



*NA-MIC*

*National Alliance for Medical Image Computing*

*<http://www.na-mic.org>*

---

# Subject Hierarchy

Csaba Pinter

Queen's University, Canada

[csaba.pinter@queensu.ca](mailto:csaba.pinter@queensu.ca)

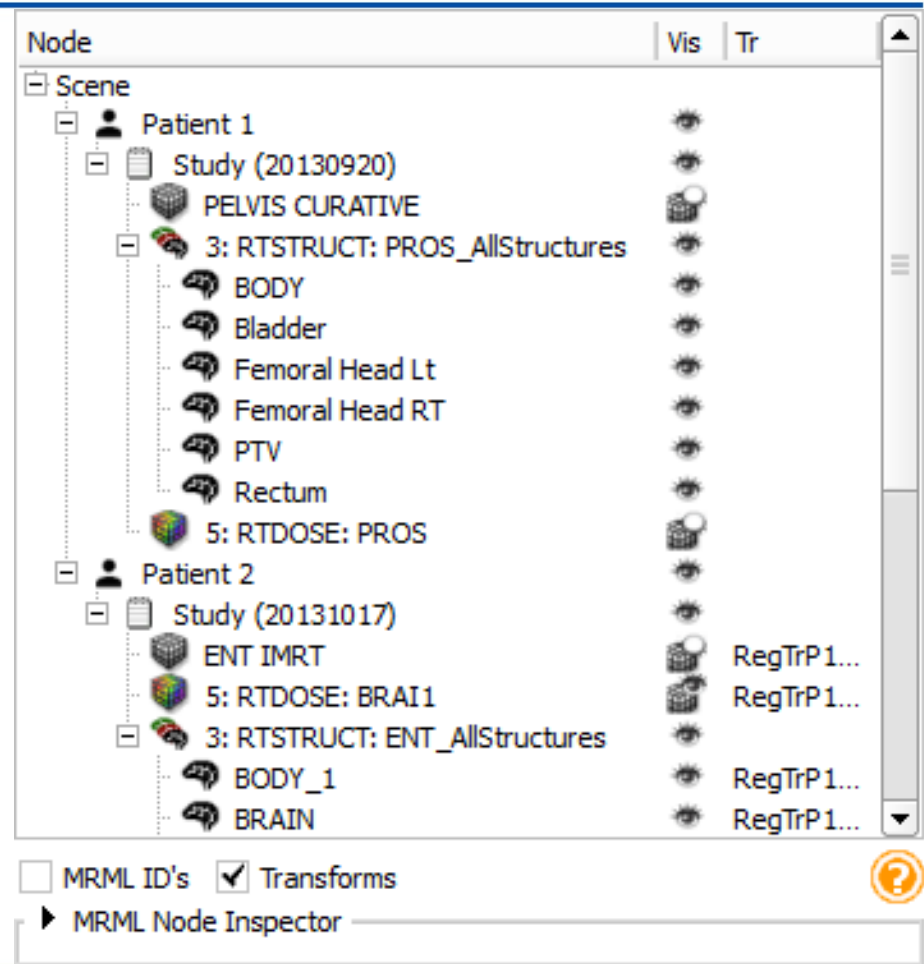
NA-MIC Tutorial Contest: Winter 2016

---



# Learning Objective

This tutorial demonstrates the basic usage and potential of Slicer's data manager module Subject Hierarchy using a two-timepoint radiotherapy phantom dataset.





# Material

---

This tutorial requires the installation of the Slicer4.5 release and the tutorial dataset. They are available at the following locations:

**Slicer** download page:

<http://www.slicer.org/pages/Downloads/>

**Tutorial dataset:** IGRT Tutorial Dataset

[http://slicer.kitware.com/midas3/download/item/205404/SlicerRT\\_WorldCongress\\_TutorialIGRT\\_Dataset.zip](http://slicer.kitware.com/midas3/download/item/205404/SlicerRT_WorldCongress_TutorialIGRT_Dataset.zip)

**Wiki page:** <http://wiki.slicer.org/slicerWiki/index.php/Documentation/Nightly/Modules/SubjectHierarchy>

---



# Platforms

---

- Developed and maintained on Windows 64bit, Mac OSX, and Linux 64bit & 32bit



- Slicer requires
  - Minimum 2GB RAM
  - 64 bit strongly suggested



# Overview

---

1. Install SlicerRT extension
2. Import and load planning data
3. Explore loaded data in Subject hierarchy
4. Load second timepoint data
5. Add loaded data into new study
6. Register second timepoint to planning study with Subject hierarchy



# Part 1: Install SlicerRT extension

---

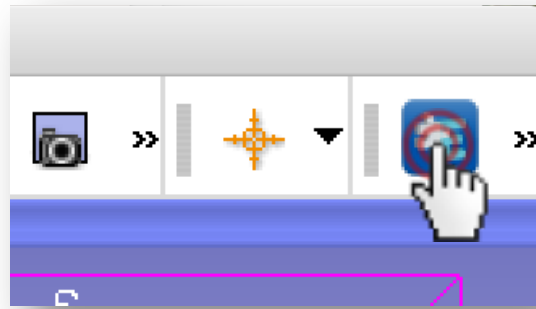
- Enables loading radiotherapy data
  - Allows demonstrating support of “exotic” data types in Subject hierarchy
  - Multiple studies by nature
- (Please ask the author about support of your data type if not yet available)



# 1/1: Install SlicerRT extension

---

- Open Extension Manager from the toolbar:



- Or from menu  
View / Extension Manager



# 1/2: Install SlicerRT extension

Extensions Manager

Manage Extensions (0) Install Extensions

Search...

### Slicer Extensions

Kitware

Categories

- All
- Applications (1)
- Cardiac (2)
- Cardiac MRI toolkit (1)
- Chest Imaging Platform (1)
- Converters (1)
- Developer Tools (4)
- Diffusion (3)
  - Tractography (1)
- Editor Effects (1)
- Examples (4)
- Exporter (1)
- IGT (10)
- Informatics (5)
- Mesh Generation (2)
- Microscopy (1)
- Nuclear Medicine (1)
- Quantification (5)
- Radiotherapy (3)**

Margin Calculator  
Kevin Wang (Princess M.)  
★★★★★ (0)  
INSTALL

SlicerRT  
Csaba Pinter (PerkLab...)  
★★★★★ (0)  
INSTALL

GelDosimetry  
Csaba Pinter (PerkLab...)  
★★★★★ (0)  
INSTALL

1. Find Radiotherapy category  
2. Click Install under SlicerRT  
3. After done, click Restart

Restart Close





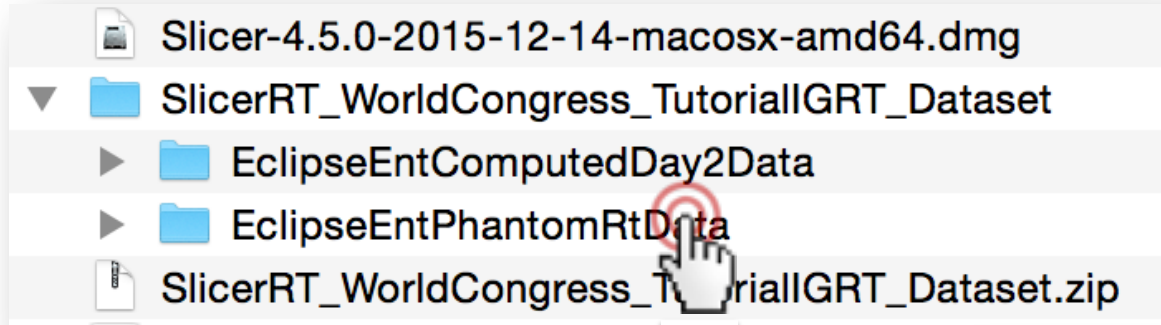
## Part 2: Import and load planning data from DICOM

