PlaneWave CDK Telescope Instructions

CDK12.5, 17, 20 and 24

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 and the primary-to-secondary mirror spacing must be set. Please note that the primary-to-secondary spacing is set at the factory and typically does not need to be adjusted unless it was moved after shipping.

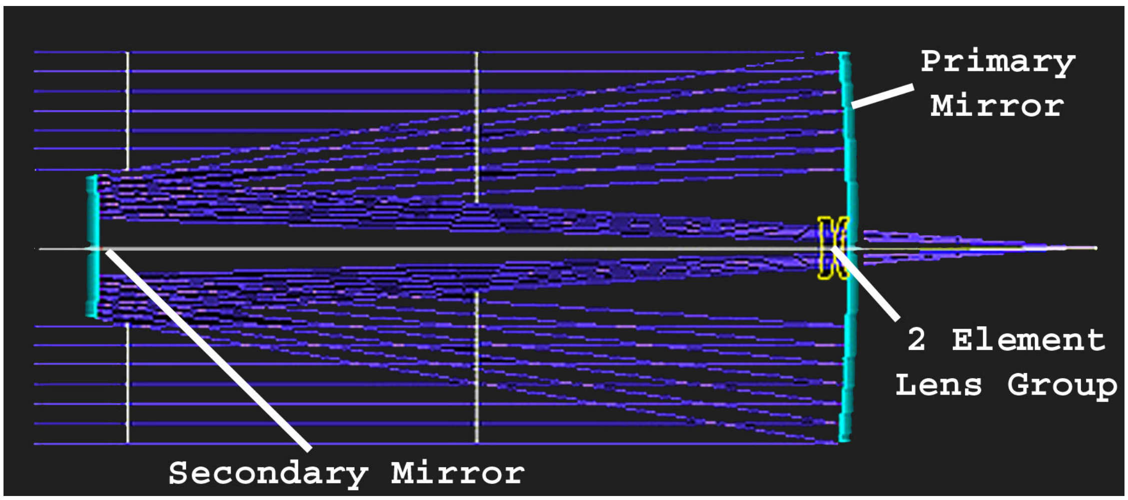


Figure 1: The optical layout of the CDK system. The system contains 4 elements: the primary mirror, the secondary mirror, and a two-element lens group.

Key Components

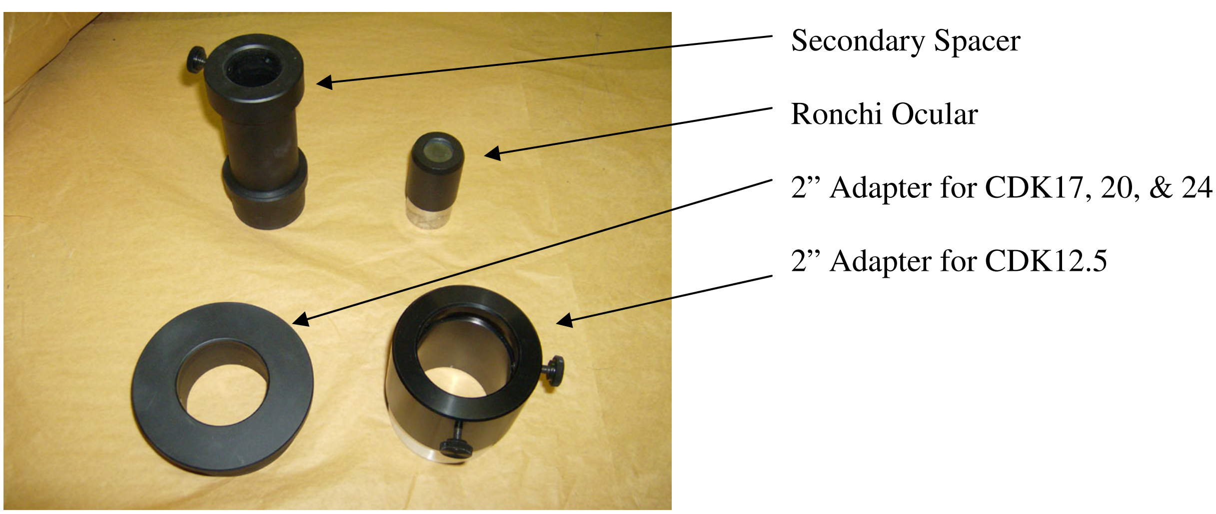


Figure 2: The standard accessories used for collimation and setting the primary-to-secondary distance for the CDK12.5, CDK17, CDK20, and CDK24.

