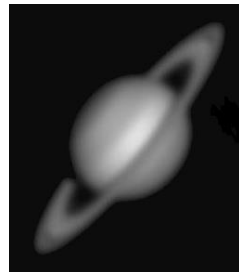
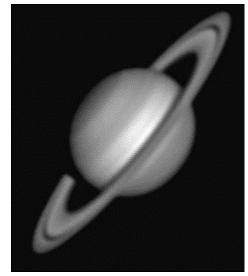
Collimating the Mallincam VRC12

Collimation is the alignment of the optical components (lenses, mirrors, prisms, eyepieces) in your telescope. If the optics are not properly aligned, they cannot bring starlight to an accurate focus and the final viewed image suffers in sharpness. Your Mallincam VRC12 Ritchey-Chrétien's Primary and Secondary mirrors were precisely collimated at the factory before being shipped to you. Nevertheless, rough treatment in transit from us could potentially cause the Secondary Mirror to be knocked out of collimation. Also, transportation by you of the VRC12 to a dark observation site along rough and bouncy roads might require you to re-adjust the collimation of the Secondary Mirror. The optical axis of the Primary Mirror of the VRC12 is less likely to be knocked out of collimation, but it is capable of being collimated if needed.



Poorly Collimated Image



Collimated Image

Checking the Collimation on Your VRC12:

You can perform a daytime rough check the collimation of both the Primary and Secondary Mirrors indoors before performing a more rigorous nighttime star test for a final tweaking in the field. There are a few different ways of accomplishing this, but we will discuss the Cheshire Eyepiece technique for collimating the Mallincam VRC12.

To perform the rough collimation check, you will need a **Cheshire Eyepiece** (approx. $60 at your local dealer). The Cheshire Eyepiece is not an "eyepiece" in the usual sense of the word, but rather it is a tube with a small hole at the top that you look through, and a shiny surface tilted at 45° and aimed at a large hole in the side of the tube. It also has a set of cross-hairs at the bottom of the tube for aligning the secondary mirror. This "all-in-one" collimation tool is excellent. In fact if you have one of these, you need nothing else.

The best feature of this tool is that it does it all and is very easy to use and this one tool does it all relatively inexpensive.

Set up your VRC12 in a well-lit room with the telescope pointed horizontally at a white or light coloured wall or flat surface. Remove the lens cover from the front of the telescope. Remove all of the extension rings that are currently attached to the back of the scope and then attach the focuser directly to the optical tube.

Now fully insert the Cheshire Eyepiece into the focuser and using the 1.25" eyepiece adapter that came with your VRC12 and lock the focuser drawtube firmly in place. Make sure there is a light source (a bright light is usually sufficient) directed at the 45° cut-out in the side of the Cheshire.

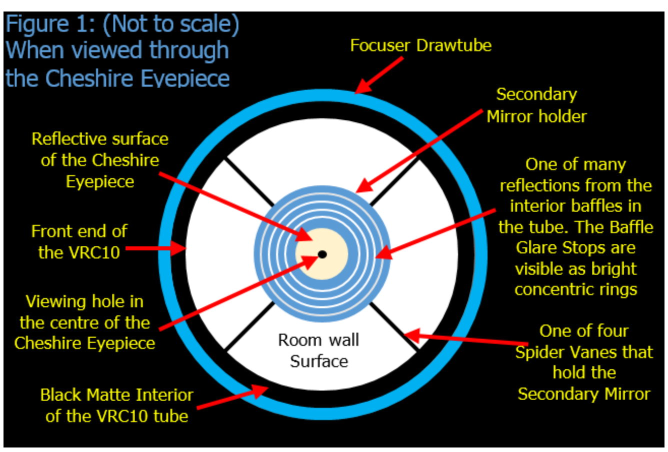


Figure 1: (Not to scale) When viewed through the Cheshire Eyepiece

Look through the back of the Cheshire eyepiece and you will see a small black dot within a centrally-located bright circle (the reflective surface of the Cheshire Eyepiece) as seen in **Figure 1**, to the left. The central black dot is the viewing hole in the center of the Cheshire Eyepiece. The bright circle around the central dot is the 45° reflective surface of the Cheshire eyepiece and the larger black circles (blue in Figure) surrounding that is a reflection of the interior of the scope's baffle tubes in the secondary mirror. Your room wall surface and the interior of the optical tube form the background. The 4 spokes are the spider vane holding the secondary mirror.

