PegasusAstro

Powered by SkySafari

SmartEye

Product Manual

Version 1.5

Version History

Version #	Implemented By	Revision Date	Reason
1.1	PegasusAstro	06/May/2025	Initial Document
1.2	PegasusAstro	20/Jun/2025	Corrections and clarifications, addition of how to update firmware via SD-Card.
1.3	PegasusAstro	14/Aug/2025	Harmonise with 1.0.2 release
1.4	PegasusAstro	01/Oct/2025	Harmonise with 1.1.0 release
1.5	PegasusAstro	01/Feb/2025	Harmonise with 1.2.0 release

Introduction

Thank you for choosing SmartEye, the world’s first smart eyepiece—designed by Pegasus Astro to elevate your stargazing experience by blending classic observation with cutting-edge technology.

Powered by the award-winning SkySafari app and featuring the Sony IMX533 color CMOS sensor, SmartEye delivers sharp, vivid images even in low light. The live view is projected onto a 2560×2560 OLEDoS display with a wide 90° field of view, offering a truly immersive visual experience.

Built-in thermoelectric cooling minimizes sensor noise, while real-time auto-stacking and enhancement bring out faint deep-sky objects, even under urban skies. SmartEye also functions as a capable astro-camera, capturing raw FITS files for post-processing.

Fully integrated with SkySafari, you can identify objects, control your telescope, and share what you see, all from one device.

Whether you’re just starting out or you’re a seasoned observer, SmartEye redefines visual astronomy without losing the magic of the eyepiece.

Aim of this document

The purpose of this document is to support the user in the operation of the SmartEye.. Please read this manual carefully before using the SmartEye device.

Any equipment damage or injury caused by improper device operation is the end user's responsibility.

Pegasus Astro has developed this instruction manual to inform all users about the product and the correct methods of interaction with the device and guarantee optimum safety conditions during its entire life cycle: transport, storage, installation, usage, and maintenance.

Warranty Period

The product guarantees quality for two years from the date of purchase. If defects are found in the product, please contact us to examine the issue and we will either repair it or replace the product/part with a new one. Damage caused by consumer responsibility, normal wear and tear, and minor defects that do not interfere with use are not covered by warranty or replacement, even within the warranty period.

Pegasus Astro will not be liable for any problems caused by the installation of parts purchased or manufactured separately by the customer. For hardware warranty issues, please contact via email: support@pegasusastro.com

Product Overview

Key Features:

- **Sony IMX533 Color CMOS Sensor**
  High-resolution sensor optimized for astrophotography with exceptional low-light performance.

- **Ultra-High Definition OLED Display**
  2560×2560 resolution with a wide 90° field of view, delivering a fully immersive visual experience.

- **Integrated SkySafari App Compatibility**
  Connects seamlessly with SkySafari Pro for real-time plate solving, SmartEye camera sequence control, and full telescope operation through an interactive planetarium map.

- **Real-Time Image Stacking & Enhancement**
  Live stacking and noise reduction reveal faint deep-sky objects, even under light-polluted skies.

- **Thermoelectric Cooling (TEC)**
  An actively cooled sensor reduces thermal noise, resulting in clearer images.

- **Dual Functionality: Viewer & Astro-Camera**
  Functions as both a digital eyepiece and a high-performance camera for saving RAW FITS images to microSD Card.

- **Built-In microSD Card Slot**
  Stores image and calibration files directly to a removable microSD card, supporting astronomical RAW FITS format.

- **Wi-Fi Connectivity**
  Enables wireless control (selective Dual Band 2.4GHz or 5 GHz), firmware updates, easy image sharing and device control.

- **Intuitive User Interface**
  Designed for ease of use, whether you're a beginner or an experienced astronomer.

- **Onboard Power Management**
  Efficient power usage with cooling control, ensuring stable operation during long observation sessions.

Packaging

SmartEye comes securely packaged inside a protective hard-shell carry case. All components are carefully arranged and cushioned within the case to ensure safe transport. Upon receiving your new SmartEye device, please inspect the contents immediately and verify that no parts have been damaged during shipment.

What's in the Box

- **Protective Hard Case** - A rugged and reliable case designed to safeguard your SmartEye and included accessories.
- **The SmartEye** - Equipped with protective caps on both ends to ensure safety during transport and storage.
- **USB-C to USB-C Power Cable (1.0m)** - A high-quality, durable cable for powering your SmartEye device with compatible power sources.
- **Power Adapter** for 12V DC to 5V (USB-C) conversion.
- **2" Nose Piece** - Features an M54 male with an M48 female thread for attaching filters.

Hardware Overview

Display Screen

SmartEye features an Ultra HD display with a 90° field of view and 12mm eye relief for sharp, comfortable viewing—even with glasses. The screen sleeps after 20 minutes of inactivity to prevent OLED wear and wakes with a button press, making it efficient for extended use under the night sky.

Astro-Crown Button

SmartEye's "Astro-Crown" is a physical rotary button that allows easy menu navigation and setting adjustments with turn-and-press actions. It offers tactile, glove-friendly control ideal for field use without interrupting your view.

Diopter Adjustment Ring

SmartEye includes a diopter ring around the eyepiece for fine-tuning the display focus to your eyesight, with an adjustment range of +1 to -5 diopters. A calibration screen on startup helps set it once, and it usually remains fixed unless another user makes changes, ensuring clear and comfortable viewing.

USB-C Port

SmartEye includes a USB-C port on the front for power input (5V/3A) and firmware updates (port allows USB2 signalling). Use the supplied cable for both powering the device and performing software upgrades when needed - lookup to "Upgrading SmartEye" section of this manual.

ST4 Guiding Port

Located on the side of the device, the ST4 port allows SmartEye to interface directly with your telescope mount. This port enables the device to send guiding correction signals for accurate tracking, particularly beneficial during long-exposure astrophotography sessions. It is also helpful for mounts that lack built-in autoguiding capabilities, offering users the flexibility to improve tracking accuracy without additional guiding equipment.

Note: ST4 functionality is currently not fully supported by the SmartEye software. Full integration is planned for a future software update, which will enhance compatibility with autoguiding methods.

Red LED Indicator

SmartEye features a red LED indicator that lights up when the device is powered on, providing clear visual confirmation of operation even in low-light conditions.

MicroSD Card Slot

Device features a MicroSD card slot for storing FITS images and calibration files, allowing users to easily collect and transfer their imaging data. This enables convenient access to raw FIT images files and dark calibration frames for further processing on a computer.

The device supports MicroSD cards up to 2TB in capacity, providing ample space for extended observation sessions. Please note that the MicroSD card must be inserted in a reverse orientation (label side facing down), which is intentional due to the device's compact design. For optimal performance, we recommend using high-quality UHS-I or UHS-II MicroSD cards to ensure fast and reliable file writing during operation.

📌 **Please Note:** The SmartEye operates without the need for an SD card. However, inserting one is necessary to enable storage and retrieval of FIT raw files and PNG stacked files.

Wi-Fi Antenna

SmartEye features a removable external dual-band Wi-Fi antenna, providing fast and reliable wireless performance on 2.4 GHz or 5 GHz networks. This ensures stable connections for remote control, image shares, firmware updates, and planetarium software. The SMA connector enables the antenna to be replaced with a higher-gain option if extended range is required, offering flexibility tailored to your observing environment.

Thermoelectric Cooling (TEC) System

SmartEye is equipped with a Thermoelectric Cooling (TEC) system designed to significantly reduce sensor noise and enhance image quality during long exposures. The TEC can cool the image sensor to as much as 30°C below ambient temperature, enabling cleaner, sharper images with reduced thermal noise. To support this cooling process, SmartEye features an integrated active cooling fan that efficiently pushes warm air away from the device, maintaining optimal thermal conditions both for the TEC module and the internal electronics. This dual cooling approach ensures consistent performance and longevity, even during extended imaging sessions or in warmer environments.

Eyepiece Barrel (2-Inch)

SmartEye features a 2-inch eyepiece barrel, compatible with standard 2-inch focusers, offering a wider field of view and better light gathering. Features an M54 male with an M48 female thread for attaching 2-inch filters, such as UV/IR cut, light pollution, or narrowband filters.

For smaller telescopes, a 1.25-inch converter can be used for compatibility with 1.25-inch focusers. Please check for the optional accessory below:

PEG-ADAPT-SE125NP M42M to 1.25" Nosepiece Adapter + M54M to M42F Adapter for Smart Eye]

Diagonal Usage

For comfortable viewing, a diagonal is recommended when using SmartEye with refractors, most reflectors, and Schmidt-Cassegrain (SCT) telescopes, as it provides a more ergonomic observation angle. However, Newtonian (including Dobsonian) telescopes do not require a diagonal, and SmartEye can be attached directly to the focuser.

While diagonals add convenience, it's important to use a high-quality diagonal, as additional optical surfaces can slightly degrade image quality. For the best imaging performance, especially during astrophotography sessions, we recommend connecting SmartEye directly to the telescope's focuser to maintain the sharpest image possible.

Filter Recommendation

To achieve optimal image quality with SmartEye, a **2-inch UV/IR cut filter is highly recommended**. This filter helps eliminate unwanted ultraviolet and infrared light that can reduce image sharpness, especially when using refractors.

Depending on your observing site and the level of ambient light pollution, you may also benefit from using light pollution filters to enhance contrast and reveal fainter celestial objects. For more advanced imaging, narrowband filters such as H-alpha (Ha) can be used to isolate specific wavelengths, particularly useful for capturing emission nebulae.

However, please note that narrowband imaging requires significantly longer exposures and is most effective when used with fast optical systems (low f-ratio telescopes).

Hardware Prerequisites

SmartEye requires installation on a motorized equatorial or altazimuth mount that supports sidereal tracking. While high-precision tracking is not required, basic sidereal movement is essential to ensure continuous object tracking during visual observation or astrophotography.

Although both mount types can work with SmartEye, an equatorial mount offers significantly better tracking performance, especially for long-duration imaging or precise object alignment. This is because:

- ➔ Equatorial mounts track using a single axis (Right Ascension), naturally matching the Earth's rotation. This minimizes tracking errors and eliminates field rotation during long exposures.
- ➔ Altazimuth mounts, on the other hand, require simultaneous movement on two axes (azimuth and altitude) and can introduce field rotation, which must be corrected either through SmartEye software or an additional derotator.

For best results, particularly in applications involving plate solving, GoTo accuracy, or astrophotography, an equatorial mount is strongly recommended.

Thanks to SmartEye's integrated image stacking and alignment algorithms, minor tracking inaccuracies, periodic errors, or lack of autoguiding are automatically corrected during live

image processing. Additionally, when used on altazimuth mounts, SmartEye automatically performs field derotation, eliminating the need for external hardware or software correction.

For best results, we recommend using short exposures of 5 to 10 seconds. This allows SmartEye to quickly accumulate and enhance your image while minimizing the impact of any residual tracking errors, ensuring a smooth and efficient observing experience.

Tip: Some telescope mounts may not track objects accurately. Before using SmartEye, it's a good idea to insert a standard optical eyepiece (at around 11mm) and confirm that your mount can keep a target object within the field of view for at least 5 minutes. This helps ensure smooth tracking and reliable image capture.

