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SKILL PILL: Visualizing Tomography Data (for free!)

Lecture 2: ITK-SNAP

OIST

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A free Tomography Data analysis workflow

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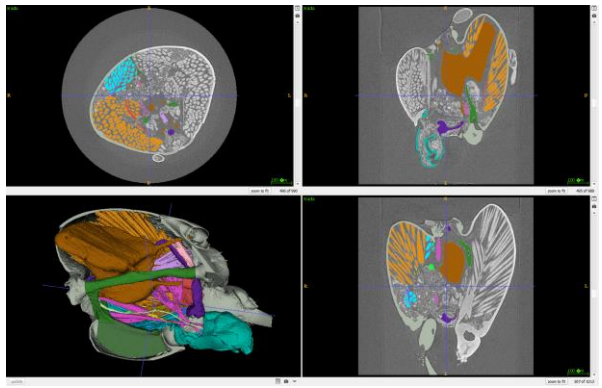
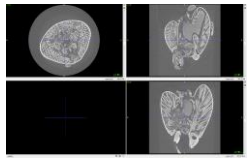
All freewares!

Lecture 2

ITK-SNAP



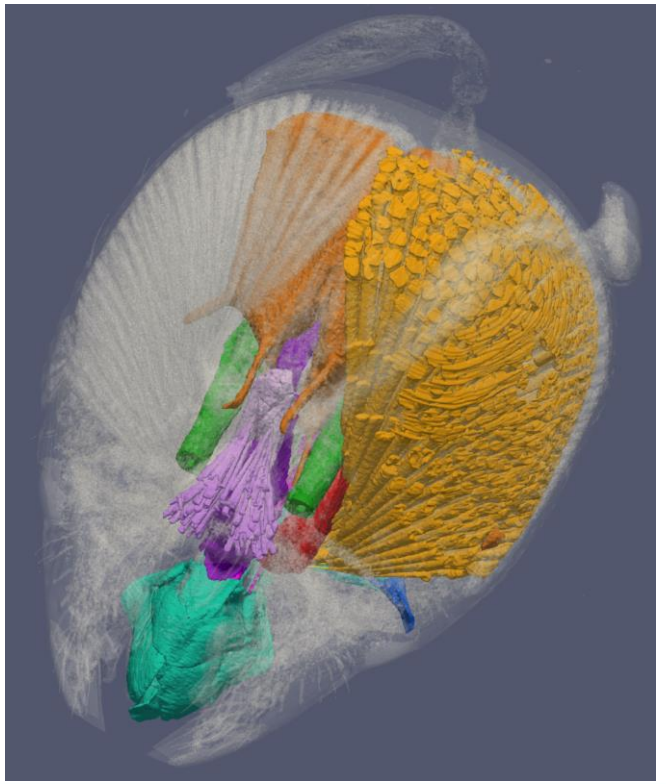


Segmentation: slow
→ Dissection, measurements

Segmented meshes

Lecture 3

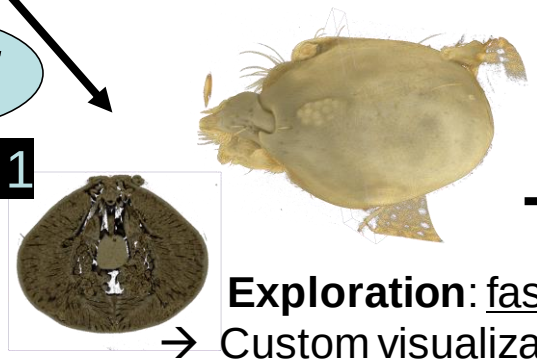
ParaView



Mesh visualization
→ Animations, snapshots, suited for publications

Drishti

Lecture 1



Exploration: fast
→ Custom visualization, animations, snapshots

Full mesh

What is ITK-SNAP?

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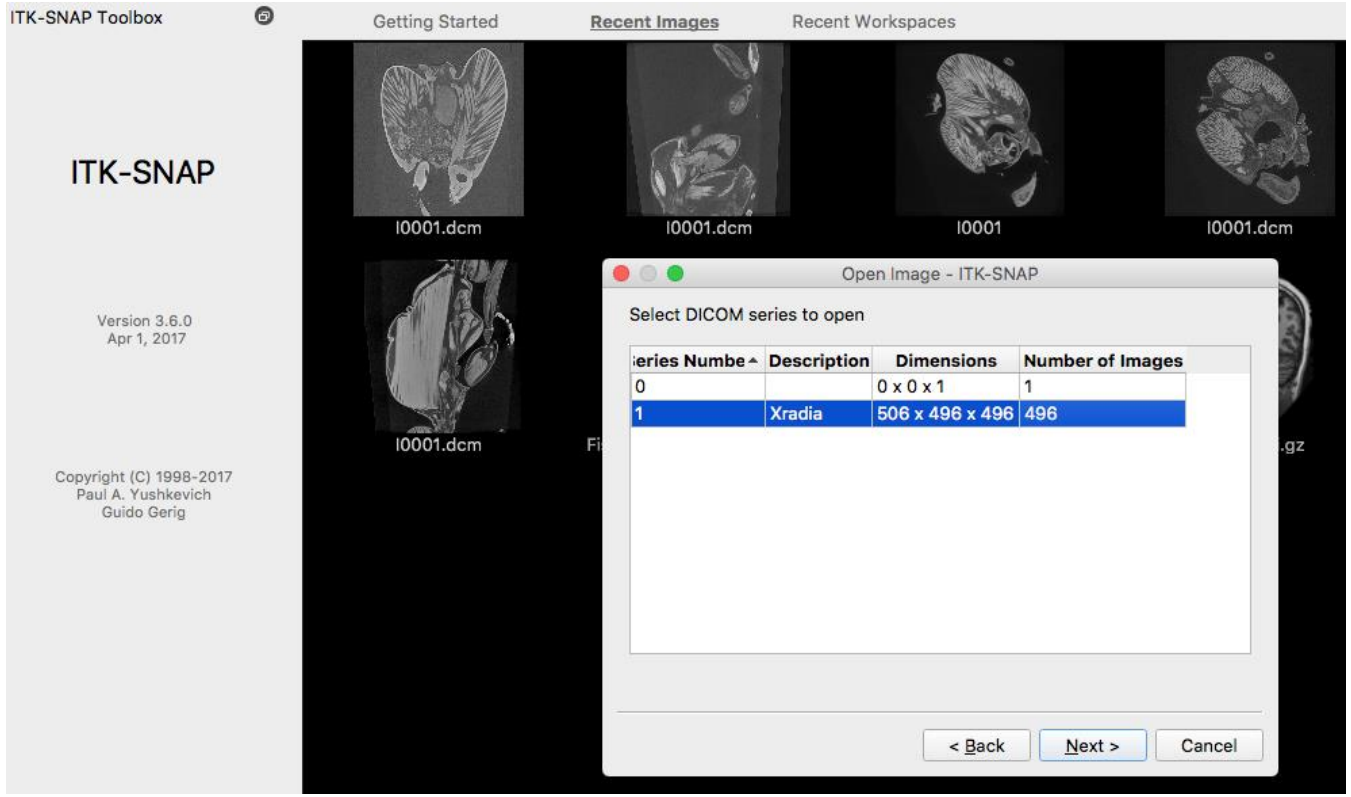
- Open-source segmentation software
- Designed by Paul Yushkevich (University of Pennsylvania) and Guido Gerig (University of Utah)
- Useful resources and links: http://www.itksnap.org/pmwiki/pmwiki.php
- ITK-SNAP is designed for segmentation: other features are kept to a minimum

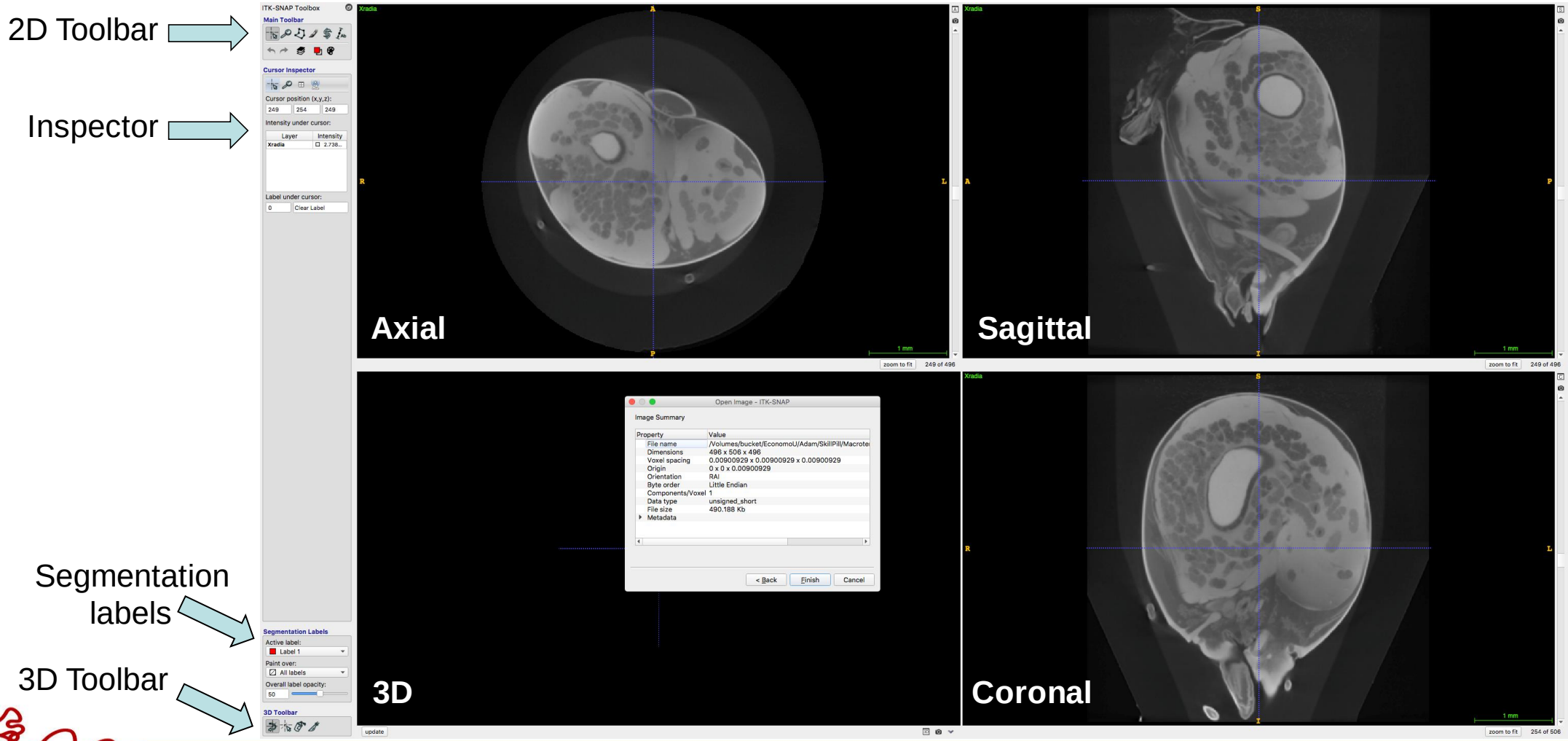
The beginning

- Open ITK-SNAP
- Drag and drop the scan folder
- Click on the file series you want to open, then on Next
- Wait for a moment…



The beginning

- When you get this screen, click on Finish



Main Toolbar

- This toolbar is crucial, start by getting familiar with the navigation tools

Segmentation tools
- Polygon
- Paintbrush
- Semi-automatic (snake)

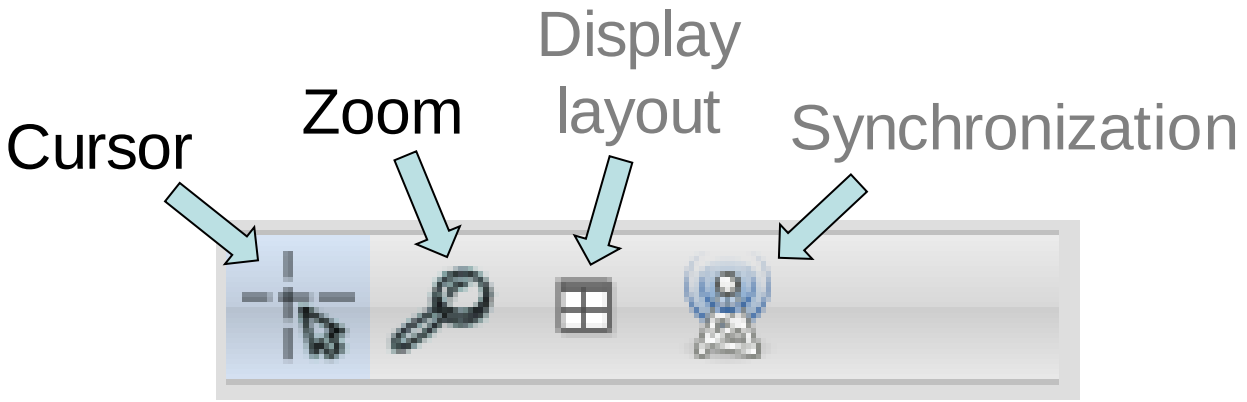
Navigation tools
- Crosshair
- Zoom

Image annotation

Layer Inspector

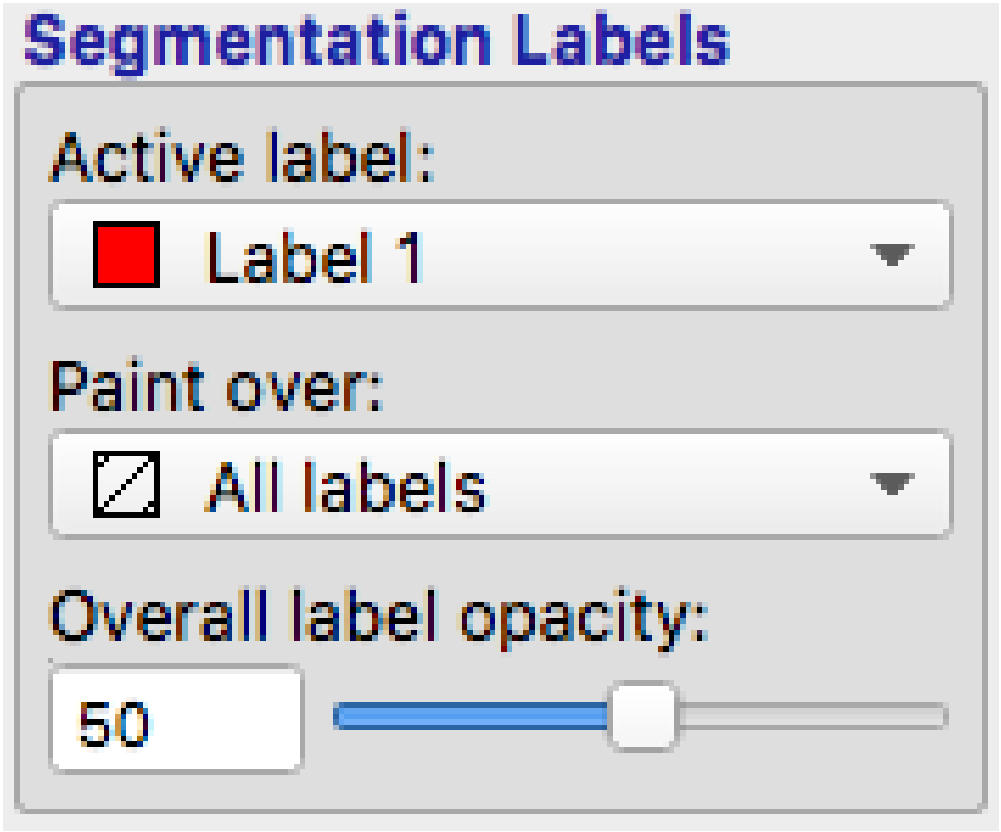
Label tools
- Picker
- Editor

- You can access informations regarding and get shortcuts for:



Segmentation Labels

- Quite explicit, and we will come to this later anyway



3D Toolbar

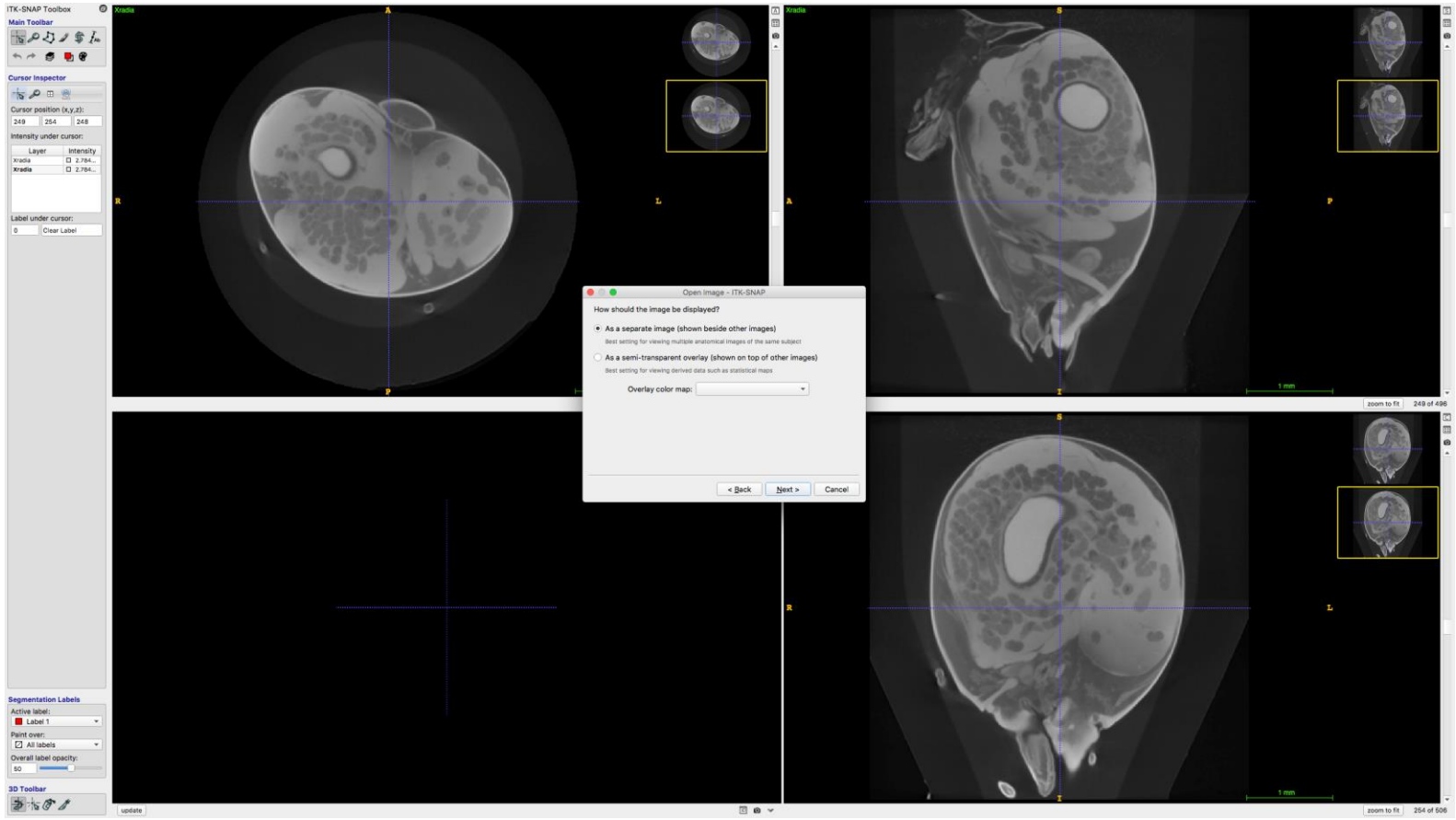
- These tools are exclusively for the 3D panel
- Segmentation on the 3D model: unique!

