Image-Intensified Observing

The versatility of this new light-amplifying observing system just might make it a game-changer in the world of amateur astronomy.

The heart of the TNVC Night Vision System is a standard-issue PVS-14 monocular. It's seen here attached to a Tele Vue 18.2-mm DeLite eyepiece on the Sky-Watcher Dobsonian reflector reviewed in the April issue. The 4½-inch-long monocular weighs only 12 ounces, making it smaller and lighter than many modern eyepieces.

TNVC-Tele Vue Night Vision System

U.S. Price from: $3,260 ($4,255 as tested with white phosphor image tube and accessories for smartphone photography)

tnvc.com / televue.com

What We Like

Excellent versatility for astronomy

Connects to a wide range of Tele Vue eyepieces

Ease of capturing images with a smartphone

What We Don't Like

Legal restrictions for ownership and use

THE UNDERLYING TECHNOLOGY for modern image intensifiers has been around for a couple of decades. It has given us a variety of self-contained, palm-size devices capable of amplifying light more than 30,000 times, and this gives us the reasonable expectation that an image intensifier could make ordinary backyard telescopes perform like monster light buckets. As such, it's fair to ask why the current generation of image intensifiers hasn't played a greater role in amateur astronomy. If there's a simple answer to that question, I don't know it. But I do know that this could change, thanks to a recent collaboration between the Tactical Night Vision Company (TNVC) and Tele Vue Optics. The resulting night-vision system (picked as one of our 2018 Hot Products in last January's issue) proved to be the most impressive visual light-amplifying setup I've ever used.

For the record, I've dabbled with image intensifiers going back to the days of war-surplus equipment offered by Edmund Scientific in the 1960s. But the most useful device I've tried for astronomy was an "electronic eyepiece" called the I³ Piece and sold by Collins Electro Optics in the 1990s. It was based on a generation-three image intensifier (essentially the same basic technology in use today). I reviewed the I³ Piece in this magazine's February 1999 issue, and I ended up buying one but

ALL PHOTOS BY THE AUTHOR

only occasionally did visual observing with it. I found it more useful for video recording things like asteroid occultations and, when adapted to wide-angle camera lenses, meteor showers.

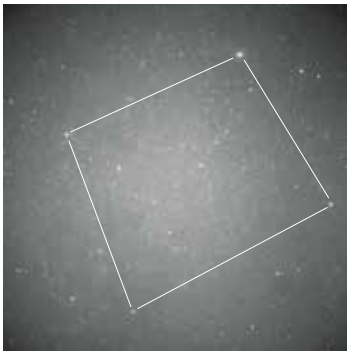
I was less than an hour into my first evening testing the TNVC night-vision system when it became clear to me that its adaptabilityg could run circles around the I³ Piece.

The TNVC Night Vision System

At the heart of the TNVC system is an unmodified, standard-issue, military-grade PVS-14 Night Vision monocular. Several versions are available from TNVC, and I tested the TNV/PVS-14 L3 Gen3 Un-Filmed White Phosphor model. That's a mouthful for sure, but basically this unit uses technology that has between 15% and 20% greater light transmission and a phosphor viewing screen with a nearly neutral color compared to other generation-three image intensifiers. For readers interested in the technical details of, and differences between, various night-vision devices, I strongly recommend checking out the excellent material on the TNVC website (**tnvc.com**), especially the sections on technology, astronomy, FAQs, and the buyer's guide. The website also has detailed sets of technical specifications for the various monoculars.

Nighttime terrestrial viewing with the PVS-14 monocular is a jaw-dropping experience. The unit delivers a circular field of view covering about 40° at 1× magnification. Just the light from my suburban night sky is enough to render my backyard as if it were daytime when viewed through the monocular. Even more impressive was the terrestrial viewing under the inky black skies in the mountains of southern New Mexico. With only starlight illuminating the ground, the monocular showed surprising detail, albeit not with the same clarity as I had under my light-polluted skies back home in Massachusetts.

Turning the monocular to the night sky was equally impressive, with stars around 8th magnitude visible. Oddly, this result was about the same in Massachusetts and New Mexico, even though the naked-eye limit was very different for these two locations. Determining the exact magnitude limit with and without the TNVC monocular was challenging, in part because the monocular's enhanced red sensitivity gives a bigger apparent boost to red stars, which shine with light less sensitive to the unaided eye.



▲ From the author's suburban home west of Boston, pointing the PVS-14 monocular at the night sky revealed more stars than are plotted in *Sky & Telescope*'s *Pocket Sky Atlas*. The monocular alone shows a 1× field of view approximately 40° in diameter. It is seen here roughly centered on the Great Square asterism of Pegasus.

