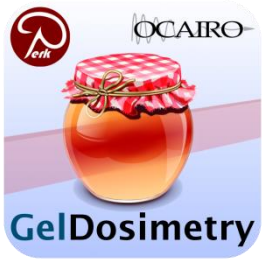
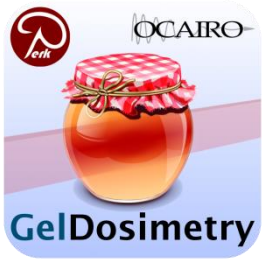
Tutorial:
Gel Dosimetry Analysis Slicelet



Kevin M. Alexander
Queen's University
Kingston, Ontario, Canada



World Congress on Medical Physics and Biomedical Engineering 2015

June 7, 2015

Laboratory for Percutaneous Surgery

Queen's University

OCAIRO

KGH Cancer Centre of Southeastern Ontario

Learning objective

This tutorial will teach you how to perform analysis of a gel dosimeter, imaged using an optical CT scanner.

Material

For those of you just joining us…

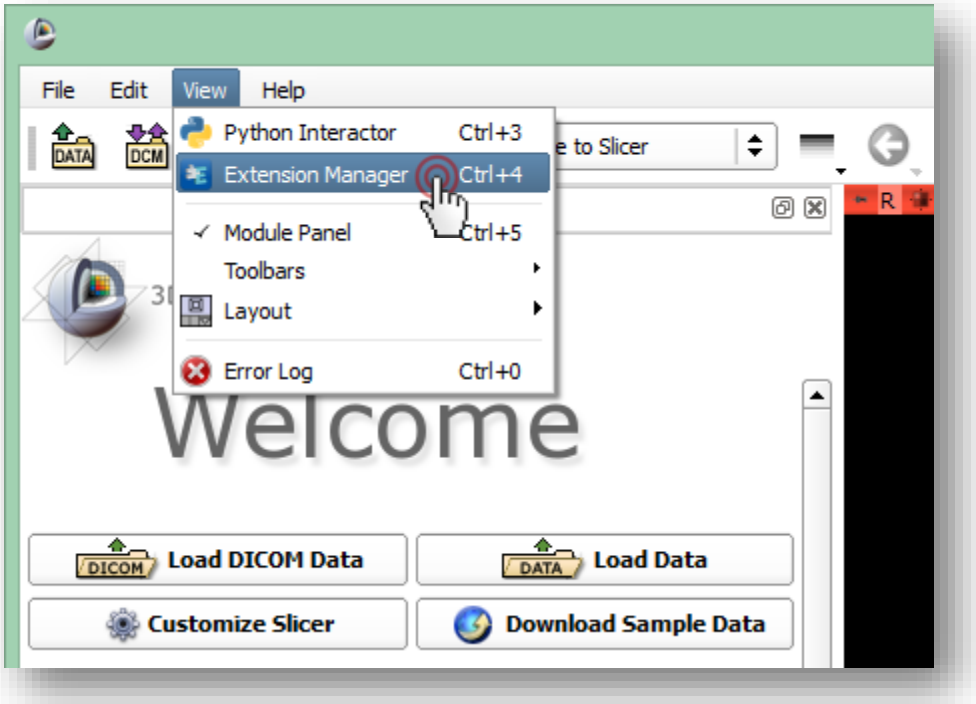
- Connect to tutorial wifi:
  SSID: *SlicerRT1*, Password: *tutorial*
- Access download page:
  Enter in your web browser: *130.15.7.247*
- Follow the instructions
- Supported platforms:
   Windows,  Mac OSX,  Linux
  – 32-bit is not supported!

Install 3D Slicer

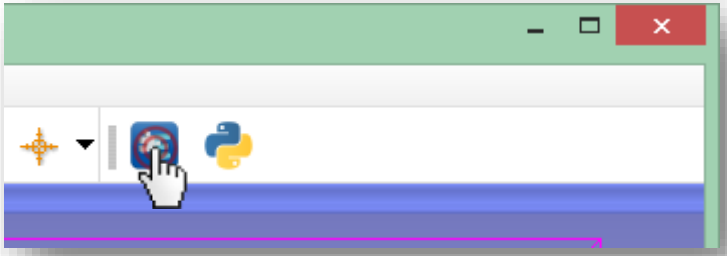
- Find the downloaded 3D Slicer package on your computer

- Follow the usual steps to install an application
  - Different for each operating system

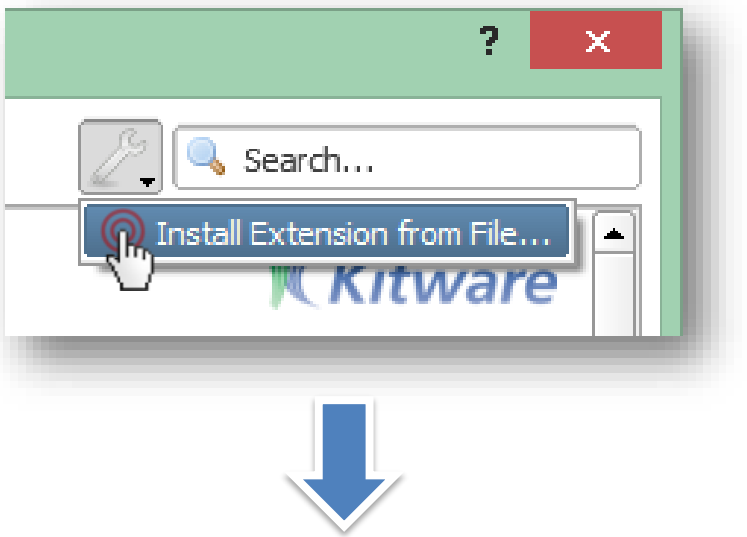
Install SlicerRT extension



or

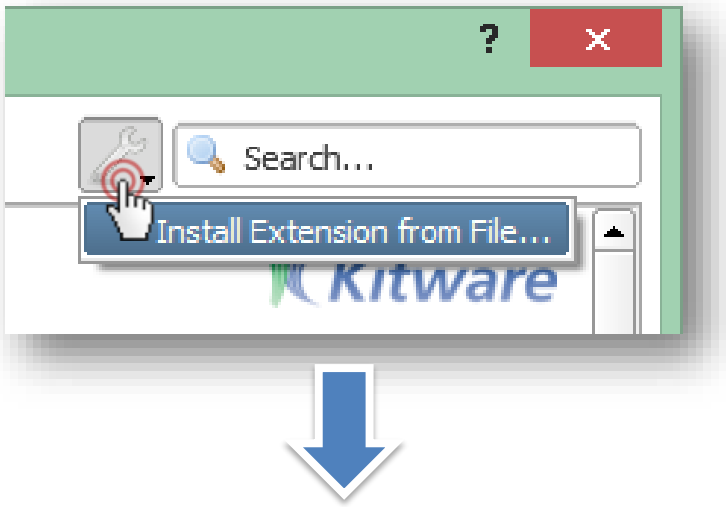


Install SlicerRT extension



Find the downloaded SlicerRT zip file on your computer

Install Gel Dosimetry Analysis extension



Find the downloaded Gel Dosimetry Analysis zip file on your computer

Click Restart

Unpack tutorial datasets

- Find the dataset you downloaded named *WC2015_Gel_Slicelet_Dataset.zip*

- Unpack it to a local folder of your choice
  - Different for each operating system

Your concerns

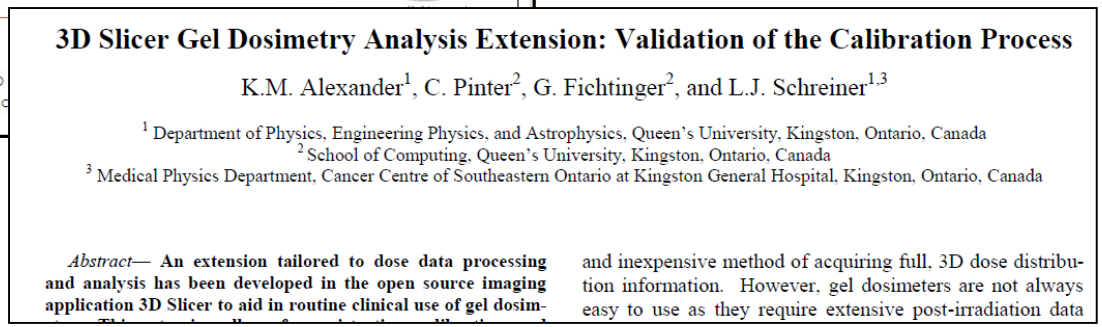
“Largest obstacle to the use of Slicer RT and gel dosimetry in general is managing the complexity of the process and keeping track of and managing the large software feature set that is needed for the process to work well.”

Your concerns

“Concerned about validating results produced from these tools.”

Your concerns

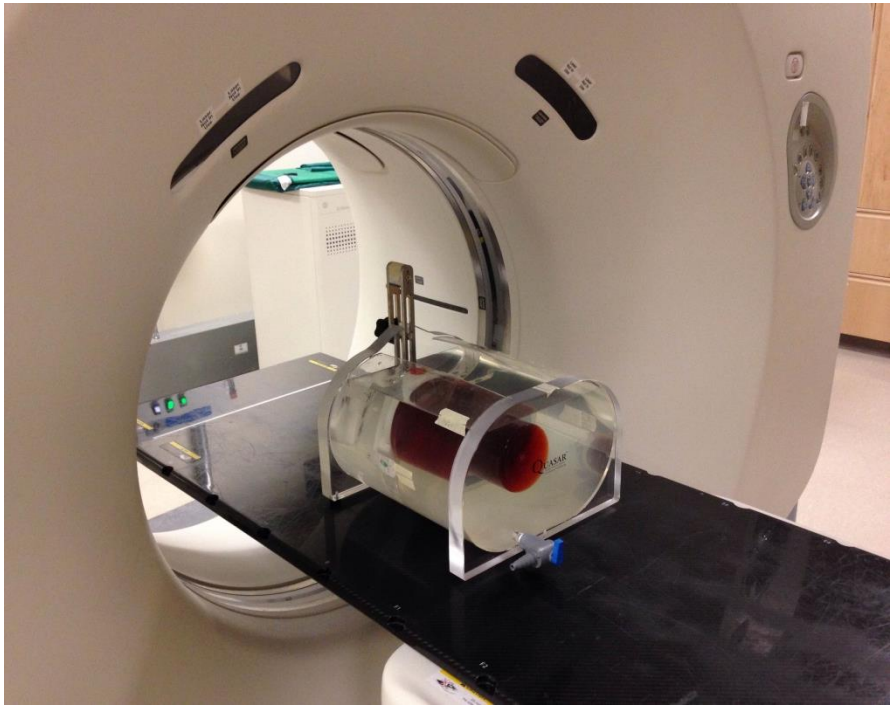
"Concerned about validating results produced from these tools."



In progress!

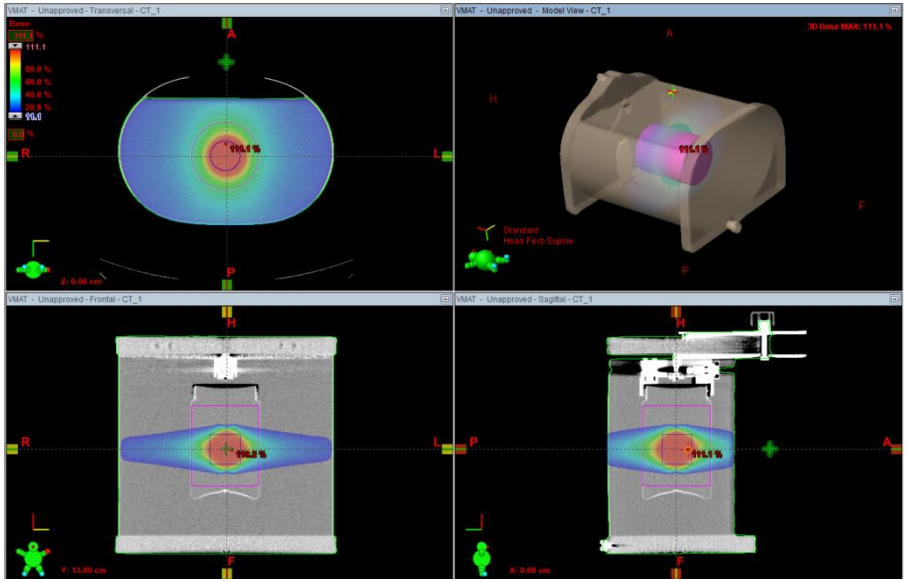
Where did this data come from?

- Gel dosimeter was positioned inside a phantom, and CT simulation images were acquired (Planning CT volume)



Where did this data come from?

- Treatment planning using Eclipse:
  - Single arc delivery with fixed field size
  - Gel jar was contoured and dose distribution was calculated



- Outputs: Planning dose volume, Structures

Where did this data come from?

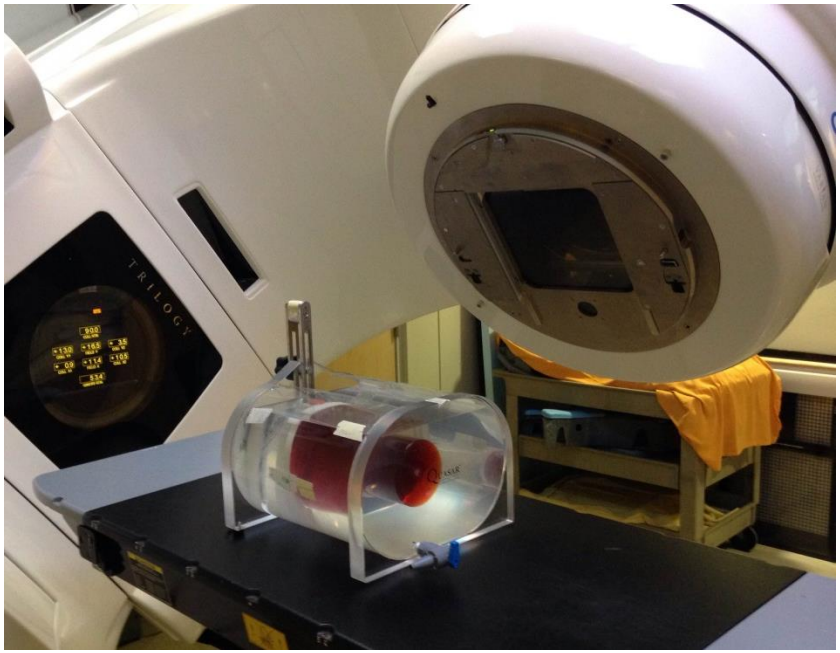
- Irradiation day:
  - Gel #1 is scanned using an optical CT scanner, then fiducial markings are made with a marker, and metal BBs are taped to those markings
  - Gel #2 is also optically scanned (no markings)

  - Phantom with gel is positioned on patient couch
  - Cone beam CT image is acquired using the On-Board Imager (OBI Volume)

Where did this data come from?

- Irradiation day:
  - Gel #1 is irradiated with planned delivery
  - Gel #2 is irradiated with an electron beam

Gel #1



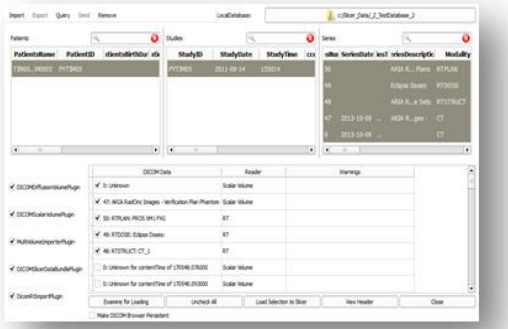
Gel #2

Where did this data come from?

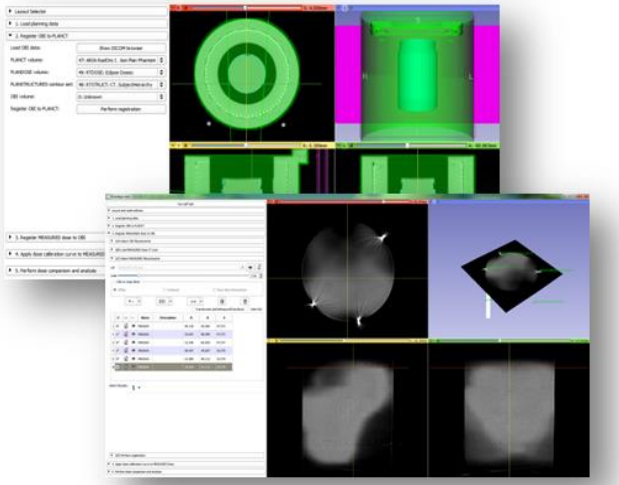
- Irradiation day:
  - Both gels are scanned post-irradiation, and are reconstructed to create 3D digital volumes (Measured gel dosimeter volume, calibration gel volume)

