Laboratory for Percutaneous Surgery

3D Slicer as image-guided therapy (IGT) software application platform

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Commercial software	Research software
Fully optimized for specific purposes	Very flexible, fits many purposes, easy to customize/extend
Simple, easy to use	Complex, may be difficult to use
Fast, robust	Might be slower, might have robustness problems
Uses closed source, in-house developed and maintained libraries	Uses state-of-the-art, actively developed open source libraries
Thoroughly tested, fully documented (fully FDA, CE compliant + as high quality as possible)	Tested & documented as reasonable (optimized for quality)
Very expensive	Mostly free

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Without an application platform

- Completely new software is developed for each problem/procedure/device
- Each application is developed from ground up
- Significant work is needed to integrate new, advanced algorithms

Quick start. Huge waste of time/money/effort overall.

Building on an application platform

- Core functionalities are already implemented
- Many new, advanced algorithms are available
- New software module can be developed for specific needs

Huge investment at the beginning: learning.

Minimal wasted efforts.

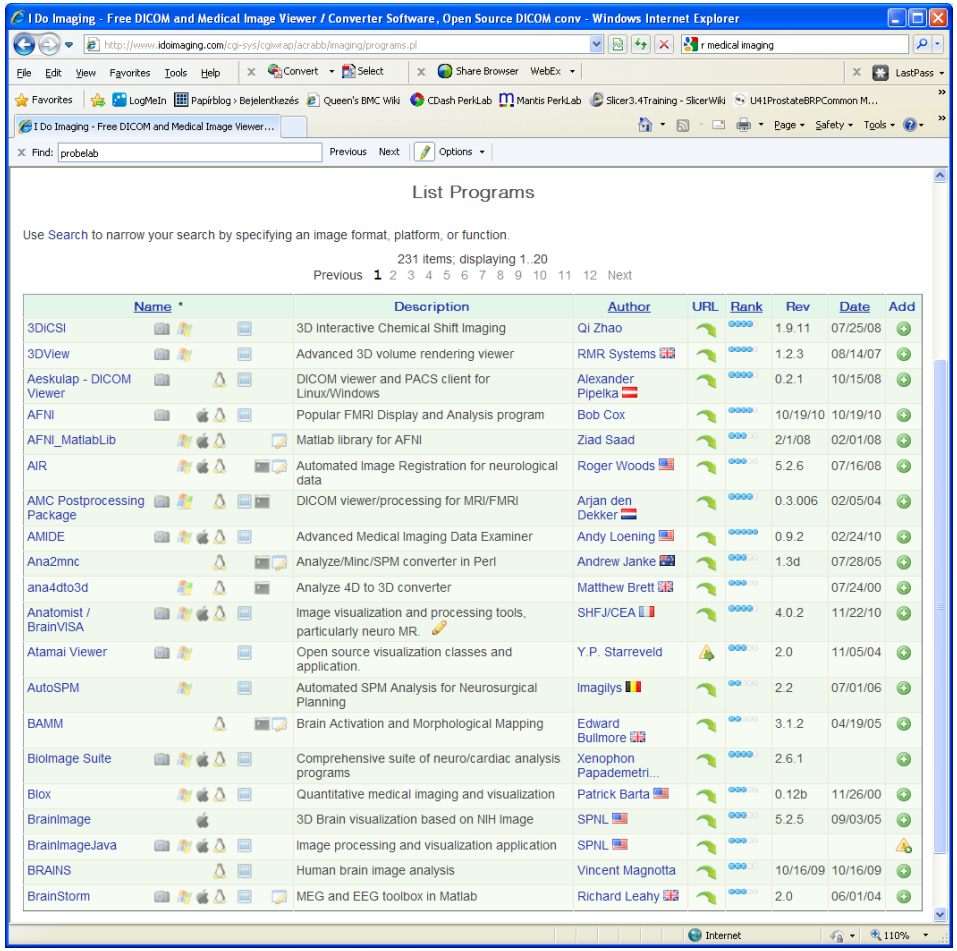
Which application platform?

100+ free medical imaging software applications

Most of them are designed to be extensible application platforms

I DO IMAGING
FREE MEDICAL IMAGING SOFTWARE

(http://www.idoimaging.com)



Not free

Not multi-platform

Not a software application

Only for brain images

Other

(Nature Methods Supplement, VOL.7 NO.3s, MARCH 2010)

