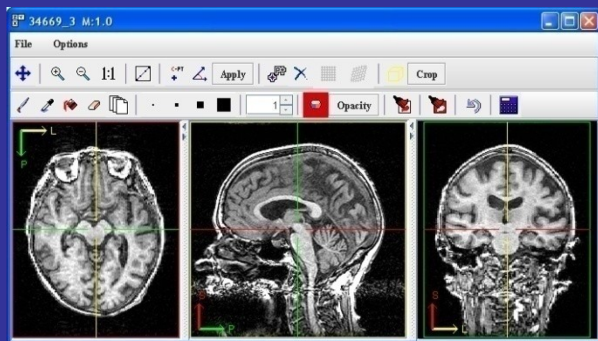
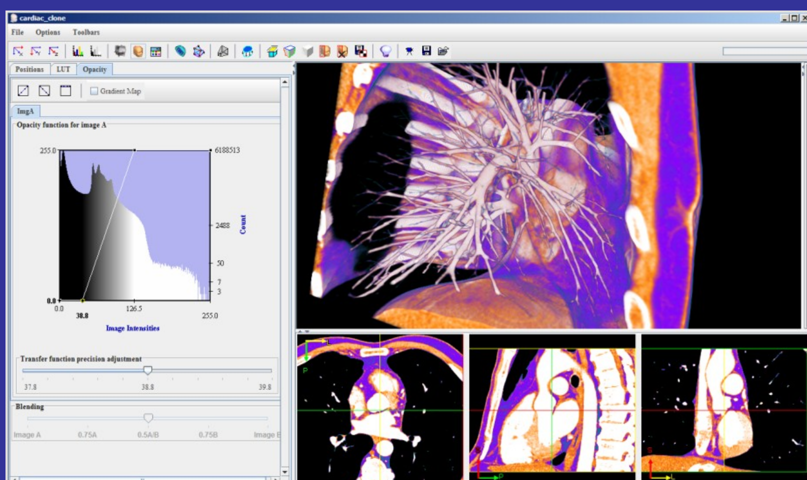
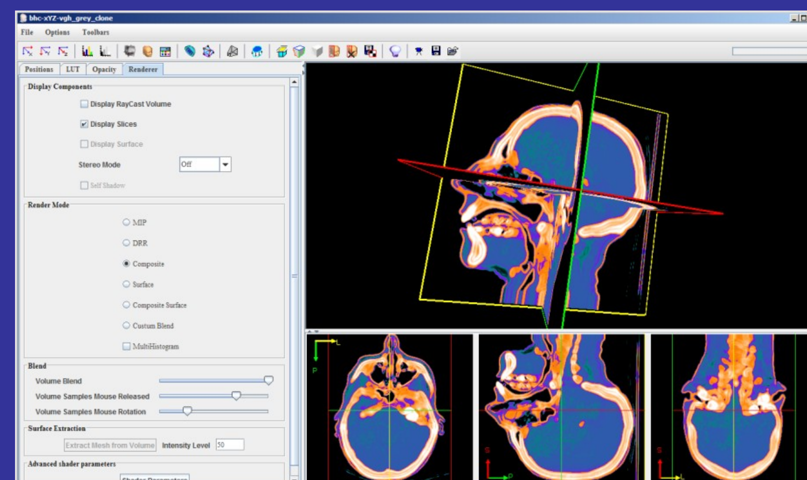
Visualization in MIPAV



http://mipav.cit.nih.gov





Visualization in MIPAV

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Geometric Tools, Inc.
Ruida Cheng
National Institutes of Health

3D Visualization Outline

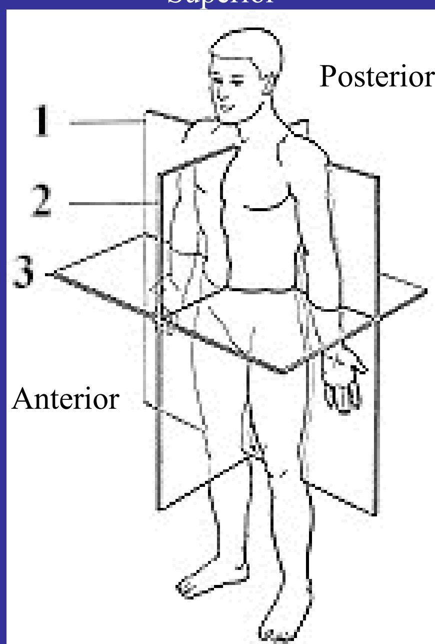
- 3D Image Processing
- Volume rendering
- Surface extraction and rendering
- Advanced rendering techniques
- Visualization Applications in MIPAV
  - Diffusion Tensor Visualization, ISO-Surface rendering, virtual endoscopy.

Course Goals

- Know what 3D visualization capabilities are available in MIPAV
- Familiar with the tools and user-interface
- Able to start creating visualizations

A Brief Introduction to 3D Medical Images

Superior



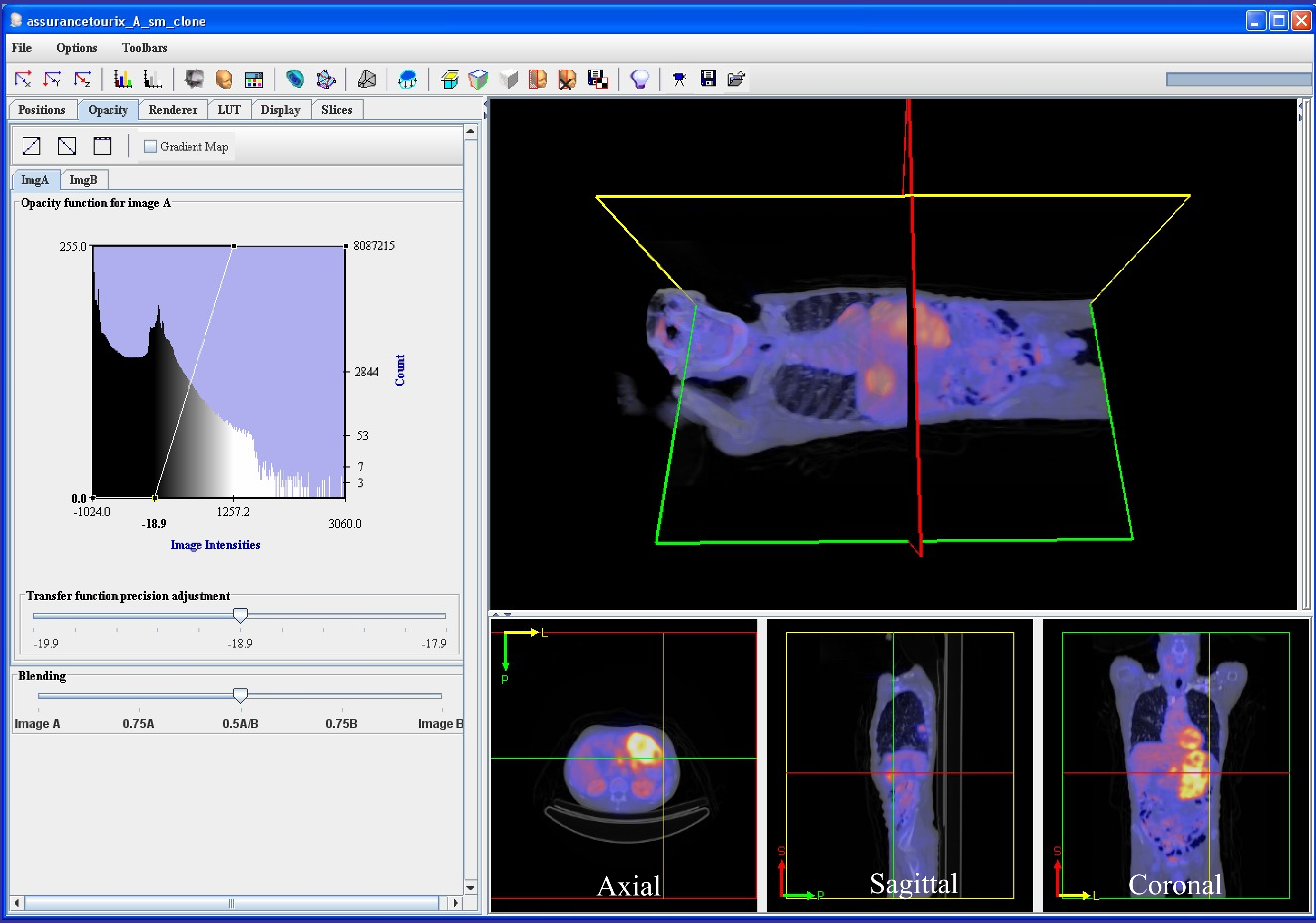
Inferior

Medical images taken of the human body are acquired or displayed in three main orientations:

<u>1.Coronal orientation:</u> in a cross section (plane), for example, across the shoulders, dividing the body into front and back halves

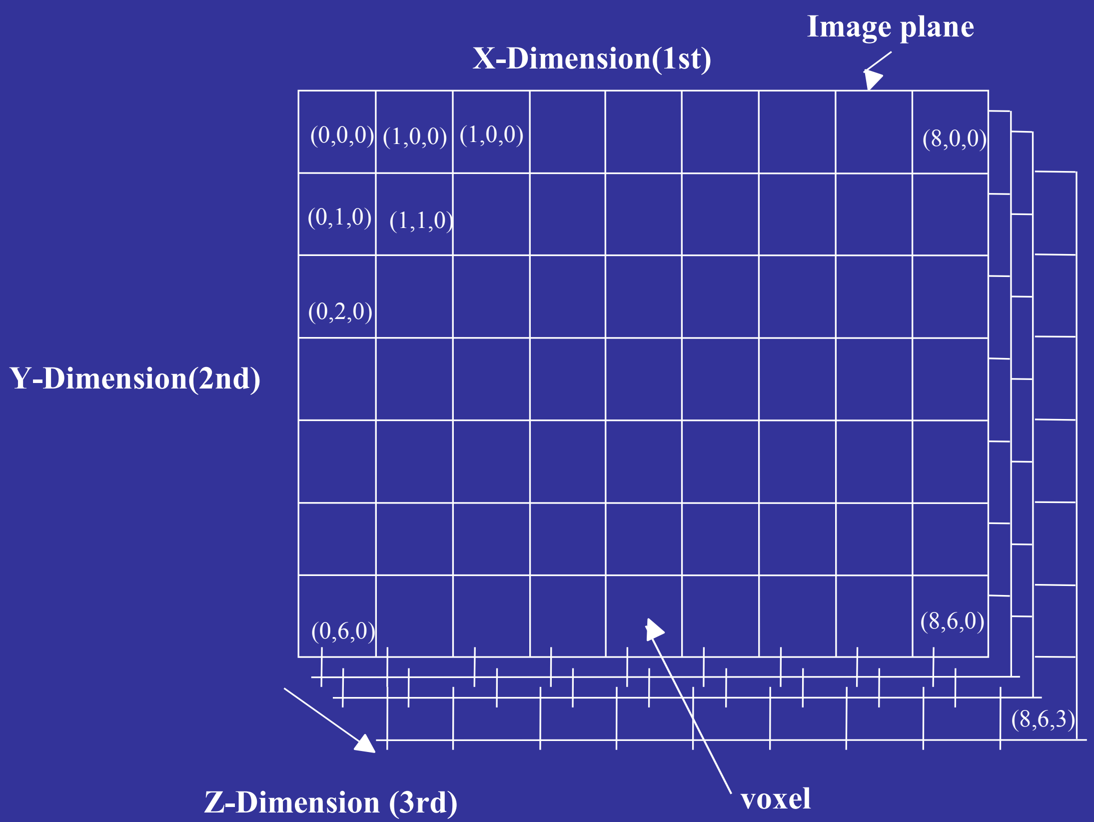
<u>2.Sagittal orientation:</u> in a cross section (plane), for example, down the middle, dividing the body into left and right halves

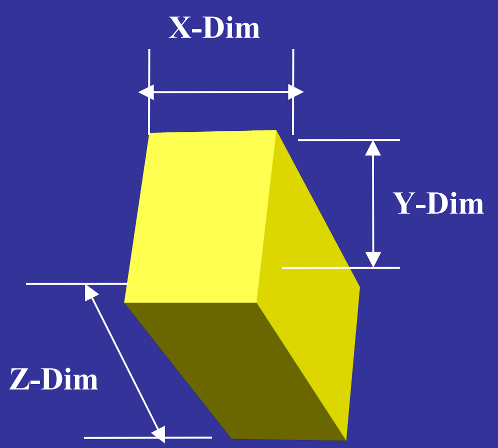
<u>3.Axial orientation:</u> in a cross section (plane), perpendicular to the long axis of the body, dividing the body into upper and lower halves



assurancetourix_A_sm_clone
File
Options
Toolbars
Positions
Opacity
Renderer
LUT
Display
Slices
Gradient Map
ImgA
ImgB
Opacity function for image A
255.0
8087215
2844
53
7
3
Count
0.0
-1024.0
-18.9
1257.2
3060.0
Image Intensities
Transfer function precision adjustment
-19.9
-18.9
-17.9
Blending
Image A
0.75A
0.5A/B
0.75B
Image B
Axial
Sagittal
Coronal

Voxel Thickness & Resolution

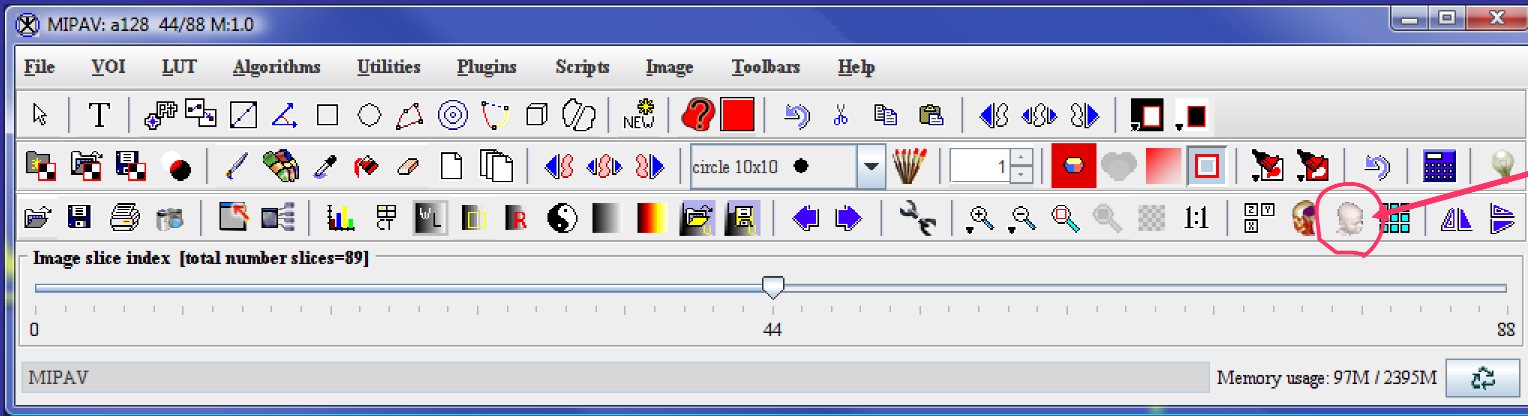


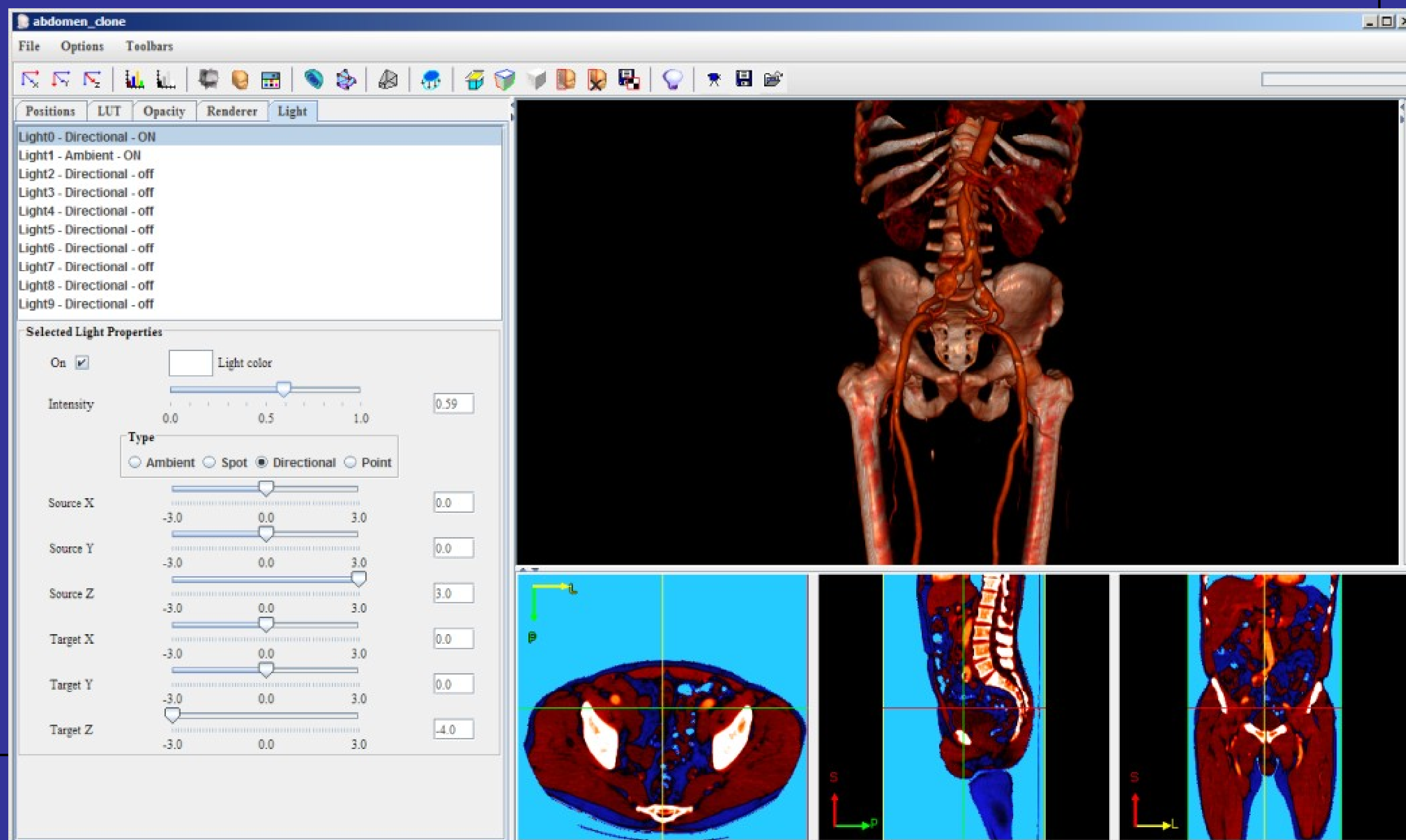


Voxels, of 3D clinical images, are typically NOT isotropic.
This factor should be accounted for in processing algorithms.