Figure 3: On the left is the 2” adapter for the CDK12.5 attached to the Secondary Spacer and the Ronchi Ocular. On the right is the 2” adapter for the CDK17, the CDK20 and the CDK24 attached to the Secondary Spacer and the Ronchi Ocular.

Step 1, Rough Collimation:

a. Put the Secondary Spacer into the 2” adapter. The 2” CDK12.5 adapter has thumb screws, and the 2” CDK17/20/24 Adapter has two 8-32 set screws which requires a 3/32 Allen wrench.
b. Insert the 2” adapter into the telescope focuser.
c. Insert a low-power 1-1/4” eyepiece into the secondary spacer (25mm to 40mm).
d. Point the telescope at a bright star.
e. Defocus the star until it becomes a donut-like ring. If the donut hole appears well centered in the donut, proceed to Step 2.
f. 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 4. Re-center the star and repeat this process until the donut hole looks centered as shown in Figure 5. See below for details on how to adjust the collimating screws.

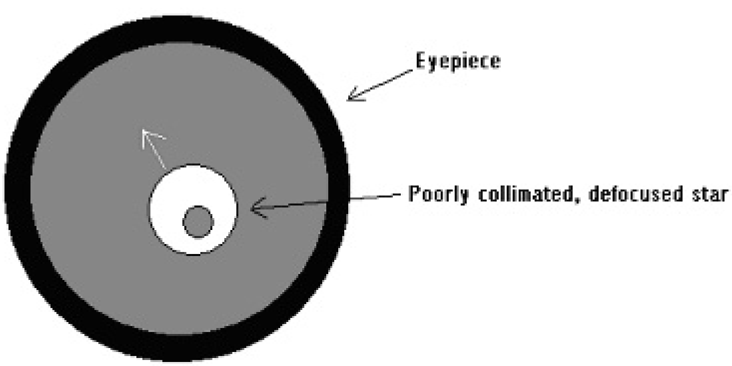


Figure 4: An example of what you would see through a low-power eyepiece for an out-of-focus, out-of-collimation telescope. To collimate this telescope you would adjust the secondary collimating screws so that the out-of-focus star moves in the direction of the arrow.

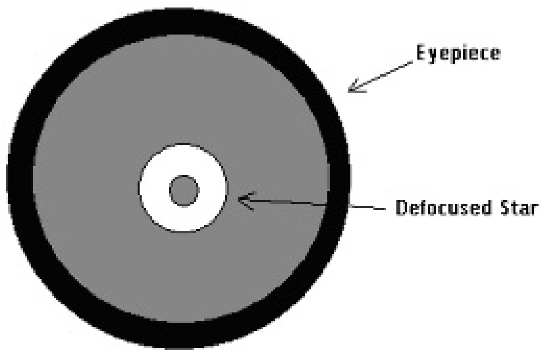


Figure 5: An example of an approximately collimated defocused star.

The CDK20 uses three ¼-20 socket head cap screws for collimation, as shown in Figure 6. These screws require a 3/16 Allen wrench. The CDK12.5 and the CDK17 have four knobs which can be adjusted by hand, as shown in Figure 7. For the CDK12.5/17 it is easiest if you simultaneously adjust two knobs that are diagonal to each other. Rotate one knob clockwise and the diagonal knob counter-clockwise in order to maintain tension between all the knobs. Always finish a move with the secondary preloaded securely against all knobs.

Collimating is 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 with a 1-1/4" nosepiece, such as the Celestron NexImage, in place of an eyepiece. With this setup, you can watch the video stream from the camera while you make adjustments.

Note that the central spacing knob is not used until Step 2.

