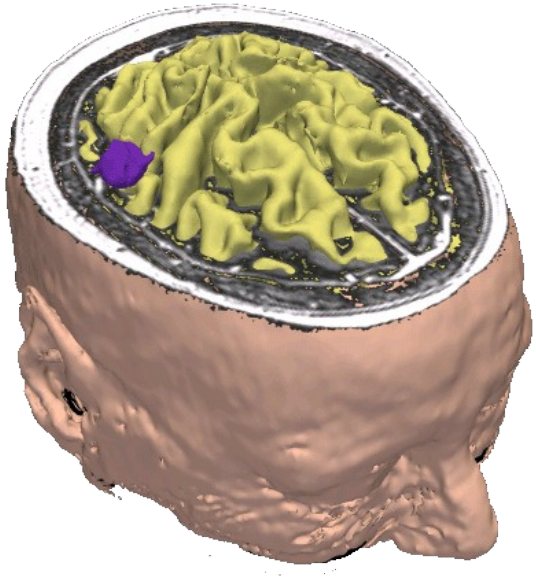
Measuring Volume Change in Tumors



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Andriy Fedorov, Ph.D.

Material

This course requires the following installation:

- 3DSlicer version 3.6 Software, which can be installed from:

  http://www.slicer.org/pages/Special:SlicerDownloads

- A reliable internet connection for downloading the data

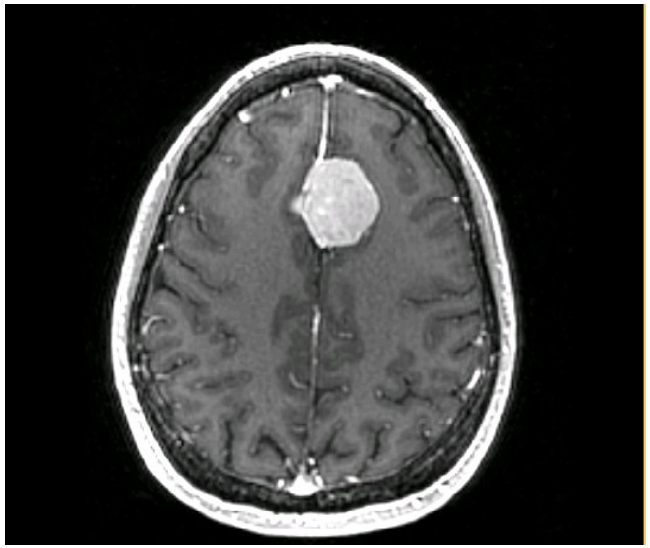
Disclaimer

It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules.

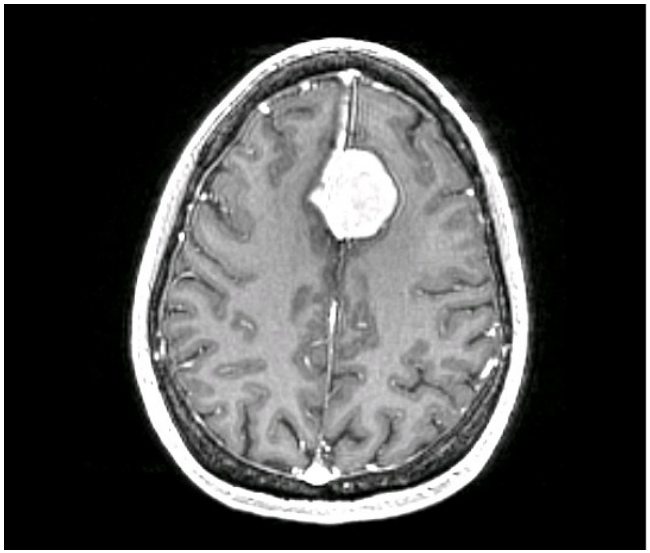
The module described in this tutorial was tested on Axial 3D SPGR T1 post Gadolinium scans (Voxel dimension: 0.94mm x 0.94mm x 1.20mm, FOV: 240mm, Matrix: 256 x 256)

Data

This course is built upon two scans of a patient with meningioma:



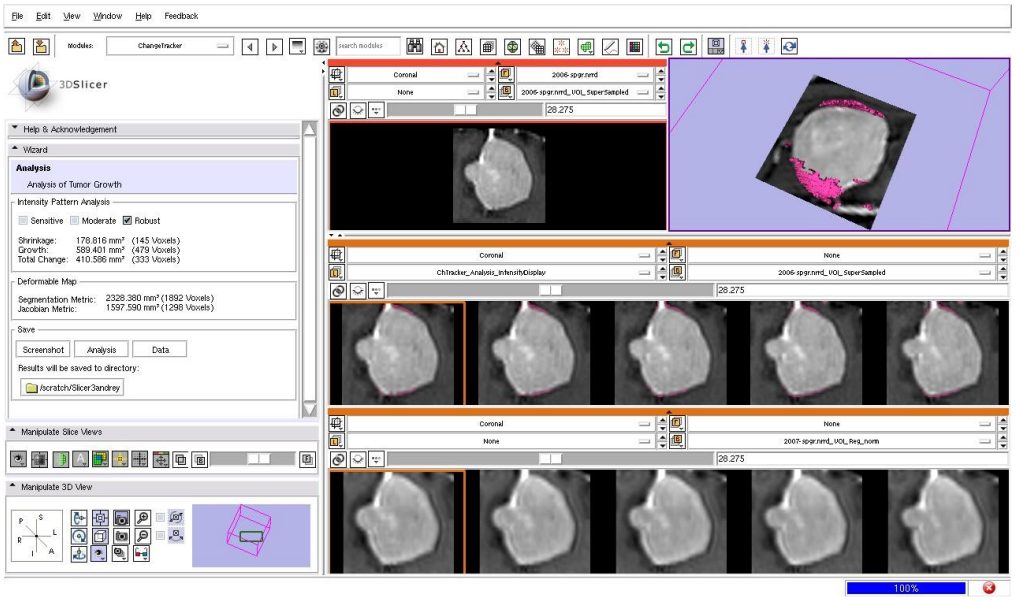
MR Scan 1



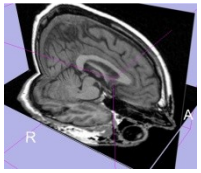
MR Scan 2

Learning objective

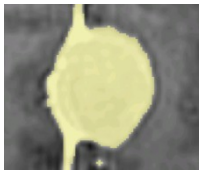
Following this tutorial, you'll be able to load two scans into Slicer3, and measure and visualize the change in volume of the meningioma between the two scans.



