



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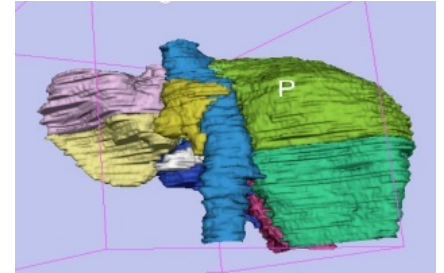
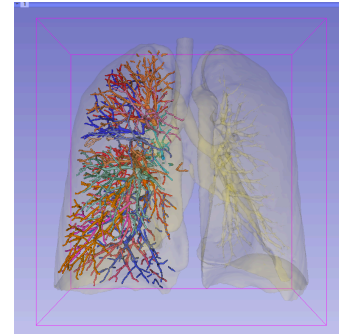
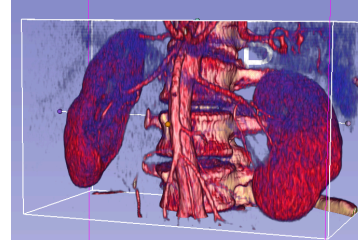
Ron Kikinis, MD, Harvard Medical School  
Surgical Planning Laboratory, Brigham and Women's Hospital



# 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.**

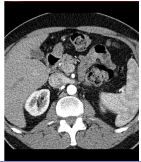




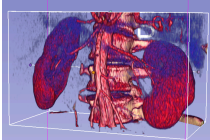


# Overview

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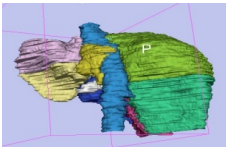
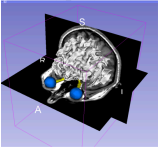


**Part I:** Introduction to the 3DSlicer software



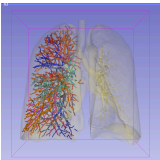
**Part II:** 3D Data Loading and visualization of DICOM images

- 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



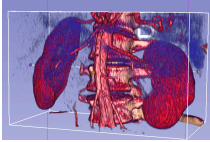


# Overview

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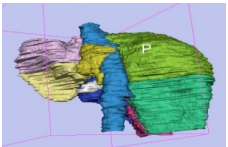
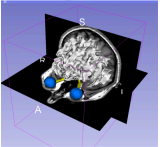


## Part I: Introduction to the 3DSlicer software



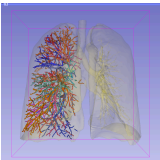
## Part II: 3D Data Loading and visualization of DICOM images

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



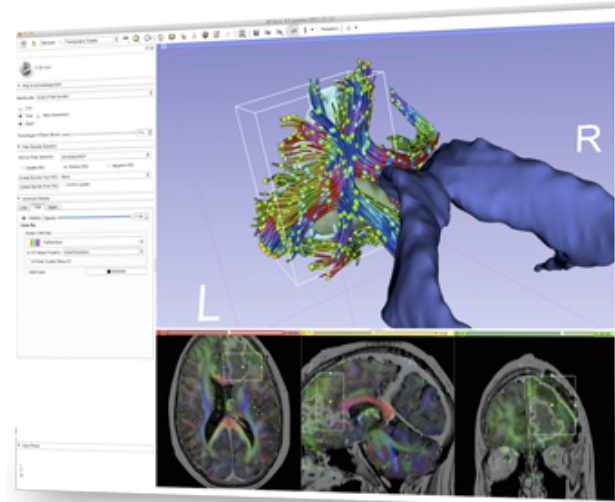
## Part III: 3D interactive exploration of the anatomy

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



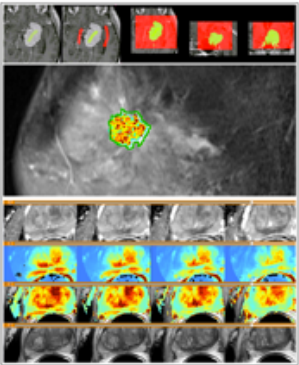
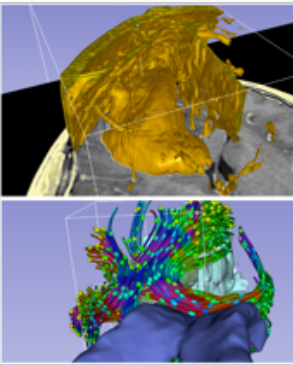
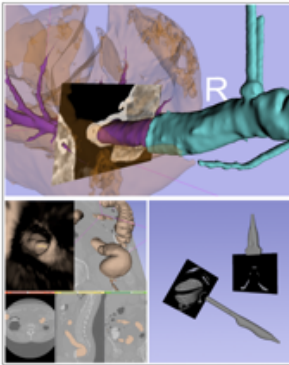



# *Introduction to the 3DSlicer software*





# 3DSlicer

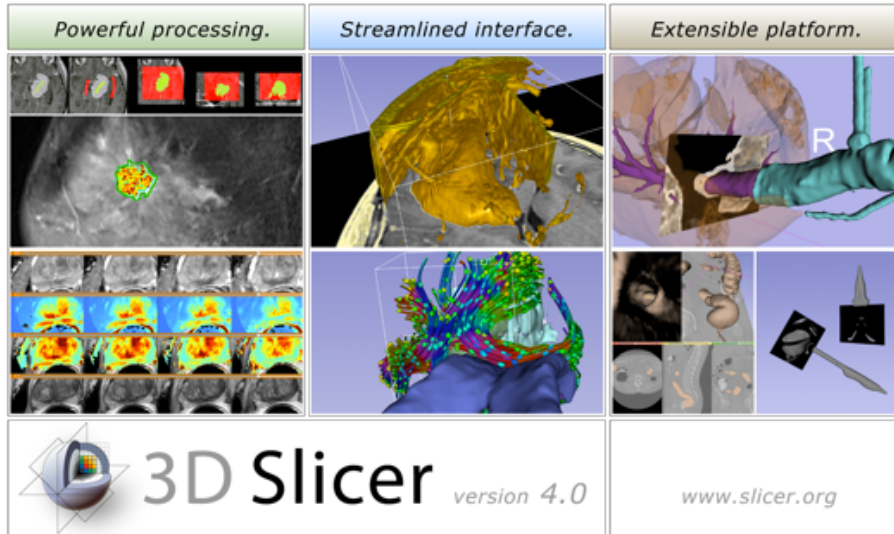
Powerful processing.	Streamlined interface.	Extensible platform.
 A grid of images showing various medical image processing tasks, including segmentation of a brain tumor and registration of different scans.	 A 3D visualization of a skull model, showing the internal structure and external surface.	 A 3D visualization of a hand model, showing the bones and soft tissue.
 <b>3D Slicer</b> <i>version 4.0</i>	<a href="http://www.slicer.org">www.slicer.org</a>	

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

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



# 3DSlicer



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

## Disclaimer

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

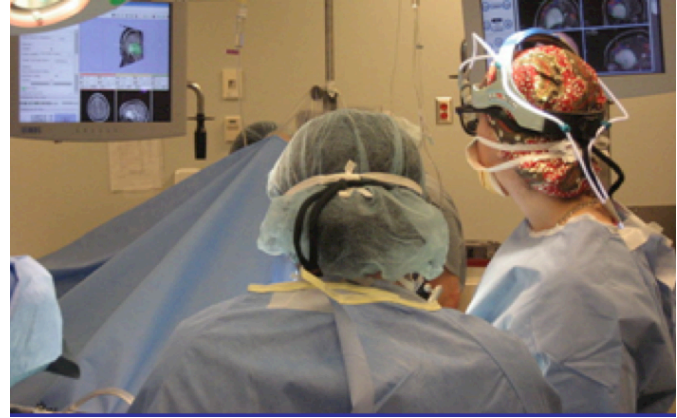


# An interdisciplinary platform

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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 Computer Science and Artificial Intelligence (MIT)

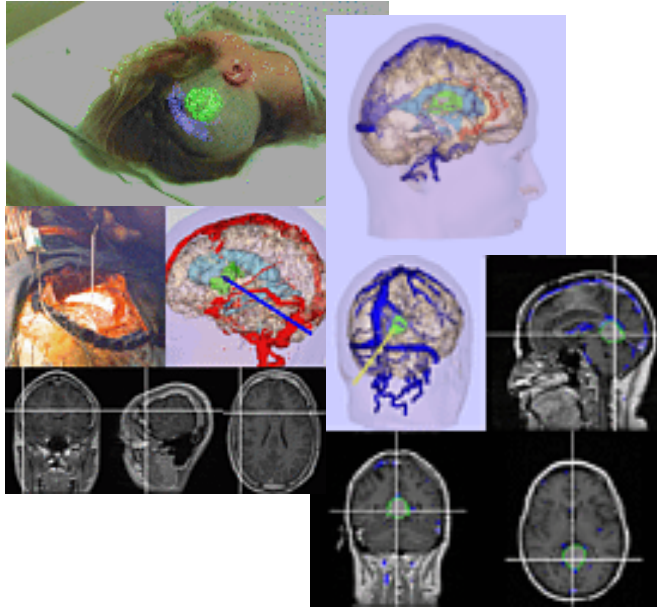


Image Courtesy of the CSAIL, MIT

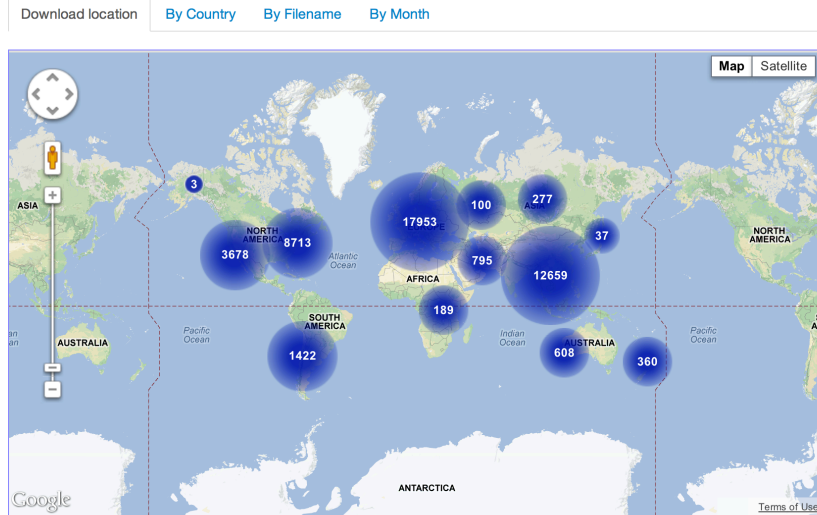




# 3DSlicer History



## Slicer 4 download statistics



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

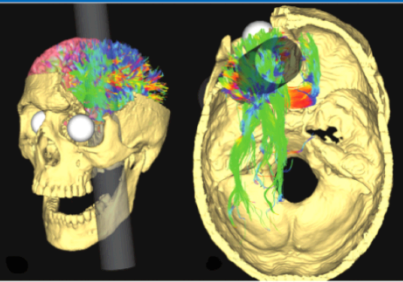
- Overview
- Organization
- Contact Us

**Center Components**

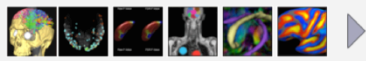
- Algorithms
- Engineering
- Driving Biological Projects
- Collaboration Grants

**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 technologies to the research community.

Supported by the National Institutes of Health (NIH) and the National Science Foundation (NSF). For information about collaborating with NA-MIC, please contact [Ron Kikinis](#).

PI: Ron Kikinis, M.D.

**NAC** **Neuroimage Analysis Center**  
"understanding the human brain through imaging"

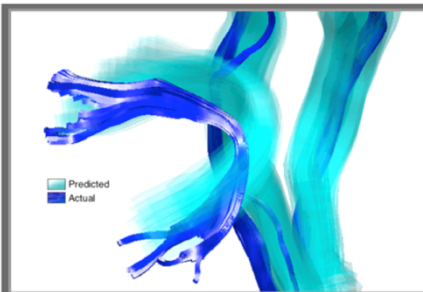
Google Custom Search GO

**About the NAC**

- Overview
- Organization
- Research Cores
- Collaborations

**Resources**

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



**FMRI-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 individual peaks and gradient landmark, AL, plus the leave-one-out LDA from the other subjects, were used to predict the location of the AL, left DSI, and right DSI. The true anatomies 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 (NCRR) (P51 RR00199) and the Institute of Biomedical Imaging and Bioengineering (NIBIB) (P41 EB005547) at the National Institutes of Health.

**NCIGT** **National Center for Image-Guided Therapy**

National Center for Image-Guided Therapy

NCIGT Wiki

**About Us**

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- Research Cores
- Research Projects
- DBPs
- People

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- 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 NCRRT and NIBIB institutes.

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



# Slicer: Behind the scenes

CDash - Slicer4

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	Error	Warn	
factory-win7.kitware	Windows7-VS2010-32bits-QT4.7.1-PythonQt-With-Tcl-CLI-Release	0	0	0	2	0	107		
factory-mac-64bits.kitware	SnowLeopard-g++4.2.1-64bits-QT4.7-PythonQt-With-Tcl-CLI-Release	1	0	0	0	0	14		
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.7-PythonQt-With-Tcl-CLI-Release	1	0	0	0	0	13		
factory-win7.kitware	Windows7-VS2008-64bits-QT4.7.1-PythonQt-With-Tcl-CLI-Release	0	0	0	0	0	1000		
factory-win7.kitware	Windows7-VS2008-32bits-QT4.7.1-PythonQt-With-Tcl-CLI-Release	1	0	0	0	0	1000		

### Nightly

Site	Build Name	Update			Configure			Build			Test			Build Time
		Files	Error	Warn	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	0	190	0	96	391			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	0	15	0	304	6			11 hours ago	
eris.kitware	Linux-g++4.4-QT4.6.3-PythonQt-CLI-Release	1	0	0	0	0	15	0	36	451			3 hours ago	
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-QT4.7-PythonQt-With-Tcl-CLI-Valgrind-Release	0	0	0	0	0	13	0	27	460			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	0	12	0	23	287			11 hours ago	
sagarmatha.kitware	Linux-g++4.3.3-QT4.7-PythonQt-With-Tcl-NoCLI-Release	0	0	0	0	0	12	0	22	288			12 hours ago	

### Continuous

Site	Build Name	Update			Configure			Build			Test			Build Time
		Files	Error	Warn	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	0	0	0	304	6		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 2,000 clinicians, clinical researchers and scientists trained since 2005





# Slicer Training events



RSNA 2011

## Major international conferences

- **RSNA** 2008, 2009, 2010, 2011, 2012
- **MICCAI** 2008, 2009, 2011, 2012
- **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

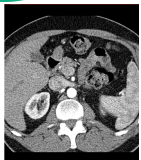
- 3DSlicer: An Open Source Platform for Segmentation, Registration, Quantitative Imaging, and 3D Visualization of Multi-Modal Image Data. #3007



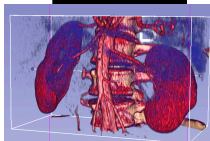


# Overview

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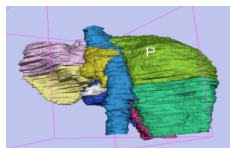
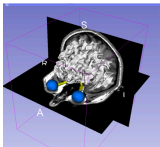


**Part I:** Introduction to the 3DSlicer software



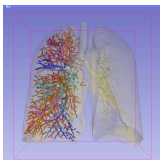
**Part II:** 3D Data Loading and visualization of DICOM images

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



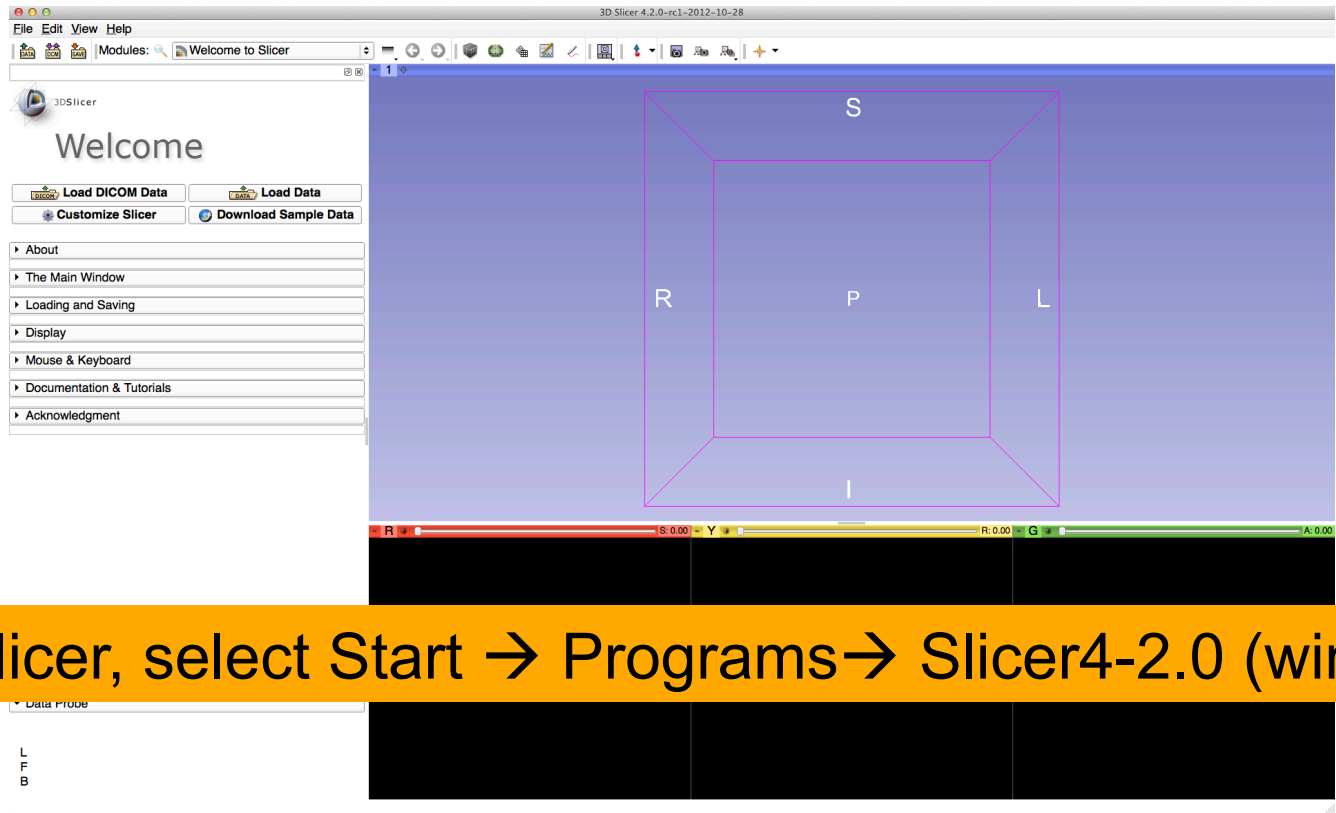
**Part III:** 3D interactive exploration of the anatomy

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





# Welcome to Slicer4



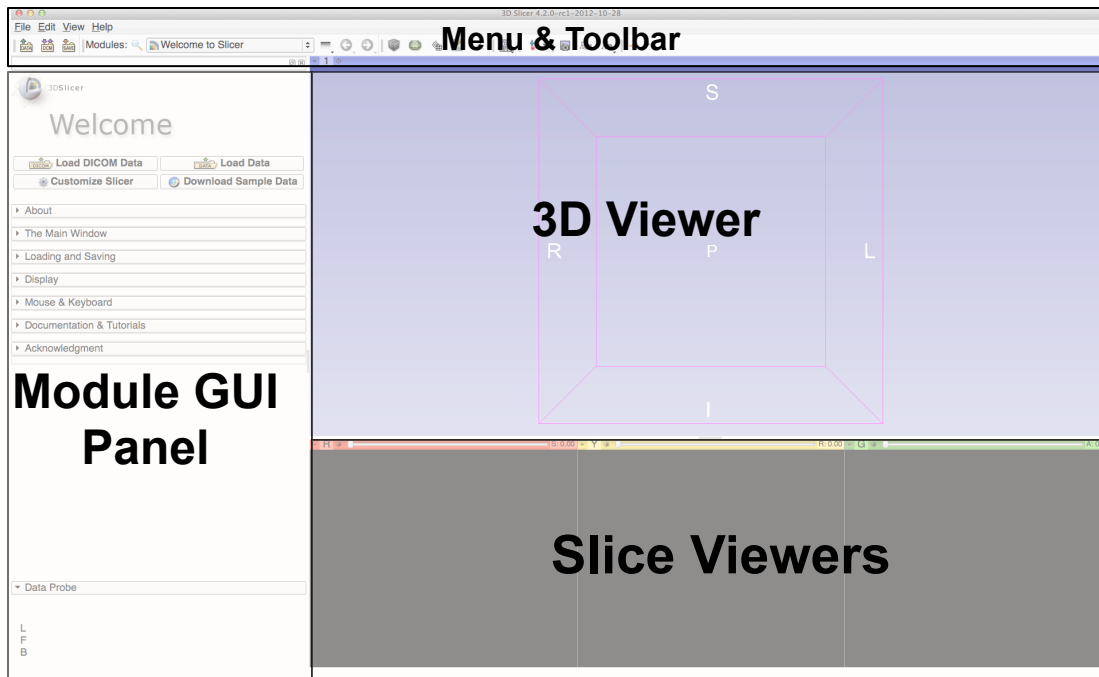
To start Slicer, select Start → Programs → Slicer4-2.0 (win64)



# Navigating the Application GUI

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

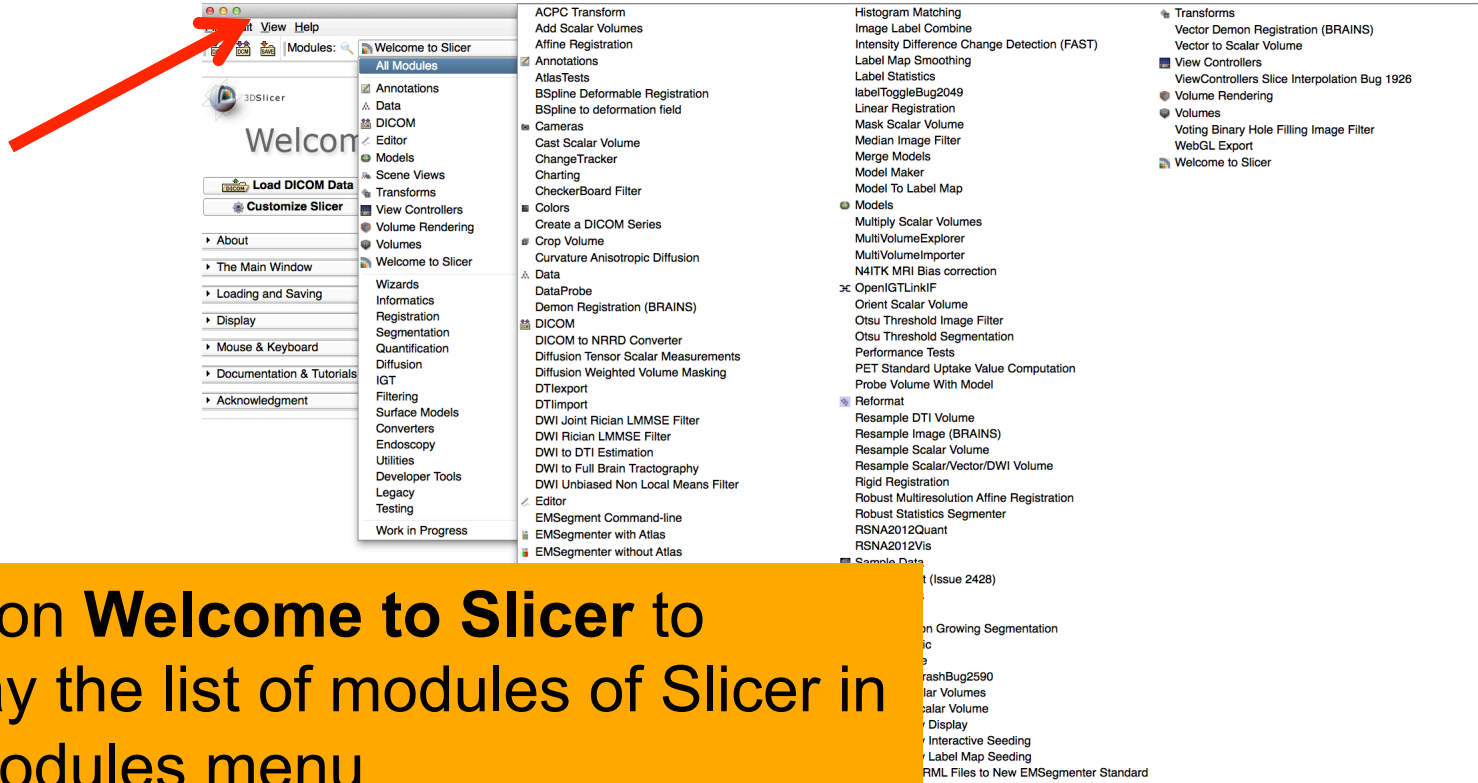
- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer





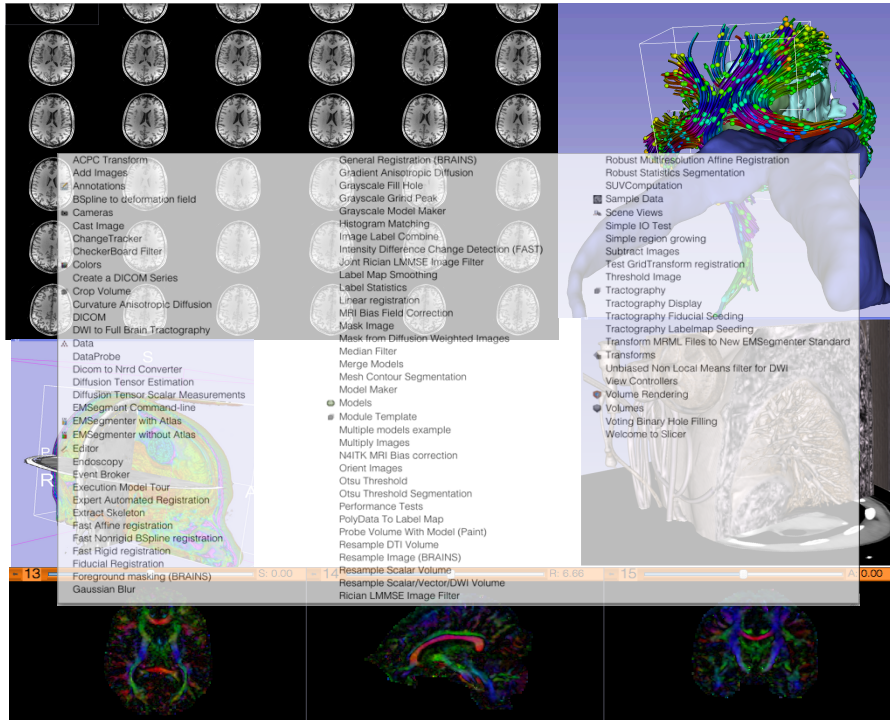


# Welcome to Slicer4.2

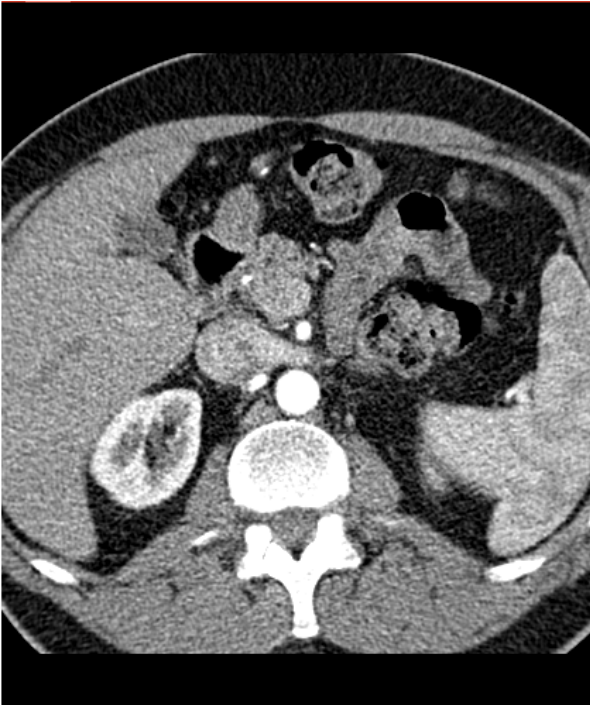




# Welcome to Slicer4



Slicer4.2 contains more than 100 modules for image segmentation, registration and 3D visualization of medical imaging data



Part 1:

Loading a DICOM Volume

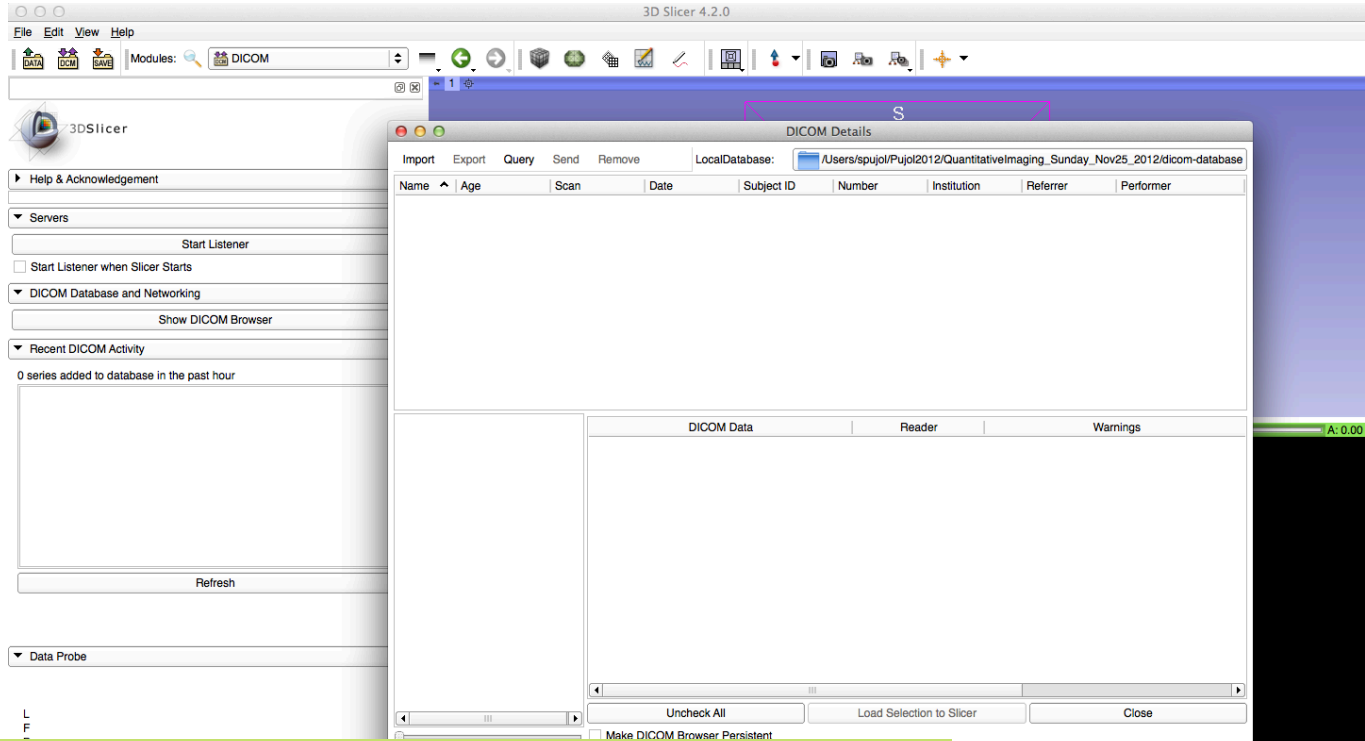


# Loading a DICOM volume

A screenshot of the 3D Slicer software interface. The window title is "3D Slicer 4.2.0-rc1-2012-10-28". The menu bar includes "File", "Edit", "View", and "Help". The "Modules" dropdown is set to "Welcome to Slicer". The left sidebar shows a "Welcome" panel with several buttons: "Load DICOM Data", "Load Data", "Customize Slicer", and "Download Sample Data". The "Load DICOM Data" button is circled in red. Below these are several expandable menu items: "About", "The Main Window", "Loading and Saving", "Display", "Mouse &amp; Keyboard", "Documentation &amp; Tutorials", and "Acknowledgment". At the bottom of the sidebar, there is a "Data Probe" section with "L", "F", "B" options and a "None RAS: (125.0, -125.0, 1.0)" label. The main 3D view area is currently empty, showing a blue background with a white 'S' in the center. A large yellow text box is overlaid on the 3D view, containing the instruction: "Click on Load DICOM Data in the panel of the Welcome to Slicer module". The bottom status bar shows "R: 0.00", "Y: 0.00", "R: 0.00", "G: 0.00", and "A: 0.00".



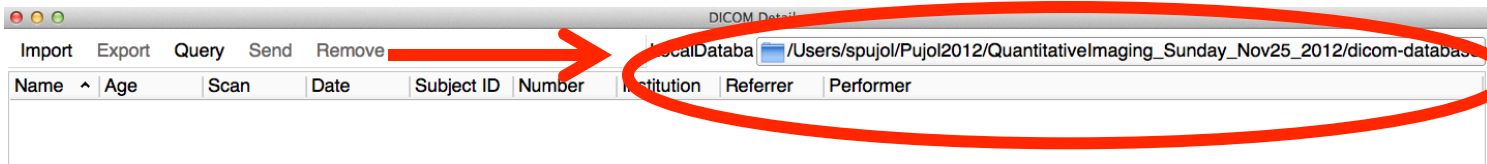
# Select DICOM local database



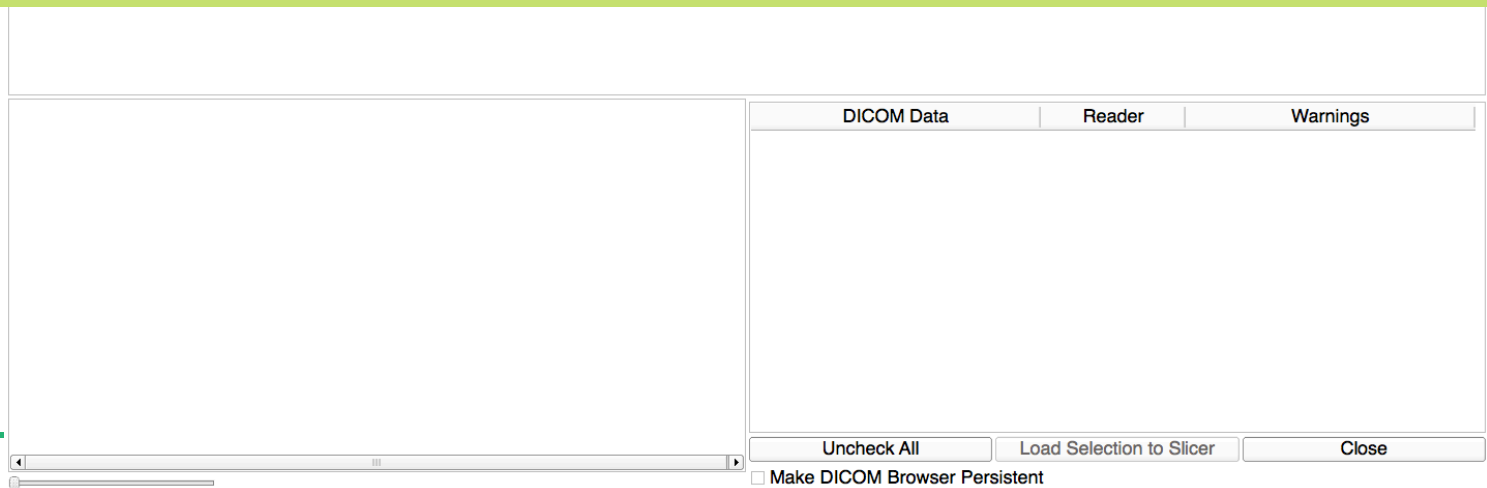
The GUI of the DICOM browser window appears



# Select DICOM local database

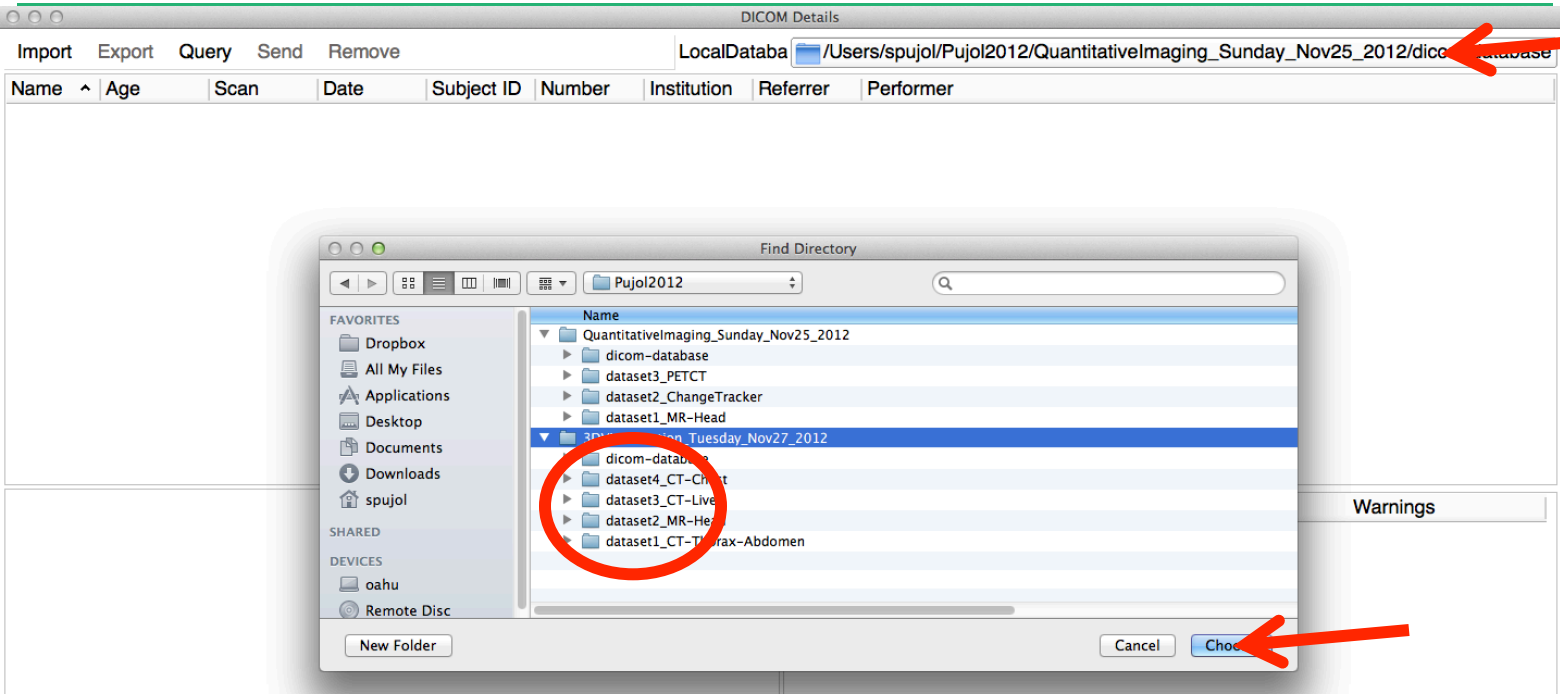


The path to the current local DICOM database of Slicer is set to  
**C:/Pujol2012/QuantitativImaging\_Sunday\_Nov25\_2012/dicom-database**





# Select DICOM local database



Click on this path name and change the local database directory to **C:/Pujol2012/3DVisualization\_Tuesday\_Nov27\_2012/dicom-database**  
Click on Choose to set this directory as the local DICOM database of Slicer



# Loading a DICOM volume

The screenshot shows a DICOM browser interface. The 'Import' menu is circled in red. An 'Import DICOM files from directory ...' dialog box is open, showing a file list with '3DVisualization\_Tuesday\_Nov27\_2012' selected and circled in red. The dialog box has 'Import' and 'Cancel' buttons. The main interface has a table with columns: Name, Age, Scan, Date, Subject ID, Number, Institution, Referrer, Performer. The 'Name' column is circled in red. The 'Reader' and 'Warnings' tabs are visible at the bottom right. The 'Uncheck All', 'Load Selection to Slicer', and 'Close' buttons are at the bottom. A checkbox for 'Make DICOM Browser Persistent' is also present.

Name	Age	Scan	Date	Subject ID	Number	Institution	Referrer	Performer
------	-----	------	------	------------	--------	-------------	----------	-----------

Import DICOM files from directory ...

