

MALLINCAM



Universe

User's Guide

Foreword

Welcome to the MallinCam Universe!

The new MallinCam Universe represents years of research and design to develop a color astronomical CCD camera that is capable of live constant refresh to provide a near real-time experience of many celestial targets. Such capability was previously only available with sensitive astronomical video imagers, such as the MallinCam Xtreme. But unlike video cameras, the Universe utilizes an APS-C size 6.1 megapixel scientific-grade CCD sensor, which provides a much larger field of view. The constant refresh image display, coupled with up to 4x4 binning in full color, is ideal for those who wish to use the camera as a live observing system, as well as a highly capable imager. Adjustments are done on-the-fly, with features such as: fully automatic or manual histogram control, gamma range and contrast adjustments, and complete white balance color control. And switching between color and monochrome modes requires only a single click.

The unique *Hyper Circuit* system found on all other MallinCam imaging cameras has been included in the Universe. This allows the camera to deliver a total variable gain of 26 dB and a dynamic range of 80 dB, with a signal-to-noise ratio of 60 dB.

The Universe is fully USB 2.0 controlled, including image transfer. A thermo-electric cooling system and sealed sensor chamber allow the imaging chip to reach -45°C below the ambient temperature to ensure extremely low noise and dark current. In most cases, shooting dark frames for noise reduction during image processing is not usually required. Obtaining high-quality publication grade images is now possible and easier than ever with the MallinCam Universe!



NGC7635: MallinCam Universe image courtesy of Chris Appleton

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Cover background image of M42/M43: MallinCam Universe image courtesy of Paul Comision

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Support and inquires contact: Rock Mallin at mallincam@gmail.com

Section 1: Supplied components



- ① MallinCam Universe CCD imaging camera
- ② T-mount to 2" threaded camera nosepiece adapter
- ③ 1.25" eyepiece adapter converter
 - ☞ This is part of the protective metal cap. Unscrew and remove the central plug to expose the converter threads required to mount the optional 1.25" eyepiece adapter.
- ④ AC-to-DC power supply
- ⑤ 16-foot (5-meter) USB 2.0 data cable
- ⑥ Disc or flash drive containing software installation files and User's Guide

The following optional components are also available for your MallinCam Universe:

- 0.5X T-mount focal reducer
 - ☞ The optional 0.5X focal reducer is a recommended accessory when using the Universe on a telescope with a long focal length and/or a high F-ratio, such as F8 or greater. A long focal length yields a relatively small field-of-view. The 0.5X focal reducer essentially cuts the telescope's focal length in half and provides a field-of-view that is twice as large in both length and width. It also reduces the F-ratio by a factor of two. For example, it makes a relatively slow F10 optical system perform like a much faster F5 configuration. This cuts the exposure time down by a factor of four. A properly exposed 8-minute image taken through an F10 telescope would only require a 2-minute exposure to achieve the same level of brightness using the focal reducer! And the sky area covered in the image would be four times greater! A highly recommended accessory to increase the near-live viewing experience!
- Focal reducer spacer
 - ☞ This is used to increase the focal reduction factor even further when using the 0.5X focal reducer. The degree of reduction varies with the telescope type.
- 1.25" eyepiece adapter
 - ☞ This adapter allows the camera to be attached to a 1.25 focuser. However, the camera's large chip requires a 2" focuser for full illumination. Using the camera on a 1.25" focuser will cause some vignetting in the images.

Section 2: Computer system requirements

The MallinCam image capture application requires a Windows-based computer running one of the following operating systems:

- Windows XP SP3 or later
- Windows Vista 32-bit or 64-bit*
- Windows 7 32-bit or 64-bit*
- Windows 8 32-bit or 64-bit*

 ***NOTE:** Installing the MallinCam Universe driver on the 64-bit versions of Vista, Windows 7, or Windows 8 may be problematic due to the Device Driver Signature Enforcement function built into these systems. If you experience difficulties installing the driver, you can override this enforcement by rebooting your computer and pressing the F8 key during the boot sequence (this must be done before the Windows logo appears). When the Advanced Boot Options screen appears, select “Disable Driver Signature Enforcement” and then press Enter to start Windows.

The minimum required computer hardware configuration includes:

- A Pentium™ IV processor running at 1.8 GHz or higher
- A CD-ROM or DVD drive (if you received the software on a disc)
- At least 1 GB of RAM if you are using WIN XP; 2 GB for WIN Vista or WIN 7
- 10 MB of hard disk space for the capture application and documentation
- 1 GB or more of hard disk space for image capturing
- A video display capable of rendering 1024x768 resolution minimum; 1280x1024 or higher is recommended, and in 24-bit color
- One available fully-specified high-speed USB 2.0 port

Other requirements:

- A 120 VAC mains power connection

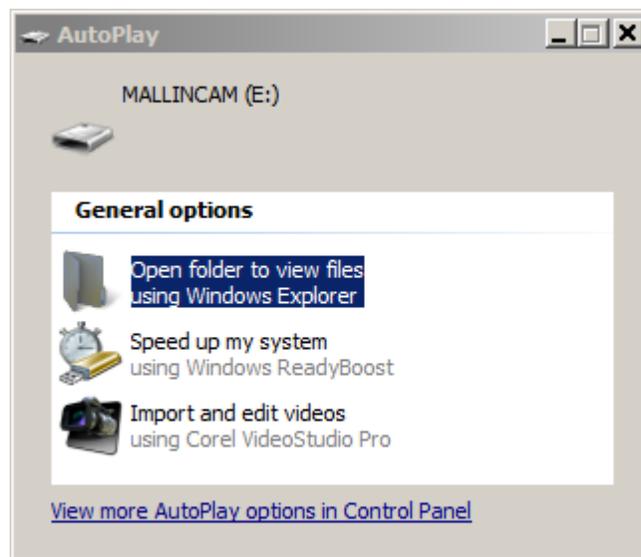
Section 3: Software installation

The MallinCam software required to operate the camera is supplied on the disc or flash drive included with your camera. You can also download and install the latest versions of the drivers and capture application over the Internet. Contact Rock Mallin at mallincam@gmail.com for details.

The installation procedure for the various supported versions of the Windows operating system are all quite similar. The recommended step-by-step installation procedure for WIN XP is detailed below as an example.

You must install the software drivers before connecting the camera to the computer. Proceed as follows:

1. Close all other applications currently running on your computer system.
2. Insert the installation disc or flash drive into your computer. A form similar to this is typically displayed:



3. Click on the *Open folder to view files using Windows Explorer* option and then click *OK*.

If this form is not automatically displayed, right-click the My Computer desktop icon to open Windows Explorer and then click on your CD-DVD drive or flash drive to view the files.

-
- Double-click the *signeddriversetup.exe* file. The camera Driver Setup Wizard opens to install the driver.
 - Click *Next* to continue. The following message may appear:



If this is displayed, click the *Continue Anyway* button to install the driver.

- The Driver Setup Wizard displays a message informing you when the setup has finished installing the camera driver on your computer.
- Click *Finish* to complete the driver installation.
- In Windows Explorer, double-click the *MallinCam Setup.exe* file. The MallinCam Setup Wizard opens:



- Click *Next* to start the installation.

10. The program prompts you for a destination folder to install the files:



You can change the suggested location or click *Next* to accept the default location.

11. The setup proceeds and notifies you when it is complete:



12. Click *Finish* to complete the software installation and close the MallinCam Setup Wizard.

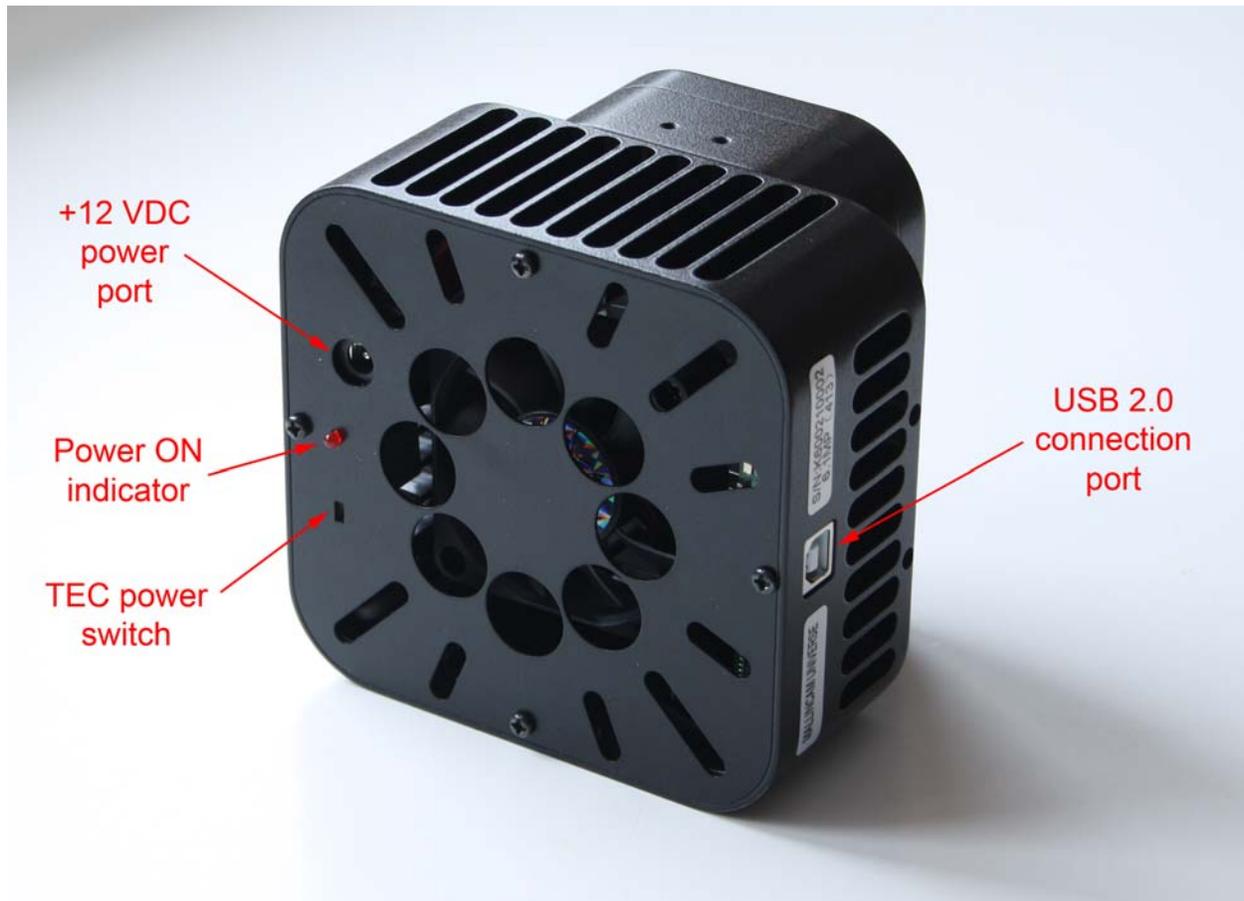
A MallinCam icon is installed on your desktop as part of the procedure. You can use this later on to launch the application.