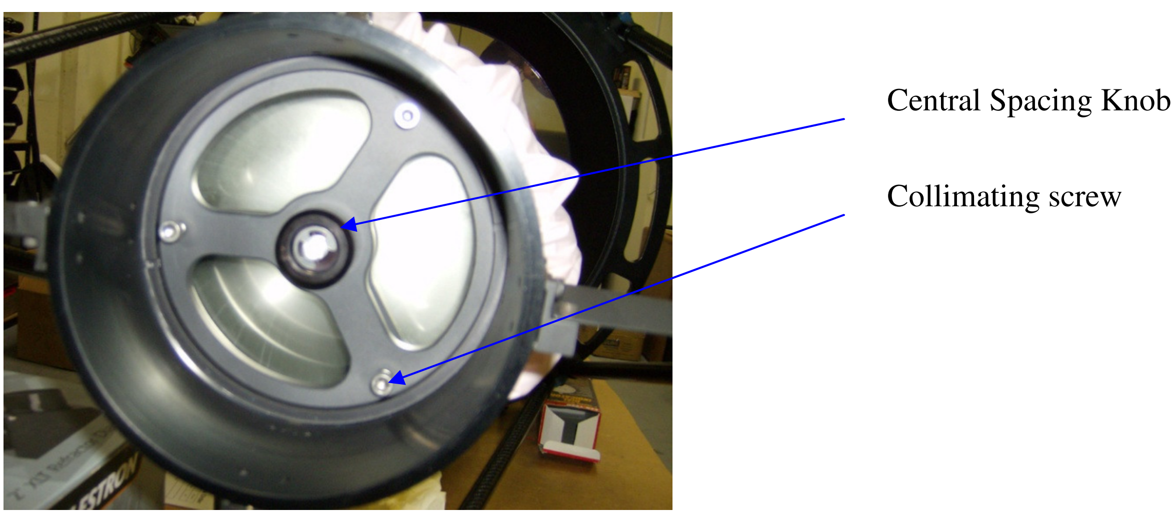


Figure 6: The CDK20 secondary housing. There are three collimating screws and a central knob. The secondary on the CDK20 is spring loaded, pulling the secondary into the three collimating screws.

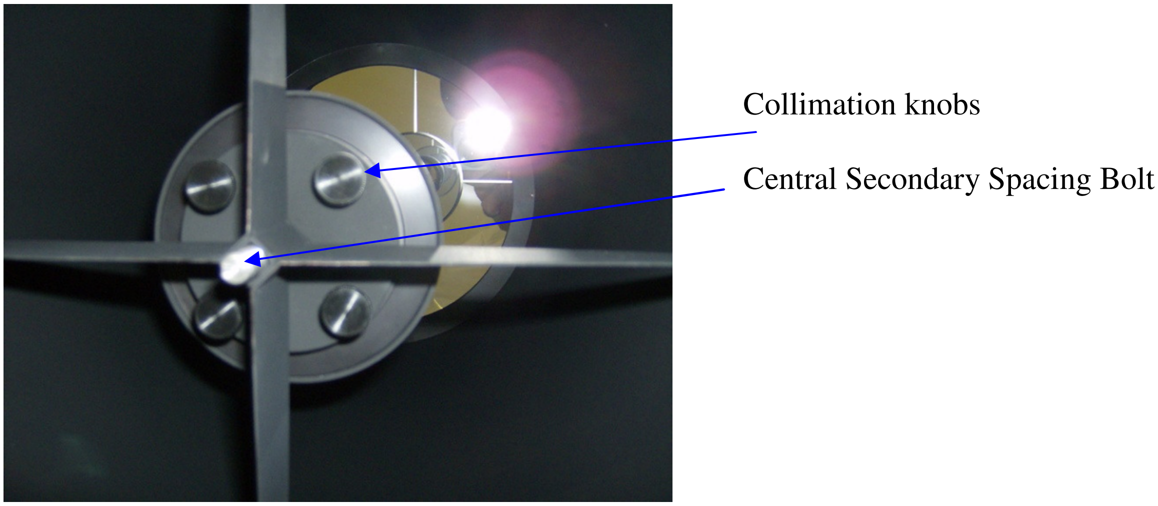


Figure 7: The CDK12.5 collimation screws and the central secondary spacing bolt. The CDK17 mechanism is identical to the CDK12.5.

