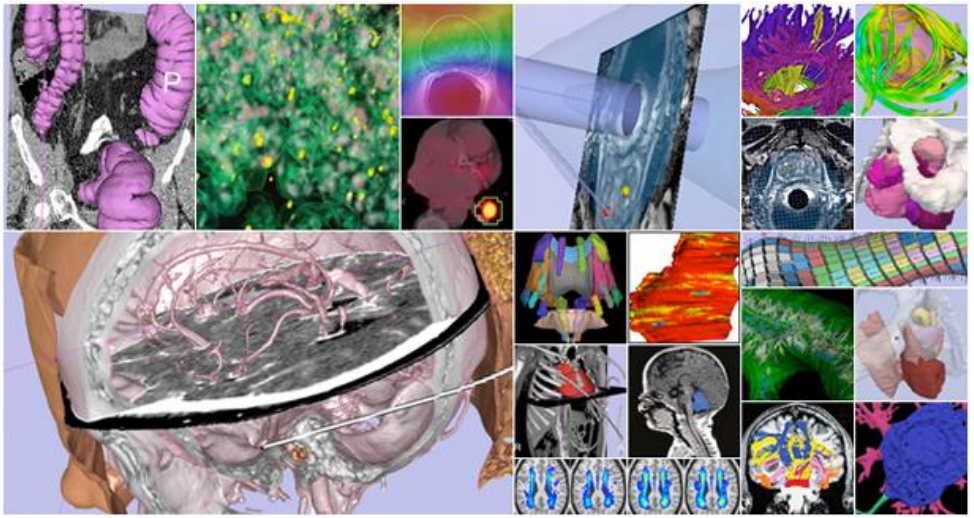
Exploring Peritumoral White Matter Fibers for Neurosurgical Planning

Sonia Pujol, Ph.D.

Ron Kikinis, M.D.

3D Slicer

- An end-user application for image analysis
- An open-source environment for software development
- A software platform that is both easy to use for clinical researchers and easy to extend for programmers



Download Slicer3.6

- Download and install the Slicer3.6.3 release version software from the Slicer web site

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

Disclaimer

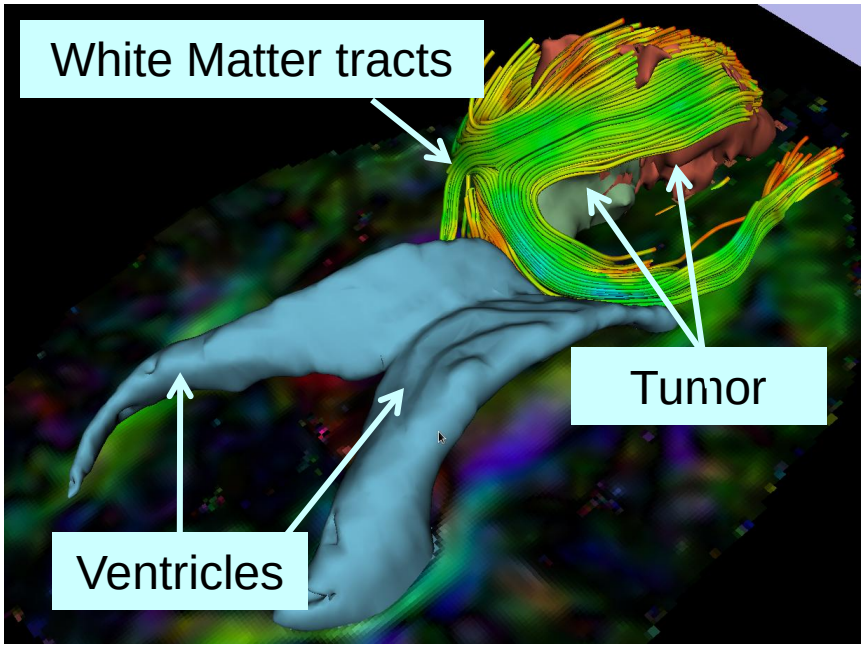
It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules.

Pre-Requisite

- This course supposes that you have taken the "*Slicer3 Data Loading and Visualization*" tutorial

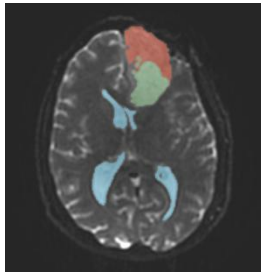
http://www.slicer.org/slicerWiki/index.php/Slicer3.6:Training#Software_tutorials

Clinical Goal

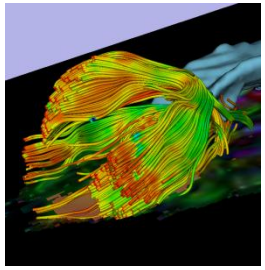


The goal of this tutorial is to explore white matter fibers surrounding a tumor using Diffusion Tensor Imaging (DTI) Tractography

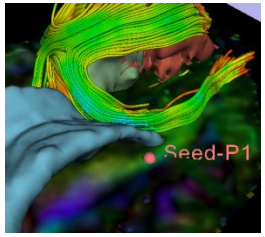
Overview of the analysis pipeline



Part1: Segmentation of the ventricles, and solid and cystic parts of the tumor



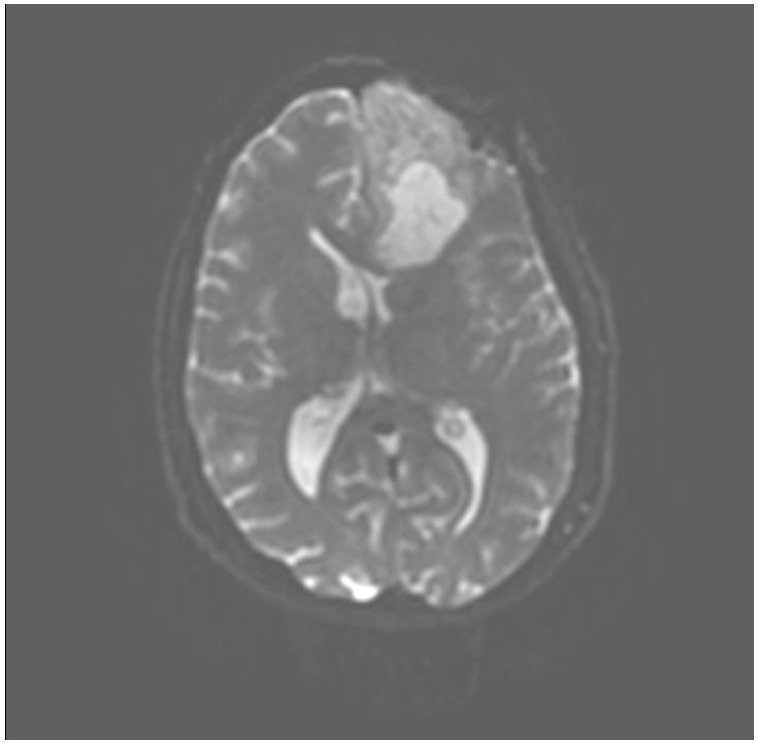
Part 2: Tractography reconstruction of the white matter fibers in the peri-tumoral volume



Part 3: Tractography exploration of the ipsilateral and contralateral fibers tracts

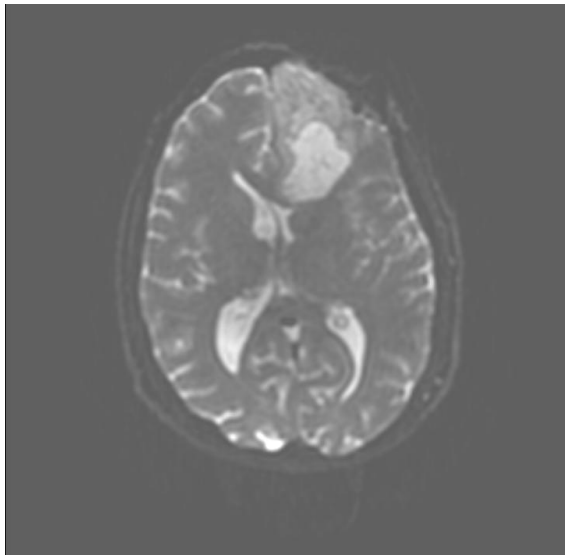
Part 1: Diffusion Data Loading and Visualization

Clinical Case



- 35 year-old male diagnosed with Glioblastoma multiforme (GBM)
- Diffusion Weighted Imaging (DWI) acquisition for neurosurgical planning

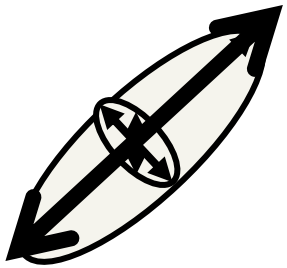
Diffusion Tensor Imaging



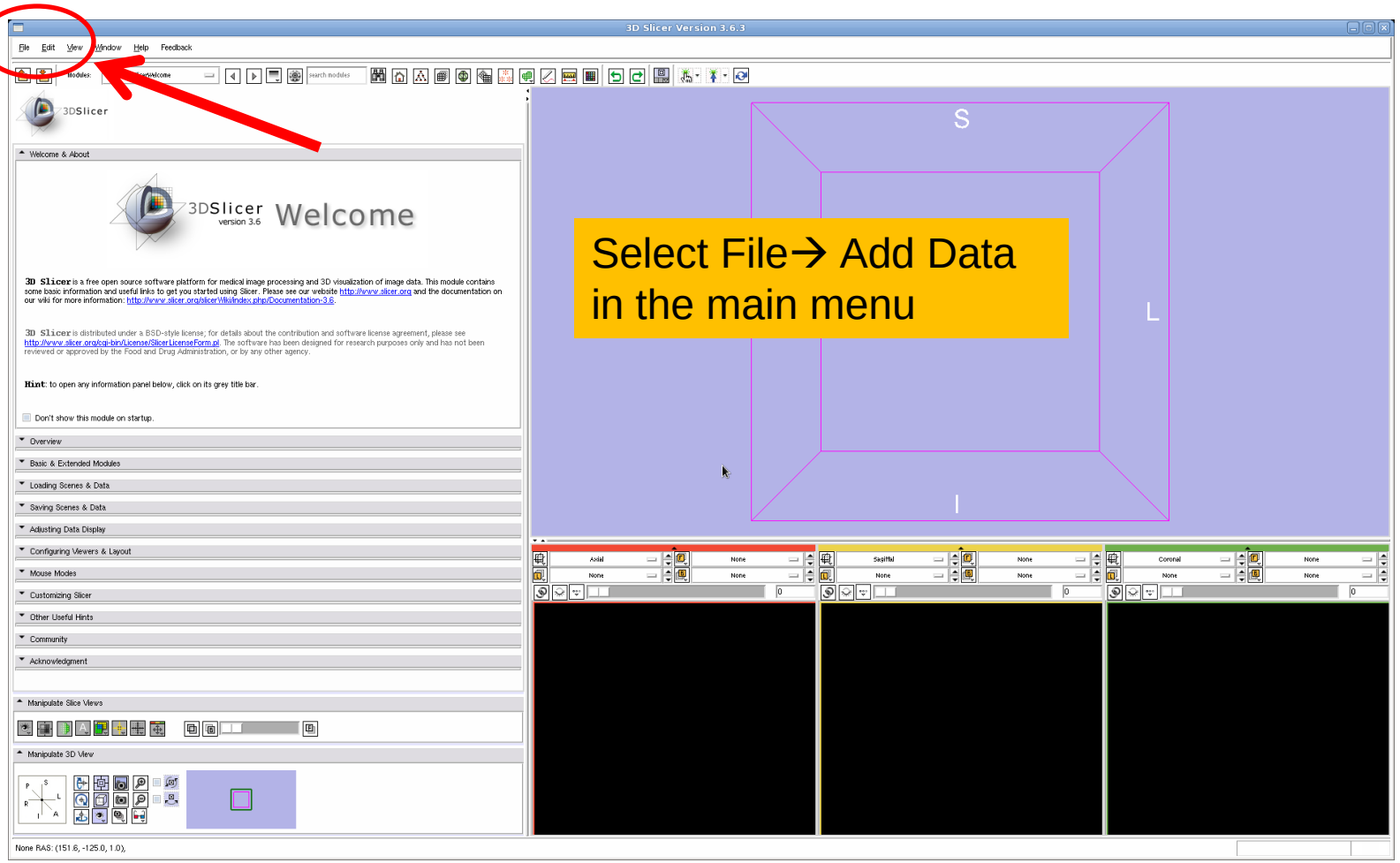
$$S_i = S_0 e^{-b\hat{g}^T D \hat{g}}$$

(Stejskal and Tanner 1965, Basser 1994)

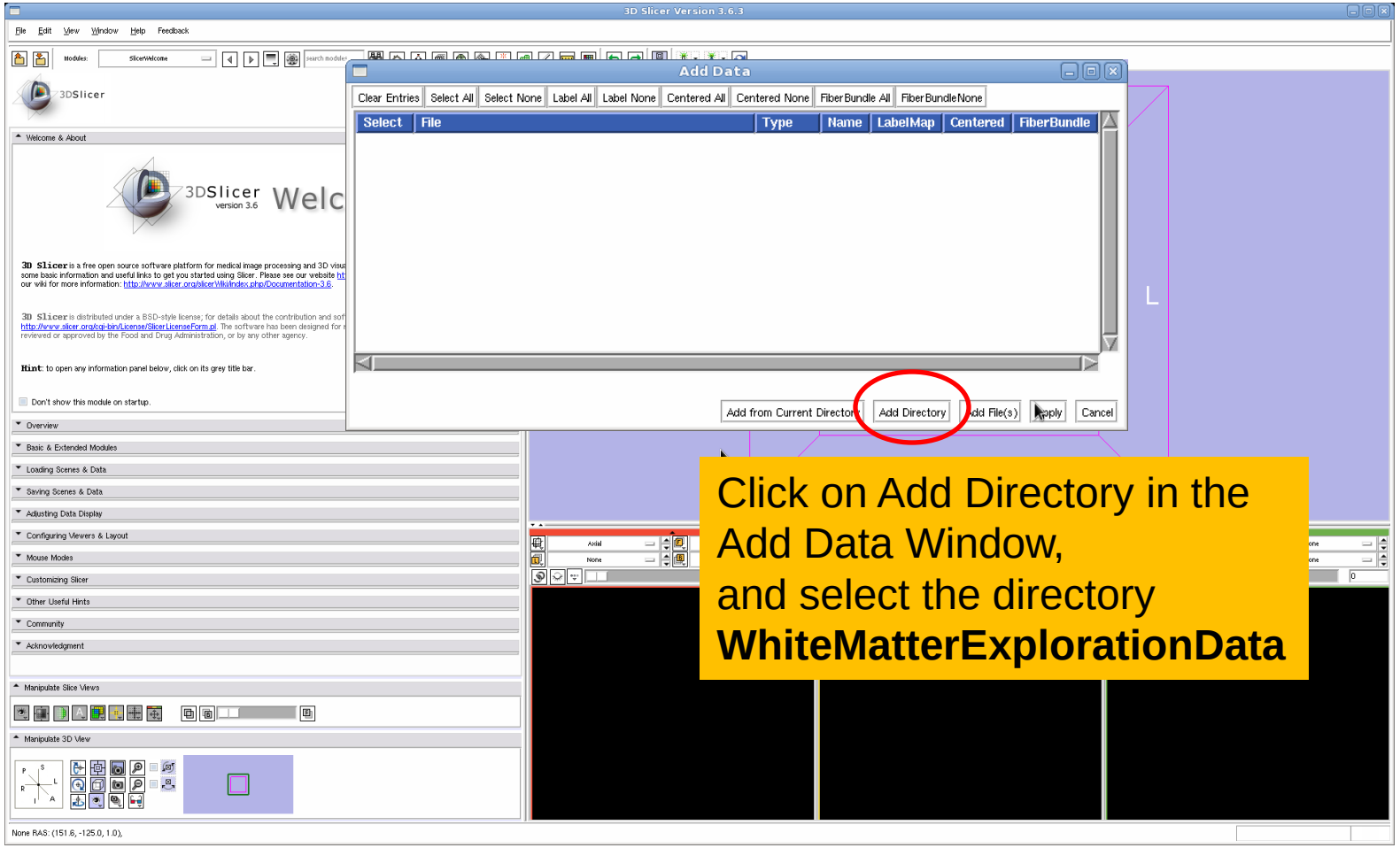
$$\underline{\mathbf{D}} = \begin{bmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{zx} & D_{zy} & D_{zz} \end{bmatrix}$$