---

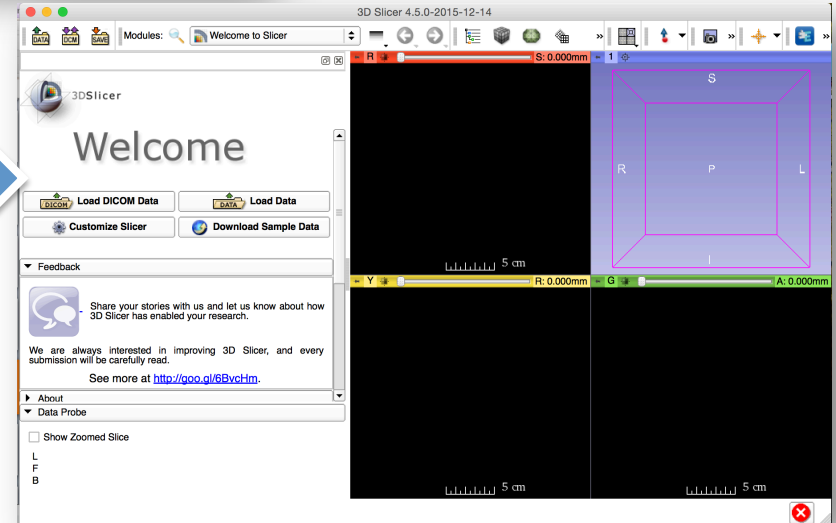
- Phantom dataset taken from a RANDO head&neck phantom
- Study contains a CT grayscale image and radiotherapy data: contours, dose distribution, treatment beams, plan information



# 2/1: Import and load planning data from DICOM

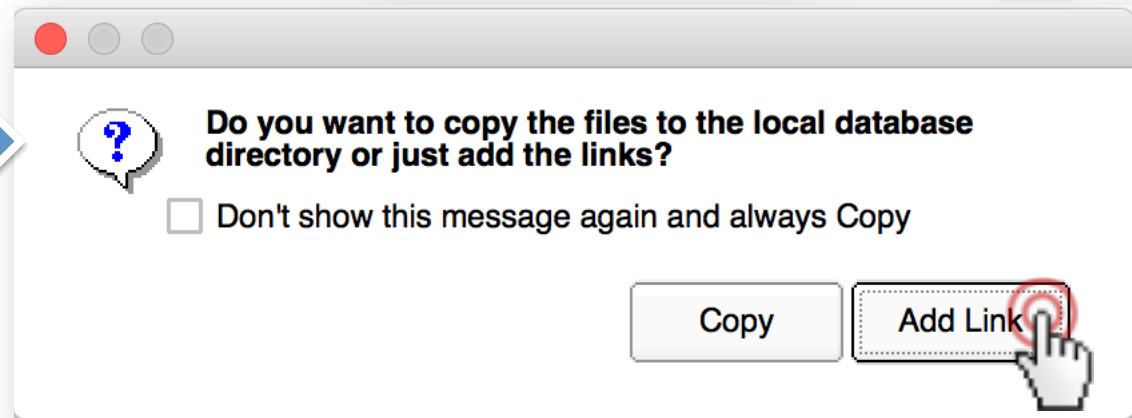
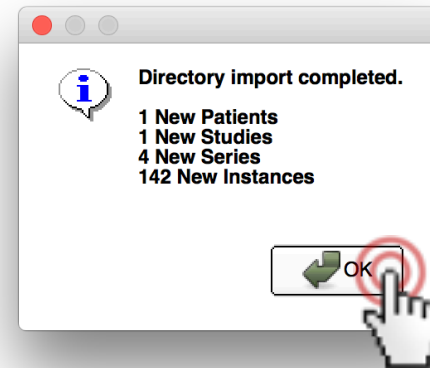
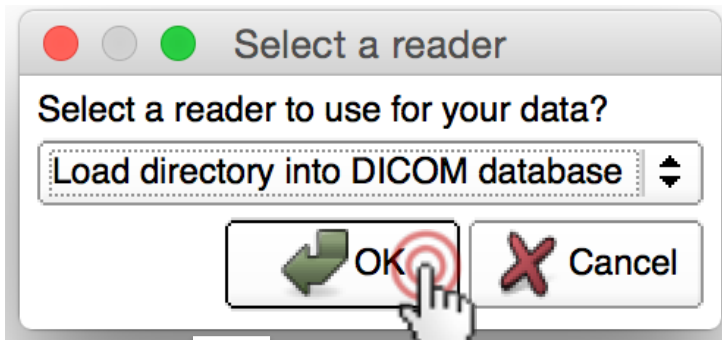


Drag&drop  
'EclipseEntPhantomRtData'  
onto the Slicer window





# 2/2: Import and load planning data from DICOM





# 2/3: Import and load planning data from DICOM

DICOM Browser

Import Export Query Send Remove Repair >>

Patients: Studies: Series:

PatientsName	PatientID	PatientsBirthDate	PatientsBirthTime	PatientsSex	PatientsAge
RANDO^ENT	TEST PHYS ENT				

