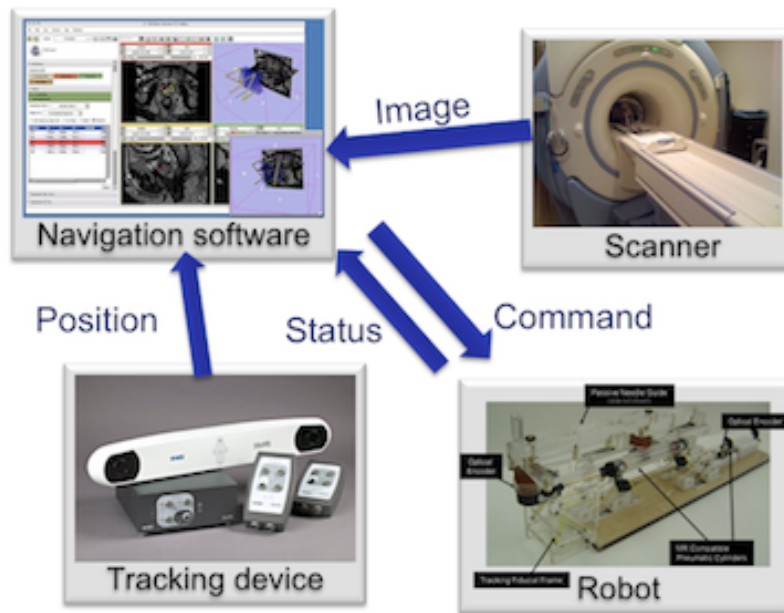


Connecting IGT Device with OpenIGTLink

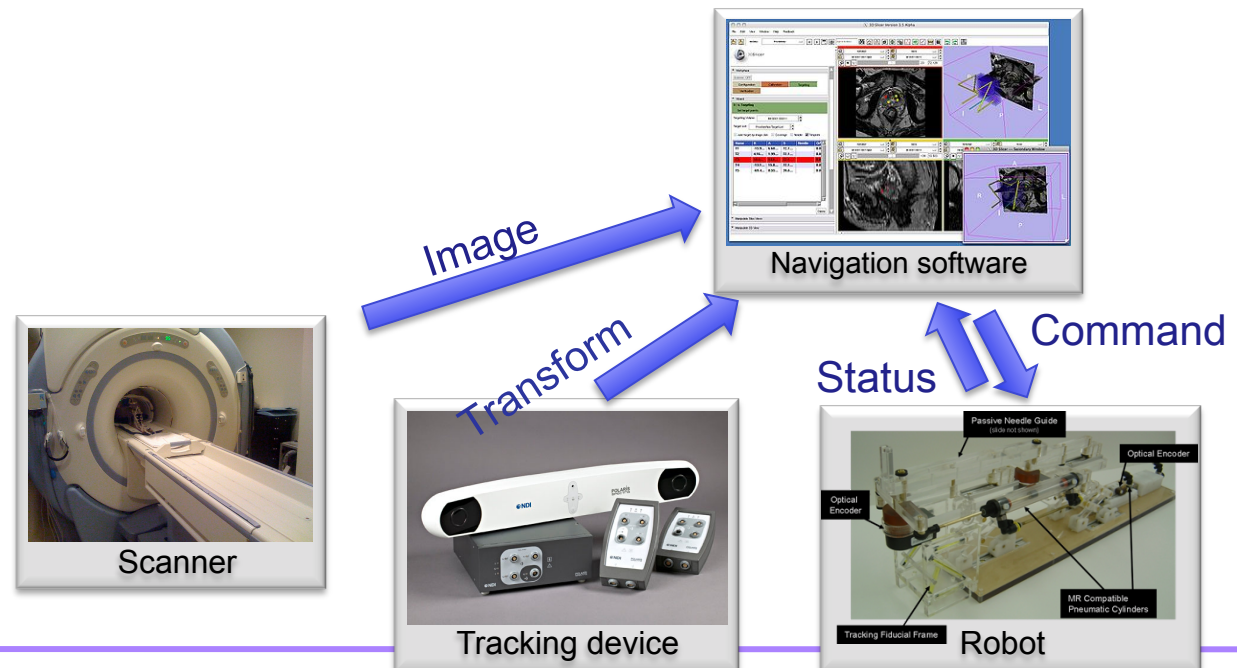


Junichi Tokuda, PhD
Brigham and Women's Hospital
Harvard Medical School

Slicer in Operating Room

3D Slicer's data I/O in OR

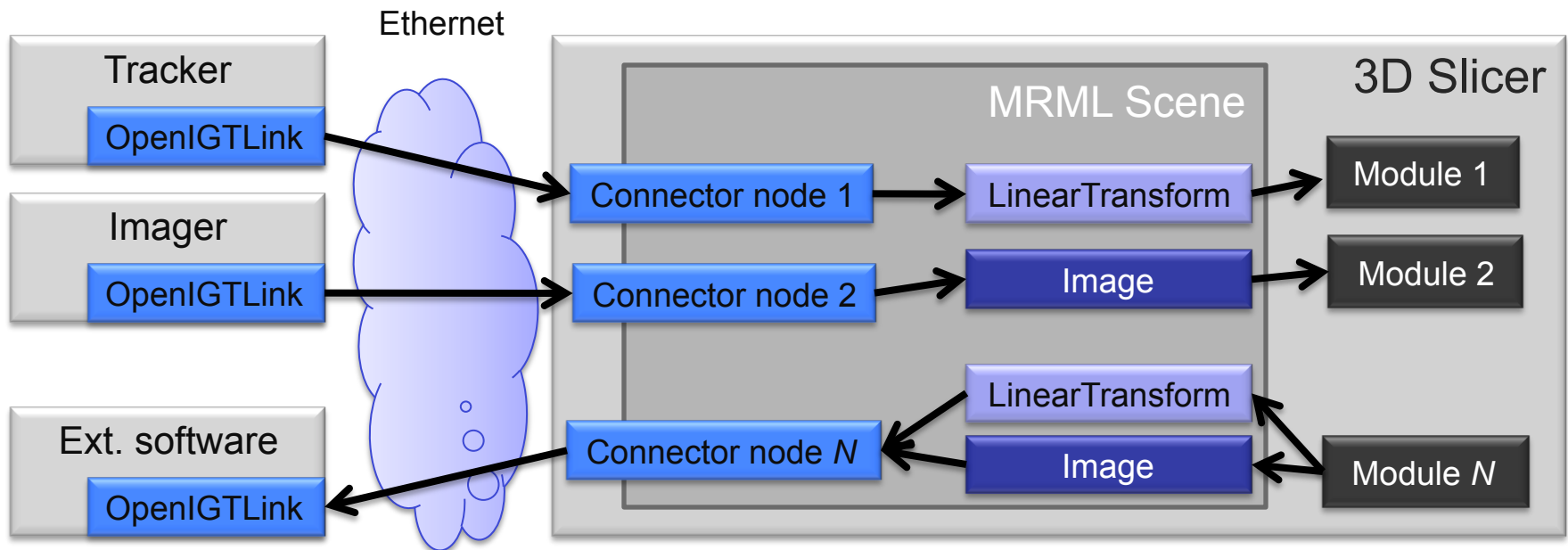
- Import images from MRI/CT/Ultrasound..
- Import tool tracking data
- Send commands to robotic devices
- ...



- 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

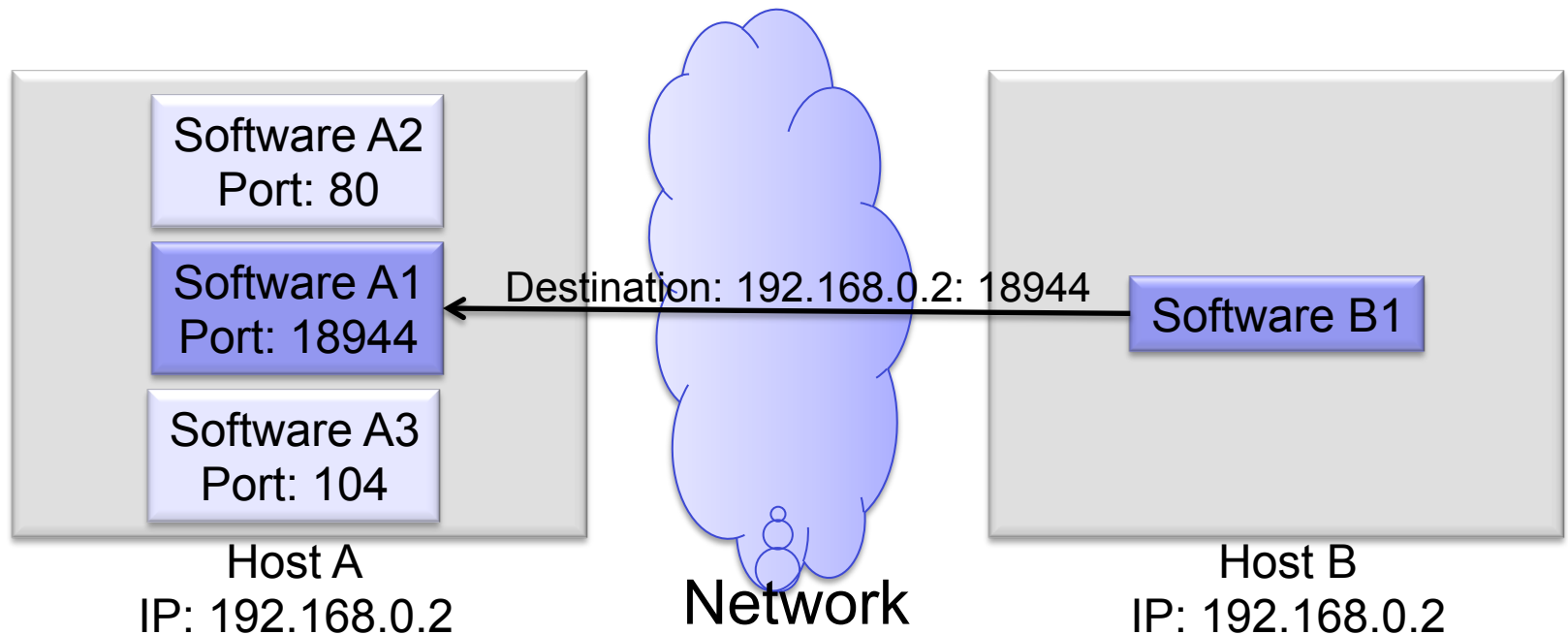
- Import data from remote host MRML scene
- Export data from MRML scene to remote host



TCP Connection Basics (1)

Remote host is specified by

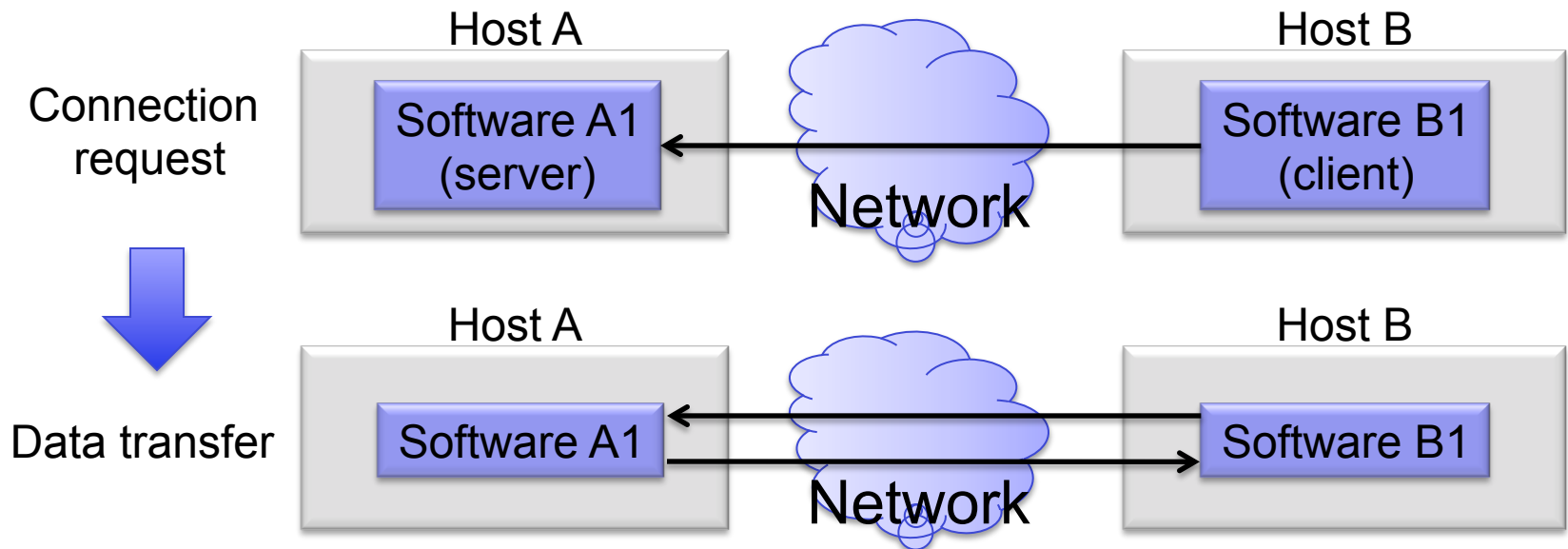
- IP address (i.e. 192.168.0.1) or network address (i.e. watson.bwh.harvard.edu)
- Port number (i.e. 18944)



