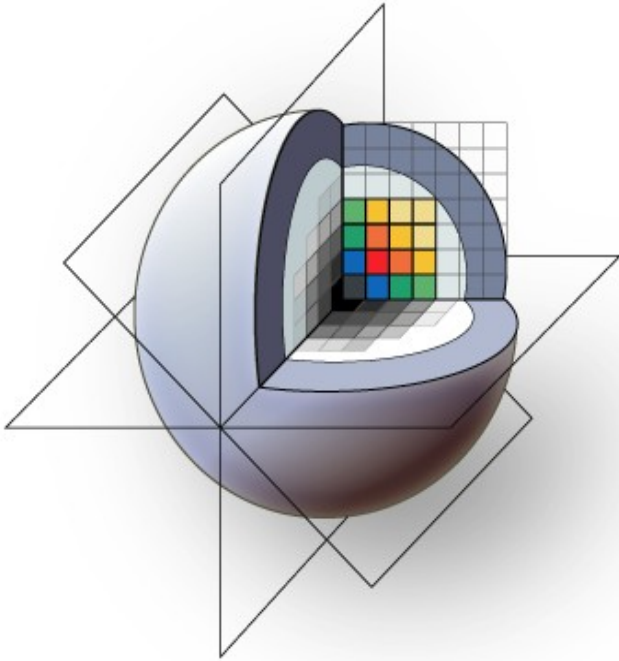




3D Slicer Training Compendium

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.

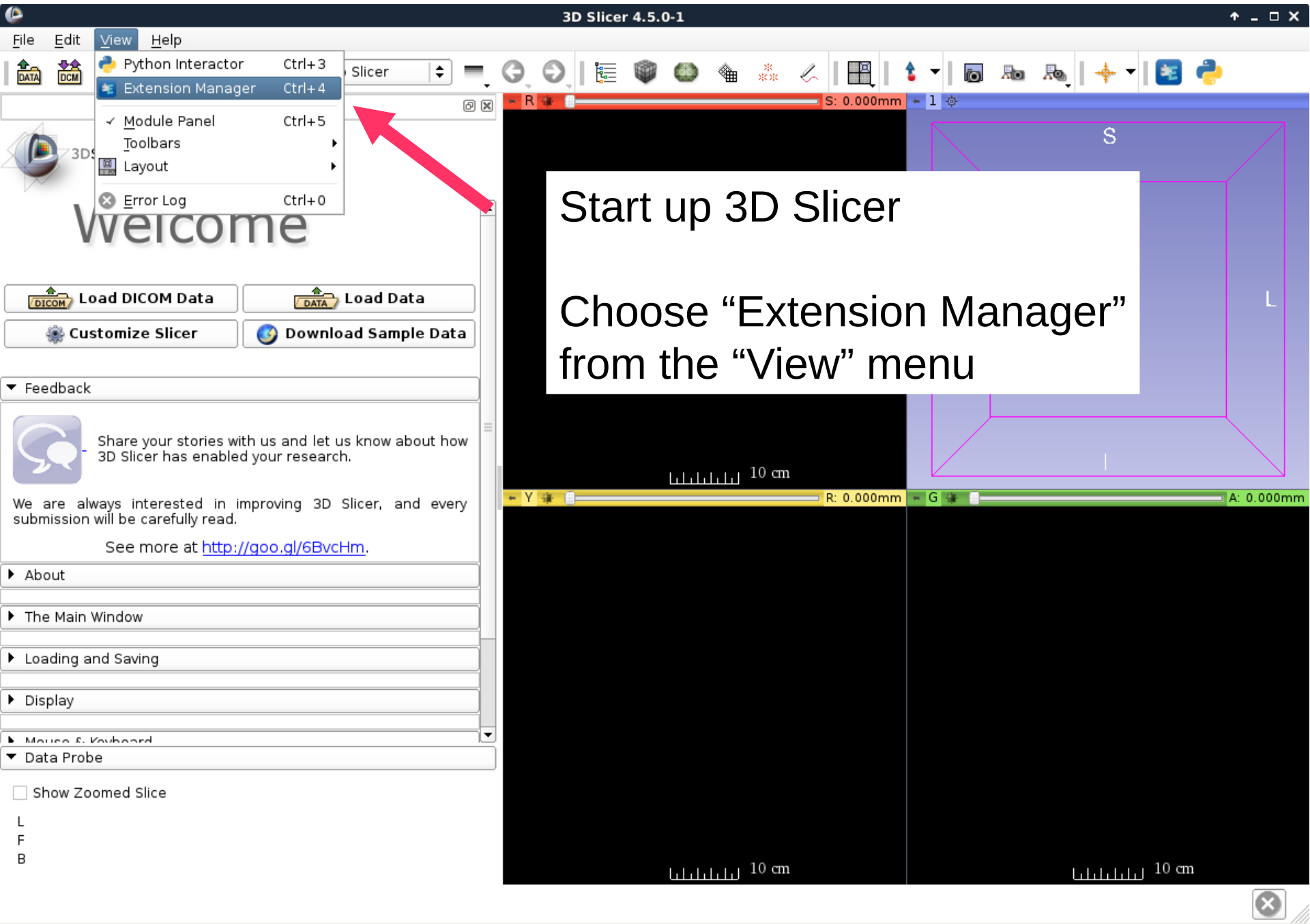
<http://bit.ly/1mgOUXh>



Part 1: Downloading the Plastimatch Extension

Plastimatch is distributed with the SlicerRT extension





Start up 3D Slicer

Choose "Extension Manager" from the "View" menu



Extensions Manager

Manage Extensions (0) | Install Extensions

Search...

Extension Name	Author	Stars	Install Button
PET-SEG	Christian Bauer (Univ...)	(0)	INSTALL
SlicerRT	Csaba Pinter (PerkLa...)	(0)	INSTALL
Percutaneous Approach Analysis	Koichiro Murakami (S...)	(0)	INSTALL
PetSpectAnalysis	Martin Bertran, Nata...	(0)	INSTALL
Pick'N Paint	Lucie Macron (Univer...)	(0)	INSTALL
Q3DC			INSTALL
Resection Planner	Lougheed (Que...)	(0)	INSTALL
PerkTutor	Tamas Ungi, Matthew.	(0)	INSTALL
Reporting	Andrey Fedorov (SPL...)	(0)	INSTALL

**Find the SlicerRT extension
Then click "INSTALL"**

Restart | Close



Extensions Manager

Manage Extensions (1) | Install Extensions | Search...