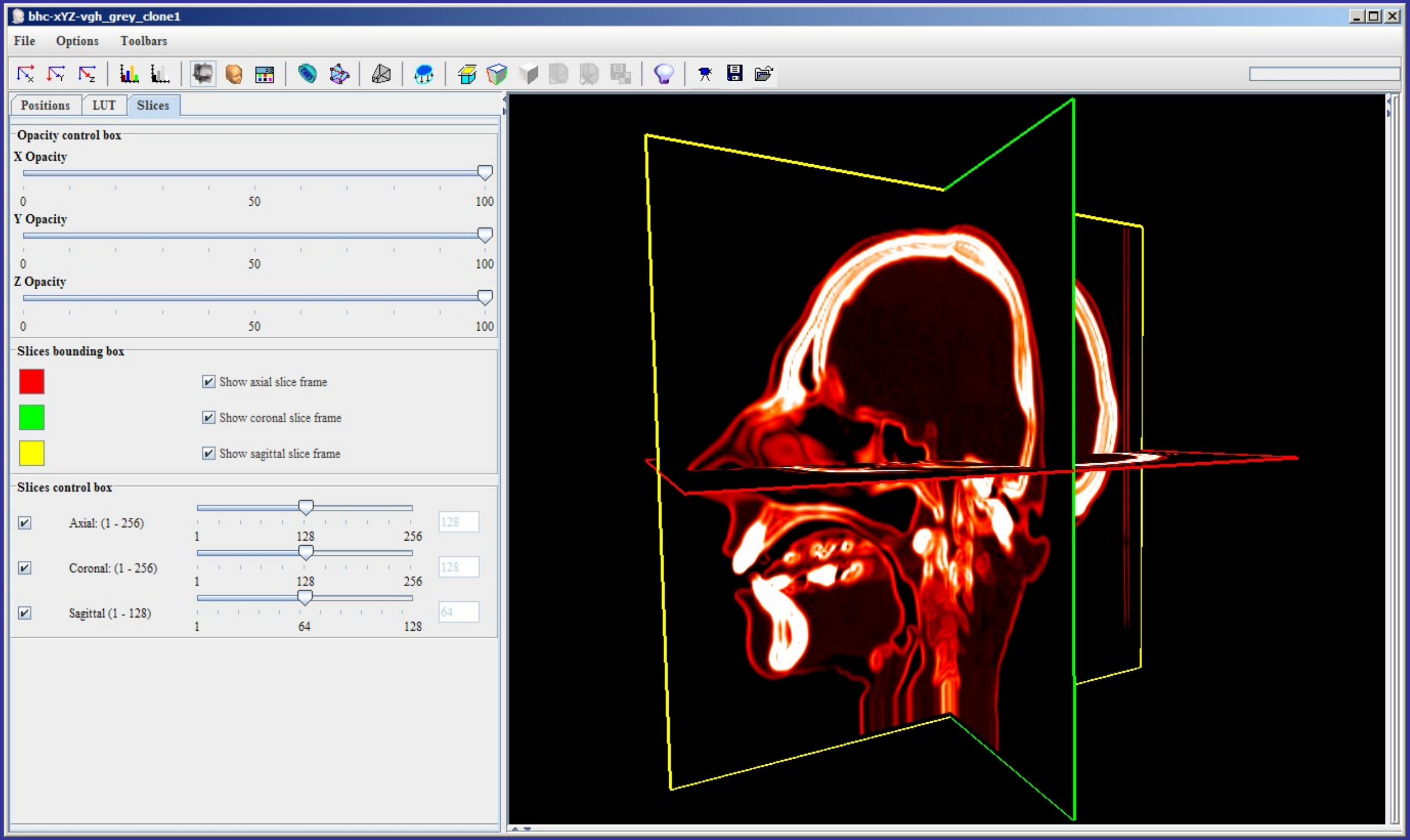
3D Visualization

Launch
GPU-Based
Volume Renderer

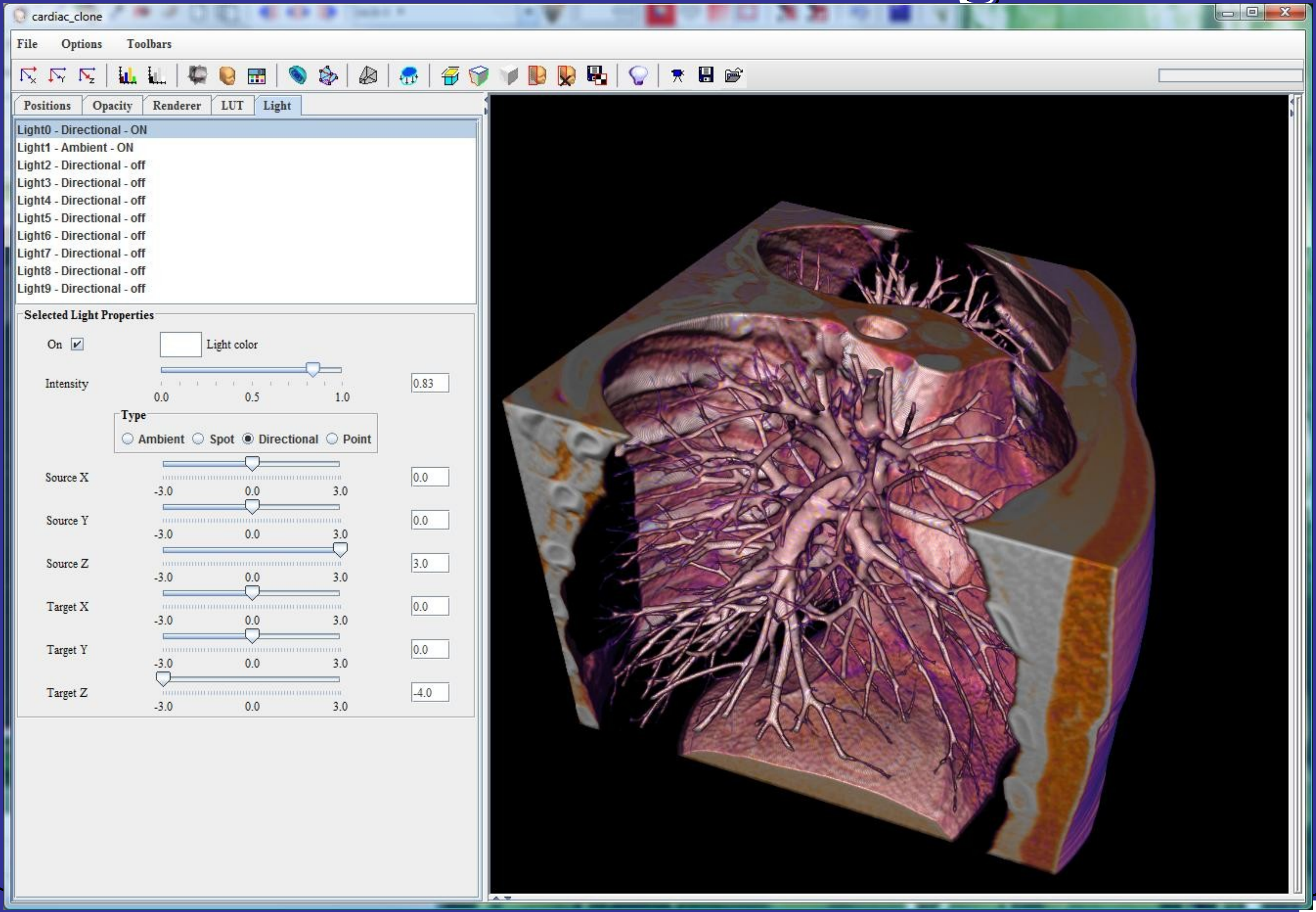




Orthogonal Plane View



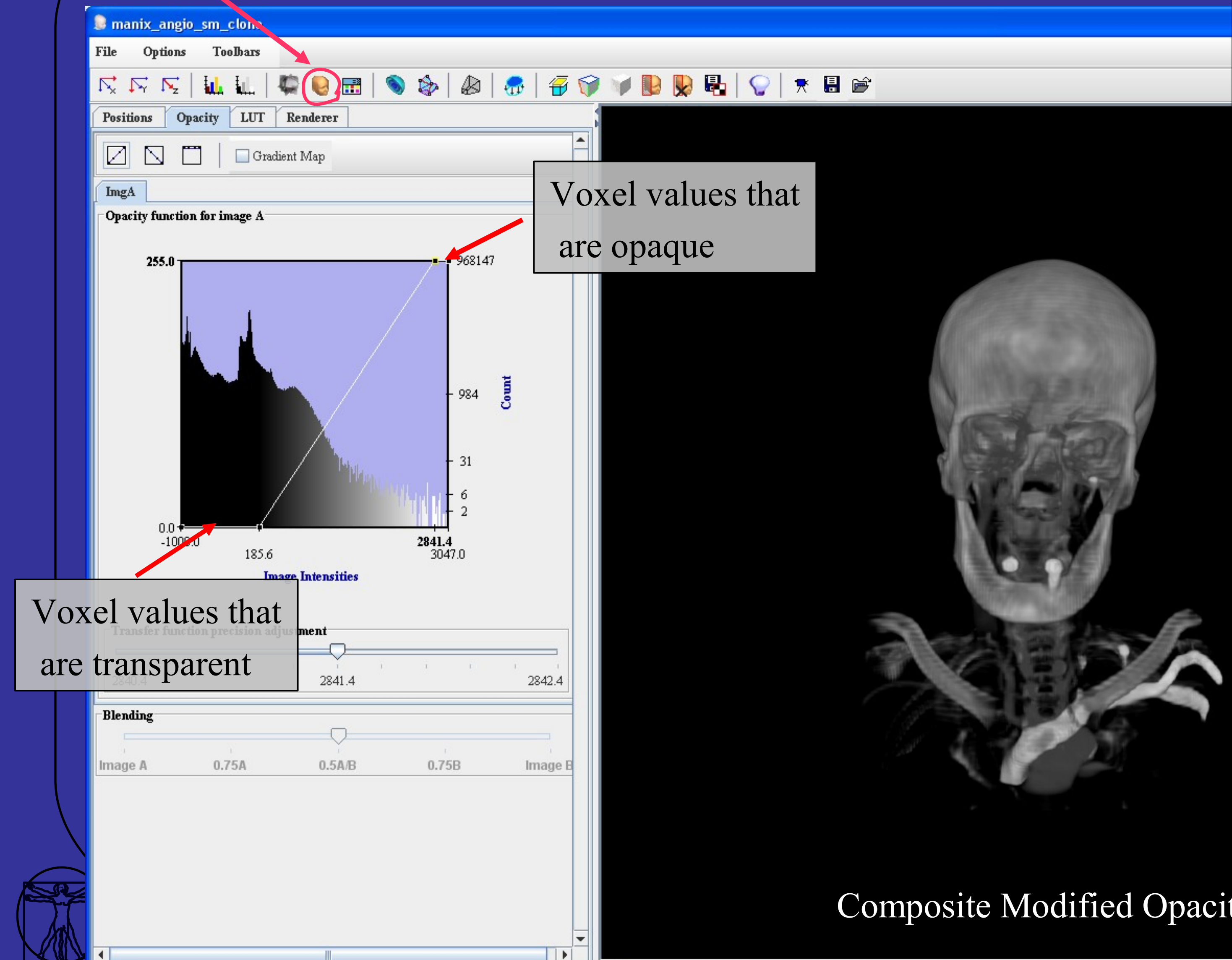
Volume Rendering

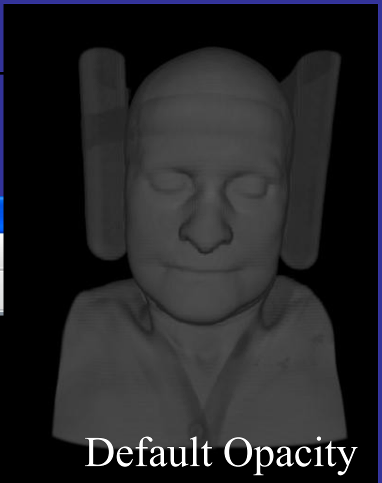


Volume Rendering

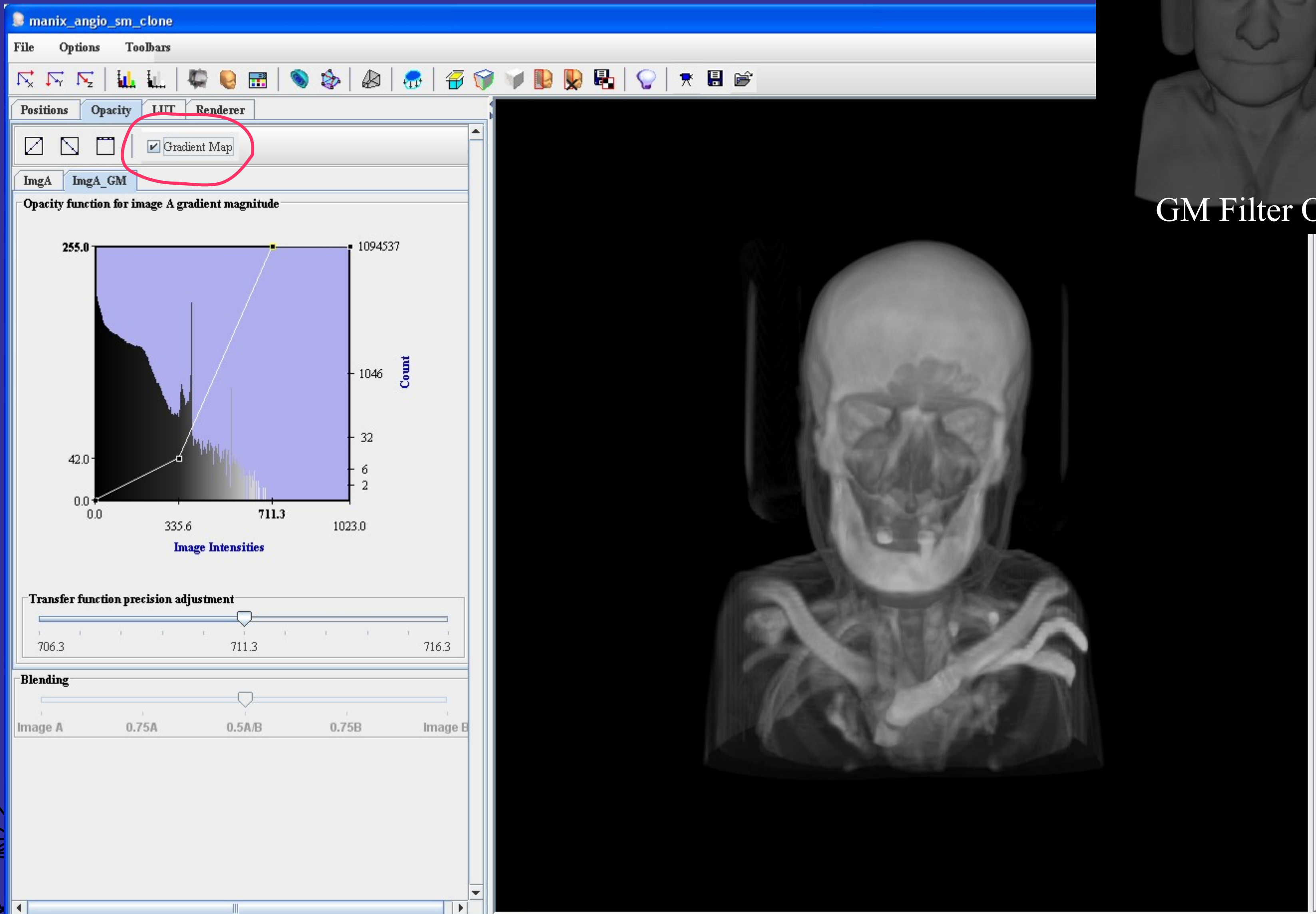
- Opacity filter
- Gradient magnitude filter
- Color Lookup Table
- Global opacity and blending
- 2D Histogram filters
- Clipping and Sculpting Volumes