StudyID StudyDate StudyTime

1445	2011-09-20	085705
------	------------	--------

SeriesNumber SeriesDate SeriesTime SeriesDescription Modality BodyPartExamined

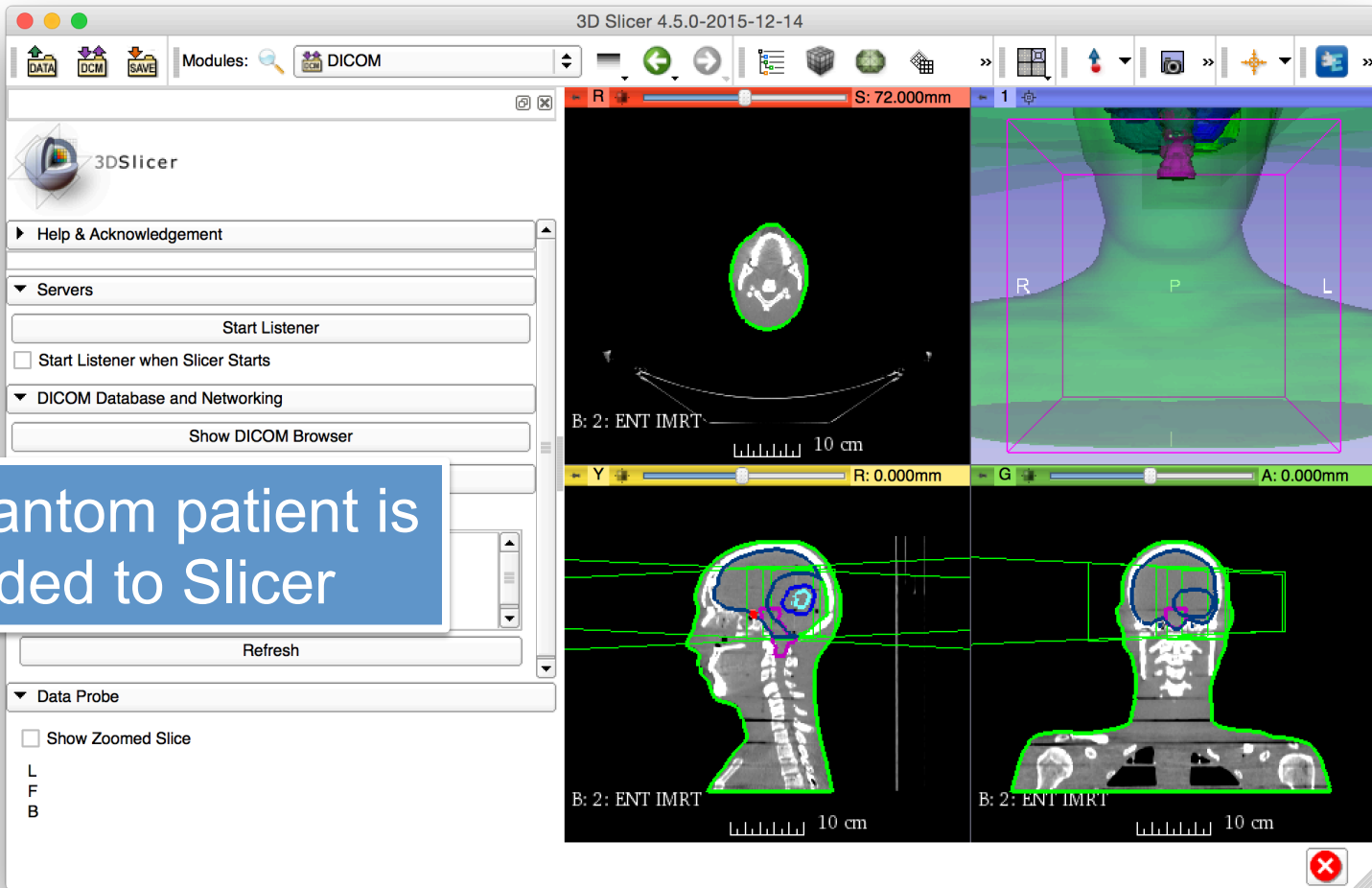
2	2011-09-20	085816	ENT IMRT	CT	
5				RTDOSE	
4				RTPLAN	
3				RTSTRUCT	

Load Metadata  Advanced  Horizontal  Browser Persistent

New patient appears  
1. Select patient 'RANDO ENT'  
2. Click 'Load'



# 2/4: Import and load planning data from DICOM



Phantom patient is loaded to Slicer



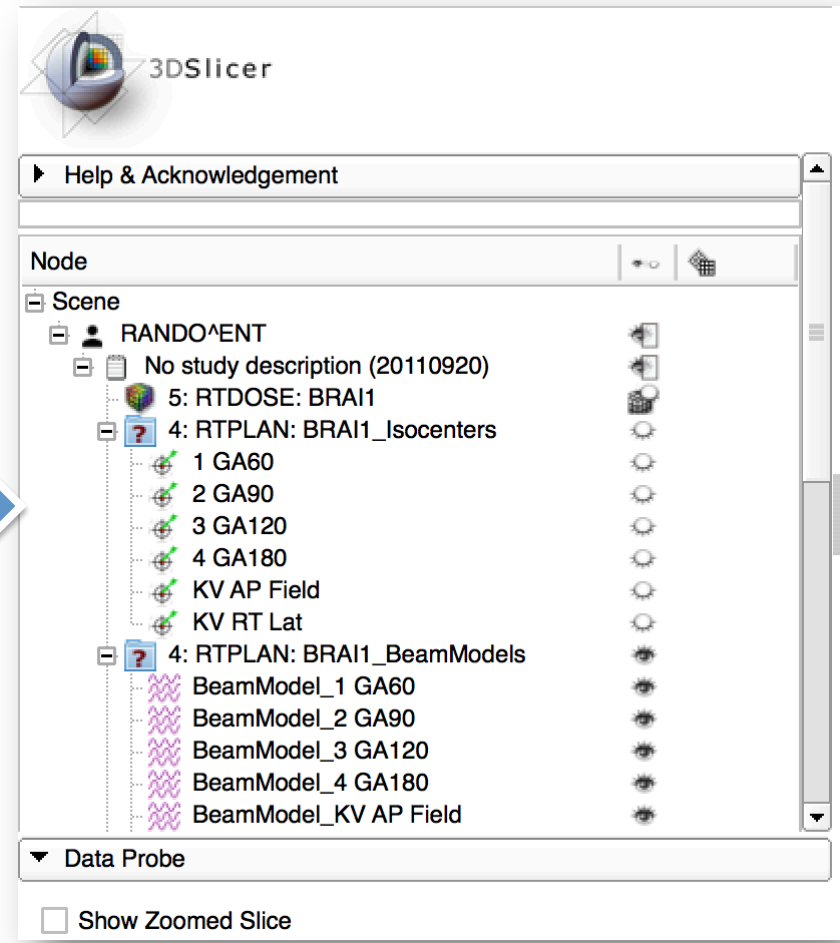
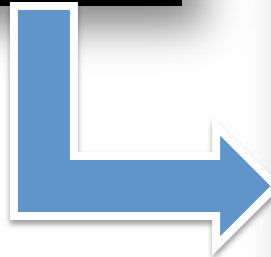
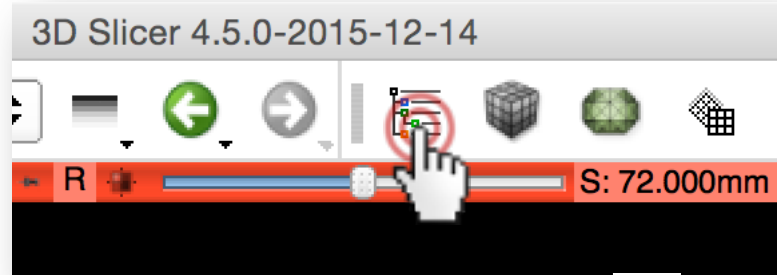
# Part 3: Explore loaded data in Subject hierarchy

---

- Subject hierarchy automatically creates hierarchy for supported DICOM types
- DICOM support can be added for any modality if not yet available



# 3/1: Explore loaded data in Subject hierarchy



Open Subject hierarchy module from the toolbar or from the module list - Choose 'Yes to All'



