Smart Telescopes 2026
From Entry-Level Instruments to Automated Astrographs

What Has Changed in Technology, Image Quality, and Workflow Since 2025

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Figure 1 Background image: My own photograph of the Whirlpool Galaxy M51 taken with the DWARF Mini

[DWARF Draco image source: Official product images, DWARFLAB, all other images from Angelika Kolb-Telieps | CellaPix]

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2025 marked a breakthrough in equatorial tracking and increasing automation. In 2026, the market is becoming more differentiated: affordable portable instruments are gaining substantial capabilities, while another class of systems is approaching the functionality of automated conventional astrophotography rigs.

Introduction: The Starting Point in 2025

When I published my first overview of smart telescopes in spring 2025, the market was already developing rapidly. Instruments from ZWO, DWARFLAB, Vaonis, Unistellar, and Celestron combined the telescope, camera, tracking, target selection, image capture, and processing in largely automated systems. This considerably lowered the barrier to entry into astrophotography and also made these instruments attractive as portable secondary systems for experienced astrophotographers.[i]

One of the most significant developments in 2025 was the introduction of equatorial tracking by several manufacturers. Until then, most smart telescopes had operated exclusively in altitude-azimuth mode and were therefore restricted to relatively short individual exposures. EQ modes and related enhancements began to push that limit. At the same time, mosaic imaging, observation planning, and onboard image processing continued to improve. It was already apparent that software development was at least as important as hardware.

The instruments differed considerably in their intended use. Affordable, lightweight systems such as Seestar and DWARF were primarily designed for easy entry and portability. At the other end of the spectrum was the Celestron Origin, with its 152 mm aperture and exceptionally fast optics. In independent comparisons, it delivered the highest level of resolved detail among the smart telescopes examined and came closer to a conventional astrophotography rig than the other systems.

The conclusion of the 2025 edition was therefore that smart telescopes had progressed beyond mere gadgets and were narrowing the gap to conventional astrophotography. Nevertheless, limitations remained: restricted choice of filters and software, short exposures with alt-az tracking, sometimes limited battery life, missing dithering, and restricted access to raw data.

Figure 2 The 2025 product range: Seestar S50, DWARF 3, and Celestron Origin

About eighteen months later, a fresh assessment is warranted. The central question is no longer whether smart telescopes should be taken seriously, but which limitations identified in 2025 have actually been overcome and which remain.

This study first examines technical developments since 2025 and then groups the current instruments by their different design concepts. Their imaging capabilities are subsequently assessed using manufacturer specifications, independent field tests, and my own experience. The key consideration is not simply the list of technical features, but their practical value.

This review distinguishes between manufacturers' technical specifications, independent field tests, documented user experiences, and my own investigations. The amount of available evidence varies considerably, particularly for recently introduced products. Independent processing of raw data provided by a manufacturer is not treated as equivalent to a complete hands-on test of a production unit. Manufacturer claims about functions that have not yet been adequately verified are identified accordingly. Editorial cutoff: 25 October 2026.

Unless otherwise credited, all graphics were created by Angelika Kolb-Telieps | CellaPix.

2025–2026: Which Limitations Have Been Overcome?

The 2025 study had already shown that smart telescopes had evolved far beyond simple electronic observing devices, while still having clear limitations compared with conventional astrophotography systems. Within approximately eighteen months, some of those limitations have been substantially reduced. Manufacturers, however, are pursuing different technical approaches.

Limitation in 2025	Developments through September 2026	Assessment
Short exposures and field rotation	EQ mode more widely available; Draco also adds integrated guiding and mechanical field derotation	substantially reduced
Origin lacked dithering	integrated since April 2026	resolved
Origin lacked mosaic mode	available since September 2026	resolved
Unistellar lacked a usable RAW workflow	Downloadable as FITS, TIFF or PNG. Raw Bayer data available in FITS format	largely resolved
Problematic stellar imaging in tested Vespera Pro	new Vespera generation with redesigned quadruplet optics	new optical approach; independent reassessment required
Some short battery runtimes	S50 Pro rated up to 9 h under defined laboratory conditions; Vespera 3/Pro 2 manufacturer rating 11 h	substantially improved, but model-dependent
Limited freedom to choose filters and software	partly improved, but closed systems remain	still relevant
Small apertures and limited resolution	compact category largely remains at 30–50 mm; Draco and Origin form a second performance category	not eliminated; market instead becoming differentiated

Table 1 Advances in smart telescopes: Comparison of May 2025 and October 2026

Tracking: From EQ Mode to Guiding and Field Derotation

In 2025, equatorial tracking was still one of the most important new developments. The earlier white paper noted that alt-az systems required short exposures and that field rotation could produce irregular image edges and noise artefacts that were difficult to remove.[ii]

By 2026, development had progressed beyond basic EQ mode. In the Seestar S50 Pro, for example, ZWO uses a new, near-zero-backlash precision drive which, according to the manufacturer, is intended to improve tracking stability, particularly in equatorial operation.[iii]

DWARFLAB goes further with Draco. Its system combines integrated guiding with mechanical compensation for field rotation by physically rotating the sensor. This is intended to permit longer exposures even in alt-az operation; DWARFLAB nevertheless recommends EQ mode for difficult positions near the zenith.[iv]

A new line of development is already evident: while compact smart telescopes refine their existing tracking arrangements, Draco incorporates components previously associated mainly with conventional astrophotography rigs.

Origin: Two Specific Weaknesses Have Been Addressed

Developments in the Celestron Origin can be compared particularly directly with the 2025 review. At that time, its high image quality was a clear strength, but the lack of dithering was explicitly identified as a weakness. The desired mosaic mode had only been announced.[v]

Both features have now been implemented. Dithering was introduced in April 2026, followed by automatic mosaic mode in early September 2026. For mosaics, the user specifies the desired field, and Origin automatically divides it into overlapping panels, captures them, and combines them.[vi]

In addition, Origin Mark II now uses the Sony IMX678 with 8.3 megapixels and 2 µm pixels. The system's central strength—the 152 mm RASA at f/2.2—remains unchanged.[vii]

Origin has therefore made substantial progress: two specific criticisms raised in the 2025 review have not merely been addressed in announcements but have now been resolved through software updates.

Raw Data: Unistellar Removes a Major Limitation

One of the most significant drawbacks of Unistellar systems in 2025 was the lack of RAW export. The white paper therefore found that experienced users were more restricted in their own image processing than with competing systems.[viii]

That criticism no longer applies. All current Unistellar models can now download data from Enhanced Vision and Citizen Science observations directly in FITS, TIFF, or PNG format. The FITS files contain Bayer-pattern raw data and can be processed further in software such as PixInsight or Siril.[ix]

With app version 5.0, introduced in 2026, Unistellar redesigned the user interface and added, among other things, a built-in planetarium and further observation-planning

functions. Its Citizen Science programme also enables users to participate in scientific observations, including exoplanet transits, asteroid occultations, and comet studies.

This is a meaningful improvement for advanced astrophotographers. Unistellar did not introduce an equivalent hardware leap in 2026, however. Development here has primarily concerned software, data access, and usability.

Vaonis: New Optics Rather Than a Fix to an Older Model

An independent test in 2025 had identified problematic star shapes in images from the Vespera Pro. Vaonis attributed this to a manufacturing defect.[viii]

It would be misleading to state that the problem has simply been 'fixed' in 2026. Instead, Vaonis introduced a new generation of optics with Vespera 3 and Vespera Pro 2. Both now use an apochromatic flat-field quadruplet arranged in three groups. According to Vaonis, the design is intended to produce, among other things, finer stars and better performance across the field.[x]

This is a new optical design, but not independent proof that the problem observed in 2025 can no longer occur. The new generation therefore needs to be reassessed using independently acquired images.

Other specifications have improved more measurably: Vespera 3 and Pro 2 are rated for eleven hours of battery life, have built-in anti-dew systems, and provide 115 GB and 225 GB of storage respectively. Vespera 3 also supports individual FITS frames and up to fifteen multi-night project slots.[x]

Some Limitations Remain

Not every drawback identified in 2025 disappears with a new product generation. Flexibility in particular remains a major difference from conventional astrophotography. On many smart telescopes, filters, cameras, mounts, and control software still cannot be exchanged freely. Even Draco does not currently support N.I.N.A., ASCOM, or INDI, according to DWARFLAB.[xi]

For DWARF 2, DWARF 3, and DWARF Mini, however, the community is developing dwarfAlp, an experimental ASCOM Alpaca interface that already enables some functionality in N.I.N.A. Draco is not currently supported by this solution. DWARFLAB itself says it is working on interfaces to external software, but has not announced a release date.[xiixi]

The limited aperture of compact systems is another constraint that software cannot eliminate. The Seestar S30 Pro, DWARF Mini, DWARF 3, S50 Pro, and Vespera models are deliberately small and portable. Their development therefore focuses above all on extracting more performance from limited optics.

This is where the transformation of the market becomes clear. Alongside ever more capable compact smart telescopes, a second line of development is emerging with DWARFLAB Draco and Celestron Origin. Their aim is no longer simply to make astrophotography easy to begin. Instead, more and more functions of a conventional imaging rig—guiding, dithering, longer exposures, derotation, calibration, and automated imaging plans—are being incorporated into a single integrated system.

This distinction underpins the following division of current instruments into two groups.

The 2026 Market: Two Lines of Development

Current smart telescopes differ not only in performance and price, but increasingly in their underlying design philosophy. This review therefore distinguishes two lines of development to enable meaningful comparisons.

The first group comprises compact smart telescopes, designed primarily for small size, mobility, and straightforward operation. It includes the DWARFLAB DWARF Mini and DWARF 3, Seestar S30 Pro and S50 Pro, and Vaonis Vespera 3 and Vespera Pro 2. Prices vary considerably within this group: the two DWARFLAB models cost approximately €430–530, while the Seestar instruments are around €700 and €1,000 respectively. Vaonis occupies the upper price segment, with Vespera 3 at €2,490 and Vespera Pro 2 at €2,990.

From Smart Telescope to Automated Astrograph

The second group consists of DWARFLAB Draco and Celestron Origin Mark II. Both are designed more specifically for demanding deep-sky photography and incorporate, to different degrees, technical elements of conventional astrophotography. For this review they are therefore termed 'automated astrographs'. This is a working definition, not a generally established product category.

Price is explicitly not the basis for this classification. For example, Vespera Pro 2 costs considerably more than Draco but, because of its design concept, still belongs to the compact smart telescope group. Classification therefore depends on the intended role of the complete system, not its price segment.

Unistellar: A Special Case

Unistellar cannot readily be fitted into these two categories. Its eQuinox 2, eVscope 2, Odyssey, and Odyssey Pro models place greater emphasis on electronically assisted observing and Citizen Science. The eVscope 2 and Odyssey Pro also feature an electronic eyepiece.

Priced between approximately €2,400 and €4,700, Unistellar occupies the premium market segment. Because of their distinct focus, these instruments are not included in the two main technical comparison matrices that follow.

Market Overview

The following table outlines the market positioning of the instruments reviewed. Prices refer to the basic packages; differences in included accessories must be considered when making direct price comparisons.

Compact Smart Telescopes	**Approx. Price**	**Automated Astrographs**	**Approx. Price**
DWARFLAB DWARF Mini	€429	DWARFLAB Draco Standard	€1,499
DWARFLAB DWARF 3	€529	DWARFLAB Draco SHO	€1,669
Seestar S30 Pro	€699	Celestron Origin Mark II	€5,499
Seestar S50 Pro	€999		
Vaonis Vespera 3	€2,490		
Vaonis Vespera Pro 2	€2,990		

Table 2 Market overview: Smart telescopes and automated astrographs

(Prices: Manufacturer prices or current German retail prices as at 30 September 2026)

Prices refer to the respective base packages. The included features and accessories differ considerably. In particular, the CLS filter (€229) and dual-band filter (€399) are optional for Vespera 3 and Vespera Pro 2, whereas comparable astronomy filters are already built into several less expensive competing instruments.[xiii]

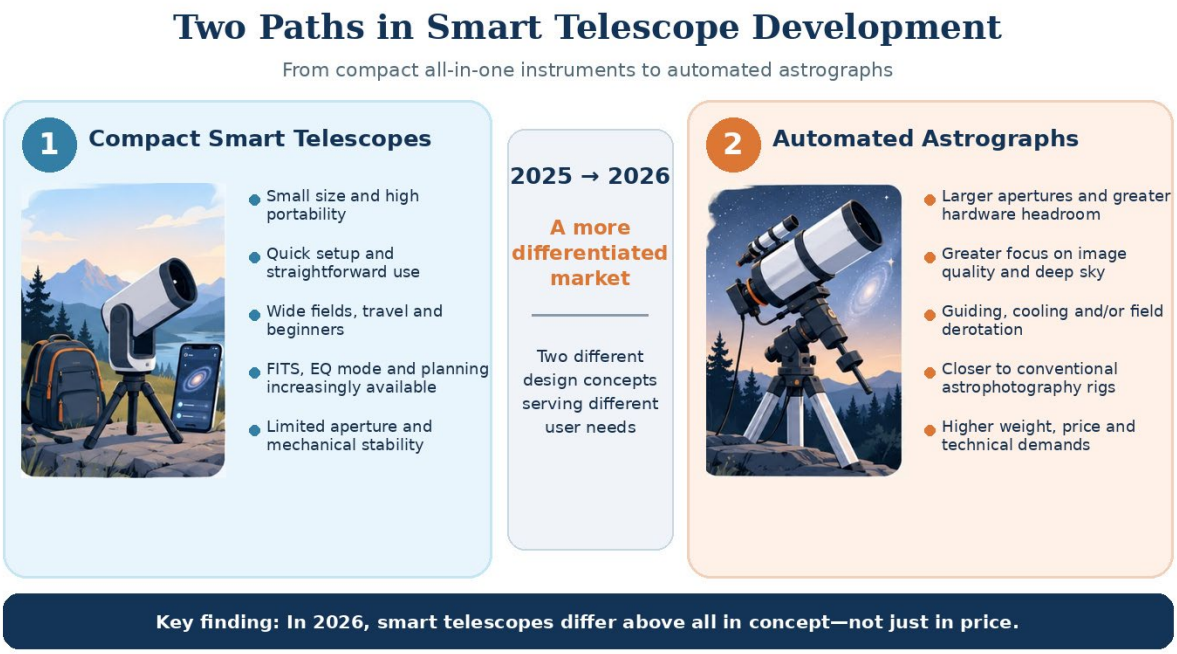

Figure 3 Two lines of smart telescope development in 2026 [Graphic created by ChatGPT]

Smart Telescopes

DWARF Mini: Technical Specifications and Manufacturer Claims

DWARFLAB positions the DWARF Mini as a particularly compact, beginner-friendly smart telescope. Weighing only 840 grams, it is significantly lighter than the DWARF 3. Its telephoto optics have a 30 mm aperture and 150 mm focal length; a wide-angle camera with a focal length of 6.7 mm is also built in. According to the manufacturer, the telephoto camera offers a field of view equivalent to approximately 1,016 mm focal length on a full-frame camera.[xiv]

The main camera uses a Sony IMX662 sensor in the 1/2.8-inch format, with 2.9 µm pixels and 2.07-megapixel resolution. The wide-angle camera also produces 2.07-megapixel images. The telephoto camera has a diagonal field of view of 2.45°, compared with approximately 50.6° for the wide-angle camera.[xiv]

Three filters are built into the telephoto optical path for astrophotography: an astronomy filter covering approximately 440–680 nm, a completely opaque dark filter, and a dual-narrowband filter. The latter has passbands near 493 nm and 656 nm and is therefore particularly suited to emission nebulae. The wide-angle camera also has an astronomy filter.[iv]

For reliable imaging sequences in EQ mode, DWARFLAB recommends individual exposures of up to 90 seconds. Since summer 2026, users have been able to select exposure times of up to 180 seconds.[xv]

Figure 4 In EQ mode, DWARF mini's main axis is parallel to Earth's rotation axis [Source: DWARFLAB]

Internal storage is 64 GB, and the permanently installed battery has a capacity of 7,000 mAh; external power can be supplied via USB-C during operation. Files can be stored in FITS or TIFF format, among others, and the device also supports JPG, PNG, and MP4. Connectivity includes Wi-Fi and Bluetooth. Measuring approximately 100 × 184 × 61 mm, it is the most compact model in DWARFLAB's current range.[iv]

DWARFLAB captures bias and flat frames for each DWARF mini at the factory and stores them on the device. The telescope automatically applies these calibration frames during onboard image processing. According to DWARFLAB, the fixed optical configuration means that users do not need to capture new flats before each imaging session.[xv]

DWARF Mini: Independent Tests

Several editorial hands-on reviews confirm the DWARF Mini's two most striking characteristics: its exceptionally small size and straightforward setup. BBC Sky at Night Magazine had the instrument running within minutes and particularly praised the ease of configuring EQ mode through the app. Targets included the Orion Nebula, Horsehead region, Leo Triplet, M81/M82, Pleiades, and Praesepe. Useful results were obtained with individual exposures of 15–60 seconds, including at higher gain settings.[xvi]

Figure 5 Orion Nebula, my own image taken with the DWARF Mini in automatic mode

Space.com reached similar conclusions after testing the instrument over several nights under Bortle 5–6 skies. Despite its small 30 mm aperture, it recorded targets including the Orion Nebula, Pleiades, and Praesepe. The reviewer particularly valued the combination of portability, easy smartphone control, and automatic stacking. The principal limitation was the resolution of approximately two megapixels: the images were suitable for phones and computer displays but less suitable for large prints or particularly detailed astrophotography.[xvii]

It is worth noting, however, that EQ mode was not examined to the same extent in these reviews. BBC Sky at Night tested exposures up to 60 seconds, while Space.com reported that it had been unable to test EQ mode itself. Neither review therefore independently establishes performance at very long individual exposure times.[xvi,xvii]

A considerably more detailed examination of equatorial operation comes from TelescopicWatch. The reviewer used the DWARF Mini over many nights under skies of varying darkness, regularly exposing for 60–120 seconds. In that experience, accurate polar alignment produced largely sharp frames up to approximately 120 seconds. At longer exposures, the proportion of trailed or rejected frames increased. With only approximate polar alignment, similar problems appeared more often even at around 60 seconds.[xviii]

The test therefore confirms the value of EQ mode while highlighting an important qualification: the longest selectable exposure is not necessarily an exposure duration that can be used reliably in all conditions.

