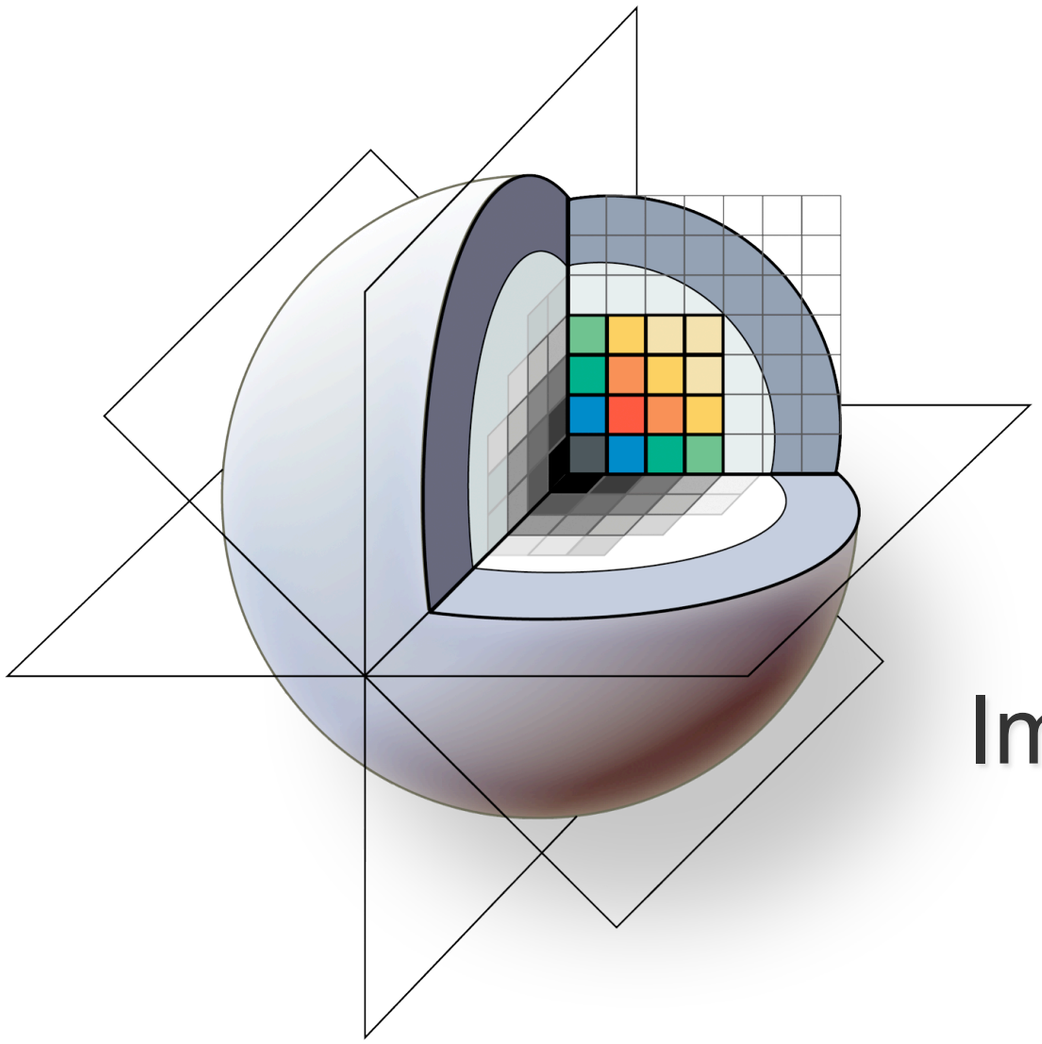
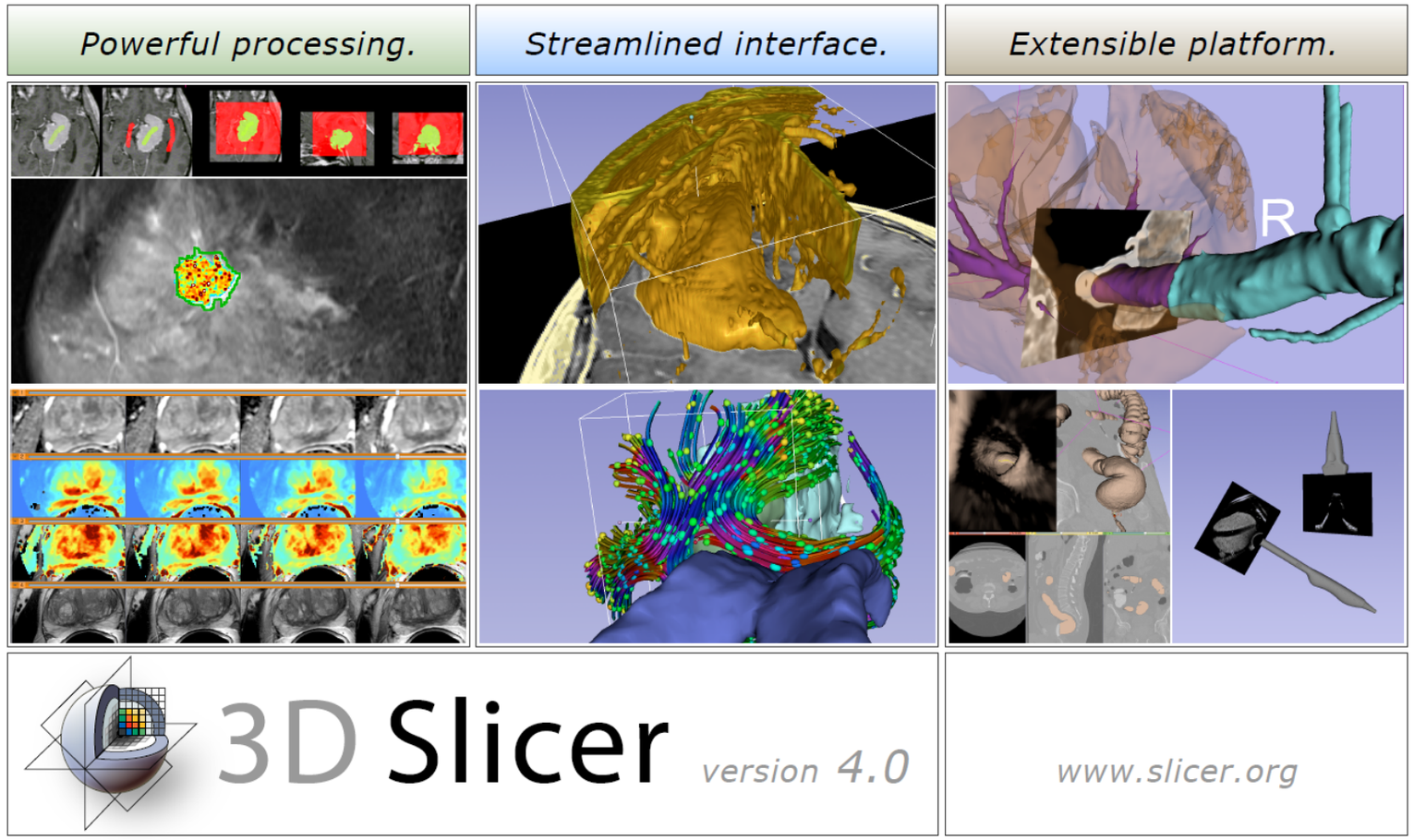


# 3D Slicer: A Free & Open Source Platform For Medical Image Analysis and Visualization

*Brigham and Women's Hospital*
*& the Slicer Community*

# 3D Slicer: An overview

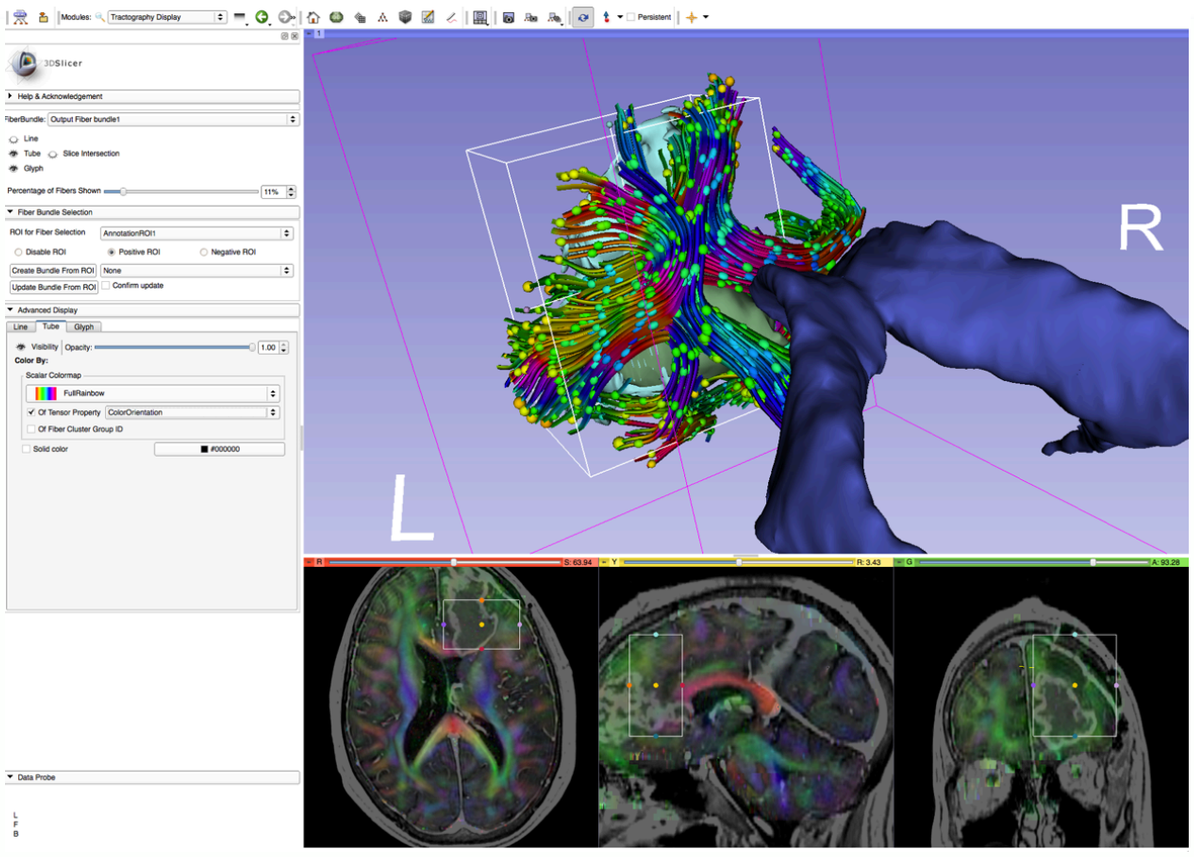
3D Slicer is a multi-platform, free and open source software package for visualization and medical image computing.




www.slicer.org

# 3D Slicer: An overview

The software platform is community created for the purpose of subject specific medical image analysis and visualization. Slicer includes support for:




Using an ROI to crop streamlines from a whole brain tractography. The streamlines display color by orientation, the ellipsoids are displaying fractional anisotropy.

