Visualization and Analysis

Kitware Course Week, Clifton Park, NY

24 July, 2019

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Outline

- Introduction
- Visualization techniques
- Volume rendering
- Data transforms
- Segmentation
- Exporting data

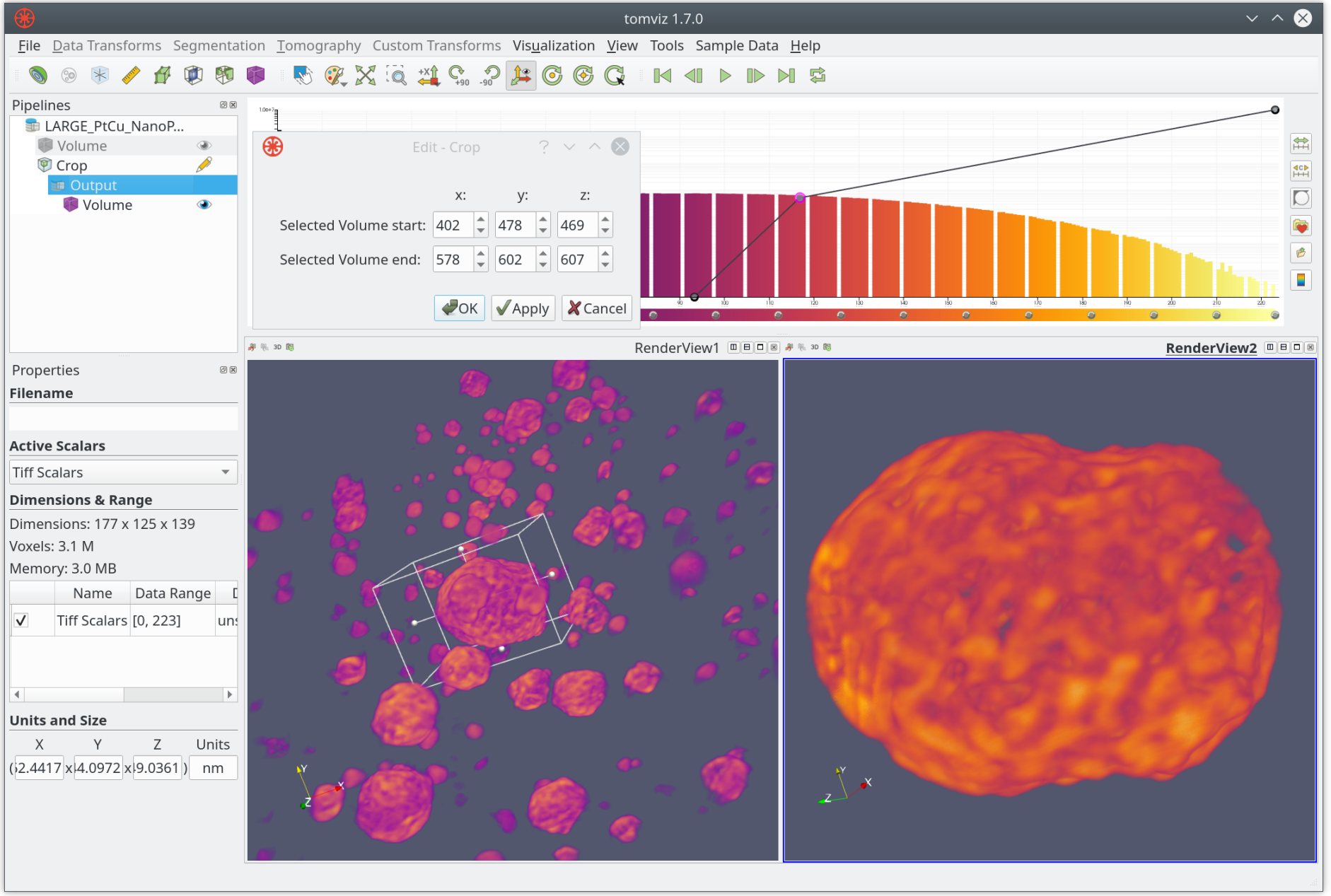
Introduction

- Saving your work
  - Tomviz saves the pipeline every five minutes
  - This can be recovered upon restart of Tomviz
- You can also save the application state
  - Snapshot of pipeline at a given moment
  - Can be restored, edited, saved again
- Note that saving state *does not* save data

What are you visualizing?

- The end of the processing pipeline
  - With no operators this is the original data
  - Normally it has had several operations applied
- You can also visualize the original data (root)
  - Select the data set, and add modules to that
  - Data sets can be cloned, creating a new root
- Visualization modules—start/end of pipelines

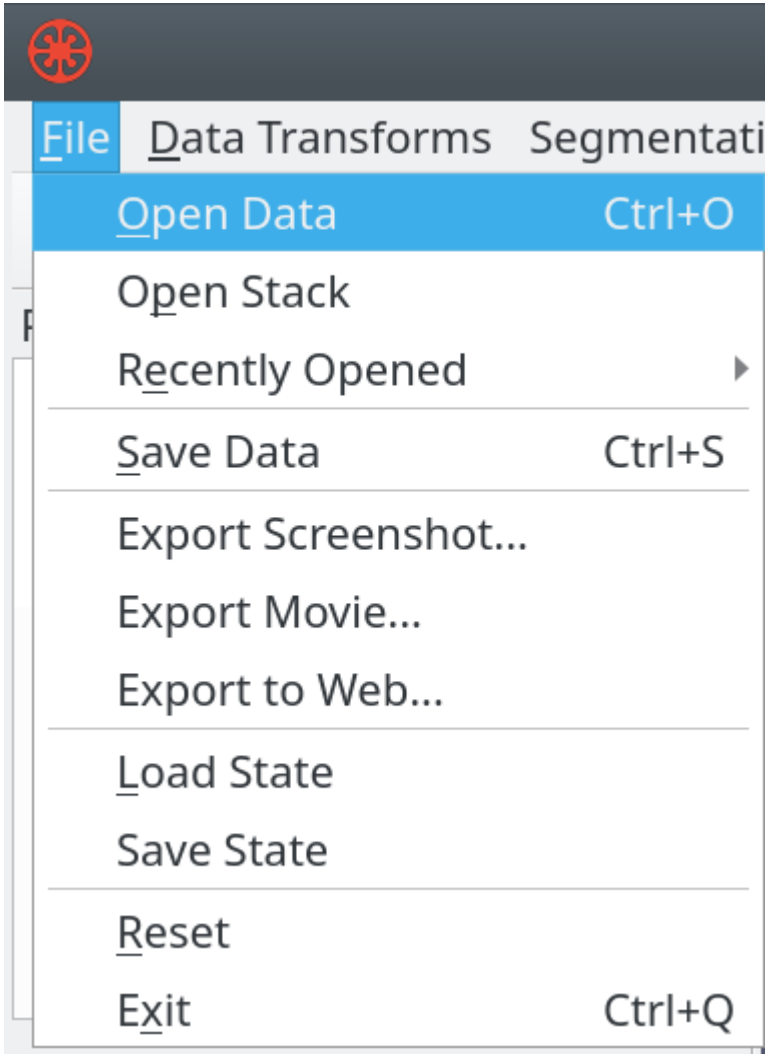
Start/End of Pipeline


tomviz 1.7.0
File Data Transforms Segmentation Tomography Custom Transforms Visualization View Tools Sample Data Help
Pipelines
LARGE_PtCu_NanoP...
Volume
Crop
Output
Volume
Edit - Crop
x: y: z:
Selected Volume start: 402 478 469
Selected Volume end: 578 602 607
OK Apply Cancel
RenderView1
RenderView2
Properties
Filename
Active Scalars
Tiff Scalars
Dimensions & Range
Dimensions: 177 x 125 x 139
Voxels: 3.1 M
Memory: 3.0 MB
Name Data Range
Tiff Scalars [0, 223]
Units and Size
X Y Z Units
2.4417 x 4.0972 x 9.0361 nm

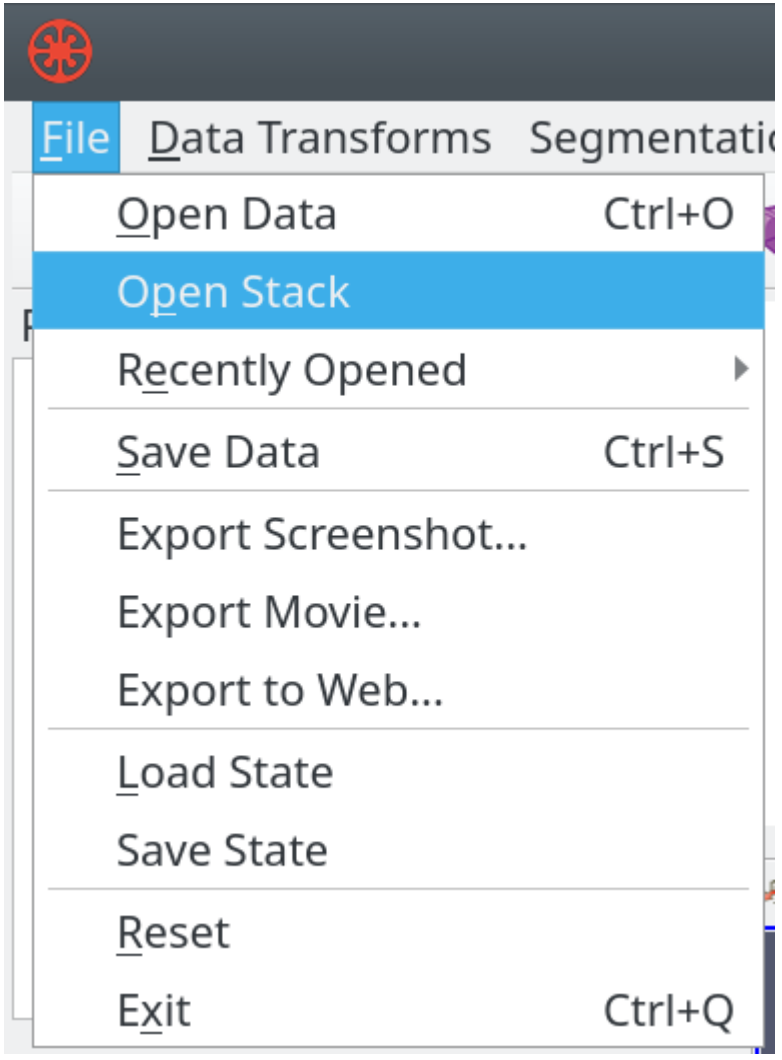
Data size

Volume	Voxels	Size (char)	Size (int)
64^3	262,144	0.25 MB	1 MB
128^3	2,097,152	2.00 MB	8 MB
256^3	16,777,216	16.00 MB	64 MB
512^3	134,217,728	128.00 MB	512 MB
1024^3	1,073,741,824	1,024.00 MB	4,096 MB

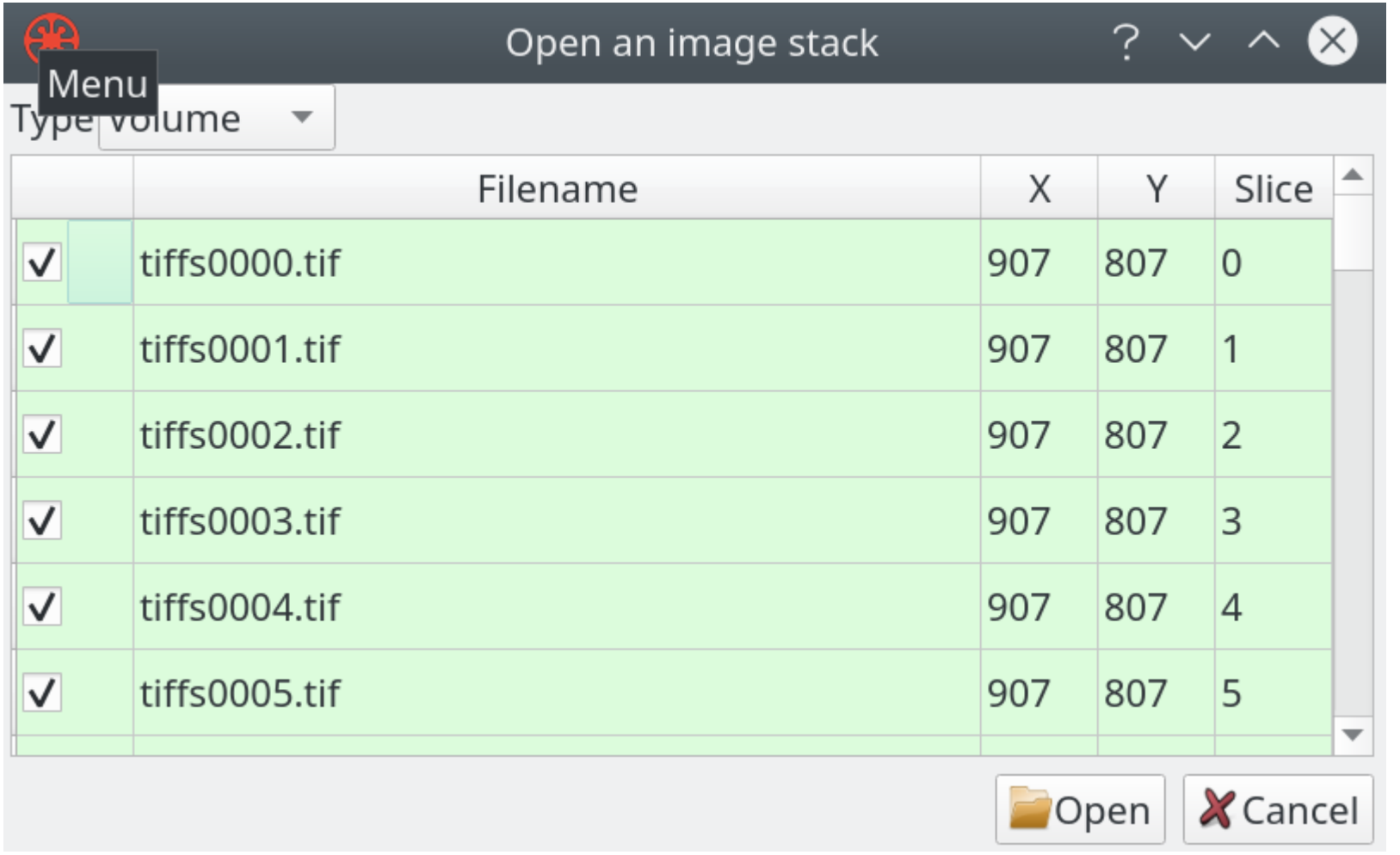
Loading data



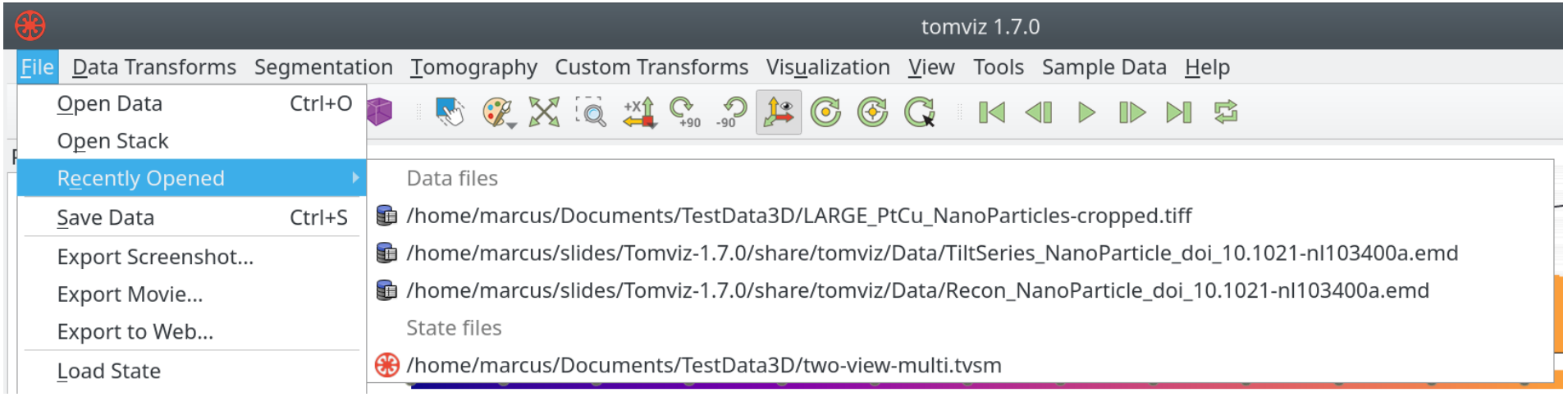
Loading data (image stacks)



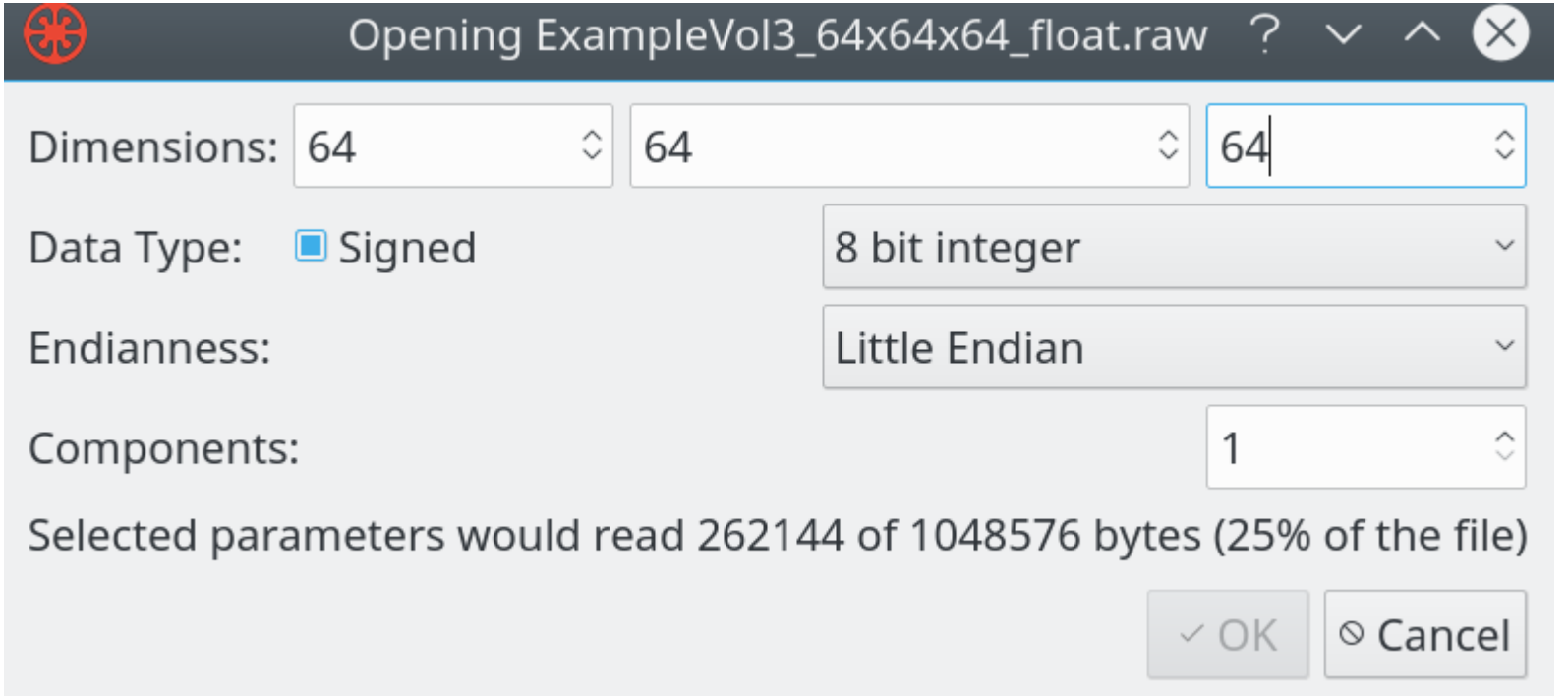
Loading data (image stacks)



