Getting the Best Images from Your Smart Telescope



Introduction

In this demonstration, we will review some of the techniques available to help get the best images out of your smart telescope. This is not intended to be an all-inclusive how-to demonstration, but to serve as a guide to some techniques and tools that you can use to get the best results from it. While this demonstration utilizes the ZWO Seestar S30 and S50 Pro, the techniques and tools should work for any smart telescope.

Note: This presentation was recorded can be viewed by selecting THIS LINK (90 minutes)

Techniques and Tools

Listed below are some of the tools and techniques used to help improve your images:

- Application Changes
  - Saving Individual Frames
  - Equatorial Mode
  - Exposure Time
  - Capturing Flats and Dark Frames
- Hardware Additions/Upgrades
  - Equatorial Mode
  - Light Shield
  - Flats
  - Alternative Filters
- Techniques and Hints
  - Maximize Integration Time
  - Filters Based on Target Type (Broadband vs Line Filters)
  - Multiple Filters
- Post-Capture Processing
  - StackingWizard – Choosing and stacking your frames
  - AstroWizard – Processing your master frame

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Terms and Concepts

Some basic terms and concepts that are important to understand when discussing smart telescopes.

- **Bias frames** are the shortest possible exposures, taken with no light, like dark frames. They capture the sensor's fixed read-out offset and pattern. Some workflows substitute *dark flats* (darks matched to the flat exposure time) for bias frames, especially with CMOS cameras. Subtracting bias frames removes this fixed offset and pattern from the Light frames.
- **Dark Frame** - Taken with the scope capped (no light reaching the sensor) at the same exposure length, temperature, and gain/ISO as your lights. They record thermal signal (dark current), amp glow, and hot pixels so these can be subtracted from the light frames. This removes fixed patterns and artifacts; the signal-to-noise (S/N) ratio itself improves with more integration time.
- **Equatorial Mode** – placing the smart telescope on an equatorial wedge (tilting it to your latitude) and configuring the application to equatorial mode allows for longer exposures and eliminates field rotation.
- **Exposure Time** – The amount of time designated to take an individual image. Generally, a longer exposure time is desired, but tracking will typically limit this value. Mounting a smart telescope in an equatorial configuration will usually allow longer exposure times before star trailing becomes an issue.
- **Field Rotation** - Field rotation is the apparent turning of the sky across your camera sensor during a long exposure and over the course of an imaging session, caused by tracking the Earth's rotation with an alt-az mount.
- **Flat frames** are images of an evenly illuminated field, such as a light panel, a light source diffused by a white T-shirt over the aperture, or the twilight sky. They're shot with the optical train and focus unchanged from the lights. Flats map vignetting, dust donuts, and pixel-to-pixel sensitivity differences so the lights can be divided by them to even out the field. This technique helps compensate for optical design and imperfections that show up when an image is taken.
- **Light frames** are the actual exposures of your target: the images containing the signal you want, along with all the noise and artifacts the calibration frames will remove. Many smart telescopes will apply Dark, Bias, and Flat frame calibration to each image before storing it in memory. If this is the case, it is important NOT to re-apply them when processing and stacking individual frames for a Master Frame.
- **Master Light Frame** - the single integrated image you get by combining many light frames. Each light is calibrated with the master dark, bias, and flat, then registered (aligned), and then stacked, usually with averaging plus outlier rejection such as sigma clipping. The result has a much higher signal-to-noise ratio than any individual sub, and it's the file you take into post-processing for stretching, color balancing, and adjusting for a final image.

- **Smart Telescope** – An all-in-one, computer-controlled imaging instrument that combines a small telescope, a dedicated camera, a motorized mount, and onboard processing in one unit, and is controlled from a phone or tablet app. Most smart telescopes have no eyepiece. It aligns itself by plate solving, finds and tracks targets automatically, and live-stacks short exposures so the image builds up on screen in real time. A few examples include the ZWO Seestar, Vaonis Vespera and Stellina, and Unistellar eVscope.

The Run-Down

There are a number of factors that can be adjusted when attempting to get the best image you can from your smart telescope. These include:

- **Increasing Integration Time** – More integration time on a given target will raise the Signal to Noise ratio. However, there are diminishing returns with increased integration time. To increase the S/N ratio by a factor of 2 you will need 4x the integration time. So, to double the S/N ratio of a 1-hour integration time photo you will need 4 hours. To double that again (for 4x S/N ratio of one hour) you will need 16 hours of integration time.
- **Increasing Exposure Time** – Longer exposures allow for more signal to be captured from a target. Exposure time is usually limited by the tracking accuracy of the smart telescope. Placing the smart telescope in an Equatorial configuration allows longer exposures.
- **Stack Frame Quality** – It is important to eliminate frames that have star trails (poor tracking), bloated stars (focus or atmospheric conditions), and skyglow (light pollution or clouds). Frames with issues should not be included in the integration stack. Frames with plane trails can be compensated for via software in the post-processing step if using third-party software (StackingWizard).
- **Filters** – Many smart telescopes have built-in filters. These filters can be especially helpful when imaging in areas with high Bortle values (light pollution). Some folks also utilize external filters to highlight additional features.
- **Post Capture Processing** – Utilizing external applications (StackingWizard and AstroWizard) can provide more control over what the final image will look like when completed rather than relying on the software that comes with the smart telescope.

