LEADERS THROUGH INNOVATION
STARLIGHT XPRESS ltd

Handbook for the SX 'Lodestar PRO C' Imaging and Guiding Camera

Thank you for purchasing a Starlight Xpress 'Lodestar PRO Colour' camera. We hope that you will be very pleased with the performance of this product.

The Lodestar PRO C is an updated version of the very popular 'Colour Lodestar' and is a very compact imager/guider, which is powered and operated via a single USB2.0 computer connection. It also provides an opto-isolated output connection for direct control of most mounts, via their 'Autoguider' sockets. This output is compatible with the 'ST4' style of RJ12 connection and supplies 4 'pull down' direction lines and a common return. Alternatively, you may send the mount control signals via a serial connection from the guider control computer. The Lodestar PRO C utilises a very sensitive Sony 'ExView2' CCD (the ICX829AK) with an array of 752 x 580 pixels in a 'half-inch' format. Although the chip is not cooled, it has a very low dark signal and very little readout noise, so it can be used to guide on faint stars that are well beyond the reach of webcams and CMOS chip based guide cameras.

The Lodestar PRO Colour specification:

CCD	-	Sony ICX829AK ExView2 colour CCD
Pixel count	-	752(H) x 580(V)
Pixel size	-	8.6 x 8.3uM
Optical size	-	6.47 x 4.81 mm
Colour filter grid	-	RGGB Bayer Matrix
Read noise	-	Typically 8 electrons
Gain	-	0.8 e/ADU
Barrel size	-	31.75mm dia. x 85mm long (1.25 inch eyepiece push fit size)
Barrel thread	-	25.4mm x 0.75mm 'CS' mount lens thread
Input connection	-	'Mini B' USB socket for USB2.0
Output connection	-	Standard RJ12 autoguider socket
Output type	-	Opto-isolated 4 lines (N,S,E & W) pull down with common return line
Download rate	-	Approx. 10 frames per second in binned 2x2 mode (recommended)

Installing the Lodestar PRO C:

Before connecting the Lodestar PRO C to your computer, please install the appropriate drivers for your operating system from the USB drive supplied with your camera.

The supplied USB stick contains all the drivers and software. To install the drivers:
1. Select the folder for your operating system
2. Double click on the "Install Drivers.exe"
3. Follow the prompts in the installer and click 'Finish' at the end of the install.

If you encounter any problems, read the README file on the USB drive or you can download the latest drivers from our web page at https://www.sxccd.com/drivers-downloads.

The Lodestar PRO C control software is Lodestarc_usb.exe. To install this:
1. Double click on the Colour Lodestar Software folder on the USB drive.
2. Double click on the Setup.exe program
3. Follow the prompts to fully install the software on to your computer.
4. Plug in your Lodestar PRO C camera – (Wait for the Install New Hardware Wizard to complete)
5. Double click on the Lodestarc_usb.exe icon on your Desktop or from your START button on your computer.
6. The first time you use the software, click on "File" then "Set Program Defaults" You will get a message, "Warning – No INI File found – Please set defaults"
7. Click "OK" – The Set Program Defaults box will appear.
8. If you are going to be using the RJ12 Autoguider Port on your Lodestar X2C, select Autoguider Socket in the "Telescope Guiding Parameters" box at the top of this box.
9. Click on "Save Changes" and you are all set to start using the camera. (The INI file that was being asked for initially has now been created and you will no longer see the Warning message)

To install Starlight Live ('Live-stacking') software:
1. Double click on the Starlight Live folder on the USB drive.
2. Double click on the Setup.exe program
3. Follow the prompts to fully install the software on to your computer.
4. Plug in your Lodestar PRO C camera – (Wait for the Install New Hardware Wizard to complete)
5. Double click on the Starlight Live.exe icon on your Desktop or from your START button on your computer.

PHD2 is also supplied on the USB stick. This is an excellent and very simple stand-alone Autoguiding Software. We would highly recommend trying this software as it is highly regarded in the Astro-Imaging community.