13. Remove the disc or flash drive from your computer.

14. Go to **Section 4: Hardware Installation** to install the hardware.

Section 4: Hardware installation

After the software has been successfully installed, you must connect the hardware to complete the initial installation process so that Windows recognizes the camera.



1. Connect the USB 2.0 cable to camera first and then to an available USB 2.0 port on your computer (USB 1.1 ports are not supported for the MallinCam Universe).

NOTE: You should always attach the USB cable to your camera and computer before powering up the camera.

2. Check to ensure that the recessed thermo-electric cooler (TEC) switch is in the ON position. The TEC unit is on when the slider switch is closest to the Power ON indicator. This is the default position and normally does not need to be changed.
3. Connect the +12 VDC lead from the AC-DC power supply to the camera's power port.
4. Plug the AC-DC power supply into a power source to turn on the camera. The Power ON indicator will light. Allow a minute for full stabilization of the hardware.

5. When the camera is powered up, the *Welcome to the Found New Hardware Wizard* form is displayed:



Click the *No, not this time* radio button and then click *Next*.

6. On the following form, click on the *Install software automatically (Recommended)* radio button and then click *Next*:



7. The *Hardware Installation* form may then appear:



If this is displayed, click the *Continue Anyway* button.

-
8. The *Completing the Found New Hardware Wizard* form is displayed when the installation is done:



9. Click *Finish* to complete the hardware installation and close the wizard.

Windows then informs you that your new hardware is installed and ready to use.

NOTE: If you plug the Universe camera into a different USB 2.0 port at a later date, you may have to repeat steps 5 through 7 above. This is typical behavior for some versions of Windows. If the *Welcome to the Found New Hardware Wizard* form is **not** displayed again, then Windows has found the driver automatically and you should be ready to operate the camera.

You're now ready to link the camera with the image capture application and start experimenting.

TIP: To familiarize yourself with the installation and operation of the Universe, you may want to perform the procedures in *Sections 5, 6* and *7* indoors prior to your first field session. Doing so will verify that the system and all its components have been properly installed and are fully functional. Imaging session time is often all too limited. Test the system and learn the basics beforehand!

Section 5: Attaching the camera to your telescope

Attaching the MallinCam Universe to the telescope is very straightforward.

1. Unscrew the metal cover protecting the sensor and attach the supplied 2" nosepiece.



NOTE: There are three small set screws in the mounting collar of the camera body. Make sure these are out far enough to allow the nosepiece to fully seat. After the nosepiece is installed, you can either tighten these down for increased security or permanent installations, or remove them. The use of these screws is optional.

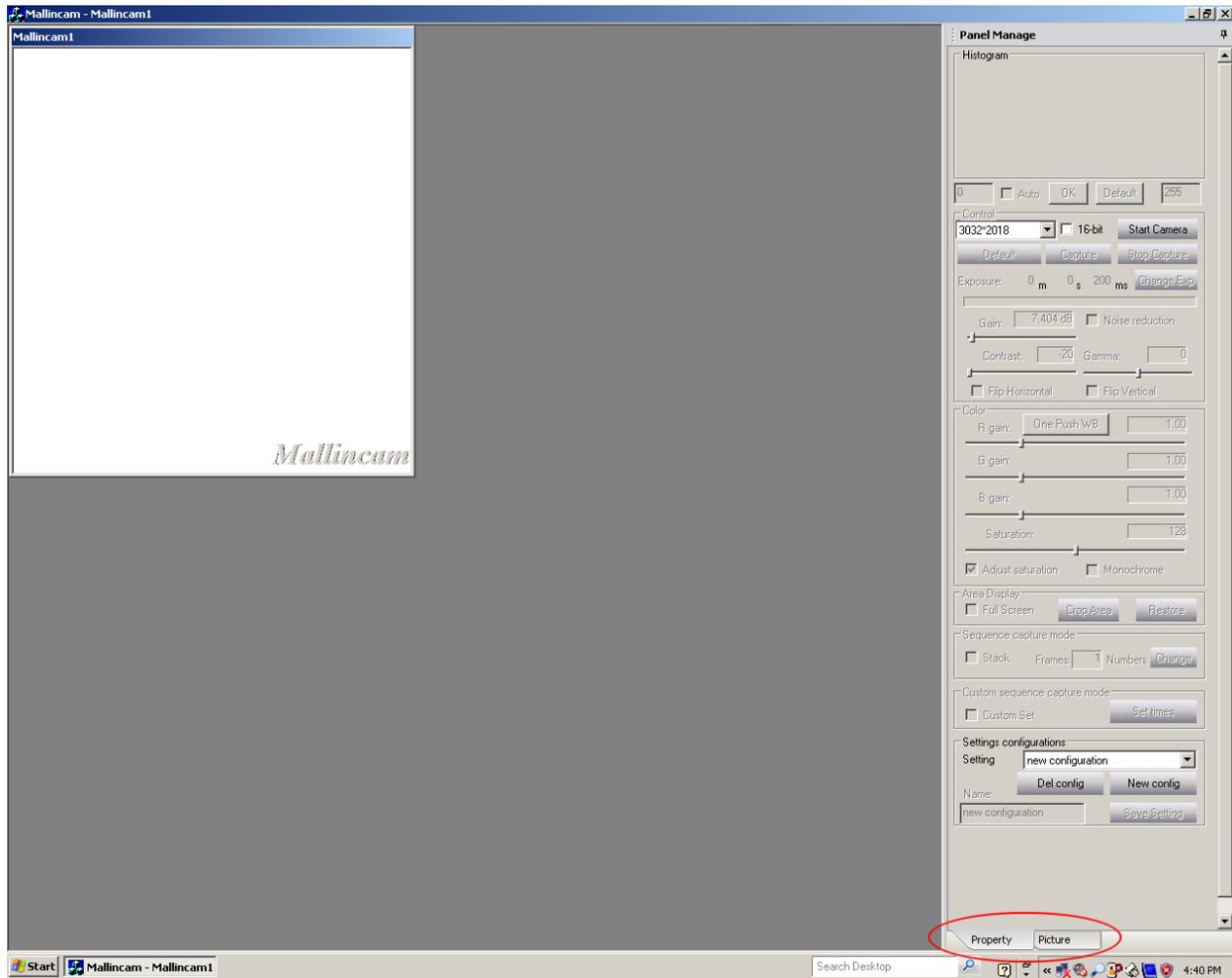
2. Make sure the nosepiece is firmly attached to the camera and then insert the nosepiece barrel into your telescope's focuser.
3. Tighten down the focuser's attachment locking screws and check that you have a firm fit.
4. Connect the USB 2.0 cable to camera first and then to an available USB 2.0 port on your computer (USB 1.1 ports are not supported for the MallinCam Universe).

NOTE: You should always attach the USB cable to your camera and computer before powering up the camera.

5. Check to ensure that the recessed thermo-electric cooler (TEC) switch is in the ON position. The TEC unit is on when the slider switch is closest to the Power ON indicator.
6. Connect the +12 VDC lead from the AC-DC power supply to the camera's power port.
7. Plug the AC-DC power supply into a power source to turn on the camera. The Power ON indicator will light. Allow a minute for full stabilization of the hardware.

Section 6: Using the MallinCam image capture application

When you launch the MallinCam Universe image capture application, the main MallinCam window opens. The window contains an image preview area and displays the *Property* panel on the right side. The *Picture* panel can be displayed by clicking the *Picture* tab at the bottom-right corner of the main screen.



The *Property* panel is used to:

- adjust the various camera settings, including: resolution, exposure time, gain, contrast, gamma, white balance, and color saturation
- view and adjust a histogram of the current image
- perform an image capture
- set up a sequence of multiple image captures
- set up a sequence of captures to produce a stacked image

The *Picture* panel is used to:

- manage image formats and files
- preview captured images
- set up a time-lapse imaging sequence

A. Setting up a proper exposure to help achieve focus

Once the camera has been powered up and the MallinCam image capture application opened, you can start setting up your initial exposure. Before pressing the *Start Camera* button, you must set up the resolution for your captured images. You can only adjust this while the camera is stopped.

In the *Control* field, use the dropdown menu to select the image resolution. Use the default value of 3032x2018. This is the camera's full, unbinned resolution. Leave the *16-bit* checkbox unchecked at this point. This will produce 8-bit files that will download and refresh more quickly than the 16-bit files.

Click the *Start Camera* button. The camera begins to capture images and display these in the preview window. Once the first image is displayed, the camera continues to capture images and show them sequentially. These are preview images to let you view what the camera sees through your telescope. They are not saved to your hard drive.

Other controls can now be adjusted while the camera is continually exposing. This "on-the-fly" capability makes it much easier and quicker to adjust the settings to obtain the image you want.

Procedure 1: Adjusting the exposure length

1. Ensure that the *Auto* checkbox under the histogram is enabled. If it does not show a checkmark, then click in the box to enable it.
2. Click the *Change Exp* button. The *Exposure* fields become active.
3. Set the desired exposure length in the *m-s-ms* fields (minutes-seconds-milliseconds) and click the *OK* button. This exposure length will be used for both the preview images as well as any single images you want to capture and save.

You must set the exposure length to obtain images that show some level of detail. If the current exposure time is too short, the image will appear black or very dark. If it is too long, the image will appear washed out or white.

 **NOTE:** If you have the exposure length currently set for a short interval (a few seconds or less) AND the histogram's *Auto* function is selected, you may notice that the *m-s-ms* fields keep resetting to the previous values as you're trying to change them. Deselect the histogram's *Auto* function to stop this behavior. You should then re-enable the *Auto* checkbox after changing the exposure length and clicking *OK*.

4. Keep adjusting the exposure length until you start seeing some details or light variations in the preview image.

Once you start seeing some light variations, you need to focus your telescope. If your current focusing adjustment is substantially off, all you may see in the preview images are variations in brightness levels in different portions of the view. If your focus is not too far off, you will see round blobs of varying brightness scattered throughout the field. These are out-of-focus stars.

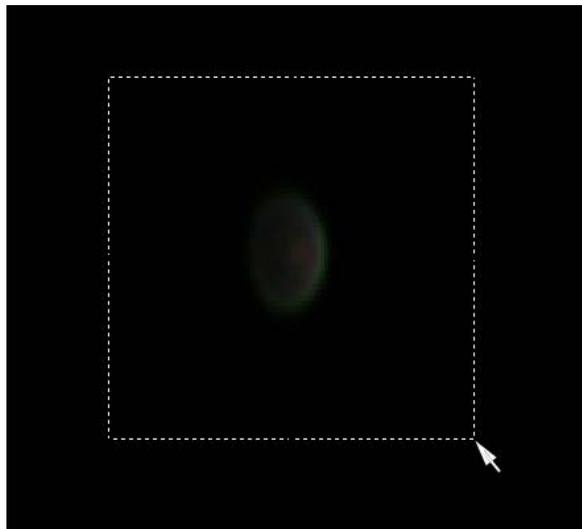
The MallinCam capture application has a feature that greatly simplifies the task of focusing. Follow *Procedure 2* to quickly achieve an optimum focus.

