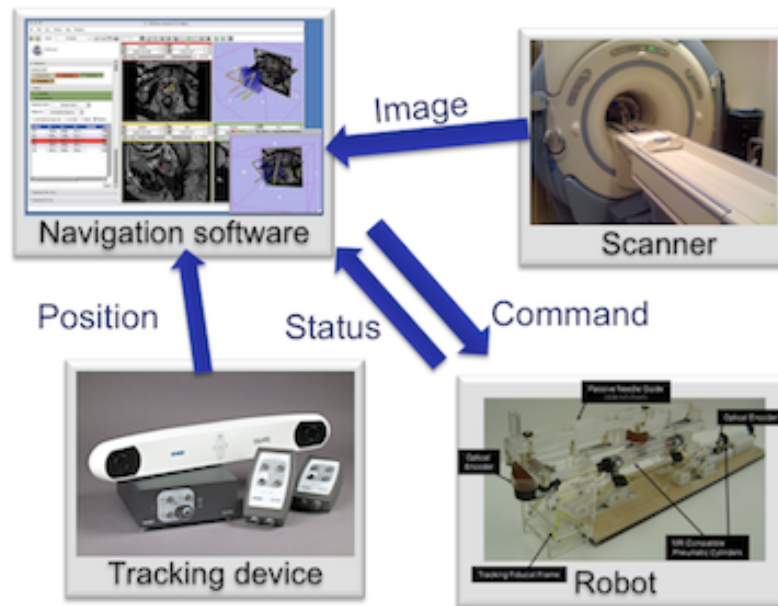


Connecting IGT Device with OpenIGTLink

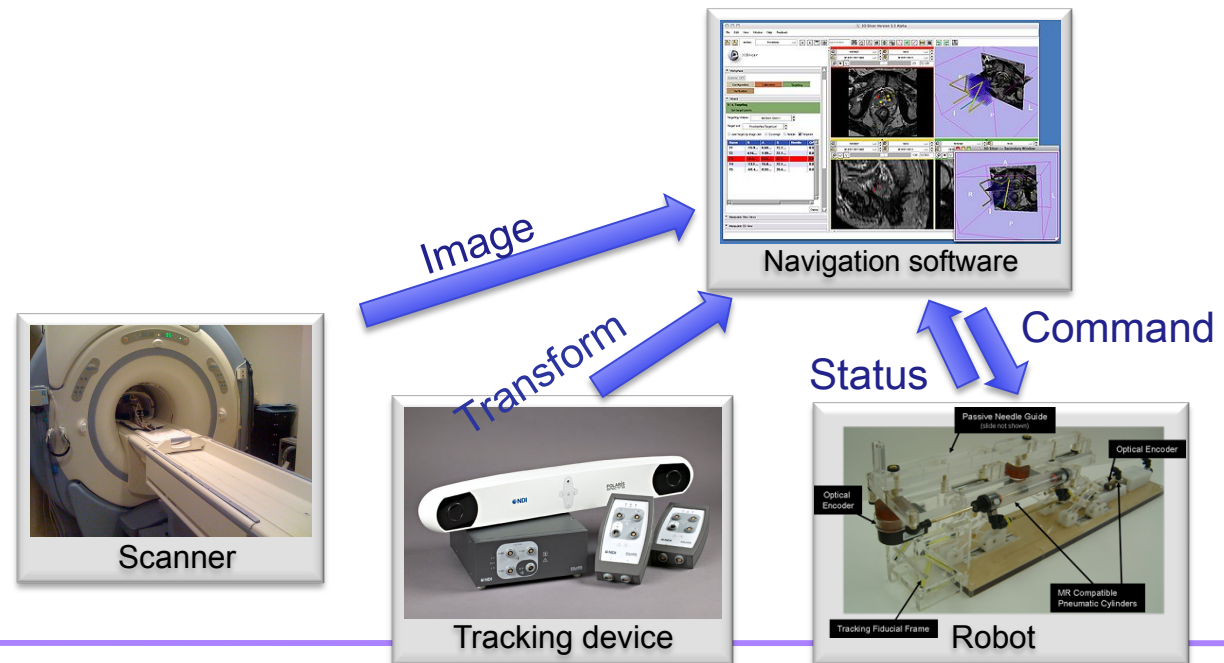


Junichi Tokuda, PhD
Brigham and Women's Hospital
Harvard Medical School

Slicer in Operating Room

3D Slicer's data I/O in OR

- Import images from MRI/CT/Ultrasound..
- Import tool tracking data
- Send commands to robotic devices
- ...



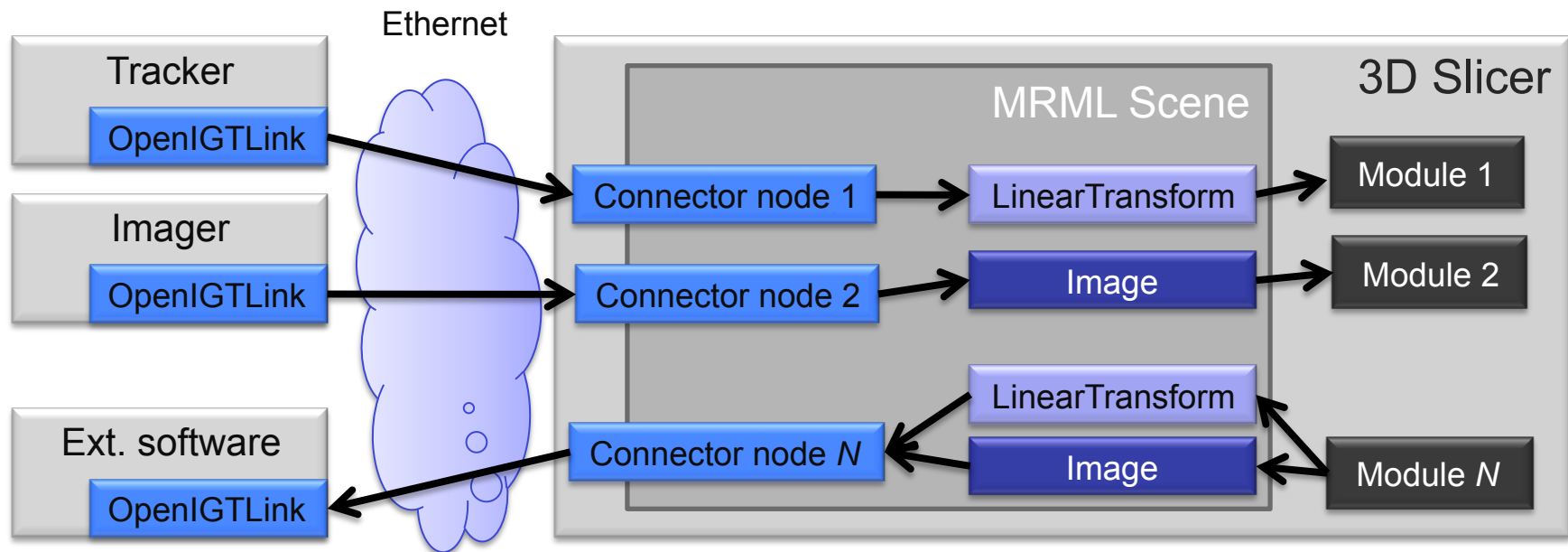


OpenIGTLink

- TCP/IP network communication
 - NDI 3D tracking systems
 - Research software
 - PLUS (Queen's), CISST library (JHU), IGSTK (Kitware), Matlab/Octave, etc
- Why TCP-based network?
 - Available in modern operating rooms
 - Affordable devices (interfaces, switchers and cables)
 - Flexible network topologies
 - Wireless capability (IEEE 802.11a/b/g/n)
 - Reasonable performance (i.e. bandwidth, latency)

3D Slicer OpenIGTLink IF

- Import data from remote host MRML scene
- Export data from MRML scene to remote host

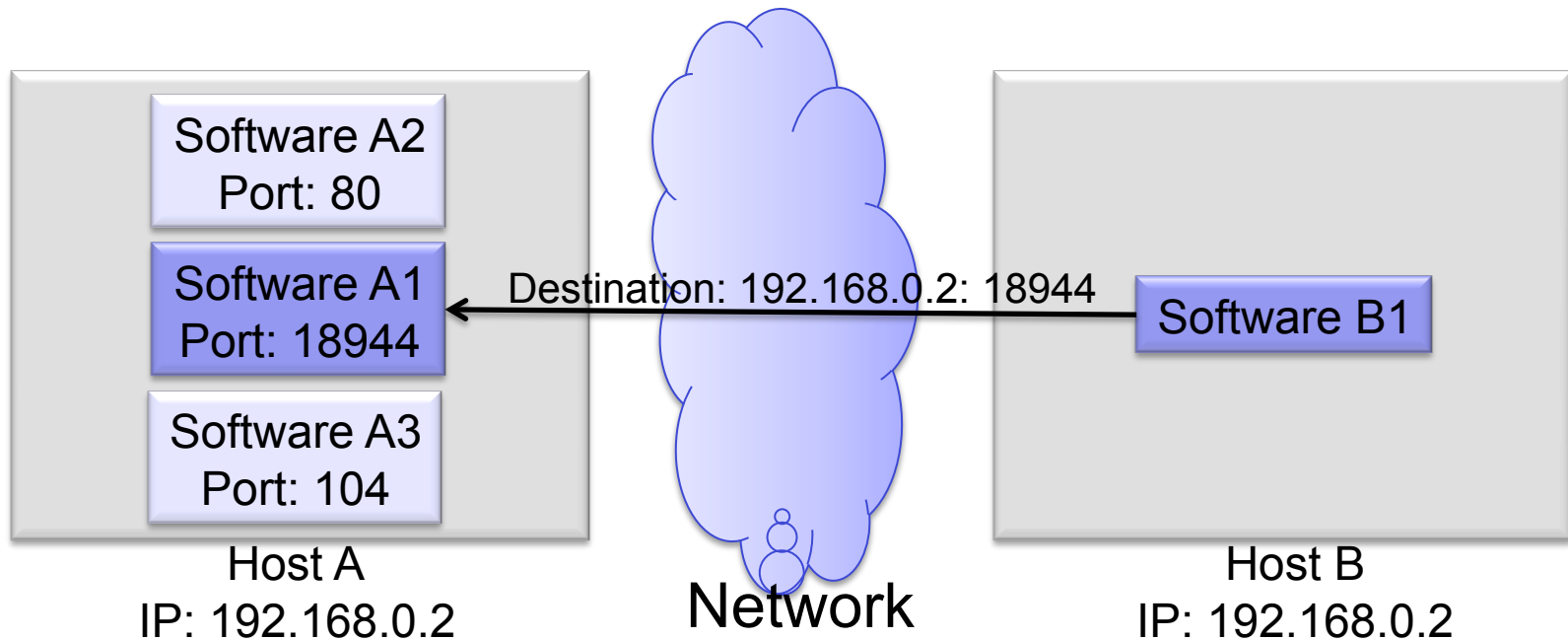




TCP Connection Basics (1)