Navigation tools
- Trackball
- Crosshair

Segmentation tools
- Spray
- Scalpel

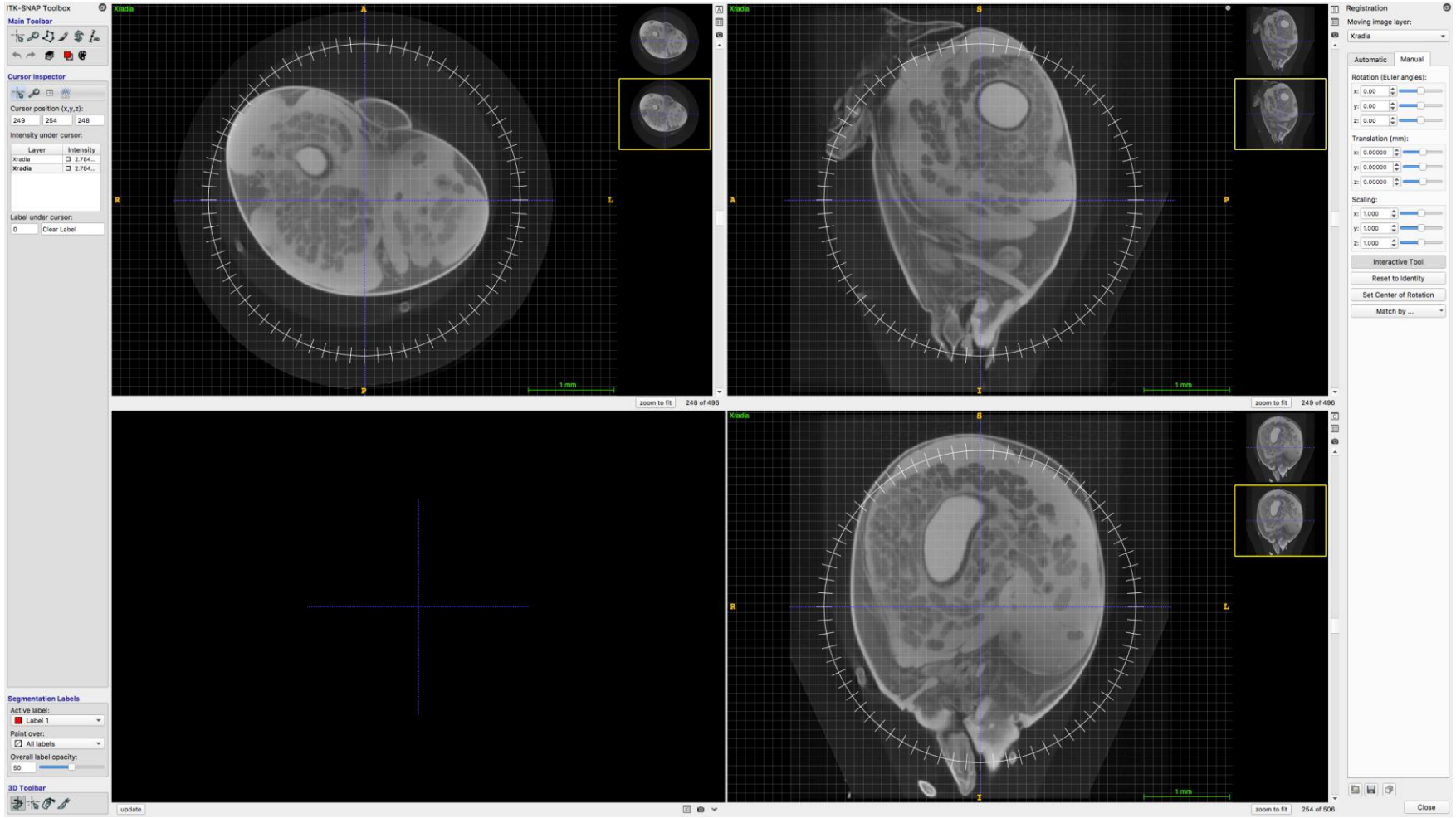
Re-align slices

- Segmentation is an active labelling process, you need to know what you are looking at → easier on well-aligned slices
- Go to File
  > Add another image
- Pick the same as you already loaded
- On the pop-up, tick *As a separate image*
- Click Next



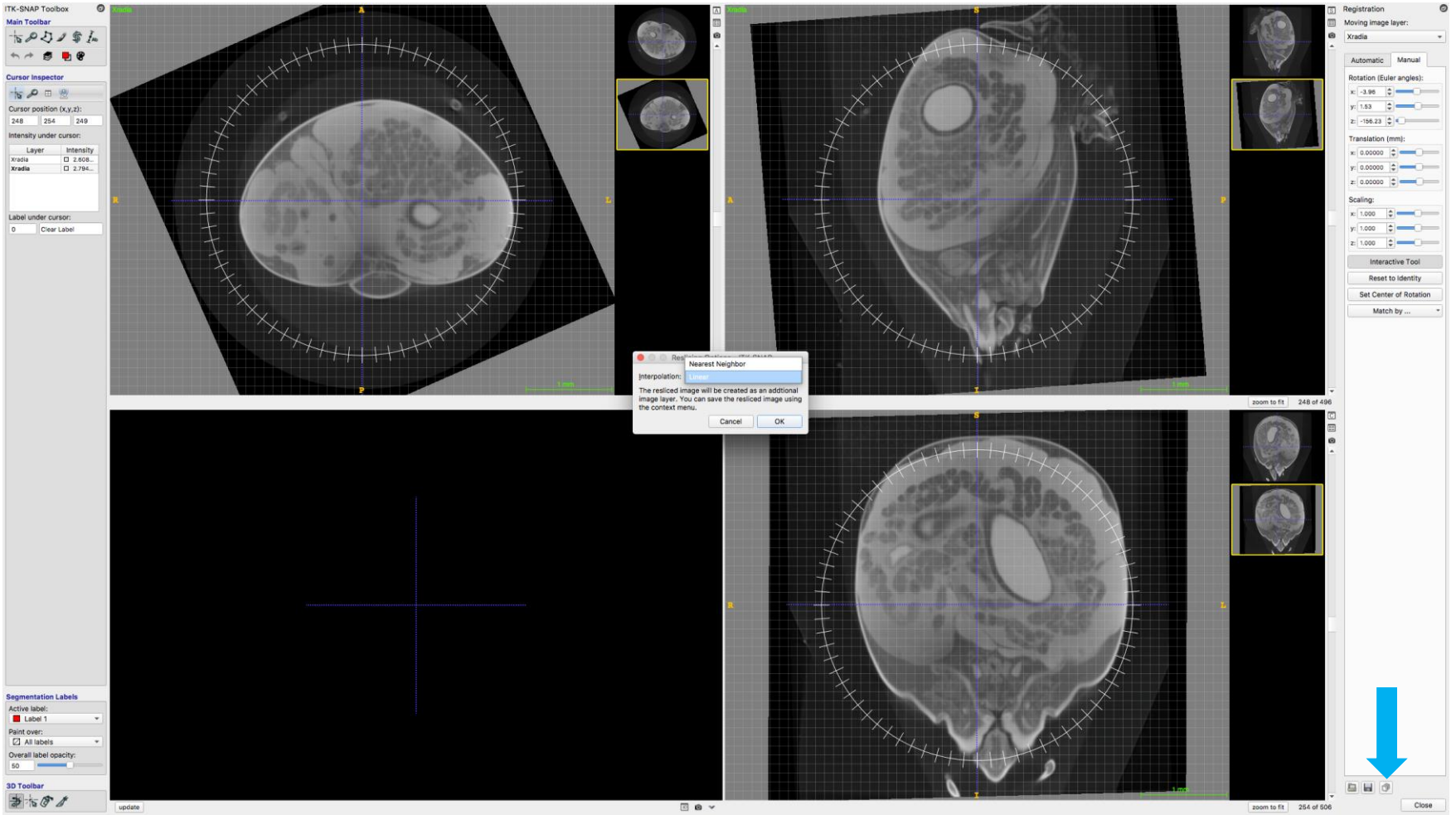
Re-align slices

- Now your scans are opened in two copies
- Go to Tools > Registration
- Access the Manual tab
- Use your mouse to rotate scans in all views



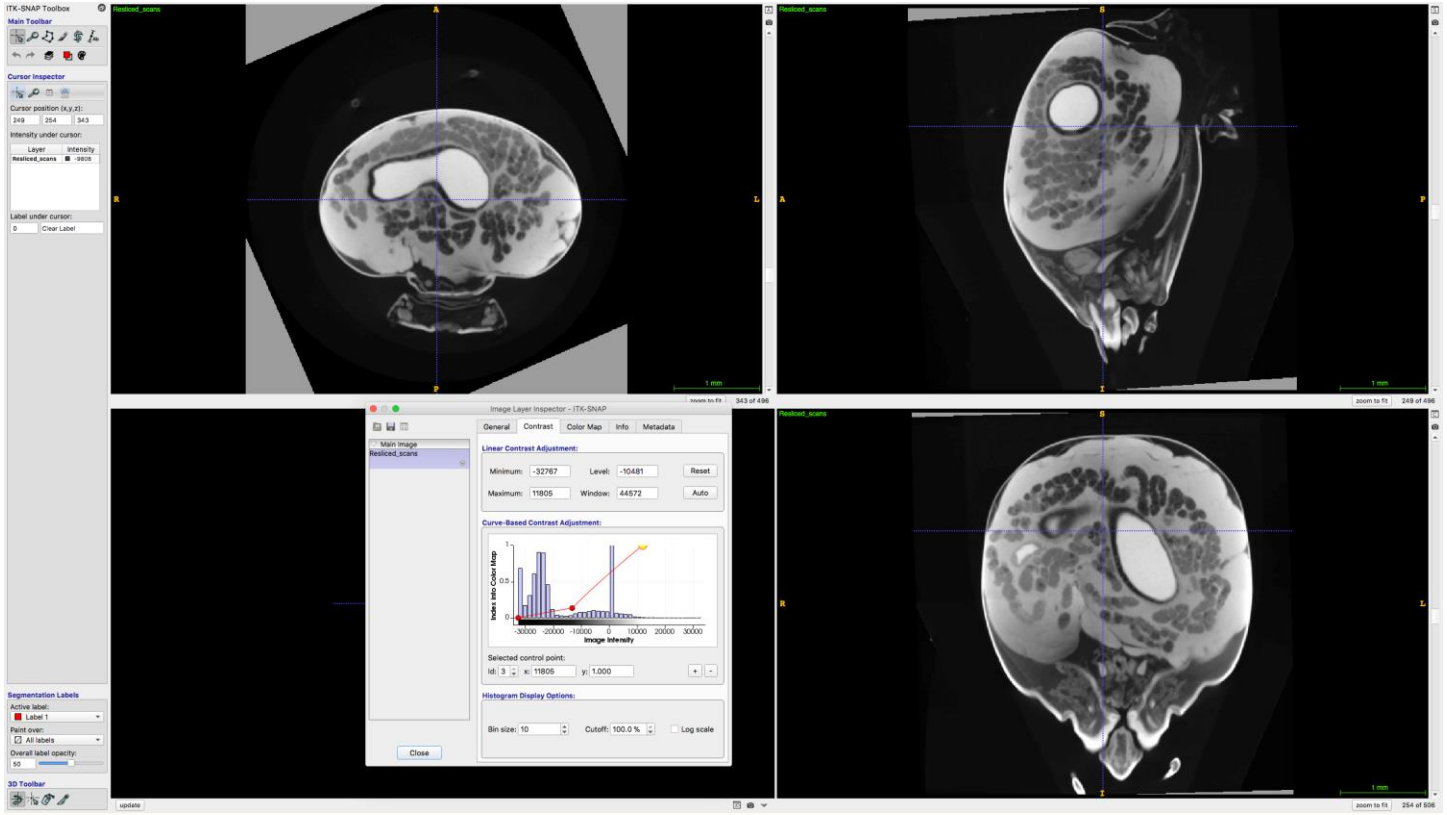
Re-align slices

- When you're done, proceed to the reslicing
- Save the resliced image (.nii.gz)
- Open it as Main Image



Semi-automatic segmentation

- Adjust the contrast of your image:
  - Tools > Image Contrast > Auto-Adjust Contrast
  - Tools > Image Contrast > Contrast Adjustment



Semi-automatic segmentation

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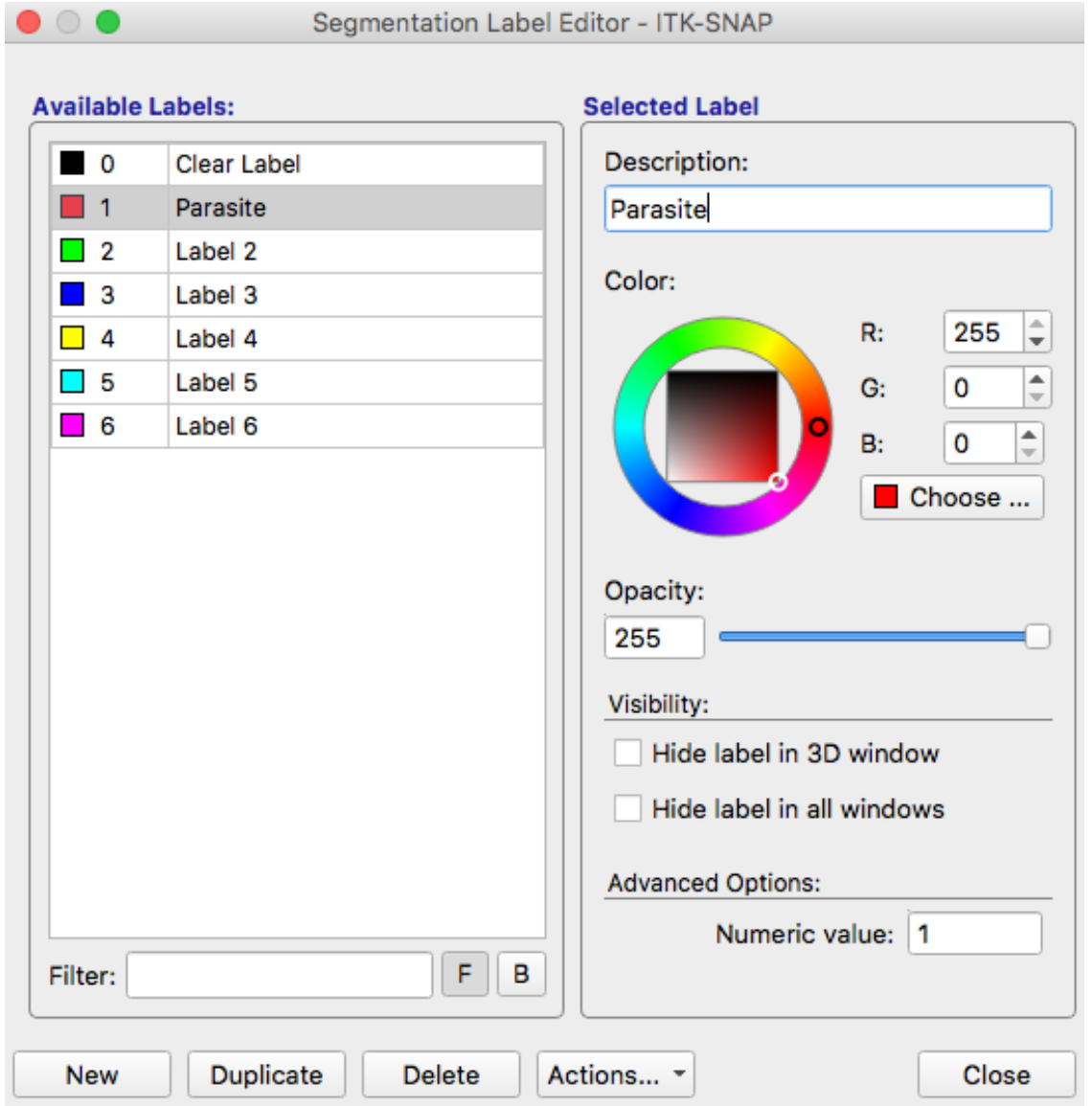
- Go to the Label Editor
- Create a *Parasite* label
- Give it the color you want
- Close the Label Editor