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



This course requires the following installation:

- 3DSlicer version 4.3.1 Software (Slicer 4.3.1 r22599), which can be installed from:

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

- Tracker Simulator:

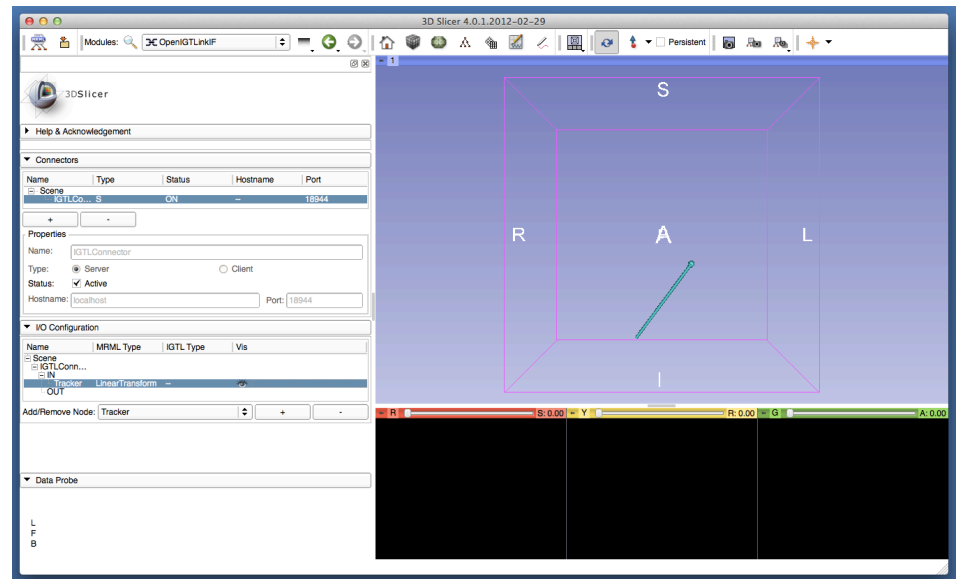
<http://wiki.slicer.org/slicerWiki/index.php/Modules:OpenIGTLinkIF-3.6-Simulators>

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.

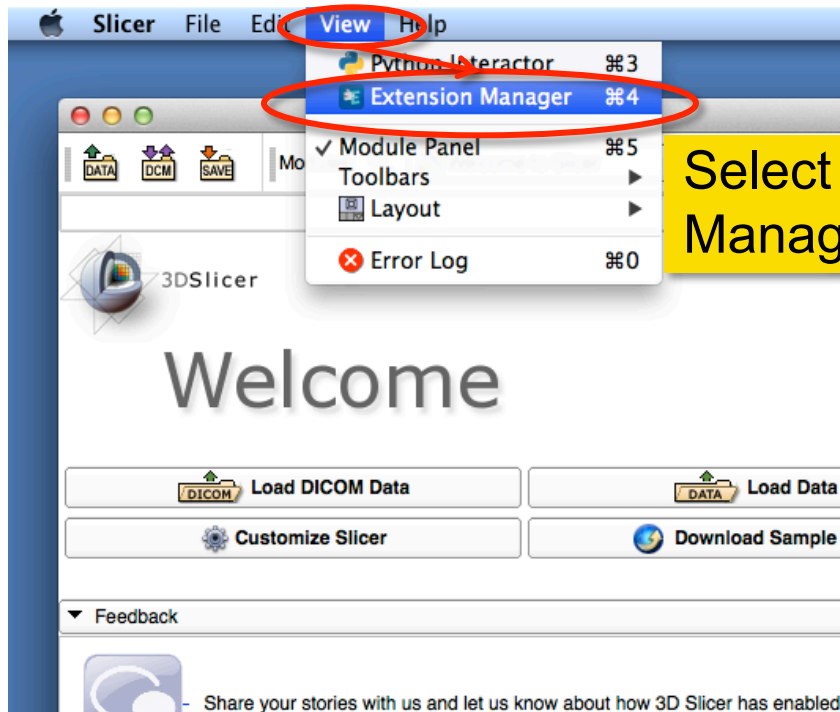


- Configuring OpenIGTLink IF module
- Setting up Test Server
- Visualizing Tracking Data



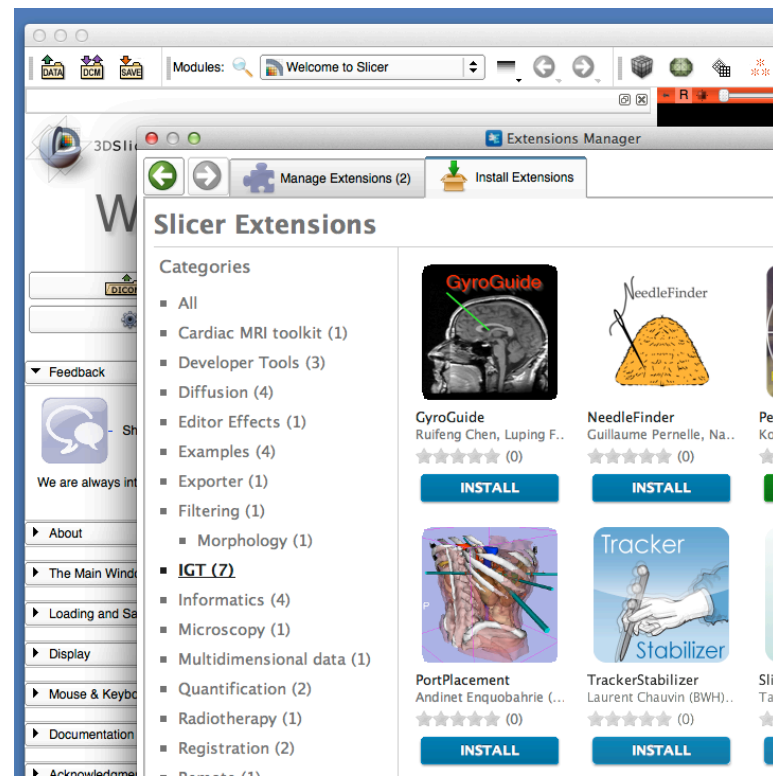
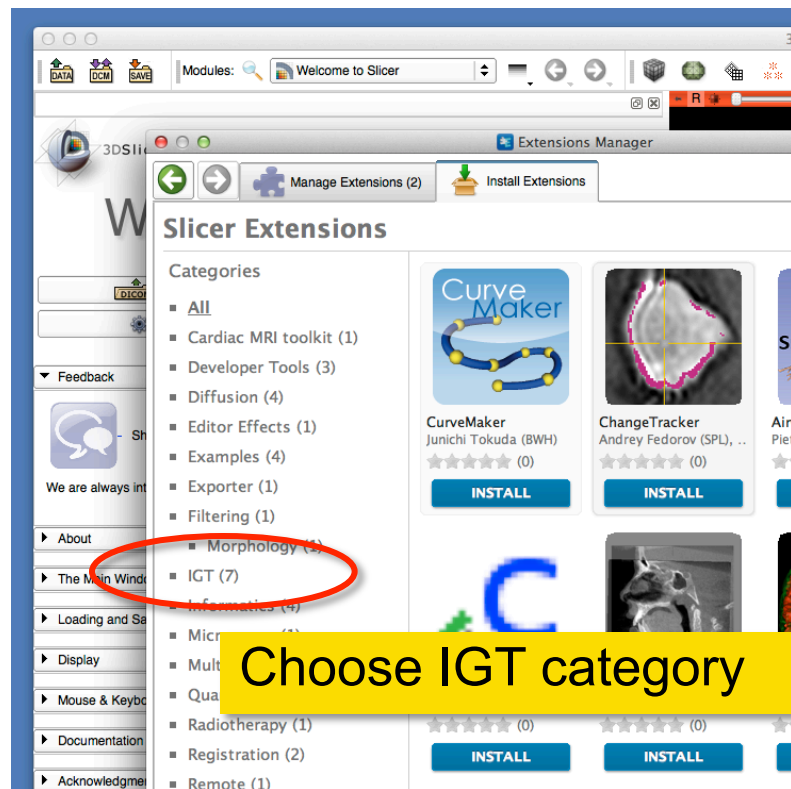
Part 1: Installing SlicerIGT module

Open Extension Manager

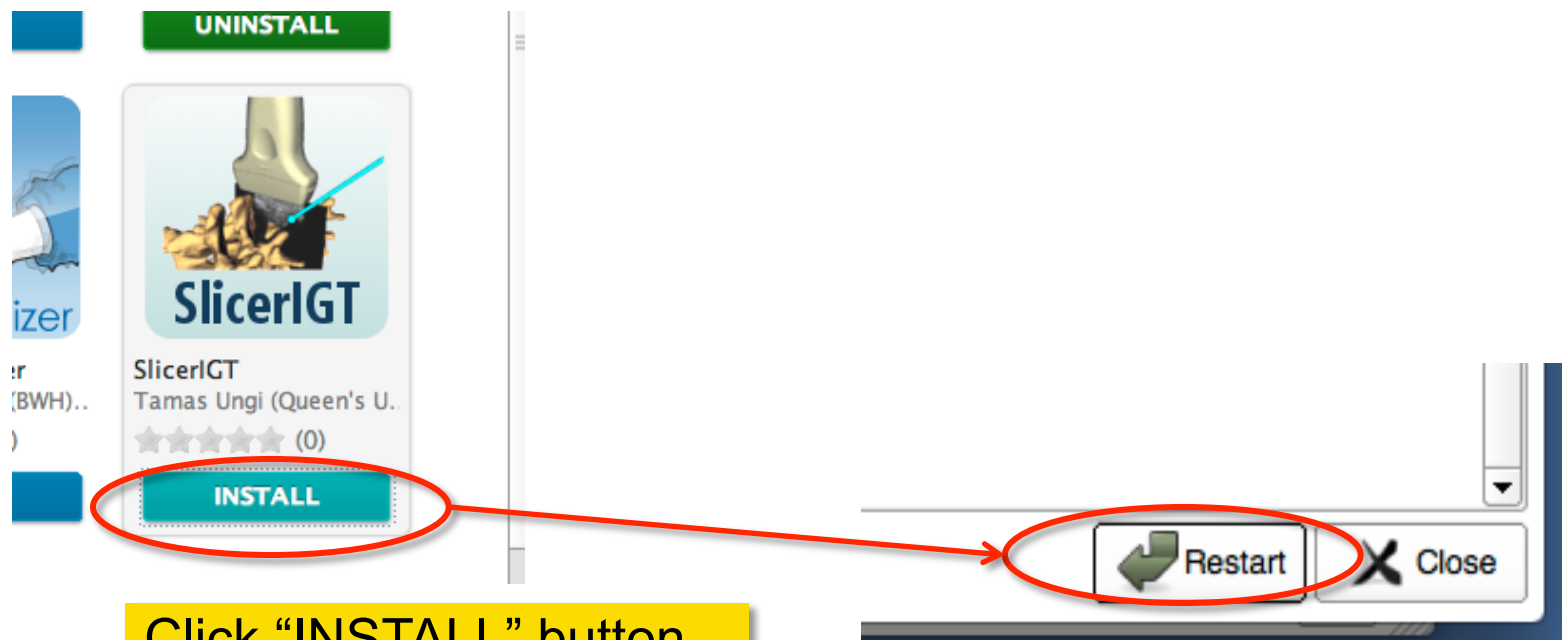


Select View menu -> Extension Manager

Open Extension Manager



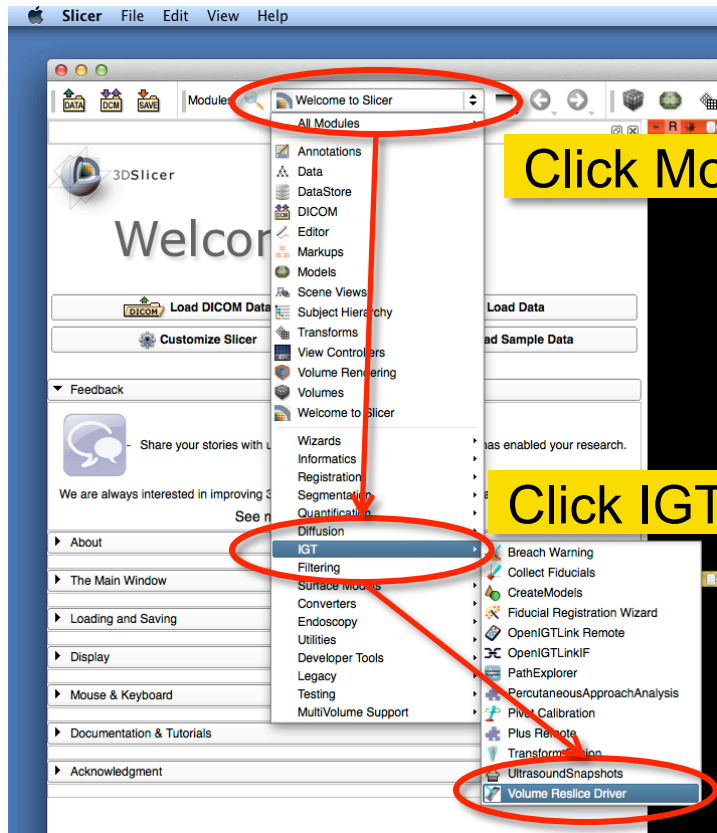
Download SlicerIGT Extension



Click “INSTALL” button
below SlicerIGT icon

Once the extension has
been downloaded, click
“Restart” button at the
right bottom of the
Extension Window

