

Tutorial:

Isocenter shifting image-guidance in SlicerRT

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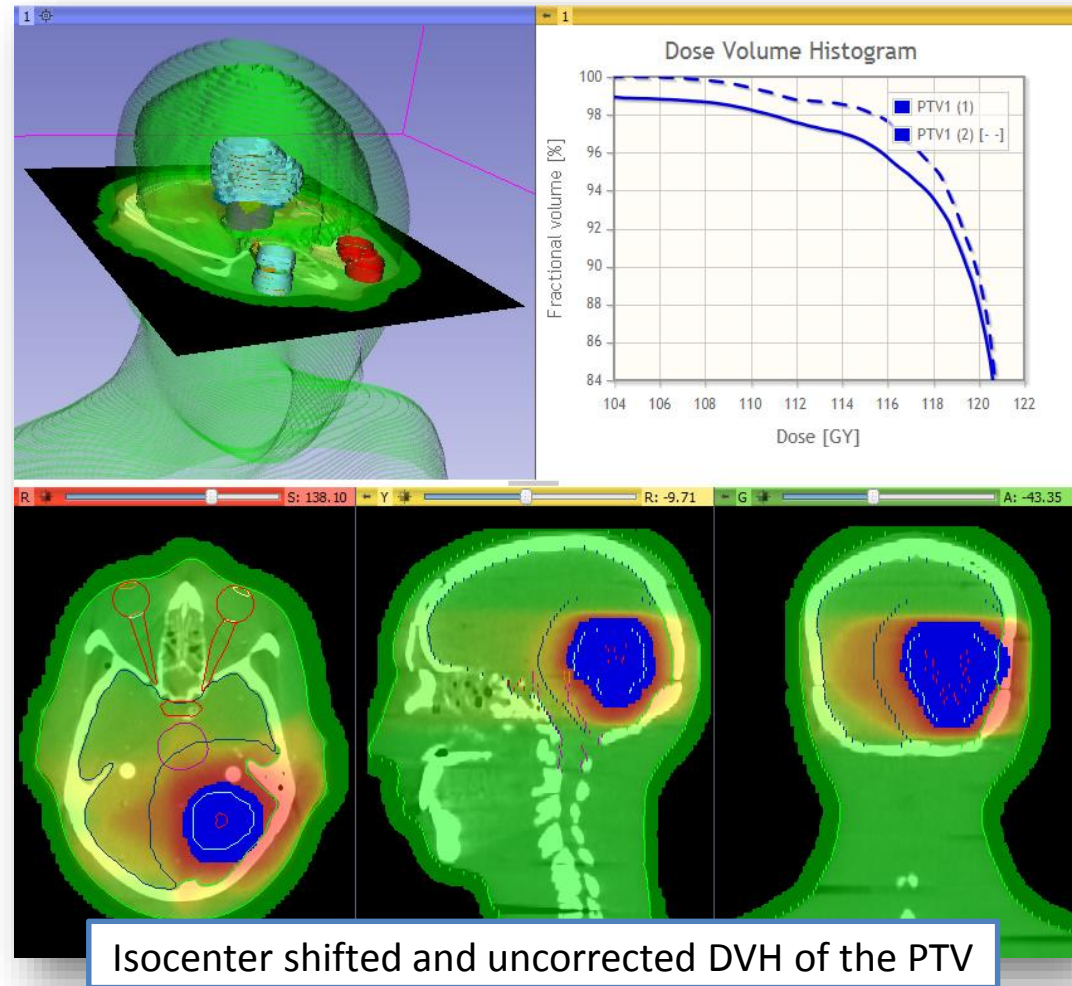
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Learning objective

This tutorial demonstrates how to perform a radiation therapy research workflow using the SlicerRT toolkit:

Isocenter shifting
image-guidance



Material

- Connect to tutorial wifi:
SSID: *SlicerRT1*, Password: *tutorial*
(Disregard popup warning about no internet)
- Access download page:
Enter in your web browser: *130.15.7.247*
- Follow the instructions
- Supported platforms:
 Windows,  Mac OSX,  Linux
– 32-bit is not supported!

Overview

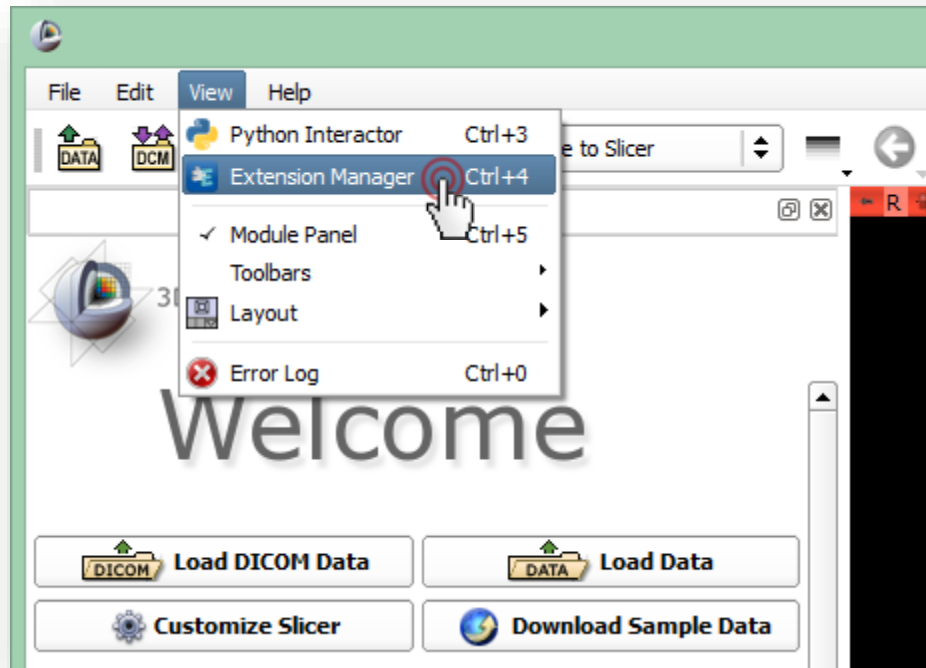
1. Install SlicerRT extension
 2. Load data from DICOM and nrrd files
 3. Perform rigid registration on CT images
 4. Transform day 2 dose volume
 5. Accumulate dose distributions
 6. Compute dose volume histogram
- +1. Create isodose lines and surfaces
- +2. Compare dose distributions using gamma



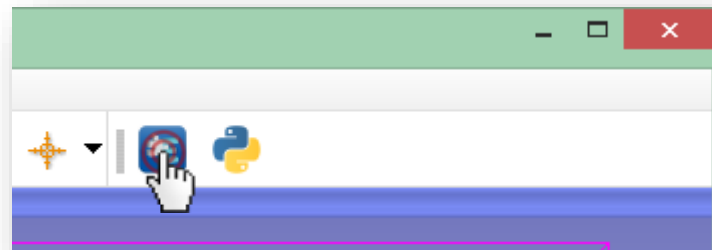
1/1. Install 3D Slicer

- Find the downloaded 3D Slicer package on your computer
- Follow the usual steps to install an application
 - Different for each operating system