Procedure 2: Adjusting the focus using the preview images

1. Set the exposure length for a fairly short interval, somewhere between 500 msec to 3 sec. This should be adequate for most telescope focal ratios. High focal ratios (F10 and above) may require longer exposures. Shorter exposure lengths will give you a quicker refresh rate on the preview images. This allows for a near real-time approach to focusing, much like the live view capability of most recent DSLR cameras.

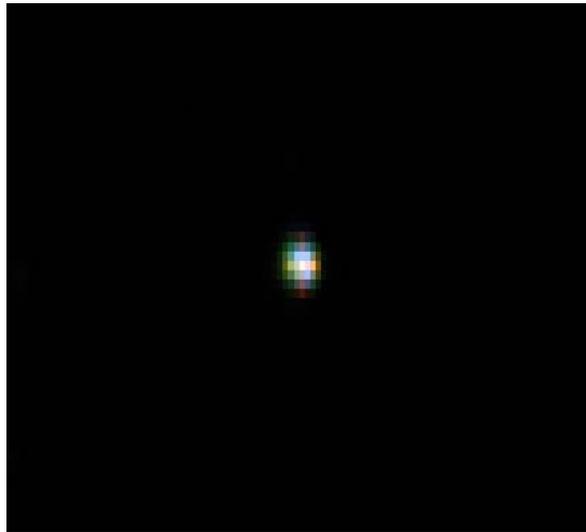
If you find that the preview is very dark, try increasing the setting of the *Gain* slider for now, rather than increasing the exposure length. Set *Gain* to maximum. This will help to show brightness variations and defocused stars in the preview. If you're still having a problem seeing anything at all in the preview, you can try increasing the exposure length or even repositioning your telescope so that a bright star is near the center of the field of view. However in most cases you shouldn't need to do this.

2. Move your telescope's focuser in one direction. If the brightness variations become more diffuse or the defocused stars become larger and dimmer then you're going the wrong way. Rack the focuser in the opposite direction so that the defocused stars become increasingly smaller and brighter. As you get closer to proper focus, you should begin to see an increasing number of fainter stars sharpening up in the field.
3. When the stars are getting close to focus, place your cursor near a brighter star, click and hold down the left mouse button and draw a box around the star.



4. Click the *Crop Area* button in the *Area Display* portion of the *Property* panel. The preview image will then only display the area you selected.
5. Click the *Full Screen* checkbox in the *Area Display*. The selected area is enlarged to fill the preview area. You now have a zoomed-in view of the defocused star. This makes seeing even the tiniest changes in your focusing much easier.
6. If the central portion of the defocused star looks too bright or saturated now, reduce the exposure time and/or the *Gain*. You want to be able to see the shape of the star clearly as you focus.

-
7. Continue adjusting the focus gradually until the star becomes as small and tight as possible.



As the star image becomes smaller, it will also become brighter. When you cannot get it any smaller, you are in proper focus. If it starts to enlarge again, then you've gone too far. Reverse the focusing direction and make very small adjustments to tighten it up again.

You'll also notice that the shape of the star changes from one preview exposure to the next. This is the result of atmospheric turbulence. Remember, you're zoomed in quite a lot on a very small portion of the overall image at this point. If your sky is very steady (i.e. good "seeing"), then the variations will not be too great. However, if the seeing is poor, the variations can be quite dramatic, and will make determining the sharpest possible focus a bit more difficult. Under poor seeing conditions, "best focus" is an approximation, since the atmosphere is continually altering the view reaching your camera. Watch the preview image for a while and adjust the focus gradually until you reach the point where you think that the star is at its smallest size for most of the time.

TIP: You can also place a focusing aid such as a Hartmann or Bahtinov mask over your aperture to help you focus. However, since these masks cut out a lot of the light reaching your camera, they should be used only once you're close to optimum focus. You may also need to increase your exposure time or the *Gain* to see the star image clearly.

8. When you are satisfied with the focus, click the *Restore* button in the *Area Display*. The preview images will then begin to show the full field again.

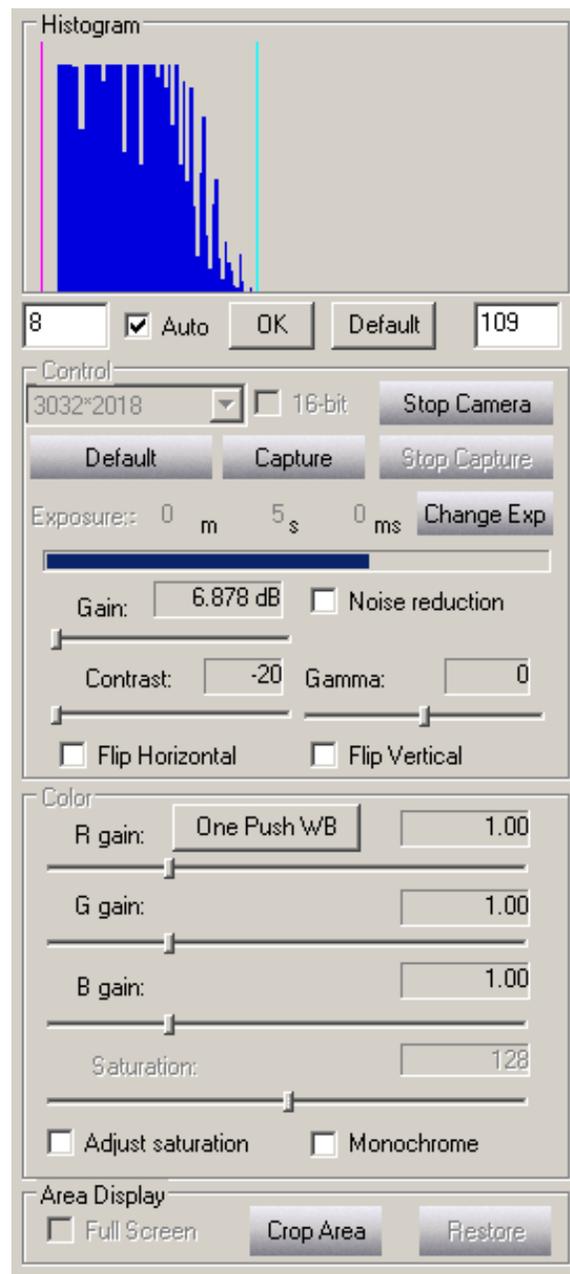
TIP: You can also use the *Area Display* function once you're centered on your intended imaging target to have a closer look at any portion of a preview image. This can help you to set the exposure controls properly to get the details you want. Note however that if you do not restore the preview image before making an actual capture, then only the selected area will be saved in your captured image file.

At this point, you are ready to adjust the other camera controls to obtain a proper image.

B. Adjusting the camera controls

All controls used to adjust the appearance of the image are on the *Property* panel. The camera must be running and generating preview images to make adjustments. If you click the *Stop Camera* button, most of controls become grayed out (inactive). The only adjustments you can make then are to change the resolution and the bit depth of the captured images.

Use of the adjustment controls is detailed in this section. Experiment with the settings to produce the image you like. There are few hard and fast rules, since astrophotography can be as much art as it is science. However, by understanding the function of each of the controls and following the provided suggestions, you'll be able to use the camera effectively and to its maximum potential.

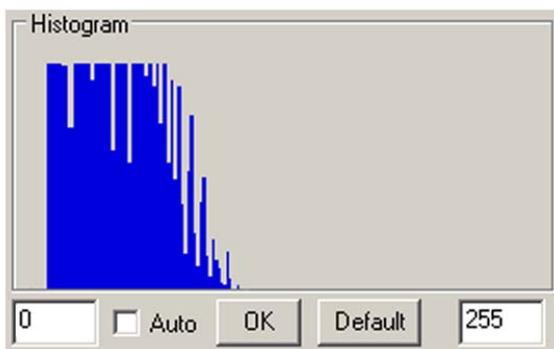


Histogram

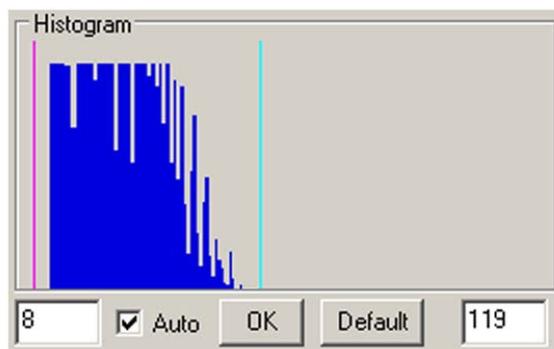
The histogram is a graphical view of the brightness range within the image. The horizontal axis represents the variation in brightness, with the darkest pixels to the left (pure black is “0” when the histogram is not stretched) and the lightest pixels to the right (pure white is “255” in 8-bit mode, or “4095” in 16-bit mode). The height of the dark blue columns in the vertical axis represents the relative number of pixels at a particular brightness value. The higher the column, the more numerous are the pixels at that brightness value.

The purpose of changing the histogram values is to increase the data visible in your image. This is called histogram stretching or dynamic range expansion. This is an important function, especially in astronomical imaging, where the majority of pixels are often just capturing dark sky background. As a result, the histogram curve tends to be towards the left side of the overall plot, indicating that darker and dimmer pixels are the most common. The right side of the histogram plot tends to be empty or sparsely populated, indicating few, if any, really bright pixels.

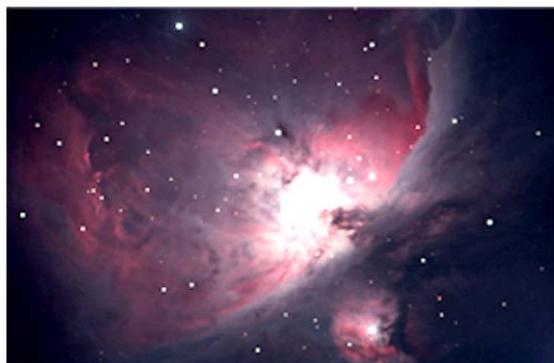
If the histogram is not stretched, then your computer will attempt to display all the captured data proportionately, resulting in a generally dark image. This is the histogram’s initial *Default* full-range setting, and its effect is seen in the example below, on the left.



Unstretched histogram



Stretched histogram



When you use either the *Auto* function or the manual method to change the histogram, you are setting new values for the black and white points in your image. In other words, you are now instructing the program to use colors that are not just pure black or pure white as the darkest and lightest colors in the displayed image. The result is shown in the example on the right. These new values appear in the text boxes. The new black point is also indicated by a vertical red line on the graph, and the new white point is indicated by a vertical cyan line.