Table 2 | A selective list of MRI visualization tools

Name	Cost	OS	Description	URL
3D Slicer*	Free	Win, Mac, Linux	Tools for visualization, registration, segmentation and quantification of medical data; extensible; uses VTK and ITK	http://www.slicer.org/
Amira	$	Win, Mac, Linux	Allows 3D slices to be viewed from any angle; provides image segmentation, 3D mesh generation; surface rendering; data overlay and quantitative measurements	http://www.amiravis.com/
Analyze	$	Win, Mac, Linux		
Anatomist	Free	Win, Mac, Linux		
AVS	$	Win, Mac, Linux	General purpose data visualization package	http://www.avs.com/
BioImage Suite*	Free	Win, Mac, Linux	Tools for biomedical image analysis; includes preprocessing, voxel-based classification; image registration; diffusion image analysis; cardiac image analysis; fMRI activation detection	http://bioimagesuite.org/
BrainSuite	Free	Win, Mac, Linux	Automated cortical surface extraction from MRI; orthogonal image viewer; automated and interactive segmentation and labeling; surface visualization	http://tiny.cc/0xv6x
BrainVisa	Free	Win, Mac, Linux	Toolbox for segmentation of T1-weighted images; performs classification and mesh generation on brain images; automated sulcal labeling	http://brainvisa.info/
BrainVoyager	$	Win, Mac, Linux	Analysis and visualization of MRI and fMRI data and for EEG and MEG distributed source imaging	http://tiny.cc/kFKlv
Cardiac Image Modeller	$	Irix	Visualization and functional analysis, in 3D space and through time of cardiac cine data	http://tiny.cc/4KY8E
BTIStudio	Free	Win		http://tiny.cc/pU9B
FreeSurfer	Free	Ma	structural MRI data	http://tiny.cc/H3u6S
FSL*	Free	Win, Mac, Linux	Comprehensive library of analysis tools for fMRI, MRI and DTI brain imaging data; includes widely used registration and segmentation tools	http://tiny.cc/NFPH0
ImageJ	Free	Win, Mac, Linux	Image processing, extensible (in Java), large user community	http://rsb.info.nih.gov/ij/
ImagePro	$	Win		
ITK	Free	Win, Mac, L		
Jim	$	Win, Mac, L		
MBAT	Free	Win, Mac, Linux	Workflow environment bringing together online resources, a user's image data and biological atlases in a unified workspace; extensible via plug-ins	http://tiny.cc/W2Tx2
MedINRIA	Free	Win, Mac, Linux	Many algorithms dedicated to medical image processing and visualization; provides many modules, including DTI and HARDI viewing and analysis	http://tiny.cc/RCptw
MIPAV	Free	Win, Mac, Linux	Quantitative analysis and visualization of medical images of numerous modalities such as PET, MRI, CT or microscopy	http://mipav.cit.nih.gov/
OpenDX	Free/$	Win, Mac, Linux	General purpose data visualization package	http://www.opendx.org/
OsiriX*	Free	Mac		
SCIRun	Free	Win, Mac, Linux	Environment for modeling, simulation and visualization of scientific problems; includes many biomedical analysis components, such as BioTensor, BioFEM and BioImage	http://tiny.cc/eLdrX
SPM	Free		data sequences; applies statistical parametric mapping methods; widely used in fMRI; provides segmentation and registration	http://tiny.cc/dVc7v
TrackVis	Free	Win, Mac, Linux	Tools to visualize and analyze fiber track data from diffusion MRI (DTI, DSI, HARDI, Q-Ball) tractography	http://trackvis.org/
TractoR	Free	Linux	Tools to segment comparable tracts in group studies using FSL tractography	http://tiny.cc/0cBH0
VTK*	Free	Win, Mac, Linux	Library of C++ code that implements many state-of-the-art visualization techniques with a consistent developer interface	http://www.vtk.org/

*Recommended and popular tools. Free means the tool is free for academic use; $ means there is a cost; free/$ means free for Windows and Linux, at a cost for Mac OS X. OS, operating system: Win, Microsoft Windows; Mac, Macintosh OS X. Tools running on Linux usually also run on other versions of Unix. Irix is SGI's Unix operating system. 2D, two-dimensional; CT, computed tomography; PET, positron emission tomography; HARDI, high angular resolution diffusion imaging.

