



StellarMate OS

User Manual

Version 3.4

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StellarMate X

StellarMate PRO

Introduction

Welcome to StellarMate! Thank you for choosing our revolutionary astrophotography platform that combines powerful open-source technology with user-friendly operation. Whether you're capturing your first lunar image or setting up a remote observatory, this manual will guide you through your astronomical imaging journey.

Core Features

StellarMate integrates industry-leading open-source software to provide a comprehensive astrophotography solution:

- **Complete Equipment Control** : Direct operation of telescopes, cameras, filter wheels, and focusers
- **Advanced Imaging** : Automated plate solving, focusing, guiding, and image sequencing
- **Cross-Platform Support** : Available on iOS, Android, Windows, MacOS, and Linux
- **Remote Operation** : Built-in WiFi hotspot and wired connectivity options

Key Components

The StellarMate ecosystem consists of three main elements:

- **Hardware** : A compact, powerful control unit for your astronomical equipment
- **Mobile App** : Intuitive control via iOS and Android devices
- **Desktop Software** : Full-featured control through KStars/EKOS

This manual covers everything from basic setup to advanced imaging techniques, helping you make the most of your StellarMate device. Each section provides clear, step-by-step instructions and helpful tips for successful astrophotography.

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StellarMate X

Warning

NEVER LOOK AT THE SUN WITH YOUR TELESCOPE OR CAMERA WITHOUT APPROPRIATE FILTERS IN PLACE. PERMANENT AND IRREVERSIBLE DAMAGE TO YOUR EYES AND YOUR EQUIPMENT WILL OCCUR.

StellarMate X is a compact and powerful Astrophotography Controller that supports numerous Mounts, Cameras, and other astronomical equipment. Powered by Open Source technologies and designed and built by Astrophotographer for Astrophotographers.

It provides unparalleled freedom in selecting your favorite platform to remotely control your equipment. You can use Ekos astrophotography tool on Windows, MacOS, or Linux. Furthermore, use StellarMate App on iOS and Android to automate your complete astrophotography workflow.

1.1 Key Features

StellarMate X is simple:

- Connect your equipment (Mount, Camera, DSLR, Focuser, Filter Wheel, etc.) to StellarMate X via USB or WiFi
- Connect to StellarMate X from either your Mobile, Tablet, or Laptop/Desktop Computer
- Start controlling your observatory and image from any major platform

StellarMate X is quiet with no moving parts. It is four times faster than its predecessor StellarMate Plus and comes with double the storage and memory capacity enabling fast and seamless control for the most demanding and high-resolution astro cameras. It features a special VESA mount to secure it to standard dovetails and clamps.

1.2 Quick Setup

The following is the quick startup guide to getting StellarMate X up and running in a few minutes using your phone/tablet:

1. Download Stellarmate App from the Android/iOS store.
2. Launch the App and Register an account.
3. Connect the power adapter to StellarMate and turn power on.
4. Open network settings in your phone/tablet and connect to the StellarMate WiFi hotspot.
5. Open StellarMate App. Go to Setup tab. Click Rescan.
6. After StellarMate is detected, click on it.
7. Start the default Simulators equipment profile or create a new equipment profile.
8. Go to Ekos tab and start using your equipment.
9. Check StellarMate network settings and status from the Device tab.

1.2.1 Ports

StellarMate runs few back-end services that use the following ports.

SSH	5624	Not Required
INDI Web Manager	8624	Required
INDI Server	7624	Required
Ekoslive Server	3000	Required
Web VNC	6080	Not Required
VNC	5900	Not Required
NetBIOS	139	Not Required
Samba	445	Not Required

1.3 Package Contents

Thank you for purchasing StellarMate! Please follow this guide before you starting using your StellarMate Gadget.

After unboxing your package, you should have the following items:

1. StellarMate X Unit.
2. USB-C Power Supply with international socket adapter
3. Quick Start Guide.
4. VESA-Mount
5. Optional plug depending on the region.



Connect the USB-C power supply cable to StellarMate X and then turn power on. There is no need to push the power button as the unit automatically boots up when power is connected. A soft blue light indicates the unit is powered up. Startup time should take less than 30 seconds after which the unit is ready to be used.

1.4 Getting Started

For detailed setup instructions and tutorials, visit our [YouTube Channel](#).

1.5 Specifications

StellarMate X leverages a passive cooling technology, and has a good thermal dissipation to prevent overheating. No fan no noise, reaching a totally silent, dust free performance:

- CPU: Intel Gemini Lake Celeron J4125 Quad-Core
- GPU: Intel HD Graphics 600

- Operating System: StellarMate OS
- Memory: 4GB/8GB LPDDR4
- Storage: 64GB/128GB eMMC Built-in
- Expandability: Micro USB up to 2TB, M.2 SSD/NVMe 2280 up to 4TB
- 4x USB 3.0 Ports
- 2x HDMI 2.0 port, support 4K@60Hz
- 1x 3.5mm Audio jack
- 1x Gigabit LAN Port
- 1x Kensington Lock Slot
- 1x USB Type-C (Only for power supply)

StellarMate Pro

Warning

NEVER LOOK AT THE SUN WITH YOUR TELESCOPE OR CAMERA WITHOUT APPROPRIATE FILTERS IN PLACE. PERMANENT AND IRREVERSIBLE DAMAGE TO YOUR EYES AND YOUR EQUIPMENT WILL OCCUR.

Warning

NEVER EXCEED 16V DC INPUT VOLTAGE AS IT MIGHT CAUSE IRREVERSIBLE DAMAGE TO THE CONTROLLER AND ANY EQUIPMENT CONNECTED TO IT.

Warning

OUTPUT VOLTAGE FOLLOWS INPUT VOLTAGE. IF OUTPUT VOLTAGE EXCEEDS THE CONNECTED EQUIPMENT VOLTAGE LIMITS, IT MAY CAUSE PERMANENT DAMAGE TO THE CONNECTED EQUIPMENT.

Warning

DO NOT DISASSEMBLE THE UNIT OR ATTEMPT REPAIRS. DO NOT SUBJECT THE UNIT TO WET ENVIRONMENTS. IRREVERSIBLE DAMAGE TO THE CONTROLLER AND ANY EQUIPMENT CONNECTED TO IT.

2.1 Introduction

Thank you for purchasing StellarMate Pro. StellarMate Pro (SM Pro) is a compact and powerful Astrophotography Controller that supports numerous Mounts, Cameras, and other astronomical equipment. SM Pro is a complete astrophotography solution and comes preloaded with all the necessary software and drivers required to operate astronomical equipment, no additional 3rd party software is required.

In addition to its role as a dedicated astronomical equipment controller, SM Pro offers comprehensive power distribution capabilities. It can power up to four 12V DC devices, two 12V Dew Heaters, and one adjustable voltage output ranging from 3-9V. To power all connected devices, a 12V @ 10A DC regulated power supply (Not included) is required. The unit ships with a robust high-density XT-60 connector, engineered to withstand currents of up to 60A.

