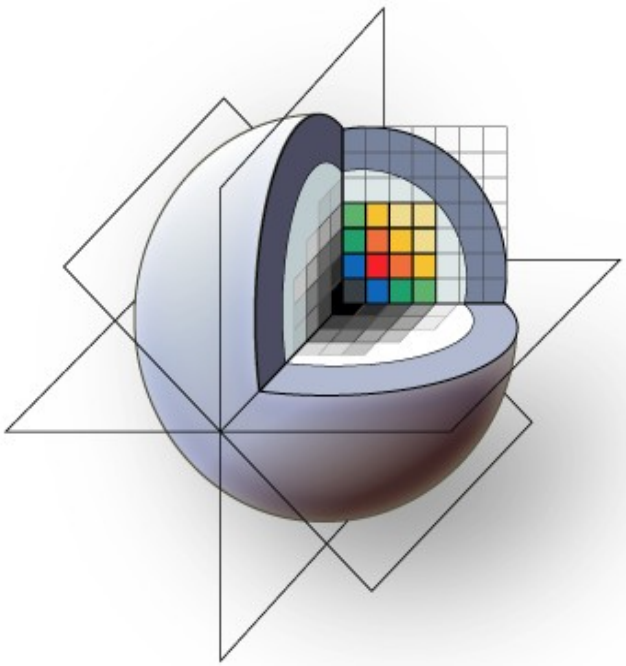
Using Plastimatch for Registration and Warping

Tutorial Version: Dec 29, 2015



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Learning Objective

This tutorial is a step-by-step guide, and includes:

1) Downloading the Plastimatch extension to 3D Slicer
2) Loading the DICOM and DICOM-RT data
3) Running and viewing deformable registration
4) Exporting DICOM-RT data *(to be developed)*

The 3D Slicer web site is: http://slicer.org
The plastimatch web site is: http://plastimatch.org

Prerequisites

Tutorial sample data is required.
You can get the data from here:

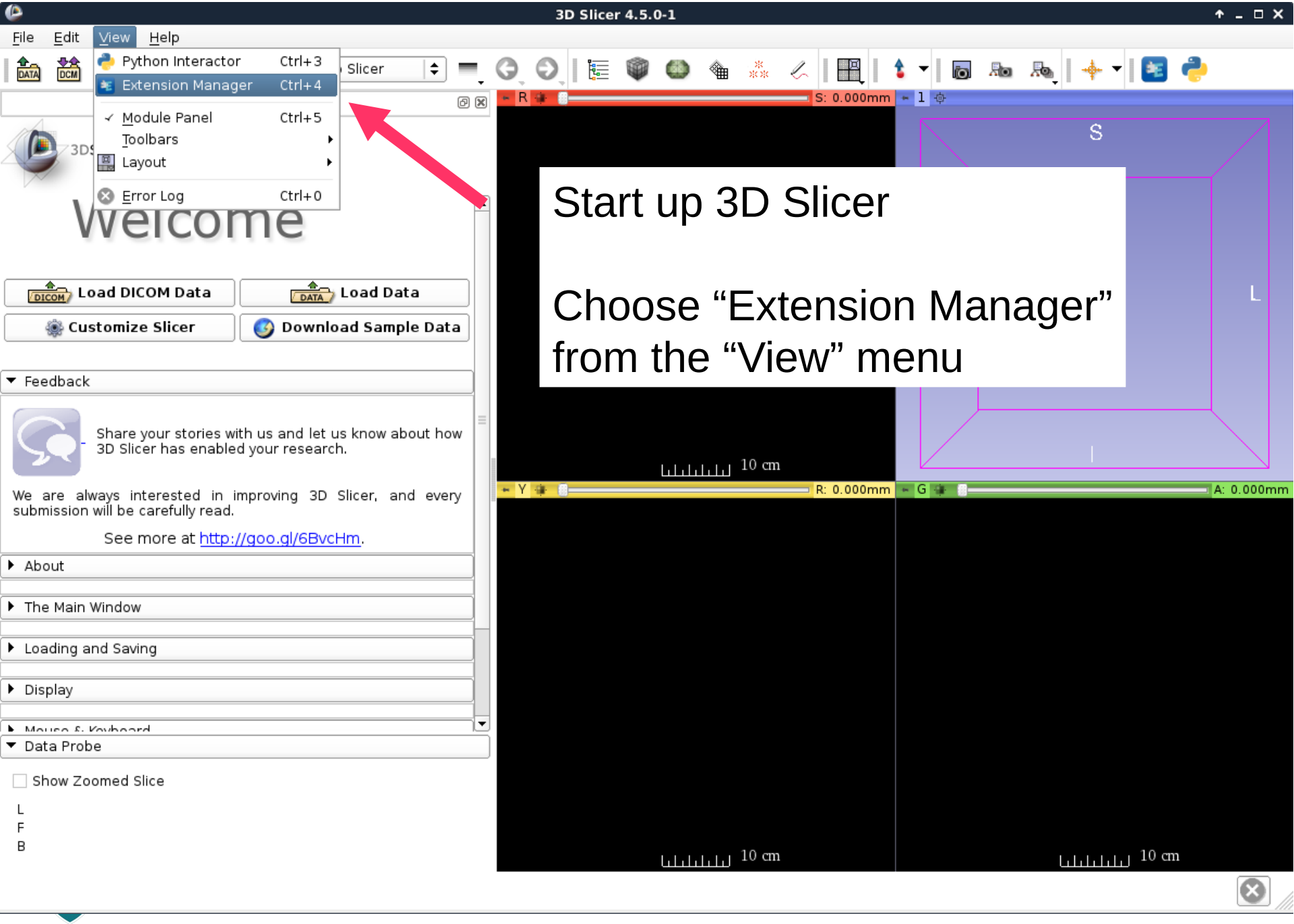
http://bit.ly/1TnQRv7

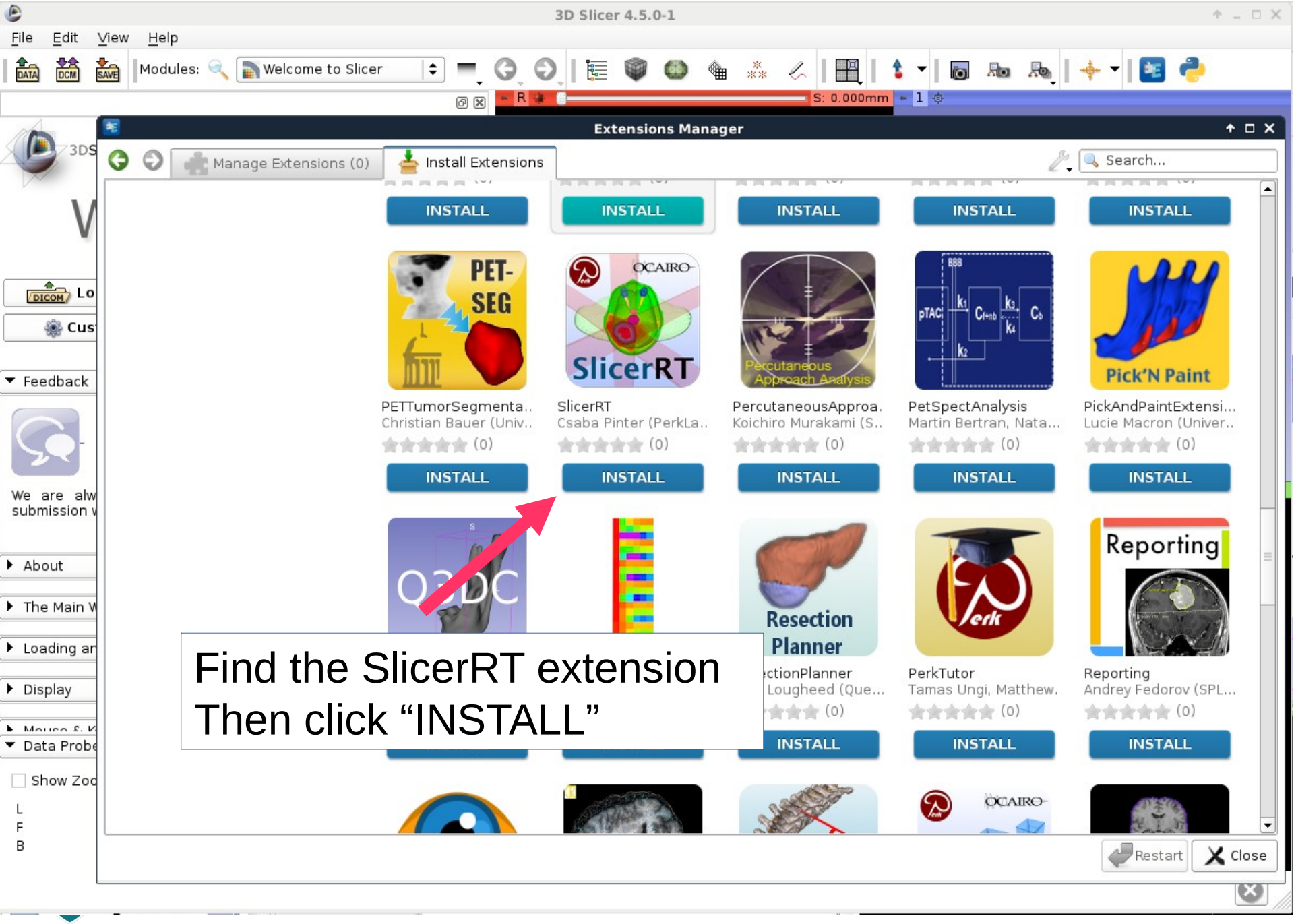
The tutorial “Slicer4 Data Loading and 3D Visualization” is recommended, but not required.