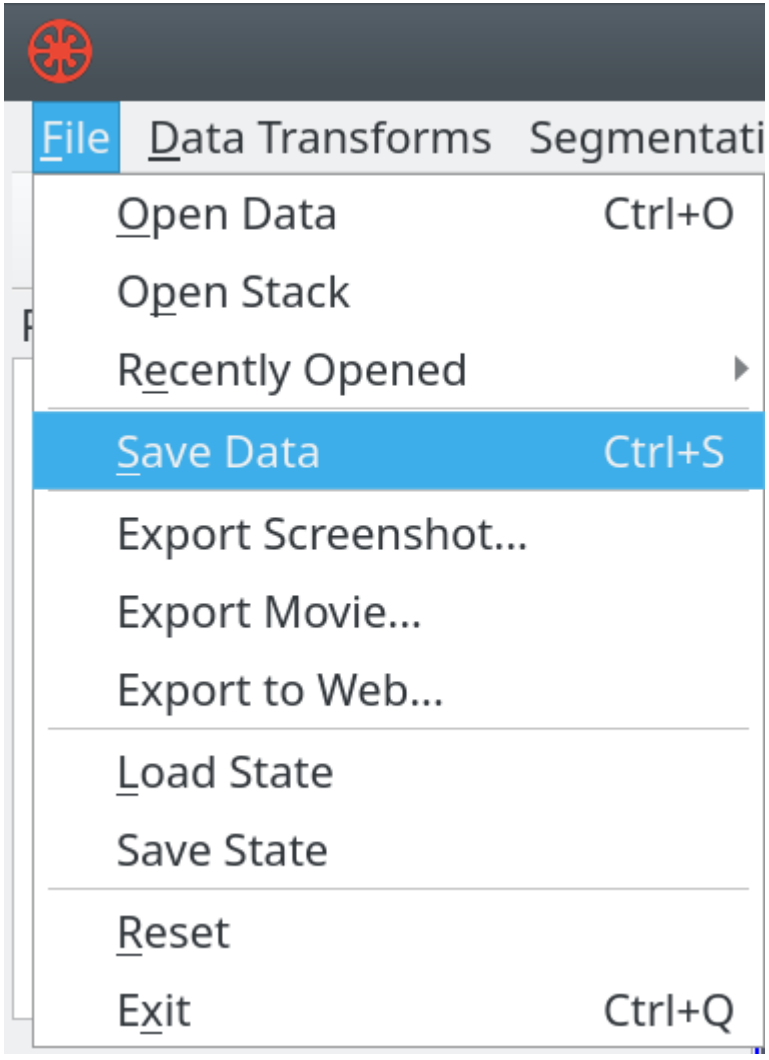
Recent files



Reading a raw file



Saving data


File
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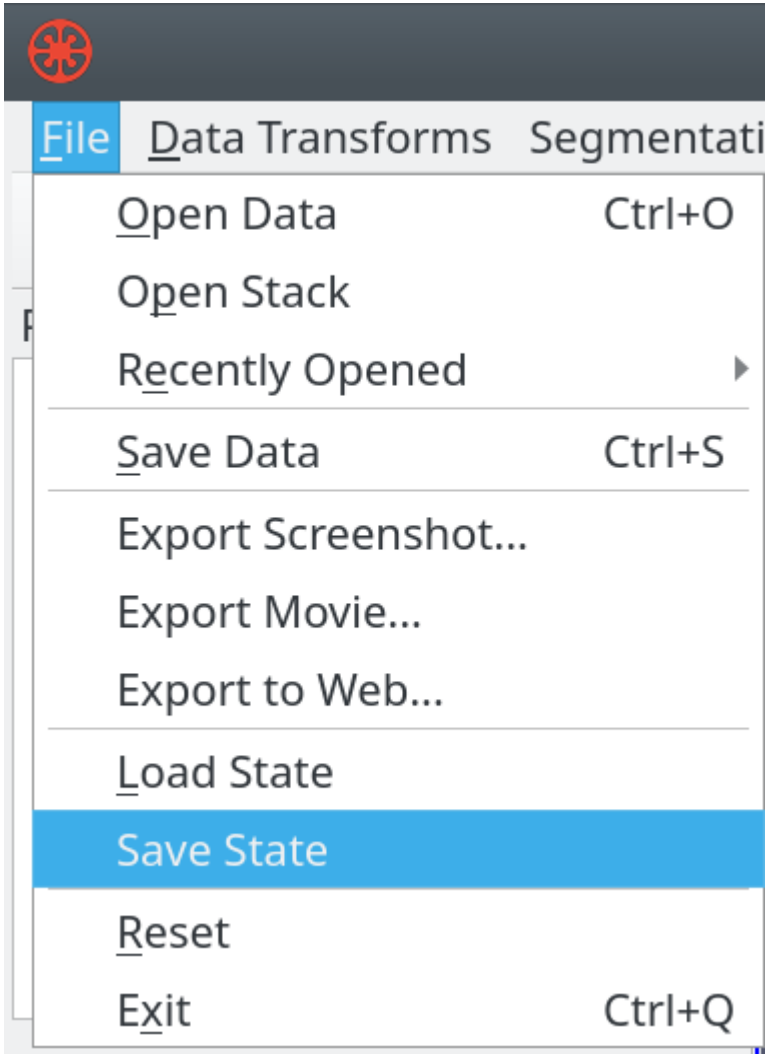
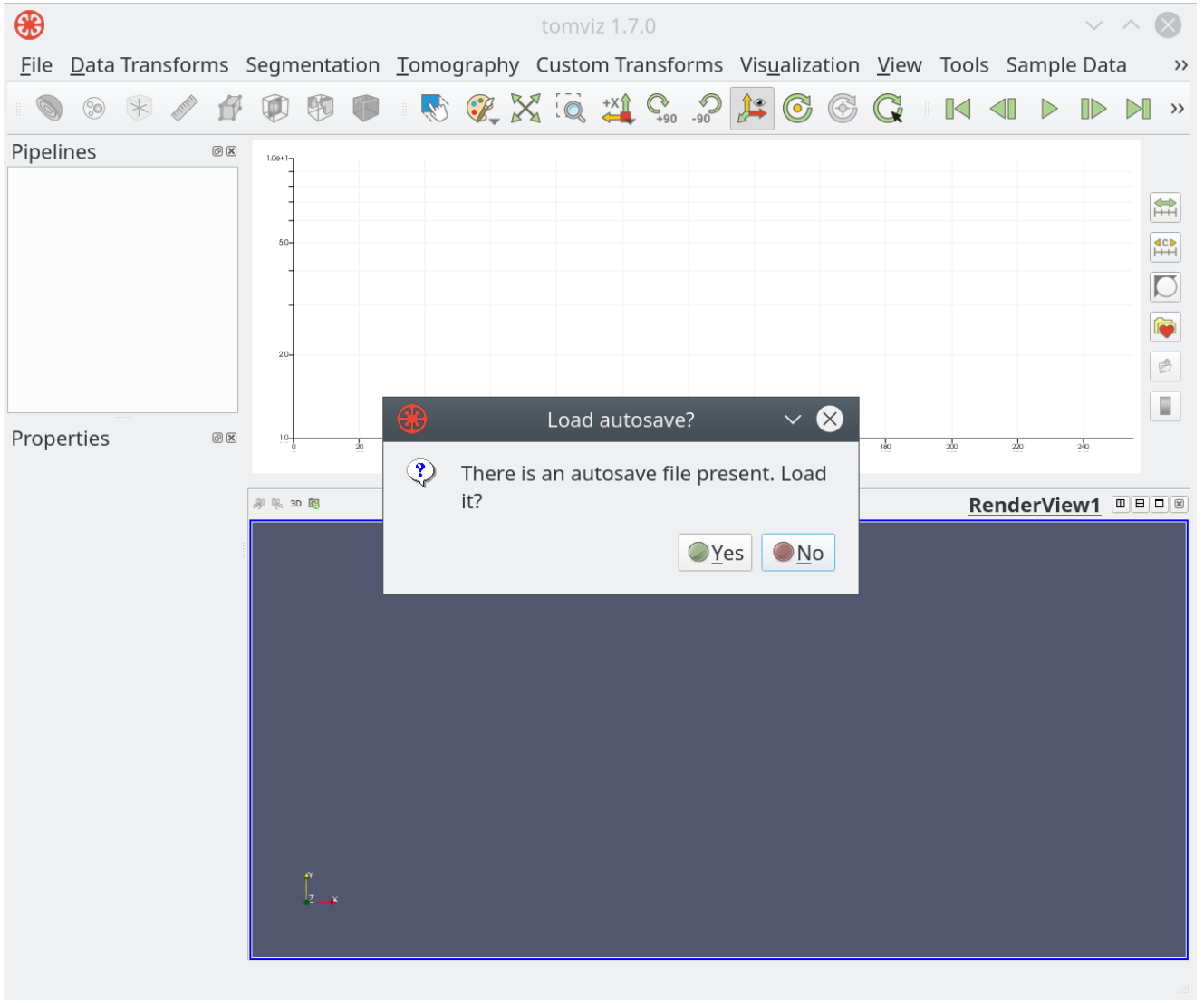
Segmentati
Open Data Ctrl+O
Open Stack
Recently Opened
Save Data Ctrl+S
Export Screenshot...
Export Movie...
Export to Web...
Load State
Save State
Reset
Exit Ctrl+Q

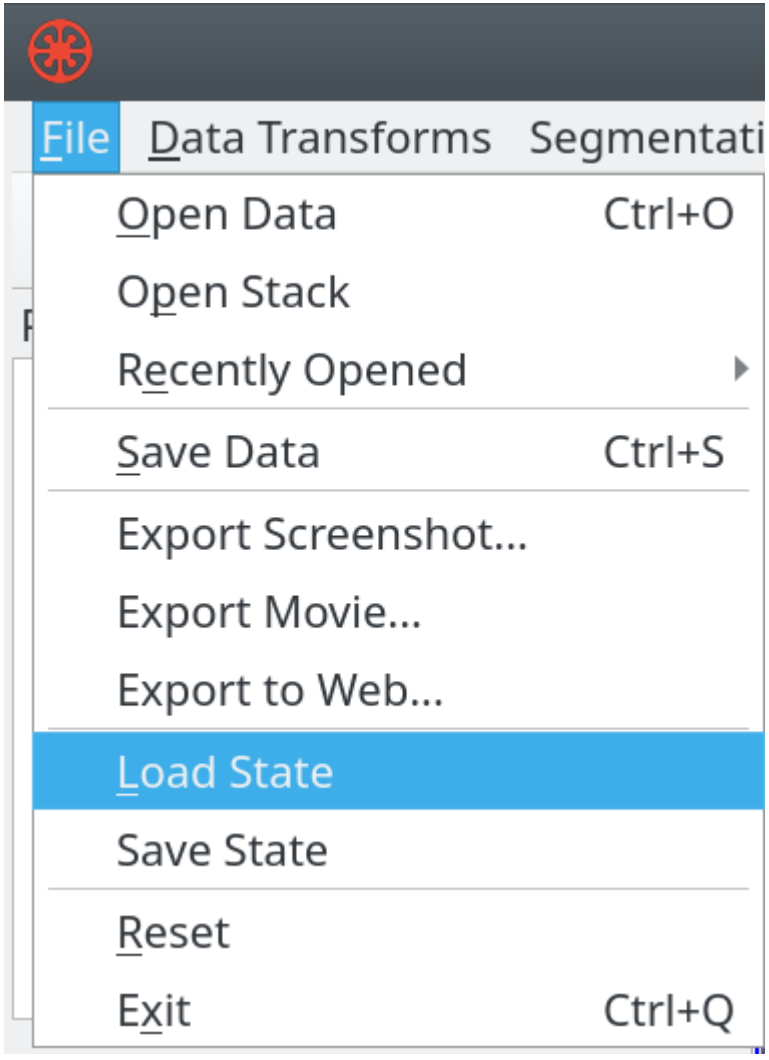
Saving state



Recovering state



Loading state



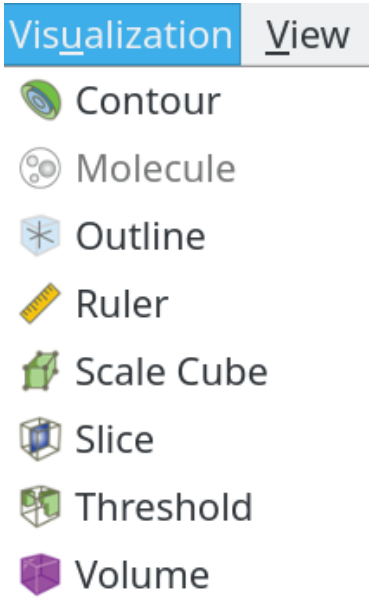
Visualization techniques

- We will go over available techniques
  - Important parameters will be explained
- GPU accelerated—need a good graphics card
  - Generally want around 1GB GPU memory
  - More is needed for larger volumes
- Volume rendering uploads volume to GPU!
- Contour uploads triangles of surface
- Destructive pipeline—still need system RAM

Available visualization modules

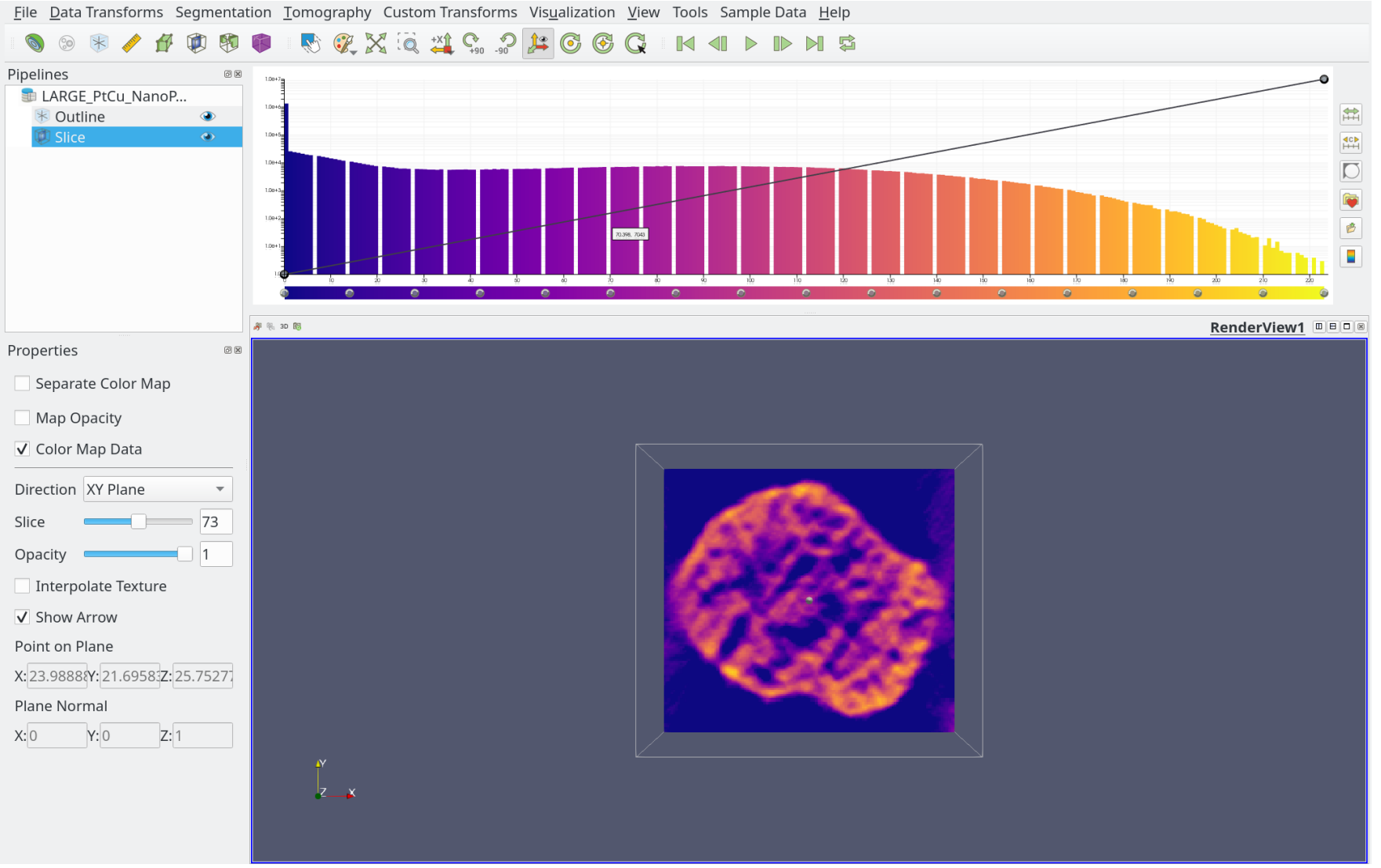
- Optimized visualization code
  - C++ to take advantage of hardware
  - Using graphics hardware acceleration, GLSL
- Also available from the visualization menu

Available visualization modules



- Optimized visualization code
  - C++ to take advantage of hardware
  - Using graphics hardware acceleration, GLSL

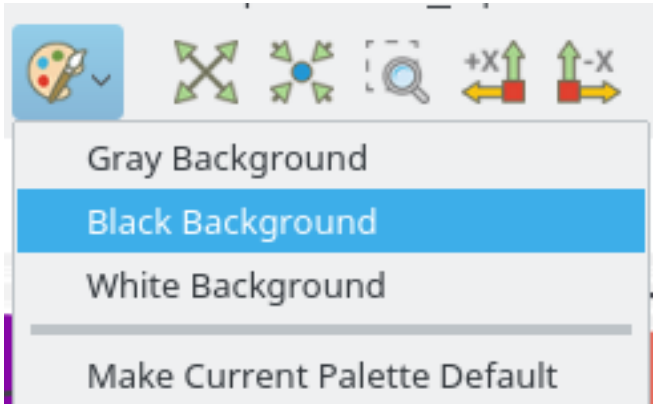
Default view of loaded data



Default view of loaded data

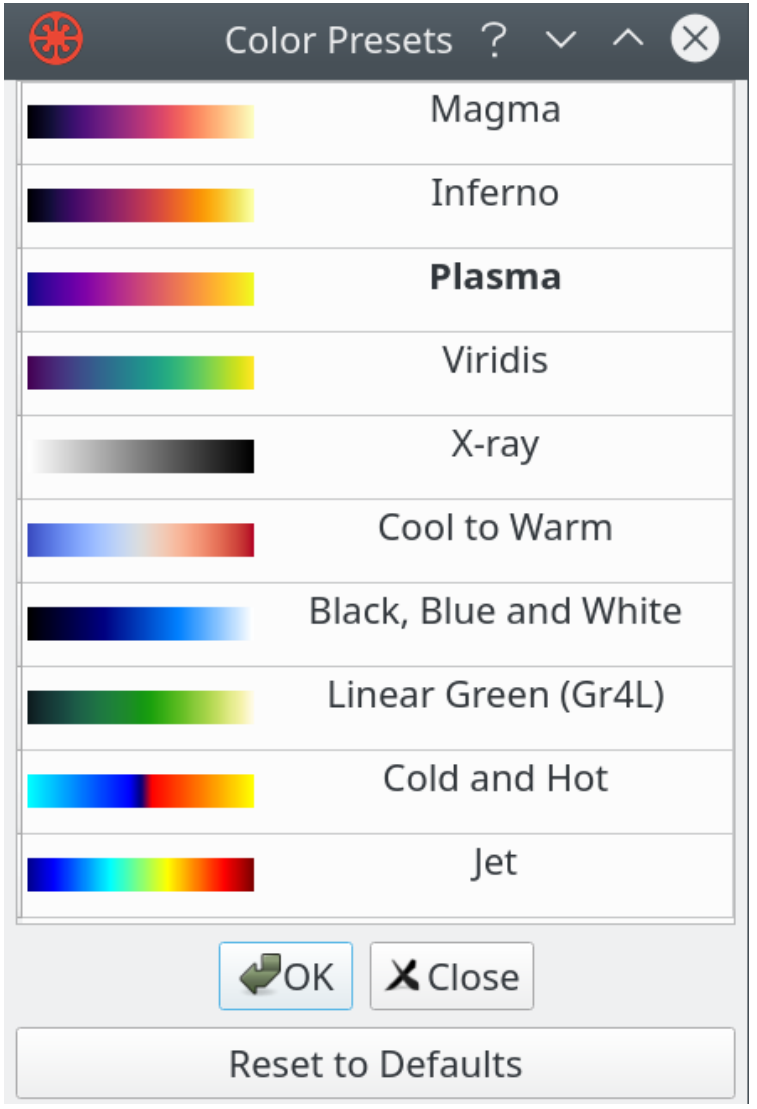
- When loading any dataset several things happen
- Default color map is used—plasma
- Histogram is calculated in background thread
  - Displayed when ready in the top-right
- Default pipeline is constructed with two modules
  - Outline to show the extent of the data
  - A slice through the center of the data

