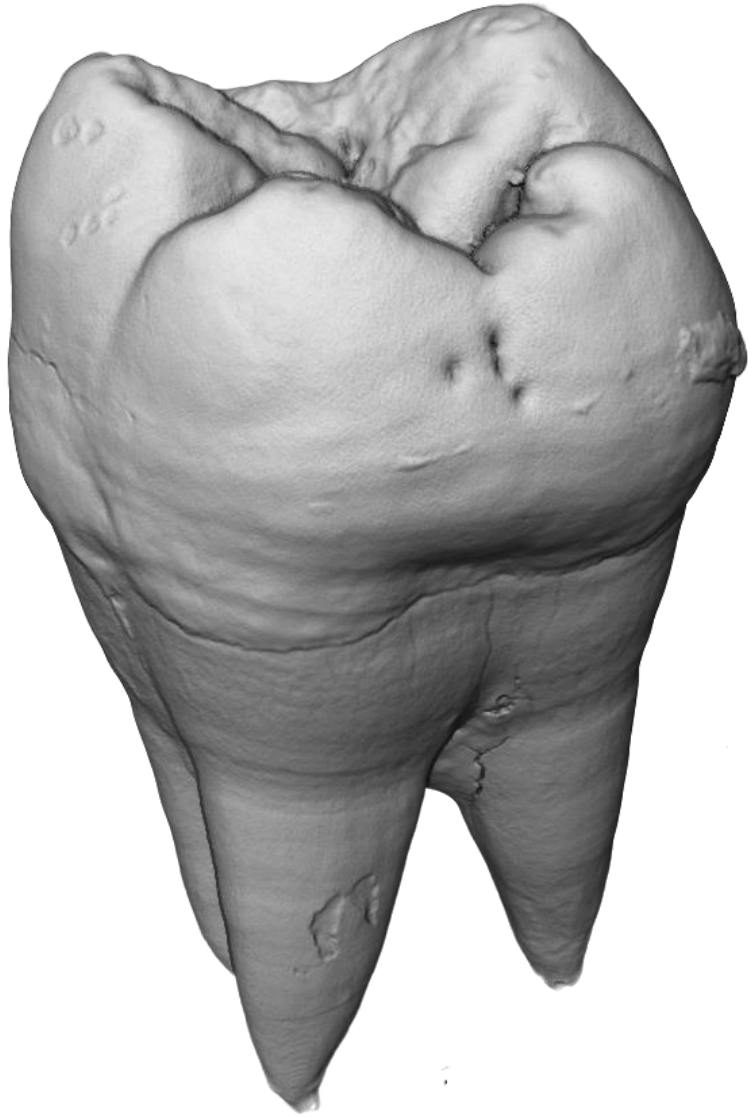




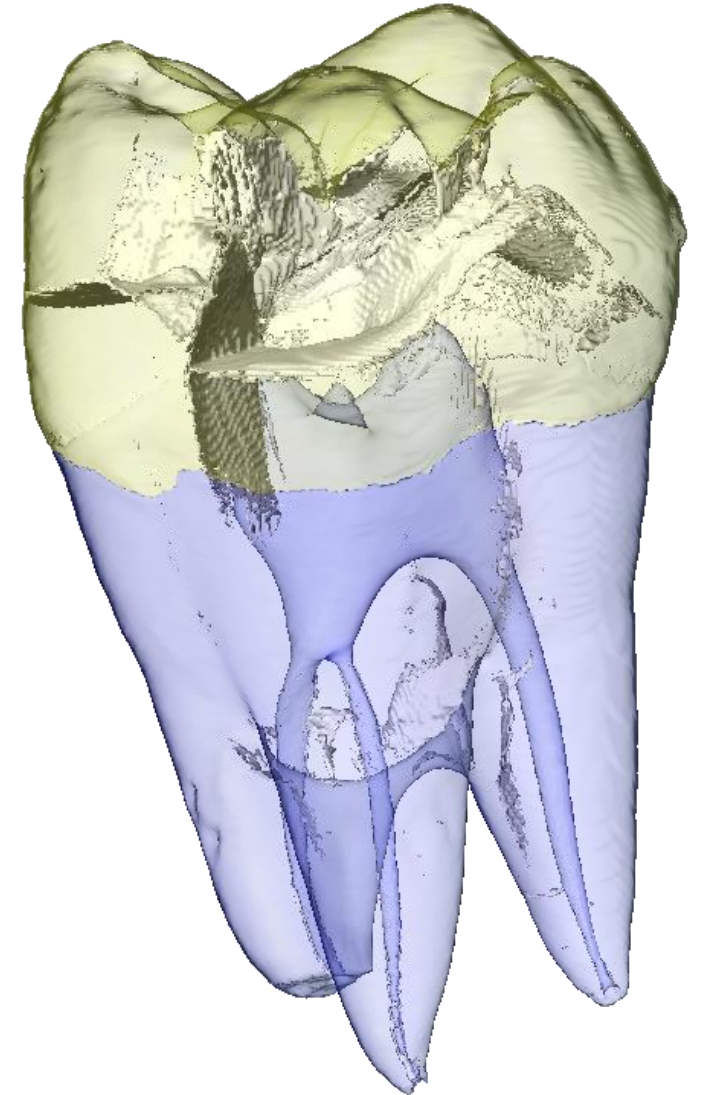
# Molar Segmentation in Thermo Scientific Avizo™ Software

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## Hands-on

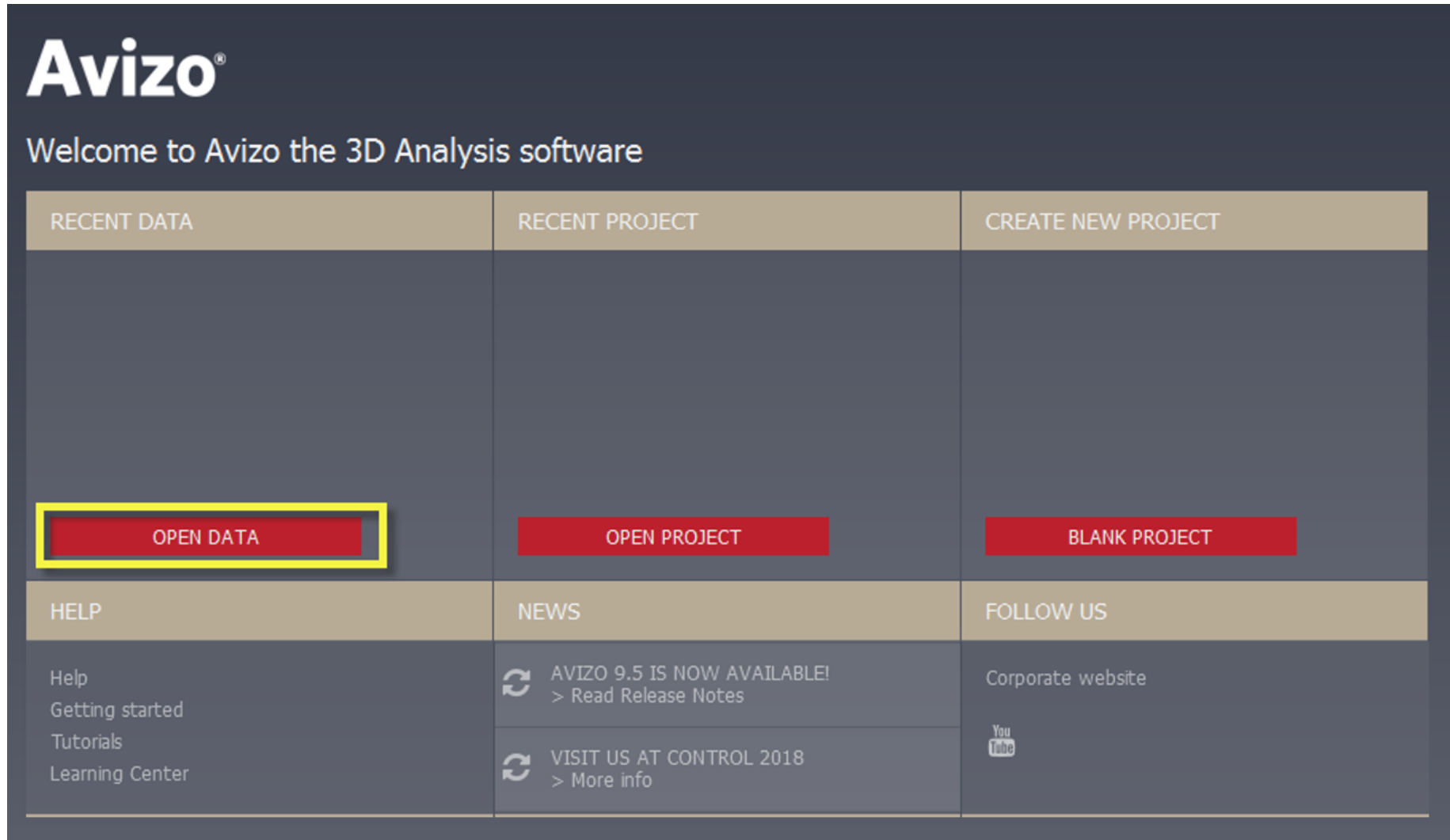
**Visualize, Segment, Measure,  
and generate a Surface mesh**



Data courtesy of Dr. Timothy Ryan, Department of Anthropology, Pennsylvania State University

# Step 1: Open the dataset

- Use the OPEN DATA button in the Start Page



## Step 1: Open the dataset

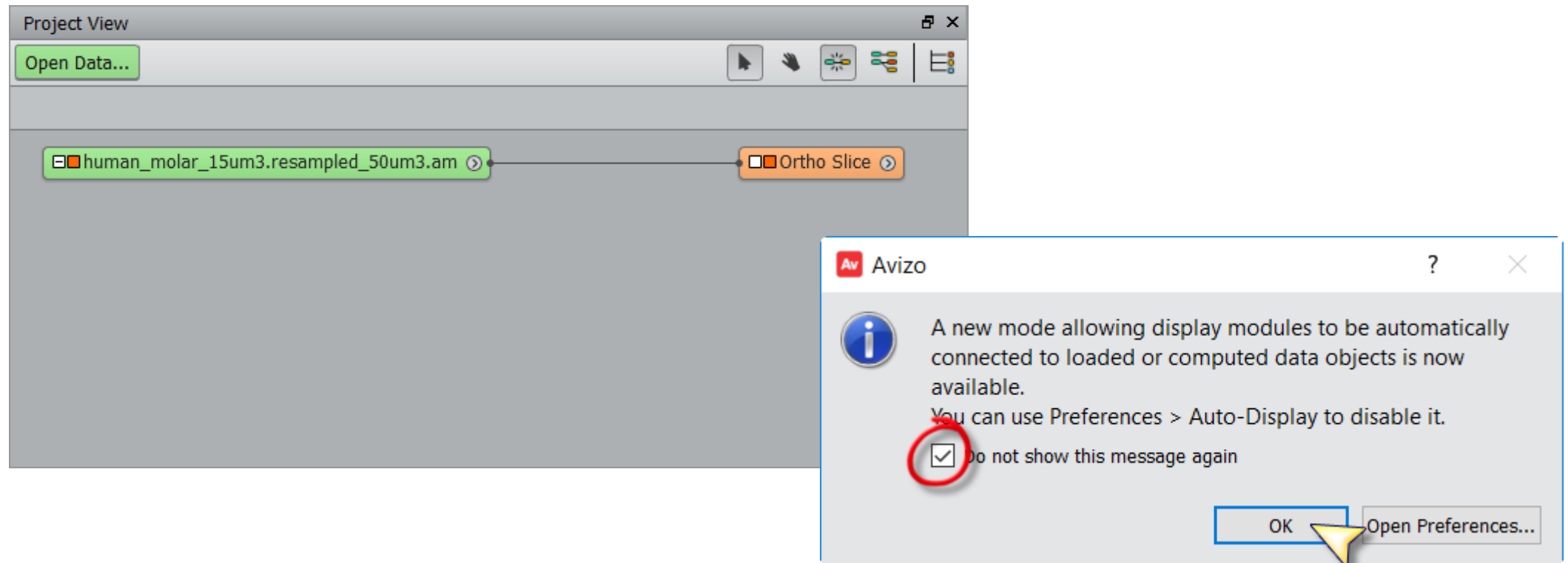
- Use the OPEN DATA button in the Start Page
- Check available file formats
- Load file 'human\_molar\_15um3.resampled\_50um3.am'

