NIRFAST Slicer



Introduction to the 3D Slicer platform

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What will be covered

- Introduction to 3D Slicer
- Loading Data
- Nodes & Module architecture
- Layout and Slice Viewers
- Volume visualization
- Modules in pipeline
- Saving/Closing a scene

Credits

This slides integrate material available at:

www.slicer.org/slicerWiki/index.php/Documentation/4.5/Training

It is built on prior work of:

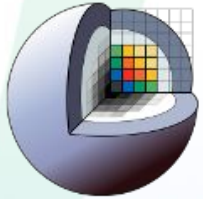
- Jean-Christophe Fillion-Robin, *Technical Expert, Kitware Inc*
- Julien Finet, *R&D Engineer, Kitware Inc*
- Sonia Pujol, *Ph.D., SPL/BWH*
- Dominik Meier, *Ph.D., SPL/BWH*
- Ron Kikinis, *M.D., SPL/BWH*

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PART 1

Introduction to 3D Slicer

What is 3D Slicer



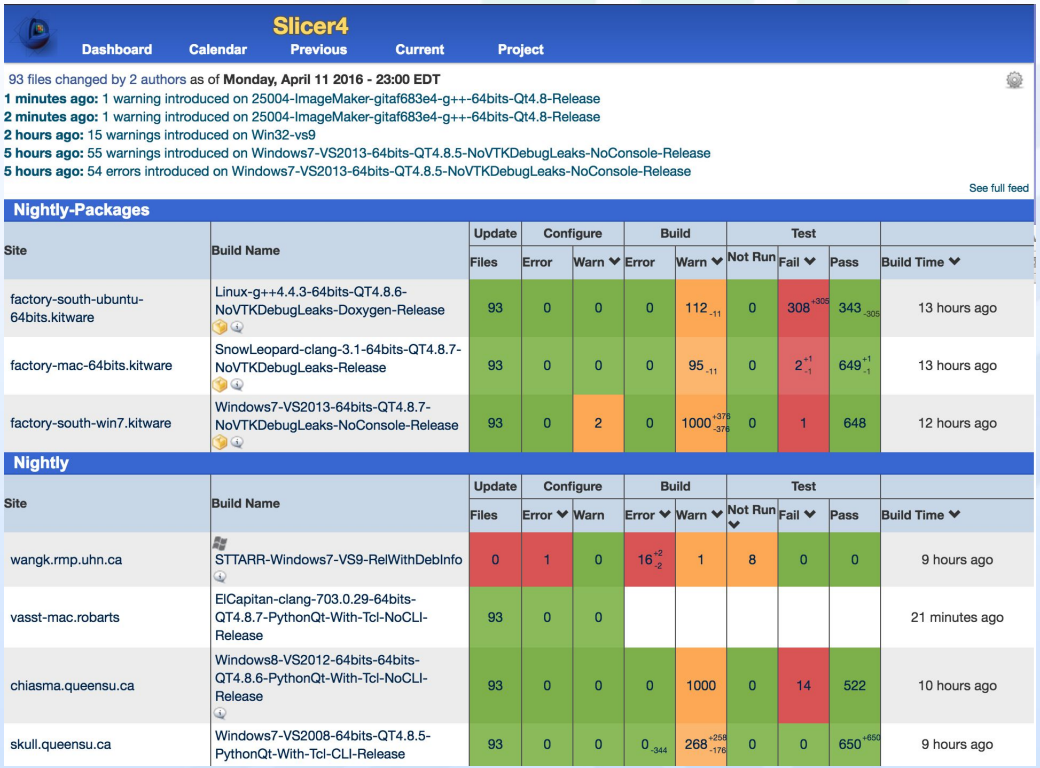
- **Software platform for:**
  - analysis (registration, interactive segmentation)
  - visualization of medical images
  - research in image guided therapy
- **Extensible:** powerful plugin capabilities
- **Free + Open Source + Cross Platform**

Behind the scene

Slicer is built **every night** on:

- Windows
- Linux
- MacOSX

CDash



Slicer4

Dashboard Calendar Previous Current Project

93 files changed by 2 authors as of **Monday, April 11 2016 - 23:00 EDT**

1 minutes ago: 1 warning introduced on 25004-ImageMaker-gitaf683e4-g++-64bits-Qt4.8-Release
2 minutes ago: 1 warning introduced on 25004-ImageMaker-gitaf683e4-g++-64bits-Qt4.8-Release
2 hours ago: 15 warnings introduced on Win32-vs9
5 hours ago: 55 warnings introduced on Windows7-VS2013-64bits-QT4.8.5-NoVTKDebugLeaks-NoConsole-Release
5 hours ago: 54 errors introduced on Windows7-VS2013-64bits-QT4.8.5-NoVTKDebugLeaks-NoConsole-Release

See full feed

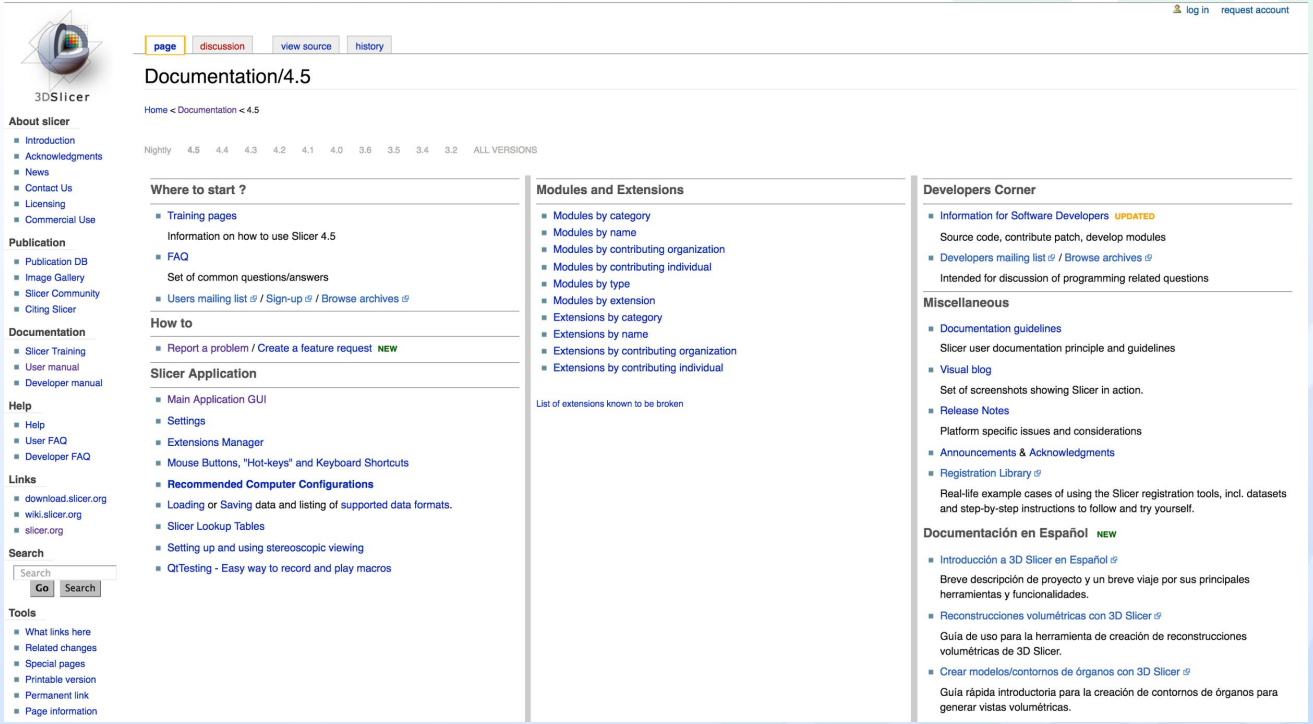
Nightly-Packages

Site	Build Name	Update	Configure		Build		Test			
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	Build Time
factory-south-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.8.6-NoVTKDebugLeaks-Doxygen-Release	93	0	0	0	112 -11	0	308 +305	343 -305	13 hours ago
factory-mac-64bits.kitware	SnowLeopard-clang-3.1-64bits-QT4.8.7-NoVTKDebugLeaks-Release	93	0	0	0	95 -11	0	2 +1 -1	649 +1 -1	13 hours ago
factory-south-win7.kitware	Windows7-VS2013-64bits-QT4.8.7-NoVTKDebugLeaks-NoConsole-Release	93	0	2	0	1000 +376 -376	0	1	648	12 hours ago

Nightly

Site	Build Name	Update	Configure		Build		Test			
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	Build Time
wangk.rmp.uhn.ca	STTARR-Windows7-VS9-RelWithDebInfo	0	1	0	16 +2 -2	1	8	0	0	9 hours ago
vasst-mac.robarts	ElCapitan-clang-703.0.29-64bits-QT4.8.7-PythonQt-With-Tcl-NoCLI-Release	93	0	0						21 minutes ago
chiasma.queensu.ca	Windows8-VS2012-64bits-64bits-QT4.8.6-PythonQt-With-Tcl-NoCLI-Release	93	0	0	0	1000	0	14	522	10 hours ago
skull.queensu.ca	Windows7-VS2008-64bits-QT4.8.5-PythonQt-With-Tcl-CLI-Release	93	0	0	0 -344	268 +258 -176	0	0	650 +650	9 hours ago

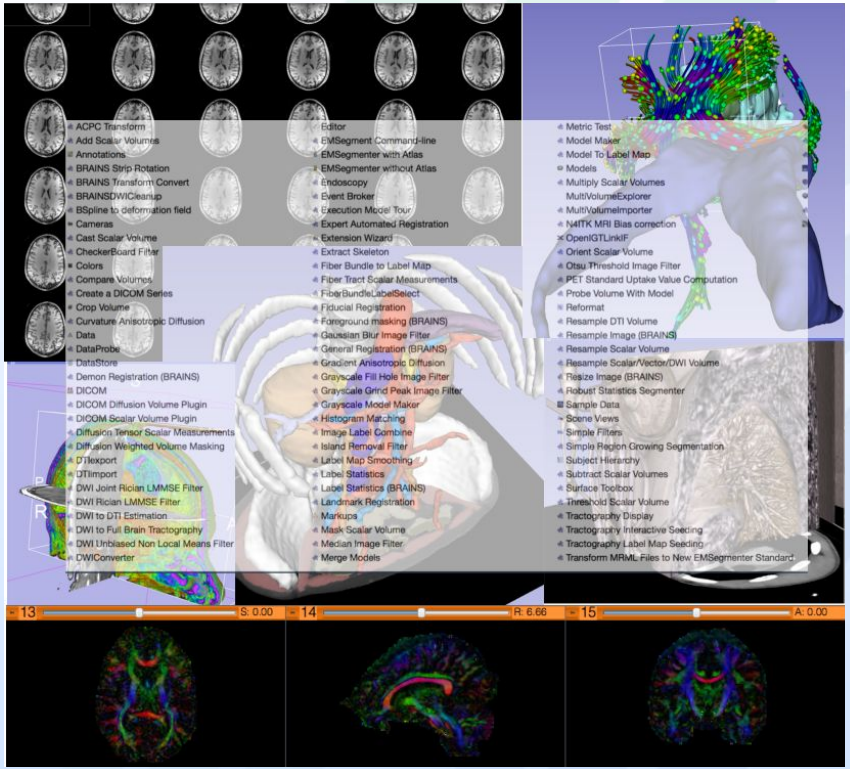
Online documentation



www.slicer.org/slicerWiki/index.php/Documentation/4.5

Over 100 modules

Slicer 4.5 contains **over 100 modules** for image segmentation, registration, and 3D visualization of medical imaging data.



