



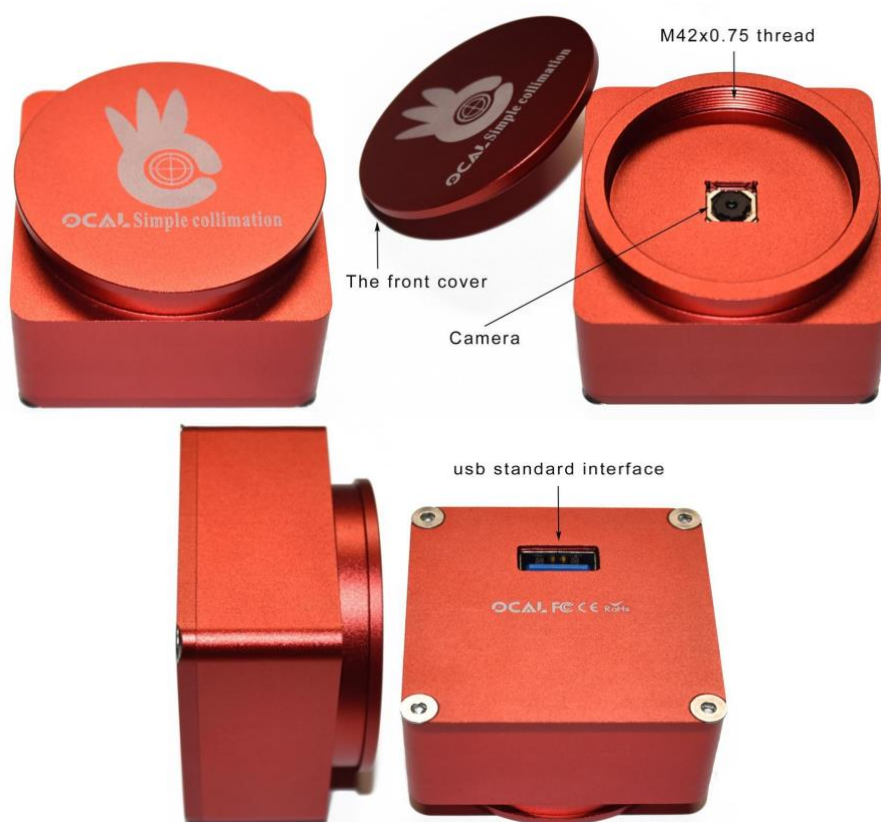
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Version : 2.00

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What's in the Box?



The latest software for Windows or Android can be downloaded from our website.
<http://www.ocalworld.com/en/>

OCAL is certificated by U.S. FCC and EU CE to ensure property safety.



What is Collimation?

Collimation is the process whereby the mirrors in a reflective telescope are aligned with each other to ensure that light is focused at the exact centre of the eyepiece or camera.

With a Newtonian telescope, there are two mirrors that need to be aligned – the large **primary** mirror at the base of the telescope, and the small **secondary** mirror held in place by the spider at the front of the telescope.

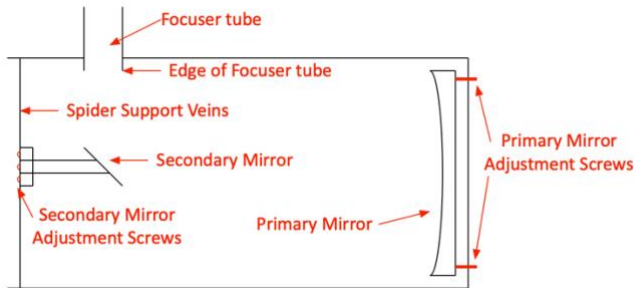


Figure 1 Newtonian Telescope

With other types of reflective telescope such as a Cassegrain, Schmidt-Cassegrain (SCT) or Maksutov (Mak), typically one of the mirrors is fixed in place and only one mirror can be aligned.

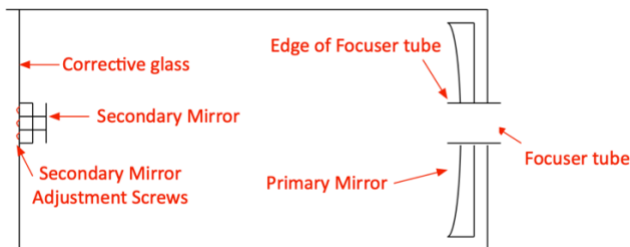


Figure 2 Schmidt-Cassegrain (SCT) Telescope

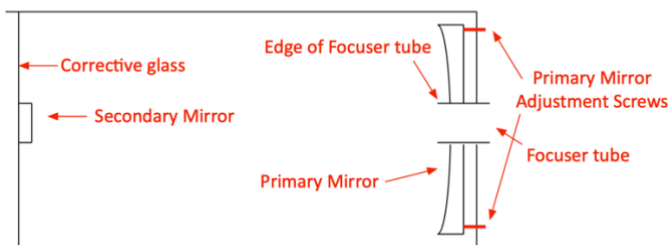


Figure 3 Maksutov Telescope

An analogy for the collimation process is to imagine the beam of light as a billiard ball bouncing off the cushions (mirrors) of the billiard table. The aim is for it to bounce off 2 cushions and go into the pocket. If you have ever played snooker, billiards or pool you will know how precise your aim at hitting the ball must be for this to be achieved. With a telescope, we can't control the ball (light beam), but we can control the angle of the cushions (mirrors). If they are not aligned, the light beam misses the pocket (camera).

