



Surgical Planning Laboratory
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Boston, Massachusetts USA

a teaching affiliate of
Harvard Medical School

3D VISUALIZATION OF DICOM IMAGES FOR RADIOLOGICAL APPLICATIONS

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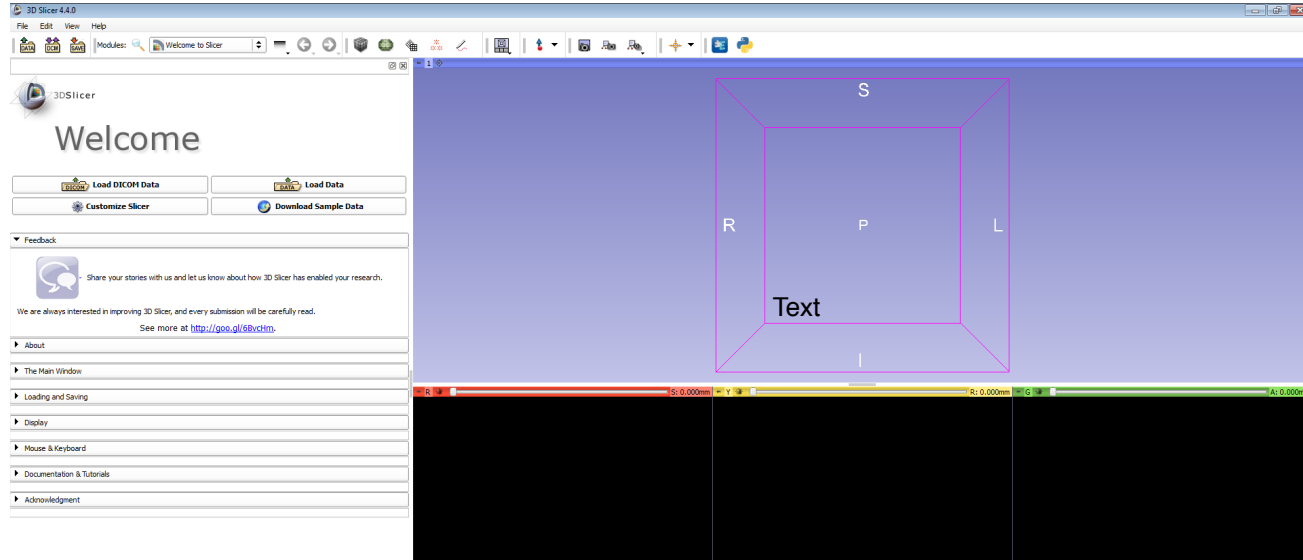
Boston University School of Medicine

Ron Kikinis, MD,

Brigham and Women's Hospital, Harvard Medical School



Welcome to Slicer4



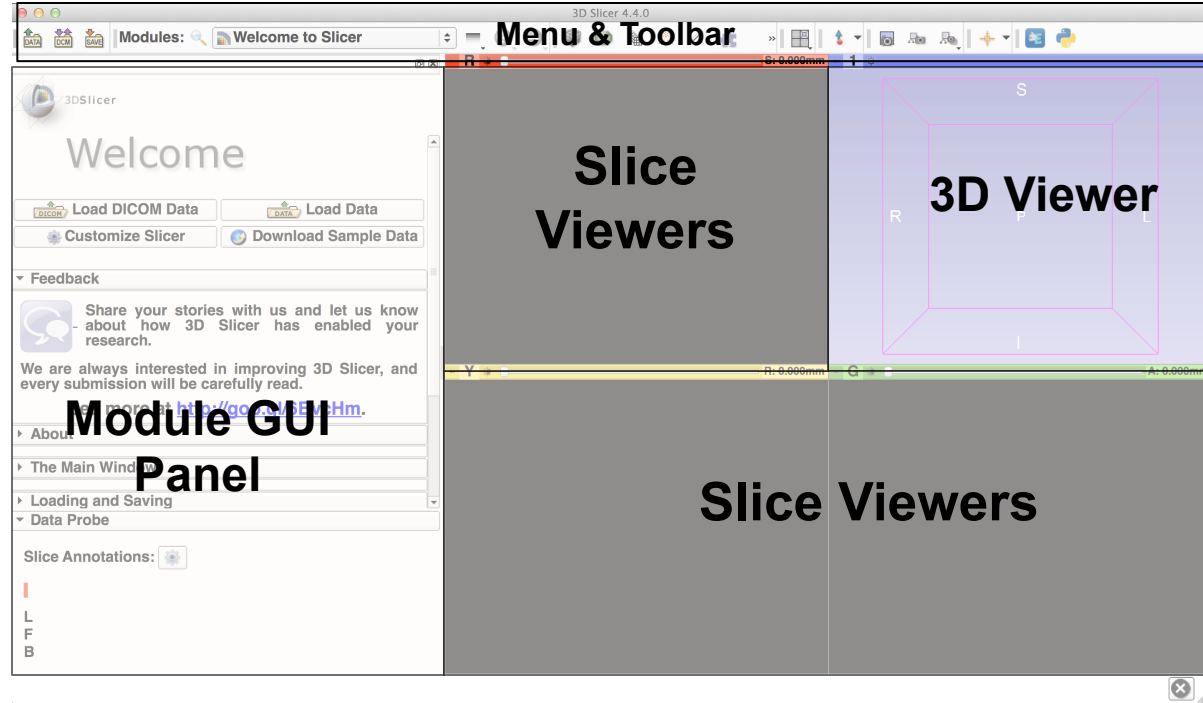
To start Slicer, double-click on the **Slicer-shortcut** icon on the Desktop (bottom left)



Navigating the Application GUI

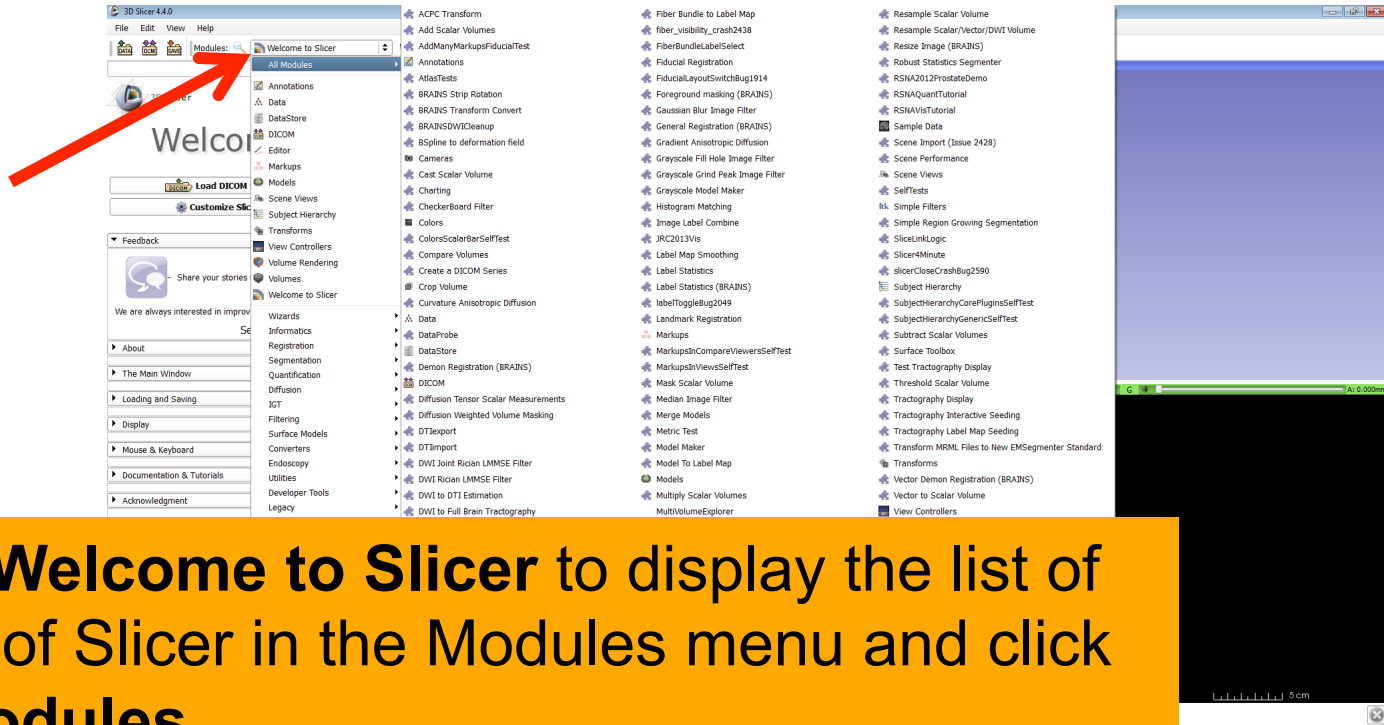
The Graphic User Interface (GUI) of Slicer4 integrates **four components**:

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





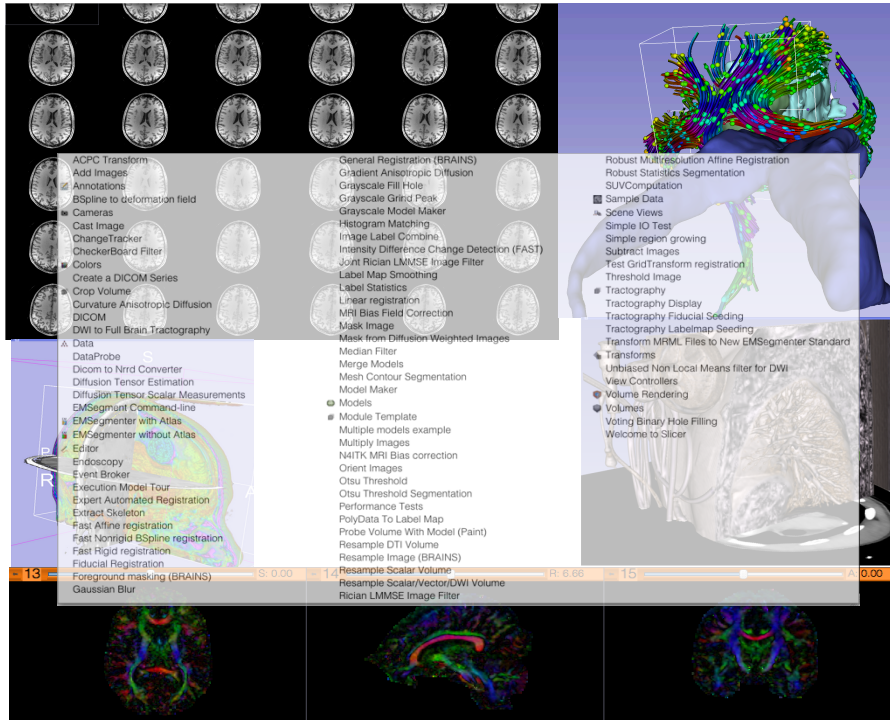
Welcome to Slicer4.4



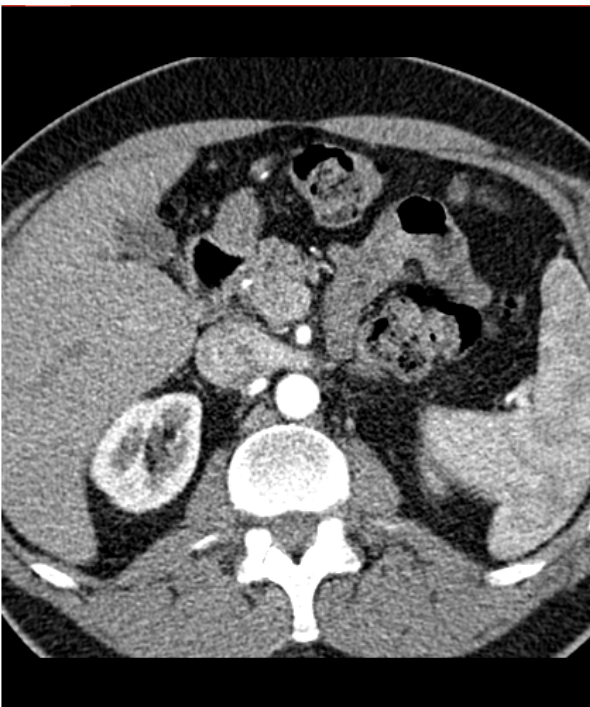
Click on **Welcome to Slicer** to display the list of modules of Slicer in the Modules menu and click on **All Modules**



Welcome to Slicer4.4



Slicer4.4 contains more than 100 modules for image segmentation, registration and 3D visualization of medical imaging data



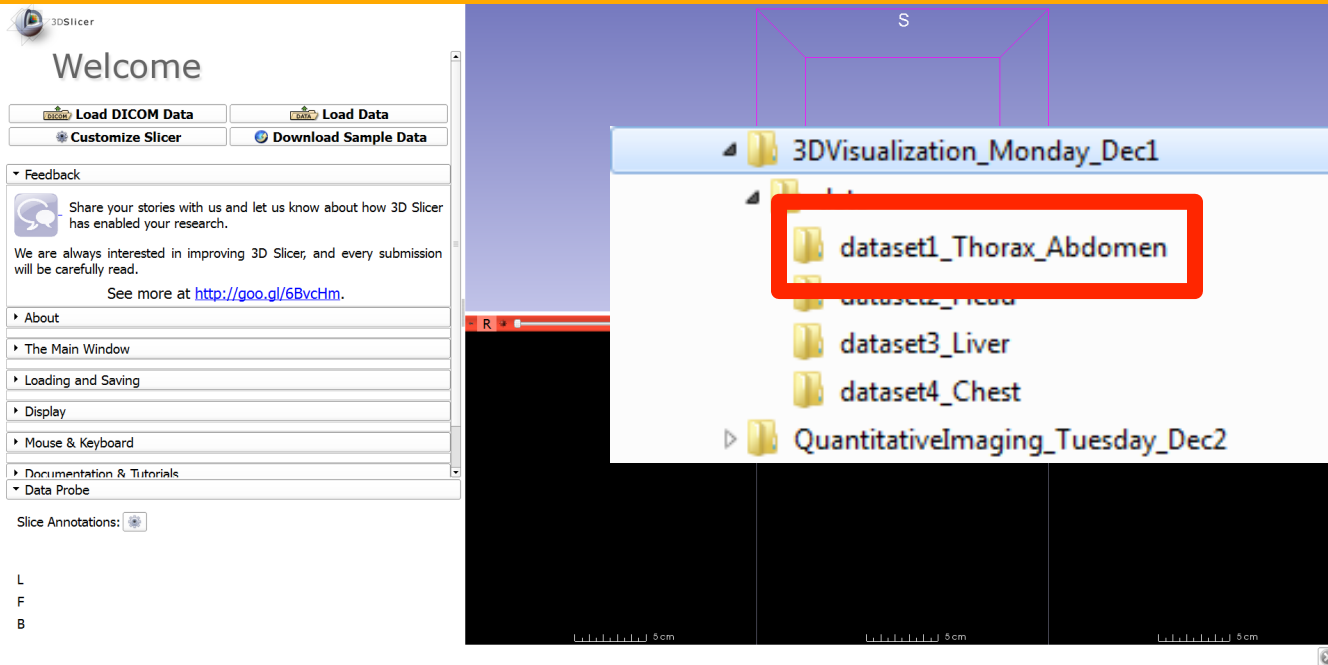
Part 1:

Loading a DICOM Volume



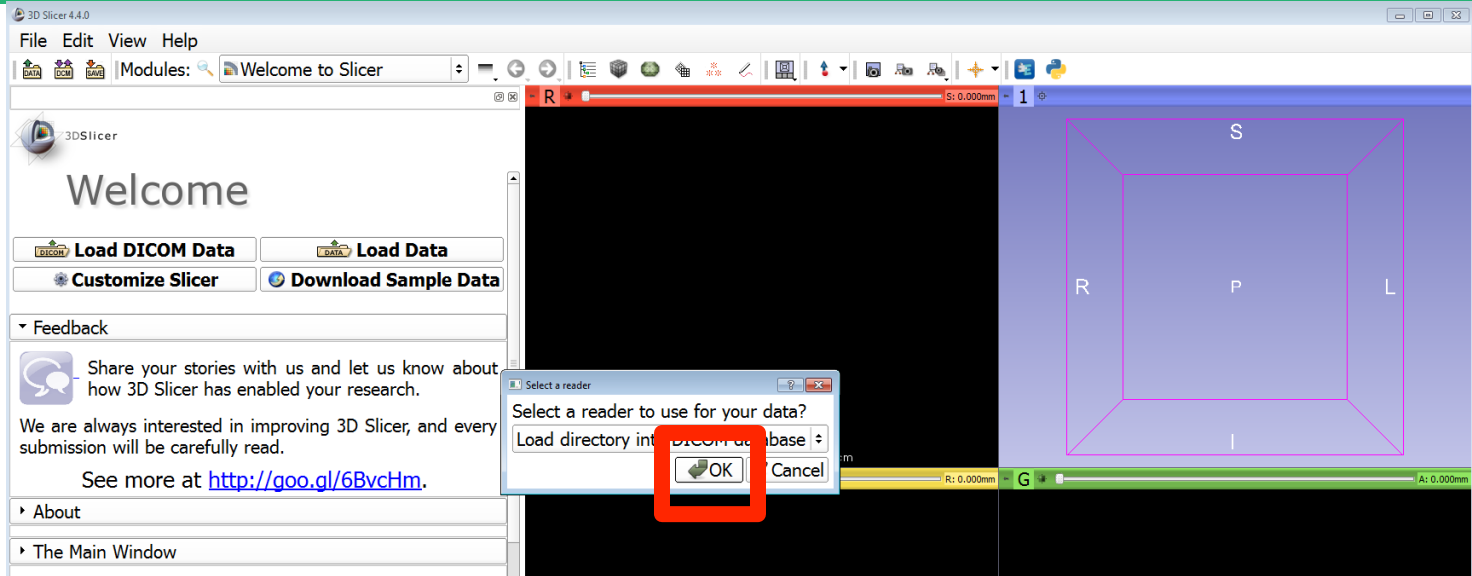
Loading a DICOM volume

Drag and drop the directory 'dataset1_Thorax_Abdomen' into Slicer





Loading a DICOM volume



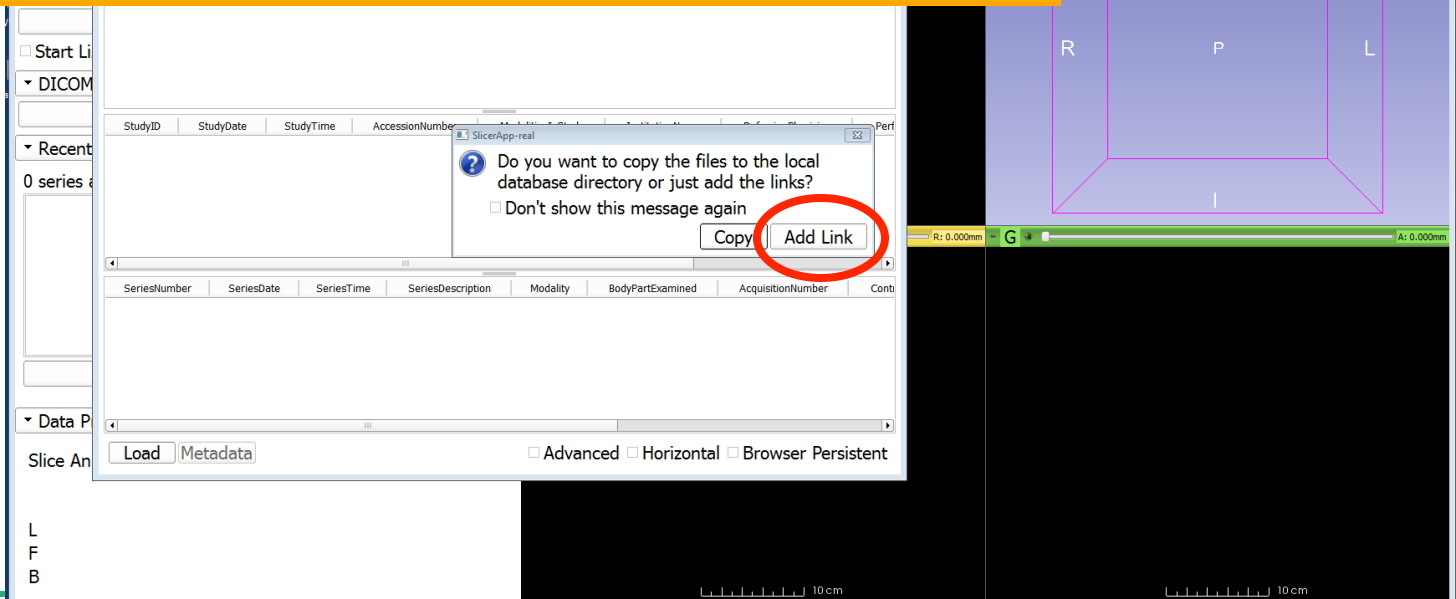
A pop-up window to select the DICOM reader appears: the option **Load directory into DICOM database** is selected by default. Click on **OK**



Loading a DICOM volume

The **DICOM Browser** appears

A pop-up window appears, click on **Add Links**





Loading a DICOM volume

Slicer starts importing the DICOM images from the directory

3D Slicer 4.4.0
File Edit View Help
Modules: DICOM

DICOM Browser
Import Export Query Send Remove Repair »

Patients:
PatientsName PatientID Pat
patient1 patient1_ID

SlicerApp-real
C:/Users/Administrator/Desktop/3DVisualization_Monday_Dec1/3DVisualization_Monday_Dec1/dataset1_Thorax_Abdomen/IM-0001-0062.dcm
21%
Cancel

StudyID	StudyDate	StudyTime	AccessionNumber	ModalitiesInStudy	InstitutionName	ReferringPhysician	Perf
6936864	2005-0						

SeriesNumber	SeriesDate	SeriesTime	SeriesDescription	Modality	BodyPartExamined	AcquisitionNumber	Conti
6	2005-06-01	120000.000000	CT_Thorax_Abdomen	CT	HEART	14	APPLIED

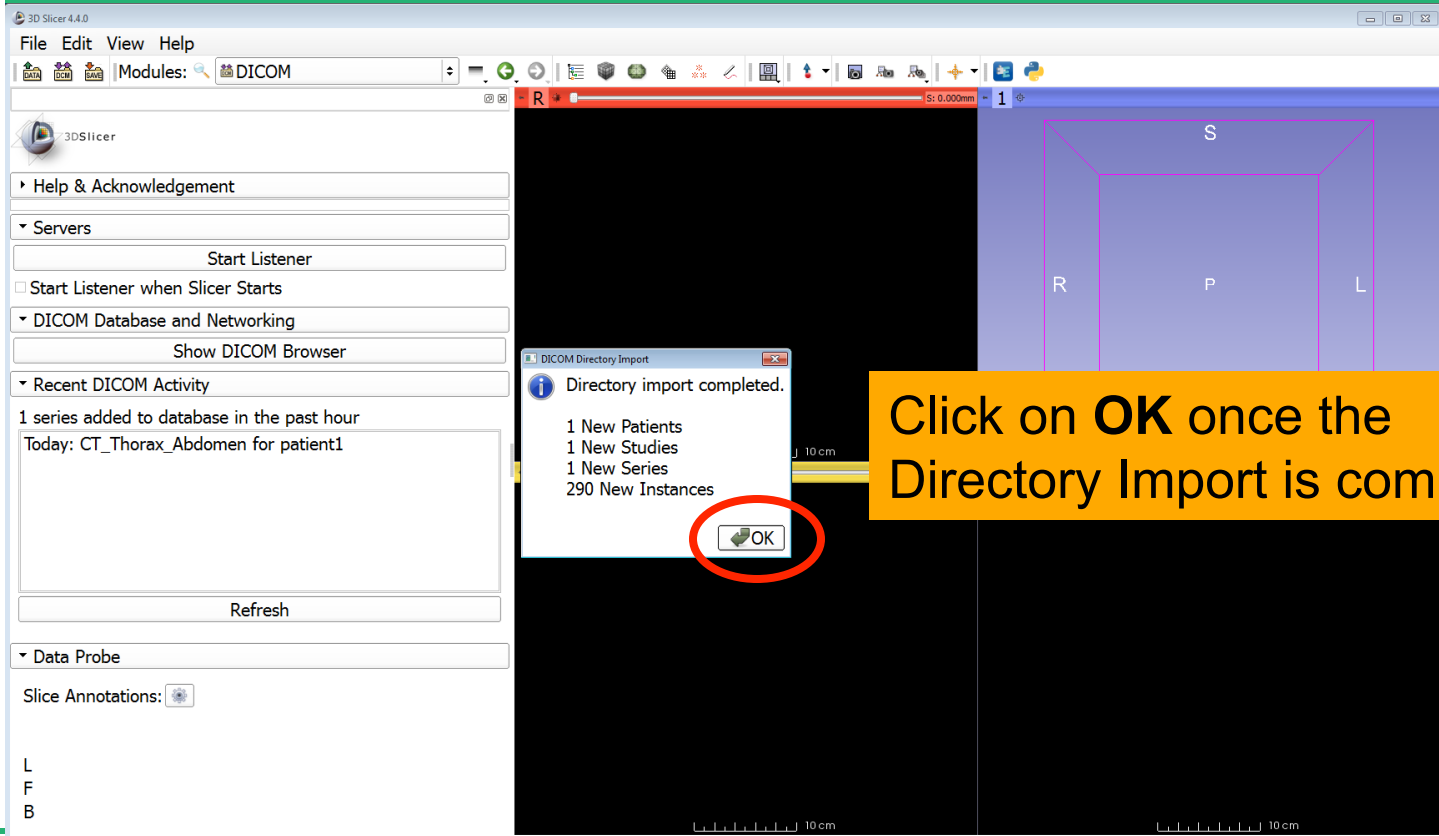
Load Metadata Advanced Horizontal Browser Persistent

L
F
B

Most recent DICOM Database addition: Sat Nov 29 17:36:57 2014



Loading a DICOM volume



Click on **OK** once the Directory Import is completed



Loading a DICOM volume

The **patient1** DICOM dataset appears in the DICOM browser.