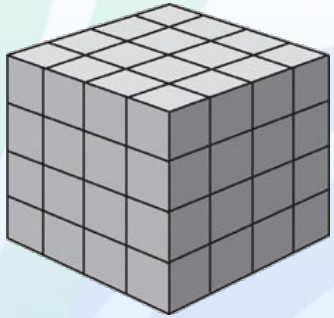
PART 2

Nodes & Modules architecture

Data Types (1/3)

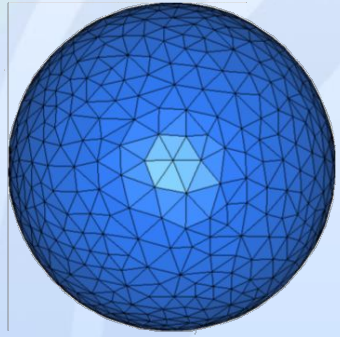
Volume: structured grid, 3D image based of voxels of a certain size (image spacing)

- **Scalar volume:** continuous voxel values
- **Label Map:** discrete integer voxel values
- **Formats:** mha, mhd, nrrd, dicom, ...

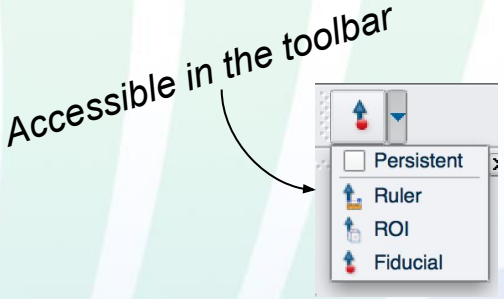


Model: polygonal mesh, 3D surface

- 3D **points** and **triangles**
- Points can hold **data**
- **Formats:** vtk, vtp, stl

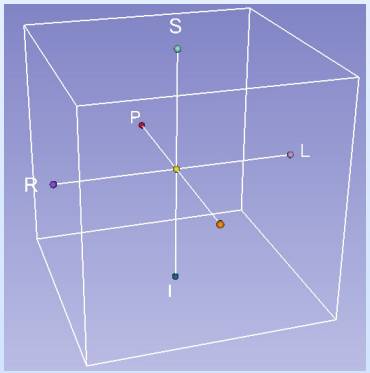


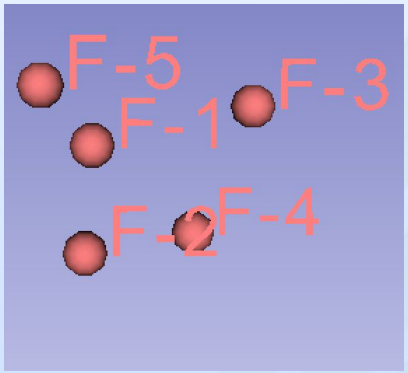
Data Types (2/3)

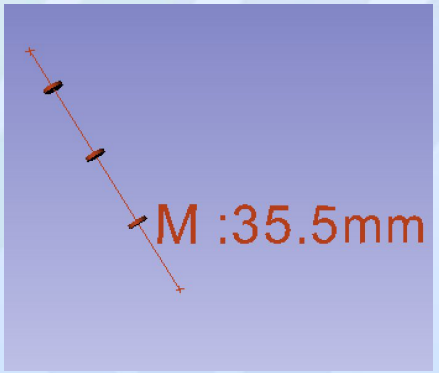


Annotations: interactive markers

- **ROI :** Region of interest (useful for cropping)
- **Fiducial:** defines a 3D position (markups)
- **Ruler:** measure distance between two positions







Data Types (3/3)

And much more:

- Transforms
- Lookup tables
- Transfer Functions
- Tables
- Double Arrays
- ...

Not really used in NIRFAST pipeline

MRML Nodes & Scene

- **MRML Library** provides API for managing medical image data types (Volumes, Models, Transforms, Fiducials, Cameras, etc) and their visualization.
- Each data type is represented by a special **MRML node**.
- A **MRML Scene** is a collection of MRML nodes.

Modules (1/3)

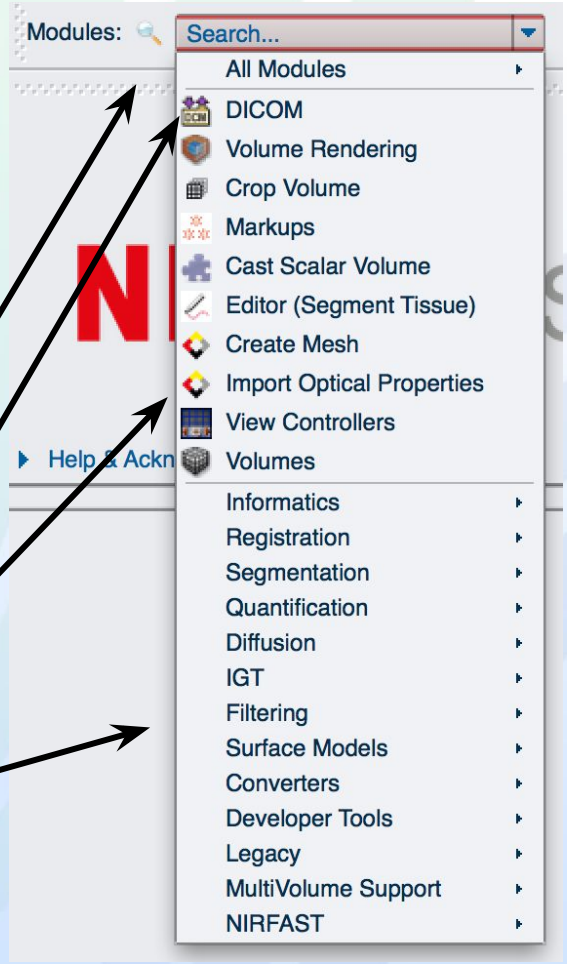
- **3D Slicer** plugin architecture allows to easily extend the core platform. Those plugins are called **modules**.

- Those modules can be implemented in:
  - C++
  - Python
  - Matlab *(link to NIRFAST-Matlab)*

Modules (2/3)

Choose your modules from the module drop-down menu:

- Magnifying glass to search a module by name
- A list of all modules can be accessed at the top
- Main modules are in the section right below
- All modules can be accessed by category



Modules (3/3)

How it works:

- Set input nodes *(ex: CT volume)*
- Set input values *(ex: threshold value, options)*
- Set output nodes (*ex: new empty node)*
- Apply

➔ Output nodes updated based on inputs

Sometimes: user interaction needed (ex: segmentation)

PART 3

Loading Data

Loading Data (1/2)

Two options :

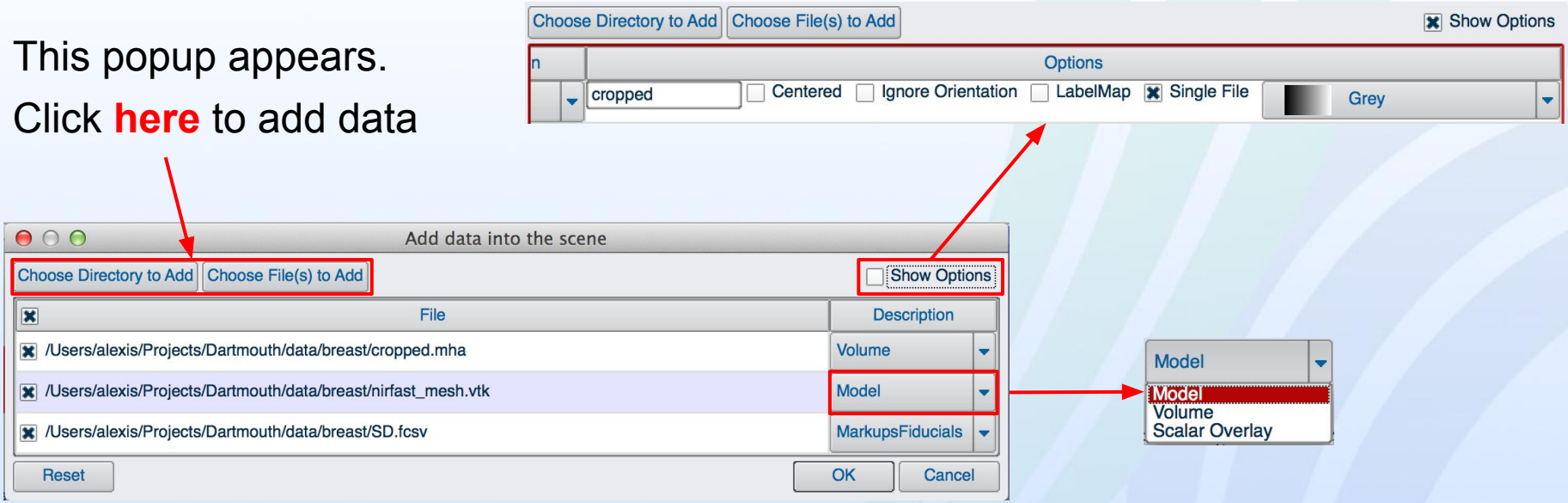
- File > Add Data
- Drag & Drop file in the application window

Same result : creation of a new object **node**

Loading Data (2/2)

This popup appears.

Click **here** to add data



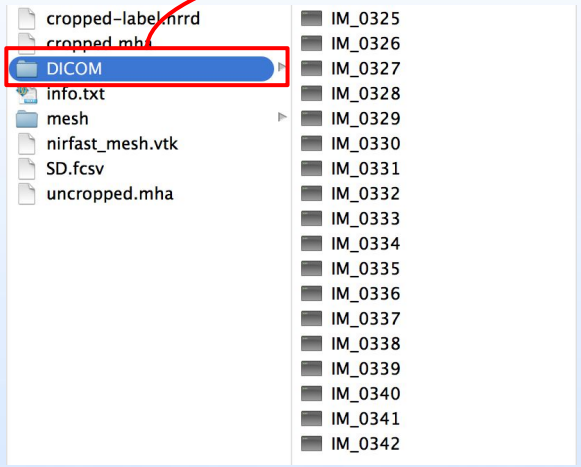
Loading DICOM (1/3)

Two options :

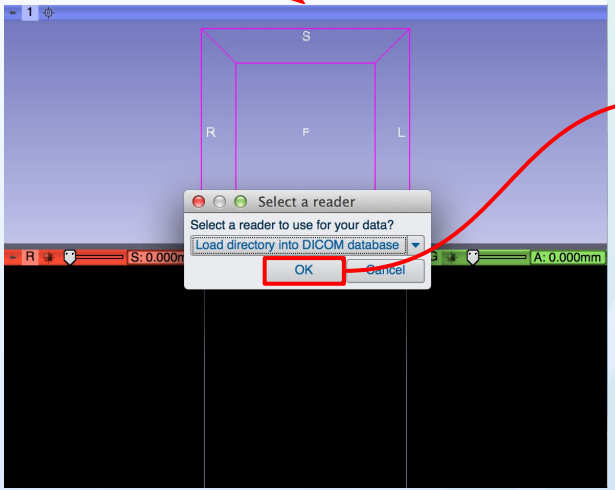
- Module DICOM > Show DICOM Browser > Import
- Drag & Drop folder containing DICOM images

Same result : imports patient info in **DICOM Browser**

Loading DICOM (2/3)

