



Carbon Star 150 Imaging Newtonian User's Manual



By Matthew M Paul
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**WARNING: Never look directly at the Sun with the naked eye or with this optic.
Permanent irreversible eye damage can result.**

What's Included

- 1- Optical Tube Assembly (OTA)
- 2- Front Dust Cover
- 3- Primary Cell Cover
- 4- Tube Rings
- 5- V Style Bar
- 6- D Style Bar
- 7- 1.25" to 2" Adapter
- 8- M6 x 18mm Cap Head Screws
- 9- 5mm Hex Key
- 10- 2.5mm Hex Key



Specifications

Model Number:	CS-6F4N
Telescope Series:	Carbon Star
Telescope Design:	Newtonian Reflector
Primary Mirror Clear Aperture:	150mm
Primary Mirror Conic:	Parabolic
Secondary Mirror Minor Axis Diameter:	62mm
Focal Length:	600mm
Focal Ratio:	f/4
Optical Substrate:	Borosilicate
Optical Coatings:	96% Enhanced Aluminum w/ Protective SiO2 Overcoat
Focuser:	2" Linear Bearing, EAF Ready
Spider / Secondary Mirror Support:	One Piece CNC Machined Aluminum
Optical Tube Material:	Carbon Fiber and CNC Machined Aluminum
Optical Tube Length:	19 3/16"
Optical Tube Diameter:	7 1/4"
Optical Tube Weight:	7lb 8oz
Telescope Weight (Assembled):	10lb 6oz

Introduction

This Apertura Carbon Star telescope is a highly optimized 150mm f/4 Imaging Newtonian. The optics are a 150mm diameter, first surface, parabolic mirror with a 600mm focal length and an optically flat 62mm minor axis secondary mirror. The optical surfaces are coated with a highly reflective 96% enhanced aluminum and protective silicon dioxide overcoat. The telescope utilizes modern materials and manufacturing techniques.

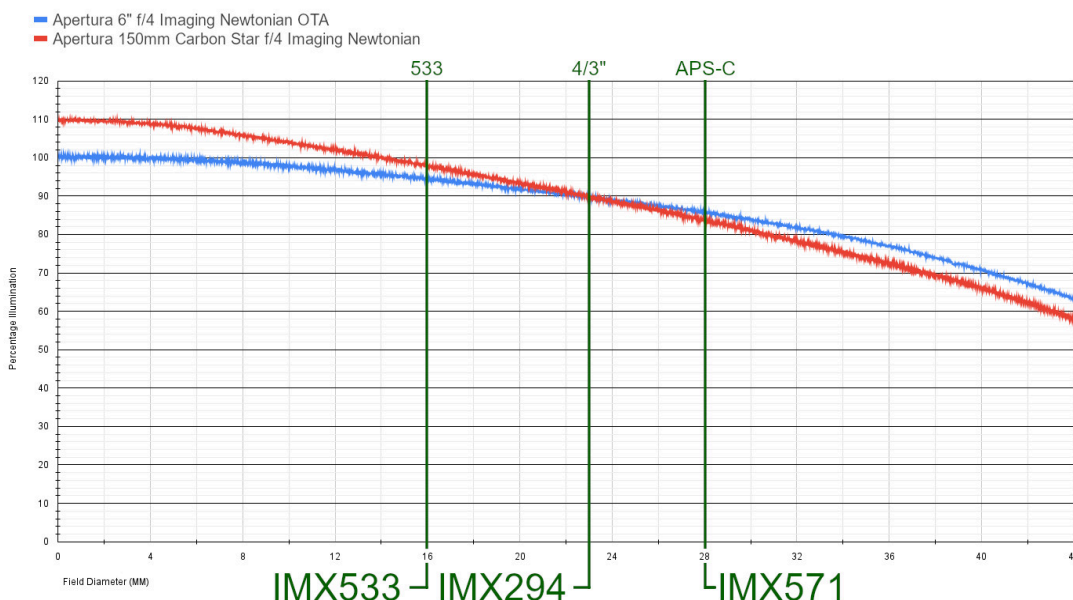
With its compact size, large aperture, and moderate focal length, the Carbon Star 150mm Imaging Newtonian is perfect for beginners and experienced imagers alike. Weighing only 10.4lb, the telescope is at home on equatorial mounts with payloads in the 30lb range.