# 3/2: Explore loaded data in Subject hierarchy

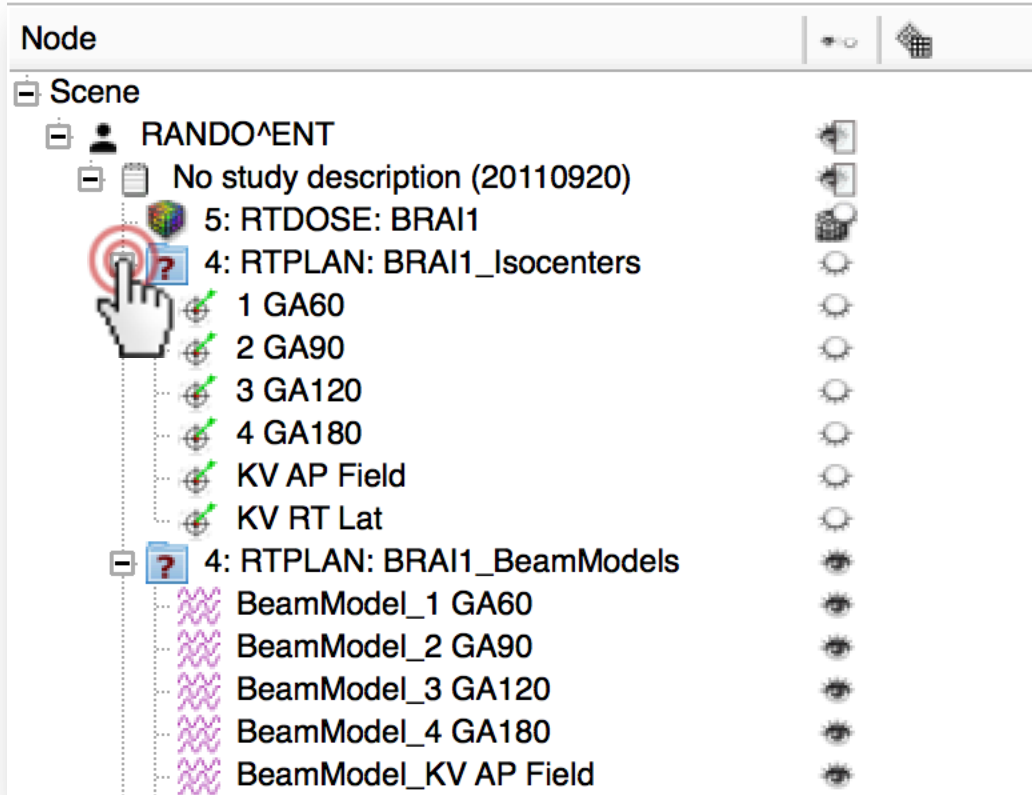
The screenshot displays a software interface for medical image exploration. On the left, a 'Scene' tree shows a hierarchy for subject 'RANDO^ENT'. The tree includes a 'No study description (20110920)' folder, followed by '5: RTDOSE: BRAI1', and then '4: RTPLAN: BRAI1'. Under '4: RTPLAN: BRAI1', there are several nodes: '1 GA60', '2 GA90', '3 GA120', '4 GA180', 'KV AP Field', and 'KV RT Lat'. Below these is another '4: RTPLAN: BRAI1\_BeamModels' folder containing 'BeamModel\_1 GA60'. A tooltip is positioned over the '4: RTPLAN: BRAI1' node, displaying the text: 'Volume (Level:Series Plugin:RtDoseVolume) (Dimensions: 176x88x136 Spacing: 2.5mm x 2.5mm x 2.5mm)'. On the right, a 3D visualization shows a cross-section of a brain with a green circular region of interest. A scale bar indicates '10 cm'. A yellow horizontal bar at the bottom of the visualization shows a slider for 'R: 0.000mm' and labels 'Y' and 'G'.

Get more information about nodes by moving the mouse over the node in the tree





# 3/3: Explore loaded data in Subject hierarchy



Collapse branches by clicking the box next to the node's icon



# 3/4: Explore loaded data in Subject hierarchy

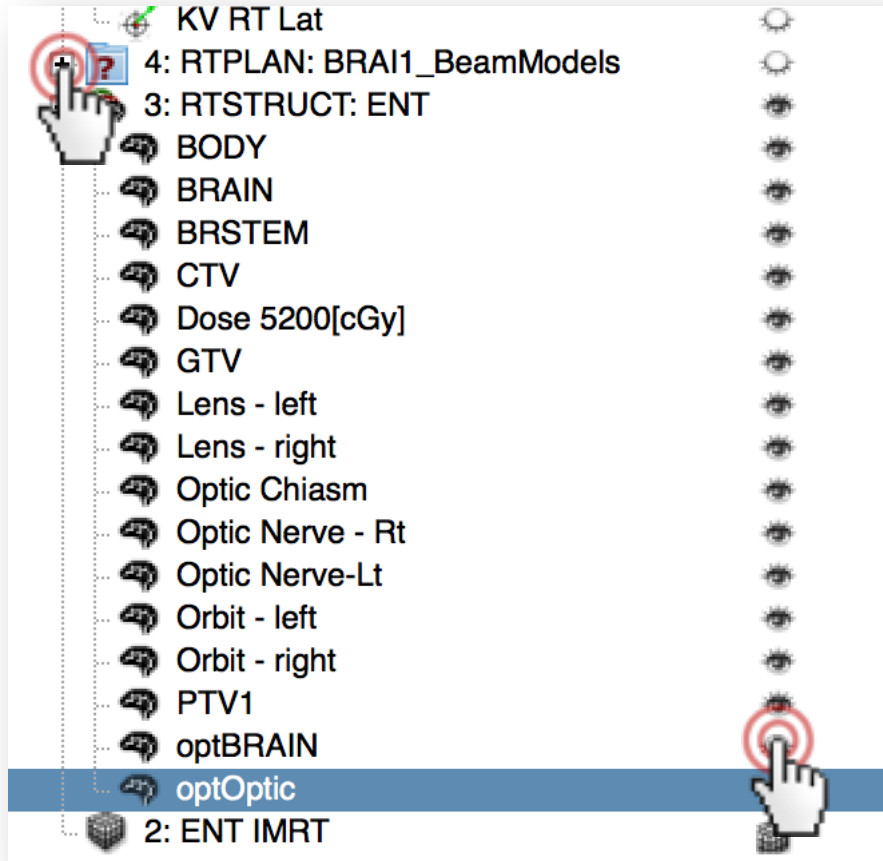
Node

- Scene
  - RANDO^ENT
    - No study description (20110920)
    - 5: RTDOSE: BRAI1
    - 4: RTPLAN: BRAI1\_Isocenters
      - 1 GA60
      - 2 GA90
      - 3 GA120
      - 4 GA180
      - KV AP Field
      - KV RT Lat
    - 4: RTPLAN: BRAI1\_BeamModels
      - BeamModel\_1 GA60
      - BeamModel\_2 GA90
      - BeamModel\_3 GA120
      - BeamModel\_4 GA180
      - BeamModel\_KV AP Field

