Adjusting a Newtonian telescope with an alignment laser

TSLA · LA1 · LA2

Contents

TSLA

LA1

LA2

WARNING

Do not look directly into the laser and the direct reflection. Of course, the laser source complies with the legal regulations and does not exceed the permissible strength, but it is still advisable to avoid direct impingement of the beam on the eye as much as possible.

You can recognize a direct reflection by the fact that the laser causes a dazzling effect.
Diffuse reflections which, for example, reach the eye when looking at the laser dot (on one of the mirrors or on the matte screen) are absolutely harmless.

Requirements

The procedure described below assumes that the telescope to be adjusted is mechanically OK and roughly pre-adjusted, i.e. that, for example, the position of the parts corresponds to the nominal values/specifications.

Checking/adjusting the laser

The TSLA, LA1 and LA2 adjustment lasers have adjustment screws. Deviations in laser alignment can thus be corrected quickly and easily.

· Checking the laser

1. Place the tube of your Newtonian telescope on a flat surface and secure it against rolling away. Alternatively, you can leave the telescope on the mount and tilt the tube to horizontal.
2. Rotate the tube so that the eyepiece extension points vertically upwards.
3. Insert the laser into the focuser and tighten the clamping screws (in the case of a ring clamp) until there is no more play, but the laser can still be rotated in the focuser. The edge of the laser must rest on the focuser without play all around.
4. Switch on the laser, look into the telescope from the front and pay attention to the laser dot, which is now visible on the main mirror.
5. Rotate the laser in the OAZ. The laser dot should barely move. However, if it describes a circle, the laser itself must be adjusted.

· Adjusting the laser

The TSLA, LA1 and LA2 lasers have three adjustment screws with which the exit direction of the laser beam can be set. If the screws are covered on your laser model, carefully remove the covers.

Now change the laser exit direction by turning the screws so that the circle drawn by the laser dot on the main mirror becomes smaller.

This usually requires that you approach the correct position in small steps by loosening and tightening the screws.

Make sure that all screws are tightened at the end of the adjustment process.

TSLA LA1 LA2

The adjustment screws are located 120 ° offset at the top of the housing.

Secondary spider

The secondary spider usually only needs to be checked after installation. Under certain circumstances, such a check may be necessary if bright stars on photographs taken with the telescope do not show normal cross-shaped, but deformed or double spikes.

For the first step, we assume that the primary mirror is centered in the tube.

1. Check - e.g. with a metal ruler or a thread stretched over the tube aperture - whether the opposite struts are in line. If this is not the case, the position of the secondary holder in the tube is probably also incorrect.
2. Measure whether the secondary holder is centered in the tube, i.e. whether the distance between the holder and the tube wall along the four struts of the spider is identical. If this is not the case, you must correct the distances by carefully loosening or tightening the opposite screws by the same amount.
   Do this in small steps and always check all four distances after each adjustment.