Remote host is specified by

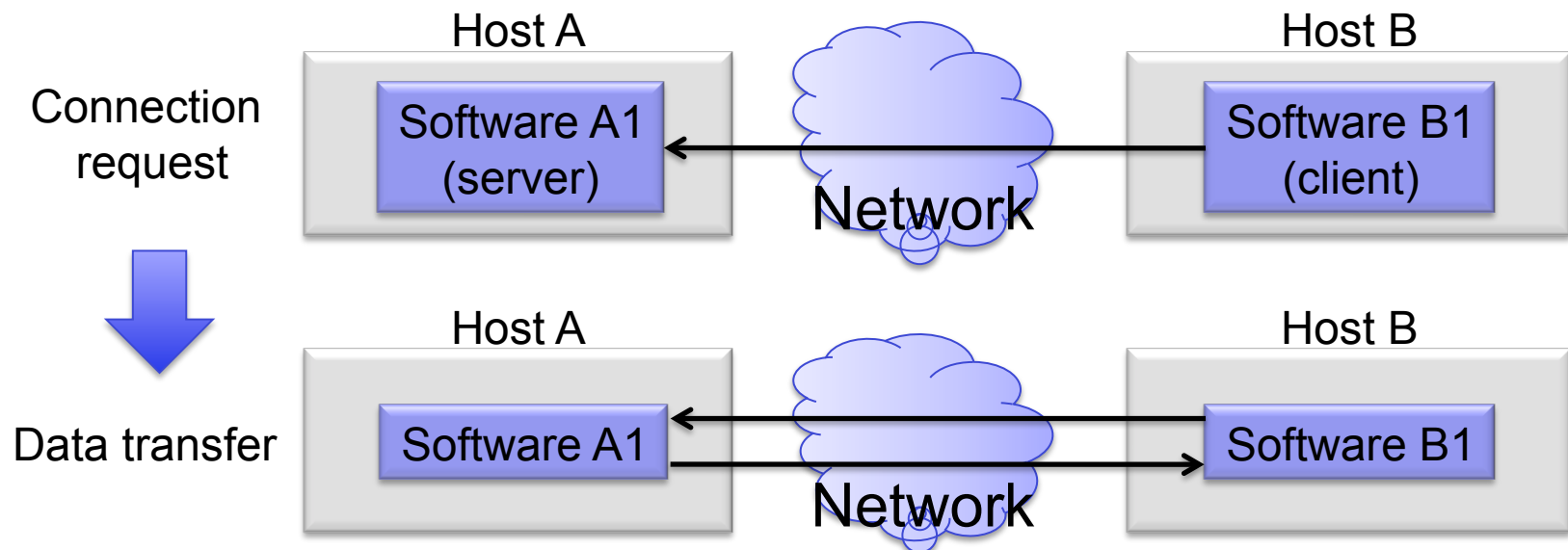
- IP address (i.e. 192.168.0.1) or network address (i.e. watson.bwh.harvard.edu)
- Port number (i.e. 18944)



TCP Connection Basics (2)

“Server” and “Client”

- The server waits for the client at given port.
- The client requests for a connection to the server.
- Server (client) is not necessarily a sender (receiver).
- Slicer can be either server or client





Material

This course requires the following installation:

- 3DSlicer version 4.1 Software (Slicer 4.1.0 21127 or newer) available from:

<http://download.slicer.org/>

- Volume Reslice Module for 3D Slicer (available as Slicer Extension; installation of this Slicer Extension is part of this tutorial)

- Tracker Simulator:

<http://wiki.slicer.org/slicerWiki/index.php/Modules:OpenIGTLinkIF-3.6-Simulators>

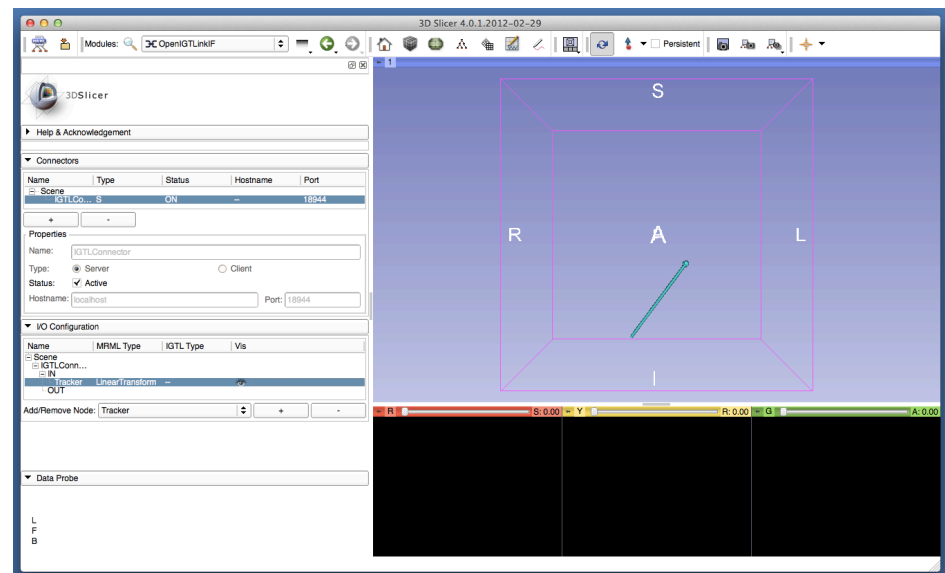
Disclaimer

It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules.



Learning objective

Following this tutorial, you'll be able to import tracking data from external devices (e.g. tracking system) through the network.





Overview

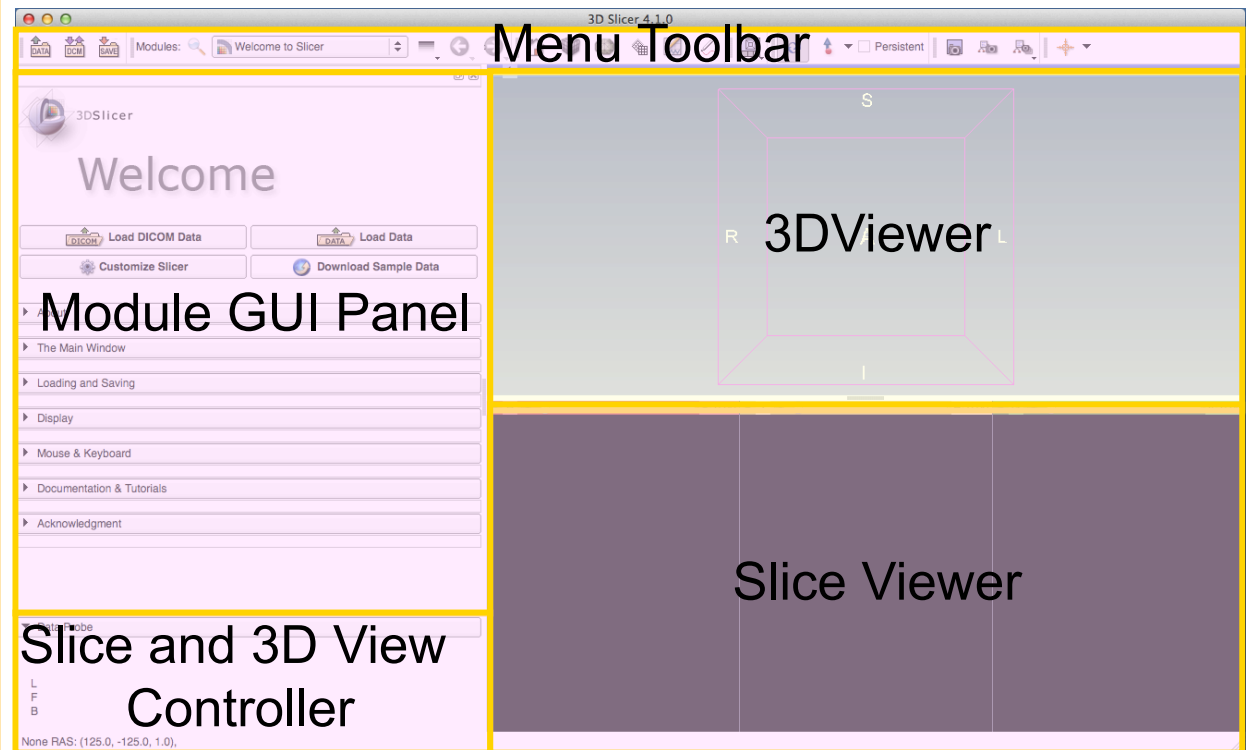
- Installation of Volume Reslice Driver
- Configuring OpenIGTLink IF module
- Setting up Test Server
- Visualizing Tracking Data

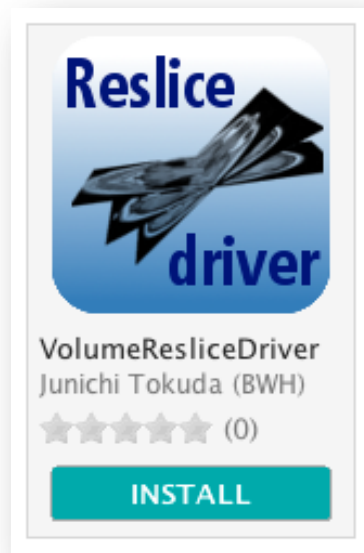


Slicer3 GUI

The Graphical User Interface (GUI) of Slicer3 integrates five components:

- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer
- the Slice and 3D View Controller