Non-BSD license (GPL), set of tools/applets

Mainly 2D visualization, Java

Very basic viewing and registration functions only

Non-BSD license, a few nice, small apps

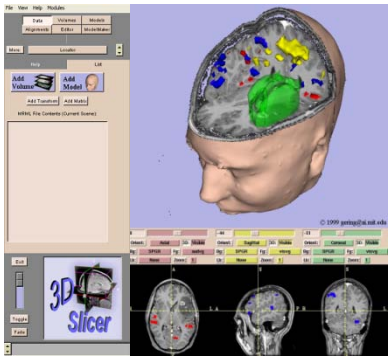
Closed source

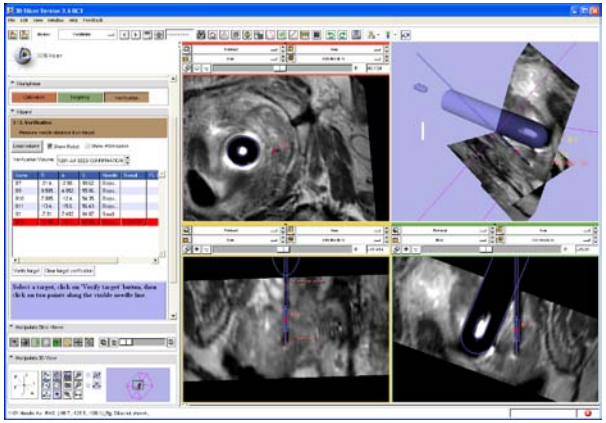
3D Slicer history

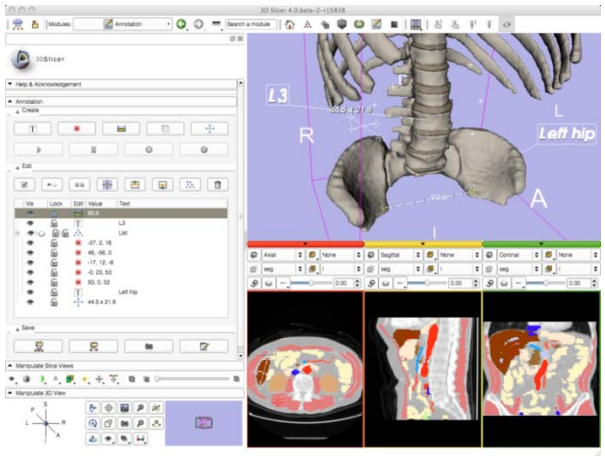
- Slicer 1: Started by Harvard SPL and MIT CSAIL labs (1998-)
- Slicer 2: fully reworked, not yet usable
- Slicer 3: full reworked, finally usable, current stable version (2007-2011)
- Slicer 4: fully reworked, not yet usable, but will be really good (2011-)

  http://www.slicer.org/slicerWiki/index.php/Slicer4

  - Graphical user interface: QT
  - Performance and usability improvements
  - New libraries: ITK4, OpenIGTLink2, ...
  - Expected for RSNA 2011 (December)