Extension Name	Author	Rating	Action
PET-SEG	Christian Bauer (Univ..)	0	INSTALL
SlicerRT	Csaba Pinter (PerkLa..)	0	UNINSTALL
Percutaneous Approach Analysis	Koichiro Murakami (S..)	0	INSTALL
PetSpectAnalysis	Martin Bertran, Nata...	0	INSTALL
Pick'N Paint	Lucie Macron (Univer..)	0	INSTALL
Q3DC	Lucie Macron (Univer..)	0	INSTALL
PkModeling	Yingxuan Zhu (GE), J...	0	INSTALL
Resection Planner	Matt Loughheed (Que...	0	INSTALL
PerkTutor	Tamas Ungi, Matthew.	0	INSTALL
Reporting	Andrey Fedorov (SPL...	0	INSTALL

Click "Restart" to restart Slicer



* Restart requested



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

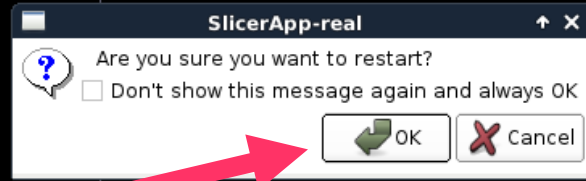
Display

Mouse & Keyboard

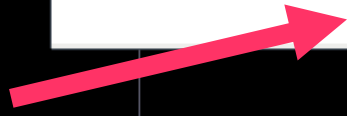
Data Probe

Show Zoomed Slice

L
F
B



Click "OK"



Part 2: Loading the DICOM and DICOM-RT data

File Edit View Help

Modules: Welcome to 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

Data Probe

Green RAS: (291.0, -1.0, -15.4) Coronal Sp: 1.0

L None

F None

B None



File Edit View Help

DATA DCM SAVE Module

3DSlicer

Help & Acknowledgements

Servers

Start Listener when Slicer starts

DICOM Database and Network

Recent DICOM Activity

0 series added to database

Data Probe

Show Zoomed Slice

L
F
B

DICOM Browser

Import Export Query Send Remove Repair >>

Patients: [] Studies: [] Series: []

PatientsName	PatientID	PatientsBirthDate	PatientsBirthTime	PatientsSex	PatientsAge
--------------	-----------	-------------------	-------------------	-------------	-------------

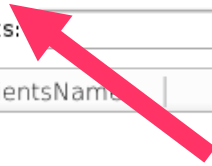
StudyID | StudyDate | InstitutionName | R

SeriesNumber	SeriesDate	SeriesTime	SeriesDescription	Modality	BodyPartExamined	A
--------------	------------	------------	-------------------	----------	------------------	---

DICOMScalarVolumePlugin
 MultiVolumeImporterPlugin
 DicomSroImportPlugin
 DICOMDiffusionVolumePlugin
 DICOMSlicerDataBundlePlugin
 DicomRtImportExportPlugin

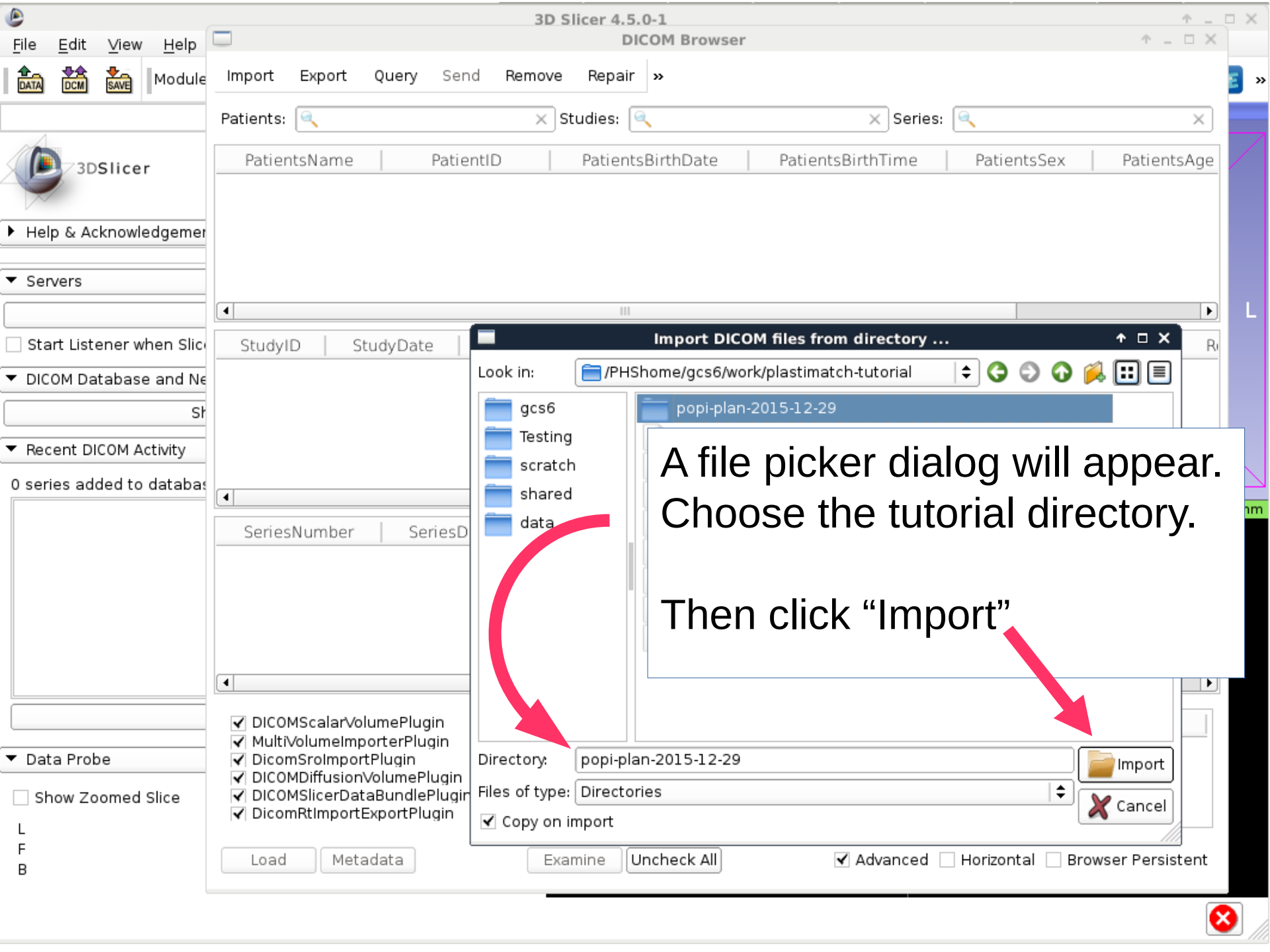
DICOM Data	Reader	Warnings
------------	--------	----------

Load Metadata Examine Uncheck All Advanced Horizontal Browser Persistent



The DICOM Browser window will appear. Click "Import".





