Exploring Peritumoral White Matter Fibers for Neurosurgical Planning

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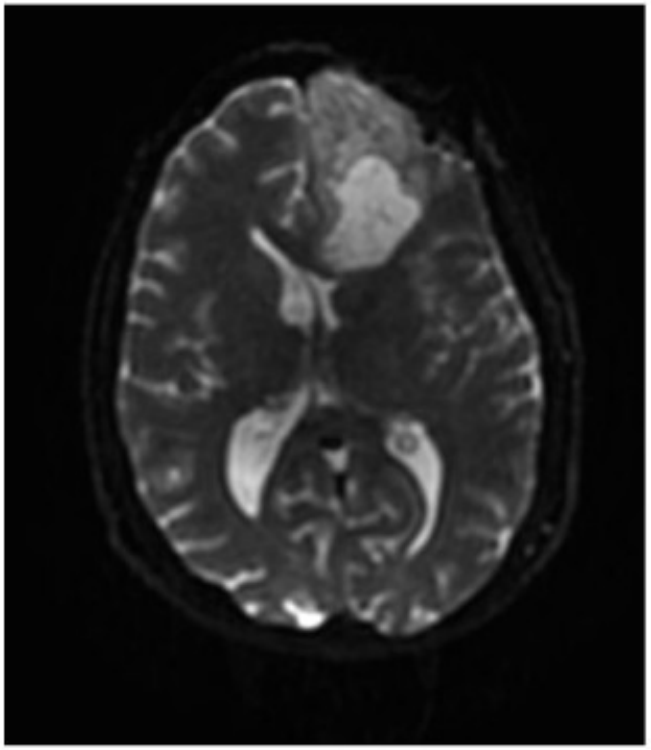
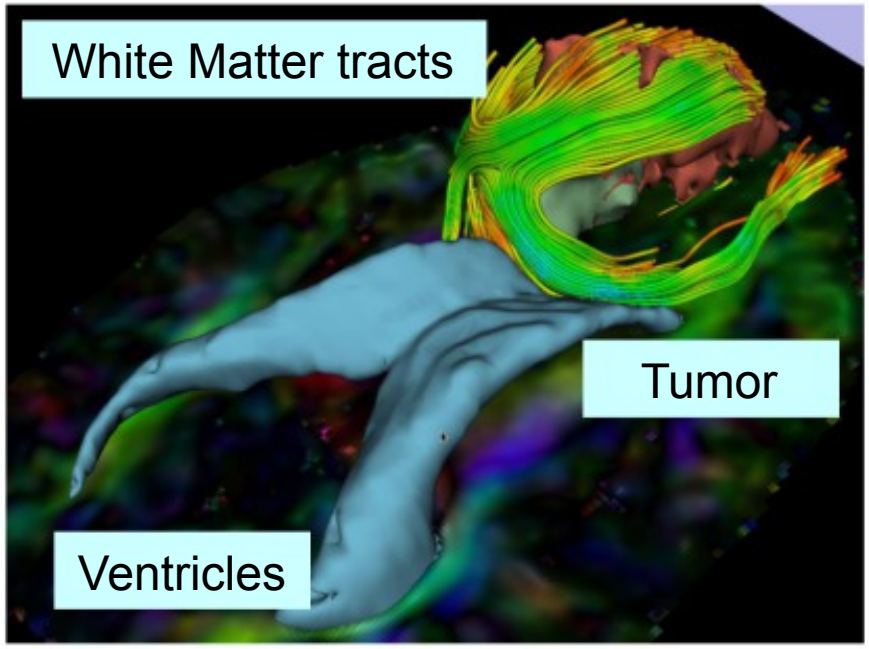
Clinical Case



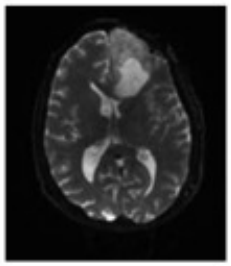
- 35 year-old male diagnosed with Glioblastoma multiform (GBM)
- Diffusion Weighted Imaging (DWI) acquisition for neurosurgical planning

Clinical Goal

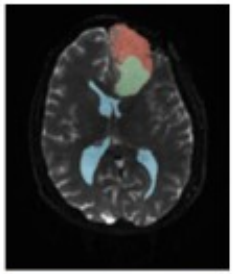


The goal of this tutorial is to explore white matter fibers surrounding a tumor using Diffusion Tensor Imaging (DTI) Tractography.

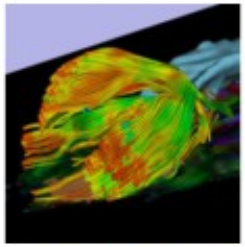
Overview of the analysis pipeline



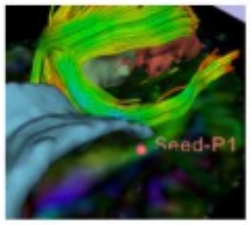
Part 1: Loading & Visualization of Diffusion Data



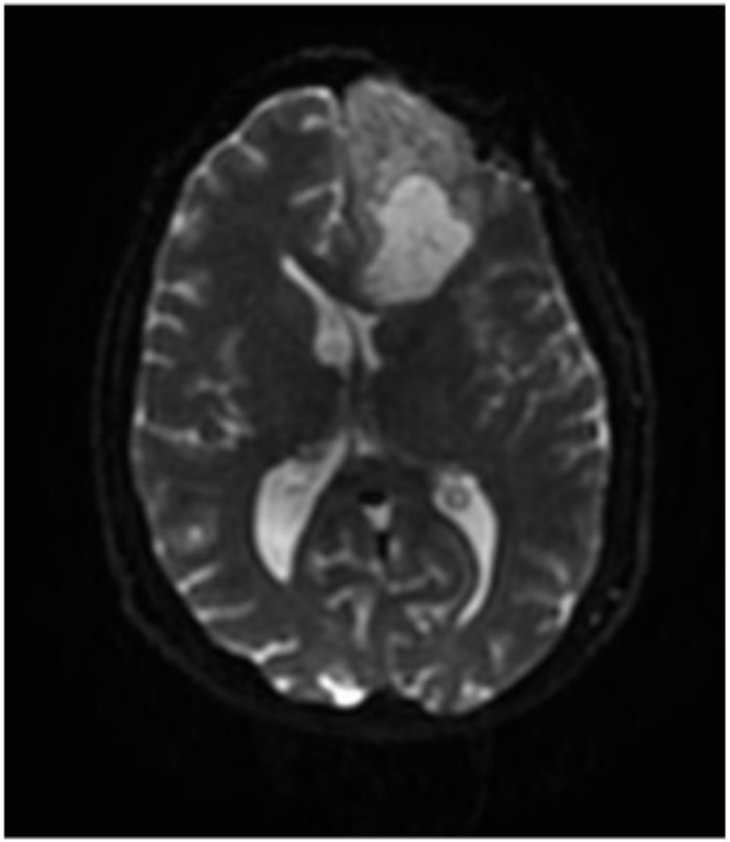
Part 2: Segmentation of lat. ventricles, and solid and cystic parts of the tumor



Part 3: Tractography reconstruction of white matter fibers in the peri-tumoral volume

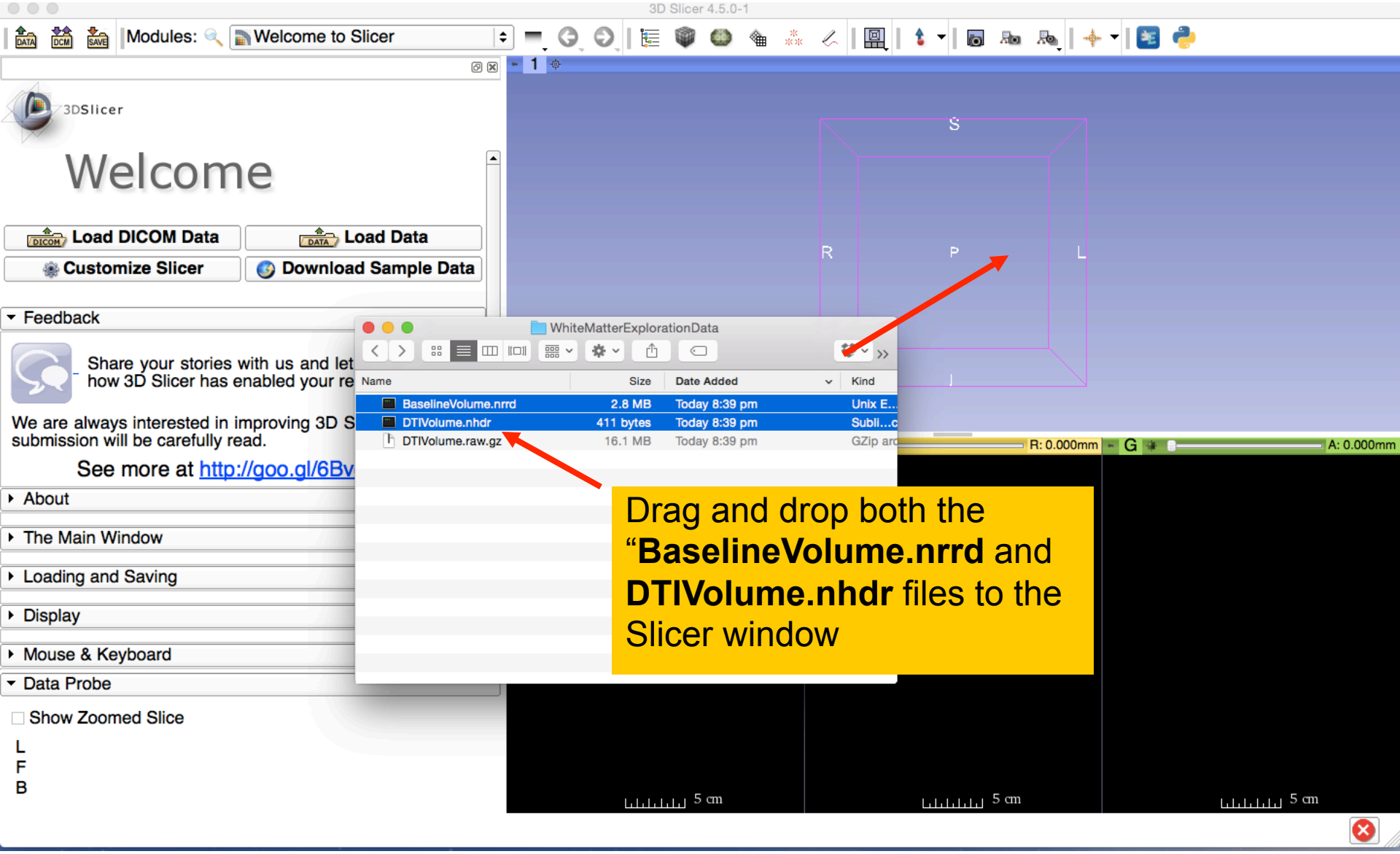


Part 4: Tractography exploration of the ipsilateral and contralateral side

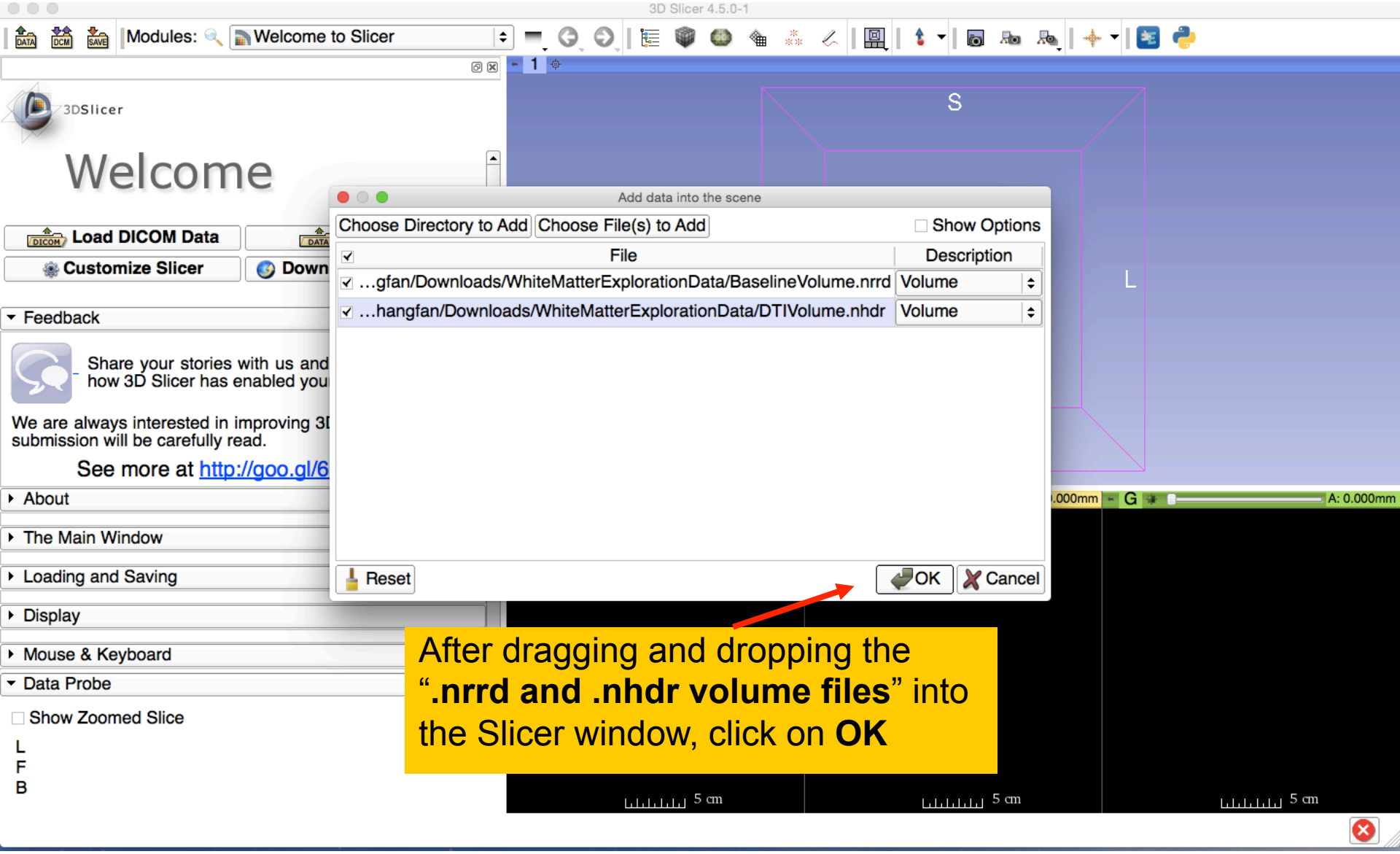


Part 1: Loading and Visualization of Diffusion Data

Loading DTI and Baseline Data

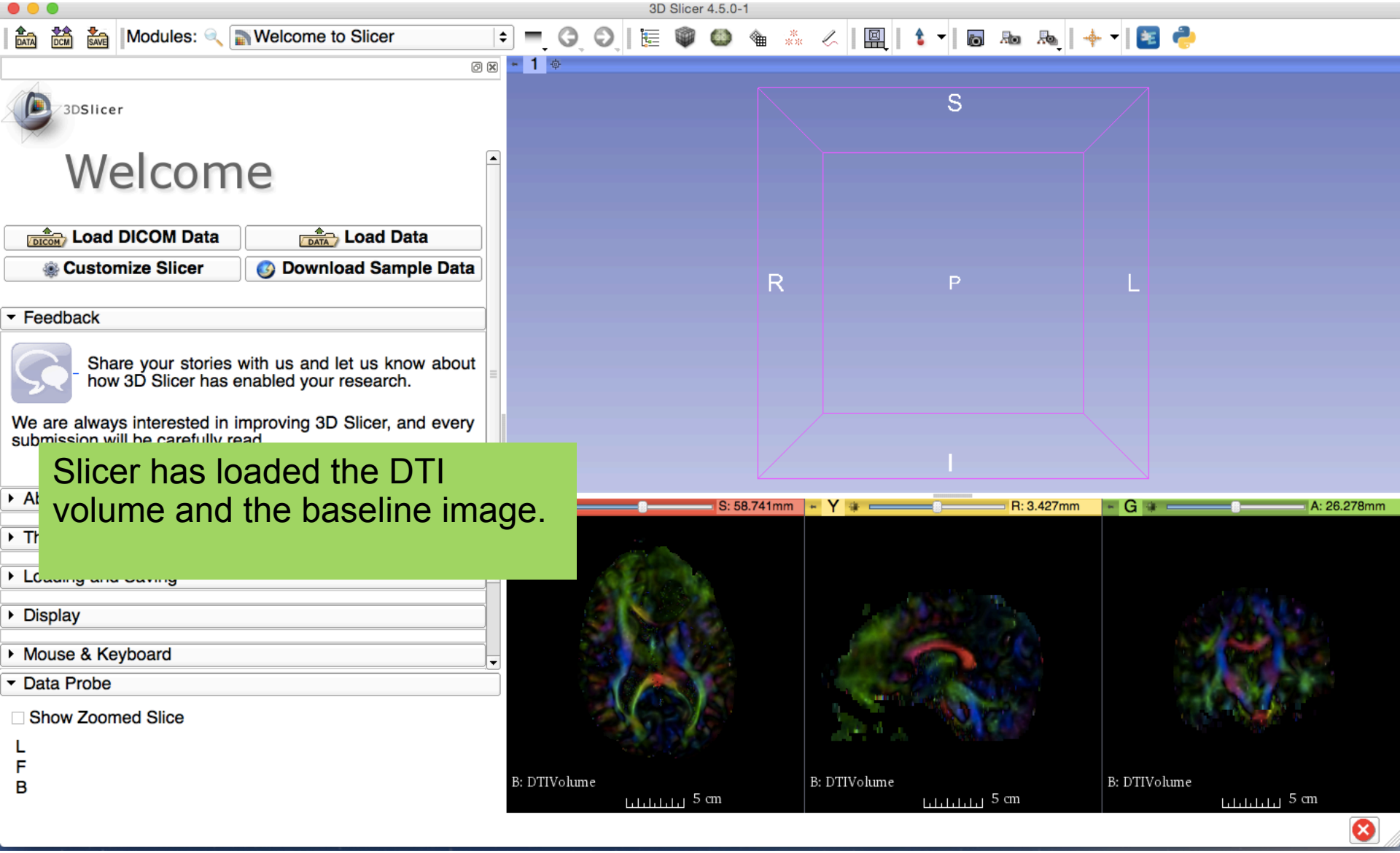


Loading DTI and Baseline Data



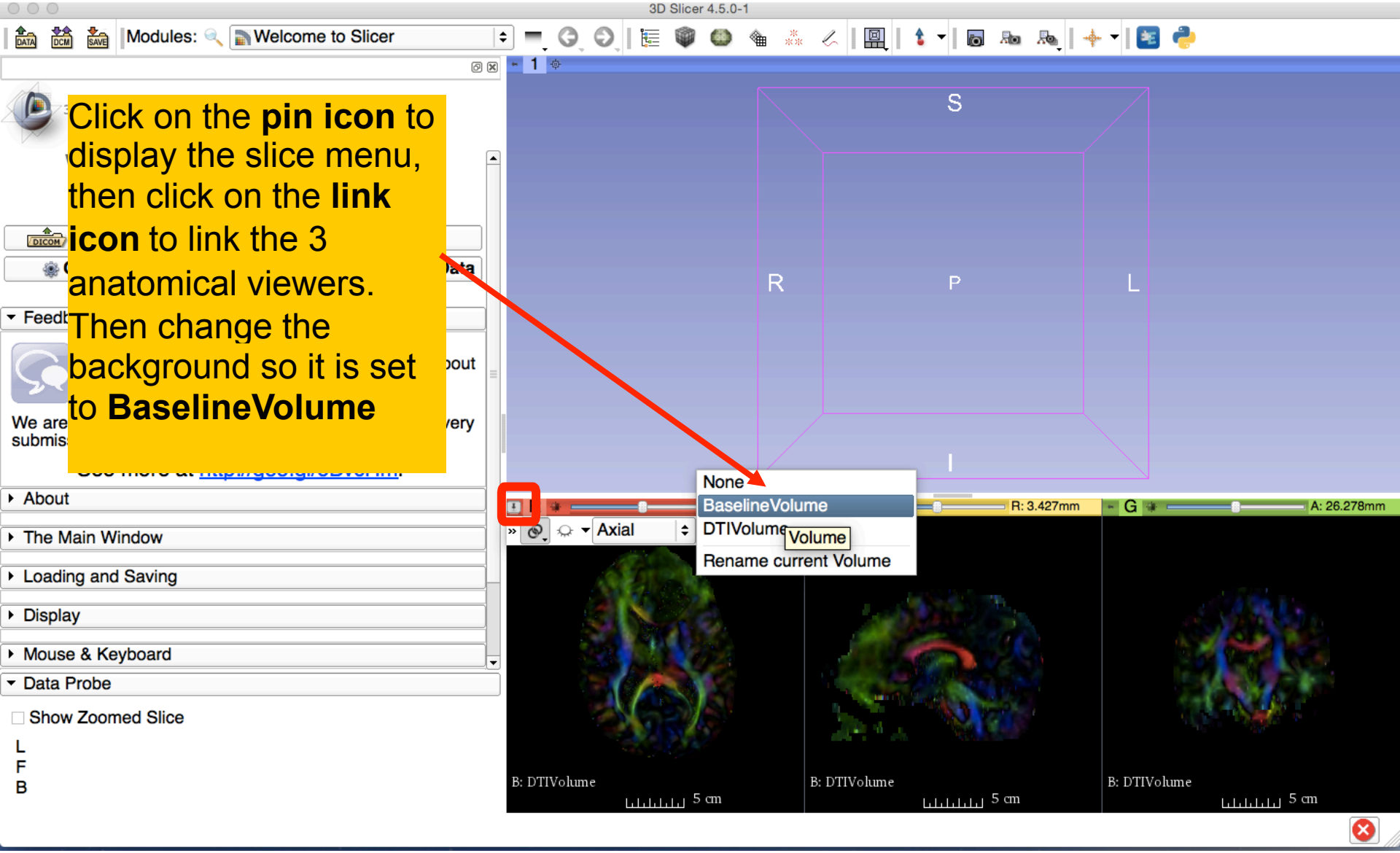
After dragging and dropping the "**.nrrd and .nhdr volume files**" into the Slicer window, click on **OK**

Loading DTI and Baseline Data

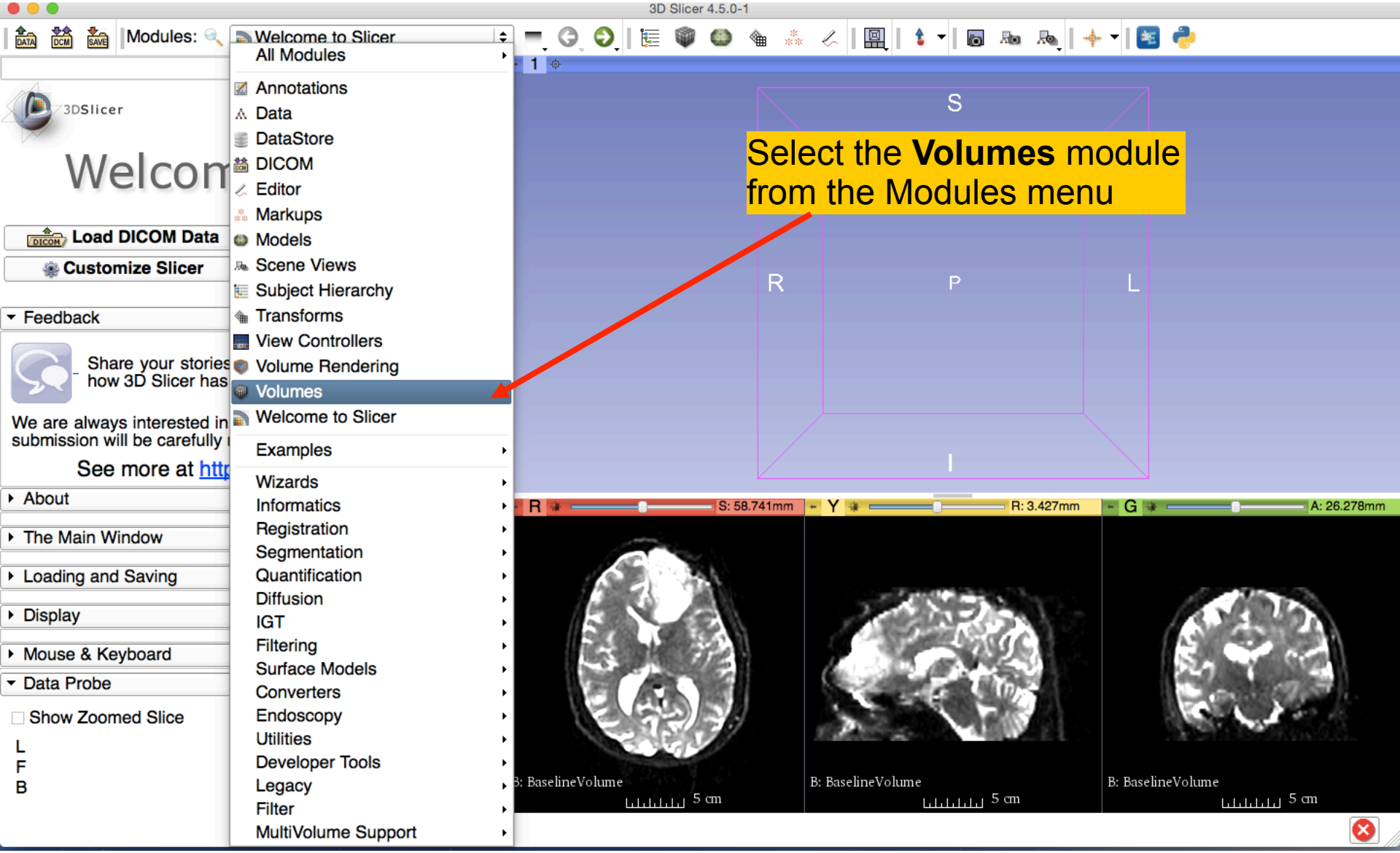


Slicer has loaded the DTI volume and the baseline image.

