



Brigham and Women's Hospital  
Boston, Massachusetts USA

a teaching affiliate of  
Harvard Medical School



# **The 3D Slicer open-source platform for segmentation, registration, quantitative imaging and 3D visualization of biomedical image data**

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Brigham and Women's Hospital, Harvard Medical School

Director of 3D Slicer Training  
National Alliance for Medical Image Computing (NA-MIC)  
Neuroimage Analysis Center (NAC)





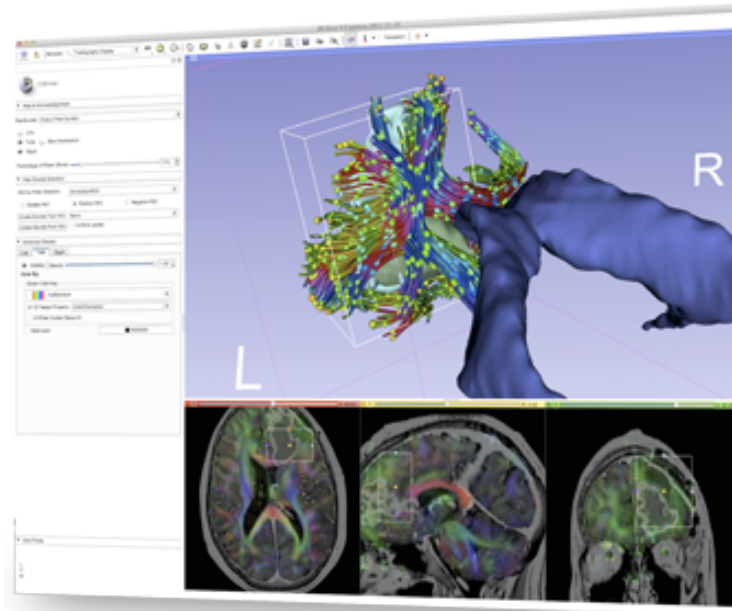
# Outline

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- Slicer History
- Slicer Functionalities
- Clinical Applications
- Training Effort





# INTRODUCTION



# Slicer 19<sup>th</sup> year Anniversary

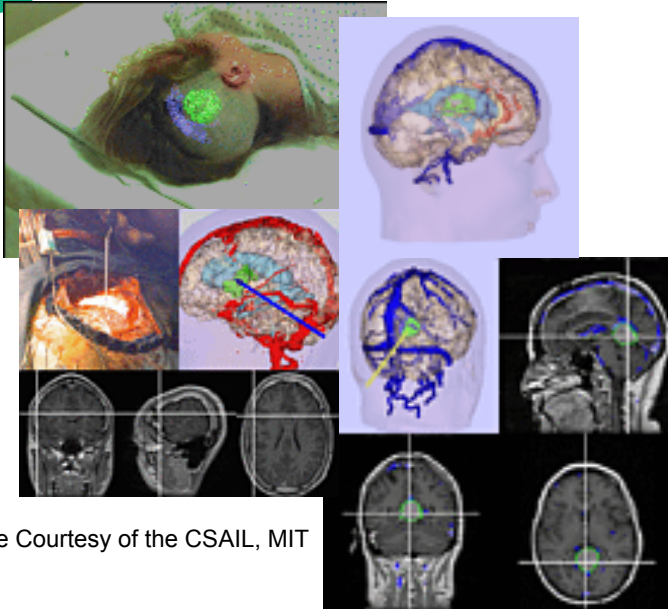
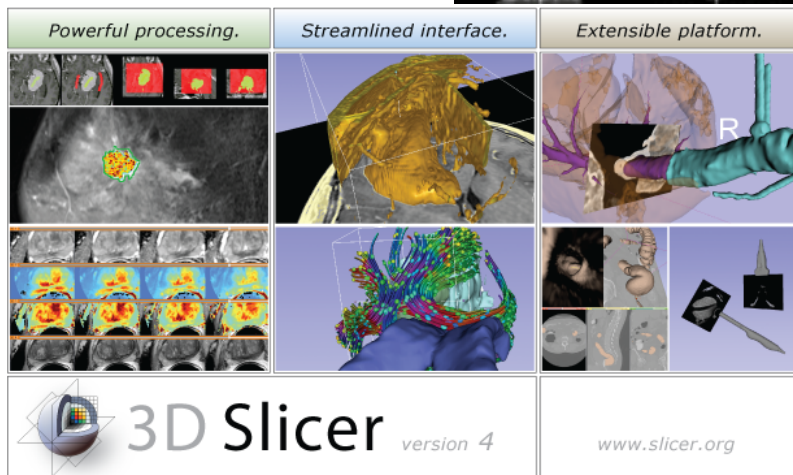


Image Courtesy of the CSAIL, MIT

- 1997: Slicer started as a Master's thesis between the Surgical Planning Lab (Harvard) and the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT
- 2016: International open-source platform for medical image computing

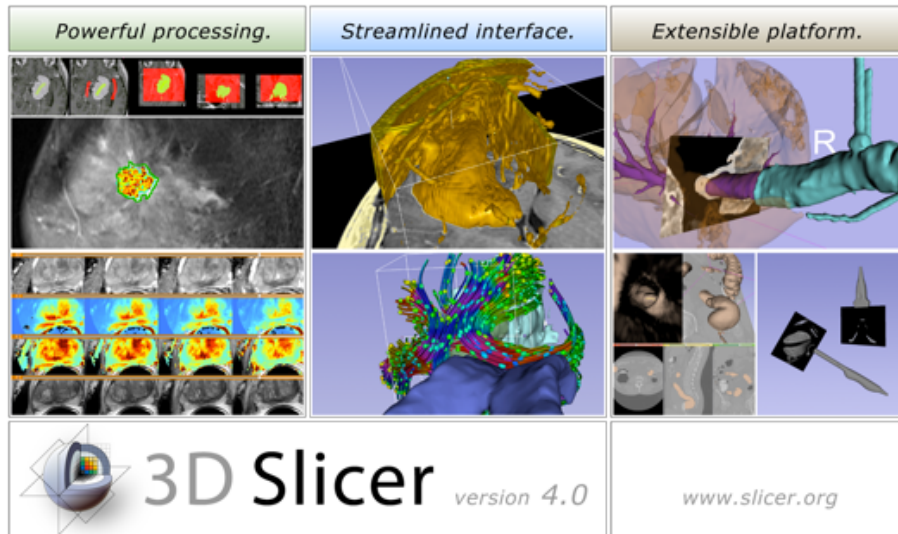


P.I. Prof. Ron Kikinis, BWH, Harvard



# 3D Slicer

- Slicer is a **freely available open-source** application for viewing, analyzing and interacting with biomedical imaging data





# 3DSlicer

- Slicer is a **freely available open-source** application for viewing, analyzing and interacting with biomedical imaging data
- Slicer is **multi-platform** and runs on Windows, Linux, and Mac

**Download Slicer4**  
the free cross-platform open-source medical image processing and visualization system

**3DSlicer**

You are one click away from downloading 3D Slicer, a free and open-source platform for analyzing and understanding medical image data. Created through multiple grants from the US National Institutes of Health (NIH) over almost two decades, Slicer brings powerful medical image processing, visualization, and data analysis tools within reach of everyone.

Slicer is built and tested on many hardware and software platforms. 3D Slicer runs on modern Windows, Mac OS X (10.7 and up), and a variety of Linux distributions.