Gel Dosimetry Analysis Roadmap

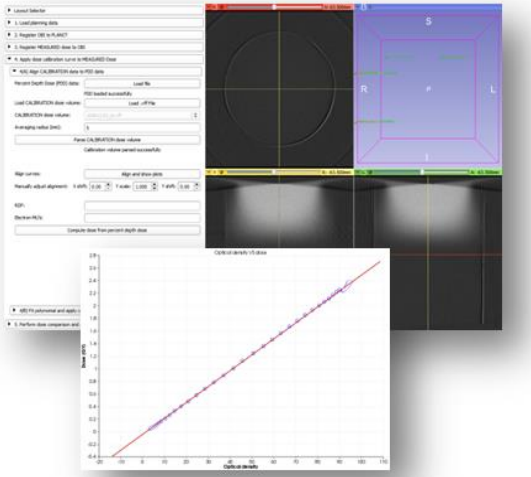
Data Import



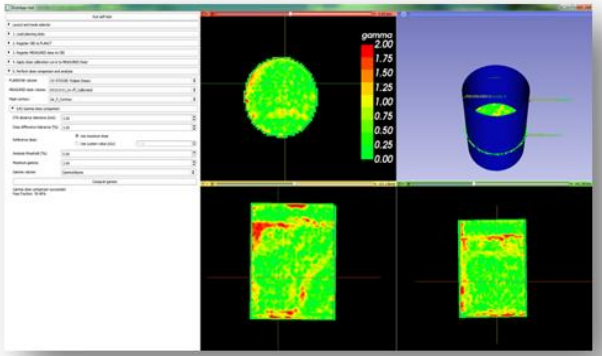
Registration



Calibration

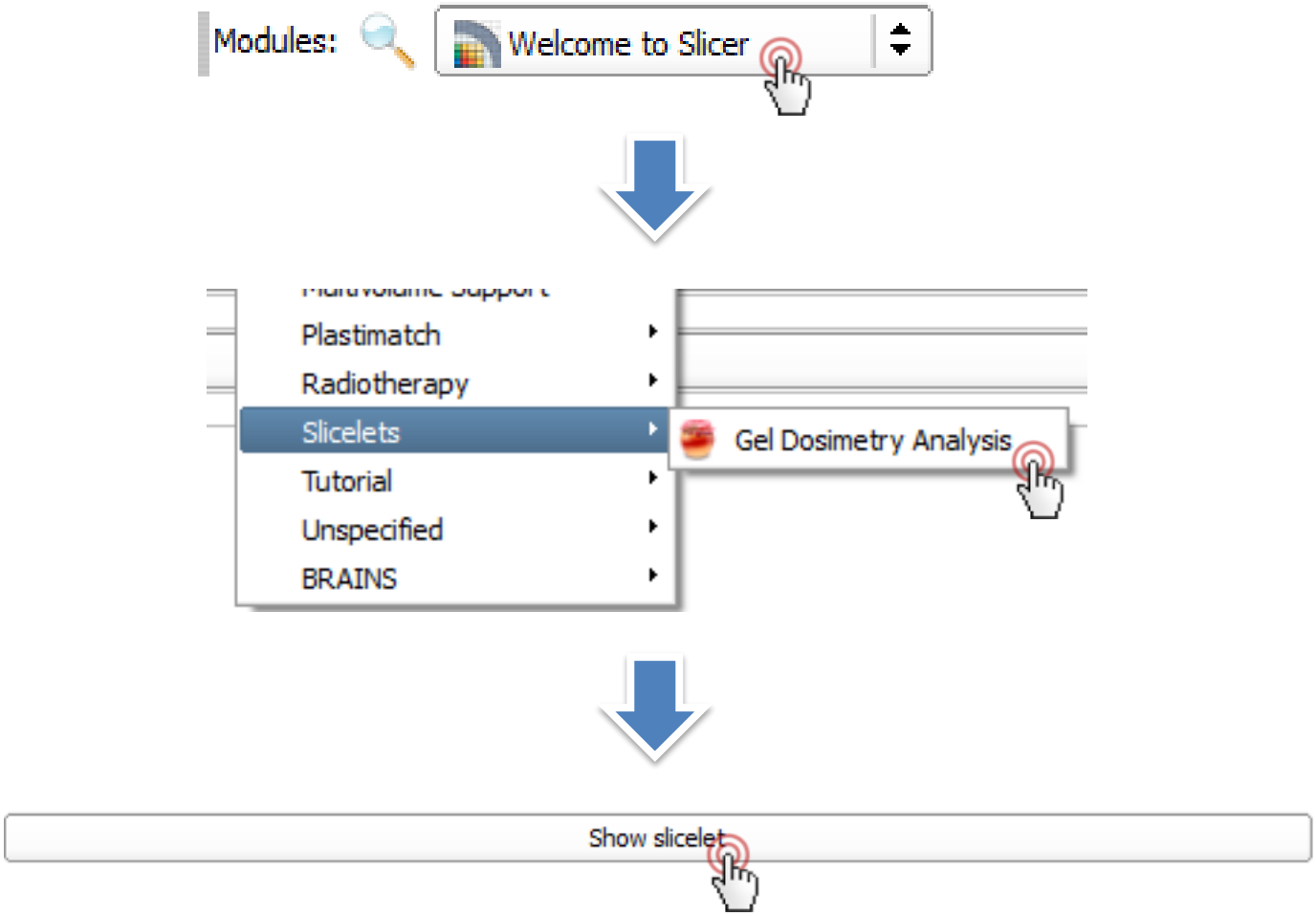


Dose Comparison



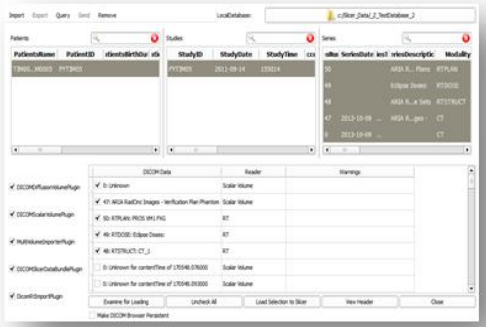
GelDosimetry

Open Gel Dosimetry Analysis Slicelet

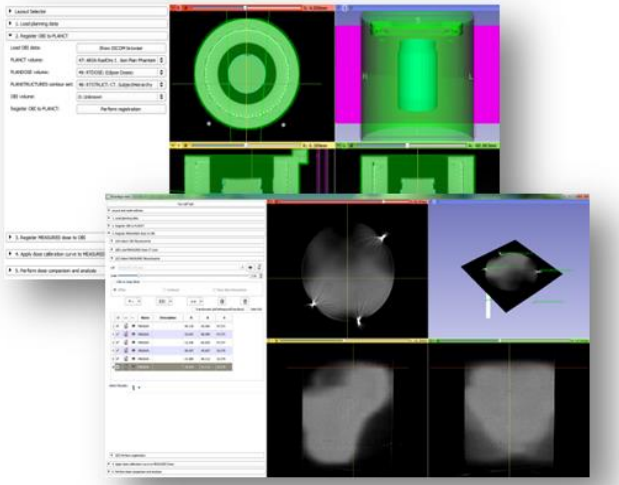


Gel Dosimetry Analysis Roadmap

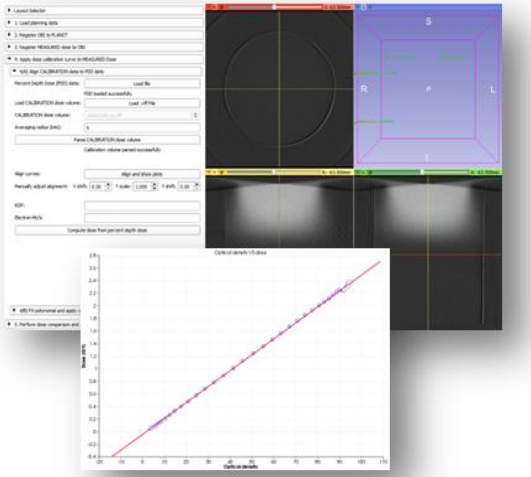
Data Import



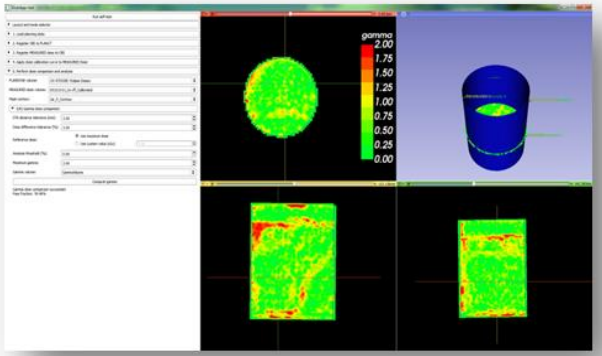
Registration



Calibration

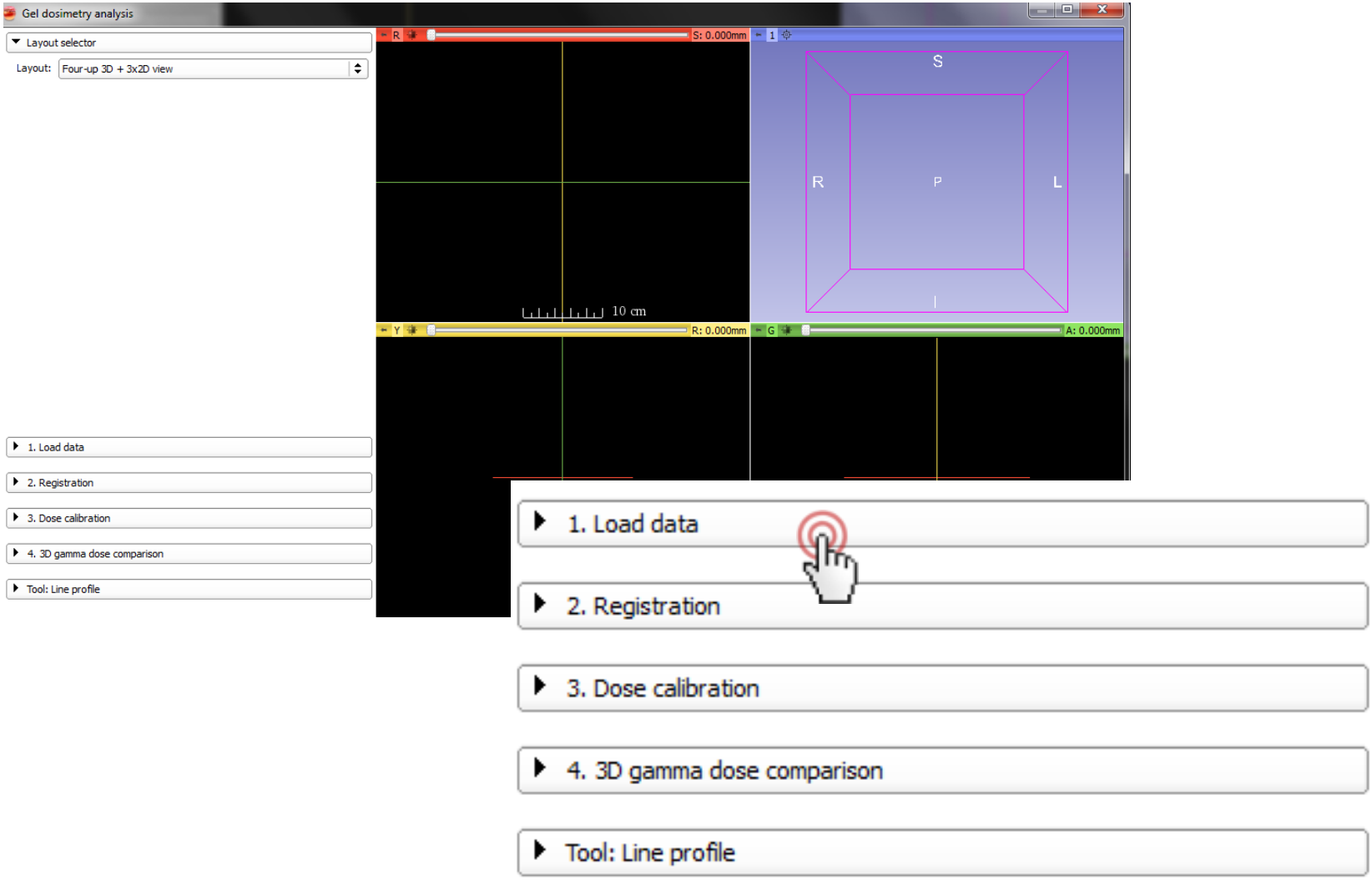


Dose Comparison

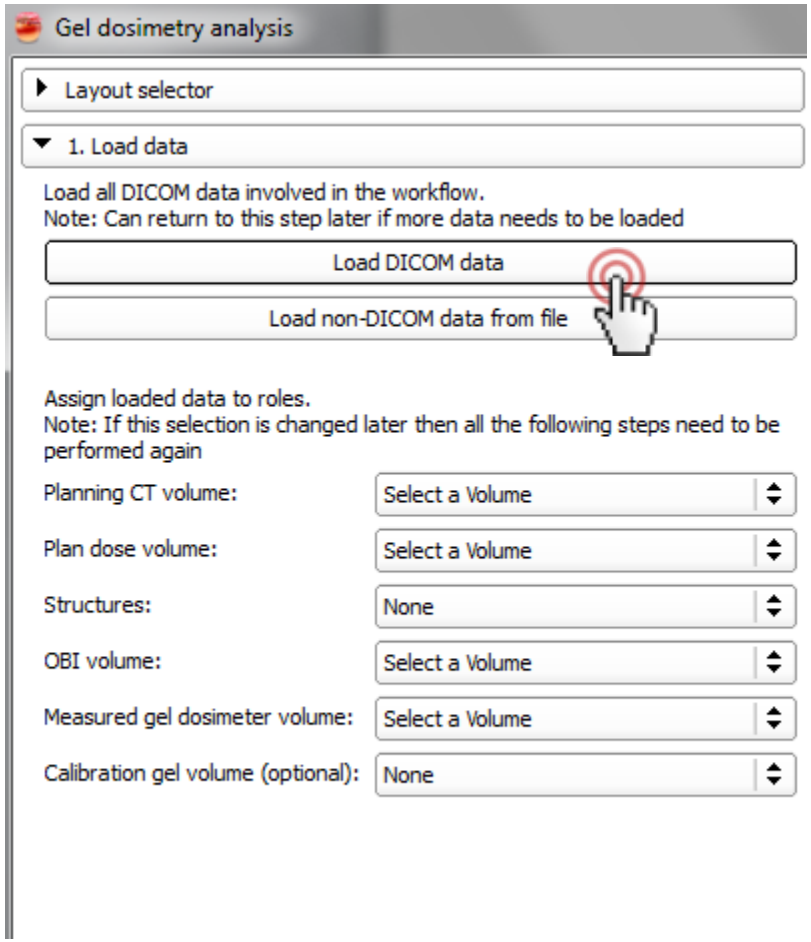


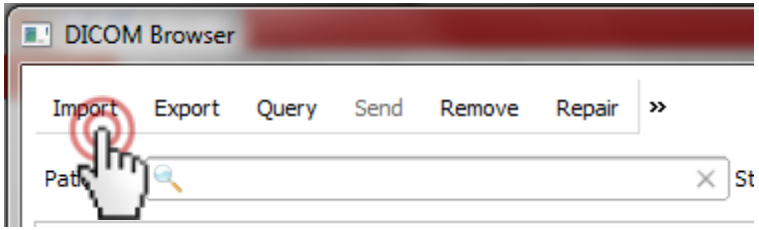
GelDosimetry

Gel Dosimetry Analysis Slicelet



1. Load Data

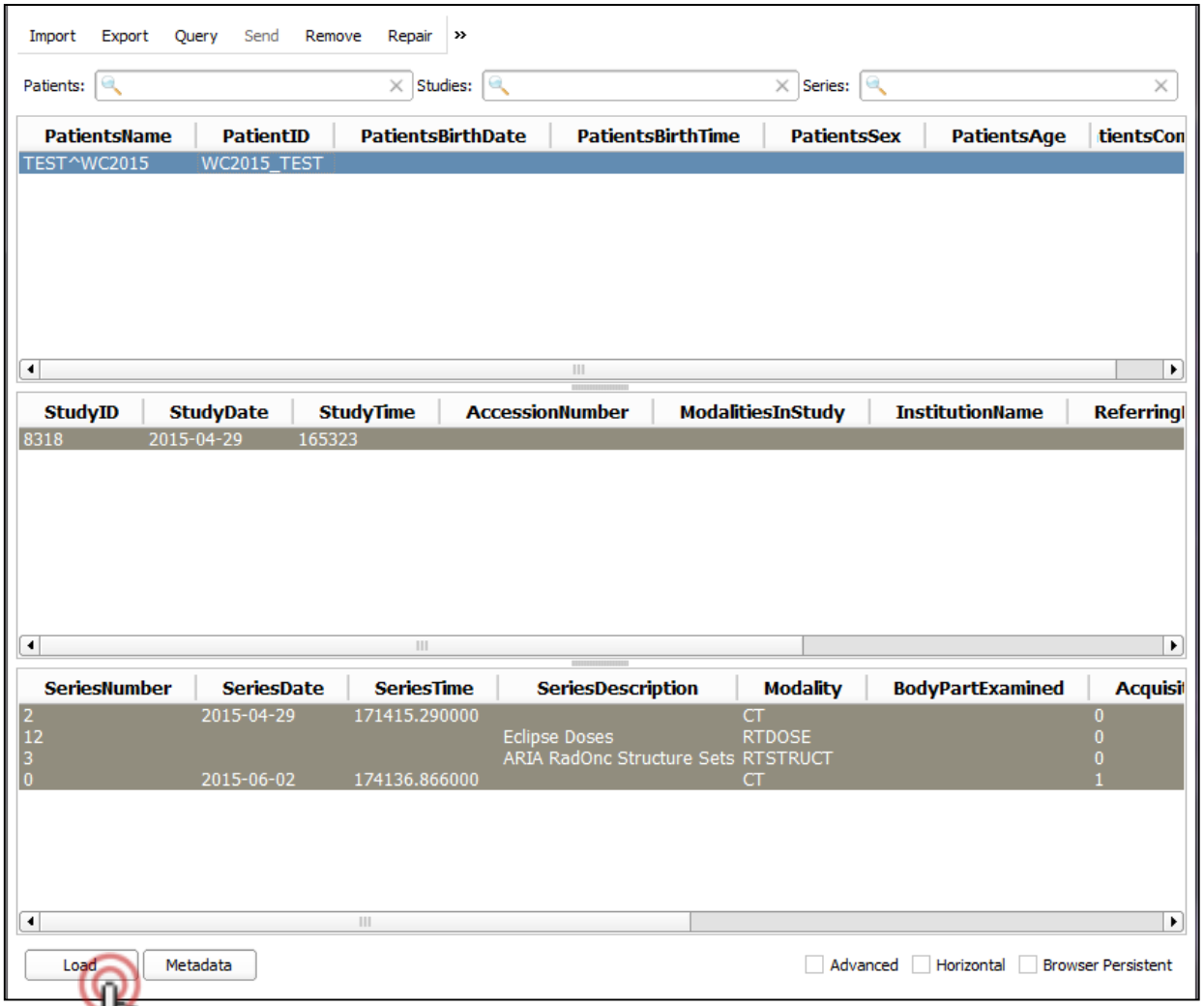




Select 'DICOM' folder that was just downloaded

1. Load Data

Select all data objects, and click Load.



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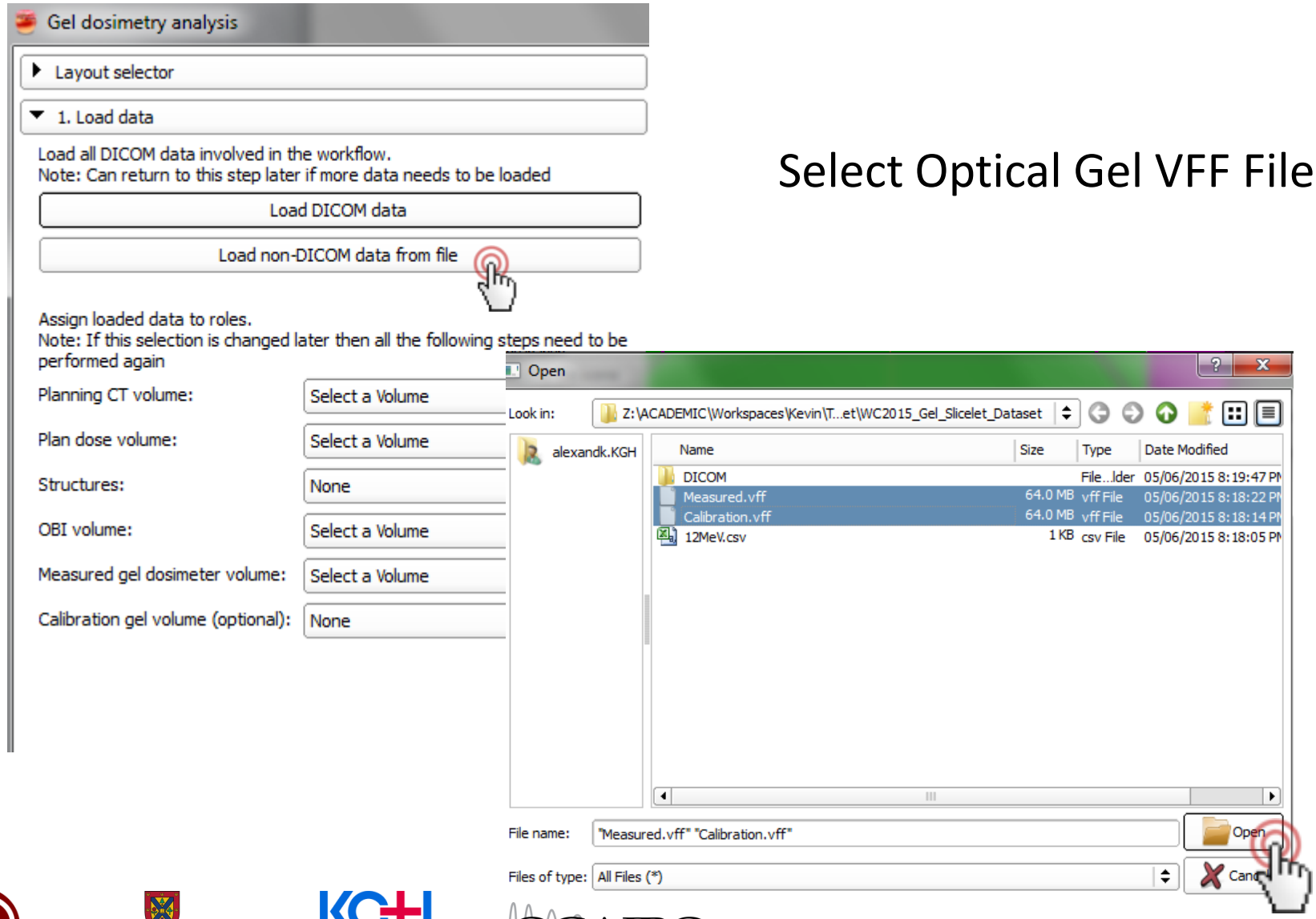
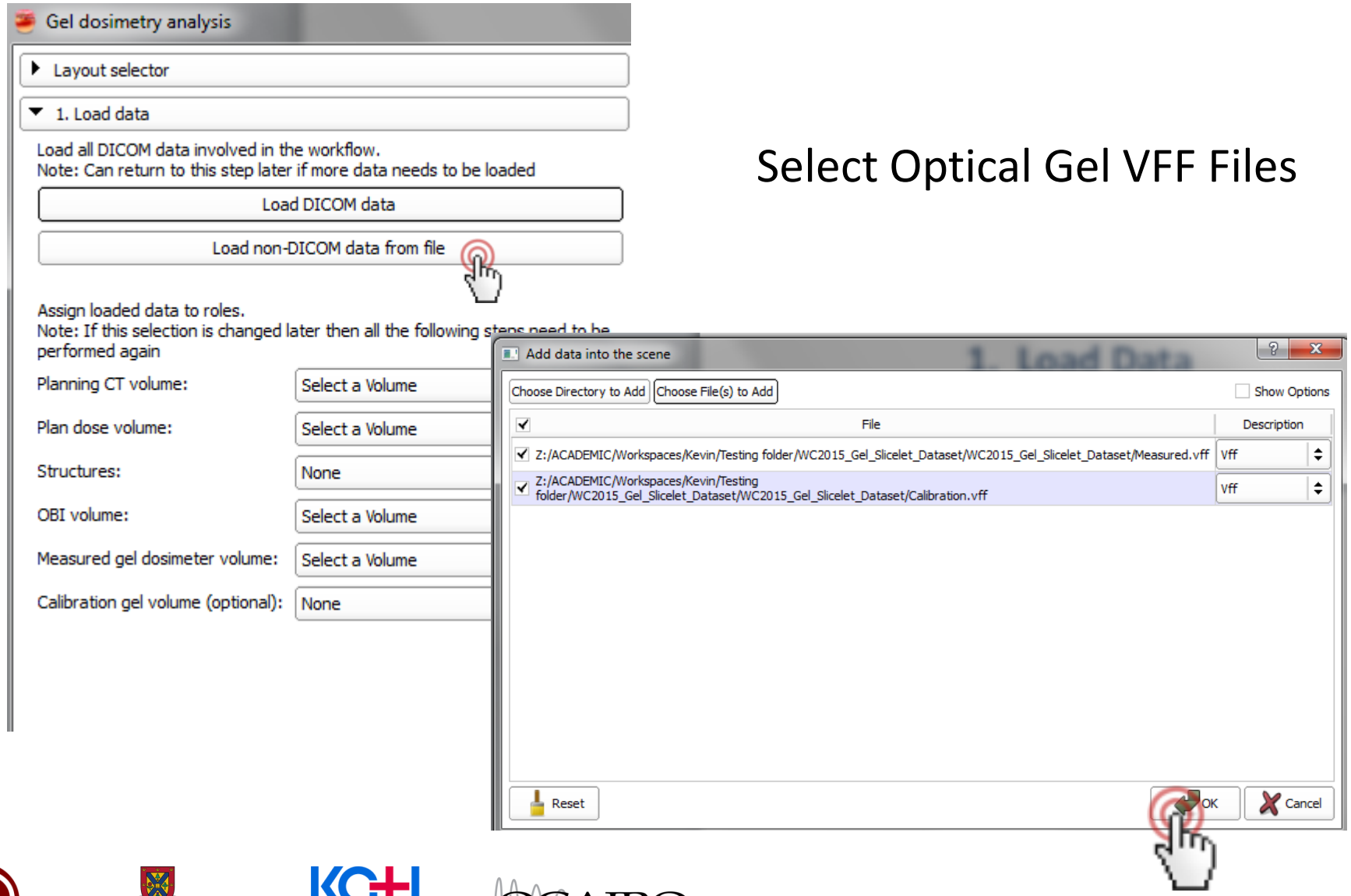