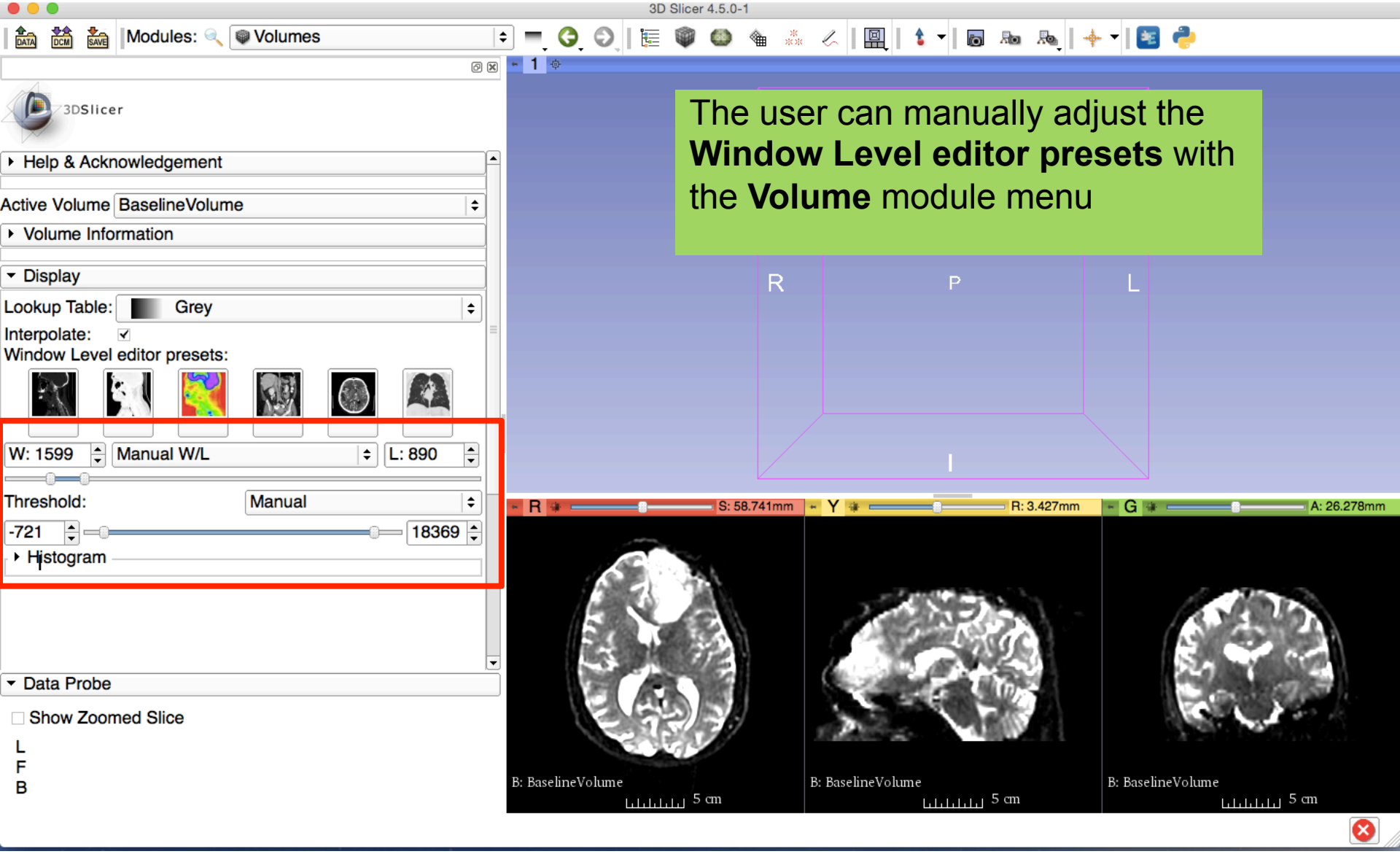
Loading DTI and Baseline Data



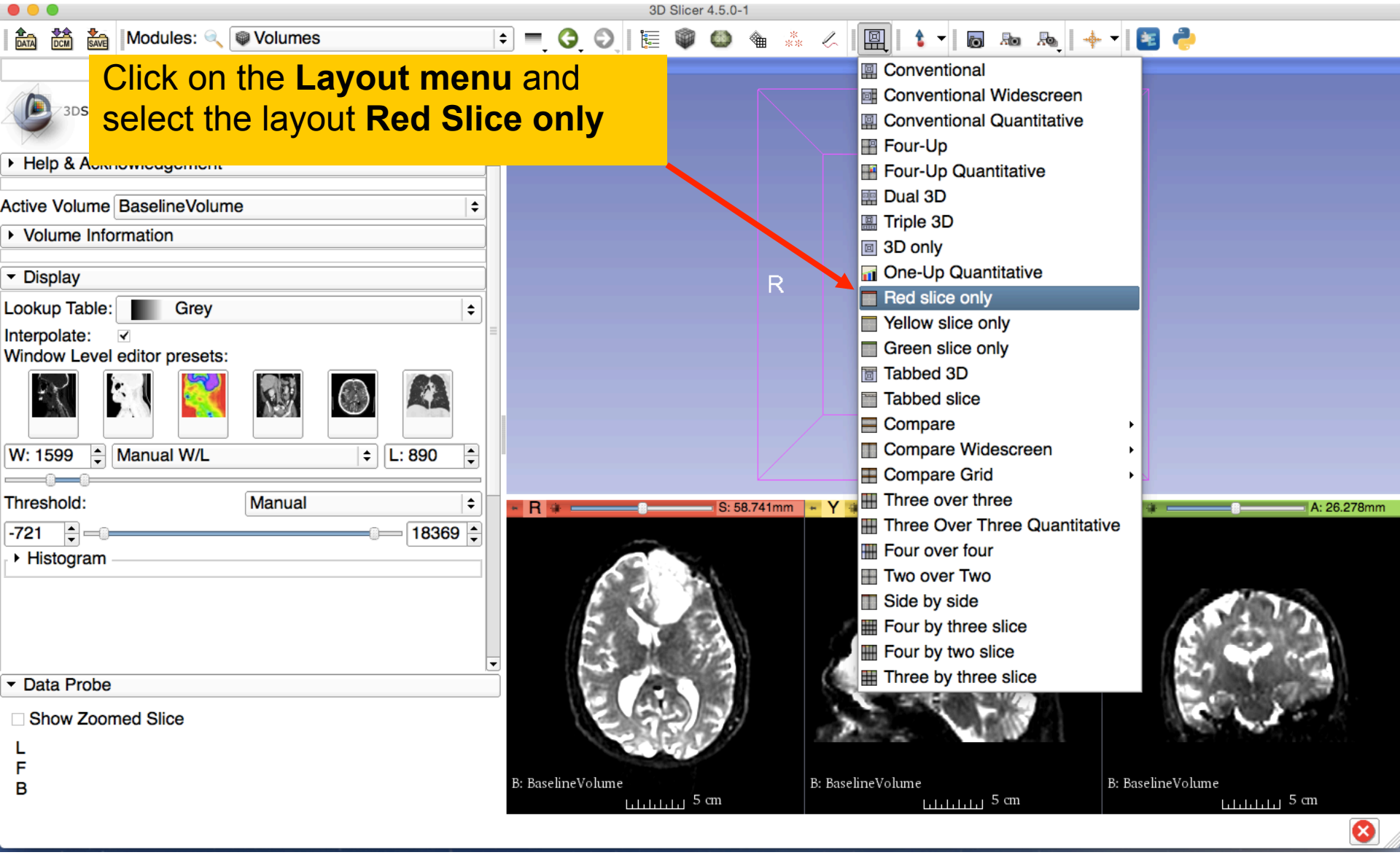
Loading DTI and Baseline Data

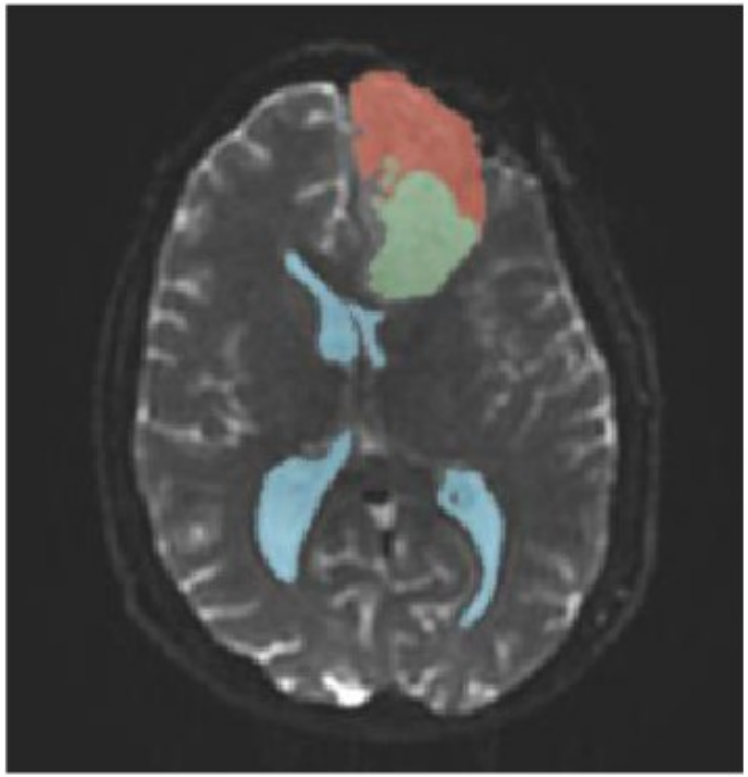


Loading DTI and Baseline Data



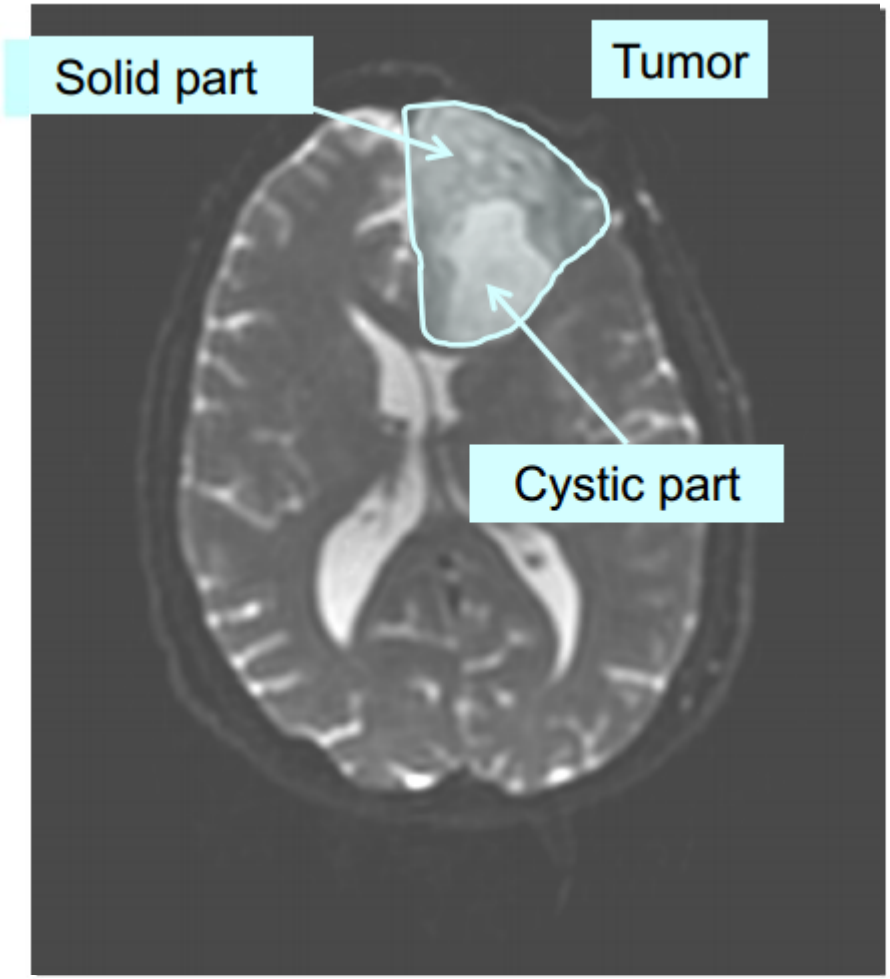
Loading DTI and Baseline Data





Part 1: Segmenting the tumor and ventricles

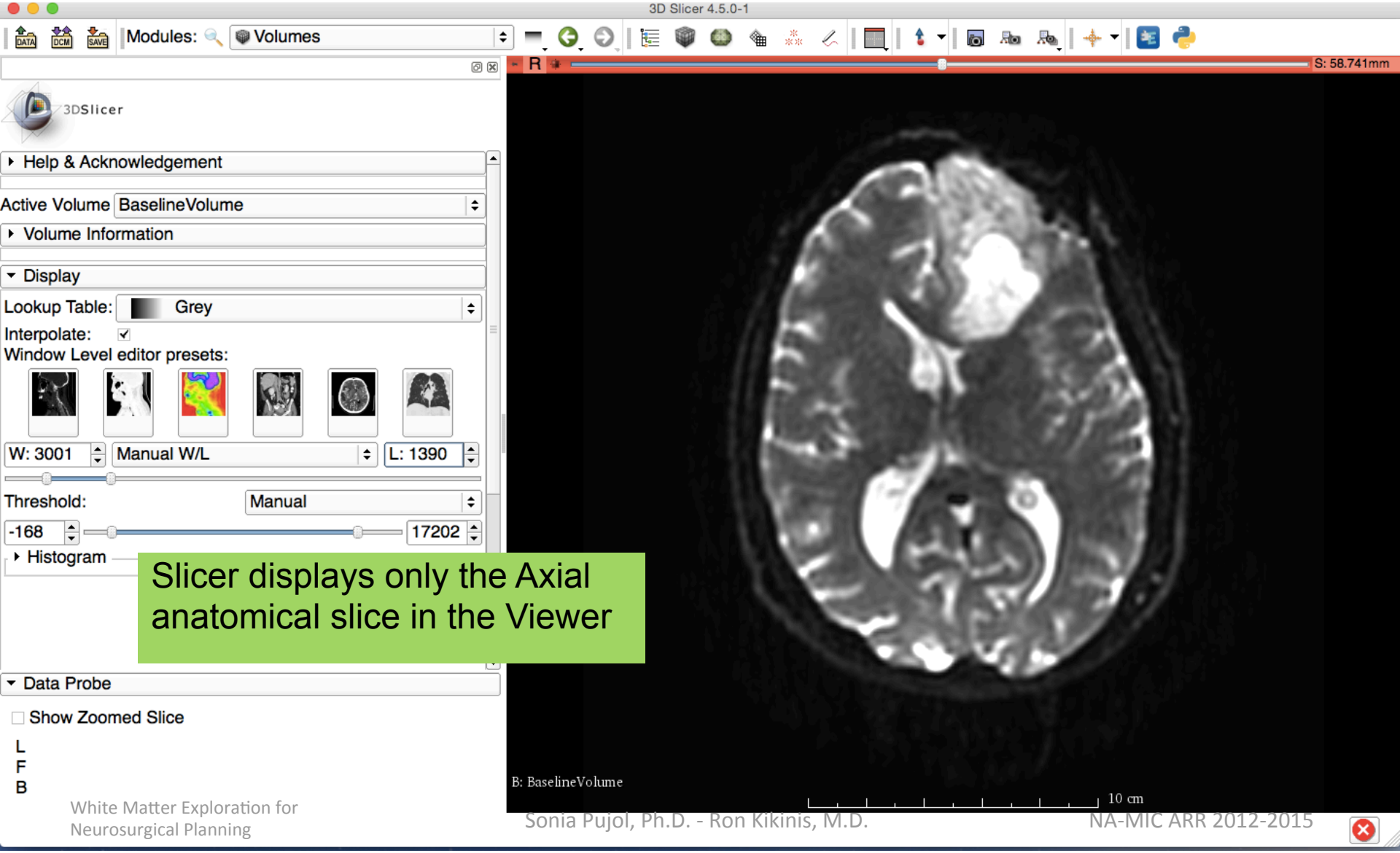
Tumor Segmentation



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

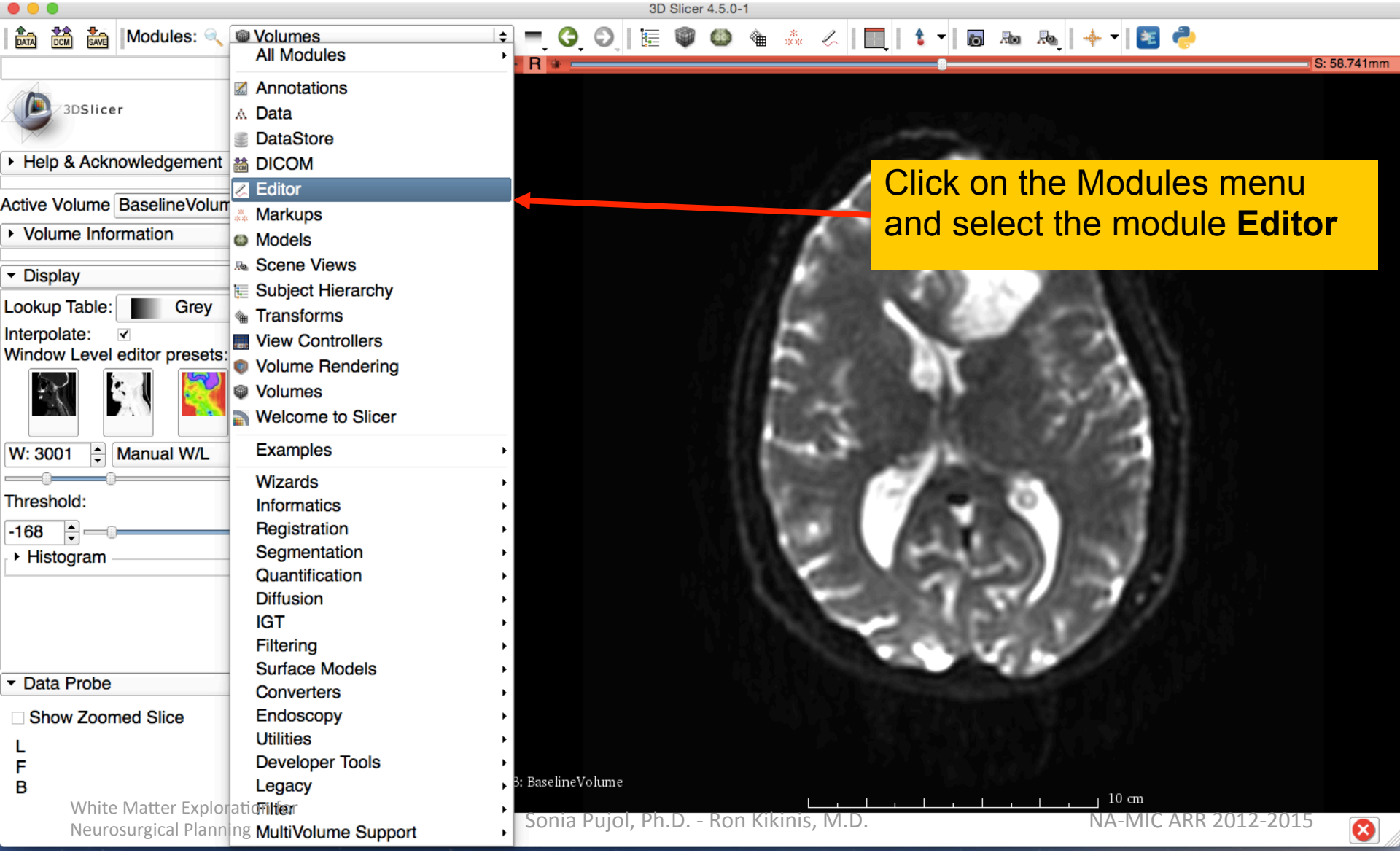
In this section, we will segment the different parts of the tumor using a Grow Cut Segmentation algorithm.

Tumor Segmentation

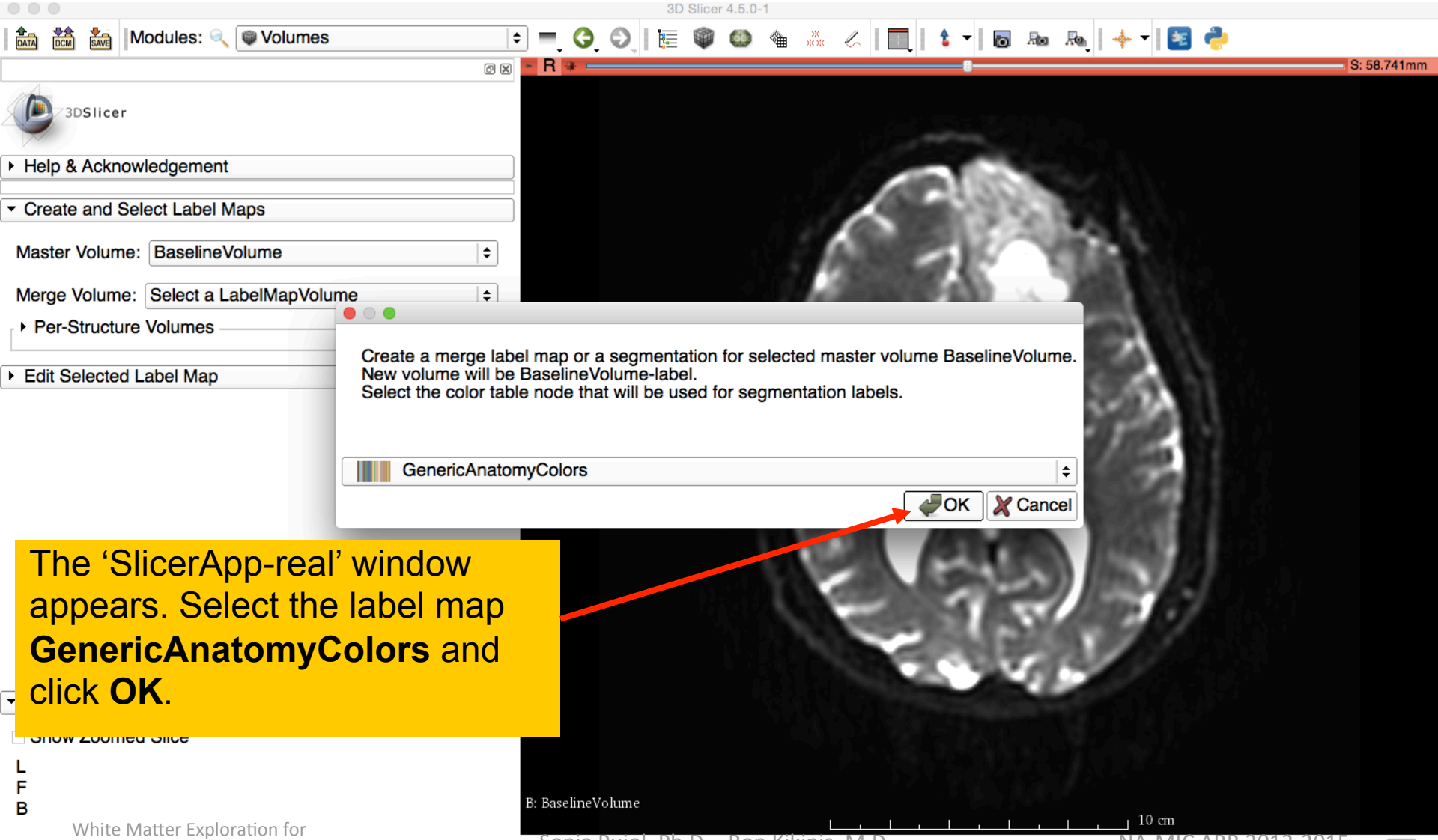


Slicer displays only the Axial anatomical slice in the Viewer

Tumor Segmentation

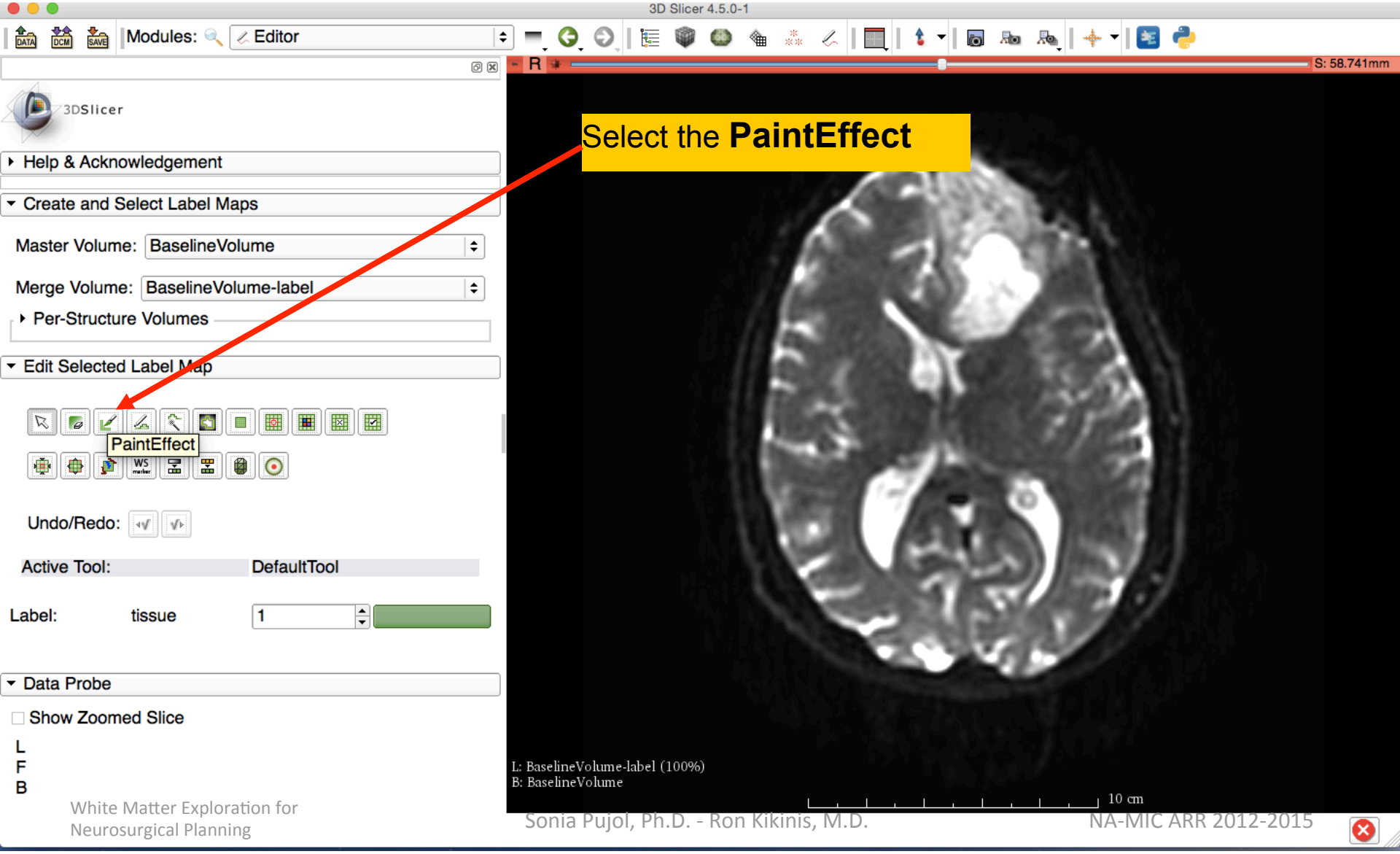


Tumor Segmentation

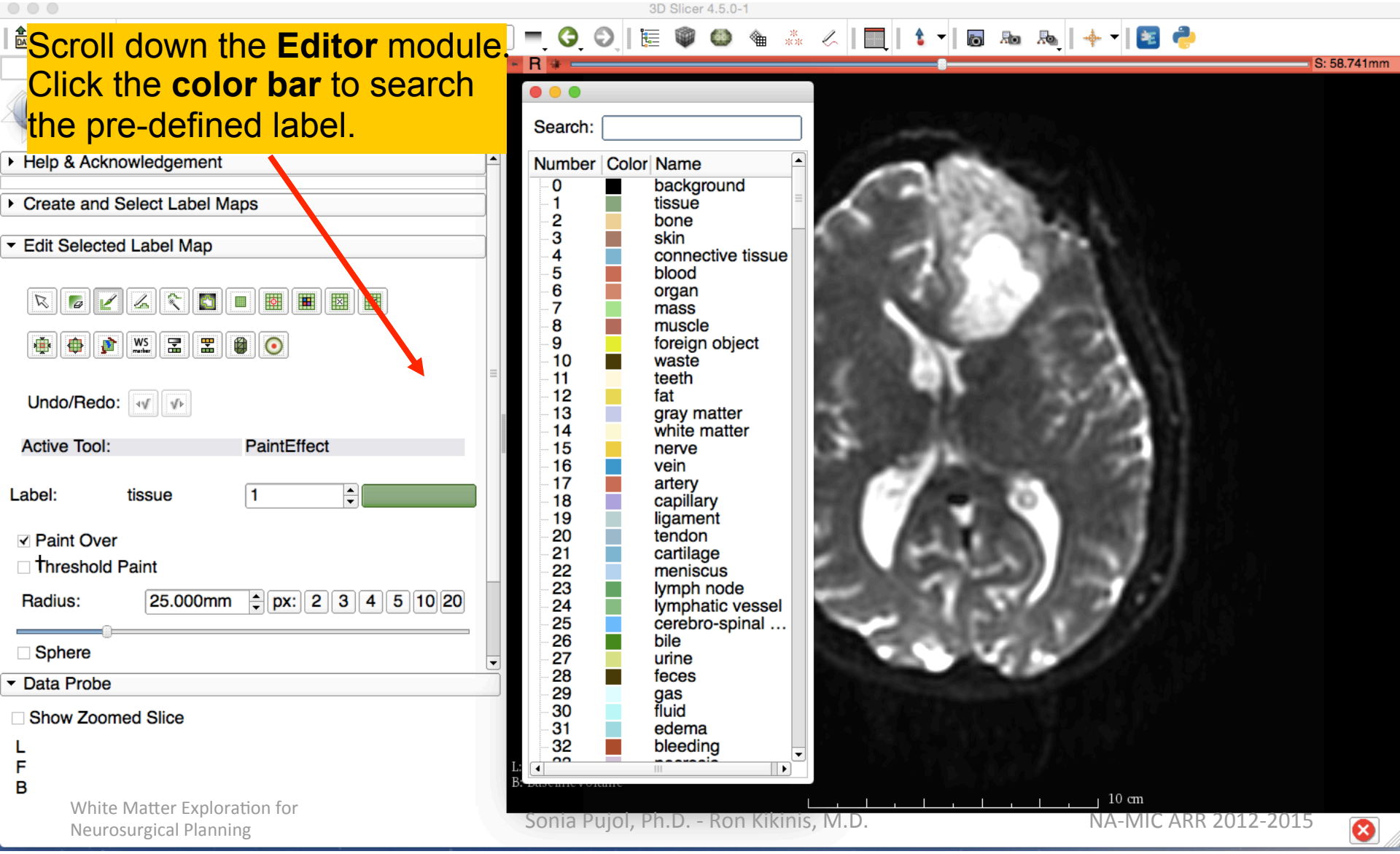


The ‘SlicerApp-real’ window appears. Select the label map **GenericAnatomyColors** and click **OK**.

