PlaneWave CDK Telescope Instructions

Setting the spacing and collimation for the CDK12.5

July 10th, 2020

Collimation and Secondary Spacing Procedure

The CDK optical design has four optical elements shown in Figure 1. The primary mirror and the two-element lens group are permanently mounted and aligned at PlaneWave Instruments. The secondary mirror is movable to allow fine collimation and to set the spacing between the primary and secondary. To get the best performance out of the CDK optical system, the optics must be collimated. Please note that the primary-to-secondary spacing is set at the factory and typically does not need to be adjusted unless it has moved by significant collimation adjustment or during shipping.

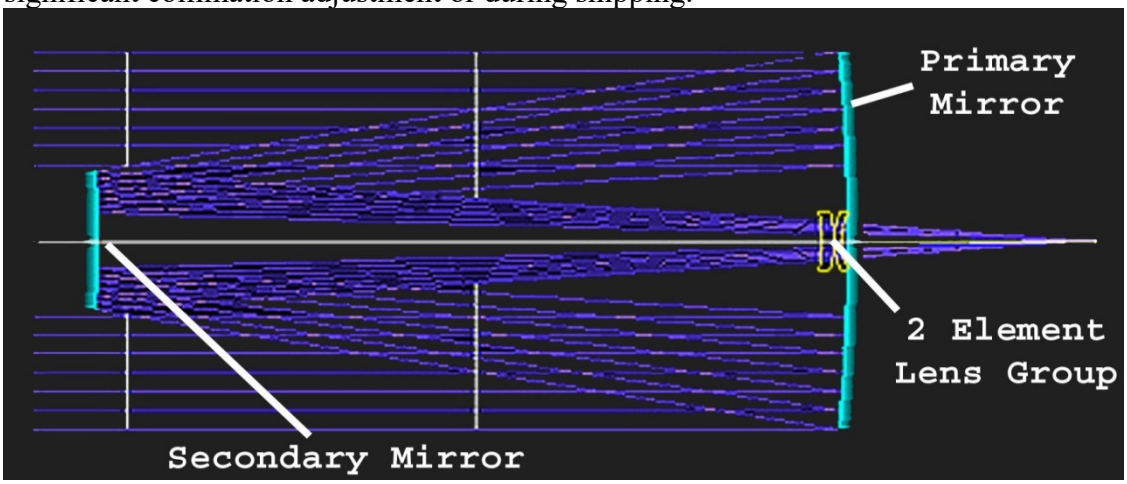


Figure 1: The optical layout of the CDK system. The system contains 4 elements: the primary mirror, the secondary mirror, and a two-element lens group.

Collimation of the CDK 12.5

The steps below cover the entire process of both collimating and correcting mirror-spacing of the CDK12.5. If your telescope is new, and/or your telescope's mirror spacing has not been adjusted since leaving the factory, it should only be necessary to address rough and fine collimation (step 1 and step 4).

Step 1: Rough Collimation:

To collimate your CDK you will need to have a low power, 1.25" eyepiece inserted into the optional Ronchi spacer.

a. Point the telescope at a bright star.
b. Defocus the star until it becomes a donut-like ring. If the donut hole appears well centered in the donut proceed to Step 5.
c. If the donut hole is not centered, adjust the collimating screws on the back of the secondary mirror so that the defocused star moves in the direction of the fat side of the donut, as shown in Figure 5. Re-center the star and repeat this process until the donut hole looks centered as shown in Figure 6. See below for details on how to adjust the collimating screws.

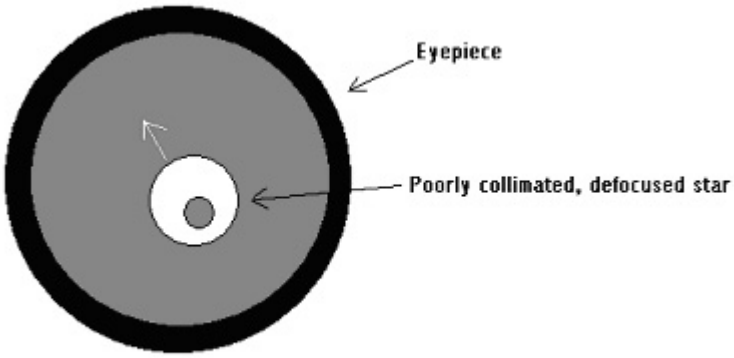


Figure 5: An example of what you would see through a low-power eyepiece for an out-of-focus, out-of-collimation telescope. To collimate this telescope you would adjust the secondary collimating screws so that the out-of-focus star moves in the direction of the arrow.

