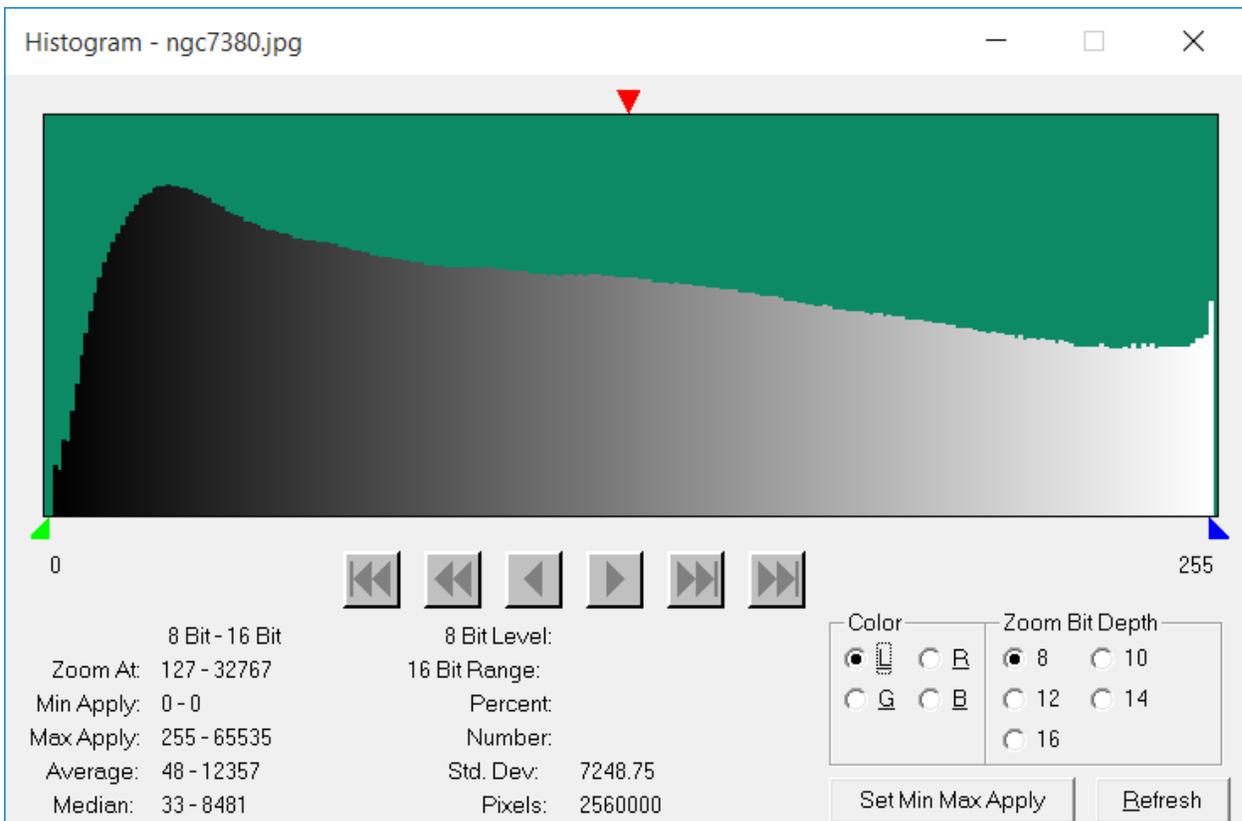


## Image Analysis Tools

The image analysis tools include the Histogram, Line Profile, Cross-Hair, Star Shape, and Time Sequence tools. The image analysis tools are located on the main ImagesPlus Modeling menu and also have buttons on the top horizontal toolbar.

### Histogram



A histogram displays the intensity distribution of an image. The x-axis of the histogram is the range of possible pixel values from black to white for a given pixel bit depth. The x-axis is a linear display of possible pixel intensity values from black to white. The y-axis of the histogram represents the number of pixels found in the image with a given pixel value. The y-axis is a logarithmic display so that both very large and very small pixel counts can be displayed in a limited amount of vertical distance. A histogram is used to display the changes to an image while using any tool that modifies the image. Move the mouse over the histogram graph to display statistics about the number of pixel for a specific pixel intensity level.

The histogram shown above can display image data in 8, 10, 12, 14, or 16 bit precision using the Zoom Bit Depth controls. The Scroll buttons are enabled if Zoom Bit Depth is set to 10, 12, 14, or 16 bit.

The red triangle at the top of the histogram marks the current zoom at position. Left-click at the top of the histogram to set the zoom at position.

The green and blue triangles at the bottom of the histogram mark the current filter min and max apply positions, respectively. Left-click and right-click under the histogram to set the min and max apply

positions, respectively. Use the Set Min Max Apply button to transfer the [min, max] range to an enhancement filter.



Activates the Histogram dialog box from the top horizontal toolbar.



The color channel toolbar buttons are disabled since this command contains its own color selection.

### Control Summary

**Zoom At:** The position of the red triangle. Marks the current zoom at position.

**Min Apply:** The position of the green triangle. Marks the current min apply position.

**Max Apply:** The position of the blue triangle. Marks the current max apply position.

**Average:** The average pixel intensity of the image. The first number is the 8, 10, 12, or 14 bit value and the second number the 16 bit value.

**Std. Dev:** The standard deviation or a measure of how much the pixel intensities vary from the average pixel intensity.