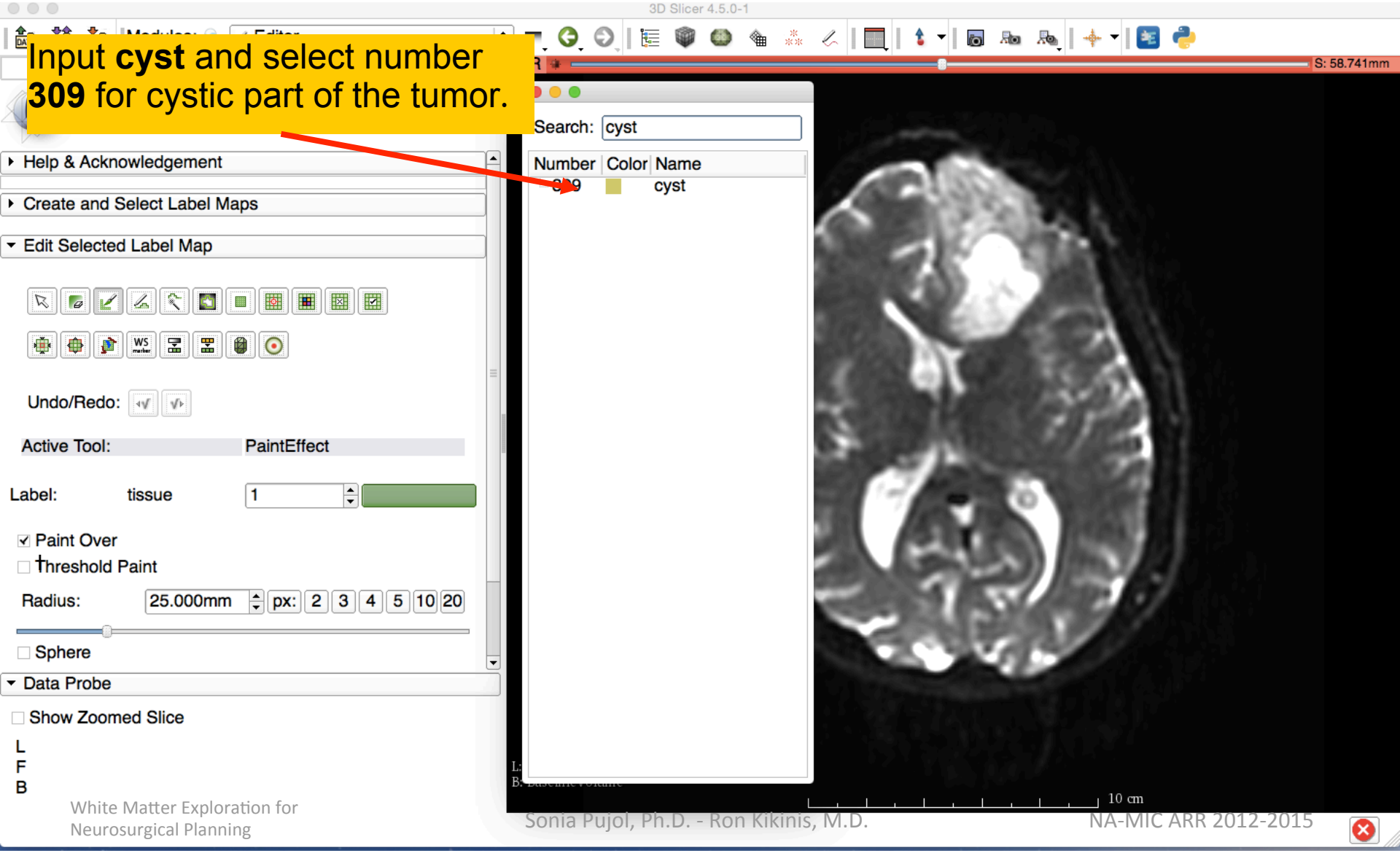
Tumor Segmentation



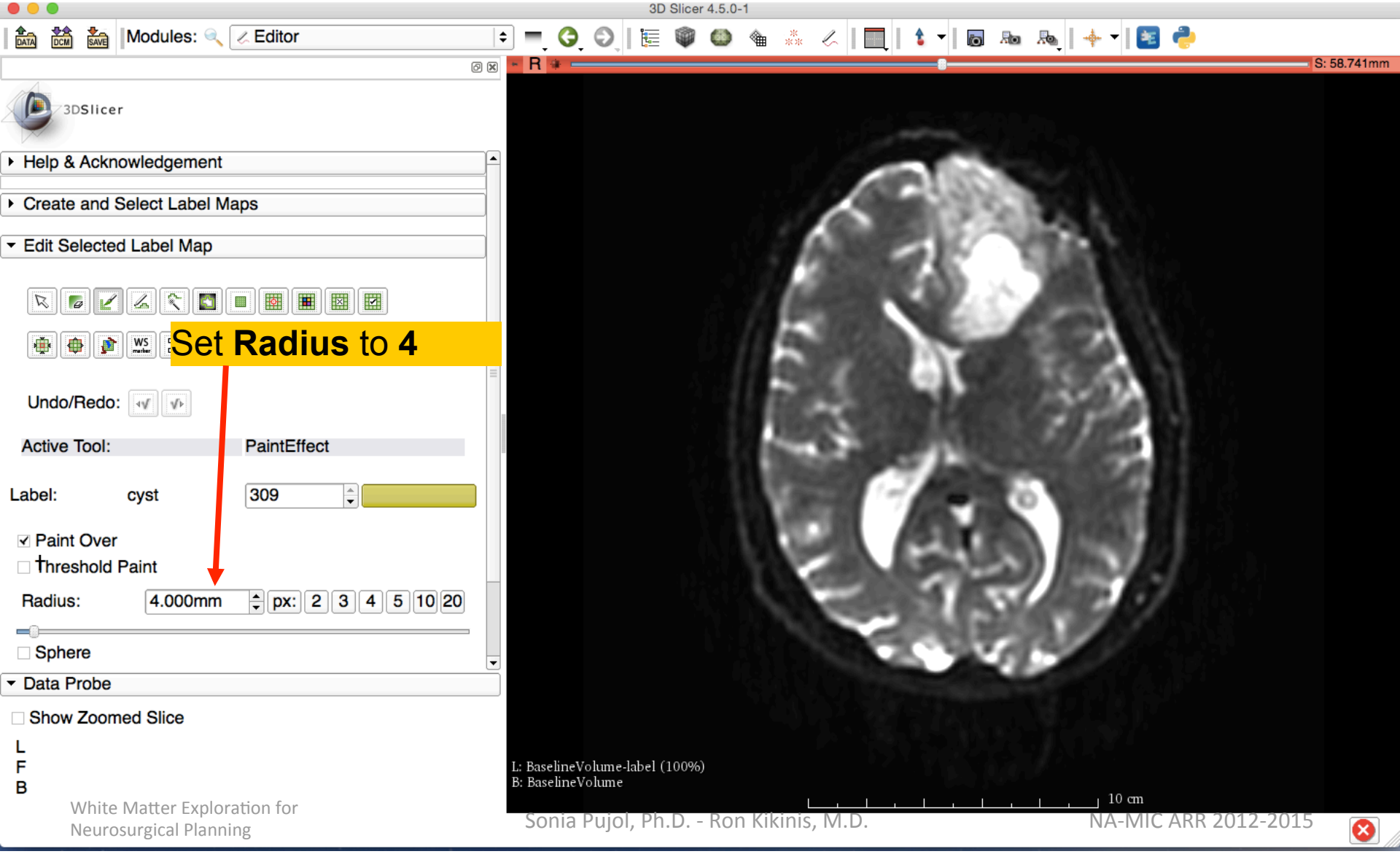
Tumor Segmentation



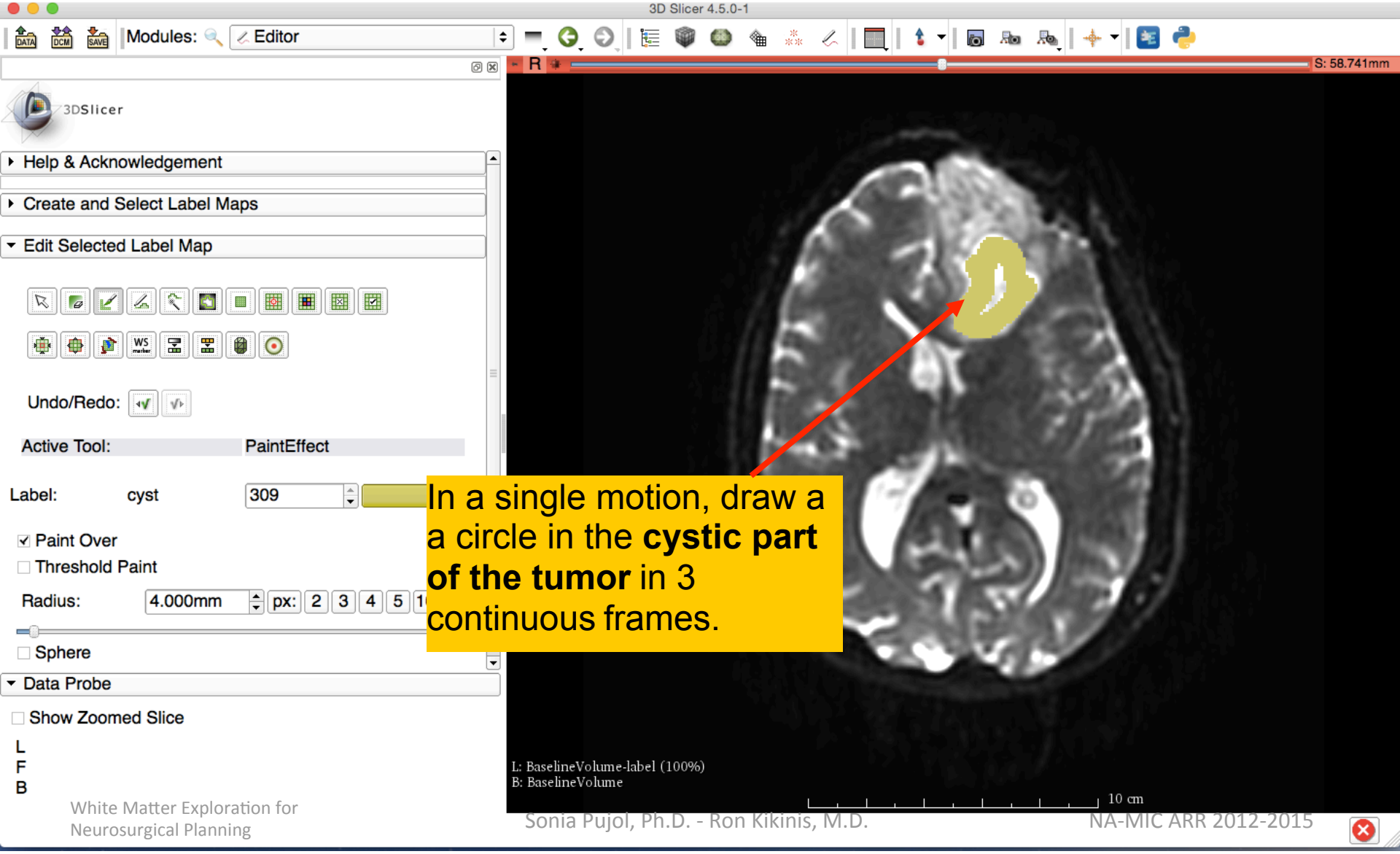
Tumor Segmentation



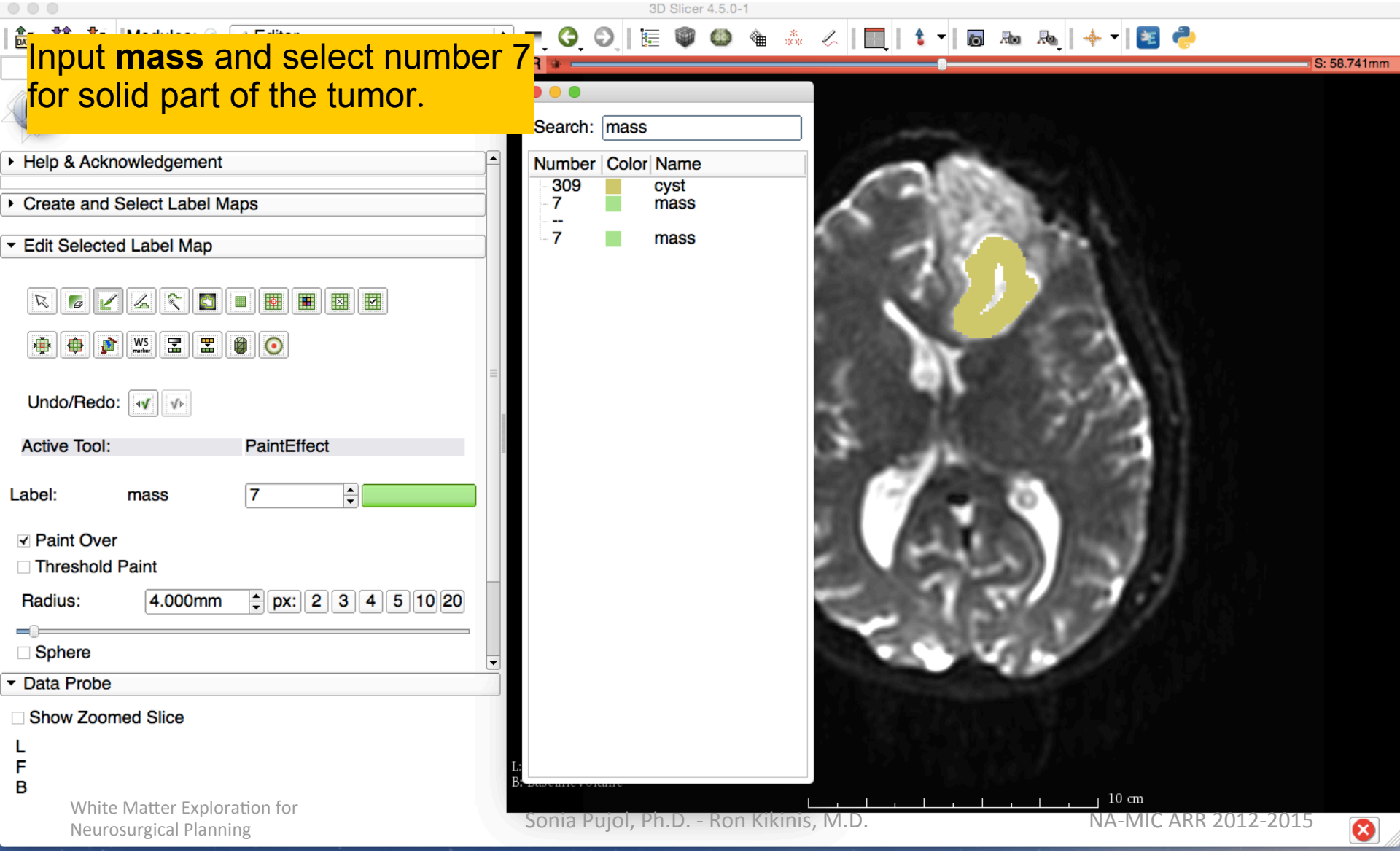
Tumor Segmentation



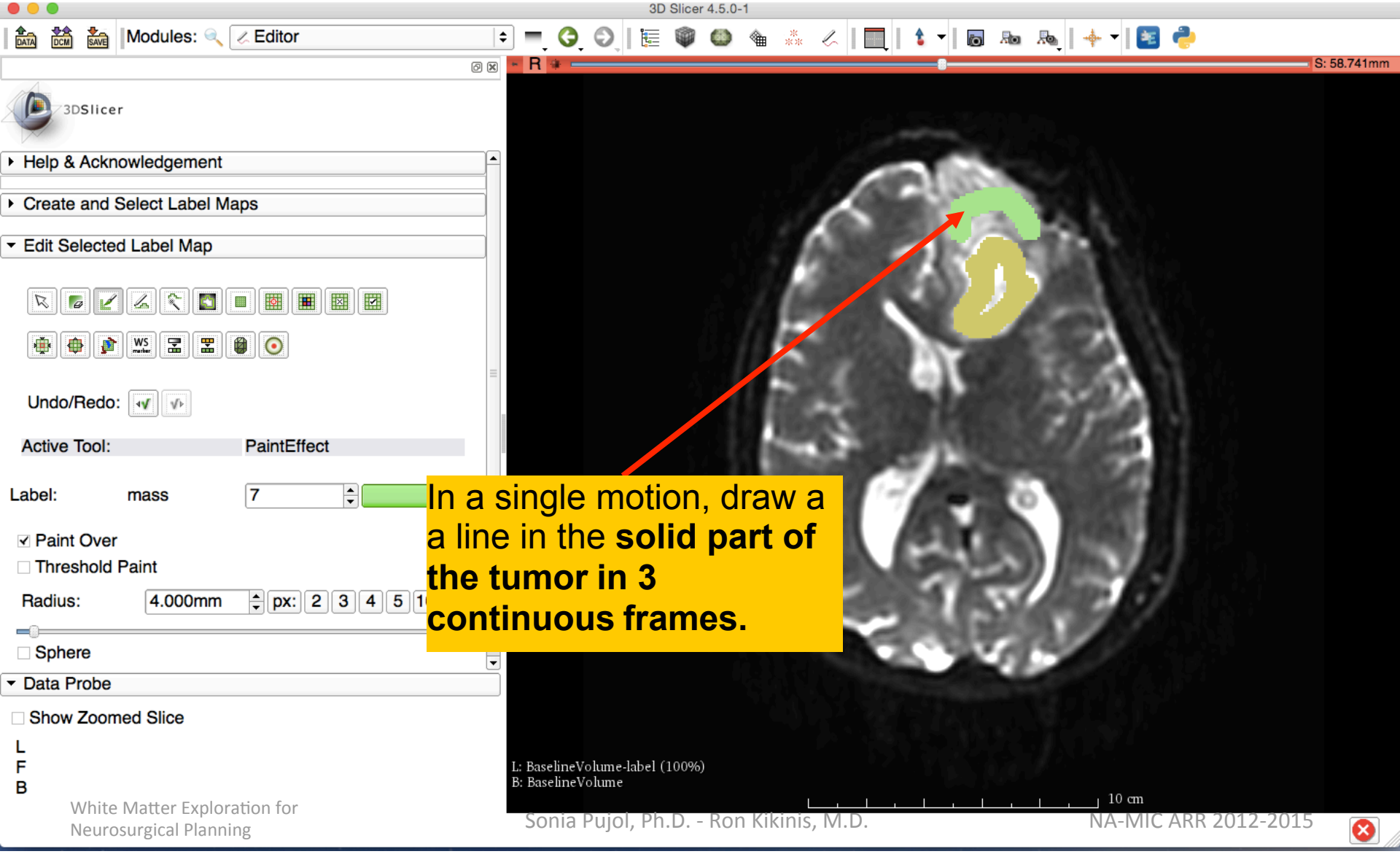
Tumor Segmentation



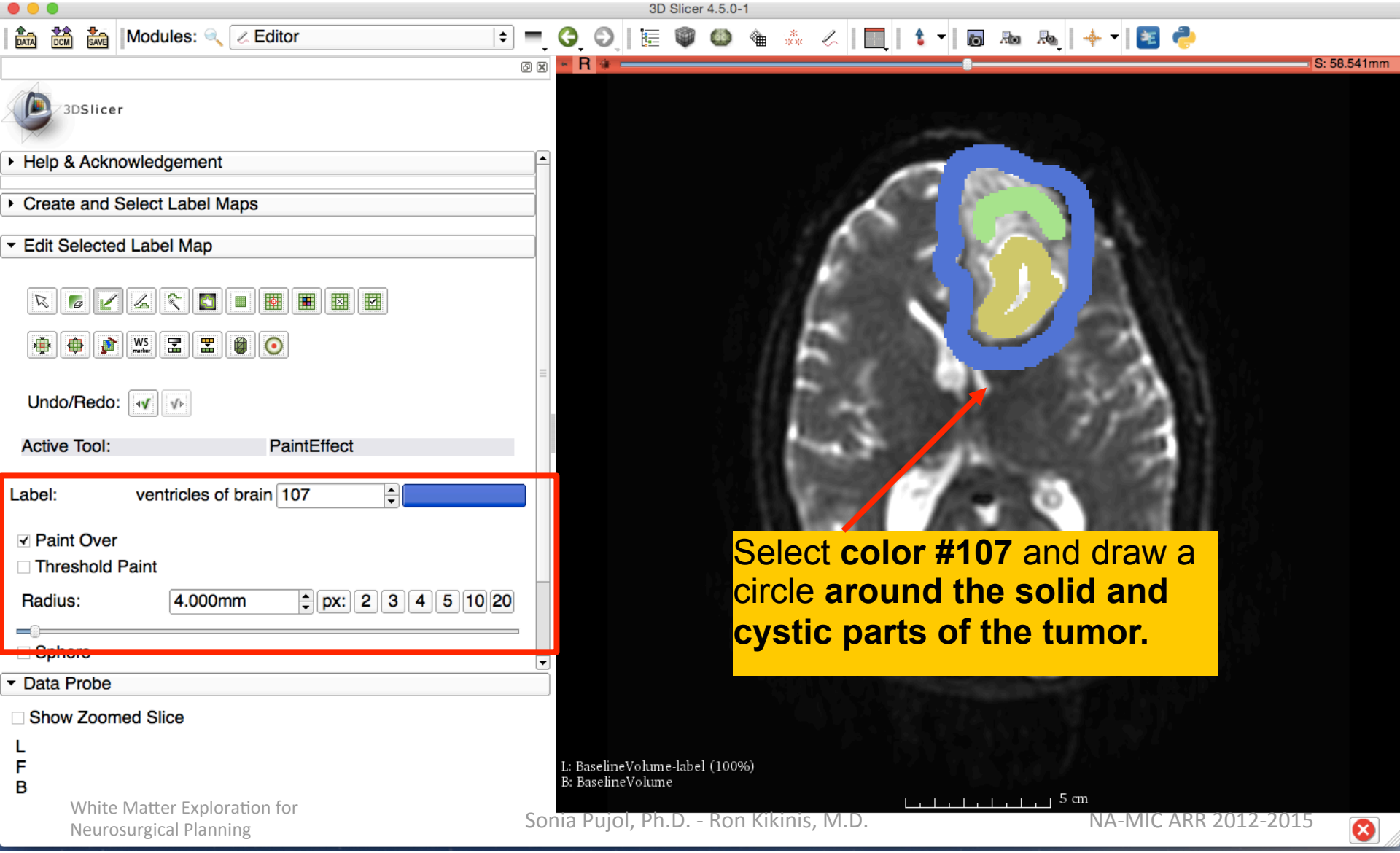
Tumor Segmentation



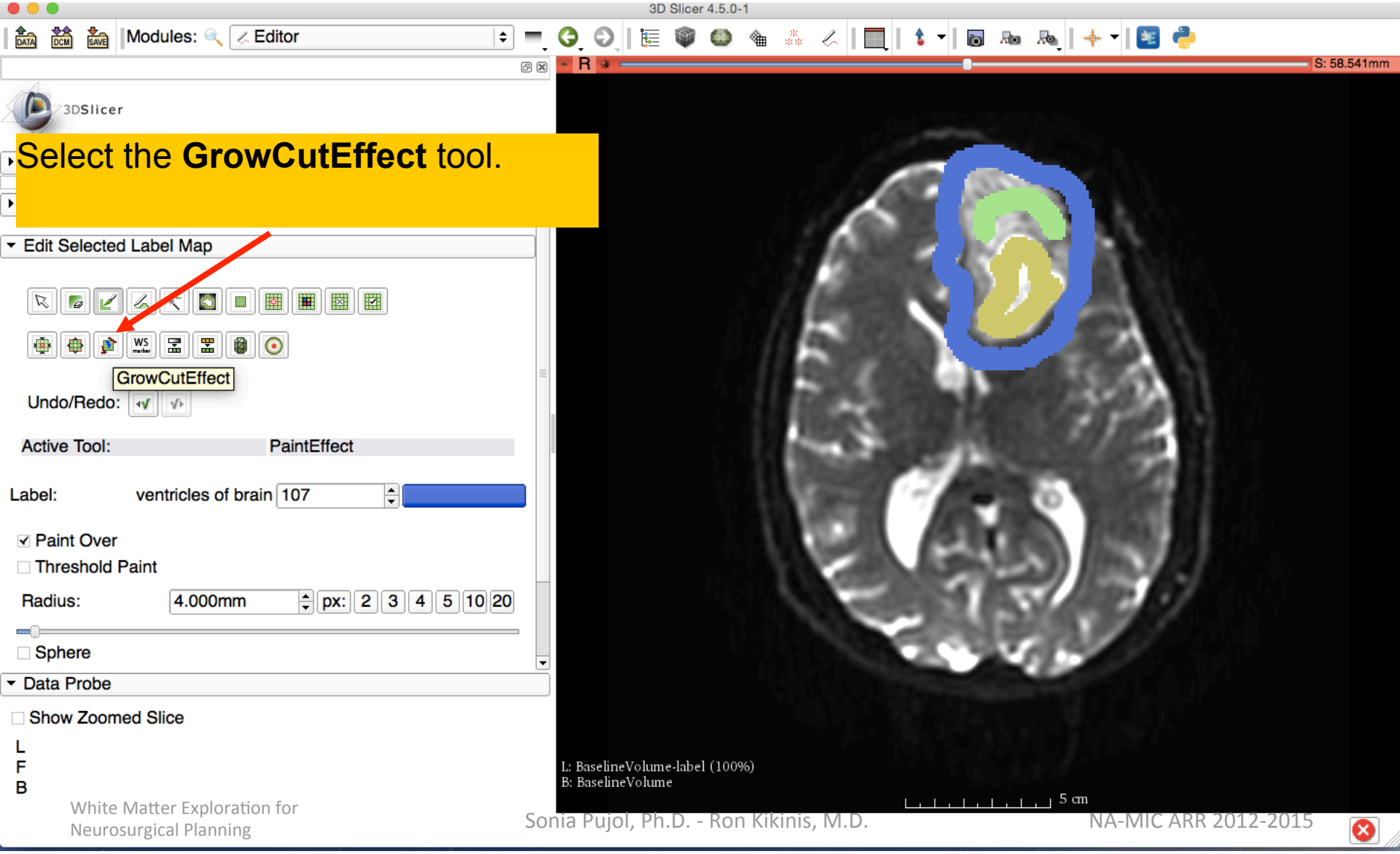
Tumor Segmentation



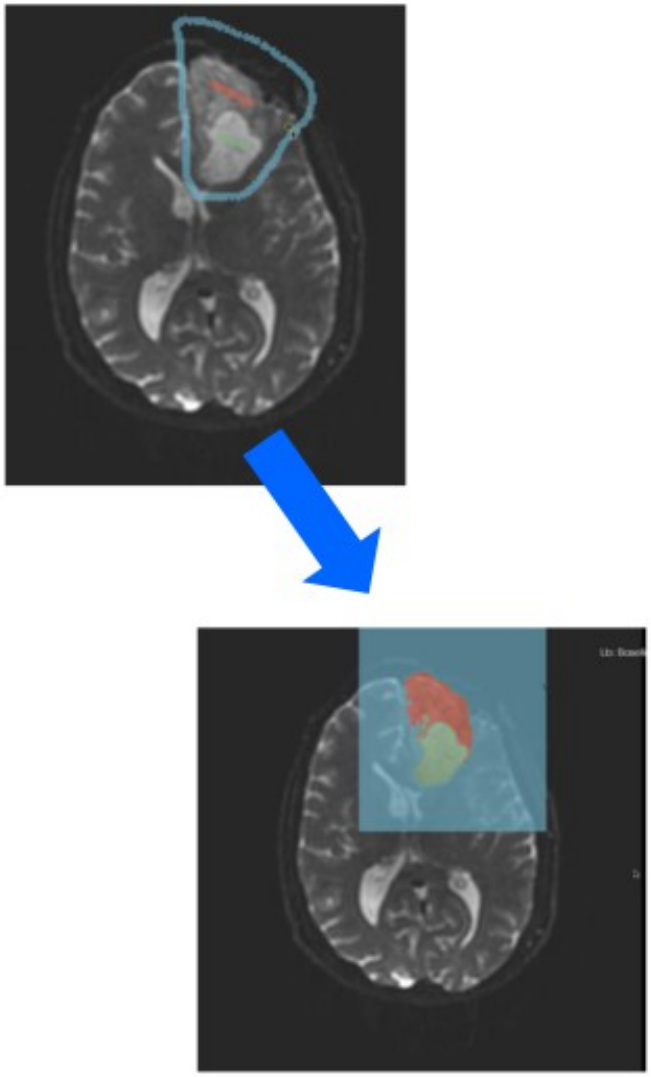
Tumor Segmentation



Tumor Segmentation

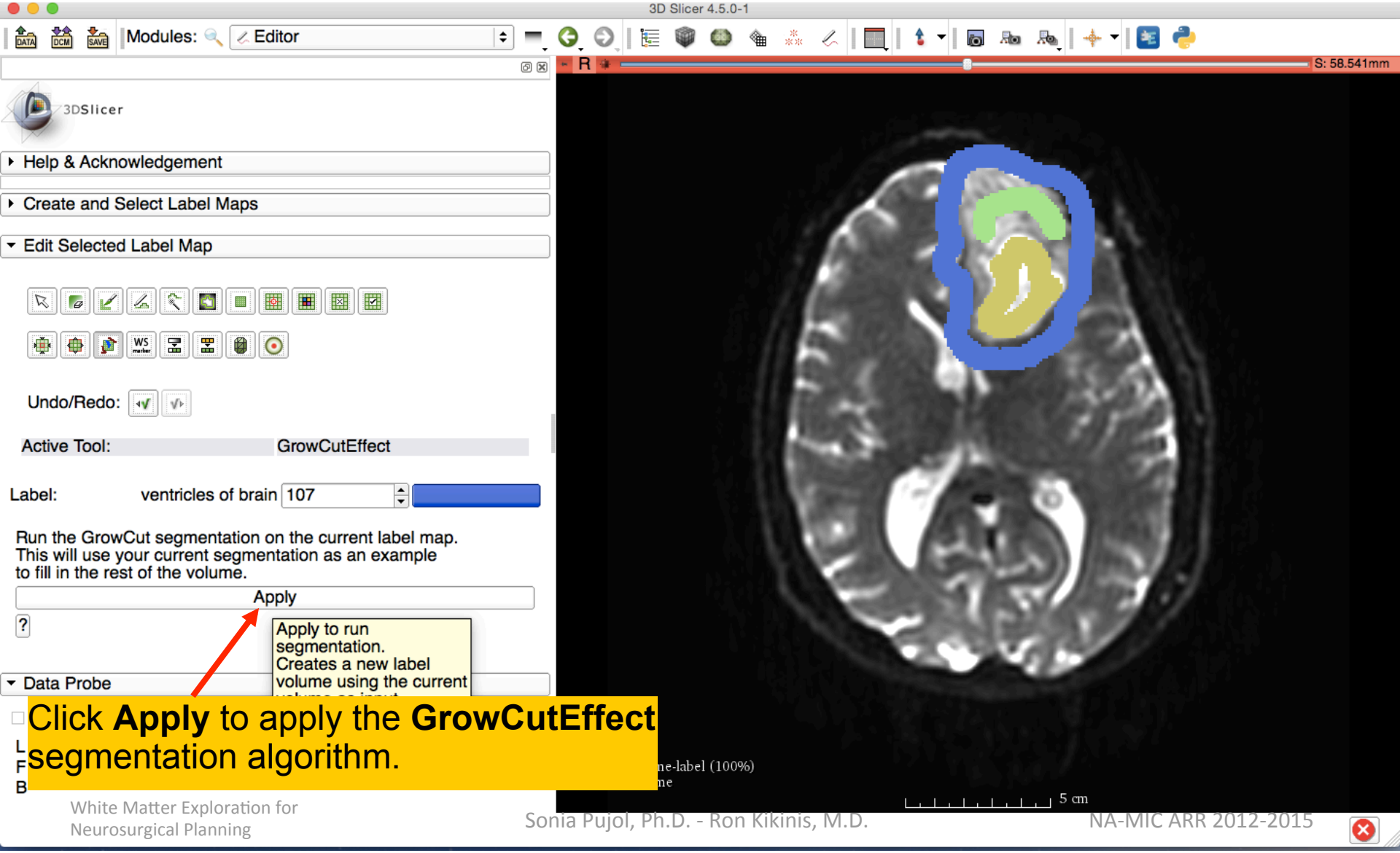


Grow Cut Segmentation

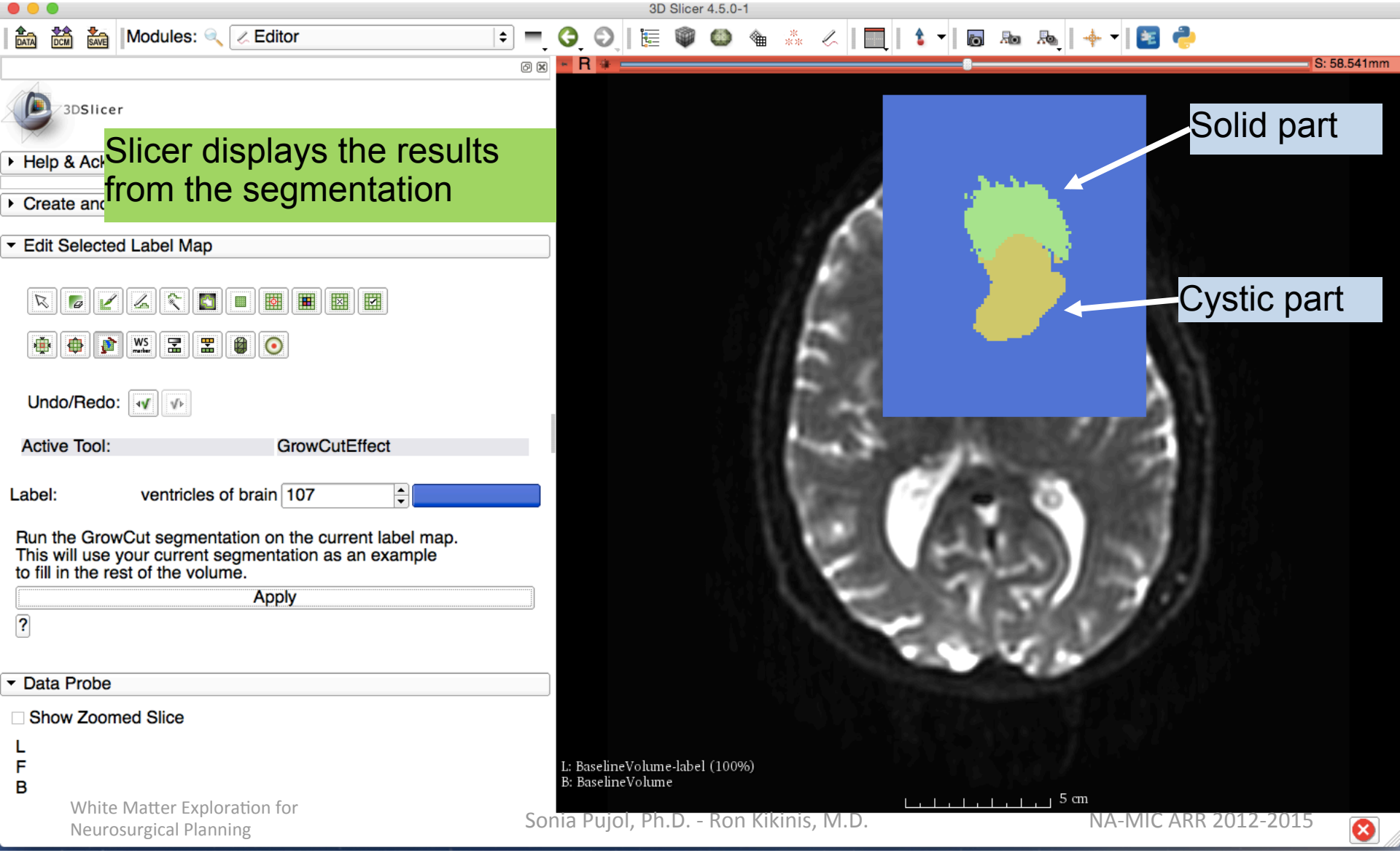


- The Grow Cut Segmentation method is a competitive region growing algorithm using Cellular Automata.