Field Illumination

Why is this telescope special? The optical design of this telescope is unique in that field illumination is optimized for the most popular camera sensors used today, such as the IMX533 and IMX294. This optimization results in more signal reaching these sensors when compared to a short focal ratio Newtonian optimized for larger camera sensors. Improvements over more conventional designs are still seen up to an APS-C sensor. *This system is not designed to offer best performance with full frame cameras. If you image with a 4/3" camera, this telescope is designed for you!*

The following chart shows the measured field illumination of the Carbon Star 150 Imaging Newtonian when compared to the older Apertura 6F4N. There is roughly a 10% gain in signal at the center of field which gently tapers to the extreme corners of an IMX294 sensor. The blue line is the older 6F4N telescope and the red line is the Carbon Star 150!

Field Illumination Comparison
(without coma corrector)



Stray Light Control

Many Newtonian telescopes suffer from the extremely degrading effects of stray light, which makes calibration frames nearly impossible to take and this stray light lowers gross contrast in images. *Apertura has addressed this problem by building the carbon fiber optical tube around nine knife edge baffles.* These baffles control stray light by blocking internal reflections and reducing its ability to reach the focal plane. We've also included a cap for the primary mirror cell which can be inserted to further reduce the ability of stray light entering the optical tube from the back side. These two key features are rarely seen on Newtonian reflectors.



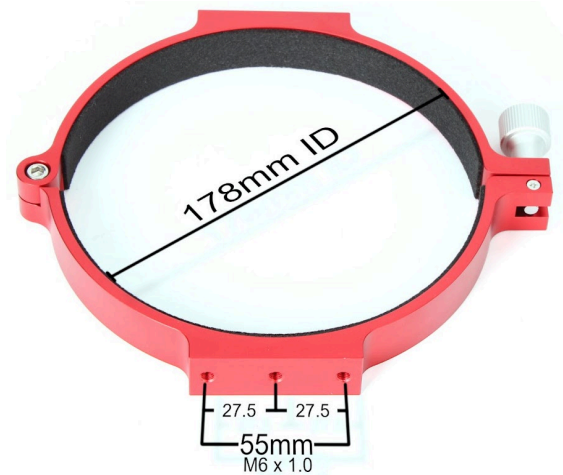
Modern Construction Materials and Methods

The Carbon Star 150mm Imaging Newtonian utilizes modern materials and construction methods. There is a robust and durable optical support which securely holds and maintains optical alignment, meaning a longer lasting collimation. Low thermal expansion materials are used where possible to further maximize performance. The optical substrate used is borosilicate glass, which provides for a large increase in optical stability as the mirrors acclimate to ambient temperature, especially when compared to soda lime glass. Carbon fiber is used as the main component of the optical tube assembly for a lightweight, rigid structure. Carbon fiber also has a low thermal expansion and has almost no focus shift as temperatures change. The same can not be said about telescopes with aluminum tubes, and the carbon fiber tube is much lighter weight than a steel tube.

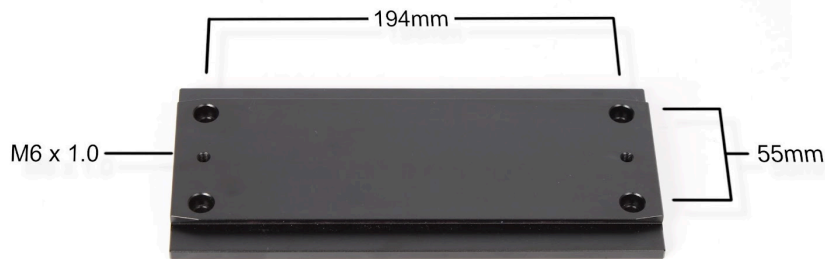
Mounting Hardware

Premium CNC machine aluminum tube rings and multiple dovetail bar offerings allow this telescope to be attached to nearly any modern equatorial mount.

The tube rings have an inside diameter of 178mm. On the top and bottom of the rings, there are three M6 x 1.0 threaded holes: One hole being centrally located, and the outer holes having a 55mm separation from each other, center-to-center.



The D series bar has M6 x 1 threaded holes centrally located on each end of the bar, M6 pass through outer holes recessed for flush mount of cap head screws, and a 194mm separation from one end to the other on the mounting holes.