Opacity Filter



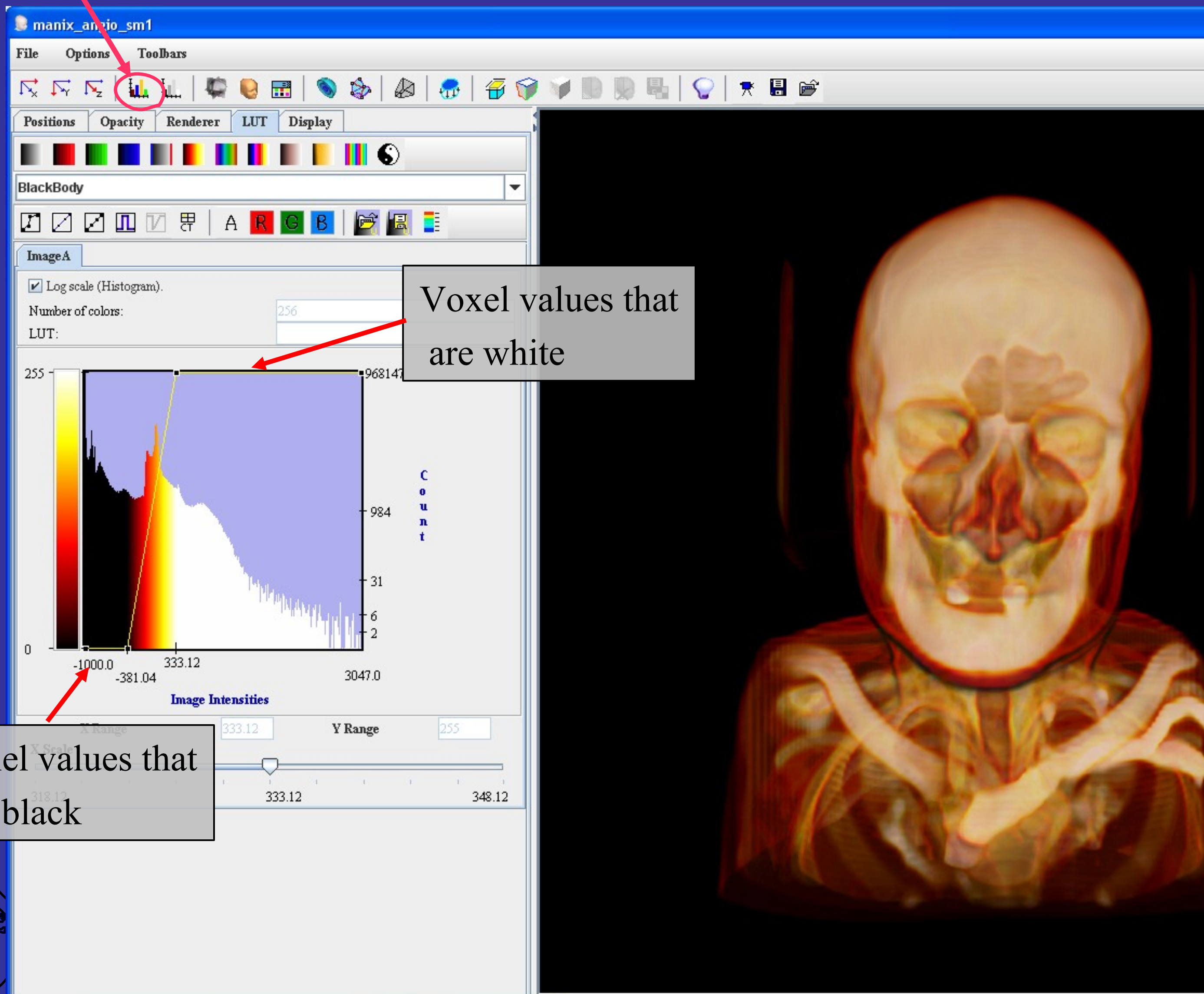


Gradient Magnitude Filter



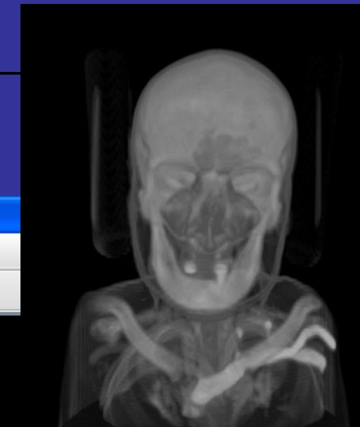
Adding Color

Select Color Lookup Table



Voxel values that are white

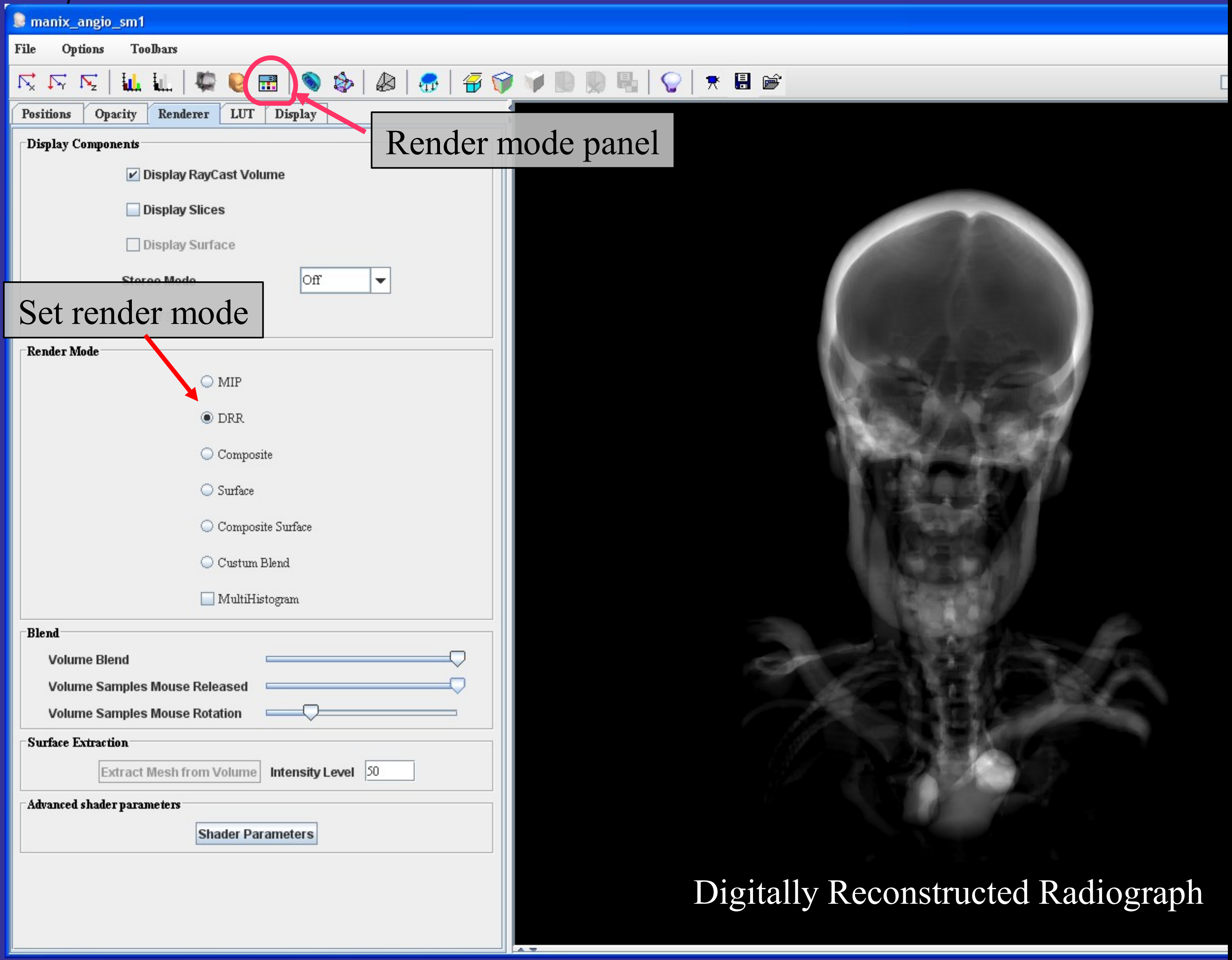
Voxel values that are black



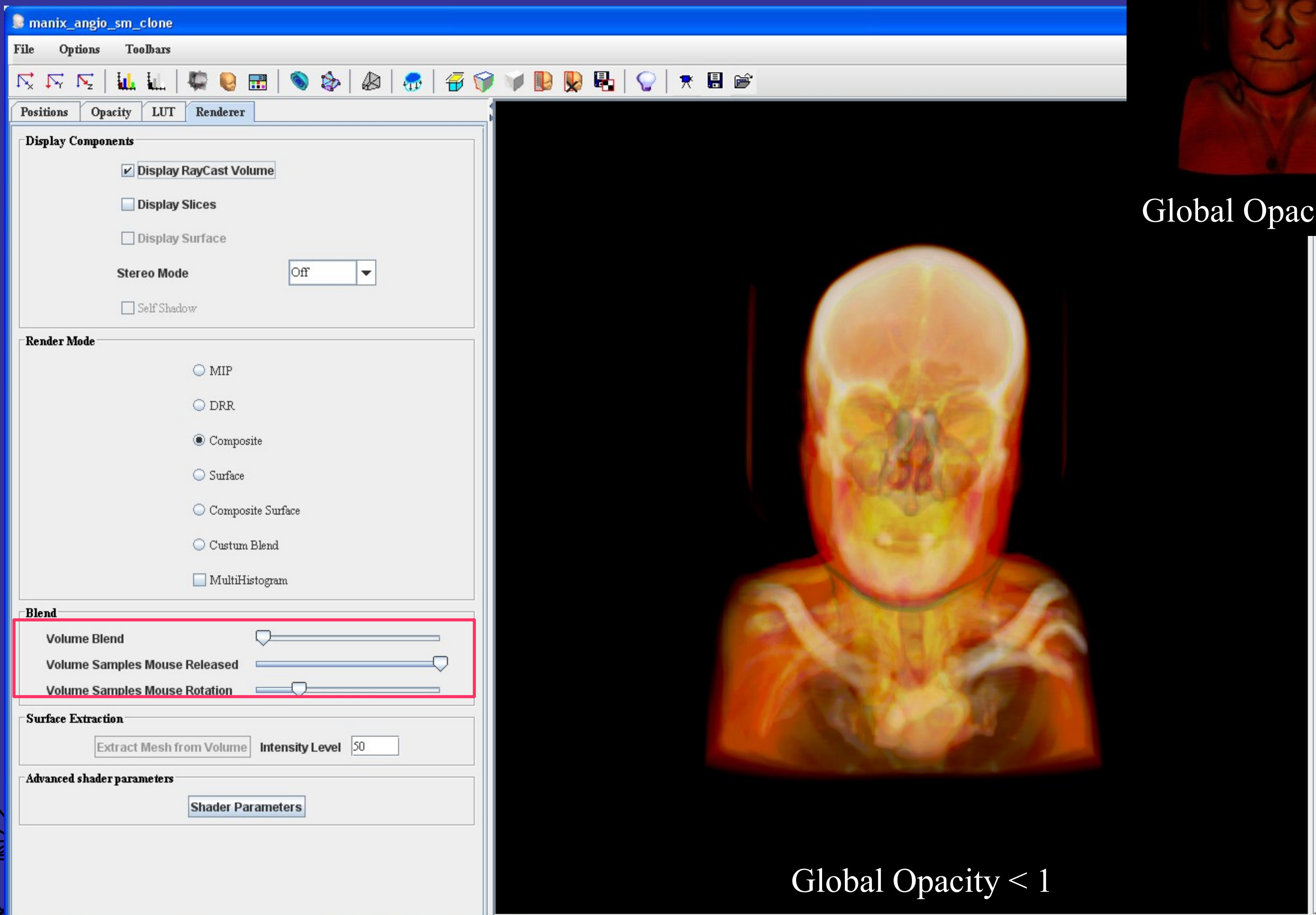
GM Filter On

GM Filter Off

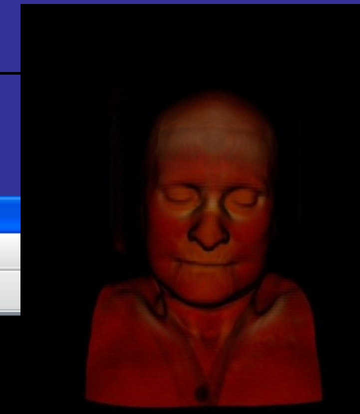
Volume Rendering Modes



Modifying Global Opacity

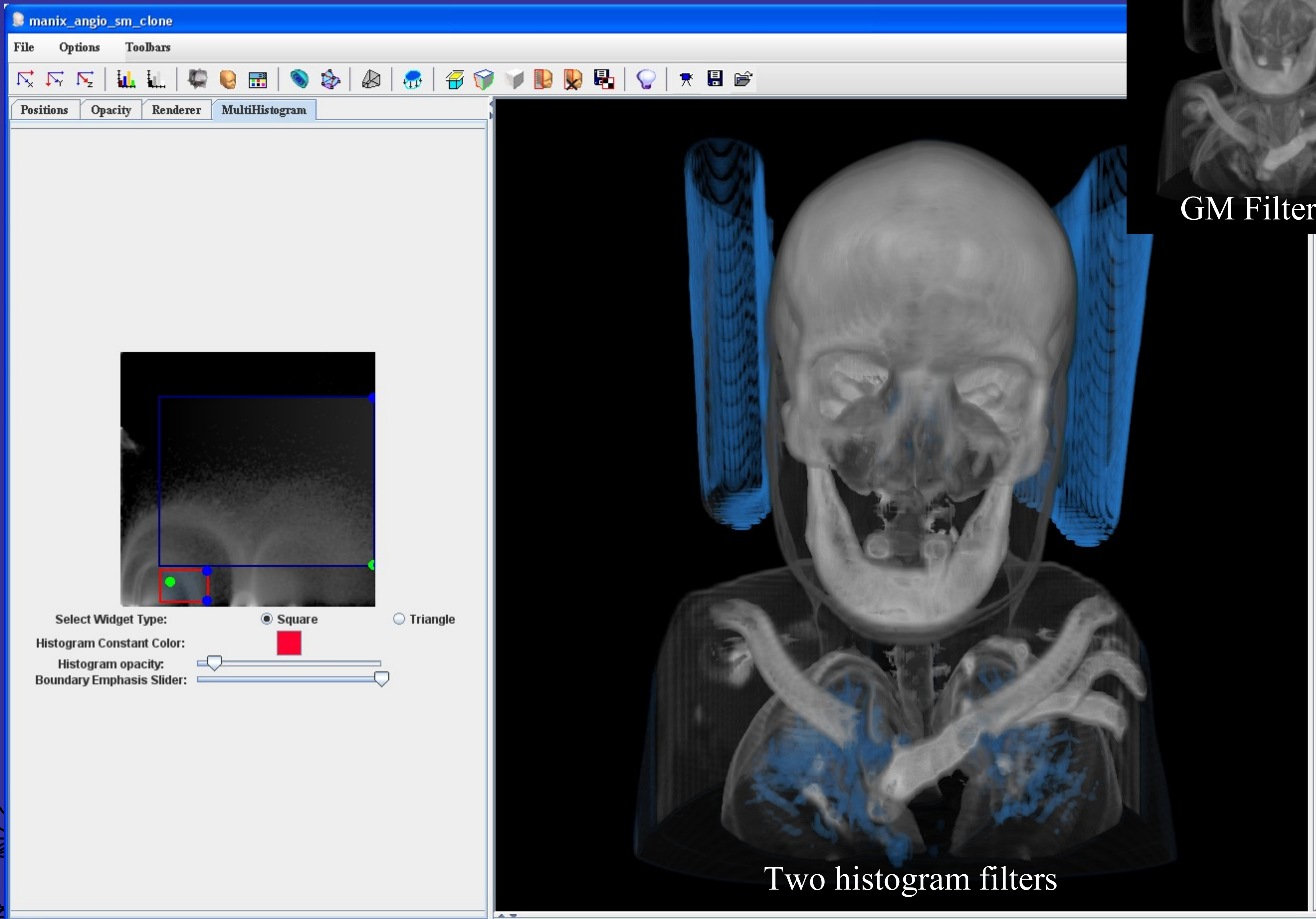


Global Opacity < 1



Global Opacity = 1

2D Histogram Tool

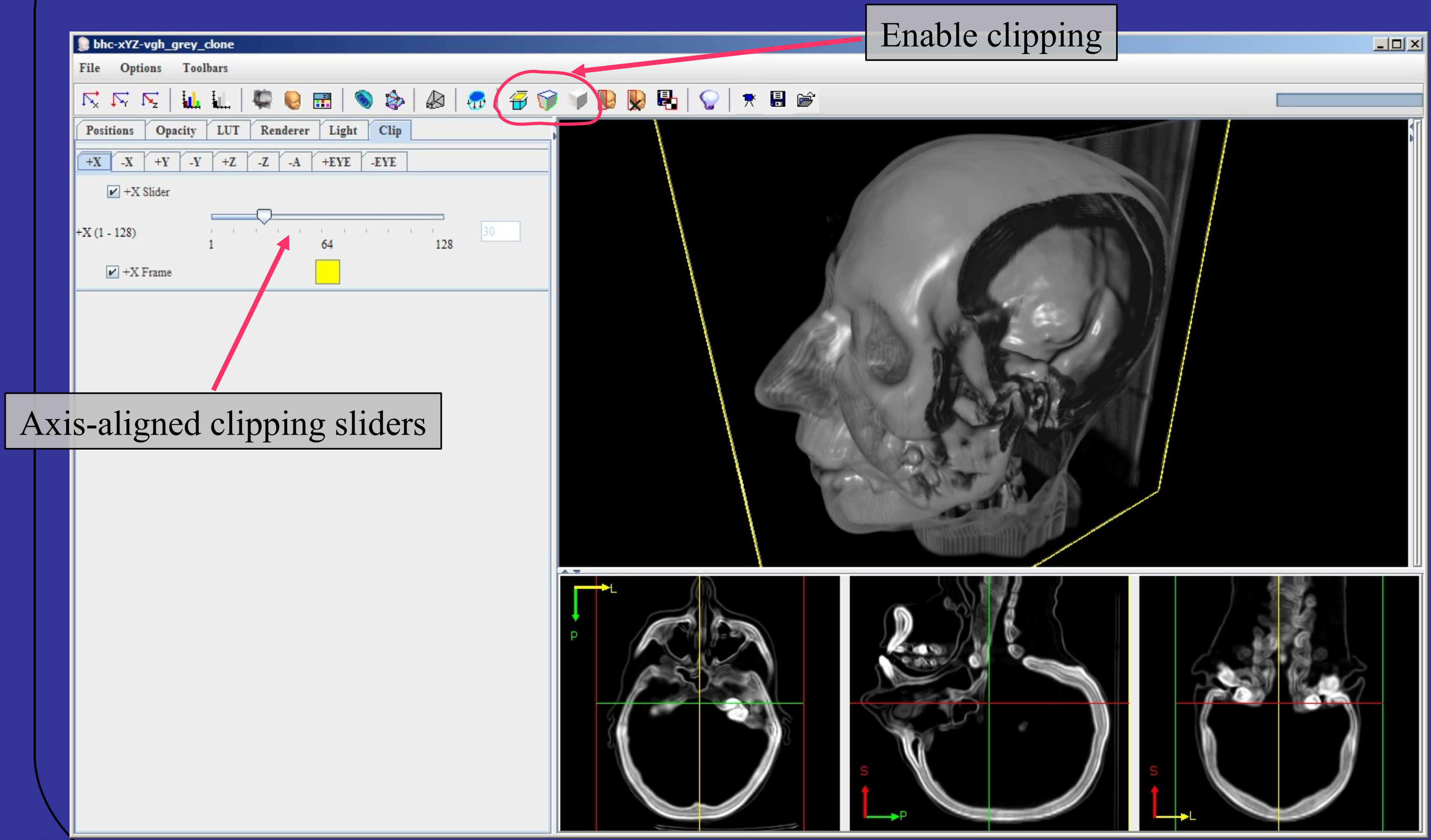


Two histogram filters

GM Filter On

2D Histogram Tool

Volume Clipping



Sculpturing Tool

User-draw sculpt region

After volume sculpting

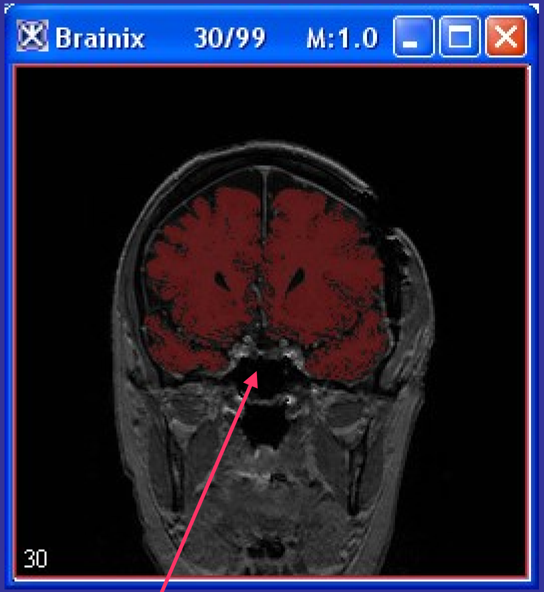
Volume Rendering Demo