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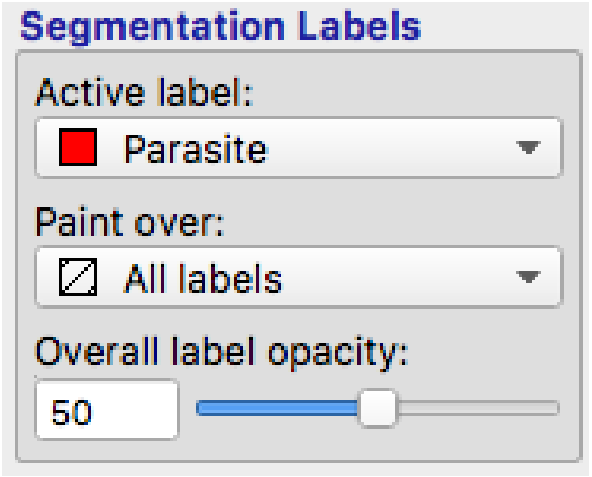
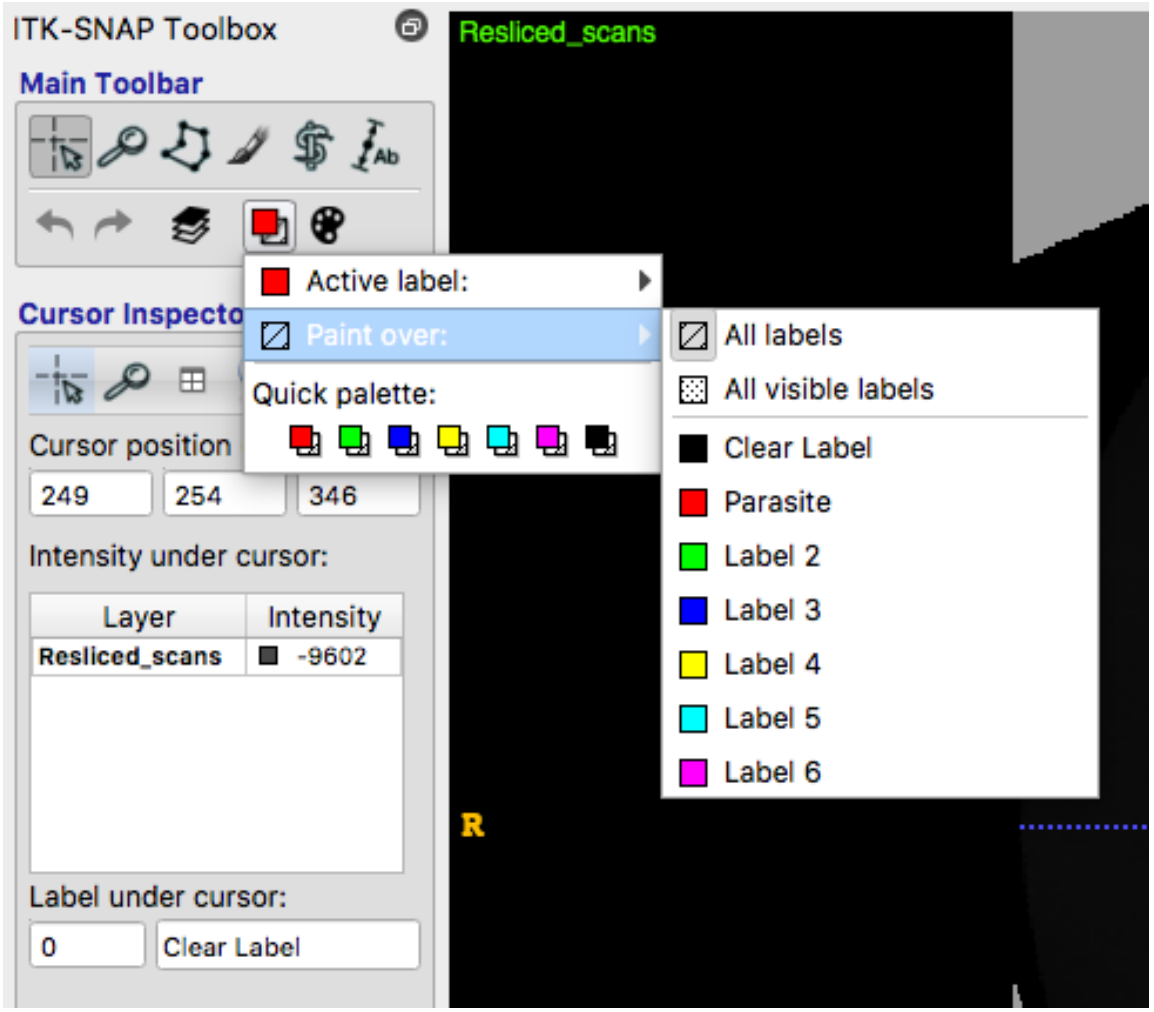
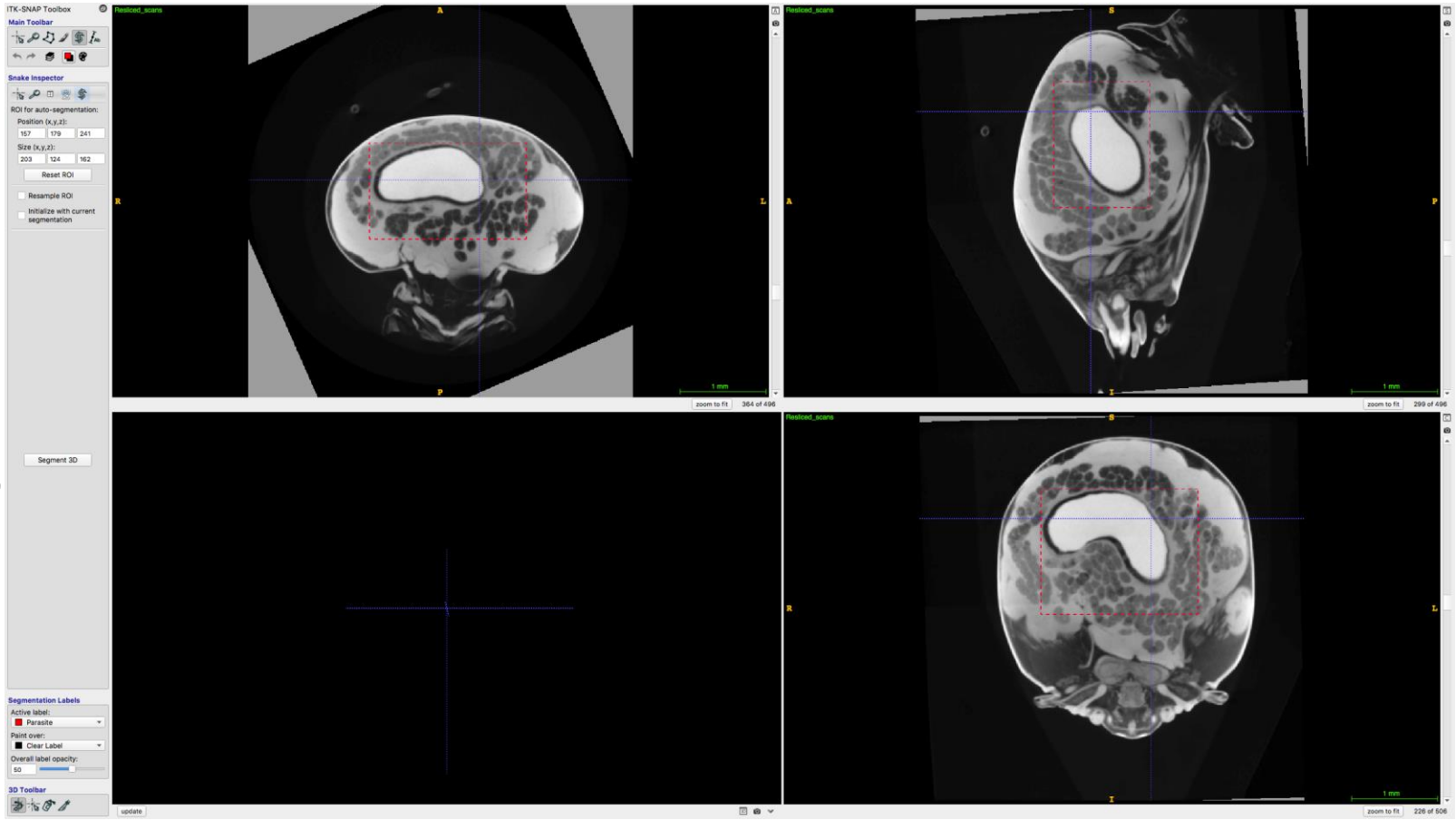
- Set the *Parasite* label as the active label
  - From the Main toolbar (label picker)
  - From the Segmentation Labels panel





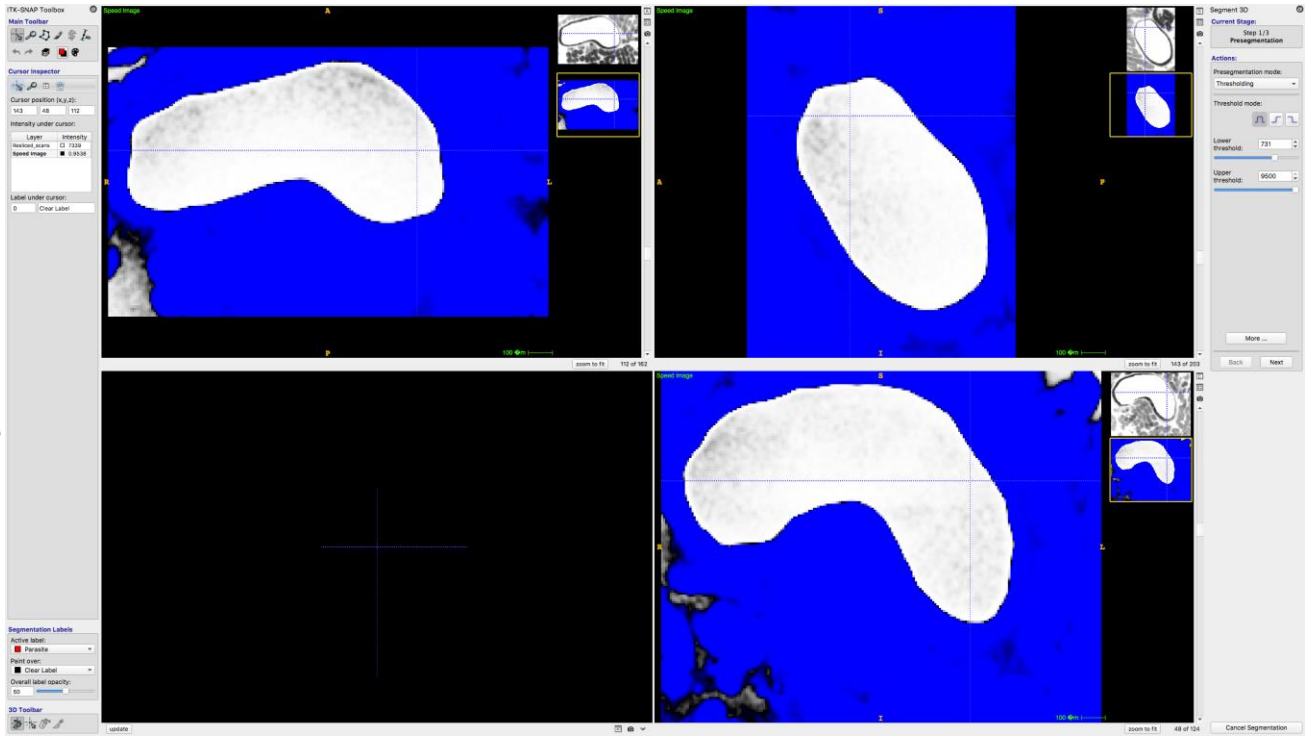
Semi-automatic segmentation

- Click on the Snake
- Set the ROI (red rectangles) around the parasite
- Do it on the 3 views
- Click on Segment 3D



Semi-automatic segmentation

- <u>Step 1: Presegmentation</u>
- Click on the second image series opened by the menu
- White areas = segmentable
- Blue areas = non-segmentable
- Adjust the threshold settings (on the right) to make the parasite only appear white



Semi-automatic segmentation

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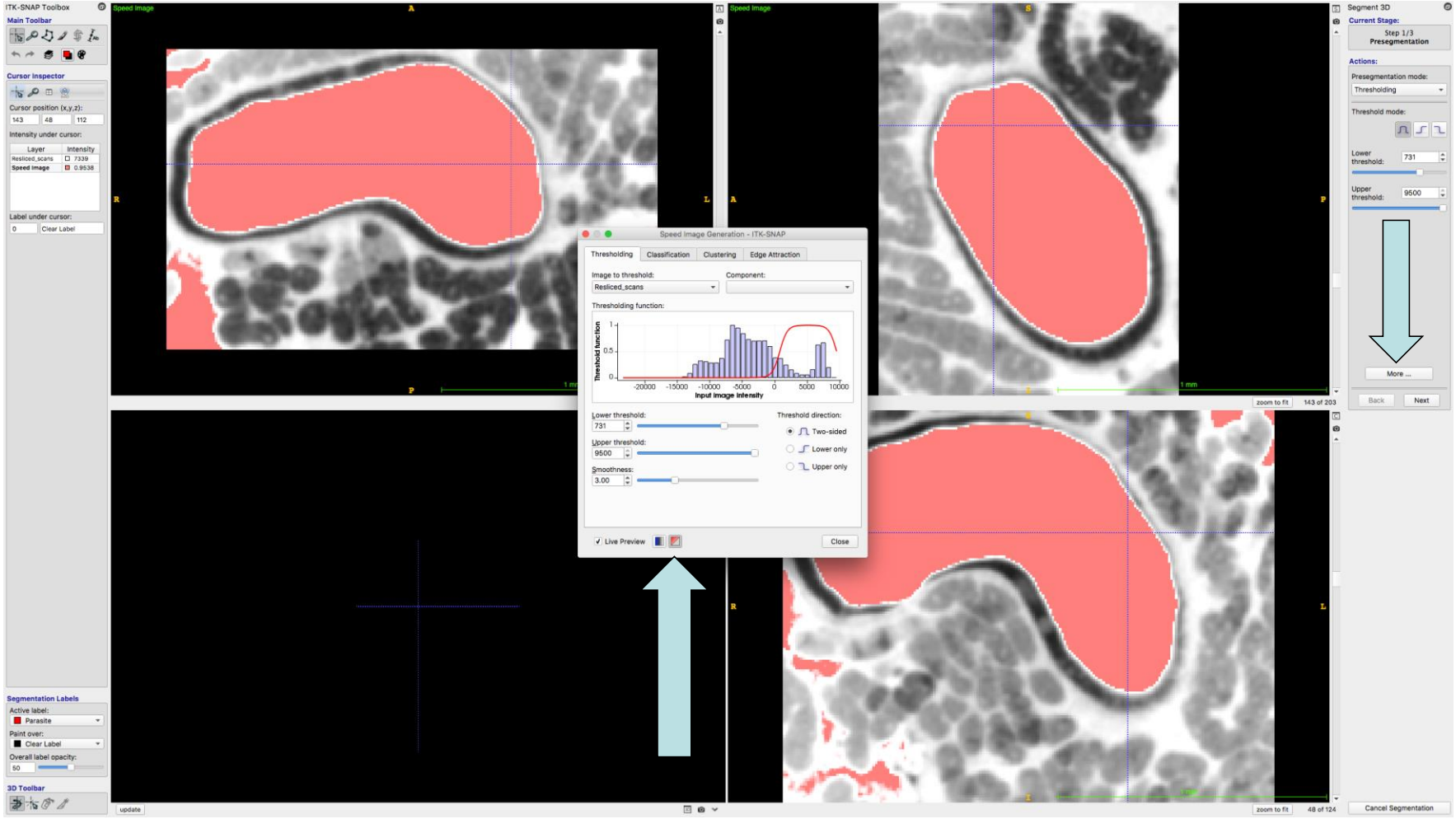
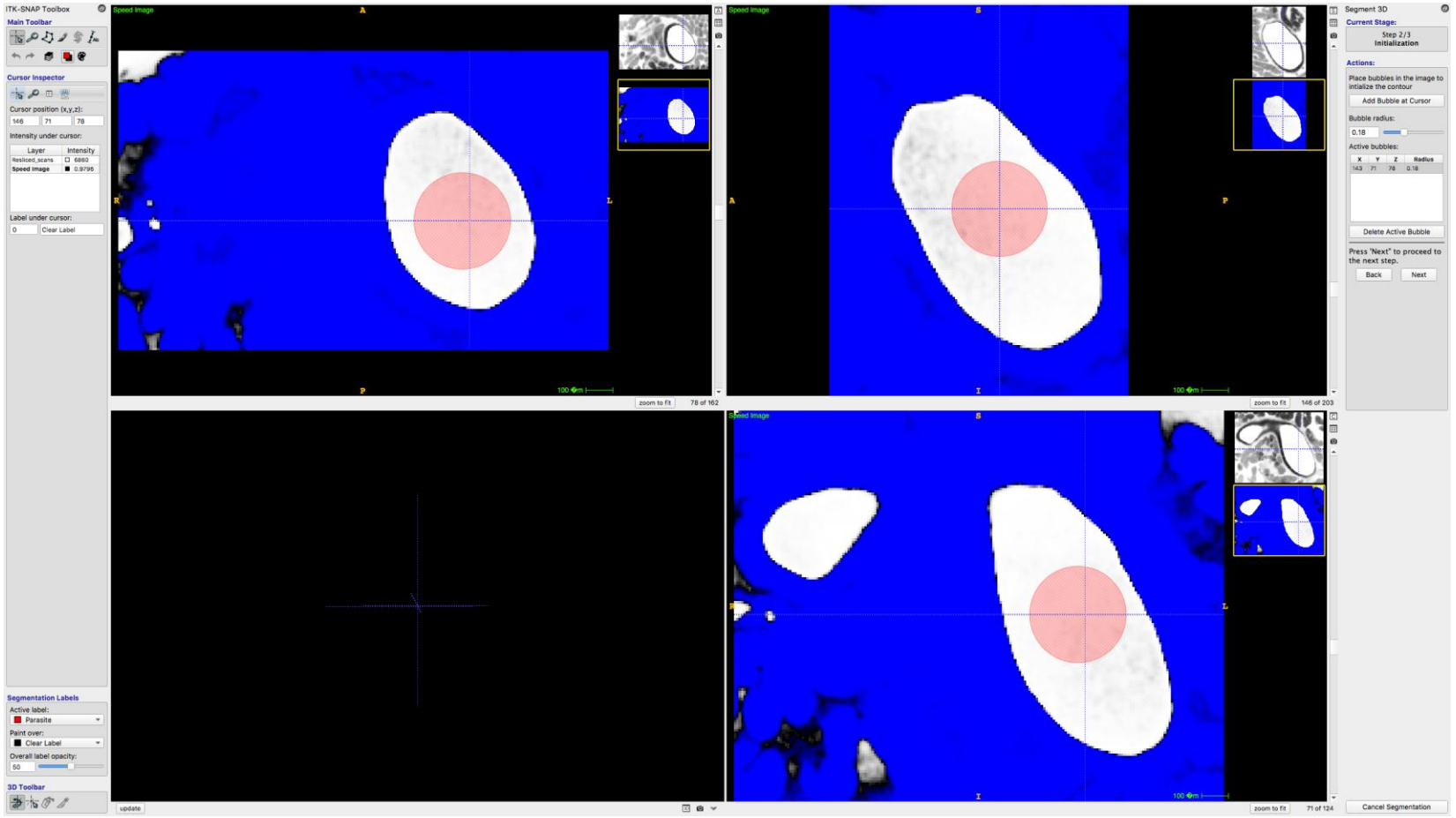
- Tip to visualize the segmentable area as inside the scan images:
  - Click on More
  - Click on the orange square
  - You can adjust the threshold
  - Then, Next



Semi-automatic segmentation

- Step 2: Initialization
- Click somewhere on the parasite
- Click on Add Bubble at Cursor
- Adjust the radius
- Next (one bubble is enough for this particular object)