Show/hide nodes or entire branches by clicking the eye icon in the node's row



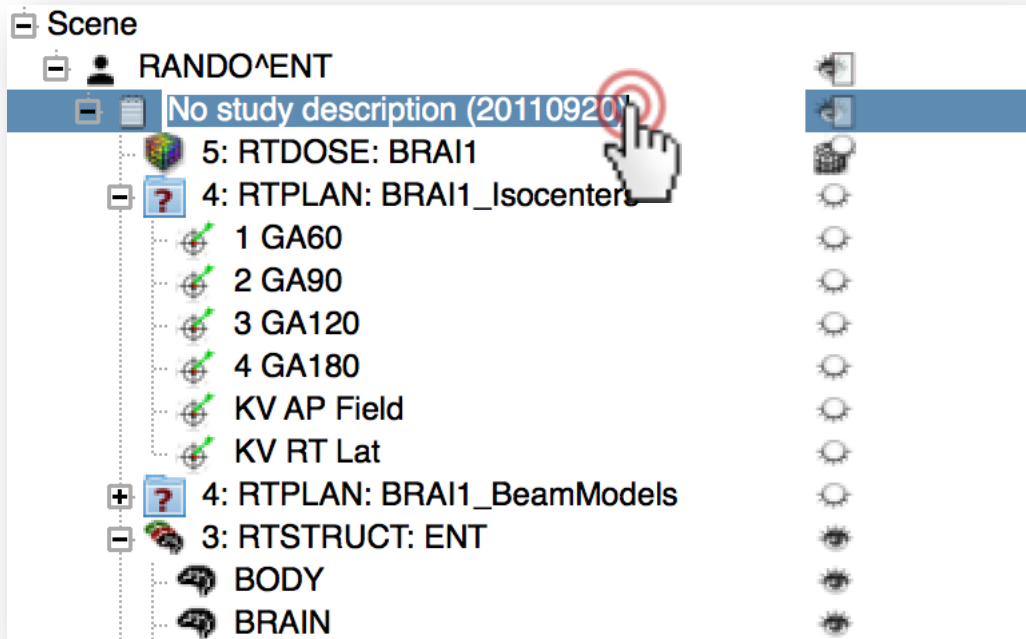
# 3/5: Explore loaded data in Subject hierarchy



1. Hide and collapse beam models to make the tree more compact
2. Hide structures 'optBRAIN' and 'optOptic' to see the inner organs in the head in the 3D view



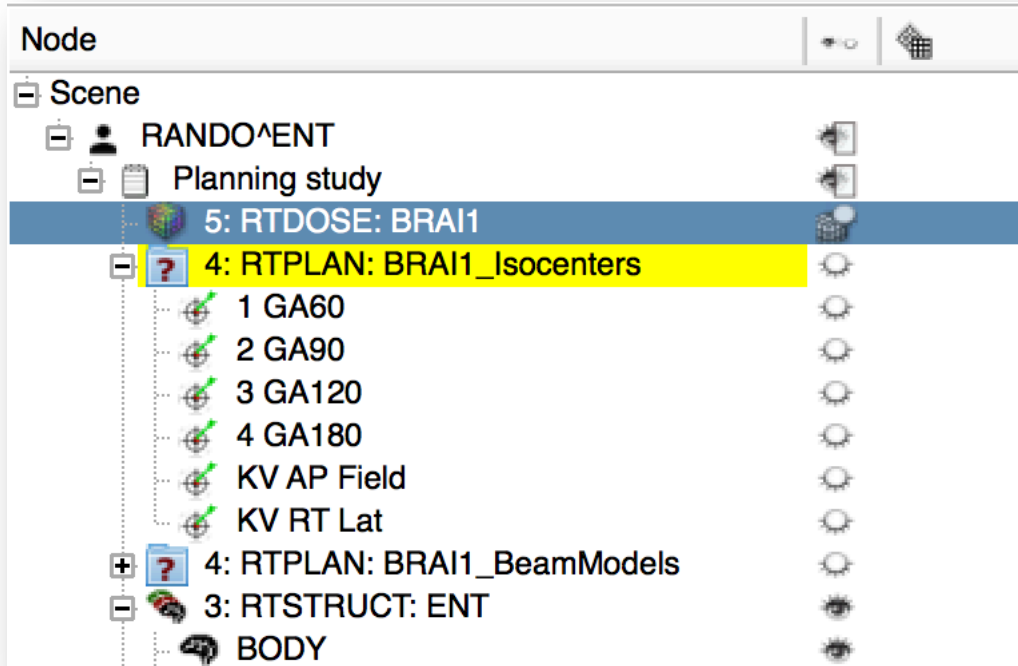
# 3/6: Explore loaded data in Subject hierarchy



1. Enter renaming mode for the study node by double clicking on its name 'No study description...'
2. Rename it to 'Planning study'
3. Press Enter



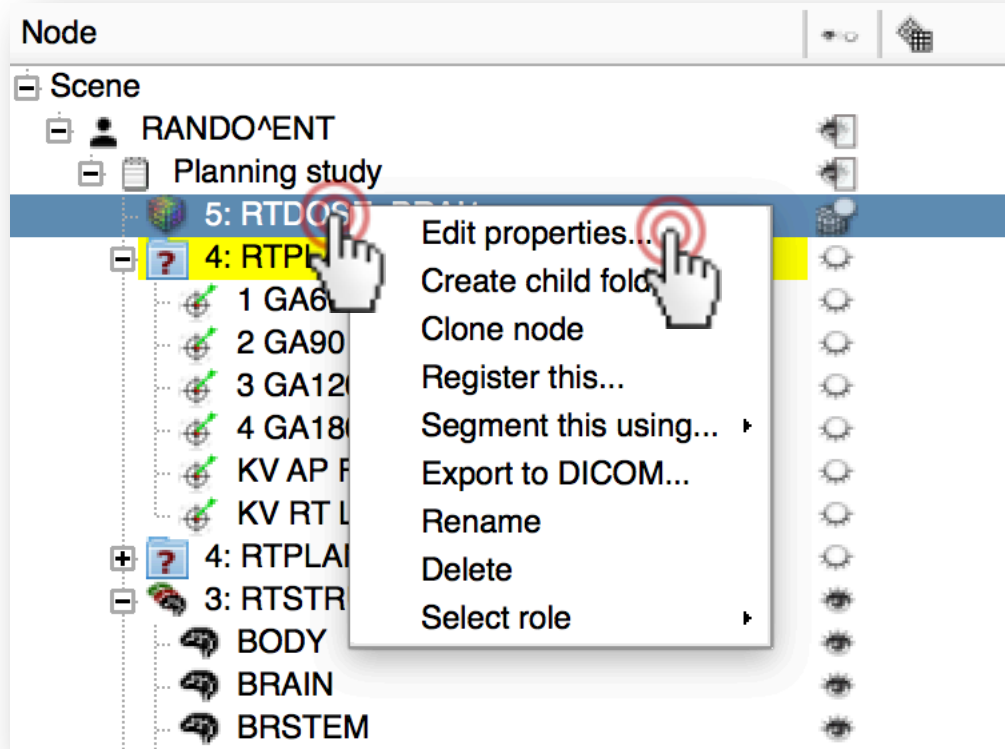
# 3/7: Explore loaded data in Subject hierarchy