- Multi-modality imaging including, MRI, CT, US, nuclear medicine, and microscopy
- Multi-organ from head to toe
- Bidirectional interface for devices and scanners
- Expandable and interfaced to multiple toolkits

# 3D Slicer: An overview

## Types of users:

Algorithm researchers who work within 3DSlicer's development environment and with associated toolkits)

Biomedical engineers (who rely on 3DSlicer's interactive enironment and scripting capabilities)

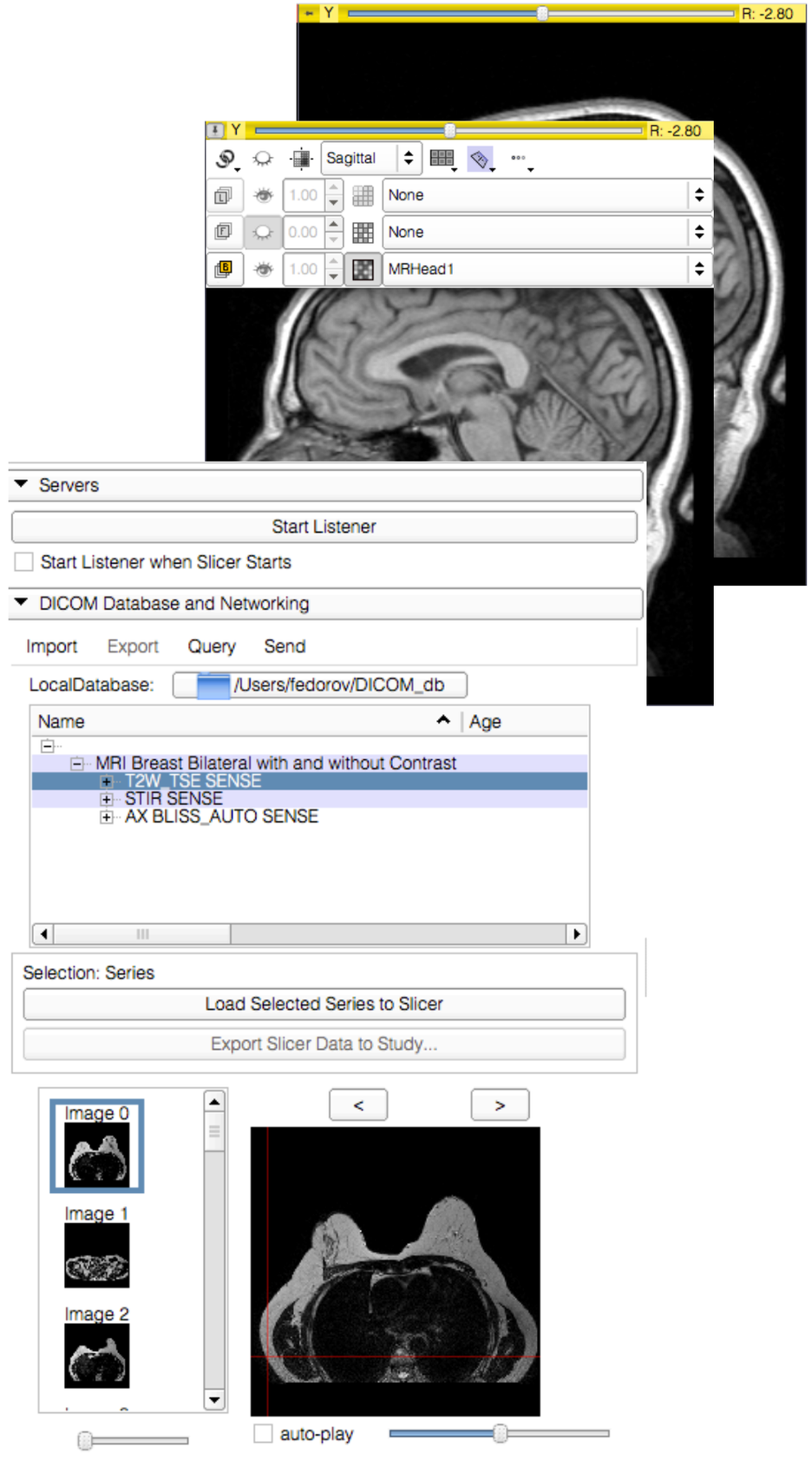
Application scientists (who use 3DSlicer as a desktop application and turnkey system)

## Core use scenarios:

- Longitudinal and multi-channel dataset analysis
- Individual and group analysis
- Real-time control and tracking in the operating theater
- Neurosurgical planning and guidance

# 3D Slicer: What's different in 4.0?

- Qt-based GUI
- Streamlined user- and developer-level interfaces
- Improved DICOM support
- 64-bit support for all platforms

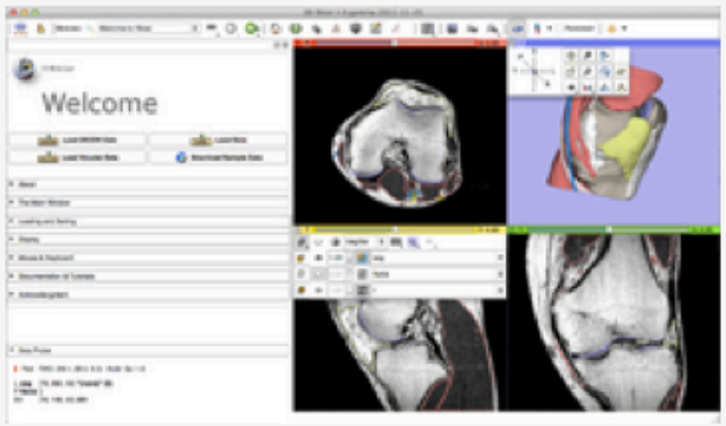


# 3D Slicer: What has not changed?

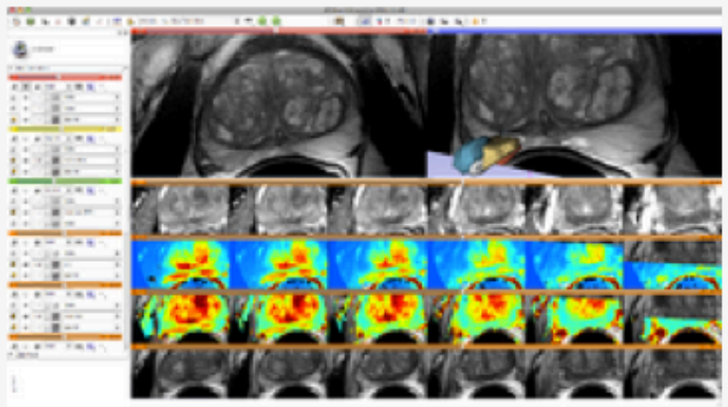
- Free Open Source Software
  - Free to use both in academic and commercial projects
- NA-MIC Kit foundation tools and robust software development practices
- Cross-platform portability: Win / Mac / Linux
- Support of user and developer communities