TelescopicWatch also identifies weaknesses less apparent in shorter reviews. These include slight chromatic aberration around bright stars and increased sensor noise associated with the uncooled sensor and the metal housing warming during extended imaging sessions.[xviii]

Battery performance also illustrates the limitations of manufacturer specifications. BBC Sky at Night and Space.com obtained approximately four hours of operation. TelescopicWatch's long-term review was more cautious, generally connecting external power after about two hours for longer sessions. All three reviews, however, confirm that the DWARF Mini can be powered via USB-C from a power bank while operating.

Another field test by Universe Today supports the DWARF Mini's suitability for everyday use. It operated reliably under heavily light-polluted city skies and at temperatures below freezing. The reviewer also highlighted the ability of long total integration times to compensate, at least partly, for the small aperture.[xix]

Additional YouTube reviews supplement these findings. The channel Astrofotografie aus Norddeutschland is particularly critical of 180-second exposures for deep-sky imaging. The reviewer also identifies limitations for planetary photography: the short focal length and low sensor resolution render planets very small, with only limited scope for enlargement in post-processing.[xx]

DAWA approaches the instrument from a different perspective, viewing the DWARF Mini primarily as a lightweight travel companion for photographers. It fits easily into a normal camera backpack and requires little familiarisation. The reviewer rates imaging of nebulae, star trails, and the 2026 solar eclipse positively, but is less impressed by Milky Way photography.[xxi]

Taken together, the independent tests present a fairly consistent picture: the DWARF Mini delivers surprisingly useful deep-sky results for its small aperture and low price, and can genuinely be deployed very quickly. Its strengths are portability, automation, and the ability to accumulate longer integrations even under light-polluted skies. Its main limitations are low sensor resolution, small aperture, lack of sensor cooling, and—at longer exposure times—polar-alignment and tracking accuracy. EQ mode substantially broadens its deep-sky capabilities. Nevertheless, the selectable 180-second maximum should not be confused with an exposure duration that can always be achieved reliably. Several reviews demonstrate how strongly tracking quality at such exposure lengths depends on polar alignment and observing conditions.

The DWARF Mini has also proved useful for the 2026 solar eclipse and star-trail photography. Milky Way performance is generally considered mediocre, while planets appear too small in the frame to be enlarged effectively at the available resolution.

DWARF Mini: My Own Field Experience

My own testing confirmed that getting started is straightforward. Because I used longer exposures, I supplemented the internal battery with a power bank and mounted the DWARF Mini on a sturdy tripod. In automatic mode, I photographed the Orion Nebula under Bortle 4 conditions using 15-second exposures and the dual-band filter. The stars remained round, and the individual frames were available as FITS files for external processing.[xxii]

Dark frames captured during an imaging session are automatically applied during onboard stacking. Each DWARF mini comes with factory bias and flat frames specific to that unit, which are automatically applied during onboard image processing. According to DWARFLAB, the fixed optical configuration means that users do not need to capture new flats before each imaging session. The individual FITS frames remain fully available for independent processing.[xxii]

EQ mode proved particularly interesting. During my Orion Nebula test I actually used 180-second exposures. Although the DWARF accepted a polar-alignment error of approximately two degrees and I did not refine it further during that session, the stars remained largely round even at 180 seconds. Compared directly with 15-second frames, the individual images showed considerably more signal, and the stack had a smoother background and somewhat finer nebular structure. The edge artefacts visible in the alt-az stack also disappeared; these were attributable to field rotation and the resulting uneven coverage by the individual frames.[xxiii]

My experience therefore differs somewhat from individual independent tests describing 180 seconds as only marginally reliable. It does not show that this duration works reliably in every situation, merely that it can be used successfully under suitable conditions. I also used 180-second exposures for longer M51 sequences, accumulating approximately three hours in Astro mode and two hours in Duo mode over several sessions. However, the proportion of rejected exposures also increased with exposure duration in my tests.[xxiv]

The limitations of onboard processing became particularly apparent when I examined the raw frames. Automatically produced stacks look attractive at first, but in my testing they smoothed away more detail and displayed, among other issues, colour gradients and incompletely removed outliers. External software did not handle the DWARF data equally well: Sequator and DeepSkyStacker encountered substantial problems with the M51 dataset, while Siril, Astro Pixel Processor, and especially PixInsight processed the FITS data much more reliably.[xxv]

The potential contained in the raw data became clear in a comparison with my conventional astrophotography setup. Over two nights I photographed M51

approximately simultaneously with the DWARF Mini and a TS121SDQ on an EQ6 mount, using a ToupTek 2600C and MGEN-3. After external processing of the DWARF data in PixInsight, significantly more structure, a smoother background, and better colour separation were visible than in the automatically generated image. In the direct comparison, the conventional 121 mm system predictably produced cleaner images with finer detail than the 30 mm DWARF Mini. The experiment nevertheless demonstrates that the DWARF Mini collects substantially better data than its automatic output initially suggests.[xxiv]

Figure 6 Whirlpool Galaxy M51: Comparison of a DWARF Mini image in EQ mode (left) and an image from a conventional telescope (right), both processed externally in PixInsight from approximately five hours of total integration time

I also used the DWARF Mini during the total solar eclipse of 2026 on Mallorca. Alongside my Nikon Z7, it served as a largely autonomous secondary system, recording video of the eclipse in automatic mode. In principle this worked well and significantly reduced my workload during the brief period of totality. Shortly before totality, however, clouds passed in front of the Sun; the autofocus reacted by focusing on the clouds rather than the Sun. For me, this highlighted an important practical limit of automation: the DWARF Mini worked well as a secondary system, but during the critical phase of a one-off event such as a solar eclipse I would no longer rely entirely on autofocus.[xxvi]

Planetary and Milky Way photography, by contrast, did not convince me.

My field tests confirm the DWARF Mini's fundamental strength as an exceptionally portable system. The physical limits of its 30 mm optics remain, however: aperture and resolution clearly constrain the level of detail.

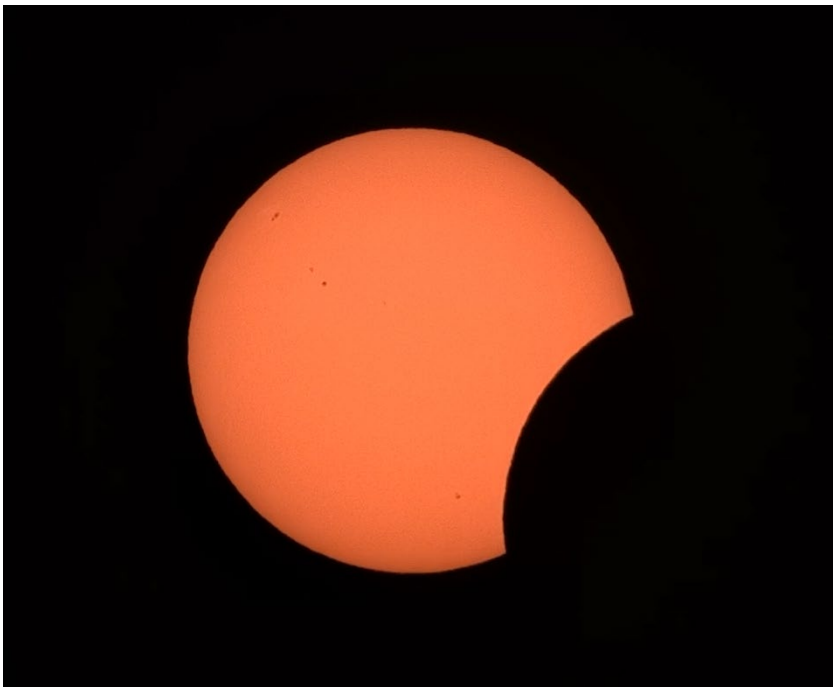

Figure 7 Partial solar eclipse of 2026: my own photograph taken with the DWARF Mini during the partial phase on Mallorca

DWARF 3: Technical Specifications and Manufacturer Claims

The DWARF 3 is not a new product in 2026; it was already included in the 2025 overview. In DWARFLAB's current range, it sits between the exceptionally compact DWARF Mini and the considerably more elaborate Draco. Its telephoto optics comprise a six-element apochromatic dual-camera lens with a 35 mm aperture and 150 mm focal length. A wide-angle camera with a 3.4 mm aperture and 6.7 mm focal length is also provided. DWARFLAB specifies a diagonal field of view of 3.38° for the telephoto camera and a full-frame-equivalent focal length of 737 mm.[iv]

The main camera uses the Sony IMX678 Starvis 2 sensor in a 1/1.8-inch format. Its native resolution is 3840 × 2160 pixels, or 8.3 megapixels, with a 2 µm pixel pitch. In 2×2 binning, four sensor pixels are combined, resulting in an effective pixel pitch of 4 µm while reducing output resolution to 1920 × 1080 pixels, or about 2.1 megapixels. The actual output resolution therefore depends on the chosen imaging mode. The wide-angle camera uses a two-megapixel Sony IMX307. Compared with the DWARF Mini, the DWARF 3 offers a larger and more capable main sensor and a slightly larger aperture. Despite their identical 150 mm telephoto focal lengths, the DWARF 3 has a larger diagonal field of view—3.38° versus 2.45° for the DWARF Mini.[iv]

Figure 8 DWARF 3 with App [Source: DWARFLAB]

The telephoto camera incorporates an infrared-blocking VIS filter, an astronomy filter, and a dual-band Hα/OIII filter. In response to a direct enquiry, DWARFLAB confirmed full widths at half maximum of 15 ± 3 nm at Hα (656.3 nm) and 30 ± 3 nm at OIII (500.7 nm).[xxvii]

DWARFLAB's own comparison table explicitly lists no mechanical field derotation. The DWARF 3 therefore remains conceptually a compact smart telescope: Polar alignment in EQ mode prevents field rotation during an exposure.[iv]

The internal battery has a capacity of 10,000 mAh and can be supplemented via USB-C while the instrument is operating. DWARFLAB specifies an average astronomy-mode runtime of up to approximately 5.5 hours at room temperature. Internal eMMC storage is 128 GB. Wi-Fi and Bluetooth provide connectivity, and the comparison table specifies a range of up to 20 metres. At 1,350 grams and measuring 222 × 142 × 65 mm, the DWARF 3 remains much easier to transport than a conventional astrophotography rig, although it is larger and heavier than the DWARF Mini.[iv,xxviii]

Raw frames can be saved in FITS or TIFF format; JPG, PNG, and MP4 are also supported.[iv]

Compared with its position in 2025, the DWARF 3's advances are less about new hardware and more about its evolving imaging and processing workflow. The DWARF 3 remains the more capable of DWARFLAB's two compact instruments in several respects because of its larger aperture, larger main sensor, greater storage, and stronger battery. Any image-resolution advantage, however, depends on the binning mode used.

Figure 9 DWARF 3 [Source: DWARFLAB]

DWARF 3: Independent Tests

A sixteen-month independent test by New Forest Astro, most recently checked against the current app and firmware in July 2026, documents several practical limitations of the DWARF 3. In light wind, approximately 5–15% of the reviewer's subframes were lost to motion blur. Battery life also varied with temperature: approximately 5.5 hours in mild conditions, but closer to three or four hours in winter.[xxix]

A September 2026 field test by SmartWorld documents the DWARF 3 in EQ mode under real observing conditions. On IC 1396, it used 60-second exposures throughout an entire night; the resulting image was described as noticeably more detailed than shorter alt-az exposures.[xxx]

Astrocologne offers a more conventional astrophotographer's perspective in an August 2026 video. He praises the compact design, the quick route to visible results, and the solar and lunar images. His verdict on deep-sky imaging is more critical. He attributes a relatively high rejection rate partly to the dithering procedure and finds the stars insufficiently sharp. He also considers the wide-angle camera unconvincing compared with current smartphones. Unsurprisingly, a comparison with a 106 mm apochromatic refractor strongly favours the much larger conventional system, illustrating primarily the DWARF 3's physical limitations. He therefore regards the DWARF 3 less as a substitute for an experienced astrophotographer's conventional rig and more as an easy entry-level instrument; he subsequently donated the DWARF 3 to a school.[xxxi]

Deepsky Son7u published two additional field tests in September 2026. After imaging the Moon and North America Nebula, he concluded that the DWARF 3 was particularly interesting as an affordable and straightforward introduction to astrophotography. In a second video he used it to create a time-lapse of a partial solar eclipse. Automatic solar imaging and tracking generally worked well, but strong wind caused clearly visible image movement. He used the tripod supplied by DWARFLAB.[xxxii,xxxiii]

These current field experiences also demonstrate that the compact system's physical and mechanical limitations remain. Wind, polar-alignment accuracy, small aperture, and limited mechanical stability continue to have a direct effect on image quality.

DWARFLAB Software for the DWARF Mini and DWARF 3: A Shared Workflow

DWARF Mini and DWARF 3 differ substantially in optics, sensor, storage, battery, and, to some extent, maximum exposure time. For control, capture, and processing, however, they use the same DWARFLAB software platform. Functions such as target search, calibration and centring, live stacking, observation planning, mosaics, dithering, Mega Stack, and Stellar Studio must therefore not be attributed to the two instruments as though they were separately developed features. Differences should be identified where the respective hardware imposes different limits.

Observation Planning and Automation

Both instruments can locate celestial targets automatically through the app and schedule longer imaging sequences. Planning mode can process several targets consecutively, with exposure time, gain, filter, and observing period set individually for each target. Mosaics can also be included in an imaging plan. New Forest Astro's long-term review now rates this planning capability as one of the system's greatest practical strengths. Field tests also show that automation is not completely error-free: occasional failed polar-alignment, autofocus, and plate-solving operations were observed with the Mini, while the DWARF 3 occasionally lost its connection. Such failures matter particularly when a session is intended to run unattended.

EQ Mode and Model-Specific Exposure Limits

For stable operation in equatorial (EQ) mode, DWARFLAB recommends single-frame exposures of up to 90 seconds for the DWARF mini and up to 60 seconds for the DWARF 3. The app allows users to select exposures of up to 180 seconds for the mini. For the DWARF 3, exposures of up to 120 seconds have been selectable since 2025. Whether

these longer exposures yield a low frame rejection rate depends on the imaging conditions.

