

Tutorial:

Isocenter shifting image-guidance in SlicerRT

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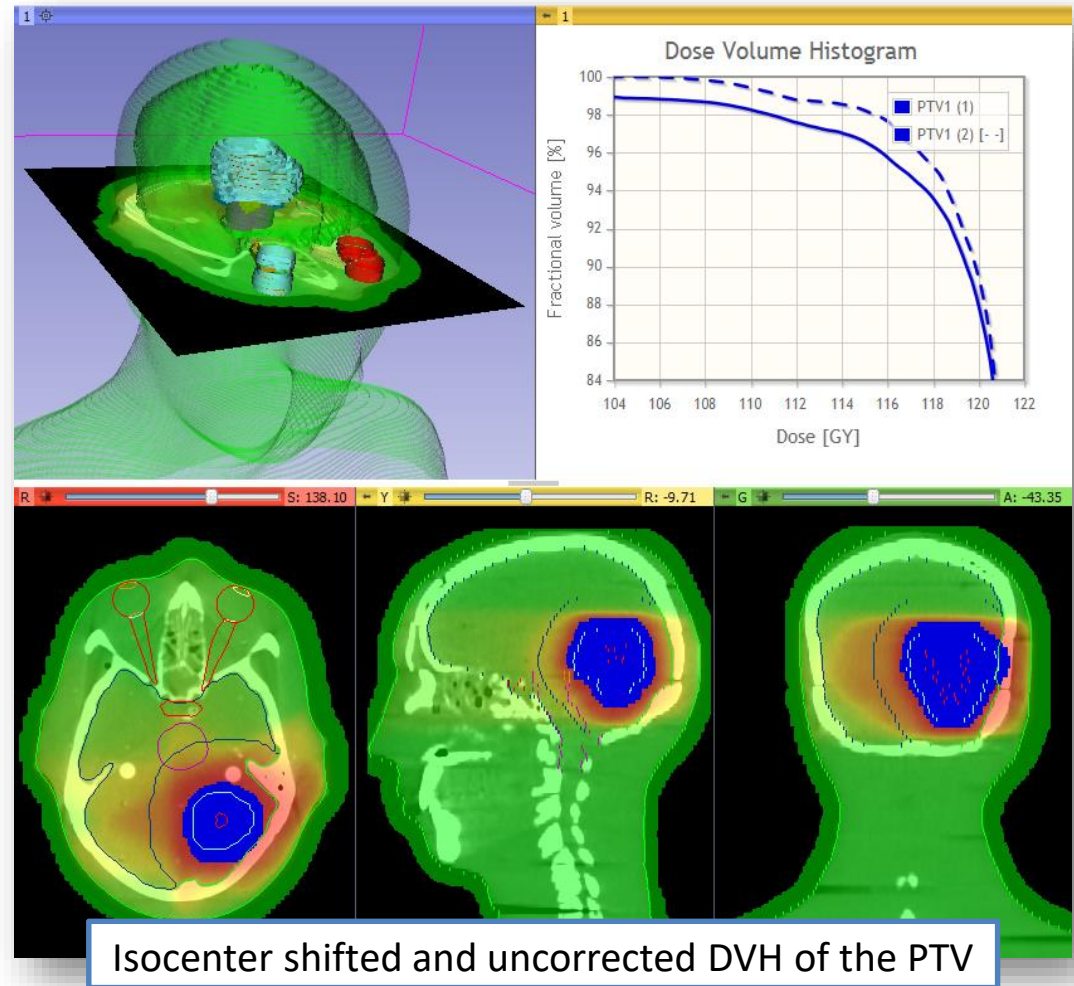
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Learning objective

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

Isocenter shifting
image-guidance



Material

- Dataset available on the Slicer Training page:

[https://www.slicer.org/wiki/Documentation/Nightly/Training#Slicer4 Radiation Therapy Tutorial](https://www.slicer.org/wiki/Documentation/Nightly/Training#Slicer4_Radiation_Therapy_Tutorial)

- Supported platforms:

 Windows,  Mac OSX,  Linux

– 32-bit is not supported!

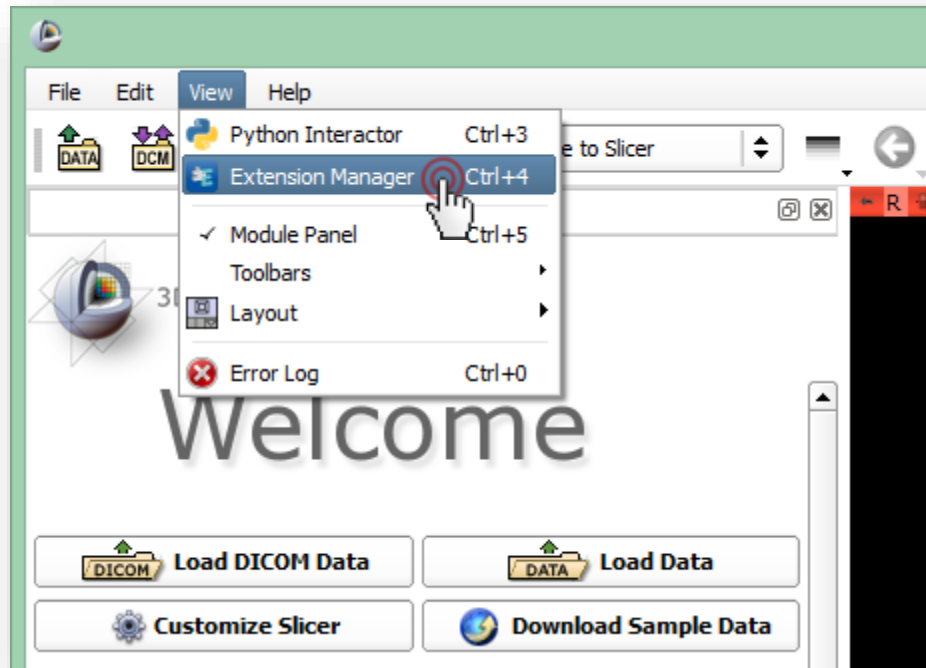
Overview

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

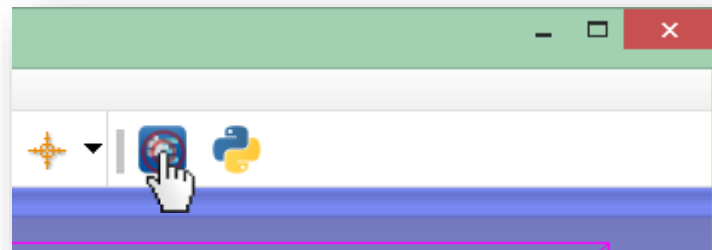
1/1. Install 3D Slicer

- Download latest 3D Slicer from <http://download.slicer.org>
- Follow the usual steps to install an application
 - Different for each operating system