But there's another aspect of the monocular than makes the magnitude comparison difficult, and this goes for observing by naked eye or with a telescope. Visual observers use various techniques to eke out the faintest stars, with averted vision being the best-known method. But with the monocular the faintest stars on the phosphor screen are seen with direct vision, even if they did teeter at the edge of visibility because of atmospheric seeing and the image intensifier's scintillation — a peppering of point-like flashes that appear randomly, especially when the monocular's gain is turned all the way up.

Perhaps a good way to illustrate the magnitude increase due to the monocular is through a pair of observations made from my backyard on a night of below-average transparency. At the time I struggled to see naked-eye stars

◀◀◀ In addition to the PVS-14 monocular, the system has available an adapter (center) that connects the monocular to any Dioptrx-compatible Tele Vue eyepiece and another adapter (left) that fits over the monocular eyepiece to connect it to Tele Vue's FoneMate smartphone camera holder (right).

◀◀ Much of the TNVC Night Vision System's versatility comes from its ability to use different Tele Vue eyepieces, thus offering the observer an easy way to vary the magnification. The author did most of his testing using eyepieces with magnifications ranging between 54× and 308× on the 18-inch Sky-Watcher telescope.

◀ The PVS-14 monocular is waterproof and powered by a single AA battery. The Duracell alkaline battery pictured here will run the monocular for about 50 hours at room temperature. The small knob above the battery compartment is the monocular's gain control, which the author usually had set to maximum for his tests.

▲ Adding to the adaptability of the system is a simple setup for capturing images seen in the night-vision monocular with a smartphone. Using a method explained in the text, the author made all the accompanying astronomical images with his Apple iPhone 6s pictured here.

in the Little Dipper fainter than Polaris and the two at the end of the dipper's bowl, but the monocular easily showed more stars in the area than are plotted in *Sky & Telescope*'s *Pocket Star Atlas*. That's a gain in the ballpark of three-plus magnitudes. And it's also about the same gain I experienced when viewing the open star cluster M67 in Cancer with and without the monocular a few minutes later using the Sky-Watcher 18-inch Stargate Dobsonian reviewed in the April issue, page 58.

Speaking of telescopic observations, this is where the TNVC Night Vision system really eclipsed my experiences with the I^3 Piece. The main reason is magnification. The I^3 Piece has the fixed magnification equivalent of roughly a 25-mm eyepiece. The TNVC system, on the other hand, connects directly to any Dioptrx-compatible Tele Vue eyepiece and thus allows you to vary the magnification by simply switching eyepieces. And many of the objects seen to advantage with an image intensifier, such as small globular and open star clusters, planetary nebulae, and faint stars, are best viewed at higher magnifications than afforded by a 25-mm eyepiece. Indeed, I spent a great deal of time observing with the TNVC unit attached to a 7-mm eyepiece, which yielded more than 300× with the 18-inch scope.

While the performance of the TNVC system was outstanding for the objects mentioned above, it was far less effective on diffuse objects such as nebulae and galaxies, with the exception of some hydrogen-emission nebulae that I'll mention later in this review. The issue here is one of contrast. While the TNVC amplifies the brightness of these diffuse objects, it equally amplifies the brightness of the background sky and as such does little to improve the contrast. In a truly dark sky, boosting the brightness of a telescopic view helps with the visibility of some faint nebulae and galaxies, but the effect is not nearly as profound as when viewing compact objects like planetary nebulae and anything involving resolvable stars.

As much as I savor the "natural" view through a telescope eyepiece, the increased magnitude reach available with the TNVC system became almost addictive at times. This was especially true when I was hunting small star clusters. The increased number of stars visible was one reason, but the ease of seeing even the faintest stars with direct vision was equally appealing.

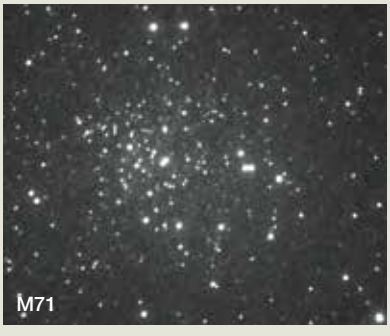
▲ Planetary nebulae were excellent targets for the 18-inch telescope and TNVC Night Vision System. This is just a small sample of the many such objects the author viewed with the setup.