Downsampled data can be downloaded from the Xtras Library: <https://xtras.amira-avizo.com/>

Data courtesy of Dr. Timothy Ryan, Department of Anthropology, Pennsylvania State University

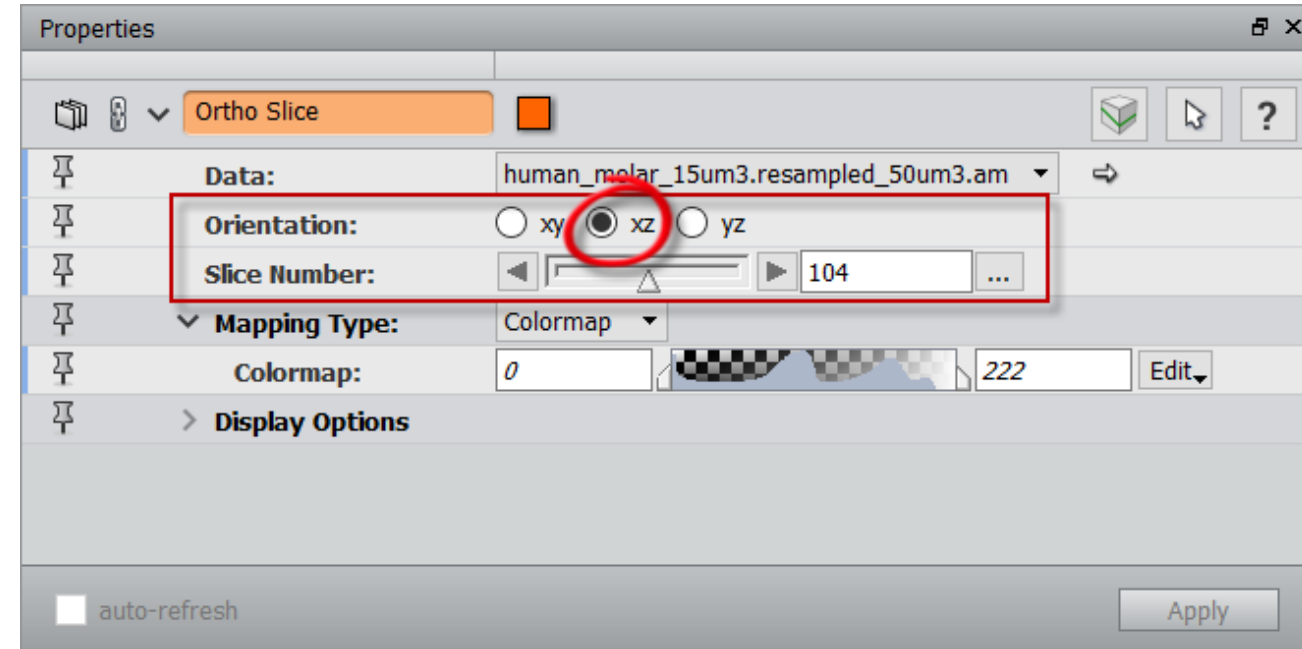
# Step 1: Open the dataset

- Use the OPEN DATA button in the Start Page
- Check available file formats
- Load file 'human\_molar\_15um3.resampled\_50um3.am'
- Configure 'Auto-Display'



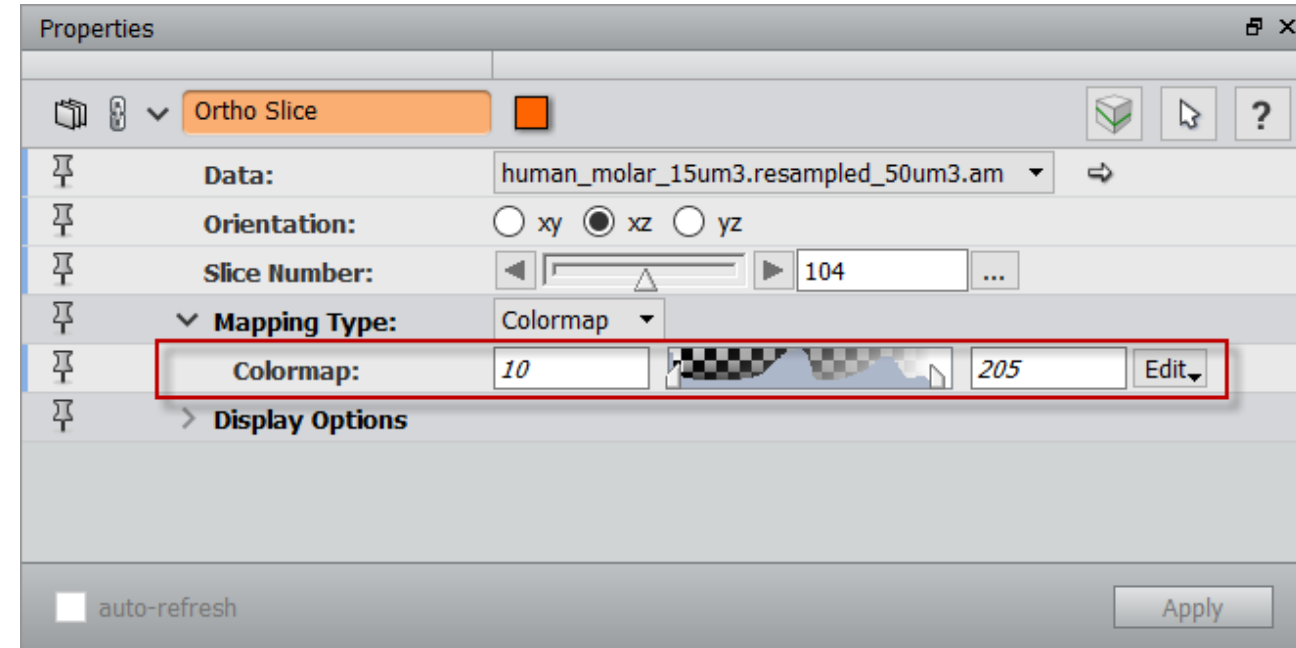
## Step 2: Visualize the data

- Auto-Display has created an OrthoSlice
- Left-click on OrthoSlice to show its properties
- Change slice position and orientation



## Step 2: Visualize the data

- Auto-Display has created an OrthoSlice
- Left-click on OrthoSlice to show its properties
- Change slice position and orientation
- Adjust Visualization Contrast using the Colormap port



To adjust value, you can:

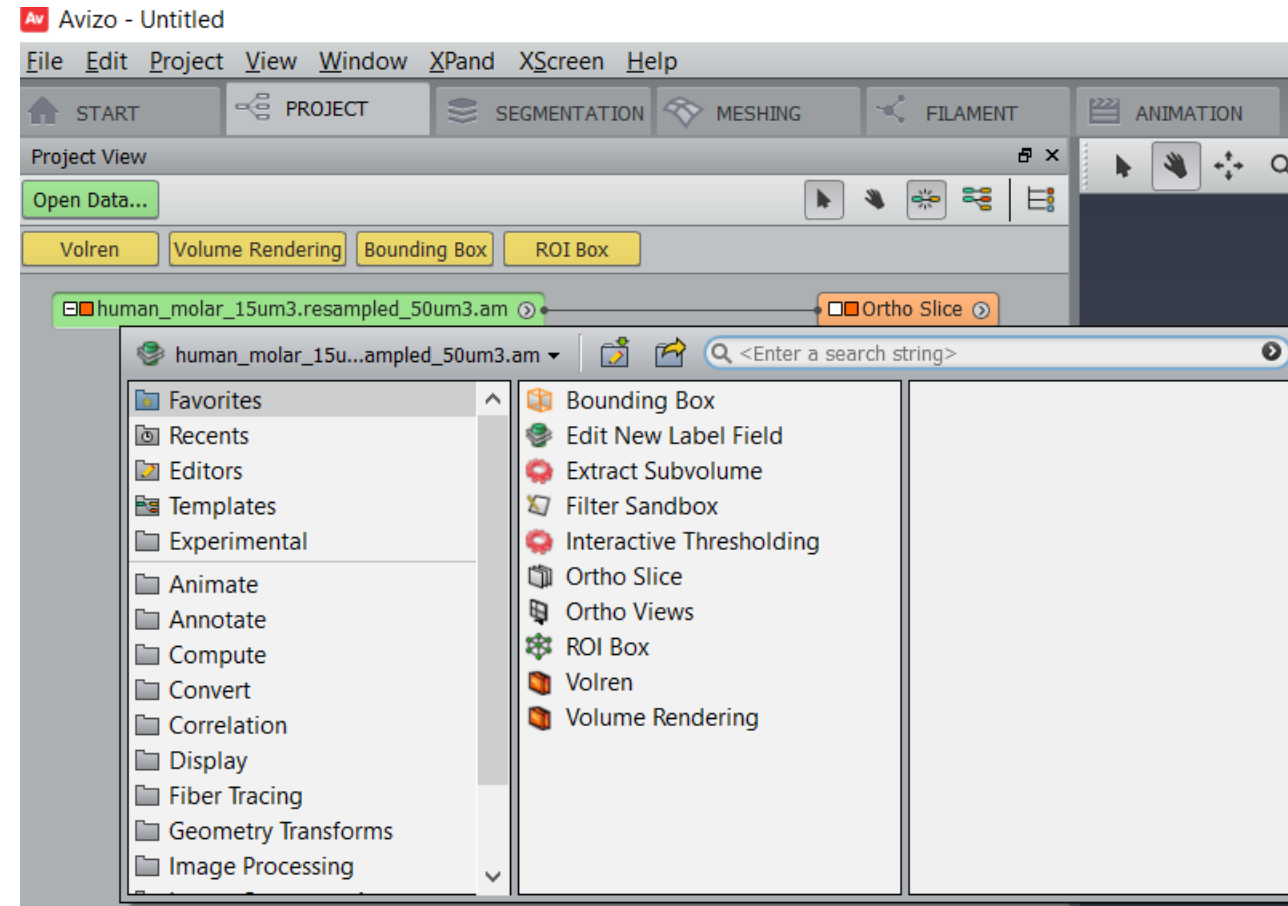
- Type in the value you wish in the box
- Position the mouse cursor over the box, and roll the mouse wheel (this works on almost all parameter box values in Avizo)
- Click on the gadgets to modify the corresponding value
- Click between the 2 gadgets to translate the colormap range (adjusts both values simultaneously)

Warning: if you double-click in the colormap area, the colormap module will appear. DO NOT DELETE IT. Select it and press Ctrl+H to hide it again.