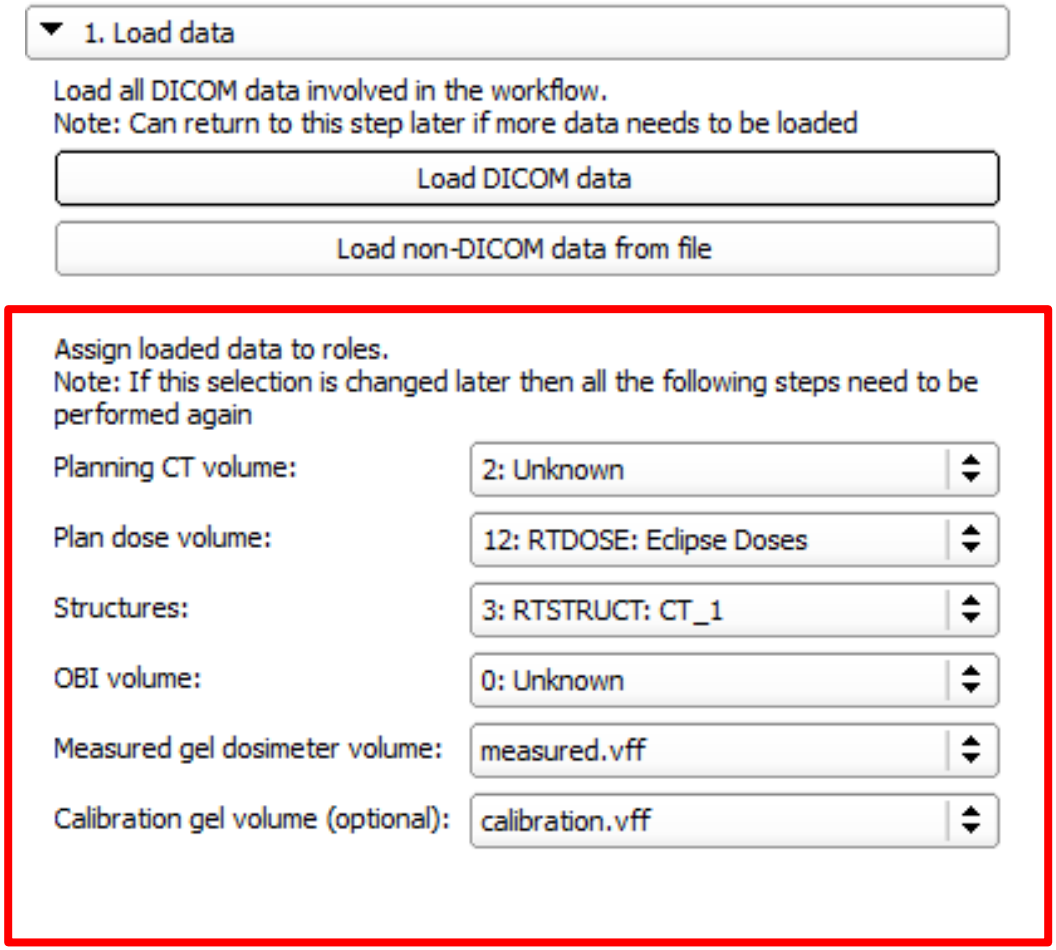
Select Optical Gel VFF Files

1. Load Data



Select Optical Gel VFF Files

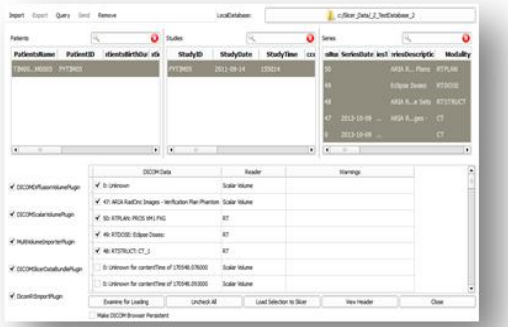
1. Load Data



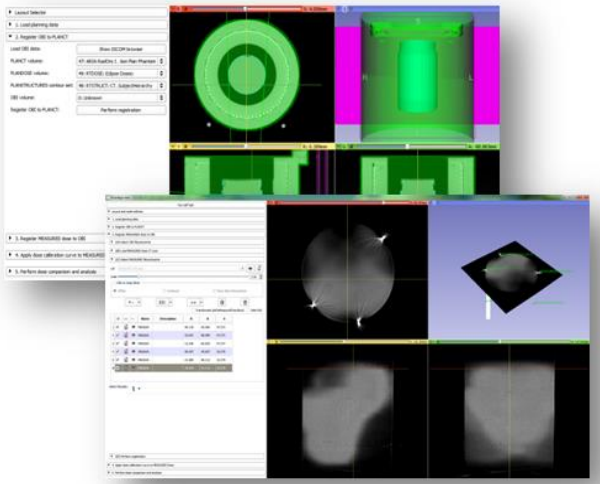
Assign data as shown

Gel Dosimetry Analysis Roadmap

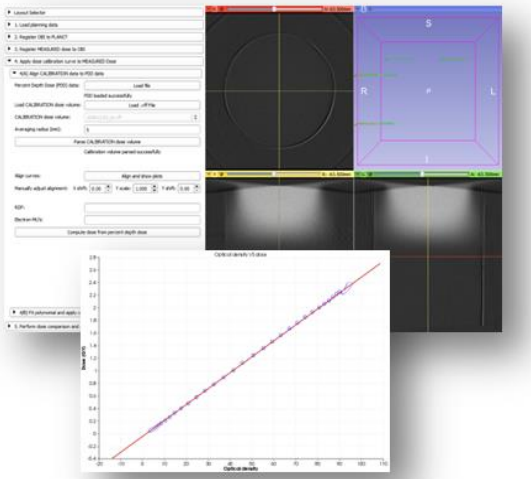
Data Import



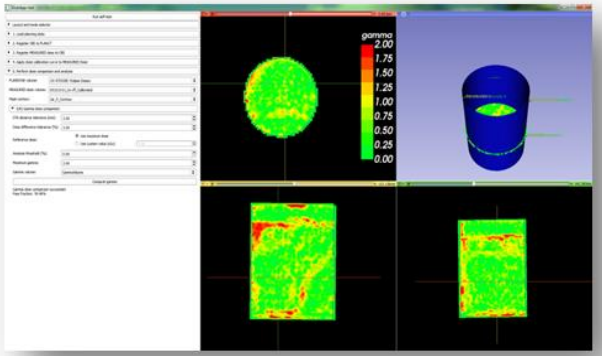
Registration



Calibration

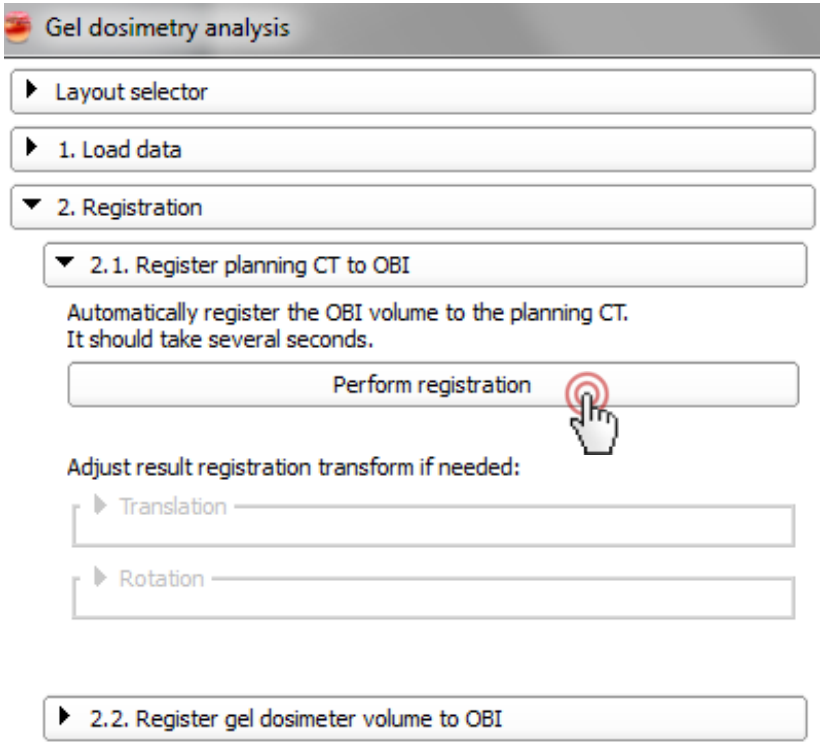


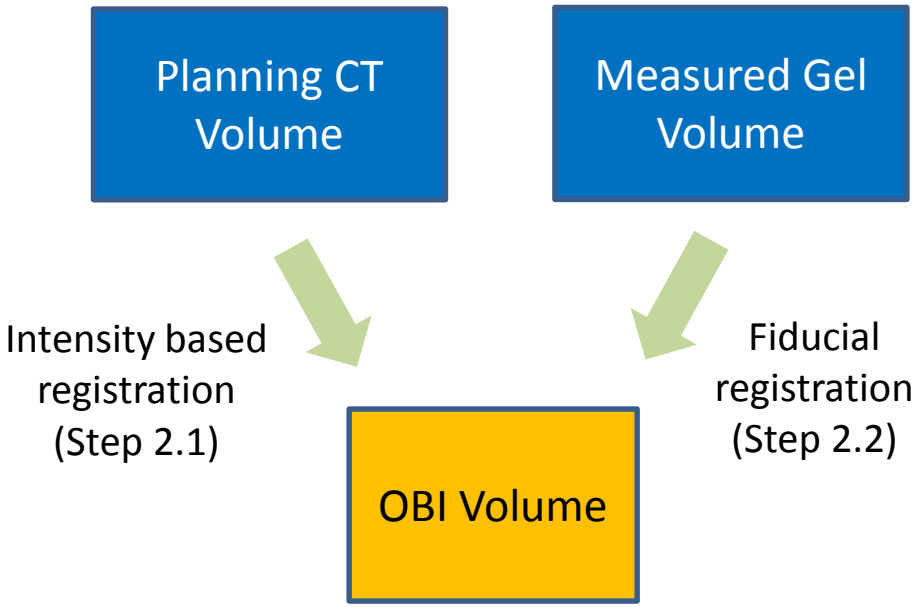
Dose Comparison



GelDosimetry

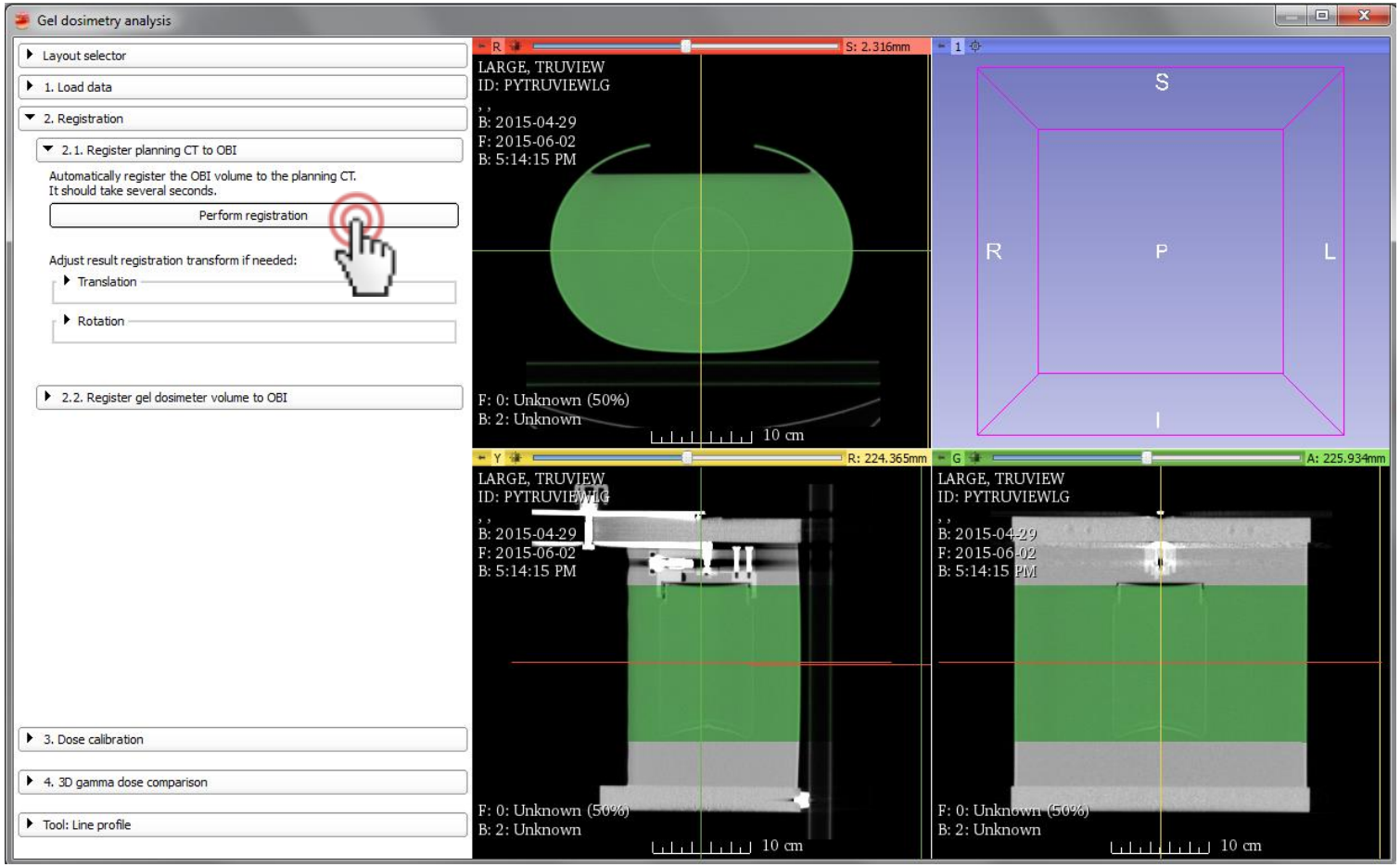
2. Registration





All data is registered to the OBI space

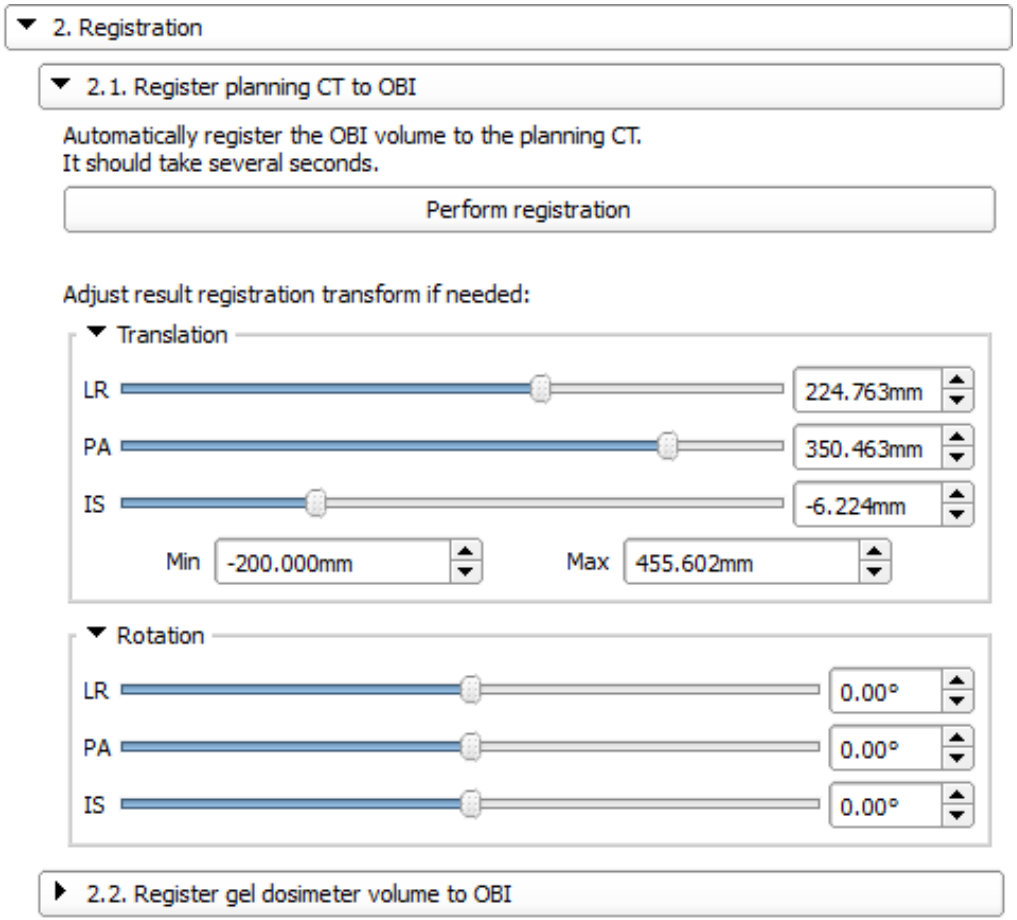
2.1 Registration



Planning CT Volume: Grey

OBI Volume: Green

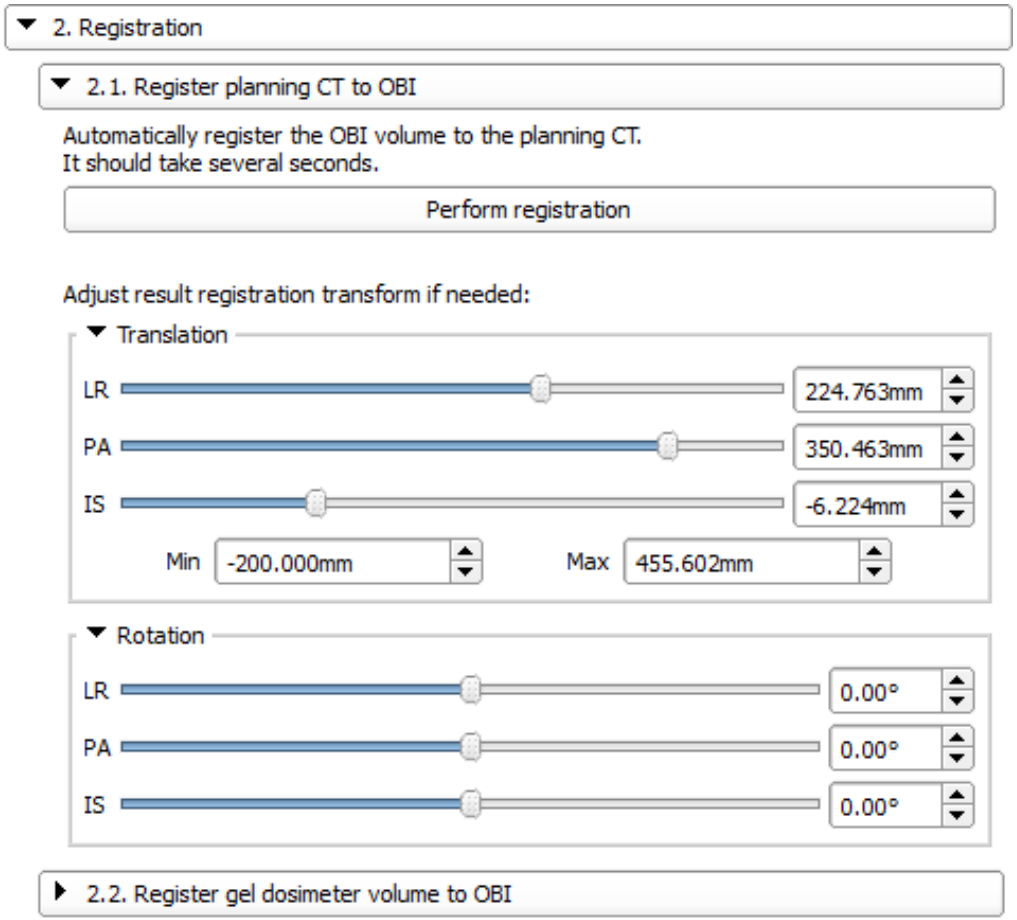
2.1 Registration



If auto-registration fails or needs adjusting, manual adjustments can be performed