Import Export Query Send Remove Repair >>

Patients: [search] Studies: [search] Series: [search]

PatientsName | PatientID | PatientsBirthDate | PatientsBirthTime | PatientsSex | PatientsAge

StudyID | StudyDate

SeriesNumber | SeriesD

- DICOMScalarVolumePlugin
- MultiVolumeImporterPlugin
- DicomSrolImportPlugin
- DICOMDiffusionVolumePlugin
- DICOMSlicerDataBundlePlugin
- DicomRtImportExportPlugin

Load Metadata

Examine Uncheck All

Advanced Horizontal Browser Persistent

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"

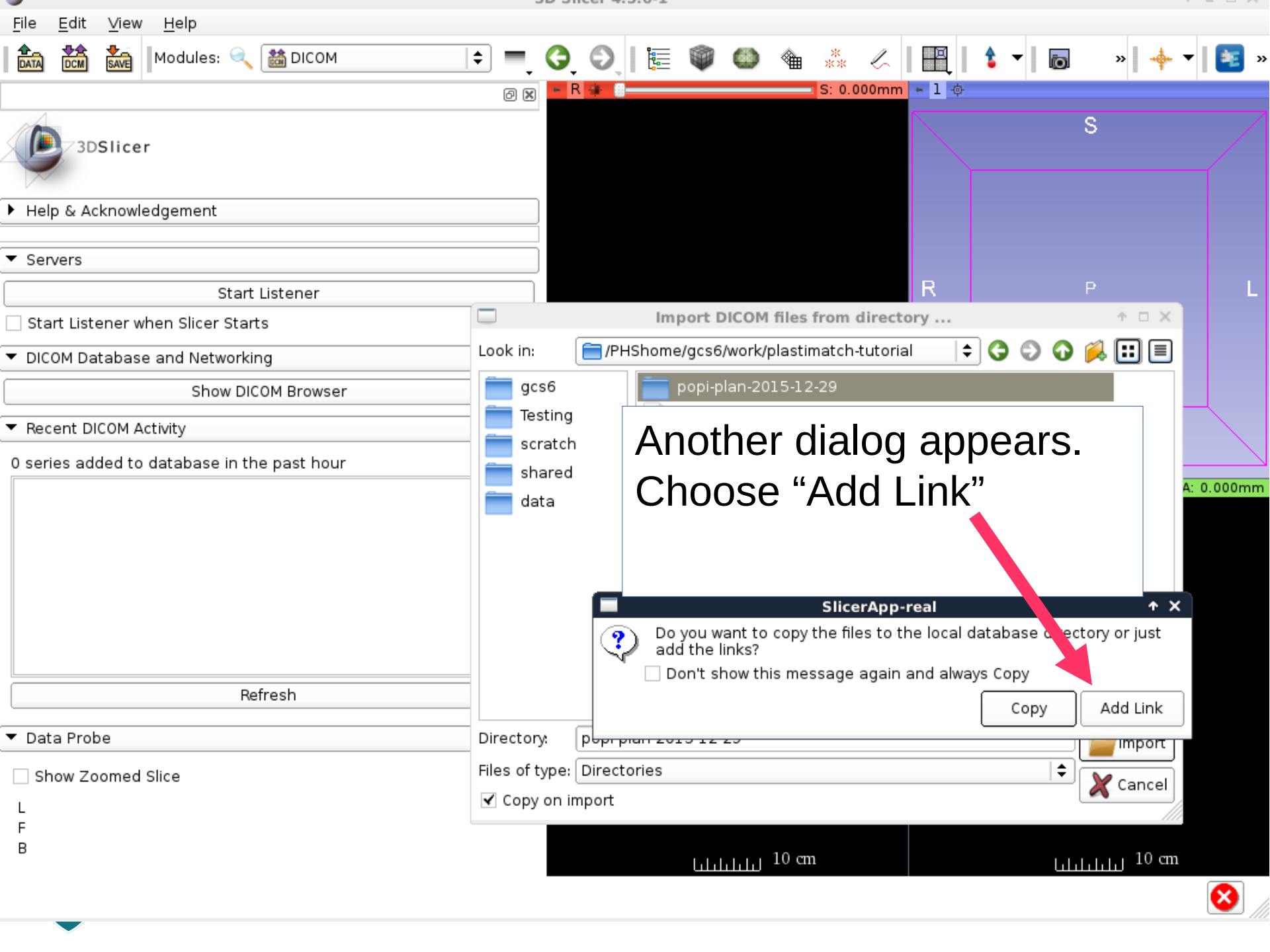
Directory: popi-plan-2015-12-29

Files of type: Directories

Copy on import

Import
Cancel





Help & Acknowledgement

Servers

Start Listener

Start Listener when Slicer Starts

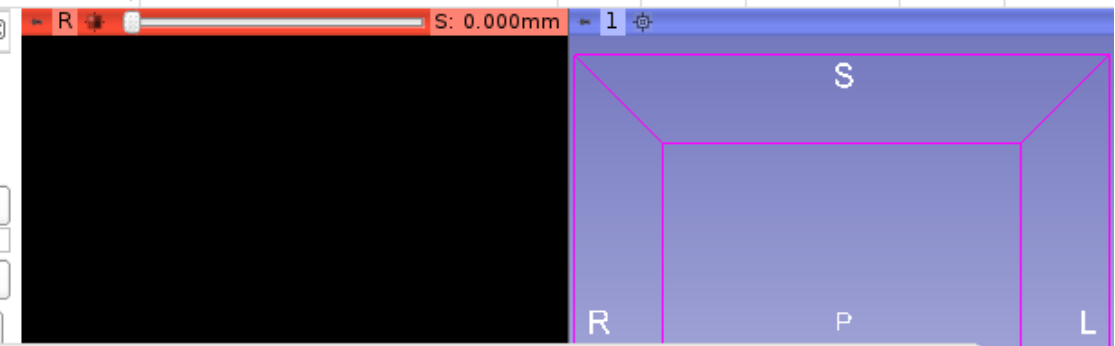
DICOM Database and Networking

Show DICOM Browser

Recent DICOM Activity

0 series added to database in the past hour

Refresh



Import DICOM files from directory ...

Look in: /PHShome/gcs6/work/plastimatch-tutorial

gcs6

Testing

scratch

shared

data

popi-plan-2015-12-29

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: popi-plan-2015-12-29

Files of type: Directories

Copy on import

Import Cancel

Another dialog appears.
Choose "Add Link"



L
F
B

10 cm

10 cm





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

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

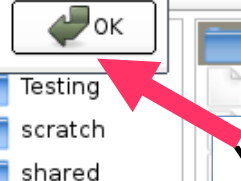
3D_Slicer_Plastimatch_DICOM_RT_Tutorial.ppt

Directory: popi-plan-2015-12-29

Files of type: Directories

Copy on import

Import Cancel



Yet another dialog appears. Click "OK".