## Step 2: Visualize the data

- Auto-Display has created an OrthoSlice
  - Left-click on OrthoSlice to show its properties
  - Change slice position and orientation
  - Adjust Visualization Contrast using the Colormap port
- 
- Right-click on dataset to open menu

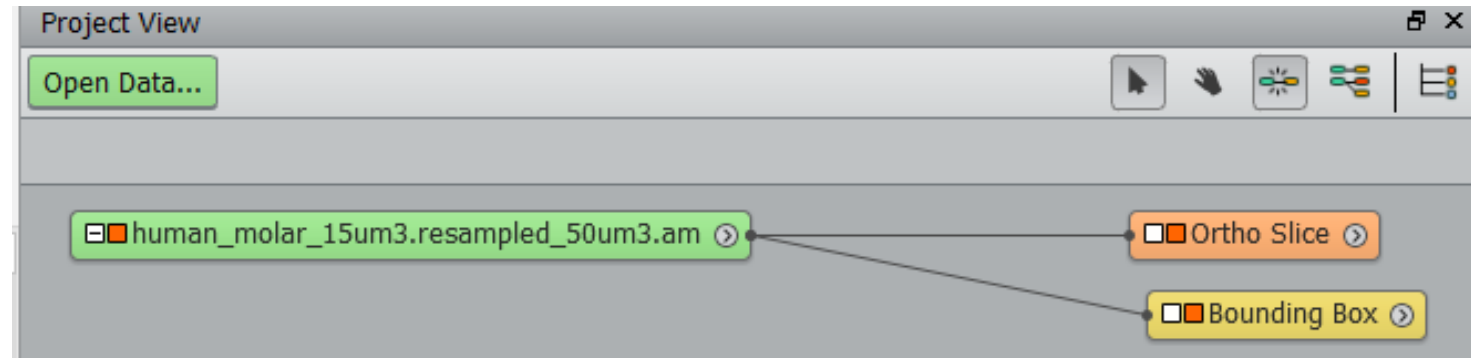
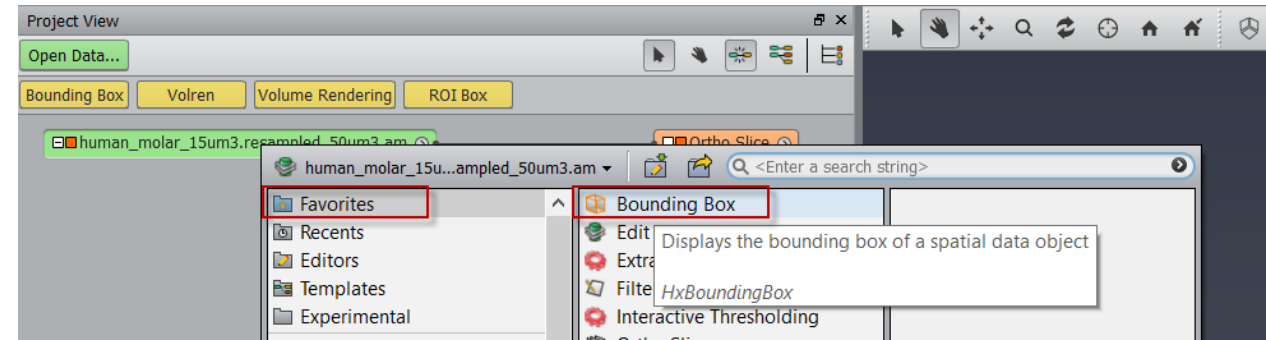


The menu is context-dependent: right-click on the dataset shows only modules that can be attached to an image



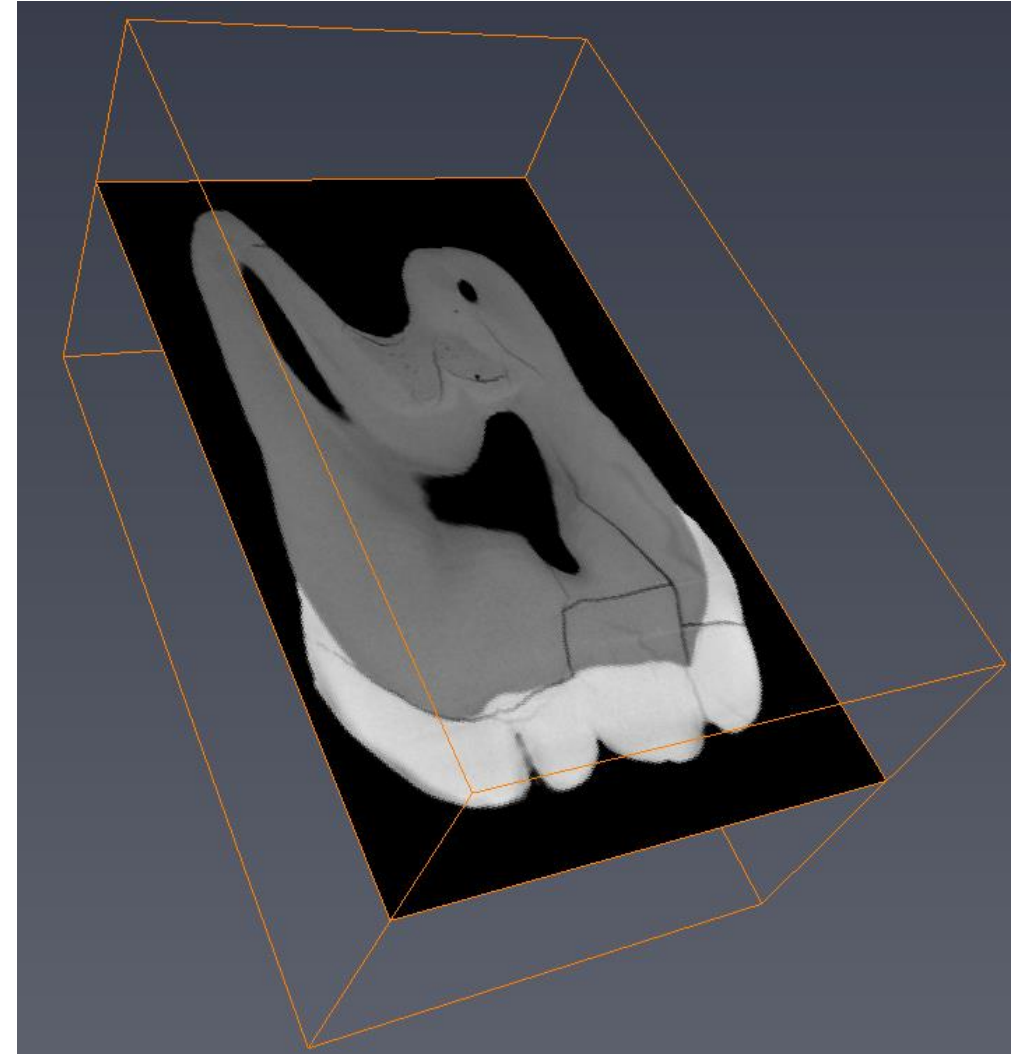
## Step 2: Visualize the data

- Auto-Display has created an OrthoSlice
  - Left-click on OrthoSlice to show its properties
  - Adjust Visualization Contrast using the Colormap port
  - Change slice position and orientation
- 
- Right-click on dataset to open menu
  - Choose Favorites->"Bounding Box"



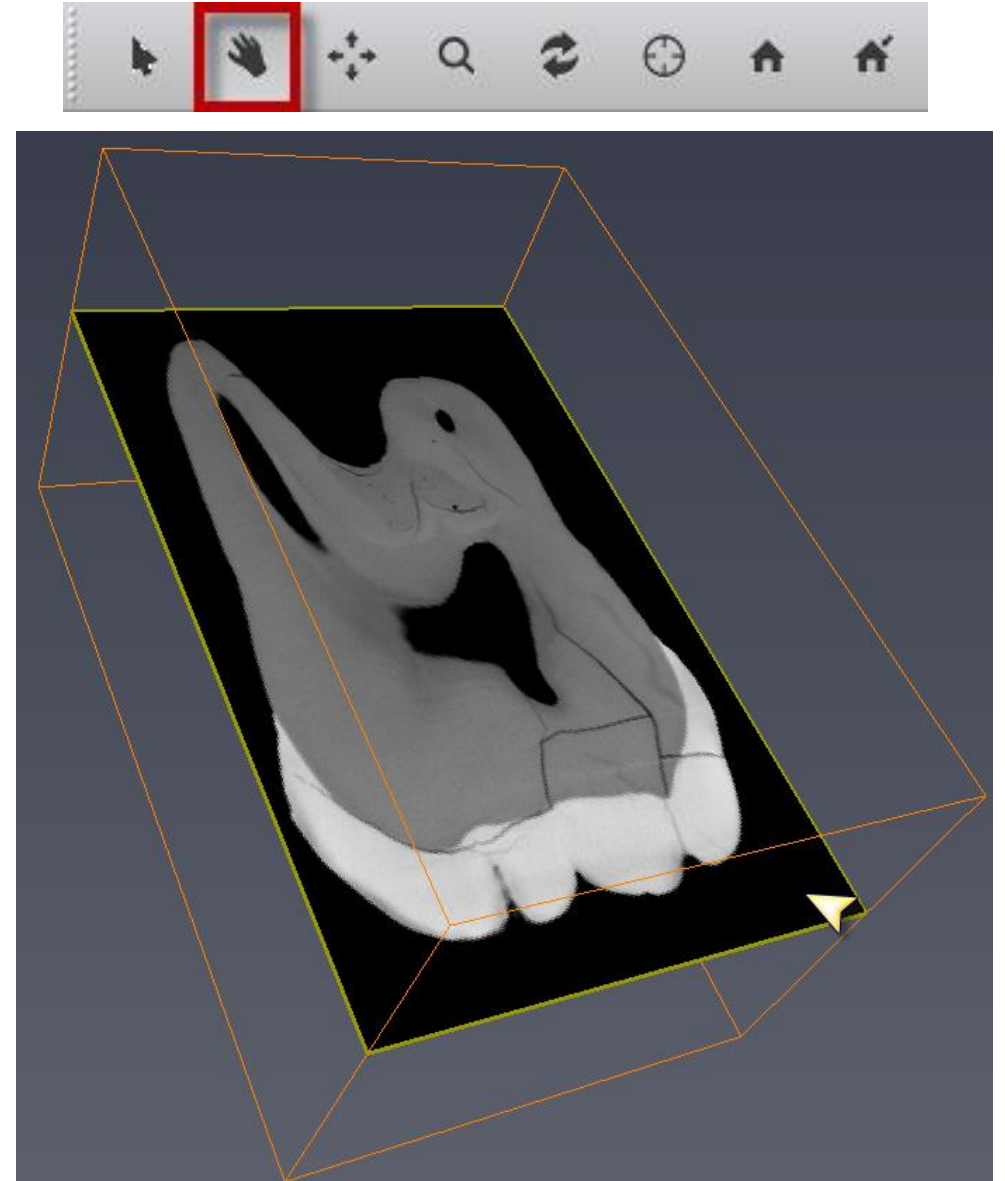
## Step 2: Visualize the data

- Select Trackball mode
- Use left mouse button in 3D view to move the camera



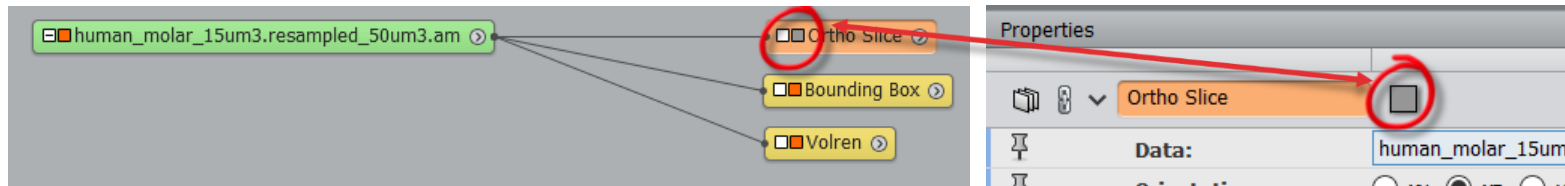
## Step 2: Visualize the data

- Select Trackball mode
- Use left button in 3D view to move the camera
- Select Interactive mode
- Change Slice Number interactively in 3D View

