Applied Chest Imaging Laboratory
Boston, Massachusetts. USA

BRIGHAM AND
WOMEN'S HOSPITAL

HARVARD
MEDICAL SCHOOL

Slicer Introduction

An intro to the Chest Imaging Platform

This tutorial will cover:

- Navigating the 3D Slicer Interface
- Loading DICOMs and other datasets
- 3D volume rendering and visualisation
- Image segmentation techniques
- 3D surface model generation
- Basic image registration
- Fiducials, rulers and regions of interest
- 3D Printing Overview
- Brief overview of other capabilities

Introduction to 3D Slicer

3D Slicer is a free, open source software package available for download on Windows, Linux and Mac Os X. 3D Slicer version 4.5 can be downloaded here.

The development of 3D Slicer has been enabled by the participation of several large scale NIH funded efforts, including the NA-MIC, NAC, BIRN, CIMIT, Harvard Catalyst and NCIGT communities.

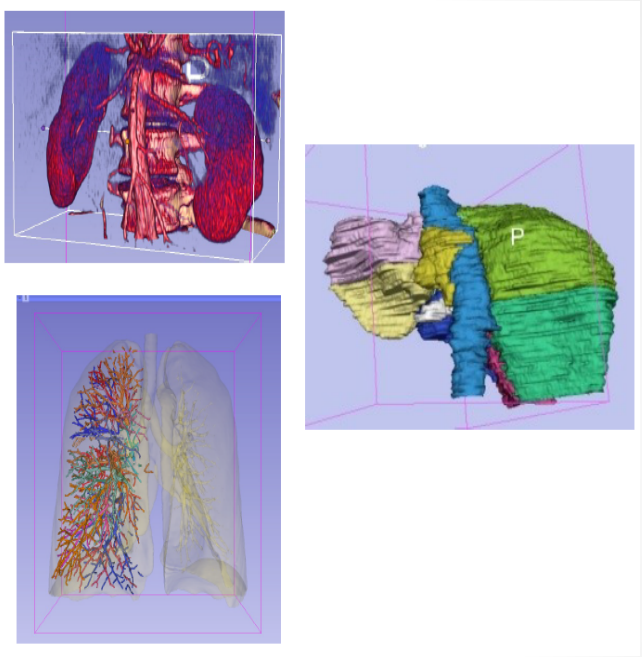


Image credits: ©2012-2014 Surgical Planning Laboratory, ARR

Useful Online Resources

3D Slicer Home Page
3D Slicer Wiki Pages
Slicer-Users Mailing List Archive (Forum help equivalent)
Slicer-Developments Mailing List Archive
3D Slicer Training Documentation

Preparing data for 3D Printing using 3D Slicer - Good introductory video.
A great overview of 3D Slicers capabilities and funding structure by Ron Kikinis.

Medical Imaging

Medical imaging is the process of creating a visual representation of the interior of the body for analysis, diagnosis and medical treatments. Medical imaging includes MRI, CT, Ultrasound, PET, X-Ray etc.

In MRI, for example, a patient is passed through an MRI scanner, which uses fluctuating magnetic fields to form a view of the body, which is then processed into a DICOM file format.

Photo credit: Jan Ainali, 2008, Philips MRI in Sahlgrenska University Hospital, Gothenburg, Sweden.

DICOM File Format

DICOM (Digital Imaging and Communications in Medicine standard) are a widely used and sophisticated set of standards for digital radiology.

DICOM files are produced by a range of medical imaging equipment, (MRI, CT, PET, Ultrasound, etc), consisting of a series or stack of cross- sectional image slices across a region of interest in the body. A stack of slices represent a volume.

3D Slicer can be used to view medical scan data across any angle of intersection with the body, as well as combine these slices to generate a 3 dimensional representation of the body.

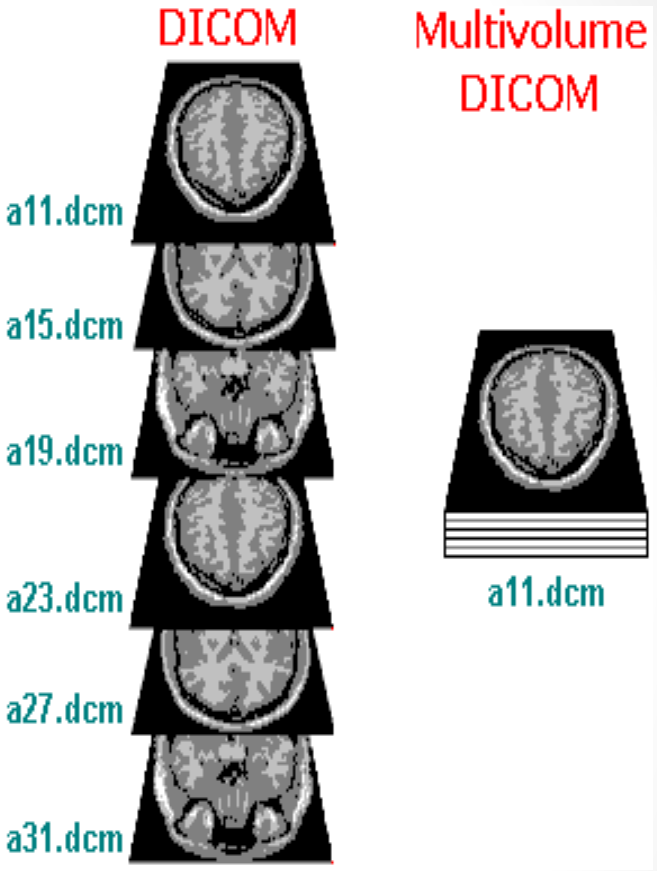


Image source: www.mccauslandcenter.sc.edu/mricro/ezdicom/activex/

DICOM File Format

The DICOM file format also contains metadata, such as:

- Aquisition date and time
- Institution name
- Modality
- Patient name and details (sex, age, birthdate etc)
- Referring Physicians name
- Equipment details
- Data collection parameters
- ...etc

3D Slicer Interface

3D Slicer Layout

Module selection menu

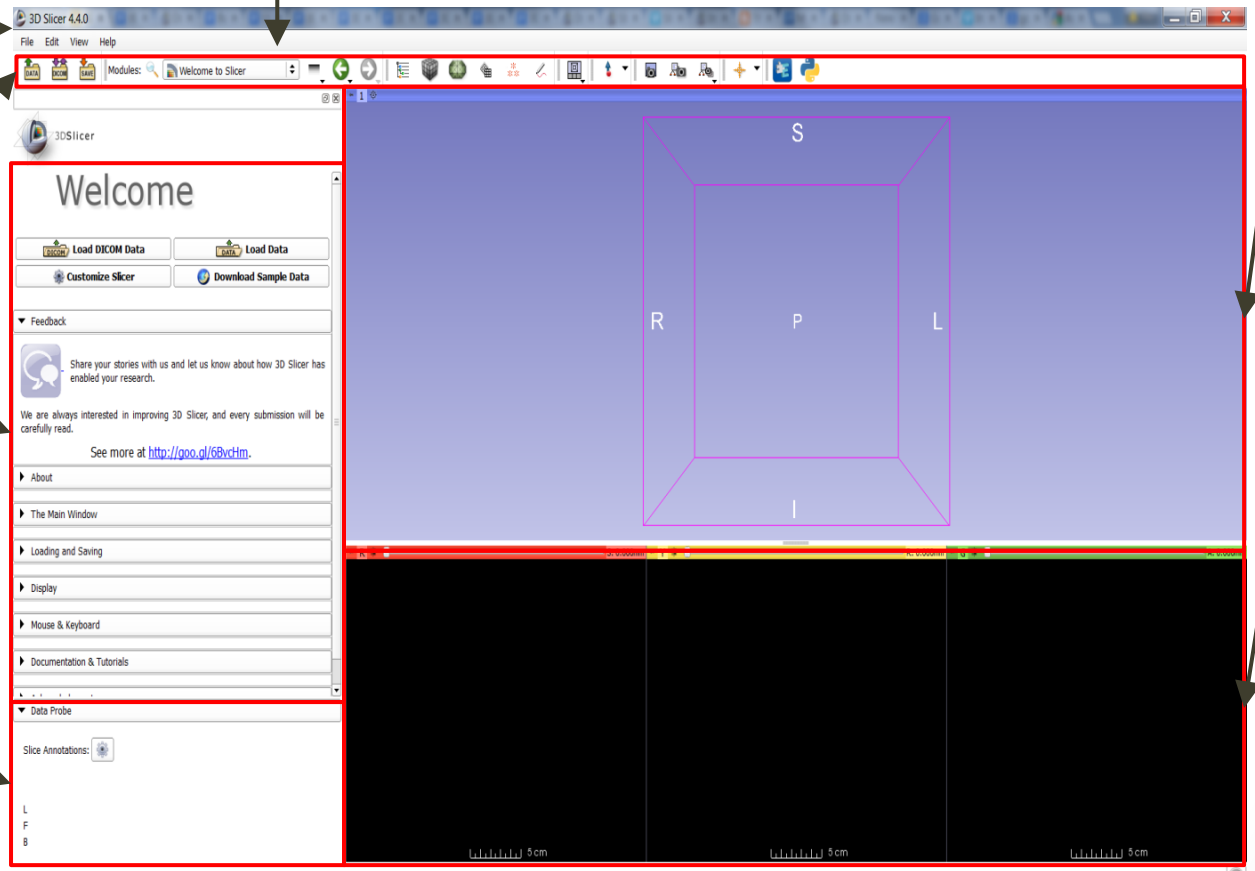
3D Slicer GUI Wiki

Main menu

Toolbar

Module user interface

Data Probe module



3D visualisation window

2D anatomical viewers

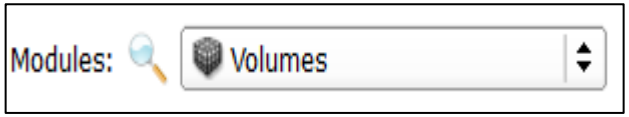
Red Slice

Yellow Slice

Green Slice

3D Slicer (Default) Toolbar

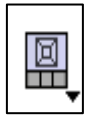
Import Data and DICOMs, save Data and Scenes



Select from list of available modules, by category, alphabetically, or via search.

View or navigate through history of modules used

Selection of core 3D Slicer modules. Left to right: Subject Hierarchy, Volumes, Models, Transforms, Markups, Editor



Change layout of 2D and 3D viewers

Toggle on or off ability of mouse to insert fiducials, rulers, or ROIs

Capture screenshots and scene views

Customise appearance of mouse cross-hairs

Launch Extensions Manager wizard and Python Interactor

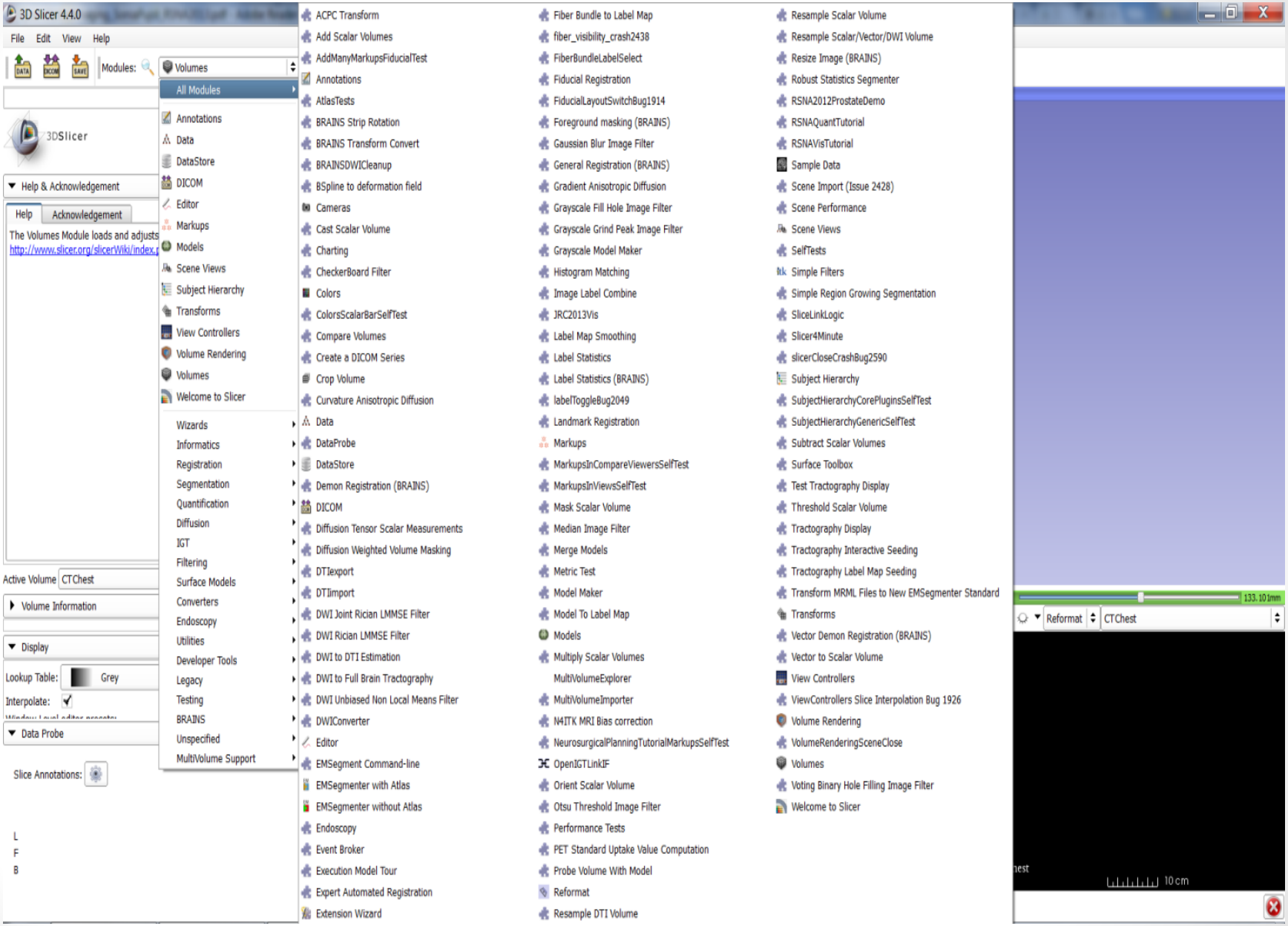
3D Slicer Modules

3D Slicer is modular in nature, and contains over 120 inbuilt modules. Additional modules can also be installed and new modules are continually being developed. You can find the 3D Slicer modules Wiki page here.

Helpful Tip: Help and acknowledgements for each module can be found at the top of that modules user interface.

3D Slicer will always start up in the 'Welcome to Slicer' Module.

'Welcome to Slicer' module user interface


3D Slicer 4.4.0
File Edit View Help
Modules:
Volumes
All Modules
Annotations
Data
DataStore
DICOM
Editor
Markups
Models
Scene Views
Subject Hierarchy
Transforms
View Controllers
Volume Rendering
Volumes
Welcome to Slicer
Wizards
Informatics
Registration
Segmentation
Quantification
Diffusion
IGT
Filtering
Surface Models
Converters
Endoscopy
Utilities
Developer Tools
Legacy
Testing
BRAINS
Unspecified
MultiVolume Support
3DSlicer
Help & Acknowledgement
Help
Acknowledgement
The Volumes Module loads and adjusts
http://www.slicer.org/slicerWiki/index.
Active Volume CTChest
Volume Information
Display
Lookup Table: Grey
Interpolate:
Data Probe
Slice Annotations:
L
F
B
ACPC Transform
Add Scalar Volumes
AddManyMarkupsFiducialTest
Annotations
AtlasTests
BRAINS Strip Rotation
BRAINS Transform Convert
BRAINSDWICleanup
BSpline to deformation field
Cameras
Cast Scalar Volume
Charting
CheckerBoard Filter
Colors
ColorsScalarBarSelfTest
Compare Volumes
Create a DICOM Series
Crop Volume
Curvature Anisotropic Diffusion
Data
DataProbe
DataStore
Demon Registration (BRAINS)
DICOM
Diffusion Tensor Scalar Measurements
Diffusion Weighted Volume Masking
DTIexport
DTIimport
DWI Joint Rician LMMSE Filter
DWI Rician LMMSE Filter
DWI to DTI Estimation
DWI to Full Brain Tractography
DWI Unbiased Non Local Means Filter
DWIConverter
Editor
EMSegment Command-line
EMSegmenter with Atlas
EMSegmenter without Atlas
Endoscopy
Event Broker
Execution Model Tour
Expert Automated Registration
Extension Wizard
Fiber Bundle to Label Map
fiber_visibility_crash2438
FiberBundleLabelSelect
Fiducial Registration
FiducialLayoutSwitchBug1914
Foreground masking (BRAINS)
Gaussian Blur Image Filter
General Registration (BRAINS)
Gradient Anisotropic Diffusion
Grayscale Fill Hole Image Filter
Grayscale Grind Peak Image Filter
Grayscale Model Maker
Histogram Matching
Image Label Combine
JRC2013Vis
Label Map Smoothing
Label Statistics
Label Statistics (BRAINS)
labelToggleBug2049
Landmark Registration
Markups
MarkupsInCompareViewersSelfTest
MarkupsInViewsSelfTest
Mask Scalar Volume
Median Image Filter
Merge Models
Metric Test
Model Maker
Model To Label Map
Models
Multiply Scalar Volumes
MultiVolumeExplorer
MultiVolumeImporter
N4ITK MRI Bias correction
NeurosurgicalPlanningTutorialMarkupsSelfTest
OpenIGTLinkIF
Orient Scalar Volume
Otsu Threshold Image Filter
Performance Tests
PET Standard Uptake Value Computation
Probe Volume With Model
Reformat
Resample DTI Volume
Resample Scalar Volume
Resample Scalar/Vector/DWI Volume
Resize Image (BRAINS)
Robust Statistics Segmenter
RSNA2012ProstateDemo
RSNAQuantTutorial
RSNAVisTutorial
Sample Data
Scene Import (Issue 2428)
Scene Performance
Scene Views
SelfTests
Simple Filters
Simple Region Growing Segmentation
SliceLinkLogic
Slicer4Minute
slicerCloseCrashBug2590
Subject Hierarchy
SubjectHierarchyCorePluginsSelfTest
SubjectHierarchyGenericSelfTest
Subtract Scalar Volumes
Surface Toolbox
Test Tractography Display
Threshold Scalar Volume
Tractography Display
Tractography Interactive Seeding
Tractography Label Map Seeding
Transform MRML Files to New EMSegmenter Standard
Transforms
Vector Demon Registration (BRAINS)
Vector to Scalar Volume
View Controllers
ViewControllers Slice Interpolation Bug 1926
Volume Rendering
VolumeRenderingSceneClose
Volumes
Voting Binary Hole Filling Image Filter
Welcome to Slicer
133.10 mm
Reformat
CTChest
10 cm

3D Slicer Core Modules

These are the major modules that are part of the standard Slicer distribution:

Welcome to Slicer

Sample Data

DICOM

Data

Data Store

View Controllers

Volume Rendering

Volumes

Editor

Subject Hierarchy

- Markups
- Annotations
- Scene Views
- Model Maker
- Crop Volume
- Models
- Simple Filters
- Label Statistics
- Transforms
- Landmark Registration