Palette and background colors

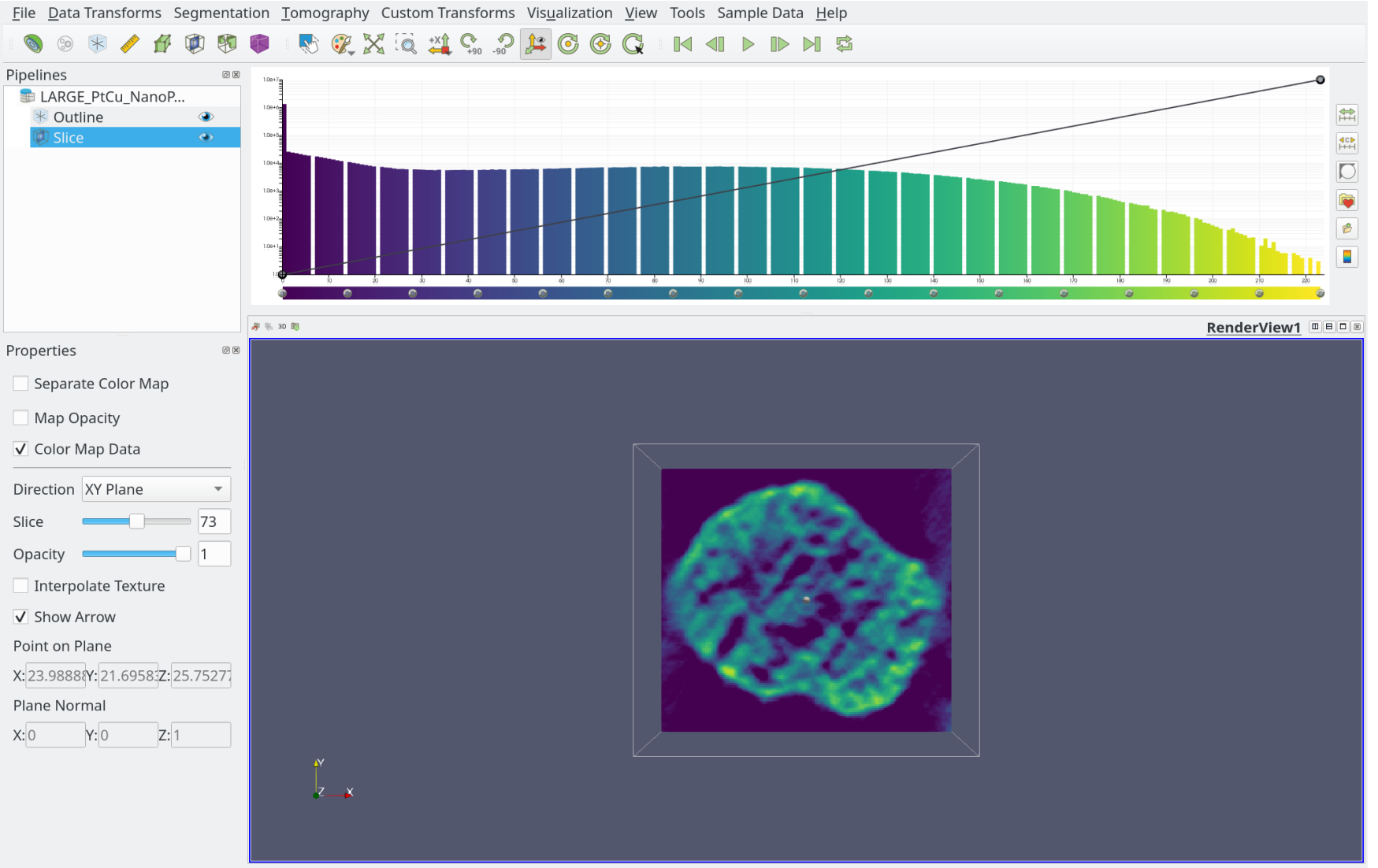


- Easily modify the palette with several presets
  - Possible to modify the default when preferred
- Black preferred in some situations on monitors
- White for print, web pages, etc to highlight sample

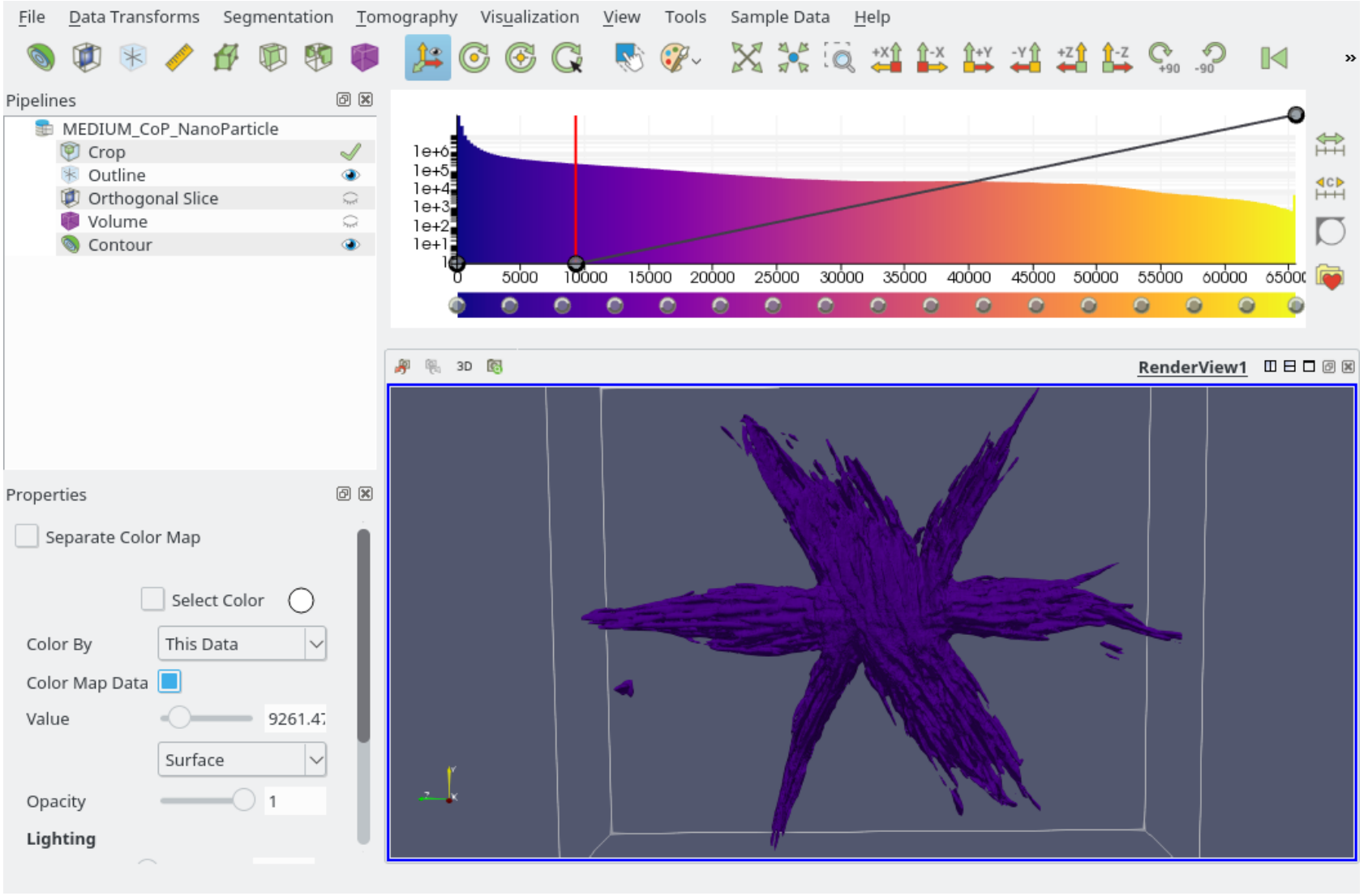
Color maps


Color Presets
Magma
Inferno
Plasma
Viridis
X-ray
Cool to Warm
Black, Blue and White
Linear Green (Gr4L)
Cold and Hot
Jet
OK
Close
Reset to Defaults

Color maps—bottom bar



Contour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MEDIUM_CoP_NanoParticle
Crop
Outline
Orthogonal Slice
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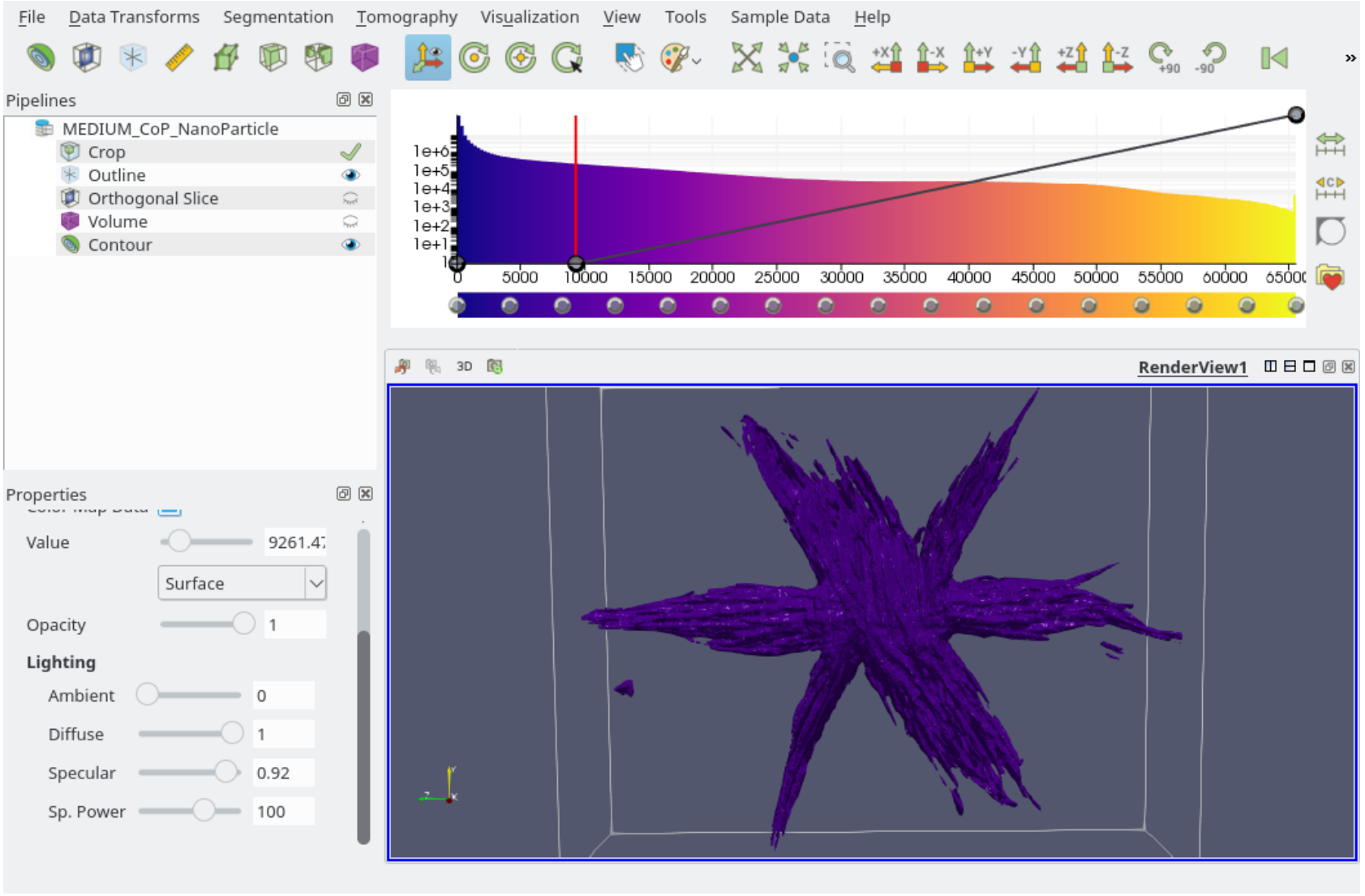
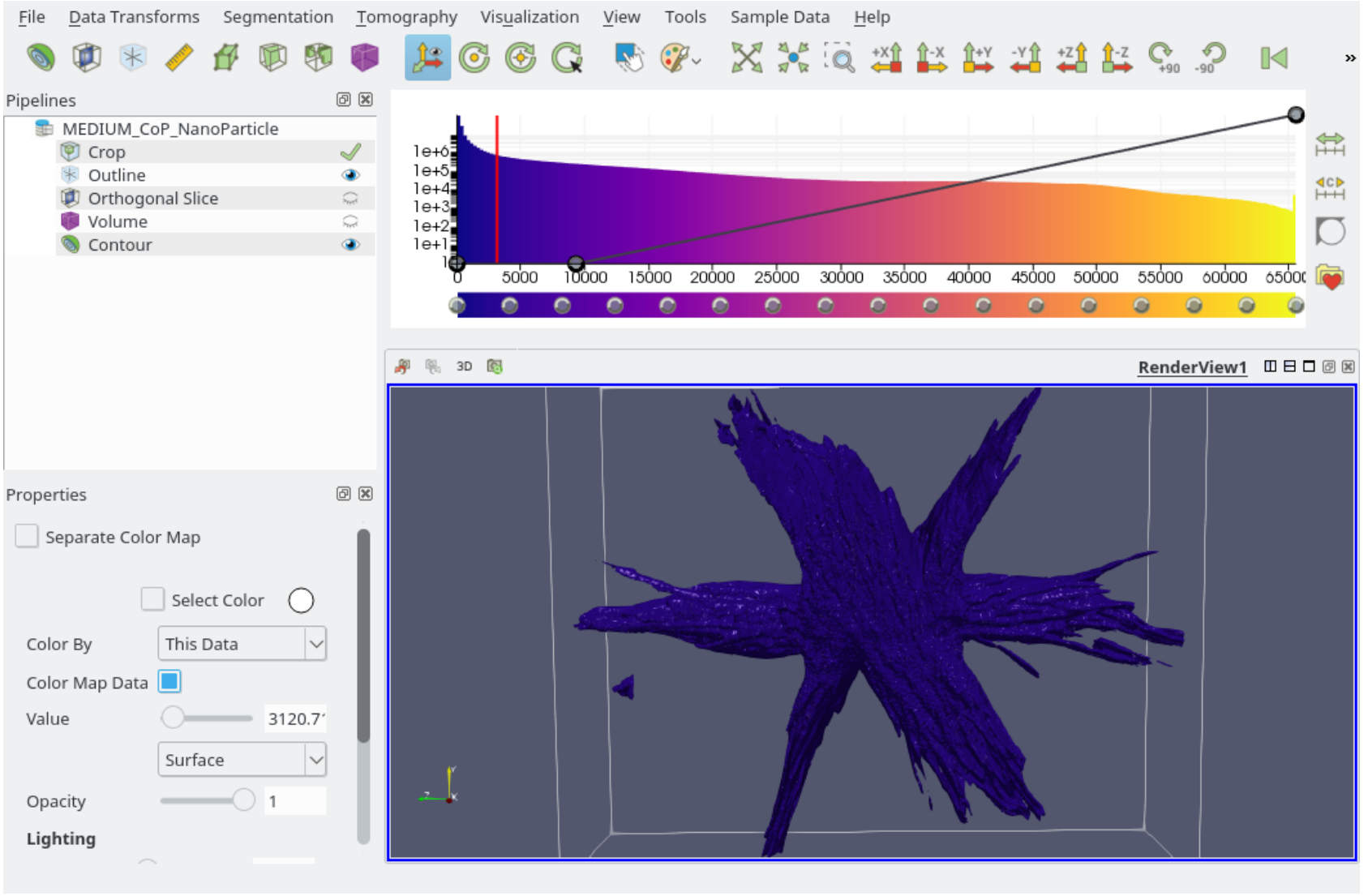
Lighting