### Installers

	Windows	Mac OS X	Linux
<b>Stable Release</b>	<a href="#">version 4.5.0-1</a> revision 24730 built 2015-11-12	<a href="#">version 4.5.0-1</a> revision 24730 built 2015-11-12	<a href="#">version 4.5.0-1</a> revision 24730 built 2015-11-12
<b>Nightly Build</b>	<a href="#">version 4.5.0+</a> revision 24775 built 2015-11-26	<a href="#">version 4.5.0+</a> revision 24775 built 2015-11-26	<a href="#">version 4.5.0+</a> revision 24775 built 2015-11-26

### Resources

**For everyone**

- Slicer home
- Slicer wiki
- General help
- Reporting problems
- Acknowledgements
- License
- Contact us

**For users**

- Training and tutorials
- User documentation
- Slicer in use
- User email list


**For developers**


- Development overview
- Building from source
- Quality dashboard
- Developer email list
- Download statistics

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# A multi-institutional effort

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

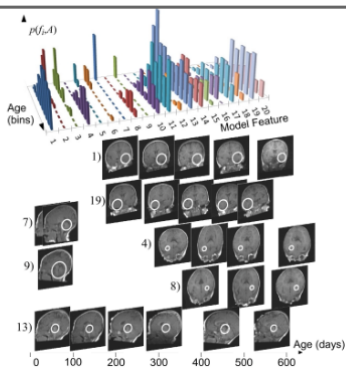


**About the NAC**

- Overview
- Organization
- Research Corres
- Collaborations

**Resources**


- Our Publications
- Downloads
- Training
- Web Archive
- Contact Us



**A Feature-based Developmental Model of the Infant Brain in Structural MRI**  
Top: distribution  $p(f_i, A)$  for the 20 most significant age-related features over 10 age categories. Below: visual examples of features (white circles) in subject image slices over age. Pairs (4, 8) and (1, 10) represent symmetric white matter patterns appearing at slightly different onsets. (7) and (9) represent distinct modes cerebellar anatomy linked with verman development and occurring exclusively in early life. (13) occurs in the brain stem across the age range, more frequently in early life. Note the lack of visible white matter under 100 days, e.g. corpus callosum.

The Neuroimage Analysis Center (NAC) develops image processing and analysis techniques for basic and clinical neurosciences. The NAC research approach emphasizes both specific core technologies and collaborative application projects. The activities of the NAC are centered at the Harvard Medical School and the Surgical Planning Laboratory at the Brigham and Women's Hospital in Boston, with collaborators throughout the United States and the rest of the world.

The NAC is a Biomedical Technology Resource Center supported by the National Institute of Biomedical Imaging and Bioengineering (NIBIB) (P41 E5015902). It was supported by the National Center for Research Resources (NCRR) (P41 RR13218) through December 2011.





## National Center for Image Guided Therapy



### NCIGT Wiki

#### About Us

- Research
- Research Labs
- Collaborations
- People

#### Resources

- AMIGO
- Our Publications
- Downloads
- Training & Dissemination
- IGT Workshop Series
- News and Events
- Contact Us

### Advanced Multimodality Image Guided Operating (AMIGO) Suite

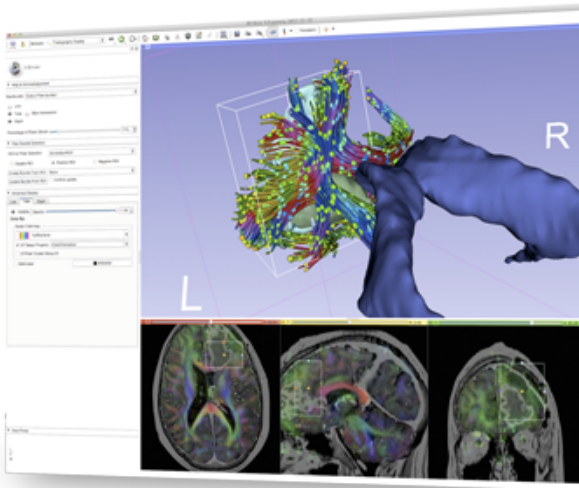
The Advanced Multimodal Image-Guided Operating (AMIGO) suite is a clinical translational test-bed for research of the National Center for Image-Guided Therapy (NCIGT) at Brigham and Women's Hospital (BWH) and Harvard Medical School. NCIGT and AMIGO are funded under the **Biomedical Technology Resource Centers** program of the National Institute of Biomedical Imaging and Bioengineering. A unique resource for Image-Guided therapy, AMIGO represents and encourages multidisciplinary cooperation and collaboration among teams of surgeons, interventional radiologists, imaging physicists, computer scientists, biomedical engineers, nurses, and technologists to achieve the common goal of delivering the safest and the most effective state-of-the-art therapy to patients in a technologically advanced and patient-friendly environment. If you are a patient and would like to learn about the offerings of AMIGO, please visit the BWH AMIGO page [here](#).





# 3D Slicer

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- Slicer is distributed under a BSD license with no restriction on use
- Slicer is not FDA-approved nor CE-marked, and is for clinical research only





# 3D Slicer

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Slicer can be used by clinical researchers on their own Mac, Windows or Linux laptops with their own data



3D Slicer workshop, PLA General Hospital, Beijing



# Slicer is built every night

Slicer4										
Dashboard Calendar Previous Current Project										
WARNING: This CDash instance is running the bleeding edge svn trunk CDash code, and is updated frequently. You have been warned.										
2 files changed by 1 author as of Friday, April 27 2012 - 23:00 EDT										
Show Filters Advanced View Auto-refresh Help										
Nightly-Packages										
Site	Build Name	Update	Configure		Build		Test			Build Time
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
factory-win7.kitware	Windows7-VS2008-64bits-QT4.7.4-PythonQt-With-Tcl-CLI-Release 🚩	2	0	0	0	391 <sup>1199</sup> <sub>198</sub>	0	0	556	3 hours ago
factory-win7.kitware	Windows7-VS2008-32bits-QT4.7.4-PythonQt-With-Tcl-CLI-Release 🚩	2	0	0	0	289 <sup>124</sup> <sub>24</sub>	0	0	556	5 hours ago
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.7.4-PythonQt-With-Tcl-CLI-Release 🚩	2	0	0	0	18 <sup>12</sup> <sub>2</sub>	0	0 <sub>2</sub>	558 <sup>12</sup>	6 hours ago
factory-mac-64bits.kitware	SnowLeopard-g++4.2.1-64bits-QT4.7.4-PythonQt-With-Tcl-CLI-Release 🚩	2	0	0	0	18 <sup>14</sup> <sub>4</sub>	0	0	558	5 hours ago
Nightly										
Site	Build Name	Update	Configure		Build		Test			Build Time
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
District9.kitware	Windows-VS2008-QT4.7.4-PythonQt-With-Tcl-CLI-Release	0	0	0	0	291 <sup>1190</sup> <sub>190</sub>	0	0	555	6 hours ago
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.7.4-PythonQt-With-Tcl-NoCLI-Coverage-Release 🚩	0	0	0	0	17 <sup>12</sup> <sub>2</sub>	0	0	356	4 hours ago
Extensions-Nightly										
Site	Build Name	Update	Configure		Build		Test			Build Time
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
factory.kitwarein.com	🍏 19951-LoadableExtensionTemplate-g++64bits-Qt4.7-Release 🚩		0	0	0	20	0	0	2	3 hours ago
factory.kitwarein.com	🍏 19951-SuperBuildLoadableExtensionTemplate-g++64bits-Qt4.7-Release 🚩		0	0	0	20	0	0	2	3 hours ago
factory-ubuntu	🚩 19951-CLIEExtensionTemplate-g++64bits-Qt4.7-Release 🚩		0	0	0	0	0	0	1	5 hours ago
factory.kitwarein.com	🍏 19951-CLIEExtensionTemplate-g++64bits-Qt4.7-Release 🚩		0	0	0	0	0	0	1	3 hours ago
FACTORY-WIN7	🚩 19951-CLIEExtensionTemplate-vs9-32bits-Qt4.7-Release 🚩		0	0	0	0	0	0	1	3 hours ago
FACTORY-WIN7	🚩 19951-CLIEExtensionTemplate-vs9-64bits-Qt4.7-Release 🚩		0	0	0	0	0	0	1	2 hours ago
factory-ubuntu	🚩 19951-LoadableExtensionTemplate-g++64bits-Qt4.7-Release 🚩		0	0	0	0	0	0	2	5 hours ago
FACTORY-WIN7	🚩 19951-LoadableExtensionTemplate-vs9-32bits-Qt4.7-Release 🚩		0	0	0	0	0	0	2	3 hours ago