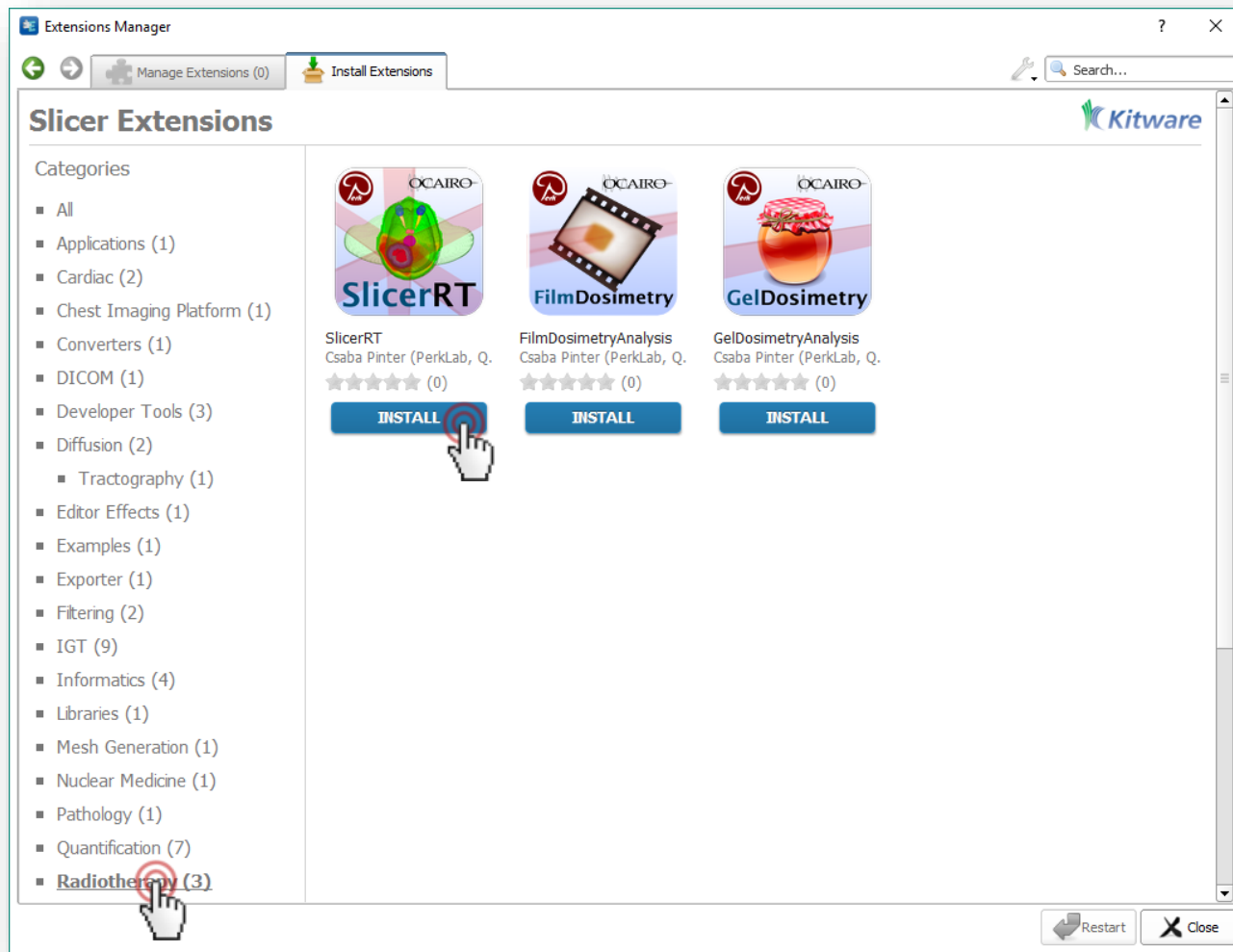
1/2. Install SlicerRT extension



or



1/3. Install SlicerRT extension



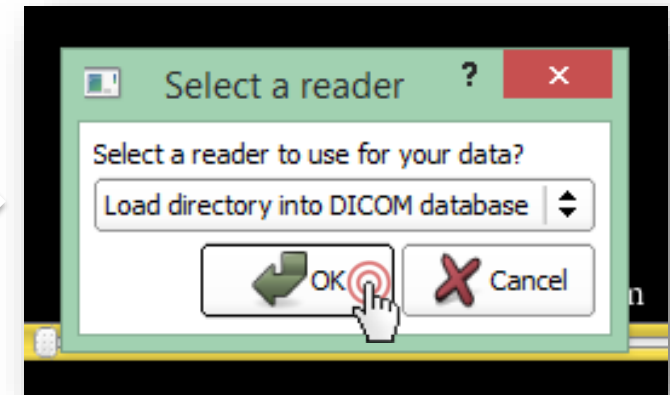
2/1. Unpack tutorial datasets

- 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

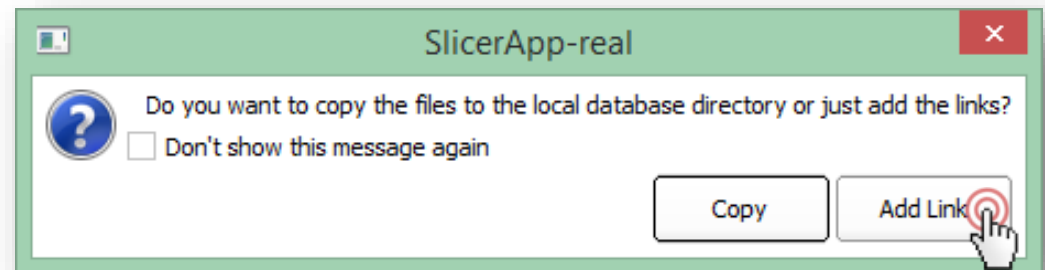
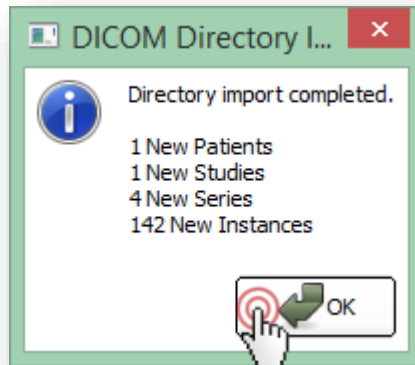


2/2. Import planning DICOM data

Drag&drop folder named
EclipseEntPhantomRtData
onto Slicer

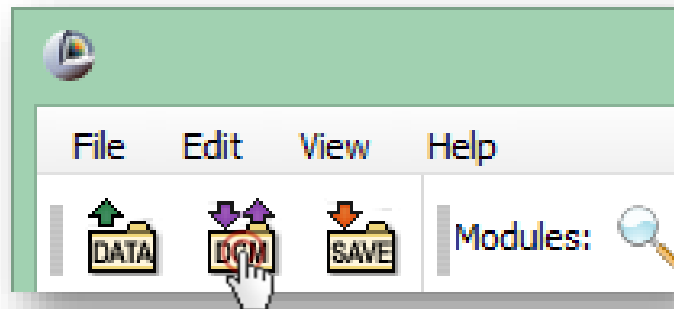


You'll be prompted for
database folder here



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

DICOM Browser

Import Export Query Send Remove Repair >> LocalDatabase: C:/Slicer_Data/_Z_TestDatabase Density: Compact

Patients: Studies: Series:

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

1. Click patient 'RANDO ENT'

StudyID	StudyDate	StudyTime	AccessionNumber	ModalitiesInStudy	InstitutionName
1445	2011-09-20	085705			

SeriesNumber	SeriesDate	SeriesTime	SeriesDescription	Modality
2	2011-09-20	085816	ENT IMRT	CT
5				RTDOSE
4				RTPLAN
3				RTSTRUCT