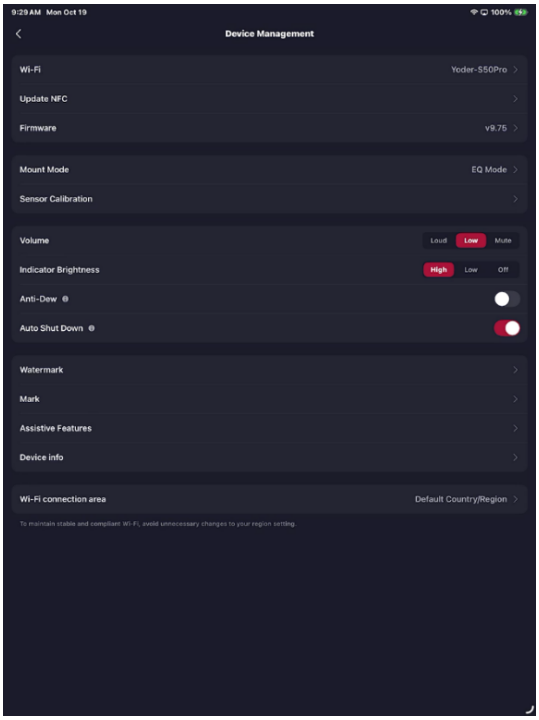
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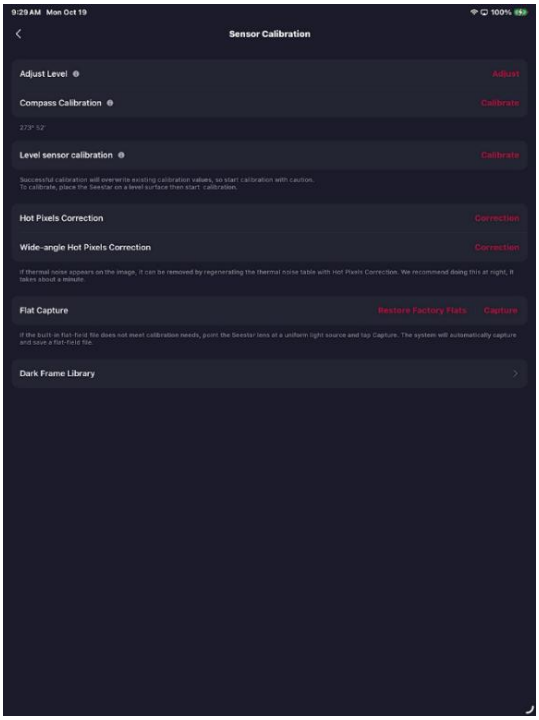
Configuration Settings

Each smart telescope supports its own set of features. Below are some of the options to consider, along with a few Seestar application screens highlighting key settings:

- Device Management Screen
  - **Mount Mode** – Configure the smart telescope for alt-az or equatorial mode
  - **Anti-Dew** – Enable/Disable dew heater
  - **Auto Shut Down** – Automatically turn off the smart telescope after imaging plan is completed.
- Sensor Calibration Screen
  - **Compass Calibration** – Used to calibrate the internal compass. Only needed when setting up at a new location.
  - **Flat Capture** – Needed when the built-in (factory) flat no longer matches your optics, for example after adding an external filter or when dust shadows appear. "Restore Factory Flats" reverts to the original.
  - **Dark Frame Library** – Where master darks are stored. Darks are taken automatically at the beginning of a plan.
- Additional settings – Found under the Stargazing and Milky Way settings:
  - Exposure Time
  - Save Each Frame

Seestar Configuration Screens





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First Steps

The first order of business is to determine what targets to image. There are a few factors to consider:

- **Light pollution** – If you are imaging at a dark site, both broadband and narrowband targets are appropriate to image. For light-polluted areas (such as your backyard) narrowband (emission) objects may be best since a light pollution filter can block much of the skyglow.
- **Field of View** (FOV) – The field of view of your smart telescope needs to be taken into consideration. A good rule of thumb is that your target should fill 20 to 80 percent of the FOV.
- **Surface Brightness** – The surface brightness of the target may help give an idea of how difficult the target will be to capture in an image. Surface brightness is how bright an object is per unit area (usually magnitudes per square arcminute); the higher the number, the fainter the target and the harder it is to capture detail.