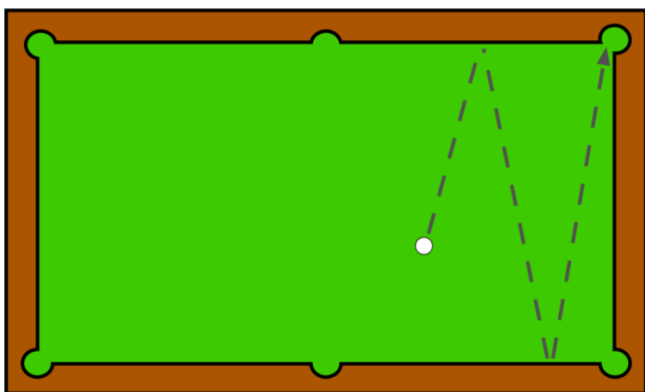
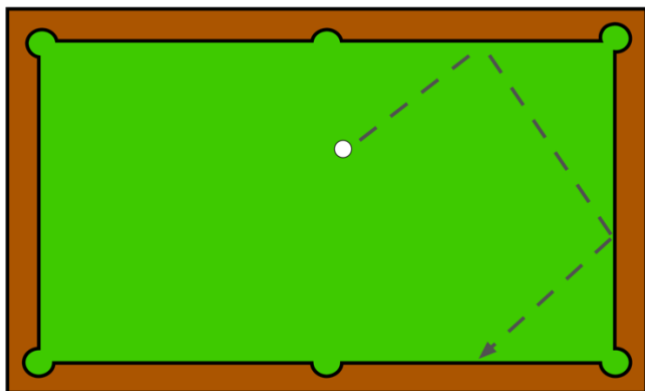


Figure 4 Aligning the cushions (mirrors)

Making Adjustments to your Telescope Collimation

Usually an adjustment is made to a mirror by adjusting the position of screws around the base of the mirror, or around the spider holding the secondary mirror.

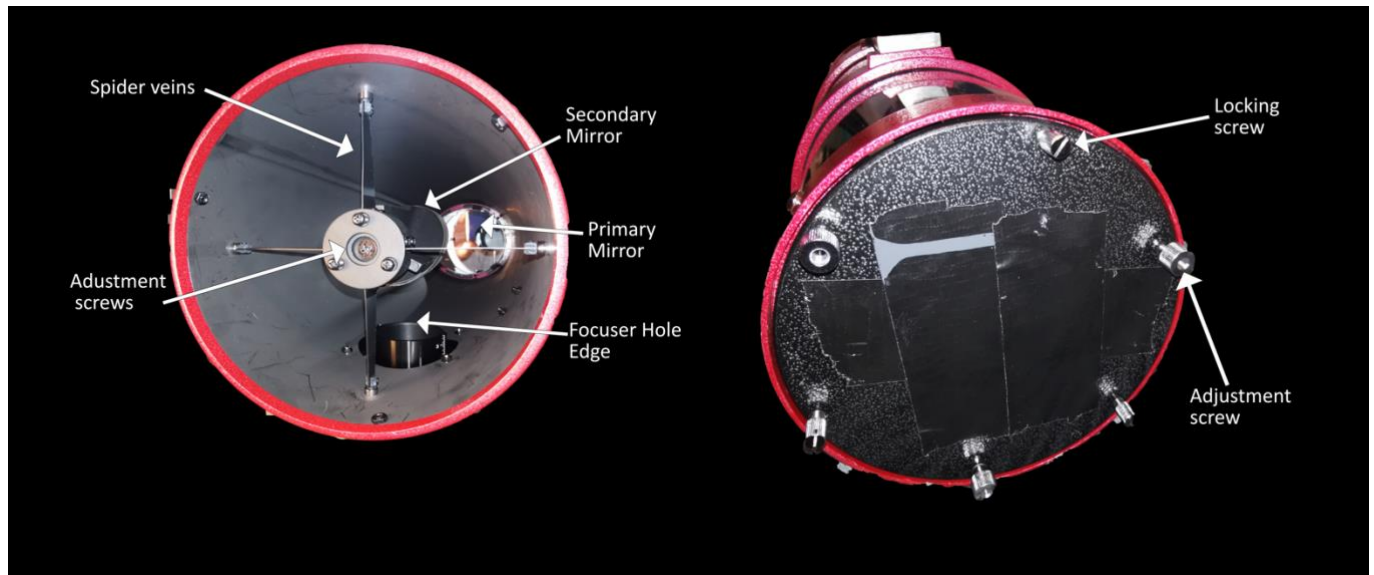


Figure 5 Newtonian Parts

Whatever type of reflective telescope you own, the telescope manual should be consulted for the correct information on what to adjust, and how it is adjusted – usually a screwdriver or allen key will be required to make the adjustment.

Do ensure that you use the correct tools – an allen key should be a tight fit, or it is probably the wrong size. Use a correctly sized Philips screwdriver for a Philips screw, a correctly size pozidrive screwdriver for a pozidrive screw. **Using the wrong type or size of tool risks damaging the screw which can make future adjustments difficult.**

There are a number of tools that you can use to help with the alignment process such as collimation caps, Cheshire eyepieces and lasers. The internet has many good tutorials to help you collimate with these tools. **We think the Ocal Collimator is a better way.**

This manual assumes you have no prior knowledge in collimation and that you will be using the Ocal Collimator to collimate your telescope.

The Ocal Collimator

The Ocal Collimator is a tool to help you collimate your telescope. It has the following advantages over other methods and tools:

1. Since the key to collimation is aligning/centring things, it is vital that the tool itself is precision made and centred (i.e. the tool itself must be collimated). This is the case with the Ocal Collimator (see later section X). Many Cheshire or lasers are not, and therefore any collimation carried out with them can have a large degree of error.
2. Since the eyepiece view is via a screen (laptop or mobile), it is very easy to view at the same time as adjustments are being made – even if they are being made many feet away from the eyepiece as is the case with larger Newtonians. This makes the whole process fast and error free.
3. It is very difficult to identify and focus on the different parts of the telescope you see through the eyepiece – but good collimation requires high precision. A Cheshire may show a blurry cross to centre. An unaided visual check may make identifying the focus hole difficult. The Ocal Collimator remedies this by having a camera with controls such as focus, exposure, zoom. These make it very easy to achieve high precision in identifying the circumferences and centres of parts – vital to the collimation process.
4. Once collimated, checking collimation at any time is now very easy and quick.