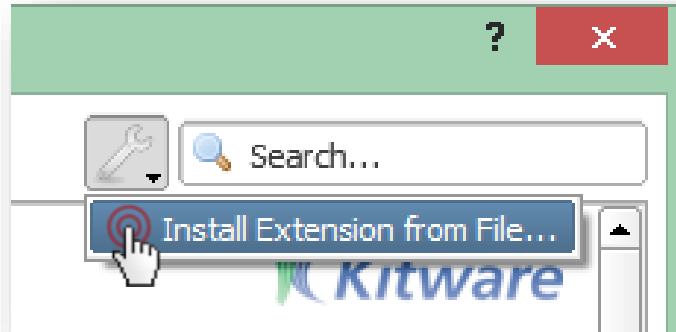
1/2. Install SlicerRT extension



or



1/3. Install SlicerRT extension



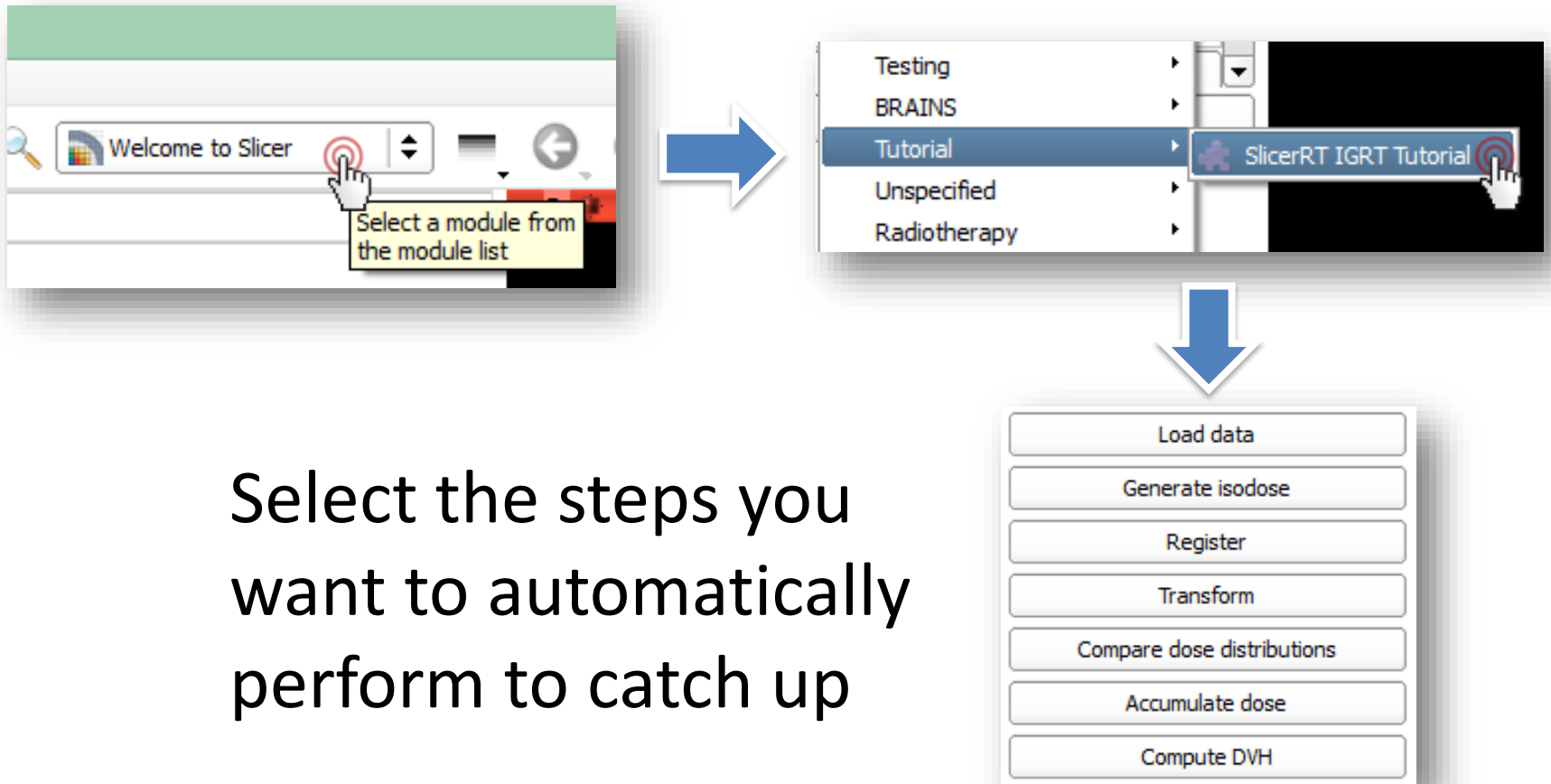
Find the downloaded SlicerRT zip file on your computer



Click Restart

In case of problems

If you fall behind, or encounter an error you can keep up using the tutorial module



Select the steps you want to automatically perform to catch up

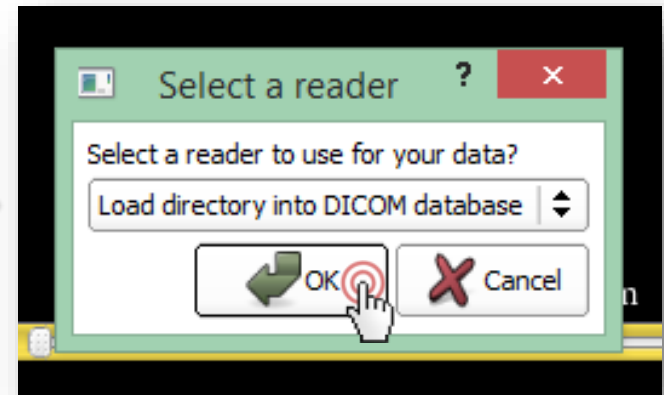
2/1. Unpack tutorial datasets

- Find the dataset you downloaded named *SlicerRT_WorldCongress_TutorialIGRT_Dataset.zip*
- Unpack it to a local folder of your choice
 - Different for each operating system

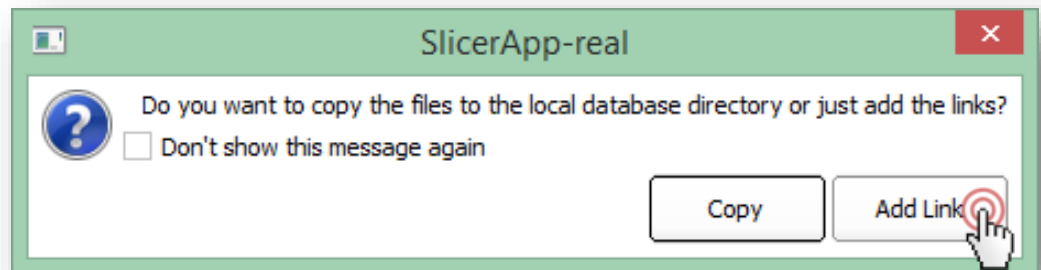
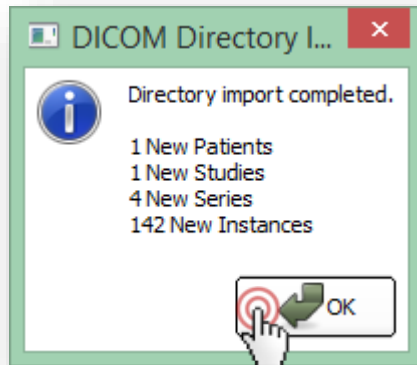


2/2. Import planning DICOM data

Drag&drop folder named *EclipseEntPhantomRtData* onto Slicer



You'll be prompted for database folder here



Note

If not importing via drag&drop, DICOM data can be imported and loaded from the DICOM browser that can be opened from the toolbar



2/3. Load planning study

The screenshot shows the DICOM Browser application window. The title bar is 'DICOM Browser'. The menu bar includes 'Import', 'Export', 'Query', 'Send', 'Remove', and 'Repair'. The 'LocalDatabase' is set to 'C:/Slicer_Data/_Z_TestDatabase' and 'Density' is 'Compact'. There are search fields for 'Patients', 'Studies', and 'Series'. The 'Patients' table has columns: 'PatientsName', 'PatientID', 'PatientsBirthDate', 'PatientsBirthTime', 'PatientsSex', and 'PatientID'. The first row is 'RANDO^ENT' with 'TEST PHYS ENT' in the PatientID column. A hand cursor points to 'RANDO^ENT'. Below this is a table with columns: 'StudyID', 'StudyDate', 'StudyTime', 'AccessionNumber', 'ModalitiesInStudy', and 'InstitutionName'. The first row is '1445', '2011-09-20', '085705'. Below this is a table with columns: 'SeriesNumber', 'SeriesDate', 'SeriesTime', 'SeriesDescription', and 'Modality'. The first row is '2', '2011-09-20', '085816', 'ENT IMRT', 'CT'. The second row is '5', 'RTDOSE'. The third row is '4', 'RTPLAN'. The fourth row is '3', 'RTSTRUCT'. At the bottom, there are 'Load' and 'Metadata' buttons. A hand cursor points to the 'Load' button. To the right of these buttons are checkboxes for 'Advanced', 'Horizontal', and 'Browser Persistent'.