Look in: /Users/spujol/Pujol2012

Name	Size
QuantitativeImaging_Sunday_Nov27_2012	-- F
3DVisualization_Tuesday_Nov27_2012	-- F

Directory: 3DVisualization\_Tuesday\_Nov27\_2012

Import  
Cancel

Uncheck All   Load Selection to Slicer   Close

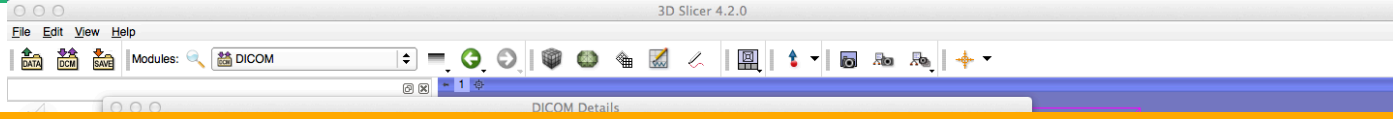
Make DICOM Browser Persistent

Click on **Import**, browse to the location of the directory **C:/Pujol2012/3DVisualization\_TuesdayNov27\_2012/**

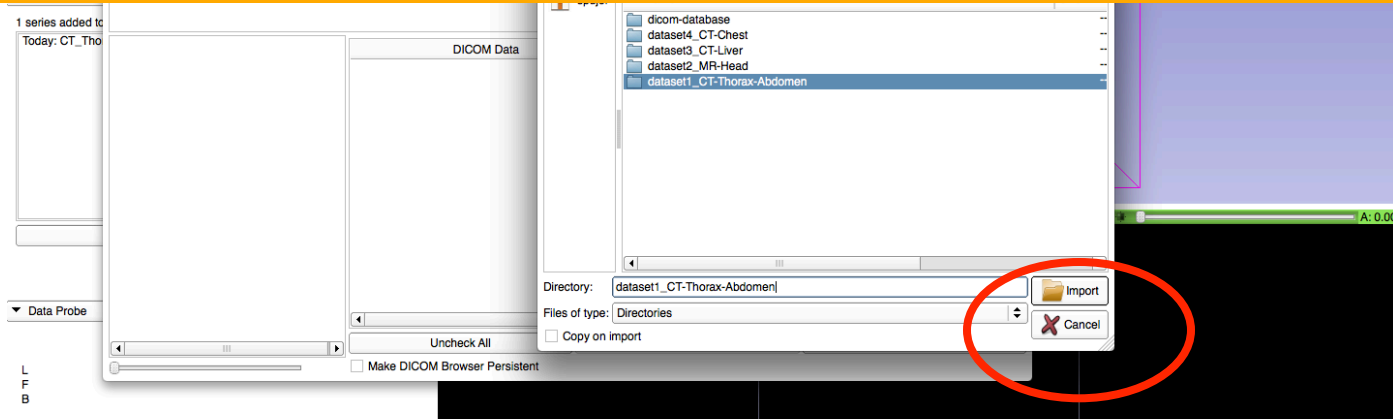




# Loading a DICOM volume



Select the directory **dataset1\_CT-Thorax-Abdomen**  
Click on **Import** to load the dataset into Slicer





# Loading a DICOM volume

The screenshot shows a DICOM browser window titled "DICOM Details". The window has a menu bar with "Import", "Export", "Query", "Send", and "Remove". Below the menu bar is a text field for "LocalData:" containing the path "/Users/spujol/workshop/RSNA2012/data/DICOM-database". The main area is a table with the following columns: "Name", "Age", "Scan", "Date", "Subject | Number", "Institution", "Referrer", and "Performer". The table contains the following data:

Name	Age	Scan	Date	Subject   Number	Institution	Referrer	Performer
patient1				patien...			
CT Thorax Abdomen			2005-...	6936864 oEfZQ...			
CT_Thorax_Abdomen CT		6	2005-...	HEART 14			

A red arrow points to the row "CT\_Thorax\_Abdomen CT". Below the table is a scroll bar. At the bottom of the window, there are three tabs: "DICOM Data", "Reader", and "Warnings". Below the tabs are three buttons: "Uncheck All", "Load Selection to Slicer", and "Close". At the very bottom, there is a checkbox labeled "Make DICOM Browser Persistent".

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**



# Loading a DICOM volume

The screenshot shows a window titled "DICOM Details" with a menu bar (Import, Export, Query, Send, Remove) and a LocalData path: /Users/spujol/workshop/RSNA2012/data/DICOM-database. Below the menu is a table with columns: Name, Age, Scan, Date, Subject | Number, Institution, Referrer, Performer. The table contains one main entry: "patient1" with a sub-entry "CT Thorax Abdomen". The "CT Thorax Abdomen" entry is expanded to show a list of 20 images (Image 0 to Image 19). A red arrow points to the "Image 1" thumbnail in the grid. To the right of the image grid is a "DICOM Data" table with columns: DICOM Data, Header, Warnings. The table lists 20 entries, each with a checked checkbox and the text "6: CT\_Thorax\_Abdo... Scalar Vol...". At the bottom of the window are buttons: "Uncheck All", "Load Selection to Slicer", and "Close". A checkbox "Make DICOM Browser Persistent" is also visible.

Name	Age	Scan	Date	Subject   Number	Institution	Referrer	Performer
patient1				patien...			
CT Thorax Abdomen			2005-...	6936864 oEIZQ...			
CT_Thorax_Abdomen CT	6		2005-...	HEART 14			

DICOM Data	Header	Warnings
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	
<input checked="" type="checkbox"/> 6: CT_Thorax_Abdo...	Scalar Vol...	

Click to expand the DICOM Browser window.

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



# Loading a DICOM volume

The screenshot shows a 'DICOM Details' window with a table of DICOM files. The table has columns for Name, Age, Scan, Date, Subject, I Number, Institution, Referrer, and Performer. The selected row is 'CT Thorax Abdomen' with a date of '2005-...' and subject '6936864 oEFZQ...'. Below the table is a 'DICOM Data' table with columns for 'DICOM Data', 'Reader', and 'Warnings'. The 'DICOM Data' table lists multiple instances of '6: CT\_Thorax\_Abdo...'. At the bottom right, there is a 'Load Selection to Slicer' button, which is highlighted by a red arrow. Other buttons include 'Uncheck All' and 'Close'. A 'Make DICOM Browser Persistent' checkbox is also visible.

Name	Age	Scan	Date	Subject	I Number	Institution	Referrer	Performer
patient1				patien...				
CT Thorax Abdomen			2005-...		6936864	oEFZQ...		
CT_Thorax_Abdomen CT	6		2005-...	HEART	14			

DICOM Data	Reader	Warnings
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
Thorax_Abdo...	Scalar Vol...	
6: CT_Thorax_Abdo...	Scalar Vol...	
6: CT_Thorax_Abdo...	Scalar Vol...	
6: CT_Thorax_Abdo...	Scalar Vol...	
6: CT_Thorax_Abdo...	Scalar Vol...	

Image 15 Image 16 Image 17 Image 18 Image 19

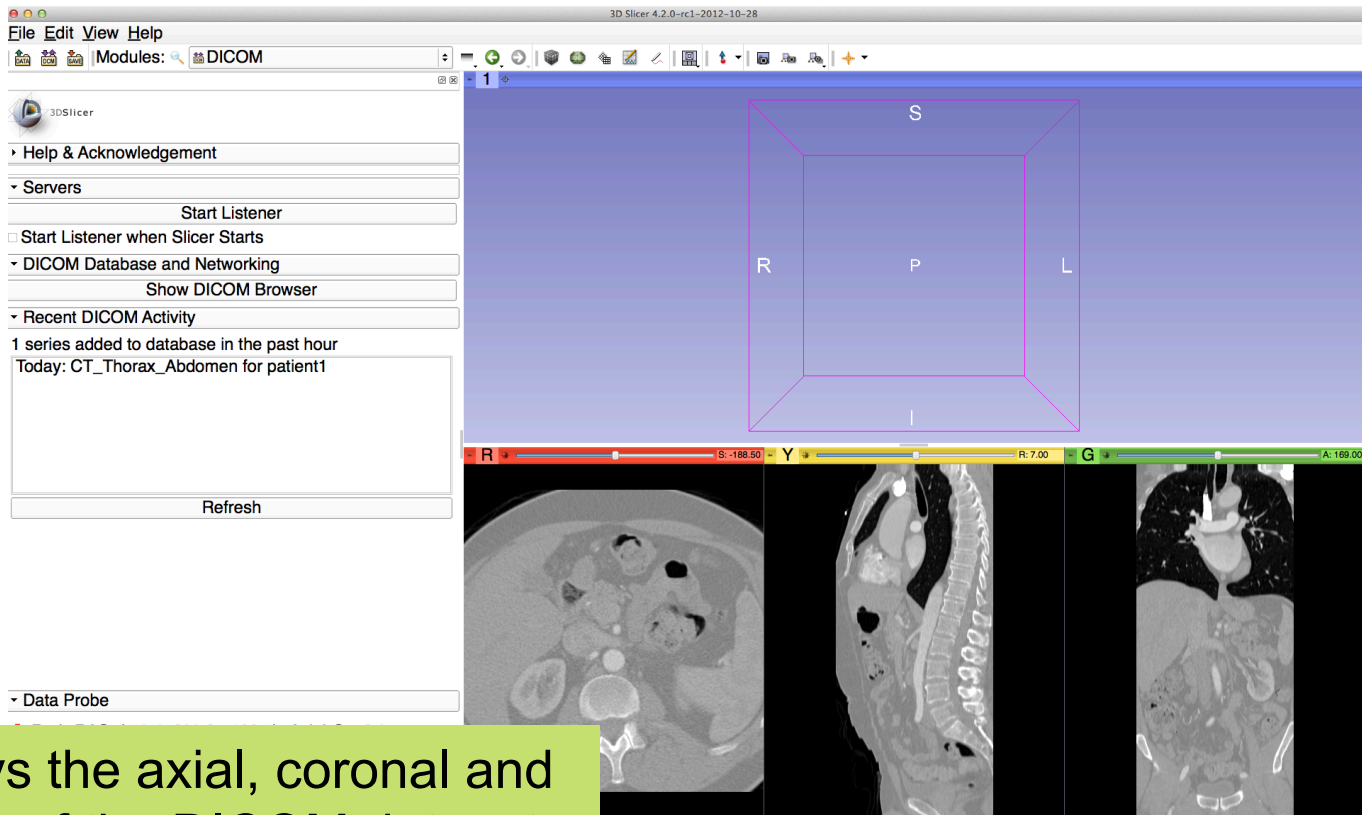
Uncheck All Load Selection to Slicer Close

Make DICOM Browser Persistent

Click on **Load Selection to Slicer** to load the DICOM volume into Slicer (note: this may take a few minutes)



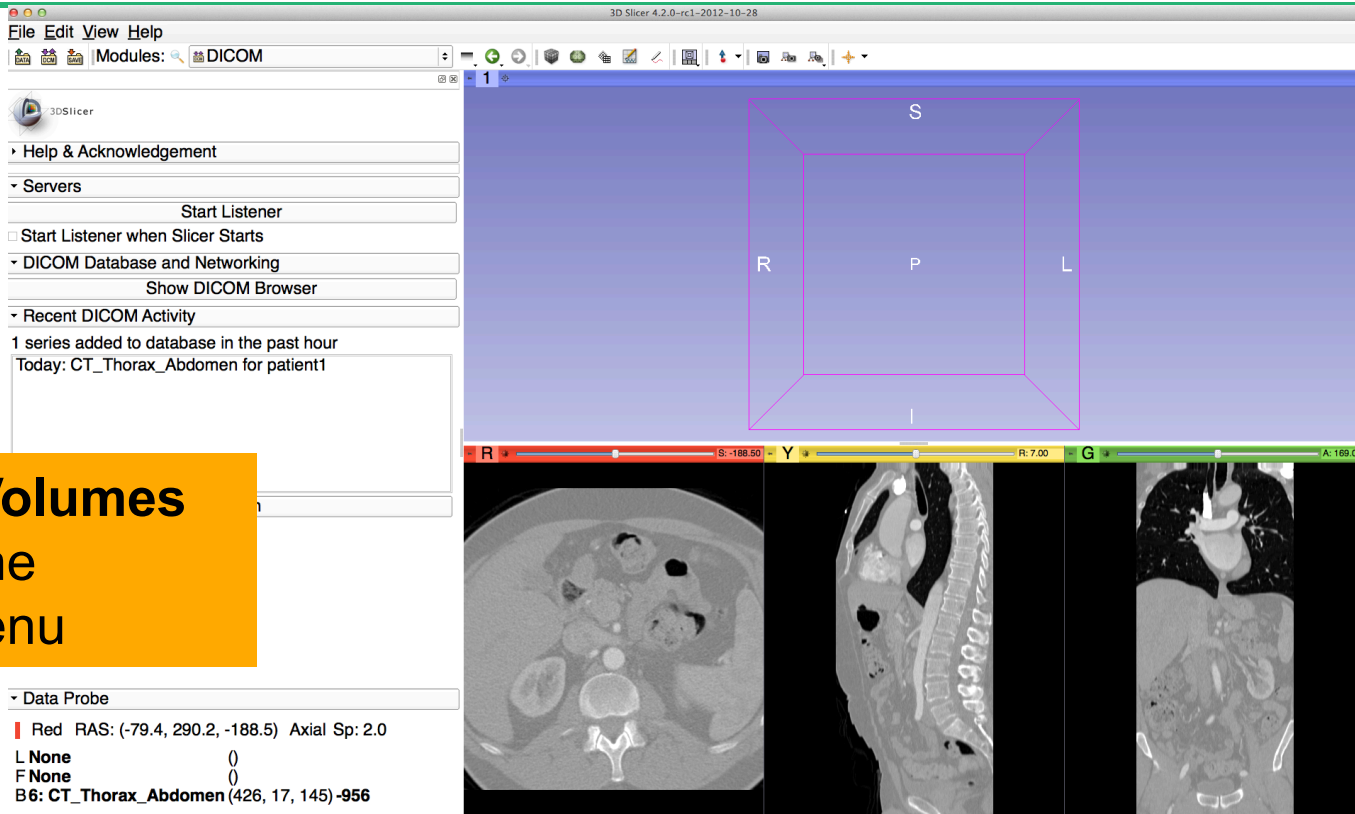
# Loading a DICOM volume



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



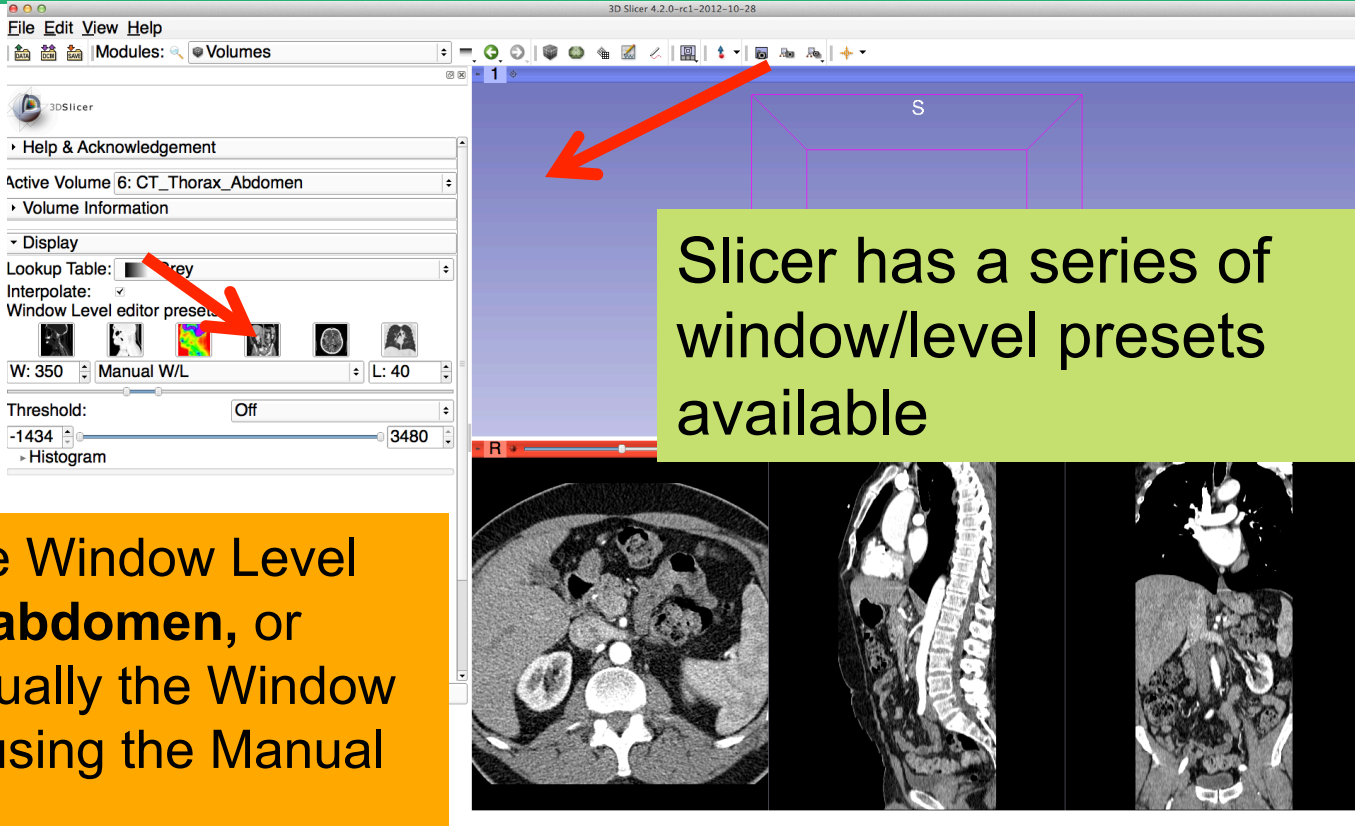
# Loading a DICOM volume



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



# Loading a DICOM volume

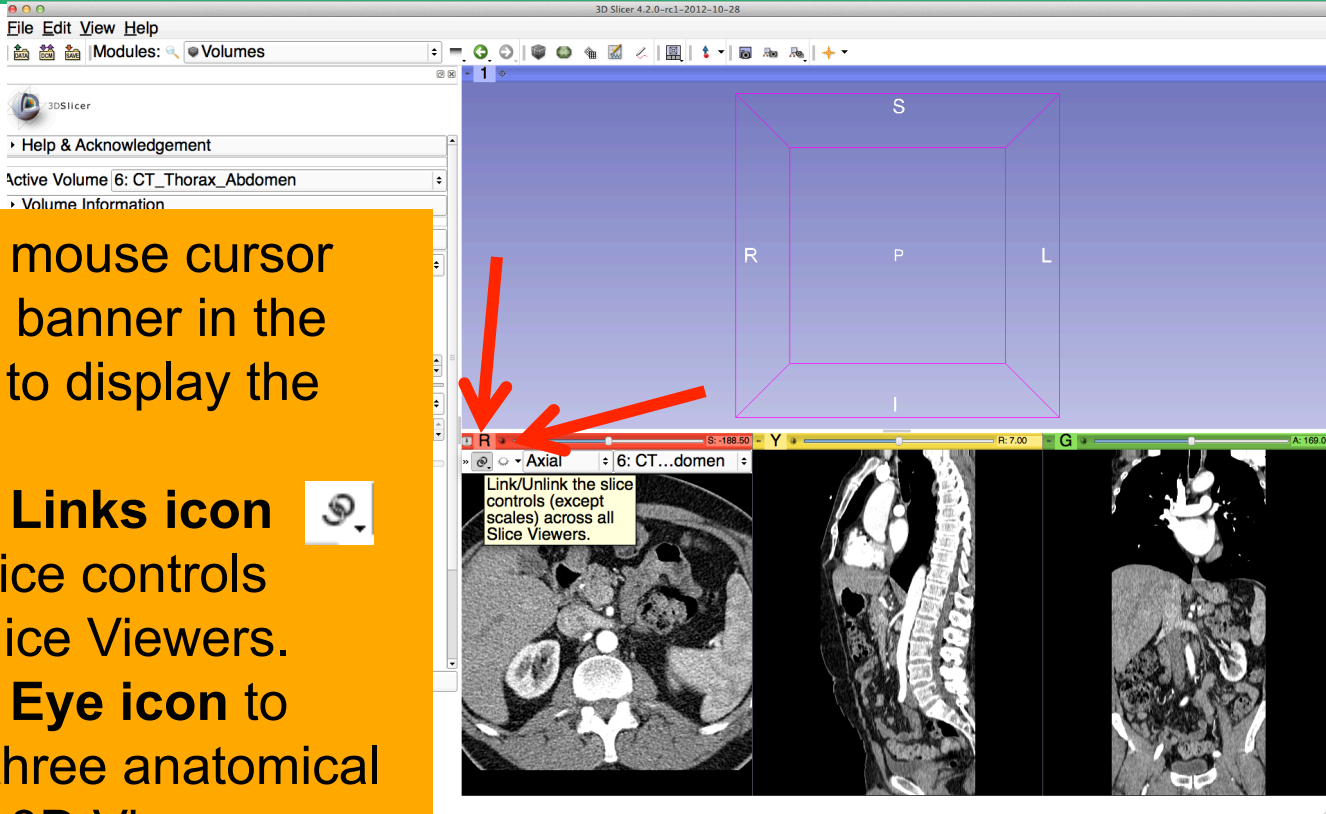


Slicer has a series of window/level presets available


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



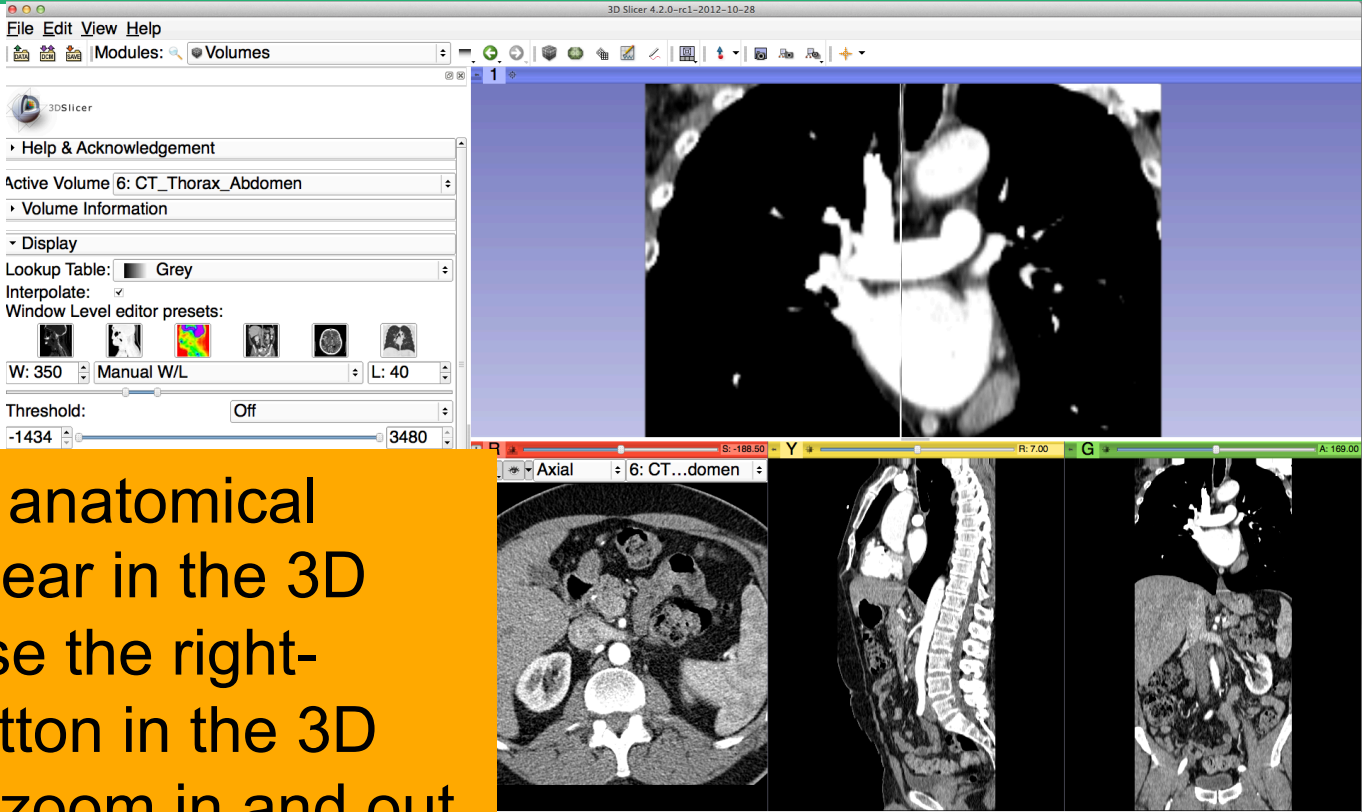
Position the mouse cursor over the red banner in the Red Viewer to display the slice menu.

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





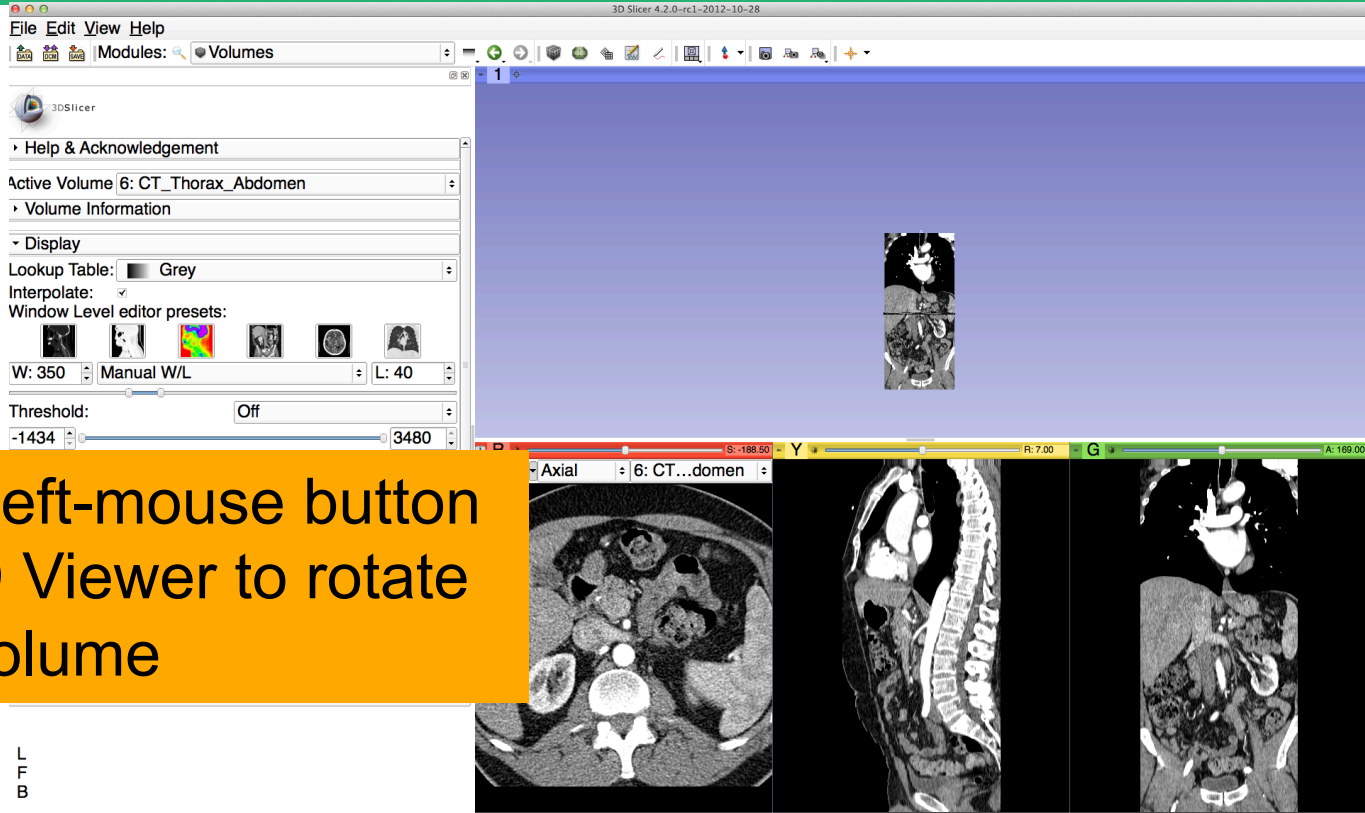
# Loading a DICOM volume



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



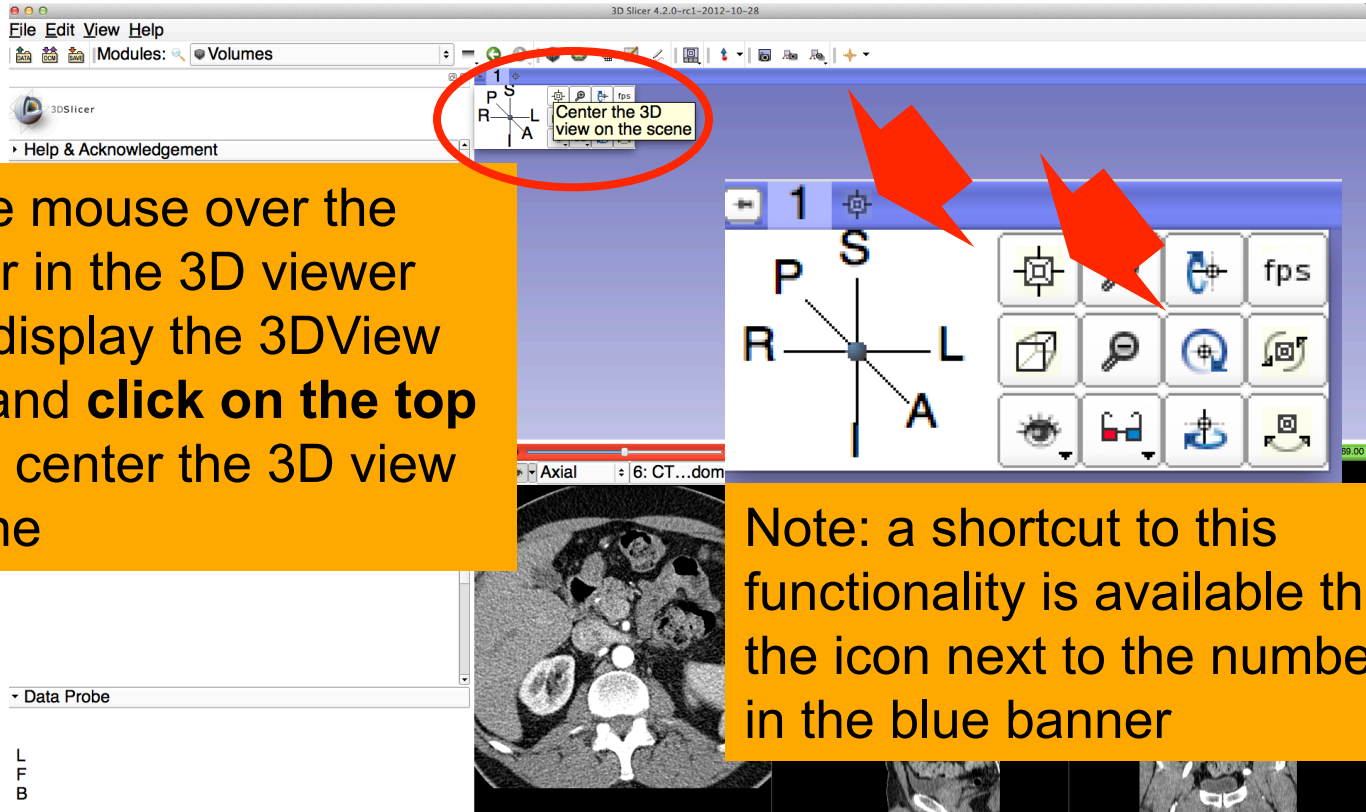
# Loading a DICOM volume



L  
F  
B



# Loading a DICOM volume

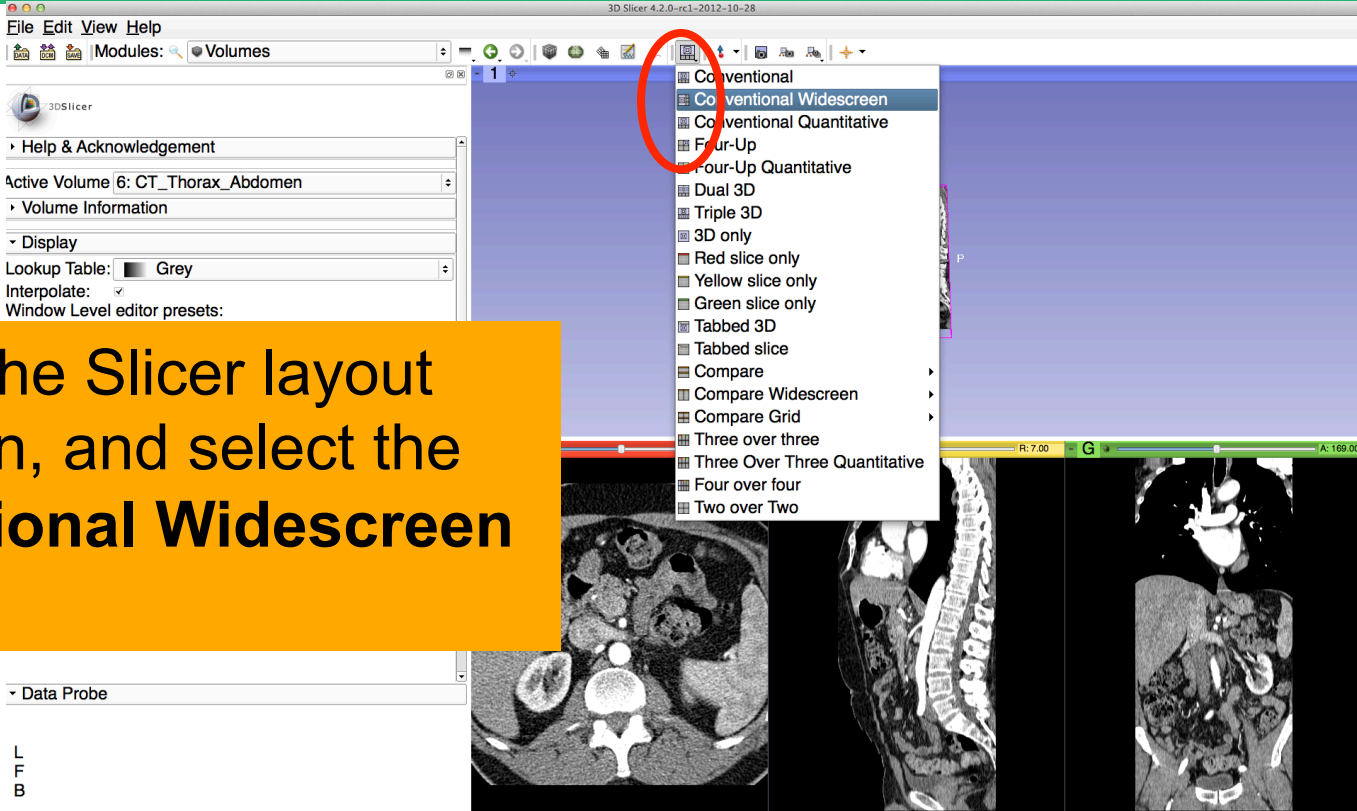


Position the mouse over the blue banner in the 3D viewer window to display the 3DView controller, and **click on the top left icon** to center the 3D view on the scene

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



# Loading a DICOM volume

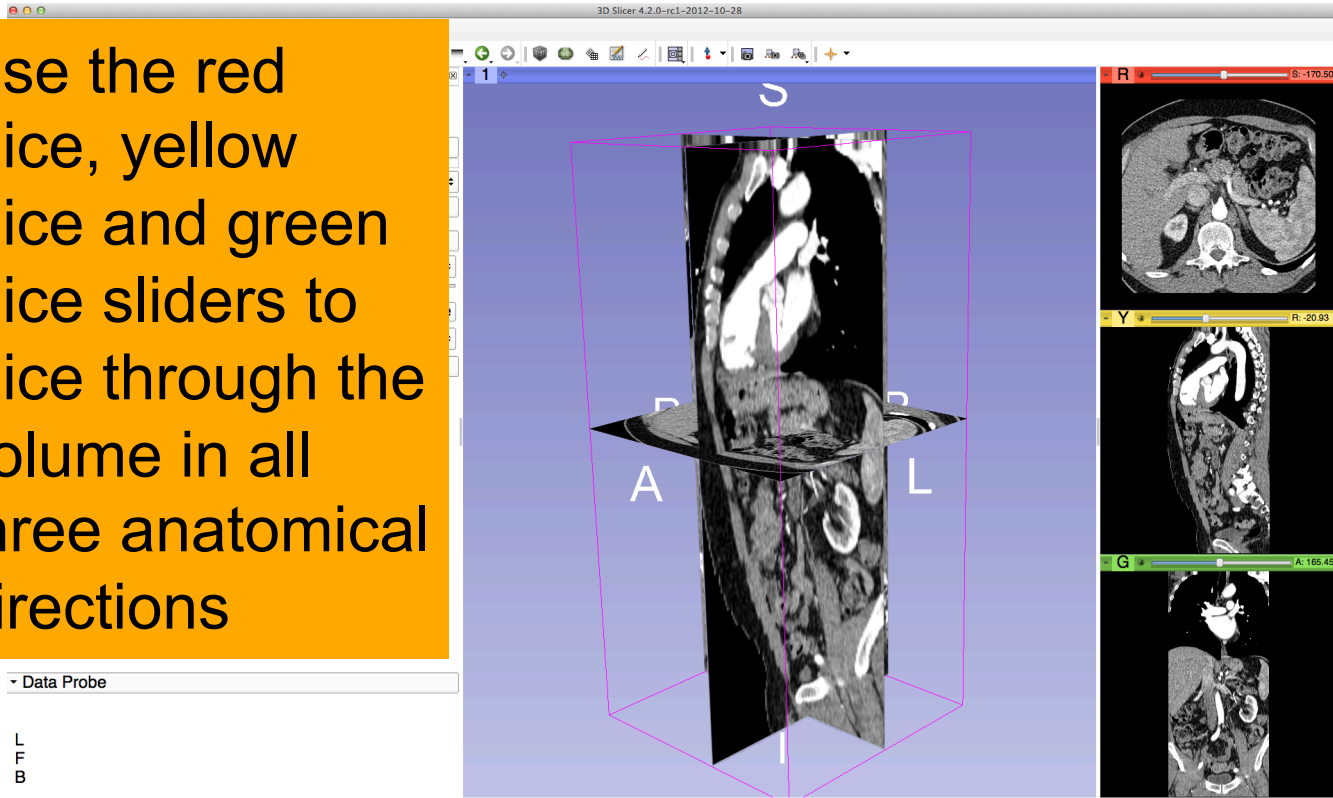


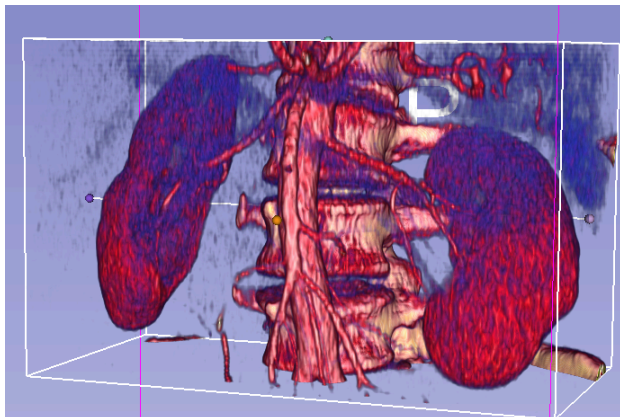
Click on the Slicer layout menu icon, and select the **Conventional Widescreen** layout