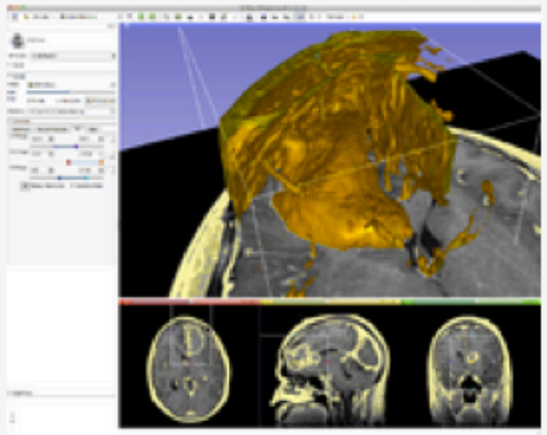

# 3D Slicer: Version 4.0 Highlights



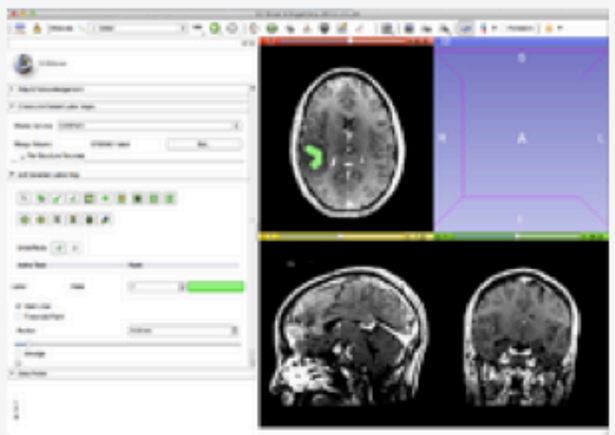

Main GUI



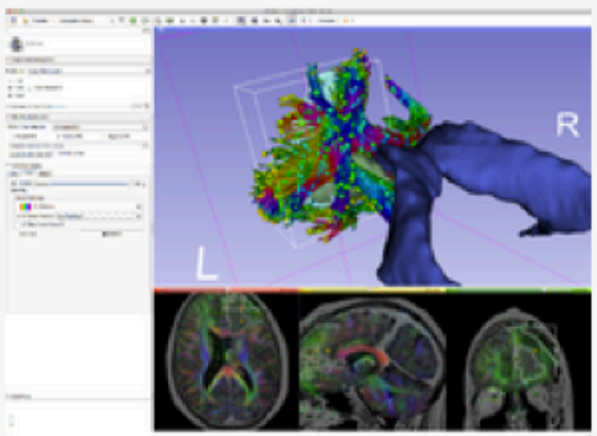
Layouts



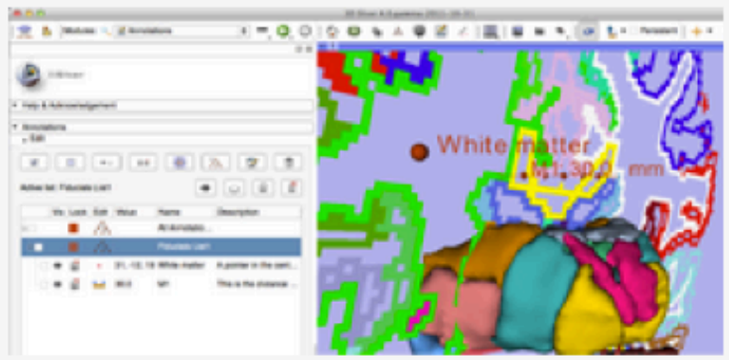
Volume Rendering



Editor

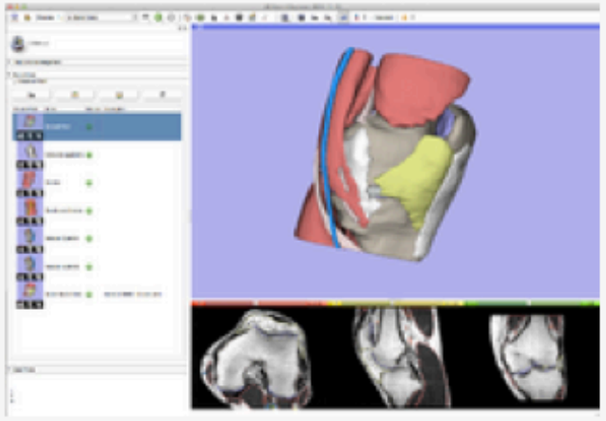



Diffusion: Fiber Display

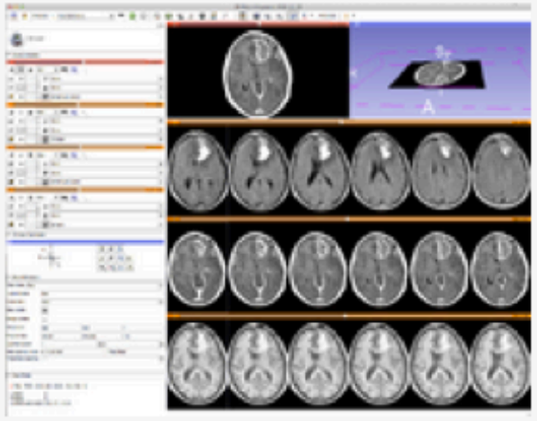



Annotations

# 3D Slicer: Version 4.0 Highlights

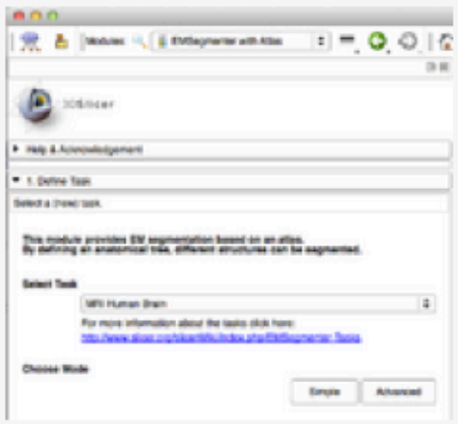


Sceneviews



View controllers

Volume module

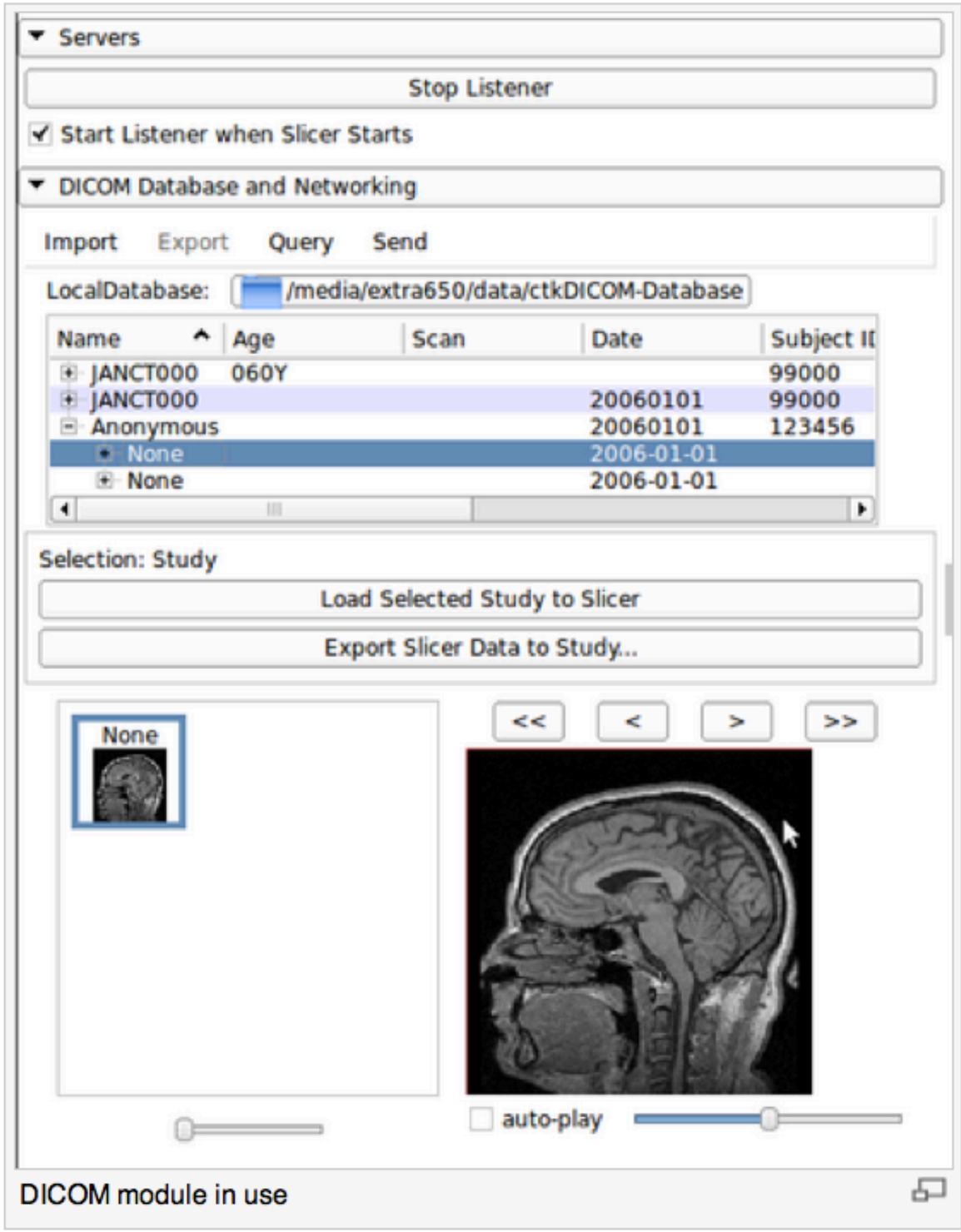



EM segmenter

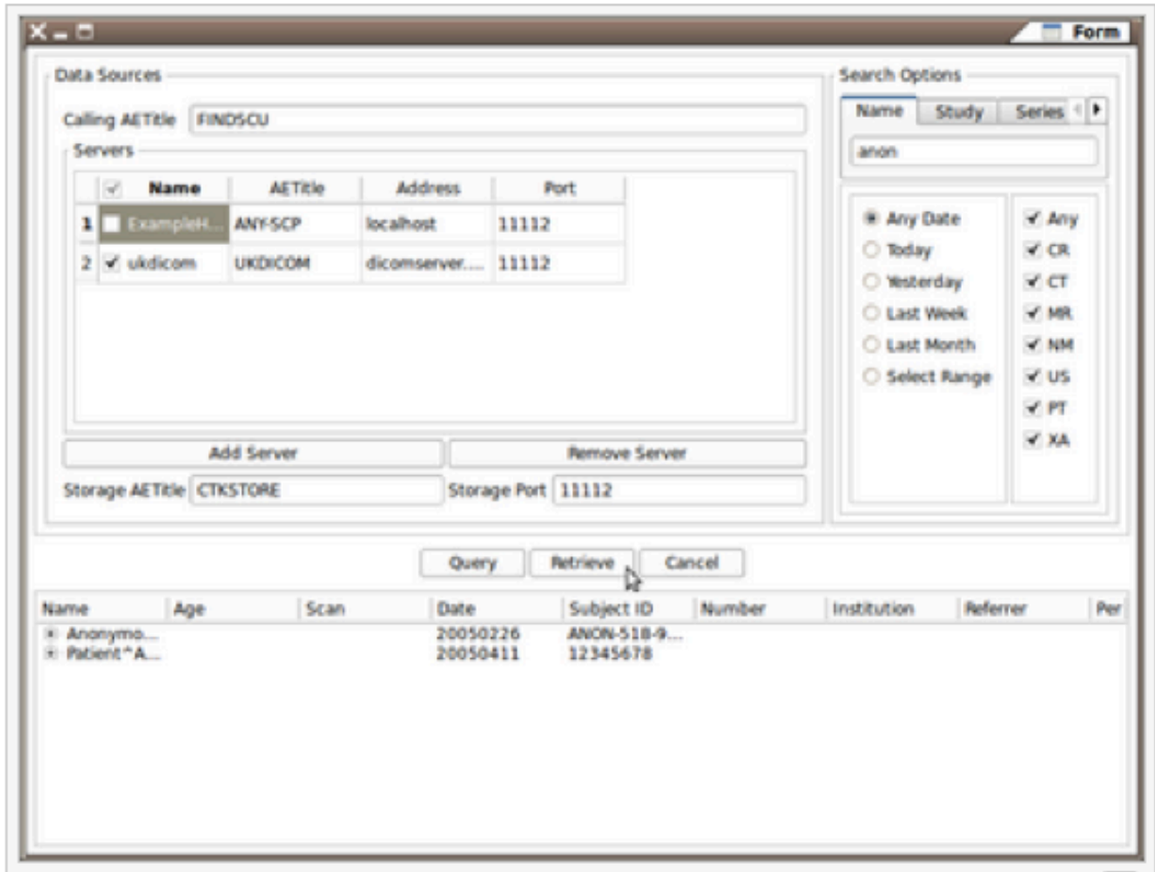

Slicer welcome module


Data probe

# 3D Slicer: DICOM Networking




DICOM module in use




DICOM Query dialog

# 3D Slicer: What extensions afford...

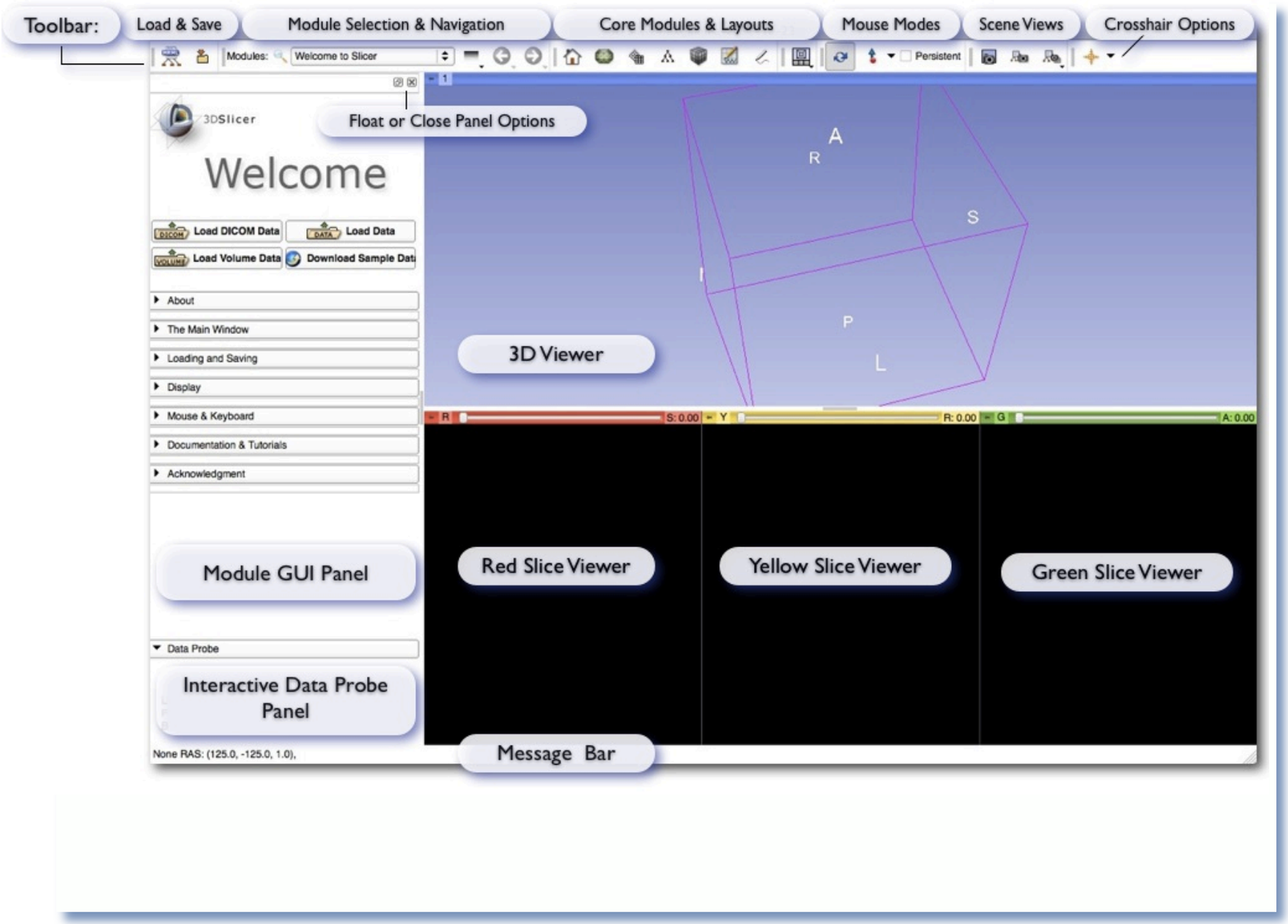
*Extensions for 3D Slicer 4.0 will be available February 2012*

- Keep the base package "lean and mean"
- Modules have individual identity
  - Per-module web site, svn, downloads, mailing lists, wiki…
- Users can customize their own subset of tools
- Easy to download compatible extensions
  - Analogous to Firefox extensions
  - Integrate extension builds into developer/nightly/release processs
- NITRC Supplement to NA-MIC providing additional infrastructure (Neuroimaging Informatics Tools and Resources Clearinghouse)
  - NITRC can host neuroimaging projects (gforge implementation)

# 3D Slicer: Integration options

| | | |
|---|---|---|
| Slicer Libs | • ModuleDescriptionParser<br>• GenerateCLP<br>• vtkITK<br>• MRML | Non-slicer specific support libraries |
| Slicer Base | • Application logic<br>• Widgets | Common infrastructure for Slicer applications |
| Built in modules | • Slice viewers<br>• Models<br>• Fiducials<br>• Transforms | Full access to Slicer internals |
| Loadable modules | • Query Atlas<br>• QDEC<br>• Volume rendering<br>• ChangeTracker<br>• EMSegment | Full access to Slicer internals |
| Scripted modules | • Editor<br>• Teem Two Tensor Tractography<br>• VMTK | Limited access to Slicer internals |
| Command line modules | • Registration | Restricted access to Slicer internals |
| Daemon | • OpenIGTLink<br>• Stochastic Tractography | Access to MRML |

# 3D Slicer: Application Interface




## User-centered design:

- User guidance and feedback incorporated into design process where possible
- Qt-based thin GUI layer
- Presentation layer independent of application logic & state
- Architecture supports scripting (Python) and command-line use

# 3D Slicer: Quick Start for New Users


Greetings and guidance from

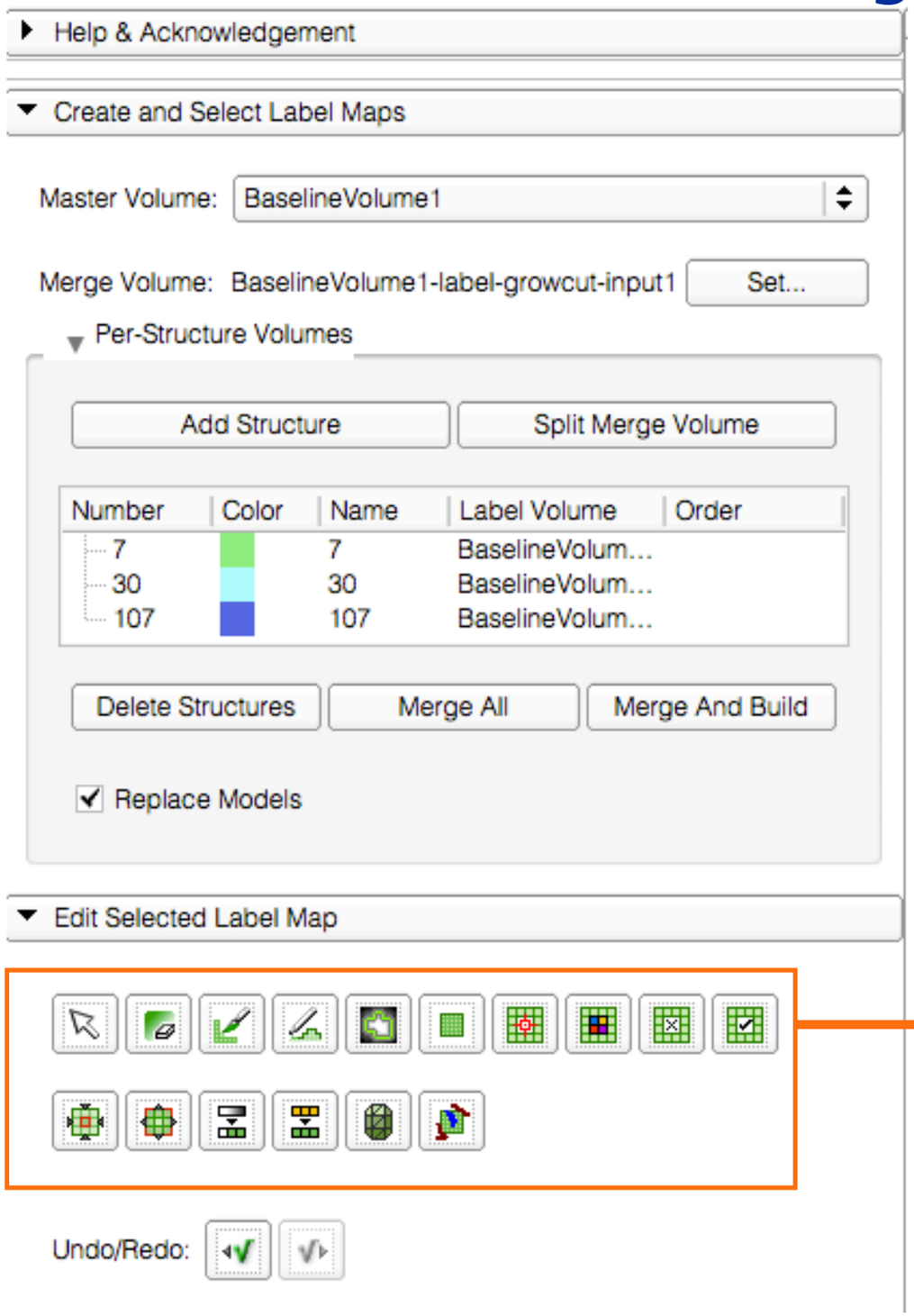
## Slicer's Welcome Module

**Default start-up module for new users:**

- Brief friendly overview of the application interface
- Describes core modules
- Describes basic data loading and saving
- Provides tips for adjusting data display
- Describes how to change layouts
- Points users to more detailed resources
- and more...