Importing DICOMs and other datasets

What does a DICOM dataset look like

A DICOM dataset is typically comprised of a collection of many small .dcm files

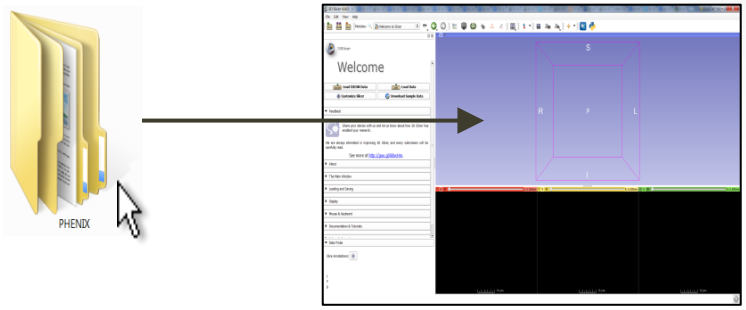
MRIHead001.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead002.dcm	15/05/2015 2:03 PM	DCM File	516 KB
MRIHead003.dcm	15/05/2015 2:03 PM	DCM File	516 KB
MRIHead004.dcm	15/05/2015 2:03 PM	DCM File	516 KB
MRIHead005.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead006.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead007.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead008.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead009.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead010.dcm	15/05/2015 2:04 PM	DCM File	516 KB
⋮			
MRIHead327.dcm	15/05/2015 2:04 PM	DCM File	516 KB

=126MB total size

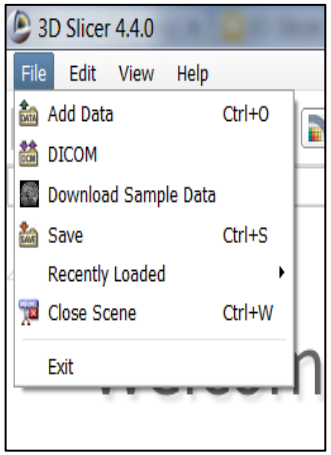
Importing a DICOM File

Multiple Approaches:

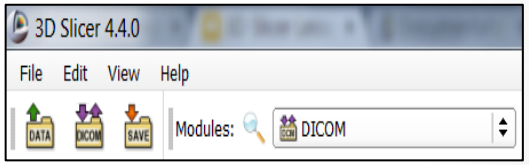
- Drag and drop DICOM data set (directory folder) into 3D Slicer window



- File -> DICOM

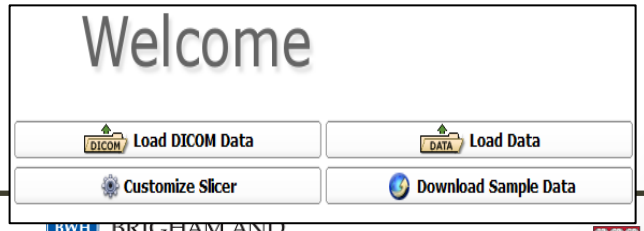


or



- Find DICOM icon in toolbar or select DICOM Module

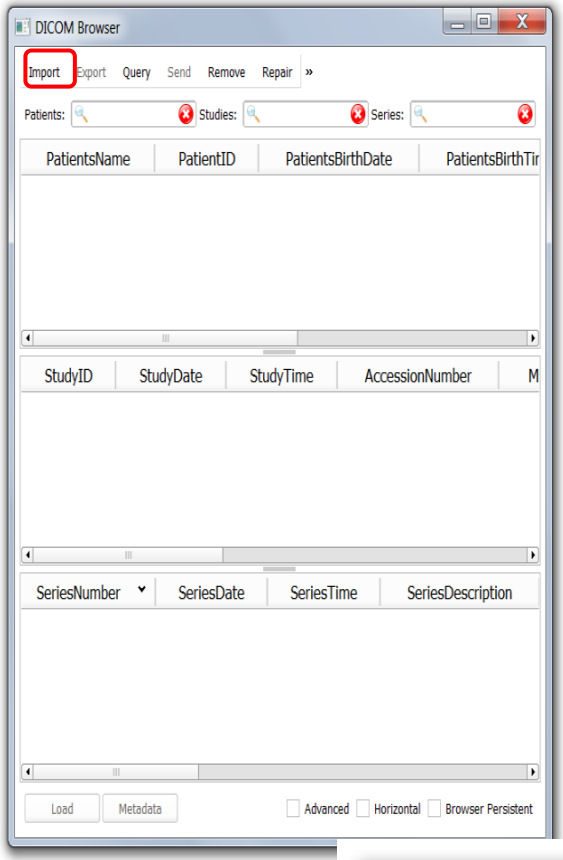
- Welcome Module -> Load DICOM Data



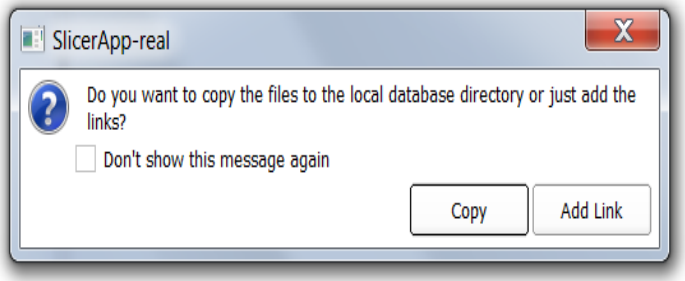
Importing a DICOM File

All methods bar ‘drag and drop’ will open the DICOM Browser.

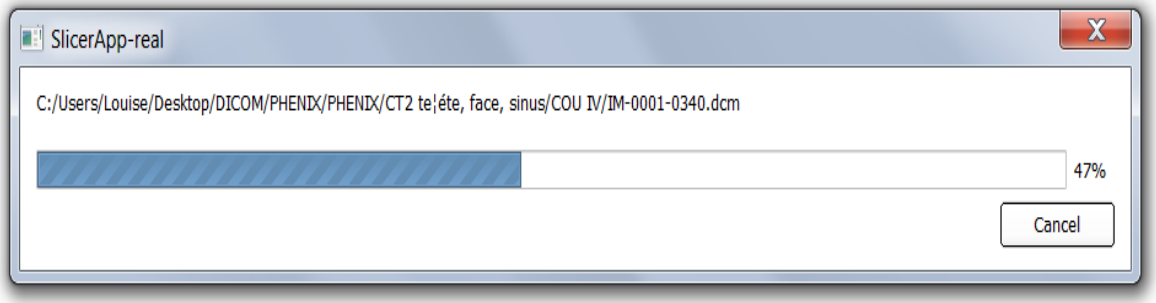
Select ‘Import’. Find data set and open.

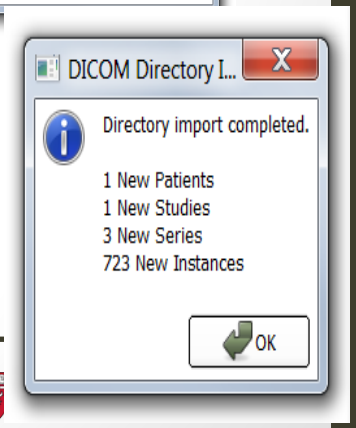


Select ‘Copy’
Or ‘Add Link’



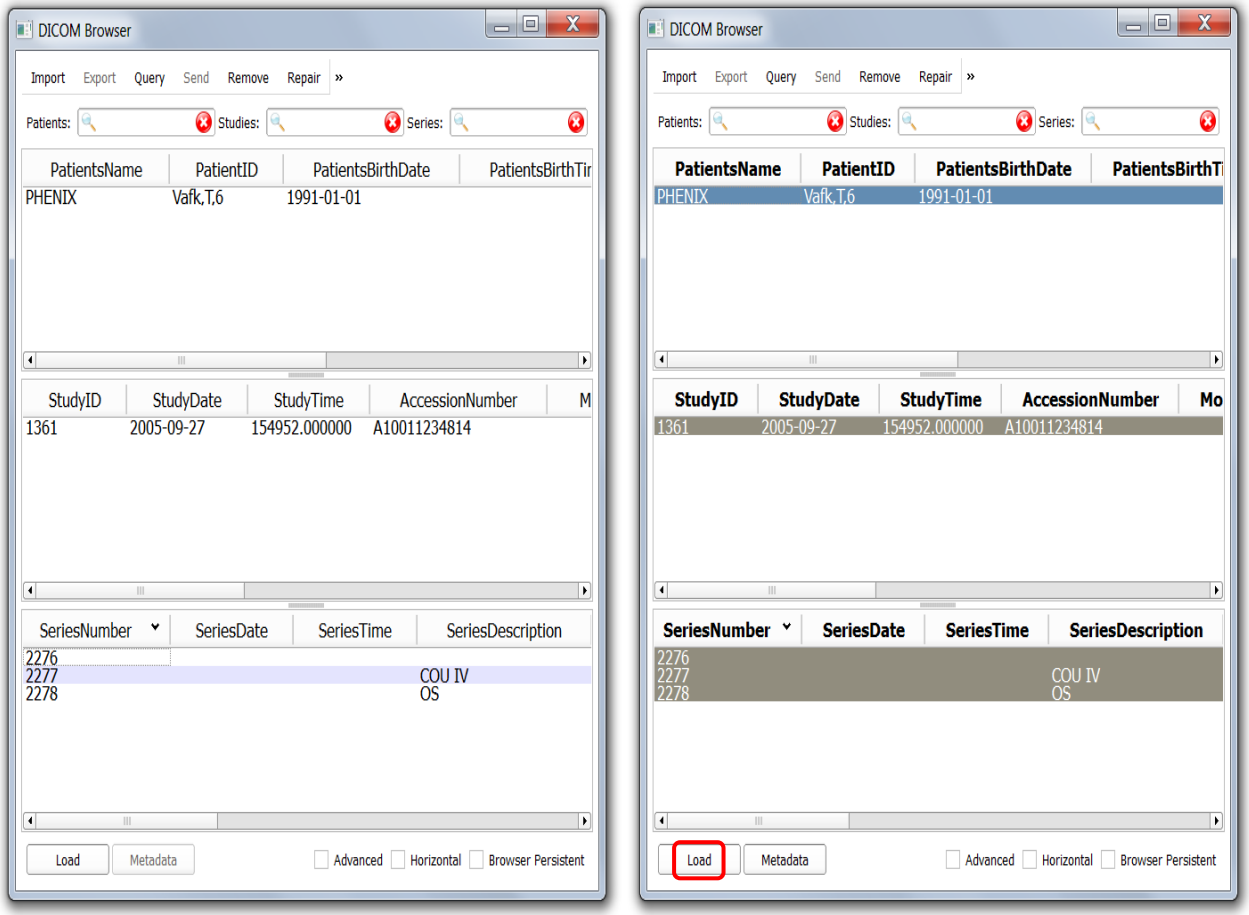
Data will load





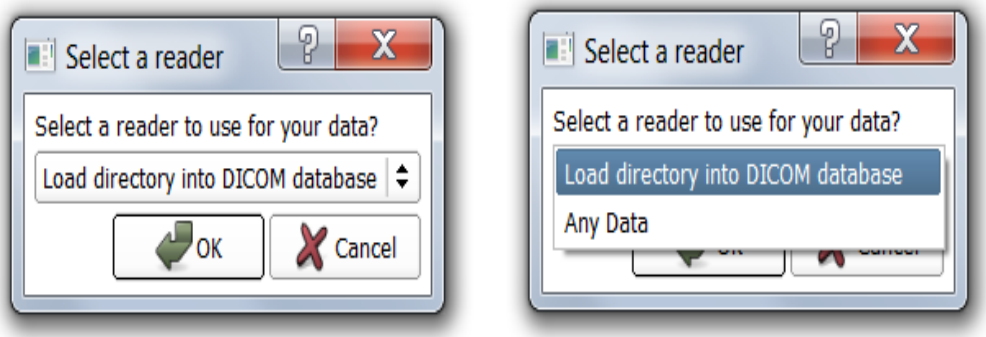
Importing a DICOM File

Select data sets and ‘Load’



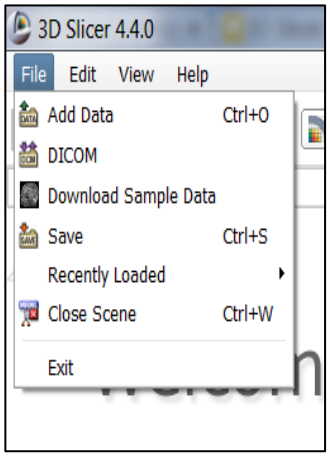
Importing a DICOM File

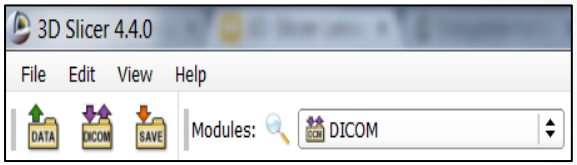
For ‘drag and drop’, a different window appears.
Select ‘Load directory into DICOM database’

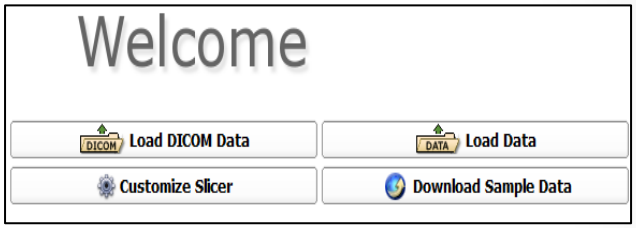


Importing other Data or a Scene

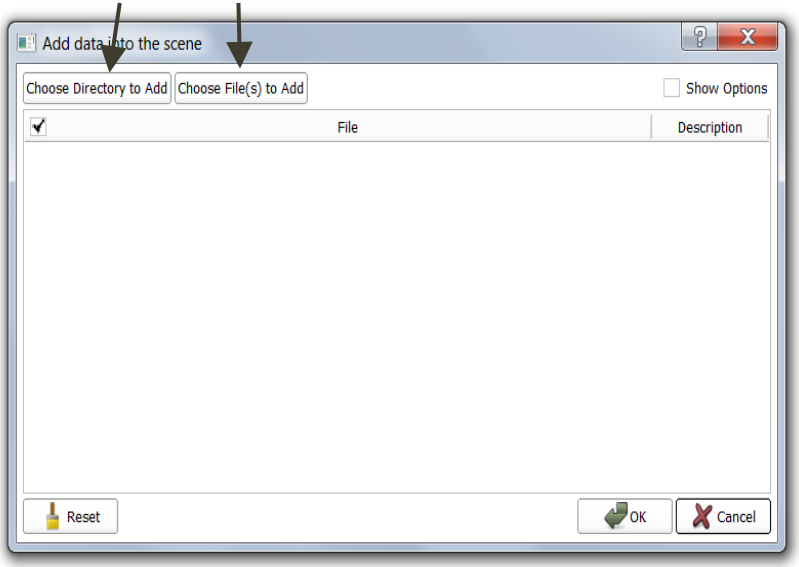
- Select File -> Add Data
- Welcome to Slicer module -> Load Data
- Find DATA icon in toolbar







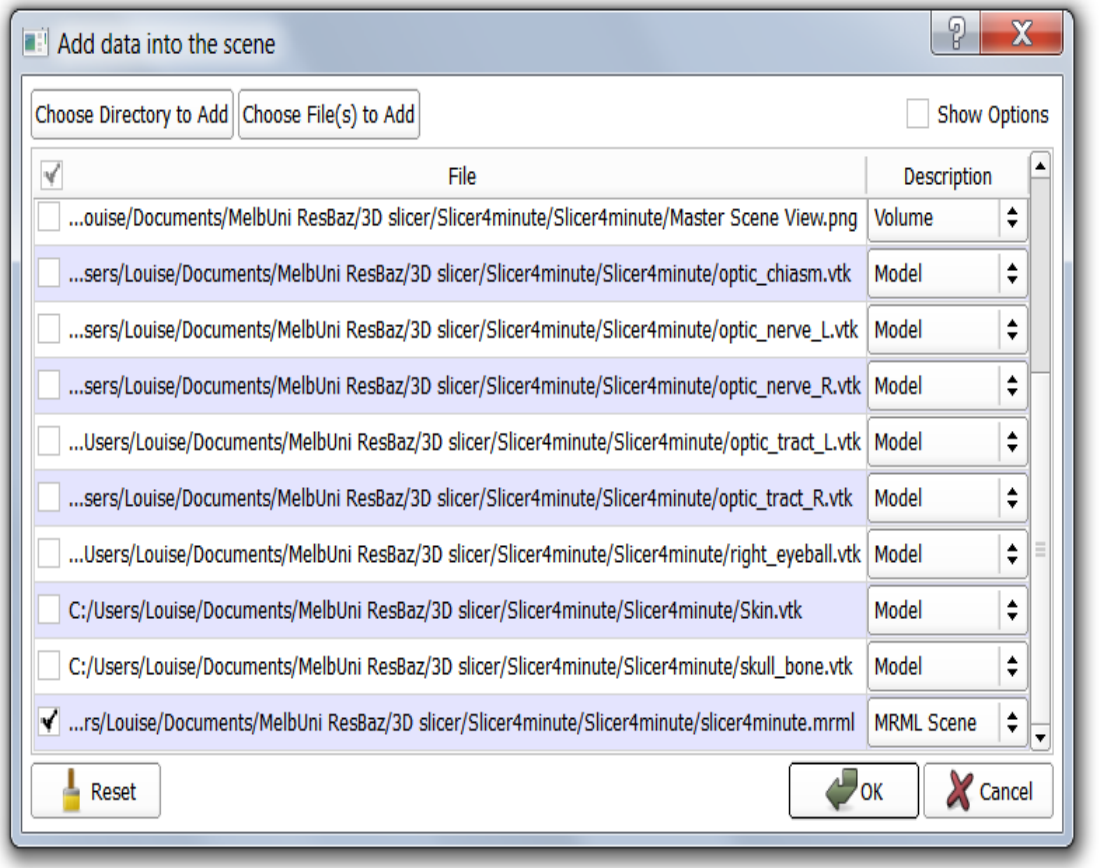
Select folder **Select file(s)**



Importing other Data or a Scene

E.g. Choose directory to add -> **Slicer4minute** (online tutorial)

In this instance we only need to select .mrml (scene) file



Data Visualization

INTRODUCTION TO 3D SLICER

Module: Welcome to Slicer

The Welcome to Slicer module is provided to introduce new users to Slicer's basic functionality, and to provide pointers to additional useful resources, such as downloadable sample data, support material, and acknowledgements etc.

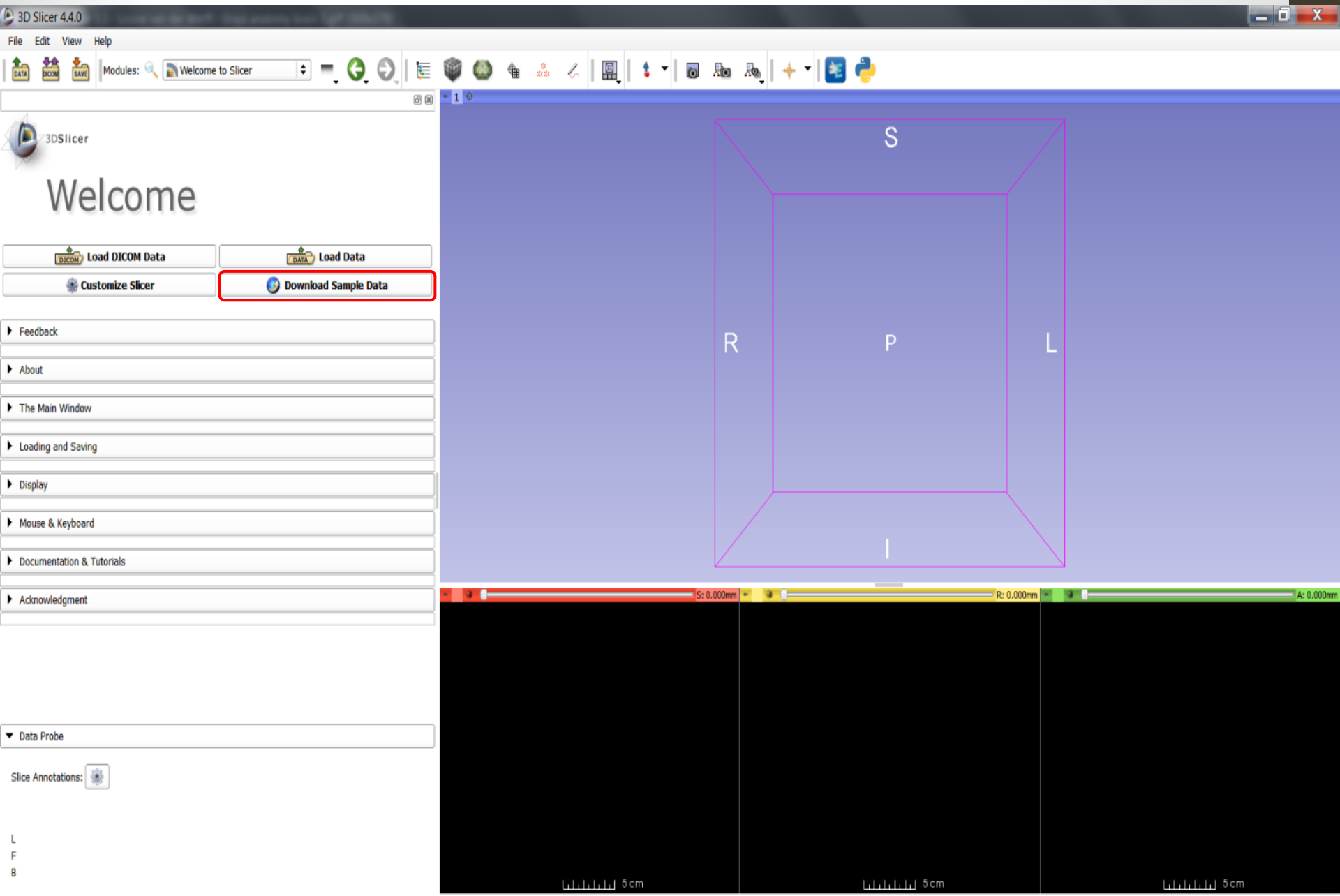
Welcome to Slicer is the default module when 3D Slicer is launched.

