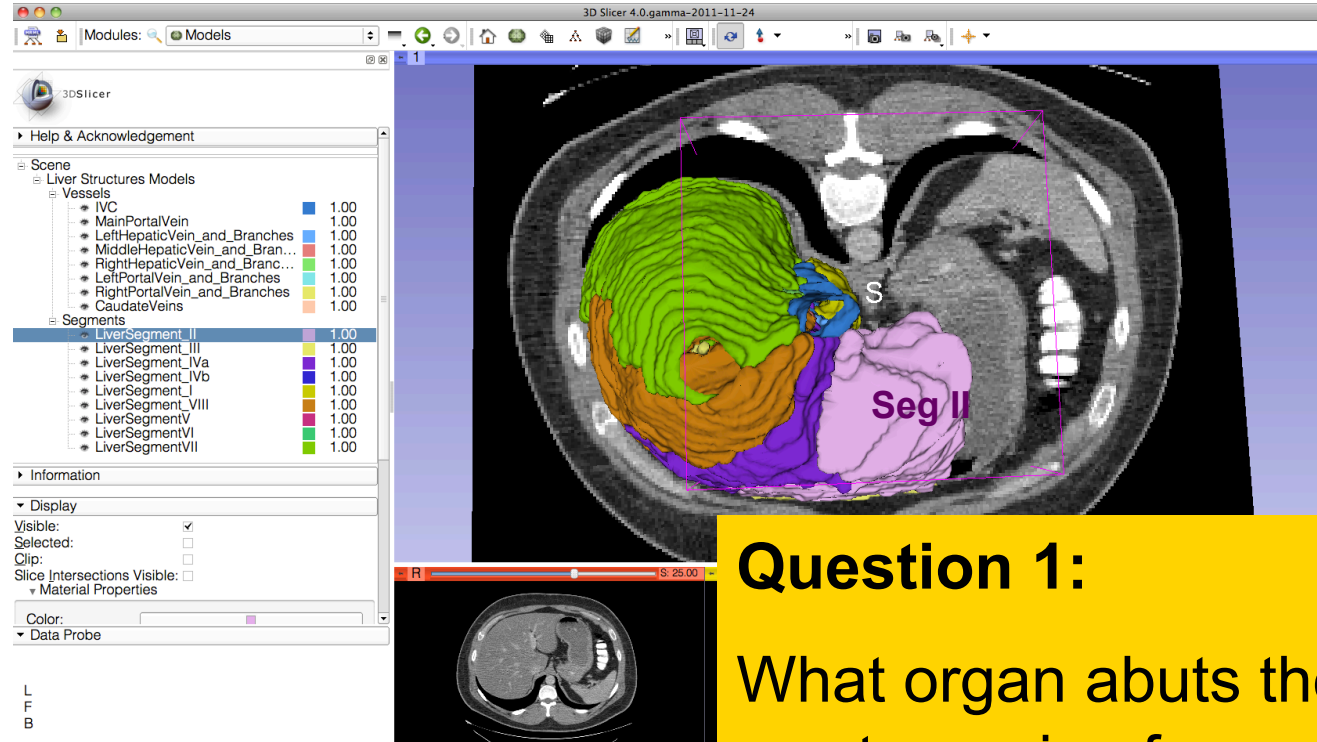
# 3D Exploration of Liver Segments

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 leftmost margin of segment II in Patient 1?

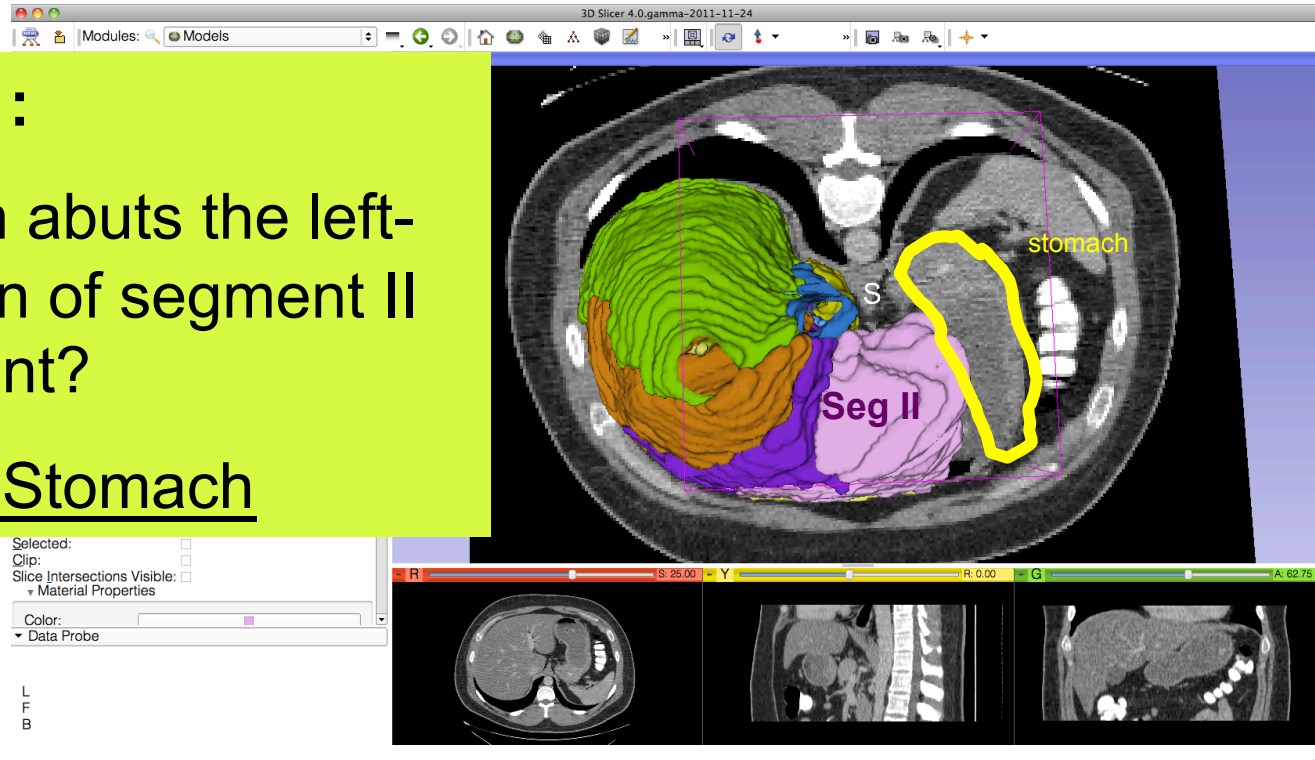


# 3D Exploration of Liver Segments

## Question 1:

What organ abuts the left-most margin of segment II in this patient?