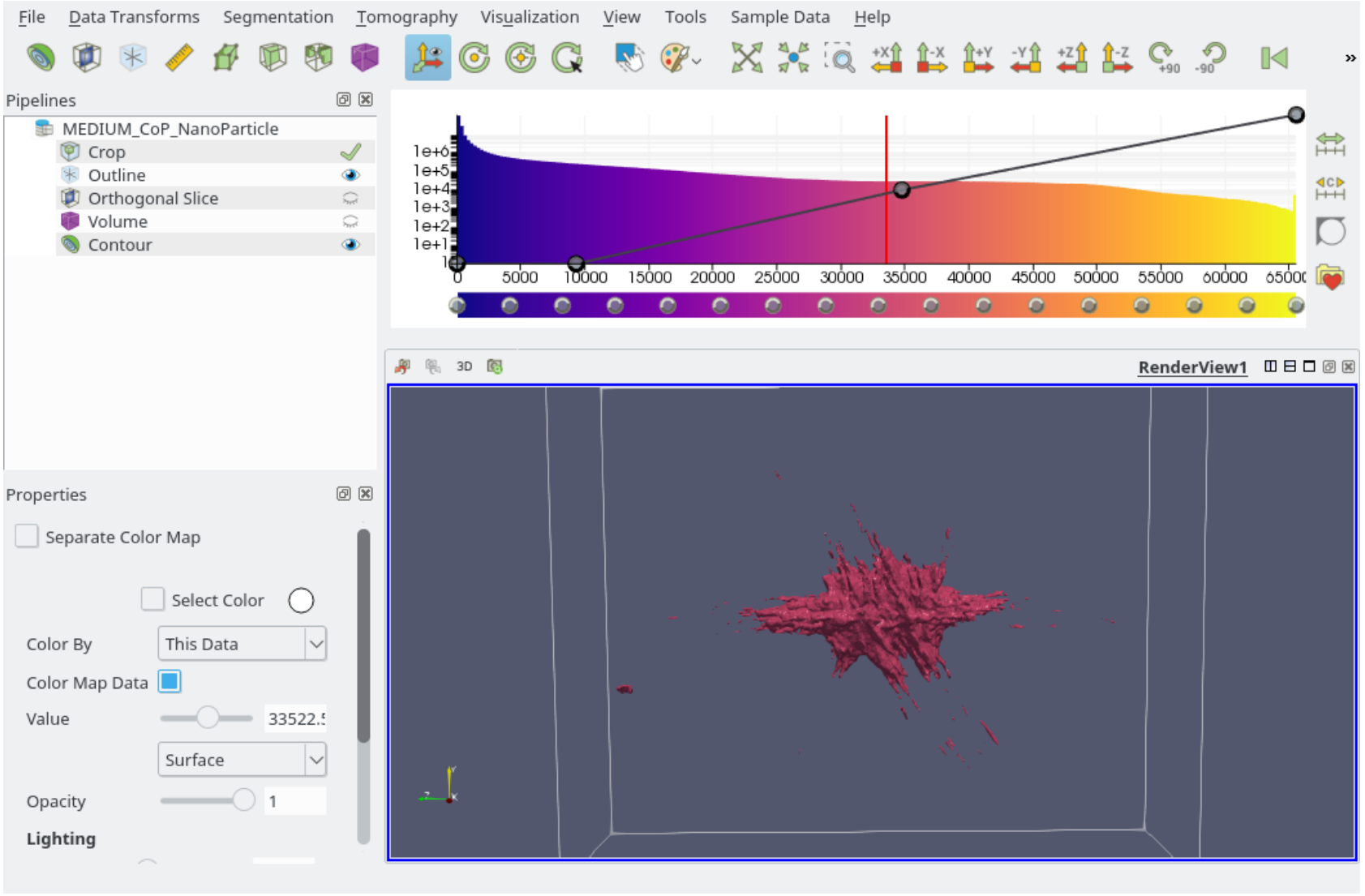
Contour—specular



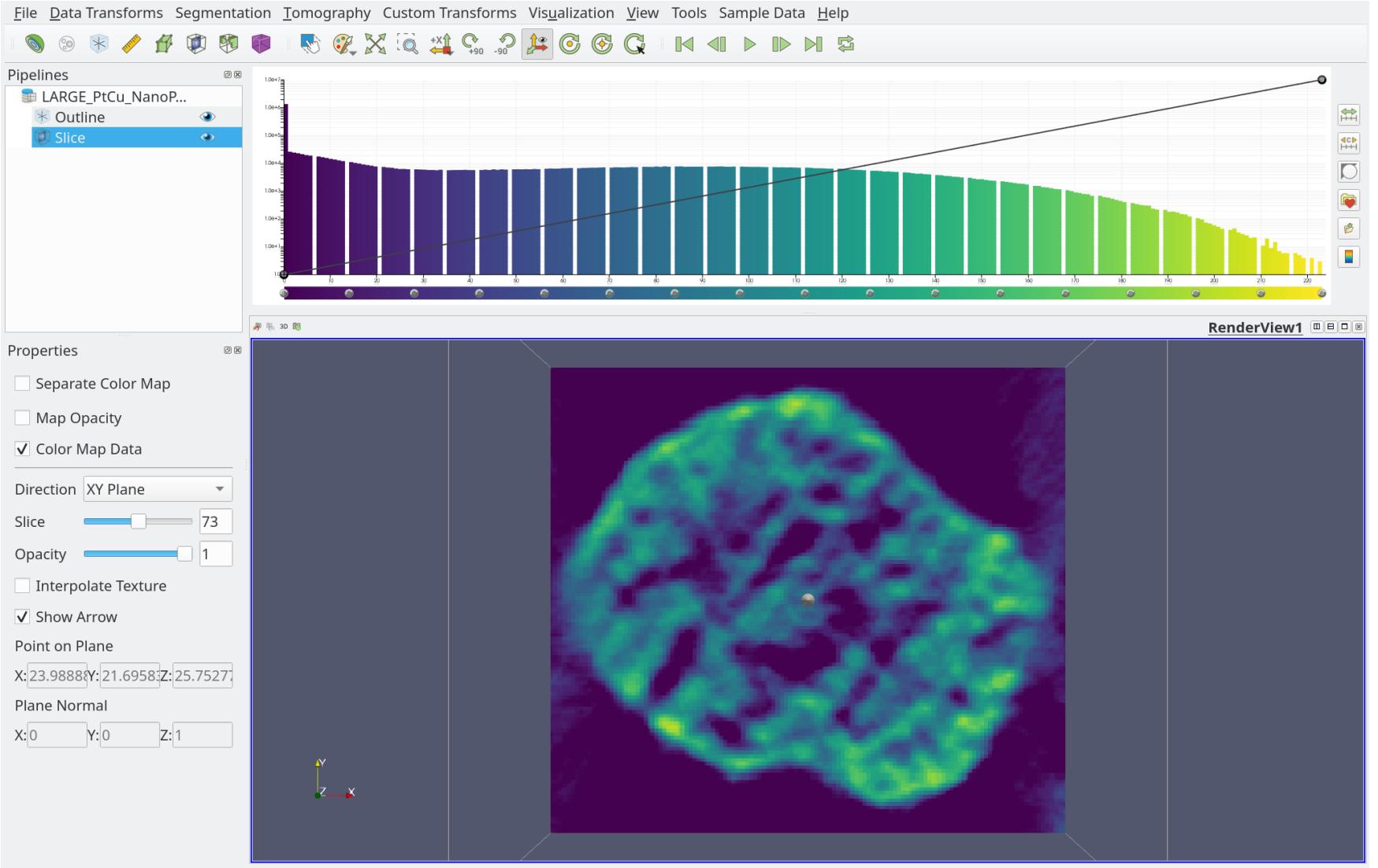
Contour—values



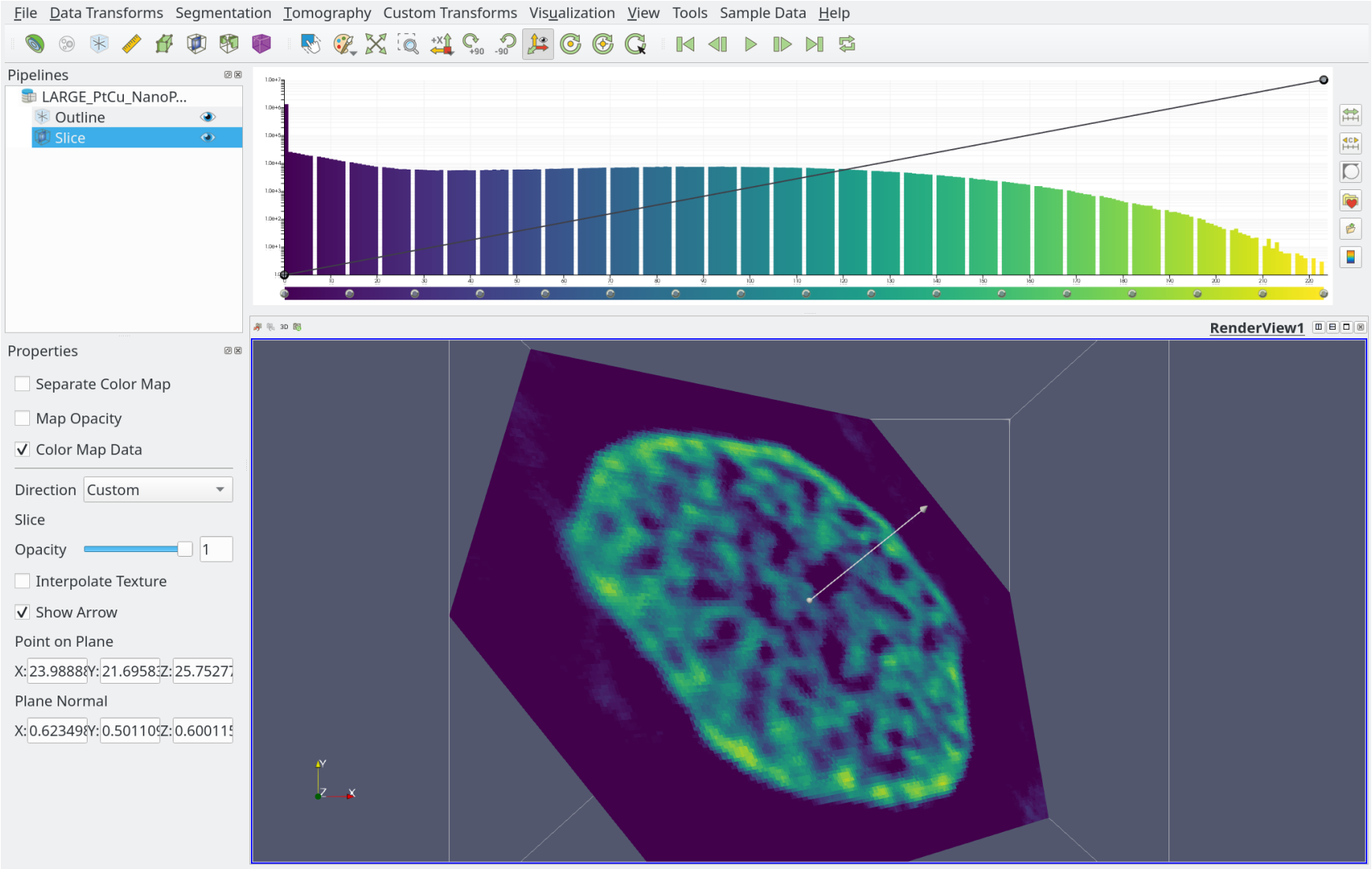
Contour—values



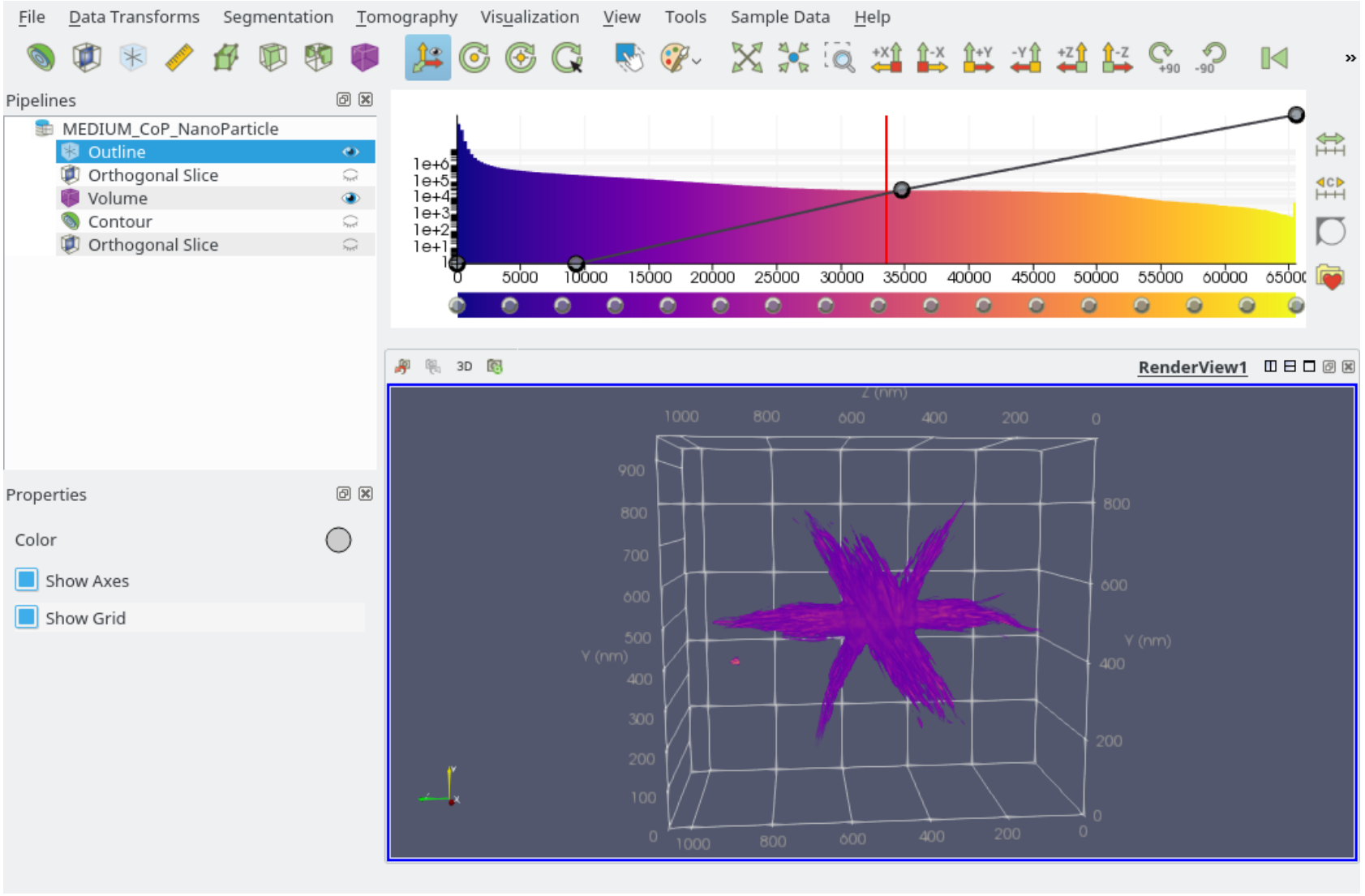
Orthogonal slice



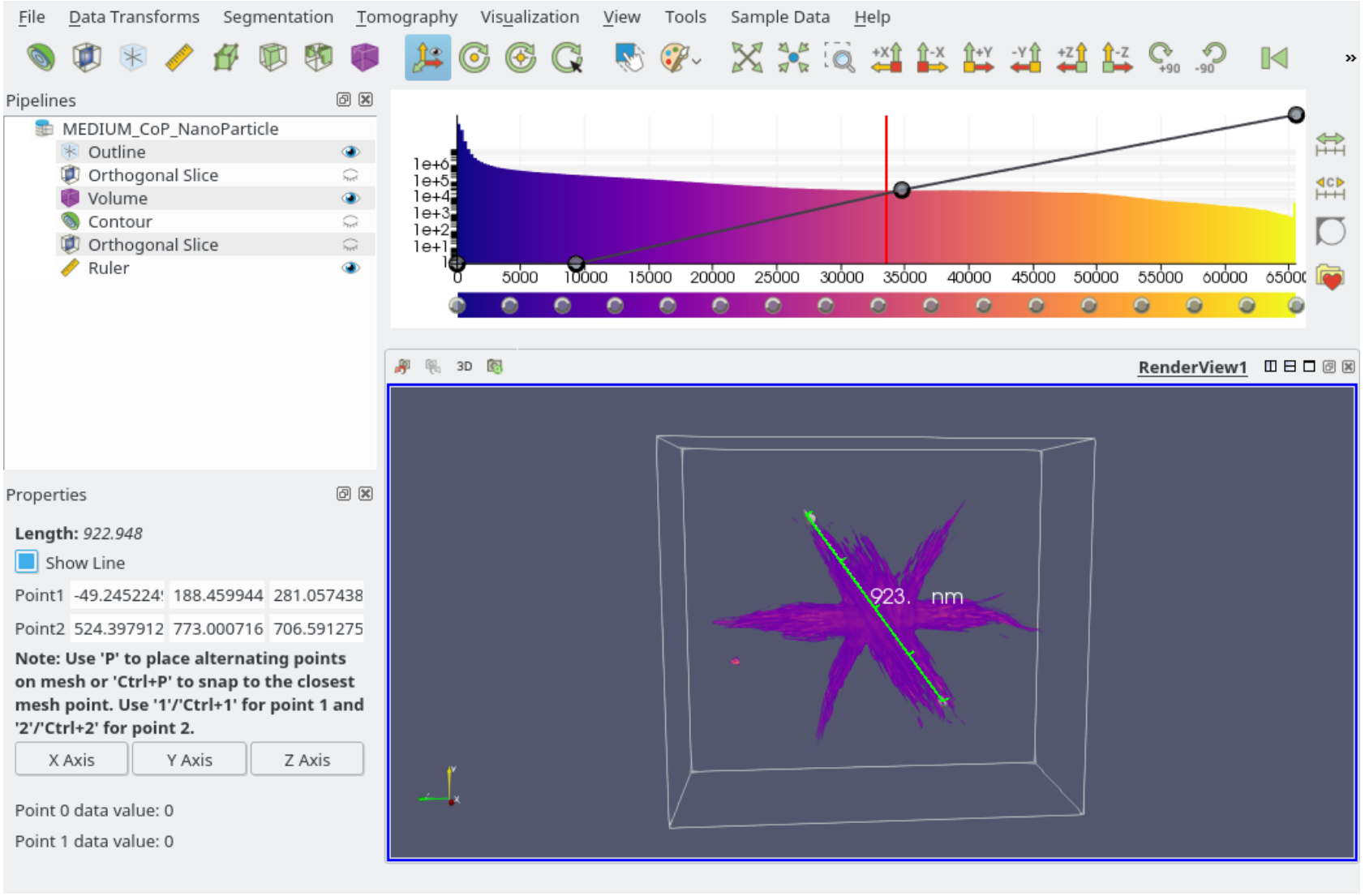
Slice—arbitrary



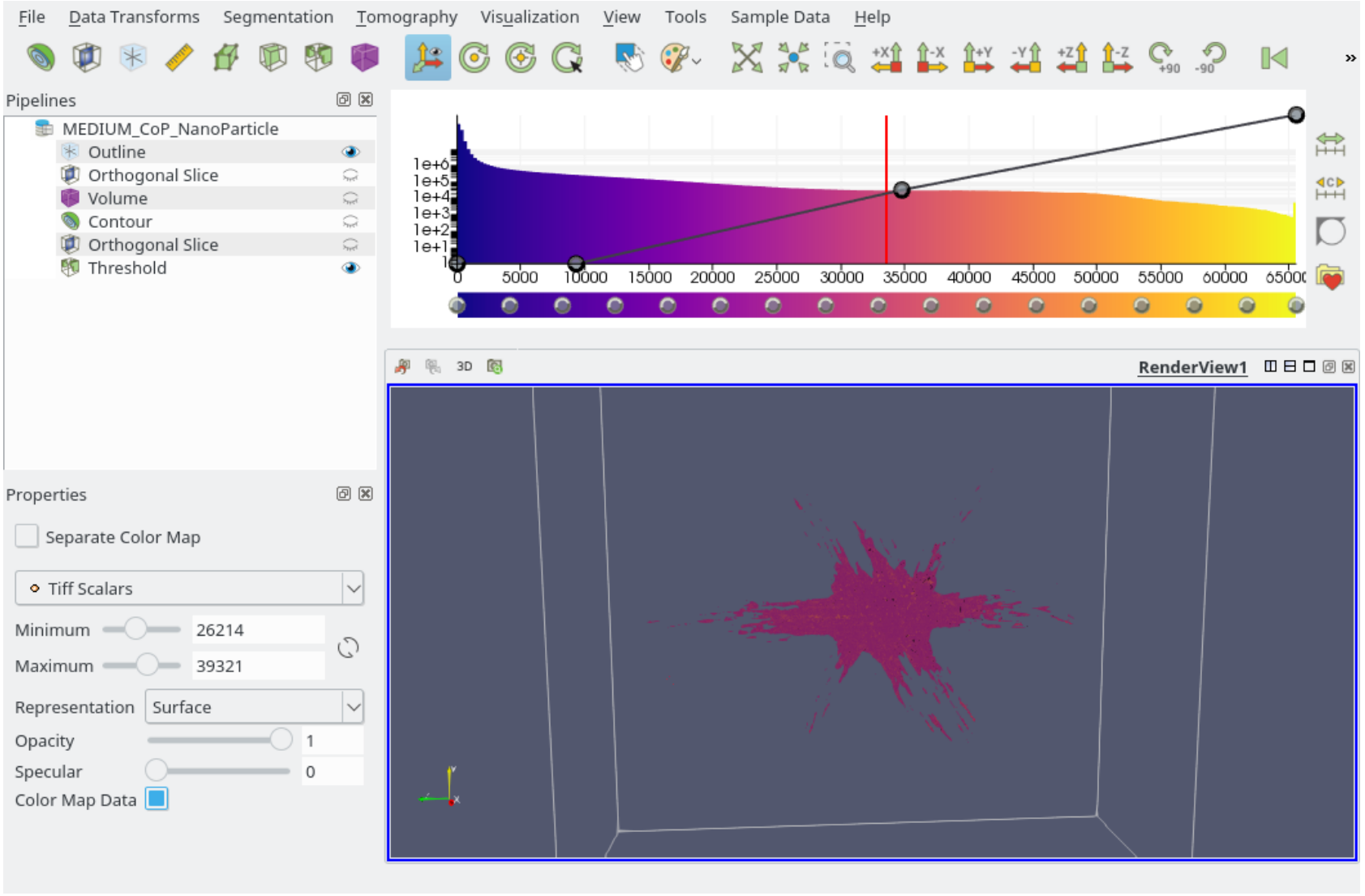
Outline—grid and axes



Ruler—making measurements



Threshold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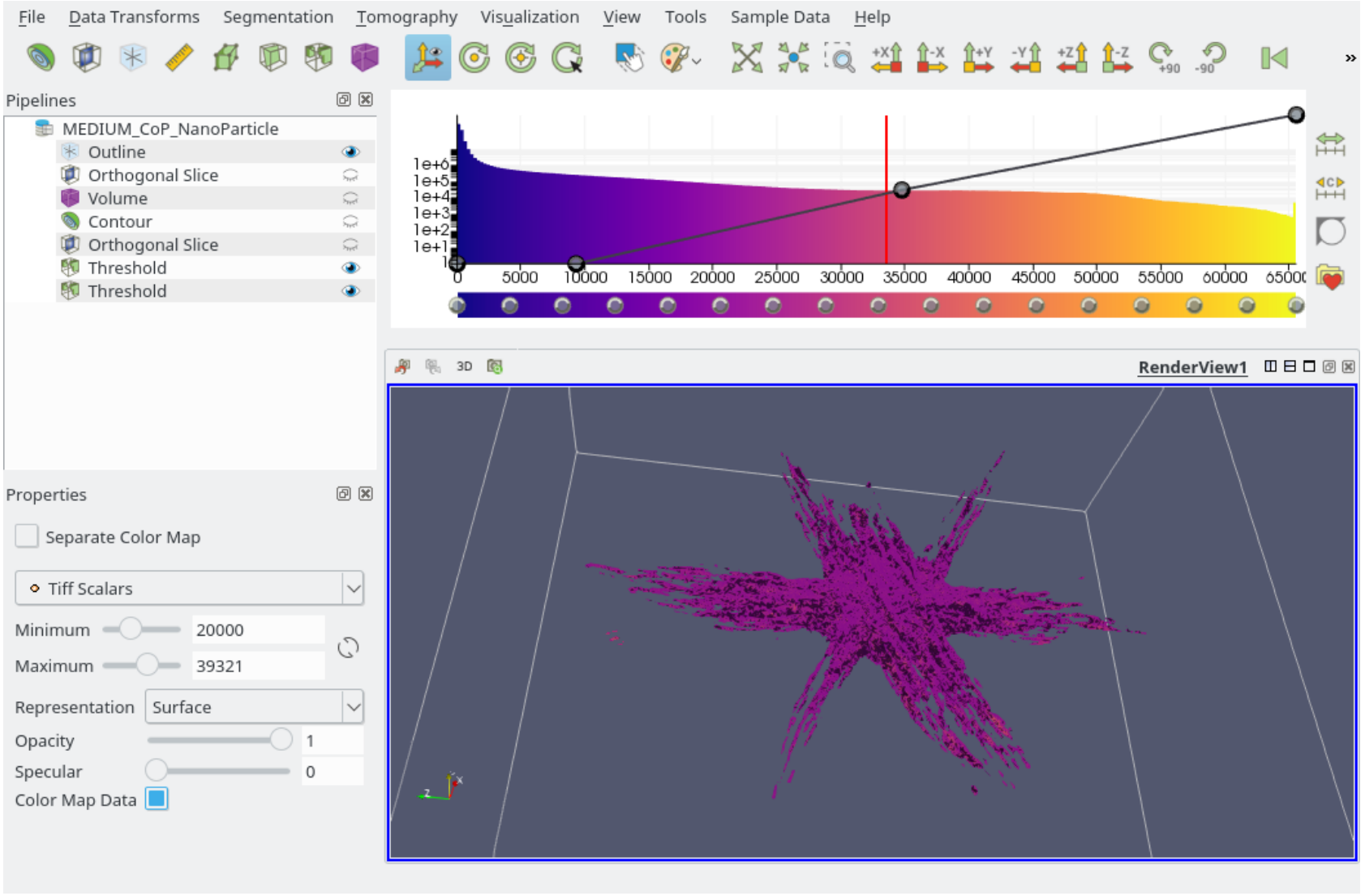
Color Map Data

