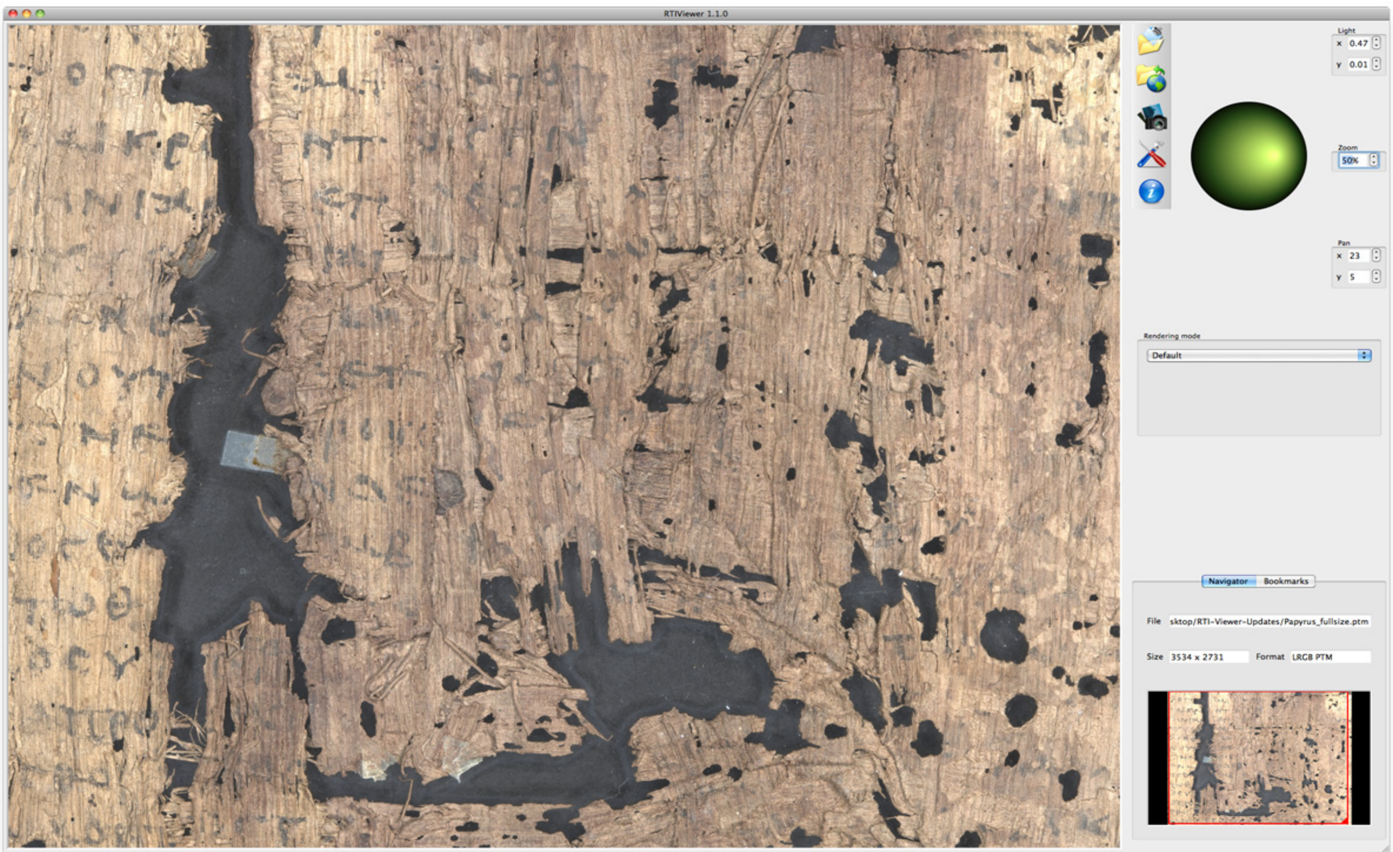
REFLECTANCE TRANSFORMATION IMAGING

GUIDE TO RTIVIEWER

Document version 1.1

Find updates and related materials at http://CulturalHeritageImaging.org/downloads/



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culturalheritageimaging.org

Cultural Heritage Imaging

a nonprofit corporation

Acknowledgments

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Installing RTIViewer

RTIViewer is available in separate versions for 32-bit Windows, 64-bit Windows, and Mac OS. It does not run on Mac PowerPC.

Download RTIViewer for your platform from the CHI web site:

http://CulturalHeritageImaging.org/downloads/

- To install the application in Mac OSX, copy the alias in the disk image into the destination folder.
- To install the application in 32-bit or 64-bit Windows, run the installer. See Installation notes for Windows below.

This viewer allows you to load PTMs and RTIs from your local machine or over the web. The download site also offers a utility, RTI Webmaker, that allows you to break up large PTMs into a folder with smaller chunks (like a zoom browser) in order to distribute large PTMs over the web; see "Preparing images for remote viewing" on page 27.

Installation notes for Windows

For older versions of Windows, if you try to start the application and it doesn't work, download and install the Microsoft Visual C++ 2010 Redistribution Package:

32-bit Windows: http://www.microsoft.com/en-us/download/details.aspx?id=5555

64-bit Windows: http://www.microsoft.com/en-us/download/details.aspx?id=14632

Memory usage in 32-bit Windows

The viewer offers the option of using a large (3GB) virtual address space, in order to optimize the handling of large images. If you are running a 32-bit version of Windows, you must set an operating-system parameter in order to take advantage of this ability. Log in as administrator and run the following command in a command shell:

In Windows XP	`bootcfg /raw "/3GB" /A /id 1`
In Windows 7/Vista	`bcedit /set increaseuserva 3072`

If you do not do this, the virtual address space is limited to 2 GB.

In order for the viewer to work properly, the memory required by an RTI you wish to load should be no more than 80% of the available virtual memory. If the RTI is too large, applying a rendering method can cause RTIViewer to crash.

To load large RTI files, you must use a 64-bit Windows system and the 64-bit Windows version of RTIViewer.

Required OpenGL library version

RTIViewer relies on the Open Graphics Library (OpenGL) version 2.1 or later for rendering graphics using the Graphics Processing Unit (GPU). The OpenGL 2.1 specification was released in July 2006, and is supported on most newer computers.

If you have an older computer, or one that uses an Intel integrated GPU from 2010 or earlier, it might not support Open GL 2.1 or later. In this case, the RTI image in the main viewing panel can appear as a red rectangle, although you will see a thumbnail of the RTI in the Navigation tab.

If you experience this problem, you might be able to solve it by updating the graphics drivers on your computer. If not, you will not be able to use RTIViewer on that computer. This issue appeared in the prior 1.0.2 version of RTIViewer, and still exists in the 1.1 version of RTIViewer. It has been reported by some users, but appears to be rare.

For more information on graphics cards that support OpenGL 2.1 and later, see:

http://en.wikipedia.org/wiki/Comparison_of_Nvidia_graphics_processing_units

http://en.wikipedia.org/wiki/Comparison_of_Intel_graphics_processing_units

http://en.wikipedia.org/wiki/Comparison_of_AMD_graphics_processing_units

New in this release

Release 1.1 of RTIViewer provides these new features:

- Numeric parameter values

  All parameters, including the rendering parameter values and the values for an RTI view's pan position and lighting angle, are now displayed with specific numeric controls as well as sliders, so that you can describe, share, and reproduce specific views accurately.

- Snapshot data record

  When you create a snapshot image of the current view, the specific numeric parameter values that were applied to the original RTI file to create the snapshot image are saved to a sidecar XML file; that is, an XML file with the same base name as the RTI file.

- Bookmarks

  The entire set of parameters that describes a view, including the pan position, lighting angle, and all rendering values, can now be saved as a named view called a *bookmark*. You can create multiple bookmarks for a single RTI file, and you can associate any number of notes with a bookmark.

  You can reload a saved bookmark to recreate a specific view. You can edit a new or saved view. If you edit a bookmarked view, you can re-save the bookmark with the new values, or save the edited view as a new bookmark in order to create variations of a given view. See "Bookmarking views" on page 11 for more information.

- Normals visualization viewing mode

  The Normals Visualization viewing mode creates a false-color view of the subject of an RTI that makes it possible to visualize the normals information that describes the surface contours and orientation. See "Normals Visualization mode" on page 23 for an example.

Using RTIViewer

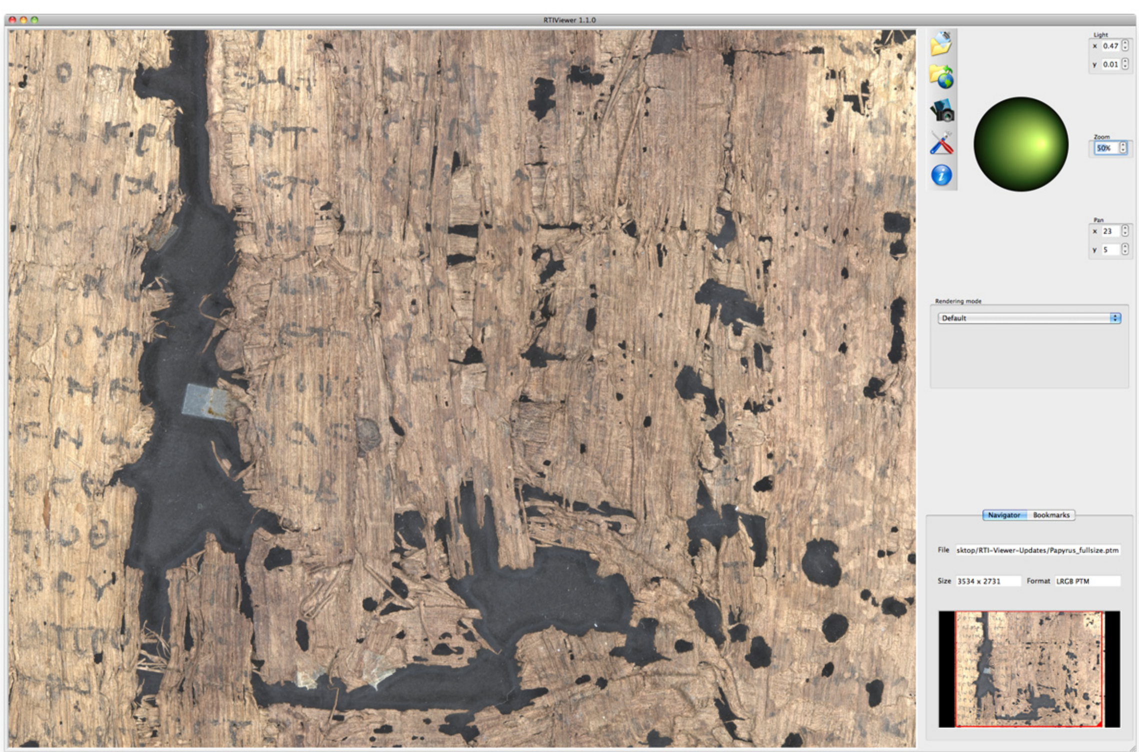
RTIViewer allows you to load and examine images created with reflectance transformation techniques. These techniques calculate both color and shape information from a set of images illuminated from different directions, and store that information in files. This tool supports these file formats, collectively called RTI files:

- Polynomial Texture Map (PTM file)
- Reflectance Transformation Imaging (RTI file)
- Multi-view RTI (MVIEW file) This is a collection of single-view images together with optical flow data that allows the generation of intermediate views.