Load Metadata

2. Click 'Load'

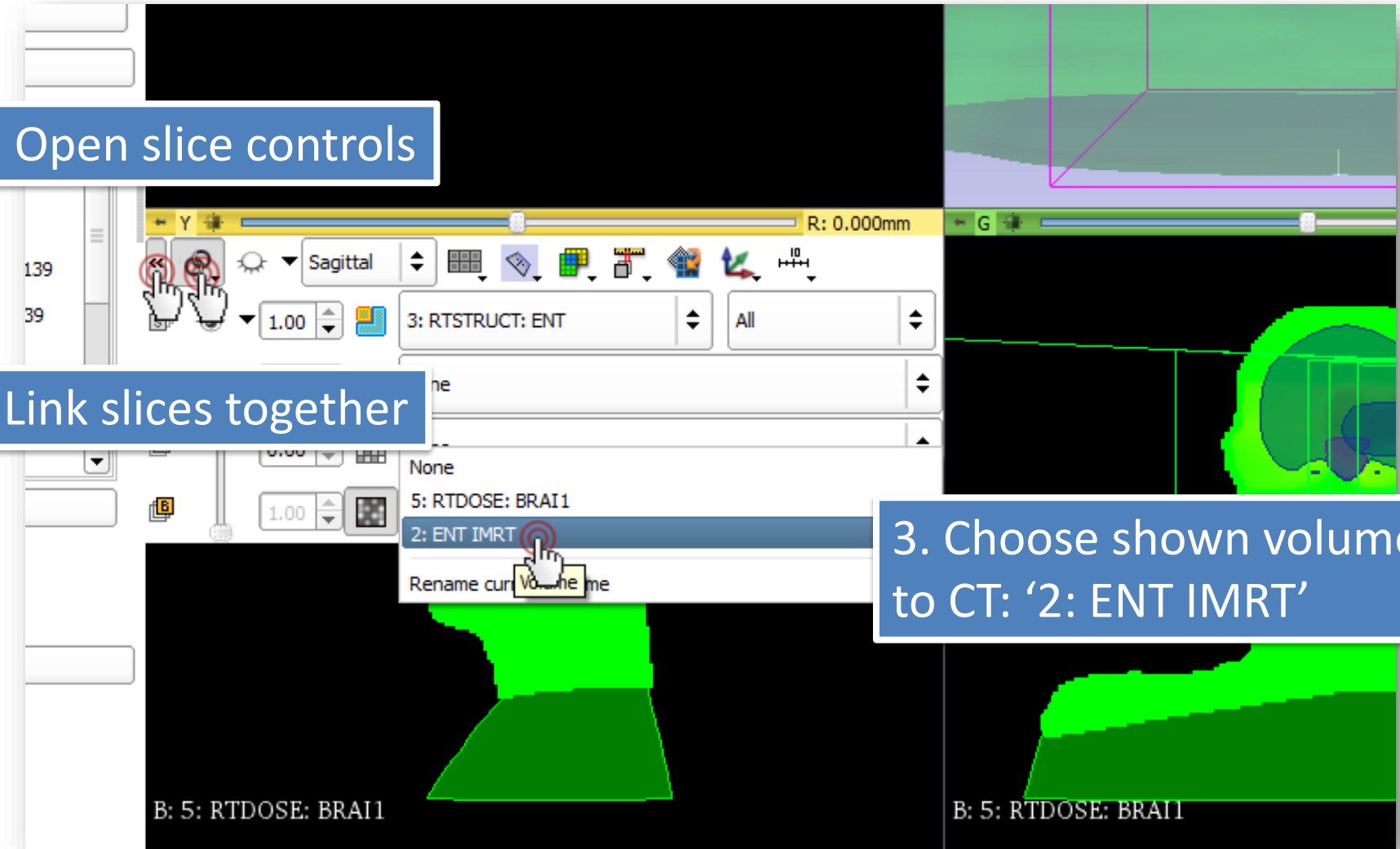
☐ Advanced ☐ Horizontal ☐ Browser Persistent

2/4. Change shown volumes

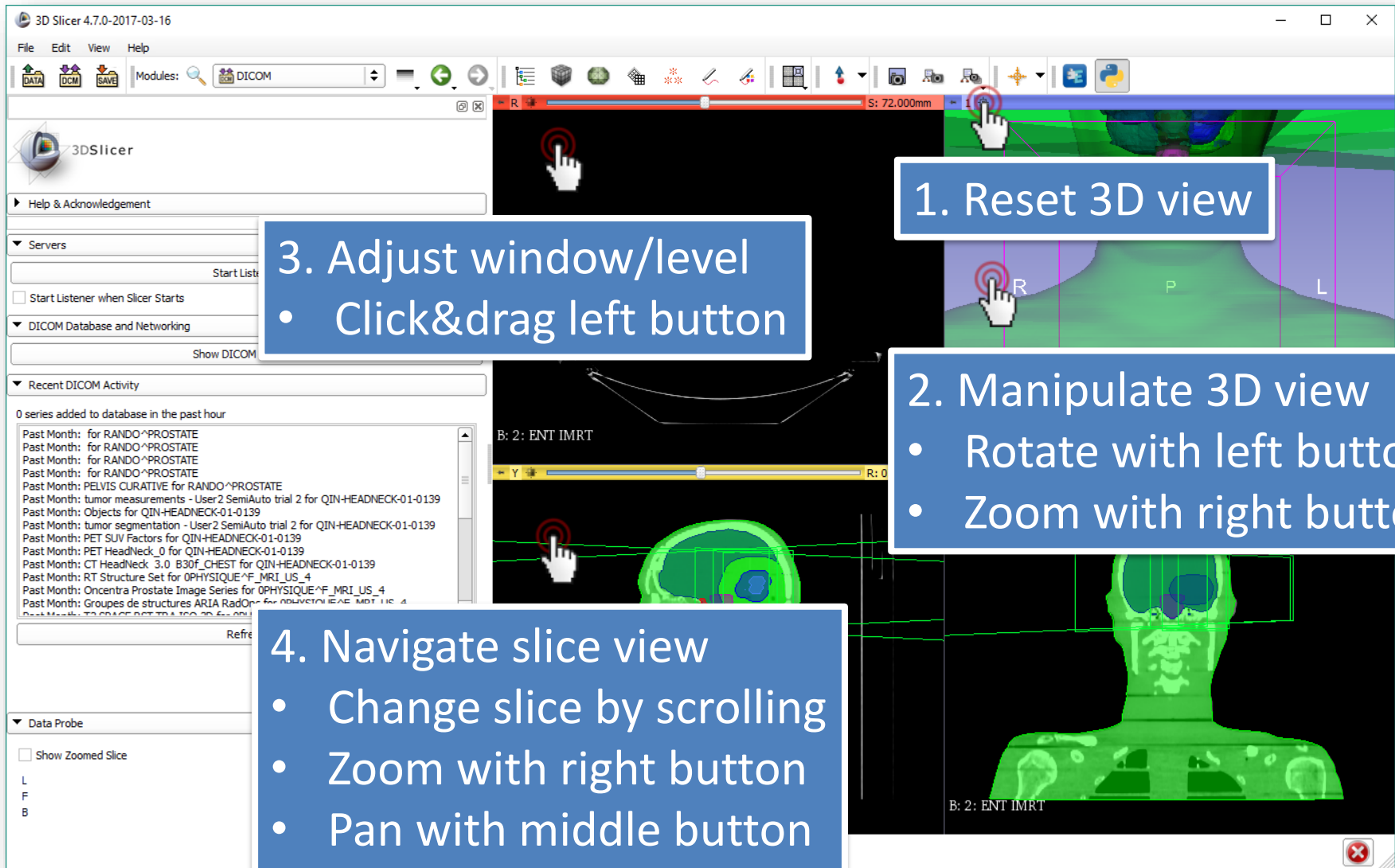
1. Open slice controls

2. Link slices together

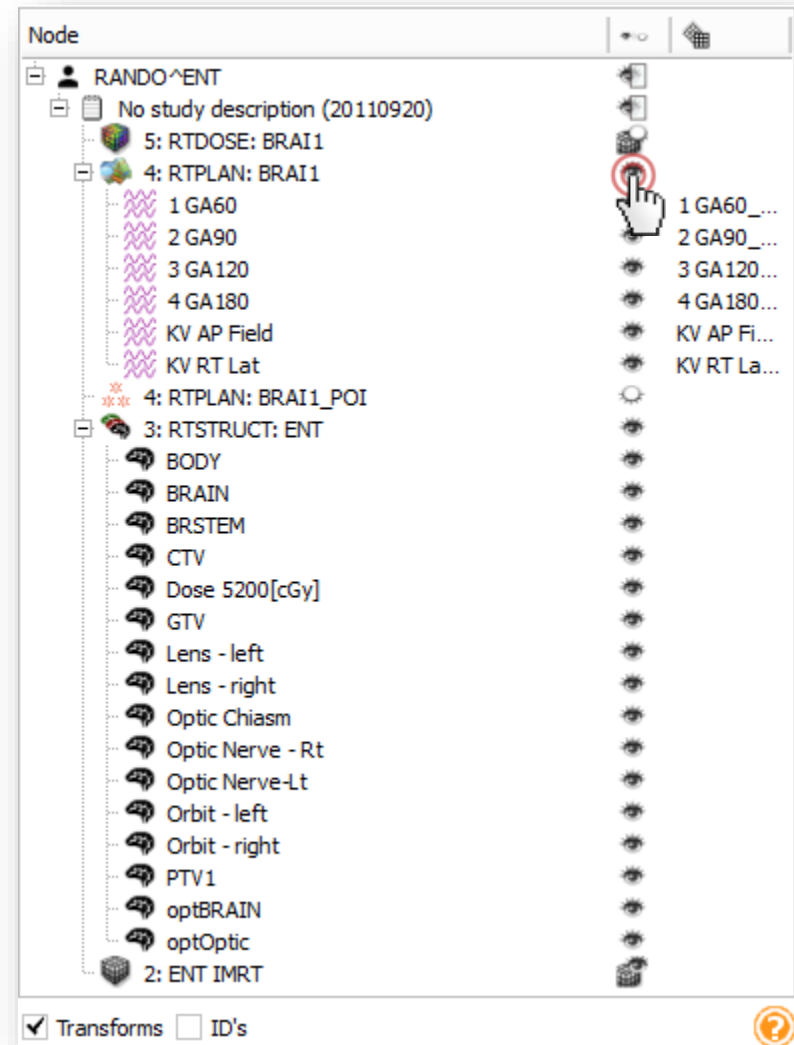
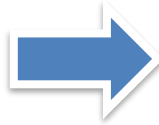
3. Choose shown volume to CT: '2: ENT IMRT'