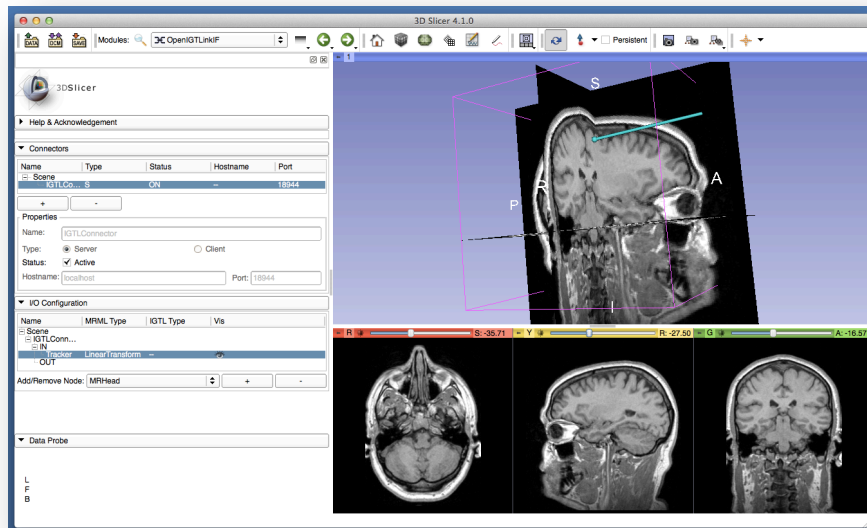
Check Installation



Click Modules menu

Click IGT

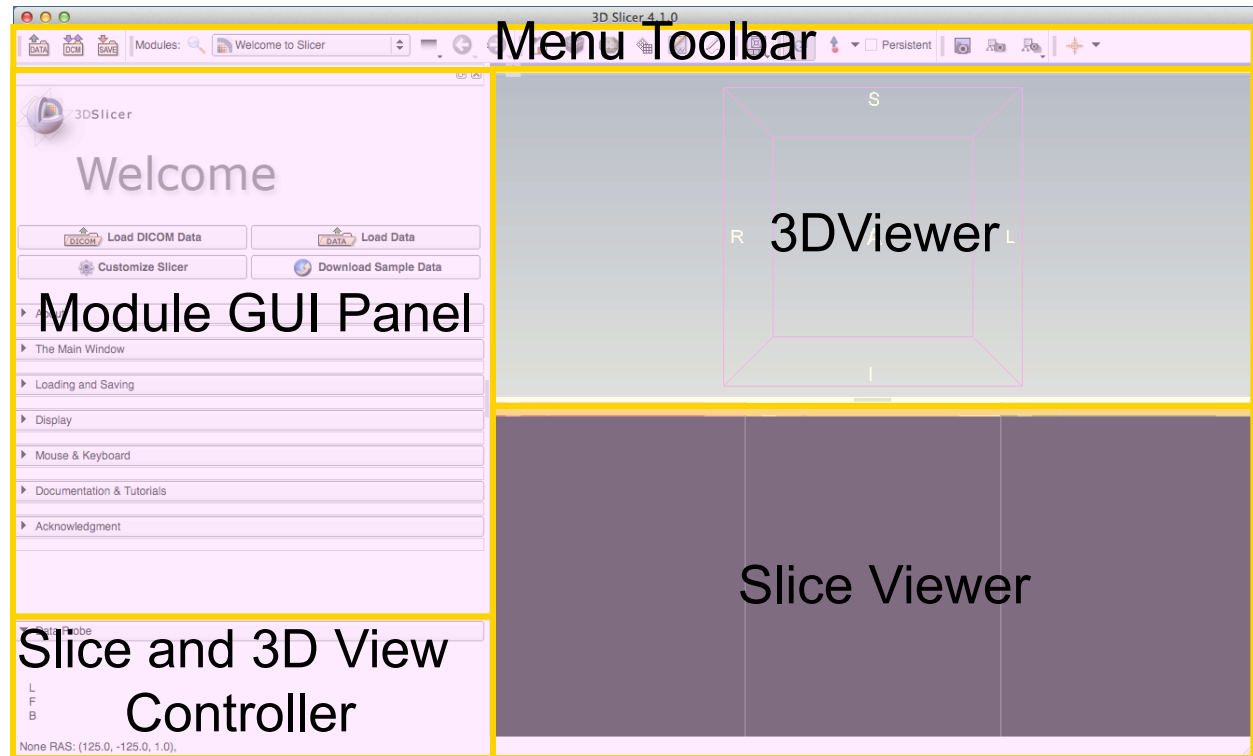
If you find Volume Reslice Driver, the installation was successful.



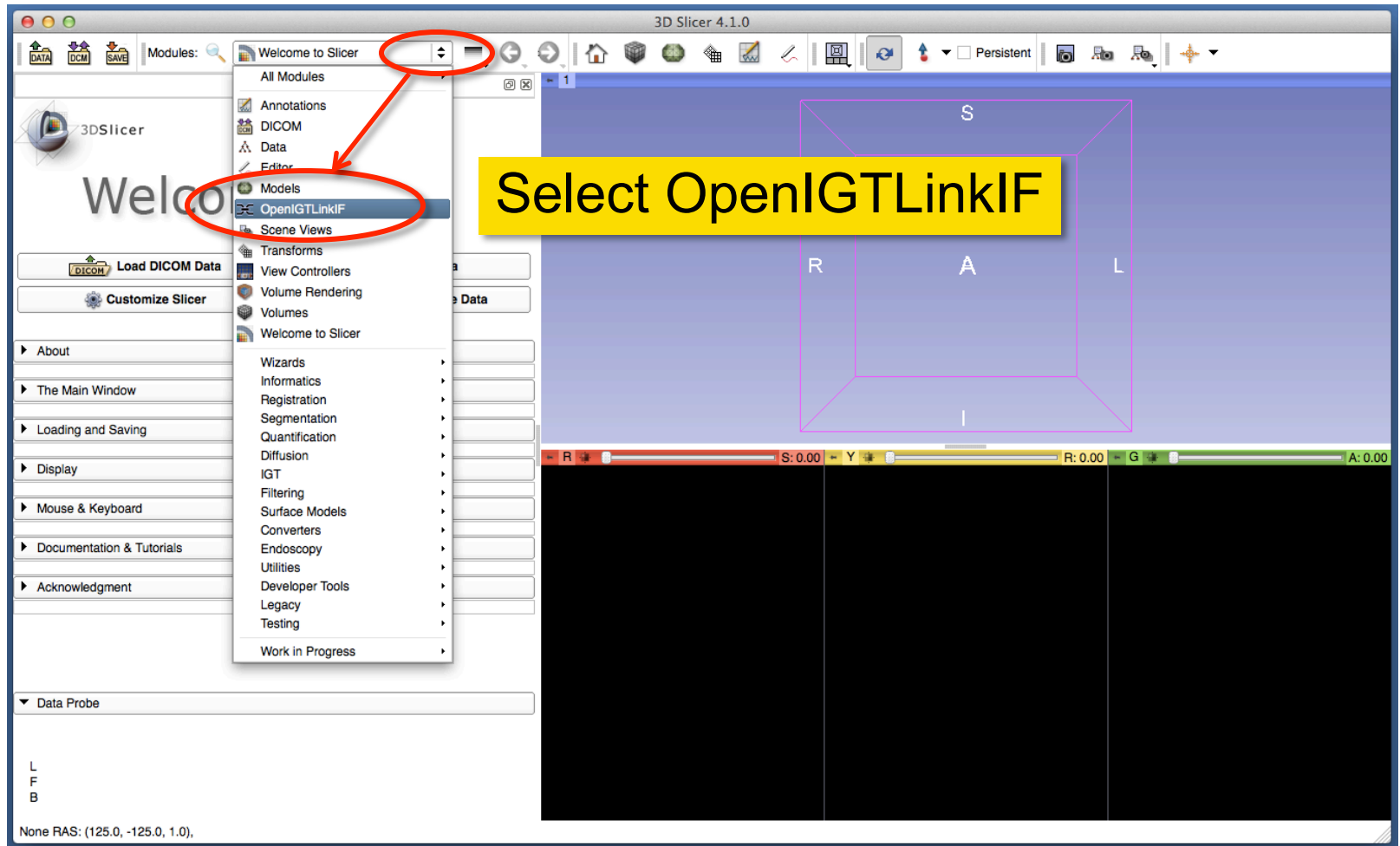
Part 2: Configuring OpenIGTLinkIF module

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

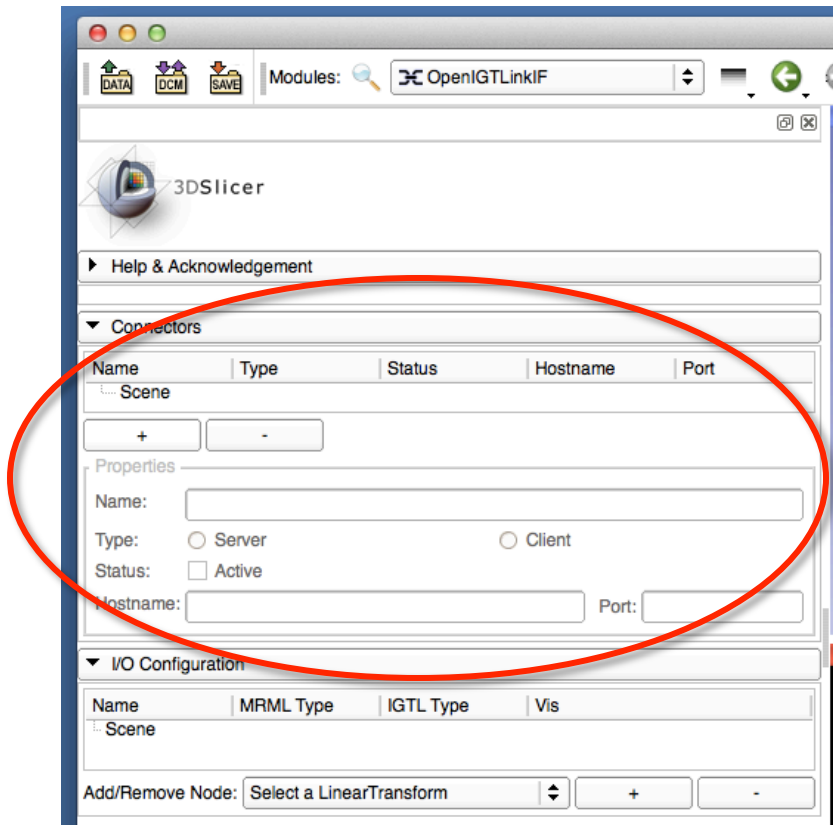
- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer
- the Slice and 3D View Controller