Slicer is under active development: built every night on every platform






# Slicer Bug Tracker

My View - Mantis

http://www.na-mic.org/Bug/my\_view\_page.php

My View - Mantis



Logged in as: *spujol* (Sonia Pujol - reporter)

2012-04-28 05:35 EDT

Project: Slicer4

Switch

Issue #

Jump

Unassigned [^] (1 - 10 / 29)

0001951

Resample Scalar/Vector/DWI module does not accept DWI input  
Command Line Modules (Modules/CLI) - 2012-04-26 15:09

0001938

Volume rendering volume received from OpenIGTLink  
Base Code - 2012-04-24 16:53

0001930

Scrolling volume slices past the last slice  
Usability - 2012-04-23 19:23

0001929

Texts in 3D are hard to see  
Usability - 2012-04-23 15:36

0001918

Color scale  
Usability - 2012-04-18 11:58

0001915

Effect of matrix bottom row in Transforms module  
Base Code - 2012-04-18 10:12

0001910

Problem with fiducial registration  
Command Line Modules (Modules/CLI) - 2012-04-17 03:11

0001899

Saving and reopening .nrrd problem  
Usability - 2012-04-12 12:43

0001887

sceneview roundtrip problem with LUT and with VR  
MRML - 2012-04-11 22:56

0001888

Ensure Capitalization rule is respected all over Slicer  
GUI - 2012-04-10 10:55

Resolved [^] (1 - 10 / 130)

0001204

Centralize revision/version/name of Slicer  
Packaging - 2012-04-26 18:53

0001167

Fix warning related to SlicerFunctionGenerateExtensionDescription  
Building (CMake, Superbuild) - 2012-04-26 17:24

0001677

SVN download of loadable extension modules does not work  
Base Code - 2012-04-26 16:51

0001747

windows build/run issues as of svn 19350  
Building (CMake, Superbuild) - 2012-04-26 16:06

0001863

To avoid \_RegisterApplication / \_CGSDefaultConnection error, create a template of launchd file for dashboard  
Building (CMake, Superbuild) - 2012-04-26 12:38

0001940

No version in mac bundle  
Packaging - 2012-04-26 10:31

0001645

update of the mouse model toolbar  
GUI - 2012-04-25 16:22

0001593

Untoggle "Place a fiducial" on click  
Annotations - 2012-04-25 16:22

0001936

make RAS box axis labels visibility camera dependent  
Usability - 2012-04-24 11:35

0001923

{{documentation/{{documentation/version}}/module-category}} doesn't support extra newline spacing in XML  
Documentation - 2012-04-23 13:47

Reported by Me [^] (1 - 10 / 37)

0001894

EM Segmenter labelmap opacity  
EMSegmenter - 2012-04-25 20:59

0001389

Tract Visibility  
Diffusion - 2012-04-18 10:27

0001893

Download of Sample MR head data failed  
Base Code - 2012-04-11 16:33

0001845

GUI issue in red slicer viewer mode on Mac  
GUI - 2012-04-11 09:17

0001892

Colors Module GUI: LUT label values issue  
Base Code - 2012-04-10 20:29

0001873

Saving a scene with a new LUT  
Base Code - 2012-04-10 15:23

0001844

Maximum path length - Fiducial seeding  
Diffusion - 2012-04-07 12:23

0001867

Restoring a scene view with tract intersection  
Diffusion - 2012-04-07 12:21

0001866

Saving Scene: path update issue  
Base Code - 2012-04-06 12:06

0001778

Tractography Display module  
Diffusion - 2012-04-06 11:37

Recently Modified [^] (1 - 10 / 776)

0001855

Link errors during CTK build  
Building (CMake, Superbuild) - 2012-04-27 17:03

0001868

crash on exit and other issues  
Scripting (Wrapping, Python) - 2012-04-27 17:00

0001850

Found PythonLibs: ... get\_filename\_component unknown component optimized  
Building (CMake, Superbuild) - 2012-04-27 16:59

0001955

EMSegmenter shows up red in Modules Setting but works fine  
Base Code - 2012-04-27 16:44

0001954

drag & drop: option to lock view settings  
GUI - 2012-04-27 10:04

0001942

Model to Label Map not working  
Diffusion - 2012-04-27 07:46

0001941

Extensions download from SVN repository fails  
Extensions - 2012-04-26 21:52

0001952

camera position after loading scene  
GUI - 2012-04-26 20:13

0001486

VTK Qt designer plugins are missing  
Packaging - 2012-04-26 19:26

0001145

Add Test to make slicer starts  
Base Code - 2012-04-26 19:04



# Slicer4 Download Statistics



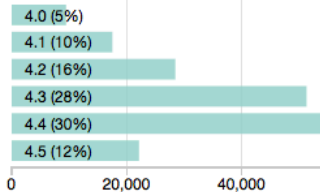
## Slicer4 download stats

183,367

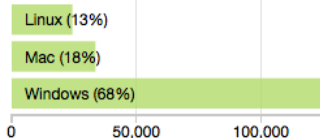
### Date range

Nov 28, 2011 - Mar 8, 2016

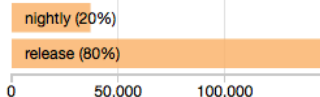
### Version



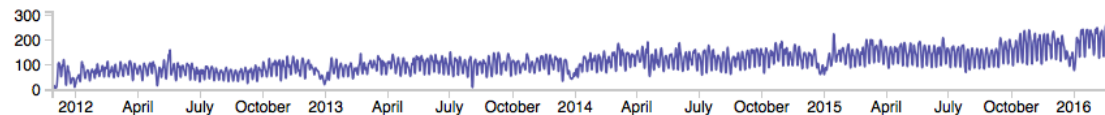
### Operating system



### Stability



### Downloads per day



### Region



### Country



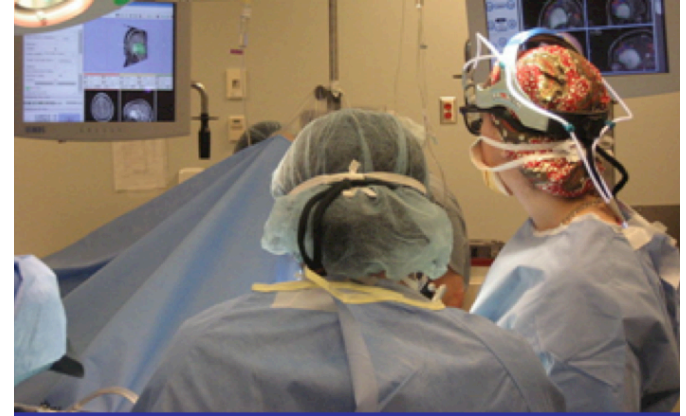


# An interdisciplinary platform

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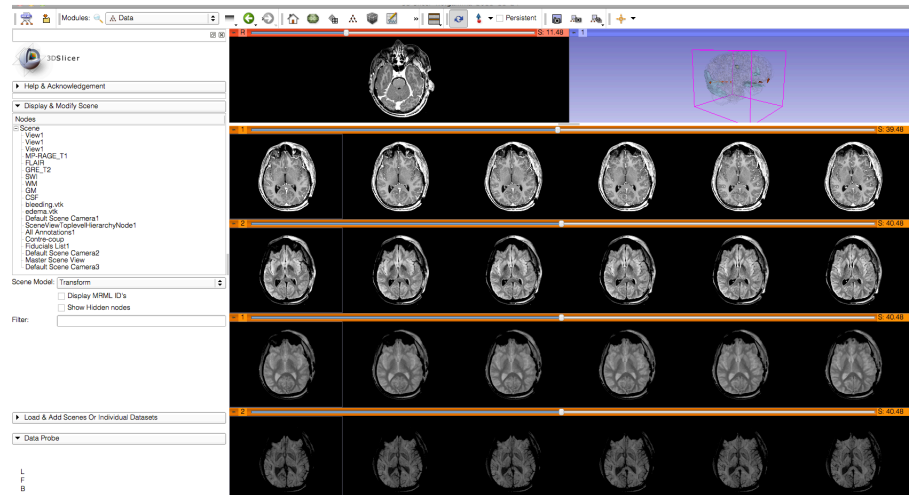