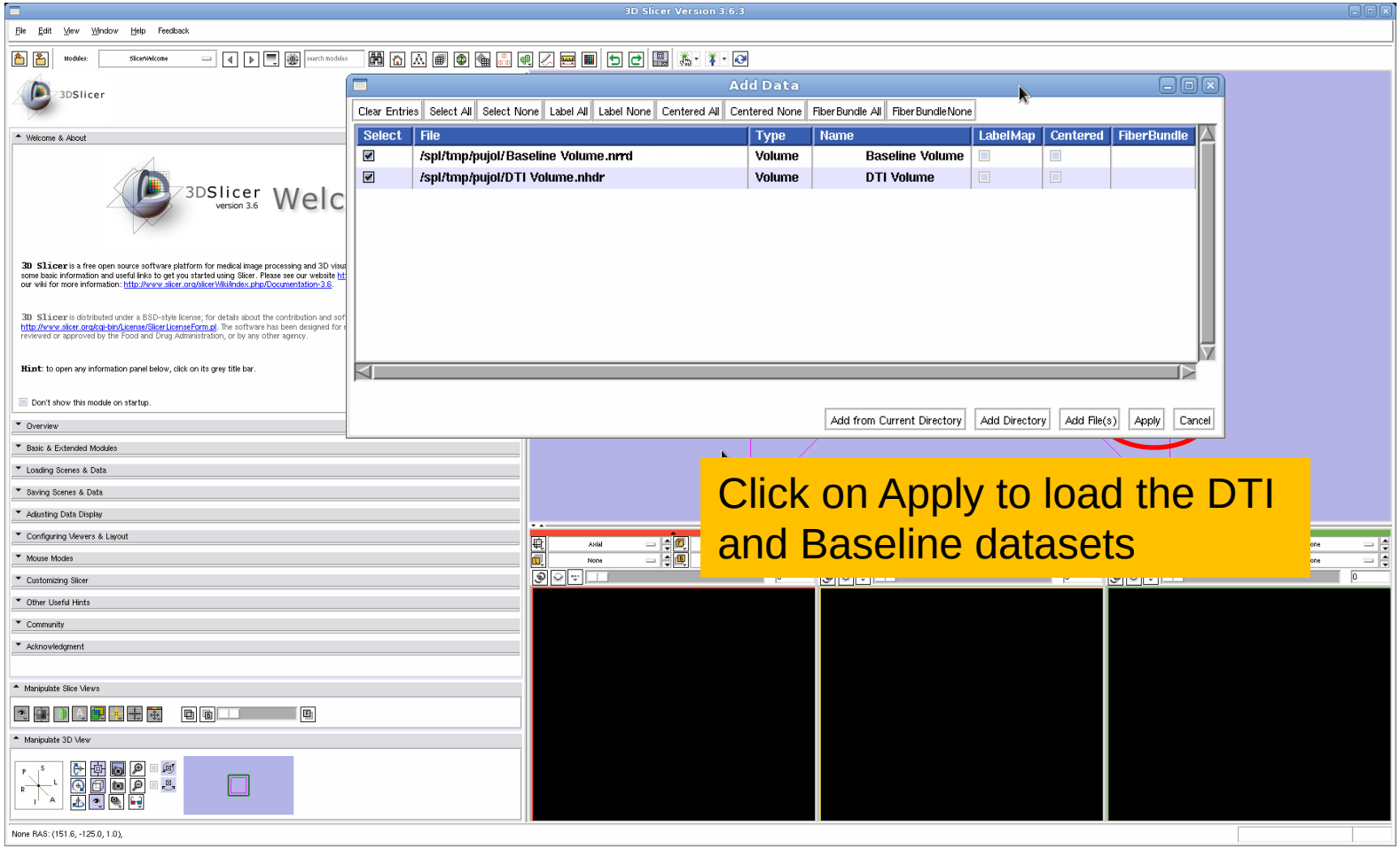
Loading DTI and Baseline Data



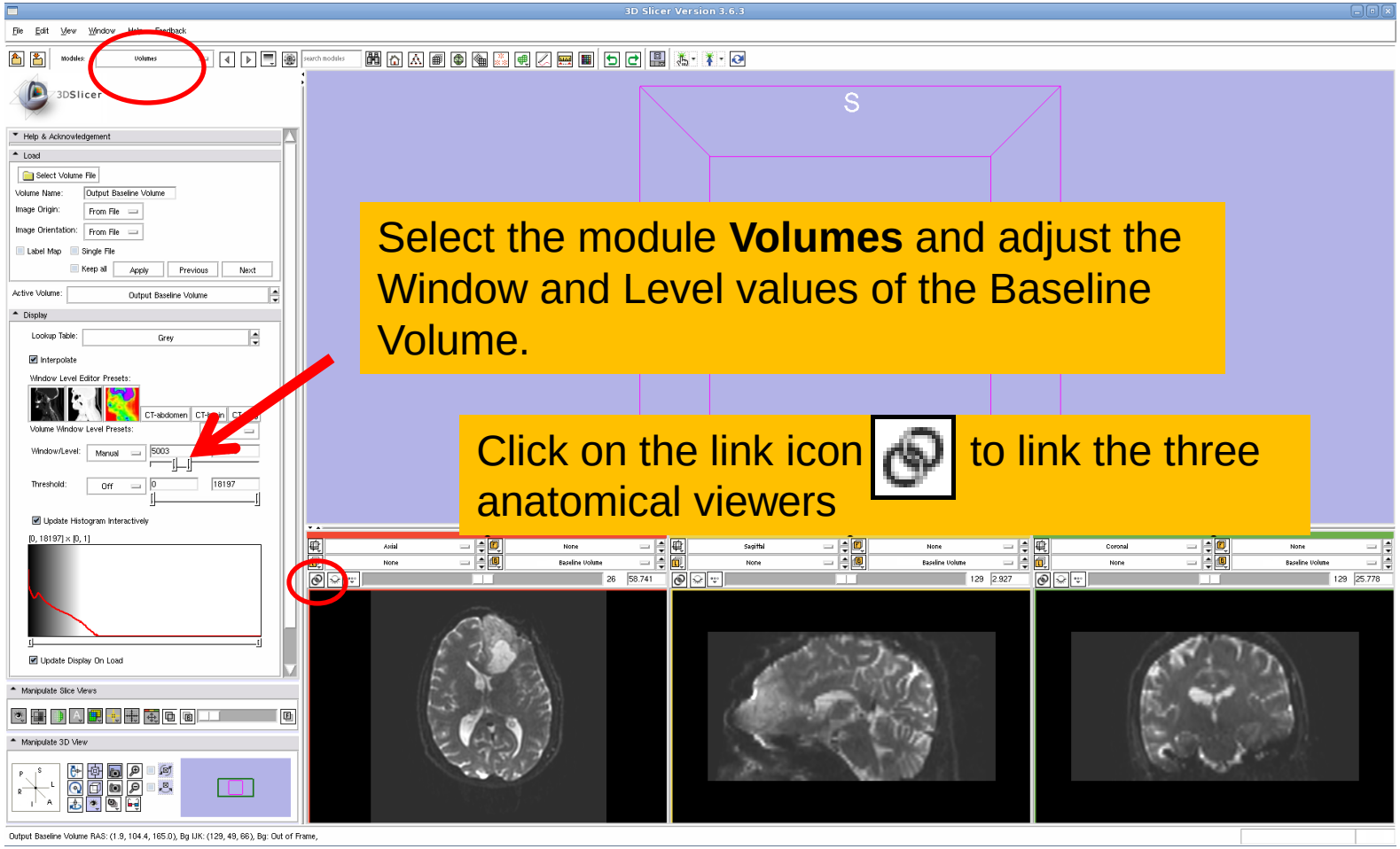
Loading DTI and Baseline Data



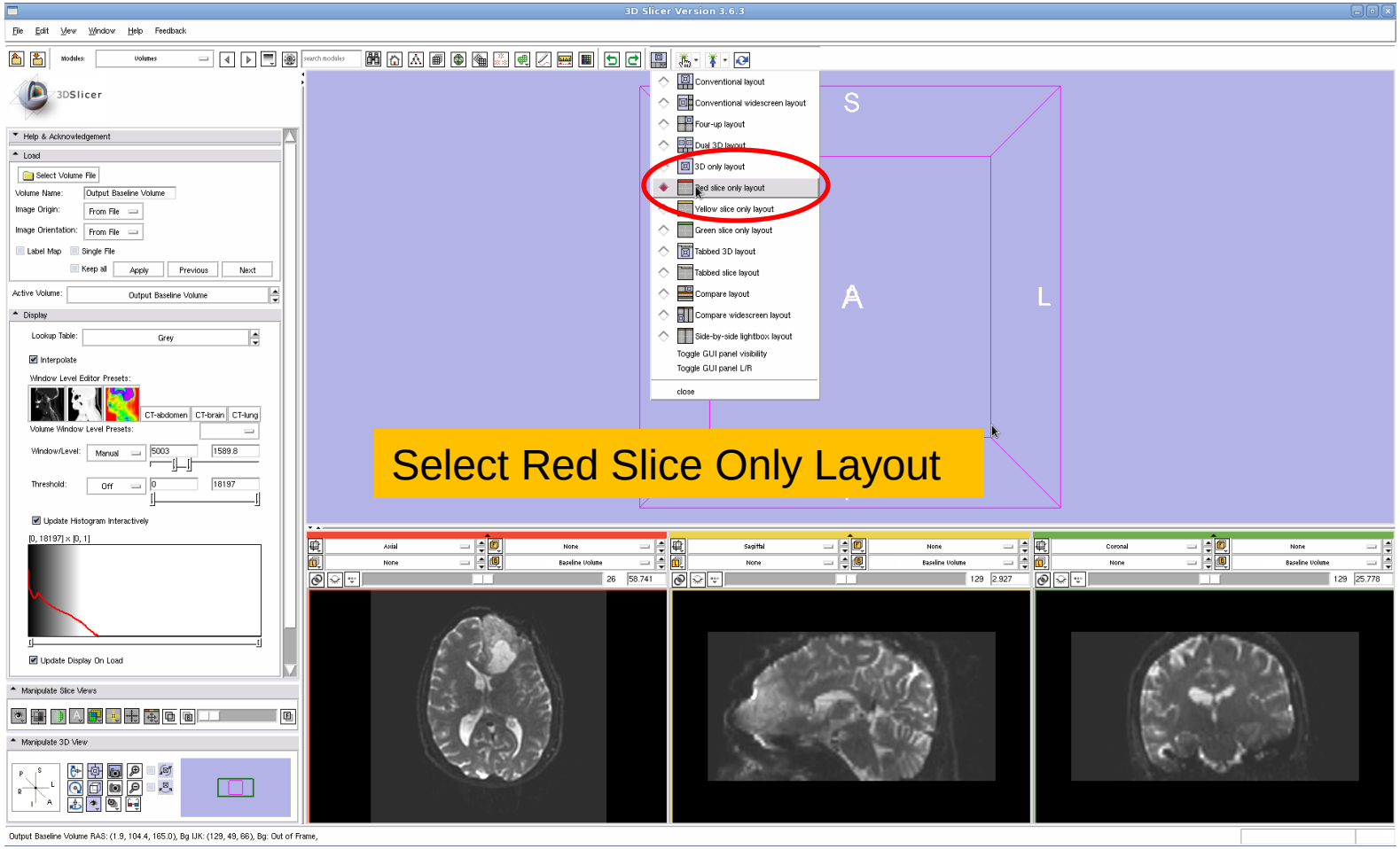
Loading DTI and Baseline Data



Loading DTI and Baseline Data

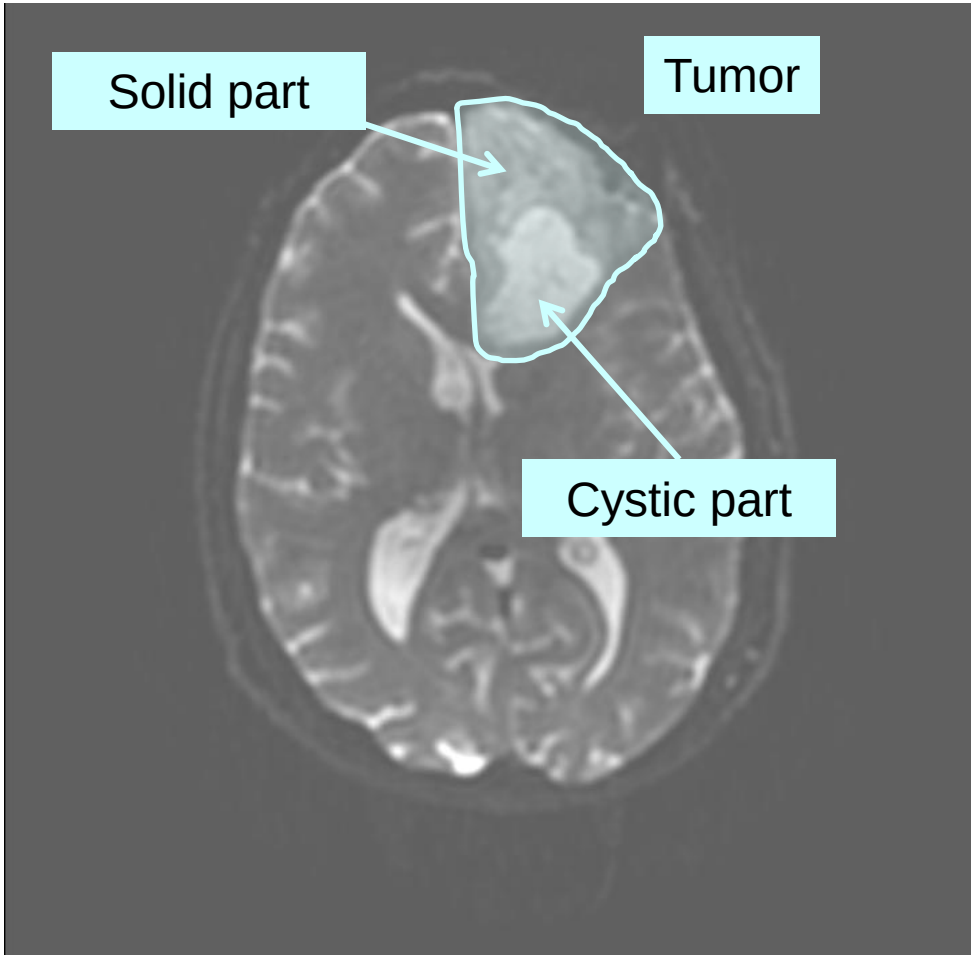


Loading DTI and Baseline Data



Part 1: Segmenting the tumor

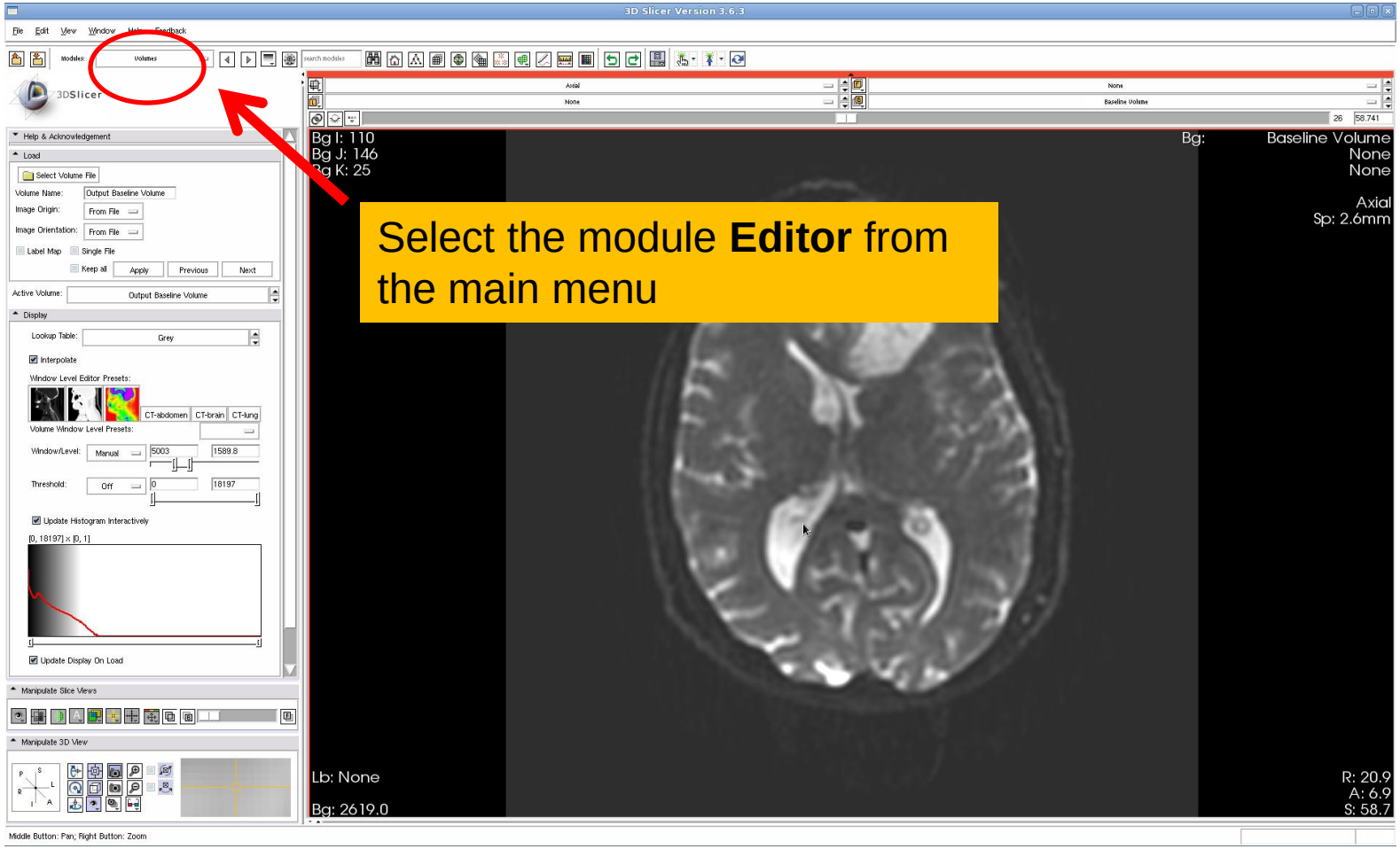
Tumor Segmentation



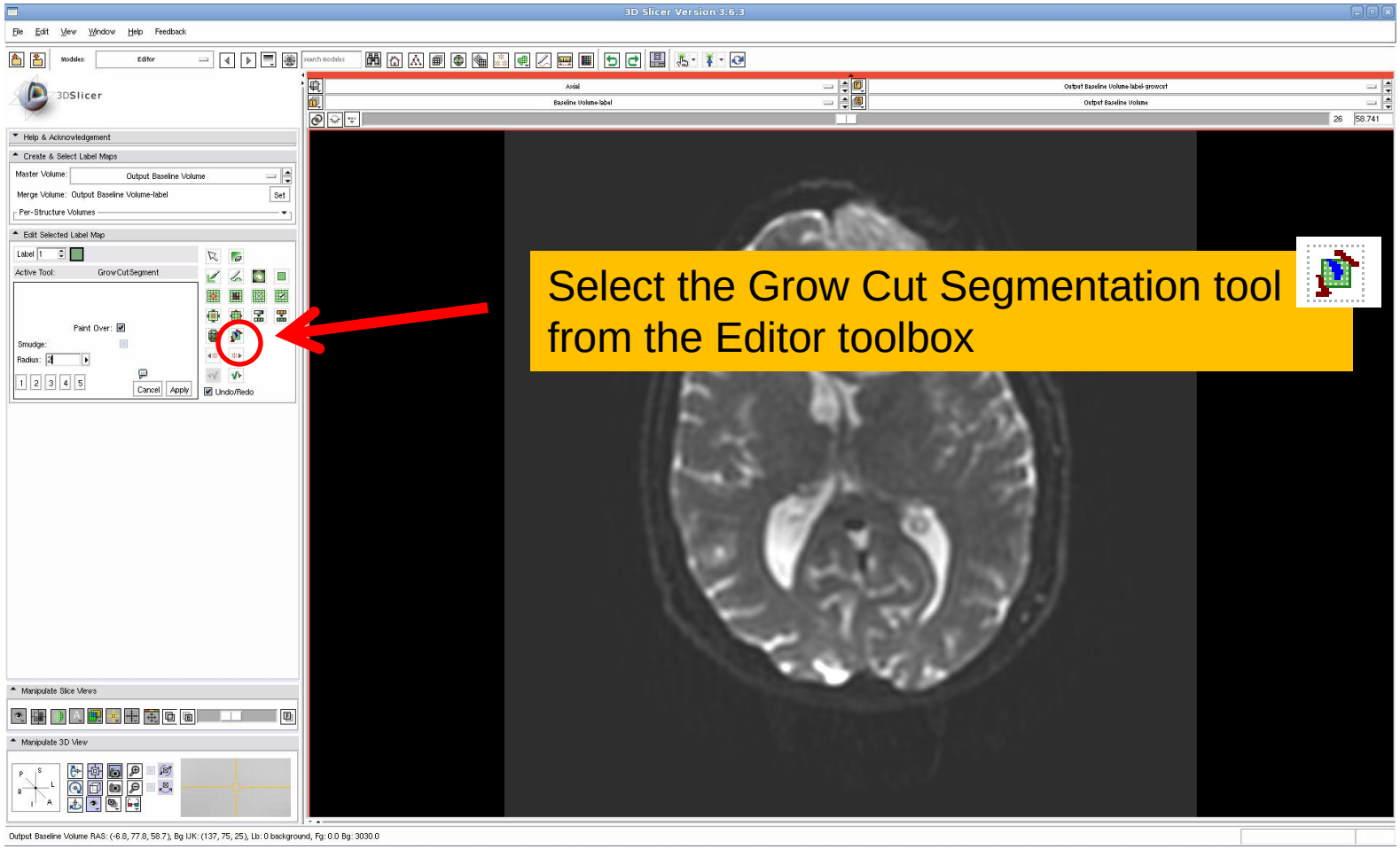
The tumor in this clinical case is composed of two parts: a solid part and a cystic part.