Other 3rd party software packages such as AstroArt, MaximDL, SkyX and others, all support the Lodestar X2C either with native drivers or through ASCOM. Our latest driver can be found on our website: https://www.sxccd.com/support/resources

Colour imaging with the Lodestar PRO C:

The Lodestar PRO C uses a CCD with Cyan, Magenta, Yellow and Green 'Secondary colour' filters integrated onto the silicon surface. These filters are arranged in a repeating grid of quads across the CCD and so suitable software can translate the different pixel brightness into colour information and create a true colour image from the monochrome data. This means that your 'raw' images are initially black and white, with a 'tiled' look, owing to the filter grid. Conversion into colour is usually handled by processing the raw images on the following day, when you can take time to optimise the colour balance, saturation etc.

Taking your first images:

There are many ways in which the Lodestar PRO C may be used to image the night sky, but all require some kind of optical system ahead of the camera. Most owners will have a telescope already available and this may well be suitable for taking good images with this camera, but you will find that a fast, short focus 'scope is much the best for your first experiments. If you have a small F5 refractor, then this will work very well, but a typical F10 SCT should be fitted with a focal reducer to bring the F number down to F6.3 or less. Using a short focus system will give strong images in short exposures and telescope tracking problems will be minimised. You might even start with a 'CS mount' CCTV lens as a very wide field optical system.

All CCD cameras have a high infrared sensitivity and this will give some strange colour results if it is not removed by an infrared blocking filter. This is not too much of a problem with nebulae, as these emit little infrared, but galaxies tend to show weak colour and daylight images of plants, grass etc. will be very 'washed out' (chlorophyll reflects infrared very strongly). Also, the infrared focusing of many lenses and refractors is poor, leading to fuzzy star images, if the IR is not filtered out. Please bear these points in mind when choosing a lens or telescope, you may find that an infrared blocking filter is essential for many such optics.
Once you have decided on your lens or telescope, attach the Lodestar PRO C so that the CCD is close to the focal plane and then point the 'scope at a bright star. Start the Lodestar PRO C software and select the camera symbol from the top row of icons. The camera control panel should open, but if you see 'USB device not found' please check that the Lodestar is connected correctly and, if so, try

opening 'Set Program Defaults' from the 'File' menu and select 'Ignore VID/PID'. Save this setting and try opening the camera dialog again.
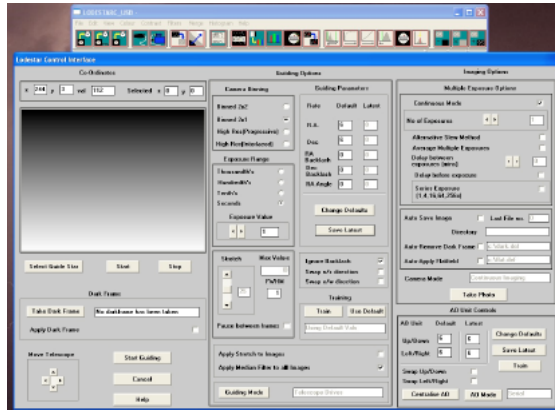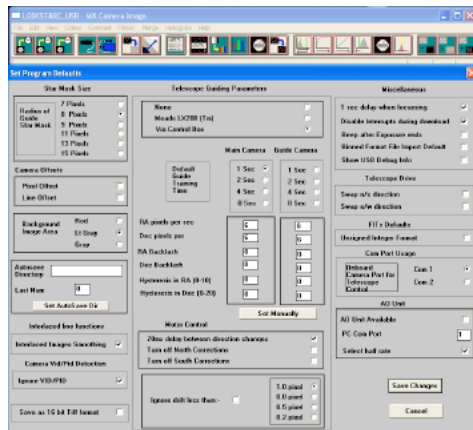