2/5. Tweak display



2/6. Explore loaded data

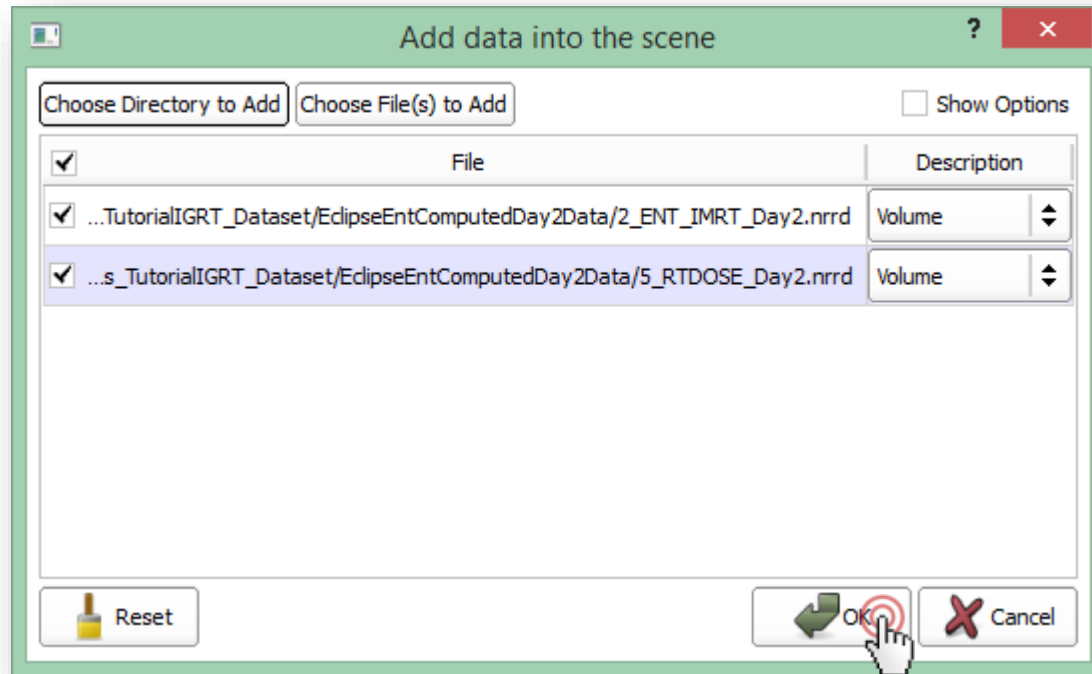
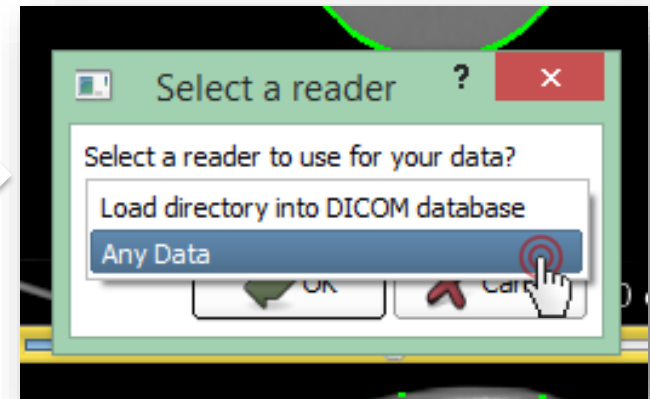


Subject hierarchy:

- 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

The screenshot shows a software interface with a 'Node' list on the left. The 'RADIO ^ENT' node is selected, and a context menu is open. The menu options are: 'Create child folder', 'Clone', 'Show volumes in branch', 'Create child study', 'Rename', 'Delete', 'Edit properties...', and 'Select role'. The 'Create child study' option is highlighted. To the right of the menu, there are two blue callout boxes with white text. The first box says '1. Right-click the patient'. The second box says '2. Create child study'. Below the second box, there is a third blue callout box with white text that says '3. Right-click (or double-click) new study item' and '4. Rename to 'Day 2''. The 'Node' list also shows other nodes like '3: RTSTRUCT: ENT', 'BODY', 'BRAIN', and 'BRSTEM'.

Node

RADIO ^ENT

Create child folder

Clone

Show volumes in branch

Create child study

Rename

Delete

Edit properties...

Select role

2 GA90_...

3 GA120...

3: RTSTRUCT: ENT

BODY

BRAIN

BRSTEM

1. Right-click the patient

2. Create child study

3. Right-click (or double-click) new study item

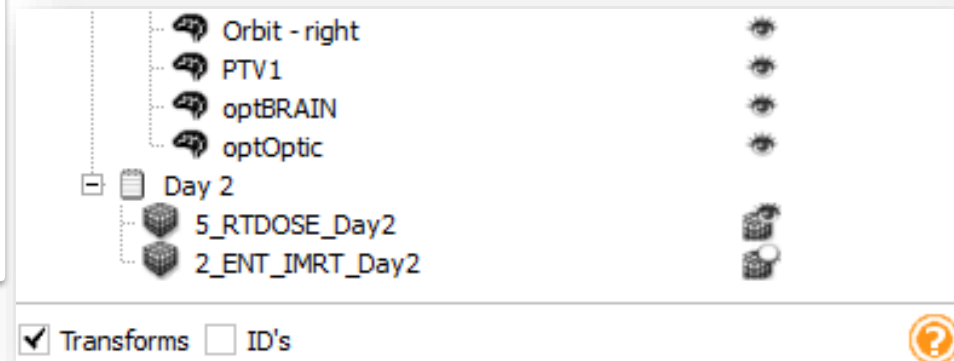
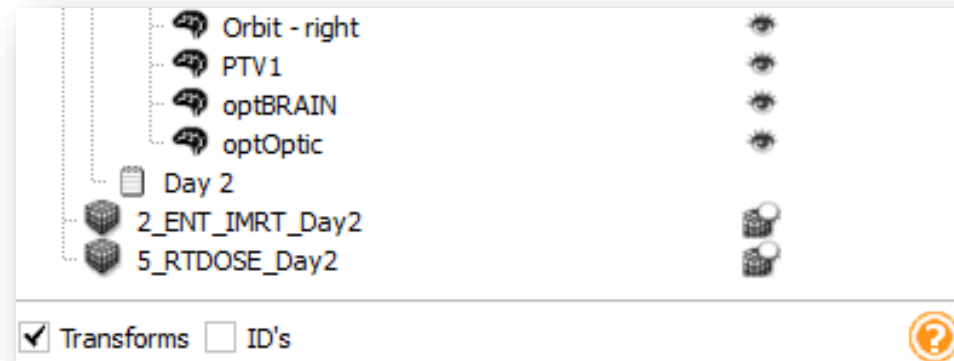
4. Rename to 'Day 2'