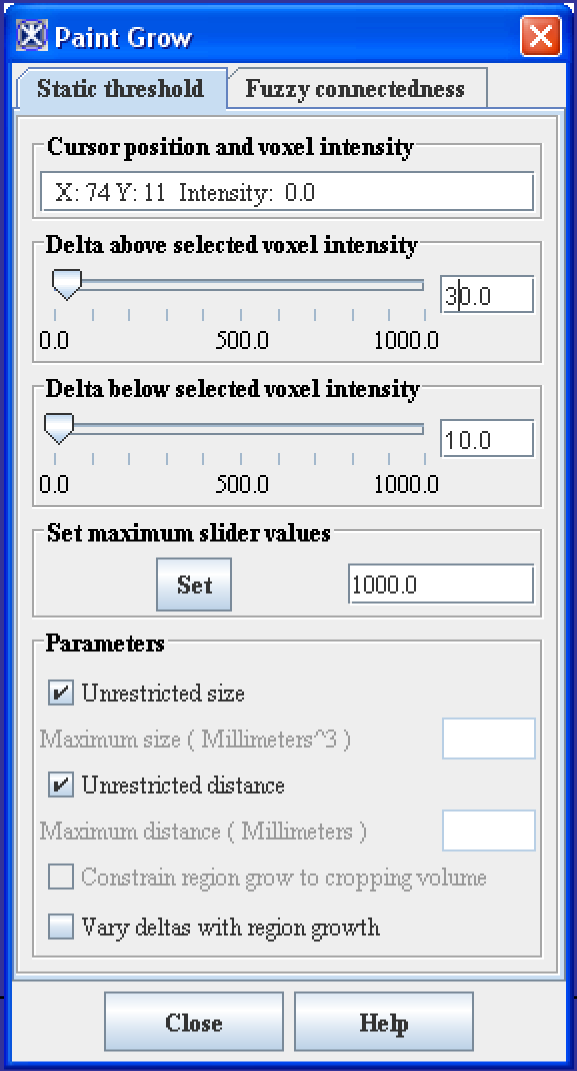
- Opacity filter
- Gradient magnitude filter
- Color Lookup Table
- Global opacity and blending
- 2D Histogram filters
- Clipping and Sculpting Volumes

Creating and Rendering Surfaces

- Creating Surfaces
- Adding a surface to the viewer
- Color and material
- Smoothing and decimation
- Painting on surfaces

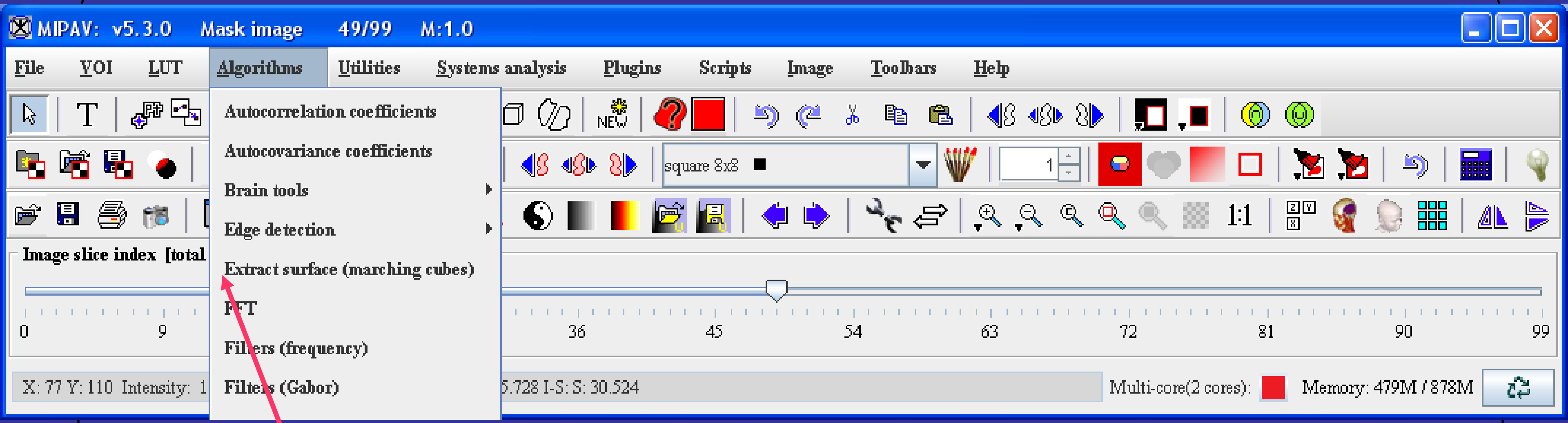
Surface Extraction from 2D Viewer



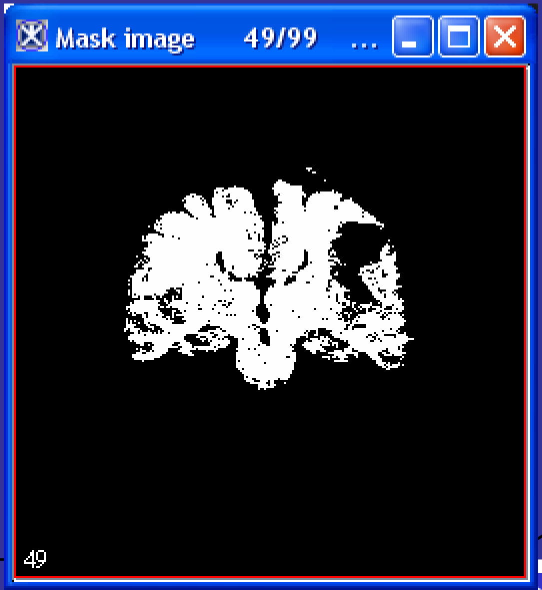


Use the Paint Can tool to grow a 3D region of paint in the image.

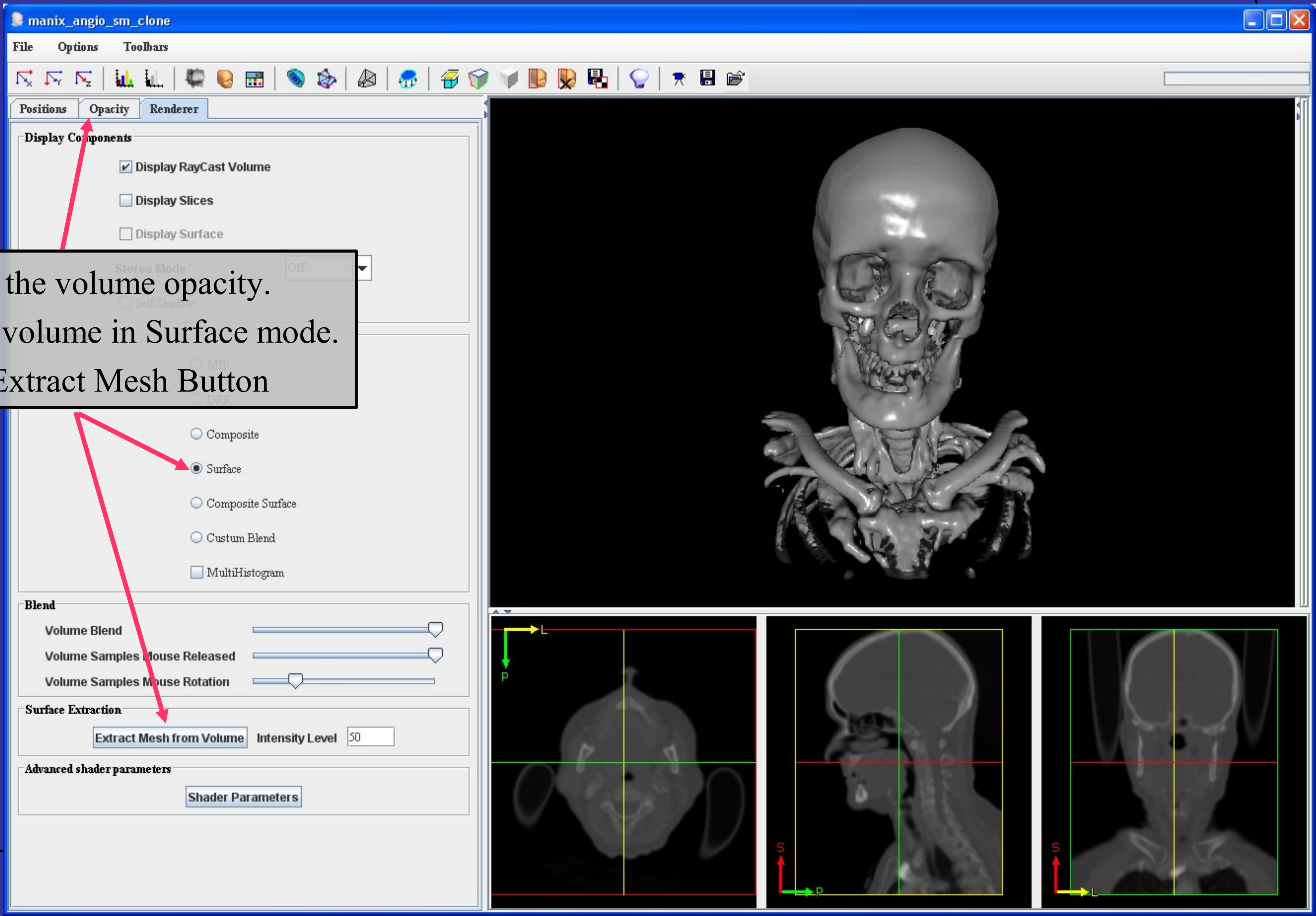
Surface Extraction from 2D Viewer



Algorithms ->Extract surface (marching cubes)
Extracts from a mask or VOI region.



WYSIWYG Surface Extraction

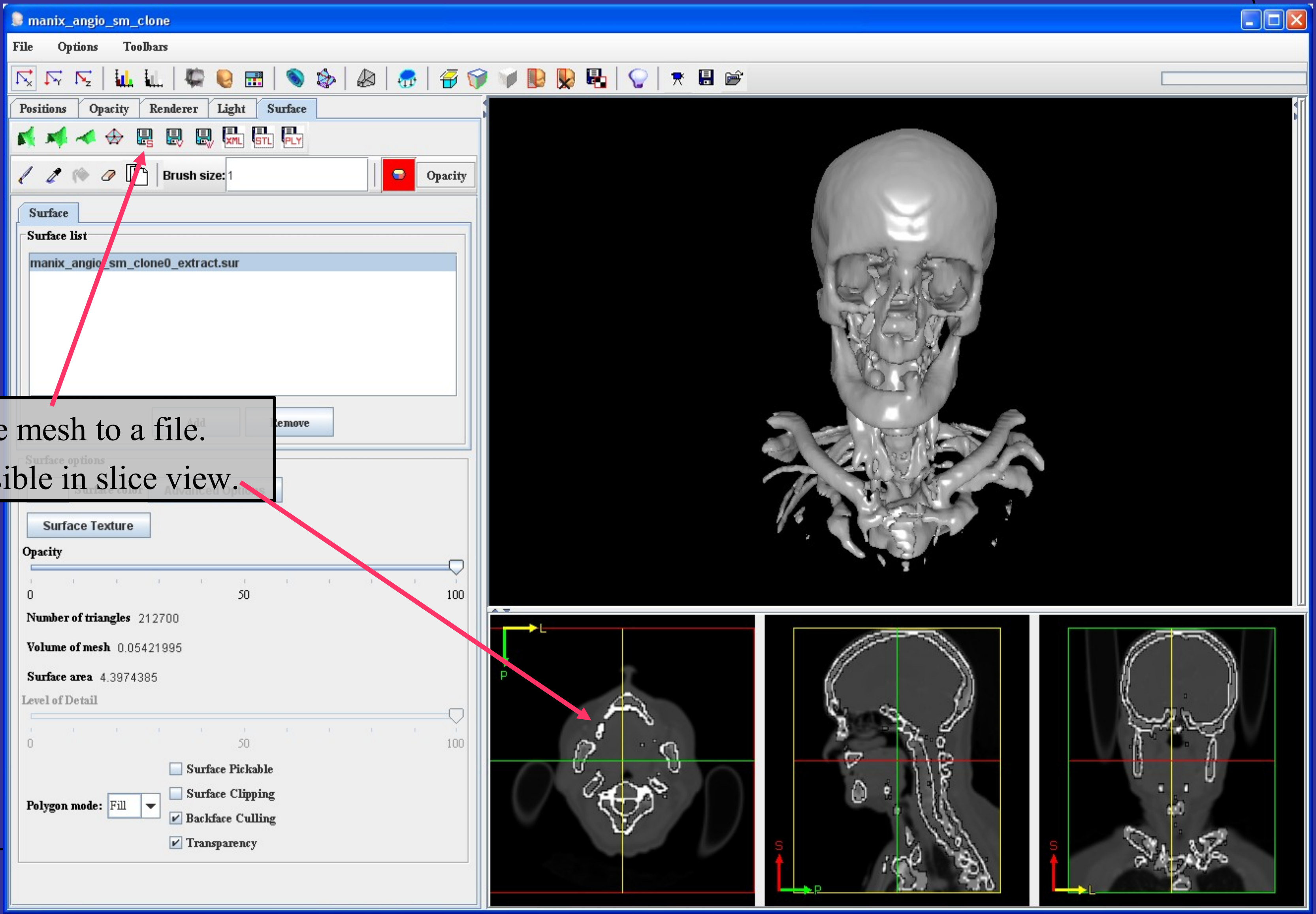


Adjust the volume opacity.