Select the DICOM volume
CT_Thorax_Abdomen

3D Slicer 4.4.0
File Edit View Help
Modules: DICOM

Import Export Query Send Remove Repair »

Patients: Studies: Series:

PatientsName	PatientID	PatientsBirthDate	PatientsBirthTime	PatientsSex	PatientsAge	PatientsComments
patient1	patient1_ID					

StudyID	StudyDate	StudyTime	AccessionNumber	ModalitiesInStudy	InstitutionName	ReferringPhysician	Perf
6936864	2005-06-01	120000.000000	6936864		oEzQHRFY..0J~zIa1dx		

SeriesNumber	SeriesDate	SeriesTime	SeriesDescription	Modality	BodyPartExamined	AcquisitionNumber	Cont
6	2005-06-01	000000.000000	CT_Thorax_Abdomen	CT	HEART	14	APPLIED

Refresh

Data Probe

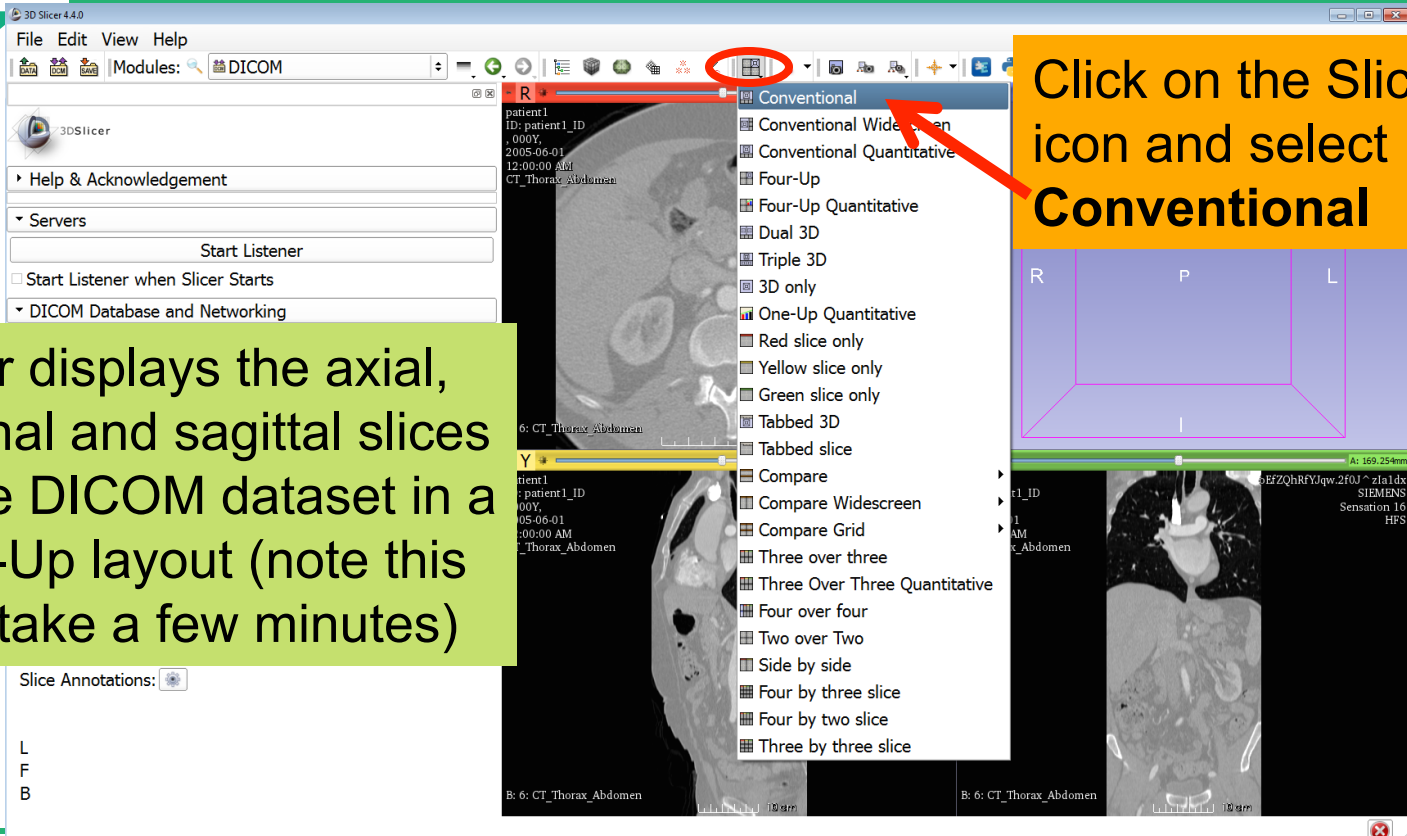
Slice Annotations:

Load Metadata Advanced Horizontal Browser Persistent

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



Loading a DICOM volume

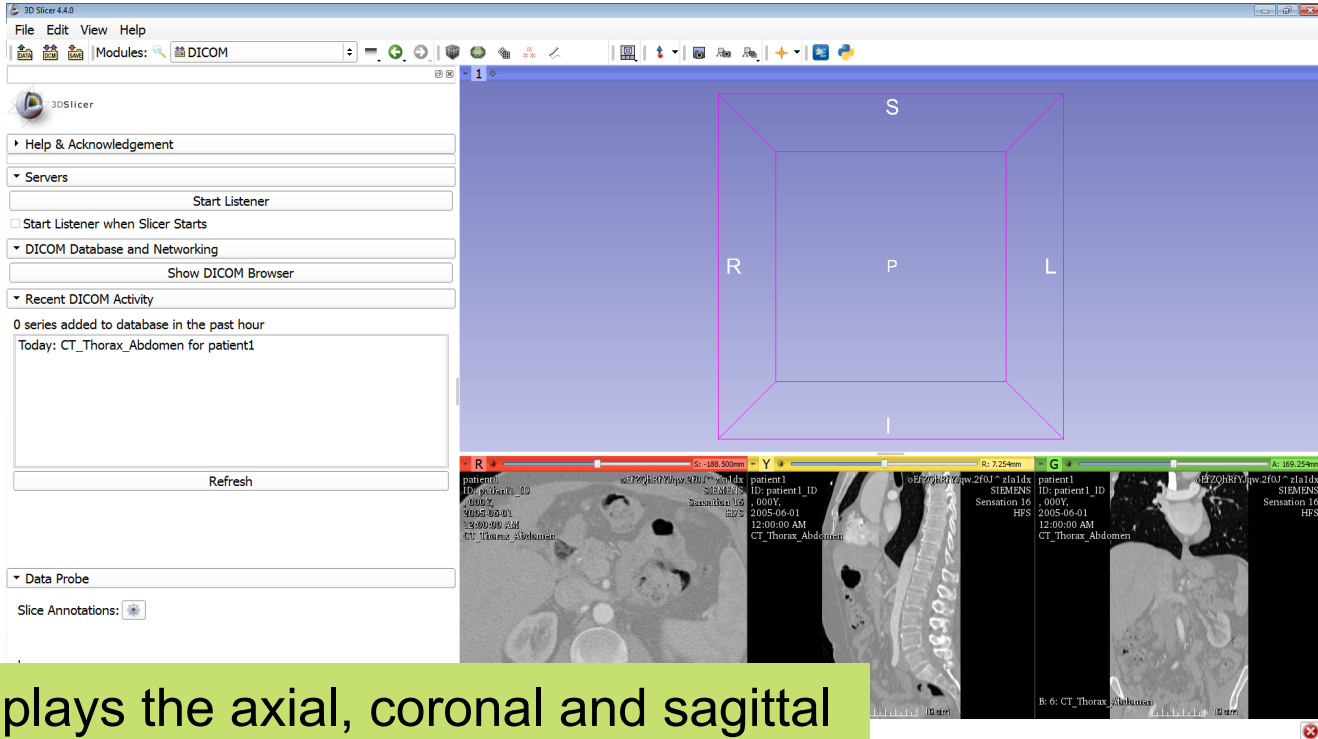


Click on the Slicer layout icon and select **Conventional**

Slicer displays the axial, coronal and sagittal slices of the DICOM dataset in a Four-Up layout (note this may take a few minutes)



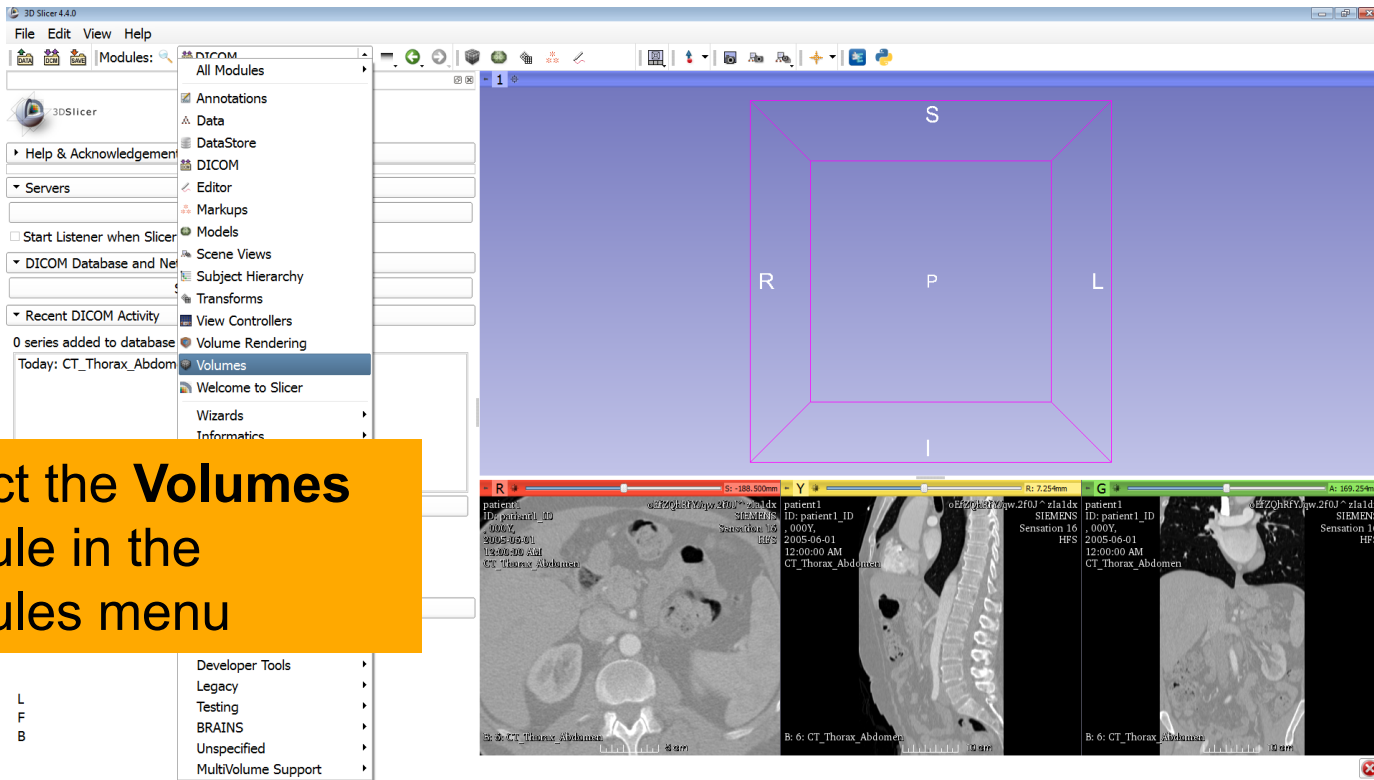
Loading a DICOM volume



Slicer displays the axial, coronal and sagittal slices in conventional viewer mode



Loading a DICOM volume



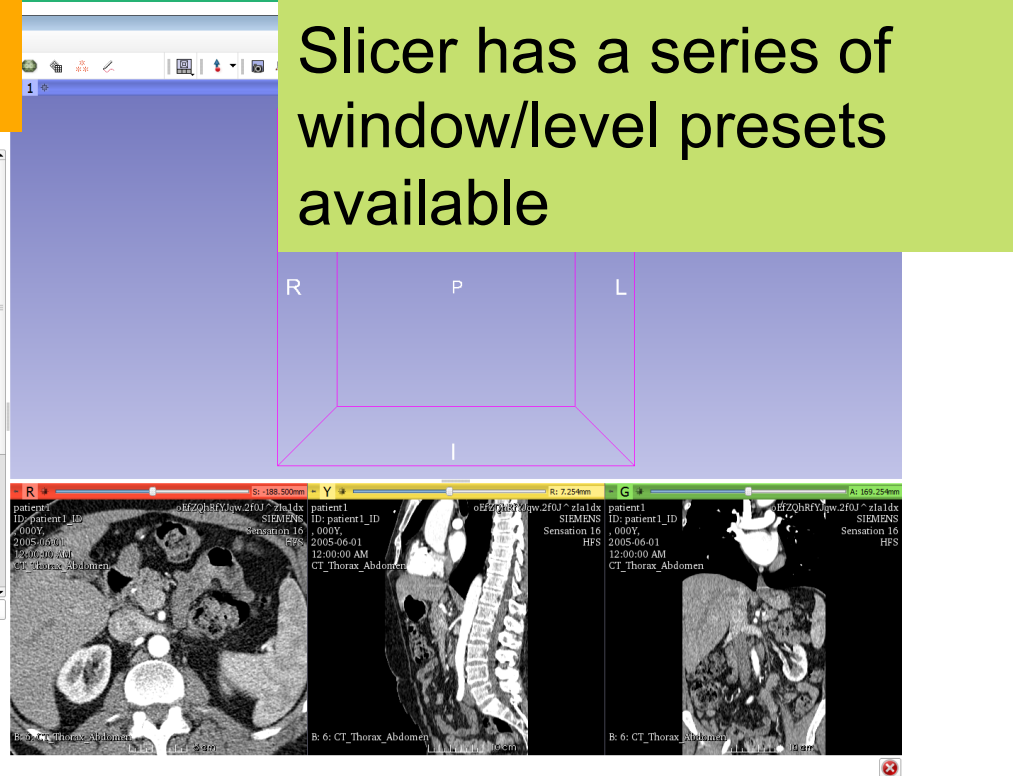
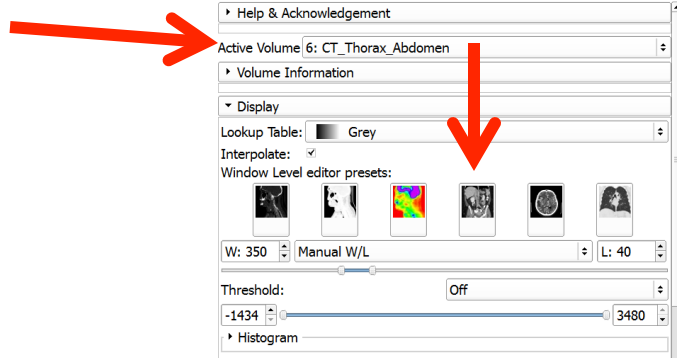
Select the **Volumes** module in the modules menu



Loading a DICOM volume

Select the Active Volume
6:CT_Thorax_Abdomen


Slicer has a series of
window/level presets
available

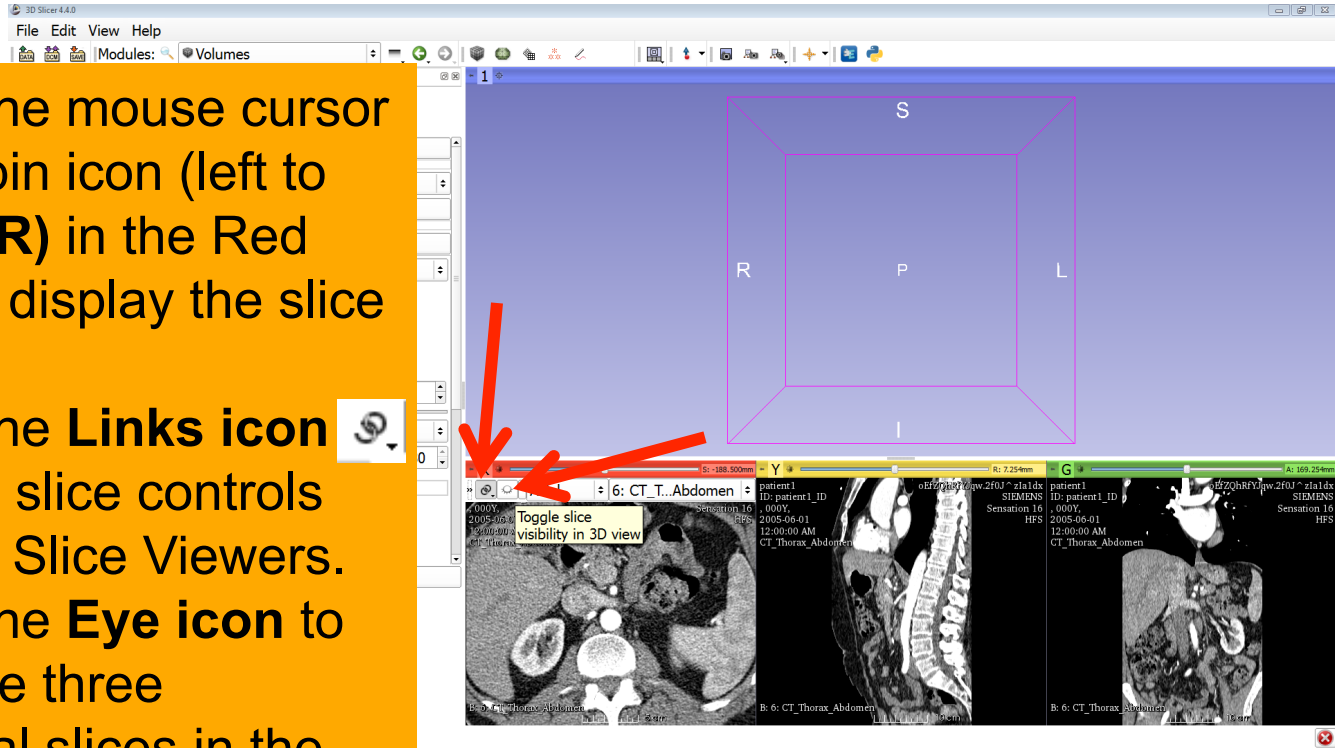


Click on the Window Level
Preset **CT-abdomen**, or
adjust manually the Window
and Level using the Manual
W/L slider



Loading a DICOM volume

- Position the mouse cursor over the pin icon (left to the letter **R**) 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

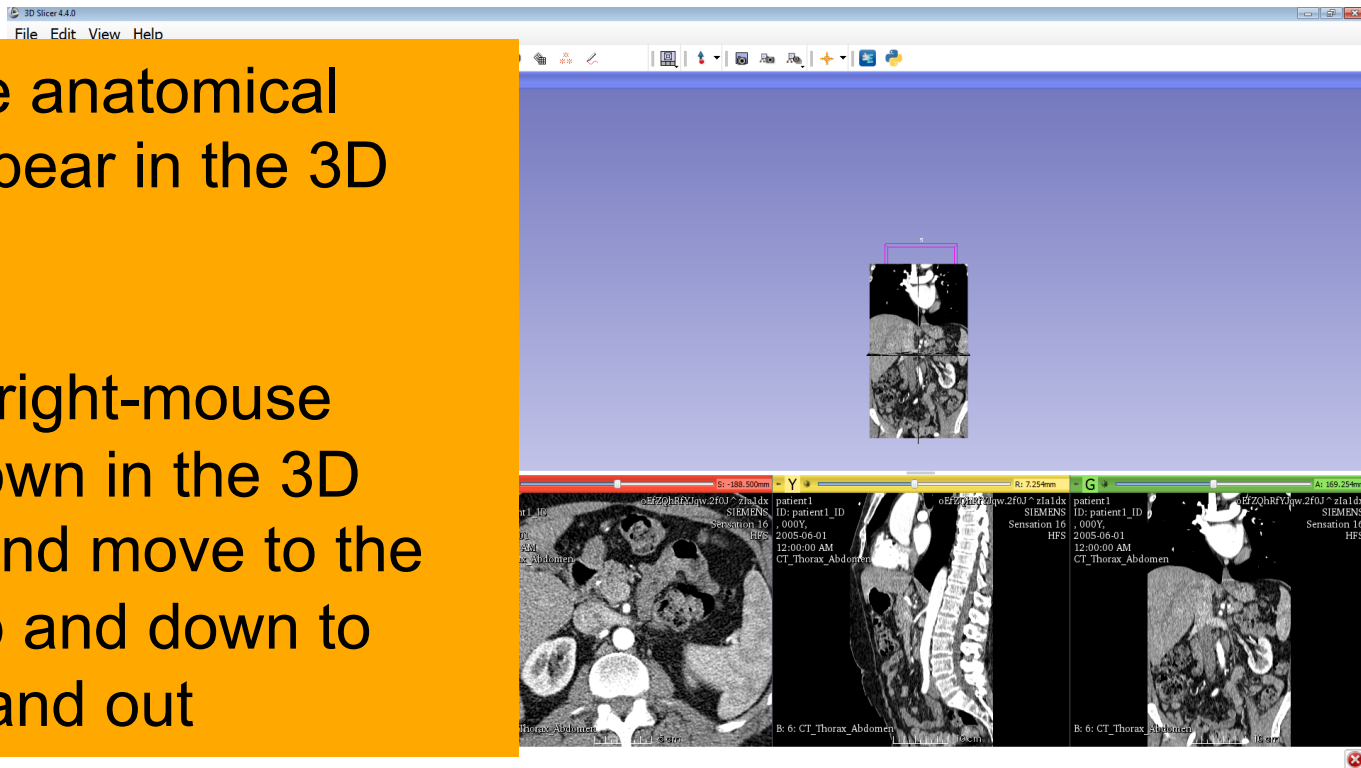




Loading a DICOM volume

The three anatomical slices appear in the 3D viewer.