# 3D Slicer: Interactive Editor

## Tools for manual segmentation & model building

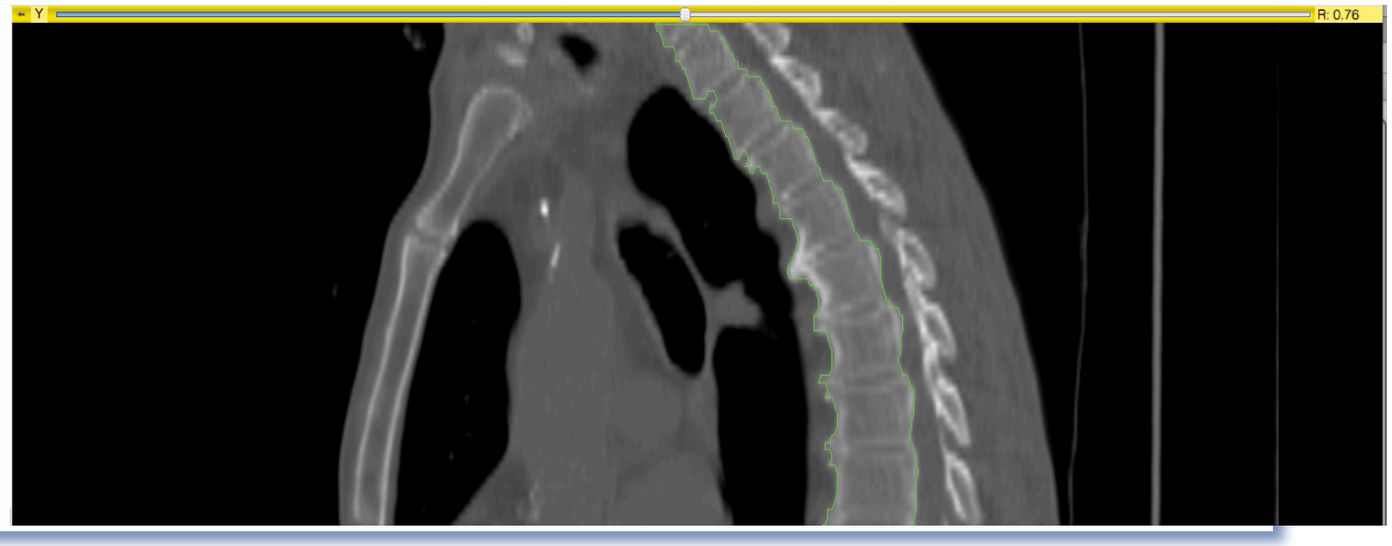


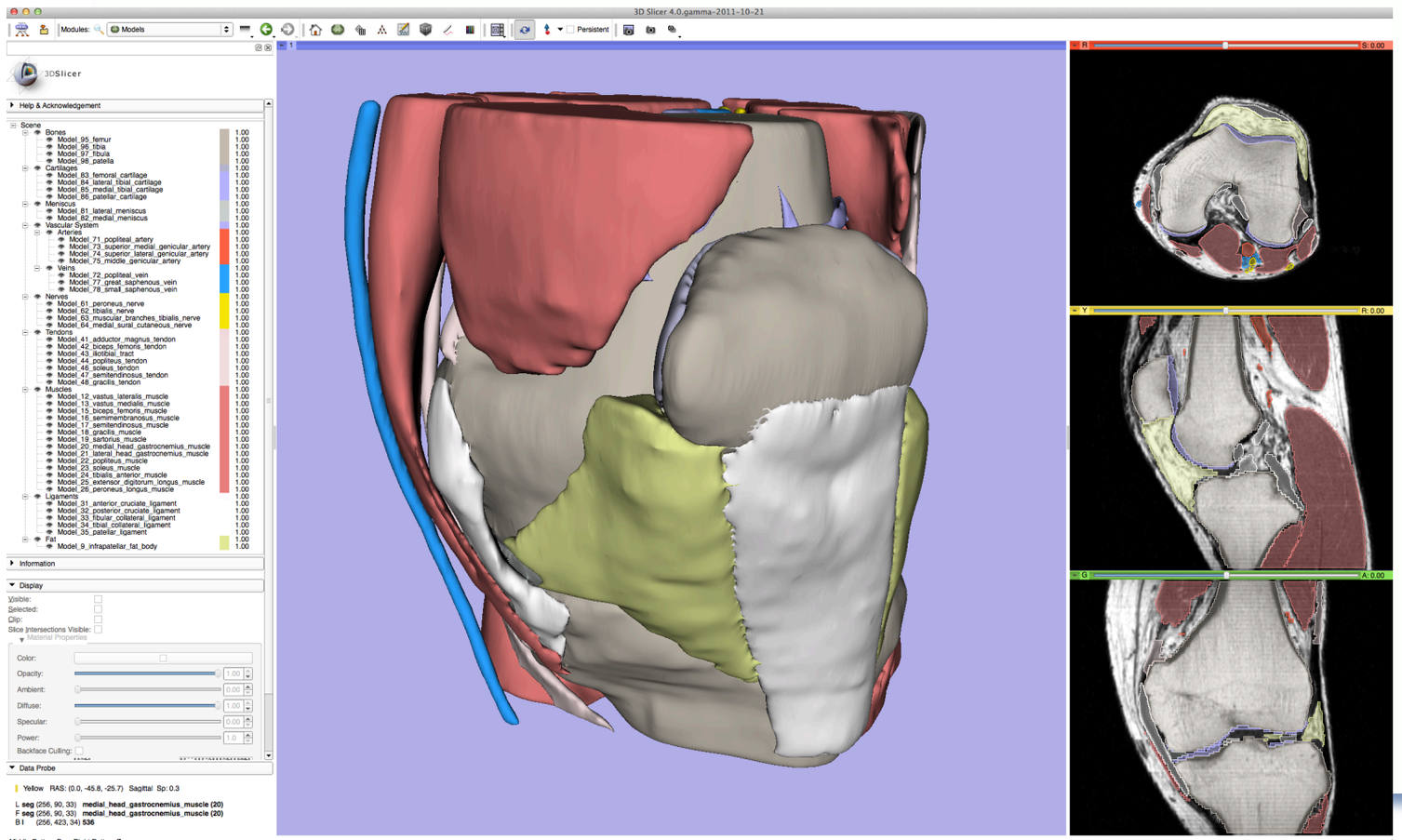

Tools include:

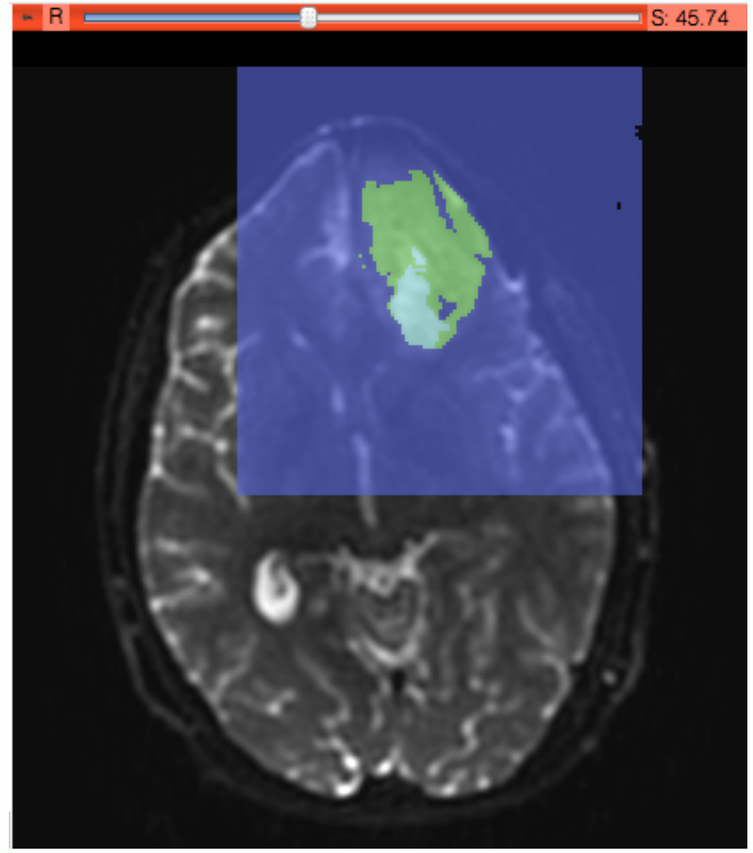
- Paint
- Draw
- Rectangle
- Level Tracing
- Change Label
- Identify Islands
- Remove Islands
- Save Island
- Erode
- Dilate
- Model Maker
- Undo / Redo

# 3D Slicer: Interactive Editor

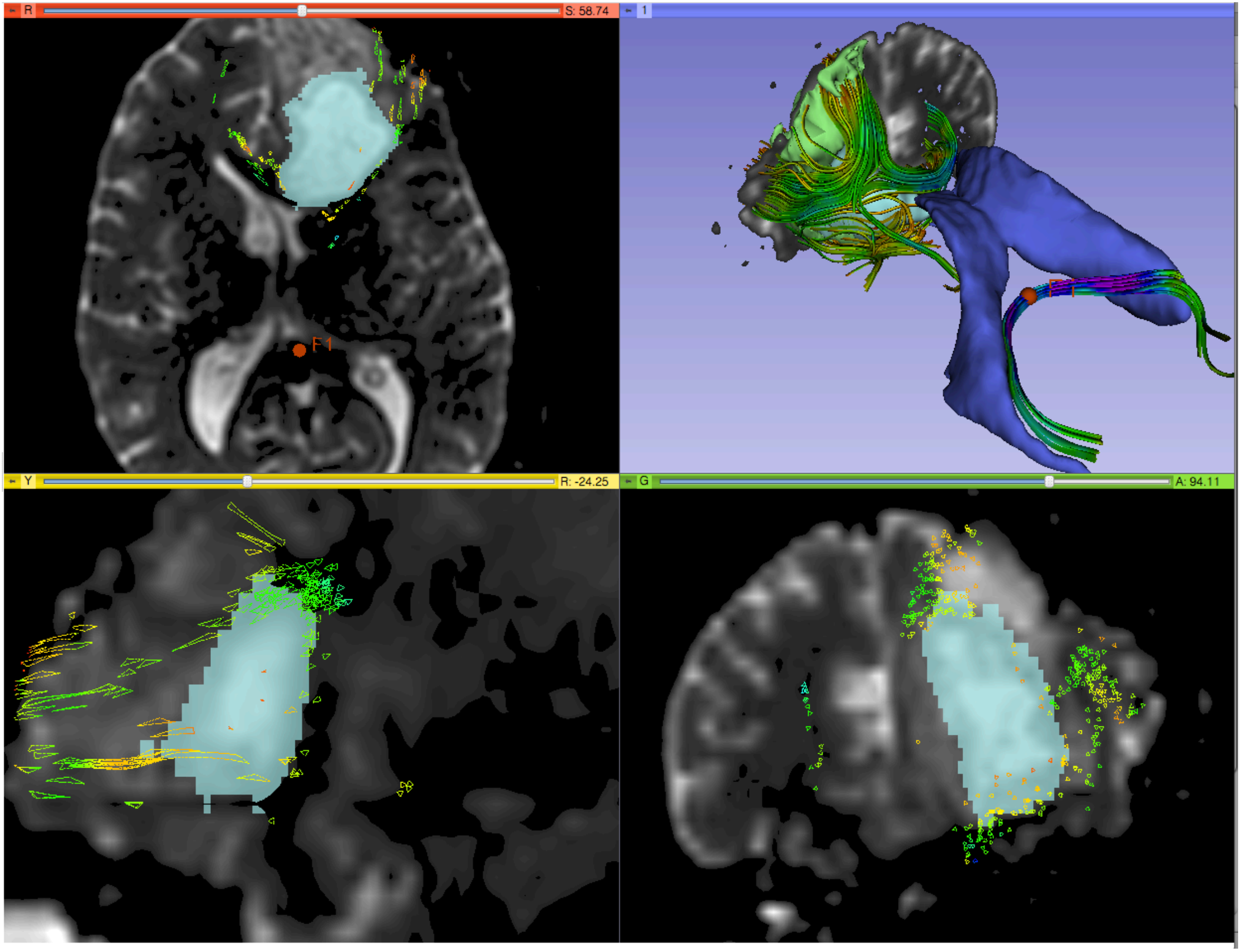
Tools for manual and automated segmentation, 3D model building