Once you see the camera control panel, as above, select 'Continuous Mode', 1 second exposure and 'Binned 2 x 1'. You can now press 'Take Photo' and you will see a steady stream of images appear in the display panel. With luck, you will see one or two out of focus stars and you can then refine the telescope focusing to get the sharpest possible result. Press 'Esc' to end the Continuous Mode sequence.
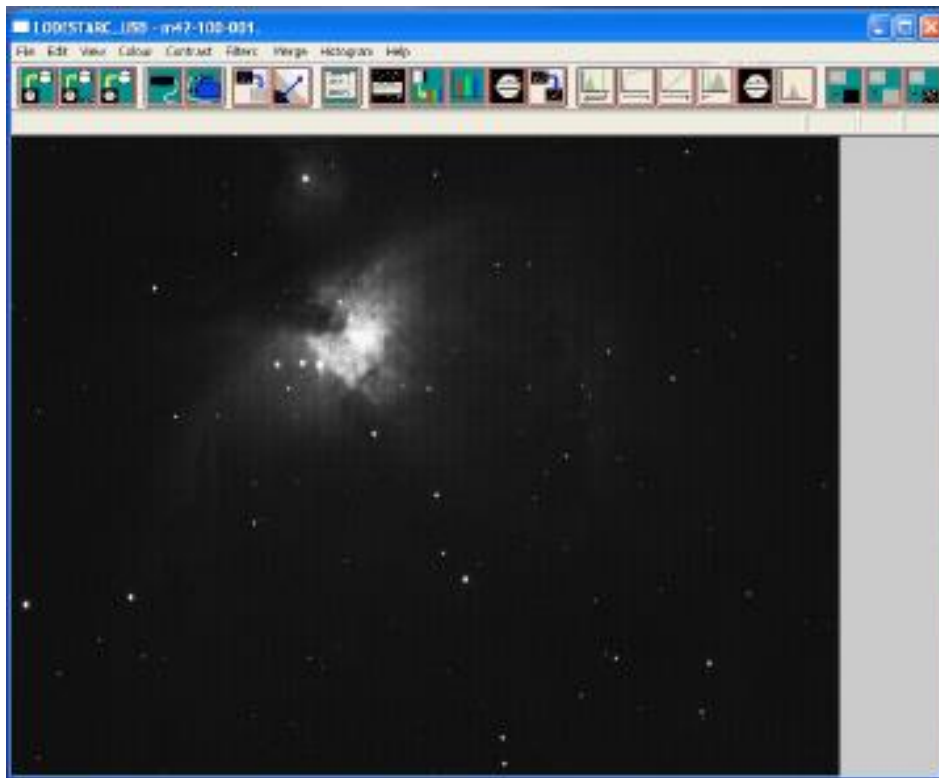
Once the focus is optimum, switch the imaging mode to High Res (Progressive) and increase the exposure time to about 30 seconds (switch off Continuous Mode). You should now see a star field with a wide range of star brightness – you might also detect a hint of a 'grid' across the image, but this is normal. The grid is caused by the filter matrix on the CCD, but will disappear when the images are converted to colour.