Procedures

Here are some techniques you may want to consider when determining what to image and how to process the captured images:

- Planning your Sessions
    - Use AI to help narrow down the list
    - Use the Smart Telescope App or the Telescopius website to determine the framing of the target.
    - Create a plan for the night; you will usually be able to image 2–4 targets. I try to limit imaging a target to when it is at least 30° above the horizon.
    - Run the same plan for the entire month/lunar cycle to gather as much data as possible.
- Stacking and processing your own images
    - Save individual frames for each target as it is captured.
    - Download the previous night's captured images to your PC after every session.
    - Software
        - StackingWizard - Frame Review and Stack (Windows, macOS, Linux)
        - AstroWizard – Process the Master Frame (Windows, macOS, Linux)
- Optimizing Images
    - Equatorial Mode
        - Equatorial Mount (Hardware)
    - Light Shield (Hardware)
    - Additional Filters (Hardware)
        - Filter Adapter
        - Flat Panel

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Increasing Integration Time

My goal is to pick out 2 to 4 targets that utilize the Light Pollution filter and capture as many hours as possible over the lunar cycle by placing the targets in a nightly imaging plan and executing the plan every night the weather permits and the Moon is not too much of an issue. In general, I image until the moon is about ¾ full, then start the next set of targets. It is also important to identify targets that the moon will not be near when imaging, or adjust your plan to spend more time on targets that are farther from the Moon.

DuckDuckGo AI Query Example

Utilizing AI to help identify targets can be more efficient than using the recommendations from the smart telescope app's target list, since that list often contains objects that may be too large or too small for the sensor in the Smart Telescope.

Question: *I have a Seestar S30 Pro and need a list of targets that will fill 20 to 80 percent of the field of view for the telephoto lens field of view. I need targets that would be appropriate for imaging in the city, meaning targets should require the pollution filter, this would be emission nebula, planetary nebula, supernova remnant, etc. The targets should be at least 30degrees above the horizon for at least one hour for the location of chandler Arizona for September.*

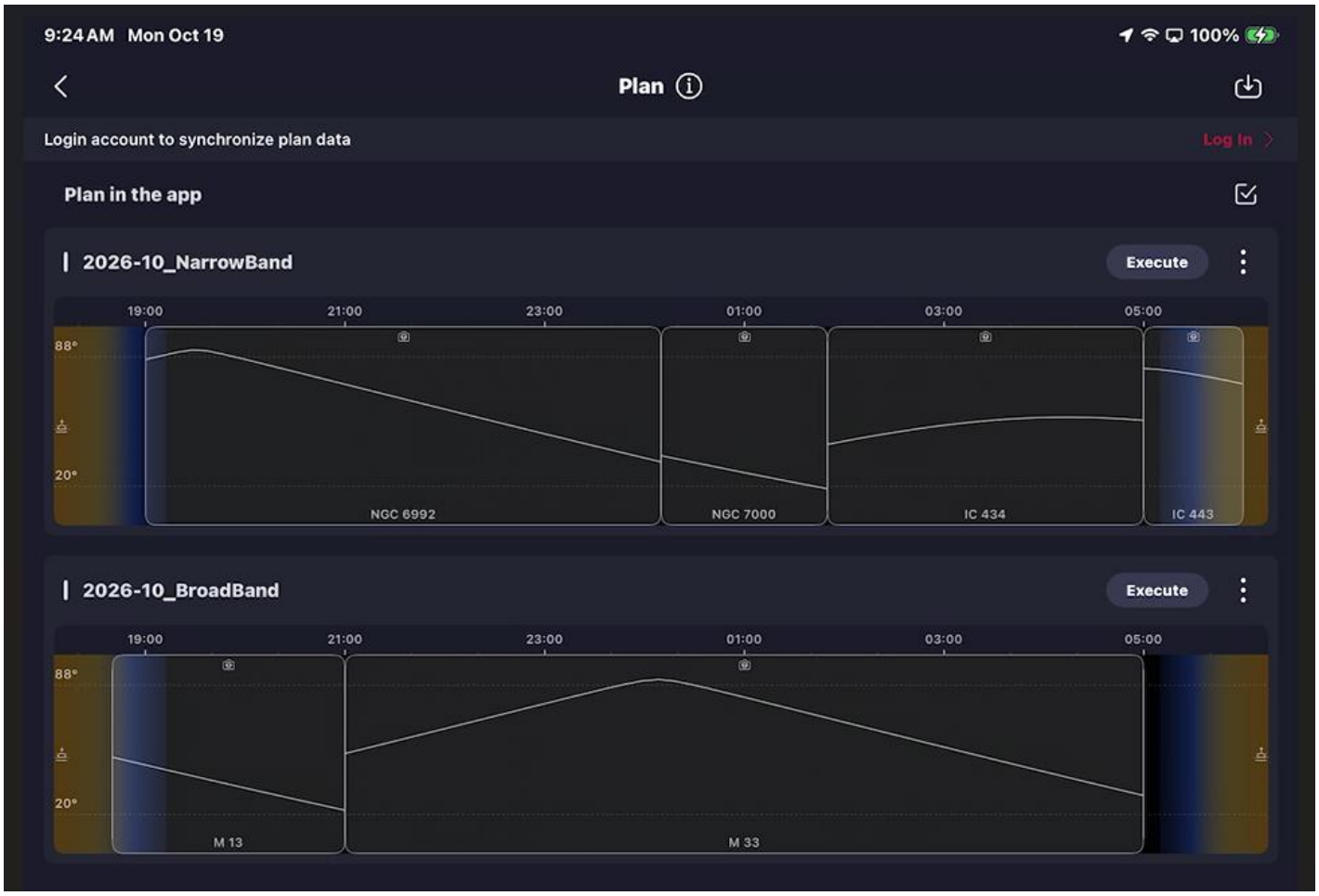
Response: *For the S30 Pro's **4.6° telephoto field**, a target spanning roughly **0.9°–3.7°** fills about **20%–80%** of that quoted field. The percentages below use the target's longest dimension divided by 4.6°; actual framing will vary with the sensor's aspect ratio and how much of the nebula is visible in your image.*