Threshold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RenderView1
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Separate Color Map
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Minimum
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Representation
Surface
Opacity
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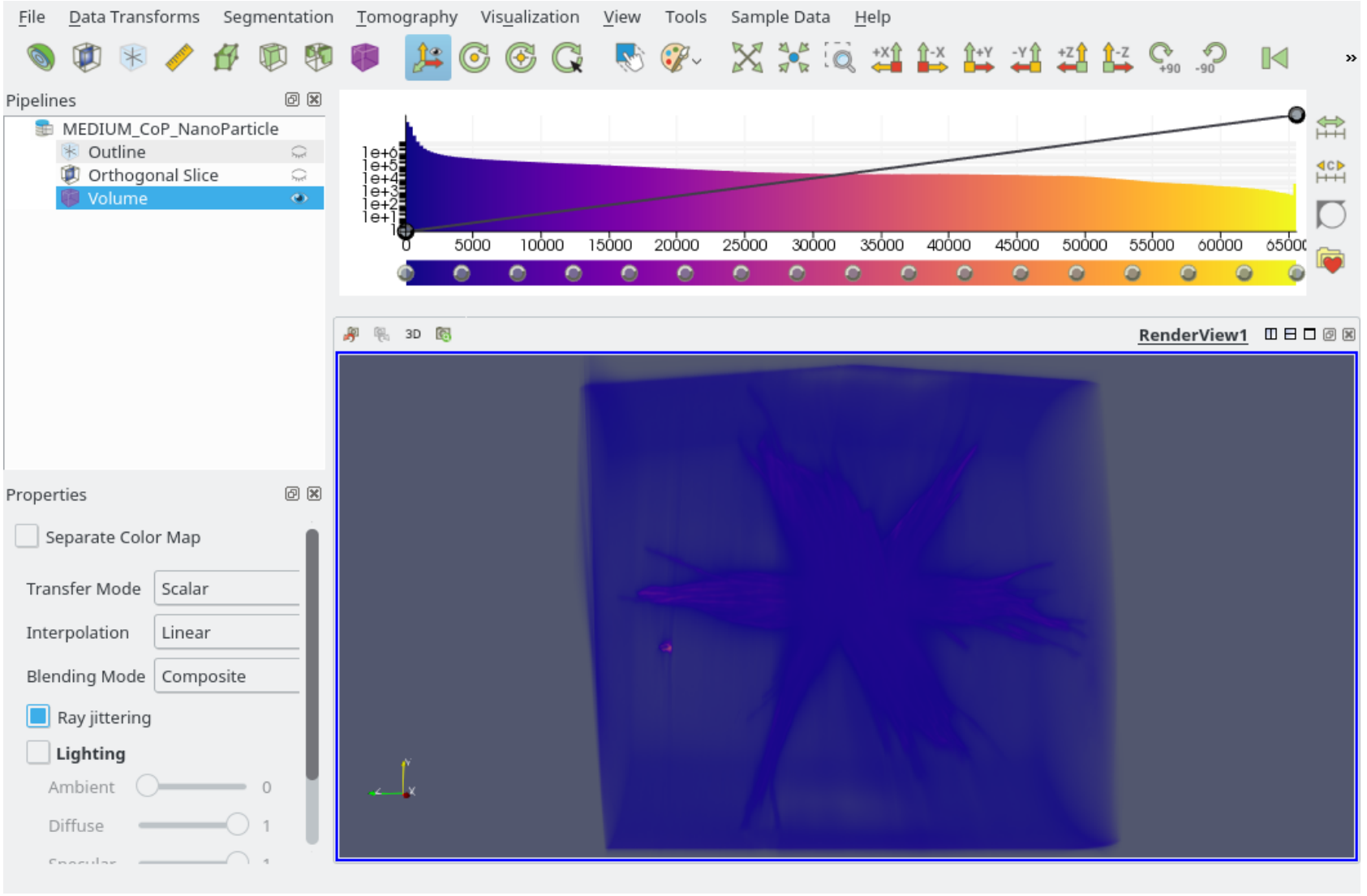
Specular
0
Color Map Data

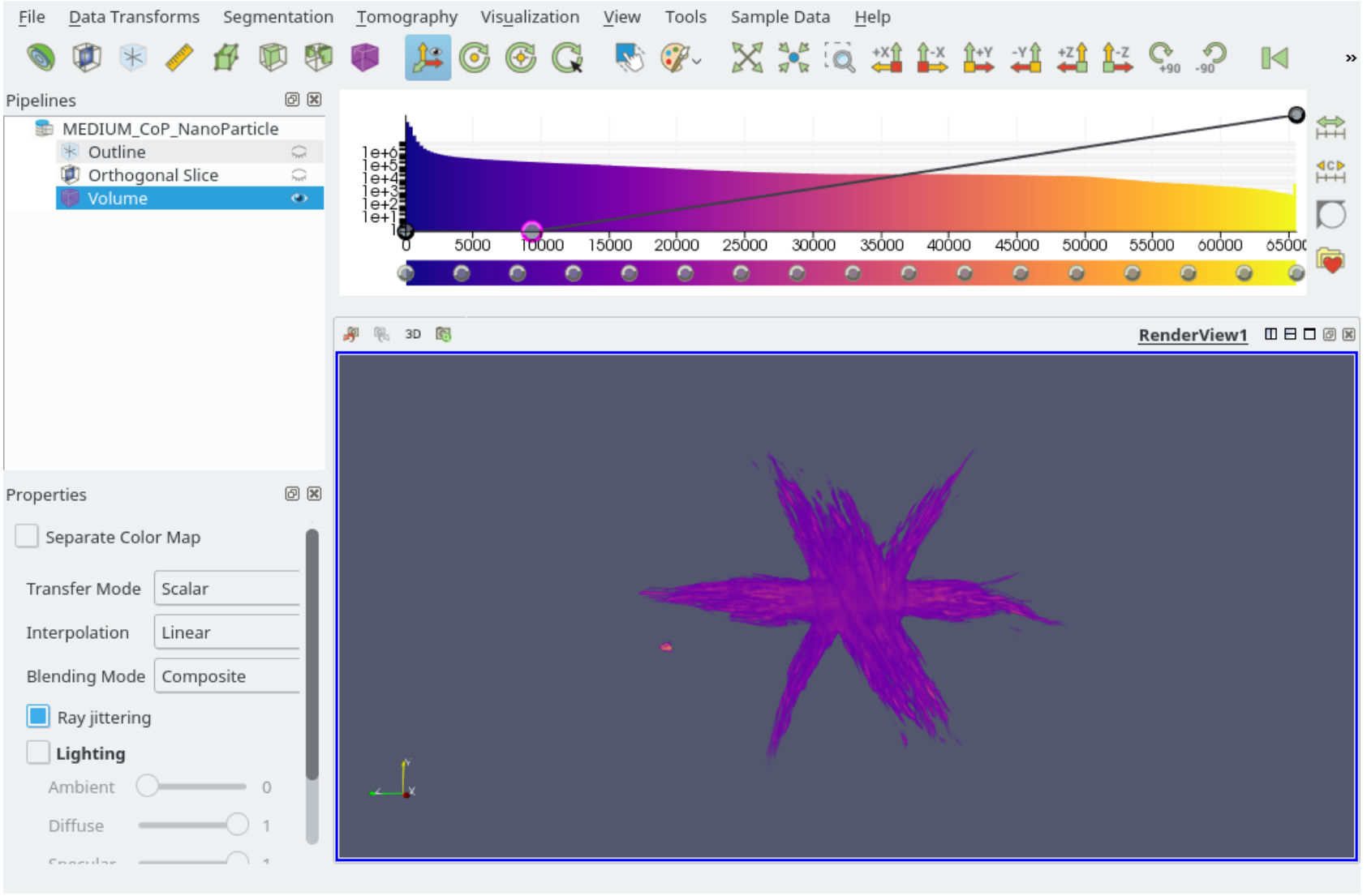
Volume rendering

- Powerful technique that traces paths of rays
- Requires GPU memory to upload volume to card
- Many different options available
  - Change the color map
  - Modify the opacity transfer function
  - Different transfer modes, interpolation, blending, lighting, jittering, etc