Data objects referenced in DICOM by the selected node are highlighted in yellow



# 3/8: Explore loaded data in Subject hierarchy



1. Right-click on a node to access all actions associated to it.
2. Click 'Edit properties...' to switch to the module that handles the node



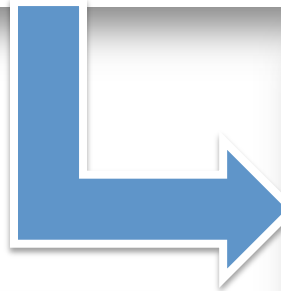
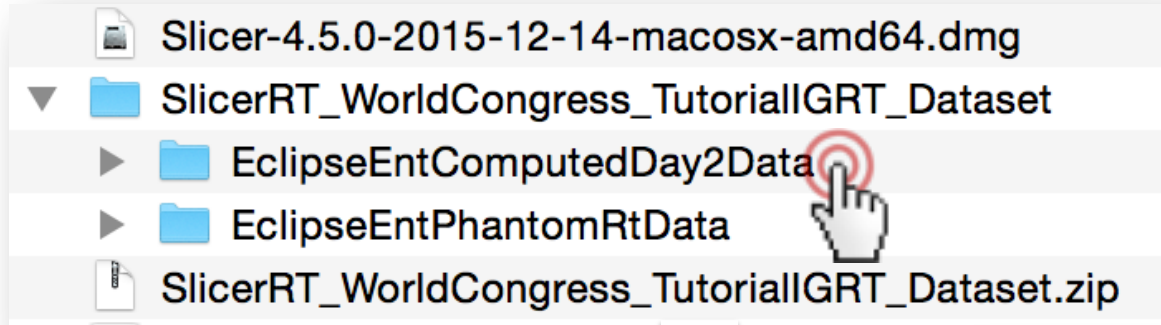
# Part 4: Load second timepoint data

---

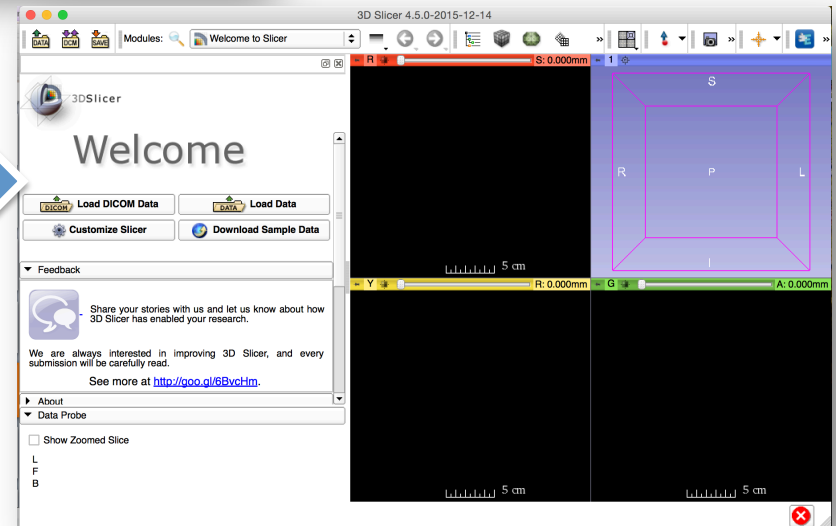
- Simulated second timepoint for the same phantom dataset
- Artificial deformation field applied on phantom CT and dose distribution
- Illustrates “day two” scenario of a hypothetical radiotherapy patient
- Stored in NRRD files



# 4/1: Load second timepoint data



Drag&drop  
'EclipseEntComputedDay2  
Data' onto the Slicer







# 4/2: Load second timepoint data

Select a reader

Select a reader to use for your data?

Load directory into DICOM database

Any Data

OK

Cancel

Add data into the scene

Choose Directory to Add Choose File(s) to Add  Show Options

File	Description
<input checked="" type="checkbox"/> ...s/SlicerRT_WorldCongress_TutorialIGRT_Dataset/EclipseEntComputedDay2Data/2_ENT_IMRT_Day2.nrrd	Volume
<input checked="" type="checkbox"/> ...ads/SlicerRT_WorldCongress_TutorialIGRT_Dataset/EclipseEntComputedDay2Data/5_RTDOSE_Day2.nrrd	Volume

OK

Cancel

1. Choose 'Any Data' in the pop-up dialog
2. Click OK. Add data window appears.
3. Click OK



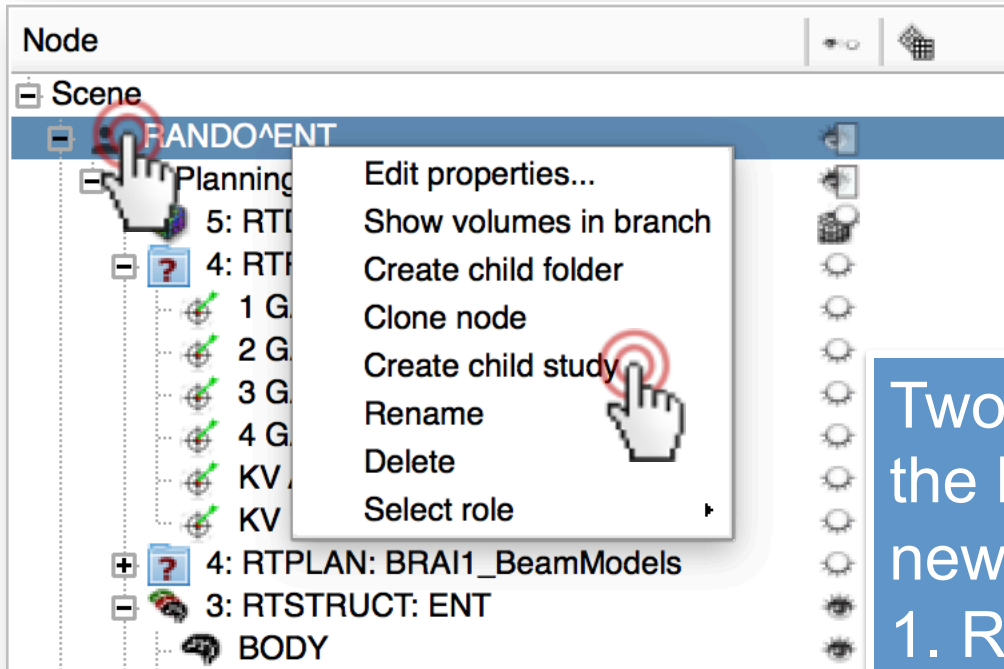
# Part 5: Add day two data into new study

---

- Non-DICOM data such as NRRD are not automatically added to hierarchy
- Manual assignment of data into studies is possible
- (Solution is in place for automatic arrangement for data loaded from local directory structure – please consult module wiki page)



# 5/1: Add day two data into new study

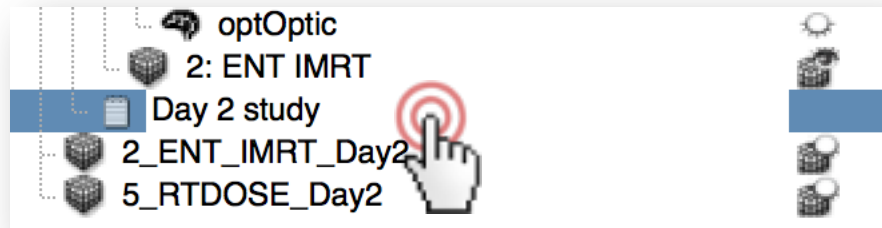


Two volumes appeared on the bottom. Let's create a new study for them.