In this section, we'll segment the different parts of the tumor using a Grow Cut Segmentation algorithm.

Editor Module



Tumor Segmentation



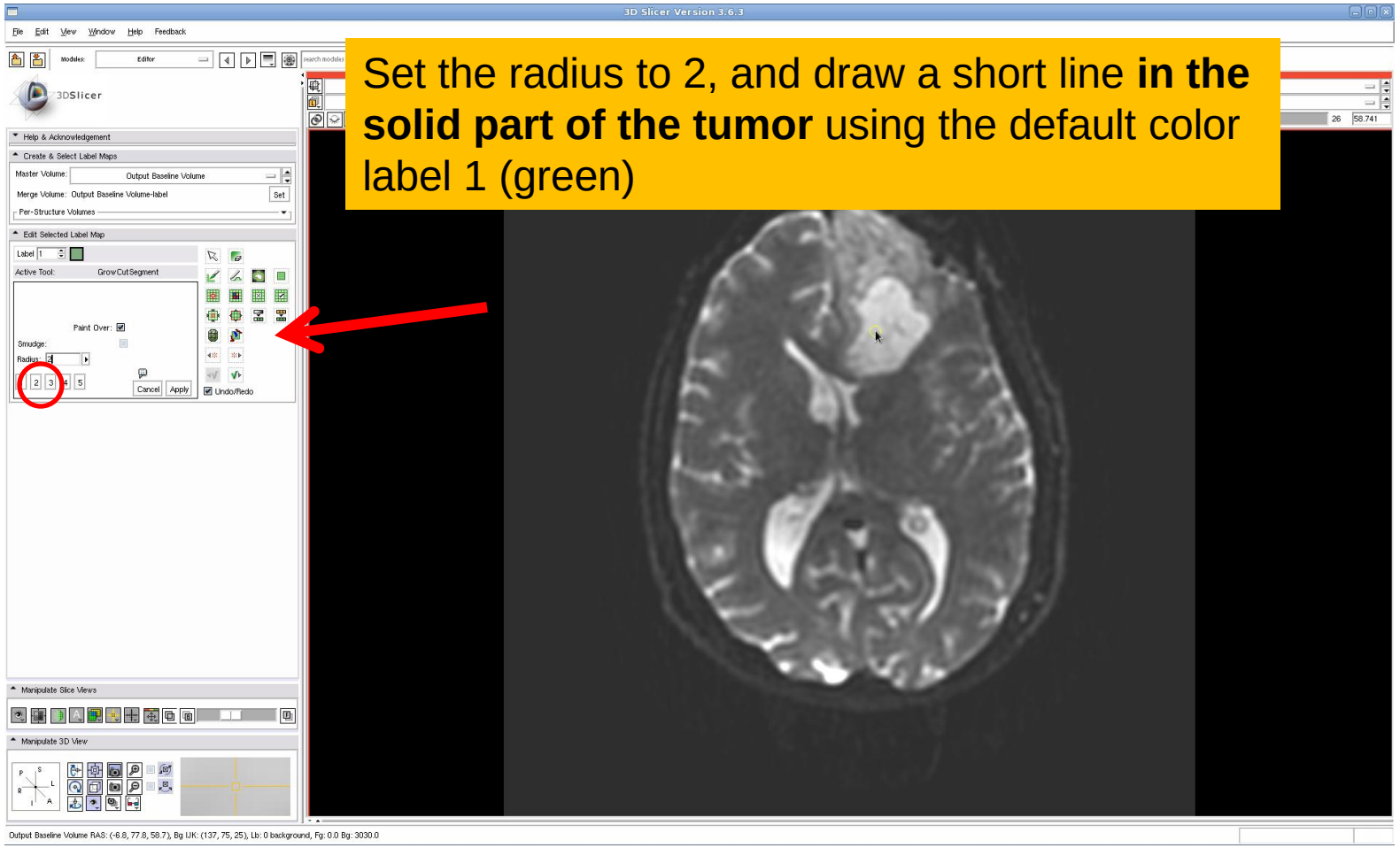
Grow Cut Segmentation

The **Grow Cut Segmentation module** is a competitive region growing algorithm using cellular automata.

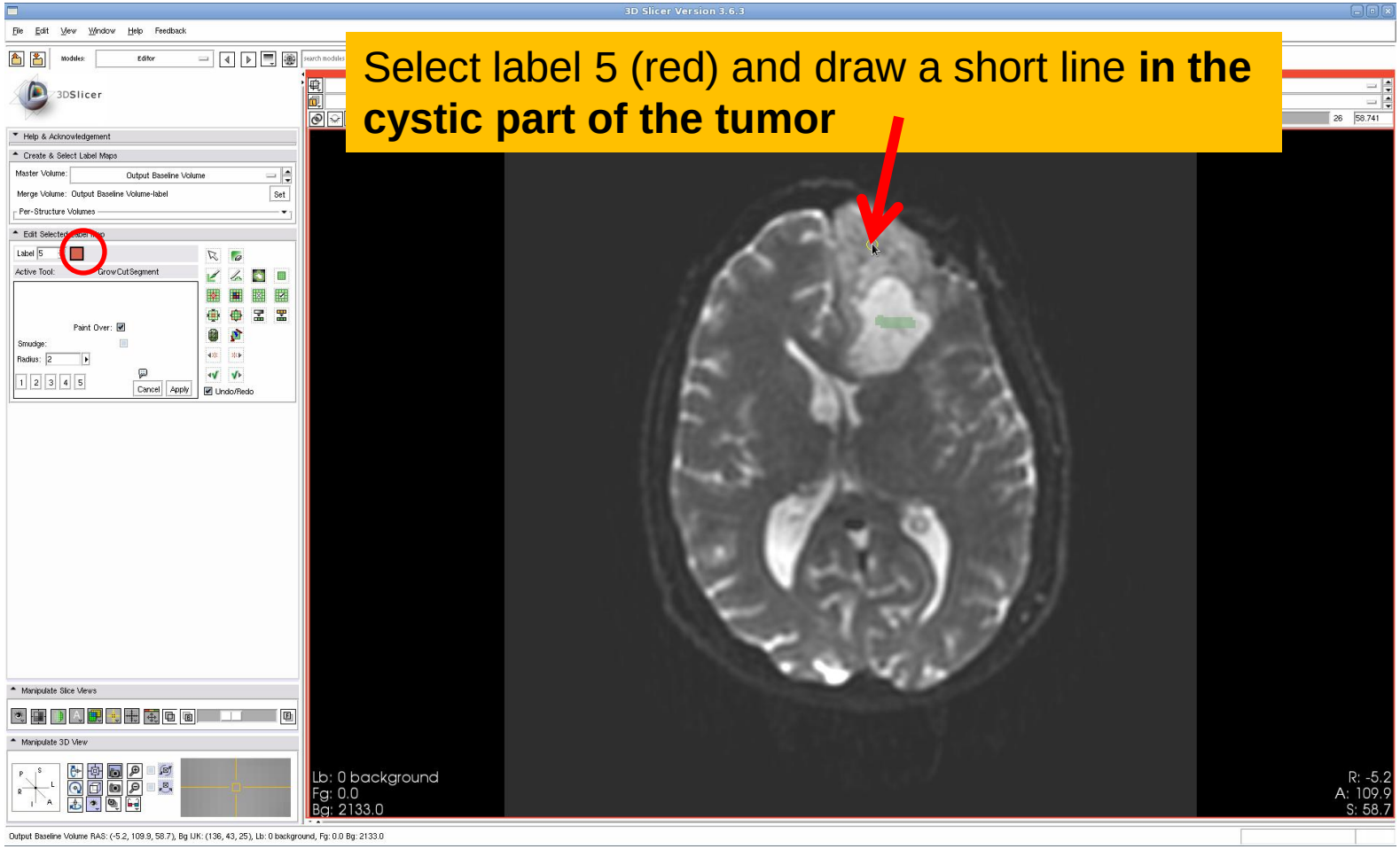
The algorithm works by using a set of user input scribbles for foreground and background.

For N-class segmentation, the algorithm requires a set of scribbles corresponding the N classes, and a scribble for the other classes.