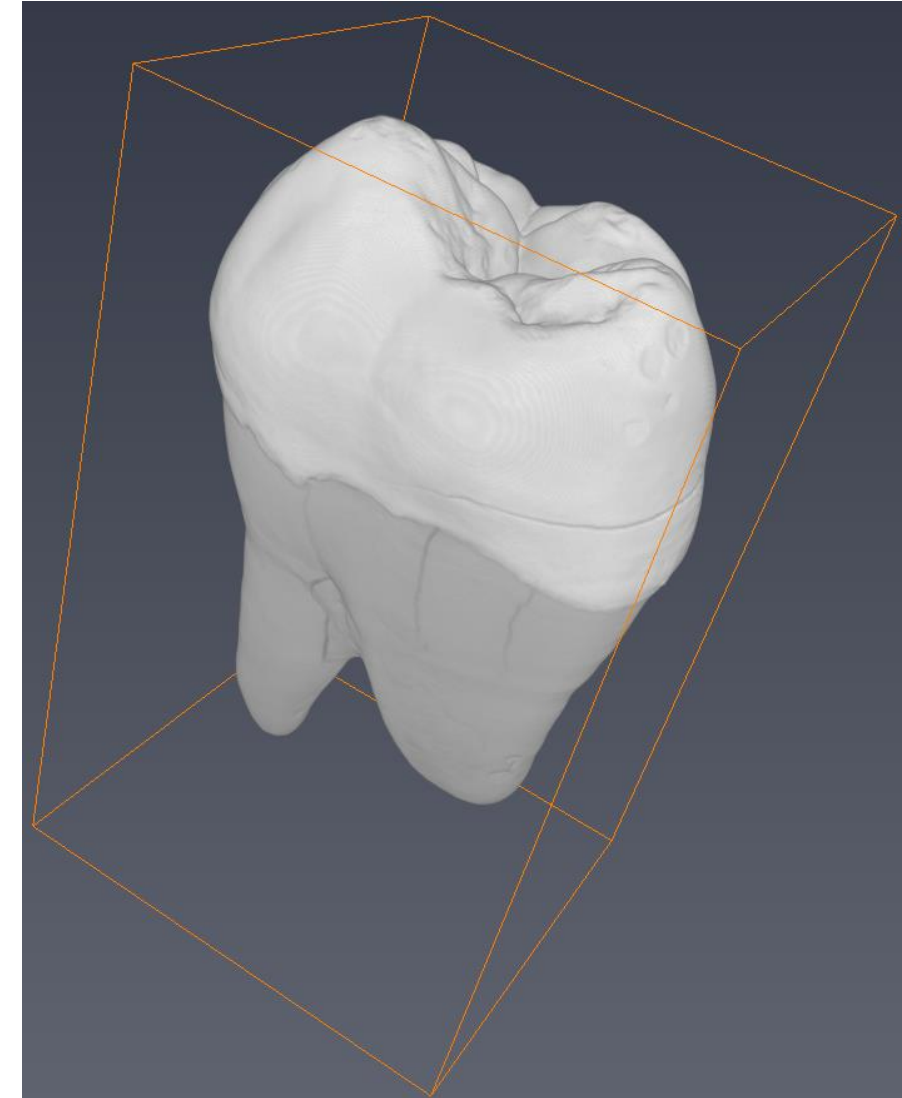
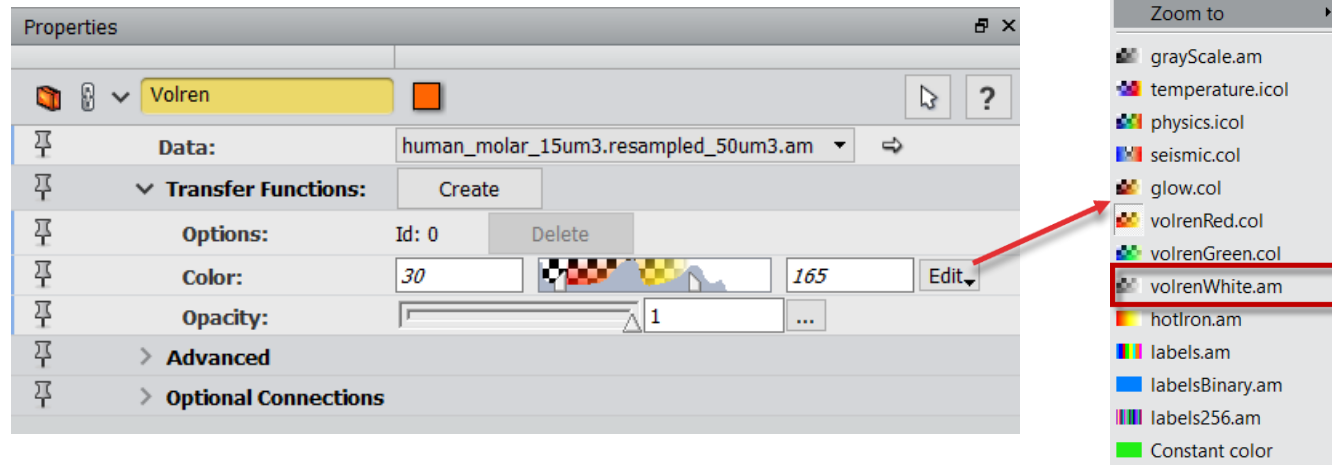


## Step 2: Visualize the data

- Connect a “Volren” module to the dataset
- Disable Visibility of the OrthoSlice



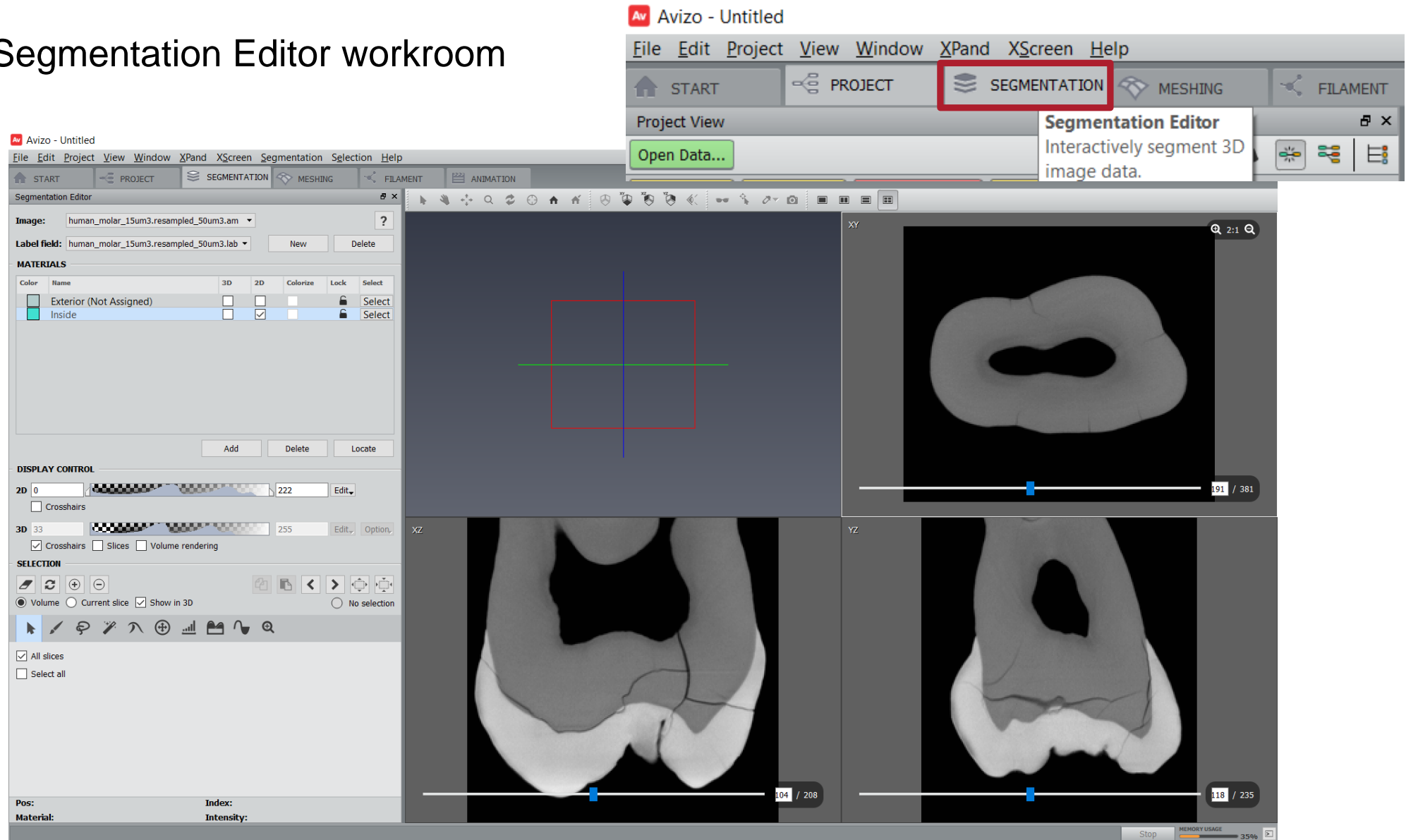
- Adjust Volren colormap range to e.g. 30-165
- Change Colormap to VolrenWhite



*Note: Volume Rendering can also be used, but may crash on laptops without a dedicated GPU, or outdated drivers*

# Step 3: Segment the data

- Open the Segmentation Editor workroom

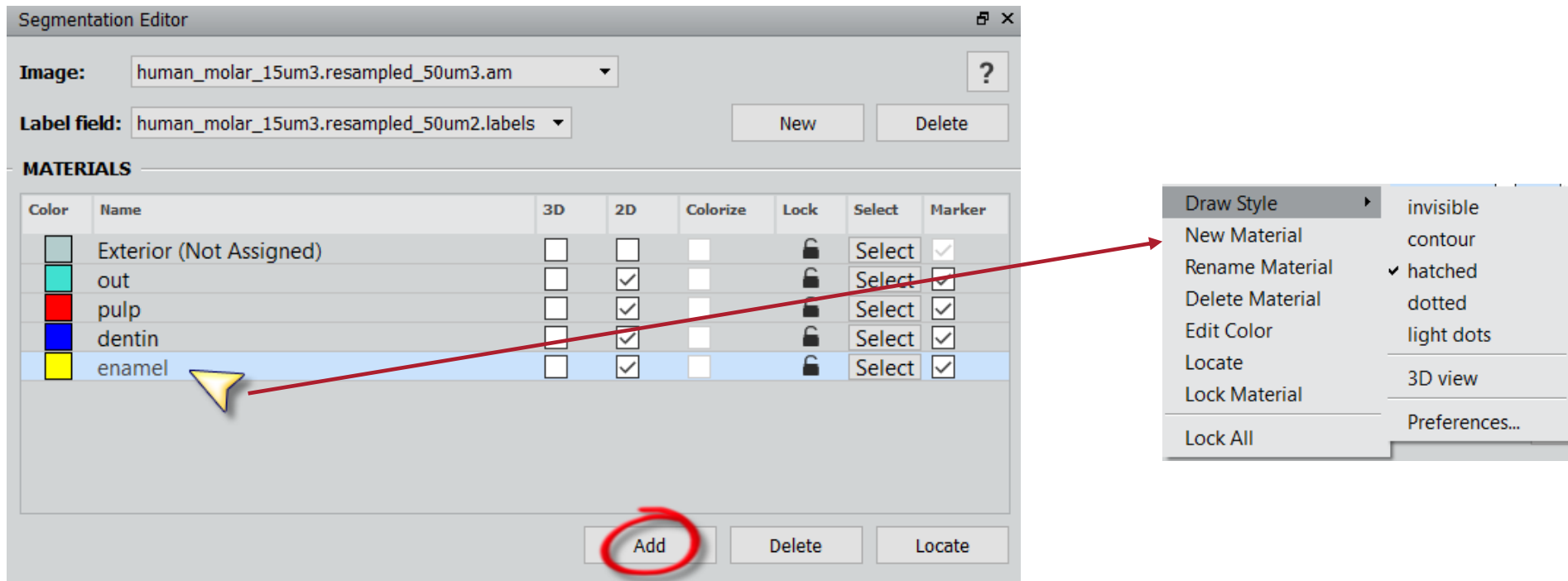


## Step 3: Segment the data

- Open the Segmentation Editor workroom
- We will start with watershed segmentation, which is good for multi-material segmentation of 'not too thin' objects (cracks will be handled separately)
- Watershed starts from markers for each materials, which will be grown by the algorithm to match where there is highest gradient (contrast) in the image.

