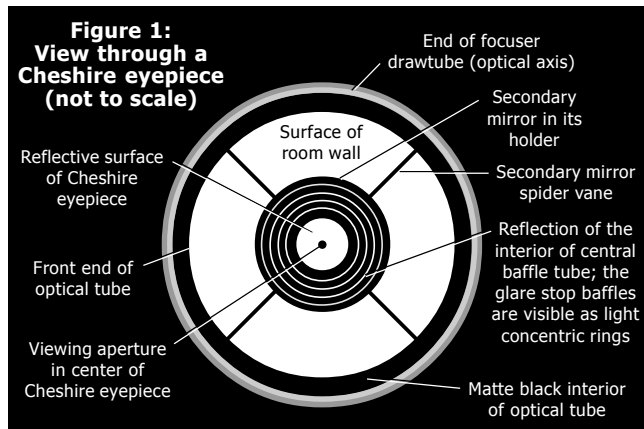


# COLLIMATING AN ASTRO-TECH AT10RC

Your Astro-Tech AT10RC Ritchey-Chrétien's primary and secondary mirrors were collimated at the factory before being shipped. Nevertheless, rough treatment in transit could potentially cause the secondary mirror to be knocked out of collimation, and rough and bumpy roads during transit to a dark sky observing site might require periodic re-adjustments. The optical axis of the primary mirror/baffle tube assembly is less likely to be knocked out of collimation, but is capable of being collimated if needed.

**Preliminary Collimation Check:** You can roughly check the collimation of both mirrors indoors before performing a more rigorous star test for a final tweaking in the field. You will need a Cheshire eyepiece to do this collimation check.

Set up your scope in a well-lit room with the telescope pointed horizontally. Remove the lens cover and point the telescope at a white (or light colored) wall. Remove all of the extension rings and attach the focuser directly to the optical tube. Insert the Cheshire eyepiece fully into the focuser using the 1.25" eyepiece adapter. Lock the focuser drawtube firmly in place. Make sure there is a light source directed at the 45° cutout in the side of the Cheshire.



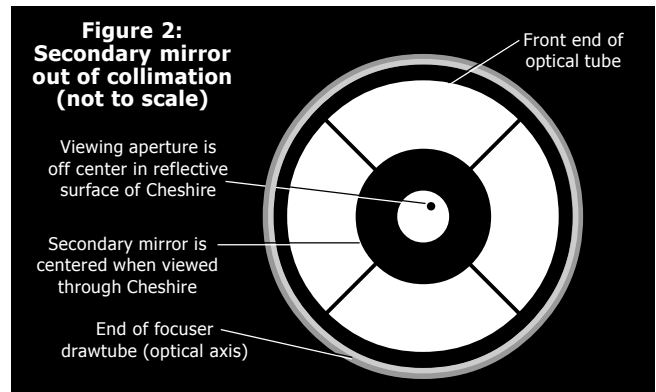
Look through the Cheshire eyepiece. You will see a small black dot within a centrally-located bright circle as seen in Figure 1, above. The central black dot is the viewing aperture in the center of the Cheshire eyepiece. The bright circle around the central dot is the 45° reflective surface of the Cheshire eyepiece and the larger black circle surrounding that is a reflection of the interior of the scope's baffle tube in the secondary mirror. Your room wall and the interior of the optical tube form the background.

Concentric light-colored rings will be visible in the black circle of the secondary mirror if your room and the light source aimed at the cutout in the side of the Cheshire are bright enough. These are the reflections from the glare stops machined into the baffle tube 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 at the sky.

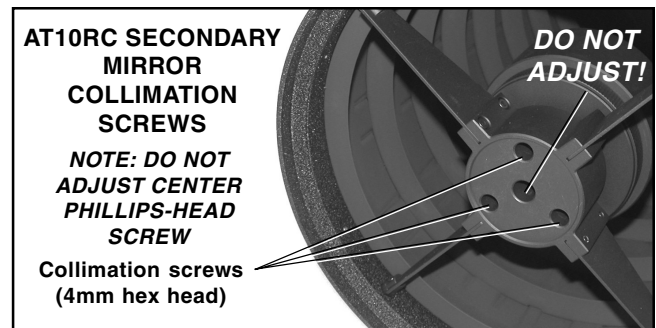
The ring of light around the entire Cheshire field, as shown in Figure 1, is the end of the focuser drawtube (the optical axis of the scope). You can disregard this for the time being. It will be covered later, when checking the primary mirror collimation.