The parts of a telescope

In order to collimate, you will need to be able to identify the following parts:

- A. The edge of the focus hole
- B. The edge of the secondary mirror
- C. The edge of the primary mirror
- D. The centre of the primary mirror

To collimate we will not be able to adjust A. However we may be able to adjust B, C and/or D. Collimation is simply the process adjusting B to be in the centre of A. Adjusting C to be in the centre of B, and Adjust D to be centred directly under the camera. Don't worry - we'll go through all this in detail, but for now, let's focus on identifying these parts.

The parts can be difficult to identify at first. Figures 6 show these parts in typical Newtonian telescope. Consult your telescope manual to help identify these parts in your own telescope.

One tip is to place a piece of coloured paper behind the secondary mirror (so that as you look down the focuser tube you see the secondary mirror in front of the coloured paper). This helps outline the secondary mirror nicely.

Here's an example from a Newtonian telescope, with a pink coloured card fitted, showing the different parts of the telescope as seen through the Ocal Collimator.

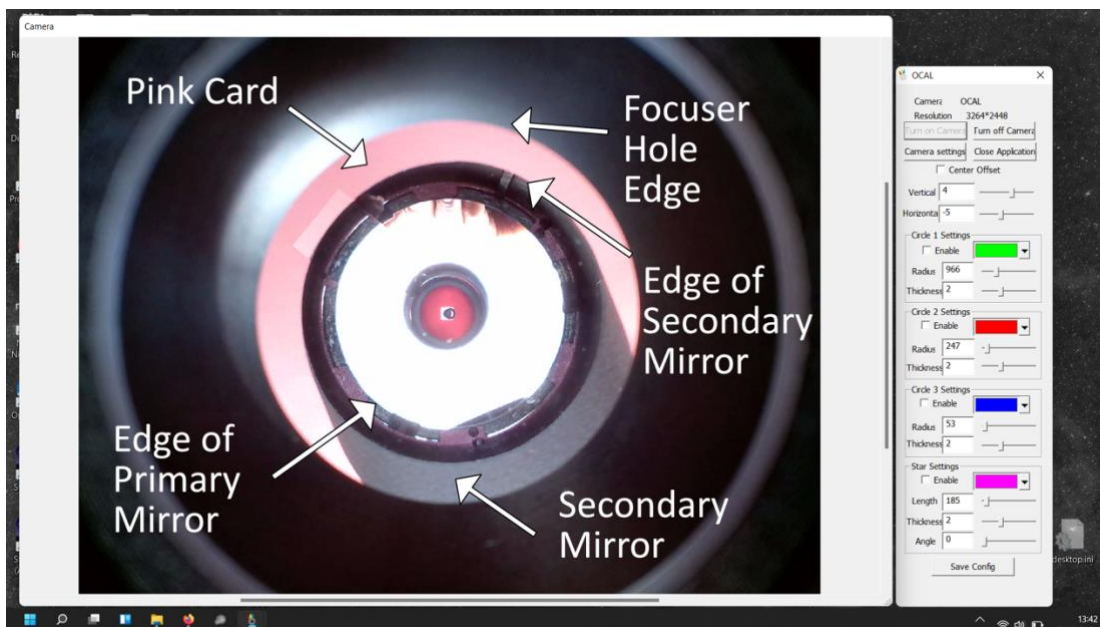


Figure 6 Part of Newtonian through Ocal Collimator

Here is a close up of the centre:

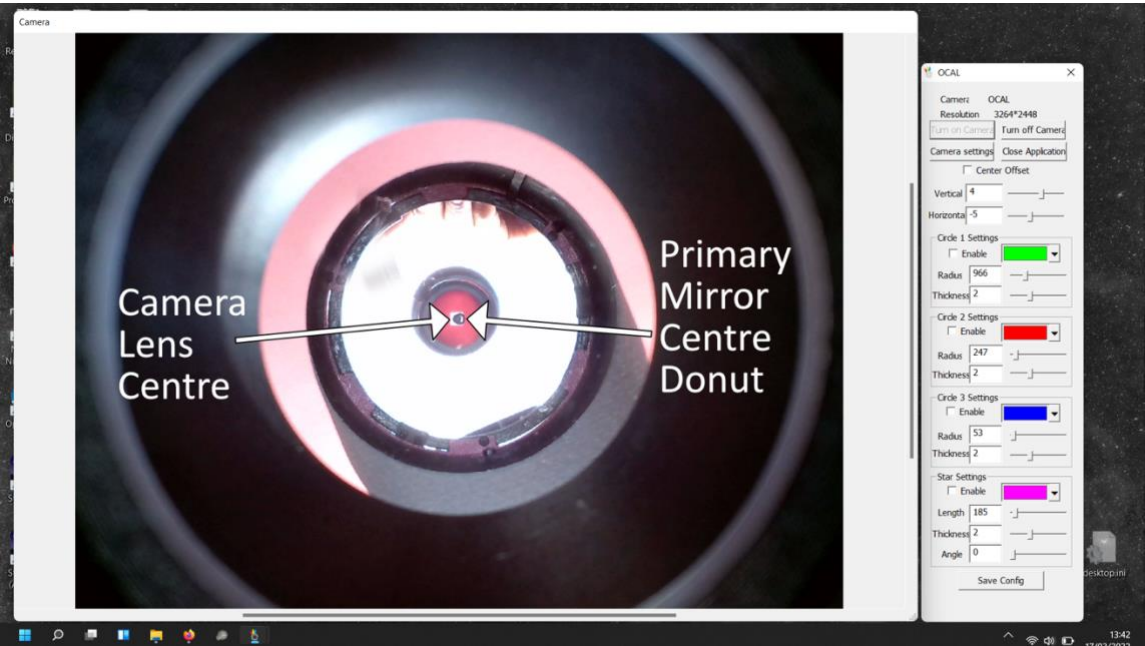


Figure 7 Zoom in for more detail of centre

Above, you can now see that the collimation is a little off, since the camera lens is not directly over the ‘donut’ sticker marking the centre of the primary mirror.

You will need to be able to identify the edge of the primary mirror, so have a good look at it directly. Are there clips at the edge or some other feature for example ?