RTIViewer offers interactive rendering of images, allowing you to change the view and alter the apparent direction of lighting. In addition, it offers a number of enhancement modes, which apply mathematical transformations to the color and shape information to enhance or emphasize particular features of the target object. These transformations do not alter the original data, but can be saved separately so that they can be reapplied.

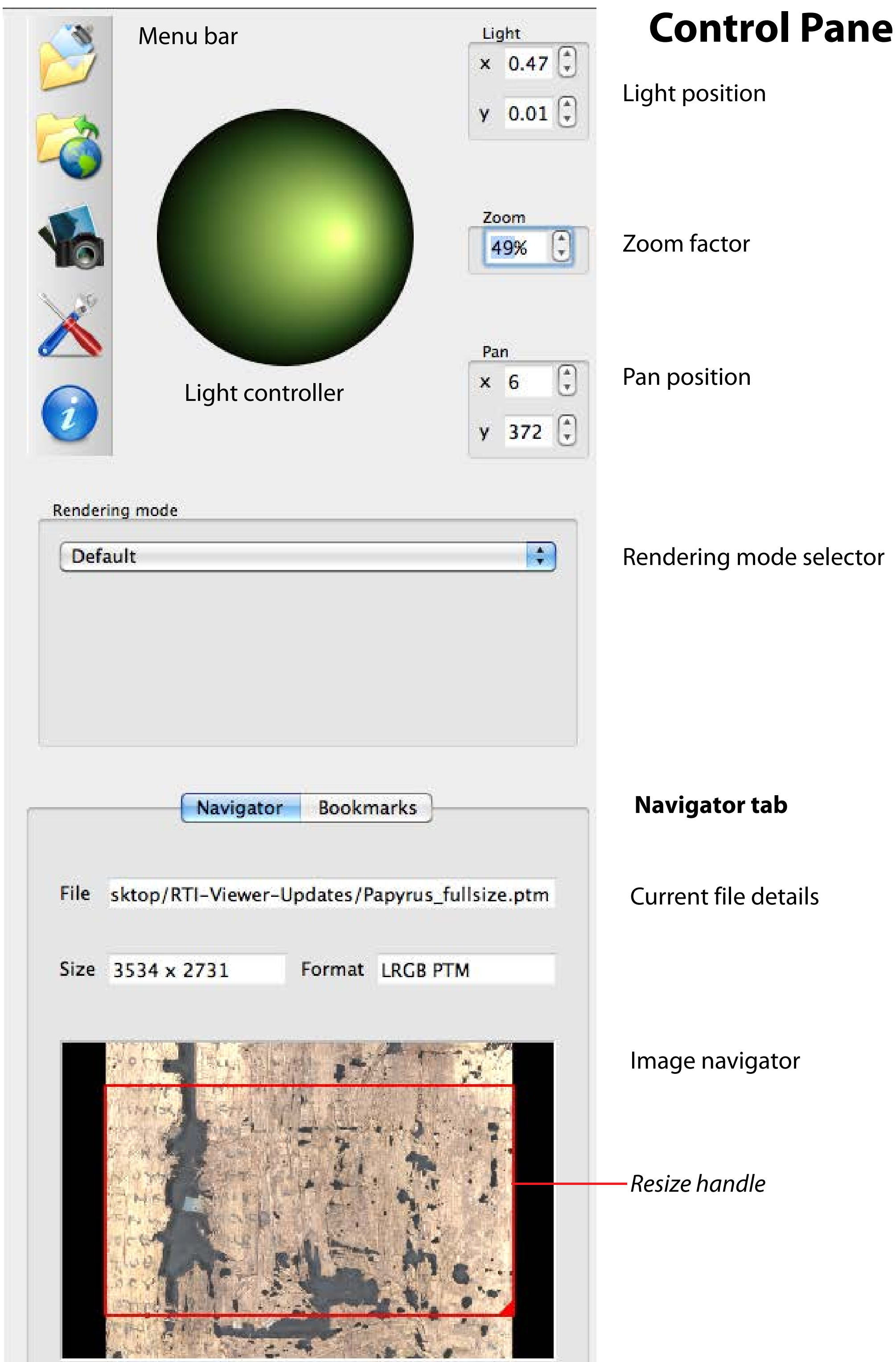
The RTIViewer window

The RTIViewer GUI allows you to load and examine image files, providing options for manipulating the image to take advantage of the captured surface data in ways that help you study the target object.



Main viewing panel **Control panel**

- The control panel on the right allows you to load image files, save views, move the angle of the virtual light on the image, and configure the view in a number of ways.
- The main viewing panel on the left displays the current image, rendered and lit according to your choices in the control panel.



Menu bar and file details

The icons on the menu bar allow you to:

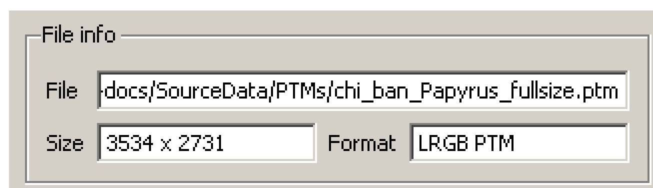
- Browse your local disk to find and load image files for viewing.
- Browse the internet to find and load image files kept on remote servers; see "Remote Viewing" on page 27.

Load from local disk

Load from network

Save snapshot of current view

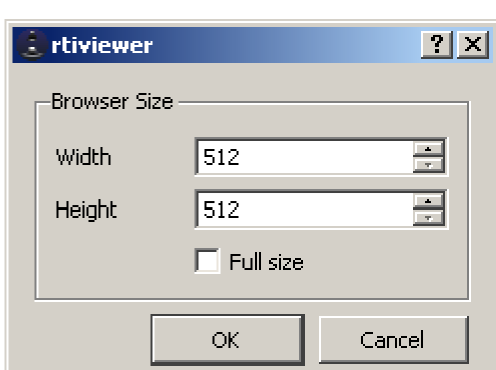
Configure the viewer



When you have loaded a file, the location, size, and format are shown in the File info box.

The menu also allows you to:

- Save a *snapshot*, which is a PNG or JPEG image of the current view shown in the main viewing panel; that is, the currently selected portion of the file, with the currently selected lighting angle and rendering style. This also saves a record of the specific parameters that were applied to produce this image, in a sidecar XML file.
- Configure the viewer; the configuration dialog allows you to set the size of the viewer window. Check the "Full size" box to maximize the image within the main viewing panel.
- Bring up the About box, which provides version information and contact information for the developers and sponsors.



Bring up About box

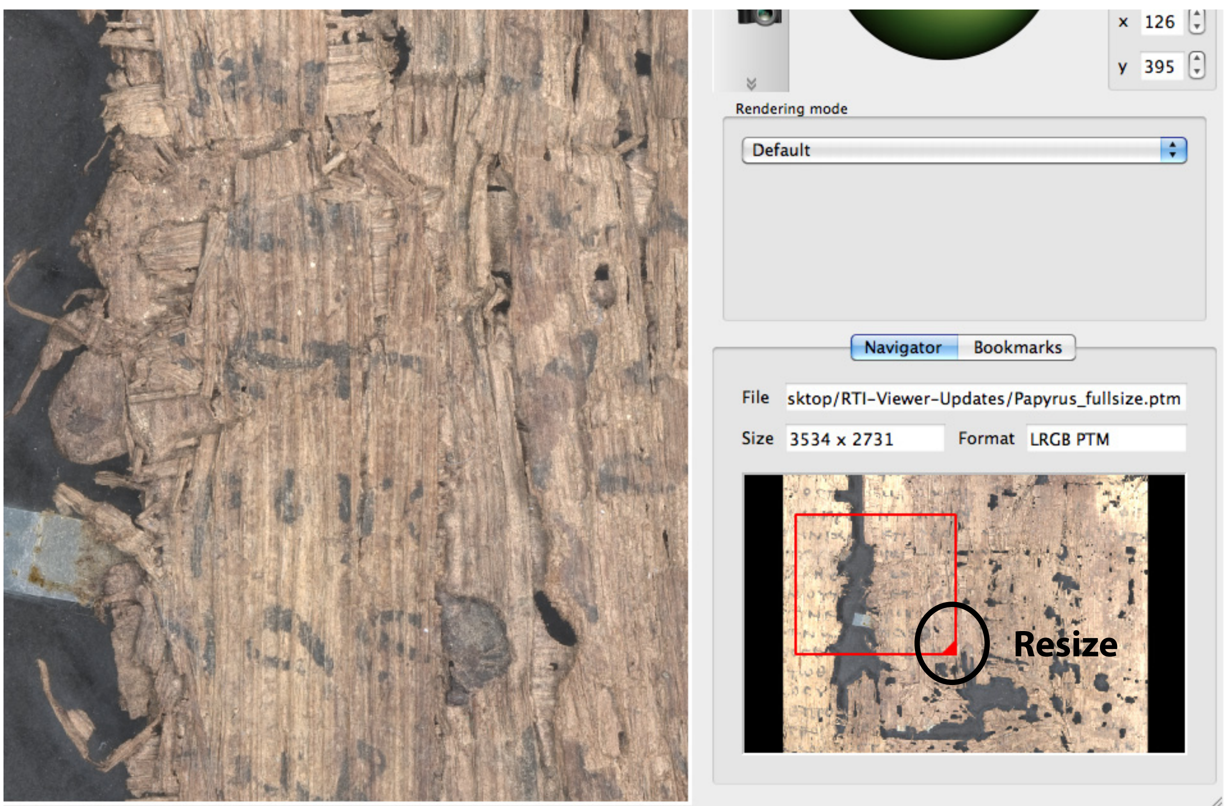
Image navigation and lighting

You can control the portion of the image you are viewing, and the angle of the virtual light; the light controller and image navigator in the control panel allow you to make changes, and also reflect the current state when you change the view by directly manipulating the image in the main viewing panel.

Using the image navigator

The small image at the bottom right allows you to select a subset of the image to show in the main image panel.

- Click anywhere in the red square to drag it around the small image. The portion of the image inside the square is shown in the large viewing panel.
- Drag the triangle in the lower right corner of the red square to resize the selection (within the built-in constraints).