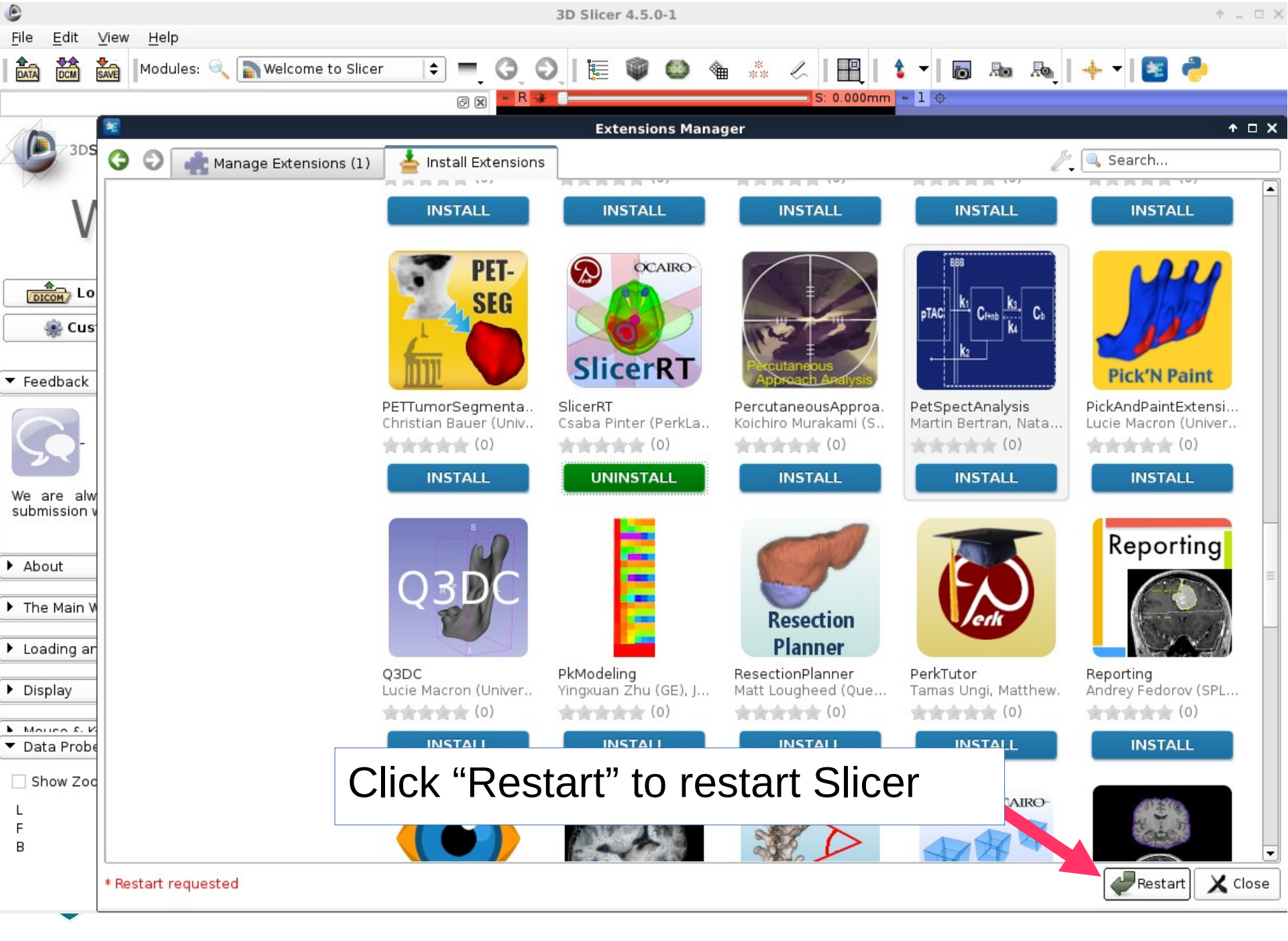
http://bit.ly/1mgOUXh

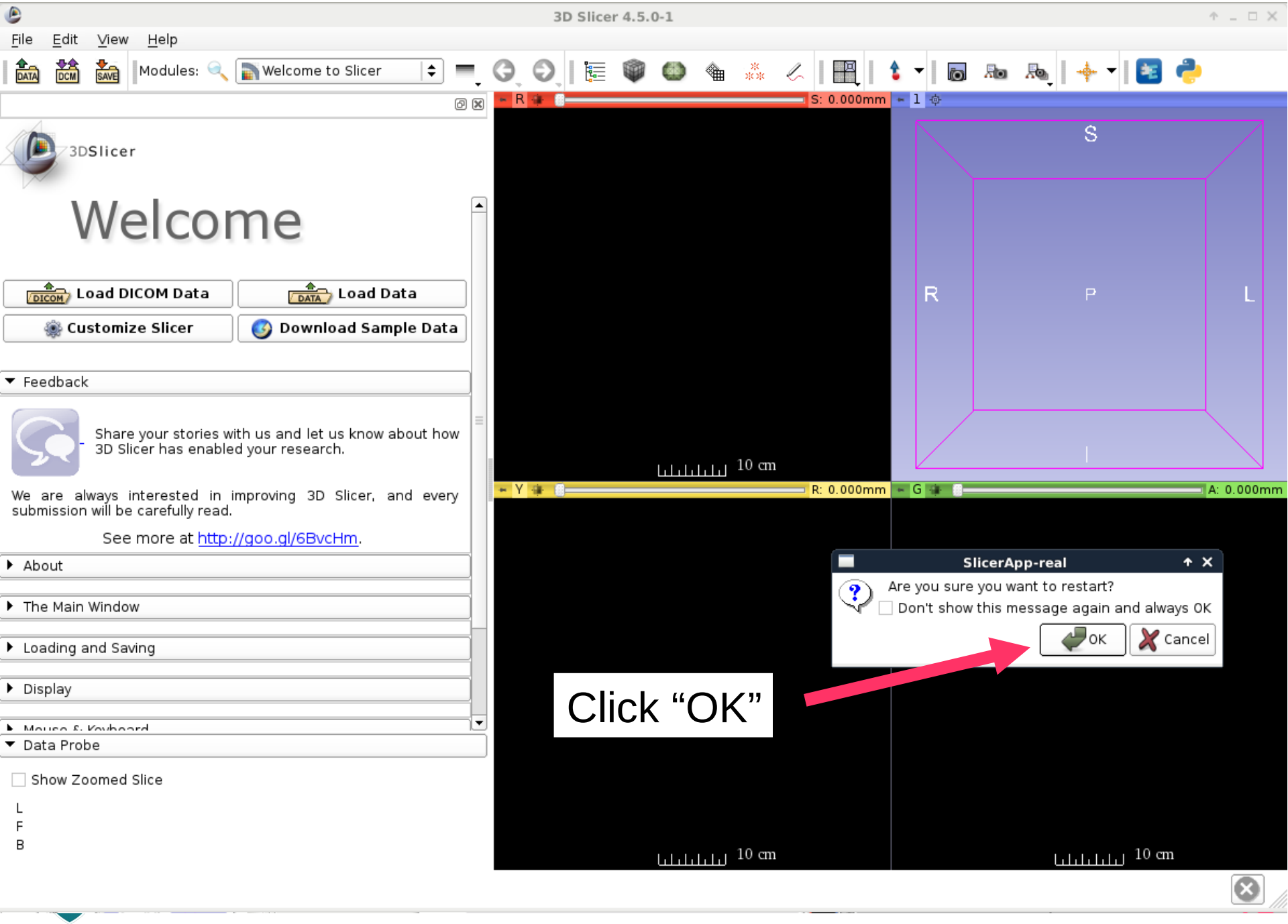
Part 1: Downloading the Plastimatch Extension

Plastimatch is distributed with the SlicerRT extension

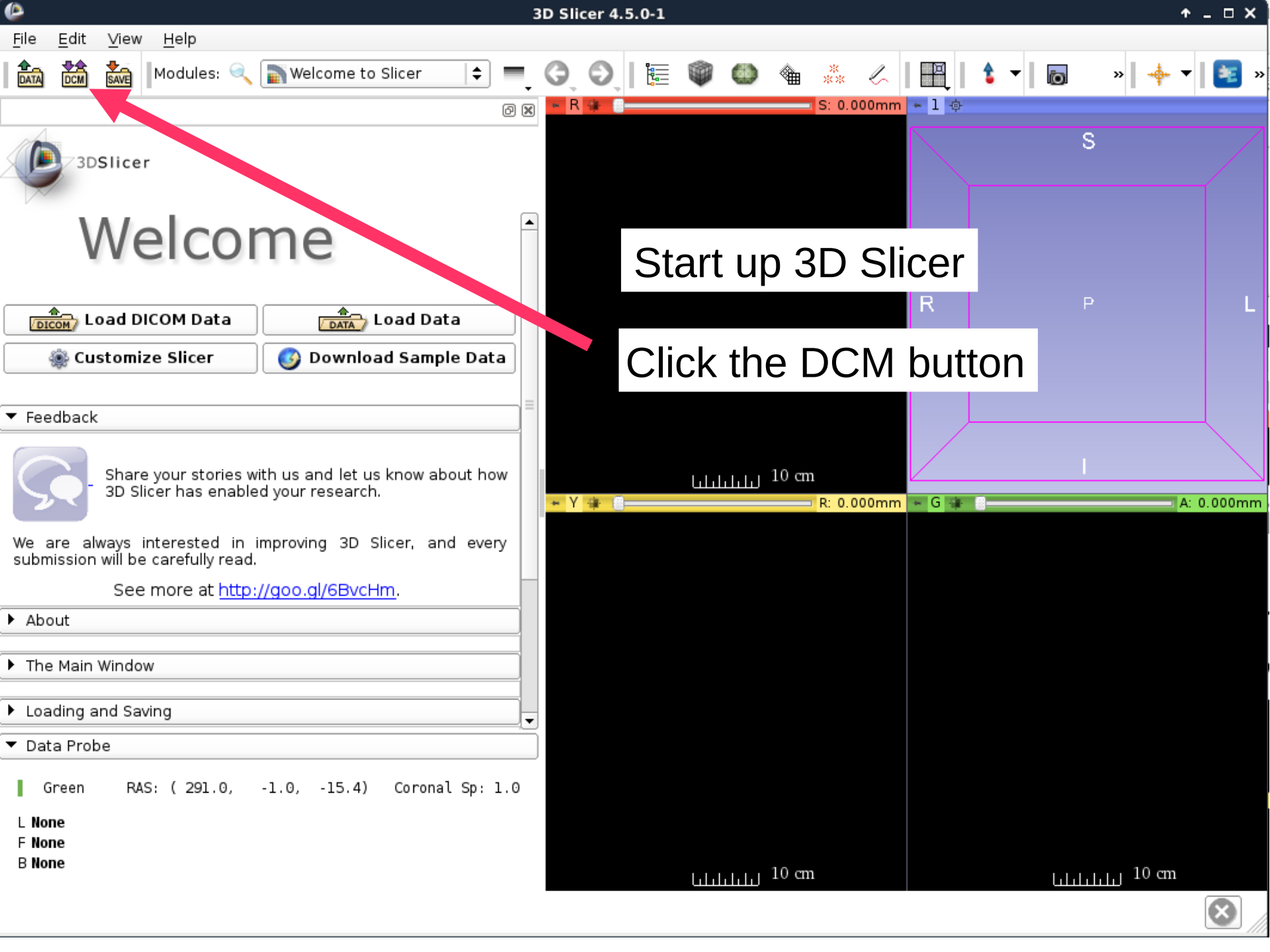

3D Slicer 4.5.0-1
File
Edit
View
Help
Python Interactor Ctrl+3
Extension Manager Ctrl+4
Module Panel Ctrl+5
Toolbars
Layout
Error Log Ctrl+0
Slicer
Welcome
Load DICOM Data
Load Data
Customize Slicer
Download Sample Data
Feedback
Share your stories with us and let us know about how 3D Slicer has enabled your research.
We are always interested in improving 3D Slicer, and every submission will be carefully read.
See more at http://goo.gl/6BvcHm.
About
The Main Window
Loading and Saving
Display
Data Probe
Show Zoomed Slice
L
F
B
S: 0.000mm
10 cm
S
L
R: 0.000mm
A: 0.000mm
Start up 3D Slicer
Choose “Extension Manager” from the “View” menu


3D Slicer 4.5.0-1
File Edit View Help
Modules: Welcome to Slicer
Extensions Manager
Manage Extensions (0)
Install Extensions
Search...
INSTALL
PETTumorSegmenta..
Christian Bauer (Univ..
SlicerRT
Csaba Pinter (PerkLa..
PercutaneousApproa..
Koichiro Murakami (S..
PetSpectAnalysis
Martin Bertran, Nata...
PickAndPaintExtensi...
Lucie Macron (Univer..
Resection Planner
PerkTutor
Tamas Ungi, Matthew.
Reporting
Andrey Fedorov (SPL...
Restart
Close
Find the SlicerRT extension
Then click “INSTALL”


3D Slicer 4.5.0-1
File Edit View Help
Modules: Welcome to Slicer
Extensions Manager
Manage Extensions (1)
Install Extensions
Search...
INSTALL
PETTumorSegmenta..
Christian Bauer (Univ..
SlicerRT
Csaba Pinter (PerkLa..
PercutaneousApproa..
Koichiro Murakami (S..
PetSpectAnalysis
Martin Bertran, Nata...
PickAndPaintExtensi...
Lucie Macron (Univer..
UNINSTALL
Q3DC
Lucie Macron (Univer..
PkModeling
Yingxuan Zhu (GE), J...
ResectionPlanner
Matt Lougheed (Que...
PerkTutor
Tamas Ungi, Matthew.
Reporting
Andrey Fedorov (SPL...
Click “Restart” to restart Slicer
* Restart requested
Restart
Close


3D Slicer 4.5.0-1
File
Edit
View
Help
Modules:
Welcome to Slicer
3DSlicer
Welcome
Load DICOM Data
Load Data
Customize Slicer
Download Sample Data
Feedback
Share your stories with us and let us know about how 3D Slicer has enabled your research.
We are always interested in improving 3D Slicer, and every submission will be carefully read.
See more at http://goo.gl/6BvcHm.
About
The Main Window
Loading and Saving
Display
Data Probe
Show Zoomed Slice
L
F
B
S
R
P
L
10 cm
SlicerApp-real
Are you sure you want to restart?
Don't show this message again and always OK
OK
Cancel
Click “OK”