Since collimation is the process of aligning these items precisely, it is worth spending some time ensuring you can identify them (and their edges). It can be quite confusing with all the reflections - take your time. We suggest making a sketch of where each part is for your telescope below:

Telescope:	Telescope:

Fitting the Ocal Collimator

The Ocal Collimator should be mounted onto your telescope as you would mount the eyepiece or the camera you intend to use. It has a female M42 x 0.75 female thread once the cap is removed for this purpose. If you use a Coma Corrector, then attach the Coma Corrector as usual, and the Ocal Collimator in the same place you would attach your camera (i.e. with same back focus). If using reducers, or flatteners these do not need to be fitted for the collimation process.

Similarly, try to position the focuser at the approximate position it would usually be in for your imaging. E.g. if it is usually 50% extended, use the same with the Ocal Collimator.

Since precision is key, it is worth considering whether mounting these items via screw fittings will give you more precision and consistency than by using tightening brass rings (which is similarly good advice for mounting your imaging camera).



Figure 8 Example of Ocal Collimator fitted to a Newtonian Telescope

Remember, the Ocal Collimator is acting as the focal point for collimation. If when you mount your camera, the camera is not centred, you will not achieve the best images.

Setting up the Ocal Collimator Software

PC Setup

Download the windows software and excel sheet from <http://www.ocalworld.com/en/>

If you do not have Microsoft Excel, Libre Office will open Excel files and is free to download and use: <https://www.libreoffice.org/>

Open the spreadsheet and search for the calibration code serial number (SN) which is written on back of your Ocal Collimator. This identifies the precise centre of your specific manufactured Camera. In the example below, the camera is marked 1d34, and searching for this finds the text "0 0 165.27 1218.68".

The image shows the back of an orange rectangular device, likely a collimator. It has four gold-colored screws at the corners. In the center is a black rectangular camera lens. Below the lens, the text 'OCAL FC CE RoHS' is printed in white. At the bottom, the serial number 'SN:1d34' is printed in large black characters.

237	1d27	0 0 1623.08 1224.35
238	1d28	0 0 1625.03 1242.58
239	1d29	0 0 1644.03 1240.87
240	1d30	0 0 1665.56 1219.51
241	1d31	0 0 1636.99 1247.87
242	1d32	0 0 1652.13 1229.49
243	1d33	0 0 1658.33 1241.07
244	1d34	0 0 1656.27 1218.68
245	test1	0 0 1600.05 1180.57

SN is 1d34

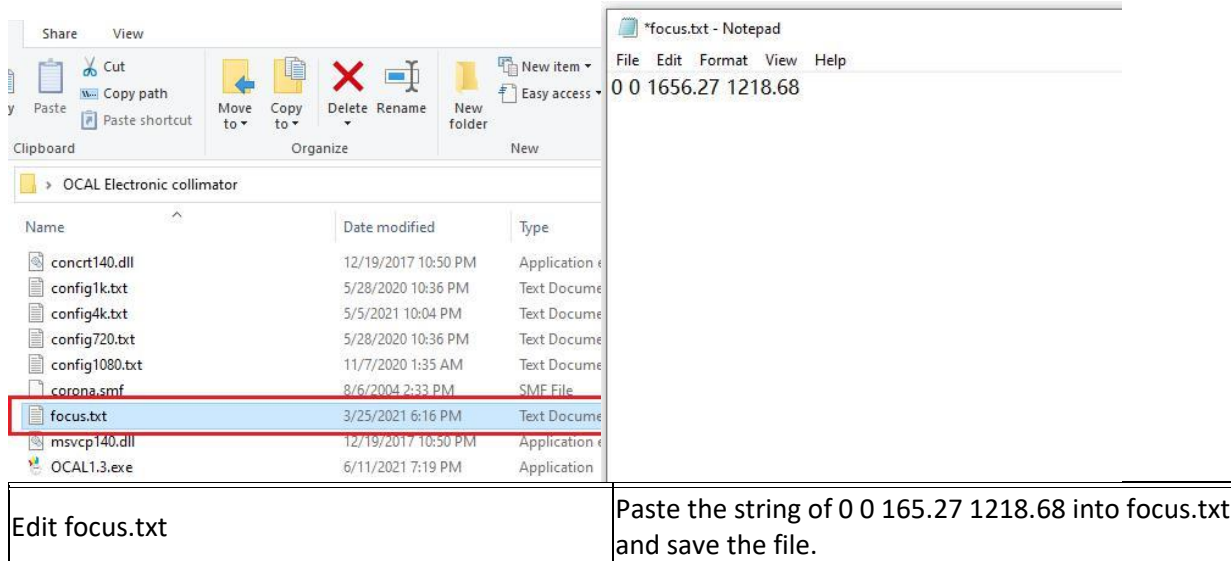
Find 1d34, then copy the string of 0 0 165.27 1218.68

Copy the text for your camera serial number (select and Cntl-C or Edit/Copy).

Unzip the windows software you downloaded (OCAL Electronic Collimator for PCx.x.zip) by right clicking the file and extracting it. You will find a directory with 3 directories underneath.

If you are using windows 7, go into the 'Win7 system need to install this plug-in' directory and open "mjpegcodecv3.2.4.exe" to install the video codec required for the camera to work. Otherwise, skip this stage.

Now open the "OCAL Electronic Collimator for PC" directory and look for the file named focus.txt. Open this in notepad (double click on it). It will have a line of text similar to the one you have copied for your camera. Delete this and paste your text in instead.