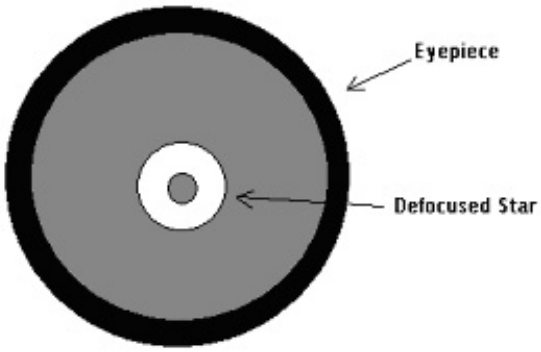


Figure 6: An example of an approximately collimated defocused star.

It may be necessary to slightly loosen the thumbscrews in pairs when tightening the other pair. Remember to always finish tightening with the secondary preloaded securely against all four screws.

Collimating is usually a two-person job: one person looks through the eyepiece while one person adjusts the collimating screws. Attempting to do this alone can be quite difficult and frustrating. If necessary, you might try using a webcam or video-rate planetary camera with a 1-1/4” nosepiece in place of an eyepiece. With this setup, you can watch the video stream from the camera while you make adjustments.

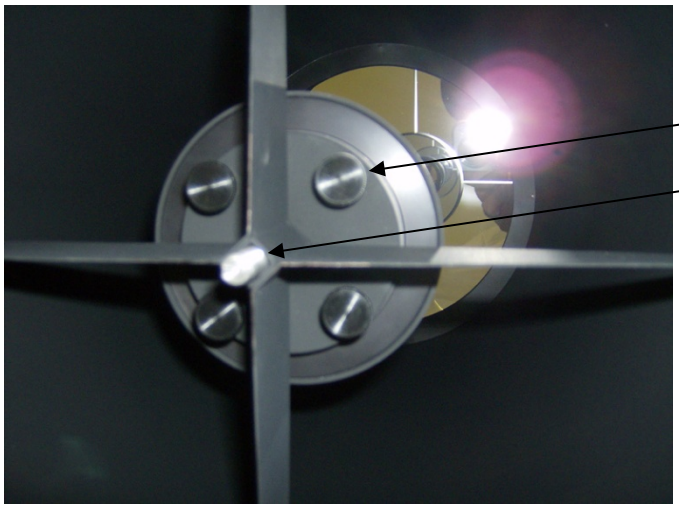


Figure 7: The CDK secondary housing. There are three collimating screws and a central knob. The secondary on the CDK is spring loaded, pulling the secondary into the three collimating screws

For the CDK12.5 there are four collimation screws and a central bolt used for spacing which is set at the factory

Step 2: Setting the Primary-to-Secondary Spacing:

The primary-to-secondary spacing is set at the factory. You will typically not need to adjust this unless the secondary has been moved significantly.

For your CDK optical system to perform as well as it should, the spacing between the primary mirror and secondary mirror should be set to an accuracy of +/- 0.7mm! Fortunately, you won't have to directly measure this spacing. When the primary-to-secondary spacing is set correctly, the focal plane will land at an exact known distance behind the fully racked in focuser. The optional Ronchi adapter and spacer places the Ronchi grating of the Ronchi ocular precisely where the focal plane is supposed to be.

About the Ronchi Test

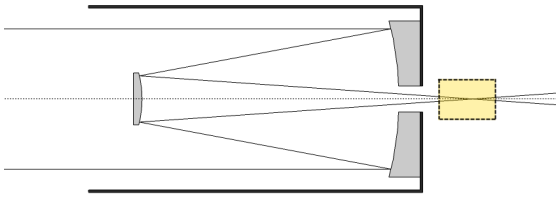


Figure 8 illustrates the basic idea behind using a Ronchi grating to identify the position of the focal plane. The light from a single bright star passes through the optical system and converges to a point on the focal plane. When the Ronchi grating is placed in front of or behind the focal plane, it will block some of the light in this light cone. This will cast a series of shadows that appear as dark, wide lines when the defocused light is viewed through the ocular.