Use up/down arrows, or type in value

2.1 Registration



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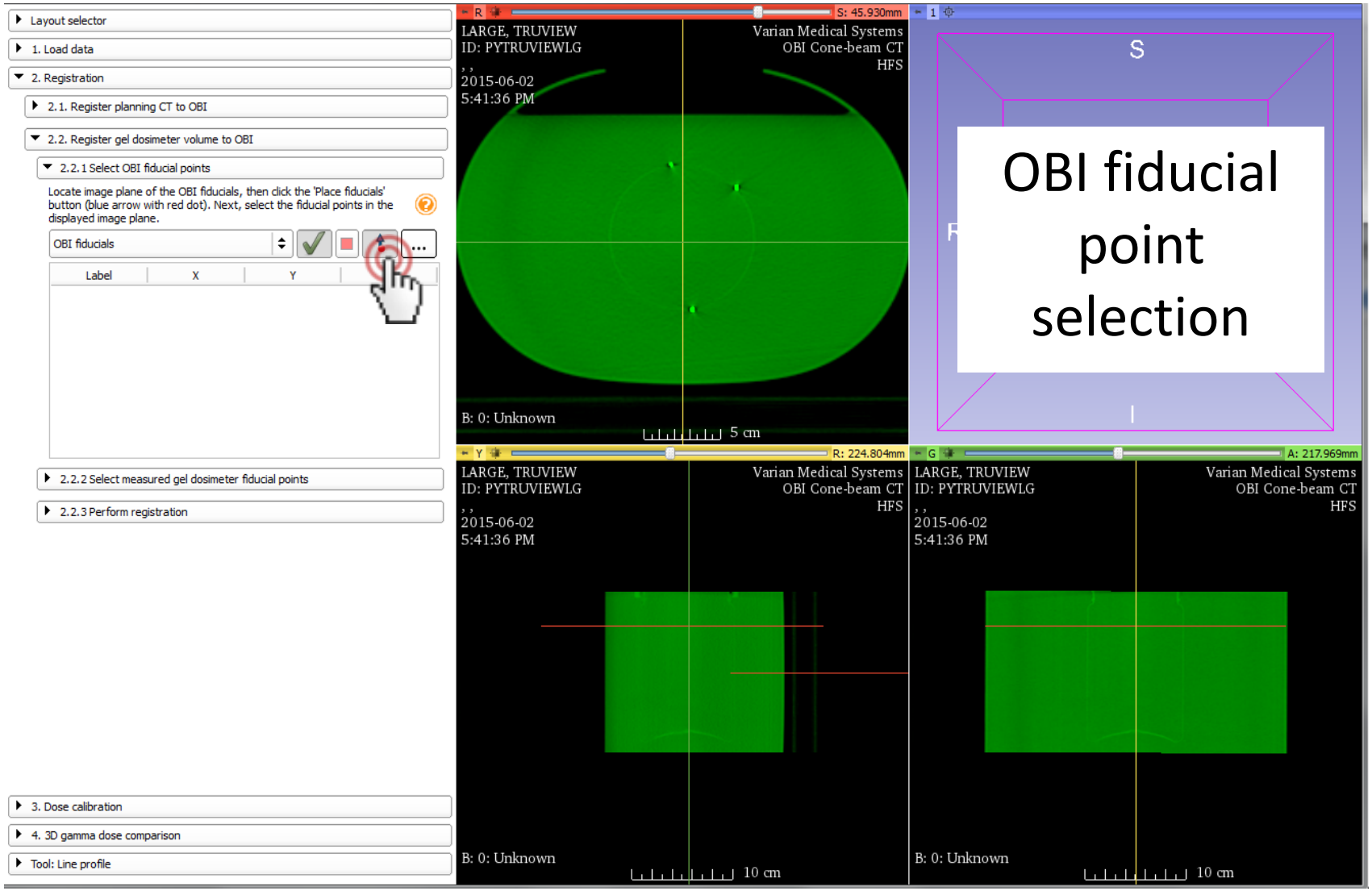
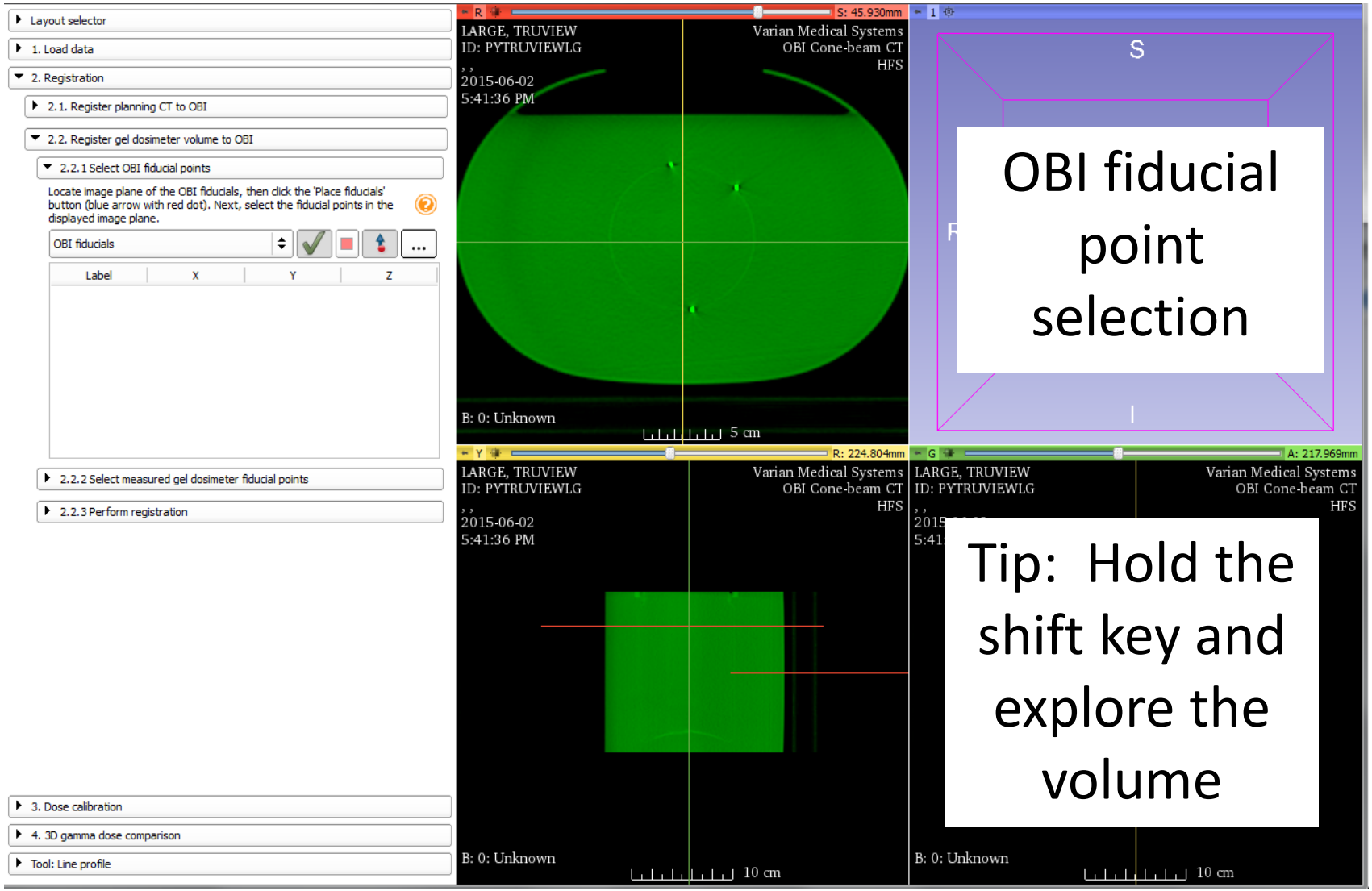
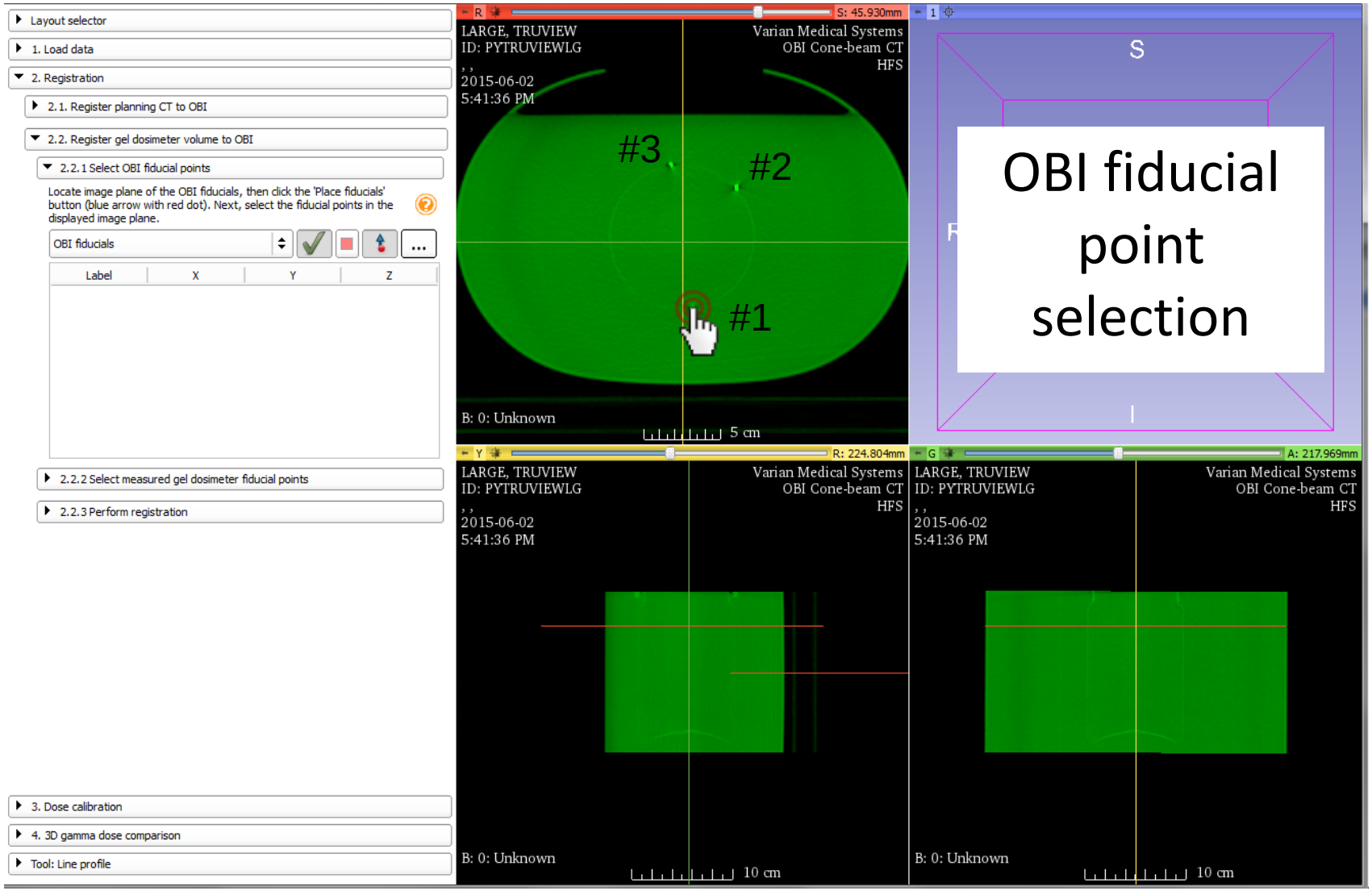
2.2 Registration