Notice the differences between the two images. The stretched version shows a lot more dimmer detail at the outer portions of the nebula. However, some of the brighter details that are visible near the center of the unstretched image are now just shown as white in the stretched version.

So generally speaking, the smaller the range between the black and white points is, the greater the contrast will be in your image. In the example above, the range was decreased from 256 in the unstretched version (0 to 255) to 112 in the stretched version (8 to 119). In addition, if you use the same range of 112 but at different points along the horizontal axis, for example, shifting it to the right at 20 to 131, the overall image will get darker. Likewise, shifting the same range to the left (say, 2 to 113) will make the overall image lighter. This demonstrates why you must carefully adjust the histogram to get the level of detail and brightness that you really want.

Alter the histogram by trying one or more of the following methods:

- Click the *Auto* checkbox, then *OK* to let the system determine an initial histogram stretch. This typically moves the black and white point values close to the leftmost and rightmost edges of where the blue columns first appear in the graph. The *Auto* function tries to maximize the dynamic range displayed onscreen in the preview image, and the image usually gets noticeably brighter. However, while *Auto* mode is **recommended** to get an initial approximation, it is not always the best choice for the final setting of your image. It can sometimes get “fooled” by the presence of a few too many bright or hot pixels, and therefore sets the white point too high. In such cases, go to manual mode and set the white point lower.

– AND/OR –

- In the manual mode, you can set the black and white points to any values in your image. With the *Auto* mode unchecked, place your cursor somewhere over the dark blue histogram columns and right-click the mouse. This sets the white point and you’ll see a cyan line appear near where you clicked. Notice how the preview image changes. Now right-click again, but this time directly over the rightmost blue column of the graph, which is where you generally want it. Repeat as required until you get it as close as possible to the right side.

Similarly, left-clicking inside the dark blue columns of the graph sets the black point and you’ll see a red line appear where you clicked. Try to place it directly over the leftmost blue column of the graph. Repeat as required until you get it as close as possible to the left.

– AND/OR –

- For greater precision, use the text boxes below the display to enter specific black point and white point values, then click *OK*. The *Auto* mode must not be checked. The range for each field is 0 to 255 in 8-bit mode (or 0 to 4095 in 16-bit mode), with the left field to be set lower than the right. As with the manual mouse-click method, the goal is generally to set the red line (the black point) near the leftmost blue column of the graph and the cyan line (the white point) near the rightmost blue column. Keep trying different values until you get these both as you want them. You’ll see the effect of your changes on the current preview image, and these values will also be applied to the next preview image.

Note that you can always click the *Default* button to return to the full (unstretched) histogram range. The *Auto* checkbox must not be checked when you do this.

The histogram can also help you to determine if you are exposing your image properly. If you only have a few blue columns clustered at the left side of the graph, then you are under-exposing. Similarly, with the majority of the blue columns towards the right, you are over-exposing. Adjust the exposure length for a greater spread of columns through the middle of the graph, if possible.

Resolution control

The resolution control is used to adjust the image size and thereby also the effective pixel resolution of your captured image. You can only set this control while the camera is stopped.

In the upper-left corner of the *Control* field, use the dropdown menu to select the desired image size. The default value of 3032x2018 is displayed initially. This is the camera's full, unbinned resolution size. You can also choose to bin the image by factors of 2x2, 3x3, or 4x4.

Binning combines multiple pixels into fewer, but effectively larger, super-pixels. In 2x2 binning for example, a square of four adjacent unbinned pixels forms one large super-pixel. This increases sensitivity, since the binned super-pixel now delivers the combined signal of the four original unbinned pixels. But the trade off with binning is that since each super-pixel covers a larger physical area of the CCD imaging chip, it "sees" a larger area of the sky, and so the spatial resolution of each such pixel is decreased. For example, if you select 2x2 Bin, the captured image size will now be only 1516x1008 pixels. It will still show the same total area of the sky as the unbinned 3032x2018 image, but will do so using only half as many pixels in both the vertical and horizontal dimensions. The actual file size of a saved 2x2 binned image will also be reduced to about one-quarter that of an unbinned image.

Since binning increases pixel sensitivity, objects such as faint nebulae will generally appear brighter and more prominent. However, some of the finer details will be lost due to the decreased spatial resolution. The higher the degree of binning, the greater the camera's sensitivity becomes.

The image sizes produced by the various binning options are as follows:

- 3032*2018 pixels: images are 3032 x 2018 pixels (full-resolution mode)
- 2x2: images are 1516 x 1008 pixels
- 3x3: images are 1008 x 672 pixels
- 4x4: images are 756 x 504 pixels

Regardless of the binning mode you choose, all images will still be in full color.

16-bit

Used to set the bit resolution of captured TIF images. When this option is not selected, TIF files are saved as 8-bit versions (RGB 24-bit). When the option is selected, the TIF files are saved as 16-bit versions (RGB 48-bit). Although 16-bit is the recommended choice, some image processing applications cannot read this richer TIF format. Refer to *Section 10* for detailed information on this setting. You can only set this control while the camera is stopped.

Exposure

Used to adjust the length of an image exposure. You should use this control in conjunction with adjusting the *Gain*, *Contrast* and *Gamma* settings to produce a preview image to your liking.

➤ Click the *Change Exp* button and enter the desired values in the *m-s-ms* fields (minutes-seconds-milliseconds), then click *OK*. The next preview image will then begin.

🔔 **NOTE:** If you have the exposure length currently set for a short interval (a few seconds or less) AND the histogram's *Auto* function is selected, you may notice that the *m-s-ms* fields keep resetting to the previous values as you're trying to change them. Deselect the histogram's *Auto* function to stop this behavior. You can then re-enable the *Auto* checkbox after changing the exposure length and clicking *OK*.

Gain

Used to set the camera's amplifier sensitivity. You should typically set the gain as low as possible and adjust the exposure time, contrast, and gamma parameters to produce the image you want. Set the gain higher if you need the additional boost in sensitivity, for instance, if you need to keep your exposures as short as possible. This can be beneficial when your telescope mount's tracking is not precise, or if you're imaging an event of short duration.

- Select a value between 6.878 dB to 26.007 dB. The higher the value, the more sensitive the camera will be. However, increasing the value of the *Gain* will also increase the relative amount of noise in the image.

Noise reduction

Used to reduce amp glow and hot pixel intensities for long exposures and high *Gain* settings.

If you take a long exposure with the *Gain* set high, you may notice a slight glow in the upper left corner of the image – that's amp glow. This results from the CCD chip's signal amplifier and is normal. The Universe imager produces very little amp glow and so this is often not apparent. However, the amount of amp glow visible will actually depend on the particular combination of exposure length, gain, contrast, and gamma settings, and the degree of histogram stretching that you choose:

- Shorter exposure lengths produce less amp glow and fewer, less-intense hot pixels
- Lower gain settings produce less amp glow and fewer, less-intense hot pixels
- Histogram stretching increases amp glow and hot pixel visibility. If you leave the histogram at its default (unstretched) setting, the amp glow will be at a minimum. However, this decreases all the visible data in your image, including your target, and so is usually not the setting you want. Whenever you use the histogram's *Auto* function (or set it manually) to get the best image, you may also increase the visibility of amp glow, if it's there at all.

The *Noise reduction* control reduces (and in many cases, eliminates) the amount of amp glow visible. It also reduces the visibility of any hot pixels. You enable this control by clicking in the checkbox. Note that some of the faintest nebulosity visible in your image may also be reduced when you use this setting.

If you want to see the effect of amp glow, try the following tests. Cap the Universe camera so that no light reaches the sensor. The images you'll take here are called dark frames, with the only "light" showing in an image coming from the camera itself. Deselect the histogram's *Auto* checkbox and capture three 5-minute images with *Noise reduction* **not** selected: one with the *Gain* set to minimum (6.878 dB), the next with *Gain* around the mid-point (~16 dB), and the last, at maximum (26.007 dB). Now repeat those exposures with *Noise reduction* selected. Compare the images to see the effect of altering the *Gain*, with and without using *Noise reduction*. Try the same set of images, but this time, make them 10-minute long exposures. Note the differences between the two sets. Particularly, notice how a 10-minute exposure at mid-gain actually generates less amp glow than a 5-minute shot at maximum gain. Note also that the overall visible effect will increase on a real (uncapped) target, depending on how much you stretch the histogram. You'll get the idea once you try a few of these comparisons.

🔧 **TIP:** You can also reduce or eliminate amp glow in an image by using dark frame subtraction (refer to *Section 10*), or by simply cropping your final image in an image processing application.

Contrast

Used to adjust the differences in luminance to make objects in the image appear more or less distinguishable. Use this control in conjunction with adjusting the *Exposure* length and *Gamma* setting to produce a preview image to your liking.

- Select a value between –20 to +20. Higher values increase the relative difference between light and dark areas of the image. You will see the effect on the current preview image.

Gamma

Used to adjust the range of brightness in the image. Since the Universe camera can capture a dynamic range of brightness greater than most computer screens can display, adjusting the gamma value allows you to adjust the image brightness to your liking. Use this control in conjunction with adjusting the *Exposure* length and *Contrast* settings.

- Select a value between –20 to +20. The default value is 0. Higher values make dark areas of the image appear darker, thereby emphasizing any bright details. Lower values make dark areas lighter, thereby emphasizing any faint details. You will see the effect on the current preview image.

Flip Horizontal and Flip Vertical

These controls do exactly what you would expect them to, flipping the image horizontally and vertically, respectively. This can be useful in matching an image to a view in a star chart. You will see the effect on the next preview image.

Color controls

Color balance (also referred to as white balance) involves making adjustments to the intensities of the primary colors (red, green, and blue) in order to remove unrealistic color casts and achieve the proper rendition of all the colors in the image. This is a complex topic, since the image captured by a CCD camera is different than the view acquired by the human eye and then processed and interpreted by the brain. In addition, ambient viewing conditions during the time of image acquisition always differ from the viewing conditions when displaying the image on a monitor later on. Color adjustments are done to try to reconcile all of these differences.

The *R gain*, *G gain*, and *B gain* sliders allow you to adjust the relative amounts of red, green, and blue in the image, respectively. The default values are 1.00 for each of these controls. You can adjust any of them to values in the range of 0.00 to 3.98. You can see the effect on the current preview image.

The MallinCam capture application also offers an automatic white balancing solution. Click the *One Push WB* button to activate this feature. When you use this, the application performs an analysis of the current image and applies a mathematical algorithm to transform the data using the known characteristics of the sensor. The system then sets the individual color slider values accordingly and you will see the effect on the current preview image. The next preview image is then started from the beginning and will use the new color slider values.

Refer to *Section 9* for more information on color balancing and the use of filters for your imaging.

 **NOTE:** The white balance should be reset whenever you change the image exposure time.

Saturation

Used to adjust the saturation of colors in the image. Saturation is the degree of intensity of a color relative to its own brightness.