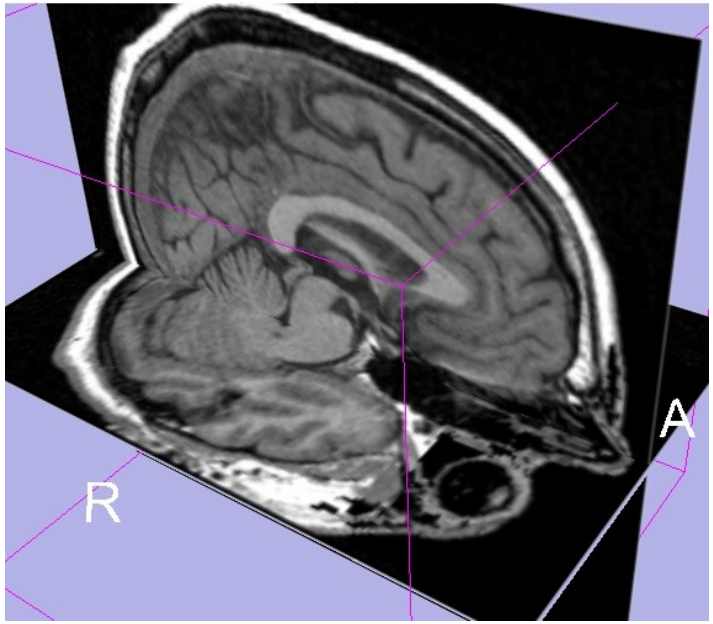
Overview



- Loading tutorial data



- Measuring volume change in tumors

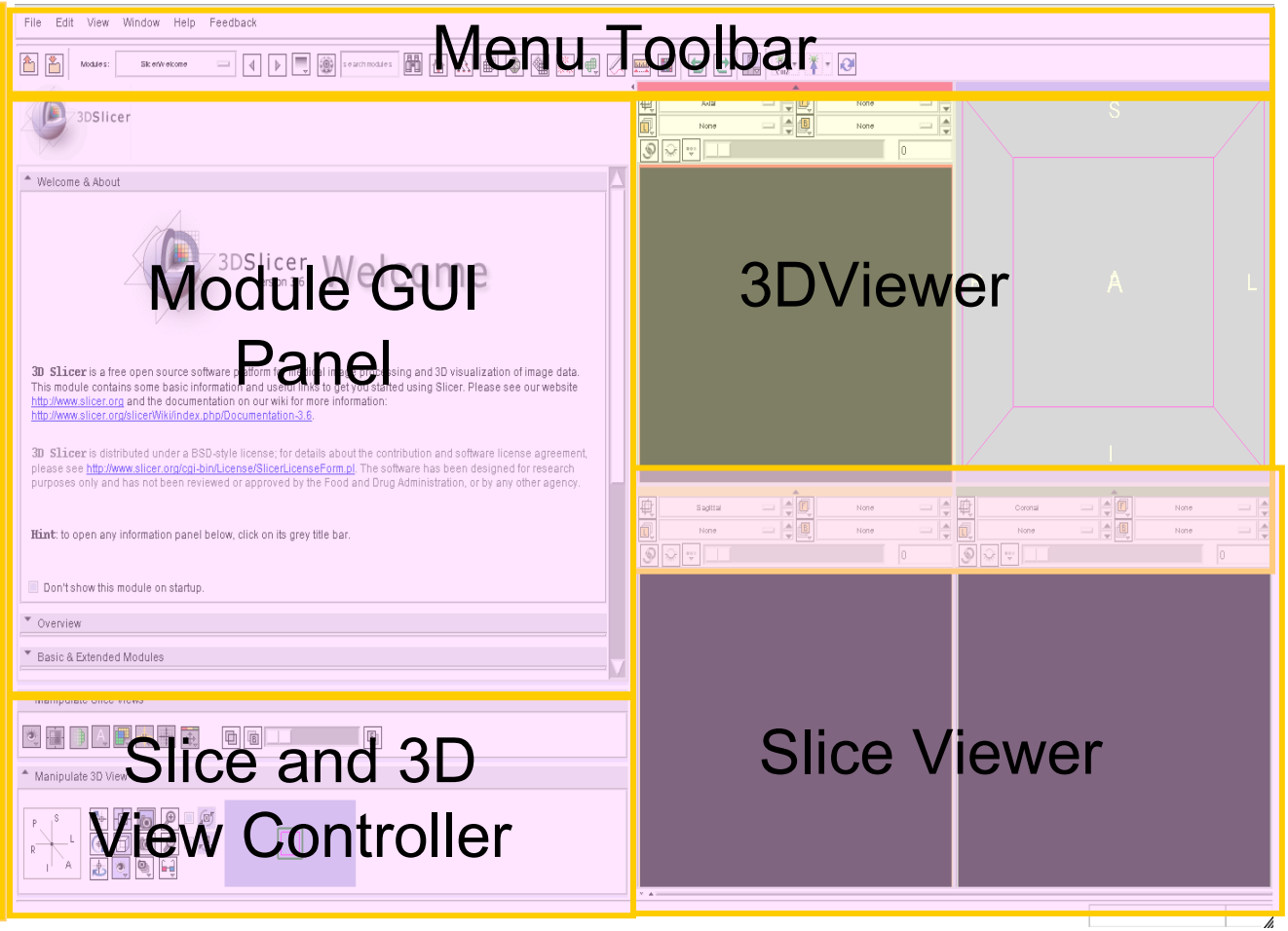


Part 1: Loading the tutorial data

Slicer3 GUI

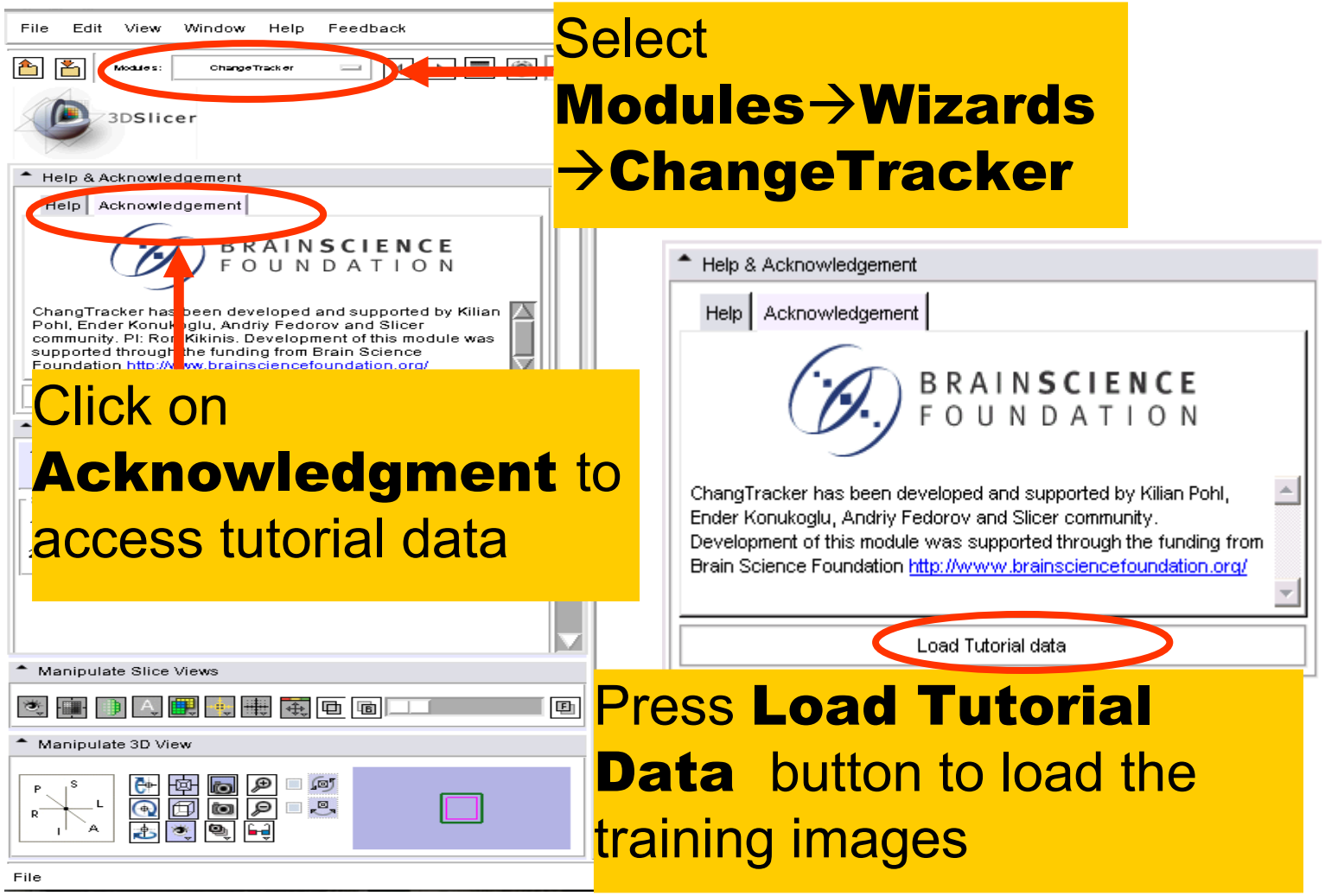
The Graphical User Interface (GUI) of Slicer3 integrates five components:

- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer
- the Slice and 3D View Controller

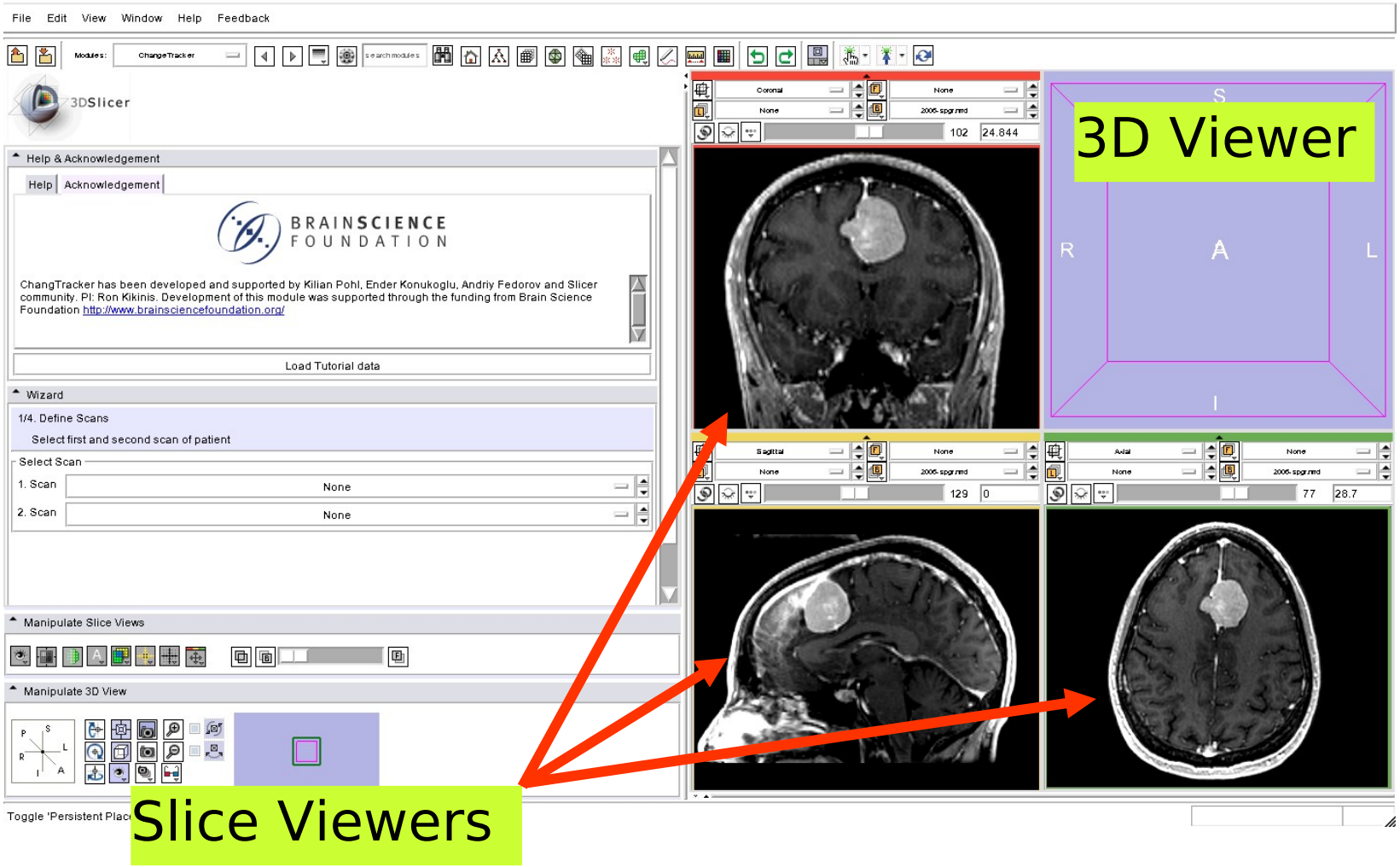


Slide courtesy of Sonia Pujol, Ph.D.