Warning

SM Pro does not include a Power Supply. A regulated 12V power supply rated at 10A or higher is required. Do not connect StellarMate Pro to a 12V field battery without a 12V Regulator as this may cause irreversible damage to the unit and/or connected devices. The official StellarMate Pro Power Supply (IKA-834) is certified to work with StellarMate Pro.

SM Pro is equipped with a built-in GPS/GLONASS receiver that provides highly accurate location and time services necessary for accurate and reliable operations of your equipment whether you are on the field or in a stationary observatory. Passive GPS and WiFi antennas are optimized to provide high gain even in noisy environments. Reliable communication between SM Pro and your controller (Mobile, Tablet, or PC/Mac) is critical for the operation of the unit.

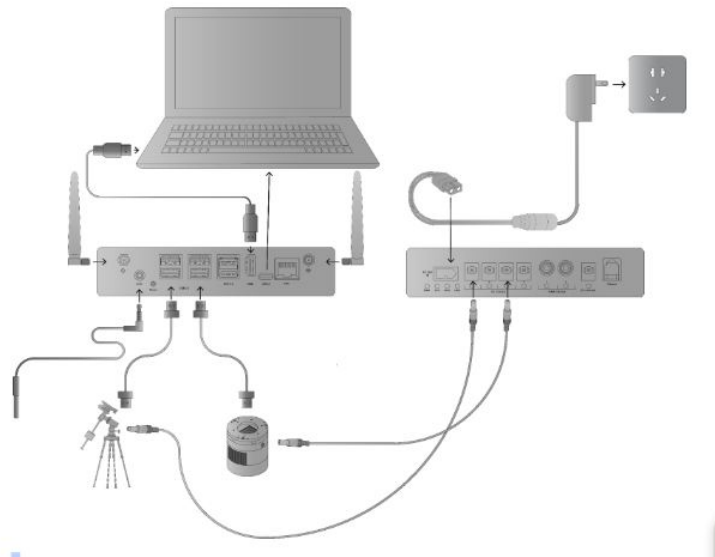
SM Pro provides unparalleled freedom in selecting your favorite platform to control your equipment:

1. **Standalone:** Since SM Pro is a mini Computer, you can connect it to an external monitor via HDMI cable and connect a mouse/keyboard to use StellarMate OS directly. However, since SM Pro is usually mounted on the telescope, this control method is not recommended.

2. **Mobile:** Operate SM Pro remotely via WiFi using StellarMate App for Android/iOS. It is highly recommended to run StellarMate App on modern Tablets/iPad with screen sizes 10" or more to get the best experience. While phones are supported, the SM App is optimized to run on tablets.
3. **Windows/Mac/Linux:** Use Ekos astrophotography tool on Windows, MacOS, or Linux. Remotely control StellarMate via WiFi, Local Area Network (LAN) or Wide Area Network (WAN). Ekos supports advanced functionality including mosaic planner and scheduler.

Using StellarMate Pro is simple. To get started right away:

1. Connect your equipment (Mount, Camera, DSLR, Focuser, Filter Wheel..etc) to StellarMate Pro via USB or WiFi.
2. Power your equipment via connecting them to SM Pro power ports.
3. Connect to StellarMate Pro from either your Mobile, Tablet, or Laptop/Desktop Computer.
4. Start controlling your setup and image from any major platform.



2.2 Specifications

StellarMate Pro is available in two variants:

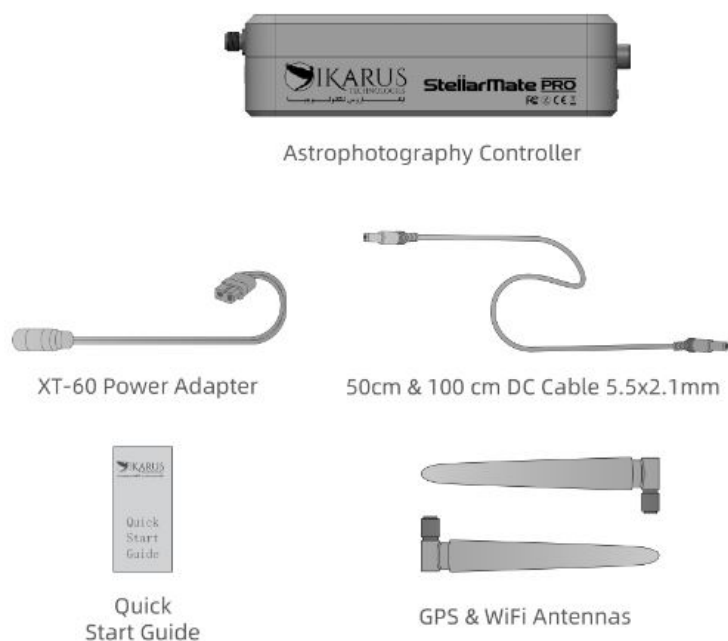
- StellarMate Pro 4GB RAM and 64GB SSD.
- StellarMate Pro 8GB RAM and 128GB SSD.

OS	StellarMate OS
Processor	Broadcom BCM2711 Quad Core
Graphics	On Chip GPU
Memory	4GB/8GB LPDDR4
Storage	64GB/128GB SSD
Network Connection	• WiFi 5 (802.11ac) Dual-band 2.4 / 5 Ghz • Bluetooth 5.0 • Gigabit Ethernet
USB	• 4x USB 3.0 • 2x USB 2.0 • 1x USB-C (Pictures transfer to host PC)
Power Output	445
Auxiliary	445

Storage

Model	OS Storage (GB)	Photo Storage (GB)	Rescue Storage (GB)
IKA-850-64GB 30		73	15
IKA-850-128GB 30		193	15