Display the volume in Surface mode.

Press Extract Mesh Button

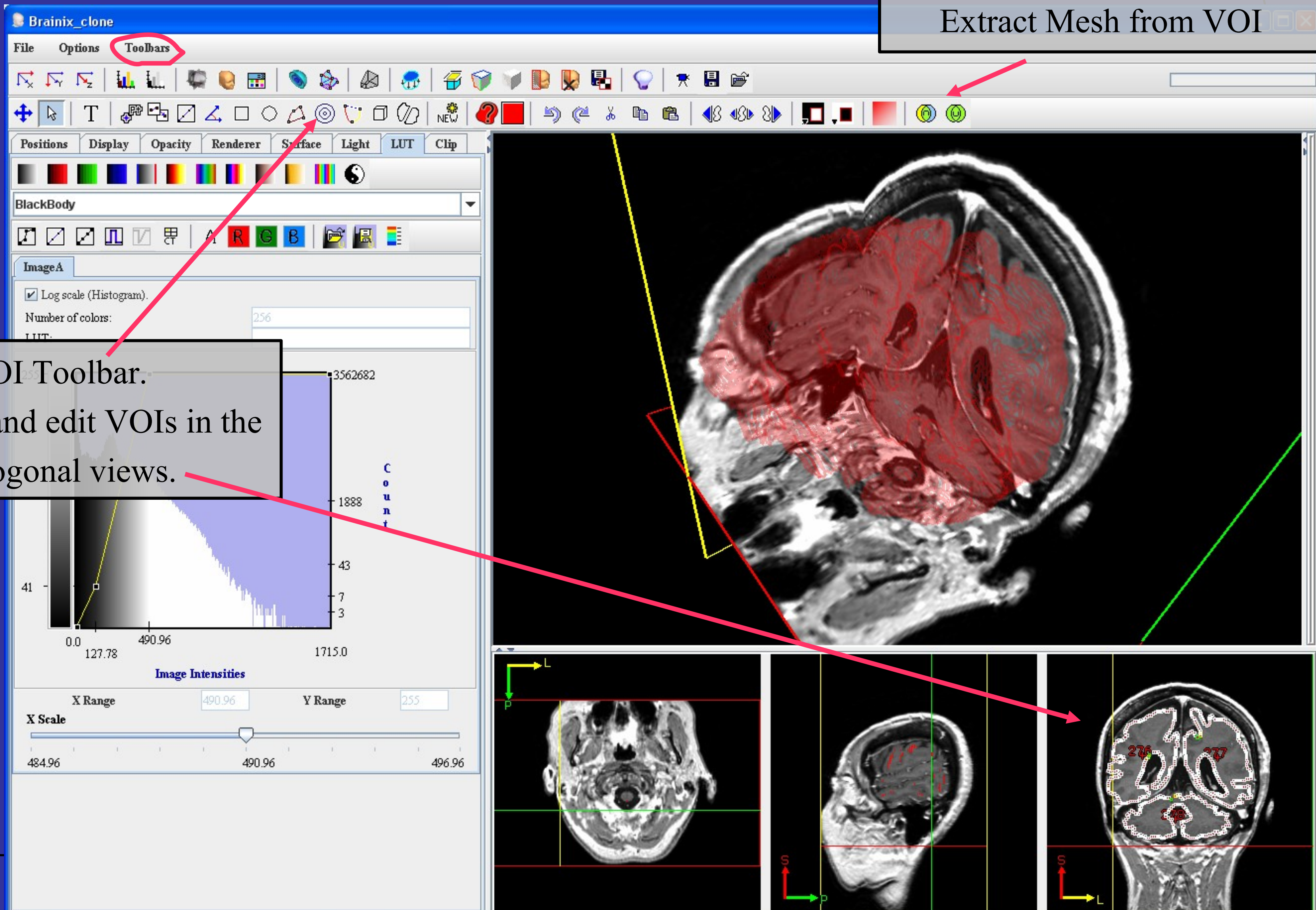
WYSIWYG Surface Extraction



Save the mesh to a file.
Surface visible in slice view.

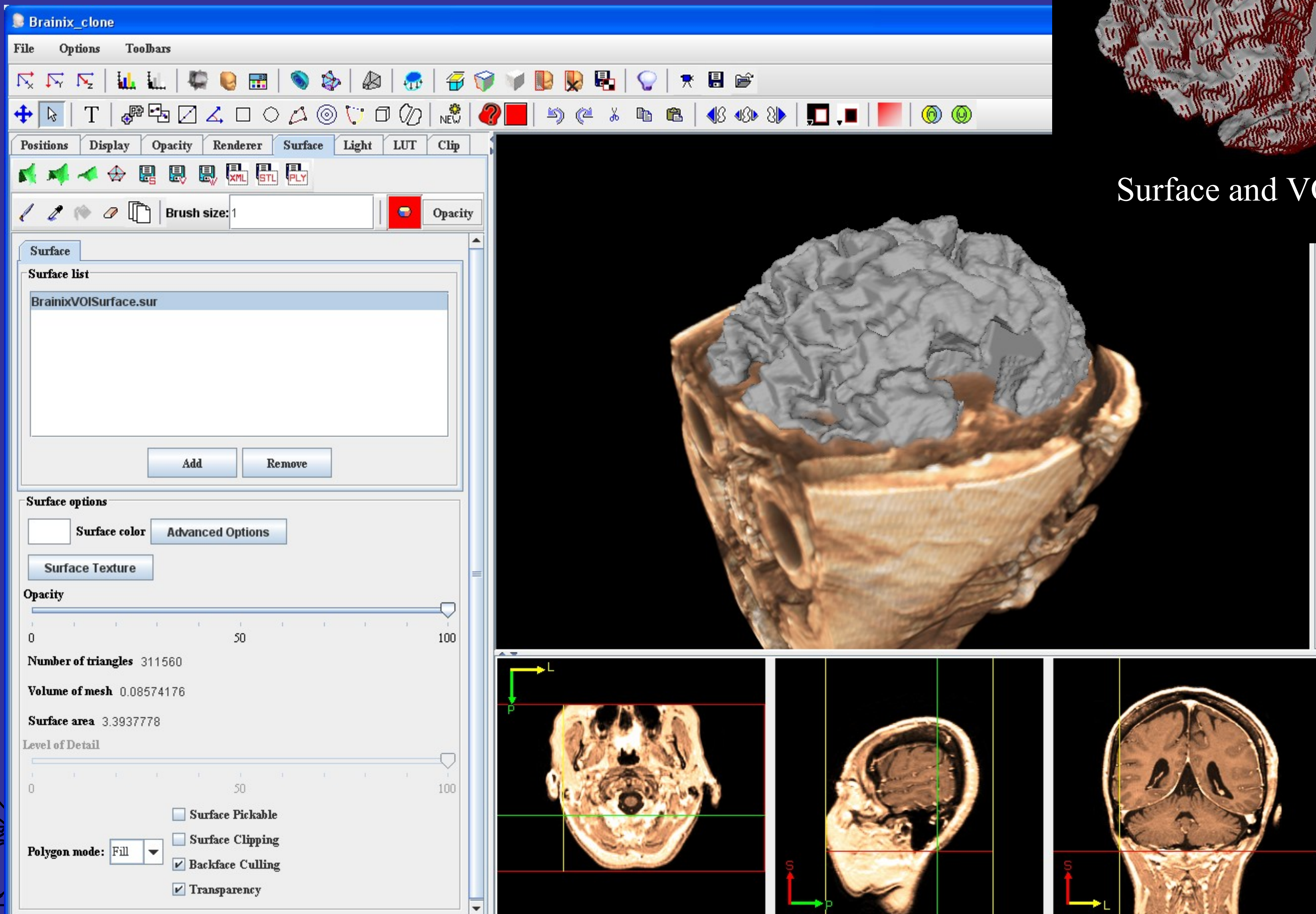
VOI Surface Generation

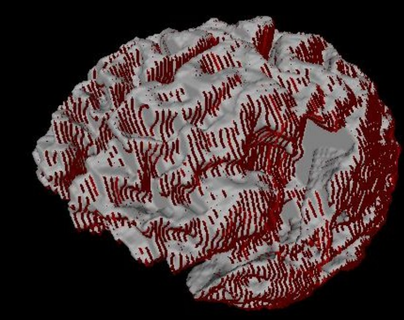
Extract Mesh from VOI



VOI Toolbar.
Can draw and edit VOIs in the orthogonal views.