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

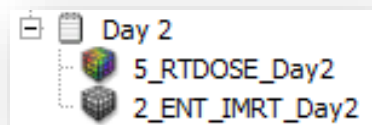
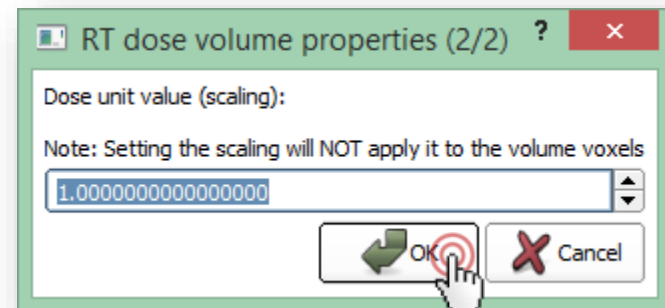
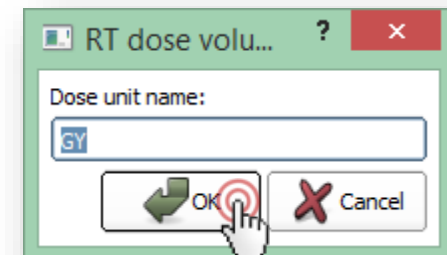
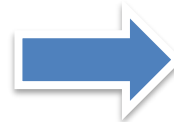
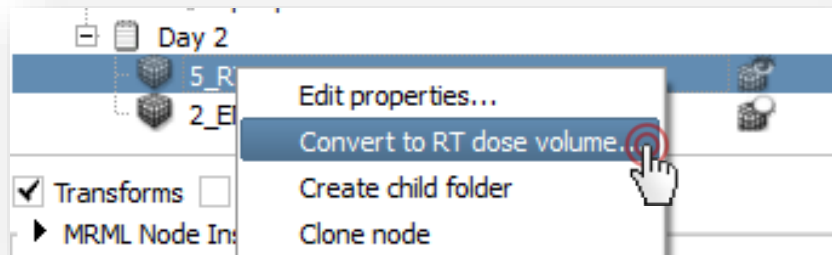
1. Drag&drop '2_ENT_IMRT_Day2' on the study 'Day 2'

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

Note: You can select both nodes while holding the Control/Cmd or Shift button, then drag&drop both at the same time



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'

Parameter set: General Registration (BRAINS)

Input Images

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: None

Slicer BSpline Transform: Rename current LinearTransform

Output Image Volume: Create new LinearTransform

Create and rename new LinearTransform

Delete current LinearTransform

Transform Initialization

Initialization transform: None

Initialize Transform Mode: ☒ Off ☐ useMomentsAlign ☐ useCenterOfHeadAlign ☐ useGeometryAlign ☐ useCenterOfROIAAlign

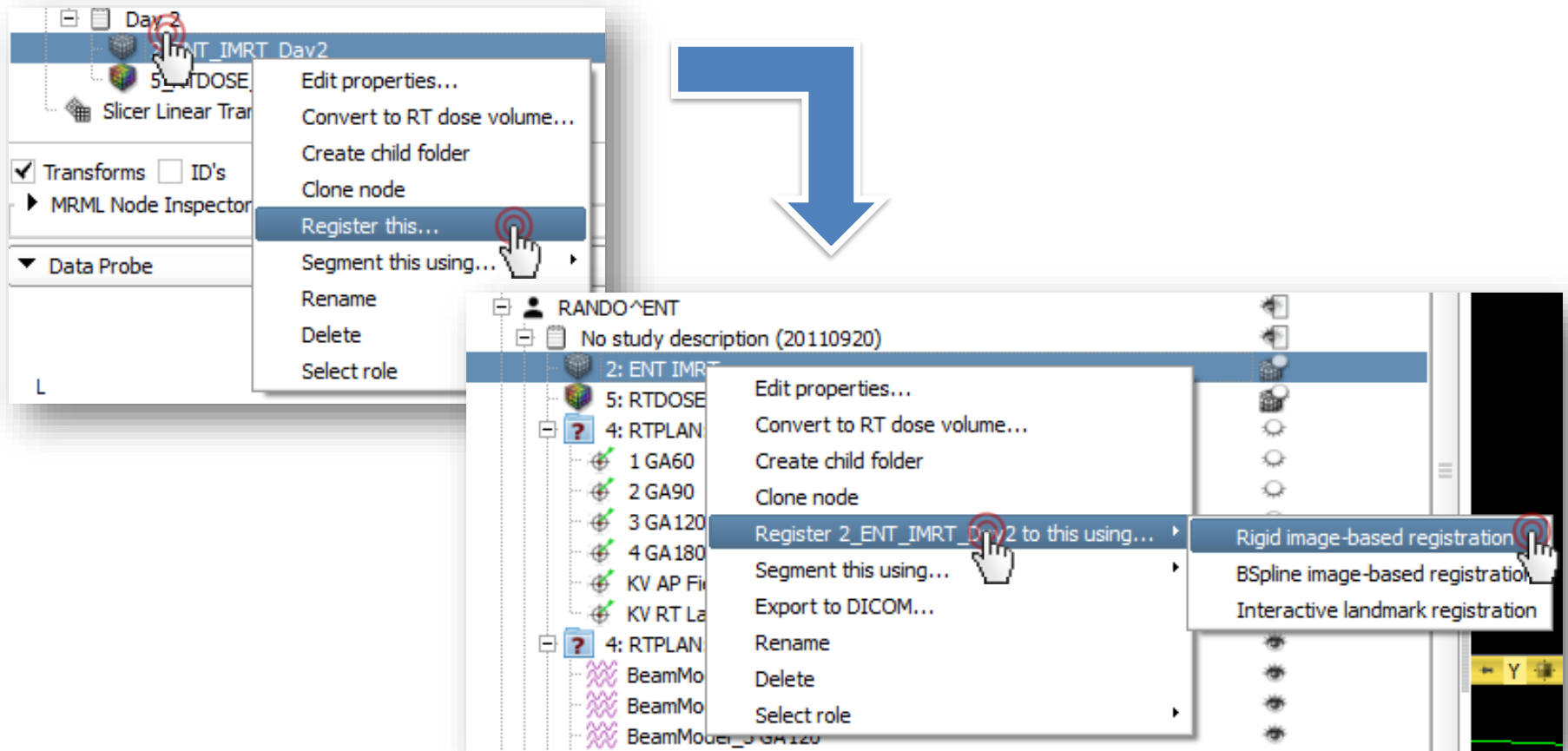
Registration Phases (Check one or more, executed in order listed)

Rigid (6 DOF)