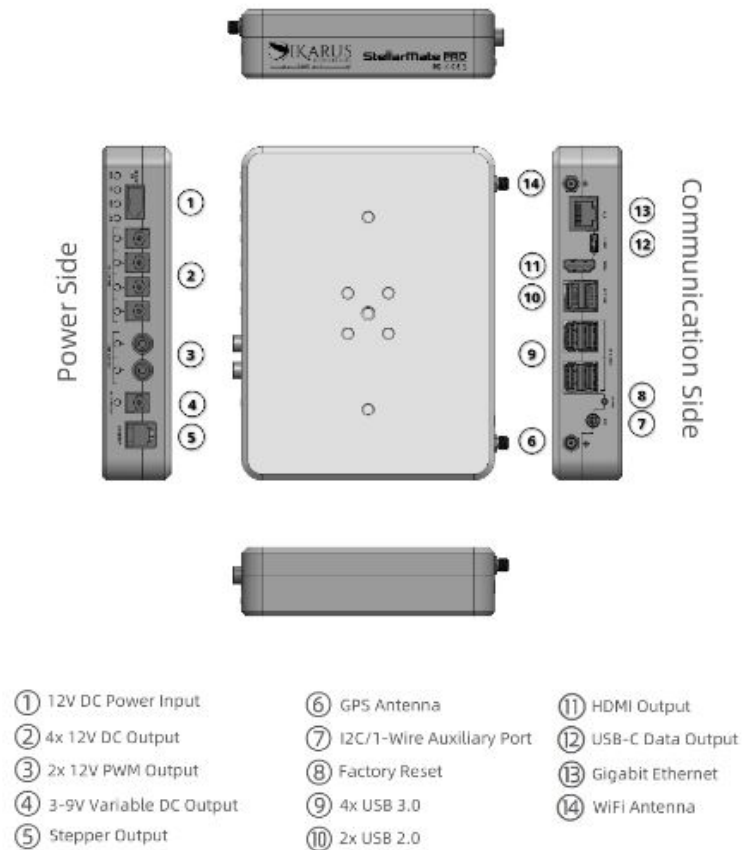
2.3 Package Contents



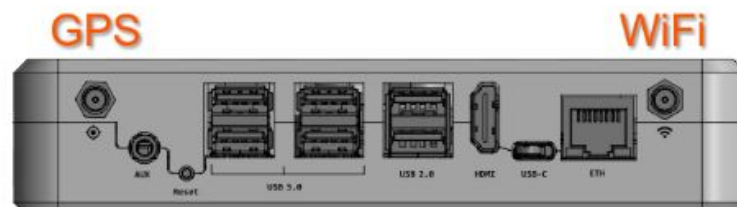
The following items are included in the StellarMate Pro box:

1. StellarMate Pro Unit.
2. Quick Start Guide and EkosLive Pro offer.
3. GPS Antenna.
4. WiFi Antenna.
5. 100cm 5.5x2.1mm DC Male to Male Cable.
6. 50cm 5.5x2.1mm DC Male to Male Cable.
7. XT-60 to DC Female Power Adapter Cable.

2.4 Assembling the Unit



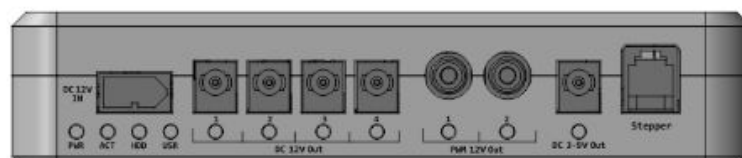
Attach the GPS and WiFi antennas to their respective SMA connectors on the SM Pro Communication Side.



Warning

DO NOT SWAP THE ANTENNAS AND DO NOT REMOVE WHILE THE UNIT IS POWERED AS THIS MAY LEAD TO COMMUNICATION LOSS.

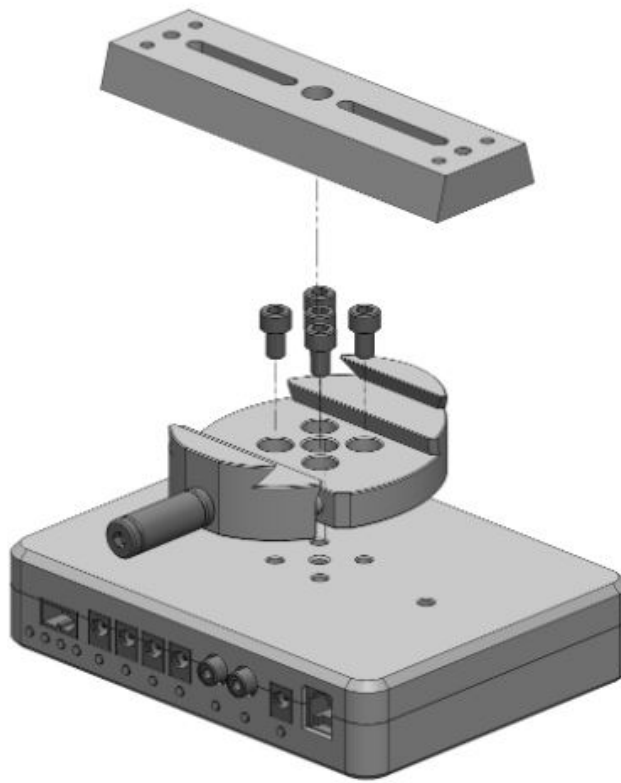
Connect the XT-60 Power Adapter to the XT-60 female plug on the Power Side. The adapter's female DC jack needs to be connected to an external regulated & stable 12V power supply rated for 10 Amperes or higher.



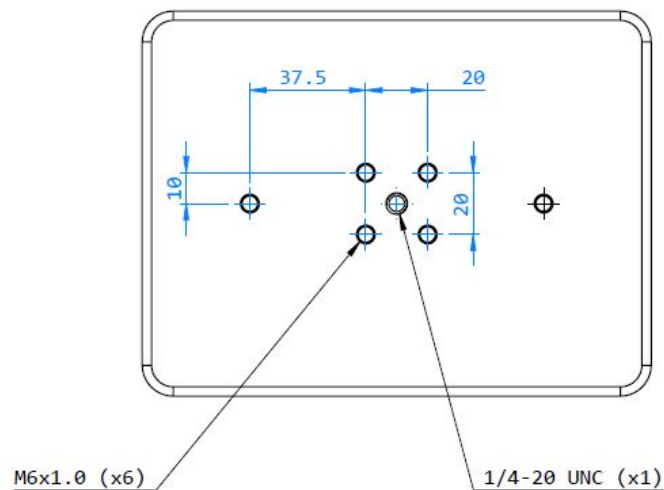
Alternatively, you may connect Ikarus Technologies certified **12V@10A** Universal Power Supply (Sold Separately) directly to the unit.

2.5 Mounting

StellarMate Pro is quiet with no moving parts. The sturdy anodized CNC-machined case can be secured to dovetails, rings, or standard tripod head. Ikarus Universal Losmandy/Vixen Clamp (Sold Separately) can be used to couple the unit to the mount's dovetail.



The case can be mounted onto a standard tripod head via the central 1/4"-20 UNC thread. All the other threads are standard M6x1.0. The M6 screws length should not exceed 10mm.



2.6 Power Connections

	Paramter	unit	min	max	Normalal
1	Voltage Input DC	v	10	16	12
2	12V DC Output (1 - 4) Load	A	—	16	—
3	12V PWM Output (1 - 2) Load	A	—	16	—
4	Variable Output Voltage	V	3	16	—
5	Variable Output Load	A	—	16	—
6	USB2 Current Capability	A	—	16	—
7	USB3 Current Capability	A	—	16	—
8	Total Output Load (12V DC + PWM Outputs)	A	—	16	—
9	Total Output Load (USB2)	A	—	16	—
10	Total Output Load (USB3)	A	—	16	—

The output voltage of the 12V DC Outputs (DC output and dew heater output) are depending on the input voltage. The outputs are not regulated, meaning the voltage on the output will be the same as the input voltage.