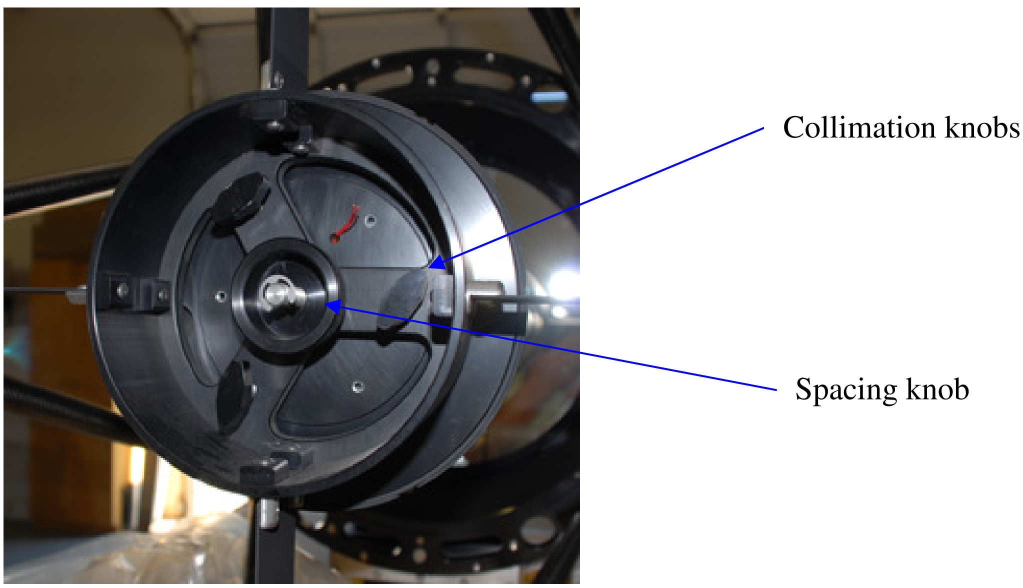


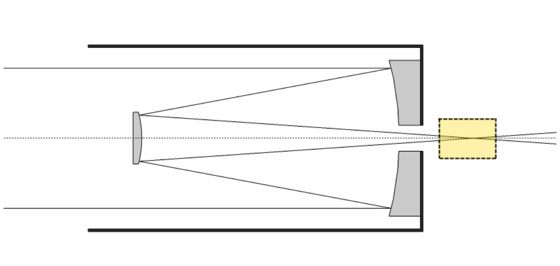
Figure 8: The CDK24 collimation screws and the central spacing knob. Collimation adjustments use the three outer knobs.

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.

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 +/- 1mm! 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 Secondary Spacer places the Ronchi screen of the Ronchi Ocular precisely where the focal plane is supposed to be.

About the Ronchi Test



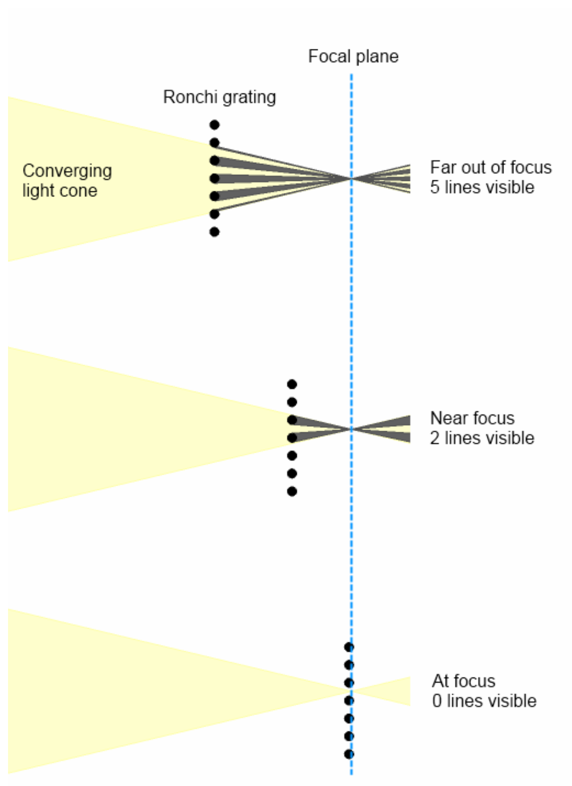


Figure 9: The Ronchi grating casts fewer shadows as it moves closer to the focal plane.

Figure 9 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.

As the grating moves closer to the focal plane, fewer lines are visible, and they become wider. When the focal plane and the Ronchi screen are perfectly aligned, no lines (or perhaps one very wide line) are visible. See Figure 10 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 screen. The job here is to move the secondary mirror such that the focal plane coincides with the Ronchi screen 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 1mm tolerance.