An **open-source environment**  
for software developers



An **end-user application**  
for clinical investigators  
and scientists

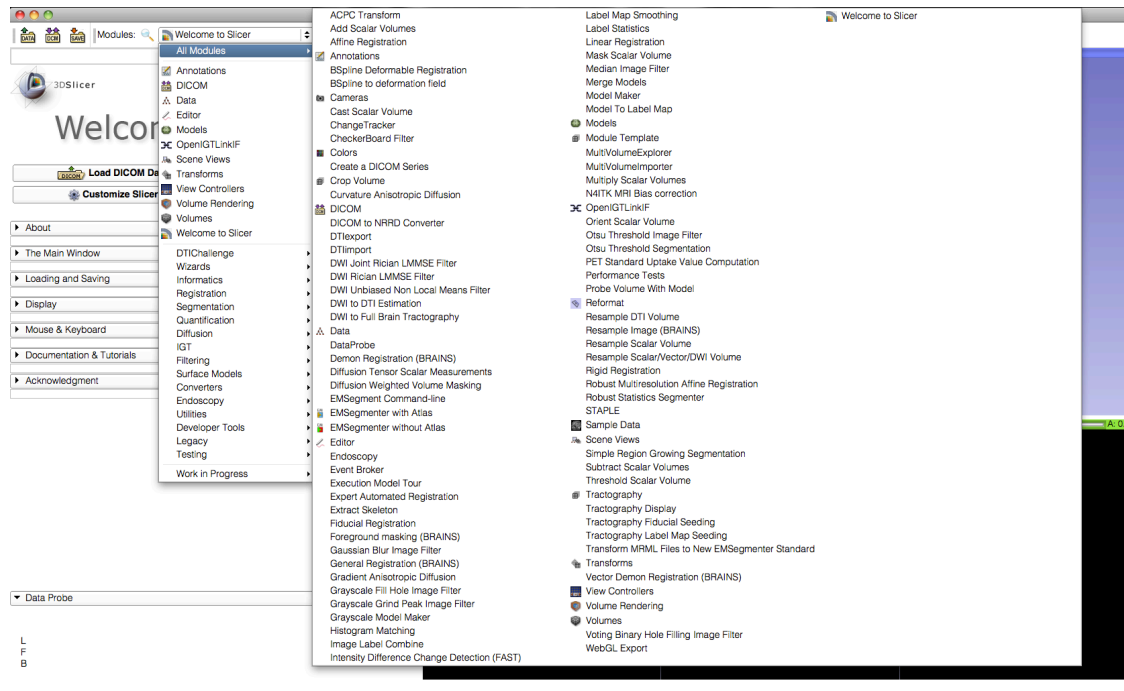
A software platform that is both **easy  
to use** for clinical researchers and  
**easy to extend** for programmers



# SLICER FUNCTIONALITIES



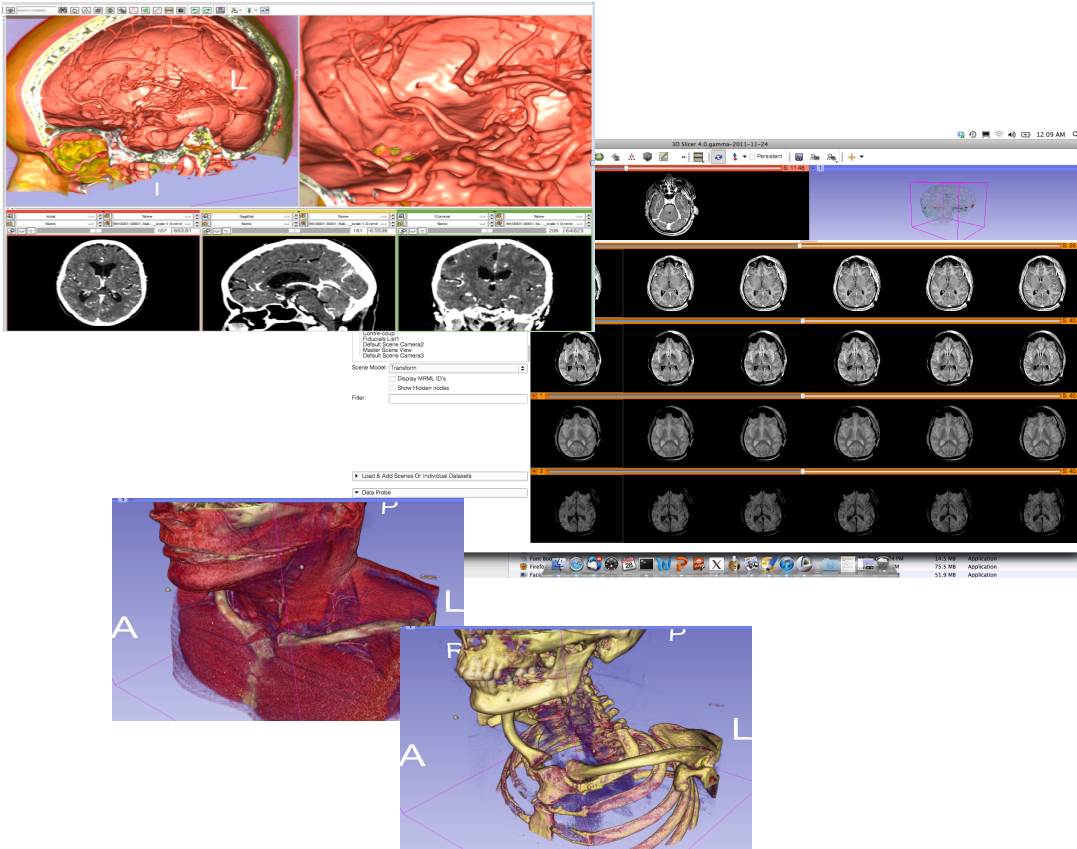
# Core Functionalities



- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification
- Reporting



# Core Functionalities

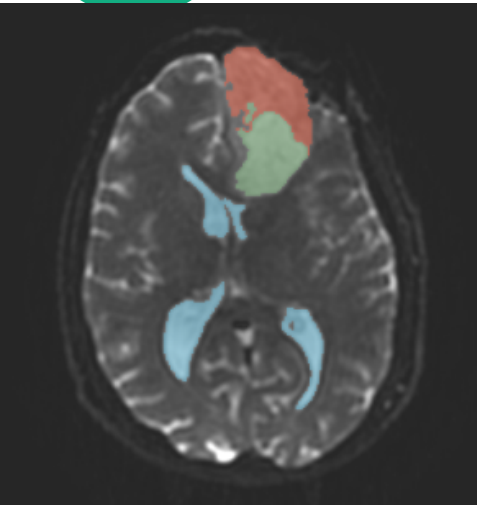


- **Visualization**
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification
- Reporting