That is why the recommended input voltage is 12V, so you can connect 12V devices on the DC outputs and PWM outputs. The DC and PWM outputs are short-circuit protected.

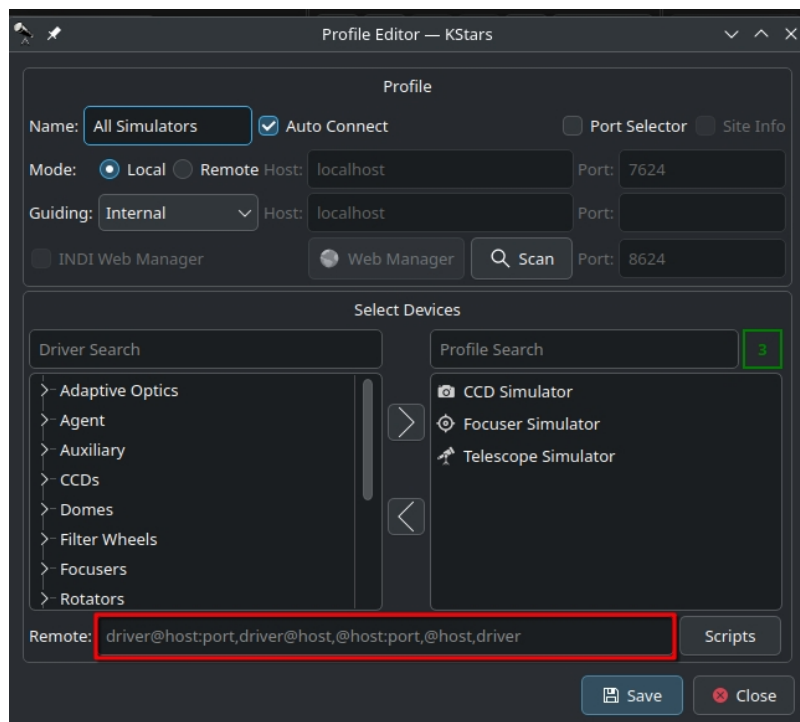
If the input voltage is different than 12V you may risk damaging the connected devices on the DC outputs.

The SM PRO is protected against over voltage, so it will not get damaged, but over voltage on the input may damage the connected devices on the DC output ports.

2.7 Connecting from PC

StellarMate Pro operates on its own dedicated port 12624. If you use StellarMate App to create equipment profiles, then the driver is automatically appended to your equipment profile. Similary, if you try to start an equipment profile remotely from a PC/Mac, then the Web Manager automatically adds the SM Pro driver to your equipment profile. However, if you create an equipment profile directly in StellarMate Pro (for example, via VNC), then you need to explicitly add the driver in the Remote Driver section:

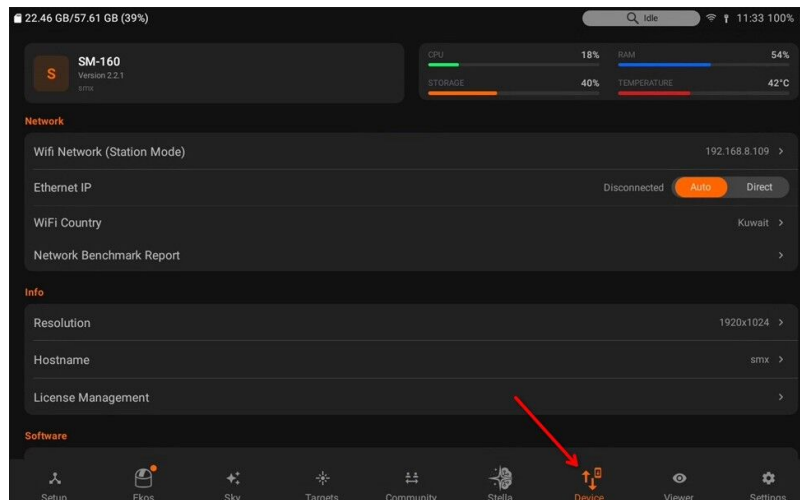
@localhost:12624



2.8 Startup

StellarMate Pro takes 30-60 seconds to fully startup from a cold start. If the buzzer is enabled (default), then a double-beep indicates the unit is ready for sure.

Once the unit is ready, all previous configuration is loaded and applied including the power status of all outputs. Please note that on a soft-restart (i.e. restarting the unit from the Device tab in the StellarMate App), then all output ports shall retain their power settings throughout the soft restart process.



After the unit is started, use the StellarMate App to connect to the unit and operate it. Start your equipment profile or schedule a session with the scheduler.

2.9 GPS

GPS StellarMate Pro comes equipped with an integrated GPS/GLONASS receiver paired with an external passive antenna. It is specifically engineered for outdoor applications and may not function optimally without an unobstructed view of the sky. This receiver offers concurrent reception capability for GPS, GLONASS, Galileo, BDS, and QZSS open service L1 signals. With an impressive tally of 33 tracking channels, 99 acquisition channels, and 210 PRN channels, the SM Pro is adept at acquiring and monitoring various combinations of satellite signals.

Beyond its location services, the GPS functionality supplies highly precise timing information, which plays a pivotal role in numerous astronomical calculations executed within the device. Precise time synchronization is achieved by utilizing the GPS Pulse-Per-Second signal (PPS). The GPS PPS signal offers an extremely accurate and stable time reference.

Warning

Any connected USB 3.0 device may interfere with the GPS signal leading to a failure to obtain 3D lock. Interference can be mitigated by using double-shielded USB 3 cables or by disconnecting any USB 3.0 devices during power up to allow StellarMate Pro to obtain a lock first. With StellarMate Pro Board v1.3 or later, external Active GPS antennas are supported.

Passive and Active GPS Antenna

By default, SM Pro is shipped with a passive GPS antenna. Due to interference issues from USB 3.0 devices and other sources, the satellite signal may not be sufficient to obtain a GPS lock. An active antenna can be used to overcome this limitation. The Ikarus Technologies Active GPS Antenna (IKA-860) is recommended. Place the antenna at least 50 cm away from SM Pro. In StellarMate App, tap the GPS status indicator to toggle between the Passive & GPS antennas.

GPS status is displayed in the StellarMate Pro App Power tab.



The USR LED is used to designate the GPS lock status:

Flashing: Satellite acquisition is in progress.

Solid: A 3D GPS lock is obtained.