**Answer 1: Stomach**

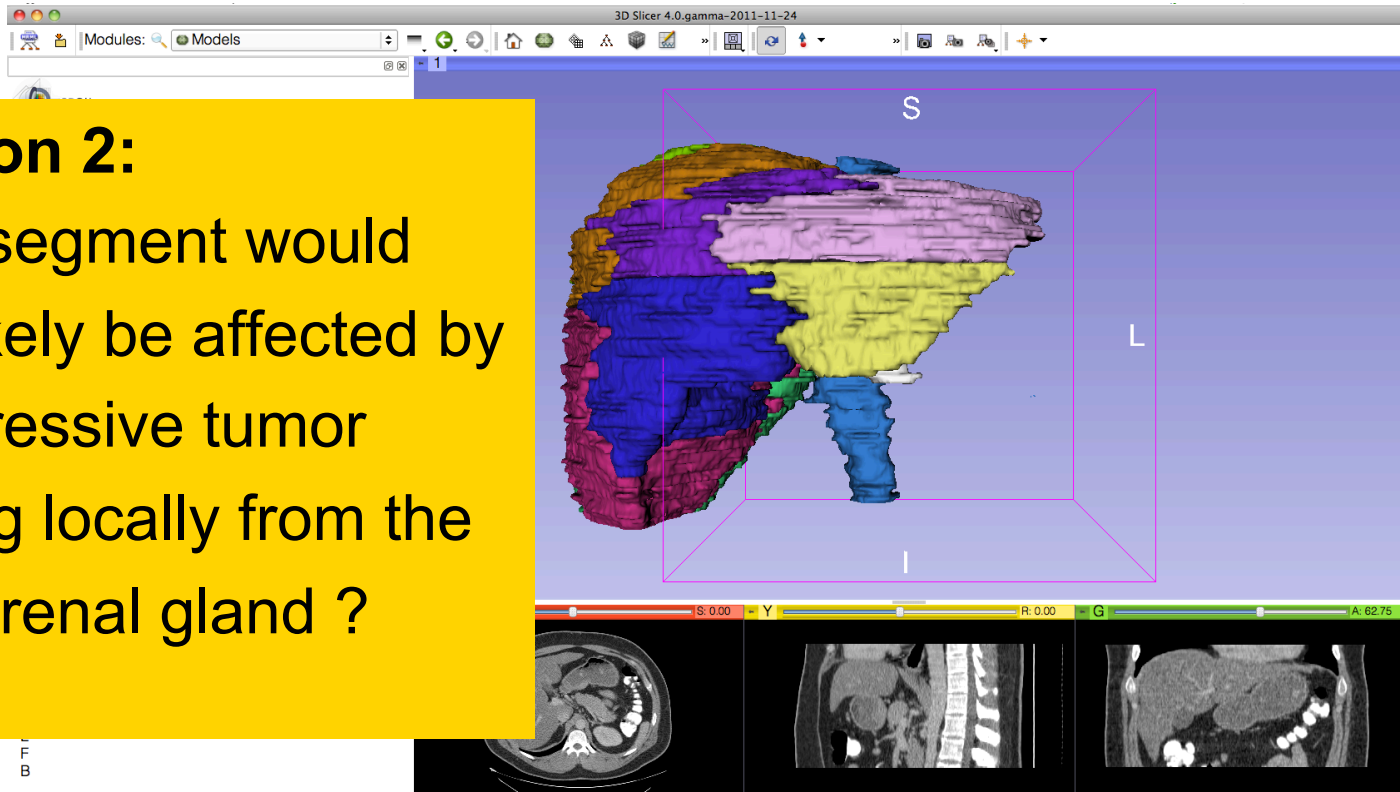




# 3D Exploration of Liver Segments

## Question 2:

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



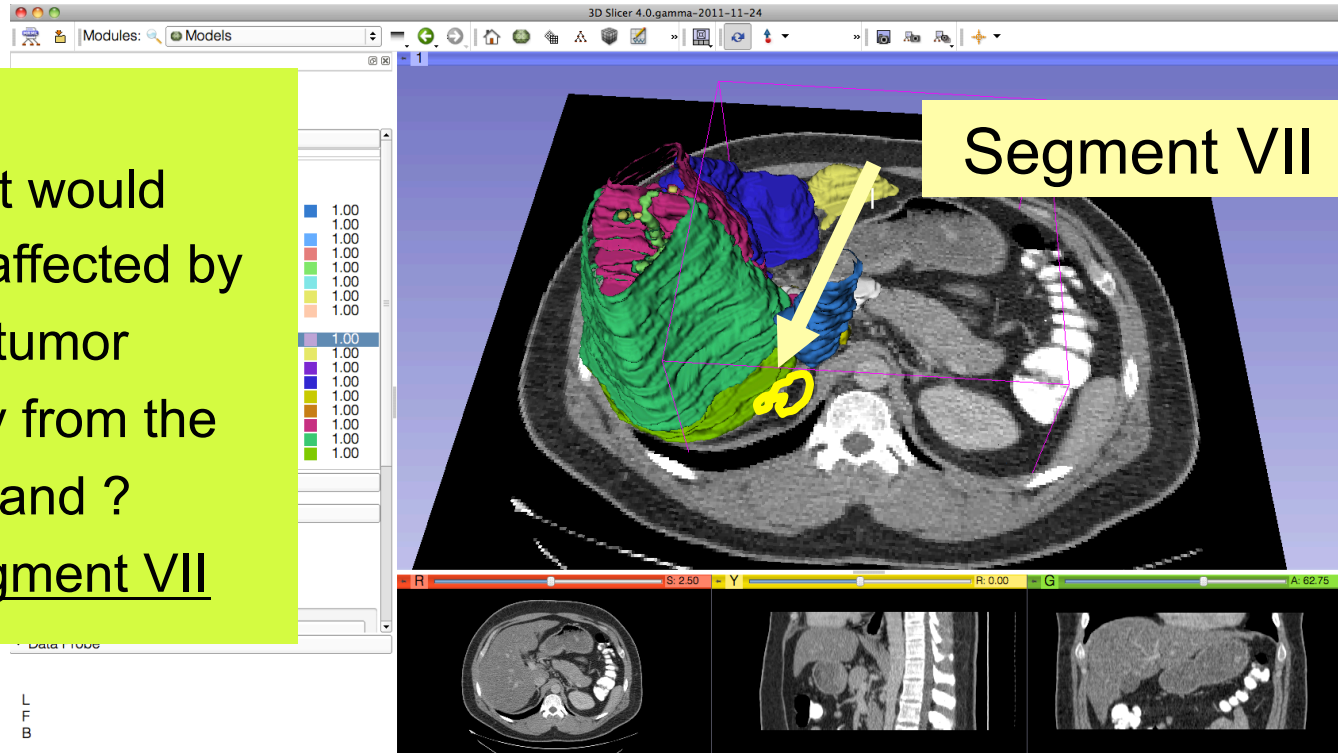


# 3D Exploration of Liver Segments

## Question 2:

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

**Answer 2:** Segment VII





# 3D Exploration of Liver Segments

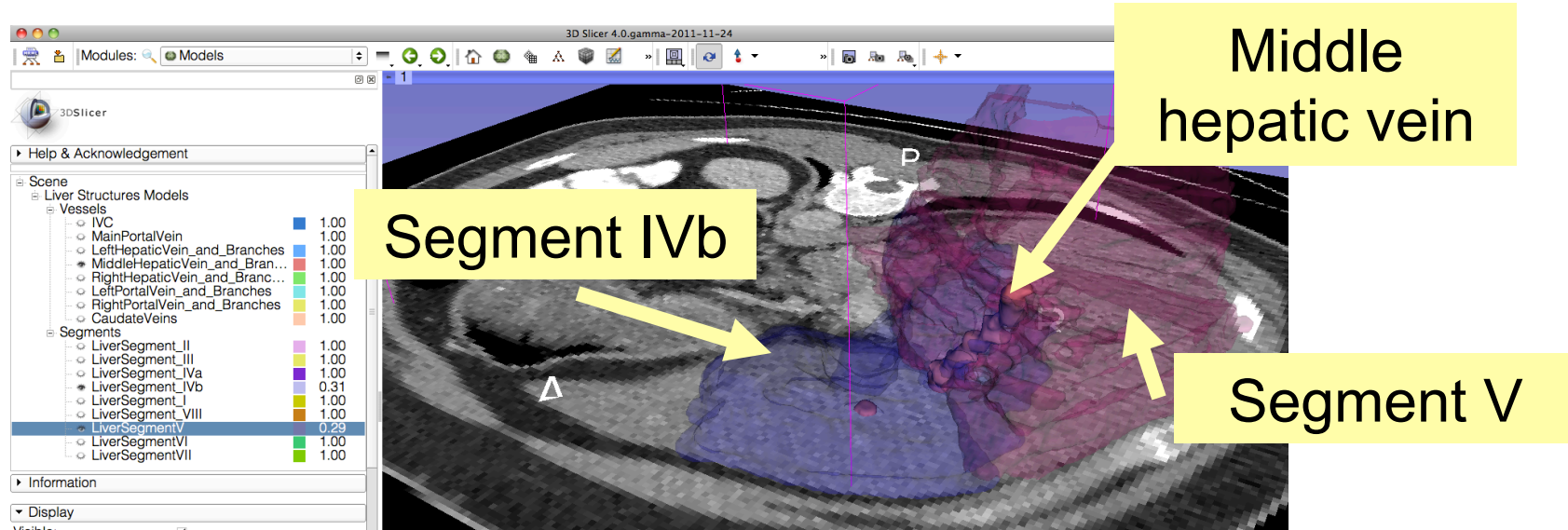


## Question 3:

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

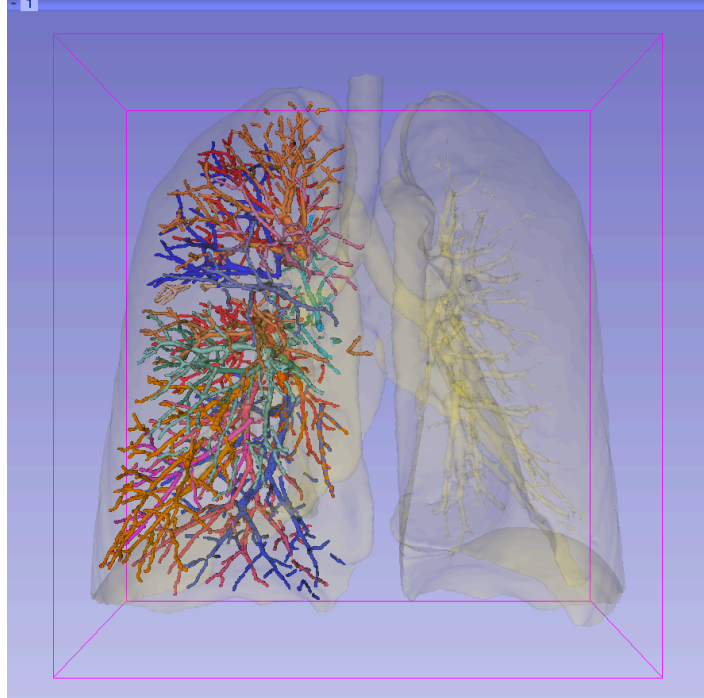




# Closing the Liver Scene

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



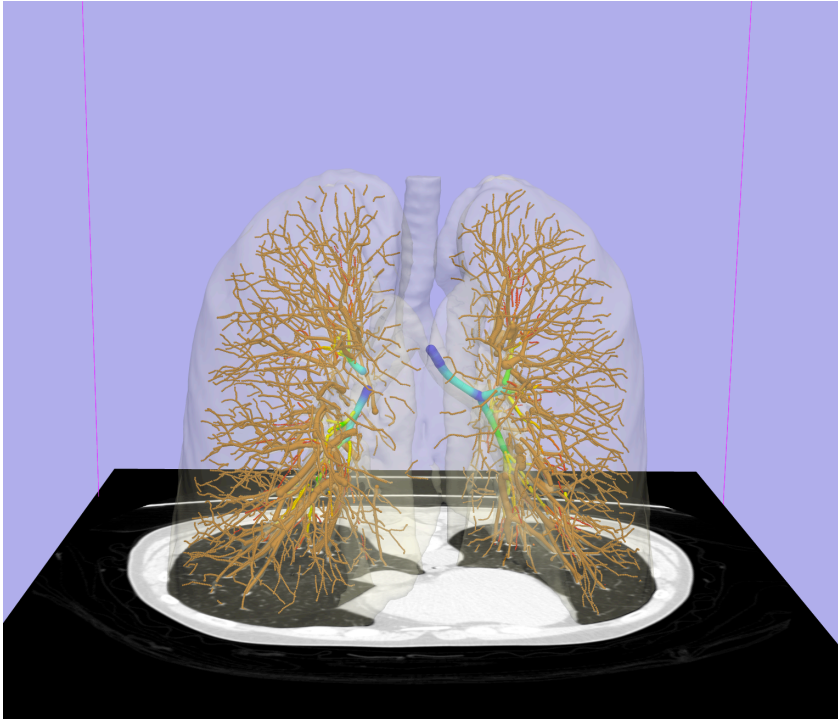


## Interactive 3D Visualization of the segments of the lungs



# Segments of the lung

---



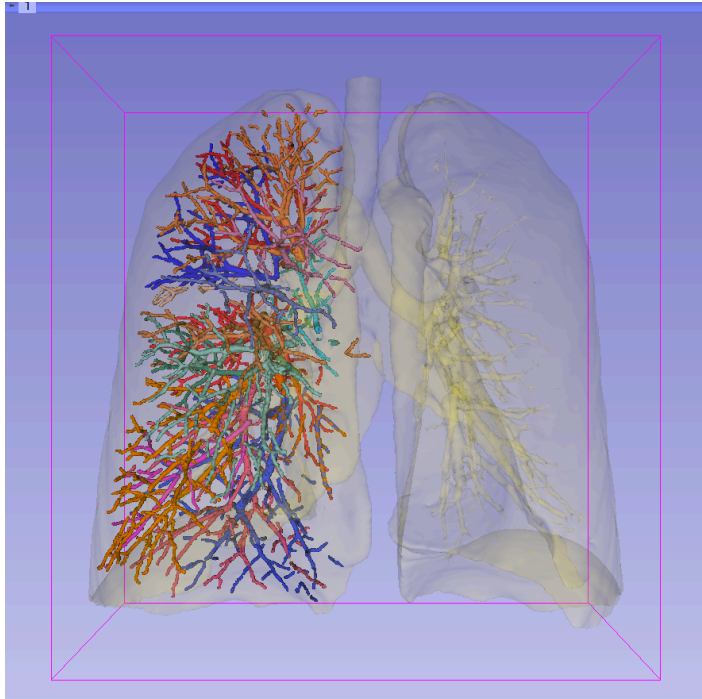
Segmentation and 3D surface reconstruction of the lung and pulmonary vessels