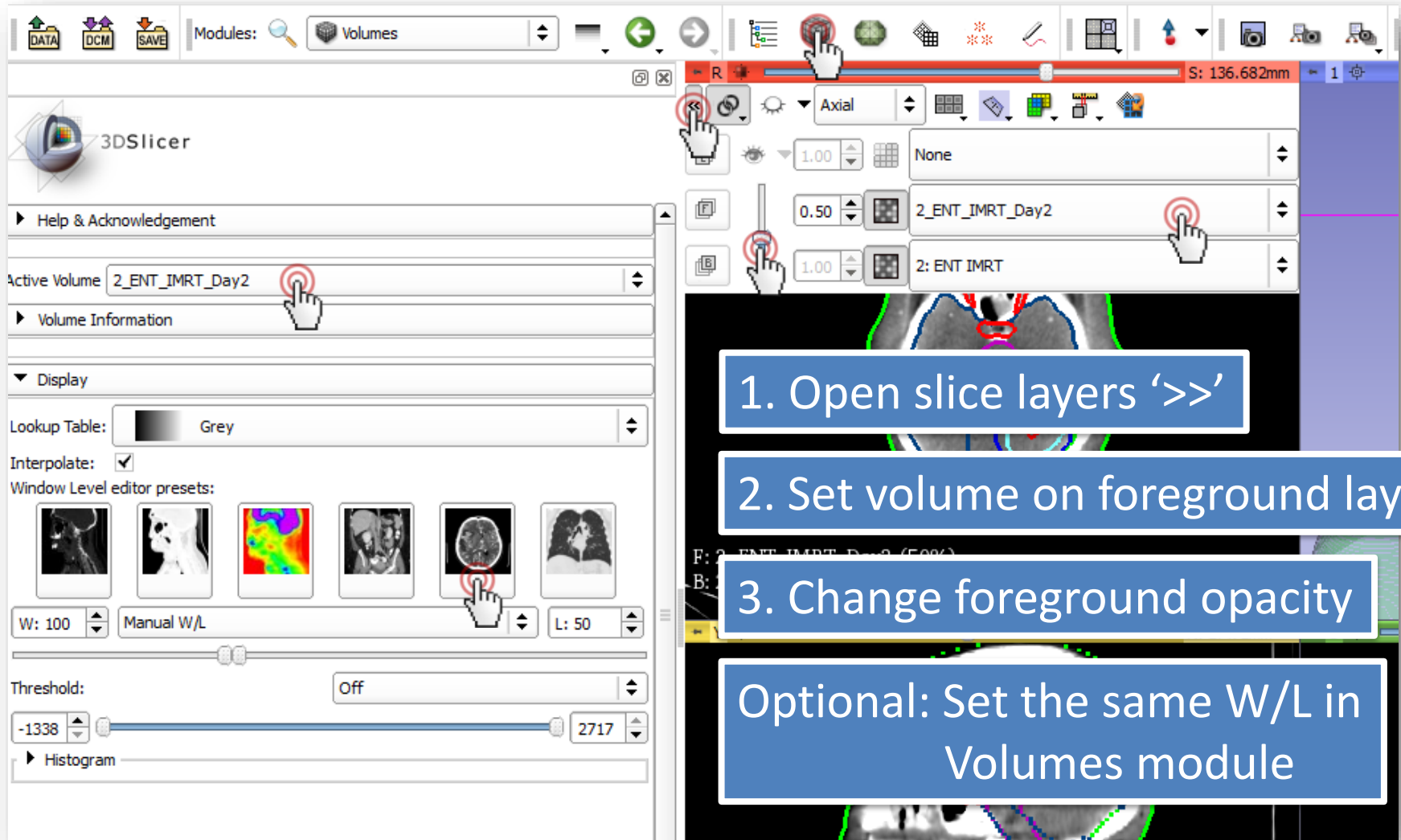
Rigid+Scale(7 DOF)

Note

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



3/2. Explore volume differences



1. Open slice layers '>>'

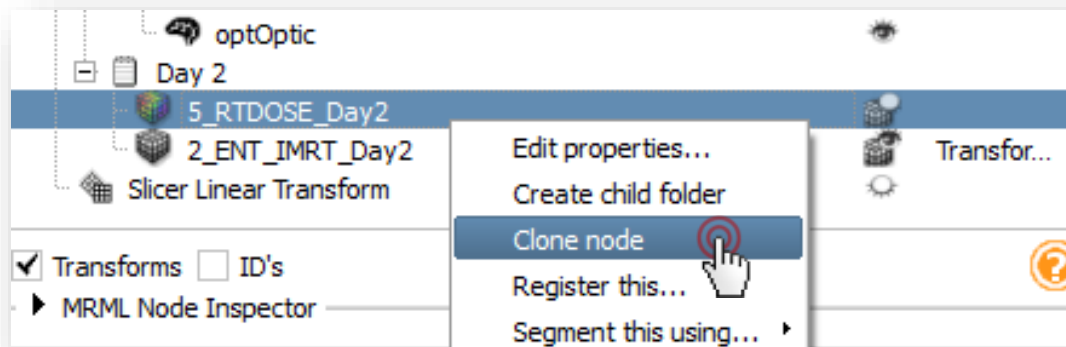
2. Set volume on foreground layer

3. Change foreground opacity

Optional: Set the same W/L in Volumes module

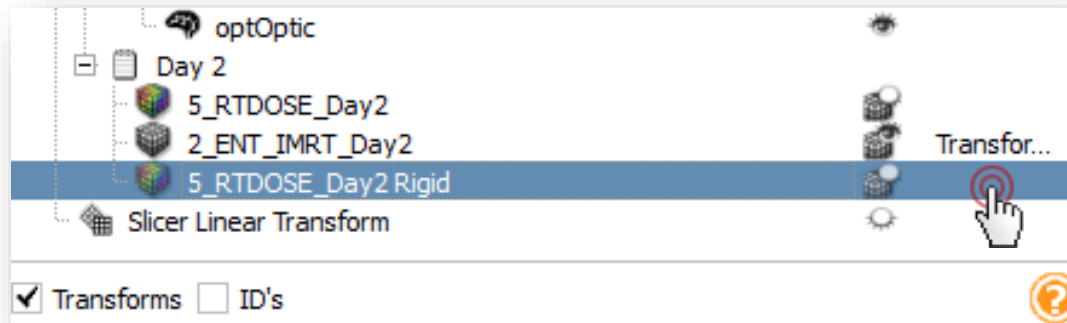
4/1. Clone dose volume

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



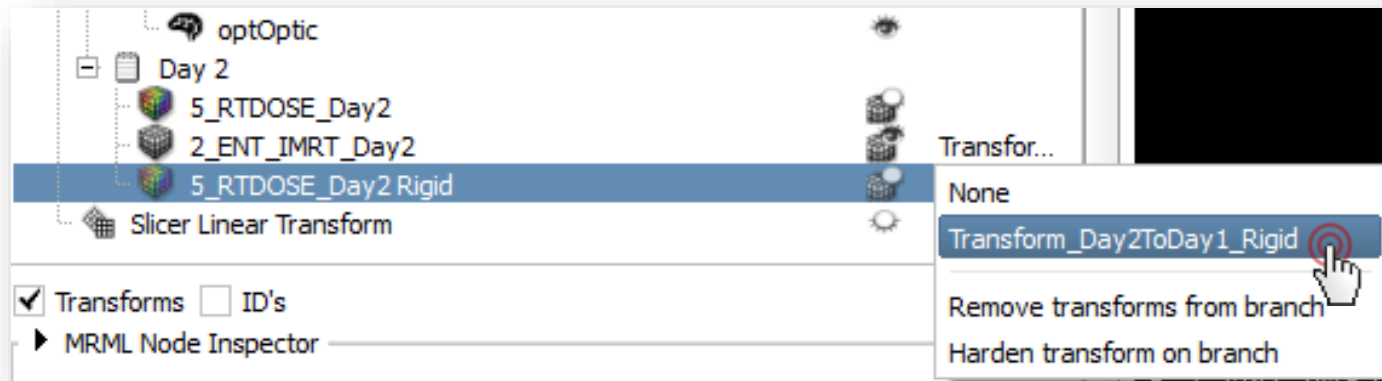
1. Switch to Subject hierarchy
2. Select 'Clone node' in context menu for day 2 dose
3. Rename it to '5_RTDOSE_Day2 Rigid'

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

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

Show all Hide all

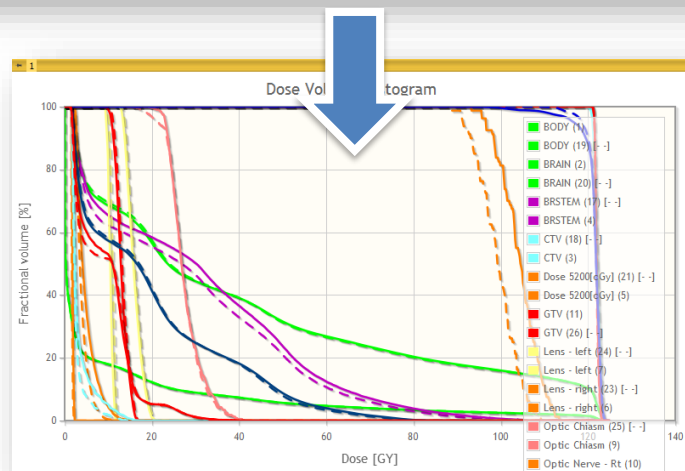
Switch layout:  