2.10 Auxiliary Ports

StellarMate Pro offers a highly adaptable and future-ready I2C/1-Wire Auxiliary port, designed to accommodate inputs from environmental sensors, relay controls, DSLR camera snap controllers, and various third-party accessories, provided they are supported by the applicable software. External auxiliary devices can be seamlessly connected to this port using a standard 4-pole TRRS connector. Furthermore, the system allows for multiple I2C connectors to be daisy-chained on the same bus, enabling access to multiple external peripherals.

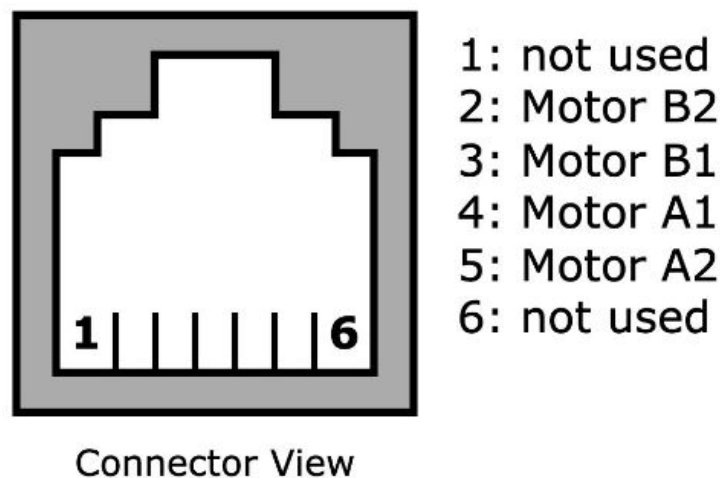
1-Wire is supported by the hardware, but software support is due pending a future firmware update.

For the acquisition of temperature and humidity data, it is recommended to employ the certified Ikarus Technologies Temperature Sensor (IKA-855). This sensor plays a critical role in specific operations, including automatic dew control.

2.11 Stepper Control

StellarMate Pro is equipped with a TMC2209 stepper controller that is certified to operate Two-Phase Bipolar Stepper Motors up to 2.8A Peak. The INDI SM Pro driver includes focuser support that can directly drive the motor and support relative positioning, backlash compensation, and homing.

Currently, there are no ready-assembled cables to connect a focuser stepper motor directly to StellarMate Pro, so you need to make your own cable using the wiring diagram below:



An male RJ12 6P4C (or 6P6C) plug needs to be wired to the motor as illustrated above.

2.12 Compatible Motors

Compatible motors
NEMA-17

2.13 Maintenance

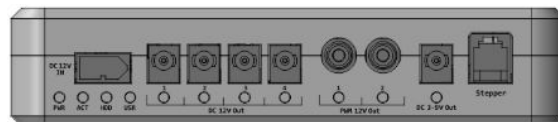
Following main sections for maintaining SM Pro:

2.13.1 Care Instructions

- Use voltage-regulated power supply with a surge protector.
- Keep StellarMate Pro's firmware updated for optimal performance and compatibility.
- Store in a cool, dry place away from direct sunlight or extreme temperatures.
- Avoid exposing StellarMate Pro to moisture or liquids to prevent damage.
- Handle the device with care to prevent physical damage or impact.
- Backup your data and configurations regularly to prevent data loss.
- Do not operate a unit below zero Degrees Celsius or higher than 35 degrees Celsius ambient temperature.

2.13.2 Factory reset

A partial or full factory reset can be performed. To perform a complete factory reset, use a thin pin (Not Included) to toggle the reset button located at StellarMate Pro communication side



The following are the steps required to perform a factory reset:

- Use a pin to press the reset button while the unit is off.
- Power on the unit.
- Wait until you start hearing a repeating slow beep.
- Release the pin
- Select the Factory Reset mode:

Partial Recovery: Restore operating system, but keep settings and photos. Use the pin to toggle the reset button momentarily.

Full Recovery: Restore operating system and settings. All settings and captured photos are reset to default. Use the pin to press and hold for at least 3 seconds then release.

- A fast beep indicates restoration is in progress. Wait until the recovery process is complete. It can take anywhere from 3 to 5 minutes to complete. Afterwards, the unit will automatically reboot.

2.13.3 Fuses

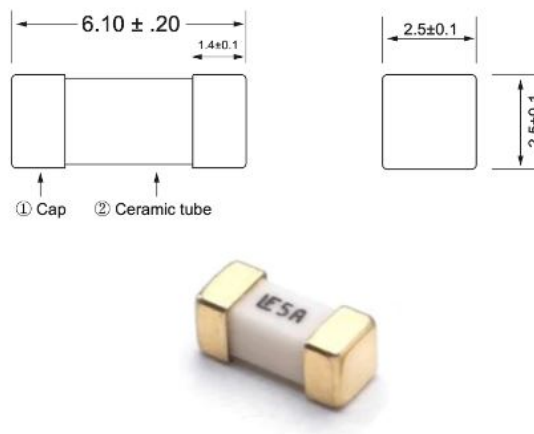
StellarMate Pro is equipped with with two fuses to protect circuit against over-current:

Top Fuse: If the top cover is removed this fuse can be easily accessed. The fuse type is a 10A (red) mini blade fuse.



This fuse is protecting the power outputs.

Bottom Fuse: If the top cover and the PCB is removed this fuse can be accessed. The fuse is an 8A very fast acting type e.g. a “NANO2” type from Littelfuse (0453008.MR), but fuses from other manufacturer are also compatible which has the following outer diameter.



This fuse is protecting the internal circuits and USB connector, if the fuse is burned please contact us before replacing.

2.13.4 Replace Computing module

This guide outlines the steps to replace a faulty Raspberry Pi CM4 on your StellarMate Pro. It is crucial to handle electronic components with care to prevent damage. Always wear an anti-static wrist strap to protect sensitive components from electrostatic discharge (ESD).

Required Tools

- Phillips head screwdriver (M2.5 and M3 sizes)
- Anti-static ESD wrist strap



Procedure

- 1) **Power Off:** Ensure the StellarMate Pro is completely powered off and disconnected from any power source.



- 2) **Remove Antennas:** Carefully detach the WiFi and GPS antennas from the device.
- 3) **Open the Case:** Unscrew the four M3 screws at the back of the StellarMate Pro case. Gently lift the lid, taking care not to damage the internal antenna cables.



Disconnect CM4

- Disconnect the pigtail cable from the CM4.
- Unscrew the four M2.5 screws securing the CM4.
- Carefully lift the CM4 from the onboard sockets.

Install New CM4

- Align the new CM4 with the sockets.
- Gently press the left side of the CM4 into place until you hear a distinct clicking noise.
- Then, gently press the right side of the CM4 into place until you hear a second clicking noise. Ensure the CM4 is fully seated.

Reconnect Pigtail Cable

- Connect the pigtail cable to the CM4. Ensure a secure connection.
- Secure the pigtail cable to the metal cable clip using the provided fastener.