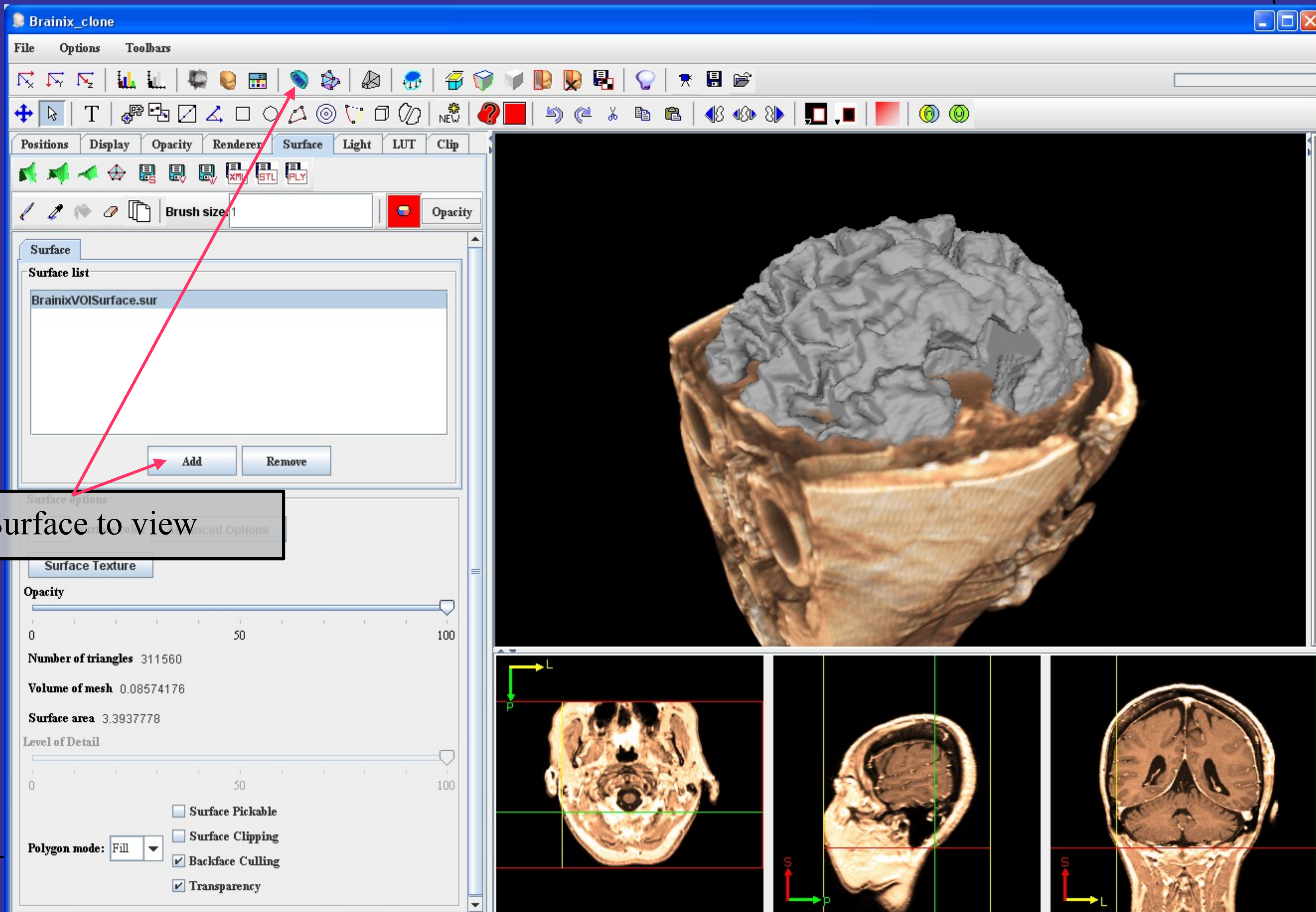
VOI Surface Generation





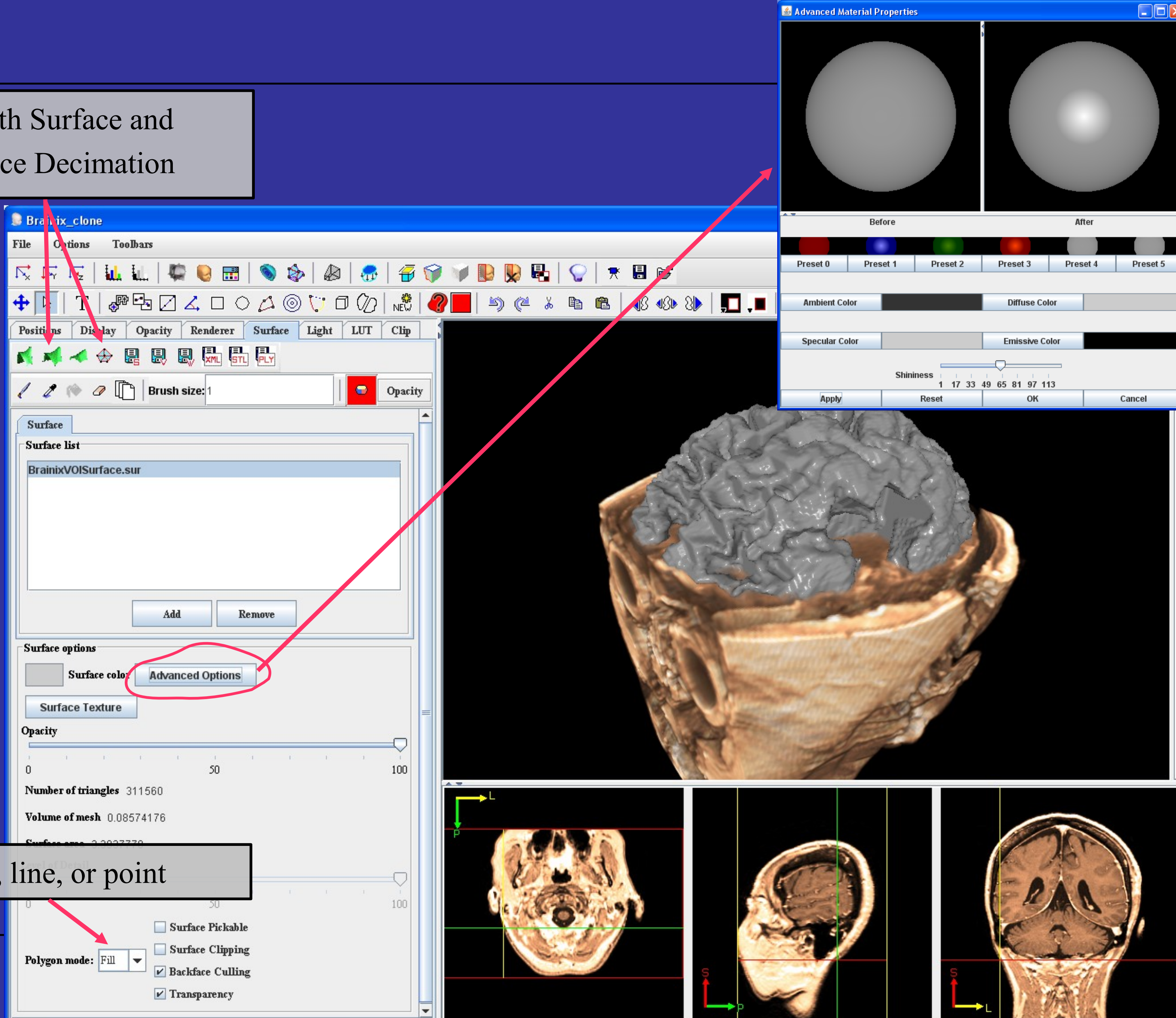
Surface and VOIs

Adding a Surface from File

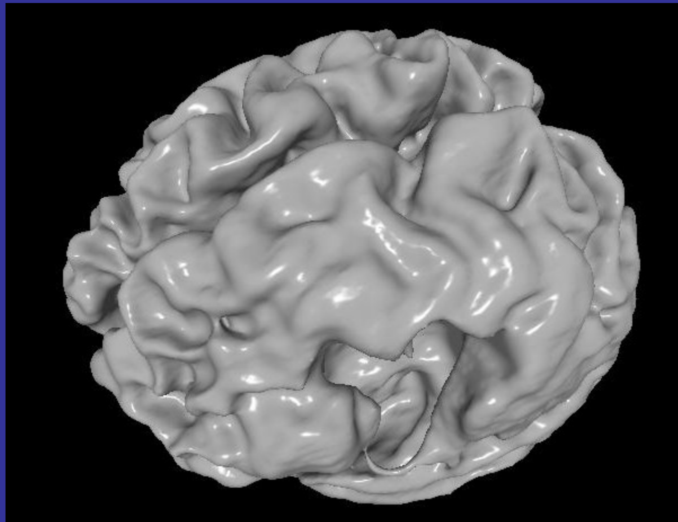


Add Surface to view

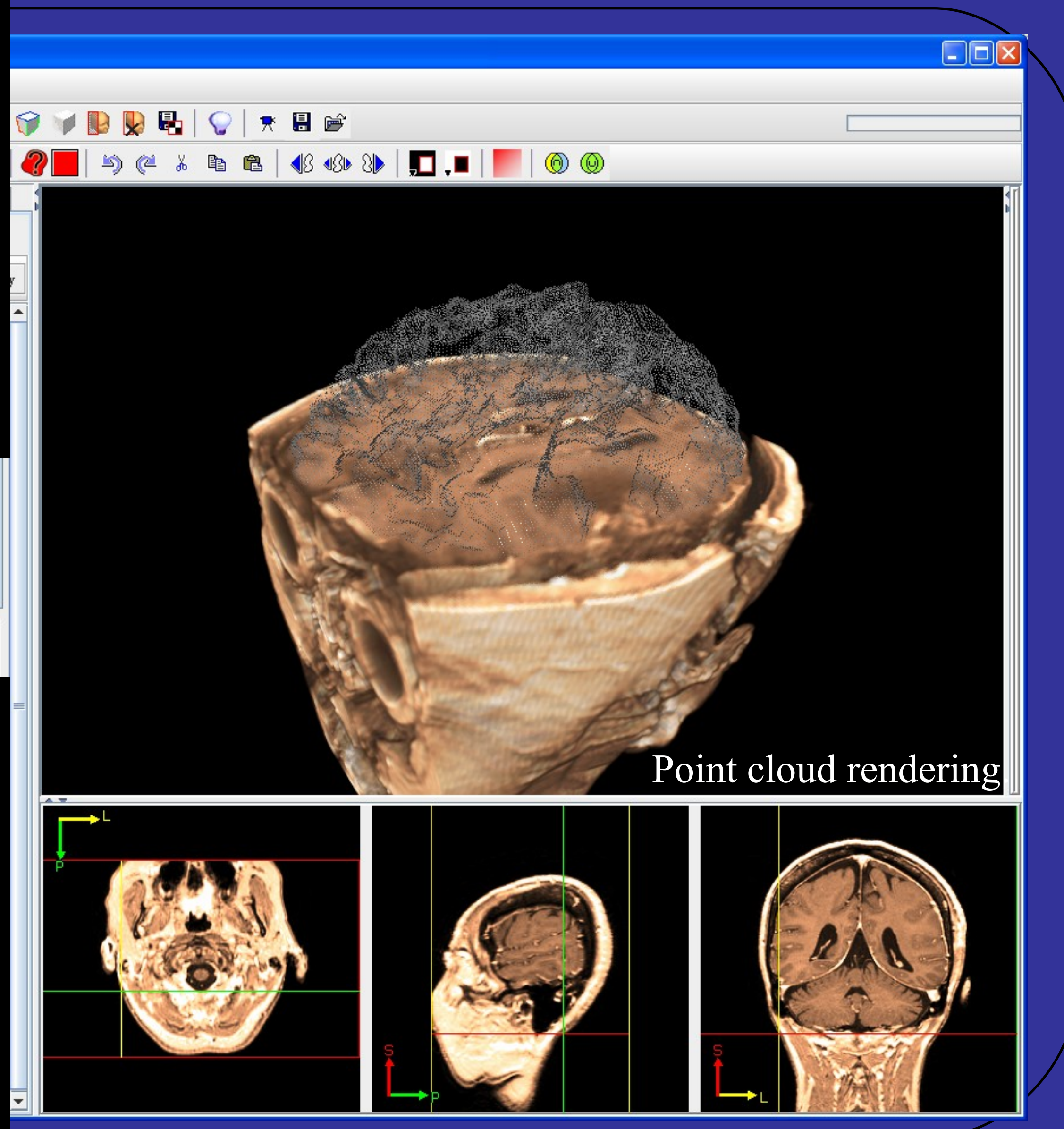
Smooth Surface and Surface Decimation



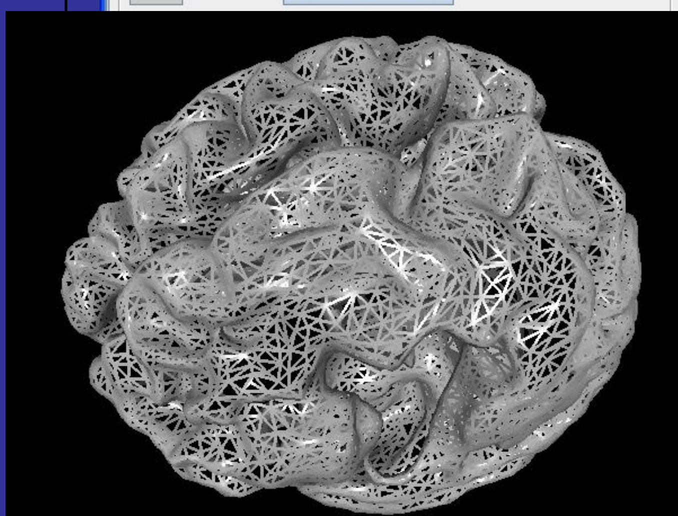
Solid, line, or point



Surface after smoothing.

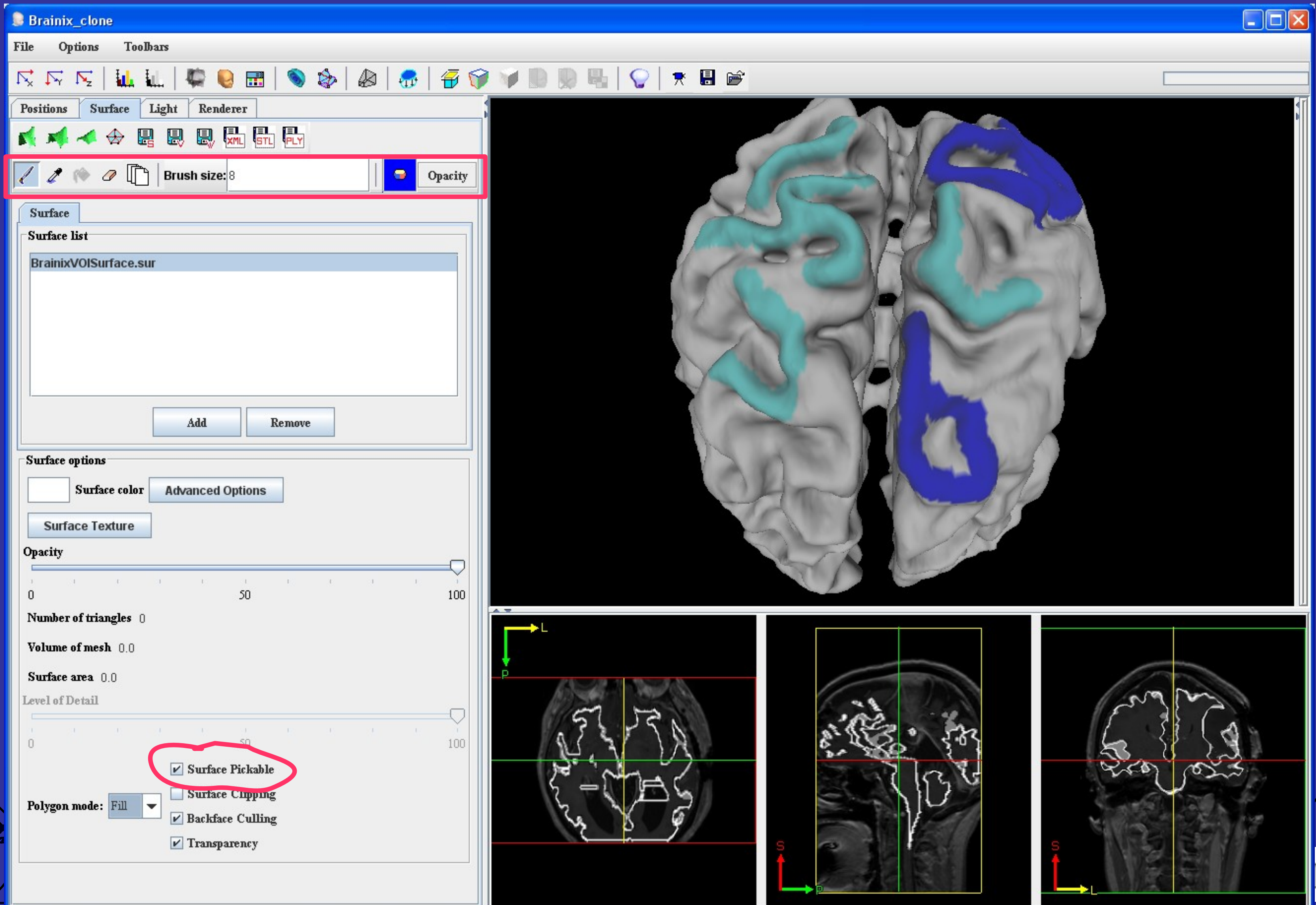


Point cloud rendering

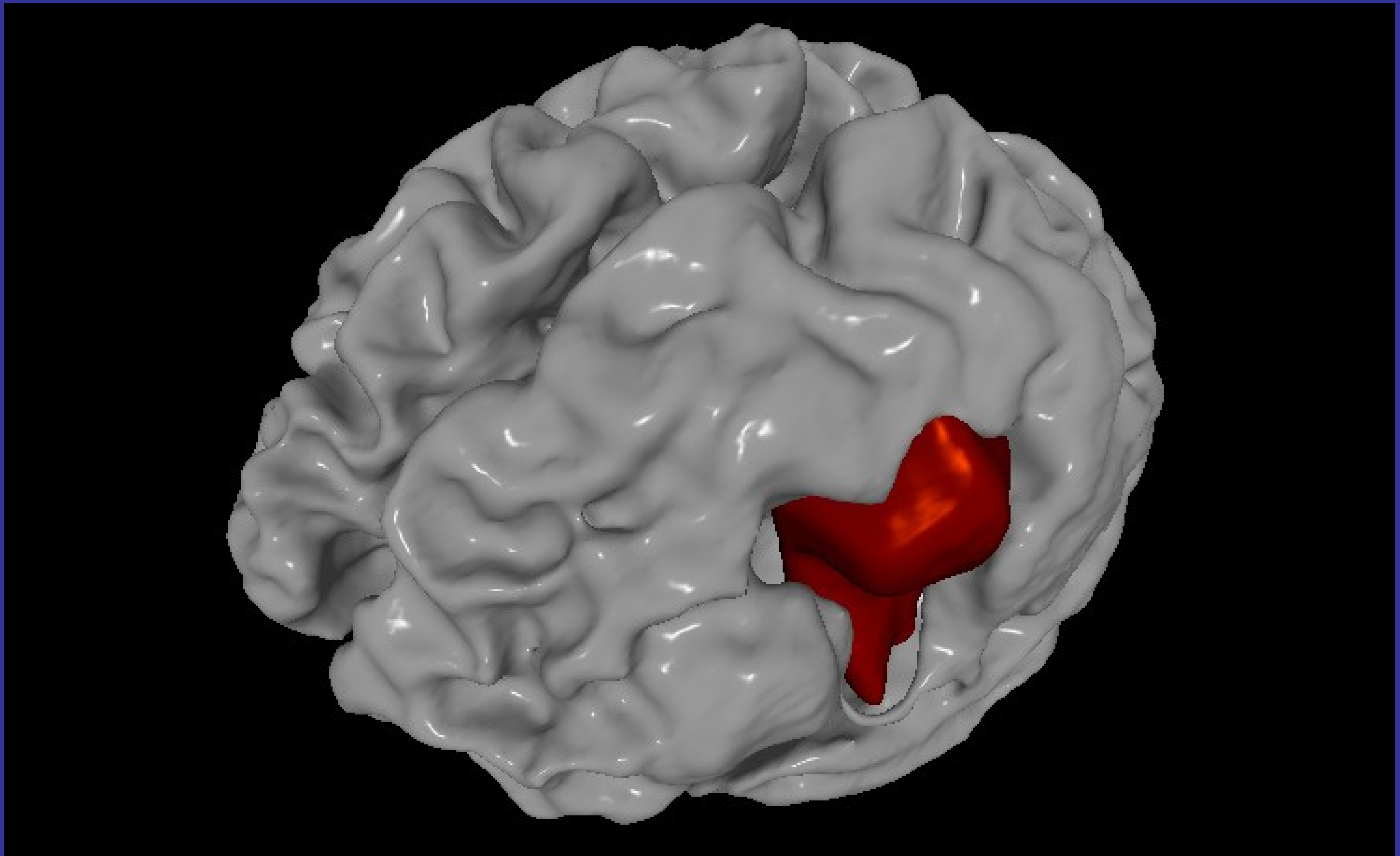


Surface after decimation.

Painting on Surface



Multiple Surfaces



Brain tumor extracted separately.

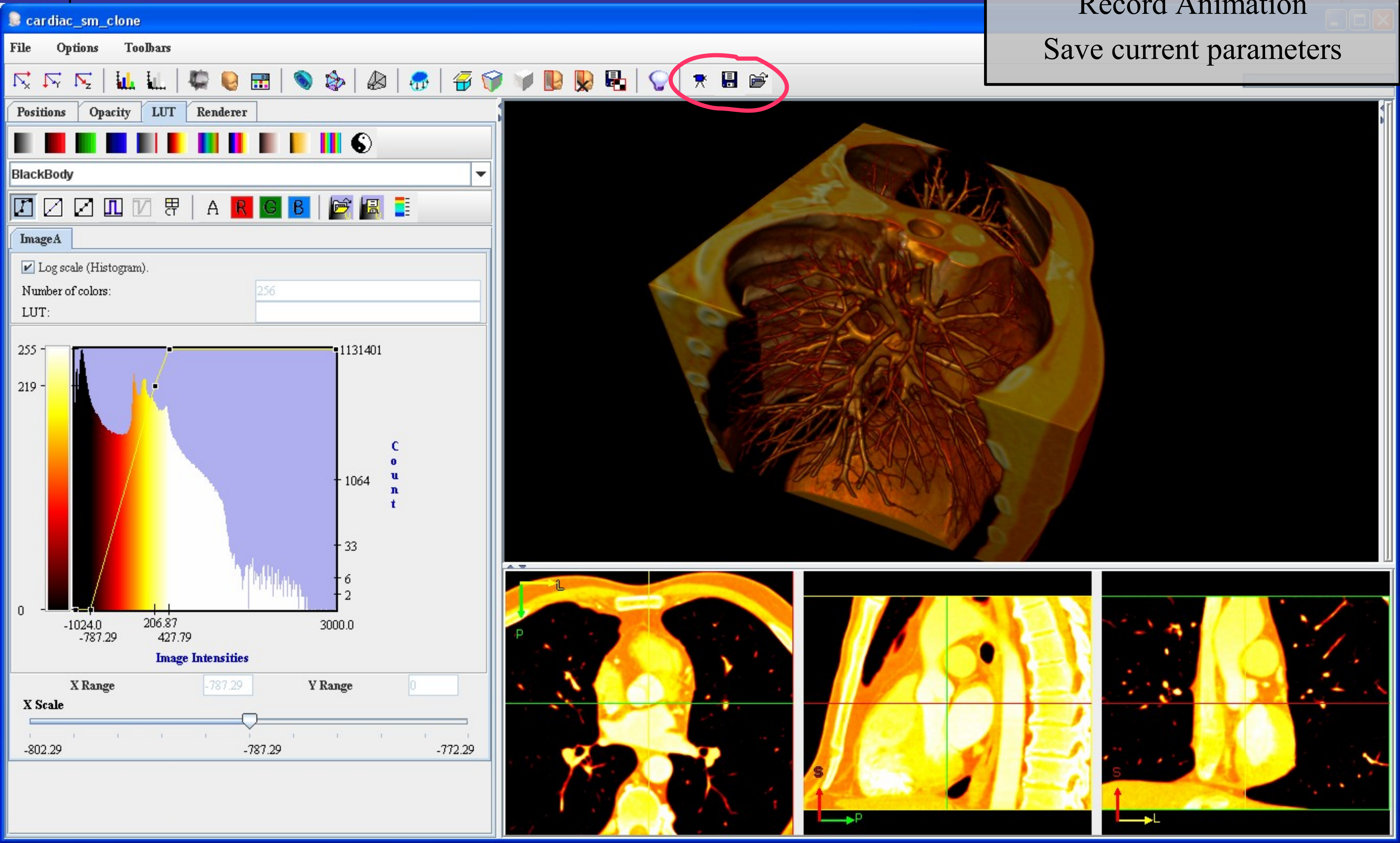
Creating and Rendering Surfaces

- Creating Surfaces
- Adding a surface to the viewer
- Color and material
- Smoothing and decimation
- Painting on surfaces