If the central black dot (the viewing aperture of the eyepiece) appears centered in the circular reflective surface of the Cheshire eyepiece as shown above, no further significant adjustment of the secondary mirror will be necessary.

**Secondary Mirror Collimation:** However, if the black dot of the viewing aperture appears off-center as in Figure 2, at the top of the next column, adjust the three secondary mirror collimation screws until the viewing aperture is centered as closely as possible in the Cheshire's circular reflective surface.



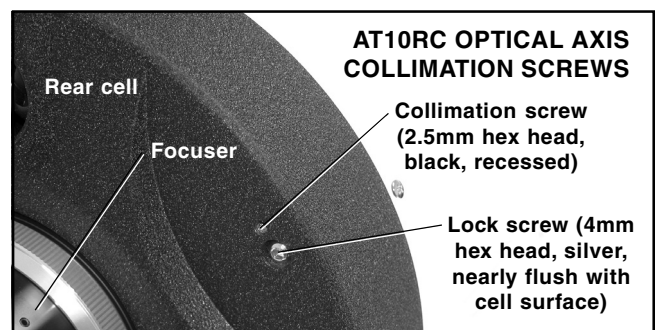
A user-supplied 4mm hex key is required to collimate the secondary mirror. Adjust only the three hex head screws around the perimeter of the holder, as shown in the illustration below. **Do not adjust the central recessed Phillips-head screw in the secondary holder. This will change the precise mirror spacing required and degrade image performance.**

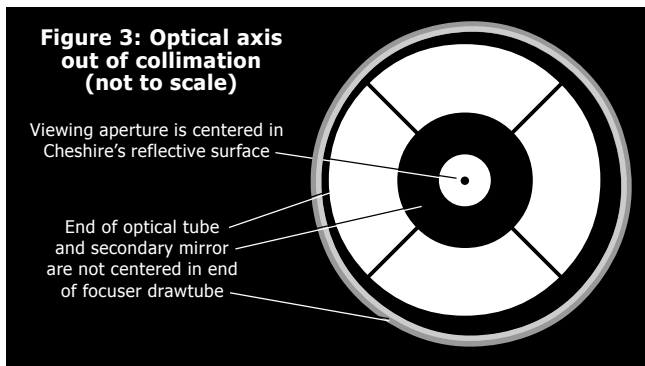


As you adjust each of these screws you will need to make equal counter-adjustments to the other two. In other words, as you tighten one screw you will need to loosen, by an equal amount, the other two. The opposite is also true. If a screw is loosened, the two opposing screws should be tightened. When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

Only minor adjustments should be required to fine-tune the collimation. Adjust the screws no more than an eighth of a turn or less at a time. This will help prevent accidentally putting the optics grossly out of collimation. The force vector diagram on the next page will show you how different adjustments affect the tilt of the secondary mirror.

The correct alignment of the secondary mirror is critical in determining if the optical axis (primary mirror) 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 mentioned on Page 1, the optical axis of the scope (the primary mirror/baffle tube assembly) will rarely need collimation. If the optical axis does get knocked out of collimation, however, 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 above. 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 4mm and 2.5mm hex keys. There are three pairs of "push-pull" hex-head screws on the rear cell of the optical tube, as shown in the illustration on the previous page. Each pair consists of a smaller black screw and a larger chrome screw. These must be adjusted in tandem. As you loosen one, tighten the other in each pair to adjust the tilt of the optical axis in relation to the secondary mirror. This procedure will require only micro-adjustments, if any. 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.