Starting OpenIGTLinkIF



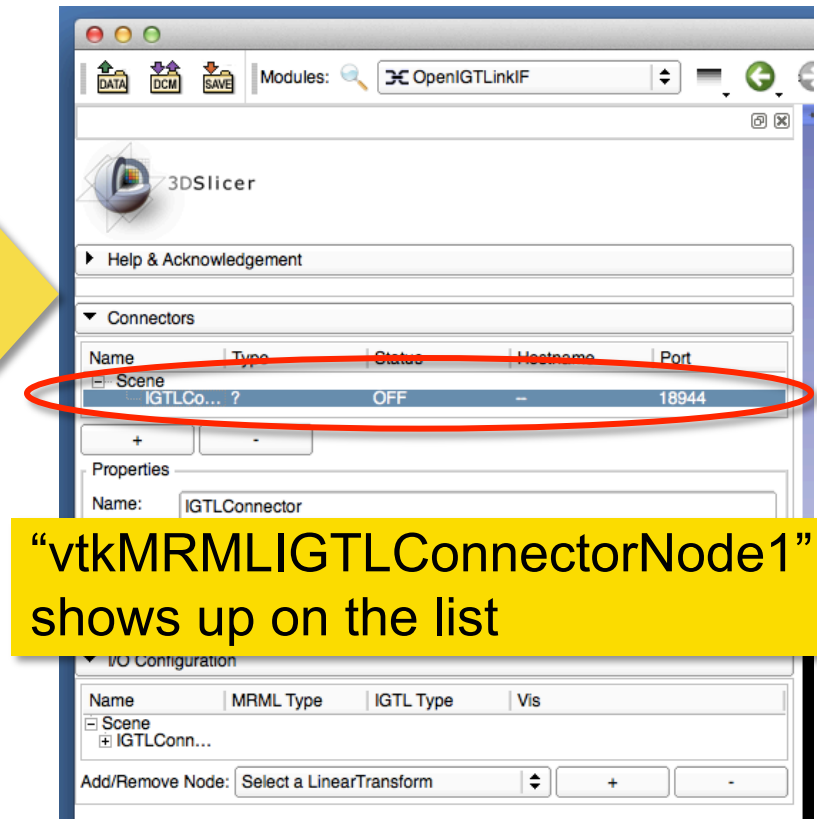
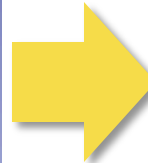
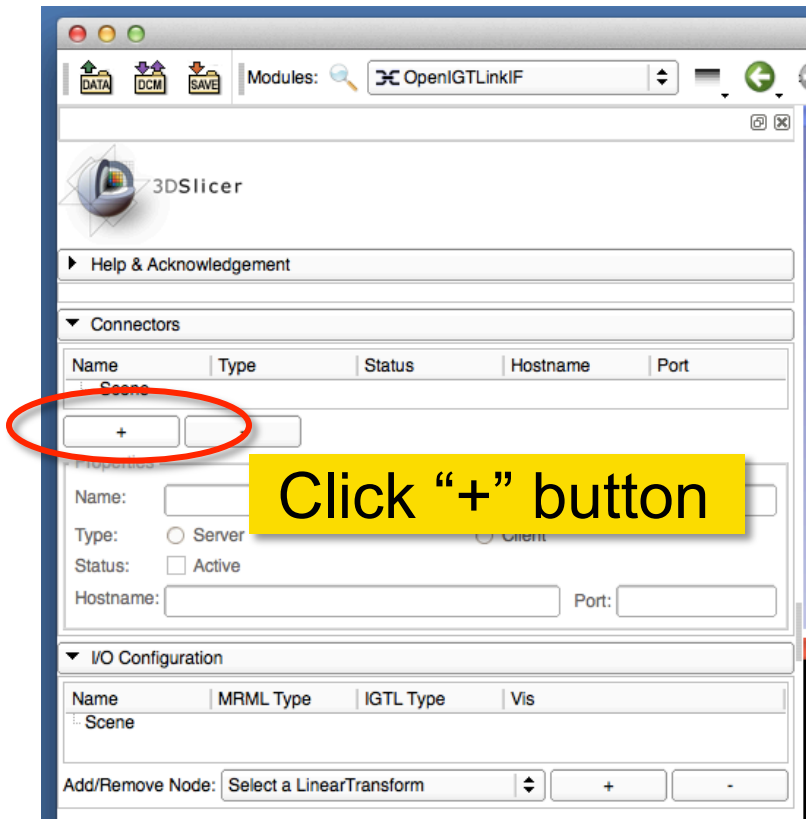
Adding Connector



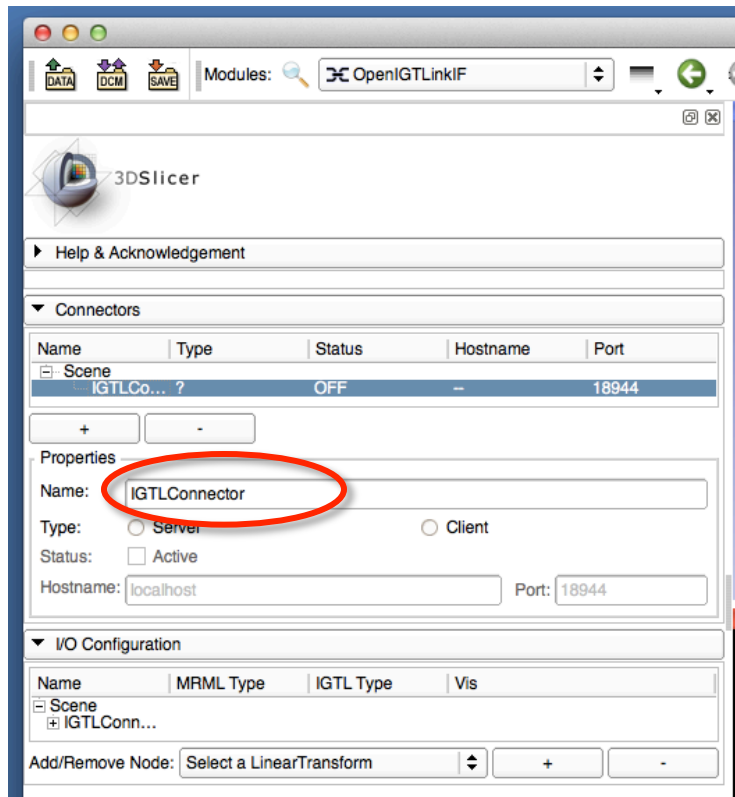
To connect 3D Slicer to external device/software using OpenIGTLink IF, a “connector” has to be created for each connection.

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

Adding Connector



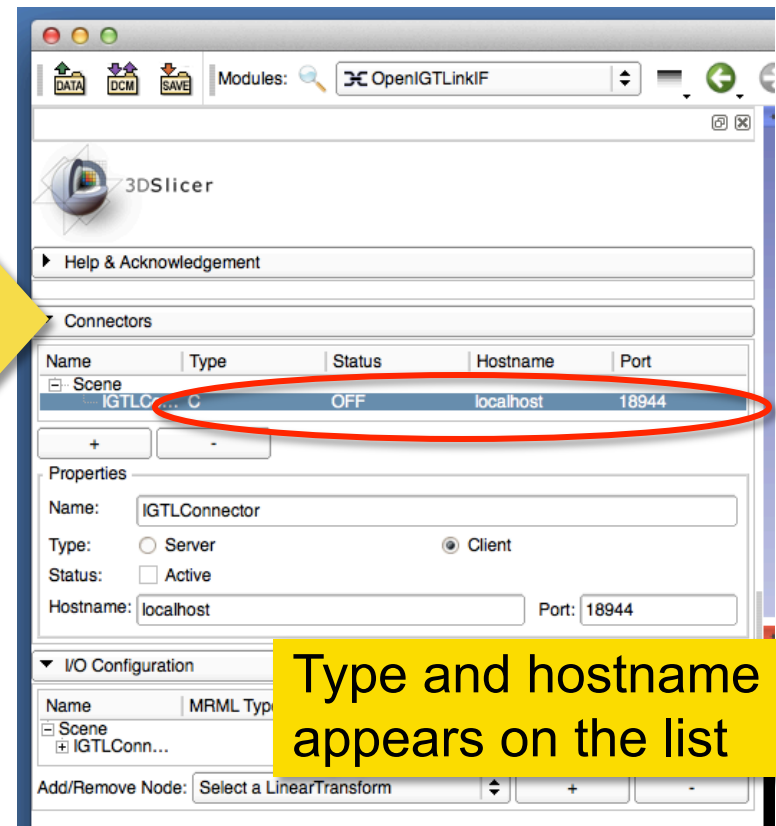
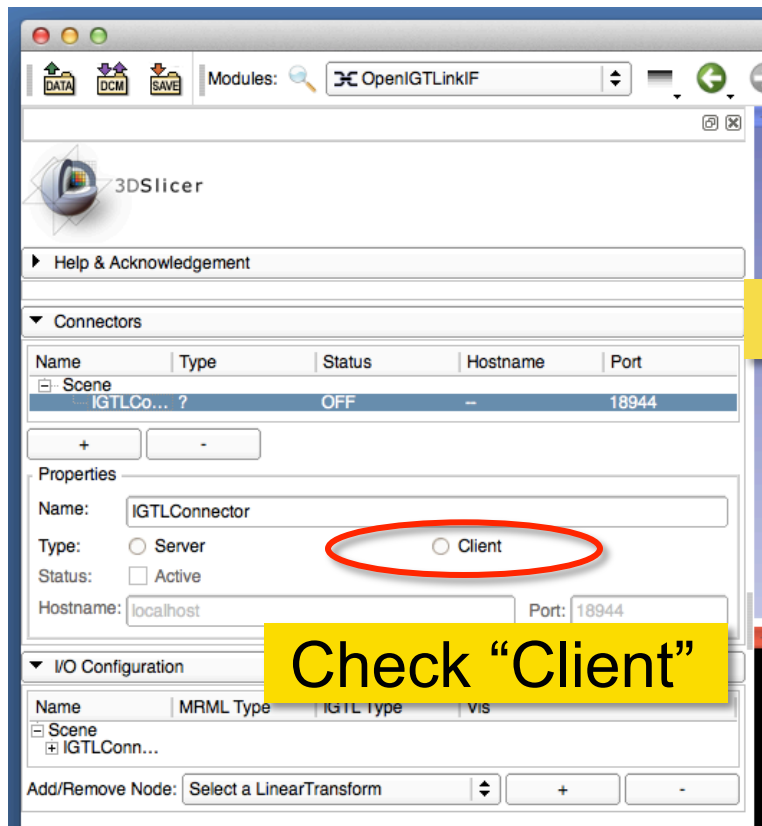
Changing Connector Name



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.