- The algorithm performs multi-label image segmentation using a set of user input scribbles.
- V. Vezhnevets, V. Konouchine. "Grow-Cut" - Interactive Multi-Label N-D Image Segmentation". Proc. Graphicon. 2005 . pp. 150-156.

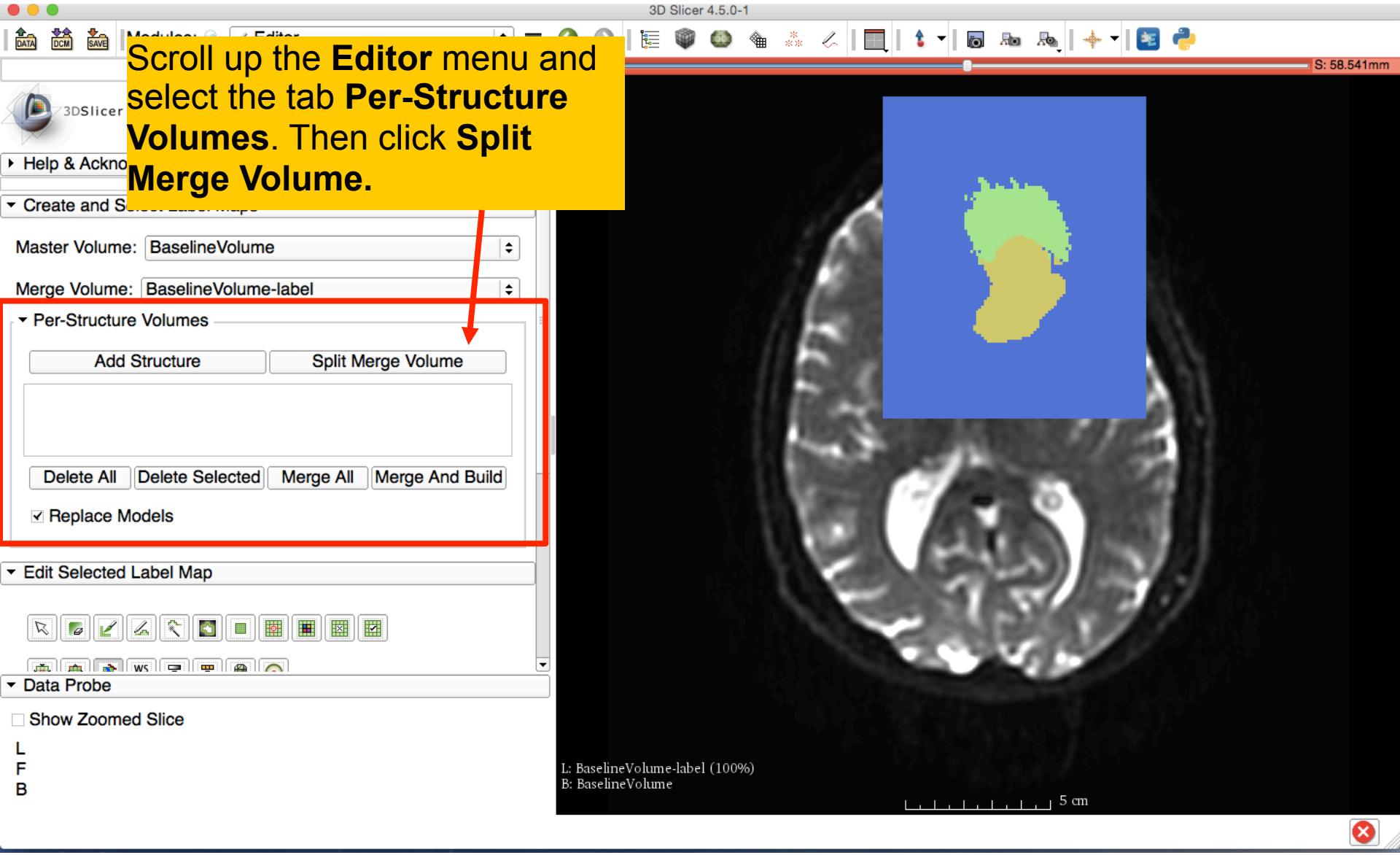
Tumor Segmentation



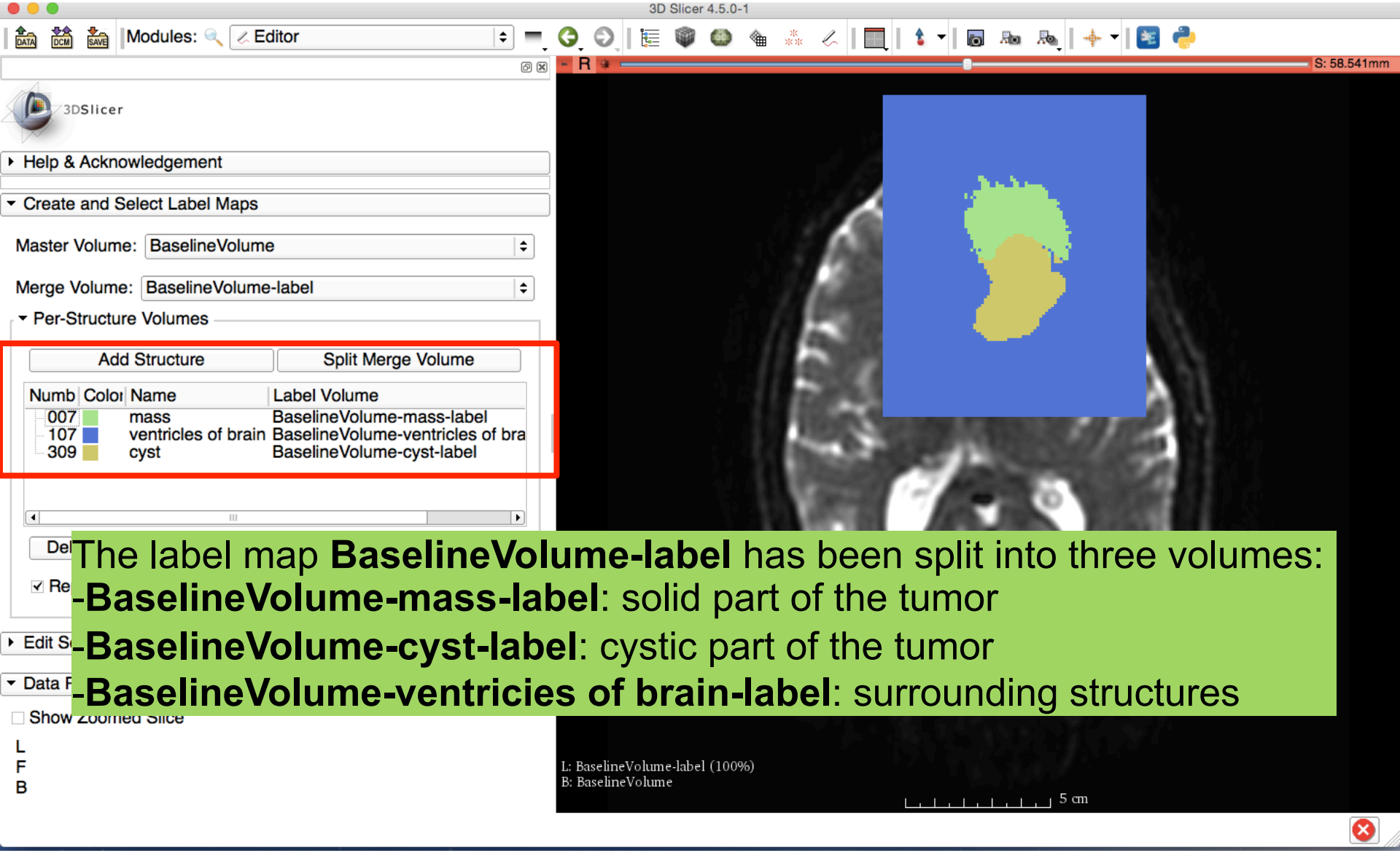
Tumor Segmentation



Tumor Segmentation



Tumor Segmentation



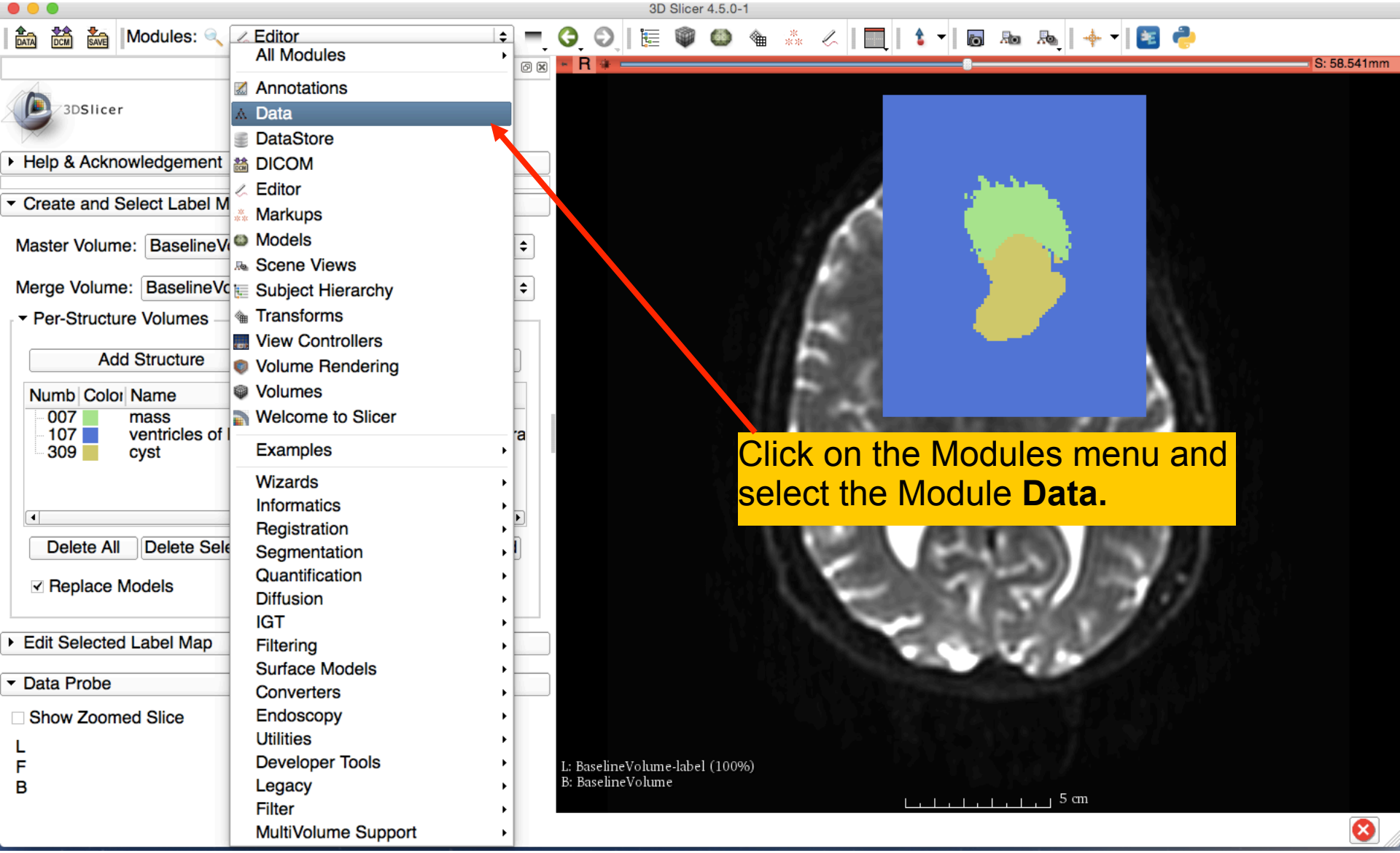
The label map **BaselineVolume-label** has been split into three volumes:

-**BaselineVolume-mass-label**: solid part of the tumor

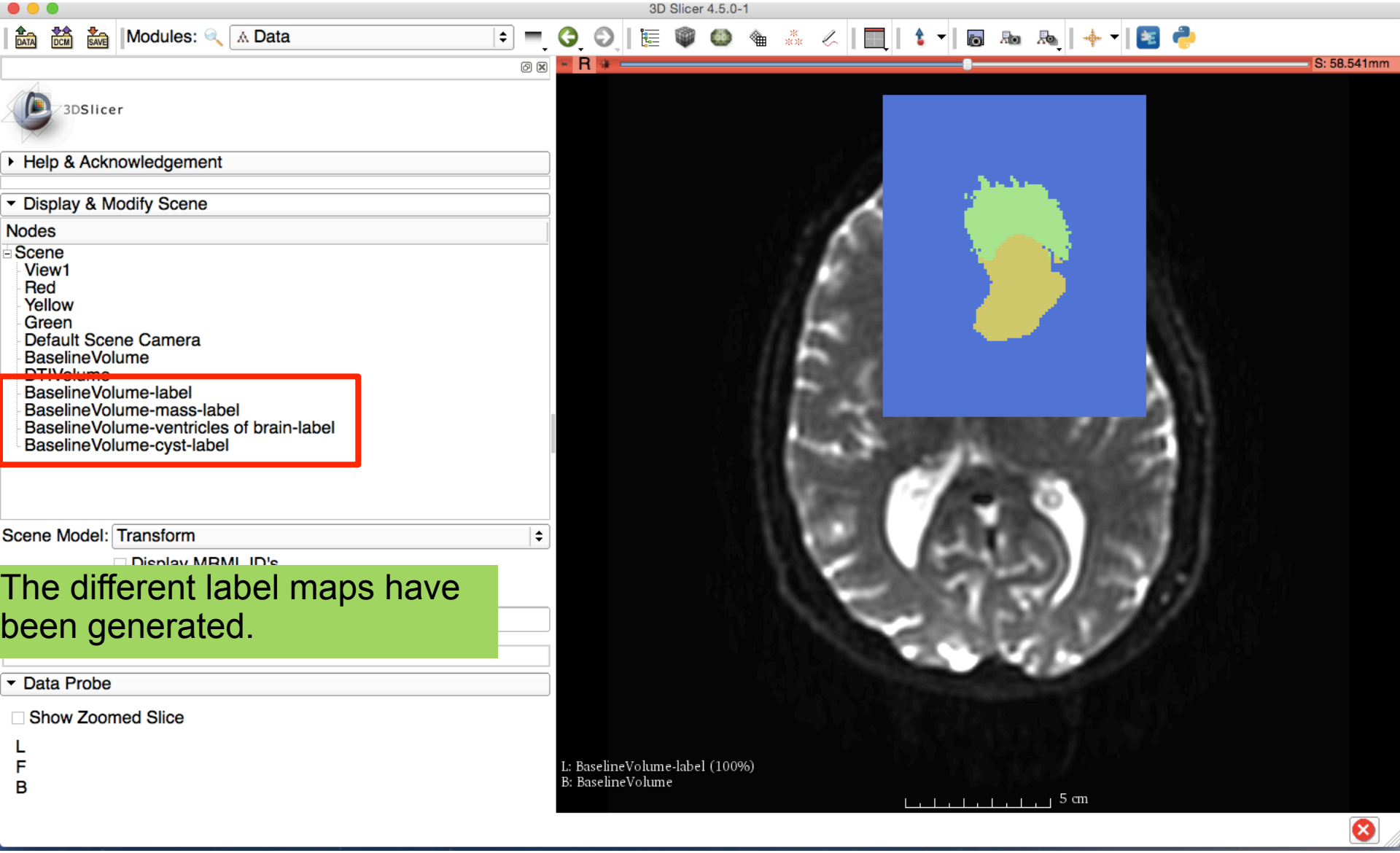
-**BaselineVolume-cyst-label**: cystic part of the tumor