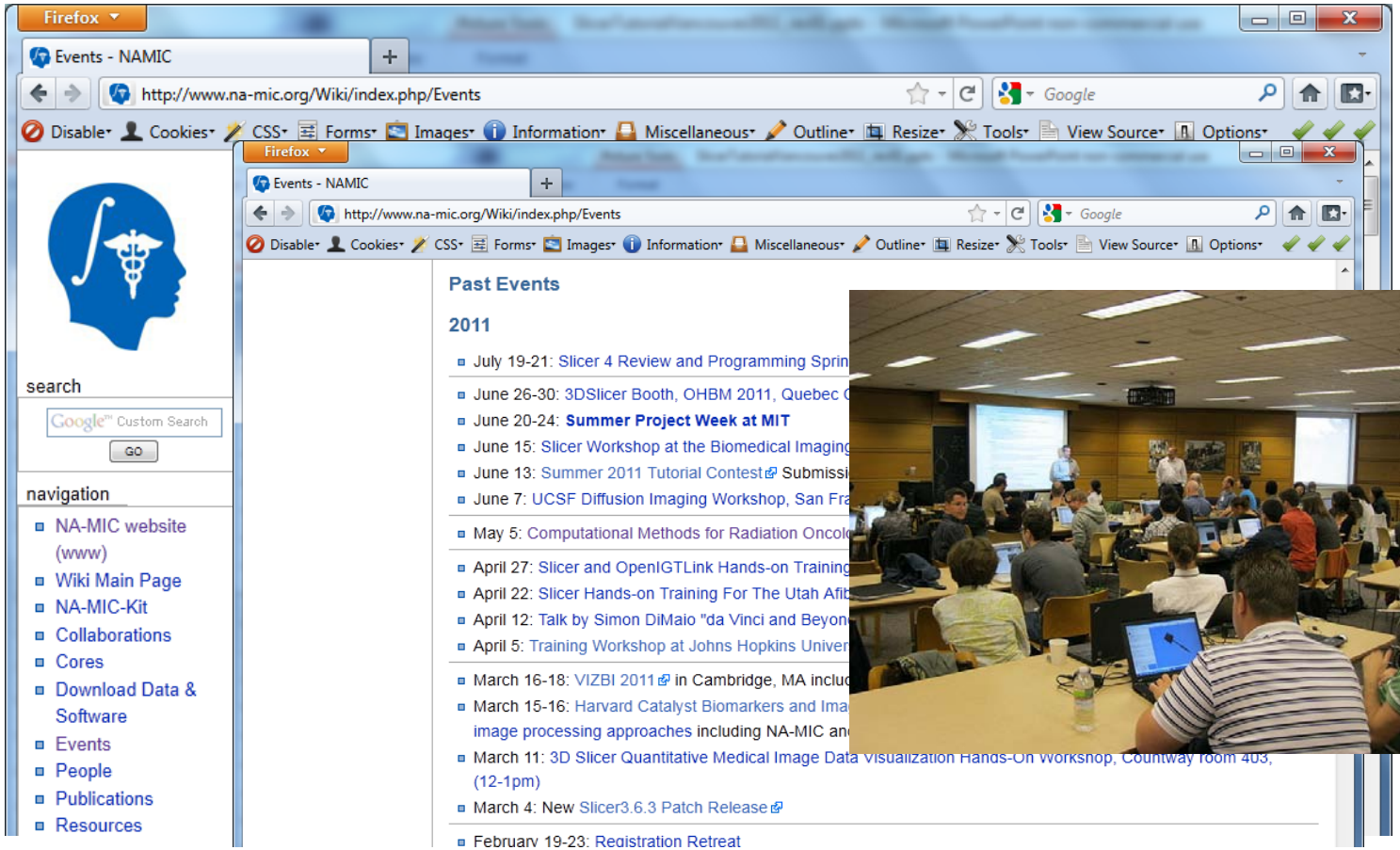




Using 3D Slicer for image-guided therapy

- Most of the needed functions are already available
- Flexible, extensible with plug-ins
- Large user and developer community: continuous improvement, good support

- Free (BSD-style), based on standard open source libraries
- Multi-platform (Windows, Linux, Mac)
- Several successful IGT examples
- Not optimized for a specific procedure: custom module and/or add experienced user needed in the OR
- Not optimized for speed or robustness



- 2 project weeks per year (≈150 developers)
- 30-40 events per year
- Mailing lists, wiki, ...

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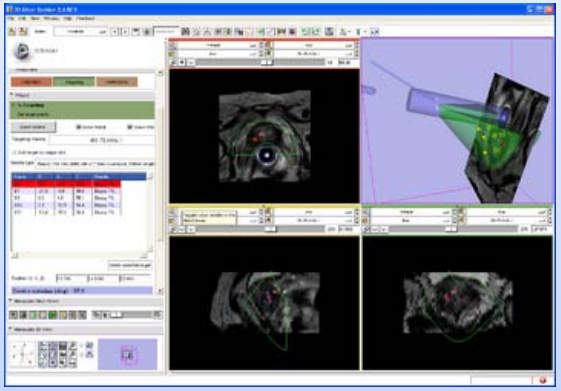
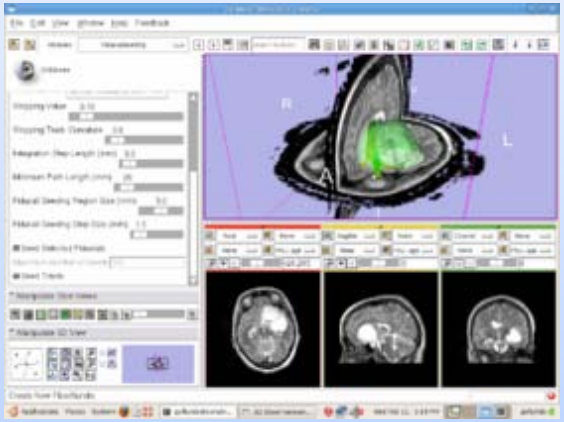
Image-guided therapy applications in Slicer 3.6



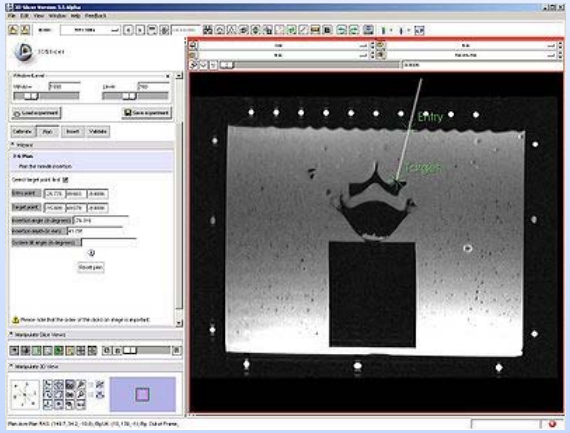
ProstateNav

- Prostate biopsy
- Used on patients



NeuroNav

- Neuro navigation
- Used on patients



PerkStation

- Spine needle insertion with AR display
- Cadaver studies

LiverAblation

MRAblation

IGTPlanning

IGTNavigation

…

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Summary

- 3D Slicer
  - Research application
  - Platform
  - Good for IGT
  - Many advantages, some limitations
  - Slicer4 is coming

www.slicer.org