# Loading a DICOM volume

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



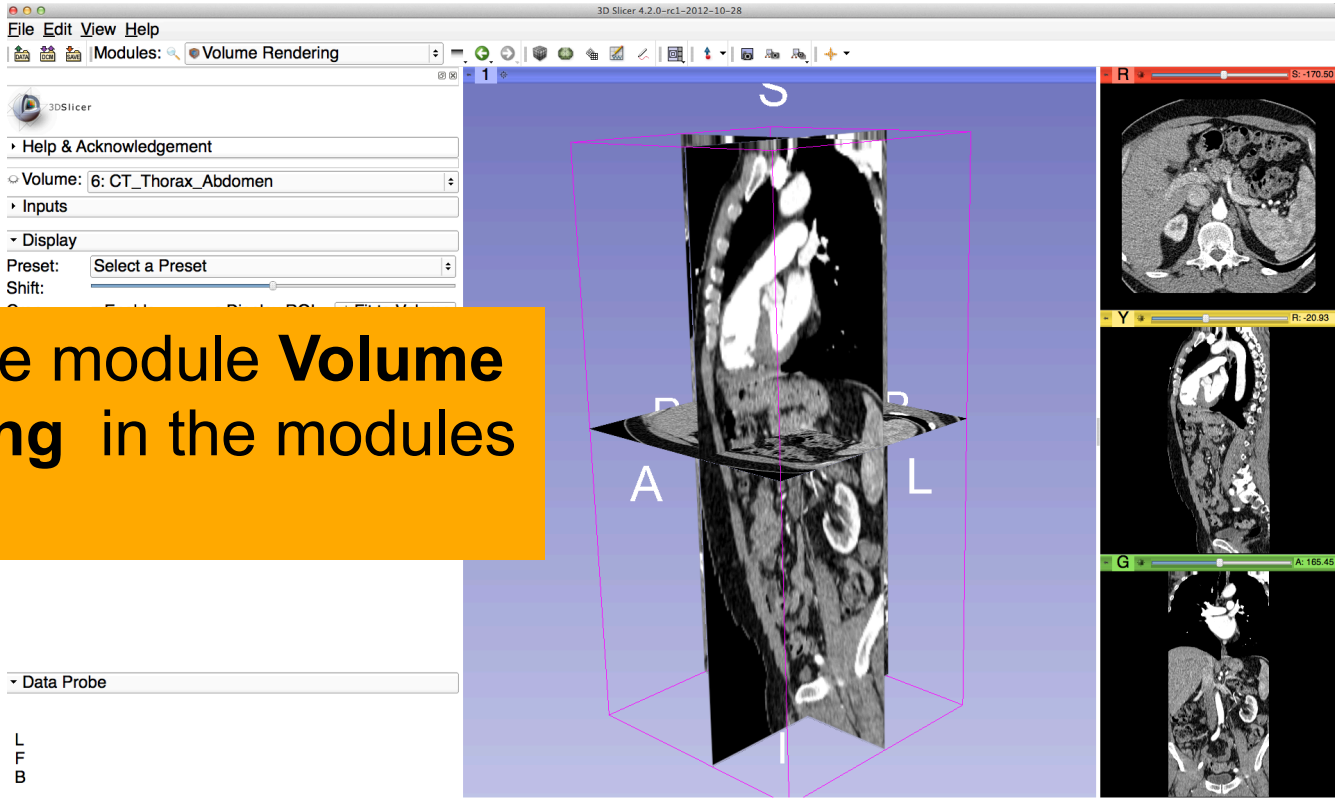


3D Interactive exploration of  
thoraco-abdominal CT data  
using Volume Rendering



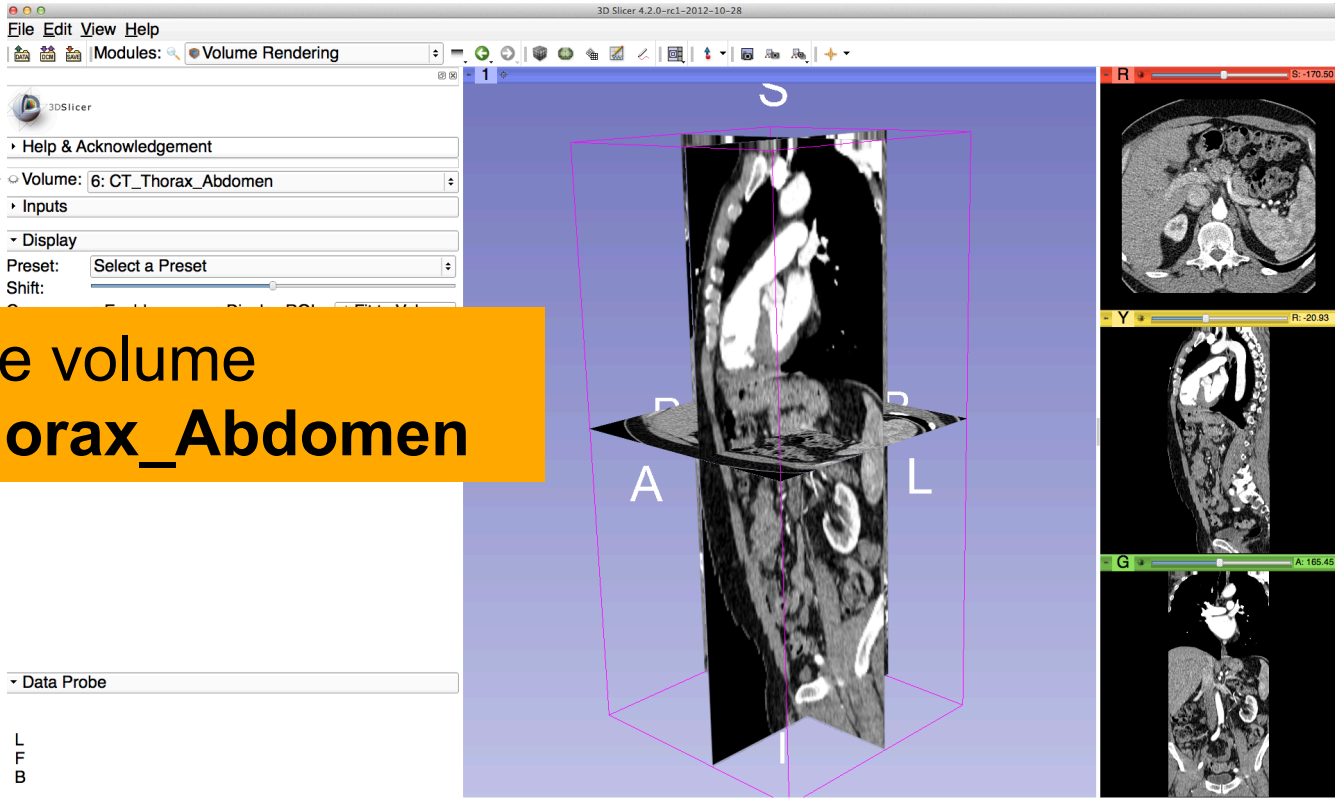
# Volume Rendering

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





# Volume Rendering

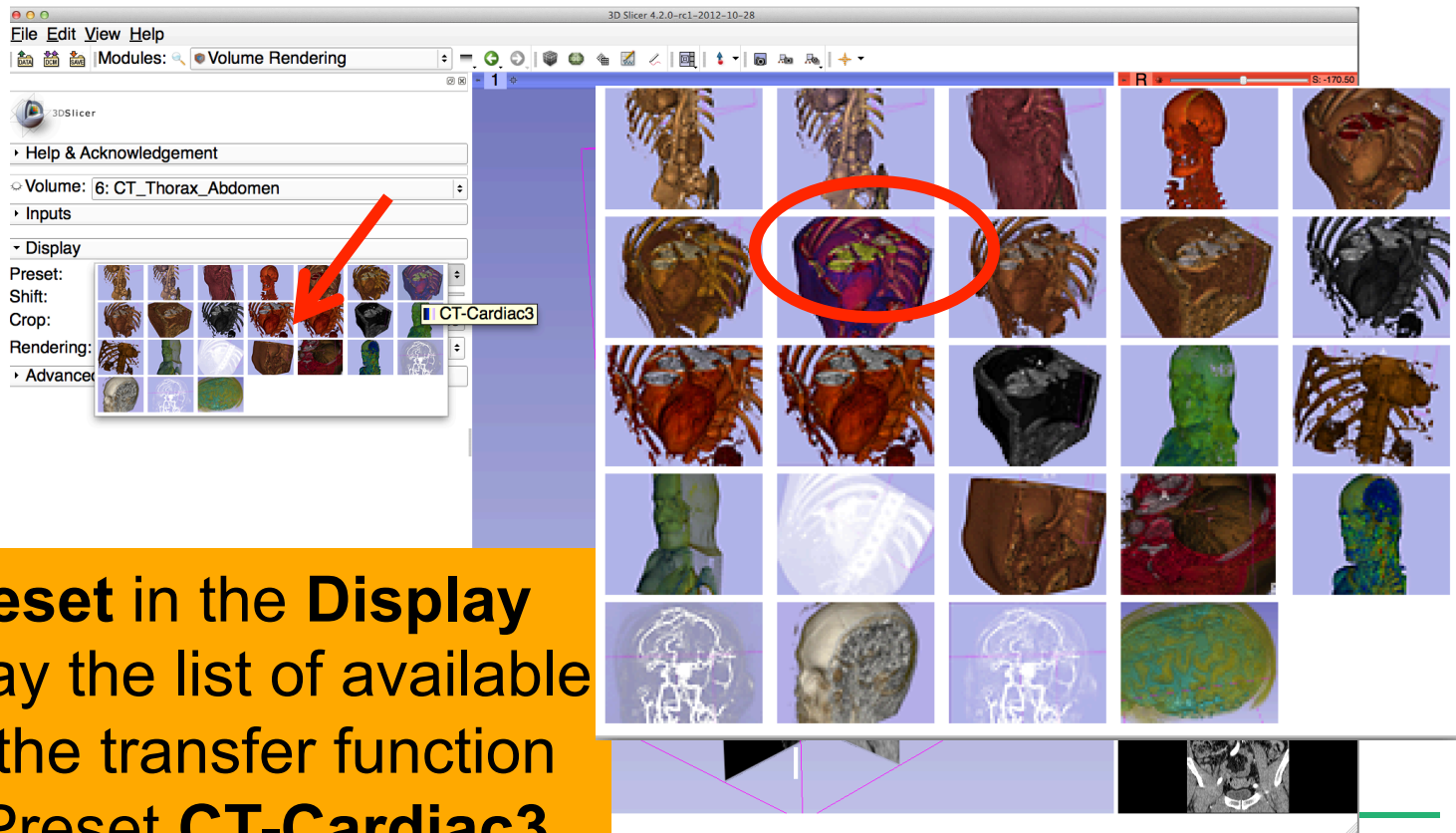


Select the volume  
6:CT\_Thorax\_Abdomen





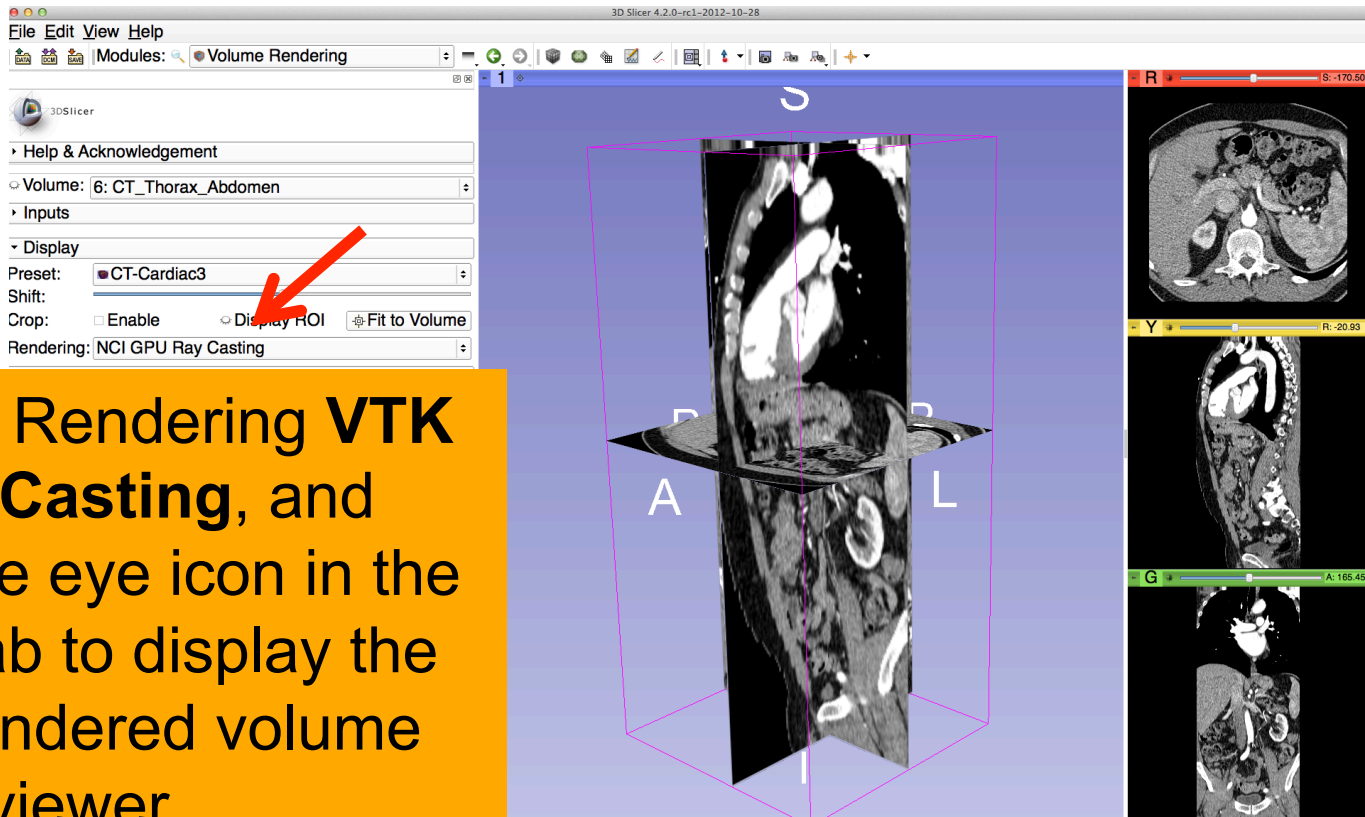
# Volume Rendering



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



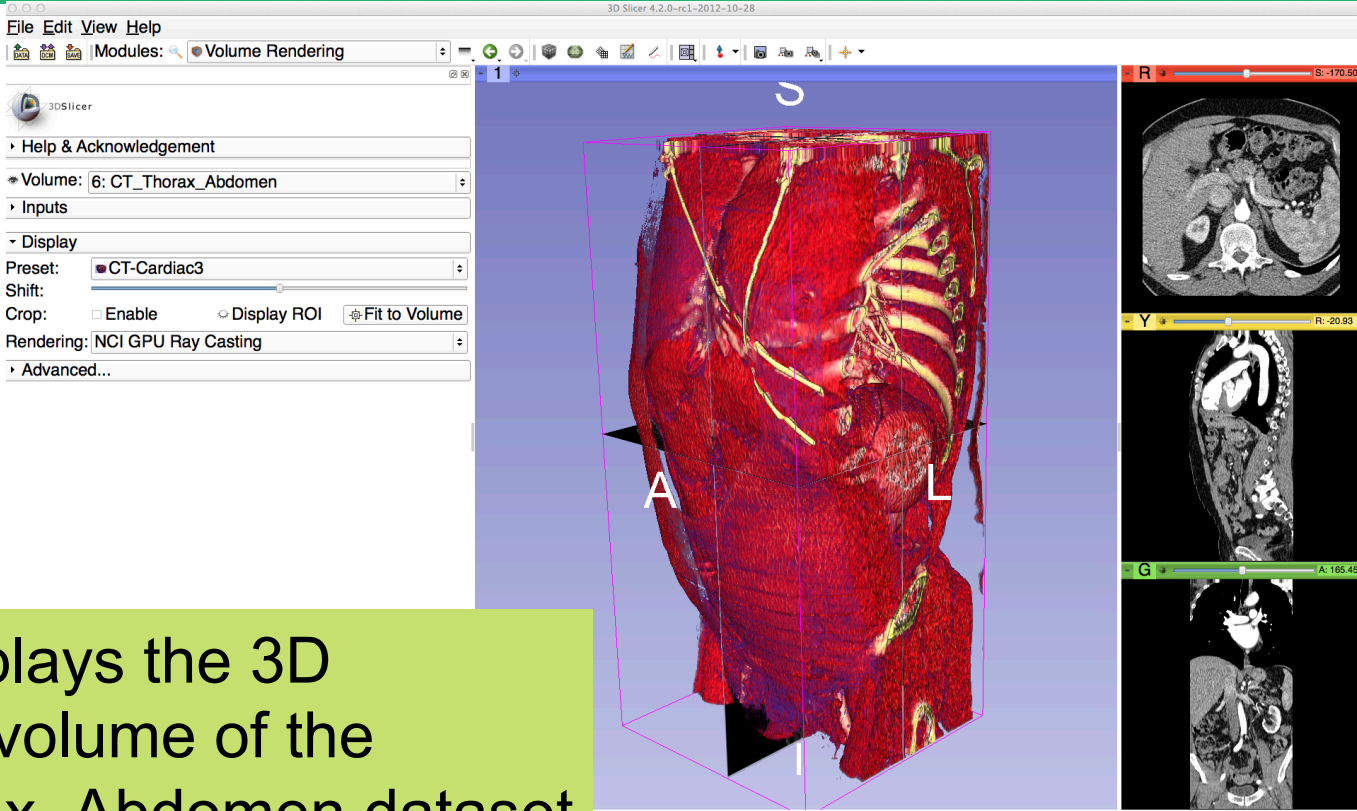
# Volume Rendering



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



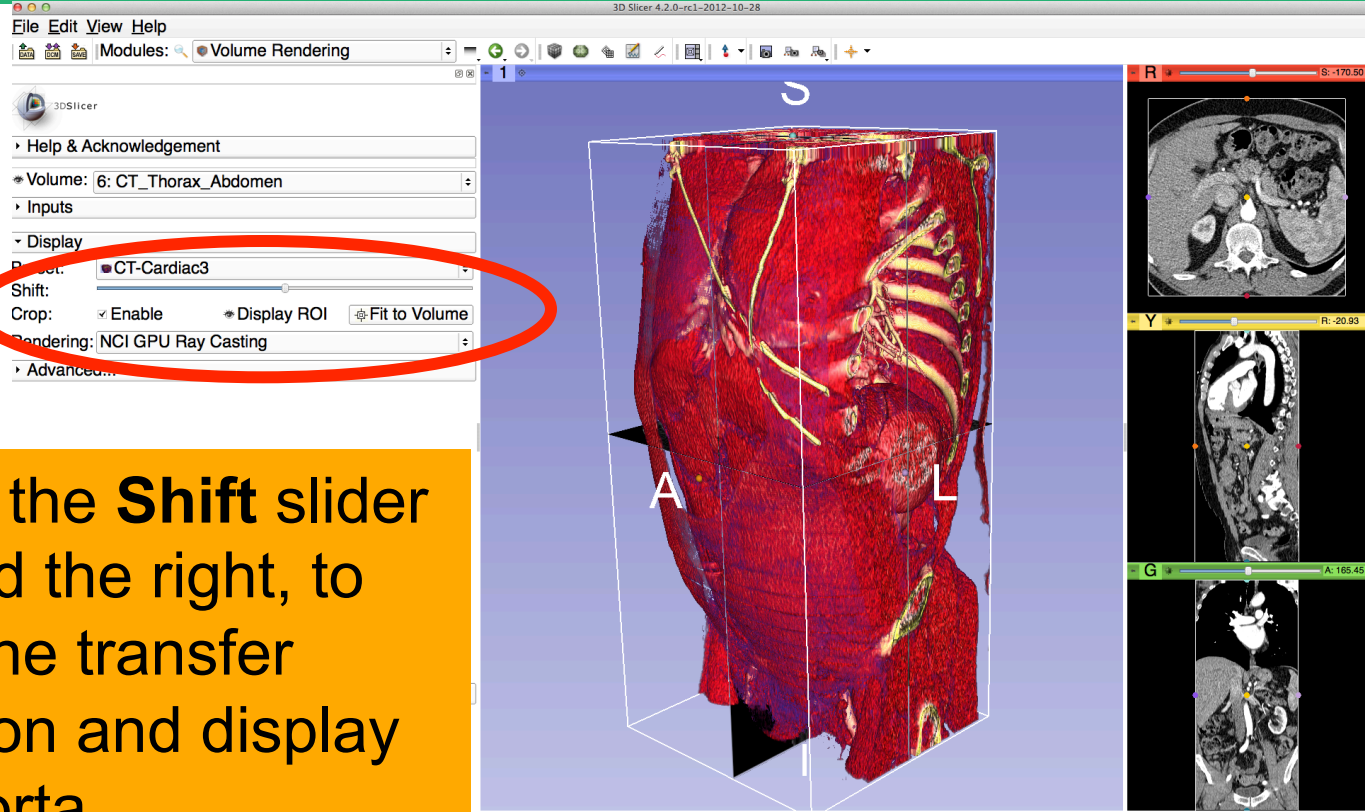
# Volume Rendering



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



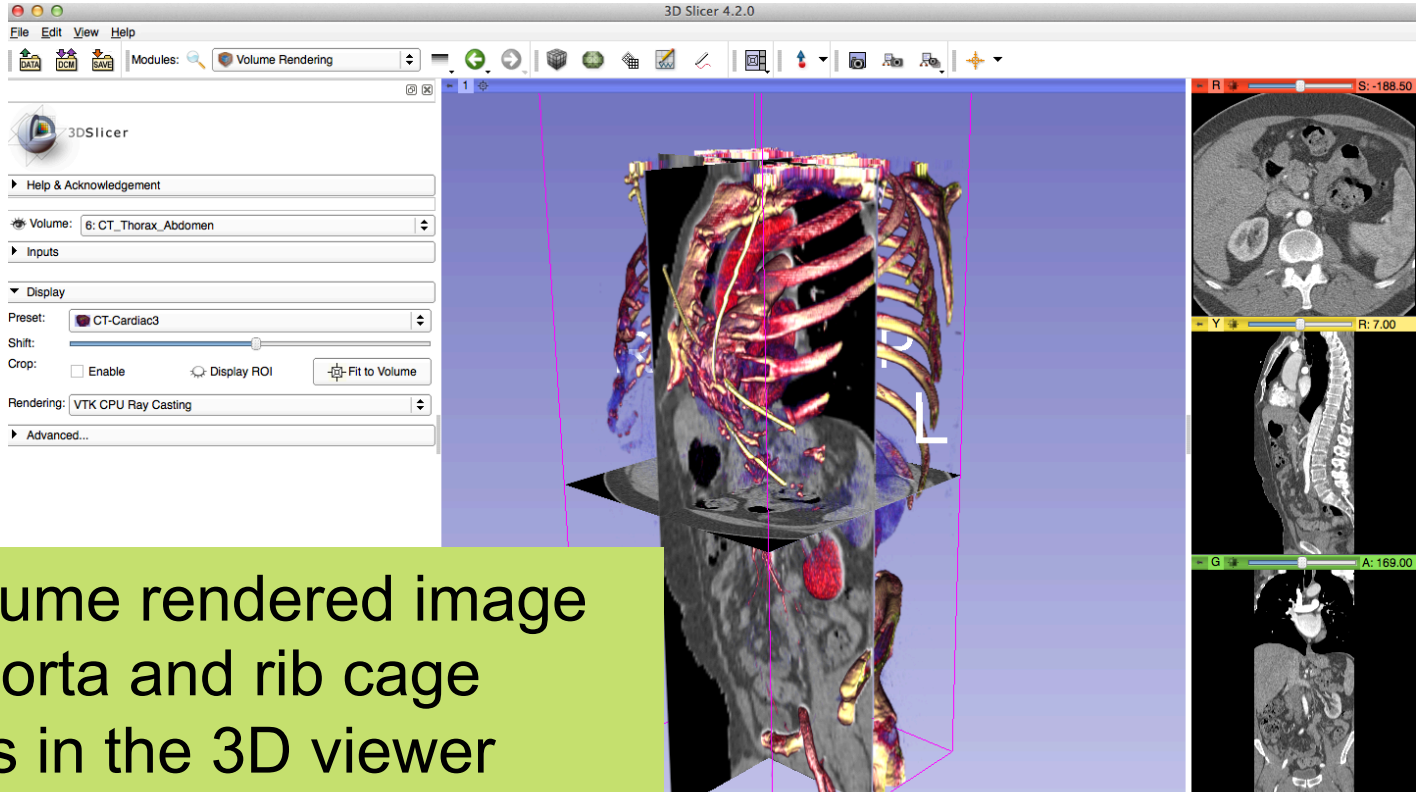
# Volume Rendering



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



# Volume Rendering



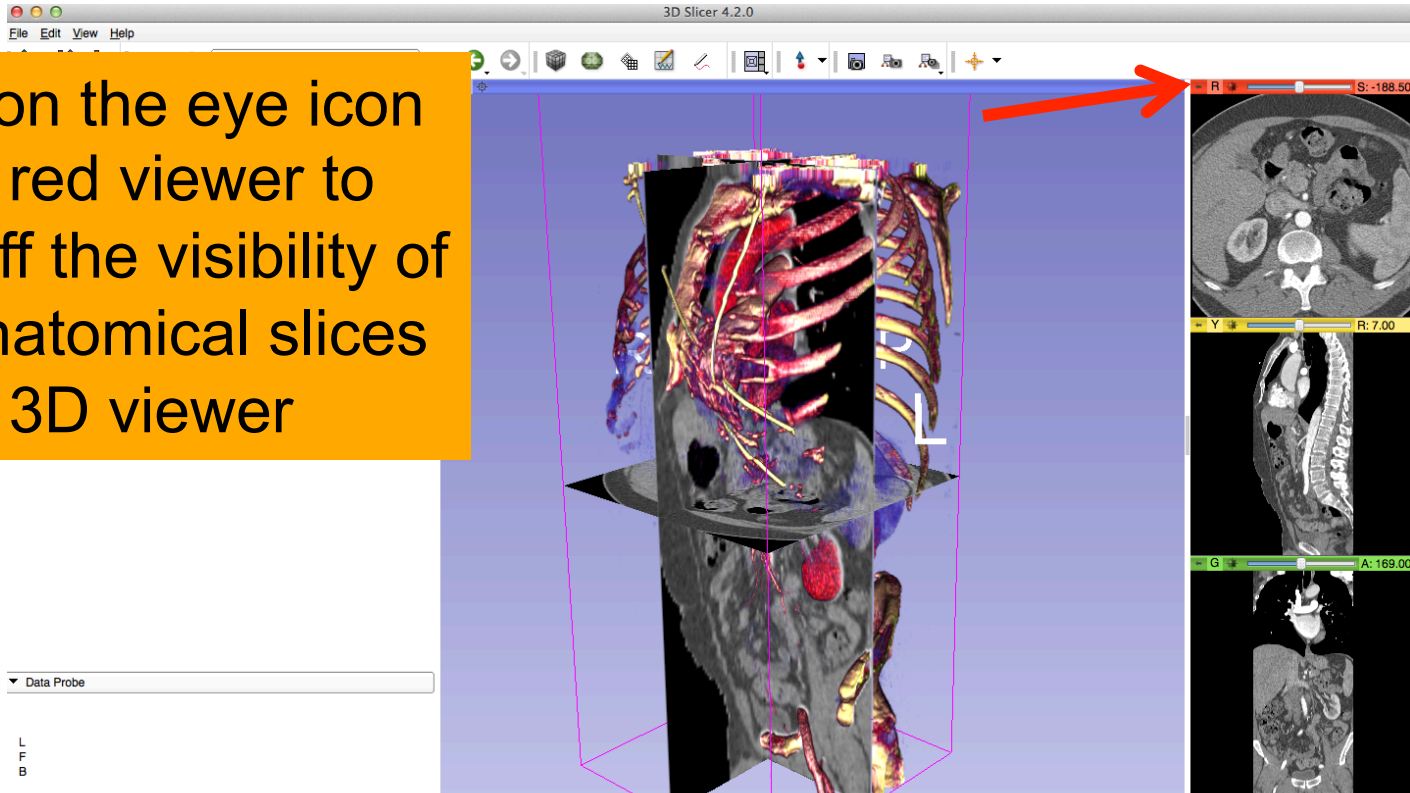
The volume rendered image of the aorta and rib cage appears in the 3D viewer





# Volume Rendering

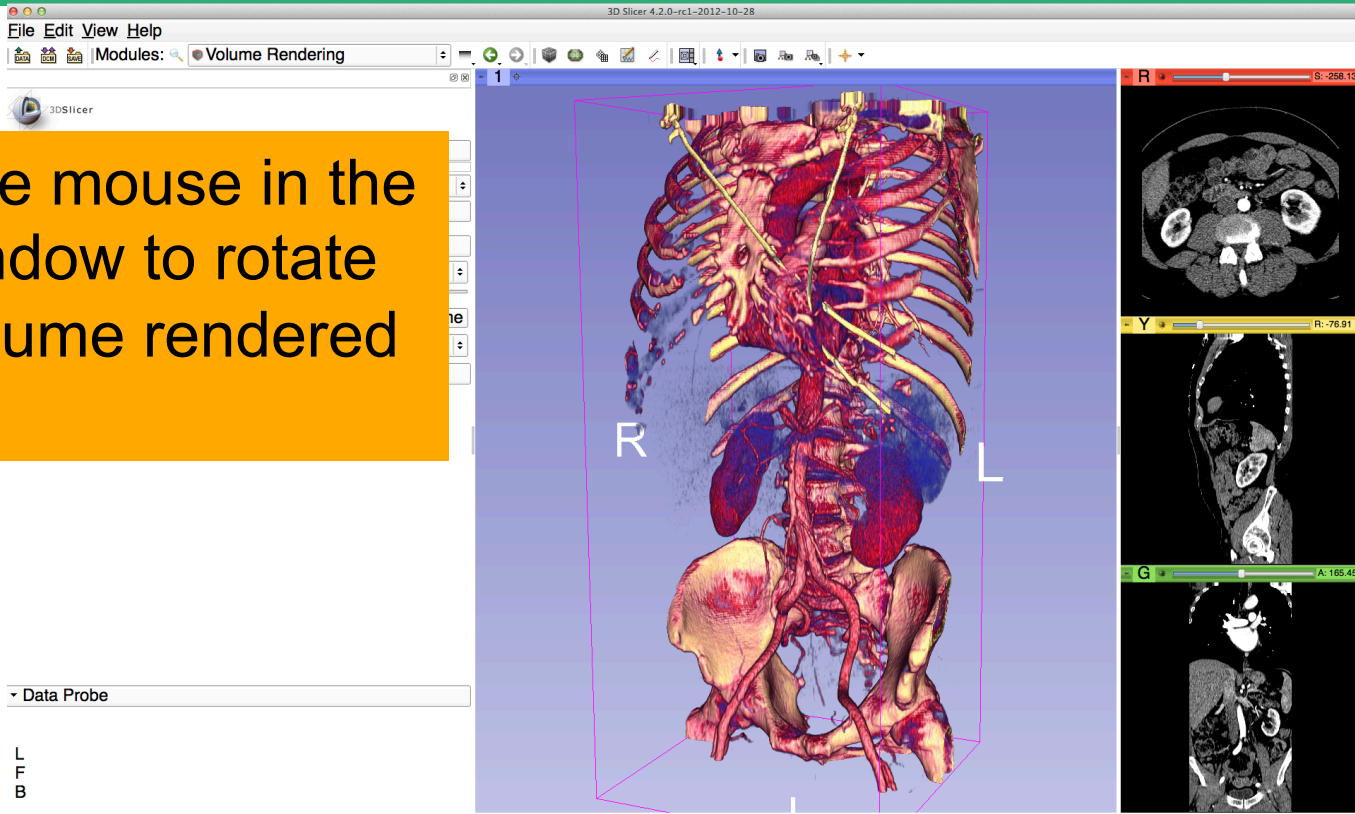
Click on the eye icon in the red viewer to turn off the visibility of the anatomical slices in the 3D viewer





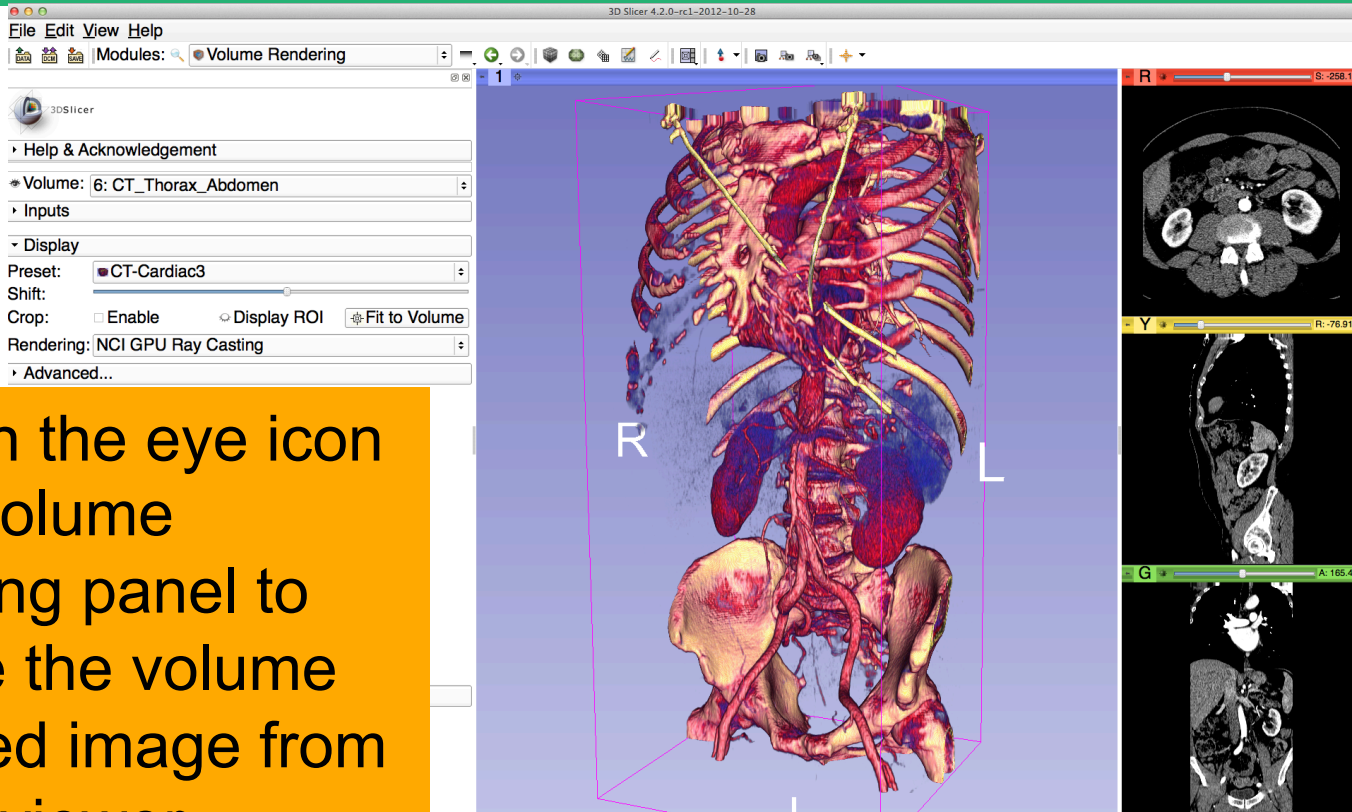
# Volume Rendering

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





# Volume Rendering

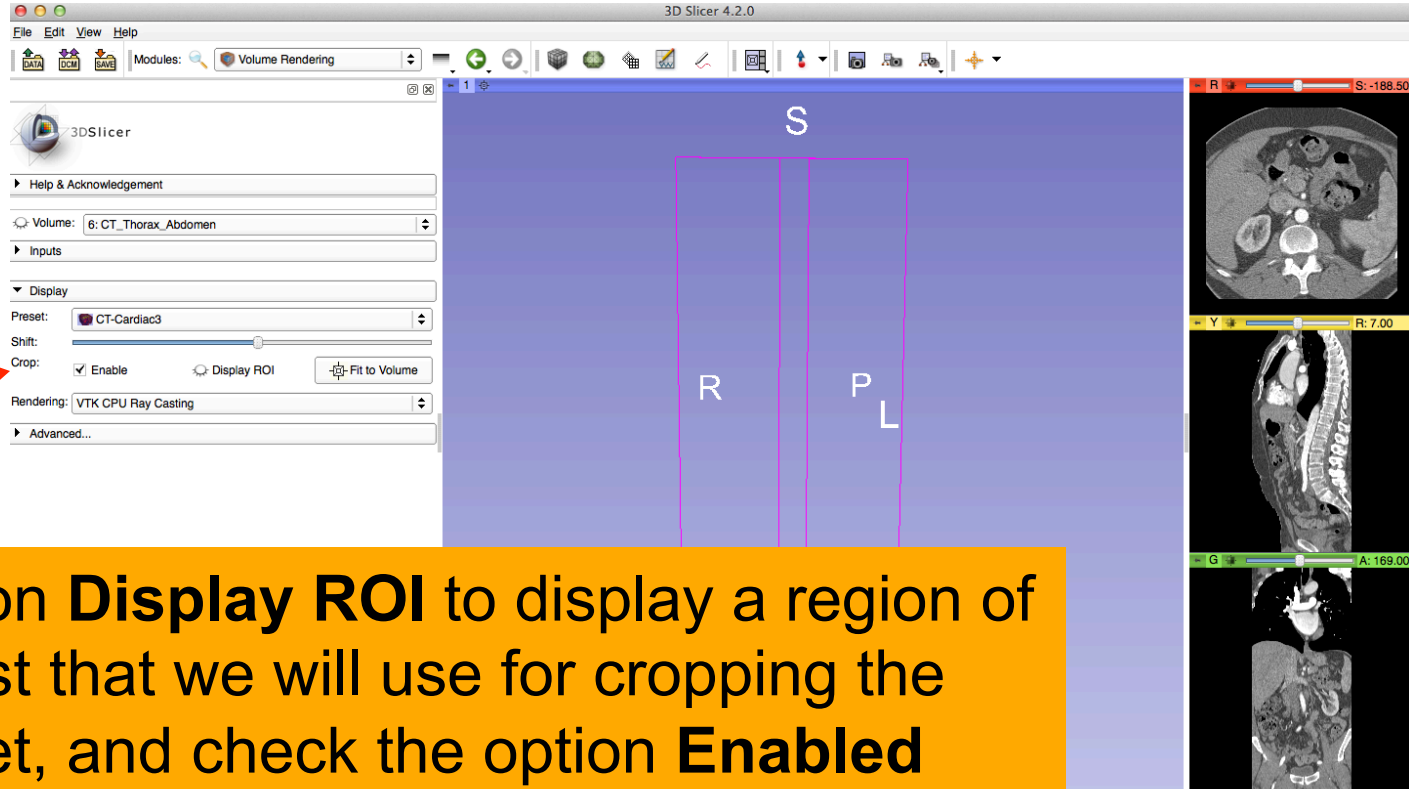


Click on the eye icon in the volume rendering panel to remove the volume rendered image from the 3D viewer