-**BaselineVolume-ventricies of brain-label**: surrounding structures

Tumor Segmentation

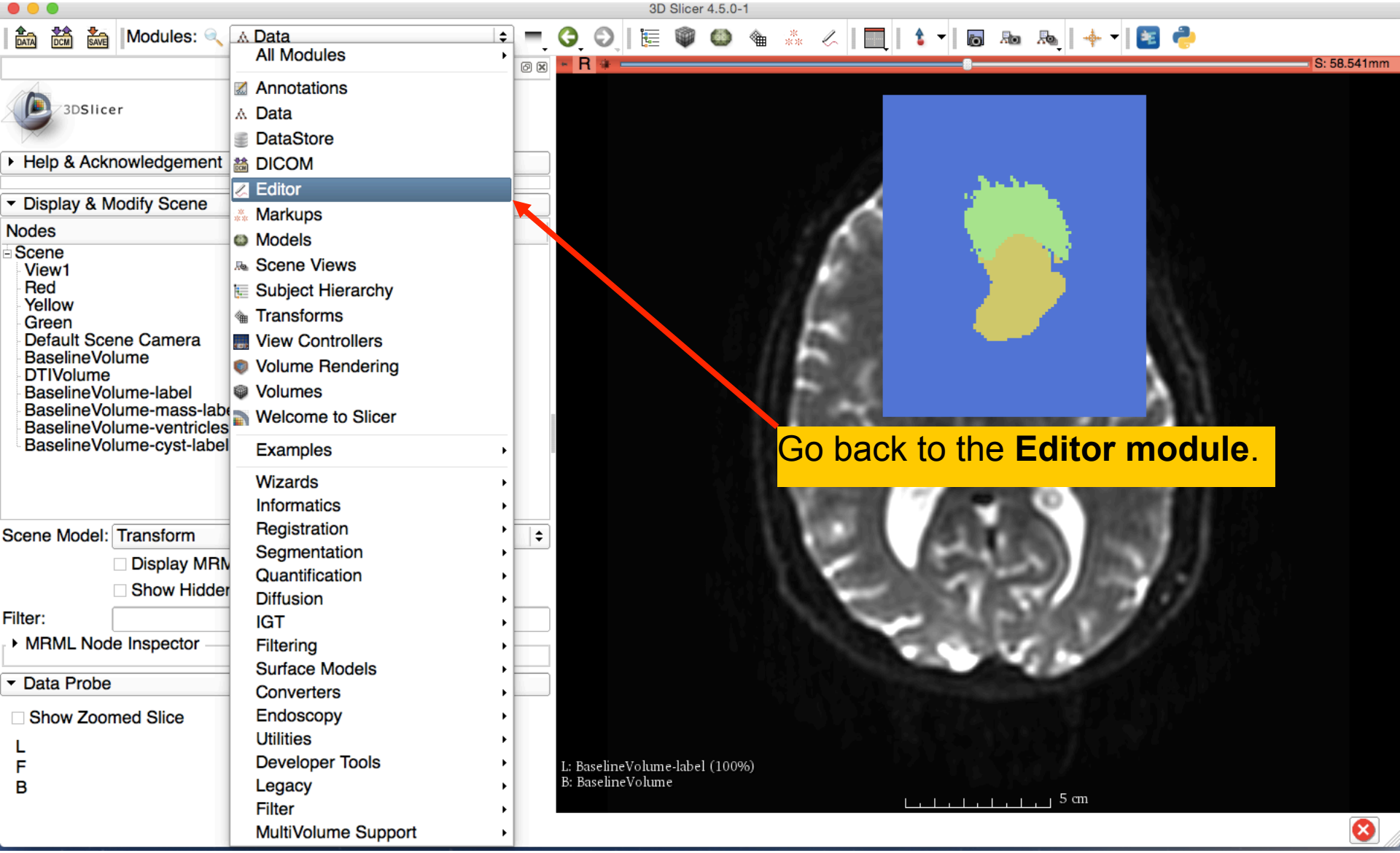


Tumor Segmentation

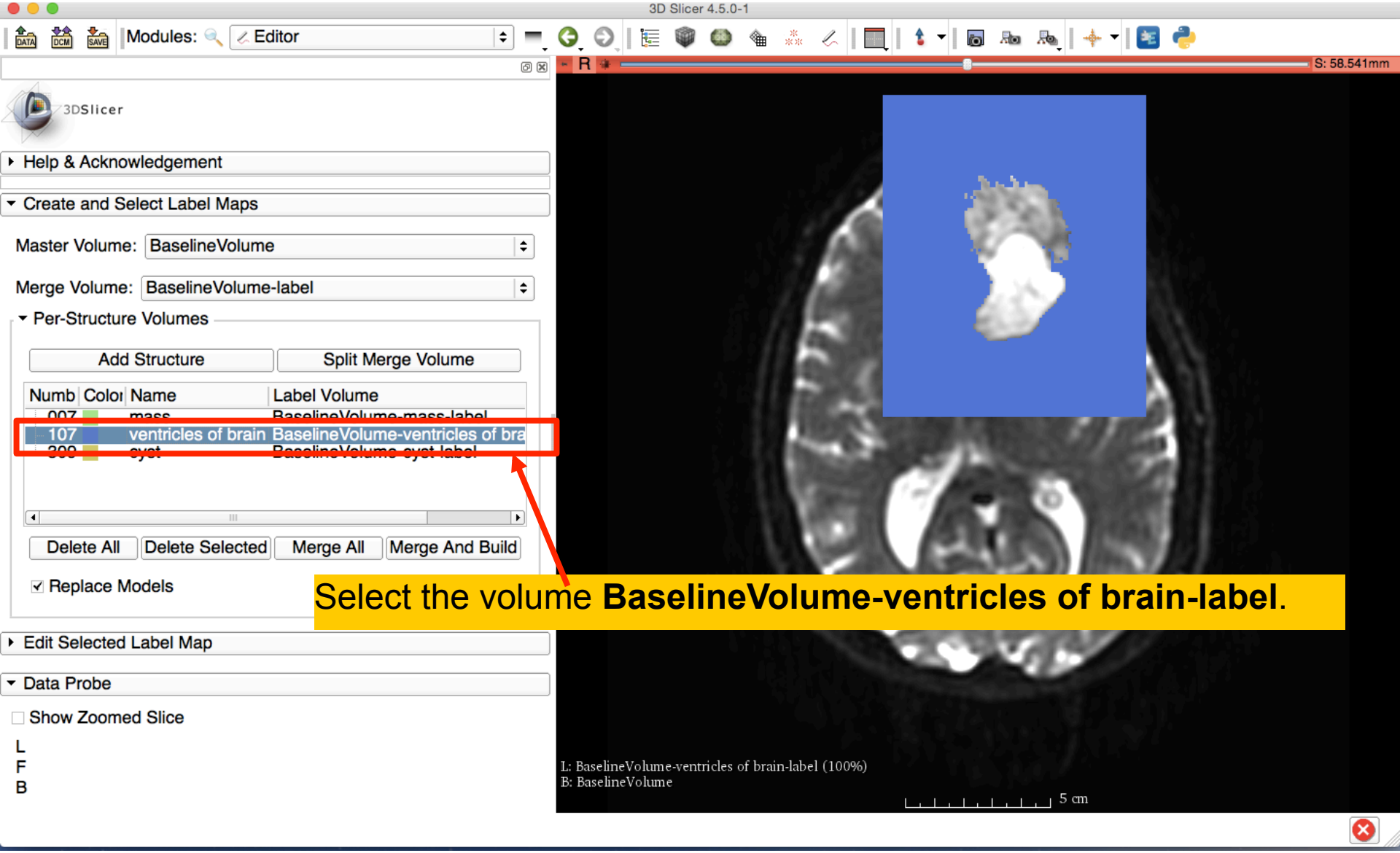


The different label maps have been generated.