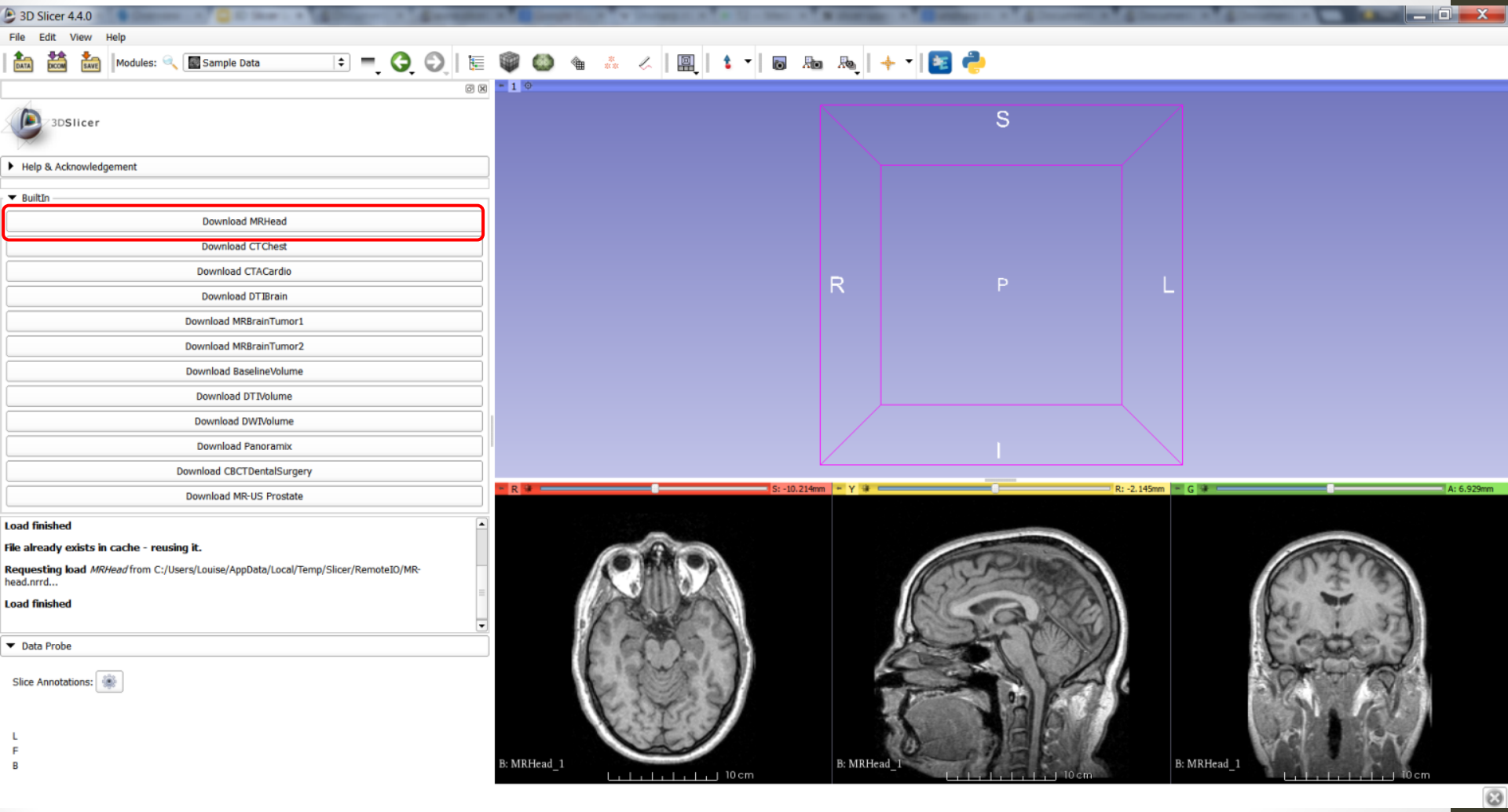
Wiki Help Link

Basic Navigation

Let’s open some sample data to learn navigation basics.
‘Welcome to Slicer’ module ->
‘Download Sample Data’ ->
‘Download MRHead’

The sample data will download and appear within the 2D anatomical viewers.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Welcome to Slicer
3DSlicer
Welcome
Load DICOM Data
Load Data
Customize Slicer
Download Sample Data
Feedback
About
The Main Window
Loading and Saving
Display
Mouse & Keyboard
Documentation & Tutorials
Acknowledgment
Data Probe
Slice Annotations:
L
F
B
S
R
P
L
I
S: 0.000mm
R: 0.000mm
A: 0.000mm
5 cm
5 cm
5 cm


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Sample Data
3DSlicer
Help & Acknowledgement
BuiltIn
Download MRHead
Download CTChest
Download CTACardio
Download DTIBrain
Download MRBrainTumor1
Download MRBrainTumor2
Download BaselineVolume
Download DTIVolume
Download DWIVolume
Download Panoramix
Download CBCTDentalSurgery
Download MR-US Prostate
Load finished
File already exists in cache - reusing it.
Requesting load MRHead from C:/Users/Louise/AppData/Local/Temp/Slicer/RemoteIO/MR-head.nrrd...
Load finished
Data Probe
Slice Annotations:
L
F
B
S
R
P
L
I
B: MRHead_1
10 cm
B: MRHead_1
10 cm
B: MRHead_1
10 cm

2D Viewer Coordinate System

3D Slicer implements the following nomenclature to define the directional views in DICOM images.

- Axial plane: Separates the head (**S**uperior) from the feet (**I**nferior)
- *Coronal plane*: Separates the Front (**A**nterior) from the Back (**P**osterior)
- *Sagittal plane*: Separates the **L**eft from the **R**ight

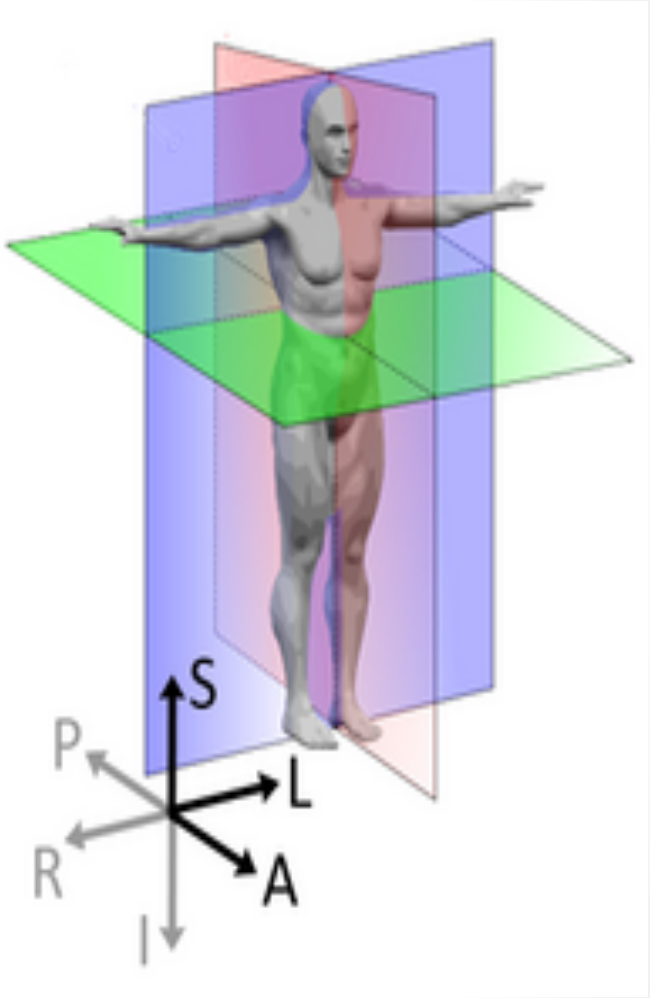
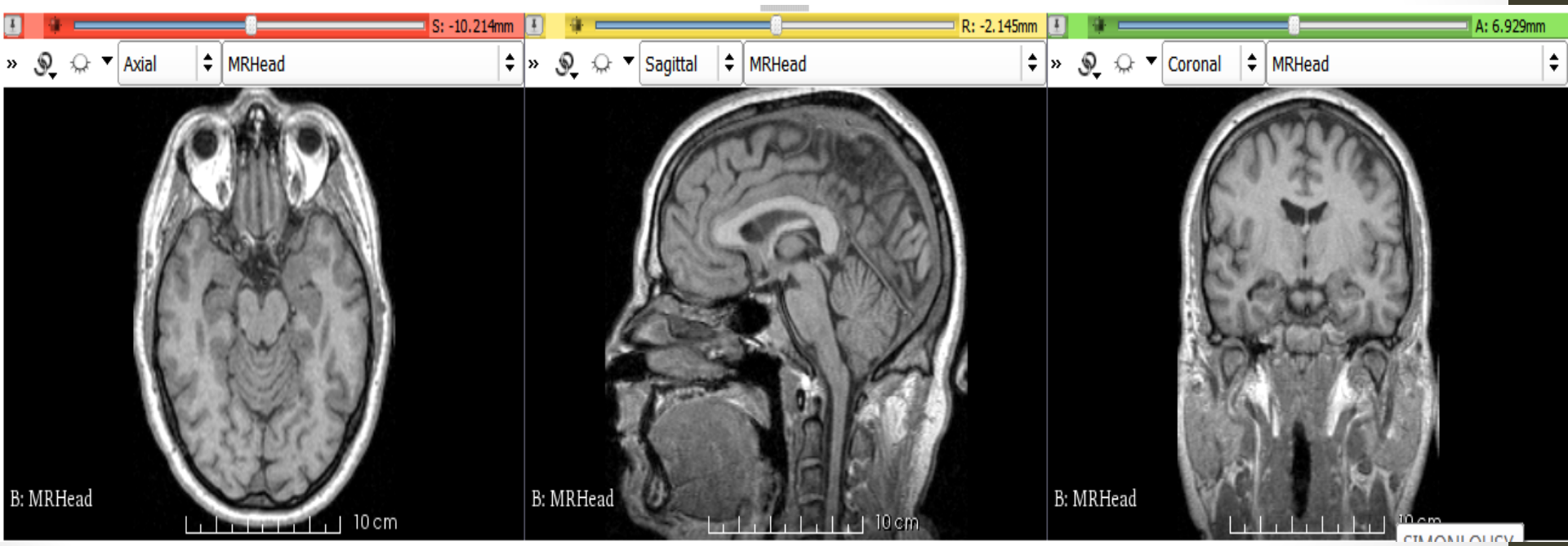


Image from 3D Slicer wiki

See the 3D Slicer coordinate systems wiki help page.

2D Anatomical Viewers

The three 2D anatomical viewers in 3D Slicer are defined by Red, Yellow and Green windows.



Axial Sagittal Coronal

Basic tips and tricks in 2D Viewers

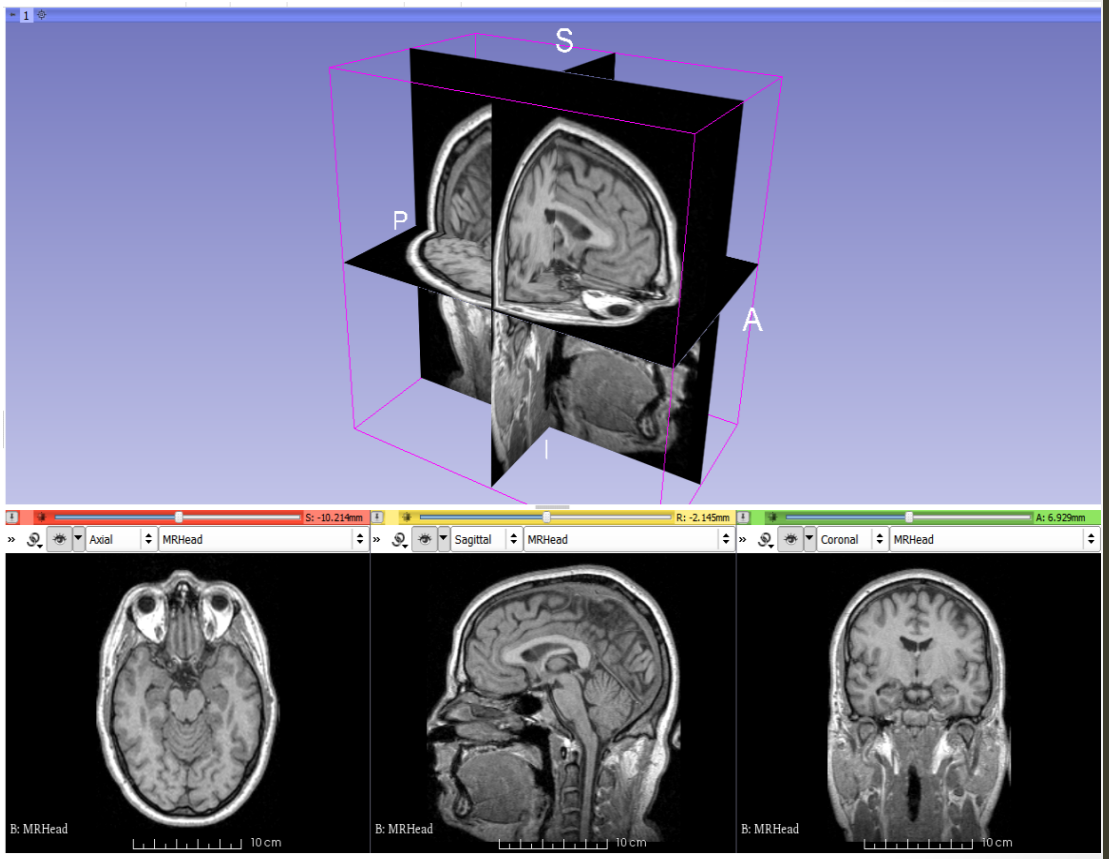
- Left clicking and dragging mouse up or down will change the **brightness** of scan data down and up respectively. *(brightness = level)*
- Left clicking and dragging mouse right and left will change the **contrast** of scan data down and up respectively. *(contrast = window)*
- Right clicking and dragging mouse up and down will **zoom** image out and in respectively.
- Middle clicking and dragging mouse around will **pan/translate** the image.
- Holding 'shift' & hovering the mouse over an area in one view plane will cause the other two views to scroll to the same position (using cross-hairs button in toolbar may be useful here).

Mouse and Keyboard Shortcuts Wiki Help Link.

2D Anatomical Viewers

The eye icon appears throughout 3D Slicer and can be toggled open and closed by the user via a mouse click. It is used to toggle views on and off.

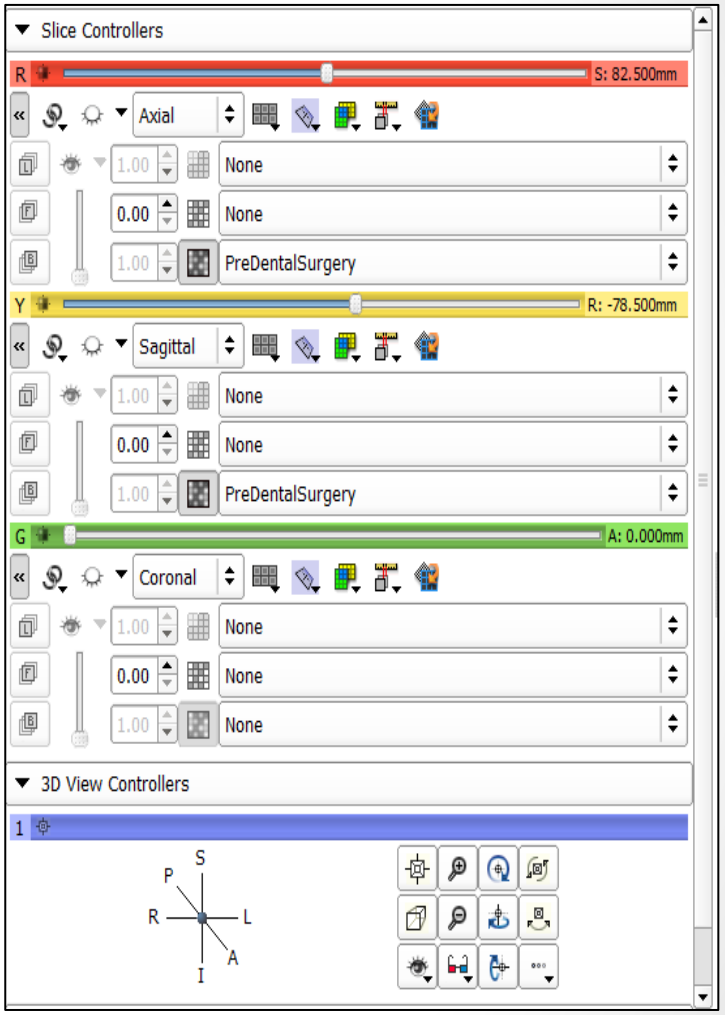
Within the 2D anatomical viewers, **opening the eye** inserts the 2D anatomical planes into the 3D visualisation window.