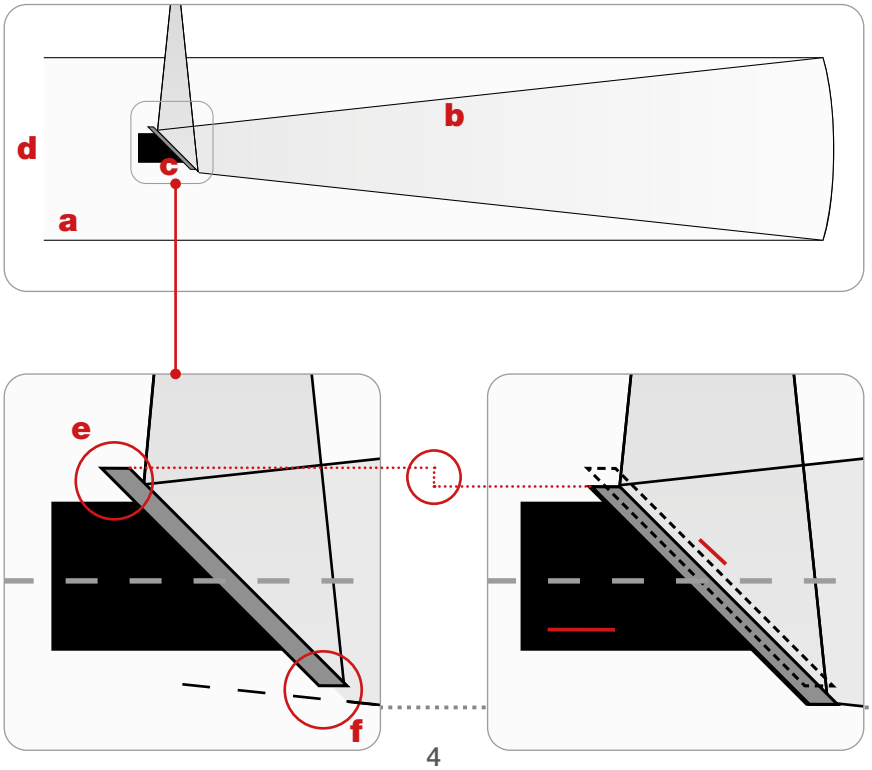
You may have to repeat the two steps several times.

Secondary mirror offset

The primary mirror of the Newtonian telescope forms the incident (parallel) light (a) into a cone (b). In this cone sits the secondary mirror (c), which deflects the light at a right angle towards the focuser. The secondary mirror should be as large as necessary (to avoid losing light from the cone) but also as small as possible (to avoid too much obstruction).

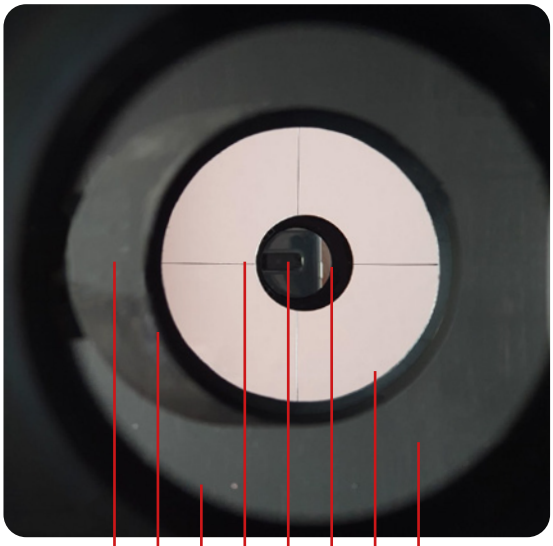
The size of the secondary mirror (small axis of the ellipse) is oriented to the diameter of the cone. If the center of the secondary mirror is placed exactly on the optical axis (d), the result is that the front end (e) protrudes beyond the light cone, while at the rear end (f) part of the light does not hit the mirror.

By mounting the secondary mirror a little off center on the holder and shifting the holder a little towards the telescope aperture, both problems are solved. This so-called offset is already considered in complete telescopes and does not have to (or cannot) be adjusted. During the adjustment it is only to be considered that it can happen (in particular with inexpensive telescopes) that the secondary mirror is not centered in the focuser because of the offset.



What can be seen in the focuser?

When the focuser is fully retracted and the eye (or camera) is close to the focuser, you will see the view below.