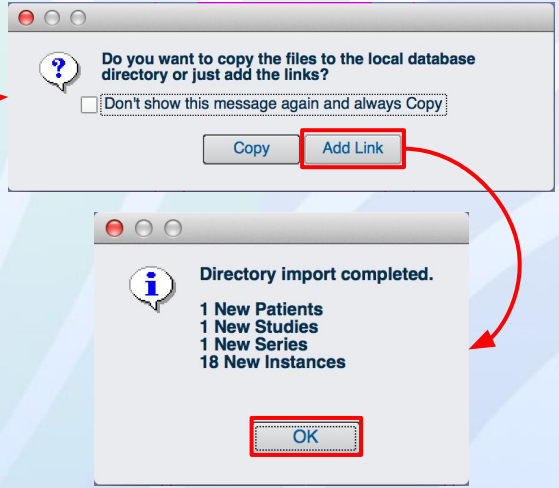


Drap & drop DICOM folder inside Slicer



Press **OK** to load directory into DICOM database

Press **Add Link** to import the directory

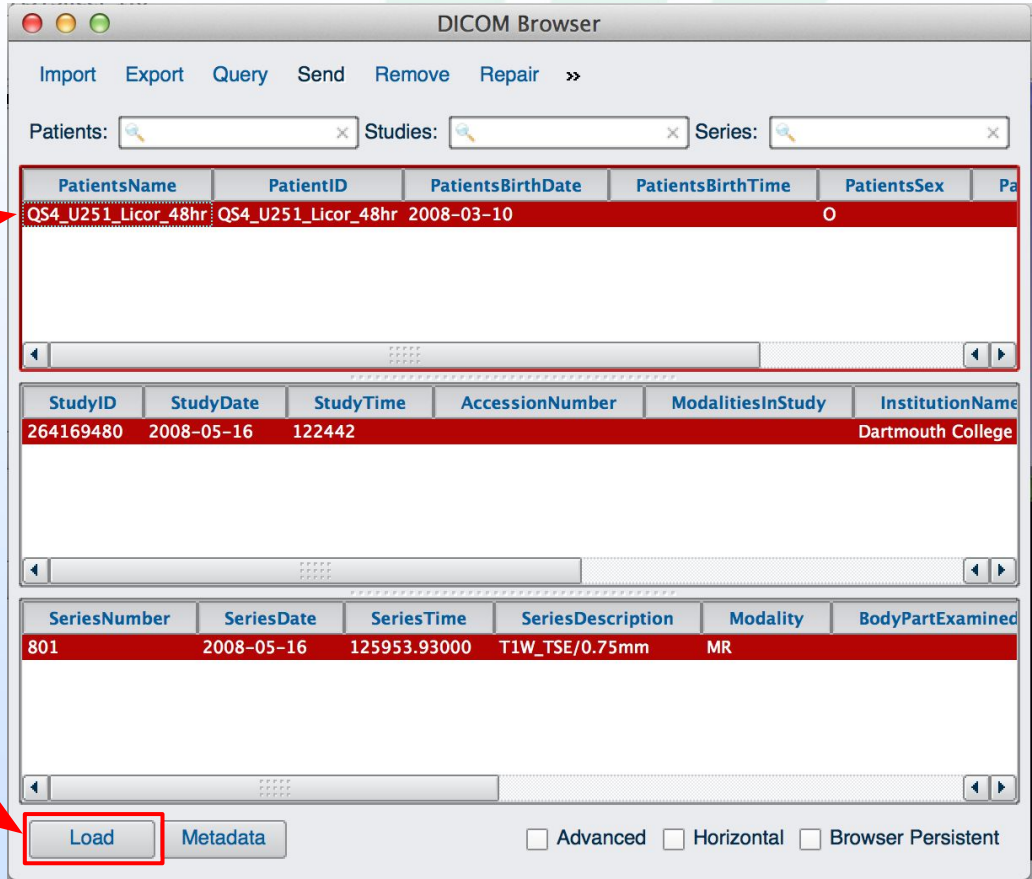


Press **OK** to finish import

Loading DICOM (3/3)

Select the dataset to load in the DICOM Browser

Press **Load** to load it in the scene as a MRML node



Data module

List of nodes, allows you to:

- Edit node properties

  redirects you to the appropriate module
- Rename node
- Delete node
- Inspect node (bottom)



PART 4

Layout and Slice Viewers

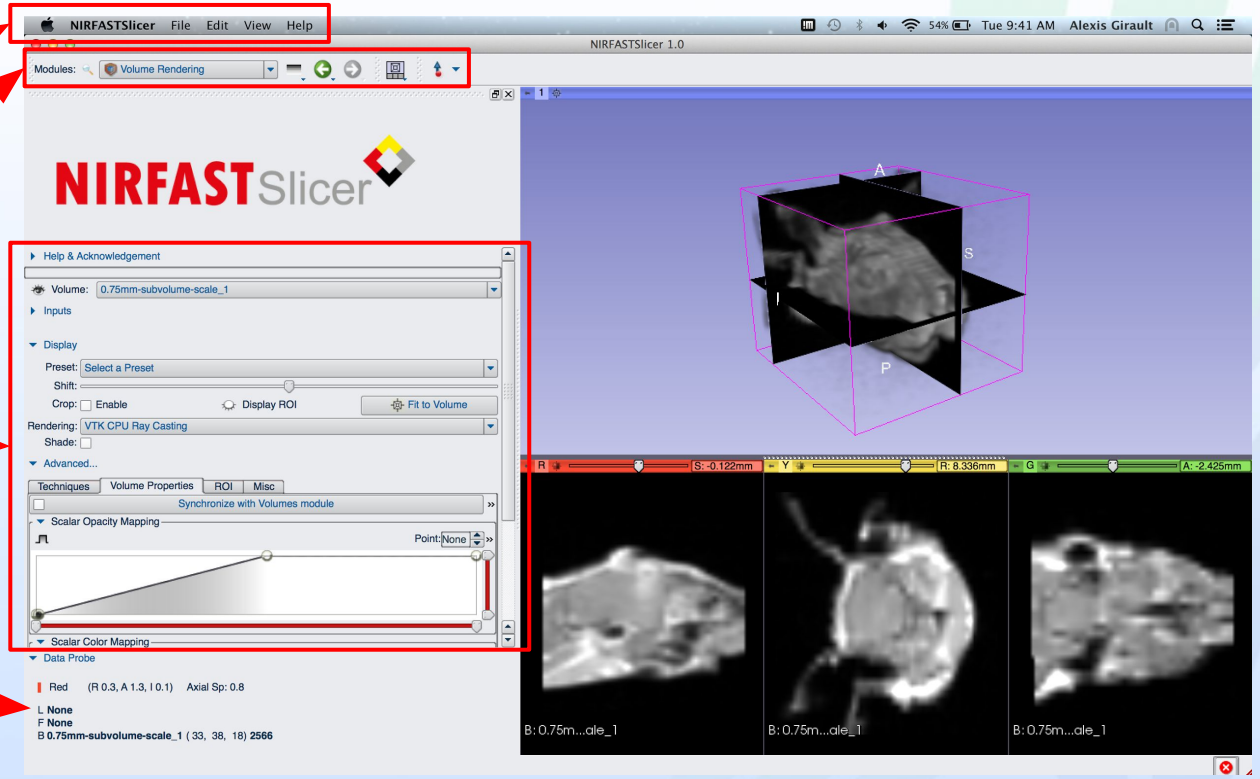
User Interface Overview

Main menu

Toolbar

Module GUI

Data Probe

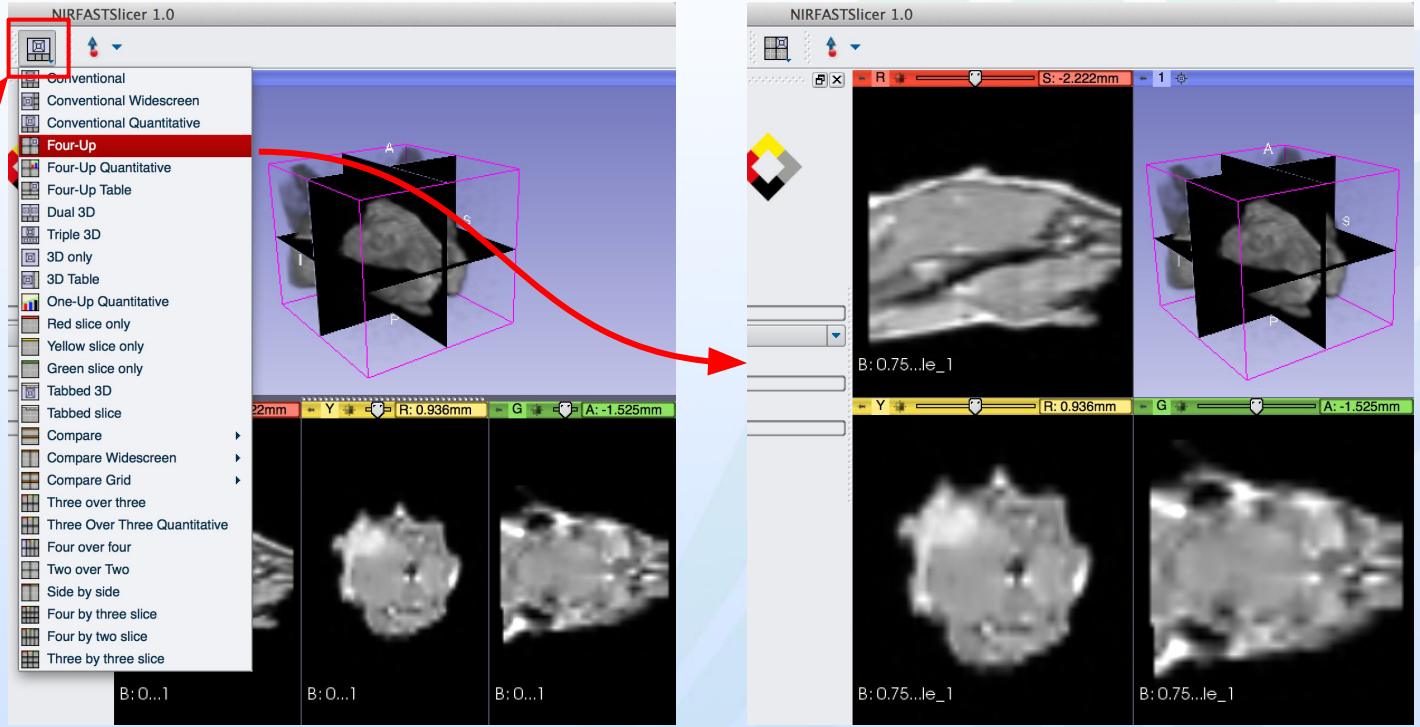


3D Viewer

2D anatomical slice viewers

Layout Manager

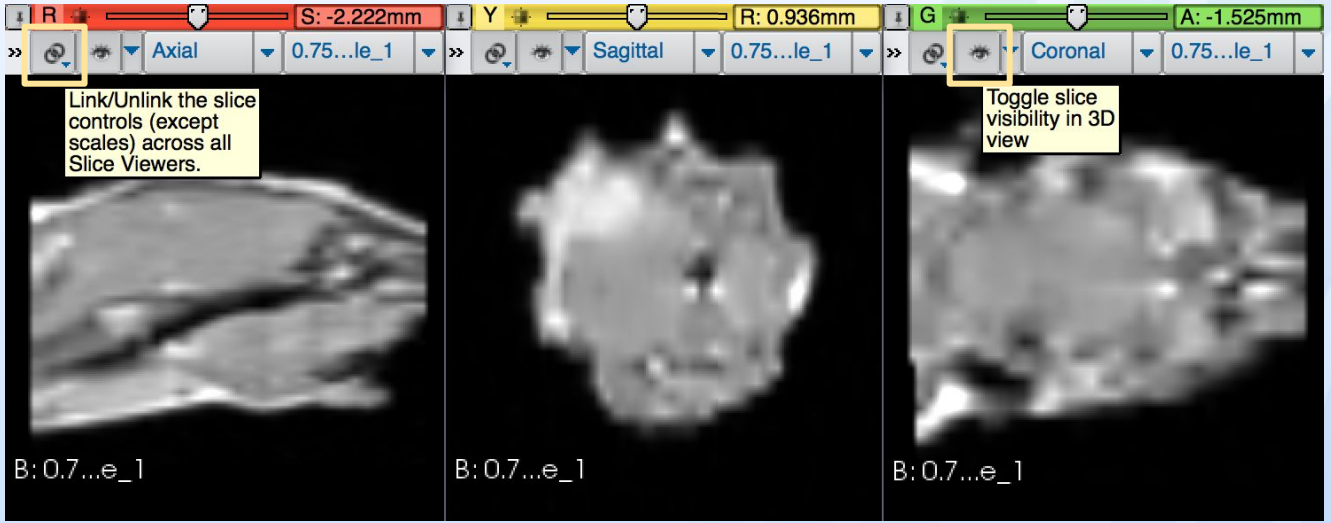
Press the layout icon in the toolbar to select a layout



Link Slice viewers (1/2)

Click on the **link icon** to link all three 2D Viewers.