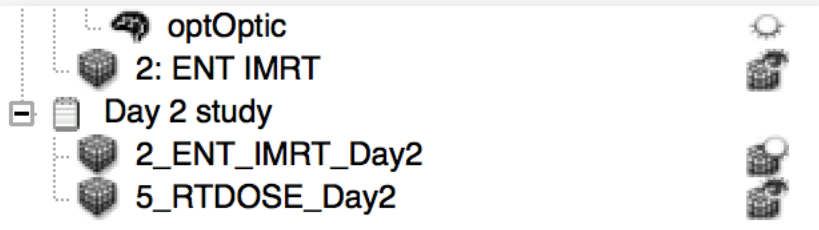
1. Right-click the patient
2. Select 'Create child study'



# 5/2: Add day two data into new study

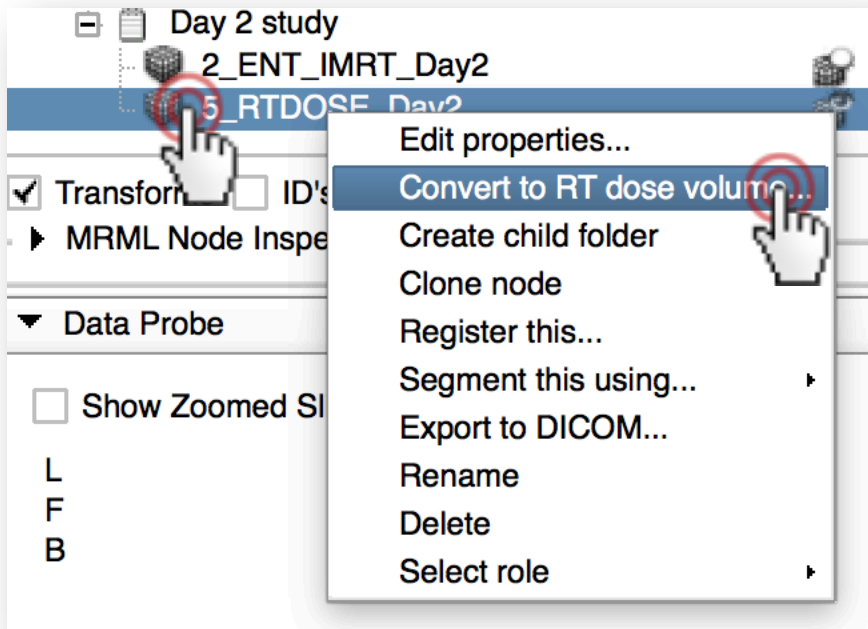


1. Rename new study (appearing under the data in the planning study) to 'Day 2 study' after double-clicking its name
2. Select the two nodes by clicking the first one, then holding shift button and clicking the second one
3. Drag&drop the two selected nodes onto Day 2 study





# 5/3: Add day two data into new study



Let's use a modality-specific action.

1. Right-click on the volume named '5\_RTDOSE\_Day2'
2. Choose 'Convert to RT dose volume...'
3. Click OK on both dialogs
4. Notice the icon change



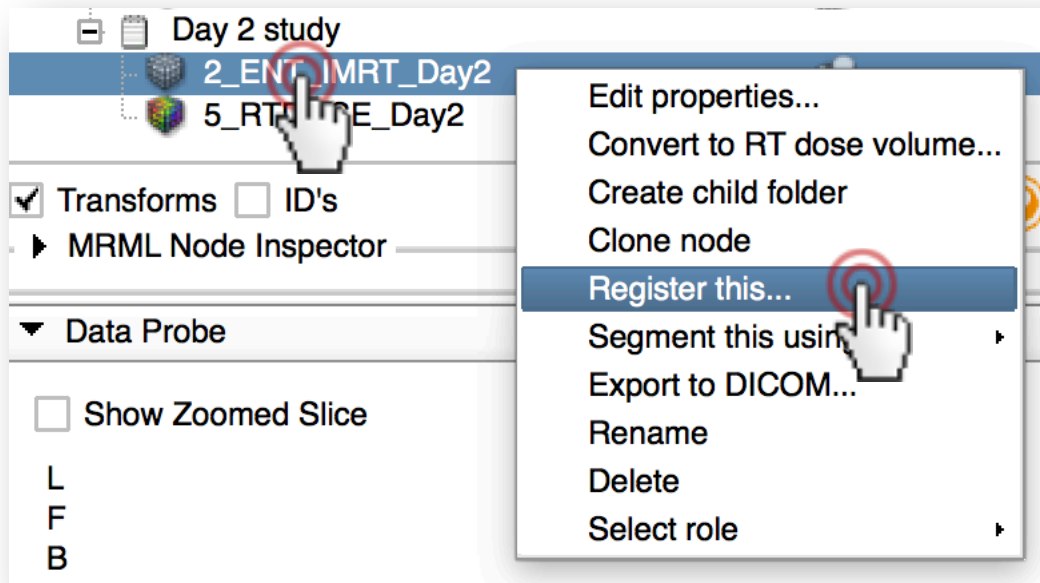
# Part 6: Register day two study to planning study

---

- Allows accumulation of dose for both day's treatment sessions
- Demonstrates actions defined by Subject hierarchy plugins facilitating direct access of functions from the hierarchy
- (Please ask the author about potential new actions)