Show Zoomed Slice

L
F
B



Import Export Query Send Remove Repair >>

Patients: [Search] X Studies: [Search] X Series: [Search] X

PatientsName	PatientID	PatientsBirthDate	PatientsBirthTime	PatientsSex	PatientsAge
MODEL^POPI	00000000	1969-12-31			0

StudyID	StudyDate
POPI	
10001	2015-12-27

SeriesNumber	Series
0	
1	CT
1	RTSTRUCT
1	RTPLAN
1	CT
303	

- DICOMScalarVolumePlugin
- MultiVolumeImporterPlugin
- DicomSrolImportPlugin
- DICOMDiffusionVolumePlugin
- DICOMSlicerDataBundlePlugin
- DicomRtImportExportPlugin

Back to the DICOM Browser
Click on the patient "MODEL^POPI"
Then click "Examine"
Then click "Load"

Load Metadata

Examine Uncheck All

Advanced Horizontal Browser Persistent



File Edit View Help



Modules: DICOM



▶ 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

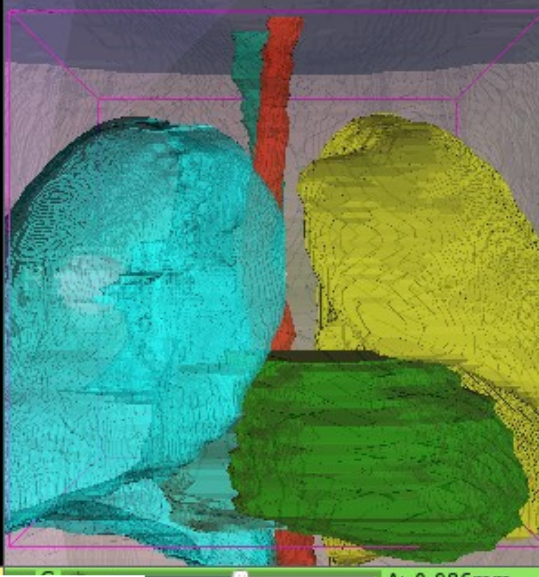
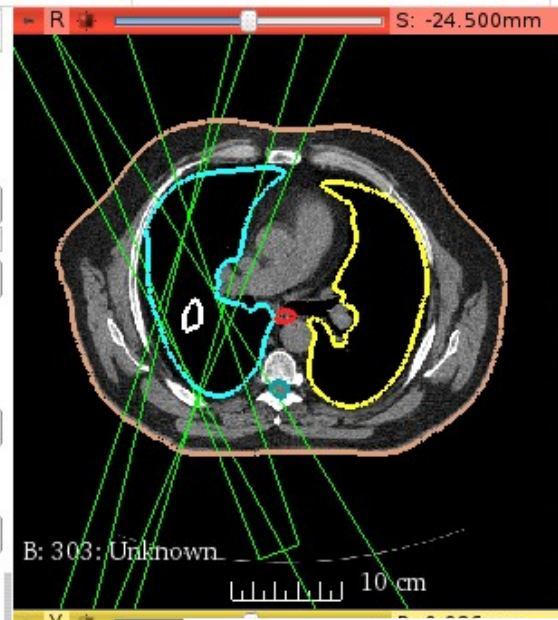
▼ Data Probe

Red RAS: (238.9, -111.3, -24.5) Axial Sp: 2.0

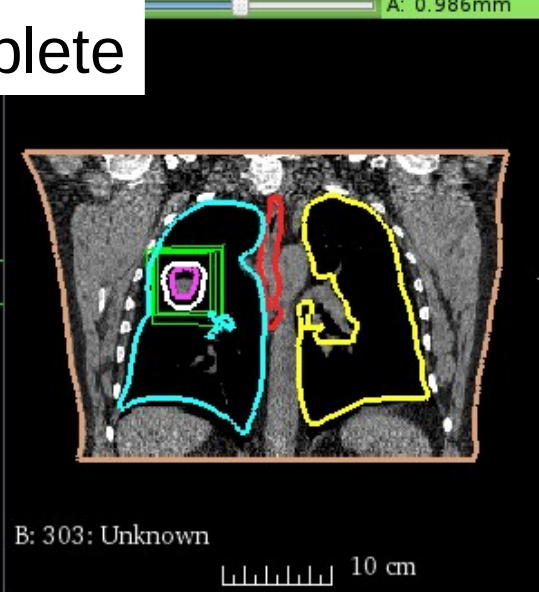
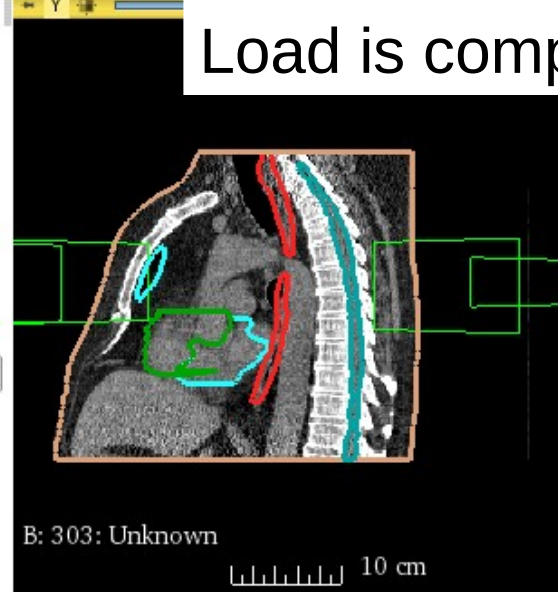
L None