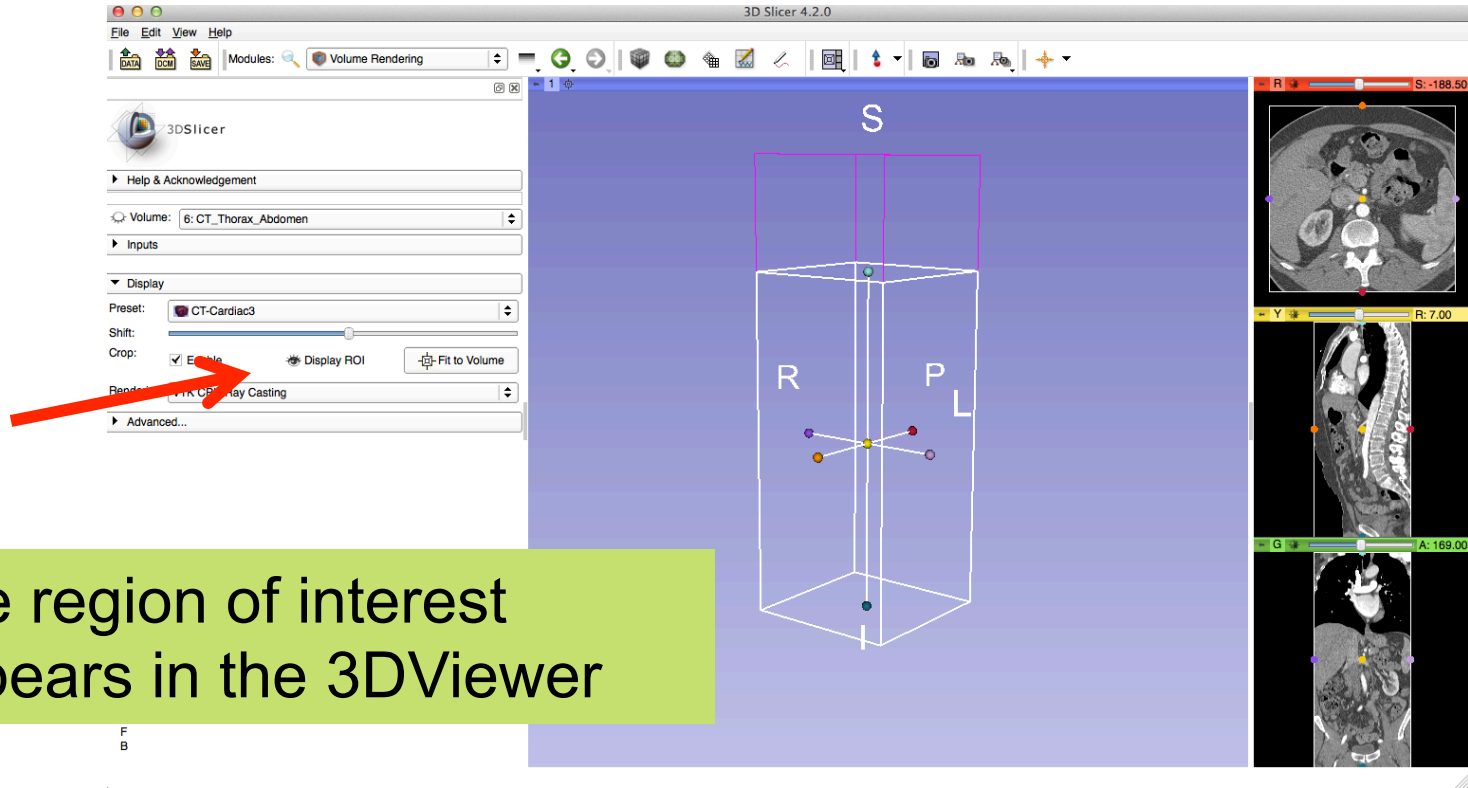
# Volume Rendering



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

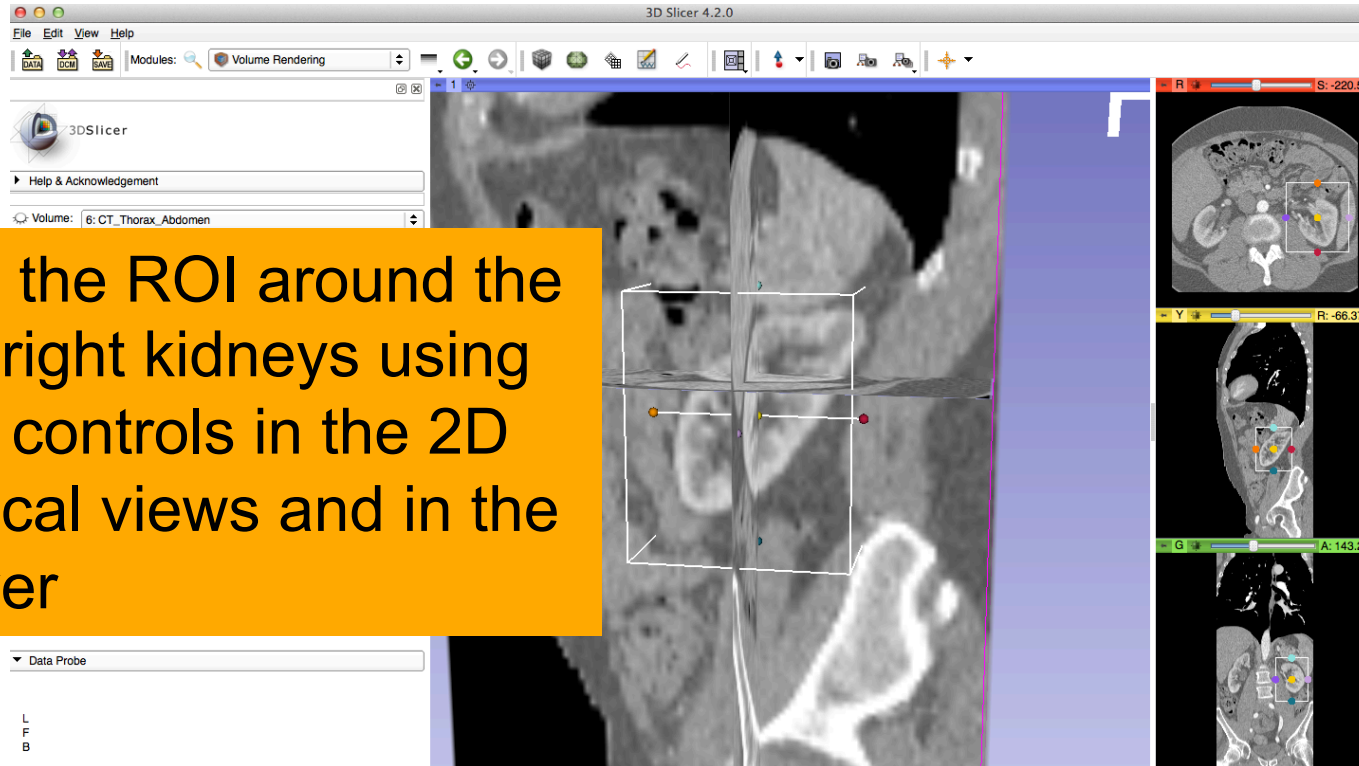


# Volume Rendering





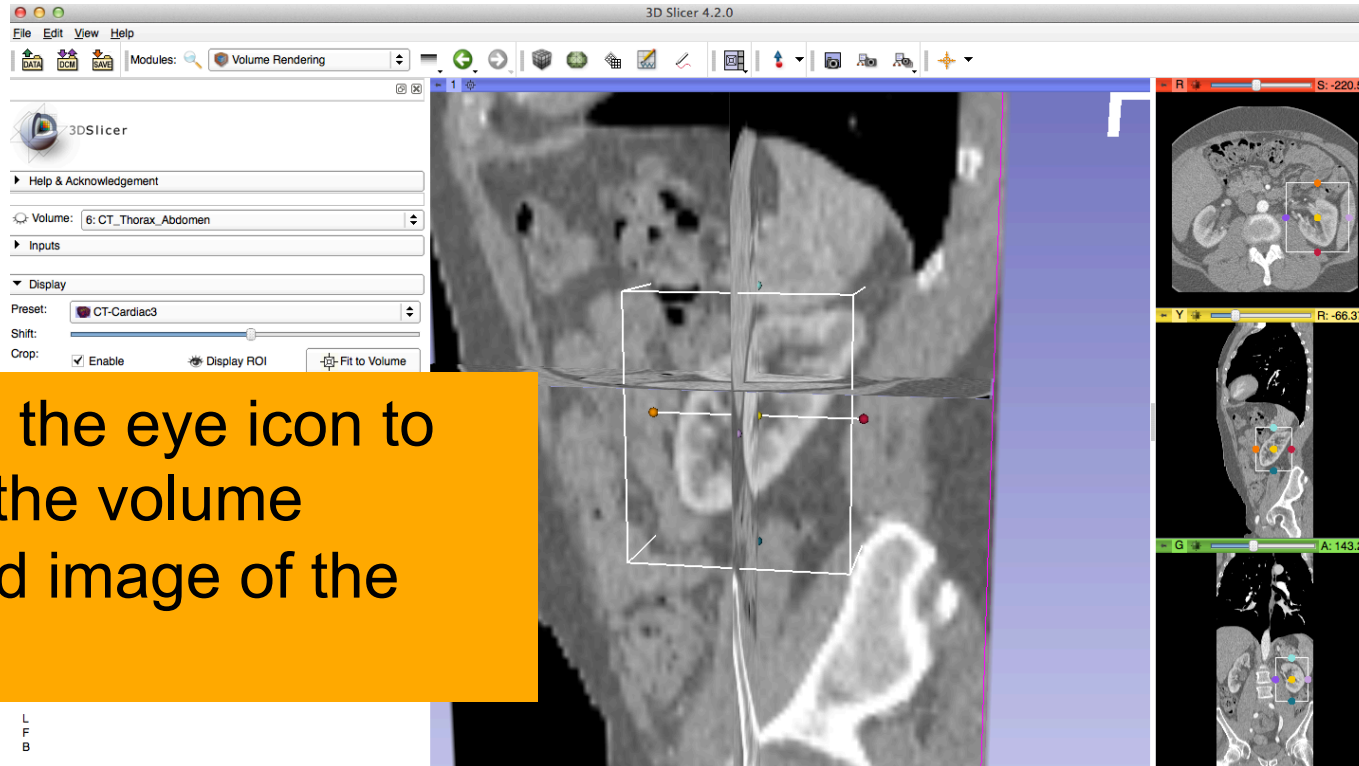
# Volume Rendering



Position the ROI around the left and right kidneys using the ROI controls in the 2D anatomical views and in the 3D viewer



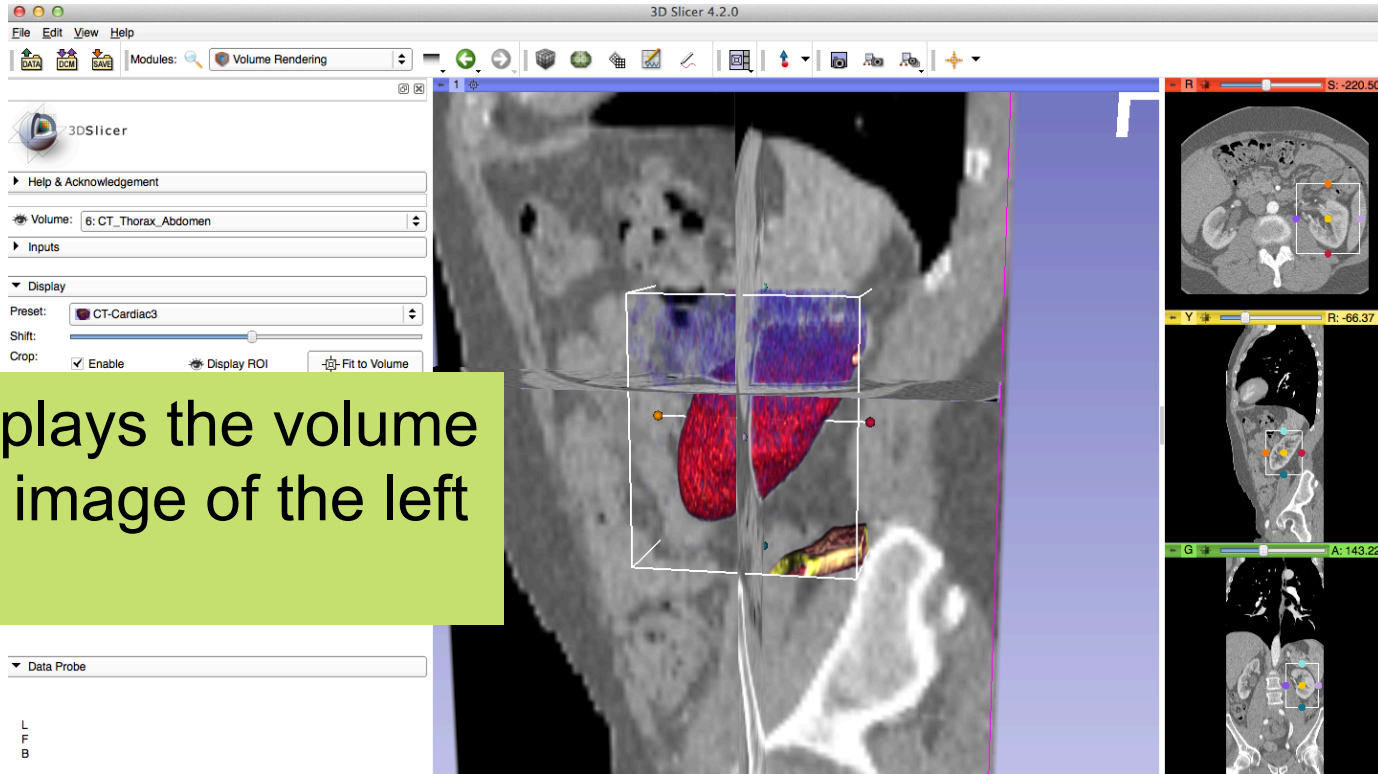
# Volume Rendering



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



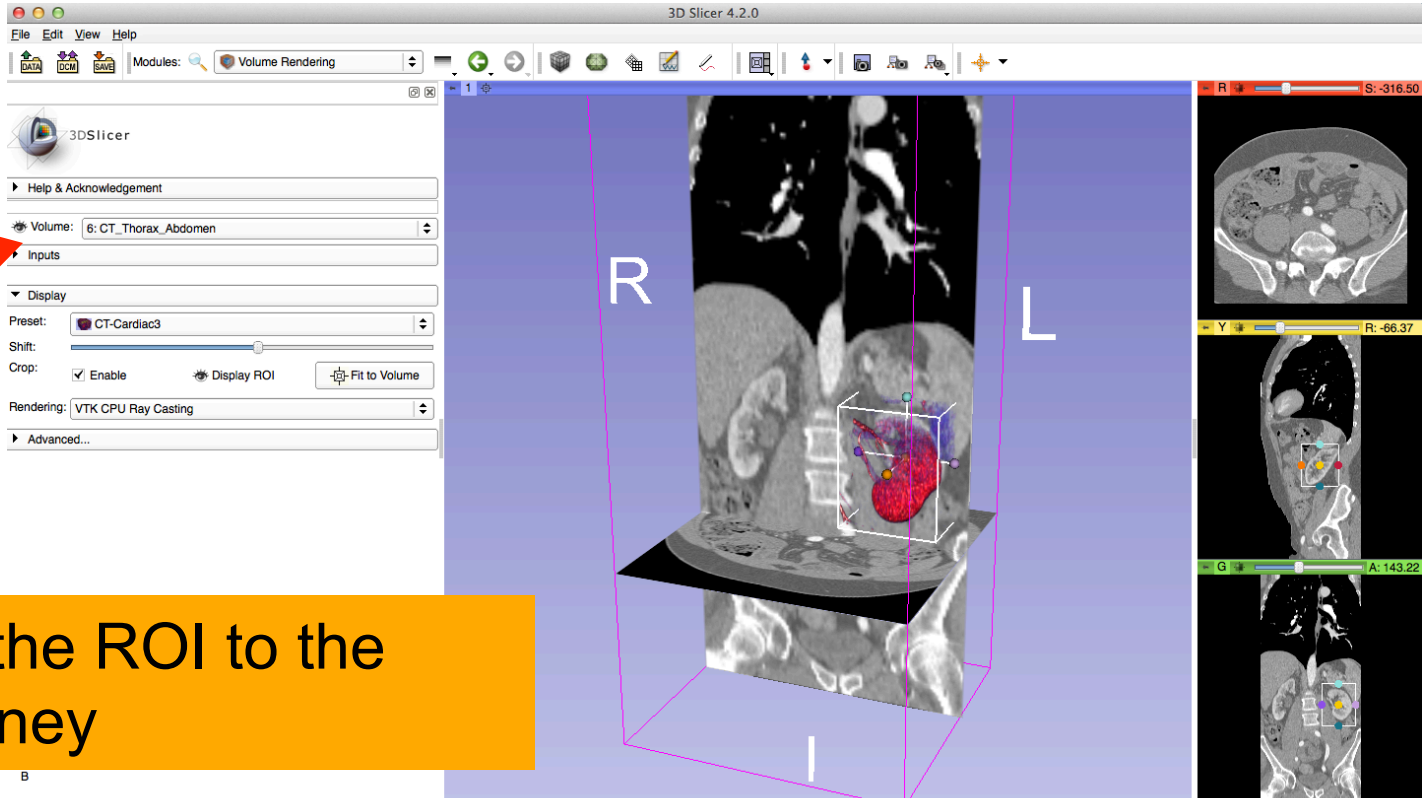
# Volume Rendering



Slicer displays the volume rendered image of the left kidney



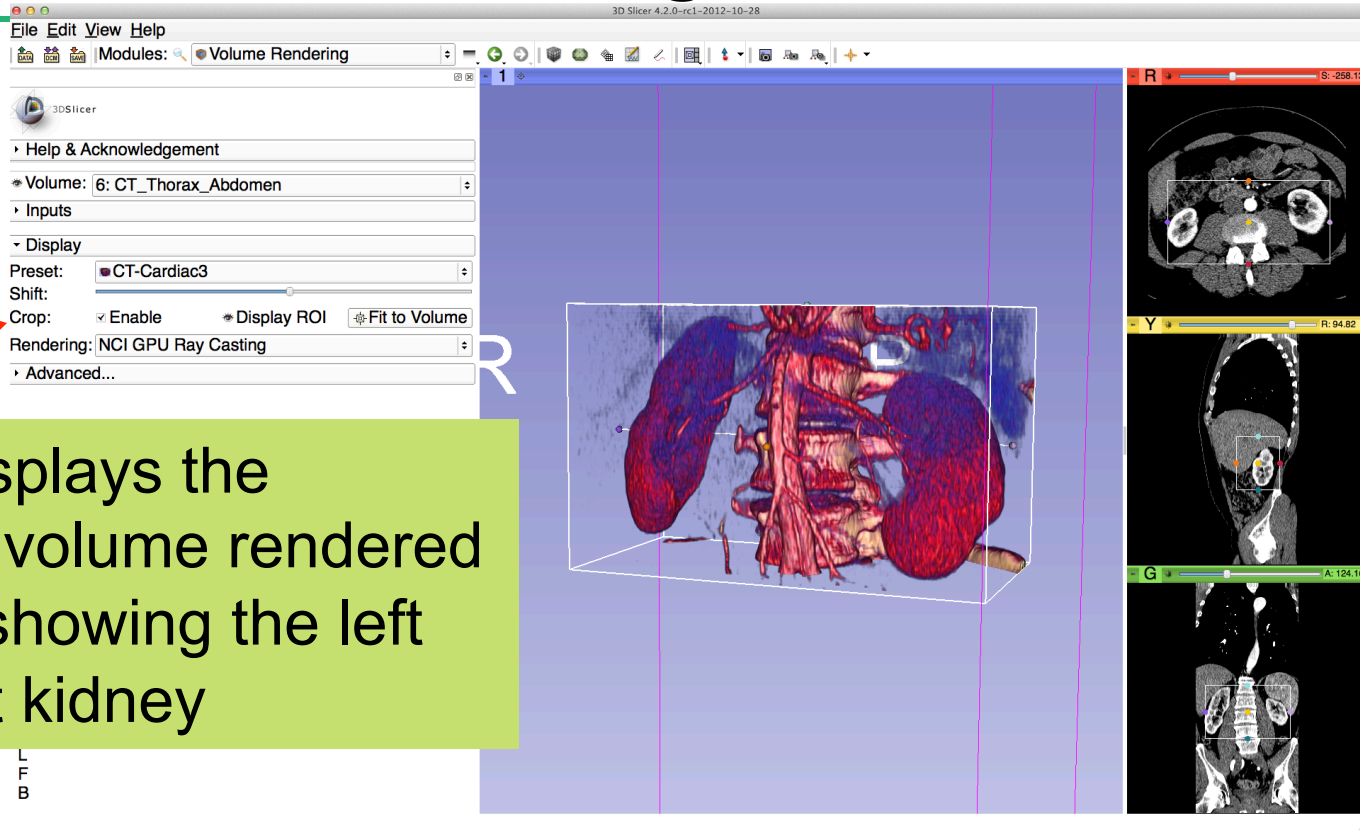
# Volume Rendering



Extend the ROI to the right kidney



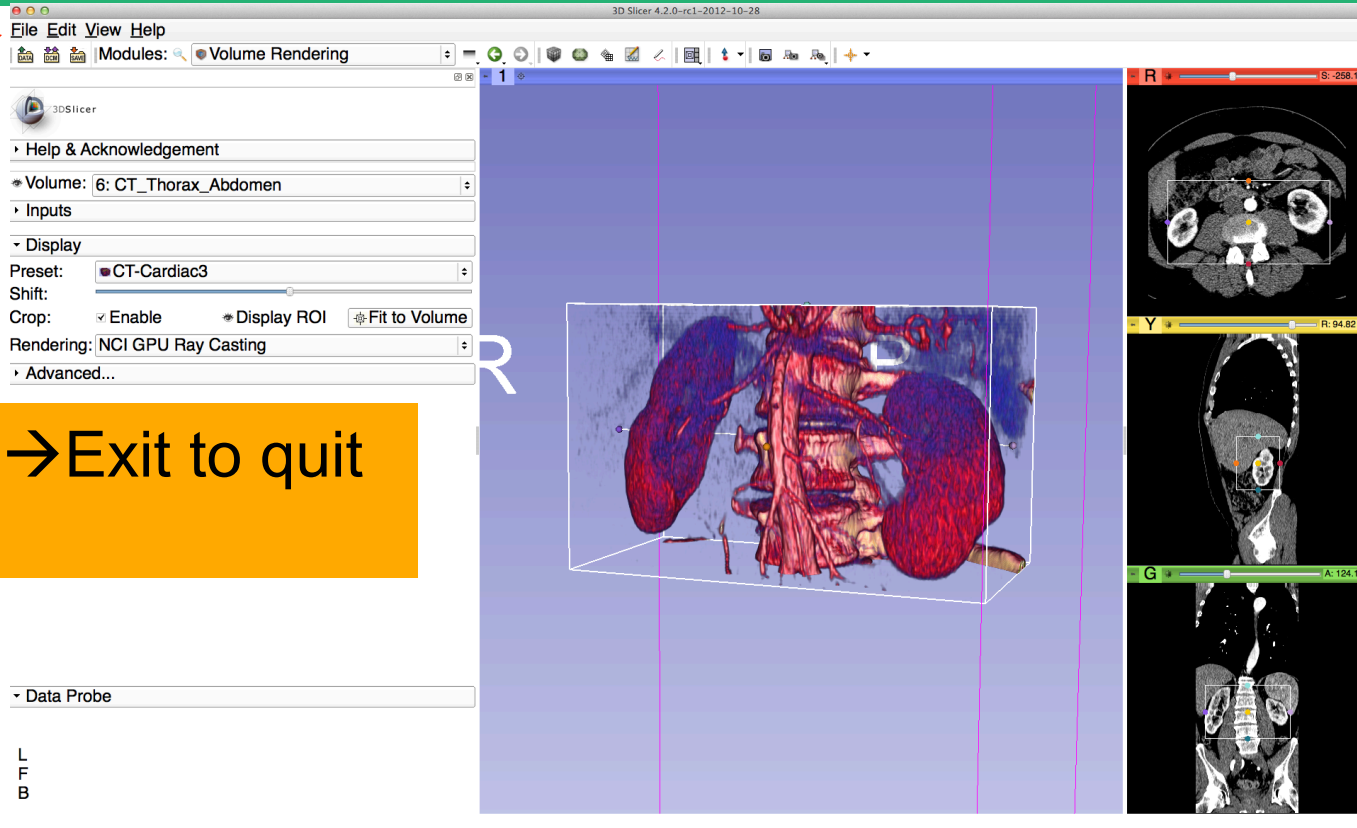
# Volume Rendering



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

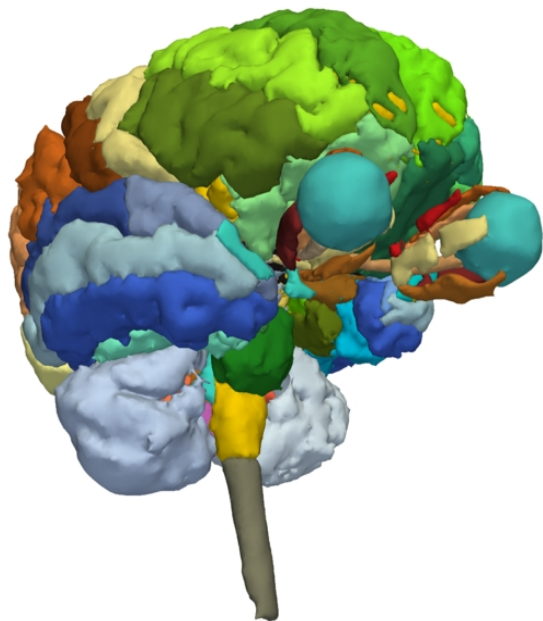


# Volume Rendering



Click on File → Exit to quit Slicer



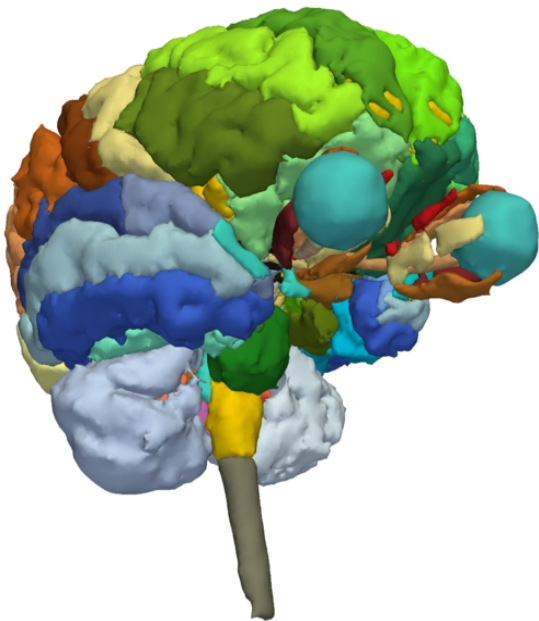


3D visualization of surface models of the brain



# 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:

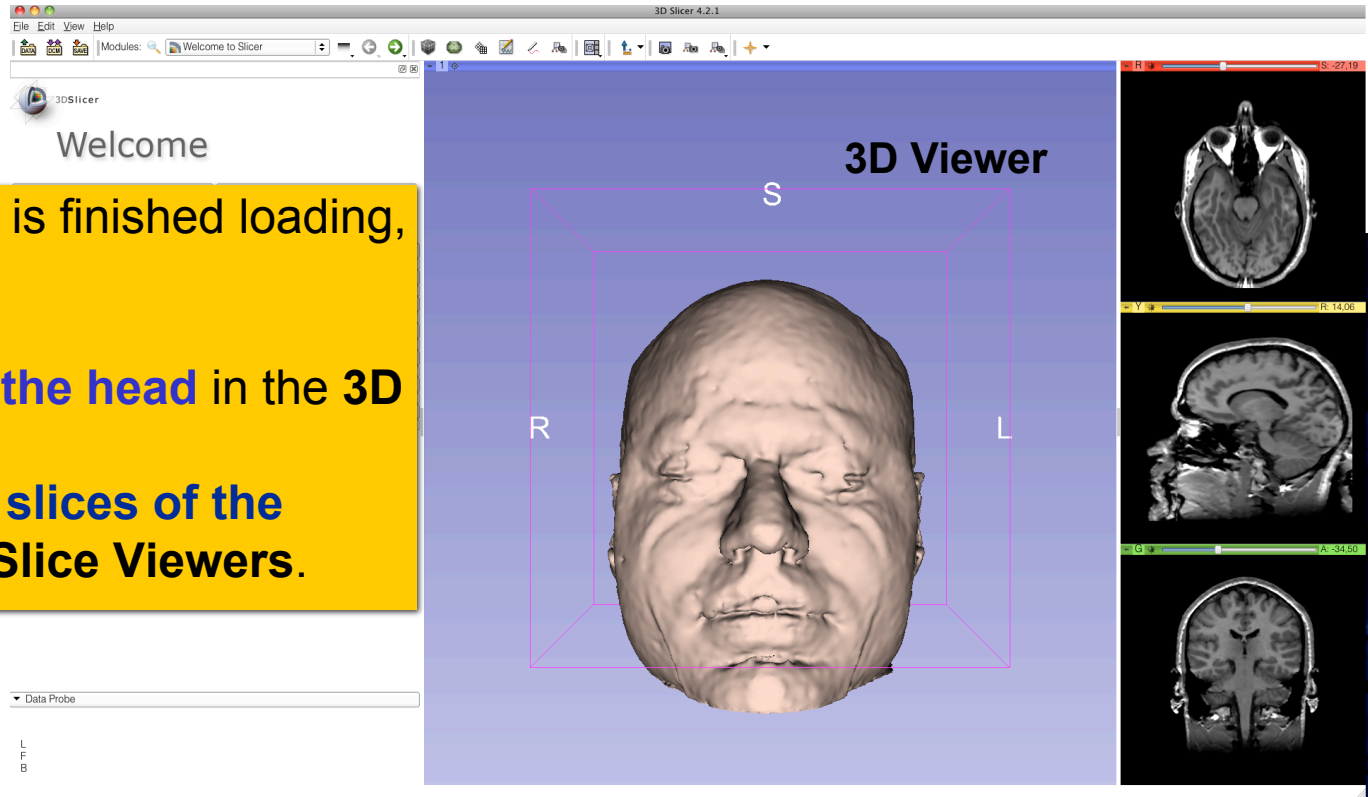
<http://www.spl.harvard.edu/publications/item/view/2037>



# Slicer4 Minute Tutorial: Viewing the Scene

When the scene is finished loading, Slicer displays:

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

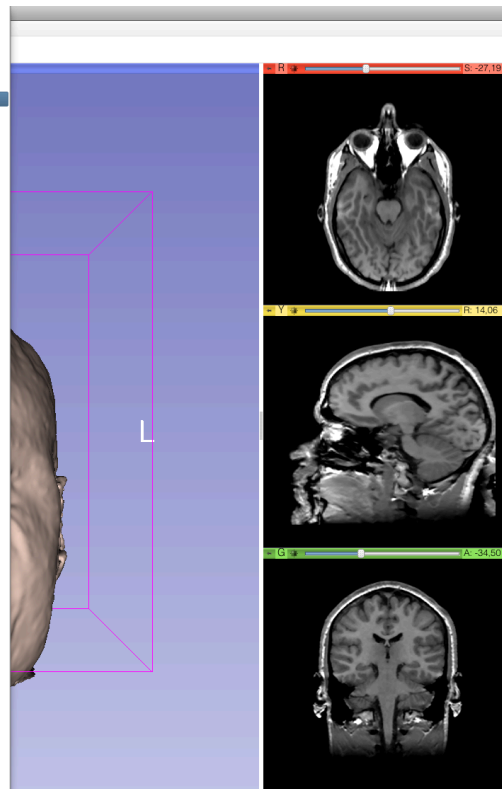
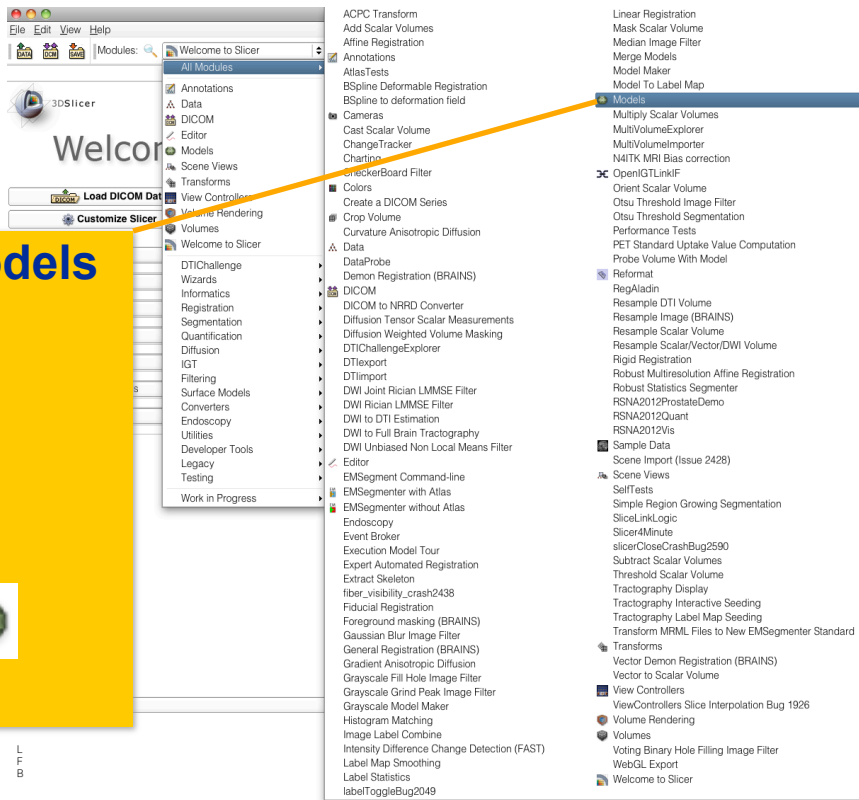




# Slicer4 Minute Tutorial: Exploring Slicer's functionality

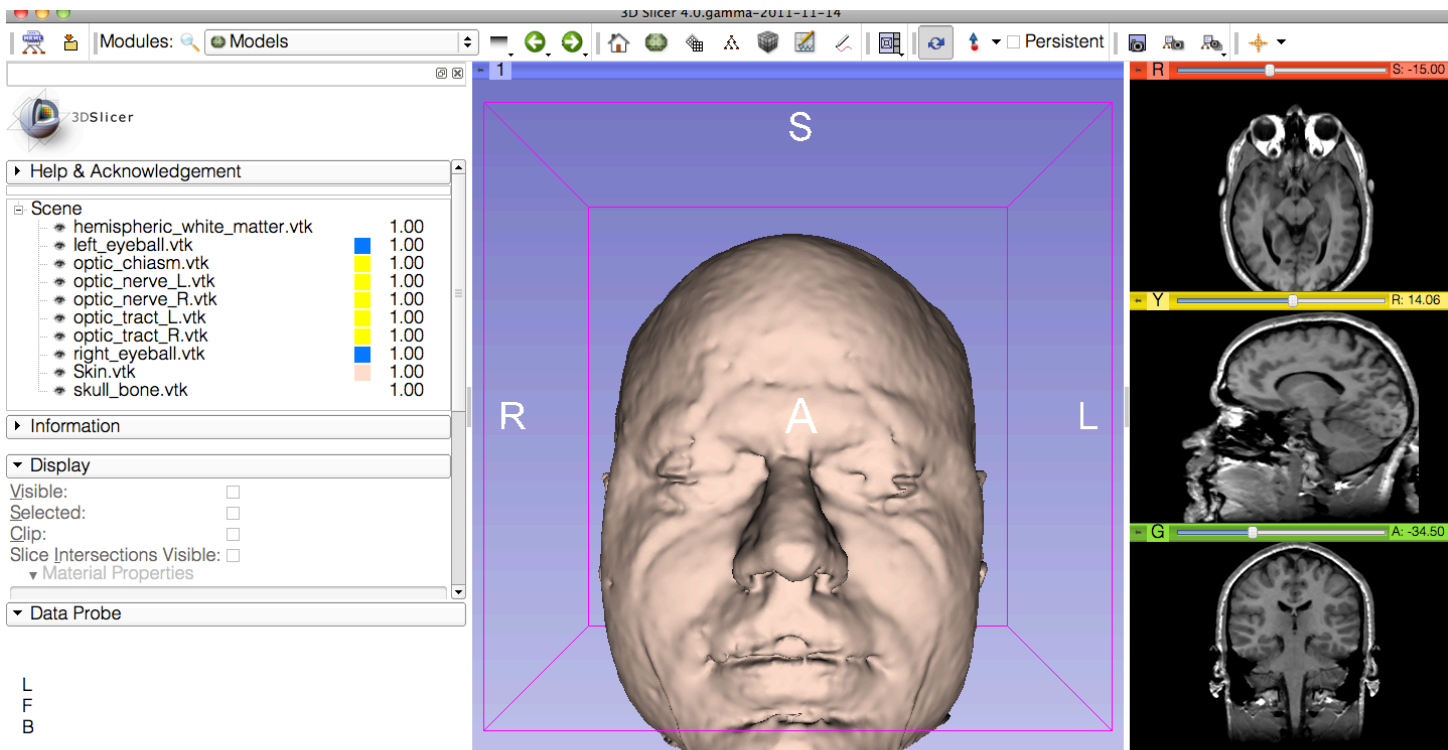
To access the **Models** module, browse through the list of modules...

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





# Slicer4 Minute Tutorial: Switching to the Models Module

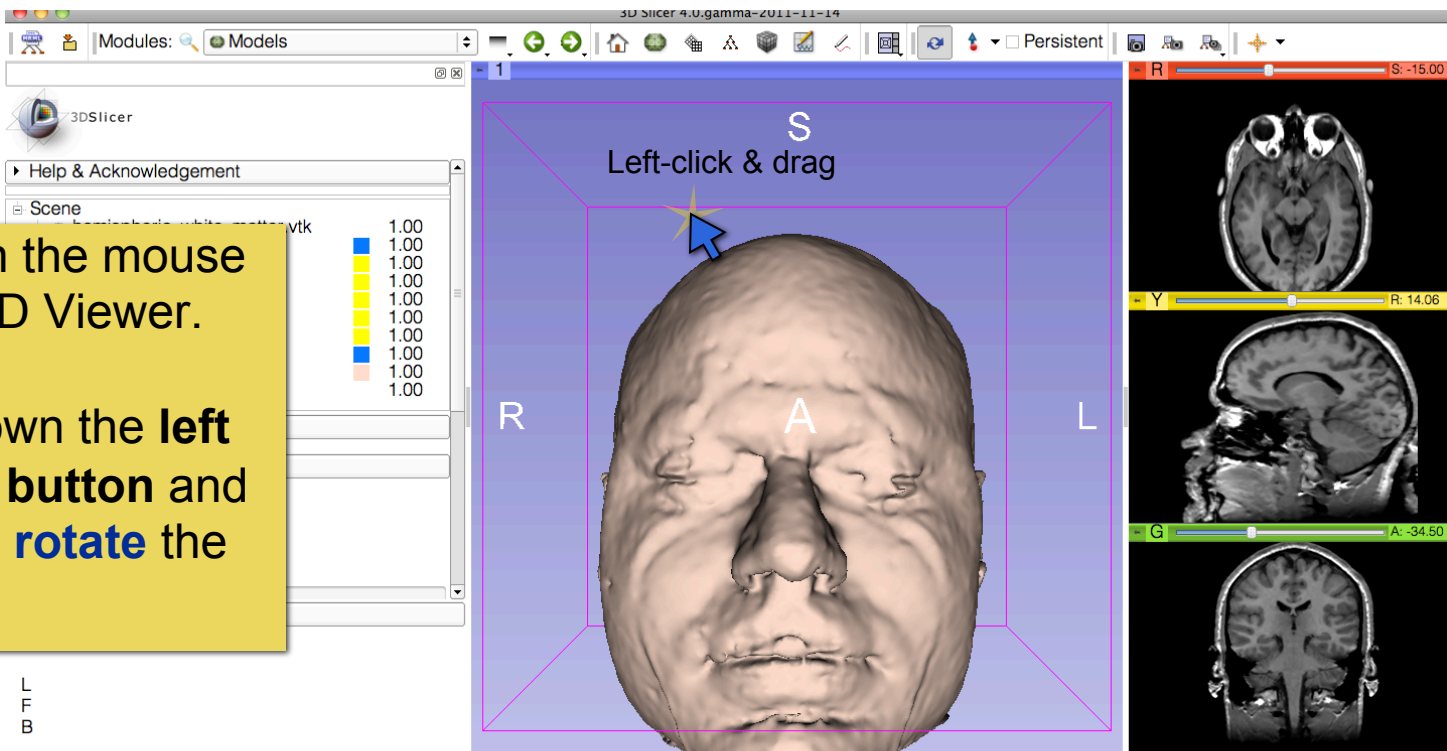




# Slicer4 Minute Tutorial: Basic 3D Interaction

Position the mouse in the 3D Viewer.

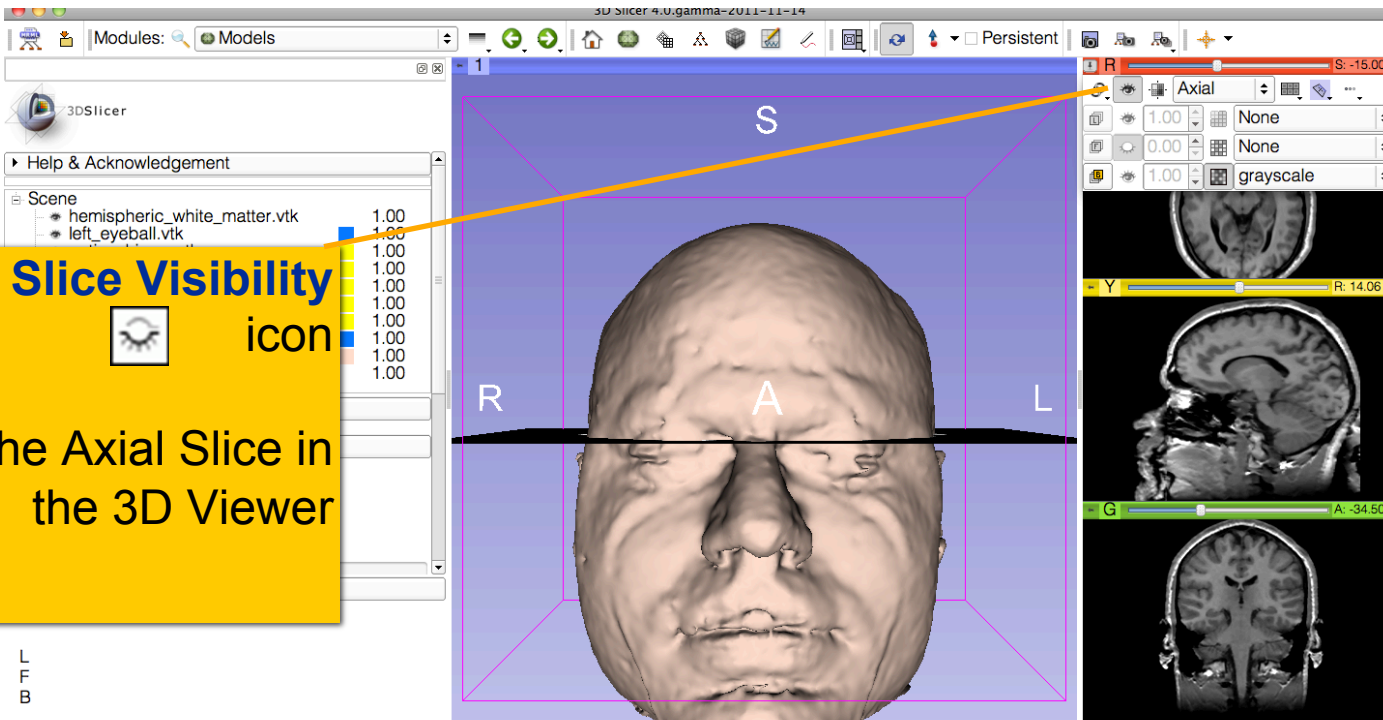
Hold down the **left mouse button** and **drag to rotate** the model.