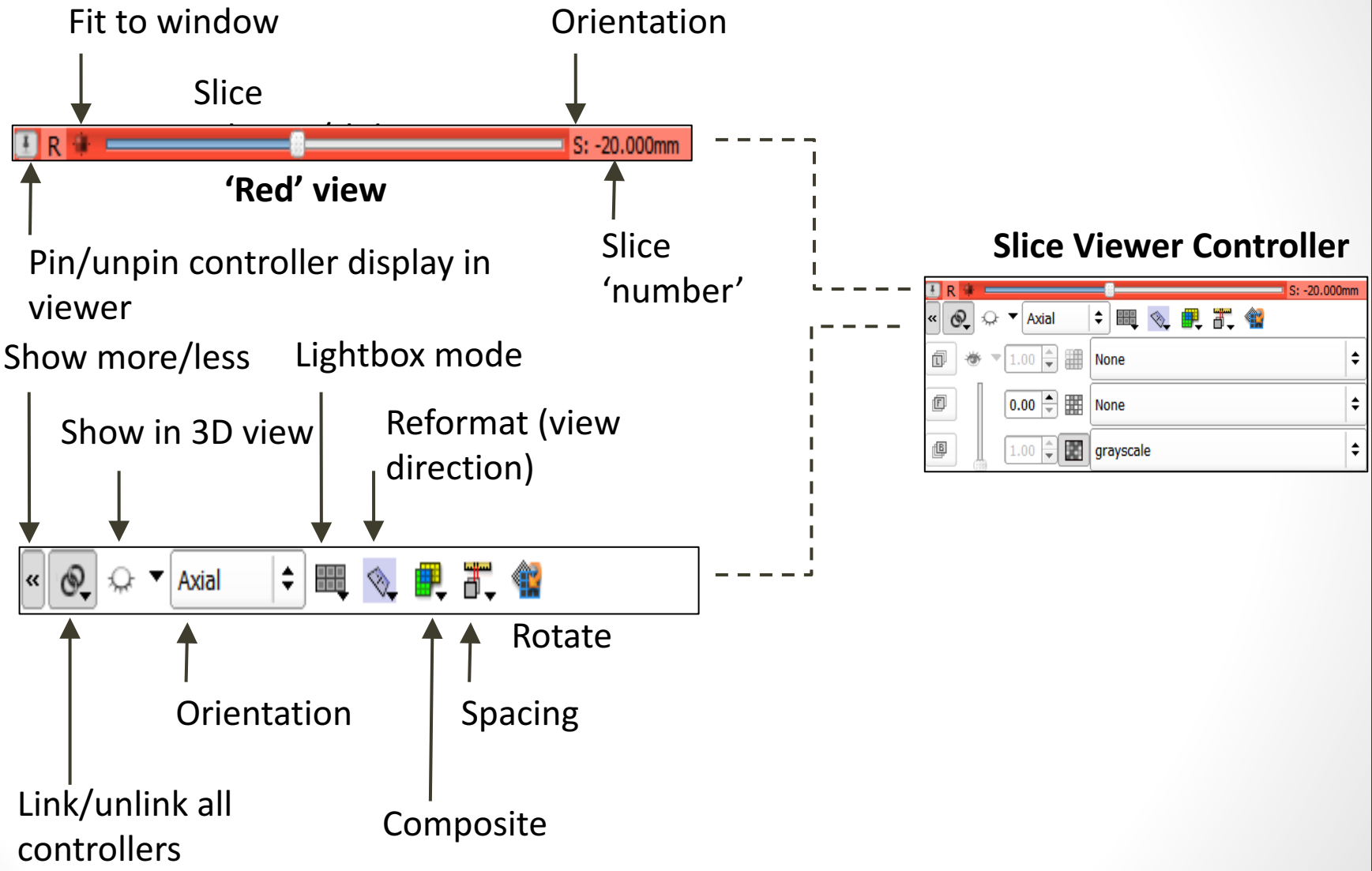
Module: View Controllers

The View Controllers module centralises the control panels for the three 2D anatomical viewers (2D Slice Controllers) and the 3D visualisation window (3D View Controllers) for ease of use.

Wiki Help Link



2D View Controllers

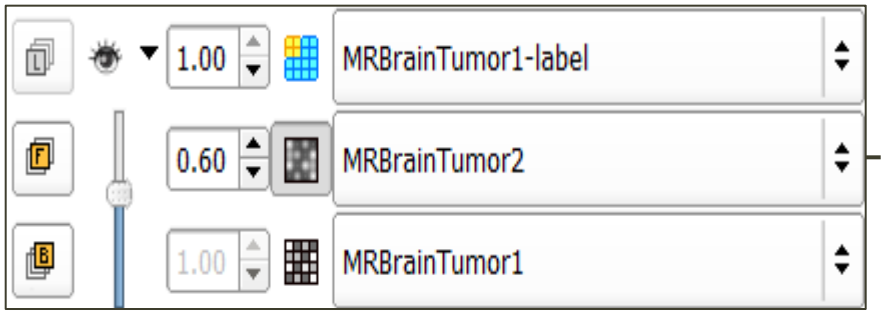


2D View Controllers

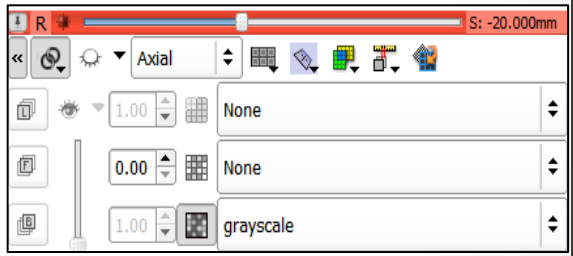
Layer options
Label (L),
Foreground (F) and
Background (B) layers

Show /hide

Toggle labelmap filled or contour



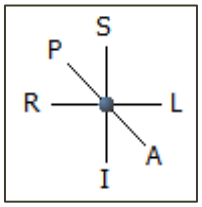
Slice Viewer Controller



Opacity slider and layer specific values

Interpolation (switch between pixelated and smoothed images

3D View Controllers



Click to set view direction in 3D viewer

Centre onto the scene

Zoom in and out

Rock and spin the 3D view

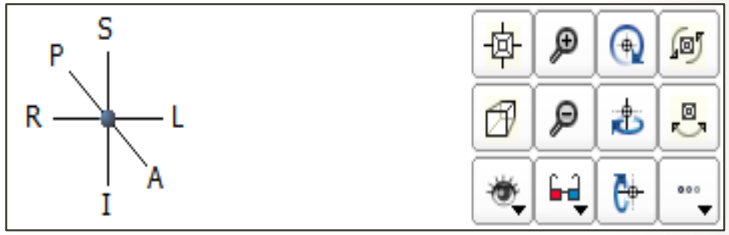
Use ‘depth peeling’

‘Roll’, ‘yawn’ or ‘pitch’ the view of the scene

Stereoscopic viewing options

Change background colour/toggle visibility of elements

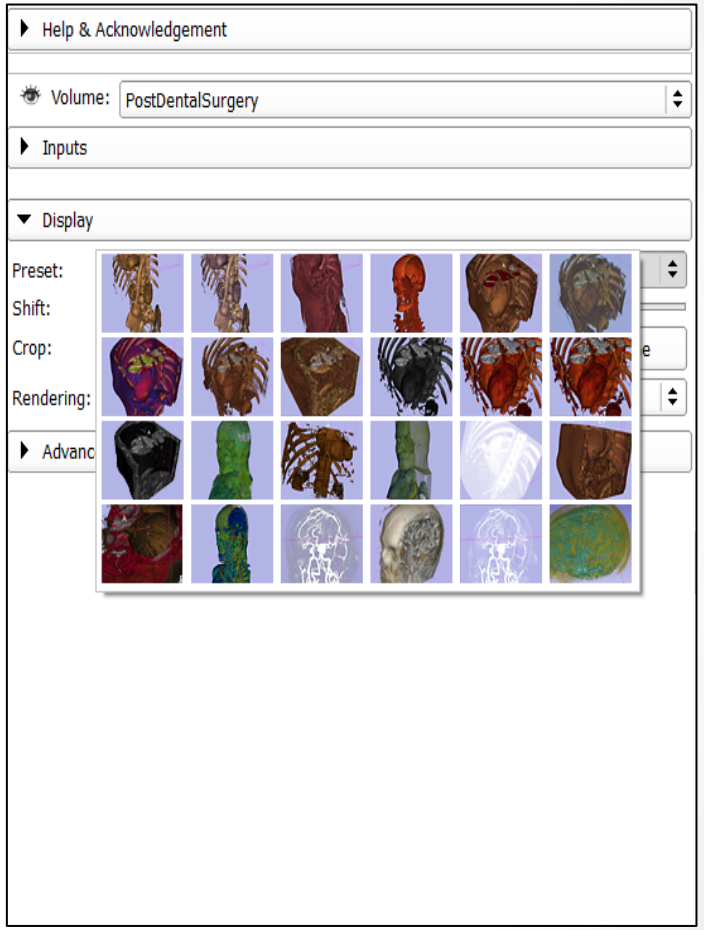
3D viewer controller



Module: Volume Rendering

This module provides a method to quickly and interactively visualize 3D image data.

Wiki Help Link



Volume Rendering Module

1. Use the volume rendering tool to visualise the ‘CTChest’ dataset in 3D space.

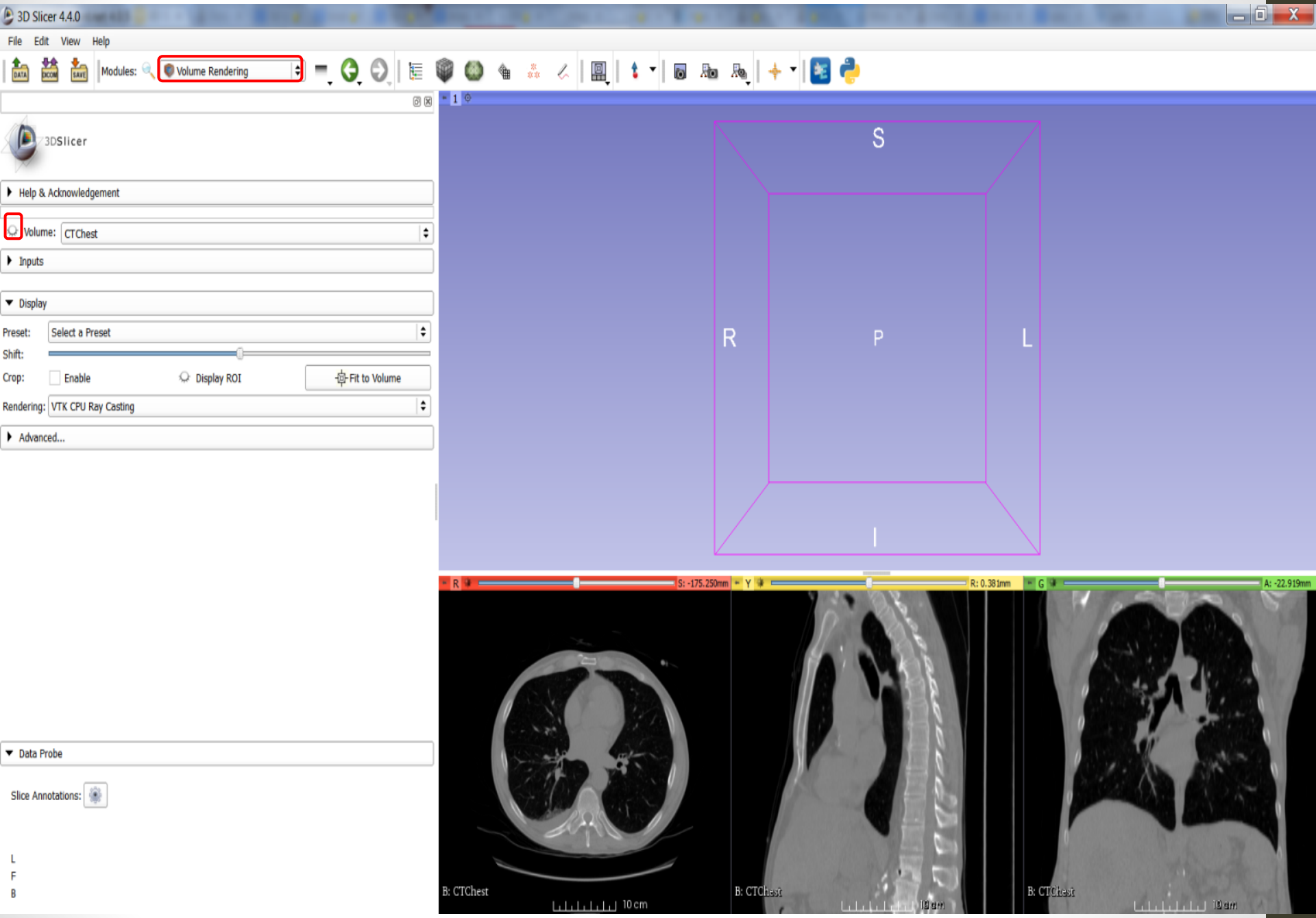
2. Download ‘CTChest’ Sample Data from ‘Welcome to Slicer’ module.

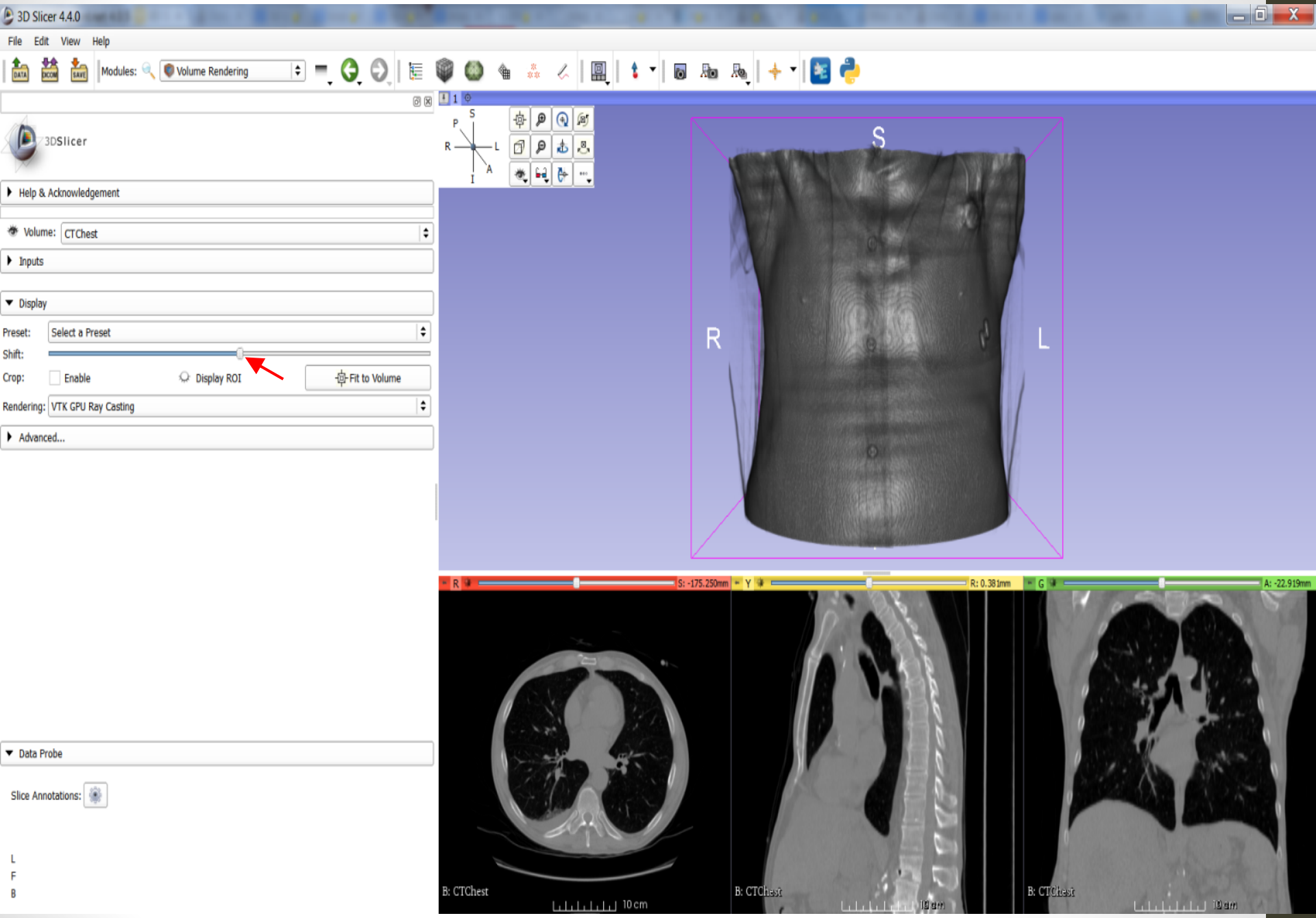
3. Select **‘Volume Rendering’** module.

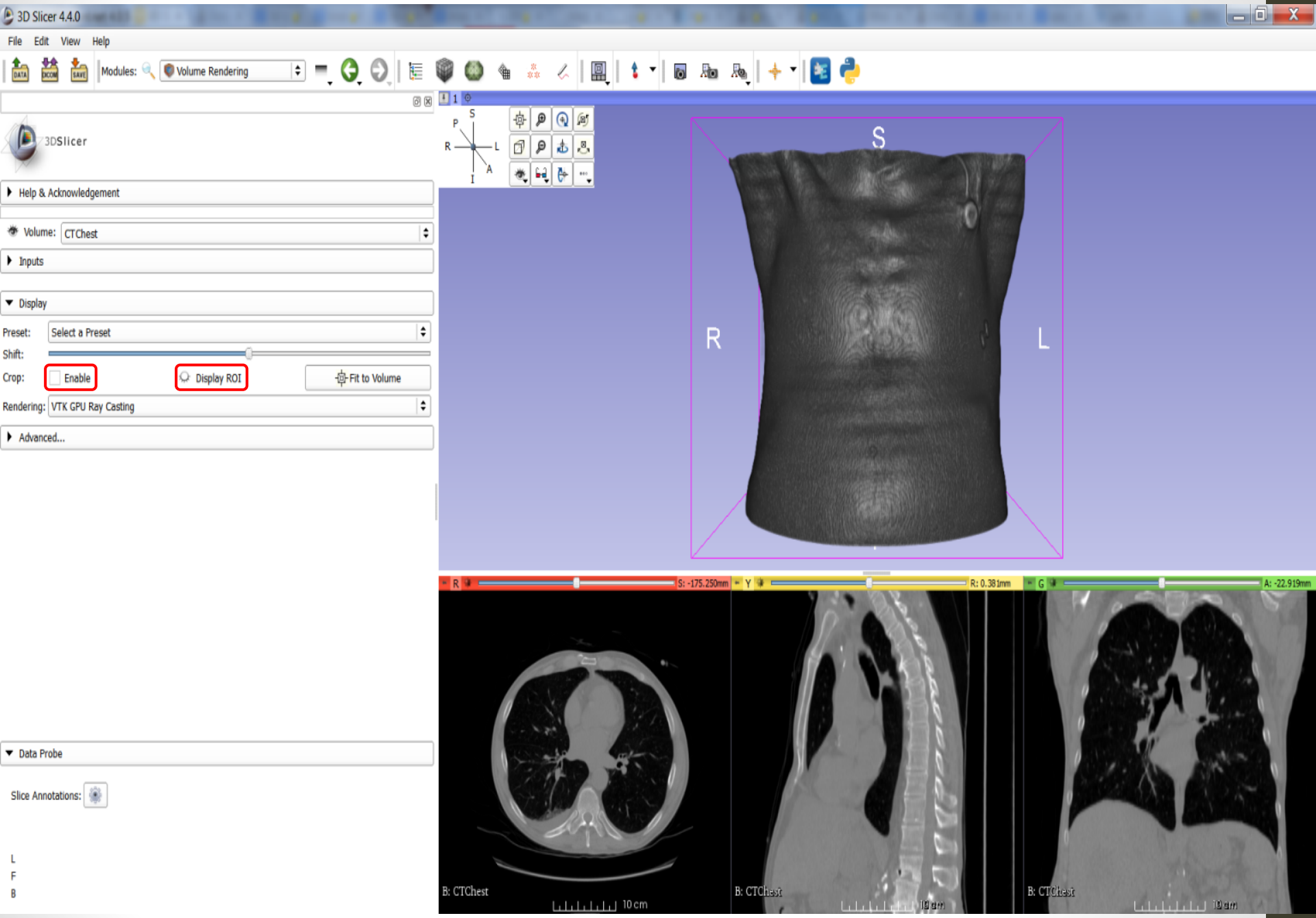
4. Open eye icon next to ‘Volume’ to generate 3D rendering of DICOM volume. Adjust view as required.