Part 2: Loading the DICOM and DICOM-RT data


3D Slicer 4.5.0-1
File
Edit
View
Help
Modules:
Welcome to Slicer
3DSlicer
Welcome
Load DICOM Data
Load Data
Customize Slicer
Download Sample Data
Feedback
Share your stories with us and let us know about how 3D Slicer has enabled your research.
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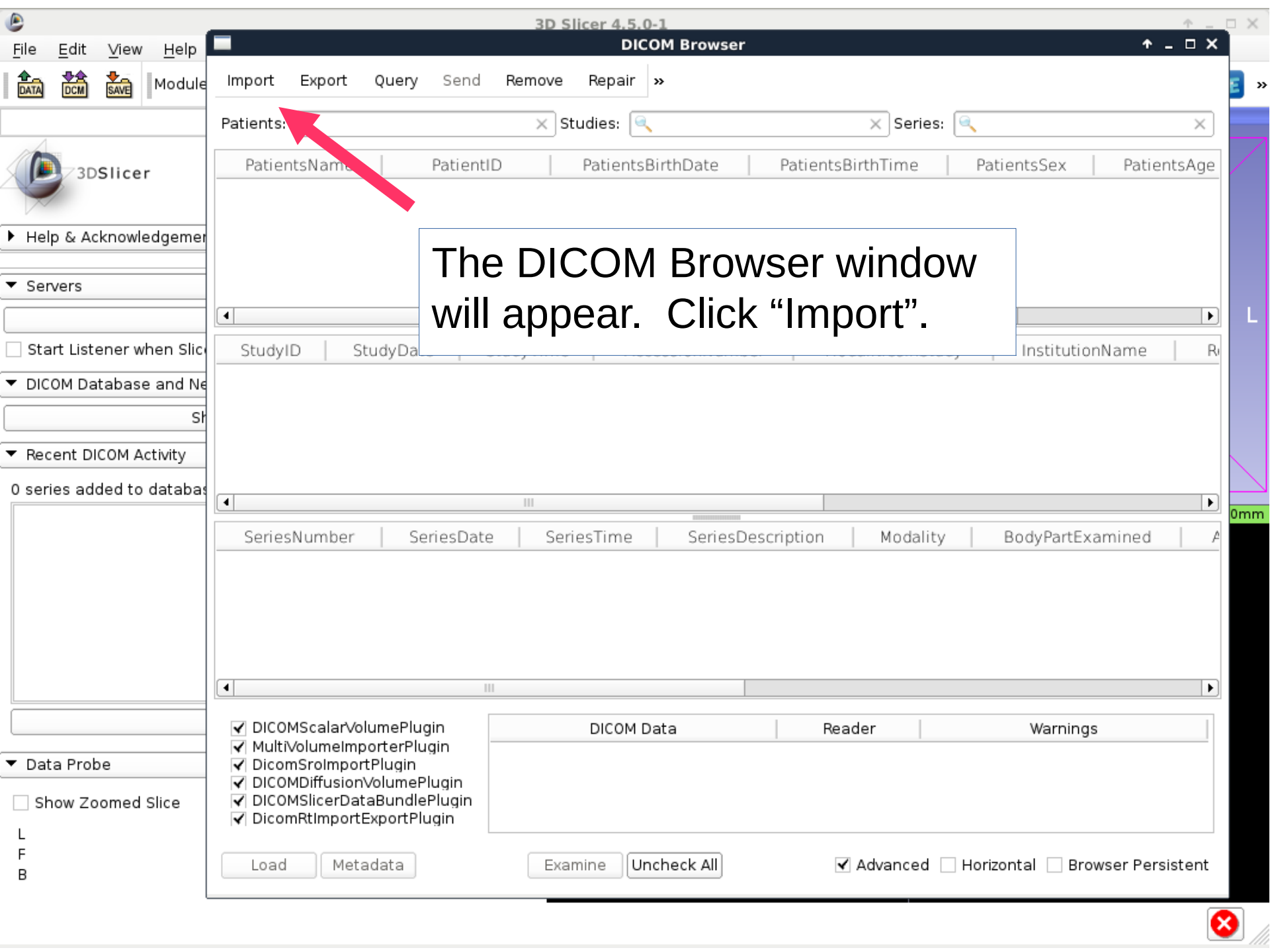
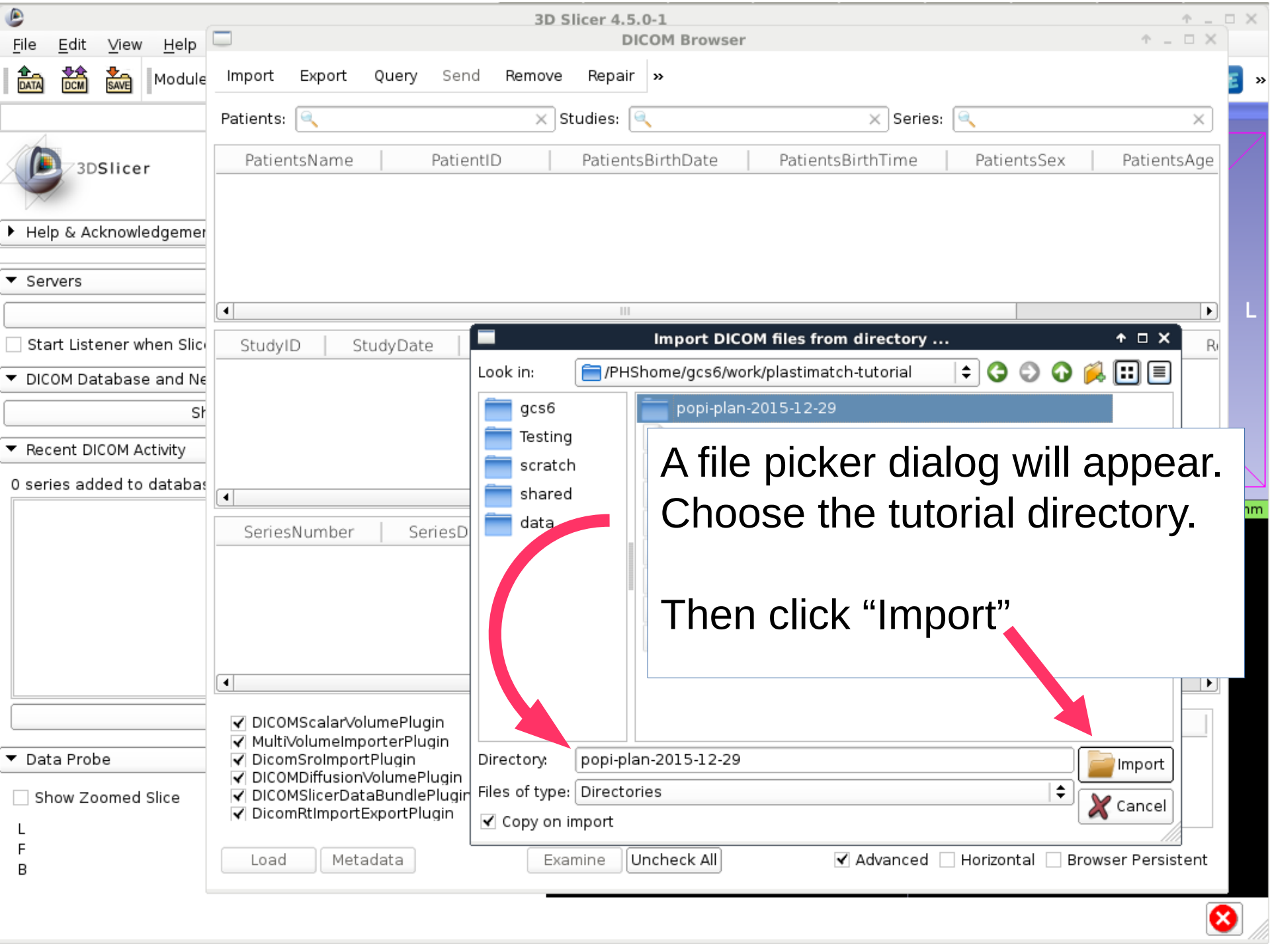
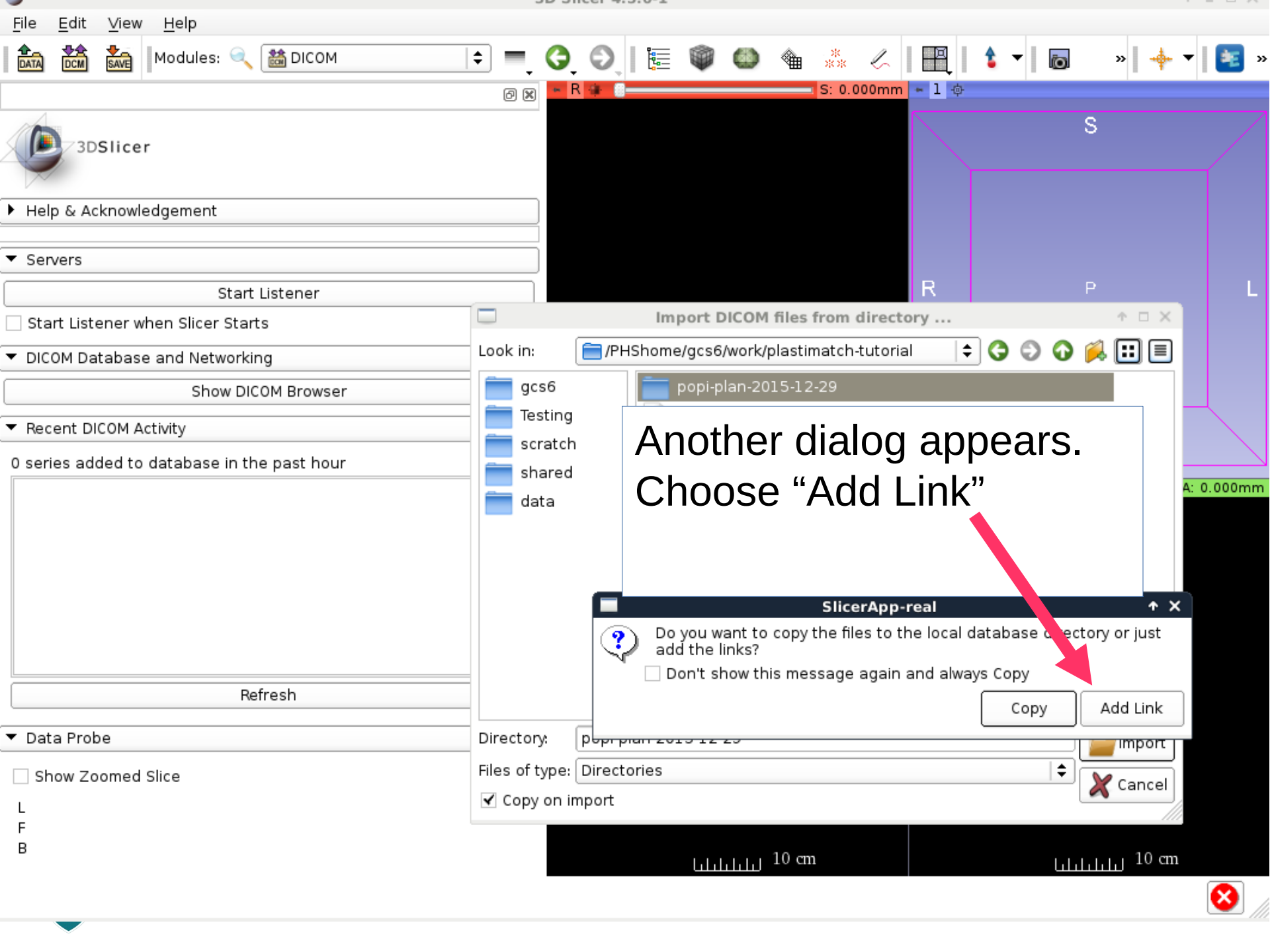
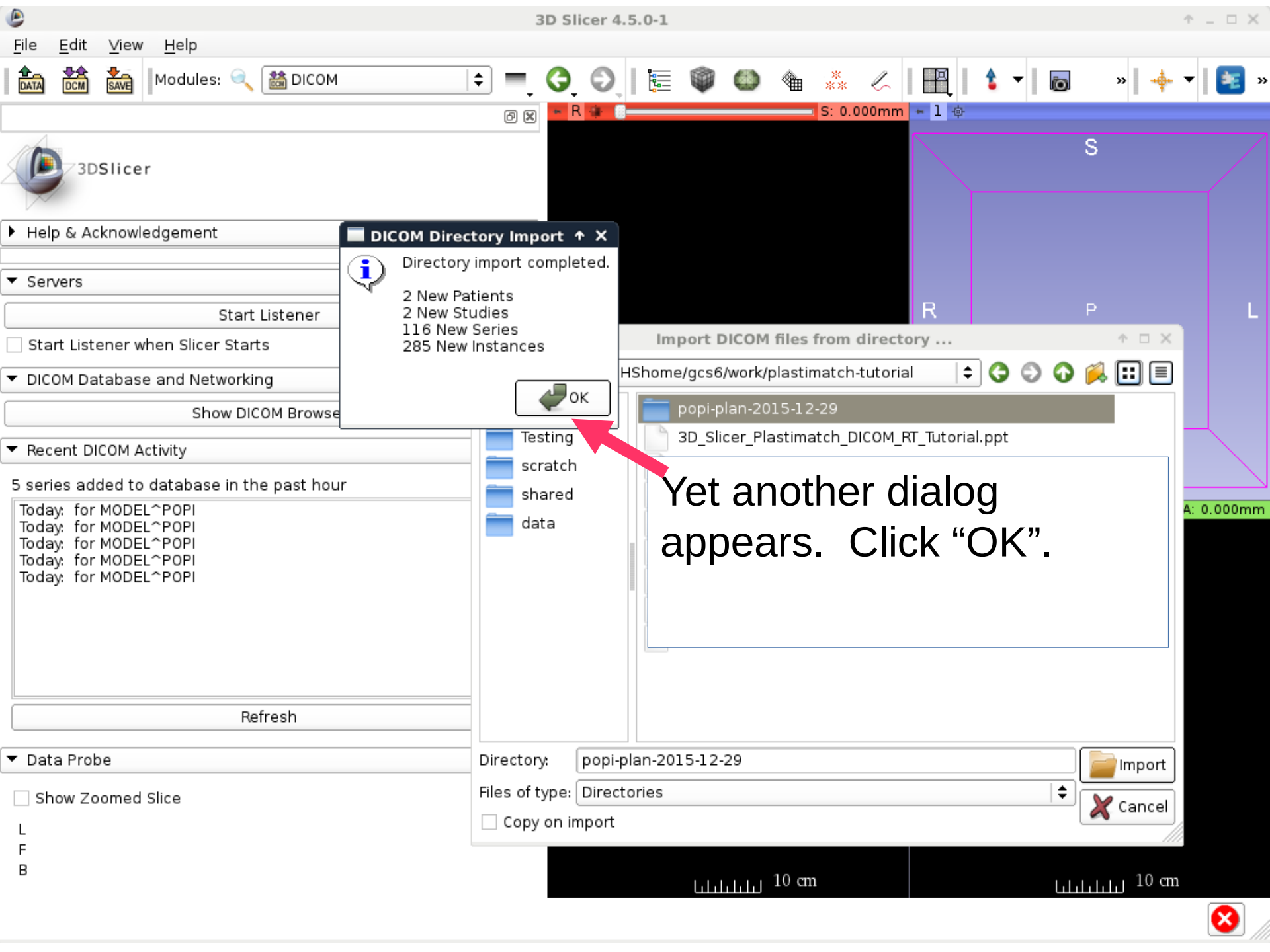
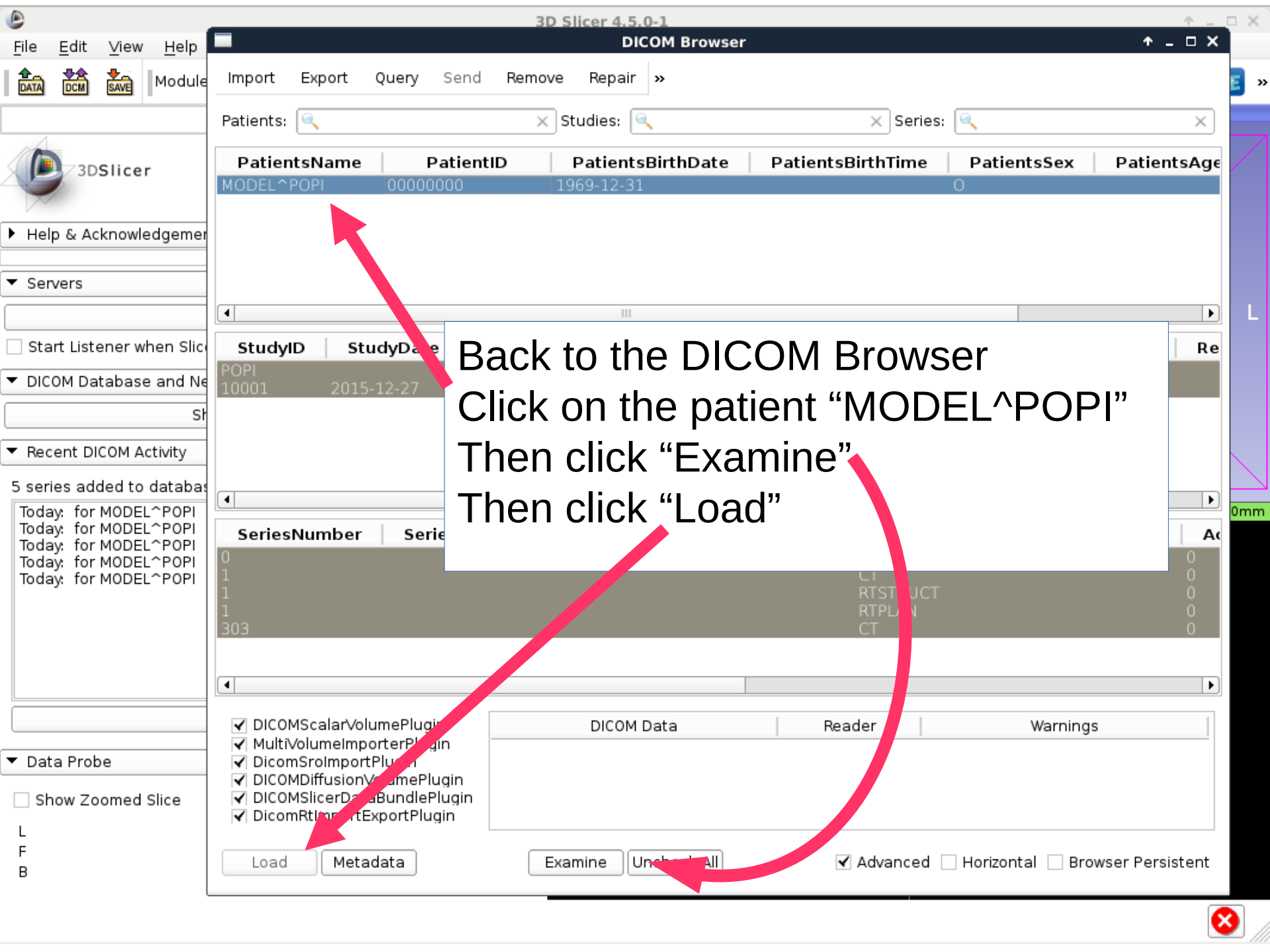
See more at http://goo.gl/6BvcHm.
About
The Main Window
Loading and Saving
Data Probe
Green RAS: (291.0, -1.0, -15.4) Coronal Sp: 1.0
L None
F None
B None
Start up 3D Slicer
Click the DCM button
10 cm
10 cm
10 cm