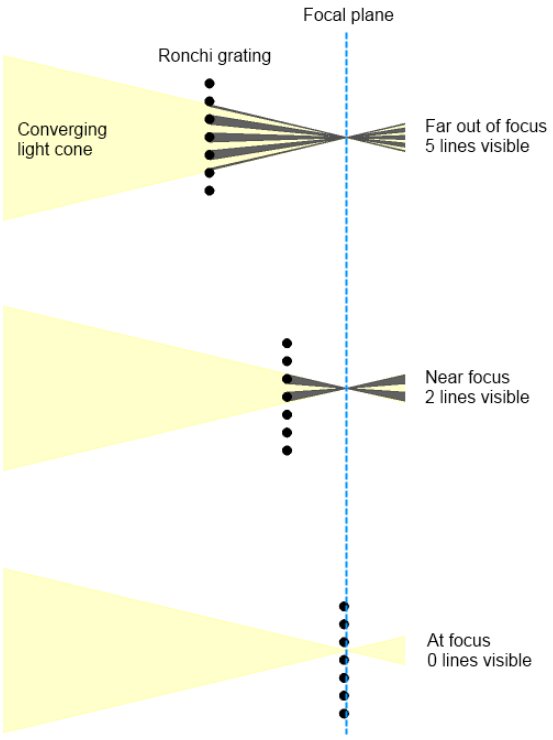


Figure 8: The Ronchi grating casts fewer shadows as it moves closer to the focal plane.

As the grating moves closer to the focal plane, fewer lines are visible, and they become wider. When the focal plane and the Ronchi grating are perfectly aligned, no lines (or perhaps one very wide line) are visible. See Figure 9 for an example.

In order to set the primary-to-secondary distance, you will be moving the secondary mirror. By adjusting secondary mirror distance, you will be moving the focal plane relative to the fixed position of the Ronchi grating. The job here is to move the secondary mirror such that the focal plane coincides with the Ronchi grating on the Ronchi Ocular. When you have done this, you have accurately set the primary-to-secondary spacing.

With reasonable effort, the primary-to-secondary spacing can be set to well within its 0.7mm tolerance.

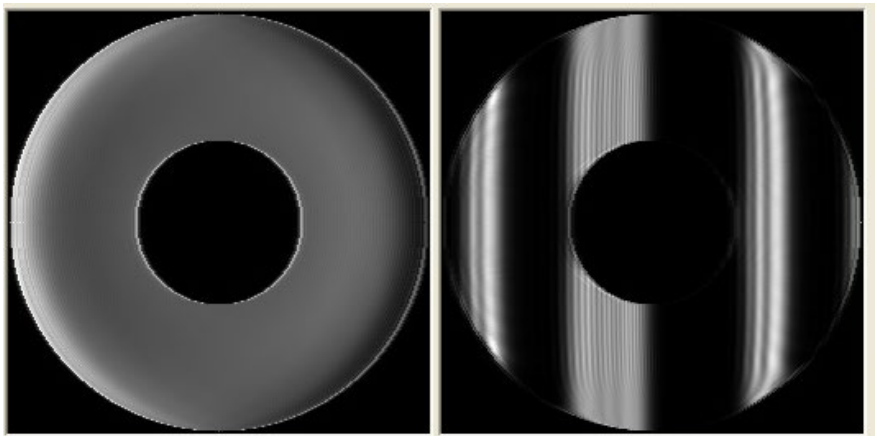


Figure 9: The left image is a simulation of what a focused star looks like through a Ronchi grating. The right image is a simulation of what an out of focus view looks like through a Ronchi grating. The right image shows 2 full lines. The more lines you see, the farther the Ronchi screen is from the focal plane.

Step 3: Setting Up the Test

Starting with a telescope that is fairly well collimated, center a bright star and replace the low power eyepiece with the optional Ronchi ocular and spacer. Rack the Hedrick focuser fully inwards towards the telescope and ensure that the Ocular is seated all the way into the adapter. If the Ronchi is nulled (you can see no lines, or one Ronchi line covers the entire aperture; see Figure 9) This means that your spacing is properly set; you may proceed to Step 5. This is not uncommon because the primary-to-secondary spacing is set at PlaneWave and you most likely will not need to adjust it.

