- *Volume rotate [default]*
- *Plane rotate*
- *Length*
- *3D Point*
- *Circle*
- *Scissors*
- *Bones removal*

All tools function as they did in the 2D viewer except the Volume rotate, Plane rotate, Circle, Scissors, and Bone removal tools. Volume rotate allows you to click and drag on the 3D image to move it in the x, y, z planes. The Plane rotate tools moved the entire 3D image in a single plane. The Circle tool allows you to draw a yellow circle on the 3D image. The Scissors tool allows you to create a polygon that can be removed from the 3D image. Selecting the Bone removal tool and then clicking on a bone (high density structure) in the 3D image, removes bones from the image.

WL/WW & CLUT & Opacity

These tools are organized as a group of three dropdown lists. All three operate as they did in the 2D Viewer. Briefly, the WL/WW allows you to change the settings for WL/WW using a series of presets. The CLUT allows you to modify the color lookup table using a series of presets or create a new CLUT using the 16-bit CLUT Editor. The Opacity tool allows you select from several preset opacity tables.

CLUT Editor

There are two CLUT editor options 8-bit and 16-bit. Clicking on the 8-bit button brings up a window that you can use to convert the image to 8-bit black and white (Figure 7.27). The 16-bit option is the default (Figure 7.28).

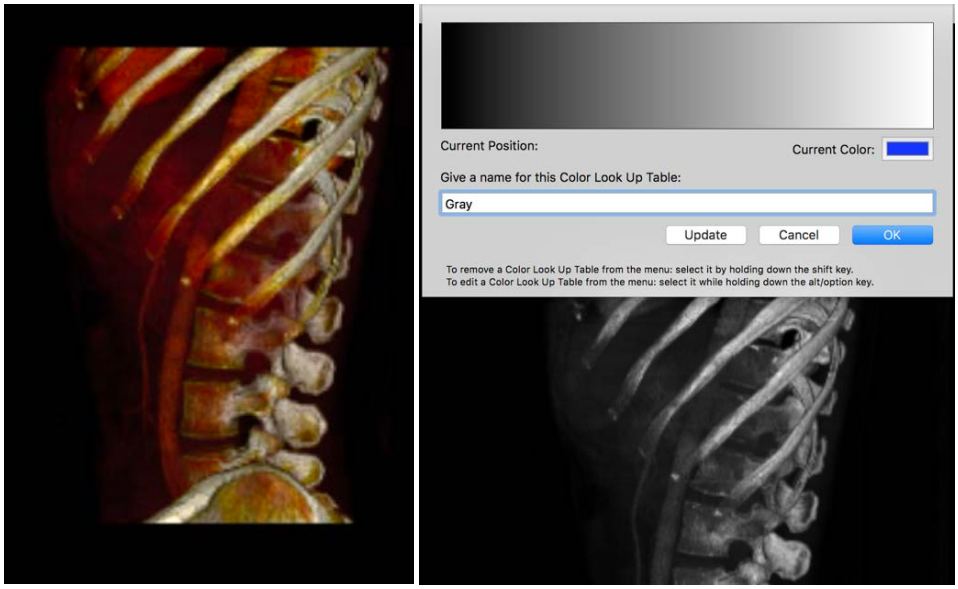


Figure 7.27. The default 16-bit CLUT is shown on the left and the 8-bit

CLUT editor popup window is on the right.

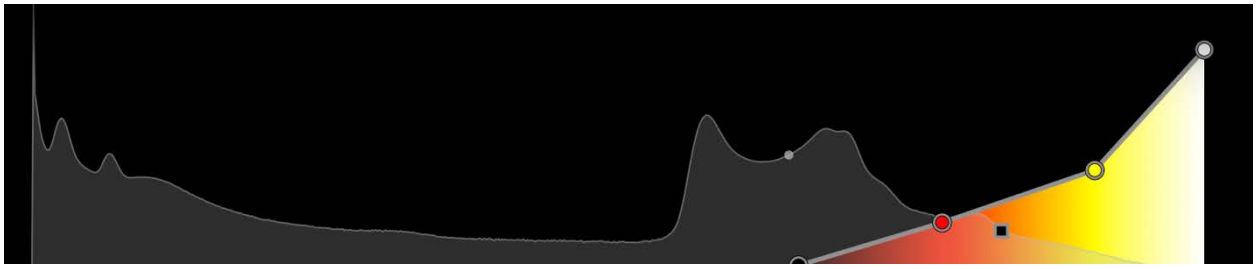


Figure 7.28. The window for the 16-bit CLUT editor.