Close the Case

- Lower the lid and secure it with the four M3 screws.
- Reattach the WiFi and GPS antennas.

Important notes

- Handle the CM4 and other components with care to avoid damage.
- Use the provided screws and avoid over tightening them.
- If you encounter difficulties, consult the StellarMate Pro support resources or seek professional assistance.

2.14 Troubleshooting

#	Issue	Possible Causes
1	Unit does not power up	1) Bad Power Supply 2) Bad Power Adapter Cable 3) Bottom fuse burned
2	Unit does not boot up: 1) HDD + ACT LEDs not blinking or dark 2) No Beep 3) No Wireless access via Hotspot or Station mode.	1) Make sure no cable is connected to the SM Pro USB-C Port. 2) SSD storage damaged or corrupted. 3) Board damaged.
3	Output DC port not supplying power	1) Check if the port is toggled in the SM App. Check for any messages about burned fuse. 2) Check cable is fully plugged in. 3) Check cable is not damaged. 4) Check the peripheral device is not damaged.
4	Output PWM port not supplying power	1) Check if the port is toggled in the SM App. Check for any messages about burned fuse. 2) Check duty cycle is properly set in the SM App. 3) Check cable is fully plugged in. 4) Check cable is not damaged. 5) Check the heating element is not damaged.
5	Variable voltage not supplying power	1) Check if the port is toggled in the SM App. Check for any messages about burned fuse. 2) Check output voltage is properly set in the SM App. 3) Check cable is fully plugged in. 4) Check cable is not damaged. 5) Check the heating element is not damaged.
6	No GPS Lock	1) Make sure you have an unobstructed view of the sky. 2) Check if the Antenna connected to GPS SMA is marked as GPS.
7	Weak or no WiFi signal.	1) Check if the antenna connected to WiFi SMA is marked as WiFi. 2) Congestion: if there are many WiFi Networks in the area surrounding StellarMate, the WiFi Hotspot might be slow due to signal and channel congestion. A possible solution in case of severe interference is to toggle WiFi frequency (2.4Ghz/5Ghz) in StellarMate OS and try to locate a channel that is relatively free of congestion. 3) HDMI Resolution: If you connect StellarMate to a monitor, try to set the resolution to 1080p.

Passwords

- The default StellarMate OS password is smate
- The default StellarMate WiFi HotSpot password is [stellar@mate](#)

Learning StellarMate

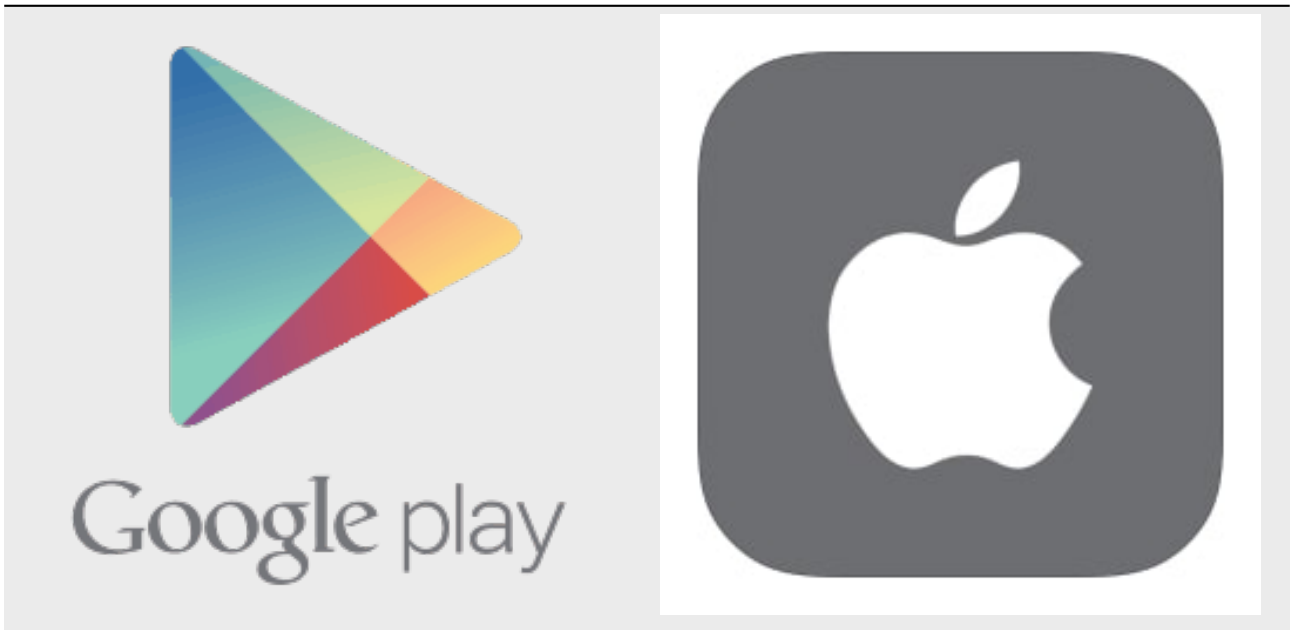
For new users, using StellarMate effectively can take a bit of a learning curve (like everything else) especially given the breadth of the features it provides. Here are some useful resources to get you started:

- [First Time Setup](#) tutorial.
- [StellarMate Video](#) tutorials.
- [Ekos Video](#) Tutorials.

StellarMate App

- 1) StellarMate Mobile App for Tablets.
- 2) PC/Mac using KStars.
- 3) Any Web browser or VNC client.

StellarMate App is the Official App for StellarMate gadget. It is available for both Android and iOS smartphones and tablets. It is primary designed for tablets in portrait mode. While it can be used for phones, for the best experience, use it with a tablet/iPad. [Download](#) and install the App on your device before you continue.



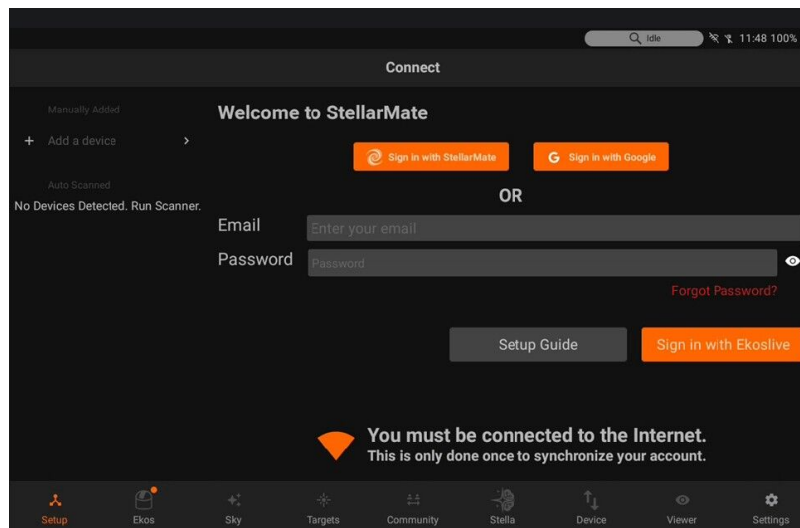
Warning

The App is required to connect to the unit and configure it for first-time use, so do this step now and do not skip ahead!