Acknowledgment:

Segmentation of the lung surface and vasculature: Raul San Jose Estepar, Ph.D., George Washko, M.D., Ed Silverman, M.D. and James Ross, MSc. Brigham and Women's Hospital (K25 HL104085) and COPDGene (01 HL089897 and U01 HL089856)



# Segments of the lung

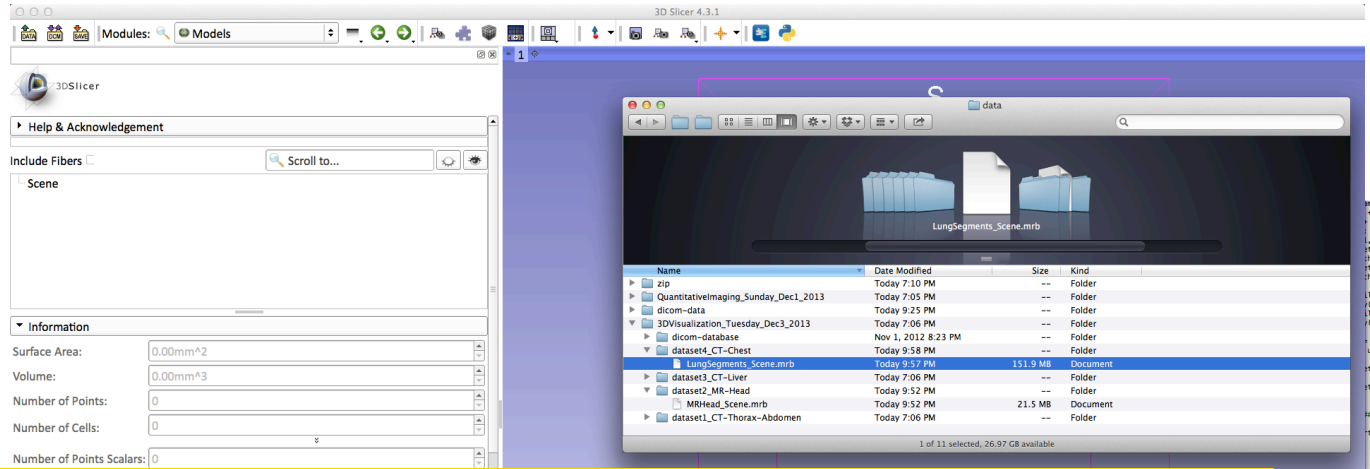


3D parcellation of arteries and veins from original model of pulmonary vessels  
(Kitt Shaffer, M.D., Ph.D. - Sonia Pujol, Ph.D.)

- Right Upper Lobe (RUL)
  - RUL Pulmonary Vein
  - RUL Anterior Segment
  - RUL Apical Segment
  - RUL Posterior Segment
- Right Middle Lobe (RML)
  - RML Pulmonary Vein 1 & 2
  - RML Lateral Segment
  - RML Medial Segment
- Right Lower Lobe (RLL)
  - RLL Pulmonary Vein 1,2,3
  - RLL Anterior Basal Segment
  - RLL Medial Basal Segment
  - RLL Lateral Basal Segment
  - RLL Posterior Basal Segment