Target	Type	Approx. size	Approx. field fill	September observing window from Chandler
Veil Nebula / Cygnus Loop (NGC 6960/6992/6995)	Supernova remnant	3° across	65%	Evening to late night; high in the sky. The full loop is about 3° across.
North America Nebula (NGC 7000)	Emission nebula	2° × 1⅔°	43%	Evening to late night; high in the sky.
IC 1396 (Elephant Trunk region)	Emission nebula	About 3° across	65%	Evening to late night; high in the sky. The Elephant Trunk itself is a much smaller feature within the larger nebula.
Sadr Region (IC 1318)	Emission nebula complex	About 3½° × 2°	76%	Evening to late night; high in the sky. Sadr is a bright foreground star, so expect glare around it.

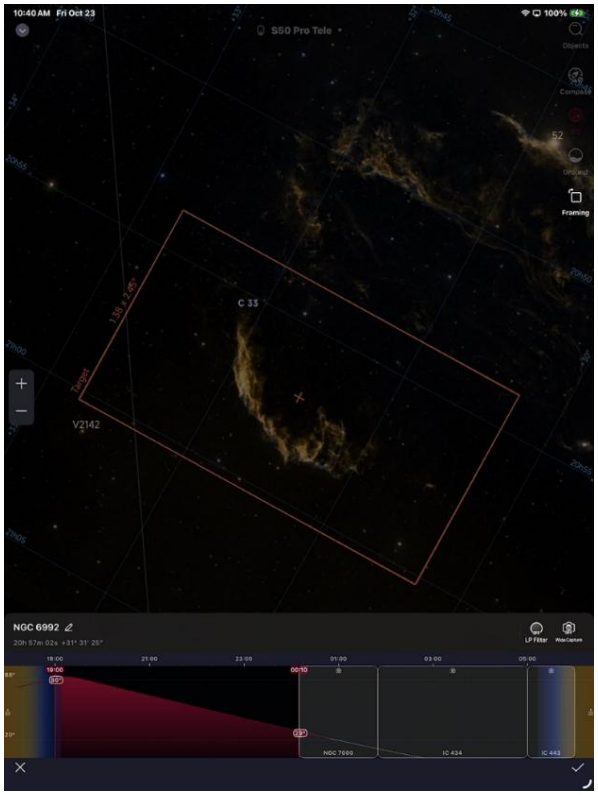
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Target	Type	Approx. size	Approx. field fill	September observing window from Chandler
Heart Nebula (IC 1805)	Emission nebula	About 2°–2½° across	43%–54%	Late evening through the night; high in the sky.
Soul Nebula (W5 / IC 1848)	Emission nebula	About 2½° × 1¼°	54%	Late evening through the night; high in the sky.
California Nebula (NGC 1499)	Emission nebula	About 2½° long	54%	Best late night into pre-dawn; it becomes better placed as September progresses.