The V-series bar has a singular M6 x 1 threaded hole centrally located on the bar, two 47mm long slots recessed for flushmount M6 or 1/4-20 cap head screws, two equidistant but centrally located recessed holes for M6 or 14-20 cap head screws with 35mm separation, and a 194mm separation from one end to the other on the mounting holes. There are four 2.5mm screws that can be used to stabilize the dovetail bar.



Focuser

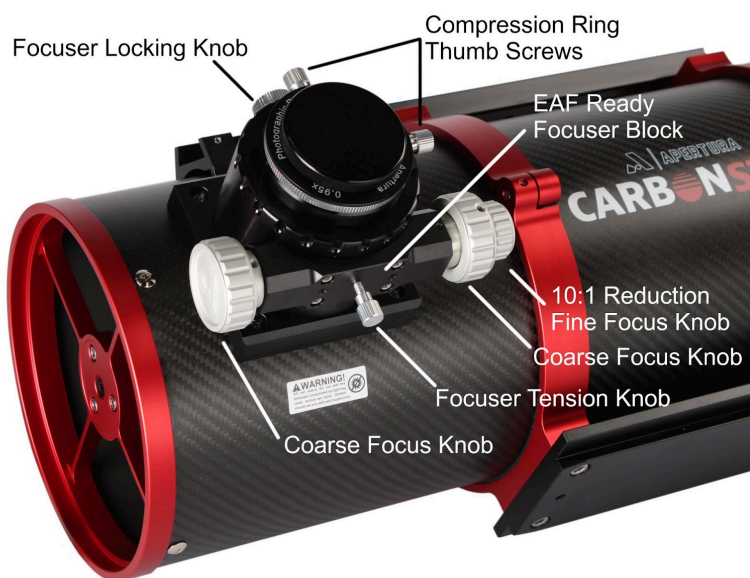
The Carbon Star Imaging Newtonian has an all new focuser! It is a linear bearing focuser which is strong and can support a cooled astronomy camera, electronic filter wheel, off axis guider, and coma corrector.

What exactly is a linear bearing focuser?

This focuser design is similar to a Crayford but uses a 100mm long rail which is supported by dozens of precision ball bearings that ride in a track. The design allows for a rigid and smooth function by distributing the focuser load across the high number of ball bearings. The focus shaft rides on a precision ground plate for a smooth and reliable operation.



The focuser block is ready to accept most of the popular Electronic Automatic Focusers (EAF) on the market, using a simple bolt-on installation. No modification or 3D printed adapter is necessary with the Carbon Star! For those who still wish to focus manually, the focus knobs have been redesigned to offer a better tactile feel with improved styling. There is a 10:1 slow motion control knob on the right hand side of the focuser. The telescope comes with a 1.25" to 2" adapter which is useful when adapting 1.25" collimation tools to the 2" focuser draw tube. Coma correctors and other imaging accessories are held in place with a brass compression ring utilizing two thumb screws. This is an extremely secure method and the precise inner diameter of the draw tube prevents axial misalignment that can be seen with some other telescope focusers on the market. The focuser can be rotated and the drawtube has a threaded ring at the top, offering M56 threads which are covered by a beautiful thread protector. This threading allows for future adaptation of thread-on accessories. The focuser has a tension knob as well as a lock knob.



Assembling the Telescope

Using the two included V and D-series dovetail bars, the telescope can be configured in a variety of ways. Depending on the mount that the telescope will be attached to, one dovetail bar might be more beneficial than the other. If your mount accepts the wider D-series bar, we recommend using this bar on the bottom and installing the smaller V-series bar on top of the rings. A top mounted V-series bar can be used to mount accessories, or, if you prefer not to install the 2nd dovetail bar, it can be left off. Choose the primary dovetail bar for your application and loosely attach it to the bottom of the telescope rings using four of the included M6 x 1.0 cap head screws and the 5mm hex key. Do not fully tighten these screws yet. If a top bar is desired, it can also be loosely attached to the rings at this point using the same size M6 x 1.0 cap head screws and the 5mm hex key.