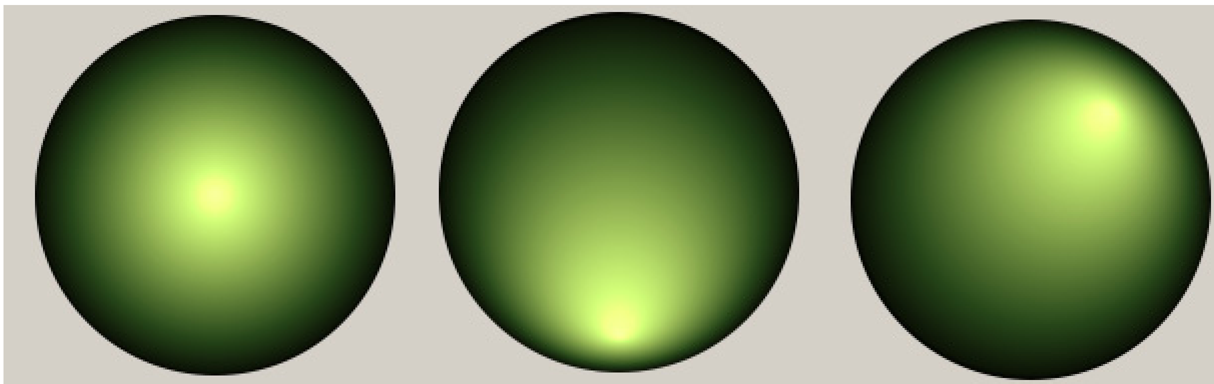


You can also use the scroll wheel on the mouse to zoom in and out interactively, from either the image navigator or the main viewing panel. See "Manipulating the image view in the main viewing panel" on page 10

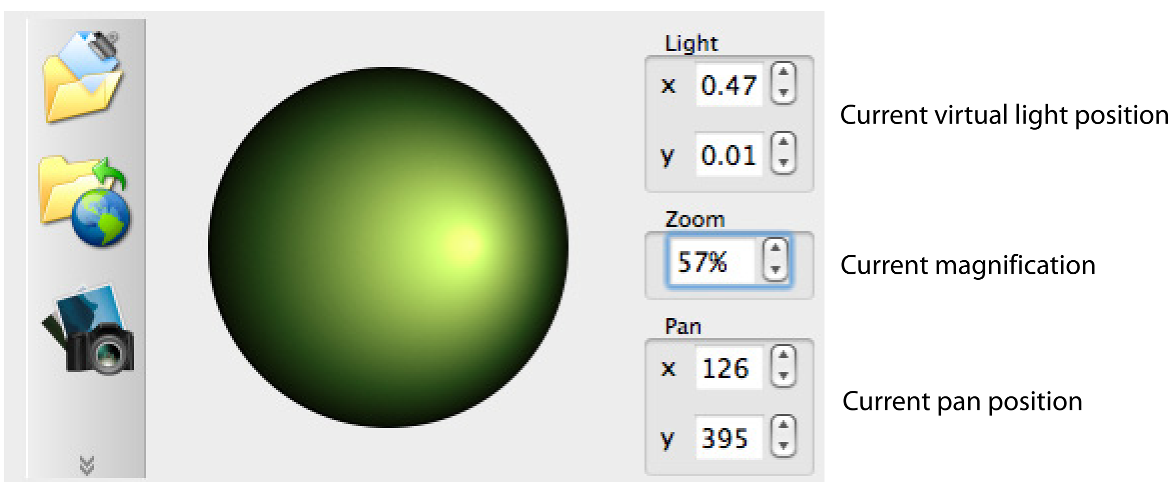
Using the light controller

The green circle controls the angle of the virtual light in the large viewing panel. The bright spot is the light source, shown as if it were reflected in a dome. You can drag the spot around the dome to change the angle interactively.

- When the light source is in the center of the dome, the virtual light comes from the "high noon" position, directly above (or in front of) the object.
- As you drag the light source to the top, bottom, right, or left, the virtual light approaches the horizon in that direction, creating a raked-lighting effect.



Next to the light controller, numeric controls show the specific coordinates and zoom factor that are reflected in the current view. The controls are all synchronized; as you change the view interactively, the numeric values update. You can also change the view by changing the numeric values. When you change the virtual light values, for example, the light controller updates to show that angle.



Zooming and panning

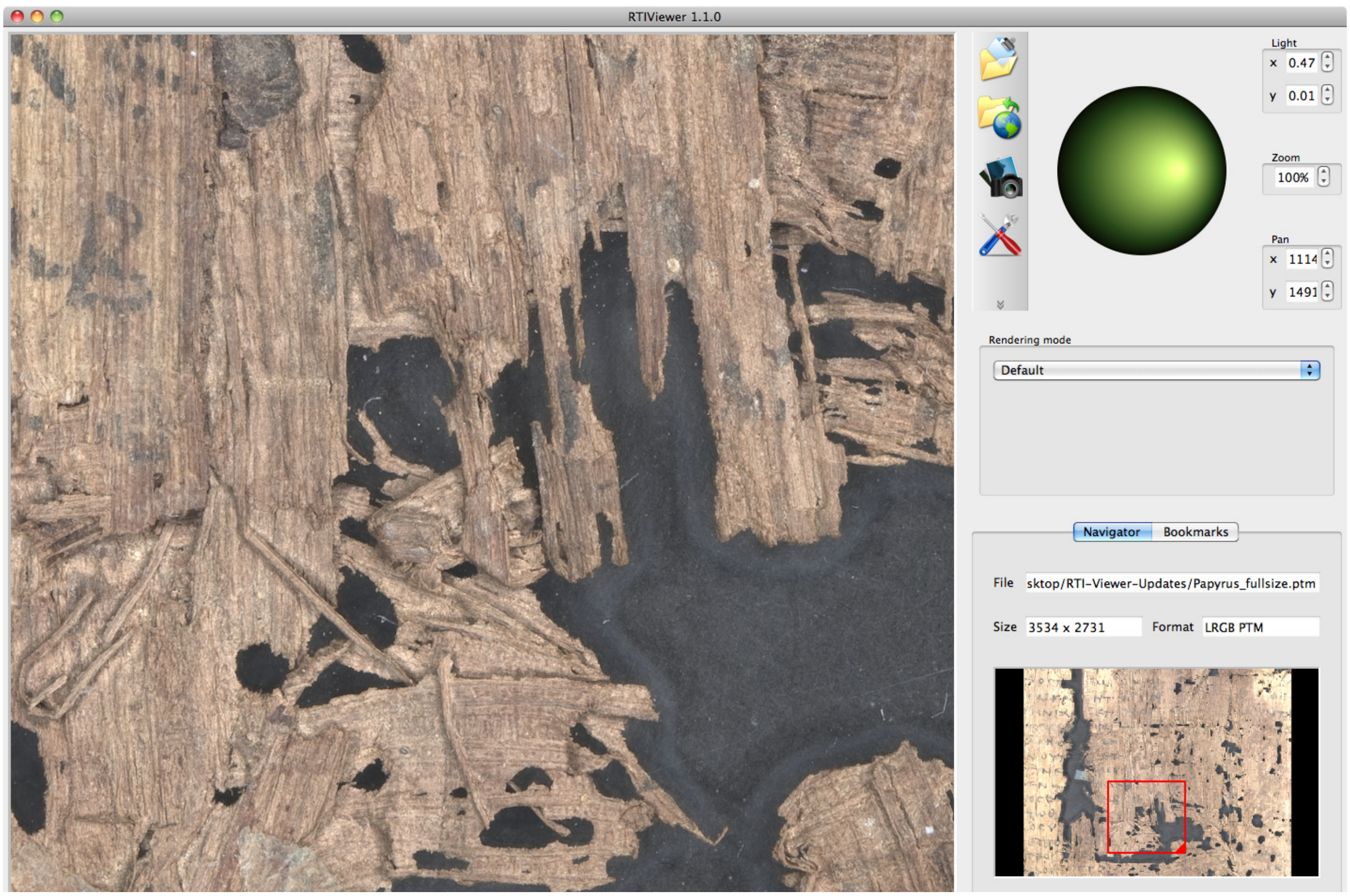
The Zoom selector allows you to change the magnification at which the image is displayed, and the Pan controls allow you to move the view to a different portion of the image. You can also change these values interactively in the image navigator below the light controller, or in the main image view.

By default, an image is displayed at a magnification factor that allows the entire image to be seen in the viewing area. You can use the up and down arrows in the Zoom selector to increase and decrease the magnification by 1% increments, or you can type a new zoom factor into the text box and press return.

You can zoom in to a magnification above 100%, although this requires interpolation beyond your real data. Rendering modes that contain color are less sharp above 100%. You can use the Specular Enhancement mode and exclude color information for an image that remains reasonably sharp at zoom factors exceeding 100%.

If you resize the displayed image using the resize handle in the image navigator, or zoom in or out using the scroll button on the mouse, the current zoom factor is reflected in the Zoom selector.

You can drag the red box in the image navigator to a new position, or drag the main image to a new position, and the position is reflected in the Pan controls. The pan position coordinates are the offset in pixels for the upper left corner of the red box in the image navigator, relative to the upper left corner of the original image.



Manipulating the image view in the main viewing panel

You can manipulate the image view directly from the main viewing panel; the navigator updates to show you what part of the image is currently displayed, the light controller updates to show you the current light angle, and the zoom selector updates to show the current magnification.

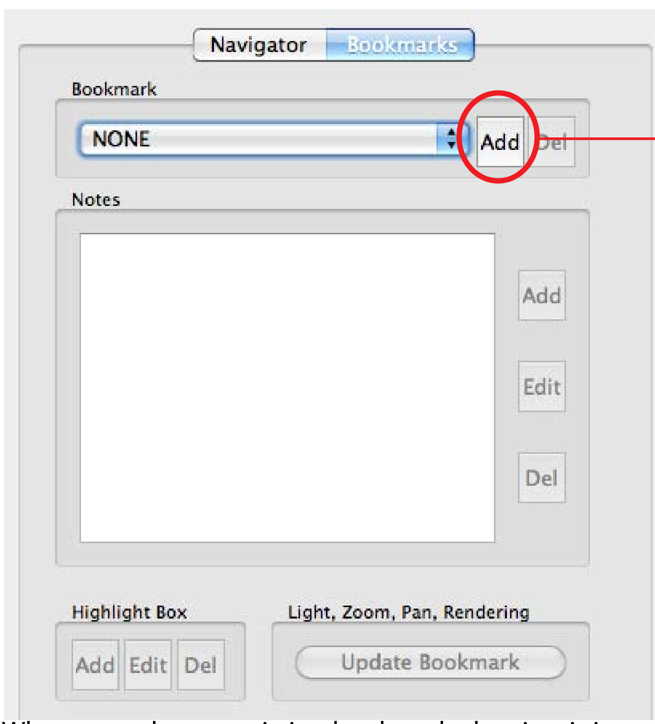
- Left-click in the large image and drag in any direction to move the image in that direction.
- Right-click in the large image and drag to adjust the lighting angle.
- Use the scroll wheel in the large image to zoom in and out. (You can also zoom in with the keyboard shortcut CTRL+ and zoom out with CTRL-.)
- In Mac OS, you can use a two-finger gesture on the mouse pad, separating the fingers to zoom in, and bringing them together to zoom out.

All interactive adjustments are reflected in the numeric controls, and when you enter numeric values they are reflected in the interactive controls and in the view.

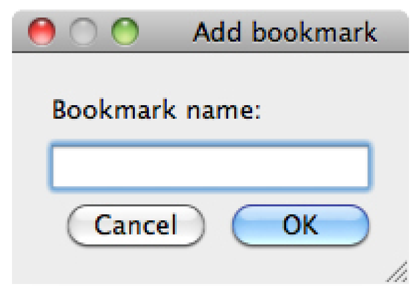
Bookmarking views

When you have completed a set of adjustments to the position, zoom factor, and light direction, you can save information about the resulting view as a bookmark. All of the numeric values that describe the view are saved to an XMP sidecar file, allowing the viewer to recreate that view when you select the bookmark. All bookmarks are included in this file.

The Bookmarks tab in the control panel allows you to save new bookmarks, display bookmarked views that you have previously saved, and edit, annotate, or delete existing bookmarked views.



To create a bookmark from the current view, simply give it a name.