1. Click patient 'RANDO ENT'

2. Click 'Load'

2/4. Change shown volumes

1. Open slice controls

2. Link slices together

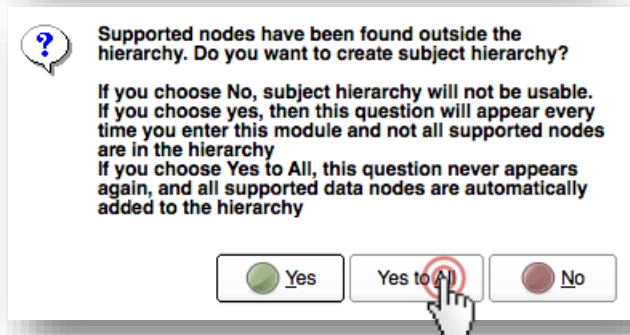
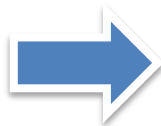
3. Choose shown volume to CT: '2: ENT IMRT'

2/5. Tweak display

The screenshot shows the 3D Slicer 4.4.0-2015-05-29 interface. The top menu bar includes File, Edit, View, and Help. Below it is a toolbar with various icons for data, DICOM, and 3D manipulation. The left sidebar contains a '3DSlicer' logo, a 'Help & Acknowledgement' section, and a 'Servers' section with a 'Start List' button. Below that is a 'DICOM Database and Networking' section with a 'Show DICOM' button. The bottom left section is 'Recent DICOM Activity', showing a list of recent series added to the database. The main 3D view area displays a 3D model of a human head and neck. Four callout boxes provide instructions on how to interact with the 3D view:

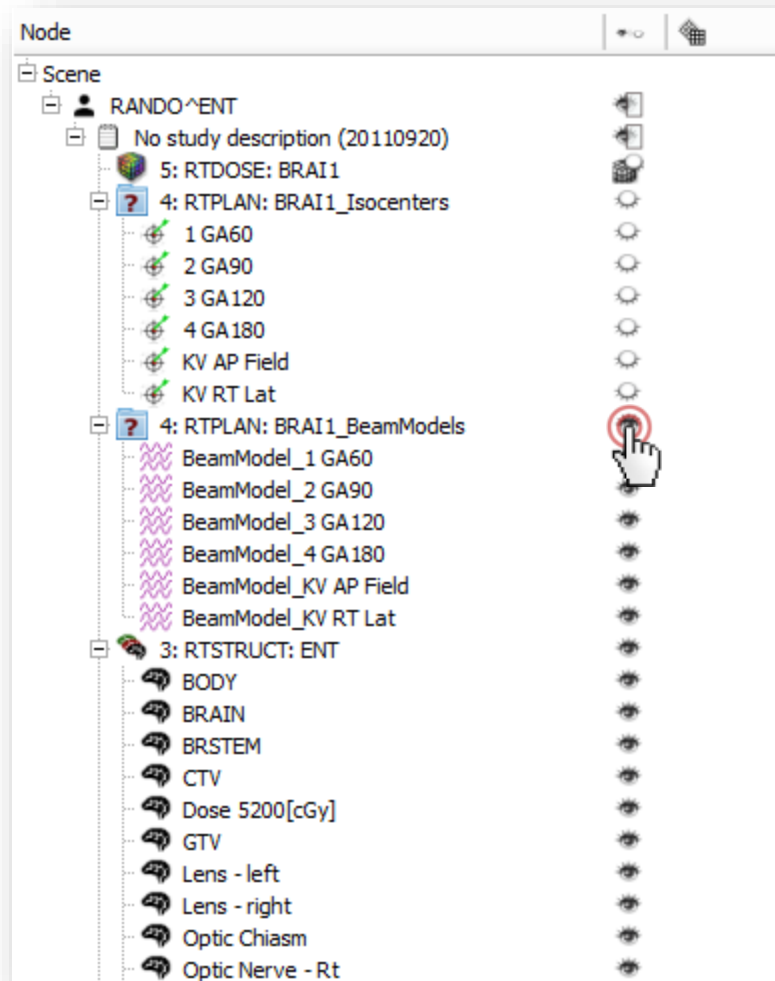
- 1. Reset 3D view**: Indicated by a hand icon clicking the 'Reset' button in the top right corner of the 3D view.
- 2. Manipulate 3D view**: Includes two sub-points: 'Rotate with left button' and 'Zoom with right button'. Indicated by a hand icon clicking the 'Rotate' button and another hand icon clicking the 'Zoom' button in the top right corner of the 3D view.
- 3. Adjust window/level**: Includes one sub-point: 'Click&drag left button'. Indicated by a hand icon clicking the 'Window/Level' button in the top right corner of the 3D view.
- 4. Navigate slice view**: Includes three sub-points: 'Change slice by scrolling', 'Zoom with right button', and 'Pan with middle button (Shift+click&drag on Mac)'. Indicated by a hand icon clicking the 'Navigate' button in the top right corner of the 3D view.

2/6. Explore loaded data



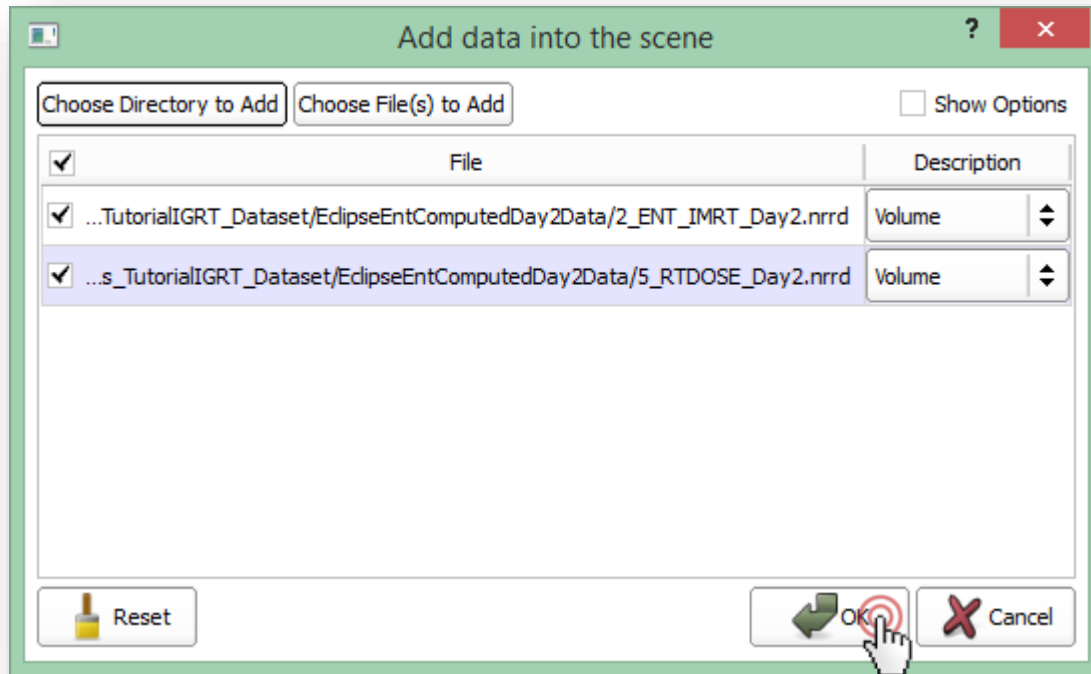
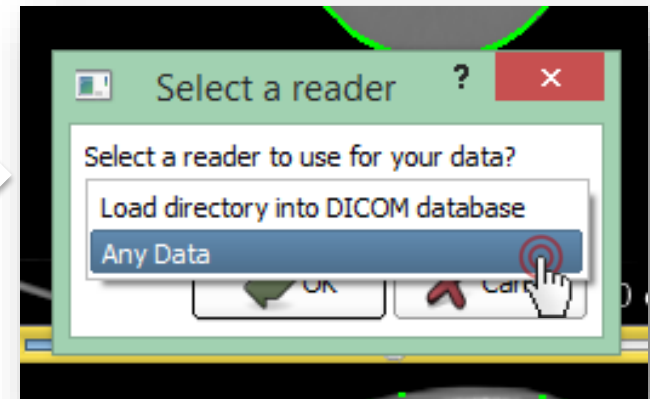
Subject hierarchy:

- Explore data in tree view
- Show/hide branches clicking the eye buttons
- Access options by right click



2/7. Load day 2 data

Drag&drop folder named
EclipseEntComputedDay2Data
onto Slicer



Note

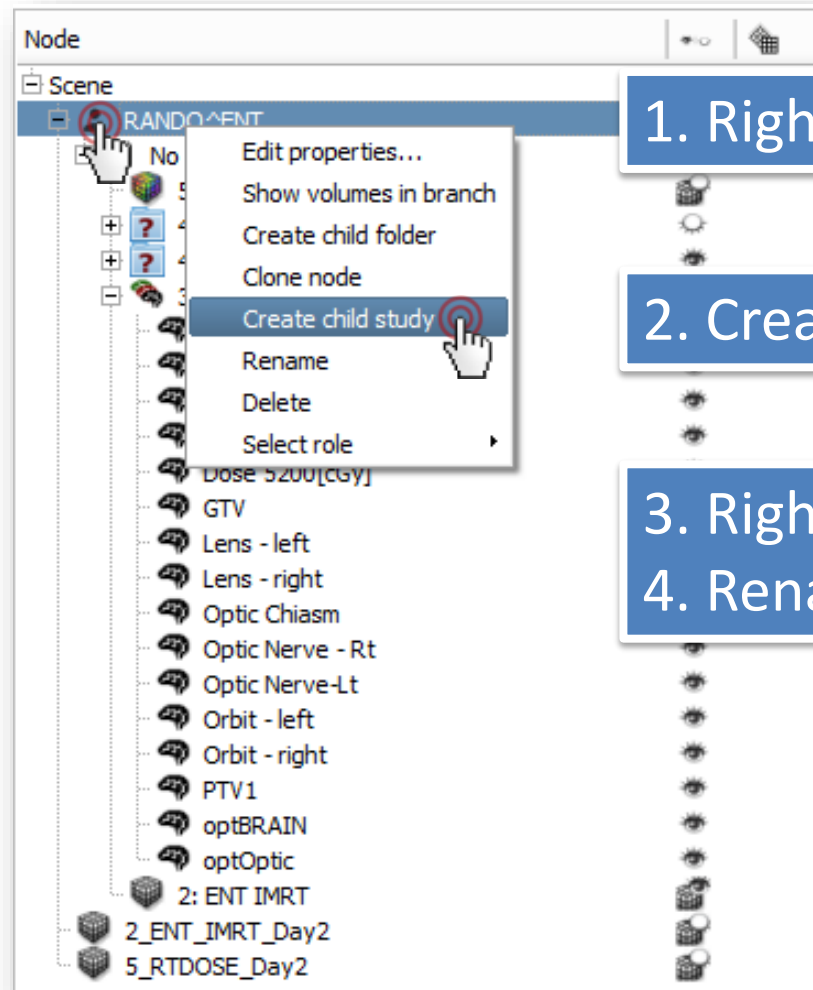
- Data type selection dialog does not appear if you drag&drop files rather than folders, as files will be handled as non-DICOM
- Non-DICOM data can be also loaded in the dialog that appears after clicking



- Data can be saved using



2/8. Add day 2 non-DICOM data to subject hierarchy



1. Right-click the patient

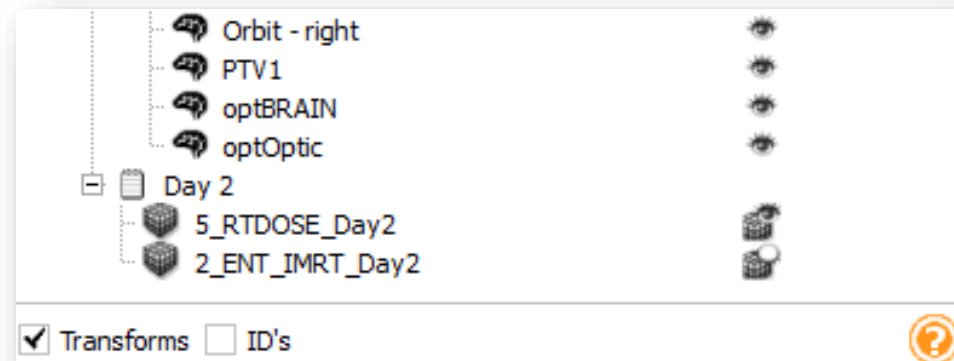
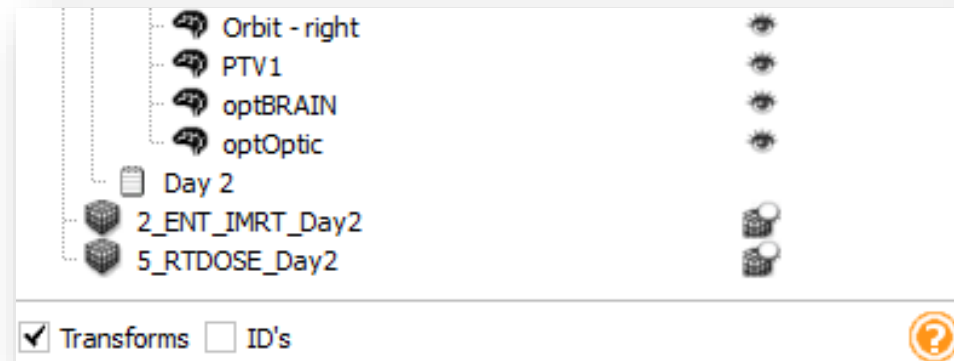
2. Create child study

3. Right-click new node
4. Rename to 'Day 2'

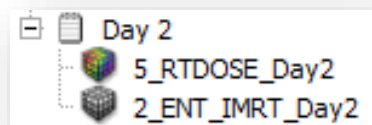
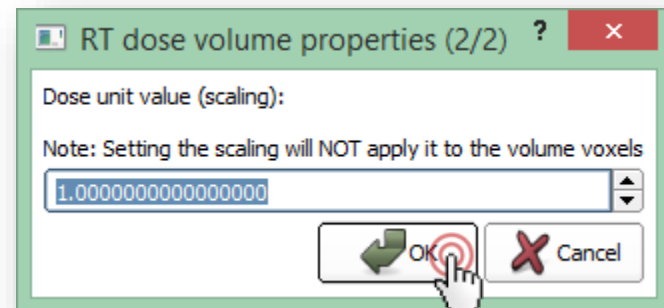
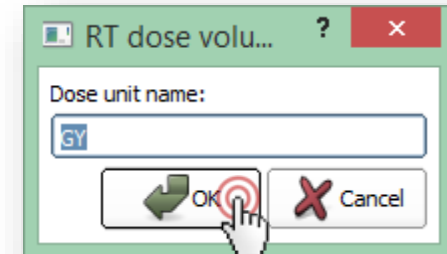
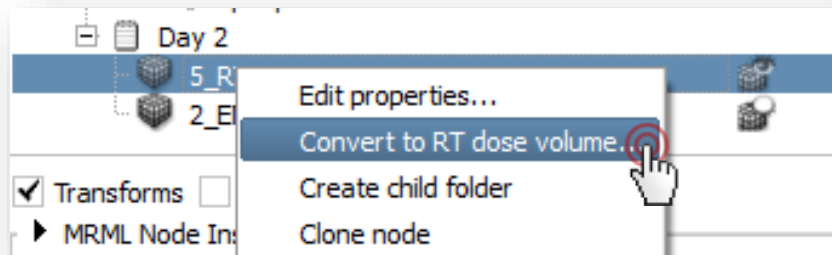
2/9. Add day 2 non-DICOM data to subject hierarchy