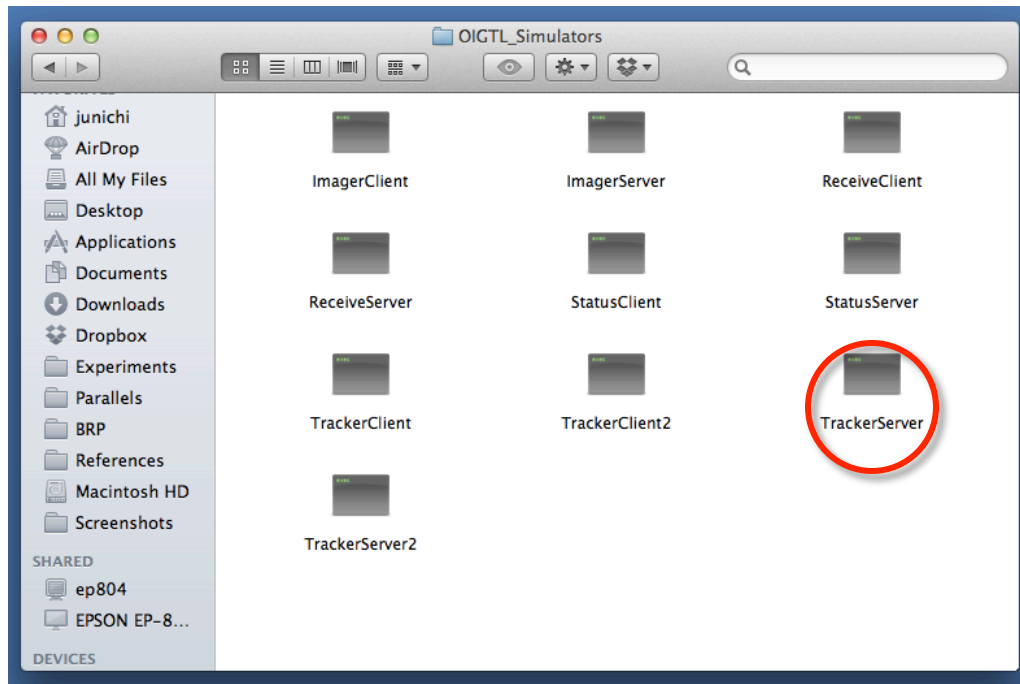
Setting Connector Type



```
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



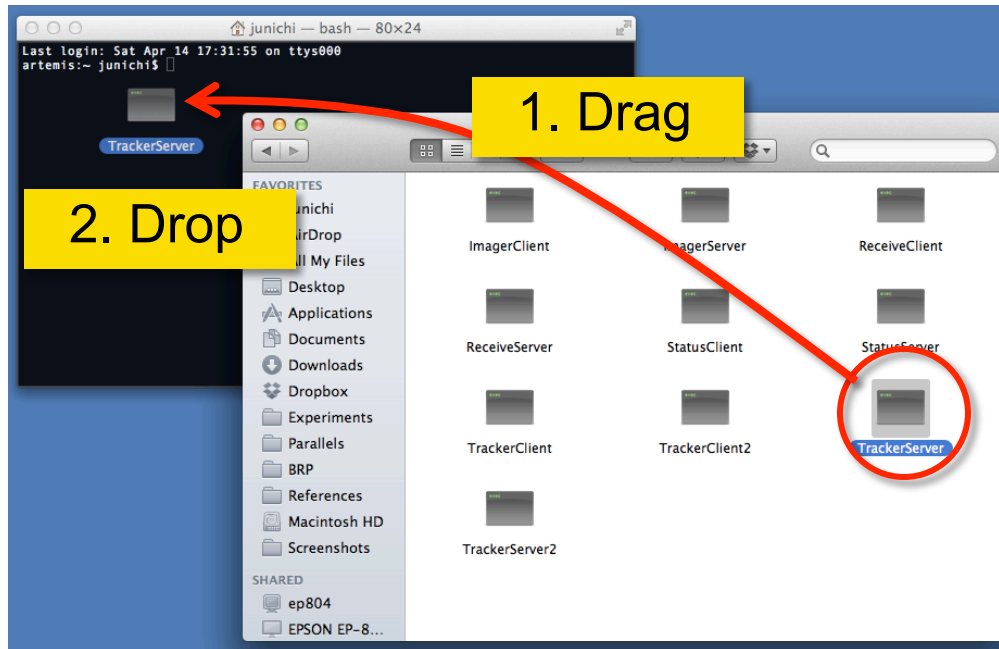
Open a terminal window.

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”.

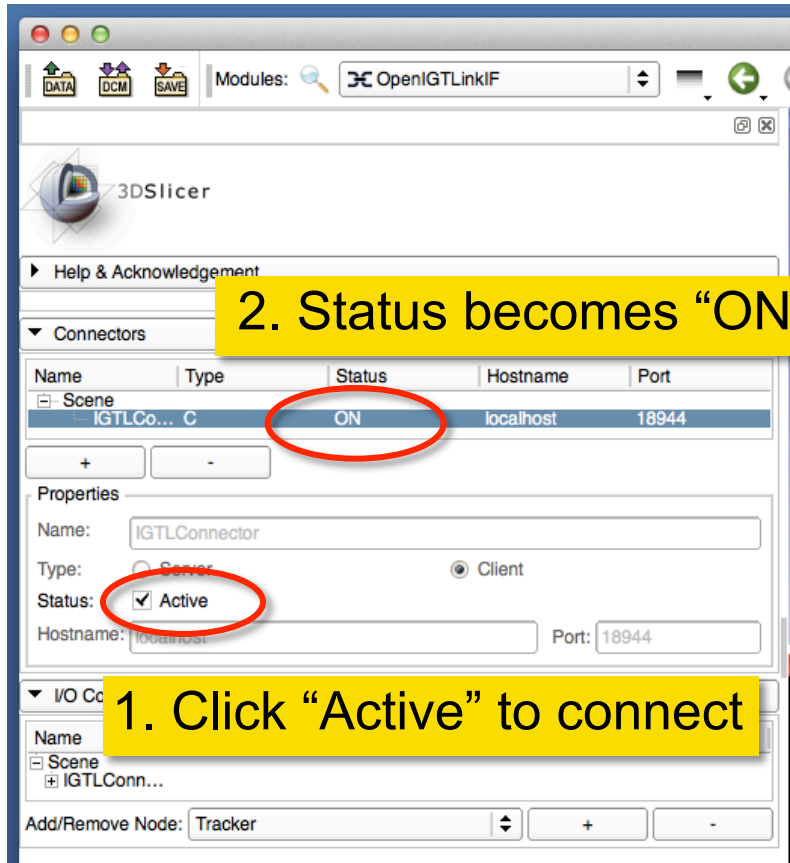
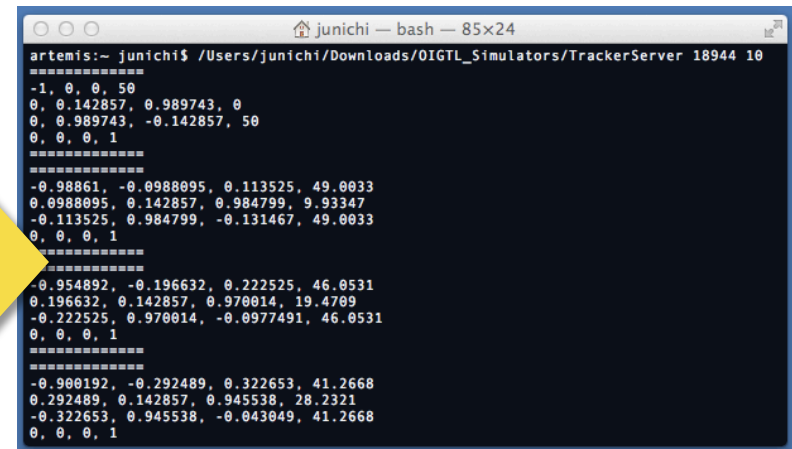
Start TrackerServer (2)