# 3D Slicer: Tractography Tools



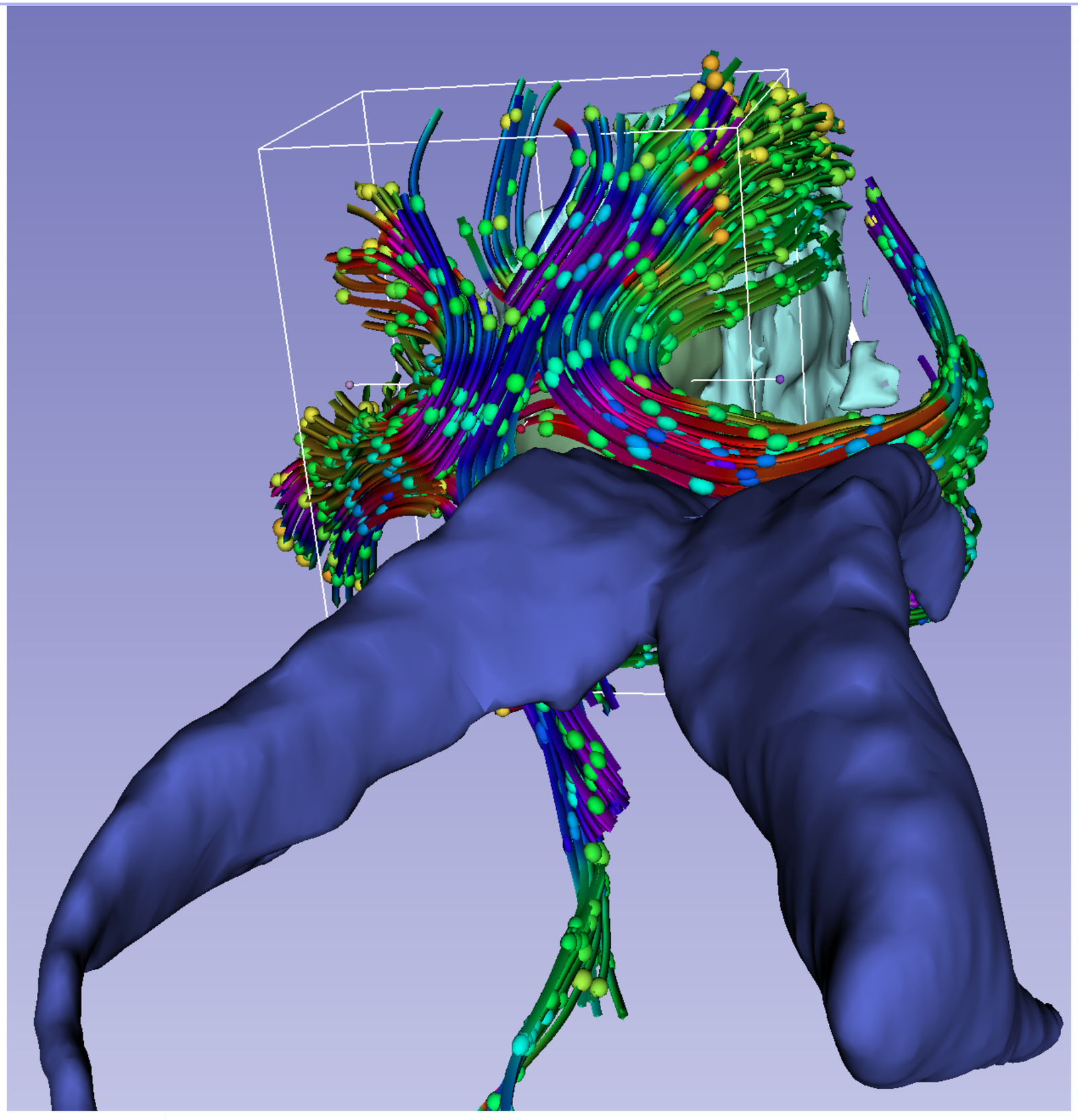
# 3D Slicer: Tractography Tools

Seeding tracks from:

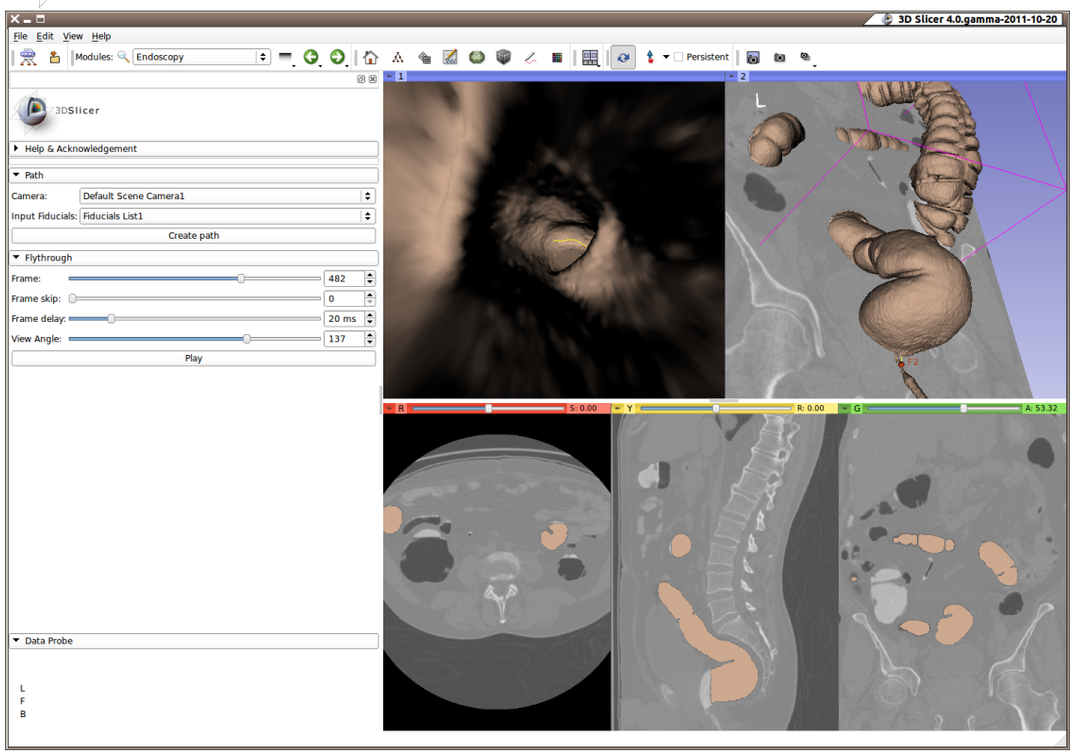
- Labels (segmentations)
- fiducial markers (points)