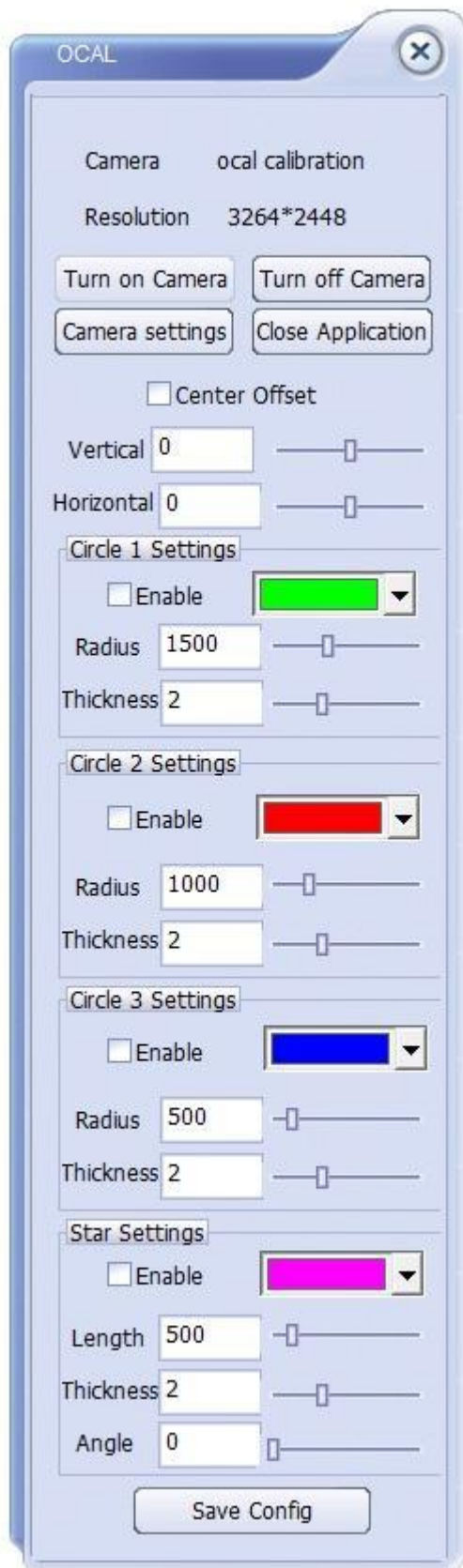


Save the file and exit notepad.

Test the Ocal Collimator by plugging the lead into a USB port and attaching it to the camera.

You will notice there are several different versions of the program in the “OCAL Electronic Collimator for PC” for compatibility. First try to open “OCAL1.32EN.exe”. If this fails with an error, open the “If you can't open the software without the DLL file, please install both” folder and run vcredist_x86.exe. Then try opening “OCAL1.32EN.exe” again. If this does not work try opening “OCAL1.32EN x64” (If ocal1.32en no work, try this one)”. If this does not work, try opening “OCAL1.3EN_SHORT.exe”. If you still cannot open the program, please contact support <http://www.ocalworld.com/en/Contact%20us-en.html>

After the program has started you should see a live video feed from the camera. Open the camera settings and experiment with the controls. Try changing the focus and exposure, and familiarise yourself with the other controls.



Camera settings opens a window where you can adjust focus, exposure, brightness, etc. It's useful to keep this open so you can adjust things as required.

You may find your focuser is not precisely centred. The 'Center Offset' can be enabled to allow you to compensate for this.

The circles sections allow you to overlap coloured circles on top of the various parts of the telescope you have identified. You can adjust the radius directly (enter numbers), via the slider or by using the mouse wheel which the mouse is hovering over the slider.

The star lets you enable the centre cross for the last stage of collimation (centring the camera lens)

Save Config saves the settings above so that they will persist the next time you open the program.

Figure 9 The Ocal Collimator Software Controls

The live view can be resized to be a larger window by dragging the edge in the usual way.

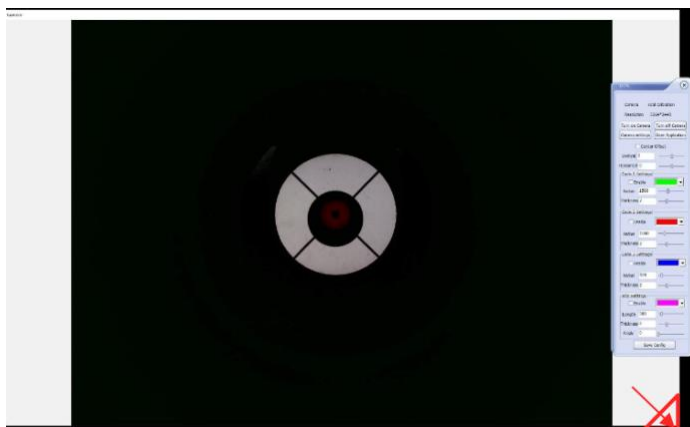


Figure 10 Live camera view

To zoom in, hover your mouse over the live view, and use the scroll wheel to zoom in and out. You will achieve better collimation accuracy if your circles are centred more accurately, so try to use as much of the screen as possible.

The Camera settings window has two tabs enabling you to control various camera features. You will probably find brightness, exposure and focus to be the most useful.

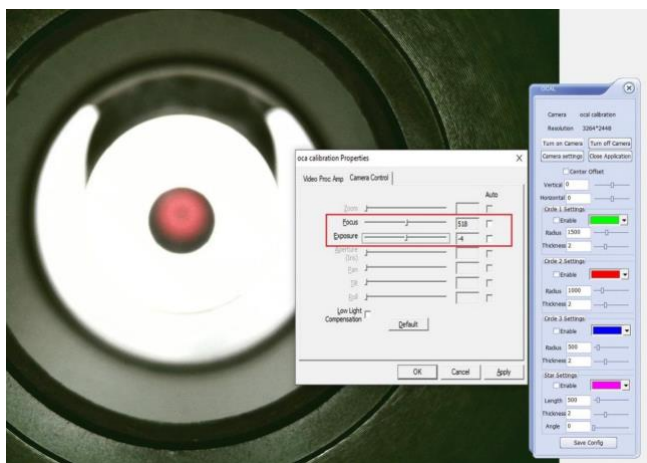
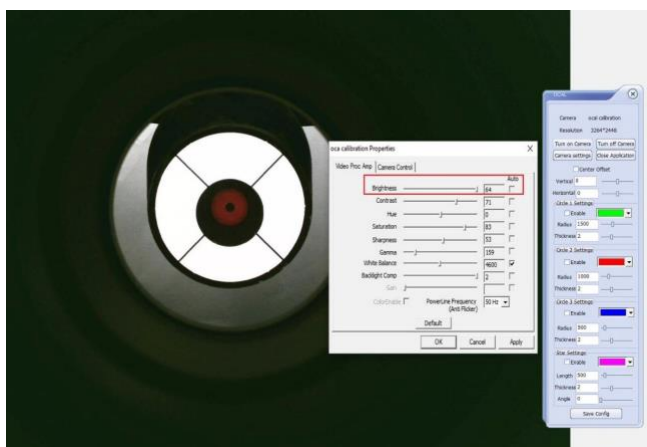


Figure 11 Camera Settings

Your Ocal Collimator is now ready to use !