F None

B 303: Unknown (11, 370, 70) -1024



Load is complete





Part 3: Running and Viewing Deformable Registration

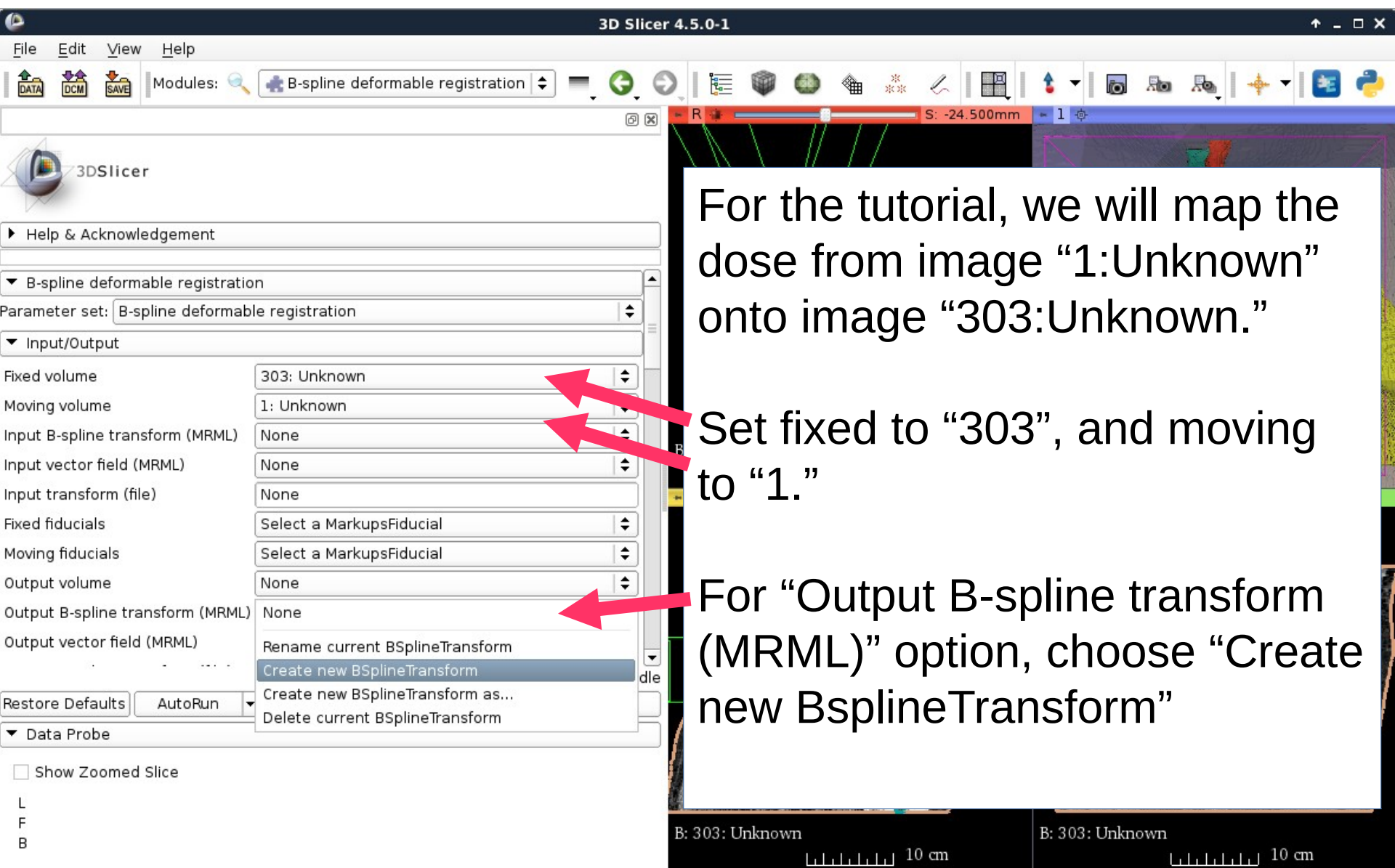


The image shows the 3D Slicer 4.5.0-1 interface. The left sidebar contains the 'Modules' list, which is expanded to show 'DICOM'. The 'DICOM' menu is further expanded to show 'Plastimatch', which is then expanded to show 'Registration'. The 'Registration' sub-menu is highlighted, and a white box lists the available registration methods: 'B-spline deformable registration' and 'LANDWARP Landmark deformable registration'. A red arrow points to the 'Modules' menu, and another red arrow points to the 'B-spline deformable registration' option. The main window displays a 3D view of a brain scan with various colored regions and a 2D view of a chest scan with a 10 cm scale bar.

Click the modules menu

Navigate to Plastimatch
"B-spline deformable registration"

- DICOM Registration Export
- Plastimatch
 - Registration
 - B-spline deformable registration
 - LANDWARP Landmark deformable registration



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”





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

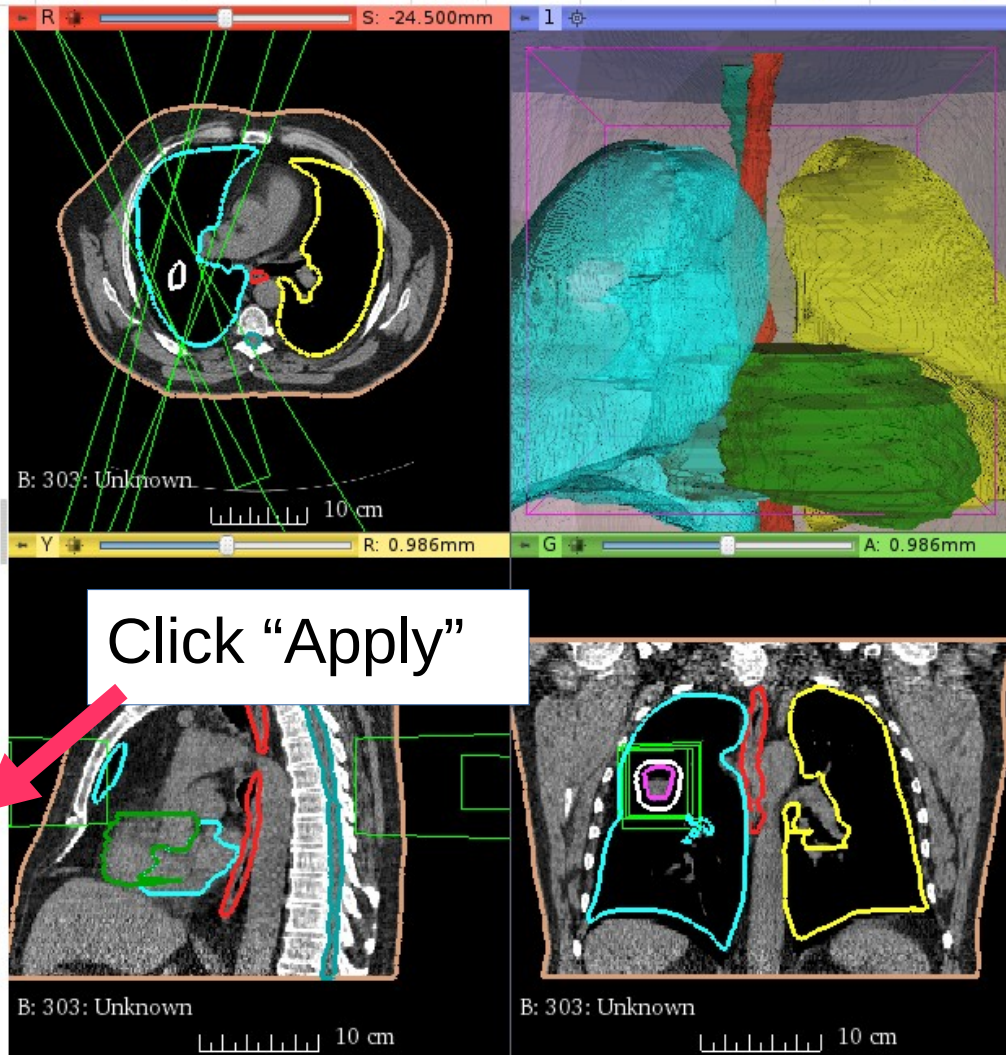
Restore Defaults AutoRun

Cancel Apply

Data Probe

Show Zoomed Slice

L F B



Click "Apply"