- To change the degree of saturation, you must first select the *Adjust saturation* checkbox. Then set a value between 0 and 255. The default value is at the midpoint of 128. This is also the value used whenever the *Adjust saturation* checkbox is **not** selected. Higher values increase the degree of saturation, making colors more vivid. But too high a value will make the image look unnatural. Lower values make colors appear more muted. You will see the effect on the current preview image.

Monochrome

Click the checkbox to produce a grayscale image instead of a color image. You will see the effect on the current preview image.

Area Display

This tool is used to crop the display image. It can be helpful when you are trying to focus your telescope (as described in *Procedure 2*), but may also be used to save only a portion of the full image captured by the Universe. For some smaller targets, you may not want to save the entire frame when you do a capture. Crop the image to show only the area of interest and discard the rest. This also reduces the file size of your captured image. A full frame 16-bit TIF file is approximately 36 Mb in size. The file size of a cropped image is proportional to the amount you crop it by. So if you select only about a quarter of the image to keep, the 16-bit TIF file size will be about 9 Mb.

Procedure 3: Cropping images for capture

1. Click and hold down the left mouse button and draw a box around the area of interest in the preview image.
2. Click the *Crop Area* button. The preview image will then only display the area you selected. Subsequent preview images will also show just this area.
3. Click the *Full Screen* checkbox in the *Area Display*. The selected area is enlarged to fill the preview area. You now have a zoomed-in view of the area of interest. This can help you to set the exposure controls properly to get the details you want.
4. Capture your images, as described in *Procedures 4 to 7*.
5. When you want to return to a full frame view, click the *Restore* button. The preview images will then begin to show the full field again.

C. Capturing images and saving your files

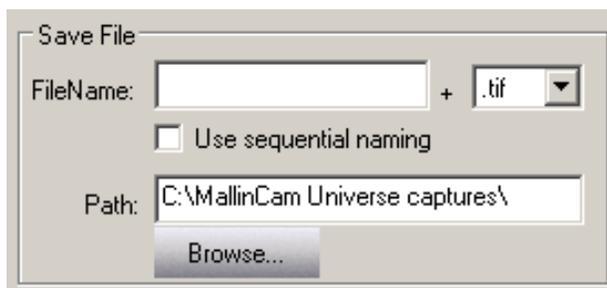
Once you have adjusted the camera's controls to your liking and focused the target in your telescope, you are ready to begin capturing images and saving them to the hard disk.

The MallinCam capture application offers a number of ways to capture and save. You can save individual images one at a time, or you can instruct the application to save a sequence of images captured one after another. The sequence of images can all have the same exposure lengths, or each image in the sequence can be customized for a unique length. You can also configure the application to capture a number of images and stack them automatically to produce a higher quality image than a single image alone can yield. Each of these methods is detailed below.

For all methods of capturing and saving images described in this section, the camera must be operating in the preview mode so that it is actively generating preview images.

Procedure 4: Capturing individual images

1. Configure all the camera settings properly so that you are satisfied with the preview image.
2. Click the *Picture* tab to display the *Picture* panel.
3. Enter the name you want to assign to the captured image in the *FileName* field, for example: **Orion Nebula**.



- If you are planning to take a number of random single shots of the same target, the application will also use this name and automatically add a number for every shot you take, for example: **Orion Nebula_1**, **Orion Nebula_2**, and so on.
- If you don't enter a name here (or forget to do so), the application will automatically enter one for you. This will be in the form "**TS_x**", where **x** is an incrementing number, for example: **TS_1**, **TS_2**, and so on.
- If you want the application to automatically enter a name, click the *Use sequential naming* checkbox. The *FileName* field will be grayed out, since it is not used. The application will automatically enter a name in the form "**abcdefghijklmn**". This name is a timestamp format, showing when the image was taken. Here "**abcd**" indicates the year; "**ef**" the month; "**gh**" the day; "**ij**" the hour; "**kl**" the minutes; and "**mn**" the seconds. So for example, the filename **20130205223146.tif** would indicate that the image was captured on 2013 February 05 at 22:31:46. The time is based on your computer's clock.

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4. In the **+** extension box, select a file format from the dropdown menu. Select one of: *tif*, *bmp*, *jpg*, or *raw*.

 **NOTE:** The 16-bit *tif* file is the preferred format. You must enable the *16-bit* checkbox on the *Property* panel to get this, otherwise the *tif* file will only be an 8-bit format. The *raw* file format also records the full bit depth of data that the camera can deliver, however, this does require additional image processing steps (see *Section 10*). The *bmp* and *jpg* formats record the image at 8-bits per color channel (as 24-bit RGB files). But be aware that *jpg* is a compressed (lossy) format and should generally **not** be used to record your original files.

5. Click the *Browse* button to select the folder you want to store the captured image in. The *Browse For Folder* window lets you choose a location on your computer. It also allows you to create a new folder on your computer. Select or create the folder and click *OK*. The *Browse For Folder* window closes and your selection appears in the *Path* field.
6. Click the *Property* tab to display the *Property* panel.
7. Click the *Capture* button. The exposure begins and its progress is shown in the incrementing exposure bar. When it is done, the file is saved in the folder you selected.

Procedure 5: Capturing a sequence of images with equal exposure times

This feature allows you to configure an automated sequence to shoot a set of images all using the same exposure length. This is very useful to produce a collection that you can use later on for stacking. Or if your conditions are variable (partly cloudy, shooting in areas of high airplane traffic, mount tracking glitches, etc.), shooting a set gives you a higher probability of getting at least a few good shots. It's also a useful when you're shooting a meteor shower and just want to take one image after another of a specific area of the sky, hoping to catch that bolide!

1. Configure all the camera settings properly so that you are satisfied with the preview image.
2. Click the *Picture* tab to display the *Picture* panel.
3. Enter the name you want to assign to the captured images in the *FileName* field, for example: **M16**.
 - The application will use this name and automatically add a number after the name for every shot in the sequence, for example: **M16_1**, **M16_2**, and so on.
 - If you don't enter a name here (or forget to do so), the application will automatically enter one for you. This will be in the form "**TS_x**", where **x** is an incrementing number, for example: **TS_1**, **TS_2**, and so on.
4. Click the *Use sequential naming* checkbox if you want the application to automatically enter a name for each of the images in the timestamp format, as described in *Procedure 4*.
5. In the **+** extension box, select a file format from the dropdown menu. Select one of: *tif*, *bmp*, *jpg*, or *raw*.
6. Click the *Browse* button to select or create the folder you want to store the captured images in. You may want to create a new folder here to help organize your captures.

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7. Click the *Property* tab to display the *Property* panel.
 8. Deselect the histogram's *Auto* function, if this is checked.
 9. If you haven't already done so, set the exposure duration you want by clicking the *Change Exp* button. The *Exposure* fields become active.
 10. Set the desired exposure length in the *m-s-ms* fields (minutes-seconds-milliseconds) and click the *OK* button. This exposure length will be used for all the images in the sequence.
 11. Click the *Change* button in the *Sequence capture mode* portion of the panel.

The *Change* button becomes *OK*, and the *Frames* and *Stack* options become active.



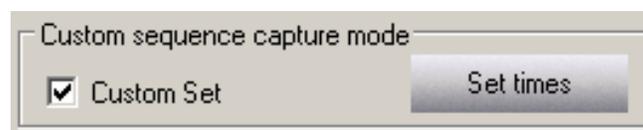
12. Enter the number of images you want to capture in the *Frames* field. You can specify up to 50 images here.
13. Decide whether or not to select the *Stack* checkbox.
 - If you do not select *Stack*, then all individual captures in this sequence will be saved.
 - If you select *Stack*, then all the individual captures in this sequence will be combined, but only the final stacked image will be saved (refer to *Section 10* for more information on stacking images). You need to ensure that your mount is tracking with great precision (and preferably auto-guided) when you use the *Stack* function.
 - ☞ **TIP:** You might want to leave *Stack* unselected, even if you intend to stack your images. Leaving it unselected saves all the files in the sequence, so later on you can choose which images to use for stacking. However, you'll need to do this in another application after your imaging session. Using this approach prevents a few bad captures (tracking glitches, passing clouds, aircraft and satellite tracks, etc.) from being combined with good captures and potentially ruining the final stacked result.
14. Click the *OK* button.
15. Select the histogram's *Auto* checkbox, if you want this function on.
16. Click the *Capture* button. The exposures begin and when they are done, the individual files (or a single stacked file, if you enabled *Stack*) are saved in the chosen folder.
 - ☞ **NOTE:** While the exposure sequence is running, the *Capture* button turns into a frame counter and indicates the number of the last frame in the sequence that was captured.
17. If you want to go back to taking single images after shooting a sequence, you must reset the value in the *Frames* field to 1. If you don't do this, then the same exposure sequence you just completed will be started again whenever you next press the *Capture* button.

Procedure 6: Capturing a sequence of images with customized exposure times

This feature allows you to configure an automated sequence with various individual exposure times for up to 10 images. This can be very useful if you are shooting an object with a high dynamic range, such as the Orion Nebula. Taking a set of images with incrementing exposure times allows you to capture levels of details at different brightness levels by simply varying the durations.

This feature is also handy for generally determining an appropriate exposure time to use. For instance, if you're shooting a galaxy, you may want to perform a custom sequence just to give you an idea of the best image duration. Once you've completed the sequence and examined the individual images, you can then take a full sequence (as described in *Procedure 5*), all at that "best duration", if you want to capture a group for stacking.

1. Configure all the camera settings properly so that you are satisfied with the preview image.
2. Click the *Picture* tab to display the *Picture* panel.
3. Enter the name you want to assign to the captured images in the *FileName* field, for example: **Cone Nebula-varied times**.
 - The application will use this name and automatically add a number after the name for every shot in the sequence, for example: **Cone Nebula-varied times_1**, **Cone Nebula-varied times_2**, and so on.
 - If you don't enter a name here (or forget to do so), the application will automatically enter one for you. This will be in the form "TS_x", where **x** is an incrementing number, for example: **TS_1**, **TS_2**, and so on.
4. Click the *Use sequential naming* checkbox if you want the application to automatically enter a name for each of the images in the timestamp format, as described in *Procedure 4*.
5. In the **+** extension box, select a file format from the dropdown menu. Select one of: *tif*, *bmp*, *jpg*, or *raw*.
6. Click the *Browse* button to select or create the folder you want to store the captured images in. You may want to create a new folder here to help organize your captures.
7. Click the *Property* tab to display the *Property* panel.
8. Click the *Custom Set* checkbox in the *Custom sequence capture mode* panel.



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9. Click the *Set Times* button. The *Set exposure times* form appears.

	Minute	Second	Millisecond
1	1	0	0
2	1	30	0
3	2	0	0
4	2	30	0
5	3	0	0
6	4	0	0
7	5	0	0
8	7	30	0
9	10	0	0
10	15	0	0

OK

10. Enter the desired values in the *Minute-Second-Millisecond* fields for each image.
11. Click *OK*. The *Set exposure times* form closes.
12. Decide whether or not you want the histogram's *Auto* function on.