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

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

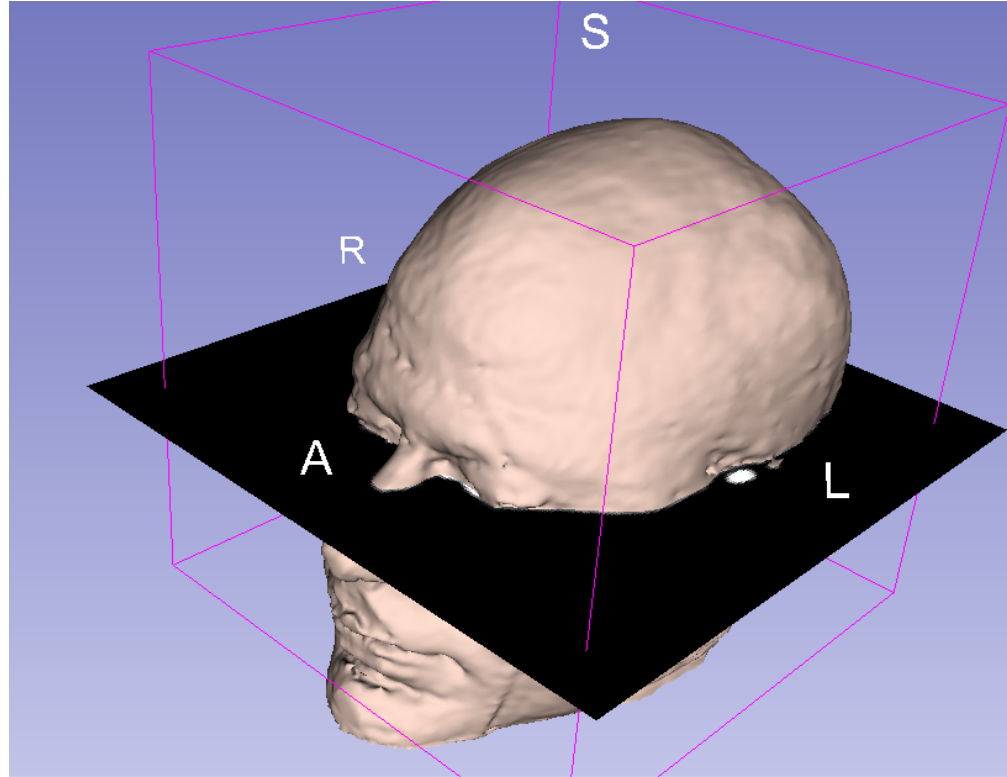


L  
F  
B



## Slicer4 Minute Tutorial: 3D Visualization

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

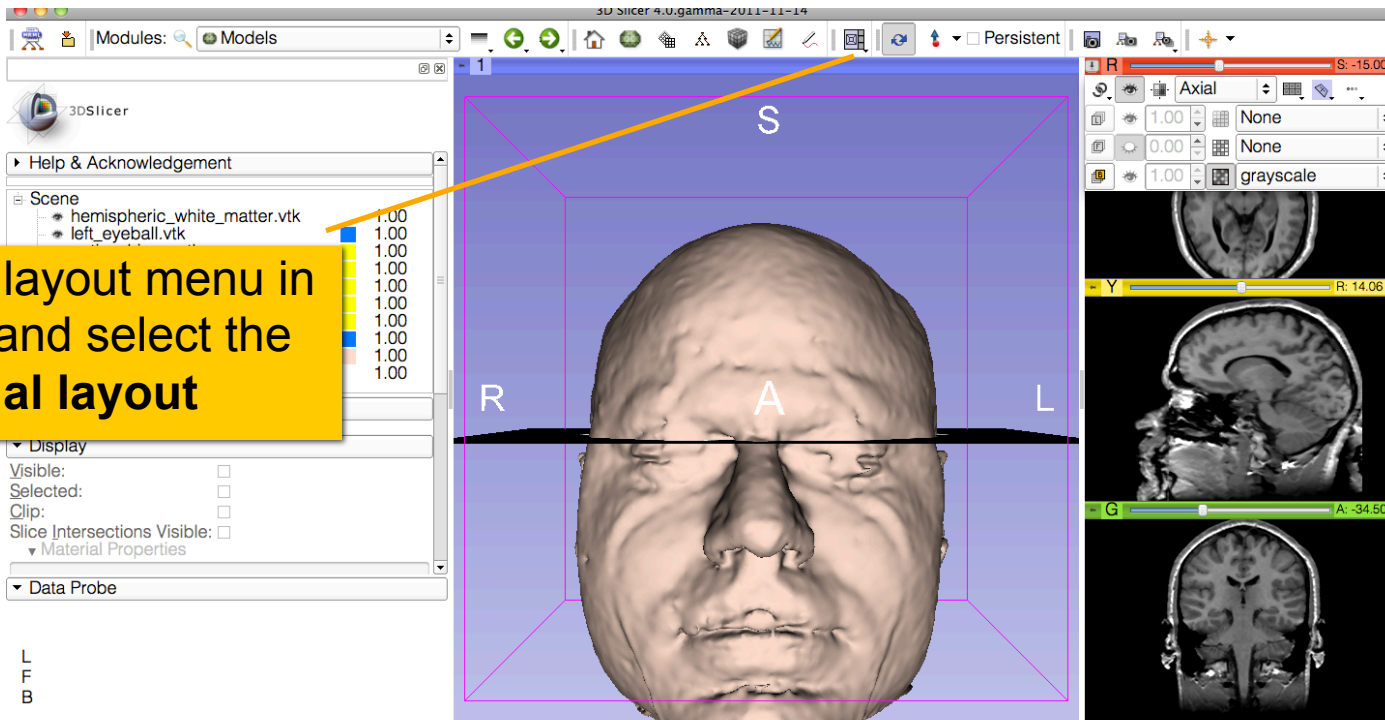






# Slicer4 Minute Tutorial: Viewing Slices in the 3D Viewer

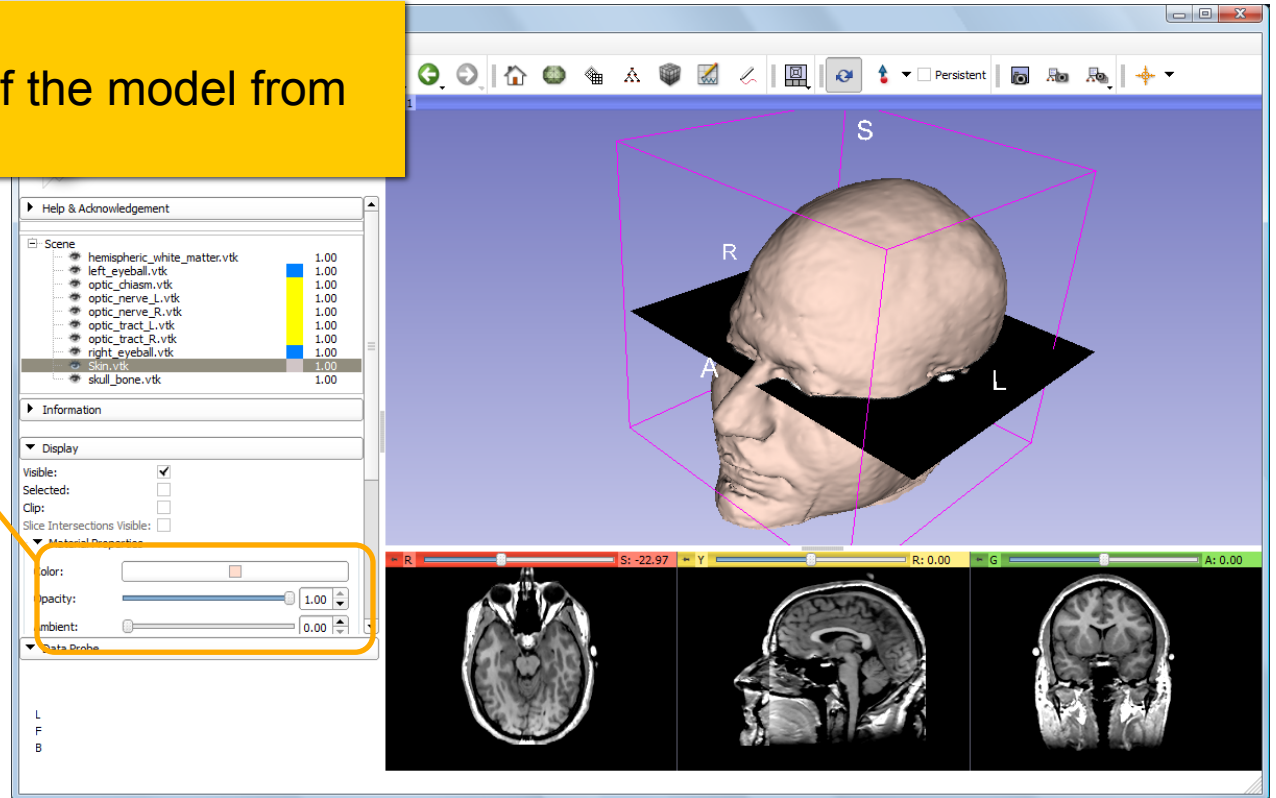
Click on the layout menu in the toolbar, and select the **Conventional layout**





# Slicer4 Minute Tutorial: 3D Visualization

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

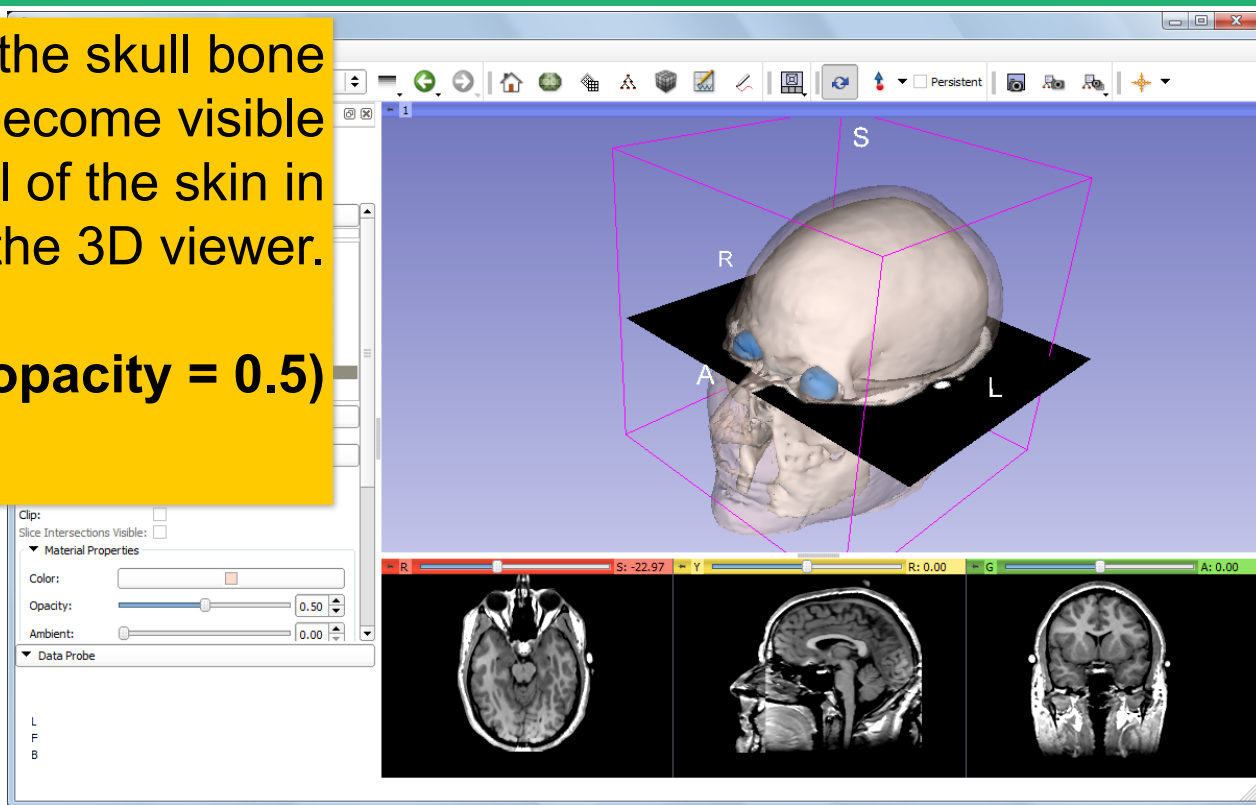




## Slicer4 Minute Tutorial: 3D Visualization

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)**

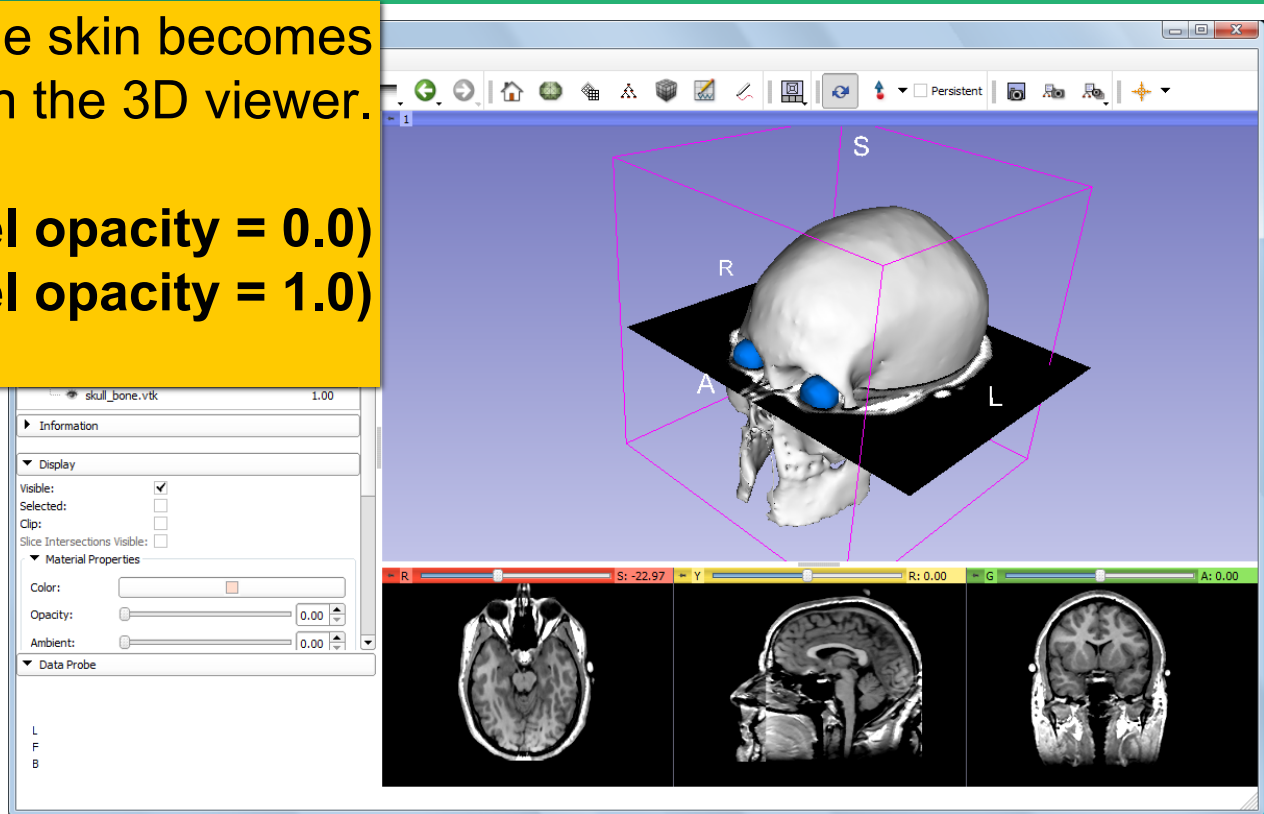




## Slicer4 Minute Tutorial: 3D Visualization

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.



Information

Display

Visible:

Selected:

Clip:

Slice Intersections Visible:

Material Properties

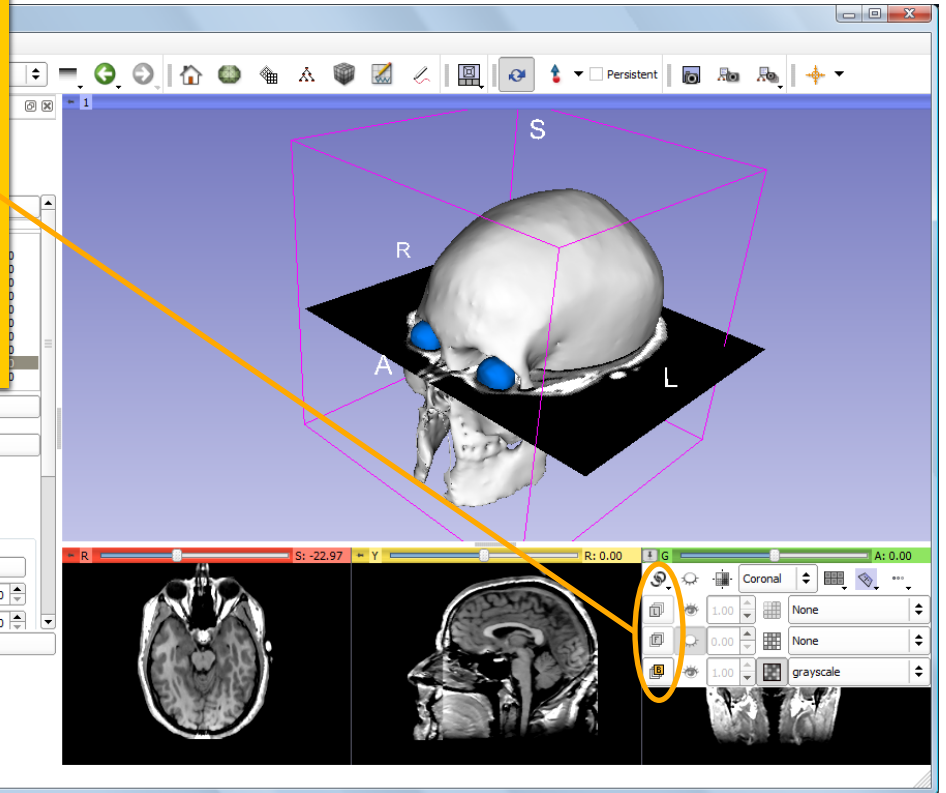
Color:

Opacity:  0.00

Ambient:  0.00

Data Probe

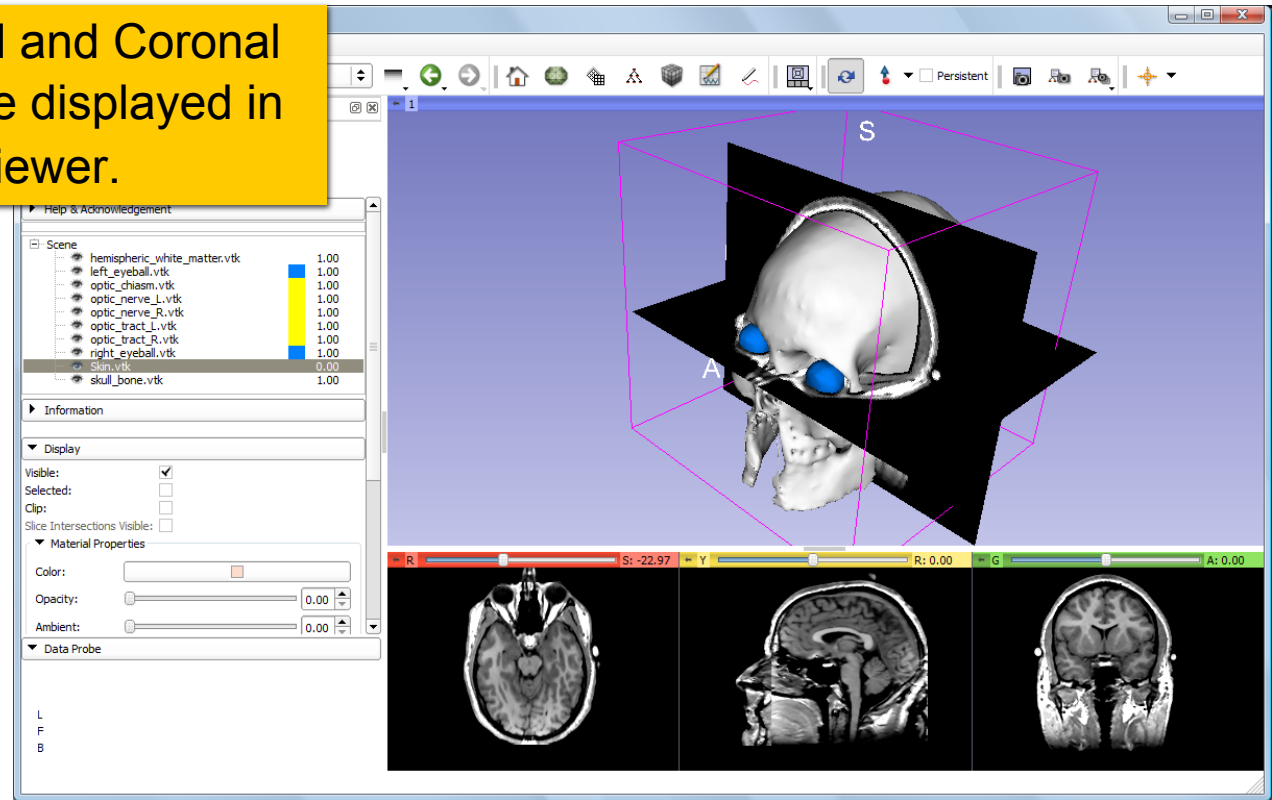
L  
F  
B





# Slicer4 Minute Tutorial: 3D Visualization

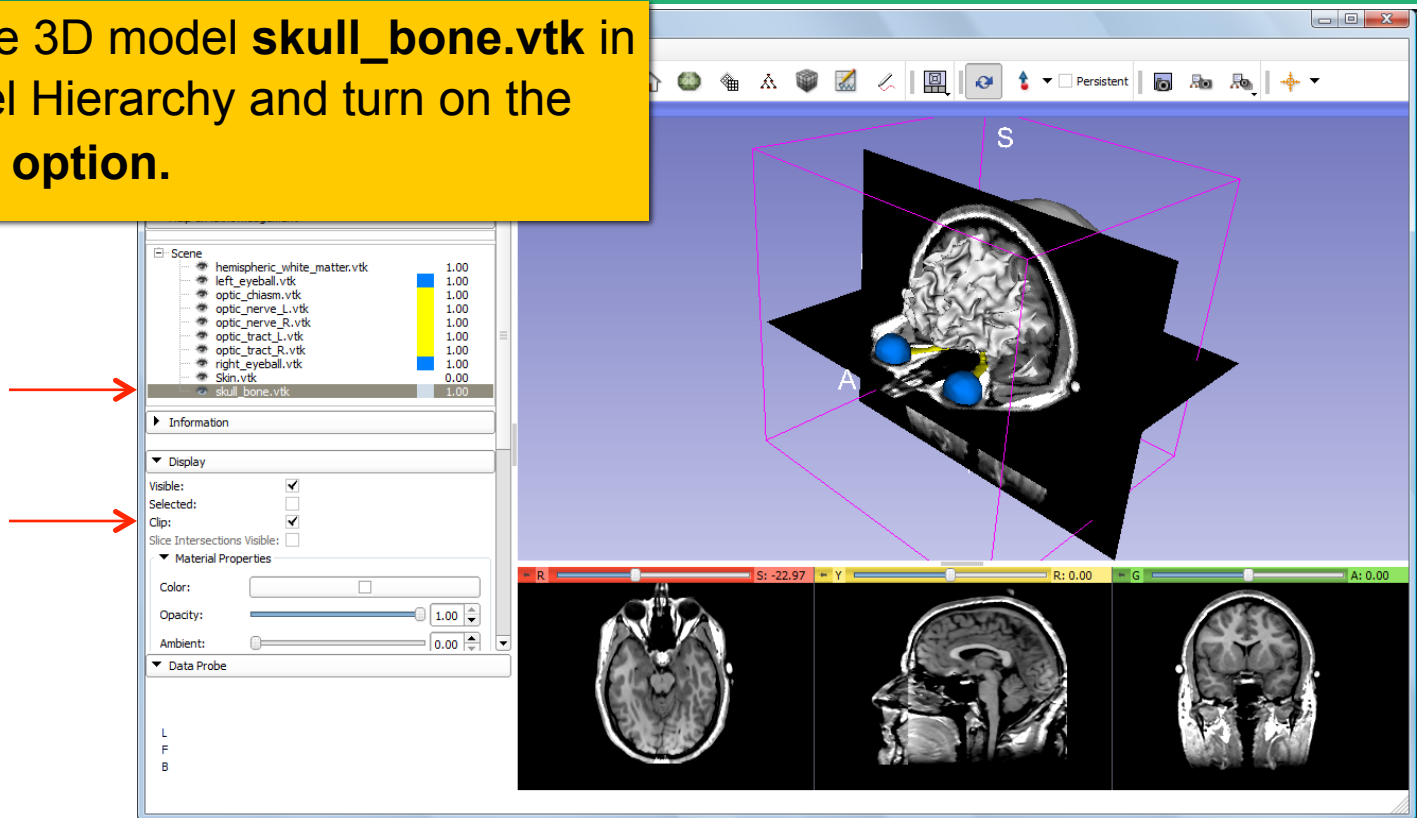
The Axial and Coronal Slices are displayed in the 3D Viewer.





# Slicer4 Minute Tutorial: 3D Visualization

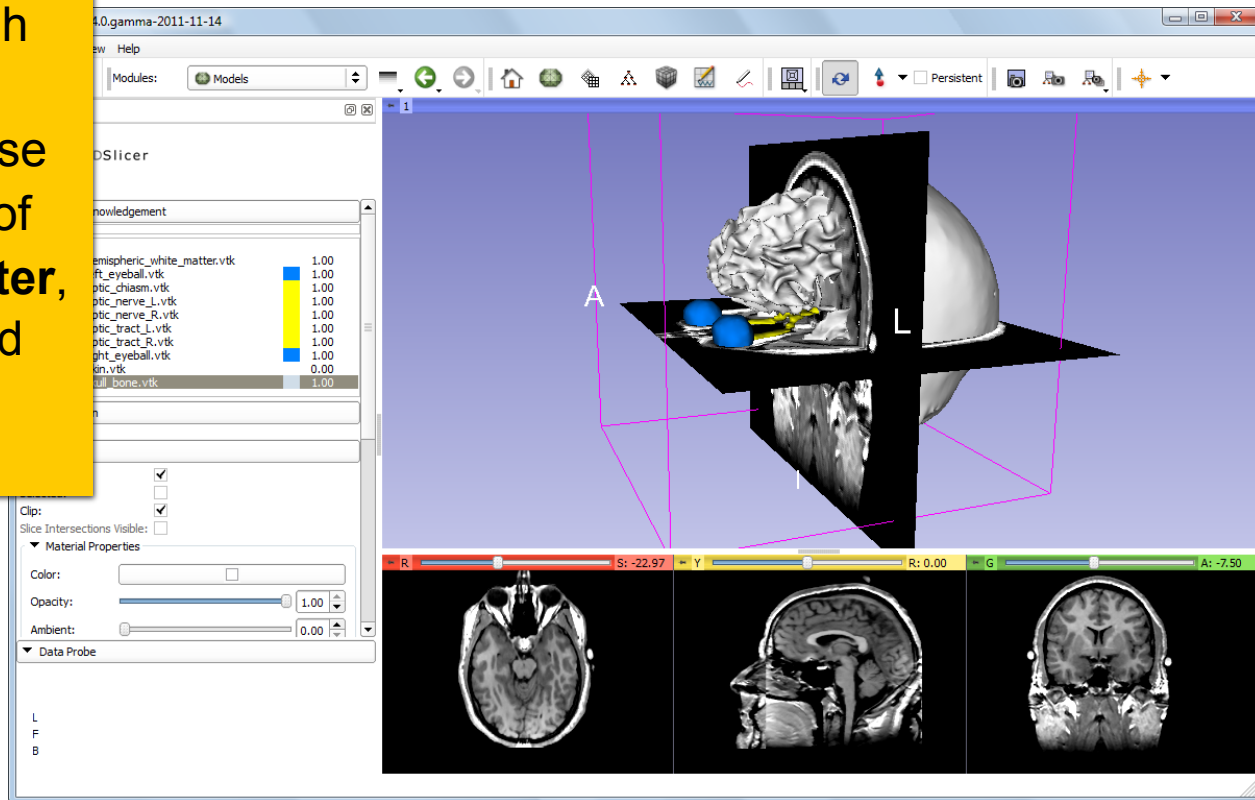
Select the 3D model **skull\_bone.vtk** in the Model Hierarchy and turn on the **Clipping** option.





# 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**.

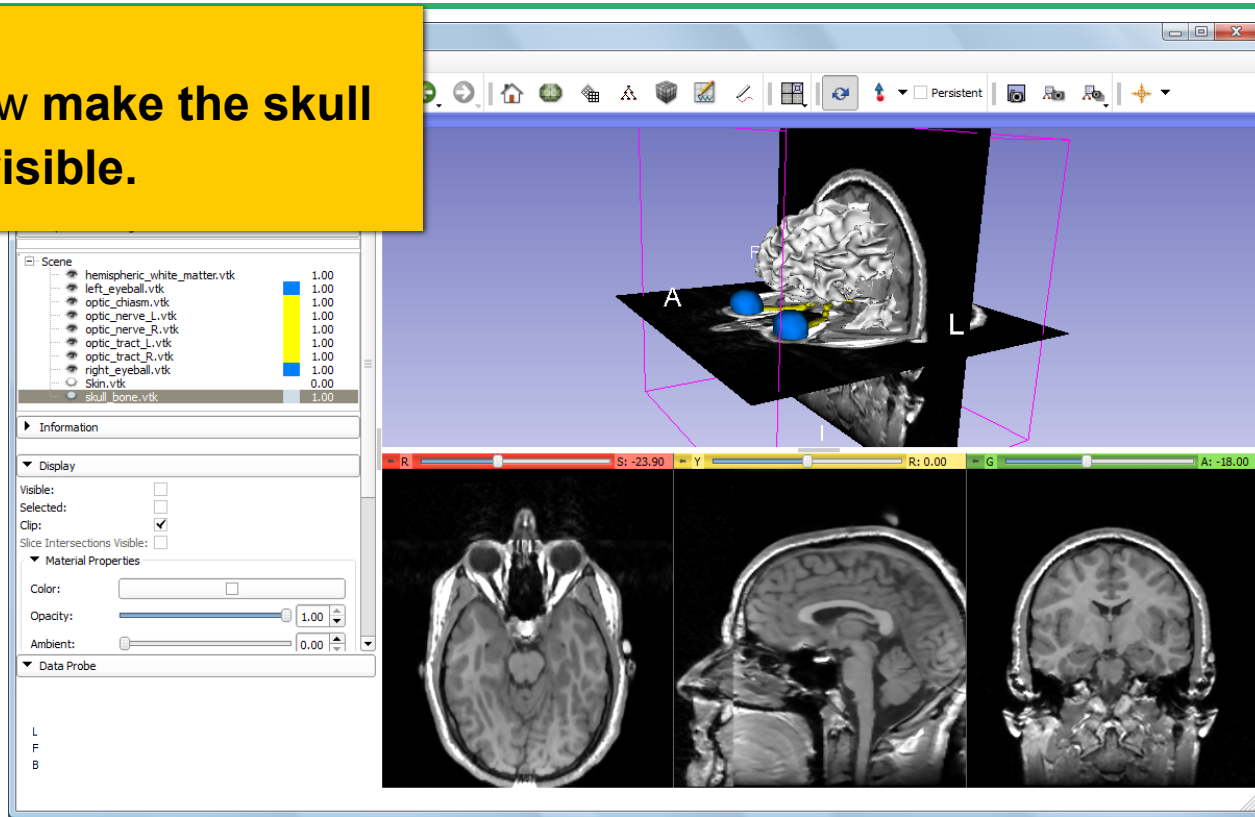






# Slicer4 Minute Tutorial: 3D Visualization

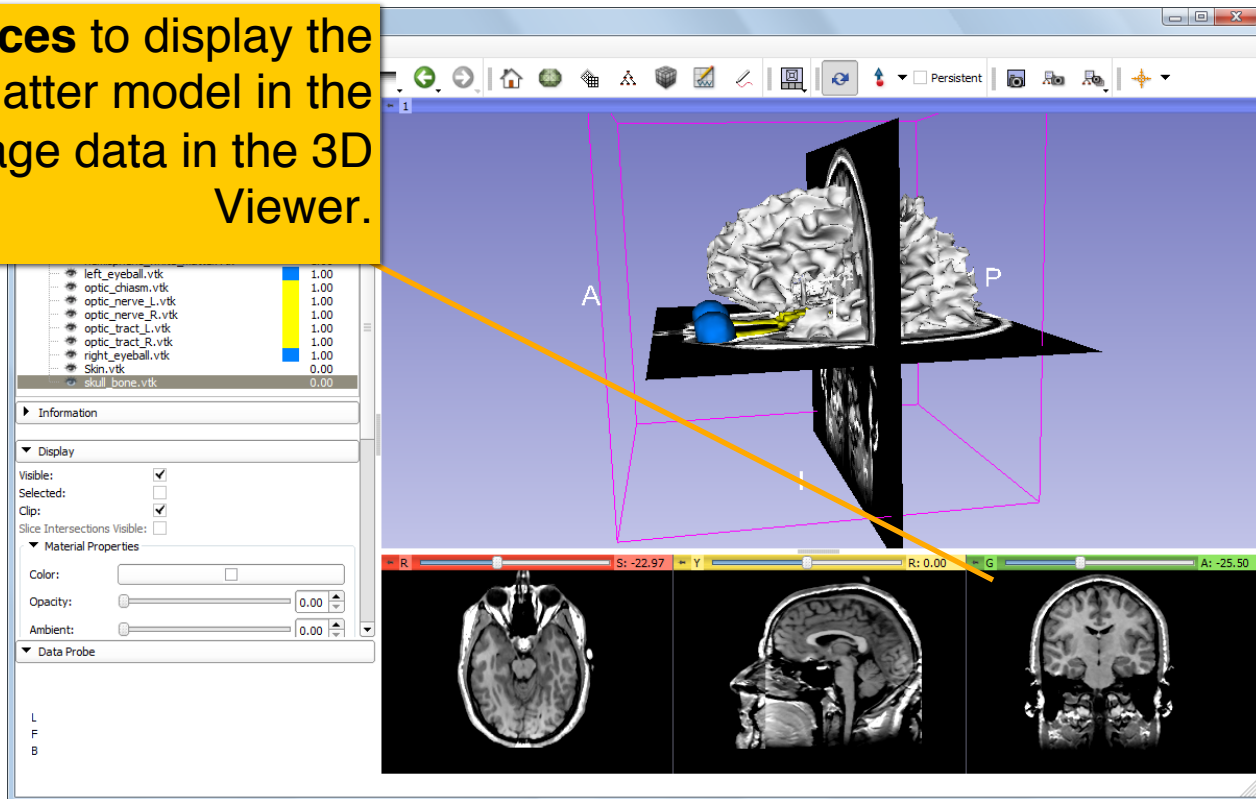
Now make the skull invisible.