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

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)

Status: Completed 100%

Restore Defaults AutoRun Cancel Apply

▼ Data Probe

Show Zoomed Slice

L
F
B

B: 303: Unknown 10 cm

B: 303: Unknown 10 cm

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

W: 25 Manual W/L L: 18

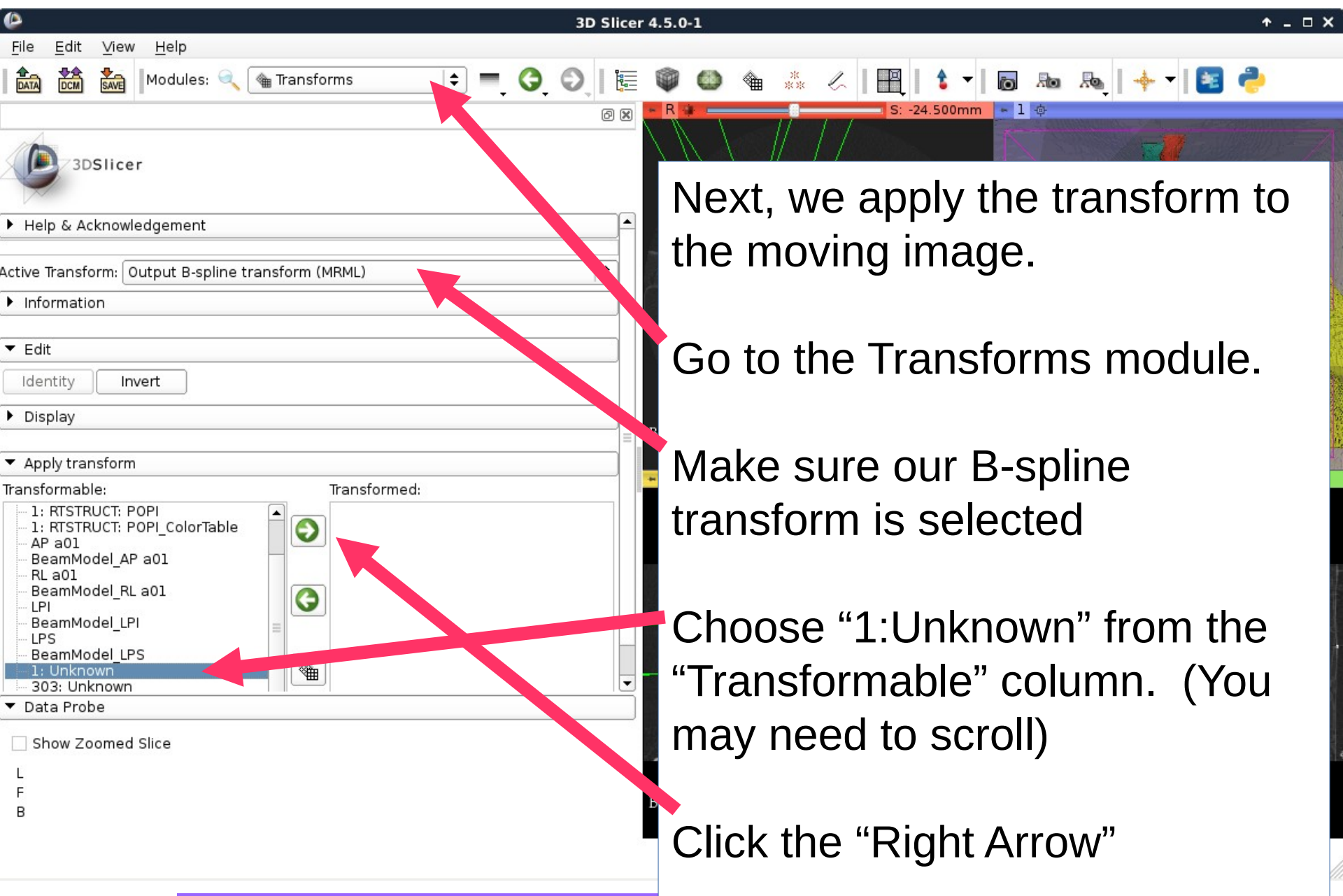
Threshold: Manual 0 600

Show Zoomed Slice

L
F
B

B: 303: Unknown 10 cm

B: 303: Unknown 10 cm



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"





Help & Acknowledgement

Active Transform: Output B-spline transform (MRML)

Information

Edit

Identity Invert

Display

Apply transform

Transformable:

- ... Dose_ColorTable
- 1: RTSTRUCT: POPI
- 1: RTSTRUCT: POPI_ColorTable
- AP a01
- BeamModel_AP a01
- RL a01
- BeamModel_RL a01
- LPI
- BeamModel_LPI
- LPS
- BeamModel_LPS
- 303: Unknown

Transformed:

- 1: Unknown



Data Probe

Show Zoomed Slice

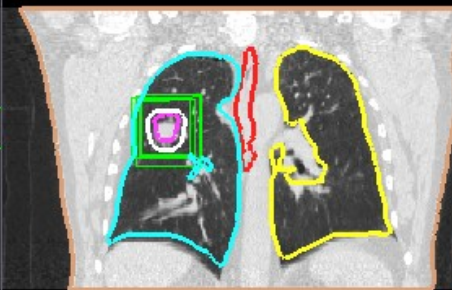
L
F
B

Image "1:Unknown" has been transformed.