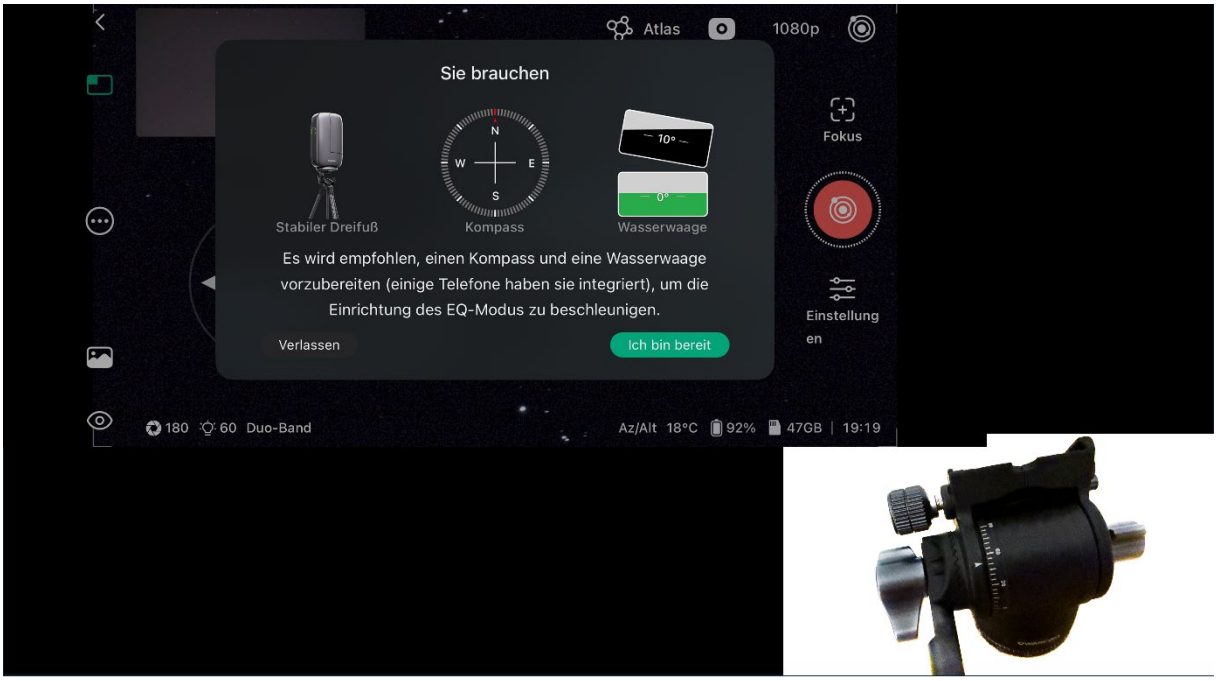

Figure 10 DWARF Mini in EQ mode: On-screen display (upper left) and tripod tilt head (lower right)

The DWARFLAB app, shown here in German, calls for a sturdy tripod and recommends having a compass and a spirit level ready to speed up setup. Some smartphones have both tools built in.

Mosaics and Dithering

Mosaic mode works on the same principles on the Mini and DWARF 3. Both can extend the native field to 1.8 × 1.8 times its original dimensions by recording up to four panels. EQ mode is required for astronomical mosaics; mosaics can be planned directly from the atlas and added to imaging sequences. Dithering is automatic. DWARFLAB currently states that exposures shorter than 60 seconds are dithered after every six captured frames, and exposures of 60 seconds or longer after every ten. The image recorded during the dither movement is rejected rather than saved. This explains why file numbering may contain gaps without any actual loss of usable captured frames.

Mega Stack and Multi-Night Projects

Mega Stack combines data from multiple sessions into a single integration. The current software can also merge frames captured with different filters and several compatible mosaic datasets, provided resolution, target coordinates, and image type match. Processing takes place locally in the telescope. Poor subframes with distorted stars may still cause stacking to fail, making careful selection of input data important.

DwarfAstro's long-term project on the DWARF 3 illustrates the practical possibilities: 8 hours 14 minutes of M51 data were combined from three nights, and the author

documented more than 157 hours of integration on 27 deep-sky targets overall. Multi-night imaging is therefore backed by real experience, not merely a manufacturer's feature list.

Stellar Studio and External Processing

Stellar Studio adds an integrated post-processing stage to the capture workflow. It is used, among other things, for final processing of deep-sky images and mosaics. The advantage is a seamless workflow within DWARFLAB's own system, although editing capabilities remain more limited than in specialist astrophotography software. SmartWorld likewise describes Stellar Studio as less comprehensive than some competing solutions. My own DWARF Mini tests also show that the FITS raw frames contain considerably more information than is apparent in the automatically generated final image.

Assessment

DWARFLAB's most important software progress in 2026 therefore lies not in the DWARF 3 or Mini alone, but in the maturation of a shared platform. What was once a single automated observation can now become a planned multi-night imaging project incorporating mosaics, dithering, multi-night stacking, and subsequent processing. This extends both instruments well beyond basic 'set up and start' operation. Differences between the Mini and DWARF 3 consequently lie more in hardware and the imaging limits that follow from it than in their underlying software capabilities.

Seestar S30 Pro: Technical Specifications and Manufacturer Claims

Released in early 2026, the Seestar S30 Pro is not merely a minor update to the original S30; it introduces substantial changes to the camera and optics. The telephoto optics retain a 30 mm aperture, but now have a 160 mm focal length at f/5.3. ZWO uses a four-element apochromatic objective with ED glass. The original S30 had a 150 mm focal length and a main sensor with significantly lower resolution.

The most important new feature is the dual-4K camera system. The telephoto camera uses a Sony IMX585 and outputs 2160 × 3840 pixels, or 8.3 megapixels. A second wide-angle camera, equipped with a Sony IMX586, also produces 8.3-megapixel images. The diagonal field of view is 4.6° for the telephoto camera and 63° for the wide-angle camera. Together, these cameras support not only conventional deep-sky imaging but also wider-field applications such as Milky Way photography, star trails, time-lapses, and landscapes. The wide-angle camera also has autofocus.

ZWO's comparison material for the S50 Pro confirms this positioning: the S30 Pro and S50 Pro both have dual-4K cameras, 128 GB storage, NFC connectivity, and features for

night landscapes and live stacking with the wide-angle camera. The principal difference is aperture and focal length: 30/160 mm on the S30 Pro, compared with 50/260 mm on the S50 Pro.[xxxiv]

An integrated UV/IR-cut filter, an astronomy light-pollution filter, and a dark filter are provided for astronomical imaging. ZWO specifies bandwidths for the astronomy filter's dual-band component of 30 nm at OIII and 20 nm at Hα. A magnetic solar filter is also included.[xxxv]

The S30 Pro normally operates in alt-az mode but also supports EQ mode. According to current manufacturer specifications, it can use individual exposures of up to 60 seconds in that mode. ZWO explicitly notes that this duration is available only in equatorial operation and requires accurate polar alignment; poor alignment may impair image quality.[xxxvi]

The S30 Pro now also provides several distinct dithering and calibration functions. ZWO confirms that automatic dithering is intended for both live stacking and continuous capture. The Seestar app additionally offers 'Flat Shoot' for taking flat frames to correct vignetting, uneven illumination, and sensor dust, among other issues. Hot-pixel correction operates separately: it creates or updates a thermal noise map intended to reduce conspicuous hot pixels. In a discussion of current image processing, Seestar support also confirmed that Seestar-generated deep-sky frames have already undergone dark subtraction. Flat correction, hot-pixel correction, and dark subtraction are thus separate calibration steps and should not be confused.[xxxvii,xxxviii,xxxixxl]

The instrument has 128 GB of eMMC storage, of which approximately 110 GB is actually available according to the manual, with the remainder used by the system. Battery capacity is 6,000 mAh. ZWO specifies approximately six hours in Stargazing mode under laboratory conditions, measured at 25 °C with tracking and image enhancement active but dew prevention disabled. For MP4 video recording in Scenery Mode with tracking switched off, ZWO specifies a battery runtime of approximately four hours. External power can be supplied via USB-C at 5 V/3 A.[xxxv]

Weighing 1.65 kg and measuring 210 × 140 × 80 mm, the S30 Pro remains exceptionally compact. Image files are stored as JPEG or FITS; video formats include MP4 and AVI. Connections include Wi-Fi, Bluetooth, USB-C, and NFC.[xxxv]

Compared with the original S30, the major advances are higher sensor resolution, the dual-camera arrangement, and extended wide-angle functions. ZWO particularly highlights the new Milky Way mode, both 4K cameras, and a greater emphasis on creative night-sky and landscape photography. The 30 mm aperture remains modest, however. The S30 Pro thus continues the concept of a highly portable smart telescope while extending its applications well beyond conventional deep-sky imaging.[xxxv]

Seestar S30 Pro: Independent Tests

Independent reviews confirm that the larger sensor area and new four-element optics make a noticeable practical difference compared with the original S30. From a Bortle 4 site, BBC Sky at Night Magazine photographed twelve star clusters, fifteen nebulae, and nine galaxies. Stars were rendered cleanly across the large field, and even crops of smaller targets showed more detail than comparable S30 images. The 4.6° field of view proved particularly useful for large targets, many of which no longer require mosaics. The new wide-angle camera also impressed in star-trail and initial Milky Way tests.[xli]

Tests of EQ mode and the raw data are also informative. Space.com used 60-second exposures on M51 and M13 and found visibly better detail than in alt-az operation. With correctly configured equatorial tracking, AstroBackyard obtained approximately 90% usable frames at 60 seconds. These tests show that the maximum exposure time is genuinely usable, although the rejection rate predictably depends on the setup and wind.[xlii,xliii]

The greater volume of data also offers additional scope for external processing. BBC Sky at Night found that unprocessed 60-second FITS frames were very dark and that DeepSkyStacker initially struggled with the dataset. Astro Pixel Processor handled them better, and restacking followed by processing in PixInsight produced visibly better results than onboard processing, especially for faint nebulae.[xli]

Data from multiple imaging sessions can now also be combined into a longer total integration. An automatic continuation of the same project across nights, comparable with Vaonis PerseverENS, has not been documented on Seestar. Instead, saved subframes of the same deep-sky target can be selected and restacked later using 'Deep Sky Stack', with processing performed inside the Seestar. Current experiences with the S30 Pro confirm that data from multiple nights can be combined this way or through external processing. Reliable documentation of the automatic continuation of an unfinished multi-night mosaic is still lacking.[xliv,xlv]

The extended automation functions are not yet as flexible as a conventional capture workflow in all respects. Space.com criticises the inability to assign exposure time and gain separately to every target in Plan mode. AstroBackyard additionally notes that the wide-angle camera image cannot be monitored while a deep-sky exposure sequence is running. Stars also appeared slightly soft in some frames, suggesting room for autofocus improvements. Another experienced photographer's field test likewise concluded that autofocus was sufficient at normal viewing sizes but did not always achieve reproducibly optimal stellar sharpness.[xlii,xliii,xlvi]

Current user experiences with dithering show that its practical implementation sometimes depended on firmware version in 2026. Although Seestar support confirms

the function for both live stacking and continuous capture, S30 Pro users running earlier firmware reported walking noise or apparently insufficient dither movements. Following the update to version 3.2, users reported the restoration of dithering in continuous capture. The function is thus available in principle, but its real-world effectiveness has not been equally reliable across all firmware versions.[xlvii]

In an August 2026 YouTube video, Maximum Astronomy compares the S30 Pro directly with the DWARF Mini. The reviewer sees particular advantages for the Seestar in wide-angle photography: Milky Way images appear significantly sharper, and automatic mosaic assembly works more reliably. He also praises the built-in dew heater and ASCOM compatibility.[xlviii]

A user report points to possible limits of dark correction during long imaging plans with substantial temperature changes. An S30 Pro exhibited temperature-dependent edge artefacts, which the user associated with insufficiently updated calibration data. ZWO has not confirmed that diagnosis, but requested the original FITS files for further investigation.[xlix,l]

The S30 Pro is therefore best understood not as a higher-resolution instrument for small targets, but primarily as a compact wide-field system. Its strengths include large nebulae, galaxies and star fields, and its separate wide-angle camera for Milky Way scenes, star trails, and night landscapes. Smaller galaxies and especially planets remain small in the image at just 160 mm focal length. EQ mode, FITS export, dithering, calibration, and subsequent multi-night stacking now support a far more advanced workflow than the original S30. Automation is nevertheless less seamless than on instruments with genuine automatic multi-night project continuation, and Plan mode still limits individual control of multiple targets.

Seestar S50 Pro: Technical Specifications and Manufacturer Claims

Introduced in August 2026, the Seestar S50 Pro represents a substantial development of ZWO's original S50. Aperture remains 50 mm, while focal length increases slightly from 250 to 260 mm at f/5.2. A new four-element apochromatic optical system with ED glass replaces the original S50's three-element APO design. ZWO particularly aims to improve control of chromatic and off-axis aberrations.[li]

Figure 11 Seestar S50 Pro [Cedits: ZWO, Seestar S50 Pro Press Kit]

The camera represents a much larger change. The telephoto system uses an OmniVision OS08B10 with a 1/1.2-inch sensor, 2.9 µm pixels, and 8.3 megapixels. Resolution therefore increases substantially from the original S50's two megapixels, while the diagonal field of view grows from 1.46° to 2.8°. The S50 Pro also adds a separate wide-angle camera with a Sony IMX586 1/2-inch sensor, 1.6 µm pixels, and 8.3 megapixels. It has a 6 mm focal length at f/1.75 and covers a 63° diagonal field. Both cameras output 2160 × 3840 pixels.[li]

The S50 Pro consequently adopts the dual-4K design already known from the S30 Pro, combining conventional deep-sky imaging with wide-angle functions. The wide-angle camera supports Milky Way, star-trail, and night time-lapse photography, as well as autofocus and live stacking. Compared with the S30 Pro, the key optical difference remains the larger aperture: 50/260 mm on the S50 Pro versus 30/160 mm on the S30 Pro. ZWO therefore positions the S50 Pro more strongly towards finer detail and greater light gathering in deep-sky imaging.[lii]

The filter system is also extensively integrated. The telephoto camera provides UV/IR-cut, dark, and dual-band filters. ZWO specifies 30 nm at OIII and 20 nm at Hα for the dual-band filter. The wide-angle camera also has a UV/IR-cut filter, and a magnetically attached solar filter is included. No additional astronomy-filter purchases are therefore required for basic applications.[lii]

The S50 Pro retains an alt-az mount mechanically, but supports EQ mode. ZWO has redesigned the drive compared with the original S50 and describes it as a precision drive with a near-zero-backlash gear mechanism. According to the manufacturer, it is intended to improve tracking stability and resistance to disturbances, particularly in

equatorial operation. Whether and to what extent these gains are confirmed in practice is examined in the independent test section.[li]

Individual exposures of up to 60 seconds are available in EQ mode. ZWO explicitly states that this duration is not available in alt-az operation and requires accurate polar alignment. The manufacturer also recommends its TH10 tilt head or an equivalently stable equatorial setup.[li]

The software handles automatic target location, centring, tracking, and live stacking. It also provides multi-target planning, automated mosaics, and dedicated modes for Milky Way photography, star trails, and time-lapses. Onboard editing includes noise reduction, star reduction or removal, and automatic background correction. Another new feature is greater interoperability: ZWO officially supports the ASCOM Alpaca protocol and explicitly mentions integration with third-party software such as N.I.N.A. This increasingly distinguishes the current Seestar platform from completely closed smart-telescope systems.[li]

The S50 Pro offers automatic dark correction. When 'Dark Corr' is enabled, it takes a dark frame automatically at the start of an imaging session; preview subframes and the onboard stack are dark-calibrated inside the instrument. Separate dark FITS files are not exported, nor can a dark-frame sequence be recorded manually. ZWO also acknowledges that temperature drift over long sessions can compromise automatic dark calibration and has announced firmware improvements. Dithering is likewise used during current S50 Pro field sessions.[liii,liv]

With Seestar app 3.4.0, ZWO introduced management of a dark-frame library and revised the procedure for capturing and applying darks. The library introduced in version 3.4 improves storage and reuse of existing calibration data. According to an October 2026 statement from Seestar support, however, new master darks are not generated during an active imaging session. Where temperatures change substantially, a sufficiently well-matched dark is therefore not guaranteed to be available. Reports of automatic switching between previously stored master darks still require practical verification.[lv,lvi]

Storage and power supply have also been upgraded compared with the original S50. The S50 Pro has 128 GB of eMMC storage, of which approximately 100 GB is usable according to ZWO, and a 10,000 mAh battery. The manufacturer quotes up to nine hours of operation. This figure was measured under specified laboratory conditions above 25 °C, using the telephoto camera in alt-az live-stacking mode, and therefore does not represent runtime in every operating mode. External power can be supplied via USB-C while operating. The telescope weighs 2.8 kg without its tripod.[lii]

Still images are available in JPEG and FITS, and video in MP4 and AVI. The individual raw frames therefore remain accessible for external processing.[lii]

Overall, the S50 Pro is much more than a higher-resolution update to the original S50. Although the aperture and basic smart-telescope concept remain, new features include four-element optics, a substantially larger and higher-resolution main sensor, a separate 4K wide-angle camera, a revised drive, greater battery and storage capacity, and officially supported integration with external astronomy software. The key question for independent reviewers is therefore how far the new optics, main sensor, and precision drive improve star rendering and tracking performance in practice.