# 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**.



Scene

- hemispheric\_white\_matter.vtk 1.00
- left\_eyeball.vtk 1.00
- optic\_chiasm.vtk 1.00
- optic\_nerve\_L.vtk 1.00
- optic\_nerve\_R.vtk 1.00
- optic\_tract\_L.vtk 1.00
- optic\_tract\_R.vtk 1.00
- right\_eyeball.vtk 1.00
- Skln.vtk 0.00
- skull\_bone.vtk 0.00

Information

Display

Visible:

Selected:

Clip:

Slice Intersections Visible:

Material Properties

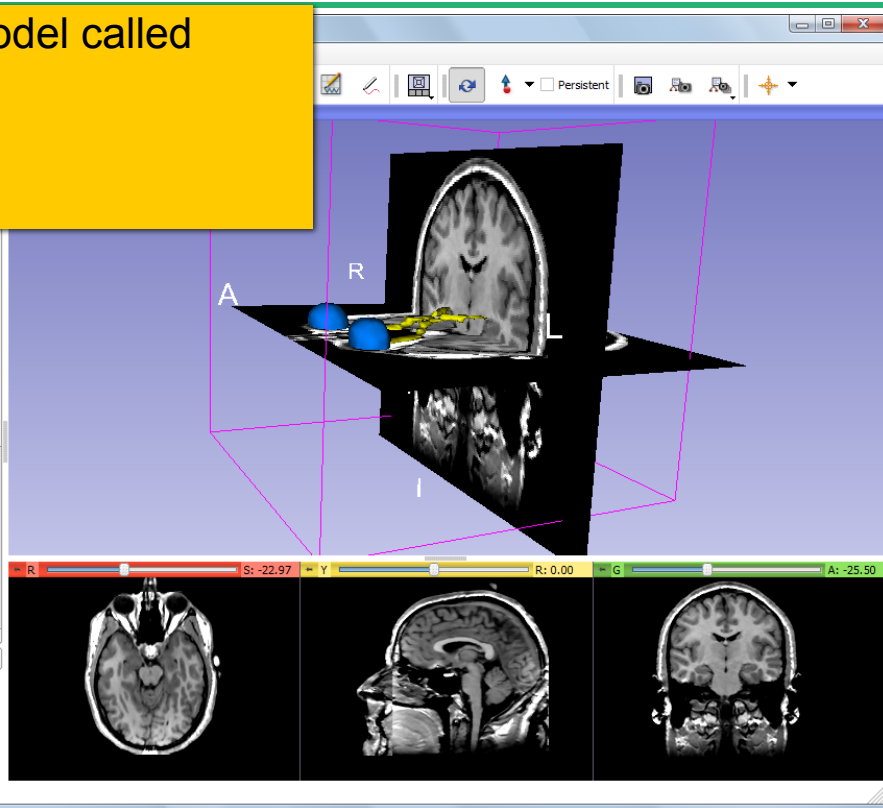
Color:

Opacity: 1.00

Ambient: 0.00

Data Probe

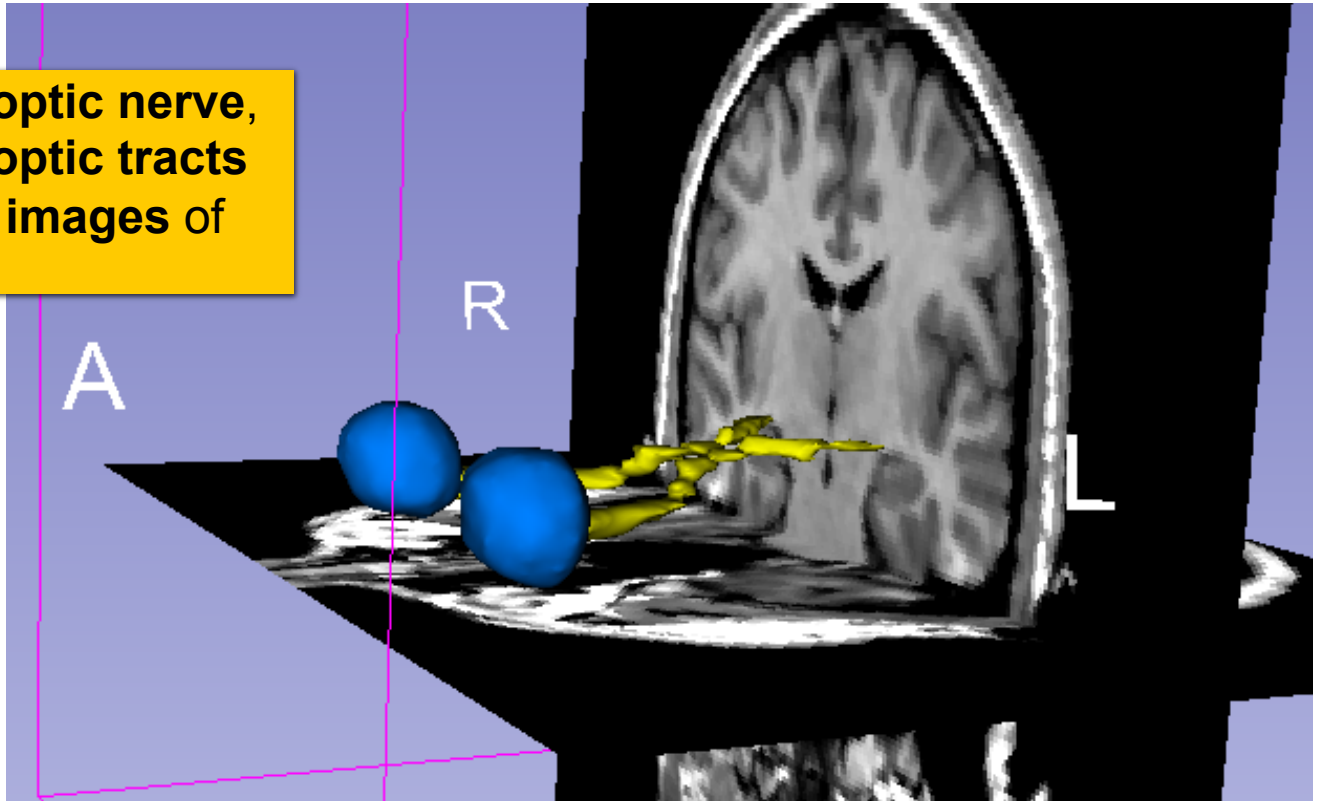
L  
F  
B





## Slicer4 Minute Tutorial: 3D Visualization

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

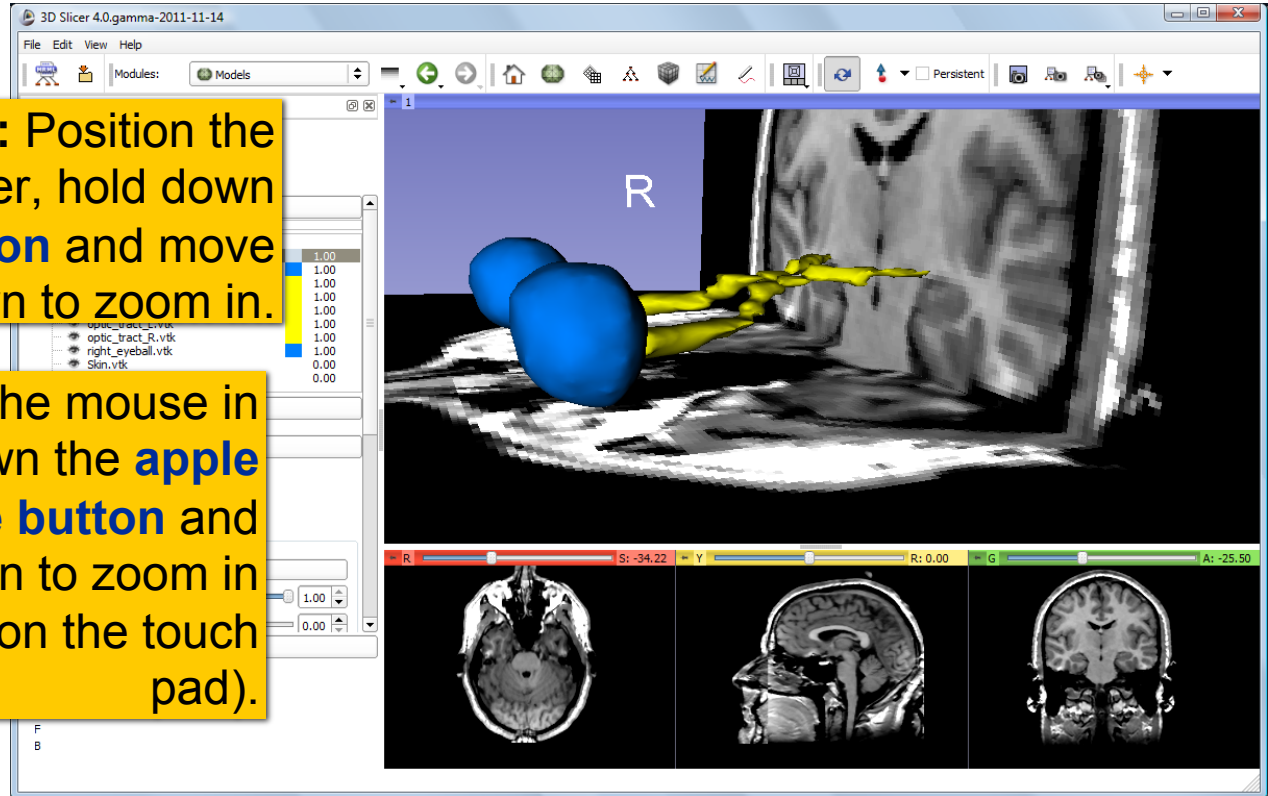




# Slicer4 Minute Tutorial: 3D Visualization: Zoom the view

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

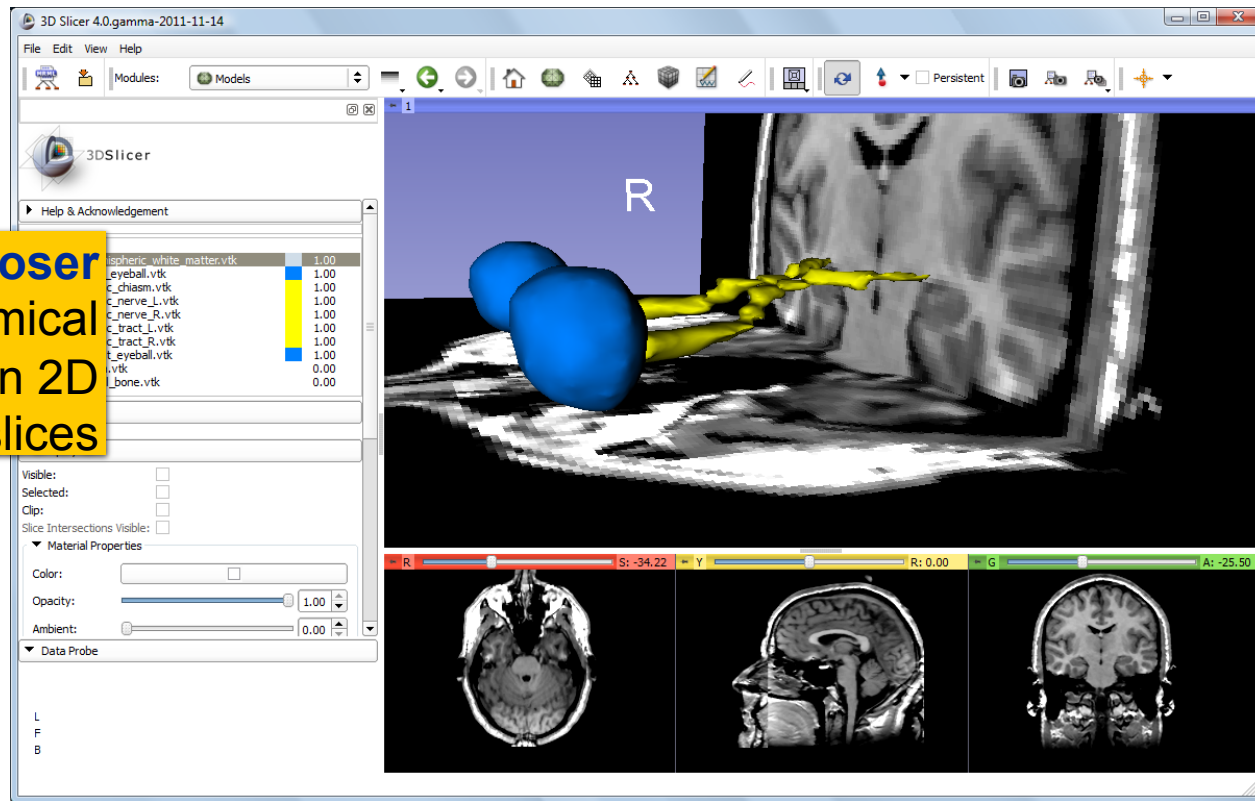
**Mac users:** Position the mouse in the 3D Viewer, hold down the **apple button and the mouse button** and move the mouse down to zoom in (or use two fingers on the touch pad).





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

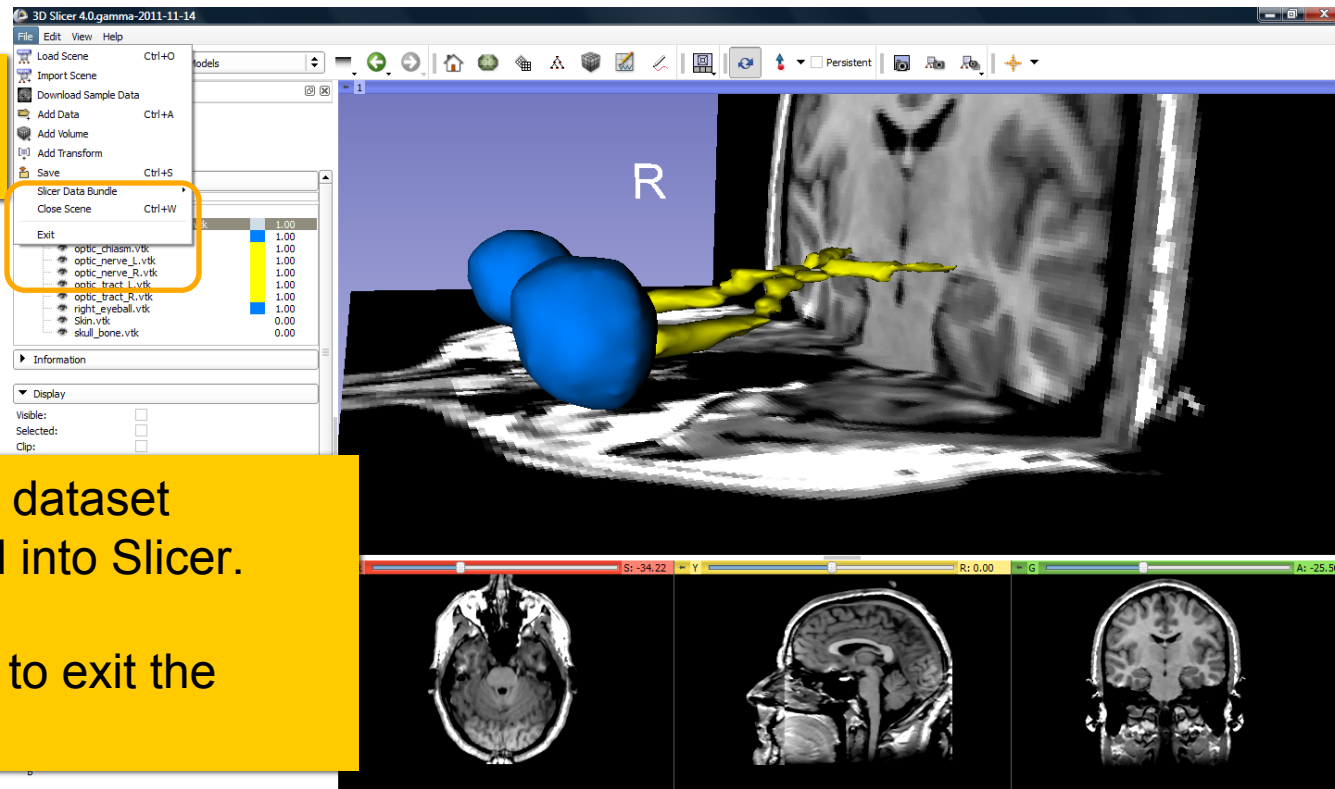
Slicer displays a **closer view** of 3D anatomical structures overlaid on 2D MR slices





# Close the existing scene and all its data

Select **File->Close Scene**



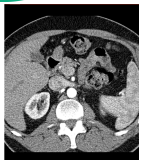
This removes any dataset previously loaded into Slicer.

Select **File-> Exit** to exit the software

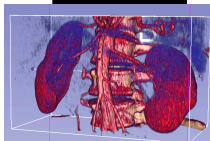


# Overview

---

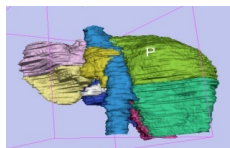
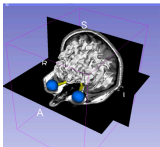


**Part I:** Introduction to the 3DSlicer software



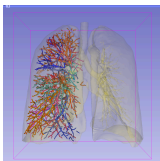
**Part II:** 3D Data Loading and visualization of DICOM images

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

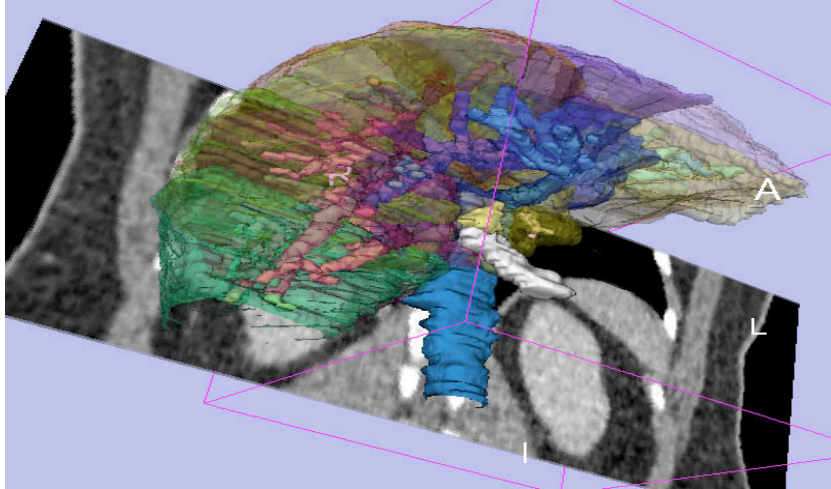


**Part III:** 3D interactive exploration of the anatomy

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



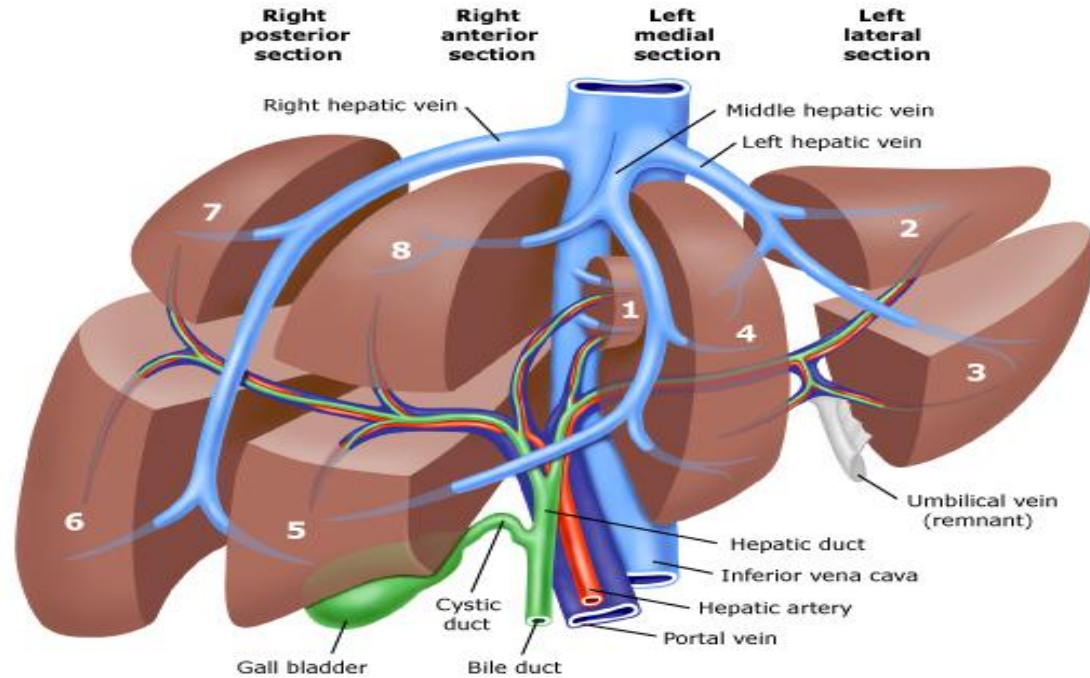




Part II:

Interactive 3D Visualization  
of the segments of the liver

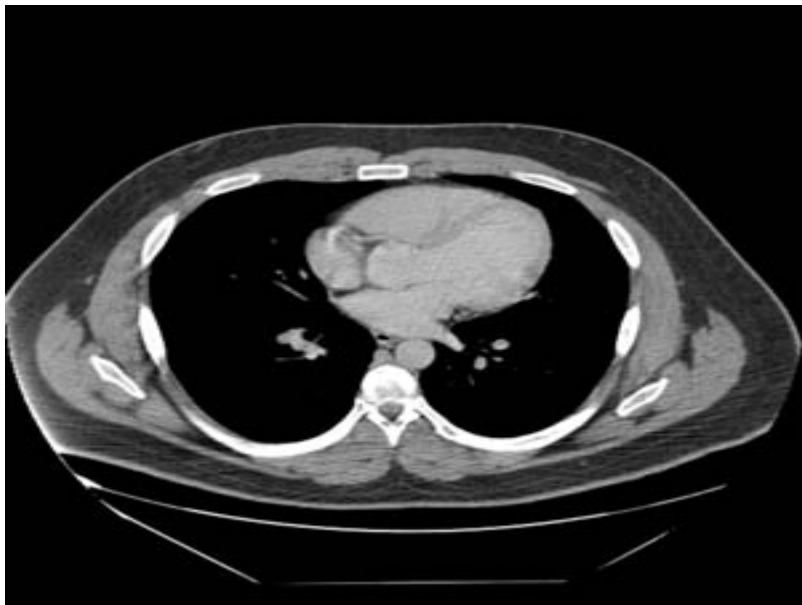
# Anatomy of the liver





# Liver dataset

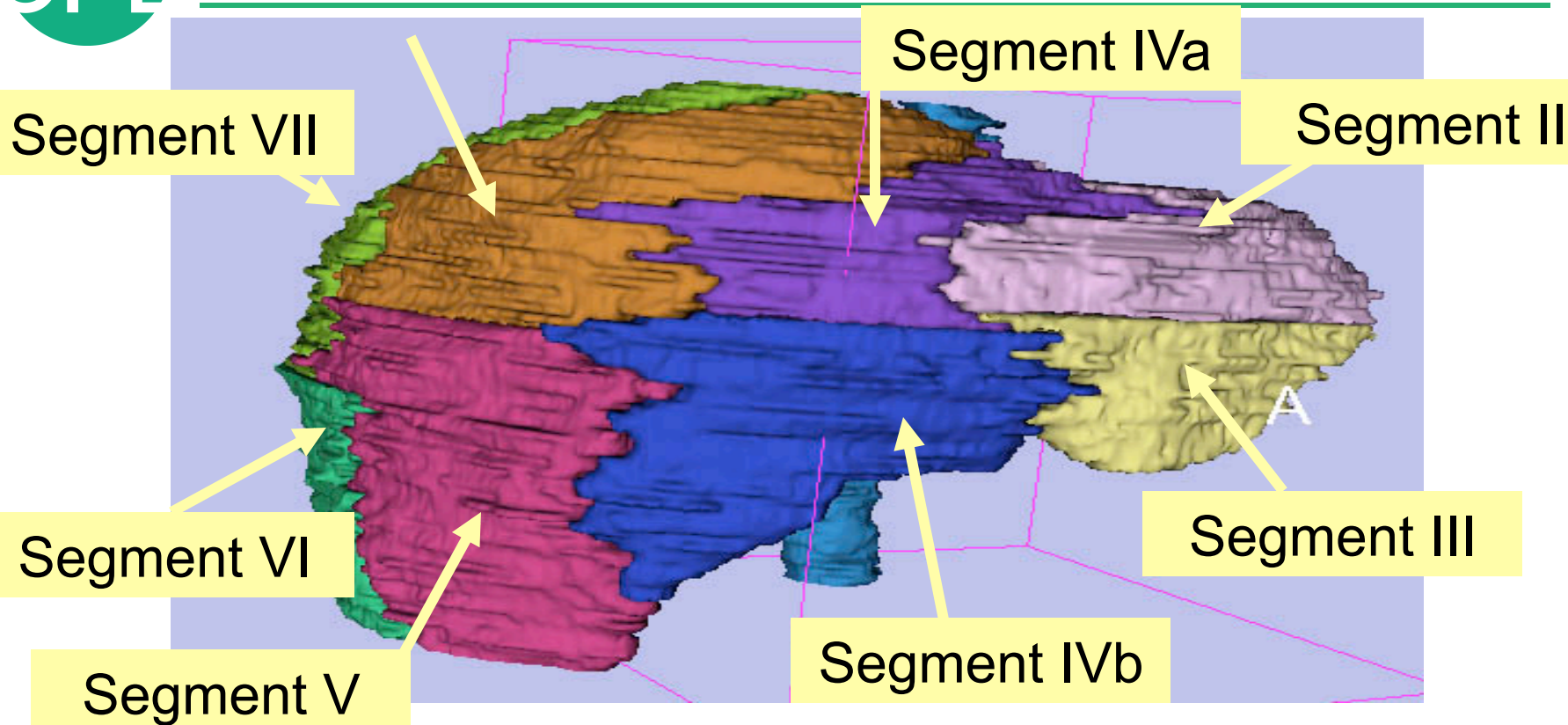
---



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

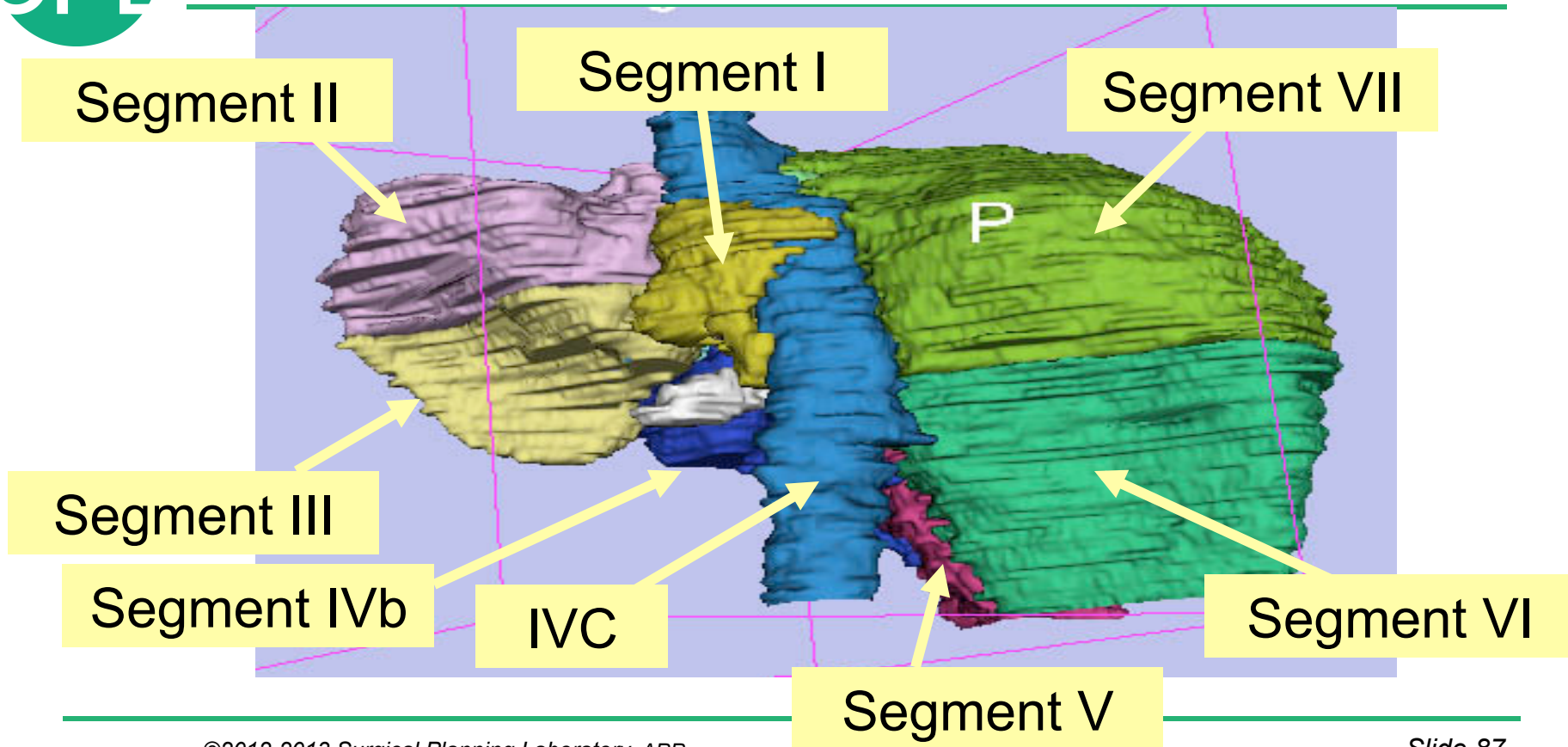


# 3D segments of the liver





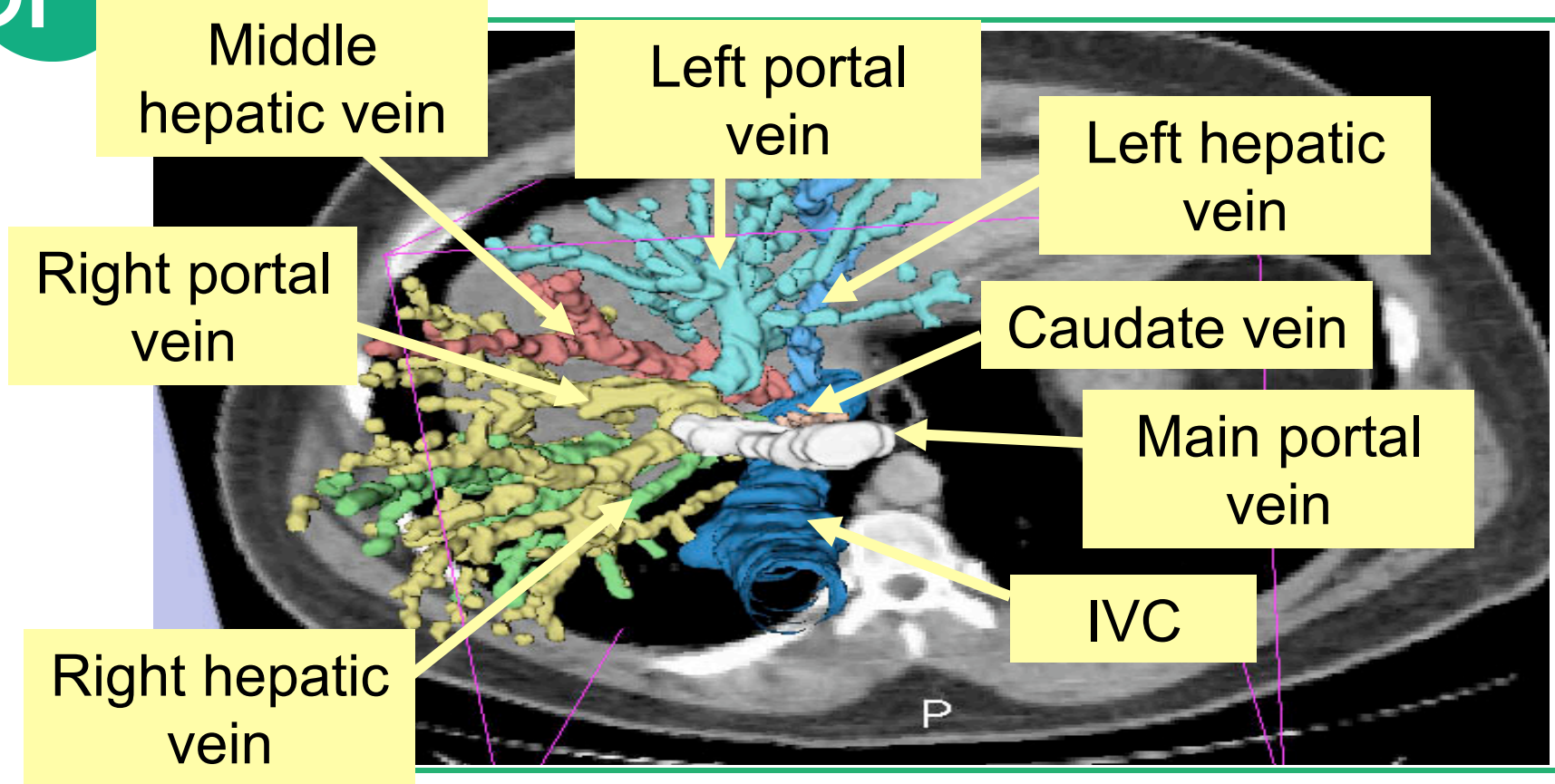
# 3D segments of the liver





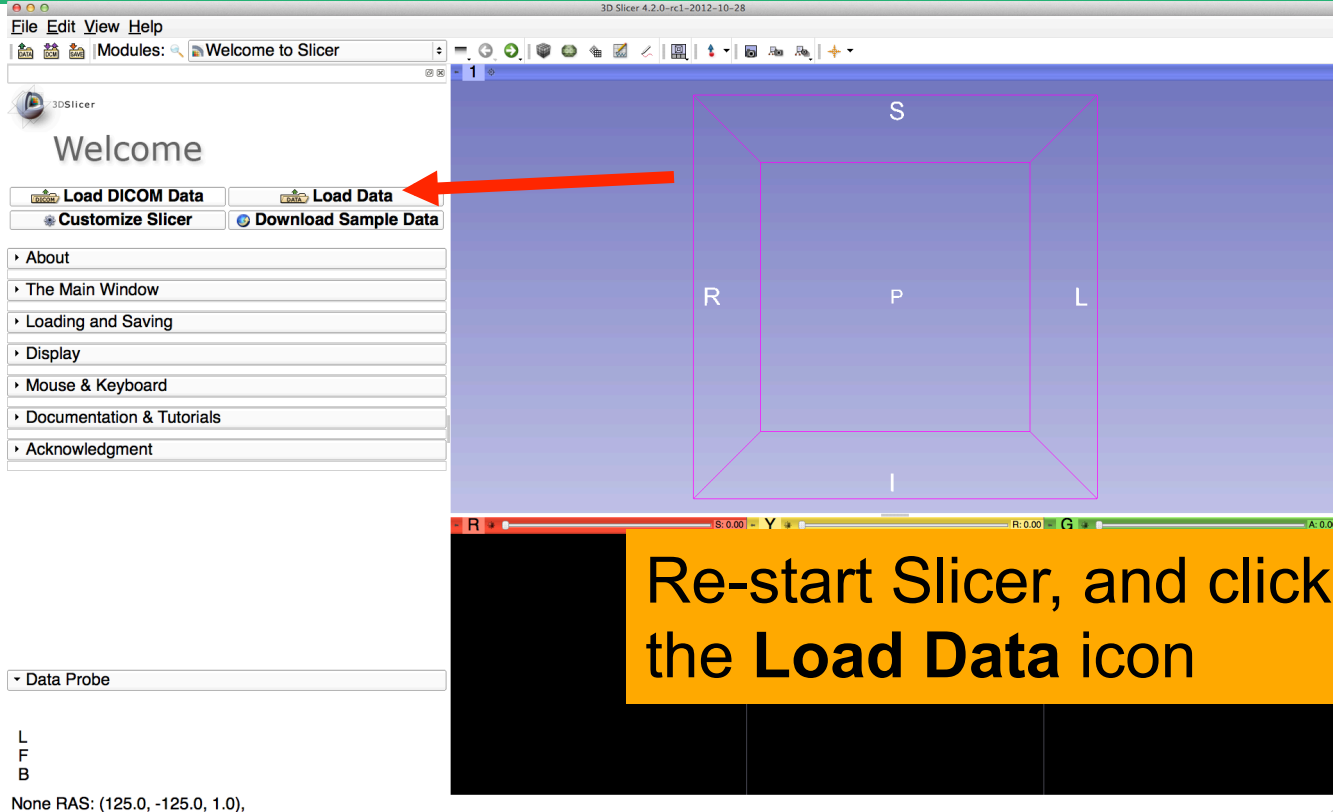


# Liver vasculature



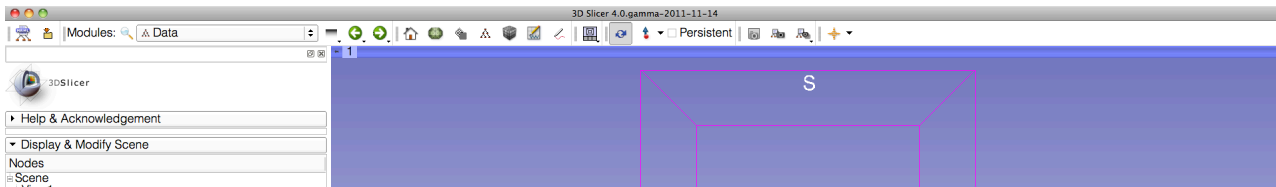


# Loading the Liver Data Scene





# Loading the Liver Scene



Browse to the directory

**C:\Pujol2012\3Dvisualization\_Tuesday\_Nov27\_2012**

Select the directory **dataset3\_CT-Liver**

Select the file **LiverSegments\_Scene.mrml**

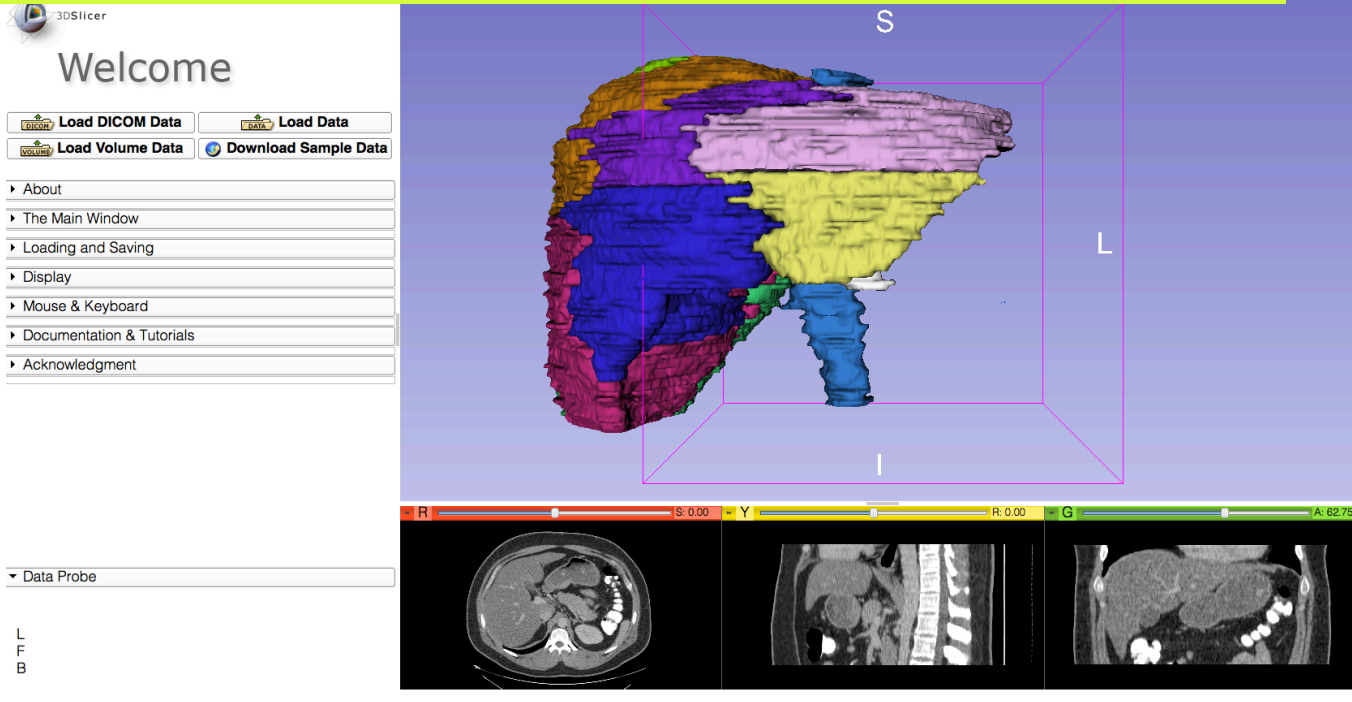
Click on OK to load the scene into Slicer