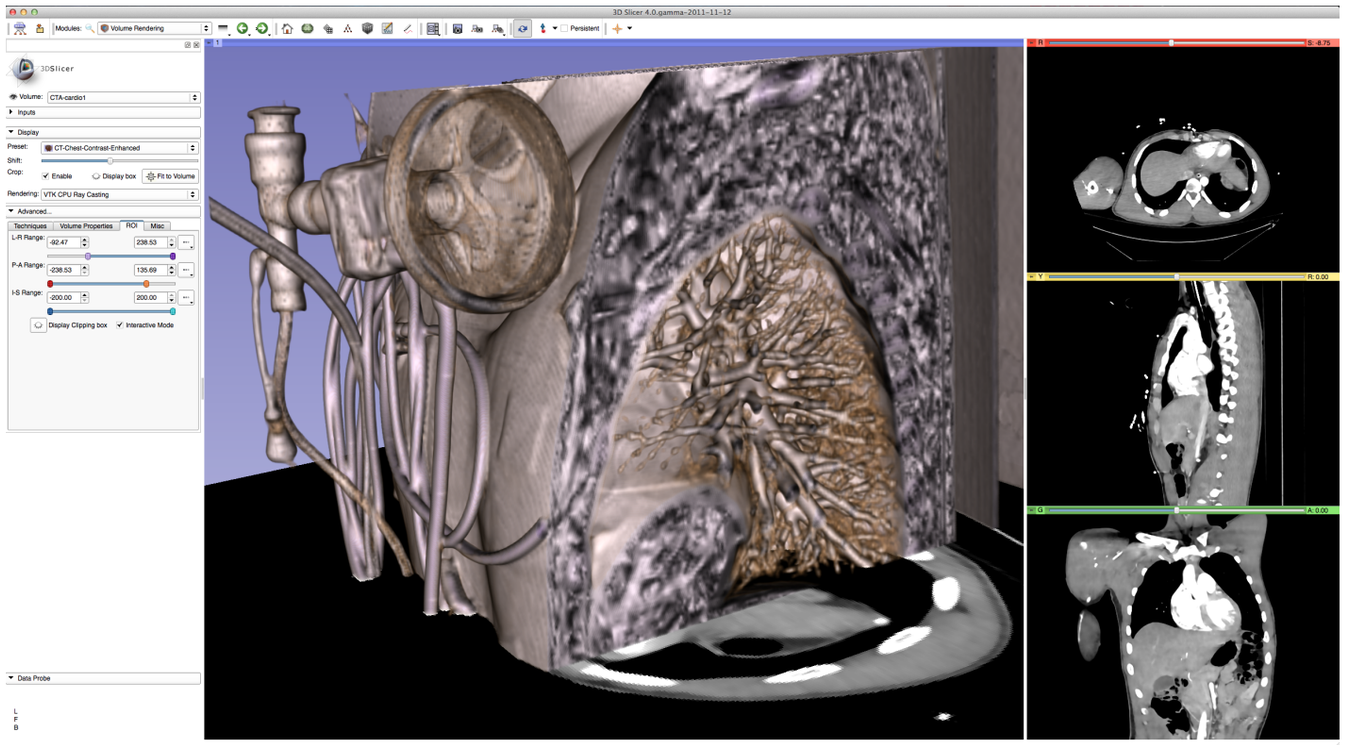
or ROIs – interactive seeding

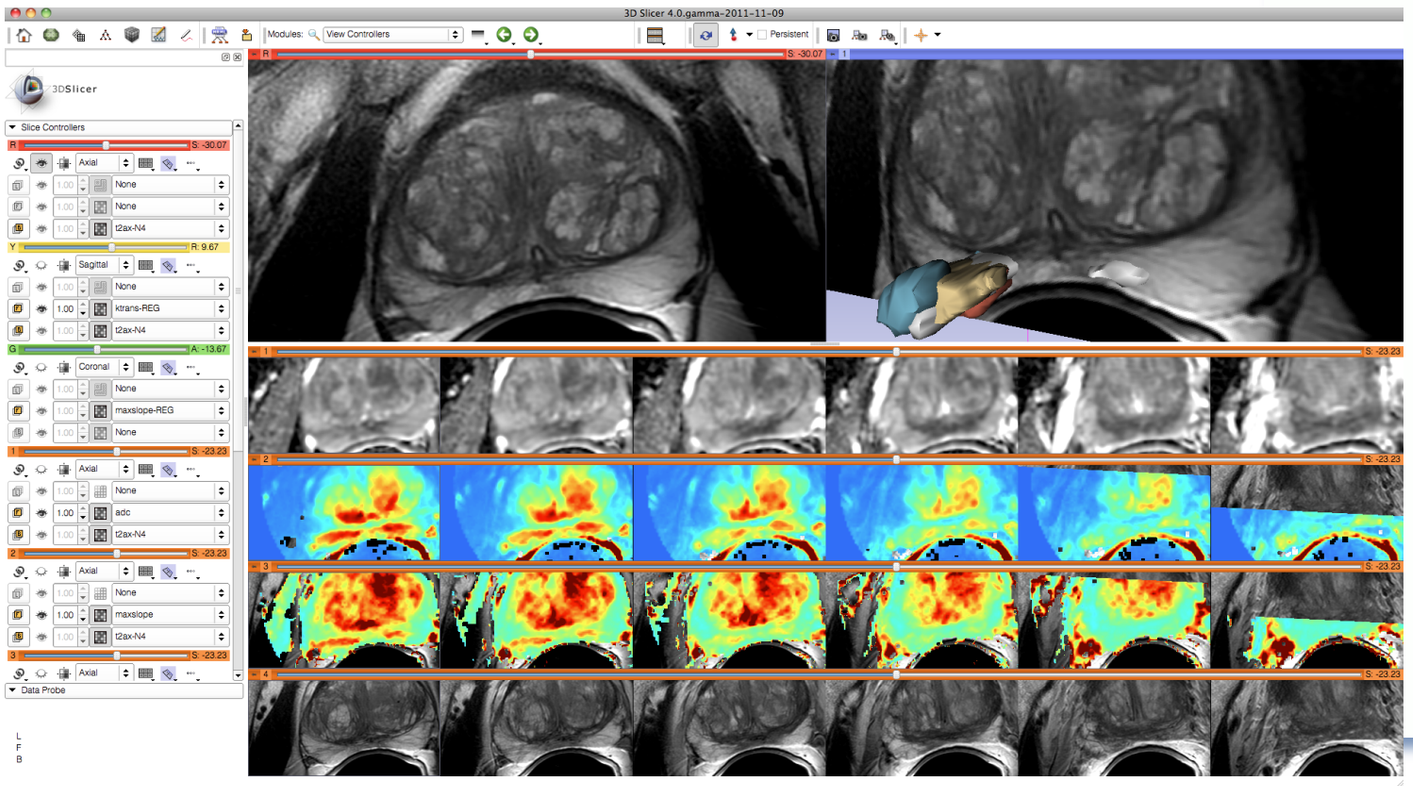
- 3D models



# 3D Slicer: Layouts



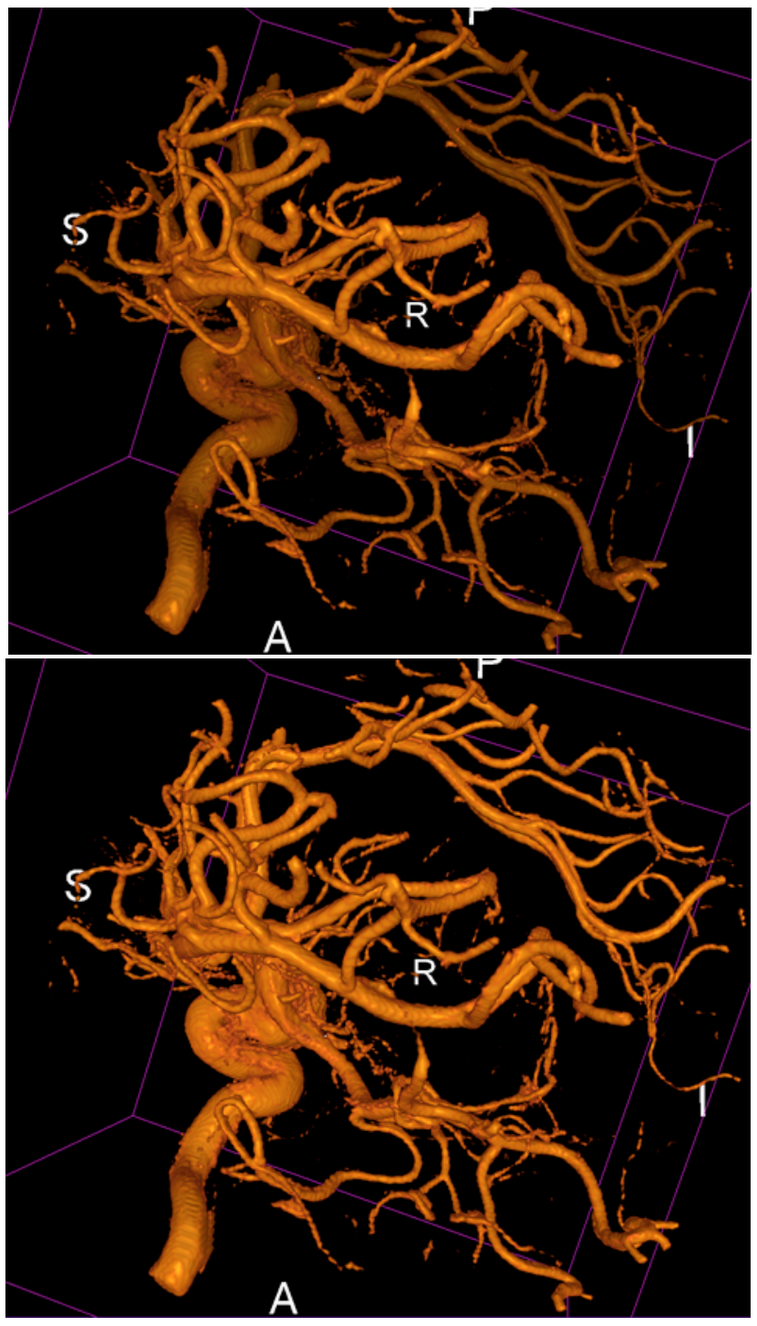




A variety of standard and specialized layouts are available including:

- Lightbox view
- Wide-screen layouts
- Study comparison view
- Dual 3D view
- Large slice viewer
- and others...

# 3D Slicer: Volume Rendering




## Rendering Methods

### VTK CPU Ray Casting

- Uses the CPU for volume rendering,
- is parallelized and can take advantage of multi-core capabilities.
- Uses level-of-detail approach where low resolution is rendered while moving, and high resolution is rendered once motion ceases.
- Allows zbuffer compositing with texture map cross sections and non-transparent triangulated surface model.

### VTK GPU Ray Casting

- Uses GPU accelerated ray caster.
- Allows z-buffer compositing with non-transparent polygon models only.
- This is currently working on Linux and Win32, but not on Mac

### VTK OpenGL 3D Texture Mapping

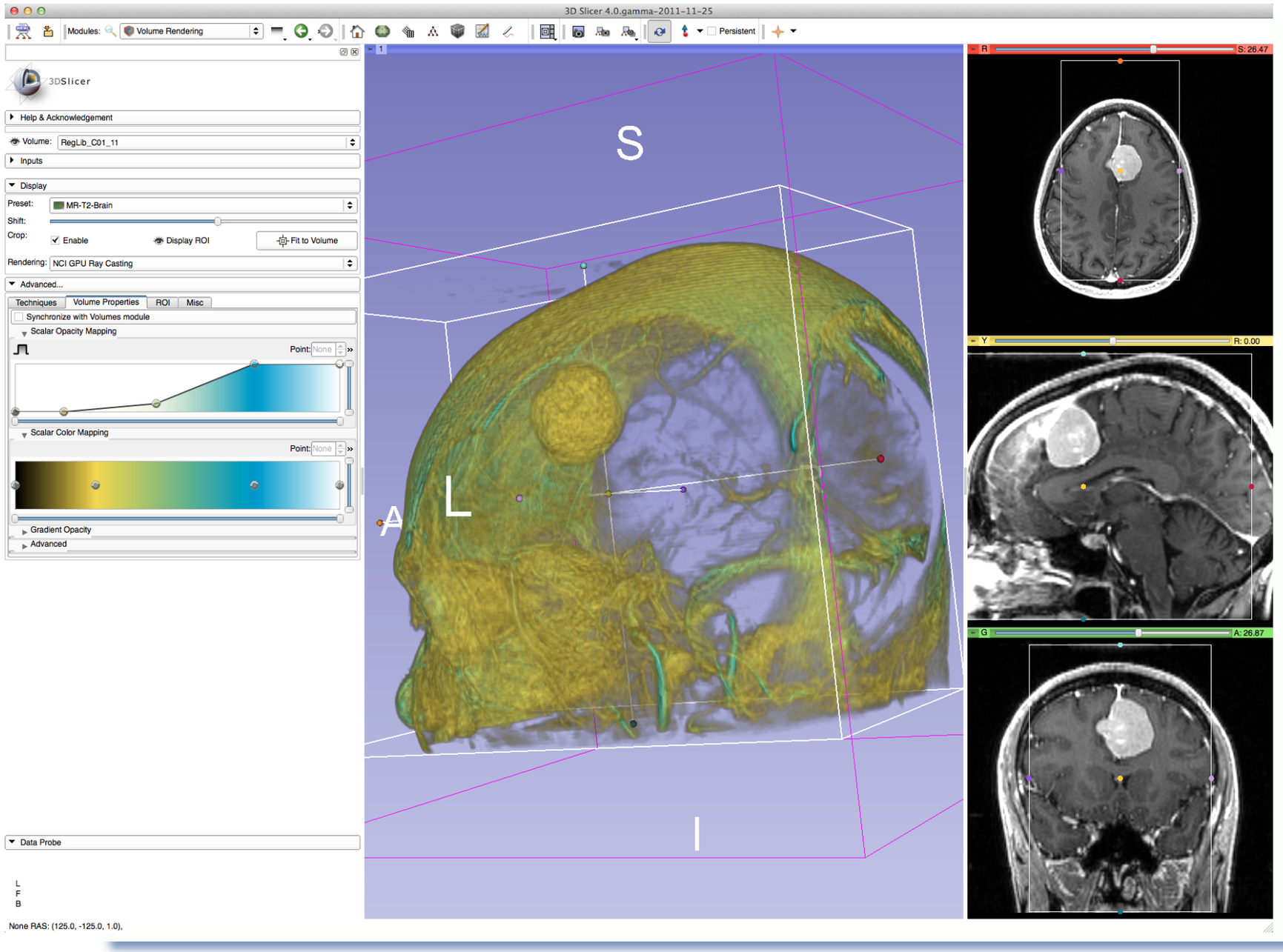
- Uses texture mapping approach to volume rendering
- compared to the two render methods above, it has slightly lower performance and slightly coarser appearance.

### NCI GPU Ray Casting

- This is a GLSL-based ray caster with several experimental mapping techniques.
- No z-buffer compositing with polygon models.
- Good performance and quality.
- No hardware restrictions on this method

# 3D Slicer: Volume Rendering

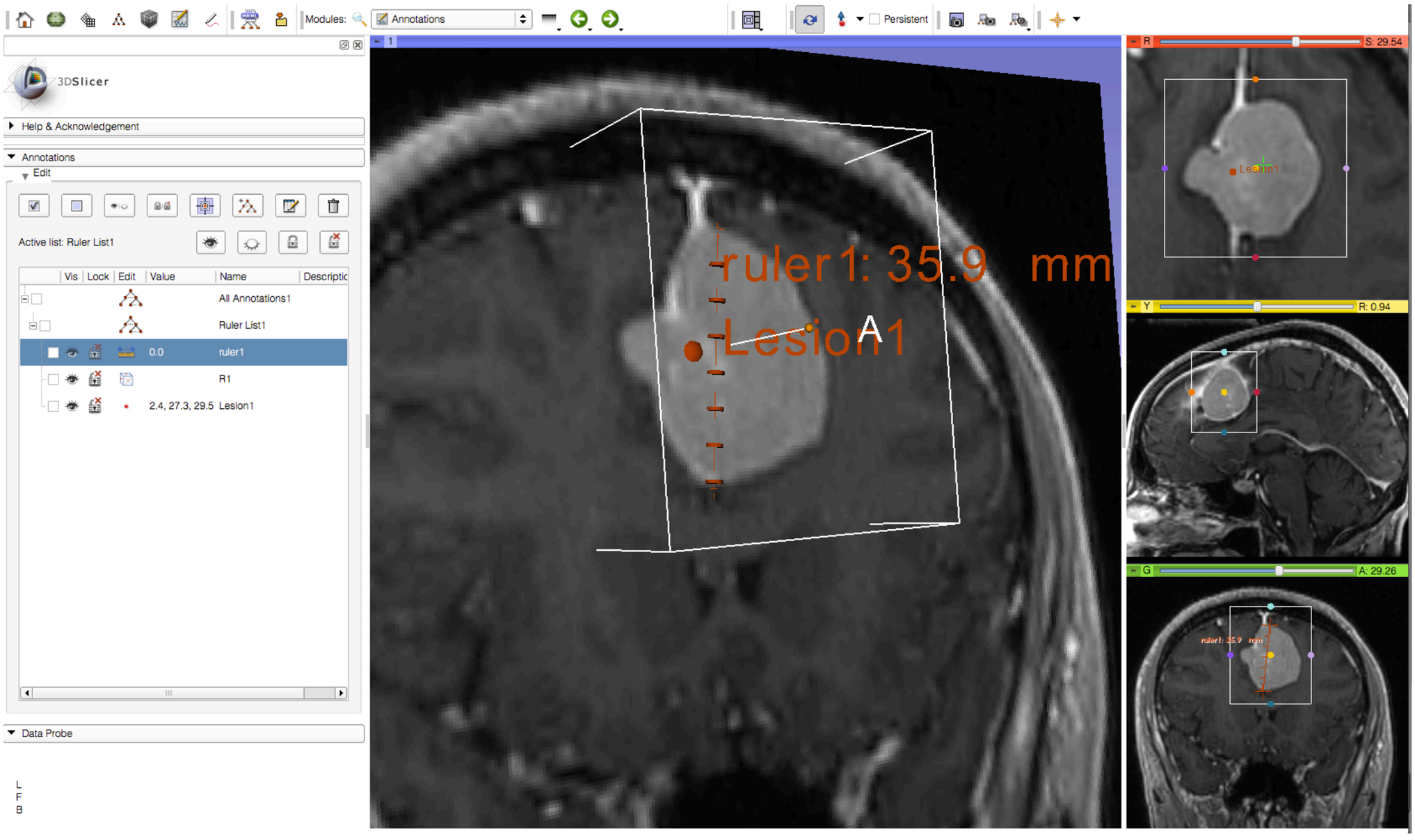
Grayscale and labelmap volumes can be volume rendered, with interactive region of interest definition.