When you click **OK** here, the bookmark file is saved and the name appears in the Bookmark pulldown list.

If you already have a bookmark file for this RTI, the new bookmark is added to that file.

When you select an existing bookmark, the view is immediately displayed. The **Del** button allows you to delete the currently selected bookmark.

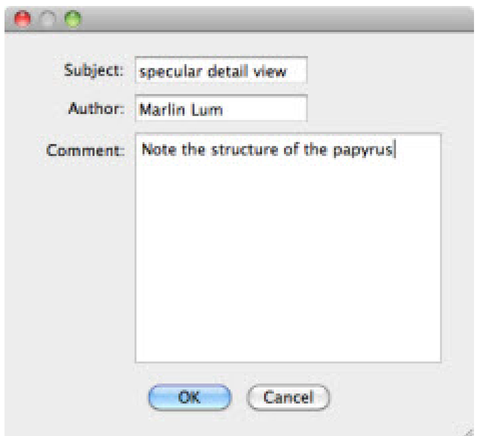
- You can associate **Notes** with a bookmarked view, and add to or change the comments in the notes.
- You can overlay a **Highlight Box** on the image to highlight something of interest, and later edit or delete the box. The highlight box is part of the bookmark data, and does not alter your original image data in any way.

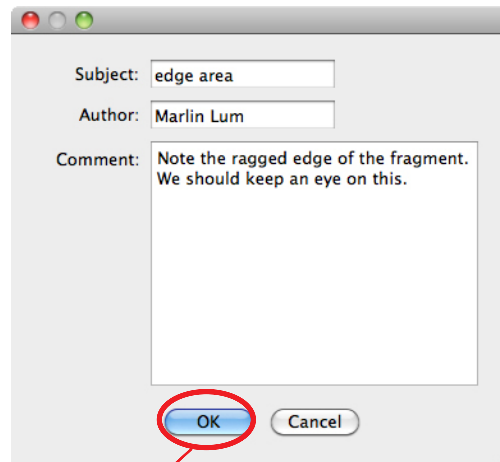
  The file for an existing bookmark is automatically updated when you make changes to the box or comments.
- You can open a bookmarked view and manipulate the viewing parameters, then click **Update Bookmark** to resave it with the new parameter set.

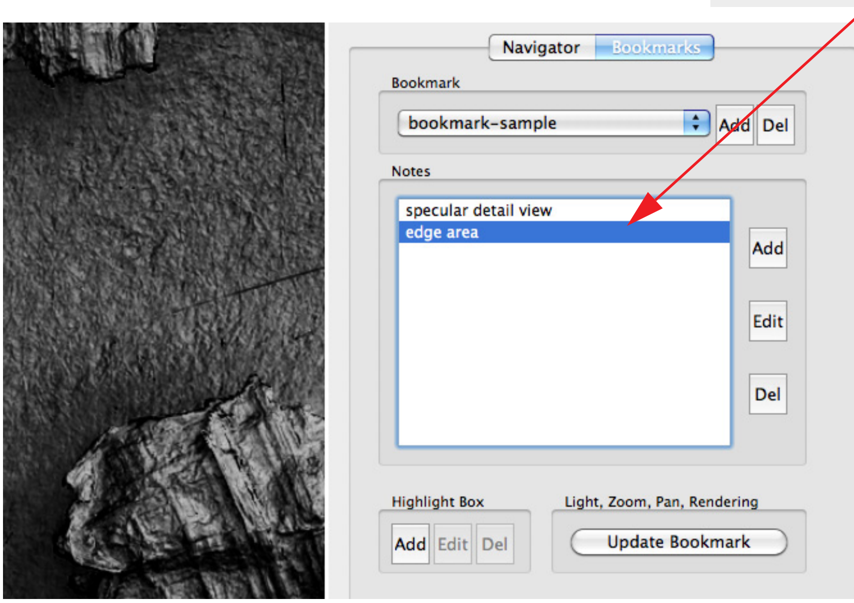
Bookmark notes

You can associate notes with a bookmarked view in order to comment on it. This is a powerful feature that can be especially useful for collaboration. When a named bookmark is selected, you can add one or more notes to it.

Click **Add** in the Notes box to associate a new note with the currently selected bookmark. A note must have a **Subject**. It can also have an **Author** and a **Comment**.



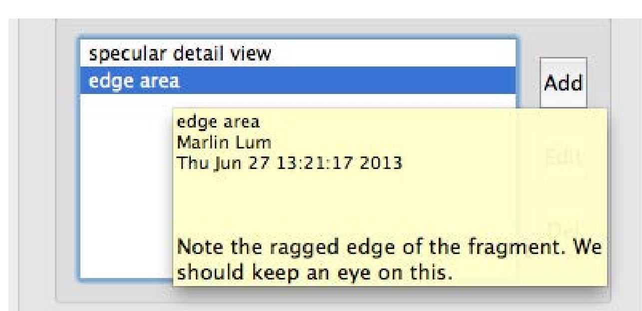




- When you click **OK** for each new note, the subject is added to the Notes box.
- You can select an existing note to edit the comments, or to delete it.

When the cursor hovers over a note, the contents of that note appear; the timestamp of the latest edit is added automatically.

The Bookmark feature is not available for multi-view (MVIEW) files. See "Multi-view RTI viewing" on page 24 for information on this format.



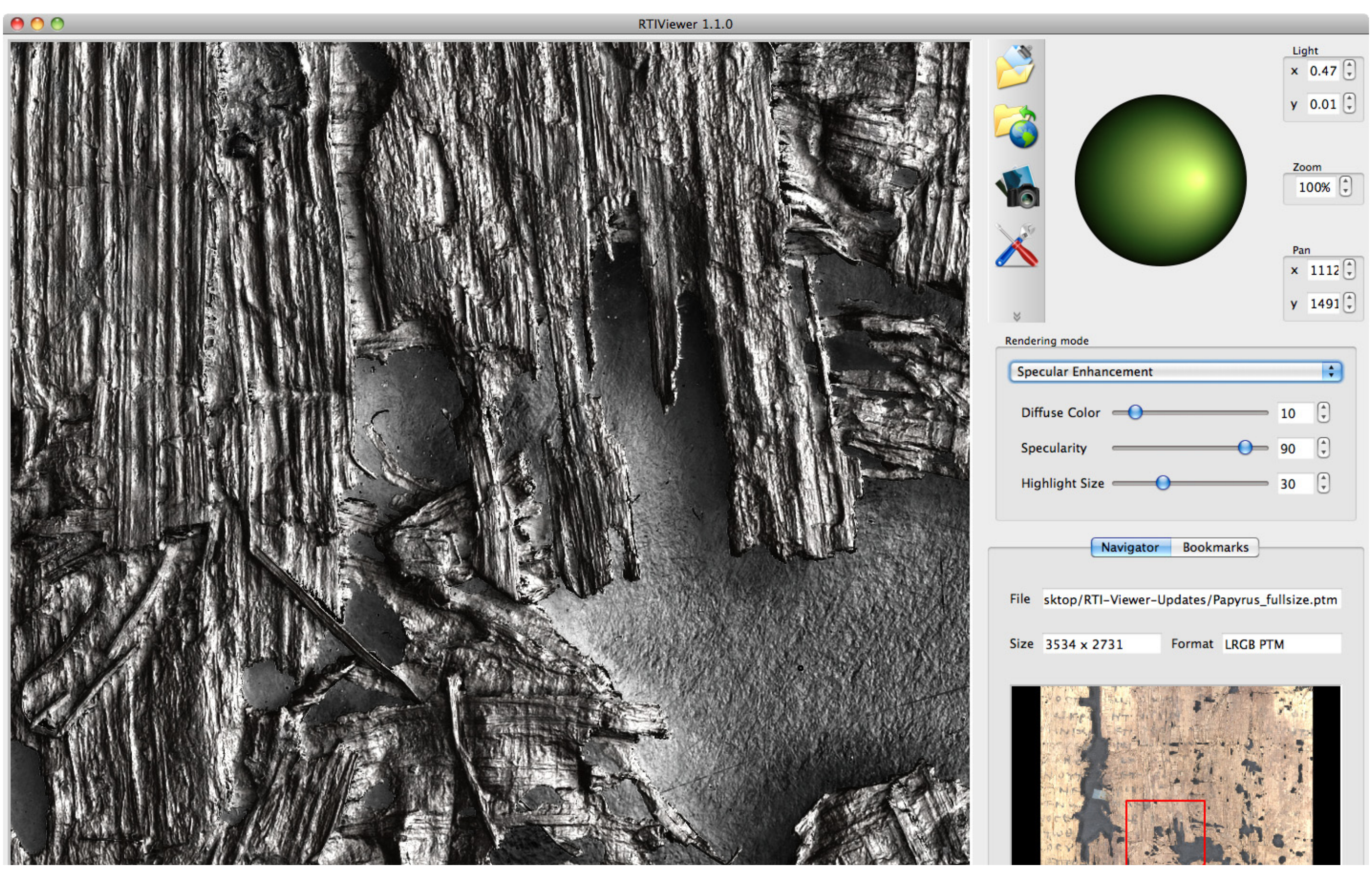
Rendering modes

While traditional image files record only color information for each pixel, an RTI also records the subject’s *surface normals* along with the RGB color information at each pixel. Each normals value encoded into the RTI image corresponds to a point on the subject, and records the angle of reflectance of light coming from any direction at that point. The normals data provides accurate information about the subject's surface shape. As you change the direction of the virtual light source in the RTIViewer, the reflectance provides your brain's perceptual system with everything it needs for you to see the subject in three dimensions.

Applications such as Adobe Photoshop can digitally enhance traditional images (to lighten or darken them, or change the color tone, for instance) by applying mathematical transformations to the color information at each pixel. Various kinds of transformations (often called *filters* or *effects*) consider the relations between pixels to find edges, for example, and perform sharpening or blurring.

RTIViewer can also apply mathematical transformations to the surface normals as well as the RGB color information, resulting in reflectance enhancements of various kinds. These enhancement tools (or *rendering modes*) use information from surface shape and color in combination or surface shape or color by themselves. By using the shape data in RTI images, the enhancement functions in RTIViewer can disclose far more information about the subject than filters that use only RGB color data at each pixel.

RTIViewer’s enhancement functions do not manipulate the color information as such (although the Specular Enhancement mode can remove color information from a rendering in order to emphasize only the reflectivity, as show in the figure below). After applying the desired lighting conditions and shape-based enhancement functions to an image, you can export it from RTIViewer. You can then use applications like Photoshop to do further color-based transformation on the exported image that already includes the desired shape-based effects.