Example Imaging Plans

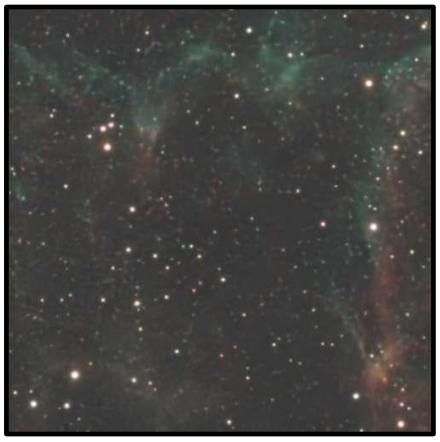


I will create two imaging plans, one for the backyard (Light Pollution Filter) and one for when I go to a dark site (No Light Pollution Filter). These two plans will be used for the entire month (moon cycle) for collecting data.

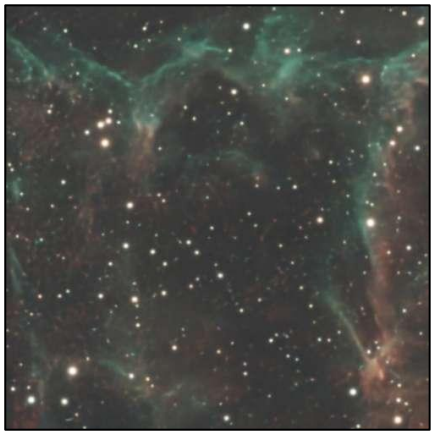


Increased integration time will increase the signal-to-noise ratio. However, there are diminishing returns: doubling the S/N ratio requires 4 times the integration time. In the examples below the S/N ratio gain between the first and second image is apparent, but the improvement from the 2nd to the 3rd image is not as apparent. Rest assured, there is an improvement; it usually shows up when stretching the image. The image with the longer integration time will tolerate much more aggressive stretching and display fewer artifacts. Note: The comparison of integration time below is not completely fair since different filters were utilized for the final image.

Integration Time Comparison.



27 frames



110 frames (4x)



440 frames (16x)

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Filter Comparison

Reviewing the various filters below, one can see how different filters may highlight different aspects of the nebula. When using an external filter, disable the internal filter. Note that none of the added filters seems to be as crisp as the Internal Light Pollution filter in the Seestar, this might be due to the physical limitations of placing a filter in front of the primary lens rather than behind the lens. The internal light pollution filter seems to do a pretty good job of getting various aspects of the nebula. Is it worth adding the extra filters? I'm not sure at this point.

East Veil Nebula Filter Comparison



Seestar LP (110 frames)



Antlia RGB (110 frames)



Askar Color Magic (110 frames)



Radian Triad (110 frames)



Combined (440 frames)

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Organizing is Critical

When collecting such large amounts of data, organization is vital. I keep a text log to track what has been captured for each object.

Image Processing Notes

Target: **NGC-6992 Eastern Veil Nebula**

Captures

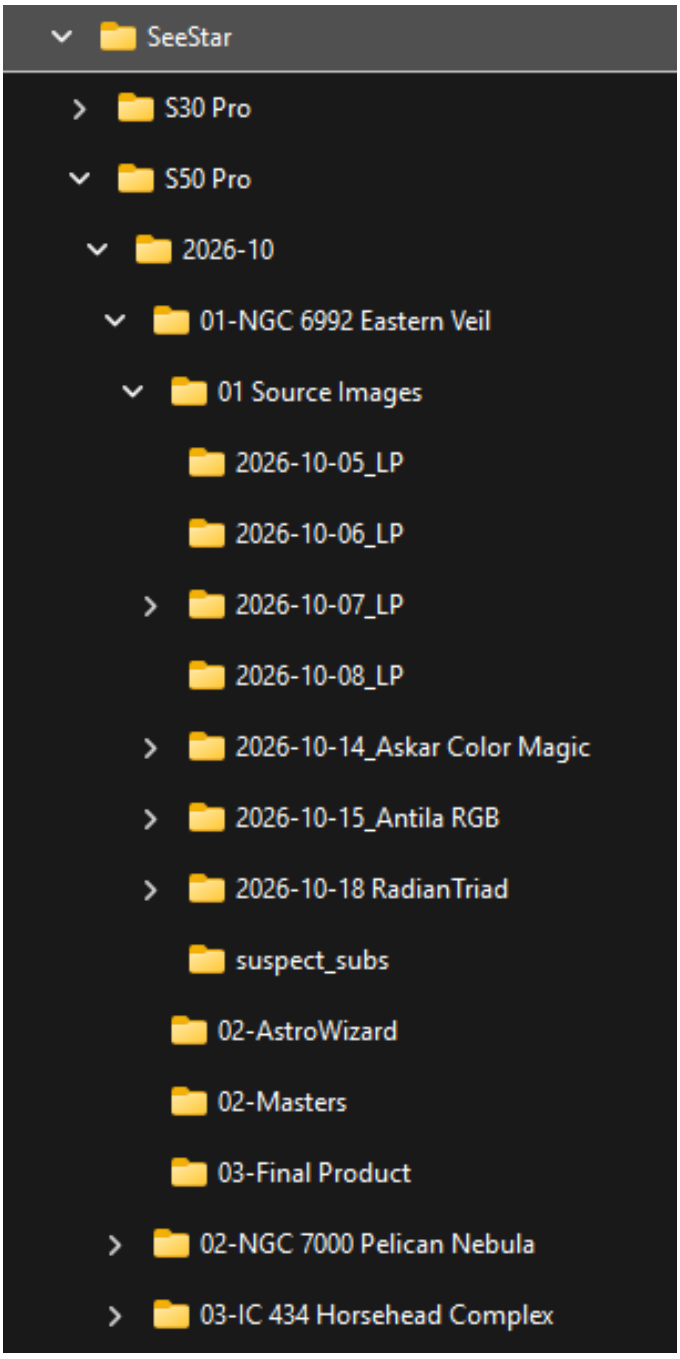
Date	Filter	Captured	Retained	Filter Values
2026-10-05	Internal LP	xxx	186	Trailing = 0.20 | Star Size = 2.11 | Noise= 0.0023 | SkyGlow=+4 | Grade=88 |
2026-10-06	Internal LP	xxx	194	Trailing = 0.20 | Star Size = 2.04 | Noise= 0.0023 | SkyGlow=+8 | Grade=95 |
2026-10-07	Internal LP	364	101	Trailing = 0.20 | Star Size = 2.10 | Noise= 0.0023 | SkyGlow=+6 | Grade=71 |
2026-10-08	Internal LP	xxx	042	Trailing = 0.19 | Star Size = 2.10 | Noise= 0.0017 | SkyGlow=+3 | Grade=73 |
2026-10-14	Askar	392	301	Trailing = 0.20 | Star Size = 2.05 | Noise= 0.0016 | SkyGlow=+6 | Grade=73 |
2026-10-15	Antlia RGB	190	114	Trailing = 0.20 | Star Size = 2.80 | Noise= 0.0022 | SkyGlow=+4 | Grade=70 |
2026-10-18	Radian Triad	519	369	Trailing = 0.20 | Star Size = 2.20 | Noise= 0.0024 | SkyGlow=+6 | Grade=75 |