1. Drag&drop '2_ENT_IMRT_Day2' on the study 'Day 2'

2. Do the same with '5_RTDOSE-Day2'



2/10. Convert day 2 dose volume actually a dose



3/1. Register CT volumes

1. Go to module Registration / General Registration (BRAINS)

Set up parameters as shown:
2. Choose '2: ENT_IMRT' as fixed image
3. Choose day 2 CT '2_ENT_IMRT_Day2' as moving image
4. Create linear transform and rename it to Transform_Day2ToDay1_Rigid
5. Choose 'Rigid (6 DOF)'

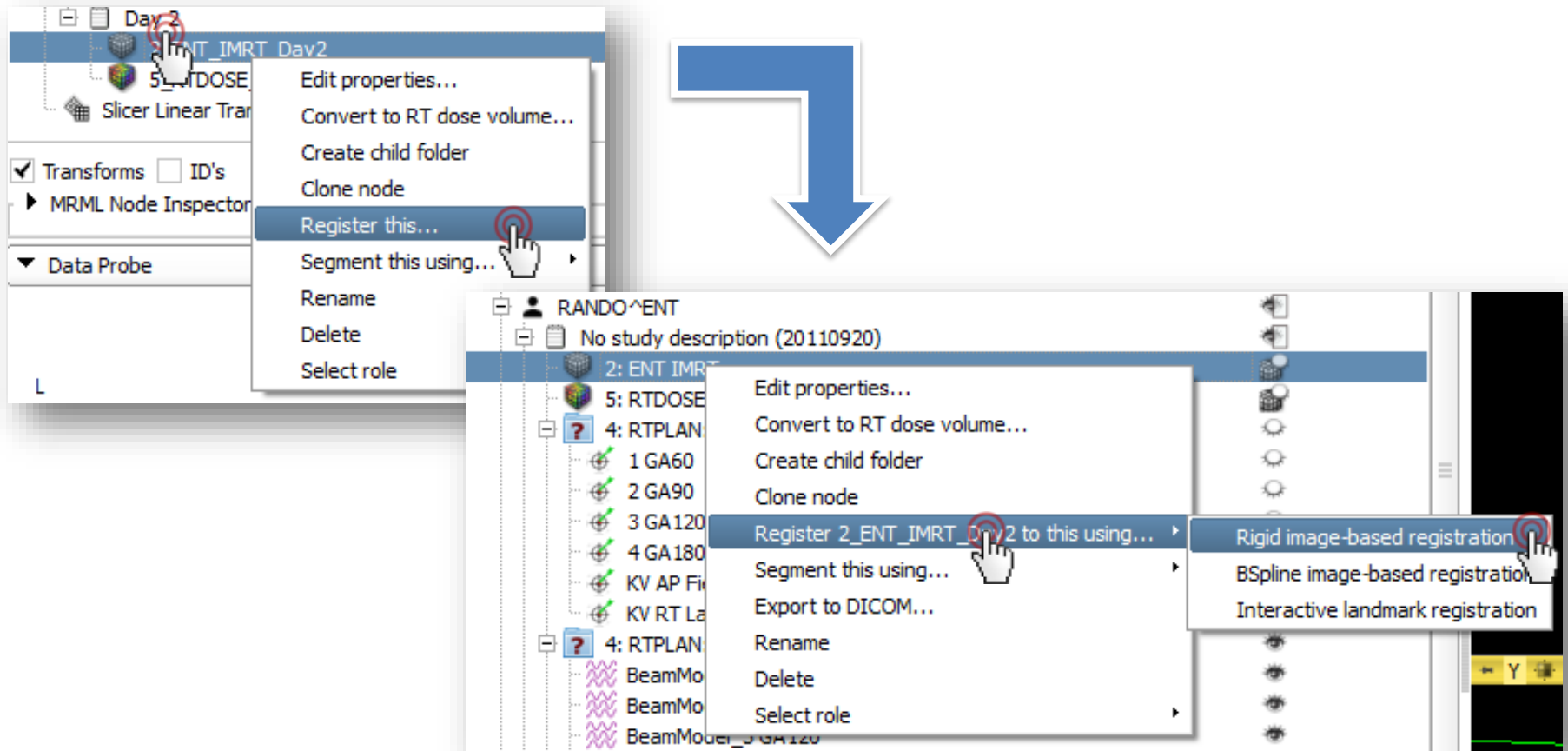
6. Click 'Apply'

The screenshot shows the 'General Registration (BRAINS)' module interface. Red circles and hand icons indicate the following steps:

- Click on the 'General' dropdown menu in the left sidebar.
- Click on the 'Fixed Image Volume' dropdown menu, which currently shows '2: ENT_IMRT'.
- Click on the 'Moving Image Volume' dropdown menu, which currently shows '2_ENT_IMRT_Day2'.
- Click on the 'Create and rename new LinearTransform' option in the 'Output Image Volume' dropdown menu.
- Click on the 'Rigid (6 DOF)' option in the 'Registration Phases' section.

Note

You can also initiate registration from subject hierarchy (alternative way for previous step):



3/2. Explore volume differences

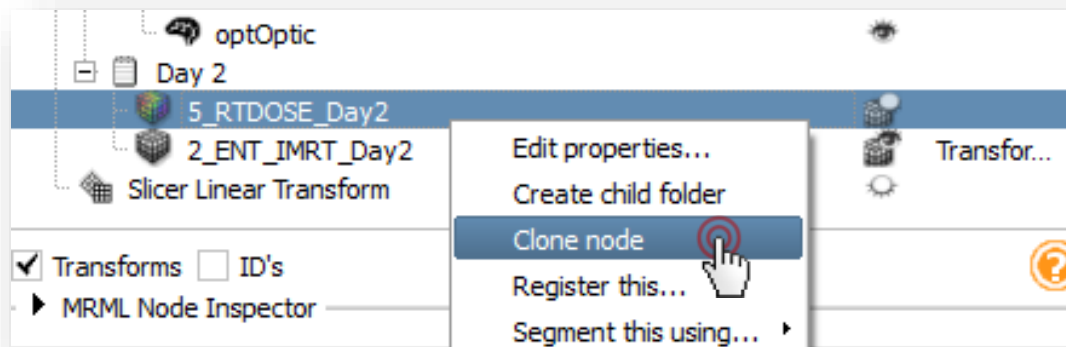
The screenshot shows the 3DSlicer software interface. On the left, the 'Volumes' module is active. The 'Active Volume' dropdown is set to '2_ENT_IMRT_Day2'. The 'Display' section shows a 'Lookup Table' set to 'Grey' and 'Interpolate' checked. The 'Window Level editor presets' section shows a hand cursor clicking on the '2: ENT IMRT' preset. The 'Threshold' section shows a slider from -1338 to 2717. On the right, the 'Slices' panel shows the '2: ENT IMRT' volume selected. The main 3D view shows a cross-section of a head with various colored overlays. Red circles and hand cursors indicate the steps described in the text boxes.

1. Open slice layers '>>'
2. Set volume on foreground layer
3. Change foreground opacity

Optional: Set the same W/L in Volumes module

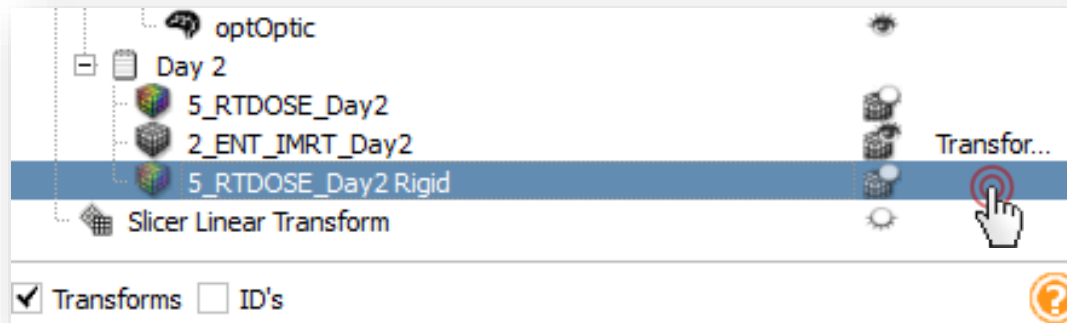
4/1. Clone dose volume

To be able to compare the non-registered (= uncorrected) and the registered (= isocenter shifted) results.