Semi-automatic segmentation

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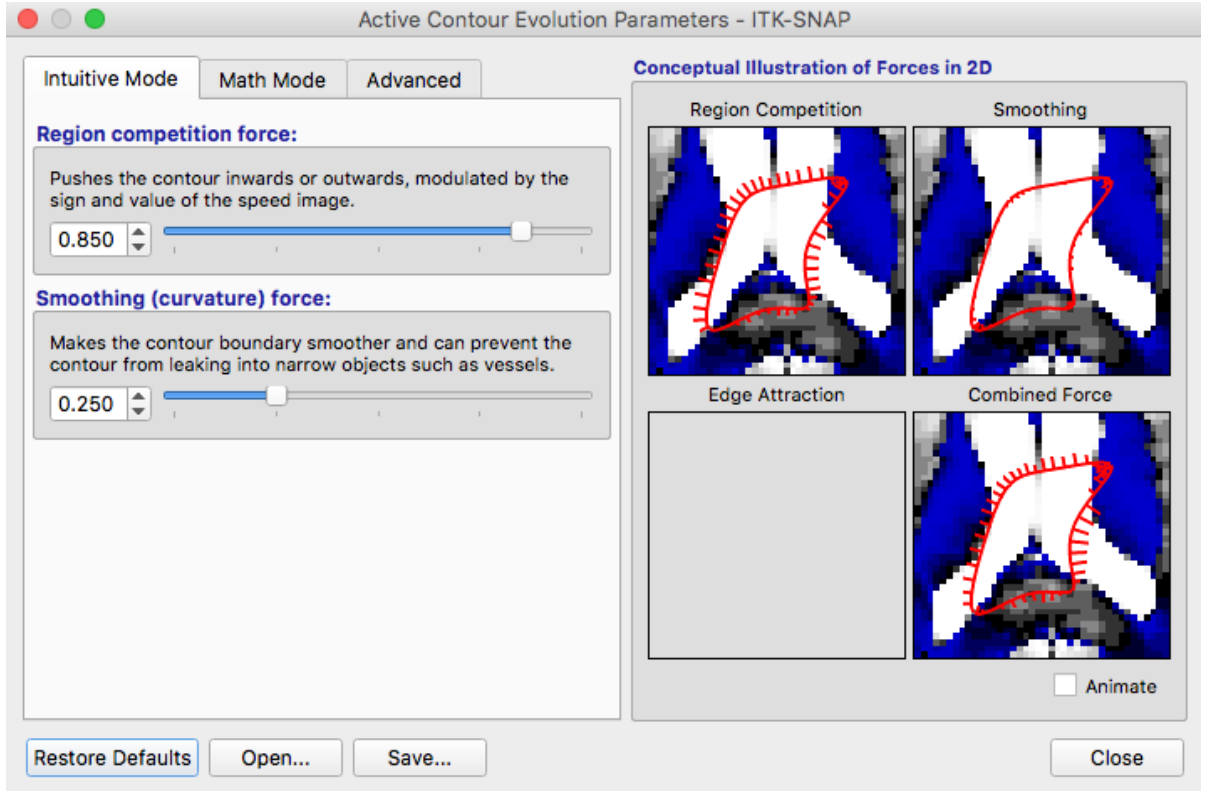
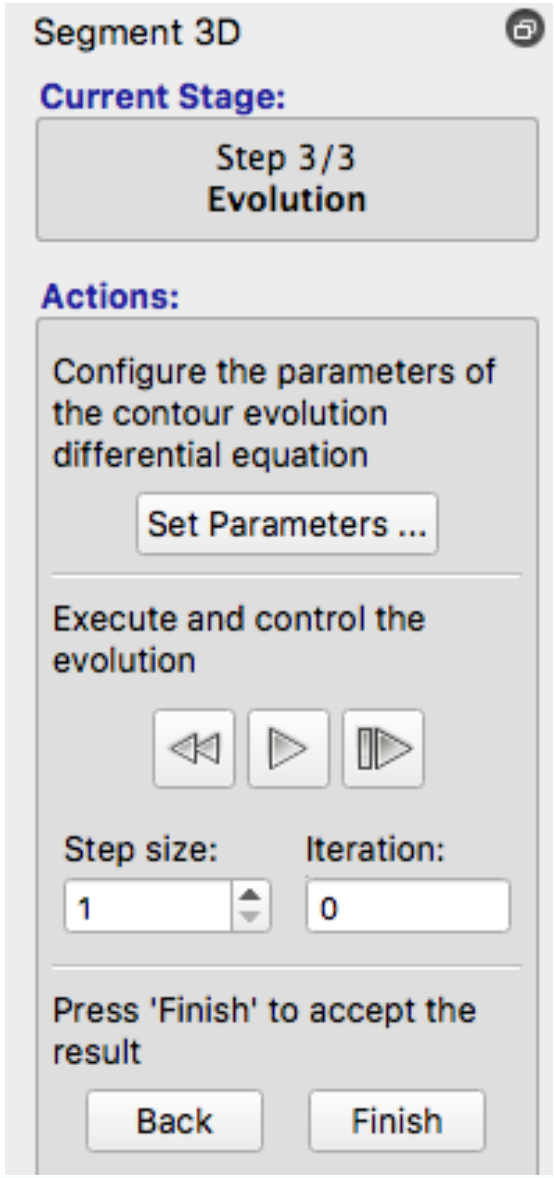
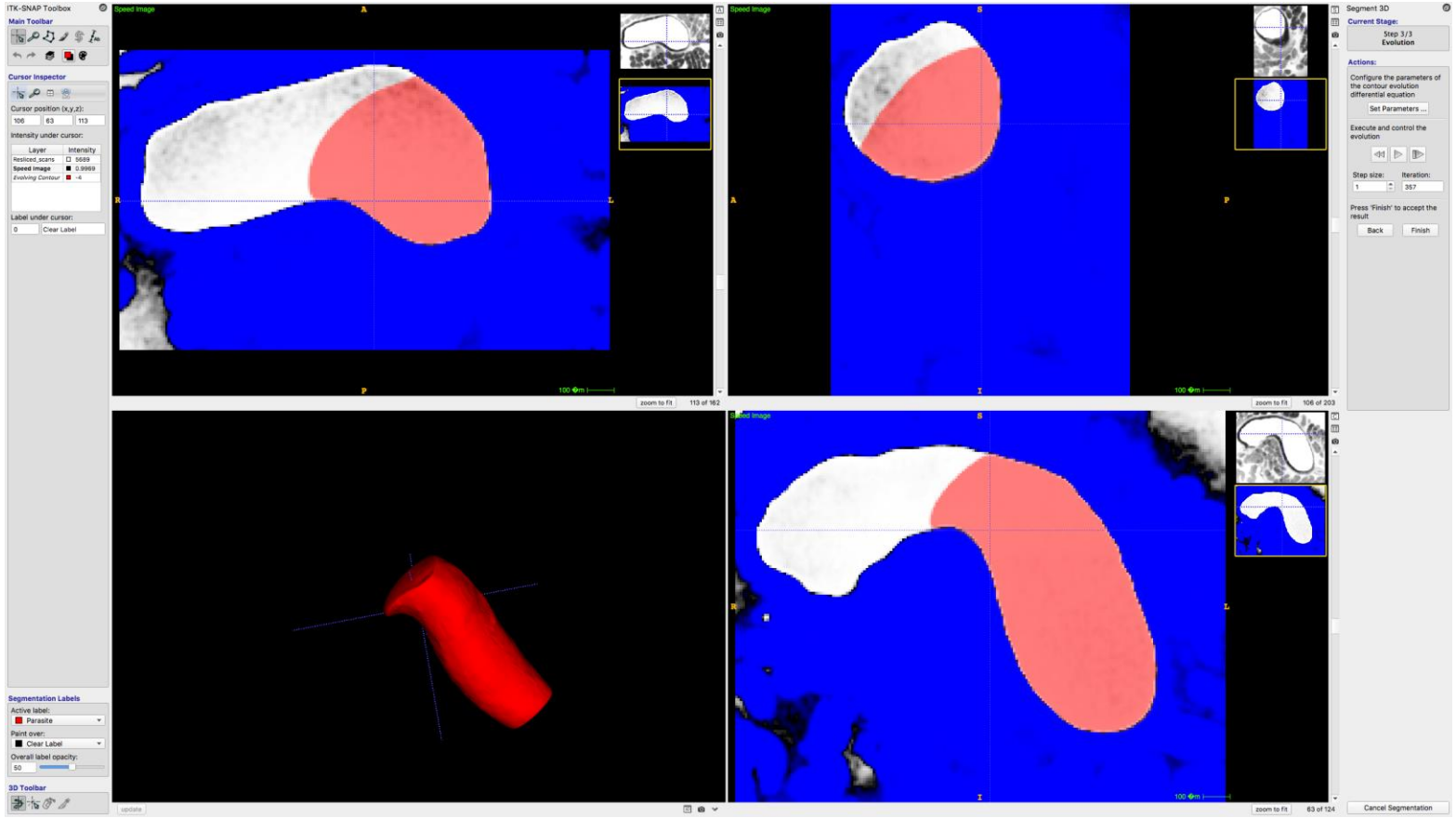
- Step 3: Evolution
- Click on Set Parameters and adjust:
  - Region competition
  - Smoothing
- Click on Play





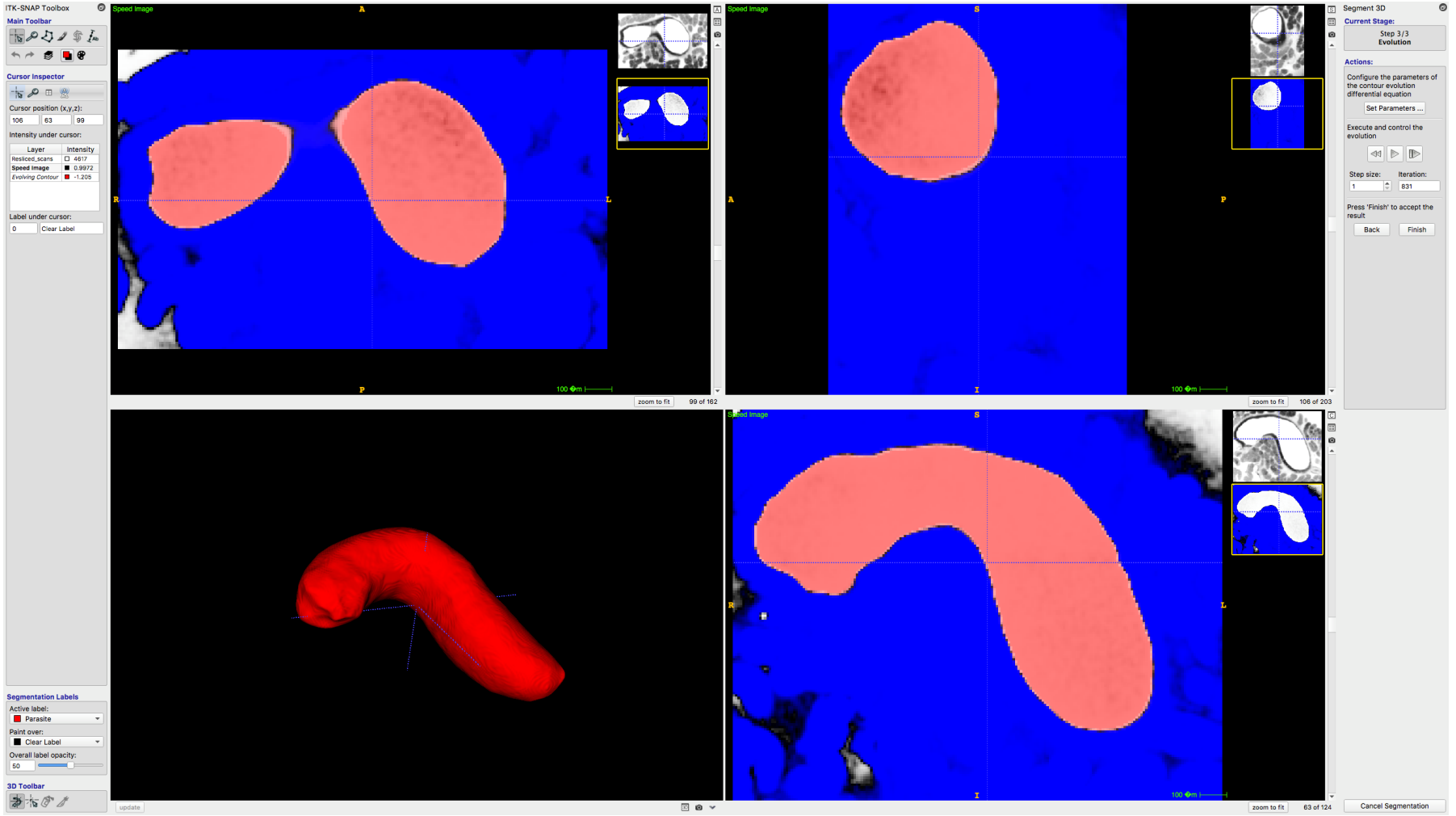
Semi-automatic segmentation

- Follow the evolution
- Press Pause to check how the label spreads
- Update the 3D window to preview the output



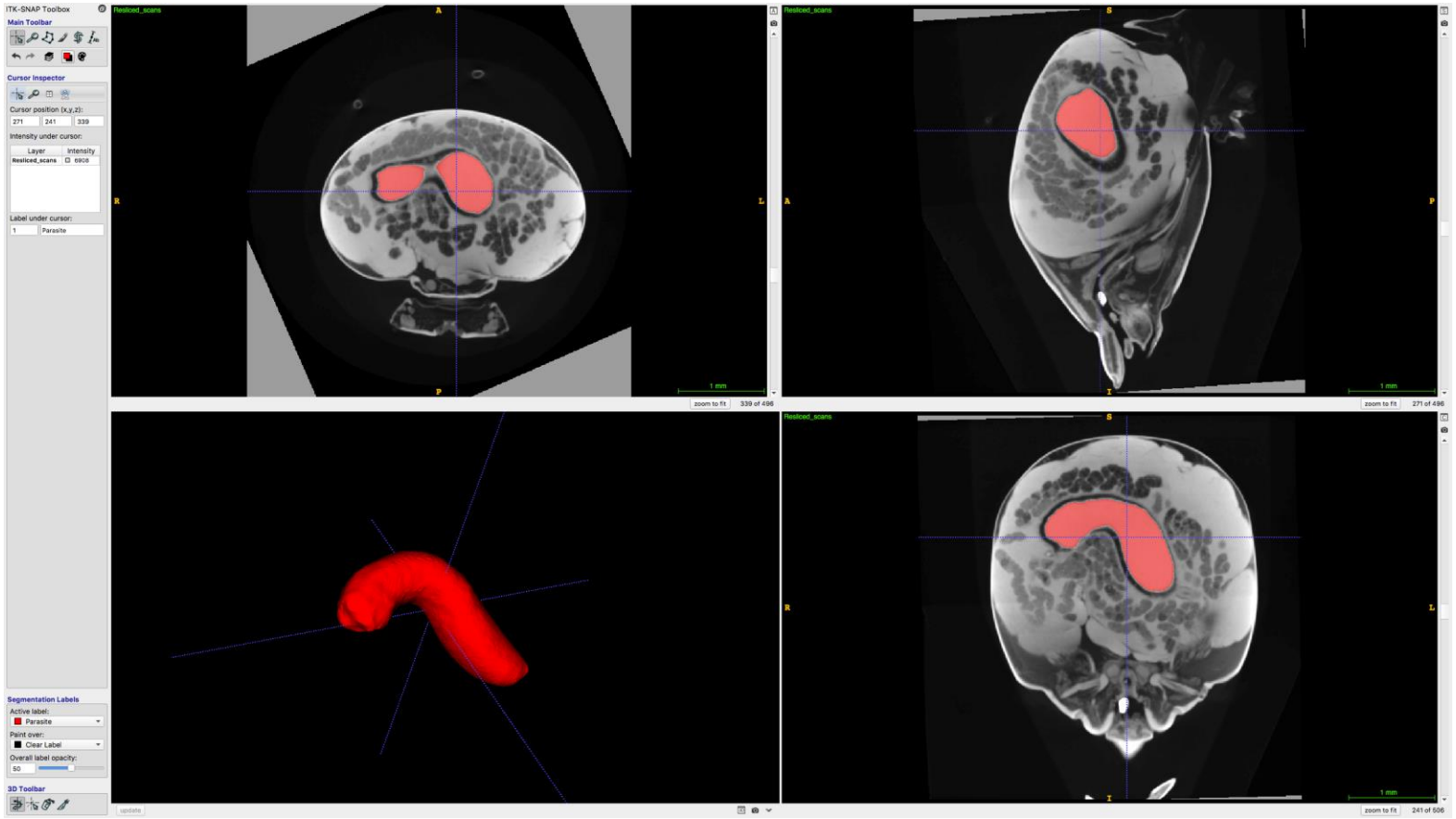
Semi-automatic segmentation

- If it looks good, click on Finish



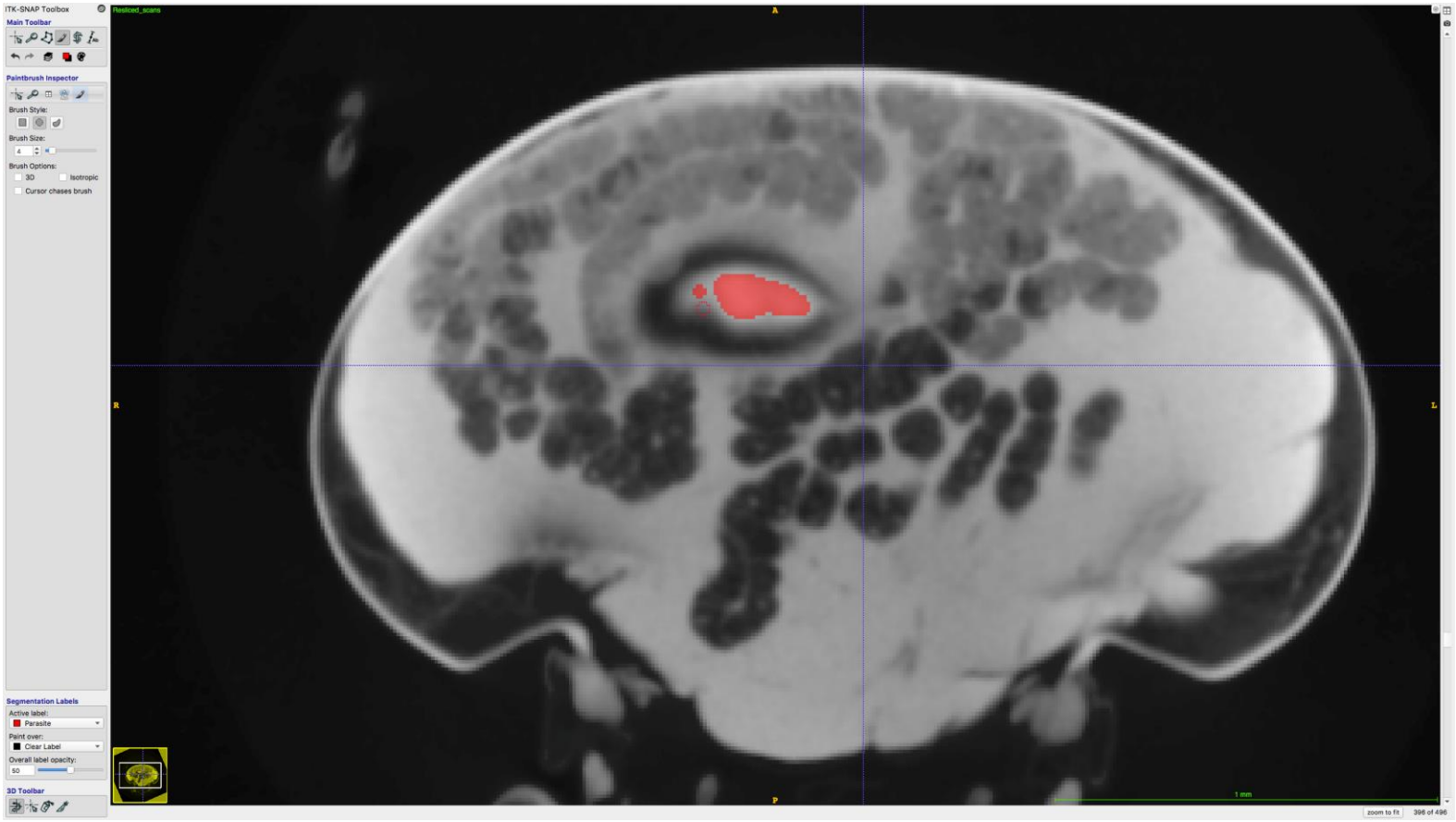
Semi-automatic segmentation

- You see that your label now appears on the scans
- Update the 3D window to visualize what you just segmented



Manual segmentation

- Usually, extreme slices need some manual refining
- In this particular case, the Polygon tool is appropriate



Manual segmentation

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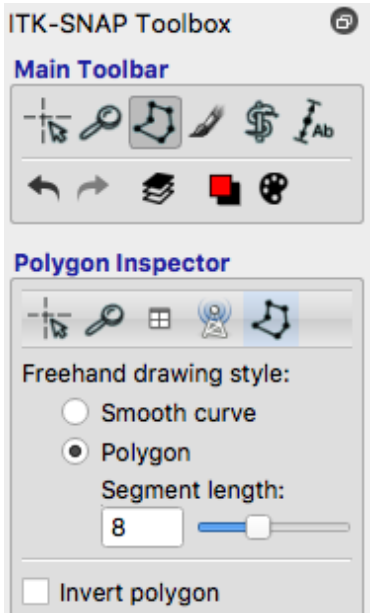
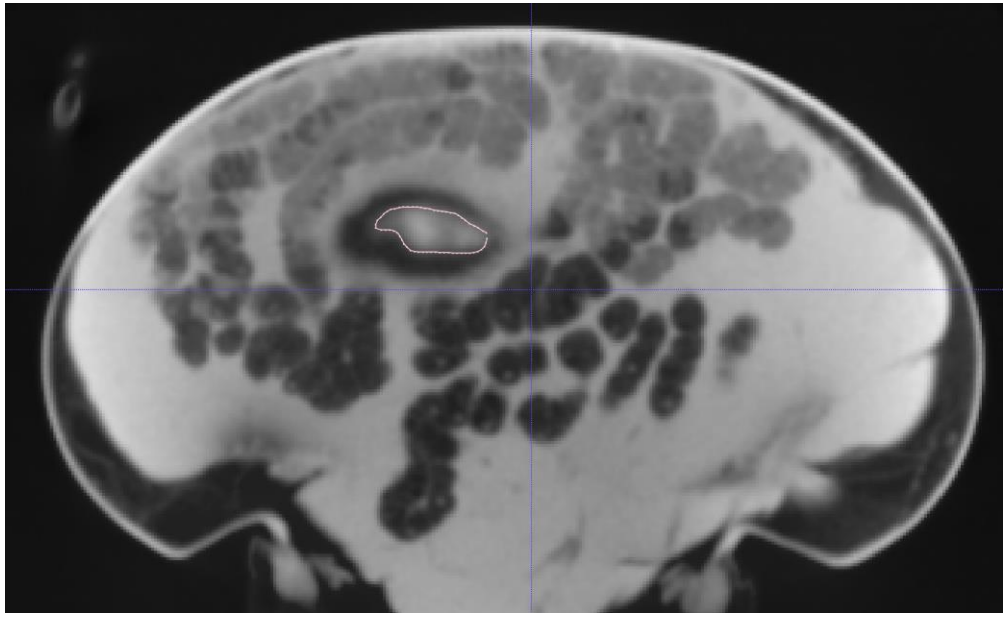
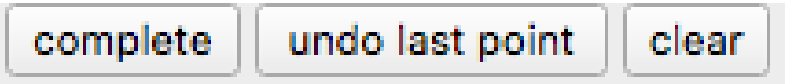
- Click on the Polygon icon
- Draw around the parasite region you want to add to your segmentation
- Use the bottom toolbar to complete/redo your polygon