▲ These images don't do justice to the impressiveness of seeing large emission nebulae through the monocular equipped with a hydrogen-alpha filter. Stars are heavily suppressed because the filter blocks 99% of visible light. And as explained in the text, emission nebulae are only seen in the central part of the field because the filter goes off band at large viewing angles. Cygnus with its famous North America Nebula (top) is reproduced in color to show the approximate hue of the monocular's white-phosphor viewing screen. The shot of Orion (above) clearly shows Barnard's Loop, but the large nebulosity surrounding the celestial Hunter's head isn't apparent because of the filter's band shift away from the center of the field.

Smartphone Imaging

My past experiences trying to capture still images with the I^3 Piece involved custom adapters and, at best, were only marginally successful. Not so with the TNVC system. An optional adapter couples Tele Vue's FoneMate directly to the monocular eyepiece, and because the phosphor screen is relatively bright, it's easily captured with a smartphone snapshot. But single exposures are rarely impressive, since they are degraded by noise and the image intensifier's scintillation mentioned earlier, which the eye/brain automatically averages out during visual use.

I don't know the features of every smartphone camera, but there's a very cool one available with my Apple iPhone 6s. When the camera's self-timer is activated, the result is not a single exposure, but rather a burst of 10 shots made in less than a second. For normal photography I'd select one good shot from the burst — when everyone had his or her eyes open, for example — and



▲ Globular and open star clusters are also excellent targets for the image-intensifier system, which showed stars at least two and sometimes three-plus magnitudes fainter than one sees by just looking through an eyepiece without the monocular attached to it.

delete the rest. But when shooting with the TNVC system I kept all 10 frames and later exported them for stacking with astronomical image-processing software. The results were remarkable, and the photos an order of magnitude better than those obtained with just a single exposure, even if they still fell somewhat short of the visual impression you get when looking through the TNVC monocular.

An Unexpected Treat

One of the most interesting experiences I had with the TNVC system is clearly biased by my long standing interest in the glowing clouds of hydrogen scattered throughout the Milky Way. It began one night at last year's Stellafane convention in Vermont when Tele Vue's founder, Al Nagler, handed me his TNVC monocular. "Here," he said, "check out the Milky Way." As I swept upward from Sagittarius to Cygnus I was dumbfounded to see amazingly faint hydrogen-emission nebulae almost magically appear as they crossed the center of the field. I'd looked for them in the past with the I[3] Piece fitted to wide-angle camera lenses, but only the brightest ones were faintly visible. Al's trick had been to attach a narrowband hydrogen-alpha filter to the front of his monocular (and as I later learned through experimentation, the fast f/1.2 speed of the monocular's objective — the camera lenses I experimented with in the past were f/2.8 and slower). Because narrowband interference filters are only effective over a limited angle of view, the hydrogen nebulae were only seen in the center of the field (approximately 20° of the monocular's full 40° field), but watching them swim in and out of visibility as they swept through the field was part of this truly novel experience.

▲ As explained in the text, the night-vision system was not as effective for viewing many galaxies as it was for planetary nebulae and star clusters. This view of the Andromeda Galaxy through the monocular was not substantially better than what was visible without it.

There's Always a Caveat

As exciting as the TNVC Night Vision System is, ownership of one comes with a catch, and in this case it's legal. This level of night-vision equipment falls under the International Traffic in Arms Regulations (ITAR) regulatory regime. While U.S. citizens are free to own the TNVC monocular, it's a federal crime to send or take one out of the country without a proper export license issued by the U.S. Department of State. I knew this from previous experiences with night-vision equipment. But I was caught off-guard by a restriction spelled out in the paperwork I signed in order to borrow the TNVC device for this review — it's a violation of ITAR rules to allow any non-U.S. citizen to look through the device even here at home. You can read the details in the FAQ section on **tnvc.com**.

It seemed a little awkward asking people if they were indeed U.S. citizens before offering them a look through the monocular, but even for the sake of a product review I'm not willing bend federal laws! Fortunately, all were citizens, and I could enjoy their gasps of amazement when they first took a peek through it.

▲ After Tele Vue's Al Nagler treated the author to views of faint hydrogen-emission nebulae with a filter-equipped monocular (described in the text), the author made this plastic piece on a lathe to fit a 3-nm hydrogen-alpha filter over the objective of the monocular he tested. The setup was used for the pictures of Cygnus and Orion on the facing page.

■ As a partner in the MDW all-sky hydrogen-alpha survey project (**mdwskysurvey.org**), DENNIS DI CICCO was particularly excited to see glowing clouds of gas with this handheld device.