# Loading the Chest Data Scene



Open the directory

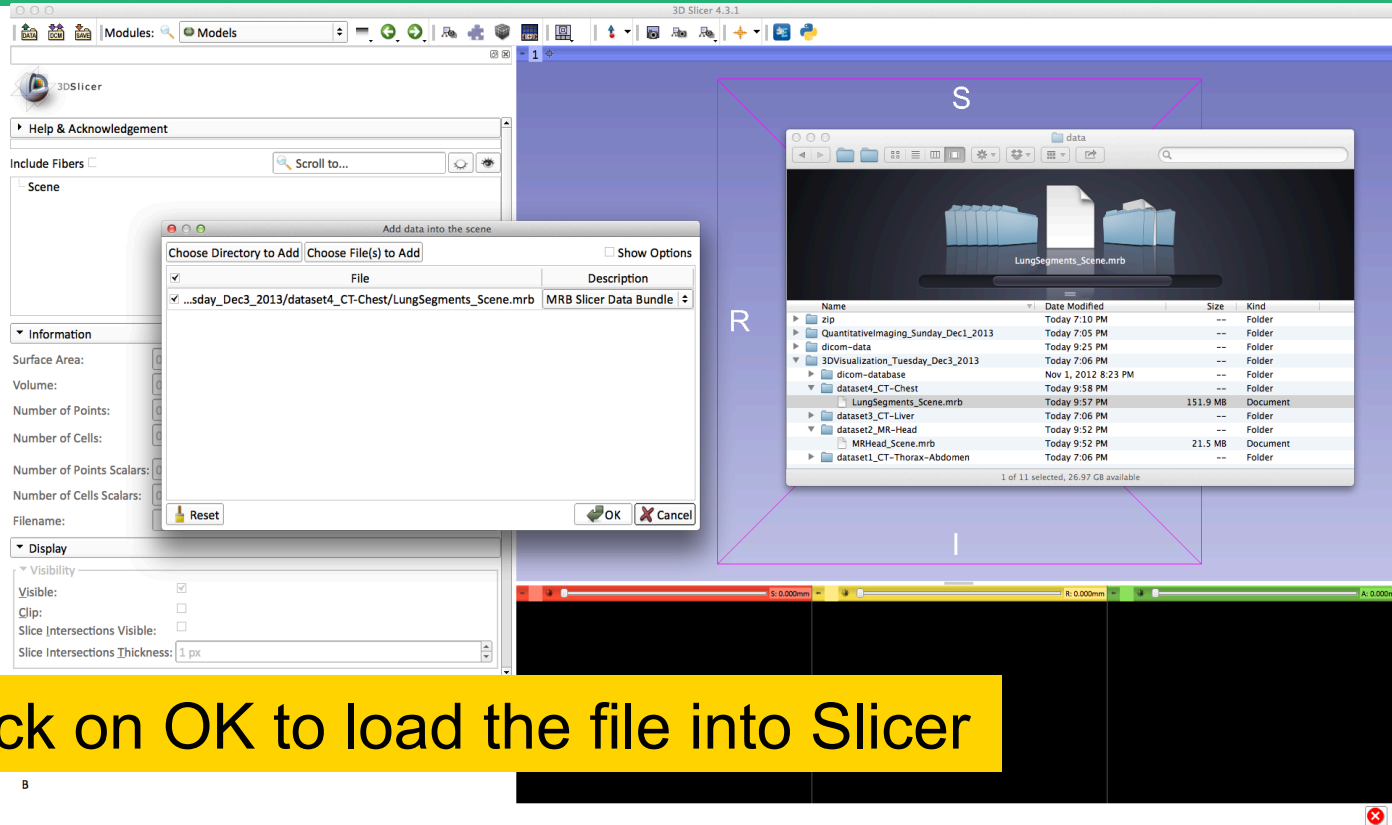
**C:\3DSlicerData\_RSNA2013\3DVisualizationDICOM\_Tuesday\_Dec3**