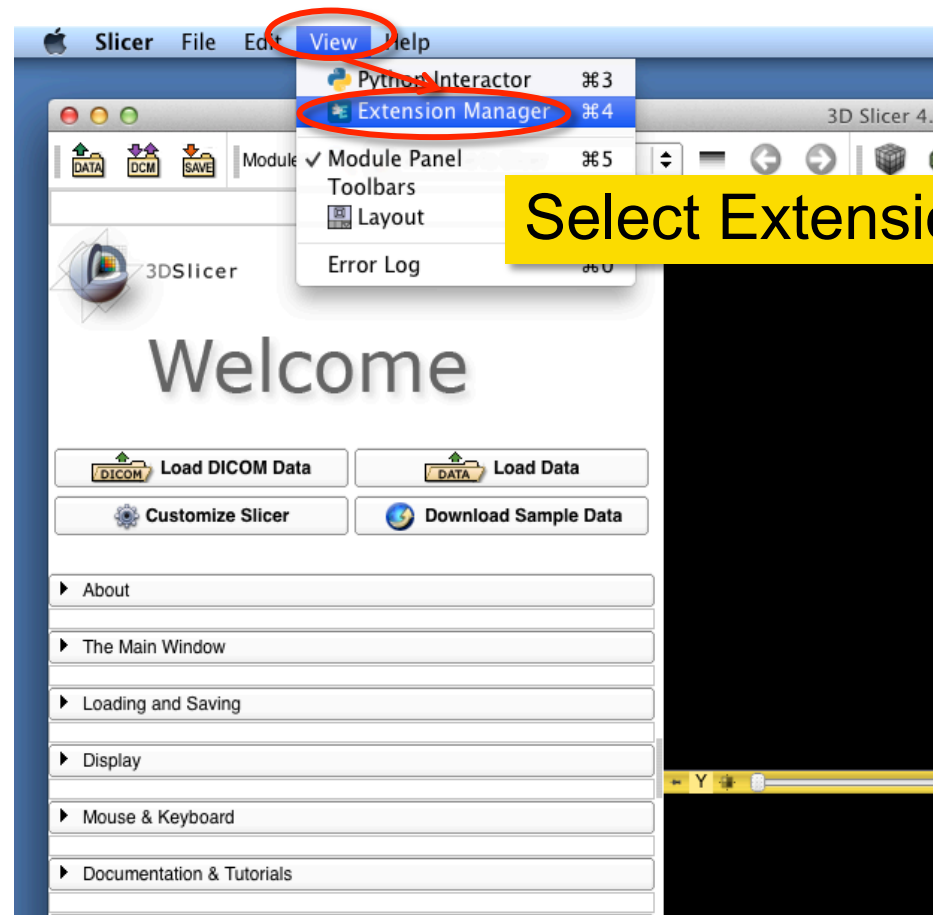




Part 1: Installing Volume Reslice Driver Module

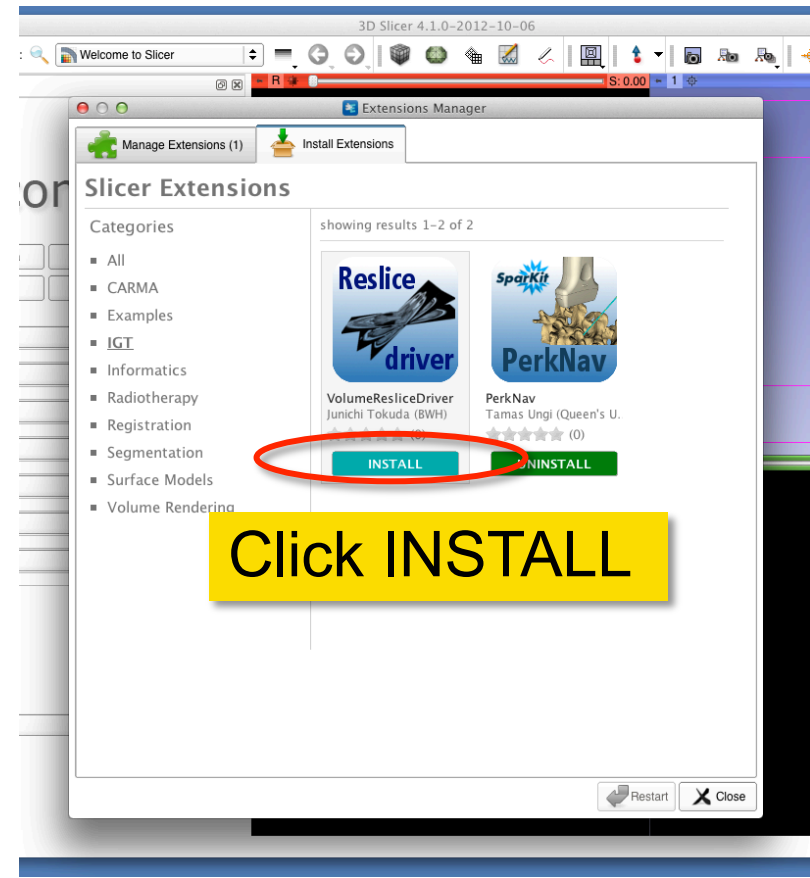
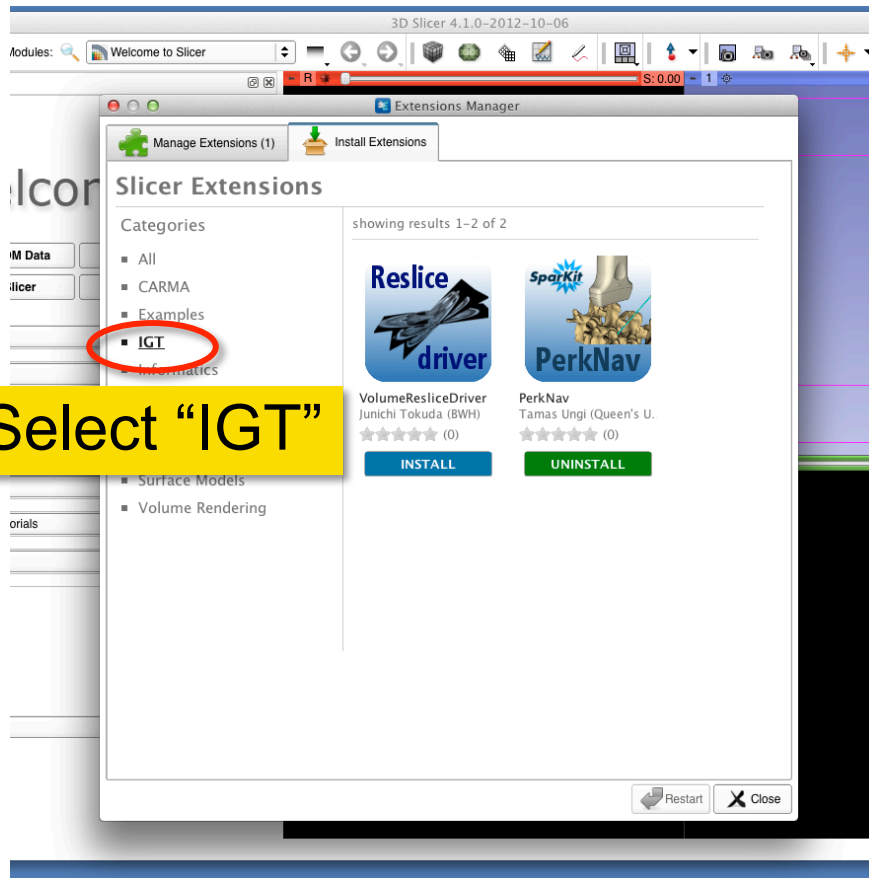