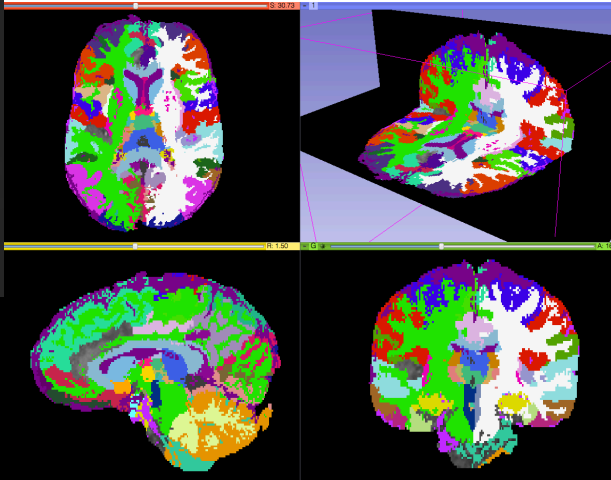




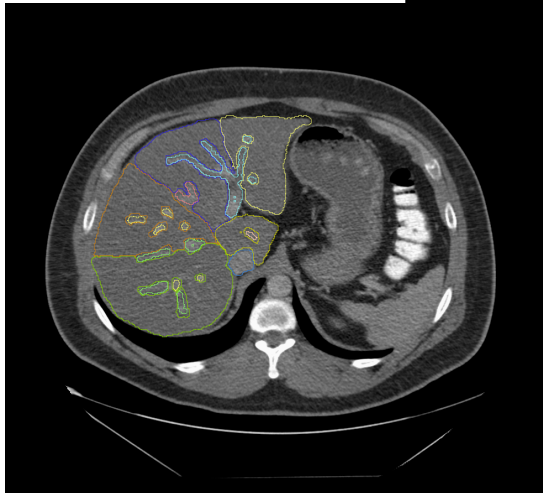
# Core Functionalities



Editor



EMSegmenter

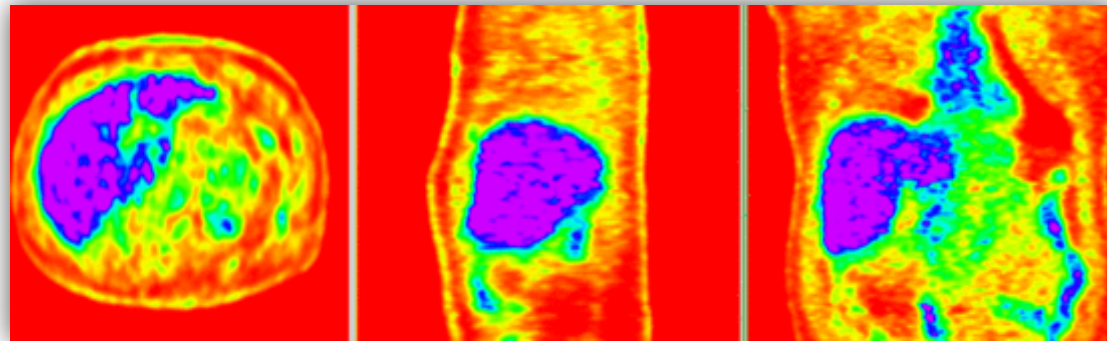


- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification
- Reporting



# Core Functionalities

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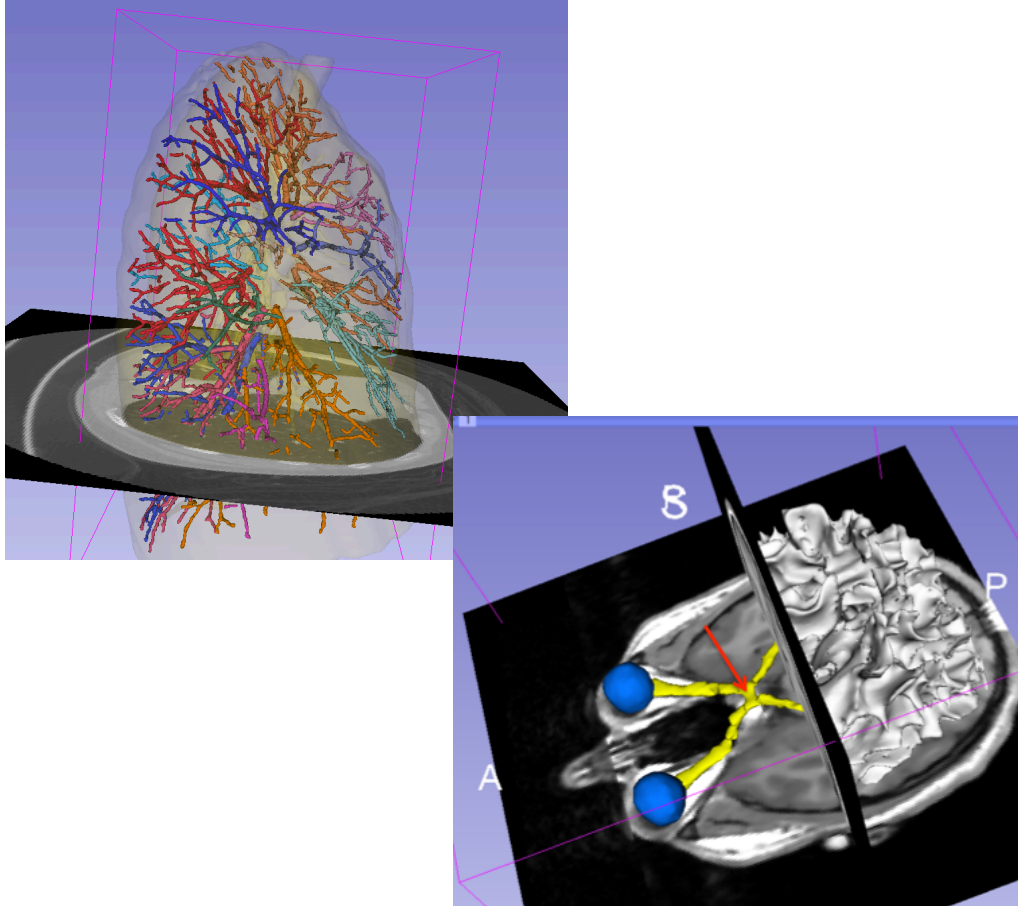
- Visualization
- Segmentation
- **Registration**
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification
- Reporting





# Core Functionalities

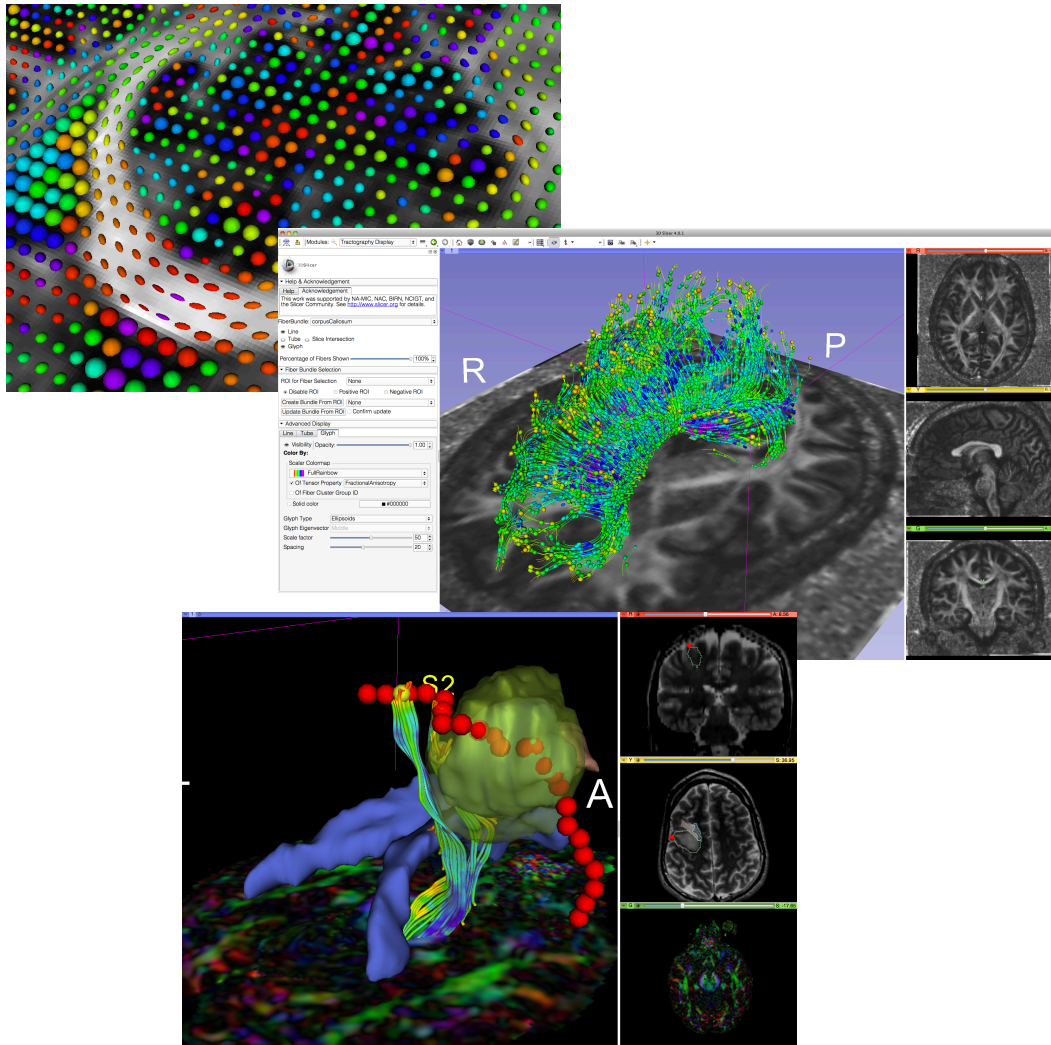
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- Visualization
- Segmentation
- Registration
- **Surface Reconstruction**
- Diffusion
- Image Guided Therapy
- Quantification
- Reporting



