Alan Dyer

Joining the Borg

Two new refractors from Borg make resistance futile for astrophotographers wanting optics with wide, flat fields.

Borg Oasis Studio 77EDII and 101ED Refractors

US Price:

Borg 77EDII with f/4 Super Reducer	$1,795
Borg 101ED with f/4 Super Reducer	$2,495

Hutech Corp.
23505 Crenshaw Blvd., #225
Torrance, CA 90505
877-289-2674
www.sciencecenter.net/hutech

New 77- and 101-mm (pictured) refractors from Borg serve as portable visual instruments and, with the f/4 Super Reducer, wide-field astrographic lenses optimized for full-frame digital SLR cameras. (Tripod and camera not included.)

ALL PHOTOGRAPHS BY ALAN DYER

WHAT WE LIKE:	WHAT WE DON'T LIKE:
Compact and lightweight	Slight chromatic aberration apparent visually
Superbly flat fields with reducer lenses	Light falloff at image corners
Versatile photo-visual system	Complex and confusing stacks of adapter rings

As digital cameras of every description appear on the scene with larger and larger sensors, manufacturers of astronomical optics are challenged to keep up. They are being asked to create systems capable of delivering tack-sharp images across the wide fields of demanding, big-chip cameras.

The Japanese telescope company Borg Oasis Studio has introduced new versions of its 77- and 101-mm apochromatic refractors that promise to do just that. Featuring objectives made with ED (extralow dispersion) glass, both scopes work with Borg's new f/4 Super Reducer ($995 if purchased separately), which turns these f/6.5 telescopes into fast astrographs. They claim to deliver sharp stars across camera chips as big as a 35-mm film frame.

I purchased the Borg 77EDII in early 2007 and used it to take dozens of images during a two-month astrophoto-palooza stint in Australia. From the moment the first images of the Large Magellanic Cloud and the Carina Nebula appeared on my camera's display, I knew the scope was performing as promised. I was impressed — and curious as to how the larger 101-mm scope would work. So, for this review, Hutech Corp., the North American distributor for the Borg line, lent *Sky & Telescope* a 101-mm-objective assembly to fit onto the tube components and focuser I already owned.

The Modular Borg

The Borg system requires some explanation. Lens, tube, and focuser parts are designed to be mixed and matched to make a scope tailored to the user. Hutech does, however, package sets of parts as complete systems, making the "smorgas-Borg" less confusing. In my case, I purchased the 77EDII telescope in its f/4 astrographic configuration, with no intention of using it visually. The package included the objective, tube components, focuser, a focal reducer, and the required adapter rings to mate it all together into a compact, 330-mm-focal-length, f/4.3 telephoto lens.

I also choose Hutech's $170 option to upgrade from the standard Borg helical focuser to a Starlight Instruments Feather Touch focuser, now common on many high-end scopes. I highly recommend this upgrade, since achieving sharp images with any fast-focal-ratio system requires ultraprecise focusing, which is something the dual-speed Feather Touch does with ease.

For this review, Hutech also lent us the Borg components needed to convert my dedicated f/4 imaging setup for use visually at f/6.5 and photographically at f/5.5 using the "conventional" 0.85× focal reducer. The unique modular nature of the Borg system allowed me to test the 101-mm lens simply by swapping it for the 77-mm objective assembly.