```
junichi — bash — 85x24
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

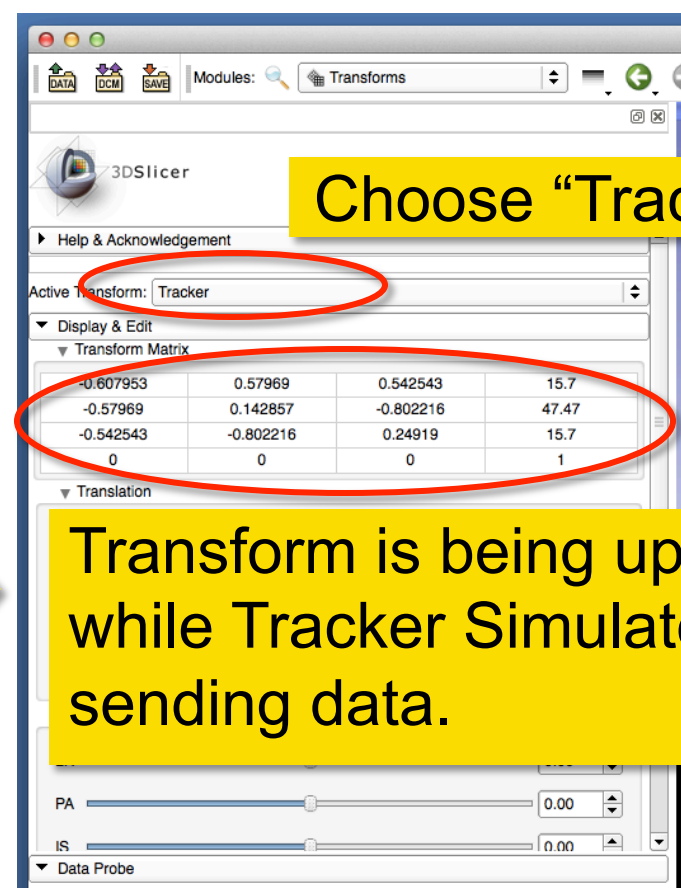
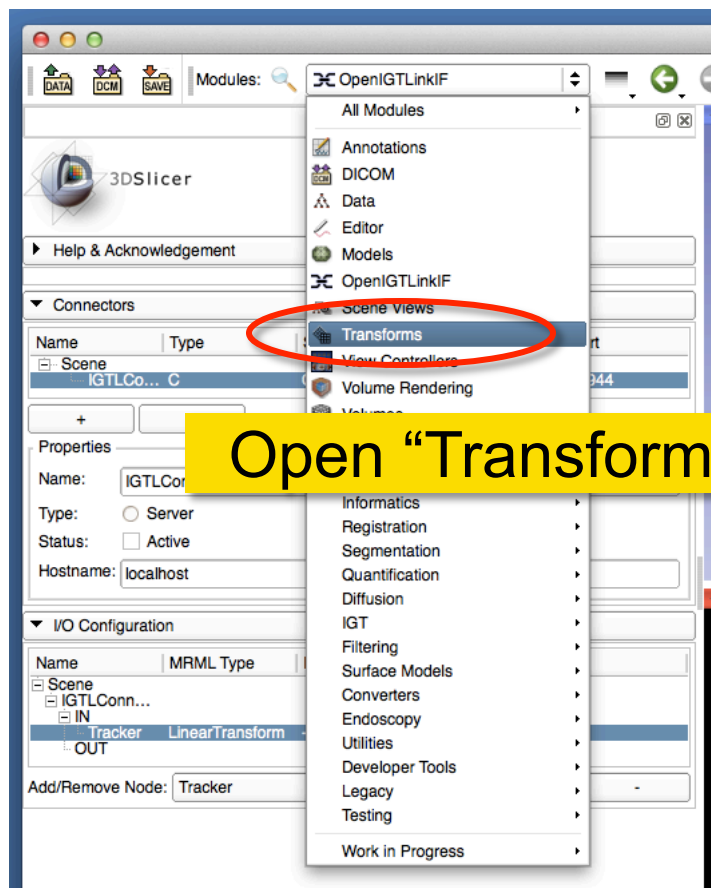
```

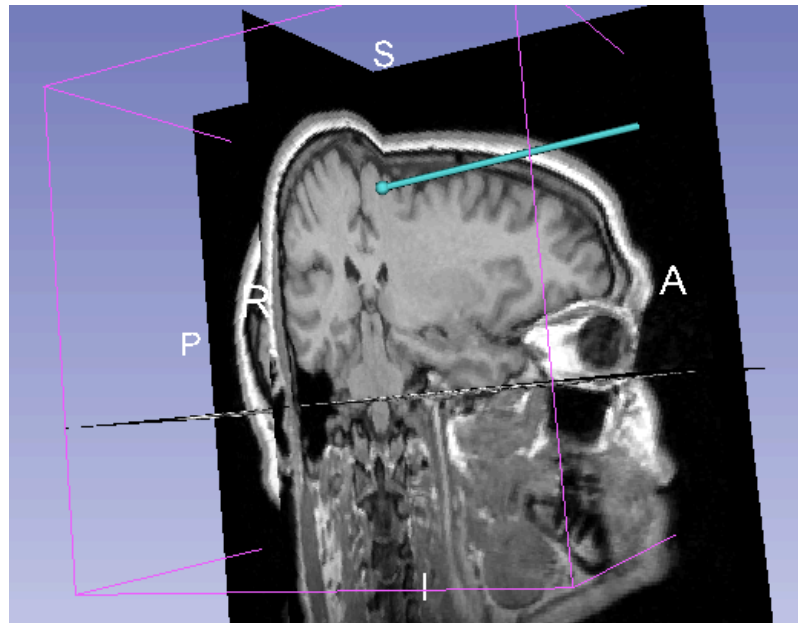
junichi — bash — 85x24
artemis:~ junichi$ /Users/junichi/Downloads/OIGTL_Simulators/TrackerServer 18944 10
=====
-1, 0, 0, 50
0, 0.142857, 0.989743, 0
0, 0.989743, -0.142857, 50
0, 0, 0, 1
=====
-0.98861, -0.0988095, 0.113525, 49.0033
0.0988095, 0.142857, 0.984799, 9.93347
-0.113525, 0.984799, -0.131467, 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.

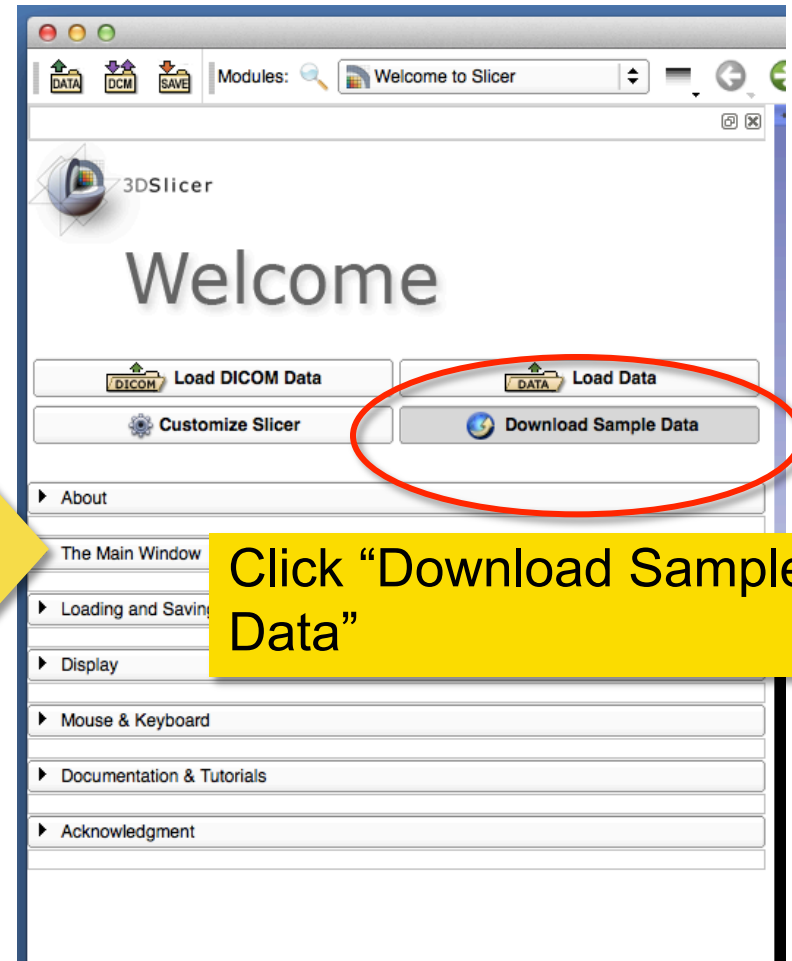
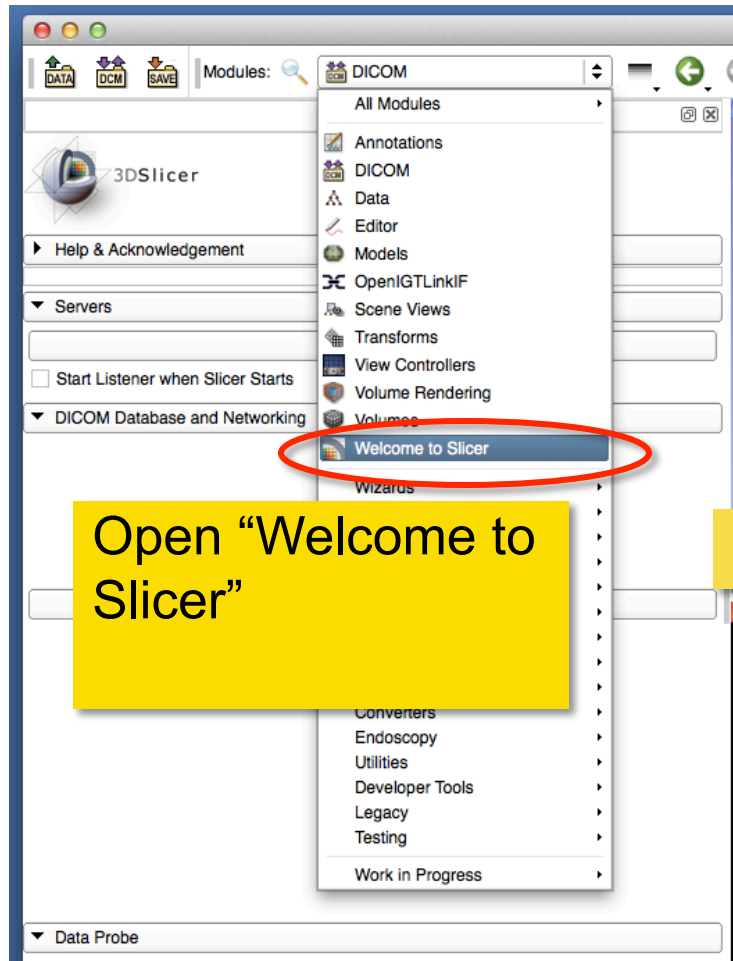
Checking Transform



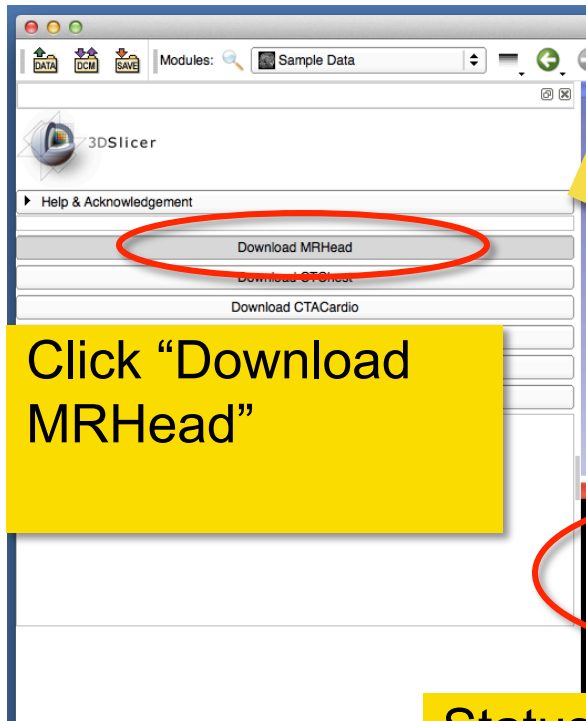


Part 4: Visualizing Tracking Data

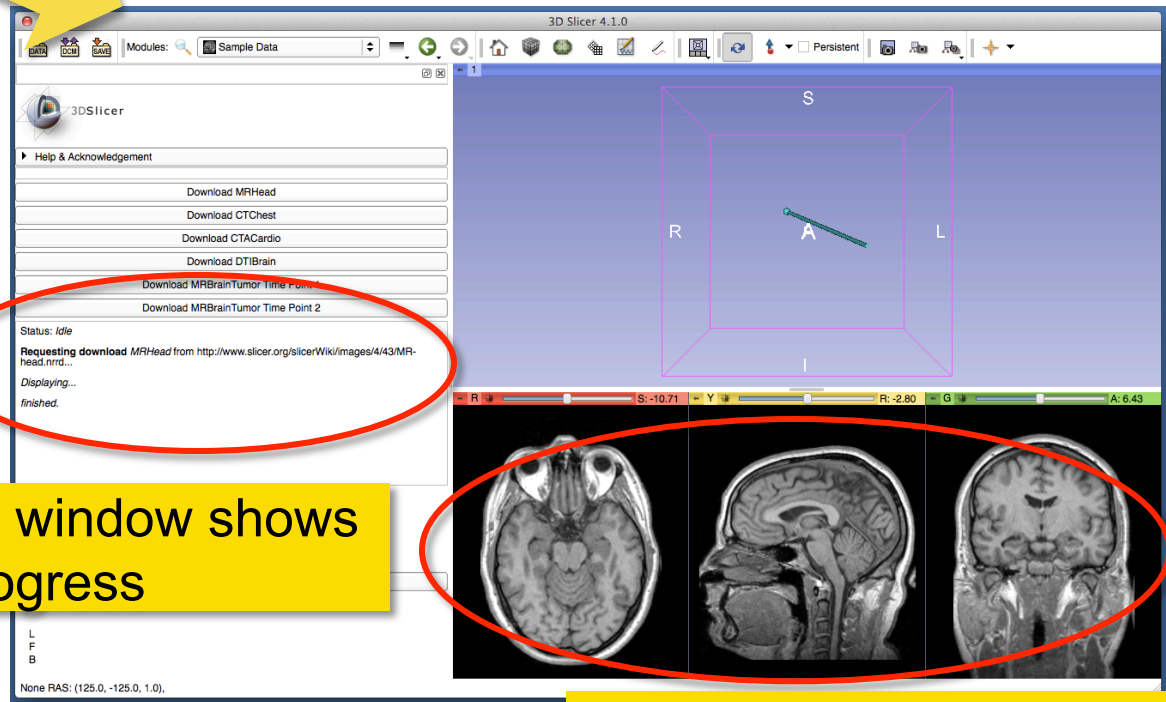
Loading Sample MRI Data



Loading Sample MRI Data



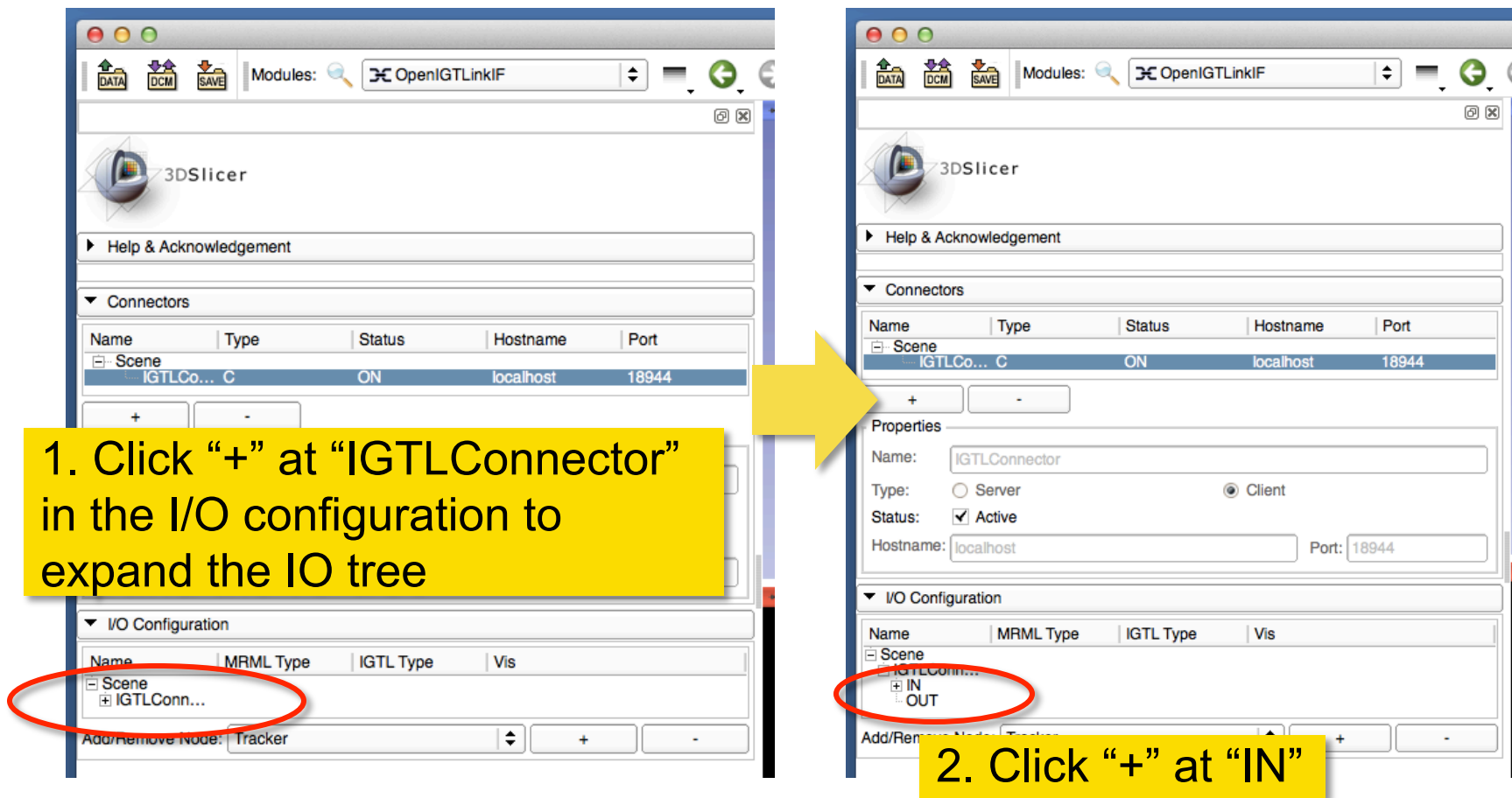
Click "Download MRHead"



Status window shows the progress

Sample image appears in the slice viewer

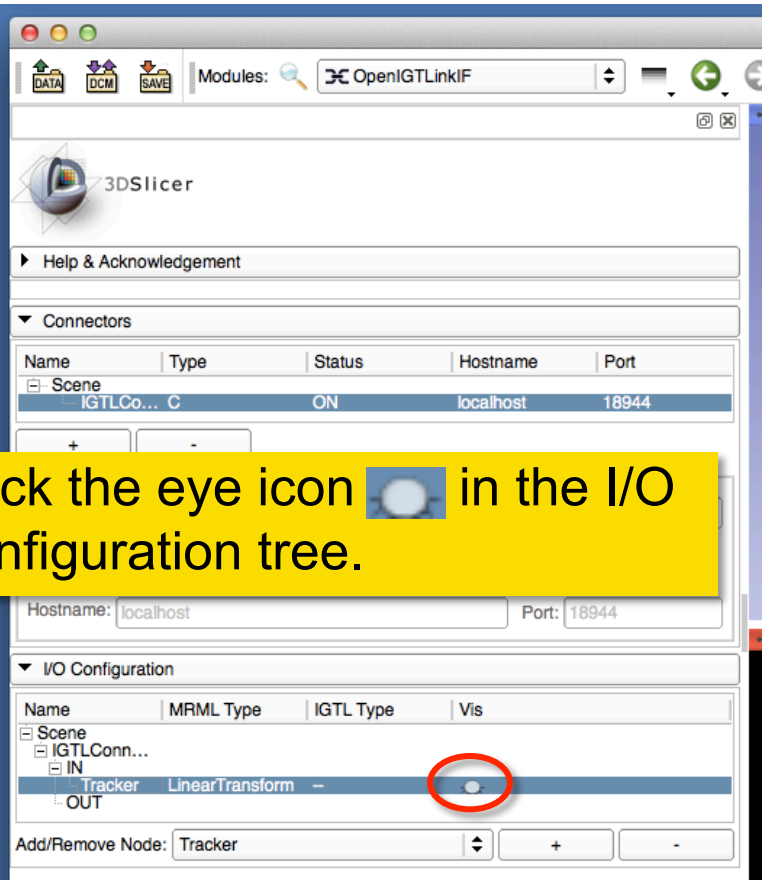
Choosing Locator Source