Loading training dataset



New Layout of Viewer

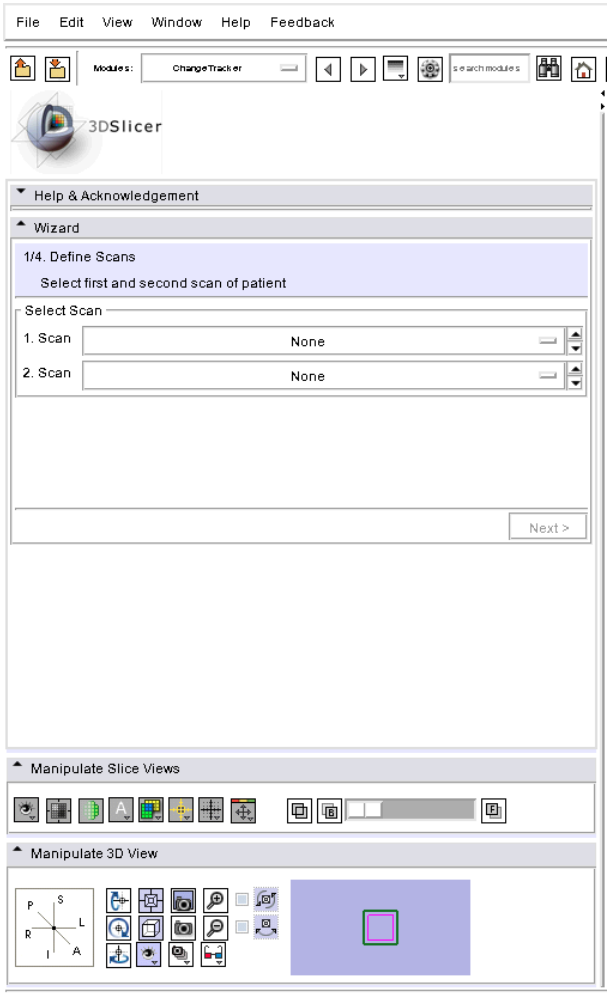


Part 2: Measuring Volume Change

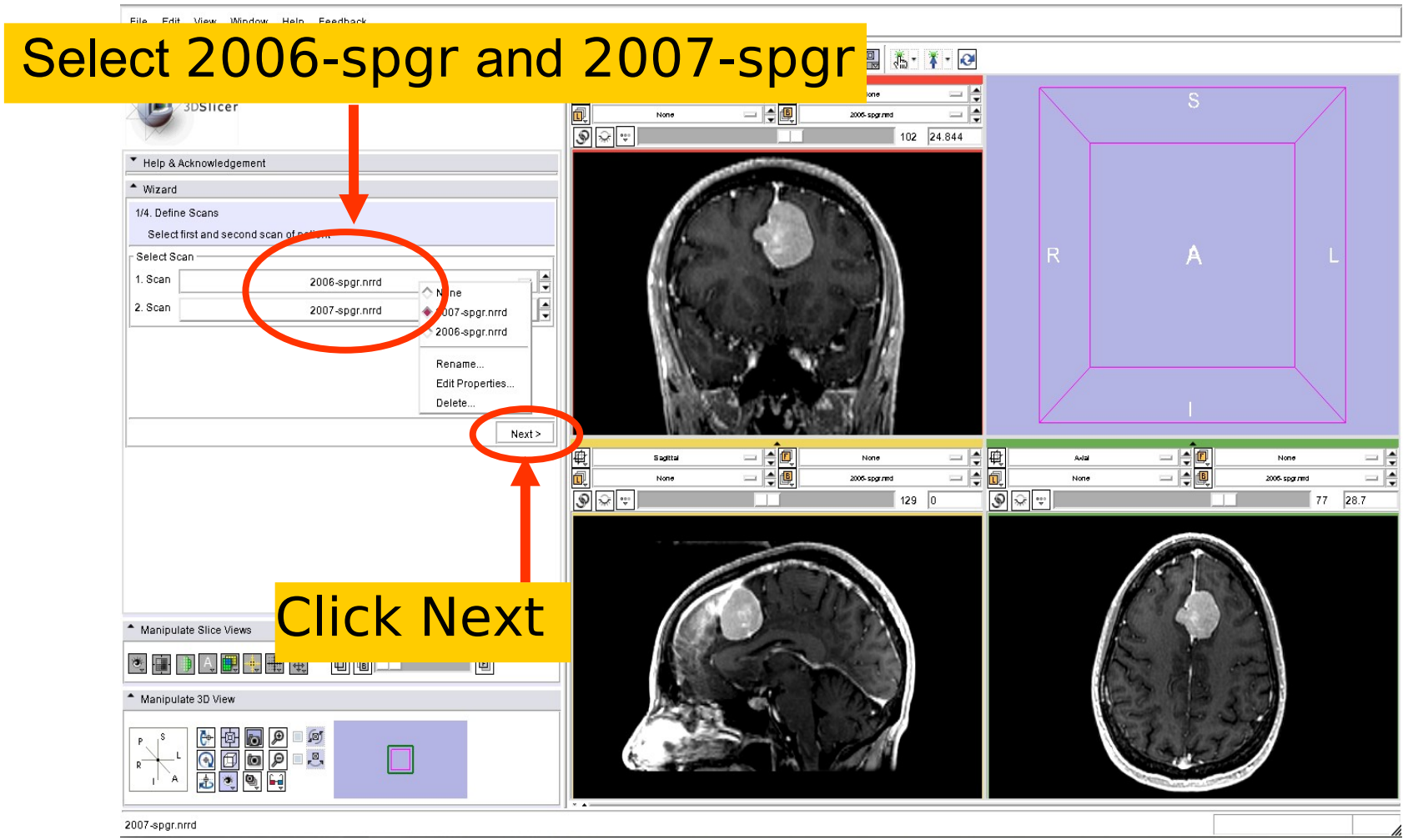
Workflow Wizard

The Workflow Wizard of Slicer3 guides the user through a sequence of steps and is defined by the following components:

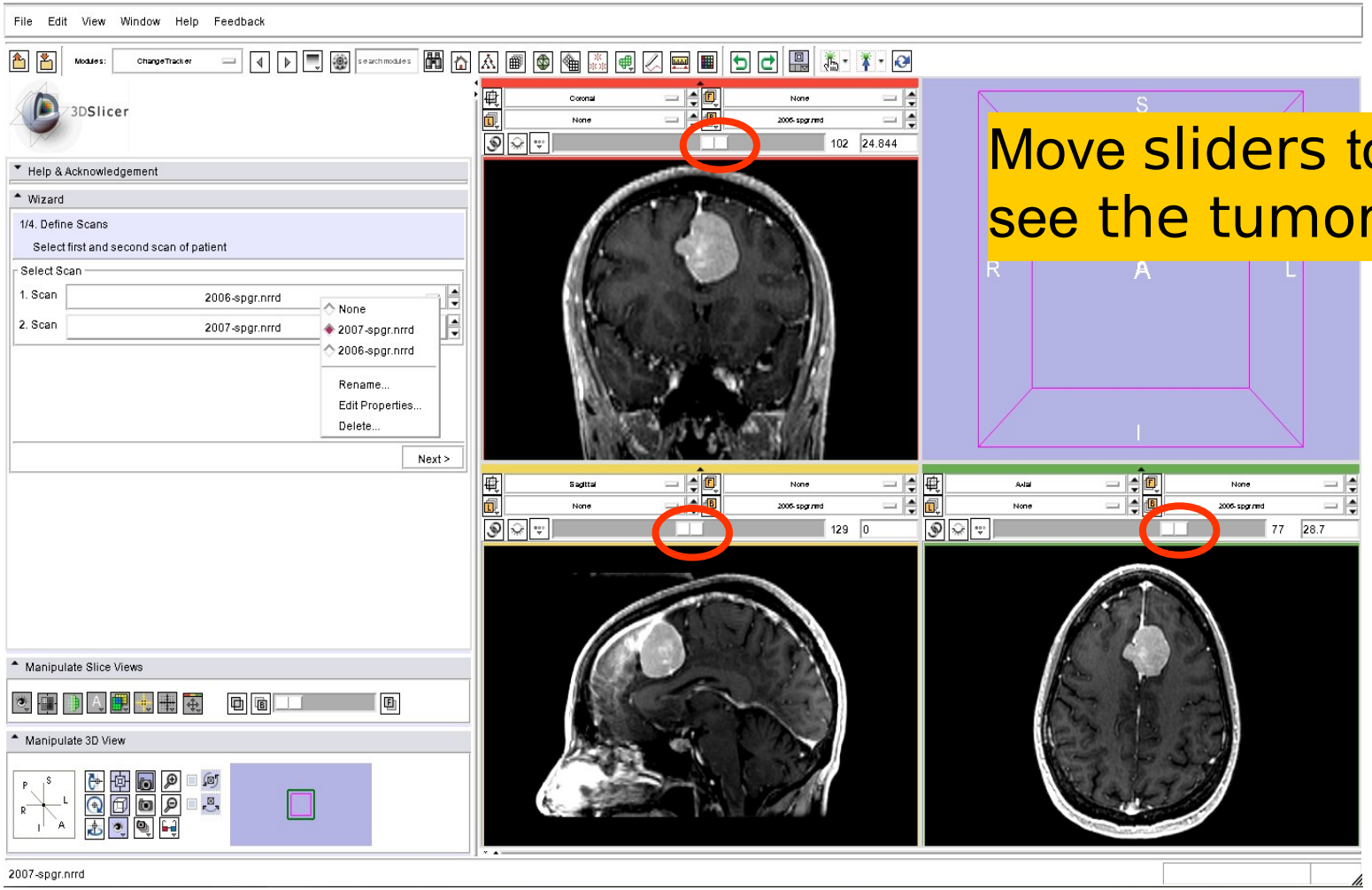
- the Step Panel
- the User Panel
- the Navigation Panel