## Step 3: Segment the data











- Open the Segmentation Editor workroom
- Add Materials for 'outside air', 'interior air' (formerly pulp), dentin, and enamel
- Double-click on a 'Material' name to rename it or use F2 (in Windows)
- Right-click a material for further options (color/draw style/...)



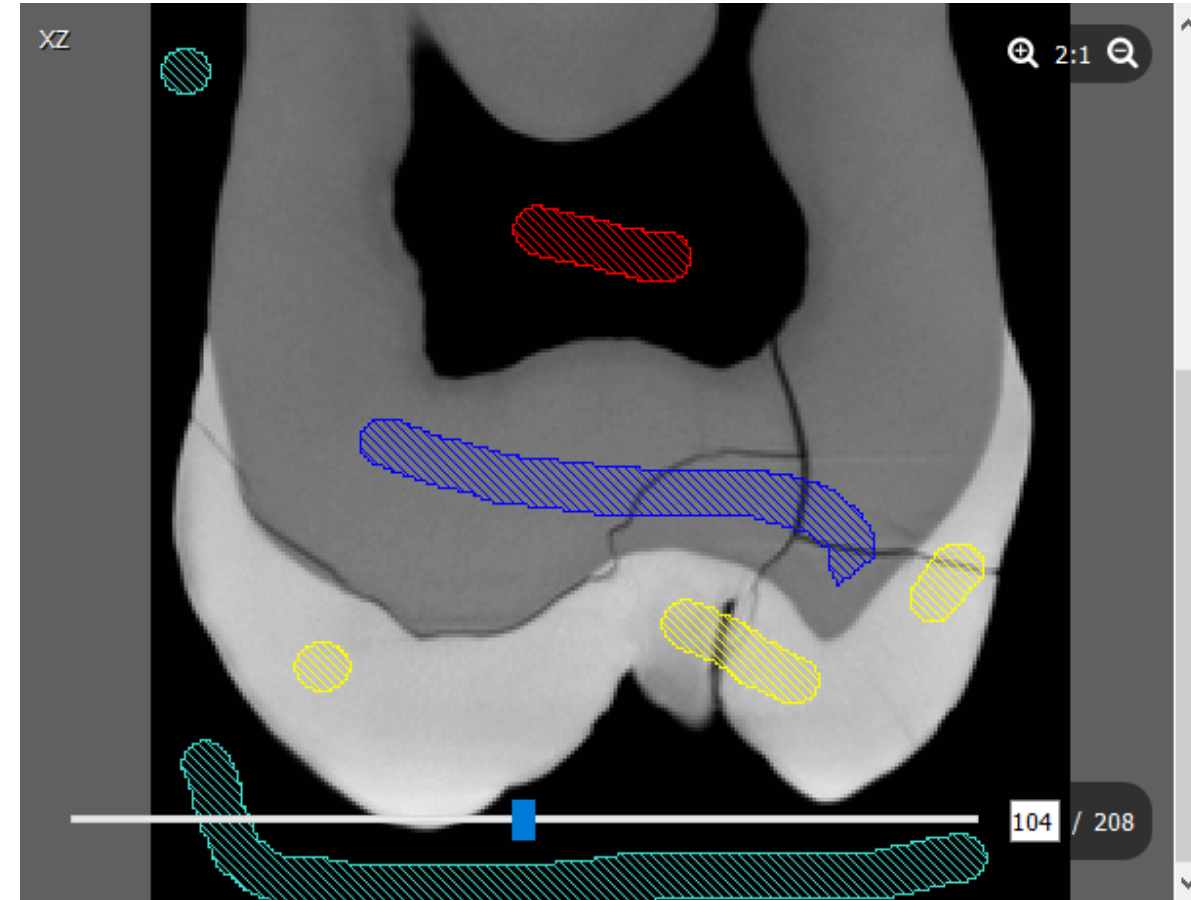
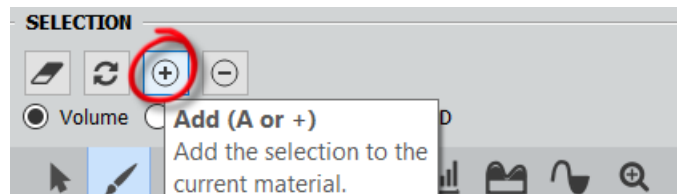


## Step 3: Segment the data

- Use the paintbrush to define some markers for each material
- 1: Paint on a slice to select some voxels  
left click to select voxels  
Ctrl+left click to de-select voxels
- 2: Select the material to assign the selection to  
(or make sure the target material is already selected)

MATERIALS						
Color	Name	3D	2D	Colorize	Lock	Select
	Exterior (Not Assigned)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Select
	out	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Select
	pulp	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Select
	dentin	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Select
	enamel	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Select

- 3: Add selection to the target material (keypad + or A)



This icon  clears a selection without assigning to a material

## Step 3: Segment the data

- Select the watershed tool

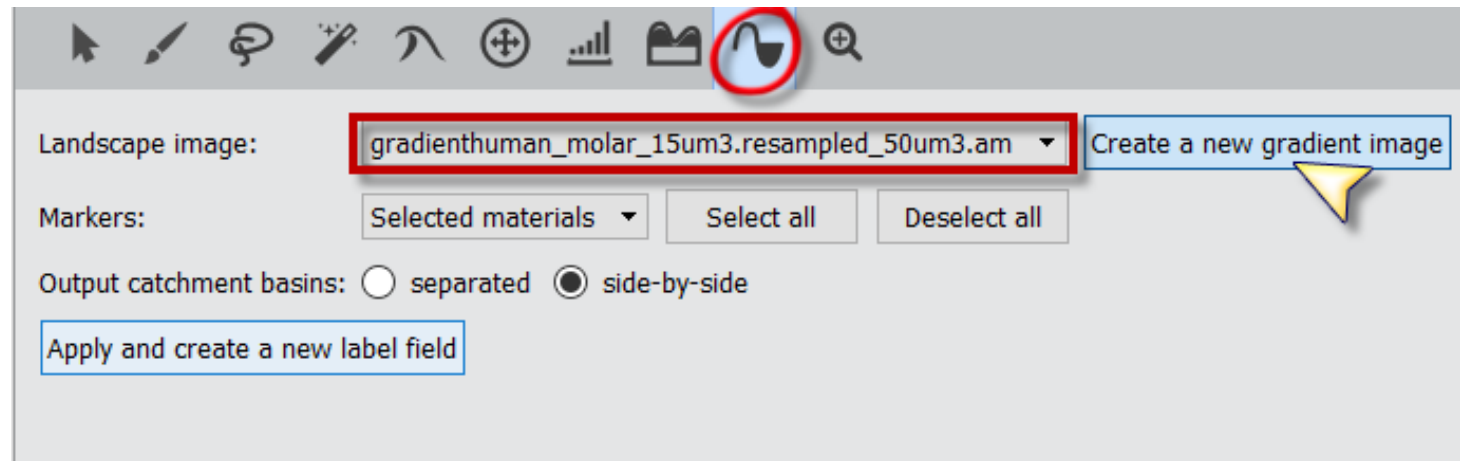


- Press 'Create a new gradient image'

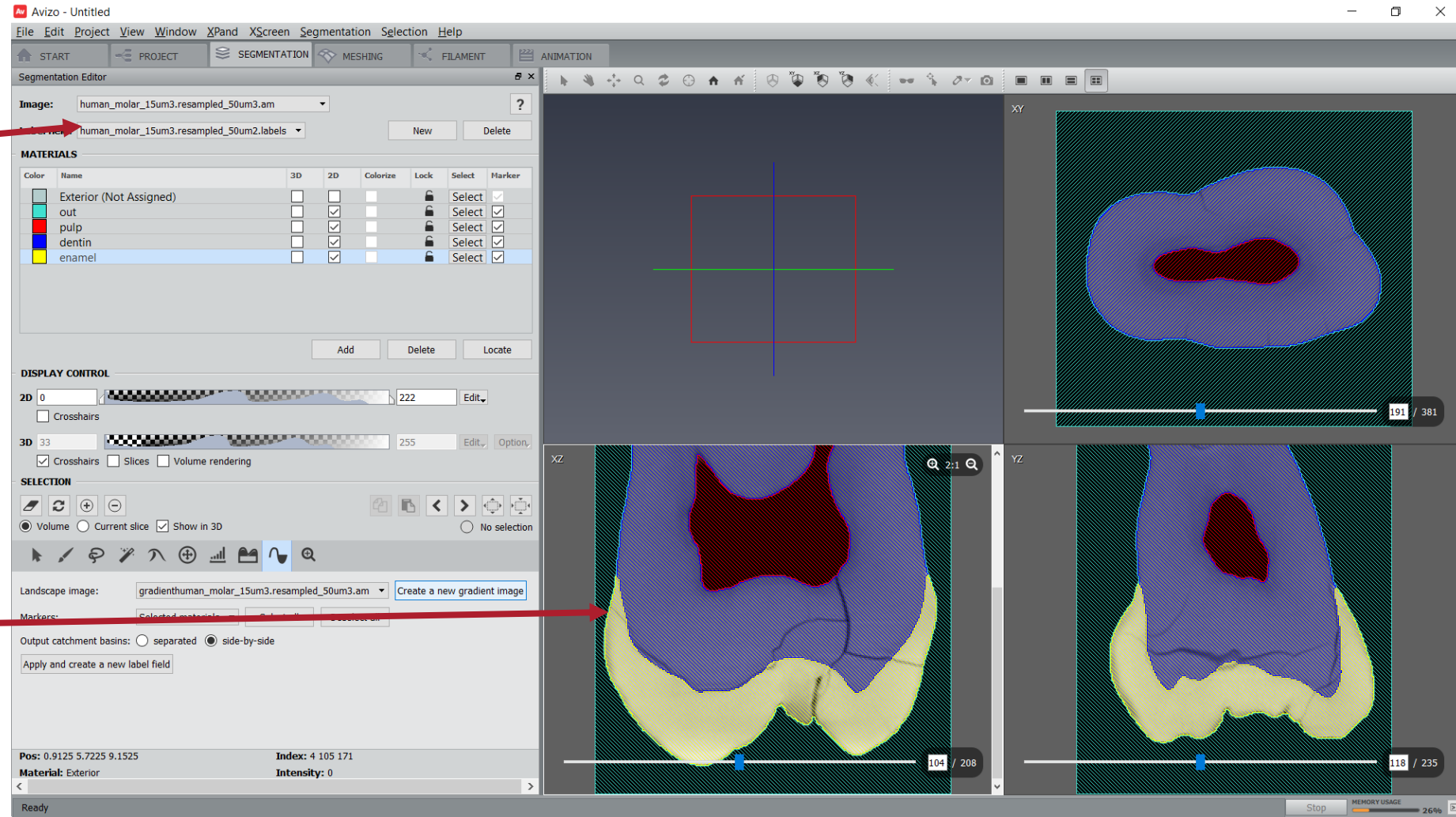
This only has to be done once. After it is done, the 'Landscape image' will indicate « gradient[imagename] »

- Press 'Apply and create a new label field'

Each time you press this button, the watershed algorithm is runned on the currently selected label field, and will generate a new label field.