5. Under ‘Display’ menu, adjust ‘Shift’ slider to remove noise.

6. Tick box ‘Crop: Enable’ and select ‘Display ROI’. An adjustable window will appear in the 2D and 3D viewers. Adjust to crop out half of the volume in the Sagittal plane.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Volume Rendering
3DSlicer
Help & Acknowledgement
Volume:
CTChest
Inputs
Display
Preset:
Select a Preset
Shift:
Crop:
Enable
Display ROI
Fit to Volume
Rendering:
VTK CPU Ray Casting
Advanced...
Data Probe
Slice Annotations:
L
F
B
S
R
P
L
I
S: -175.250mm
R: 0.381mm
A: -22.919mm
B: CTChest
10 cm


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Volume Rendering
3DSlicer
Help & Acknowledgement
Volume:
CTChest
Inputs
Display
Preset:
Select a Preset
Shift:
Crop:
Enable
Display ROI
Fit to Volume
Rendering:
VTK GPU Ray Casting
Advanced...
Data Probe
Slice Annotations:
L
F
B
S
R
L
B: CTChest
10 cm


3D Slicer 4.4.0
File
Edit
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Help
Modules:
Volume Rendering
3DSlicer
Help & Acknowledgement
Volume:
CTChest
Inputs
Display
Preset:
Select a Preset
Shift:
Crop:
Enable
Display ROI
Fit to Volume
Rendering:
VTK GPU Ray Casting
Advanced...
Data Probe
Slice Annotations:
L
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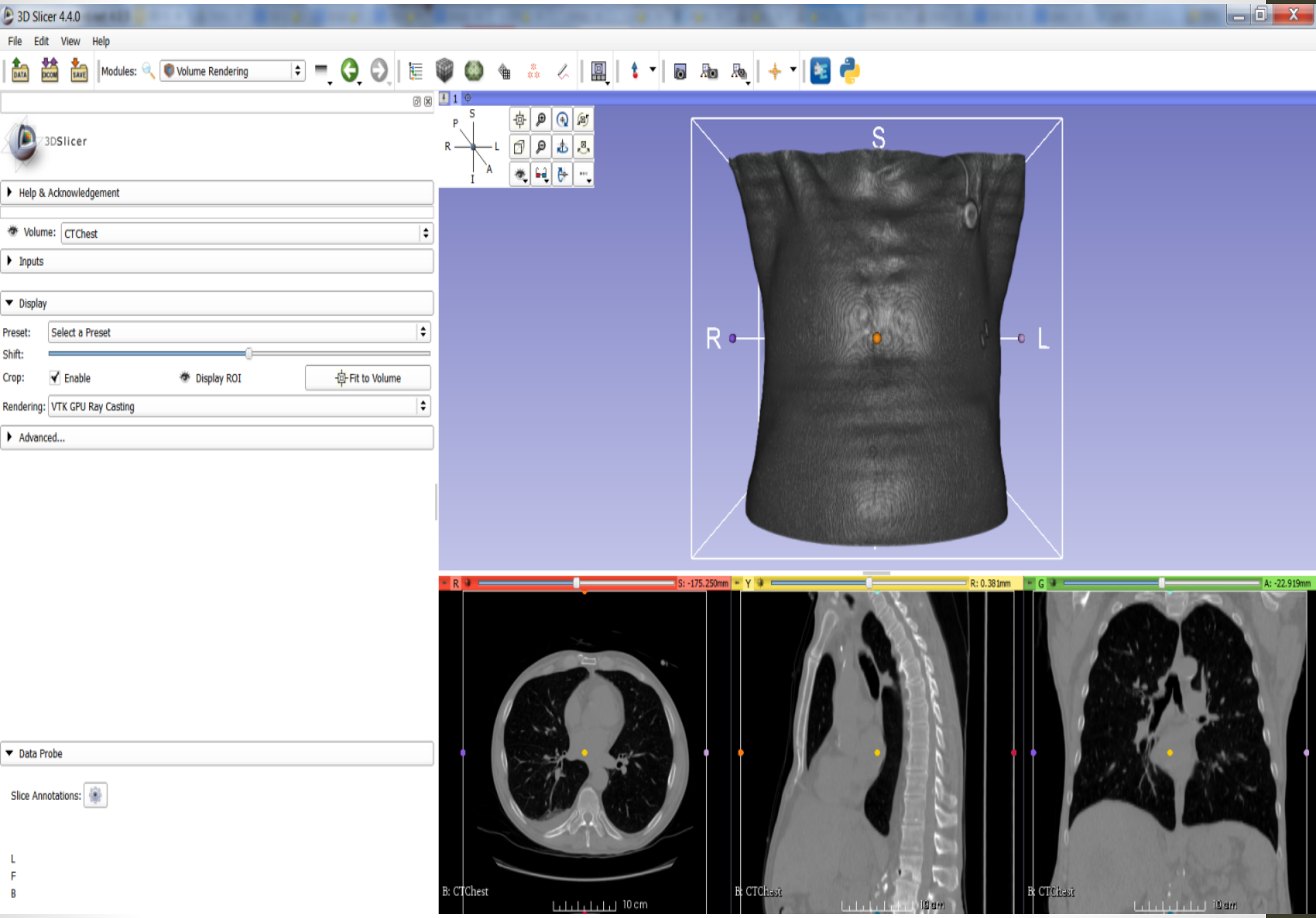
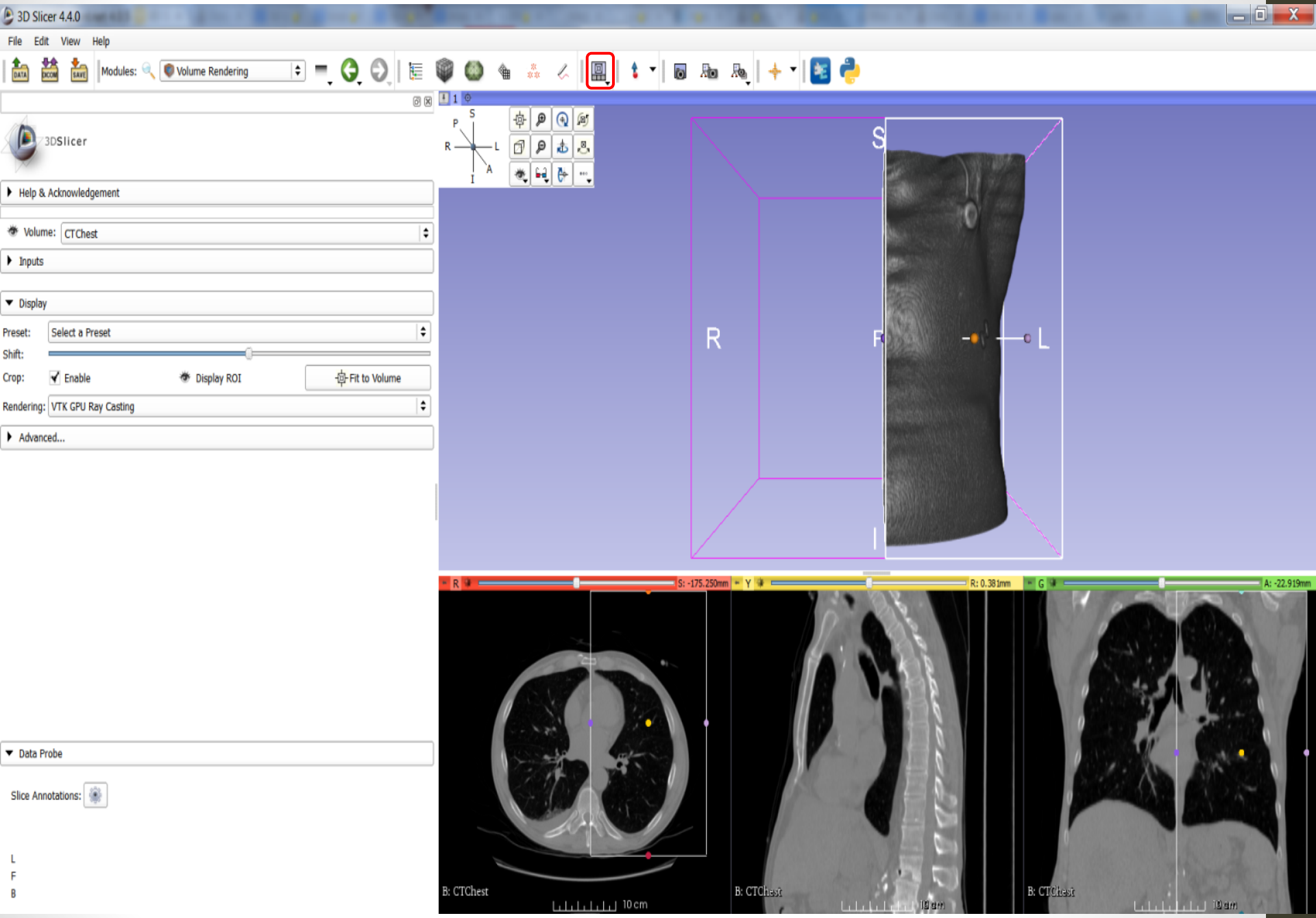
S: -175.250mm
R: 0.381mm
A: -22.919mm
B: CTChest
10 cm


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Volume Rendering
3DSlicer
Help & Acknowledgement
Volume:
CTChest
Inputs
Display
Preset:
Select a Preset
Shift:
Crop:
Enable
Display ROI
Fit to Volume
Rendering:
VTK GPU Ray Casting
Advanced...
Data Probe
Slice Annotations:
L
F
B
S
P
R
L
A
I
S
R
L
S: -175.250mm
R: 0.381mm
A: -22.919mm
B: CTChest
10 cm
B: CTChest
B: CTChest


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Volume Rendering
3DSlicer
Help & Acknowledgement
Volume:
CTChest
Inputs
Display
Preset:
Select a Preset
Shift:
Crop:
Enable
Display ROI
Fit to Volume
Rendering:
VTK GPU Ray Casting
Advanced...
Data Probe
Slice Annotations:
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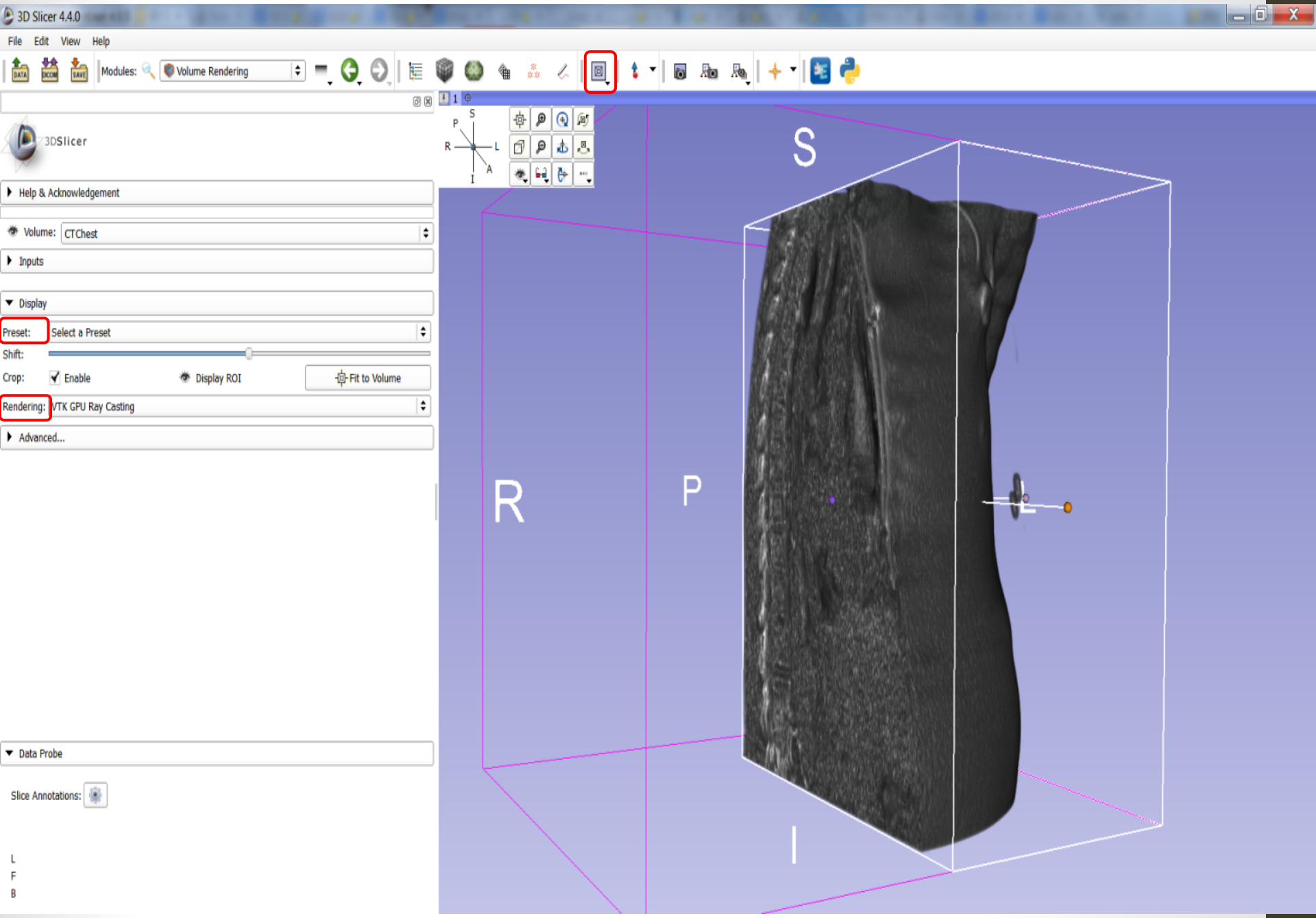
P
R
L
A
I
R
L
S: -175.250mm
R: 0.381mm
A: -22.919mm
B: CTChest
10 cm

Volume Rendering

1. Rotate the view in 3D space to display the exposed internal view.
2. Change layout of viewers to display 3D viewing window only.
3. Experiment with the presets; adjusting the ‘shift’ slider to change the thresholding.

4. We can take a snapshot of the volume rendering using the ‘screenshot’ buttons in the toolbar. The export the screenshot as a .png (or .jpg etc) using ‘save’.

Tip: The Volume Rendering module can also be used to visualise labelmaps in 3D space. We will explore this more later.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Volume Rendering
3DSlicer
Help & Acknowledgement
Volume:
CTChest
Inputs
Display
Preset:
Select a Preset
Shift:
Crop:
Enable
Display ROI
Fit to Volume
Rendering:
VTK GPU Ray Casting
Advanced...
Data Probe
Slice Annotations:
L
F
B
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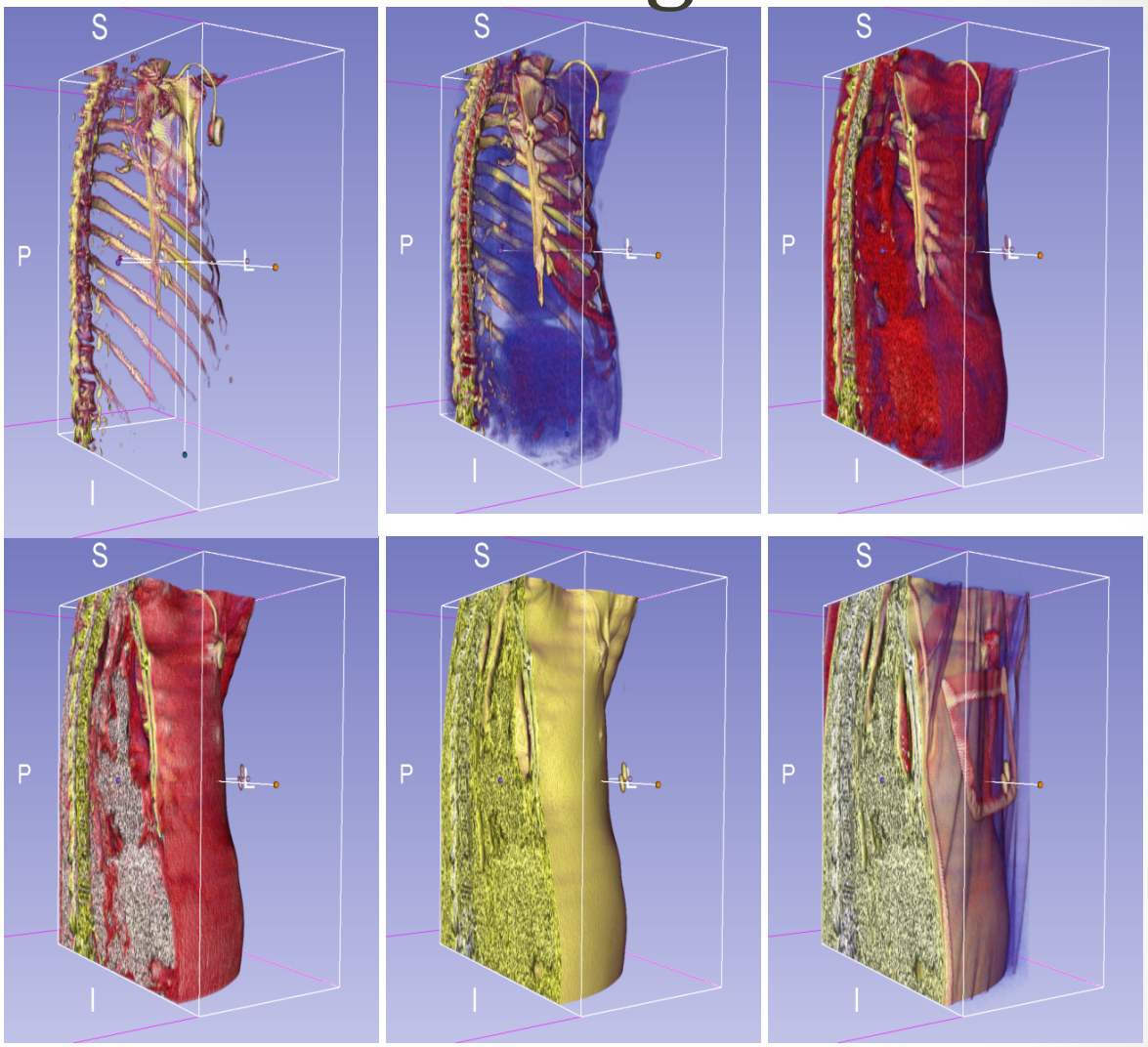
L
I

Volume Rendering

Preset: CTCardiac3

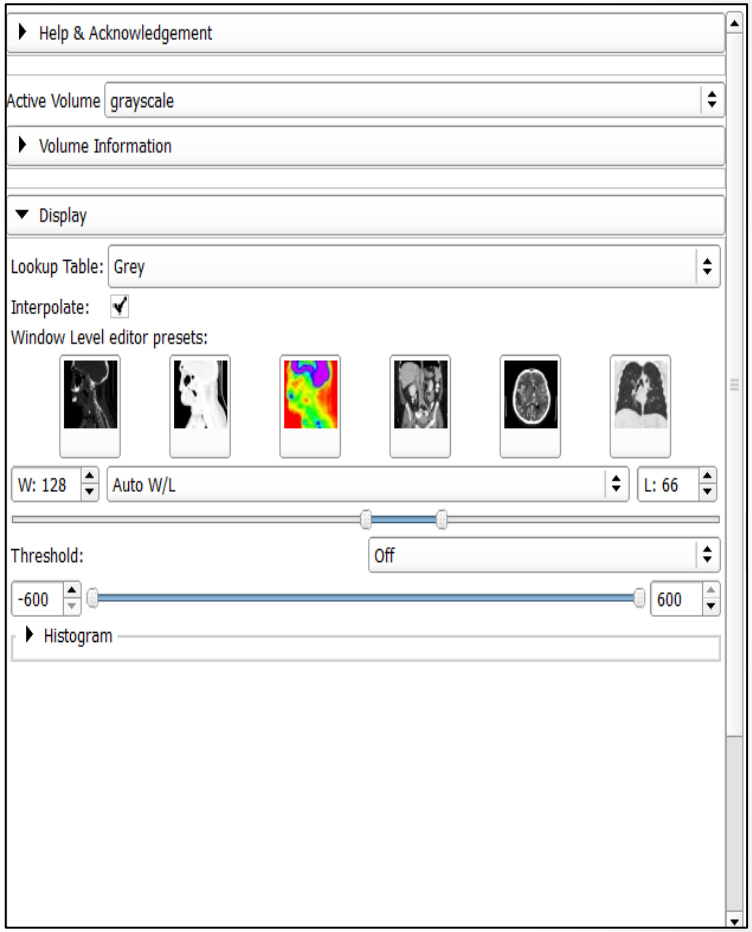


Change in rendering by adjusting ‘Shift’ slider

Module: Volumes

This module loads and adjusts display parameters of volume data. It is used for changing the appearance of various volume types.