Click on the **eye icon** to display the slices in the 3D Viewer.



Link Slice viewers (2/2)

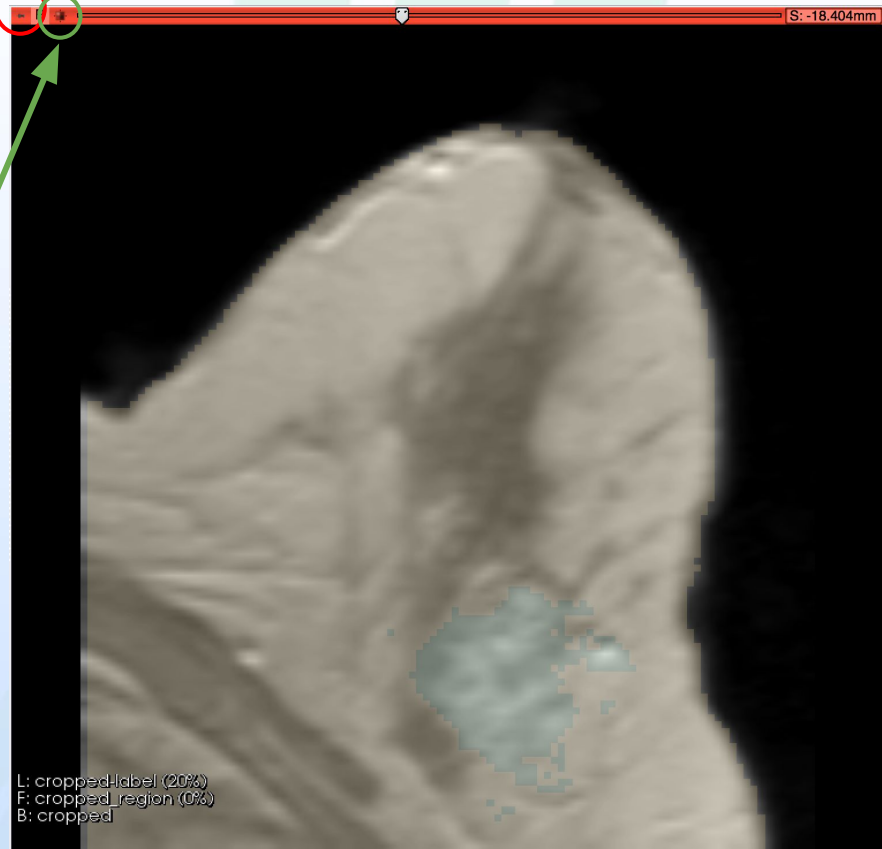
Propagate actions to other views

- Unlink  : action applies **only** to the current viewer
- Link  : action applies to **all** current viewer

Slice viewer toolbar (1/3)

Position your mouse over the **pin icon** to display the slice viewer toolbar.

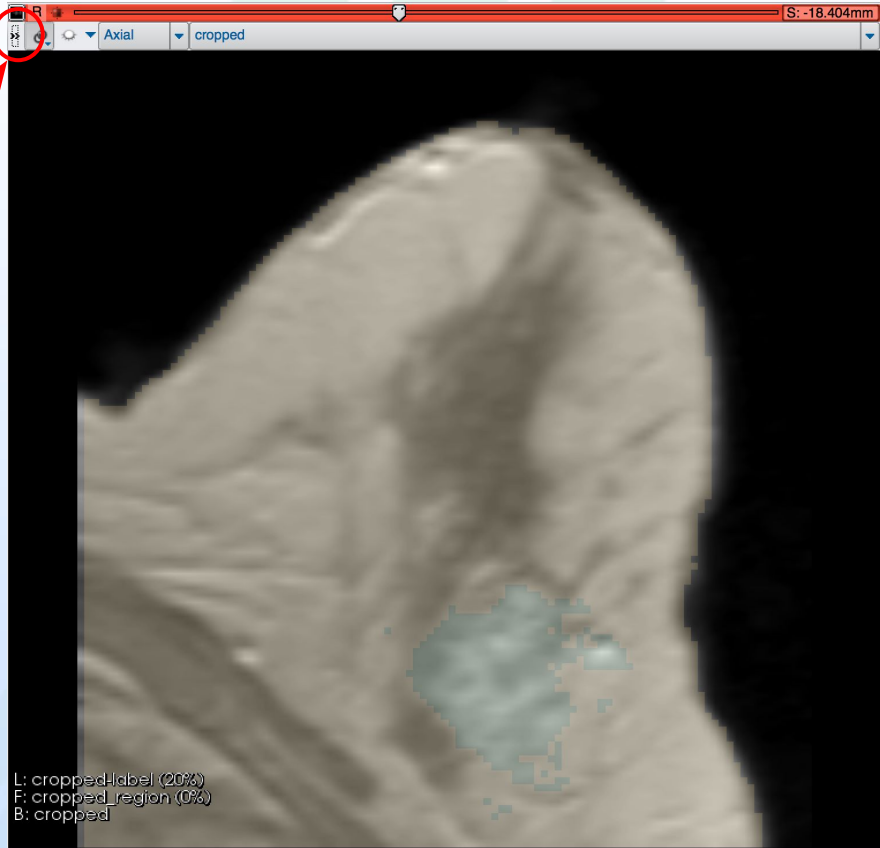
Re-center your slice within the window.
(useful after changing the displayed volume)



Slice viewer toolbar (2/3)

This shows the background volume and the view names.

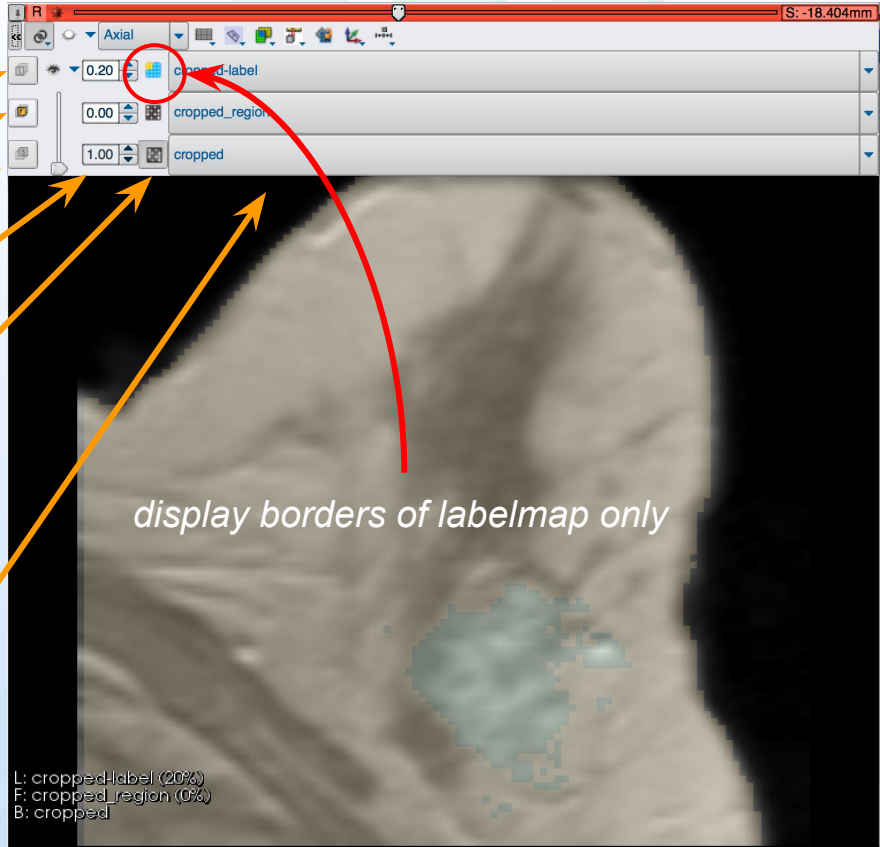
Press the **>> button** to open the full viewer toolbar.



Slice viewer toolbar (3/3)

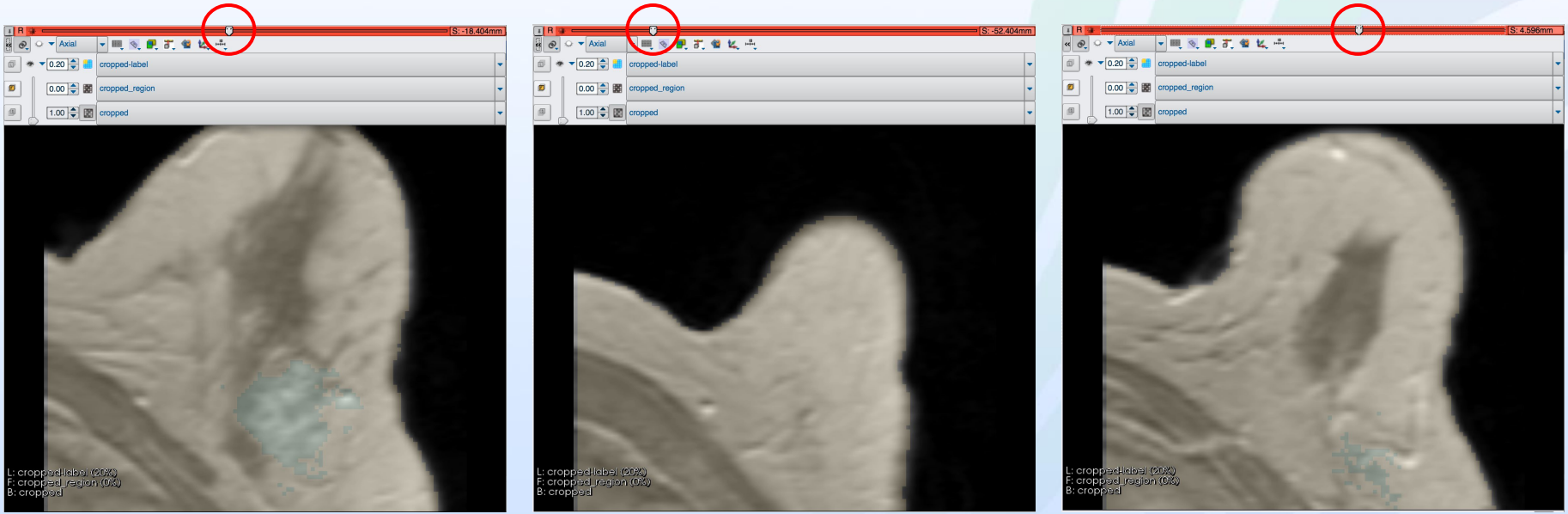
The viewer bar has:

- 3 lines for:
  - Label Map
  - Foreground
  - Background
- 3 columns for:
  - Opacity
  - Interpolation (on/off)
  - Name of displayed node



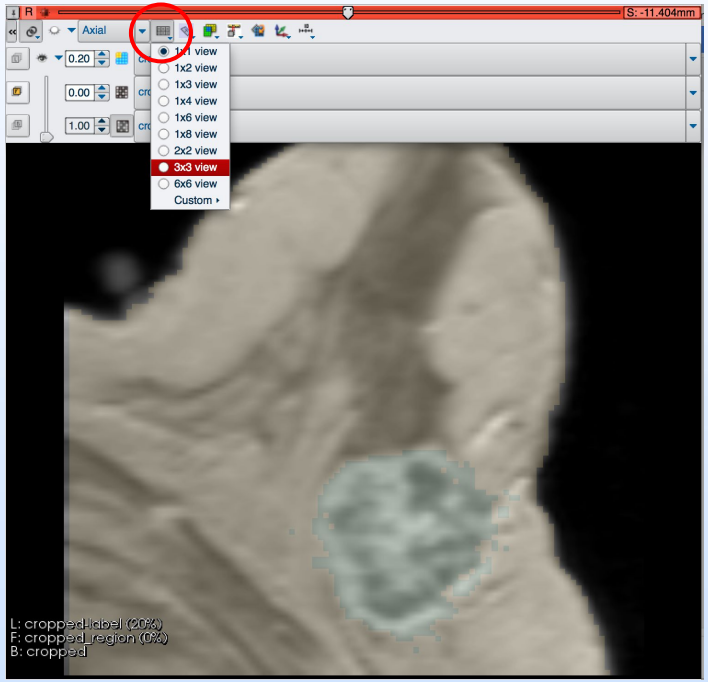
Select displayed slice

Move the slider to display slice along the viewer axis.



Display multiple volumes

Click on this icon to display multiple slices at once.





View controllers module

You can also access the viewer toolbars in the **view controllers** module.



PART 5

Volume visualization

Move volume in Viewer

You can displace a slice in its view by pressing a specified key and dragging your mouse like explained below:

Reset to original:

Press 

Zoom in:

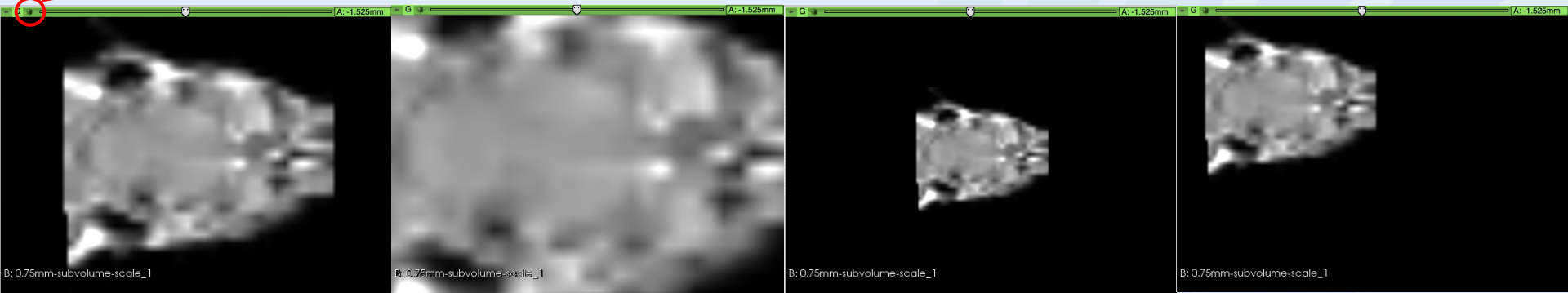
Shift + drag up

Zoom out:

Shift + drag down

Translate:

Ctrl + drag mouse

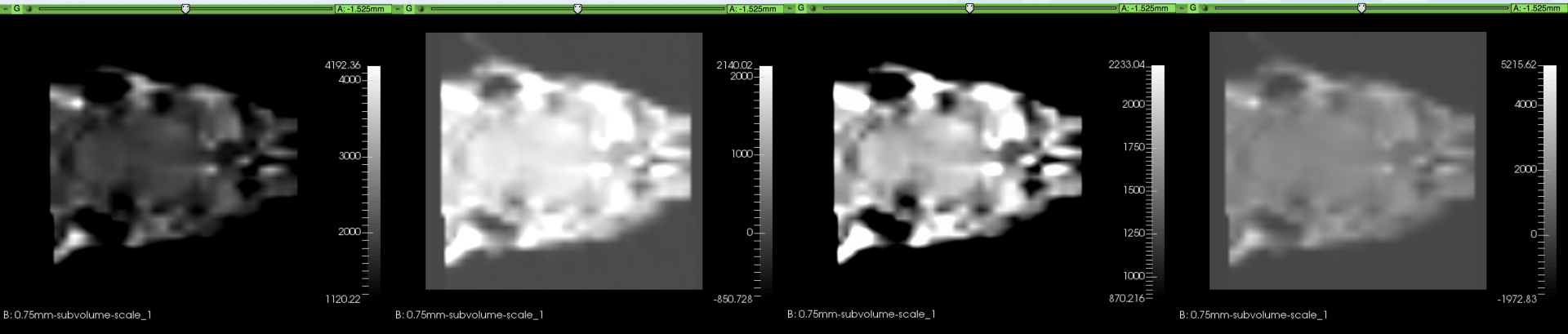


Window level

You can update the window level by dragging the mouse in the 2D Viewers.

(To display the scalar bar, go in module Data Probe > Scalar Bar > Enable)

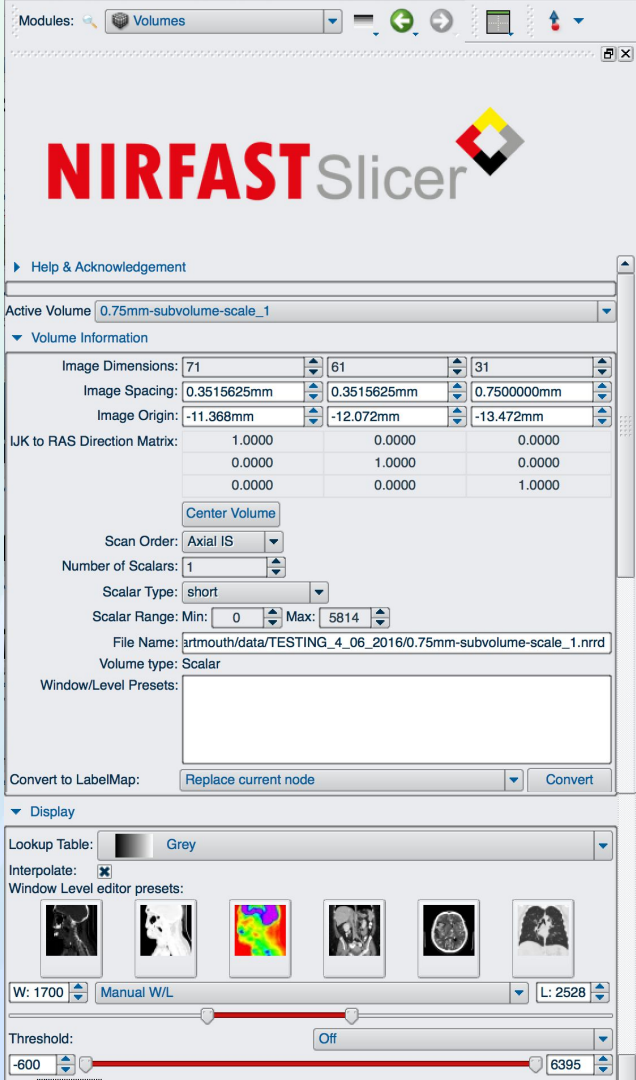
Darker:	**Brighter:**	**More contrast:**	**Less contrast:**
Drag mouse up	Drag mouse down	Drag mouse left	Drag mouse right



Volumes info/display

Volumes module offers:

- **Volume Information**
  - Image dimensions, spacing, origin
  - Scalar Range
  - ...
- **Display parameters**
  - Select lookup table (scalar value to RGB)
  - Interpolate voxel values (smoothing)
  - Select Window Level (manual, automatic)
  - Set Threshold



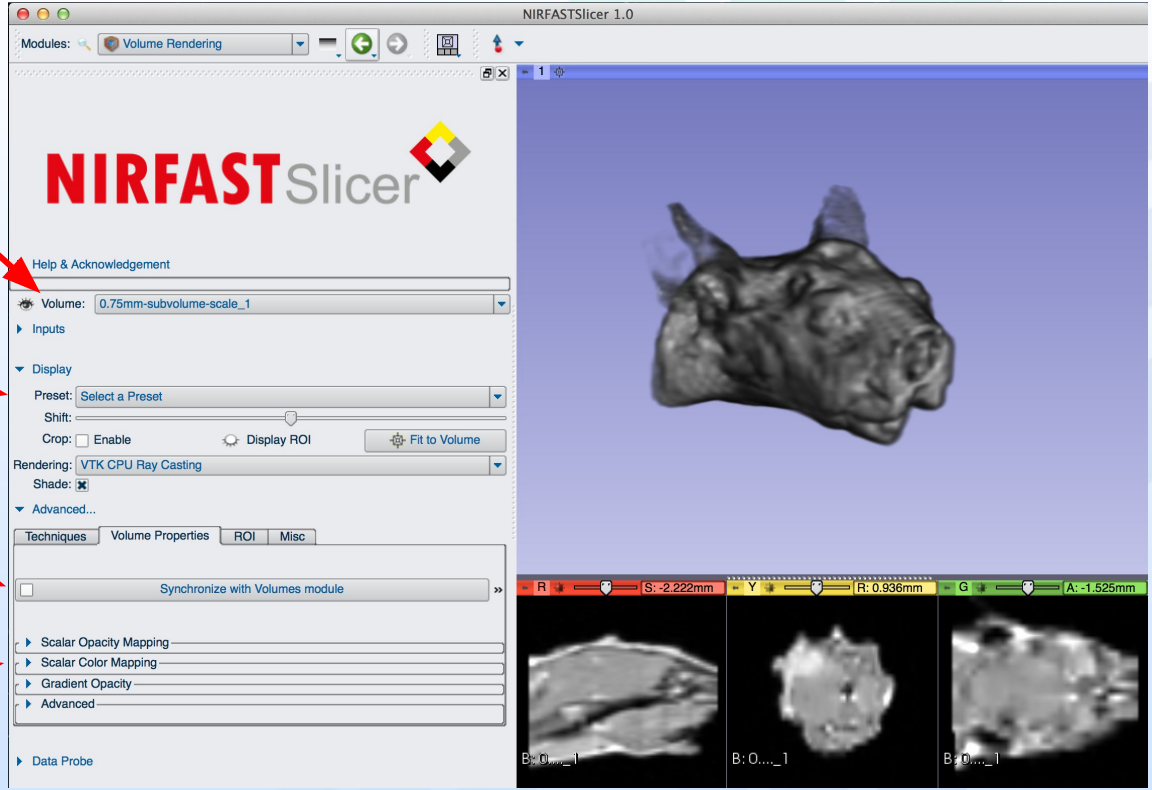
Volume Rendering (1/2)