Basic rendering modes

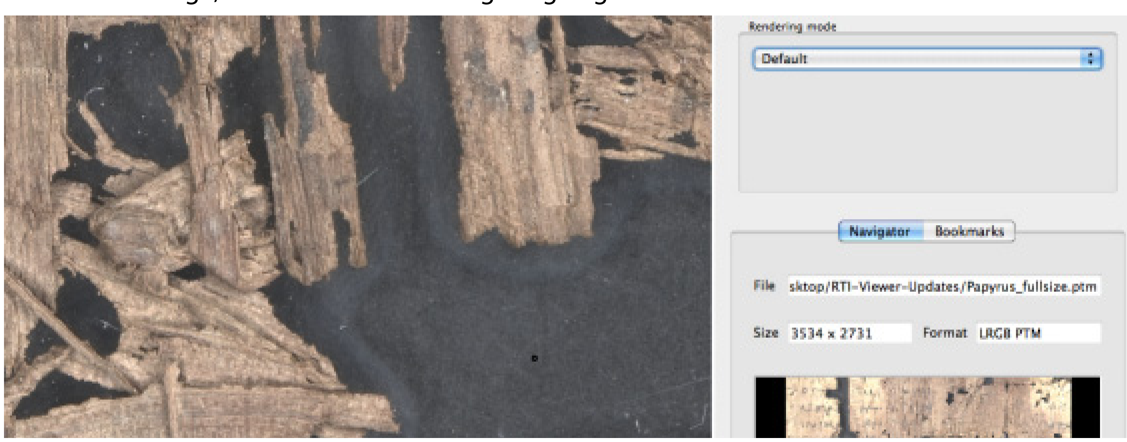
The rendering mode that you choose controls how the information in the RTI is transformed to an image on the screen. When you select a rendering mode, the UI provides appropriate controls with which to set the parameters that mode uses.

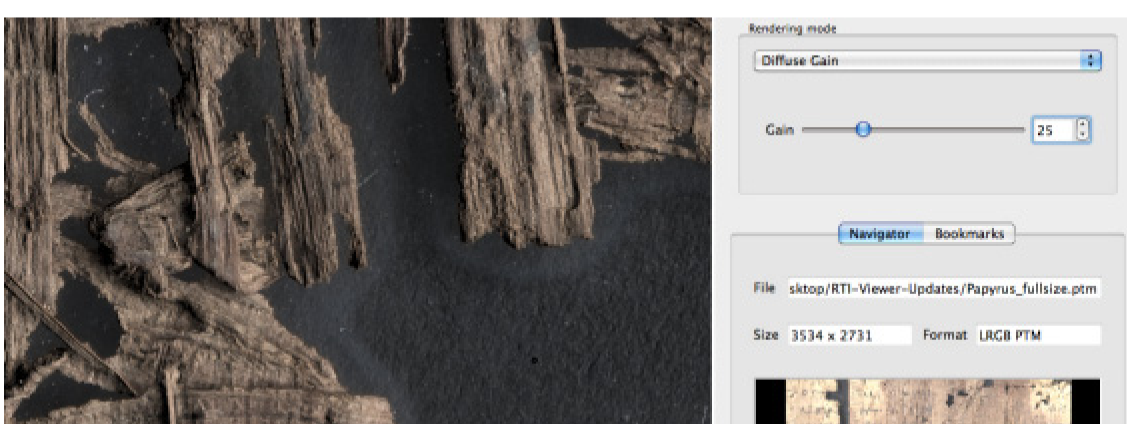
Not all rendering modes can be applied to all types of images; only those that can be applied to the current image are offered in the drop-down menu.

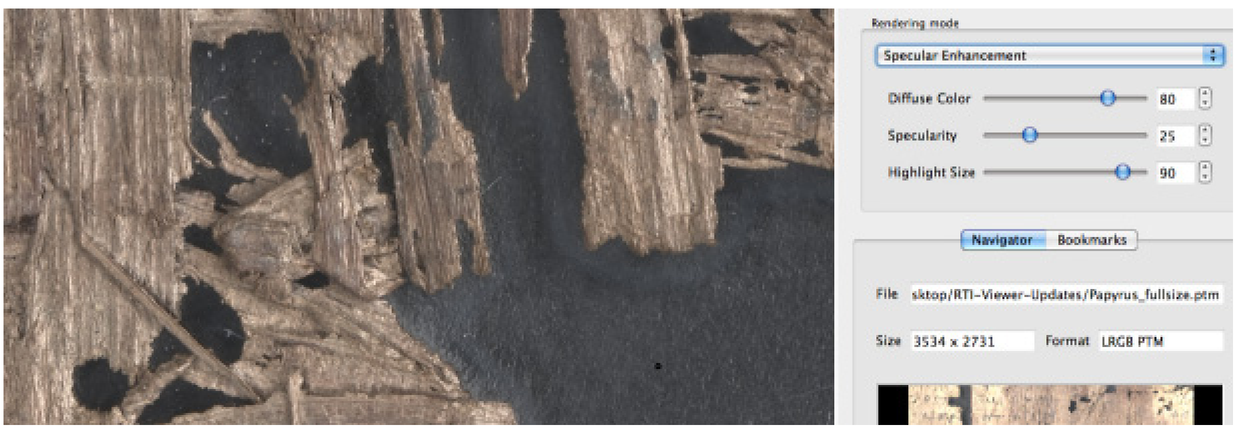
Rendering mode	Description
Default	Presents the RTI image without mathematical enhancement. This mode has no parameters.
Diffuse gain	Increases the representation of quickly-changing height and depth on the subjects surface. For example, if a surface area has a quickly-changing sequence of normals directions that form a depression, this enhancement function deepens the depression by increasing the directional rate of change (the second derivative) of the surface's slope. This mode enhances the perception of surface shape features of the subject for interpretive purposes. This mode can have the side effect of introducing false color in some images. Use caution in assessing the reliability of RGB color values in the resulting image. *Parameters:* **Gain**: Adjusts the amount of enhancement.
Specular enhancement	Different materials have different degrees of shininess. Matte objects (such tennis balls) have large and soft specular reflections while very smooth materials (such as billiard balls) have small and sharp specular reflections. This algorithm separates out the diffuse RGB color, specular reflection derived from the surface shape of the subject, and the size of the specular highlights. It can then render the shape-based reflections and RGB color either separately or in combination. This mode also enhances the perception of the surface shape.

Rendering mode	Description
Specular enhancement *(cont'd)*	*Parameters:* The parameter names are based on variables in the computer rendering algorithm, the Phong reflectance model. **Diffuse Color**: Adjusts the percentage of diffuse RGB color information used in the rendering. When *Diffuse Color* is at 100% and *Specularity* is at 0%, only diffuse RGB color is rendered. **Specularity**: Adjusts the percentage of specular reflection, derived from the surface shape of the subject and its reflection of light from any given direction. When *Specularity* is at 100% and *Diffuse Color* is at 0%, only the effects of reflected light from a given direction are rendered. **Highlight Size**: Describes the size of the area encompassed by individual specular reflections. A low value produces a large, soft (matte) reflection. A high value produces a small sharp (shiny) reflection. The range is 0-150. When using specular enhancement in isolation from the RGB color information, you can reduce the *Highlight Size* value to spread the area influenced by the specular reflections, in order to illuminate the entire surface. This can be helpful when composing a rendering for image export.

These figures show examples of the application of diffuse gain and specular enhancement to the same portion of the same image, with the same initial lighting angle.







Sharpening modes

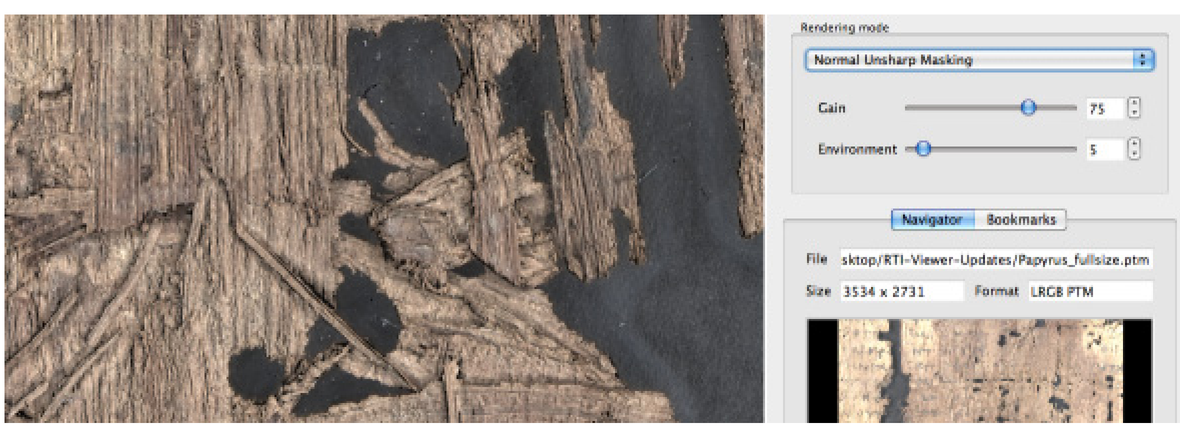
Sharpening applies an *unsharp mask* to the image data in order to enhance the high frequency details and increase the edge contrast of the image. Sharpening algorithms look for discontinuities in the data that typically indicate edges in the photographed object. In an RTI, the mask can be applied to the normals data, finding and emphasizing sharp changes in depth as well as color.

RTIViewer offers several variations on the sharpening algorithm:

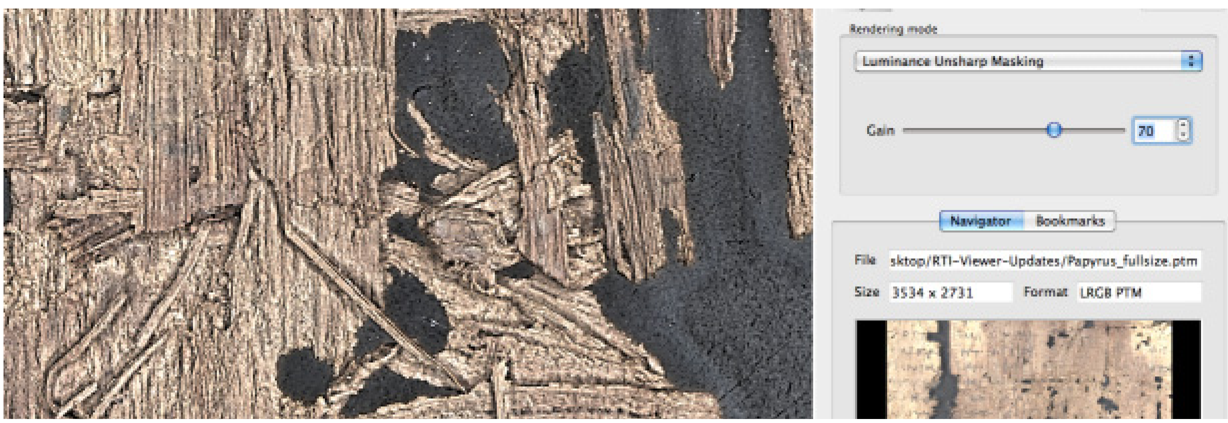
- Image unsharp masking enhances edge contrast by applying the specified gain factor to image color data.
- Normals unsharp masking enhances surface contrast by applying the specified gain factor to image normals data, as well as color data.
- Luminance unsharp masking creates a different effect, amplifying depth discontinuities without affecting the color, by applying the specified gain factor only to normals data.
- Coefficient unsharp masking emphasizes discontinuities in reflectivity, by applying the gain factor to each coefficient of the reflectance function.

Rendering mode	Description
Normals Unsharp Masking	Applies an unsharp mask to the surface normals. *Parameters:* **Gain**: Adjusts the amount of enhancement. **Environment**: Adjusts the amount of indirect lighting.
Image Unsharp Masking	Applies an unsharp mask to the Y channel of the color space YUV. *Parameters:* **Gain**: Adjusts the amount of enhancement.
Luminance Unsharp Masking	Applies an unsharp mask to the luminance component of an LRGB PTM; cannot be applied to simple RGB files, which do not include luminance data. *Parameters:* **Gain**: Adjusts the amount of enhancement.
Coefficient Unsharp Masking	Applies an unsharp mask to the coefficients of the polynomial of the PTM. *Parameters:* **Gain**: Adjusts the amount of enhancement.