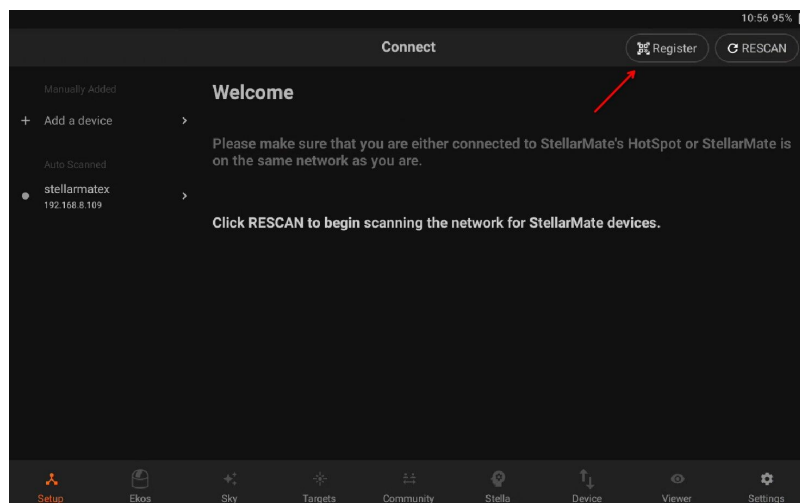
5.1 Startup

When using StellarMate App for the first time, you need to sign-in either using with Ekoslive, StellarMate or Google/Login account. Beware that you must be connected to the internet for the initial sign in to proceed. After sign in is successful, no internet connection is required and you can switch network to StellarMate hotspot if desired.

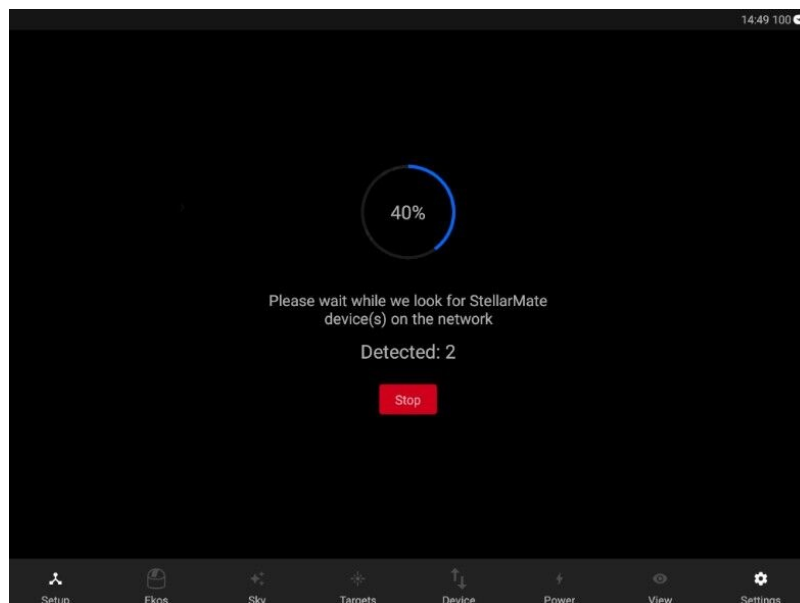
You can sign-in with your Google account in android and Sign-in with your Apple account on iOS devices



- 1) **StellarMate X:** If you purchased an SM X or SM Pro device, you need to register the device after Signing in. Press on the Register button and then follow the on screen guide.



- 2) **StellarMate OS:** If you purchased StellarMate OS, or already have registered the device before, you can simply rescan and connect to your StellarMate device.



Register via:

- 1) Scan QR code
- 2) Enter Manually

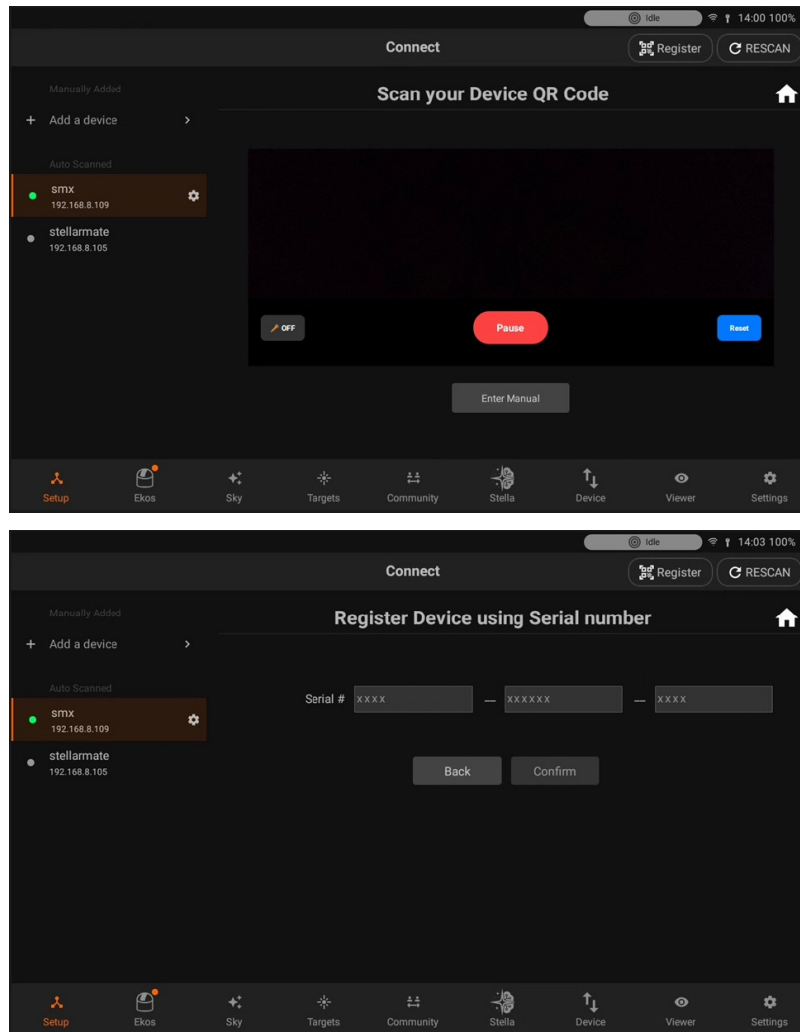
5.1.1 QR Code

If you received the StellarMate Controller, you will find the Device QR Code on the back of the unit.