**Median:** If the pixel intensities are sorted by increasing intensity, then the median intensity is the intensity at the middle of the sorted list. The first number is the 8 bit value and the second number the 16 bit value.

**Pixels:** The number of pixels in the image or histogram. This is the product of the image width and height.

**Level:** The current intensity under the mouse. An 8 bit value in the range 0 for black and 255 for white.

**Intensities:** The level value converted to the range of 0 to 65535 for a 16 bit image, e.g. level 54 represents the intensities 13824(= 54\*256) to 14079(=55\*256 - 1) in the 16 bit range.

**Percent:** The sum of the number of pixels from level 0 to the current level divided by the total number of pixels.

**Number:** The number of pixels at the current intensity level.

### Color Channel

For a color image a luminance, red, green, or blue data histogram can be displayed using the L, R, G, or B color options. The histogram of a monochrome image can be grayscale luminance, red, green, blue, cyan, magenta, or yellow. The Color | Interpret – Mix Colors tool is used to set the monochrome color type of a monochrome image.

### Zoom Bit Depth & Scroll Buttons

Sets the histogram display to 8, 10,12, 14, or 16 bit depth. An increase or decrease in zoom bit depth creates a zoom in or zoom out effect, respectively. The left and right scroll buttons are enabled if 10, 12, 14, or 16 bit depth is selected.



Sets the display to far left or black side of the histogram.



Moves the histogram display toward to the left by a large step value.



Moves the histogram display toward to the left by a small step value.



Moves the histogram display toward to the right by a small step value.

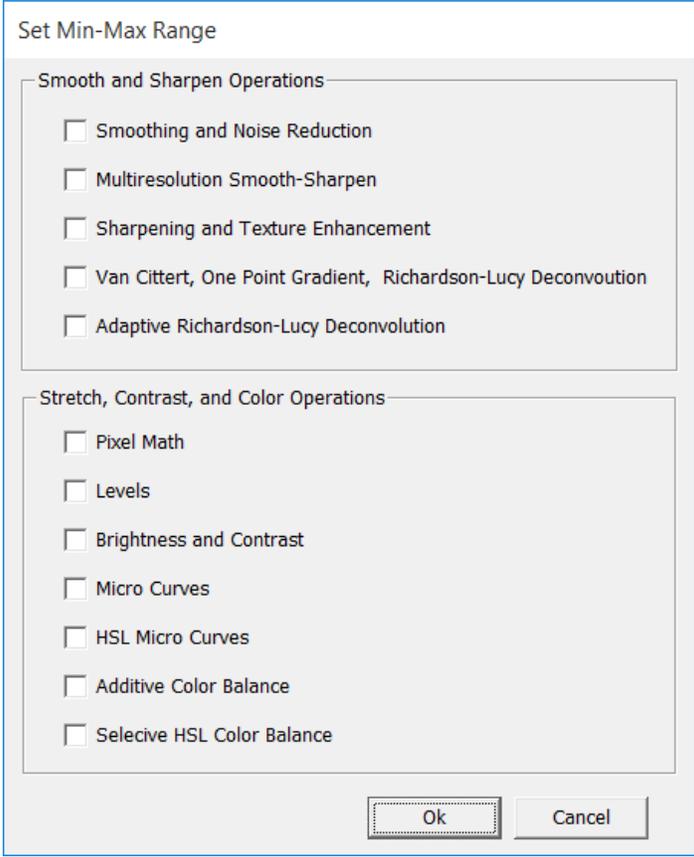


Moves the histogram display toward to the right by a large step value.



Sets the display to far right or white side of the histogram.