I suggest that you now try imaging something with good colour, such as M42 or M27. M42 needs about 60 seconds exposure at F5, while M27 will need about 5 minutes for a reasonable image density. Save a selection of unprocessed image frames for experimenting with and practising your processing techniques. Don't spend much time colour processing at the 'scope – this will waste good imaging time! Once you have some good images to experiment with, you can try some colour processing, as follows:
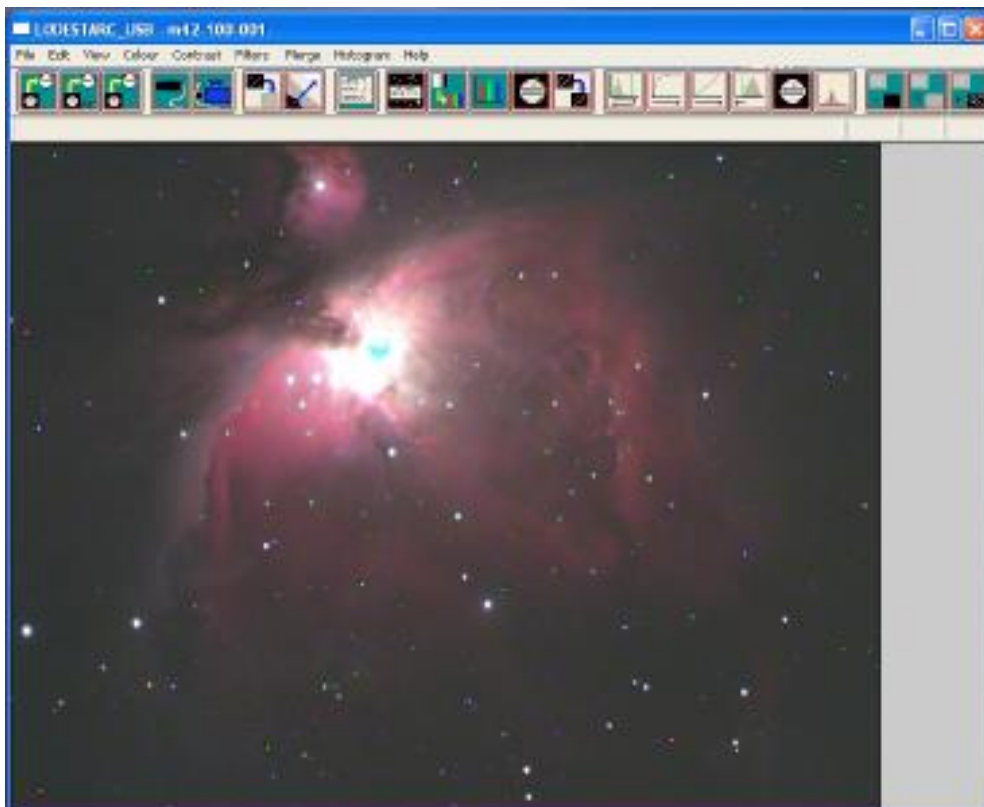
Open an image and then select 'Set program defaults'. Make sure that the Pixel and Line offsets in 'Camera Offsets' are both unchecked – this affects the way that the colour filters on the CCD are assumed to be organised and both 'off' is usually correct. You can confirm this by taking a daylight image and confirming that the colours are essentially correct when using this setting. If the colours are badly wrong, try other offsets until they are correct. It is possible that future firmware updates could change the correct settings, so beware of this.

Now save the changes and then go to the main menu. Select 'Colour' followed by 'Colour Synthesis'.

The settings shown in the picture are generally suitable for getting the best results, so try these first. Here is a typical daylight image, taken through an infrared blocking filter:

Once you have some good astronomical images, try using the same settings and you should get some nice results:

The raw image:

After colour conversion and some power law contrast stretching:

Post processing of your images is necessary, if you are to see the best results. Most astronomical images have a very wide 'dynamic range' (brightness from very dim to very bright in the same image) and so you may need to compress this range. This is quite easy to do by applying a 'Power Law Stretch' with a power setting of less than 1. Call up 'Power Law Stretch' in the 'Contrast' menu and set the slider to 0.3. Apply this and your image will brighten a lot and show much more dim detail. A 'Normal' stretch will allow you to restore the background to a darker level and you can apply the power law again, if necessary. The picture of M42 above was processed in this way.

Guiding with the Lodestar PRO C:

The Lodestar PRO C is generally used with a separate guide telescope, or via an off-axis guider. It is designed to be inserted into a standard 1.25" focuser assembly, but also has a 25mm 'C' type camera lens thread in the front to allow standard CCTV lenses to be attached. Please note that the chip to lens distance is only 12.5mm and so a 'CS' to 'C' extension will be needed to permit a standard C lens to reach focus. Lenses designed for 'CS' mount cameras will focus without an extension tube, but many of these lenses cannot fully illuminate a half-inch format CCD, so take care when selecting a lens for this purpose.
A typical set up might consist of an inexpensive 80mm F5 refractor 'piggybacked' onto an SCT, with the Lodestar fitted directly into its focus barrel. Many such telescopes are designed to be used with an inverting prism ahead of the eyepiece and so the focuser may be too short when the Lodestar is inserted directly. In this case, an extension tube may often be made from a cheap Barlow lens assembly with the lens removed.