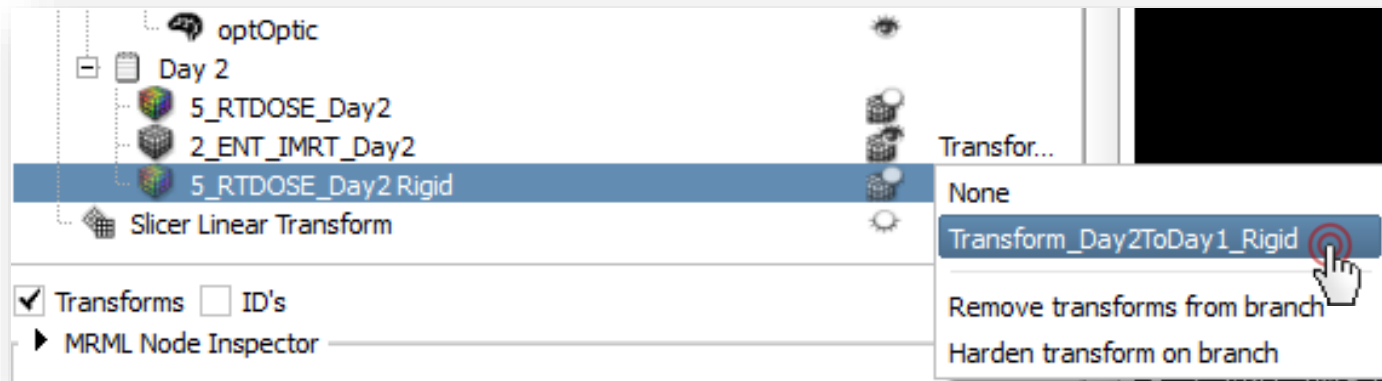
1. Switch to Subject hierarchy
2. Select 'Clone node' in context menu for day 2 dose
3. Rename it to '5_RTDOSE_Day2 Rigid'

4/2. Transform cloned dose volume



1. Double-click transform column of cloned dose

2. Click 'None' to open drop-down



Note

We can transform the whole study too if we want to transform multiple objects (an alternative way for previous step):



1. Double-click transform column of study

2. Click 'None' to open drop-down



5/1. Accumulate dose distributions

▼ Input

Reference dose volume: 5: RTDOSE: BRAI1

☒ Show dose volumes only

	Dose Volume	Weighting Factor
<input checked="" type="checkbox"/>	5: RTDOSE: BRAI1	1.00
<input checked="" type="checkbox"/>	5_RTDOSE_Day2	1.00
<input type="checkbox"/>	5_RTDOSE_Day2 Copy	1.00

▼ Output

Accumulated dose volume: None

2: ENT IMRT

5: RTDOSE: BRAI1

3: RTSTRUCT: ENT

2_ENT_IMRT_Day2

5_RTDOSE_Day2

5_RTDOSE_Day2 Rigid

► Data Probe

Rename current Volume

Create new Volume

1. Go to module Radiotherapy / Dose Accumulation

2. Choose reference, then planning and day 2 dose volumes

3. Create output volume

4. Click 'Apply'

5/2. Accumulate dose distributions

Reference dose volume: 5: RTDOSE: BRAI1

☒ Show dose volumes only

	Dose Volume	Weighting Factor
<input checked="" type="checkbox"/>	5: RTDOSE: BRAI1	1.00
<input type="checkbox"/>	5_RTDOSE_Day2	1.00
<input checked="" type="checkbox"/>	5_RTDOSE_Day2 Rigid	1.00
<input type="checkbox"/>	Accumulated_5: RTDOSE: BRAI15_RTDOSE_Day2	1.00

1. Uncheck day 2 dose volume

2. Select registered day 2 dose

3. Create new output volume

4. Click 'Apply'

6/1. Compute DVH for unregistered

▼ Input

Dose volume: Accumulated_5: RTDOSE: BRAI15_RTDOSE_Day2 ☐ A/O

Segmentation: 3: RTSTRUCT: ENT

▶ Select individual structures

☒ Show dose volumes only

Compute DVH

1. Go to module Radiotherapy / Dose Volume Histogram


2. Choose unregistered accumulated dose


3. Choose '3: RTSTRUCT: ENT'

Optional: Choose individual structures to speed up computation


4. Click 'Compute DVH'

6/2. Compute DVH for registered




Dose volume: Accumulated_5: RTDOSE: BRAI15_RTDOSE_Day2 Rigid  ☐ A/O

Segmentation: 3: RTSTRUCT: ENT 

▶ Select individual structures

☒ Show dose volumes only  **Compute DVH**

▼ Output

Chart: Select a Chart   Show/hide all 

		Structure	Volume name	Volume (cc)
1	<input type="checkbox"/>	BODY	Accumulated_5: RTDOSE: BRAI15_RTDOSE_Day2	8053.83
2	<input type="checkbox"/>	BRAIN	Accumulated_5: RTDOSE: BRAI15_RTDOSE_Day2	1114.72

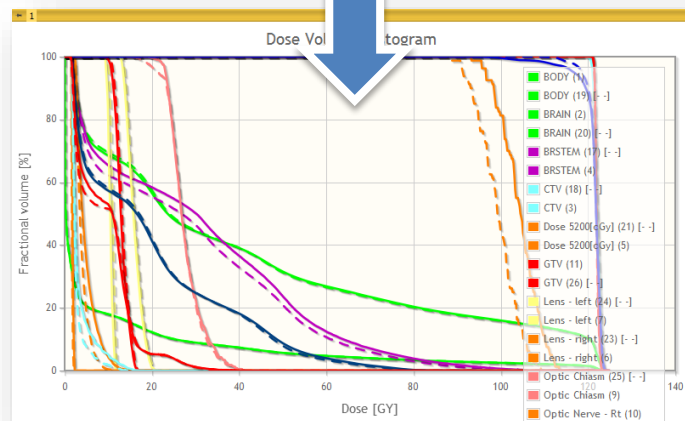
1. Choose registered accumulated dose

2. Click 'Compute DVH'



3. Create chart

4. Click 'Show/hide all'

5. DVH curves appear




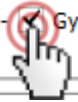
6/3. Quantify improvement

Chart: Chart ⬆️⬆️ ☒ Show/hide all  

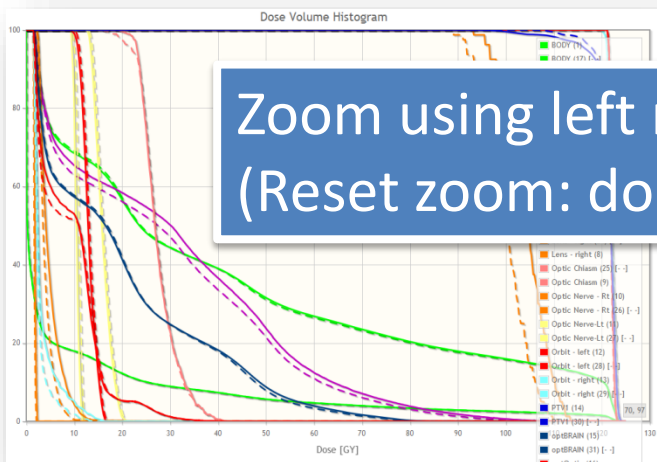
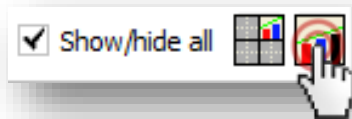
	Structure	Volume name	Volume (cc)	Mean dose (GY)	Min dose (GY)	Max dose (GY)	V50 (%)	D99% (Gy)
1	<input checked="" type="checkbox"/> BODY	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	8054	8.76107	0	124.52	5.64	0.00
2	<input checked="" type="checkbox"/> BRAIN	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	1114.79	41.1543	1.27333	124.52	31.57	1.58
3	<input checked="" type="checkbox"/> BRSTEM	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	31.5742	30.5489	1.69507	113.388	23.69	1.79
4	<input checked="" type="checkbox"/> CTV	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	70.1289	122.158	119.76	124.176	100.00	120.54
5	<input checked="" type="checkbox"/> Dose 5200[cGy]	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	0.15625	104.27	93.2519	113.388	100.00	93.26
6	<input checked="" type="checkbox"/> GTV	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	8.49219	122.051	121.093	123.294	100.00	121.26
7	<input checked="" type="checkbox"/> Lens - left	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	0.128906	10.4467	9.39761	11.5707	0.00	9.34