### Set Min Max Apply:



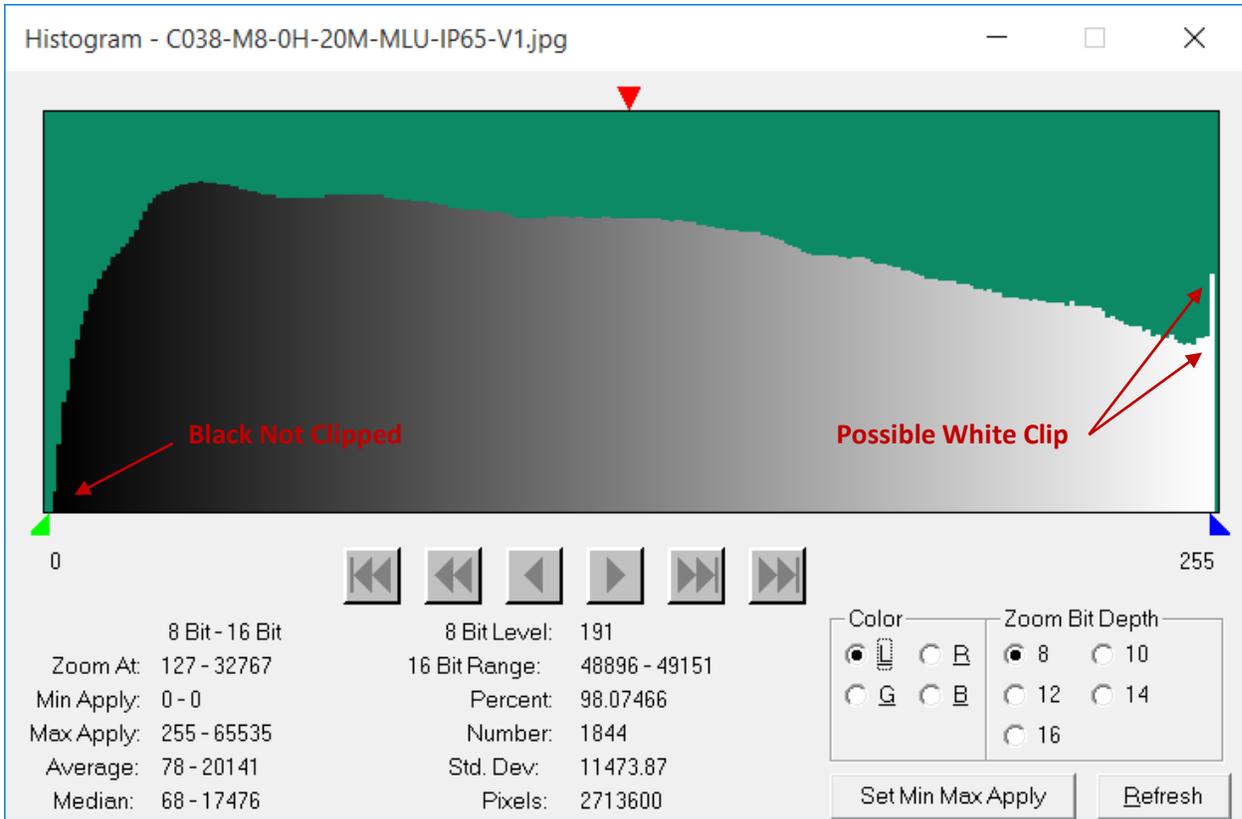
The dialog box titled "Set Min-Max Range" contains two sections of options. The first section, "Smooth and Sharpen Operations", includes checkboxes for "Smoothing and Noise Reduction", "Multiresolution Smooth-Sharpen", "Sharpening and Texture Enhancement", "Van Cittert, One Point Gradient, Richardson-Lucy Deconvolution", and "Adaptive Richardson-Lucy Deconvolution". The second section, "Stretch, Contrast, and Color Operations", includes checkboxes for "Pixel Math", "Levels", "Brightness and Contrast", "Micro Curves", "HSL Micro Curves", "Additive Color Balance", and "Selecive HSL Color Balance". At the bottom right, there are "Ok" and "Cancel" buttons.

This window is used to transfer the [min, max] range selected on the histogram using the green and blue triangles to an enhancement filter. A feather option is available on the enhancement filter window.

Min and Max apply can also be set by a left-click on an image with an enhancement filter open. Changes made to Min and Max apply from an enhancement filter are updated on the Histogram command if the Histogram command is open.

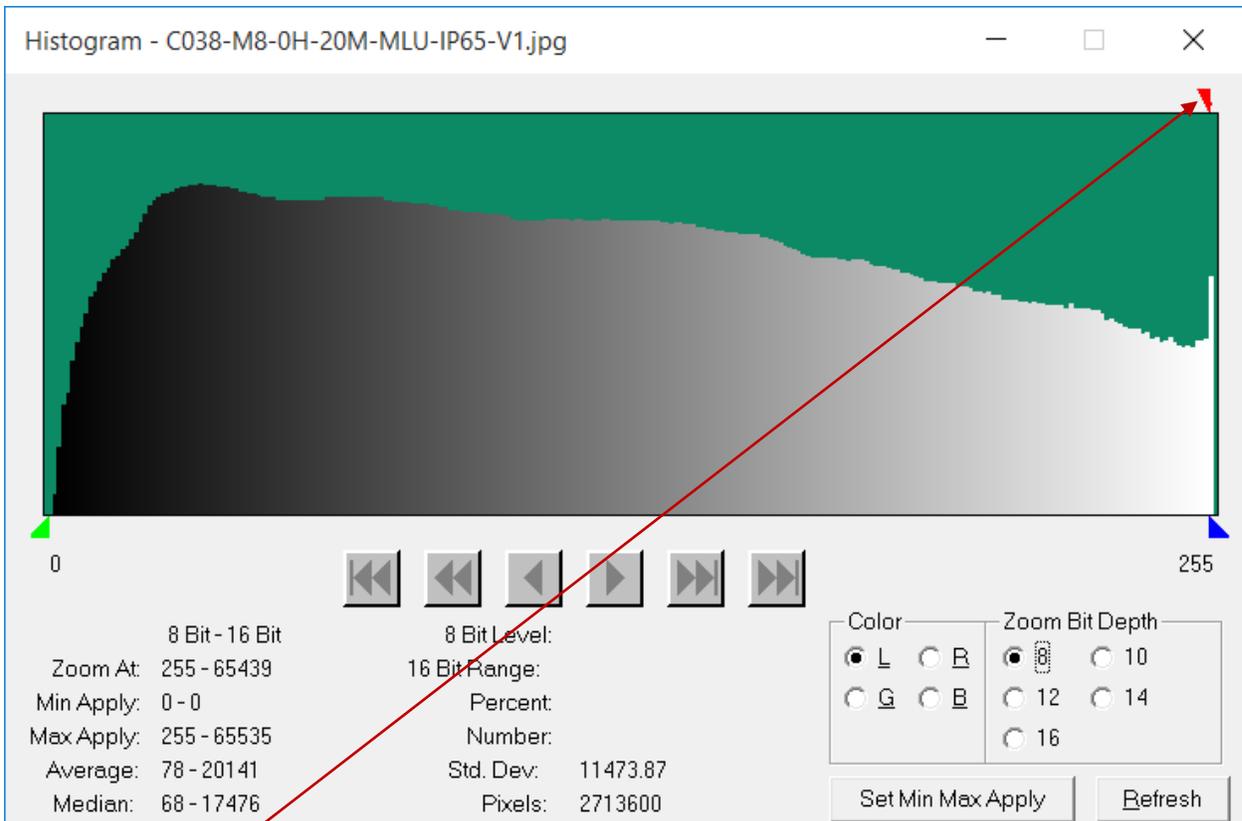
**Refresh:** Press this button to calculate and display the histogram of the current active image.