**The Lodestar PRO C attached to an 80mm F5 guide 'scope**

The focal length of your guide telescope is not especially critical for good guiding, as the guiding software searches for the 'centroid' of the guide star image and can resolve shifts of far less than 1 pixel. Using a guide scope with a relatively short focal length (between 300 and 500mm) makes guide star finding very easy and this is a recommended setup for general purpose guiding.
The control of your telescope mount will depend on what inputs are provided. The Lodestar output connector supplies 4 pull-down lines and a common return line to simulate an 'ST4' style autoguider output. The lines are isolated from the Lodestar electronics by opto-isolator chips and so there is no risk of damage when connecting the outputs to mounts with unprotected electronics. A standard 'RJ12' style output lead is supplied with the Lodestar and this may be connected to any ST4 compatible autoguider input socket on the mount. It is also possible to guide by using serial data from the computer to an RS232 input on the mount, but this will be covered later and is less effective than the direct hardware connection.
The preferred guiding mode is 2x2 binned, as this gives both fast downloads and high sensitivity without any 'interlacing' issues. The 'Fast' 2x1 mode is also useful if you are working with a short focal length guide 'scope, as it offers somewhat finer RA guiding resolution in the X axis if this is oriented East-West.

**Guiding with the Starlight Xpress Lodestar software**

With the Lodestar PRO C connected to the PC and mount, open 'Lodestar.exe' and find the 'Set program defaults' menu under the 'File' heading. If this is the first run of the software, you will get a warning about the 'ini file not found', but ignore this and click on OK. You should now see a screen similar to the one shown below:
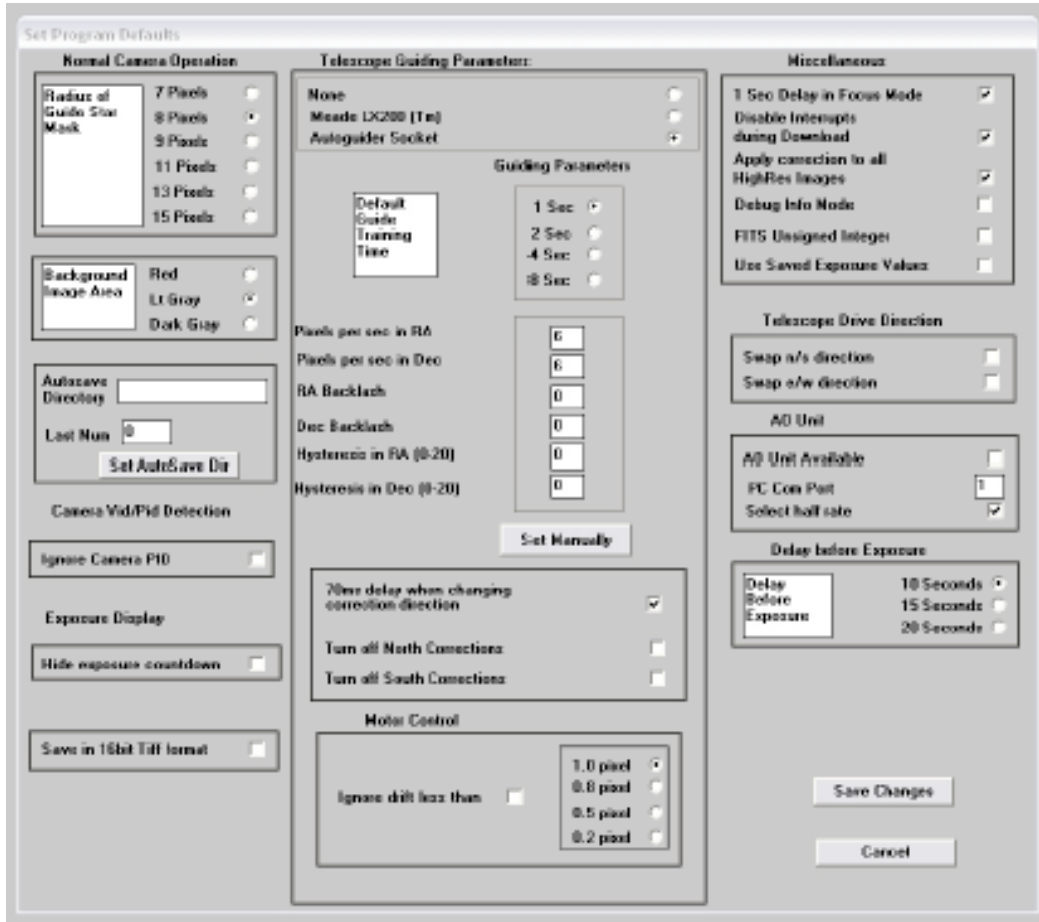
The settings shown above are generally satisfactory as a starting point, although some will probably need refinement for best results. In the example shown, the 'autoguider socket' on the Lodestar is providing the control signals to the mount, but you might alternatively use the 'LX200' mode via the serial port of the computer, if this is preferred. The Guiding Parameters are set to 6 pixels per second, which corresponds to the typical drift rate of a 1000mm focal length guide telescope when the mount is guiding at 0.5x sidereal speed. Longer focal lengths and/or higher guiding rates will require a larger value to be set so as to avoid excessively fast corrections, which can cause erratic guiding or even oscillation of the guiding errors to either side of the guide star.

