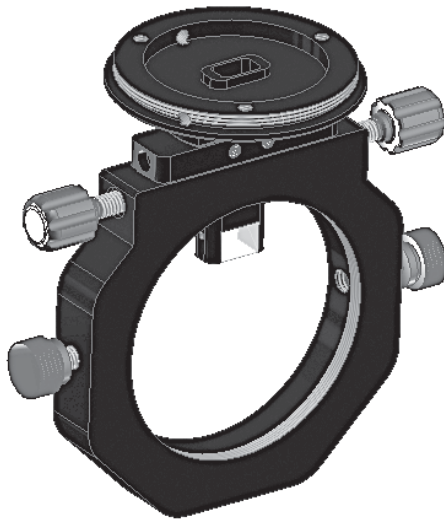


# INSTRUCTION MANUAL

## Orion Thin Off-Axis Guider (TOAG)

#5531



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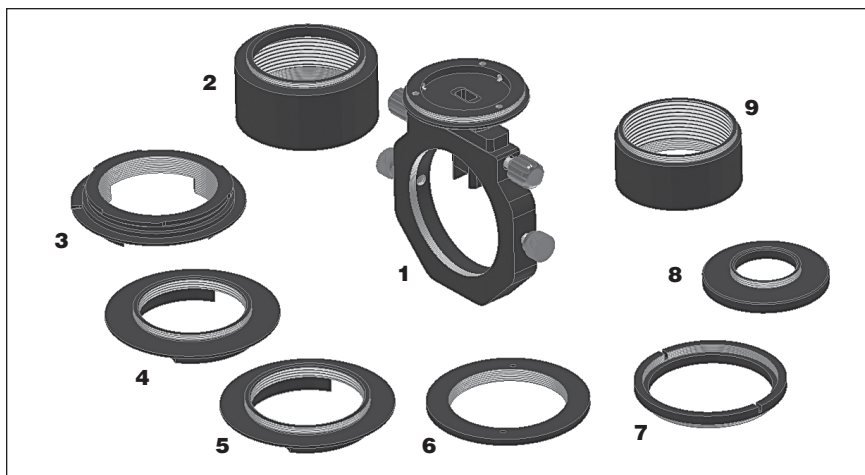
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**Figure 1.** Parts included with the TOAG

## Parts List (Figure 1)

1. Thin Off-Axis Guider main body
2. 2" Nosepiece
3. Canon camera-compatible ring adapter (bayonet)
4. Camera T-thread ring adapter
5. Step-down ring (M48 male to T-threads female)
6. Coma corrector spacer
7. C-mount to T-threads (Male-Female) adapter
8. Spacer (18mm long)
9. Hex key (not shown)

Congratulations on your purchase of the Orion Thin Off-Axis Guider (Orion TOAG). This useful imaging accessory enables you to image and guide through the same telescope, thereby eliminating the need for a separate guide scope, which reduces payload weight on your mount and helps eliminate guiding error due to flexure. All telescopes are prone to some degree of flexure, but an Off-Axis Guider detects the exact same movement as the main camera so you are assured high-accuracy guiding.

**WARNING:** *Never look directly at the Sun with the naked eye or with a telescope – unless you have a proper solar filter installed over the front of the telescope! Otherwise, permanent, irreversible eye damage may result.*

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The Orion Thin Off-Axis Guider (TOAG) is especially useful where space (back-focus) is critical, such as with Newtonian telescopes where back-focus is limited, and for Schmidt-Cassegrain telescopes, which can experience “mirror flop”.

## **Things You Should Know Before Using the Orion TOAG**

*What a Thin Off-Axis Guider (TOAG) Is Used For:*

A TOAG is a device used for astrophotography. It uses a small pick-off prism that redirects a tiny portion of the incoming light from the telescope to an auxiliary guide camera (autoguider).

*Thin Off-Axis Guiders and DSLR Cameras:*

Modern imaging cameras include dedicated astronomy CCD cameras and DSLR cameras that provide an easy and affordable method of image acquisition.

One of the drawbacks of using a DSLR camera is the long back-focus (around  $\pm 44$  mm depending on model). This limits its application on some telescopes, especially where back-focus is limited, such as Newtonian telescopes with or without coma correctors.