Testing for Flatness

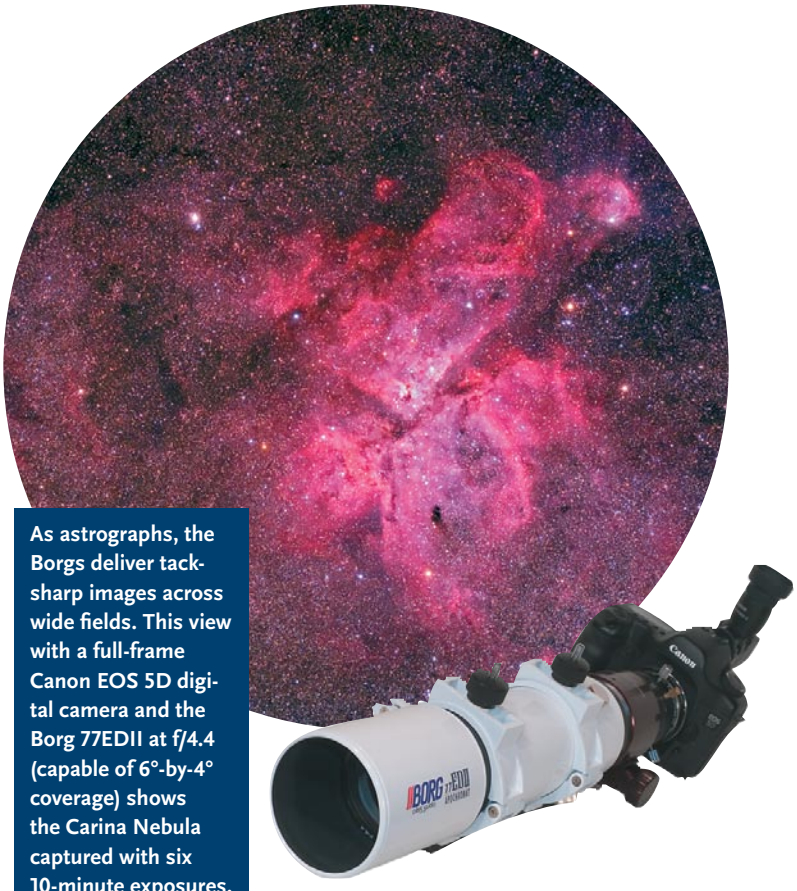
I was particularly interested in testing the astrographic performance of the scopes with the f/4 Super Reducer. I was familiar with the 77-mm's performance, but would the 101-mm work as well?

"Field flatness" is an ambiguous term. For photographers it can mean a frame with pinpoint star images corner to corner, or it can mean a frame that is uniformly illuminated corner to corner. I tested both characteristics. In the sharpness test, both Borgs passed with honors. In the uniformity test, there were problems, but ones that are easily solved during image processing.

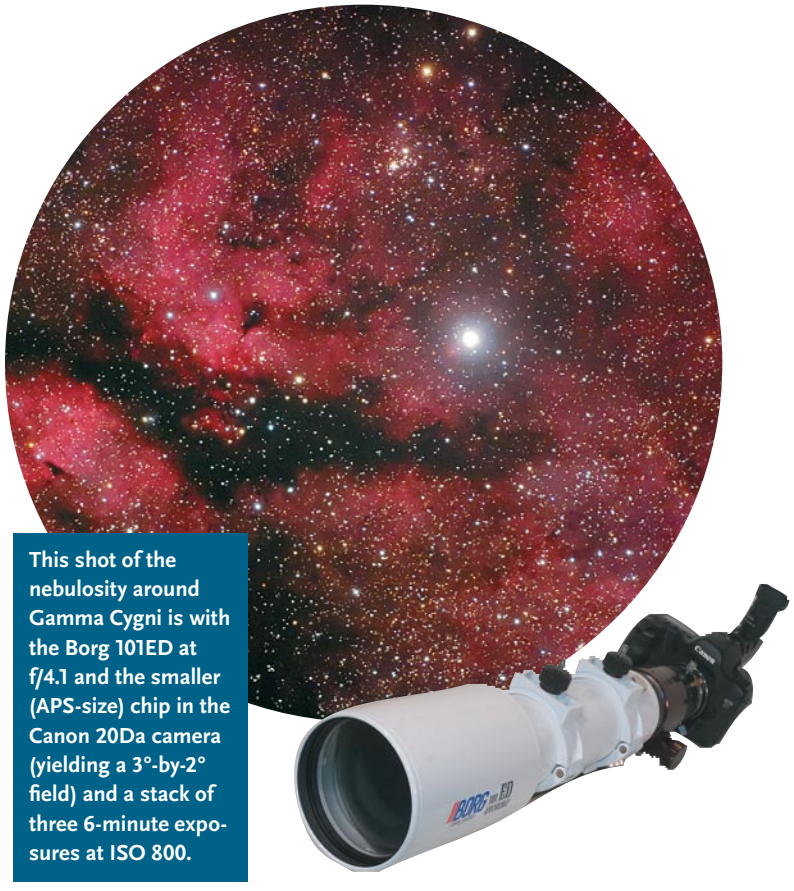
I used a filter-modified Canon EOS 5D camera (also from Hutech), which is among the new breed of digital SLRs with a 24-by-36-mm chip, the size of a 35-mm film frame. The combination of this "full-frame" camera and the Borg f/4 optics proved a superb match. Both the 77- and 101-mm objectives, coupled with the f/4 Super Reducer, produced sharp stars across the 5D's entire frame. Both scopes performed equally well. There was only a slight elongation of star images at the extreme corners of the frame, mostly apparent, I found, on shots with slightly soft focus. With digital SLR cameras having the smaller, APS-size sensors, images were absolutely clean to the corners.