Loosely clamp the rings to the OTA with the ring clamping knobs facing up and on the opposite side of the telescope than the focuser. Position the rings/cradle assembly at the desired position on the telescope and tighten the knobs on the ring closest to the focuser. Then, secure the dovetail bar hardware for this ring. Moving to the second ring closest to the primary mirror, make sure that it is inline with the front ring and not rotated. Tighten the dovetail bar hardware for this ring and then secure the clamping knob of this final ring. At this point the cradle assembly which consists of the dovetail bars and rings should be square and inline. For the V-series bar, there are four small set screws which can be tightened with the 2.5mm hex key. These screws offer additional support to the narrow V-series bar.

The ring assembly can now be loosened from the telescope and repositioned using the hand knobs if any repositioning is to be done. Sliding the telescope within the tubes can be used to get more travel for balancing, if desired.



Using the Telescope

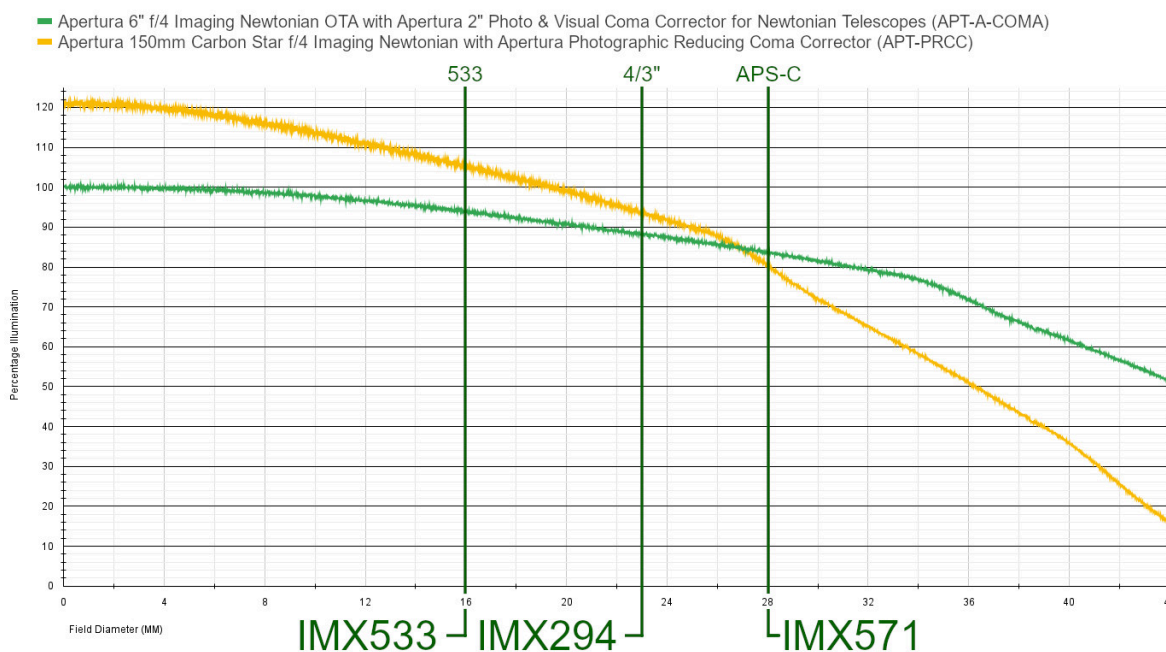
Coma Corrector

We highly recommend using this telescope with the Apertura Photographic Reducing Coma Corrector, though the telescope will work with most other coma correctors on the market. This manual will cover how to use the telescope with the PRCC. Other coma correctors will follow a similar process.



The PRCC has a well-corrected and illuminated image circle of 28mm, which makes it perfect for sensors up to APS-C. It offers a 0.95x reduction which makes this f/4 telescope operate at f/3.8. When the Carbon Star 150mm Imaging Newtonian and PRCC combine, we see an approximate 20% increase in signal at the center of the field when compared to the older 6F4N and coma corrector! Our test results can be seen in the following chart:

Field Illumination Comparison
(with coma corrector)



Back Focus

Sub-aperture correctors, like field flatteners, coma correctors, and focal reducers, have a specific working distance built into their design. In the astronomy hobby, we call this back focus. The most standard distance is 55mm. Most DSLR cameras with a T-ring occupy 55mm back focus, and most cooled dedicated astronomy cameras are set up for 55mm of back focus.