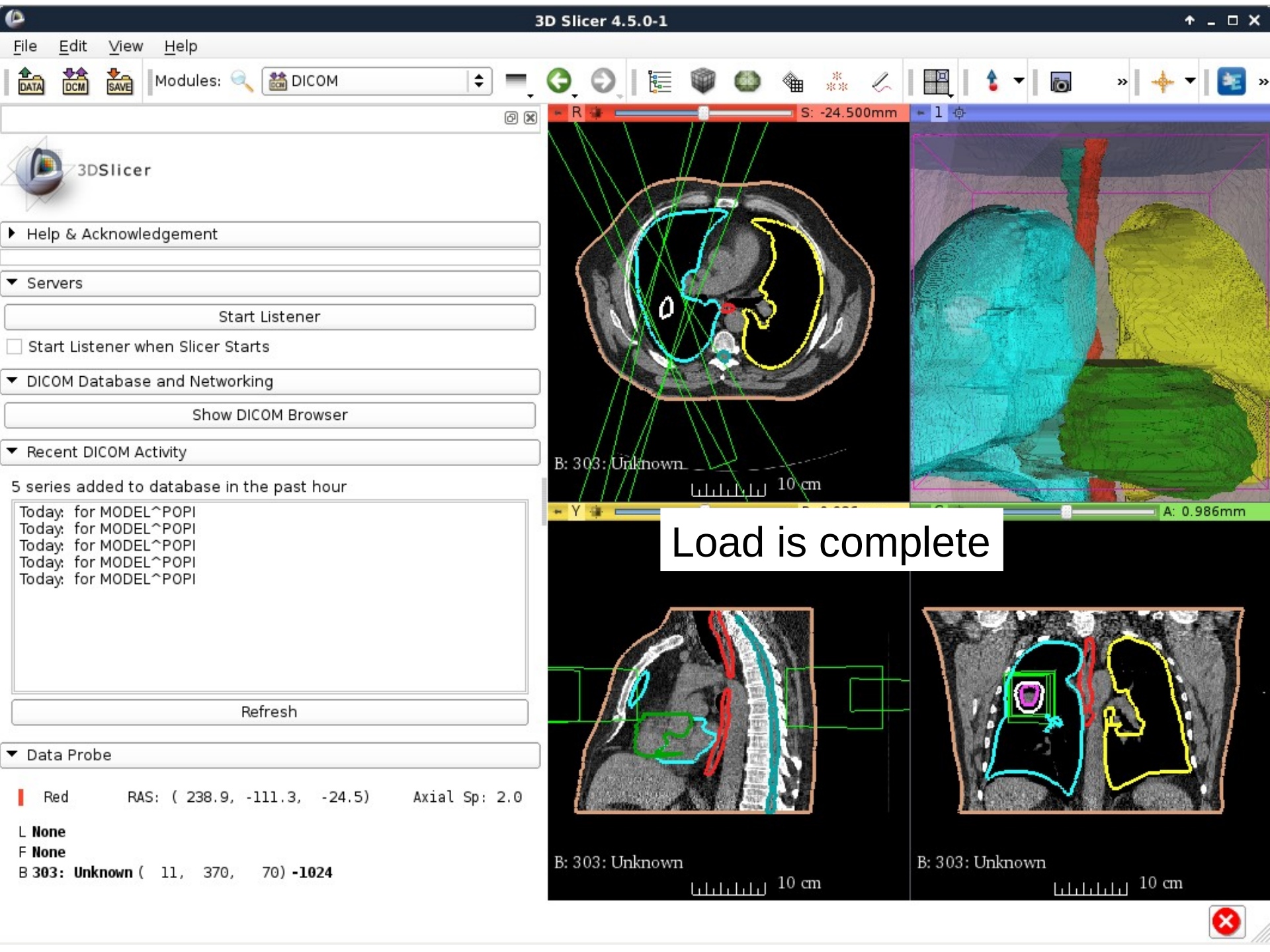

3D Slicer 4.5.0-1
File
Edit
View
Help
DICOM Browser
Import
Export
Query
Send
Remove
Repair
Patients:
Studies:
Series:
PatientsName
PatientID
PatientsBirthDate
PatientsBirthTime
PatientsSex
PatientsAge
StudyID
InstitutionName
SeriesNumber
SeriesDate
SeriesTime
SeriesDescription
Modality
BodyPartExamined
The DICOM Browser window will appear. Click “Import”.
DICOMScalarVolumePlugin
MultiVolumeImporterPlugin
DicomSroImportPlugin
DICOMDiffusionVolumePlugin
DICOMSlicerDataBundlePlugin
DicomRtImportExportPlugin
DICOM Data
Reader
Warnings
Load
Metadata
Examine
Uncheck All
Advanced
Horizontal
Browser Persistent
3DSlicer
Help & Acknowledgemer
Servers
Start Listener when Slic
DICOM Database and Ne
Recent DICOM Activity
0 series added to databas
Data Probe
Show Zoomed Slice


3D Slicer 4.5.0-1
File Edit View Help
DICOM Browser
Import Export Query Send Remove Repair
Patients: Studies: Series:
PatientsName PatientID PatientsBirthDate PatientsBirthTime PatientsSex PatientsAge
StudyID StudyDate
SeriesNumber
Import DICOM files from directory ...
Look in: /PHShome/gcs6/work/plastimatch-tutorial
gcs6
Testing
scratch
shared
data
popi-plan-2015-12-29
A file picker dialog will appear.
Choose the tutorial directory.
Then click “Import”
Directory: popi-plan-2015-12-29
Files of type: Directories
Copy on import
Import
Cancel
DICOMScalarVolumePlugin
MultiVolumeImporterPlugin
DicomSroImportPlugin
DICOMDiffusionVolumePlugin
DICOMSlicerDataBundlePlugin
DicomRtImportExportPlugin
Load Metadata Examine Uncheck All
Advanced Horizontal Browser Persistent
Help & Acknowledgemer
Servers
Start Listener when Slic
DICOM Database and Ne
Recent DICOM Activity
0 series added to databas
Data Probe
Show Zoomed Slice

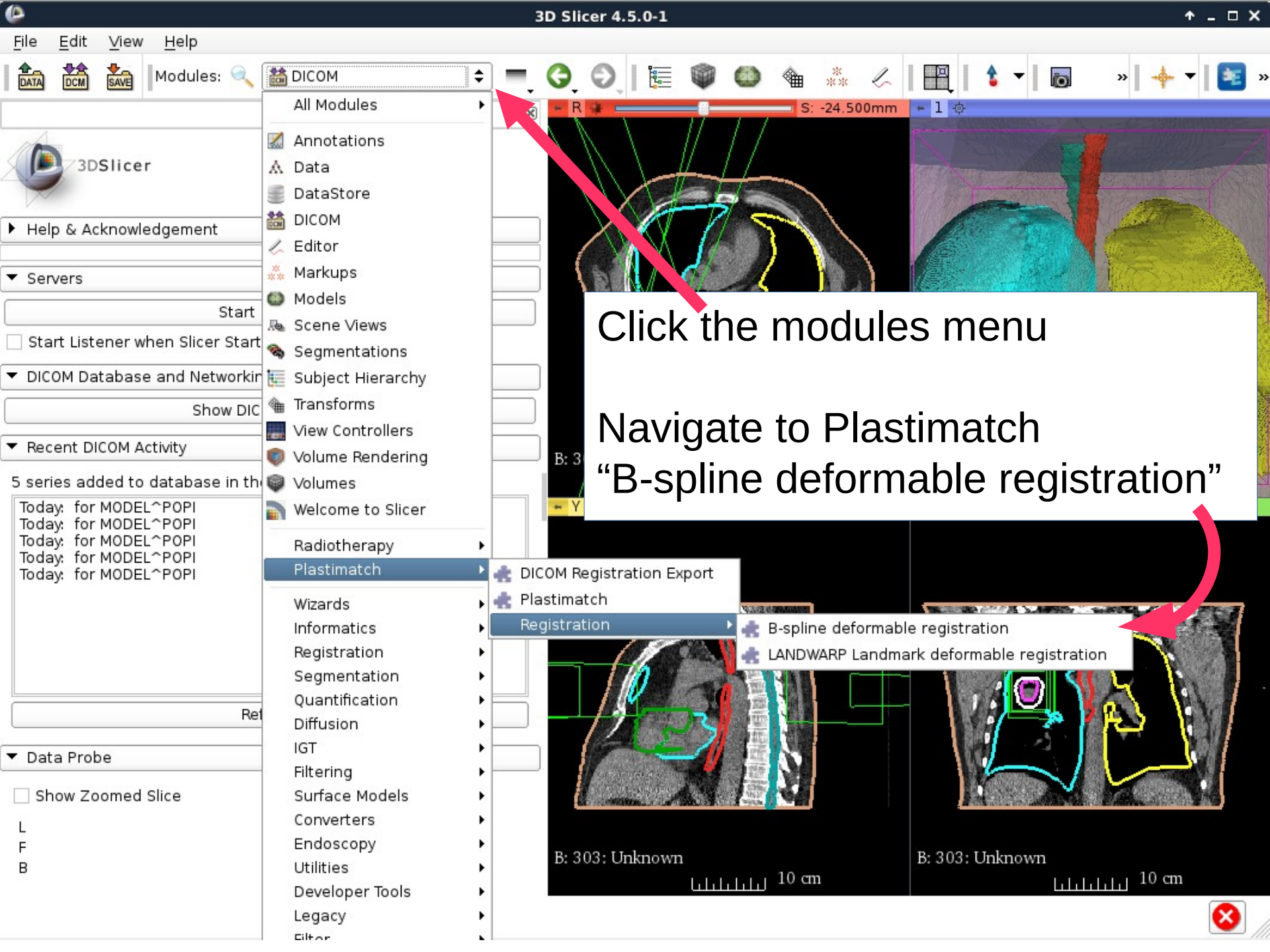

File
Edit
View
Help
Modules:
DICOM
3DSlicer
Help & Acknowledgement
Servers
Start Listener
Start Listener when Slicer Starts
DICOM Database and Networking
Show DICOM Browser
Recent DICOM Activity
0 series added to database in the past hour
Refresh
Data Probe
Show Zoomed Slice
L
F
B
S: 0.000mm
S
R
P
L
Import DICOM files from directory ...
Look in:
/PHShome/gcs6/work/plastimatch-tutorial
gcs6
Testing
scratch
shared
data
popi-plan-2015-12-29
Another dialog appears.
Choose “Add Link”
SlicerApp-real
Do you want to copy the files to the local database directory or just add the links?
Don't show this message again and always Copy
Copy
Add Link
Directory:
Files of type:
Directories
Import
Cancel
Copy on import
10 cm
10 cm