Offset

opposing inner side of the tube
HS edge (reflection in the secondary mirror)
secondary mirror reflection in the main mirror
camera in OAZ view (reflection secondary-main-secondary)
secondary mirror spider (reflection via main and secondary)
inner focuser edge
secondary mirror edge
secondary mirror side surface

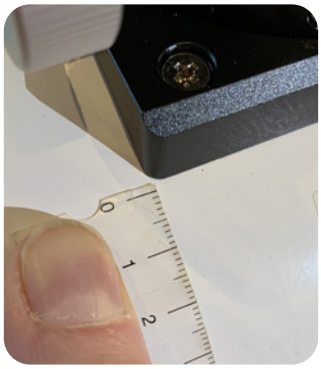
Focuser

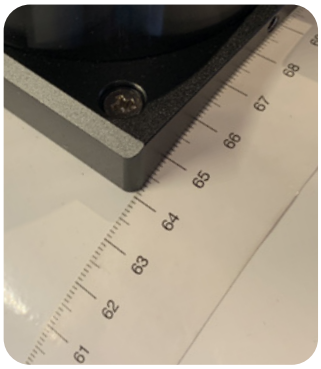
The center axis of the focuser should be aligned perpendicular to the optical axis. The two axes should meet as closely as possible at the correct point on the secondary.

The best way to check and adjust the focuser alignment is with the secondary removed. Usually this procedure is only done when the telescope is being assembled. If the focuser is to be changed, it is a good idea to adjust the telescope beforehand so that the new focuser can be correctly aligned with the existing system.

If a new alignment is necessary (without secondary mirror), the position of the center of the focuser bore must first be determined (position on the circumference of the tube and distance from the front edge of the tube), and then a mark must be made on the opposite inner side of the tube.

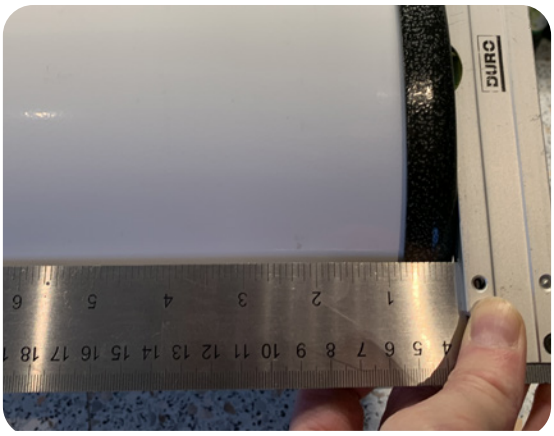
For this purpose, with the OAZ removed, a measuring tape can be placed around the tube from one edge of the OAZ bore to the other and the opposite spot can be determined. If the mounted focuser has a symmetrical base plate, its corners can serve as reference points.

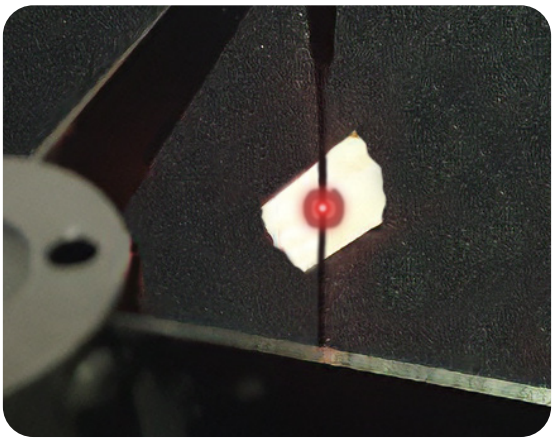




The determined position can be transferred to the front edge of the tube with a stop bracket and the mark can be applied to the inside at the correct distance from there.
A piece of masking tape and a suitable pen are sufficient. It is useful to make the mark on the outside as well, in order to know the correct position for any future adjustment work.

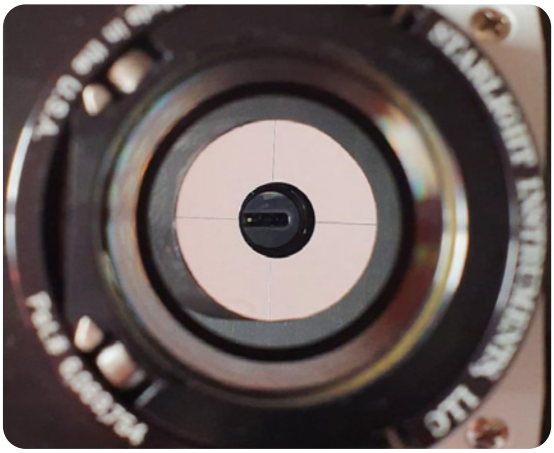
When the focuser is mounted, the adjustment laser is inserted into it and the focuser is adjusted with the adjustment screws so that the laser dot hits the reference mark.