# Core Functionalities



- Visualization
- Segmentation
- Registration
- Reconstruction
- **Diffusion MRI**
- Image Guided Therapy
- Quantification
- Reporting



# Core Functionalities

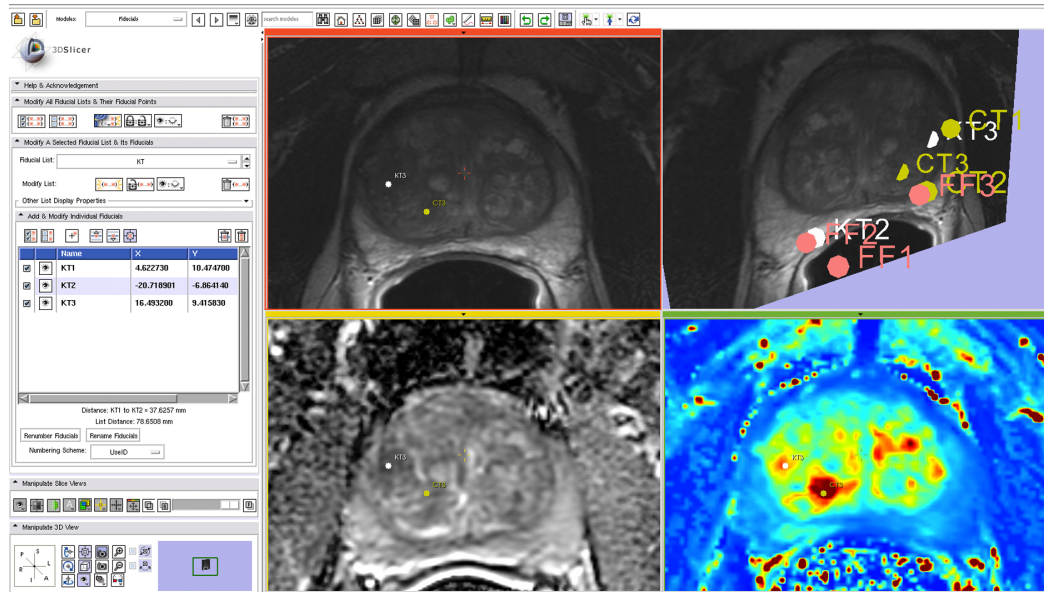
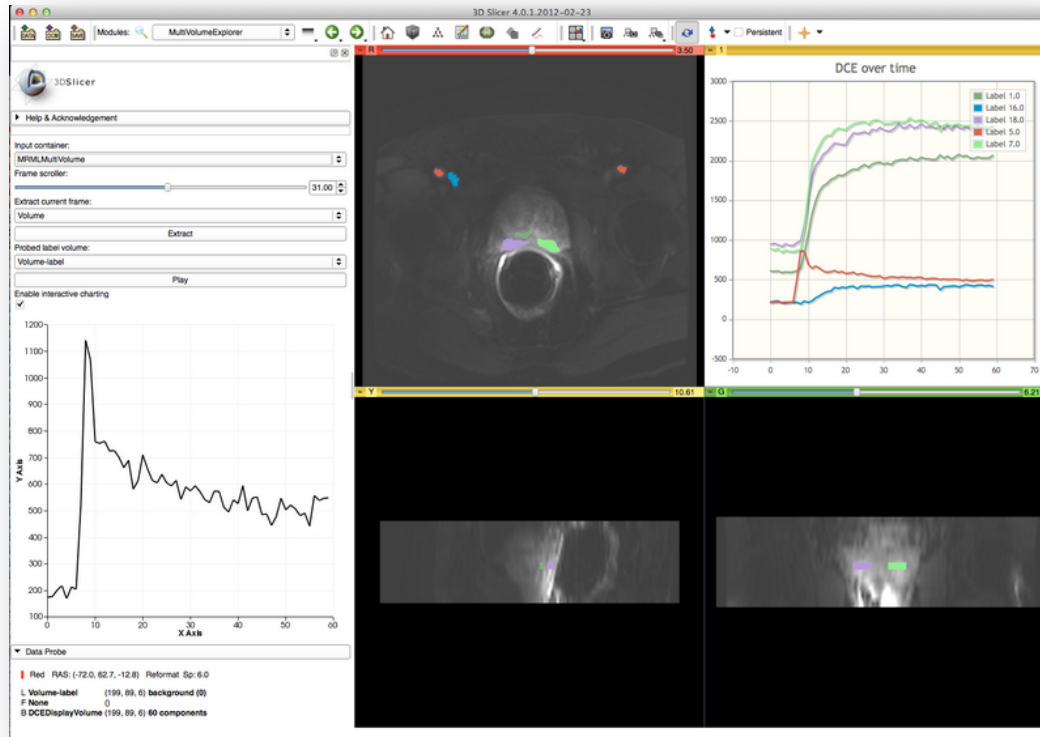


Image Courtesy A.Fedorov, T.Penzkofer, R.Kikinis

- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Filtering
- Image Guided Therapy
- Quantification



# Core Functionalities



- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Filtering
- Image Guided Therapy
- Quantification

Image Courtesy A.Fedorov, R.Kikinis

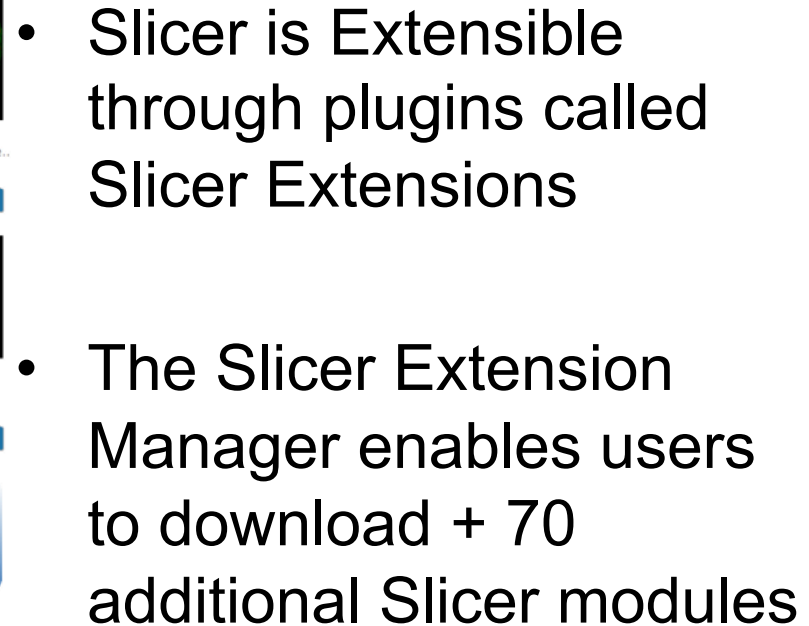
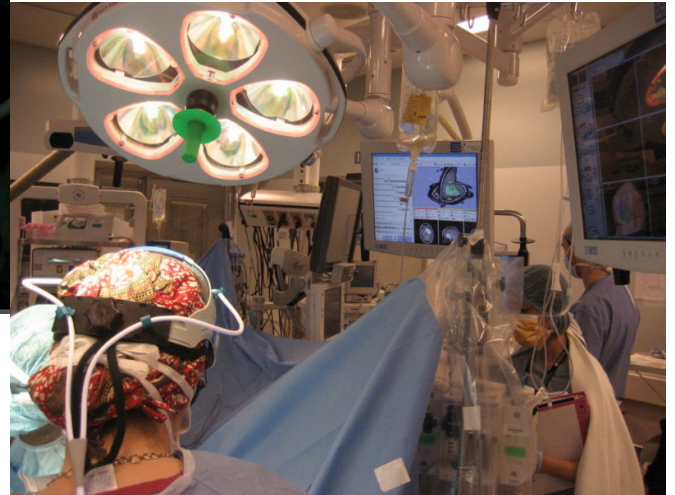