Totals | Frames Retained: 1,307 => 653.5 min => 10.9 h |

Master Files

NGC-6992_Master_2026-10-05_LP_186f_30s.fits
NGC-6992_Master_2026-10-06_LP_194f_30s.fits
NGC-6992_Master_2026-10-07_LP_101f_30s.fits
NGC-6992_Master_2026-10-08_LP_042f_30s.fits
NGC-6992_Master_2026-10-14_Askar_301f_30s.fits
NGC-6992_Master_2026-10-15_Antlia_114f_30s.fits
NGC-6992_Master_2026-10-18_RadianTriad_369f_30s.fits
NGC-6992_Master_2026-10_MultiFilters_1307f_30s.fits

Folder structure is also key to understanding what you have at a glance. I download the previous night's data every morning and periodically clean out the Smart Telescope's storage to ensure the Smart Telescope does not run out of storage space while executing an imaging plan.



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Software

With the development of Lukomatico's StackingWizard and AstroWizard applications (both free and available for Windows, Mac and Linux operating systems), integrating and processing large sets of images has become a breeze compared to earlier methods. While applications such as PixInsight provide the same functionality as StackingWizard and AstroWizard, they cost money and are much more complicated to use (although an experienced user can get slightly better results).

Although the applications are free, PLEASE donate to the developer if you find yourself using these applications; this will help ensure future development and continued life of these products. How much to donate? I'm sure the developer will welcome any amount. I personally compare what something like PixInsight costs and scale my donation accordingly (e.g., $100). Bottom line: it's up to you—donate based on how much you use and need these tools. I continue to make donations about once a year to help ensure development continues on the software.

Here we will briefly discuss the applications and provide some pointers on key processing steps and features to pay particular attention to. The best and latest information on how to use these applications effectively can be found on the lukomatico channel on YouTube. A PDF manual can also be downloaded from the AstroWizard website.

StackingWizard

This application is used to review and select individual frames to keep and stack (combine) to create one Master file that will be processed in AstroWizard. The use of this application is pretty straightforward. Here we briefly describe each step in creating a Master file and provide some pointers on key areas to pay attention to.

- **Step 1 – The Pile**: In this step you load the Lights, Darks, Flats, and Bias frames taken for the target in question. NOTE: It is important that you understand what the Light frame is composed of from your smart telescope. Most smart telescopes will take Darks, Flats and Bias frames and automatically apply them to the Light frame before storing the Light frame, so when loading files in the StackingWizard to process, ONLY the light frame is needed. You do not want to re-apply Darks, Flats or Bias frames to a Light frame that has already had these applied to it.