A histogram is often used to determine if an image is clipped at black or white. The image shown in Figure 1 has what appears to be a clipped histogram on the far right white side since the number of pixels with the maximum white value appears to be very large.

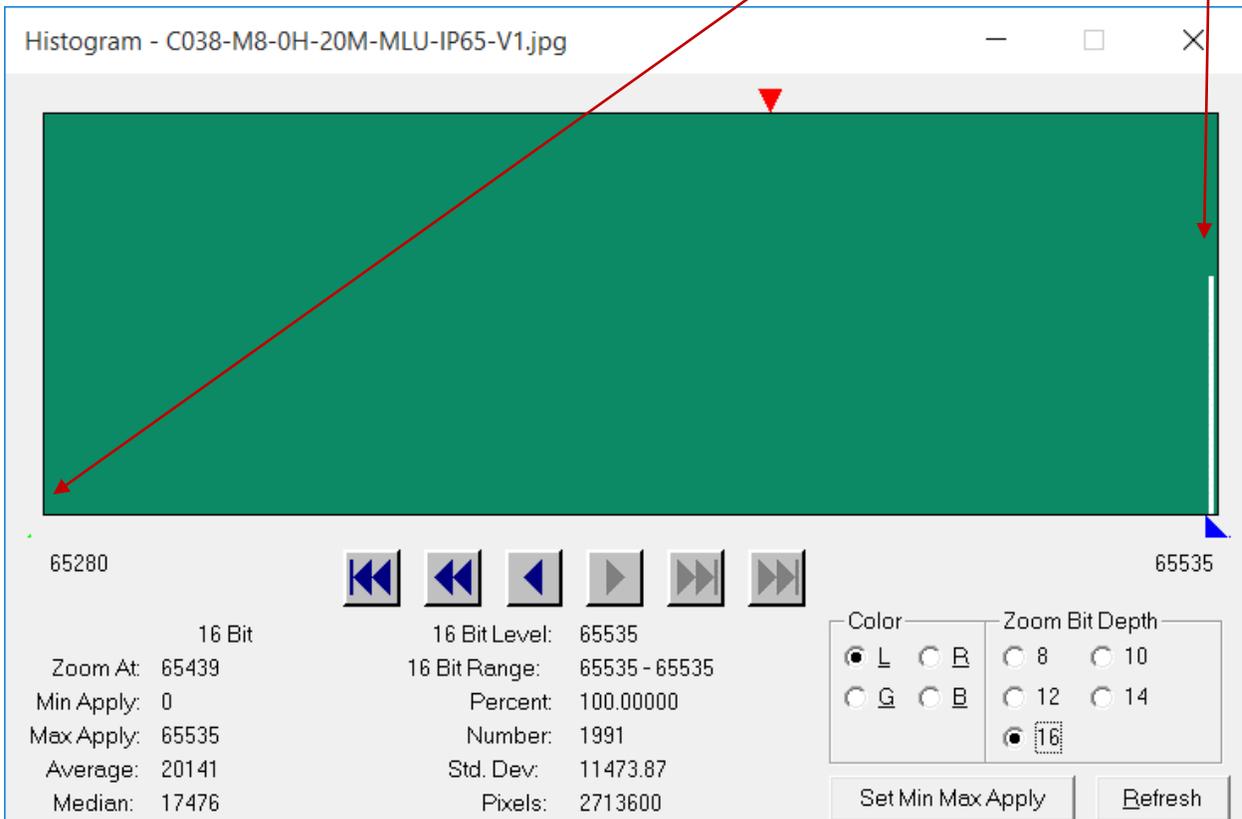
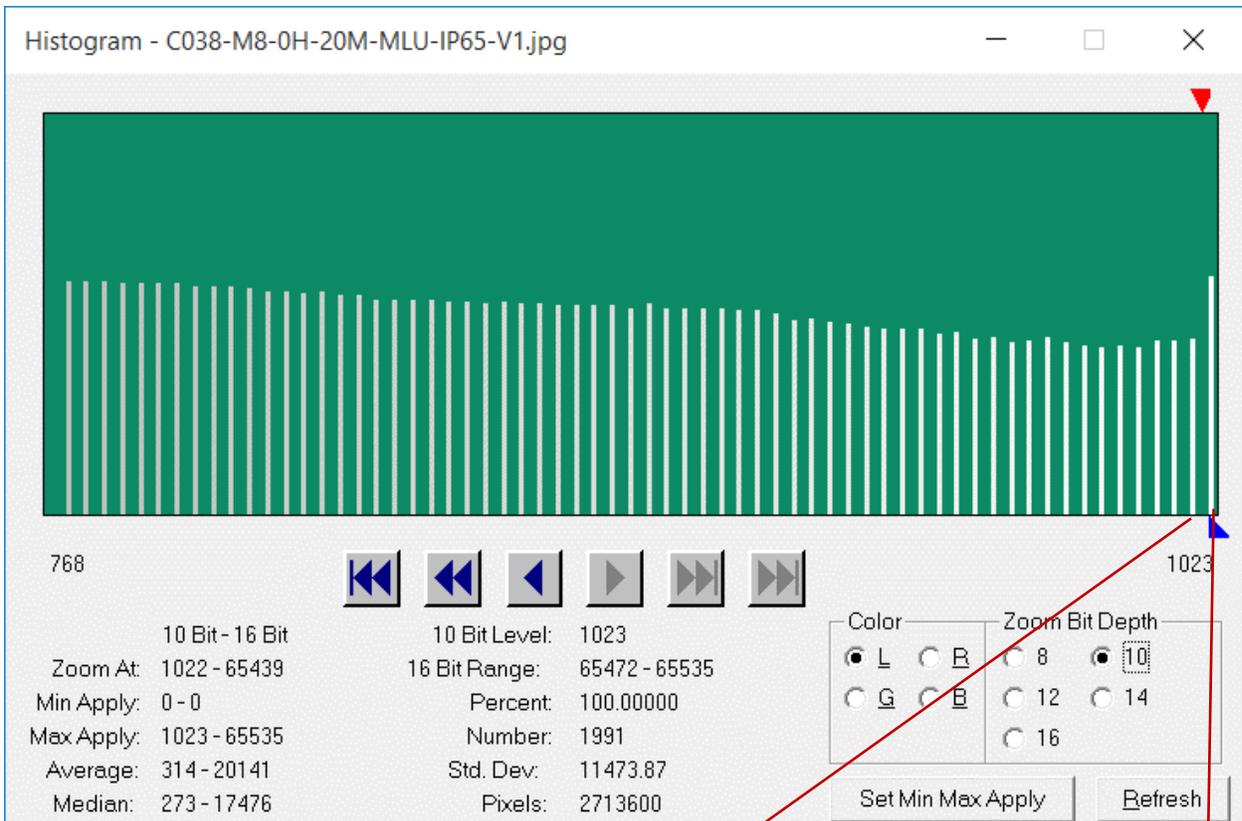