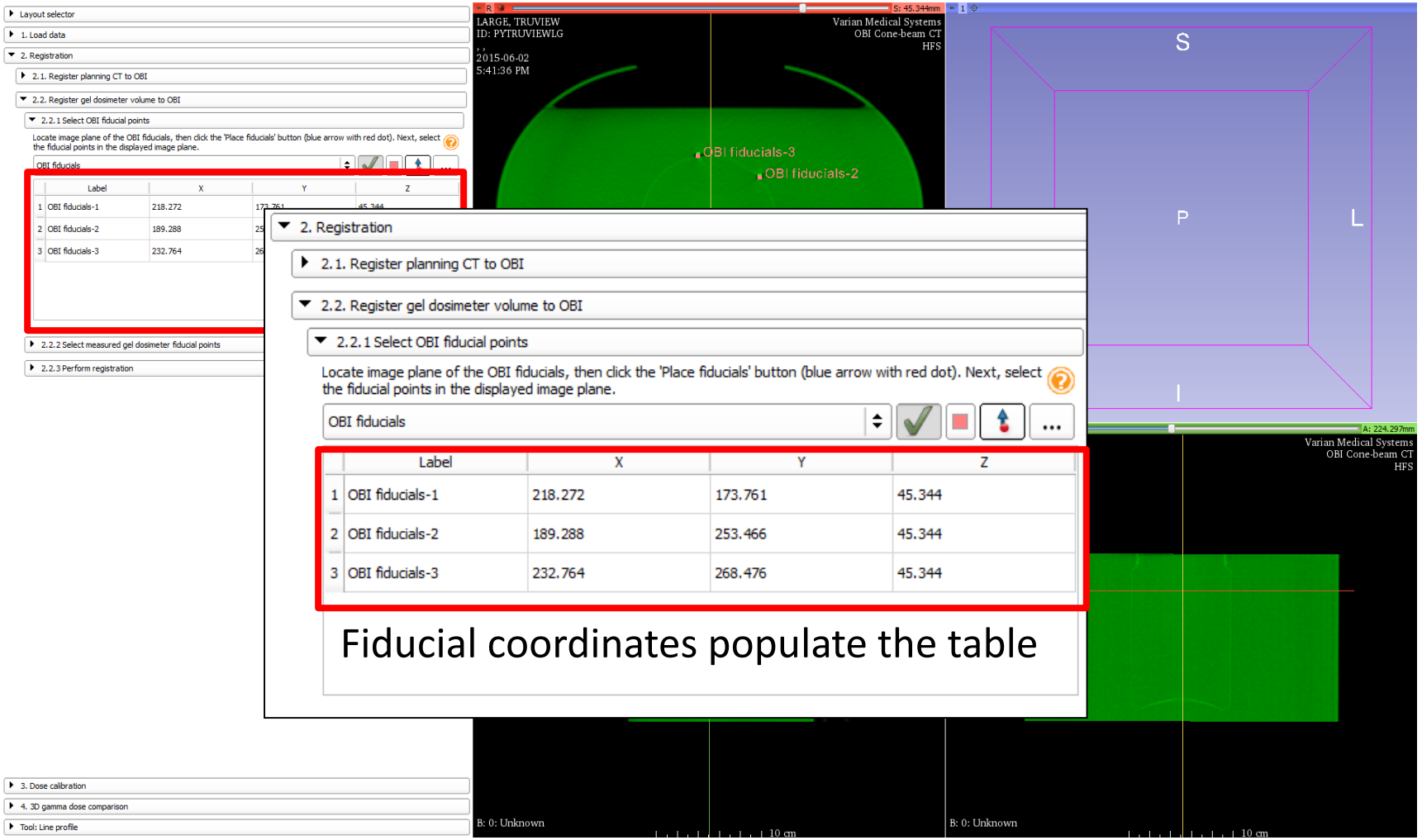
2.2 Registration



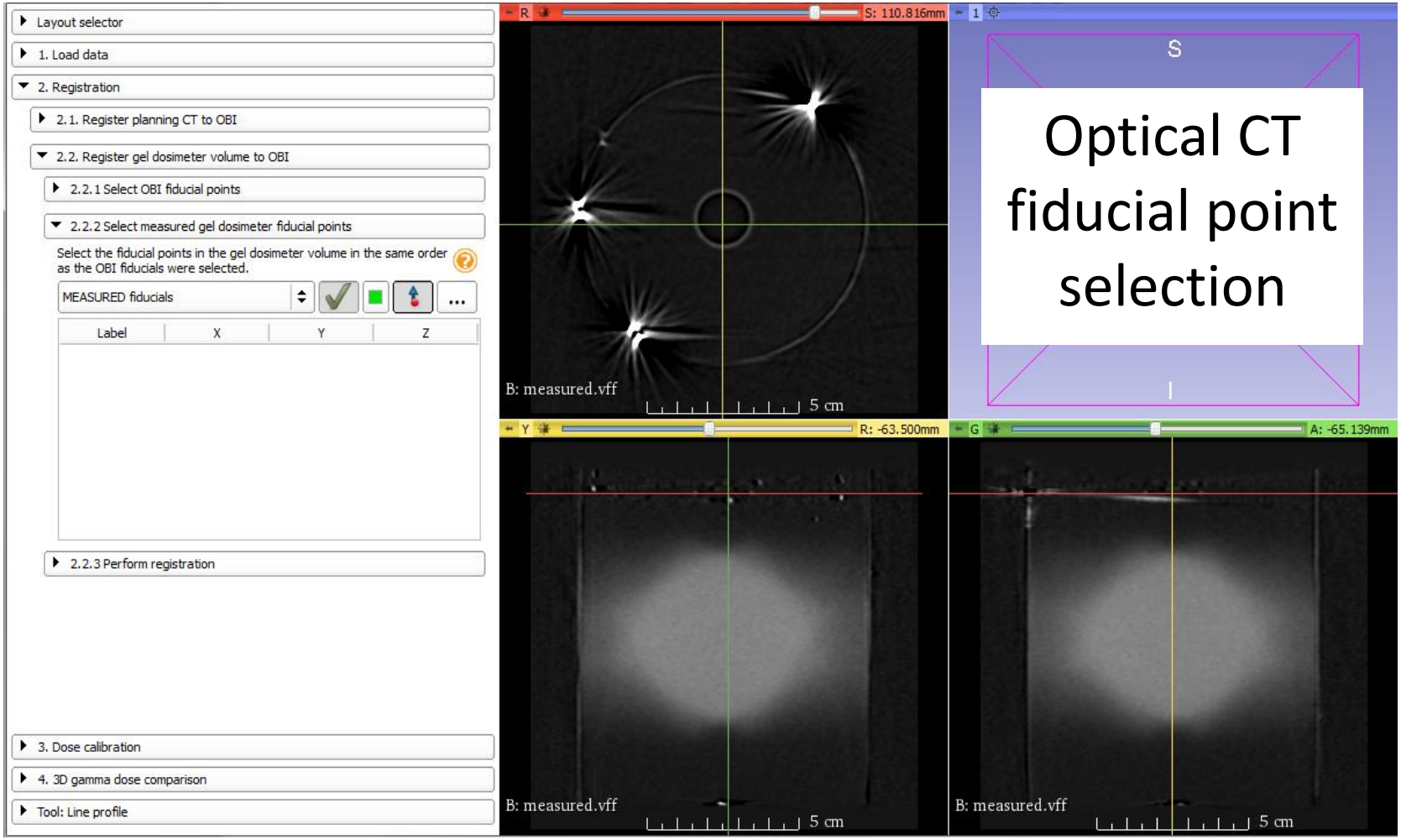
2.2 Registration



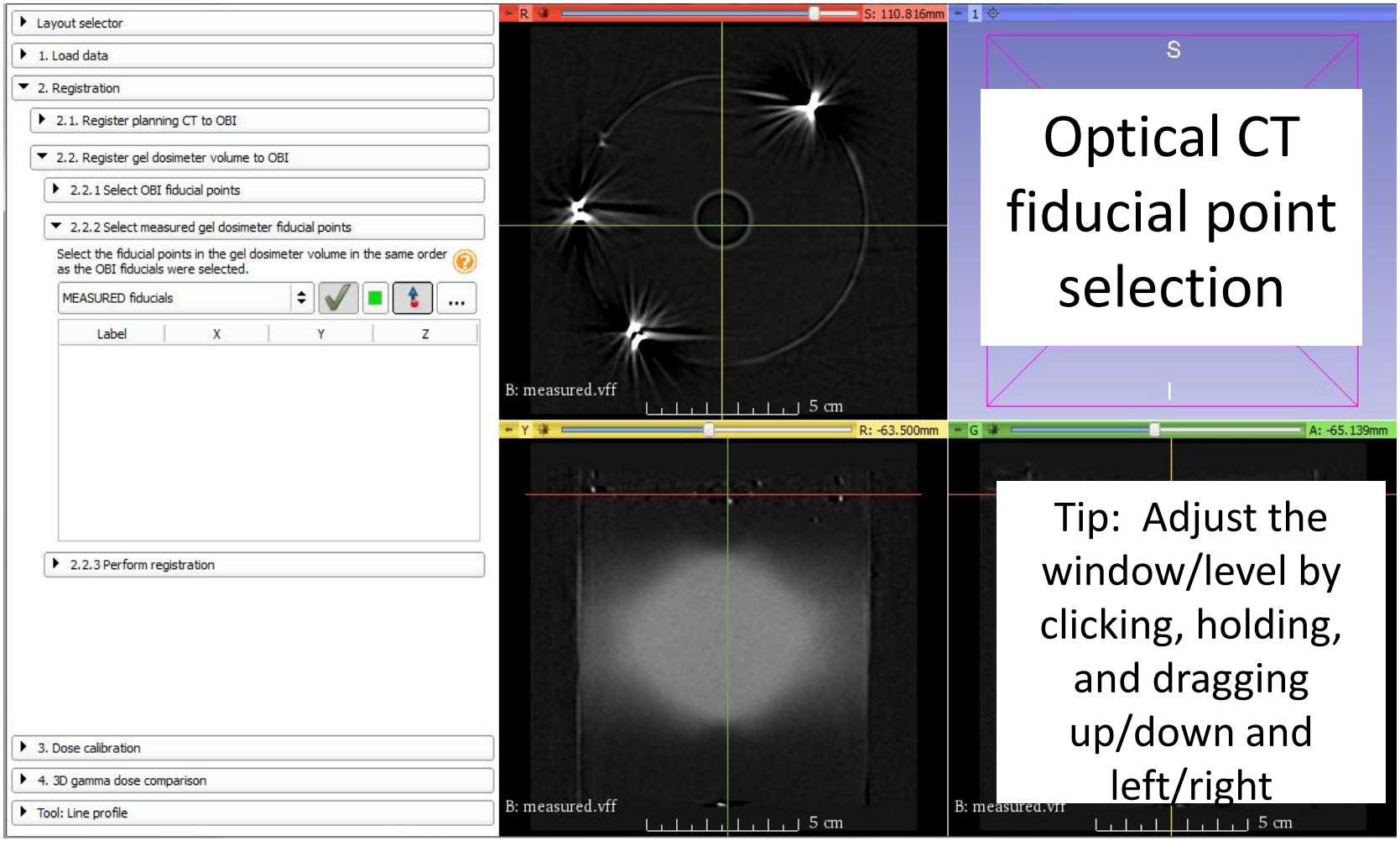
2.2 Registration



2.2 Registration



2.2 Registration



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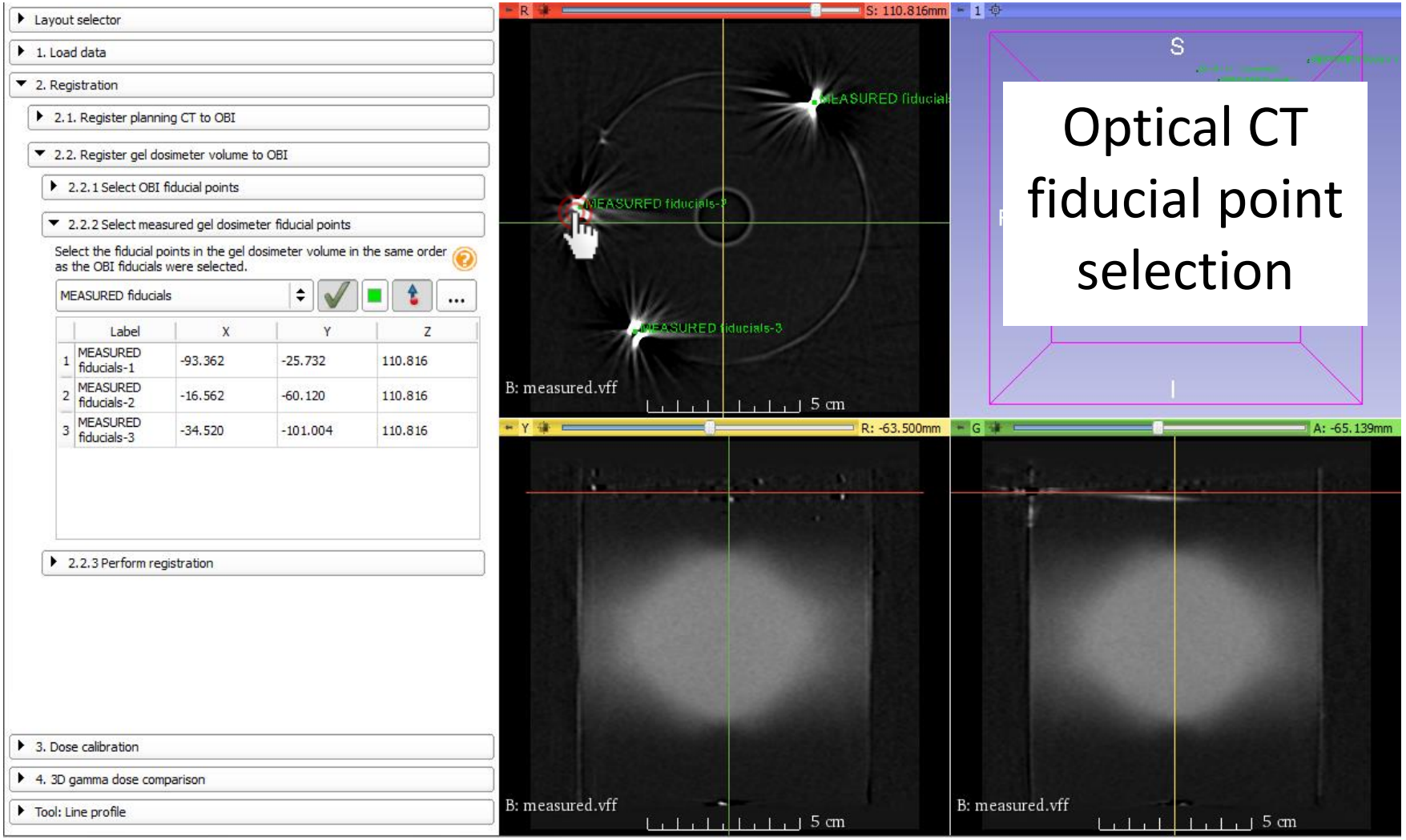
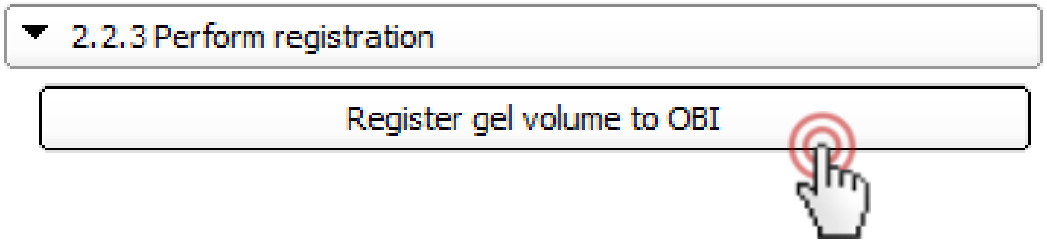
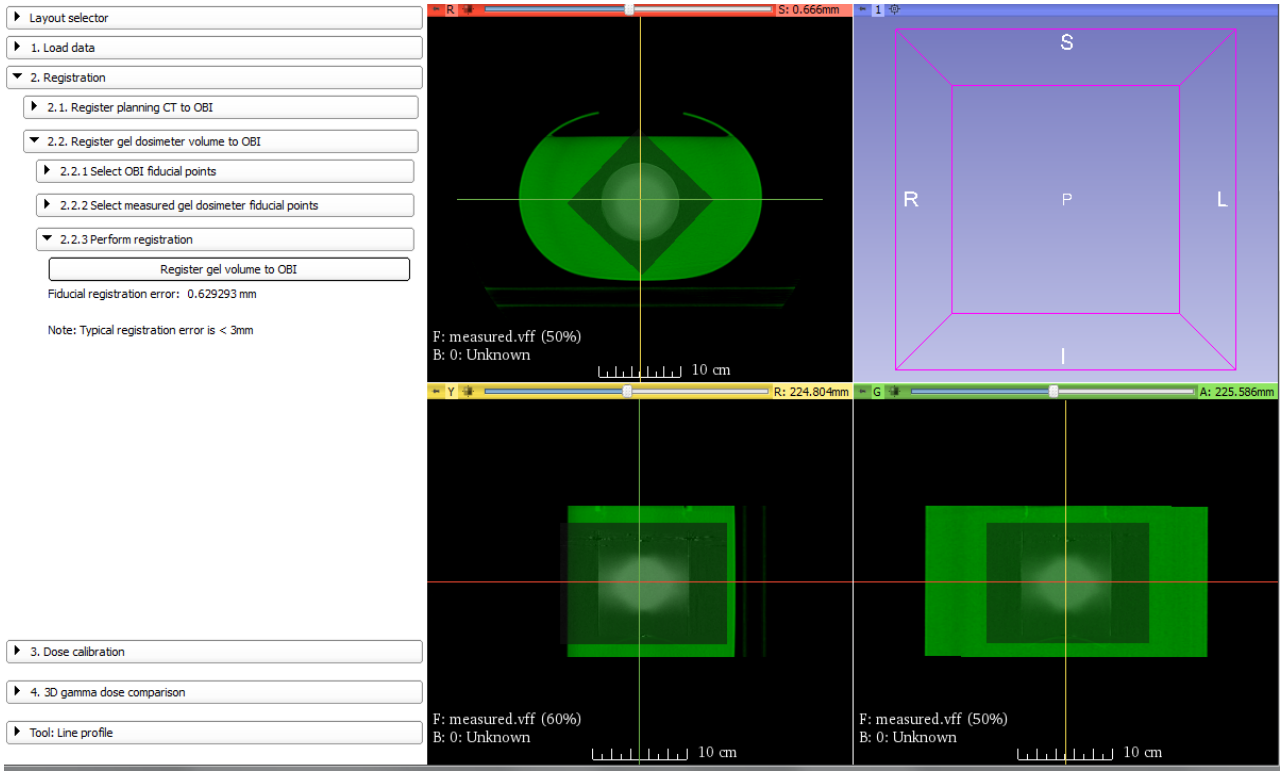


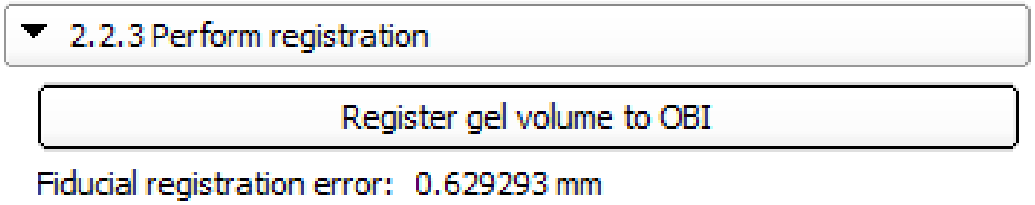
2.2 Registration





From our online survey

"How accurate is fiducial registration?"



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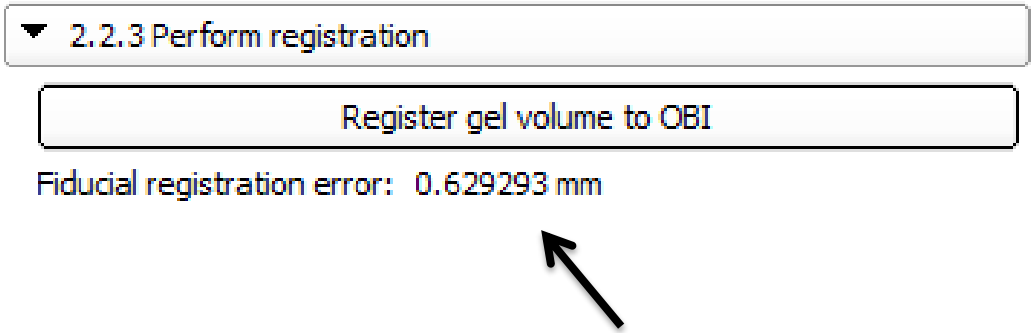
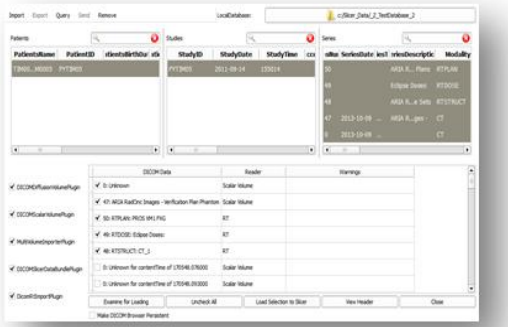


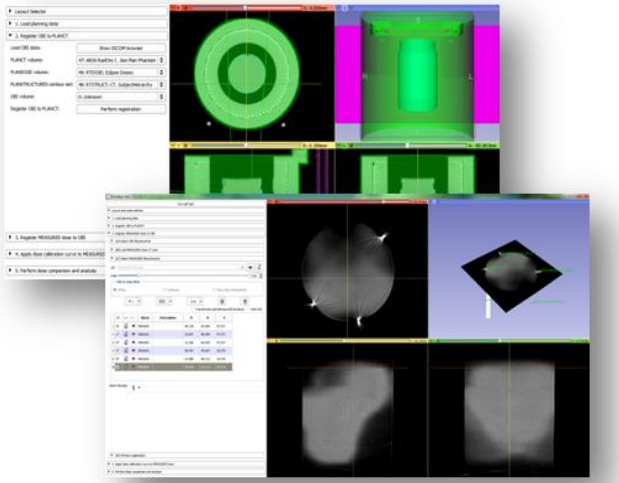
Root-mean square error between the two sets of fiducial points

Gel Dosimetry Analysis Roadmap

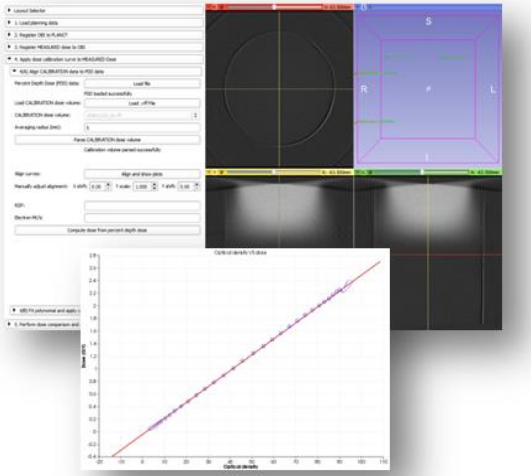
Data Import



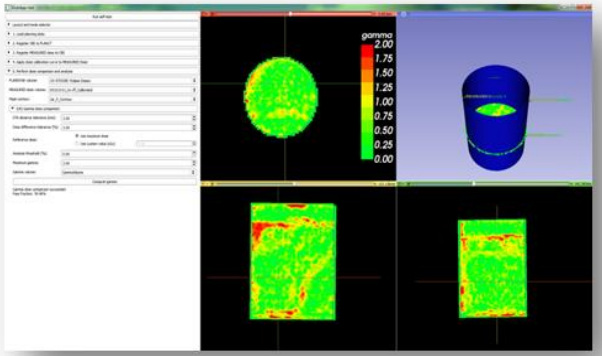
Registration



Calibration



Dose Comparison

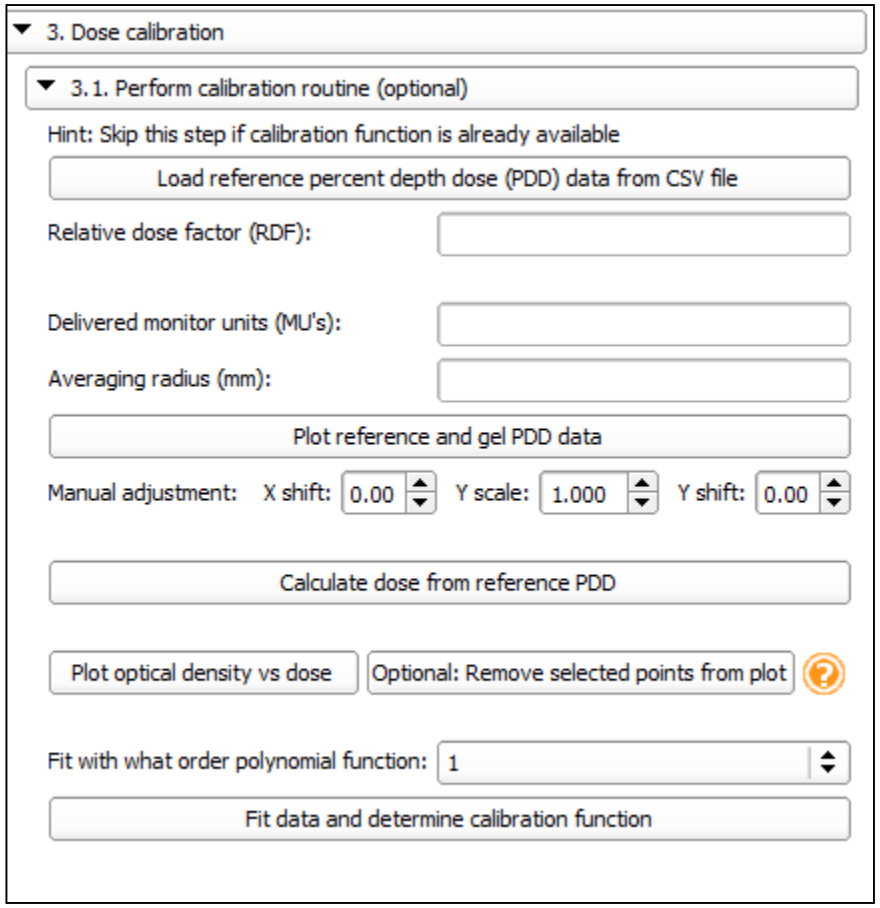


GelDosimetry

3. Calibration

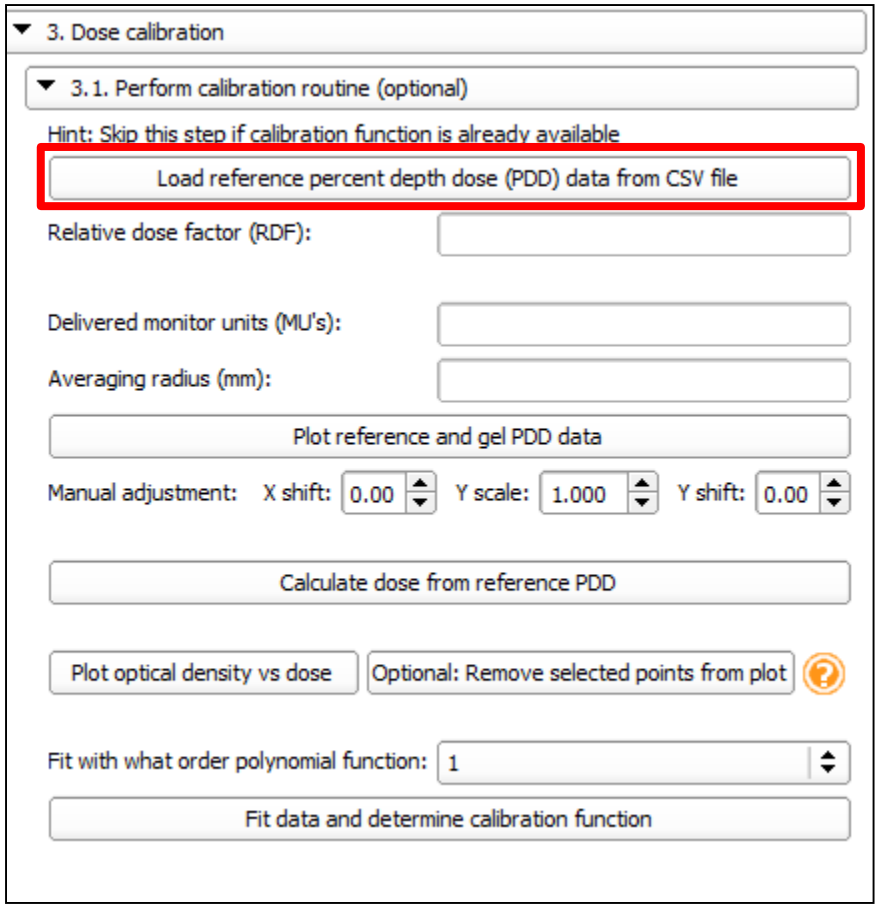
- Determine how optical density in the gel relates to dose
- Here, we use a percent depth-dose (PDD) method about the central axis of the gel jar
- We will align:
  - Gel optical density measurements
  - Water tank ion chamber PDD data

