DOUBLE VISION

Here's a great way to boost your imaging output when conditions are favorable.

▲ **TWO "EYES" ON THE SKY** Canadian astrophotographer Ron Brecher gets nearly twice as much exposure time with every target by piggybacking a Takahashi FSQ-106ED astrograph atop a Sky-Watcher Esprit 150 triplet apochromatic refractor. The larger scope images with a monochrome QHY16200A CCD camera, while the smaller FSQ records the same field with a QHY367C Pro color CMOS camera.

For most astrophotographers, clear skies can be infrequent and brief, particularly in the summer months when astronomical darkness lasts just a few hours. Setting up the equipment, recording calibration frames, and refocusing periodically all consume precious time and further reduce how much light we can capture in a single night. And if you have to travel to escape bright skies, you can lose even more valuable hours. So, what can you do to maximize your output on those rare nights when the stars do beckon? Here's a novel approach that can double your output.

Taking inspiration from the rock band Foreigner's classic rock song "Double Vision," I recently installed a pair of telescopes and cameras on my equatorial mount so that both can simultaneously accumulate images. It takes some planning, but a dual-scope imaging setup can vastly increase your output. Here's how to do it.

It's All About the Mount

As with any astrophotography, several pieces of hardware need to work together efficiently in a tandem imaging setup. At minimum, you'll need a solid tracking mount, two imaging telescopes, two cameras, and a control computer. Most setups will also require two electronic focusers and an autoguiding setup consisting of a guide camera attached to a guidescope or an off-axis guider.

First let's consider the mount. Regardless of whether you're using small refractors or large astrographs, a solid tracking mount is the key to a reliable dual-imaging platform. Your mount will be holding a lot of extra mass and will still need to be able to track precisely. I suggest keeping the total weight well below the manufacturer's stated limit, or else you may end up rejecting lots of poorly tracked images, defeating the entire point of the two-scope configuration. Imagers with light-duty mounts can use two small refractors or even a pair of telephoto lenses — the key is accurate tracking.

Be sure to either weigh or look up the weights of the individual components and add them together. Include everything that will ride on your mount — don't forget the dovetail plates, clamps, tube rings, filter wheels, focusers, guidescopes, and electronic components. The total must be less than the maximum load capacity of your mount.

Optical Choices

The next consideration for a dual-scope imaging system is the optics themselves. You need to ask yourself what you want each scope to do. Some imagers use identical telescopes and matching cameras to maximize the total exposure time. An extreme example of this method is the Dragonfly array in New Mexico (*S&T:* May 2019, p. 64), which uses 48 similar cameras and lenses on two mounts to record 48× more exposure time per hour than would be possible with a single assembly! Others opt for two different telescopes with slightly different tasks, such as having one shoot luminance while the other telescope records color data that will contribute to the same image.

I've found that dual-scope imaging platforms are easier to put together using refractors rather than reflectors. One reason is that optical elements are more prone to shifting and flexure in a mirror telescope than in a refractor. Additionally, it's extremely difficult to align and stack star images from two scopes that produce diffraction spikes. Other compound optical designs, such as Schmidt-Cassegrain telescopes, sometimes suffer from mirror shift, which further complicates a dual-scope system.

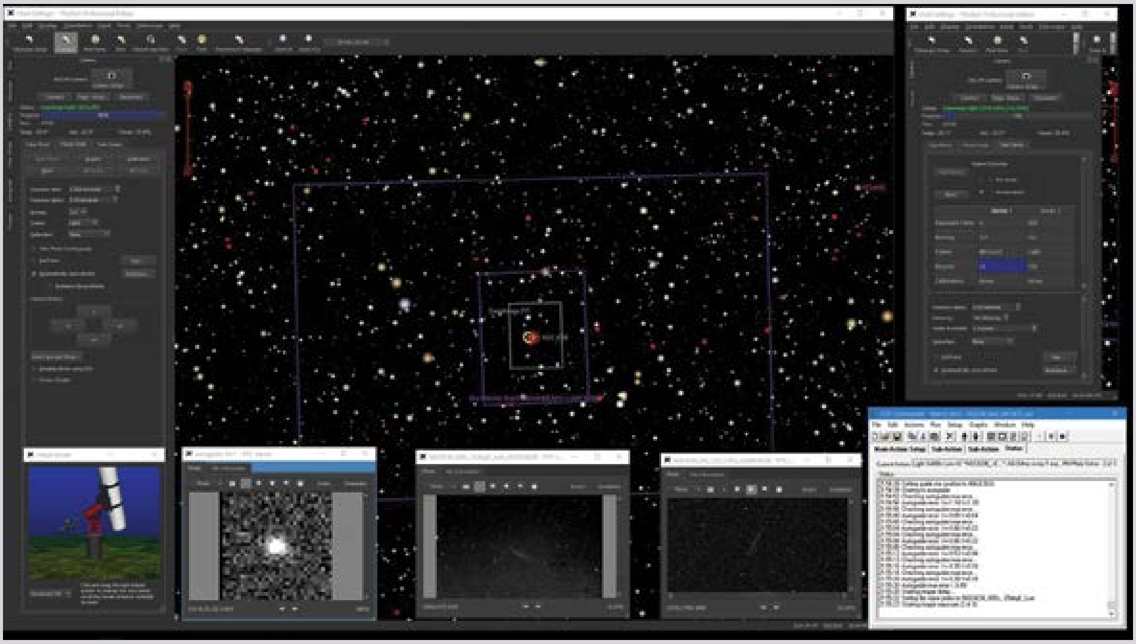
For my setup, I use a Sky-Watcher Esprit 150 6-inch apochromatic refractor (*S&T:* Feb. 2020, p. 68) with a QHYCCD QHY16200A monochrome CCD camera to record high-resolution images with an image scale of about 1.1 arcseconds per pixel. While the Esprit acquires luminance (monochrome images with UV and IR wavelengths blocked) or narrowband images, a Takahashi FSQ-106ED paired with a QHY367C Pro one-shot color (OSC) camera records color images at 2.6 arcseconds per pixel.