1. Click “+” at “IGTLConnector” in the I/O configuration to expand the IO tree


2. Click “+” at “IN”

Enable Locator



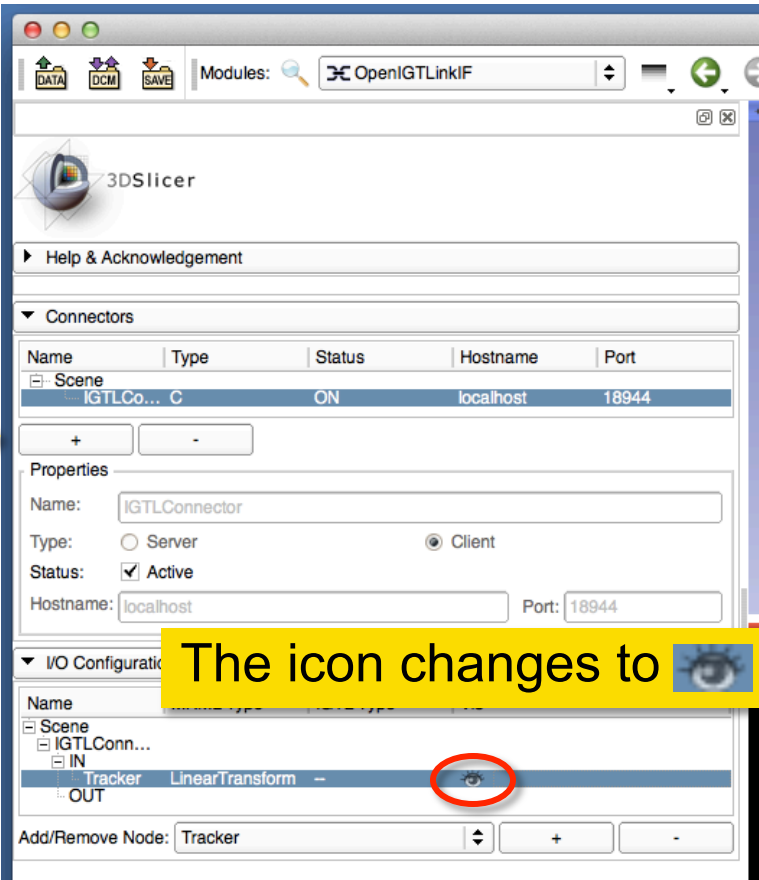
Click the eye icon  in the I/O configuration tree.


Hostname: localhost Port: 18944

Name	MRML Type	IGTL Type	Vis
Scene			
IGTLConn...			
IN			
Tracker	LinearTransform	--	
OUT			


Add/Remove Node: Tracker

→



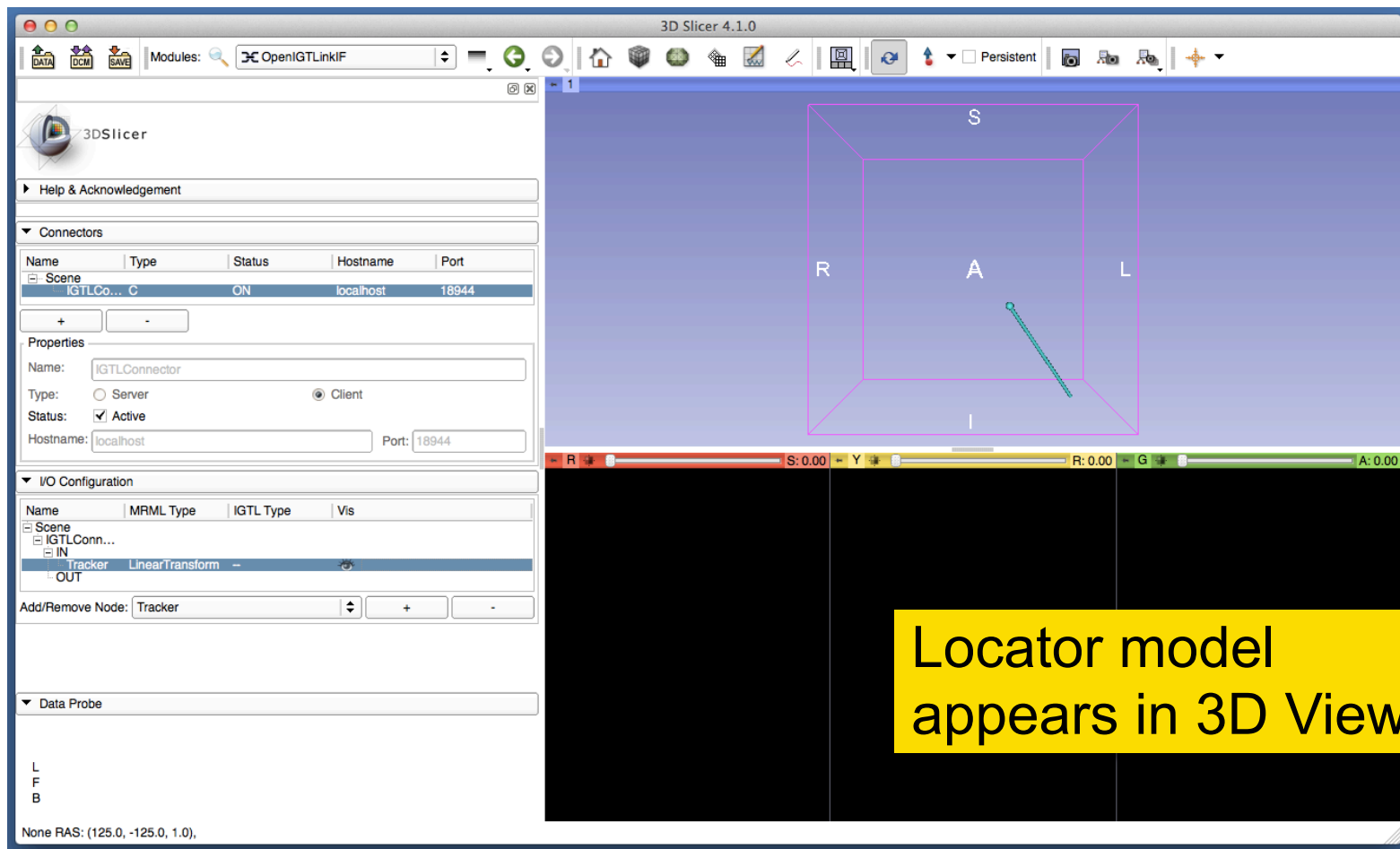
The icon changes to 

Hostname: localhost Port: 18944

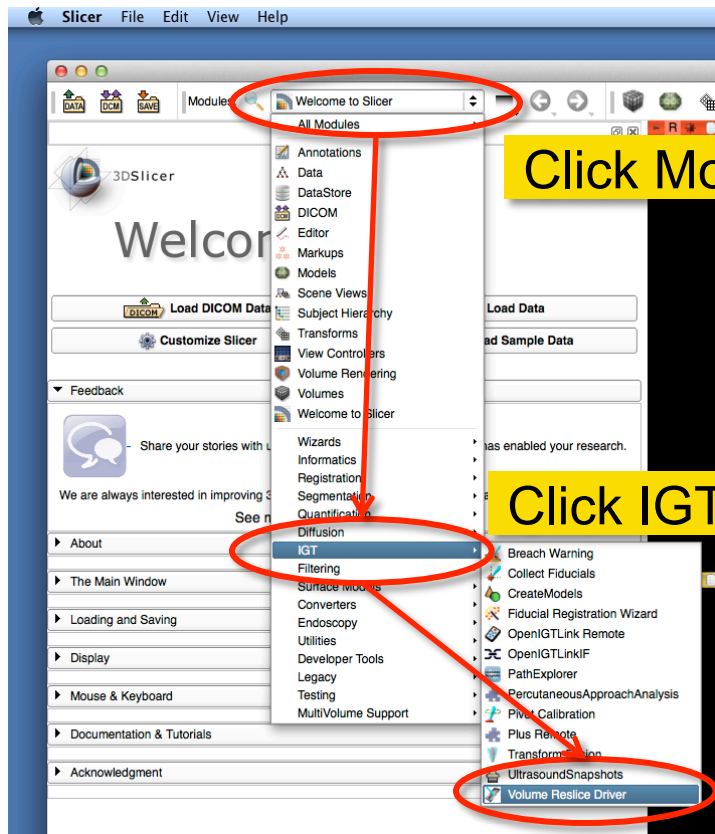
Name	MRML Type	IGTL Type	Vis
Scene			
IGTLConn...			
IN			
Tracker	LinearTransform	--	
OUT			

Add/Remove Node: Tracker

Visualizing Locator



Open Volume Reslice Driver

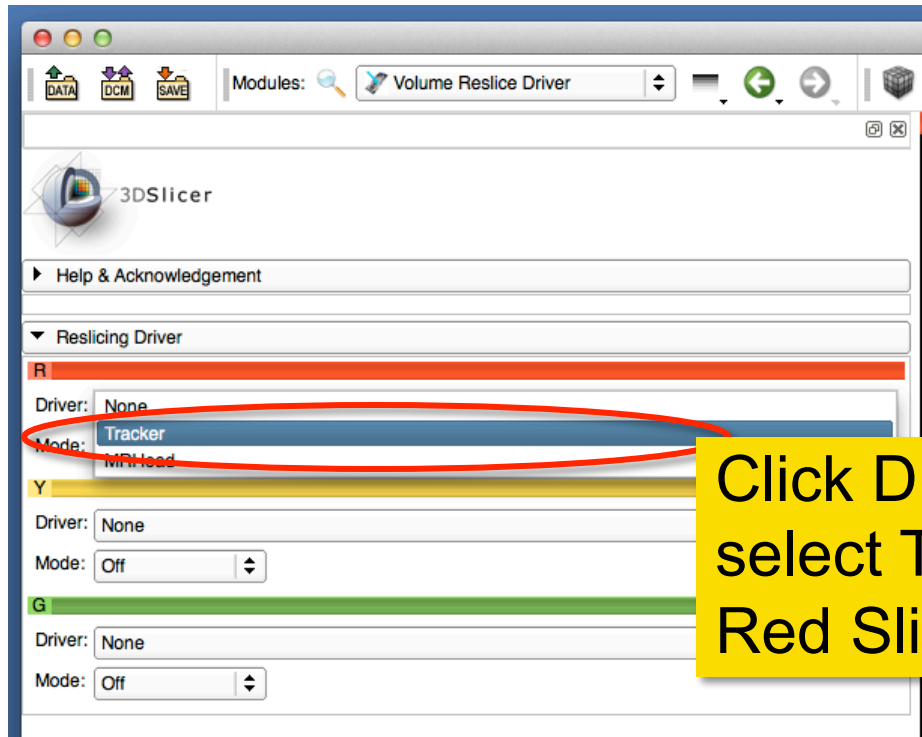


Click Modules menu

Click IGT

Click Volume Reslice Driver

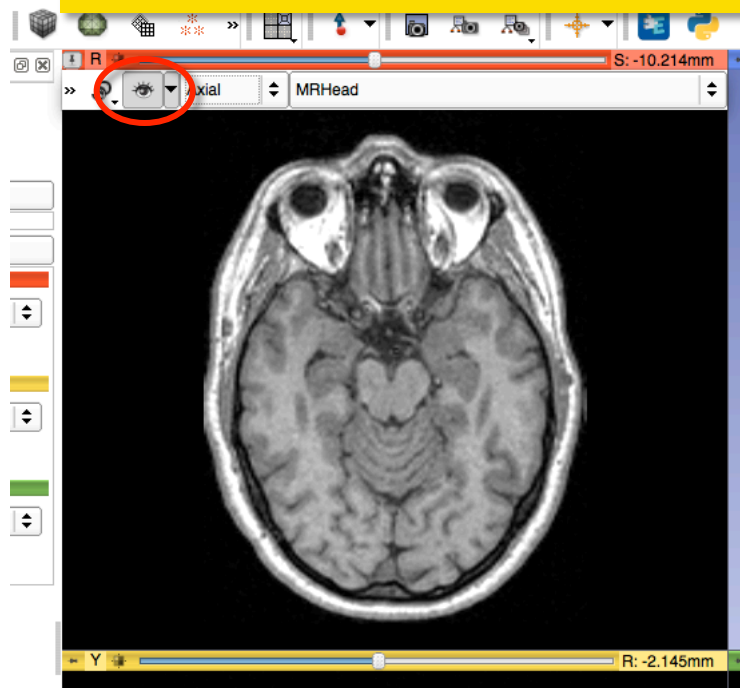
Choose Driver Transform



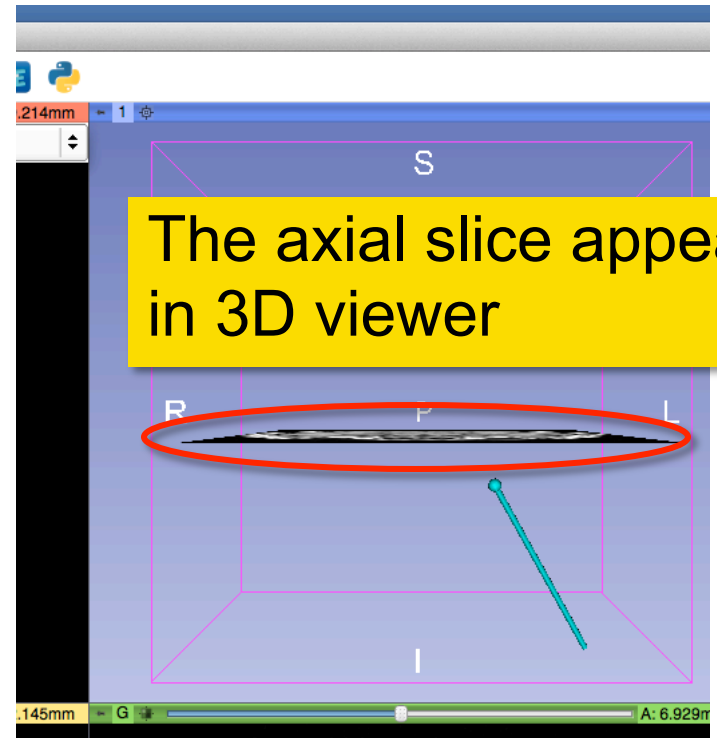
Click Driver menu ->
select Tracker in the
Red Slice frame

Choose Driver Transform

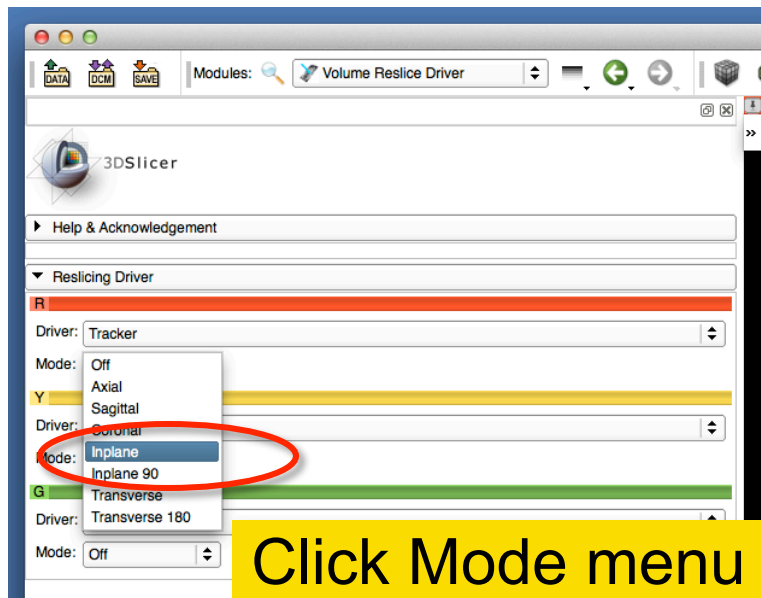
Click  Eye icon to show the slice in 3D viewer