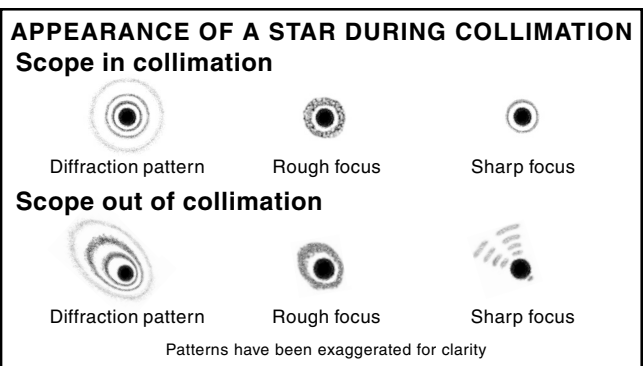
Once the optical axis has been collimated, recheck the secondary mirror collimation and tweak as necessary, then confirm the optical axis collimation one last time.

**Star Testing:** For optimum imaging performance, perform a star test to confirm the accuracy of your collimation. The star test relies on your eye and an out of focus star for collimation, rather than a Cheshire eyepiece. Seeing conditions will affect the end result, so it is somewhat more difficult than collimating indoors.

Install all three extension rings between the scope's rear cell and the focuser. Using the 1.25" compression ring adapter, insert an eyepiece directly into the focuser drawtube and visually center and focus on a bright star at a reasonably high magnification. Do not use a star diagonal in the system and be certain that the focuser tension and drawtube lock knobs are tightened firmly after focusing. Choose a star close to the zenith rather than at the horizon to minimize atmospheric distortions.

The diagram at the top of the next column 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 center 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.

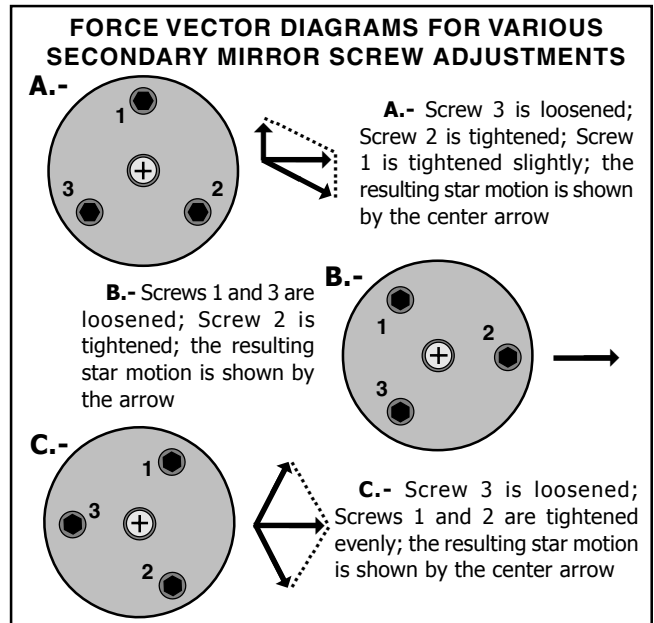
If collimation is needed, begin by placing a bright star in the center of a low to medium power eyepiece field (again without using a star diagonal). Defocus the image until it is about the apparent size of a dime or nickel held at arm's length. This will show the diffraction pattern, which should look like a bull's-eye with the circular shadow of the secondary mirror holder in the center, as shown in the illustration in the next column. If the shadow of the secondary is not precisely in the center of the diffraction



rings, 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.

Always make adjustments to the collimating screws in tiny increments, only a fraction 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. Recenter 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 diagrams below, which show the direction the star image will move when different combinations of collimating screws are loosened and tightened. In all cases, the star image needs to be shifted in the 3 o'clock direction. The screws that must be adjusted depend on the orientation of the three collimating screws in relation to the desired star movement direction.



Repeat the collimation procedure several times, using successively higher power eyepieces, until you are sure the collimation is exact. Finally, after the final adjustments have been made, make sure that all of the collimating screws are snugged down tightly and evenly to ensure that the collimation will hold for many trips out into the field.



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[www.astronomytechnologies.com](http://www.astronomytechnologies.com)

from Astronomy Technologies, 680 24th Avenue SW, Norman, OK 73069