Some Newtonian telescopes, such as fast Newtonian astrographs (below f/4.5) require the use of coma correctors in order to obtain pinpoint stars across the focal plane. Coma correctors are usually optimized for a specific distance to the imaging chip; about 54-56mm long depending on the camera maker and the telescope focal ratio and corresponds to the back-focus of the camera plus the thickness of a DSLR T-threads adapter, or T-ring.

DSLR T-rings are usually 10 mm thick. Our TOAG is about 10.5 mm thick to insure compatibility with coma correctors.

*Thin Off-Axis Guider and Newtonian Telescopes*

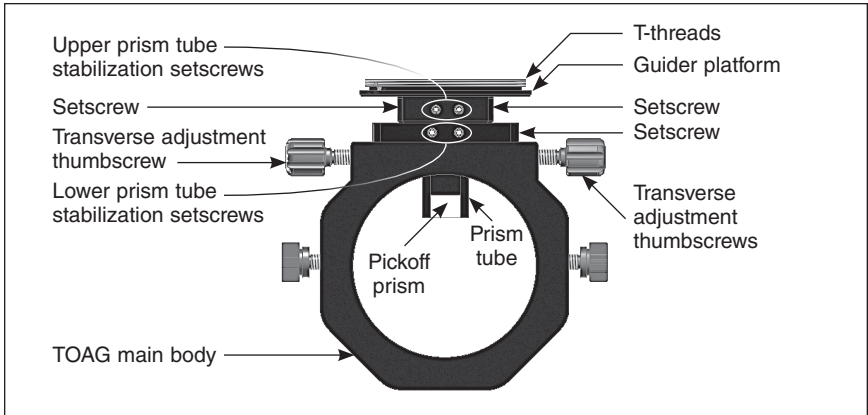
Newtonian telescopes offer the best combination of aperture and cost; they can also be very fast (low f/ratio) making them especially interesting for astrophotography as they provide a wide field of view (FOV) and allow short exposure times. Newtonians are also constructed in such a way that back-focus is, by design, very limited. Guiding with a standard off-axis guider is usually not possible, making the TOAG an essential accessory item when attempting to use a Newtonian for deep sky imaging (since it adds very little back focus - around 10.5 mm).

## **1. Getting Started With a DSLR**

Please take a moment to familiarize yourself with the parts (**Figure 1**).

The Orion TOAG comes with a 2" nosepiece (#2) with a T-female to C-mount adapter already attached (#7). Two camera ring adapters (#3 and #4) are supplied in a separate plastic bag. You should remove the C-mount to T-threads adapter (#7) from the main body as you may require it to guide with your particular autoguider.

The TOAG accommodates nearly any autoguider camera, but special attention should be taken with the autoguider weight since the TOAG has a very nar-



**Figure 2.** Parts of the TOAG

row support base. We recommend using a compact autoguider, such as the StarShoot AutoGuider or any guider the size of an eyepiece barrel. However many other autoguider cameras with female T-threads or eyepiece male barrel size are also appropriate.

## Using the TOAG

1. Adjust the prism
2. Set the correct imaging camera and autoguider spacing
3. Determine what kind of setup you wish to use

### 1.1 Adjusting the Prism Position

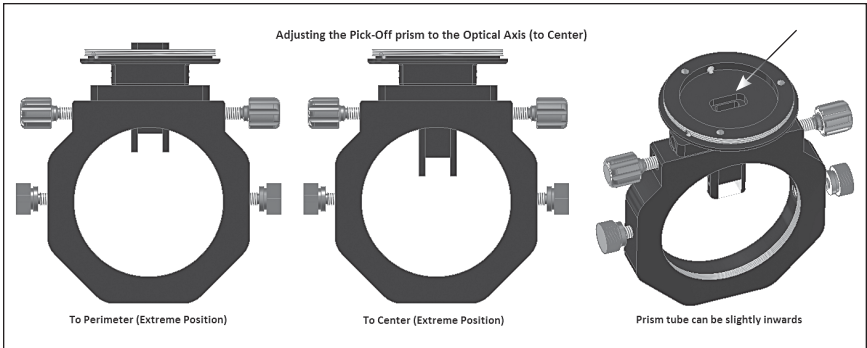
It is important to set the pick-off prism to the proper position