Select the subdirectory **dataset4\_Chest**

Drag and drop the file **LungSegments\_Scene.mrb** into Slicer



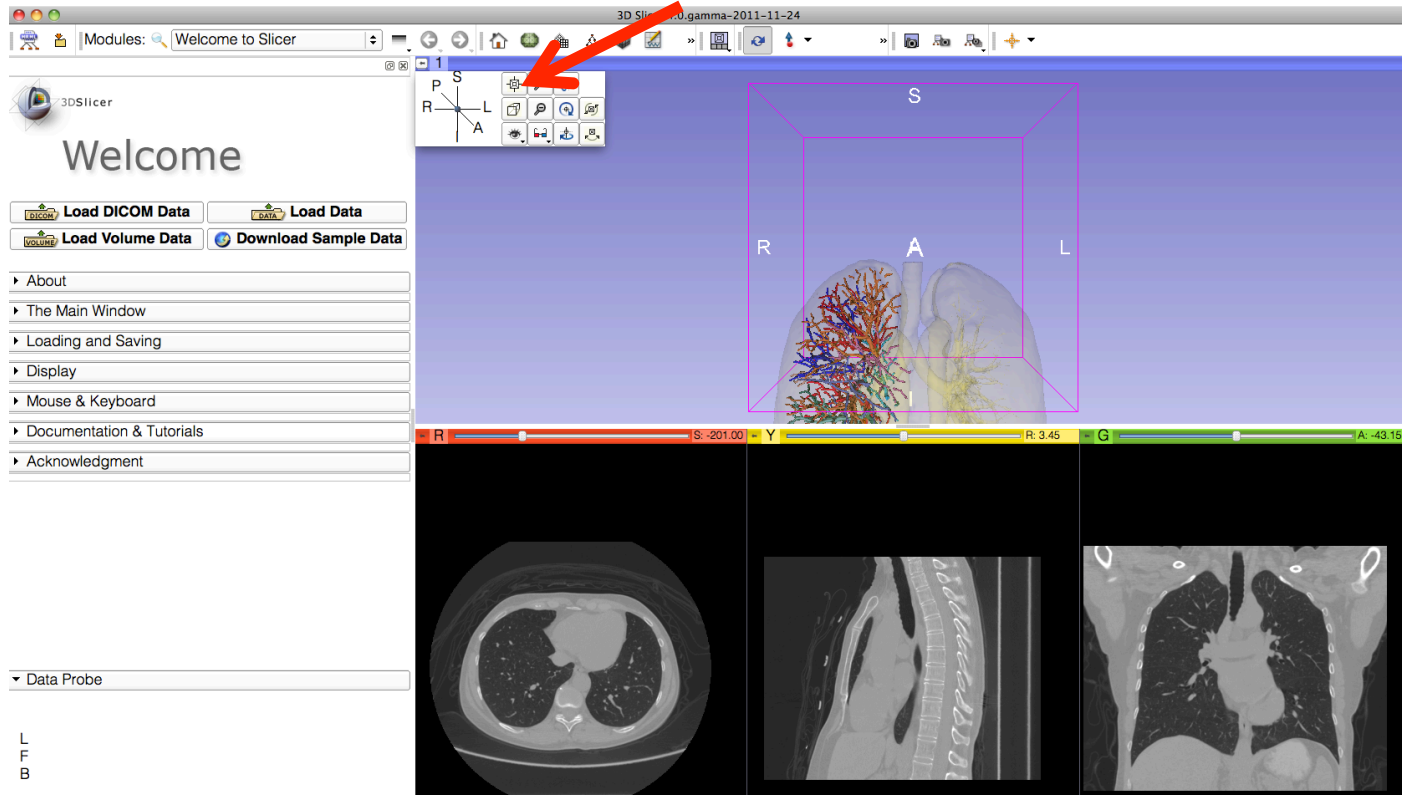
# Loading the Lung Scene



Click on OK to load the file into Slicer

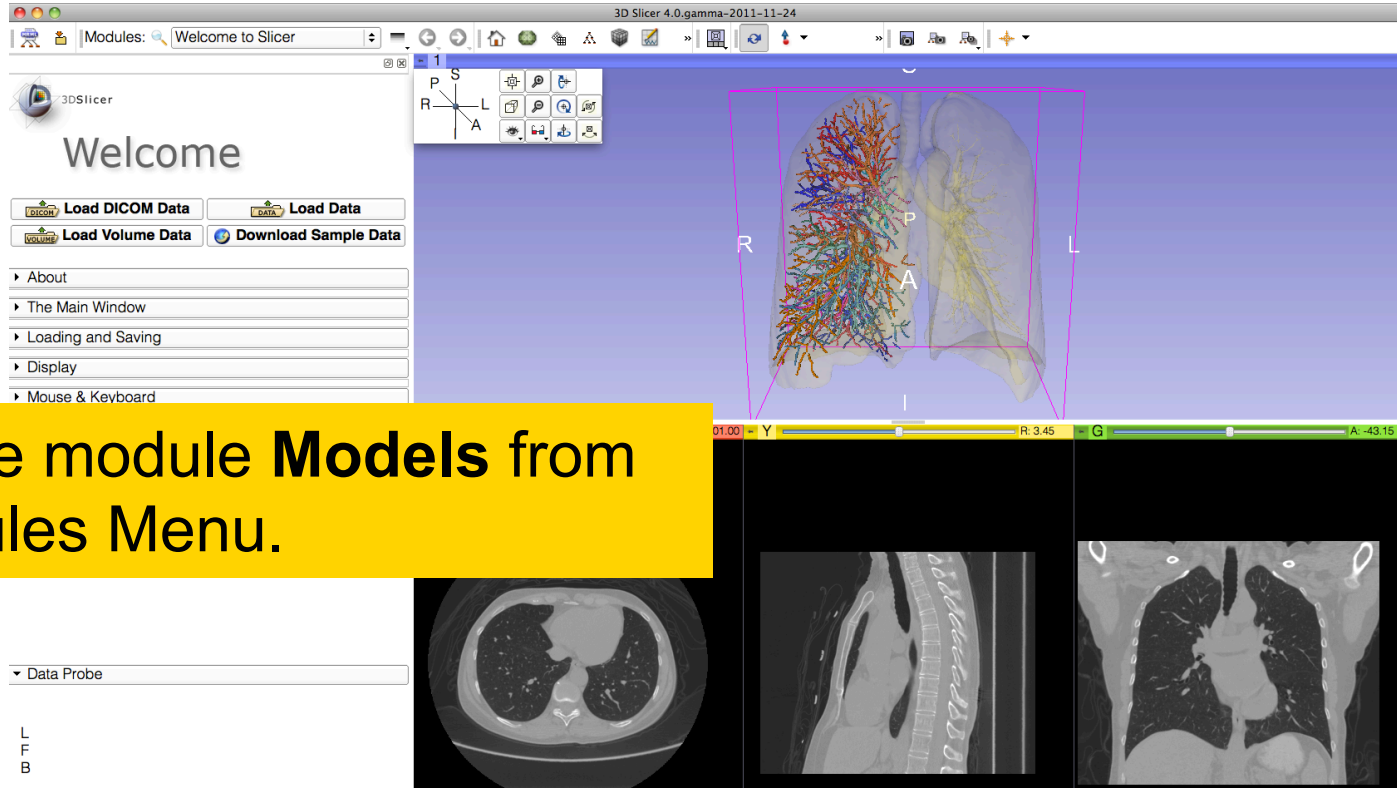


# Loading the Lung Scene





# Loading the Lung Scene

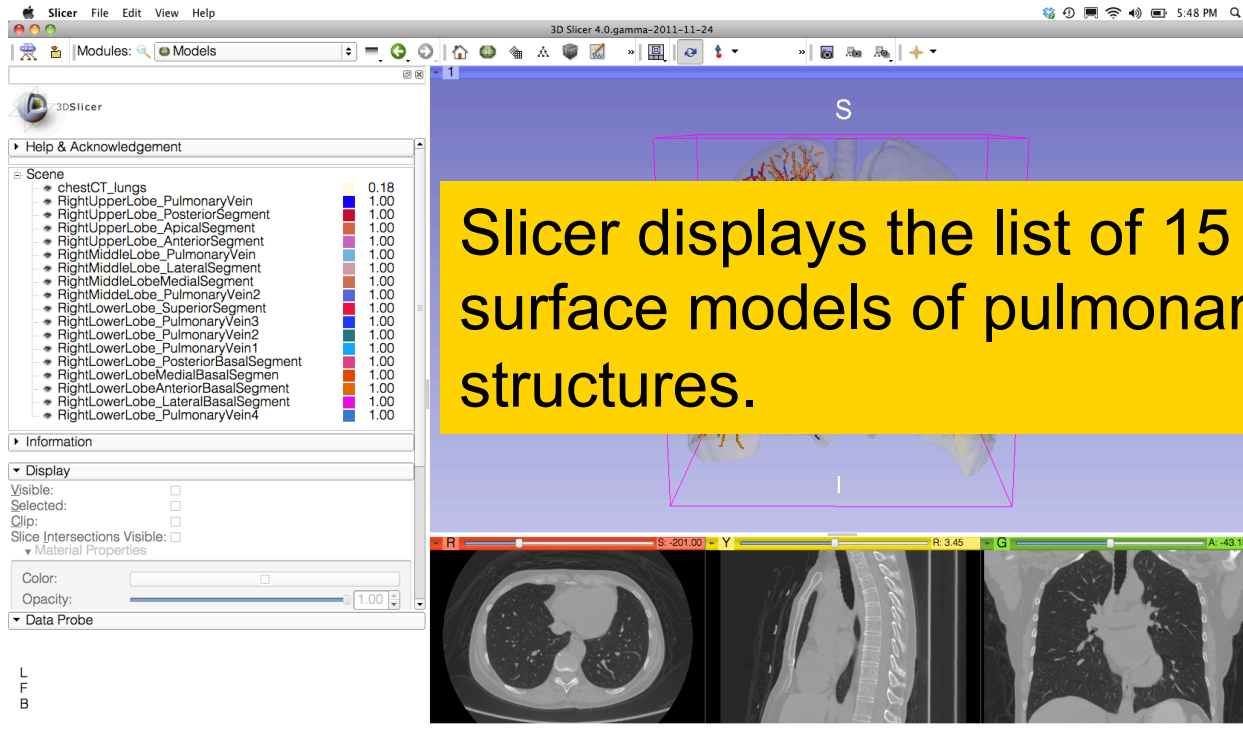


Select the module **Models** from the modules Menu.





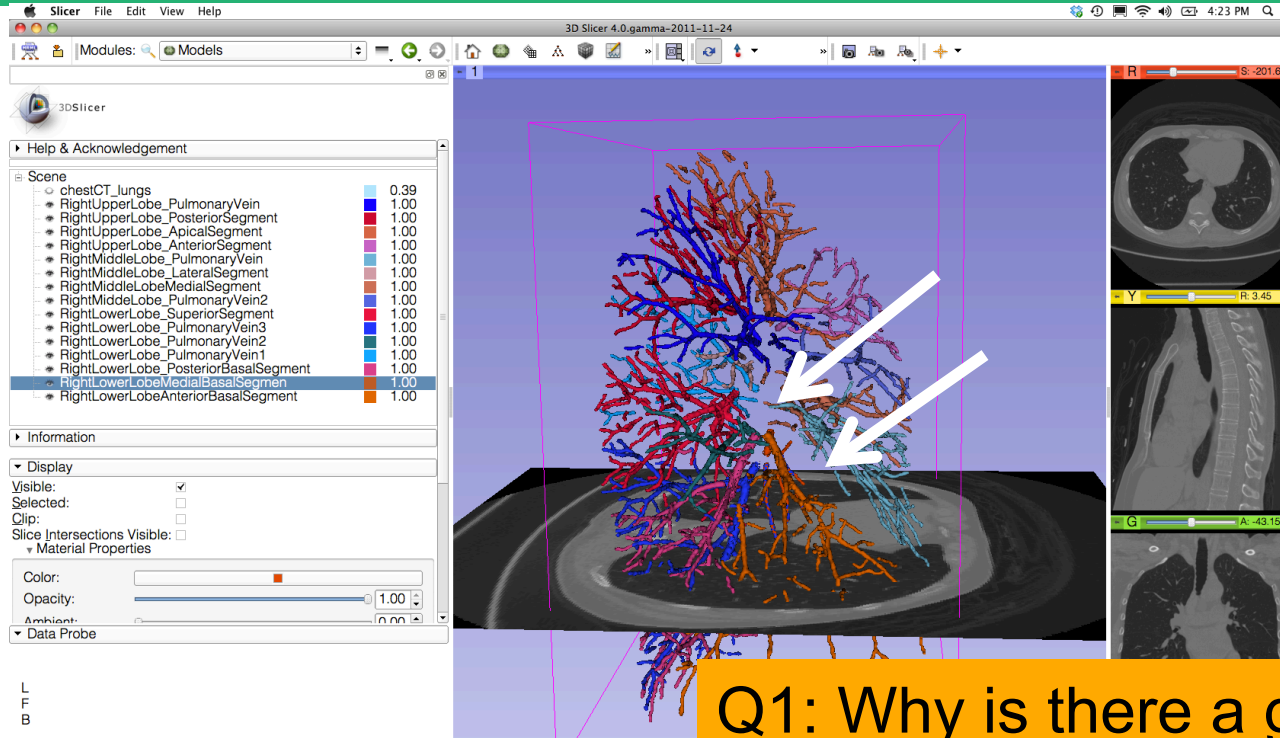
# Lung Segments



Slicer displays the list of 15 surface models of pulmonary structures.