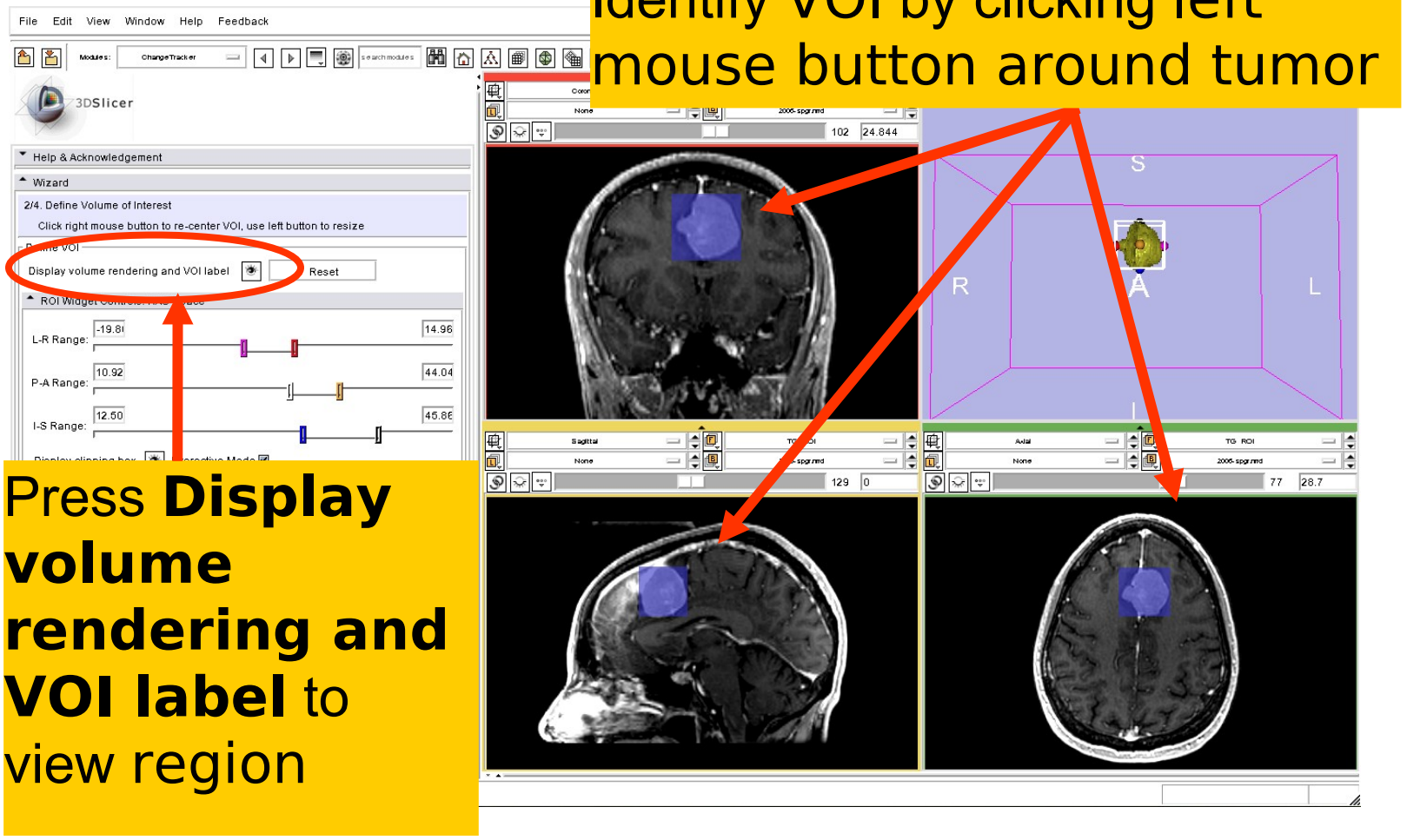
Select Scans



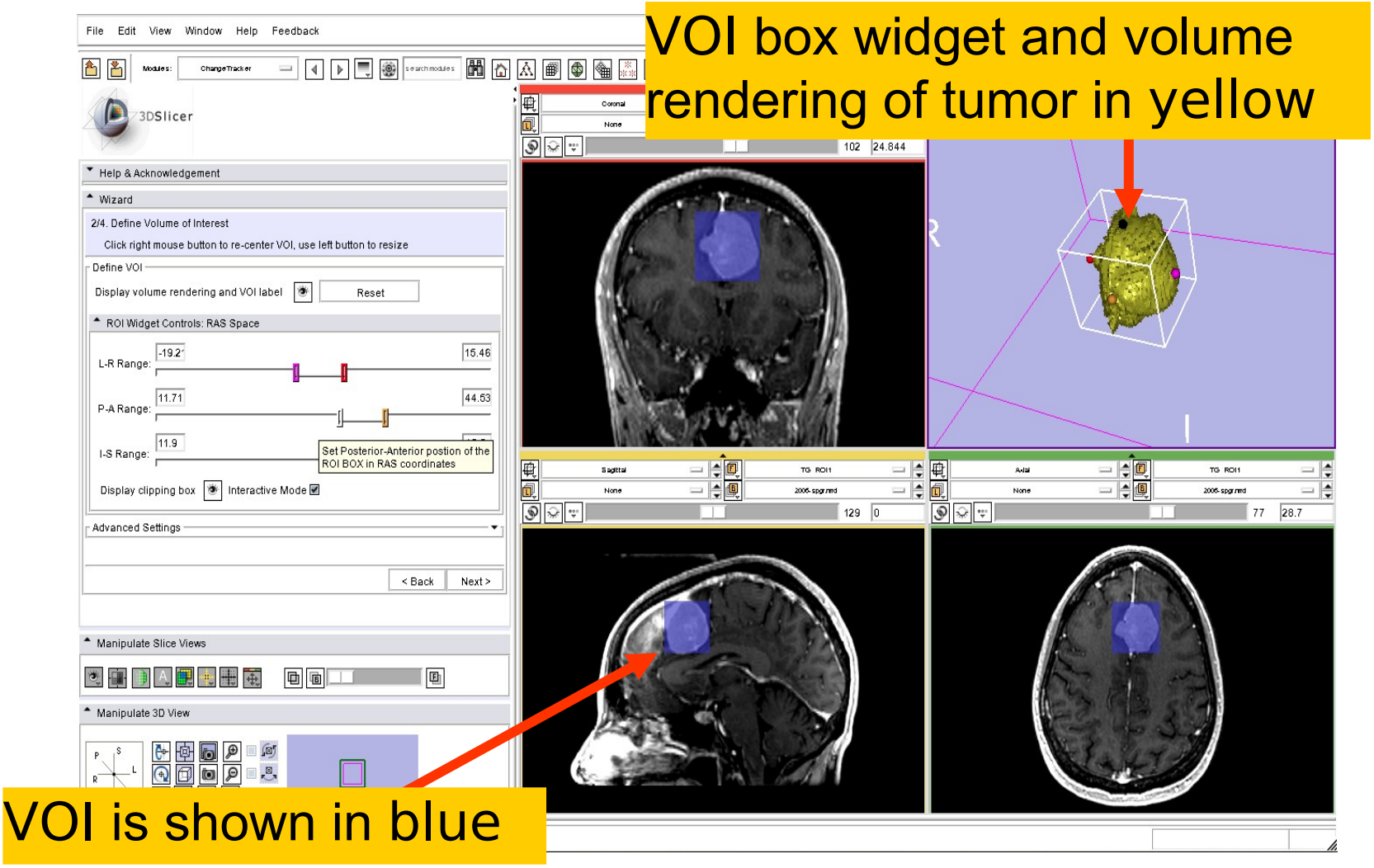
Identify Volume of Interest



Identify Volume of Interest

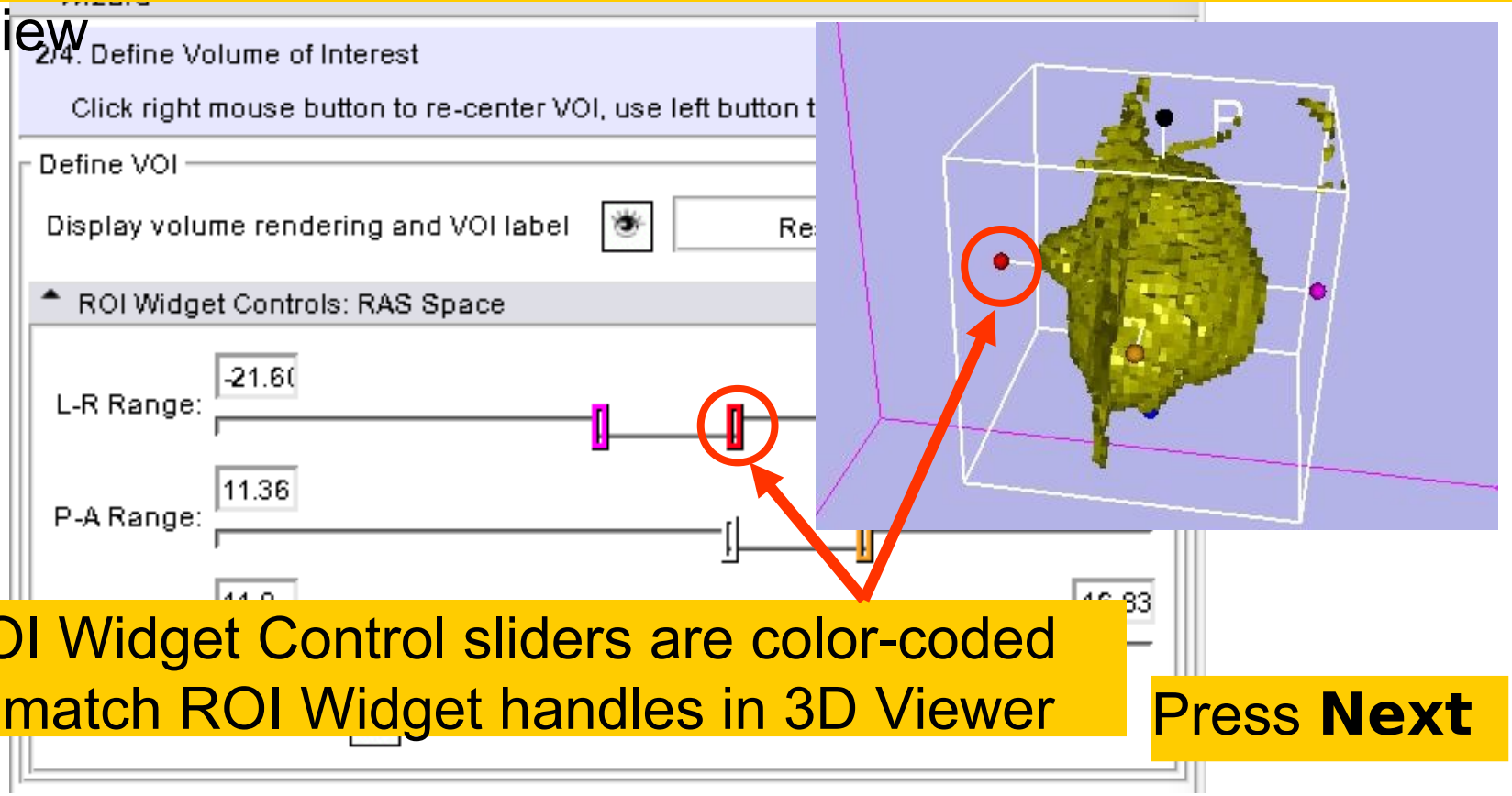


Identify Volume of Interest



Identify Volume of Interest

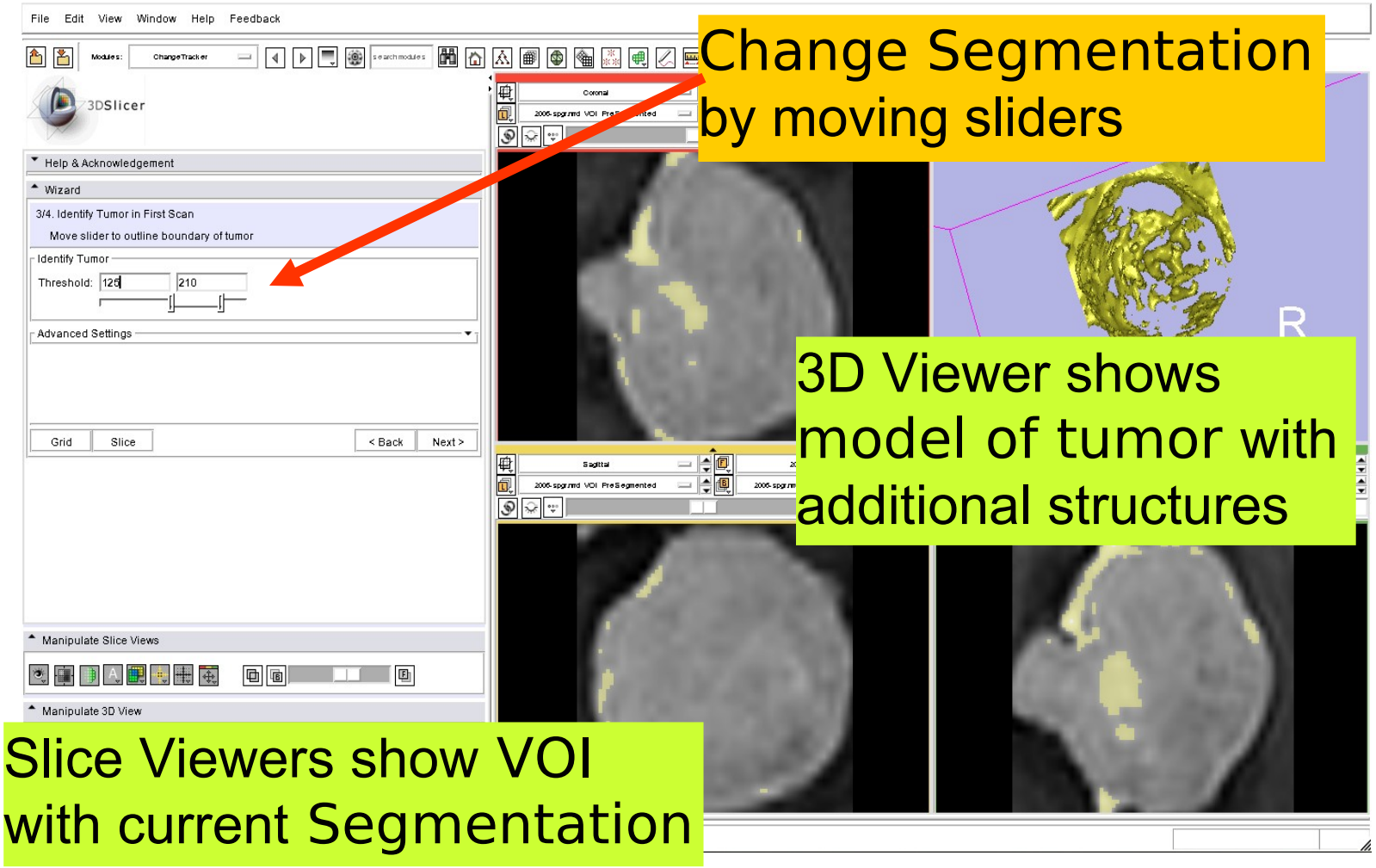
Adjust ROI by moving the **ROI Widget Control sliders** in the Step panel, or by moving the ROI Widget handles in 3D view



ROI Widget Control sliders are color-coded to match ROI Widget handles in 3D Viewer