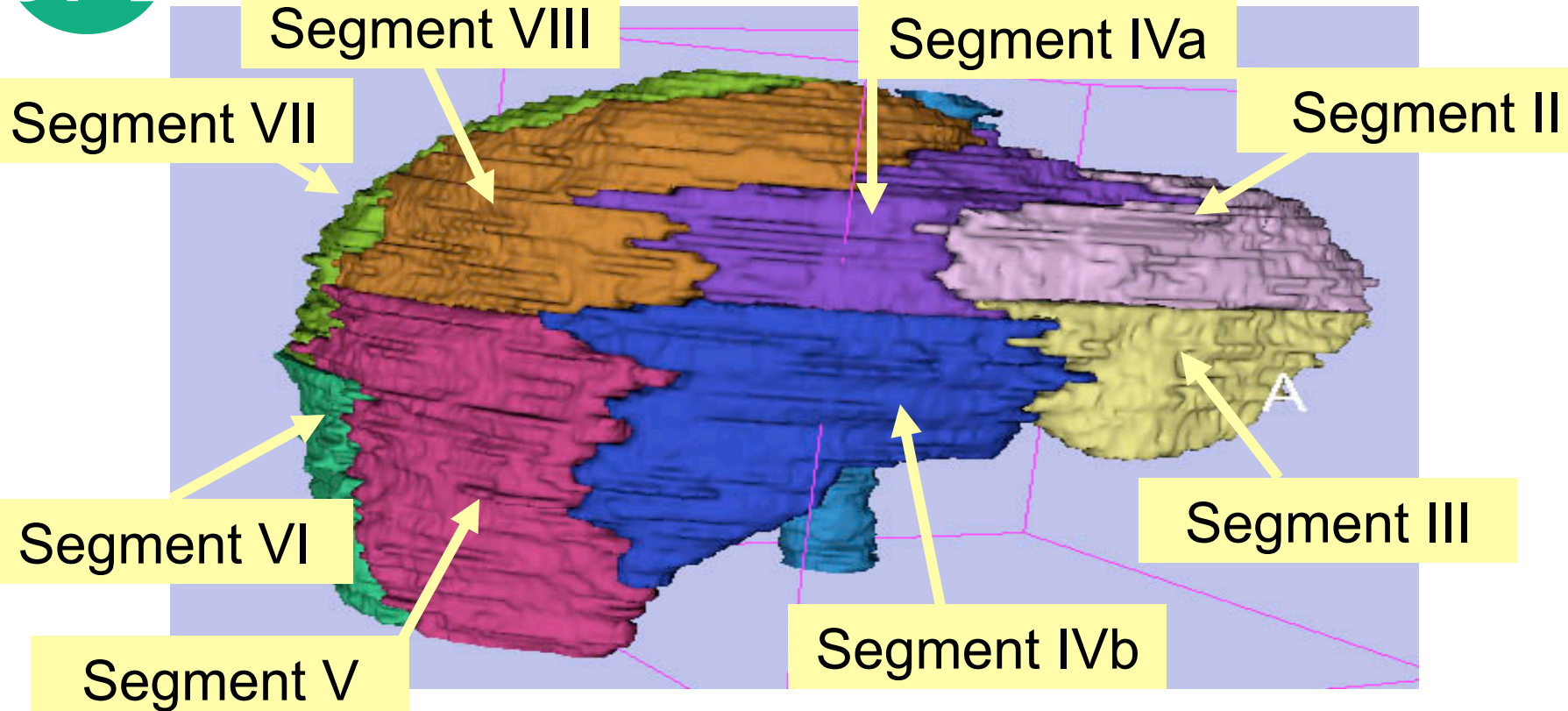
# Liver Segments Scene

The elements of the scene appear in the Viewer



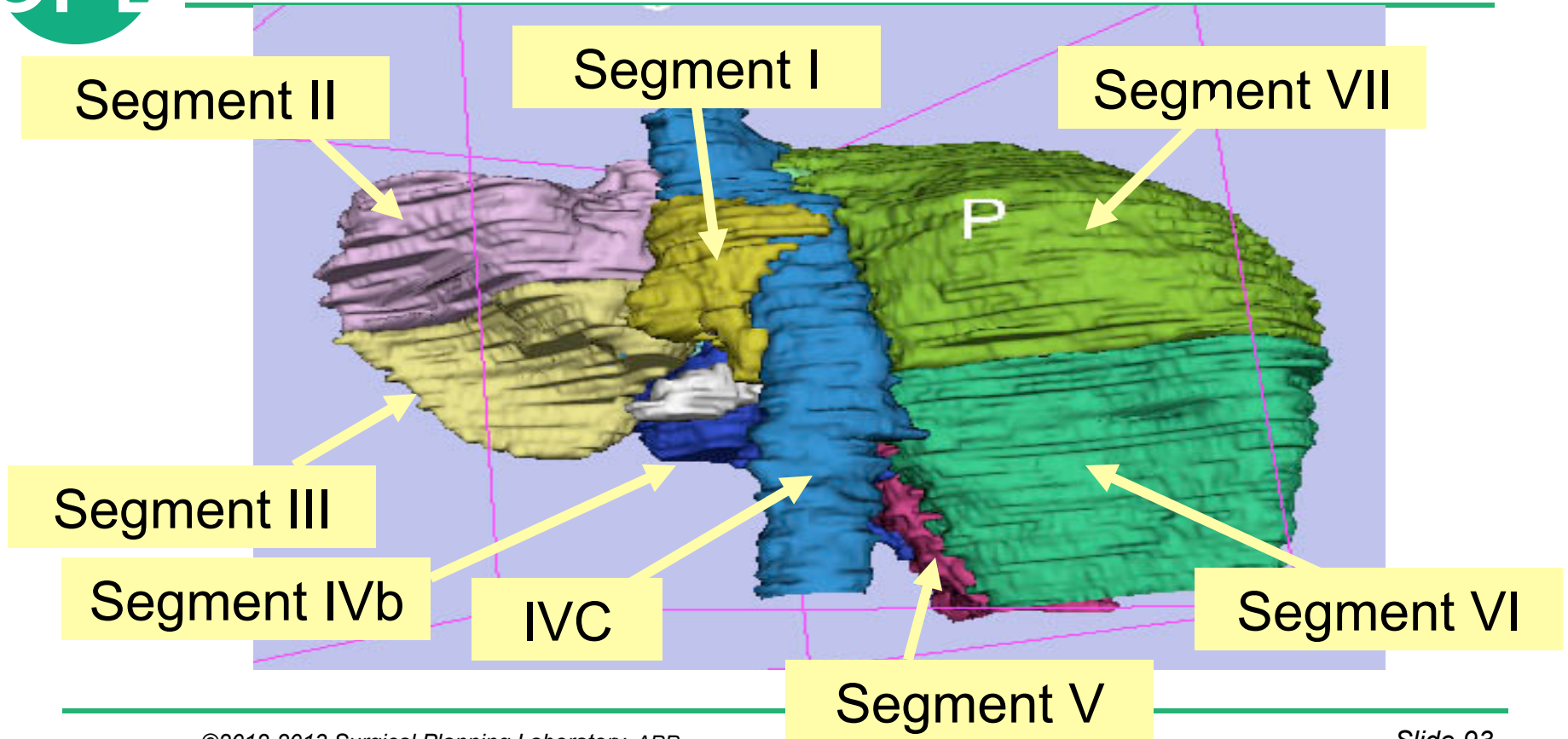


# 3D models of the liver



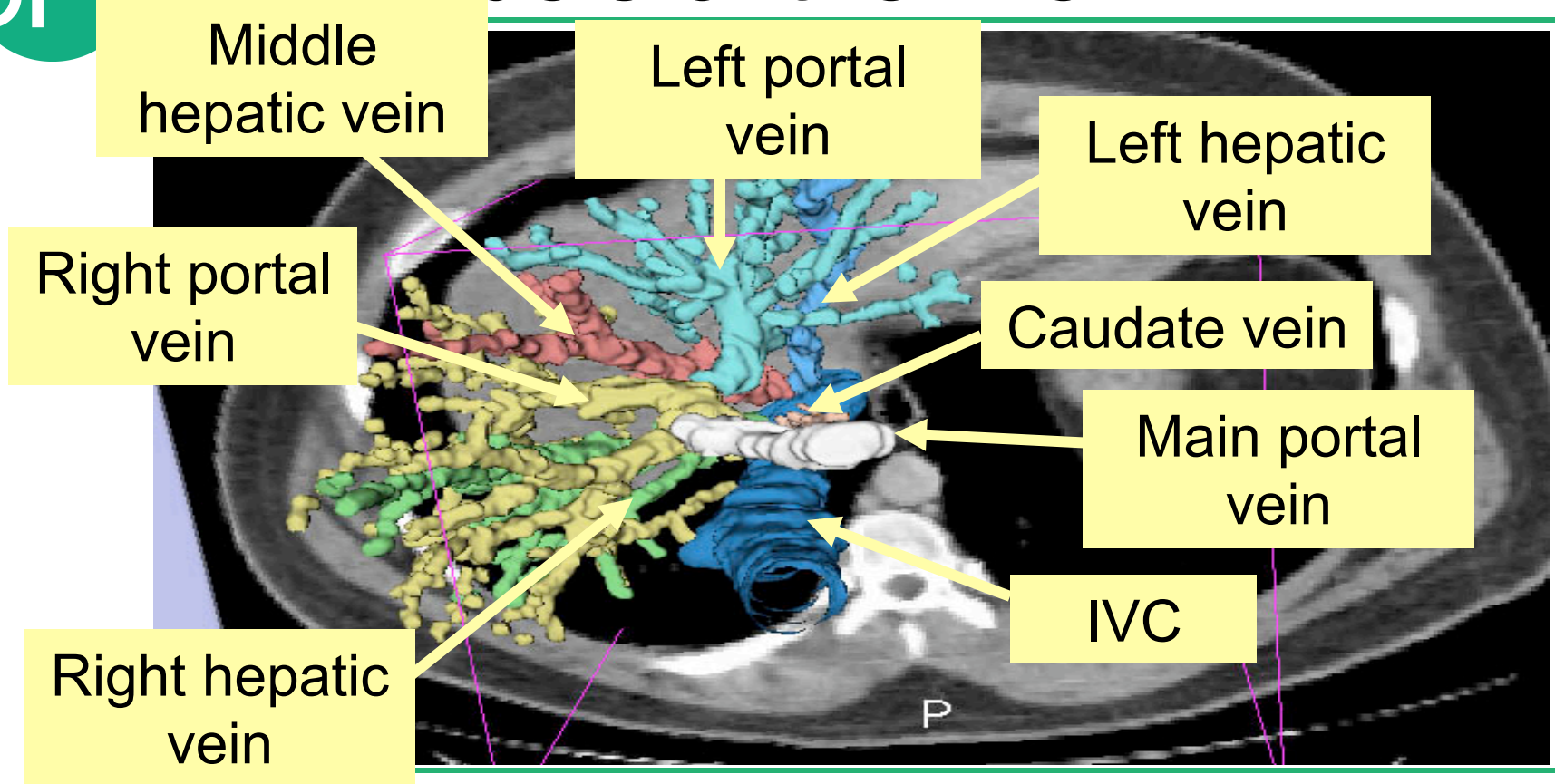


# 3D models of the liver



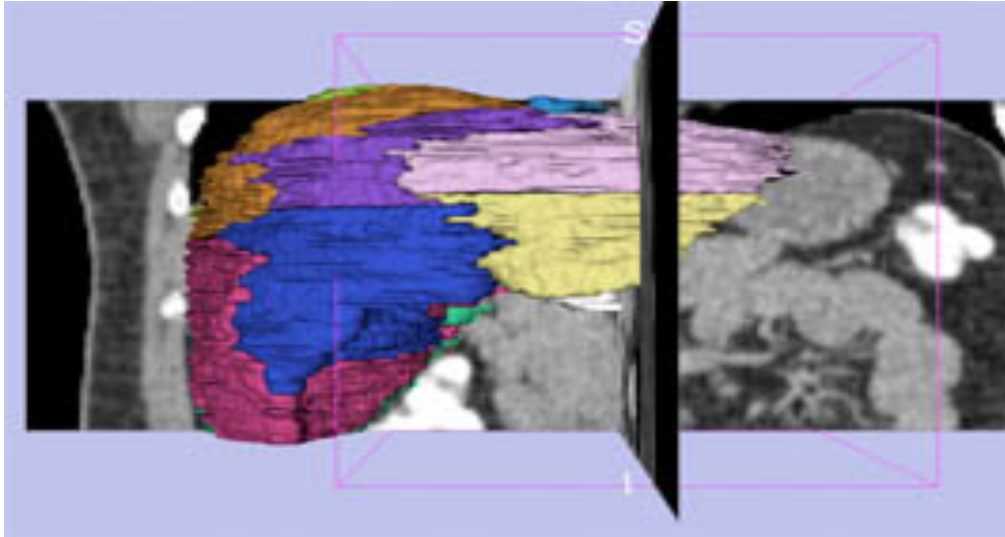


# 3D models of the liver





# 3D Exploration of Liver Segments

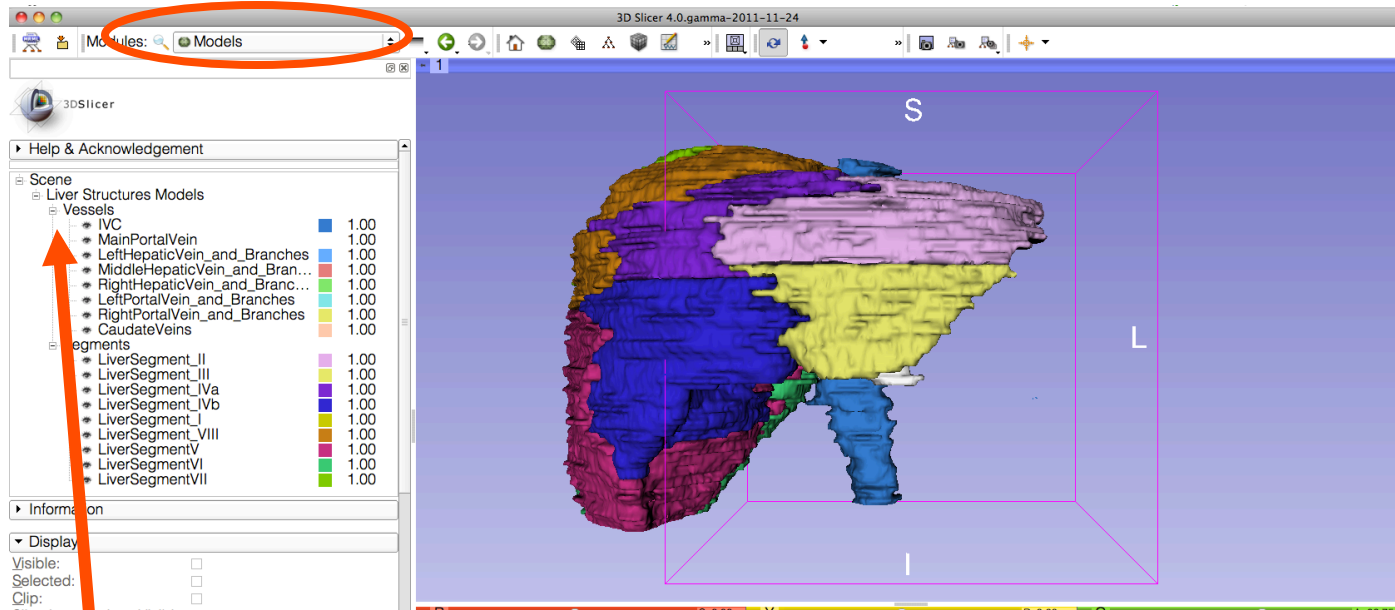


## Example:

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



# 3D Exploration of Liver Segments



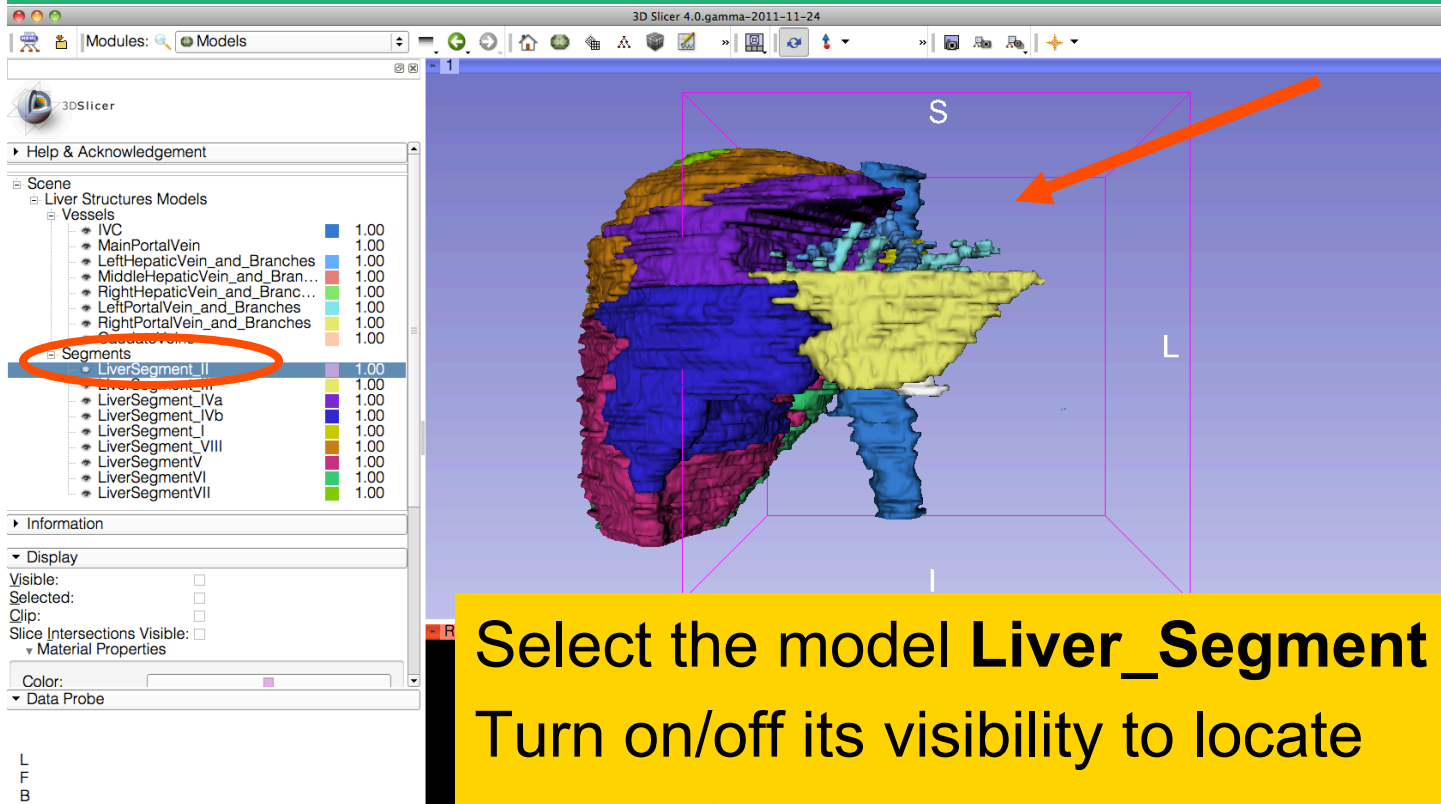
Select the module **Models**

Click on the Liver Structures Models Hierarchy





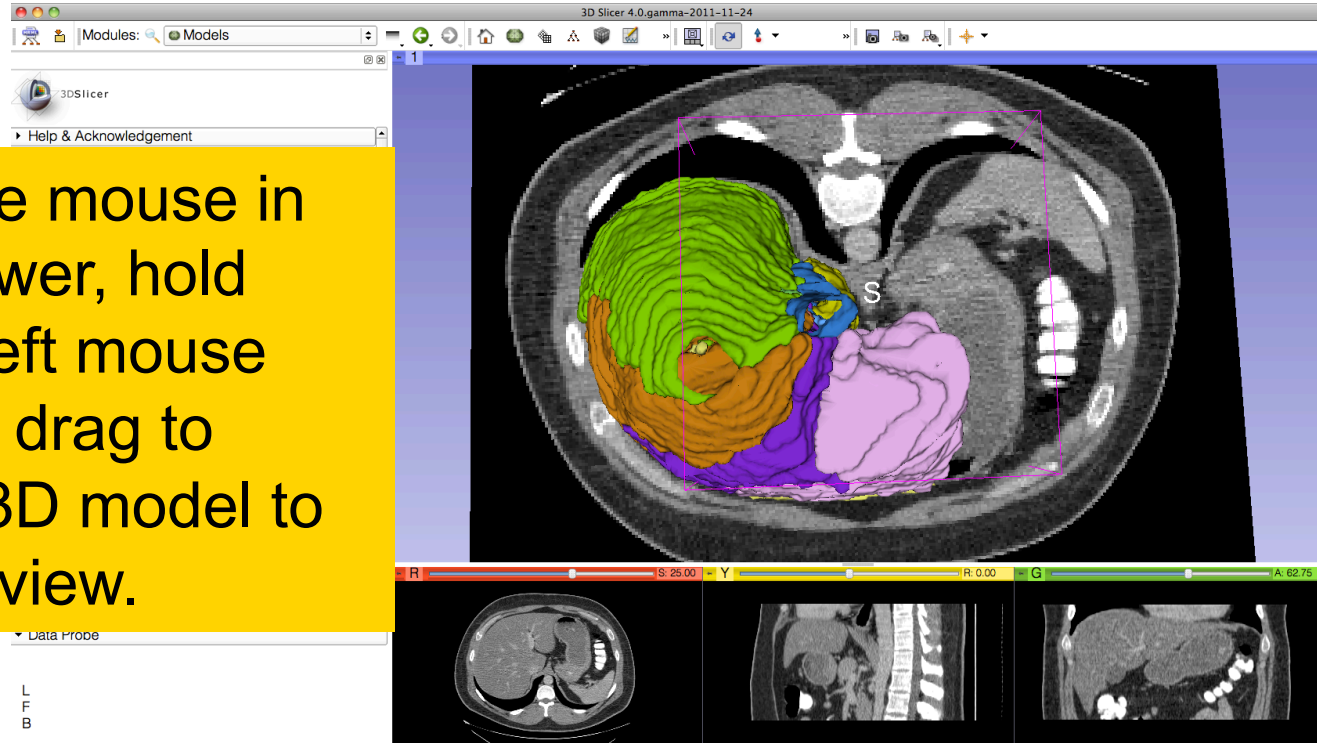
# 3D Exploration of Liver Segments





# 3D Exploration of Liver Segments

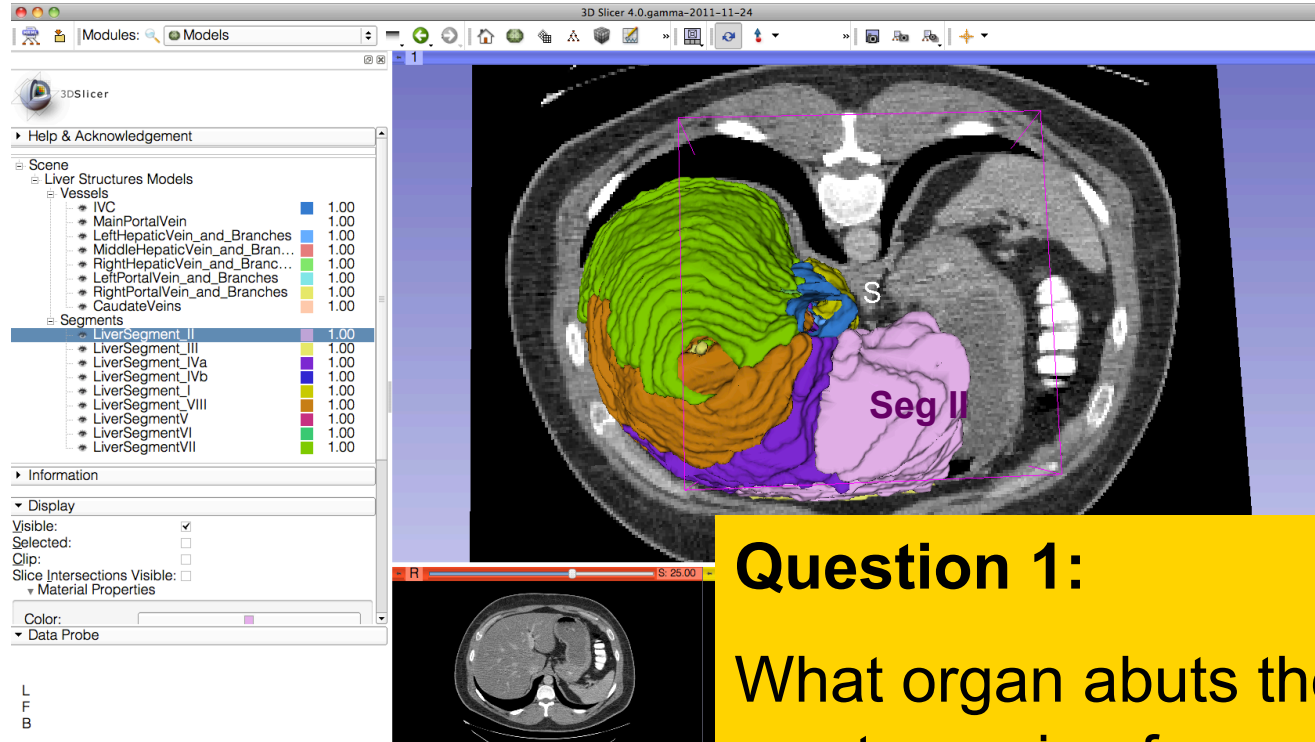
Position the mouse in the 3D Viewer, hold down the left mouse button and drag to orient the 3D model to a superior view.







# 3D Exploration of Liver Segments



## Question 1:

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

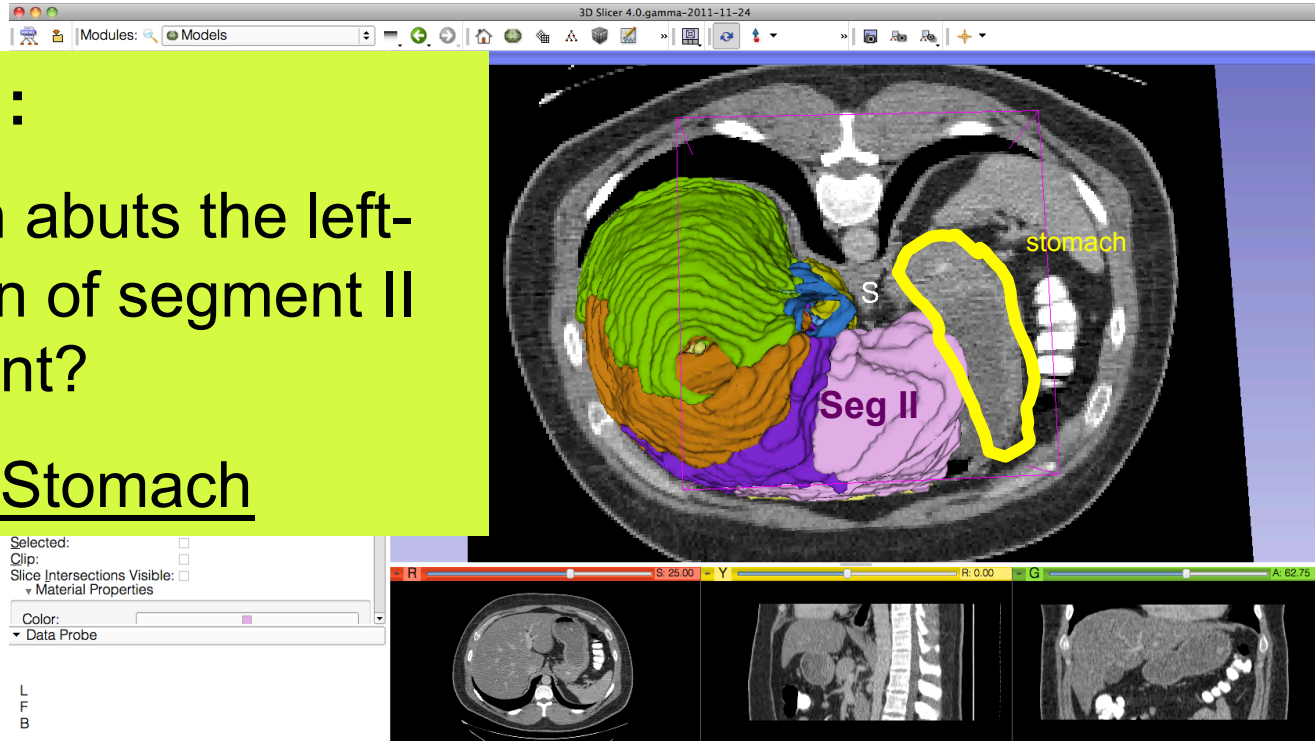


# 3D Exploration of Liver Segments

## Question 1:

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

**Answer 1: Stomach**

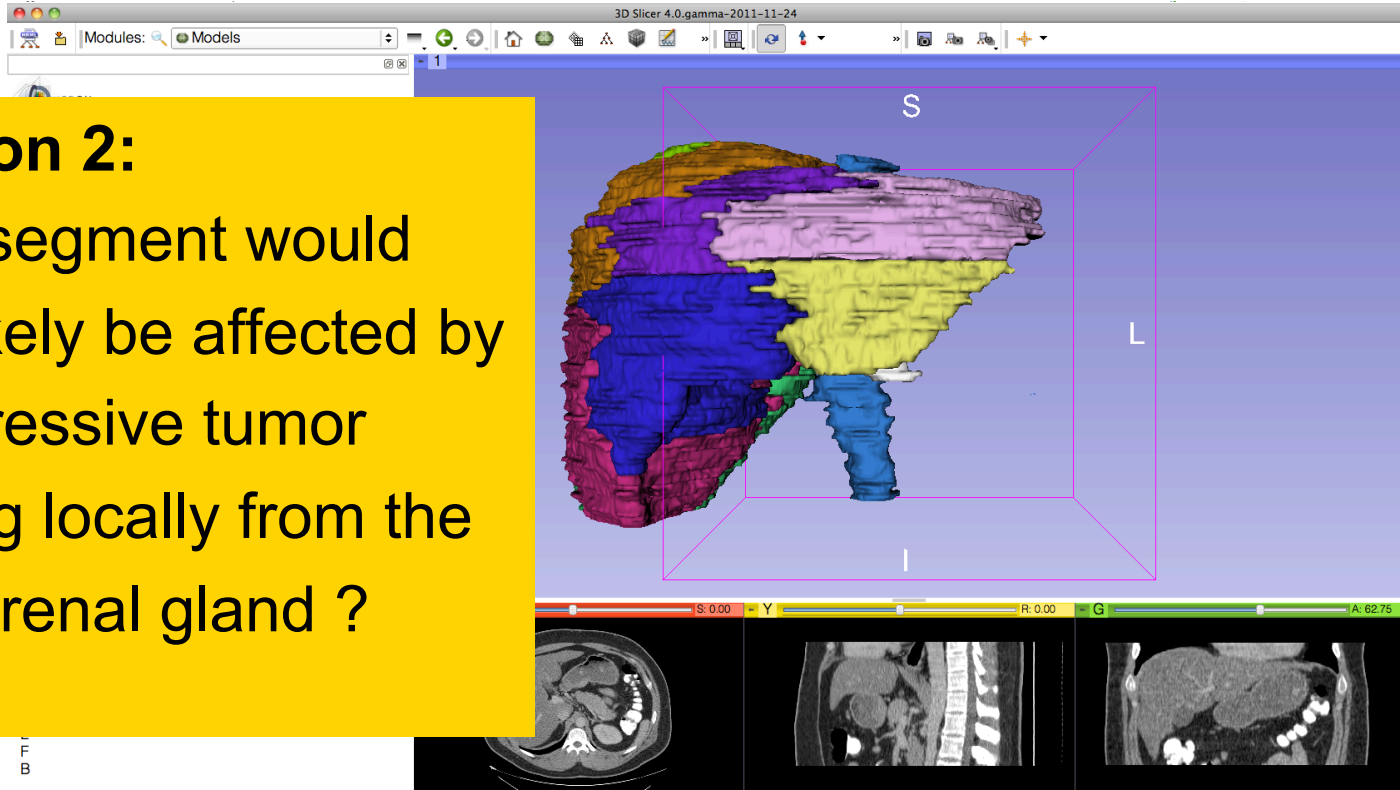




# 3D Exploration of Liver Segments

## 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

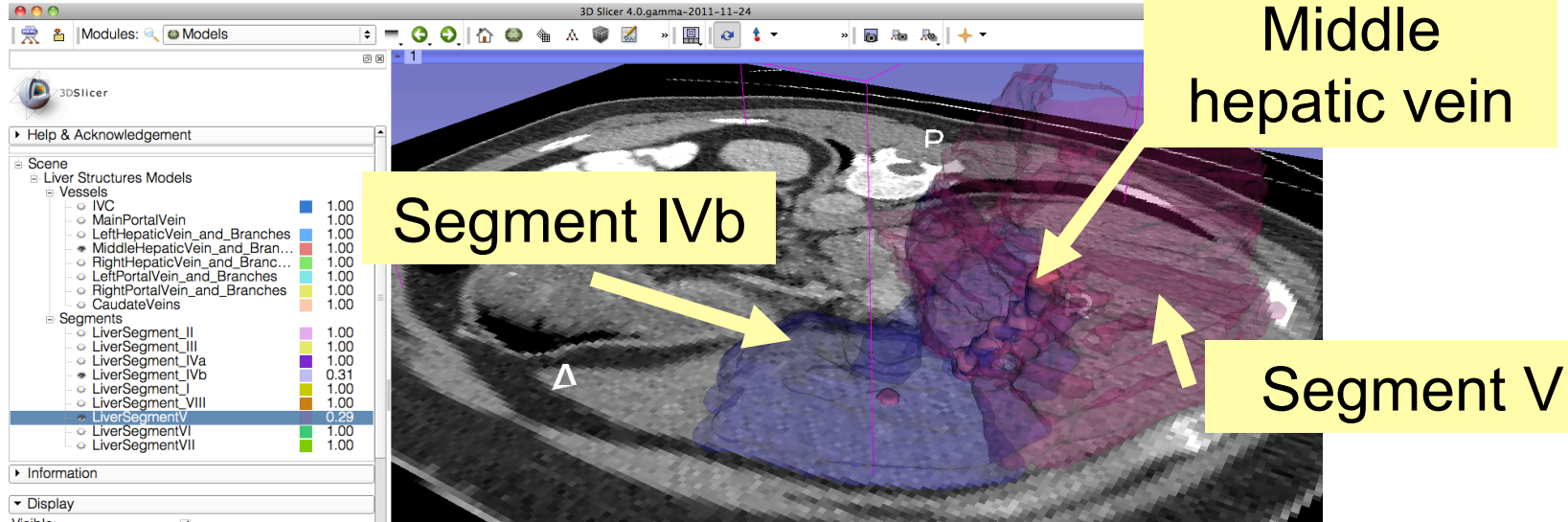


## Question 3:

Which vessel separates Segment IVb and Segment V?



# Middle Hepatic Vein



## Question 3:

Which vessel separates Segment IVb and Segment V?

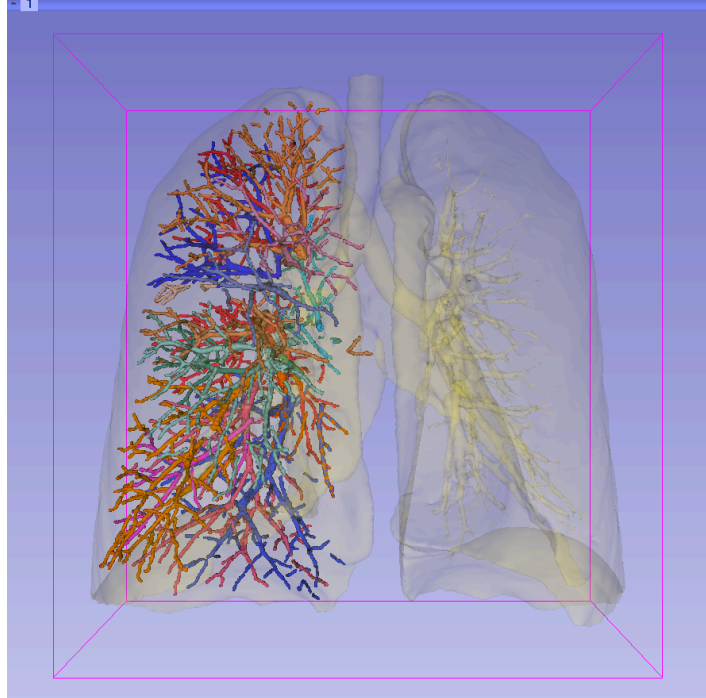
**Answer 3:** The middle hepatic vein





# Closing the Liver Scene





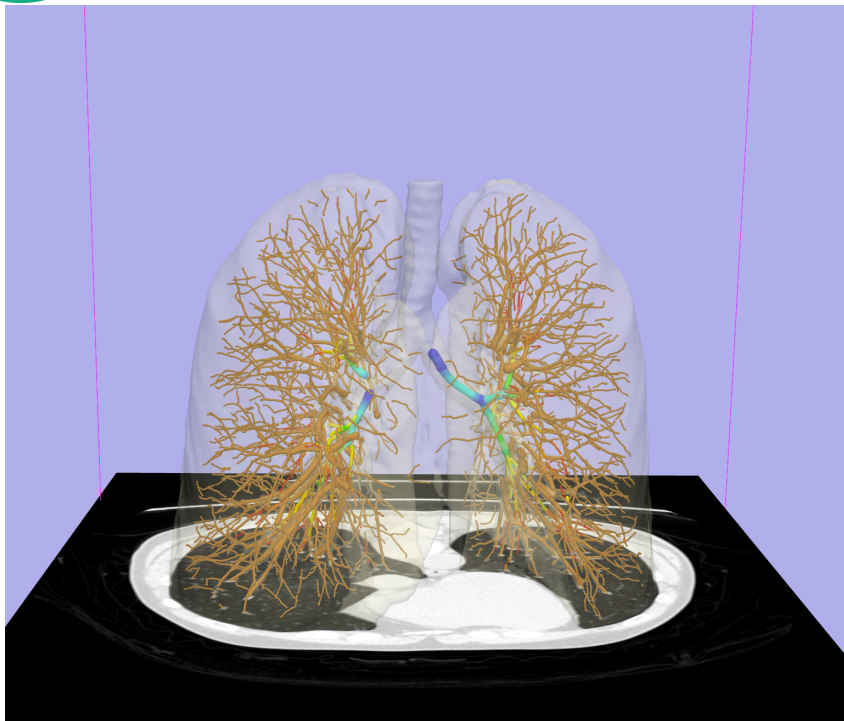
## Interactive 3D Visualization of the segments of the lungs





# Segments of the lung

---



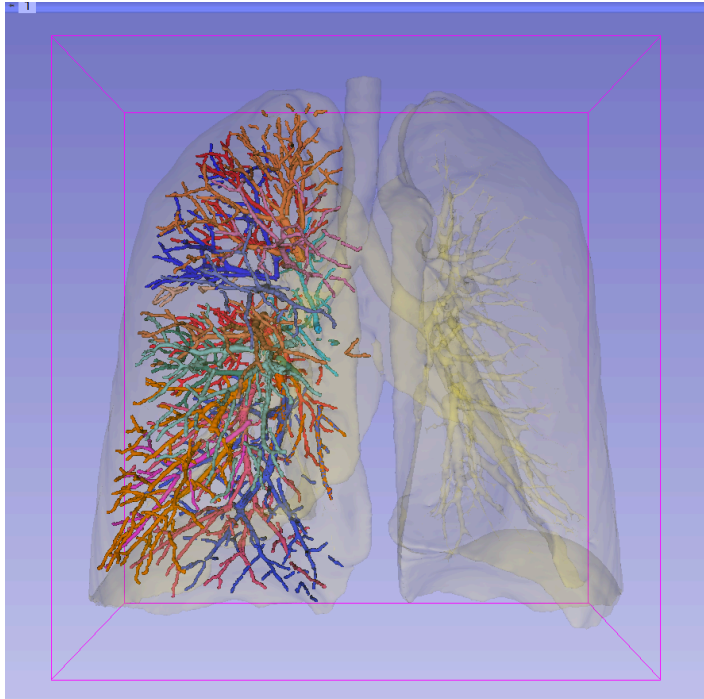
Segmentation and 3D surface reconstruction of the lung and pulmonary vessels

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

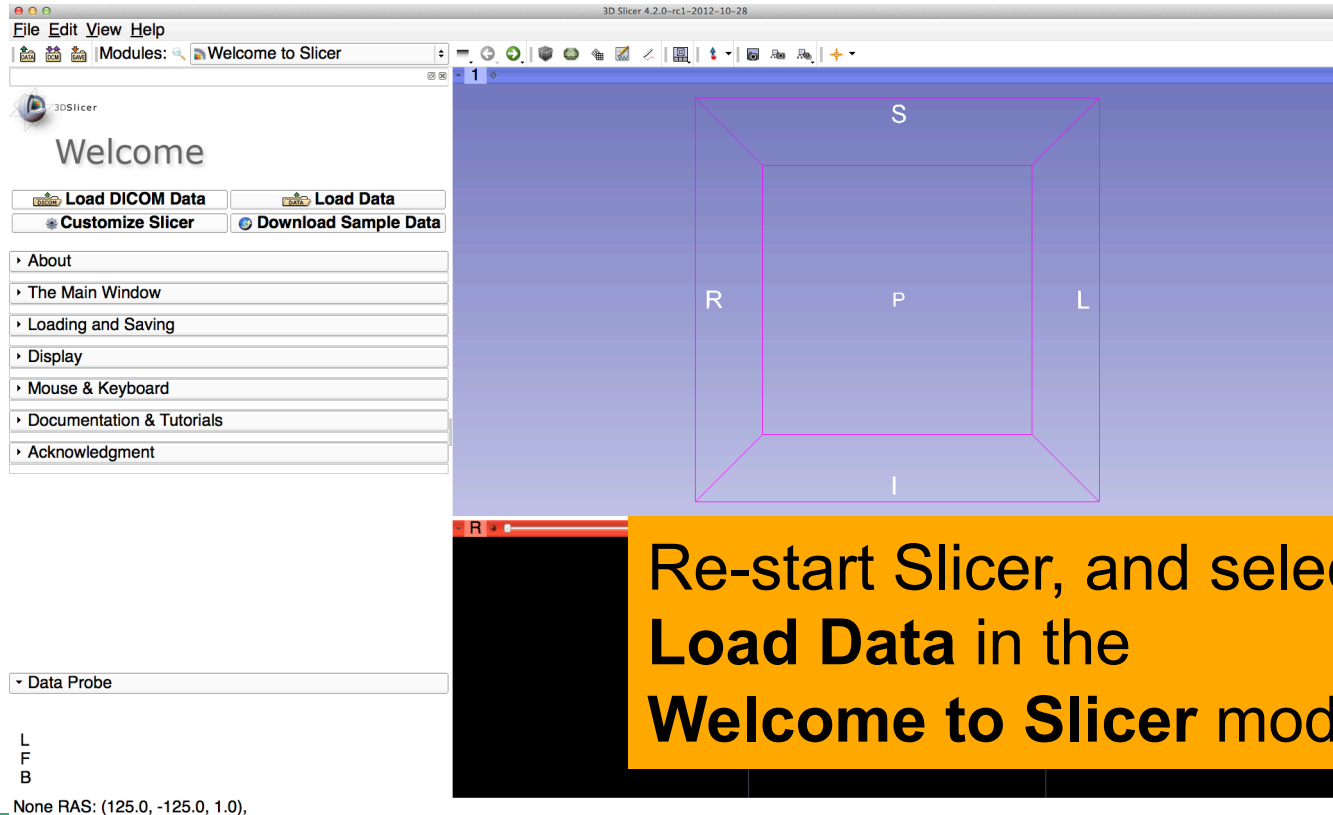


3D parcellation of arteries and veins from original model of pulmonary vessels  
(Kitt Shaffer, M.D., Ph.D. - Sonia Pujol, Ph.D.)