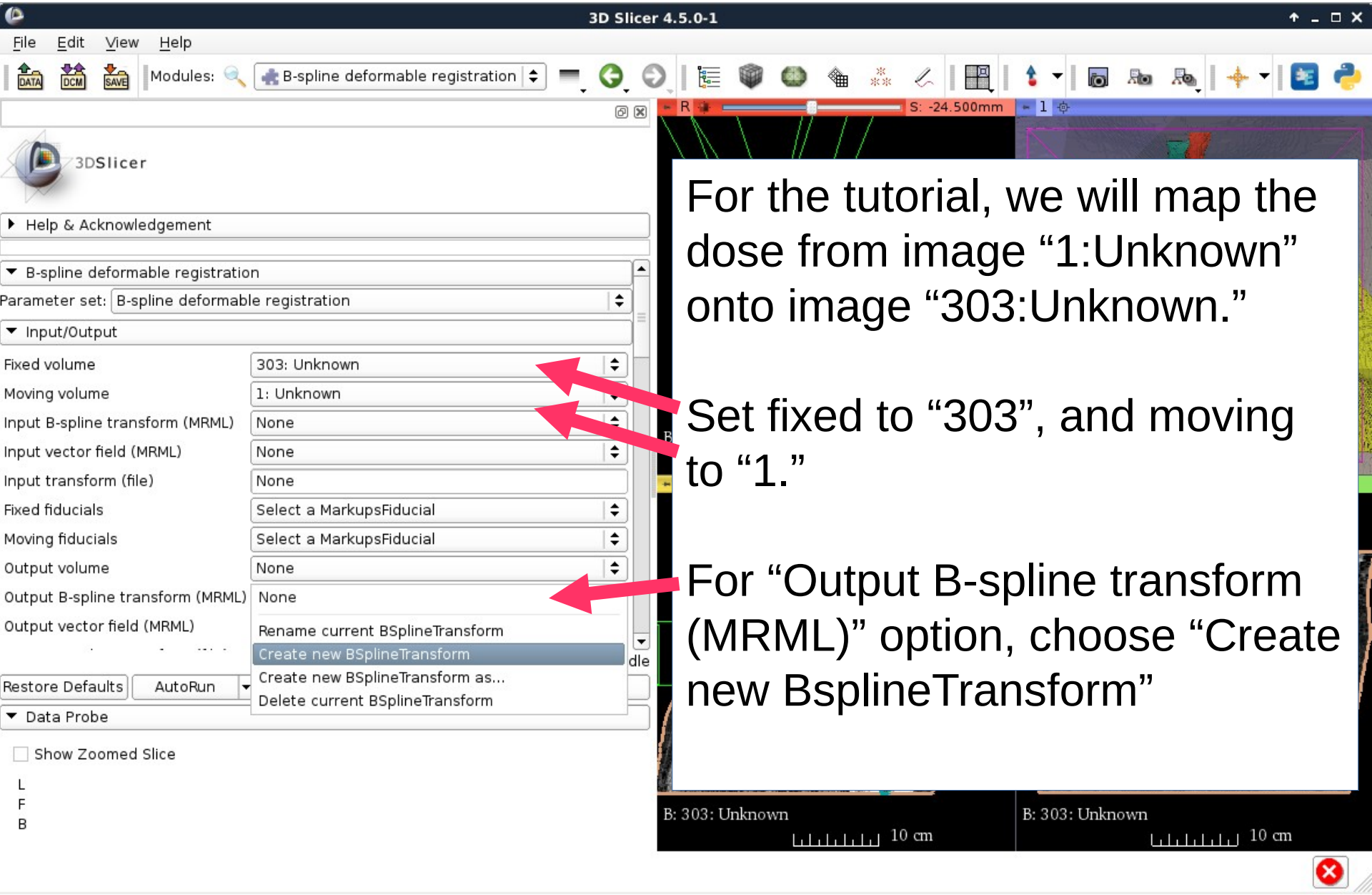

3D Slicer 4.5.0-1
File Edit View Help
Modules: DICOM
3DSlicer
Help & Acknowledgement
Servers
Start Listener
Start Listener when Slicer Starts
DICOM Database and Networking
Show DICOM Browse
Recent DICOM Activity
5 series added to database in the past hour
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Refresh
Data Probe
Show Zoomed Slice
L
F
B
DICOM Directory Import
Directory import completed.
2 New Patients
2 New Studies
116 New Series
285 New Instances
OK
Import DICOM files from directory ...
HShome/gcs6/work/plastimatch-tutorial
popi-plan-2015-12-29
3D_Slicer_Plastimatch_DICOM_RT_Tutorial.ppt
Testing
scratch
shared
data
Directory: popi-plan-2015-12-29
Files of type: Directories
Copy on import
Import
Cancel
Yet another dialog appears. Click “OK”.
S: 0.000mm
A: 0.000mm
S
R
P
L
10 cm
10 cm


3D Slicer 4.5.0-1
File
Edit
View
Help
DICOM Browser
Import
Export
Query
Send
Remove
Repair
Patients:
Studies:
Series:
PatientsName
PatientID
PatientsBirthDate
PatientsBirthTime
PatientsSex
PatientsAge
MODEL^POPI
00000000
1969-12-31
O
StudyID
POPI
10001
2015-12-27
SeriesNumber
0
1
1
1
303
CT
RTSTRUCT
RTPLAN
CT
DICOM Data
Reader
Warnings
DICOMScalarVolumePlugin
MultiVolumeImporterPlugin
DicomSroImportPlugin
DICOMDiffusionVolumePlugin
DICOMSlicerDataBundlePlugin
DicomRtImportExportPlugin
Load
Metadata
Examine
Advanced
Horizontal
Browser Persistent
Back to the DICOM Browser
Click on the patient “MODEL^POPI”
Then click “Examine”
Then click “Load”
3DSlicer
Help & Acknowledgemer
Servers
Start Listener when Slic
DICOM Database and Ne
Recent DICOM Activity
5 series added to databas
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Data Probe
Show Zoomed Slice
L
F
B


3D Slicer 4.5.0-1
File
Edit
View
Help
Modules:
DICOM
3DSlicer
Help & Acknowledgement
Servers
Start Listener
Start Listener when Slicer Starts
DICOM Database and Networking
Show DICOM Browser
Recent DICOM Activity
5 series added to database in the past hour
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Today: for MODEL^POPI
Refresh
Data Probe
Red RAS: (238.9, -111.3, -24.5) Axial Sp: 2.0
L None
F None
B 303: Unknown (11, 370, 70) -1024
R
S: -24.500mm
B: 303: Unknown
10 cm
1
Y
A: 0.986mm
Load is complete
B: 303: Unknown
10 cm
B: 303: Unknown
10 cm

Part 3: Running and Viewing Deformable Registration

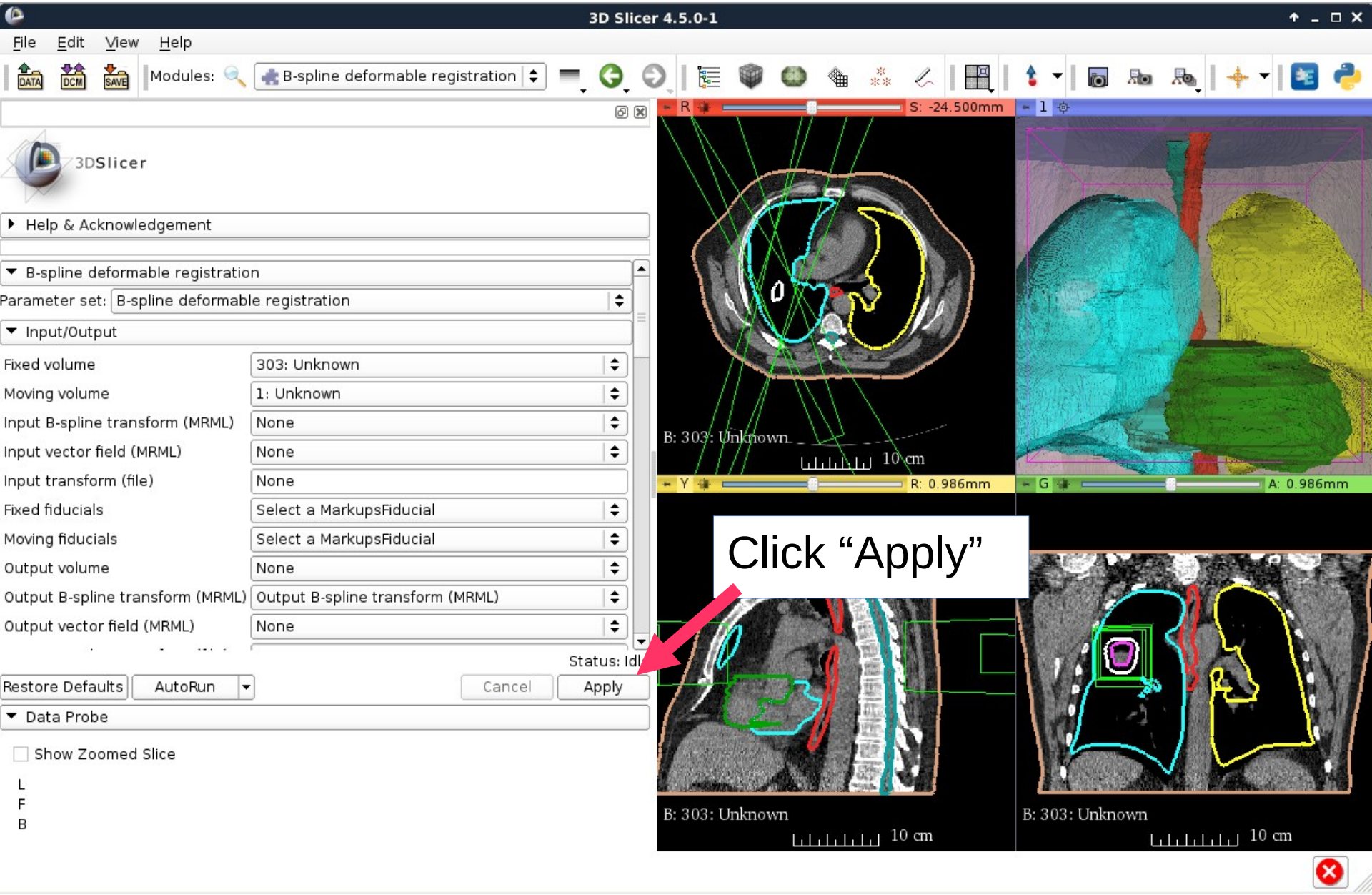

3D Slicer 4.5.0-1
File
Edit
View
Help
Modules:
DICOM
All Modules
Annotations
Data
DataStore
DICOM
Editor
Markups
Models
Scene Views
Segmentations
Subject Hierarchy
Transforms
View Controllers
Volume Rendering
Volumes
Welcome to Slicer
Radiotherapy
Plastimatch
Wizards
Informatics
Registration
Segmentation
Quantification
Diffusion
IGT
Filtering
Surface Models
Converters
Endoscopy
Utilities
Developer Tools
Legacy
DICOM Registration Export
Plastimatch
Registration
B-spline deformable registration
LANDWARP Landmark deformable registration
Click the modules menu
Navigate to Plastimatch
“B-spline deformable registration”
B: 303: Unknown
10 cm
B: 303: Unknown
10 cm