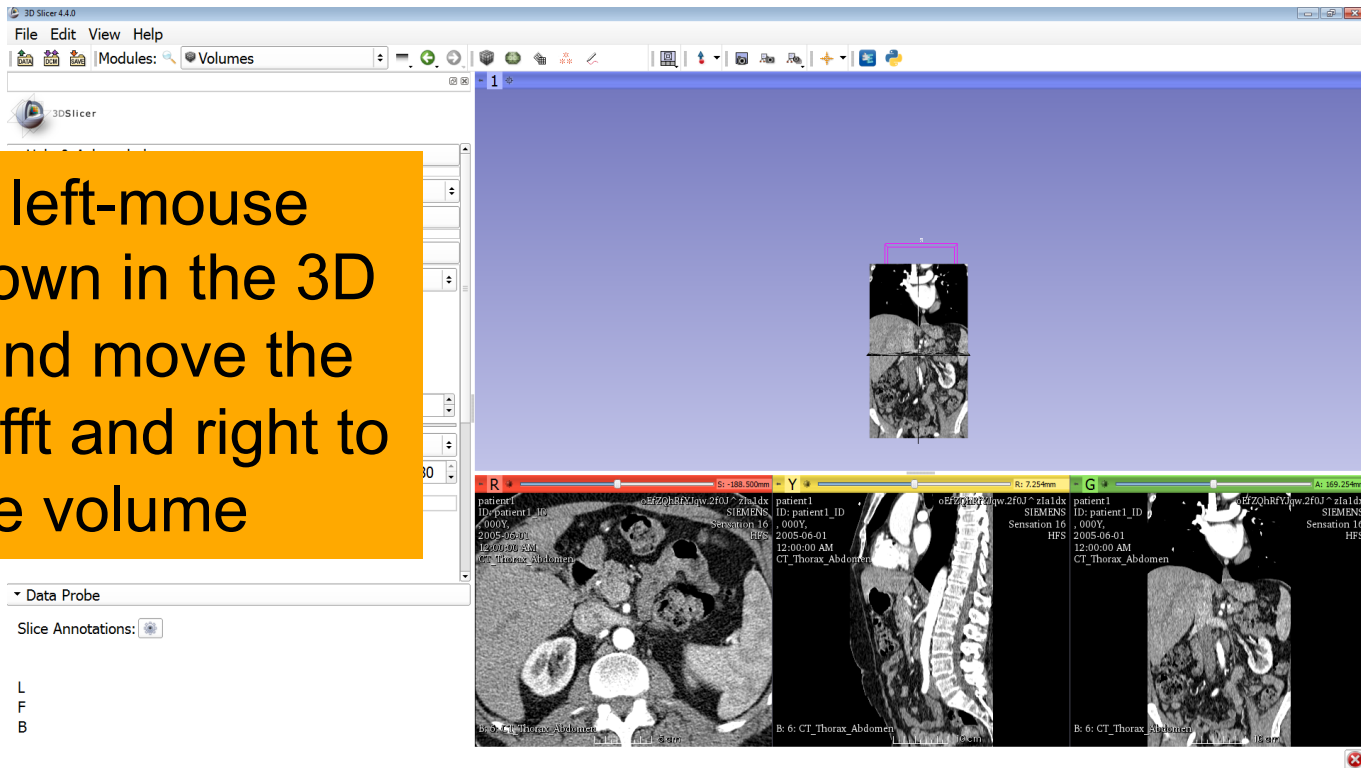
Hold the right-mouse button down in the 3D Viewer, and move to the cursor up and down to zoom in and out





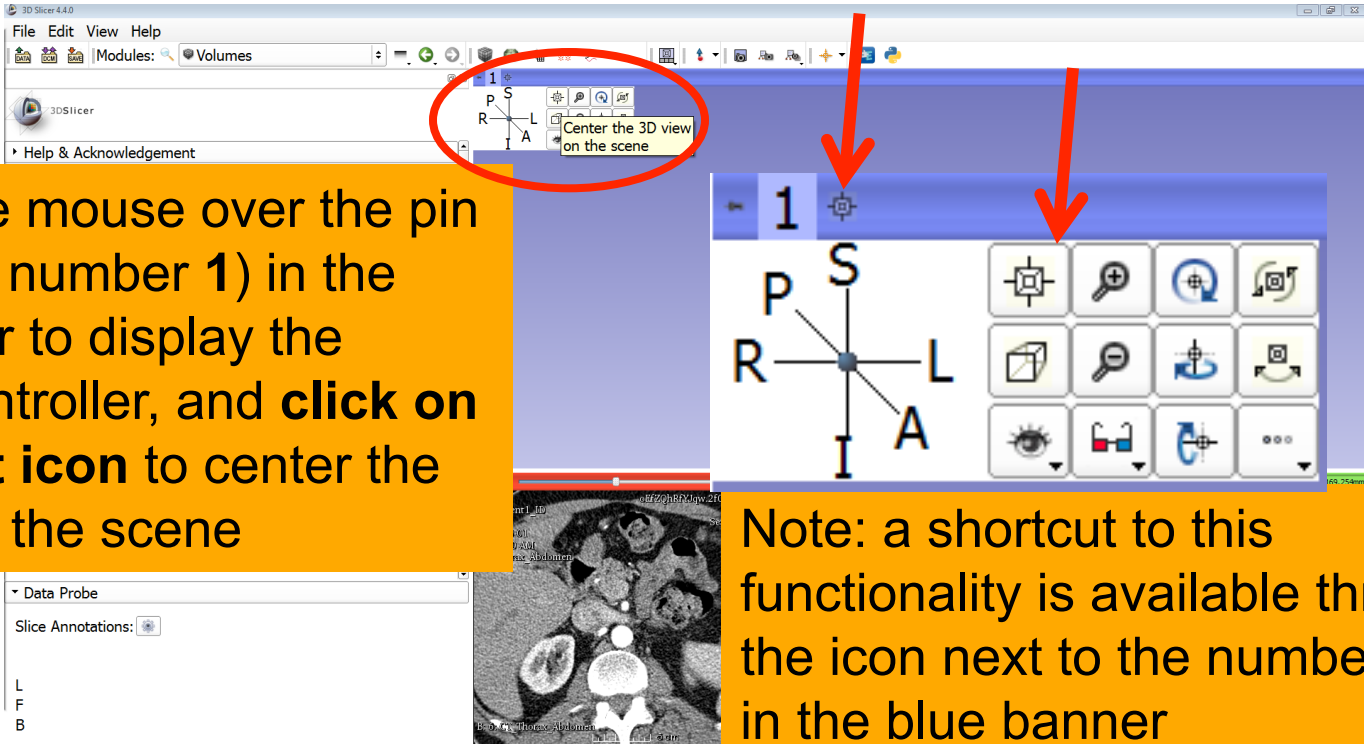
Loading a DICOM volume

Hold the left-mouse button down in the 3D Viewer and move the cursor left and right to rotate the volume





Loading a DICOM volume

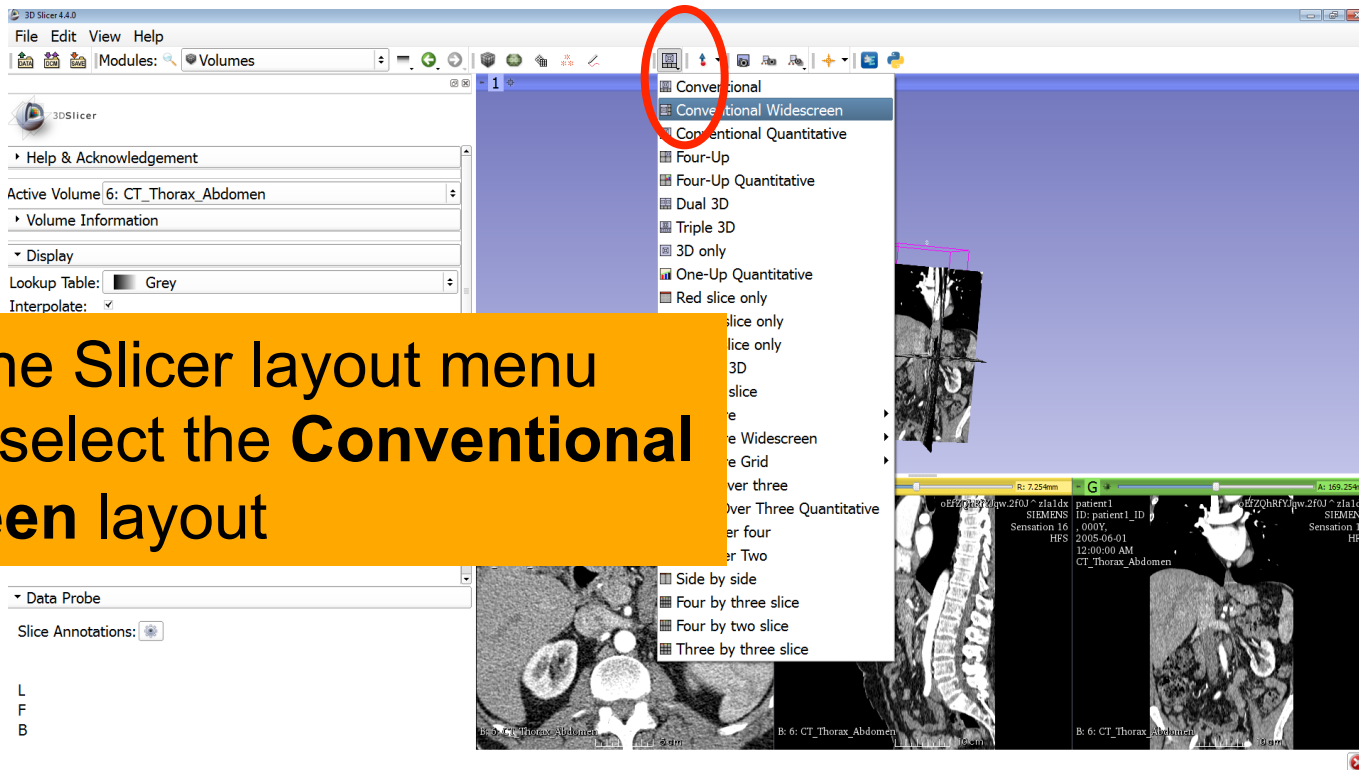


Position the mouse over the pin icon (left to number 1) in the blue banner to display the 3DView controller, and **click on the top left icon** to center the 3D view on the scene