Telescope Recommendations

SmartEye is compatible by default with all telescopes featuring a 2-inch focuser. The device includes a detachable 2-inch barrel, which can be replaced with an optional 1.25-inch barrel for use with smaller focusers. Alternatively, 1.25" to 2" eyepiece adapters, widely available on the market, can also be used for compatibility with 1.25" focusers.

For optimal imaging performance, we recommend using telescopes with a focal ratio of f/7 or lower. Faster systems collect more light in shorter exposures, allowing SmartEye's real-time stacking engine to produce clean, detailed images more efficiently. If you're using a longer focal length telescope, such as a Schmidt-Cassegrain (SCT), a focal reducer can help bring the system to a more suitable f-ratio. In such cases, a low-profile (we are working on that) diagonal may be required to maintain adequate backfocus.

While SmartEye can still deliver good results with slower optical systems (higher f-ratios), faster telescopes are generally preferred for achieving quicker, high-quality results.

You'll be amazed by what SmartEye can reveal through even a compact 4-inch refractor. Its advanced imaging capabilities make it the perfect companion for travel telescopes, unveiling colorful deep-sky targets that would remain invisible to the naked eye, even when viewed through a 20-inch telescope.

Power Requirements

SmartEye is a high-power device, as it features a quad-core CPU capable of performing real-time image stacking, alignment, and other essential image processing tasks. Additionally, the thermoelectric cooling system required to maintain clear images also demands a significant amount of power. To ensure optimal performance, SmartEye requires a stable power supply of 5V with a current draw of 3A, with occasional spikes that may exceed 3A during peak usage.

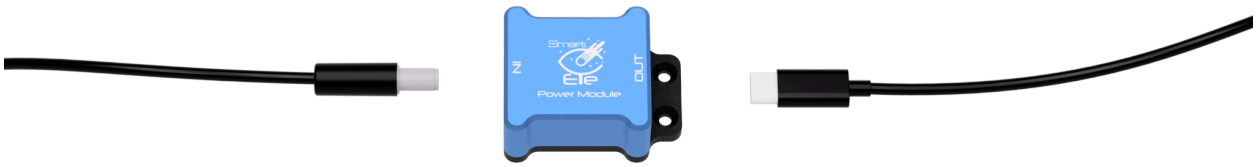
For reliable power delivery, we strongly recommend connecting the device using the provided USB-C to USB-C cable, which ensures a stable and sufficient power supply. Additionally, for convenience, we include a 12V to 5V (up to 6A) power adapter that provides the necessary power to keep the device running smoothly. This adapter is especially useful when operating in the field, as it allows you to convert power from a 12V battery (via a 2.1mm DC barrel connector) to 5V (USB-C connector), ensuring you can use SmartEye with ease during extended observation sessions.

Please note that the power adapter below requires a 9-14 Volt power input. A 12V / 2A supply is sufficient to power the SmartEye reliably.

⚠️ **Warning: Do not use a higher input voltage, as this may damage the device.**

12V DC Battery or Power Adapter

to SmartEye device (USB-C to USB-C)



For optimal performance, we strongly recommend using our PegasusAstro 12V / 2A Power Adapter: **SKU: PEG-PSU-1220**

SmartEye Revision 2

SmartEye hardware revision 2 now supports the USB Power Delivery (PD) protocol, allowing the device to negotiate a higher 12V input to reduce current consumption and improve power efficiency. This also acts as a protection measure, preventing issues if a user accidentally supplies a higher voltage than the standard 5V USB.

SmartEye revision 2 remains fully backward compatible with 5V USB power, and can safely operate with input voltages ranging from 5V up to 28V, offering maximum flexibility for different power setups.

SmartEye and NYX88 Harmonic mount.

The SmartEye power module can be mounted directly onto the Pegasus Astro NYX-88 Harmonic mount, which includes a dedicated attachment point for this purpose.

To power this module, use the PEG-CABL-GX12 cable (shown below). Simply connect it to the “Out” power port of the NYX-88, and the module will receive power through this connection.

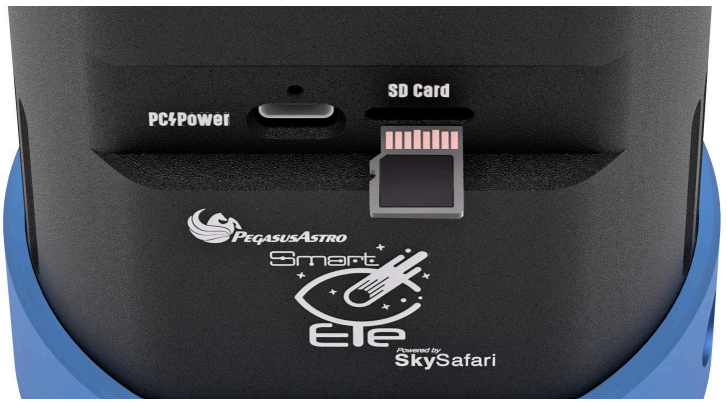
Power Consumption Table

Here's a table showing how long SmartEye, which draws 3A at 5V, can run on different power banks (10Ah, 20Ah, and 50Ah) rated at 3.7V (a common internal voltage for Li-ion cells before being boosted to 5V via USB).

Power Bank Capacity	Voltage (Nominal)	Energy (Wh)	Estimated Runtime (at 3A, 5V)
10,000 mAh (10Ah)	3.7V	31 Wh	~2.1 hours
20,000 mAh (20Ah)	3.7V	62 Wh	~4.2 hours
50,000 mAh (50Ah)	3.7V	152 Wh	~10.5 hours

Inserting an SD Card

To insert the microSD card into SmartEye, ensure that it is placed in reverse orientation (upside down), with the label facing inward. Push the card until you feel a click/latch lock. Please check the image below regarding the correct card orientation placement into the microSD card socket.



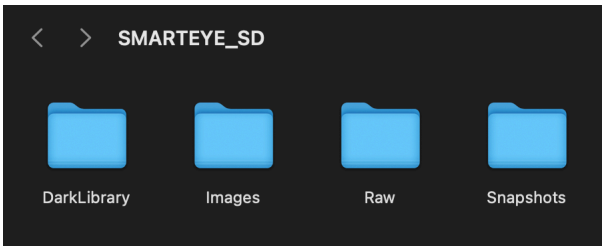
The card should be formatted with FAT32 or exFat for optimal compatibility. If your card is not already formatted in this way, SmartEye offers an option in the menu to format it correctly. It is also important to safely unmount the microSD card through the SmartEye menu before physically removing it, as this prevents potential data corruption. For best results, it is recommended to insert the microSD card before turning on the device.

⚠️ **Important: Do NOT remove the SD card while the system is writing data or powered on without ejecting first. Improper removal may result in corrupted images, lost recordings, or permanent damage to the card.**

“Take a moment to eject safely - it protects your data.”

SD Card Directory Structure

When an SD card is inserted or formatted, SmartEye automatically creates the following directory structure:



- **DarkLibrary**
  Contains master dark calibration files in FIT format, categorized by camera temperature and exposure time.

  Example filename: StackDark_20C_25_350.fit
  (Represents a 25-second dark frame taken at 20°C)

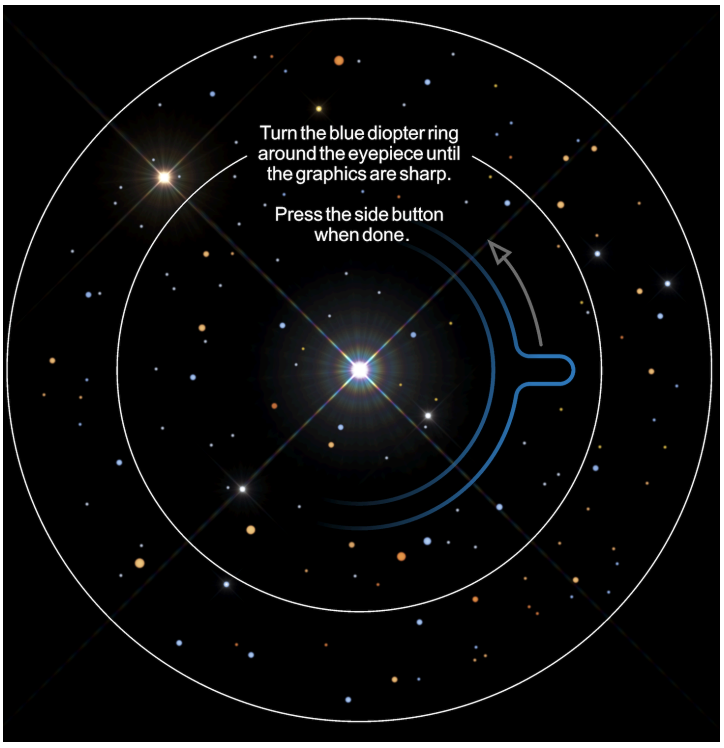
- **Images**
  Includes final stacked images in PNG format, accompanied by a JSON file containing metadata such as camera details and exposure settings.

- **Raw**
  Contains uncalibrated raw image files in FIT format.

  Example filename: exp_000092_0001_0001_25sec_20C.fit
  (Indicates a 25-second exposure taken at 20°C.)

Booting Up SmartEye

1. Remove both protective caps from the camera sensor and the eyepiece display.
2. Attach the 2” barrel adapter to the camera side by securely screwing it into place.
3. Install a 2” filter (such as a UV/IR cut filter) by threading it onto the end of the barrel adapter, if desired. (highly recommended).
4. Mount the SmartEye onto your telescope:
    a. For refractors, SCTs, and most reflectors, insert it into a diagonal.
    b. For Newtonians or Dobsonians, insert it directly into the telescope’s focuser.
5. Connect the USB-C power cable:
    a. Plug one end into the USB-C port on the SmartEye.
    b. Plug the other end into the provided power adapter.
    c. Then, connect a 12V power source to the adapter using the standard 2.1mm barrel connector.
6. Power On: SmartEye will automatically start. A red LED will illuminate, indicating power.
7. Startup Sequence: Device loads, and after 10-15 seconds, the SmartEye boot logo will appear in the eyepiece display.
8. Cooling Activation: Shortly after boot, the internal fan and thermoelectric cooler (TEC) will activate. The TEC will then begin cooling the camera sensor to the user-configured target temperature, ensuring optimal performance for image capture.
9. Display DIopter Calibration: On startup, a calibration screen will appear, prompting you to adjust the diopter ring until the display text is sharp and clear. Once properly focused, press the “Astro-Crown” button to proceed to the main menu and begin using the device.



Operating SmartEye

Main Menu Overview

To access and navigate the main menu on SmartEye, use the “Astro-Crown” button located on the side of the device. Press the button once to enter the menu. Turn the dial to scroll through the available options, and press again to select a highlighted item.