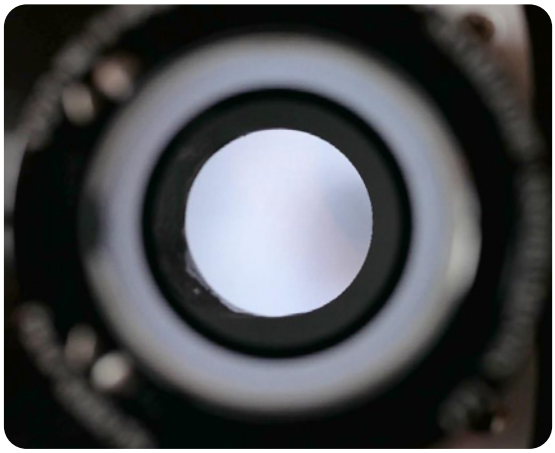




Preparing the secondary adjustment

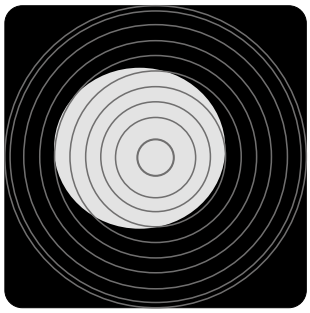
After mounting the secondary, a rough adjustment is necessary. Because the reflections of the main mirror can be irritating when looking into the focuser (left), it is useful to place a sheet of paper between the main mirror and the secondary mirror. This way, the secondary mirror stands out well from the background (tube wall) as a matte white surface without disturbing reflections (right).



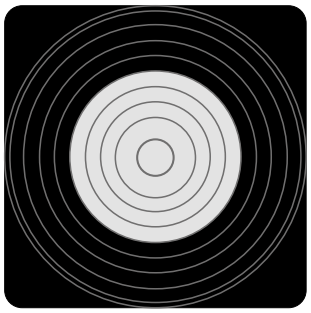


Secondary mirror coarse adjustment

For coarse adjustment of the secondary, a Concenter eyepiece is suitable, e.g. the Concenter eyepiece 1.25” or the Concenter eyepiece 2”. Insert the Concenter eyepiece into the focuser and secure it in place. Now look into the focuser and check the position of the secondary. Most likely, the secondary will not appear perfectly round at first, nor will it be centered in the Concenter eyepiece.



Rotate and move the secondary until the mirror is positioned (after tightening the screws) as shown in the picture on the right. If necessary, you may need to loosen the adjustment screws a little to move it towards the telescope aperture. If necessary move the focuser a little bit inward or outward to match the circles in the center eyepiece to the diameter of the secondary mirror. to the diameter of the secondary.



Excluding sources of error

- **Tilting of the laser in the focuser**

  Insert the alignment laser into the focuser and secure it carefully. Observe the laser spot on the primary mirror. Loosen the clamping screw and tighten it again. The laser dot should not move or move very little and should be in the same position after each clamping. If this is not the case, your focuser has a slightly too large inner diameter, which can cause the laser to tilt. A strip of thin adhesive tape on the barrel of the laser can prevent tilting.

- **Clearance in the focuser**

  To prevent clearance in the focuser from affecting the adjustment, the focuser must be fully retracted and locked in place.

- **Checking the mechanical stability**

  Rotate the tube around the longitudinal axis while observing the position of the laser dot. Also bring the tube into an oblique or vertical position. Rotate the tube around the longitudinal axis while observing the position of the laser dot. Also bring the tube into an oblique or vertical position. The laser dot must not change the position on the main mirror.