◀ **MOUNTED CONTROL** A dual-scope imaging system needs more ports than typically available on standard laptop computers. The author controls the mount, both imaging cameras, an autoguiding camera, two electronic focusers, and a filter wheel through his Primaluce Eagle 3 computer, seen mounted between the two refractors.

This combination works well and solves a few of the challenges posed by a dual-telescope system. First, because our eyes perceive detail mainly in the *lightness* (brightness and contrast) of an image, I can add the color from the lower-resolution pictures taken with the 106-mm scope to the higher-resolution luminance from the 150 Esprit to achieve a high-resolution color result.

A second benefit is the Takahashi has a much larger field of view than the Sky-Watcher, making it relatively easy to aim both telescopes at the same field. There's usually no need to fine-tune the mounting of the two scopes to ensure the high-resolution instrument's field completely falls within the field of view of the wide-field instrument. This means

▼ **TEAM EFFORT** Shooting deep-sky targets takes about half the time when using a dual-scope setup. As the FSQ-106ED recorded this wide-field image of the Running Man nebula with a QHY367C Pro color camera (top left), the Sky-Watcher Esprit 150 simultaneously captured luminance-filtered exposures with a monochrome QHY16200A CCD camera (bottom left). The right picture shows the result of combining both data sets.



◀ BUSY PROGRAMS The system is controlled using two instances of *TheSkyX Professional Edition*. One copy of the software monitors the mount and controls the main camera and autoguider (left), while a second copy is open on the top right, controlling the color camera.

▲ ZOOMING IN One novel benefit of imaging through a dual-scope system with different focal lengths is that the resulting images from both scopes offer distinct perspectives. *Left:* This wide-field shot taken with the FSQ-106ED of a region in Cygnus captures several interesting objects, including reflection nebula NGC 6914 (bottom right) and Simeis 57, the Propeller Nebula (top left). North is at left. *Right:* A closeup of NGC 6914 uses color from the wide-field image combined with high-resolution hydrogen-alpha data taken with the Sky-Watcher 150.

you don't have to utilize complex mounting hardware that permits tiny adjustments between the telescopes (a potential source of flexure).

Side-by-Side or Tandem Mounting?

With your mount and optics chosen, you next need to determine the best way to assemble everything. There are two common ways to attach a pair of telescopes to a single mount: side-by-side or with one scope piggybacked on the other.

Regardless of how you mount your equipment, proper balance is crucial to achieving good results (*S&T:* June 2019, p. 64). Flexure in the mounting hardware and the effects of gravity can lead to *differential flexure*, in which one telescope shifts slightly relative to the other. This can ruin every exposure from one scope, or even both if you're using a separate guidescope that might also flex relative to the two imaging scopes. Solid mounting hardware supplemented by some well-placed bungie cords can reduce or eliminate any differential movement. Troubleshooting flexure can take several nights of trial-and-error to determine the source of the problem and how to best address it.

Several manufacturers, including ADM Accessories (**admaccessories.com**), Losmandy Astronomical Products (**losmandy.com**), and Orion Telescopes & Binoculars (**telescope.com**), offer side-by-side saddle plates and tube rings.

Guiding Challenges

If you need to autoguide, consider using an off-axis guider (OAG), particularly if your telescopes have significantly different focal lengths. An OAG avoids the additional weight and reduces the risk of differential flexure that come with a separate guidescope. Placing the OAG in the longer focal-length instrument's optical path should produce round stars in both telescopes.

Dithering your exposures by randomly offsetting the field slightly between images may also require increasing the delay between the end of an exposure and the start of the next on the second camera. Otherwise the second camera may be recording an exposure when the dither movement occurs. This slight movement may not be visible in the lower-resolution images, if the offset is smaller than the pixel scale of your secondary imaging system.

Adding a longer delay doesn't always work, particularly when the download speed differs significantly between the two cameras, or if the software takes more time than usual to dither the guide star or adjust focus. An additional software solution is required that I'll discuss shortly.