If you see two or more lines, you should move the secondary toward or away from the primary.

Determining the Direction to Move the Secondary

To determine which way to move the secondary, gently slide the Ronchi Ocular out of the spacing tube. If the Ronchi reaches null as you do this, the focal plane is too far back and you need to move the secondary mirror **away** from the primary. If the number of lines grows as you slide the Ronchi out of the spacing tube, the focal plane is too far forward and you need to move the secondary **toward** the primary.

Remember that the secondary mirror acts as a magnifier. So a small change in secondary spacing can translate into a much larger change at the focal plane. For example, for every 1mm the secondary spacing is changed on the CDK12.5, the focal plane moves 7.5mm. You want to keep the error at the focal plane to 5mm or better, which equals just under two lines on the Ronchi. This corresponds to an error in primary-to-secondary spacing of about +/- 0.7mm. See table below for spacing tolerance for all CDK models.

CDK	Focal plane change for every 1mm of secondary spacing change	Allowable primary-to-secondary spacing tolerance to keep focal plane within 5mm of optimal
12.5	7.5mm	+/- .7mm

Figure 9 shows a Ronchi simulation with the Ronchi screen set at the focal plane and also with the focal plane 10mm away from the Ronchi screen. The image on the left is what you will see if the primary-to-secondary spacing is perfect. The image on the right is what you will see if the primary-to-secondary spacing is off by about 2mm. Remember, you want better than +/- 0.7mm spacing accuracy for the CDK12.5.

Adjusting the Secondary Spacing

The CDK secondary mirror is not spring loaded, so you must always keep tension in the collimating screws and the central bolt. To move the secondary **toward** the primary mirror:

1. Loosen four screws for the CDK12.5 secondary in equal amounts to maintain your collimation.
2. Hold the secondary housing with one hand. This is to keep the housing from rotating. (*The collimation screws sit in shallow recesses and you would like them to go back in the recesses when the procedure is complete)*.
3. Take a flat-head screwdriver and place the tip in the central bolt of the secondary assembly.
4. Turn the collimation knobs in equal amounts until the assembly is tight again.
5. Check the Ronchi grating and repeat this process as necessary until you get a null.

To move the secondary **away** from the primary:

1. Loosen the collimation screws. Loosen them in equal amounts to maintain your collimation.
2. Hold the secondary housing with one hand. This is to keep the housing from rotating. (*The collimation screws sit in shallow recesses and you would like them to go back in the recesses when the procedure is complete)*.
3. Take a flat-head screwdriver and place the tip in the central bolt of the secondary assembly. Rotate the central bolt in a **counter-clockwise** direction.
4. Rotate the four collimation knobs in equal amounts until the assembly is tight again.
5. Check the Ronchi screen and repeat this process as necessary until you get a null.

Re-checking Collimation

After you are satisfied that the secondary spacing is correct, replace the Ronchi ocular with the low power eyepiece and repeat step 1 to verify that the collimation is still close. If re-collimation adjustments are necessary, make them and repeat step 3.

Step 4: Fine Collimation:

Use a high-power eyepiece (5mm or less) and follow the same procedure described in Step 1 (adjust the secondary so that the donut hole is in the center of the donut). You may want to