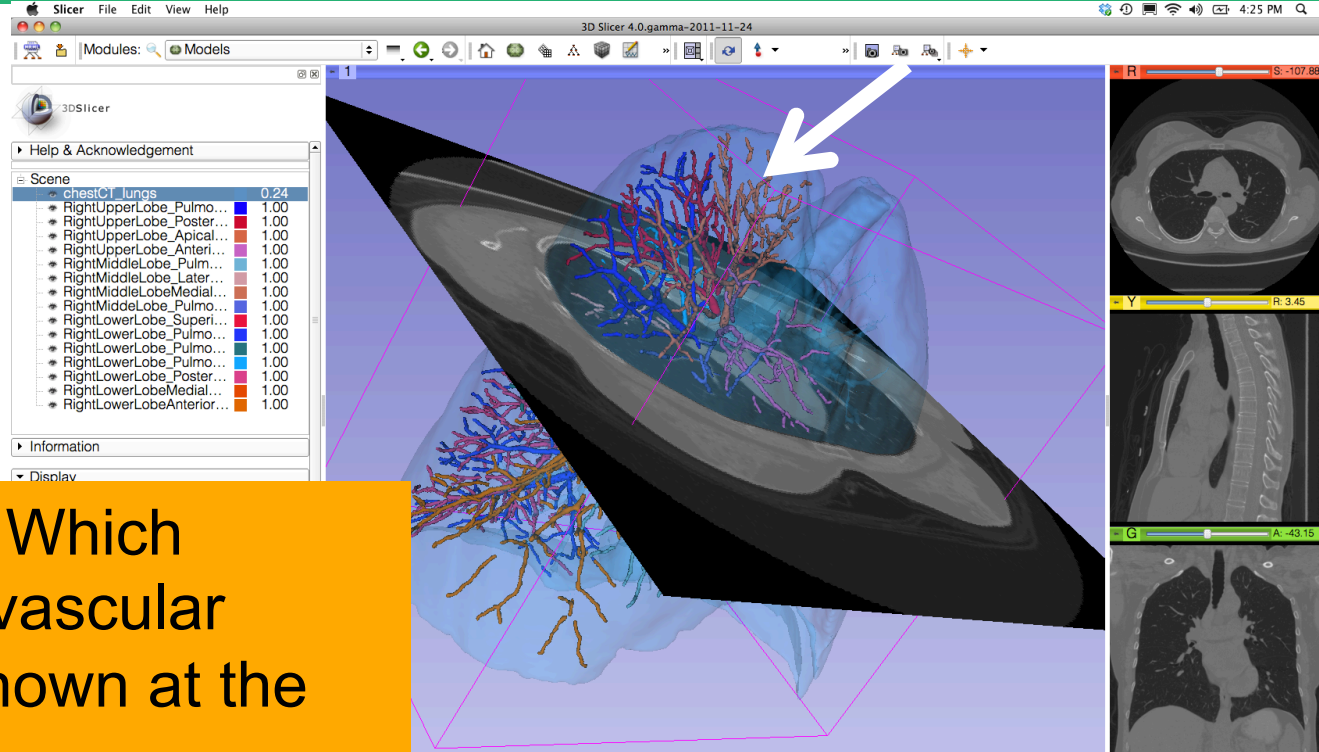
# Lung Segments – Question 1



Q1: Why is there a gap in the vessels at the arrows?



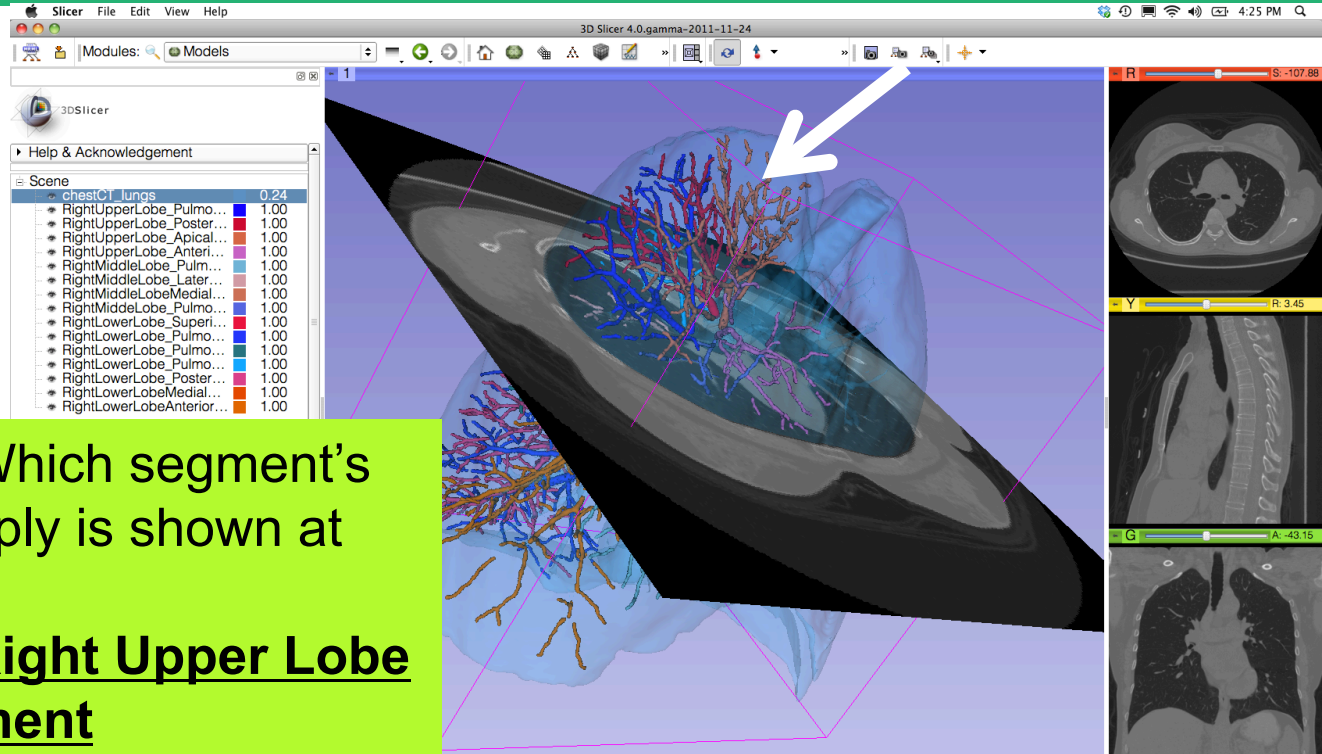
# Lung Segments – Question 2



Question 2: Which segment's vascular supply is shown at the arrow?