Wiki Help Link

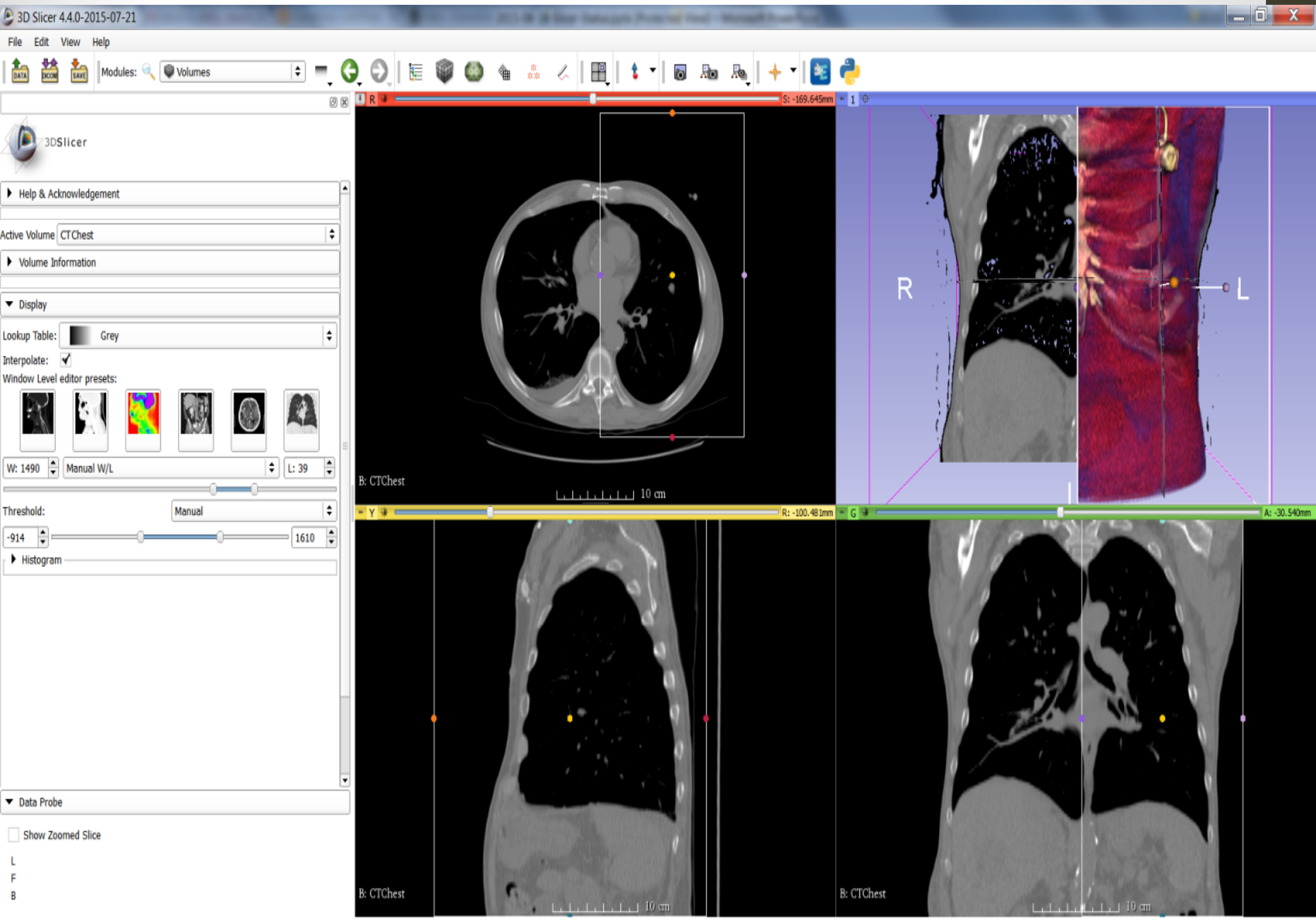


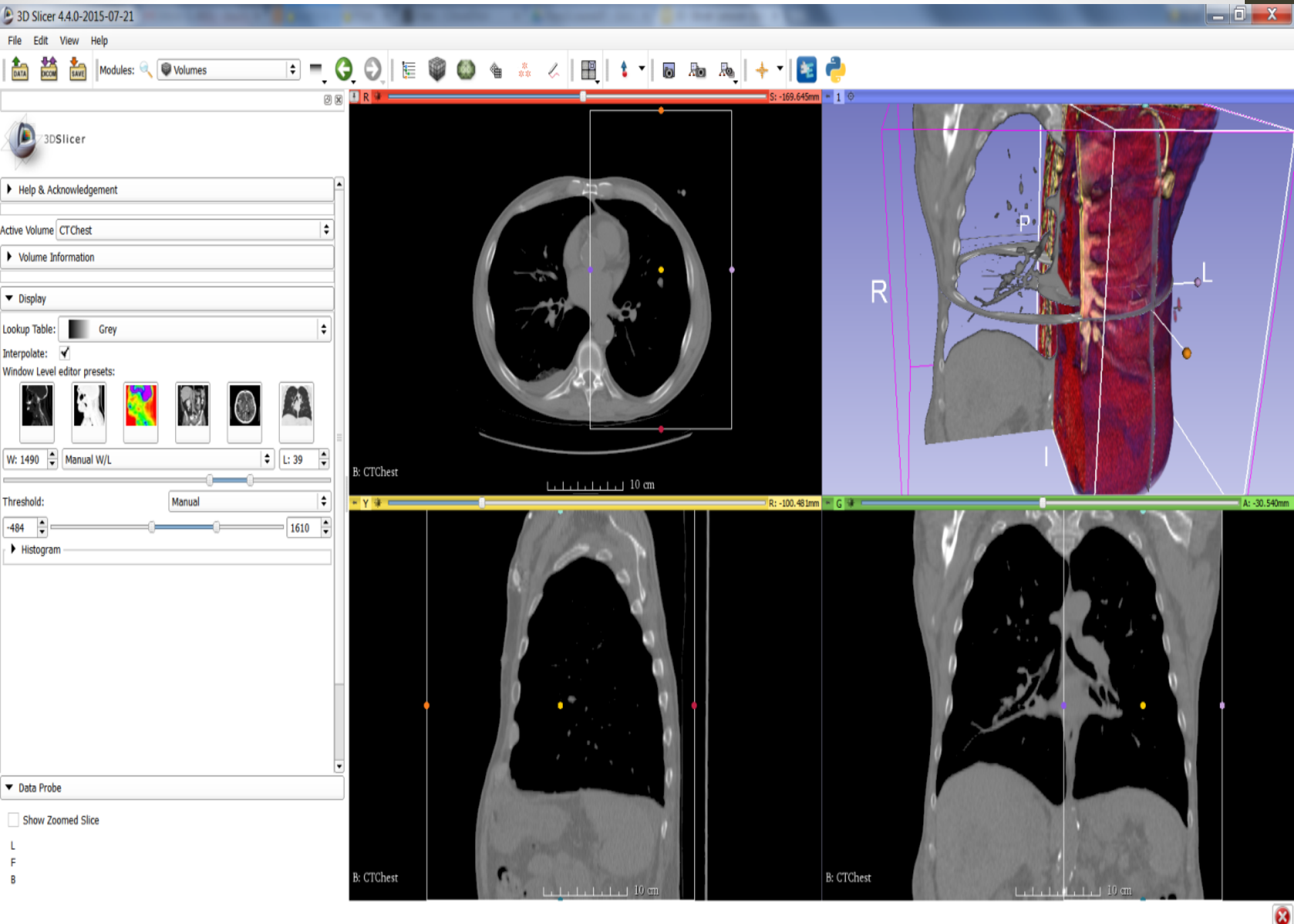
Volumes Module

- The volumes module can be used to change the appearance of volume data.
  - Unlike the Volume Rendering module, a 3D representation of the data is not rendered. Rather, the visual appearance in the 2D slice views changes.
- Can be used to make areas of a slice layer differently coloured or even transparent.

1. Turn on visibility of slices in 3D viewing window.
2. Go to ‘Volumes’ module.
3. Select last preset (CT lung).

Adjust the threshold slider to change the visual representation of the 2D slices.


3D Slicer 4.4.0-2015-07-21
File
Edit
View
Help
Modules:
Volumes
3DSlicer
Help & Acknowledgement
Active Volume
CTChest
Volume Information
Display
Lookup Table:
Grey
Interpolate:
Window Level editor presets:
W: 1490
Manual W/L
L: 39
Threshold:
Manual
-914
1610
Histogram
Data Probe
Show Zoomed Slice
L
F
B
R
S: -169.645mm
B: CTChest
10 cm
1
R
L
Y
R: -100.481mm
G
A: -30.540mm
B: CTChest
10 cm
B: CTChest
10 cm


3D Slicer 4.4.0-2015-07-21
File Edit View Help
Modules: Volumes
3DSlicer
Help & Acknowledgement
Active Volume CTChest
Volume Information
Display
Lookup Table: Grey
Interpolate:
Window Level editor presets:
W: 1490
Manual W/L
L: 39
Threshold:
Manual
-484
1610
Histogram
Data Probe
Show Zoomed Slice
L
F
B
R
S: -169.645mm
B: CTChest
10 cm
1
P
R
L
I
Y
R: -100.481mm
G
A: -30.540mm
B: CTChest
10 cm
B: CTChest
10 cm

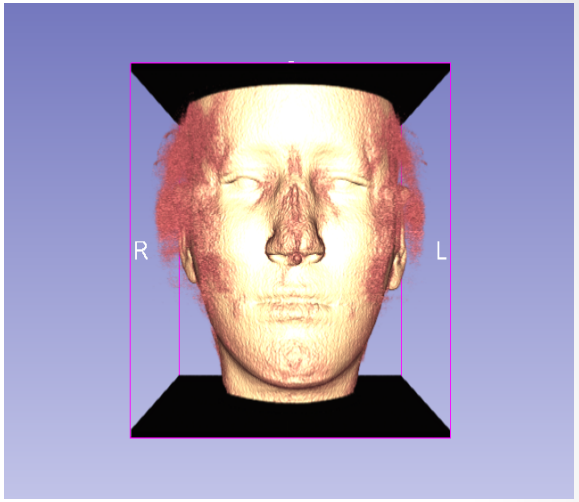
Editor Effect and Model Generation

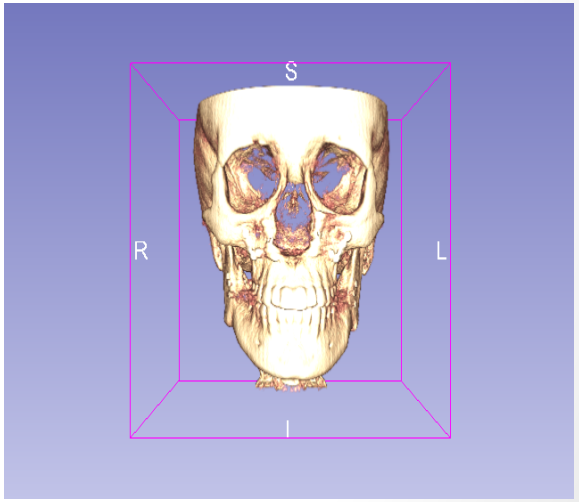
AUTOMATIC SEGMENTATION VIA THRESHOLDING

Automatic Segmentation

- We will now use a thresholding effect for simple automatic segmentation.
  - This is appropriate for datasets with well defined boundaries between tissue of interest. E.g. bone in a CT scan.

1. Load sample dataset CBCTDentalSurgery.
2. Firstly have a look at the data using the Volume Rendering tool. E.g. use CT-bone preset
3. This dataset was selected for thresholding because of the well defined bone-soft tissue interface.



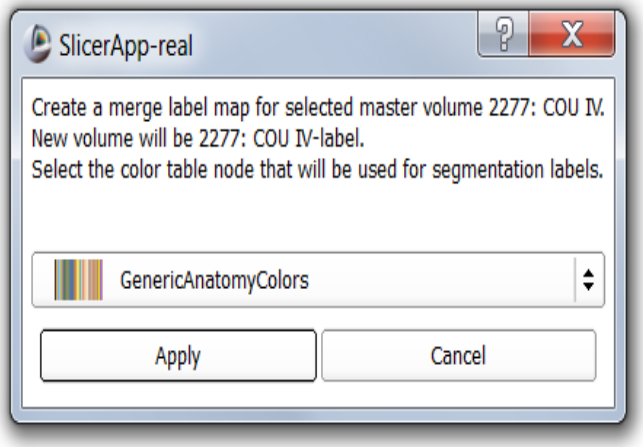


Volume Rendering of dataset

Automatic Segmentation

1. Open the ‘Editor’ module. This module can be used for automatic and manual segmentation.

2. When the Editor module is opened, you will be asked create a merge label map. Select ‘Apply’ for GenericAnatomyColours.

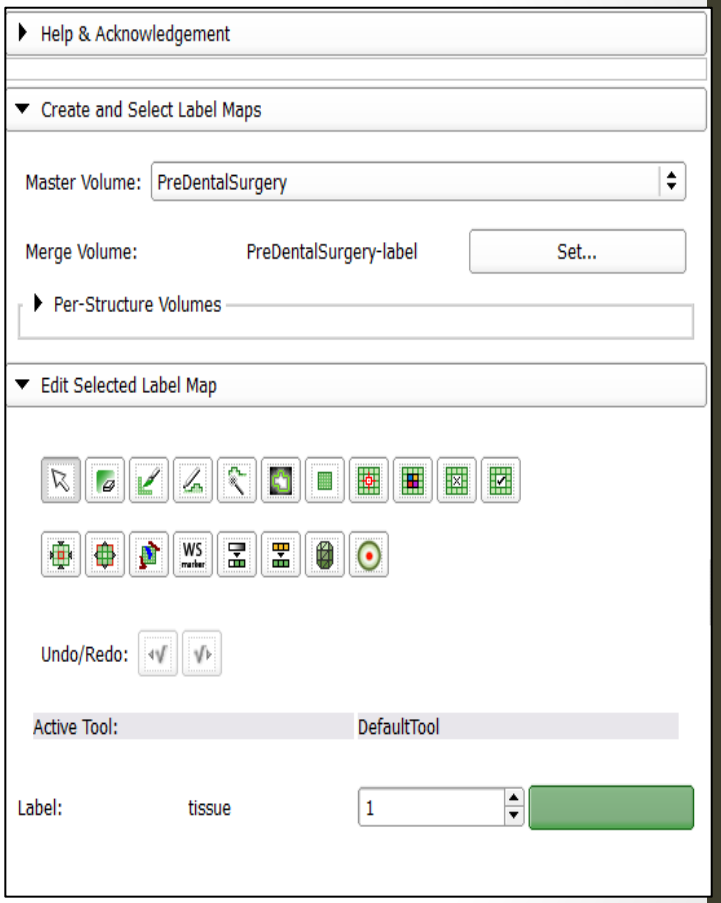


Module: Editor

- This module is used for automatic and manual segmentation of volumes.
  - Some of the tools mimic a painting interface like photoshop or gimp, but work on 3D arrays of voxels rather than on 2D pixels.

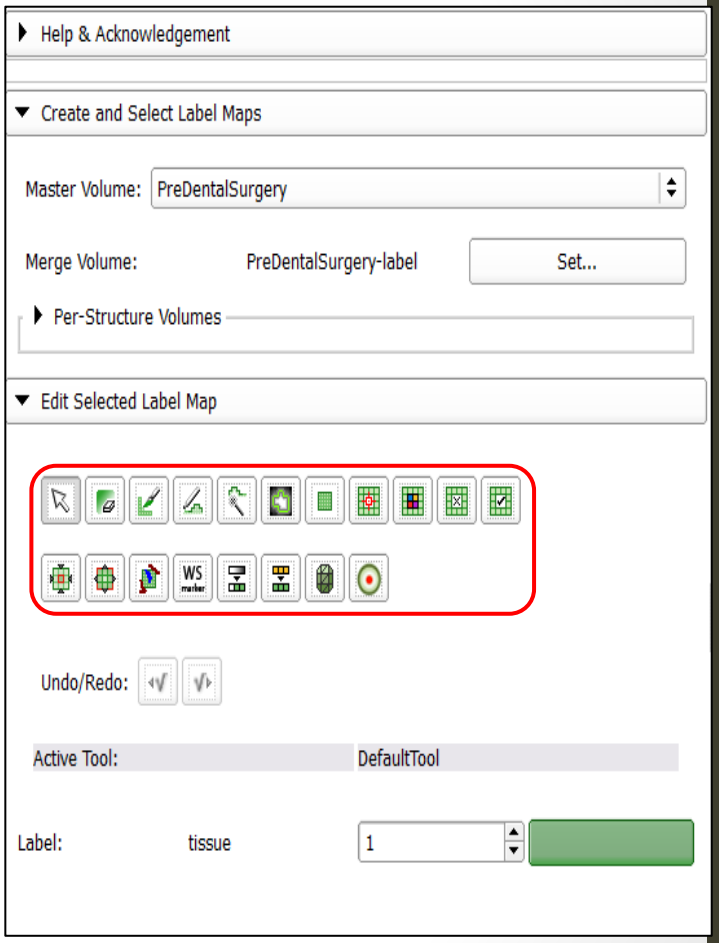
- Create label maps of different anatomical features.