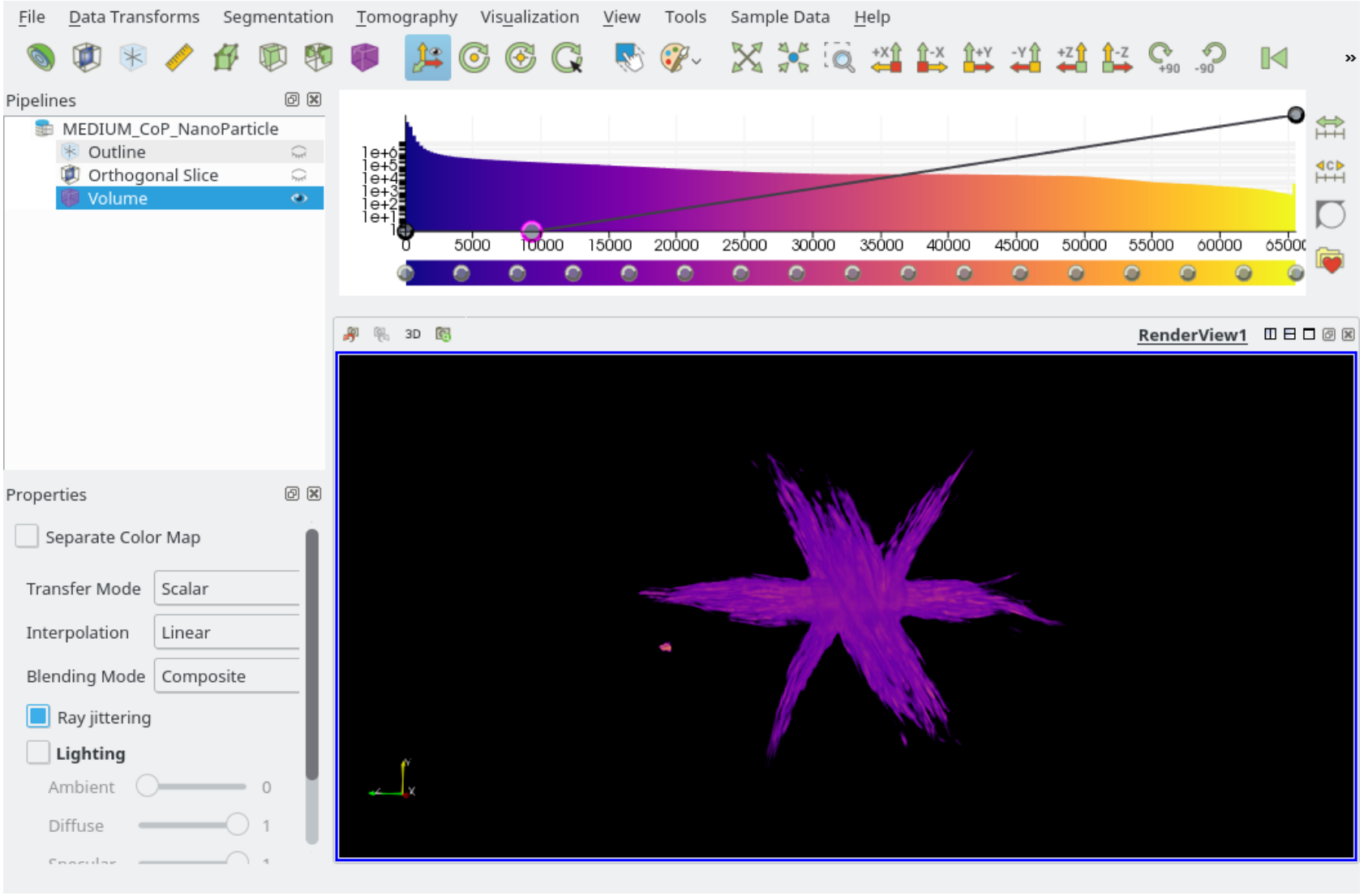
Volume rendering—default



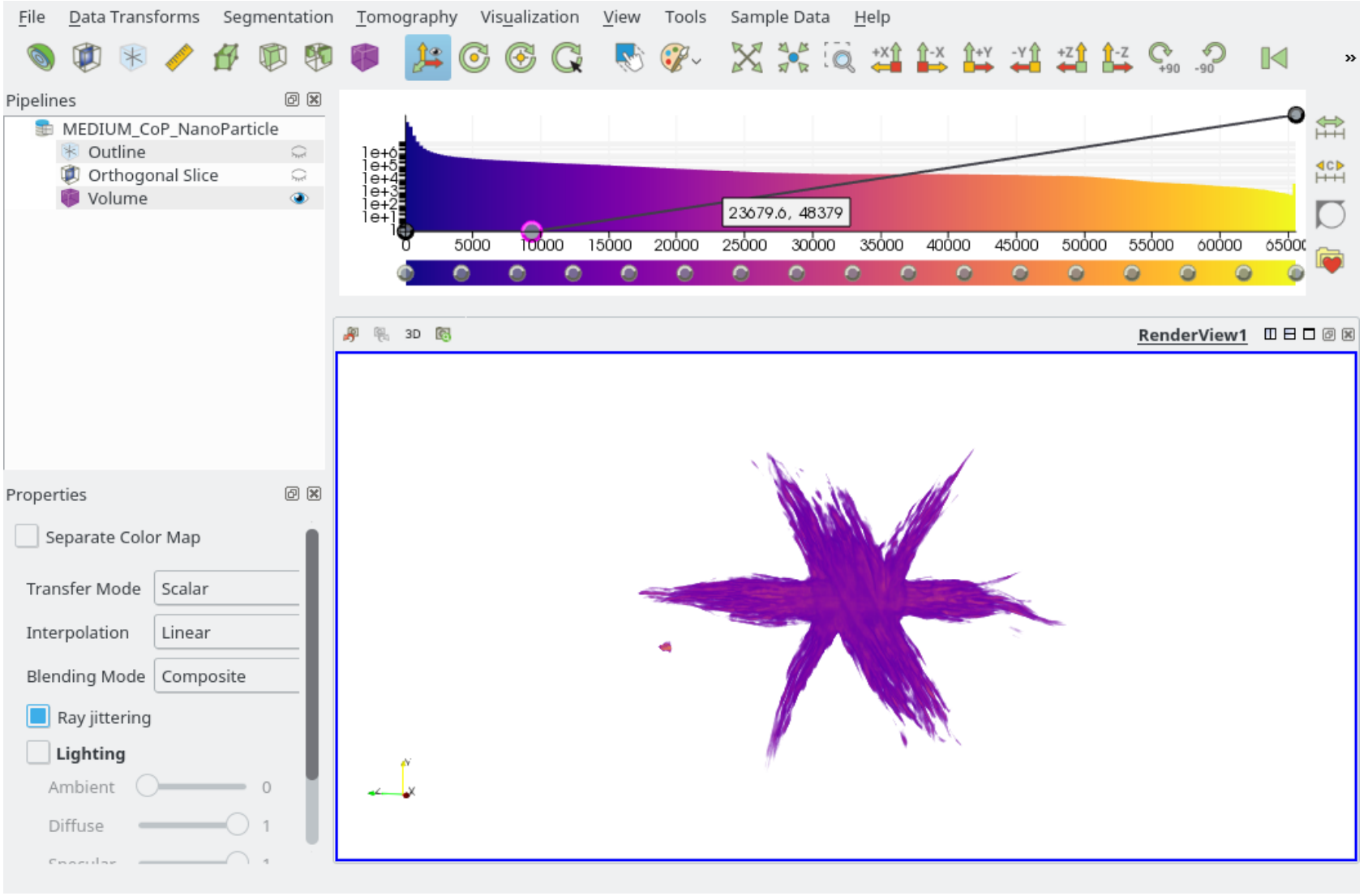
Volume rendering—opacity



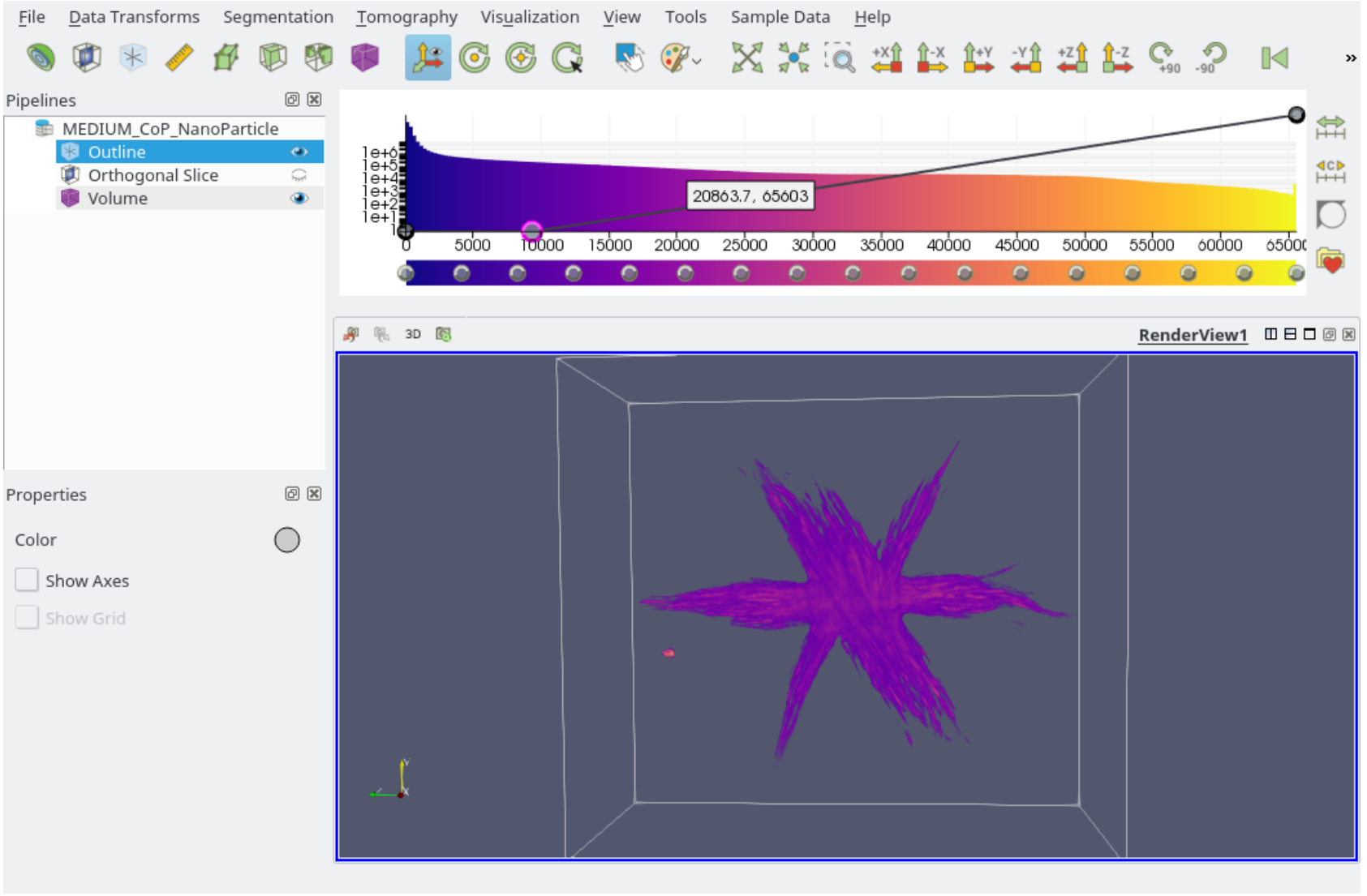
Volume rendering—black background



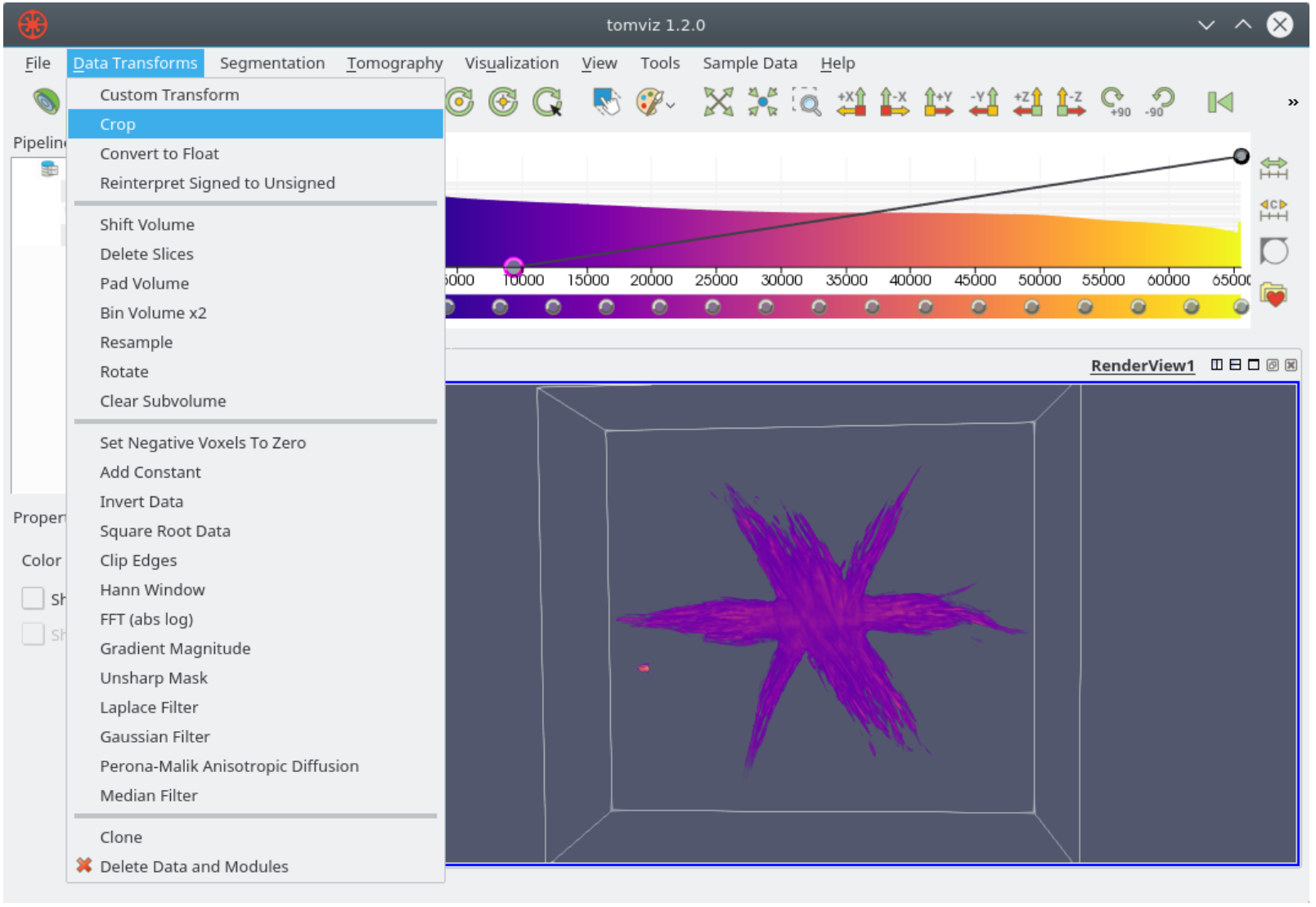
Volume rendering—white background



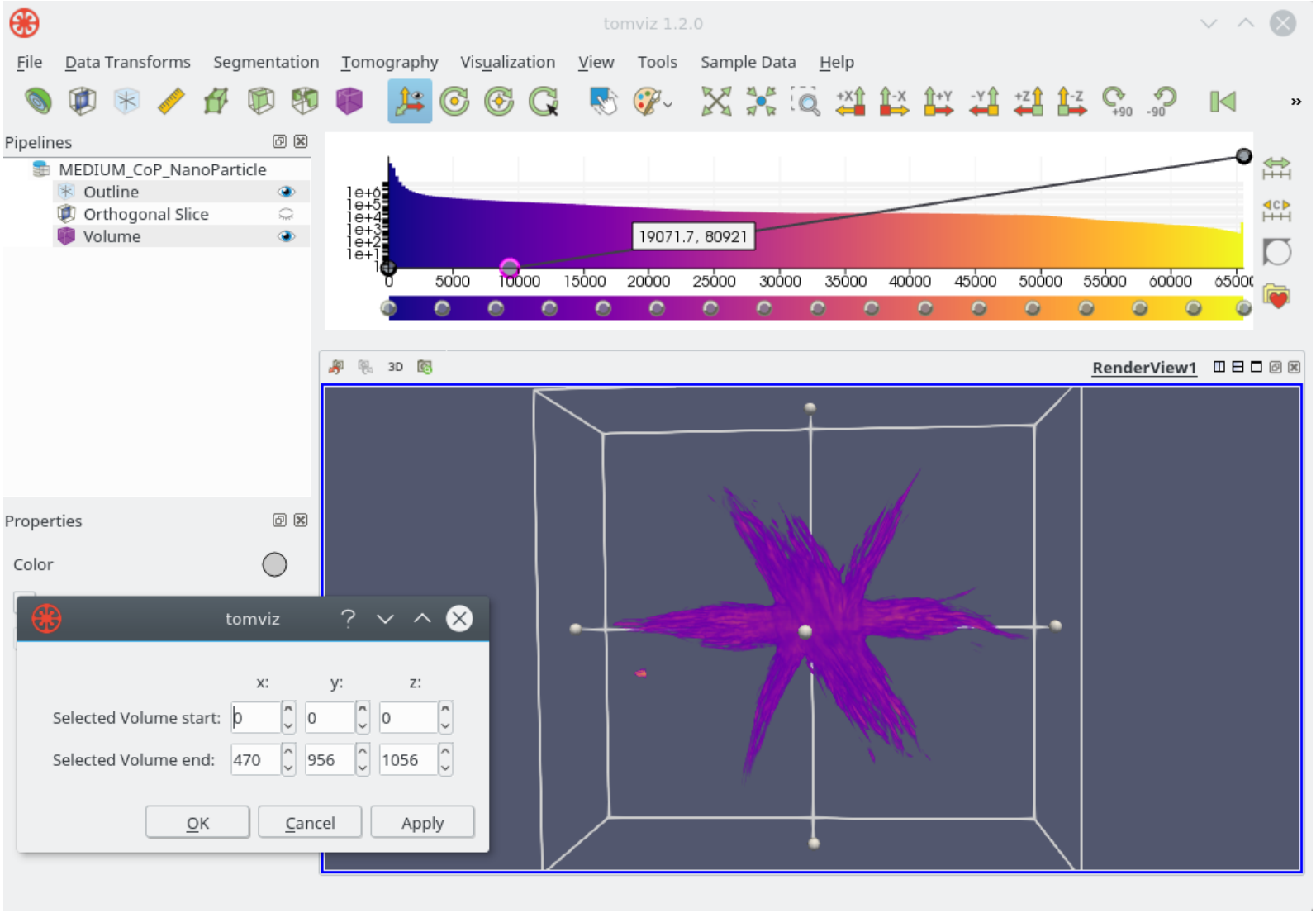
Volume rendering—empty space



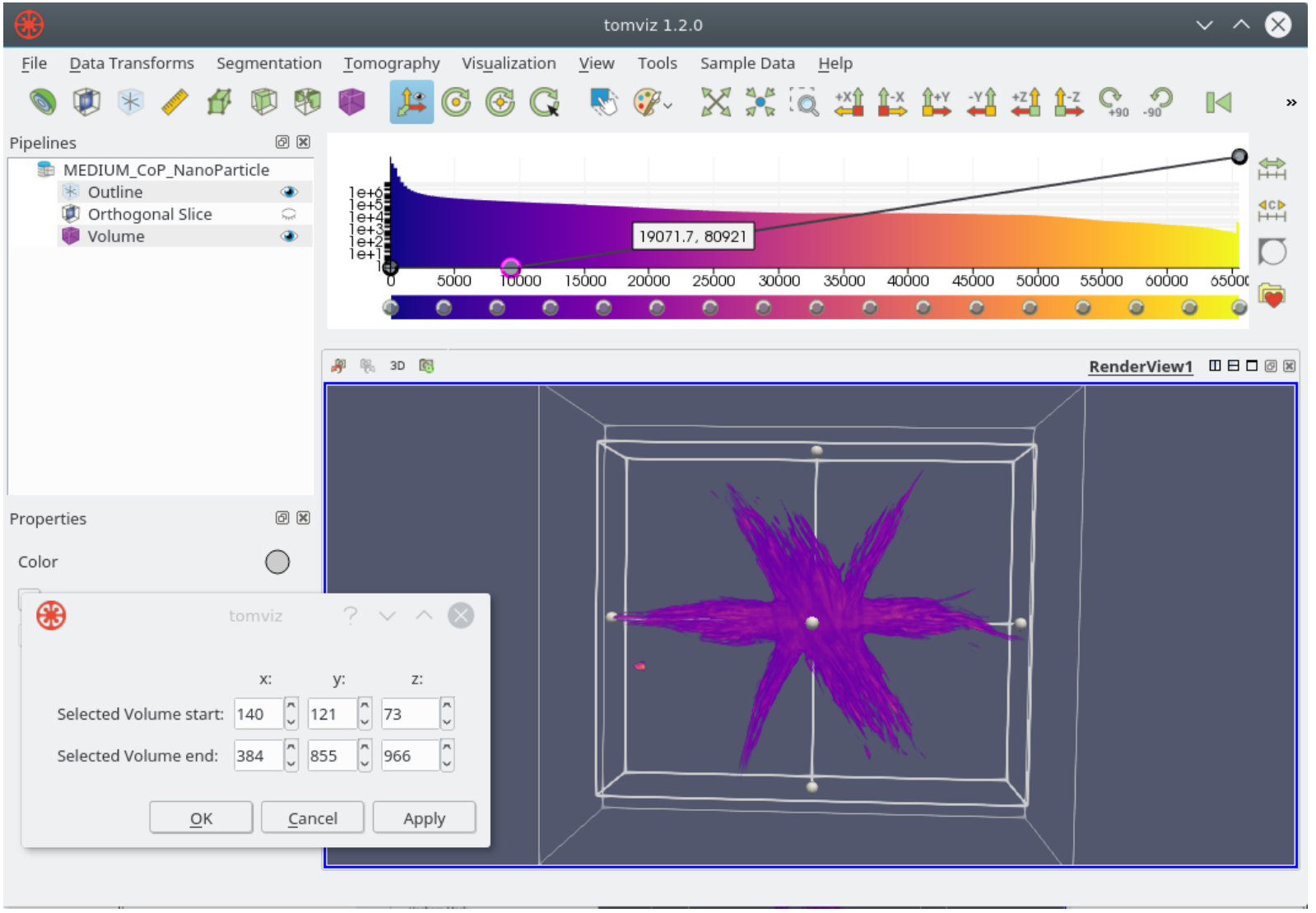
Volume rendering—cropping



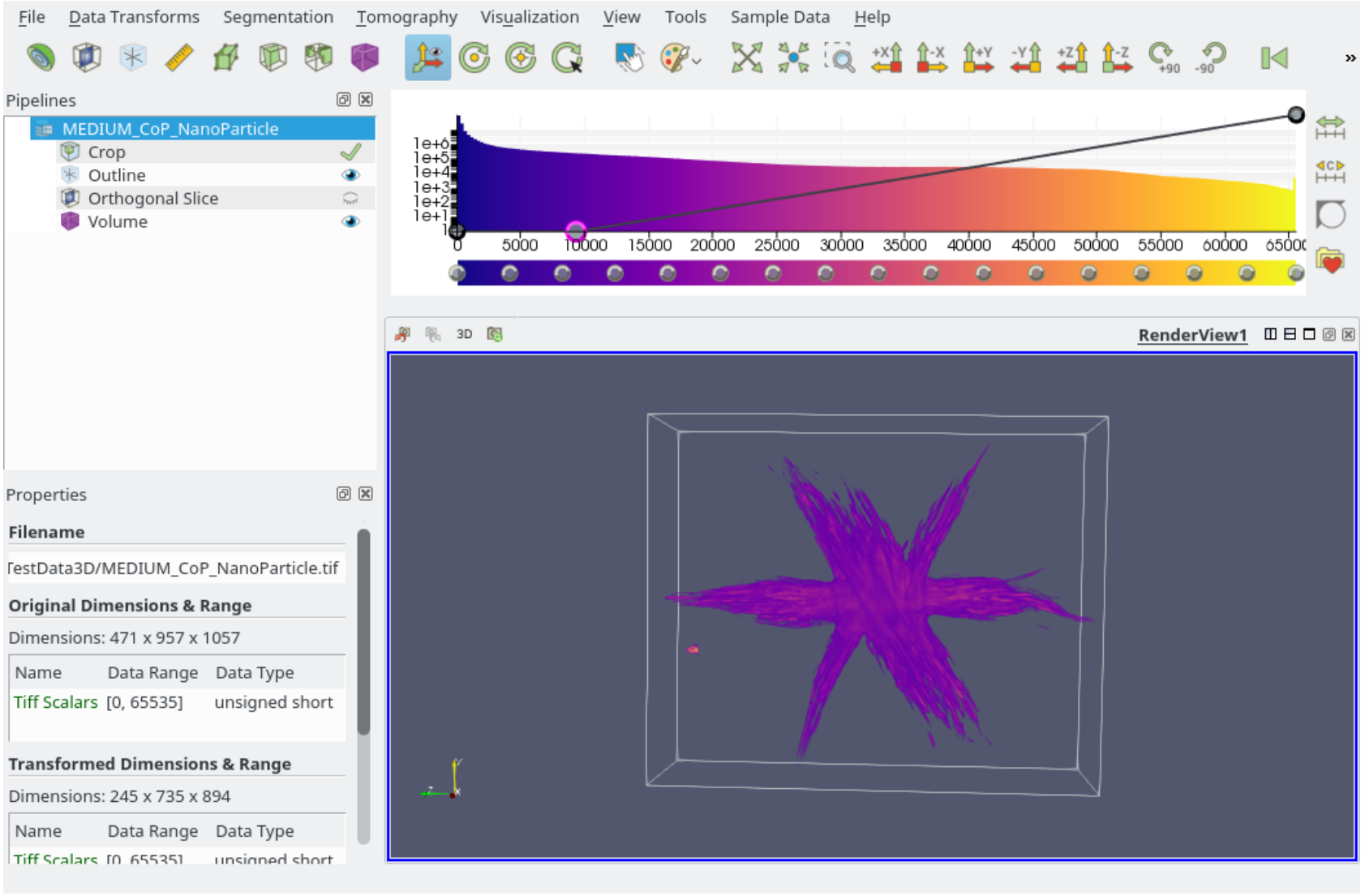
Volume rendering—cropping



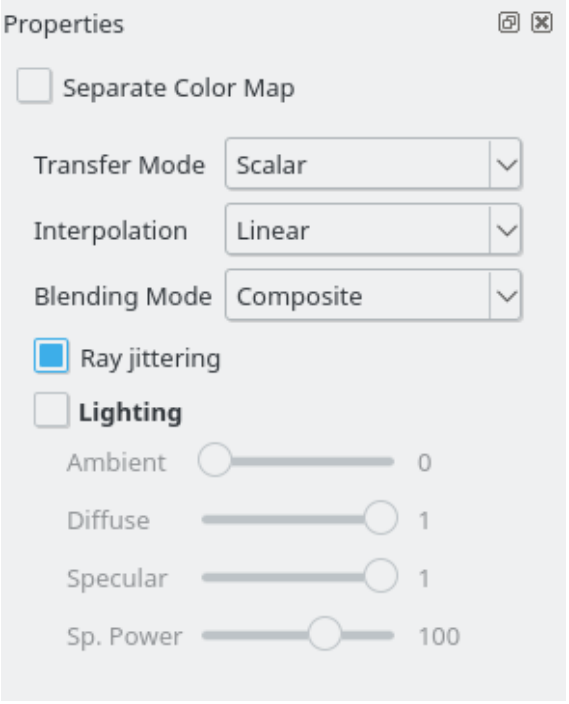
Volume rendering—cropping



Volume rendering—cropping

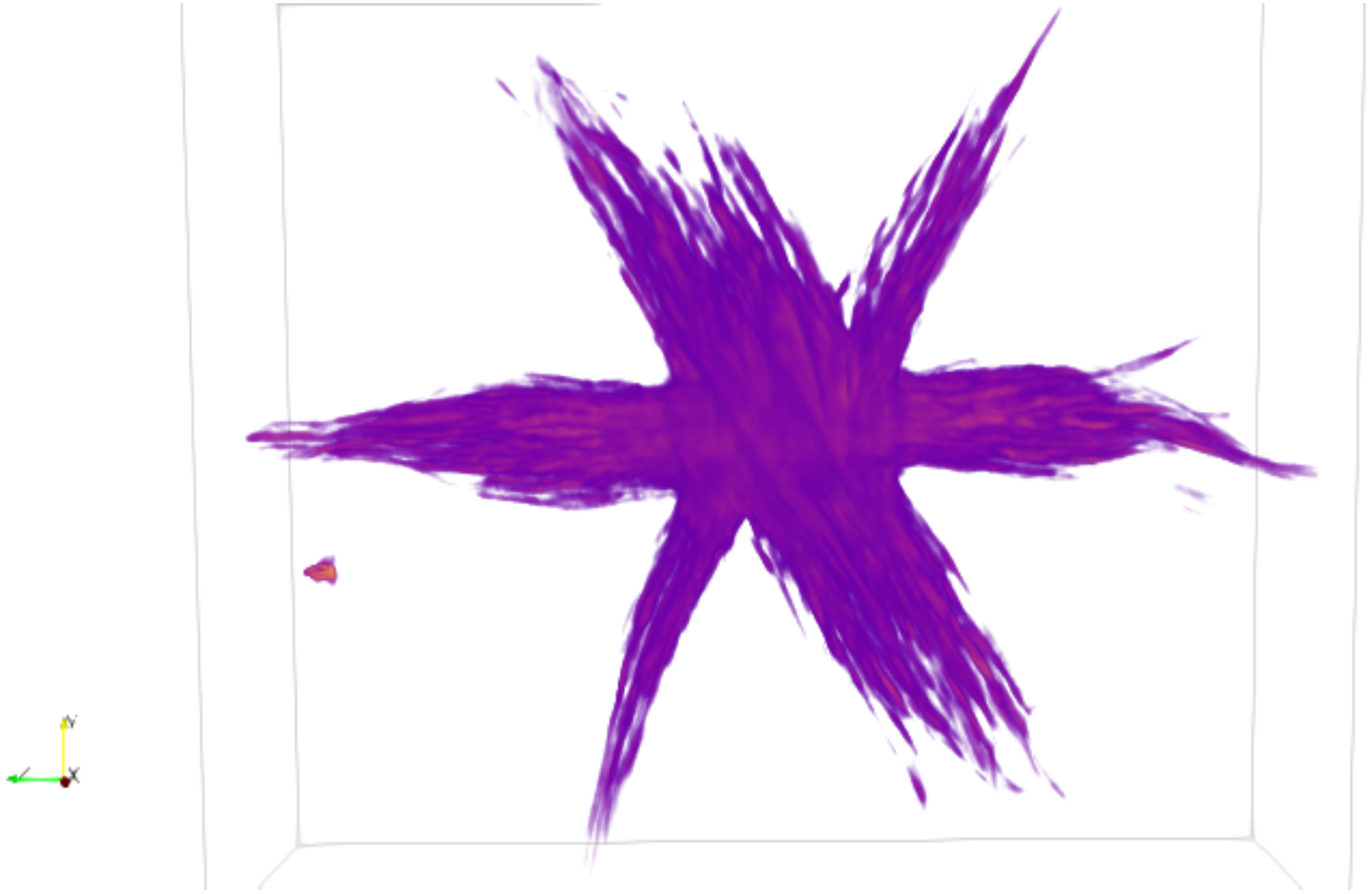


Volume rendering—properties

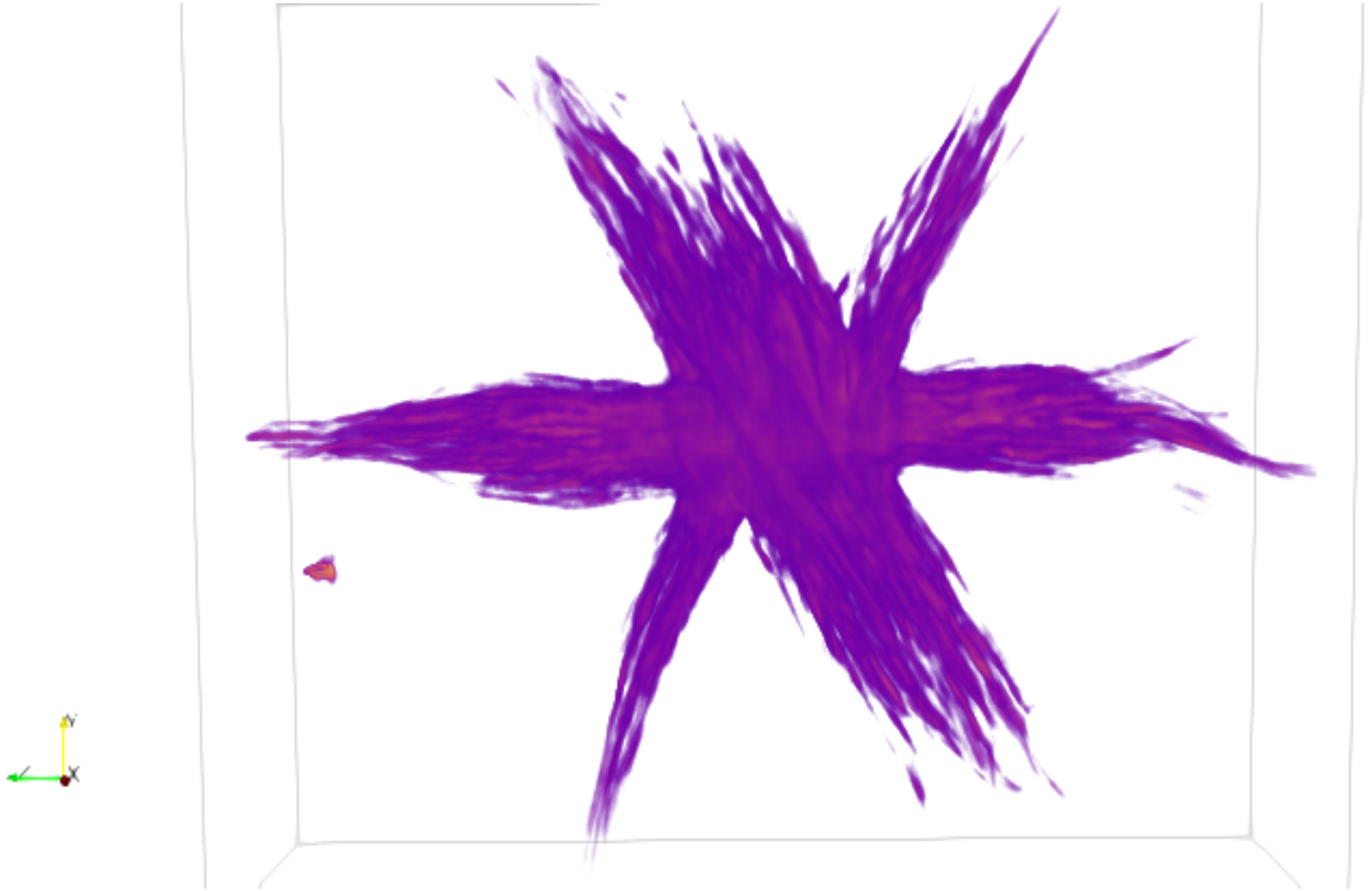


- Many volume rendering properties
  - Affect rendering in different ways

Volume rendering—default

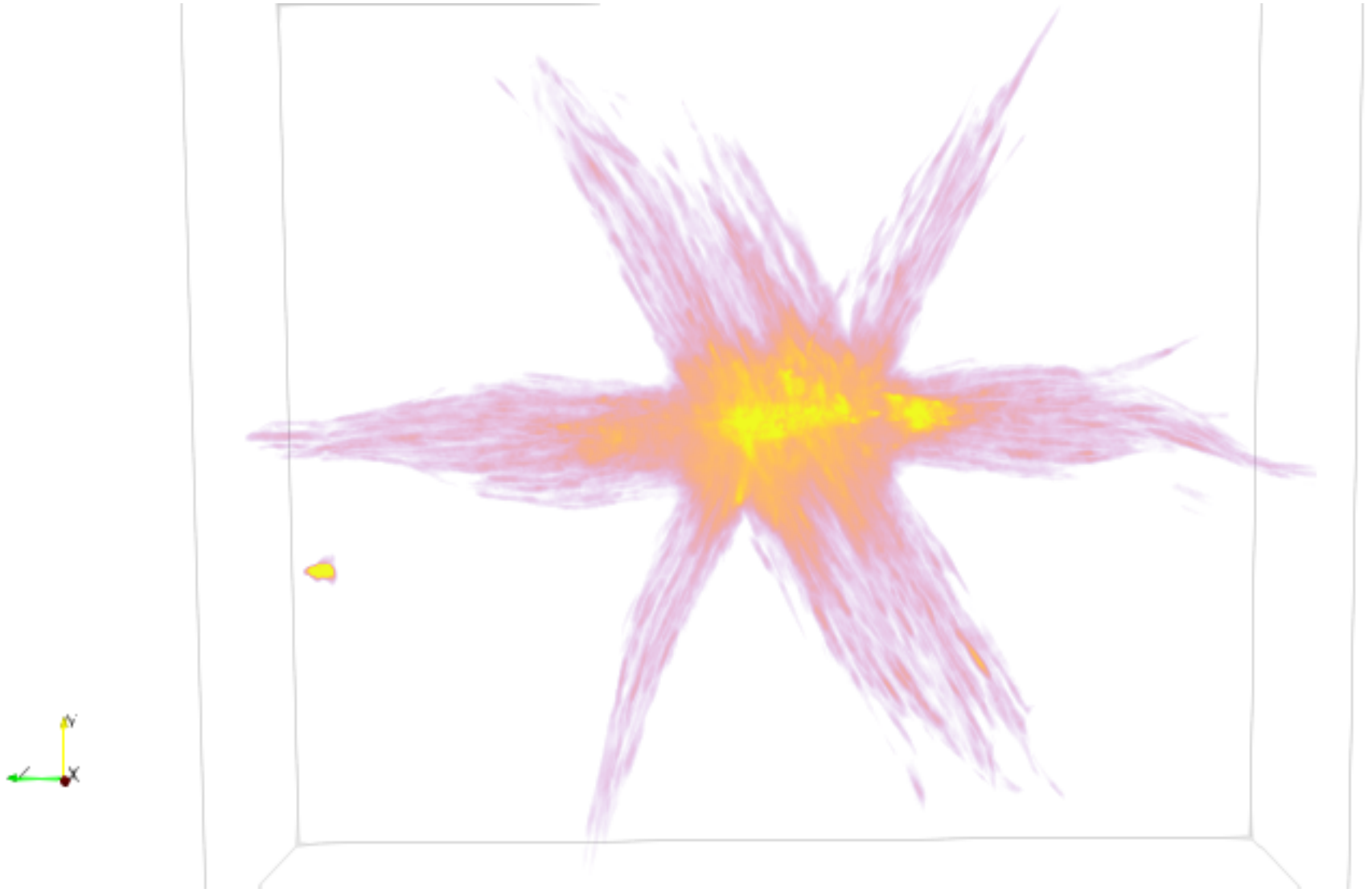


Volume rendering—no jittering

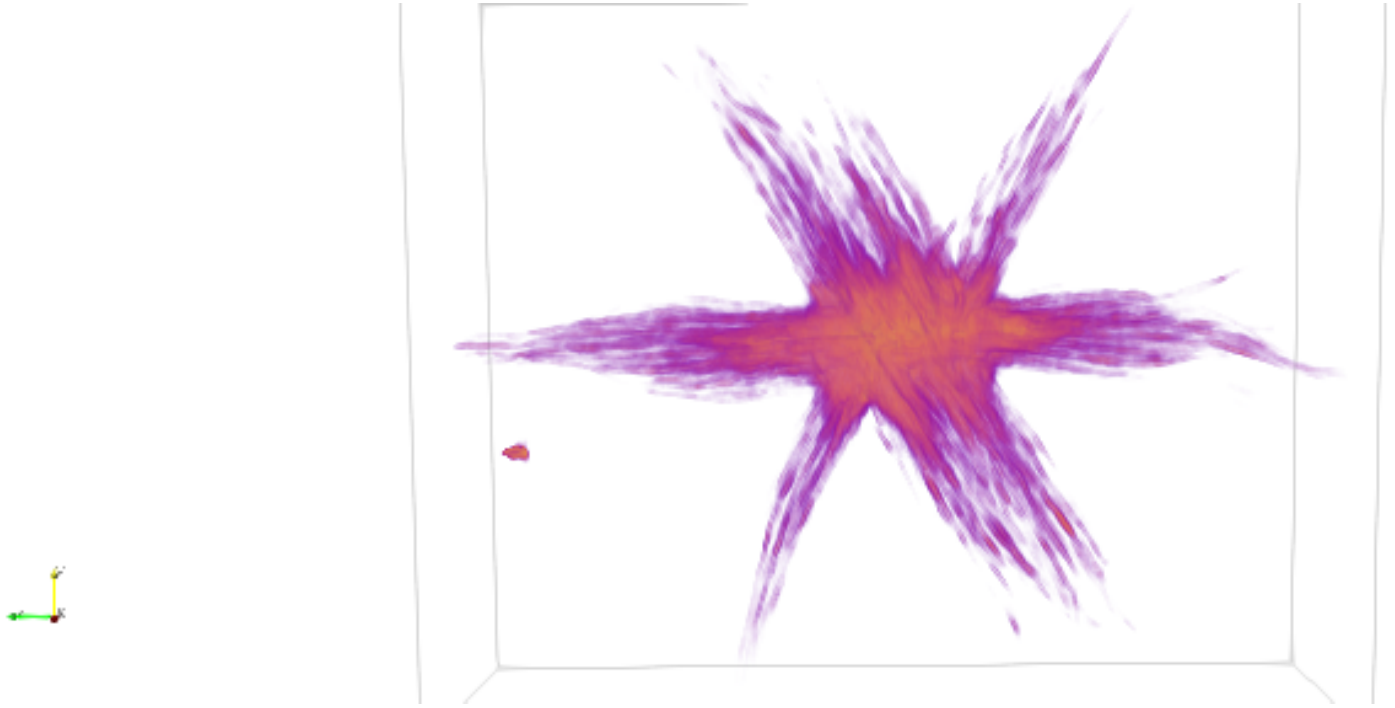


Volume rendering—lighting

Volume rendering—max intensity

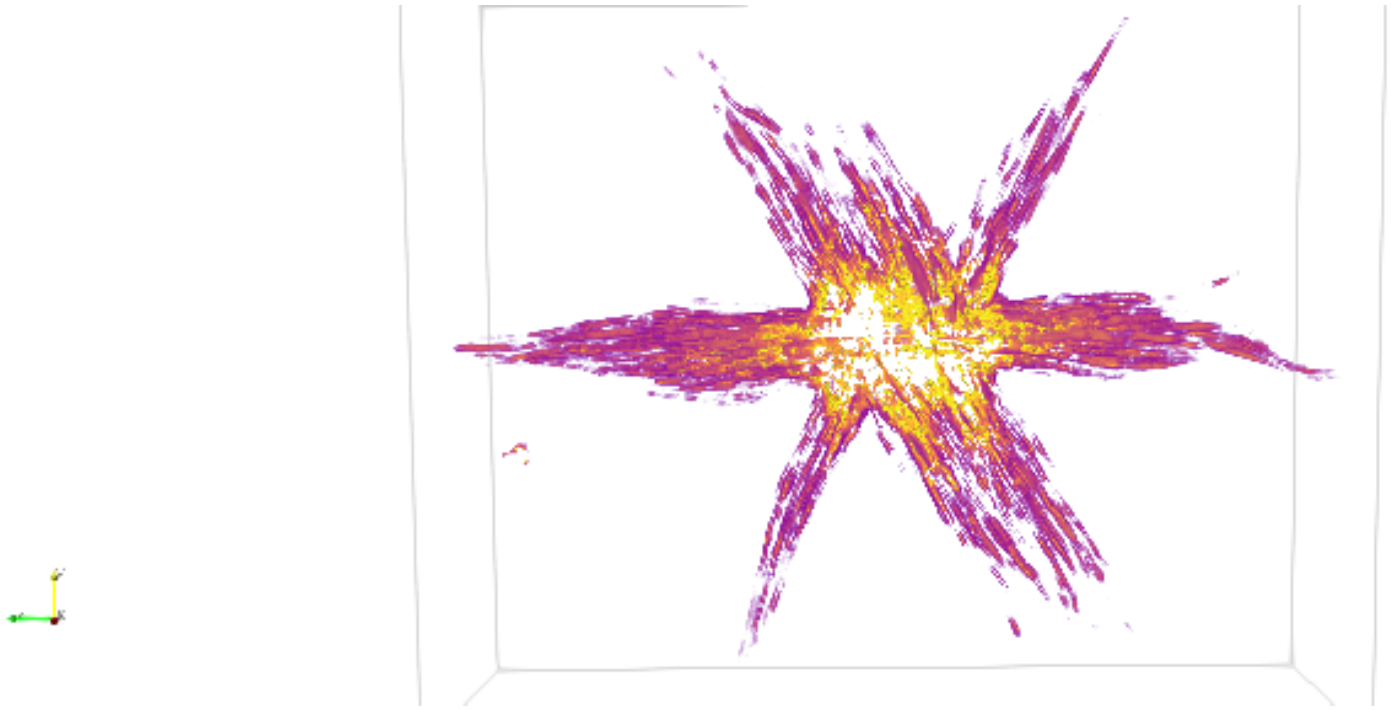


Volume rendering—1D transfer



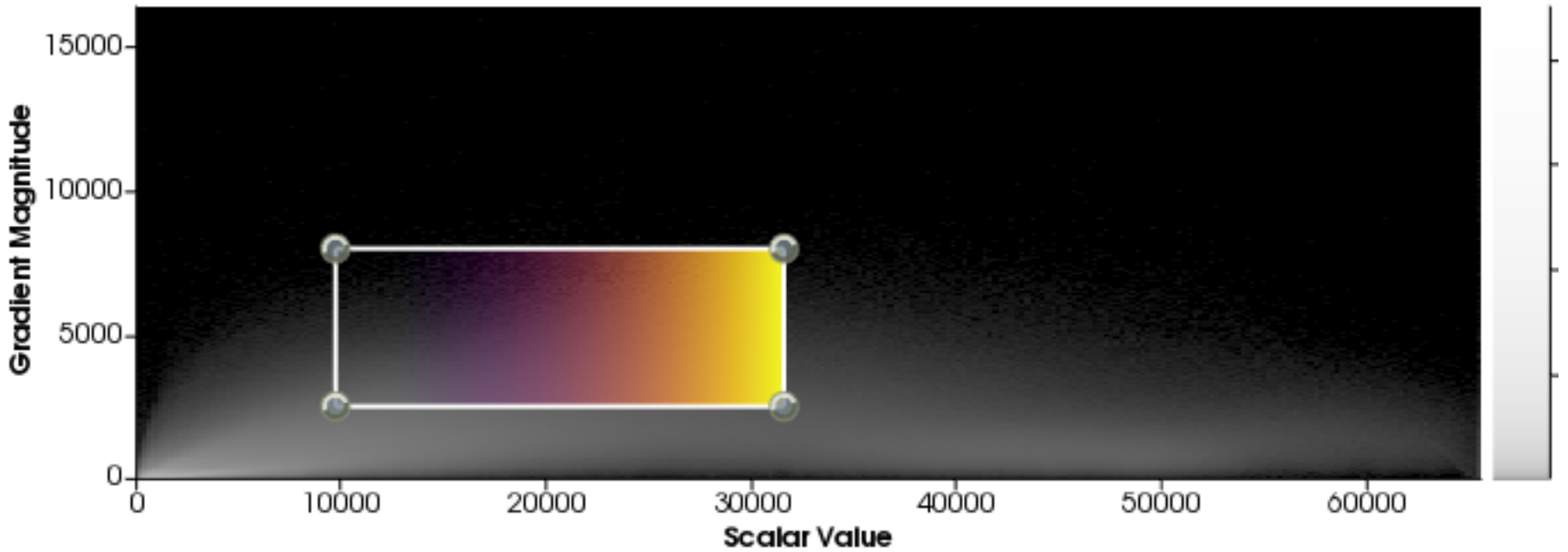
- 1D transfer function highlights gradients

Volume rendering—2D transfer



- 2D transfer function highlights gradients
  - More selectivity for some data