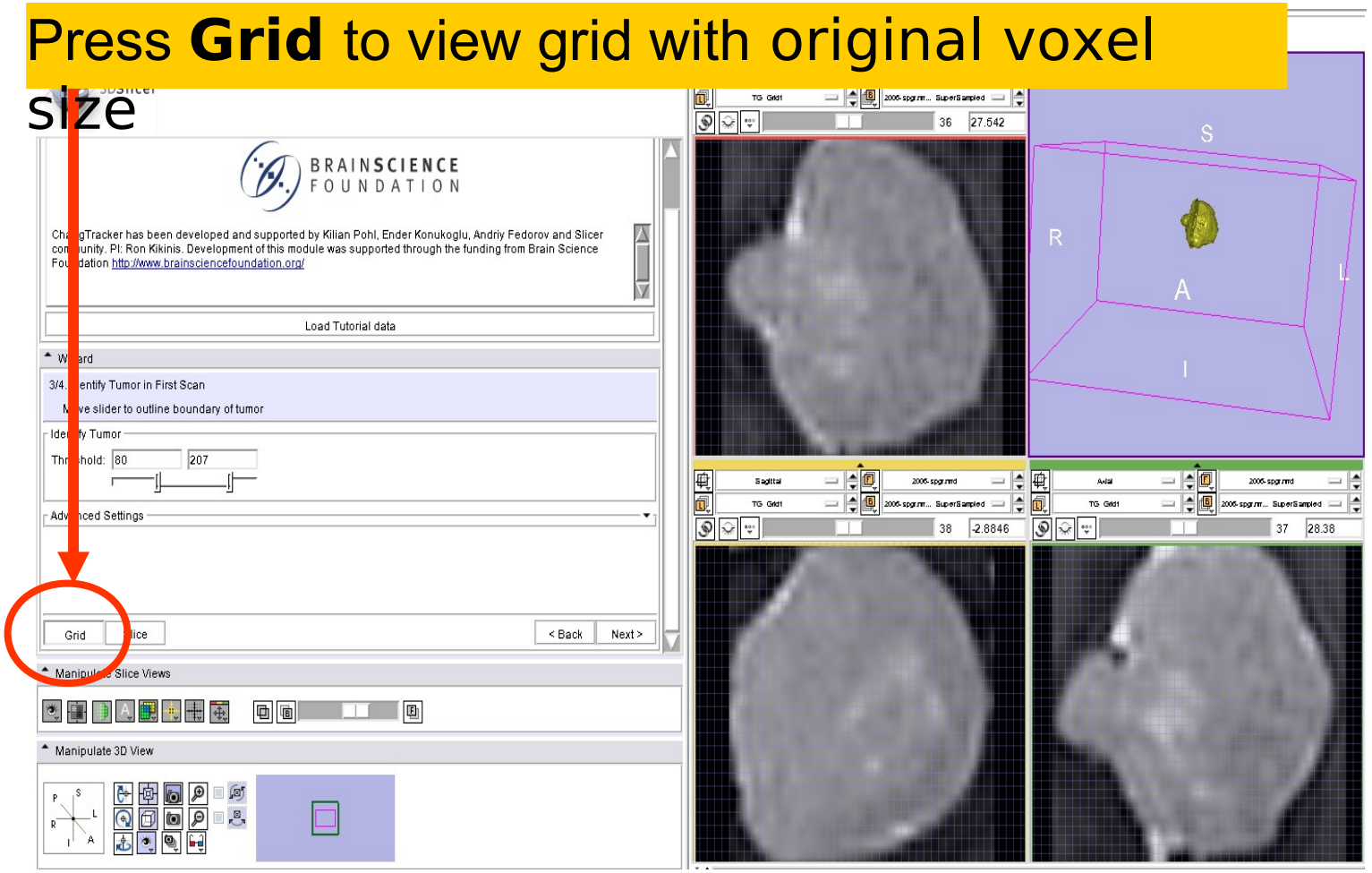
Press **Next**

Segment Tumor



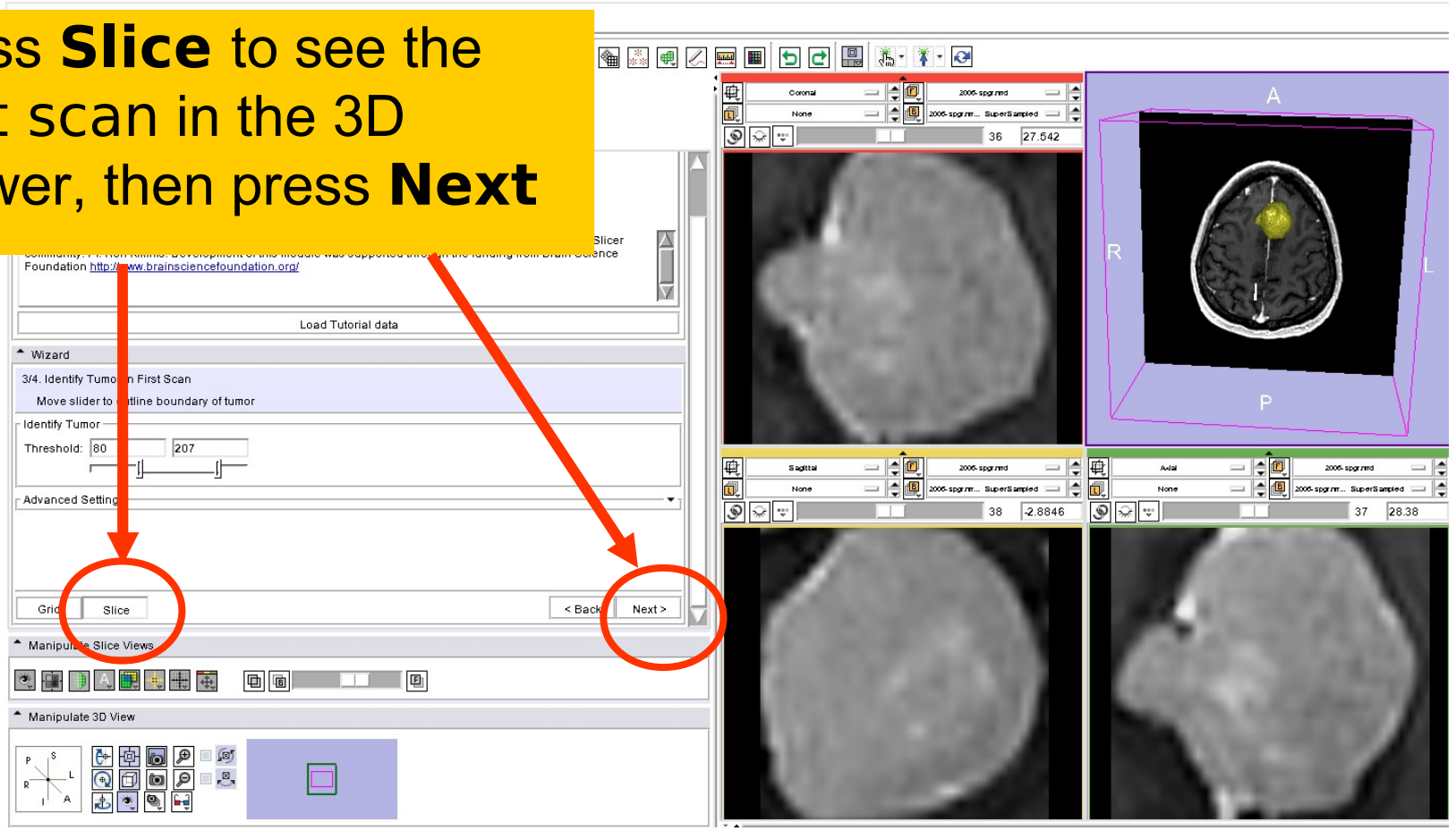
Segment Tumor

Press **Grid** to view grid with original voxel size

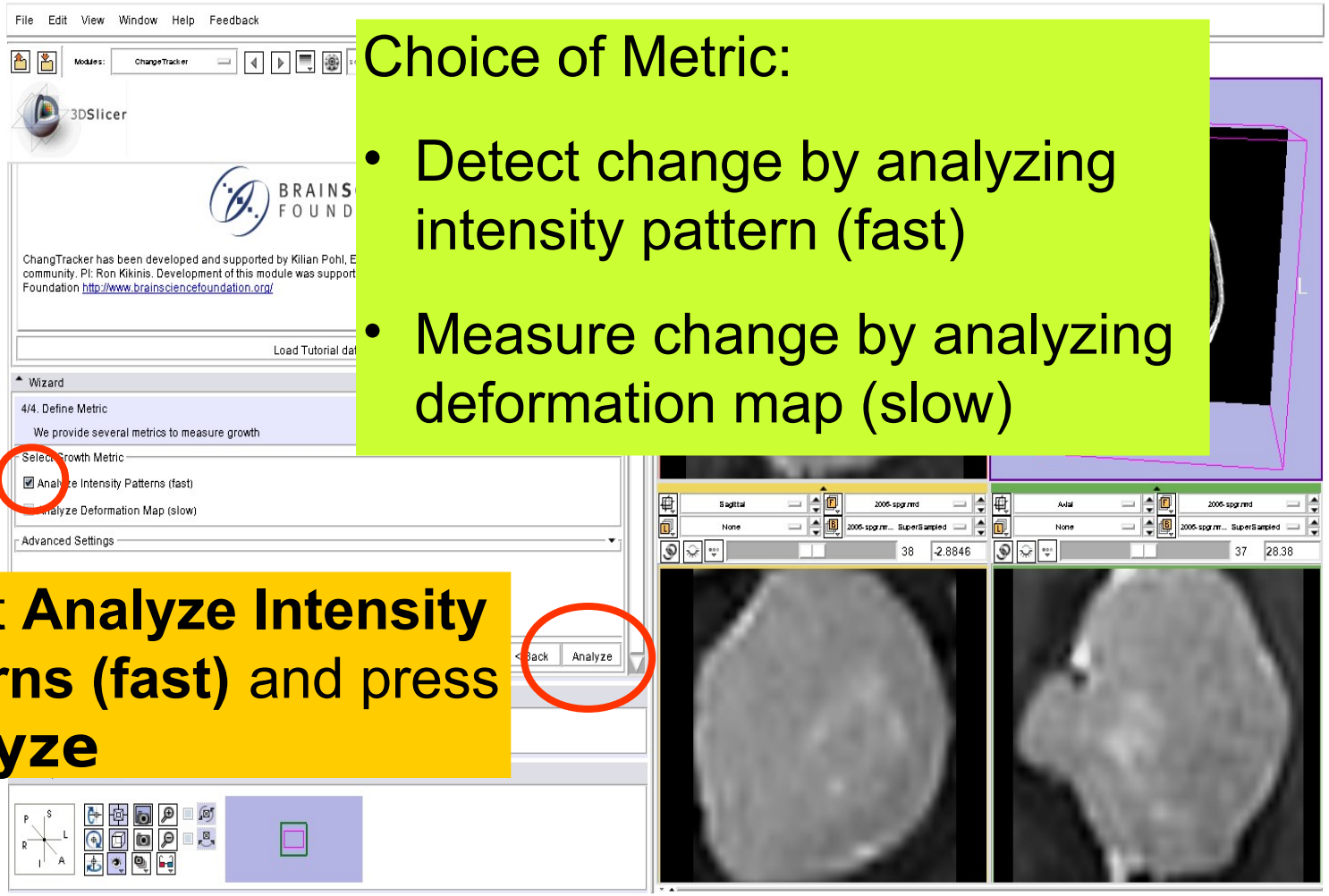


Segment Tumor

Press **Slice** to see the first scan in the 3D Viewer, then press **Next**



Choose Metric Type

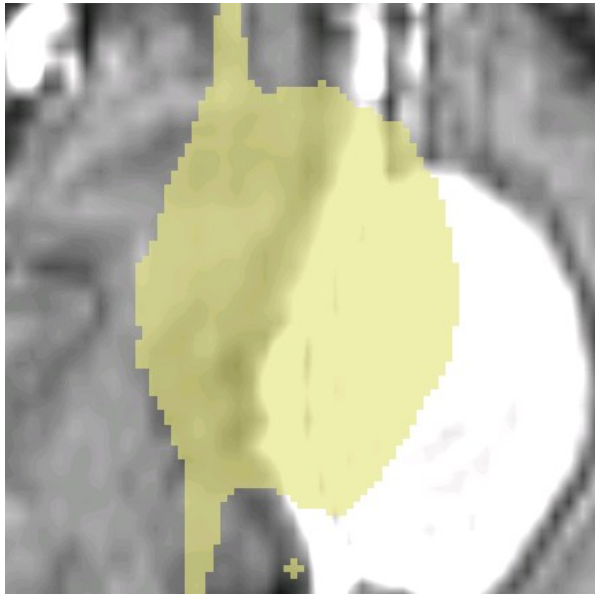


Choice of Metric:

- Detect change by analyzing intensity pattern (fast)
- Measure change by analyzing deformation map (slow)

Select **Analyze Intensity Patterns (fast)** and press **Analyze**

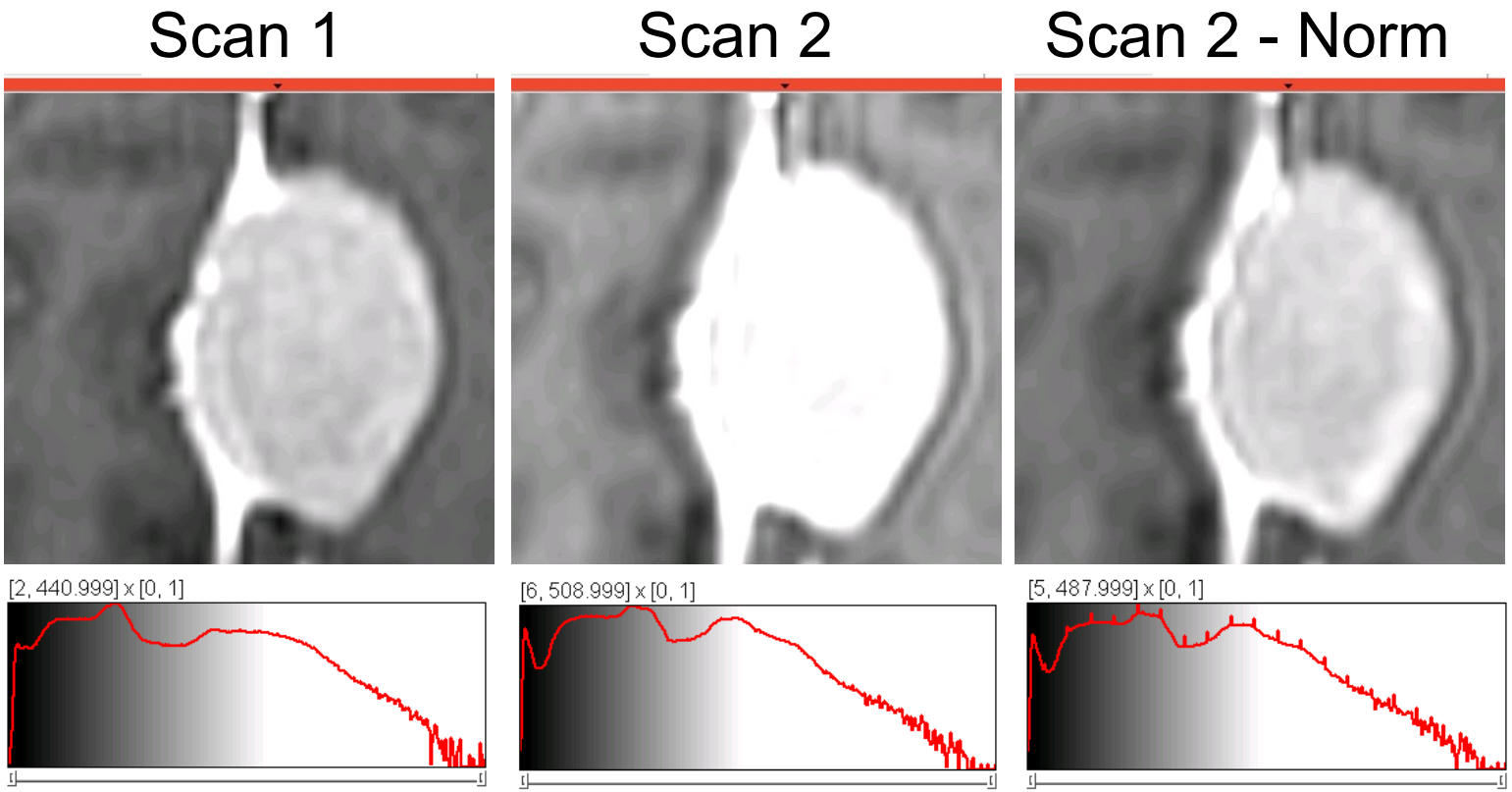
Analysis I: Volume Preserving Registration



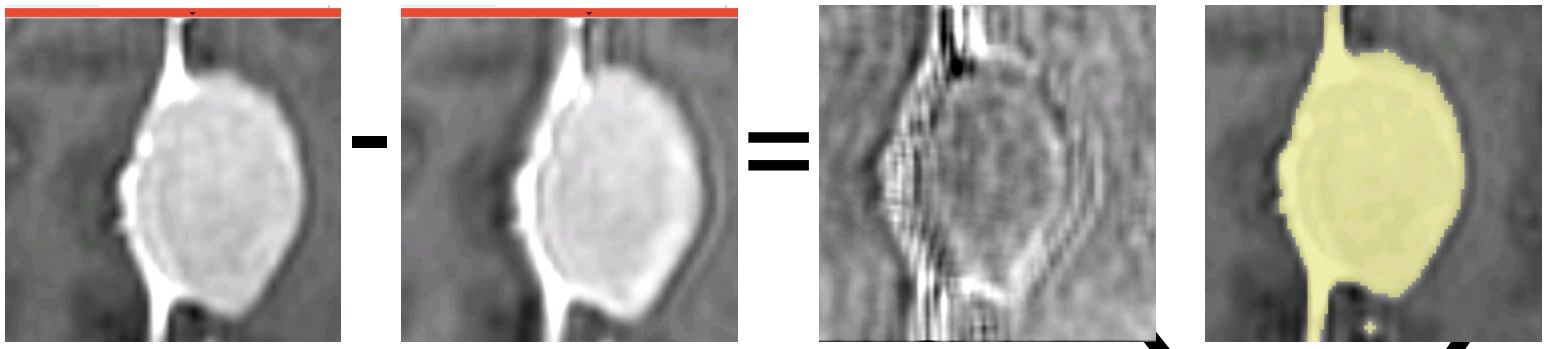
Before

After

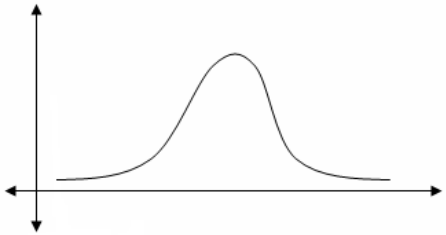
Analysis II: Normalize Intensities



Analysis III: Detect Change – Intensity Based



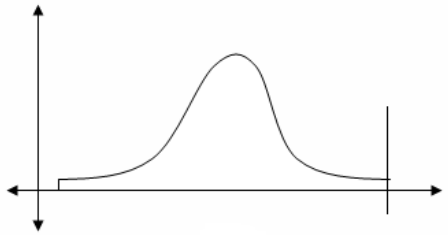
PDF of Dormant Tissue

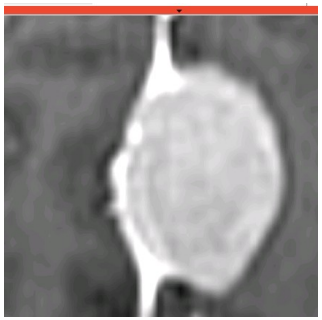


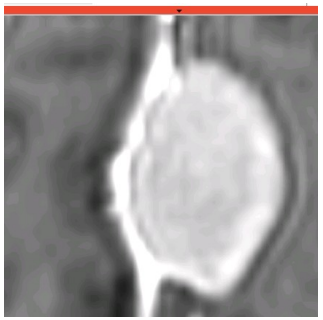
Compute statistics of static tissue	Subtract Scan2 from Scan1	Define region of static tissue	Determine probability density function

Analysis III: Detect Change – Intensity Based

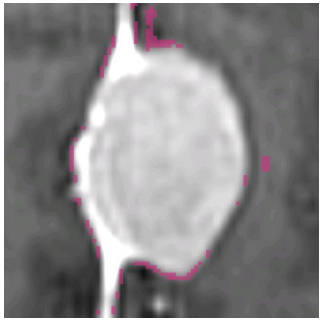
Data







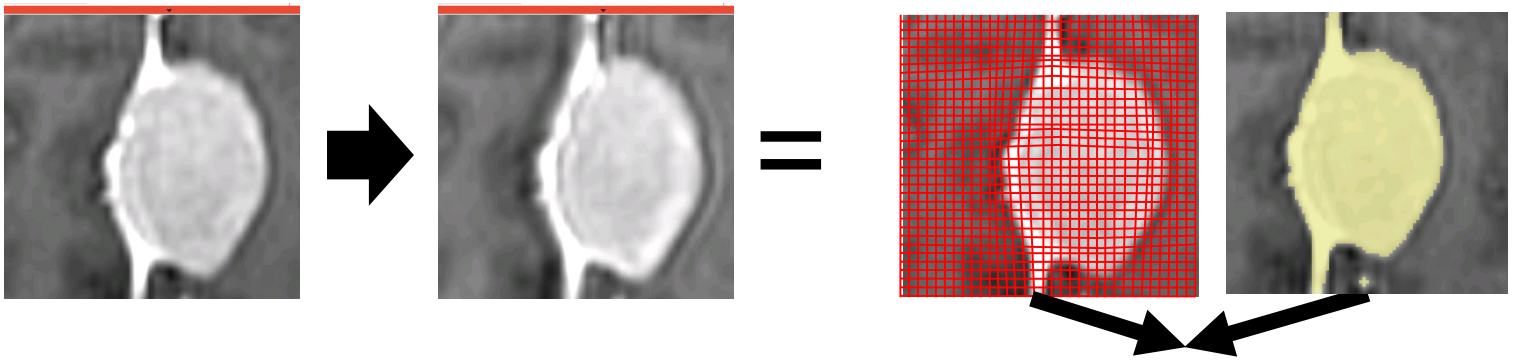
Analysis



Mode :	Sensitive	Moderate	Robust
False Positive Risk:	High	Medium	Low
Growth (mm^3) :	1301	547	100
Growth (voxel):	1057	444	81