Open Extension Manager

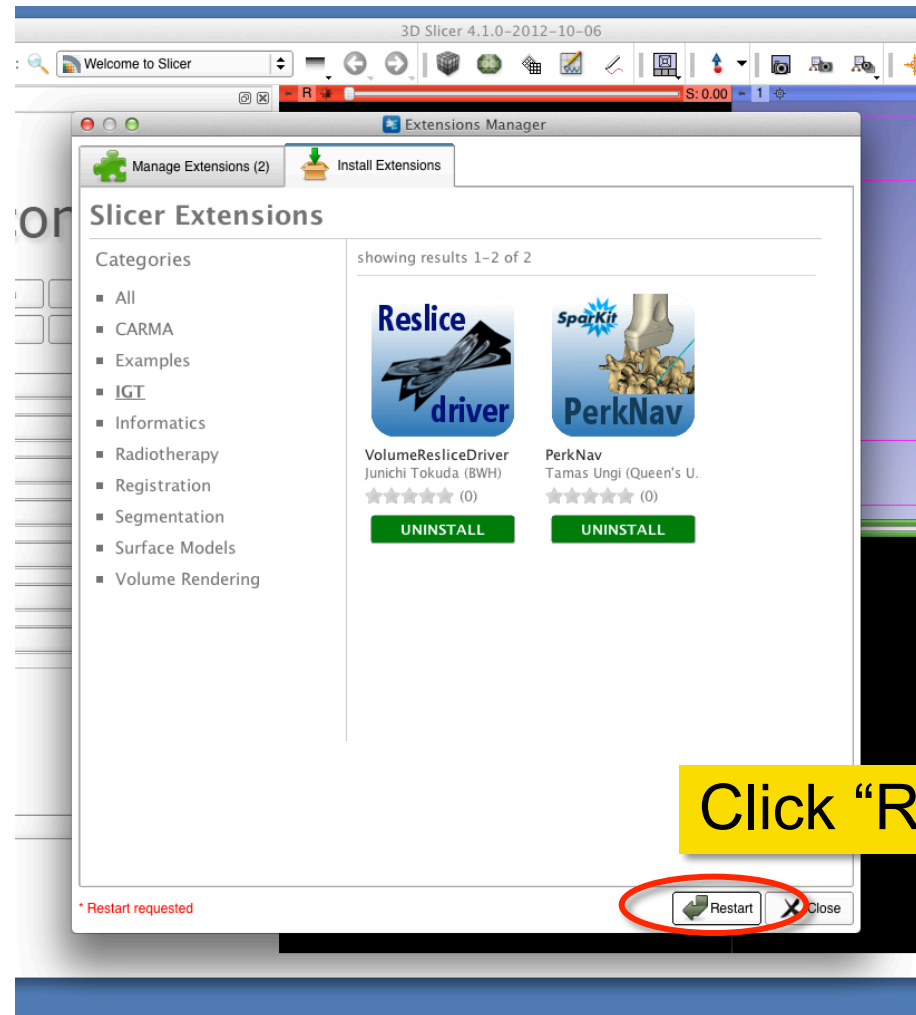




Open Extension Manager

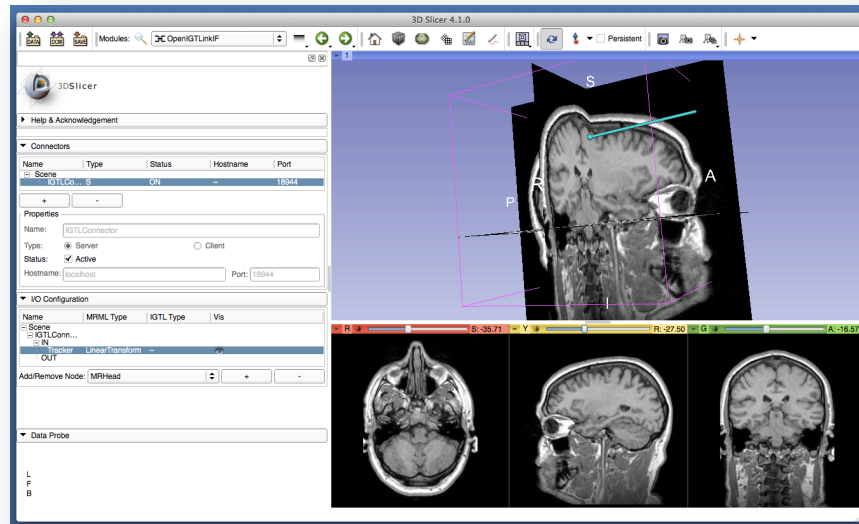


Restart 3D Slicer





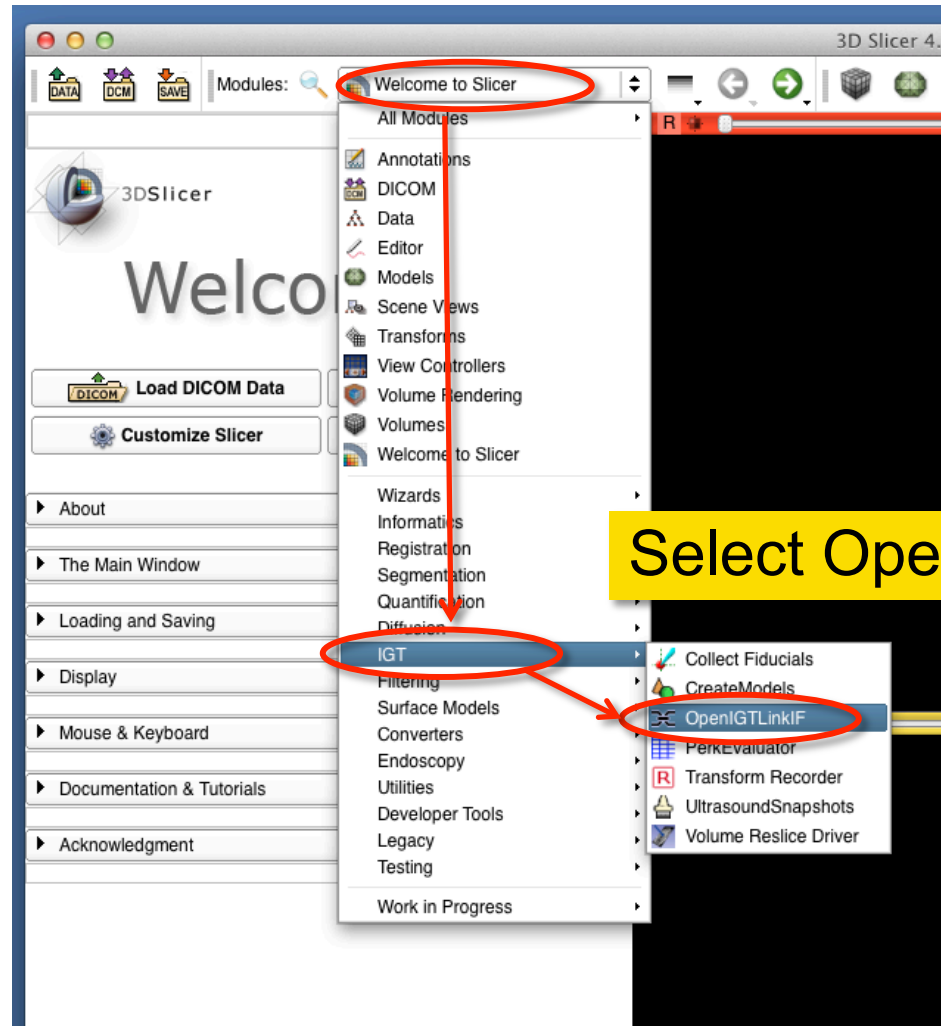
3DSlicer



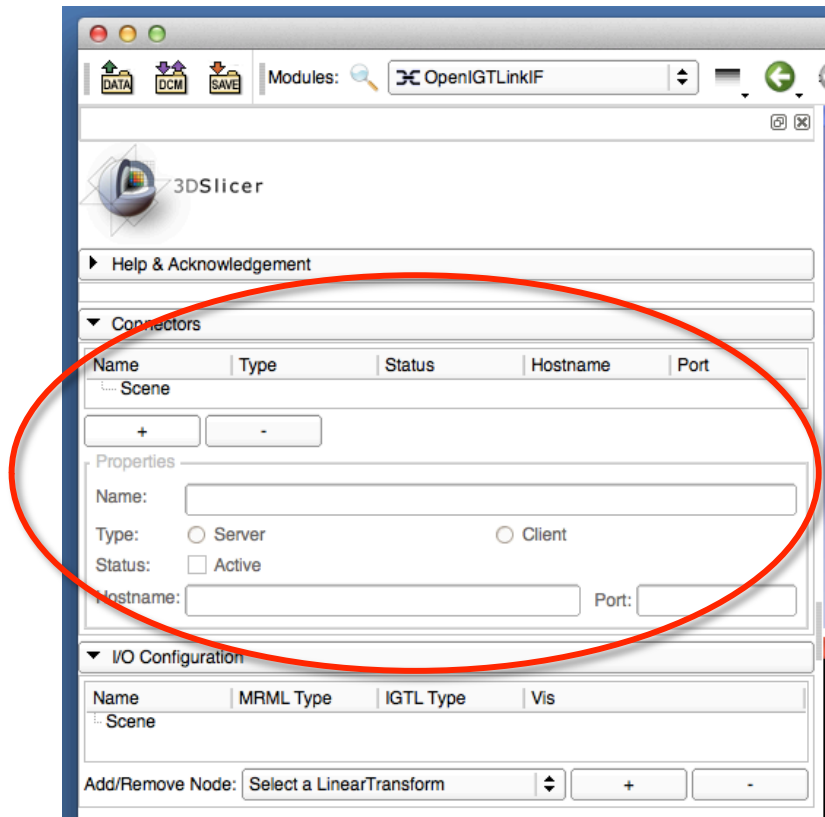
Part 2: Configuring OpenIGTLinkIF module



Start OpenIGTLinkIF



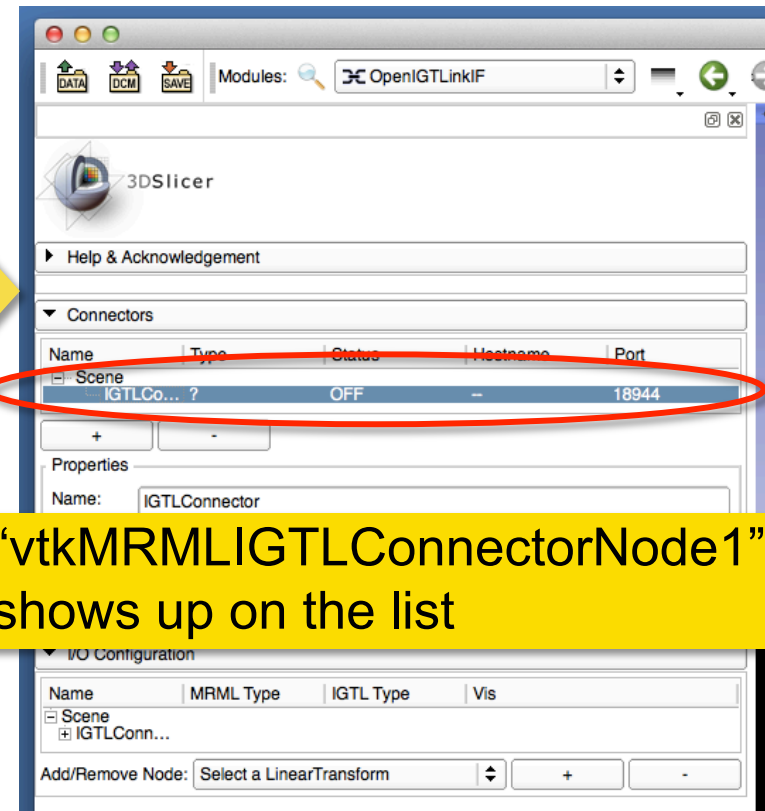
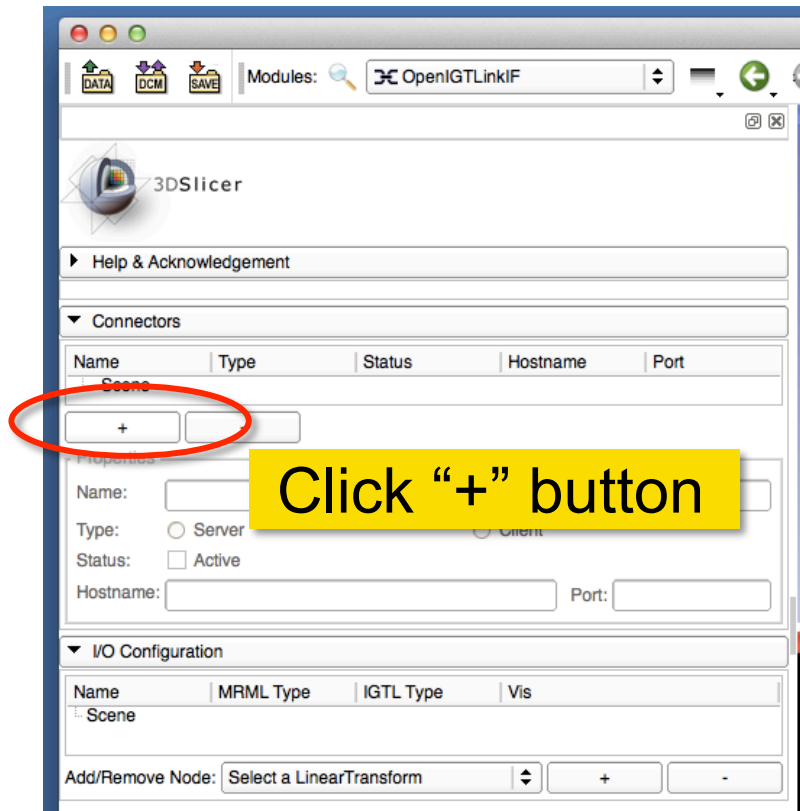
Add Connector



To connect 3D Slicer to external device/software using OpenIGTLink IF, a “connector” has to be created for each connection.

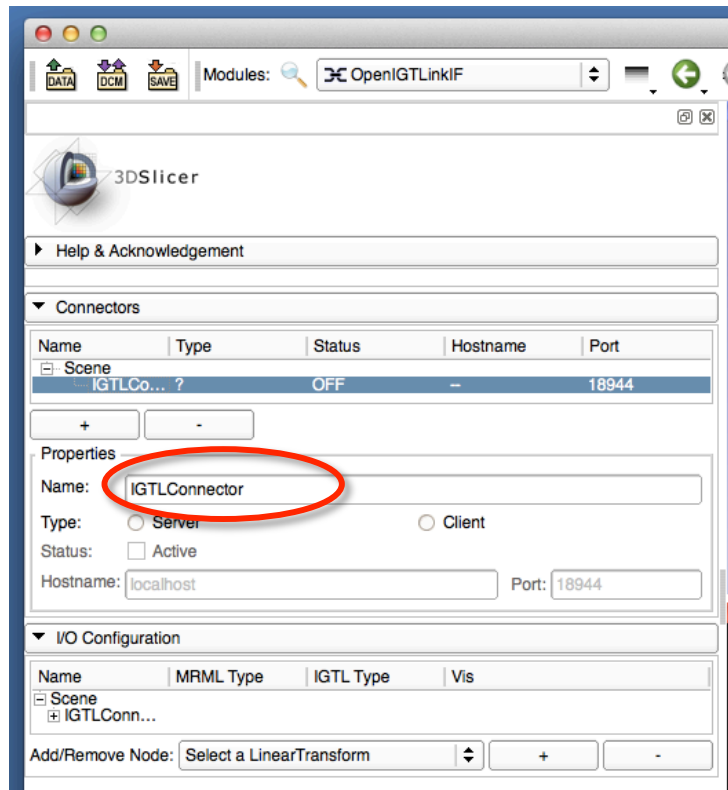
Connectors can be configured in “Connectors” Tab in OpenIGTLink IF module.

Add Connector





Change Connector Name

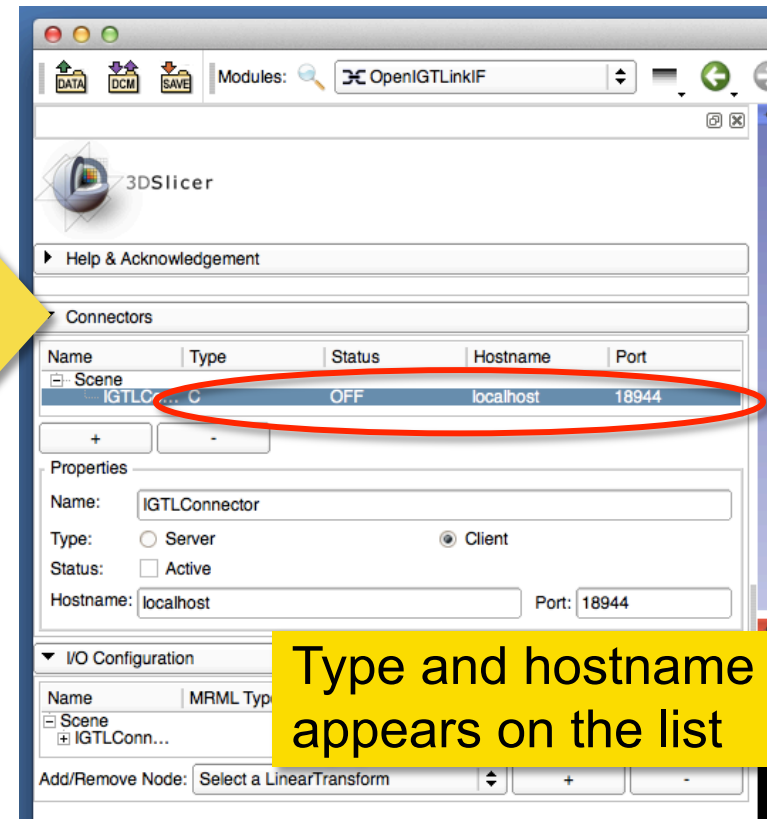
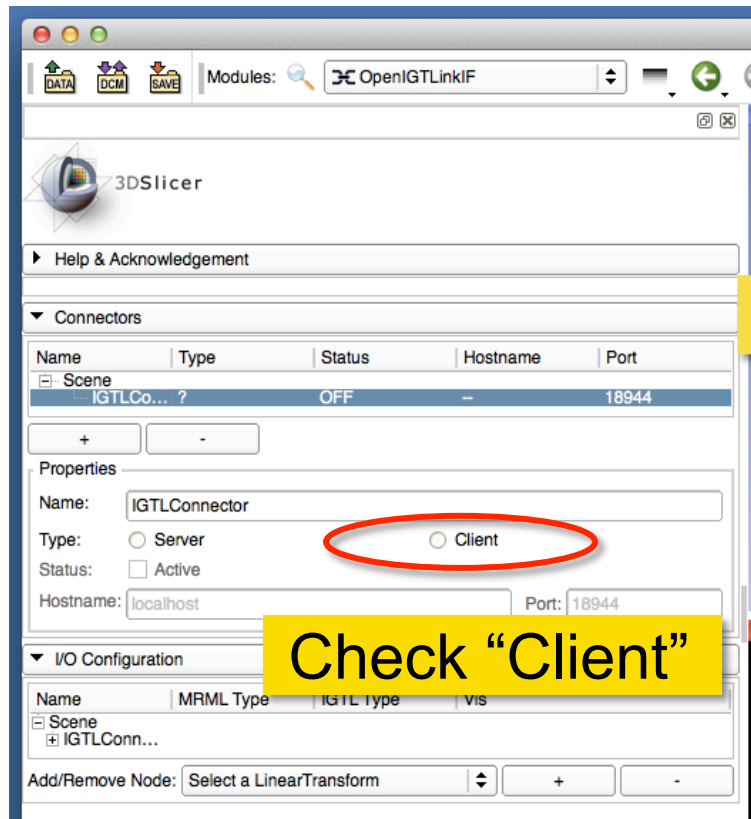


You may change the name of the connector by type in a new name and hit Return key.