 **TIP:** Since you are capturing images of various exposure lengths here, you may want to leave this off and set the histogram values manually before starting the sequence. In that way, the same stretch will be used for all the images in the sequence. The only differences between images will be due to their varying exposure lengths. When the histogram's *Auto* function is on, it will try to compensate for the different light levels and therefore apply a different stretch to each image.

13. Click the *Capture* button. The exposures begin and when they are done, the files are saved in the folder you selected.

 **NOTE:** While the exposure sequence is running, the *Capture* button turns into a frame counter and indicates the number of the last frame in the sequence that was captured.

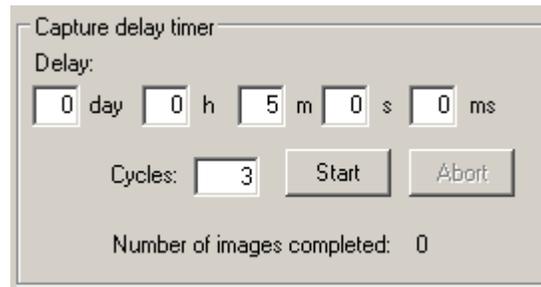
14. Once the custom set of exposures has completed, the Universe resumes taking individual preview images. It uses the time of the last exposure in the custom set for these previews.
15. If you want to go back to taking single images after shooting a custom set, you must click on the *Custom Set* checkbox again to deselect it. You can then change the exposure length of the individual preview images by clicking on the *Change Exp* button and setting the desired values in the *m-s-ms* fields (minutes-seconds-milliseconds), as usual. Then click *OK*. The preview images will start to display using this exposure setting.

If you do not deselect the *Custom Set* checkbox, then the same custom exposure sequence you just completed will be started again whenever you next press the *Capture* button.

Procedure 7: Capturing a set of images using the Capture delay timer

You can also set up a sequence of captures using the *Capture delay timer* section of the *Picture* panel. This feature allows you to set a delay time between exposures and to set the number of captures you want. Use this function if you want to do a time-lapse sequence of exposures of an event such as the motion of Jupiter's moons, the movement of a comet against the background stars, the progression of an eclipse, and so on.

This feature works in conjunction with either the *Sequence capture mode* (described in *Procedure 5*) or the *Custom sequence capture mode* (described in *Procedure 6*). The delay timer applies its delay in cycles to either of these modes. Therefore, you must configure one of these modes before starting the delay timer. Examples are provided below.



The camera must be operating in the preview mode and actively generating preview images.

➤ *Working with the Sequence capture mode*

1. Configure all the camera settings properly, including the length of the exposure, on the *Property* panel so that you are satisfied with the preview image.
2. If you want to:
 - a. capture a set of single images with a time delay between each image, then click the *Change* button in the *Sequence capture mode* panel. Enter the number “1” in the *Frames* field and click *OK*.
 - b. capture a group of images with a time delay between each group, then click the *Change* button in the *Sequence capture mode* panel. Enter the number of images you want in each group in the *Frames* field and click *OK*.
3. Click the *Picture* tab to display the *Picture* panel.
4. Enter the name you want to assign to the captured images in the *FileName* field, for example: **NGC891**.
 - The application will use this name and automatically add a number after the name for every shot in the sequence, for example: **NGC891_1**, **NGC891_2**, and so on.
 - If you don't enter a name here (or forget to do so), the application will automatically enter one for you. This will be in the form “**TS_x**”, where **x** is an incrementing number, for example: **TS_1**, **TS_2**, and so on.
5. In the + extension box, select a file format from the dropdown menu, as described in *Procedure 4*.

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6. Click the *Browse* button to select or create the folder you want to store the captured images in. You may want to create a new folder here to help organize your captures.
 7. Set the amount of *Delay* between exposures using the *day-h-m-s-ms* fields in the *Capture delay timer* section.
 8. Set the number of cycles in the *Cycles* field. You can specify a value up to 9999 here. As an example, enter the number “12” in this field.
 - a. If you entered the number “1” in the *Frames* field in step 2, then what you will end up with when the sequence is complete is 12 images. Each of these will have the delay you specified in step 7 applied before the start of the exposure.
 - b. If you entered the number other than “1” in the *Frames* field in step 2, then the timer operates a little differently. For example, let’s say you entered the number “4” in step 2. When you start the sequence, the timer will initially apply the delay you specified in step 7 and then a group of four images will be taken, with no delay between them. This completes the first cycle. The timer will then apply the delay again and the next group of four will be taken, also with no delay between them. This completes the second cycle. This will continue until all the cycles are finished. In this example, you will end up with 48 images.
 9. Click the *Start* button to begin the time-delayed capture sequence.

The *Number of images completed* counter will show you the total number of images that have been captured so far. For the example in step 8b, it would indicate “48” once the last cycle is complete.
 10. To stop a capture sequence before it is completed, click on the *Abort* button.

➤ ***Working with the Custom sequence capture mode***

You can also use the *Capture delay timer* with the *Custom sequence capture mode*. This works in basically the same way as described above for the *Sequence capture mode*. The main difference is that you must set the customized exposure times as described in *Procedure 6*.

When you have configured all the other camera settings as you want them, enter the amount of *Delay* between cycles using the *day-h-m-s-ms* fields in the *Capture delay timer* section. Then set the number of cycles in the *Cycles* field.

When you click the *Start* button, the time-delayed custom sequence capture begins. The timer will apply the specified delay before beginning the first capture. The application will then capture each exposure you configured in the custom sequence, but with no delay between these shots. Once the custom sequence is completed, the timer will apply the delay again and the next cycle begins, also with no delay between images. This repeats until all the cycles are completed.

As an example, if you configure eight custom exposure times in the *Custom sequence capture mode* and you set the delay timer’s *Cycles* field to “3”, you will end up with 24 images when the last cycle is completed. Each group of eight images will be delayed from the next by the *Delay* length you specify for the timer.

The *Number of images completed* counter will show you the total number of images that have been captured so far during the run.

D. Saving and loading your camera settings

Once you have used the MallinCam capture application on a variety of targets (deep sky, lunar, solar) you'll notice that the camera's control settings can vary widely to produce a properly exposed image. Use the *Settings configurations* function to save the control settings at any time to a custom configuration that you can load and reuse in the future.



Procedure 8: Saving your camera settings

1. Adjust the camera control settings as required.
NOTE: The state of the histogram's *Auto* function is **not** recorded when you save a new configuration. The *Auto* function should be deselected while you save your camera settings, otherwise it may interfere with the process.
2. Click the *Stop Camera* button.
3. Click the *New config* button in the *Settings configurations* section of the *Property* panel. An **Operation successful** message is displayed.
4. Click *OK*. The name "new configuration" is displayed in the *Setting* and *Name* fields.
5. Click the *Start Camera* button. The camera starts generating preview images again.
6. Enter a name for your configuration in the *Name* field and click the *Save Setting* button. Your configuration is saved and its name appears in both the *Setting* and *Name* fields.

Procedure 9: Loading a saved configuration

1. Click the *Stop Camera* button.
2. Click the dropdown arrow in the *Setting* field and select the desired configuration from the list. The camera settings are reset according to the chosen configuration and its name appears in both the *Setting* and *Name* fields.
3. Click the *Start Camera* button. The camera starts generating preview images again.

Procedure 10: Deleting a saved configuration

1. Click the *Stop Camera* button.
2. Click the dropdown arrow in the *Setting* field and select the configuration you want to delete from the list, if it's not the one you're currently using. The camera settings are reset according to the chosen configuration and its name appears in both the *Setting* and *Name* fields.
3. Click the *Del config* button. The selected configuration is deleted.
4. Click the dropdown arrow in the *Setting* field again and select the configuration you want to use now from the list. The camera settings are reset according to the chosen configuration and its name appears in both the *Setting* and *Name* fields.
5. Click the *Start Camera* button. The camera starts generating preview images using the settings of the configuration you selected.

Section 7: Viewing your captured images

The MallinCam image capture application allows you to view the images you've captured in the current session.

There are two preview windows on the *Picture* panel. They are the *All images preview* and the *Sequence capture preview*.

➤ *All images preview:*

The *All images preview* window lets you view all the images you've captured and saved in the current session since you started the capture application, including all single and sequenced captures. If there are other image files in the current path folder that were captured during an earlier session, these will **not** be seen in this preview window.



To scroll through the current group of images, use the left (<<) and right (>>) buttons.

You can also click on the *Large* button to get a bigger view. Click on the *Large* button again to return to the normal view.

➤ *Sequence capture preview:*

The *Sequence capture preview* window lets you view the set of images you've captured and saved in the current session using either the *Sequence capture mode* or the *Custom sequence capture mode* functions. It only shows the images of the last sequence you obtained by using either of these capture modes. If you've just been shooting single exposures, the window shows only the last such capture.

If there are other image files in the current path folder that were captured earlier in this session or on a previous date, these will **not** be seen in this preview window.



To scroll through the current group of images, use the left (<<) and right (>>) buttons.

You can also click on the *Large* button to get a bigger view. Click on the *Large* button again to return to the normal view.

NOTE: You can click the *Save All* button while previewing images in the *Sequence capture preview* window to save a duplicate copy of all the images in the current set. Enter the base name you want to assign to the duplicated images in the *FileName* field, for example: **M42**. The application will use this name and automatically add a number after the name for every shot in the sequence, for example: **M42_1**, **M42_2**, and so on.

If you click the *Save* button instead, you will save a duplicate copy of only the current image that is showing in the *Sequence capture preview* window. Enter the name you want to assign to the duplicate image in the *FileName* field.