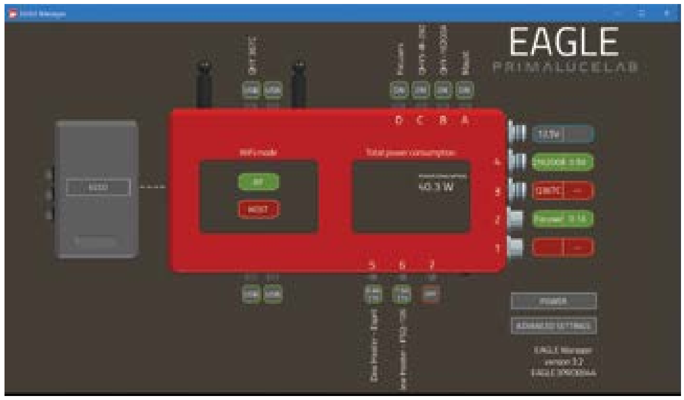
Control Management and Software

While everything mentioned so far can be operated through a laptop computer, there are additional considerations when assembling a dual-scope imaging platform that may be more than a laptop can handle.

Although not a lot of computing power is required for image acquisition, a dual-scope setup needs more power capabilities and ports for equipment connections than are typically available on a standard laptop. You'll need a lot of USB ports or an external, powered USB hub to connect your mount, two imaging cameras, their associated filter wheels, two motorized focusers, and possibly an autoguider. And when estimating your battery requirements for a night of portable imaging, remember that you may also need a dew-prevention system for each optic. Several companies offer small, integrated solutions that can be fitted to the telescope mount and controlled with a smart device, such as Software Bisque's Sky Fusion (**bisque.com**) or Primaluce Lab's Eagle control unit (**primalucelab.com**).

Even the control software is challenging when assembling a dual-scope setup. Most astronomical imaging software can operate a single camera, while some software suites like *MaxImDL* (**diffractionlimited.com**) and *TheSkyX Imaging Edition* permit users to control a secondary camera for autoguiding. If your mount is accurate enough to forgo guiding, then you can use this option to control your second camera and save the resulting images.

▲ **TANDEM MOUNTING** Another mounting option is to install both telescopes on a tandem platform. As seen here, imager Rogelio Bernal Andreo uses a pair of Takahashi FSQ-106 astrographs with two SBIG STL-11000M CCD cameras. Typically, he uses one scope to record color-filtered images while the other collects filtered luminance.



▲ **DEVICE MANAGEMENT** The *Primaluce Lab Eagle 3 PC control panel* lets users manage its many power and USB ports on a smart device or computer via a WiFi connection. It also includes three RCA ports to connect dew heating strips that can each be remotely switched on or off as needed.

If you require autoguiding, there is another solution. The free open-source astronomical imaging software called *N.I.N.A.* (**nighttime-imaging.eu**) includes synchronized guiding and image downloads from multiple cameras. It works by launching two instances of the software to control each camera, though both copies communicate with each other and ensure that dithering occurs only when both imaging cameras are idle, and exposures begin again on both cameras once the mount has settled to the new position.

I prefer to simply run two instances of my camera control software. I use *TheSkyX Imaging Edition* to connect to my mount, monochrome camera, filter wheel, focuser, and the autoguider. I then launch a second instance and connect it to the OSC camera and its focuser. During an imaging session, the first instance of *The SkyX* runs all night, capturing images, autoguiding, and periodically refocusing the Esprit 150, while the second instance of the software controls my OSC camera, recording sub-exposures and periodically focusing the FSQ-106ED.

Processing the images from both scopes is just like processing the data from a single scope — simply calibrate all the images, then align and stack them together and proceed with your usual image-processing workflow.

Imaging Strategies

Once you've got your dual-scope imaging rig up and running, you can plan on acquiring much more data in a single night. With two identical telescopes and cameras, you can dedicate one scope to acquisition of color data while the other captures unfiltered luminance or even narrowband exposures. Or you can use one telescope to exclusively record narrowband images while the other scope focuses on recording broadband natural-color exposures. Each can yield a beautiful image in its own right, or they can be blended to impart natural-color stars to narrowband nebula images.

Using a dual-scope setup with telescopes of different focal lengths also offers the opportunity to present images from each telescope individually as two distinct perspectives, such as a wide-field and a complimentary closeup. Look for opportunities in which your low resolution, wide-field shots can make an attractive standalone picture. For example, NGC 6888, the Crescent Nebula in Cygnus, is beautiful either as a close-up portrait or set within the extensive nebulosity of the region. Many popular targets in the Milky Way offer "twofer" imaging opportunities.

Regardless of the equipment you use, the number of clear, moonless nights is often the main limiting factor to completing an imaging project. Employing two telescopes simultaneously is an effective and efficient way to greatly increase the quantity of images recorded even in a relatively short night. It's only a little more challenging than using a single telescope, so maybe it's time to think about filling your eyes — or at least your cameras — with that double vision.

■ **RON BRECHER** is continually thinking of ways to improve his astro-imaging technique. Visit his website at **astrodoc.ca**.

▼ *Left:* Captured using the dual-scope system, this deep image of spiral galaxy NGC 4465 consists of nearly 22 hours of exposures recorded simultaneously. *Right:* Likewise, this richly colored photo of NGC 4236 uses more than 34 hours of total exposure taken in less than 19 hours over several nights.