Borg 50 Guide Scope and X-Y Stage

A Solid, Versatile Guide-Scope Platform with a New X-Y Twist

By Craig Stark

The Mini Borg has been on the market in various incarnations for many years now and like all Borg telescopes, it comes in many flavors. As discussed in my review of the Borg 101 ED f/4 (*ATT* April 2008), it's more accurate to say that it is a build-to-suit telescope that you can configure (and re-configure) to suit your needs. Astro Hutech offers a number of pre-configured versions, but these can be thought of as suggestions or examples in what is really an à la carte menu.

One suggestion, or rather set of suggestions, configures the Mini Borg as a guide scope (**Image 1** on next page). I say "set of suggestions," for while their current website lists "basic" and "deluxe" 50-mm versions, there are in fact eight variations on the theme. In true Borg style, with the choice of two objectives, one has 16 possible configurations of the optical tube assembly (OTA) itself (and there are in fact four possible objectives). Flexibility is a central tenet of the Borg philosophy. Heck, there are even three ways you can choose to mount your guide camera to the scope. In truth, there are even two versions of the "basic" model as well. Lest this seem daunting, I can say that with any of the configurations, you'll end up with an excellent guide scope.

The Parts

The Mini Borg system has four possible objectives: a 45-mm f/7.2 ED doublet, a 50-mm f/5 achromat, a 60-mm f/5.4 achromat, and a 60-mm f/5.8 ED. Since the goal here is service as a guide scope where image quality is not paramount, the least expensive objective (the 50-mm achromat) is tested here. Next in line after the objective are a number of tubes with the number and length varying depending on how much distance is needed to let your camera (or eyepiece) reach focus. The tube length selected will vary, of course, based on what other parts you have attached (e.g., style of focuser). After this, you have a number of options to choose from.

First, you can attach a basic drawtube that slides in and out and is fixed in place with two non-marring thumbscrews that hold it very solidly when locked down. For some, this drawtube will be used for rough focus as a helical focuser will be added downstream. If this is going to serve as a guide scope only, the drawtube can serve as the one and only focuser. It's true that finding focus is a bit annoying with a simple drawtube, but it is effective and since this is a guide scope, odds are you can focus once and never need to change it. Being perfectly functional for this use, this serves as the focusing option in the "basic" version supplied by Astro Hutech.

Your next option is an X-Y stage that moves the camera around in the field of view. The X-Y stage is the centerpiece of the "deluxe" version and is the place where the Borg guide scope makes a substantial departure from typical guide rigs. The stage has threads on both ends to provide a solid connection to the rest of the telescope and to your camera or fine focuser. Two screws run along sides of the stage and knurled knobs at both

Image 1: Borg guide scope with (a) drawtube , (b) X-Y stage, and (c) helical focuser all attached. For most uses, either the drawtube or the helical fine focuser would be used but not both. Several extension tubes (d) that let you customize the length of the main tube are also shown. Inset shows close-up of X-Y stage and helical focuser. Note, silver set-screws on focuser provide 3-point clamping of 1.25-inch tubes and can be removed to allow a T-mount camera to attach even more securely. The black setscrew on the bottom of the focuser locks the focuser in place.

ends of both screws allow you to easily slide the camera around, hunting for your guide star. The system is very effective and very solid. I've seen a similar looking unit from another vendor that appears to use 1.25-inch tubes and set-screws to hold things in place rather than threaded connections. Given the potential for flex in tubes, my money would be on the Borg's threaded version. After using this, I'm ditching my rings. The motions are smooth, intuitive, and flex is a non-issue. Yes, it's that good.

Finally, you can opt for a helical fine focuser. This is another gem of a part. Like the other Borg helical focusers, the unit does not rotate, so you can remove the image of typical eyepiece fine focusers from your mind. Instead, it acts like a SLR camera lens focuser, smoothly moving in and out. It goes beyond this by providing some well thought-out details. First, it's marked in 50-micron increments along the 10 mm of travel to let you hit the same focus position across sessions. Second, it has a nice locking mechanism to let you clamp down your focus. Third, when

using the 1.25-inch eyepiece-style connection, it uses two set screws at 120 degrees apart to provide a solid 3-point clamp onto your camera's nose (the third point being the other side of the tube). Finally, Borg thought to thread the outside edge of the focuser with T-threads so that you can hard-mount your camera onto the focuser and still have a smooth control over focus. Flex in the focuser is minimal.

Flex Tests

In the last year, I've given talks at NEAIC and at the Julian Starfest in which I covered modifications to a Meade ETX-70 refractor to get it up to snuff for guide-scope duty. Stock, the scope had a good amount of flex in various places and since I'd bought this used and in rough shape, I didn't mind solving the problems by liberally applying glue to all moving parts (once focus had been achieved). To further reduce flex, I use a T-thread adapter screwed onto the back of the built-in flip mirror assembly. The resulting guide scope still had some flex, but a lot less than it started with and a lot less than the rigs many people use routinely. This glued-up refractor served as the basis for a comparison test with various versions of the Borg rig.