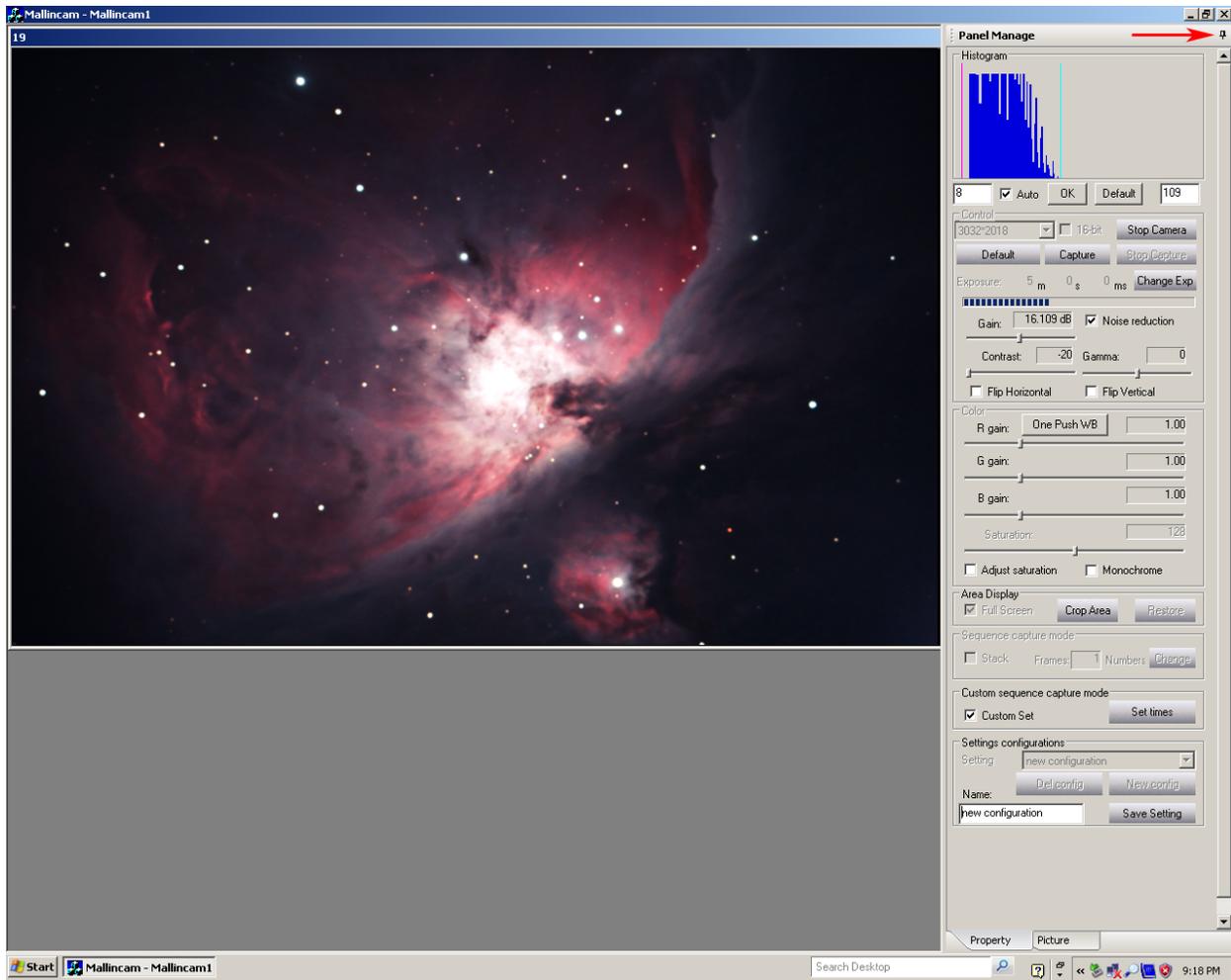
The *Save* and *Save All* buttons only apply to images in the *Sequence capture preview* window.

TIP: You may want to browse for a different folder or create a new one to place your duplicate files into prior to using *Save* or *Save All*. This can help you sort through and organize the files later on.

Section 8: Viewing the preview images

The Universe offers an additional display mode that is useful for viewing by groups, or if you just want to sit back and enjoy the scene.

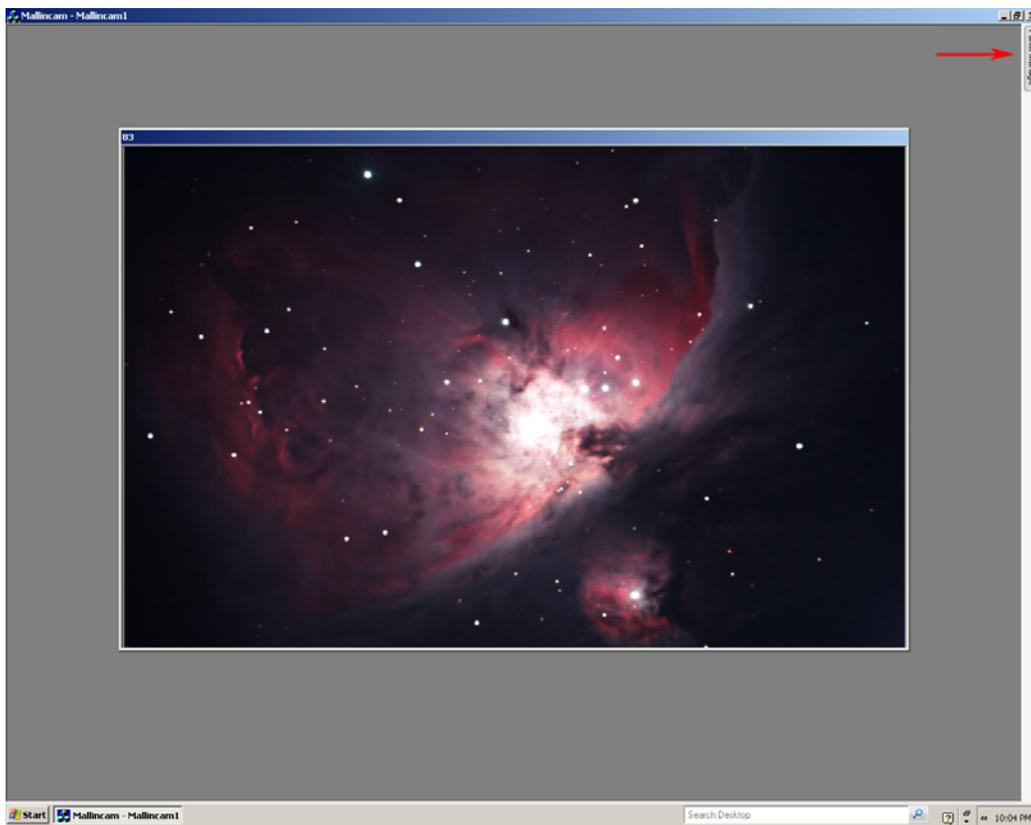
Once the telescope has been aimed and the camera configured for a proper exposure of the target, the preview image is constantly refreshed as each exposure is completed. This is the normal mode of operation.



However, if you click the pin icon at the upper right portion of either the *Property* or *Picture* panel, the panel is retracted.

Now you can see the preview without the distraction of the controls visible. Click and hold on the image's title bar to drag and center it, if you prefer.

 **NOTE:** You can also use this display mode while actually capturing a set of images.



M42/M43: MallinCam Universe image courtesy of Paul Comision

To reinstate the *Property* or *Picture* panel, just click the *Panel Manager* tab and then click the pin icon again.

For some targets such as the Moon, planets, the Sun (with proper filtering), and brighter deep sky objects that require only short exposures, the constant preview image refresh can provide a near real-time viewing experience. The scene may be refreshed at a rate of up to once per second.

The actual rate of preview refresh is dependant on a number of factors. If you are exposing a target that requires several seconds or minutes, the preview will refresh accordingly. So if you want to minimize the exposure time to increase the refresh rate, try one or more of the following:

- Bin the image to increase sensitivity. The greater the binning, the shorter the exposure needed.
- Boost the *Gain* setting. This shortens the exposure length but may increase visible image noise.
- Consider using the optional MallinCam 0.5X focal reducer. This cuts the exposure time by a factor of four, while providing four times the area of sky coverage.
- Use a “faster” telescope. An F5 configuration will produce the same level of brightness in your image as an F10, but in only one-quarter of the exposure time.
- Use the *Crop Area* tool for smaller images. While this doesn't affect the exposure length, the smaller images will download more quickly from the camera, increasing the refresh rate.
- Also try deselecting the *16-bit* setting. While this doesn't affect the exposure length, the smaller 8-bit images will download more quickly from the camera, increasing the refresh rate.

Section 9: Using filters and adjusting color balance

The CCD sensor on the MallinCam Universe is not filtered in any way. This allows you maximum freedom to filter an exposure in the way you want. For instance, you may want to experiment with a Hydrogen-alpha filter to capture the deep red light of many emission nebulae. Unlike stock DSLR cameras whose installed filters cut out much of the H-alpha emissions, the Universe passes this light unattenuated.

As with most CCD imaging sensors, the Universe's chip responds strongly in the red portion of the spectrum, including into the infrared region. So proper filtering and color balancing are important considerations in obtaining a good image.

For most imaging, we suggest at least the use of a 2" IR-cut or Luminance filter. These filters block the usually unwanted infrared and ultra-violet wavelengths, which can cause blurring, glare, and reduced contrast. They also help you attain a proper color balance, which can minimize the amount of image processing you might otherwise need to do.

If you are imaging in an area where light pollution is an issue, we recommend that you use a light pollution reduction filter. These filters not only cut out unwanted IR and UV wavelengths, they also block many of the emissions from man-made sources such as sodium vapor street lamps. Also note that these filters are available both for imaging use and visual observing. Make sure you use one designed for imaging.

These and other filters are available from manufacturers such as Baader, Astronomik, Orion, Celestron, Lumicon, and so on. The 2" camera nosepiece adapter supplied with the Universe allows you to attach such a filter easily. Simply thread the filter into the front of the adapter.

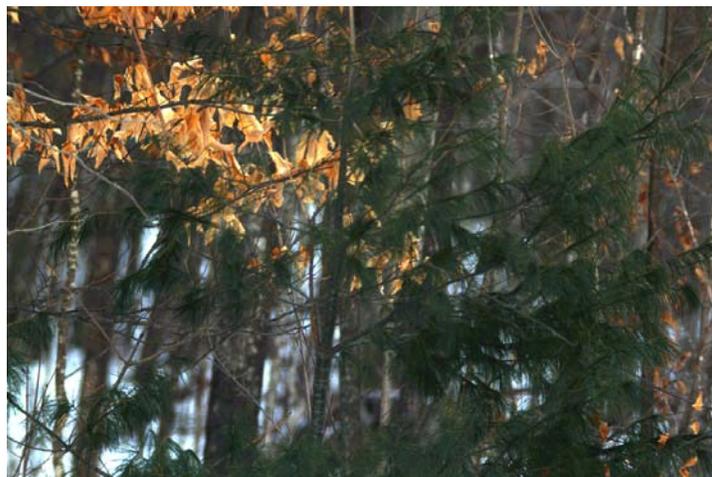
As an example of the effect a simple luminance filter can have on your image, consider the following two images. A daytime terrestrial example is used here to make the differences obvious. No post-processing was done, so the images are as they were captured. The capture application's *One-Push WB* function was used to try to obtain a good color balance.

This first image was captured with no filter installed. It shows trees and leaves. Some of the leaves are green, others are yellow-orange. Snow is seen through the branches in the distance.



The *One-Push WB* function set the color gain sliders to Red = 0.73, Green = 1.00, Blue = 1.48.

The next image was captured with a luminance filter installed. Note the difference in the overall color balance of the scene. This second image is quite a faithful reproduction of the actual view, again, with no post-processing involved.



In both cases, the *One-Push WB* function adjusted the Red, Green, and Blue gain sliders in a similar fashion, though by different amounts, and with obvious differences in the end results. For the filtered image, the Red slider was decreased to only 0.97, the Green slider was left at the default value of 1.00, and the Blue slider was increased to 1.79.