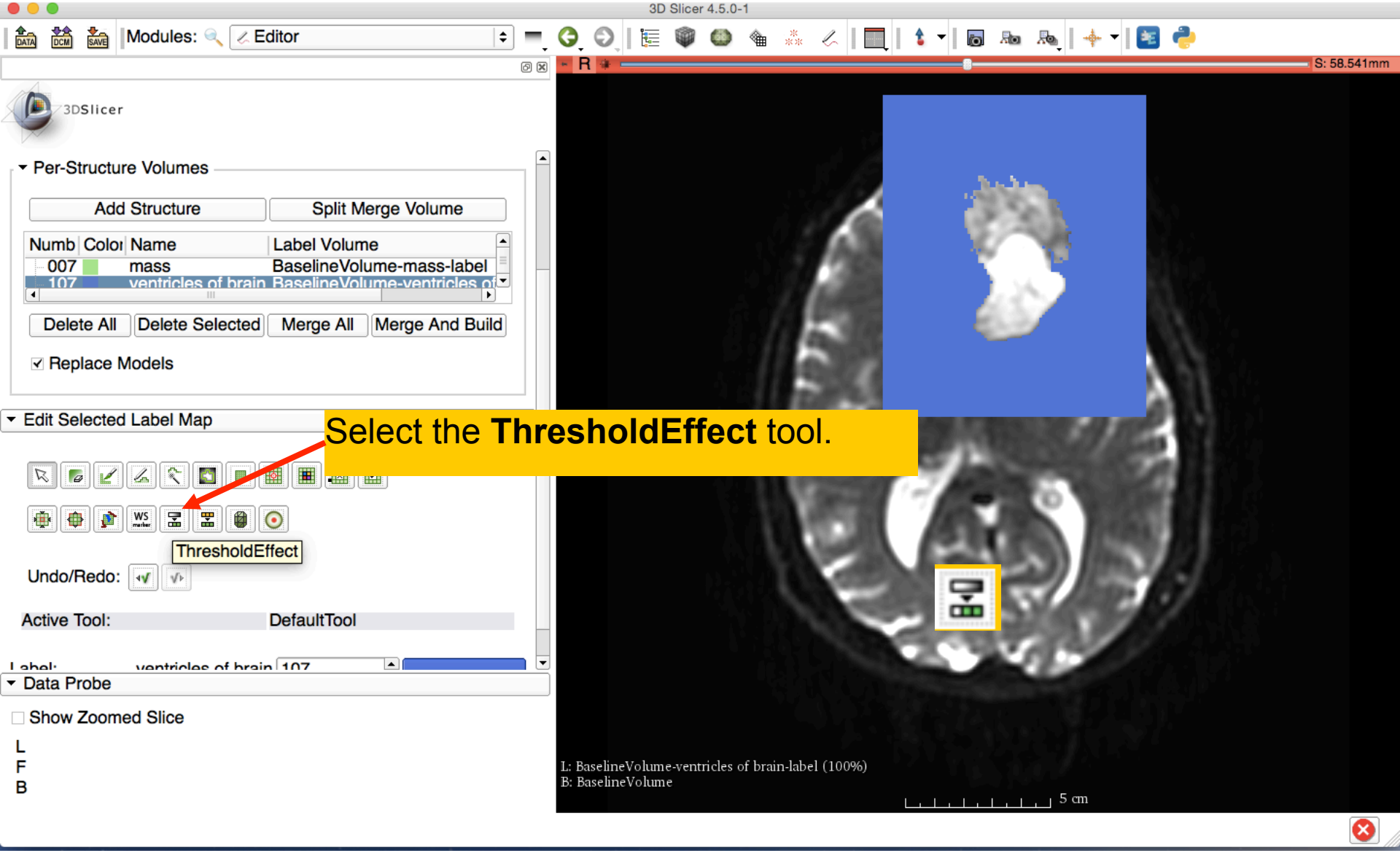
Ventricles Segmentation



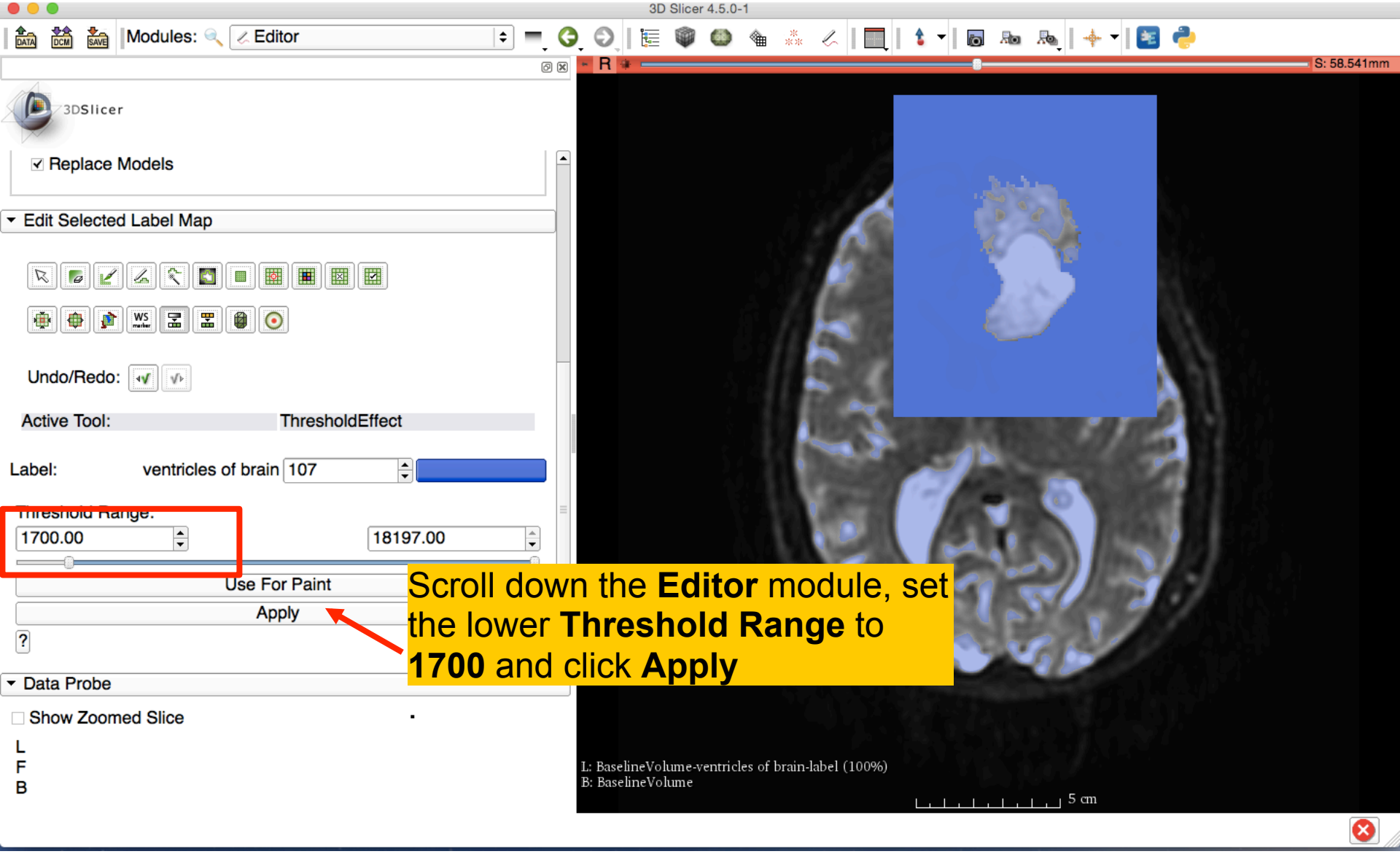
Ventricles Segmentation



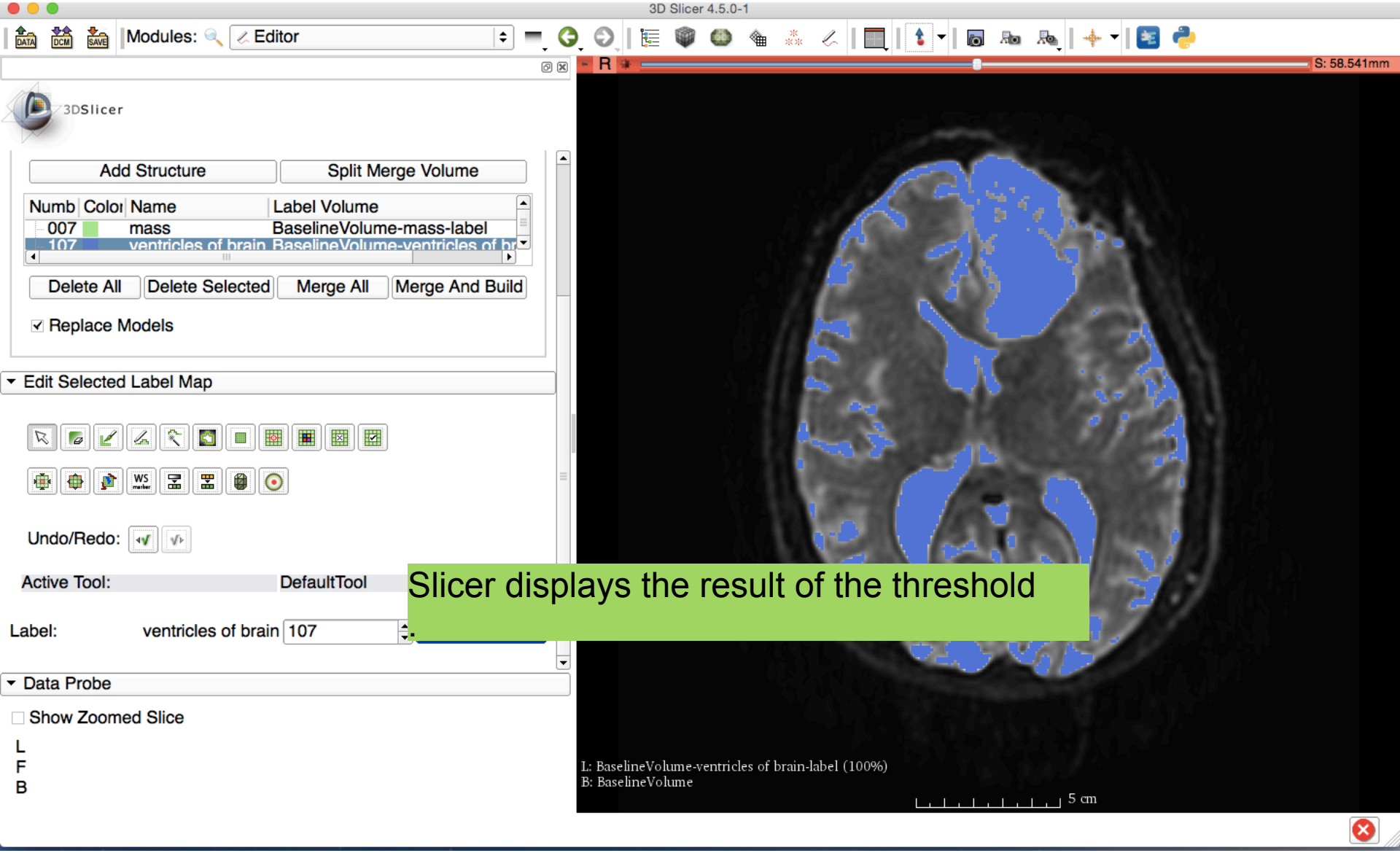
Ventricles Segmentation



Ventricles Segmentation

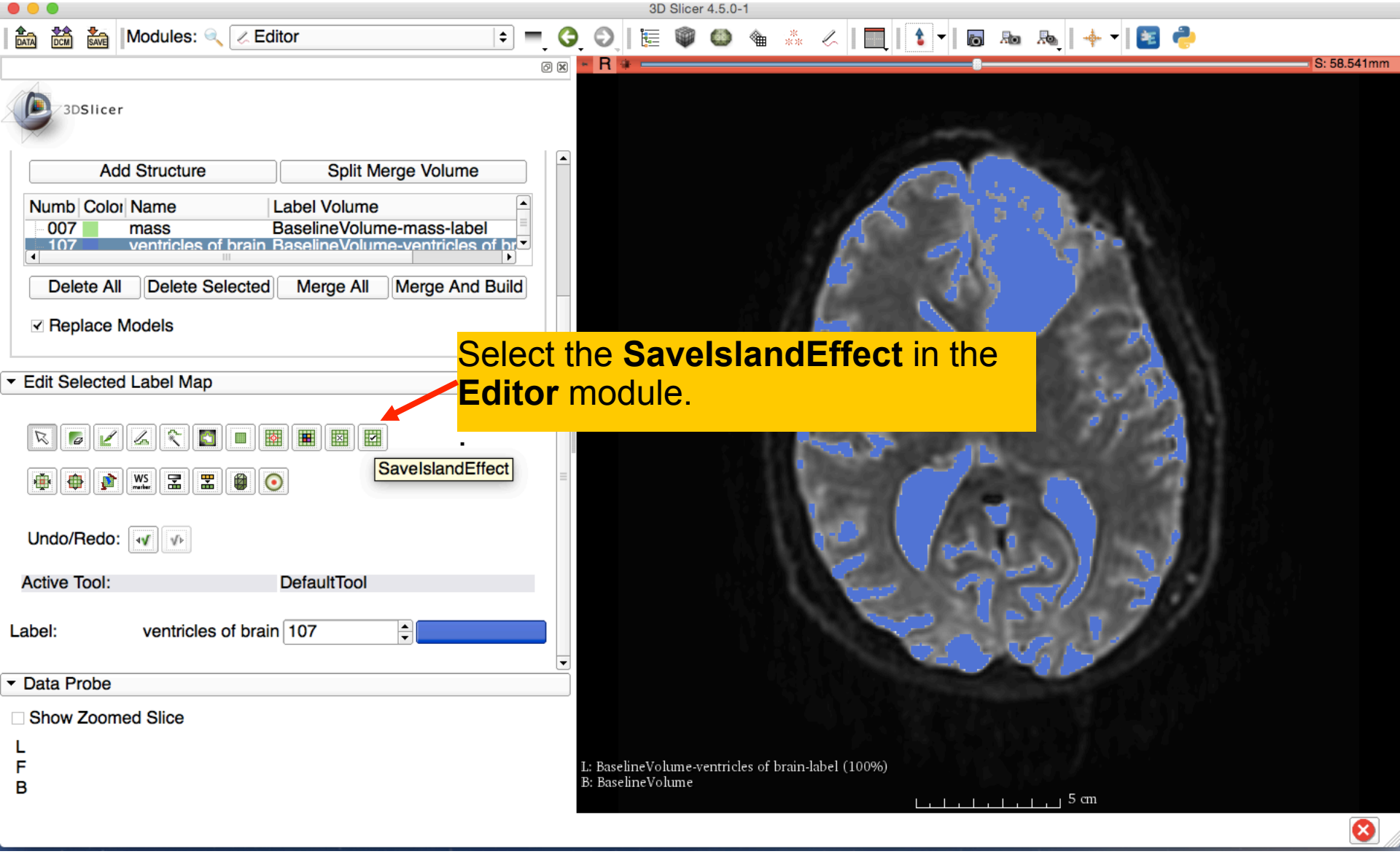


Ventricles Segmentation

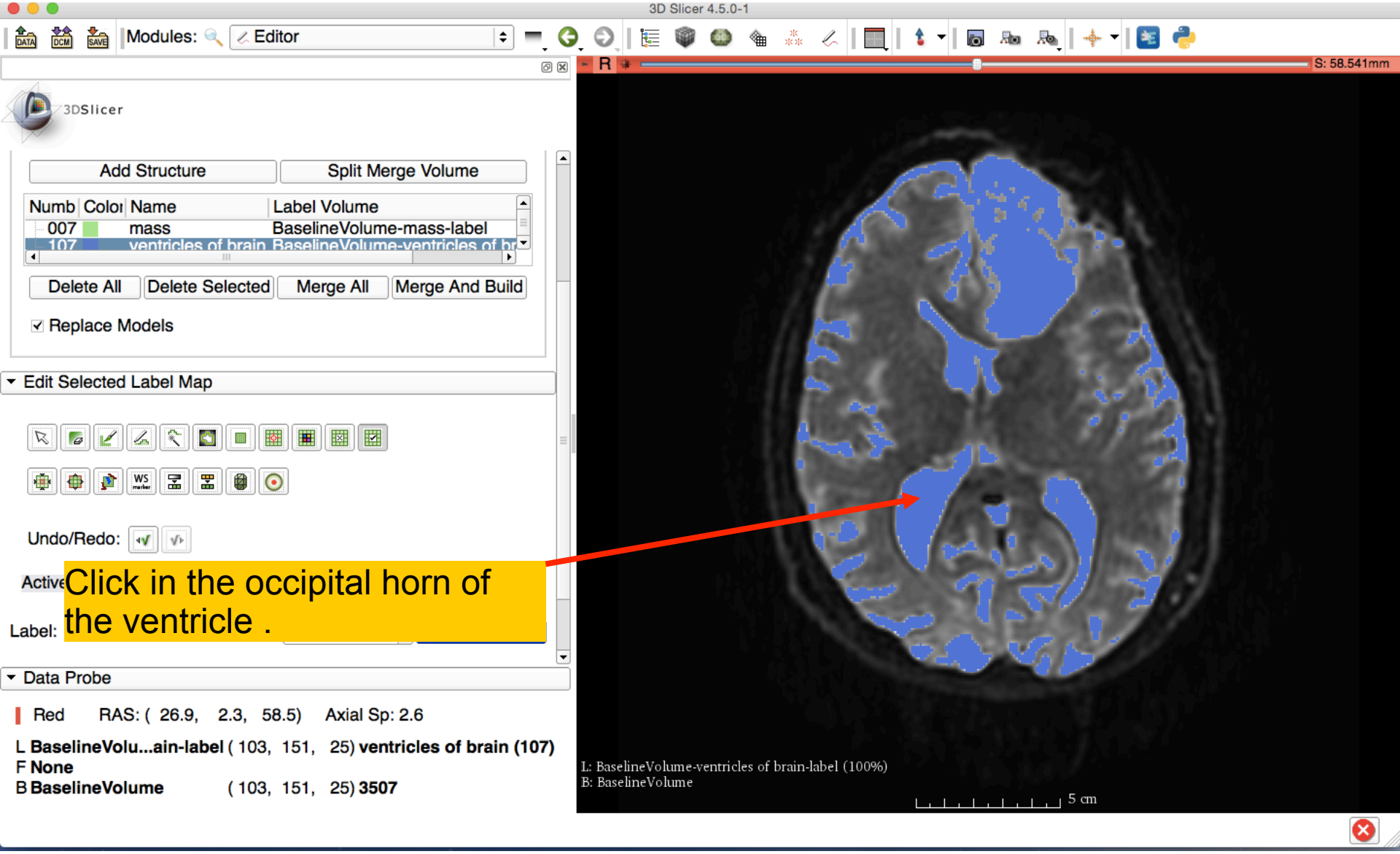


Slicer displays the result of the threshold

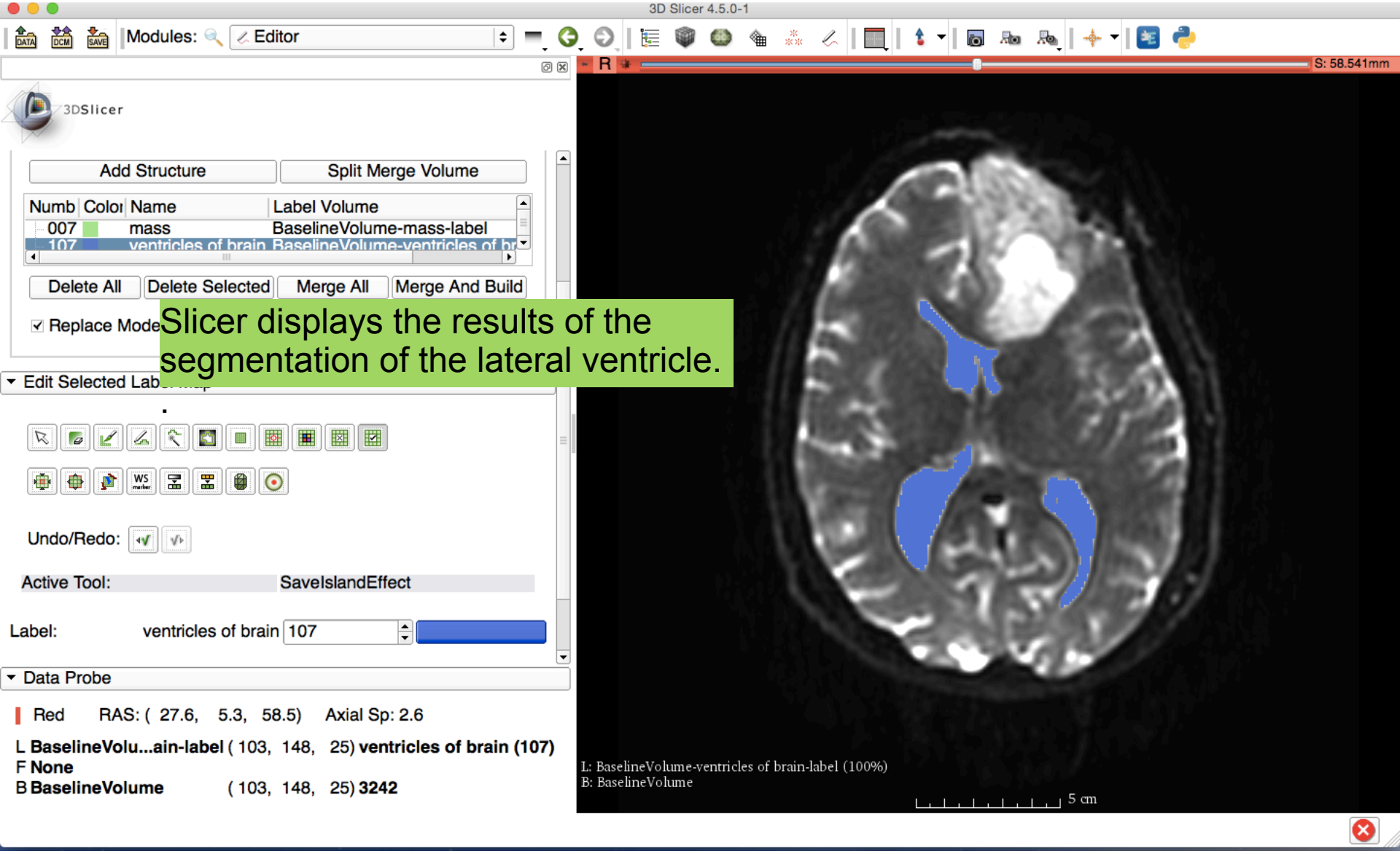
Ventricles Segmentation



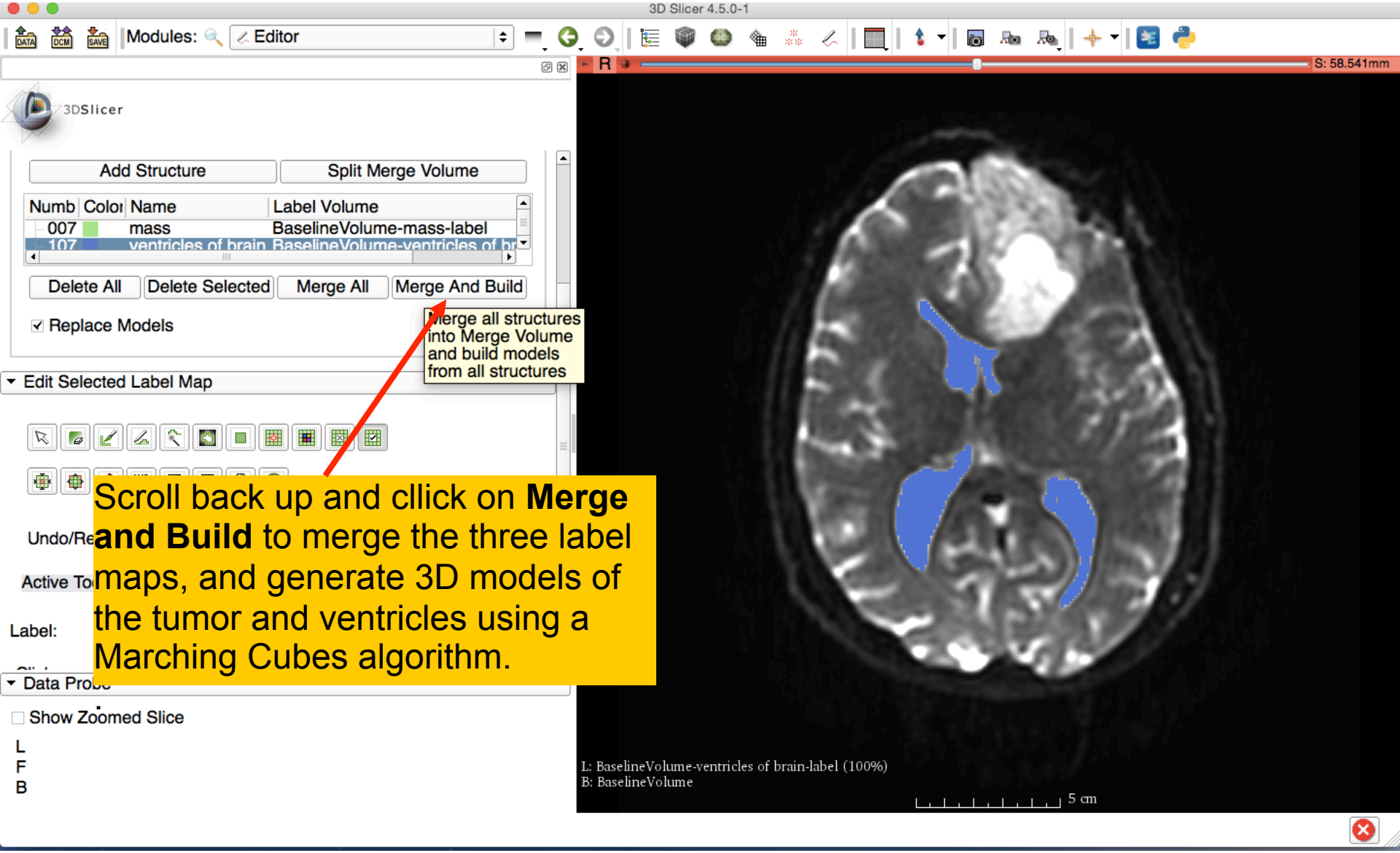
Ventricles Segmentation



Ventricles Segmentation

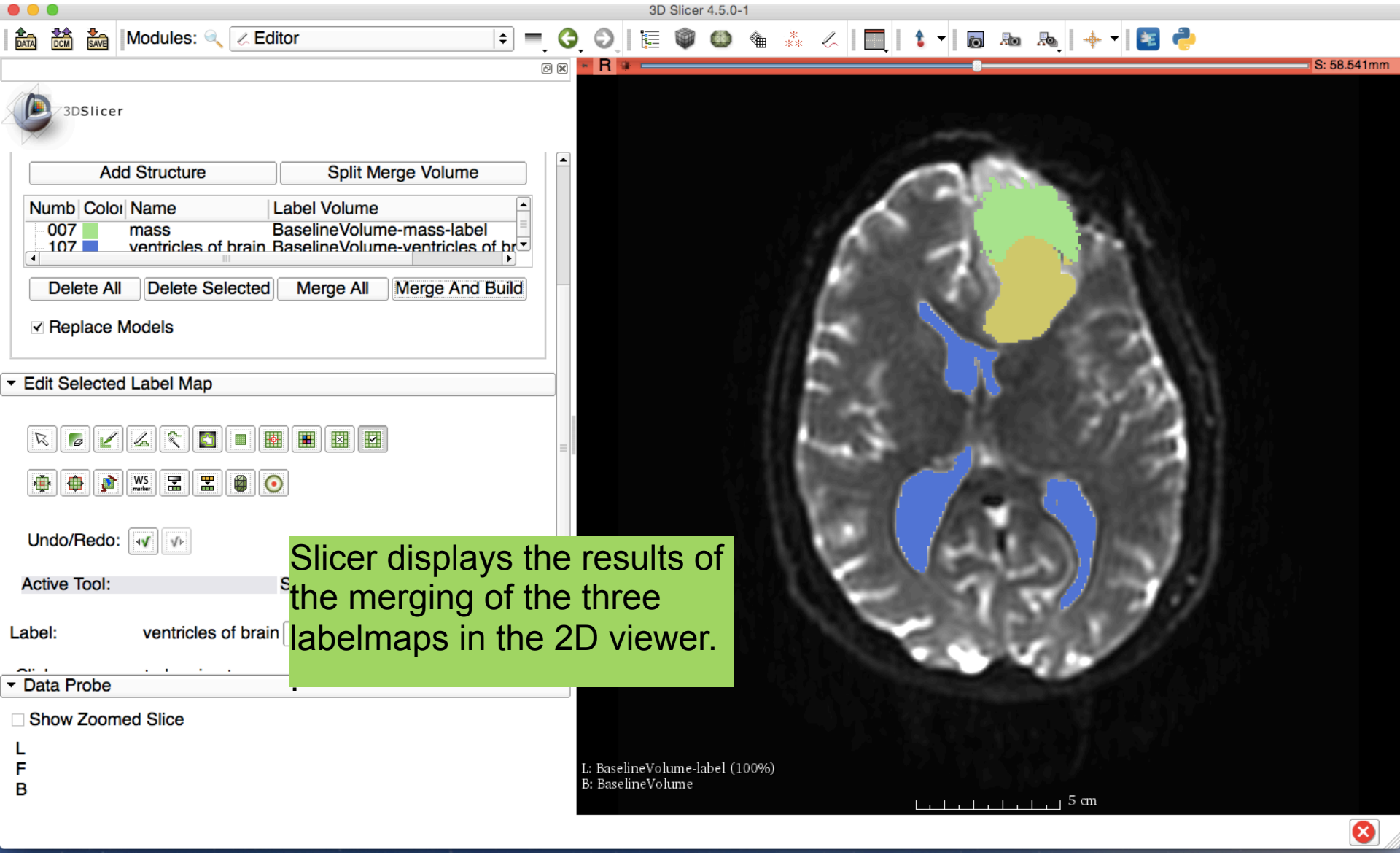


Ventricles Segmentation



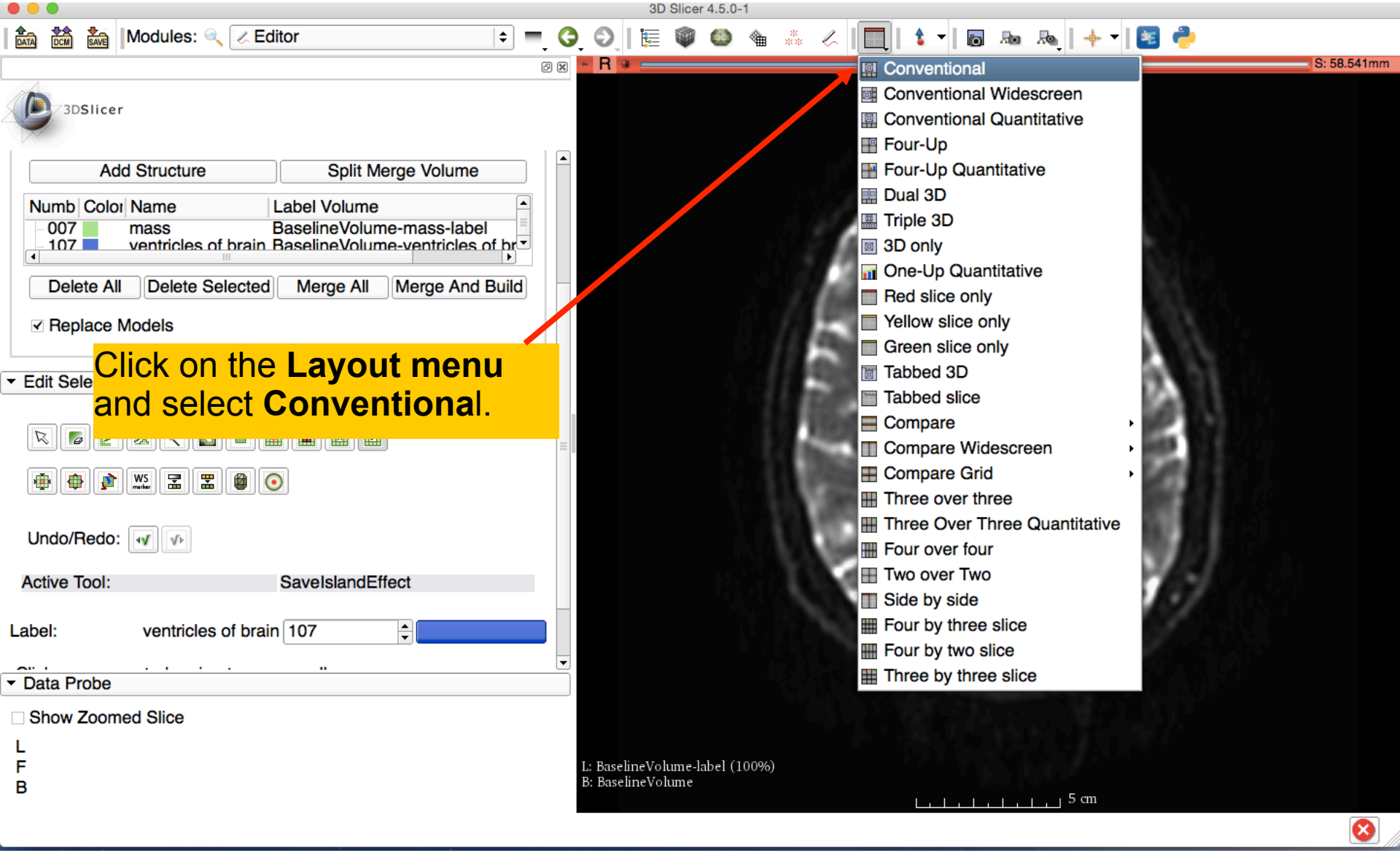
Scroll back up and cllick on **Merge and Build** to merge the three label maps, and generate 3D models of the tumor and ventricles using a Marching Cubes algorithm.

Final Result of Segmentation

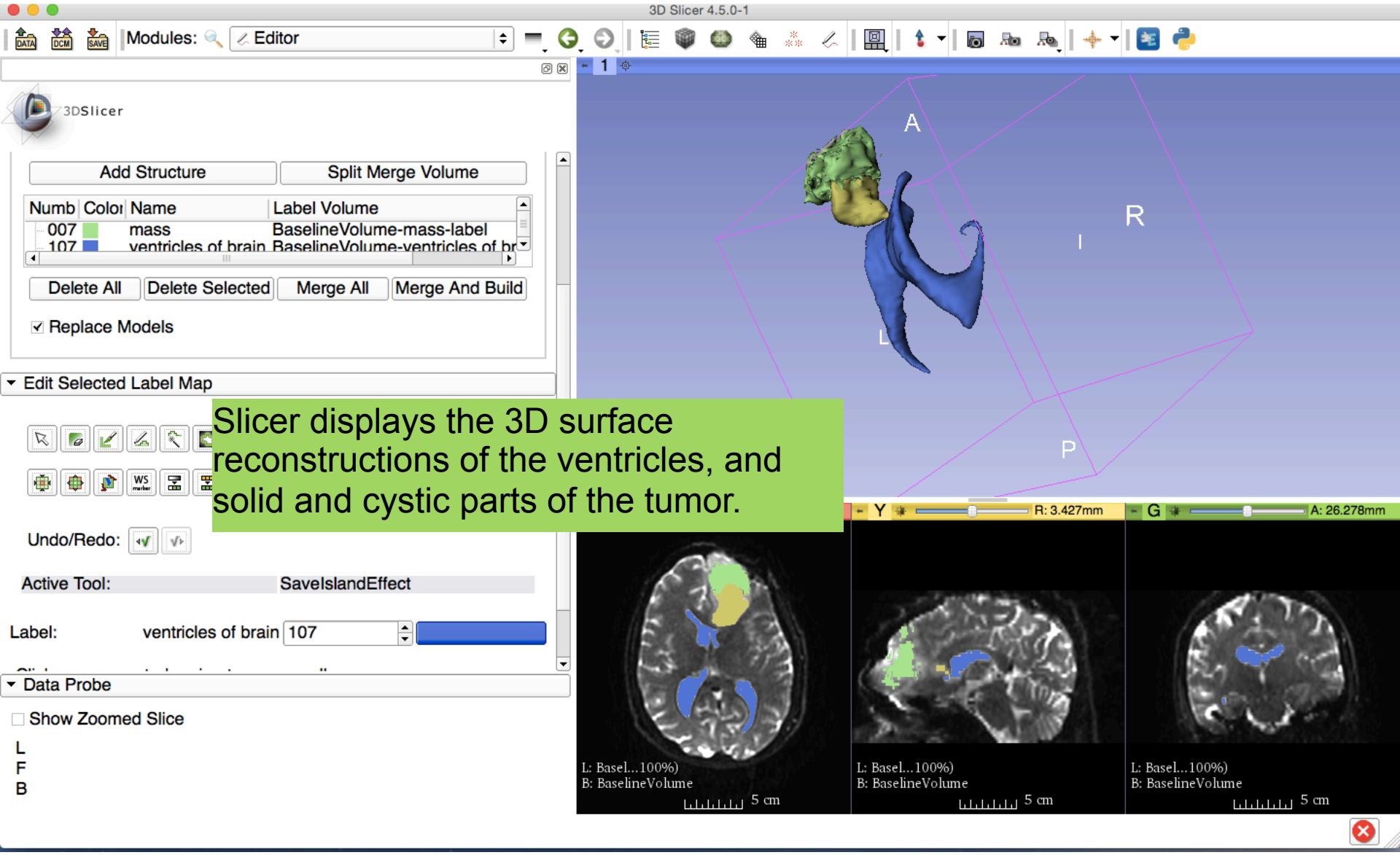


Slicer displays the results of the merging of the three labelmaps in the 2D viewer.

Final Result of Segmentation

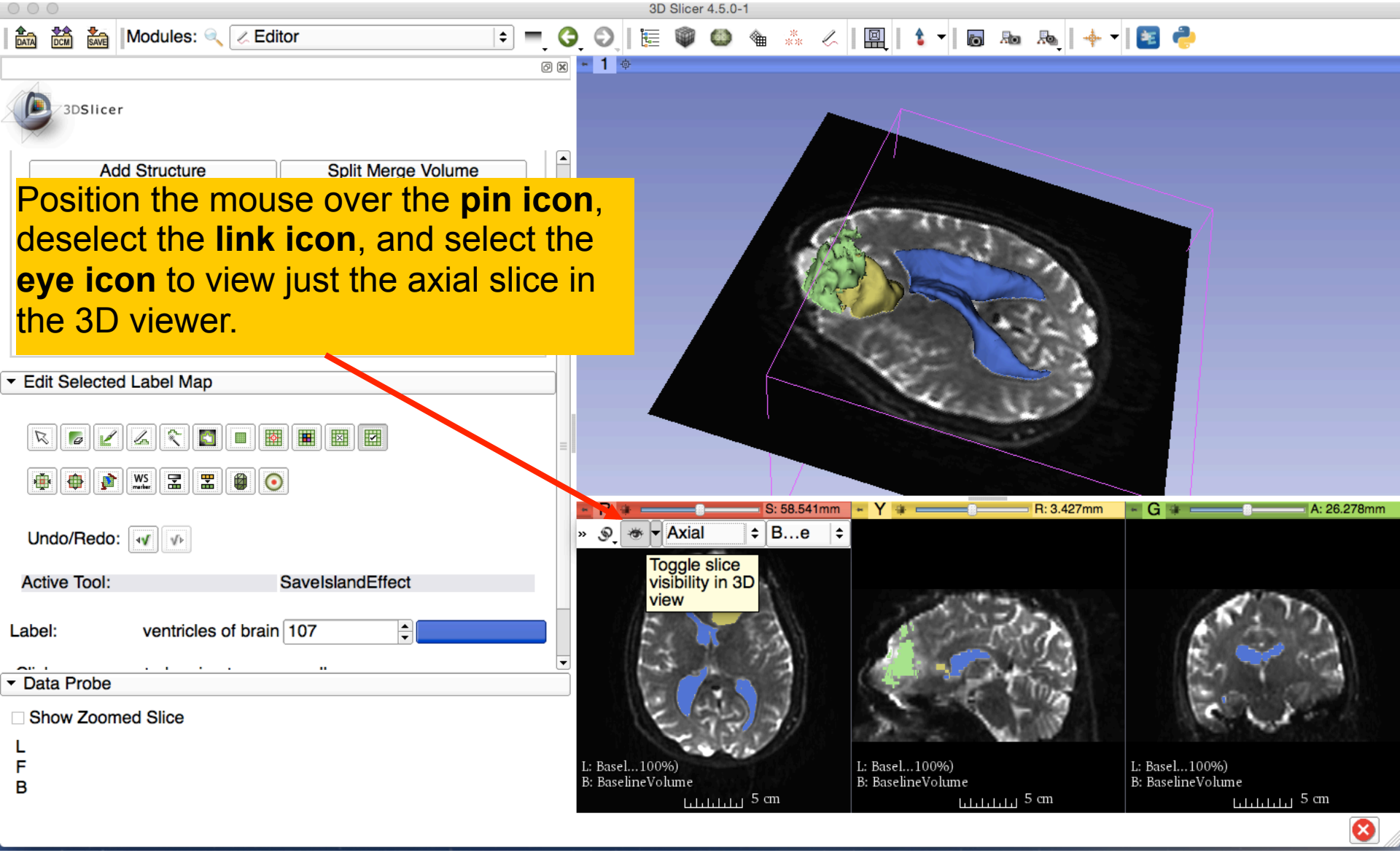


Final Result of Segmentation

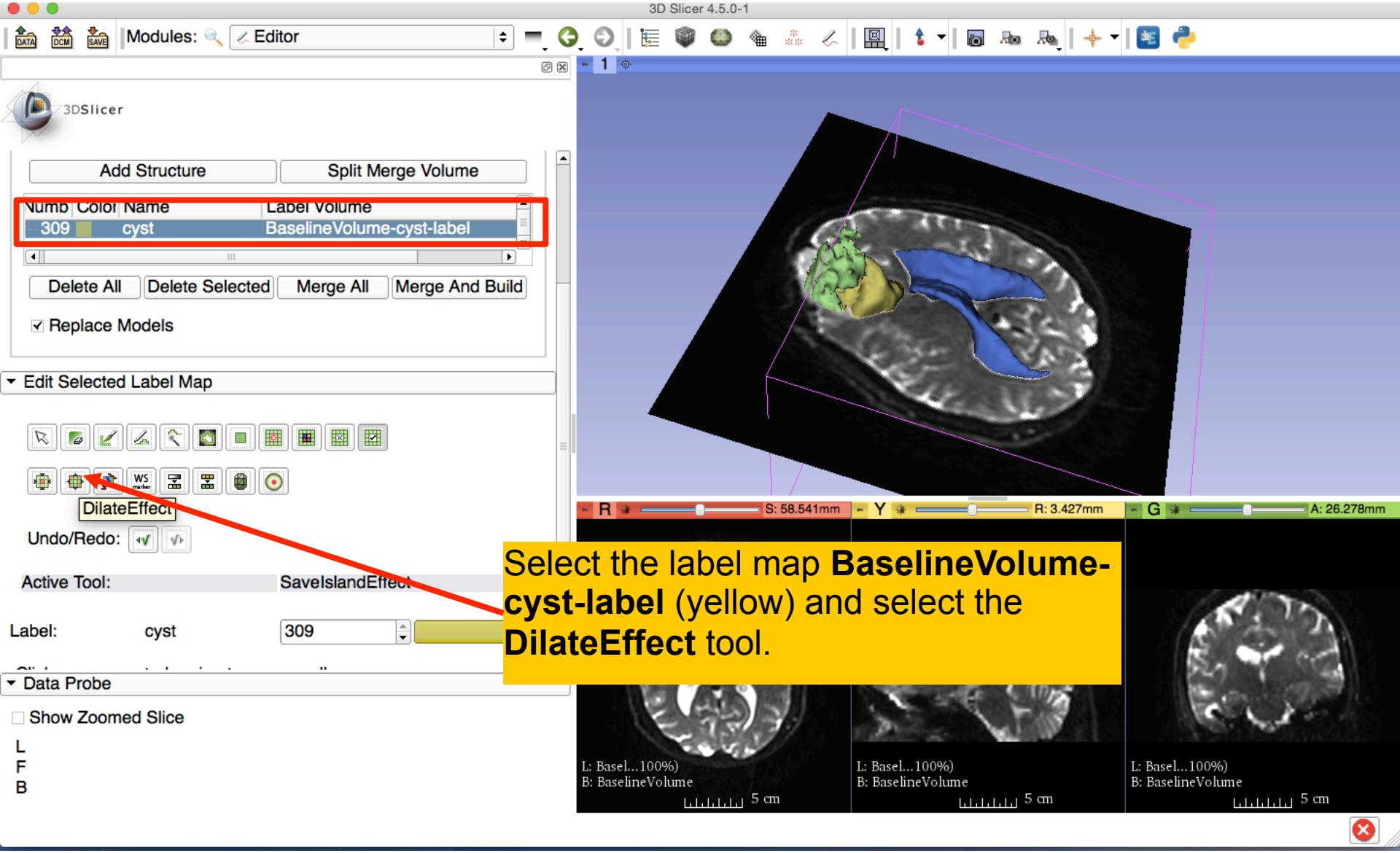


Slicer displays the 3D surface reconstructions of the ventricles, and solid and cystic parts of the tumor.