Once the defaults have been set to values which you think will be approximately correct, save the settings and open the 'View' menu. In this you will see an option called 'Max palette stretch'. Open this and check the 'Activate stretch display' check box. This will automatically boost the image brightness so that faint guide stars can be easily seen – if necessary, you can adjust the slider for the best results.

Now click on the camera icon to open the Lodestar X2Control dialog, as below:
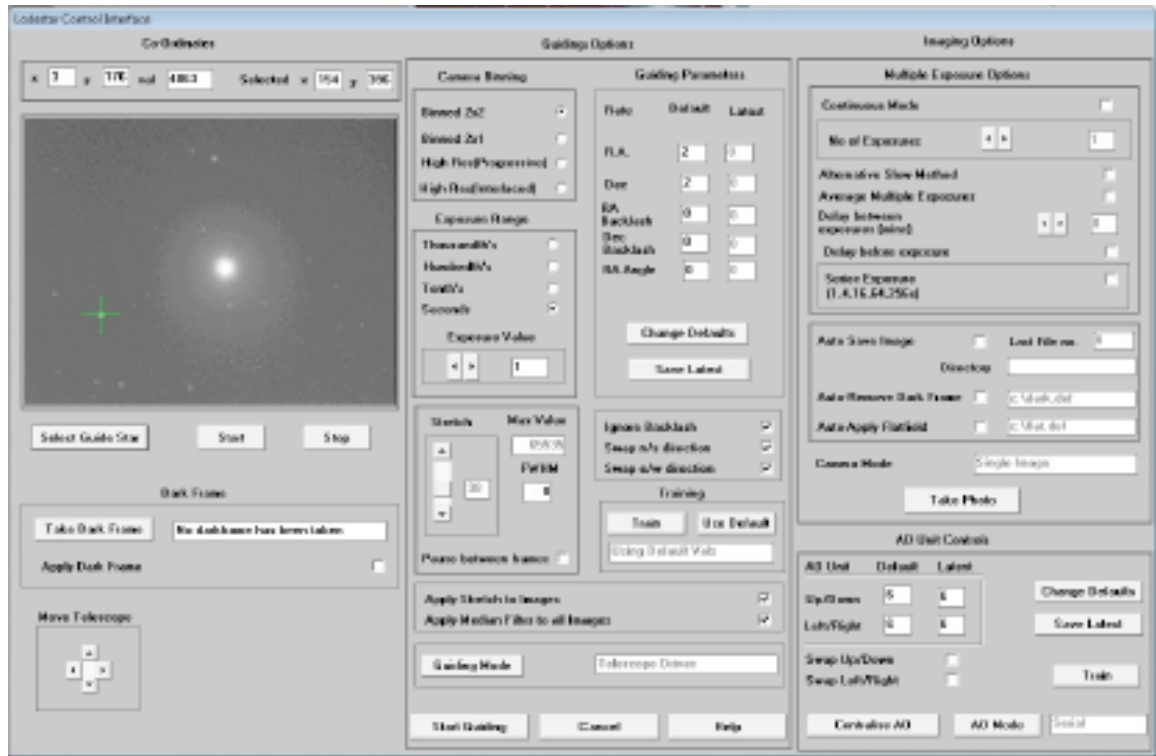
The image box will be empty at this point, but we need a frame to select the guide star from, so use the guiding options to select a suitable exposure time (say 1 second) and press the 'Start' button below the image box. A sequence of images will be shown and you can refine the image focus and centring as required. Before attempting to guide, it is wise to check that you have control of the telescope drive via the Lodestar software. This is easily done by pressing the 'Move Telescope' buttons at the lower left of the control box. Check that pressing the arrow buttons causes the star field to drift left, right, up and down, as appropriate. The LED at the back of the Lodestar should change colour when the buttons are pressed. If all is well, move onto the next step below:
Once a good guide star has been found, press the 'Stop' button and then the 'Select guide star' button. You can now click the mouse arrow on the guide star and a green cross will appear, centred on the star (see above). Don't select a very bright guide star, as this will result in poor guiding due to saturation of the core pixels in the star image. The example above shows the region around Vega and it is clear that Vega itself would make a very poor guide star due to its large saturated core.
Once the guide star is selected, a small box appears with the star coordinates. If they look good, just click on OK.