Selecting the 16-bit editor brings up a second window at the bottom of the 3D image window (Figure 7.28).

3D Presets

You can select from a pre-defined set of rendering options by clicking on the 3D Presets button in the tool bar. This brings up a popup window (Figure 7.29) that show the presets available in three groups; Basic, Bone CT, and Soft tissue CT. For example, selecting the Bone + Skin II preset in the Bone CT group generates the 3D rendering shown in Figure 7.30 after you press the Apply button. Clicking on the Info button brings up an info box with details about the preset (Figure 7.8).

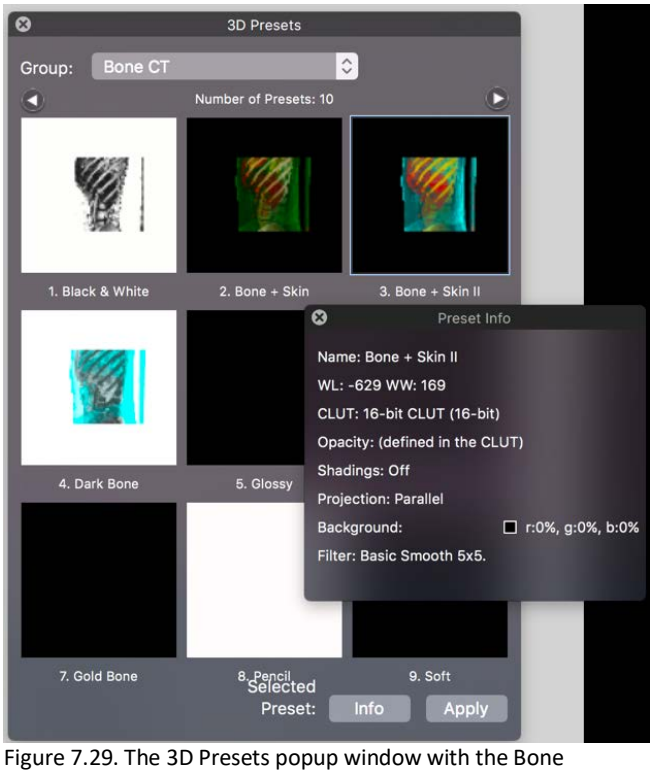


Figure 7.29. The 3D Presets popup window with the Bone CT group selected and the info box displayed for the Bone + Skin II preset.

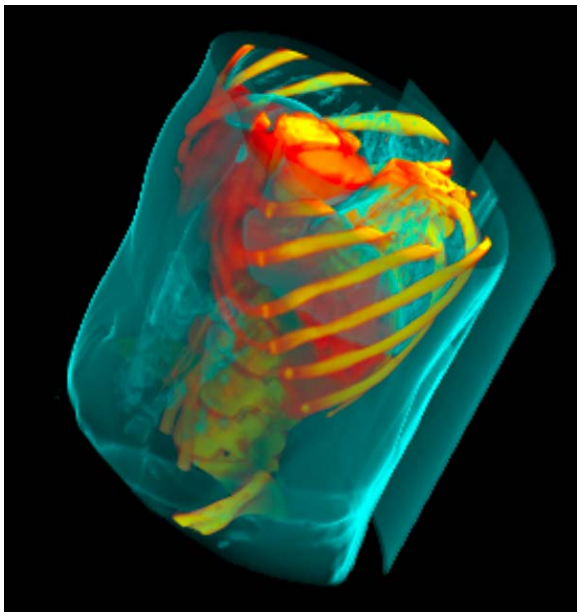


Figure 7.30. The Bone + Skin II preset displayed as a 3D volume rendering.

Level of Detail

You can select a finely rendered or a coarsely rendered image by moving the slider on the Level of Detail tool to the right or left.

Best Rendering

Clicking the Best Rendering tool forces Horos to render a high-quality image temporarily.

Engine

The Engine tool allows you to choose the computer's CPU (central processor) or GPU (graphics processor) engine to render images.

Cropping Cube

The Cropping Cube allows you to resize the area that will be rendered. The cube has 6 sides, each with a green ball in the middle of the plane. Clicking and dragging on one green ball moves that plane in or out. Data outside the bounds of the cropping cube will not be rendered (Figure 7.31).