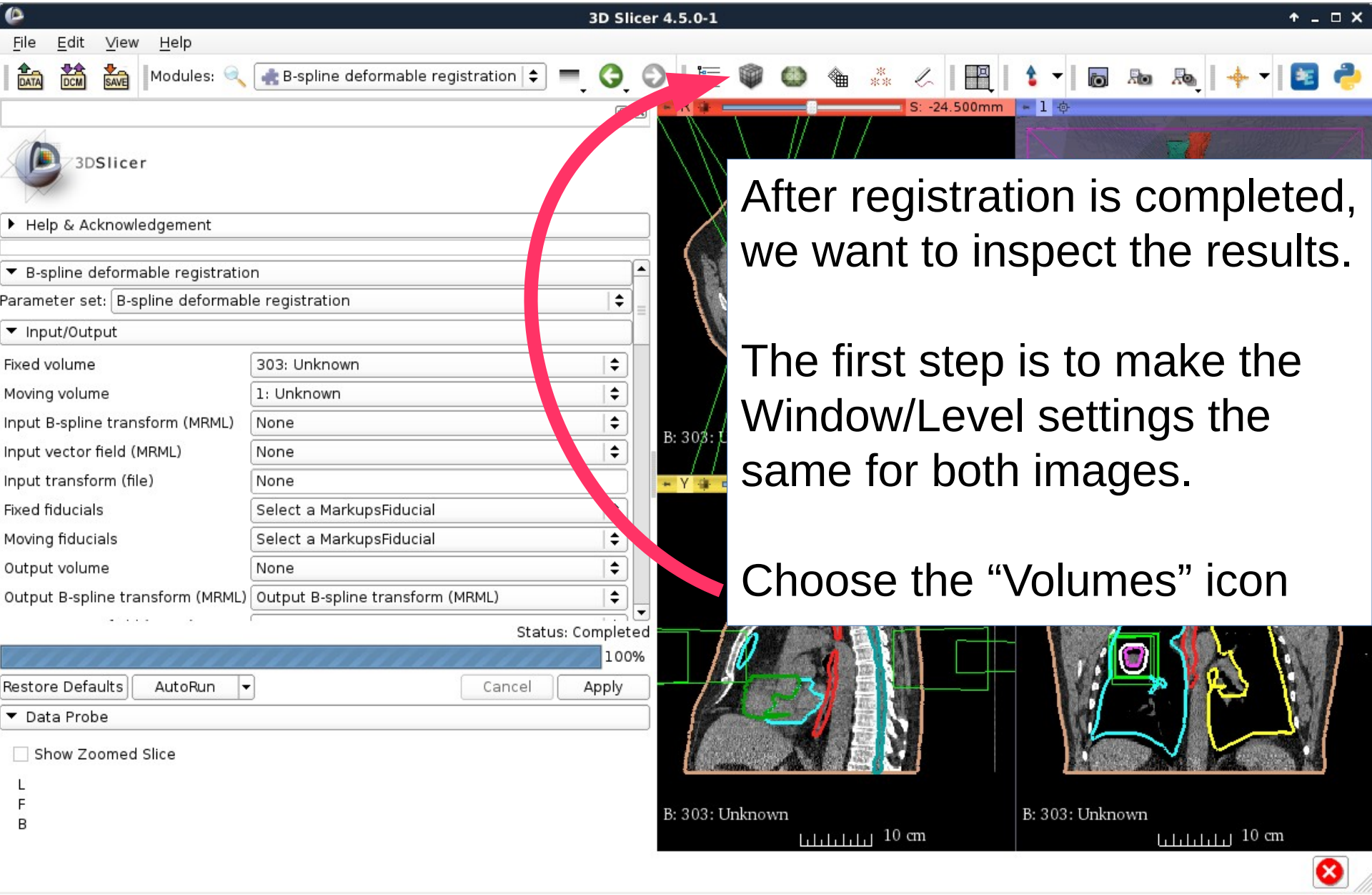


For the tutorial, we will map the dose from image “1:Unknown” onto image “303:Unknown.”

Set fixed to “303”, and moving to “1.”

For “Output B-spline transform (MRML)” option, choose “Create new BsplineTransform”

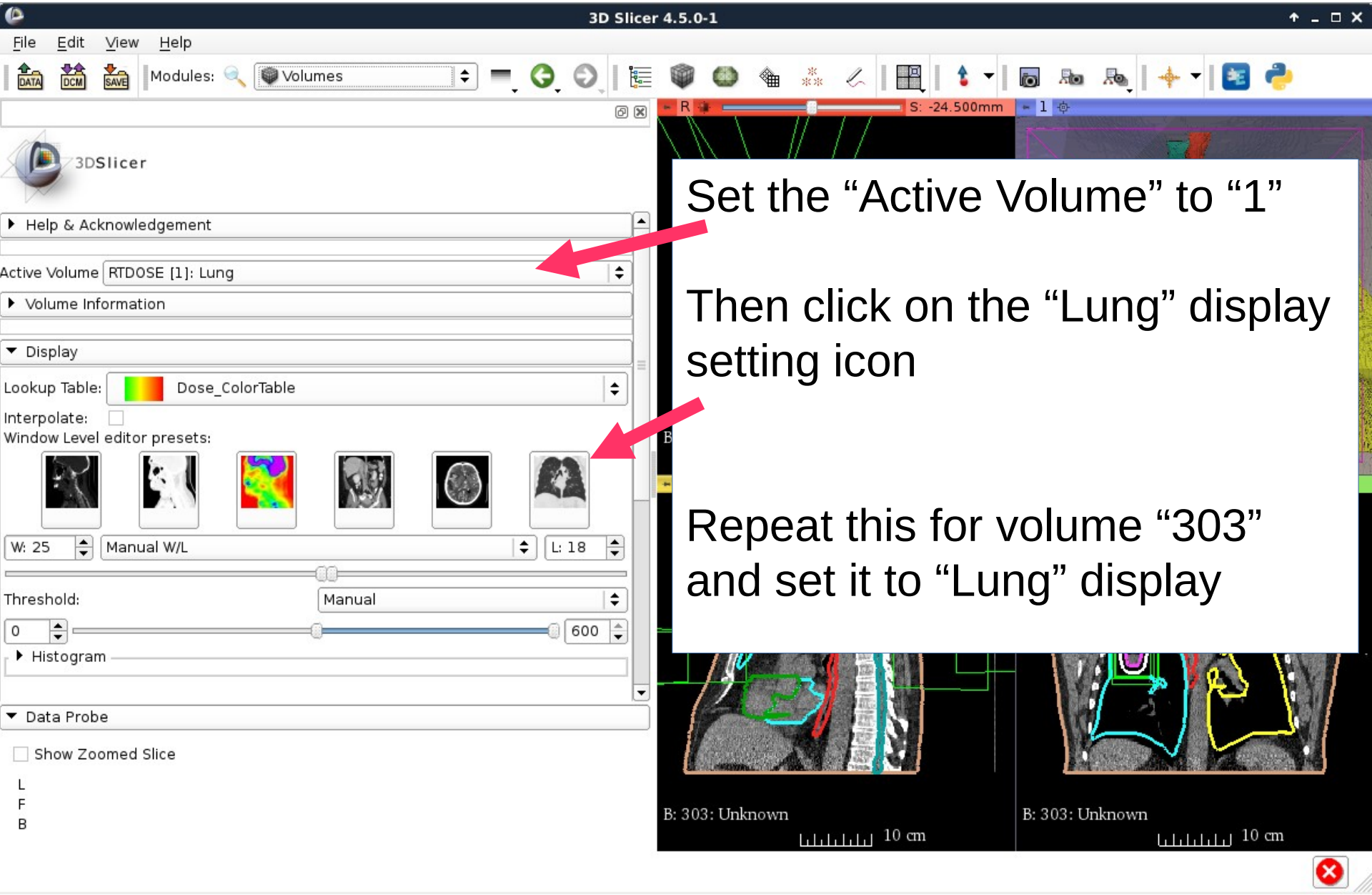

3D Slicer 4.5.0-1
File Edit View Help
Modules:
B-spline deformable registration
3DSlicer
Help & Acknowledgement
B-spline deformable registration
Parameter set: B-spline deformable registration
Input/Output
Fixed volume 303: Unknown
Moving volume 1: Unknown
Input B-spline transform (MRML) None
Input vector field (MRML) None
Input transform (file) None
Fixed fiducials Select a MarkupsFiducial
Moving fiducials Select a MarkupsFiducial
Output volume None
Output B-spline transform (MRML) Output B-spline transform (MRML)
Output vector field (MRML) None
Status: Idl
Restore Defaults
AutoRun
Cancel
Apply
Data Probe
Show Zoomed Slice
L
F
B
R S: -24.500mm
B: 303: Unknown
10 cm
1
Y R: 0.986mm
G A: 0.986mm
Click “Apply”
B: 303: Unknown
10 cm
B: 303: Unknown
10 cm



After registration is completed, we want to inspect the results.

The first step is to make the Window/Level settings the same for both images.

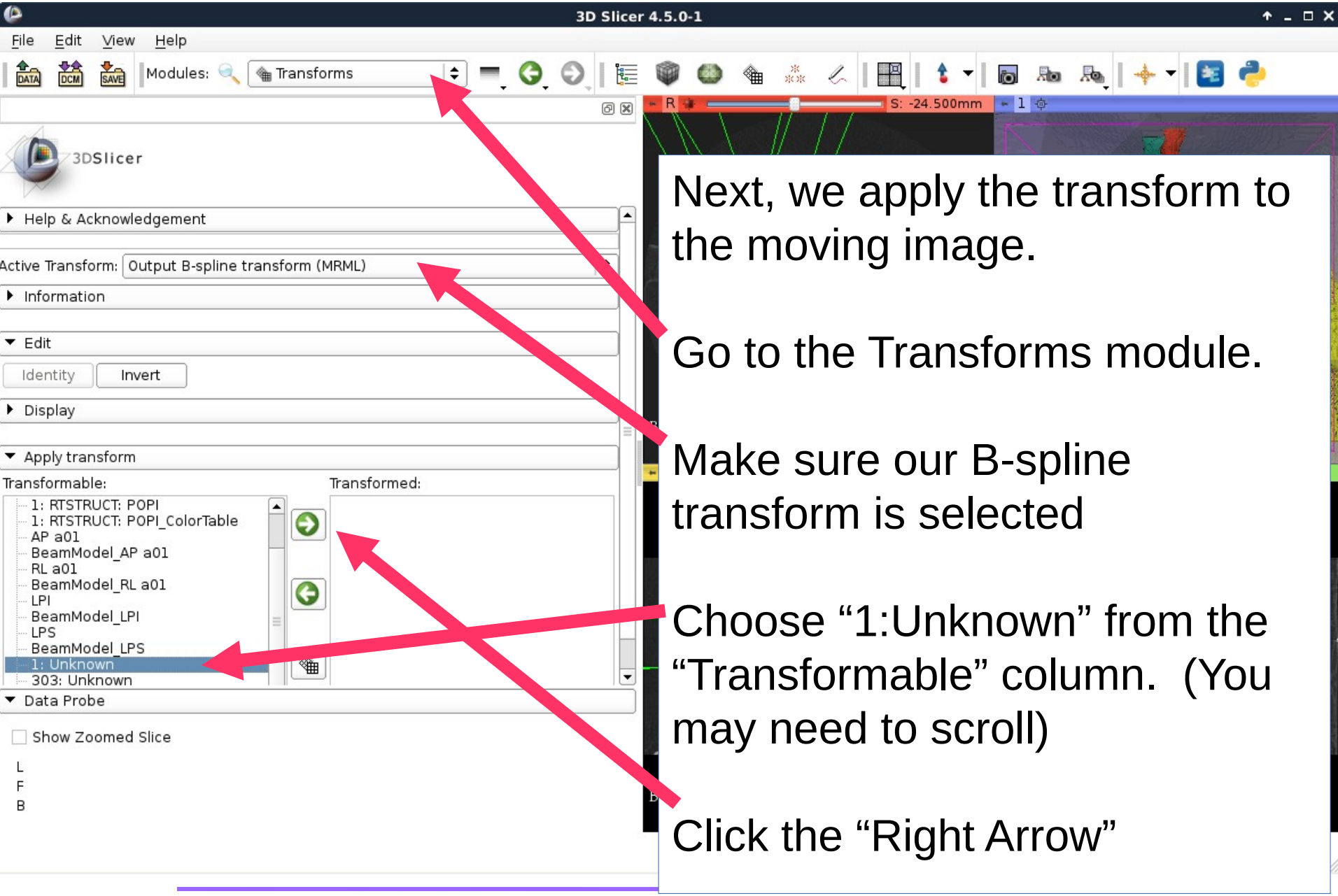
Choose the “Volumes” icon



Set the “Active Volume” to “1”

Then click on the “Lung” display setting icon

Repeat this for volume “303” and set it to “Lung” display



Next, we apply the transform to the moving image.

Go to the Transforms module.

Make sure our B-spline transform is selected

Choose “1:Unknown” from the “Transformable” column. (You may need to scroll)

Click the “Right Arrow”