# Step 3: Segment the data



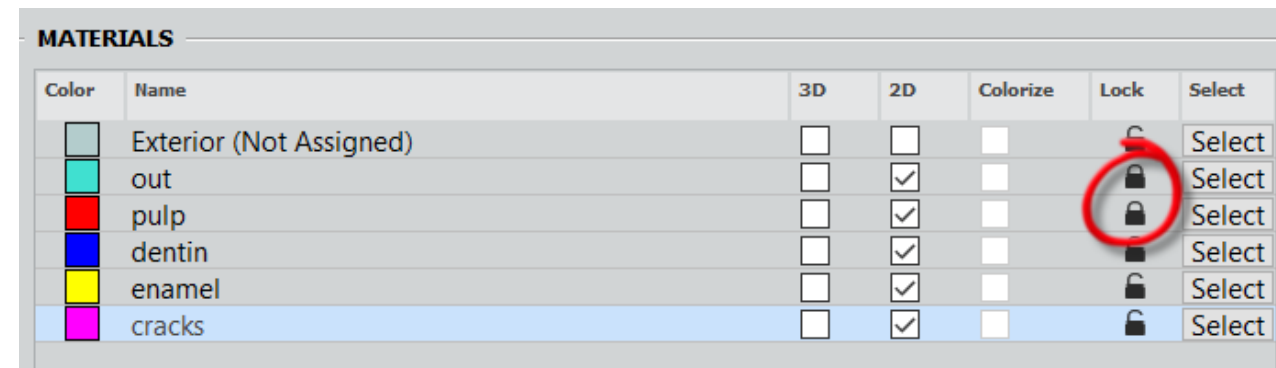
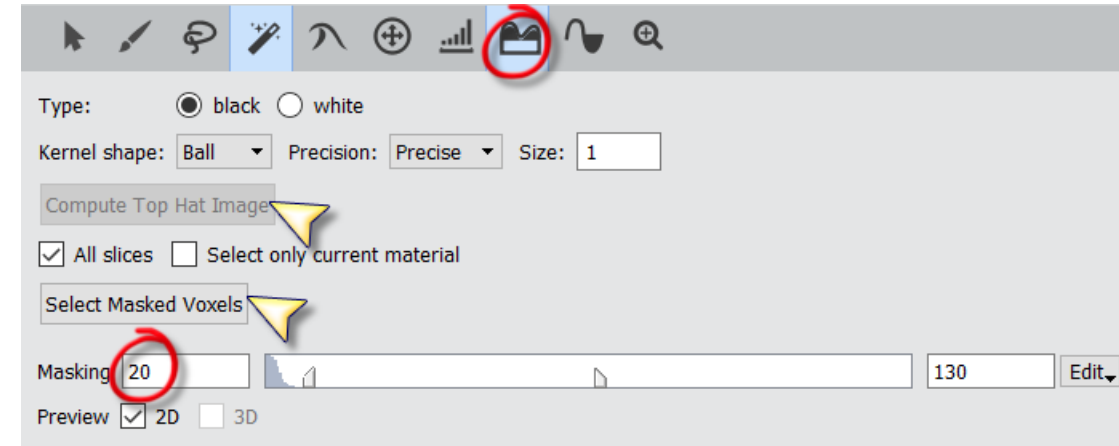
A new label field is created, but the original label field (watershed markers still exists)

The entire image (formerly 'Exterior' material) has been 'invaded' by the markers

If necessary (in case of a significant leakage) it is possible to go back to the previous label field (markers), update it, and re-apply the watershed. It is also possible to edit the result from the watershed to fix small issues.

## Step 3: Segment the data

- Let's now extract the cracks, using the Top Hat tool
- 1: Select the Top Hat tool
- 2: use a Ball if Size 1 as a Kernel
- 3: Compute the Top Hat Image
- 4: Adjust the 'masking' range: only adjust the lower threshold value. 20 seems a good value.
- 5: Select Masked Voxels (make sure to have 'All slices' selected)
- 6: Create a material 'cracks'  
Lock the 'out' and 'pulp' materials  
Assign the selection to the 'cracks' material
- 7: Delete the material 'out'



## Step 3: Segment the data

- Go back to the 'Project' workroom
- Identify which modules correspond to what...

Original grayscale image

The first label field created by Segmentation Editor is tightly attached to the grayscale image.  
If relevant, you can delete this connection using the 'Image Data' port

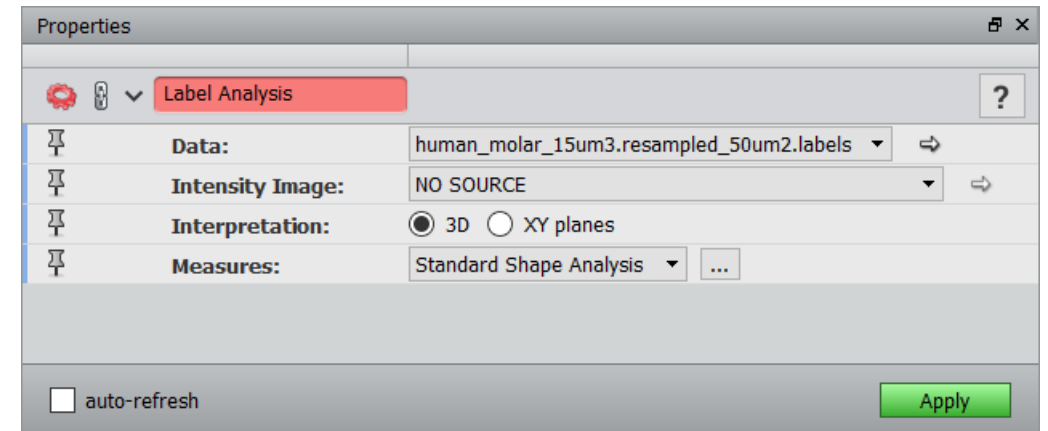
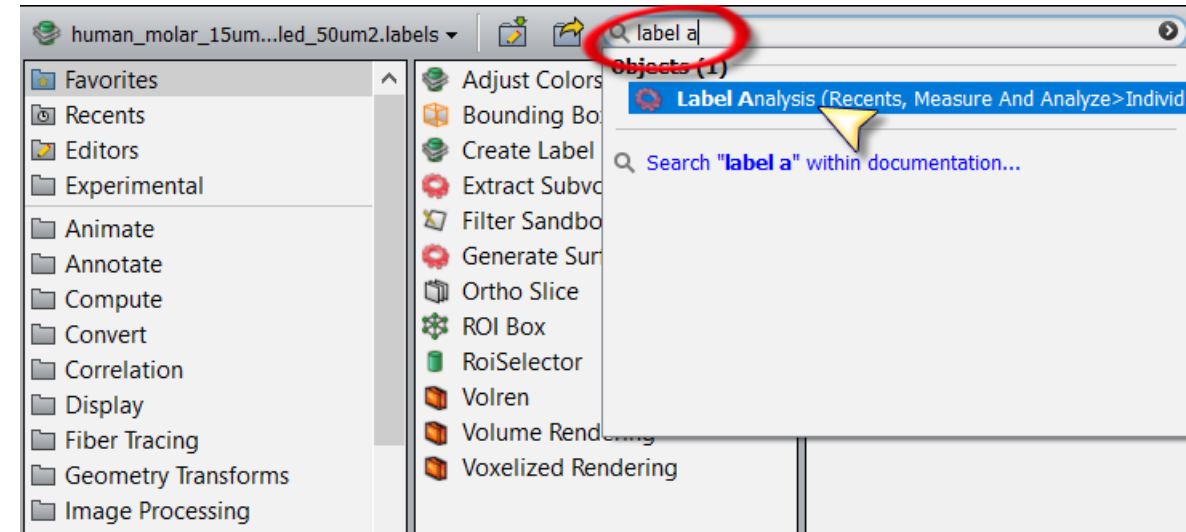
Gradient Magnitude of the grayscale image, computed when the 'Create a new gradient image' is pressed.

Final label image



## Step 4: Measure

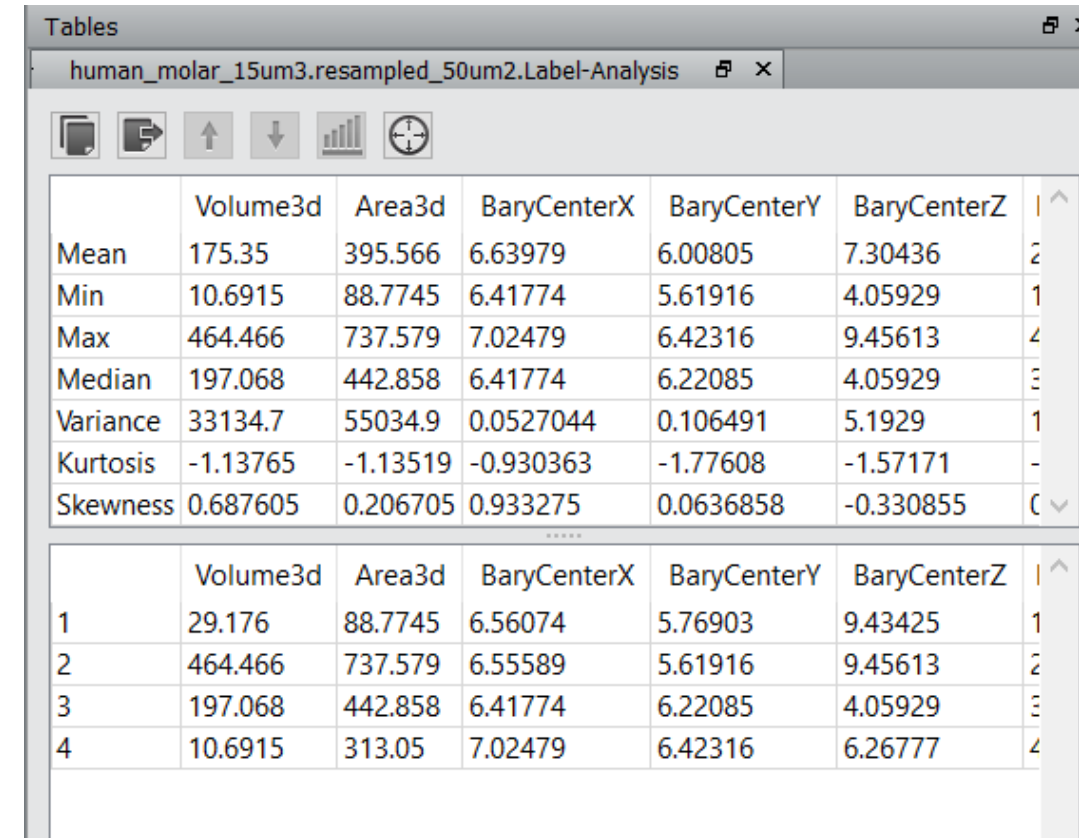
- Right-click on the final label image
- Create a 'Label Analysis' module
- Select the measures 'Standard Shape Analysis'
- Optionnally, connect the 'Intensity Image' to the grayscale data
- Apply