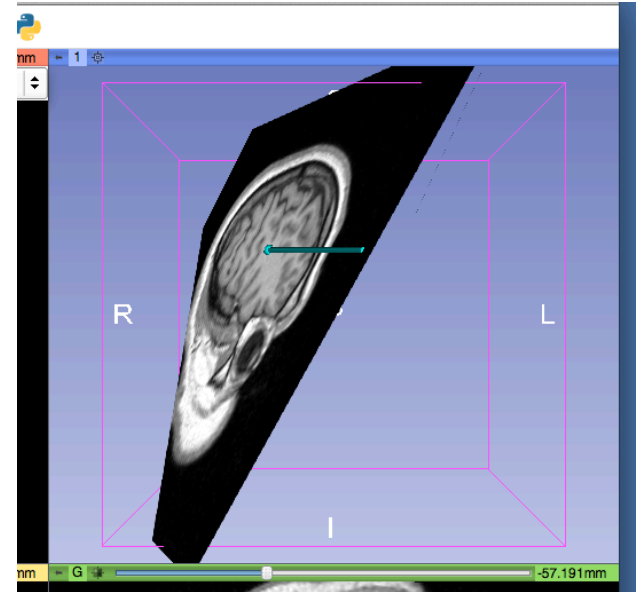
The axial slice appears in 3D viewer



Activate Reslicing



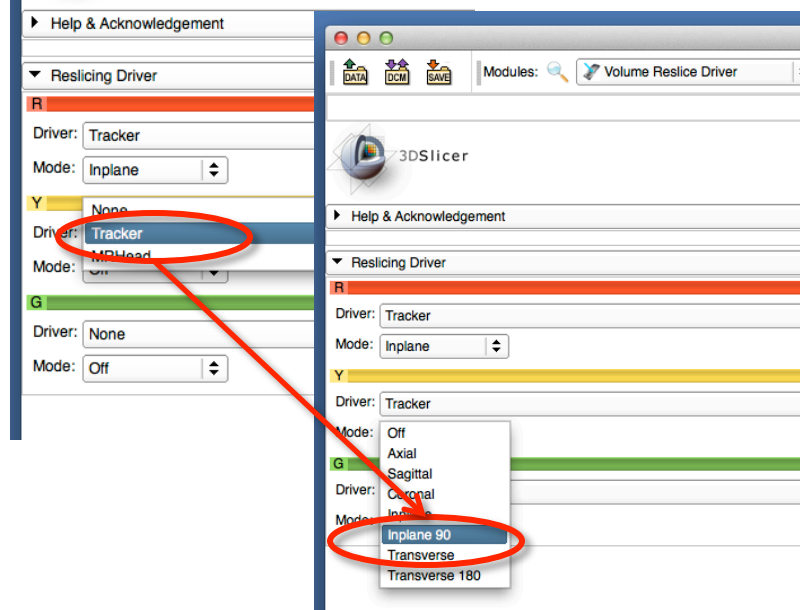
Click Mode menu ->
select "Inplane" in the
Red slice frame



The slice starts
following the locator

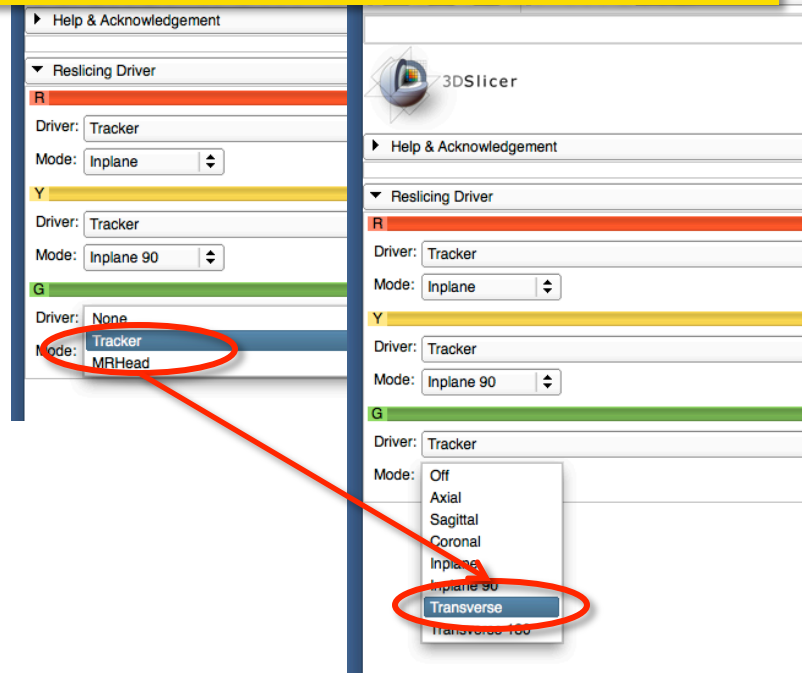
Activate Reslicing for Other Planes

In the Yellow slice frame, select Tracker from the Driver menu



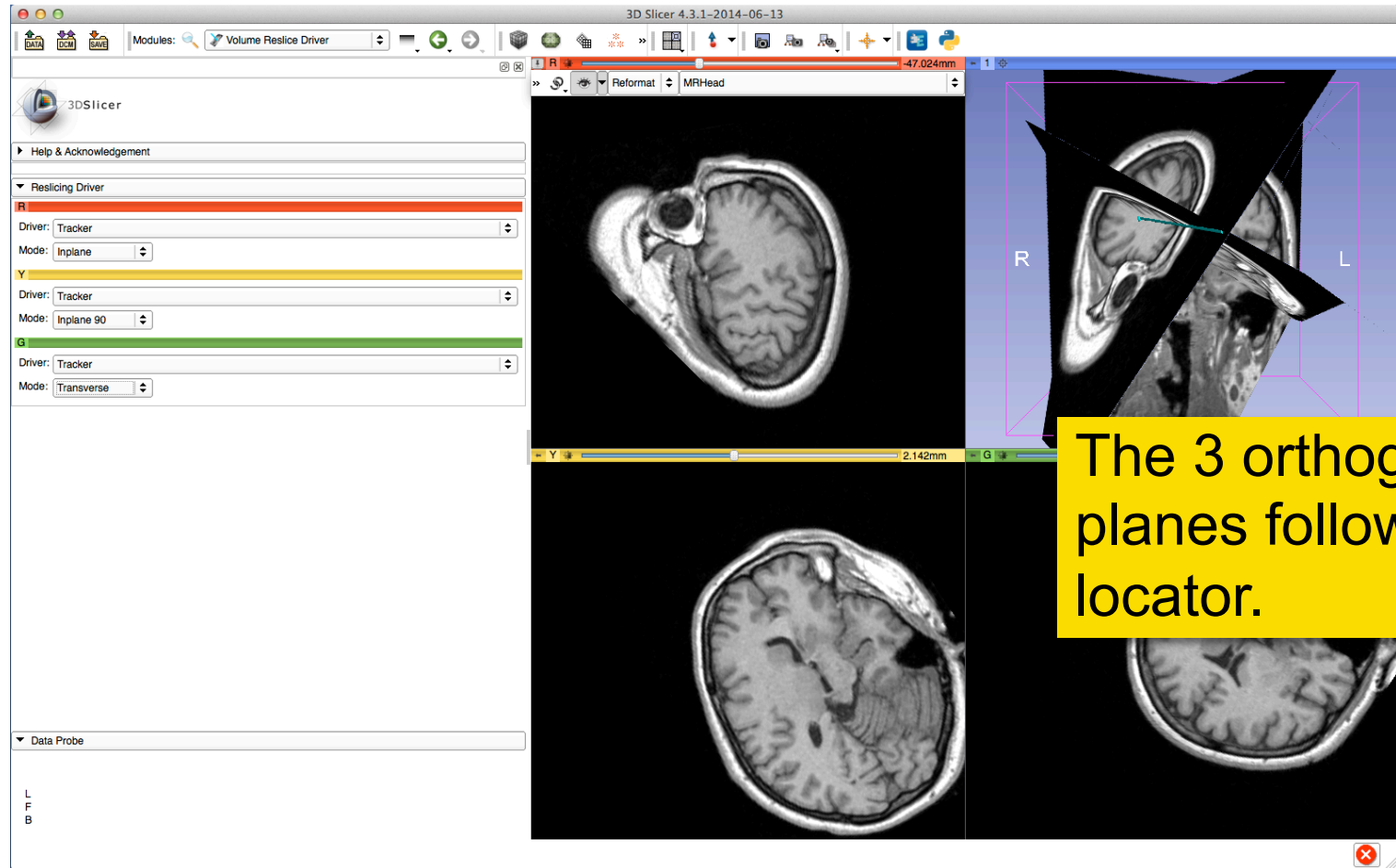
Select Inplane 90 from the Mode menu

In the Green slice frame, select Tracker from the Driver menu



Select Transverse from the Mode menu

Activate Reslicing for Other Planes



- 3D Slicer OpenIGTLinkIF Documentation Page

[http://www.slicer.org/slicerWiki/index.php/Documentation/4.3/
Modules/OpenIGTLinkIF](http://www.slicer.org/slicerWiki/index.php/Documentation/4.3/Modules/OpenIGTLinkIF)

- 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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R01CA138586)



National Alliance for Medical Image Computing
(NIH U54EB005149)



Intelligent Surgical Instruments Project of METI
(Japan)