These figures show the application of various sharpening modes to the same portion of the same image, with the same initial lighting angle.




Rendering mode
Image Unsharp Masking
Gain
49
Navigator
Bookmarks
File
sktop/RTI-Viewer-Updates/Papyrus_fullsize.ptm
Size
3534 x 2731
Format
LRGB PTM


Rendering mode
Luminance Unsharp Masking
Gain
70
Navigator
Bookmarks
File
sktop/RTI-Viewer-Updates/Papyrus_fullsize.ptm
Size
3534 x 2731
Format
LRGB PTM

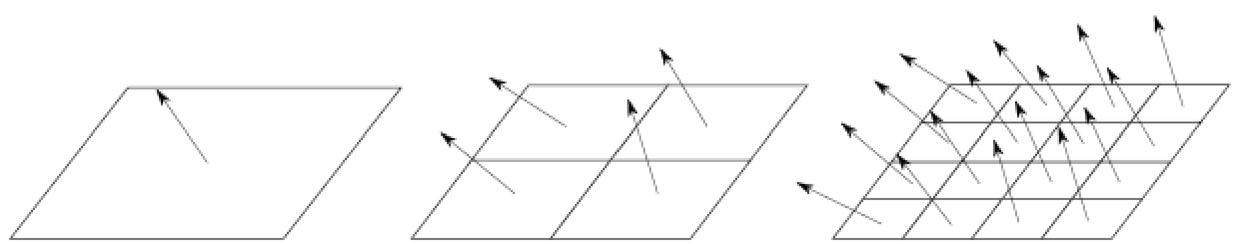

Coefficient Unsharp Masking
Gain
60
Navigator
Bookmarks
File
sktop/RTI-Viewer-Updates/Papyrus_fullsize.ptm
Size
3534 x 2731
Format
LRGB PTM

Multi-light enhancement modes

The multi-light enhancement modes choose different lighting angles for parts of an image in order to enhance surface details, optimizing sharpness and brightness. For example, if you choose a low, raking light to maximize contrast, there will be areas that are in deep shadow and show no detail. These rendering modes can add detail back to those areas by choosing a higher lighting angle for them, without changing the lighting angle in the areas that are already sharp. The resulting view looks as if light was coming from several directions, in addition to the virtual light source you have chosen using the Light Controller.

To achieve this effect, the algorithm subdivides the image into tiles, then, for each tile, chooses a light direction that maximizes a chosen *energy function*. It chooses a nearby light direction that increases local contrast, in order to enhance as many details as possible in a single view.

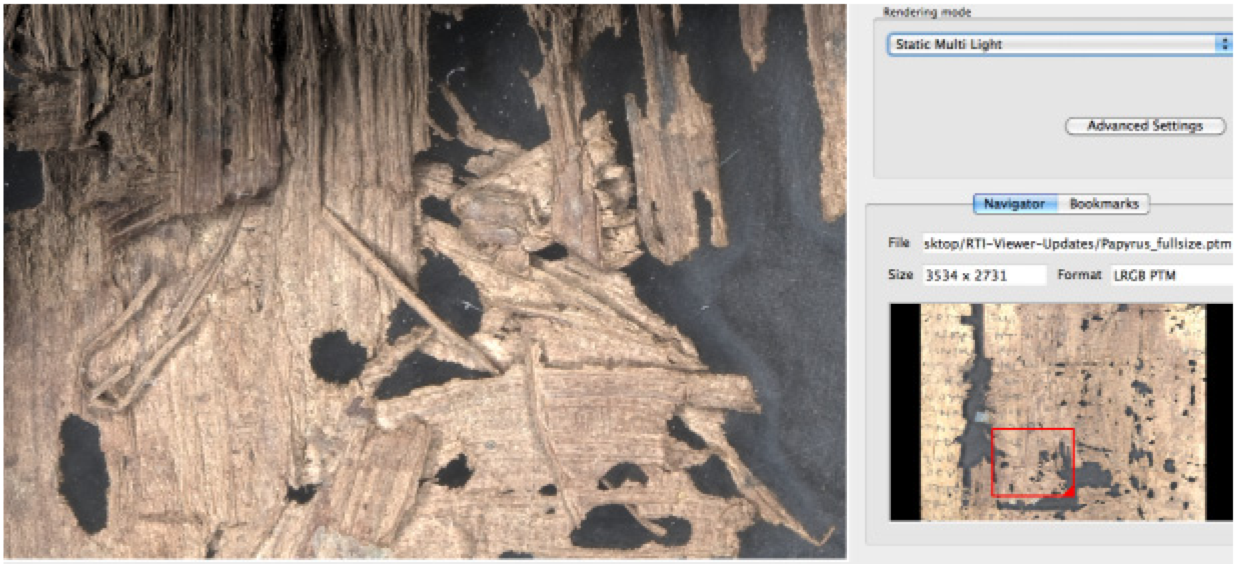
The image is first divided into an *initial* number of tiles, and the choice of lighting angles for each tile is constrained to be within a specified offset from the original light direction, as indicated by the Light Controller. The optimal lighting angle chosen for each initial tile then influences the choice of angles when that tile is subdivided.

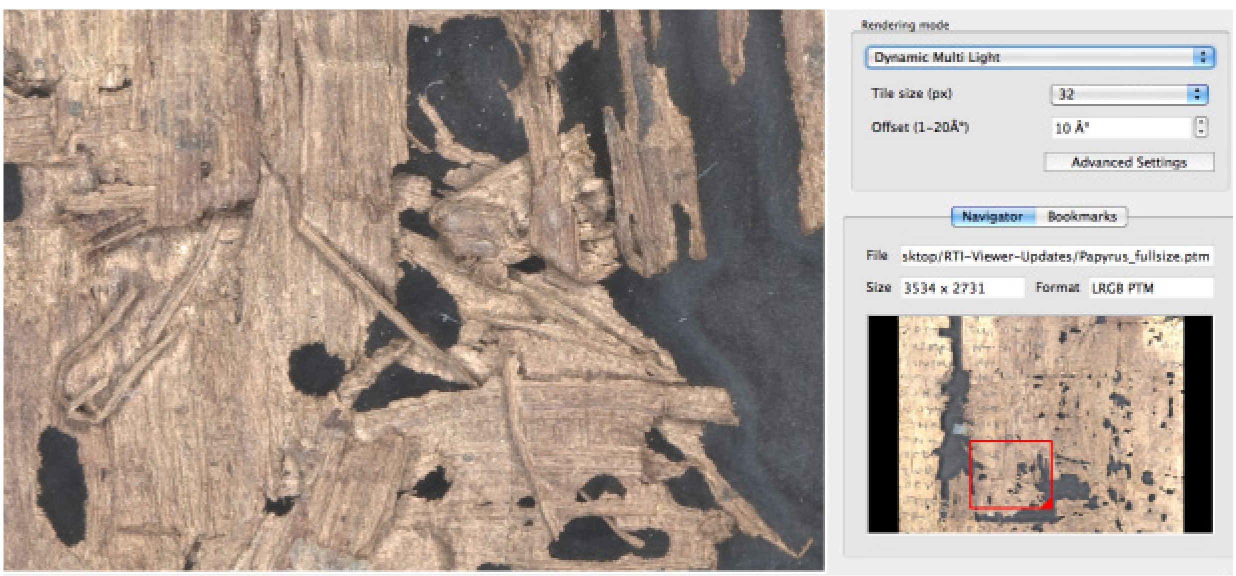


There is a static mode, and a dynamic mode:

- The static mode applies the rendering you have chosen to the current view; you cannot change the starting light source interactively while this view is displayed. This is a special case of the dynamic mode, which is optimized to produce a high-contrast, well-illuminated static image, suitable for stand-alone presentation, high-quality printing, and so on.
- The dynamic mode automatically re-applies the rendering as you change the starting light source interactively, using the Light Controller. This mode allows more detailed control, but can also produce visual artifacts where there are great lighting variations across the image.

These figures show an application of static and dynamic multi-light renderings to the same portion of the same image with the same initial lighting angle.

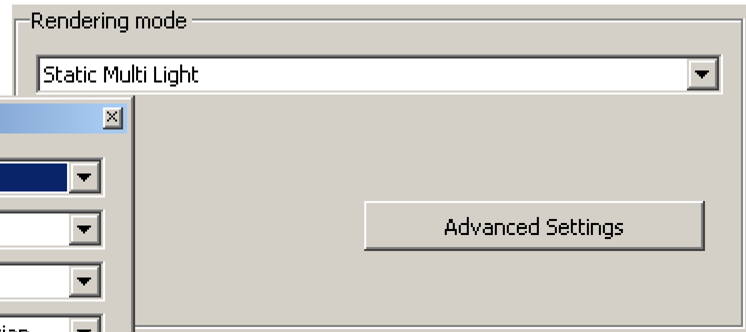


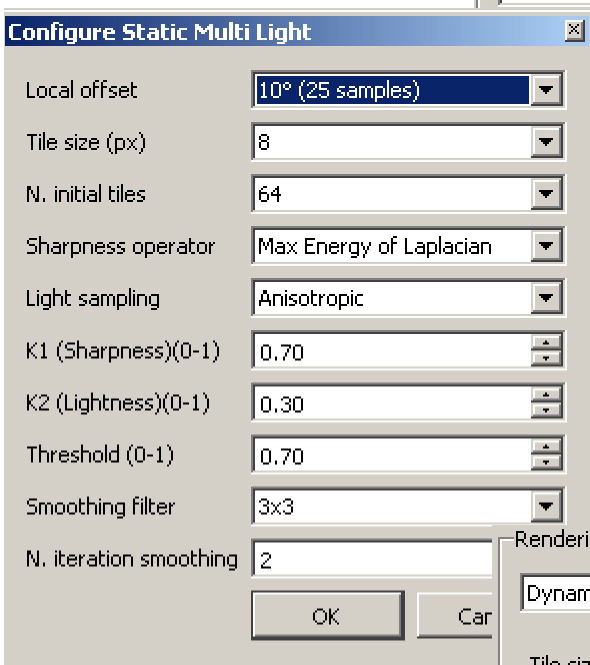


Multi-light enhancement parameters

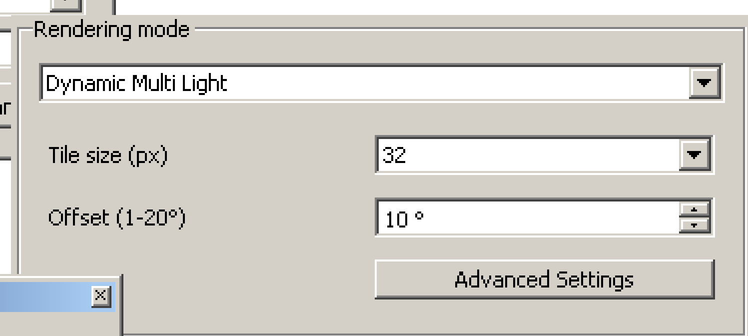
The two multi-light enhancement modes have a number of parameters that allow you to vary the effects. You can specify the number and size of the tiles, the energy function to maximize, and various factors in the algorithm.