Astronomical imaging is understandably different than terrestrial imaging. In terrestrial imaging, most of the light you deal with is reflected light, coming either from the sun or man-made sources. In astronomical imaging, the light is being emitted by your target of interest, such as a nebula, galaxy, or star cluster, along with a contribution from natural sky glow. In both cases, the color balance of the image needs to be adjusted for proper color rendition. You can correct the balance to a degree afterwards using an image processing application. But this may not yield very good results if the originally-captured color balance was considerably off to begin with.

With astronomical imaging, the *One-Push WB* function can provide a good starting point if your target is fairly large and bright. However, it may be limited in its analysis for lesser targets. As a suggestion, you may want to initially set the color sliders manually, similar to the terrestrial example above (Red ~ 1.00, Green = 1.00, Blue ~ 1.80). This assumes that you're using a luminance or light pollution reduction filter. If not, then perhaps try Red ~ 0.75, Green = 1.00, and Blue ~ 1.50 as a starting point. Keep a record of your results. When you find a combination that works for you, try using it on various target types. You might even want to compare your images with the works of other experienced astro-imagers for a point of reference.

While these suggestions should help you get closer to a truer color balance, there are other factors at play that will be unique to your situation. The optimum color balance will be affected by the specific manufacture of any filter that you use, the exposure length you set, and by the optics of your telescope. A full discussion of attaining proper color balance is beyond the scope of this guide, but there are many good sources of information available on the Internet to help you out. One technique you might also consider is to take an image through your telescope of a standard photographic gray card, illuminated by a white light source. You can then adjust the color gain sliders to try and match the gray shade in your capture with the actual shade of the card. But note that such a comparison will be *strongly* influenced by the monitor you're viewing the image on. Color calibrating your monitor is highly recommended for this purpose.

Section 10: Processing astronomical images

The MallinCam Universe is capable of producing high-quality astronomical images with little or no subsequent image processing required. However, image processing techniques can enhance your images even further, bringing out all the subtle detail that the camera can capture.

A full discussion of image processing is well beyond the scope of this guide, but there are a few suggestions we can make to help you along.

➤ Using 16-bit TIF and RAW files

The MallinCam capture application offers two methods of saving an image with the maximum color resolution that the camera can deliver: the 16-bit TIF file and RAW files.

In an 8-bit file format such as BMP, the data in each color channel (Red, Green, and Blue) is divided into 256 different levels of intensity. Such files are also referred to as 24-bit RGB files, since each color channel is 8-bits and there are three channels. However, in a 16-bit file, each color channel contains 65,536 levels. This is equivalent to dividing a single level in an 8-bit file into 256 sub-levels. This finer graduation of the color information allows for much more intensive image processing and the ability to bring out subtle details not possible when using 8-bit files. Such 16-bit files are also referred to as 48-bit RGB files, since each color channel is 16-bits and again, there are three channels.

The 16-bit TIF file is the preferred format for processing images in programs such as Adobe Photoshop™. Select the *16-bit* checkbox to produce 16-bit files. Note that some image processing applications cannot read this richer TIF format. But other programs, such as the very capable freeware GIMP application, are also available that can read the 16-bit files and convert them to 8-bit, if that's what you need.

 **TIP:** It's better to save the 16-bit files, since you can always convert them to 8-bit files, if required. You can't convert an original 8-bit file to 16-bit at a later date, because that additional data was never recorded – it's lost. Keeping the original image that contains the full 16-bit per channel data just makes good sense, though of course, it'll cost you some extra hard drive space.

The RAW format also contains the full 16-bit per channel data. The MallinCam RAW files can be converted using the ImageJ program. ImageJ is a free, public domain, Java-based image processing program. It can read and process many different file formats at various bit depths and then convert them to other formats such as BMP, JPG, or even FITS files.

The ImageJ program can be downloaded from:

<http://rsbweb.nih.gov/ij/>

If you want to download a free plug-in for ImageJ that will convert your RAW files to the popular astronomical imaging FITS format, this can be found at:

<http://www.umanitoba.ca/faculties/science/astronomy/jwest/plugins.html>

➤ Using dark frames and flat fields

Dark frames are images that you take by capping your telescope to block all light coming into the camera. The only “light” that will appear in your image is electronic noise generated by the camera itself. This includes amplifier glow, dark current background noise, camera read noise, and any hot pixels.

You can use such dark frames to subtract this residual camera noise from your actual images.

The MallinCam Universe is remarkably quiet in terms of the noise it generates. You often don’t need to worry about dark frames to produce high-quality images. However, if you want to produce the best possible imagery, consider learning more about dark frames and their usage. Many sources of such information are available on the Internet. Popular programs such as Adobe Photoshop, Nebulosity, MaxIm DL and freeware programs such as Registax and DeepSky Stacker all facilitate dark frame subtraction.

Flat fields are yet another aspect of image processing you may want to consider at some point. These are images taken through your telescope of a featureless, uniform light source such as a cloudless blue sky (best done after sunset or in the early morning), or using an artificial diffuse white light source (commercial kits are available).

Flat fields record any unevenness in the illumination reaching your camera’s CCD sensor. You can use these to calibrate your actual images to remove such unevenness caused by factors like vignetting, dust and other particles on optical surfaces, and various telescope artifacts.

➤ Stacking your images

Stacking (also referred to as combining or integrating) your images is a technique used to increase the signal-to-noise ratio of your final processed image. It involves capturing a number of images of your target, all at the same camera settings, and then layering these “sub-frames” one on top of each other to mathematically combine them into one final version of the image. Since the “noise” in each of the individual sub-frames is random, it will get averaged out and therefore suppressed with respect to the signal – the object that you’re trying to image. The object’s light data is constant from frame to frame, so stacking numerous images serves to build that signal.

Popular programs such as Adobe Photoshop, Nebulosity, MaxIm DL and freeware programs such as Registax and DeepSky Stacker all allow you to stack images. This capability is also included in the MallinCam image capture application. You can set up the application to capture a sequence of images and automatically stack them for you. Refer to *Procedure 5* in *Section 6* to learn how to perform this function. Note that if you stack your images using the capture application, your telescope’s mount **must** be accurately polar-aligned and preferably auto-guided. This is required so that the image fields in each of the sub-frames will be identically positioned, otherwise drift will be obvious in the final combined image. One advantage of doing the stacking *after* your imaging session is that the programs mentioned above allow you to precisely shift the individual sub-frames with respect to one another to bring them into perfect alignment. Another advantage is it allows you choose which images to use or discard. A few bad captures (caused by tracking glitches, passing clouds, aircraft and satellite tracks, car headlights, etc.) may spoil the final result if they are included in the stack automatically.

The result of stacking multiple images into one final combined image can be quite profound.

Here's an example provided by Paul Comision of Ottawa, Canada from his first session with the MallinCam Universe. Five one-minute exposures of M27 were taken and then combined:



The image on the left is a single 60-second exposure, while the image on the right is a stack of five 60-second exposures, with no other processing done. Note the difference in the level of background noise and the degree of nebular detail visible between the two.

Further image processing of the combined image yielded this final result:



Section 11: Troubleshooting

➤ Your computer doesn't recognize the camera once it is connected.

This can occur for a number of reasons, including:

- ❑ USB 2.0 port: Make sure that you are using a fully-specified USB 2.0 high-speed port. Try switching to a different USB 2.0 port, if one is available. The camera will not operate if plugged into a USB 1.1 port.
- ❑ Power supply: Check that the camera's power supply is securely connected and that the Power ON LED is lit.
- ❑ USB cable: Older USB 1.1 cables will not work properly. Use the supplied high-speed USB 2.0 cable. If the cable has been damaged, that might not be apparent from a visual inspection. Try using a known good cable.
- ❑ Ensure that your computer meets the specifications stated in *Section 2*.
- ❑ Check that the camera driver has been properly installed. Open the Windows Device Manager and look for an entry under *Imaging devices* that is named "TM-6 USB Camera". If this is not listed or a conflict is indicated, then the driver has not been properly installed. Try uninstalling and then re-installing the driver again, as described in *Section 3*.

➤ The camera and drivers seem to install, but Windows issues a message stating that: "The device might not work properly".

- ❑ There may be a conflict with another USB device connected to your computer. Remove any other unnecessary devices, reboot the computer, and try connecting the camera again.
- ❑ Your USB cable may be too long. If you are using a cable longer than the originally supplied one, the data stream through the cable may be getting degraded. Only use a high-quality active (repeater) USB 2.0 cable if you need to extend the length beyond the originally supplied cable.

➤ The optical window above the CCD sensor is fogged.

- ❑ Under severe conditions of humidity, dew might accumulate on the glass above the sensor due to the cooling provided by the TEC. Try shutting off the TEC by moving the recessed slider switch (use a ballpoint pen tip) to the position furthest away from the Power ON indicator. Refer to the Universe picture in *Section 4* to locate the switch. Apply *gentle* or gradual heating (no hair dryers!) to remove the dew, if required.

➤ The downloaded images appear very noisy.

- ❑ Certain devices such as power supplies and even cell phones can cause interference with the image data as it is downloading from the camera to the computer. If there are any such devices near your USB cable, try positioning them further away. Also, if you are using active USB extension cables, keep the total cable length to a maximum of 80 feet (25 meters).
- ❑ Your *Gain* setting may be too high. Try decreasing the gain and increasing the exposure length instead.

Section 12: Specifications

CCD sensor:	Sony SuperHAD ICX413AQ-S Color (scientific grade)
Sensor size:	25.10 x 17.64 mm
Active pixel array size:	3032 x 2018 (6.1 megapixels)
Pixel size:	7.8 x 7.8 microns
Analog-to-Digital converter:	12-bit RAW output, with 16-bit application data
Total variable gain:	26.007 dB
Dynamic range:	80 dB
Signal-to-noise ratio:	60 dB
Exposure time range:	0.001 seconds to 55 minutes 59.999 seconds
Binning modes:	1x1, 2x2, 3x3, 4x4; all in full color
Filtering:	No filtering of the CCD sensor
Thermo-electric cooling:	-45° C below ambient temperature (maximum)
Weight:	32.5 oz. (924 gm)
Mounting interface:	T-thread or 2" nosepiece

➤ Field-of-View reference

The following reference table provides a list of some common telescope focal lengths and the approximate angular field-of-view provided by the Universe when connected to these scopes. The measurements shown are in arc-minutes.

Focal length	Field-of-View	Field-of-View with optional 0.5X focal reducer
300 mm	270' x 180'	540' x 360'
400 mm	204' x 138'	408' x 276'
500 mm	162' x 108'	324' x 216'
750 mm	108' x 72'	216' x 144'
1000 mm	84' x 54'	168' x 108'
1500 mm	54' x 36'	108' x 72'
2000 mm	41' x 27'	82' x 54'
2500 mm	32.5' x 21.6'	65.0' x 43.2'
2800 mm	29.0' x 19.3'	58.0' x 38.6'
3000 mm	27.1' x 18.0'	54.2' x 36.0'
3500 mm	23.2' x 15.4'	46.4' x 30.8'
4000 mm	20.3' x 13.5'	40.6' x 27.0'