**Figure 1.** 8 bit histogram of 32 bit floating point image data maintained by ImagesPlus. The black left side of the histogram shows a small number of pixels with value 0 but the white right side appears to have a large number of white pixels with values near 255.

The appearance of a histogram depends on the bit depth of the histogram and also how the x and y values are plotted. The appearance of the large number of white pixels near 255 in Figure 1 is due to the logarithmic display of the histogram's y-axis and also because the histogram is only 8 bit precision. With the 32 bit floating point image data maintained by ImagesPlus, which means pixel values can have decimal values, several different floating point values for a pixel are counted as the same value when the image data is viewed as only 8 bit data. For example, all 32 bit floating point pixel values between 65280.0 and 65535.0 are counted as the same value of 255 by an 8 bit histogram so the pixel count can seem elevated. To see a more accurate pixel count set the top red zoom triangle to the far right side of the histogram as shown in Figure 2 then set Zoom Bit Depth to 10 bit followed by 16 bit as shown by Figure 3.



**Figure 2.** Left click a little above the histogram display on the far right to set the red zoom triangle.

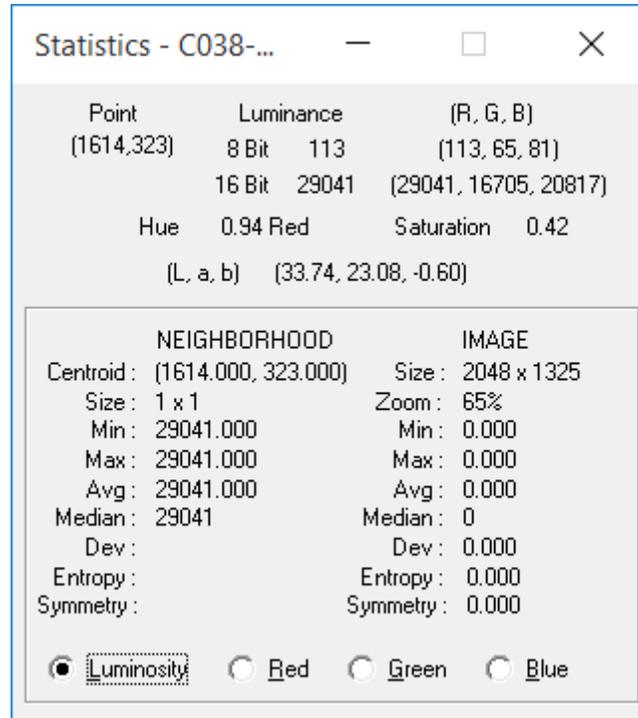


**Figure 3.** 10 and 16 bit histograms of the same 32 bit floating point image data.

The 10 and 16 bit histograms in Figure 3 show that the real number of maximum white pixels with value 65535.0 is only 1991 out of 2713600 total pixels so the image is not clipped on the white side.

Additional information about the histogram tool can be found at [Using the 8-16 Bit Histogram](#) .