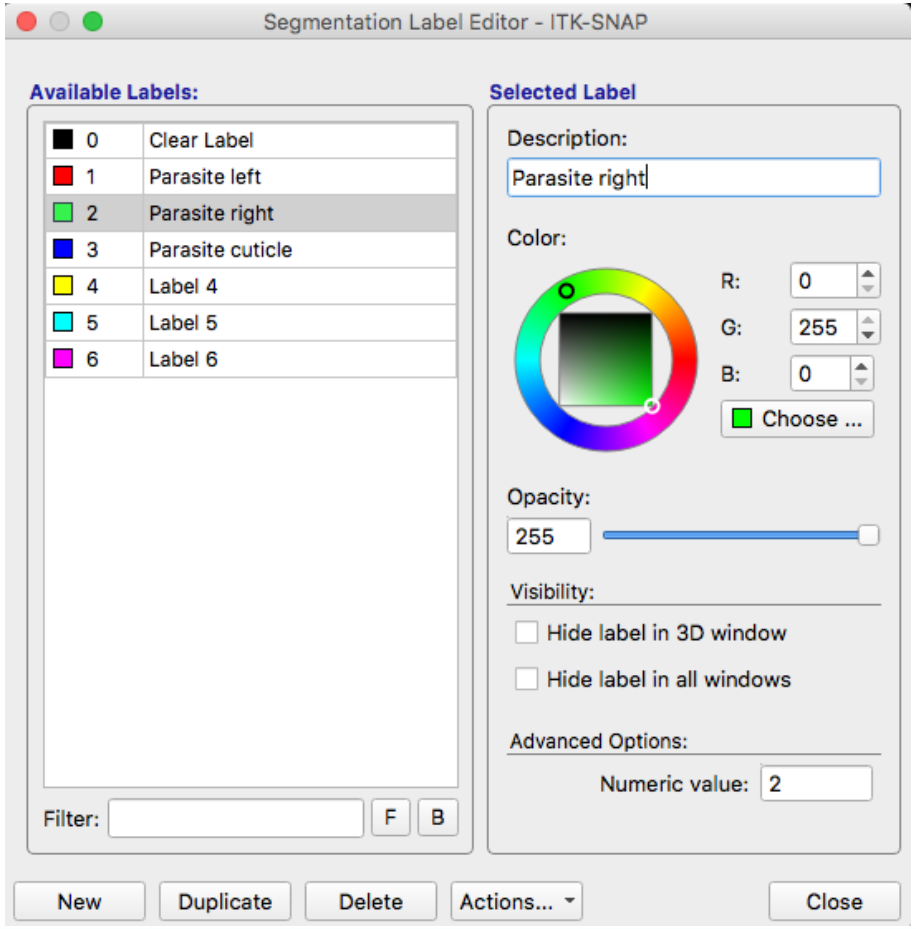




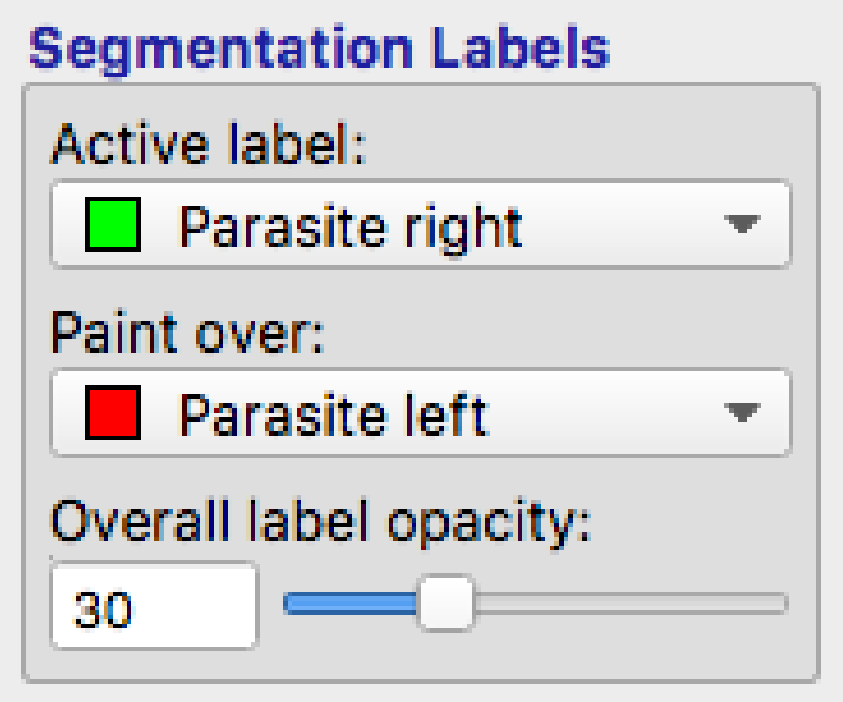
- Do this on the areas that need some resegmentation

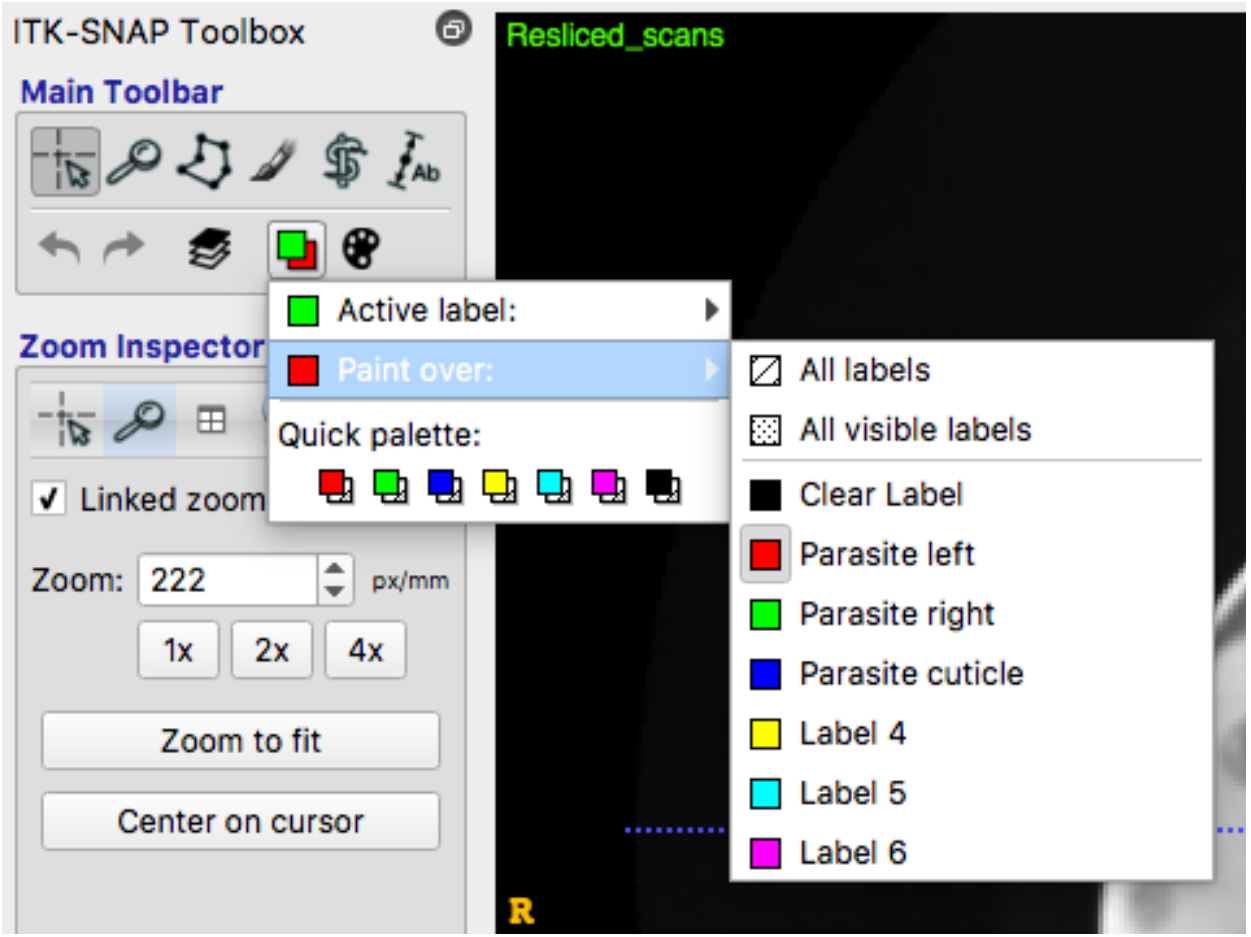
3D segmentation

- Let's say we want 2 colors for the parasite:
  - Right side of the termite head
  - Left side of the termite head
- Open the Label Editor
- Rename our label *Parasite left*
- Name a second *Parasite right*



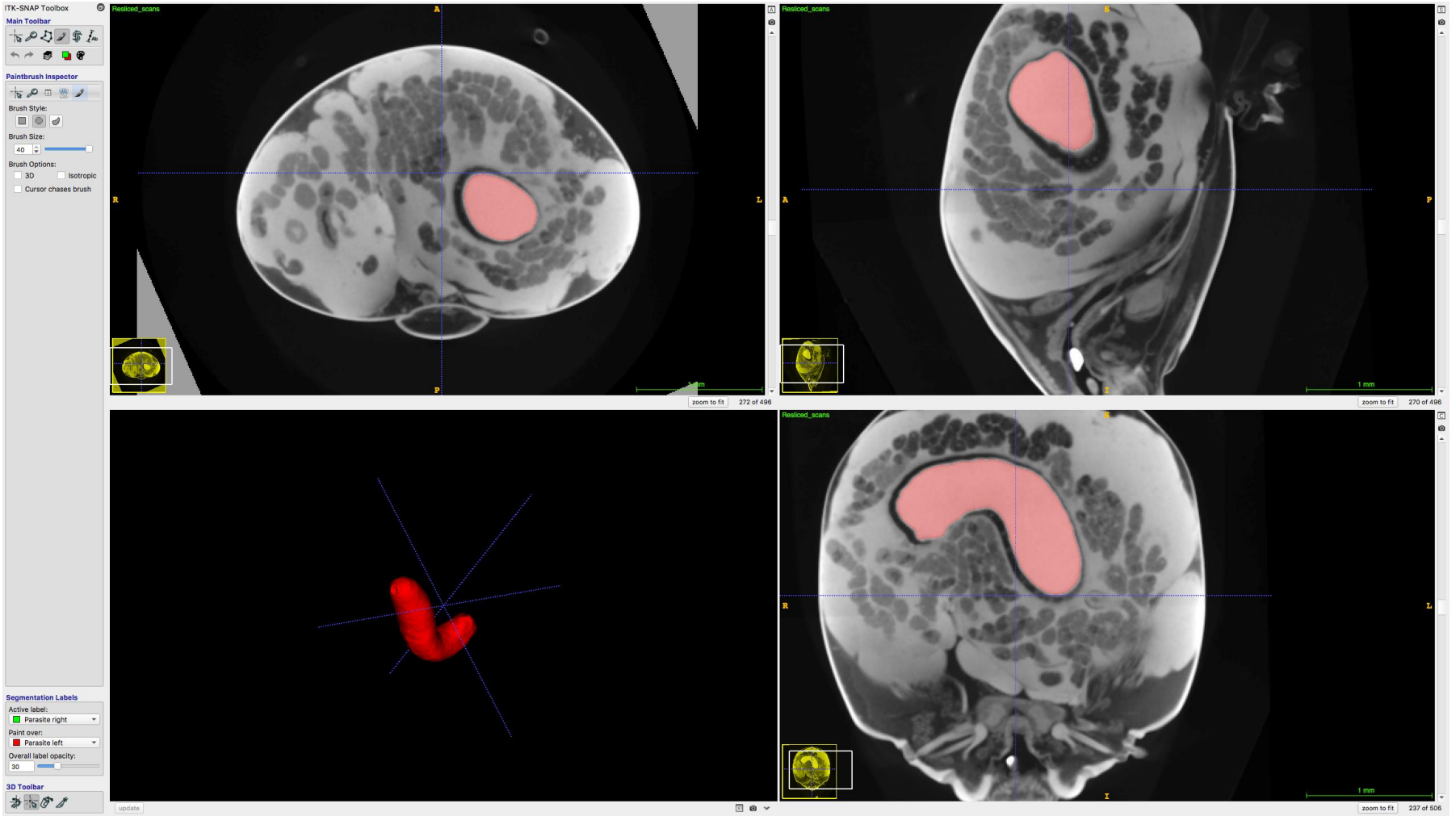
- Go to Segmentation Labels / Click on the Quick Label Picker
- Set Active label as *Parasite right*
- Set Paint over as *Parasite left*





3D segmentation

- Place your cursor in the middle of lateral axis of the termite head



3D segmentation

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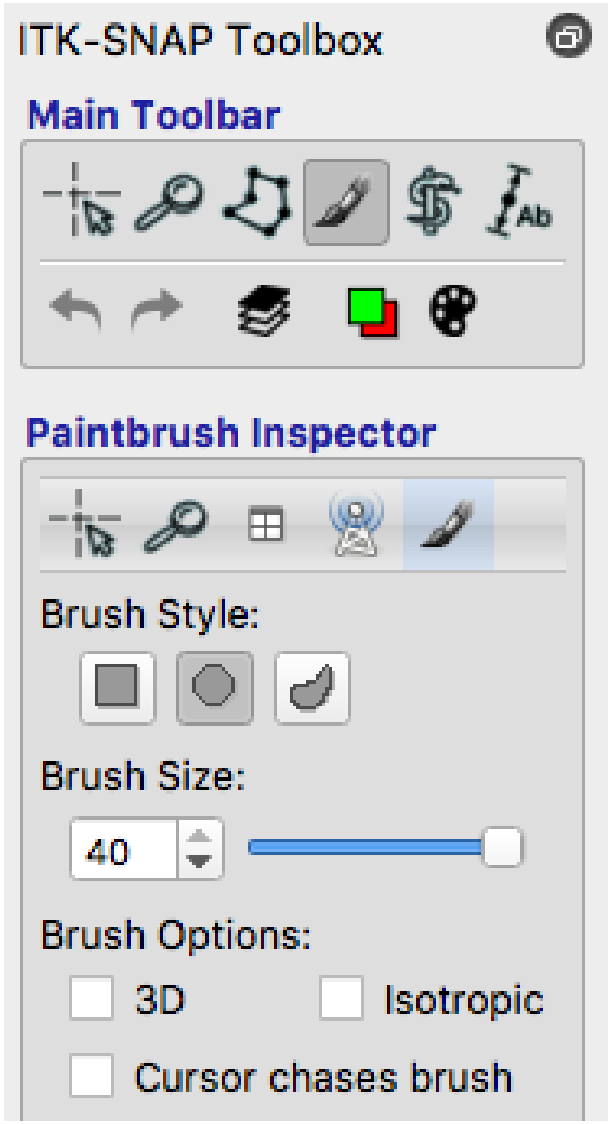
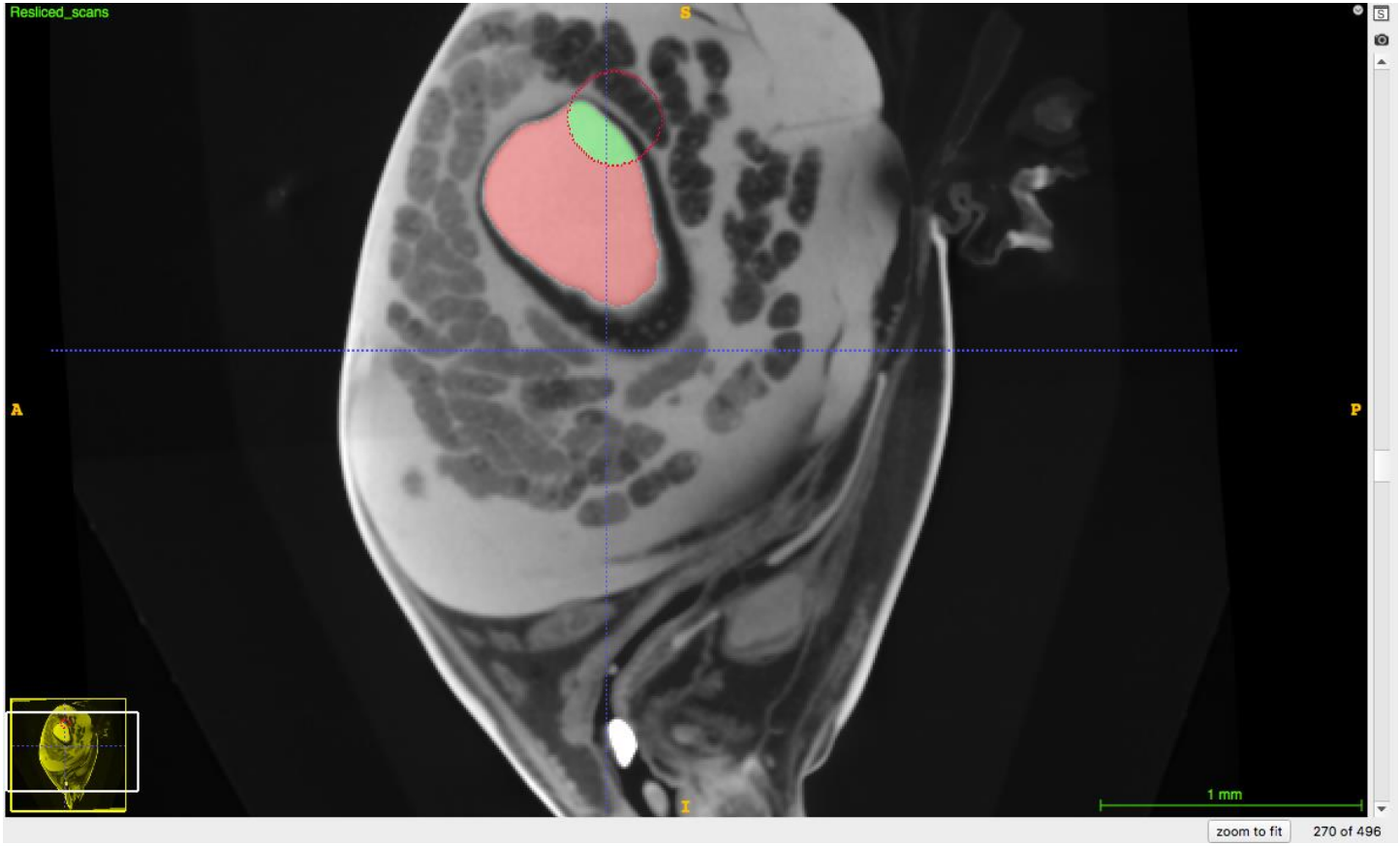
- Select the brush
- Set the style to round shape
- Set the size to maximal (40)