Select the **Volume** to render in 3D and click on the **eye** icon

You can select a **Preset**, slide the **Shift** slider, or unselect **Shade** to get a better rendering

Click on **Synchronize with Volumes module** to use the window level of the 2D viewer

More advanced options if needed

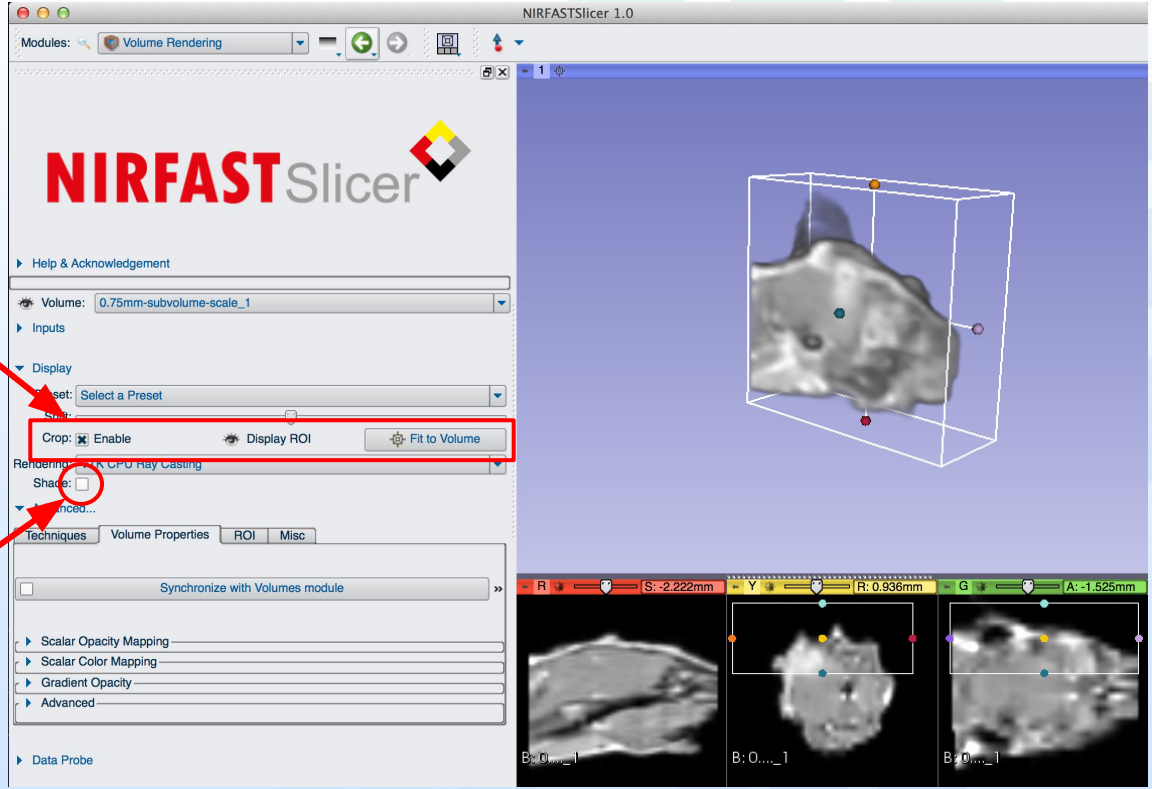


Volume Rendering (2/2)

Use those options to manipulate the **Region Of Interest** that was created with the volume rendering.

You can **manipulate** the ROI annotation in the 3D and the 2D Viewers.

Uncheck **Shade** to properly visualize within the volume.

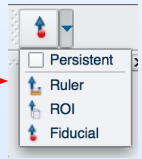


PART 6

Modules in pipeline

Crop volume

- **Role:** crop volume to region of interest
- **Input volume:** select volume to crop
- **Input ROI:** either:
  - Create new AnnotationROI
  - created in volume rendering
  - created with annotation

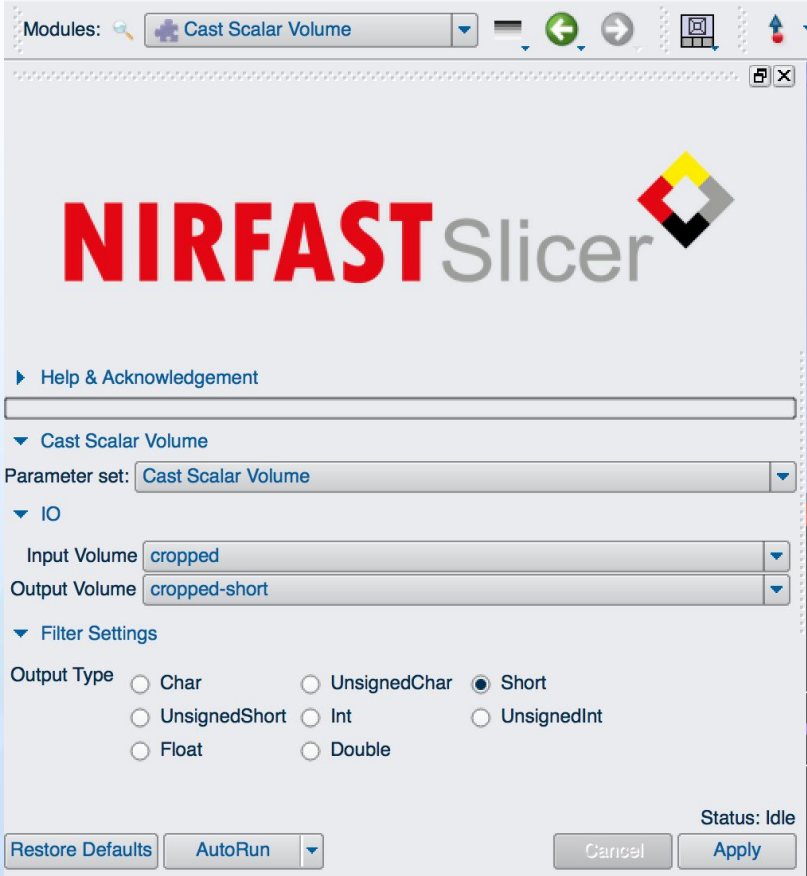


- **Crop!** Creates a cropped file named: **“inputname”-scale_1**



Cast Scalar Volume

- **Role:** convert the volume voxel scalar values to short type *(required for automated segmentation techniques)*
- **Input volume:** cropped volume
- **Output volume:** either:
  - Create new Volume (as…)
  - same as input (overwrites it)
- **Apply:** updates the output volume

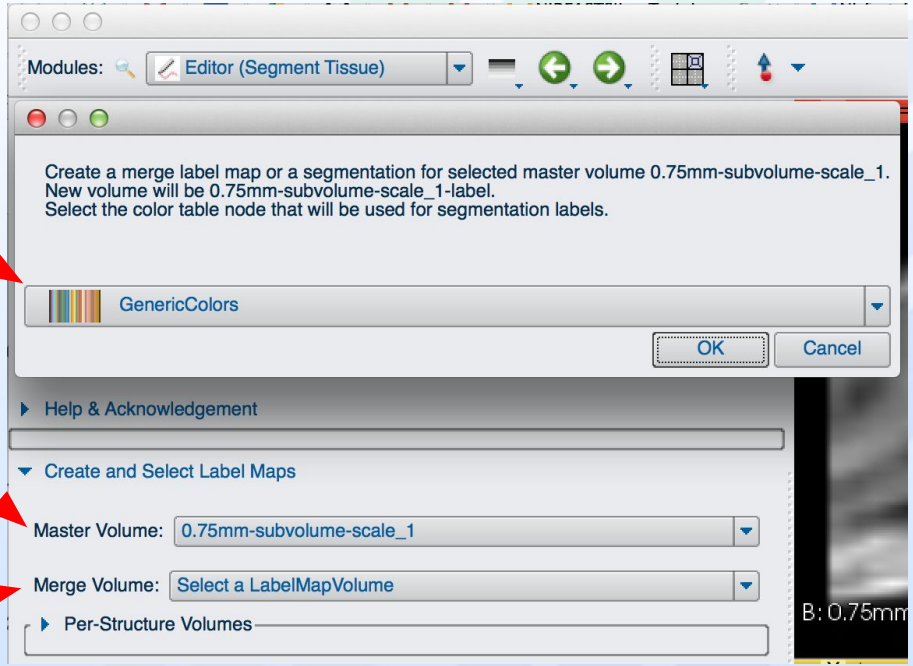


Editor - Segment Tissue (1/3)

When selecting the **Editor** module, a pop-up shows up to ask you what color table to use. Select **GenericColors** and press **OK**

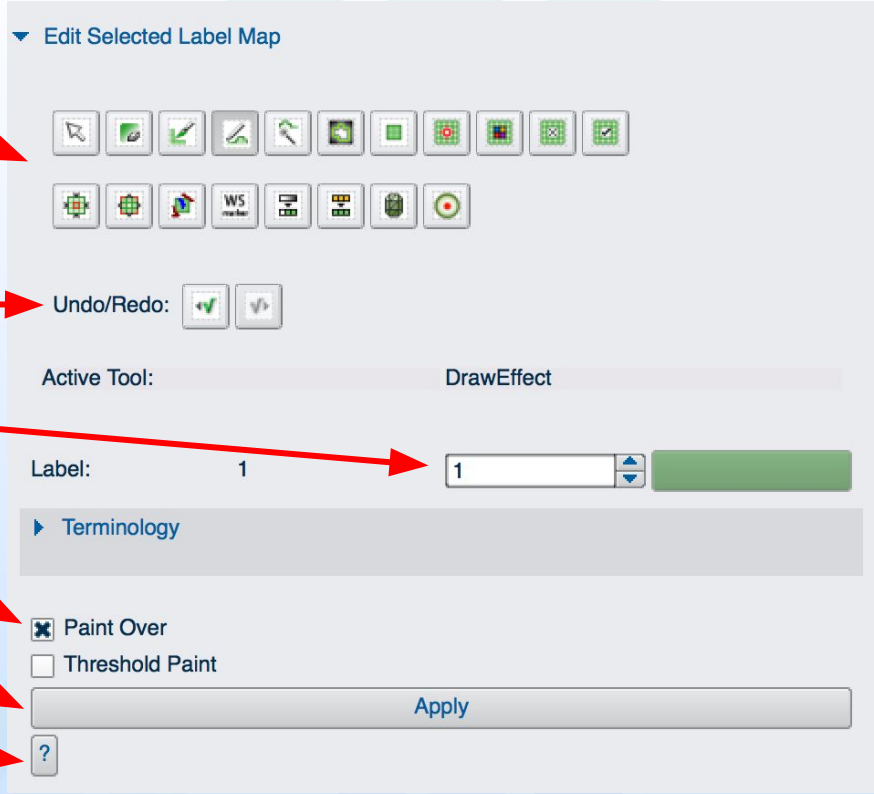
Make sure the **Master Volume** is the volume you wish to segment, if not, select the good node here