Now click on 'Start Guiding':
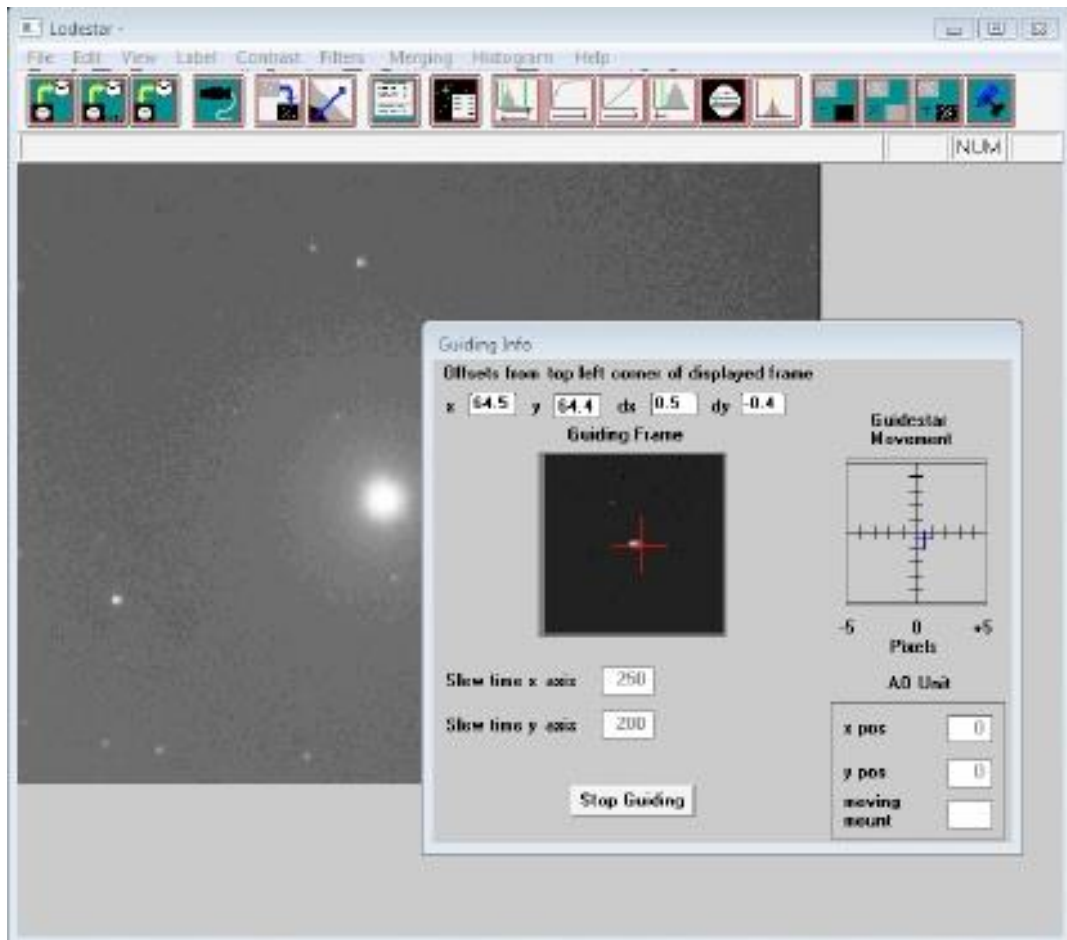
After a brief delay, the Guiding Info window will open, as above, and you will see the guide star, along with error values and a reticule showing the guide star location with respect to the reference position. If all is well, you should see the guide star location being forced towards the centre position with each successive guide image. However, it is quite likely that it will be pushed away from the correct position, due to an error in the guiding default settings. If this is the case, note the direction of travel, and then reverse the appropriate direction setting in the guiding defaults menu. For example, if the star moves away to the left or right, try reversing the 'Swap e/w direction' setting. If guiding works, but is sluggish, try reducing the 'Rate' setting in the guider settings, or increase it if the guiding oscillates from one side of the guide star to the other.