The Apertura PRCC has a back focus of 55mm and an M48 mounting thread. This makes attaching your camera to the M48 threads on the Apertura Photograph Reducing Coma Corrector a breeze.

Focusing

When using this PRCC with the Carbon Star 150mm Imaging Newtonian, the telescope will focus **around the 20mm mark** on the focuser's drawtube. This is just a starting point but should allow you to see stars through the telescope upon the first exposure, allowing you to easily make small adjustments to the focus position and start imaging!

Use the coarse adjustment knob to get the focus close and then use the 10:1 reduction to see pinpoint stars! To use an electronic focuser, see the following section. If an electronic focuser will not be used, we recommend the [Apertura Bright Focus Mask for 90mm to 6" Telescopes](#).



EAF Installation

1. Remove the coarse focus knob by loosening the internal set screw using a 2mm hex key.



2. Remove the focuser tension screw.



3. Attach a 5mm adapter to the EAF and loosely attach the EAF mounting bracket to the focuser block using two M4 screws positioned at the "EAF Ready" mounting points.



4. Slide the 5mm Adapter and EAF over the focuser's protruding shaft and gently start the screws which connect the focuser to the bracket, they will be M4.



5. Then tighten the two M4 screws from the motor to the bracket.



6. Tighten the focuser shaft fitting set screws on to the focuser shaft.



7. Tighten the two remaining focuser motor bracket to Focuser block screws.



8. Reinsert the focuser tensioner knob and firmly tighten this in place.



9. Optional: Rotate focuser 90-deg. to more easily allow the use of a flat panel.

- Support the focuser so that it does not fall or become damaged when the screws are loosened.
- Loosen the two 2mm set screws at the base of the focuser assembly.
- Rotate the focuser to the desired position.
- Tighten the two set screws at the base of the focuser assembly.



Mounting an ASIAIR or Apertura Armored USB Hub

An imaging control device like the ZWO ASIAIR can be mounted to the finder shoe next to the focuser. Alternatively, the device can be bolted to the V-series dovetail bar using a $\frac{3}{4}$ " long $\frac{1}{4}$ -20 bolt or cap head screw, or by using the appropriate third party dovetail bar clamp.