Photographically, I found little sign of chromatic aberration, nor did I see any odd halos or internal reflections around bright stars. On rare occasions, a bright star near the edge of the 5D's field did produce a large but faint nebula-like lens flare.

The Borgs' principle optical flaw is one inherent to most fast systems incorporating focal reducers: image brightness falls off toward the corners of the field. The 5D's frame had a bright central area and dark corners. A camera with a smaller chip would crop the field and not reveal as much of this vignetting. I found, however, that even the 5D's images were a snap to fix using the *Adobe Photoshop* Lens Correction filter (located in the software's CS2 and CS3 versions under Filter > Distort > Lens Correction), which



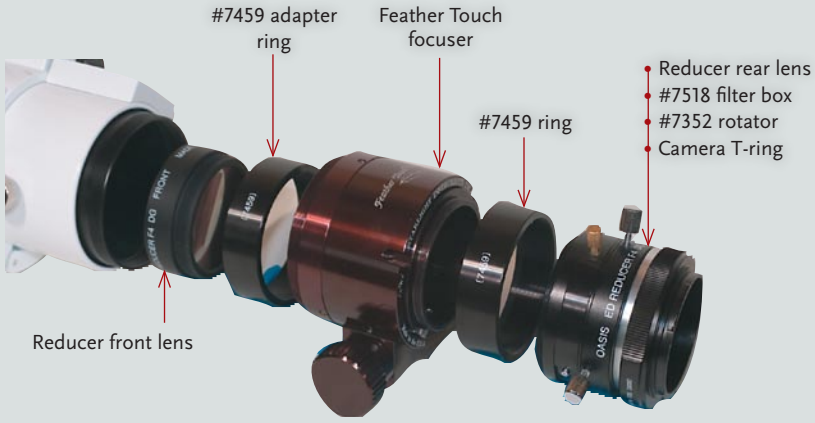
As astrographs, the Borgs deliver tack-sharp images across wide fields. This view with a full-frame Canon EOS 5D digital camera and the Borg 77EDII at f/4.4 (capable of 6°-by-4° coverage) shows the Carina Nebula captured with six 10-minute exposures.



This shot of the nebulosity around Gamma Cygni is with the Borg 101ED at f/4.1 and the smaller (APS-size) chip in the Canon 20Da camera (yielding a 3°-by-2° field) and a stack of three 6-minute exposures at ISO 800.

makes it easy to brighten up the corners and even out the sky background.

The image circle with the f/4 Super Reducer is about 55 mm in diameter with both Borgs. This is more than enough to fill most of today's camera chips, but it's less than that offered by some refractors with giant focusers and huge field flatteners designed to cover medium-format film and heavyweight CCD cameras. On the other hand, the Borgs aren't giant scopes! They are wonderfully light and compact, doing exactly what they are optimized to do: fill a full-frame digital SLR camera with pinpoint stars.



The Borg f/4 Super Reducer includes a lens that screws onto the front of the focuser (in this case the optional Feather Touch model) and another doublet at the rear. The rear assembly also includes a slide-in filter box, a camera-angle adjuster for orienting the camera without losing focus (it worked very well), and a T-ring for your SLR camera body. Adapters for astronomical CCD cameras from SBIG and Starlight Xpress are also available.

The f/5 Alternative

The two Borgs don't have to be used with the f/4 Super Reducer. The 77- and 101-mm scopes can be purchased as traditional visual instruments and used with Borg's less-costly 0.85× DG-L focal reducer ($349). This combination turns the 77-mm into an f/5.5 telephoto lens with a focal length of about 420 mm. The 101-mm becomes an f/5.3 lens with a focal length of about 550 mm. Exposure times are longer for extended (nonstellar) objects than at f/4, but the extra focal length is ideal for framing smaller targets.