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



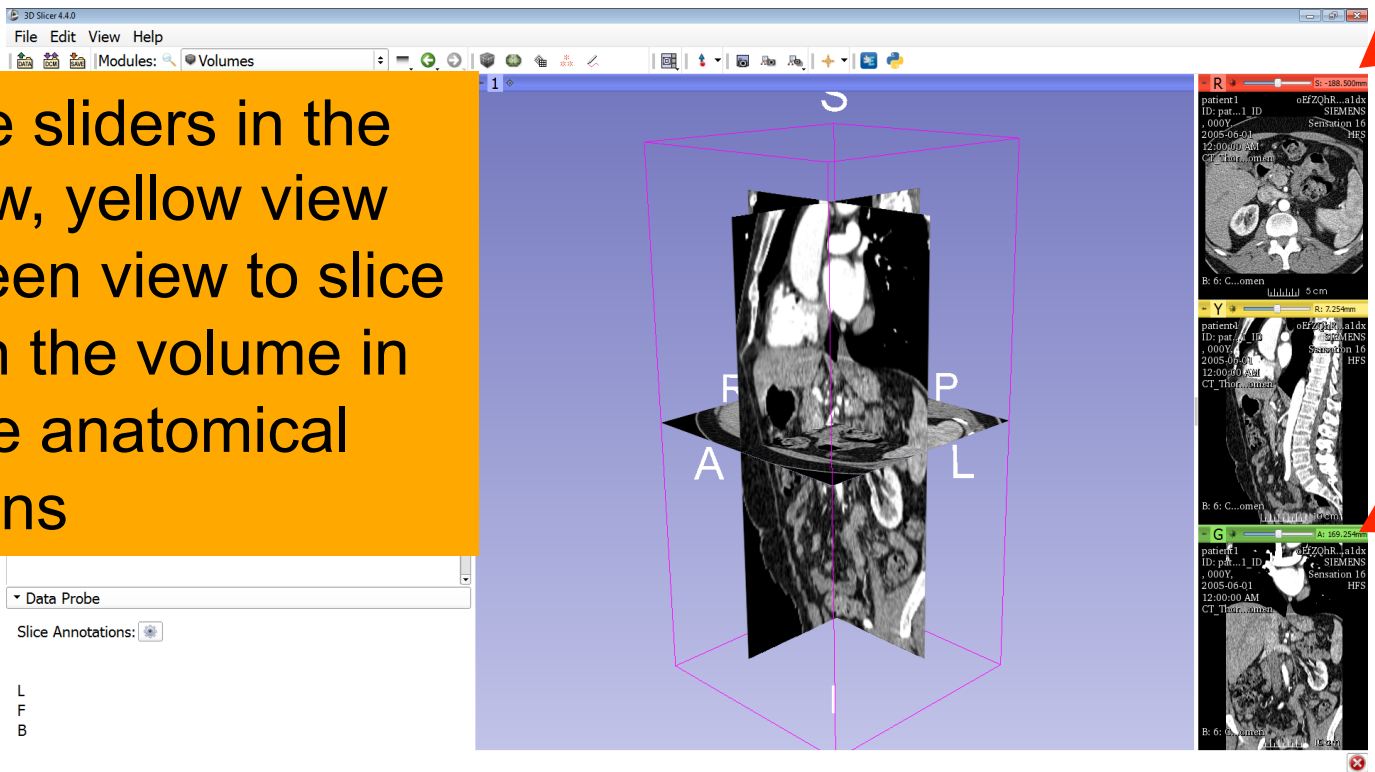
Loading a DICOM volume

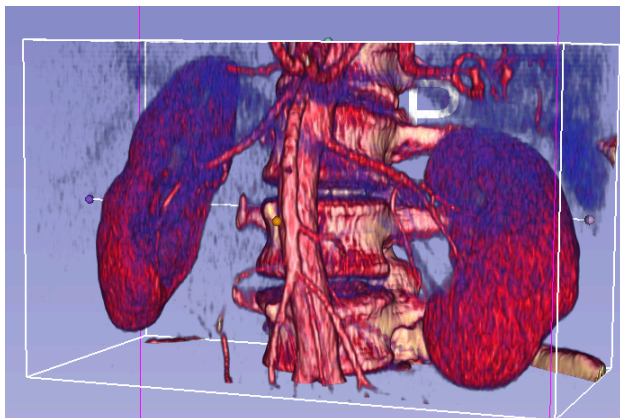




Loading a DICOM volume

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



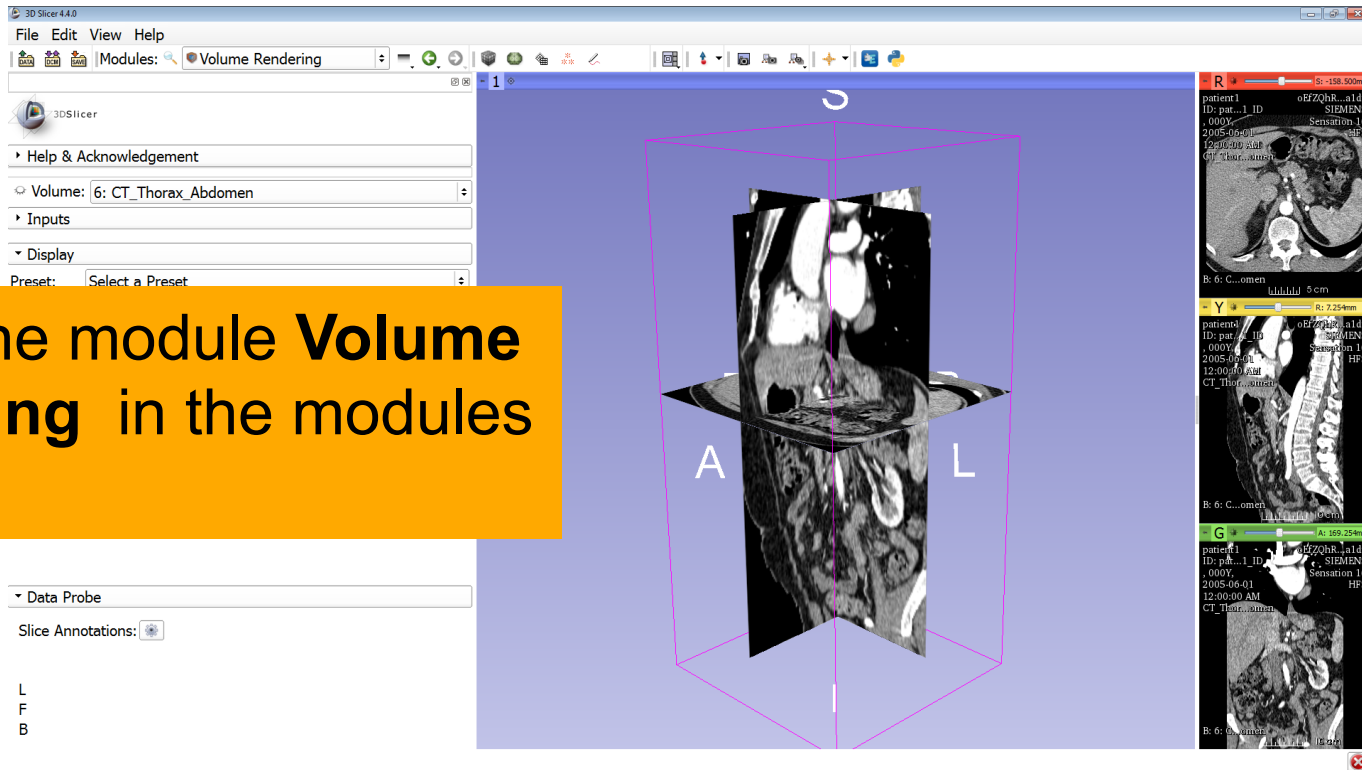


3D Interactive exploration of
thoraco-abdominal CT data
using Volume Rendering



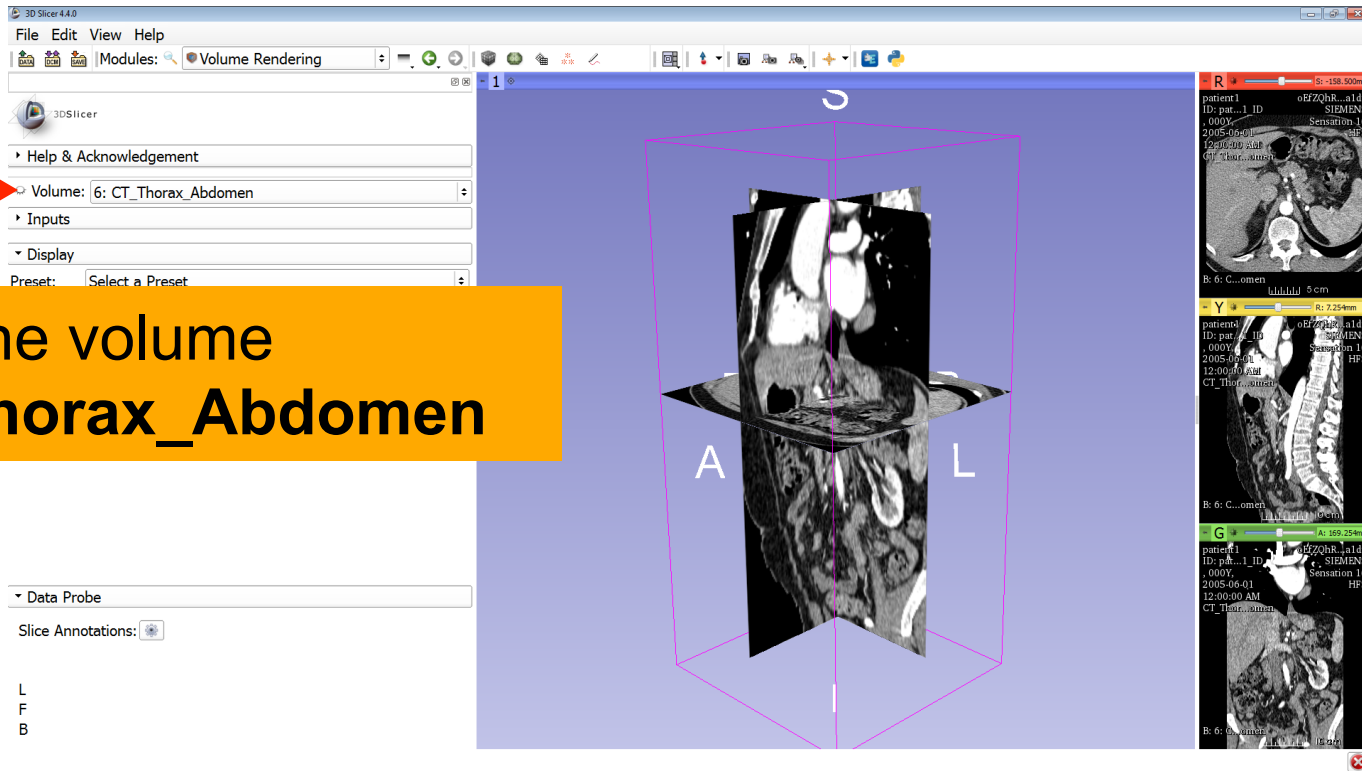
Volume Rendering

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





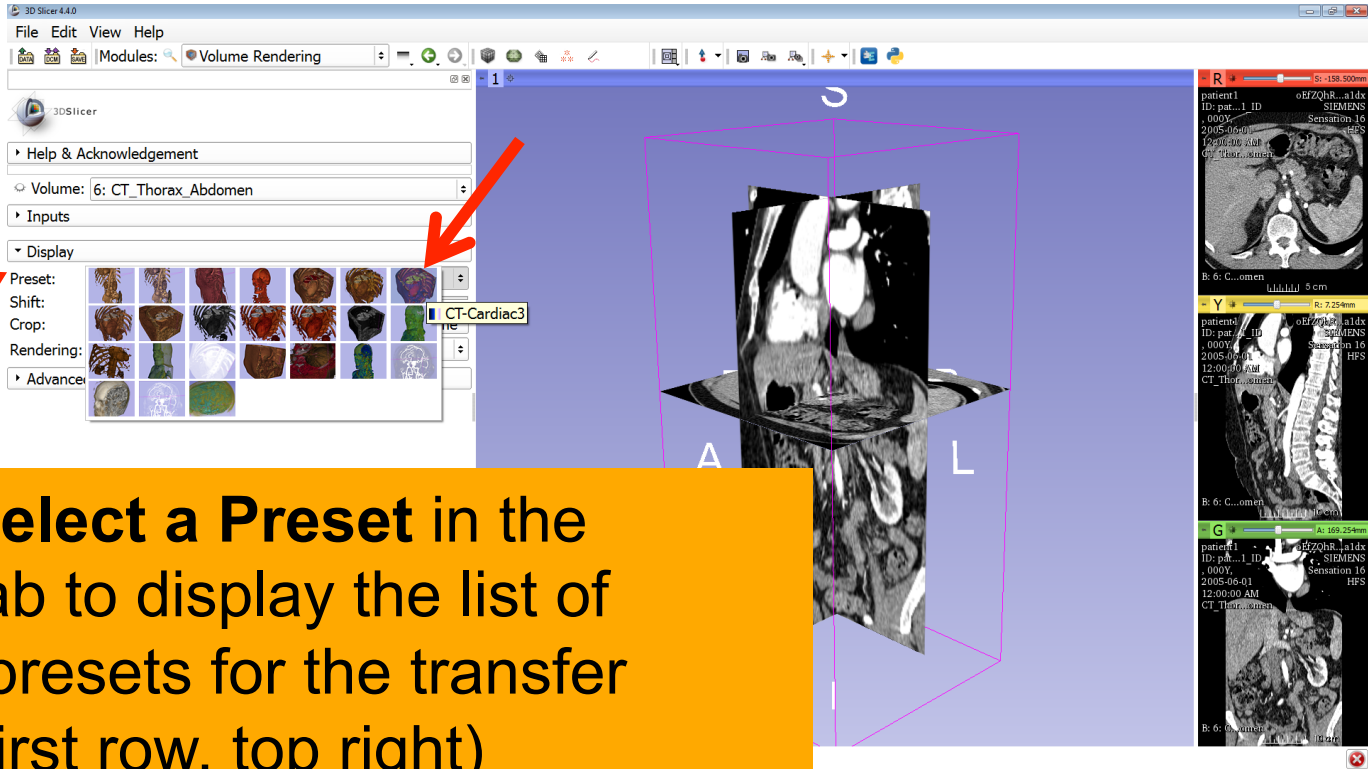
Volume Rendering



Select the volume
6:CT_Thorax_Abdomen



Volume Rendering



Click on **Select a Preset** in the **Display** tab to display the list of available presets for the transfer function (first row, top right)
Select the Preset **CT-Cardiac3**



Volume Rendering

3D Slicer 4.4.0

File Edit View Help

Modules: Volume Rendering

3DSlicer

Help & Acknowledgement

Volume: 6: CT_Thorax_Abdomen

Inputs

Display

Preset: CT-Cardiac3

Shift:

Crop: Enable Display ROI Fit to Volume

Rendering: **VTK CPU Ray Casting**

Advanced...

Data Probe

Slice Annotations: [X]

L
F
B

patient1 oEz0hR..._11dx SIEMENS Sensation 16 HFS
100Y 2005-06-01
13:05:00 AM
CT_Thorax_Abdomen
R: 6: C...omen 0 cm

R: 7.254mm
Ez0hR..._11dx SIEMENS Sensation 16 HFS
A: 169.254mm
Ez0hR..._11dx SIEMENS Sensation 16 HFS
13:24

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



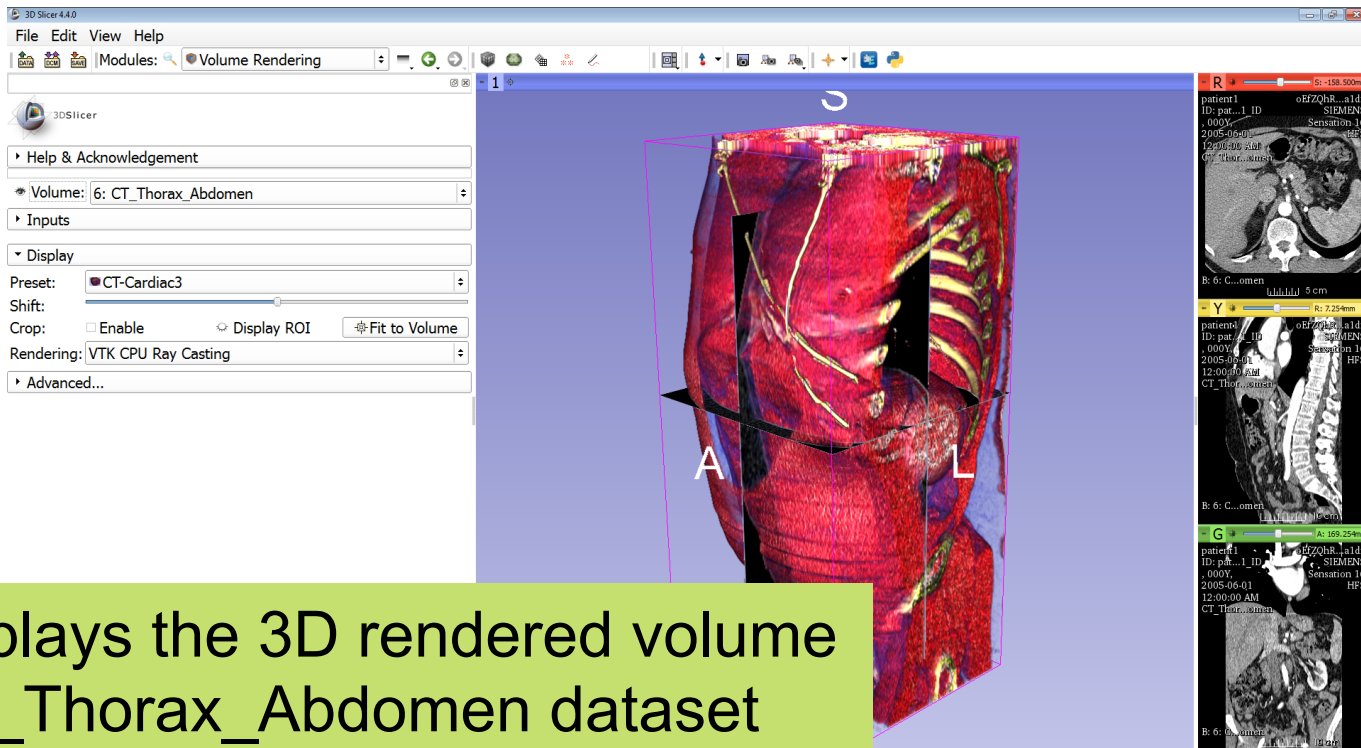
Volume Rendering

The screenshot shows the 3D Slicer 4.4.0 software interface. On the left is the 'Volume Rendering' panel, which includes sections for 'Help & Acknowledgement', 'Volume: [6: CT_Thorax_Abdomen]', 'Inputs', 'Display', 'Preset: [CT-Cardiac3]', 'Shift', 'Crop' (with 'Enable', 'Display ROI', and 'Fit to Volume' options), 'Rendering: [VTK CPU Ray Casting]', and 'Advanced...'. A red arrow points to the eye icon next to the volume name. Below this panel are 'Data Probe' and 'Slice Annotations' sections. The main 3D view shows a CT scan of a thorax and abdomen with a purple wireframe bounding box. On the right, there are three orthogonal slice views (axial, sagittal, and coronal) with patient information and scale bars. A large orange text box is overlaid on the 3D view.

Click on the eye icon next to Volume to display the volume rendered image



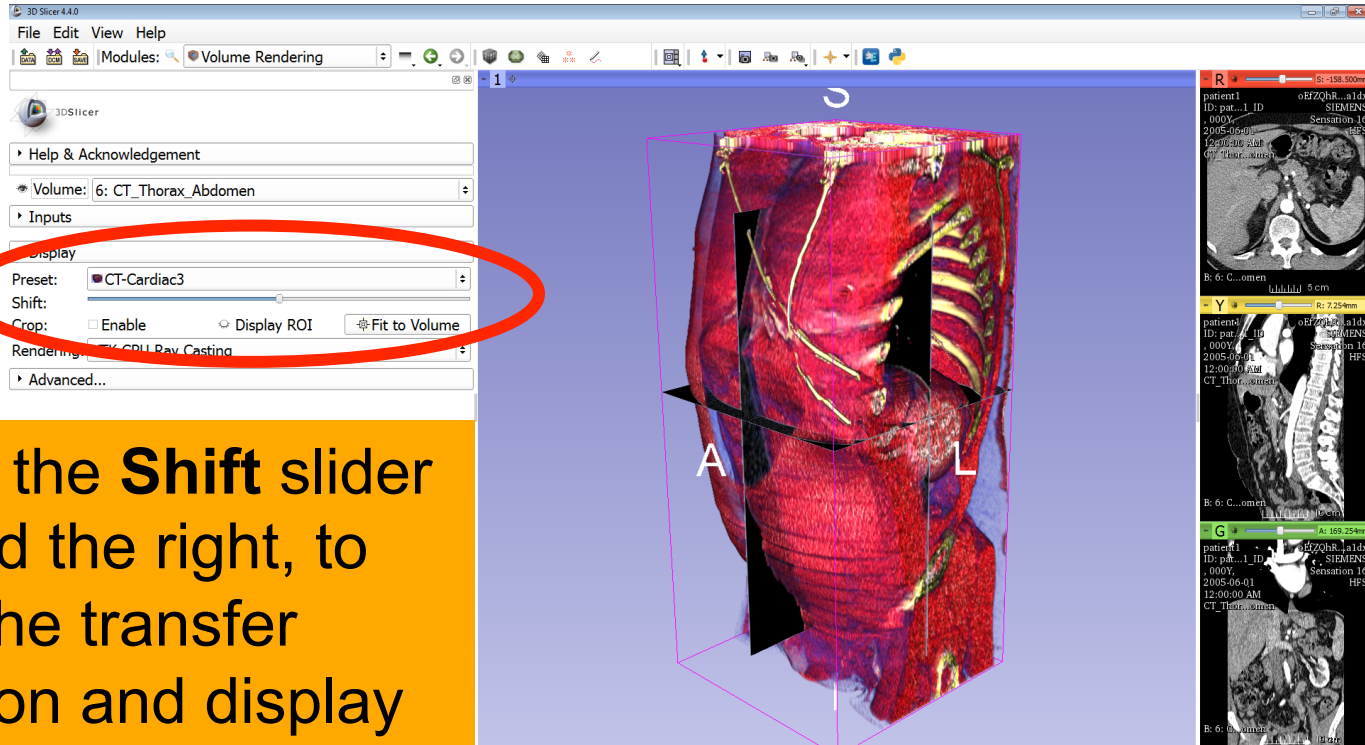
Volume Rendering



Slicer displays the 3D rendered volume of the CT_Thorax_Abdomen dataset



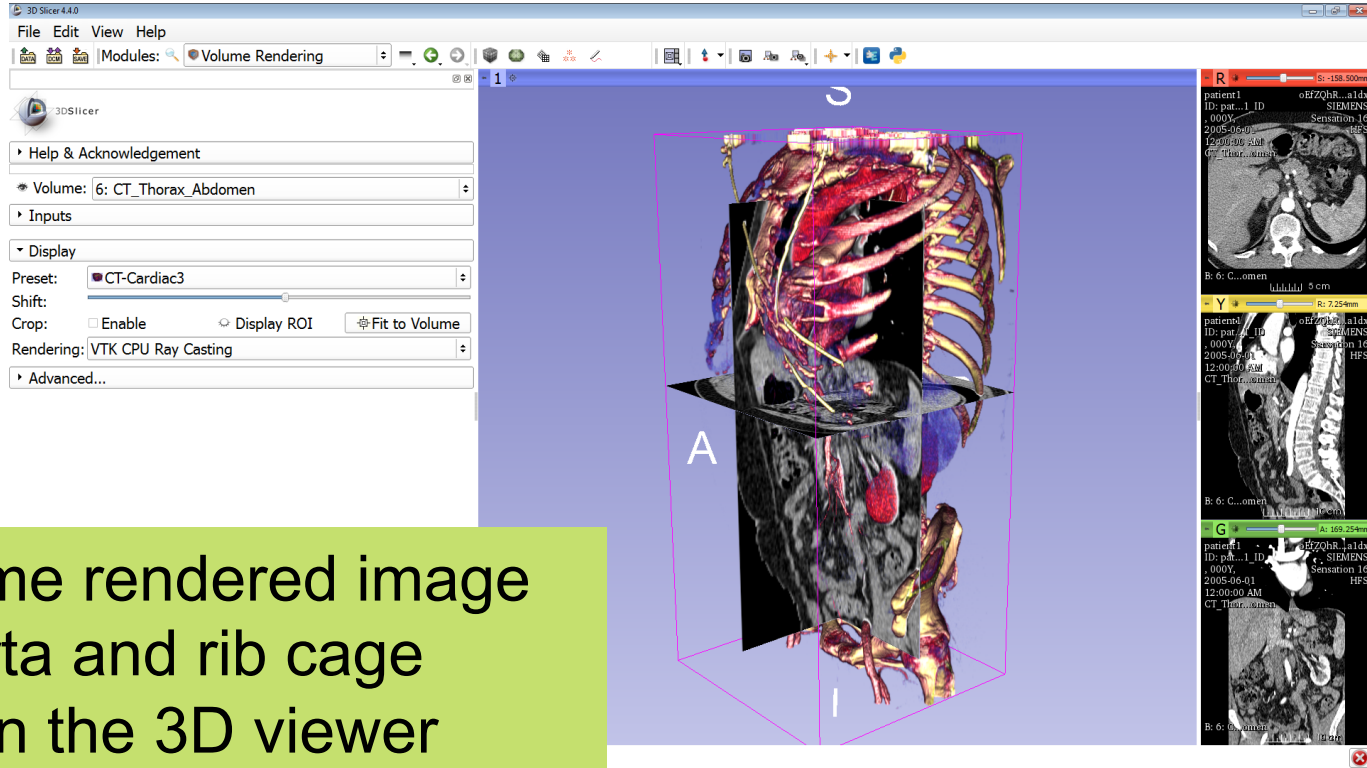
Volume Rendering



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



Volume Rendering

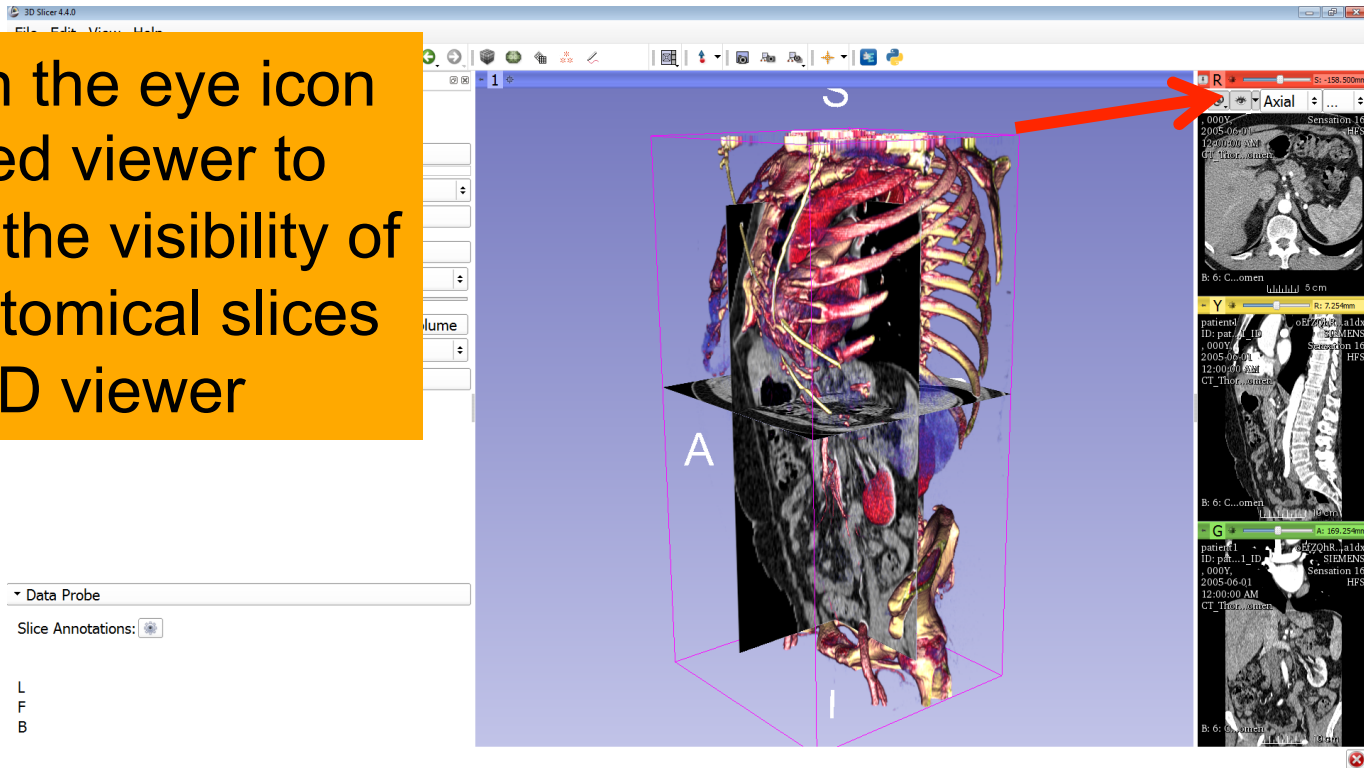


The volume rendered image of the aorta and rib cage appears in the 3D viewer



Volume Rendering

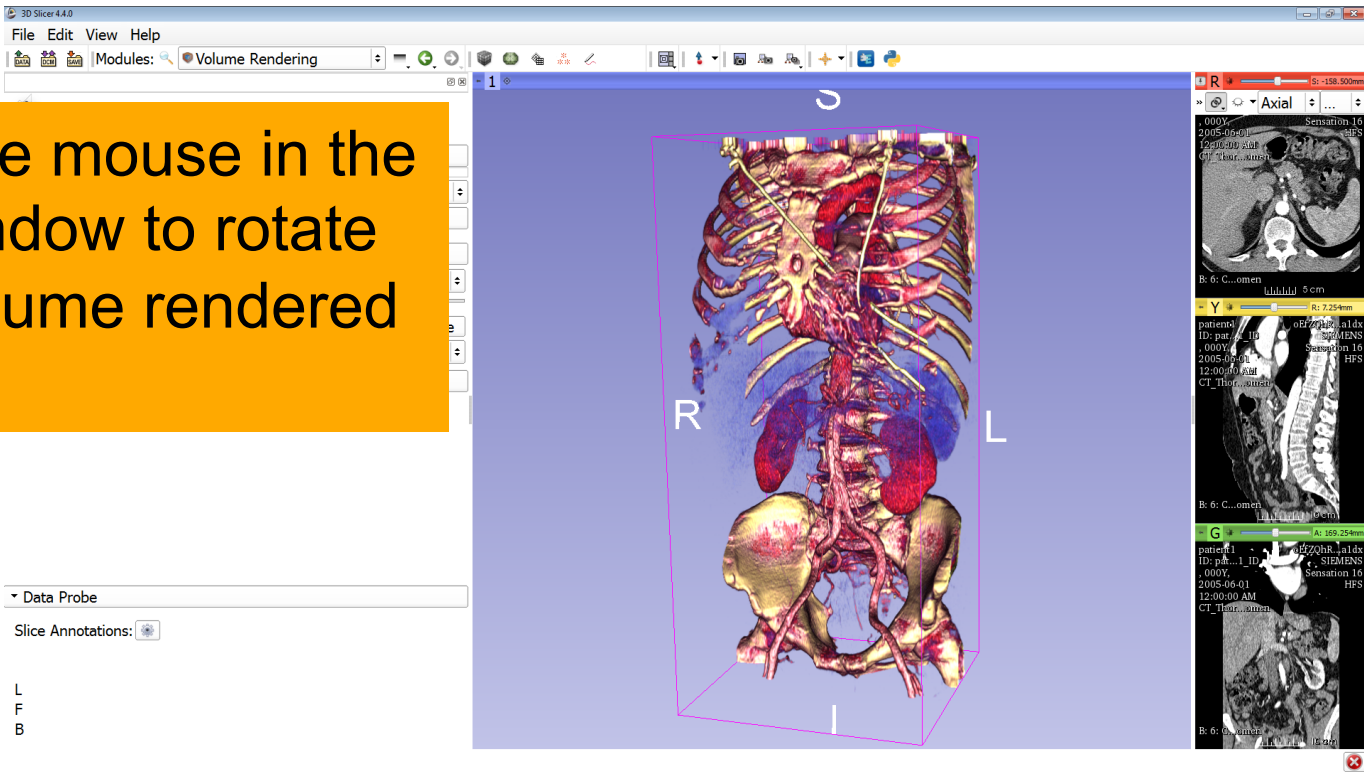
Click on the eye icon in the red viewer to turn off the visibility of the anatomical slices in the 3D viewer