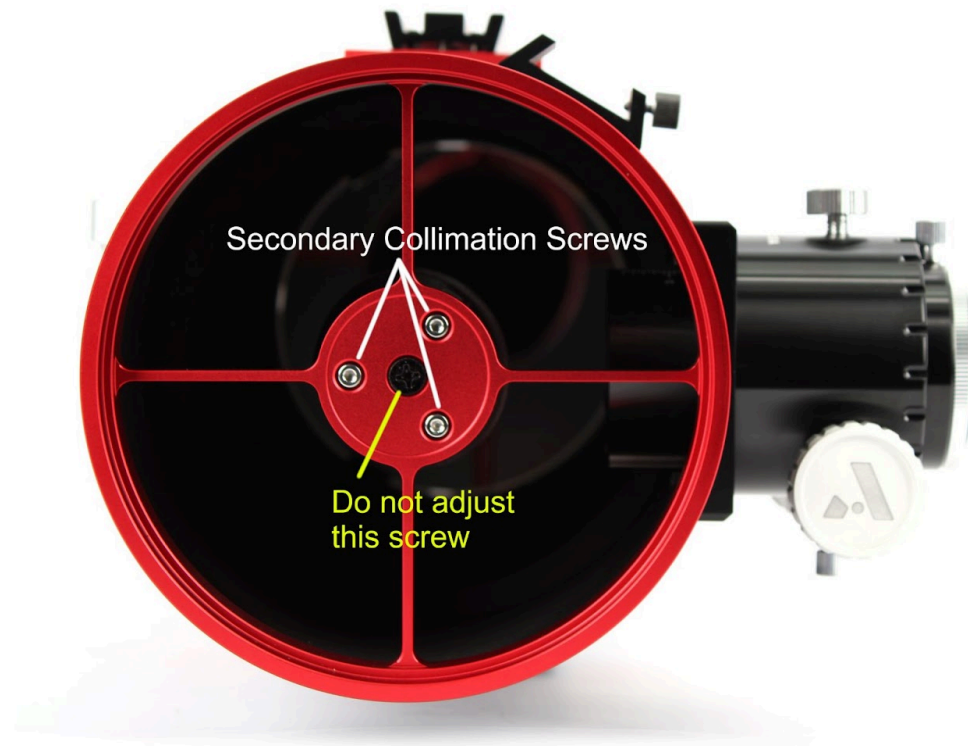


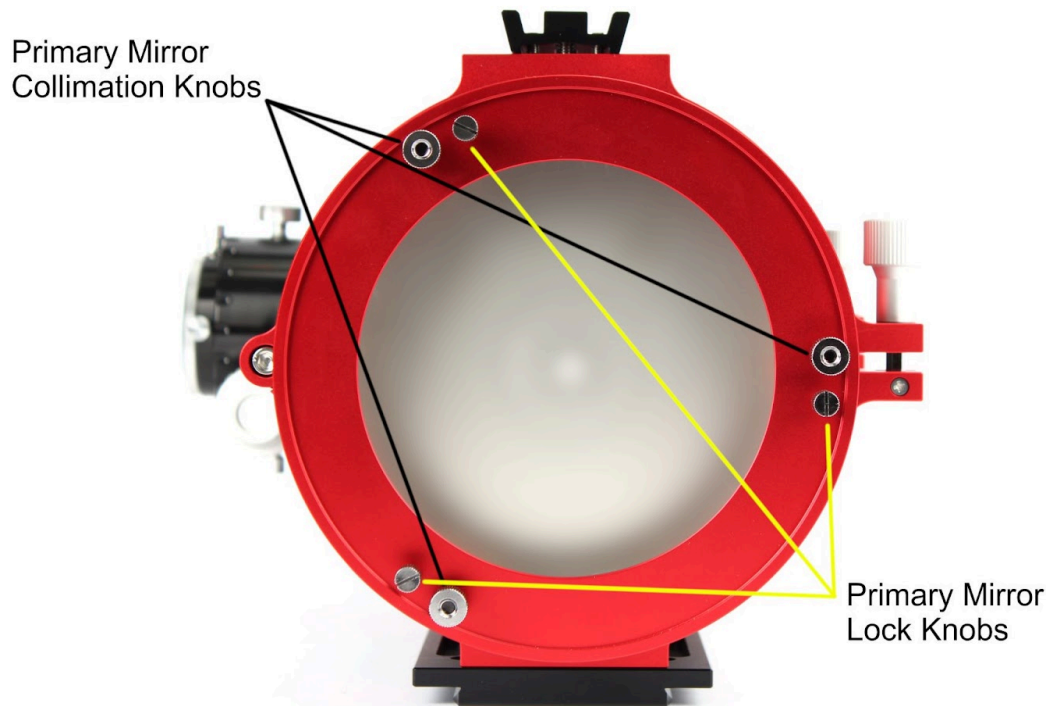
Maintenance

Collimation (Aligning the Optics)

To maximize performance, it is very important that the telescope is well collimated. There are many different ways to collimate a telescope and many amateur astronomers already own the tools to perform this task. We recommend using a combination of a laser and a cheshire eyepiece. The laser is used initially to do a quick collimation, then the cheshire is used to fine tune the telescope. With a final quick check with the laser, the telescope is ready to be tested under the night sky. If the star shape looks good from corner to corner, a defocused star in the center of the field of view is symmetrical, and the brightest field illumination is centrally located, you can be extremely confident that the telescope will be performing to the best of its ability.

The [Apertura 1.25" Laser Collimator with 45-deg Angled Face](#) and [Apertura Cheshire Collimation Eyepiece](#) are the two tools that we recommend. Both of these tools will be inserted into the 1.25" to 2" adapter that comes installed into the focuser of the Carbon Star telescope.





Laser Collimation

For an initial and speedy collimation check the laser is used. Remove the front dust cover from the telescope. Insert the laser into the focuser and turn it on. Adjust the secondary mirror screws at the front of the telescope so the laser beam centers on the spot of the primary mirror. Then, unlock the primary mirror locking screws by loosening them. Adjust the primary mirror collimation screws so the laser beam returns to the center of the collimator target.