Volume rendering—2D transfer

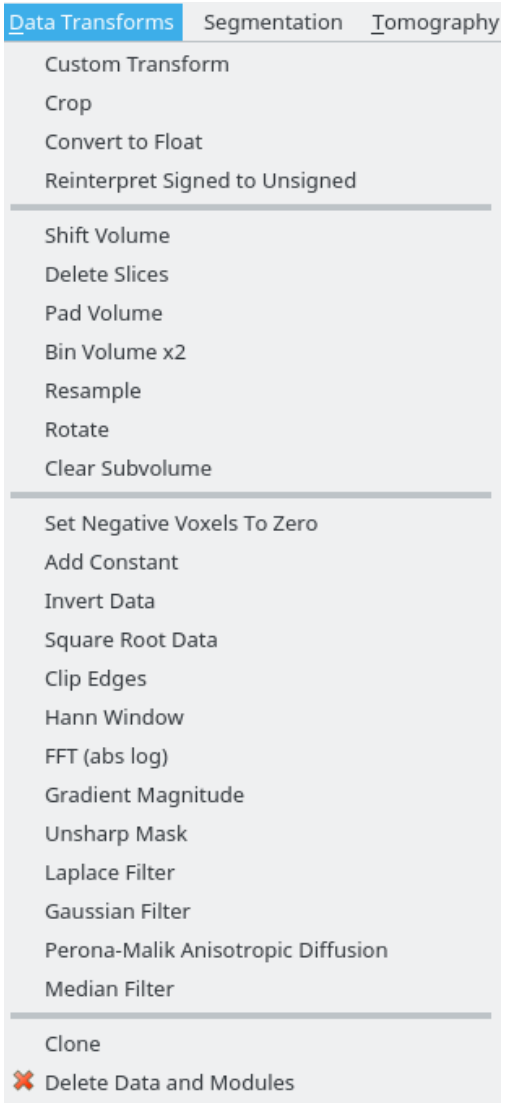


- 2D transfer function highlights gradients
  - Select a box in the 2D histogram

Data transforms

- Data transforms can be applied to your data
  - Implemented as operators in C++ or Python
- Operate in place on the data
- Some have graphical interfaces
- Can edit the source code from the context menu
- The operators execute in a background thread
  - Application remains interactive
  - Can edit the pipeline while they run

Data transforms

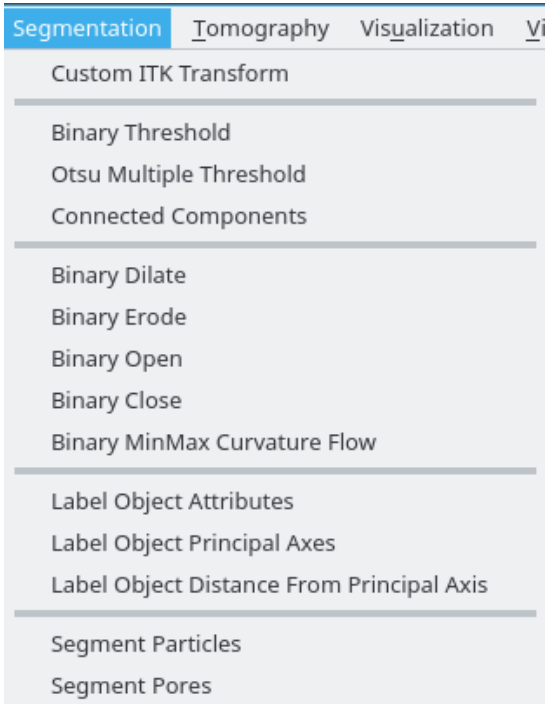


Data transforms

- Most are quite self-explanatory
  - Already showed the crop operator
- They make extensive use of NumPy
- Custom transform shows source code immediately
  - Operate on a NumPy array, return new data

Segmentation

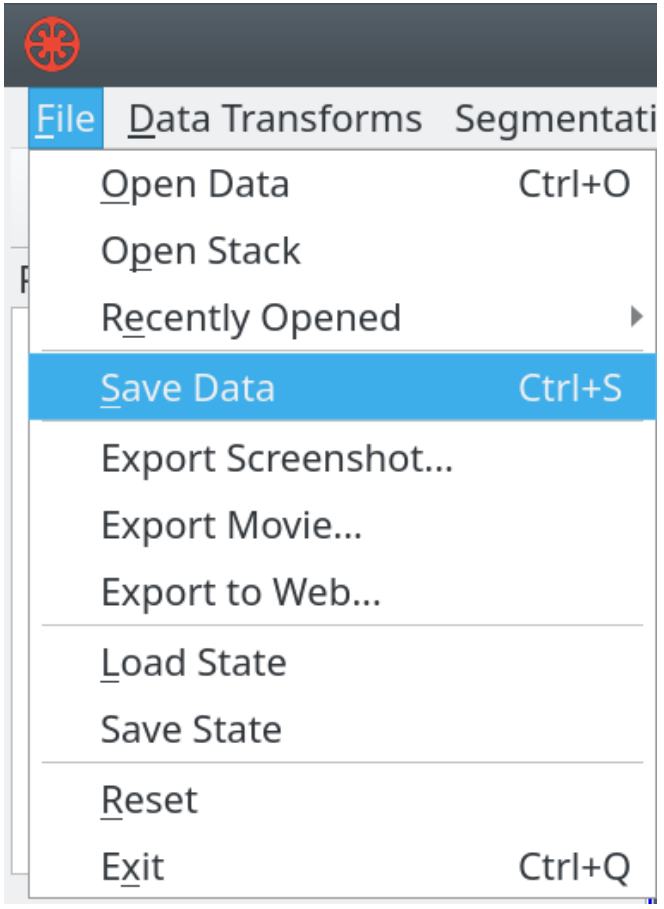
- Most use ITK to segment data in various ways
- Simple topological segmentation
- Labeling of data, summarization, etc



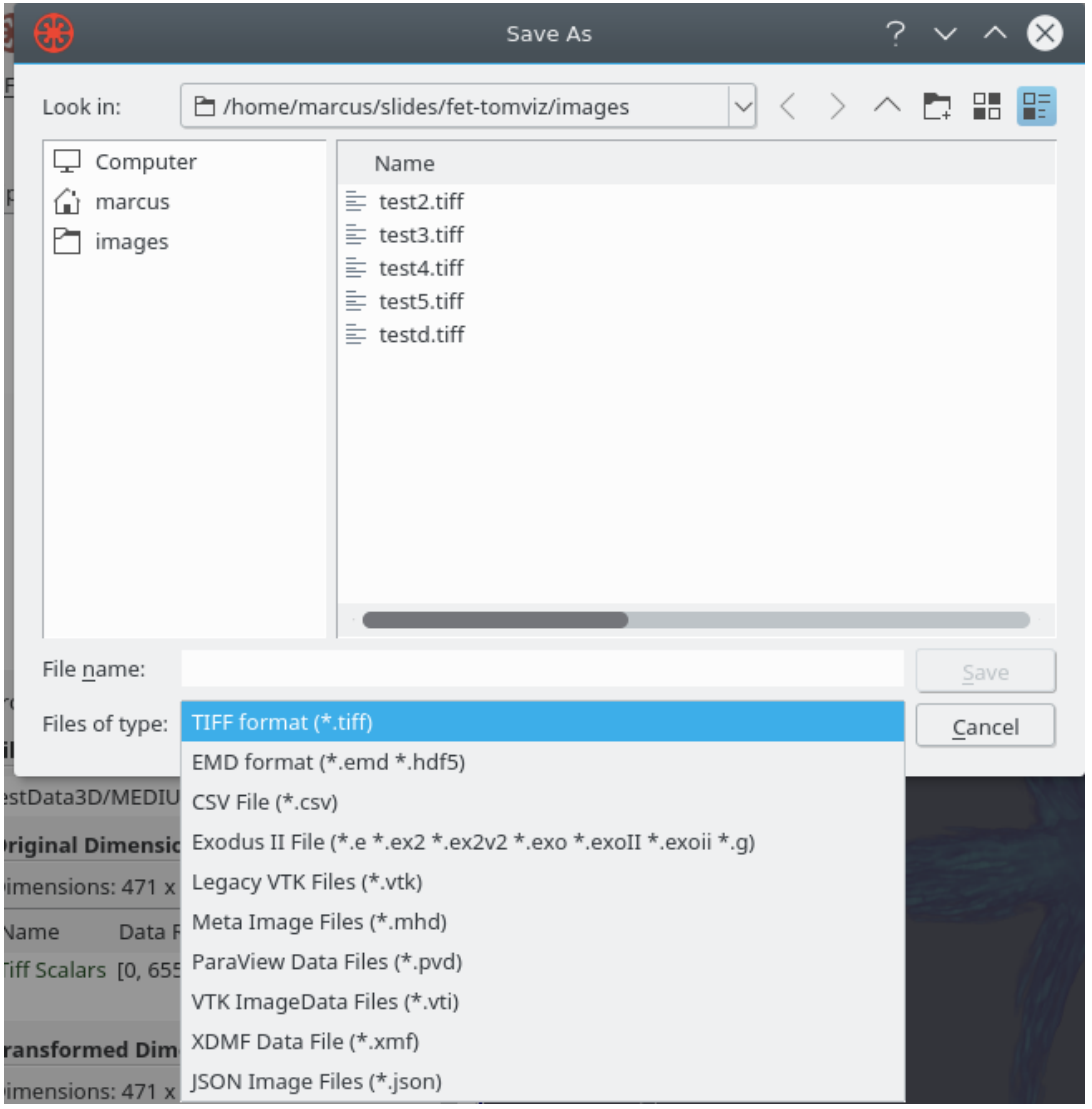
Exporting data

- When you are happy with your data—export!
  - Data to standard formats
  - Screenshot of the render view
  - Animations of the render view
  - An interactive scene for web browsers
  - Geometry for 3D printing
  - Images of slices