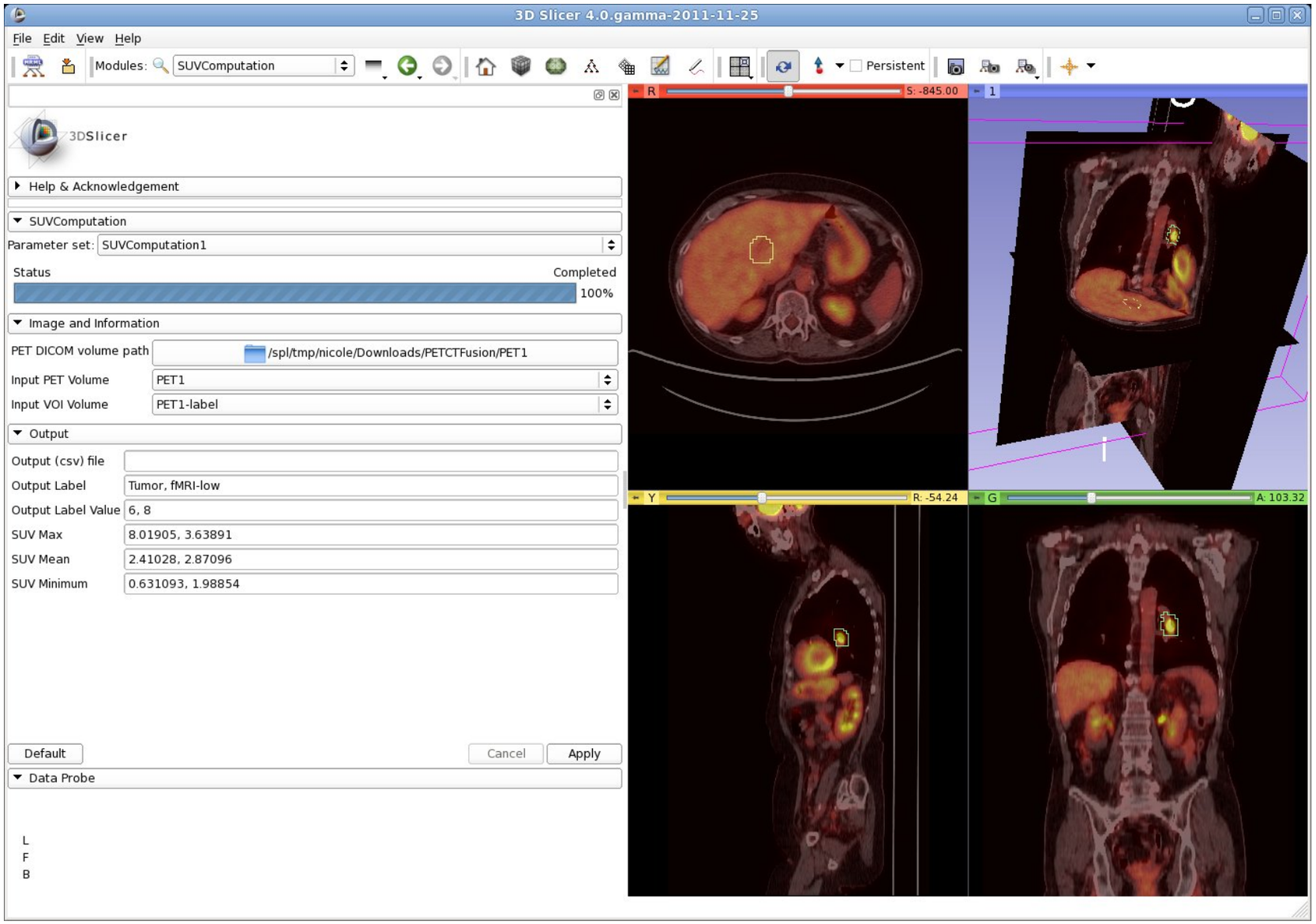

Dedicated GPUs with dedicated GPU memory are recommended for GPU accelerated methods.

# 3D Slicer: Annotations

Fiducials (point markers), box-shaped ROIs and rulers are currently supported



# 3D Slicer: PET/CT SUV computation



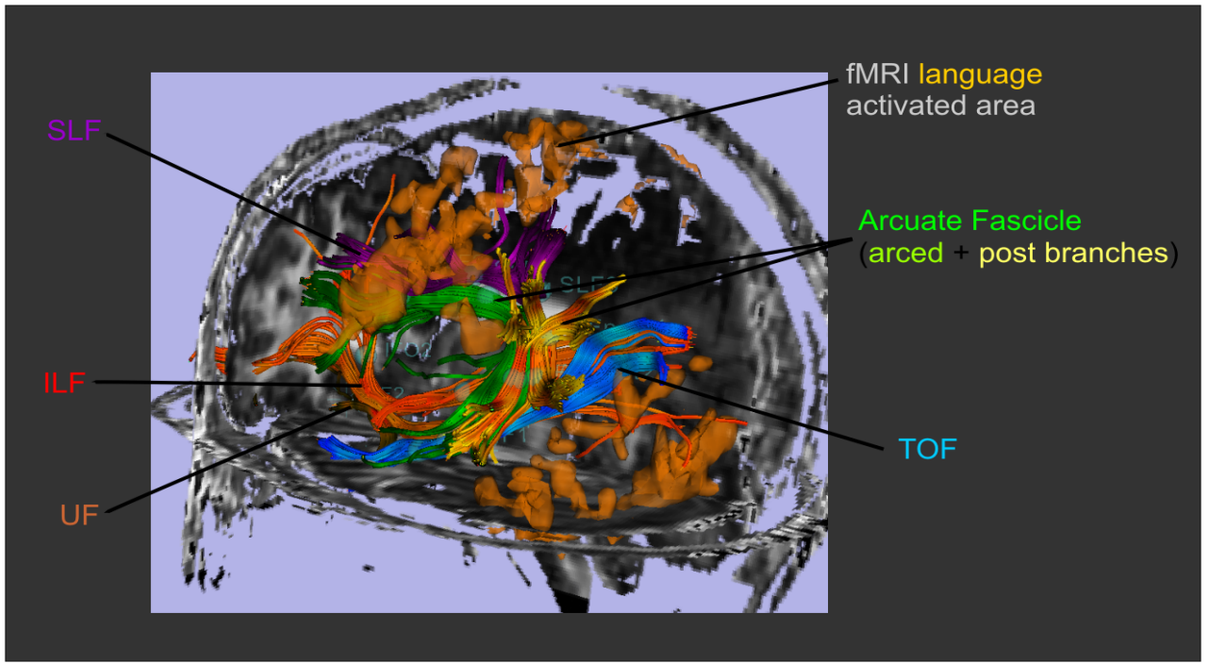

- Combined visualization of structural and colorized functional images
- VOIs defined in Slicer's Editor Module
- extracted DICOM study parameters used in computation
- Computation of Standardized Uptake Value (based on patient body weight) per VOI.

# 3D Slicer: Image-Guided Therapy

3D Slicer has been used in clinical research, with IRB clinical protocols appropriately created and managed.

In image-guided therapy (IGT) research, Slicer is frequently used to construct and visualize collections of MRI data that are available pre- and intra-operatively, and to display the tracked spatial position of surgical instruments.

# 3D Slicer: Image-Guided Therapy

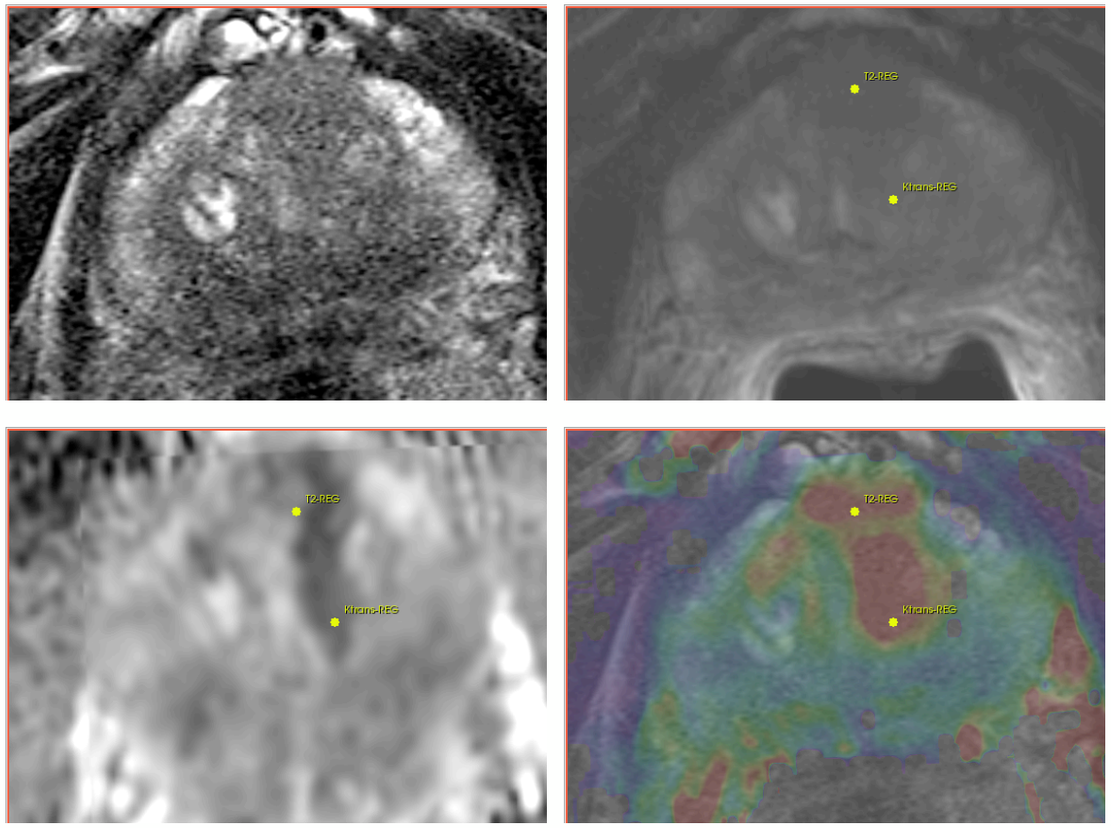



3D Slicer has been used extensively for brain tumor resection planning and guidance during surgery.

Integration of 3D Slicer with the surgical navigation BrainLab system allows **to track surgical instruments in real-time**, and transfer the position to 3D Slicer.

This project is a joint collaboration between BWH, Yale University and BrainLab.

# 3D Slicer: Image-Guided Therapy




Targeted MRI guided prostate cancer biopsy attempts to improve the biopsy precision while reducing the number of tissue samples that need to be collected.

This is achieved by first using diagnostic multi-parametric MRI to highlight the suspicious areas. The biopsy procedure takes place in the MR bore.