Main Menu (as per firmware release 1.2.0)

Live View
New Observation
Resume Observation
Settings

- Display
  - Screen Brightness
    - 1% to 100%
  - Crosshair Overlay
  - Focus Assist
  - Alignment Error Msg
  - Modes
    - Color, Monochrome, Night Vision
- Light Sensor
  - Sensor Temperature
    - 20, 10, 5, 0, -5, -10, -15 (° Celsius)
  - Integration Time
    - 5s, 10s, 15s, 20s, 25s, 30s
  - Take Dark Frames
  - Clear Darks
  - Alpaca Mode
  - Adjust Fan Speed
    - 10% to 100%
- Localization
  - Wi-Fi Region
- Storage
  - Storage & Capacity
  - Eject SD Card
  - Format SD Card
  - Save Raw FITS
- General
  - About
  - SmartEye WI-FI
  - Guest View Sharing
  - Web Dashboard
  - Reset to AP Mode
  - Factory Reset
- Shut Down

Using the Live View

Live View provides a fast and effective way to focus and center your target. The SmartEye uses 0.5-second exposures at high gain to quickly reveal faint details, allowing you to center your target and focus stars easily.

Starting a New Observation (Live Stacking)

When initiating **Live Stacking**, SmartEye follows a precise sequence to ensure optimal image quality and stability:

- **TEC Temperature Check**: The device first verifies that the thermoelectric cooler (TEC) has reached the user-defined target temperature, ensuring imaging sensor stability before imaging begins.

- **Sub-Exposure Capture:** Once thermal equilibrium is confirmed, SmartEye begins capturing sub-exposures based on the configured integration time and gain settings.

- **Dark Frame Calibration:** SmartEye applies the master dark calibration frame on each light frame, captured at the same temperature and exposure settings, to reduce thermal noise and correct fixed-pattern artifacts.

- **Image Alignment:** Each new frame is aligned in real time with the master light reference image to correct for any drift or motion. If the image is not suitable for alignment due to vibrations or very poor tracking, it is automatically discarded.

- **Stacking Process:** Aligned frames are stacked continuously, improving the signal-to-noise ratio (SNR) and revealing finer details with each additional exposure.

- **Real-Time Enhancements:** After stacking, SmartEye performs color calibration, boosts color saturation, applies noise reduction, and adjusts brightness to bring out structure and vibrance in the target.

- **Real-Time Preview:** The evolving stacked image is displayed live to the eyepiece.

This automated process allows for deep-sky imaging with minimal effort, even under moderate tracking conditions.

📌 **Please Note**: As SmartEye begins stacking sub-exposures, the initial frames appear in monochrome, allowing you to quickly see the shape and structure of the target while the signal-to-noise ratio (SNR) is still low. As more frames are stacked and the SNR improves, color gradually starts to emerge, revealing the object's natural hues and finer details. Over time, the image evolves from a faint outline into a vivid, high-contrast view, with rich colors and sharp structures fully visible. This dynamic stacking process allows you to witness your celestial target come to life in real time, with each frame adding clarity, brightness, and depth.

Gamma Adjustment During Stacking

While SmartEye is stacking your images, you can turn the rotary knob to adjust the gamma of the resulting stacked image in real-time.

- What does Gamma do:
    - Gamma controls the brightness curve of the image.
    - Turning the knob adjusts how bright or dark the background and structures appear.

This allows you to:

- Brighten faint features without overexposing the image.
- Darken the background to enhance contrast.
- Fine-tune the visibility of structures based on your viewing preferences.

⚙️ Adjust it live during stacking to get the most optimal view, your changes are applied immediately to the display!

Resuming an Observation

If live stacking is interrupted, for example, by opening the menu or adjusting settings, SmartEye allows you to resume the session using the “Resume Observation” option in the main menu. This function restores the stacking process from where it left off, preserving the current stacked image and settings. It ensures minimal disruption and lets you continue imaging without starting over.

Settings Menu

Display Settings

Screen Brightness

SmartEye allows you to adjust the display brightness from 5% to 100%, ensuring optimal viewing comfort under varying lighting conditions. Whether you're protecting your night vision or need maximum clarity, the setting is easily accessible through the main menu. Once adjusted, the brightness level is stored in the device's memory, so your preferred setting is automatically restored on the next startup.

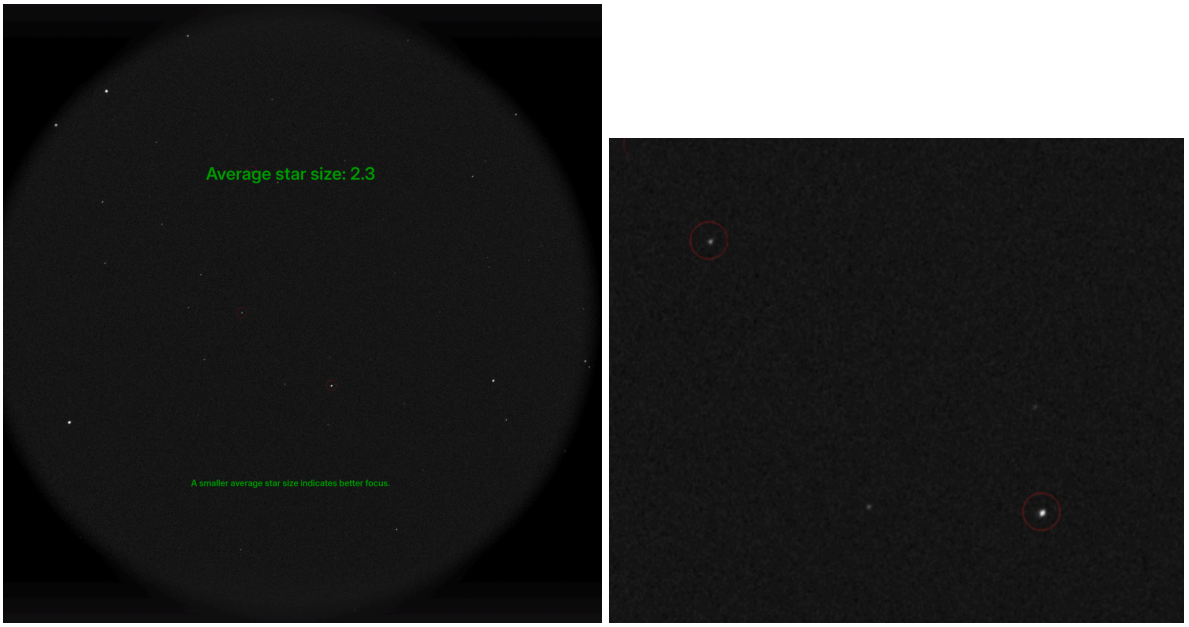
Crosshair Overlay

The Crosshair Overlay option in Live View provides a clear on-screen reference point to help you precisely center and align your target. Whether framing a deep-sky object, positioning a guide star, or fine-tuning your telescope alignment, the crosshair overlay makes it easier to achieve accurate positioning in real time, improving both setup speed and overall imaging accuracy.

Focus Assist

Focus Assist helps you achieve precise focus by analyzing bright stars in the live image view and calculating their HFD (Half Flux Diameter). It continuously measures multiple stars and provides an average star size value, giving you a reliable indication of overall focus quality. The lower the number, the sharper the stars, and therefore, the better the focus.

T**he goal is to adjust your focuser until you reach the lowest possible average star size (in technical terms: HFD value) for that night.** Keep in mind that this value depends on seeing and atmospheric conditions, so the "best" number will vary from night to night.



Modes: Color vs Monochrome vs Night Vision

SmartEye gives you the flexibility to view the stacked image in either full color, monochrome or night vision mode. This allows you to choose between the vivid, realistic appearance of color for general observation or the high-contrast clarity of monochrome, which can sometimes help reveal faint structures and details. You can toggle between modes directly from the menu based on your observing preferences.

Night Vision mode adds a subtle green tint to the stacked image, simulating the look and feel of traditional phosphor intensifier night-vision devices.

Light Sensor Settings

Setting Sensor Cooling Temperature

This menu allows you to adjust the camera sensor's thermoelectric cooling (TEC) temperature to improve image quality and reduce thermal noise during long exposures. You can choose from preset target temperatures: 20°C, 10°C, 5°C, 0°C. Lower temperatures are ideal for deep-sky imaging, as they minimize dark current and enhance signal clarity.

⚠️ Please note:

- The TEC system can cool the sensor up to 30°C below ambient temperature (ΔT = -30°C).
- Ensure your target temperature is realistically achievable based on your environmental conditions.
- Lower TEC temperatures increase power consumption, so plan accordingly, especially during field use or battery operation.

The selected temperature is automatically regulated and maintained throughout the session for consistent performance.

Light Integration Time

With SmartEye, you can select the light integration time by choosing sub-exposure durations of **5, 10, 15, 20, 25 or 30** seconds. This setting allows you to optimize your imaging based on both target brightness and your telescope's optical system. Shorter exposures are ideal for bright objects or when using mounts without precise tracking. For fainter deep-sky targets, longer exposures help gather more light to improve image detail. If your telescope has a slower focal ratio (f/7 or higher), using longer sub-exposures is recommended to ensure enough light is collected for effective stacking. SmartEye will automatically apply your chosen exposure time throughout the stacking process to gradually enhance image quality.

Calibration Frames

Take Dark Frames

SmartEye offers an automated dark frame capture function to improve image quality by reducing sensor noise and thermal artifacts. When selecting this option, the device will capture a series of dark frames—images taken with no light exposure—and generate a master dark frame. This master dark is then automatically applied to all future subexposures, enhancing signal-to-noise ratio during live stacking and live view.

You can select the desired integration time for which you want to create darks, matching your usual subexposure settings. SmartEye also takes separate darks for live view, helping provide a cleaner preview image.

SmartEye automatically checks the TEC sensor temperature and adjusts it to the configured level before capturing any flat frames. It also captures multiple dark calibration frames to generate a master dark file, which is stored in the device's internal memory.

⚠️ **Important**:

- Always close the telescope's front cap or cover the optics when taking dark frames to ensure no light leaks into the sensor.
- If you change the TEC cooling temperature, you'll need to retake dark frames, as noise characteristics vary with temperature.
- SmartEye automatically tags each master dark frame with the specific temperature at which it was captured and stores it in internal memory. Creating a new dark frame for a given temperature will overwrite the existing one for that setting.

Clear Darks

This option removes all dark calibration frames from SmartEye's internal memory, ensuring that none are applied during image stacking or live view. Dark frames that are also copied and stored in the SD card are not deleted.

ASCOM Alpaca Mode

SmartEye includes an ASCOM Alpaca server mode, which can be enabled to allow the device to function as a standalone astro-camera on your Wi-Fi network. When activated, SmartEye announces itself as an ALPACA-compatible camera, making it accessible to external imaging software that supports the ALPACA protocol, such as N.I.N.A. In this mode, SmartEye's internal menus are disabled, and all camera control is handed over to the external software. To return to standard operation, simply press the "Astro-Crown" button again — this will shut down the ALPACA server and restore full control to SmartEye's internal interface.