## Step 4: Measure

- Right-click on the final label image
- Create a 'Label Analysis' module
- Select the measures 'Standard Shape Analysis'
- Optionnally, connect the 'Intensity Image' to the grayscale data
- Apply
- This creates an output dataset (spreadsheet)
- Table is shown on the right part of the screen



	Volume3d	Area3d	BaryCenterX	BaryCenterY	BaryCenterZ
Mean	175.35	395.566	6.63979	6.00805	7.30436
Min	10.6915	88.7745	6.41774	5.61916	4.05929
Max	464.466	737.579	7.02479	6.42316	9.45613
Median	197.068	442.858	6.41774	6.22085	4.05929
Variance	33134.7	55034.9	0.0527044	0.106491	5.1929
Kurtosis	-1.13765	-1.13519	-0.930363	-1.77608	-1.57171
Skewness	0.687605	0.206705	0.933275	0.0636858	-0.330855

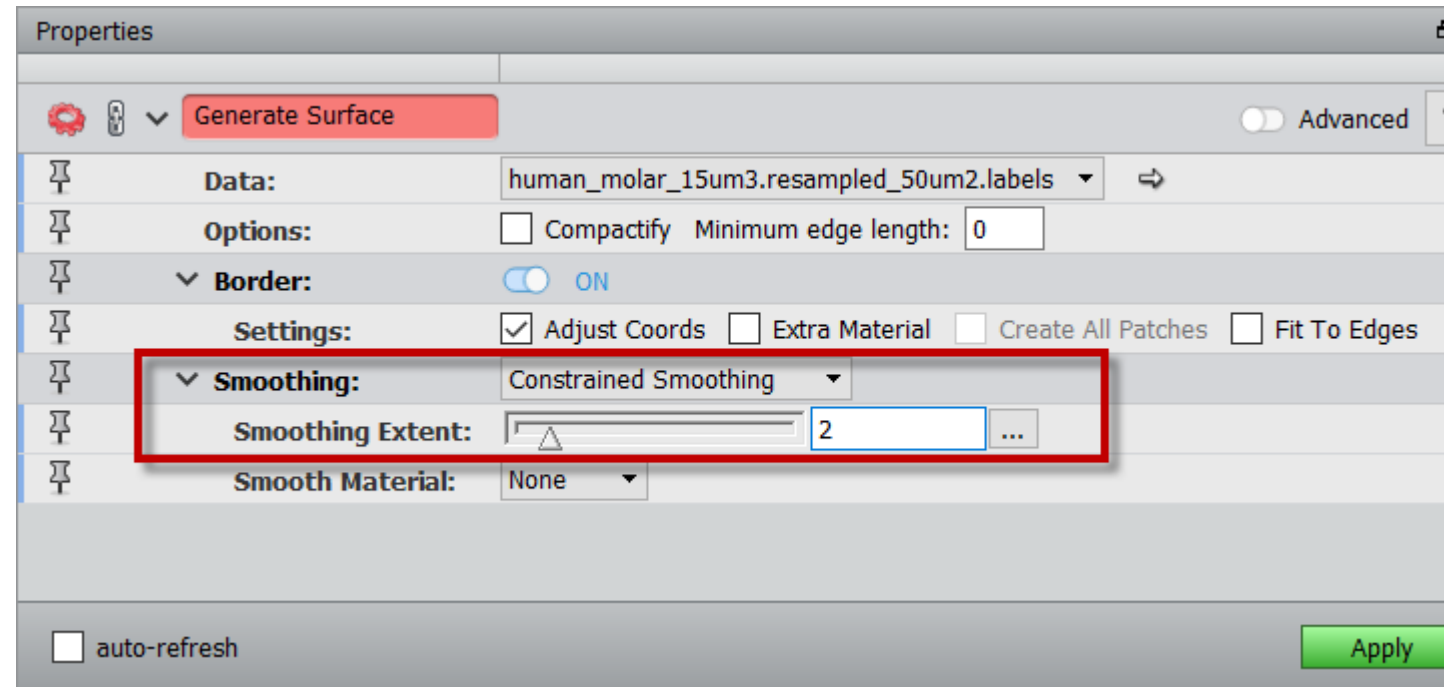
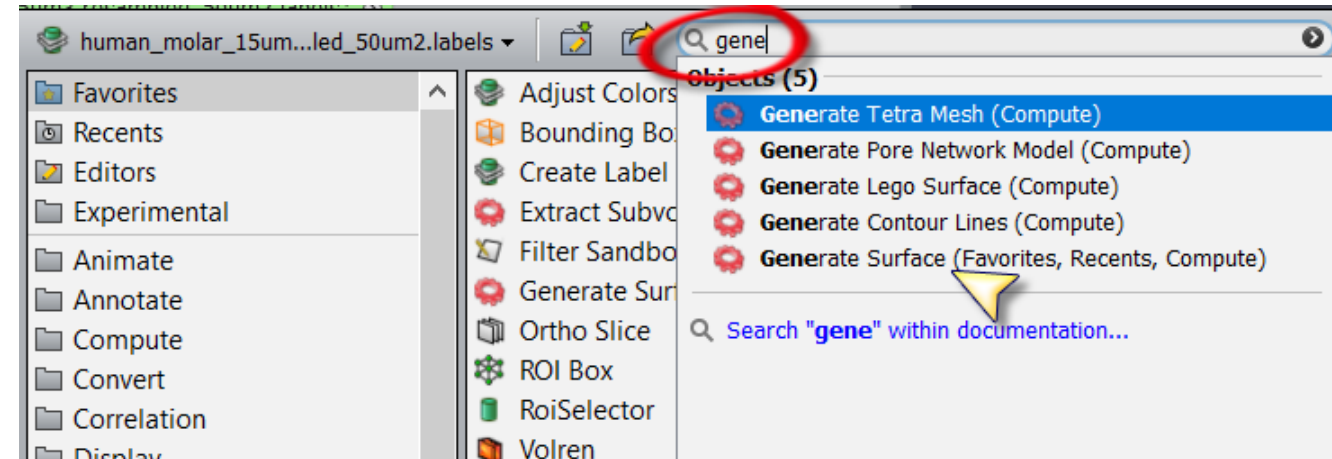
  

	Volume3d	Area3d	BaryCenterX	BaryCenterY	BaryCenterZ
1	29.176	88.7745	6.56074	5.76903	9.43425
2	464.466	737.579	6.55589	5.61916	9.45613
3	197.068	442.858	6.41774	6.22085	4.05929
4	10.6915	313.05	7.02479	6.42316	6.26777



## Step 5: Generate surface

- Right-click on the final label image
- Search for the 'Generate Surface' module
- Select Constrained Smoothing  
(Warning: Unconstrained smoothing tends to suppress thin structures such as cracks or filaments)
- Apply



# Step 5: Generate surface

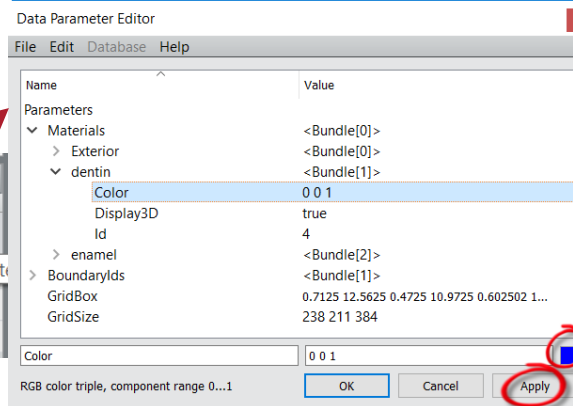
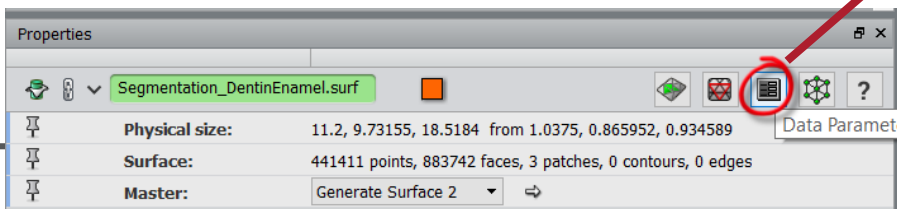
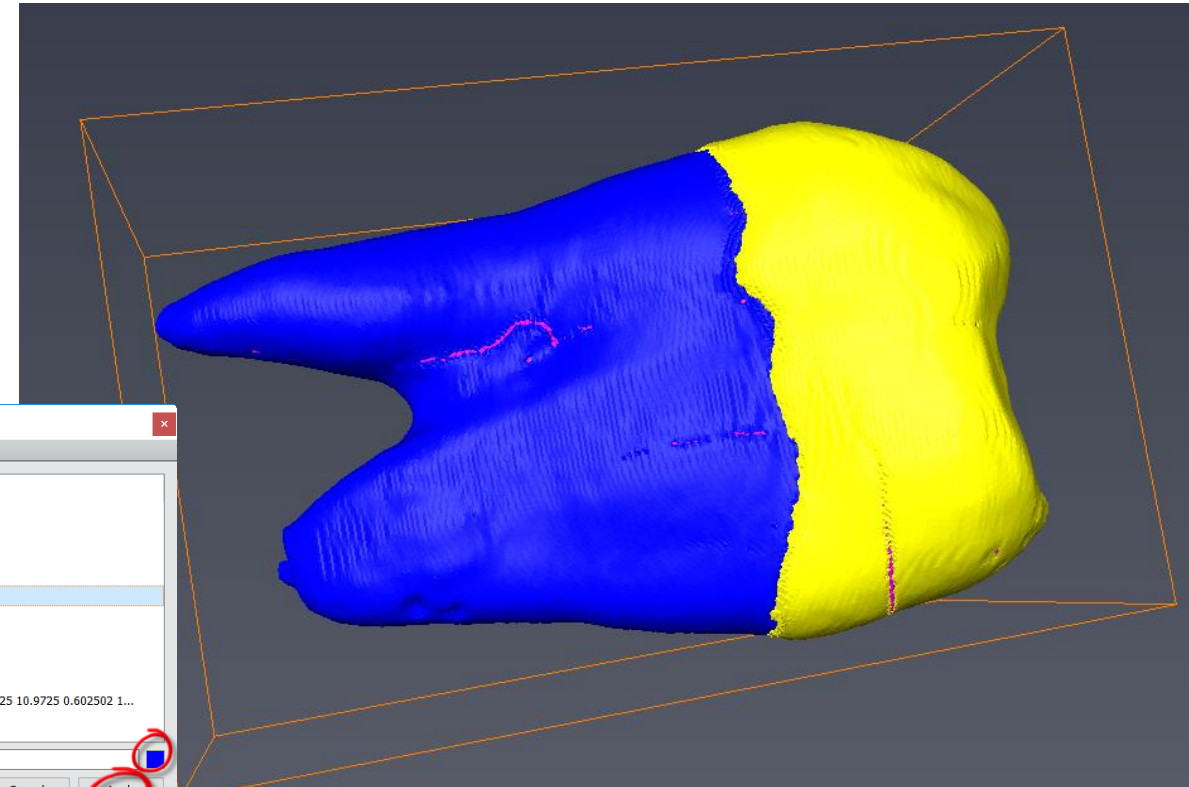
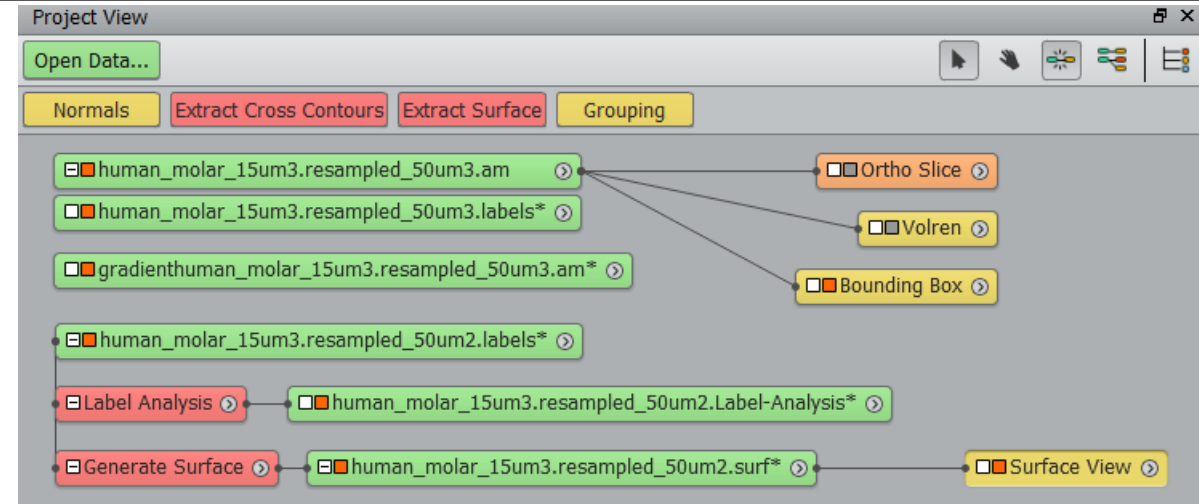
- Right-click on the final label image
- Search for the 'Generate Surface' module