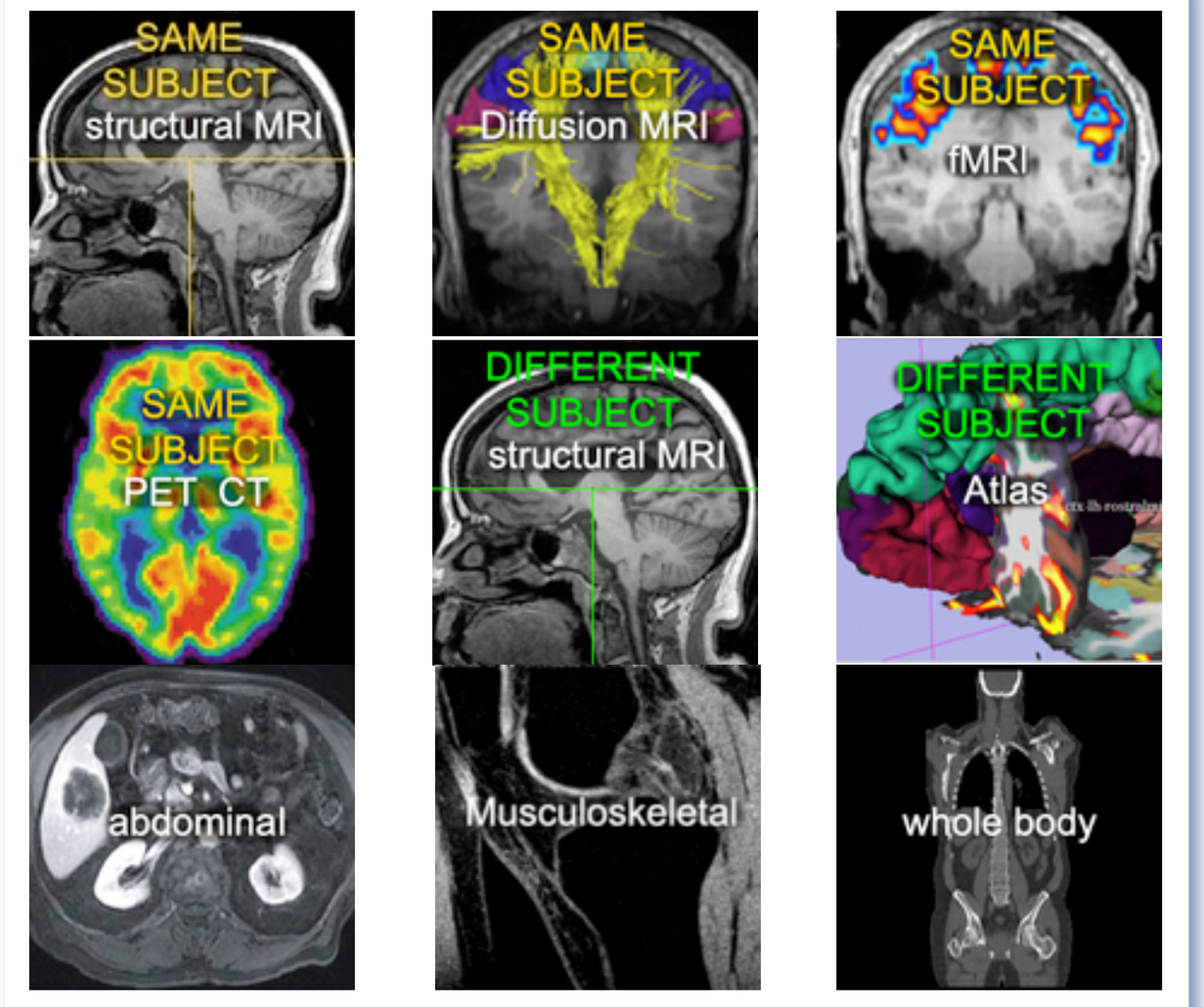
3D Slicer is used for MRI visualization and fusion, target planning, deformable registation, and needle trajectory planning.

Deformable registration is used to fuse the diagnostic image data to the intra-procedural configuration of the gland.

# 3D Slicer: Registration Tools

Slicer also provides a variety of **registration methods** and **resources** to support versatile applications:

- Deformation models: rigid, affine, non-rigid, fluid
- Algorithm types: fiducial-, surface-, intensity-based
- Image types: scalar, vector, tensor

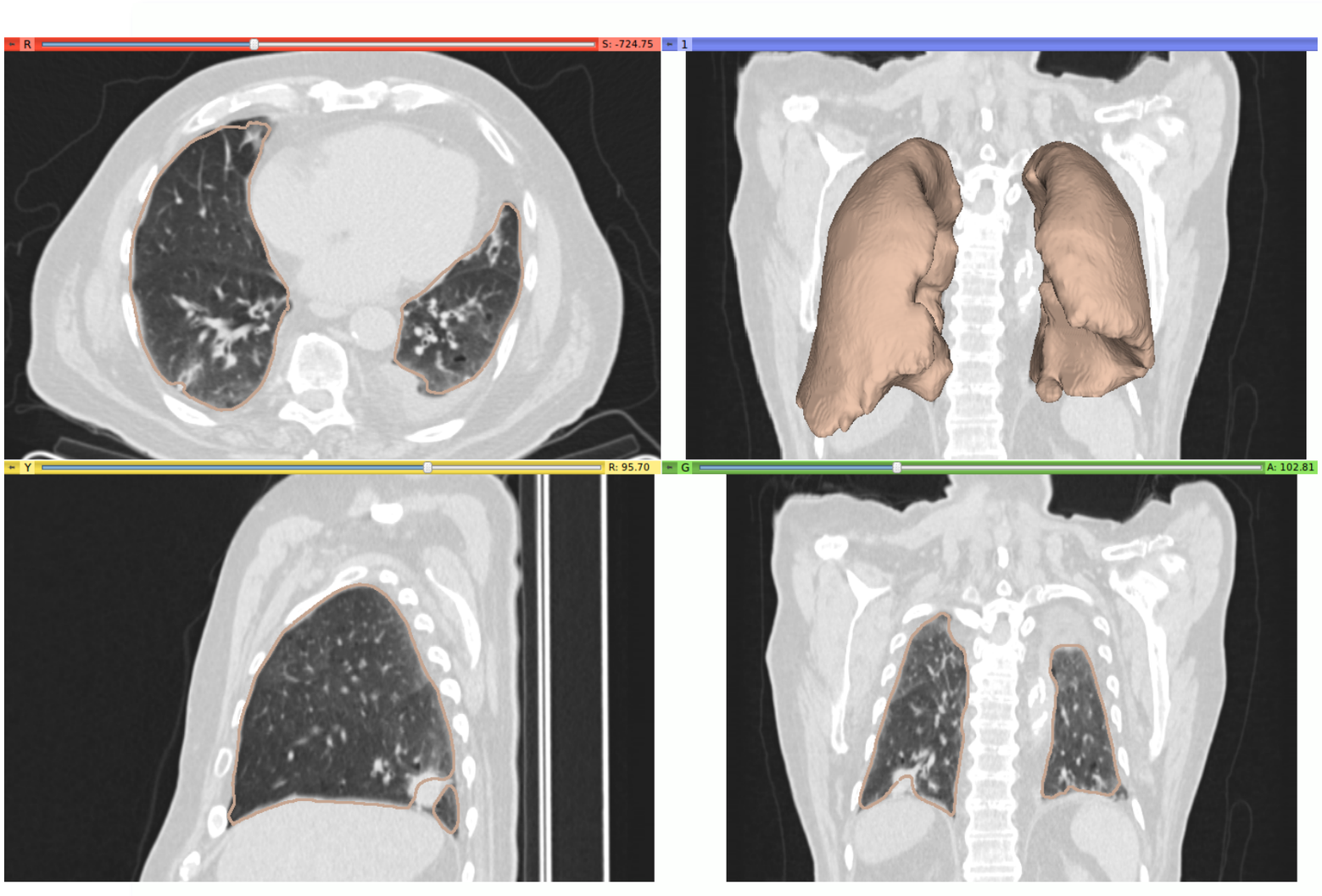



Resource: find an extensive collection of Slicer registration cases and recipes at:

www.slicer.org/slicerWiki/index.php/Slicer3:Registration

# 3D Slicer: Segmentation Tools

Segmentation is required for defining features of interest in imaging data for quantification and analysis.

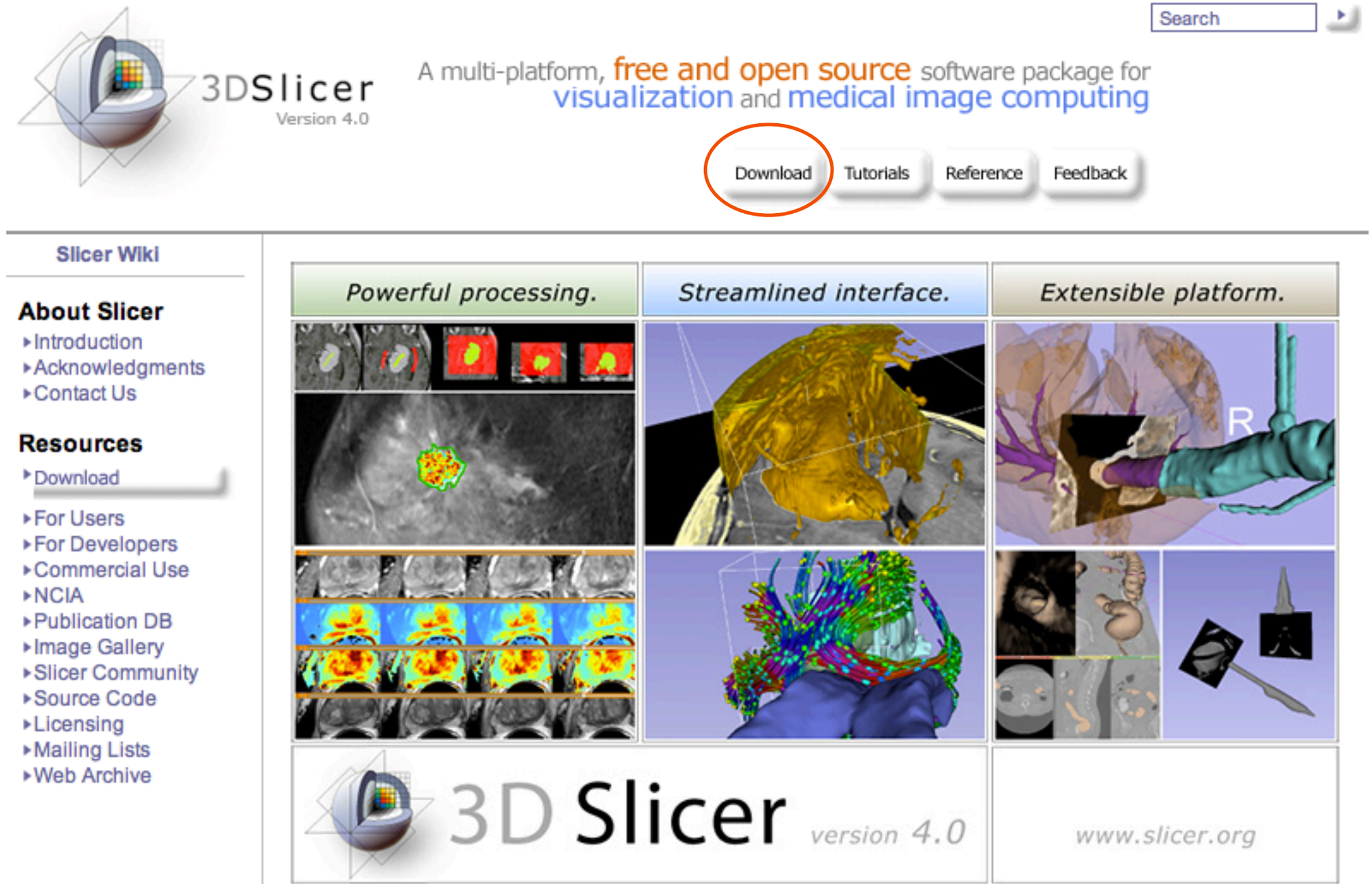



3D Slicer has a variety of interactive and automated segmentation methods:

- Editor Module for manual contouring and editing
- region growing and level sets
- graph cuts with gesture support
- EM-segmentation
- hierarchical brain segmentation for morphological studies

# 3D Slicer: Get the software

http://www.slicer.org



# 3D Slicer: Find Tutorials & More

http://www.slicer.org

# 3D Slicer: Information for Developers

www.slicer.org/pages/DeveloperOrientation

| **Slicer 3.x** (Current development version) | |
|---|---|
| Slicer Developer Documentation | Development Project Homepage, Execution Model Documentation and Building a Slicer 3 Module GUI |
| Build Instructions | Slicer 3 Build Instructions |
| Coding Considerations | Slicer 3 Coding Style and Slicer 3 Interface Design |
| SVN Source Code Repository Browsing | View VC |
| API | Slicer 3 Doxygen Source Documentation, |
| Slicer 3 SVN Repository and SVN Instructions | svn Repository and Introduction to Slicer 3 svn |
| Dashboard | Slicer 3 Dashboard |
| Bug Tracker | Slicer 3 Bug Tracker |
| Visual Blog | Visual Blog |
| Developer Discussion | Developer's Mailing List |
| Module Execution Documentation | Execution Model and Adapting Slicer to Large Scale Experiments |

# 3D Slicer: Acknowledgements

## Major Sponsors & Contributors

National Institutes of Health

National Center for Research Resources

National Institute of Biomedical Imaging and Bioengineering

National Cancer Institute

Telemedicine & Advanced Technology Research Center of the US Army

Georgia Institute of Technology

New Energy and Industrial Technology Development Organization, Japan

Neuroimaging Analysis Center

Center for Integration of Medicine and Innovative Technology

National Alliance for Medical Image Computing

National Center for Image Guided Therapy

Biomedical Informatics Research Network

GE Global Research

Neuroinformatics Tools and Resources Clearinghouse

Surgical Planning Laboratory

Laboratory of Mathematics in Imaging

Massachusetts Institute of Technology

Johns Hopkins University CISST

Isomics, Inc.

Kitware, Inc.

The Martinos Center Massachusetts General Hospital

Harvard NeuroDiscovery Center

Psychiatric Neuroimaging Laboratory

Scientific Computing and Imaging Institute

The Harvard Clinical and Translational Science Center

Surgical Navigation and Robotics Laboratory

3D Slicer User Community

3D Slicer Developer Community