▼ Advanced Options

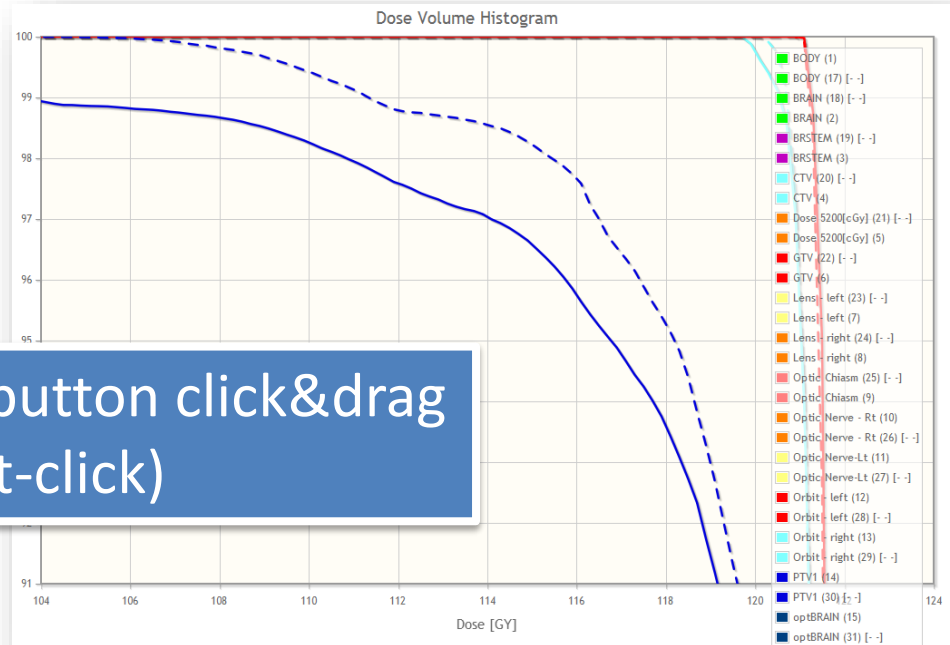
V metric for dose values: 50 Gy - ☐ cc ☒ % 

D metric for volumes: cc - ☒ Gy ☐ % 

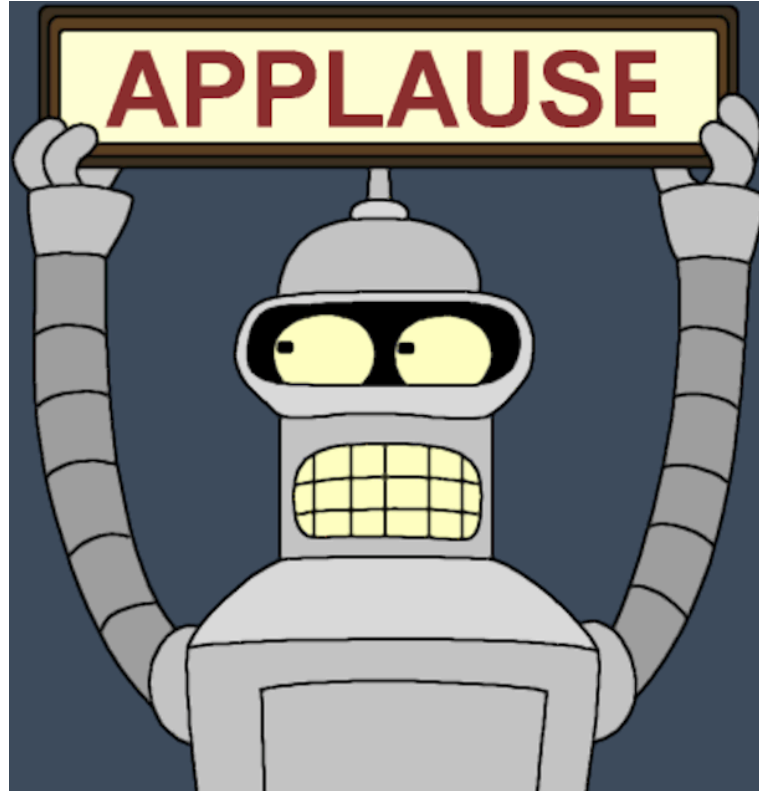
6/4. Visualize improvement



Zoom using left mouse button click&drag
(Reset zoom: double left-click)



Congratulations!



Thanks for attending!

Appendix: Optional steps for IGRT









Optional 1/1. Isodose lines/surfaces

Parameter set: IsodoseParameterSet_5: RTDOSE: BRAI1

▼ Input

Dose volume: 5: RTDOSE: BRAI1

Number of iso levels: 6

		Label	Opacity
1		5	0.20
2		10	0.20
3		15	0.20
4		20	0.20
5		25	0.20
6		30	0.20

▼ Display options

☒ Show isodose surfaces

☒ Show isodose lines

▼ Scalar bar

☐ Show scalar bar in 3D viewer

☐ Show scalar bar in 2D viewer

Apply

1. Choose Radiotherapy /
Isodose module

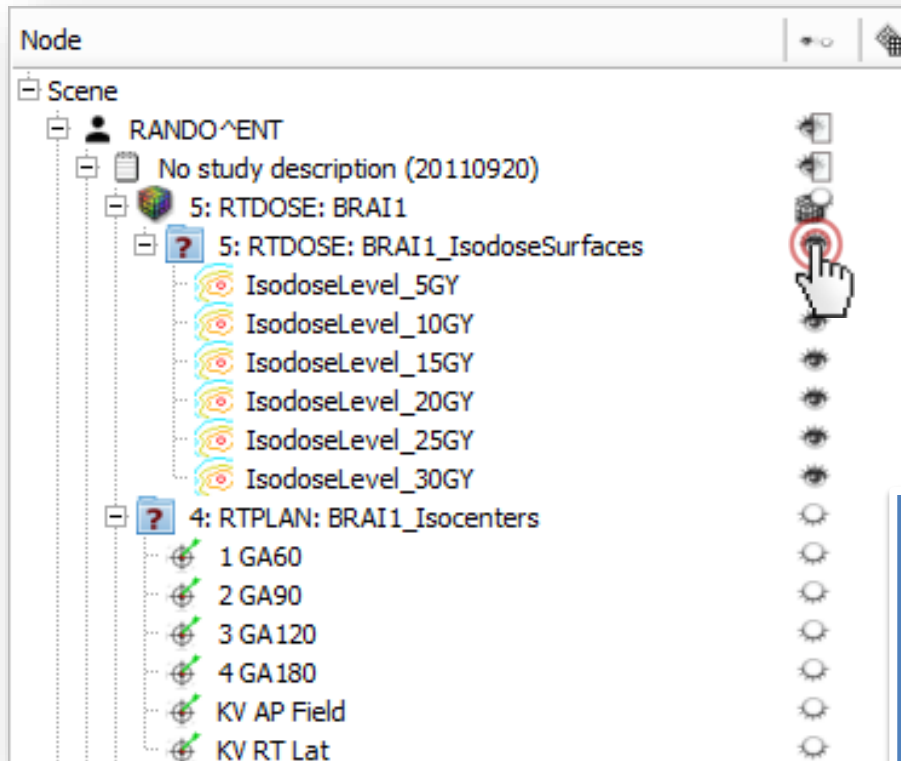
3. Select '5: RTDOSE: BRAI1'
volume as Dose volume