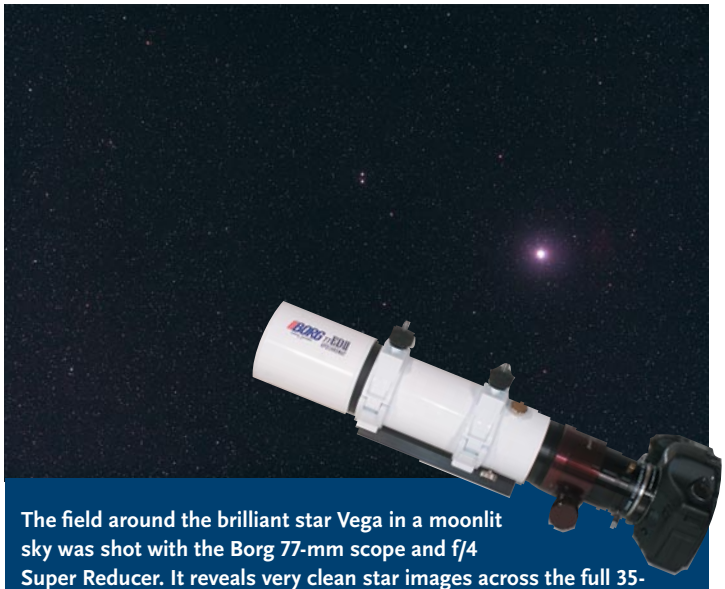
Images with the 0.85× reducer also proved tack sharp across the full frame of the 5D. Darkening of the frame corners was less pronounced than with the f/4 setup. In *Photoshop,* only about half as much anti-vignetting compensation had to be applied to even out the frame illumination.

Switching modes from f/4 to f/5.5 requires a lot of disassembly of lenses and adapters, along with the insertion of additional extension tubes. It's not a swap that I would recommend observers try doing in the field when it's dark outside.

But Can You Look Through Them?

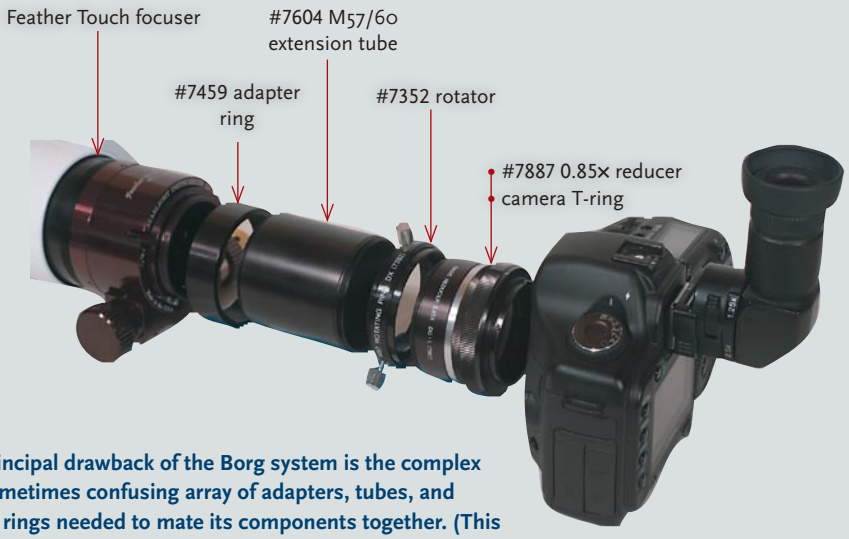
You bet! Both instruments by nature are f/6.5 apo refractors. Without any focal reducers, and with the appropriate 2-inch adapter (Borg part #7504, $37) and extension tube (#7604, $35) in place, the scopes work well with 2-inch diagonals and eyepieces.

Both exhibited classic ED-doublet performance: very little false color, even when I was observing bright stars, planets, and



The field around the brilliant star Vega in a moonlit sky was shot with the Borg 77-mm scope and f/4 Super Reducer. It reveals very clean star images across the full 35-mm-size frame of a Canon 5D camera.

The same sky region was also captured with the 101-mm scope and f/4 Super Reducer. As with the Canon 5D view made using the smaller objective, only at the very corners of the frame are star images slightly distorted.