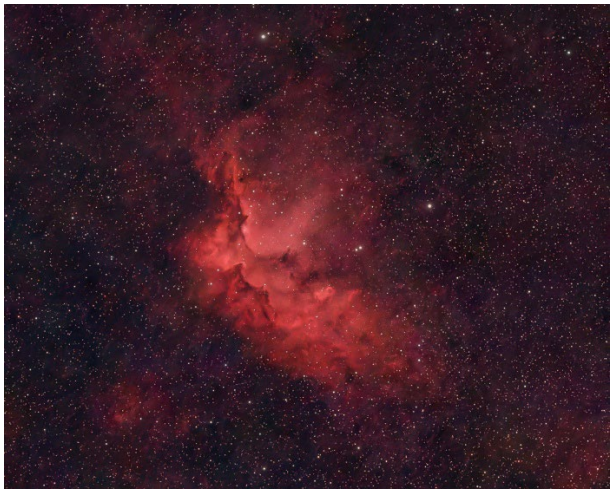

Figure 12 Seestar S50 Pro, image taken with Seestar S50 Pro [Source: ZWO, Seestar S50 Pro Press Kit]

Seestar S50 Pro: Independent Tests

Since the Seestar S50 Pro was introduced in August 2026, several independent field tests and longer-term user reports have appeared. They confirm improvements in field of view, optics, and photographic applications. At the same time, they show that the quality of extended imaging projects depends on more than the sensor or maximum selectable exposure time.

Image Quality and Raw Data

Trevor Jones (AstroBackyard) tested the S50 Pro on emission nebulae and the Andromeda Galaxy in alt-az and EQ modes. His documented EQ datasets include 171 × 30 seconds on NGC 7822 and 491 × 30 seconds on the Crescent Nebula. Subsequent FITS processing shows that additional structure and more selective background treatment are possible beyond the onboard stack. Compared with the original S50, the main benefit is the substantially larger sensor field and expanded imaging workflow, rather than an equally dramatic change in image scale.[lvii]

Damon Scotting (The Telescope Man) reports accumulating more than 100 hours of imaging in alt-az mode. Compared with the S30 Pro, he finds that the S50 Pro reveals more detail particularly in heavily cropped images; differences are smaller at normal

viewing sizes. He also considers the colours in certain S50 Pro images easier to edit than those from Vaonis instruments. His review explicitly does not compare EQ performance.[lviii]

Richard Harris (ScopeTrader) tested a unit supplied by ZWO for about a month in both alt-az and EQ modes. He documents longer sequences of 60-second exposures, including an M31 mosaic comprising 250 such frames. He rates the optical performance positively in relation to the larger sensor field, but notes that an integrated instrument does not replace the flexibility of conventional equipment with guiding and a freely selectable camera.[lix]

EQ Operation and Tracking Limitations

Jamie Carter (Digital Camera World) and Harris confirmed that individual exposures of up to 60 seconds can be used in EQ mode. This does not mean every exposure of that duration will be usable. A stable mounting and accurate polar alignment remain essential. One documented practical issue concerns attachment to the tilted mount head: a quick-release plate with a thread adapter may work loose or rotate, producing star trails. This must be distinguished from a tracking defect in the telescope itself.[lx]

Star Shapes: Conflicting Findings

Assessments of stellar imaging differ. While Harris describes generally good field correction, Frank Sackenheim (Astrophotocologne) documented markedly different star sharpness on opposite sides of the image from his review unit. Several owners on ZWO's support forum have likewise reported asymmetric stars or unusual ASTAP measurements. ZWO requested original FITS files for investigation and confirmed that the reports had been passed on internally.[lix, lxi, lxii]

At the same time, Blick ohne Grenzen could not reproduce an initially conspicuous asymmetry to the same extent in later tests at different sky positions and exposure times. The available observations therefore establish neither a clear cause nor the proportion of instruments potentially affected. Sensor tilt is one proposed explanation, not a confirmed defect affecting the entire production series.[lxiii]

Sensor Characteristics

Cuiv, The Lazy Geek, compared the S50 Pro's OmniVision OS08B10 sensor with the S30 Pro's Sony IMX585 using SharpCap sensor measurements. In the tested instrument, the OmniVision had a lower full-well capacity at low gain settings but also lower read noise. At around gain 150, measured read noise fell to approximately 0.86 electrons. These figures point to different sensor strengths, not a categorical advantage for either model.

Low read noise matters particularly in workflows involving many short individual exposures.[lxiv]

Observation Planning, Mosaics, and Multiple Nights

Observation planning first means that the telescope works through several selected targets automatically during one night. A 28 September report from Blick ohne Grenzen identifies a limitation: exposure time was selected before starting the plan and then applied to the planned observations; it could not be adjusted for individual targets during execution. Another test documented the app generating a mosaic grid for planned deep-sky targets even though the user preferred a simple single-frame observation.[lxv,lxvi]

Mosaic mode itself is used to capture a larger area of sky from overlapping panels. It works in principle: for a 1.7× mosaic of the Veil Nebula, Blick ohne Grenzen recorded 181 minutes of effective stacked integration during a seven-hour session. The difference was not caused solely by the mosaic function; moonlight, intermittent thin cloud, panel changes, and rejected exposures also played a role. This figure should therefore not be treated as a generally applicable efficiency rate. A separate planned M31 observation yielded 85 minutes of effective integration.[lxvii,lxviii]

Seestar app 3.4.0 made it possible to change and rotate the framing of telephoto-camera mosaics already scheduled in a plan. An independent follow-up test on 15 October confirmed the new option. However, problems with the original handling of field rotation for a later scheduled observing time were not fundamentally eliminated; the framing could instead be corrected afterwards.[lxix,lxx]

Capturing the same target over several nights is again different from automatic project continuation. AstroBackyard demonstrated a three-night S50 Pro project, but the datasets had to be combined afterwards. 'Deep Sky Stack' can restack saved subframes inside the telescope, including frames from different folders since Seestar app 3.2. There is no evidence that the S50 Pro autonomously resumes a project while managing earlier progress in the way Vaonis PerseverENS does.[lxxi,lxxii,lxxiii]

Battery, Wide-Angle Imaging, and Calibration

The separate wide-angle camera adds Milky Way and star-trail imaging to the range of applications. Jamie Carter rates these features positively in his field test.[lxxiv]

Blick ohne Grenzen documents approximately seven hours and ten minutes of battery operation with the dew heater switched on throughout. Runtime depends on temperature and operating mode.[lxxv]

App version 3.4.0 introduced dark-frame library management and revised the procedure for acquiring and applying darks. With dark correction enabled, individual FITS frames

are already calibrated in the telescope. They must therefore not undergo another dark subtraction when subsequently processed in software such as PixInsight. The update announcement confirms the new library management, but by itself does not demonstrate reliable temperature compensation over long sessions.[lxxvi, lxxvii]

Temperature changes remain the decisive limitation. According to documented user experiences, Seestar does not create new master darks during an active imaging session. Information attributed to ZWO and reproduced on Astrotreff states that after each subframe, the instrument should check whether an existing master dark more closely matches the current sensor temperature, switching if appropriate. This requires a sufficiently populated library covering the relevant exposure times and temperatures. It has not yet been independently demonstrated systematically that the library reliably resolves the calibration problems encountered during long observing nights.[lxxviii]

Assessment

Independent field experience confirms a substantial expansion in capabilities compared with the original S50: the wider field, usable EQ mode, and accessible FITS data particularly improve deep-sky imaging. The seamless execution of demanding automated projects currently appears to be the least mature aspect. Questions also remain about consistency of star shapes between individual units. For purchasers, documented field results and their own checks of stellar sharpness across the frame are therefore more informative than technical specifications alone.

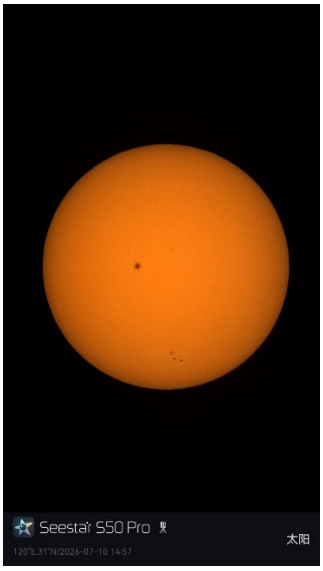

Abbildung 13 Sun, image taken with Seestar S50 Pro [Source: ZWO, Seestar S50 Pro Press Kit]

Vaonis Vespera 3: Technical Specifications and Manufacturer Claims

This detailed examination focuses on Vespera 3, since meaningful independent field experience is already available for this model. Vespera Pro 2 is included in the market

overview but is not assessed as though an equivalent body of independent test evidence existed.

Figure 14 Previous model Vespera II [Source: Vaonis Press Kit]

With Vespera 3, introduced in April 2026, Vaonis has revised its compact Vespera range not only through a new sensor, but above all through new optics. Aperture remains 50 mm; focal length is now 245 mm at f/4.9. The new optical design is an apochromatic flat-field quadruplet with four elements in three groups. Vaonis claims better correction of field curvature and chromatic aberration, and finer star images extending into the corners. Whether these improvements are actually achieved across the full field must be assessed from independent tests.[lxxix]

Vespera 3 uses a Sony IMX585 colour sensor in the 1/1.2-inch format, with 3840 × 2160 pixels or 8.3 megapixels and a pixel pitch of 2.9 µm. Current manufacturer specifications give a native field of view of approximately 2.6° × 1.4°. This makes the sensor considerably larger than those in earlier Vespera models and particularly suitable for extended deep-sky targets.[lxxix]

Vaonis's CovalENS mosaic mode remains a central feature. It enables Vespera 3 to capture and assemble larger areas of sky automatically. Vaonis specifies a maximum mosaic resolution of 24 megapixels and a field of view of approximately 4.3° × 2.4°. The system handles image alignment and assembly automatically.[lxxix]

The basic mount design is unchanged: Vespera 3 uses an alt-az mount. The Vespera range has no mechanical field derotator. Instead, Vaonis uses individual exposures of ten seconds, with software compensating for field rotation during stacking. Expert mode allows exposure time and gain to be adjusted. This remains a different approach from DWARFLAB and ZWO, whose current compact devices also support equatorial operation.[lxxx]

The automated long-term imaging workflow has been introduced or further extended. PerseverENS enables Vespera 3 to resume a deep-sky project over several nights. Framing, exposure time, gain, and mosaic and stacking progress are retained from one night to the next. Up to fifteen multi-night projects are supported on Vespera 3. Existing multi-night projects can also be included in 'Plan My Night' alongside ordinary targets.[x,lxxxi,lxxxiv]

Vespera 3 comes with a built-in hygrometer that monitors temperature and humidity. When conditions favour dew formation, the integrated objective heater activates automatically and switches off again when no longer needed. Dew prevention is therefore fully integrated into the imaging workflow.[lxxxii,lxxxiii]

Vaonis takes a different approach to filters from ZWO and DWARFLAB. Neither a light-pollution filter nor a dual-band filter is built in as a switchable astronomy filter. Several less expensive smart telescopes, by contrast, already incorporate such filters.

For planned multi-night imaging, this manual filter system has a direct consequence: if a filter is used when a plan is created, the plan is tied to that telescope configuration, and Vaonis recommends leaving the filter installed for the entire plan. Automatic switching between unfiltered, CLS, and dual-band exposures during one unattended night is therefore not possible. Firmware V3.3 of 16 June 2026 did improve the reliability of initialisation with filters fitted.[lxxxiv,lxxxv]

Internal storage is 115 GB. Individual subframes can be saved as 16-bit FITS, prestacked images as 16-bit TIFF, and final images as JPEG. This preserves the option of external raw-data processing. USB-C is provided for file transfer.[lxxxi,lxxxi,lxxxvi]

Vaonis quotes up to eleven hours for the built-in battery, with longer operation possible using an external power bank. At 5 kg, Vespera 3 remains portable but is substantially heavier than the DWARF Mini, DWARF 3, or Seestar S30 Pro. An adjustable-height aluminium tripod is included.[x]

Vespera 3's technical development thus differs clearly from ZWO's approach. Vaonis continues to forgo EQ mode and long individual exposures, instead refining its integrated alt-az design. New optics, a larger sensor, automatic mosaics, multi-night integration, automatic dew control, and onboard processing aim to maximise imaging performance with minimal intervention. The new quadruplet optics are especially interesting in this

review because independent tests of the previous Vespera generation had found problems with star shapes. Whether the revised design has eliminated that issue is therefore examined in the following section using current independent tests.

Vespera 3: Independent Tests

There are still fewer detailed independent reviews of Vespera 3, introduced only in 2026, than of ZWO's current devices. One of the most thorough was published by Cuiv, The Lazy Geek, in July 2026. He tested the instrument on M57 and M13, among other targets, and examined multi-night imaging, observation planning, onboard and external processing, and solar photography. Overall, he rates its optics and mechanics positively, identifying reliable star rendering and largely automated operation as particular strengths.[lxxxvii]

Multi-night imaging receives especially favourable reviews. An unfinished observation can be resumed later without the user having to register and stack the earlier data manually. The reviewer sees this as a key advantage of Vaonis's approach. The integration with observation planning is not yet entirely seamless, however: repeated planned observations across several nights can result in new projects instead of continuing existing ones, requiring subsequent manual project management. A detailed field test explicitly describes this as a present limitation of an otherwise useful feature.[lxxxviii]

Calibration is another point of criticism. Automatic calibration with Vaonis Universal Master Dark is a feature of the Pro models and is not available on Vespera 3. Although Vespera 3 can capture its own dark frames in Expert mode, these are not automatically applied to the active observation; instead, they are intended for later manual calibration and external FITS processing. Automatic dark calibration therefore remains a functional difference from the Pro model.[lxxxviii,lxxxviii]

The manual filter system is also a limitation in field tests. Switching between broadband and dual-band exposures requires user intervention and interrupts a fully automated observing night. The comparatively high prices of accessories add to the cost. Compared with Seestar and DWARF, this remains a clear disadvantage in the degree of automation.[lxxxviii]

The long battery runtime also appears to hold up in practice. A recent field test achieved approximately twelve hours, including app communication and image processing. Autofocus is also more automated than the term 'continuous' alone might suggest: the system focuses automatically before each observation, and AcutENS checks and updates focus during capture, particularly after temperature drops of more than about 3 °C. Together with automatic dew control, this supports longer unattended sessions.[lxxxviii,lxxxix]

Other owner reports reinforce these findings. One user who operated the instrument over several weeks under both Bortle 2 skies and Bortle 6 skies during a full Moon particularly praised the combination of the new optics and mosaic mode. At the same time, the user criticised the total price, especially when optional filters were included. Such reports do not replace controlled testing, but demonstrate that strengths and weaknesses identified in detailed reviews also recur in everyday use.[lxxxix]

The most relevant issue for this white paper is the new optical design. An independent test of the earlier Vespera Pro examined in 2025 had revealed stars that were not perfectly round. Current Vespera 3 experience provides no similarly strong indication of that problem; on the contrary, reviewers generally rate its optical quality positively. However, the evidence is still insufficient to conclude that the new quadruplet has definitively eliminated the earlier problem. That would require repeatable measurements from several instruments and, in particular, systematic assessment of stellar images right into the corners.

The tests to date therefore primarily confirm the Vespera 3's overall philosophy: rather than relying on EQ mode or exceptionally long individual exposures, Vaonis pursues a highly automated workflow within a closed system. Multi-night imaging, CovalENS mosaics, observation planning, AcutENS autofocus, and dew control work closely together. Clear limits nevertheless remain: filters must be changed manually, Vespera 3 lacks automatic dark calibration, and control is possible only through the Singularity app. USB-C connectivity is for data transfer alone; control through N.I.N.A., ASCOM, SharpCap, or comparable external software is not supported.

The following table summarises the specifications and test results for the compact smart telescopes examined in detail in this white paper.