Saving Visualization Data

Record Animation

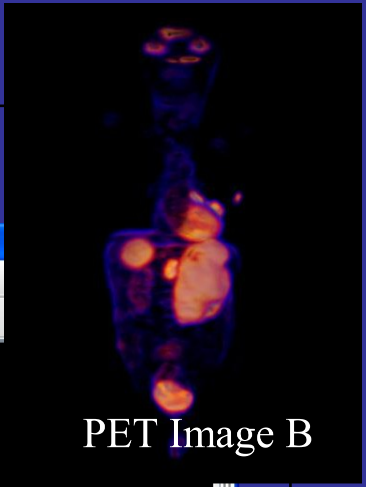
Save current parameters

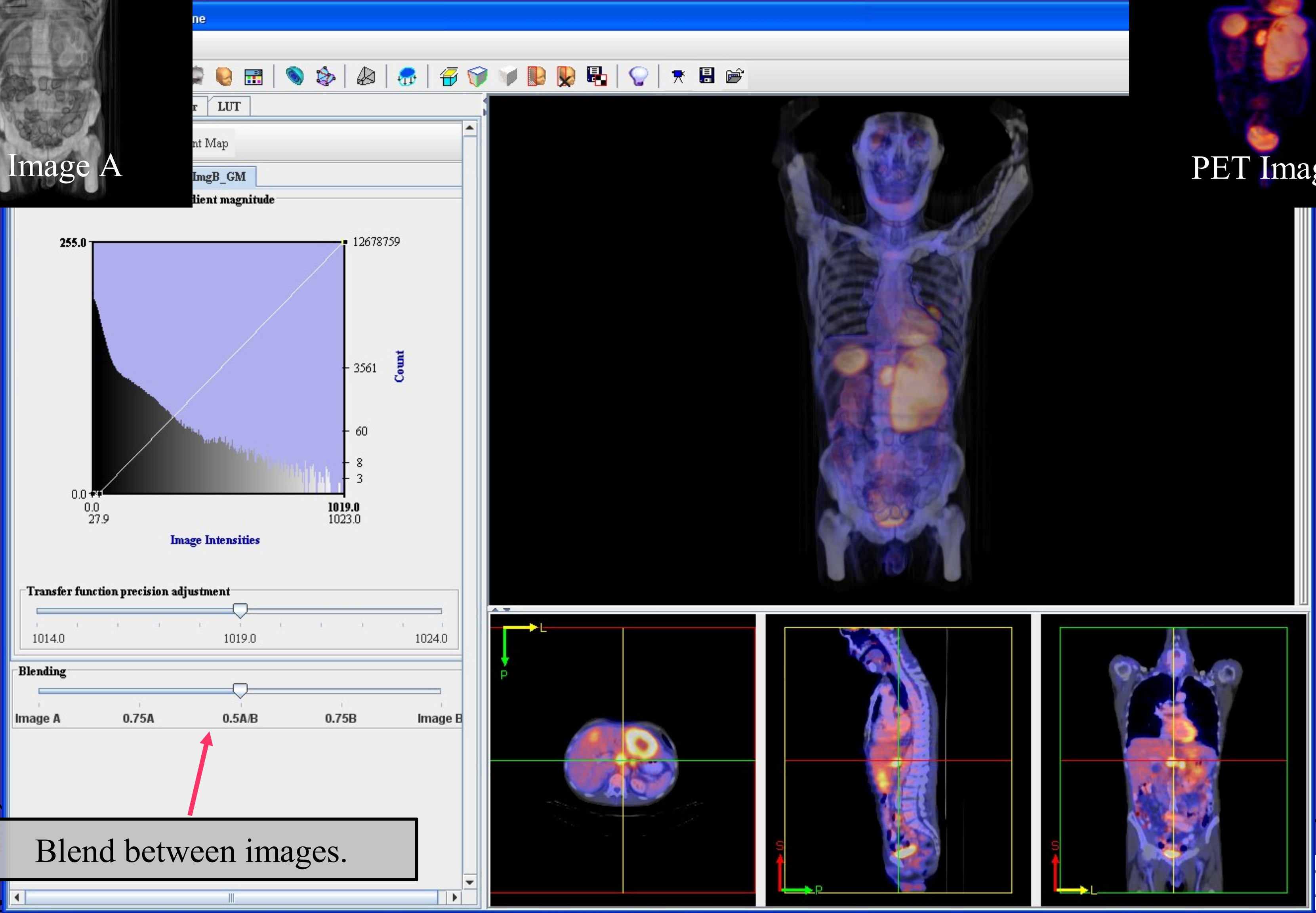


Advanced 3D Visualization

- Image Fusion
- 4D Volume Rendering
- 3D Stereo viewing

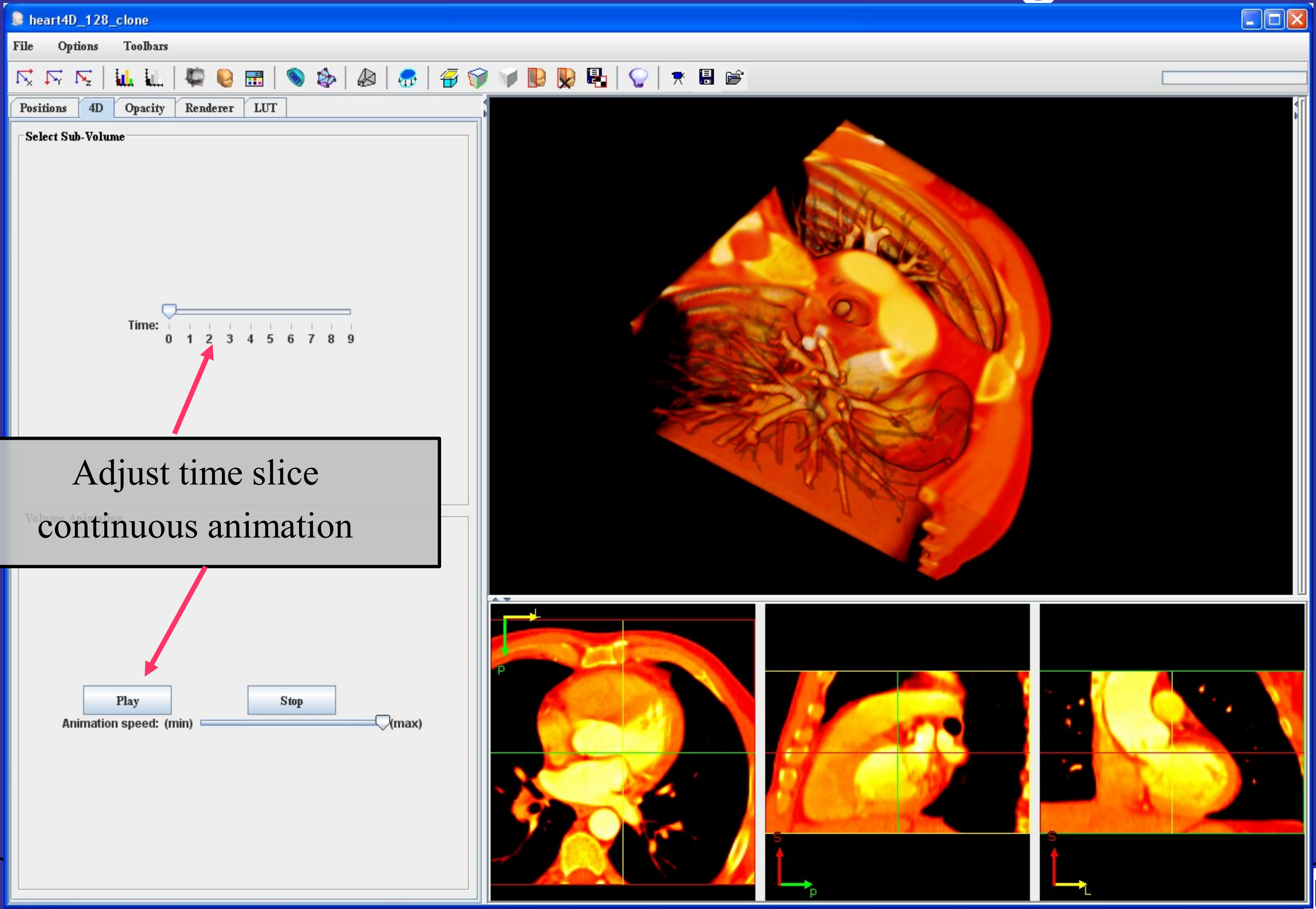
Image Fusion





Blend between images.

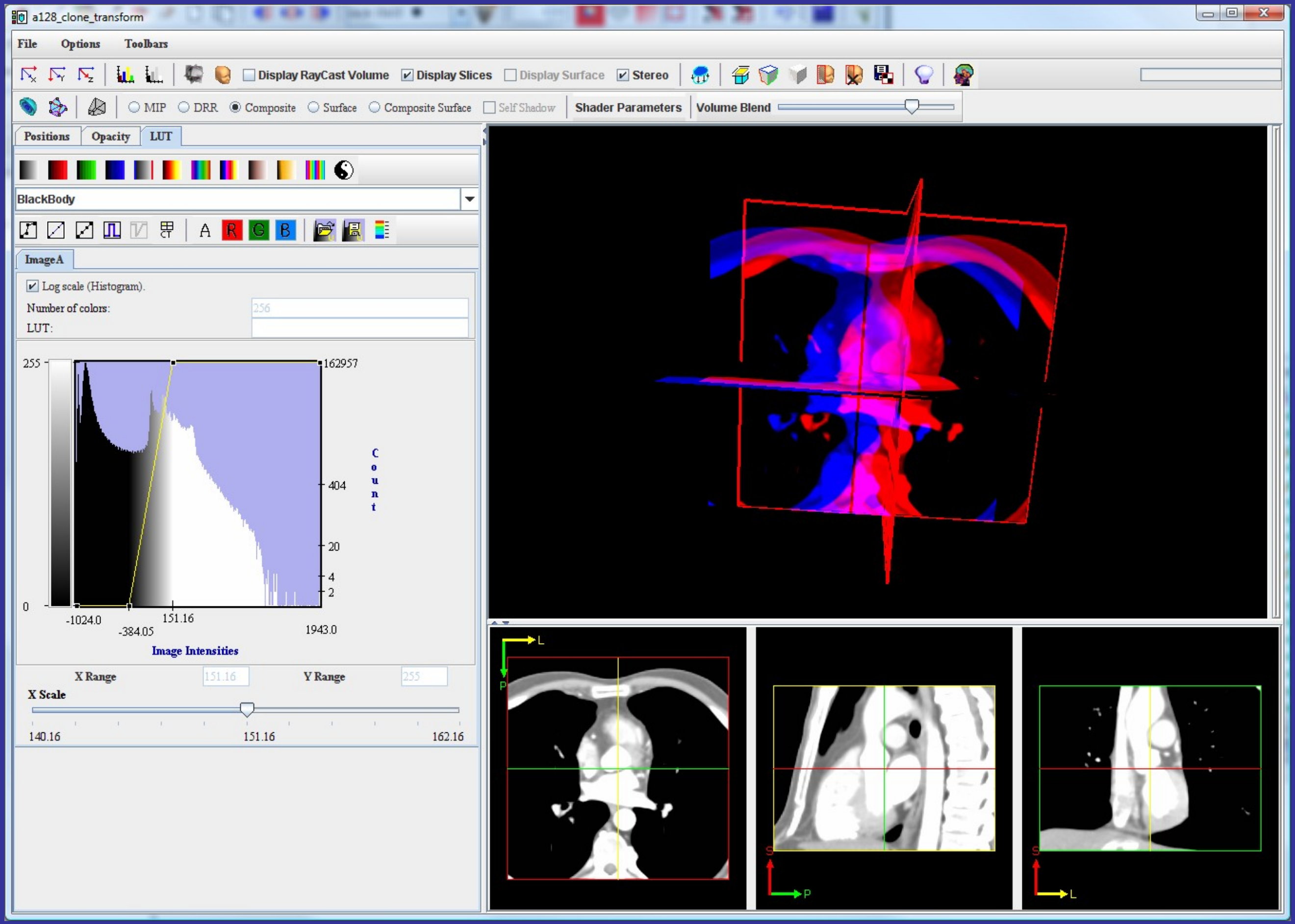
4D Volume Rendering



Adjust time slice

continuous animation

Stereo View

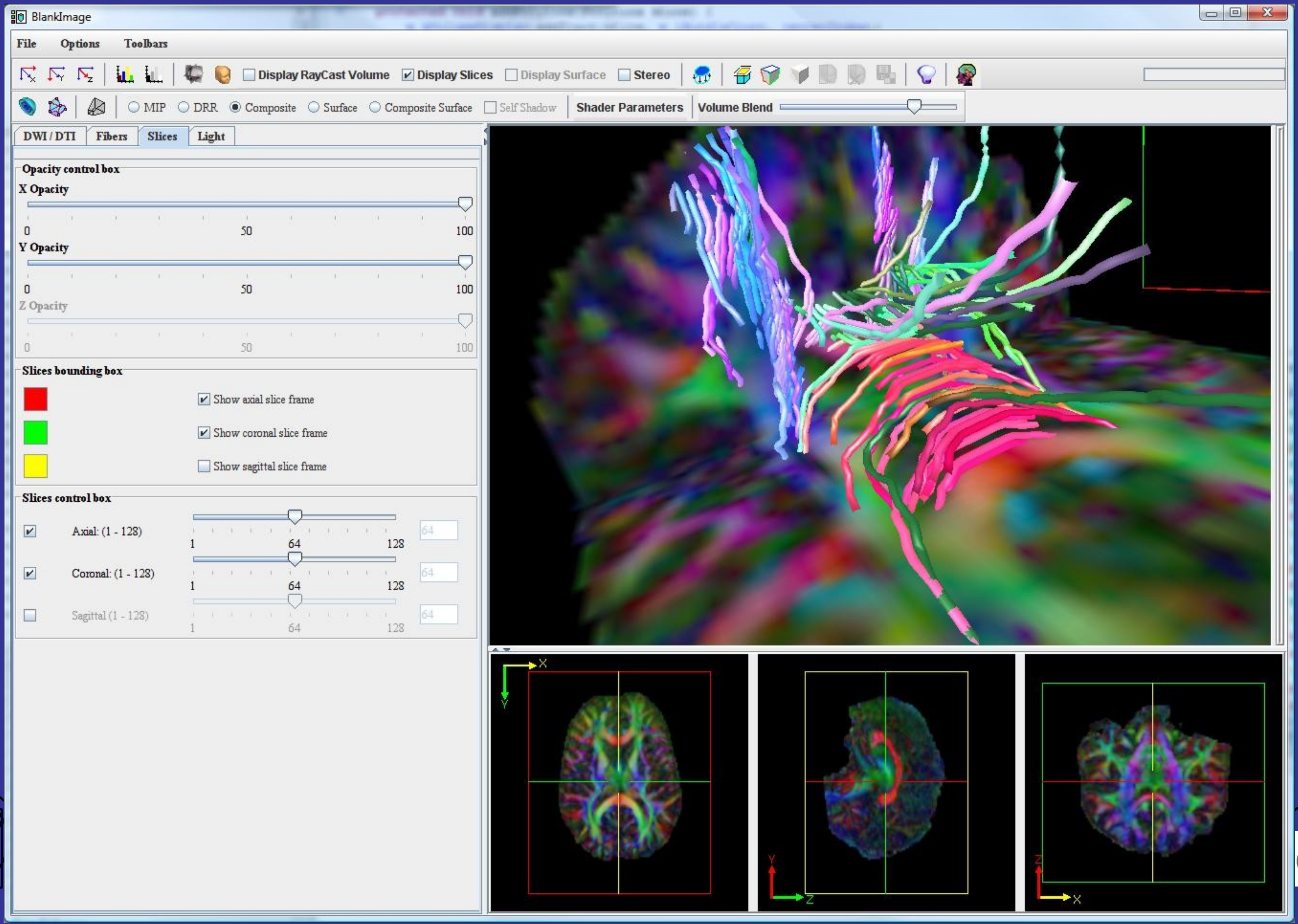


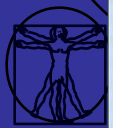
a128_clone_transform
File
Options
Toolbars
Display RayCast Volume
Display Slices
Display Surface
Stereo
MIP
DRR
Composite
Surface
Composite Surface
Self Shadow
Shader Parameters
Volume Blend
Positions
Opacity
LUT
BlackBody
Image A
Log scale (Histogram)
Number of colors:
LUT:
255
162957
404
20
4
2
0
-1024.0
-384.05
151.16
1943.0
Count
Image Intensities
X Range
Y Range
X Scale
140.16
151.16
162.16