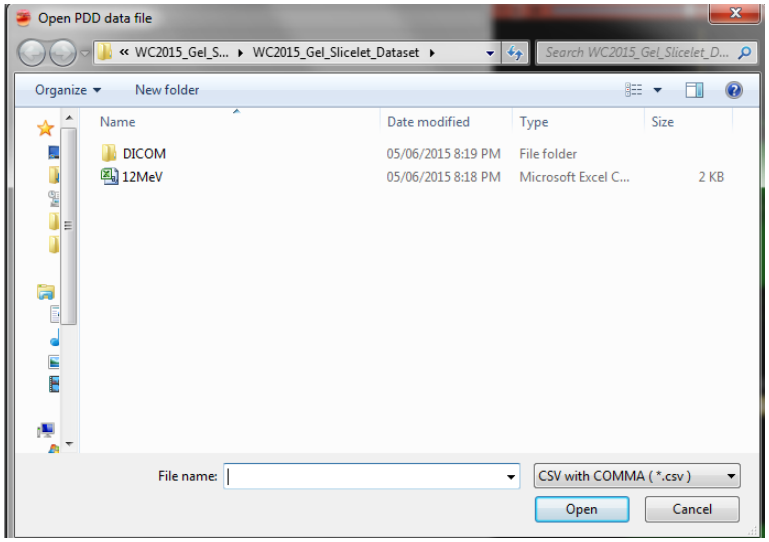
3.1 Calibration



Gel #2

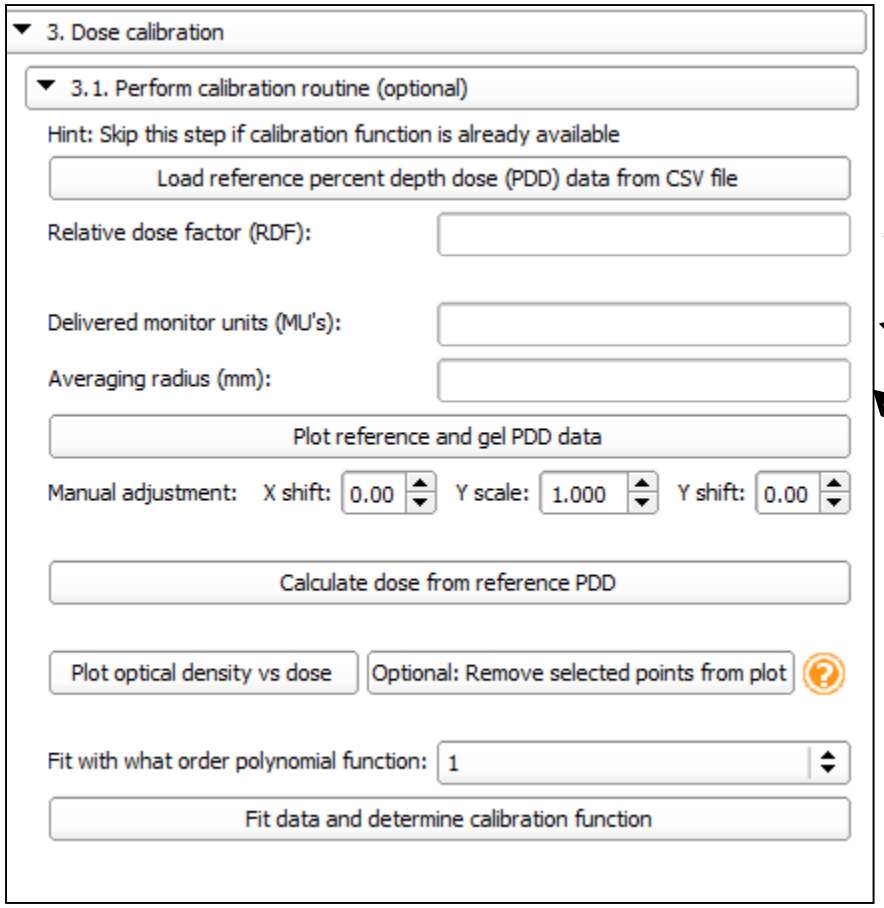
3.1 Calibration





Select *12MeV.csv* file, and click 'Open'

3.1 Calibration



For this delivery:

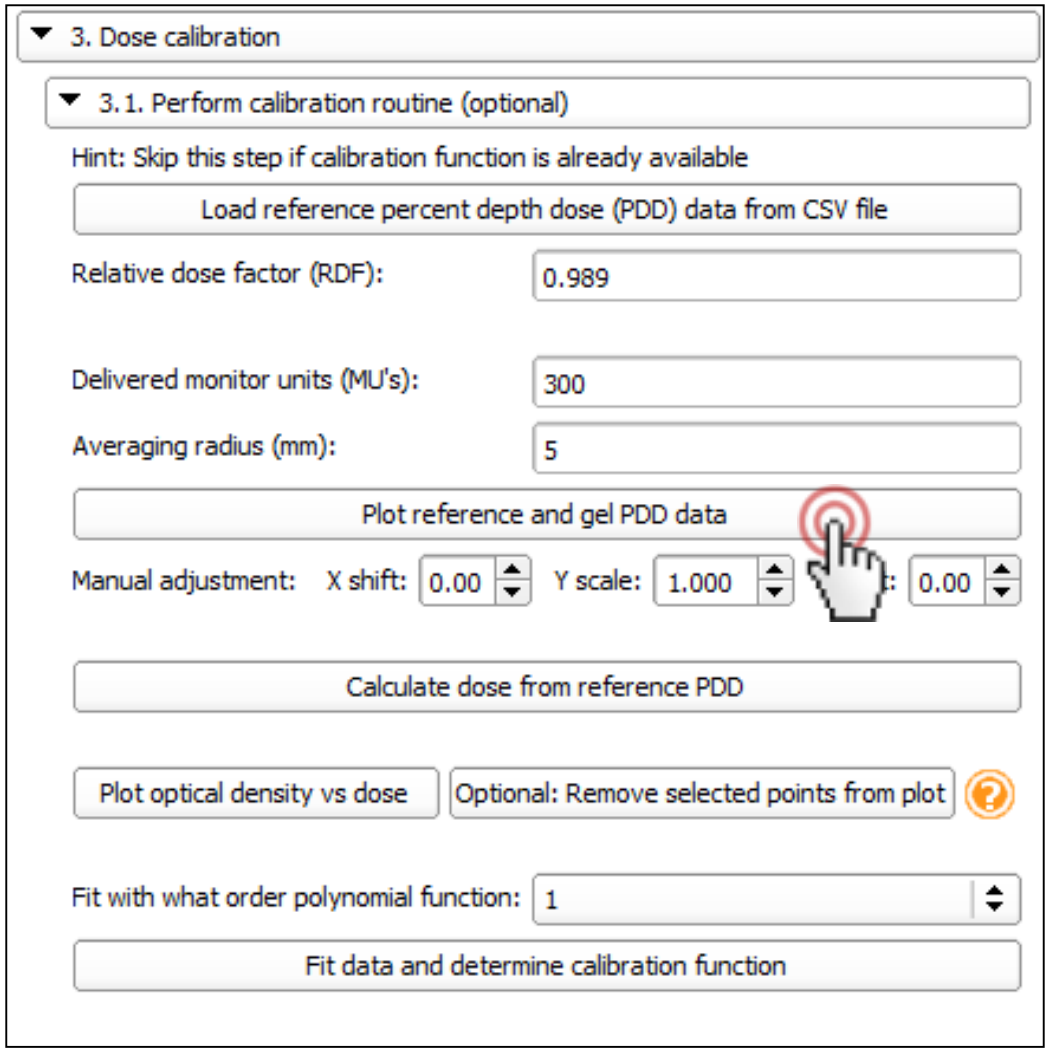
Relative dose factor (RDF) = 0.989

(6x6 cm^2, 12 MeV electron beam)

Delivered monitor units (MUs) = 300

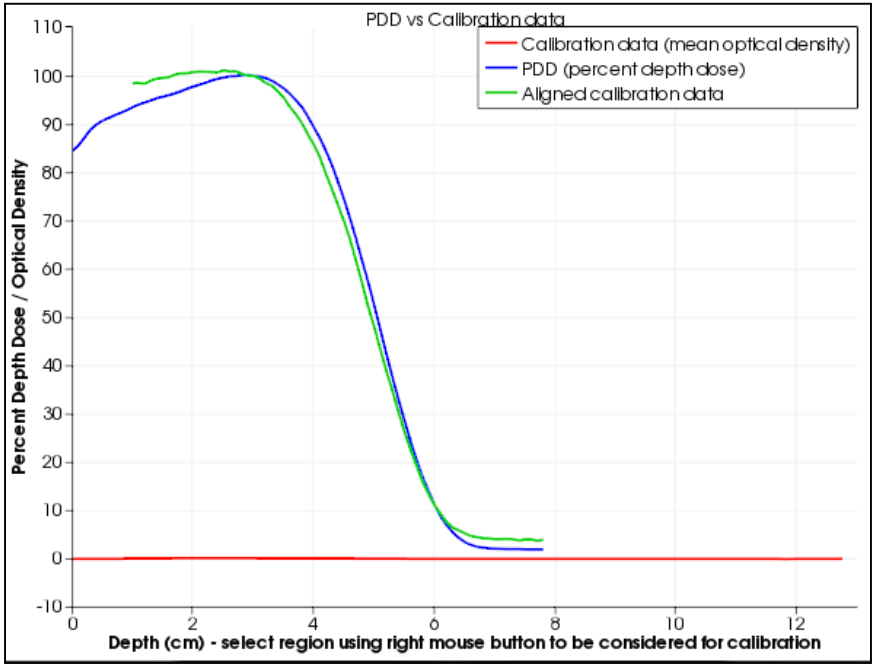
Averaging radius (mm) = 5

3.1 Calibration



3.1 Calibration

Automated PDD alignment



Adjust alignment using:

X shift: 0.00 Y scale: 983.796 Y shift: 2.67

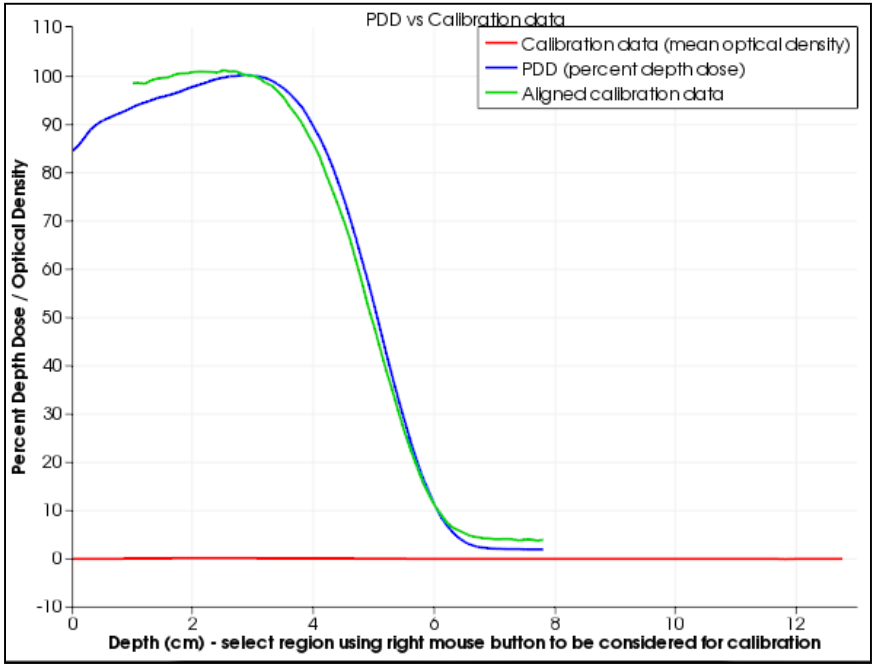
Blue: Commissioning PDD data

Red: Raw optical density data

Green: Shifted and scaled optical density data

3.1 Calibration

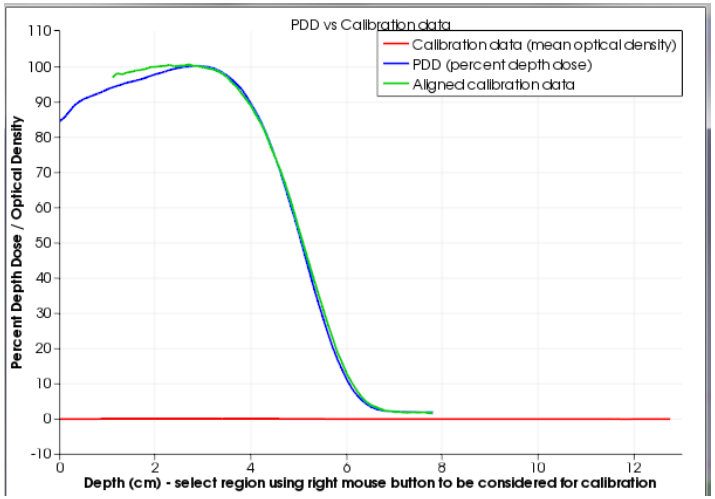
Automated PDD alignment



Adjust alignment using:

X shift: 0.00 Y scale: 983.796 Y shift: 2.67

X shift: 0.16 Y scale: 1000.00 Y shift: 0.47



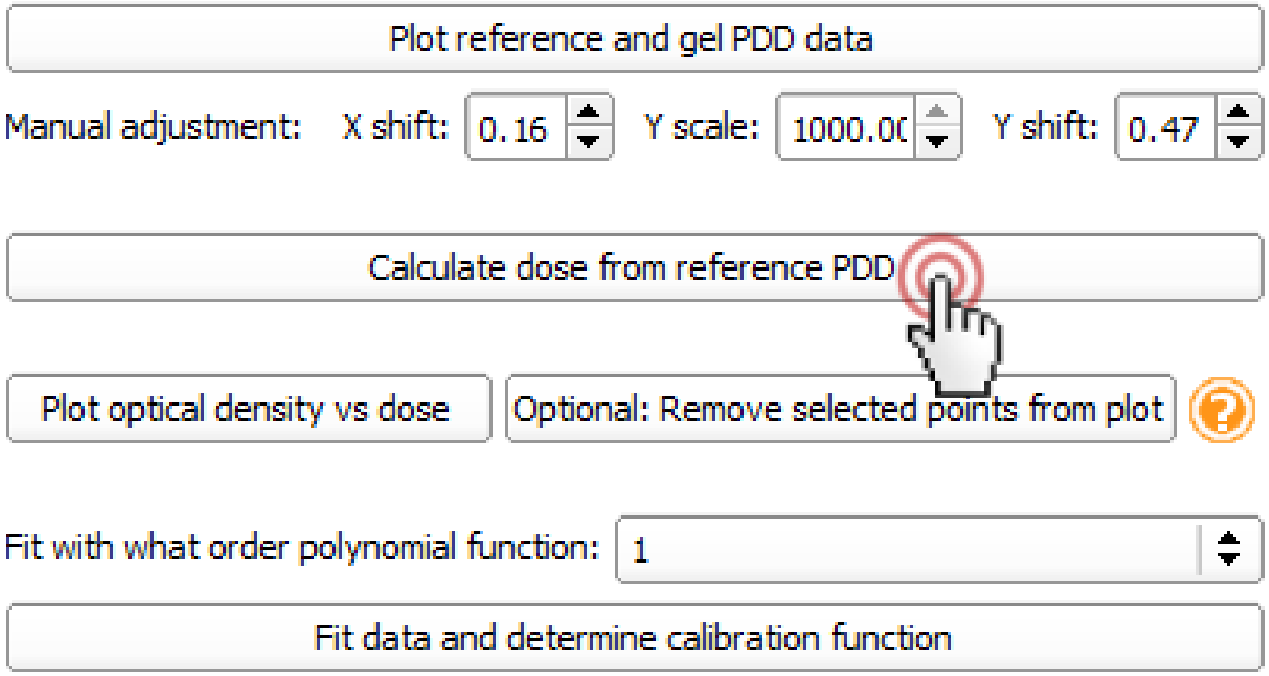
Blue: Commissioning PDD data

Red: Raw optical density data

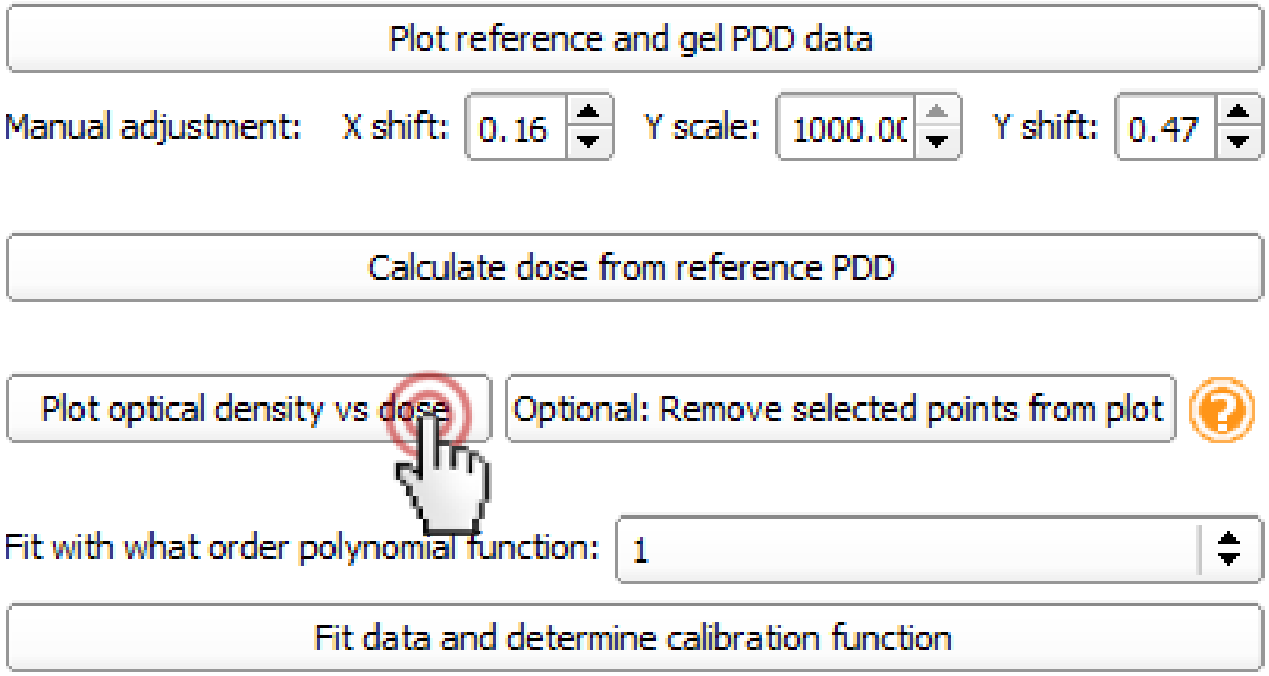
Green: Shifted and scaled optical density data

