

# Conversion of a *Philips SPC880* webcam for astro-imaging

*Compiled for Bolton AS by Ross Wilkinson*



These high-spec CCD cameras are available from *Morgan Computers*:

<http://www.morgancomputers.co.uk/shop/detail.asp?ProductID=6313>

With the firmware supplied, they will operate as *Philips PCVC750K* webcams under *WindowsXP* (and older Operating Systems), but their firmware will need to be updated to *SPC900* for use with *Vista* and *Seven* – see the details here:

[http://www.home.zonnet.nl/m.m.j.meijer/D\\_I\\_Y/spc900nc.htm#6.%20Convert%20a%20ToUcam%20Pro%20to%20a%20SPC900NC...](http://www.home.zonnet.nl/m.m.j.meijer/D_I_Y/spc900nc.htm#6.%20Convert%20a%20ToUcam%20Pro%20to%20a%20SPC900NC...)

Or if you've got the camera working under *XP*, you can then use this process to load the drivers into *Vista*:

<http://www.azcendant.com/VistaToUcamInstall.htm>

Once you've got it working with your PC as a standard webcam, the next step is to attach it to your telescope: this requires the removal of the built-in lens and its replacement with an adaptor – either an eyepiece fitting or a T-thread flange:



e.g. <http://www.morgancomputers.co.uk/Shop/detail.asp?ProductID=6342>

The details of how to remove the lens are here:

[http://www.home.zonnet.nl/m.m.j.meijer/D\\_I\\_Y/spc900nc.htm#1.%20Cracking%20it%20open](http://www.home.zonnet.nl/m.m.j.meijer/D_I_Y/spc900nc.htm#1.%20Cracking%20it%20open)

Note that you'll need the "long-thread" type of adaptors to reach the fitting inside the camera body. Alternatively, if you already have an older "short-thread" type, the alternative is to transplant the camera circuitry into a new box – this is the approach which I have used (see the following pages).

And if your telescope includes any lenses (or if you're using eyepiece-projection or a Barlow lens), it's also a good idea to fit an *Infra-Red-blocking* filter in the optical path – otherwise, as the CCD is sensitive to near-IR, you'll get fuzzy focus due to dispersion of the IR light:

<http://www.morgancomputers.co.uk/Shop/detail.asp?ProductID=6348>

Whichever approach you use to attach it to your telescope, you can now use the unmodified camera for imaging bright objects: the Moon, Jupiter, Saturn, Mars and Venus, (or even the Sun *using special filters, or projection methods*).

There are some examples of such images here:

<http://homepage.ntlworld.com/rossjwilkinson/astro.html>

But to use the camera on fainter objects, it's necessary to dabble with a little electronics! Fortunately, design of this camera makes it relatively easy to convert for long exposures – there's no really fiddly soldering of surface-mount components (unlike with the earlier versions of the *TouCam!*)

The modifications consist of two steps:

The **SC1**<sup>1</sup> modification enables long-exposures;

And the **SC1.5** modification considerably improves the “dark-frames” (see below).

As it stands, the SC1-modified camera suffers from the widely-reported “amp-glow” effect: a blue glow emanating from the top-left quadrant during exposures of tens of seconds or more. This is due to *electroluminescence* generated by the CCD's on-chip amplifier, but can be reduced considerably if this amplifier is powered-down during the exposure – by the “Amp-Off” or **SC1.5** modification:



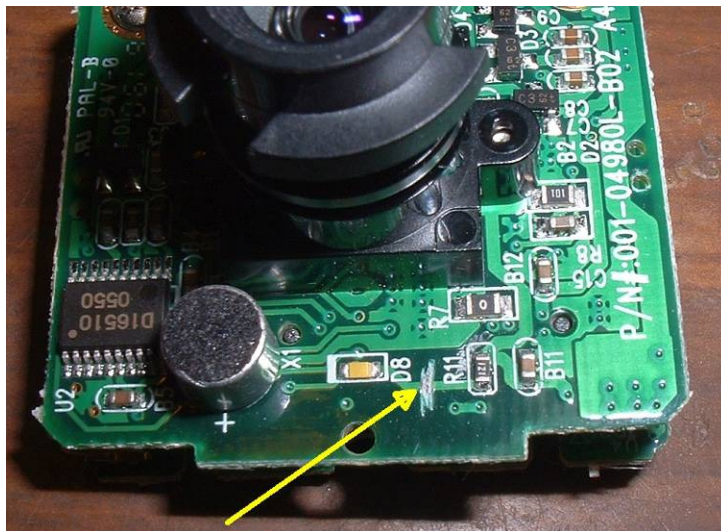
60-sec test exposures before and after the “Amp-Off” modification

To perform these modifications, you just need a few hand-tools, a soldering iron, some tin/lead (NOT *lead-free*) solder and a degree of manual dexterity...