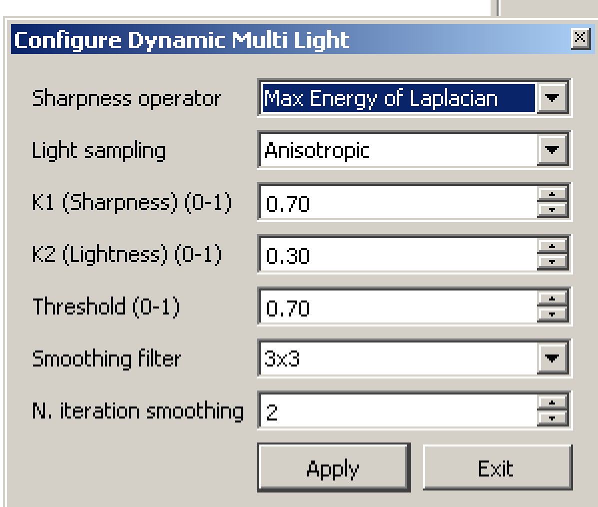
The parameters are offered slightly differently for the two modes, but are essentially the same. The dynamic mode offers different defaults and more range of choices (although this means, of course, that the calculations take longer).





Click **Advanced Settings** to bring up the configuration dialog.





In Dynamic mode, you can apply a set of parameters, then change the initial lighting angle and re-apply the same rendering.

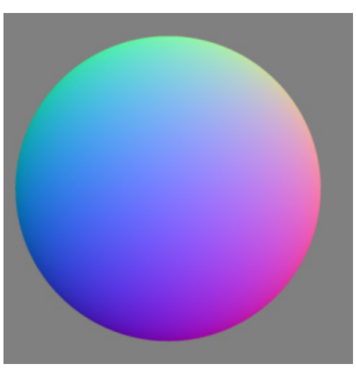
Multi-light mode parameters	
Local offset (*static*) Offset (1-20^{o}) (*dynamic*)	Constrains the choice space of additional light directions to be within a chosen offset from the starting direction chosen in the Light Controller. ▶ For Static mode, you can choose from these values: 5^{o} (9 samples) 10^{o} (25 samples) 15^{o} (49 samples) ▶ For Dynamic mode, you can choose any value between 1 and 20 degrees.
Tile size (px)	Sets the size of the tiles in square pixels. ▶ For Static mode, you can choose from these values: 8 16 32 ▶ For Dynamic mode, you can choose from these values: 8 16 24 32
N. initial tiles	Sets the initial number of tiles for Static mode. This constrains the selection of light directions to avoid rendering imperfections. ▶ For Static mode only, you can choose from these values: 4 16 64
Sharpness operator	The method used to compute the sharpness of each tile. ▶ You can choose from these values: Max Laplacian Max Energy of Laplacian L1 norm Sobel L2 norm Sobel
Light sampling	The strategy used to select the light direction. ▶ You can choose from these values: Isotropic Anisotropic
K1 (Sharpness)(0-1)	The weighting factor for the sharpness value. ▶ You can choose a percentage value from 0.0 to 1.0.

K2 (Lightness)(0-1)	The weighting factor for the brightness value. ▶ You can choose a percentage value from 0.0 to 1.0.
Threshold (0-1)	A factor that affects the choice of candidates for the light direction for each tile. ▶ You can choose a percentage value from 0.0 to 1.0.
Smoothing filter	The size in tiles of a filter used to smooth the selected light direction over the entire image. ▶ You can choose from these values: 3x3 5x5 7x7
N. iteration smoothing	The number of times to apply the smoothing filter. ▶ You can choose a value from 0 to 10.

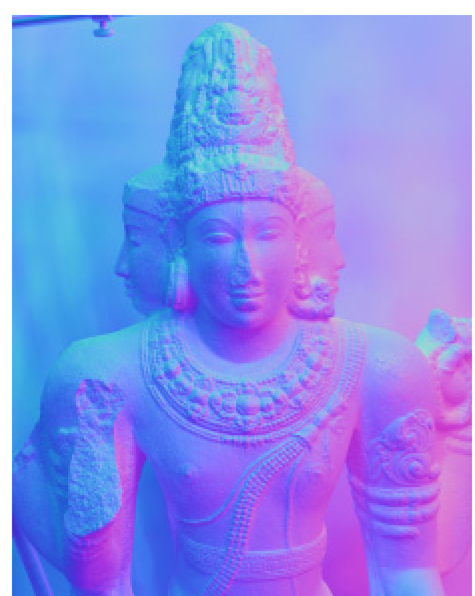
Normals Visualization mode

RTIViewer's Normals Visualization mode creates a false-color rendering that shows the subject's pixel-by-pixel surface orientation. In this rendering, the X, Y, and Z components of the normal value at each pixel are represented as red, green, and blue, respectively.

The result is that the normal direction at each pixel (which represents the surface orientation in the image data) is represented by a particular color. This false-color normals visualization of a hemisphere shows how the colors correspond to specific surface directions.



Below, the visualization is applied to an RTI image of a sculpture (in front of a flat background which is out of focus).



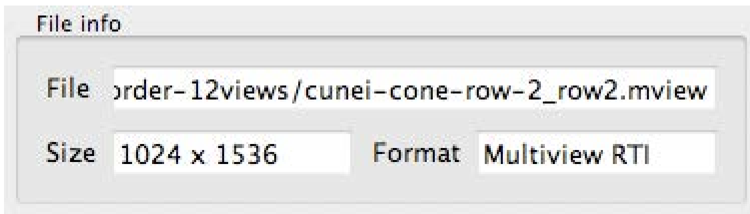
As the surface orientation changes around the surface of the sphere, the false color representation changes with it. For example, the green colors on the part of the sphere where the surface orientation is pointed upward correspond to the color of the upward facing areas on the Shiva sculpture.

This rendering makes it much easier to visualize the normals information that describes the surface contours.

For more information about surface normals, see:
http://culturalheritageimaging.org/Technologies/RTI/#how_RTI

Multi-view RTI viewing

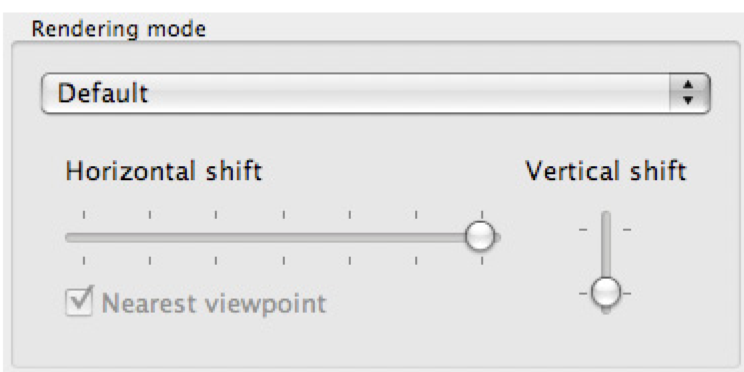
RTIViewer allows you to view multi-view RTIs; that is, a set of RTIs that were created from multiple camera viewpoints and can be viewed in an integrated manner. This type of image is contained in a set of files with the `.mview` extension. When you load such an image, the viewer indicates that the file is of type **Multiview RTI**.



This technology was developed at the University of California Santa Cruz. The current MVIEW file format specification can be downloaded at http://CulturalHeritageImaging.org/downloads/. The software to build an MVIEW file from appropriate captured and numbered sequences of RTIs is available under the GNU General Public License version 3, by writing to info@c-h-i.org.

NOTE: The Bookmark feature of RTIViewer is not available for multi-view (MVIEW) files.

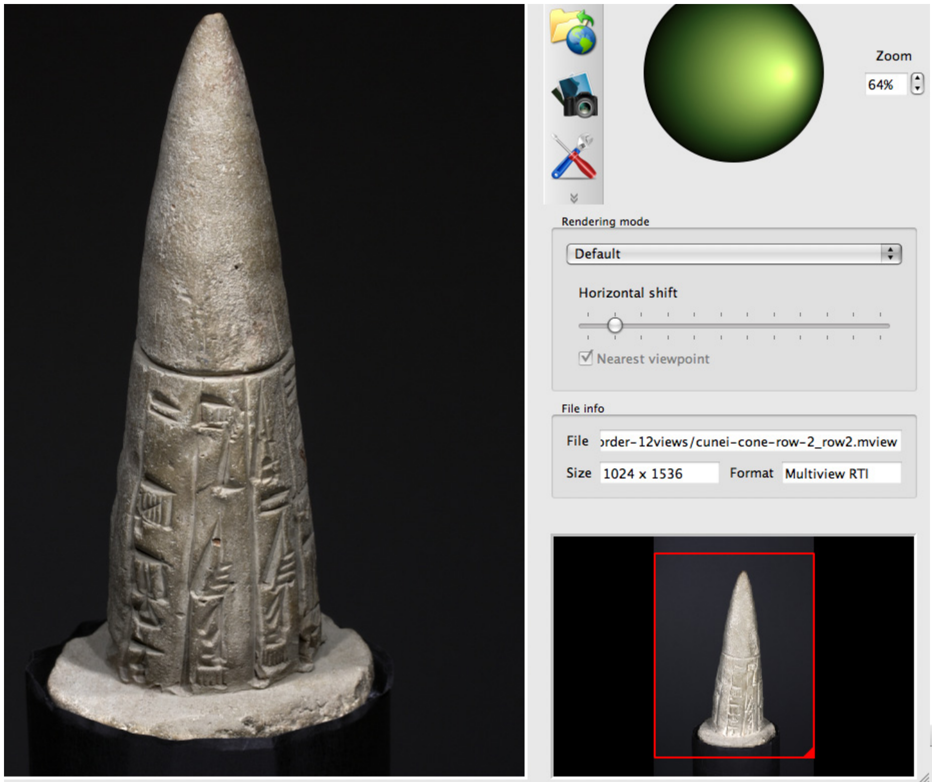
The default rendering mode for multi-view images allows you to choose among the contained set of viewpoints. As determined by the number of latitudinal samples (horizontal rotation of viewpoint right of left around the subject) and the number of longitudinal samples (vertical rotation of the viewpoint up and down around the subject), you are offered a choice of horizontal and vertical viewpoints from which to explore the subject.