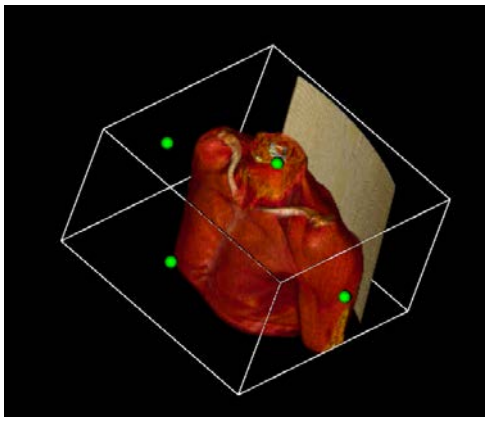


Figure 7.31. The Cropping Cube.

Orientation Cube

You can hide or display the orientation cube and labels using this tool. When displayed, there is a small orientation cube in the upper right corner and 4 small labels on each side of the image. The labels include left (L), right (R), posterior (P), anterior (A), superior (S), and inferior (I).

Shadings

You can modify the shading settings for a Volume Rendering (not an MIP) by clicking on the edit button in the Shading tool. This brings up a floating window (Figure 7.32) where you can adjust the levels of Ambient coefficient, Diffusion coefficient, Specular coefficient, and Spectral power. There are 4 predefined presets and you can create a new preset by clicking on the + to the right of the presets. Clicking on the edit button allows you to edit the four coefficients by using the slider to adjust the values. When you are satisfied, you can add this new preset by giving it a name and clicking the + to the right of the presets list

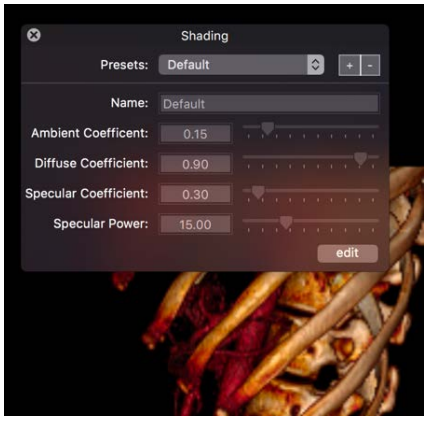


Figure 7.32. The Shading popup window.

You can turn shading on or off by clicking the check box.

Perspective

You can choose from three rendering perspectives; parallel, perspective, and endoscopy.

Filters

The Filters tool allows you apply convolution filters to the 3D image. There are 22 filters are available (Figure 7.33). Details for each filter are provided in Chapter 6.

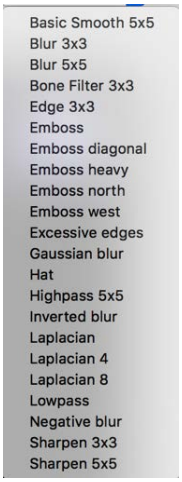


Figure 7.33. The convolution filters available from the Filters tool in the 3D Viewer.

Clipping

The Clipping tool allows you to create 2 clipping planes of defined thickness (using the slider). All image data outside the clipping planes will not be rendered. You can move the clipping planes by dragging the mouse over the image. You can also turn the clipping planes on or off by checking or unchecking the small checkbox.

Movie Export

You can create a movie of the 3D volume using the Movie Export tool. A popup window (Figure 7.34) allows you to choose the following options:

The number of frames to be generated – up to a maximum of 360 frames
The rotation amplitude (180º or 360º) and direction (horizontal or vertical)
The rendering quality (Current or Best)
The size of the movie (current, 512x512, 768x768)

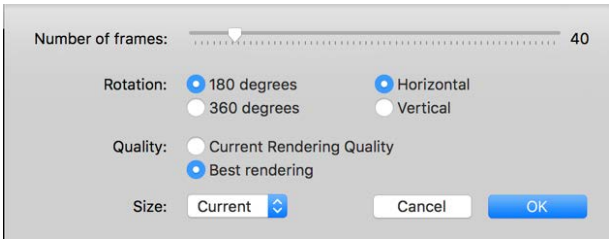


Figure 7.34. The Movie Export options window in the #D Viewer.