Compact Smart Telescopes 2026 – Comparison Matrix

Aspect	DWARF Mini	DWARF 3	Seestar S30 Pro	Seestar S50 Pro	Vespera 3
Price	approx. €429	approx. €529	approx. €699–700	€999	€2,490
Aperture / Focal Length	30 / 150 mm	35 / 150 mm	30 / 160 mm	50 / 260 mm	50 / 245 mm
Optical Design – Manufacturer	6 apochromatic elements; grouping unspecified	6-element apochromatic telephoto optics; grouping unspecified	4-element APO with ED glass	4-element APO with ED glass	Flat-field APO, 4 elements / 3 groups
Main Sensor	Sony IMX662, 1/2.8"	Sony IMX678 Starvis 2, 1/1.8"	Sony IMX585, 1/1.2"	OmniVision OS08B10, 1/1.2"	Sony IMX585, 1/1.2"
Resolution / Pixel Pitch	2.07 MP / 2.9 µm	8.3 MP / 2.0 µm native; approximately 2.1 MP / 4.0 µm in 2×2 binning	8.3 MP / 2.9 µm	8.3 MP / 2.9 µm	8.3 MP / 2.9 µm
Main Camera Field, Diagonal	2.45°	3.38°	4.6°	2.8°	approx. 2.95° (calculated from 2.6° × 1.4°)
Wide-Angle Camera	2.07 MP, approx. 50.6°	2 MP, approx. 50.6°	8.3 MP, 63°	8.3 MP, 63°	none
Built-In Astronomy Filters	Astro, dark, dual-band	VIS, Astro, dual-band; Hα 15 ± 3 nm / OIII 30 ± 3 nm	UV/IR, dark, Hα/OIII	UV/IR, dark, Hα/OIII	no built-in switchable filters; accessory filters
Filter Changes	internal	internal	internal	internal	manual; filter configuration tied to plan / multi-night project
Storage	64 GB	128 GB	128 GB, approx. 110 GB usable	128 GB, approx. 100 GB usable	115 GB
Battery / Manufacturer Runtime	7,000 mAh / approx. 4 h	10,000 mAh / up to approx. 5.5 h	6,000 mAh / approx. 6 h	10,000 mAh / up to 9 h	capacity unspecified / up to 11 h
Weight	840 g	1,350 g	1,650 g	2,800 g	5,000 g
EQ – Manufacturer / Feature	Up to 90 s recommended for reliable tracking. Up to 180 s selectable	Up to 60 s recommended for reliable tracking. Up to 120 s selectable since 2025	yes, up to 60 s	yes, up to 60 s	no
EQ – Field Tests	60–120 s usually good; more rejected frames above 120 s	60 s demonstrated throughout entire nights; wind can cause rejections	60 s confirmed; approx. 80–90% usable depending on conditions	60 s confirmed; rejection rate at 60 s varies substantially more than at 30 s	not applicable
FITS / Raw Data – Manufacturer	FITS and TIFF	FITS and TIFF	FITS	FITS	16-bit FITS; 16-bit TIFF for prestacked data
FITS / Raw Data – Field Tests	External processing confirmed. CellaPix: M51 externally processed with more detail and a smoother background than onboard stack	External processing confirmed	External stacking improves faint structures in particular	External processing provides additional latitude	External processing confirmed
Observation Planning – Manufacturer	multiple targets/mosaics; Sleep/Wake	multiple targets/mosaics; Sleep/Wake	yes	multiple targets; scheduling; automatic mosaics	Plan My Night; multiple targets; mosaics and existing multi-night projects can be included

Aspect	DWARF Mini	DWARF 3	Seestar S30 Pro	Seestar S50 Pro	Vespera 3
Observation Planning – Field Tests	Generally reliable; occasional focusing, plate-solving, or connection errors	Automated multiple targets; occasional disconnects	Plan mode: exposure/gain cannot be set freely per target; no automatic multi-night project continuation	Multi-target planning demonstrated; exposure selected globally before starting and cannot be changed during the plan	Field use confirmed; interaction between repeated plans and multi-night projects not yet independently tested sufficiently
Mosaics – Manufacturer	yes, max. 1.8 × 1.8 / 4 panels; can be included in imaging plans	yes, max. 1.8 × 1.8 / 4 panels; can be included in imaging plans	yes	yes; automatic mosaics	CovalENS; up to 24 MP / approx. 4.33° × 2.43°; compatible with multi-night and Plan My Night
Mosaics – Field Tests	BBC: Orion Sword and Praesepe successful	Demonstrated in practice (including SmartWorld)	Positive; wide native field reduces the need	Extended mosaic sessions demonstrated; large mosaics can substantially reduce net integration time. Framing of deep-sky targets in Plan mode sometimes cannot be deselected	Positive; key system feature. Mosaics and multi-night imaging can be combined within the automated workflow
Multi-Night Data – Manufacturer	Mega Stack: multiple nights, filters, and compatible mosaics	Mega Stack: multiple nights, filters, and compatible mosaics	Deep Sky Stack: subframes of the same target can be combined retrospectively across sessions	Deep Sky Stack: subframes of the same target can be combined retrospectively across sessions	PerseverENS; 15 slots; retains framing, exposure, gain, mosaic progress, and stack progress
Multi-Night Data – Field Tests	Multi-night stacking independently confirmed	M51: 8 h 14 min / 3 nights; over 157 h total on 27 deep-sky targets	Multi-night integration works; manual combination through Deep Sky Stack or externally	Multi-night integration works; data must be combined afterwards in Deep Sky Stack or external software	Multi-night project continuation demonstrated; high automation without manual re-registration or stacking
Automatic Continuation of Same Project – Manufacturer	not documented as autonomous project continuation	not documented as autonomous project continuation	no; automatic multi-night project continuation not documented	no; automatic multi-night project continuation not documented	yes, PerseverENS; existing multi-night projects can be included in Plan My Night
Automatic Project Continuation – Field Tests	—	—	New sessions are not resumed automatically; data must be combined afterwards	New sessions are not resumed automatically; subsequent data combination required	Works; repeated scheduled sessions can sometimes start new projects instead of continuing existing ones
Onboard Editing – Manufacturer	Stellar Studio (cloud-based)	Stellar Studio (cloud-based)	Seestar editing	Seestar editing	SkyColor
Onboard Editing – Field Tests	Quick usable results; potentially heavy cropping; external processing more flexible	Useful; SmartWorld finds fewer editing options than in some competing systems; external processing more flexible	Onboard results usable; external processing reveals more faint structure	Onboard results usable; FITS adds processing options	Strongly integrated into the workflow
Autofocus – Manufacturer	yes	yes	yes	yes	AcutENS; autofocus before session and automatic refocusing after temperature drops above approximately 3 °C
Autofocus – Field Tests	Usually reliable; occasional failures. CellaPix: focused on clouds during solar eclipse	No recurring weakness established	Usable, but not always reproducibly optimal	No general problem demonstrated	Autofocus positively reviewed; no recurring weakness established

Aspect	DWARF Mini	DWARF 3	Seestar S30 Pro	Seestar S50 Pro	Vespera 3
Dew Prevention – Manufacturer	No integrated active dew heater documented	No integrated active dew heater documented as a primary feature	active dew heater	active dew heater	built-in temperature/humidity sensor; automatic objective heater
Dew Prevention – Field Tests	Mixed; strongly condition-dependent	—	Positive	Positive	Positive; automatic dew control demonstrated in practice
Dithering / Calibration – Manufacturer	Automatic dithering; Factory bias and flat frames for each unit, automatically applied during onboard processing; darks depend on settings and temperature	Automatic dithering; intervals depend on exposure duration; factory bias/flats; darks depend on settings and temperature	Automatic dithering during live stacking and continuous capture; Flat Shoot; hot-pixel correction; built-in dark filter	Dark Corr: automatic dark at session start; Flat Shoot; hot-pixel correction. Dithering supported, exact S50 Pro behaviour not separately documented. Dark-library management and improved calibration workflow from app 3.4.0	Dark frames available in Expert mode for external stacking; no automatic Universal Master Dark calibration on Vespera 3; model-specific dithering not separately documented
Dithering / Calibration – Field Tests	—	—	Dithering generally confirmed, although some S30 Pro reports mention walking noise or insufficient movement. Flat Shoot and hot-pixel correction are available	Dithering used in S50 Pro sessions; dark library exists but no automatic generation of new master darks during active sessions. Temperature-dependent calibration quality remains limited or unresolved	Missing automatic dark calibration cited as a limitation; hot pixels may remain visible. Dithering not assessed separately
External Control – Manufacturer	No official ASCOM/N.I.N.A. integration; community project dwarfAlp	No official ASCOM/N.I.N.A. integration; community project dwarfAlp	ASCOM Alpaca support	ASCOM Alpaca; N.I.N.A. explicitly mentioned	Singularity only; no PC/ASCOM/N.I.N.A. control; USB-C for file transfer only
Star Shapes – Field Tests	Usable; slight colour fringes; more rejections above 120 s. CellaPix: stars sometimes largely round at 180 s	Mixed: Astrocologne reports soft/bloated stars; other tests show usable results	Generally clean across the field; autofocus occasionally soft	Asymmetric star shapes reported on several units, only partly reproduced in follow-up tests. Cause and prevalence unknown	Positive to date; no evidence of recurrence of the earlier Pro issue. Systematic testing of multiple units into the corners still missing
Battery – Field Tests	Approx. 4 h (temperature-dependent). External power recommended for longer sessions.	approx. 5.5 h in mild conditions; 3–4 h in winter	Depends on usage; no conspicuous deviation so far	over 6 to approximately 7+ h; dependent on heating and temperature	approx. 12 h in one test, including app communication and image processing

Table 3 Comparison matrix: Compact smart telescopes in 2026

How Far Has the Compact Category Progressed by 2026?

Compact smart telescopes have advanced considerably since 2025, less through any single breakthrough than through the combination of better sensors, additional tracking options, and more mature capture workflows. EQ modes on the DWARF Mini, DWARF 3, and current Seestar models allow longer individual exposures and therefore a workflow closer to conventional astrophotography. FITS raw frames are also available for external processing. Independent tests show just as clearly, however, that the longest selectable exposure is not automatically a reliably usable one: polar alignment, wind, and mechanical stability continue to have a direct effect on the yield of acceptable frames.

Advances in sensors and field of view are particularly evident. The DWARF 3 offers a main sensor with much higher native resolution than the compact Mini, while the S30 Pro and S50 Pro combine deep-sky and wide-angle photography in dual-4K systems. The S50 Pro additionally has a larger 50 mm aperture. This increasingly differentiates the instruments by application: the S30 Pro emphasises large sky fields, while the S50 Pro is more focused on detailed deep-sky imaging.

Software is now at least as important. Observation planning, automated mosaics, subsequent combination of multiple sessions, and onboard processing support increasingly complex and prolonged imaging projects. Implementation varies markedly between manufacturers. The change is particularly apparent with the DWARF 3: its hardware has remained largely unchanged since 2025, while EQ operation, Mega Stack, mosaics, and planning have considerably enhanced the workflow. Vaonis goes further towards an integrated autonomous system with PerseverENS: multi-night projects, CovalENS mosaics, Plan My Night, AcutENS autofocus, and automatic dew control all work together.

These different designs also show that there is no single ideal technical approach within the compact category. DWARFLAB and ZWO expand capabilities through measures including equatorial operation and longer individual exposures. Vaonis retains alt-az operation and short exposures, mitigating their limitations more through software, mosaics, and multi-night integration. The systems also differ substantially in their filters and openness to external software. By 2026, these distinctions have become more important than simply asking which instrument has the highest sensor resolution.

The physical constraints nevertheless remain. Software cannot compensate fully for apertures of only 30–50 mm, uncooled sensors, or extremely compact mechanics. Small galaxies and planets remain resolution-limited; wind and tracking errors still affect images. Sophisticated external processing can extract more from the raw data,

but cannot replace missing aperture. This is evident both in independent tests and in my direct comparison of the DWARF Mini with a conventional 121 mm system.

By 2026, compact smart telescopes have not become replacements for conventional astrophotography, but they have become considerably more credible alternatives for certain tasks. Progress consists above all in allowing users to choose among different levels of automation: from a largely automatic result generated in the app, through scheduled sequences and mosaics, to multi-night projects or the subsequent merging of separate sessions, as well as FITS export and external processing. Which functions can be combined, and how completely they are automated, still varies substantially by manufacturer. The next stage begins where guiding, active sensor cooling, mechanical derotation, or significantly larger apertures are integrated into the automated system. This is where Draco and Origin enter the picture—and where the second development line in this white paper begins.

Which Smart Telescope Is Right for Me?

Current smart telescopes differ considerably in their imaging capabilities and degree of automation. A general ranking by specifications or price is therefore of little use. The key questions are which tasks the instrument should perform and which features are actually needed for those tasks.

Beginners usually place the greatest value on easy operation, quick results, and manageable cost. Experienced astrophotographers looking for a second instrument are more likely to prioritise field of view, access to raw data, and how the device complements their existing equipment. The following buying advice therefore considers different applications instead of repeating technical specifications.

Five Questions to Ask Before Buying

Five basic questions help narrow the choices:

1. Am I looking for my first astrophotography system or a second instrument?

Beginners benefit from a reliable, straightforward imaging workflow. Experienced astrophotographers need to consider what additional capabilities the instrument provides alongside their existing equipment.

2. How Important Are Weight and Portability?

Anyone taking a telescope on trips or hikes will place more weight on size and portability than someone imaging primarily from their own garden.

3. What Do I Mainly Want to Photograph?

Extended nebulae, star fields, and the Milky Way require different fields of view from smaller galaxies or compact deep-sky objects. Preferred targets are therefore an essential selection criterion.

4. Do I Want to Process My Images Myself?

Anyone wishing to process FITS files in PixInsight or Siril, for example, needs adequate resolution reserves and a suitable raw-data workflow. Users who primarily want finished images as quickly as possible will place greater importance on onboard processing.

5. How Much Do I Want to Control Myself—and How Much Should the Telescope Handle?

Some users want extensive control over capture settings, processing, and the planning of longer projects. Others prefer a system that can execute even complex imaging sequences almost independently.

These questions already provide an initial shortlist. The following sections show which instruments best meet the various requirements.

Maximum Portability and a Low Entry Price: DWARF Mini or DWARF 3?

The DWARF Mini is a particularly interesting option for anyone seeking an extremely light and affordable smart telescope. It suits beginners who want initial experience of astrophotography without a large financial outlay, as well as photographers needing the smallest possible second instrument.

Its small size comes with limited sensor resolution, which is often adequate for on-screen viewing and smaller outputs. Those planning larger prints, substantial crops, or the extraction of especially fine structure will reach its limits sooner.

For these applications, the DWARF 3 offers a better starting point. At its native resolution of 8.3 MP, the DWARF 3 offers more room for cropping. With 2×2 binning, it produces images of about 2.1 MP, roughly the same pixel count as the DWARF mini. Particularly for experienced astrophotographers who wish to process their FITS files themselves, this difference may matter more than the additional weight and higher purchase price.

Both instruments use the same fundamental software platform. The decision should therefore be based less on app features and more on individual requirements for portability and image quality. Nor are the respective maximum exposure times reliable evidence of overall superiority, since their practical usefulness depends on observing conditions.

The decision can thus be reduced to one simple question: is the smallest, most affordable instrument my priority, or would I prefer more scope for processing in return for a relatively small price increase? The DWARF Mini suits the former, and the DWARF 3 the latter.

Wide Fields, the Milky Way, and Large Nebulae: When Is the S30 Pro the Better Choice?

Choosing between the Seestar S30 Pro and S50 Pro depends primarily on preferred subjects. The S30 Pro has the wider native field and is therefore well suited to extended nebulae, star fields, and larger groups of objects. Many such targets fit without requiring mosaic imaging.

The wide-angle functions are also attractive for landscape and nightscape photographers. The Milky Way, star trails, and nocturnal landscapes extend its usefulness beyond conventional deep-sky photography. Although the S50 Pro also has a wide-angle camera, the two models differ considerably in the sky area covered by their telephoto systems.

As a second instrument in particular, the S30 Pro can therefore be the more useful addition. Someone already photographing small galaxies and fine nebular details with a larger telescope may gain more from a supplementary wide-field system than from another instrument with a longer focal length.

The S50 Pro, by contrast, is more attractive when smaller deep-sky objects and finer detail are priorities. Its larger aperture and longer focal length provide better starting conditions for those subjects.

The deciding question is therefore whether I want to photograph the largest possible sky fields or render smaller targets at a larger image scale. For wide-angle photography and extended nebulae, the cheaper S30 Pro may be the better choice; for more compact deep-sky objects, the S50 Pro has stronger advantages.