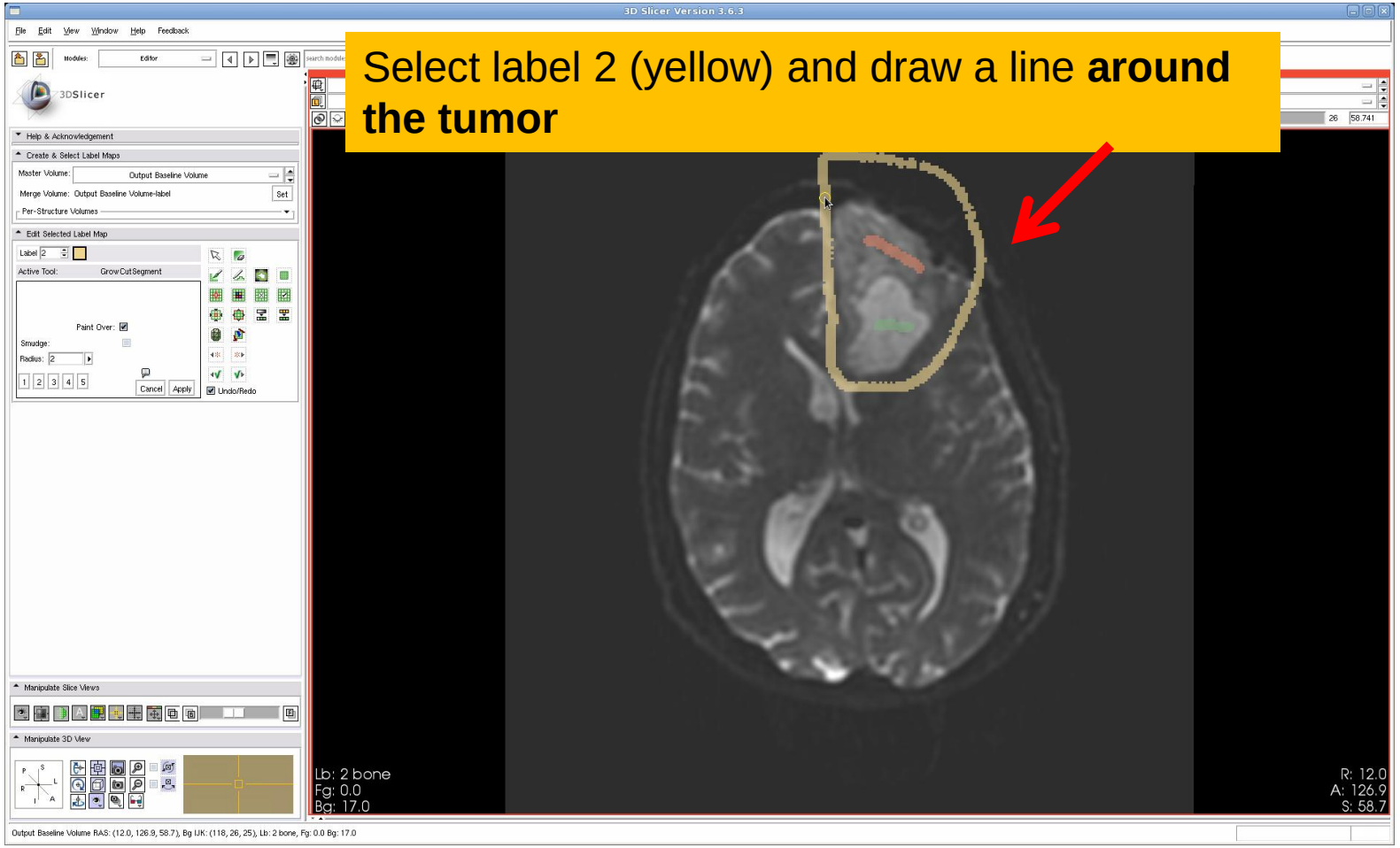
Tumor Segmentation



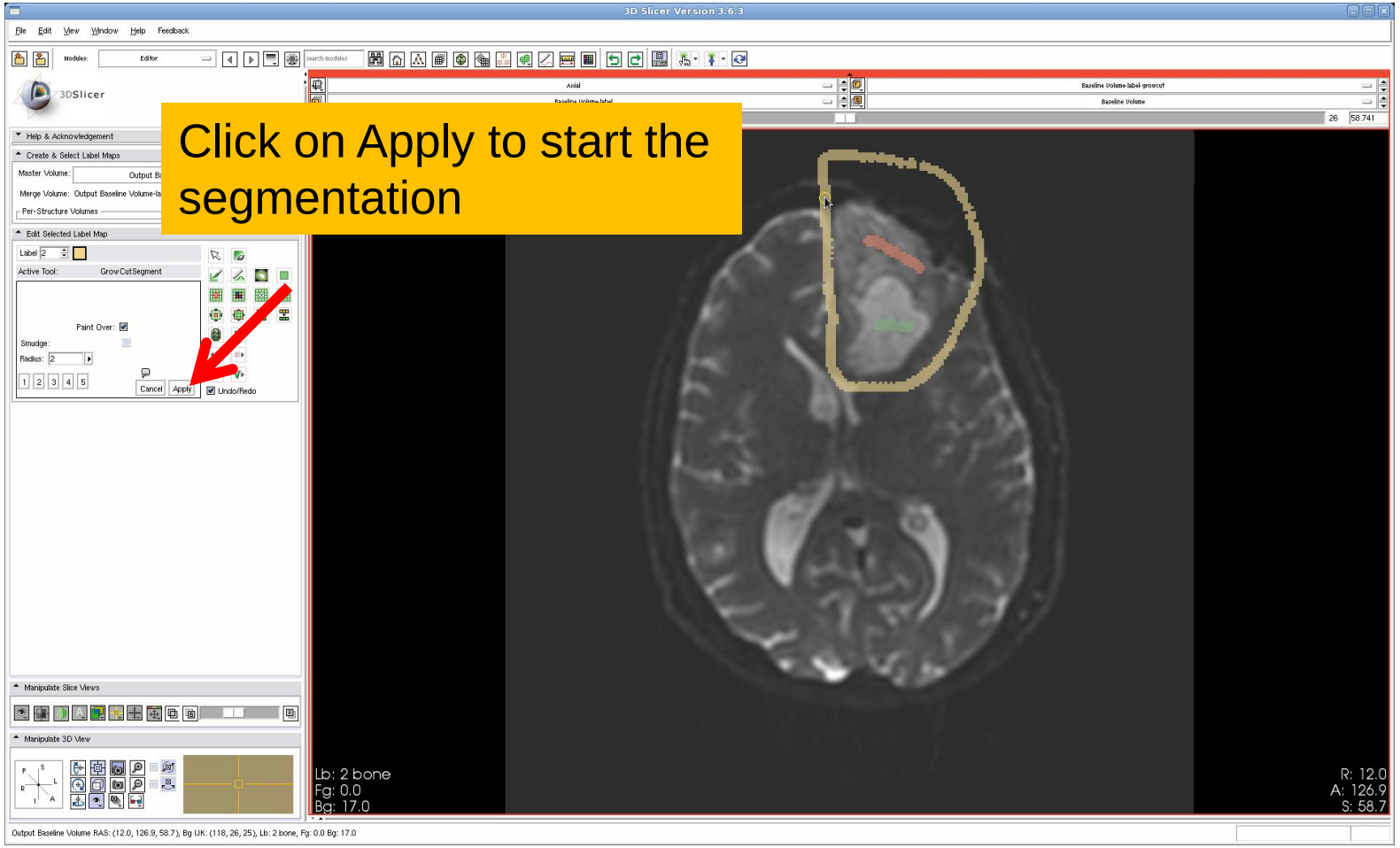
Tumor Segmentation



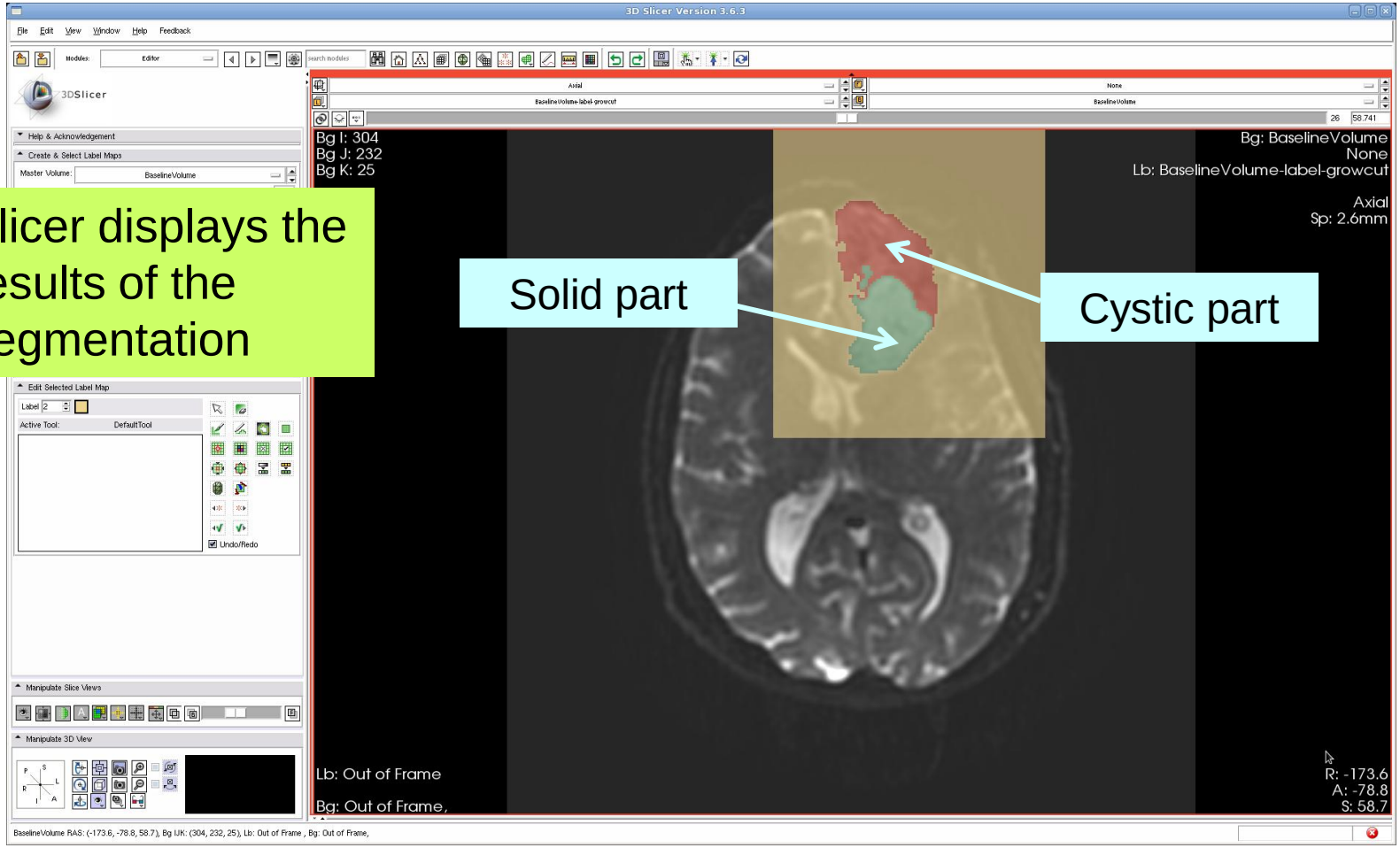
Tumor Segmentation



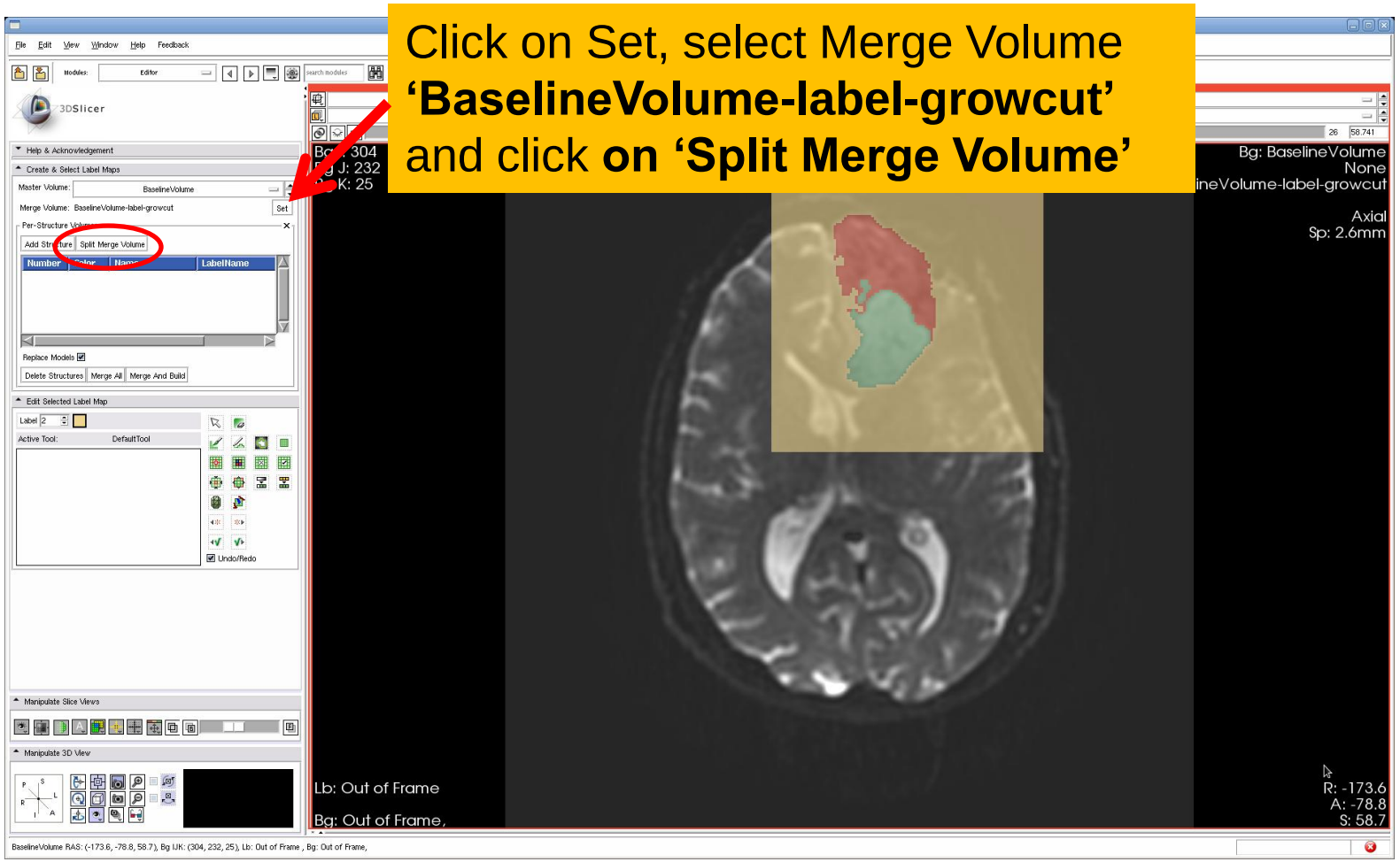
Tumor Segmentation



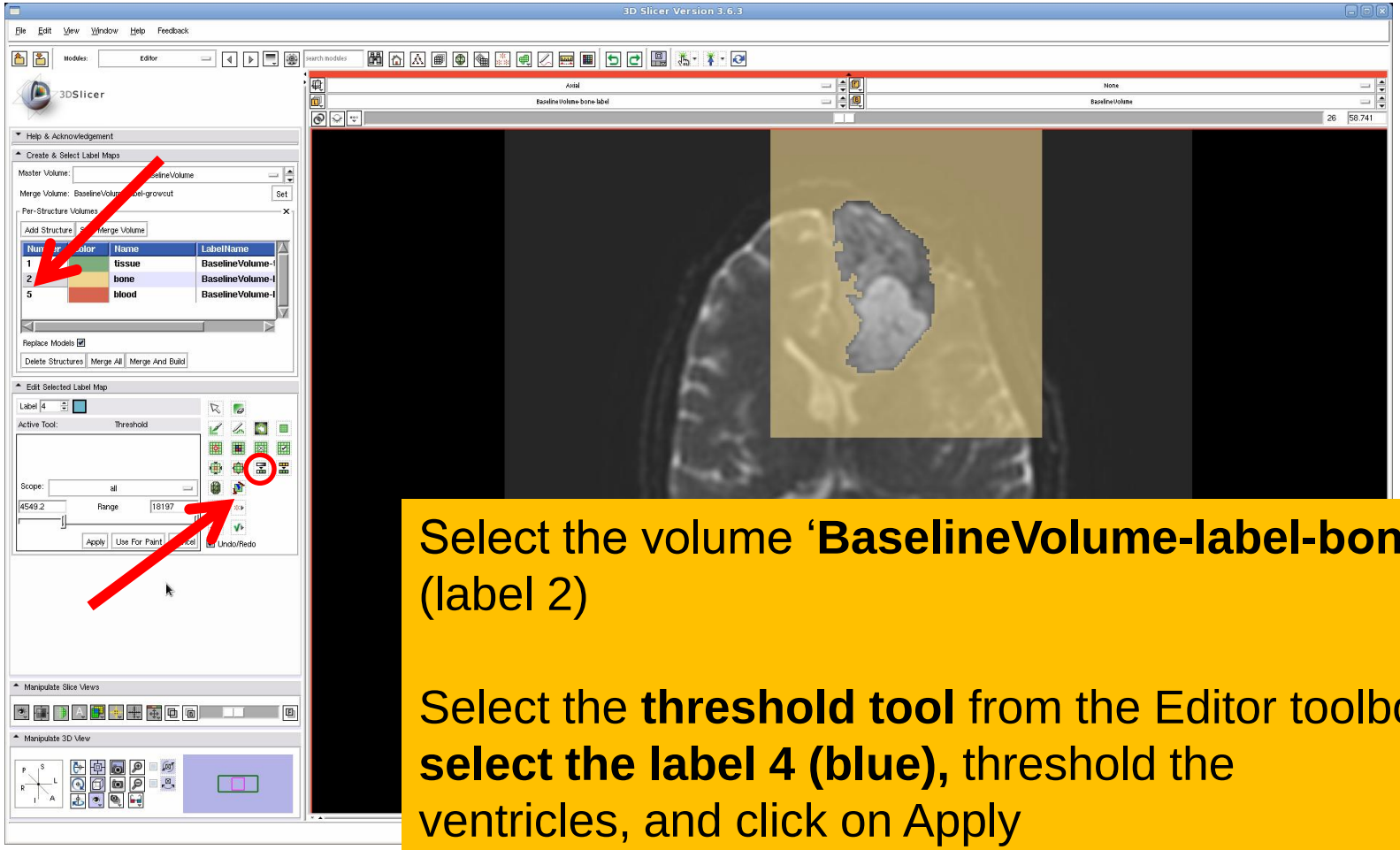
Tumor Segmentation



Tumor Segmentation



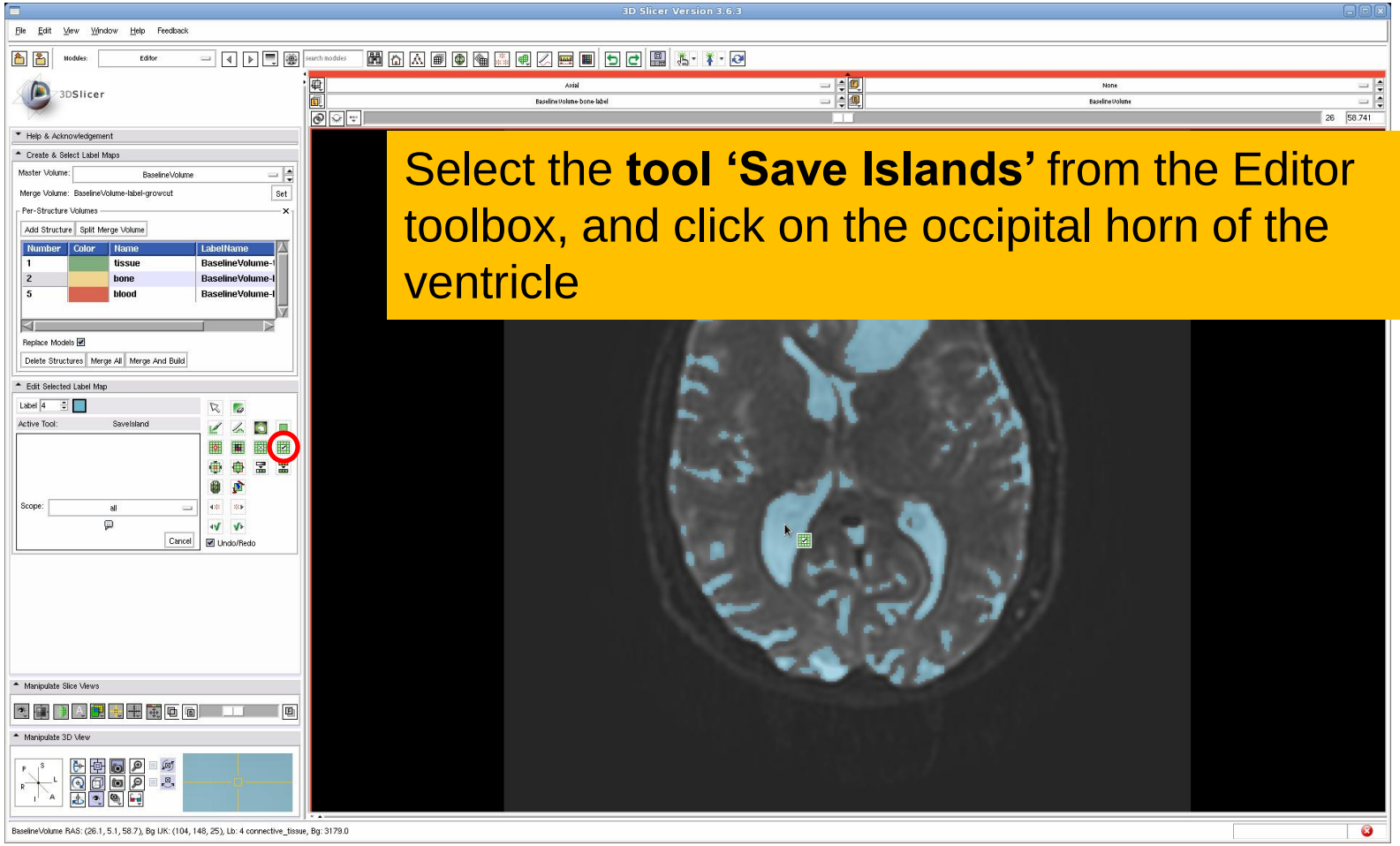
Ventricles Segmentation



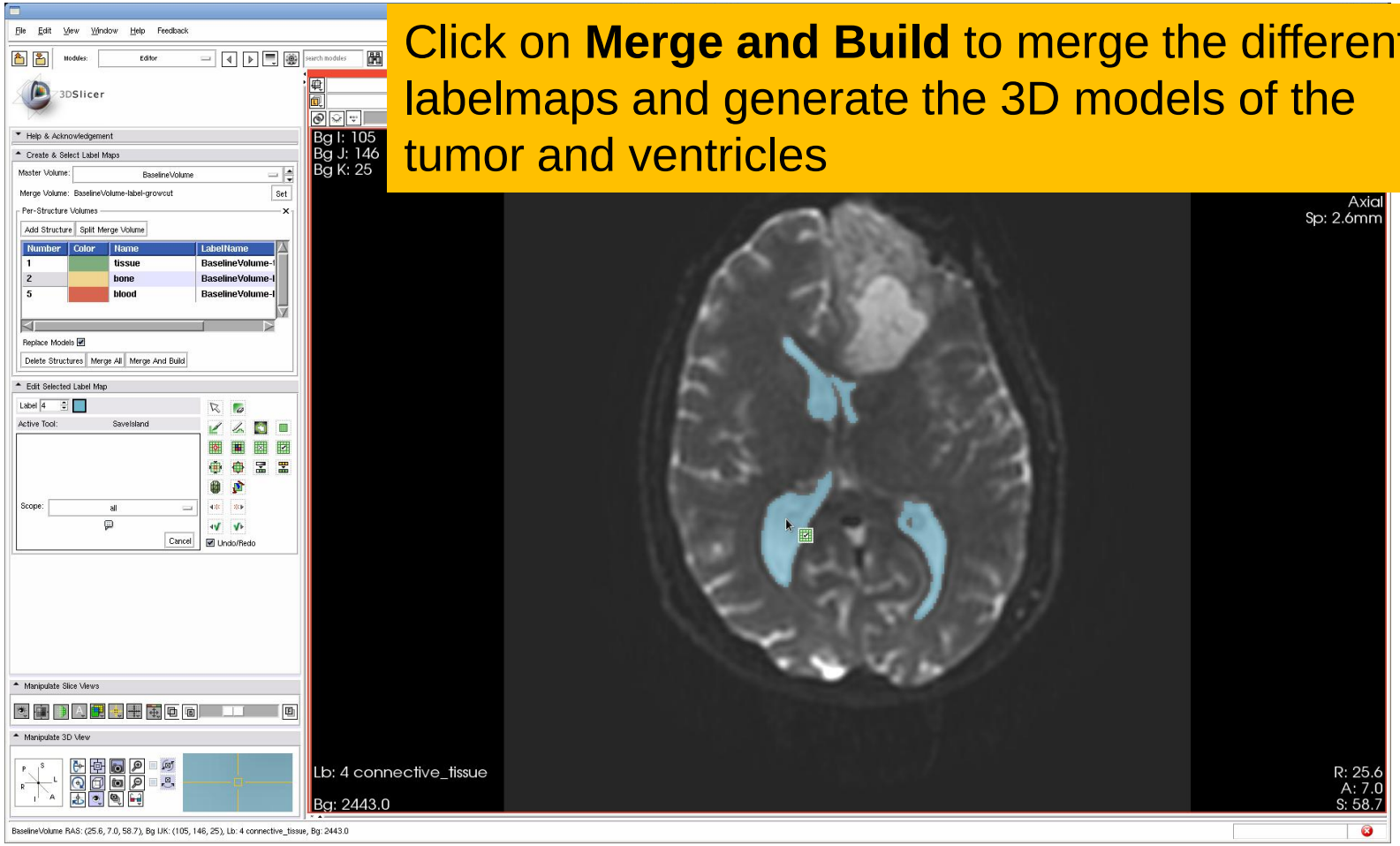