The test was simple. I mounted a main, imaging OTA (Borg 101 ED at f/6.3) and camera (Canon EOS XSi) on one side of my Telescope Stability Systems dual-saddle (Vixen-style dovetails for the scopes and a Losmandy style plate to attach to the mount). The guide scope under test was mounted in the other saddle and a Fishcamp Starfish was attached to the guide scope (the Fishcamp is a rather substantial guide camera). For the Meade refractor, a pair of ADM adjustable rings was used and for the Borg guide scope, the supplied fixed rings were used.

The rig was placed on one side of the mount (Takahashi EM-10 riding on a Telescope Stability Systems StableMax tripod) and a distant terrestrial target (a cell phone tower about 3 miles away) was centered in both cameras by adjusting the mount (main camera) and the rings or X-Y finder (guide cam-

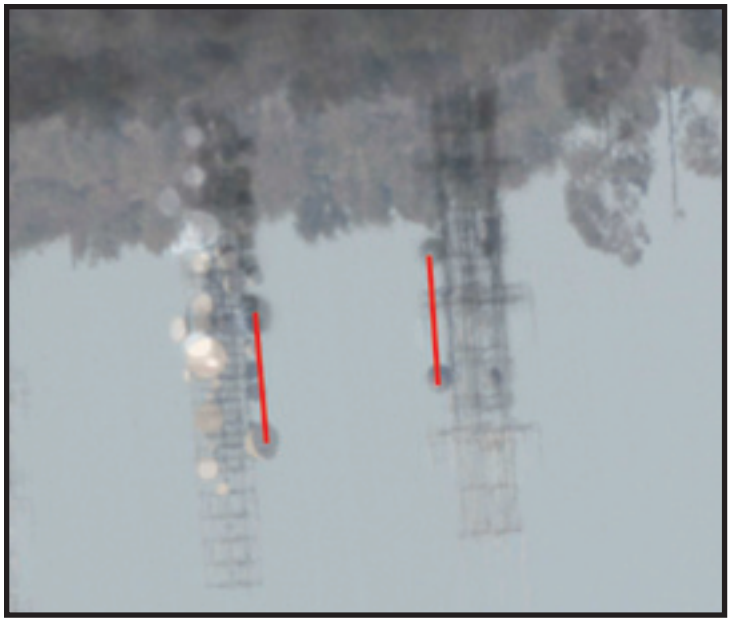

Image 2: Flex in the modified ETX-70 guide scope. Red lines indicate amount of flex (differential between images taken on both sides of the mount) in the entire system.

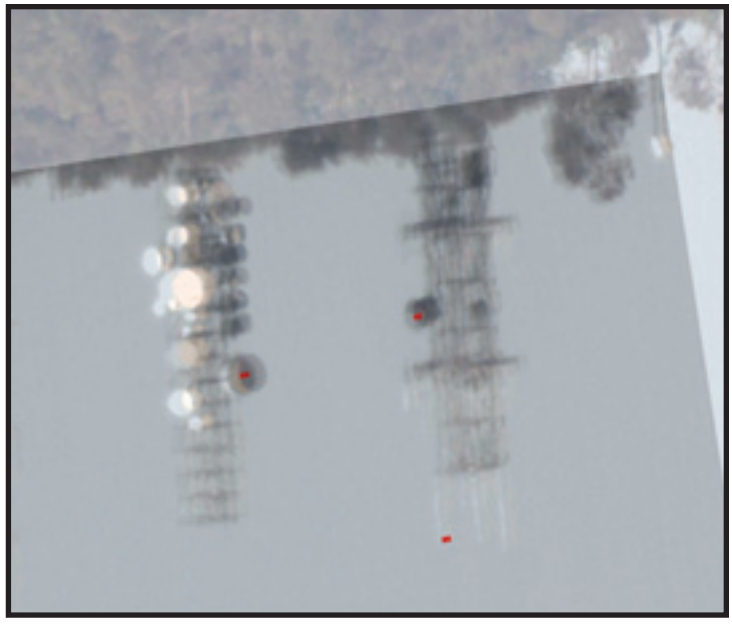

Image 3: Flex in the Borg guide scope with only the helical fine focuser attached.

era). A picture was taken through each camera and the rig was rotated to the other side of the mount. By rotating the rig like this, gravity is now pulling in the opposite direction on each part. Any differential flex between the two cameras will now be at its worst. The same target was again centered in the main camera by adjusting the mount and no adjustment was made for the guide camera. A picture was then taken through each camera and the process was repeated for the various configurations under test.