### Cross-Hair Analysis



The Cross-Hair window displays information about the entire image or on a selected neighborhood of the image. The Cross-Hair window displays statistics and the color type for a monochrome image or luminance for a color image. You can select individual color channels of a color image.

If the Cross-Hair window is active, moving the mouse over the active image will update the display. The size of the neighborhood can be decreased using ctrl-right-click and increased using ctrl-left-click. The position of the cross-hair can be adjusted using the standard arrow keys.

Current cross-hair This group of statistics is calculated using only the pixel under the cross-hair.

Point: The (x, y) coordinates of the cross-hair.

Luminance: The intensity of the pixel at the current cross-hair position in 8 and 16 bit precision.

(R, G, B): The red, green, and blue intensity values at the current cross-hair position in 8 and 16 bit precision.

Hue: Displays the hue of the current pixel under the cross-hair. Hue can have values of red, green, blue, cyan, magenta, or yellow.

Saturation: Displays the hue saturation of the current pixel under the cross-hair. Saturation can range from 0 for grayscale to 1.0 for full hue saturation.

(L, a, b): Displays the Lab color of the current pixel under the cross-hair. L is luminance, a represents red-green, and b represents yellow-blue.

The [Color Models & Color Tools](#) chapter of the ImagesPlus image processing user manual contains a detailed description of hue, saturation, luminance (HSL) and Lab color space.

Image Statistics This group of statistics is calculated using all pixels in the image.

Size: The width and height of the image in pixels.

Zoom: The display scale factor applied to the image.

Min: The minimum pixel value of the image.

Max: The maximum pixel value of the image.

Avg: The average pixel value of the image.

Median: The median or middle pixel value of the image.

Dev: The standard deviation of the images pixel values.

Entropy: The entropy of the image.

Symmetry: The symmetry coefficient of the image.

Neighborhood Statistics This group of statistics is calculated using only the pixels in a N X N neighborhood about the pixel under the cross-hair. Neighborhood size can range from 1 x 1 or a single pixel to 99 x 99. The default size is 1x1. The size of the neighborhood can be decreased using ctrl-right-click and increased using ctrl-left-click on the image. The position of the cross-hair can be adjusted using the standard arrow keys.

Centroid: The neighborhoods center of luminosity.

Size: The width and height of the N x N neighborhood in pixels.

Min: The minimum pixel value within the neighborhood.

Max: The maximum pixel value within the neighborhood.

Avg: The average pixel value within the neighborhood.

Median: The median pixel value within the neighborhood.

Dev: The standard deviation of the pixel values within the neighborhood.

Entropy: The entropy calculated on pixel values within the neighborhood.

Symmetry: The symmetry coefficient of the neighborhood histogram.



Activates the Cross-Hair dialog box from the top horizontal toolbar.



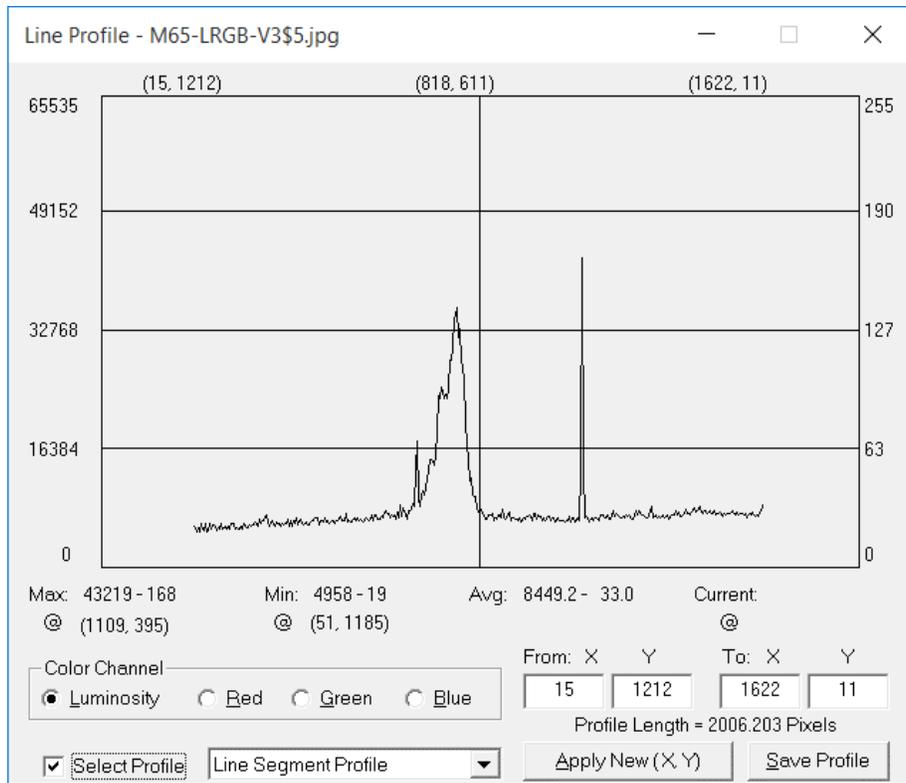
The color channel toolbar buttons are disabled since this command contains its own color selection.