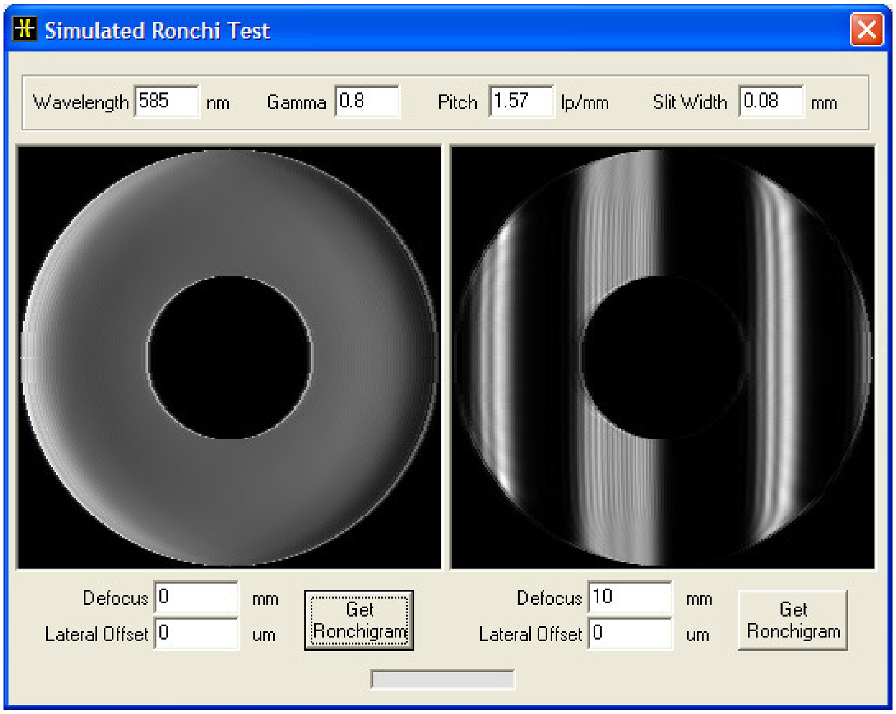


Figure 10: The left image is a simulation of what a null looks like through a Ronchi screen. The right image is a simulation of what an out of focus view looks like through a Ronchi screen. The right image shows 2 full lines. The more lines you see, the farther the ronci screen is from the focal plane.

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 Ronchi Ocular that was provided with the telescope. Rack the focuser all the way in, as far as it goes. Make sure the 2" adapter is seated all the way into the focuser and the Secondary Spacer is seated flush into the 2" adapter. If the Ronchi is nulled (you can see no lines, or one Ronchi line covers the entire aperture; see Figure 10), this means that your spacing is already set; you may proceed to Step 3. 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. The mechanics for moving the CDK12.5/CDK17 and the CDK20 secondary mirrors are a little different.

Determining the Direction to Move the Secondary (CDK12.5 / CDK17)

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.

For every one unit the secondary spacing is changed on the CDK12.5/17, the focal plane moves 7.5 units. 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 +/- .7mm. Figure 10 shows a Ronchi simulation for the CDK20 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 1mm spacing accuracy for the CDK12.5/17.

Adjusting the Secondary Spacing (CDK12.5 / CDK17)

The CDK12.5 / 17 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 the four collimation knobs. 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 four screws sit in shallow detents and we would like them to go back in the detents 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 **clockwise** direction. **For reference, rotating ¼ turn moves the secondary .4mm, which moves the focal plane 3mm.**
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.

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

1. Loosen the four collimation knobs. 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 four screws sit in shallow detents and we would like them to go back in the detents 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. **For reference, rotating ¼ turn moves the secondary .4mm, which moves the focal plane 3mm.**
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.

Determining the Direction to Move the Secondary (CDK20)

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.

For every one unit the secondary spacing is changed, the focal plane moves five units. Or, if the focal plane is within 5mm (about two ronchi lines), the secondary spacing is within its 1mm tolerance. Figure 10 shows a Ronchi simulation of the CDK20 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 about 2mm off.

Adjusting the Secondary Spacing on the CDK20 and the CDK24

Since the CDK20 secondary mirror is spring loaded, small adjustments in spacing can be made by tightening or loosening the collimating screws by equal amounts. For large spacing adjustments, one may need to adjust the center knob shown in Figure 6 (for the CDK20) or Figure 8 (for the CDK24). To move the secondary **toward** the primary, **loosen the center knob** and **tighten the collimating screws** by equal amounts until everything feels snug. To move the secondary **away** from the primary, **loosen the three collimating screws** by equal amounts and **tighten the center knob**.