First, dismantle your camera, as detailed here:

[http://www.home.zonnet.nl/m.m.j.meijer/D\\_I\\_Y/spc900nc.htm#1.%20Cracking%20it%20open](http://www.home.zonnet.nl/m.m.j.meijer/D_I_Y/spc900nc.htm#1.%20Cracking%20it%20open)

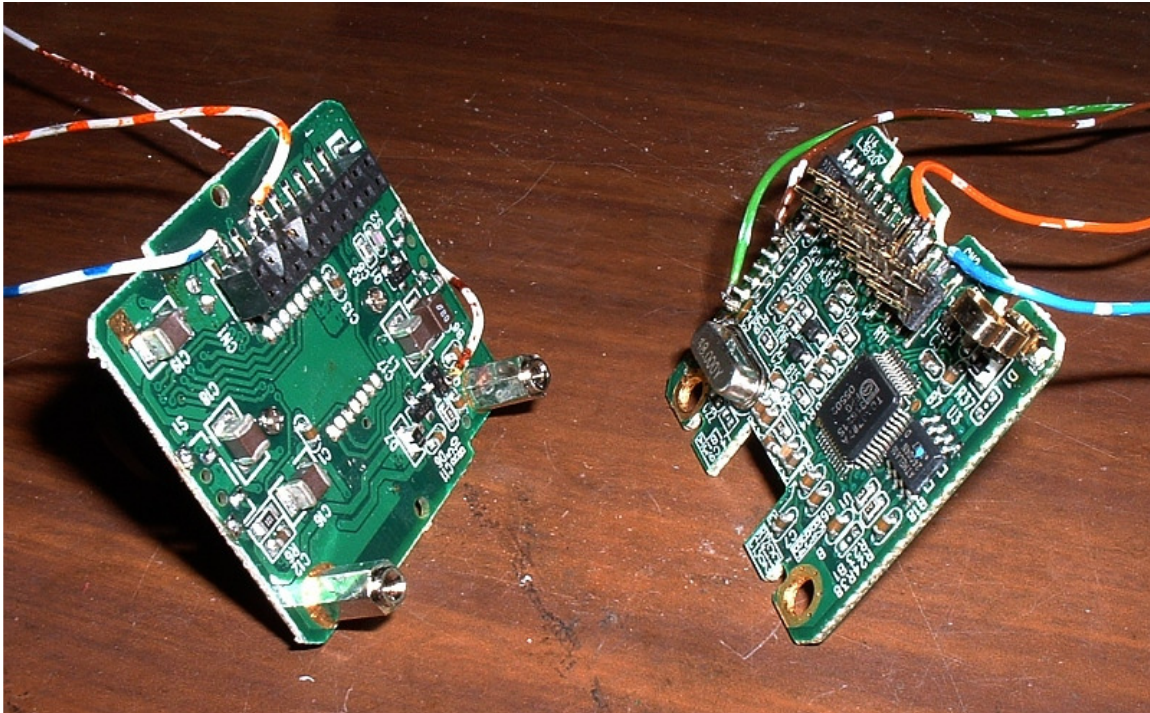
Once you've got it apart, the first thing to do is not related to the Long-Exposure process at all, but to extinguish the annoying white-LED “floodlight” on the front of the camera - just cut the PCB track between D8 and R11 with a scalpel or small chisel:



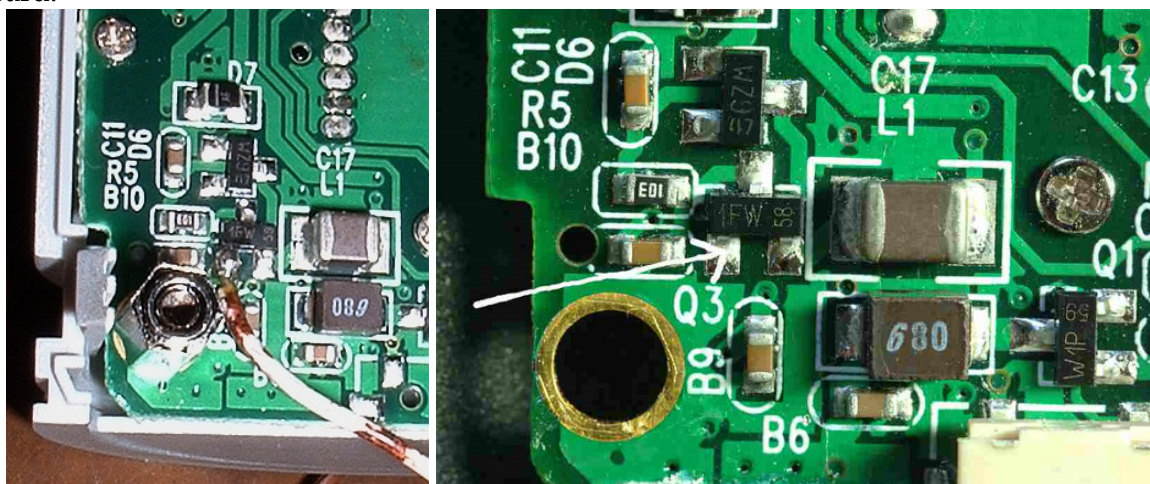
<sup>1</sup> These “SC” mods were originally developed by Steve Chambers

Now for the actual **SC1** mod: first carefully separate the two boards, and bend back the two pins (they are the second and fourth on the outer row, see the picture below) on the connector, then cut little notches (using a craft-knife or small needle-file) in the socket side of the connector to accommodate the bent-over pins.

Next, solder on wires onto the four connector pads which connect to these pins, plus two more to the 5V and 0V pins on the back of the USB interface socket. It's best to use different-coloured wires for each: this helps to distinguish them at the next stage:



And finally, (to make the **SC1.5** mod) there is one more connection to make to the camera; at the base terminal of transistor “Q3” in the voltage-regulator circuit<sup>2</sup> on the back of the CCD board:



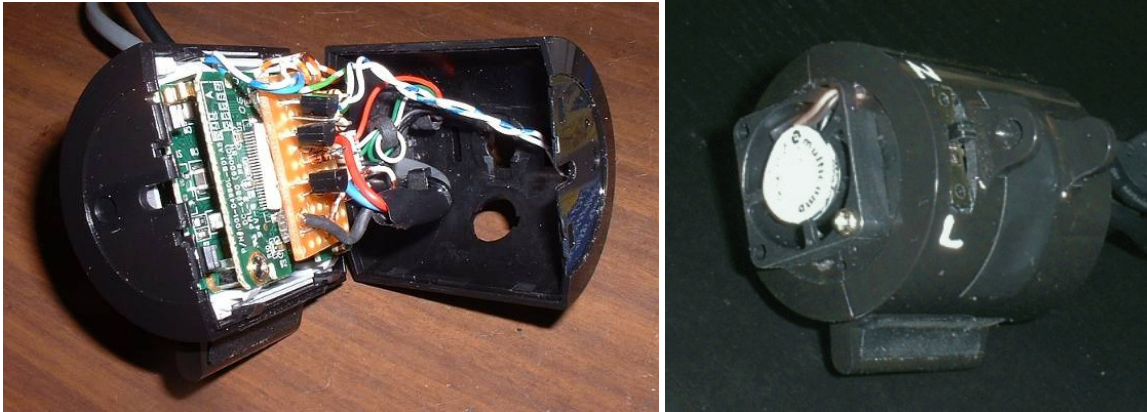
Once these seven wires are fitted, you can re-assemble the camera boards together.

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<sup>2</sup> This method for the SC2 modification was developed by Greg Beeke for the earlier *Vesta* webcam