- Select Constrained Smoothing

(Warning: Unconstrained smoothing tends to suppress thin structures such as cracks or filaments)

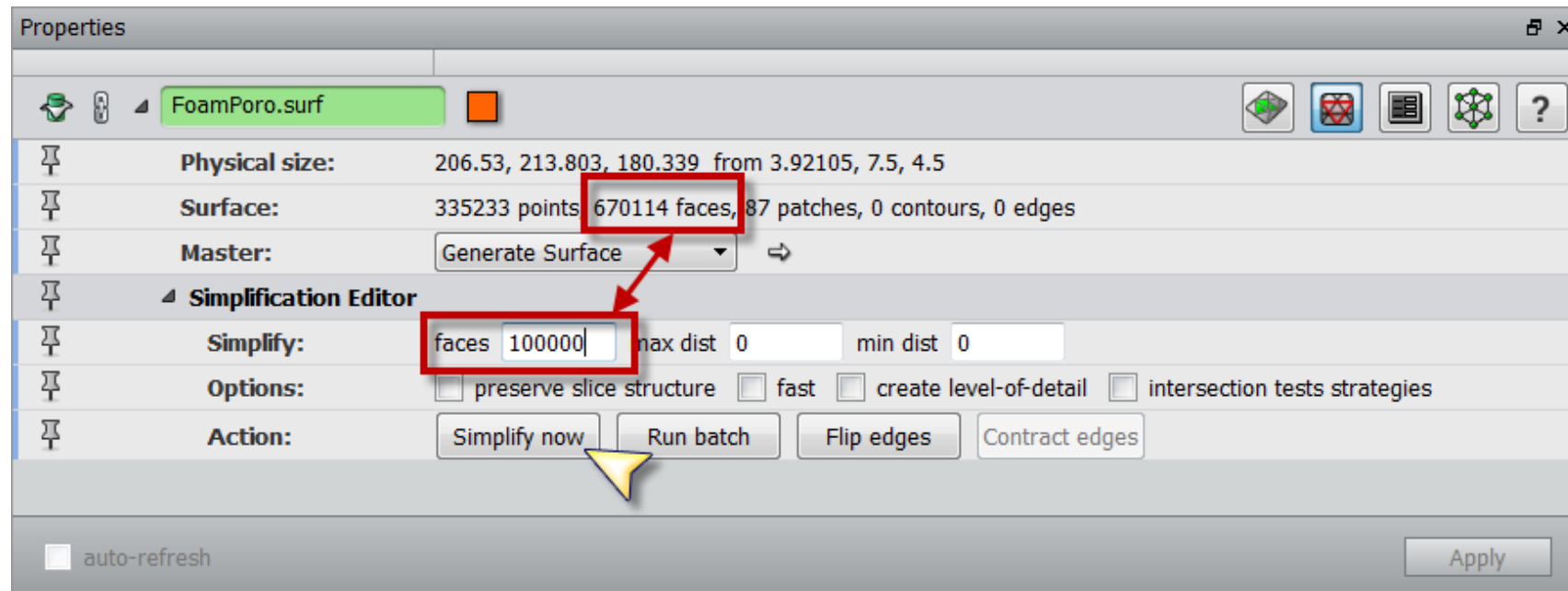
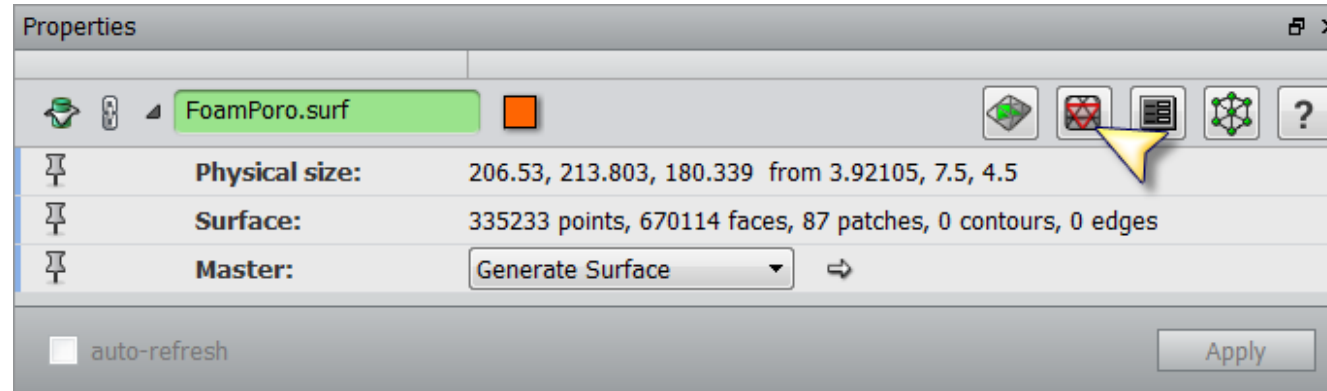
- Apply
- Visualize the result with Surface View

*Surface colors corresponds to those defined in the Segmentation Editor  
The surface colors can be modified from the Data Parameters windows*



## Step 5: Generate surface

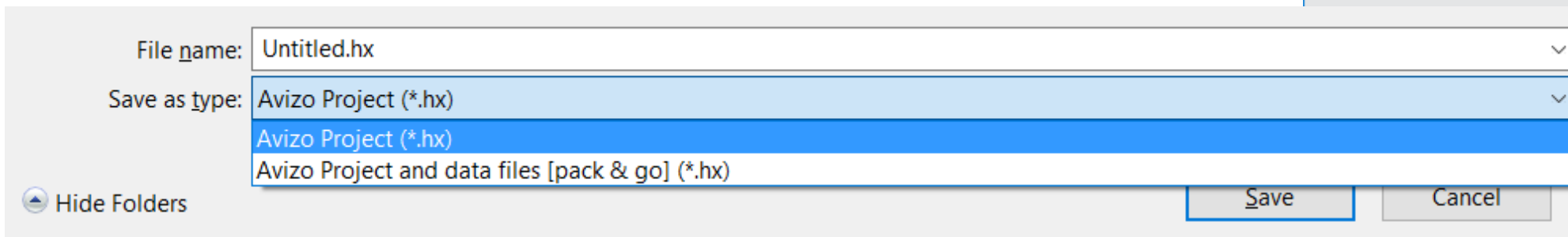
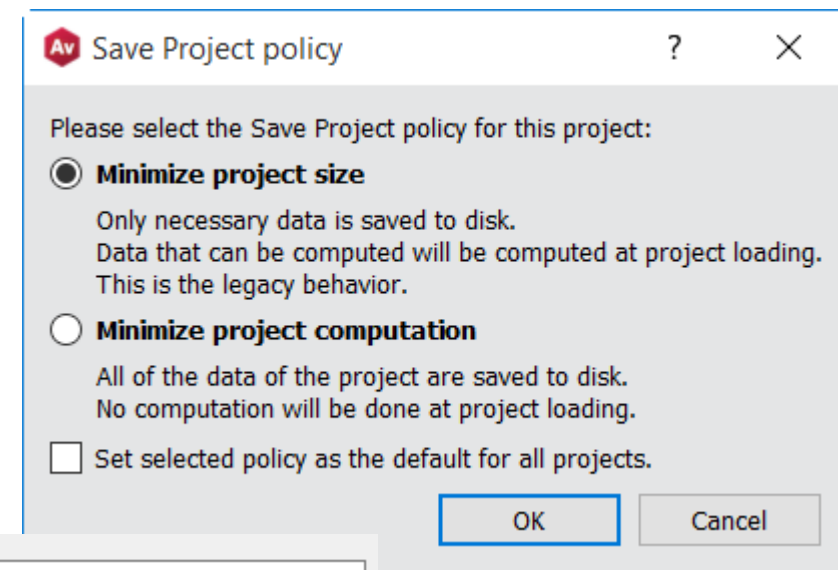
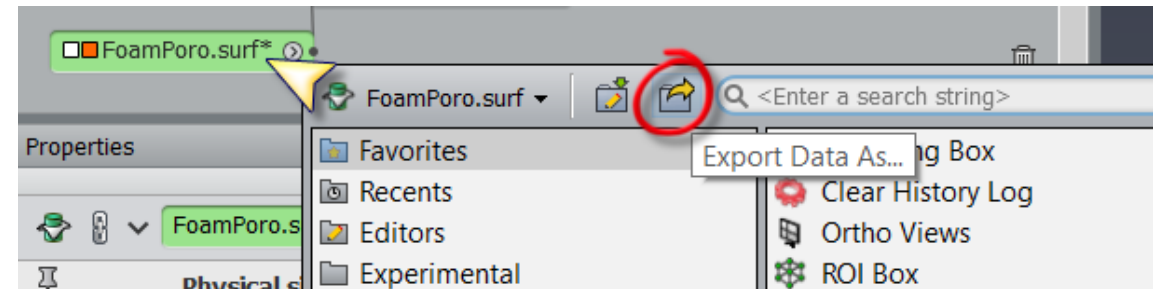
- Use Simplification Editor to reduce the number of triangles



# Save / Export datasets and projects

- Exporting a dataset to 3<sup>rd</sup> party software:
  - Right-click on the module, and select Export Data
  - Select the relevant format
- Saving a project: File > Save Project (As) ...
  - Use 'Minimize project computation' when a filter takes a long time to compute
  - Use 'Pack & Go' if you need to archive or transfer the project to a different computer.

This will copy the input dataset(s) inside the project folder. Otherwise, these files are only referenced via their path on the disk, and the project will not load if this path is no longer valid.



# Thank you!

Find out more at:  
**[Amira-Avizo.com](https://Amira-Avizo.com)**