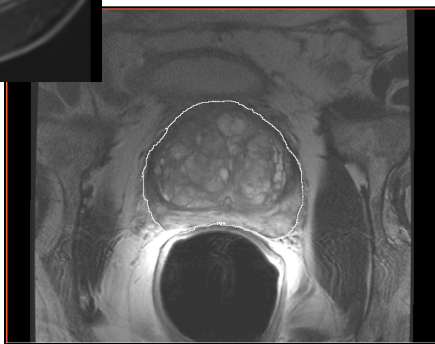
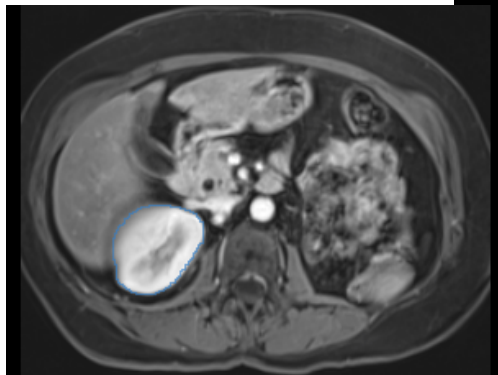
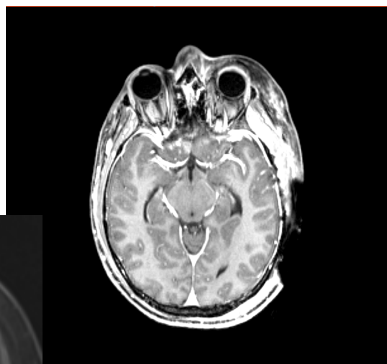
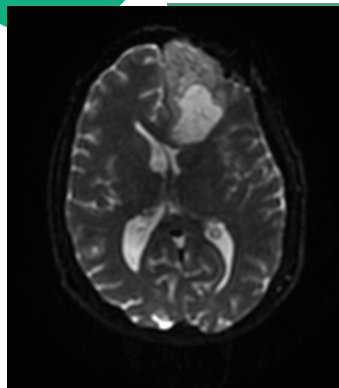


Image Courtesy A.Golby



# 3D SLICER: APPLICATIONS

- Driving Biological Projects leading to the development of new tools
- Applied science oriented toward subject specific analysis in the presence of pathology





# Slicer use in clinical research environment

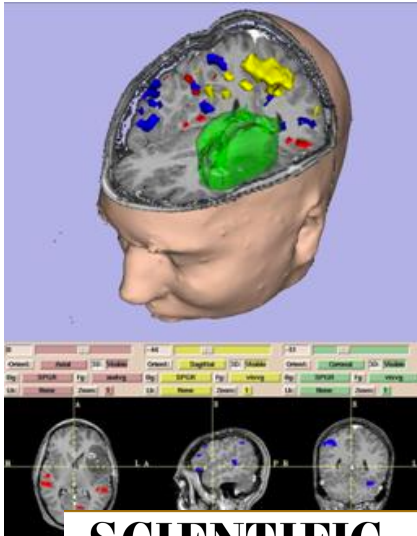
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- AMIGO, BWH, Boston, USA (DTI)
- Slicer RT – Canada
- Quantitative Image Network collaboration with German Cancer Research Institute (PET/CT)





# Image-Guided Therapy Research at BWH: Open MRI (1991)



**SCIENTIFIC  
AMERICAN**

JUNE 1999 \$4.95

www.siam.com

EXPEDITIONS:  
THE BATS OF BELIZE

## Scanners and Scalpels

X-ray vision?  
Virtual reality gives surgeons  
something much better

**The Limits  
of Logic**

**Mapping  
the Universe**

**Germ War  
against  
Crops**





# Image-Guided Therapy Research at BWH: AMIGO (2011)

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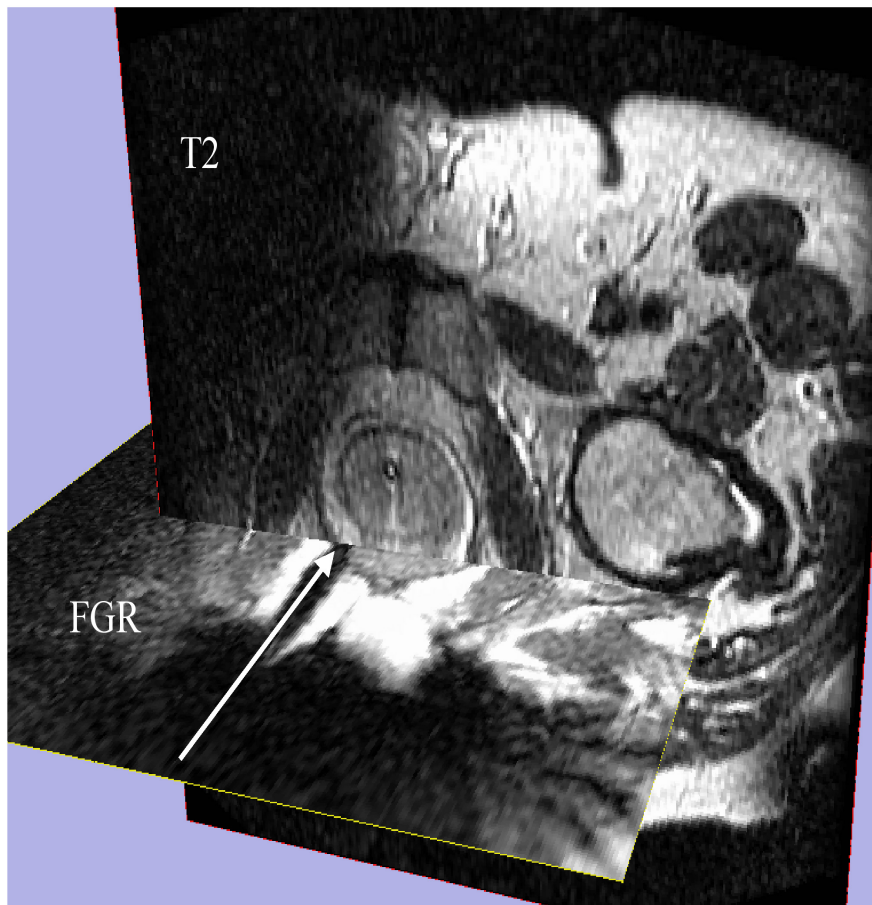