Perk Queen's University KGH Cancer Centre of Southeastern Ontario OCAIRO

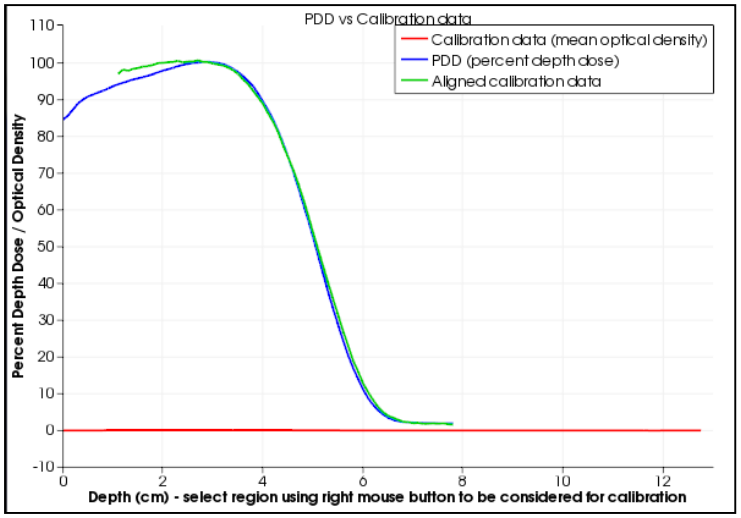
3.1 Calibration



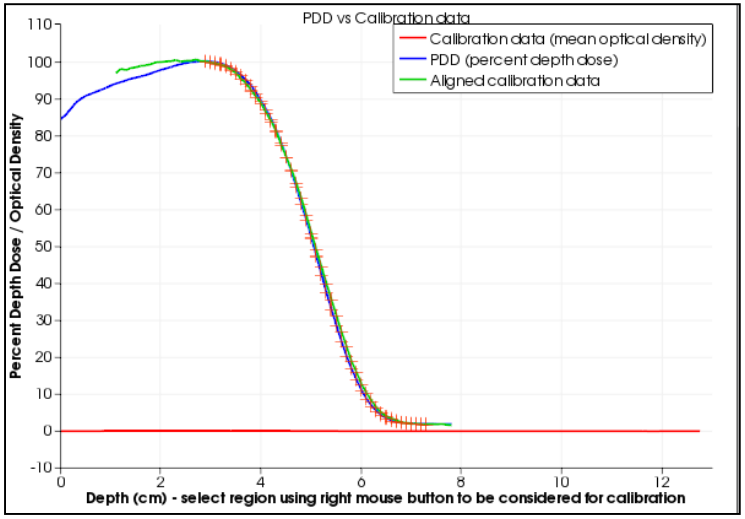
3.1 Calibration

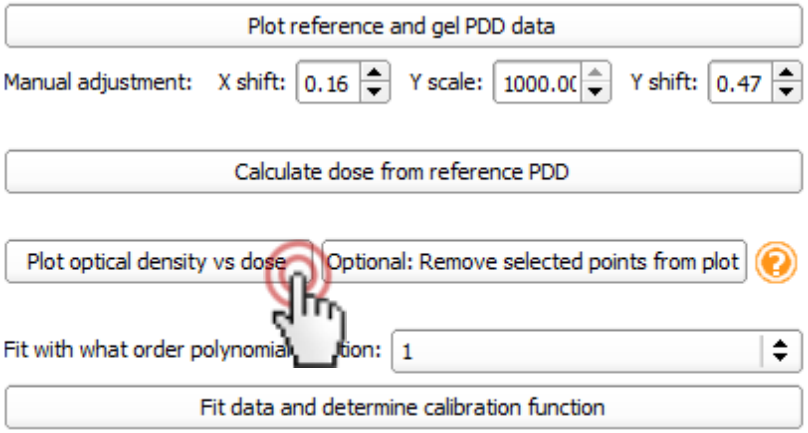


3.1 Calibration

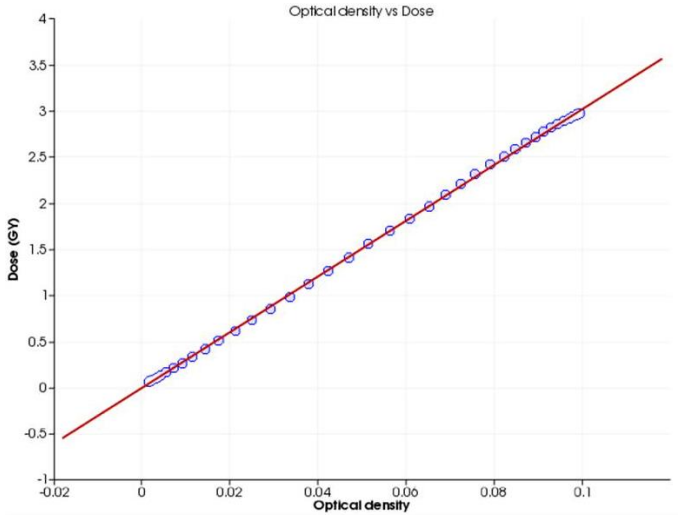


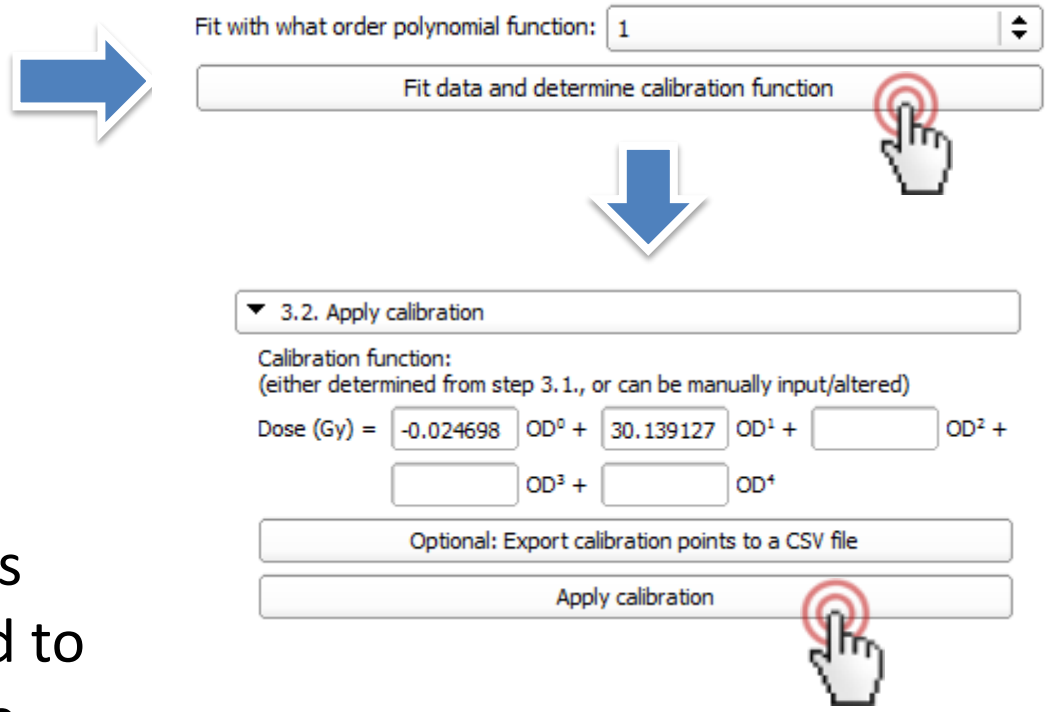
Right click and draw box around region to use for calibration





3.2 Calibration

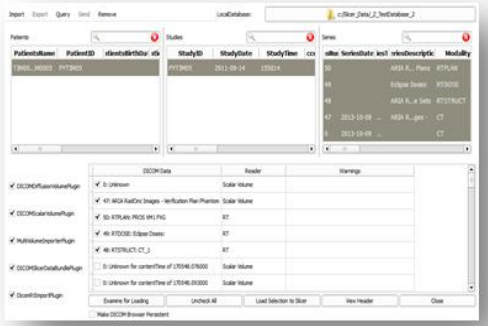




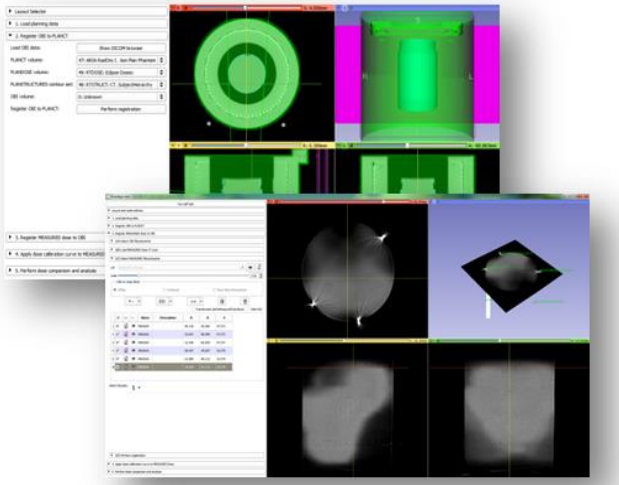
Calibration function is determined and applied to measured gel volume

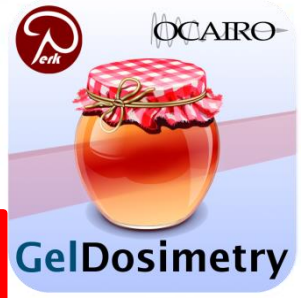
Gel Dosimetry Analysis Roadmap

Data Import

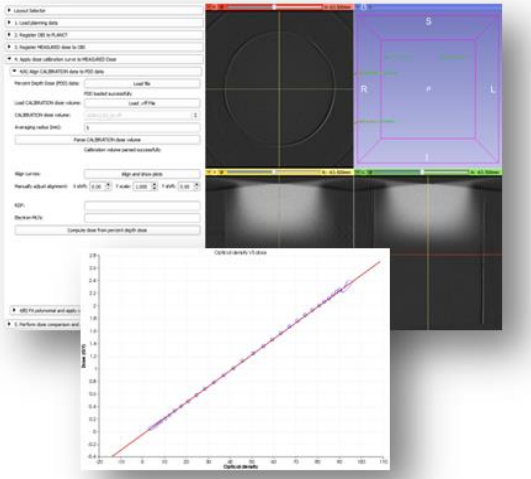


Registration

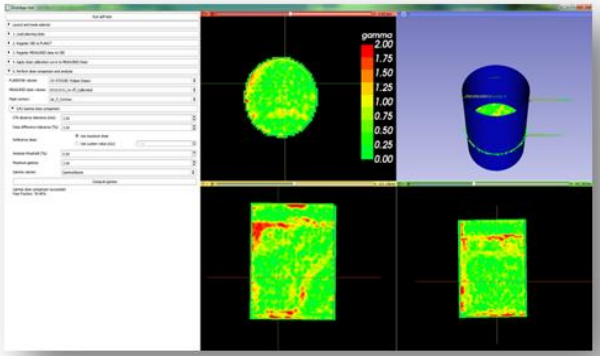




Calibration



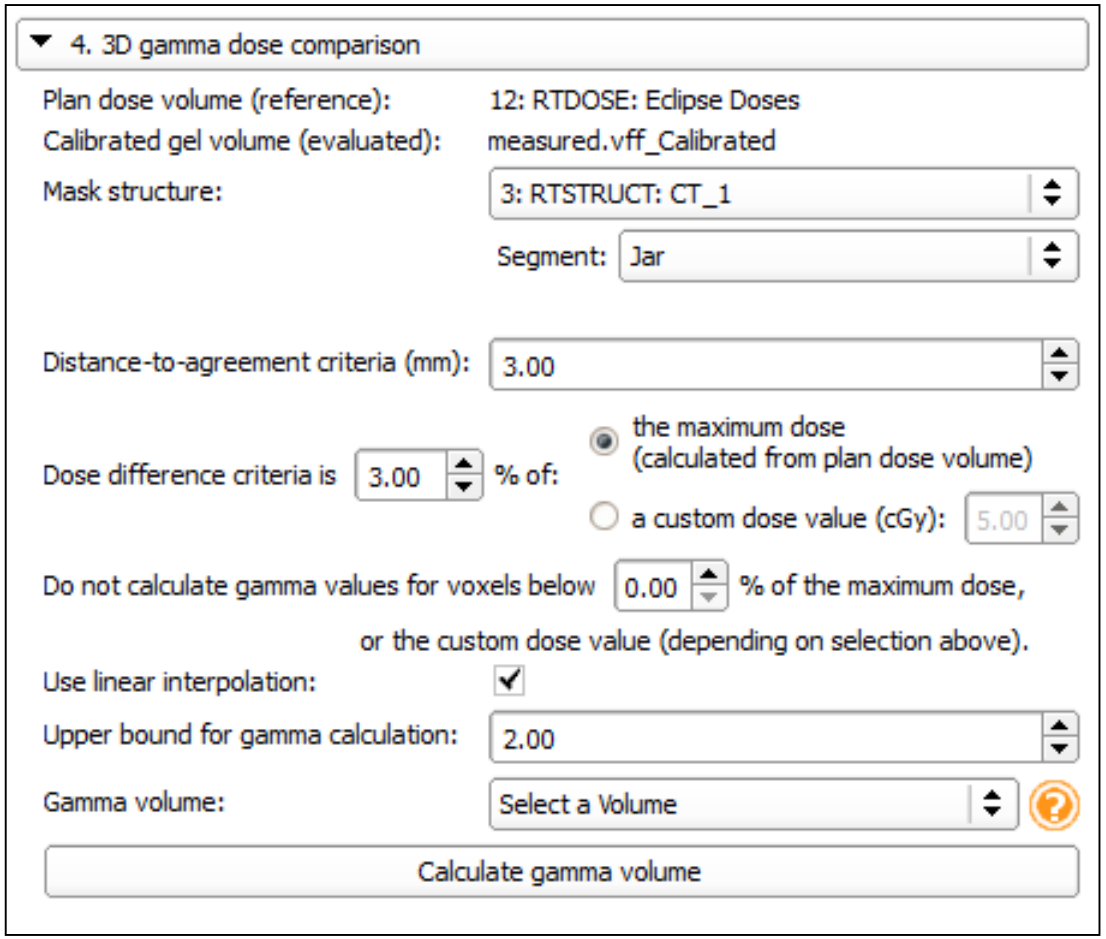
Dose Comparison



4. Dose Comparison

- Last step! Compare the measured gel dose volume with the planned dose volume (using the treatment planning system)
- We will use a 3D gamma comparison
- Criteria: 3% dose difference, 3mm distance-to-agreement

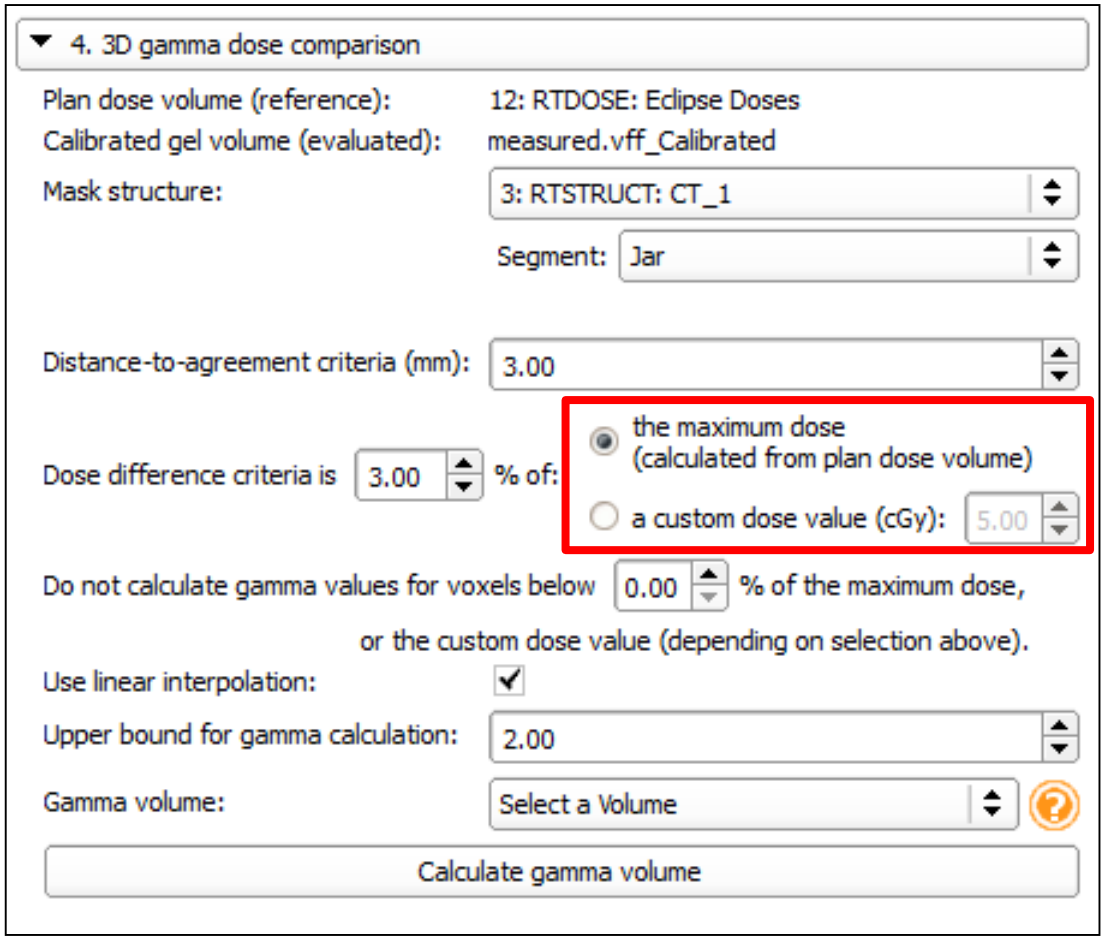
4. Dose Comparison



Volumes are automatically assigned

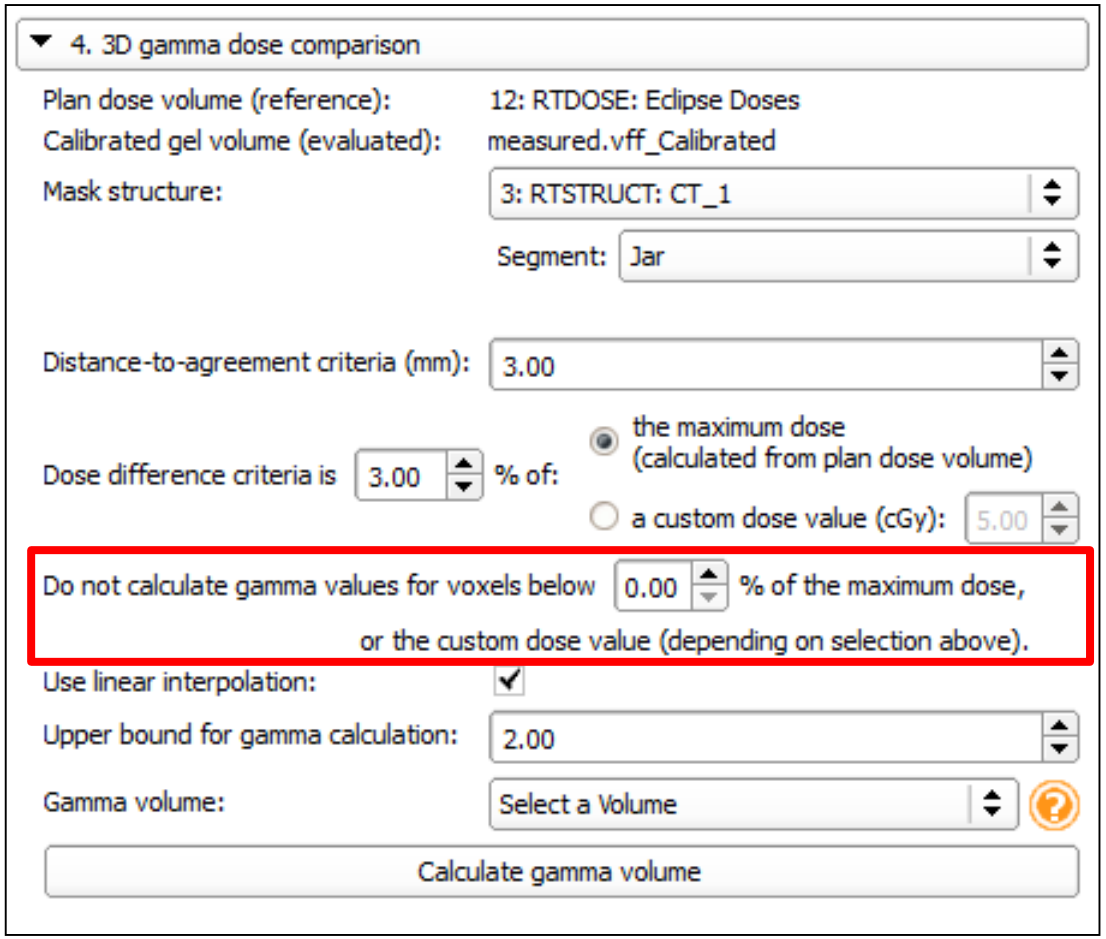
Select ‘CT_1’ structure set
Choose the ‘Jar’ structure