Cheshire Eyepiece Collimation

Remove the dust cover from the front of the telescope. Insert the cheshire eyepiece into the 1.25 to 2" adapter in the focuser. Position the angled reflective surface of the collimating eyepiece towards the brightest portion of the room or sky so that the wire crosshairs of the eyepiece are well illuminated. Looking in the eyepiece, make sure the center spot of the primary mirror is centered on the wire crosshairs of the Cheshire collimating eyepiece. If they are not, adjust the secondary mirror collimation screws so the view of the center spot on the primary mirror aligns with the wire crosshairs. Loosen the primary mirror locking knobs. Then, adjust the primary mirror collimation knobs, if necessary, so the reflection of the round illuminated reflective surface on the eyepiece is centered on the wire crosshairs. Gently turn the locking knobs until they just make contact with the primary mirror cell. You should just start to feel a little resistance

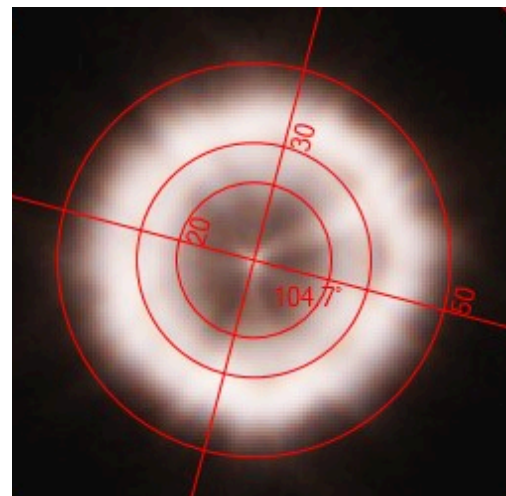
when tightening them. Once all three locking knobs have just begun to make contact, progressively tighten them moving from one to the next until they are fully tightened.

For a complete guide on collimating a telescope with the [Apertura Cheshire Collimation Eyepiece](#), please see the following AstronomyHUB article: [Collimating a Newtonian Telescope with the Apertura Cheshire Collimating Eyepiece](#).

Perfecting the Primary Mirror Collimation with a Star Test

It is possible for the collimation to be checked in an even more precise method, though it should be noted that this is generally considered to be an “over the top” procedure that is not necessary. This telescope will perform exceptionally well using the above mentioned collimation steps with a laser, cheshire, or combination of the two. The following process is for those more advanced or detail oriented users looking to take collimation to the *extreme*.