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



B: 303: Unknown



B: 303: Unknown



Next, set the display to "Green Only"



Information

Edit

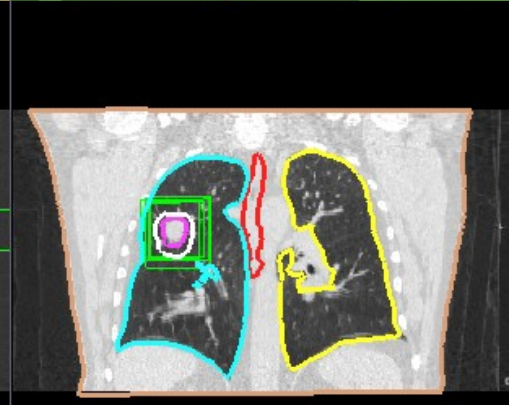
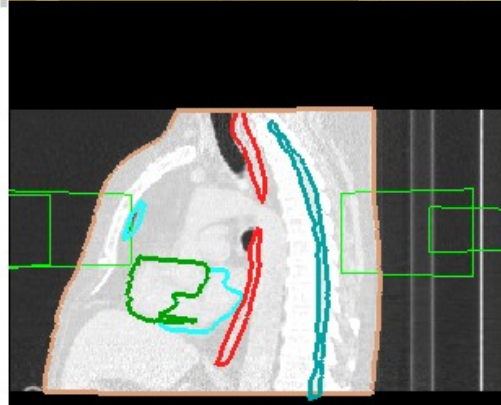
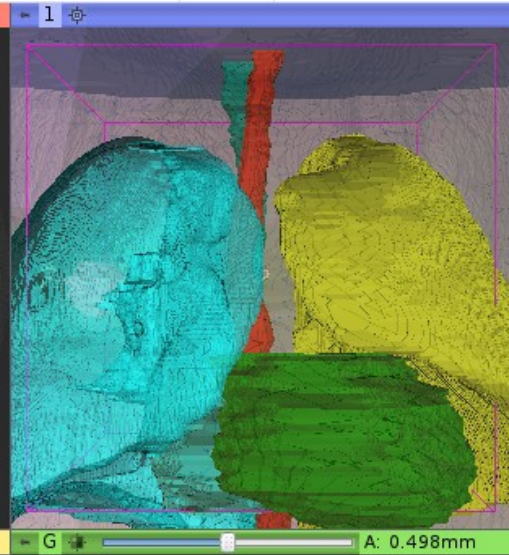
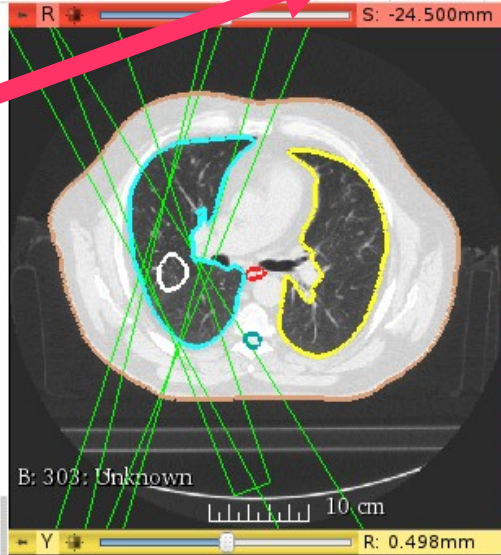
Identity Invert

Display

Apply transform

Transformable:	Transformed:
RTDOSE [1]: Lung	1: RTSTRUCT: POPI
Dose_ColorTable	1: Unknown
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

L

F

B



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

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

L

F

B

F: 1: Unknown (100%)