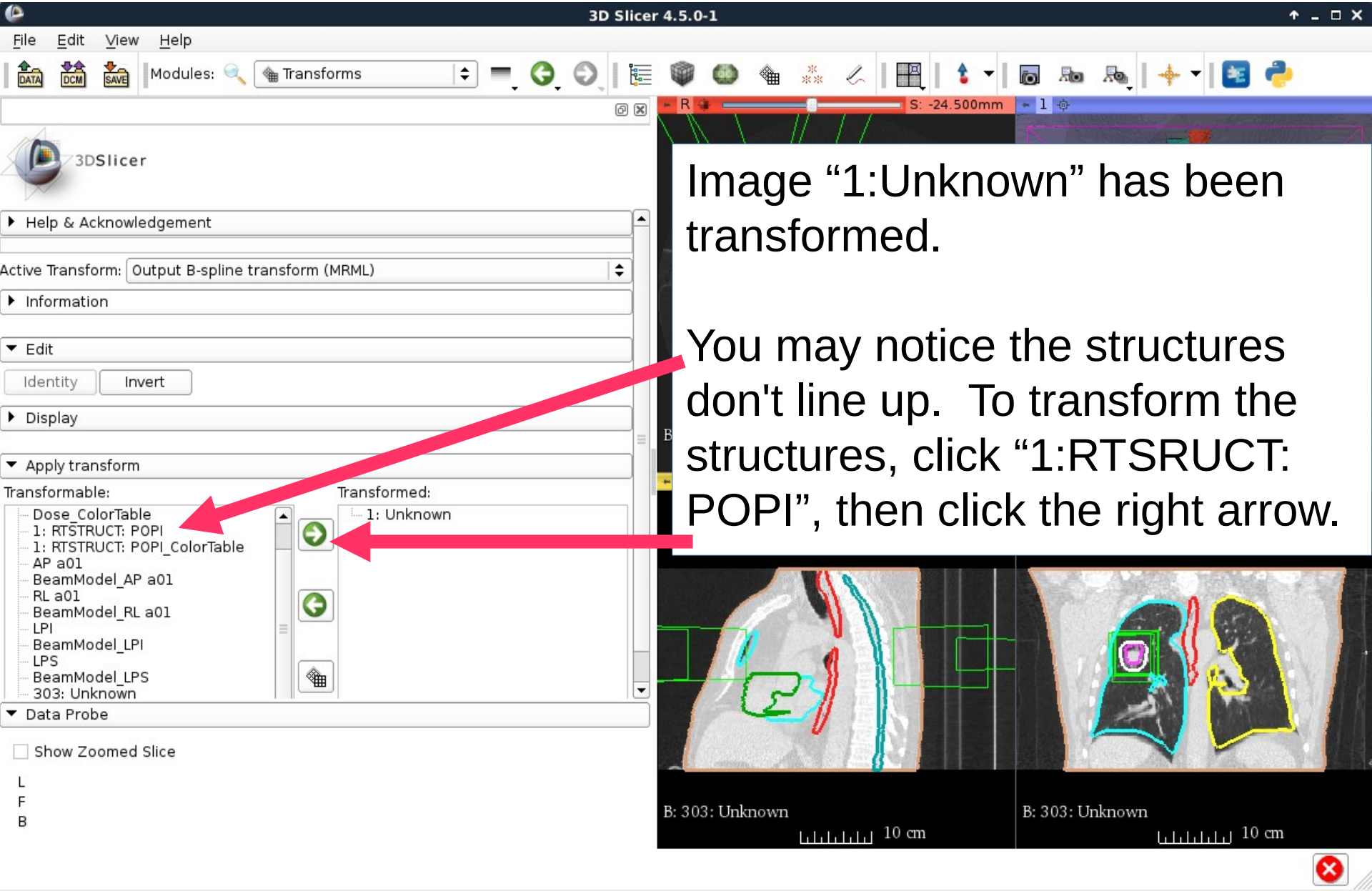
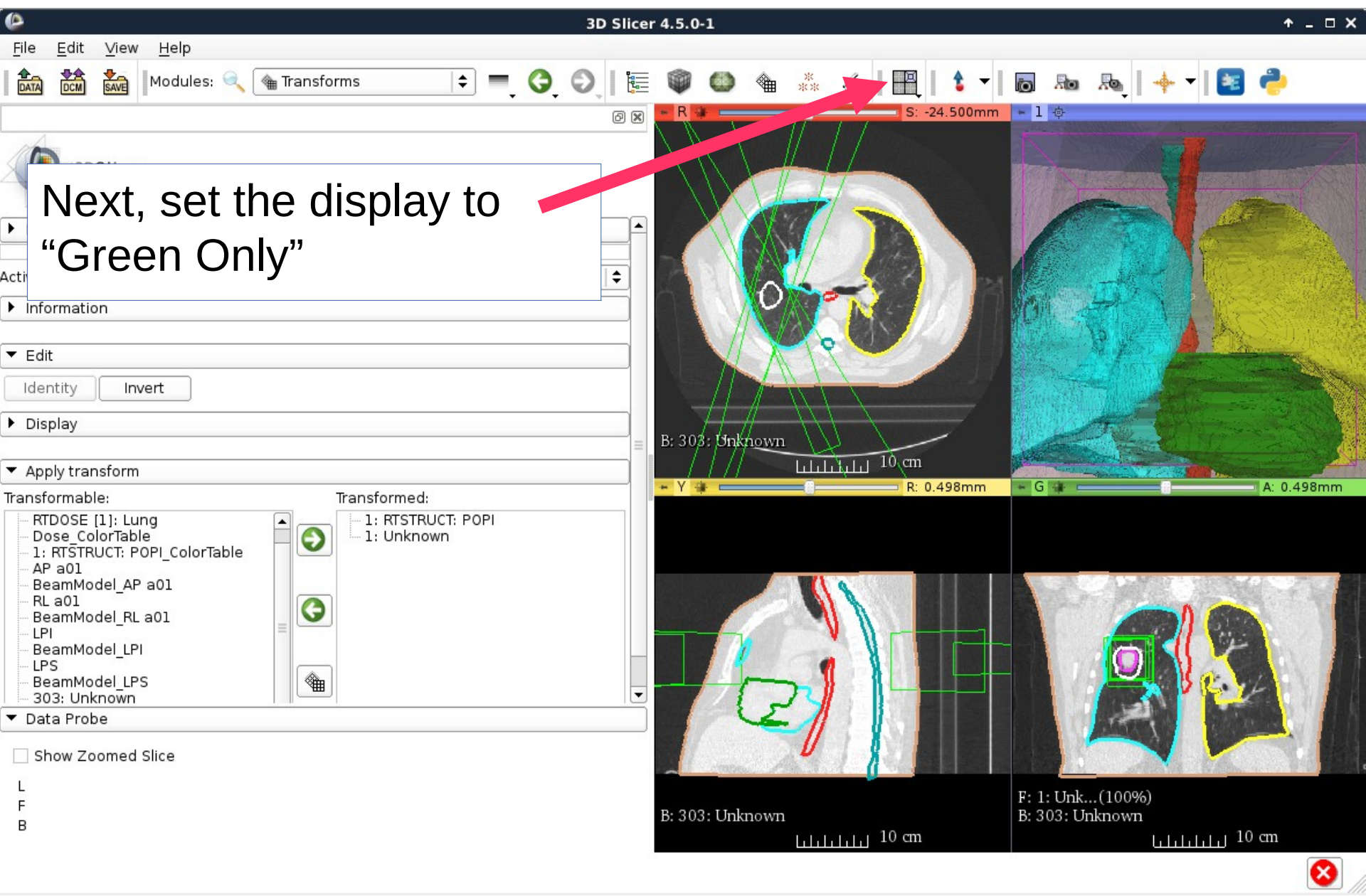
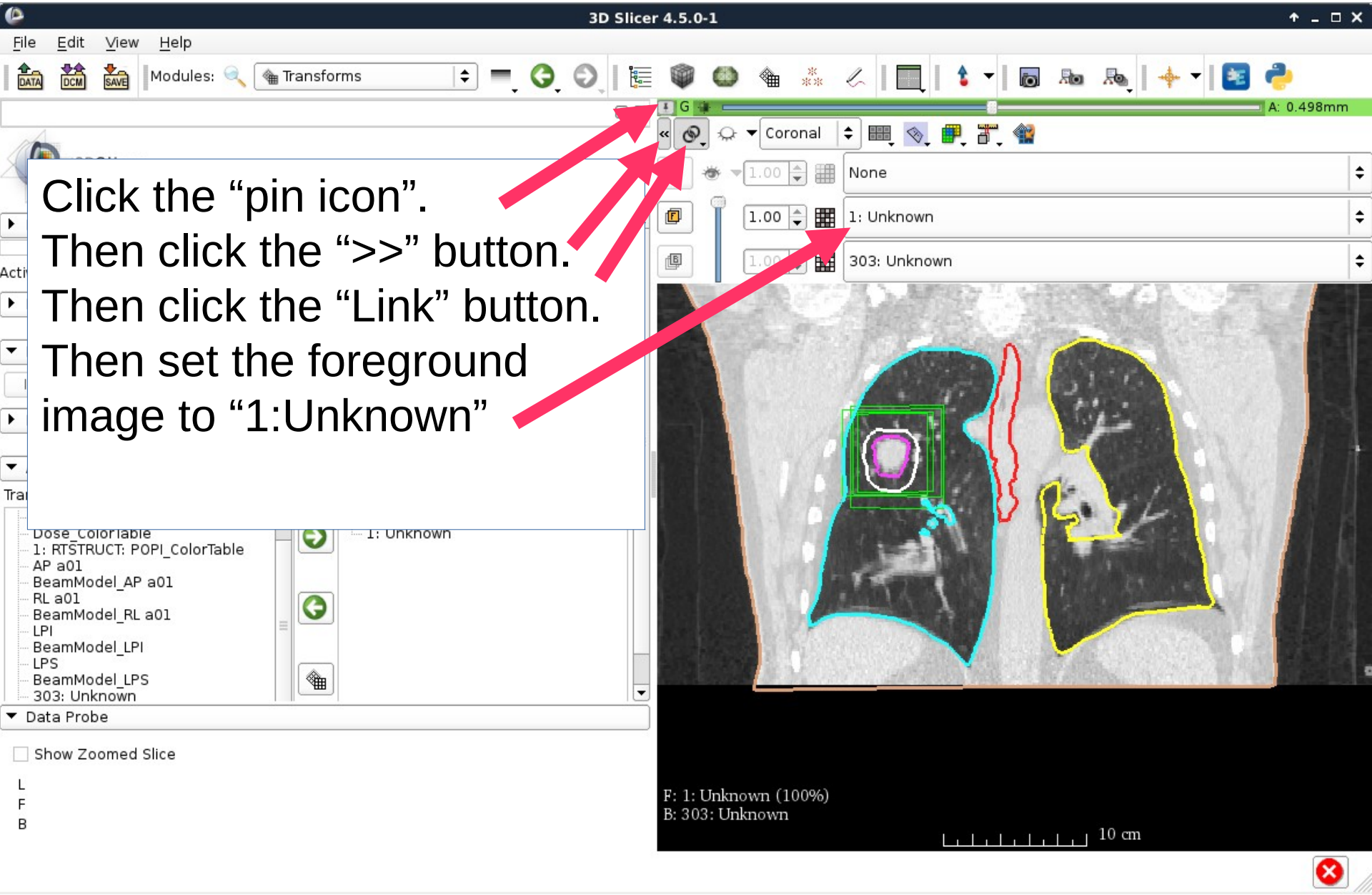


Image “1:Unknown” has been transformed.

You may notice the structures don't line up. To transform the structures, click “1:RTSRUCT: POPI”, then click the right arrow.

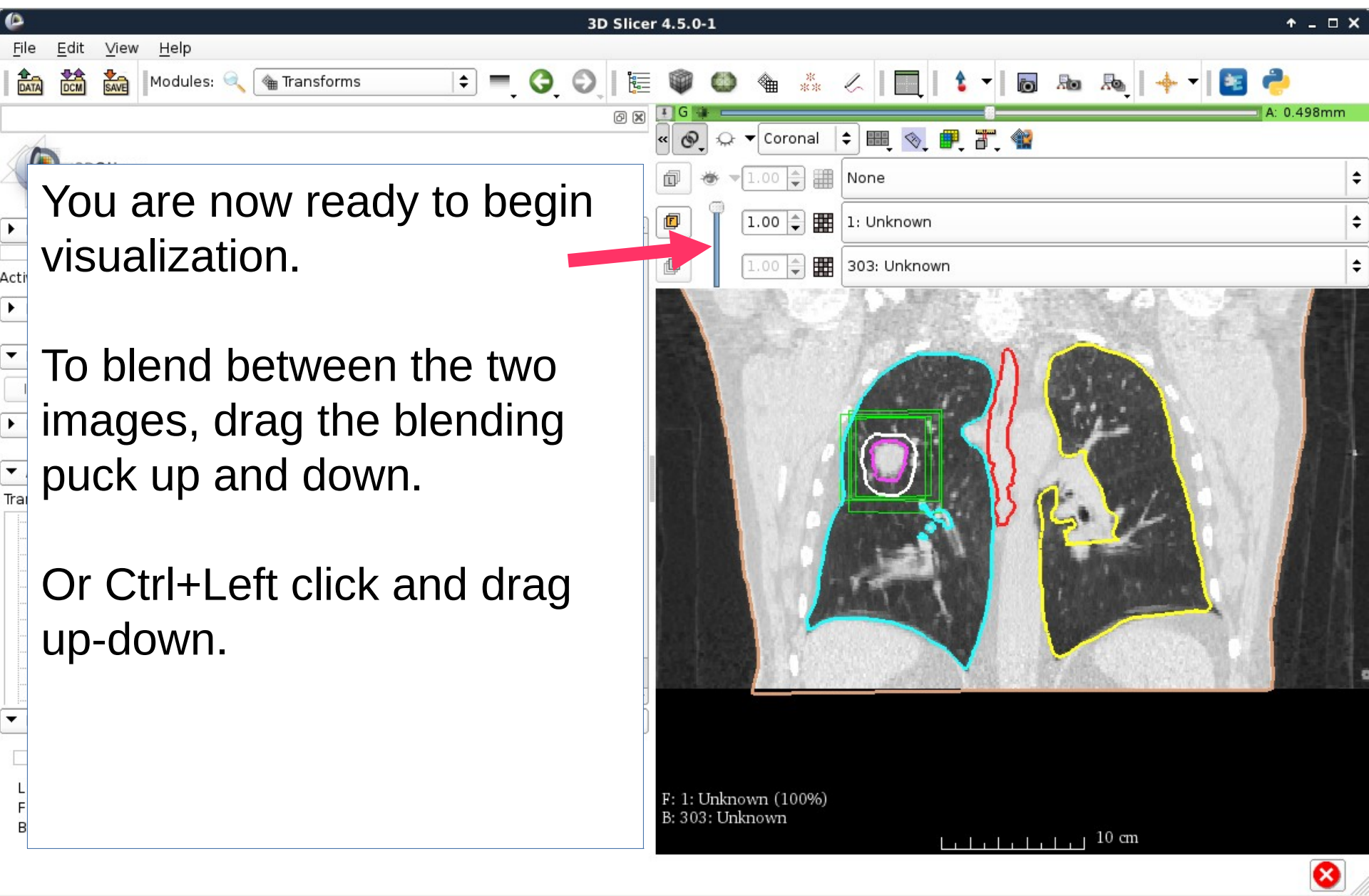

3D Slicer 4.5.0-1
File
Edit
View
Help
Modules:
Transforms
Next, set the display to "Green Only"
Information
Edit
Identity
Invert
Display
Apply transform
Transformable:
RTDOSE [1]: Lung
Dose_ColorTable
1: RTSTRUCT: POPI_ColorTable
AP a01
BeamModel_AP a01
RL a01
BeamModel_RL a01
LPI
BeamModel_LPI
LPS
BeamModel_LPS
303: Unknown
Transformed:
1: RTSTRUCT: POPI
1: Unknown
Data Probe
Show Zoomed Slice
L
F
B
R
S: -24.500mm
B: 303: Unknown
10 cm
1
Y
R: 0.498mm
G
A: 0.498mm
B: 303: Unknown
10 cm
F: 1: Unk...(100%)
B: 303: Unknown
10 cm