## Control Summary

### Color Channel

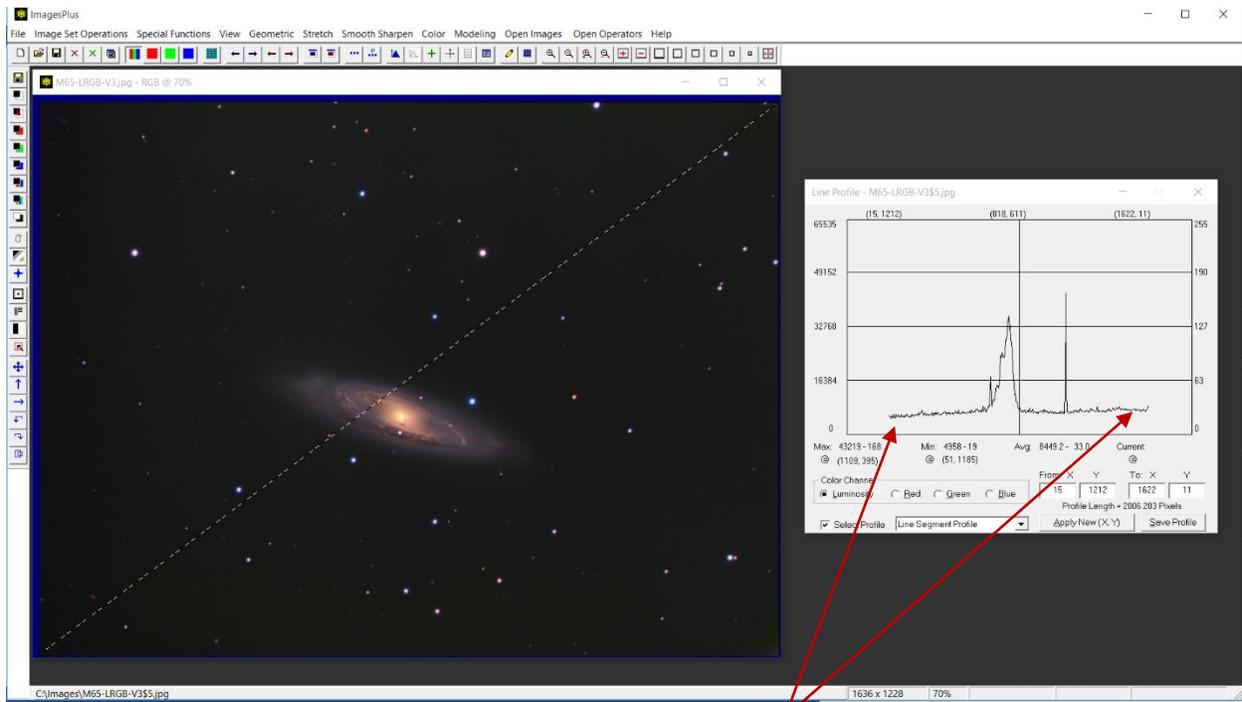
The color type is displayed for a monochrome image. For color images the luminance is displayed. Statistics of each color channel can be displayed separately using the Red, Green, or Blue commands.

### Line Profile



The Line Profile window displays a pixel intensity cross-sections of an image. The cross-section can be a line segment created by dragging the mouse across the image while holding the left button down as shown below. The line segment can also be a horizontal or vertical line across the entire image created by left-clicking on the image. Use the Line Segment Profile list box to select the type of line profile.

Image statistics are displayed when you move the mouse over the line segment graph. The position and value of the maximum, minimum, average, and current intensity under the mouse are displayed.



The line profile is useful when detecting gradients. Note that upward slope of the line profile which shows a gradient from lower left to upper right. The line profile tool can be used to determine background flatness while using the Special Functions | Multi-point Flatten tool to [remove gradients](#). The line profiles of a flat and light frame should be similar for good flat calibration. See [Necessary Relation of Flat and Light Frames for Good Flat Calibration](#) for an example.

 Activates the Line Profile dialog box from the top horizontal toolbar.

 The color channel toolbar buttons are disabled since this command contains its own color selection.

## Control Summary

### Color Channel

The color type is displayed for a monochrome image. For color images the luminance is displayed. The histogram of each color channel can be displayed separately using the Red, Green, or Blue commands.

The From: X Y and To: X Y boxes are used to enter or modify the coordinates of the starting and ending point of the line profile.

**Line Segment Profile List:** Selects a line segment, horizontal, or vertical line profile.

**Apply New (X, Y):** Updates the line profile using the values entered in the From X Y and To X Y boxes.

**Save Profile:** Use this button to save the line profile data to a text file.

## Star Shape

	Luminance	Red	Green	Blue
Star Brightness:	29409	32877	30116	31626
Background Near Star:	3443	4312	4541	4596
FWHM:	3.75	3.74	3.65	5.14
HFD:	4.58	4.96	4.71	5.77
Major Axis:	Right Diagonal	Right Diagonal	Right Diagonal	Right Diagonal
Minor Axis:	Left Diagonal	Left Diagonal	Left Diagonal	Left Diagonal
Eccentricity:	0.448	0.549	0.444	0.500
Horizontal Axis:	5.96	5.82	5.75	7.68
Vertical Axis:	6.16	6.22	5.84	8.07
Left Diagonal Axis:	6.35	6.29	6.32	8.04
Right Diagonal Axis:	6.94	7.28	6.49	8.91
Stars Detected - Used:	816 - 110	748 - 109	672 - 102	553 - 69

Analysis Area

Star Neighborhood     Top Left     Top Center     Top Right

Left Center     Center     Right Center

Complete Image     Bottom Left     Bottom Center     Bottom Right

Compute FWHM     Compute HFD

Units: Pixels

Update Save Cancel Print

The Star Shape tool is used to measure the size, eccentricity, brightness, and background brightness of well defined stars. The Star Neighborhood mode can be used to measure star statistics under the mouse. The Complete Image, Top Left, or other sub-image options are used to automatically detect all well defined stars in an image and calculate average statistics. Star shape statistics can be used to evaluate tracking, optical quality, and field curvature of a camera telescope system.