# Lung Segments – Question 2

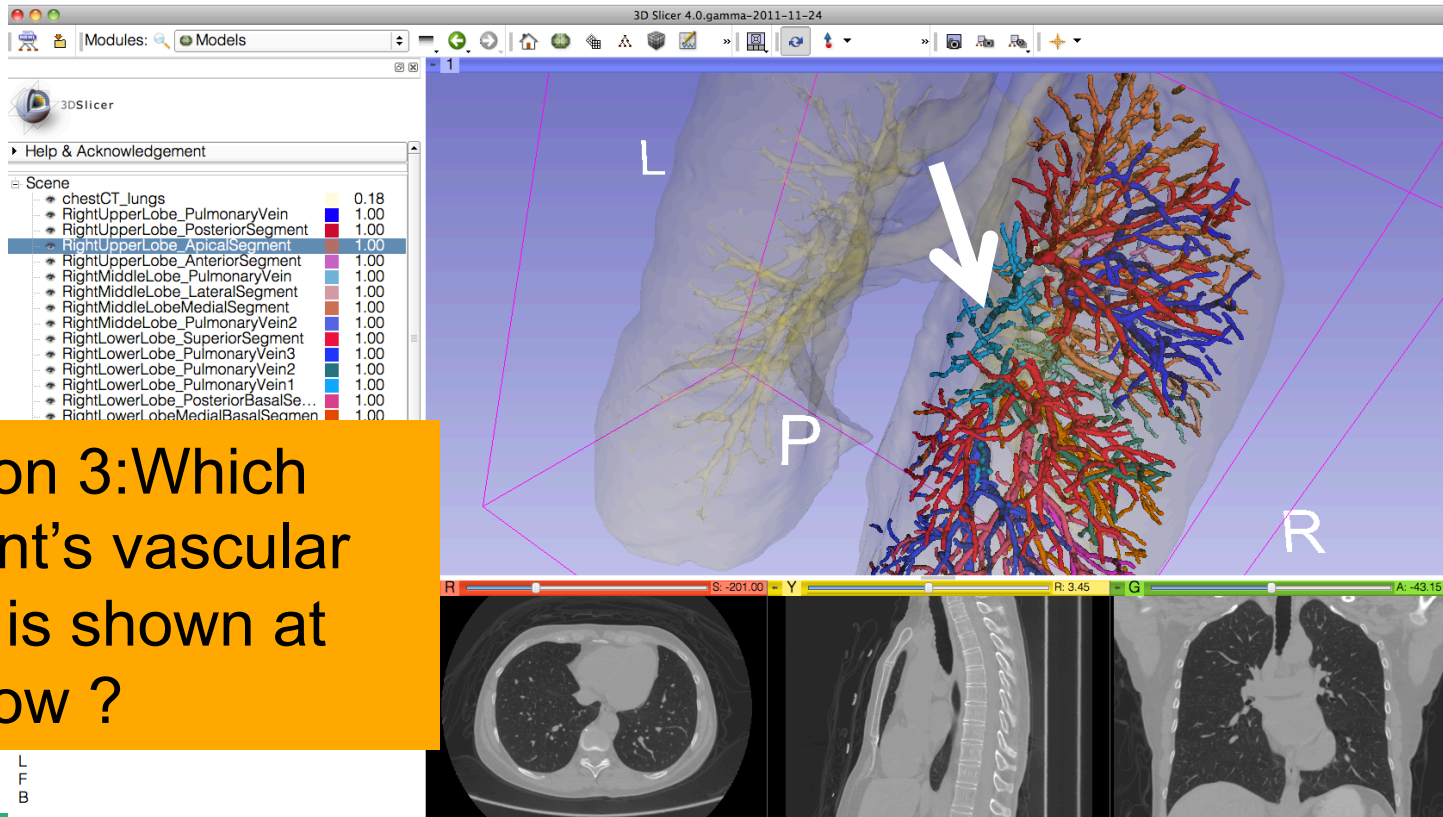


Question 2: Which segment's vascular supply is shown at the arrow?

**Answer 2: Right Upper Lobe Apical Segment**



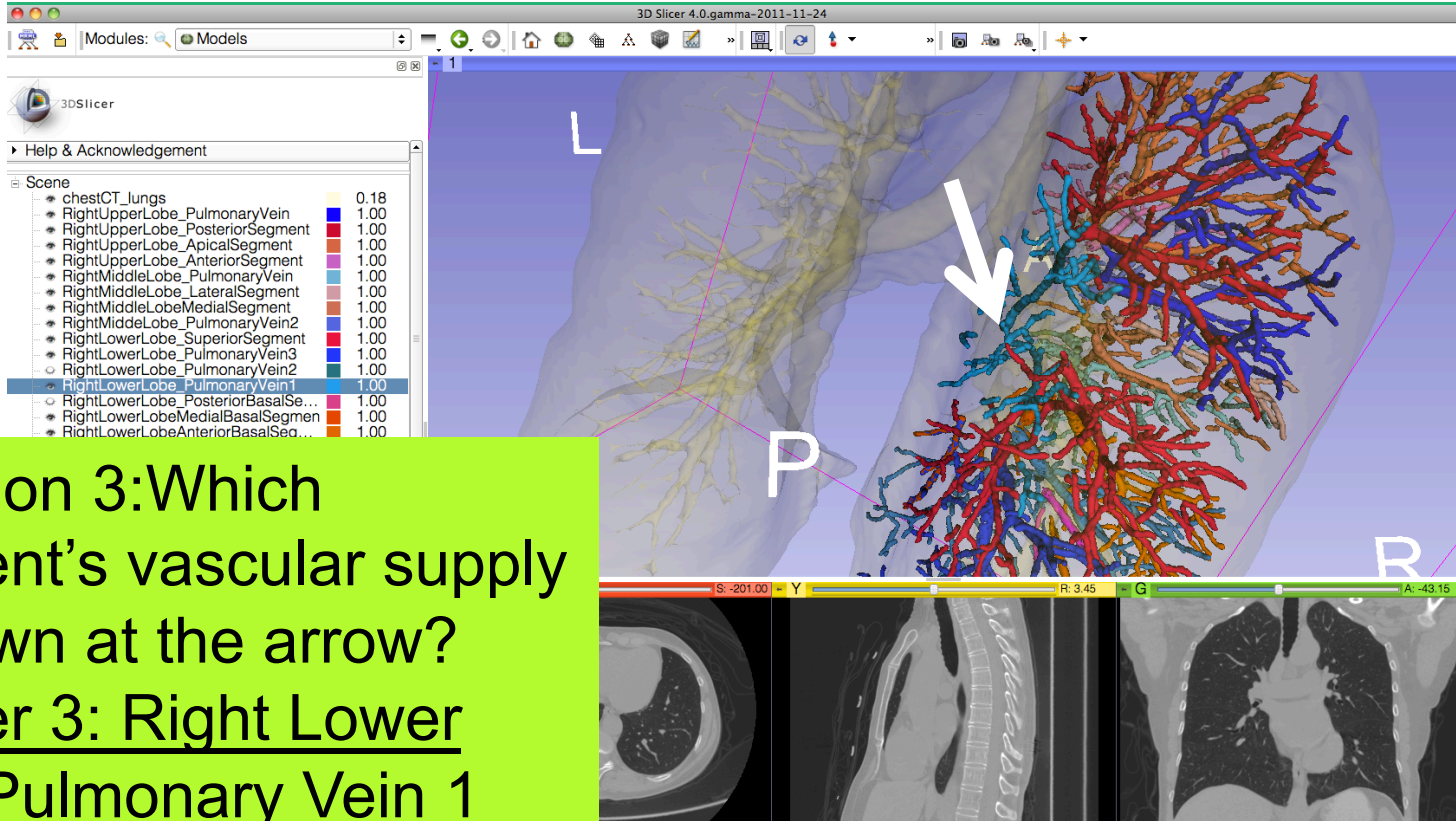
# Lung Segments – Question 3







# Lung Segments – Question 3



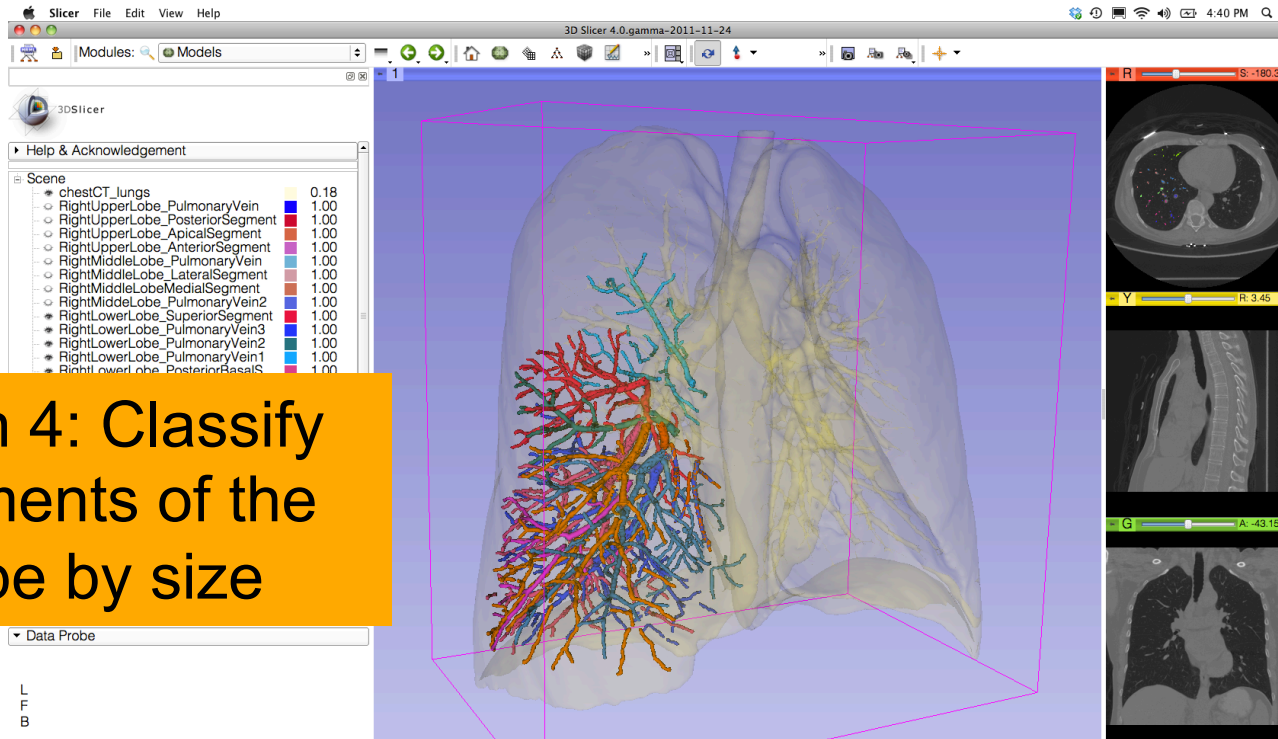
Question 3: Which segment's vascular supply is shown at the arrow?