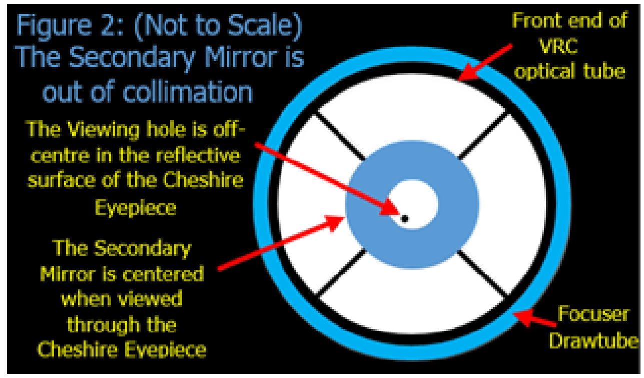
If a light source aimed at the cut-out on the side the Cheshire Eyepiece is bright enough you will see concentric light-coloured rings in the black circles of the Secondary mirror. These light circles are the reflections from the Glare Stops machined into the baffle tube's interior. You are seeing the front of the Glare Stops that face the sky and their visibility here simply shows that they are doing their job of reflecting stray light back towards the sky.

The ring of light around the entire Cheshire field, as shown in **Figure 1**, is the end of the focuser drawtube (the optical axis of the scope). You can disregard this for the time being. It will be covered later, when checking the Primary Mirror collimation.

If the location of the central black dot (the viewing aperture of the Cheshire Eyepiece) appears centered in the circular reflective surface of the Cheshire eyepiece as shown in **Figure 1**, then no further significant adjustment of the Secondary Mirror will be necessary.

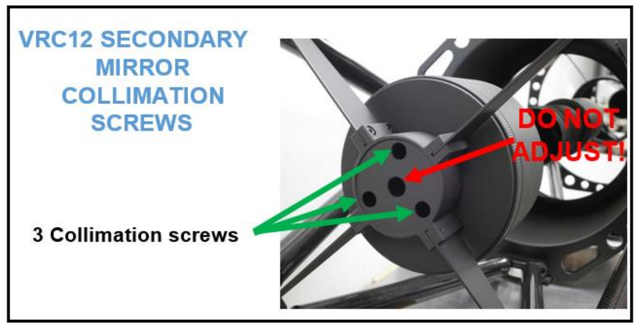
Performing a Secondary Mirror Collimation:

If the location of the black dot of the viewing aperture appears to be off-centre as in **Figure 2** below then we will need to adjust the three Secondary Mirror collimation screws until the viewing aperture is centered as closely as possible in the Cheshire's circular reflective surface.



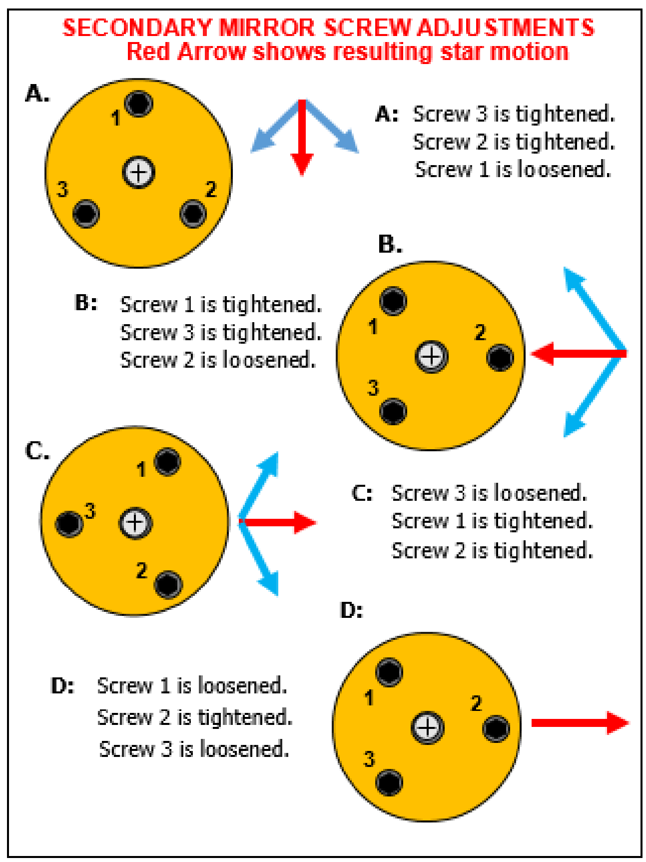
To collimate the Secondary Mirror, you will require a hex key. It is recommended that you use a hex key that has a handle rather than one that has just a bend. I would attach a small wrist strap through the handle and wrap it around your wrist in such a manner as to prevent the hex key from falling into the telescope tube if you happen to drop it.