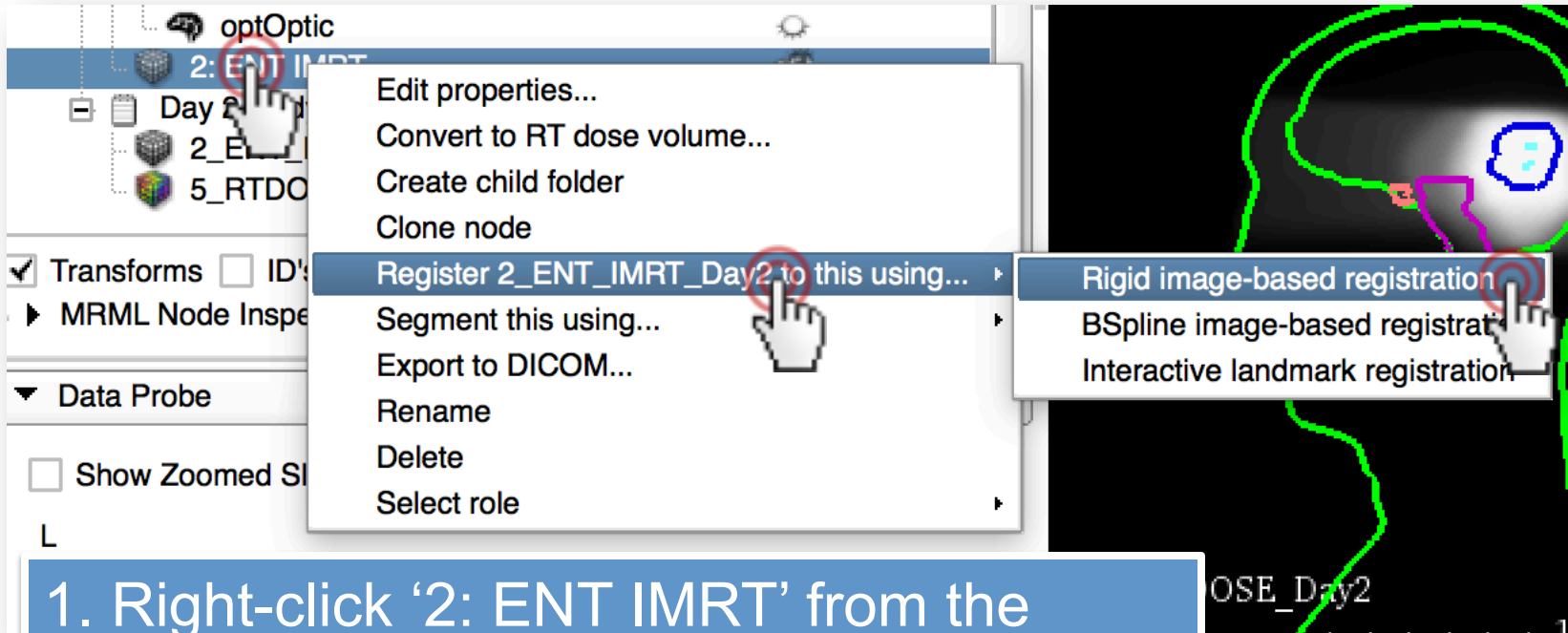
# 6/1: Register day two study to planning study



1. Right-click on '2\_ENT\_IMRT\_Day2'
2. Select 'Register this...'



# 6/2: Register day two study to planning study



1. Right-click '2: ENT IMRT' from the planning study
2. Go to 'Register 2\_ENT\_...'
3. Select 'Rigid image-based registration'





# 6/3: Register day two study to planning study

Fixed Image Volume	2: ENT IMRT
Moving Image Volume	2_ENT_IMRT_Day2
Percentage Of Samples	0.002
B-Spline Grid Size	14,10,12
▼ Output Settings (At least one output must be specified)	
Slicer Linear Transform	LinearTransform_2_ENT...T_Day2_To_2: EN
Slicer BSpline Transform	None
Output Image Volume	None
▶ Transform Initialization Settings	
▼ Registration Phases (Check one or more, executed in order listed)	
Rigid (6 DOF)	<input checked="" type="checkbox"/>
Rigid+Scale(7 DOF)	<input type="checkbox"/>
Rigid+Scale+Skew(10 DOF)	<input type="checkbox"/>
Affine(12 DOF)	<input type="checkbox"/>
Restore Defaults	AutoRun
Cancel	Apply

Notice that

- BRAINS registration module was selected
- Inputs were selected
- Output transform was created
- Rigid (6 DOF) phase was selected

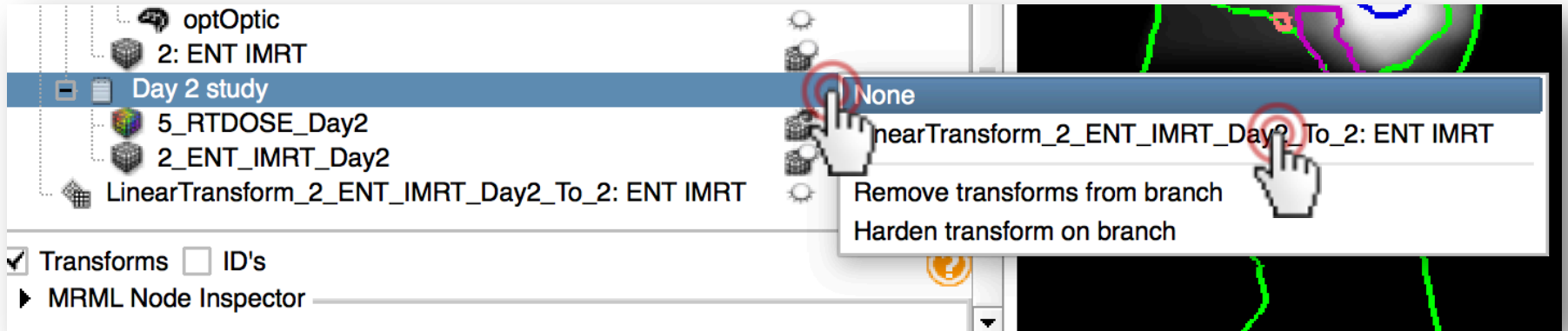
1. Click Apply

Status: Idle

Apply



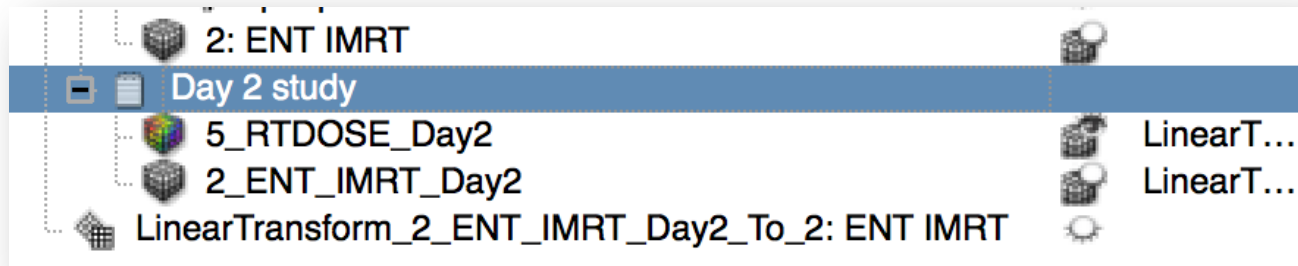
# 6/4: Register day two study to planning study



1. Once registration is done, switch back to Subject hierarchy
2. Notice that the transform was already applied to the CT volume
3. Double-click on the empty space in the rightmost transform column of Day 2 study
4. Open the selector by clicking 'None', and select the transform



# 6/5: Register day two study to planning study



Notice that the transform was also set to the dose volume. Using the same action, any transform can be applied to whole branches.

This step allowed us to accumulate dose distributions for a patient delivered over two time points.



# Conclusion

---

Subject hierarchy is a central access point to review and organize data loaded into Slicer, while offering direct access to Slicer functions.

New data types and actions can be added to Subject hierarchy.



# Acknowledgments

---



**National Alliance for Medical Image Computing**  
NIH U54EB005149



**Ontario**  
Cancer Care Ontario  
Action Cancer Ontario

**Cancer Care Ontario**



**Ontario Consortium for Adaptive  
Interventions in Radiation Oncology**