Orientations

Clicking on the four Orientations button in the Toolbar switches your view of the 3D volume beginning with axial (on the left), coronal, left sagittal, and right sagittal (on far right).

Reset

Choosing the Reset tool in 3D Volume Rendering changes the zoom, pan, rotation, WL/WW values, and camera position back to their default setting.

Revert

The Revert tool reloads and re-renders the image data from the original DICOM files. It cannot be undone.

Save as DICOM

You can create snapshots of your 3D scene, save them to disk as DICOM files, and add them to the database. Clicking on the DICOM tool opens a popup window (Figure 7.35) where you can create a new series name for the exported snapshots. You can also modify the size of the images by choosing between current, 512x512, or 768x768. Depending on the volume rendering you are using, you can also choose between 8-bit RGB or 16-bit BW formats. Note that 16-bit BW only works with MIP rendering. You can choose to only export the current image, an animated 4th dimension sequence (if available), or an animated series of images from the rotating volume. If you choose the animated series, you can change the number of frames to render (up to 360 frames), the direction of rotation for the animation, and the render quality. Finally, you have the option to mark the images as key images and the option to send the exported images to a DICOM node.

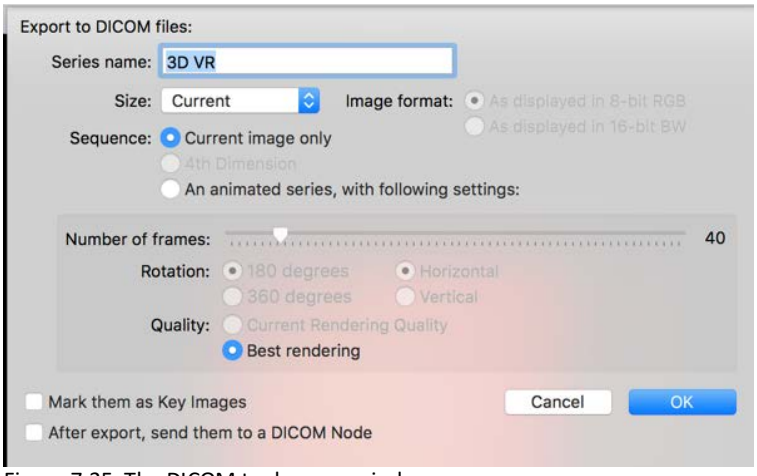
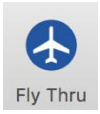


Figure 7.35. The DICOM tool popup window.



FLY THRU

You can create movies of 3D scenes in three 3D viewers; 3D MIP, 3D Volume Rendering, 3D Surface Rendering, and 3D endoscopy Viewer. To begin, open a patient series, double click on an image from that series in the bottom of the database window, and then choose 3D Volume render from the 2D/3D options button in the toolbar. With your 3D volume rendered, select the 3D Viewer menu from the top menu bar (Figure 7.36) and click on Add FlyThru Point option (or use the keyboard shortcut ⌘ **F1)**.

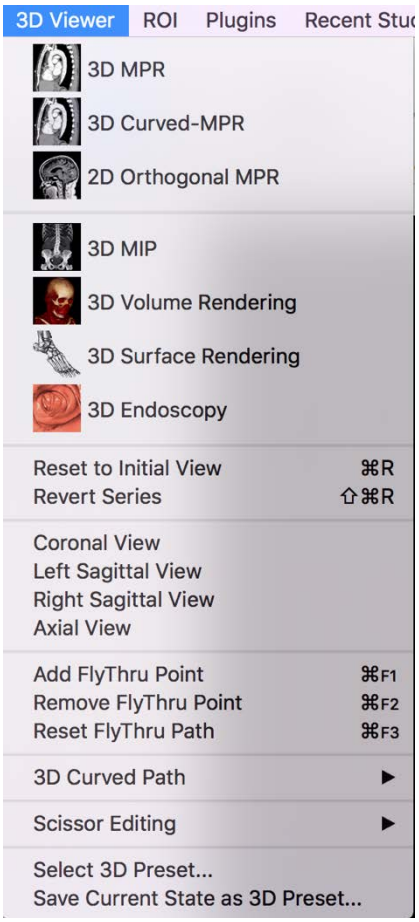


Figure 7.36. The options under the 3D Viewer menu bar.