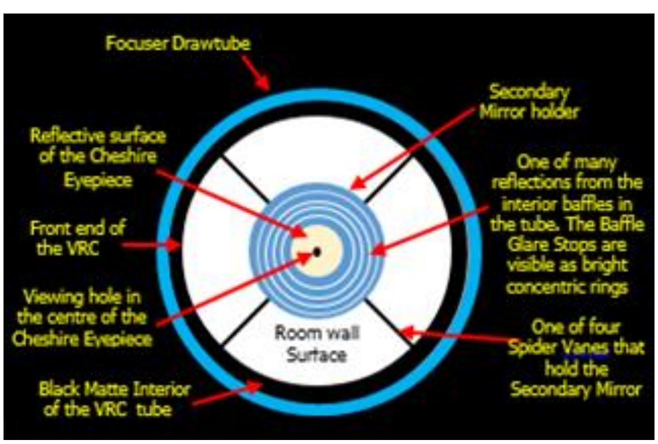
You will only be adjusting the three hex head screws around the perimeter of the center Head Screw, so it is very important that you **do not adjust** the central recessed Phillips-head screw in the Secondary holder. This screw provides the precise mirror spacing required for the VRC12 to operate properly and any adjustments will degrade image performance.



As you adjust each of these collimation screws you will need to make equal counter-adjustments to the other two screws. In other words, as you tighten one screw you will need to loosen, by an equal amount, the other two screws. The opposite is also true. If a screw is loosened, the two opposing screws should be tightened. When the process is complete you should have equal tension on all three screws. Only minor adjustments should be required to fine-tune the collimation of the secondary mirror.

Adjust the screws no more than a sixteenth of a turn or less at a time as this will help prevent accidently putting the optics grossly out of collimation. The image of the Secondary's shadow will move in the direction of the collimating screw that is being tightened. If the Secondary's shadow needs to be shifted in a direction between two screws, those two must be tightened to make the image shift in that direction, while the single screw on the opposite side should be loosened. The force vector diagram on the right will show you how different adjustments affect the tilt of the secondary mirror. It will take a couple of trials before you become comfortable with moving the viewing hole to the centre of the reflecting surface.



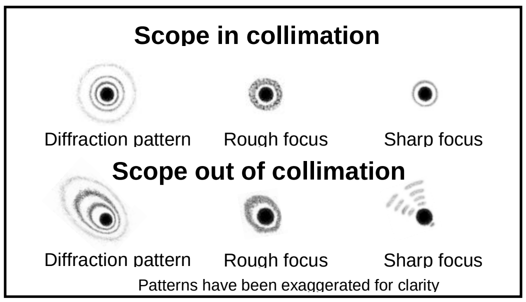


Star Collimation:

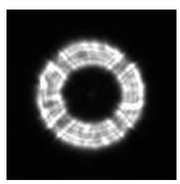
To obtain the optimum imaging performance it is best to implement a star test to confirm the accuracy of your collimation. The star test relies on using your Mallincam Camera and an out of focus star for collimation. Since seeing conditions will affect both the process and the end result, you may find it somewhat more difficult to collimate this way than using the Cheshire Eyepiece and collimating indoors. You may find it easier to connect the camera's output to a small monitor that you can place near the front of the telescope so that you can immediately see how your adjustments affects the star's image.

Install the extension rings between the scope's rear cell and the focuser, the number of extension rings depends upon the imaging camera and focal reducers attached to the camera. Using the 1.25" compression ring adapter, insert your camera directly into the focuser drawtube and visually center and focus on a bright star close to the Zenith being certain that the focuser tension and drawtube lock knobs are tightened firmly after focusing on a star. You do not use a star Diagonal in this setup (you will usually never use a Diagonal when imaging with the VRC12).

The diagram below illustrates the appearance of collimated (top) and out of collimation (bottom) images of the star being examined. The top left image is the diffraction pattern in a collimated scope. The centre and right hand images show what the star looks like when roughly focused and sharply focused. The bottom row of images show the same sequence through an out-of-collimation scope.