Mobile Setup

If you purchased the Pro version of the Ocal Collimator, you can optionally use the android application. Download this from <http://www.ocalworld.com/en/>

The application must be 'side-loaded' as it is not being installed via the google app store. This may require you to allow the installation of 3rd party software via android settings. Usually this can be found under Settings/More Settings/Install apps from external sources, and then ensuring that your android browser (e.g. Chrome) is enabled (set to Yes).

The Ocal Collimator should be connected to your phone or tablet via the OTG adapter which came with the Ocal Collimator pro. The functionality of the software is the same as the windows software.

Collimating your Telescope

STEP 1: Identify the Focuser hole edge, and centre it

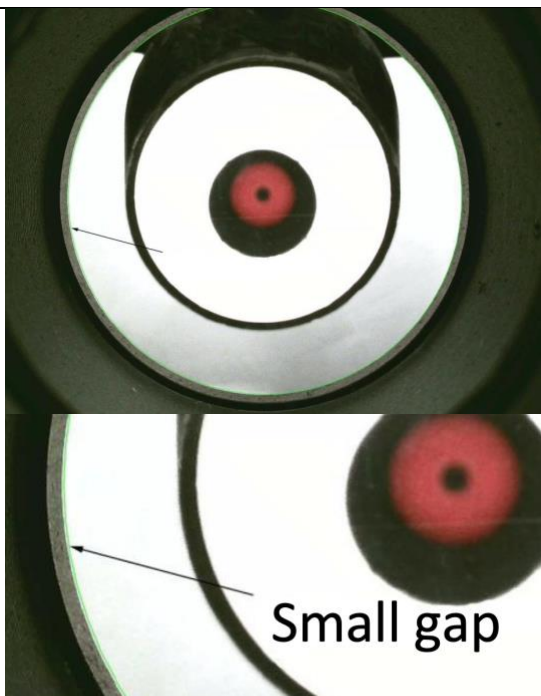
Use the mouse wheel while hovering over the camera image to zoom into the image if required. Aim to have the focus hole fully visible.

Use the camera settings focus and exposure controls to get a sharp picture of the focus hole edge. Now, use the controls to outline the edge of the focus hole with the **green circle**. If it is not centred, firstly check whether your imaging chain (focuser, focus tube, any extensions, coma corrector, etc) are all correctly seated.

If after checking and resizing, the circle is still not centred over the hole, enable the offset control and adjust it so that the circle precisely outlines the focus hole – this can happen due to tolerances in the manufacture of your telescope and is normal. All of your subsequent actions will use this as the reference, so it is vital that this is as accurate as possible.



In this example, no offset was required – the circle can be sized precisely over the focuser hole edge.



Here you can see the circle cannot be sized precisely over the focuser hole edge. So we would enable the offset and shift it slightly so that it is precisely aligned. Note how we try to be as accurate as possible here.

What can be done next depends on your telescope type...

- If the secondary and primary can be adjusted (e.g. Newtonian), do all steps.
- If only the secondary can be adjusted (e.g. SCT) skip step 4.
- If only the primary can be adjusted (e.g. Mak) skip step 2 and 3.

STEP 2: Centre the Secondary Mirror and ensure it is circular.

You are now ready to move on to adjusting the secondary mirror. Use the focus and exposure controls to focus on the secondary mirror edge. If you have difficulty identifying it, place a piece of coloured paper at the back of it if possible. Turn on the **red circle** and adjust the size to match the secondary mirror circumference.

A number of problems may be apparent at this stage:

1. The secondary mirror may not be centred
2. The secondary mirror may not appear circular



Figure 12 Not Collimated Example: secondary mirror not circular, can't see full primary mirror, etc

Use the adjustment screws on your secondary mirror to solve these issues – the centre screw will move the secondary up/down, the mirror can be rotated until it is circular, and the spider arms may need adjusting to centre the mirror also. For this stage, you may find the coloured paper tip mentioned above helps you identify the edges of the secondary mirror.



Figure 13 Adjusting the Secondary Mirror. On this Newtonian the length of the spider arms are fixed.

To centre the spider arms, they just need to be accurately measured to all be the same length. You can do this with a ruler, or alternatively, draw a circle on a piece of paper with the same diameter as your telescope aperture.

Fold this paper in half along the centre of the circle in horizontal and vertical directions, and mark where the fold crosses – this is the exact centre. Cut a small hole here, large enough to see the centre of the screw in the spider centre. Now you can use this as a template to adjust the lengths of the spider arms to accurately centre the mirror holder.

STEP 3: Adjusting the Secondary mirror to centre the Primary mirror.

The next step is to ensure that the whole of the primary mirror is visible in the secondary mirror. We know this must be inside the bounds of our **red circle** (since this outlines the edges of the secondary mirror). Use the exposure and focus controls to focus on the edge of the primary mirror.

Look down the end of your telescope to familiarise yourself with what the primary mirrors looks like. It may have small clips around the edge, or some feature around the base that you can look for.

Use the adjustment screws to adjust the angle of the secondary mirror until the primary mirror is fully visible. Turn on the **blue circle** and use this to precisely outline the edge of the primary mirror. Now further adjust it, so that it is concentric with the edge of the secondary mirror.

If after doing this, the secondary is now not centred or not circular, you should return to Step 2 and go through this alignment once more until you get both precisely correct.

STEP 4: Centring the camera lens with the centre of the primary

The final step is to ensure that the centre of the primary mirror is precisely over the camera lens. Since the previous stages have centred the mirrors, all we need to do to achieve this step is to centre the camera lens in the image. To do this, adjustments must be made to the primary mirror tilt.