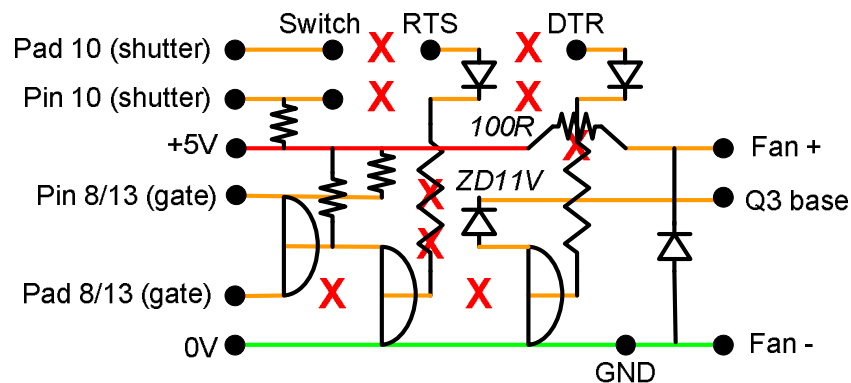
My original conversion used the Parallel (LPT) Port on an old laptop to control the camera, but since few modern PCs have this interface, all subsequent cameras have been configured for Serial (COM) Port control (often via a *USB-to-serial adaptor*).

My switching board was designed to be small enough to fit inside the back of the original camera case:



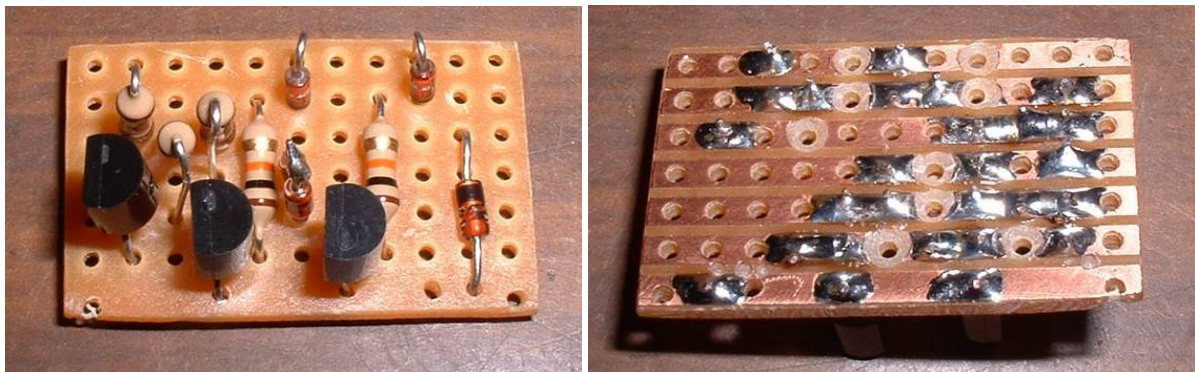
but this is a bit of a squash (particularly with the extra switch, connector and fan) so I prefer to transplant the whole lot into a new ABS plastic project box.

Here's my own design for a little circuit to control the *LX shutter* and *Amp-Off* functions using the COM port lines DTR (pin 4), RTS (pin 7) and GND (pin 5):



The horizontal lines are the *Veroboard* tracks and the red-crosses indicate track-cuts. The unmarked resistors are all 10K, the diodes are 1N4148s and the transistors BC548s.

*Take care to observe the correct orientation of the diode and transistors!*



*(My prototype built on an offcut of Veroboard, and before fitting the fan-speed resistor)*

And this is how it looks when fitted to the camera:



Now test the camera at this stage, whilst everything is out in the open.

If you need to do any de-bugging, you'll need a voltmeter to measure a few signals, and a suitable image-capture program to control the camera.

Clip the black meter lead onto the grounded end of the 1N4148 diode at the right-hand end of the *Veroboard*.

The RTS and DTR control signals can be measured at the protruding leads of the two diodes at the top of the board: they should be a few volts positive when "on" and a few volts negative when "off".

Check the voltage at the base of the left-most transistor (which switches the pin 8/13 signals in the camera): when the RTS signal switches "on", this should drop from 5V to around 0V.

Also check the voltage on the protruding lead of the 11V Zener diode: this should drop from around 15.5V to 11V when the DTR control turns on.

And once you're happy that all is working, you can put it in the box.

*Here are some notes if you plan to re-use the existing case:*

In order to provide the "tilt" function, the original camera is mounted in an inner "cage", which slides within the outer case. But as this is no longer needed, I stuck the front half of the inner cage (with the camera boards fitted) into the front half of the case (using strips of double-sided tape). Then we no longer need to fit the rear half of the cage: indeed dispensing with it makes more room in the back of the case.