#### *Prism Tube Stabilization Setscrews*

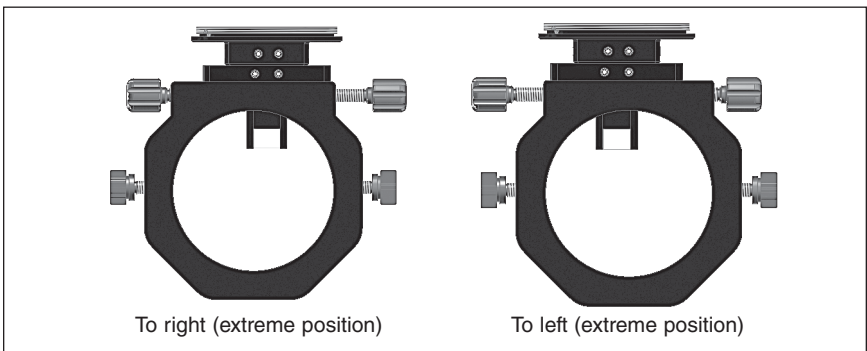
Since the initial release of the TOAG, we have added four prism tube stabilization setscrews to eliminate any possible flexing of the guide camera relative to the TOAG main body (**Figure 2**). No other thin off-axis guider on the market has this unique stabilization feature. The four setscrews provide enhanced rigidity to the prism tube and, thus, to the autoguider platform where the guide camera is installed. These four setscrews are perpendicularly oriented relative to the other, lateral setscrews that also serve to secure the prism tube to both the guider platform and the TOAG main body. This cross-directional stabilization provides a highly rigid, flexure-free unit to insure trouble-free guiding.

#### *Center to Perimeter Adjustment*

The pick-off prism should be positioned as close as possible toward the center of the TOAG but without obstructing the light path to the main imaging camera. If you can see the shadow of the prism on your images, you should move the prism up and out of the light path.



**Figure 3.** Up-down, or center to perimeter adjustment.



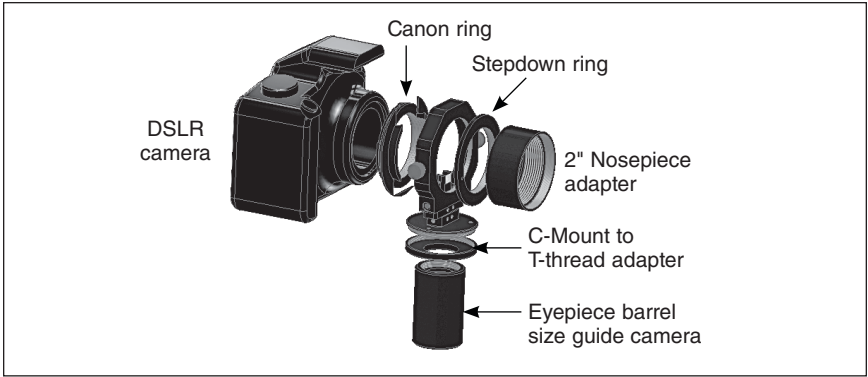
**Figure 4.** Side-to-side adjustment

To adjust the prism's vertical position (**Figure 3**), first loosen the lower two prism tube stabilization setscrews under the guider platform, facing the telescope side. Use the included hex key to loosen each about half a turn. Then loosen the lateral setscrew to the right of the *lower* two stabilization setscrews. Now the prism tube should be able to be moved freely up or down. Set the correct position (see **Section 3**) then re-tighten the three setscrews.

Note that you can move the prism tube relative to the guider platform a limited amount by loosening the upper two prism tube stabilization setscrews and the two lateral setscrews to the left and right of them. The top of the prism tube can be sunk down slightly from the surface of the guider platform (see right-most illustration of **Figure 3**), but care should be taken to avoid having the tube drop down too far or slip out.