Lodestar maintenance

The Lodestar head is designed for a long and reliable lifespan and needs very little maintenance to keep it in good working order. The only common issue is with dust particles which collect on the CCD window and can shade areas of the image field. These are best removed with a quick blast of compressed air from a 'Dust off' aerosol, or similar air blower. More permanent marks may be removed with a drop of alcohol on a 'microfibre' lens cloth.

Dear User,

Thank you for purchasing a Starlight Xpress product. We are confident that you will gain a great deal of satisfaction from this equipment, but please read carefully the instruction manual, supplied with your product, to ensure that you achieve the best performance that it is capable of providing.

As with most sophisticated equipment a certain amount of routine maintenance is necessary to keep the equipment operating at its optimum performance. The maintenance has been kept to a minimum, and is fully described in the manual.

Starlight Xpress Ltd. warrants all Starlight Xpress products to be free from defects in workmanship and materials, under normal operating use and conditions, for a period of two (2) years following the original invoice date. This limited warranty does not cover failures due to abuse, accidental damage, or when repairs have been made or attempted by anyone other than Starlight Xpress. A defective product meeting the warranty conditions set forth herein will be replaced or repaired at no charge.

Replacement or Repair
If a product arrived with the user and is immediately faulty, Starlight Xpress, if contacted within 30 days of purchase, and with evidence proving a defective product, will offer a free replacement, subject to the verification of the defect or malfunction. The customer shall return the complete product package, including all parts, accessories, and manuals, etc. for a replacement.

Exclusions:

1. The equipment shall only be used for normal purposes described in the standard operating instructions, and within the relevant safety standards of the country where the equipment is used.
2. External mechanical force (i.e. dropped, scratched sensor window, damaged metalwork, a broken or damaged USB port, power supply connector etc.)
3. Water or moisture inside the product due to improper storage or use.
4. The guarantee shall not apply to the equipment damaged by flood, fire, earthquake, lighting strike etc. (Force majeure)
5. Disassembling, repairing, or refurbishment made or attempted by anyone other than Starlight Xpress without prior authorisation.
6. This guarantee shall not apply to components that have a naturally limited life.
7. Starlight Xpress' decision in all matters is final, and any faulty component which has been replaced will become the property of Starlight Xpress Ltd.

This Limited Warranty is NOT transferable and applies ONLY to direct customers who purchase product from Starlight Xpress or/and its authorized dealers.

Please don't forget to register your SX Product at https://www.sxccd.com/support/warranty-policy-and-registration/ to initiate your warranty

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