Practical example: the Andromeda Galaxy

The optical disk of M31 measures approximately 3.17° × 1.00° (190' × 60'). With a favourable orientation, it fits within a single frame of the Seestar S30 Pro, leaving a small margin. With the DWARF 3, the fit is tight. The other models require multiple panels.

Model	Focal length (mm)	Sensor width × height (mm)	Single-frame field of view (° × °)	Does M31 fit in one frame?	Automatic mosaic	Frame orientation
DWARF mini	150	5.57 × 3.13	2.13 × 1.20	No	Yes, in EQ mode	Fixed for a single frame
DWARF 3	150	7.68 × 4.32	2.93 × 1.65	Very tight at a favorable diagonal angle. Use a mosaic for margin around the galaxy.	Yes, in EQ mode	Fixed for a single frame
Seestar S30 Pro	160	11.14 × 6.26	3.99 × 2.24	Yes, with room to spare at a favorable orientation	Yes, Framing mode	Target frame can be rotated
Seestar S50 Pro	260	11.14 × 6.26	2.45 × 1.38	No	Yes, Framing mode	Target frame can be rotated
Vaonis Vespera 3	245	11.14 × 6.26	2.60 × 1.40	No	Yes, CovalENS	Mosaic frame can be rotated
Vaonis Vespera Pro 2	245	7.07 × 7.07	1.60 × 1.60	No	Yes, CovalENS	Mosaic frame can be rotated
DWARFLAB Draco	340	9.80 × 7.35	1.65 × 1.24	No	Yes	Sensor rotates for field derotation
Celestron Origin Mark II	335	7.71 × 4.36	1.32 × 0.75	No	Yes	Camera can be rotated manually

Model	Focal length (mm)	Sensor width × height (mm)	Single-frame field of view (° × °)	Does M31 fit in one frame?	Automatic mosaic	Frame orientation
Unistellar Odyssey / Odyssey Pro	320	4.19 × 3.13	0.75 × 0.56	No	Undocumented	Manual angle selection undocumented
Unistellar eQuinox 2 / eVscope 2	450	5.97 × 4.48	0.76 × 0.57	No	Undocumented	Manual angle selection undocumented

Table 4 Andromeda galaxy in the field of view of smart telescopes

Figure 15 Image of the Andromeda Galaxy, taken with a refractor telescope

Deep-Sky Imaging and Independent Processing: Which Instrument Offers the Most Options?

All the instruments considered allow astronomical images to be processed externally in principle. The relevant question is therefore less whether FITS files are accessible than what quality and resolution reserves they contain, and how much control the user has over image capture.

The DWARF Mini already demonstrates the considerable benefits of external processing. In my tests, I recovered substantially more detail and a better background from FITS data than from automatic stacks. Low resolution remains a limitation, however. Anyone seeking more cropping and editing latitude without sacrificing portability is therefore better served by the DWARF 3.

Between the two Seestar models, the choice again depends more on the intended subjects. The S30 Pro combines external processing with a large field, making it attractive for extensive deep-sky targets. The S50 Pro offers better conditions for smaller structures and more demanding deep-sky projects.

The S50 Pro also offers experienced astrophotographers ZWO's officially supported ASCOM Alpaca integration. This creates additional opportunities to incorporate the instrument into existing software workflows. Anyone not wishing to operate a smart telescope exclusively through its manufacturer's app should take particular account of this feature.

Nevertheless, the S50 Pro still has limitations in observation planning and tracking accuracy with longer individual exposures. There are also reports of asymmetric star shapes on individual units. The cause is being investigated; a defect affecting the entire product series has not been established.

S50 Pro buyers should therefore inspect stellar images soon after receiving their instrument. Several FITS subframes of a star-rich field should be taken, and stars compared at the centre, edges, and corners. Repeating the test at a different sky position can help eliminate incidental effects. If persistent anomalies remain, the retailer should be contacted, preferably within the applicable withdrawal or return period. Anyone able to defer a purchase can also consider waiting for further test results.

Vespera 3 likewise allows external processing of raw data, but follows a different philosophy. Its emphasis is not on unrestricted capture control, but on a largely automated end-to-end process. Buyers intending to perform every processing step themselves may attach less value to this extra automation.

The choice therefore also depends on whether the smart telescope should primarily collect raw data for independent processing or produce finished results with minimal intervention. DWARF and Seestar are particularly interesting for the former, while users seeking a more automated capture workflow should examine Vespera 3 more closely.

Maximum Automation: What Are You Actually Paying for with Vespera 3?

Vespera 3's relatively high price is explained less by a larger aperture or greater sensor resolution than by the extensive integration of the entire imaging workflow. Vaonis aims to make even prolonged and complex observing projects possible with minimal manual intervention.

The automatic continuation of multi-night projects is particularly noteworthy. Whereas the other compact systems considered can combine images from separate sessions afterwards, Vespera 3 manages the progress of an ongoing project and allows it to continue on subsequent nights. Together with mosaics, observation planning, automatic focusing, and dew control, this creates an especially seamless workflow.

This can appeal to beginners who want minimal technical work and for whom budget is a secondary concern. For experienced astrophotographers, Vespera 3 is particularly attractive as an autonomous second instrument gathering data over several nights alongside a conventional rig.

However, extensive automation does not mean every task is integrated. Filters must still be changed manually; Vespera 3 lacks the automatic dark calibration of the Pro models, and external capture control through N.I.N.A. or ASCOM is unavailable. Users wanting automatic changes between filter configurations during a night or unrestricted control over the capture process therefore encounter limitations.

The buying decision therefore depends strongly on the value placed on automation. Those who prefer to plan, control, and process images themselves may not benefit fully from Vespera 3's price premium. Others who want to spend as little time as possible on setup, supervision, and continuation of multi-night projects get a degree of automation not offered in this form by the cheaper systems.

The following decision aid brings together these requirements and shows which compact smart telescope is particularly well suited to each type of use.

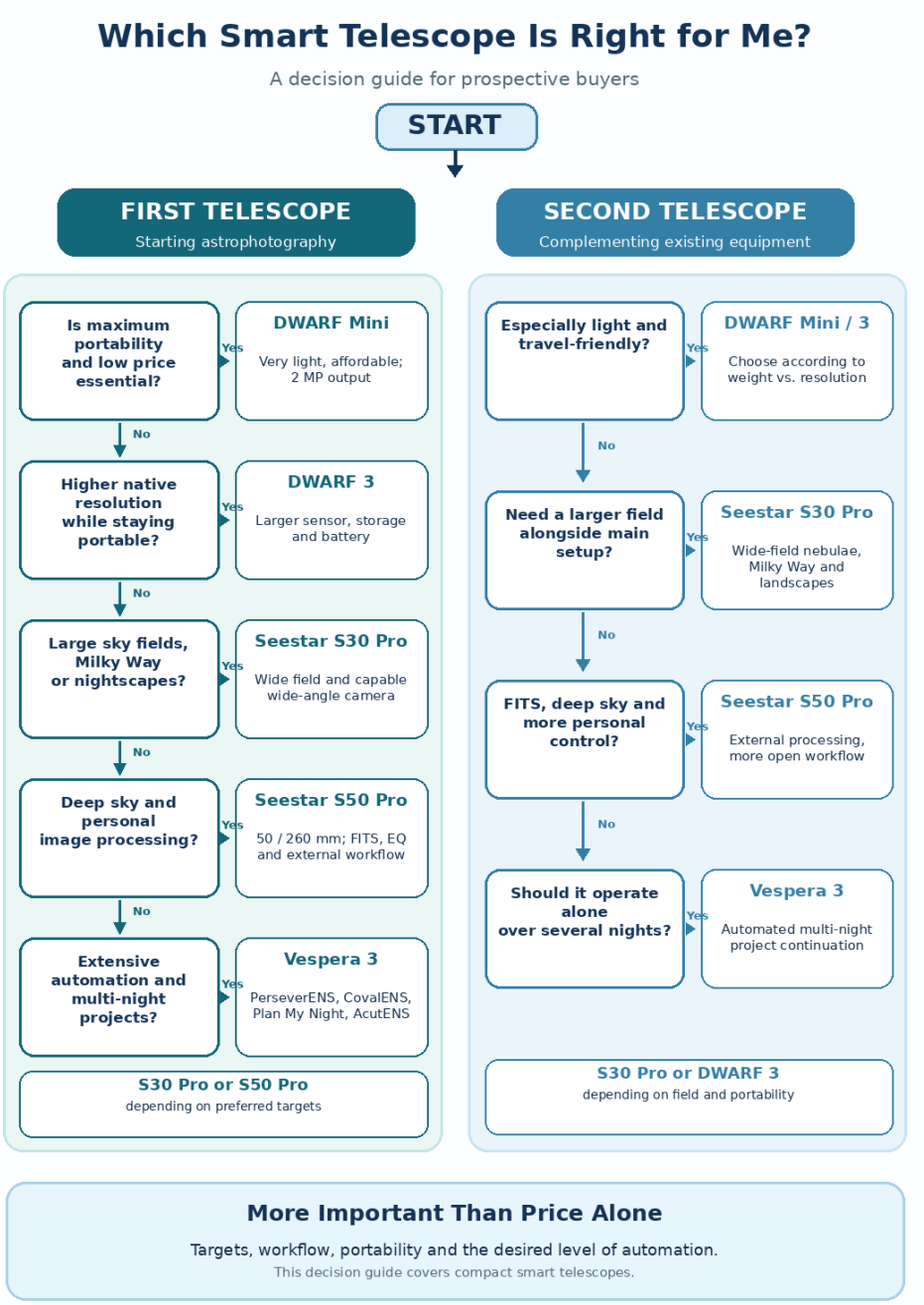

Figure 16 Decision-making process for choosing a smart telescope [Graphic created by ChatGPT]

Automated Astrographs

What Distinguishes an Automated Astrograph from a Compact Smart Telescope?

DWARFLAB Draco and Celestron Origin represent a second line of development. Both combine the largely automatic target selection, tracking, capture, and processing familiar from smart telescopes with more powerful optics and components associated

with conventional astrophotography. They are therefore termed 'automated astrographs' below. This is a working definition, not an established market category.

With 90 mm and 152 mm apertures respectively, Draco and Origin have substantially more light-gathering area than the previously examined compact systems of 30–50 mm. Both also support autoguiding—built into Draco, and available on Origin through an optional autoguider used with an equatorial wedge. Their technical approaches differ considerably: Draco integrates guiding, sensor cooling, and field derotation into a comparatively compact system, while Origin primarily relies on its large, very fast optics, which can be extended with accessories.

These differences also change the basis of evaluation. For compact smart telescopes, the balance between portability, imaging performance, and automation was paramount. For automated astrographs, the performance and reliability of integrated technology become more important. The crucial point is not simply which features are present or what maximum exposures are possible, but how reliably they work during long sequences under real-world conditions.

The following assessment first examines Draco and Origin in terms of manufacturer information and independent field experience. It then compares optics, sensors, tracking, guiding, cooling, field derotation, dithering, calibration, filters, exposure times, raw-data access, and capture automation. This helps establish how far both systems bridge the gap between compact smart telescopes and conventional astrophotography rigs.

DWARFLAB Draco: Technical Specifications and Manufacturer Claims

DWARFLAB introduced Draco in September 2026. With a 90 mm aperture and 340 mm focal length at f/3.8, it uses a fast folded optical system. Its compact design fits the comparatively long focal length into a housing only about 39 cm high. DWARFLAB promises well-corrected star images right into the corners. Collimation is performed at the factory and cannot be adjusted by the user.

The main camera uses an OmniVision OV50Q40 1/1.3-inch sensor with a native resolution of 50.33 megapixels and a pixel pitch of 1.197 µm. For deep-sky imaging, Draco uses 2×2 binning, producing images of approximately twelve megapixels with an effective pixel pitch of 2.394 µm. The native field of view is about 1.65° × 1.24°. For lunar, solar, and planetary photography, Draco reads out the native 1×1 pixels, but restricts the output to roughly twelve megapixels through cropping. The nominal 50 megapixels are therefore not currently available as full-frame output resolution.

The separate wide-angle camera also uses a nominally 50.33-megapixel OmniVision OV50E40 sensor. At an actual focal length of 5.56 mm, it covers an 85.74° diagonal field

and likewise outputs images of approximately twelve megapixels. Both cameras can operate simultaneously, allowing deep-sky targets and wider sky views to be recorded together. A third, monochrome camera with a 4.09-megapixel OS04C1B sensor is used exclusively for guiding.

Integrated guiding is one of Draco's principal technical innovations. Separate guide optics monitor the positions of stars and allow continuous tracking corrections. Draco also features mechanical field derotation: during capture, the main sensor is physically rotated to compensate for field rotation. This is intended to permit longer individual exposures without disruptive field rotation even with an alt-az setup. Draco can alternatively operate in EQ mode, which DWARFLAB recommends particularly for targets near the zenith, where field rotation is fastest.

According to the manufacturer, individual exposures of up to 300 seconds are possible. Actual tracking performance depends on setup, wind, and other observing conditions. Automatic dithering between frames is also supported through the integrated guiding system.

Draco uses a thermoelectric cooler (TEC) and a fan to cool its main sensor. According to DWARFLAB, the sensor operates at approximately 5 °C below ambient temperature when cooling is active, depending on operating conditions. Cooling is enabled by default and runs automatically. Users can switch it on or off in the app but cannot set a target sensor temperature.[xv] Waste heat from the cooler warms the optics and helps prevent dew from forming.

Calibration is also intended to be largely automatic. According to DWARFLAB, flat and bias calibration data are factory-stored in the instrument, while dark frames are generated during imaging sessions. Corrections are applied directly to live stacking. It remains unclear how the stored flats could account for later changes in the optical system, such as newly deposited dust.

The filter system differs by version. Both variants include a broadband astronomy filter covering approximately 430–690 nm, a dark filter, and a dual-narrowband Hα/OIII filter. The latter is centred at 656.3 nm and 500.7 nm; DWARFLAB specifies a full width at half maximum of 13 ± 3 nm for both passbands.

The Standard version additionally includes a built-in ND5 solar filter for the telephoto camera, which can be moved into position automatically. The SHO version replaces it with a second dual-narrowband filter for SII at 671.6 nm and OIII at 500.7 nm, also with 13 ± 3 nm bandwidths. Automatic switching between the two narrowband filters enables data capture in the three emission lines SII, Hα, and OIII, which can then be combined into an image using the Hubble palette. Unlike colour assignments generated entirely in software, this uses genuine SII measurements. Solar imaging with the SHO version requires the included external ND filter to be attached before observing.

Draco uses the shared DWARFLAB app platform for capture control. Automatic target location, autofocus, live stacking, planning, mosaics, combining separate sessions, and editing with Stellar Studio build on functions already available on the DWARF Mini and DWARF 3. In Pro mode, exposure time, gain, and filter can be selected manually. Mosaics can extend to 1.8 times the original image width and height. FITS and TIFF files are available for external processing alongside JPEG and PNG, and individual FITS raw subframes can be exported.

A stronger emphasis on remote operation is new. According to DWARFLAB, PhotonLink allows Draco to be controlled over the internet. Wired networking through a USB-C Ethernet adapter is also supported. File access nevertheless has limitations: PhotonLink currently allows stacked images to be downloaded, but not individual FITS subframes. Direct control through N.I.N.A., ASCOM, or INDI is also not yet supported. Despite enhanced remote access, Draco's capture automation therefore remains tied to DWARFLAB software.

Draco weighs approximately 5.5 kg and measures 196 × 386 × 133 mm. Its internal battery is rated at 77 Wh, equivalent to 10,000 mAh at 7.7 V. DWARFLAB specifies approximately five hours of operation, with USB-C external power supported. Features also include 128 GB internal storage, Wi-Fi, Bluetooth, NFC, and an aluminium tripod. The specified operating temperature range is −20 to +45 °C. The Standard version has a regular price of €1,499 and the SHO variant €1,669.

With Draco, DWARFLAB combines several components normally used separately in conventional astrophotography systems into a single device. Particularly interesting are the combination of guiding and mechanical field derotation, integrated cooling, and automatic filter changing on the SHO version. Whether these features work reliably together, and what photographic performance they can actually deliver, remain questions for independent field testing.[xc,xci,xcii]

Figure 17 Draco on its tripod [Source: DWARFLAB]

DWARFLAB Draco: Independent Tests

DWARFLAB published initial FITS datasets from test instruments which several experienced astrophotographers independently analysed. Those investigations allow a more informed preliminary assessment of image quality, but do not replace testing in which reviewers operate the instrument themselves and control the observing conditions.