#### *Optional Side-to-Side Adjustment (Transverse Adjustment)*

The pick-off prism can be adjusted side-to-side a small distance, using the two transverse adjustment thumbscrews (**Figure 2**). Turn both thumbscrews toward or away from you to move the prism laterally (**Figure 4**). This is a great feature when looking for a suitable guide star, as it allows having a virtual prism with about twice the width of the original prism. This adjustment should only be done after



**Figure 5.** DSLR camera and eyepiece barrel-size autoguider

setting the correct main camera and autoguider spacing and when looking for a guide star.

### **1.2. Setting the Correct Main Camera and Autoguider Spacing**

The main camera and autoguider must come to the same focus point to successfully operate the TOAG. The imaging chip in your CCD or DSLR camera and the detector in your autoguider must be equidistant to the focal plane of your telescope. We suggest using the Orion T-thread Spacing Kit #05528 (not included) to add spacing, if necessary, to achieve the required focus distance. It may be necessary to add more than one spacer to the imaging end or to the guide end.

Start by measuring the distance from the main camera sensor to the center of the TOAG. The measured distance should then be applied to the same autoguider sensor as well.

## **2. Matching the Orion TOAG to Different Imaging Trains**

Once having successfully determined the required spacing between the main camera and autoguider to the prism (both cameras are now equidistant), and adjusted the pick-off prism depth, you are ready for the next step: preparing your setup. Here are three examples to help you get started.

### **2.1. Basic Imaging Train Set-Up**

An imaging train is usually composed of a main camera, the autoguider, the TOAG and other useful accessories such as a filter wheel.

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Simple imaging trains are preferable to more complex ones. Simplicity means fewer variables to control. Below you will find some examples that we consider simple and that cover a diversity of use.

*2.1.1. DSLR Camera and Autoguider*

*2.1.2. DSLR Camera with Coma Corrector*

*2.1.3. CCD Imaging Camera and Autoguider*

### **2.1.1. DSLR Camera and Autoguider**

This is probably the most common use of a TOAG as it allows it to be used with a wide range of telescopes and DSLRs. Below we discuss mounting a Canon DSLR body onto a telescope. Refer to the schematic in **Figure 5**.

Choose the Canon-camera compatible adapter (#3) from the supplied adapters. Start by removing the DSLR objective lens, by pressing the objective release button on the camera body to remove the lens.

Installing the Canon-camera compatible adapter is done the same way as installing a lens. Rotate it until it clicks, just like the lens would do.

Now place the autoguider on the guide end of the TOAG. You can thread the guide camera to the supplied C-mount to T-threads adapter (#7) if the autoguider is compatible with C-mount threads, or alternatively you can thread the autoguider to the TOAG if it uses T-threads.

We have designed the TOAG so even autoguiders that are not compatible with C-mount or T-threads can be used (if the autoguider has a 1.25" barrel). Simply insert the camera barrel on the guide platform inside the ring of T-threads and use the supplied hex key to secure it.

Insert the TOAG (the autoguider already installed) into the Canon-camera ring so that the pick-off prism is centered between the Canon Ring "lips" (**Figure 5**). This is important if you wish to use the side-to-side adjustment, as it requires enough space to move the prism from one side to the other.

Spacers might be required to adjust the distance from the guide camera sensor to the TOAG prism.

### **2.1.2. DSLR Camera with Coma Corrector**

The TOAG is especially interesting when used in combination with a coma corrector, which can improve star size and star shape on the edge of the image frame.

As mentioned before, the correct distance between the coma corrector and the camera sensor is important to achieve good results. Getting pinpoint star images across the full frame depends on how well the correct distance is achieved. This distance depends not only on the telescope f-ratio but also on the camera make/model. In the example below, we use the MPCC III Coma Corrector (not included).



**Figure 6. a)** DSLR Camera with TOAG and MPCC spacer, **b)** Coma-corrector at the required distance to the camera sensor.

This coma corrector is optimized for a working distance of 55mm for an f-ratio of f/4.5.