3D Slicer 4.5.0-1
File
Edit
View
Help
Modules:
Transforms
Click the “pin icon”.
Then click the “>>” button.
Then click the “Link” button.
Then set the foreground image to “1:Unknown”
Coronal
None
1: Unknown
303: Unknown
Dose_ColorTable
1: RTSTRUCT: POPI_ColorTable
AP a01
BeamModel_AP a01
RL a01
BeamModel_RL a01
LPI
BeamModel_LPI
LPS
BeamModel_LPS
303: Unknown
Data Probe
Show Zoomed Slice
F: 1: Unknown (100%)
B: 303: Unknown
10 cm

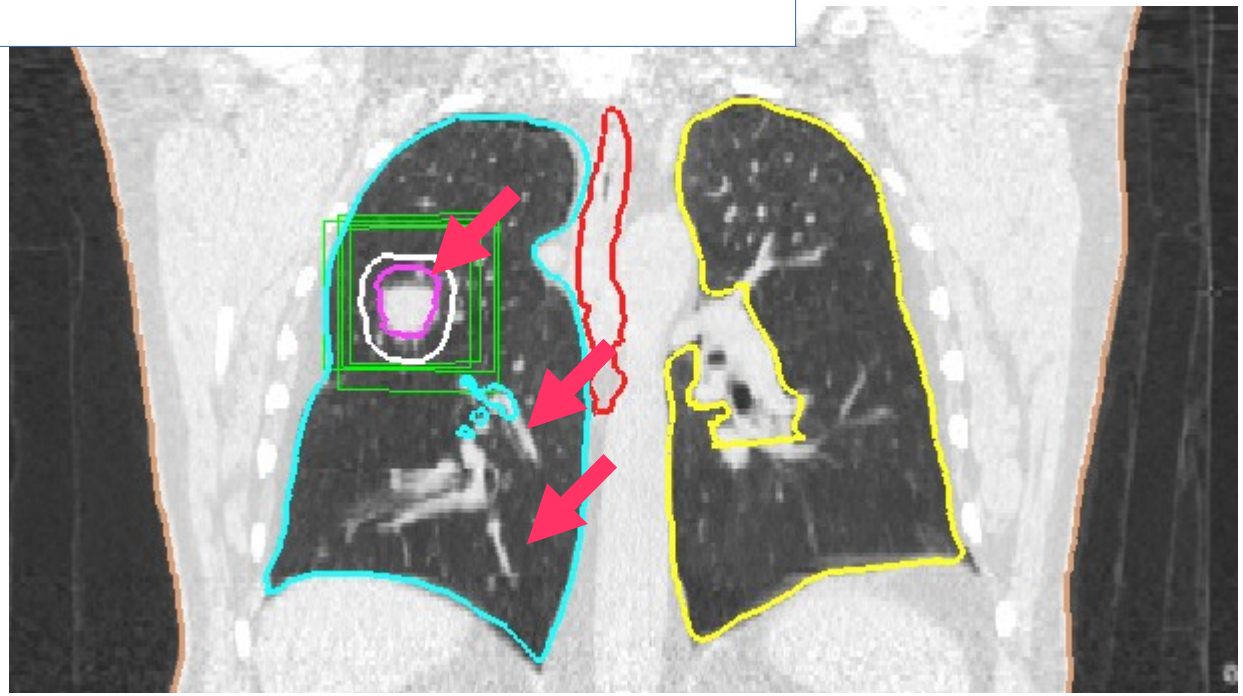
You are now ready to begin visualization.

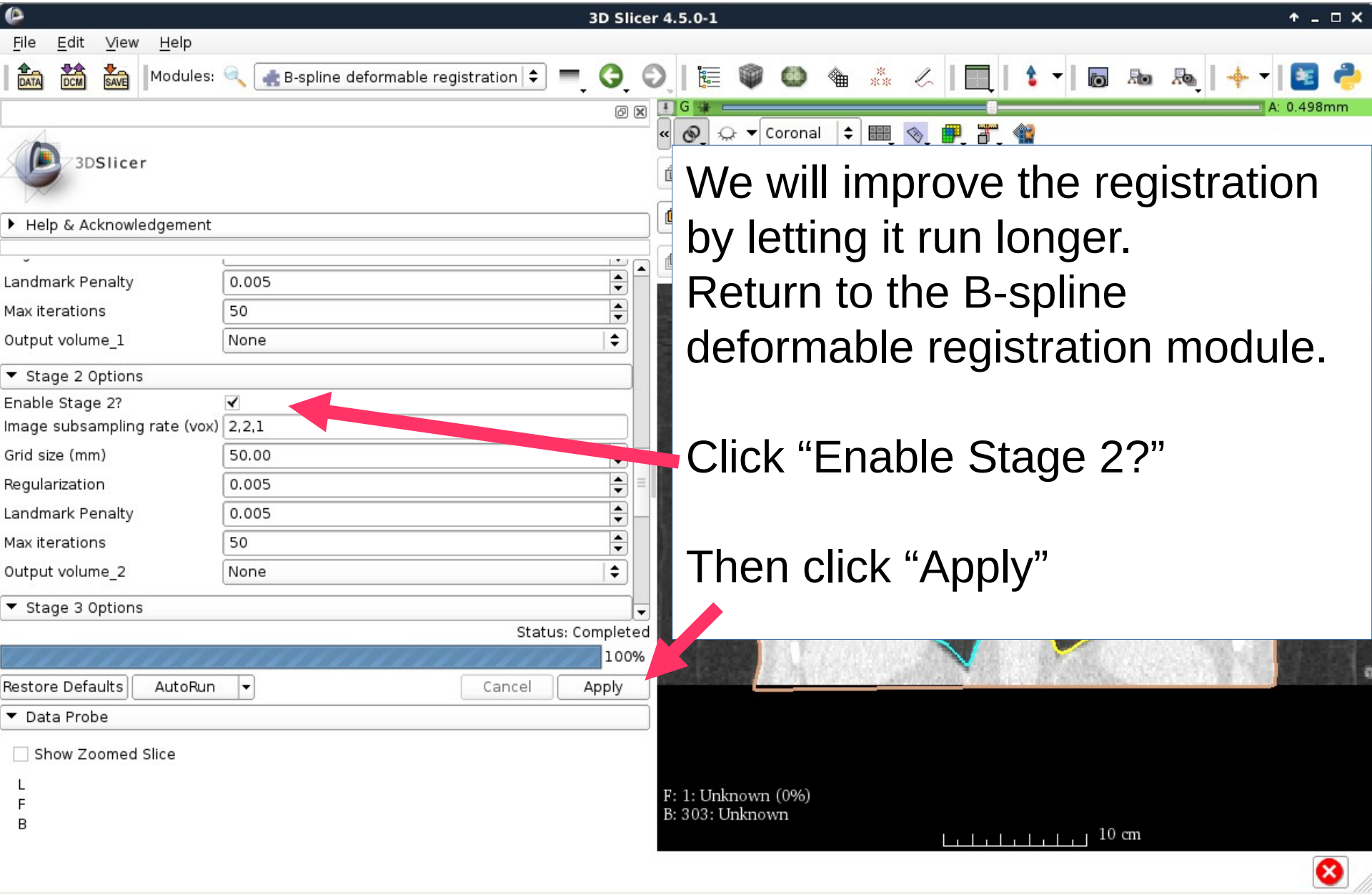
To blend between the two images, drag the blending puck up and down.

Or Ctrl+Left click and drag up-down.



The registration result is fair.
The diaphragm is aligned, but tumor and vessels need improvement.



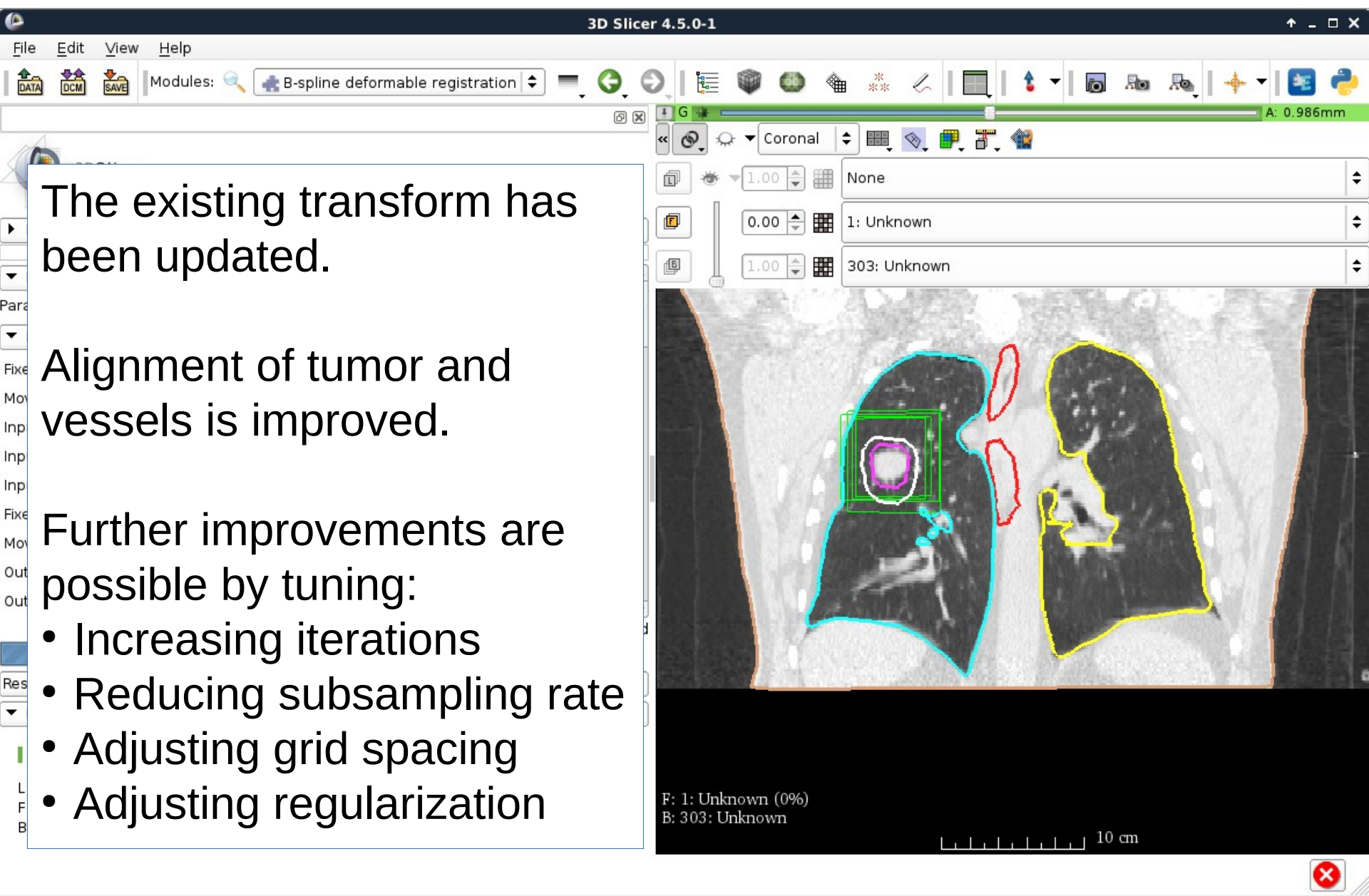

3D Slicer 4.5.0-1
File Edit View Help
Modules: B-spline deformable registration
3DSlicer
Help & Acknowledgement
Landmark Penalty 0.005
Max iterations 50
Output volume_1 None
Stage 2 Options
Enable Stage 2?
Image subsampling rate (vox) 2,2,1
Grid size (mm) 50.00
Regularization 0.005
Landmark Penalty 0.005
Max iterations 50
Output volume_2 None
Stage 3 Options
Status: Completed
100%
Restore Defaults
AutoRun
Cancel
Apply
Data Probe
Show Zoomed Slice
L
F
B
Coronal
A: 0.498mm
We will improve the registration by letting it run longer.
Return to the B-spline deformable registration module.
Click “Enable Stage 2?”
Then click “Apply”
F: 1: Unknown (0%)
B: 303: Unknown
10 cm

The existing transform has been updated.

Alignment of tumor and vessels is improved.

Further improvements are possible by tuning:

- Increasing iterations
- Reducing subsampling rate
- Adjusting grid spacing
- Adjusting regularization



Part 4: Exporting DICOM-RT Data

(This part of the tutorial is under construction)

Conclusion

Congratulations! You have completed the tutorial.

Please send corrections or suggestions to:

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Or visit the web page at:

http://plastimatch.org

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