The principal drawback of the Borg system is the complex and sometimes confusing array of adapters, tubes, and spacer rings needed to mate its components together. (This is the stack required for the 0.85× focal reducer.) Lose or forget one crucial ring, and the telescope can be rendered useless.

the lunar limb at high magnification. Color became apparent only when I racked the telescopes out of focus, with stellar diffraction disks showing a green rim outside of focus and a magenta cast inside focus. The 77-mm showed a little less color than the 101-mm, as expected for its smaller aperture, and it didn't exhibit any noticeable spherical aberration or astigmatism. In sensitive star testing, the 101-mm did show slight spherical aberration, indicating the lens was a little undercorrected, but this had marginal effect on the sharpness of in-focus images.

Both instruments worked well with eyepieces ranging from panoramic views with a Tele Vue 31-mm Nagler to high-power close-ups with a Tele Vue 3-mm Radian. The generous back focus of the Borgs allowed them to work with a popular imported binoviewer and 2-inch star diagonal, as long as the binoviewer's compensating Barlow lens was in place. Without the Barlow lens, the binoviewer just barely reached focus with a 1¼-inch diagonal.

The Borgs have the advantage of being much smaller than other telescopes in their aperture class. For example, the 101-mm I tested is similar in length and weight to popular 90-mm apos. For the versatility of a lightweight travel scope that can serve as a top-class astrophoto lens and as a fine visual instrument, you can't beat the Borgs.

The Beauty of the Borgs

A 300- to 400-mm-focal-length range is ideal for capturing large nebulae and Milky Way star fields, but until now the options in that range have been limited and costly. Sure, you can get dedicated telephoto lenses to do this job, but a 400-mm f/4 name-brand telephoto can cost upward of $5,000 and, I suspect, still might not offer the good color correction and flat field of the little Borgs. Big, hefty telephotos are certainly much harder to focus precisely and attach securely to a telescope or mount.

By contrast, the drilled mounting rings for the Borg system make it easy to attach them to dovetail plates and mount heads. A filter box that connects to the f/4 Super Reducer makes it easy to slide a specialty filter into the light path, something not practical with most big telephoto lenses.

The two Borgs in their f/4 configuration nicely bridge the gap between short, easy-to-piggyback telephoto lenses (200 mm and less) and most other telescopes whose focal lengths start at 500 mm with narrower fields and slower f/5 to f/6 focal ratios.

I'm a big fan of wide-field imaging — deep-sky shots 3° to 6° across — using optics that are fast and sharp, to keep quality up and exposure time down. If, like me, you want great deep-sky images of nebulae and star fields with a minimum of effort, the 77- and 101-mm Borg astrographic refractors will deliver. Take it from this satisfied user: they work great. I highly recommend them. ✦

***Alan Dyer** says that he wouldn't be doing astrophotography if it weren't for today's superb, portable, fast optics and easy-to-use digital SLR cameras.*

SPECIFICATIONS & MEASUREMENTS*

BORG 77EDII		BORG 101ED	
Clear aperture	76 mm	Clear aperture	100 mm
Effective focal length	331 mm	Effective focal length	414 mm
Focal ratio	f/4.36	Focal ratio	f/4.14
Weight	4.2 pounds (1.9 kg)	Weight	6.2 pounds (2.5 kg)
Minimum tube length	16.5 inches (42 cm)	Minimum tube length	20 inches (51 cm)

* All measurements by *Sky & Telescope*; telescopes equipped with f/4 Super Reducer and optional Feather Touch focuser.

S&T RATINGS

Optics	★★★★
Mechanics	★★★★
Overall	★★★★

★★★★★ Sensibly perfect. No meaningful improvements possible
★★★★ Any shortcomings will go unnoticed in normal use.
★★★ Problems noticeable but do not seriously affect performance.
★★ Problems noticeable during normal use — performance compromised.
★ Problems so severe that the equipment is virtually unusable.

Ratings are intended to convey performance compared with equivalent equipment and should not be used to predict the relative performance of instruments having markedly different designs or specifications.

Bottom-line summary:
Built around a modular system that lets you mix and match components, including objectives and focusers, the 77- and 101-mm Borg ED refractors are lightweight, highly versatile instruments for visual and photographic use at several effective focal ratios.