	Show	Structure	Volume name	Volume (cc)
1	<input type="checkbox"/>	BODY	Accumulated_5_RTDOSE_Day25: RTDOSE: BRAI1	8053.86
2	<input type="checkbox"/>	BRAIN	Accumulated_5_RTDOSE_Day25: RTDOSE: BRAI1	1114.72

1. Choose registered accumulated dose



2. Click 'Compute DVH'

3. Click 'Show all'




DVH curves appear

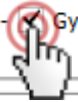
6/3. Quantify improvement

Chart: Chart ⬆️ ⬆️ ☒ Show/hide all  

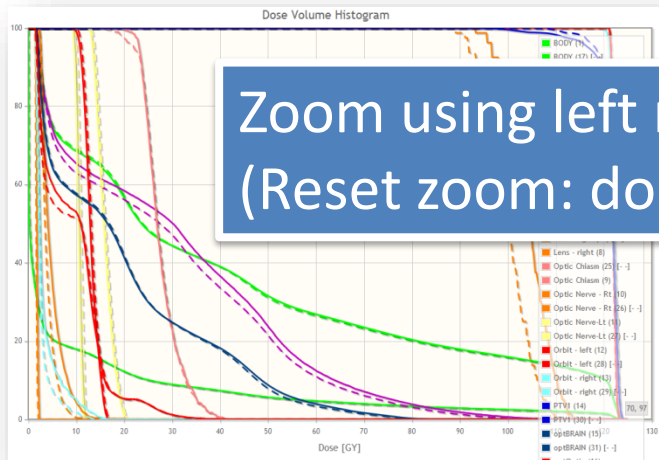
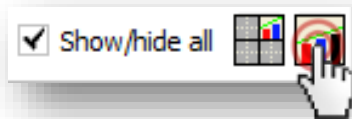
		Structure	Volume name	Volume (cc)	Mean dose (GY)	Min dose (GY)	Max dose (GY)	V50 (%)	D99% (Gy)
1	<input checked="" type="checkbox"/>	BODY	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	8054	8.76107	0	124.52	5.64	0.00
2	<input checked="" type="checkbox"/>	BRAIN	Accumulated_5 RTDOSE Day25: RTDOSE: BRAI1	1114.79	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

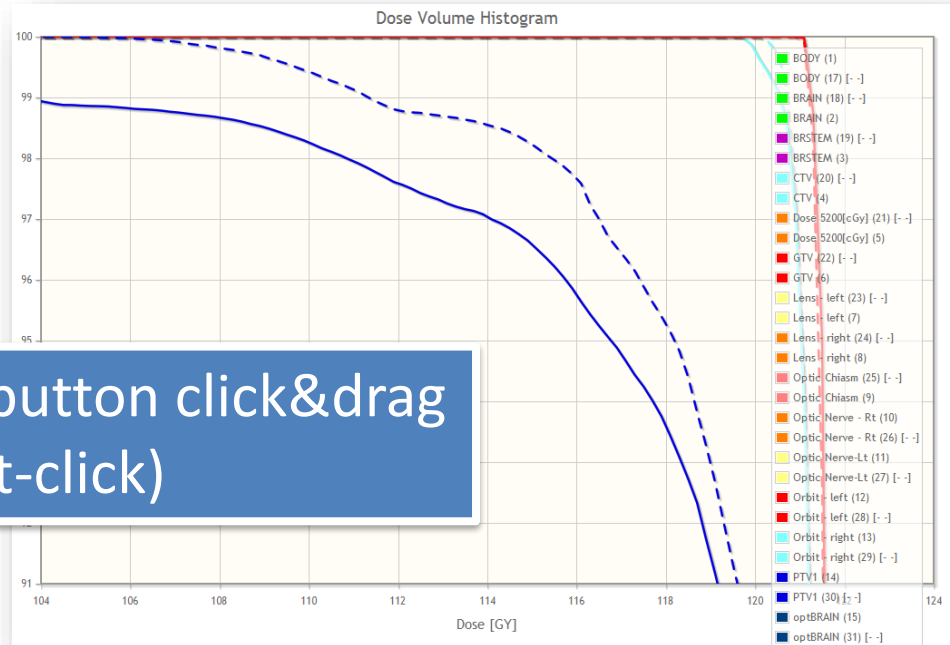
V metric for dose values: 50 Gy - ☐ cc ☒ % 

D metric for volumes: cc - ☒ Gy ☐ % 

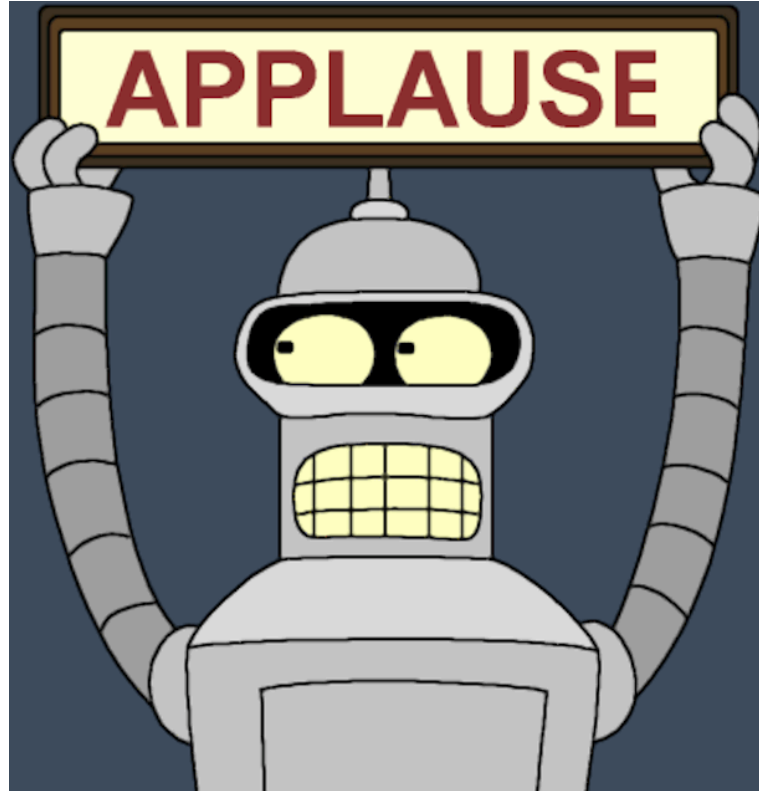
6/4. Visualize improvement



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

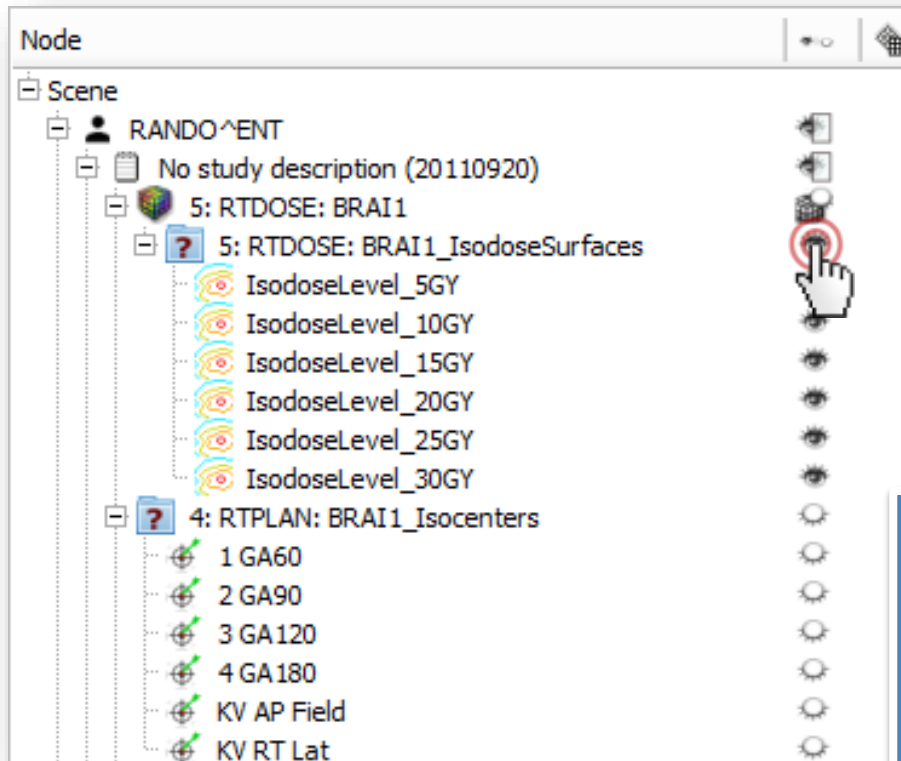
3. Select '5: RTDOSE: BRAI1'
volume as Dose volume