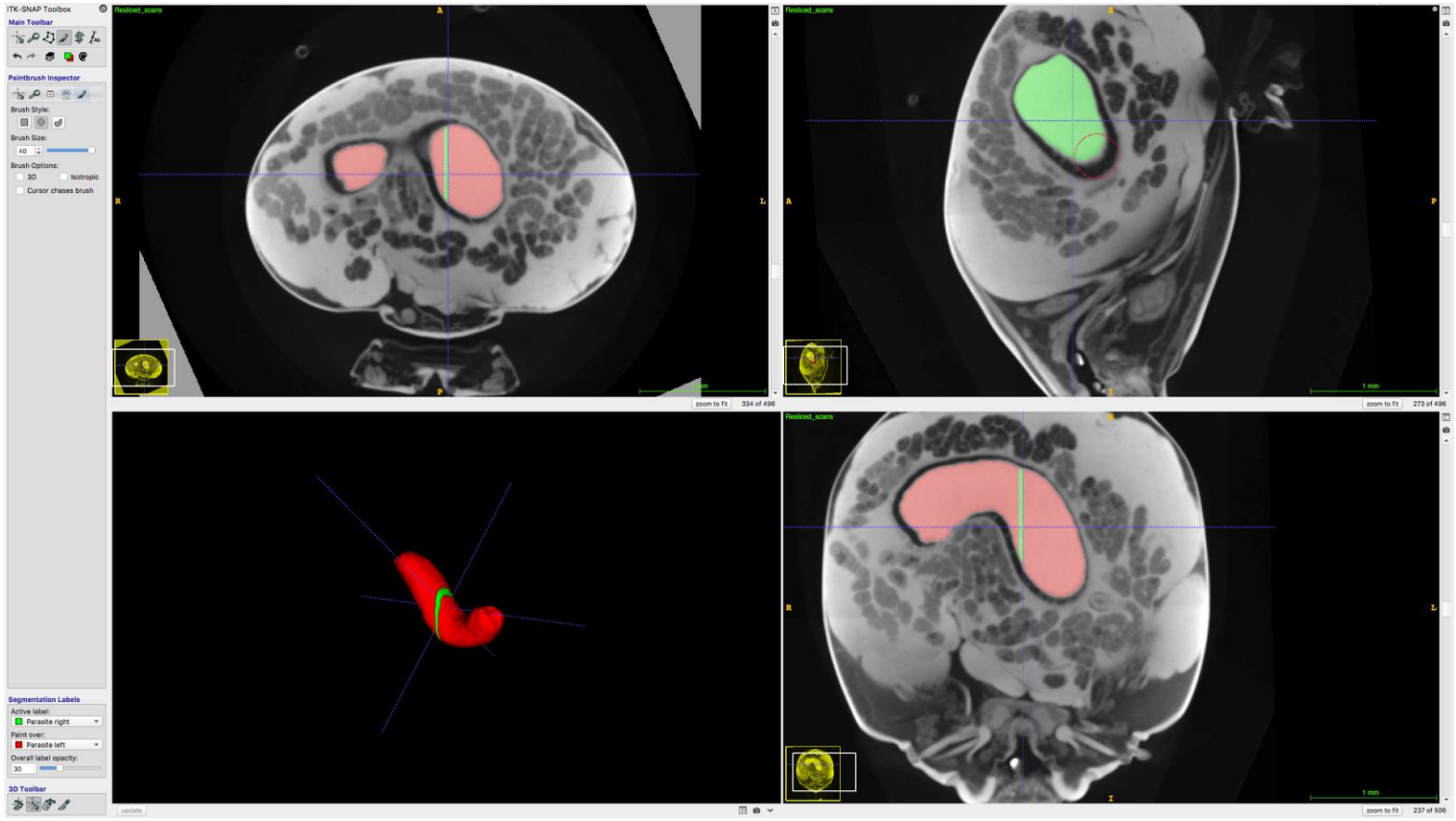
3D segmentation

- Use the brush on the lateral view
- Only the previous parasite label is overwritten!



3D segmentation

- Do it on 3-4 slices
- Update the 3D model
- Zoom in the 3D panel



3D segmentation

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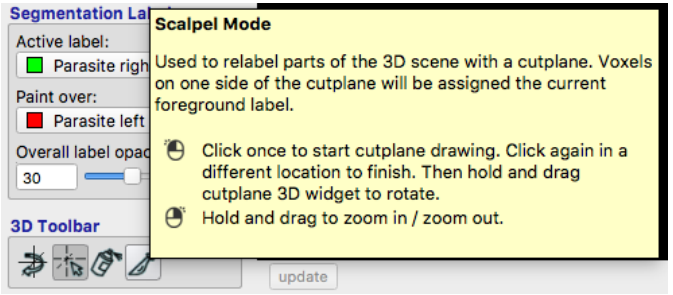
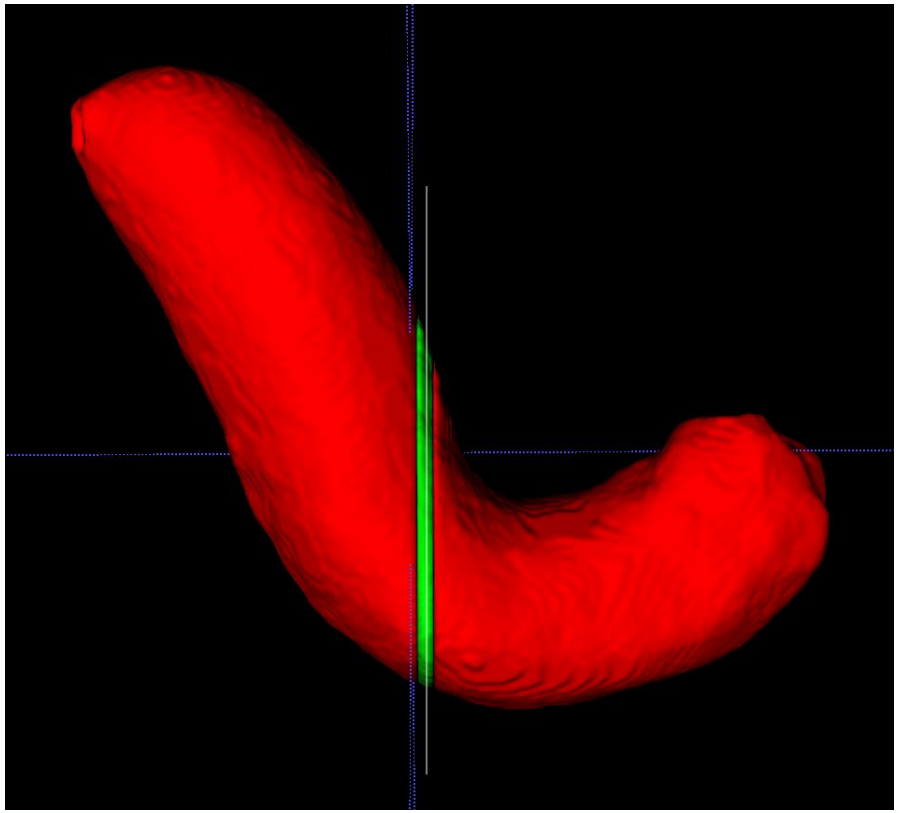
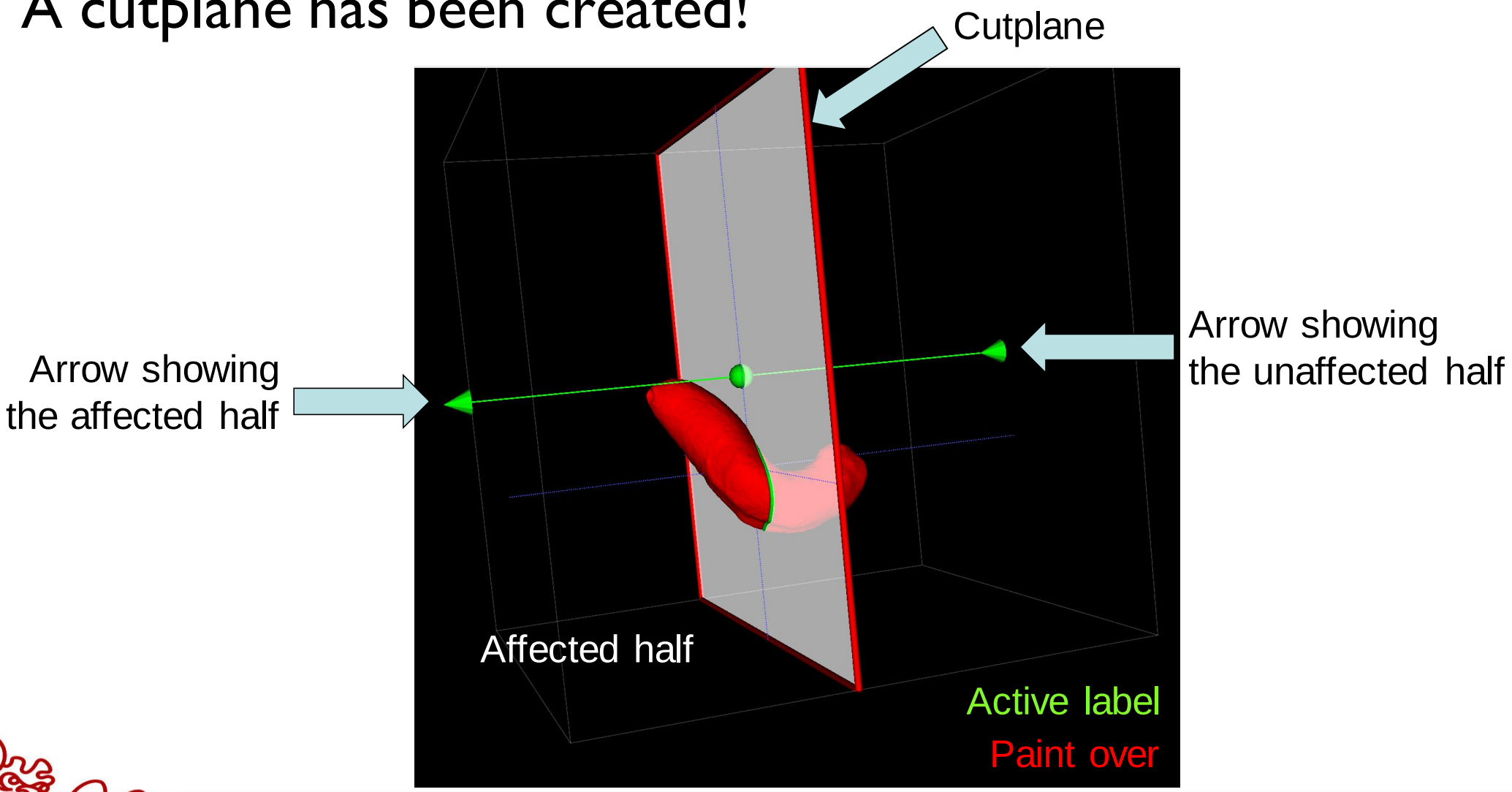
- Click on the Scalpel tool
- Move your 3D model to see the resegmented slices from the side
- Click once above these slices
- Click once below (see the line being drawn)





3D segmentation

- A cutplane has been created!



3D segmentation

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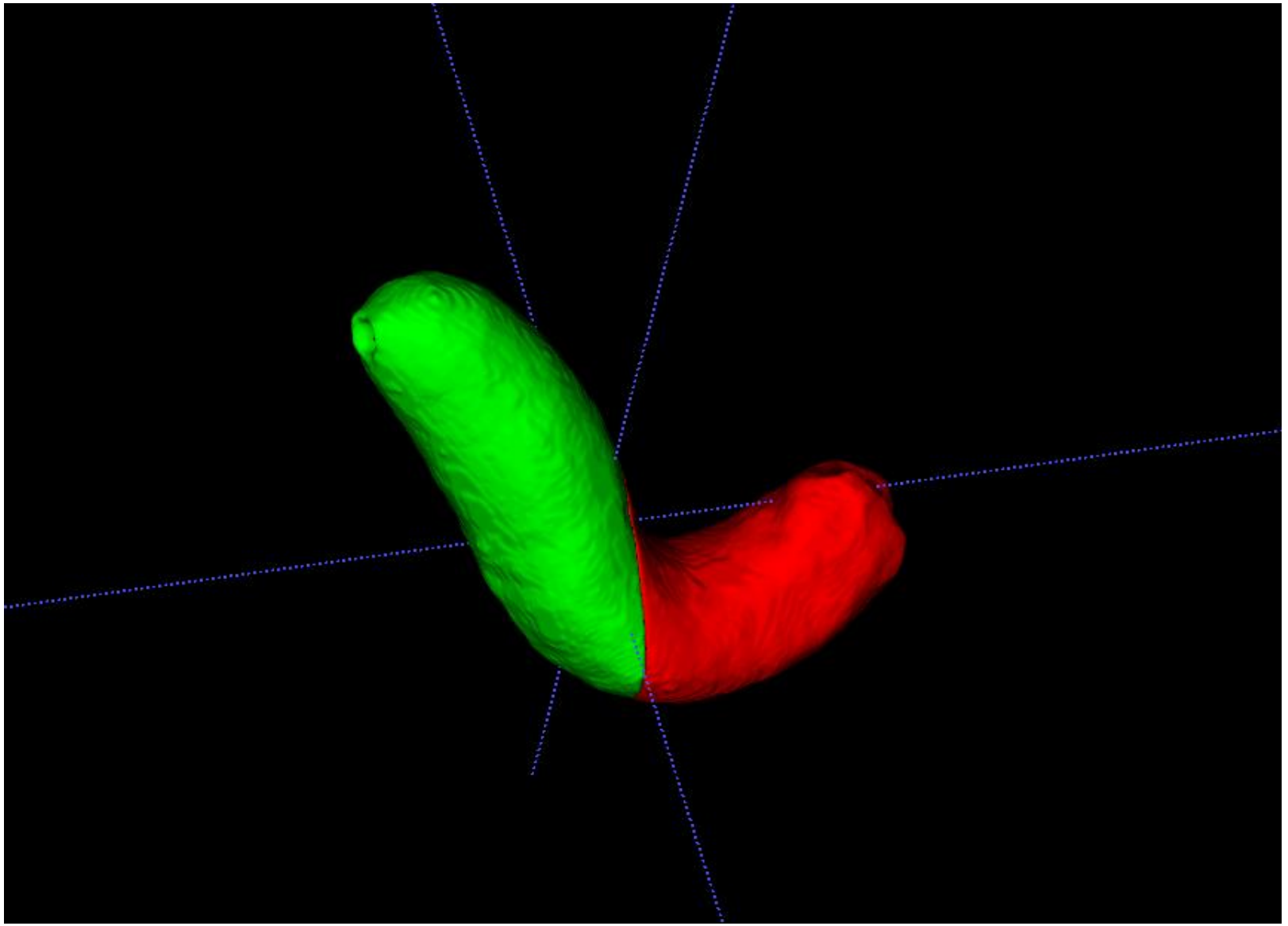
- Adjust/Flip/Redo the cutplane if needed
- Accept
- Update



Volumes and Statistics

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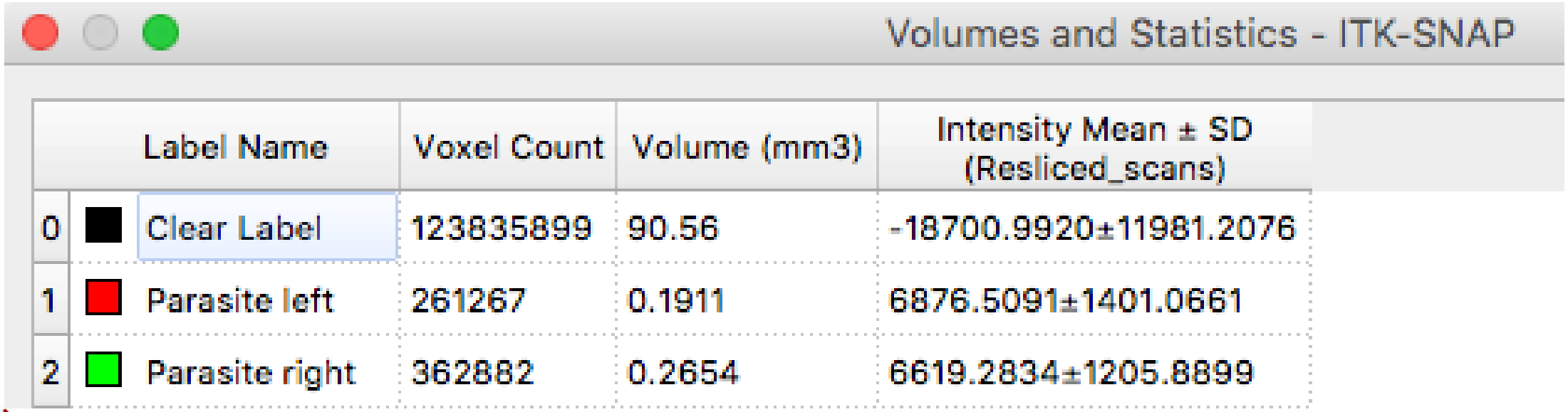
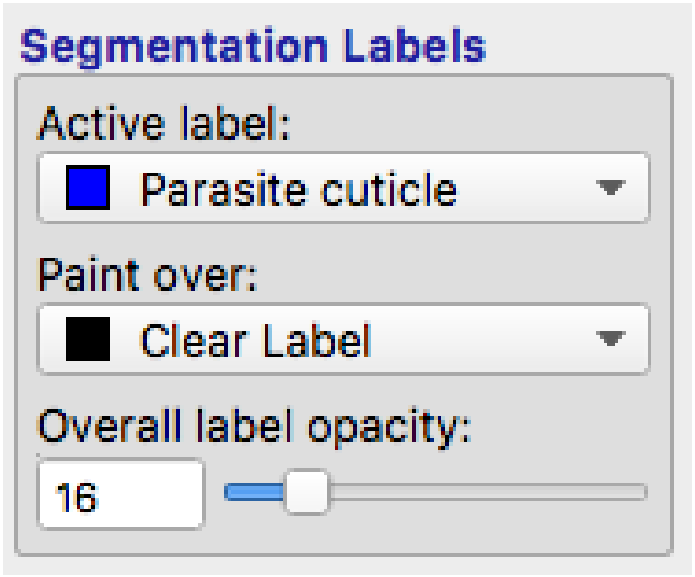
- Go to Segmentation > Volumes and Statistics…
- ITK-SNAP uses the voxel size and number of voxels to calculate the volume of labelled structures
- Is the parasite more on the right or left side of the head?