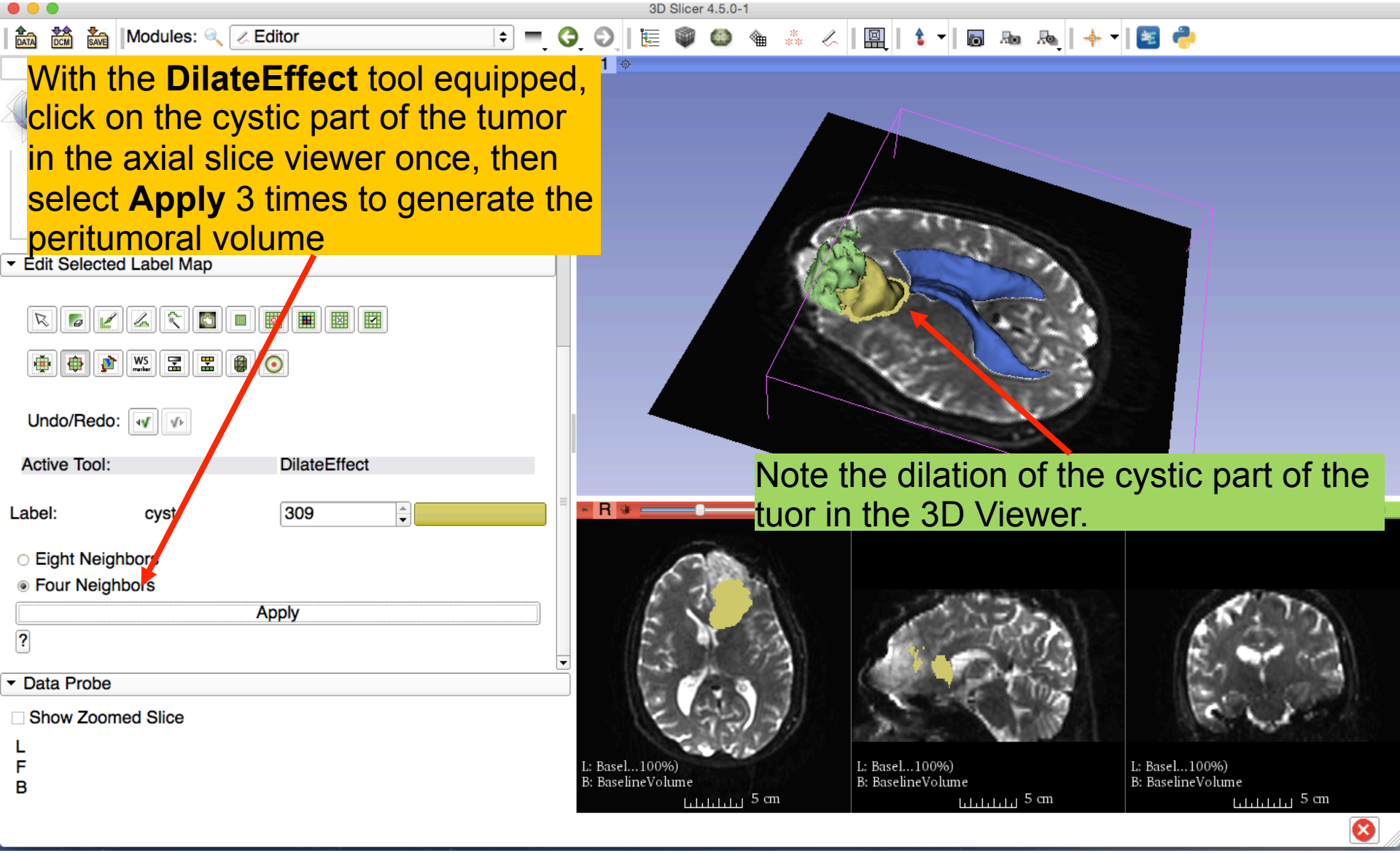
Definition of peri-tumoral volume

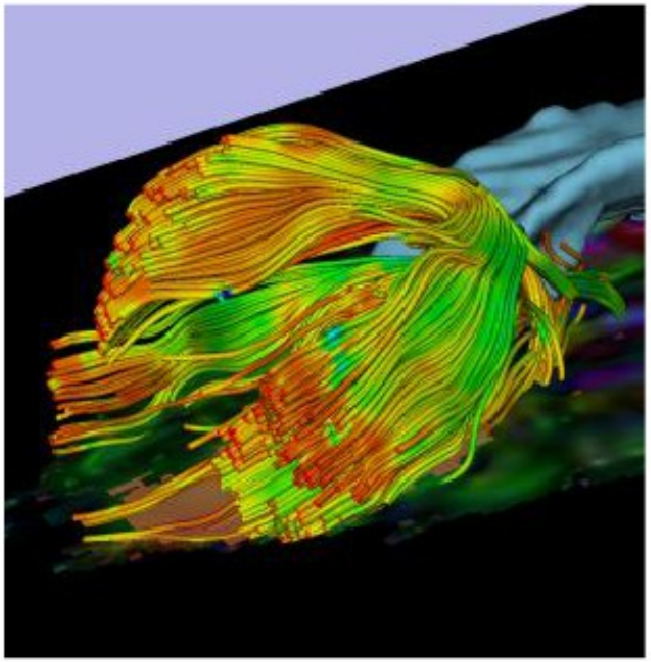


Definition of peri-tumoral volume



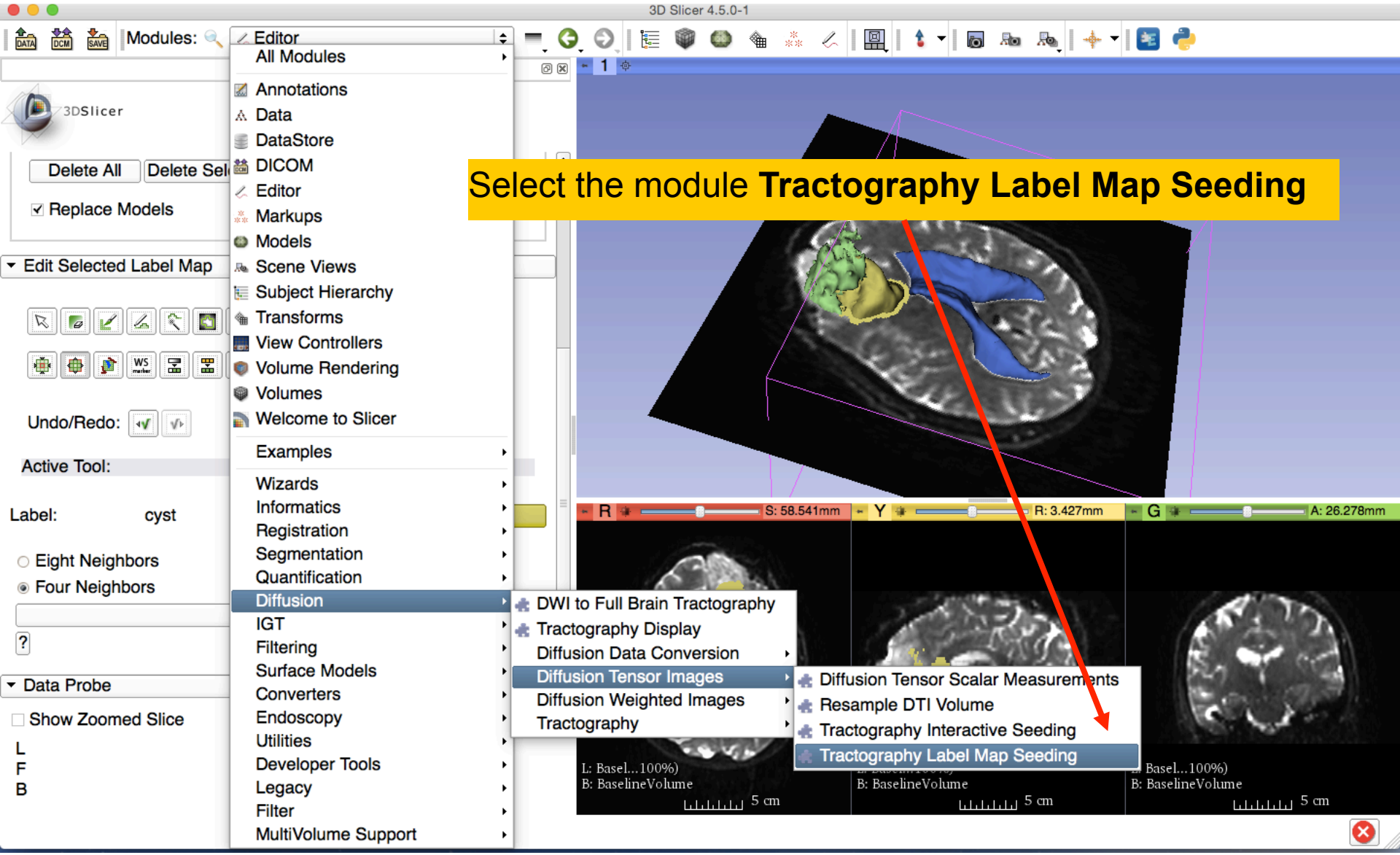
Definition of peri-tumoral volume



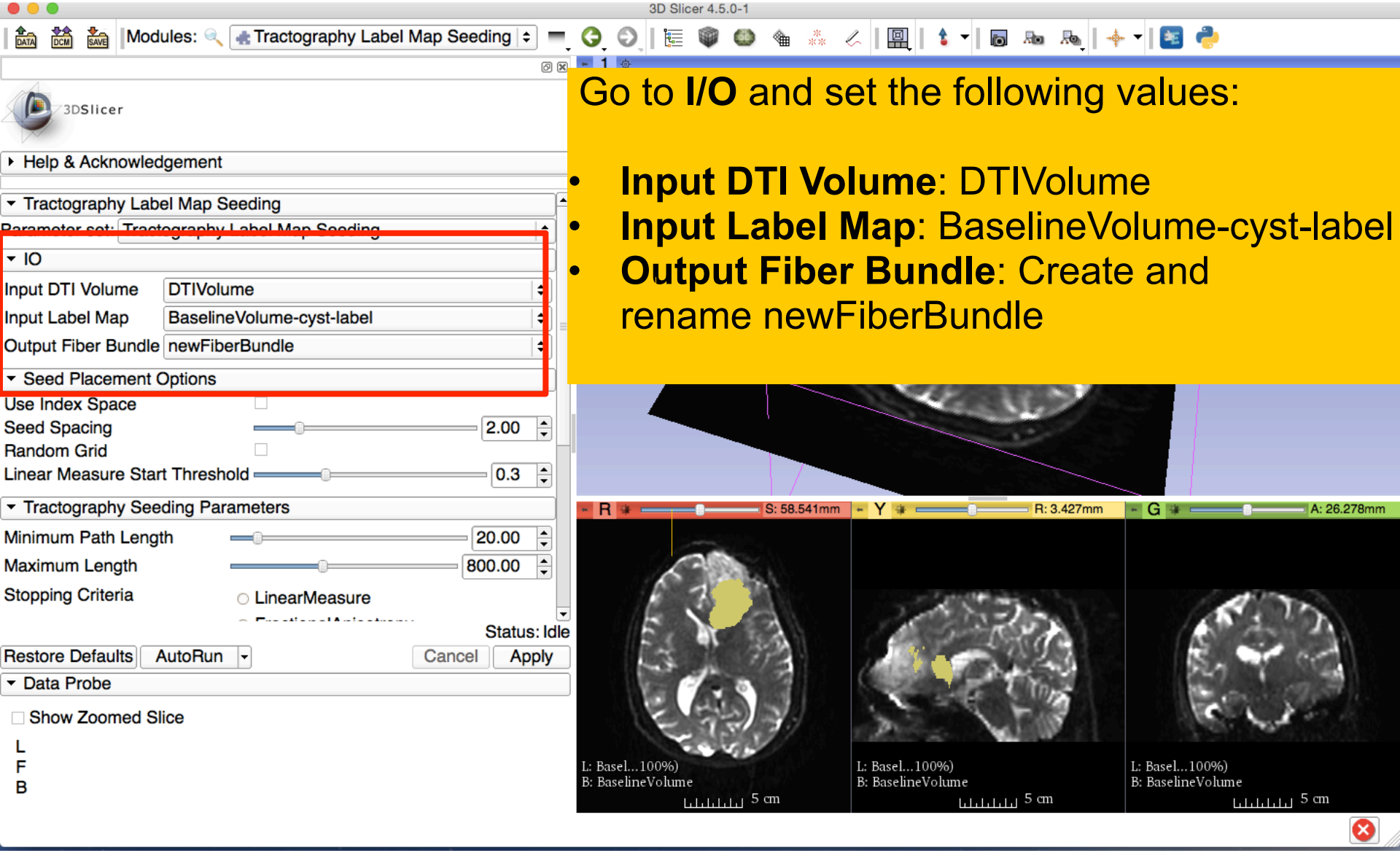


Part 2: Tractography exploration of peri-tumoral white matter fibers

Tractography LabelMap Seeding



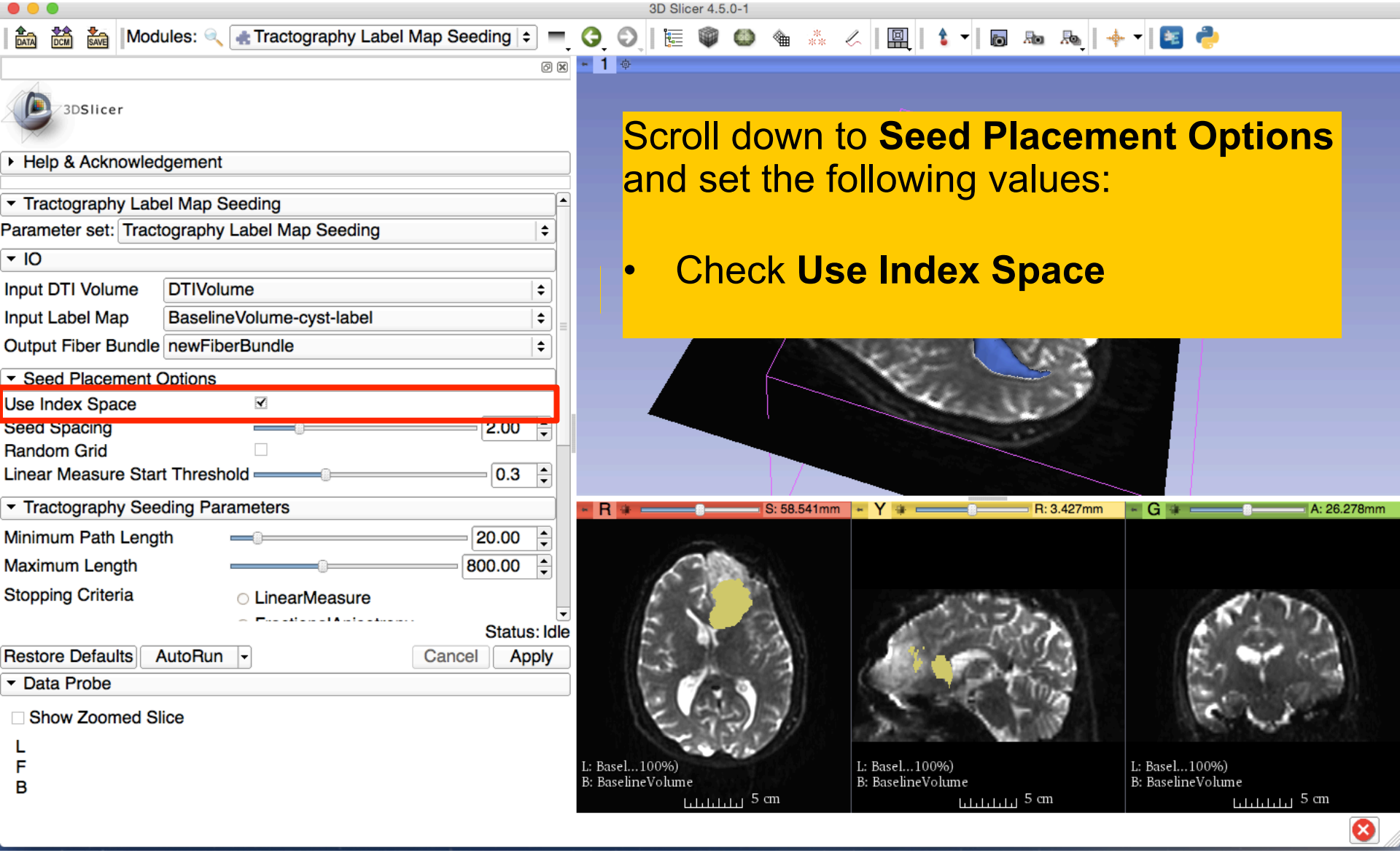
Tractography LabelMap Seeding



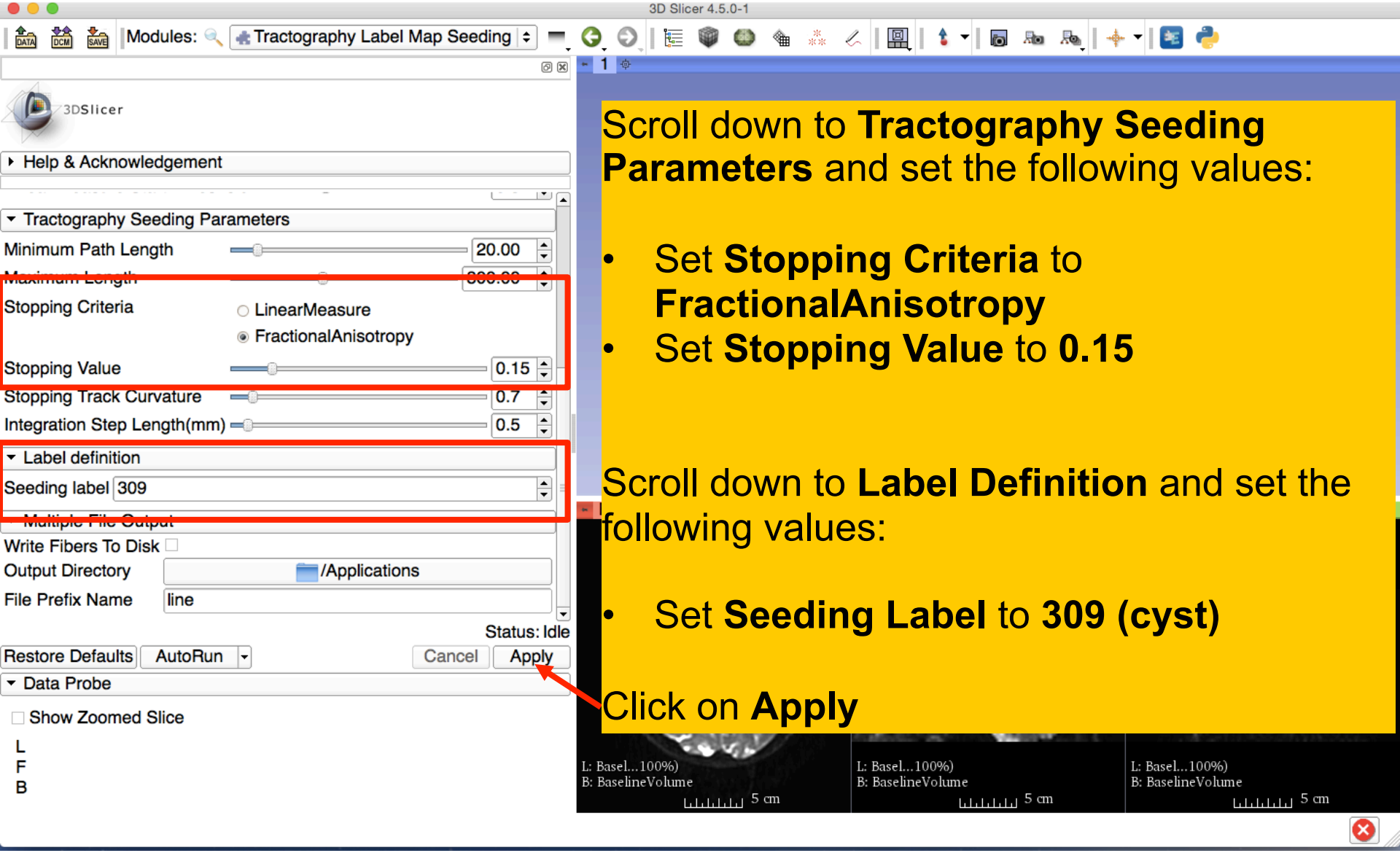
Go to **I/O** and set the following values:

- **Input DTI Volume**: DTIVolume
- **Input Label Map**: BaselineVolume-cyst-label
- **Output Fiber Bundle**: Create and rename newFiberBundle

Tractography LabelMap Seeding



Tractography LabelMap Seeding



Scroll down to **Tractography Seeding Parameters** and set the following values:

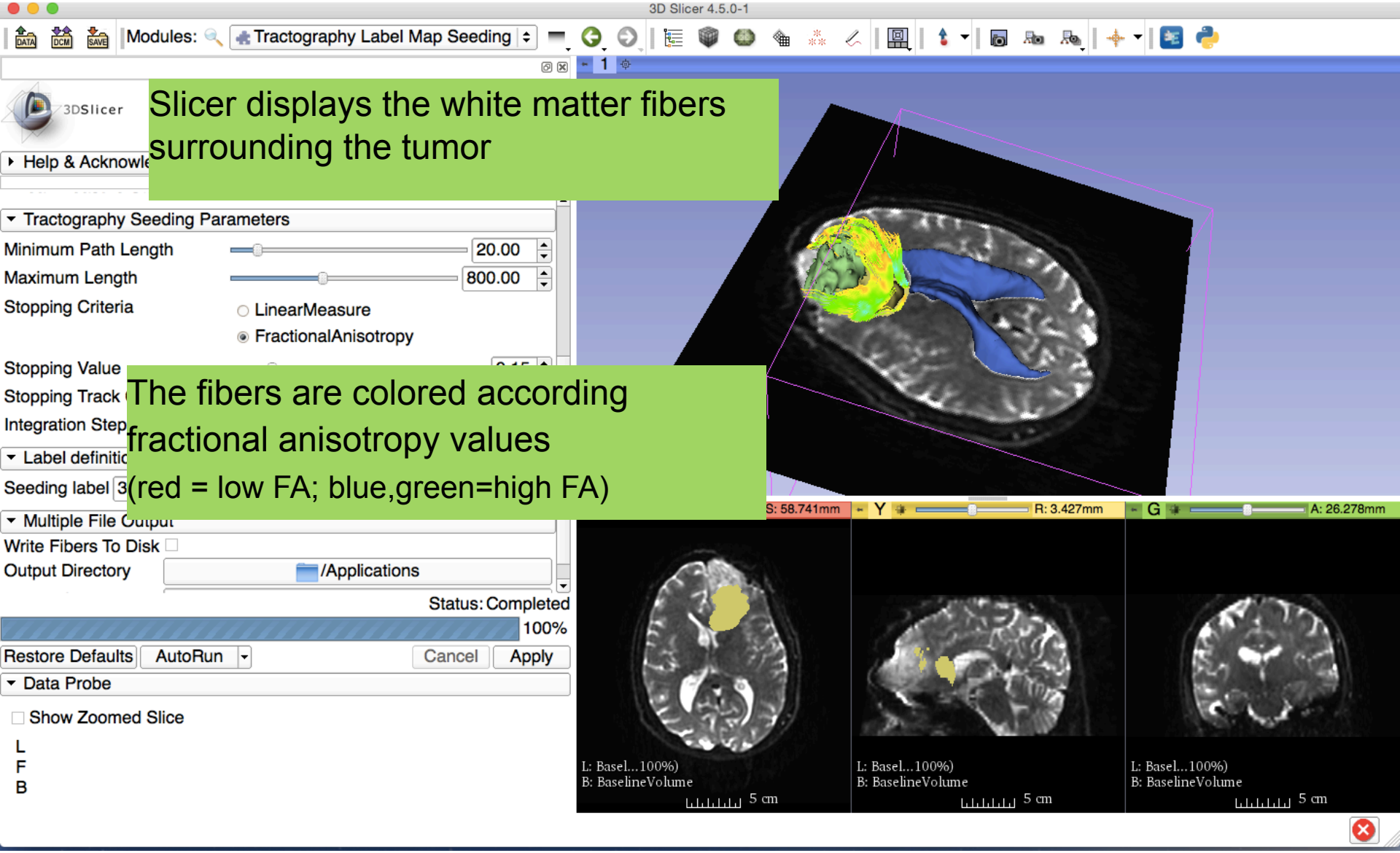
- Set **Stopping Criteria** to **FractionalAnisotropy**
- Set **Stopping Value** to **0.15**

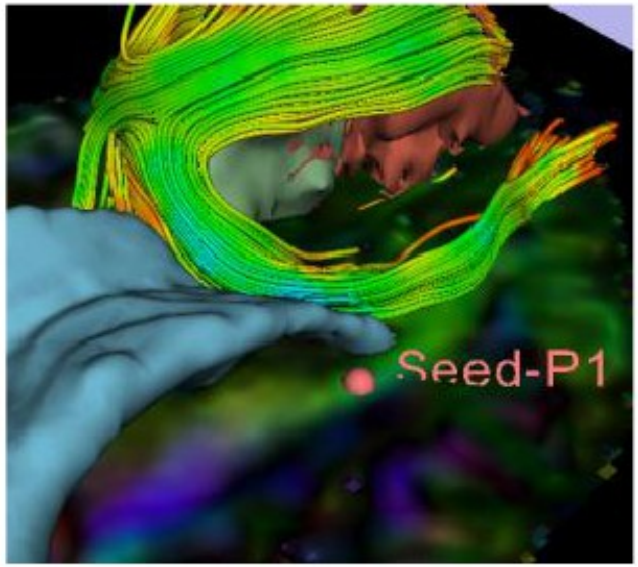
Scroll down to **Label Definition** and set the following values:

- Set **Seeding Label** to **309 (cyst)**

Click on **Apply**

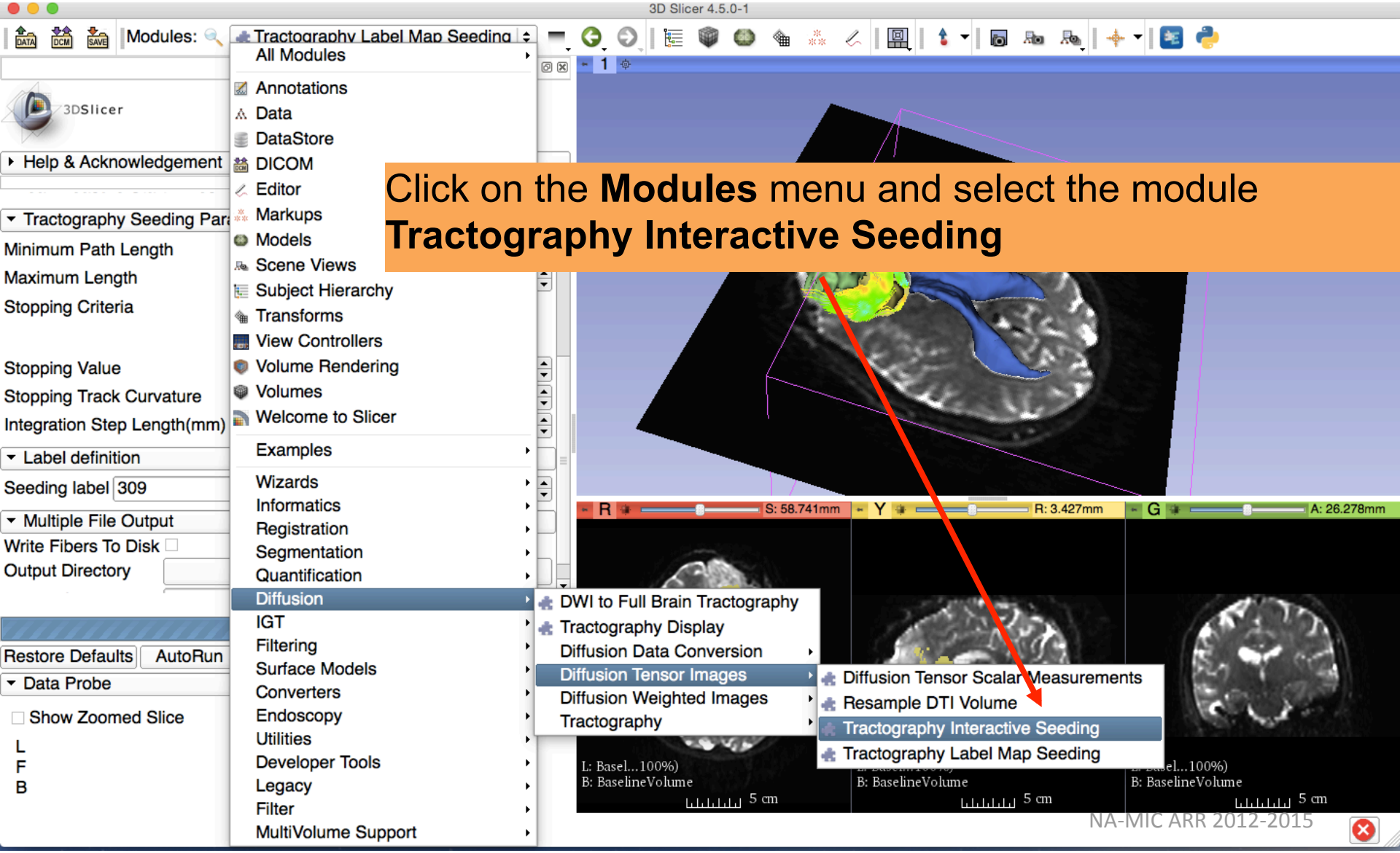
Tractography LabelMap Seeding



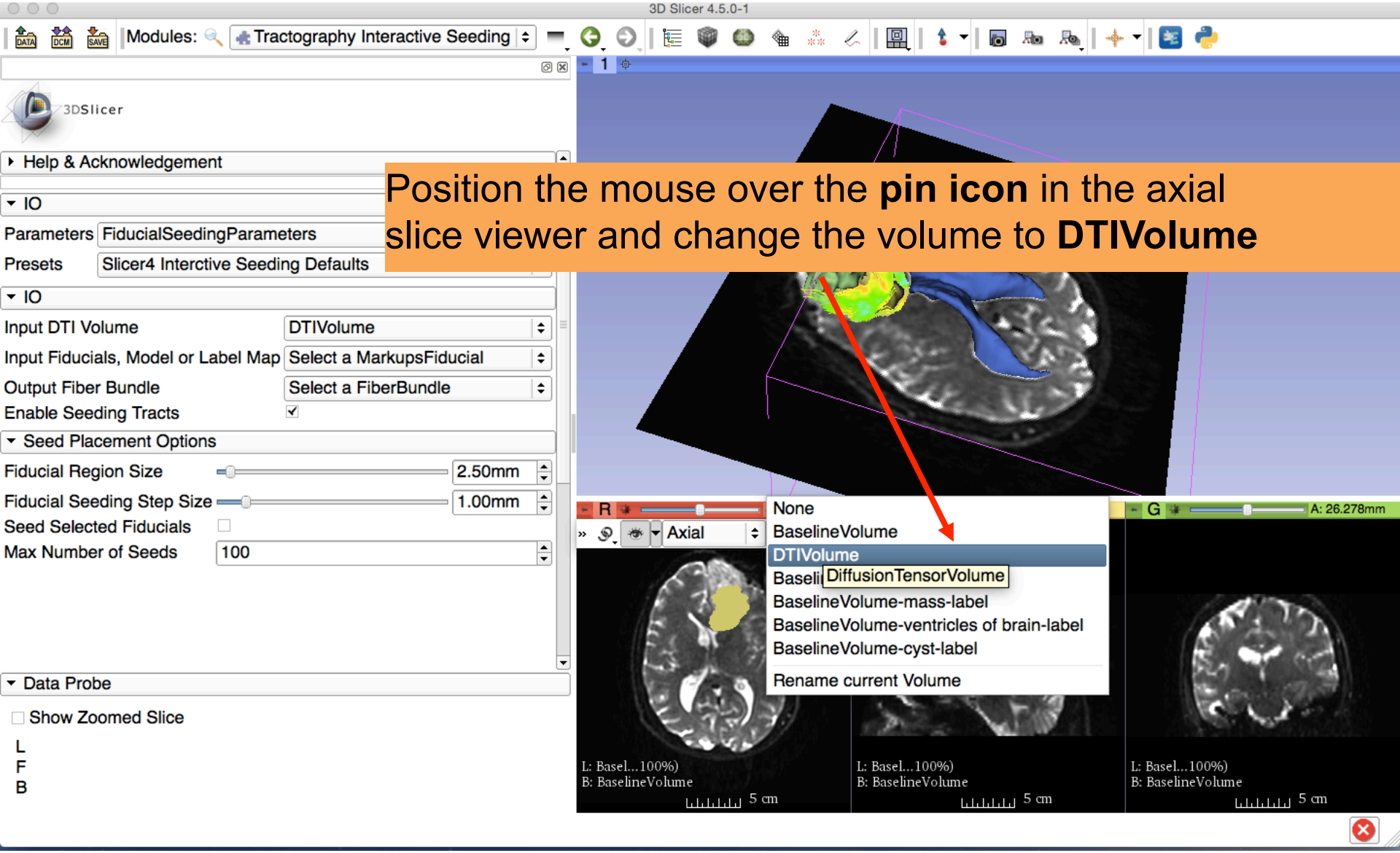


Part 4: Tractography exploration of the ipsilateral and contralateral side

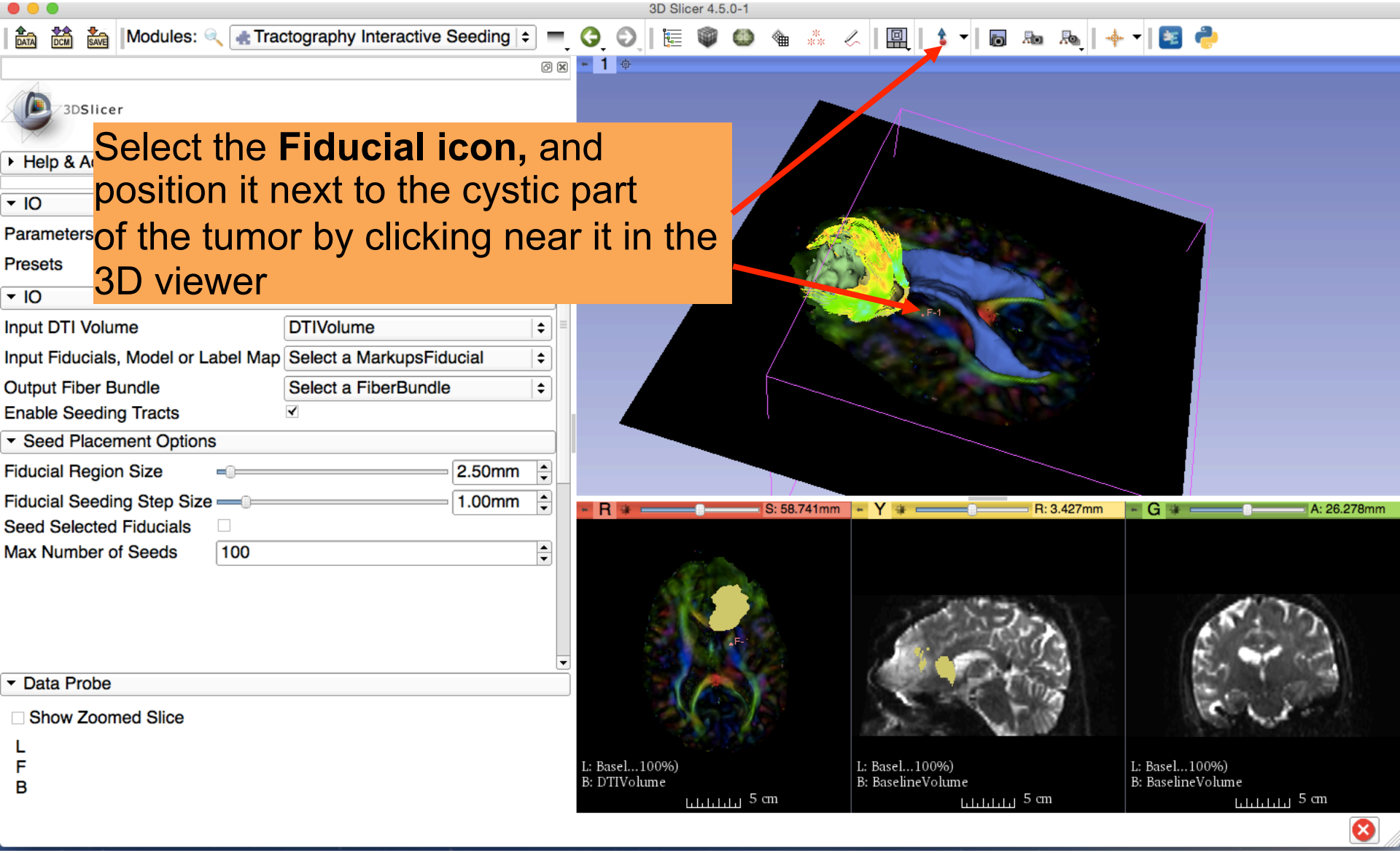
Tractography on-the-fly



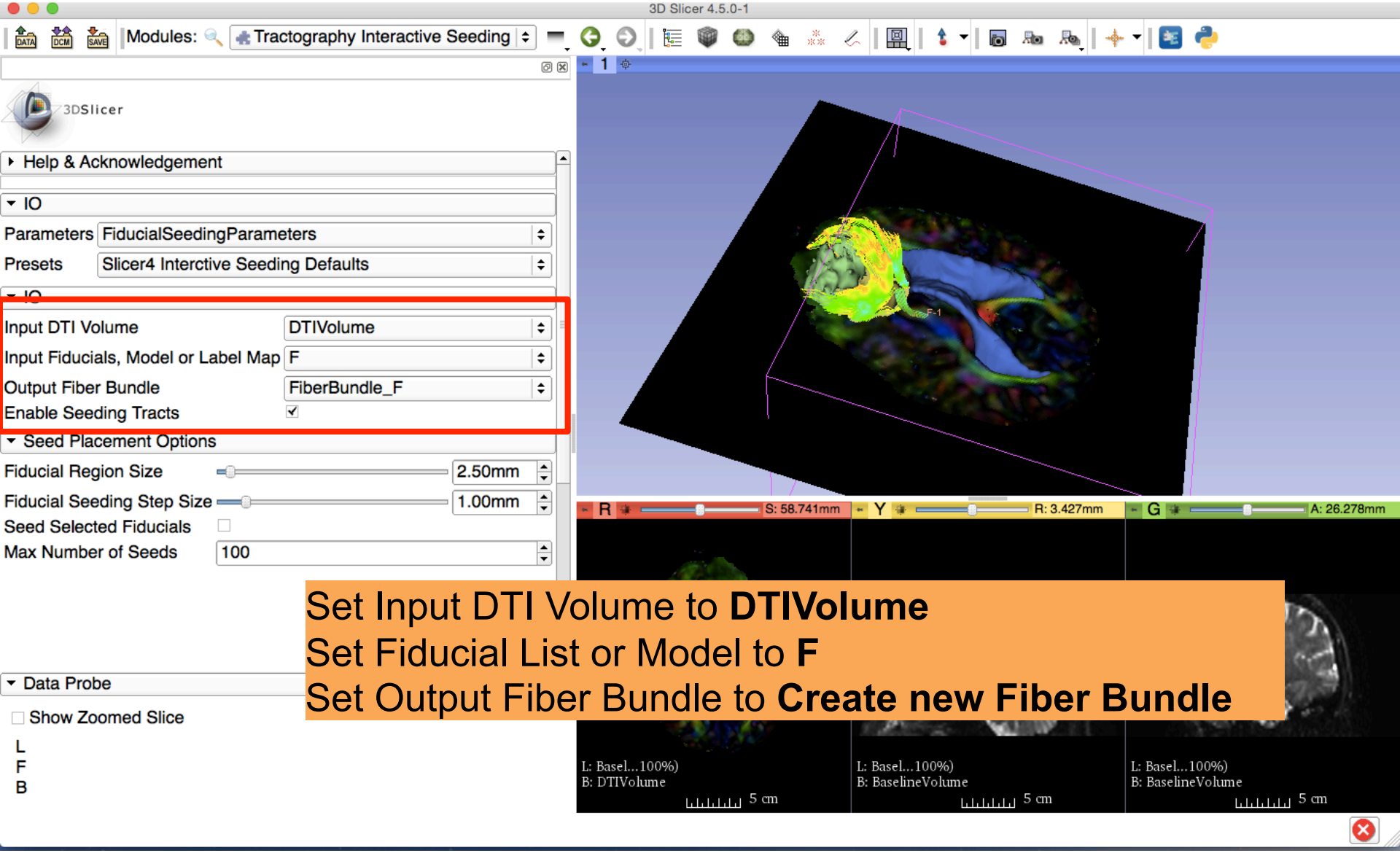
Tractography on-the-fly



Tractography on-the-fly

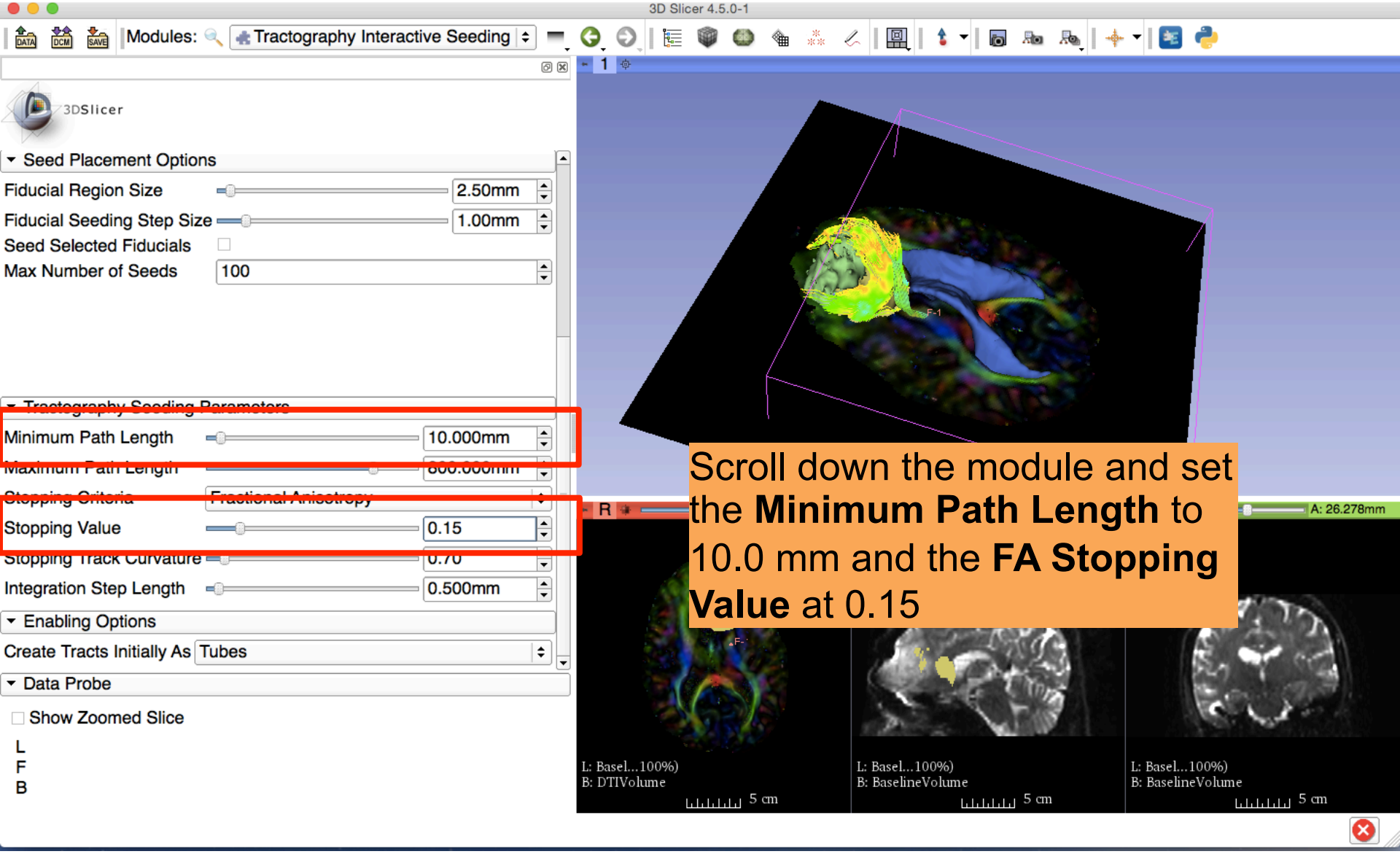


Tractography on-the-fly

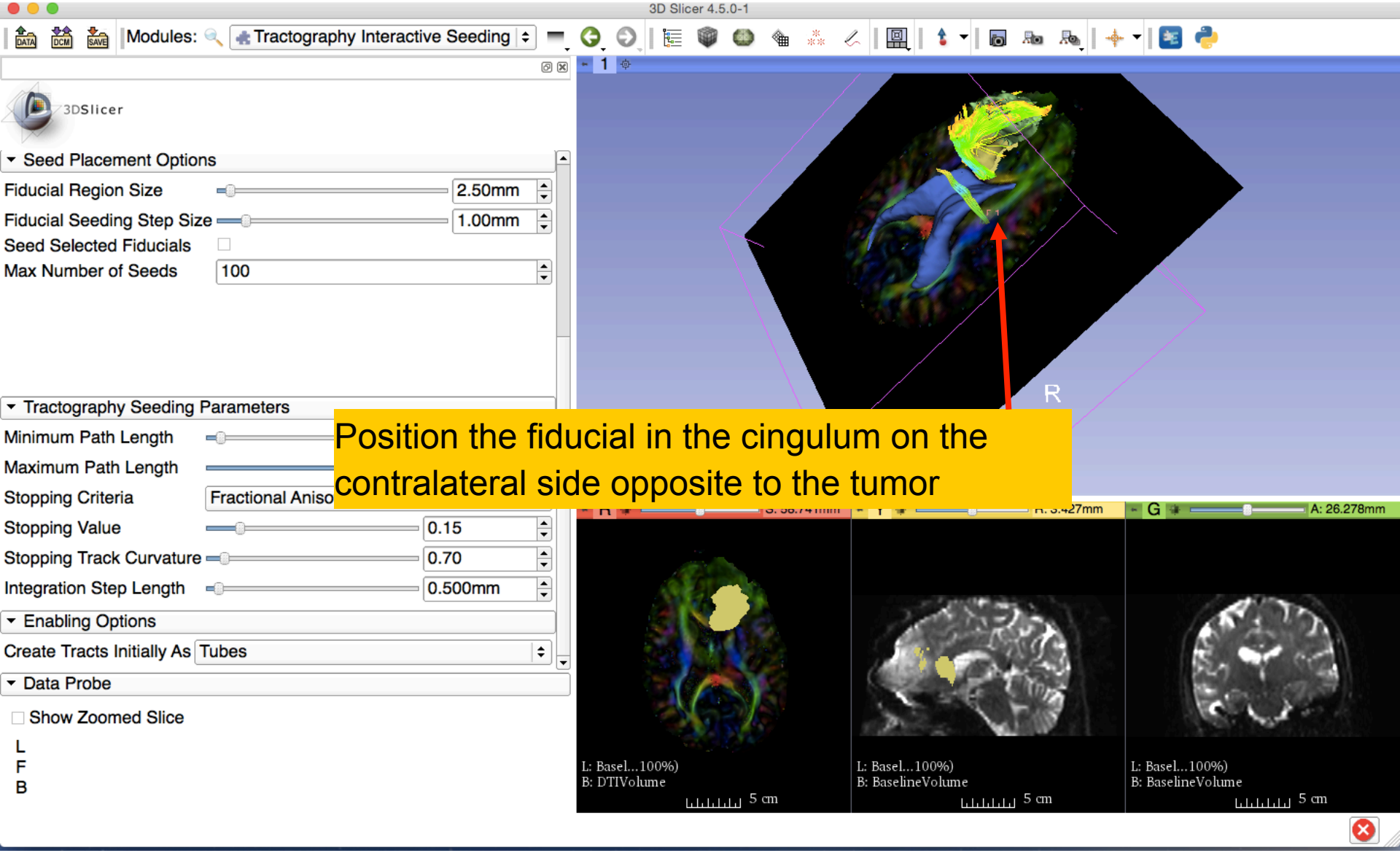


Set Input DTI Volume to **DTIVolume**
Set Fiducial List or Model to **F**
Set Output Fiber Bundle to **Create new Fiber Bundle**

Tractography on-the-fly

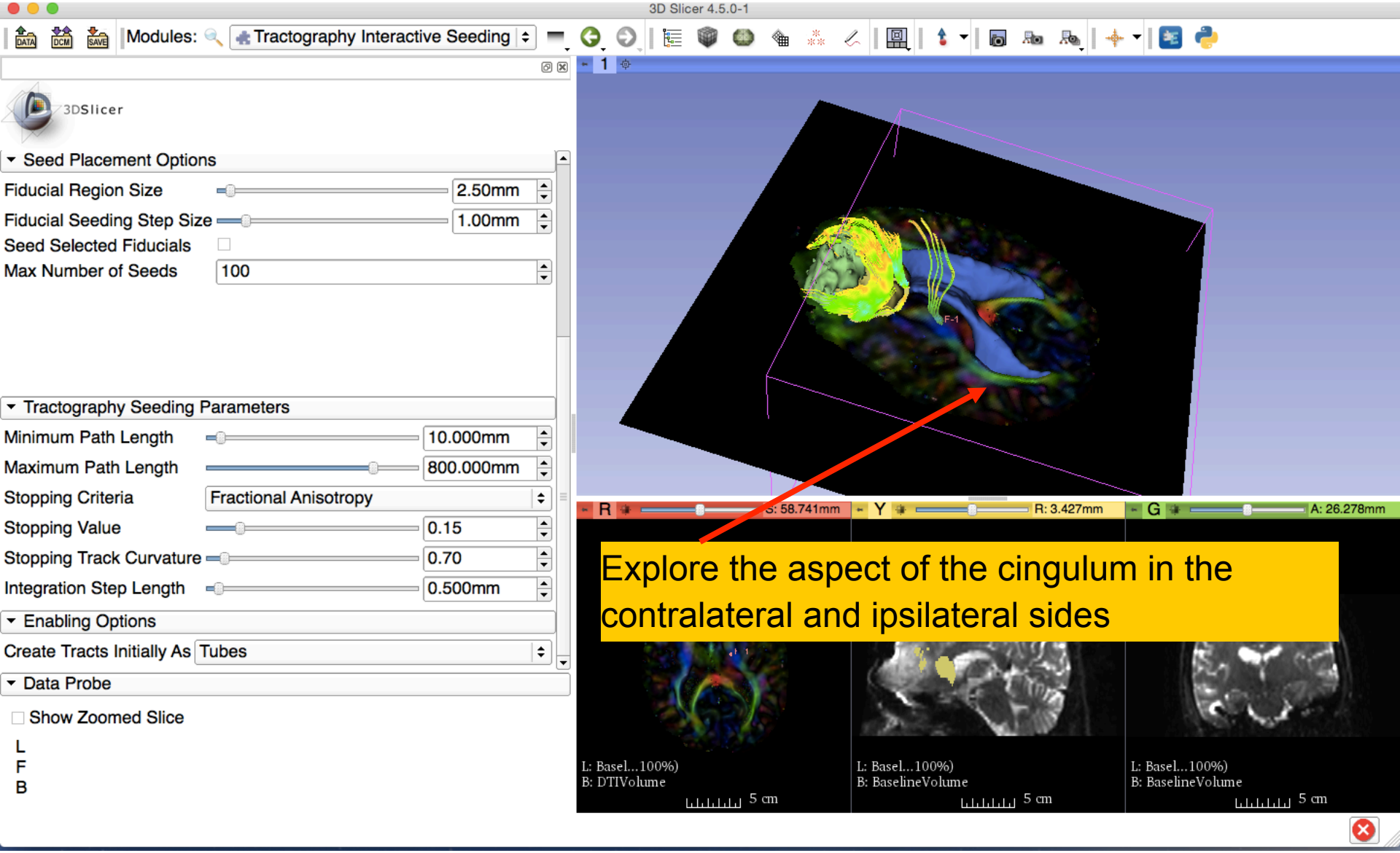


Tractography on-the-fly



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

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

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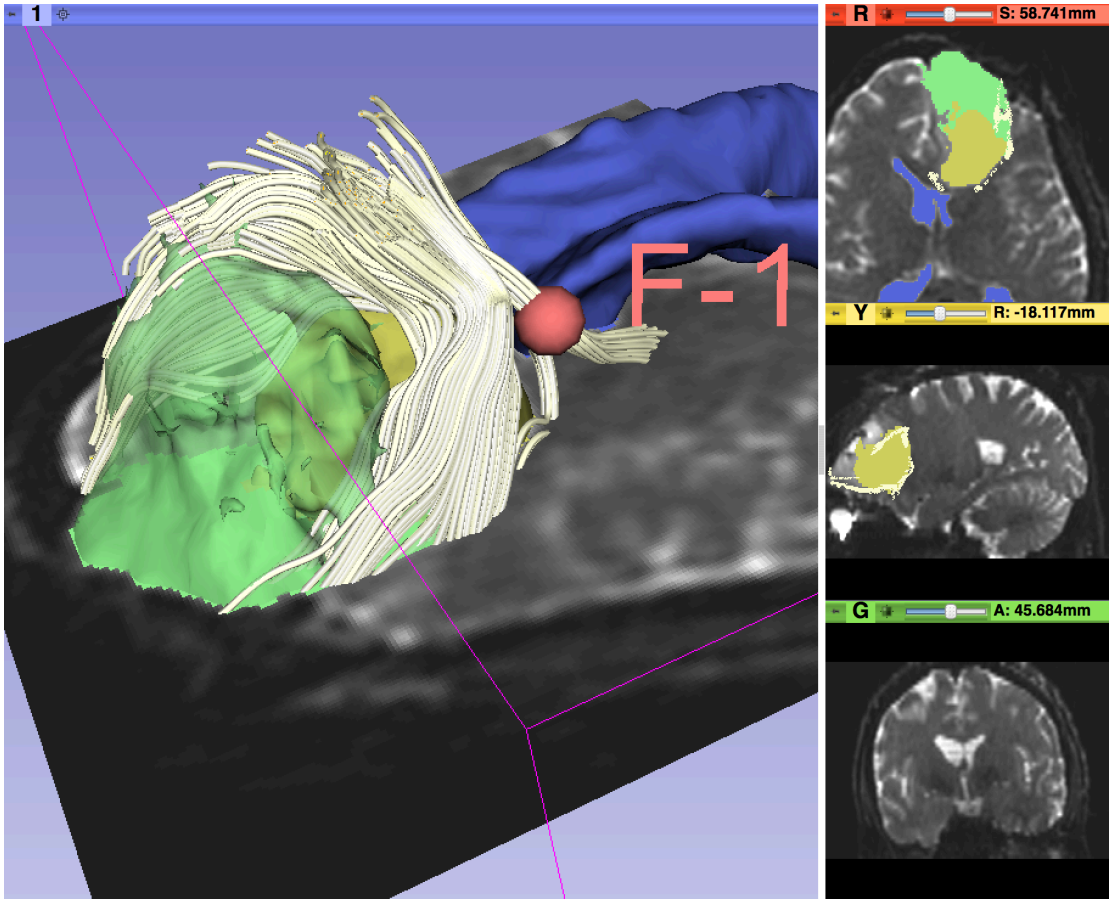
  NIH U54EB005149

- Neuroimage Analysis Center (NAC)

  NIH P41RR013218

- Fan Zhang, University of Sydney

Questions/Comments



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