Select the volume '**BaselineVolume-label-bone**' (label 2)

Select the **threshold tool** from the Editor toolbox, **select the label 4 (blue),** threshold the ventricles, and click on Apply

Ventricles Segmentation



Final Result of the Segmentation



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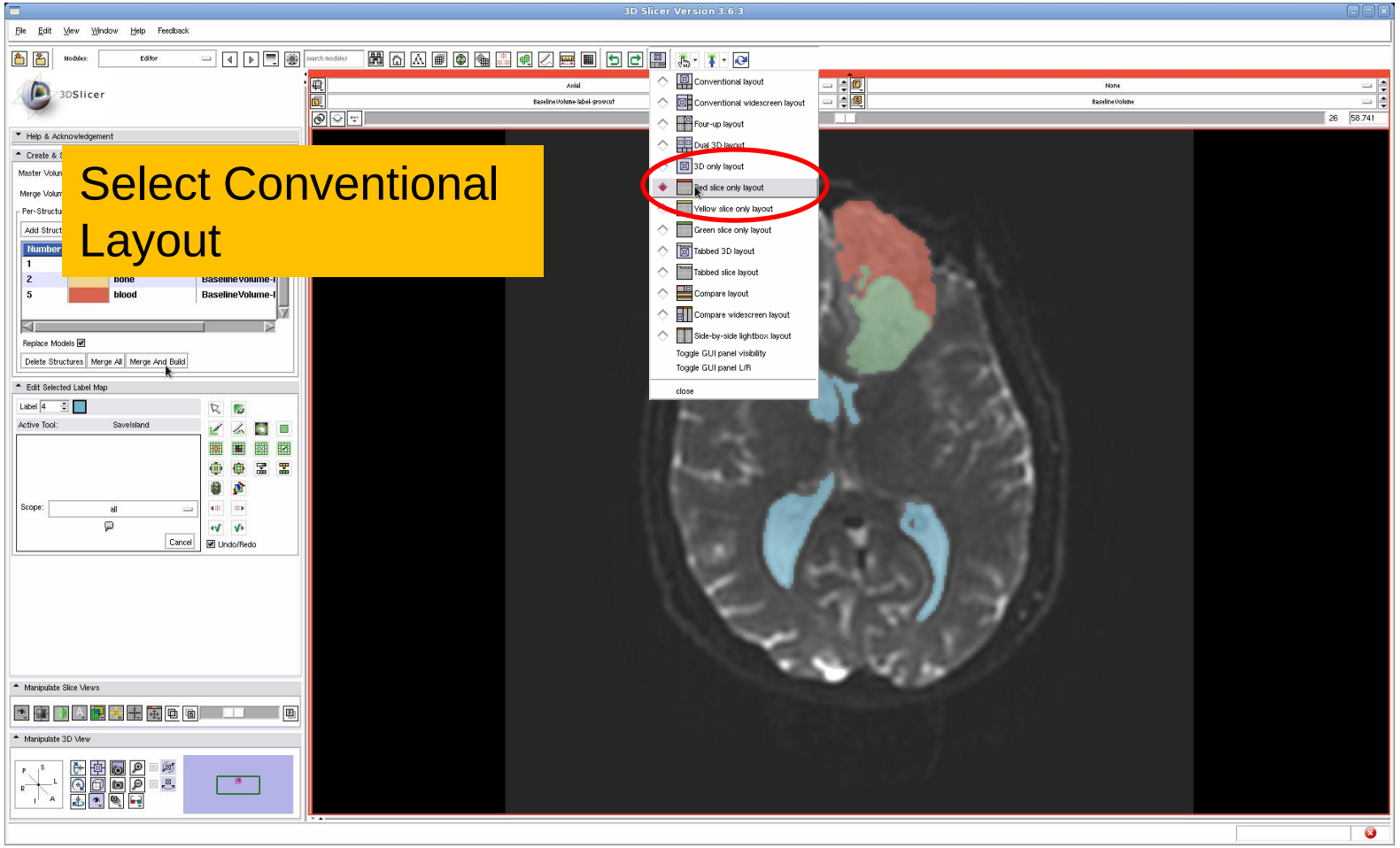
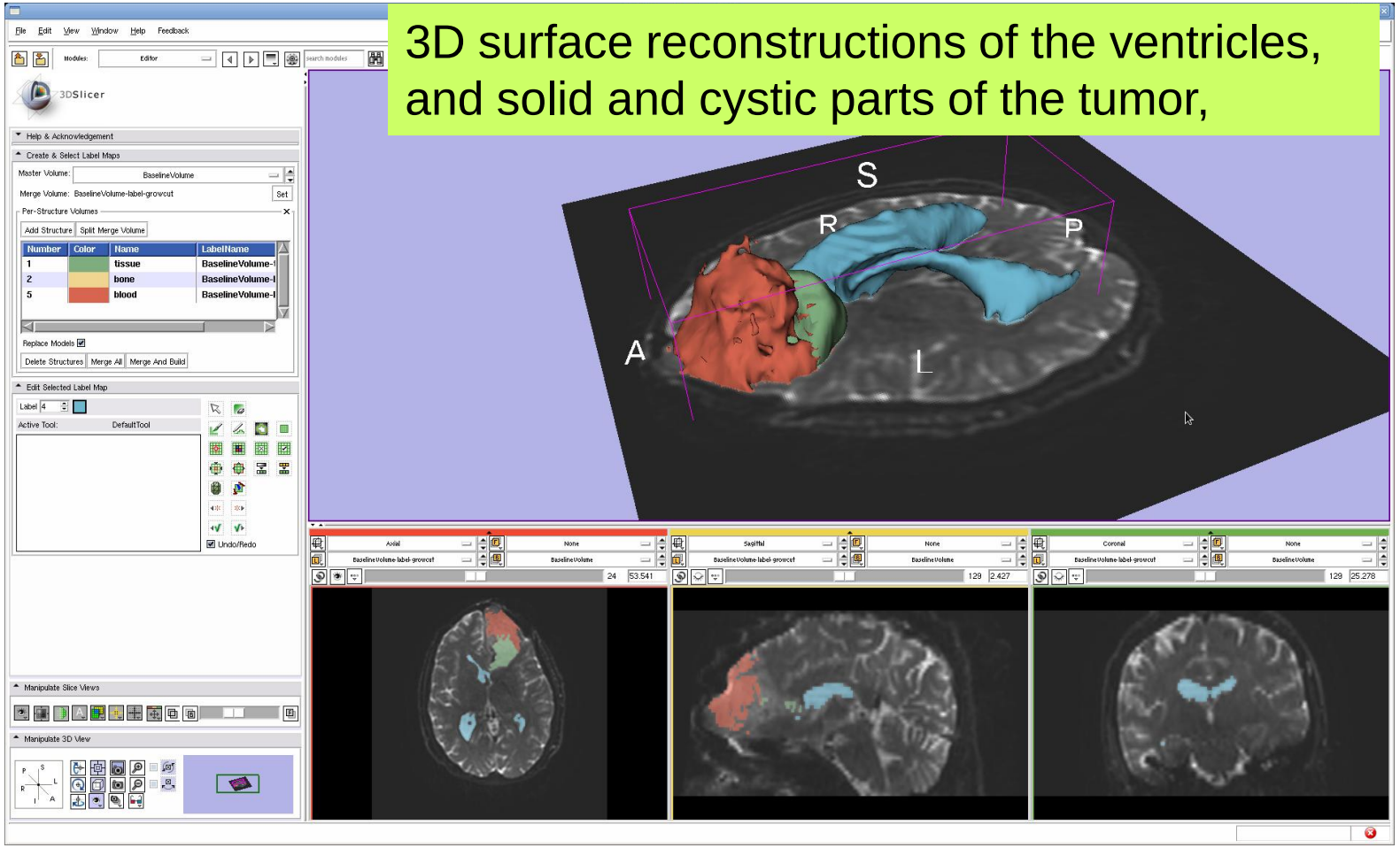
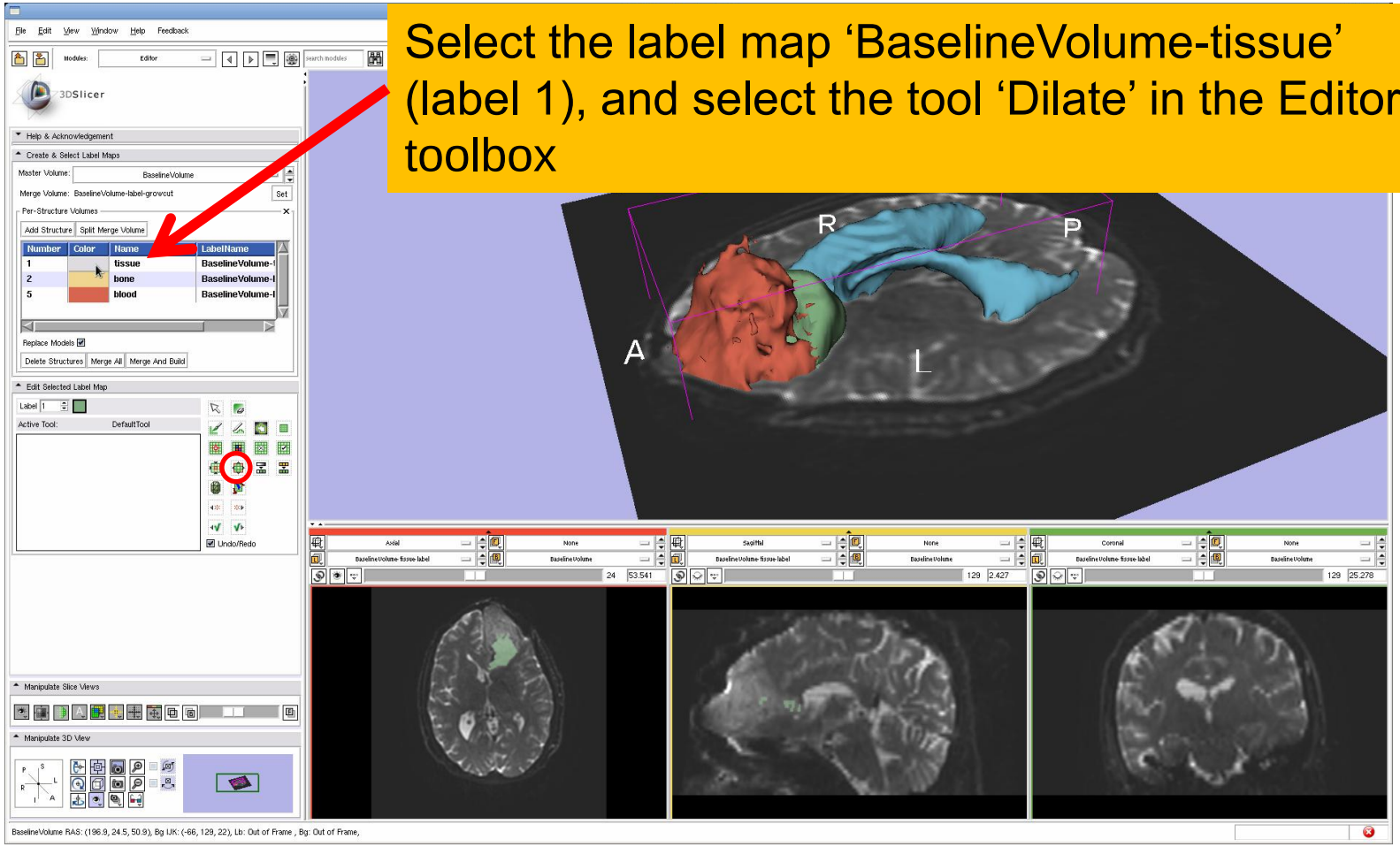