Only well defined isolated single stars that are not part of a galaxy, cluster, or nebula are used to calculate star shape statistics. So not all stars in an image or under the mouse will be used to calculate statistics.

Star size statistics can be displayed in pixels or arcseconds per pixel. The Arcsecond Per Pixel Setup command is used to specify camera and telescope properties so that arcseconds per pixel for a given image can be calculated.



The color channel toolbar buttons are disabled since this command contains its own color selection.

### Star Size Statistics

Star Brightness: 16-bit brightness value of a star.

Background Near Star: The 16-bit average background brightness near a star. Does not include the star.

FWHM: The full width half maximum diameter of a star.

HFD: The half flux diameter of a star. This metric is more stable with respect to seeing than FWHM.

Major Axis: The largest diameter of a star.

Minor Axis: The smallest diameter of a star perpendicular to the major axis.

Eccentricity: A measure of how much a star has been deformed from a circle to an ellipse. If eccentricity is 0 then the star is a perfect circle. As eccentricity moves from 0 -> 1 the star becomes more oval.

Horizontal Axis: The horizontal diameter of a star.

Vertical Axis: The vertical diameter of a star.

Left Diagonal Axis: The left diagonal diameter of a star.

Right Diagonal Axis: The right diagonal diameter of a star.

Stars Detected - Used: Total number of stars detected and used in the average shape statistics.

### Analysis Area

**Star Neighborhood:** Compute star shape statistics for a single well defined star under the mouse.

**Complete Image:** Display average statistics for the entire image.

**Top Left:** Display average statistics for the top left rectangle of the image.

**Left Center:** Display average statistics for the left center rectangle of the image.

**Bottom Left:** Display average statistics for the bottom left rectangle of the image.

**Top Center:** Display average statistics for the top center rectangle of the image.

**Center:** Display average statistics for the center rectangle of the image.

**Bottom Center:** Display average statistics for the bottom center rectangle of the image.

**Top Right:** Display average statistics for the top right rectangle of the image.

**Right Center:** Display average statistics for the right center rectangle of the image.

**Bottom Right:** Display average statistics for the bottom right rectangle of the image.

**Compute FWHM:** If checked the average full width at half maximum of all well defined stars is calculated.

**Compute HFD:** If checked the average half flux diameter of all well defined stars is calculated.

**Update:** Starts calculation of complete image star shape statistics.

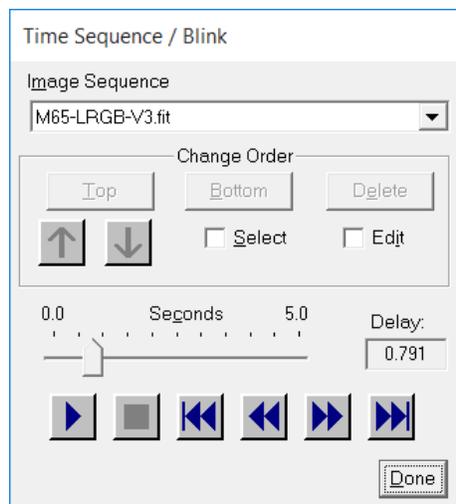
**Save:** Saves the complete image star shape analysis broken down into 9 subregions in a file.

**Cancel:** Cancels complete image star shape calculation.

**Print:** Prints the complete image star shape analysis broken down into 9 subregions.

**Units:** Select the star size units. The Arcsecond Per Pixel Setup command is used to specify camera and telescope properties so that arcseconds per pixel for a given image can be calculated.

## Time Sequence | Blink



The Time Sequence command can be used to blink or animate a sequence of open images. To create an image sequence, check the Select box and then click on the client area of the images that you want to include. The images will be displayed in the order they were chosen.

It is not necessary to close the Time Sequence dialog box before applying an image processing operation to the sequence elements.

*The Image Set Operations / Blink Files tool is used to blink a set of image files without having to open the complete set of images.*

### Control Summary

**Image Sequence:** Shows the time sequence display order. The image at the top of the list is displayed first and the image at the bottom of the list is displayed last.

### Change Order

**Top:** Move an image to the top of the time sequence display order.

**Bottom:** Move an image to the bottom of the time sequence display order.

**Delete:** Deletes an image from the time sequence.

 Moves an image up 1 position in the time sequence.

 Moves an image down 1 position in the time sequence.

**Select:** Checking this box enables sequence element selection using the mouse. Click on the images in the order that you want them to appear in the sequence.

**Edit:** Check this box to enable the time sequence change order controls.

**Seconds Delay:** The time delay, in seconds, between time sequence elements.

 Starts the time sequence loop.

 Stops the time sequence loop.

 Displays the first image in the time sequence.

 Displays the previous image in the time sequence.

 Displays the next image in the time sequence.

 Displays the last image in the time sequence.

**Done:** Choose this button to close the Time Sequence dialog box