  Because small deviations are difficult to detect, you should repeat the procedure with the adjusted telescope. Then the laser dot is within the center mark of the primary mirror.

  The causes for a position-dependent deviation can be an insufficiently tensioned secondary mount, one or more loose screws, a too weakly designed spider or a deflecting tube. The latter two fundamental problems can lead to permanent errors during adjustment.

Adjusting the secondary mirror

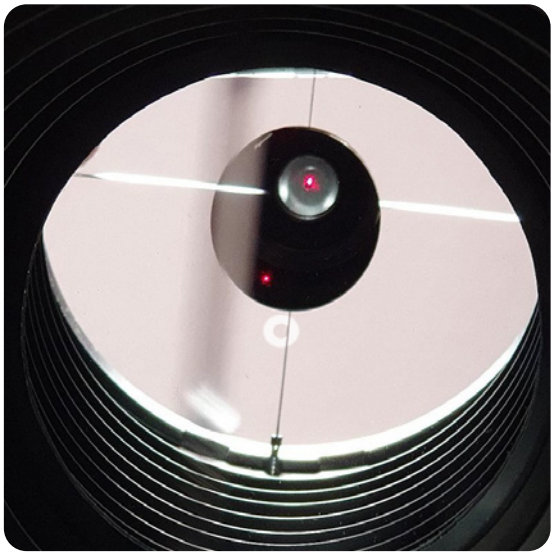
The secondary mirror is adjusted exclusively with the three adjustment screws; the centrally located fixing screw must not be loosened again.

The aim is to align the secondary mirror to the primary mirror in such a way that the laser spot hits the primary mirror in the center.

Turn the adjustment screws only a little at first to determine in which direction the laser spot is shifted in each case. It is useful to alternately tighten one screw and loosen another to achieve the desired movement. This prevents excessive pressure on the secondary holder. If one adjustment screw needs to be adjusted to a greater amount, it is necessary to loosen the other two screws minimally to avoid distortion and/or damage to the secondary mirror holder.

The laser dot must hit the center mark of the primary mirror exactly. Once you have achieved this, check that all adjustment screws are tight.

After this step, check with the Concenter eyepiece to make sure that the secondary mirror still appears round and centered in it. Especially if the secondary had to be adjusted strongly, it may be necessary to repeat the coarse and fine adjustment.



Before adjustment

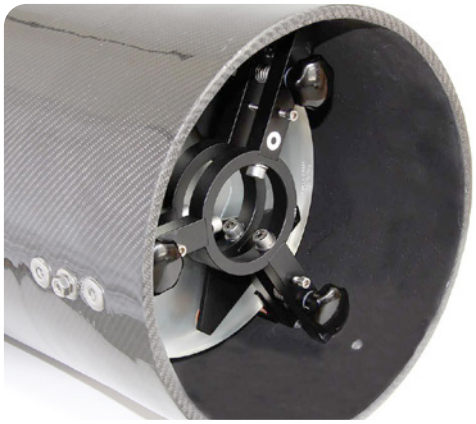
Correctly adjusted secondary mirror

Main mirror alignment

Tip: Rotate the laser so that the aperture with the matte screen faces the back end of the telescope.

This will allow you to view the matte screen while adjusting the primary mirror.

Usually there are three pairs of screws on the main mirror cell. In the telescope shown on the right, the adjustment screws have a star grip, while the locking screws have a hexagon socket head.
Loosen the locking screws a little and then proceed as with the secondary mirror: first determine the respective direction of movement, then adjust. The laser dot visible on the matte screen of the alignment laser must be aligned with the central hole.



If this is the case, the locking screws must be tightened carefully. Do not do this in one pass, but tighten the screws one after the other. Make sure that the laser dot does not move anymore.

Before adjustment

Correctly adjusted primary mirror

Now the adjustment is completed.