4. Dose Comparison



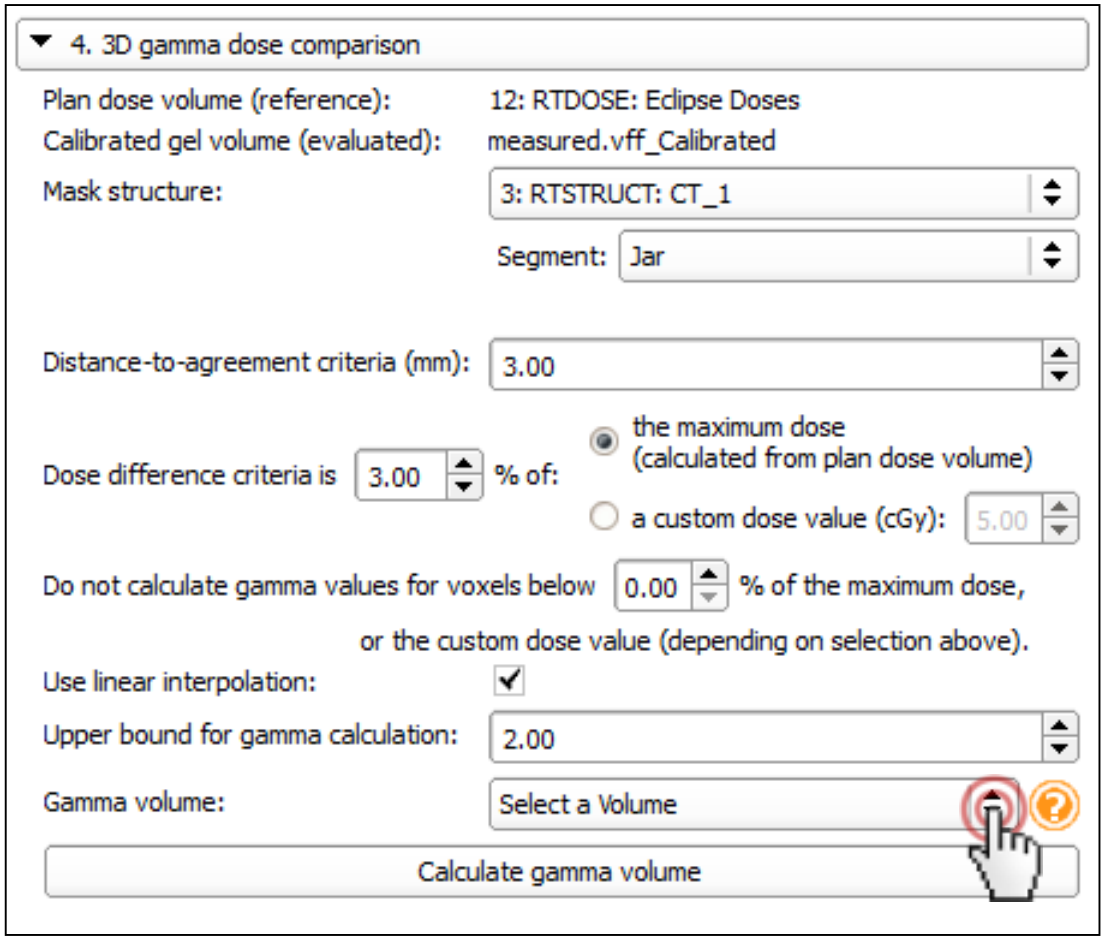
Note: Two ways to specify dose difference

4. Dose Comparison



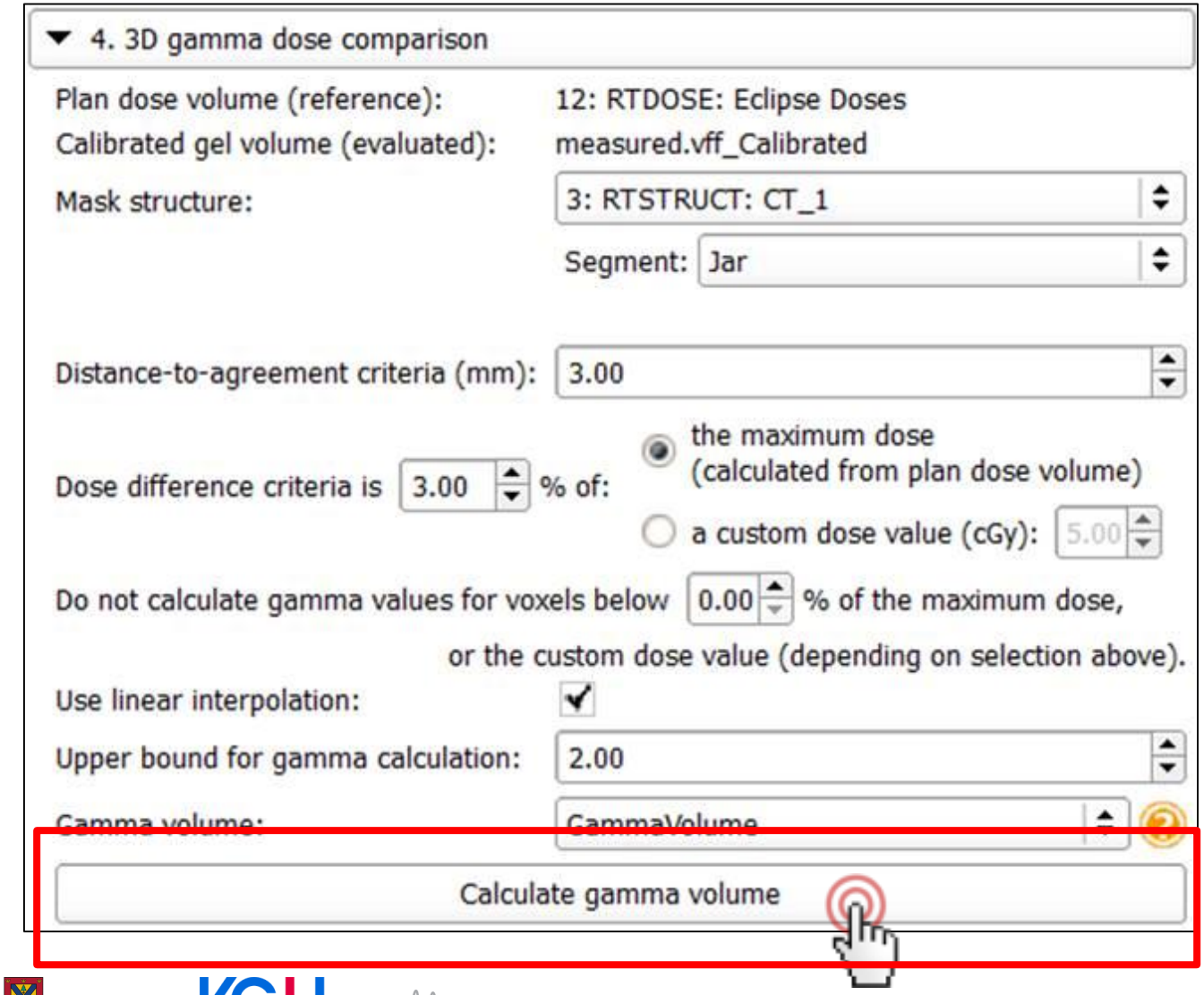
Dose threshold: Where to calculate gamma

4. Dose Comparison

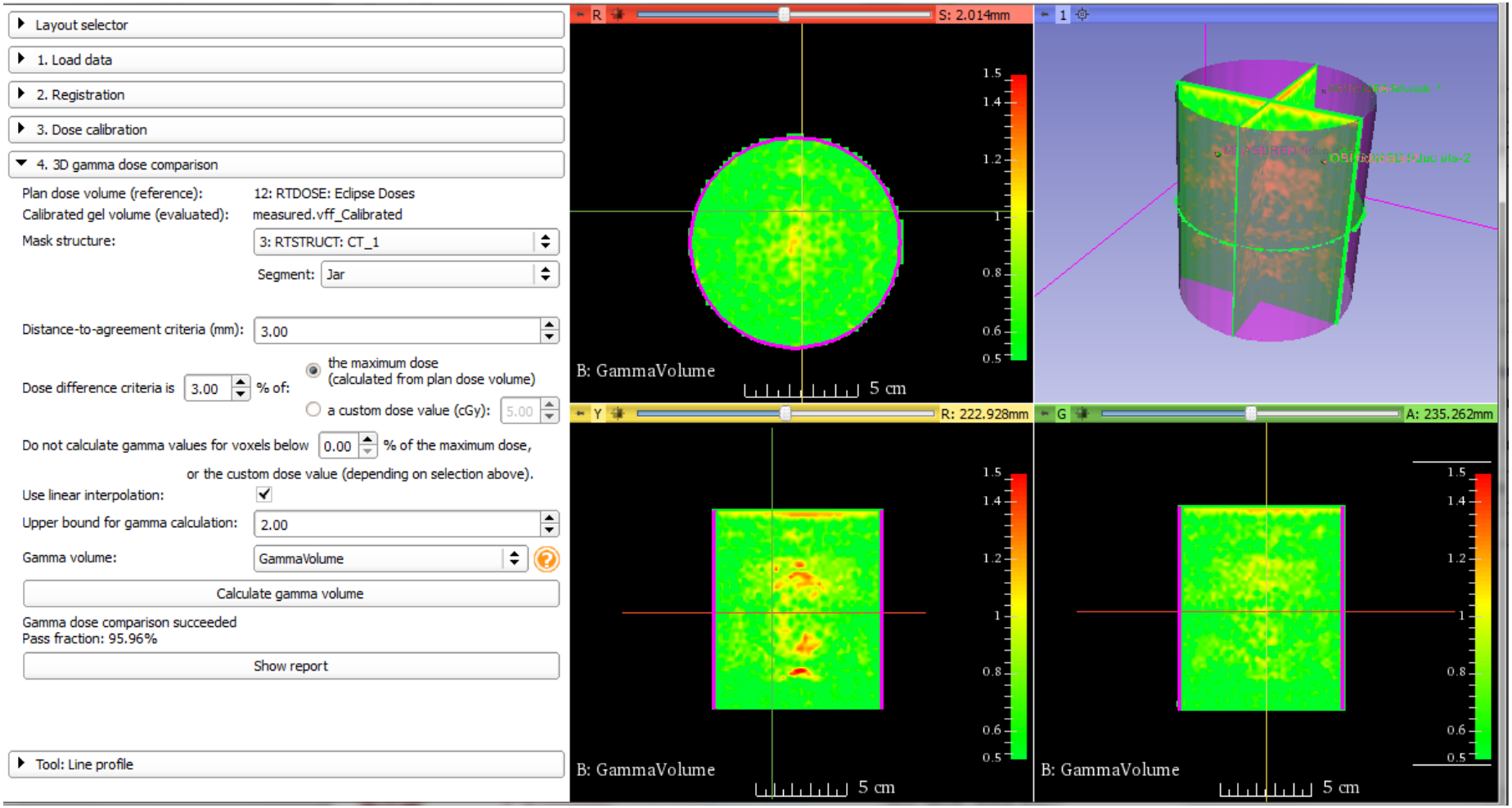


Create new gamma volume

4. Dose Comparison

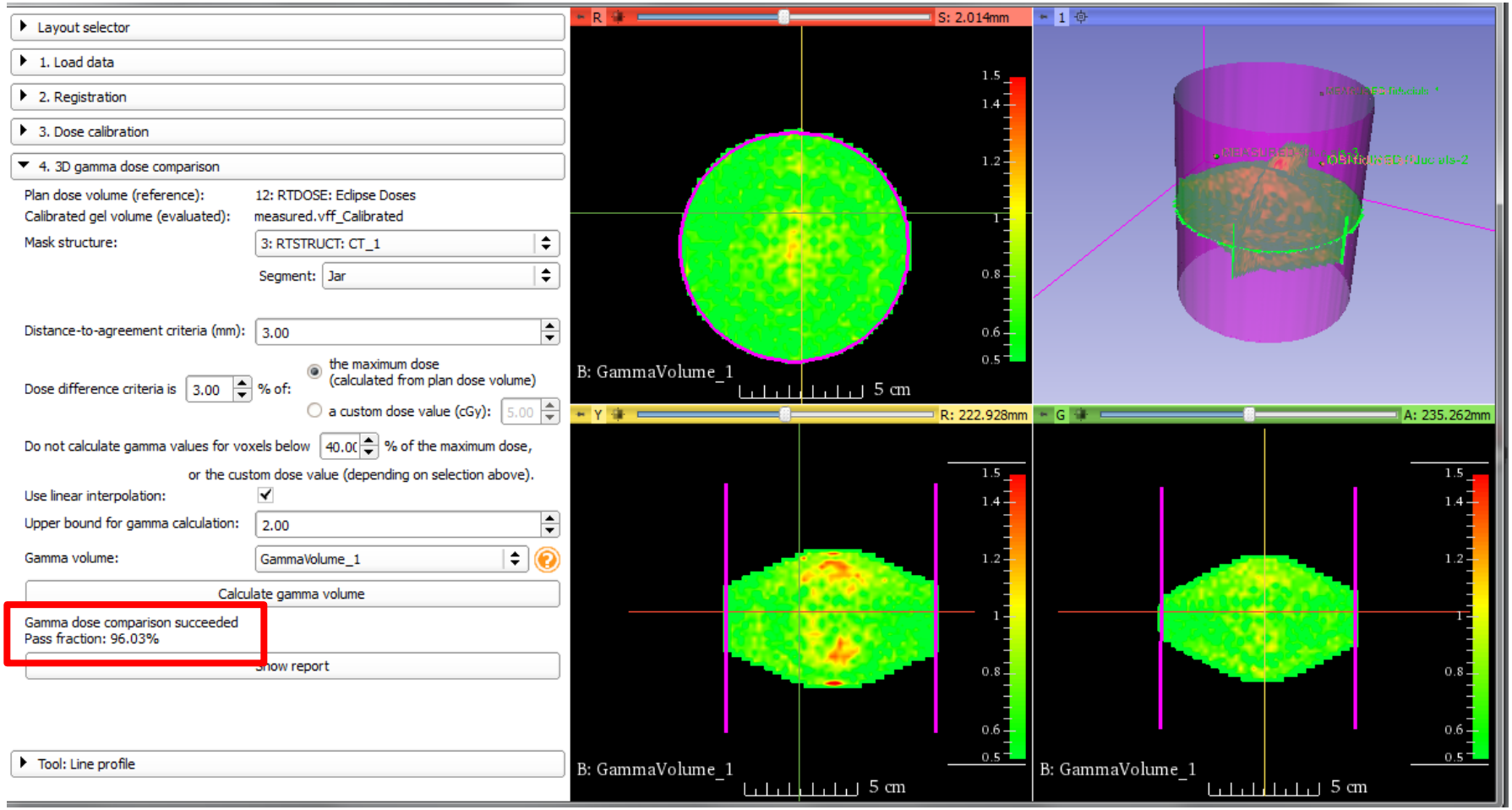


4. Dose Comparison

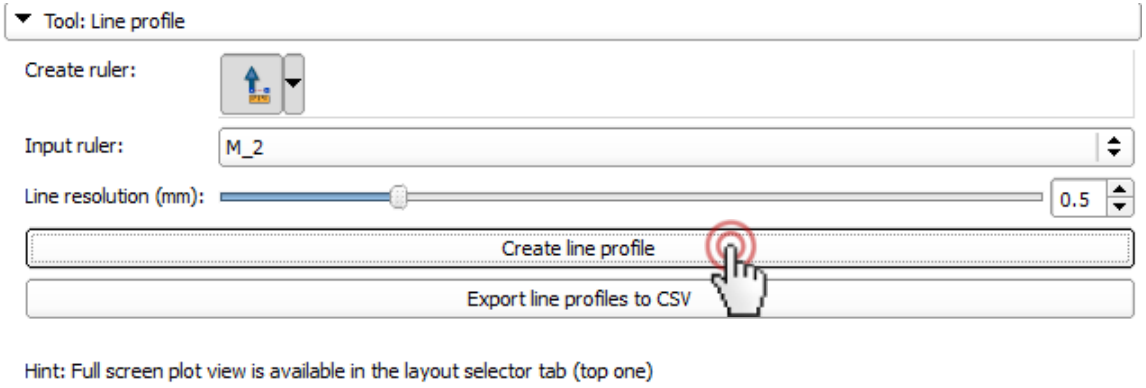


4. Dose Comparison

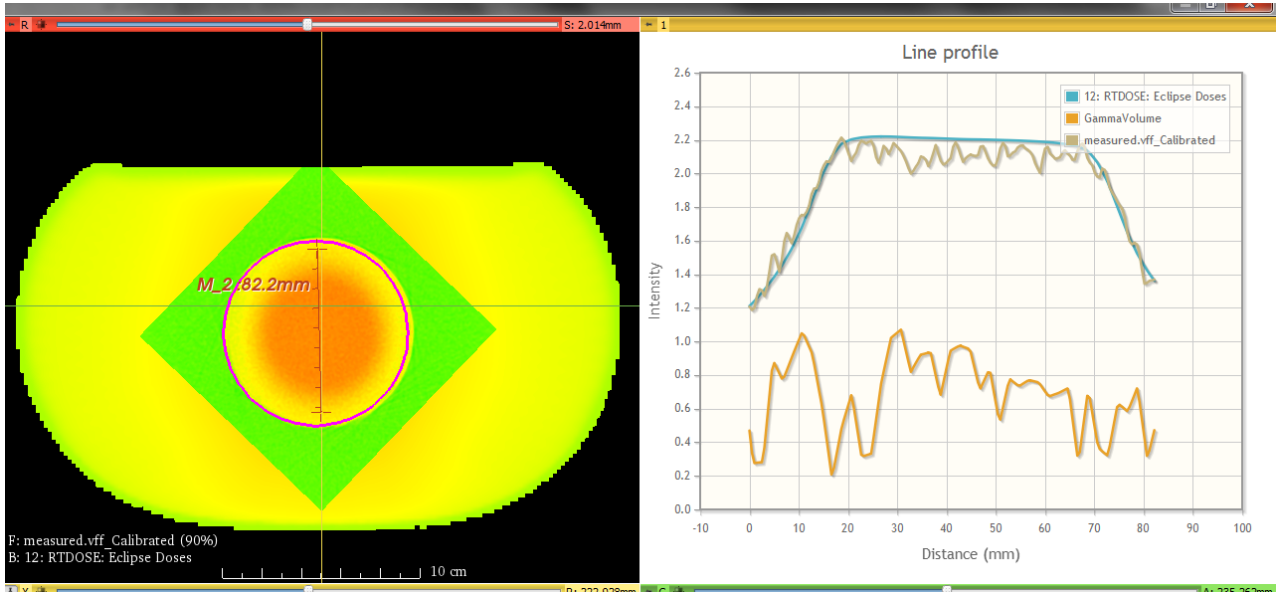
Dose threshold at 40% of max. dose



Line Profile



Draw line profile, with ruler tool, then click ‘Create line profile’ to view.



From our online survey

“Concerning Gel Dosimetry slicelet:

Is it possible to save the result of an analysis? What if I don't want to go over the procedure every time for the same piece of data?”


Are yOu gellin'?
Outrageous comfort and support
with Massaging Gel
massaging
gel


Are yOu gellin'?
Outrageous comfort and support with Massaging Gel
massaging gel


YEAH
IM GELLIN'
zipmeme

Wrap-up

- Thanks for participating!
- Let us know if you have any questions/suggestions
- Have a great week and conference!