Use the exposure and focus controls to focus on the camera lens itself. You may wish to zoom in further for this step (we don't need to care about the circles here) . Turn the centre **purple cross** on. Use the primary adjustment screws to adjust the camera lens position until it is precisely under the cross.

You will find that the centre of the primary mirror (usually marked by a 'donut' sticker or other mark) is also now perfectly aligned with the camera lens. If it is not, it is probably that the 'donut' sticker is not precisely in the centre of your primary mirror (see Appendix B).

Your telescope is now collimated!

NOTE: You may notice that the camera lens appears offset within the black part (focuser tube reflection). This is typically the case with faster Newtonian telescopes (approximately less than F5) and is perfectly normal and probably mentioned in your telescope manual.

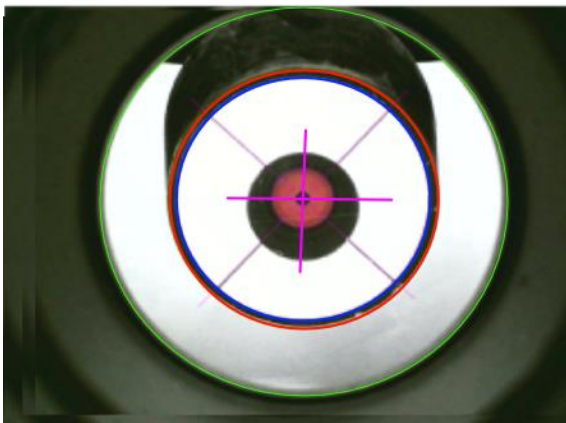
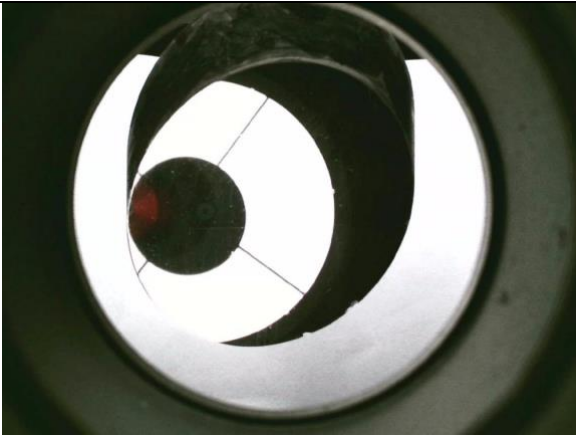


Figure 14 Collimated Fast (F5) Newtonian – showing slight offset

Typically non Newtonian telescopes will require only infrequent collimation from this point forward. Newtonian telescopes tend to require more frequent re-collimation but this is usually constrained to adjustments of the primary mirror (i.e. just do step 4)

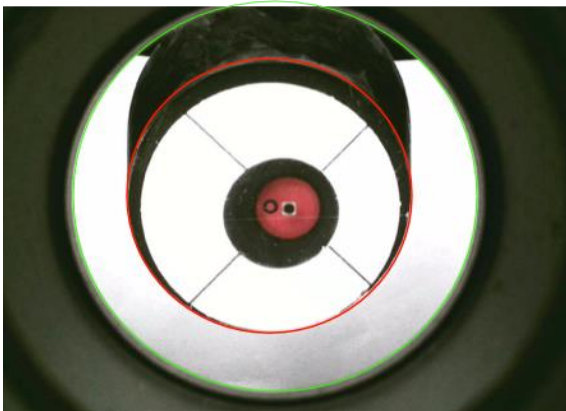
Remember, at any point to check it is still collimated, you need only attach the Ocal Collimator, and turn on the coloured circles. If you saved the settings last time, they should appear exactly as they did before, aligned with the respective telescope parts. If the camera lens is still centred all is well. If not, you can make the adjustment required quickly and accurately.

Appendix A: Walkthrough Collimation of an Actual Newtonian Telescope

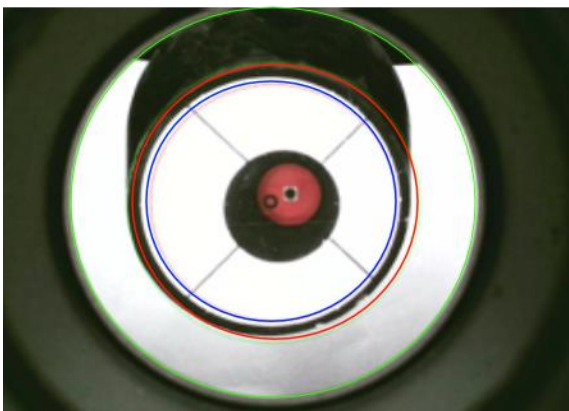


Oh dear! Our telescope has some major problems:

- Our secondary is not centred or circular.
- We can't see the whole of the primary mirror.
- The camera lens is nowhere near the centre.



First, we turn the **green circle** on and move it to outline the edge of the focuser tube. we loosen the centre screw so we can move the secondary mirror up and down, and rotate it. We get the mirror to be circular and in the centre, using the **red circle** to outline to edge of the secondary mirror. We ignore what the primary mirror is doing at this point

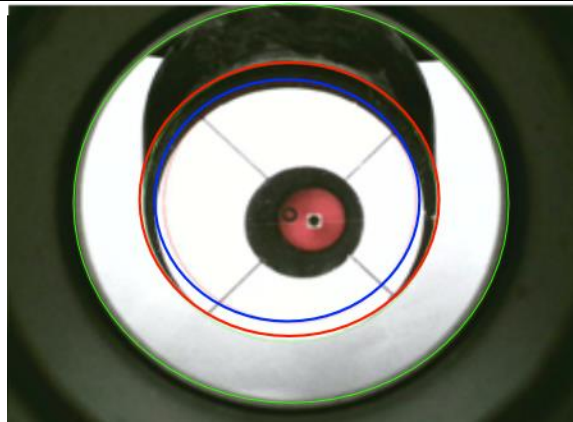


Now we use the adjustment screws to alter the angle of the secondary (small turn anticlockwise on one, followed by a small turn clockwise by another). We keep making small adjustments towards getting the primary centred in the secondary, while trying to keep the secondary still centred.