The Fly Through popup window appears (Figure 7.37) with a thumbnail of the 3D volume rendered image in index 1. Move or rotate the 3D volume to a new position and click on the + symbol at the bottom left of the Fly Trough popup window. This adds a new index for that position. You can continue to add (plus sign) or delete (minus sign) index steps to the Fly Through window (Figure 7.37) or using the Remove FlyThru Point (⌘ **F2**) or Reset FlyThru Point (⌘ **F3**) options from the 3D Viewer menu. When you are finished, you will have a series of steps that comprise the movie (think of them as scenes). You can now create and export the movie using the Export button at the bottom of the Fly Through window. Horos will interpolate the missing frames between the steps (indexed frames) to generate a smooth sequence of frames

for your movie. If you choose the Movie button at the top right of the Fly Through window, you will see a new popup window that allows you to choose how many frames between indexed steps, the method for interpolation (spline or linear), and an option to loop the movie (Figure 7.37). The Spline method generates smoother transitions between steps. Clicking on the Compute button generates the interpolated movie.

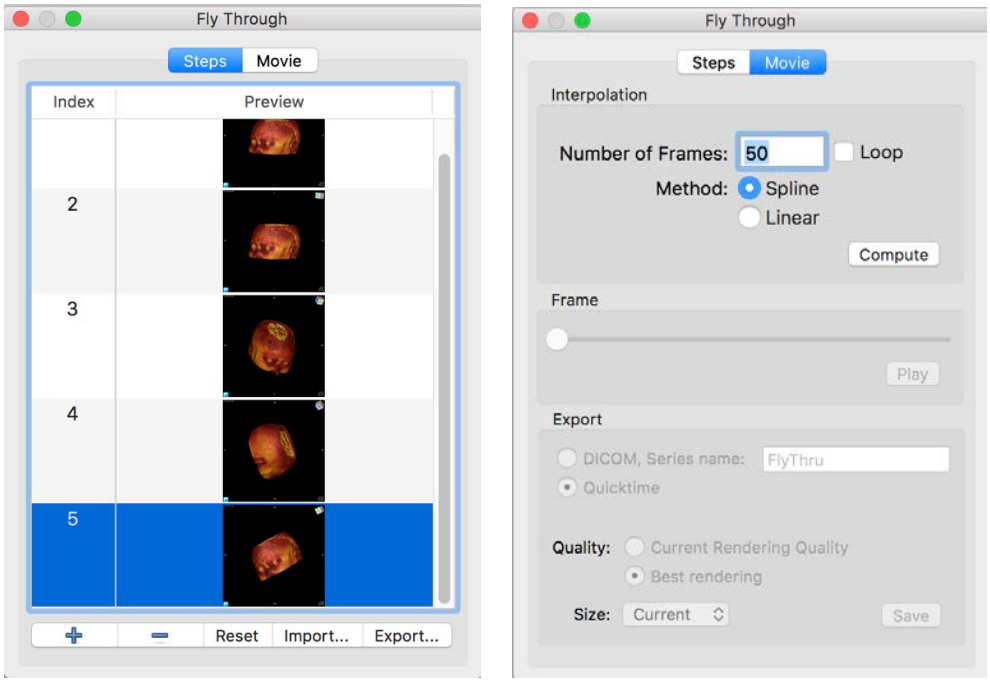


Figure 7.37. The Fly Through popup window. The left image is the Steps mode showing a series of 5 indexed steps. The right image is the Movie mode with 50 frames between each step.

You can play the newly created movie using the Play button in the middle of the Movie popup window. Finally, you can export the movie as a DICOM series or as a Quicktime (.mov) file in three size options (using the Size dropdown choices).

Note that in addition to rotating or moving the image between steps, you can also change image transparency, thresholding, color settings or other parameters between indexed images. Horos allows you to save a script file of the indexed images in XML format to disk for later retrieval.

Indexed steps are also called key steps and are d-dimensional vectors with d parameters. For example, if K is a key step, then:

$$\boldsymbol{K = k_1, k_2, \cdots, k_d}$$

Where k_i is the ith parameter.

A linear path between two key steps K and L is a series of n points (P_i with i =1, …, n) where P_1 = K and P_n = L.