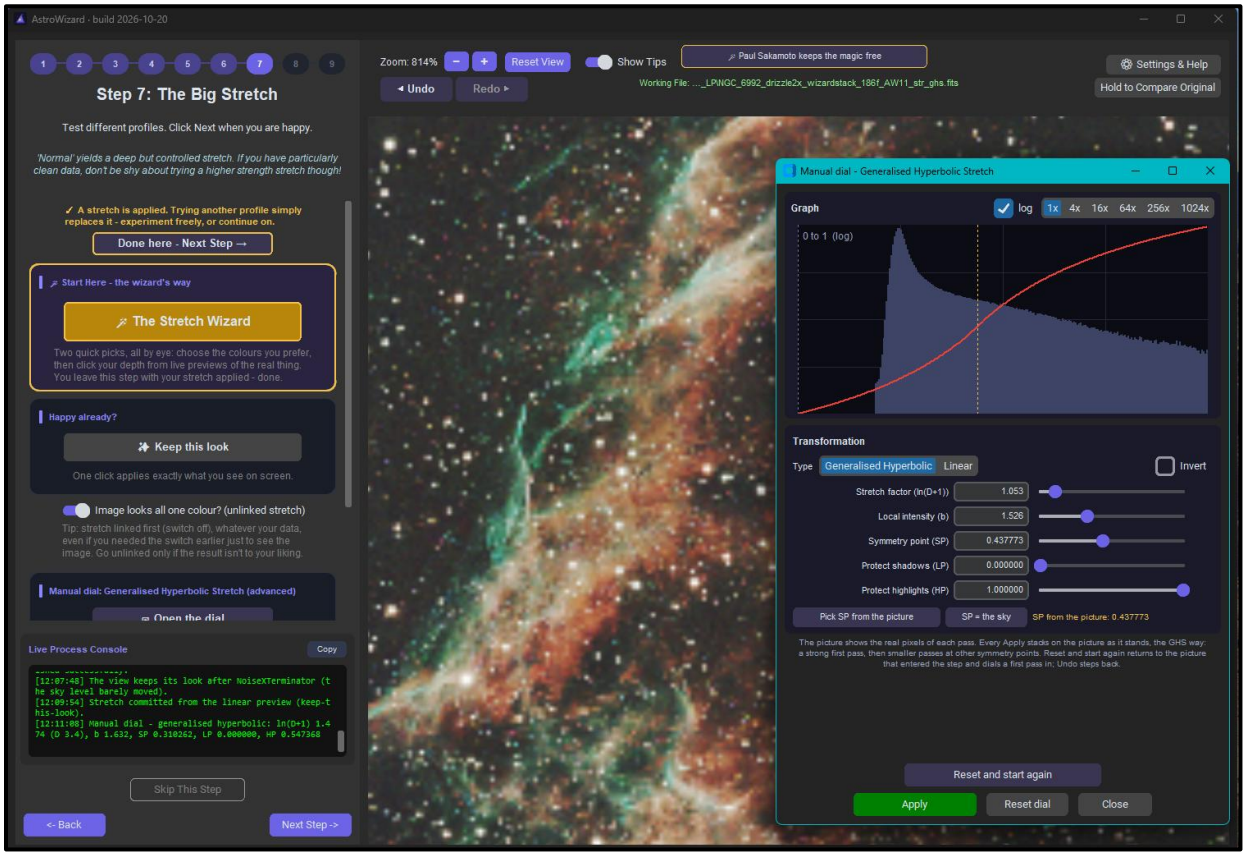
- **Step 2 – The Looking Glass**: This is the step where individual frames are analyzed and reviewed. We will eliminate any frames that do not meet our selection criteria. My process is to select the "ruthless" option followed by sorting by each column (trailing, noise, sky glow, star size and grade) one at a time and eliminating outliers. I also take note of the remaining upper limit for these values for use in future ratings that can be specified by using the "Manually Configure" option.
- **Step 3 – The Stack**: In this step each frame is aligned and stacked together to create a "Master" frame that is a compilation of all the frames that were not rejected in Step 2.
- **Step 4 – The Handoff:** This is the final step in the StackingWizard where we can save this night's Master file and optionally combine it with previous nights' Master files to create a Master file with all approved frames up to this point. After saving the Master file you can use the "Send to AstroWizard" button to start the AstroWizard application.

AstroWizard

This application is used to process the Master file that has been created for the target and will produce the final processed image. While the application can run on its own and produce some good images there are also some plug-ins that you can purchase (links are in the application). These are AI tools from RC-Astro (BlurXTerminator, StarXTerminator, and NoiseXTerminator) and are exceptional. The bundle runs $189 (October 2026) but is well worth it, and it can be used in other applications such as PixInsight with no additional cost. The RC-Astro purchase link is located in the "Settings & Help" screen under the "Download Links & Setup" section by selecting the "Get Standalone Bundle" button. Here we briefly describe each of the processing steps in the application and provide some hints on how to improve the final result.