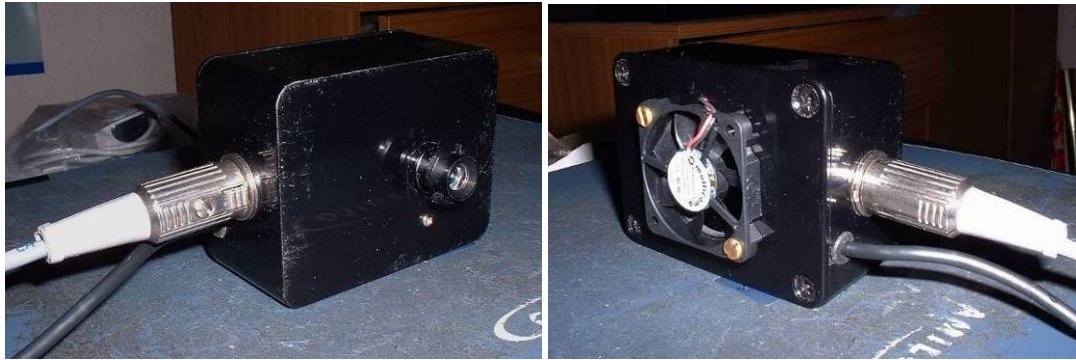
Next I made two holes in one side of the rear half of the case for the USB and Serial cables (since now there isn't enough room to use the existing hole in the back). I also broke out the tripod bush insert - it's only glued in, so screw it onto a tripod head and snap it out.

Then to select between the *Normal webcam* and *Long-Exposure* modes, a sub-miniature slider-switch was fitted in the back of the case, into a slot which I cut with a file:

The final stage is to stick the *Veroboard* onto the top of the large IC on the top camera board using a double-sided sticky pad, and then carefully mate the two halves of the case, taking care not to trap any wires. I taped over the two holes left by the USB cable and tripod bush.

And finally I cut some more ventilation slots and fitted a 25mm fan on the side of the case.

But even though it is possible to re-use the existing case in this way, it really is quite fiddly to cram everything in there, so the re-boxing method is probably the quicker to build, and definitely the easier to get back inside if you ever need to do any repairs!



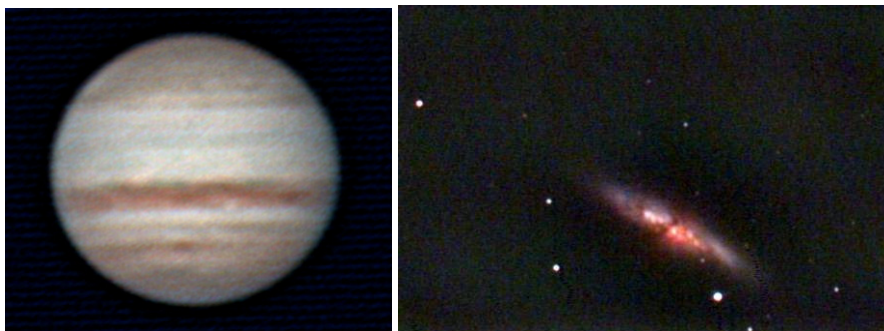
First work out where the camera boards will fit in the box (leave room for your *Veroboard*, switch and connector!) and then cut a 14mm hole in the front of the box, gently opening it out with a circular abrading tool (I used some sandpaper wrapped around a pencil) to be a good fit around the lens shroud assembly.

I also cut holes in the side of the box for the switch, control connector and USB lead, and lastly, a big hole for the fan in the lid, and a couple of air-intake holes in the front of the box.



I used two M2 bolts and spacers to anchor the camera boards into the box (using the existing threaded pillars) but as an alternative *Super-Glue* could be used to secure the lens shroud to the box (but make sure that you don't get any *inside* the thread!).

With my T-adaptor fitted on the front, I can now mount my box onto the back of either of my telescopes, and so use exactly the same camera for imaging bright planets at high magnification, or for long-exposures of deep-sky objects:



*Two early tests with my converted SPC880*

Since the webcam CCD is very small, it only gives a narrow field-of-view through a telescope, but an alternative is to use old 35mm SLR camera lenses for wider views – here are a couple of examples of home-made brackets to attach them to the webcam:



And here are some examples of imaging with 50mm and 200mm lenses:



*Imaging “large” deep-sky objects using converted SPC880 with camera lenses*

### ***Imaging with the camera***

First download **wxAstroCapture** from: <http://arnholm.org/astro/software/wxAstroCapture/> (and you’ll need to download the *Visual C++* program from *Microsoft* before installing it).