This is an optional step. It is a good idea to name connectors, especially if you have multiple connections.



Set Connector Type



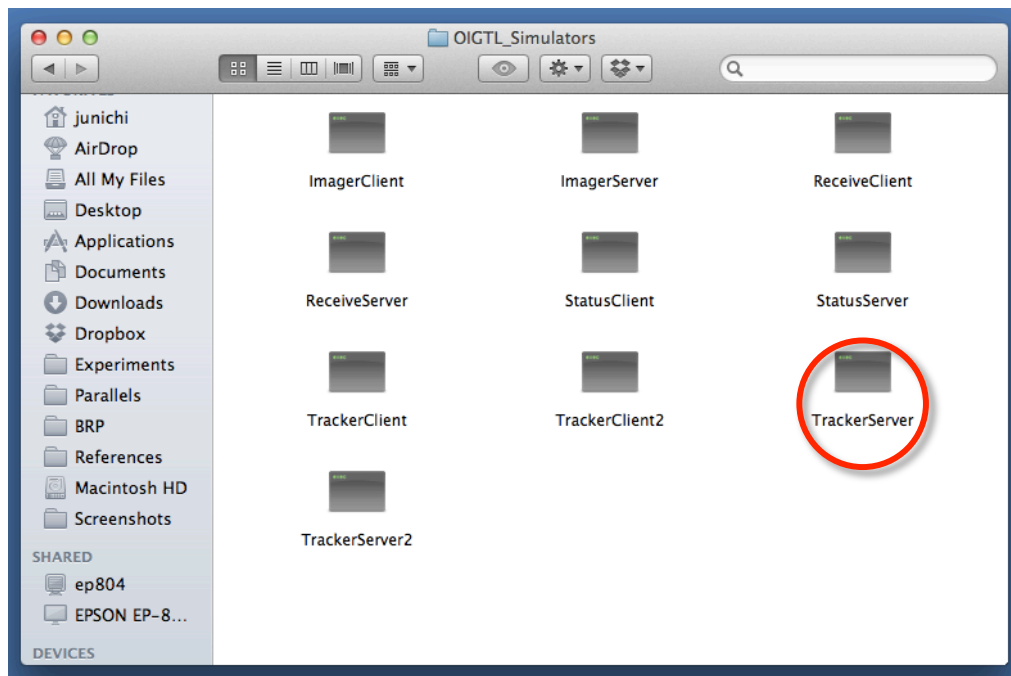


3DSlicer

```
bin — bash — 80x24
-0.452844, 0.142857, -0.88007, 40.6838
-0.464957, -0.88007, 0.096389, 29.066
0, 0, 0, 1
=====
^C
artemis:bin junichi$ ./TrackerServer 18944 10
=====
-1, 0, 0, 50
0, 0.142857, 0.989743, 0
0, 0.989743, -0.142857, 50
0, 0, 0, 1
=====
-0.98861, -0.0988095, 0.113525, 49.0033
0.0988095, 0.142857, 0.984799, 9.93347
-0.113525, 0.984799, -0.131467, 49.0033
0, 0, 0, 1
=====
-0.954892, -0.196632, 0.222525, 46.0531
0.196632, 0.142857, 0.970014, 19.4709
-0.222525, 0.970014, -0.0977491, 46.0531
0, 0, 0, 1
=====
```

Part 3: Setting up TrackerServer

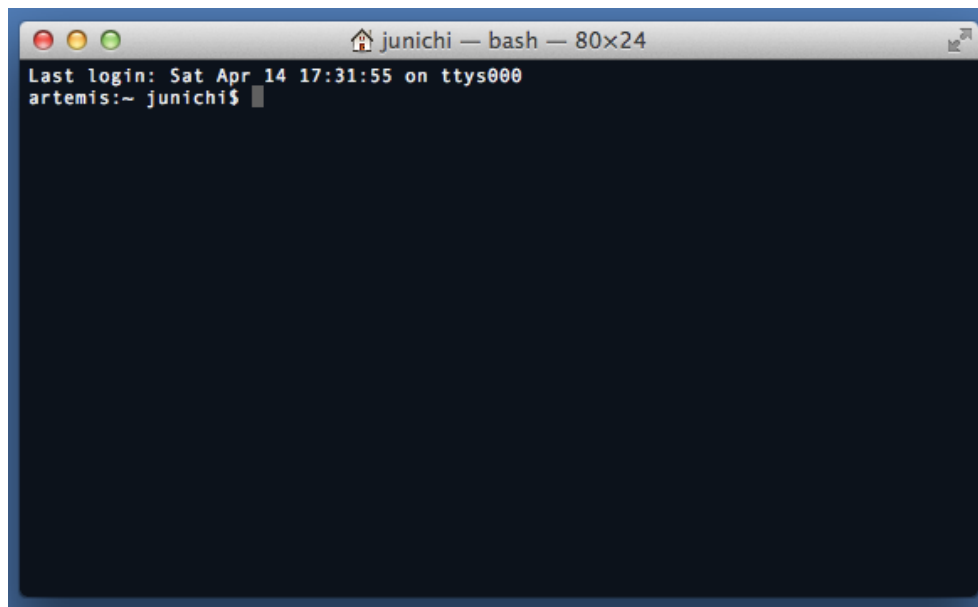
Extract Server Program



Uncompress the archived simulator files downloaded from the simulator page. Find TrackerServer binary file.



Open Terminal



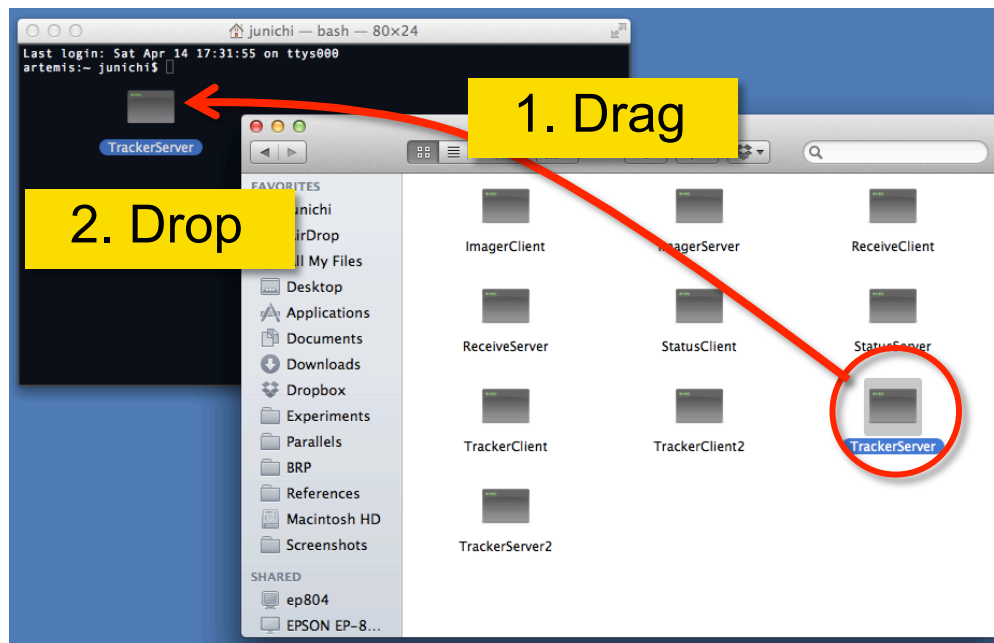
Open a terminal window.

Windows: Open the start menu, type “cmd” in the search box area and then press Enter key.

Mac: Open “Utilities” in “Application” folder and double-click the “Terminal.app” icon.

Linux: Open terminal window.

Start TrackerServer (1)



Windows/Mac: Drag
“TrackerServer” icon
from Explorer (Win) or
Finder (Mac) and drop
into the command
window.

Linux: Type the path to
the binary file of
“TrackerServer”.



Start TrackerServer (2)

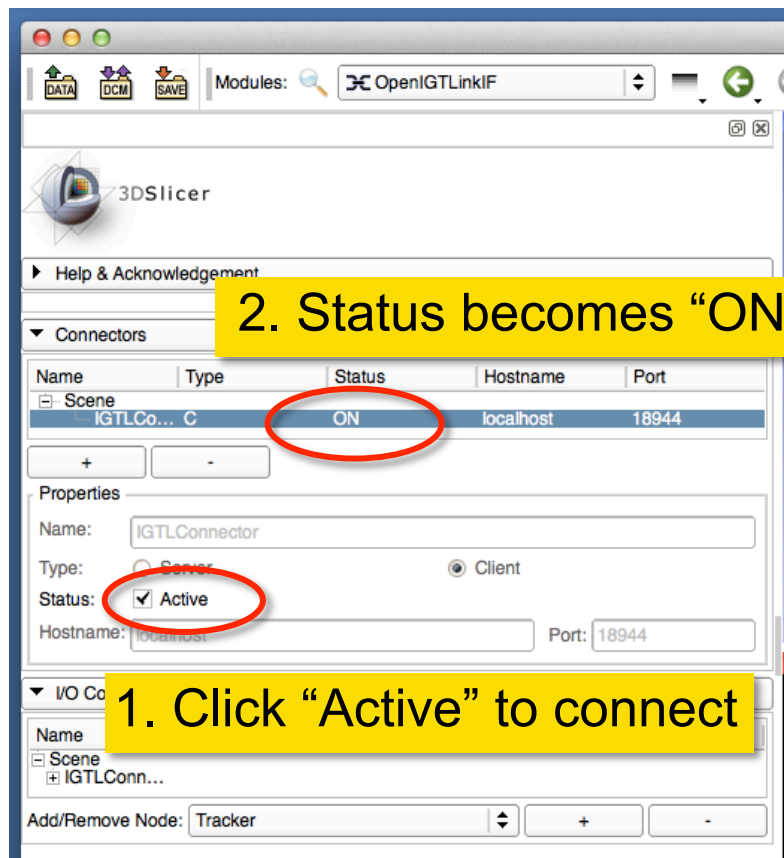
A screenshot of a terminal window. The title bar shows "junichi — bash — 85x24". The terminal text shows the command: `artemis:~ junichi$ /Users/junichi/Downloads/OIGTL_Simulators/TrackerServer 18944 10`. The cursor is at the end of the command line.

```
artemis:~ junichi$ /Users/junichi/Downloads/OIGTL_Simulators/TrackerServer 18944 10
```

Specify port number (18944) and frame rate (10 frames/second) in the terminal window. Once the return key is pressed, the TrackerServer starts waiting for a client.