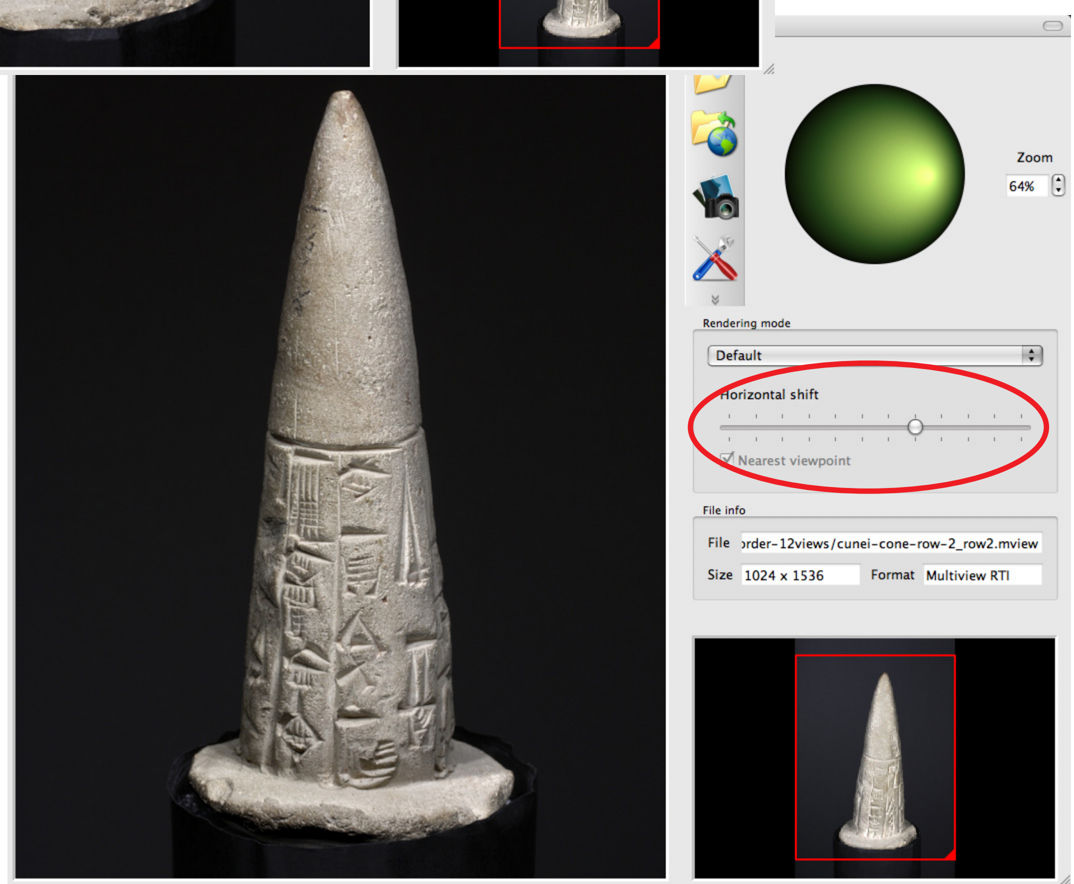
The number of views on each scale corresponds to the number of available sampled viewpoints. Images with more viewpoints are, of course, much larger than those with fewer.

In the case where all the acquired Multi-view RTI viewpoints that encompass the subject are along the same latitude, RTIViewer is configured as shown in the following figures.

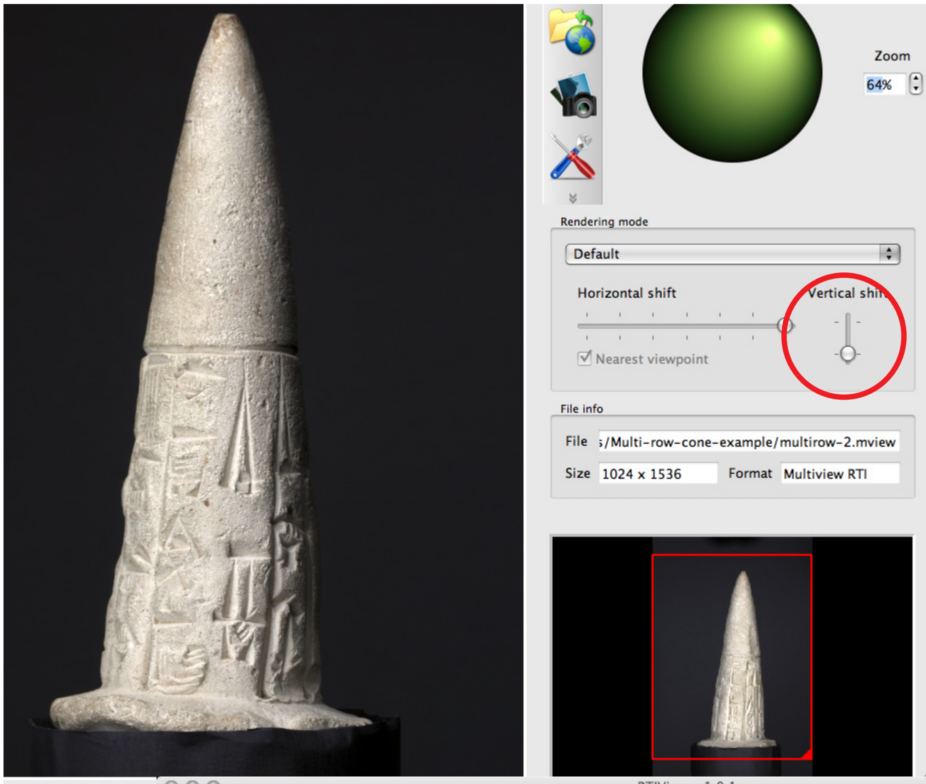
The top left figure is displaying the second viewpoint from the left-most viewpoint. The figure in the lower right displays the subject six viewpoints further to the right. You can display and relight the subject at each of the sampled viewpoints.



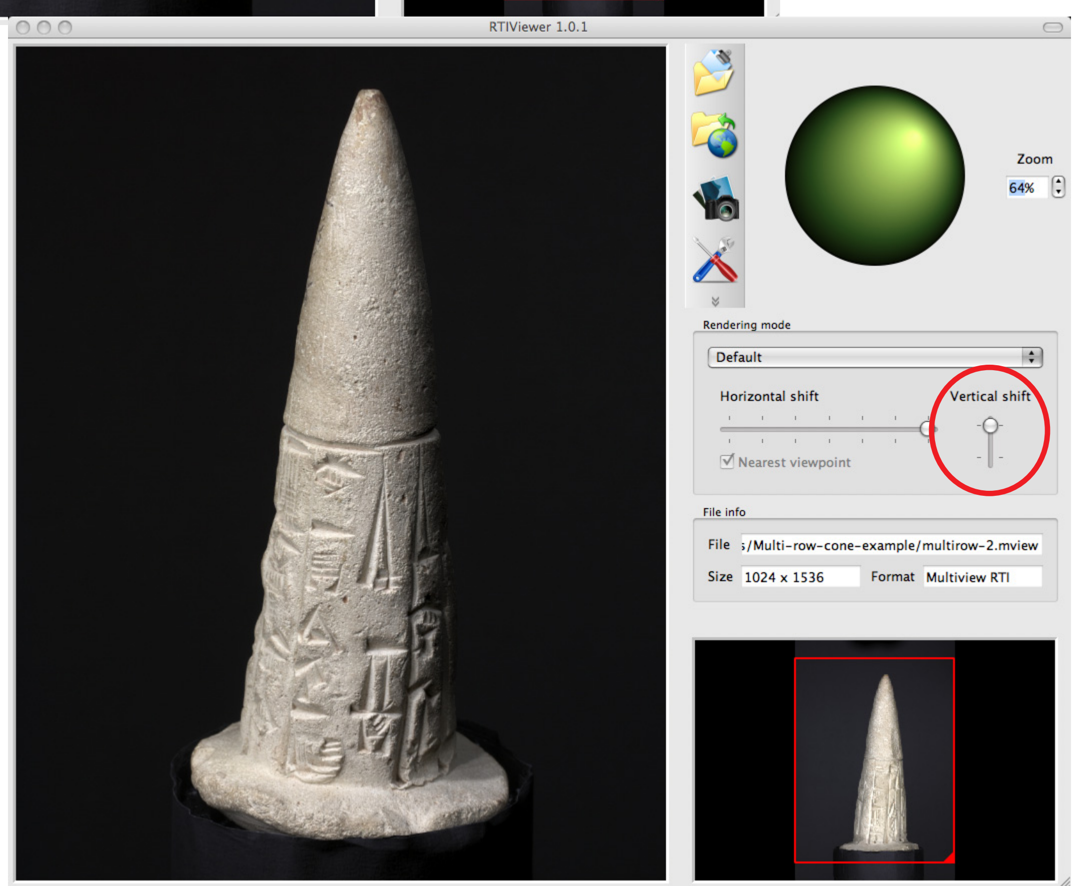
As you change the horizontal viewpoint, the object appears to rotate in the horizontal plane.



When a Multi-view RTI is captured at more that one latitude, a Vertical shift tool appears to the right of the Horizontal shift tool. These figures show the subject at two different longitudinal viewpoints.



As you change the vertical viewpoint, the object appears to rotate toward or away from you.



Exploring an RTI subject between viewpoints

RTIViewer is designed to accommodate the integration of new features for rotating and relighting multi-view RTI subjects that will allow you to explore a subject between the captured viewpoints. When appropriate optical-flow data is available, the viewer can display the subject from any desired rotational position between the captured viewpoints, and relight the subject interactively; activate this mode by deselecting the "Nearest viewpoint" check box.

NOTE: This feature is still in the early research stage of development, and is of experimental quality that is not user-friendly. Much of the functionality is currently designed for use with relatively low resolution files.

Even within the significant limitations, the research team has used optical flow technology to demonstrate that it is possible to create highly information-rich and interactive three-dimensional displays between captured viewpoints. Future implementations may address the generation and display of arbitrary rotation and relighting within high-resolution MVIEW files.

Remote Viewing

RTIs are typically large files with very fine resolution; for this reason, it can be more practical to store the images on servers for sharing. The RTIViewer allows you to load and display images stored on a local hard drive, or on a remote server through an HTTP connection.

Preparing images for remote viewing

Remote viewing is available only for files in the LRGB PTM and HSH RTI formats. In order to use it, you must preprocess the target file using the RTI Webmaker command-line tool. This tool converts the PTM images into a more compact format that permits remote loading in chunks through HTTP. The command takes two arguments, the *path* to the PTM or RTI file, and the *resolution level*, which controls level and number of chunks to produce. For example:

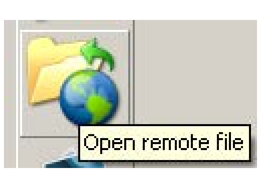
```
RTIWebmaker ..\rtiImage\test.ptm 3
```

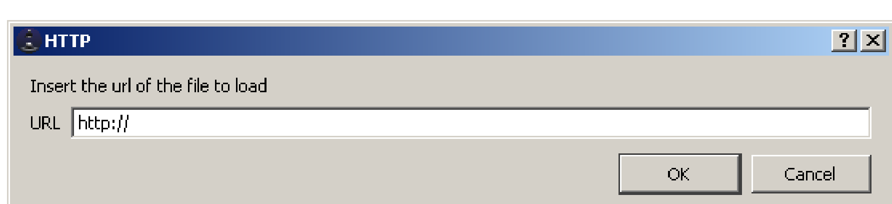
The tool produces a folder containing the converted files; you can copy the entire folder to the server. The URL of the image is the path of the file in that folder that has the extension `.ptm` or `.rti`.

To install the RTI WebMaker in Mac OSX, copy the alias in the disk image into the same folder as RTIViewer. In Windows, run the installer.

Viewing remote image files

To browse for a remote image file, click the "Open remote file" icon, and enter the URL in the resulting dialog.





Tiled image data with increasing resolution allows incremental loading from a remote site. Efficient storage of RTIs using multi-resolution tiling and JPEG2000 compression allows asynchronous loading, with increasing resolution as loading proceeds.

Images courtesy of the VISUAL Computing Lab of CNR Pisa