We can use the **blue circle** for the edge of the primary mirror. In this picture we are nearly there, but still making adjustments.

If we have a gap at the top of the circle, the secondary needs to be lower (towards the primary). This can be achieved by an anticlockwise turn of the centre screw. If the gap is at the bottom, a clockwise turn.

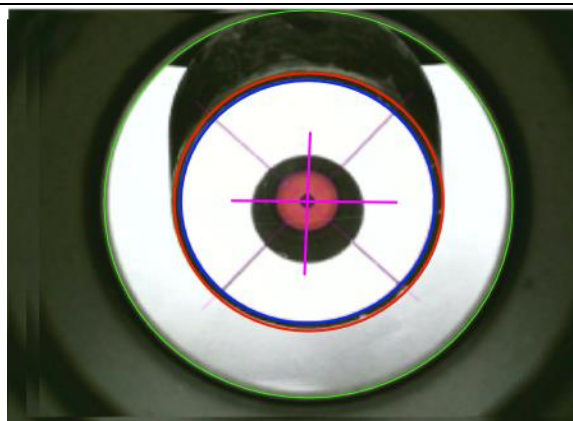
Remember to turn the centre screw clockwise, you will need to first loosen the other 3 screws.



If your collimation was bad to start with, it might take a few tries to get both things to line up. Here, we've done a good job of getting the secondary mirror circular and concentric with the focuser tube edge, but the primary mirror is not centred in the secondary. We will keep making small adjustments until you get steps 2 and 3 completed.



Now we have step 2 and 3 completed! Our secondary mirror is circular and in the centre (red circle). Our primary is in the centre (blue circle). Our camera though, is not in the centre. We can see this by enabling the **purple crosshair**. Next we need to adjust the primary mirror – step 4.



To adjust the primary mirror we make small adjustments to the screws one at a time after loosening all the locking screws. When we get the Ocal Collimator lens perfectly under the **purple crosshair**, we are done – **our telescope is collimated !**

At any time in the future we can simply plug our Ocal Collimator back in, and check our collimation:

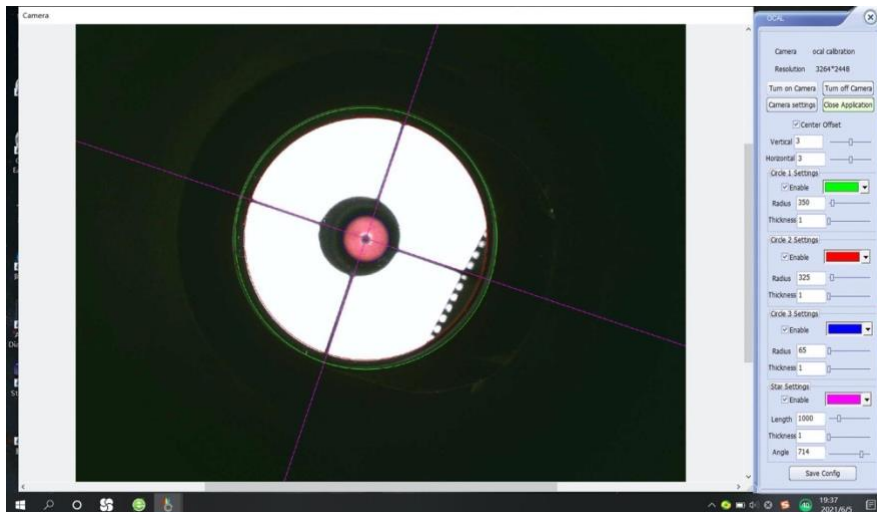


Figure 15 Well Collimated Telescope

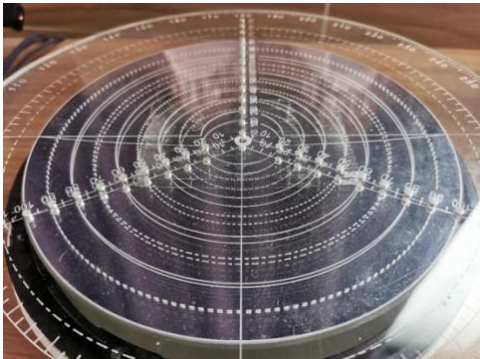
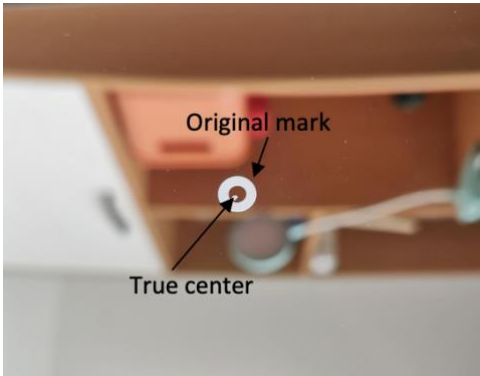
Lets get 'First Light' with our newly collimated telescope:



Figure 16 'First Light' of Collimated Telescope - M51 Whirlpool Galaxy

Looking good ! 😁

Appendix B: Troubleshooting

Issue	Solution
Edge of focus tube/mirror is blurry	Use the camera settings/focus to move the focus point in and out till it is sharp. If it is too close to focus, try moving the focus tube out so that the Ocal Collimator is further from the telescope optics
Software does not load	Try the other version of the software. Ensure that the usb cable is plugged into the camera and computer. If using a usb hub, try removing this and connecting directly to PC
picture is too dark	Use the camera settings exposure to brighten the picture, but this will reduce the frames per second. Alternatively, try to ensure more light enters the telescope – e.g. do collimation outside (DO NOT POINT AT SUN), or shine a bright light into telescope tube. Moving a torch beam around while looking at the image can help point the light at the item you are concentrating on (e.g. focus tube)
After collimating, the 'donut' sticker is not in the centre.	To check this you would need to use a concentric jig on the primary mirror, and then move the sticker to the actual centre.  

support <http://www.ocalworld.com/en/Contact%20us-en.html>