And where:

$$\|\boldsymbol{P_i} - \boldsymbol{P_{i+1}}\| = \|\boldsymbol{P_{i+1}} - \boldsymbol{P_{i+2}}\| \; \forall \boldsymbol{i} \in \{\mathbf{1}, \cdots, \boldsymbol{n} - \mathbf{2}\}$$

The difference between a linear path and a spline path is that a linear path contains points of a succession of paths going from K_i to K_{i+1} (i =1, …, m-1) and a spline path is a succession of equidistant points from a polynomial interpolation.

At each key step the camera position, camera focal point, camera view up, and camera view angle are recorded. If available, WL/WW, fusion percentage, and cropping box dimension and position are also recorded. A 3D state in generated for each point and a new frame is rendered along the interpolated path.

Custom Tools

Photos

You can export the current image to iPhoto using the Photos tool in the toolbar. It will open Apple's iPhoto application and adds the current 3D image as a JPEG.

Email

Selecting the Email tool opens Apple's Mail application, creates a new email message, and attaches the current image as a JPEG file.

Mode

The Mode tool allows you to switch back and forth between VR (volume rendering) and MIP (maximum intensity projection) modes.

Fusion

If you are viewing a fused series in 3D, you can use the Fusion tool to modify the fusion percentage.

4D Player

If you are viewing a 4D dataset, you can animate the time parameter of your 4D Series. The 4D Player tool allows you to play/pause the animation using the Paly button, choose the frame rate (images per second), and choose the time position using the sliders.

Stereo

You can create an anaglyph image of your 3D volume using the Stereo tool. An anaglyph is a 3D stereoscopic effect achieved by creating two colored images one for each eye. The 3D effect is achieved by wearing red/blue glasses.

3D Scissors State

The 3D Scissors State tool allows you to use the Scissors tool on 3D images. This tool is also available in the 3D Viewer menu.

ROI Manager

If you are working with a DICOM series that contains ROIs, the ROI Manager tool allows you to modify the appearance of the 3D ROIs (Figure 7.38). You can change the color of the ROI volume by changing the RGB values and the opacity of the ROI from transparent (0) to opaque (1). You can also turn the texture on or off.

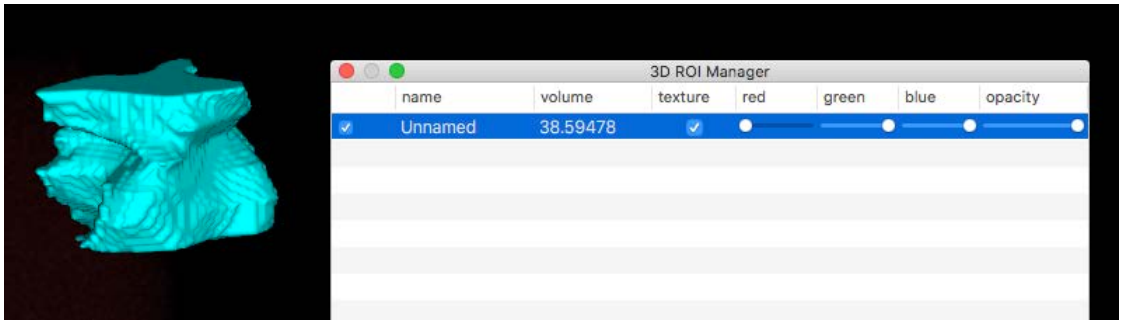


Figure 7.38. The ROI Manger popup window.

Background Color

You can change the background color of the 3D volume using any of the standard Mac OS X color pickers (Figure 7.39)

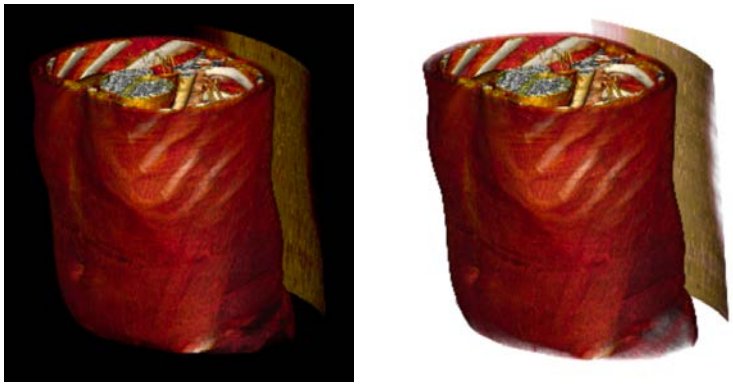


Figure 7.39. Two different choices of background color for a 3D volume rendering.