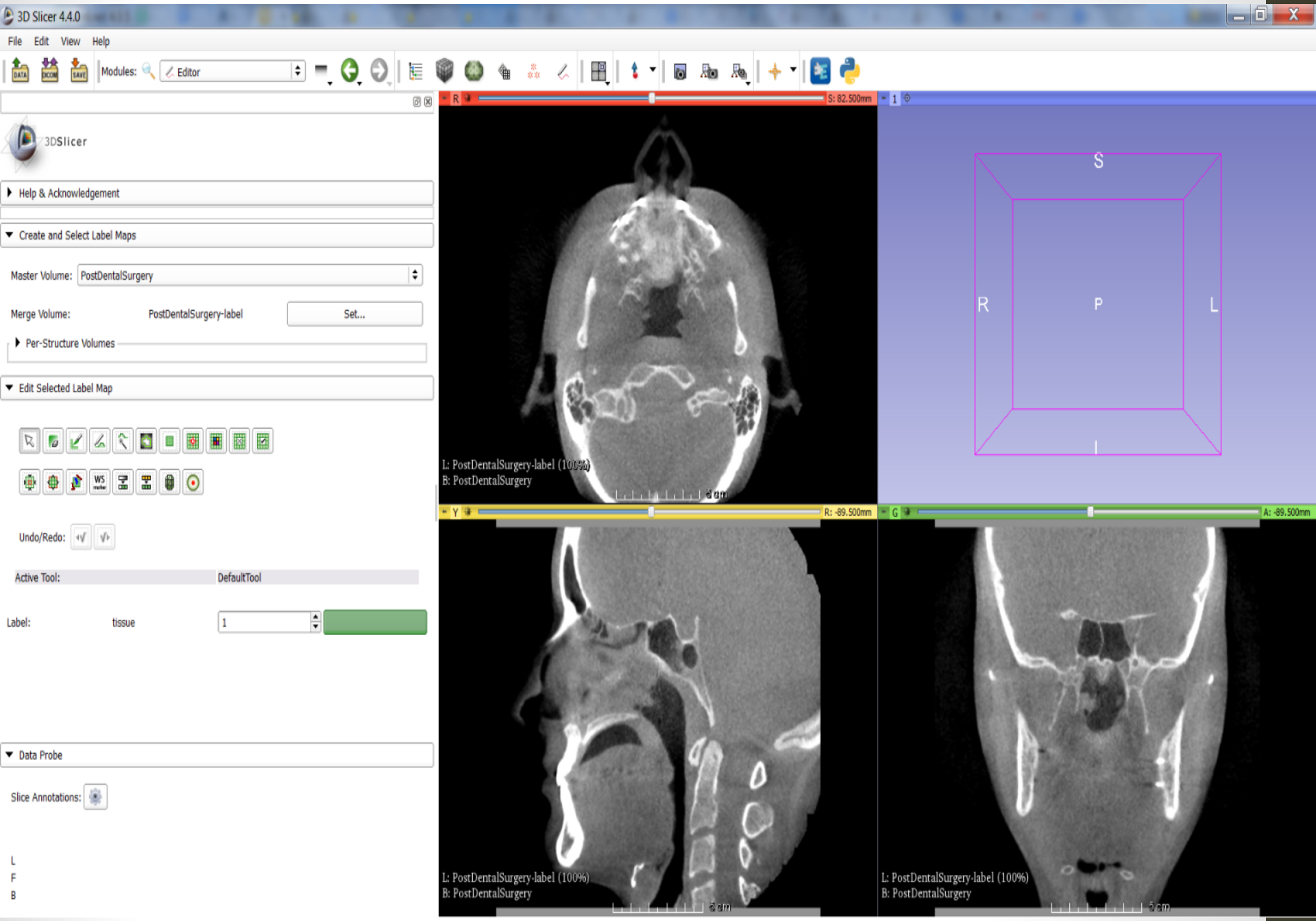
Wiki Help Link



Modules: Editor

- Default tool
- Eraser
- Paint
- Draw
- Wand
- Level Tracing
- Rectangle
- Identify Island
- Change Island
- Remove Island
- Save Island
- Erode
- Dilate
- GrowCut
- Watershed From Marker
- Threshold Effect
- Change Label
- Make Model
- Fast Marching



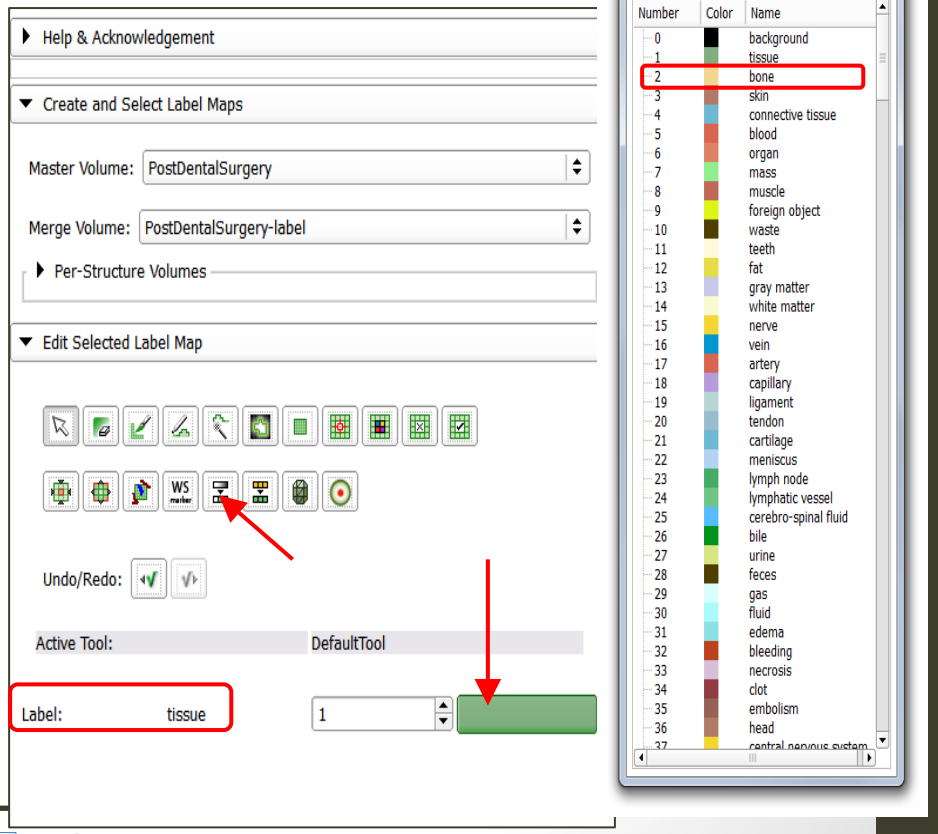

3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Editor
3DSlicer
Help & Acknowledgement
Create and Select Label Maps
Master Volume:
PostDentalSurgery
Merge Volume:
PostDentalSurgery-label
Set...
Per-Structure Volumes
Edit Selected Label Map
Undo/Redo:
Active Tool:
DefaultTool
Label:
tissue
1
Data Probe
Slice Annotations:
L
F
B
S: 82.500mm
L: PostDentalSurgery-label (100%)
B: PostDentalSurgery
S
R
P
L
I
R: -89.500mm
A: -89.500mm
L: PostDentalSurgery-label (100%)
B: PostDentalSurgery
L: PostDentalSurgery-label (100%)
B: PostDentalSurgery

Automatic Segmentation

1. In Editor module, set Master Volume to ‘PostDentalSurgery’.
2. Next to ‘Label:’ Click on coloured box.

3. This will bring up a number/colour key for different types of tissues. Select ‘bone’.

4. Select the ‘Threshold Effect’ tool.

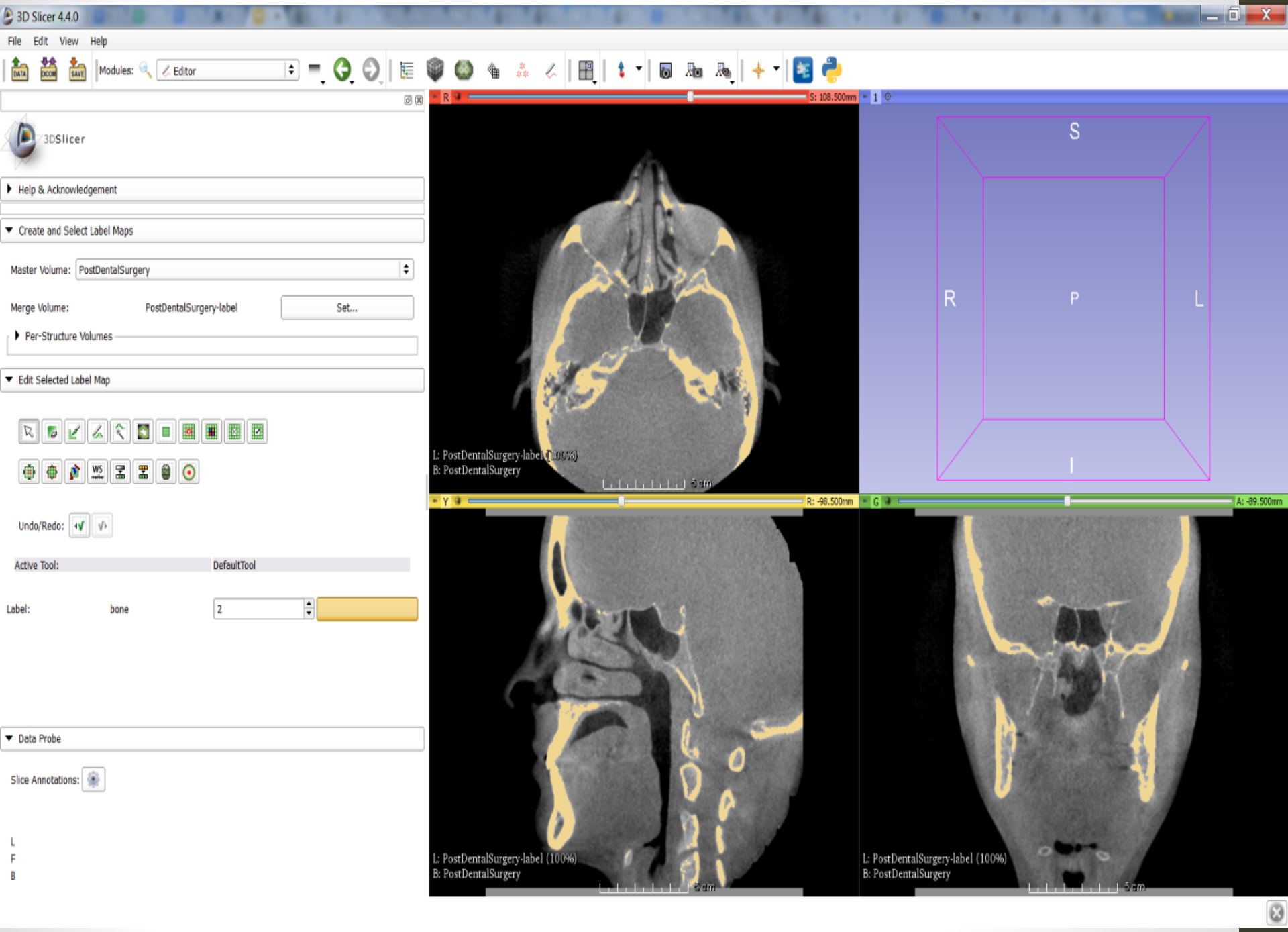


Automatic Segmentation

1. Once ‘Threshold Effect’ is selected, you will see flashing regions of that coloured label appear over the volume in the 2D viewers.

2. Adjust the threshold range using the sliders, to select bone as accurately as you can. Use the sliders in the 2D viewing windows to check the selection across the specimen (but don’t worry, it won’t be perfect.)

3. Click ‘Apply’, and the labelmap will be set.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Editor
3DSlicer
Help & Acknowledgement
Create and Select Label Maps
Master Volume:
PostDentalSurgery
Merge Volume:
PostDentalSurgery-label
Set...
Per-Structure Volumes
Edit Selected Label Map
Undo/Redo:
Active Tool:
DefaultTool
Label:
bone
2
Data Probe
Slice Annotations:
L
F
B
S
R
P
L
I
L: PostDentalSurgery-label (100%)
B: PostDentalSurgery
5 cm

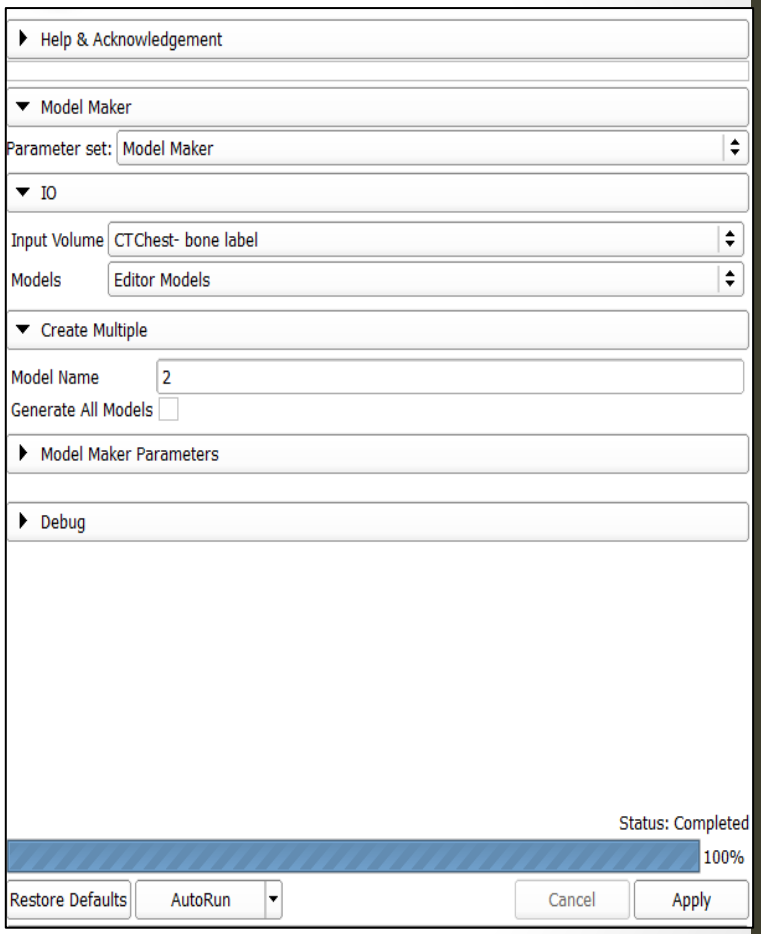
3D Model Generation

Once we have created a labelmap via segmentation, we can generate a 3D surface model representing that selection, using the ‘Model Maker’ module.

Module: Model Maker

- This module is used to create 3D surface models from segmented image data, called label maps.

Wiki Help Link



3D Model Generation

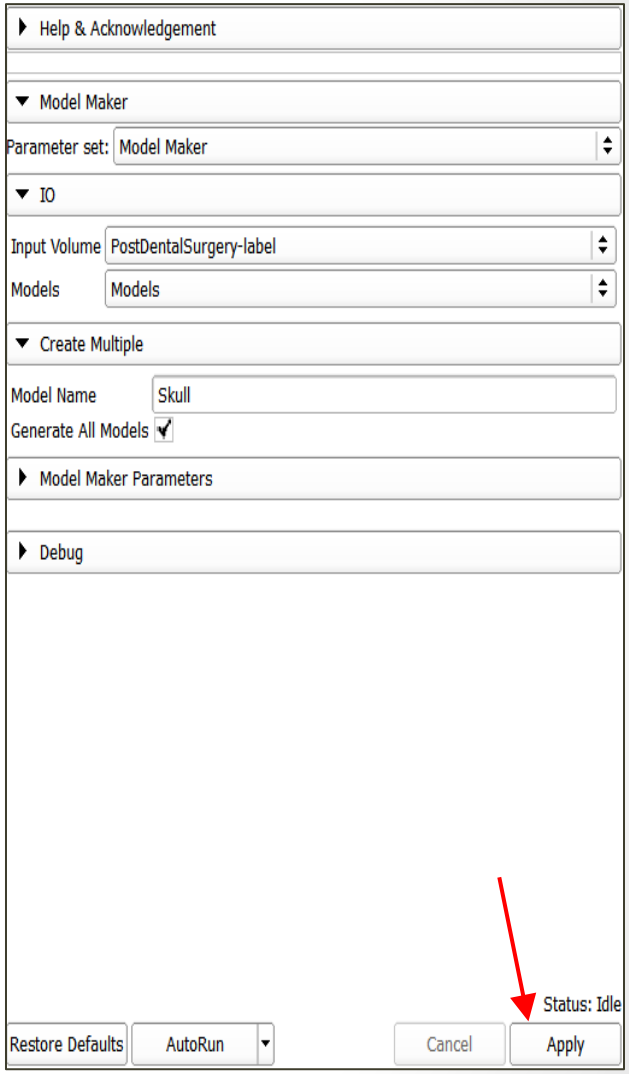
In ‘Model Maker’ module, input volume should read ‘PostDentalSurgery-label’.

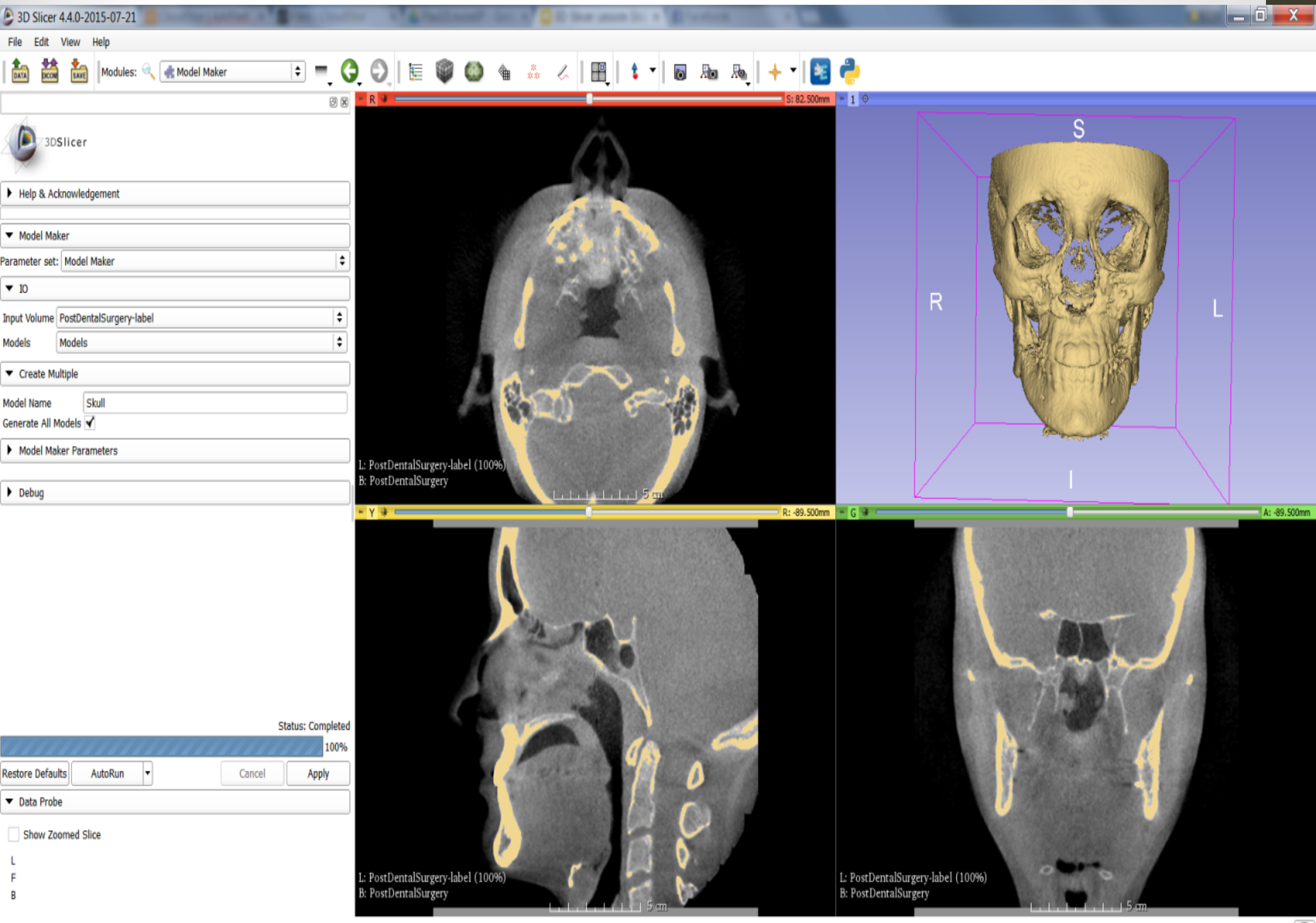
Models: Create new ModelHierachy

Model name: (your choice) In this tutorial I will name it ‘Skull’

Click ‘Apply’.

Model will generate.