To use SmartEye as an ASCOM Alpaca camera over Wi-Fi:

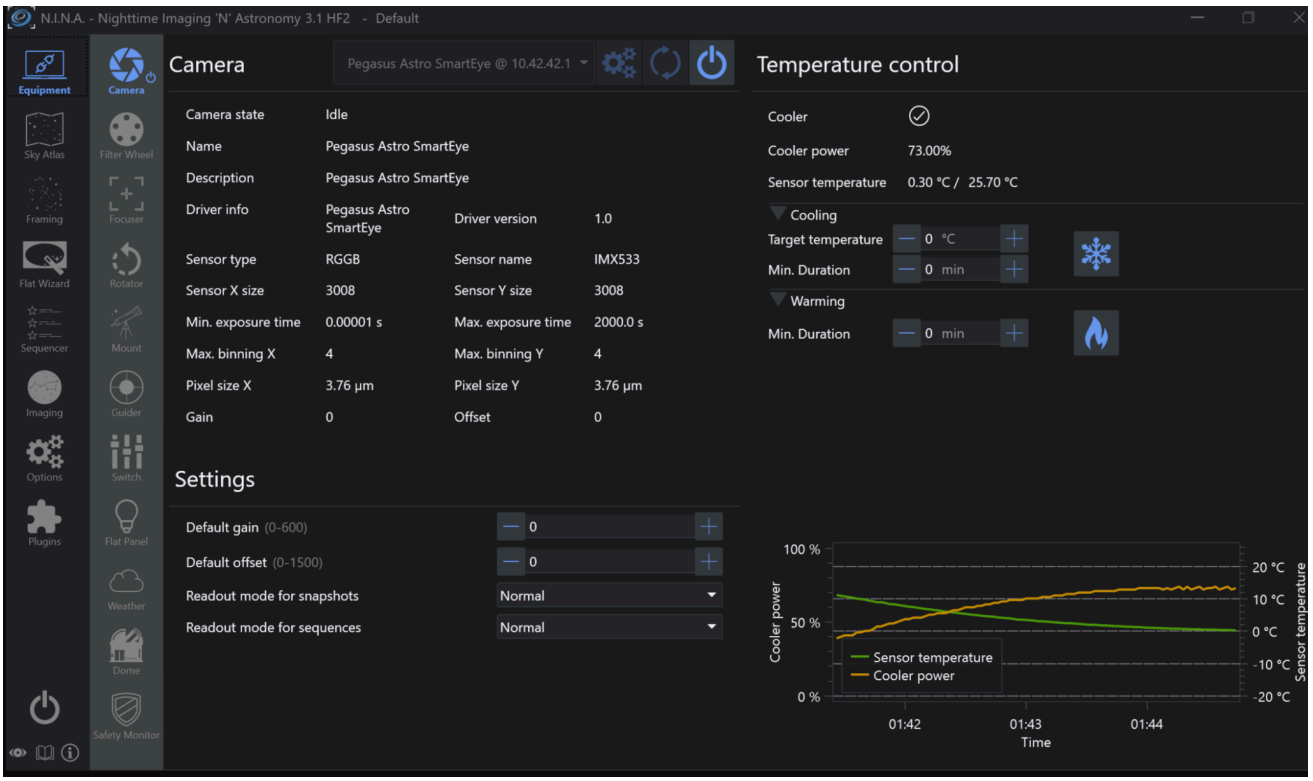
- Select “Alpaca Mode” from the light sensor menu.
- Press “Start Alpaca” to activate it. SmartEye will now be exposed as an Alpaca-compatible camera device.
- Connect your computer to the SmartEye Access Point. The Wi-Fi password can be seen in the SmartEye Wi-Fi menu.

Access Point Name	SmartEye-**XXXXXX**
Default Password	PW**XXXXXX**

The 6-character alpharithmetic sequence **XXXXXX** is the unique ID of each SmartEye device. (e.g 8EE6E1).

Alternatively, you can connect the SmartEye to your local network. When an Alpaca client sends a discovery request, the SmartEye will automatically announce itself as an Alpaca camera on the network.

- Open an imaging application that supports ASCOM Alpaca, such as N.I.N.A.
- Search for available Alpaca cameras, you will see “Pegasus Astro SmartEye” discovered and listed.
- Select the SmartEye device and connect. You can now use SmartEye just like any other astrophotography camera.



Adjust Fan Speed

The fan speed can be adjusted in 10% increments, ranging from 10% up to 100%, giving you fine control over cooling performance. For optimal operation of the TEC, it is recommended to keep the fan running at a minimum of 20%, as lower speeds may reduce efficiency and long-term stability. In warmer climates or during high ambient temperatures, a higher fan speed may be necessary to maintain a lower TEC delta and ensure consistent cooling performance.

Localization

Setting Your Region

This menu allows you to configure your geographic location, enabling SmartEye to automatically apply the correct time zone and Wi-Fi region settings. Accurate regional configuration ensures proper time stamping of captured images, compliance with local wireless regulations, and optimal performance of Wi-Fi connectivity and plate-solving operations.

Storage Management

Viewing Storage & Capacity

This menu provides a clear overview of the device's internal memory and external storage status. It displays the total internal memory in megabytes (MB), along with how much of it is currently used by user data. If an SD card is inserted, the menu also shows its total capacity, the amount of space used, and the corresponding usage percentage.

Safely Ejecting the SD Card

A safe eject of the microSD card ensures that all read and write operations to the card are properly completed before removal, preventing data corruption or loss. Users are advised to always use this option before physically removing the SD card from the device.

Once SmartEye confirms that the card can be safely removed, it is disconnected from active use, ensuring the integrity of stored data and the longevity of the card itself.

Formatting the SD Card

This option allows users to prepare the card for use by erasing all existing data and applying the FAT32 file system along with SmartEye directory structure. This format ensures compatibility with the device and supports SD cards with capacities up to 2TB.

Users should be aware that formatting will permanently delete all files on the card, so backing up important data beforehand is recommended. Once formatted, the card is ready for reliable data storage and optimal performance within the system.

General Settings

About SmartEye

The About menu shows the current firmware version, software version, device board revision and copyright information.

SmartEye Wi-Fi

The Wi-Fi menu shows the current mode: either Access Point (AP) or Wi-Fi Client (connected to a local network).

By tapping “How to connect”, you can view the access point SSID and password. A QR code is also displayed on-screen, which can be easily scanned with your mobile phone to connect directly to the SmartEye access point — no typing required.

The web dashboard allows you to switch between Access Point and Wi-Fi Client modes. If you switch to Wi-Fi Client mode and SmartEye is unable to connect to your network, it will automatically fall back to Access Point (AP) mode.

If you experience any connectivity issues, you can easily reset all settings to default either through the web dashboard or via the SmartEye device menu. There is also an option in the SmartEye menu to set the device to Access Point mode with default settings. (2.4GHz and High Security - WPA2).

Guest View Sharing

The Guest View Sharing feature allows others to easily view the latest image captured by SmartEye.

This page shows the latest stacked image, along with important details such as integration time, total stacked duration and count of valid stacked captures.

For convenience, if scanning the QR code isn’t possible, a direct link is also shown:

Guest Dashboard URL	**http://smarteye.local**

This makes it simple to share your observations in real time without requiring app installations or special setup.

📌 **Please Note**: To use Guest View, the client device must be connected either to the SmartEye Access Point or to the same Wi-Fi network that SmartEye is connected to as a client. This ensures the device can communicate with SmartEye and access the live image preview and related information through the local network.

Connect your computer to the SmartEye Access Point. The Wi-Fi password can be seen in the SmartEye Wi-Fi menu.

Factory default Wi-Fi (Access Point) credentials

Access Point Name	SmartEye-**XXXXXX**
Default Password	PW**XXXXXX**

The 6-character alpharithmetic sequence **XXXXXX** is the unique ID of each SmartEye device. (e.g 8EE6E1).

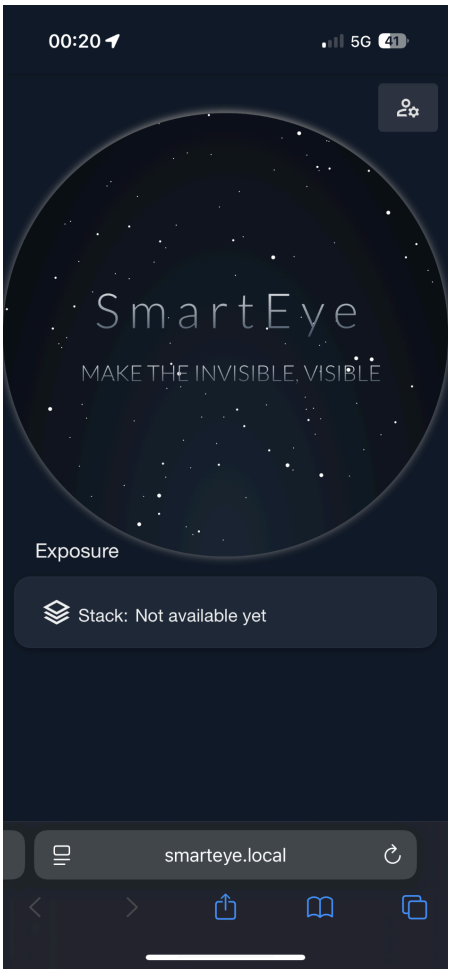
Accessing the Web Dashboard

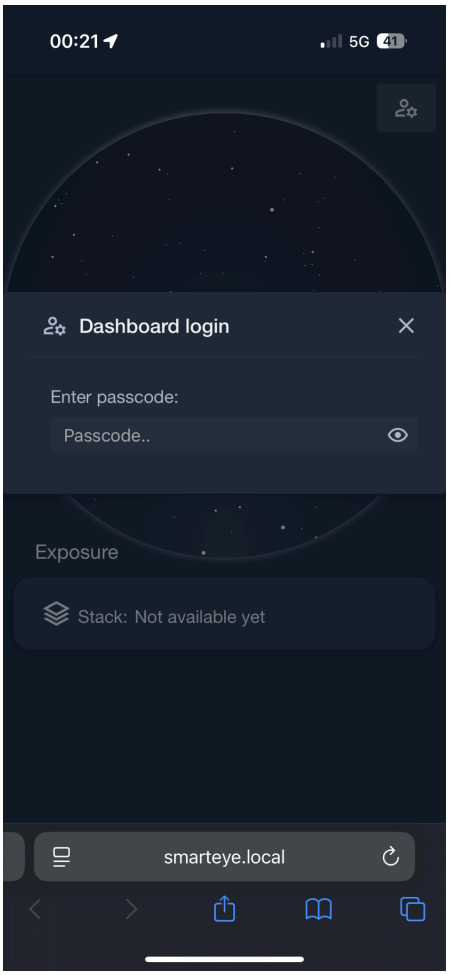
The Web Dashboard allows you to control SmartEye's settings, view system information, and configure features — all through your web browser. A QR code is displayed that links directly to:

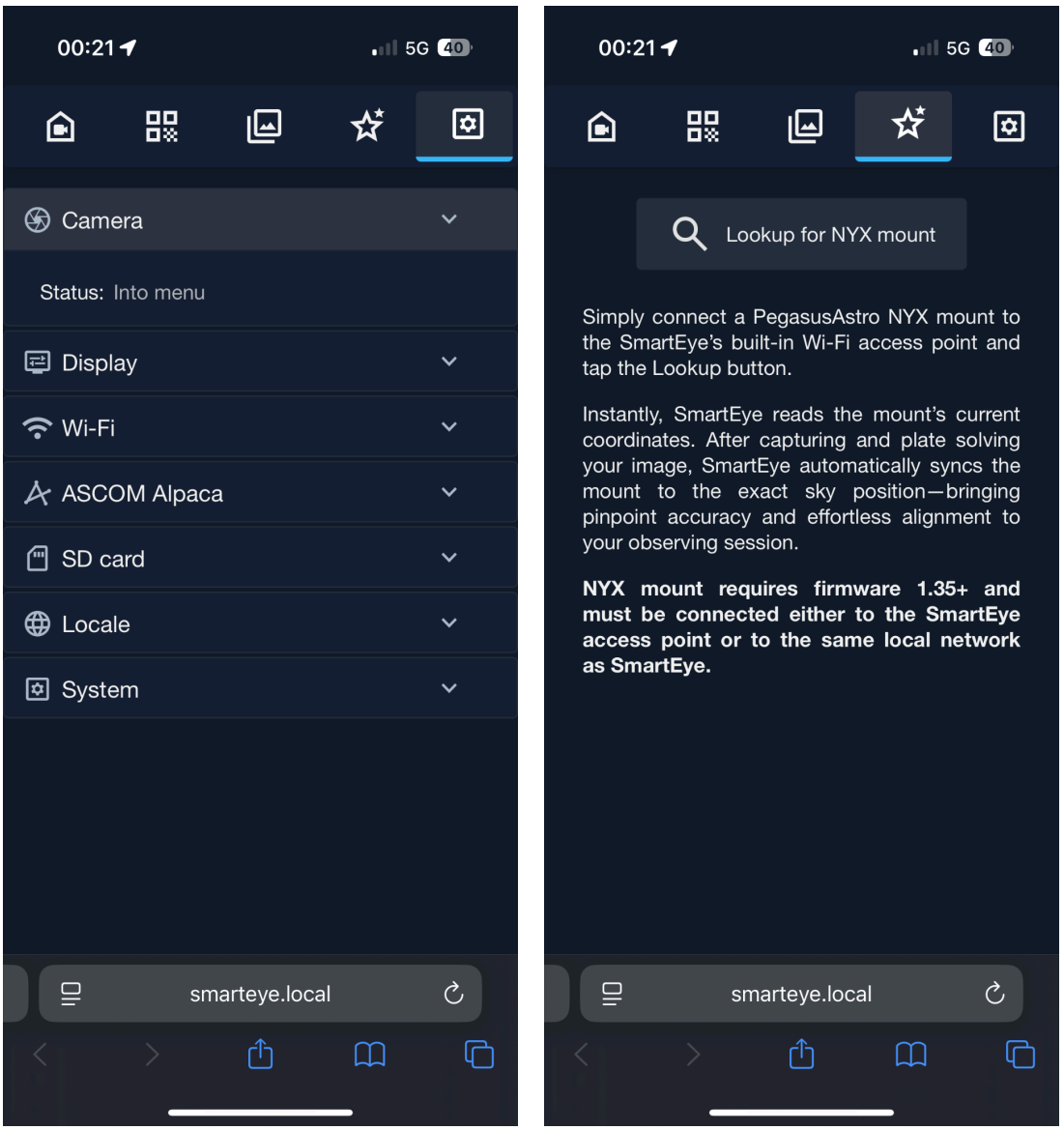
SmartEye Dashboard URL	http://smarteye.local/dashboard

You can also access the Web Dashboard by visiting **http://smarteye.local** in your browser. Click the password button at the top right of the main page, enter the password provided below, and unlock all admin options and SmartEye configuration settings.

Web Dashboard Admin Password	**smart**





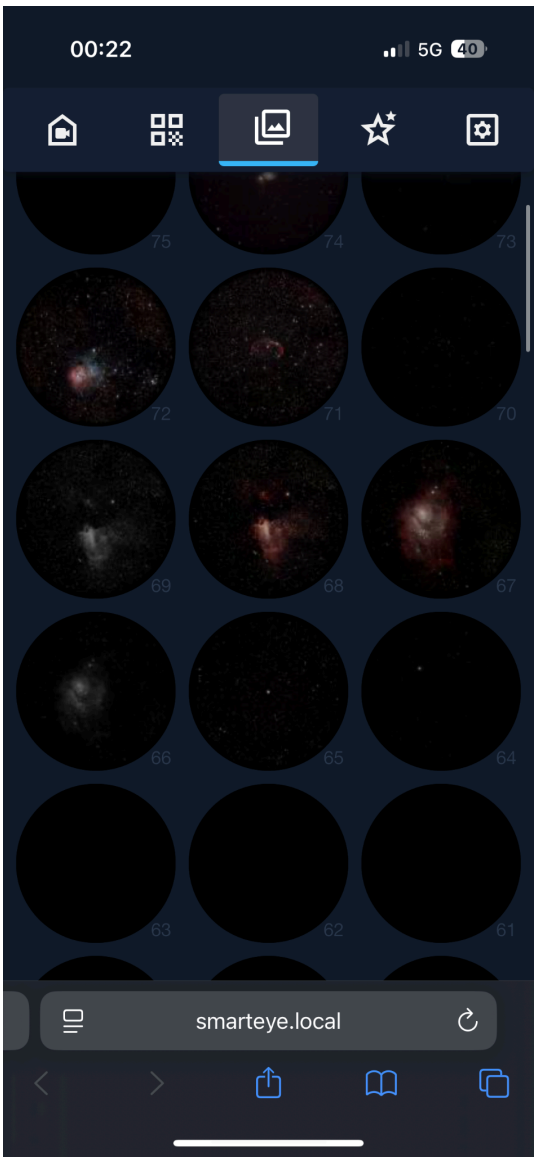


The SmartEye Web Dashboard is your central control hub, putting the full power of your device at your fingertips, right from your web browser.

With it, you can:

- Configure and control SkySafari remotely without ever touching the device.
- Perform Plate Solving directly and natively when paired with a PegasusAstro NYX mount, streamlining your workflow for faster and more accurate alignment.
- Browse your SD Card image gallery to instantly view and download your latest stacked deep-sky observations, ready to share or process further.

Whether you're running an outreach event or working from the comfort of your home observatory, the Dashboard keeps everything accessible, simple, and powerful.



Reset to AP Mode.

SmartEye will reset and switch to Access Point mode, operating on the **2.4 GHz** band with **High Security (WPA2)** enabled by default.

Resetting to Factory Default

The Factory Reset option restores SmartEye to its original settings, erasing all user configurations, saved Wi-Fi networks, and custom preferences.

Use this option if you encounter persistent issues or need to prepare the device for a new setup. Resetting ensures a clean start, just like when the device was first powered on.

Connect SmartEye with Telescope mount and SkySafari Pro.

Using SmartEye as a Wi-Fi Access Point

SmartEye can operate as a **Wi-Fi Access point (AP)** on the 2.4 GHz or 5 GHz band, or as a **Wi-Fi Client** connected to your home network.

In this example, we'll configure SmartEye as an **Access point at 2.4 GHz with WPA2 security**.

📌 **Important Compatibility Notes:**

- Most telescope mounts **only support 2.4 GHz Wi-Fi**, not 5 GHz. For this reason, make sure SmartEye is set to the **2.4 GHz band** when running as an access point.

- Some mounts, such as the **ZWO AM3/5**, do not support WPA2 security. In these cases, set SmartEye access point to **Low Security (WPA)** so the mount can connect successfully.

Step 1:

Configuring Access Point Mode

From the web dashboard, set SmartEye Wi-Fi to Access Point, with the 2.4 GHz band selected.

- Use **High Security (WPA2)** for Pegasus mounts.
- Use **Low Security (WPA)** for ZWO or SkyWatcher mounts.

📌 For Access Point quick switch at 2.4GHz with High Security (WPA2) you goto:
Menu → Settings → General → Reset to AP Mode

Step 2:

Connect your telescope mount to the SmartEye

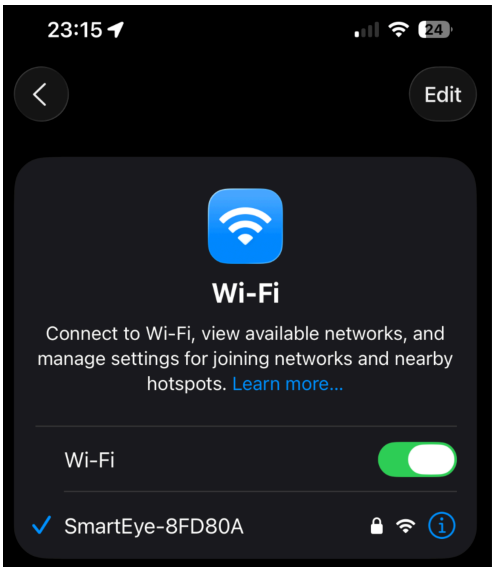
Your telescope mount must connect as a Wi-Fi client to the SmartEye access point. To do this:

- Log in to your telescope mount's dashboard/control panel.
- Scan for available Wi-Fi networks.
- Find the Wi-Fi network named SmartEye-**XXXXXX**
- Connect to it using the known credentials. (default: PW**XXXXXX).**

Step 3:

Connect your mobile device to SmartEye

Locate the SmartEye-XXXXXX network from your mobile phone and connect to it.



Step 4:

Use SkySafari Pro to connect to your telescope mount.

Now that both your telescope mount and your mobile phone are connected to the SmartEye's access point, you can control them directly through SkySafari Pro.

In our example below, we will use the **PegasusAstro NYX-88 or NYX101** harmonic mount, which features built-in ASCOM Alpaca support and connects directly to SkySafari Pro.

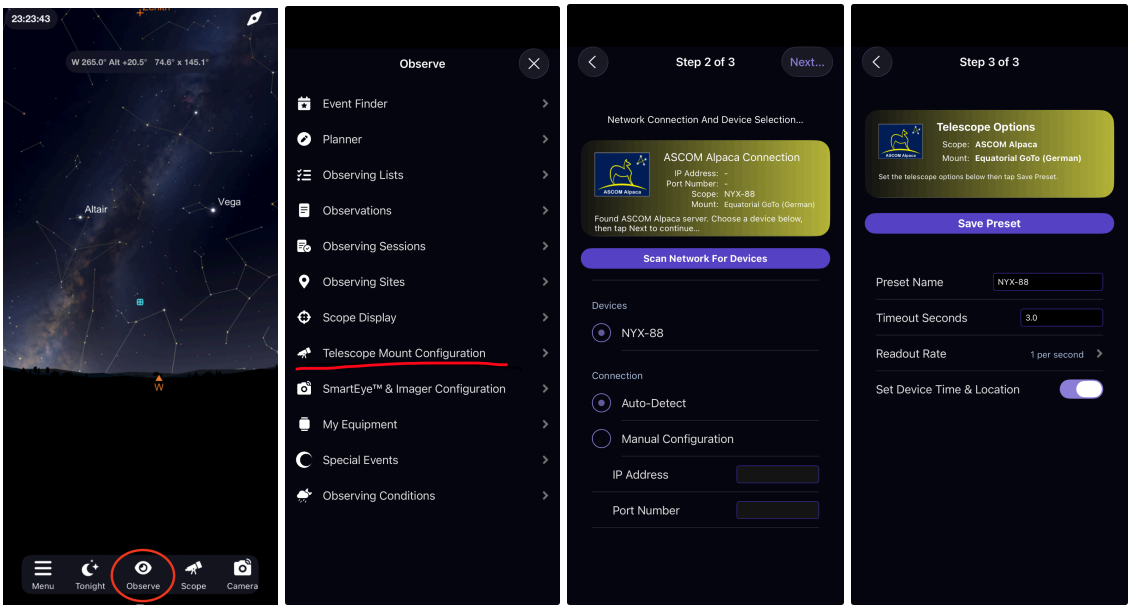
SkySafari communicates with your telescope mount so you can:

- Perform plate solving on captured images.
- Automatically sync the mount to the solved celestial coordinates.
- Use SkySafari's catalog to send GoTo commands directly to the mount.