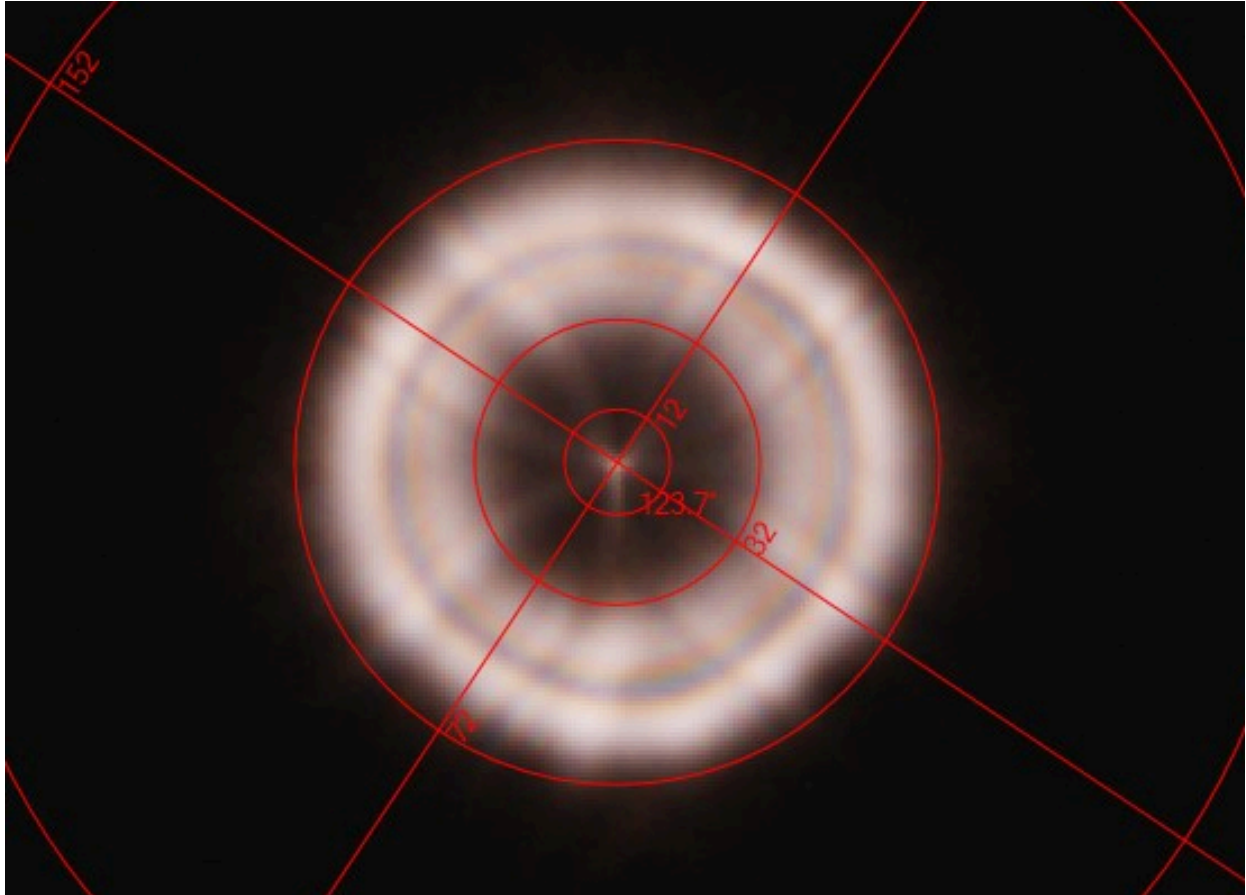
To take collimation fine tuning to the extreme, the telescope is best checked and finely adjusted using a real star under the night sky after performing the previously mentioned methods. Choose a moderately bright star. Usually constellation stars are a good choice for this. Using a live view or looping short exposure, center this star *perfectly* in your camera. Then, ever so slightly defocus the star. You'll need to zoom in using your imaging software to see the details necessary. If the star is defocused too much, the detail necessary to perfect the collimation will not be visible. When the star is ever so slightly defocused, a small spot can be seen at the center. This is referred to as a Poisson's Spot and it can be seen in the following example image.



The Poisson's Spot is the bright point located at the center of the red crosshair. Moving away from the center of the crosshair, the circle becomes darker. This is referred to as the secondary mirror shadow. If the star is defocused too much, this shadow will be very large and the Poisson's Spot will not be visible. When collimation is out by a larger amount, the secondary shadow can be used for adjustment and the star can be defocused by a larger amount. It is only when we seek the perfect collimation that the slightly defocused star and Poisson's Spot are used. It is critical that the star being used is exactly at the center of the field of view. In the sample images we used an imaging software called SharpCap. This software and many others have the option to overlay different crosshairs on the live image. In this case, one with adjustable concentric circles really can help make sure that everything is well aligned and centered. If the spot is not centered, adjustments to the primary mirror will be necessary.

One simple trick for fine tuning the alignment is to use the mount control buttons to move the star around the field of view until it looks best. Find the position in the field of view where the star becomes the most concentric. This is the approximate location of the optical axis. We want

to move the optical axis to the center of the field of view. This is, in essence, exactly what we are doing when we collimate a telescope. We adjust the mirrors so the optical axis of the telescope coincides with the center of our field of view within the focuser, whether that be an eyepiece or a camera. By finding the optical axis within the telescope using the above method, we simply need to adjust the primary mirror screws in order to recenter the star. That's right! Don't use the mount controls to re-center the now perfect looking star, use the primary mirror collimation screws. Double check that the defocused star, now back at the center of the field, looks good, and tighten down the locking knobs for the primary mirror. It's time to refocus and get some imaging in!



Storing the Telescope

Like any other telescope, it is best kept indoors in a low humidity, temperature controlled environment. Use the provided front and rear covers as well as the included focuser dust cover if the telescope will not be stored with the camera in place. The factory packaging provides a secure and safe storage option for longer term storage.

Warranty

The Apertura Absolute Warranty provides two years of coverage against product defects. After the initial two-year warranty expires, this product qualifies for Apertura's Three-Year Accident Replacement Program. In addition, the Apertura Absolute Warranty is transferable! It is important to keep your original receipt and the product's original boxes and packaging, should you need to make a claim.