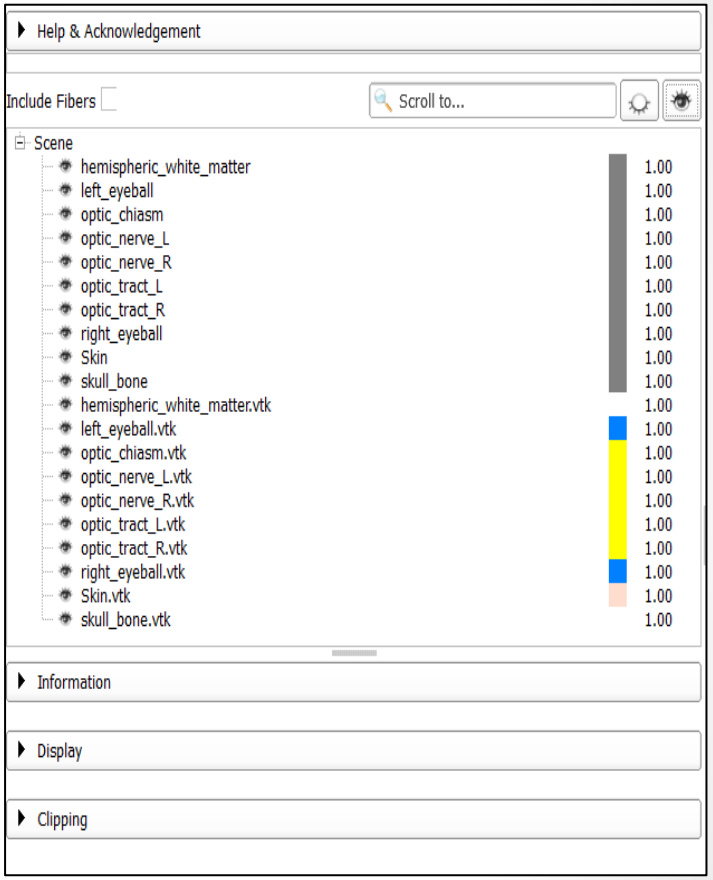



3D Slicer 4.4.0-2015-07-21
File Edit View Help
Modules: Model Maker
3DSlicer
Help & Acknowledgement
Model Maker
Parameter set: Model Maker
IO
Input Volume PostDentalSurgery-label
Models Models
Create Multiple
Model Name Skull
Generate All Models
Model Maker Parameters
Debug
Status: Completed
100%
Restore Defaults AutoRun Cancel Apply
Data Probe
Show Zoomed Slice
L
F
B
L: PostDentalSurgery-label (100%)
B: PostDentalSurgery
5 cm
S
R
L
I
L: PostDentalSurgery-label (100%)
B: PostDentalSurgery
5 cm
L: PostDentalSurgery-label (100%)
B: PostDentalSurgery
5 cm

Module: Models

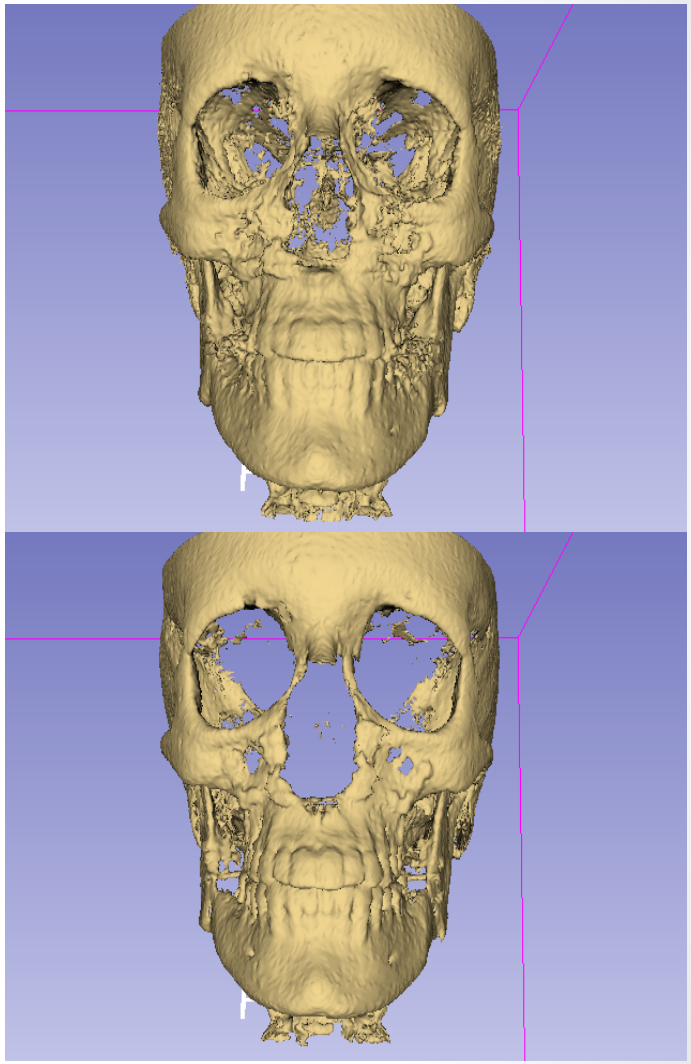
- This module is used to load and adjust display parameters of loaded or generated 3D surface models.
  - Toggle model views on and off
  - display information about that model, like surface area (mm^2), volume (mm^3), number of points etc.
  - Adjust colour and opacity of 3D surface models.

Wiki Help Link



Improving Model

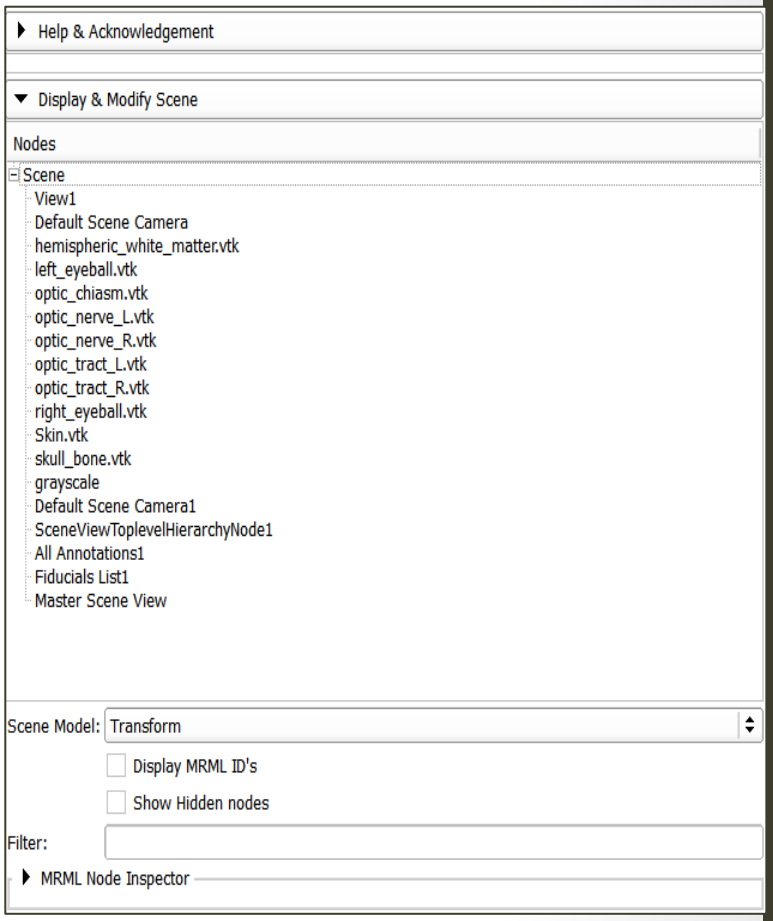
- So we have generated a 3D model fairly quickly, but it is probably not perfect.
- Depending on your threshold range selection, you may have some or lots of scattered ‘island’ regions, and regions other than bone may have been selected.



Module: Data

- This module lists the objects of the current scene and permits general operations (such as search, rename, delete, move) on the MRML tree.
- It can also be used to create and edit transformation hierarchies.

Wiki Help Link

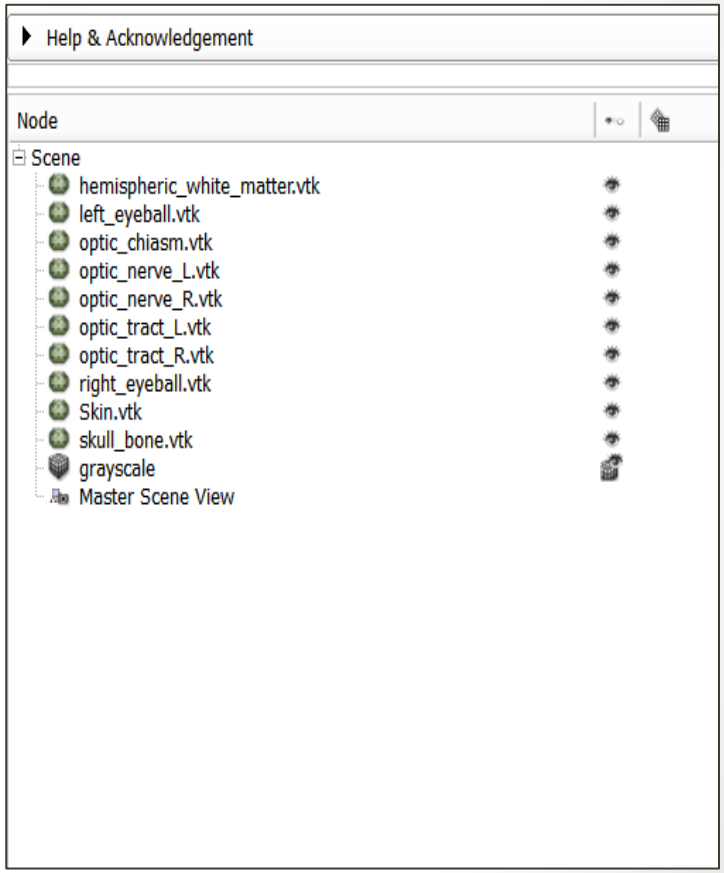


Module: Subject Hierarchy

- This module acts as a central data-organizing point in Slicer.

- The Subject Hierarchy module provides a nice and intuitive tree view of the loaded data. It acts as a convenient central organizing point for many of the operations that 3D Slicer and its extensions perform.

Wiki Help Link



File formats

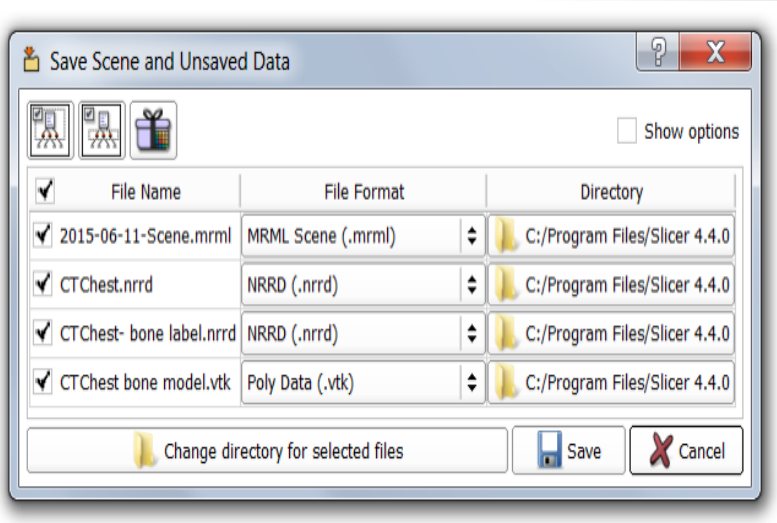
SAVING DATA

Saving Data and Scene

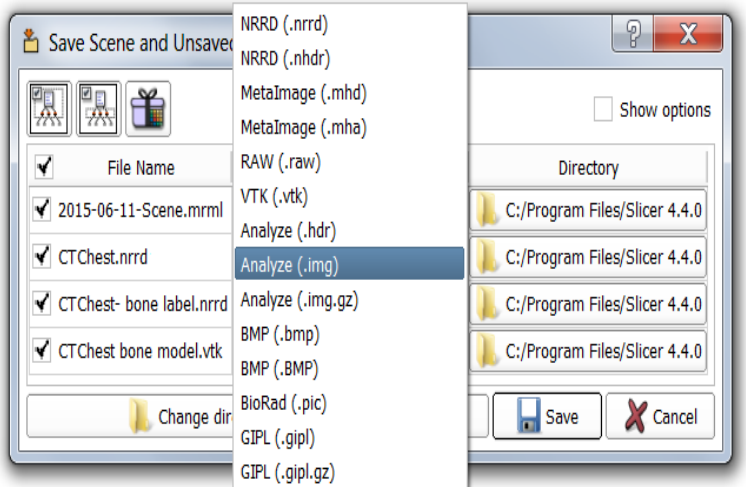
- 3D Slicer provides a rich set of options for saving data. The "Save Data" panel is accessed through the File menu using **File->Save.**

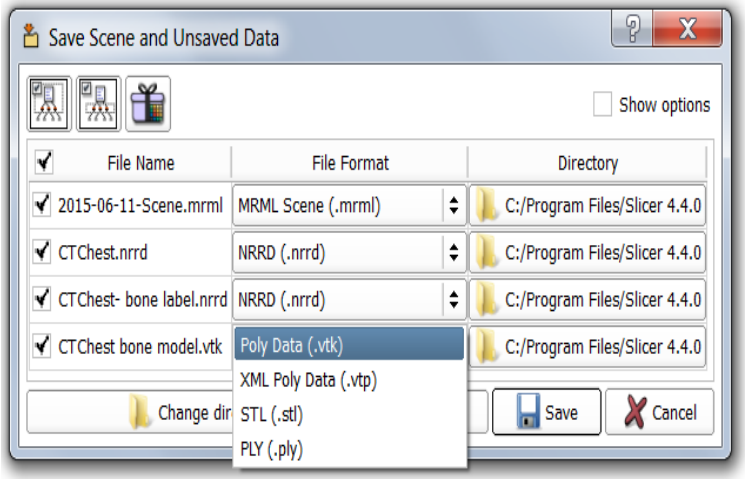
- The user is given options to save the overall state of the program at a given time (MRML scene), as well as any other components, such as label maps, 3D models etc

- Users can select which components to save (checkboxes), the file format for each, and the directory in which it is saved.



[Wiki Help Link]





Different file formats can be selected for different components.

Some file types are more ‘lossy’ than others, i.e. they may not contain all of the original metadata.

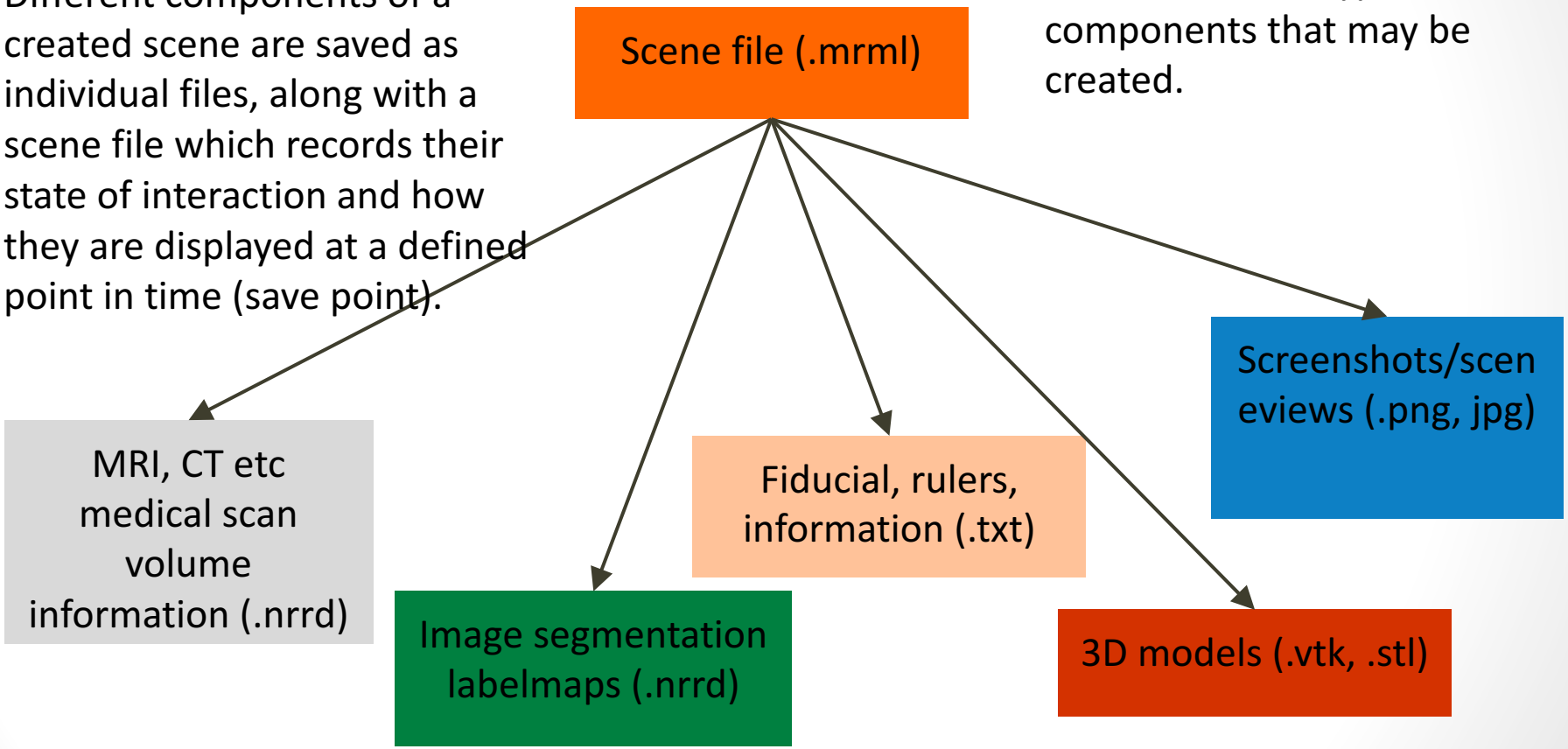
e.g. Can change model to .stl format, a widely compatible file type.

(STL files describe only the surface geometry of a three-dimensional object without any representation of color, texture or other common CAD model attributes. STL coordinates must be positive numbers, there is no scale information, and the units are arbitrary)

Typical file organisation structure

Different components of a created scene are saved as individual files, along with a scene file which records their state of interaction and how they are displayed at a defined point in time (save point).

These are some typical scene components that may be created.



Overview of Key File Formats

.mrml - *Medical Reality Markup Language.* A 3D Slicer scene description file. Contains scene metadata and stores references to 3D datasets and scene properties to reconstruct a 3D scene.

.mrb - an archive file that contains all data for loading into Slicer. Like a .zip file.

.dcm - *DICOM.* A standardised file format for the storage of medical scan data such as MRIs, CTs etc. DICOM files contain medical scan data as well as patient identification information.

.nrrd - *Nearly Raw Raster Data.* Encodes n-dimensional raster data. Supports scientific visualization and image processing applications.

.stl - *STereoLithography.* Describes the surface geometry of a 3D object with no information regarding colour, texture etc. A standard file type used by most additive manufacturing systems including 3D printing. The model surface is triangulated.

.vtk - *Visualisation ToolKit.* Binary 3D data format used by a software system for image processing, 3D graphics, volume rendering and visualization.

.txt - *Plain Text File.* Comprised of plain text that is human-readable as well as software readable.

.csv - *Comma Separated Value.* Stores tabular data in plain text. Commas separate entries.

.tiff, .bmp, .jpg, .png - Commonly used file formats for storing raster graphics images.

All Supported File Types

3D Slicer reads and writes to a wide range of file formats, a list of which can be found here.

- **Scenes:** .mrml, .mrb, .zip, .xml, xcat, .xar
- **Rastor Images (2D and 3D):** .dcm, .nrrd, .nhdr, .mhd, .mha, .vtk, .hdr, .img, .img.gz, .nia, .nii, .nii.gz, .bmp, .pic, .mask, .gipl .gipl.gz, .jpg, .jpeg, .lsm, .png, .spr, .tif, .tiff, .mgz, .mrc, .rec
- **Models:** .vtk, .vtp, .stl, .obj, .orig, .inflated, .sphere, .white, .smoothwm, .pial, .g, .byu
- **Fiducials:** .fcsv, .txt
- **Rulers:** .acsv, .txt
- **Transforms:** .tfm, .txt, .mat, .nrrd, .nhdr, .mha, .mhd, .nii, .nii.gz
- **Transfer Functions:** .vp, .txt
- **Lookup tables:** .txt, .ctbl
- **Double Arrays:** .mcsv, .txt

Saving Data and Scene

"Many file formats are 'lossy' when it comes to saving and restoring image orientation metadata. For example, Analyze format cannot store all image orientations and .vtk format for images does not store orientation information at all. When exporting data to a new format, please reload the data to ensure the correct data has been saved. In general, NRRD, NIfTI, and Meta formats preserve exported information. All meta-information other than image content and image orientation (such as patient name, acquisition-related details) is lost when the image loaded from DICOM is saved into any of the non-DICOM formats!"

- SavingData Wiki Page