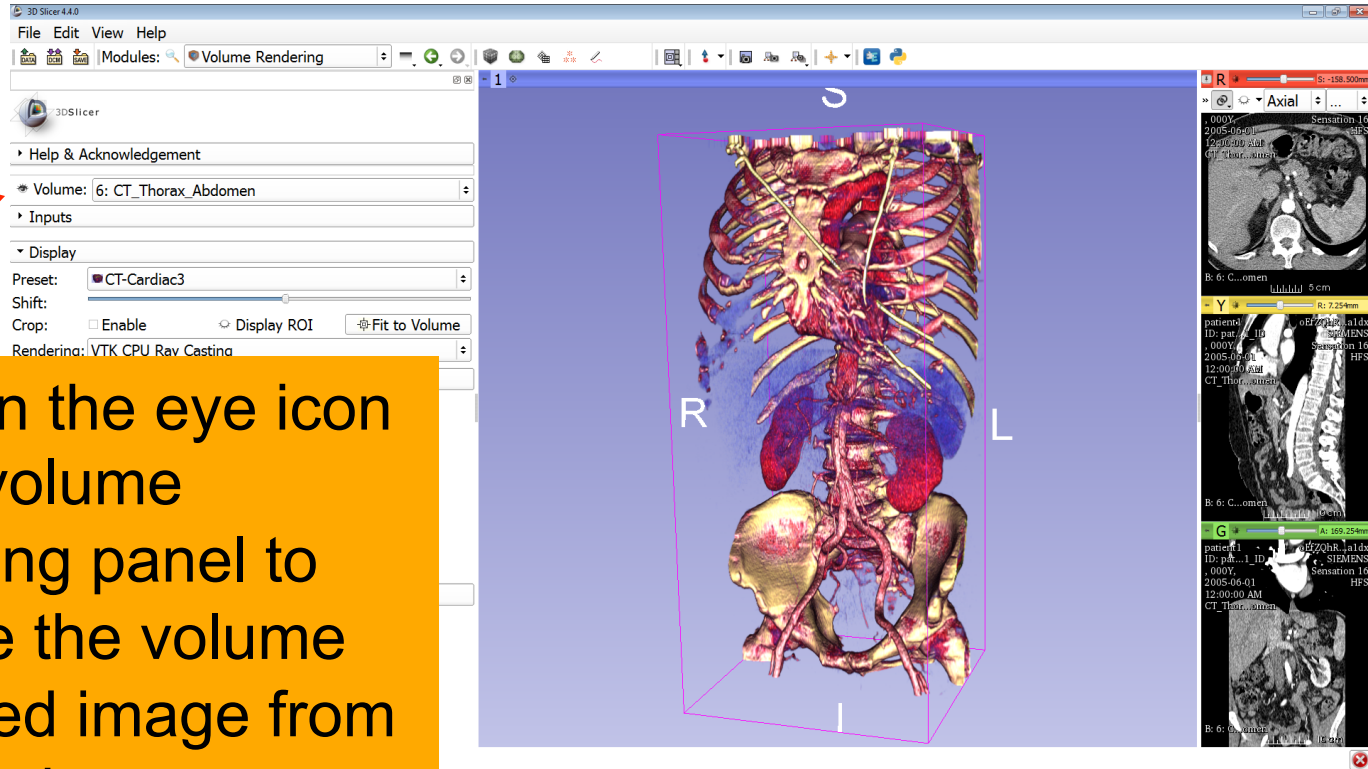
Volume Rendering

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





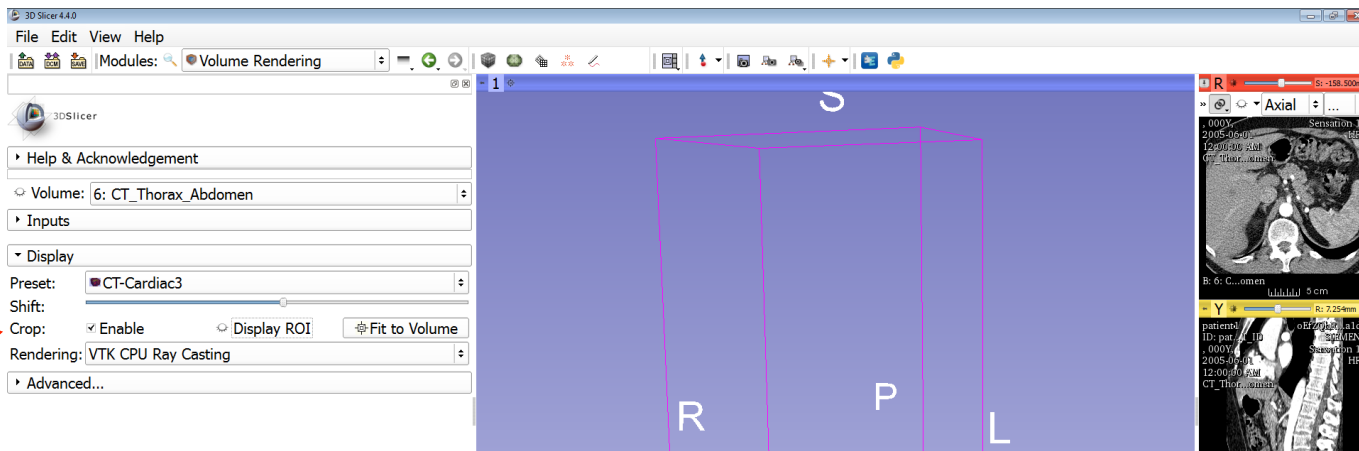
Volume Rendering



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



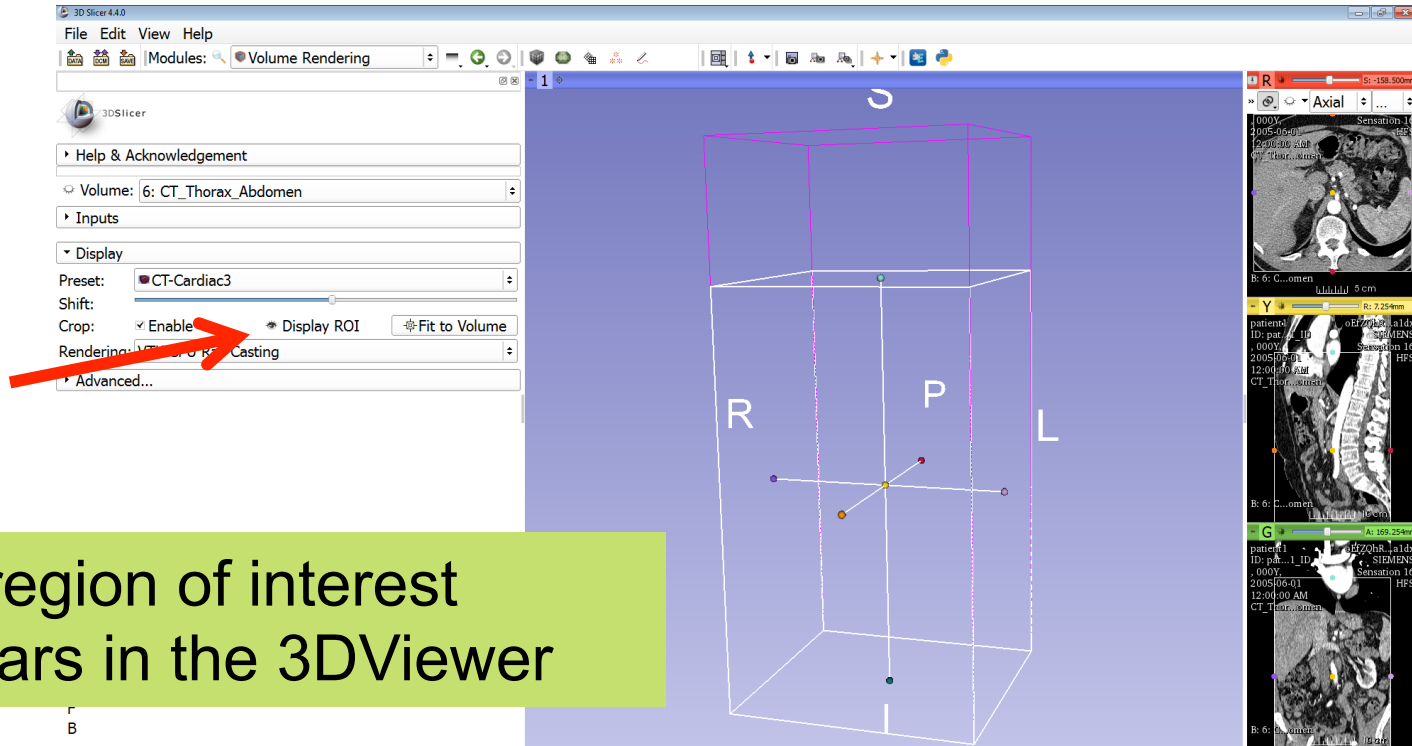
Volume Rendering



Click on **Display ROI** to display a region of interest that we will use for cropping the dataset, and make sure the option **Crop** is selected ('**Enable**' should be checked)



Volume Rendering

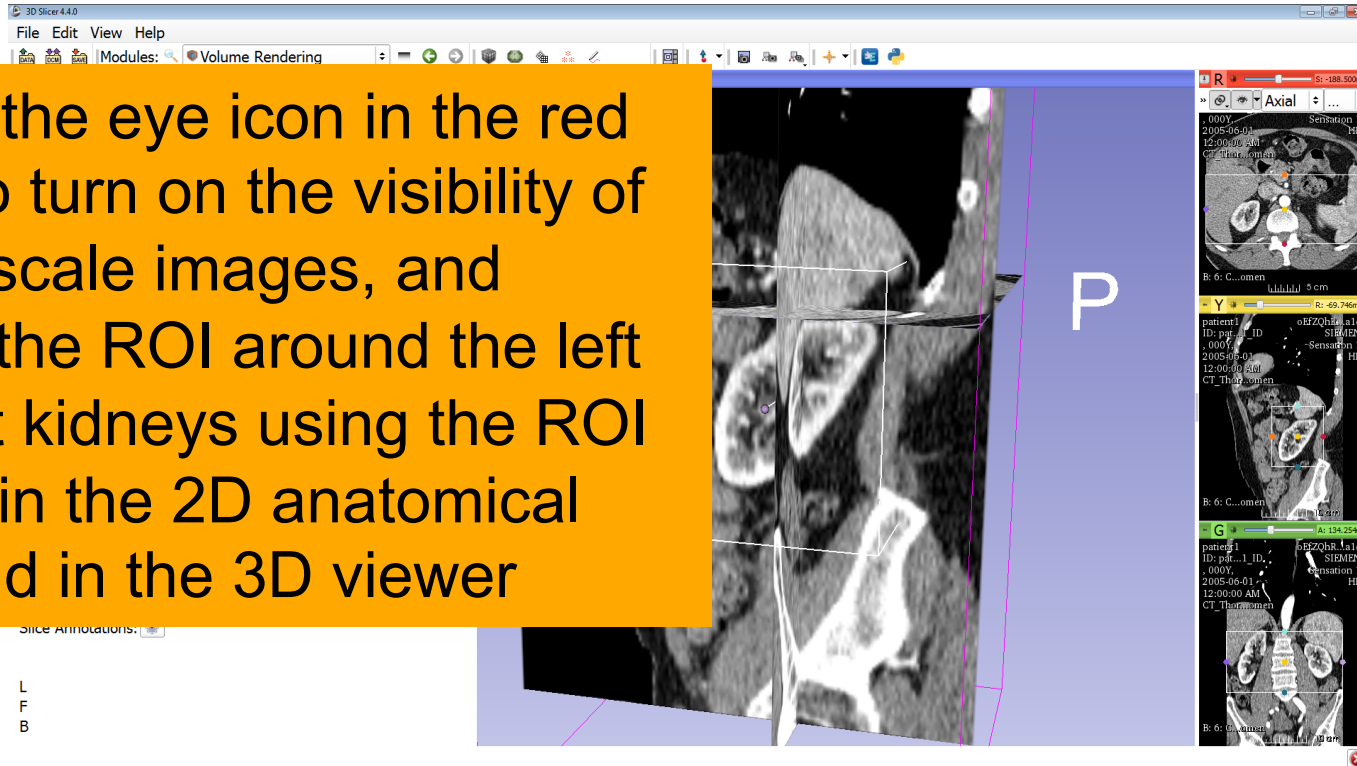


The region of interest appears in the 3DViewer



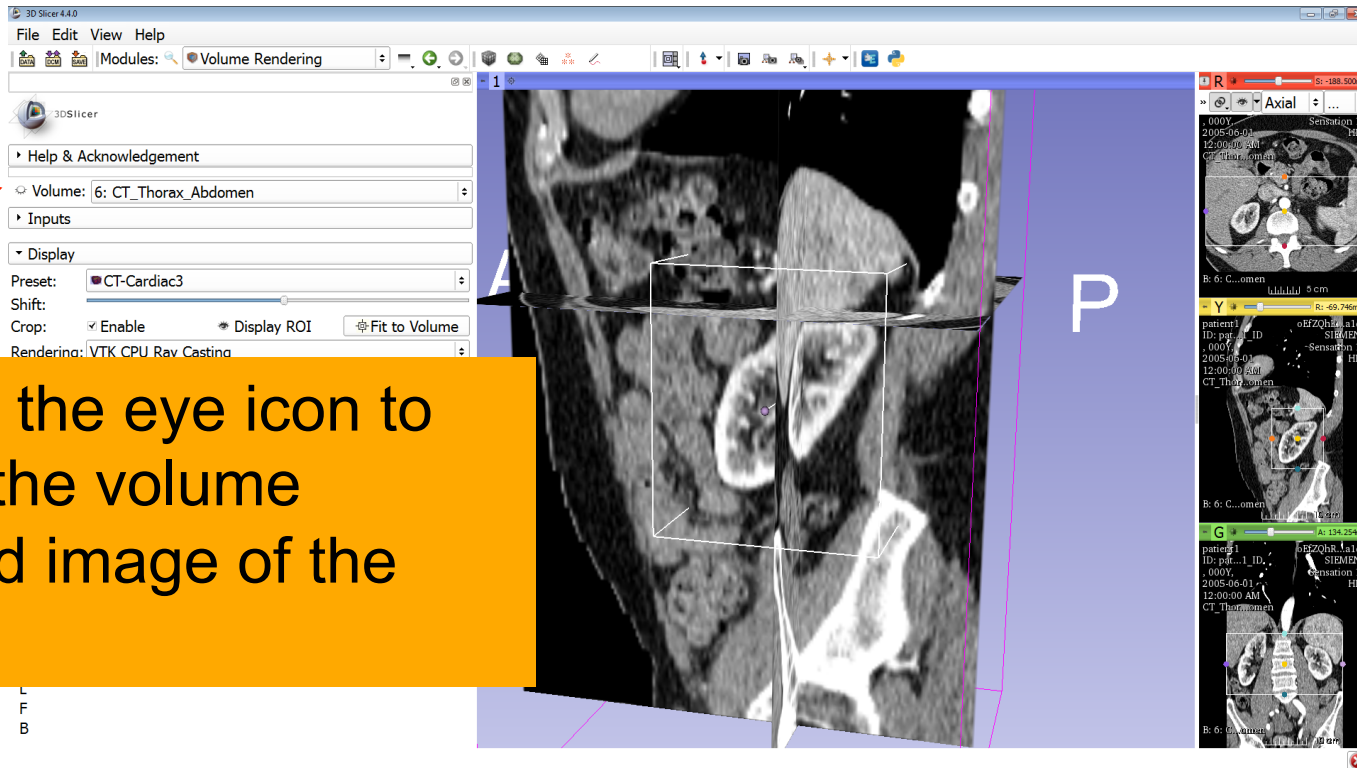
Volume Rendering

Click on the eye icon in the red viewer to turn on the visibility of the grayscale images, and position the ROI around the left and right kidneys using the ROI controls in the 2D anatomical views and in the 3D viewer





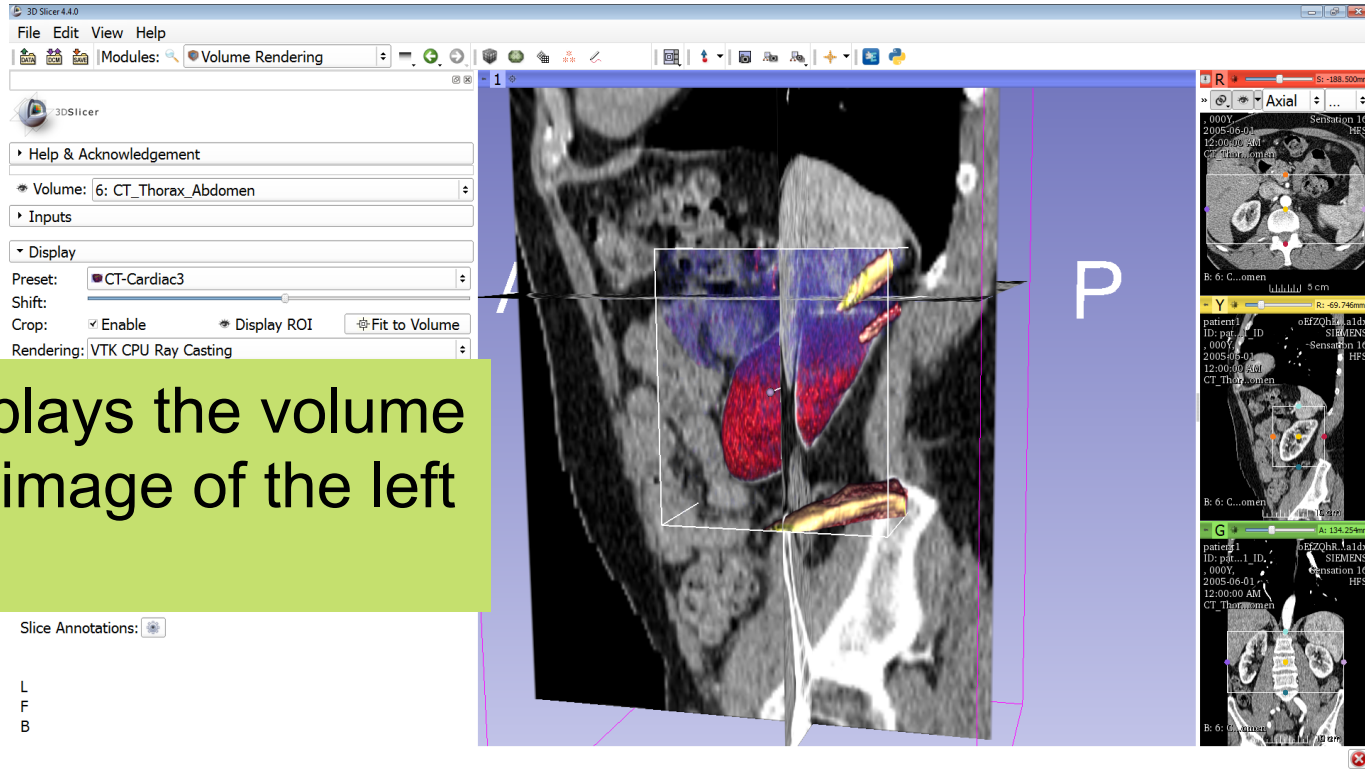
Volume Rendering



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



Volume Rendering



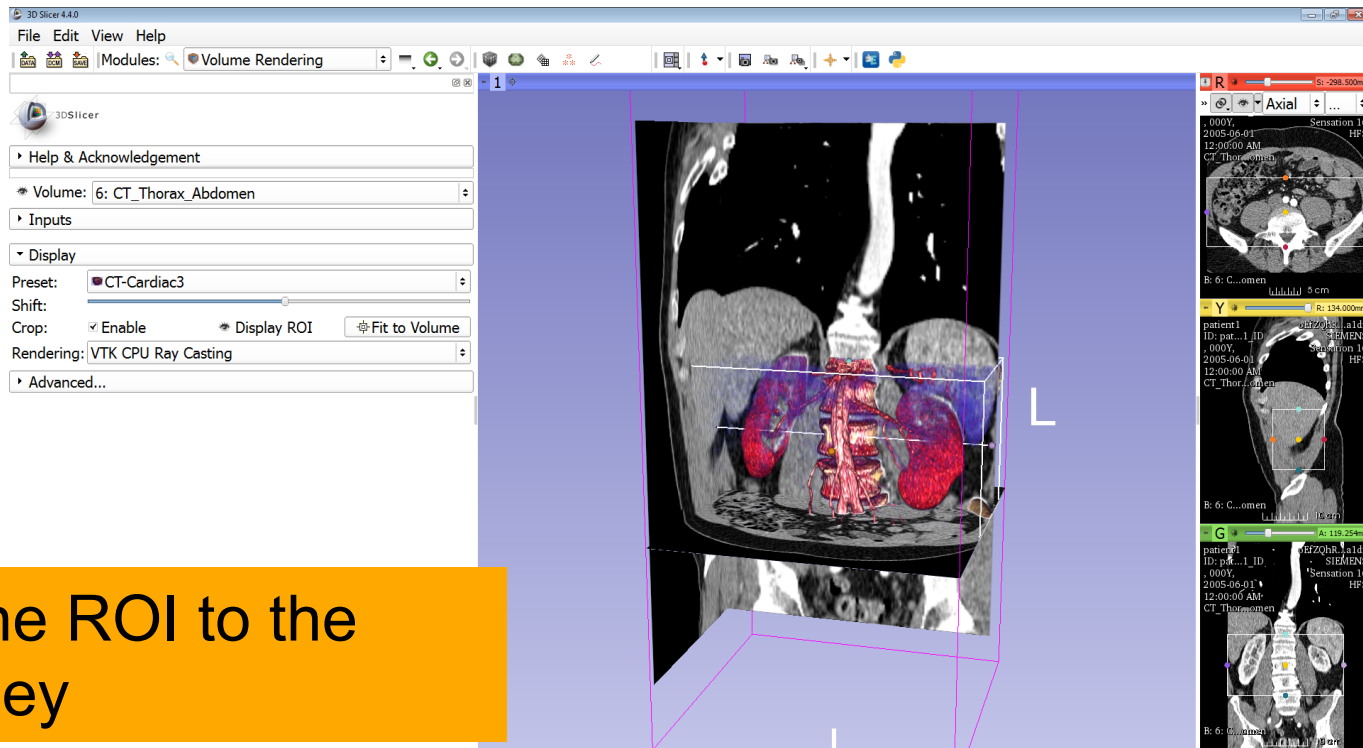
Slicer displays the volume rendered image of the left kidney

Slice Annotations:

L
F
B



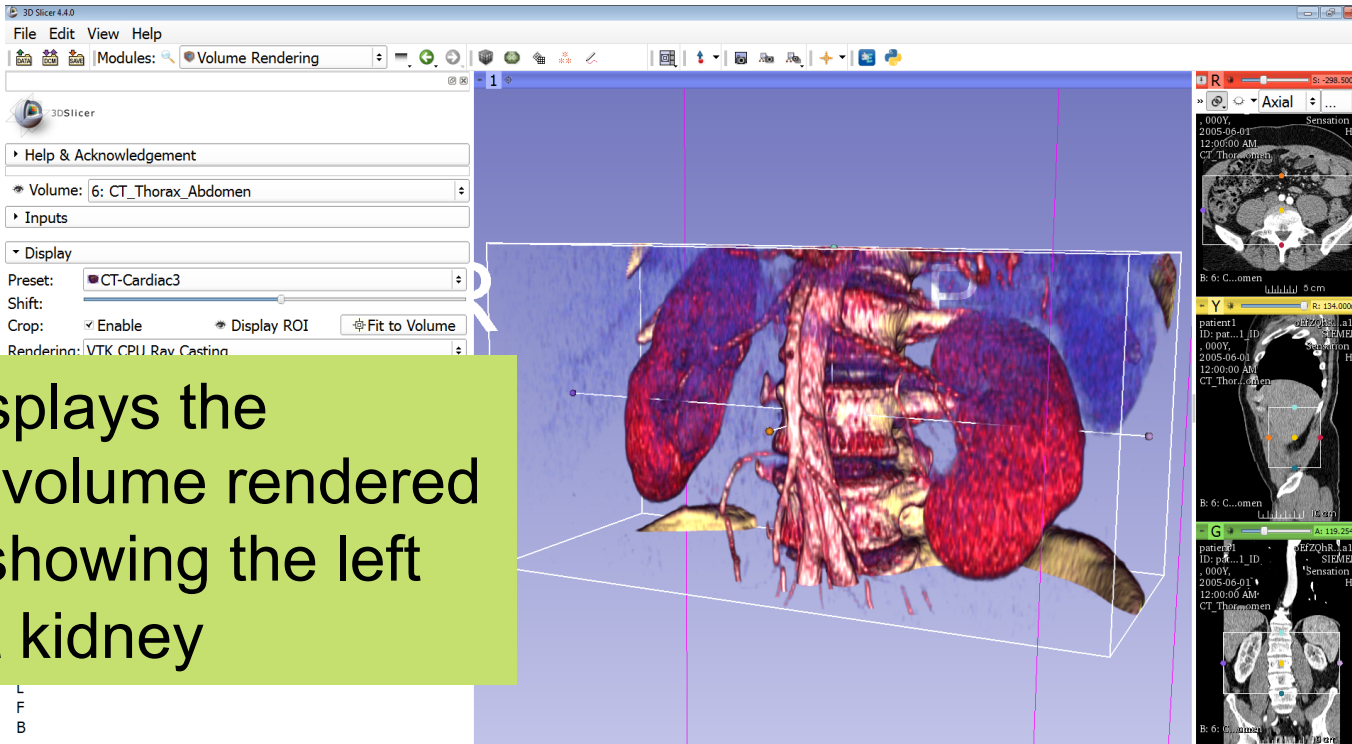
Volume Rendering



Extend the ROI to the right kidney



Volume Rendering



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



Volume Rendering

3D Slicer 4.4.0

File Edit View Help

Modules: Volume Rendering

3DSlicer

Help & Acknowledgement

Volume: 6: CT_Thorax_Abdomen

Inputs

Display

Preset: CT-Cardiac3

Shift: [Slider]

Crop: Enable Display ROI Fit to Volume

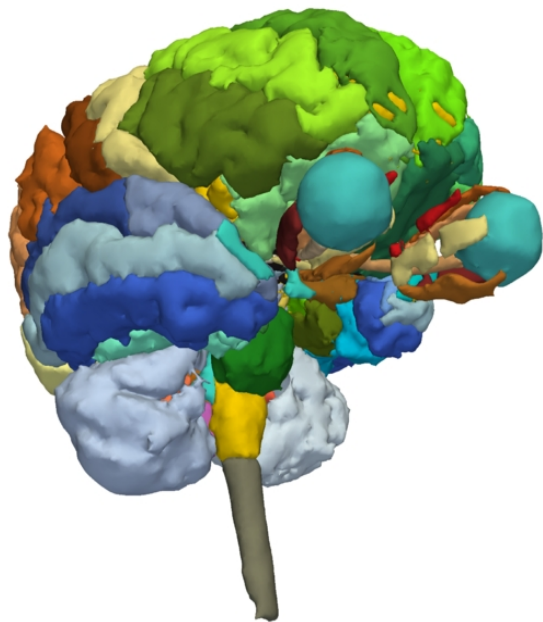
Rendering: VTK CPU Ray Casting

Slice Annotations: [Icon]

L
F
B

Click on **File**→**Close Scene** to close the scene

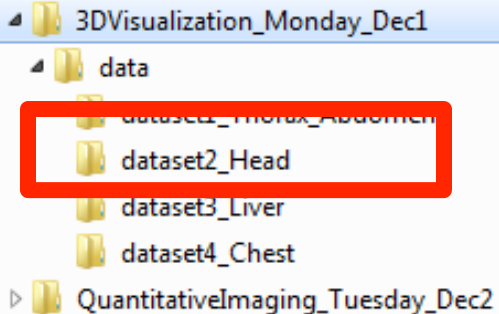
Click on **File**→**Exit** to quit Slicer



Part 2: 3D visualization of surface models of the brain



3D Data Loading and Visualization



- Open the directory **3DVisualization_Monday_Dec1** on the Desktop

- Select the directory **dataset2_Head**

- Select the file **MRHead_Scene.mrb**

This file is composed of an MR scan of the brain and 3D surface reconstructions of anatomical structures.

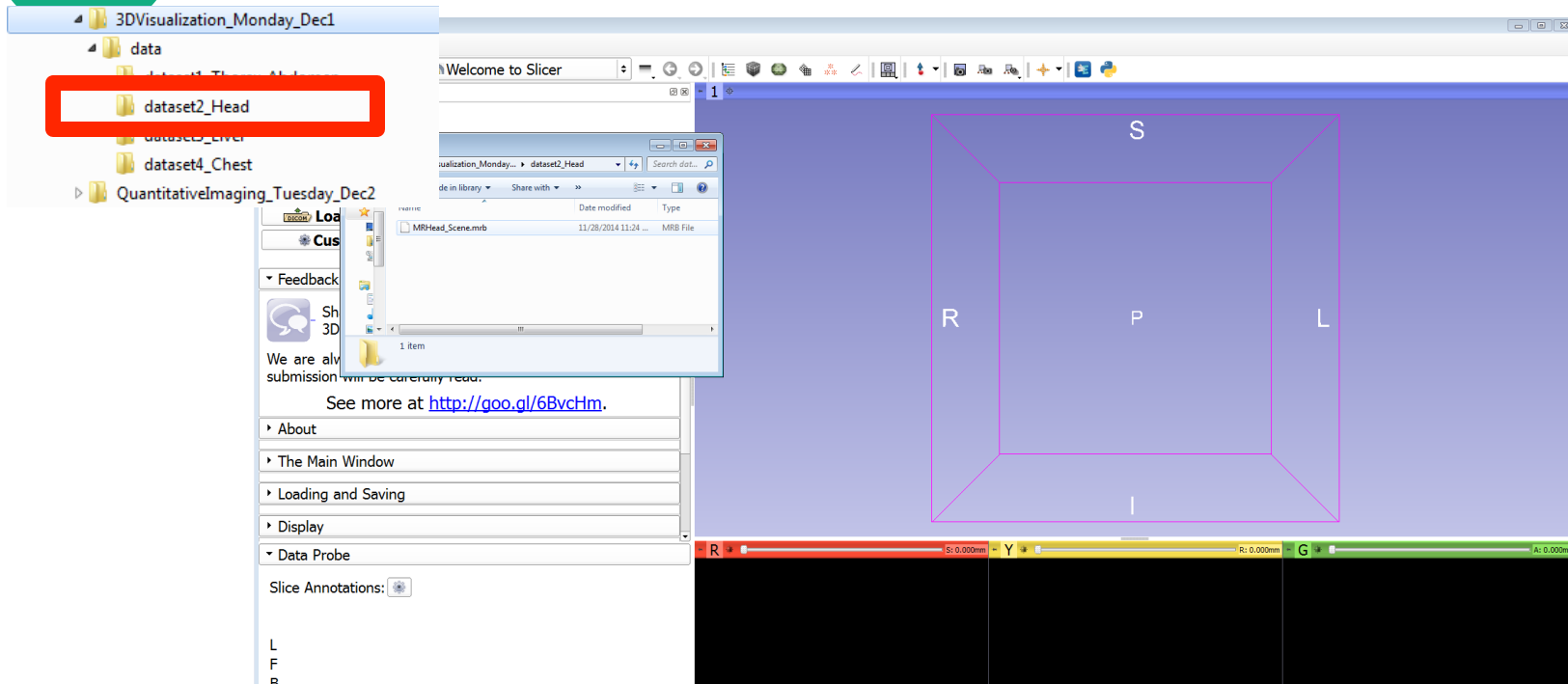
The data are part of the SPL-PNL Brain Atlas developed by Talos, Jakab, Kikinis et al. The atlas is freely available for download at:

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





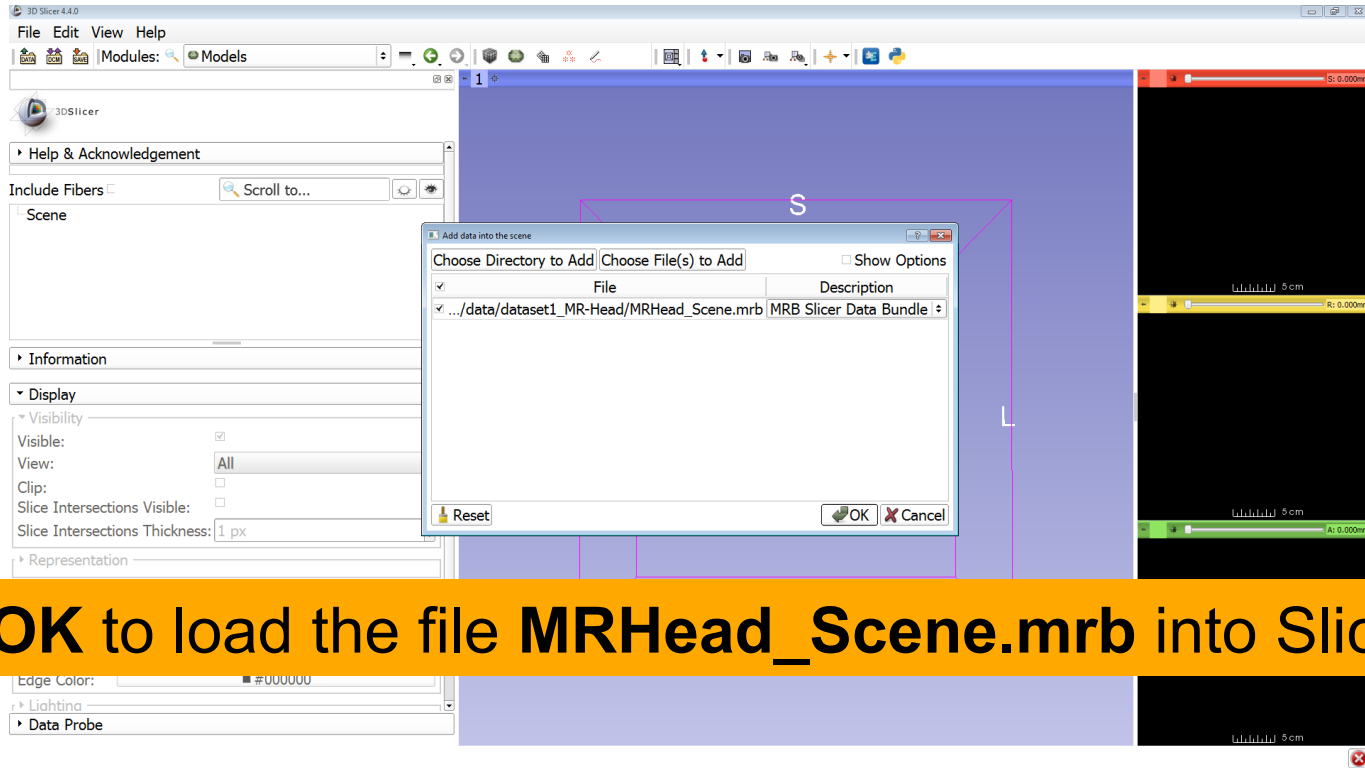
3D visualization of surface models of the brain



Drag and drop the file **Head_Scene.mrb** into Slicer



3D visualization of surface models of the brain



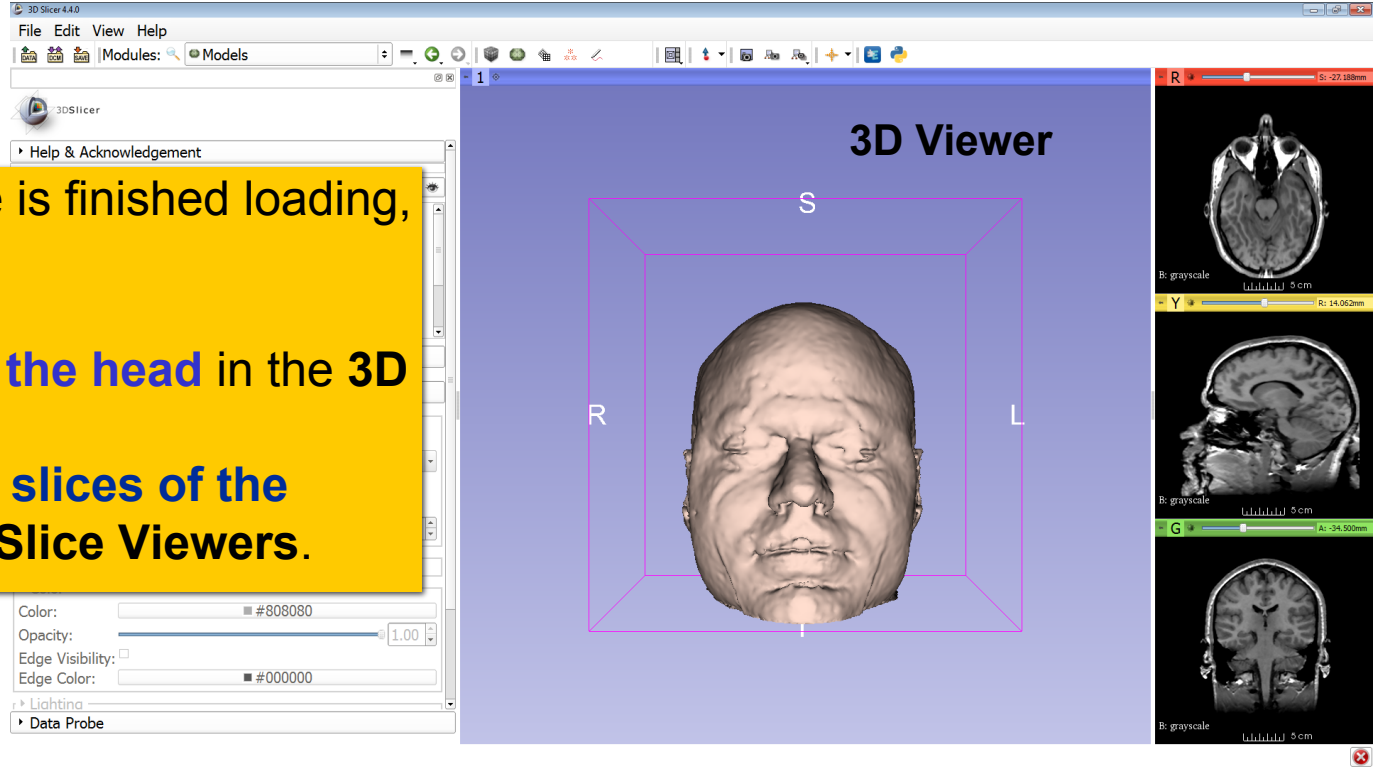
Click on **OK** to load the file **MRHead_Scene.mrb** into Slicer



3D visualization of surface models of the brain : Viewing the Scene

When the scene is finished loading, Slicer displays:

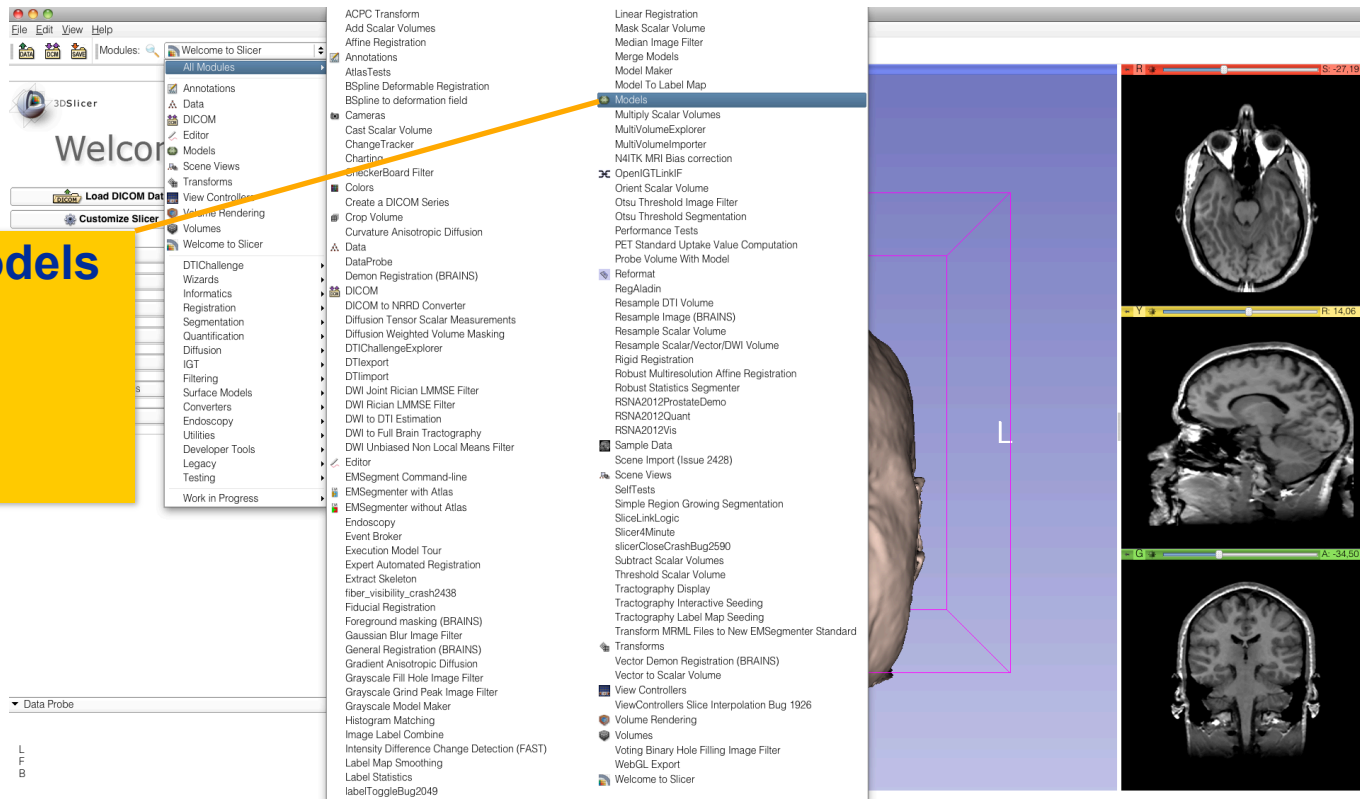
- a **3D model of the head** in the **3D Viewer**, and
- anatomical **MR slices of the brain** in the **2D Slice Viewers**.





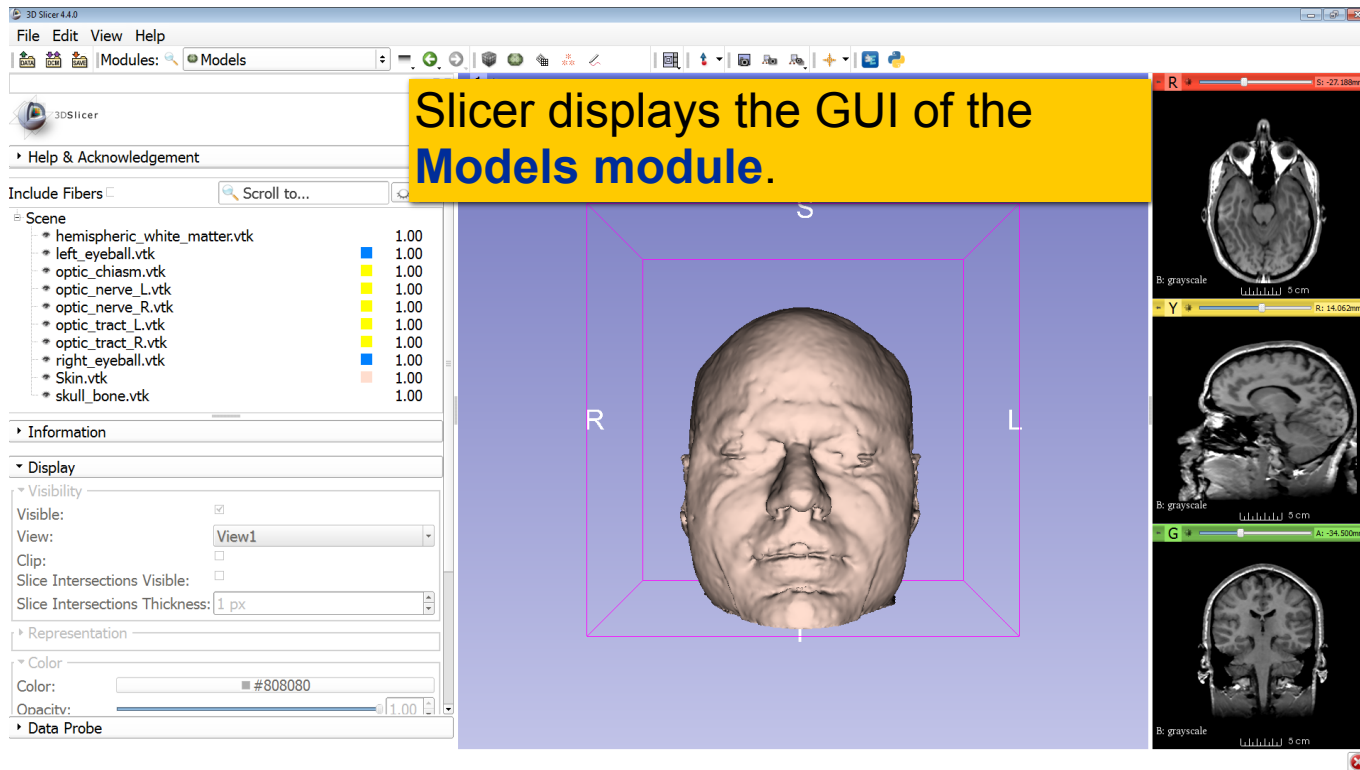
3D visualization of surface models of the brain : Exploring Slicer's functionality

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





3D visualization of surface models of the brain : Switching to the Models Module

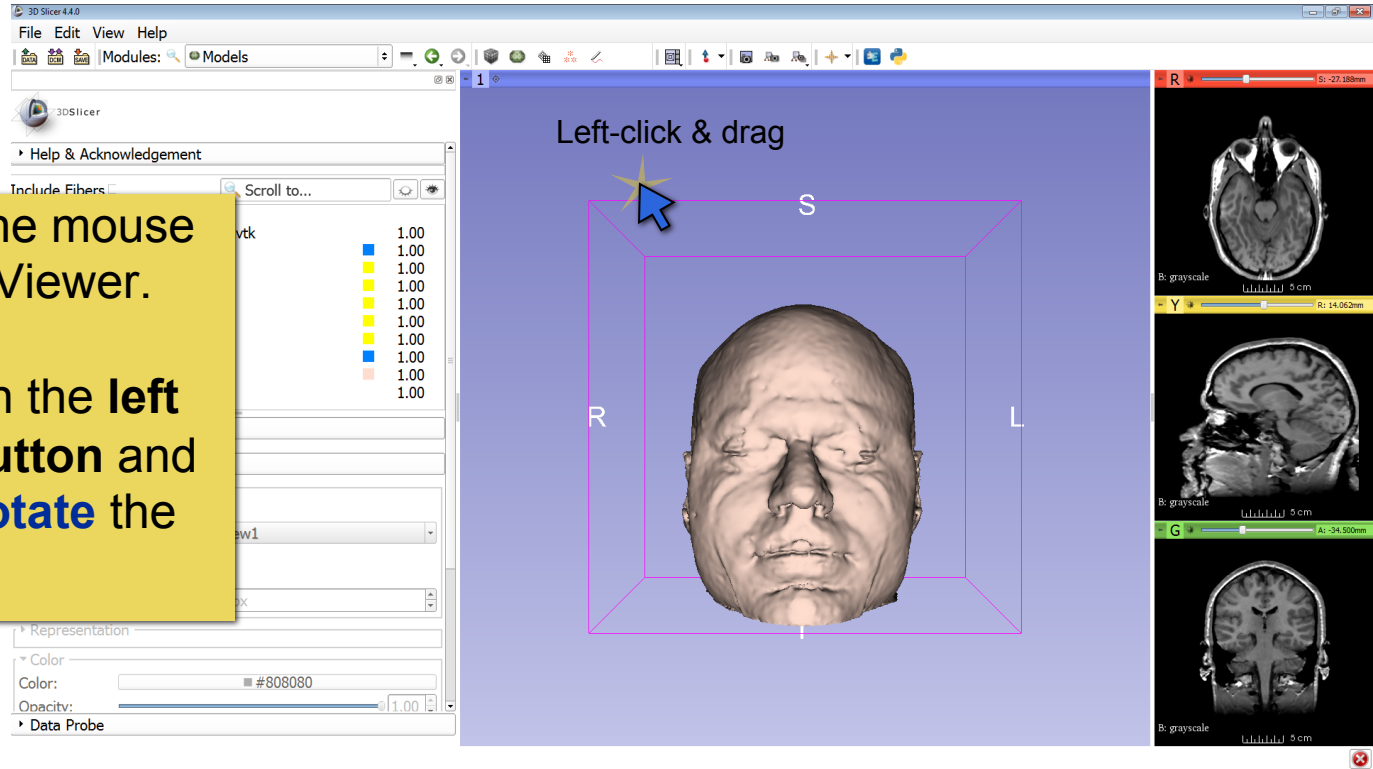




3D visualization of surface models of the brain : **Basic 3D Interaction**

Position the mouse in the 3D Viewer.