Answer 3: Right Lower Lobe Pulmonary Vein 1



# Lung Segments – Question 4

Question 4: Classify the segments of the lower lobe by size



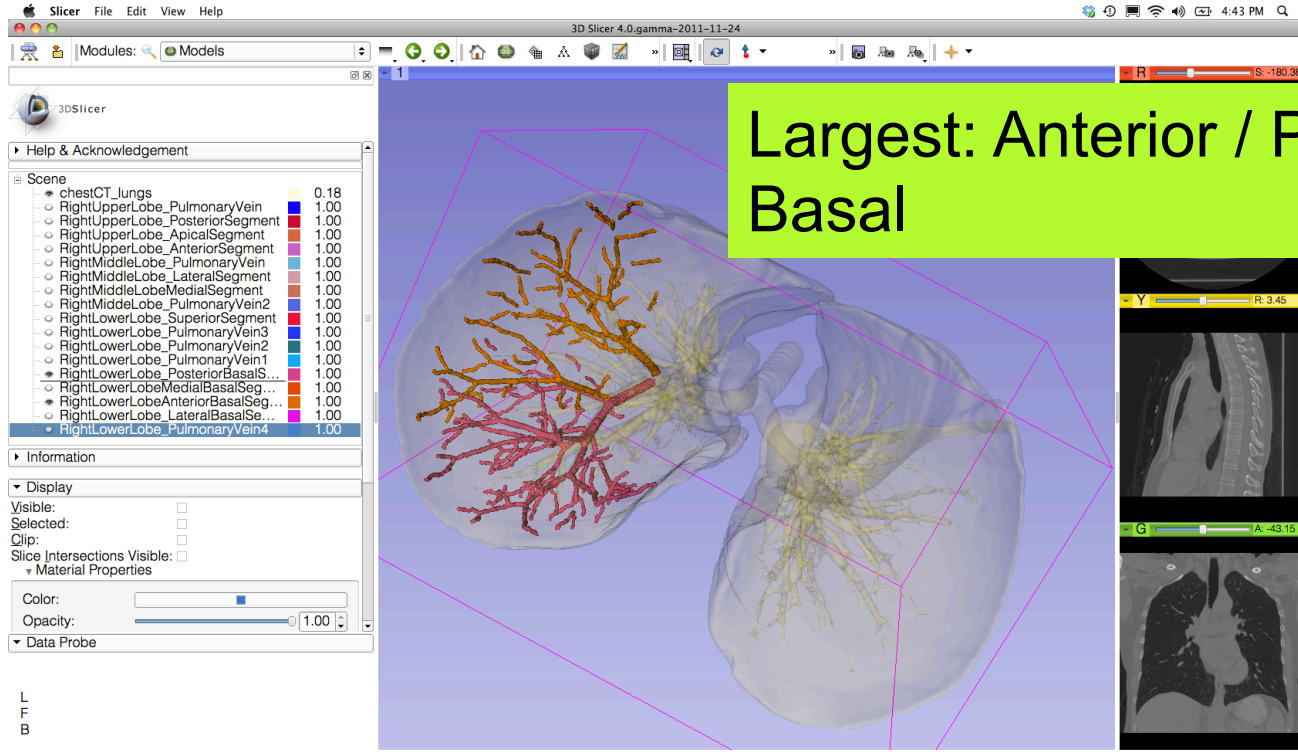


LFB



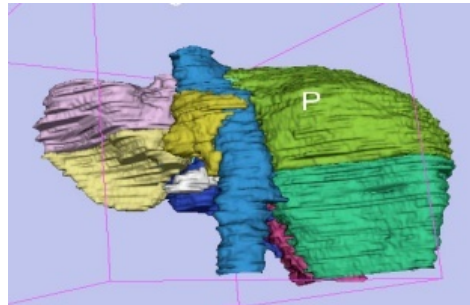
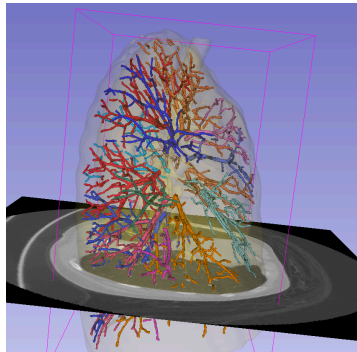
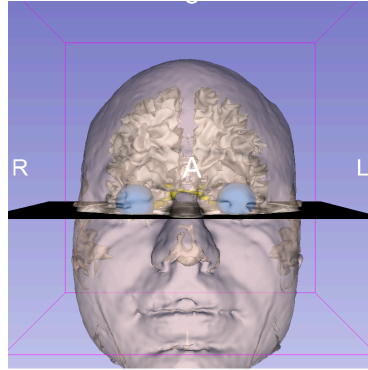
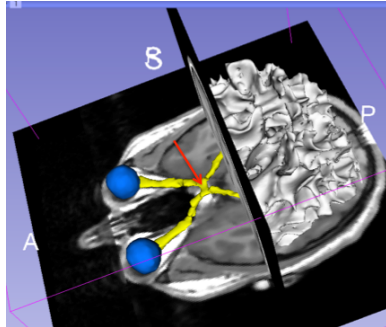


# Lung Segments – Question 4





# 3D Visualization of DICOM images



- Interactive user-interface to load and manipulate greyscale volumes, labelmaps and 3D models.
- User-defined 3D view of the anatomy
- 3D Open-source platform for Linux, Mac and Windows



# 3DSlicer website

**3DSlicer**

A multi-platform, **free and open source** software package for **visualization** and **medical image computing**

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- Publication DB
- Image Gallery
- Slicer Community
- Source Code
- Licensing
- Mailing Lists
- Web Archive

**Powerful processing.**

**Streamlined interface.**

**Extensible platform.**

**3D Slicer** *version 4*

[www.slicer.org](http://www.slicer.org)

The community of Slicer developers is proud to announce the release of Slicer 4.2. Find out more...

Webinar: Introduction to Slicer 4.1

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See [here](#) for more information about the web infrastructure.



# 3DSlicer at RSNA 2013

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## Quantitative Imaging Reading Room Exhibit QIRR 1028

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



# Additional Related Hands-on courses

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

**Sunday 11:00 am** – Quantitative Imaging for Medical Research and Practice

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

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

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

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



# 3DSlicer at RSNA

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

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



# Acknowledgments

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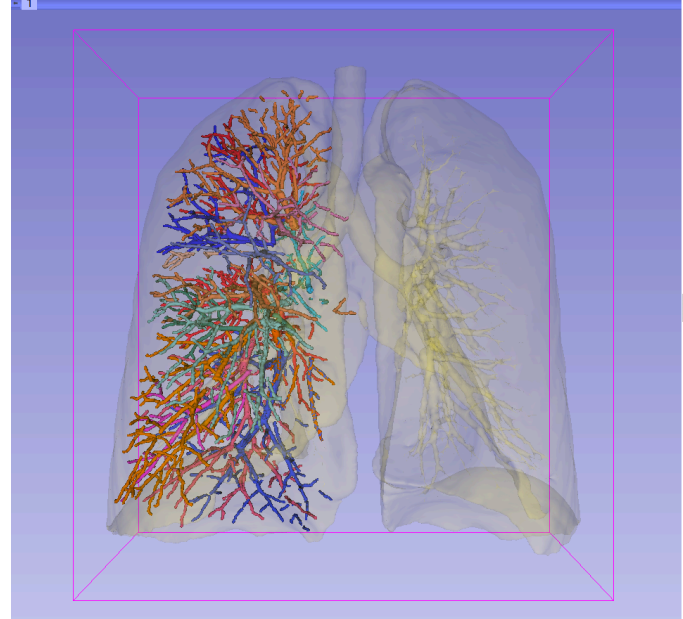
National Alliance for Medical Image Computing (NA-MIC)  
(NIH Grant U54EB005149)



Neuroimage Analysis Center (NAC)  
(NIH Grant P41 RR013218)

Marianna Jakab, Surgical Planning Laboratory, Brigham  
and Women's Hospital

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[www.na-mic.org](http://www.na-mic.org)



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