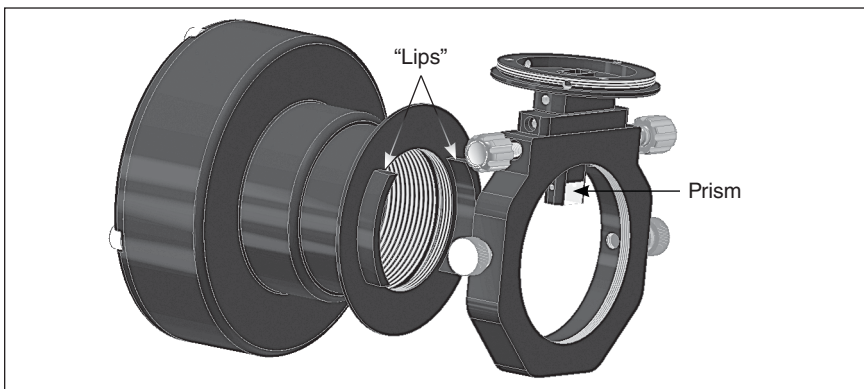
Refer to **Figures 1 and 6** as you do the following:

- Start by removing the step-down ring (#5) from the TOAG and replace it with the Coma Corrector Spacer (#6).
- Prepare the MPCC III to be installed into the TOAG by removing the T-ring and M48 flange from the MPCC as shown in **Figure 7**. The MPCC now has M48-male threads exposed that can be threaded to the spacer.
- Thread the MPCC to the TOAG body. The total distance from the MPCC III to the camera sensor is now about 55.5mm (**Figure 6b**), within the MPCC III specification.
- The TOAG/Camera/Coma Corrector can now be installed in your telescope's focuser.





**Figure 7.** Removing the MPCC III T-threads adapter to expose the M48 threads.



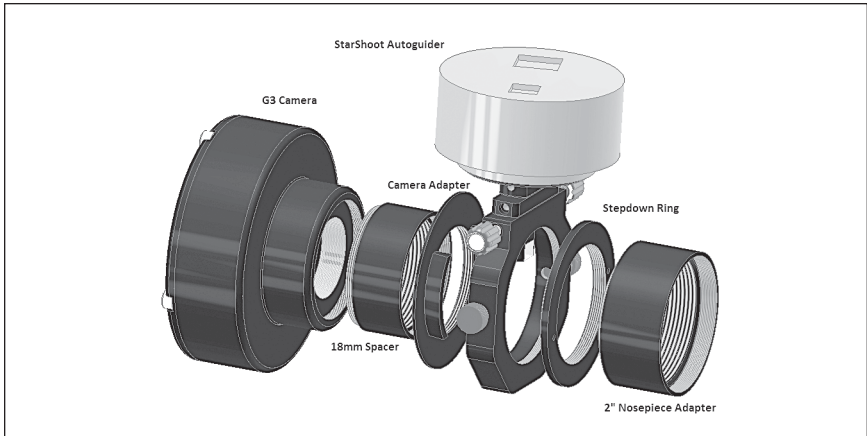
**Figure 8.** The camera adapter “lips” are shown parallel to the pick-off prism tube.

### **2.1.3. CCD Imaging Camera and Autoguider (Using the StarShoot G3 and StarShoot AutoGuider as an example)**

Dedicated CCD imaging cameras usually have fairly short back-focus requirements. This allows more flexibility when setting up the imaging train. Filter wheels and other dedicated accessories are normally difficult to use with the limited back-focus of Newtonian reflectors and normal off-axis guiders; an Orion TOAG is thin enough to allow their use.

To adapt a CCD imaging camera to the TOAG:

- a. The supplied Camera T-thread Adapter (#4) with its male T-threads should be installed on the main camera (**Figure 8**).
- b. The Camera T-thread Adapter lips should be parallel to the prism tube. This allows the prism to freely move side-to-side if required. Place the camera with the installed ring into the TOAG and tighten the two (lower) lateral thumbscrews. It is important to keep the system as solid as possible.



**Figure 9.** StarShoot G3 camera with StarShoot Autoguider

- c. Thread the StarShoot Autoguider onto the T-threads of the guider platform and the TOAG body onto a filter wheel (if being used) or the 2" nosepiece adapter for attaching the unit to a telescope, as shown in **Figure 9**.

### 3. Adjusting the Autoguider On the TOAG

When your main camera and autoguider are installed and the TOAG is connected to your telescope, you are ready to adjust the distance between the autoguider and the TOAG.