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





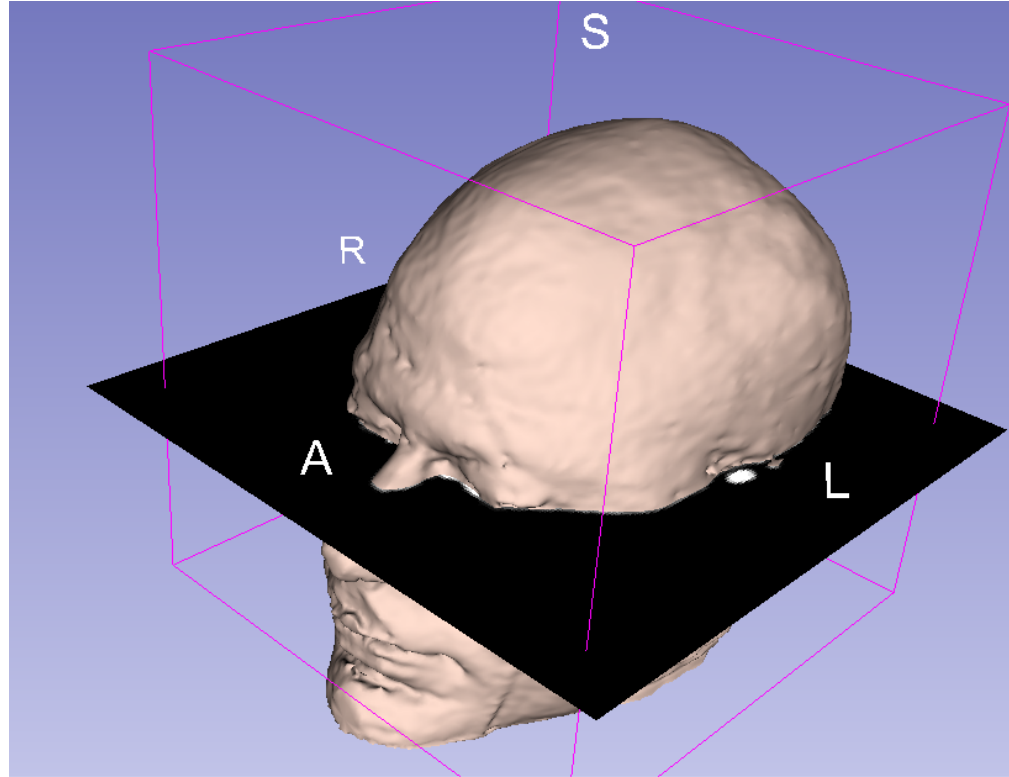
3D visualization of surface models of the brain : Viewing Slices in the 3D Viewer

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



3D visualization of surface models of the brain

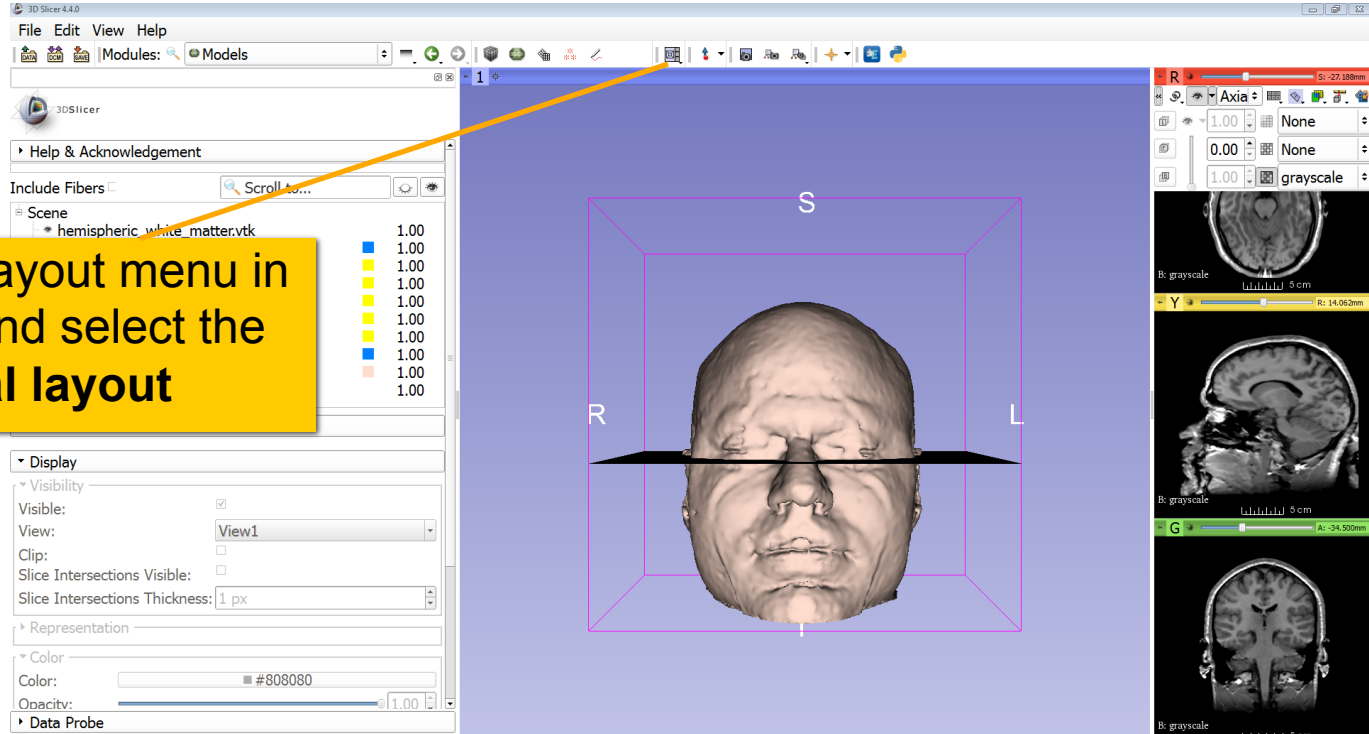
Slicer adds a view of the **Axial slice** in the 3D View.





3D visualization of surface models of the brain : Viewing Slices in the 3D Viewer

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





3D visualization of surface models of the brain

Select the model **Skin.vtk**

Click to expand the tab **Display**

Select the tab **Color**, and change the opacity of the model from **1.0** to **0.0**.

Clip:
Slice Intersections Visible:
Slice Intersections Thickness: 1 px

Representation

Color

Color: #ffddce

Opacity: 1.00

Edge Visibility:
Edge Color: #000000

Lighting

Material

Scalars

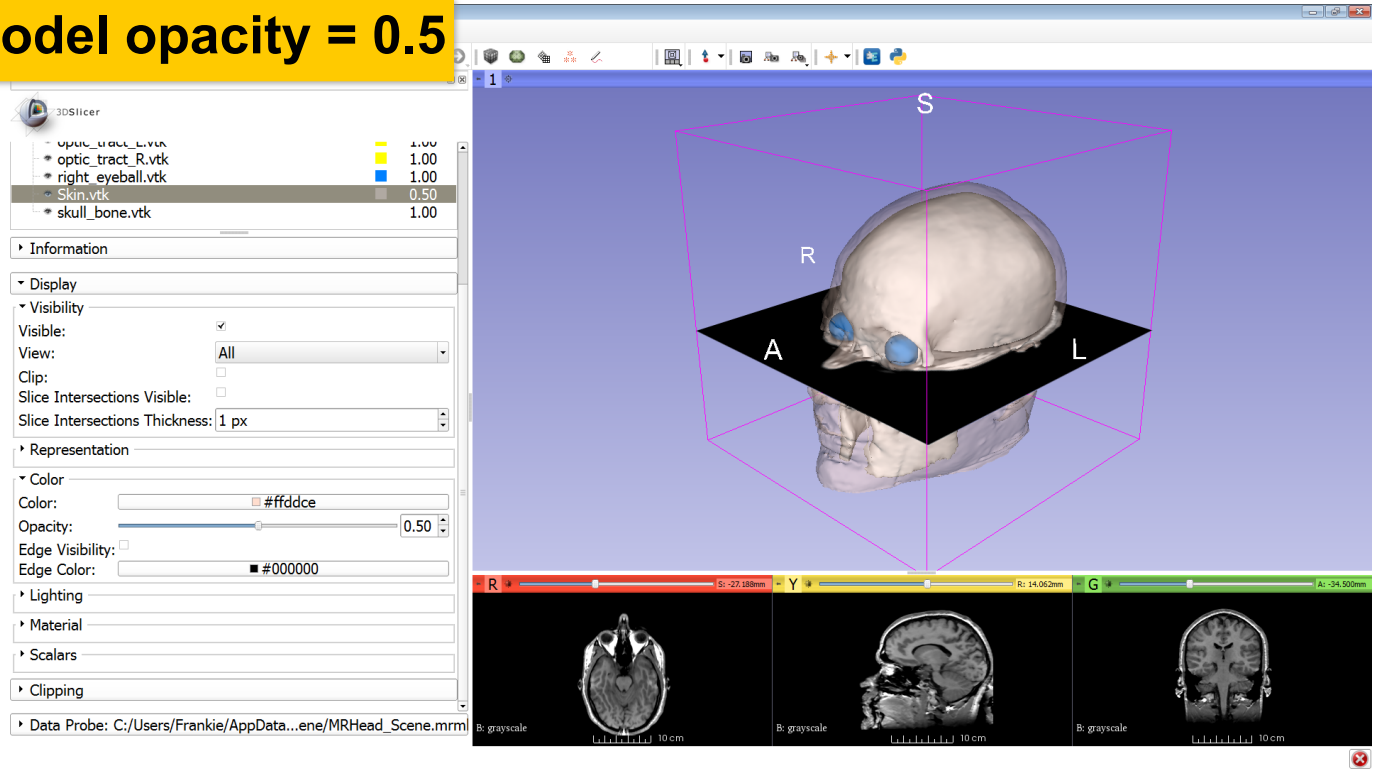
Clipping

Data Probe: C:/Users/Frankie/AppData...ene/MRHead_Scene.mrml



3D visualization of surface models of the brain

skin model opacity = 0.5





3D visualization of surface models of the brain

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

(skin model opacity = 0.0)

Clip:

Slice Intersections Visible:

Slice Intersections Thickness: 1 px

Representation

Color

Color: #ffddce

Opacity: 0.00

Edge Visibility:

Edge Color: #000000

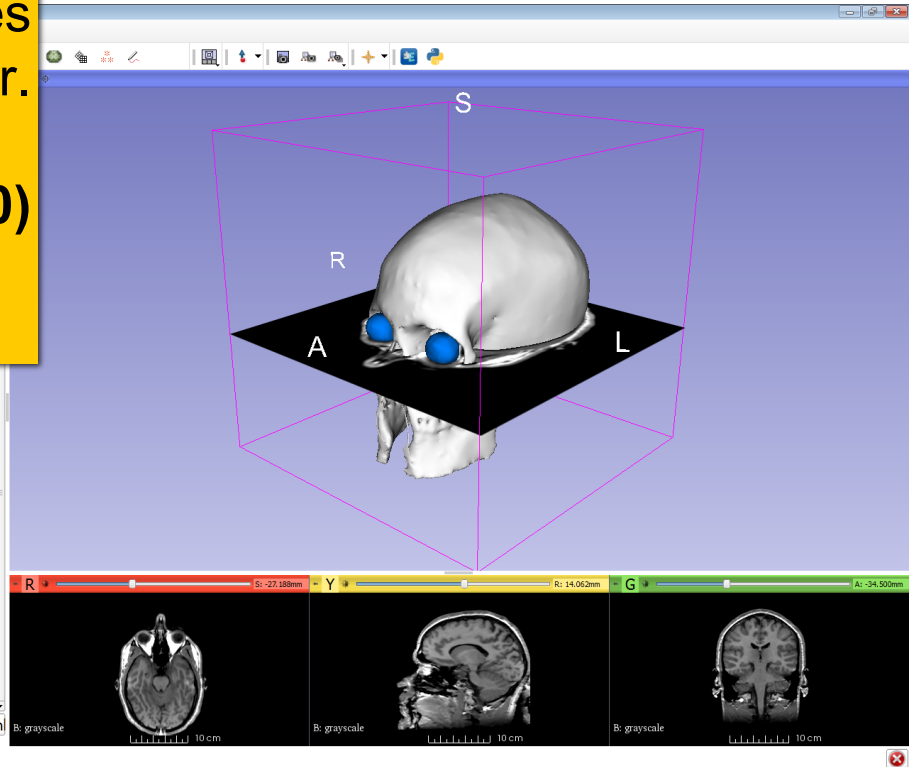
Lighting

Material

Scalars

Clipping

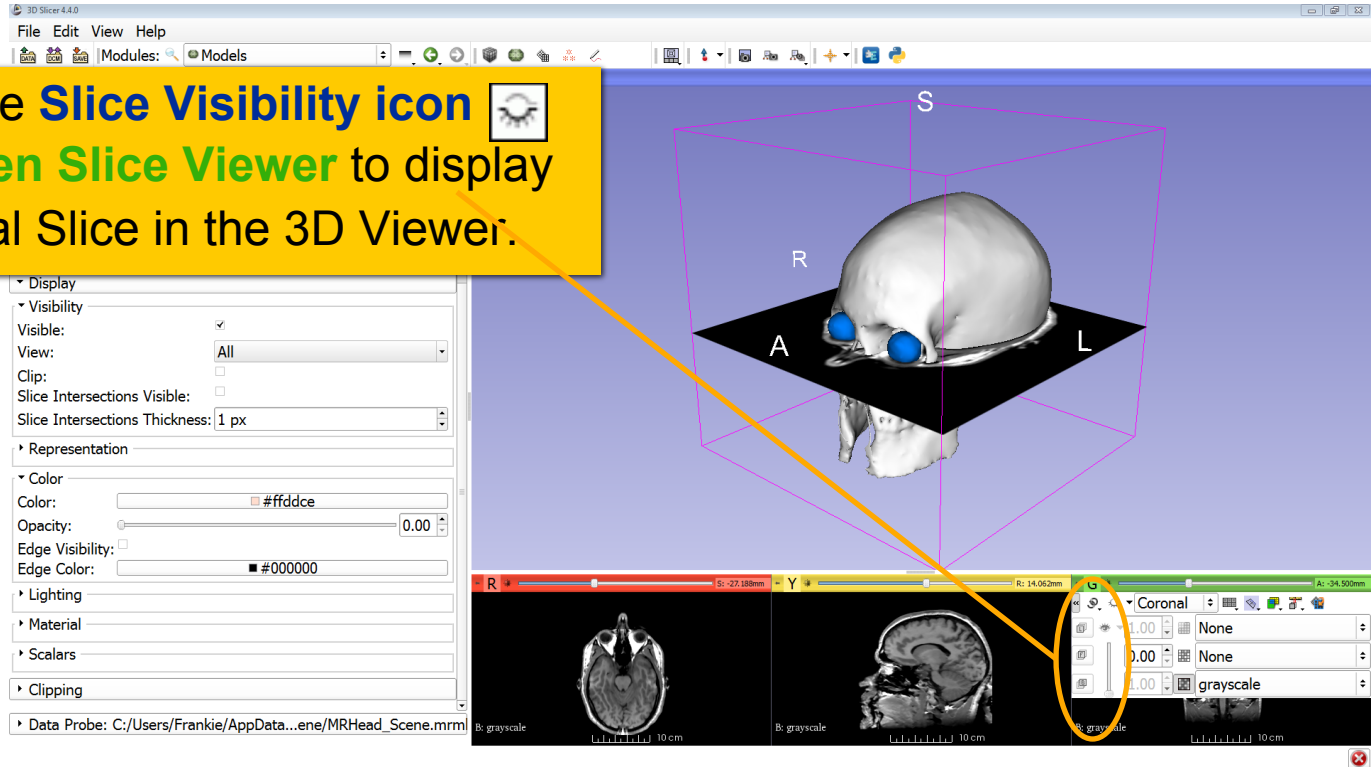
Data Probe: C:/Users/Frankie/AppData...ene/MRHead_Scene.mrm





3D visualization of surface models of the brain

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





3D visualization of surface models of the brain

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

skin.vtk 0.00
skull_bone.vtk 1.00

Information

Display

Visibility

Visible:

View: All

Clip:

Slice Intersections Visible:

Slice Intersections Thickness: 1 px

Representation

Color

Color: #ffddce

Opacity: 0.00

Edge Visibility:

Edge Color: #000000

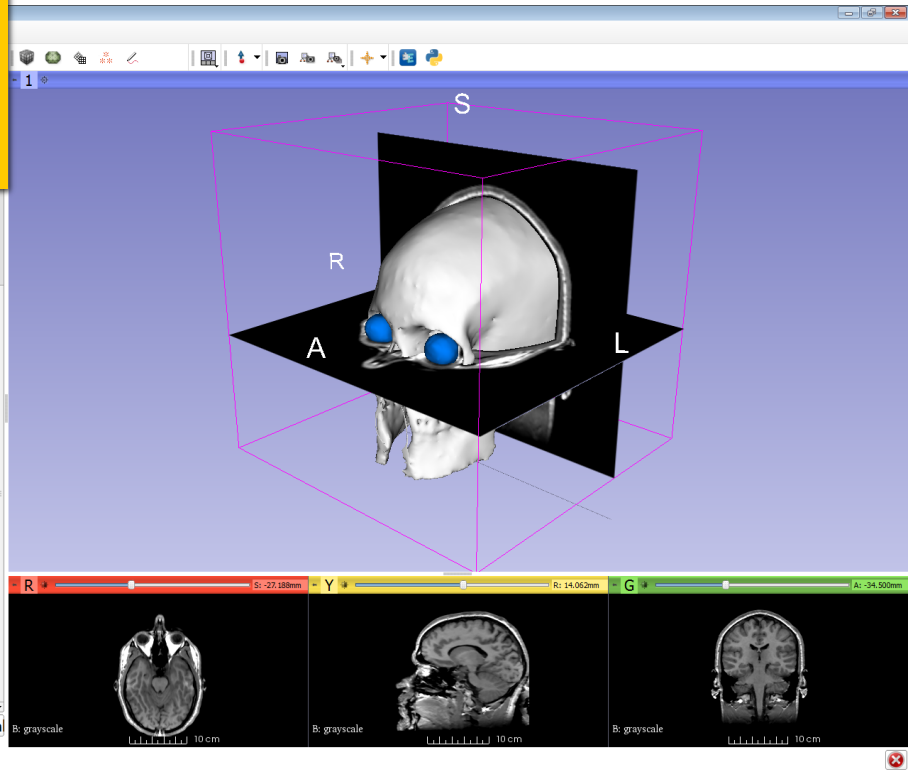
Lighting

Material

Scalars

Clipping

Data Probe: C:/Users/Frankie/AppData...ene/MRHead_Scene.mrml





3D visualization of surface models of the brain

Select the 3D model **skull_bone.vtk** in the Model Hierarchy

Click to expand the tab **Display**

Click to expand the tab **Visibility**

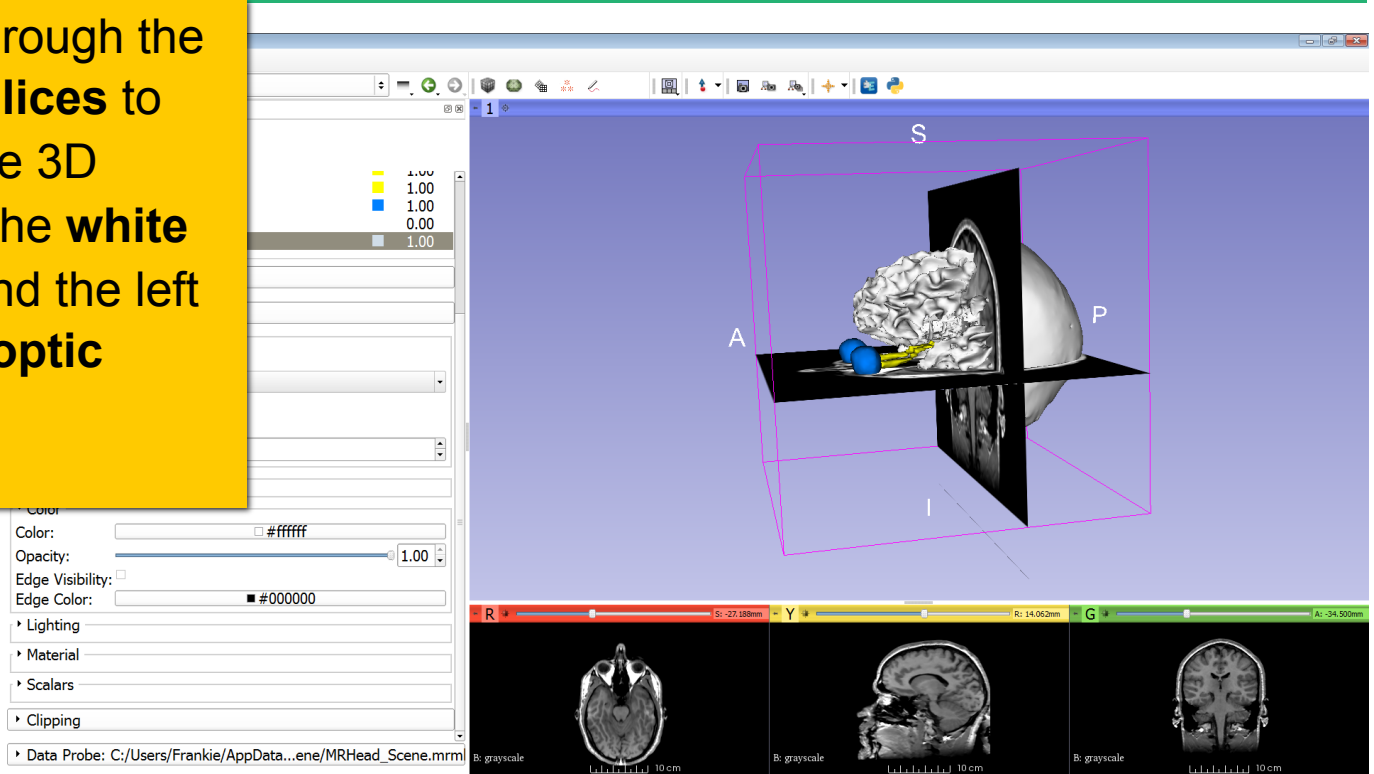
Check the option **Clip**

The screenshot shows the 3D Slicer 4.4.0 interface. The Model Hierarchy on the left lists several models: optic_tract_L.vtk, optic_tract_R.vtk, right_eyeball.vtk, Skin.vtk, and skull_bone.vtk. The 'skull_bone.vtk' model is selected. The Properties panel on the right shows the 'Display' tab expanded, with the 'Visibility' sub-tab also expanded. The 'Clip' checkbox is checked. The 'Color' section shows a color of #ffffff and an opacity of 1.00. The 'Lighting' and 'Material' sections are also visible. The bottom of the interface shows three 2D viewports: Axial, Sagittal, and Coronal, each displaying a grayscale MRI slice of the brain with the skull bone model overlaid.