Then check camera in daylight: fit a lens and point it out of the window at a distant object. Switch the camera to “N” mode and plug it in via the USB port.

Run *wxAstroCapture* and **Connect** in 640x480 I420 mode.

Using **Properties ...** set *Full Auto* and you should then see a picture on the screen.

And (after you’ve set the *Capture folder* in **Options..Settings..Video Capture**), you can **Capture** an AVI file and then view it in *Media Player* or similar.

### ***Lunar & planetary imaging***

Since the Moon and planets are *sunlit* objects, you don’t need the LX-mode, but you do need lots of *magnification* – use a telescope and a *Barlow lens* or *eyepiece-projection adaptor* (but note that the more magnification you use, the more wobbly and dimmer the image will be!).

Your telescope will need to *track* reasonably accurately, to keep the target within the narrow field-of-view for a few minutes at a time.

In *wxAstroCapture*, open **Properties ...** freeze the *white balance*, turn off *Auto* and set 5 *fps*, *shutter* to 1/25 and *gain* to 100.

Once you’ve got your target on the screen, you can optimise the exposure (*shutter* and *gain*) settings. Turn down the *gain* to 75 or less to reduce the noise, and then select the **shortest shutter** which still produces a bright image (but use the *Histogram* to make sure that you’re not saturating (keep the reported numbers below 250)).

Focussing on a wobbly (due to atmospheric turbulence) image is really difficult - I re-optimize the focus before each set of images, and hope that I'll get it spot-on on at least one run in an evening!

Once you're happy with the settings, **Capture** a sequence of hundreds of frames as an AVI file for processing with *RegiStax*, then (re-focus and) repeat as many times as you can!

If your target is rising in the East, then the *seeing* should improve as it gains altitude, and as the cooling air in your telescope settles down, so your images should improve as the evening wears on!

## Setting up LX-mode

Now for the interesting bit...

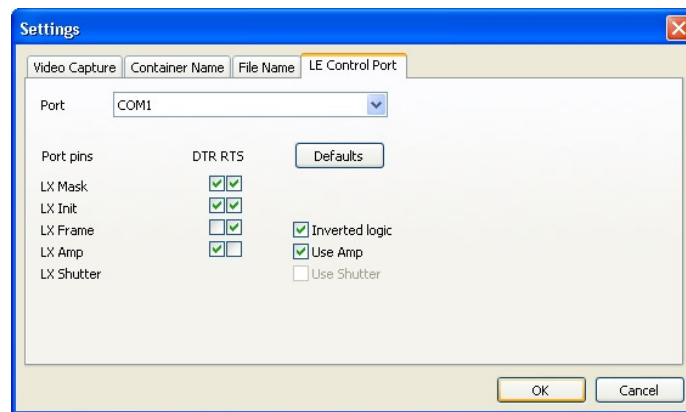
If you're using a *USB-to-serial adaptor*, make sure that you've installed it *before* you start *wxAstroCapture*, and check which **COM** port it's using.

Next set the camera to "L" mode and plug it in via USB.

Then connect the serial lead to your COM port.

Now start *wxAstroCapture* and **Connect** to the camera as before.

Next check the **Options..Settings..LE Control Port** menu:



(set the Port to the correct COM number for your adaptor)

Using **Properties ...** freeze the white balance, turn off *Auto*, set 5 fps, and gain to 75.

Now you're ready to activate **LE** mode - set the exposure time to 2-sec initially, and test in a darkened room: you should now be able to see in the dark!

## Deep-sky imaging

Since the webcam has a very small CCD (only 4.6 x 4 mm), you don't need a long focal-length optics get much magnification (and a narrow field-of-view). So for the larger deep-sky objects (like M31, M42 and M45), old SLR lenses between 50mm and 200mm focal length are ideal, whereas short telescopes (up to 1000mm focal length) are better for more compact clusters and galaxies. Focussing can be tricky, but focus aids such as a *Bahtinov mask* can help.

Once you've acquired your target, make a few tests to choose a suitable exposure time (a *light-pollution filter* can help to achieve longer exposures without saturating the sky background). Then **Capture** an AVI file of dozens of frames: the more you get, the better you'll be able to average out the noise!

And once you get more proficient, take a set of *bias* (offset) and *dark-frames* and *flat-fields* to help calibrate your images for more advanced post-processing.

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