- 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

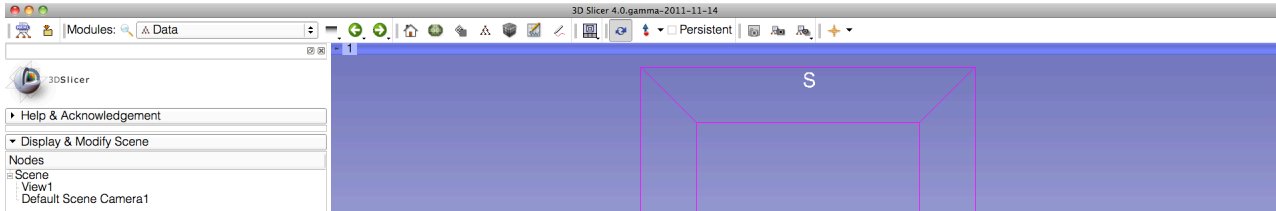


# Loading the Chest Data Scene





# Loading the Lung Scene



Click on Choose Files and browse to the directory

**C:\Pujol2012\3DVisualization\_Tuesday\_Nov27\_2012**

Select the subdirectory dataset4\_CT-Chest

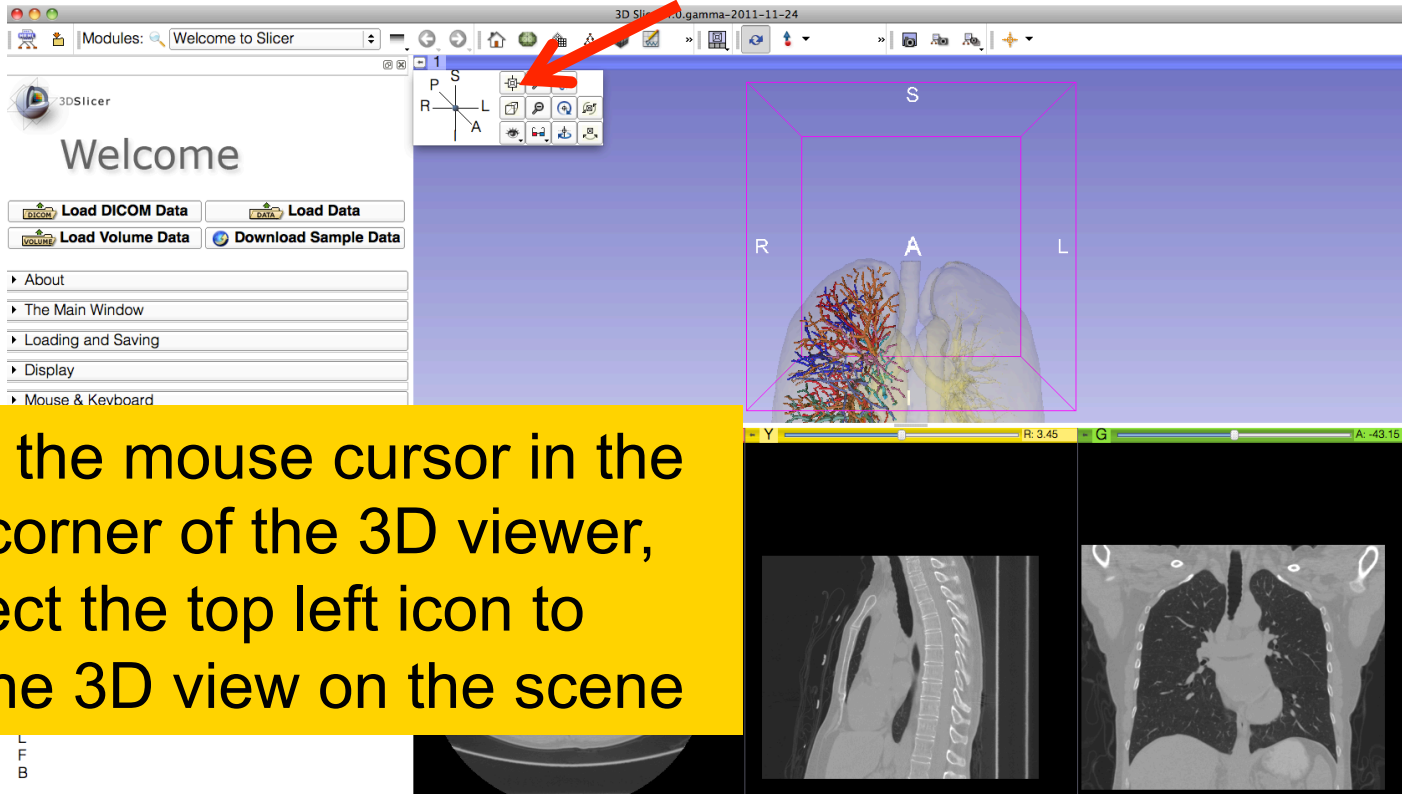
Select the file **LungSegment\_Scene.mrml**

Click on Open

Click on OK to load the scene in Slicer



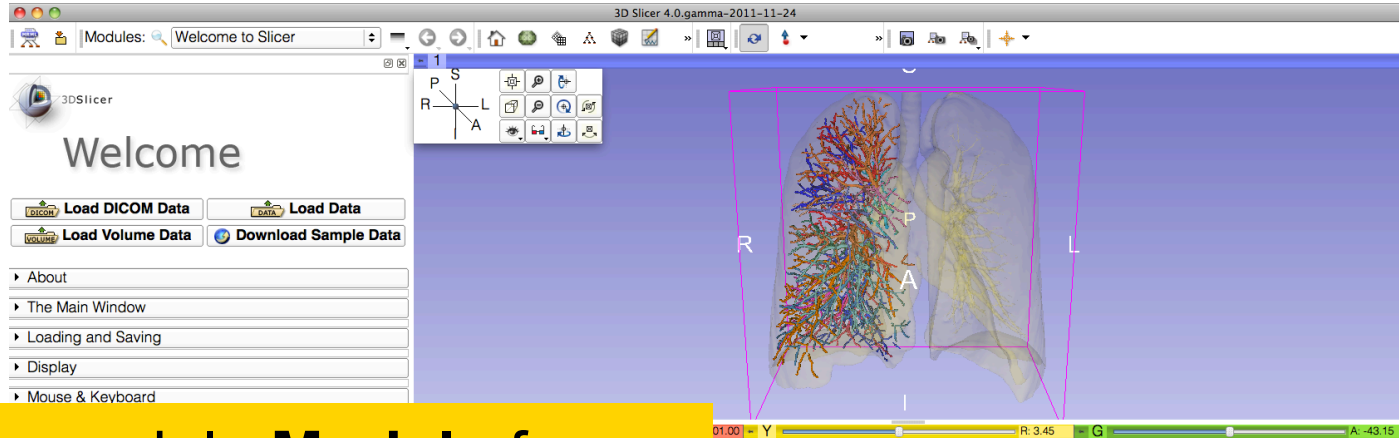
# Loading the Lung Scene



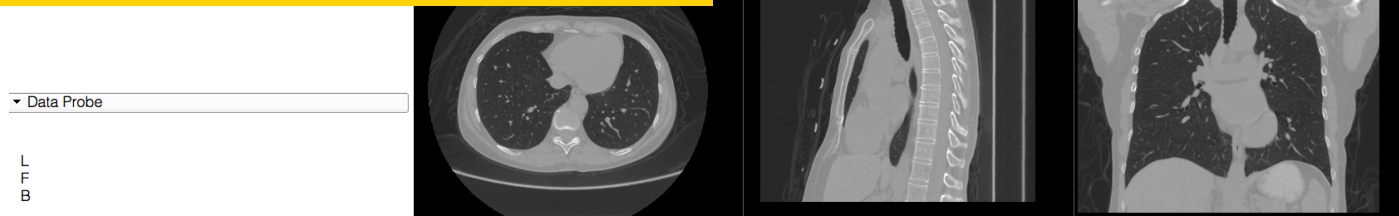
Position the mouse cursor in the top left corner of the 3D viewer, and select the top left icon to center the 3D view on the scene



# Loading the Lung Scene



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





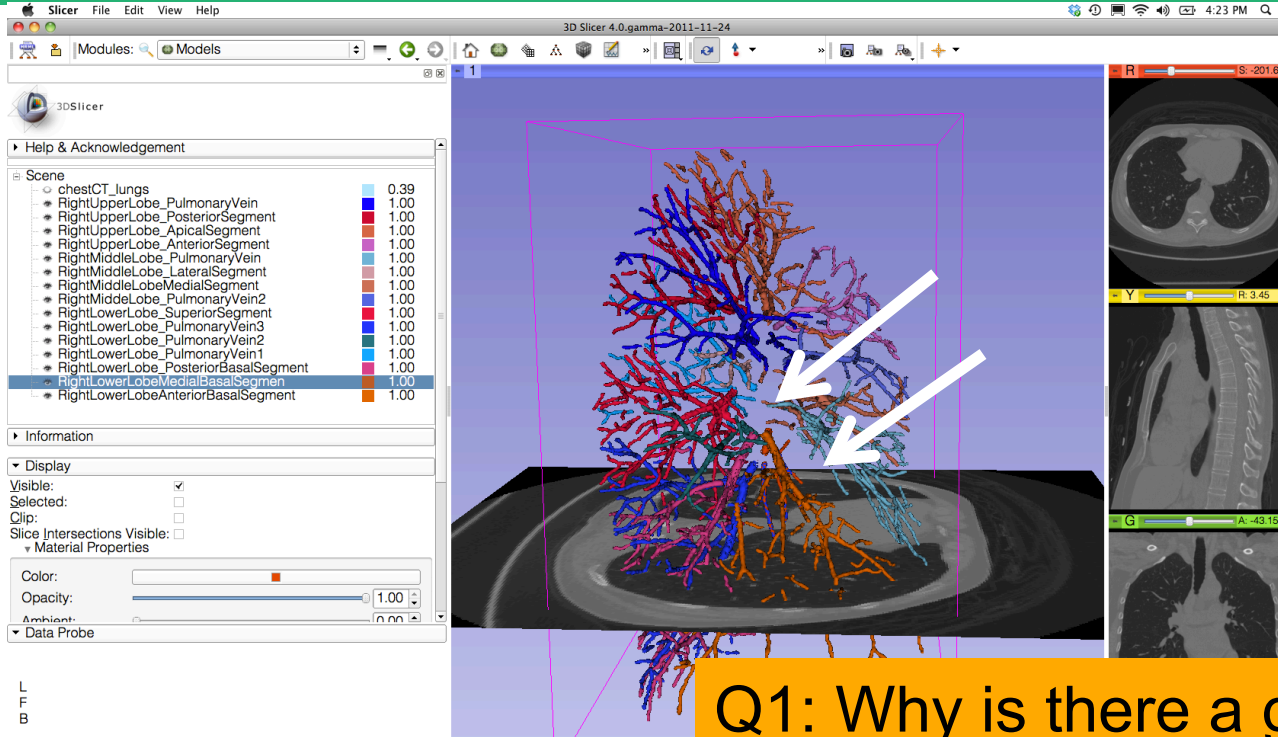
# Lung Segments



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



# Lung Segments – Question 1

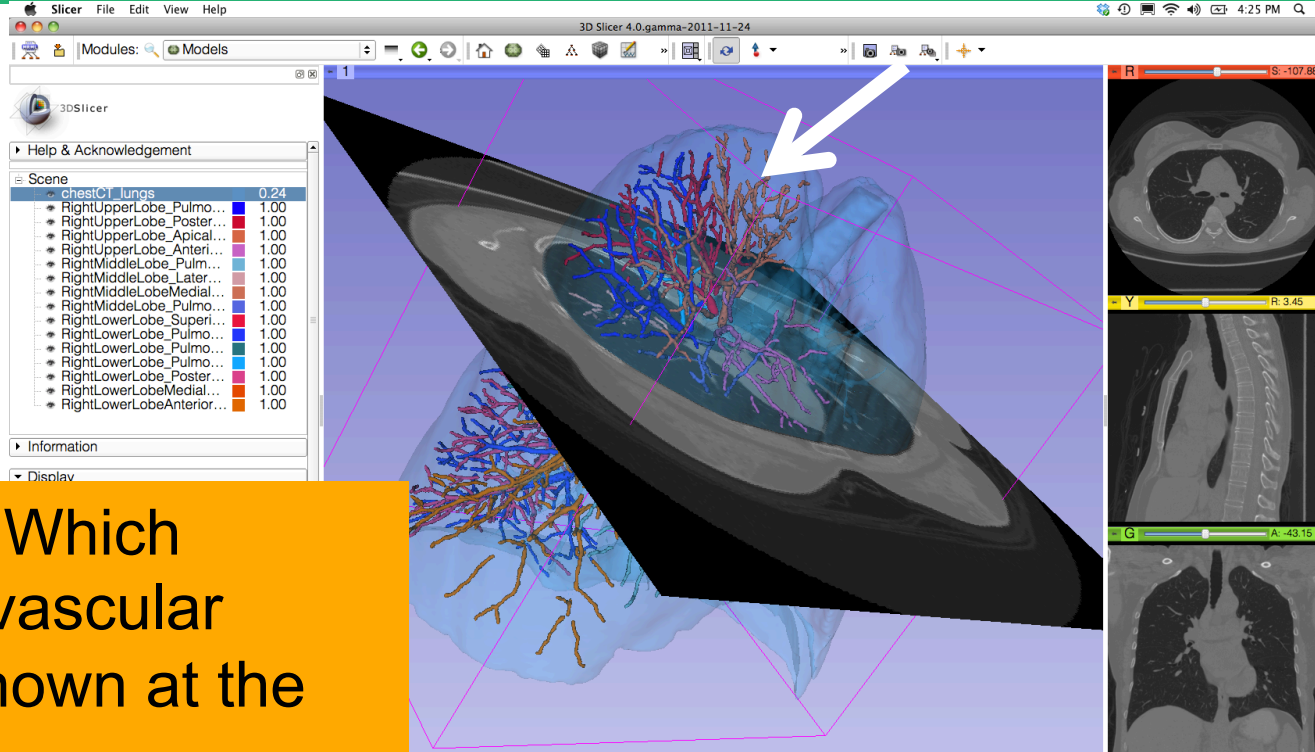


Q1: Why is there a gap in the vessels at the arrows?





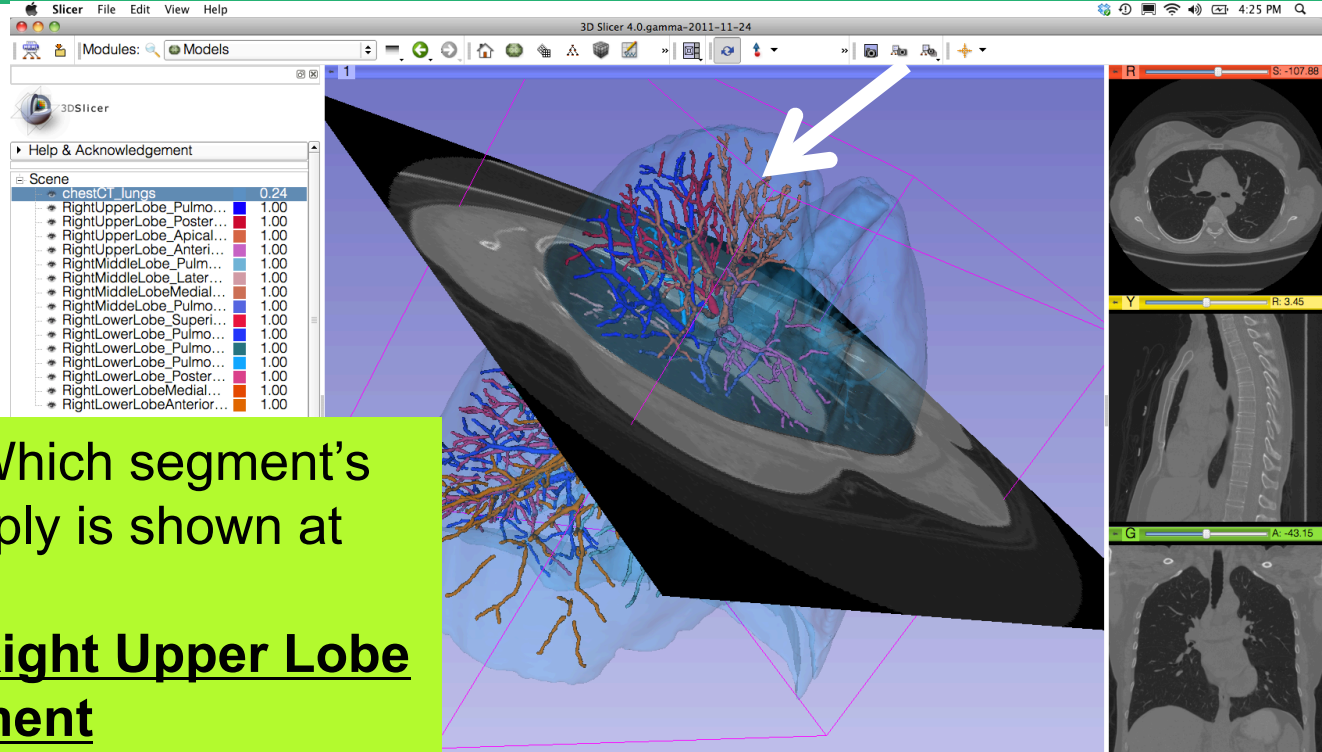
# Lung Segments – Question 2



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



# Lung Segments – Question 2

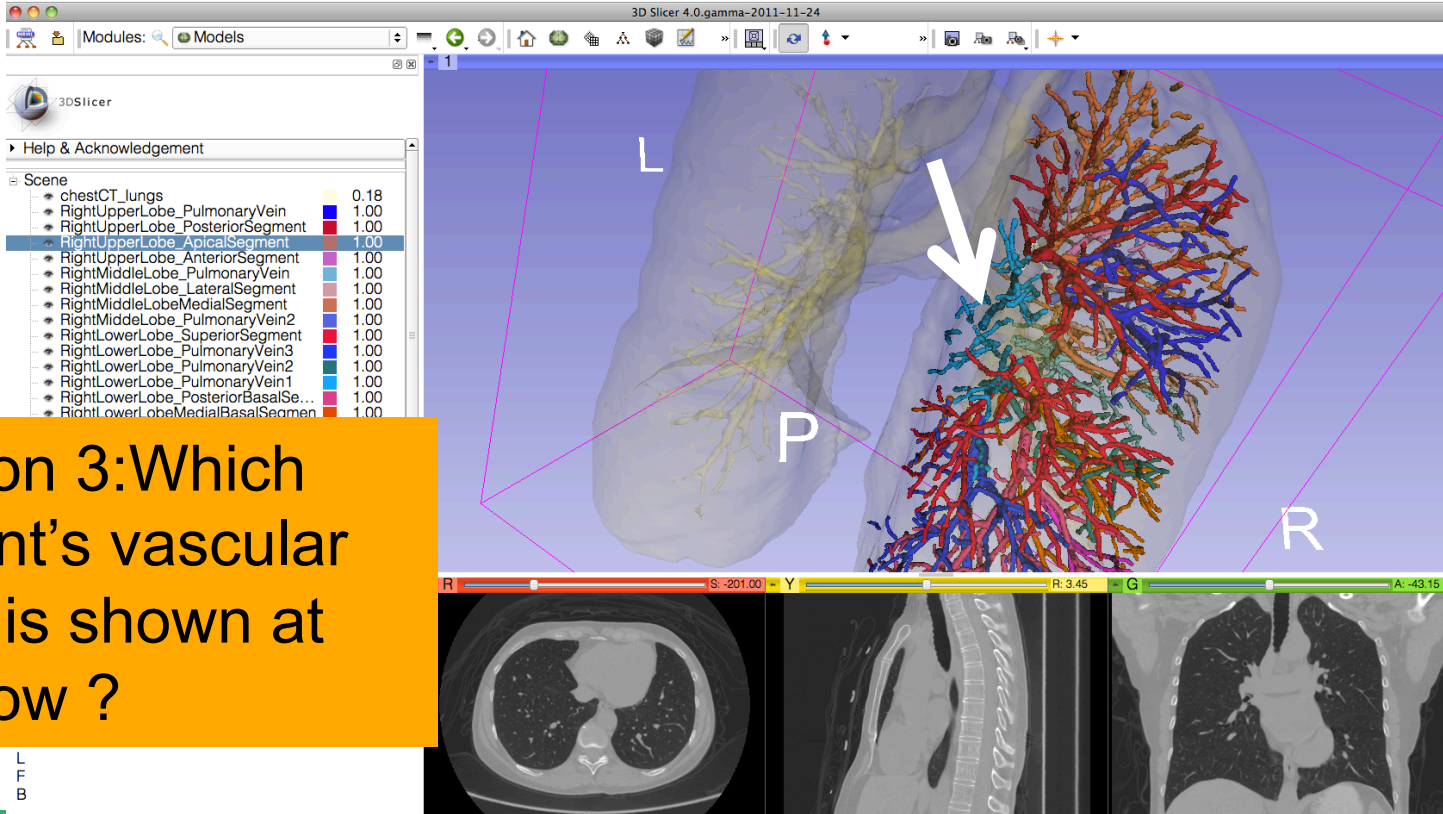


Question 2: Which segment's vascular supply is shown at the arrow?

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



# Lung Segments – Question 3

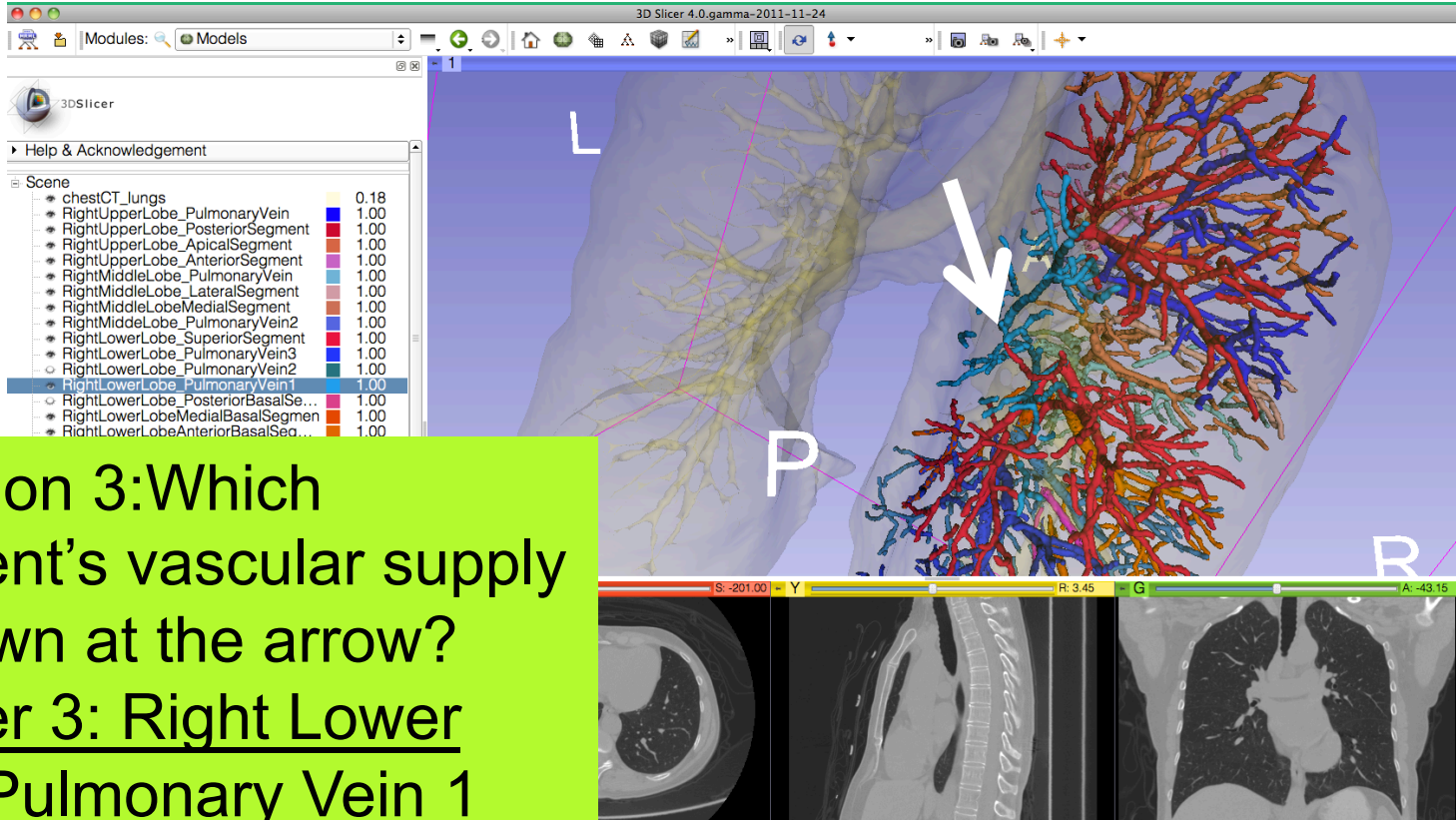


Question 3: Which segment's vascular supply is shown at the arrow?

L  
F  
B



# Lung Segments – Question 3



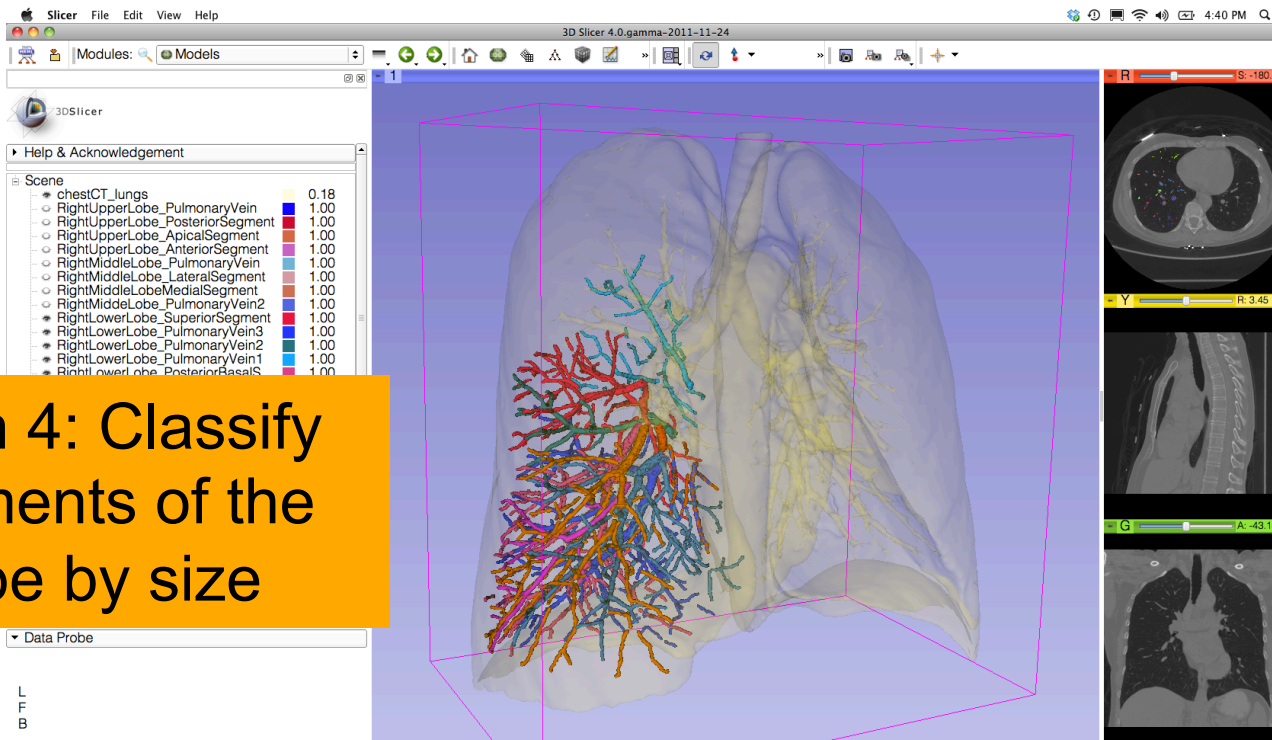
Question 3: Which segment's vascular supply is shown at the arrow?

Answer 3: Right Lower Lobe Pulmonary Vein 1



# Lung Segments – Question 4

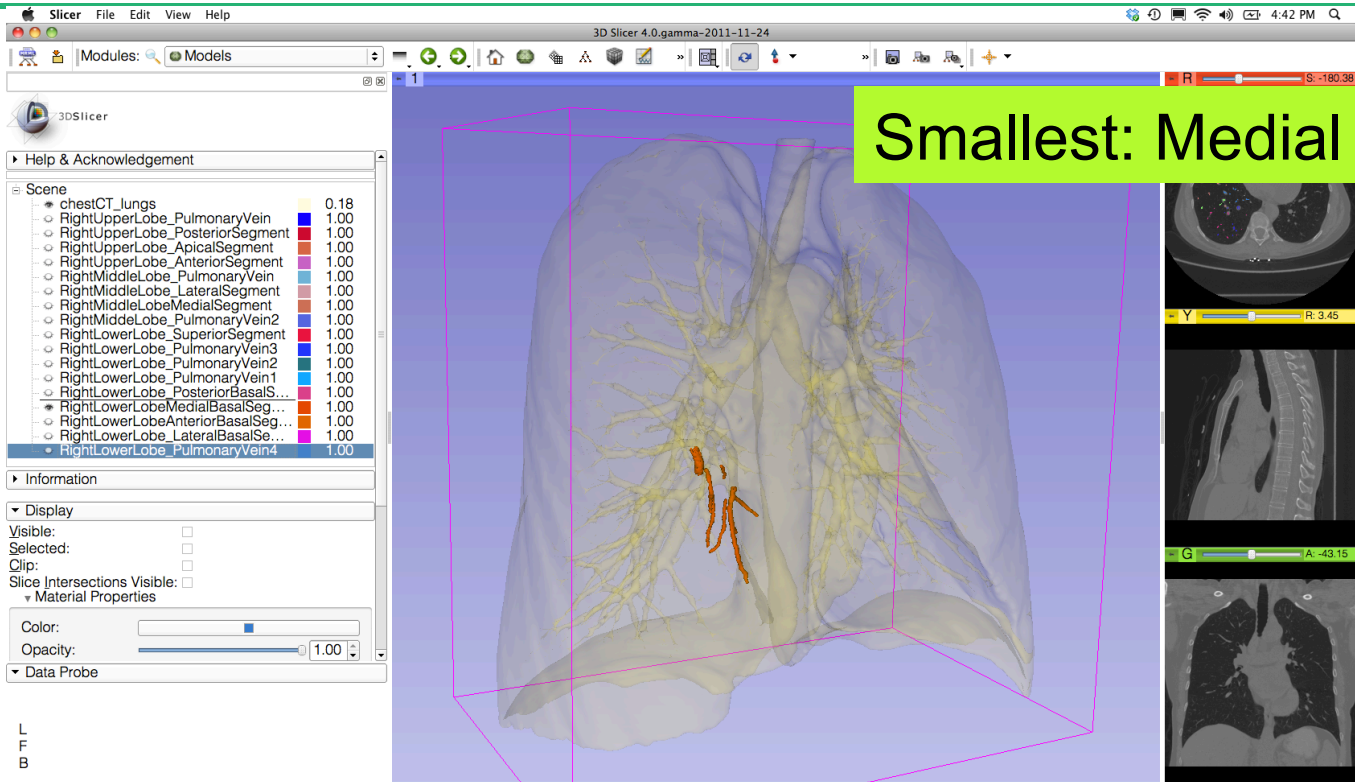
Question 4: Classify the segments of the lower lobe by size





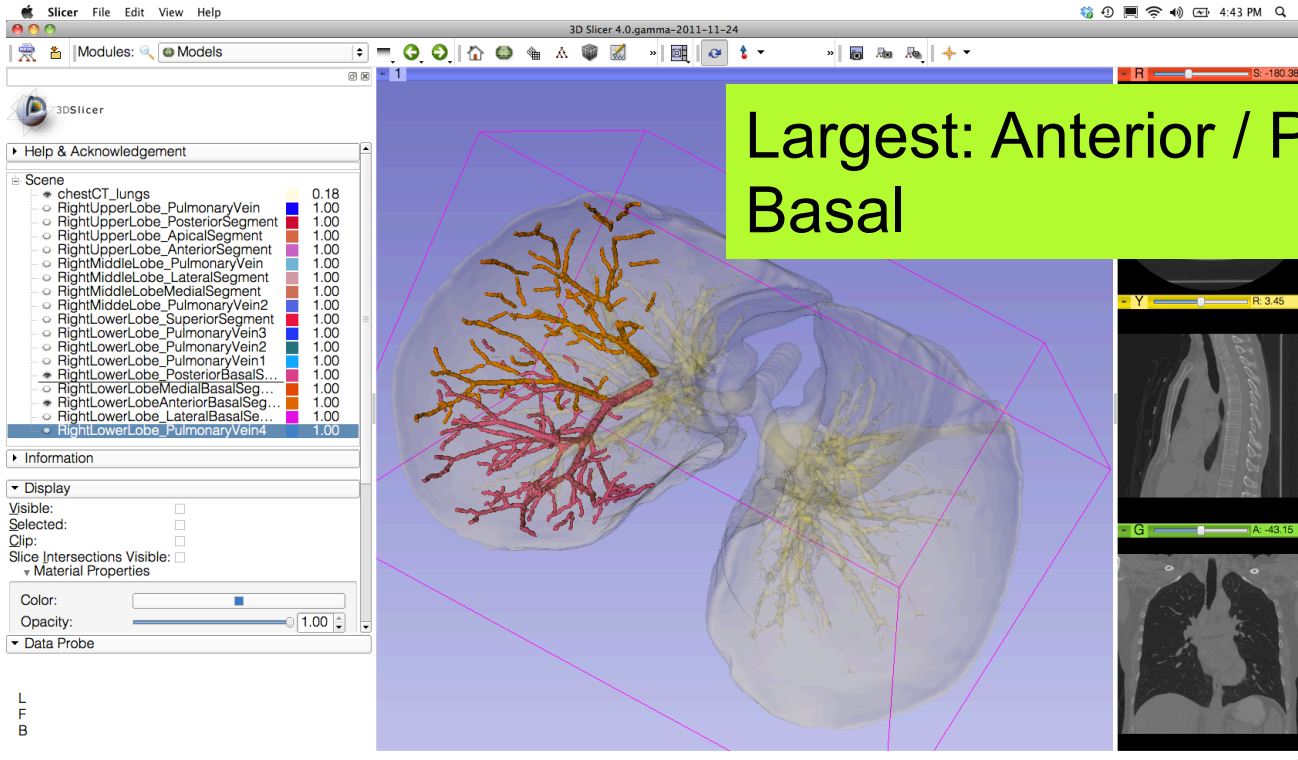


# Lung Segments – Question 4



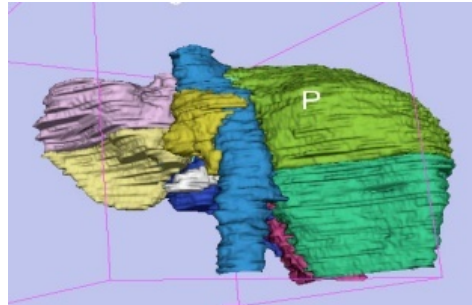
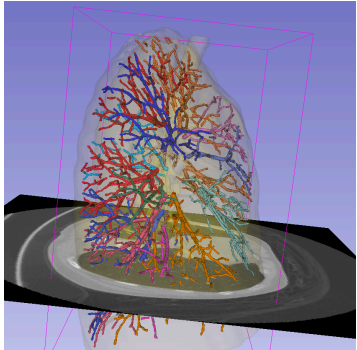
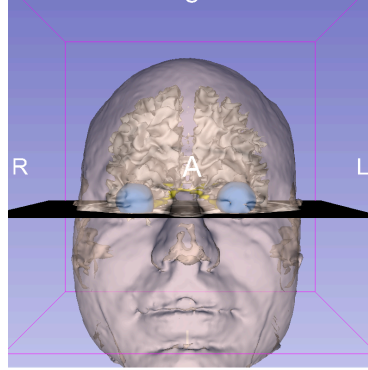
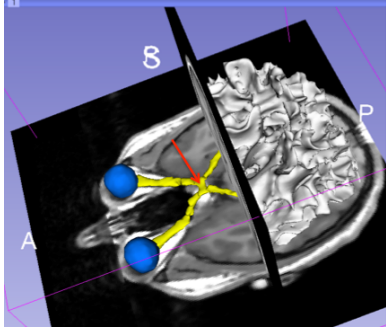


# Lung Segments – Question 4





# 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





# 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



# 3DSlicer website



The screenshot shows the 3DSlicer website homepage. At the top left is the 3DSlicer logo, a stylized sphere with a grid. To its right is the text "3DSlicer" and a tagline: "A multi-platform, free and open source software package for visualization and medical image computing". Below the tagline are four buttons: "Download", "Tutorial", "Feedback", and "Documentation". A search box is located in the top right corner. On the left side, there is a "Slicer Wiki" section with "About Slicer" (Introduction, Acknowledgments, Contact Us) and "Resources" (Download, For Users, For Developers, Commercial Use, NCIA, Publication DB, Image Gallery, Slicer Community, Source Code, Licensing, Mailing Lists, Web Archive). The main content area features three columns: "Powerful processing." (showing medical image processing), "Streamlined interface." (showing a 3D model of a brain), and "Extensible platform." (showing various 3D models and tools). Below these columns is a large banner for "3D Slicer version 4" with the website URL "www.slicer.org". At the bottom, there is a news item about the release of Slicer 4.2 and a copyright notice for 2012.

**3DSlicer** A multi-platform, **free and open source** software package for **visualization** and **medical image computing**

Download Tutorial Feedback Documentation

**Slicer Wiki**

**About Slicer**

- Introduction
- Acknowledgments
- Contact Us

**Resources**

Download

- For Users
- For Developers
- Commercial Use
- NCIA
- 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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Contact [webmaster@bwh.harvard.edu](mailto:webmaster@bwh.harvard.edu) for questions about the use of this site's content.  
See [here](#) for more information about the web infrastructure.



# NIH/NCI Cancer Imaging Archive Course

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The NIH/NCI Cancer Imaging Archive (TCIA): A Comprehensive Source of DICOM Imaging Data for Research

C. Carl Jaffe MD, John B. Freymann BS, Justin Kirby, Fred William Prior, PhD, Lawrence R. Tarbox PhD

Wed. Nov. 28, 10:30 am – 12:00 pm SCD 401



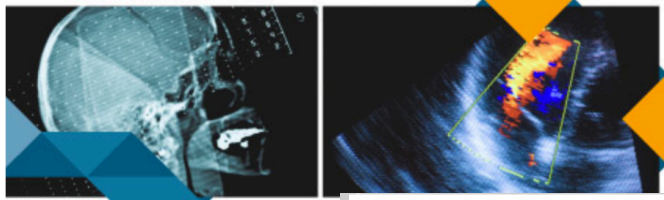
# Upcoming Slicer courses



9 - 14 February 2013  
Disney's Coronado Springs Resort  
Lake Buena Vista (Orlando Area),  
Florida, United States

## SPIE 2013, Orlando, Florida Cars 2013, Heidelberg, Germany

View the program online and register today



**Plan to attend** this multidisciplinary, in latest, cutting-edge research and develop you are presenting to your peers, or you that will enhance your research, this co

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**June 26-29, 2013**  
**Heidelberg, Germany**

## CARS 2013

**Computer Assisted Radiology and Surgery**  
27<sup>th</sup> International Congress and Exhibition

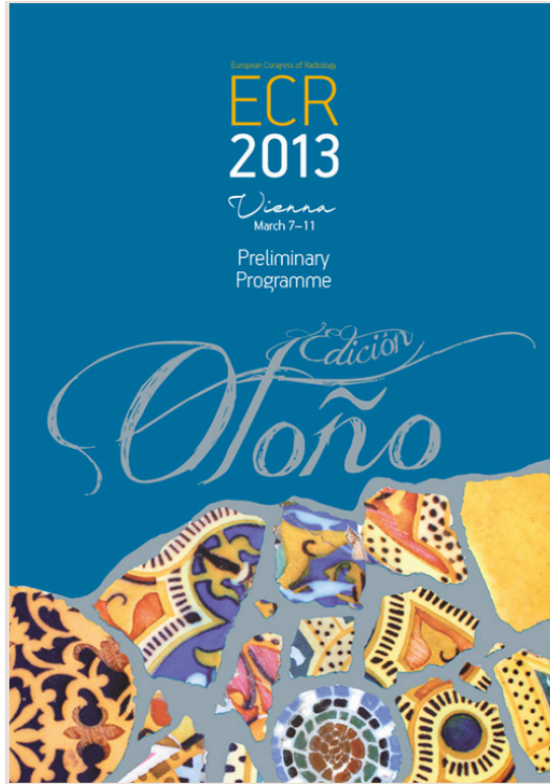


**Important Notes:**

Download the  
2nd Announcement [here](#)



# Upcoming Slicer courses



## ECR 2013 Novel technology that shapes Radiology: EIBIR presents IMAGINE

The **IMAGINE sessions** give research institutes, university groups and companies a chance to present **their novel technological developments** in medical image analysis and image-guided interventions to the radiology community.

**Be part of it!** Submit your abstract to be in with a chance to present it to the right audience.

The core of the IMAGINE sessions are interactive sessions in which the presenters demonstrate their work and visitors get hands-on experience with developed techniques and tools.

The session topics will describe novel techniques in one of the following areas:

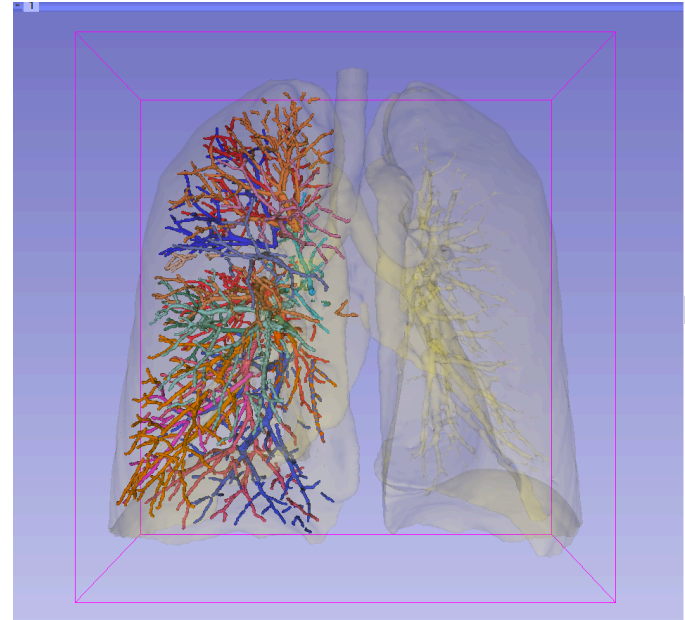
- Quantitative Image Analysis
- Computer-aided Diagnosis
- Image-guided Interventions
- Image Processing





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

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



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