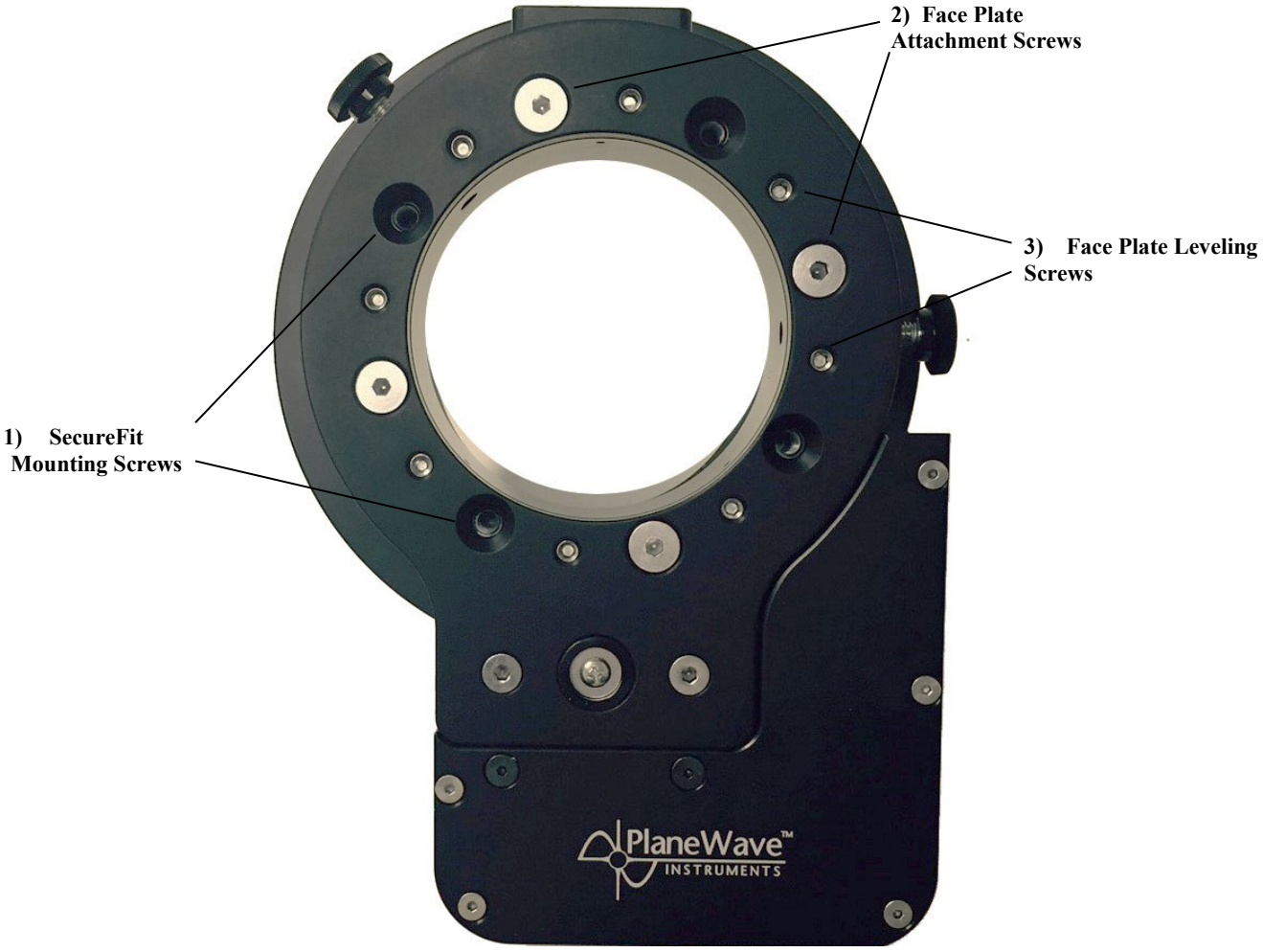
switch to a low-power eyepiece while making adjustments and carefully re-centering the star after every adjustment, and back to high power to check the collimation.

If only small adjustments were made in Step 3, the spacing should be within the design tolerance. It very large adjustments were made involving multiple turns of the collimation knobs use of the optional Ronchi ocular and adapters may be needed involving Step 3 and 4 and a repeat of fine collimation.

Back Focus

The CDK design does not have any moving optical components, so the focal point is fixed. This means that the focal plane of the telescope is a set distance behind the backplate of the telescope. The back focus of the CDK12.5 is 10.445" from the rear of the telescope or 7.19" from the flange of the supplied Hedrick focuser when fully racked inwards.

Mounting SecureFit Spacers to the Hedrick Motorized Focuser



1. The face plate of the focuser (200340) has four threaded holes that should be used to mount any of Planewave's SecureFit adapter. Use the ¼-20 screws provided with your SecureFit adapter to mount it on the face of the focuser.
2. The remaining four holes has screws that hold the face plate to the body of the focuser and should not be removed.
3. There are also a series of set screws that are used to level the face plate relative to the image plane. These set screws should not be removed or loosened in any way.