Final Result of the Segmentation

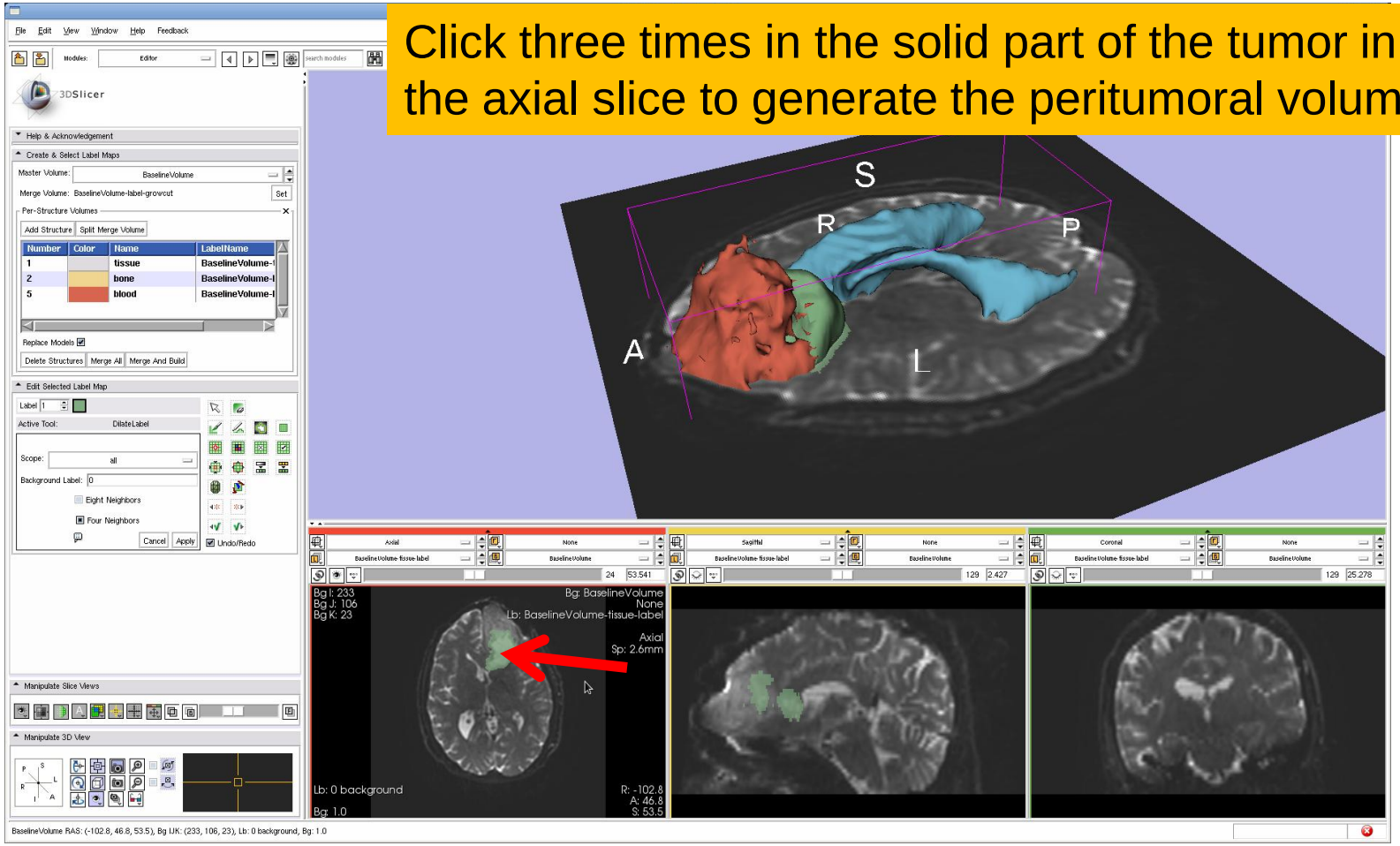


Part 2: Tractography exploration of peri-tumoral white matter fibers

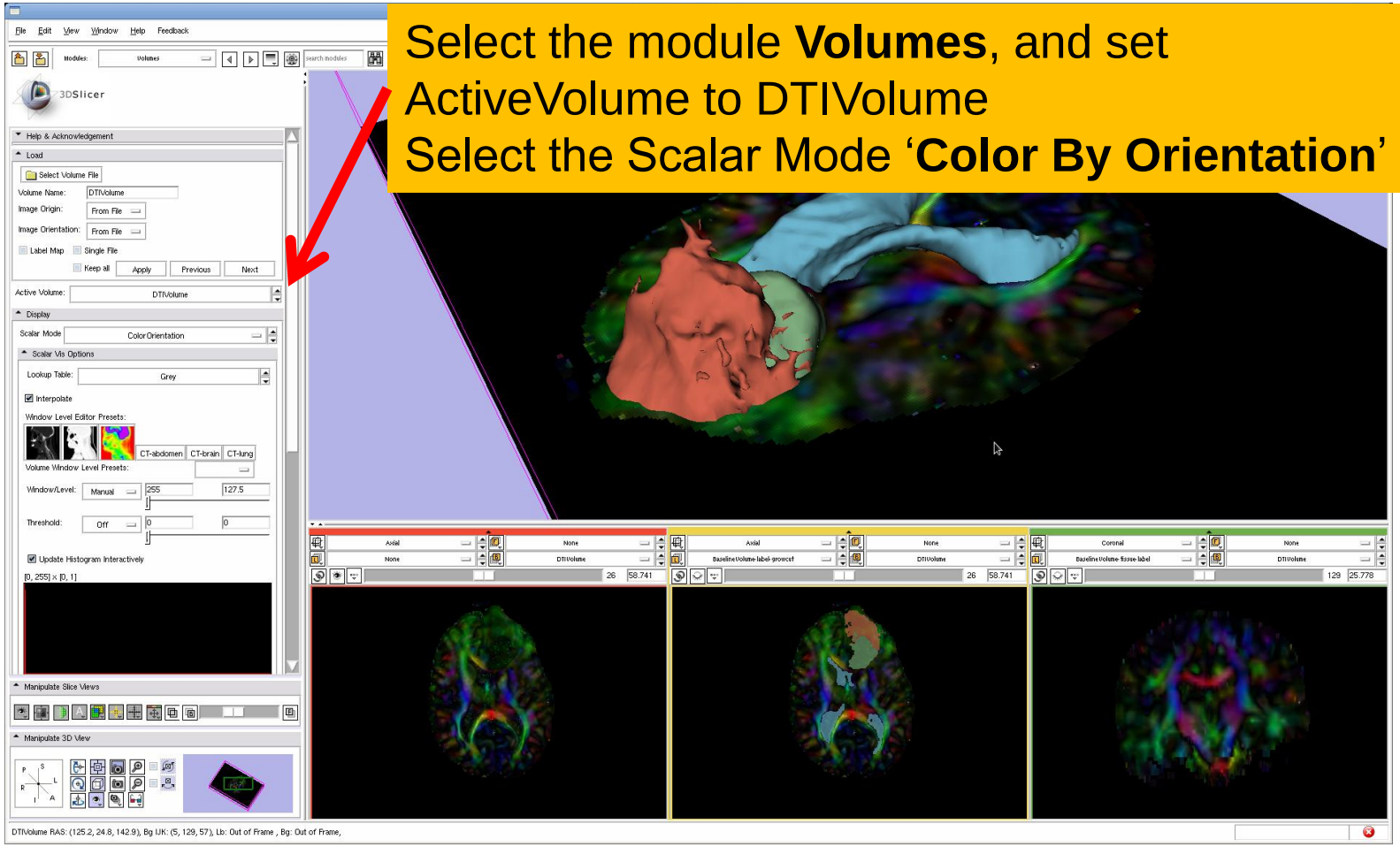
Definition of the peri-tumoral volume



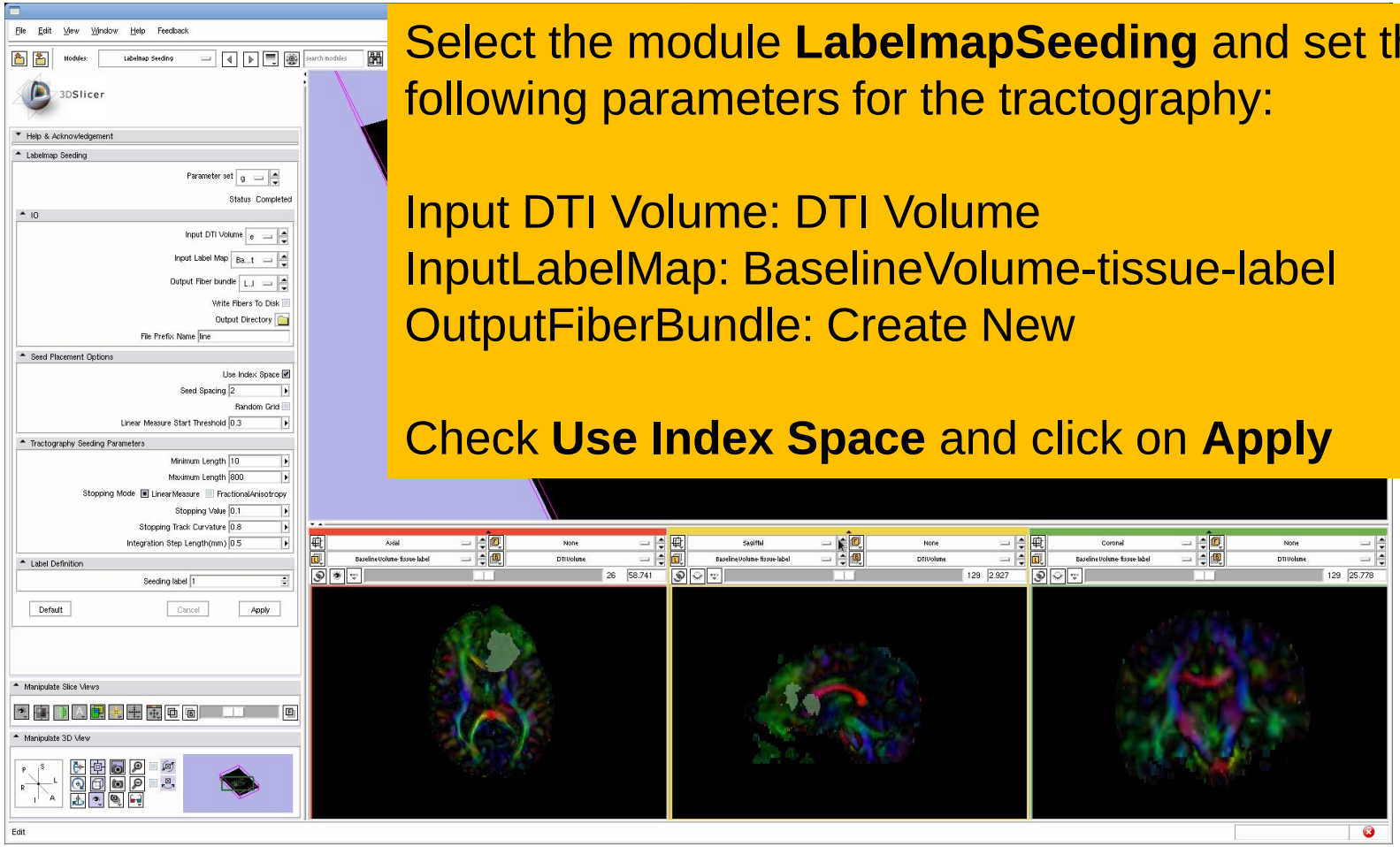
Definition of the peri-tumoral volume



Visualization of the DTI Volume



Tractography Parameters

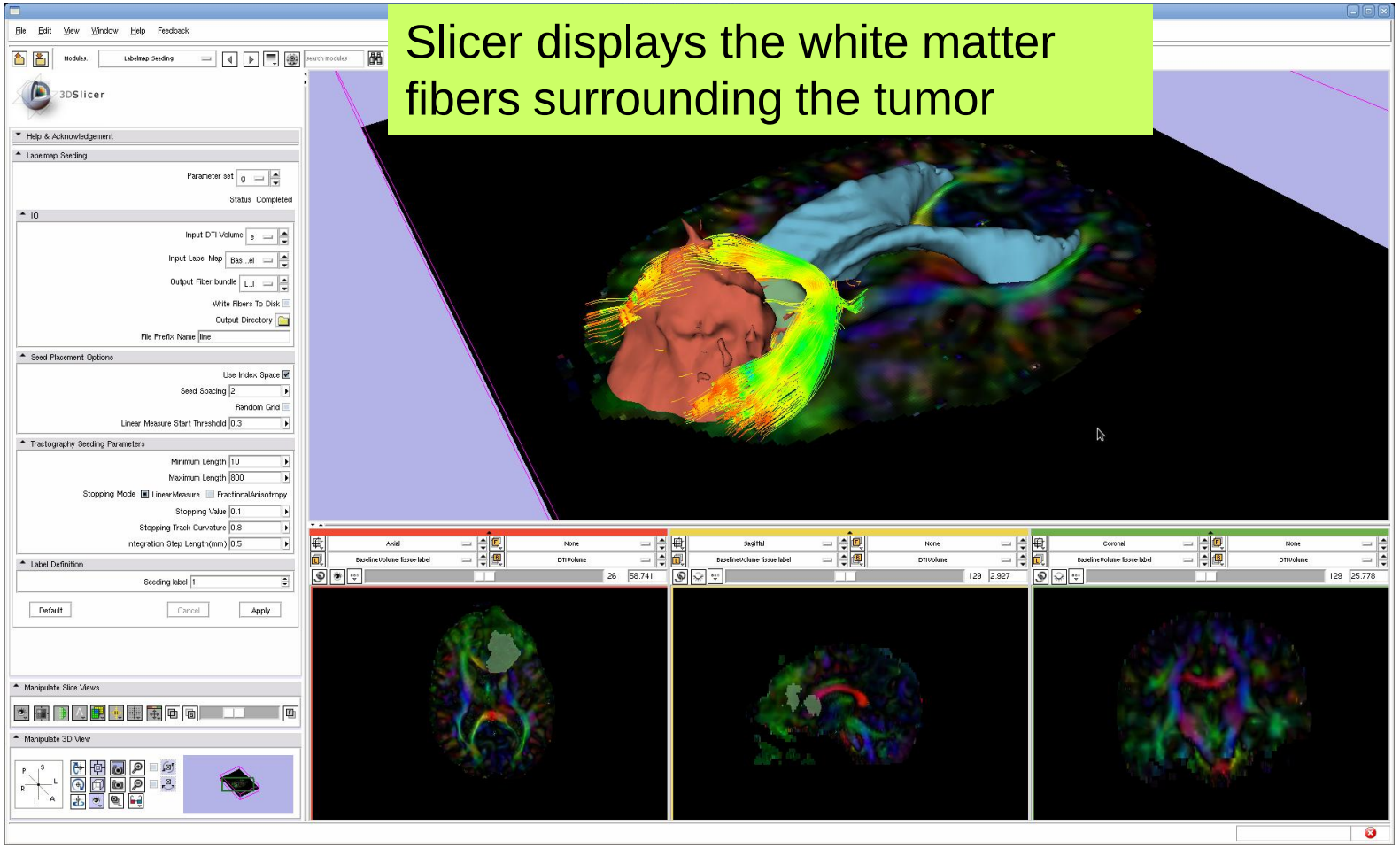


Select the module **LabelmapSeeding** and set the following parameters for the tractography:

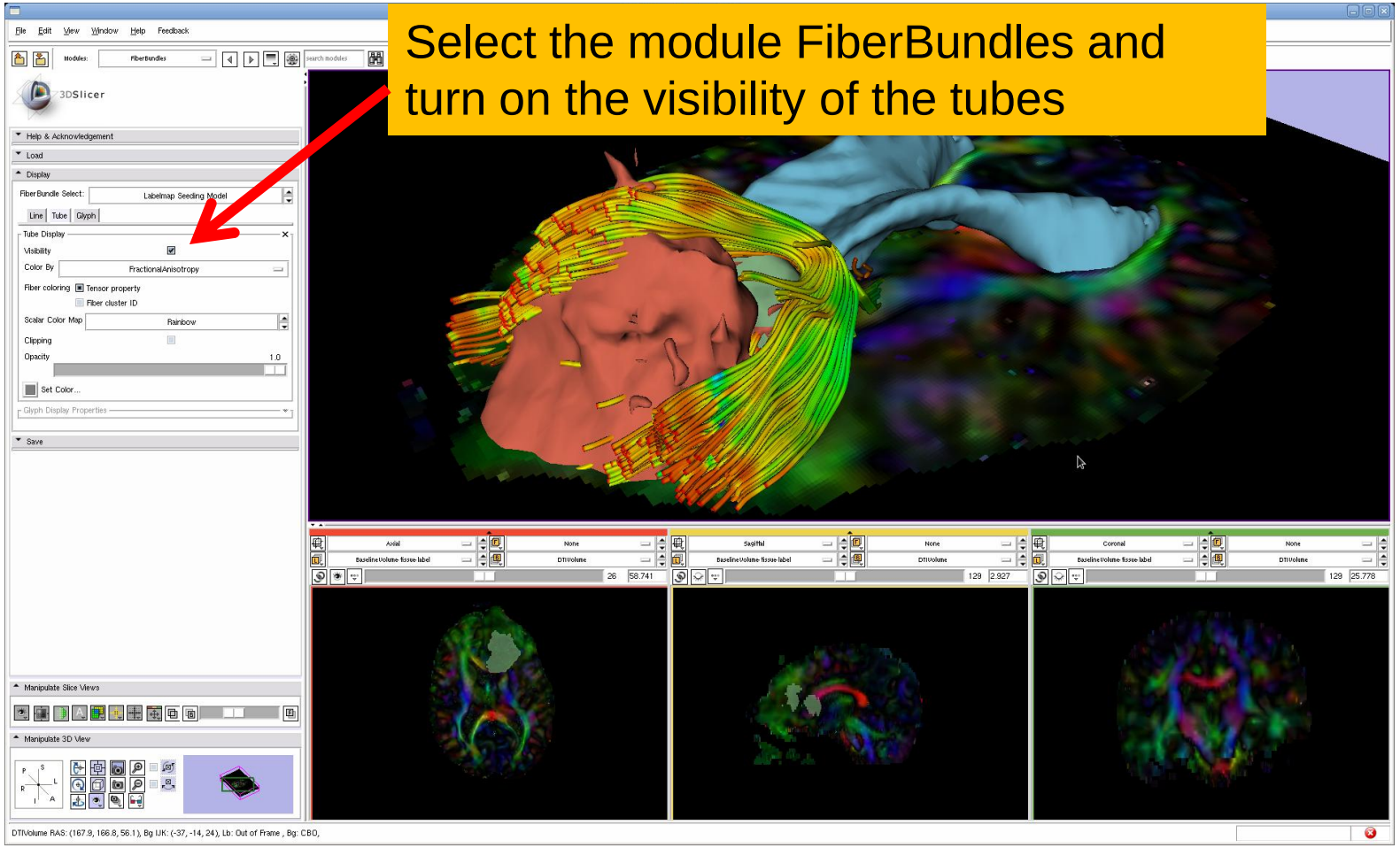
Input DTI Volume: DTI Volume
InputLabelMap: BaselineVolume-tissue-label
OutputFiberBundle: Create New

Check **Use Index Space** and click on **Apply**

Tractography Results



Tractography Results



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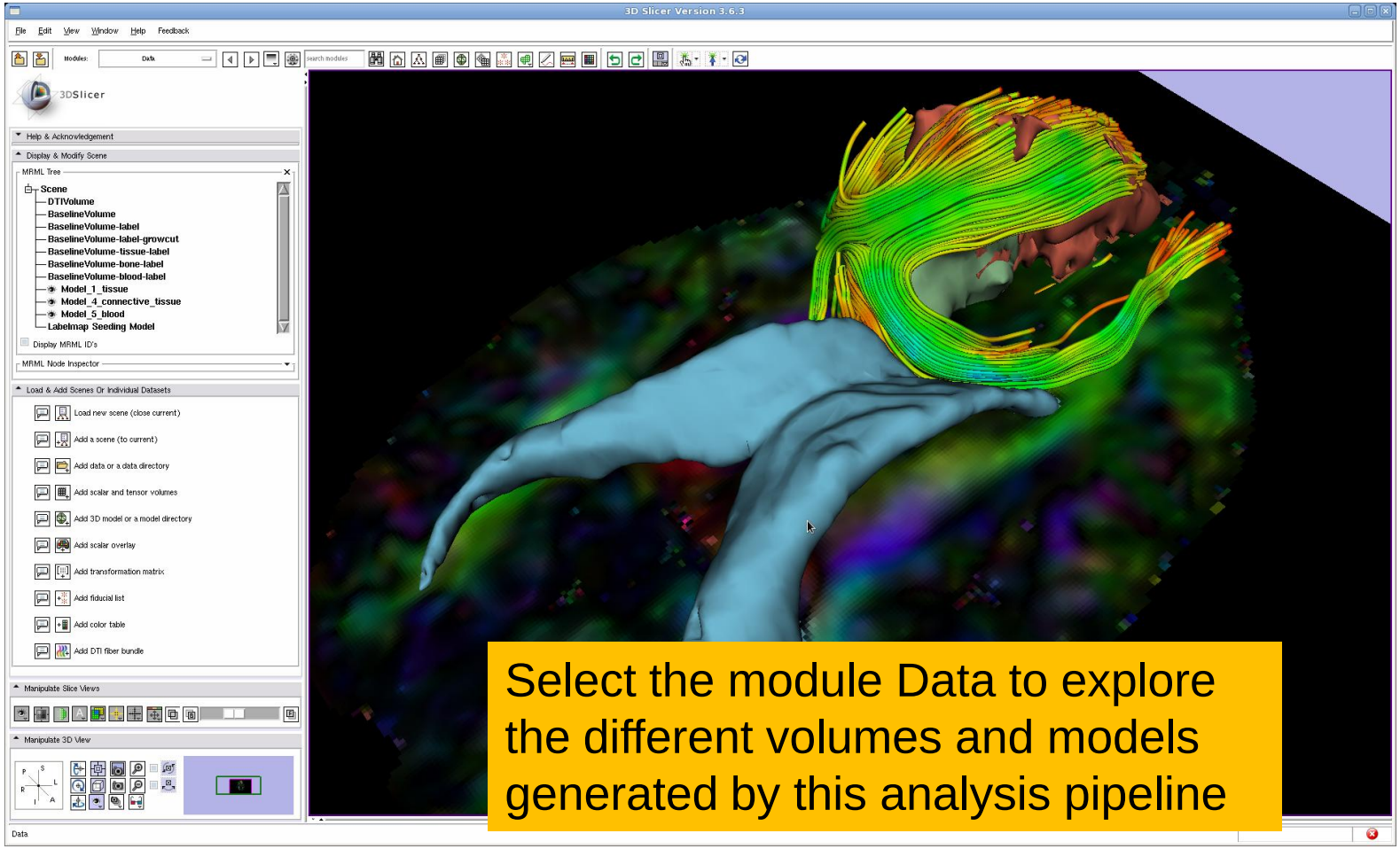
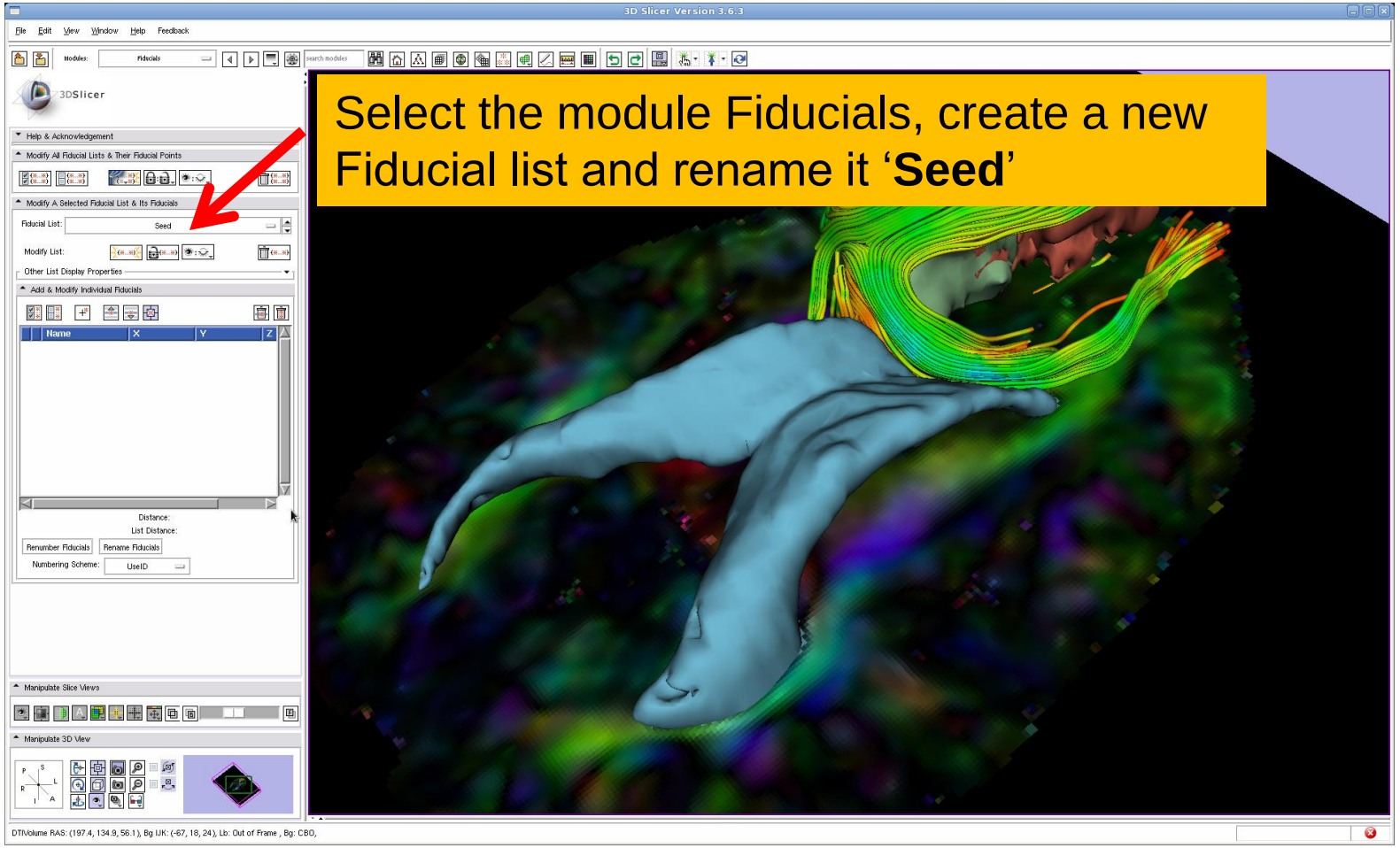
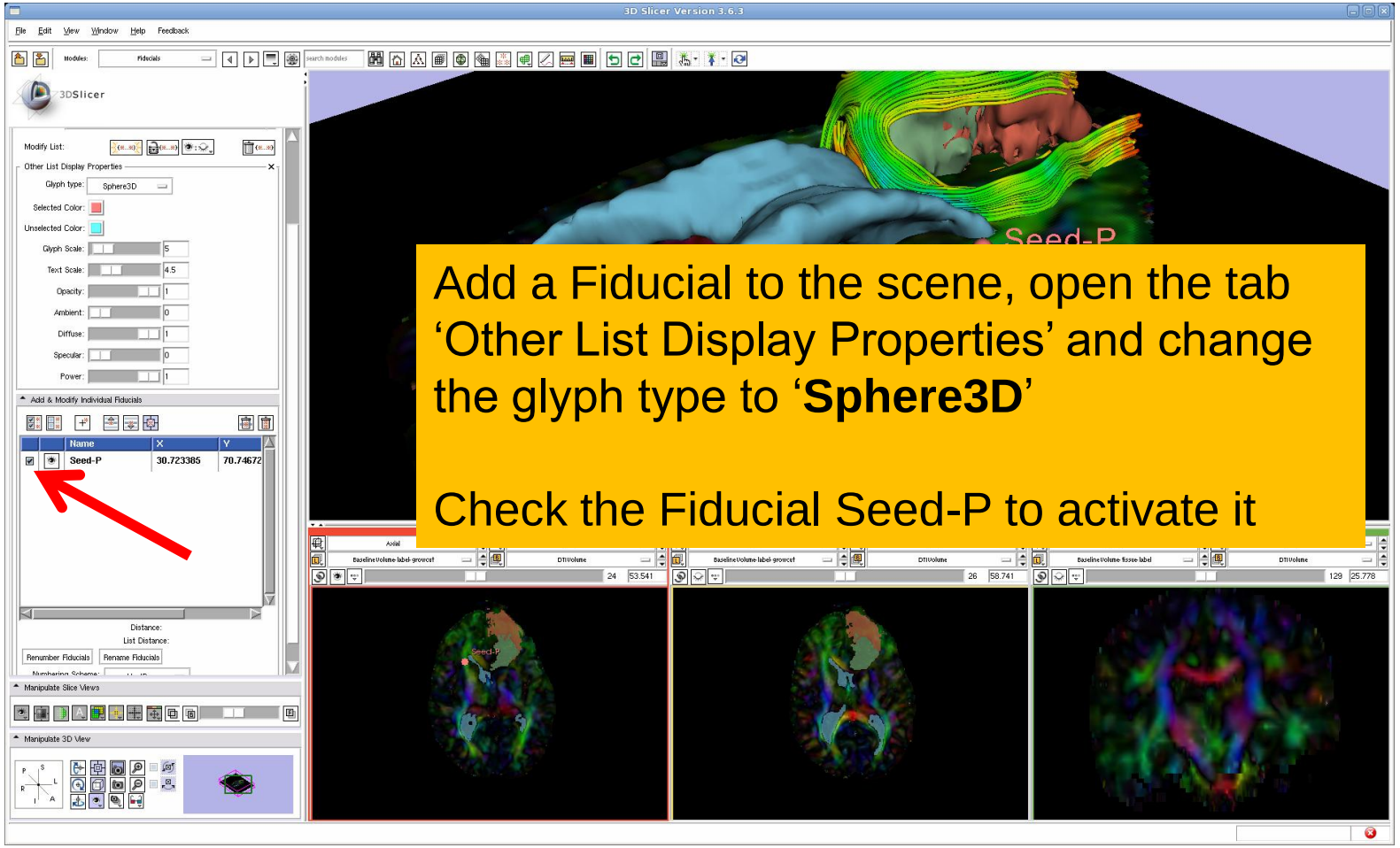