To connect your mount with SkySafari Pro:

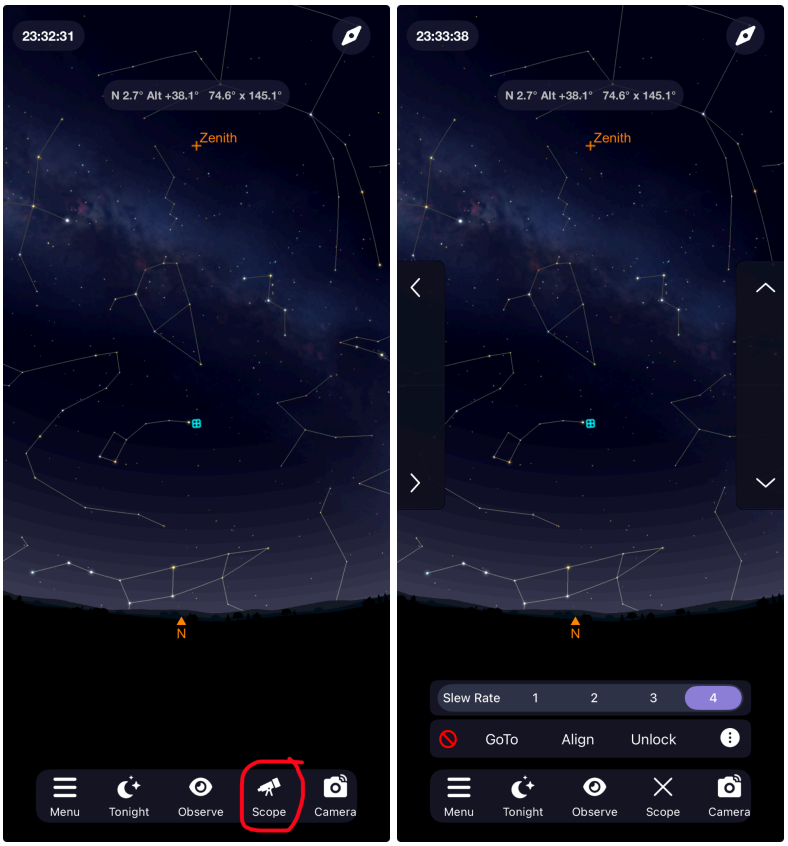
Observe → Telescope Mount Configuration → +Add Device → ASCOM Alpaca → Scan Network for Devices and follow discovery **Next…** steps.

Save Preset and make sure you have selected "**Set Device Time & Location**"



📌 If your mount does not support ASCOM Alpaca, choose **Other** or any compatible option from the SkySafari list below:

After selecting the preset you just created, tap the **Scope** button. SkySafari will then connect to your telescope mount and display the available controls for GoTo and Slew operations.



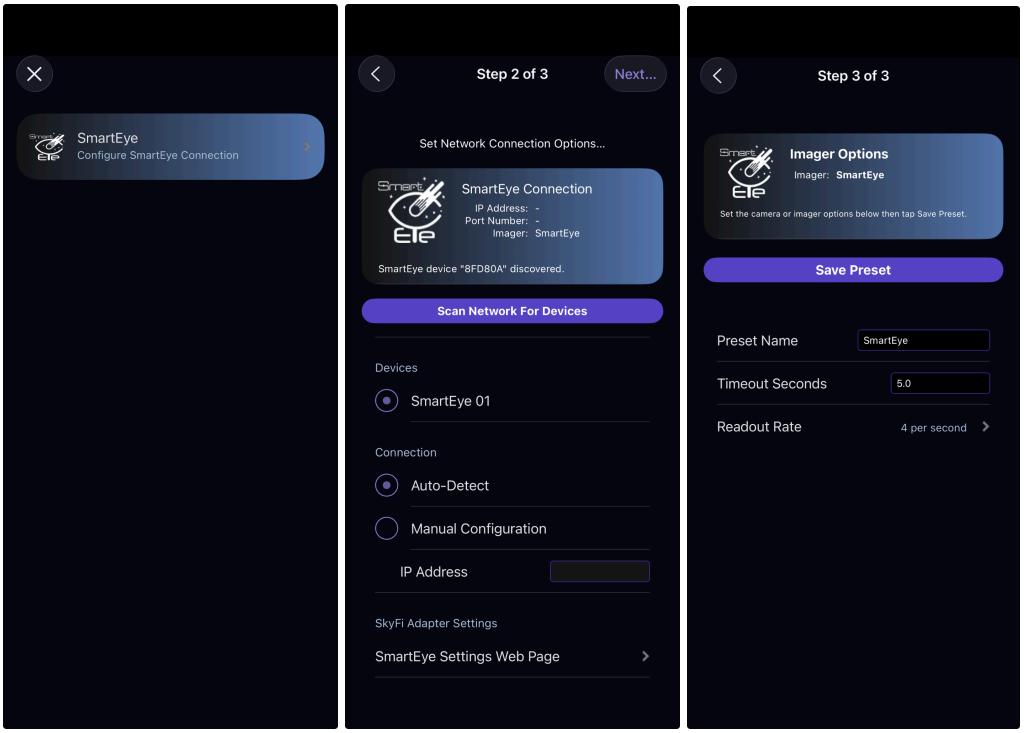
Step 5

Finally, Connect SmartEye with SkySafari Pro

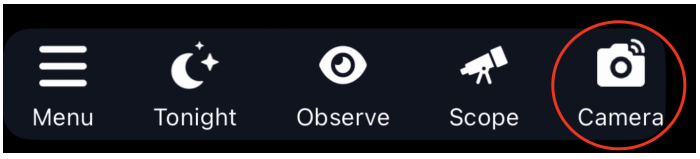
📌 To interact with the SmartEye, you will need **SkySafari Pro**.

SkySafari Pro can connect directly to SmartEye and trigger plate-solving operations on the device. Plate solving is performed internally by SmartEye with a local database, and the resulting sky coordinates are sent back to SkySafari. If a telescope is also connected to SkySafari, it can then synchronize the telescope's position with the plate-solved coordinates, allowing for precise alignment.

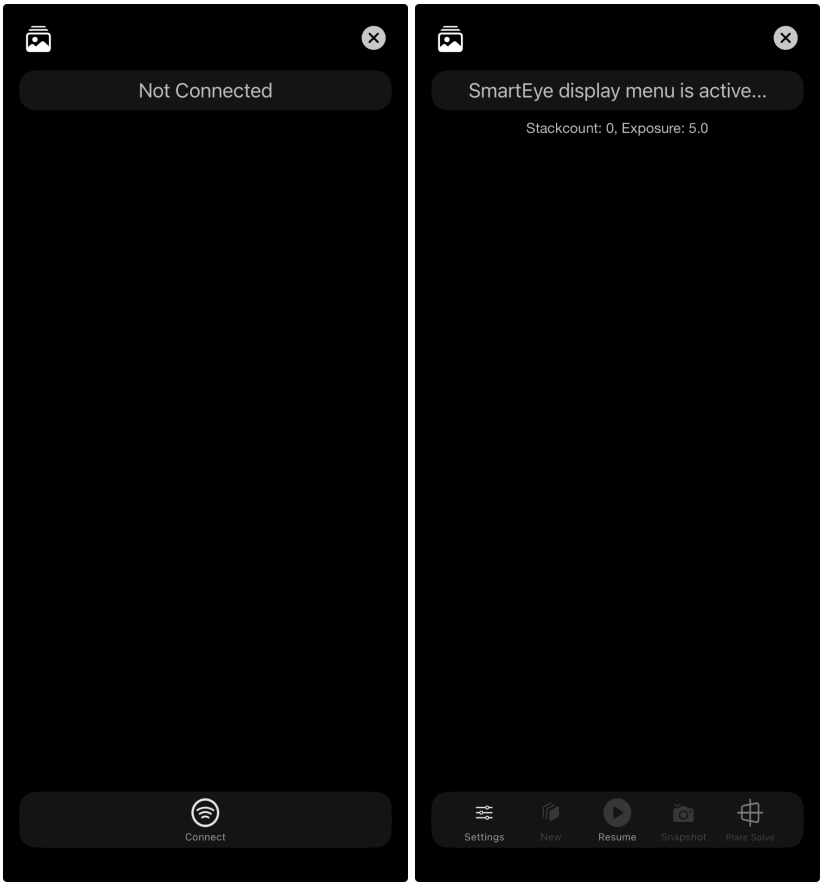
- Open SkySafari Pro on your mobile device.
- Press "**Observe"** Icon → "**SmartEye and Imager Configuration"**
- Press **the (+ Add Device)** button.
- Select "**SmartEye"**
- Press **"Scan Network for Devices"** and press Next.
- Press **"Save Preset"** button.



- Press the "**Camera"** icon on the toolbar.



Press the ‘**Connect**’ button to establish a connection with the SmartEye device.



Using SmartEye as a Wi-Fi Client (Home Network)

Step 1:

Connect SmartEye to your home Wi-Fi

- If SmartEye is in access point mode, connect your mobile phone to the SmartEye-XXXXXX Wi-Fi network first.
- Browse to the SmartEye dashboard.
- List all available Wi-Fi networks in your area.
- Select your home network and enter the password for SmartEye to connect.

📌 If your home router supports a 5GHz network, we strongly recommend connecting SmartEye there. The 5GHz band provides much faster transfer speeds, ensuring significantly quicker image downloads between your mobile device and SmartEye compared to the 2.4 GHz band.

Step 2:

Connect your telescope mount

- Ensure your telescope mount is also connected to the same home Wi-Fi network.

  ⚠️ You should connect with the telescope mount to 2.4GHz, as most mounts do not support the 5GHz band. Most home routers simultaneously support dual-band Wi-Fi. (2.4 & 5 GHz).

- Browse to your telescope mount's dashboard/panel and connect it as a client to your Wi-Fi home network.

Step 3:

Connect your phone or tablet

- Now join the same home Wi-Fi network with your mobile device.
  Again, if you have a 5GHz band available, prefer the 5GHz for higher transfer speeds.

Step 4:

Control them with SkySafari Pro

- Open SkySafari Pro.
- Connect to the telescope mount and SmartEye as shown in the previous example.

You are ready to go!