- **Step 1 – Load & Inspect**: Here you load and specify what type of file you will be processing.
- **Step 2 – Cropping & Framing**: Used to crop and orient the image. It is critical that you crop the image to include only the area that all frames contribute to. Inspection of the edges of the image should be a good guide for where to trim. Improper trimming can lead to poor final results since many of the tools assume a uniform contribution from all frames.

- **Step 3 – Background Extraction**: This step removes background gradients due to skyglow and light pollution. The GraXpert tool (a free plug-in) is exceptional at this process.
- **Step 4 – Colour Calibration**: Used to adjust color to more closely match true colors of the objects in the image.
- **Step 5 – Deconvolution & Sharpening**: This step tries to undo the blurring that happened to an image on its way to the sensor, recovering sharper stars and finer detail than the raw data appears to show.
- **Step 6 – Linear Noise Reduction**: Used to reduce noise in the image. Use NoiseXTerminator if you have this plug-in.
- **Step 7 – The Big Stretch**: This is where the image is stretched to show the most detail possible. For ease of use you can use "The Stretch Wizard". I use a combination of "Keep this look" as a first pass, then utilize the Generalised Hyperbolic Stretch (i.e., "Manual Dial") to fine-tune features to be highlighted.



- **Step 8 – Final Polish**: Used to darken the background, adjust saturation levels and adjust the star size. First remove stars from the image, then adjust the background and saturation and then replace the stars for the best result.
- **Step 9 – Final Export**: Here the image is exported to a file.

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Accessories

There are many accessories you can purchase to help performance or make life easier when using a smart telescope.





- **Tripod** – A camera tripod raises the smart telescope off the ground, providing a better vantage point and making it easier to access.
- **Equatorial Wedge** – While you can purchase a wedge from ZWO, third-party wedges can be cheaper and provide more fine-tuning options. I needed a replacement screw used to tighten the clamp so the base does not collide with the screw head.
- **Tripod Leveler** – Can be used to fine-tune leveling a tripod.
- **Dew/Light Shield** – Dew shields can delay the formation of dew on the lens (not really an issue in Arizona) and are great for cutting down stray light being captured when taking a photo. Remove it before the Seestar shuts down, since the arm closes over it.
- Electroluminescent (EL) Panel – Can be used for taking Flats.
- **Magnetic USB C Adapter** – Breakaway adapter for battery connection.
- **External Battery** – Battery backup for all-night sessions.
- **Battery Tray Holder** – Holds a spare battery and helps avoid cable wrap.

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ASCOM Alpaca Support

The ASCOM support is available for both Seestar S30 and S30 Pro models. I have not used this feature myself; the following information is provided by DuckDuckGo AI.

The connection is over Wi-Fi through the Seestar's **ASCOM Alpaca** support—not by plugging the telescope into the computer as a USB camera. ZWO lists Alpaca support for the S50 Pro, and SharpCap users have connected Seestar telescopes through it.

Connect SharpCap to the telescope

1. Update the Seestar app and telescope firmware, and install the current SharpCap and ZWO/ASCOM software on your Windows computer.
2. In the Seestar app, connect to the telescope and turn on **Station Mode** under the device's Wi-Fi settings. Join the same Wi-Fi network with your computer. **seestar.com1**
3. Open the Seestar app first, set your location, and enter **Stargazing** mode. If the telescope arm is closed, open it in the app before trying to control the mount from SharpCap.
4. In SharpCap, rescan the camera list and choose the Seestar/Alpaca camera. Connect the mount as well if you want SharpCap to handle pointing. Some controls or features may behave differently depending on firmware and SharpCap version; if the devices do not appear, confirm both are on the same network and rescan.

Take or save images and videos

Once connected, use SharpCap's **Live View** to frame and focus. For a deep-sky target, use SharpCap's **Live Stacking** to build an image as frames arrive, then save the finished stack; the **Sequencer** can automate a capture session. SharpCap forum testing reports these features working with Seestar, though some controls—such as ROI, parking, or dithering—have had limitations or firmware-dependent behavior. **Cloudy Nights1**

For planetary or lunar video, use the Seestar app's **Solar System** mode: center and focus the target, switch to video recording, and enable RAW if you want an AVI file for later processing. For daylight scenes, use **Scenery** mode and select video or time-lapse from the mode bar. **seestar.com**

If you mainly want straightforward photos or videos, the Seestar app is the simpler route. In the app, **Stargazing** is for deep-sky imaging; **Solar System** is for the Moon and planets; and **Scenery** is for daytime subjects. The S50 Pro manual and quick guide are available from ZWO's Guides & Manuals page.