2. Click Apply

3. Select '5_RTDOSE_Day2'
volume as Dose volume

4. Click Apply

Optional 1/2. Visualize isodose lines

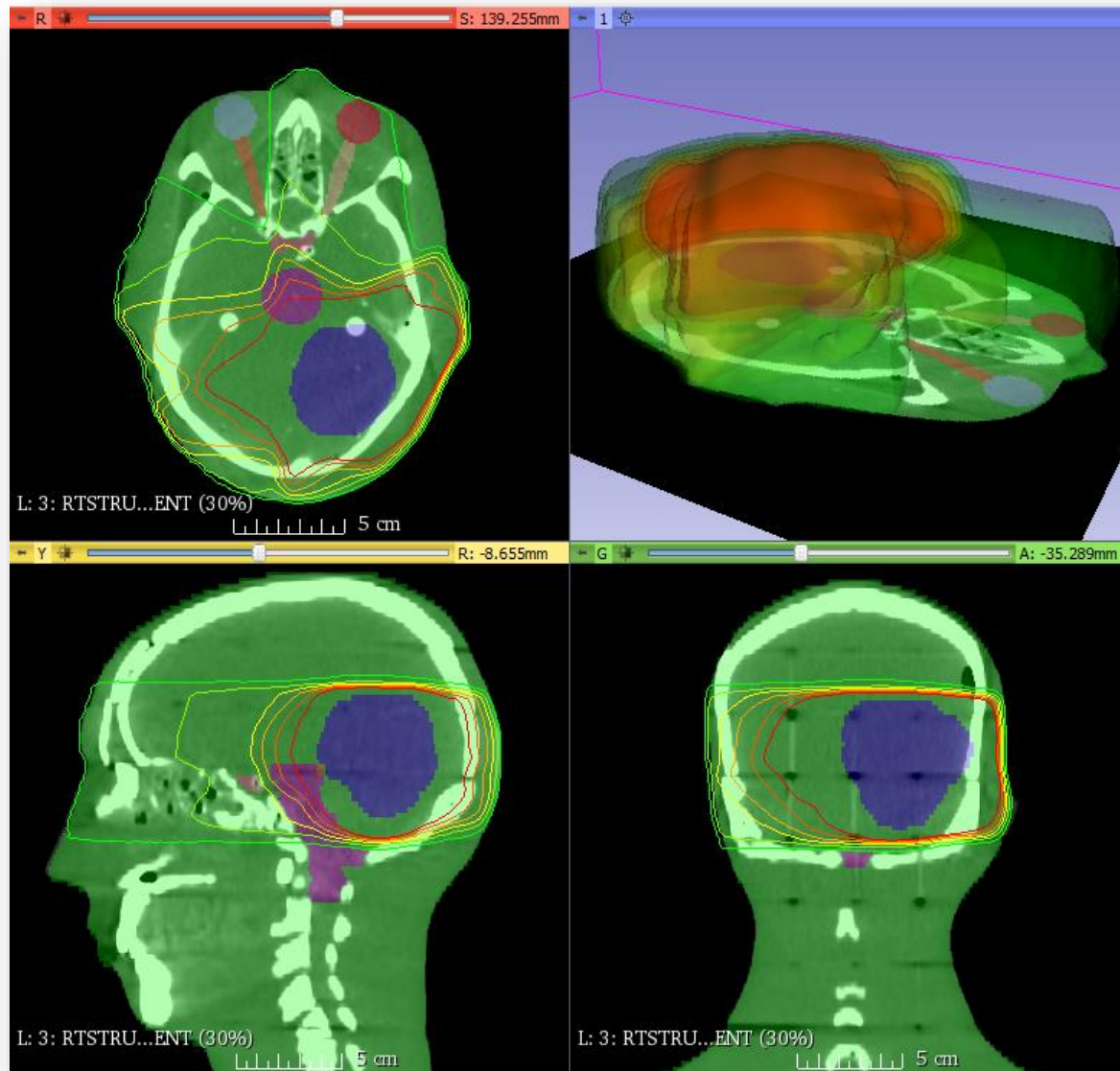


1. Switch to Subject Hierarchy

2. Turn on and off visualization of isodose line and surface groups by clicking the eye icon next to the parent node

Note: Display volumes in the 2D viewers by clicking the volume show/hide icon next to the volumes

Optional 1/3. Isodose lines/surfaces



Optional 2/1. Compare dose volumes using gamma comparison

The screenshot shows a software interface for dose comparison. It is divided into two main sections: 'Input' and 'Output'.
Input Section:
- 'Reference dose volume:' is set to '5: RTDOSE: BRAI1'.
- 'Compare dose volume:' is set to '5_RTDOSE_Day2'.
- 'Mask:' is set to 'None', with a note below stating 'No node is selected'.
- 'DTA distance tolerance (mm):' is set to '3.00'.
- 'Dose difference tolerance (%)': is set to '3.00'.
- 'Reference dose:' has two options: 'Use maximum dose' (selected) and 'Use custom value (Gy):' (set to '50.00').
- 'Analysis threshold (%)': is set to '10.00'.
- 'Maximum gamma:' is set to '2.00'.
Output Section:
- 'Gamma volume:' is set to 'None'.
- 'Pass fraction:' is set to 'N/A'.
- An 'Apply' button is located at the bottom right of the interface.

Numbered callouts on the interface:
1. Points to the 'Reference dose volume' and 'Compare dose volume' fields.
2. Points to the 'DTA distance tolerance' and 'Dose difference tolerance' fields.
3. Points to the 'Gamma volume' field.
4. Points to the 'Apply' button.

1. Go to module Radiotherapy / Dose Comparison

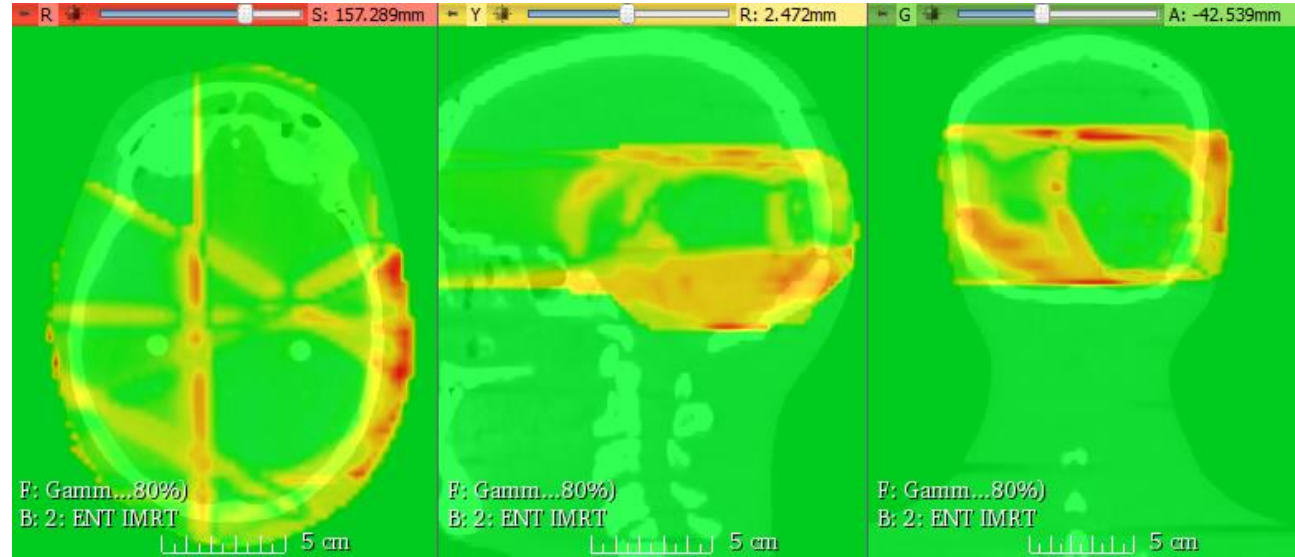
2. Set input volumes you want to compare

3. Create new output gamma volume

4. Click 'Apply'

Optional 2/2. Evaluate improvement

Plan dose
vs
Uncorrected
Day 2 dose



Plan dose
vs
Corrected
Day 2 dose