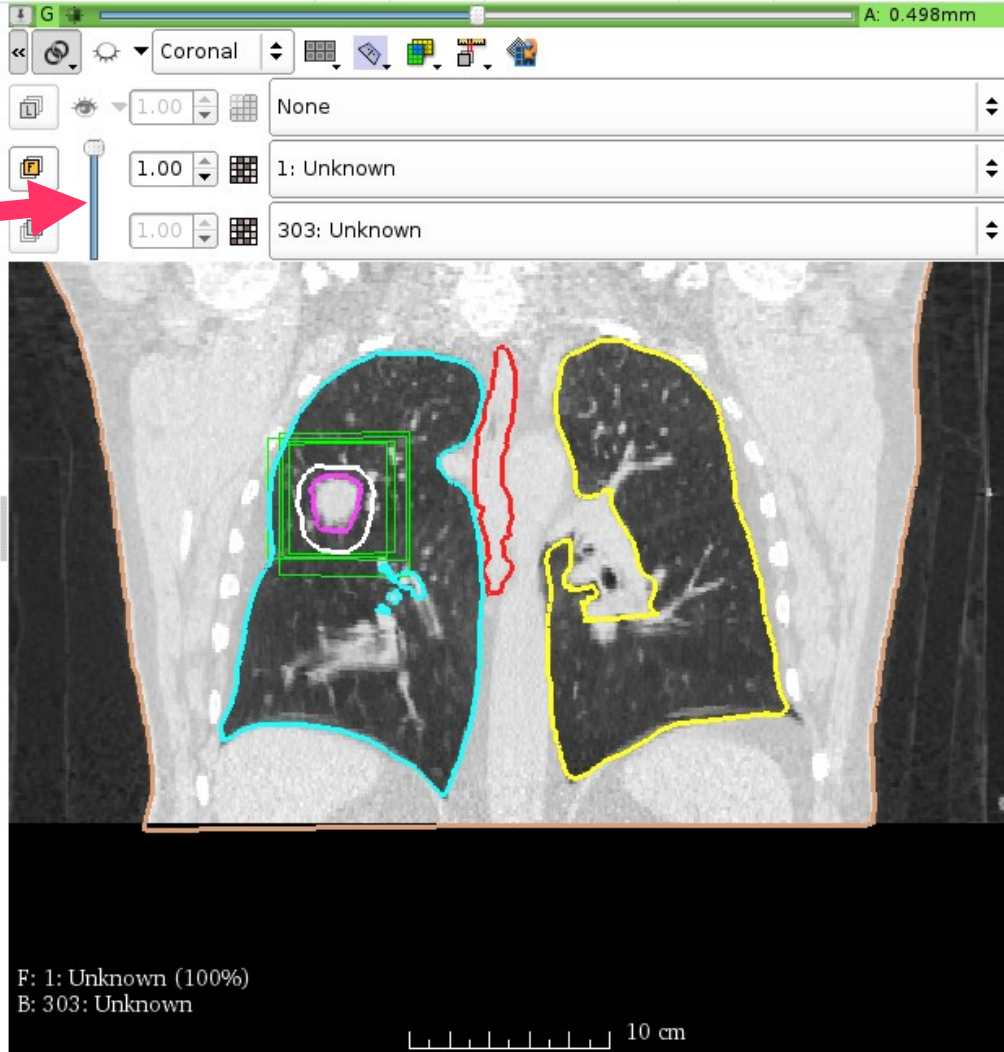
B: 303: Unknown

10 cm

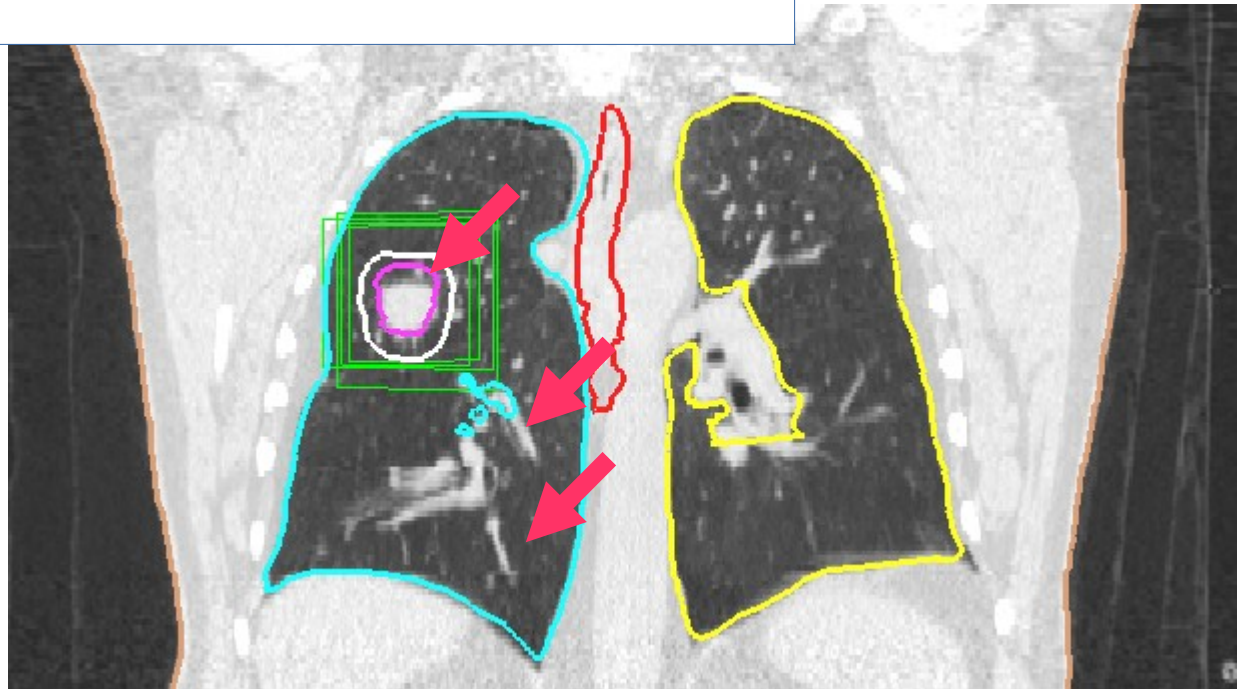
You are now ready to begin visualization.

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.



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

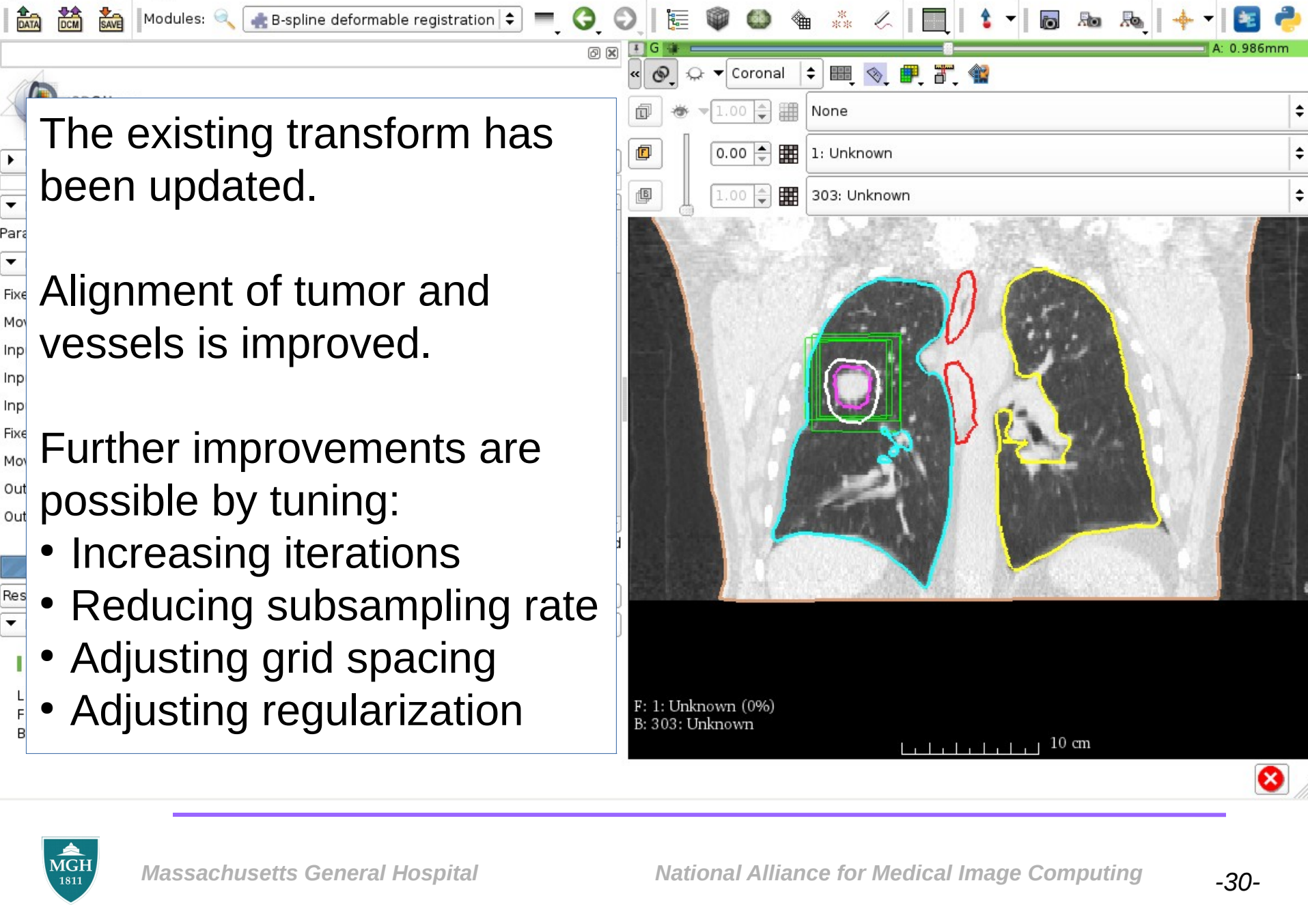
F: 1: Unknown (0%)
B: 303: Unknown

10 cm

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"



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:

Greg Sharp

gcsharp@partners.org

Or visit the web page at:

<http://plastimatch.org>





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