3D visualization of surface models of the brain

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





3D visualization of surface models of the brain

Uncheck the option **'visible'** to make the skull invisible.

Help & Acknowledgement

Include Fibers Scroll to...

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
- Skin.vtk 0.00
- skull_bone.vtk 1.00

Information

Display

Visibility

Visible: →

View: All

Clip:

Slice Intersections Visible:

Slice Intersections Thickness: 1 px

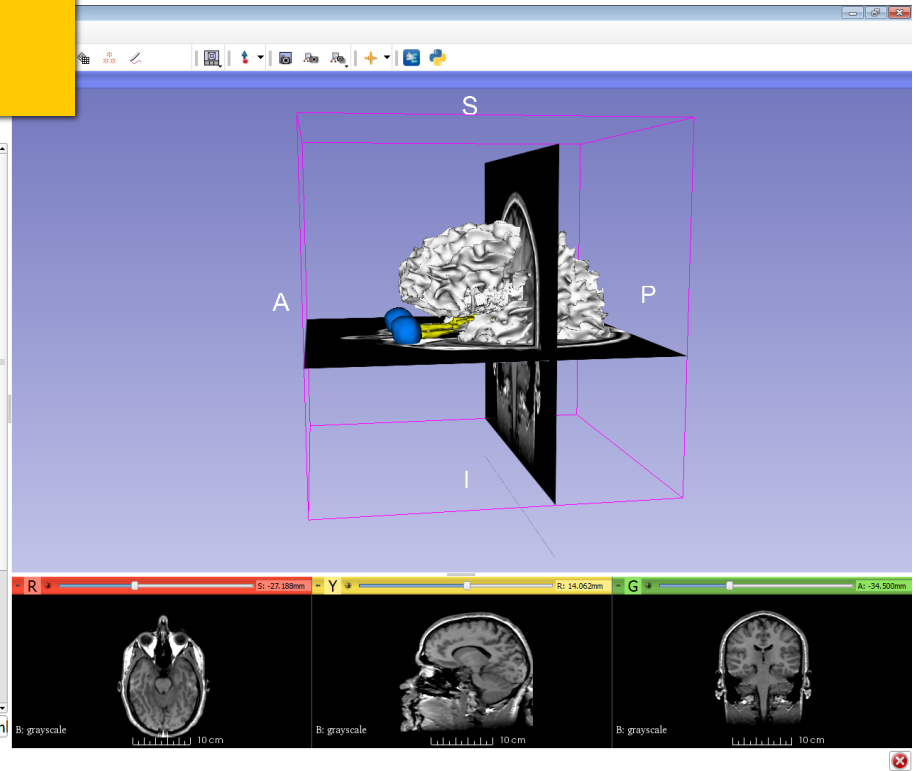
Representation

Color

Color: #ffffff

Opacity: 1.00

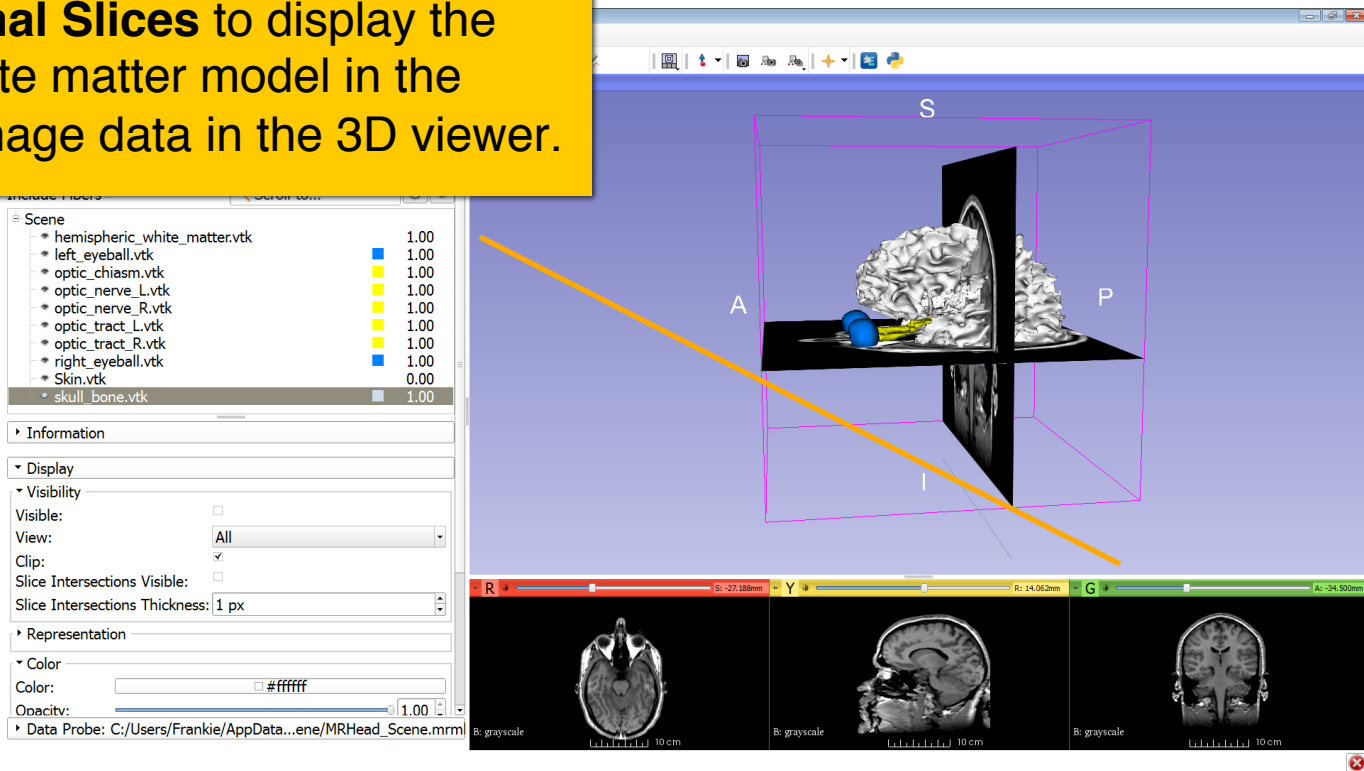
Data Probe: C:/Users/Frankie/AppData...ene/MRHead_Scene.mrm





3D visualization of surface models of the brain

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





3D visualization of surface models of the brain

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

Turn off its **visibility**.

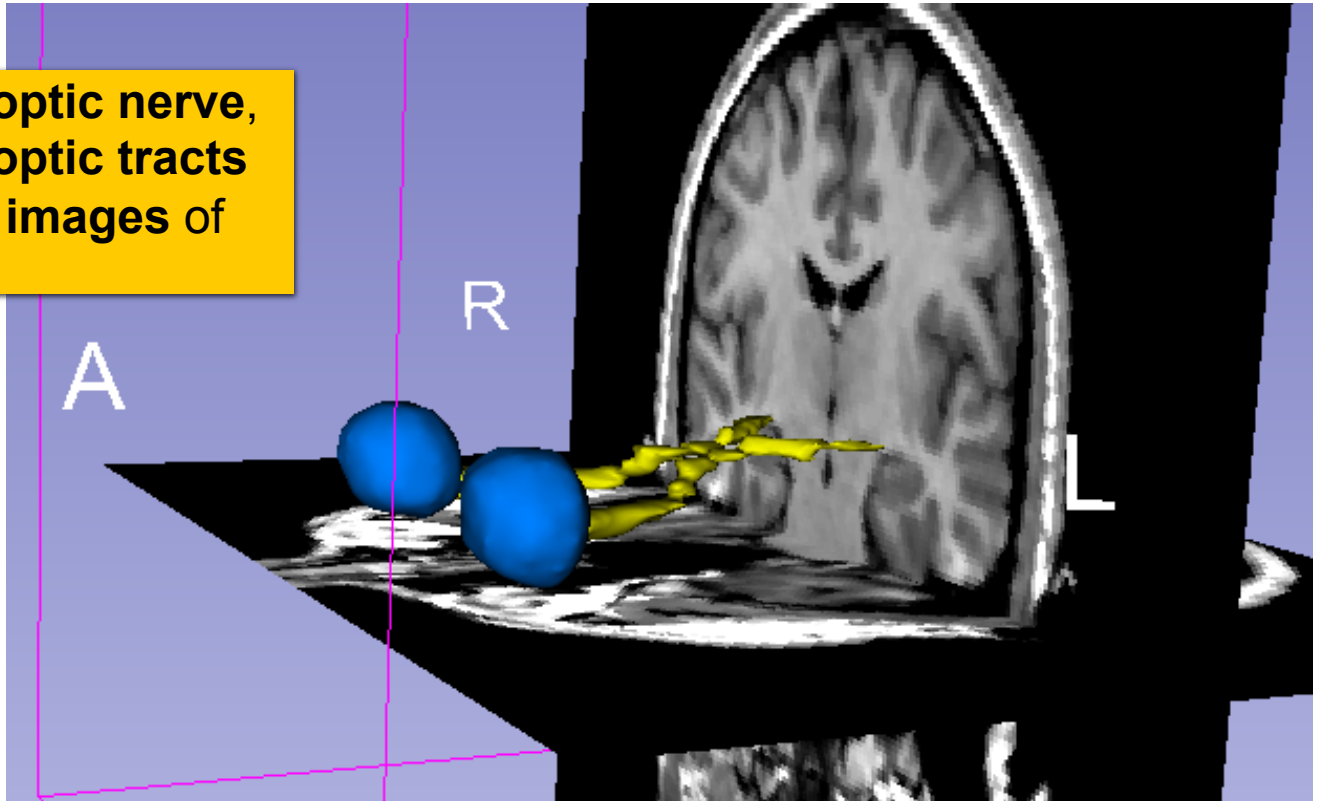
The screenshot shows a software interface with a 3D visualization window on the right and a control panel on the left. The 3D window displays a brain model with a yellow tract and blue spheres, with axes labeled S (Superior), R (Right), P (Posterior), A (Anterior), and I (Inferior). The control panel on the left has a tree view of models, with 'hemispheric_white_matter.vtk' highlighted by a yellow box. Below the tree view, the 'Visibility' section has a 'Visible:' checkbox that is unchecked, indicated by a red arrow. The bottom of the interface shows three grayscale slice views (axial, sagittal, and coronal) with their respective axes and scales.

Model Name	Visibility
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
Skin.vtk	0.00
skull_bone.vtk	1.00



3D visualization of surface models of the brain

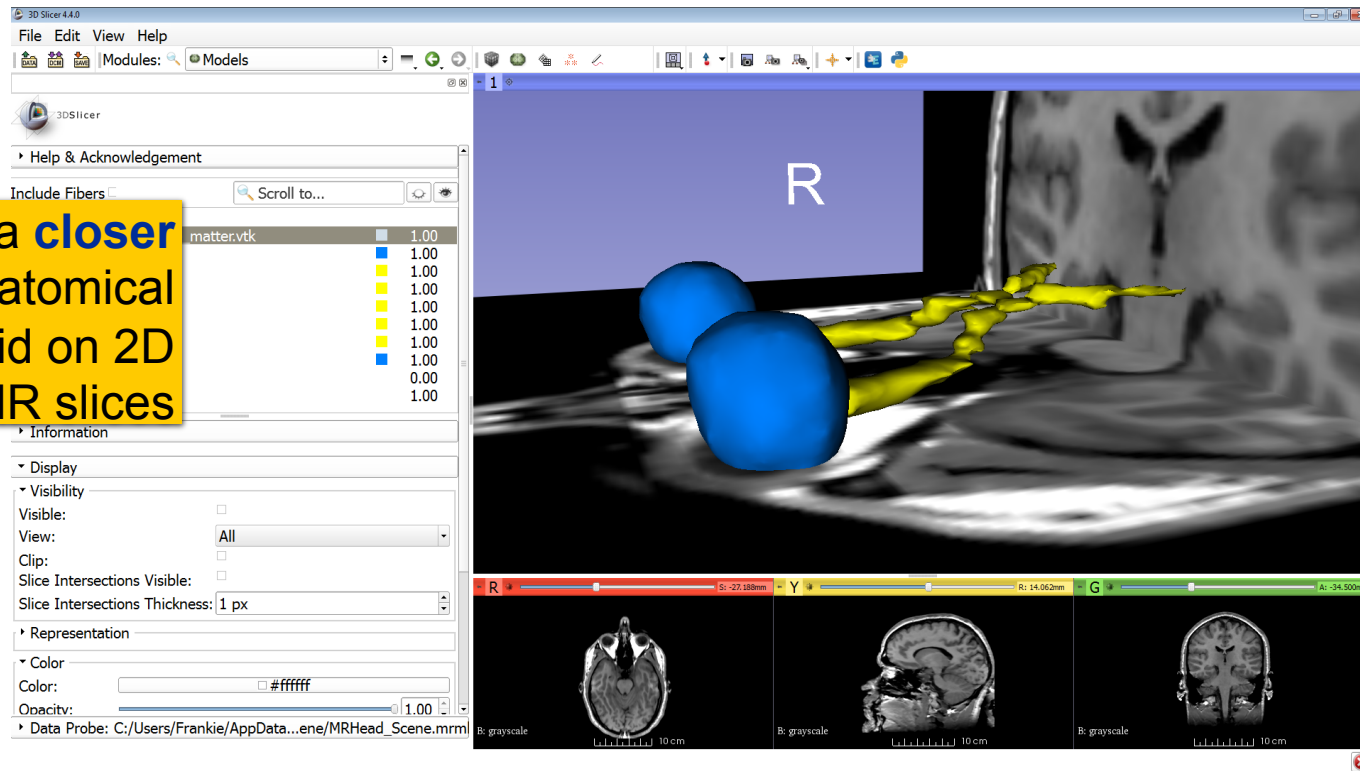
Slicer displays the **optic nerve**, **optic chiasm** and **optic tracts** overlaid on the **MR images** of the brain.





3D visualization of surface models of the brain

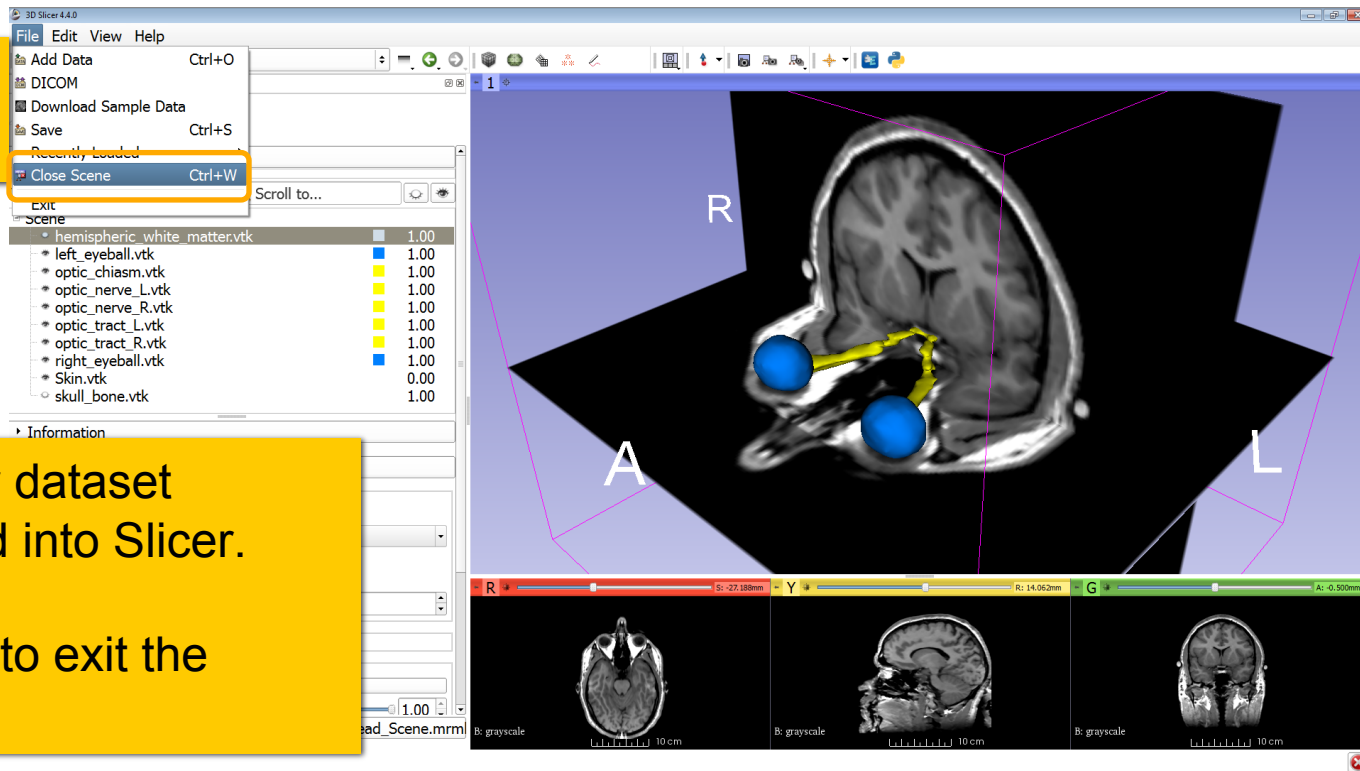
Slicer displays a **closer view** of 3D anatomical structures overlaid on 2D MR slices





Close the existing scene and all its data

Select **File->Close Scene**

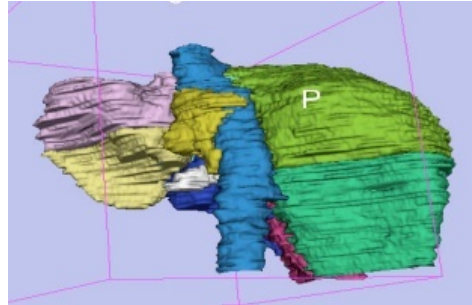
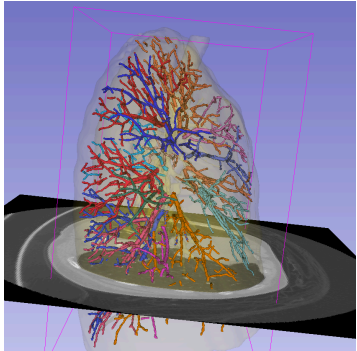
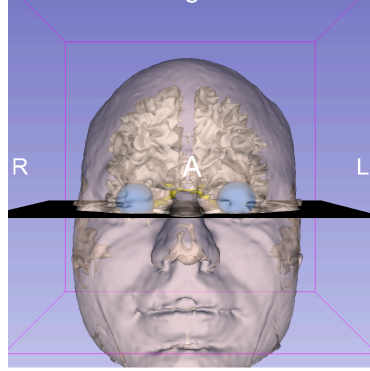
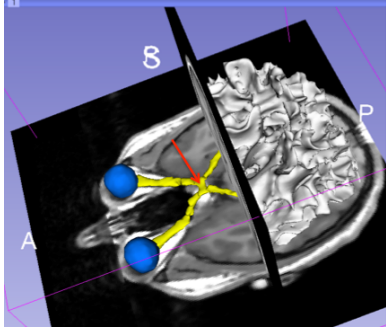


This removes any dataset previously loaded into Slicer.

Select **File→Exit** to exit the software



3D Visualization of DICOM images



- Interactive user-interface to load and manipulate DICOM volumes, labelmaps and 3D models
- User-defined 3D view of the anatomy



3DSlicer

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

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- Feedback
- Documentation

Slicer Wiki

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- Slicer Community
- Source Code
- Licensing
- Mailing Lists
- Web Archive

Powerful processing.	Streamlined interface.	Extensible platform.

3D Slicer

version 4

www.slicer.org

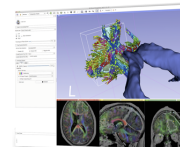
The community of Slicer developers is proud to announce the release of Slicer 4.2. Find out more...

Webinar: Introduction to Slicer 4.1

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3DSlicer



Get Slicer 4.

Slicer 4 is the latest version of 3D Slicer, a free, comprehensive software platform for medical image analysis and visualization developed with NIH support. 3D Slicer is distributed under a permissive BSD-style open source license. It has a thriving user and developer community.

Pre-compiled binaries

		Windows	Mac OS X	Linux
stable release	64 bit	4.4.0 64 bit installer 2014-11-02 (23774 (164.3MB))	4.4.0 64 bit installer 2014-11-02 (23774 (224.0MB))	4.4.0 64 bit archive 2014-11-02 (23774 (244.3MB))
	32 bit	4.3.0 32 bit installer 2013-09-06 (22408 (197.2MB))		
nightly build	64 bit	nightly 64 bit installer 2014-11-14 (23782 (164.3MB))	nightly 64 bit installer 2014-11-17 (23785 (224.0MB))	nightly 64 bit archive 2014-11-17 (23785 (244.3MB))
	32 bit	nightly 32 bit installer 2013-11-24 (22717 (199.0MB))		



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