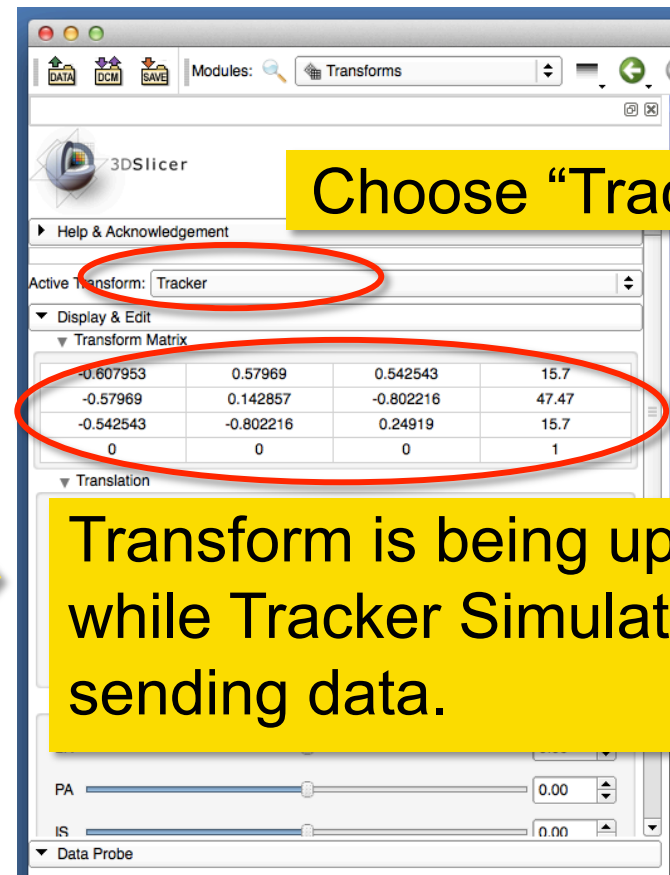
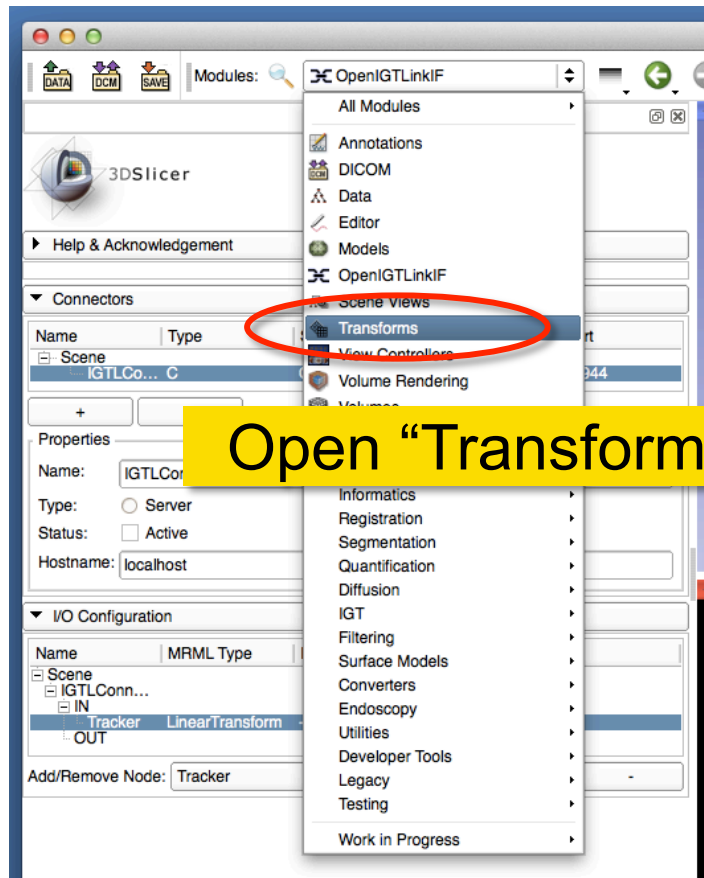
Connect to Test Server

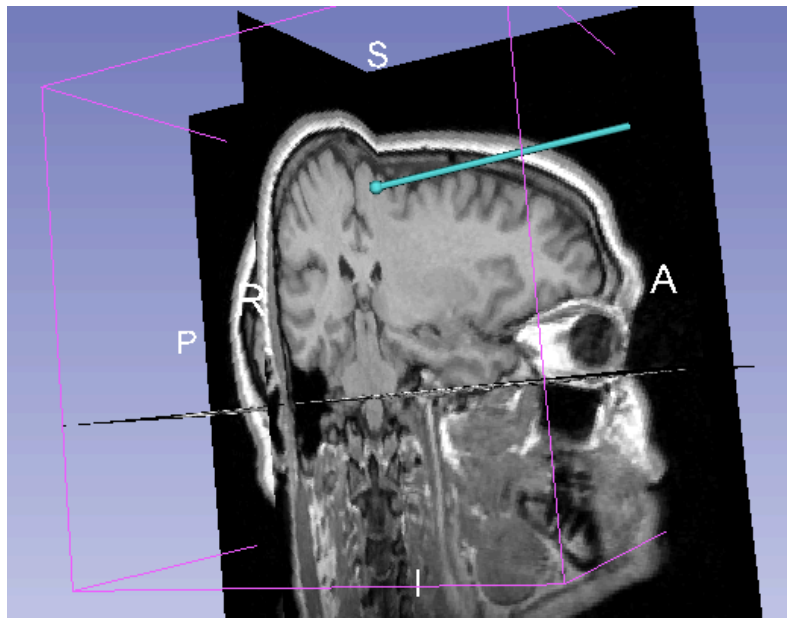


```
artemis:~ junichi$ /Users/junichi/Downloads/OIGTL_Simulators/TrackerServer 18944 10
=====
-1, 0, 0, 50
0, 0.142857, 0.989743, 0
0, 0.989743, -0.142857, 50
0, 0, 0, 1
=====
-0.98861, -0.0988095, 0.113525, 49.0033
0.0988095, 0.142857, 0.984799, 9.93347
-0.113525, 0.984799, -0.131467, 49.0033
0, 0, 0, 1
=====
-0.954892, -0.196632, 0.222525, 46.0531
0.196632, 0.142857, 0.970014, 19.4709
-0.222525, 0.970014, -0.0977491, 46.0531
0, 0, 0, 1
=====
-0.900192, -0.292489, 0.322653, 41.2668
0.292489, 0.142857, 0.945538, 28.2321
-0.322653, 0.945538, -0.043049, 41.2668
0, 0, 0, 1
```

3. Simulator starts printing random transform matrix values in the terminal window.

Check Transform





Part 4: Visualizing Tracking Data



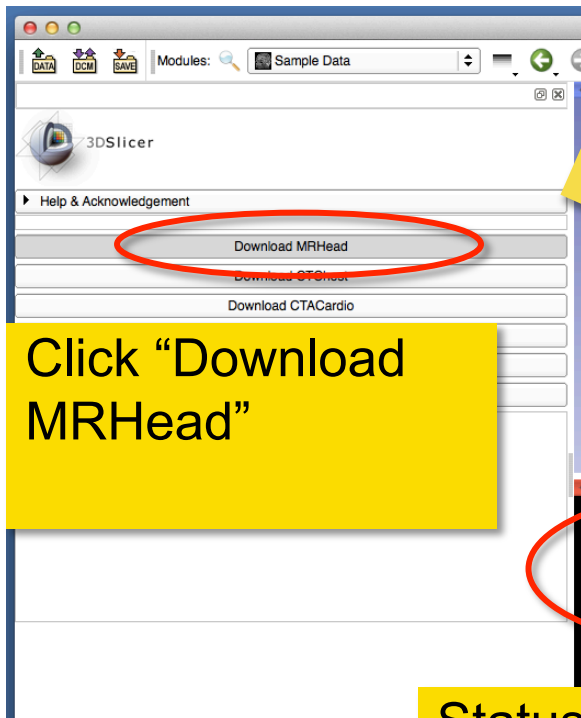
Load Sample MRI Data

Open "Welcome to Slicer"

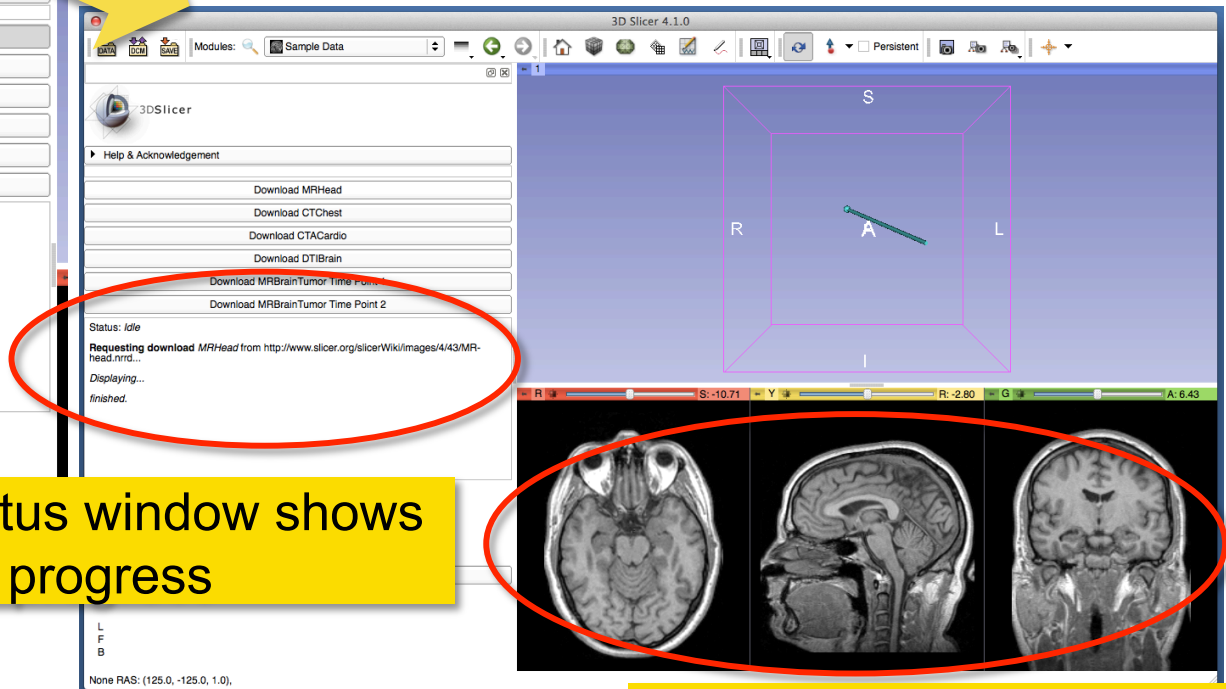
Click "Download Sample Data"



Load Sample MRI Data



Click "Download MRHead"