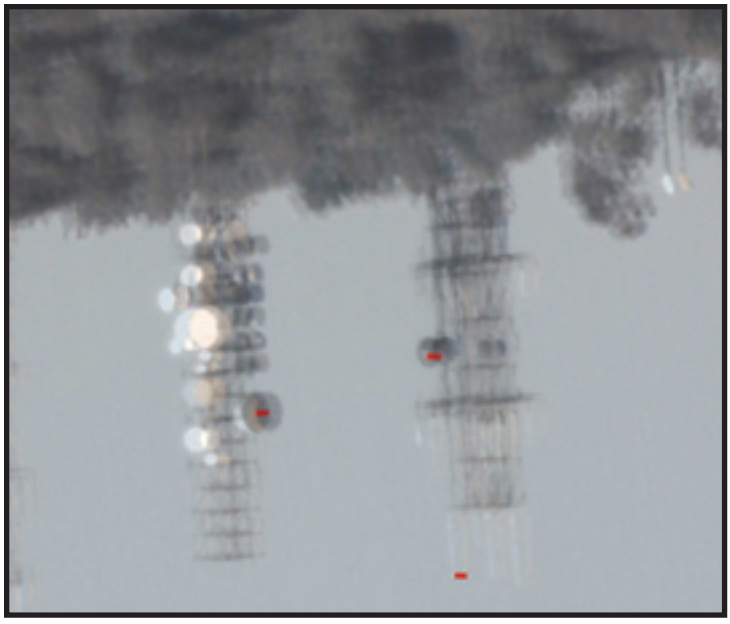

Image 4: Flex in the Borg guide scope with the X-Y finder and helical fine focuser attached.

The images were then analyzed in *Photoshop*. Using the Transformation tool the image scale, translation, and rotation was determined by overlaying the first pair of images from the two cameras. If there were no flex in the system at all, this same transformation could be applied to the images from the other side of the mount and the result would be a perfectly overlapping pair of images. If there is flex anywhere in the system, some displacement will be apparent. Lines were drawn between common points in the two images and measured to both visually and quantitatively measure how much flex is in each setup. It is worth reiterating that the flex shown here in **Images 2-4** is the total flex in the entire system. Any flex in either focuser, either tube, either method of mounting the tubes, etc. will show up in these images.

What we can see from these images is that the difference in flex between my current guide rig (that had its moving parts glued in place) and the Borg is nothing short of remarkable. While the Borg in various configurations ranged from 20-30 pixels (35-50 arcseconds) of total flex (not all of which will be in the Borg guide scope), my other guide rig came in at 250 pixels (425 arcseconds). The other guide rig is no slouch but did register about 1 pixel of flex-induced drift every 7 minutes while imaging with my 8-inch f/4 scope at 2 arcseconds/pixel. With the Borg showing 10x less flex, this would come to under one pixel of flex-induced drift in my main image camera in an hour. I can certainly live with that.

Coverage Tests

I mentioned before that the X-Y finder was a joy to use. Its motions were not only smooth and accurate, but they were also far more intuitive than typical three-screw adjustable guide rings. I've got nothing against guide rings and the pair I own from ADM are very well-made and solid. For guide rings, I couldn't ask for anything more. However, for ease of finding a guide star, three-point rings leave a bit to be desired. Or at least they do after you've had a chance to try the X-Y stage. What used to be a somewhat frustrating chore is now entirely effortless as one spins the knobs to smoothly and easily pan around the field of view.

All this joy would be short lived if the adjustments were limited and this was a concern of mine going in. How much could I move around in the field of view and how much of the field of view would produce decent stars? Using the stars around Vega, I measured the total travel of the X-Y stage on the Borg guide scope at 3.6 degrees field of view (FOV) with a 1/2-inch guide chip of about 1.5 degrees and total FOV covered was 4.9 degrees over the entire adjustment range. Within this range, 2.5 degrees worth of sky produced very clean stars. Odds are pretty good you can find a guide star in a swath of sky that is five moons across and five moons high. Adjustment range is not an issue.

Conclusions

The Mini Borg has long been used as a finder scope, a wide-field scope, and a travel scope. To this list, we can certainly add the ability to be a guide scope. The Borg 50-mm guide scope is well engineered for this task and has it where it counts. The guide scope is incredibly solid. All of the parts either thread together or, when tubes are used, tolerances are tight and dual set-screws are used for a rigid assembly.

The rig is also very light, weighing in at between 0.8 and 1.4 lbs (without rings or dovetail), another key consideration for a guide scope. Finally, the system is incredibly versatile. You will never be in the position of being unable to reach focus or being unable to mount something solidly to the scope. No matter which configuration you choose, you won't go wrong. If anyone wants a glued-up old guide scope, I know where you can find one as Ted at Astro Hutech isn't getting this Borg 50 guide scope back. Instead, he's getting my credit card number. ATT