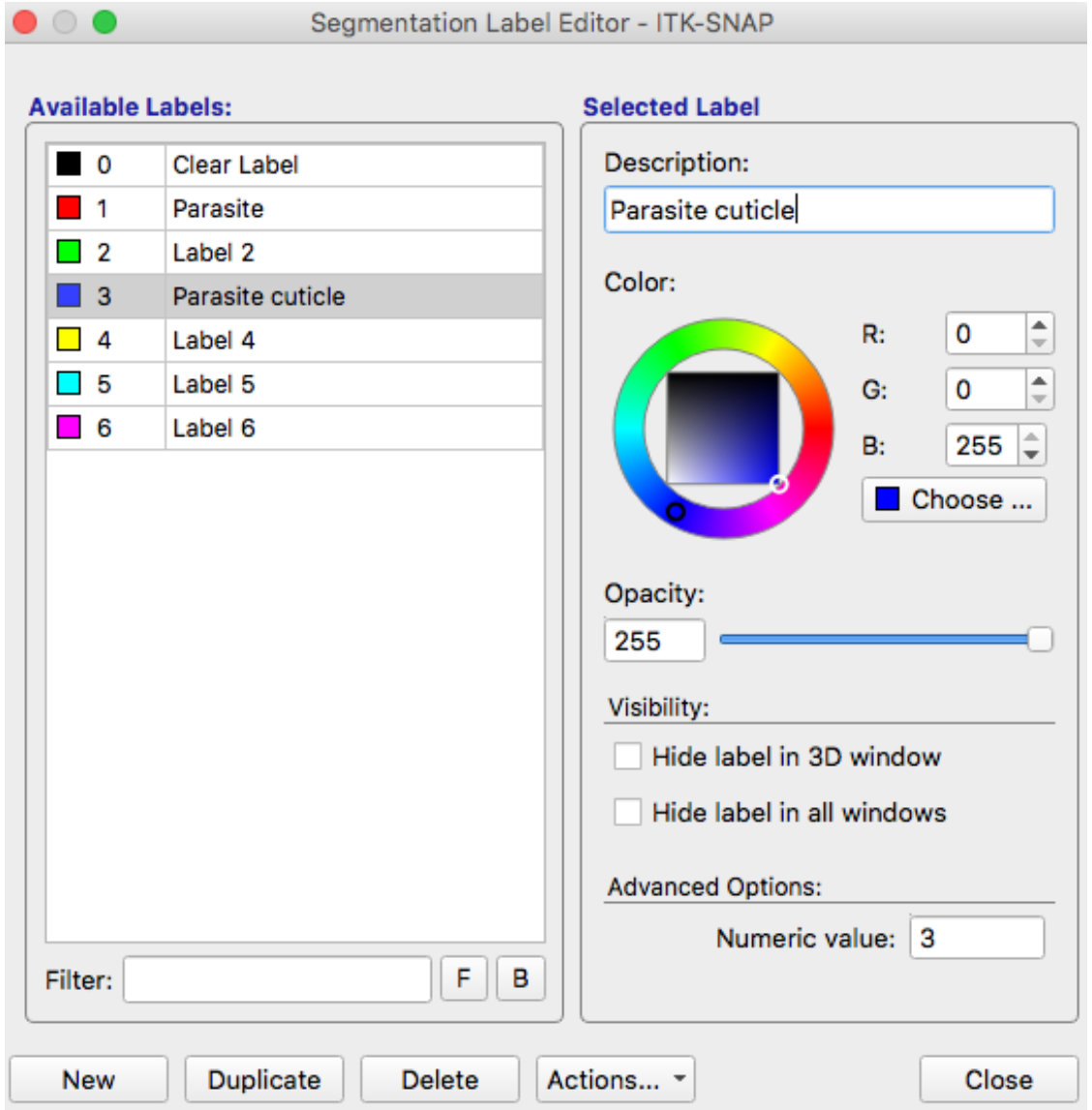


	Label Name	Voxel Count	Volume (mm3)	Intensity Mean ± SD (Resliced_scans)
0	Clear Label	123835899	90.56	-18700.9920±11981.2076
1	Parasite left	261267	0.1911	6876.5091±1401.0661
2	Parasite right	362882	0.2654	6619.2834±1205.8899

Manual segmentation

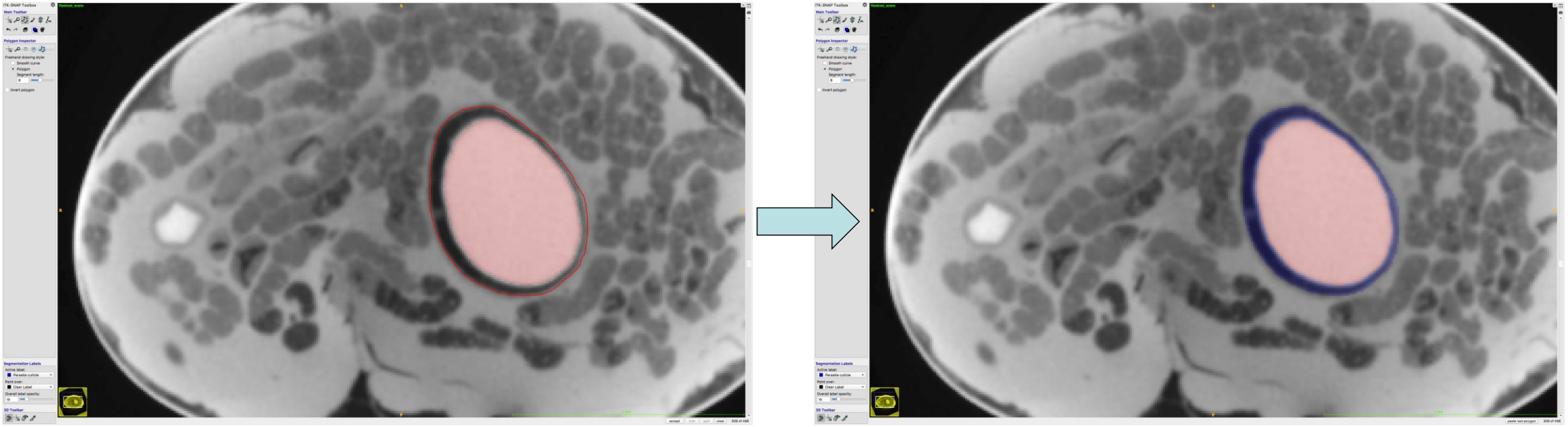
- Create a new label *Parasite cuticle*
- Set it as the new active label
- Choose to paint over *Clear label*





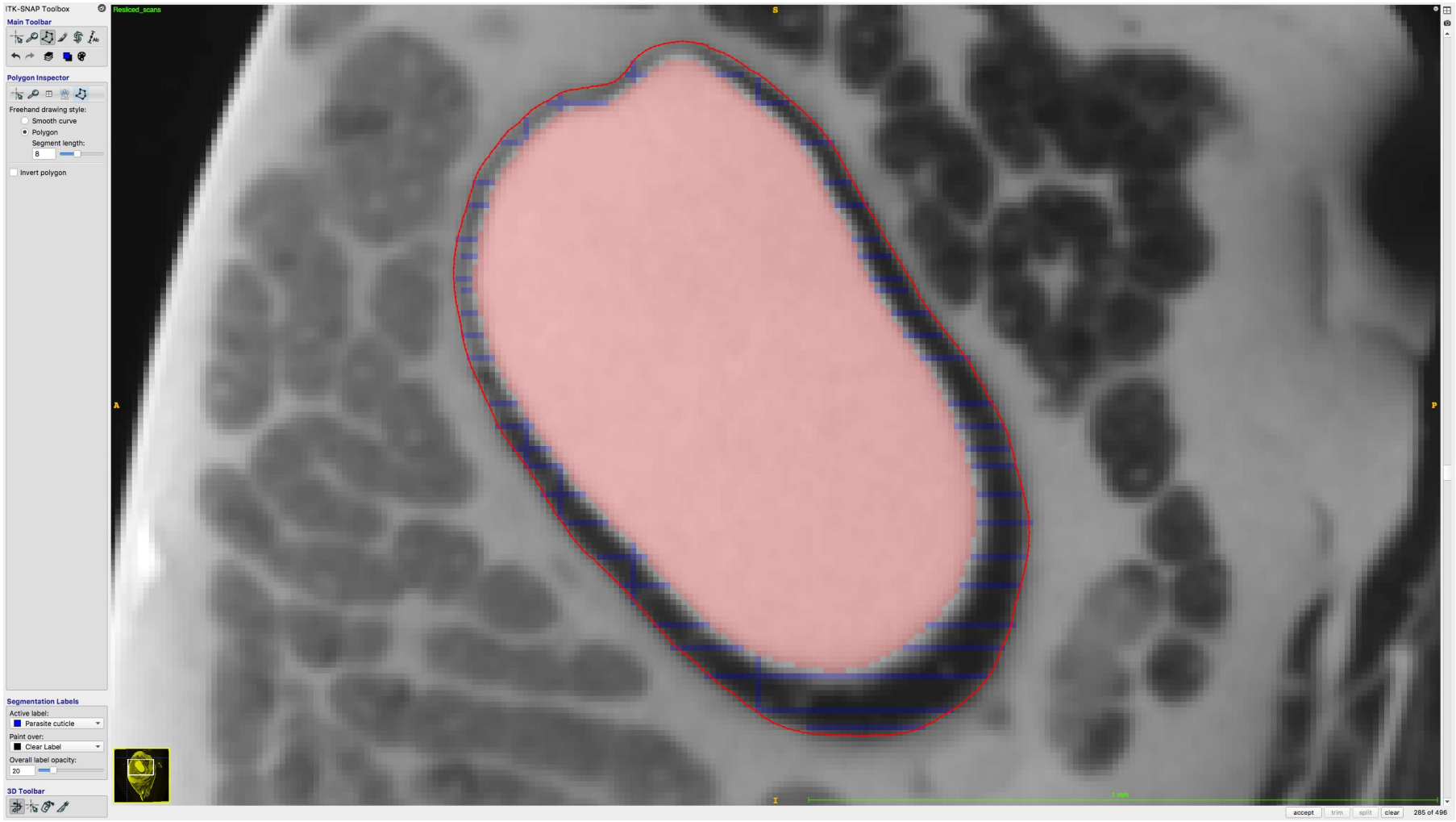
Manual segmentation

- On a slice, draw a polygon around the parasite and its cuticle
- Apply → the label only appears on non-labelled voxels

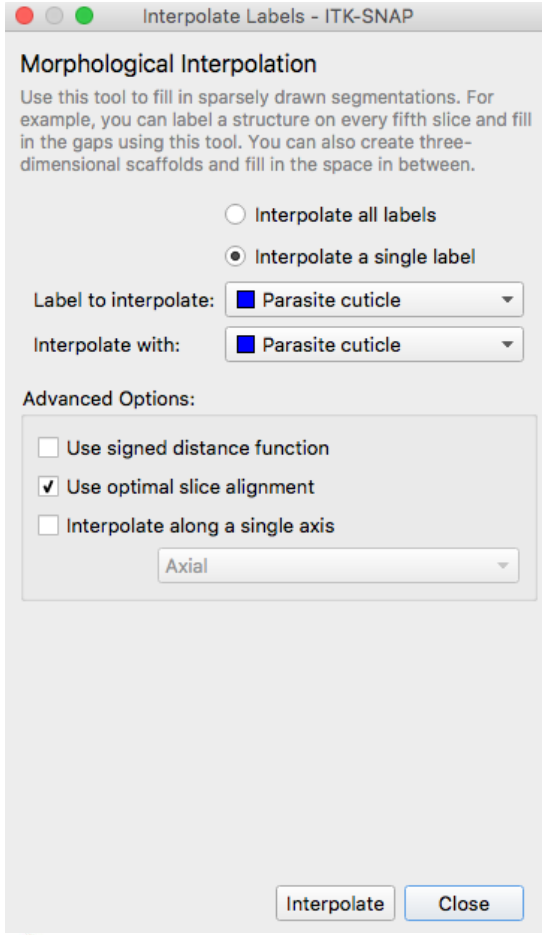


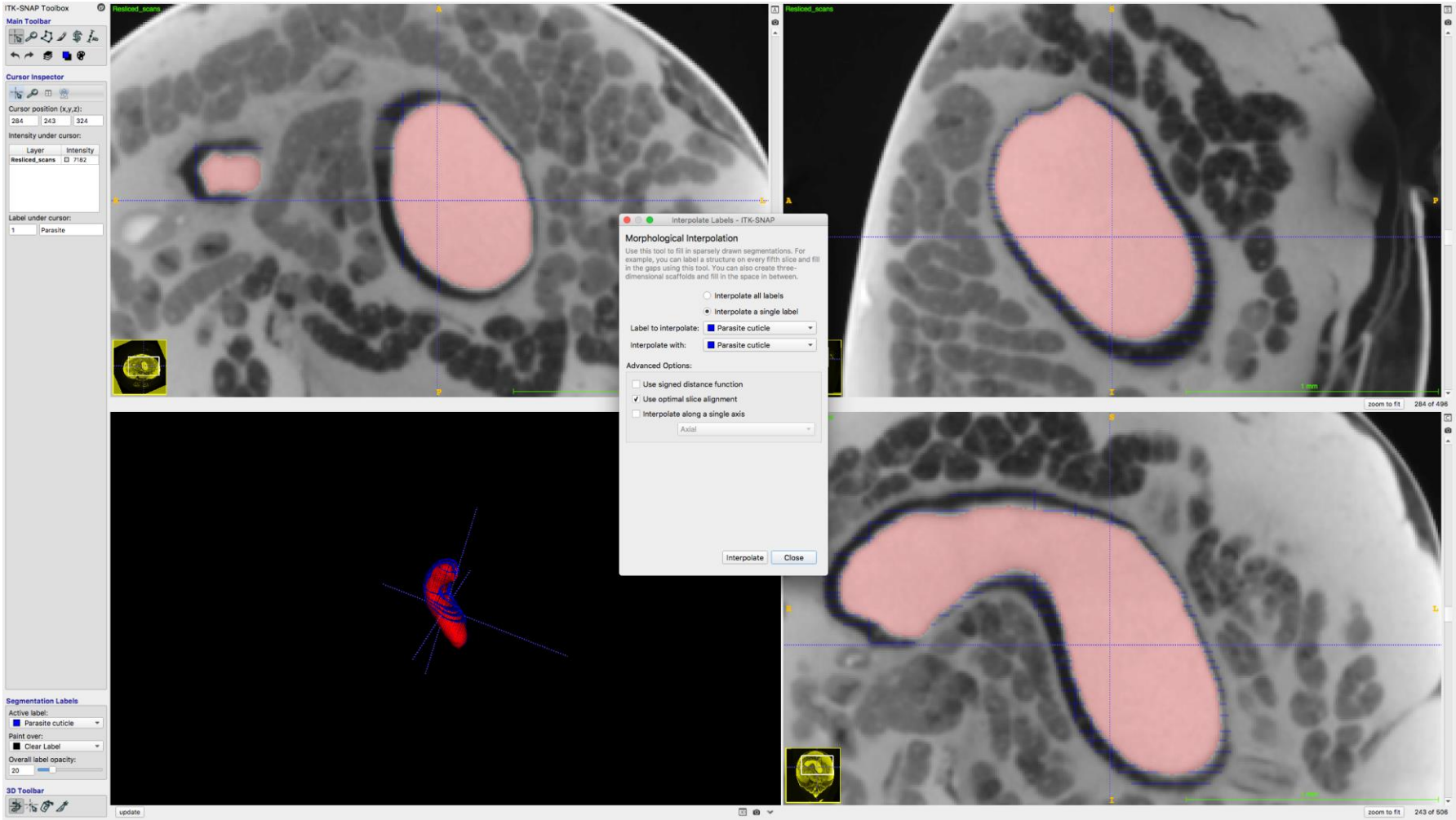
Interpolation

- Segment manually the cuticle every 5/10 slices
- On all views



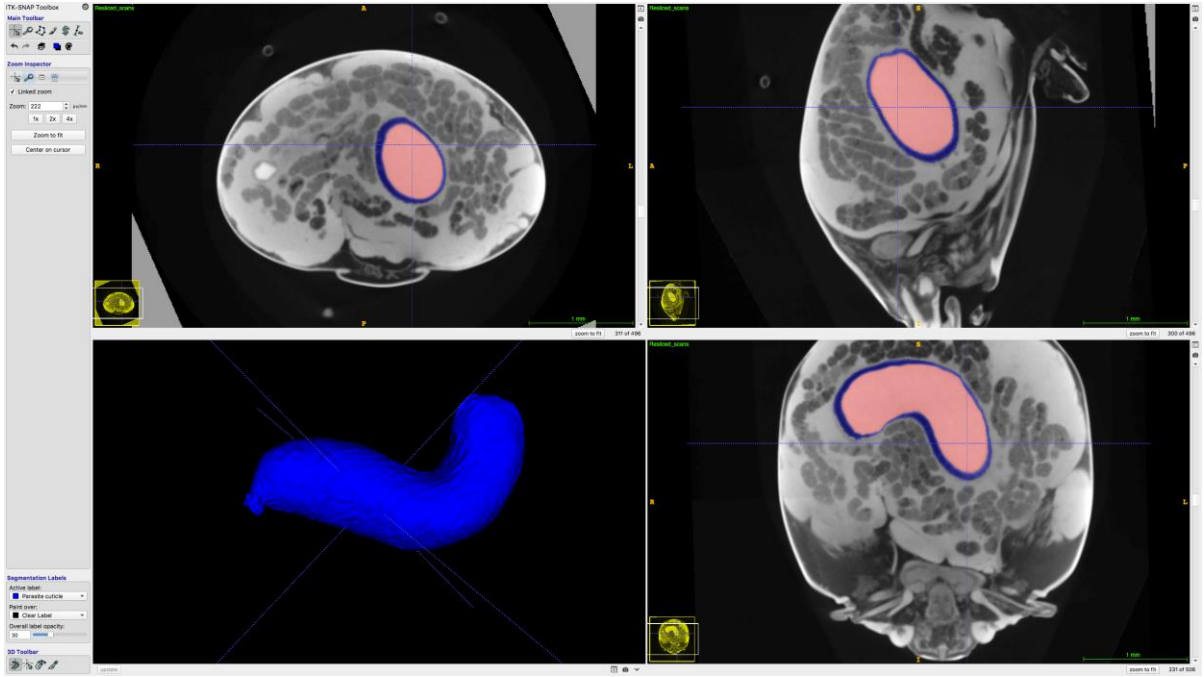
- Go to Tools > Interpolate Labels…





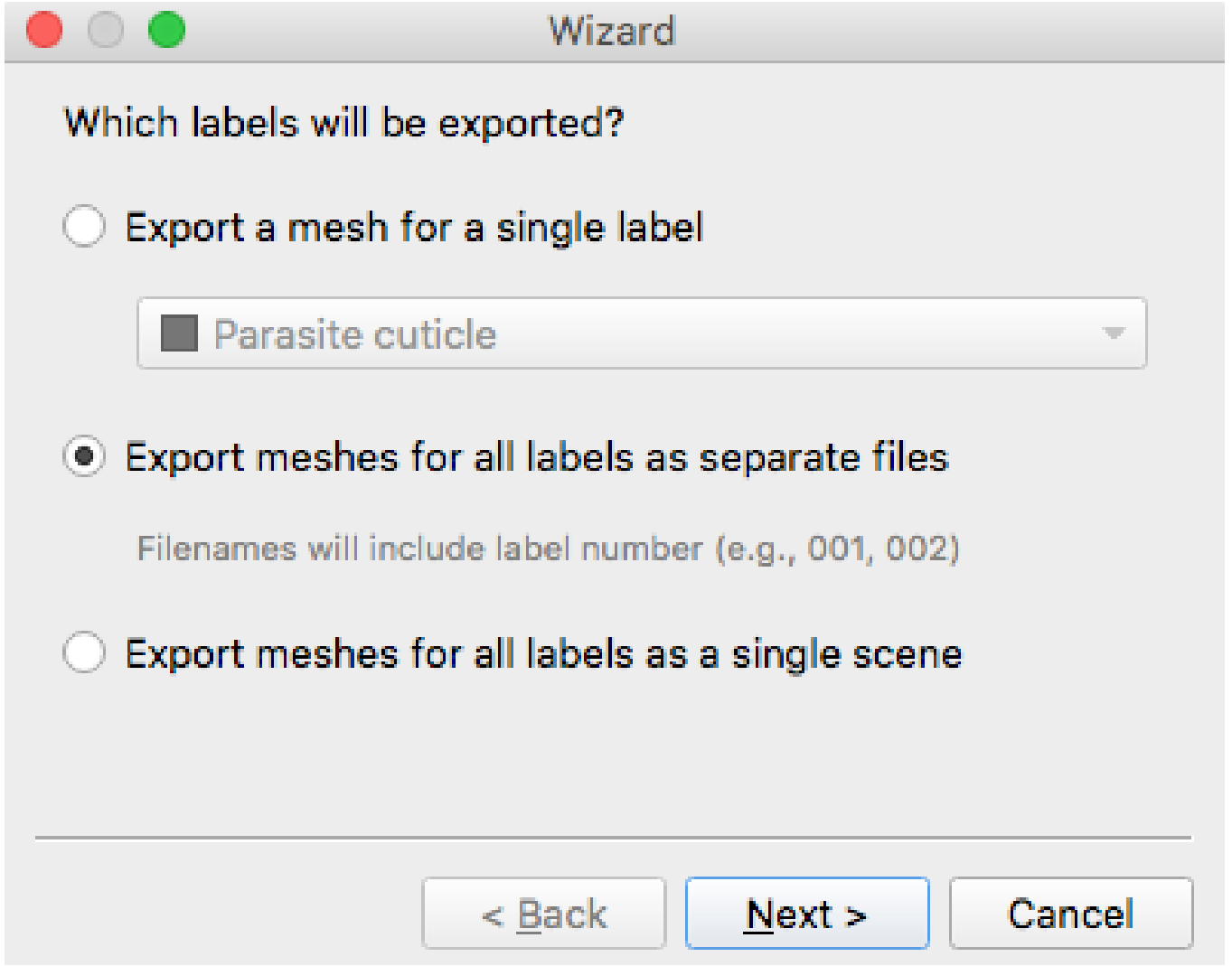
Interpolation

- Check the result on 3D and scans
- Interpolation relies on
  - the number of labelled slices
  - the quality of labelling
- If not satisfied: do some editing before or after interpolating