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 2.

Step 3, 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 re-centering the star, and back to high power to check the collimation.

Finally, use the Ronchi Ocular to re-check the spacing. As long as only small adjustments were made in Step 3, the spacing should still be fine. If it is not, repeat Step 2 and Step 3.

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 for the various telescope models in shown in Table 1 below.

	Backfocus from mounting surface of telescope backplate	Focuser Spacer (only on CDK24 and CDK700)	Back focus from fully racked in focuser
CDK12.5	10.45”	n.a.	7.2”
CDK17	8.81”	n.a.	5.81”
CDK20	8.81”	n.a.	5.81”
CDK24	13.177”	4.367” (#240343)	5.81”
CDK700	*11.16”	n.a	7.535”

Table 1: Shows the back focus with and without the focuser installed for the various PlaneWave telescope models. *The CDK700 is referenced, not from the backplate of the telescope, but from the end of the altitude hub which is the mounting surface for the optical train. Also, the CDK700 is using the Focuser/Rotator 600180, which uses 3.625” of backfocus on the CDK700.

The CDK24 has significantly more backfocus than the other telescopes in the PlaneWave lineup. In order to take advantage of the existing line of CCD spacers and accessories, a spacer pushes the focuser out so it exactly matches the other telescopes. If more back focus is needed, then a shorter spacer can be purchased.

Another reason to push the focuser out to the same position as is used on the rest of the CDK line is that it reduces the torque on the focuser. If the focuser which can easily hold 25lbs worth of equipment 5.8” out was then made to hold the same equipment 10” out, the torque on the focuser would increase 172%. In order to keep flexure to minimal levels, we do not want to move the focuser closer to the telescope unless it is absolutely necessary.

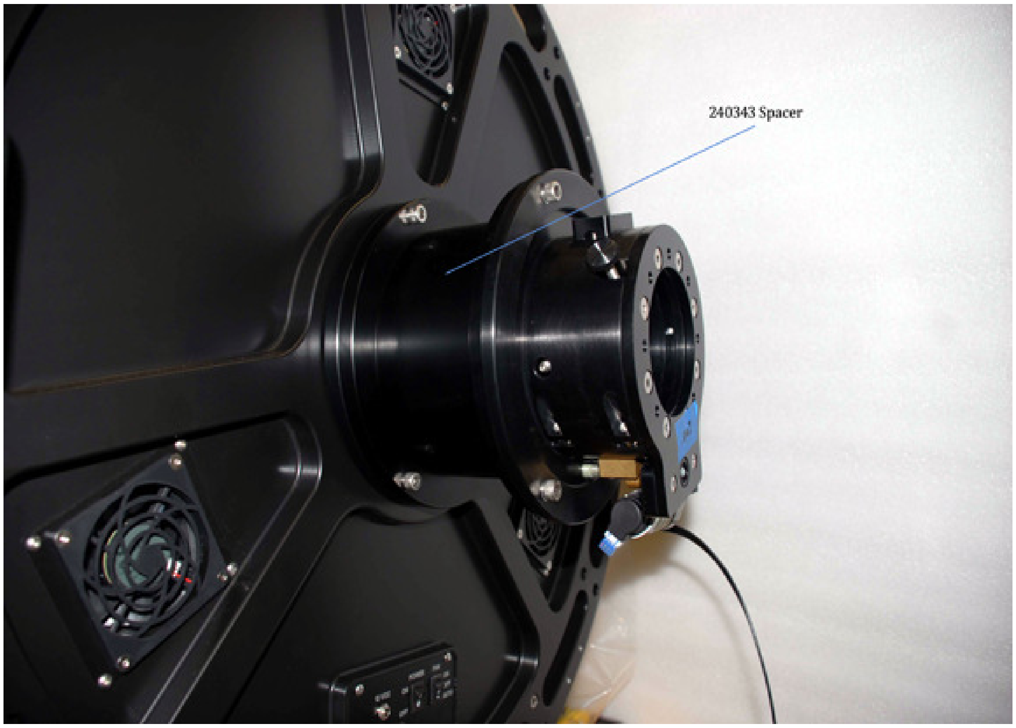


Figure 11: The CDK24 has more back focus than the other CDK models, so a spacer is used to put the focuser the same distance from the focal plane as the other CDK models. This means the same spacers will work with all the different models, with exception of the CDK12.5.