Plate Solving Images using SkySafari Pro

Tapping the “Plate-Solve” button on the right opens the plate-solving interface. The “Telescope Focal Length” field is automatically pre-filled based on the following logic:

- **Previously Used Value:**
  If you’ve performed a plate solve before, the field will be populated with your last entered value. This is stored as a user preference.
- **FOV Indicator with Telescope:**
  If an active Field of View (FOV) Indicator includes a telescope, the focal length of that telescope will be used as the default.
- **Default Fallback:**
  If neither of the above applies, the field defaults to 600mm.

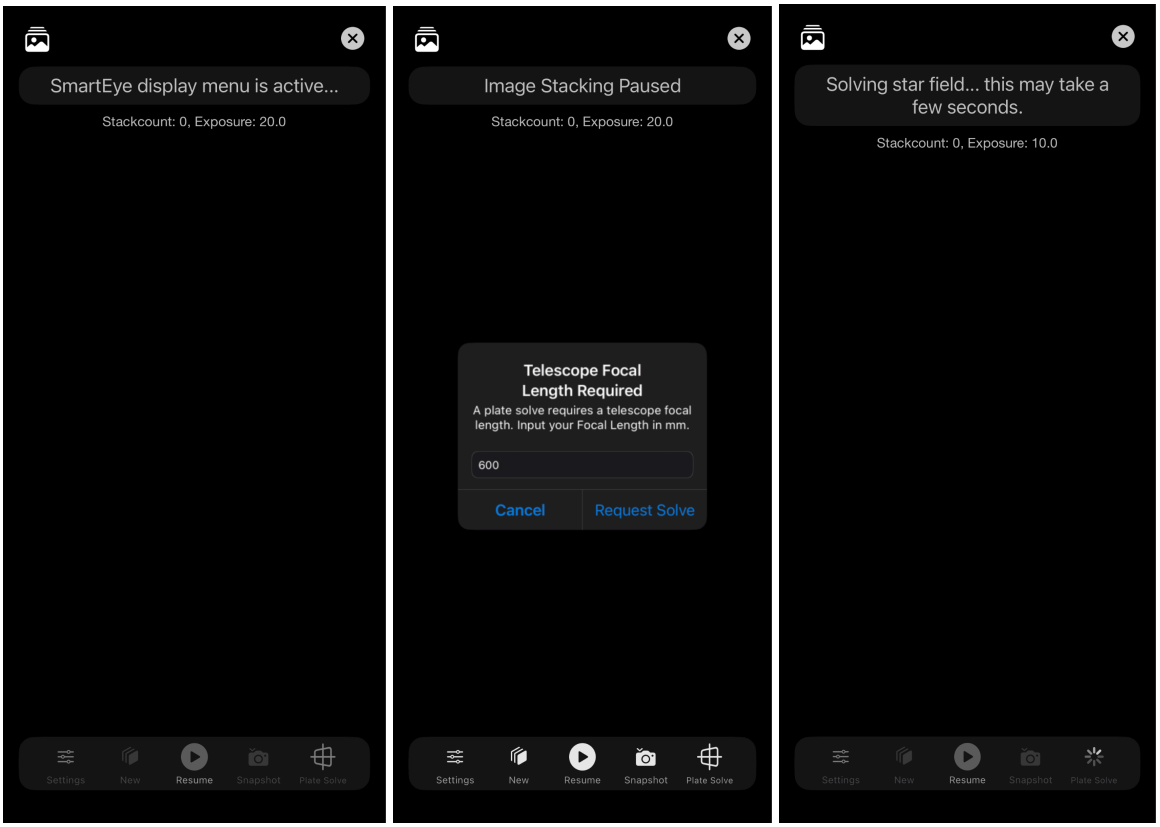
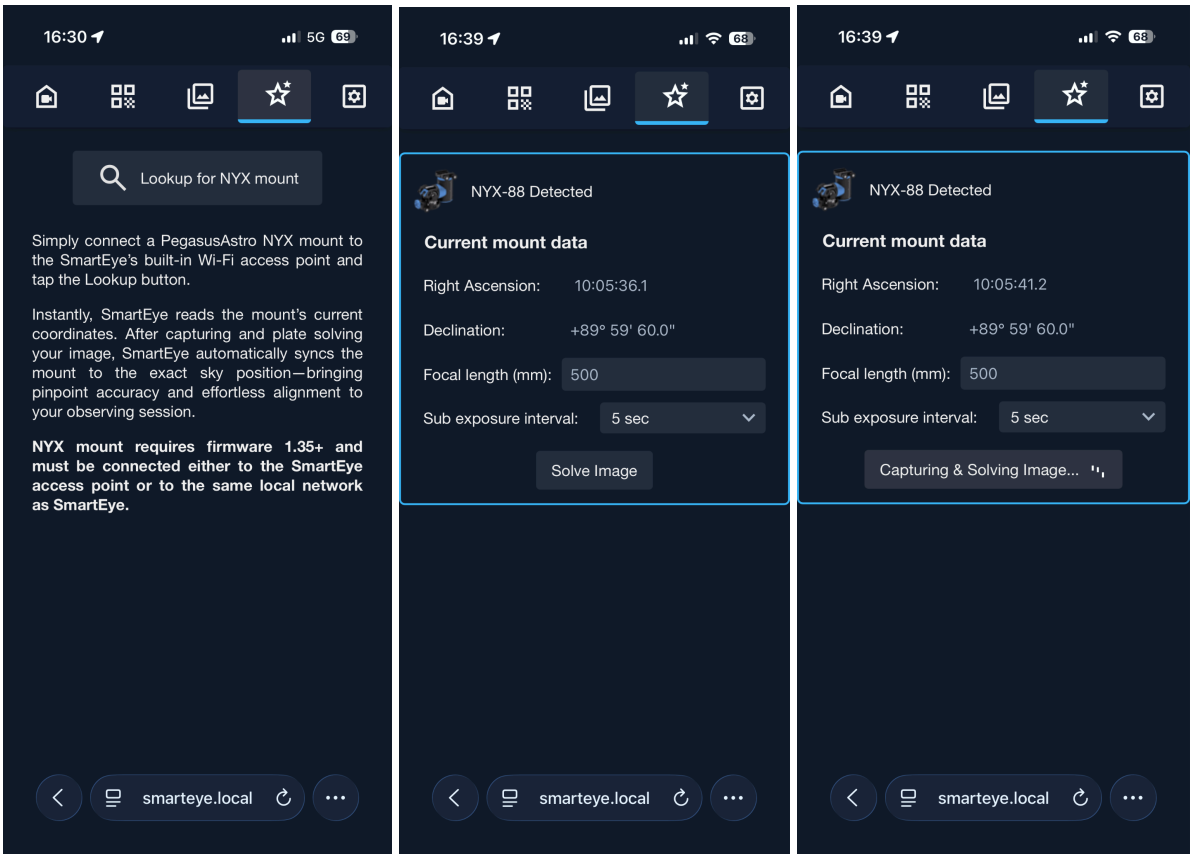


Plate Solving Images using Pegasus NYX Mounts & Dashboard

- Open the SmartEye dashboard and locate the platesolving star icon on top.
- Press the “Lookup NYX Mount” button.
- SmartEye will automatically detect your NYX mount.
- Check your network connection. Ensure your mobile device and the telescope mount are on the same network as SmartEye (either AP or client mode).
- Enter your telescope’s focal length.
- Click the “Solve Image” button.
    - SmartEye will plate-solve the image.
- The solved coordinates will be sent back to the mount for synchronization.



Updating SmartEye

The SmartEye device is continuously improved through frequent updates that include new features, performance enhancements, and important bug fixes. We strongly recommend always upgrading to the latest release using the SmartEye Update software to ensure optimal functionality and the best user experience.

The SmartEye Update software is available for download from the official website at https://smarteyepiece.com

SmartEye supports three methods for getting updates. Via:

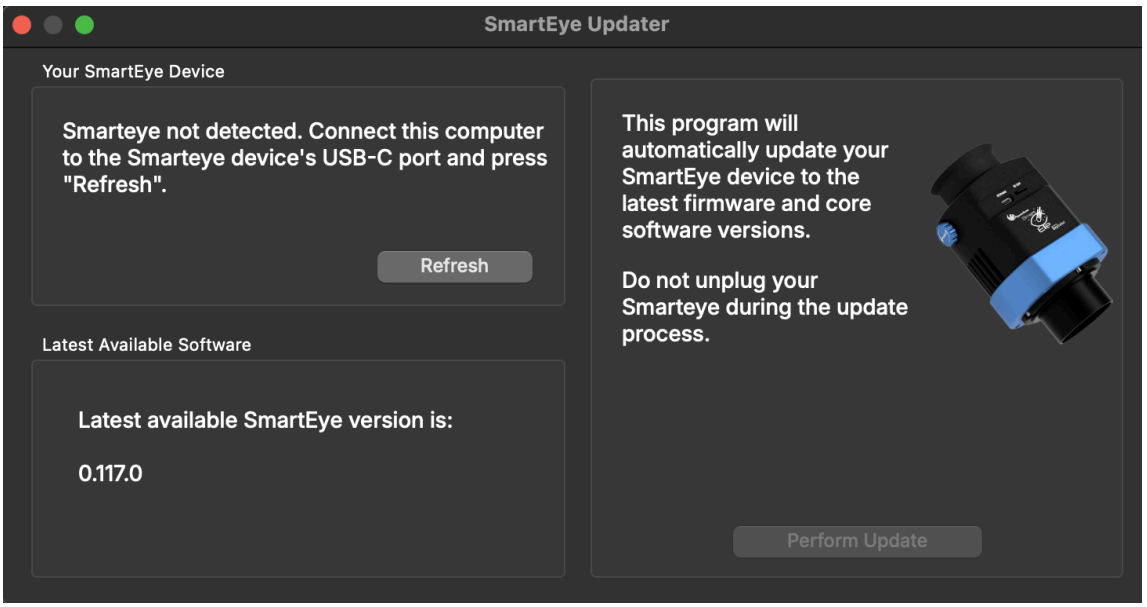
- USB-C port.
- SD-Card.
- Web Dashboard and Internet Access.