This will create a node for your label map in **Merge Volume**



Editor - Segment Tissue (2/3)

- **Tools:** select your tool (drawing tools, filters…)
- **Undo/Redo:** allows you to go back step by step if you are not satisfied with your changes
- **Label:** active label for the tool
- **Options:** options of the tool/filter
- **Apply:** apply the filter (filter only)
- **?:** information on the selected tool



Editor - Segment Tissue (3/3)

For detailed documentation on each tool and filters, go to:

www.slicer.org/slicerWiki/index.php/Documentation/4.5/Modules/Editor

Web search keywords:

Slicer wiki editor module

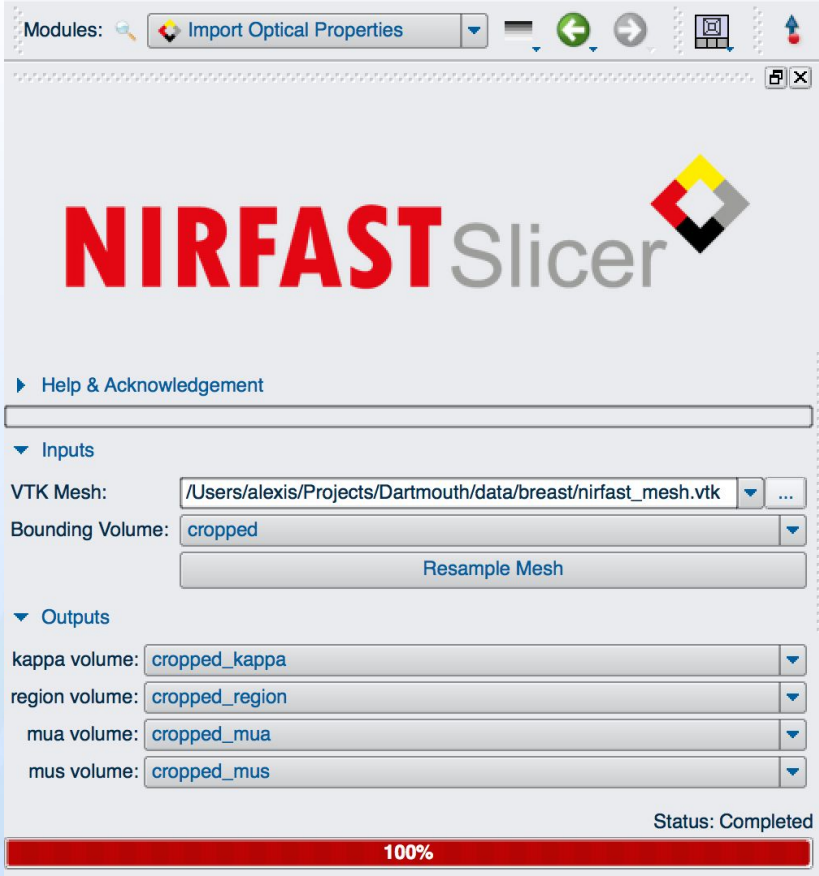
Create Mesh

- **Role:** create NIRFAST volumetric mesh and allows you to place the light sources and detectors
- **Input Label Map:** segmented volume
- **Sources/Detectors:** placed fiducials
- **Output Mesh Dir/Name:** path where the volumetric mesh will be saved
- **Apply:** launches NIRFAST-Matlab window



Import Optical Properties

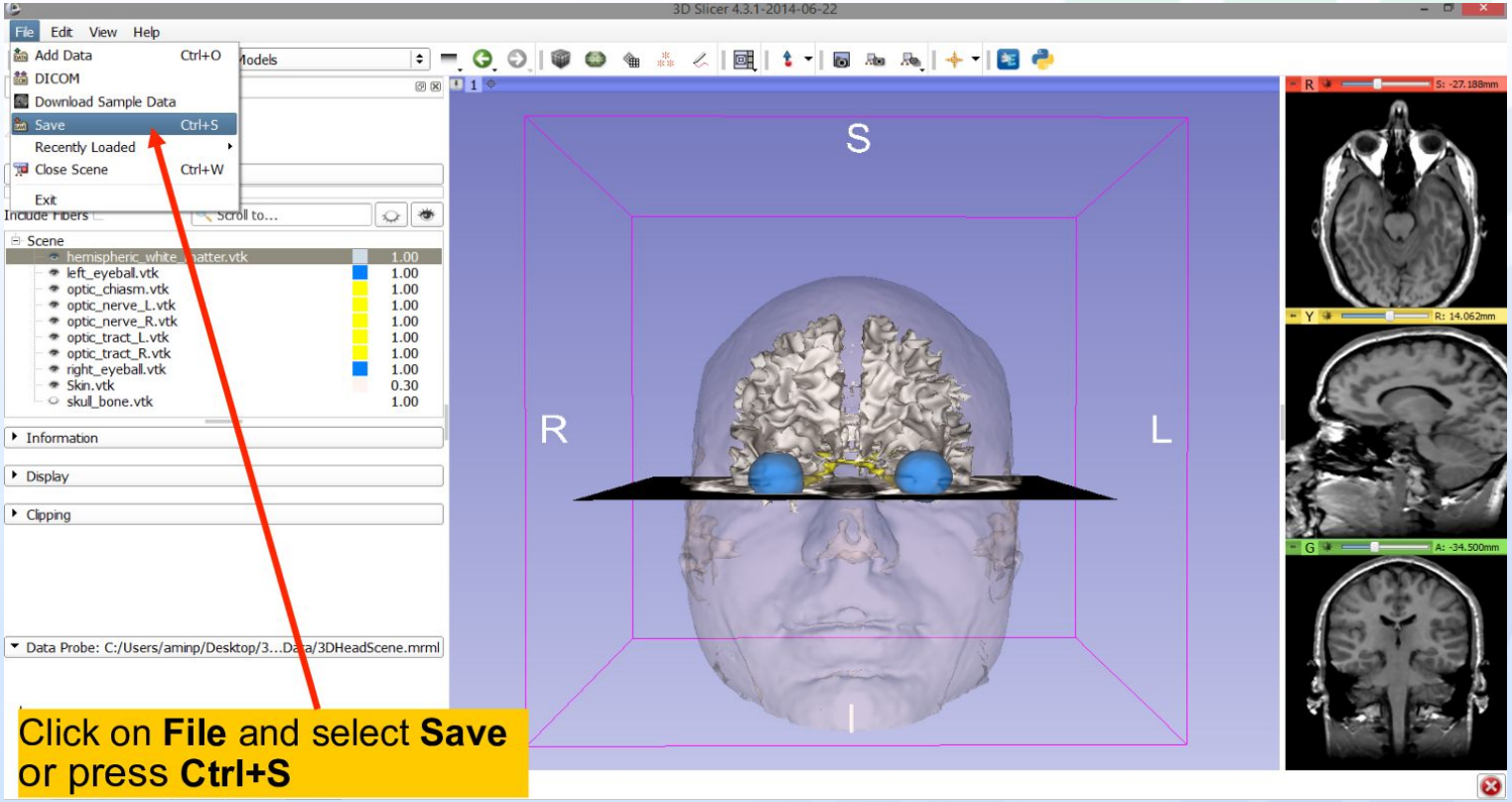
- **Role:** extract the point data of the VTK volumetric mesh and resamples it in volumes for each optical property
- **VTK Mesh:** VTK file created after light reconstruction in NIRFAST-Matlab
- **Bounding volume:** either:
  - original cropped volume
  - none (will need to specify spacing)
- **Apply:** dynamically outputs volume nodes and display them accordingly