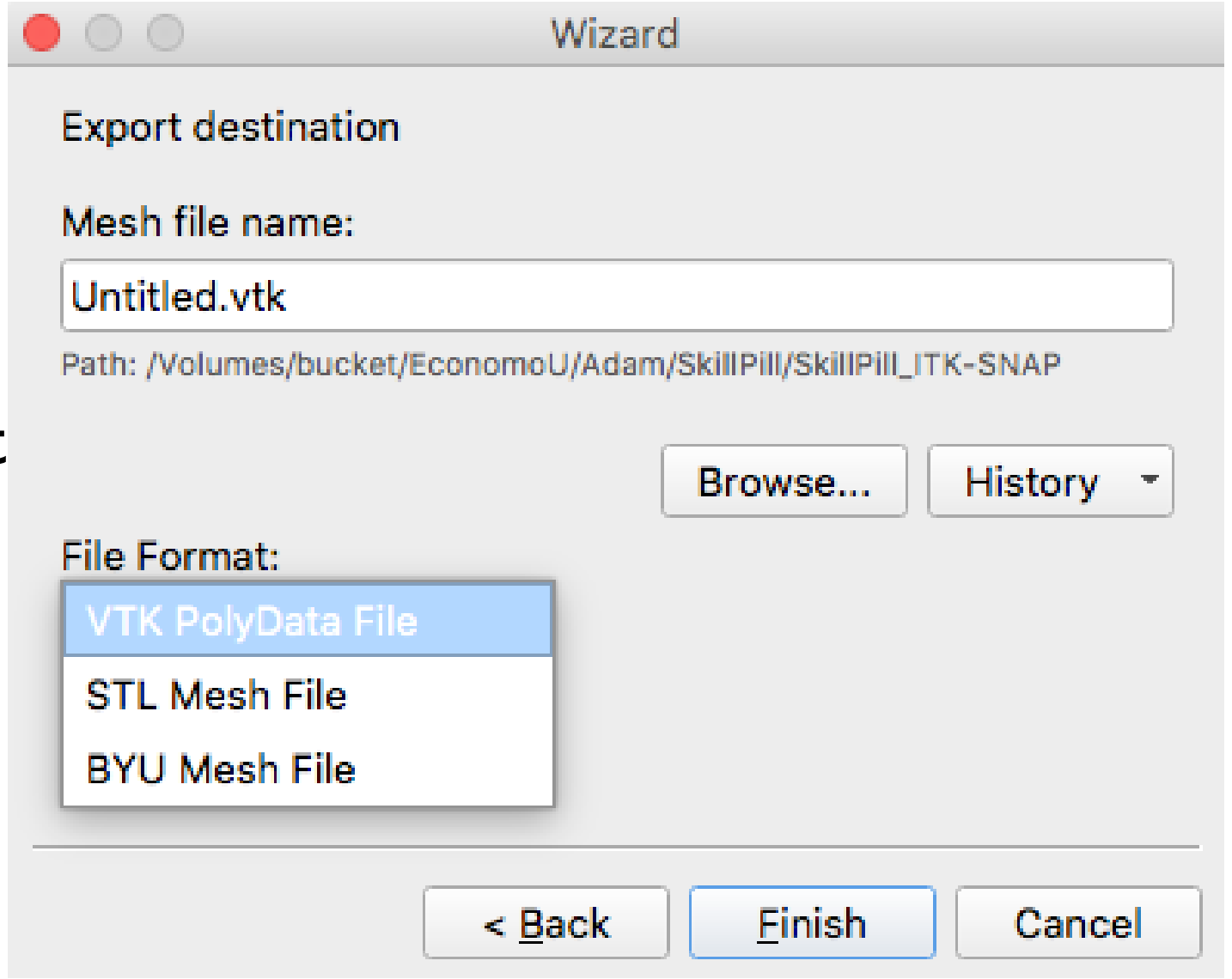
Export meshes

- Mesh = 3D object, made of triangles
- Go to Segmentation > Export as Surface Mesh
- Export meshes for all labels as separate files



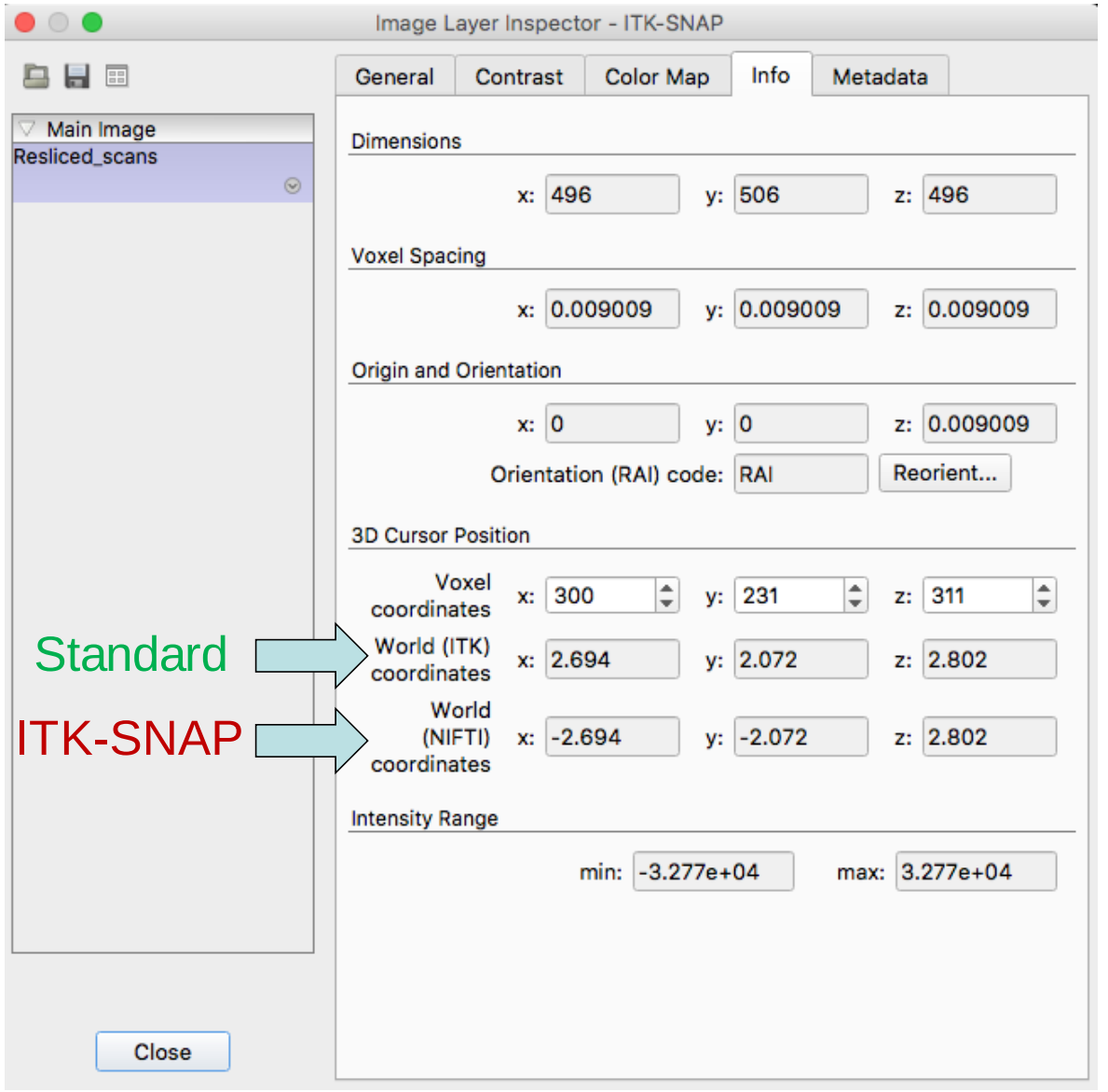
Export meshes

- Select a path, a name, and a file format
  - .stl: used by many softwares
  - .vtk: used in ParaView
- Color information will not be written in the file



Export meshes

- Additionnal modifications are required for the workflow
- ITK-SNAP exports meshes with NIFTI coordinates instead of standard ITK coordinates
- I asked the developer: potential update in next version



Export meshes

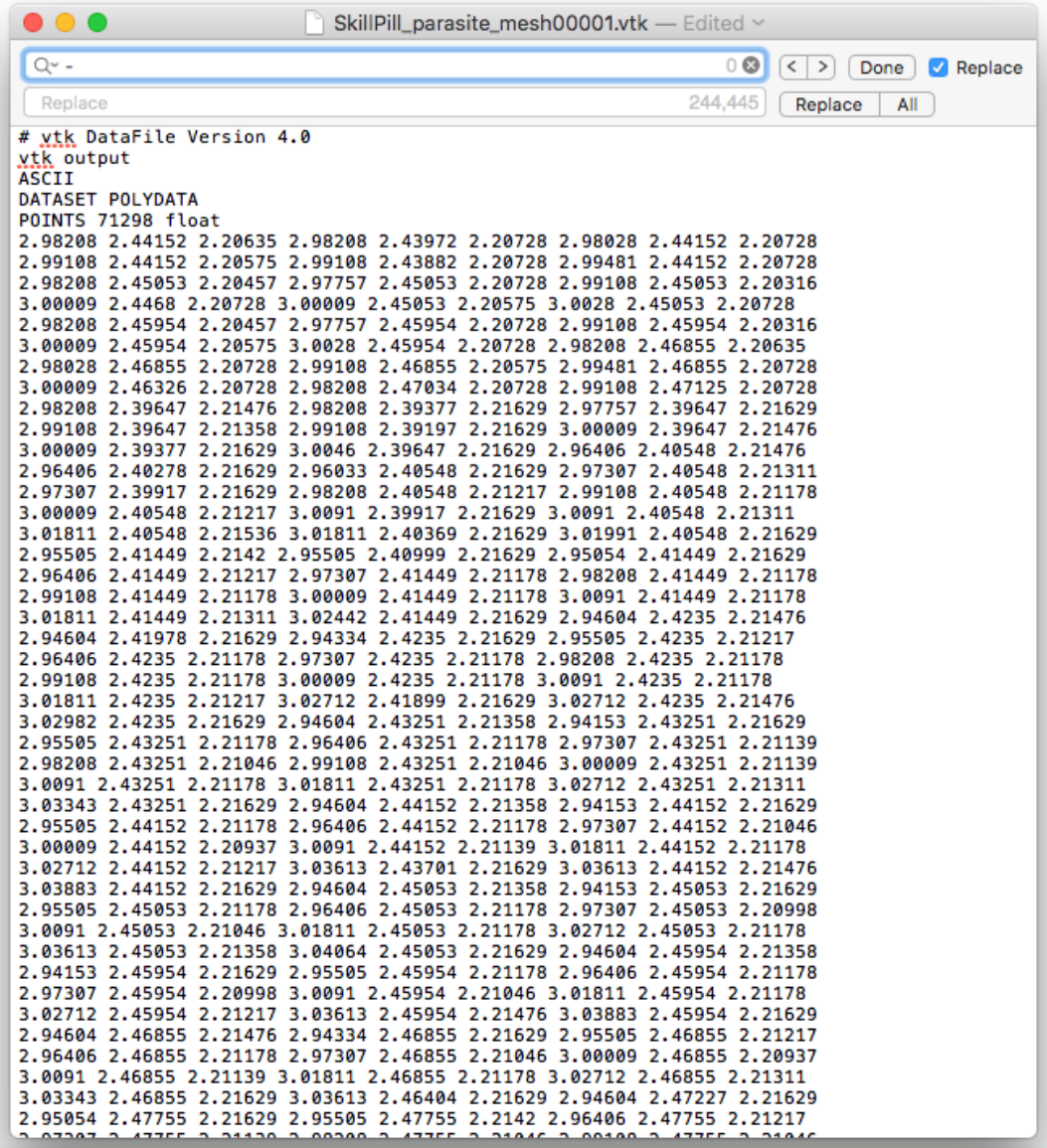
- One solution: remove manually the minus signs
- Open the VTK files with a text editor (e.g. Notepad)

SkillPill_parasite_mesh00001.vtk

```
# vtk DataFile Version 4.0
vtk output
ASCII
DATASET POLYDATA
POINTS 71298 float
-2.98208 -2.44152 2.20635 -2.98208 -2.43972 2.20728 -2.98028 -2.44152 2.20728
-2.99108 -2.44152 2.20575 -2.99108 -2.43882 2.20728 -2.99481 -2.44152 2.20728
-2.98208 -2.45053 2.20457 -2.97757 -2.45053 2.20728 -2.99108 -2.45053 2.20316
-3.00009 -2.4468 2.20728 -3.00009 -2.45053 2.20575 -3.0028 -2.45053 2.20728
-2.98208 -2.45954 2.20457 -2.97757 -2.45954 2.20728 -2.99108 -2.45954 2.20316
-3.00009 -2.45954 2.20575 -3.0028 -2.45954 2.20728 -2.98208 -2.46855 2.20635
-2.98028 -2.46855 2.20728 -2.99108 -2.46855 2.20575 -2.99481 -2.46855 2.20728
-3.00009 -2.46326 2.20728 -2.98208 -2.47034 2.20728 -2.99108 -2.47125 2.20728
-2.98208 -2.39647 2.21476 -2.98208 -2.39377 2.21629 -2.97757 -2.39647 2.21629
-2.99108 -2.39647 2.21358 -2.99108 -2.39197 2.21629 -3.00009 -2.39647 2.21476
-3.00009 -2.39377 2.21629 -3.0046 -2.39647 2.21629 -2.96406 -2.40548 2.21476
-2.96406 -2.40278 2.21629 -2.96033 -2.40548 2.21629 -2.97307 -2.40548 2.21311
-2.97307 -2.39917 2.21629 -2.98208 -2.40548 2.21217 -2.99108 -2.40548 2.21178
-3.00009 -2.40548 2.21217 -3.0091 -2.39917 2.21629 -3.0091 -2.40548 2.21311
-3.01811 -2.40548 2.21536 -3.01811 -2.40369 2.21629 -3.01991 -2.40548 2.21629
-2.95505 -2.41449 2.2142 -2.95505 -2.40999 2.21629 -2.95054 -2.41449 2.21629
-2.96406 -2.41449 2.21217 -2.97307 -2.41449 2.21178 -2.98208 -2.41449 2.21178
-2.99108 -2.41449 2.21178 -3.00009 -2.41449 2.21178 -3.0091 -2.41449 2.21178
-3.01811 -2.41449 2.21311 -3.02442 -2.41449 2.21629 -2.94604 -2.4235 2.21476
-2.94604 -2.41978 2.21629 -2.94334 -2.4235 2.21629 -2.95505 -2.4235 2.21217
-2.96406 -2.4235 2.21178 -2.97307 -2.4235 2.21178 -2.98208 -2.4235 2.21178
-2.99108 -2.4235 2.21178 -3.00009 -2.4235 2.21178 -3.0091 -2.4235 2.21178
-3.01811 -2.4235 2.21217 -3.02712 -2.41899 2.21629 -3.02712 -2.4235 2.21476
-3.02982 -2.4235 2.21629 -2.94604 -2.43251 2.21358 -2.94153 -2.43251 2.21629
-2.95505 -2.43251 2.21178 -2.96406 -2.43251 2.21178 -2.97307 -2.43251 2.21139
-2.98208 -2.43251 2.21046 -2.99108 -2.43251 2.21046 -3.00009 -2.43251 2.21139
-3.0091 -2.43251 2.21178 -3.01811 -2.43251 2.21178 -3.02712 -2.43251 2.21311
-3.03343 -2.43251 2.21629 -2.94604 -2.44152 2.21358 -2.94153 -2.44152 2.21629
-2.95505 -2.44152 2.21178 -2.96406 -2.44152 2.21178 -2.97307 -2.44152 2.21046
-3.00009 -2.44152 2.20937 -3.0091 -2.44152 2.21139 -3.01811 -2.44152 2.21178
-3.02712 -2.44152 2.21217 -3.03613 -2.43701 2.21629 -3.03613 -2.44152 2.21476
-3.03883 -2.44152 2.21629 -2.94604 -2.45053 2.21358 -2.94153 -2.45053 2.21629
-2.95505 -2.45053 2.21178 -2.96406 -2.45053 2.21178 -2.97307 -2.45053 2.20998
-3.0091 -2.45053 2.21046 -3.01811 -2.45053 2.21178 -3.02712 -2.45053 2.21178
-3.03613 -2.45053 2.21358 -3.04064 -2.45053 2.21629 -2.94604 -2.45954 2.21358
-2.94153 -2.45954 2.21629 -2.95505 -2.45954 2.21178 -2.96406 -2.45954 2.21178
-2.97307 -2.45954 2.20998 -3.0091 -2.45954 2.21046 -3.01811 -2.45954 2.21178
-3.02712 -2.45954 2.21217 -3.03613 -2.45954 2.21476 -3.03883 -2.45954 2.21629
-2.94604 -2.46855 2.21476 -2.94334 -2.46855 2.21629 -2.95505 -2.46855 2.21217
-2.96406 -2.46855 2.21178 -2.97307 -2.46855 2.21046 -3.00009 -2.46855 2.20937
-3.0091 -2.46855 2.21139 -3.01811 -2.46855 2.21178 -3.02712 -2.46855 2.21311
-3.03343 -2.46855 2.21629 -3.03613 -2.46404 2.21629 -2.94604 -2.47227 2.21629
-2.95054 -2.47755 2.21629 -2.95505 -2.47755 2.2142 -2.96406 -2.47755 2.21217
-2.97307 -2.47755 2.21139 -2.98208 -2.47755 2.21046 -2.99108 -2.47755 2.21046
-3.00009 -2.47755 2.21139 -3.0091 -2.47755 2.21178 -3.01811 -2.47755 2.21217
-3.02712 -2.47755 2.21476 -3.02982 -2.47755 2.21629 -2.95505 -2.48206 2.21629
-2.95955 -2.48656 2.21629 -2.96406 -2.48656 2.2142 -2.97307 -2.48656 2.21217
```

Export meshes

- Go to Edit > Replace
- Write –
- Click on Replace All
- Save it, and change the name of the file to remember it has been edited



Export meshes

SKILLPILLS

- Other solutions include:
  - Segment the full specimen in one label in ITK-SNAP
    → Create a mesh with same coordinates, without Drishti
  - Use the Transform filter in ParaView to align the global mesh (by eye, not very precise)
  - Find a way to change the coordinates in ParaView

Questions?

- Ask me now
- Ask me later
  - OIST mail: adam.khalife@oist.jp
  - UPMC mail: adam.khalife@etu-upmc.fr
- Ask the software itself (hovering icons/menus help)
- Ask Paul Yushkevich and the ITK-SNAP user community: https://groups.google.com/forum/#!forum/itksnap-users