#### How to Adjust the Autoguider Distance

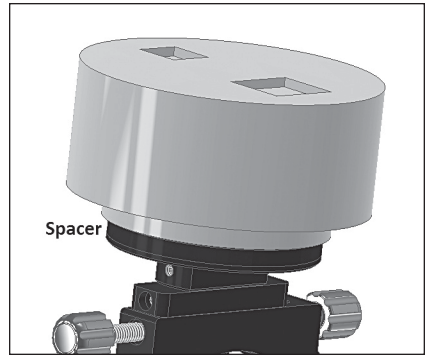
Because the pick-up prism only intercepts a small portion of the light coming from the telescope, finding a guide star without interfering with the main camera view can sometimes be challenging. To familiarize yourself with an off-axis guider we suggest that the initial distance adjustment should be set during daytime.

- a. Start by focusing the main camera. Use the telescope's focuser; we suggest using a distant terrestrial object as target. This ensures that the obtained focused image is at a focuser barrel position close to infinite focus (star focus position).
- b. Although the distance from the main camera to the TOAG is approximately the same from the autoguider sensor to the center of the TOAG you may need to refine this distance (using optional spacer rings).
- c. Compare the obtained main camera image to the autoguider image. The autoguider image might be out of focus. If so, loosen the upper two prism tube stabilization setscrews and the two lateral setscrews adjacent to them (refer to **Figure 2**). This allows you to move the guider platform up or down a few millimeters – without moving the prism tube. Move the guider

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platform up or down until you reach focus (if possible). Then re-tighten the four setscrews.

- d. If the focus is further in you should add some spacing to the main camera side. If it is further out you will need to add a spacer between the guide platform and your guide camera, as depicted in **Figure 10**.



**Figure 10.** Adding a spacer to get optimum distance

## 4. Debunking Off-Axis Guider Myths

### **How Does Autoguider Focus Affect the Guiding Performance?**

It is not required to get razor sharp focus with the autoguider camera. Most autoguiders have a very small pixel size. The algorithm used for guiding takes into account the centroid of the star. Some people even find that better results are achieved when slightly defocused guide stars are used.

However one should try to get a fairly focused image so that the star flux is high against the background. Autoguider sensitivity plays an important role in this matter.

### **Off-Axis Guiders Are Less Sensitive than Guidesopes?**

The answer is no and... yes. Yes, because you only get a tiny portion of the light cone from the telescope. But then again you are getting the pick-off prism light from a fairly larger aperture (telescope aperture) compared to what you would get with a guidescope.

A 6" aperture telescope with an OAG will always show more guide stars than a 50mm guidescope.

### **Finding Suitable Stars with an Off-Axis Guider Is Difficult!**

Autoguider sensitivity plays a major role in finding suitable guide stars, more than the off-axis guider itself. There are more pros than cons with an OAG. Telescope differential flexure is compensated only with an OAG. But there's also the camera, focuser, adapter flexure and any other variables between the OAG and the telescope to consider. With the OAG all these variable are under control.

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## 5. Care and Storage

Be careful not to accidentally strike the delicate pick-off prism inside the guider. If necessary, you may use a cotton swab with cleaning solution (approved for multi-coated glass) to gently clean the surface of the prism.

The Orion TOAG, if treated with care, should last a lifetime. Store the TOAG in its original packaging when not in use.

### One-Year Limited Warranty

This Orion product is warranted against defects in materials or workmanship for a period of one year from the date of purchase. This warranty is for the benefit of the original retail purchaser only. During this warranty period Orion Telescopes & Binoculars will repair or replace, at Orion's option, any warranted instrument that proves to be defective, provided it is returned postage paid. Proof of purchase (such as a copy of the original receipt) is required. This warranty is only valid in the country of purchase.

This warranty does not apply if, in Orion's judgment, the instrument has been abused, mishandled, or modified, nor does it apply to normal wear and tear. This warranty gives you specific legal rights. It is not intended to remove or restrict your other legal rights under applicable local consumer law; your state or national statutory consumer rights governing the sale of consumer goods remain fully applicable.

For further warranty information, please visit [www.OrionTelescopes.com/warranty](http://www.OrionTelescopes.com/warranty).



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