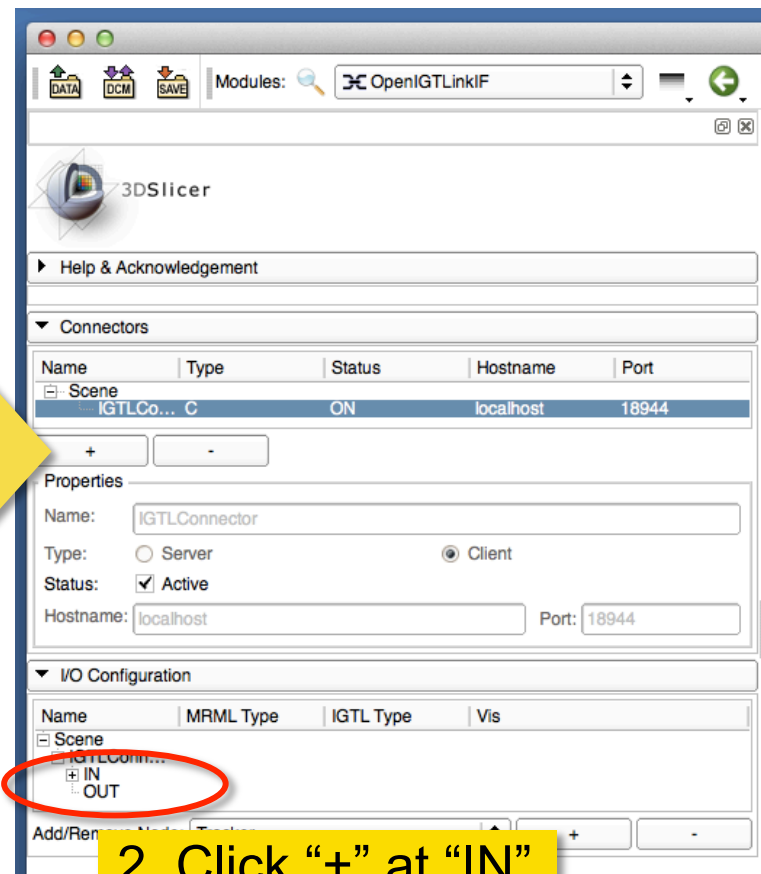
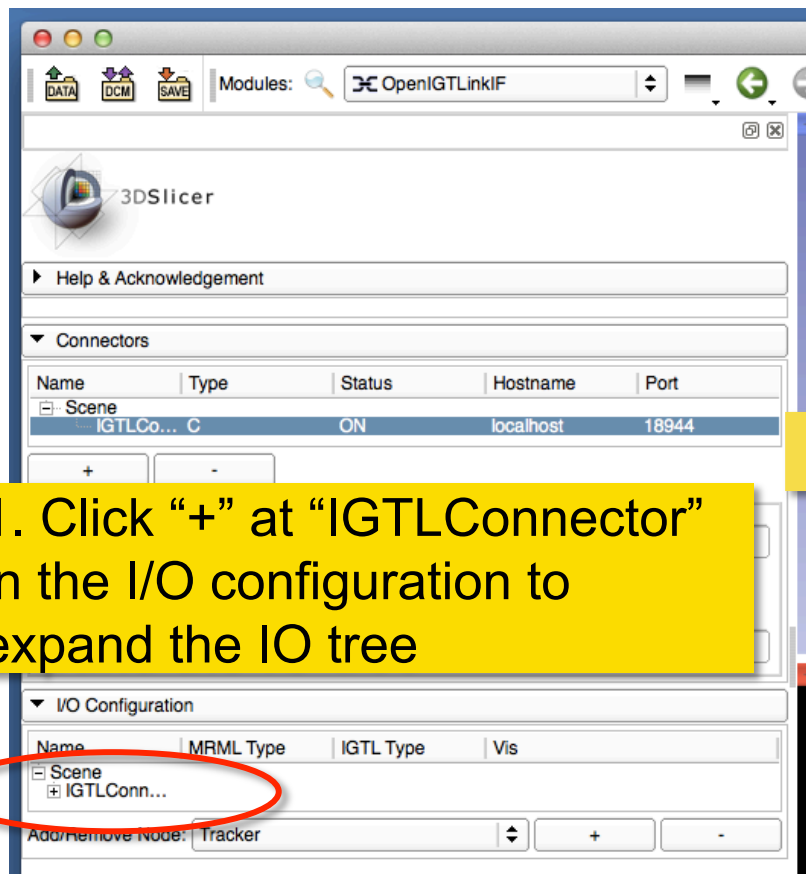


Status window shows the progress

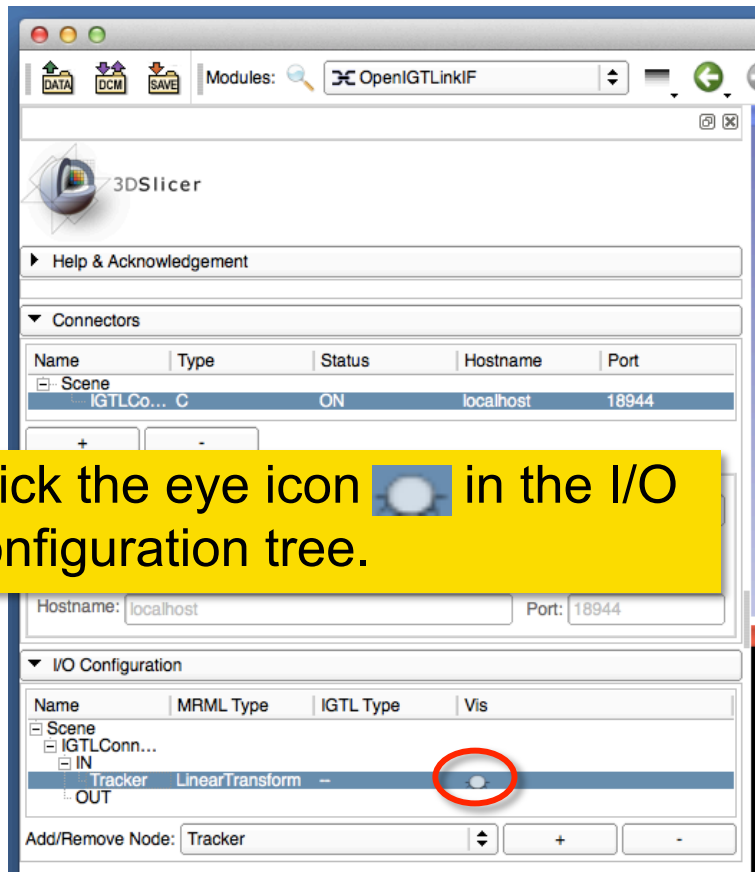
Sample image appears in the slice viewer



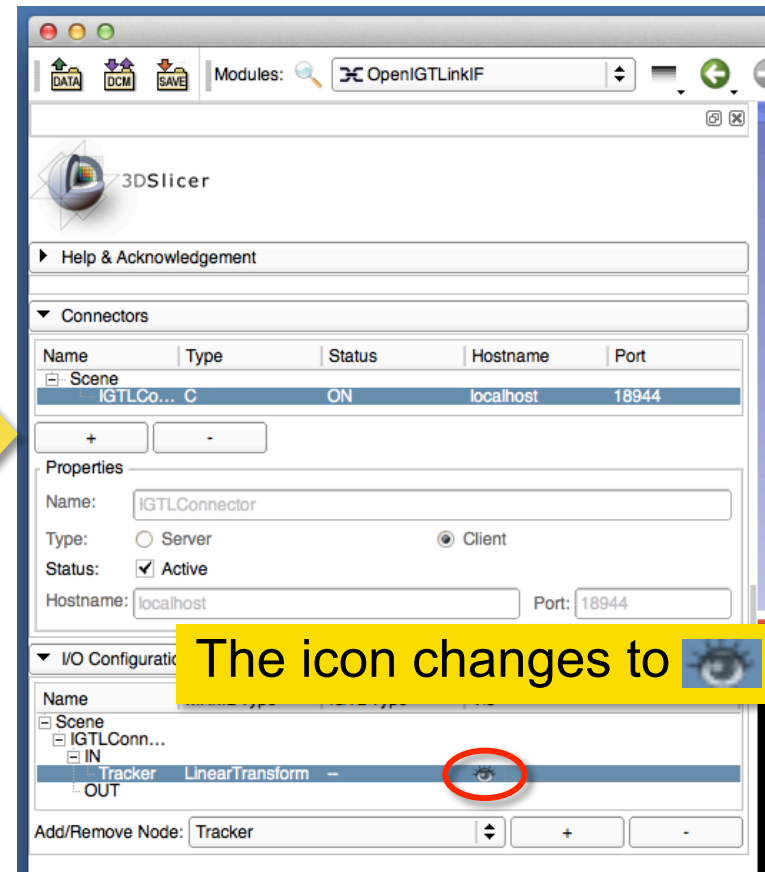
Choose Locator Source



Enable Locator



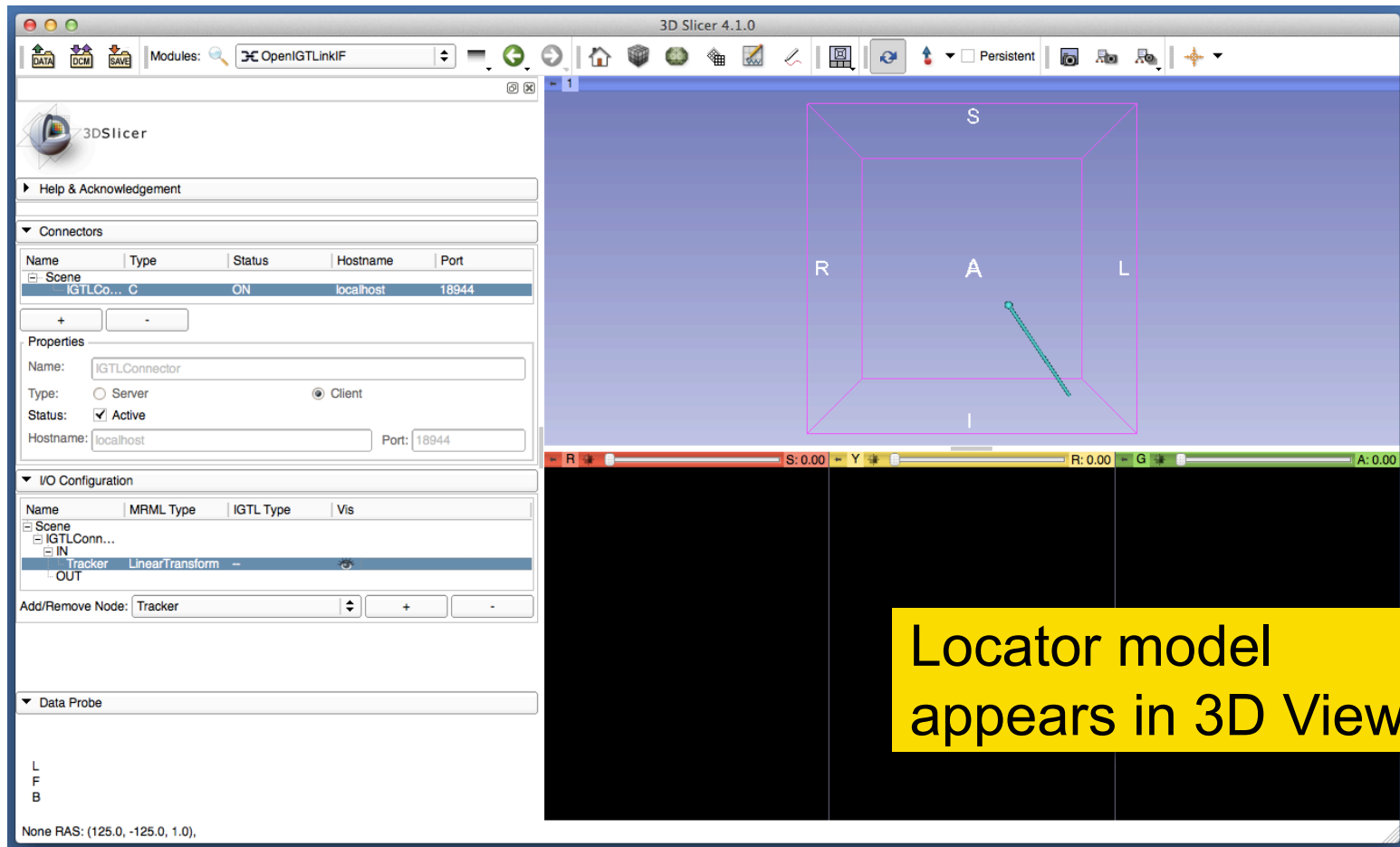
Click the eye icon  in the I/O configuration tree.