Part 3: Tractography exploration of the contralateral side

Tractography on-the-fly

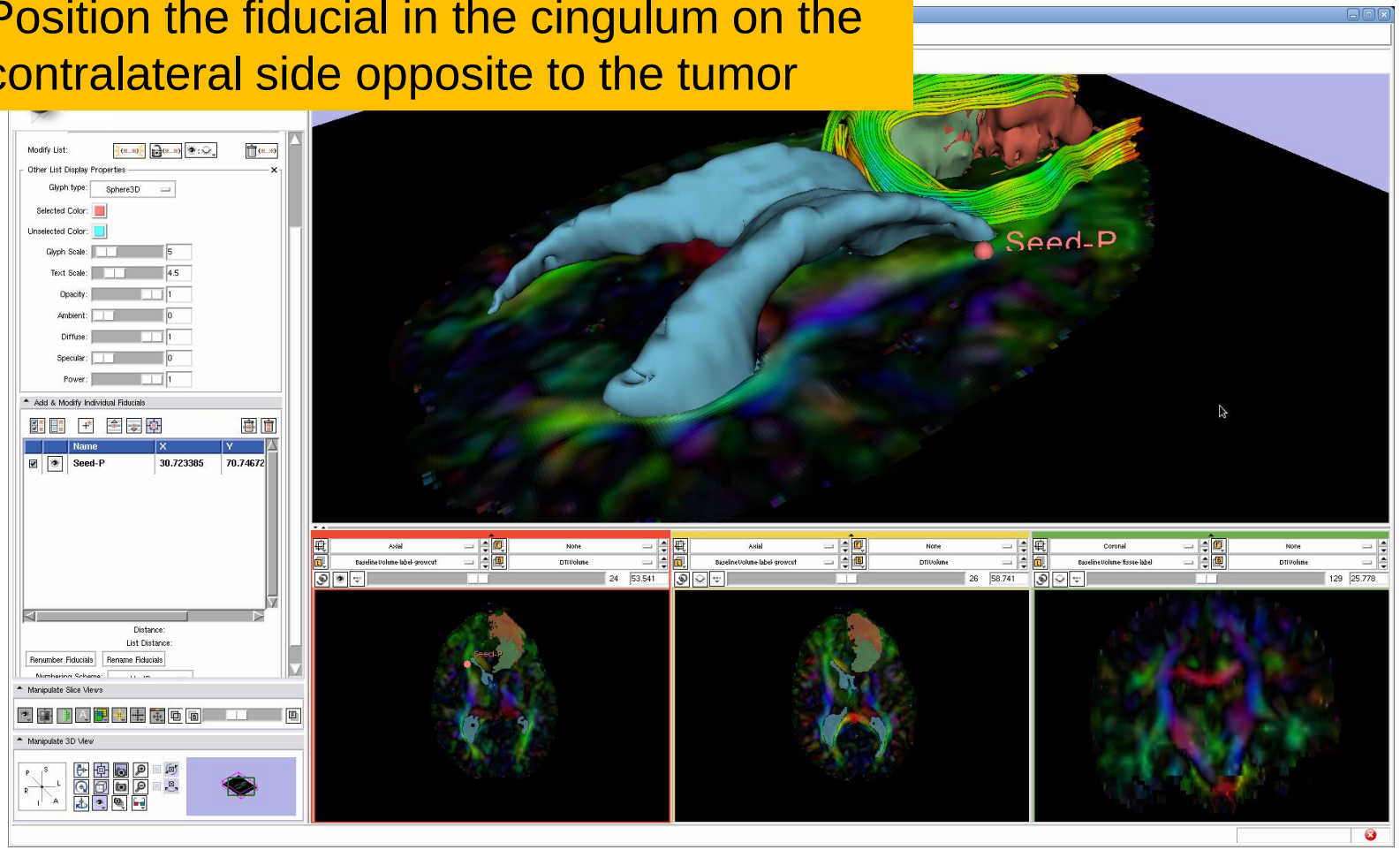


Fiducial Seeding

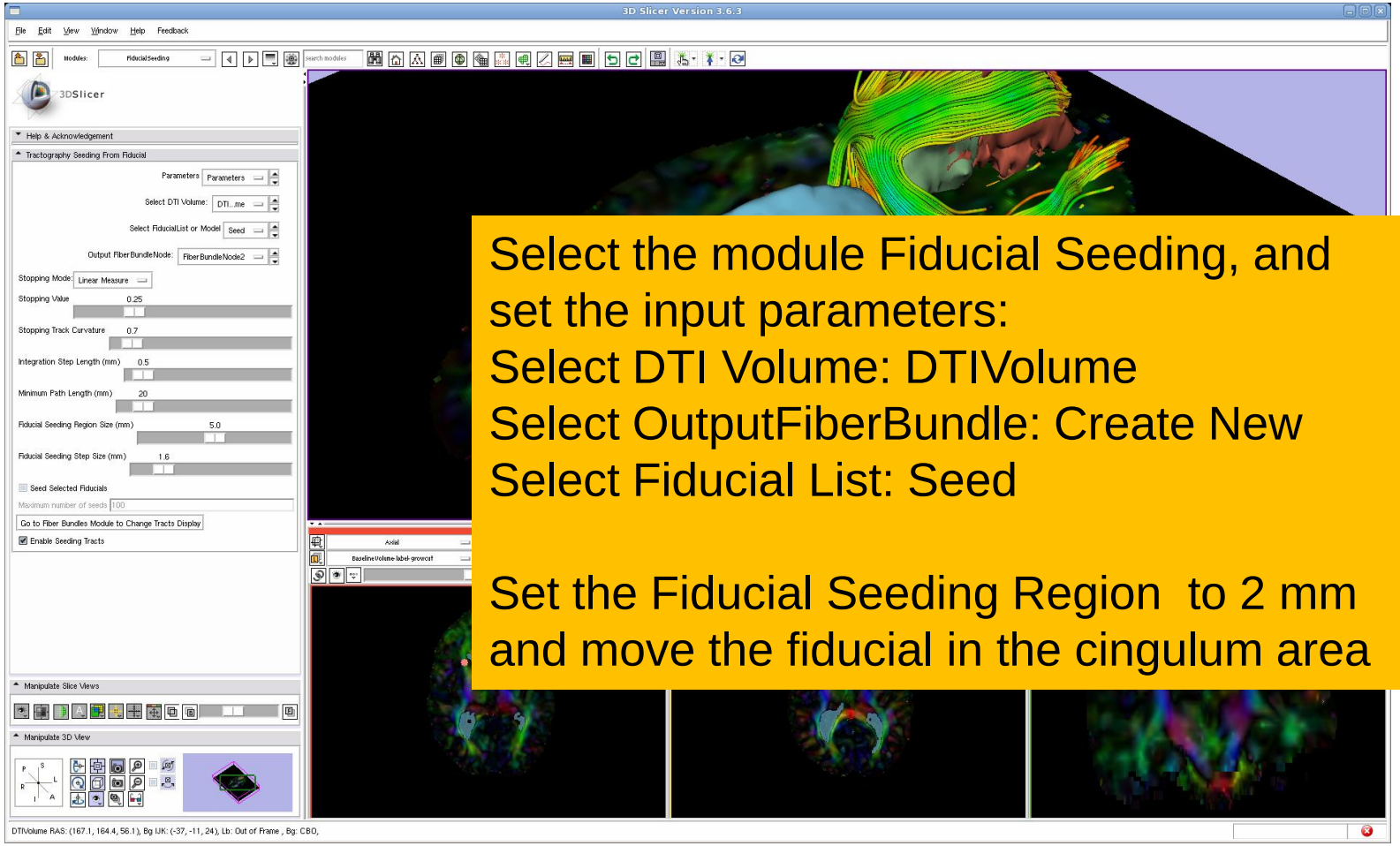


Fiducial Seeding

Position the fiducial in the cingulum on the contralateral side opposite to the tumor



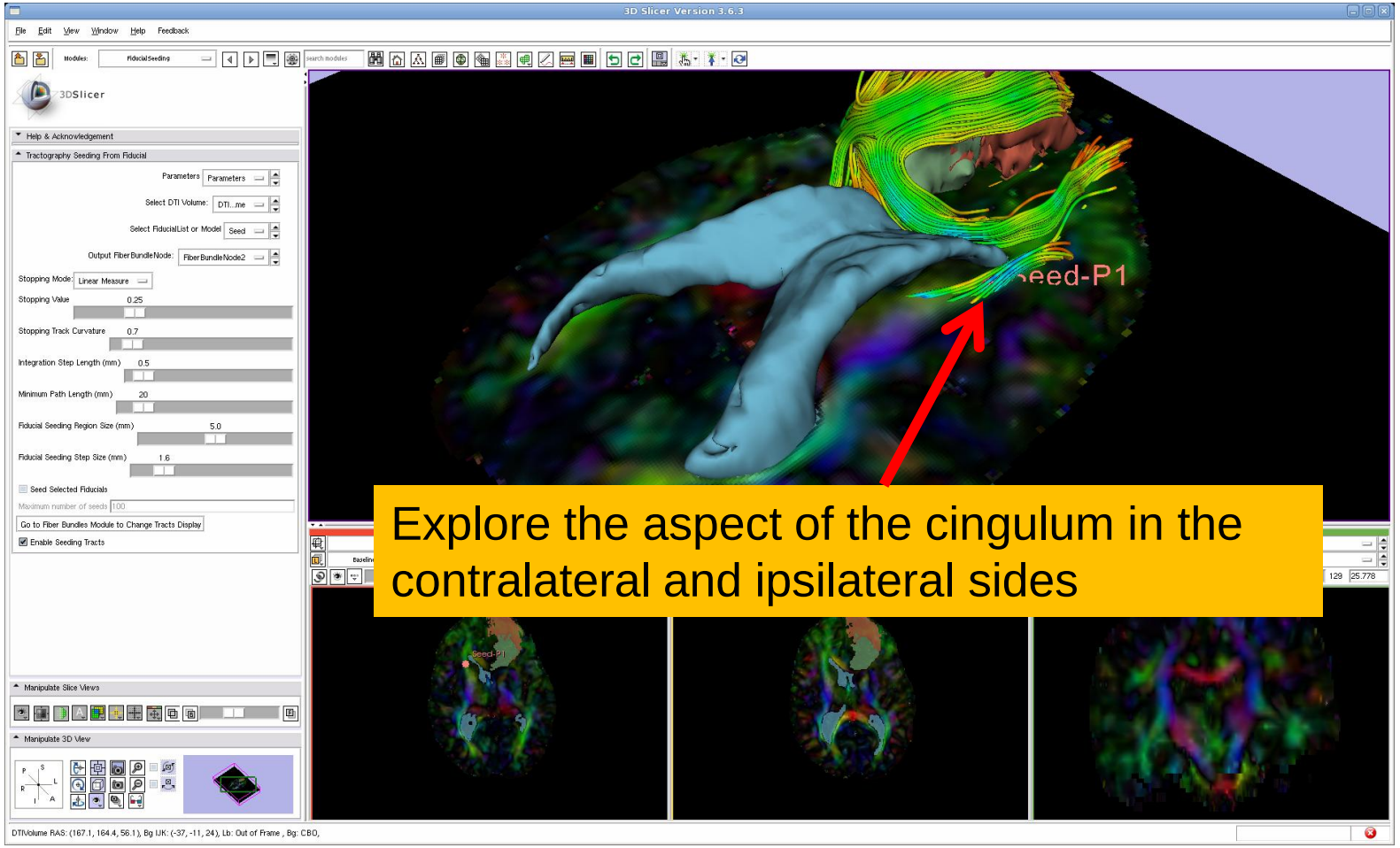
Tractography on-the-fly



Select the module Fiducial Seeding, and set the input parameters:
Select DTI Volume: DTIVolume
Select OutputFiberBundle: Create New
Select Fiducial List: Seed

Set the Fiducial Seeding Region to 2 mm and move the fiducial in the cingulum area

Tractography on-the-fly



Conclusion

- Fully integrated pipeline for semi-automated tumor segmentation and white matter tract reconstruction
- 3D interactive exploration of the white matter tracts surrounding a tumor (peri-tumoral tracts) for neurosurgical planning

Acknowledgments

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