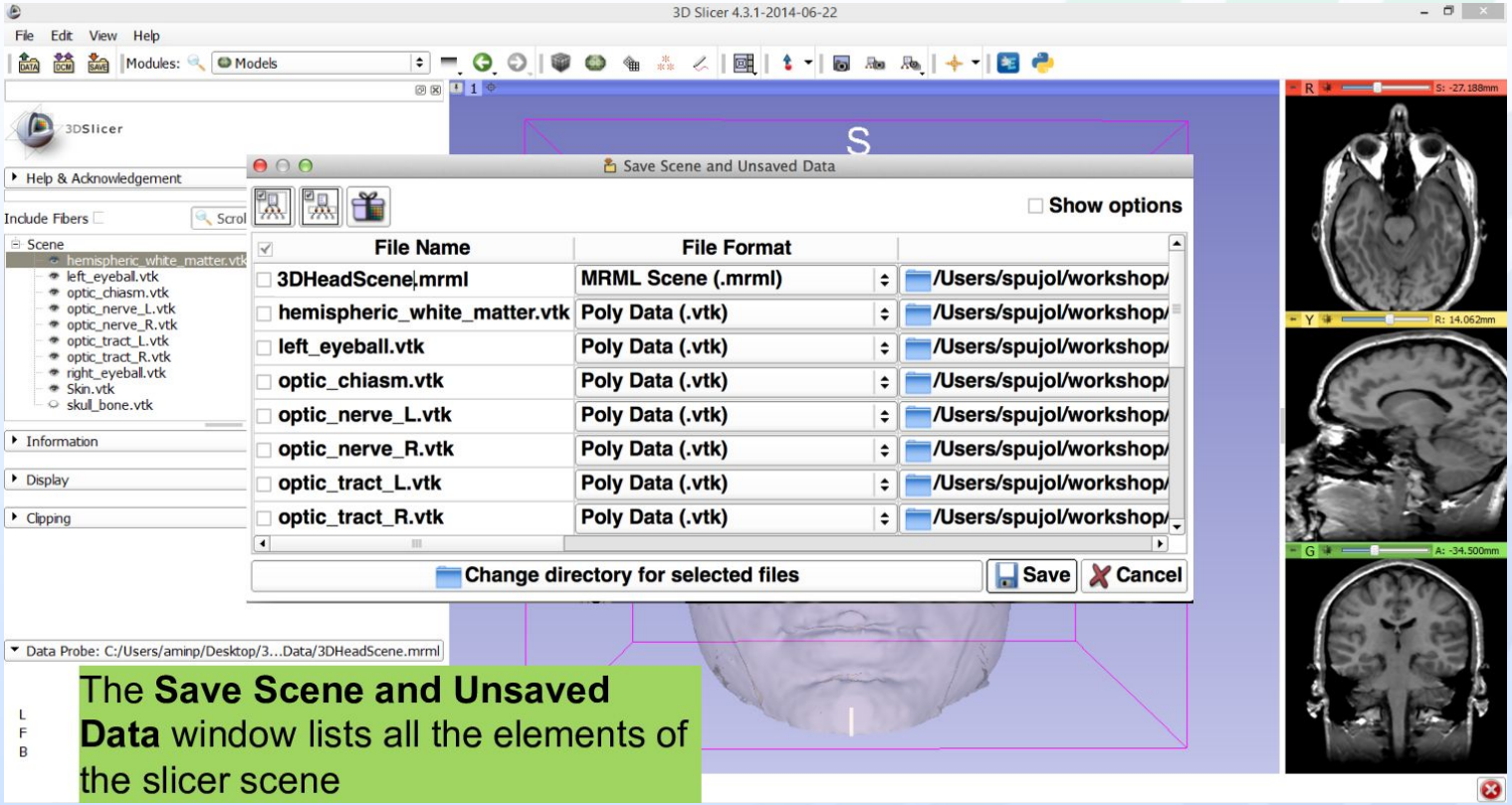
PART 7

Saving/Closing a scene

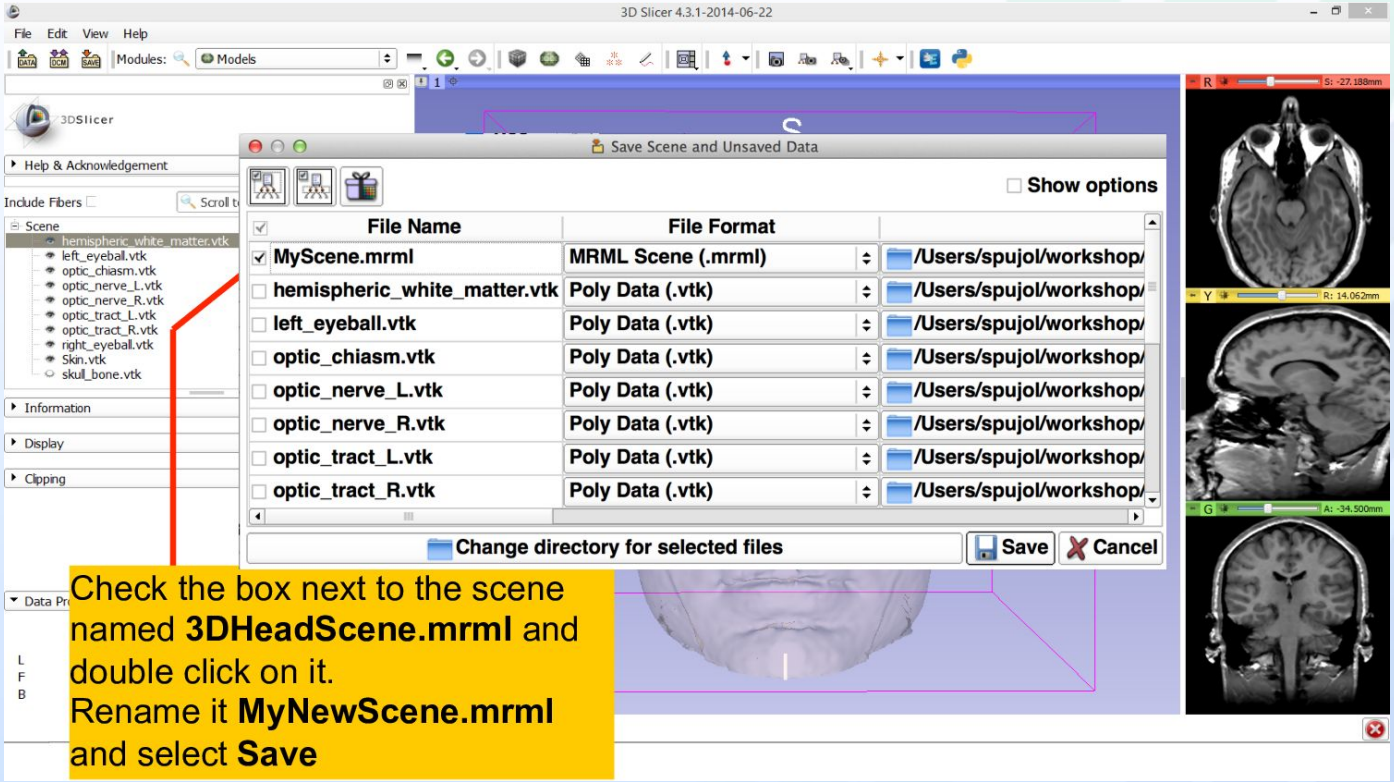
Saving a scene (1/3)



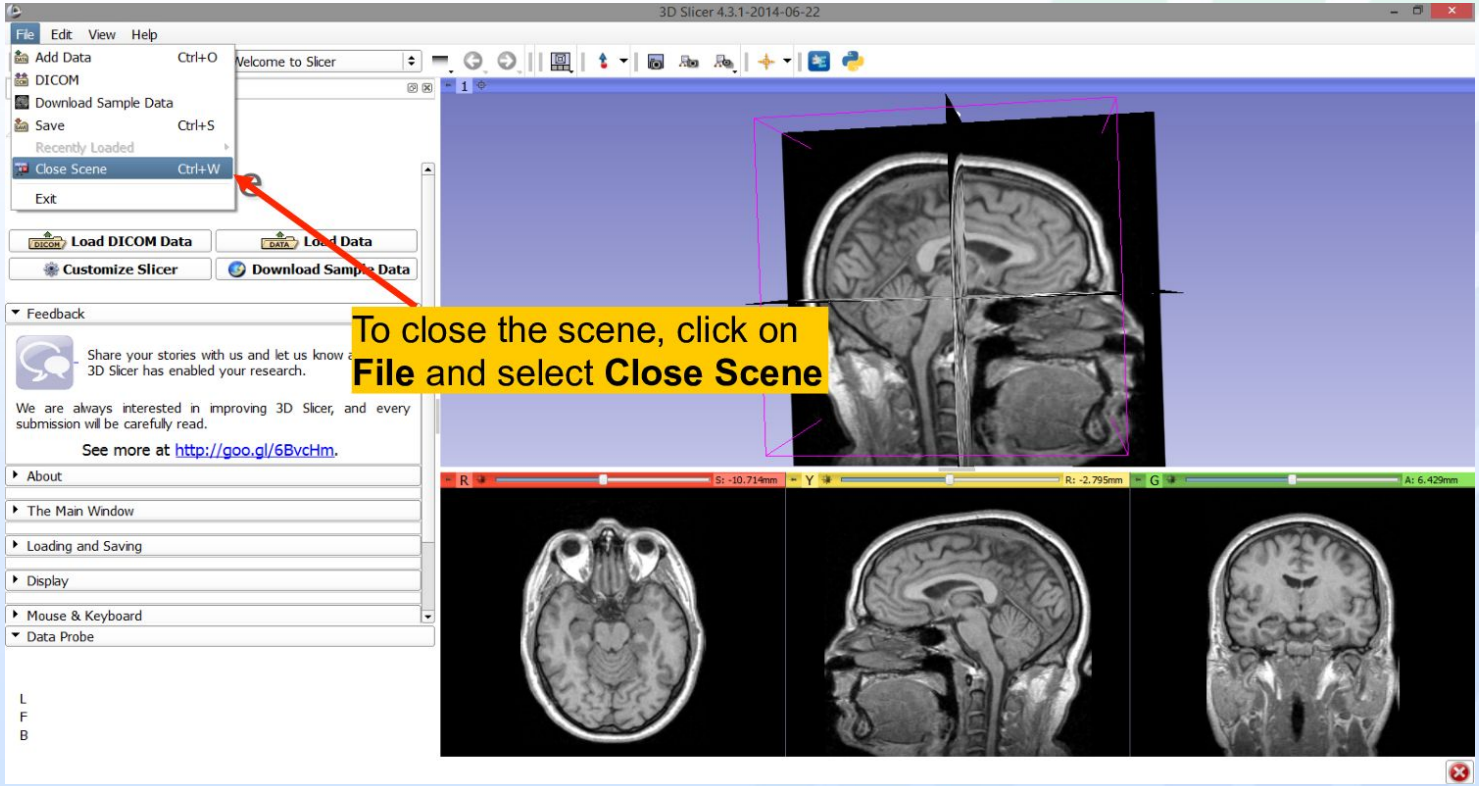
Saving a scene (2/3)



Saving a scene (3/3)



Closing current Scene




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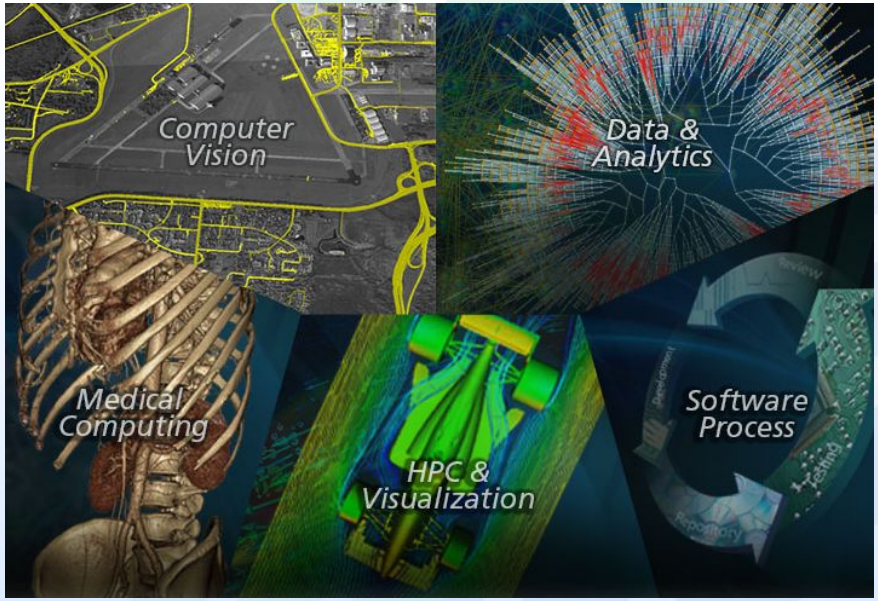
Open source scientific computing

Collaborative Software R&D

- Algorithms & applications
- Software process & infrastructure
- Support & training
- Open source leadership

Supporting all sectors

- Industry, government & academia



Customers & Collaborators

Over 75 academic institutions including:

Harvard
MIT
University of California, Berkeley
Stanford University
California Institute of Technology
Imperial College London
Johns Hopkins University
Cornell University
Columbia University
Dartmouth College
Robarts Research Institute
University of Pennsylvania
Rensselaer Polytechnic Institute
University of Utah
University of North Carolina

Over 50 government agencies and labs including:

National Institutes of Health (NIH)
National Science Foundation (NSF)
National Library of Medicine (NLM)
Department of Energy (DOE)
Defense Advanced Research Projects Agency (DARPA)
Army Research Lab (ARL)
Air Force Research Lab (AFRL)
Sandia (SNL)

Over 100 commercial companies in fields including:

Automotive
Aircraft
Defense
Energy technology
Environmental sciences
Finance
Industrial inspection
Oil & gas
Pharmaceuticals
Publishing



Successful small business

- Founded in 1998, privately owned
- More that 110 current employees, with 37% MSc, 47% Ph.D
- $21.3 M revenue in 2013

Offices

- Clifton Park, NY
- Carrboro, NC
- Santa Fe, NM
- Lyon, France

Awards

- 2016 Winner of the Top Workplaces Award
- 2010, 2011, 2012, 2015 HPCwire Best HPC Visualization Product or Technology awarded to VTK and Paraview
- 2007 to 2013 Inc. Magazine's list of 5,000 fastest-growing private companies
- 2011 Inc. Top Small Company Workplaces Award
- 2011 Tibbetts Award for Outstanding Research



Current Openings

We're always looking for talented and motivated people. For more information about **Kitware** and **available positions**, visit http://jobs.kitware.com



- Business Development Representative
- Software Developer
- Software Developer
- Recruiter
- Scientific Visualization Web Developer
- Software Developer for ITK and Slicer
- Statistical Analysis/R Programmer
- Internship in Computer Vision Research
- Internship in Web-based Bioinformatics
- Computer Vision Software Developer
- Image Guided Intervention Applications Research and Development Engineer
- Biomechanical Modeling and Surgical Simulation Research and Development Engineer
- Technical Lead in Biomedical Image Analysis and Visualization
- Earth and Space Science Software Developer
- Scientific Visualization Developer
- Computer Vision Researcher
- Research and Development Involving Machine Learning and Medical Image Analysis