Among the most informative is an analysis by Wido Oerlemans, who processed seventeen 300-second individual exposures of the eastern Veil Nebula (NGC 6992) in PixInsight. The total integration of 85 minutes was acquired under Bortle 3 skies. Even the minimally processed data show fine nebular structure with relatively little noise. Additional analyses of the Heart Nebula using three hours of integration also illustrate the potential of the fast optics. Comparisons with the DWARF 3 and Seestar favour Draco clearly, but different sky conditions, filters, and integration times mean they should not be treated as controlled performance comparisons.[xciii,xciv,xcv]

Closer analysis also reveals limitations in stellar images. Oerlemans measured a mean stellar FWHM of 3.51 pixels, corresponding to approximately 5.1 arcseconds, in the Draco stack. Star eccentricity varied diagonally across the field from 0.44 to 0.58, suggesting that stellar performance was not entirely uniform. Potential explanations include optical alignment errors or effects associated with sensor derotation. The available data do not establish the cause conclusively. A direct comparison with the reviewer's conventional setup, which achieved substantially sharper stars, also has limited value because conditions differed.[xciii]

Another issue concerns conspicuous haloes around bright stars. Both Oerlemans and Steff Sarek (Astro-Nerd) document such artefacts in the released images. Sarek examined four datasets, including the Heart and Orion Nebulae, and found some pronounced, slightly asymmetric haloes that remained visible even after star removal. He suspects reflections between the sensor cover glass and the dual-band filter. Whether the filter coatings are responsible, and whether the same effects occur on production units, remains unresolved.[xciii,xciv]

The cooling and calibration findings are also revealing. FITS headers in the sequence analysed by Oerlemans recorded sensor temperatures between 11 and 15 °C. There is therefore no indication of the fixed-temperature regulation familiar from conventional cooled astronomy cameras, making temperature-matched darks particularly important. The provided calibration data were insufficient to check the entire automatic calibration process. Small shifts in position between frames also suggest automatic dithering. A 113-minute session yielded 85 minutes of usable integration; DWARFLAB attributed the interruptions to passing clouds. A reliable rejection rate for 300-second exposures cannot be established from this dataset.[xciii]

The published frames thus demonstrate that Draco can acquire high-quality deep-sky data in five-minute exposures under favourable conditions. What remains unproven is the long-term reliability of guiding and mechanical field derotation at different sky positions. Independent cooling measurements, systematic alt-az versus EQ comparisons, and complete field tests of the SHO filters, observation planning, and multi-night projects are also missing.

The results so far show substantial photographic potential. Particularly promising is the amount of signal collected in relatively short total integration times. However, the variations in stellar rendering and conspicuous filter haloes mean that optical quality cannot yet be assessed conclusively. The first independent tests of production instruments will be decisive. Only these can show whether Draco reliably delivers the promised advantages of guiding, cooling, and field derotation in everyday observing conditions.

First Independent Field-Test Results

A field test published by Lineastro on October 25, 2026, provides initial insights into the performance of a DWARF Draco operated by an independent reviewer. The test was conducted with a pre-production unit under Bortle 4 skies and included comparisons with the Seestar S50 Pro and a conventional astrophotography setup. Individual exposures of 300 seconds were successfully captured in alt-azimuth mode with active tracking and field derotation. The images demonstrate a high level of detail, particularly in extended emission nebulae. However, quantitative measurements of tracking accuracy, star quality across the entire field of view, and the rejection rate of individual exposures are still lacking.

Critical observations primarily concern sensor cooling and dark-frame calibration. Even small temperature differences of approximately 1 °C between light and dark frames were associated with residual hot pixels in the resulting images. Furthermore, the automatic acquisition of additional dark frames during an observing session caused interruptions in light-frame acquisition. It remains unclear whether these issues are related to temperature regulation, calibration software, or the current stage of firmware development. Unusual star shapes observed in some images also require systematic investigation.

As the firmware was updated several times during the test period, the results have limited reproducibility. The test confirms important imaging capabilities of the Draco under real-world conditions but does not yet allow a conclusive assessment of image quality, calibration reliability, or production readiness.[xcvi]

Figure 18 DWARF Draco in use [Source: DWARFLAB]

Celestron Origin Mark II – Technology

The Celestron Origin Mark II continues the concept of a largely automated home observatory introduced in 2024. The main hardware change from the original Origin is the camera; optics, mount, and basic construction are unchanged. Several software updates have also extended functionality, benefiting owners of the first-generation instrument as well.

At its optical heart is still the Rowe-Ackermann Schmidt Astrograph (RASA), with a 152 mm aperture, 335 mm focal length, and f/2.2 focal ratio. In this design, the camera sits in the front optical path. The high optical speed allows considerable signal to be gathered in relatively short individual exposures, a major advantage for faint deep-sky targets. The large aperture also provides a higher theoretical resolving power than the smaller smart telescopes. How much of that potential appears in actual images depends on the sensor, optical quality, and atmospheric conditions.[xcvii]

The main innovation in Mark II is the Origin 678C camera with a back-illuminated Sony IMX678 from the Starvis 2 family. It replaces the earlier IMX178 with 6.4 megapixels and 2.4 µm pixels. The new sensor offers approximately 8.3 megapixels at 3856 × 2180 pixels, with a 2.0 µm pixel pitch. The calculated image scale therefore improves from 1.48 to 1.23 arcseconds per pixel. The aspect ratio also changes from about 3:2 to 16:9. Native field of view is now 1.32° × 0.75°, compared with 1.27° × 0.85° previously. More pixels therefore do not mean a correspondingly larger field, but primarily finer sampling. Independent tests are needed to establish whether this actually yields more resolved detail. Owners of the original Origin can replace their camera with the new 678C.[xcvii,xcviii,xcix]

The single-arm alt-az GoTo mount remains unchanged. It continues to offer largely automatic setup through StarSense, including sky alignment, target location, and autofocus. By default, Origin takes ten-second subframes, which are automatically registered and stacked. Frames with tracking errors are rejected. The RASA's fast optics allow faint structures to become visible even with these short exposures.[xcvii]

For more demanding imaging, Origin can now be operated in EQ mode using an optional equatorial wedge. This eliminates field rotation and permits longer individual exposures. The optional StarSense Autoguider can further improve tracking accuracy. Celestron recommends this combination particularly for exposures longer than 30 seconds. The manufacturer also notes that at f/2.2, exposures of just 10–30 seconds are sufficient under many sky conditions, while longer exposures may saturate bright regions. EQ mode therefore broadens imaging options but is not necessary for every observation.[xcvii,c]

The addition of dithering and mosaics extends the photographic capabilities of both Origin generations. Dithering also works without the optional autoguider. In mosaic mode, users specify a larger field, which the telescope divides into overlapping panels, captures, and combines automatically. Later firmware updates particularly improved panel registration and reduced visible seams. Independent field tests are still needed to assess how reliably these functions work on longer projects.[xcvii,c]

Observation planning allows multiple targets to be scheduled and captured automatically in sequence during a night. Onboard processing also replaces much of the conventional post-processing chain, combining live stacking with noise reduction, deconvolution, and automatic background correction. Celestron describes these algorithms as AI-assisted, while emphasising that they do not generate additional image content. Advanced users can disable individual processing modules or adjust the display manually.[xcvii]

Individual raw frames can be saved as FITS and transferred to a computer via USB or network for external processing. Raw-data recording must be explicitly enabled beforehand. The files can then be independently calibrated, registered, and integrated in software such as PixInsight or Siril. Origin thus offers access to its source images, while actual capture control remains centred on the Celestron Origin app. Direct integration with conventional acquisition software such as N.I.N.A. is still not part of the intended functionality.[xcvii]

Origin uses factory-stored dark and flat frames for calibration. However, users can take their own calibration frames through the app, replacing the existing data when needed. This is particularly relevant after changes in observing conditions, a camera replacement, or new contamination in the optical path. Since Origin does not have regulated sensor cooling, factory darks may be inadequate at substantially different

temperatures. Celestron therefore recommends taking new darks under conditions as similar as possible to the actual observation if hot pixels or other artefacts remain. A new bias is also generated in the process. For flats, Celestron supports PrimaLuceLab's specially adapted GIOTTO flat-field panel, which can be controlled directly from the Origin app. Other suitable illuminated panels or, under certain conditions, sky flats may also be used.[xcvii]

Unlike DWARFLAB Draco, Origin has no active thermoelectric sensor cooling. Two built-in fans help the optics reach ambient temperature and cool the electronics, but cannot provide a regulated reduction in sensor temperature. Origin does, however, have automatic dew prevention with an environmental sensor, front-element heater ring, and removable dew shield.[xcvii]

Its filter system is comparatively flexible, but requires manual intervention. A built-in filter drawer accepts standard 1.25-inch or 2-inch astronomical filters, allowing different broadband and nebula filters to be fitted. Automatic filter changes during scheduled capture are not supported. With the very fast RASA optics, particular care is also required to ensure that narrowband filters are suitable for the steep light cone. Celestron warns that its optional nebula filter can produce pronounced reflection haloes around bright stars.[xcvii]

Basic dimensions and power arrangements are unchanged. The complete system—optical tube, mount, and tripod—weighs approximately 18.9 kg. The components can be assembled and transported without tools, but are considerably heavier than the compact smart telescopes examined earlier. The built-in LiFePO4 battery has a capacity of 97.9 Wh. Celestron specifies more than six hours of operation, while acknowledging that runtime can fall substantially in cold conditions. External power is possible. The regular German list price is €5,499.[xcvii,ci]

Origin Mark II therefore continues to emphasise the high optical speed of its RASA and a highly automated capture workflow. The new sensor provides finer sampling, while optional equatorial tracking and autoguiding extend its applications. Independent field tests are required to show whether these improvements actually translate into finer resolved detail and more reliable image capture.

Celestron Origin Mark II: Independent Field Experience

Unlike DWARFLAB Draco, introduced only in autumn 2026, Celestron Origin Mark II already has several independent field reviews and longer-term reports using the new 678C camera. They confirm in particular the high imaging performance of its RASA optics and the straightforward entry into deep-sky photography. They also show that the additional capture functions are not yet reliable in every situation.

BBC Sky at Night Magazine published one of the first detailed reviews in March 2026. Origin Mark II was assembled and ready to image in less than five minutes. Galaxies such as NGC 6946 and nebulae such as M27 became clearly visible after only a few ten-second exposures. After approximately an hour, detailed images were available with most processing performed automatically. Onboard background correction also worked convincingly under urban skies. The reviewer noted, however, that the relatively small sensor uses only a limited portion of the RASA's large corrected field, and explicitly criticised the mosaic function that was still missing at that time.[cii]

Space.com reached similar conclusions in June 2026. Under Bortle 4 conditions, the reviewer photographed M51, M81, and NGC 4565, among other targets. Significant structure was visible in the automatic images after only five to ten minutes of total integration. The reviewer particularly praised sharp star images and low visible noise, but encountered repeated Wi-Fi connection problems. Fine manual focusing was also awkward because the app responded with delays. Both magazine reviews therefore confirm strong imaging performance and ease of use, but do not yet provide systematic measurements of star shapes or a controlled comparison with the previous camera generation.[cii,ciii]

More technically revealing are the investigations of experienced astrophotographer Ron Brecher, who has used an Origin Mark II provided by Celestron since August 2026. In an image of galaxy NGC 6946 and open cluster NGC 6939, he compared the automatic stack with his own calibration and integration of individual FITS frames in PixInsight. Without drizzle, he found practically no difference between the results. Only an additional 2× drizzle integration produced a clear improvement. This indicates that onboard calibration and registration are already effective, while more demanding external processing can still extract additional detail from the data.[civ]

Brecher also tested EQ operation with the StarSense Autoguider and dithering. For the Pacman Nebula, NGC 281, he recorded 474 exposures of 30 seconds, giving three hours and 57 minutes of total integration, with dithering after every six frames. Subsequent processing in PixInsight, including 2× drizzle, produced a detailed result. This demonstrates that equatorial tracking, guiding, and dithering can work together successfully over a multi-hour project. Brecher did not, however, publish systematic measurements of guiding accuracy or a complete rejection-rate analysis.[cv]

Further evidence comes from German Origin owners. In September 2026, one user documented a multi-night M31 project with the new 678C camera. In EQ mode with the StarSense Autoguider and dithering enabled, 1,011 usable 60-second exposures were recorded, equivalent to 16 hours 51 minutes of integration. According to the photographer, subsequent PixInsight processing showed no walking noise. This also documents the practical use of 60-second exposures over several nights. However, after

a session was aborted, a Wi-Fi connection problem occurred which could only be resolved by restarting the instrument.[cvi]

The first independent tests of mosaic mode, introduced in September, are less convincing. In October 2026, an owner captured a twelve-panel mosaic of the Andromeda Galaxy in alt-az mode. Each panel contained ninety ten-second subframes. Automatic acquisition worked in principle, but the internally assembled mosaic showed highly irregular edges resulting from field rotation. The panels also differed noticeably in noise, and slight walking noise was visible in places. Only external registration and integration in Siril produced a more satisfactory composite, measuring 7,550 × 4,950 pixels after cropping. Another user had already found visible brightness transitions in a sixteen-panel mosaic in September, which could largely be removed by reprocessing in Astro Pixel Processor.[cvii,cviii]

These experiences show that mosaic mode can overcome the limitations of the small native sensor field, but that internal processing was not yet fully mature, at least with the first firmware versions. Firmware 1.5.6286 has since introduced improvements to panel registration, suppression of visible seams, and preservation of faint nebular structure. There is not yet sufficient independent evidence to establish whether the observed problems have been fully resolved.[cix]

Battery life also needs to be qualified under real observing conditions. BBC Sky at Night Magazine achieved only about three hours at winter temperatures near freezing—well below Celestron's stated runtime of over six hours. External power is therefore recommended for extended imaging projects, particularly in cold weather.[cii]

Overall, independent tests confirm Origin Mark II's high performance for deep-sky imaging. Particularly convincing are the rapid signal acquisition enabled by the RASA optics, the quality of internal processing, and the now demonstrated practical use of EQ guiding and dithering. The new camera provides finer sampling and, with external drizzle processing, can produce highly detailed results. A controlled measurement of the actual resolution improvement over the original IMX178 is still lacking.

The functional advances since 2025 must therefore be assessed separately. Dithering has proved effective in long imaging projects, while mosaic mode generally works but still exhibited shortcomings in onboard processing. There are also occasional connection problems and substantially shorter battery runtime in winter conditions. Automatic resumption of interrupted multi-night projects, comparable with Vaonis PerseverENS, has not been demonstrated. Origin has developed into a powerful automated astrophotography system but does not yet match the reliability and flexibility of a carefully configured conventional rig across every workflow.

Automated Astrographs 2026: Comparison Matrix

DWARFLAB Draco (Standard / SHO) and Celestron Origin Mark II · As at 25 October 2026

The entries distinguish manufacturer specifications from independent field evidence. Where reliable hands-on tests of production units are unavailable, this is noted explicitly.