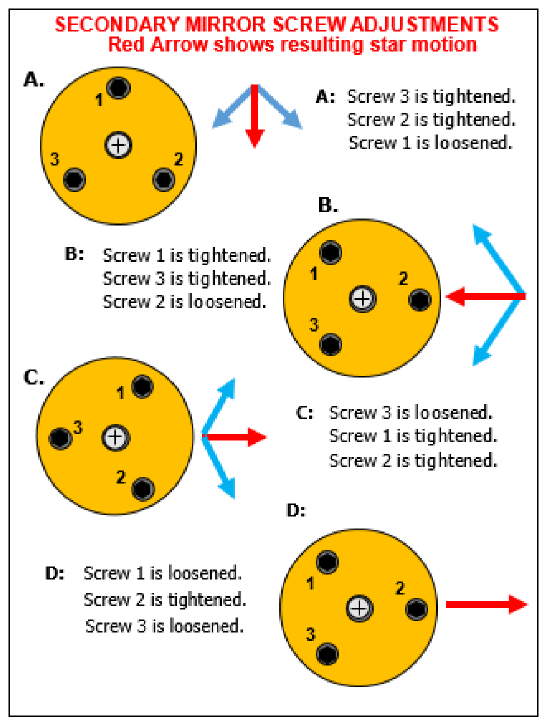


If after viewing the image you determine that collimation is needed, then centre a bright star in the monitor's image and magnify the image as much as you can without losing too much detail. Now defocus the image of the star until it is large enough to show the diffraction pattern, which will look like a bull's-eye with the circular shadow of the Secondary Mirror holder in the center with the four Secondary support Spider Vanes, as shown in the image on the right. If the shadow of the secondary is not precisely in the center of the diffraction rings, then you will need to adjust the collimating screws to tilt the Secondary Mirror until the shadow of the Secondary is centered in the diffraction pattern and the diffraction rings are concentric. Again, it is a lot easier to perform this procedure with a monitor or laptop in a location where it is convenient for you to observe the image as you make your adjustments.



Always make any adjustments to the collimating screws in tiny increments, only about an eighth to a sixteenth of a turn at a time. The image of the Secondary shadow will move in the direction of the collimating screw that is being tightened. If the Secondary shadow needs to be shifted in a direction between two screws, those two must be tightened to make the image shift in that direction, while the single screw on the opposite side should be loosened. As each adjustment is made, the Secondary shadow will move off center. Re-center the star's image in the field before making the next adjustment. You need to keep the star precisely centered in your field of view while collimating, which is critical to avoid false negatives.

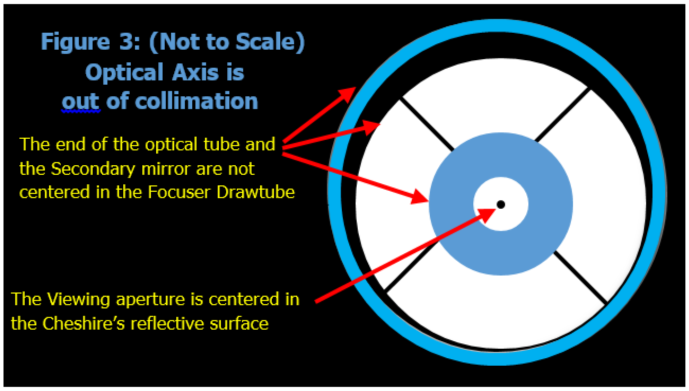
Refer to the diagram on the right, which show the direction the star image will move when different combinations of collimating screws are loosened and tightened. The screws that must be adjusted depend on the orientation of the three collimating screws in relation to the desired star movement direction.



The correct alignment of the Secondary Mirror is critical in determining if the optical axis (Primary Mirror) of the VRC12 requires alignment. Be certain you have properly aligned the secondary mirror before proceeding to the next step of adjusting the optical axis collimation, using the primary mirror collimation screws shown below.

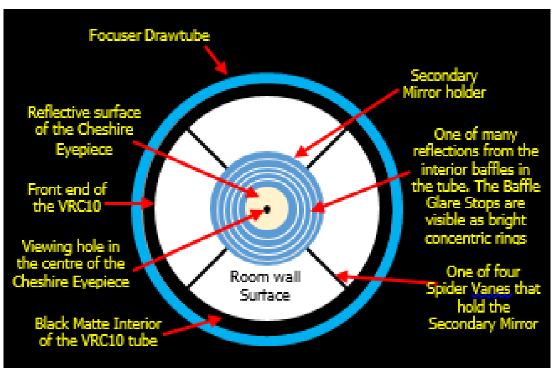
Optical Axis (Primary Mirror) Collimation:

As previously mentioned on Page 1, the optical axis of the scope (the Primary Mirror/baffle tube assembly) will **rarely need collimation**. But, If the optical axis does get knocked out of collimation you will notice that the image through the Cheshire eyepiece will appear to be shifted to one side within the light ring formed by the end of the focuser drawtube, as shown in **Figure 3** below. If properly collimated, all of the light and dark circles will be concentric, as shown in **Figure 1** on Page 1.



Adjusting the optical axis will require user-supplied hex keys. There are three pairs of "push-pull" hex-head screws on the rear cell of the VRC12 optical tube, as shown in the illustration below.

Each "push-pull" pair consists of a smaller black hex screw and a larger silver hex screw. These must be adjusted in tandem, that is, as you loosen one, you must tighten the other in the pair. The adjustment of a pair of screws will tilt of the optical axis in relation to the secondary mirror. This procedure will require only micro-adjustments to align the Primary Mirror. When properly aligned you will see a concentric outer white circle around the perimeter of your view through the Cheshire eyepiece and all circular light and dark elements will be concentric as seen below.



Once the optical axis has been collimated, recheck the secondary mirror collimation and tweak as necessary, then confirm the optical axis collimation one last time.