2. Click Apply

3. Select '5_RTDOSE_Day2'
volume as Dose volume

4. Click Apply

Optional 1/2. Visualize isodose lines

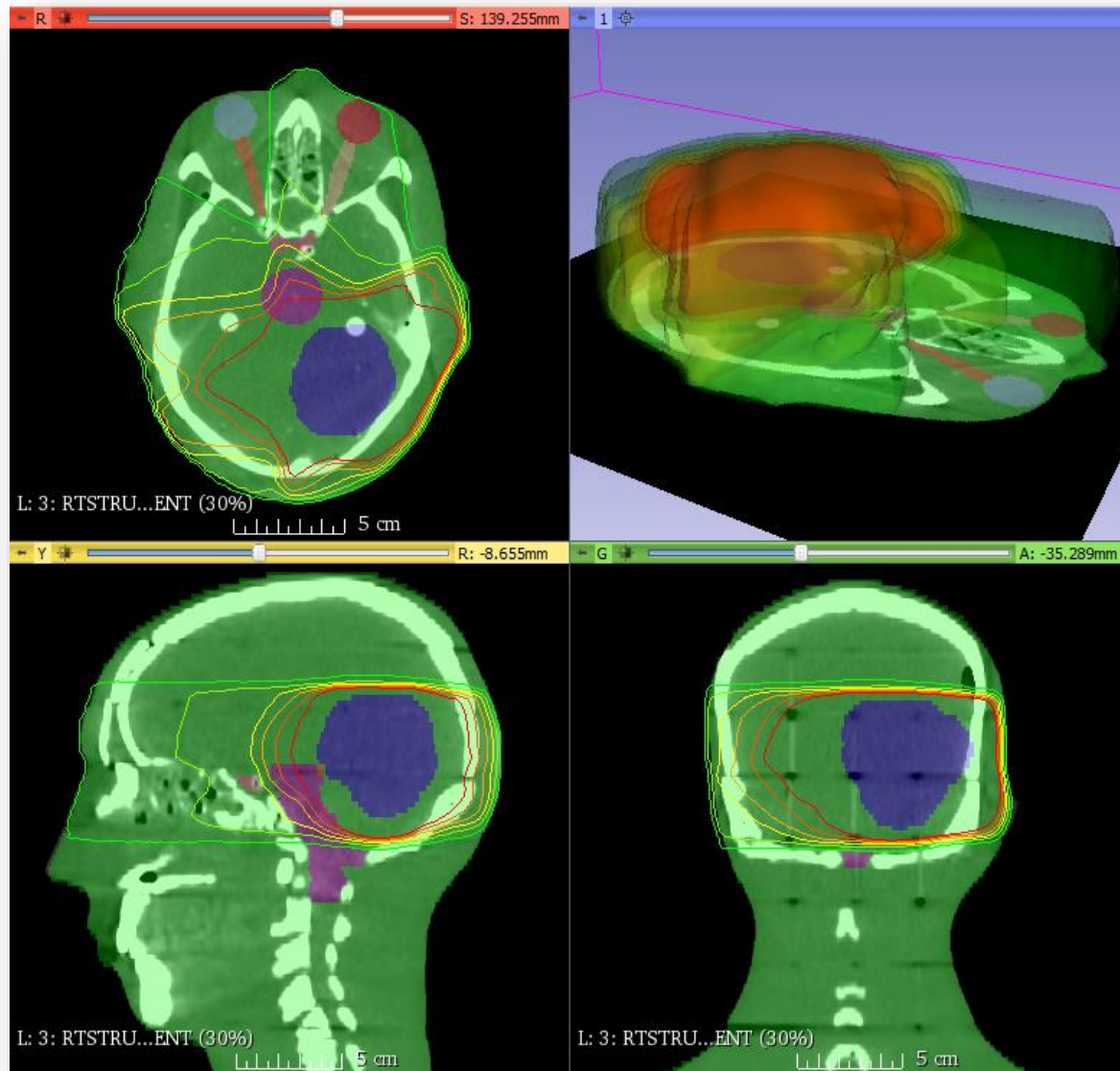


1. Switch to Subject Hierarchy

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

Input

Reference dose volume: 5: RTDOSE: BRA11

Compare dose volume: 5_RTDOSE_Day2

Mask: None
No node is selected

DTA distance tolerance (mm): 3.00

Dose difference tolerance (%): 3.00

Reference dose:
☒ Use maximum dose
☐ Use custom value (Gy): 50.00

Analysis threshold (%): 10.00

Maximum gamma: 2.00

Output

Gamma volume: None

Pass fraction: N/A

Apply

1. Go to module Radiotherapy / Dose Comparison

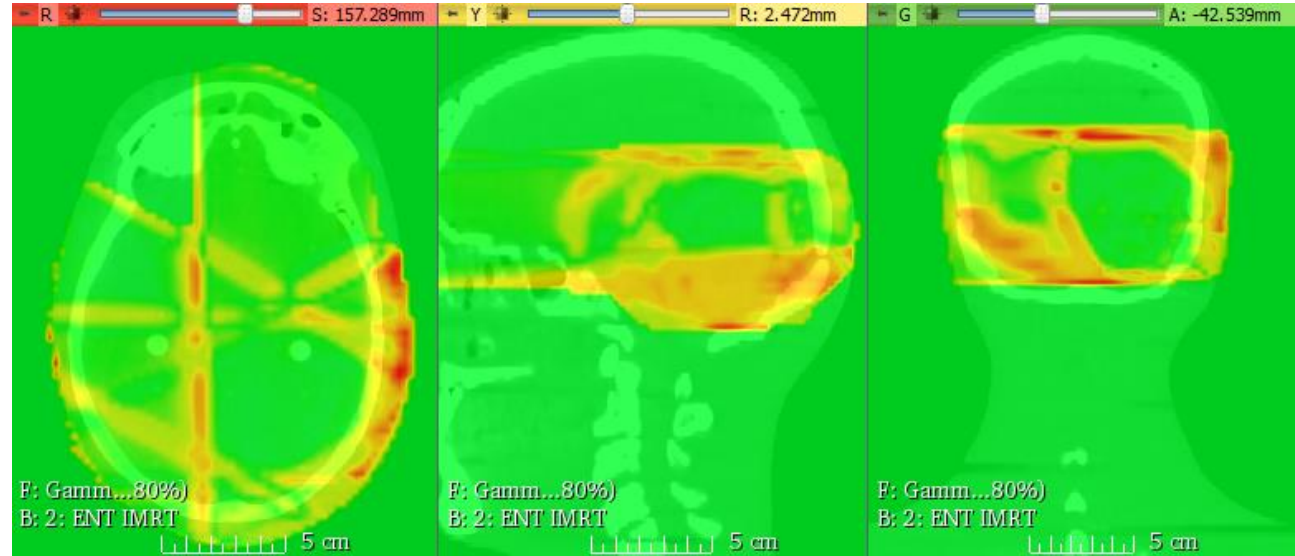
2. Set input volumes you want to compare

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