Aspect	DWARFLAB Draco	Celestron Origin Mark II
Optics and Sensors		
Aperture / Focal Length	90 / 340 mm	152 / 335 mm
Optical Design / Focal Ratio	Folded catadioptric system; f/3.8	6-inch RASA (Rowe-Ackermann Schmidt Astrograph); f/2.2
Main Sensor	OmniVision OV50Q40; nominal 50.3 MP; 1.197 µm pixels	Back-illuminated Sony IMX678; 8.3 MP; 2.0 µm pixels
Deep-Sky Output	Approx. 12 MP through 2×2 binning; effective 2.394 µm pixels	8.3 MP (3856 × 2180); calculated image scale approx. 1.23"/pixel
Native Field of View	approx. 1.65° × 1.24°	approx. 1.32° × 0.75°
Additional Cameras	Wide-angle OV50E40, approx. 12 MP output, 85.7° diagonal; separate monochrome guiding sensor (4.09 MP)	No separate wide-angle camera; StarSense Autoguider available as external accessory
Tracking and Acquisition		
Mount / Operating Modes	Built-in alt-az mount; EQ operation also possible	Single-arm alt-az GoTo mount; EQ mode with optional equatorial wedge
Guiding – Equipment	Separate guiding sensor and guide optics built in	Optional StarSense Autoguider; equatorial wedge additionally required for longer EQ exposures
Guiding – Independent Tests	No adequate independent long-duration tests of production units yet; guiding accuracy unknown	Multi-hour autoguided projects documented, including 474 × 30 s and 1,011 × 60 s over multiple nights; no complete rejection statistics
Field Derotation	Main sensor physically rotated in alt-az mode; EQ also supported	No mechanical derotation; alt-az field rotation corrected in stacking software; avoided in EQ mode
Derotation – Independent Tests	Reliability over long alt-az sequences not yet independently demonstrated	Alt-az capture established; field rotation causes edge losses in mosaics and complicates processing
Individual Exposure Length	Manufacturer's maximum of 300 s achieved in an alt-az test with a pre-production unit. Frame rejection rate unknown	Standard operation usually 10 s; 30 s and 60 s in EQ mode independently documented. No universal success rate
Dithering	Automatic function specified; small positional shifts in test data suggest use	Integrated since April 2026, including without autoguider; multi-hour use confirmed
Cooling, Calibration, and Filters		
Sensor Cooling – Design	TEC cooling; manufacturer claims approx. 5°C below ambient; no user-selectable temperature setpoint	No active TEC sensor cooling; fans for optical and electronic thermal management
Sensor Cooling – Field Evidence	Test-series FITS headers: 11–15 °C; cooling performance cannot be independently quantified without ambient measurements	Not applicable; temperature-matched calibration remains relevant under changing conditions

Aspect	DWARFLAB Draco	Celestron Origin Mark II
Dew Prevention	Waste heat from sensor cooling used to warm the optics (manufacturer claim)	Environmental sensor, automatic objective heater, and dew shield
Darks / Flats / Bias – Design	Factory-provided flats and bias; manufacturer states that darks are recorded automatically during sessions	Factory darks/flats; user darks and flats can be captured through the app, including new bias calibration
Calibration – Independent Tests	Entire automatic process not yet independently verified; factory flats do not account for new dust	Without drizzle, onboard stack compares well with independently calibrated PixInsight integration; user calibration available
Filters / Switching	Built-in switching: Astro, dark, Hα/OIII; Standard includes internal ND5; SHO substitutes SII/OIII for internal ND5. Narrowband passbands 13 ± 3 nm each	Manual filter drawer accepts 1.25"/2" filters; narrowband filters must suit f/2.2; no automatic switching
Filter Artefacts – Field Evidence	Sometimes pronounced asymmetric haloes around bright stars in independently processed manufacturer FITS; cause unresolved	Reflection haloes possible with optional nebula filter; no systematic testing across production units
Automation, Data, and Operation		
Observation Planning	Multiple targets and automated capture through the shared DWARFLAB app; production-unit field testing outstanding	Multi-target planning in Origin app; occasional connection losses reported in real use
Mosaics – Function	Up to 1.8 × 1.8 times native field; shared DWARFLAB app platform	Automatically calculated and stacked mosaic panels; available since September 2026
Mosaics – Independent Tests	Not yet demonstrated in comprehensive independent Draco tests	12- and 16-panel mosaics achieved; early issues with seams and noise. Firmware improvements released, not yet thoroughly retested
Multi-Night Imaging	Mega Stack intended to combine sessions; no autonomous, reliable continuation of a project demonstrated	Multi-night FITS projects documented; no confirmed automatic continuation of the same project
Raw Data / Image Processing	Individual FITS subframes exportable; onboard stacking and Stellar Studio; independent PixInsight analysis available	Optional recording of individual FITS frames; onboard processing, external PixInsight/Siril workflows, and 2× drizzle tested
External Control / Remote Access	PhotonLink remote control over internet; only stacked-image downloads there, not FITS subframes. No official N.I.N.A./ASCOM/INDI control	Origin app; transfer by USB/network; no regular N.I.N.A./ASCOM control
Field Assessment and Cost		
Star Shapes – Independent Tests	Analysed data show field asymmetry (eccentricity approx. 0.44–0.58); cause and consistency across production units unresolved	Magazine and owner images generally positive; controlled IMX678-versus-IMX178 resolution comparison missing
Battery Runtime	Manufacturer: approx. 5 h (77 Wh). Independent long-term experience missing	Manufacturer: over 6 h (97.9 Wh); approx. 3 h in one magazine test under cold conditions
Weight / Transport	Approx. 5.5 kg for instrument; aluminium tripod supplied	Approx. 18.9 kg for complete system including tube, mount, and tripod. The weights do not describe precisely identical configurations

Aspect	DWARFLAB Draco	Celestron Origin Mark II
Regular Price	€1,499 Standard; €1,669 SHO	€5,499; equatorial wedge and autoguider extra
Status of Independent Tests	Mainly independent processing of manufacturer FITS so far; no comprehensive long-term production-unit testing	Several independent device reviews and longer owner projects with 678C; some firmware and reliability questions remain
Main Unresolved Question	How reliably do guiding, derotation, cooling, and SHO filters perform in real 300-second sequences?	How much real resolution does the new camera add, and how well does the improved mosaic function work on extended projects?

Table 5 Comparison matrix: Automated astrographs

Two Technical Paths to the Same Goal

DWARFLAB Draco and Celestron Origin Mark II pursue the same goal, but with different priorities. Draco integrates as many components of a conventional astrophotography rig as possible into a compact system. Origin primarily uses the capability of its large, exceptionally fast optics and extends the acquisition system with optional accessories when needed.

This difference also shapes exposure strategies. Origin's RASA optics collect a high signal level even with short individual exposures. Draco relies more heavily on combining longer guided exposures, mechanical field derotation, and active sensor cooling. Actual image quality, however, cannot be inferred solely from focal ratio or the longest possible individual exposure. The decisive measure is how much useful image information each system delivers under comparable conditions.

The requirements for automation also differ. Draco needs little additional hardware for its advanced capture features. Origin may require an equatorial wedge and autoguider, partly offsetting the simplified setup. On the other hand, the capability of this combination has now been documented in independent long-duration imaging projects. Draco's more complex integrated system still needs to prove itself during sustained real-world use.

The two approaches therefore demonstrate that smart telescope development need not follow a single path. Whether extensive technical integration or high-performance optics with optional extensions offers more practical value depends on conditions and users' requirements. Ultimately, the question is which approach consistently delivers high-quality results over long periods with the least effort.

How Much of a Conventional Astrophotography Setup Can Draco and Origin Replace?

A conventional deep-sky imaging setup consists of far more than a telescope and camera. It also requires a mount, tracking corrections, focusing, power, potentially a filter wheel and sensor cooling, plus a computer and capture software. Longer projects

additionally involve calibration frames, inspection of individual exposures, and subsequent image processing. Draco and Origin perform much of this work within an integrated system. How far they can actually replace a conventional setup depends on requirements for image quality, observation planning, and flexibility.

Basic capture automation has already been largely replaced. Both instruments handle sky alignment, target location, focusing, tracking, and image capture. Subframes are automatically registered, stacked, and processed into an immediately viewable result. A separate acquisition computer running software such as N.I.N.A. is unnecessary, as are separate controllers for the mount and focuser. Scheduled sequences and mosaics can also generally be acquired without additional software. This removes a substantial proportion of the technical workload for astrophotographers wanting relatively straightforward deep-sky imaging.

Draco does not need separate guiding or field-derotation components. On Origin, longer guided exposures instead require an additional equatorial wedge and StarSense Autoguider. The reliability of these approaches in practical use has already been examined in the independent tests.

Camera, filters, and calibration are also only partly comparable with conventional systems. Draco has active sensor cooling and automatically switchable filters; the SHO version can capture multi-channel narrowband data without manual filter changes. However, cooling cannot be regulated to a user-selected fixed sensor temperature. Origin offers greater freedom in choosing filters but has neither automatic filter changes nor active sensor cooling. Both systems automate important calibration steps without completely removing the need for suitable calibration data. In particular, factory-stored flats cannot account for dust introduced later. Significant temperature changes may also make new temperature-matched darks necessary.

Integrated calibration therefore simplifies the workflow without eliminating the underlying calibration requirements.

A similar distinction applies to image processing. For quickly available results, onboard processing replaces much of the conventional processing chain. Those seeking the full potential of their data, however, still benefit from external treatment of the FITS raw frames. Ron Brecher's investigations with Origin show, for example, that onboard calibration and integration already perform well, but additional drizzle processing can bring further improvements. My own experiments with the DWARF Mini likewise showed how much extra image information sophisticated external processing can reveal. PixInsight or comparable software therefore remains valuable for experienced astrophotographers.

The greatest limitation relative to a conventional rig is flexibility. In a modular system, optics, cameras, filters, mounts, and control software can be chosen, exchanged, and

upgraded independently. Draco and Origin tie these components much more closely to their respective manufacturer's platform. Although Origin's camera can be replaced and standard astronomy filters used, arbitrary combinations of cameras, mounts, and capture software are not supported. Draco offers even fewer options for exchanging components and currently lacks control through N.I.N.A., ASCOM, or INDI. In addition, PhotonLink permits remote download of stacked images but not the individual FITS subframes.

Consequently, the reliability of long unattended projects depends more strongly on each manufacturer's integration of hardware and software. Existing Origin tests show that multi-hour imaging with guiding and dithering is possible, but also document connection problems and limitations in onboard mosaic processing. Evidence remains too limited for a comparable assessment of Draco. For both systems, the question is therefore how reliably long projects can run without intervention and be resumed after interruptions. Power must also be considered on extended observing nights; independent Origin tests found markedly shorter battery life in winter than the manufacturer specifies.

Draco and Origin thus replace a substantial part of conventional capture equipment and automate many tasks. Their flexibility for individual configuration and later expansion nevertheless remains significantly restricted. Whether integration offsets this loss of freedom depends above all on the requirements of the imaging workflow.

An Additional Option for Visual Astronomy

Draco and Origin can also be useful additions for experienced visual observers. Electronically Assisted Astronomy (EAA) is not primarily about producing the highest-quality astrophotographs through prolonged exposure. Instead, short subframes and live stacking reveal increasing detail in celestial objects on a screen during the observation itself. This can make features visible—such as spiral structure in galaxies and colours or faint detail in nebulae—that are often barely perceptible through an eyepiece.

Celestron Origin Mark II appears particularly suitable for this use. Its fast optics can provide informative views of many deep-sky objects after only a few ten-second exposures. Independent field tests confirm this advantage and recommend the instrument for public astronomy events and group observing sessions. Draco's compact design and live stacking offer broadly similar possibilities, although independent experience with this specific application is still scarce.

Used alongside an existing visual telescope, both systems therefore provide two different perspectives on the same object: direct viewing through an eyepiece and an electronically enhanced image on a screen. This combination can enrich astronomical observing without the need for a complex conventional astrophotography rig.[cx,cii]

Which Automated Astrograph Is Right for Whom?

DWARFLAB Draco and Celestron Origin Mark II offer capabilities well beyond those of compact smart telescopes. Whether buying one is worthwhile depends less on the number of added features than on the photographer's requirements and previous experience. Four user groups are worth distinguishing.

Beginners Seeking Higher Image Quality

Both systems are attractive to those wanting high-quality deep-sky images without the complexity of a conventional astrophotography rig. Origin Mark II in particular provides a relatively straightforward route to more demanding results through its large, fast optics and largely automated workflow. Independent tests confirm that detailed images can be produced after relatively short integration times.

However, the purchase price of approximately €5,500 is substantial. Longer guided exposures may also require further expenditure on an equatorial wedge and autoguider. Draco, by contrast, offers extensive equipment—including integrated guiding, sensor cooling, and automatic filter switching—for approximately €1,500–1,700. Whether these components work together reliably over extended real-world use has not yet been adequately assessed independently.

For beginners, the more technically elaborate or expensive instrument is therefore not necessarily the better choice. Anyone first wanting to establish whether astrophotography will become a long-term hobby can start with a far less expensive compact smart telescope.

Experienced Astrophotographers Looking for a Second Instrument

Draco may be especially interesting for owners of conventional astrophotography setups. This relatively compact instrument integrates many functions that would otherwise require separate components. It could be a useful addition for travel or parallel imaging. The SHO version's filter system also enables automated narrowband projects without manual filter changes during the night.

Origin takes a different approach. Its particular strength is the large, fast RASA optics, advantageous especially when capture time is short. Those who already own a capable conventional setup must nevertheless decide whether this advantage justifies the high purchase price and additional transport weight.

System openness is also especially important to experienced astrophotographers. Neither instrument can be configured in the same way as a conventional mount with freely selected cameras, filter wheels, and N.I.N.A. Anyone wishing to retain complete control over planning, calibration, and components will continue to find a modular setup more flexible.

Visual Astronomers and Electronically Assisted Observing

Another user group consists of visual observers who want to supplement their familiar telescope with electronically assisted observing. While an object is viewed directly through the eyepiece, a smart telescope can simultaneously reveal fainter structures and colours.

Origin has a particular advantage for this application. Its fast optics make many deep-sky targets visible on screen after just a few short exposures. This also makes it attractive for group observing sessions and public astronomy events.

With its live stacking, Draco can in principle serve the same purpose, while being substantially lighter and less expensive. Further field tests must show whether it is equally convincing when rapidly switching between different observing targets.

Buying either instrument solely for electronically assisted observing should nevertheless be considered carefully. Much cheaper smart telescopes also support EAA. Draco and Origin are most interesting where the observing experience is accompanied by higher expectations of photographic results.

Advanced Astrophotographers Choosing Between Integrated and Conventional Systems

Anyone planning to invest several thousand euros should compare Draco and Origin not only with each other but also with the possibilities of a conventional astrophotography setup.

An integrated system substantially reduces the work involved in choosing, assembling, and coordinating components. In return, later modifications are limited. A conventional setup allows cameras, optics, filters, and mounts to be replaced or upgraded individually, with much greater freedom in selecting acquisition and processing software.

In Origin's case, a full set of accessories for longer guided exposures increases an already high purchase price. At this price point, capable conventional astrophotography systems are also available. Draco offers a much less expensive integrated package, but its actual performance and long-term reliability have not yet been independently established sufficiently.

The choice should therefore depend primarily on the value placed on an integrated imaging process. Automated astrographs are interesting alternatives for users seeking quality deep-sky images with minimal technical effort. Those who wish to develop their equipment over time and retain complete control over capture will often place greater value on the flexibility of conventional systems.

For Draco in particular, waiting for further independent tests before purchasing is advisable. Published images so far demonstrate promising potential but do not yet permit a definitive assessment of reliability in longer imaging projects.

Interim Conclusion: Automated Astrographs

With Draco and Origin Mark II, smart telescopes enter a new stage of development. Both show that more demanding astrophotography can increasingly be automated without assembling a conventional rig from many separate components. The main benefit is reduced technical workload, balanced against more limited flexibility.

The evidence for the two systems currently differs. Origin's performance is largely supported by numerous independent field reports, while key aspects of Draco still lack equivalent confirmation. Draco's technical potential is promising, but its long-term reliability has not yet been investigated adequately.

Automated astrographs are therefore credible alternatives for particular applications, but not universal replacements for conventional astrophotography systems. Their actual value depends less on the maximum feature set than on users' needs and working methods.

Conclusion Smart Telescopes 2026: Reliability Is the Next Step

Smart telescope development has reached a point where technical specifications and feature lists reveal increasingly little about practical value on their own. What matters now is how well the components work together and how reliably they produce useful observations and images under real conditions.

This also changes the criteria for evaluation. What counts is not the maximum possible exposure time but the number of genuinely usable frames; not merely the presence of automatic observation planning, but its ability to complete long projects reliably under changing conditions; and not nominal sensor resolution, but the level of real detail that can be extracted from the images.

Another finding is the growing importance of software. Unlike conventional telescopes, smart systems need not remain technically unchanged after purchase. Firmware updates can add functions, correct weaknesses, and substantially increase usefulness. At the same time, this creates greater dependence on manufacturers. How long will they maintain their instruments, how reliably will new releases work, and what options will remain if development stops?

The study also shows how essential independent field tests have become. With newly released instruments in particular, there is often considerable uncertainty between promised capabilities and their actual performance in routine use. A few successful images are therefore insufficient to assess an entire system.

For prospective buyers, the fundamental implication is that the long-term value of a smart telescope is determined not only by its equipment, but equally by software quality, automation reliability, and the freedom to work further with the acquired data.

Progress in the coming years should therefore be measured not merely by new sensors, larger apertures, or additional features. Equally important will be whether manufacturers develop their systems into mature astronomical instruments that remain useful over the long term.

Companion videos and contact details

These videos are in German. For English audio or subtitles, check the language options in the YouTube player.

- Deep-sky imaging with the DWARF mini in automatic mode
- DWARF mini in EQ mode: Are 180-second exposures worth it?
- Stacking DWARF mini data: Which software works best?
- Processing DWARF mini images in PixInsight: A comparison with a conventional telescope
- Filming a solar eclipse with the DWARF mini: From still images to time-lapse

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