Konukoglu et al. ,“Monitoring Slowly Evolving Tumors”, ISBI, 2008

Analysis III: Detect Change–Deformation Map

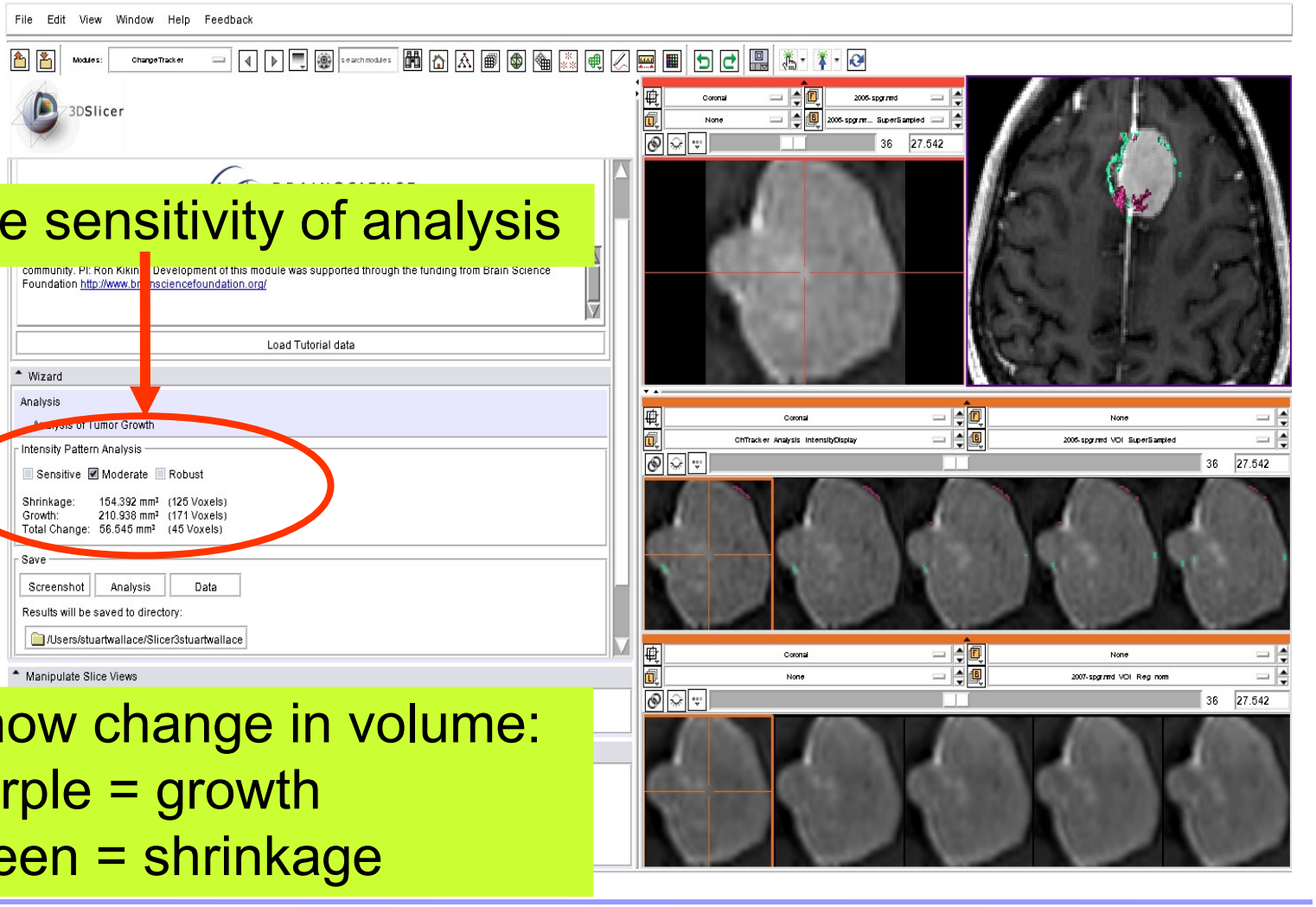


Mode : Segmentation
Growth (mm^3) : 1386
Growth (voxels): 1126

Mode : Jaccobian
Growth (mm^3) : 1291
Growth (voxels): 1049

Determine change via mapping:	Compute diffeomorphic mapping between scans	Compute Jacobian	or	Apply mapping to segmentation

Show Change in Pathology



Define sensitivity of analysis

Show change in volume:
purple = growth
green = shrinkage

Show Change in Pathology

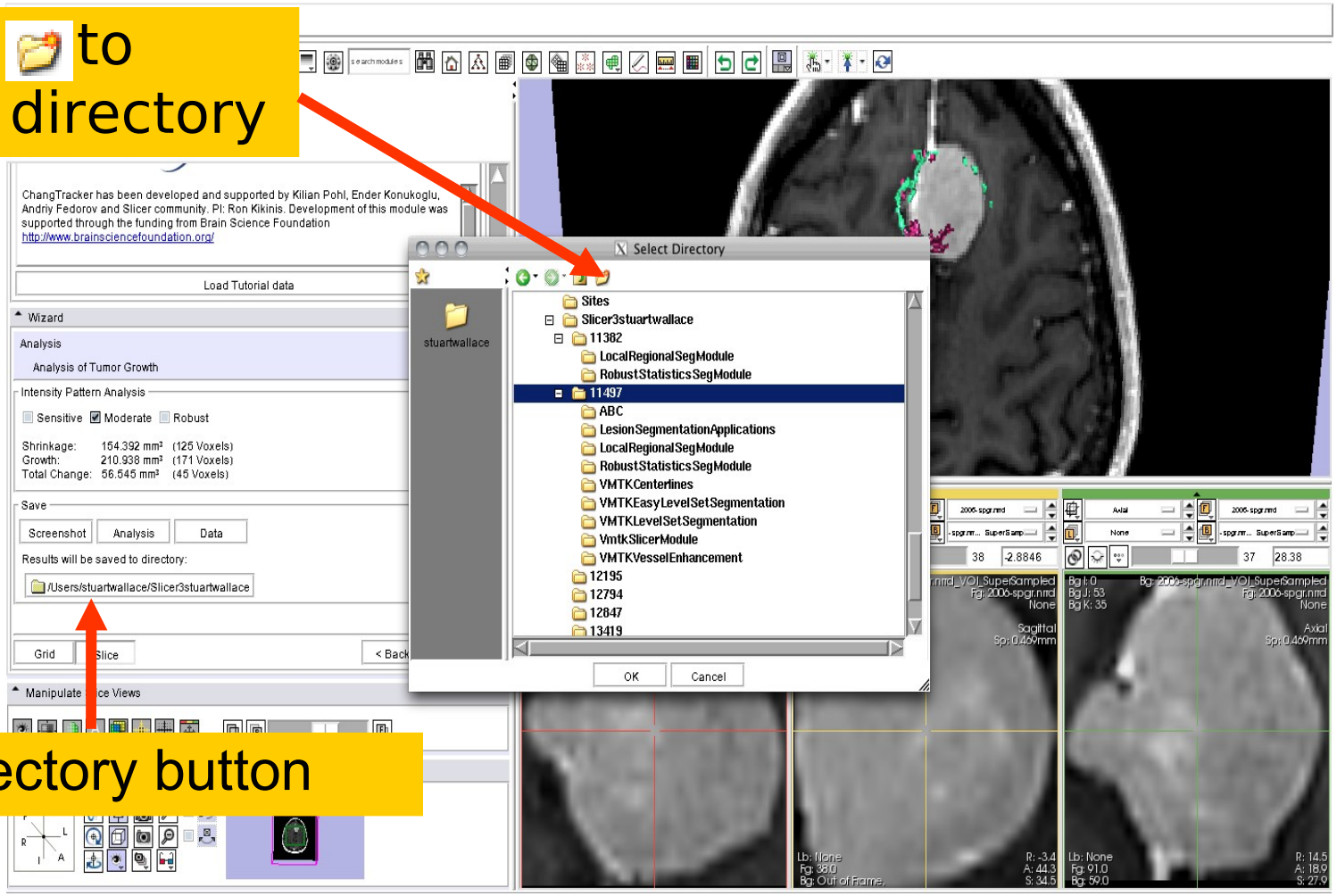
You can hide slice controls to have more screen space for viewing the images

Lightbox View shows 5 consecutive slices for the ROI in the first scan (top), and in the second scan (bottom)

You can switch to  Four-up layout or other layout at any time.