The icon changes to 

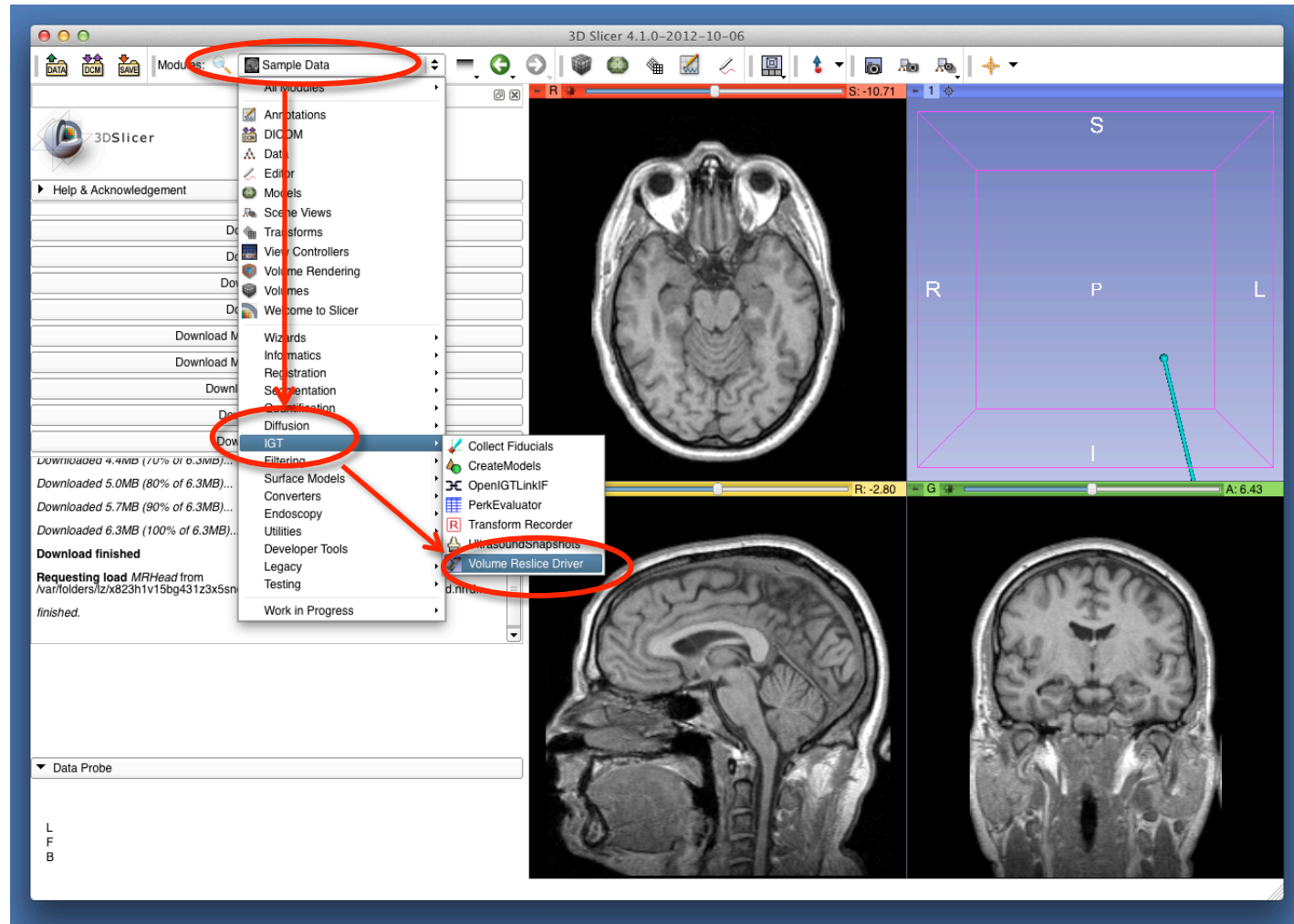


Visualize Locator





Open Volume Reslice Driver



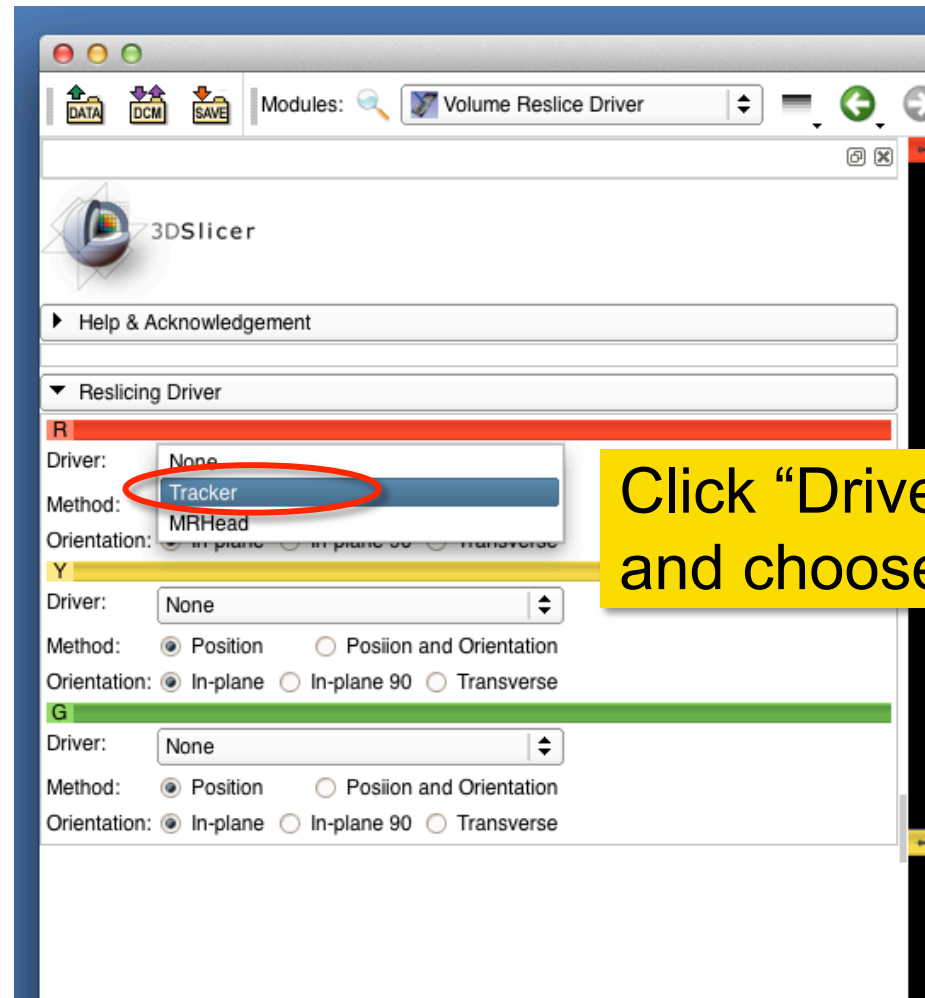
Tokuda, J

National Alliance for Medical Image Computing

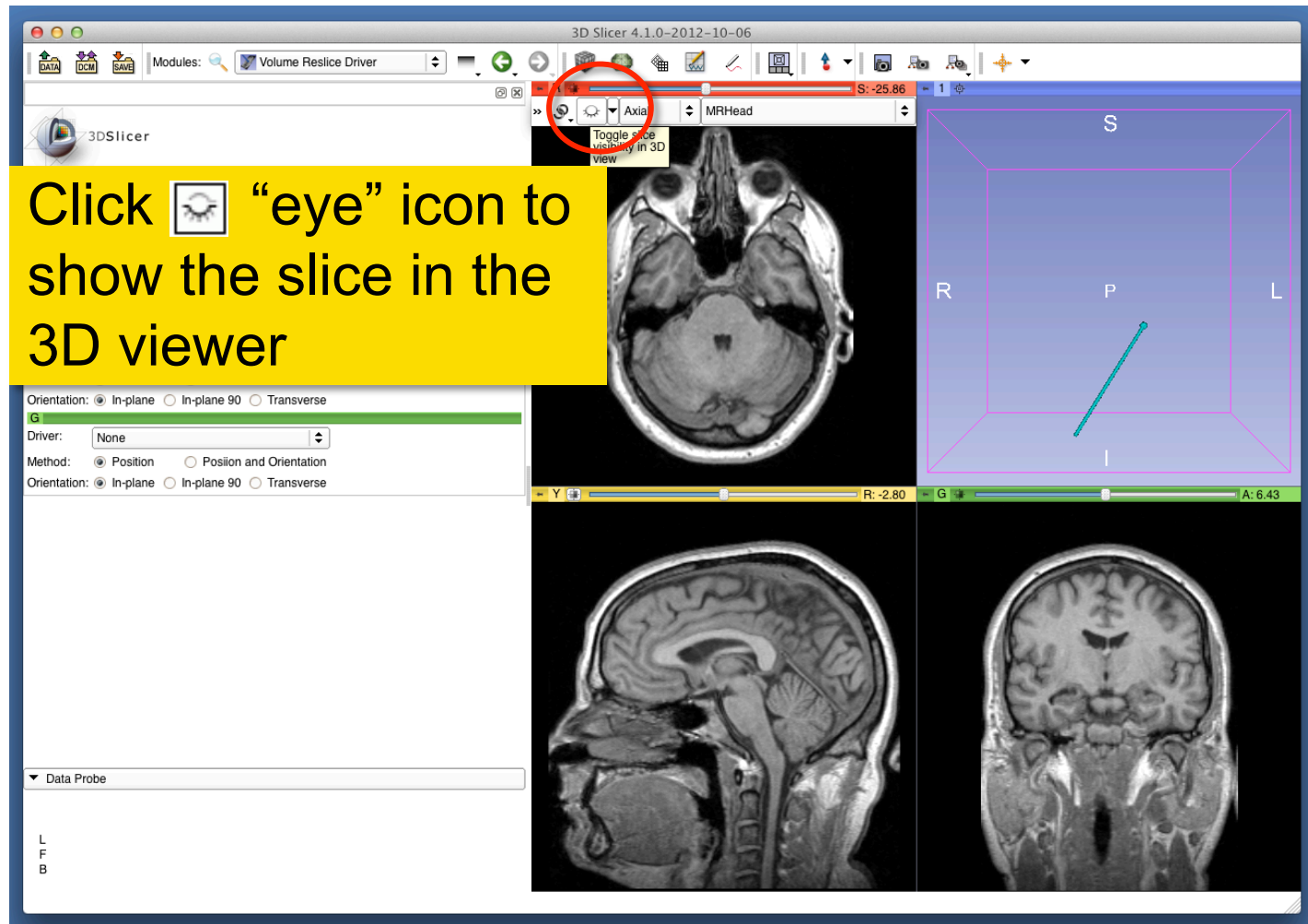
NA-MIC© 2010-2012




Choose Driver Transform



Turn On 3D View



Click  “eye” icon to show the slice in the 3D viewer

3D Slicer 4.1.0-2012-10-06

Modules: Volume Reslice Driver

Orientation: In-plane In-plane 90 Transverse

Driver: None

Method: Position Position and Orientation

Orientation: In-plane In-plane 90 Transverse

Y R: -2.80 G A: 6.43

L
F
B



Update Slice Orientation

3D Slicer 4.1.0-2012-10-06

Modules: Volume Reslice Driver

3DSlicer

Help & Acknowledgement

Reslicing Driver

IR

Driver: Tracker

Method: Position Position and Orientation Position and Orientation

Orientation: In-plane In-plane 90 Transverse

Y

Driver: None

Data Probe

L
F
B

Click "Position and Orientation"

The slice starts changing its orientation



Configure Other Drivers

Volume Reslice Module can drive up to 3 slices independently



References

- 3D Slicer OpenIGTLinkIF Documentation Page

[http://www.slicer.org/slicerWiki/index.php/
Modules:OpenIGTLinkIF-Documentation-4.1](http://www.slicer.org/slicerWiki/index.php/Modules:OpenIGTLinkIF-Documentation-4.1)

- OpenIGTLink Protocol Web Page:

<http://www.na-mic.org/Wiki/index.php/OpenIGTLink>

- Paper

Tokuda J., *et al.* OpenIGTLink: an open network protocol for image-guided therapy environment. *Int J Med Robot.* 2009 Dec;5(4):423-34. PMID: 19621334. PMCID: PMC2811069.



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P01CA067165, R01CA111288, and
R01CA138586)



National Alliance for Medical Image Computing
(NIH U54EB005149)



Intelligent Surgical Instruments Project of METI
(Japan)