Applications of MIPAV 3D Visualization

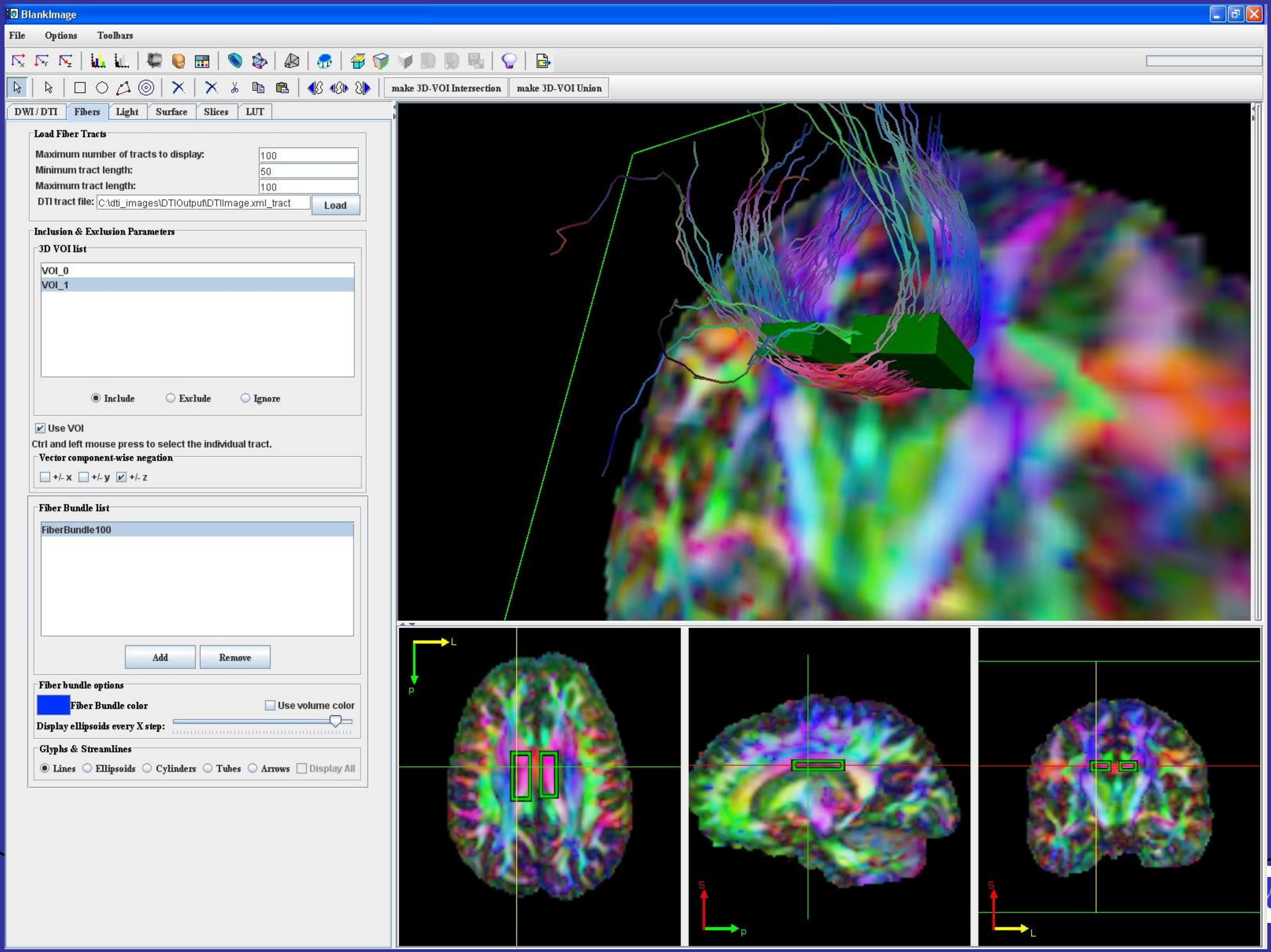
CIT

DTI Visualization

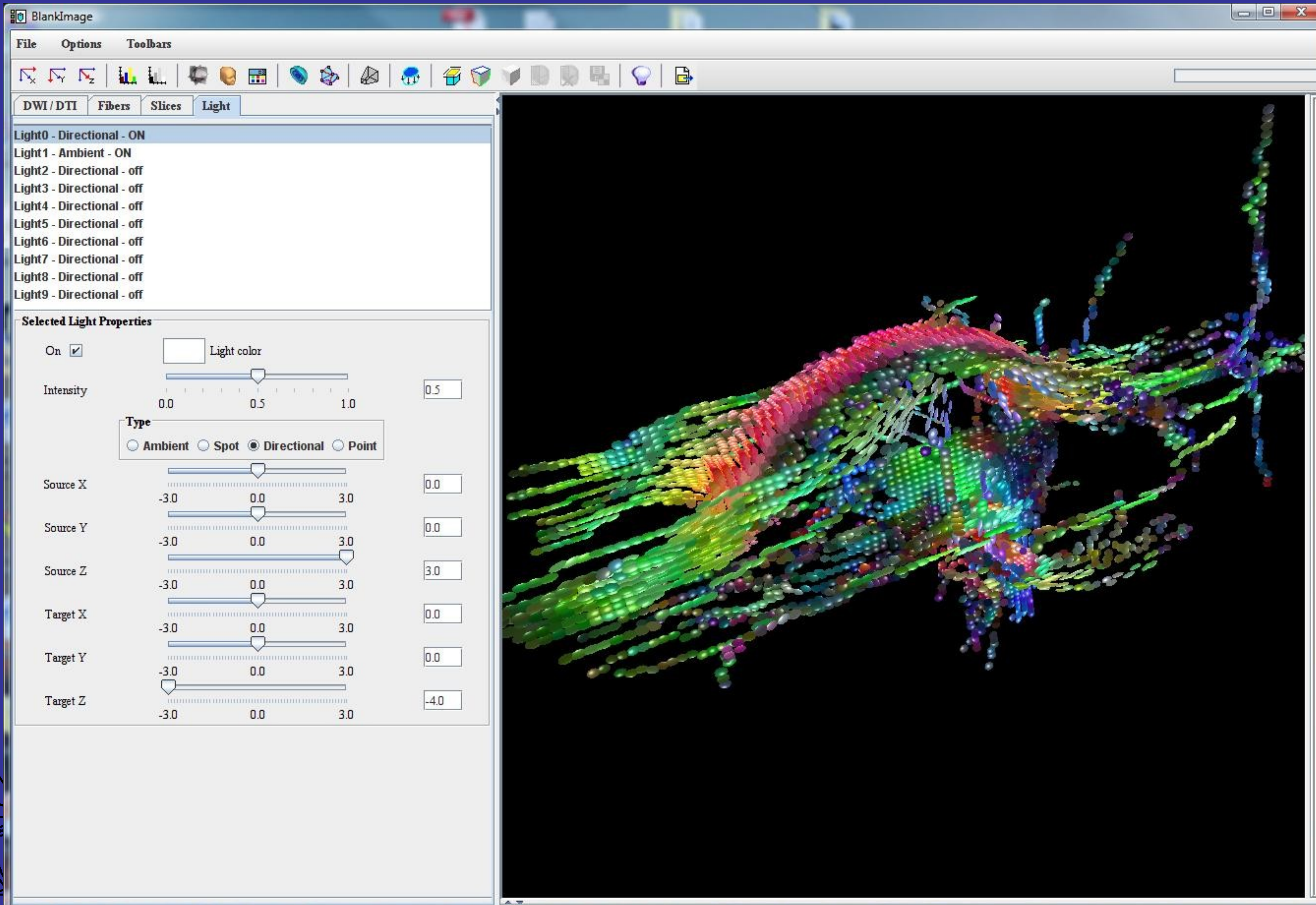




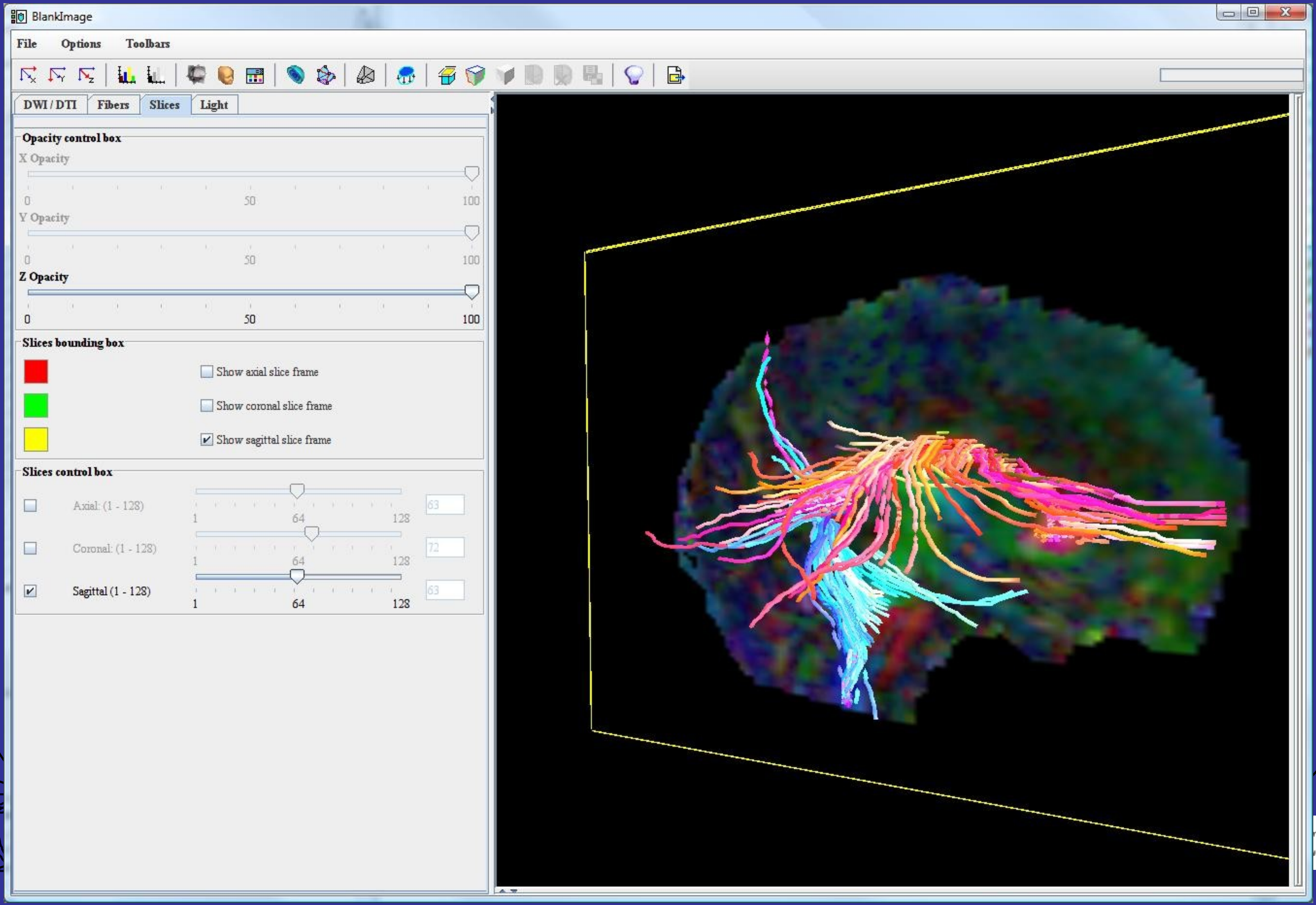
DTI Visualization



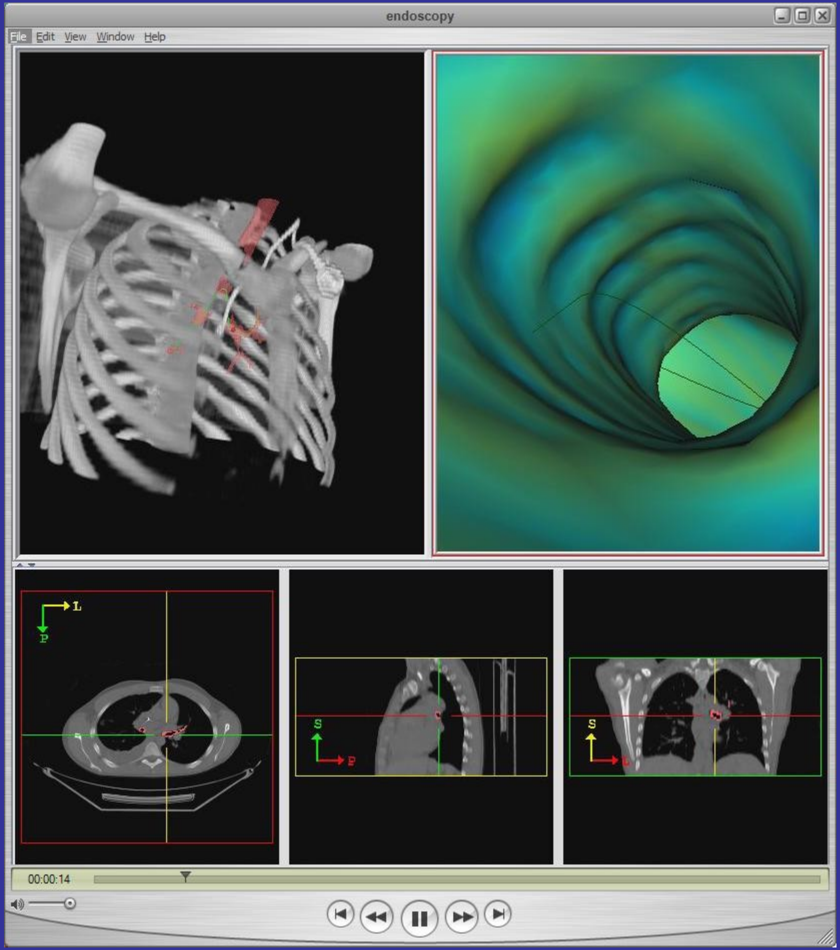
DTI Visualization



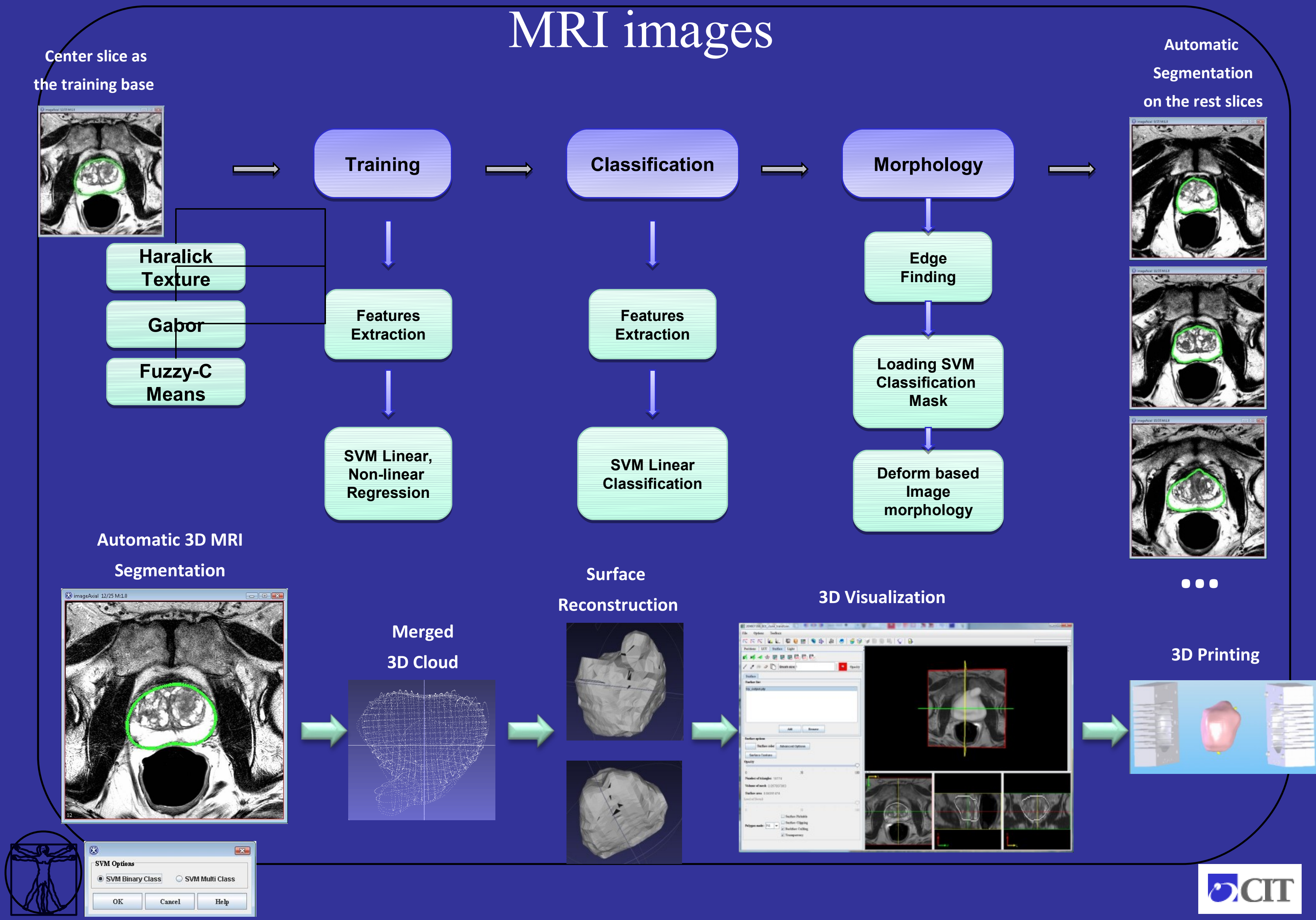
DTI Visualization



Visual Endoscopy Simulation



SVM based Automatic Prostate Segmentation on 3D MRI images



OpenCL

Open Compute Language

Use the Graphics Processing Unit (GPU) as a general massively parallel compute device.

Currently available for FFT

Soon to be available in other MIAPV Algorithms

M I P A V

Medical Image Processing, Analysis, & Visualization