Update via USB-C port

📌 **Please Note:** *Firmware upgrades via USB-C port require a computer USB port capable of delivering up to 2A of power. If your computer's USB port cannot supply sufficient power, you may encounter errors such as "USB port disabled" or "excessive power draw detected." In such cases, we strongly recommend using the* ***SD card update*** *method instead.*

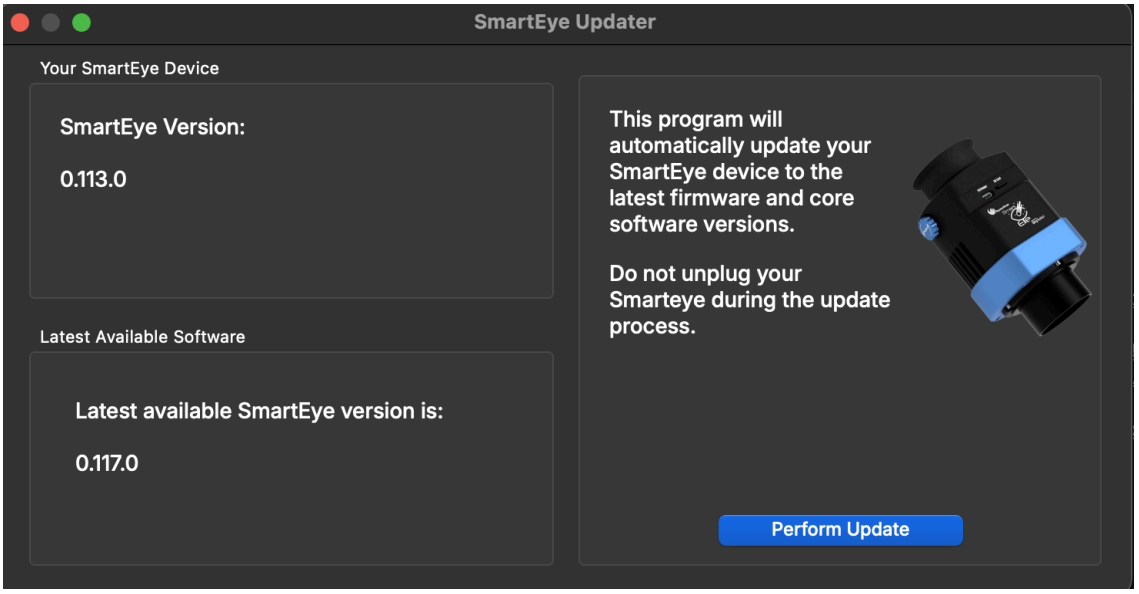
Ensure your computer's USB-C port supports Power Delivery (PD) output. Most modern computers and laptops do. If SmartEye is not detected when connected, try using a powered USB-C hub with PD pass-through or refer to Updating via SD Card below.

Upon launch, the update program automatically checks for both an active Internet connection and a connected SmartEye device. If either is not detected, the user is prompted with a message instructing them to connect the device and/or ensure Internet access, then click the "Refresh" button to retry.



Once both conditions are met, the software compares the device's current version with the latest version available on the server. The user is then either prompted to perform an update or informed that the device is already up to date.

Below is the interface shown when an update is available.

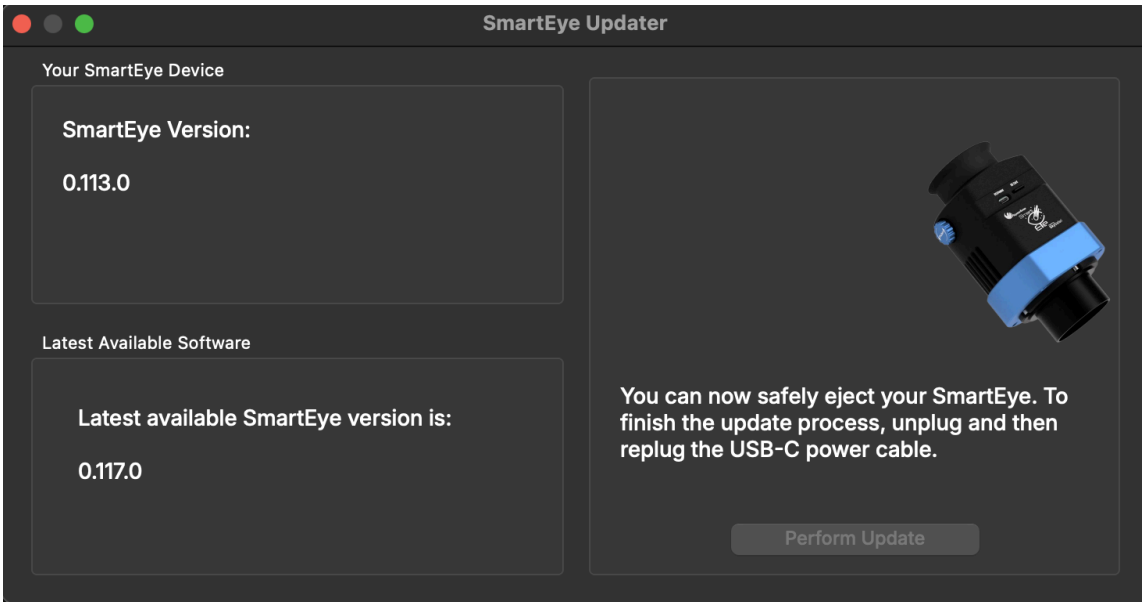


Once the user clicks the "Perform Update" button, it downloads the update from the remote server and copies it to the device. A progress indicator is displayed during the download.

It does take a few seconds after the download to upload the update to the device via USB cable.

When the initial step is complete, the user will be prompted to restart the device. At this point, we strongly recommend unplugging the USB-C cable and connecting the device to its

standard **12V -> USB-C stock power module t**o ensure the upgrade process continues smoothly.



After restarting, the device will begin the upgrade process of the uploaded file and will reboot one more time when the update is fully completed.

Please wait for the welcome message (diopter adjustment) to appear on your device before starting any new operation.

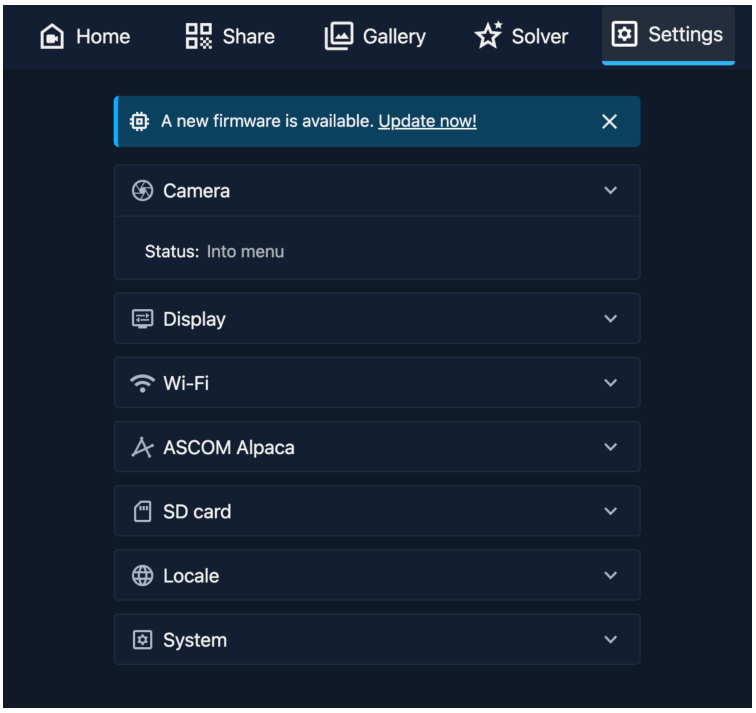
Update via SD-Card

- Insert the **microSD card** into your **SmartEye** device.
  Format the card using the SmartEye interface:
  Menu → Settings → Storage → Format SD Card
- Remove the microSD card and insert it into your computer using an SD card slot or reader.
- Launch the **SmartEye Updater** on your computer and select **Perform Update** when prompted.
- Once the update is complete, safely eject the microSD card, reinsert it into the SmartEye, an**d restart the device to complete the proc**ess.
- Please wait until you see the diopter adjustment screen. **The update process may take up to 5 minutes, and the device may reboot one or more times during the update. This is normal behavior—please do not interrupt the process.**

Update via Web Dashboard

To check for firmware updates, your SmartEye device must be connected to the internet. Simply connect it to your home network with internet access.

If a new version is available, a notification will appear in the dashboard settings, informing you that a new firmware update is available and can be installed. Just click the link and follow the on-screen instructions to upgrade to the latest firmware directly through the web dashboard.



⚠️ **Note:** Do not power off or disconnect the device from the internet during the update process.

Troubleshooting Table

Symptom	**Suggested Solution**
Device power or fan switches off randomly.	USB power may be insufficient. Please use the provided power adapter or connect to a high-power USB 3.0 or USB-C port capable of delivering up to 3 A for reliable operation.
The USB-C cable is plugged in, but SmartEye's LED does not turn on.	Make sure you use the provided power adapter. If the problem remains, please contact support.
LED starts to blink slowly when I plug the USB-C cable.	Make sure you use the provided power adapter. If the problem remains, please contact support.
The stacking count does not increase. I do not see a change in the produced image.	Polar alignment may be significantly off, or the current field may not contain enough stars for the alignment process to match frames. Try pointing to a different area of the sky or increasing the exposure time to capture more stars in the field.
Telescope mount cannot discover the SmartEye Access Point.	Ensure that the SmartEye Access Point is set to 2.4 GHz, as most telescope mounts do not support the 5 GHz band. You can switch the Wi-Fi band at any time from the SmartEye dashboard. If you use a ZWO or Skywatcher mount, ensure that Access Point is in **LOW SECURITY** (WPA) and **2.4GHz**. For Pegasus mounts, use only **HIGH SECURITY** (WPA2).
The screen is too bright or too dim.	Adjust screen brightness from the menu or from the dashboard: 1% - 100%.
Camera TEC cannot reach the configured temperature.	Maximum ΔT (temperature difference) is limited to 30 °C. Please reduce the camera's cooling power and ensure that your dark frames were captured at or near the current sensor temperature for best results. Ensure the fan is also in higher RPMs to help TEC lower the temperature.
ST4 port does not work.	ST4 functionality is currently not supported by the software. However, support for guiding via the ST4 port is planned for a future software update.
My microSD card is plugged in, but is not recognized.	Ensure the SD card is formatted with the VFAT or exFAT file system, or format it directly using the SmartEye menu for optimal compatibility.

Technical Data

Feature	Specification
Sensor Type	Sony IMX533 Color CMOS
Sensor Resolution	9 MP (3008 x 3008 pixels)
Sensor Distance	Backfocus 12mm
Pixel Size	3.76 µm
Sensor Format	1-inch square format
Cooling	Thermoelectric (TEC) with active fan, user-controllable, Cooling down to 30°C below ambient temperature.
Display Type	OLEDoS (OLED on Silicon)
Display Resolution	2560 x 2560
Field of View (Display)	90° circular
Diopter Adjustment	Range from +1D to -5D, catering to various visual acuity needs.
Data Storage	microSD card slot (supports RAW FITS image storage)
Plate Solving	Real-time, onboard plate solving
Telescope Control	Fully compatible with SkySafari Pro; supports GoTo commands via planetarium map
Camera Control	Built-in sequence control for image capture and stacking
Image Processing	Live stacking, contrast and color enhancement, noise reduction
Connectivity	Dual-band Wi-Fi support (2.4 GHz or 5 GHz 802.11 b/g/n/ac). (Access Point & Client modes).
	Bluetooth 5 with Bluetooth Low Energy (BLE) support.
Software Compatibility	SkySafari Pro, INDI, ASCOM (planned), web-based interface.
Power Requirements	USB-C 5V (~3A recommended).
Operating Temperature	-20°C to 40°C (non-condensing).
Weight	795g (28 oz)

Mount Compatibility	2-inch eyepiece barrel, compatible with standard 2-inch focusers.
Construction Material	Anodized aluminum with thermal dissipation design
Mobile Apps	Compatible with both iOS and Android devices.
ASCOM Alpaca	Announced in Wi-Fi as an Alpaca camera.

Mechanical Drawing