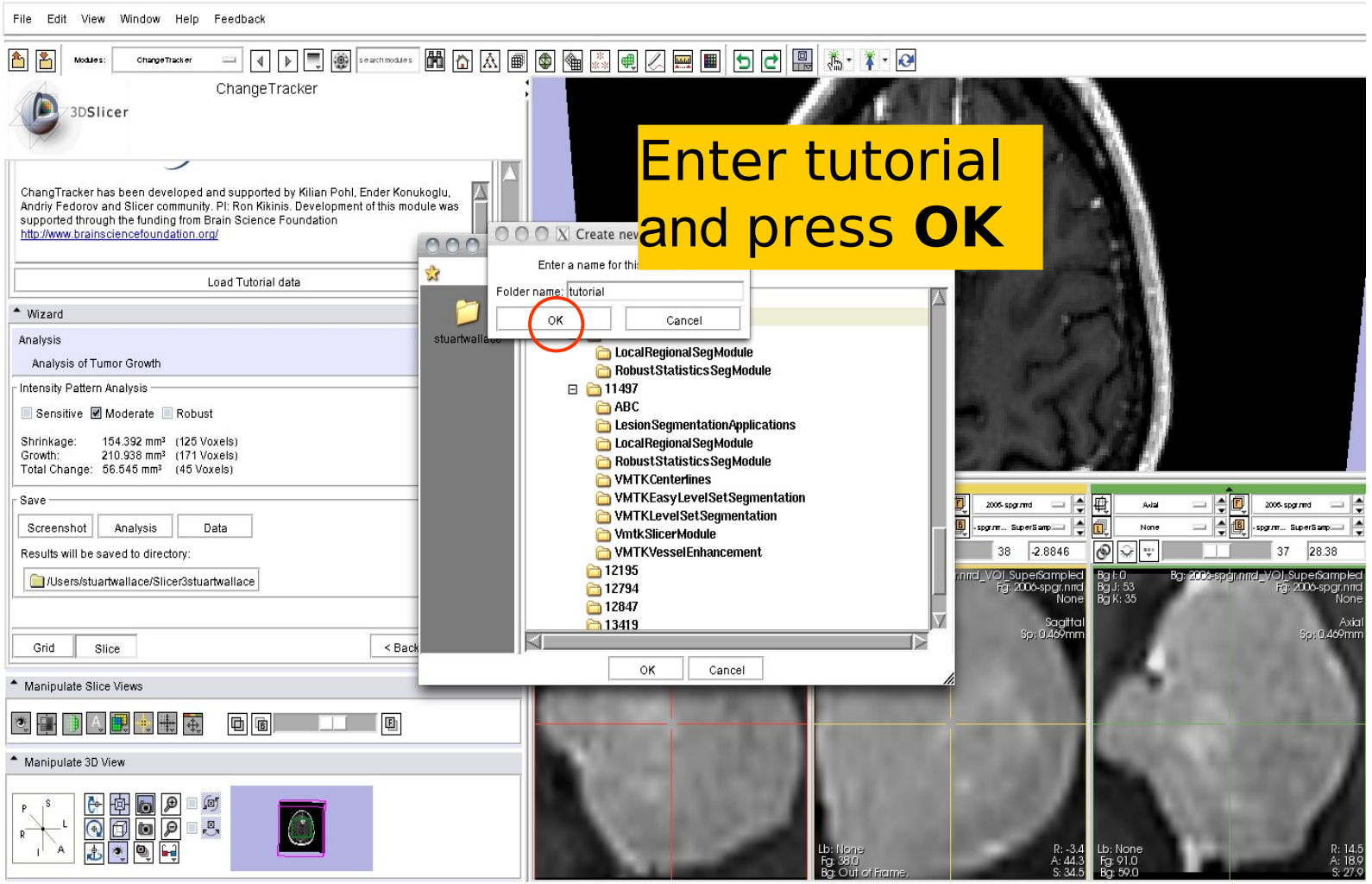
Define Working Directory

Select to create directory

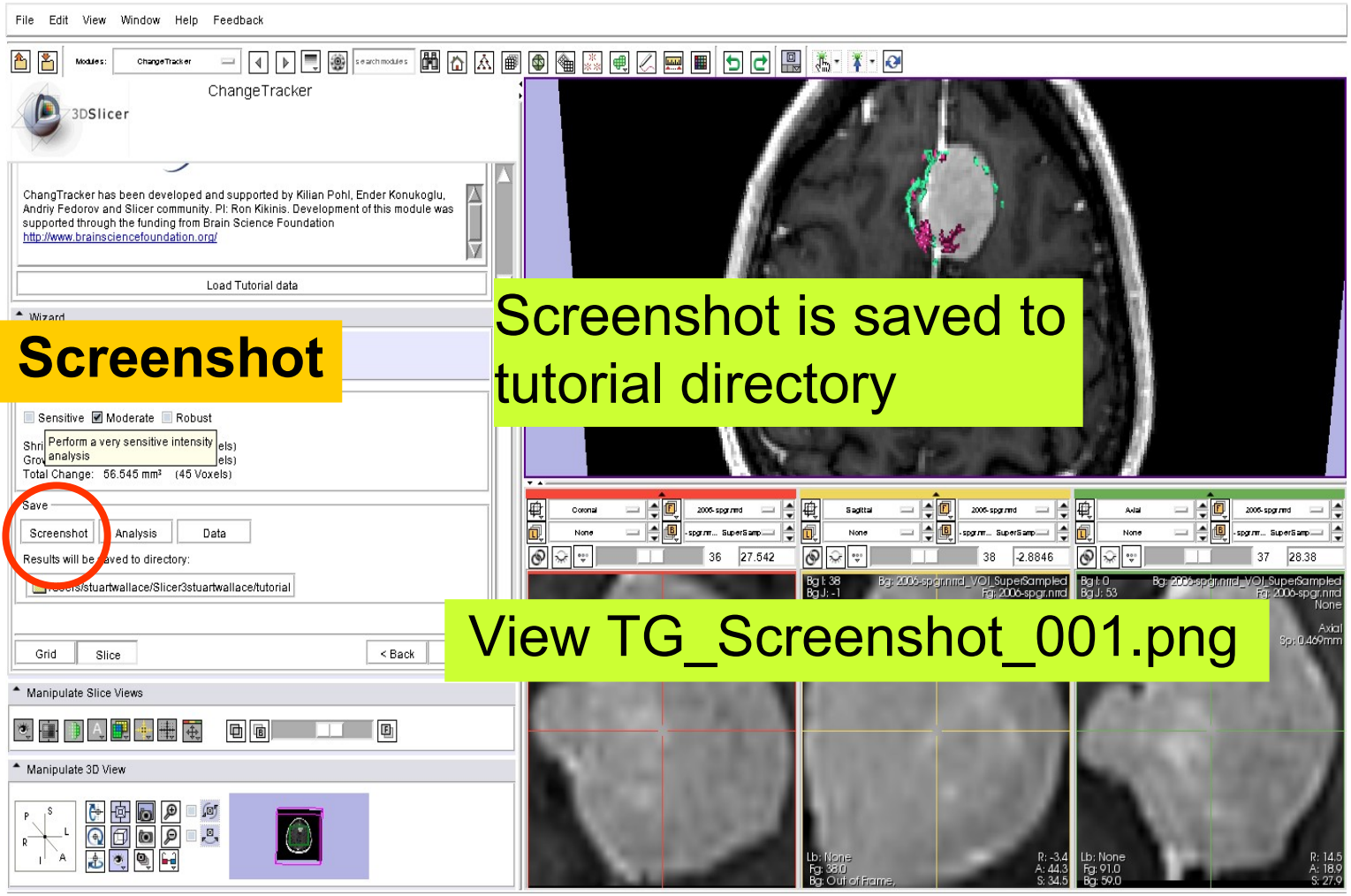


Press directory button

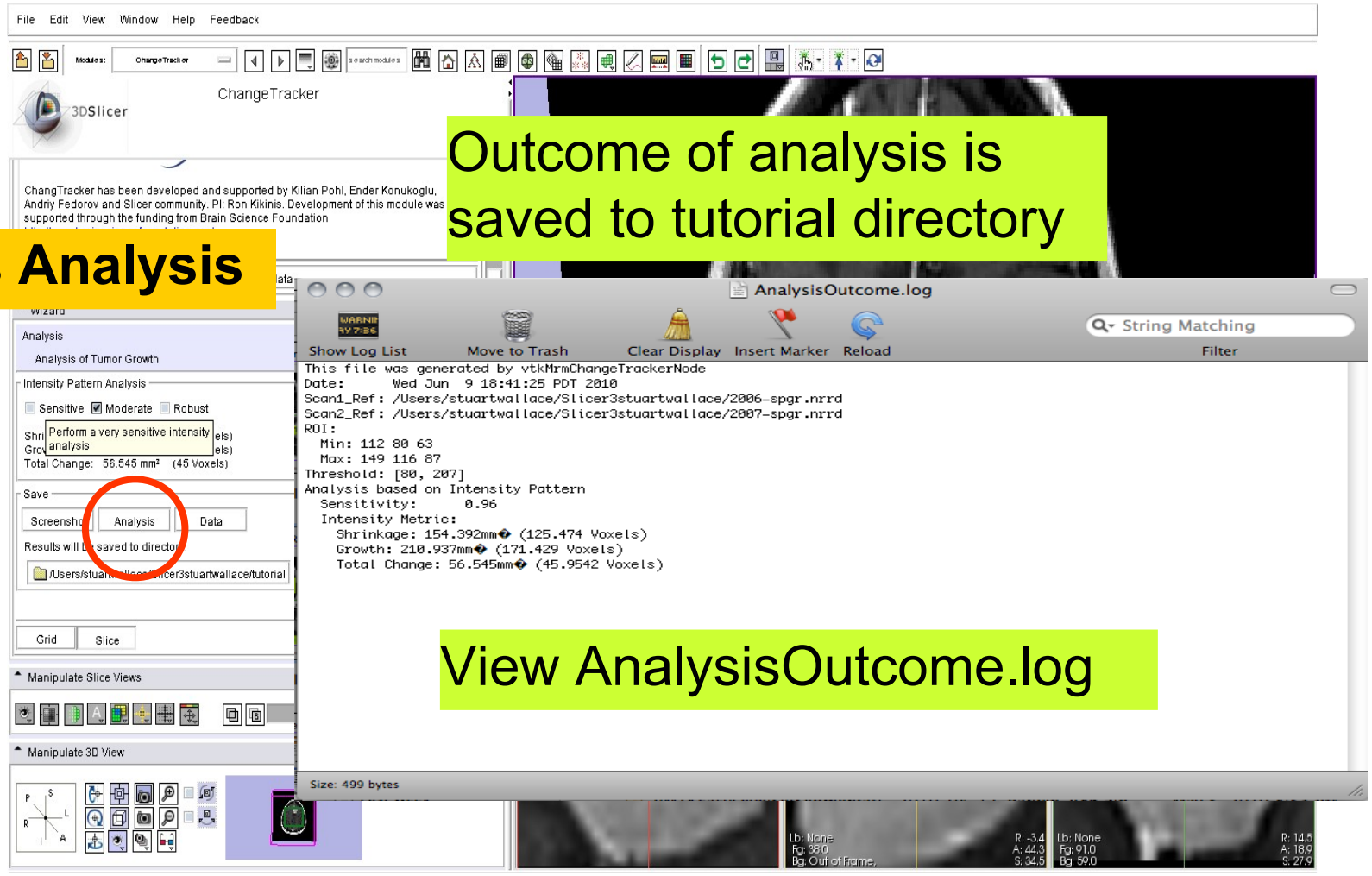
Define Working Directory



Save Screenshot

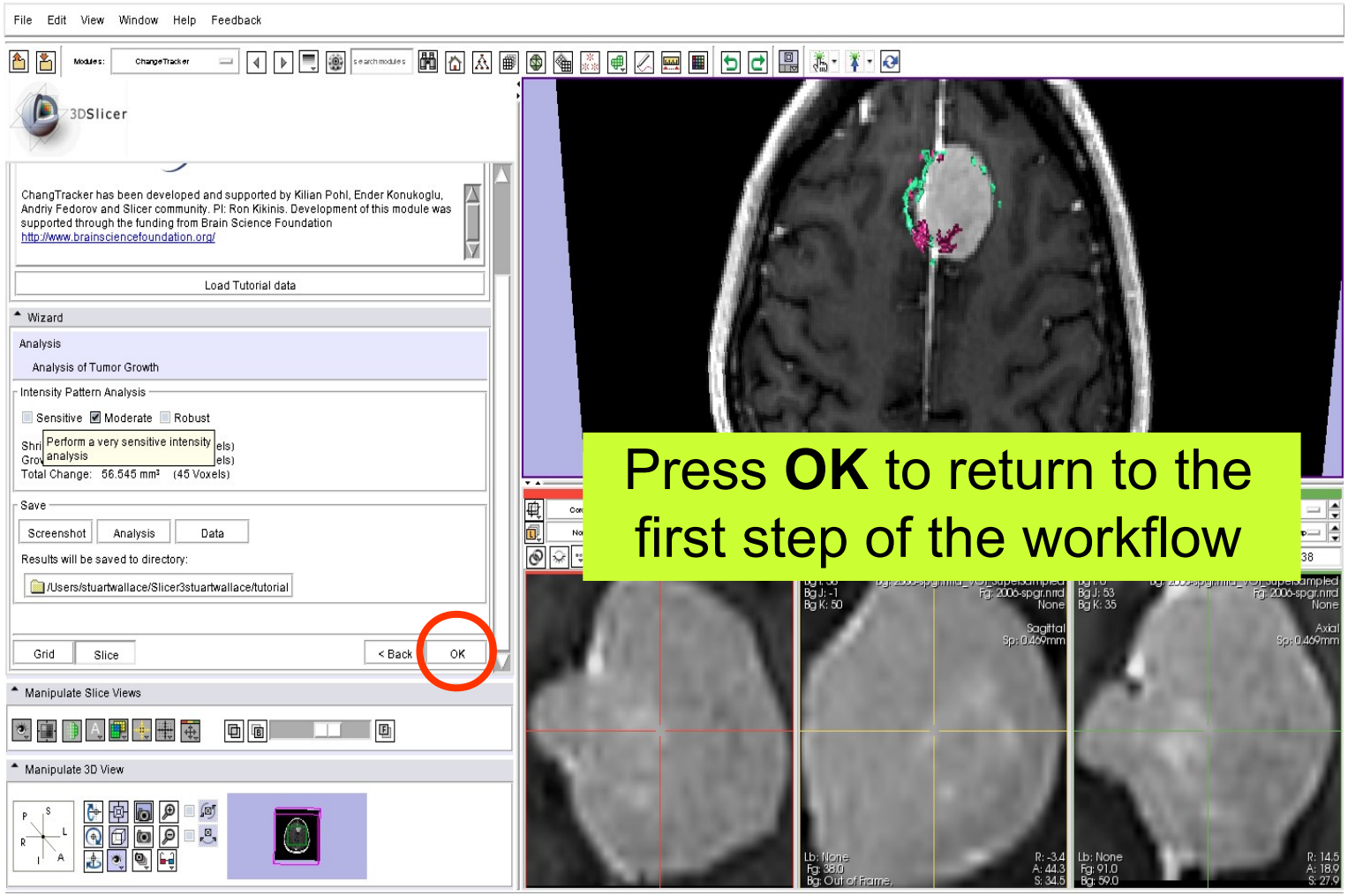


Save Analysis Result

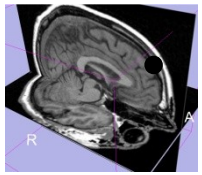


Save Intermediate Results

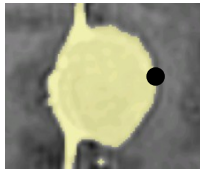
Finish Workflow



Overview



- Loading a scene



- Measuring volume change in tumors

Information

- We tested the tool on Axial 3D SPGR T1 post Gadolinium scans
  (Voxel dimension: 0.94mm x 0.94mm x 1.20mm, FOV: 240mm, Matrix: 256 x 256)
- We expect the tool to work also on set of scans that fulfill the following requirements:
  - same patient was scanned
  - scans were acquired with the same acquisition protocol
  - scans have isotropic resolution
  - pathology appearance is hyper-intense

Acknowledgments

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