Export


File
Data Transforms
Segmentati
Open Data
Ctrl+O
Open Stack
Recently Opened
Save Data
Ctrl+S
Export Screenshot...
Export Movie...
Export to Web...
Load State
Save State
Reset
Exit
Ctrl+Q

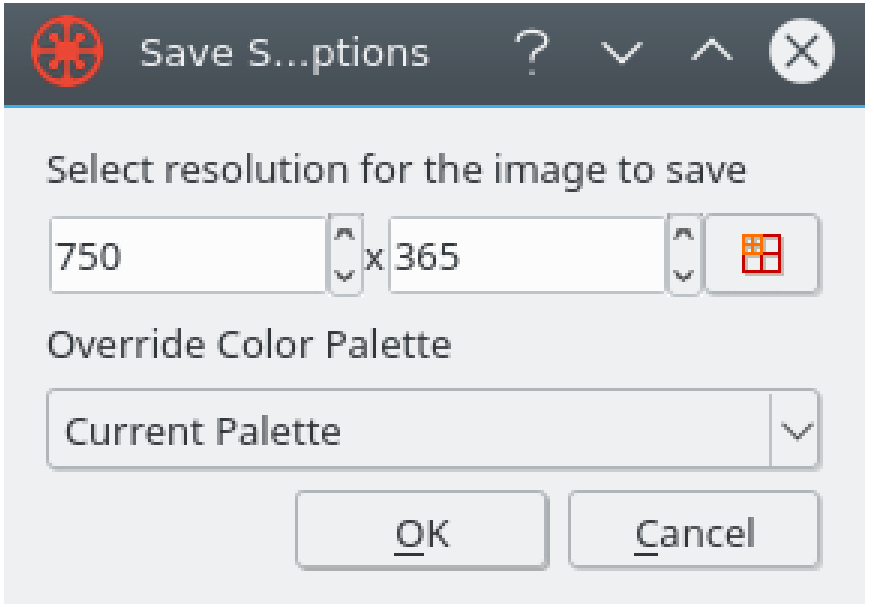
Data formats



Data formats

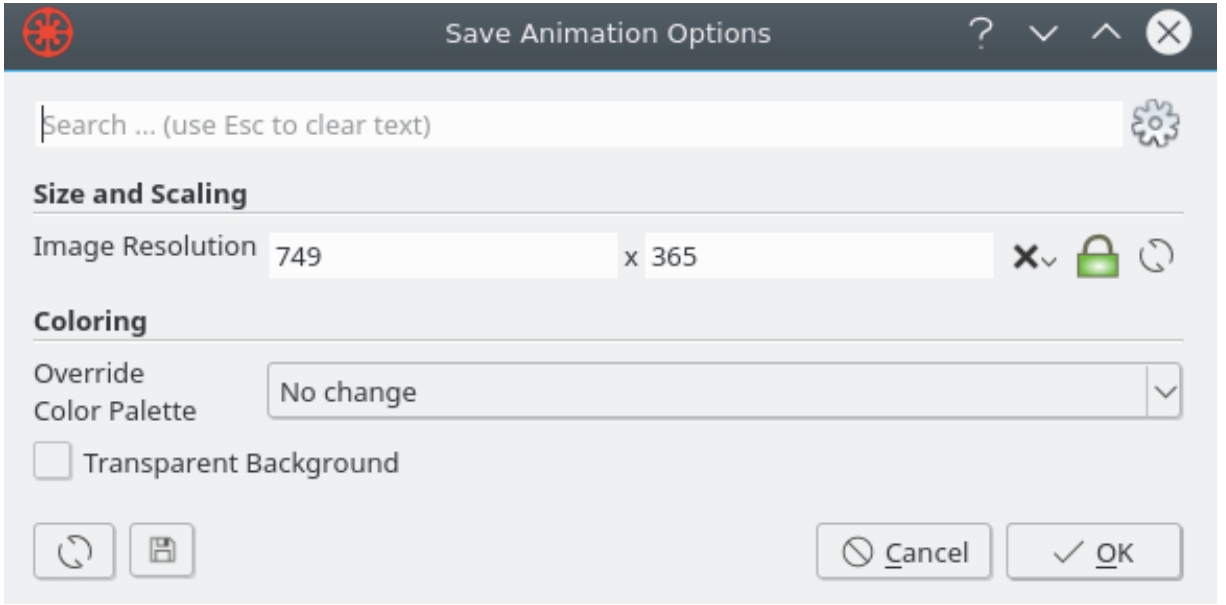
- Recommend EMD (HDF5 based) for saving data
  - Supports saving units in all three dimensions
  - Supports all types used in Tomviz
  - Open, specified, but not as widely supported
- TIFF is often the most diverse to export to
  - Only supports limited types
  - Limited support for units/dimensions
  - Open, wide support in many packages
- Others may be of use in special circumstances

Export screenshot



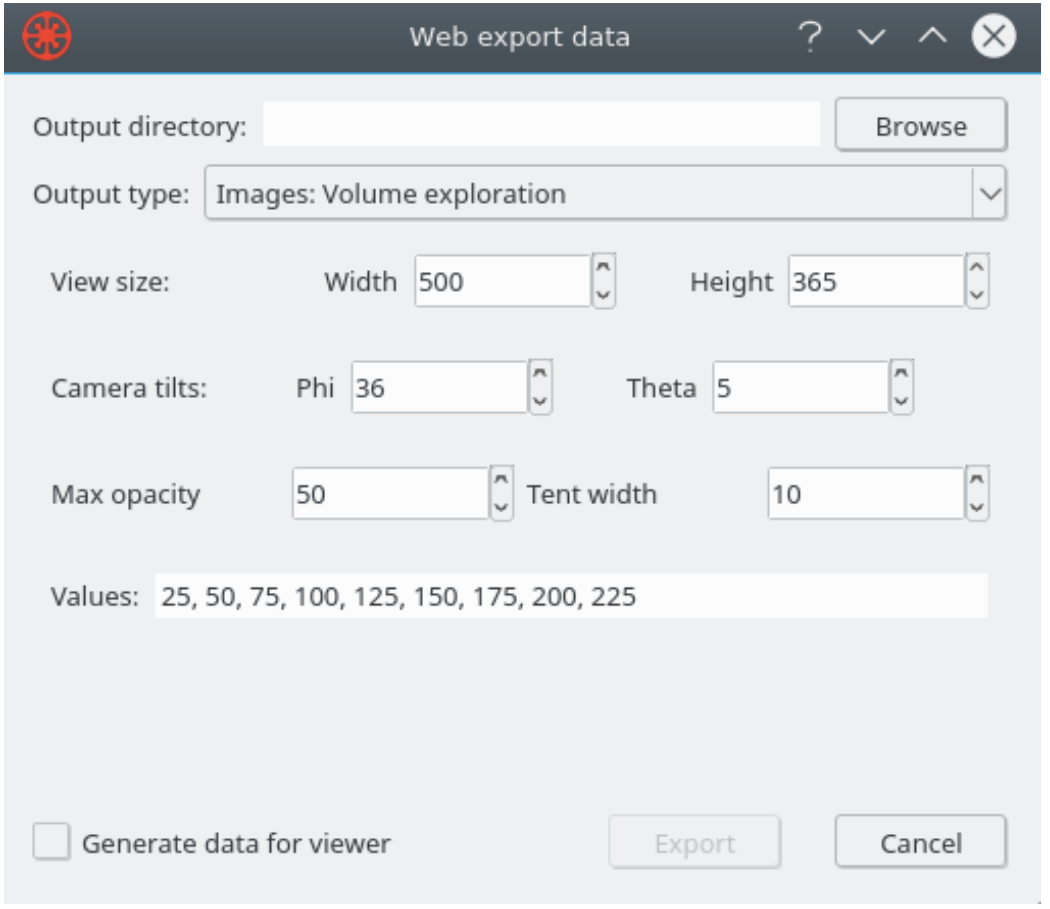
- Specify size, supports a number of image formats
- Override palette, use transparent backgrounds

Export movie



- Defaults to an orbit of the data
- Set the resolution, save defaults before generating
- Supports common movie formats

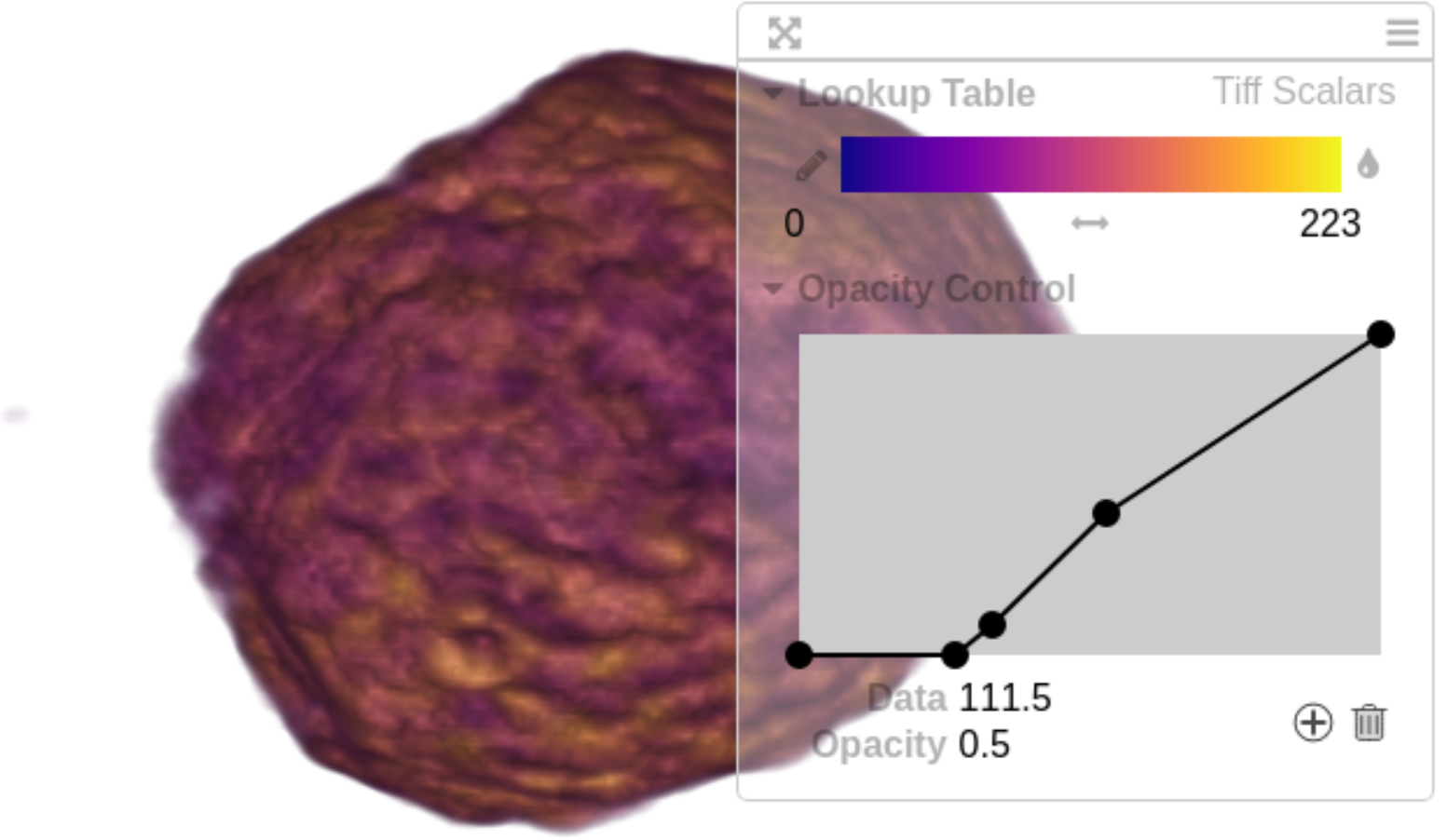
Export to the web



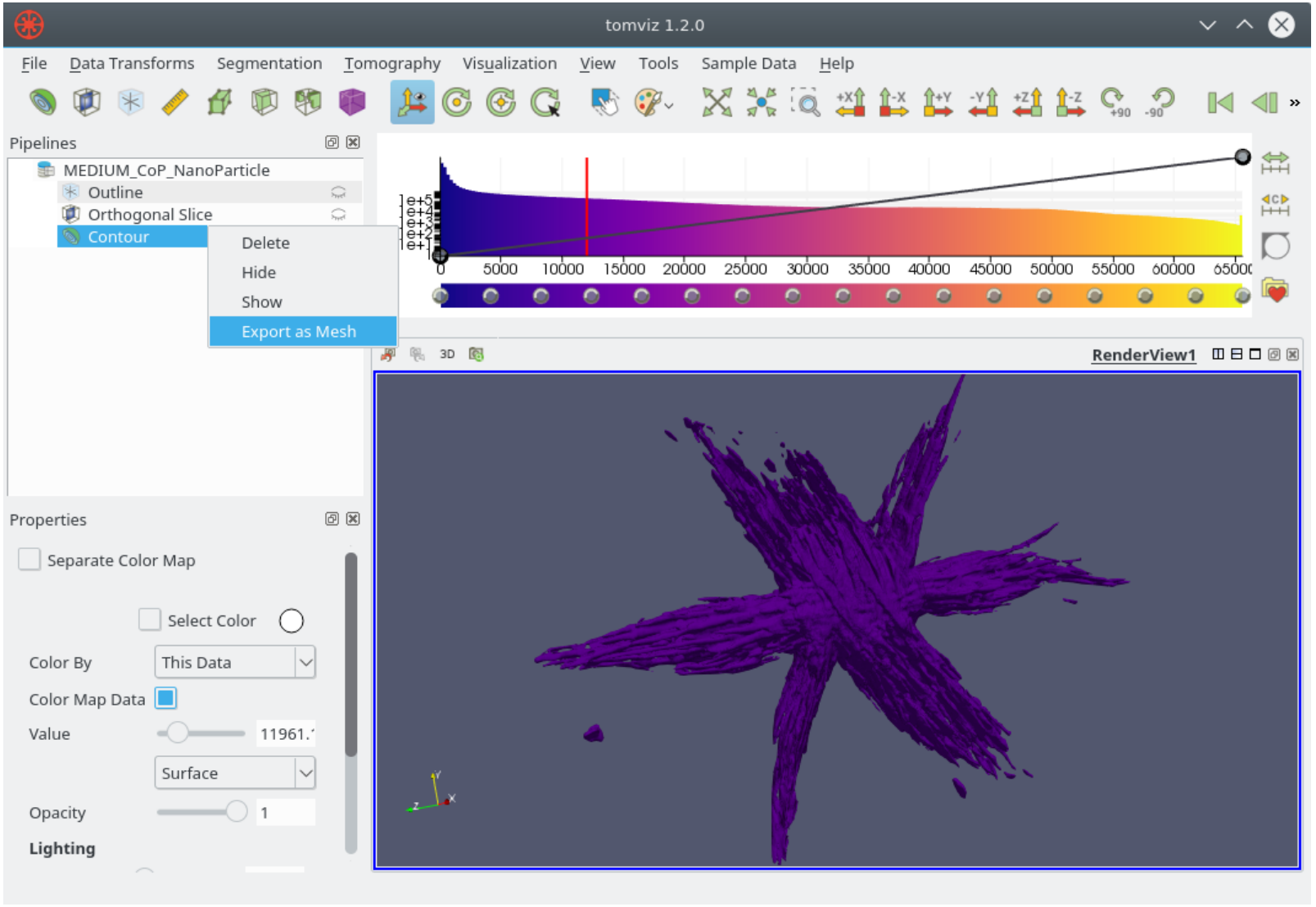
Export to the web

- Image based default to generate images
  - No need for WebGL in the browser
  - Limited angles, etc
- Geometry based where actual data is exported
  - Often needs to be downsampled for browsers
  - Better interactivity
- Generate data for viewer option
  - Integrate exported in larger web site
  - Defaults to single HTML page with data

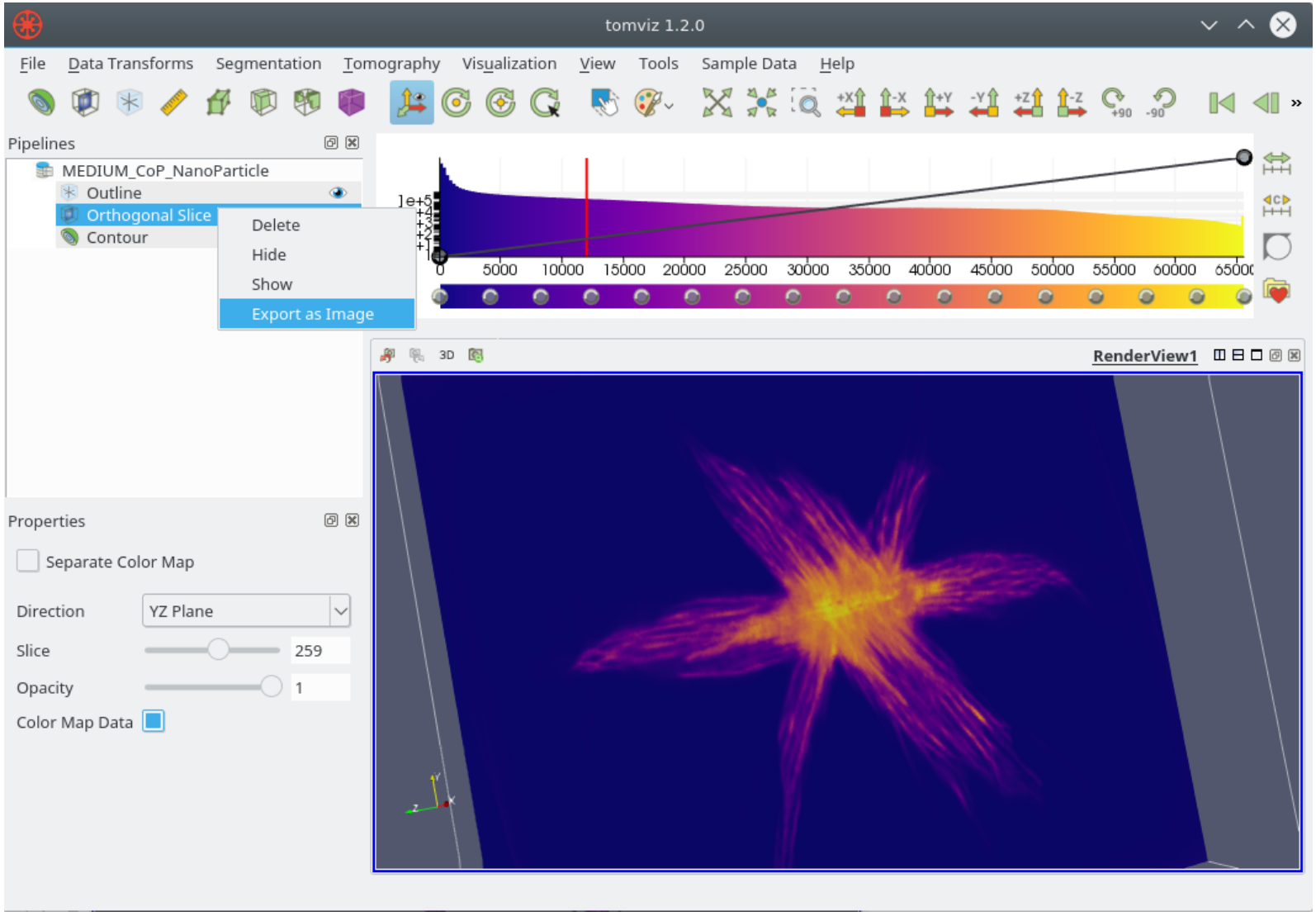
Export to the web



Export mesh—3D printing (STL)



Export image from slice



Summary

- Covered working with and visualizing volume data
- Data transforms and segmentations can be used
- Many options for contours, volume rendering, etc
- Different visualization types can be combined
- Export of data to various formats/media