# AMIGO (2011-2016): +1,000 clinical cases

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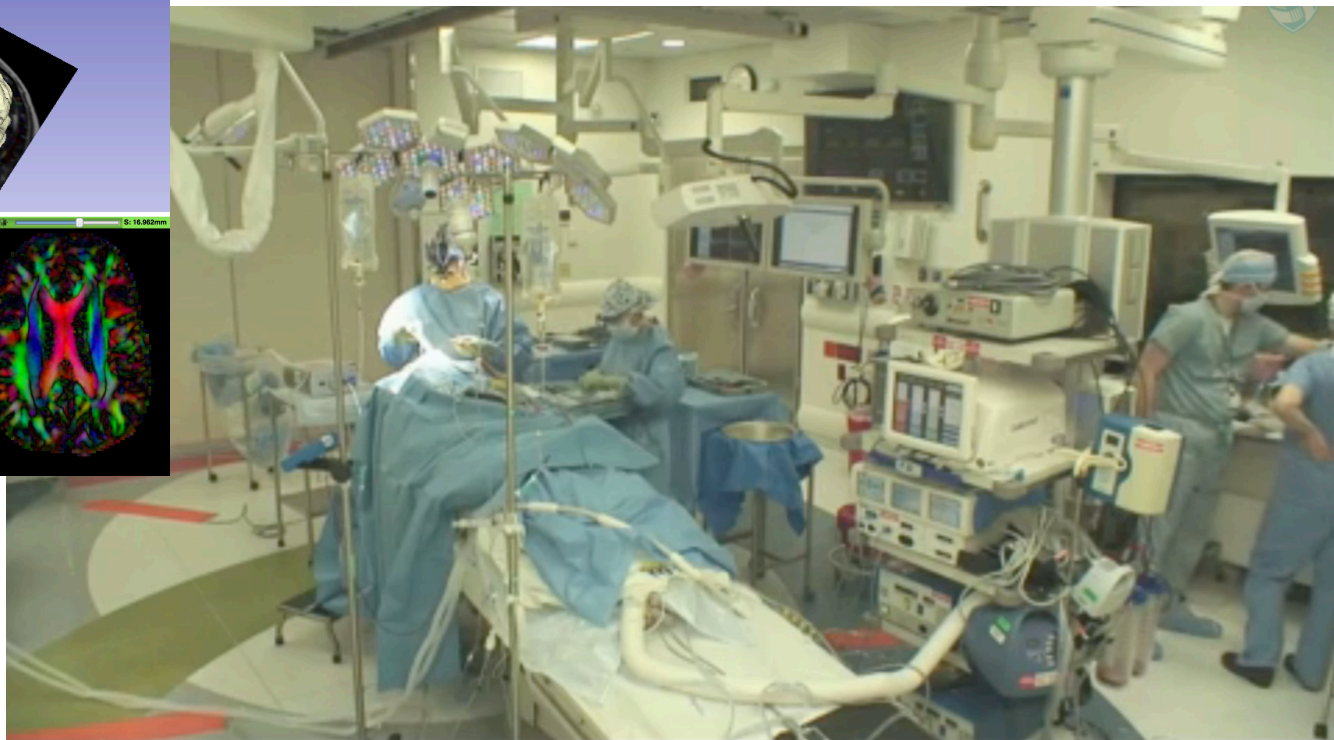
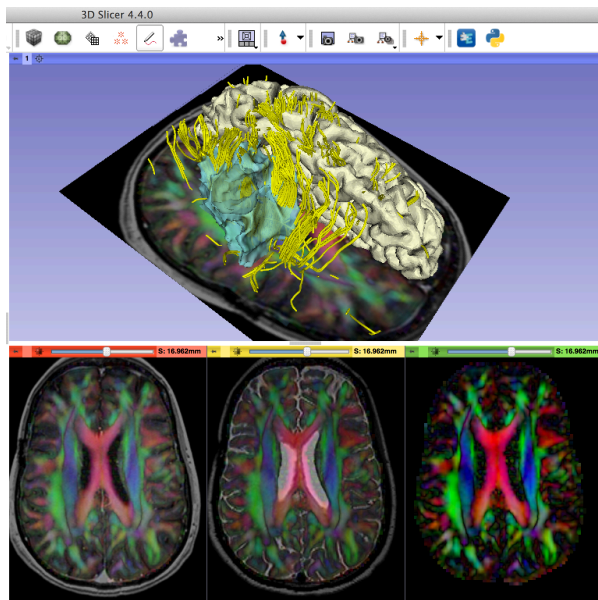
- Image-guided therapy for prostate interventions:
- Brachytherapy Planning
  - Navigation for Biopsy

Haker SJ, Mulkern RV, Roebuck JR, Barnes AS, Dimaio S, Hata N, Tempany CM.: Magnetic resonance-guided prostate interventions. *Top Magn Reson Imaging*. 2005 Oct;16(5):355-68.

Image Courtesy of Steven Haker, PhD and Clare Tempany, MD



# Neurosurgical Intervention



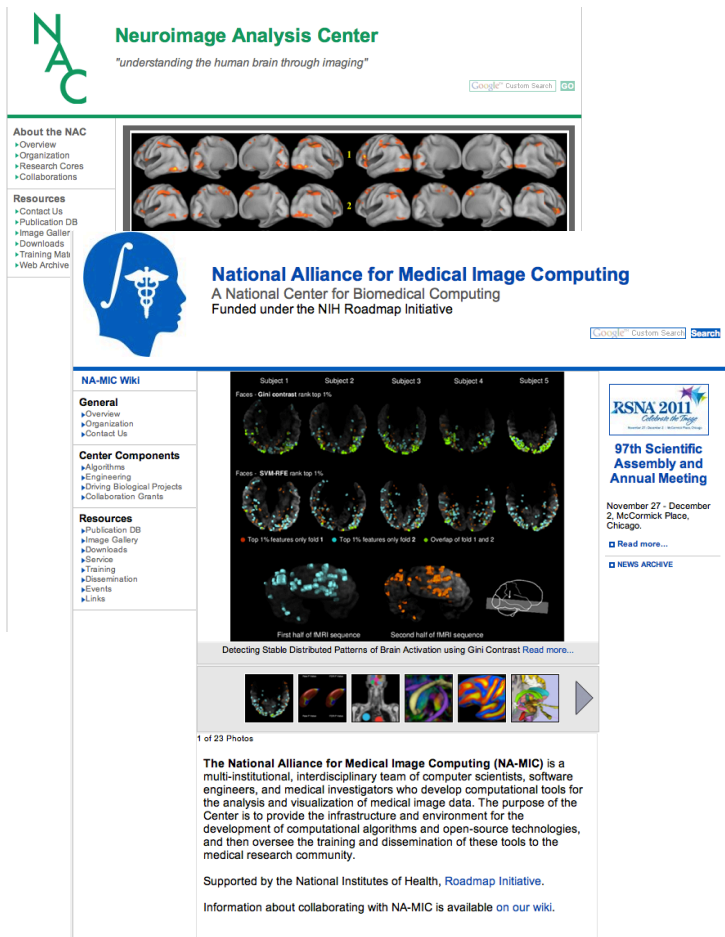




# 3D SLICER: TRAINING



# Slicer Training History: 2005-2016



- Training Core of two NIH-funded consortia: the National Alliance for Medical Image Computing (NA-MIC) and the Neuroimage Analysis Center (NAC) (P.I. Ron Kikinis)



# 3D Slicer Training

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- Training effort to transfer scientific advances in medical image computing to clinical researchers
- Courses tailored for clinicians and scientists at national events, invited seminars, and international conferences





# Slicer Trainees

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- Clinical investigators
- Senior scientists
- Postdoctoral fellows
- Programmers
- Undergraduate and graduate students
- Staff researchers
  
- +3,500 trainees worldwide



# Slicer Project Weeks

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- Bi-annual week of hands-on programming
- Practical exchange of idea and experience
- 21 project weeks in the US since 2005



# Conclusion

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- Slicer is an open-source research platform for medical image analysis
- The Slicer community is an open community with contributors from all over the world
- Slicer is a versatile platform for translational research and subject specific analysis of biomedical image data





# Acknowledgments

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National Alliance for Medical Image Computing  
NIH U54EB005149

Neuroimage Analysis Center  
NIH P41RR013218