If you purchased StellarMate OS, the Device Serial Number is automatically generated for you.

5.1.2 Manually



Enter the serial number located on the back of your StellarMate device. Once the correct serial number has been entered and pressed submit, it will be successfully registered to your account. Ensure that your device is connected to the Internet before proceeding.

5.1.3 Steps

Register your controller after downloading the SM App. Make sure your tablet is connected to the internet.

- 1) Launch StellarMate App on iOS or Android.
- 2) Sign-in to your account
- 3) Press Register button on the top right
- 4) Scan the QR Code found at the back of the unit.

Upon successful registration, the serial key will be linked to your email address.

Software vs Hardware licenses Software licenses are obtained through the purchase of StellarMate OS, whereas Hardware licenses are obtained through the purchase of StellarMate Hardware devices (e.g., SM X, SM Pro). Software licenses are activated automatically. Hardware licenses, however, must be activated manually using the StellarMate App's registration feature, as described above.

Why do I get No License Information Found?

Starting with StellarMate App v3.0, StellarMate switched to a different management server for license data. If stale license data is encountered, you might receive this error.

The data can only be refreshed after signing in again to the App. Therefore, there are two approaches:

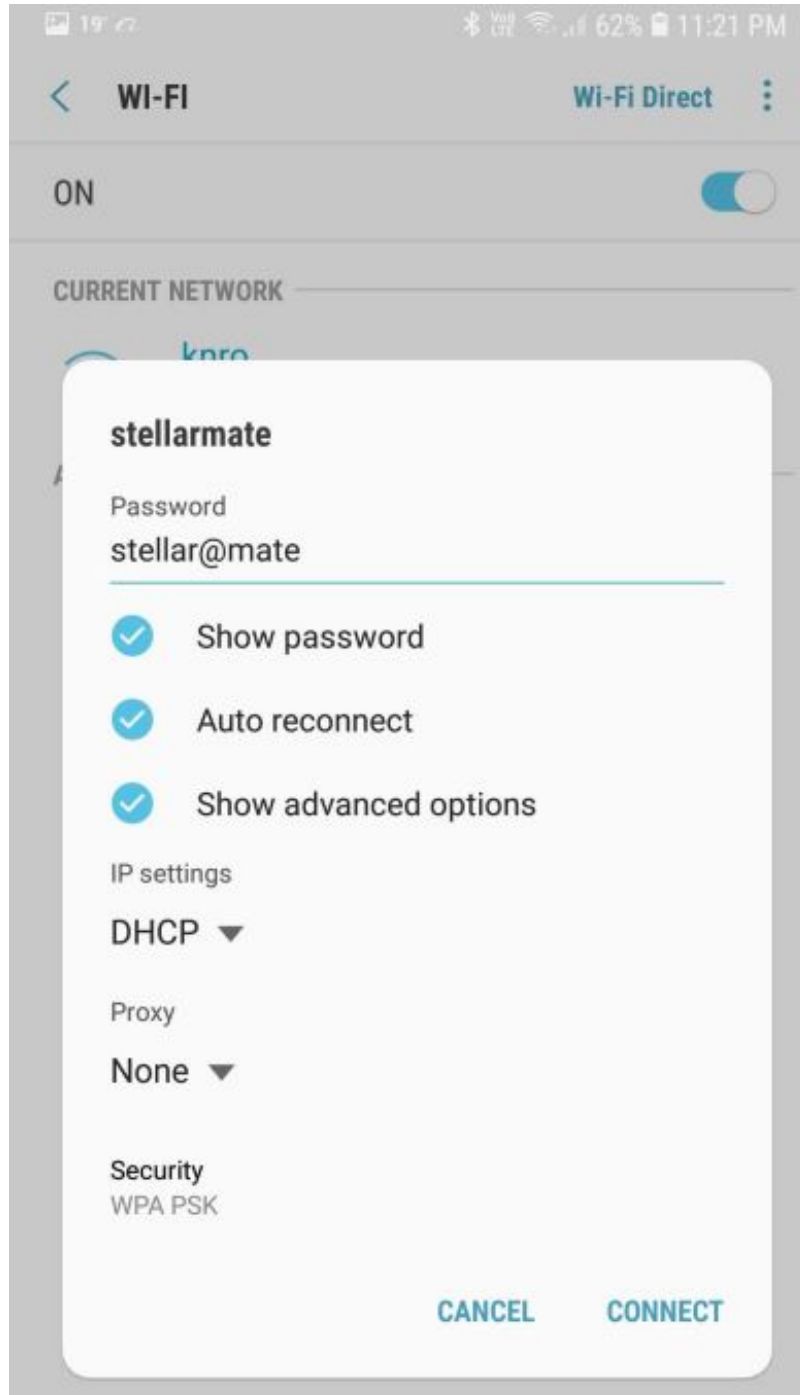
- Go to Settings → Logout and close the App and sign in again to refresh the data.
- Completely uninstall and reinstall the App to ensure there is no residual cache left that might affect this issue.

5.2 Setup

Go to your mobile OS WiFi settings and connect to the StellarMate hotspot. - Hotspot: stellarmate - Password: stellar@mate

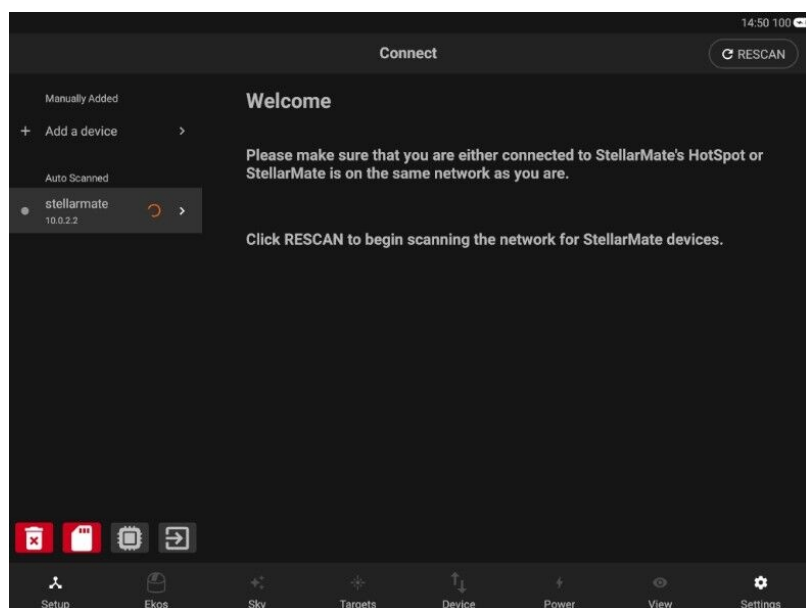
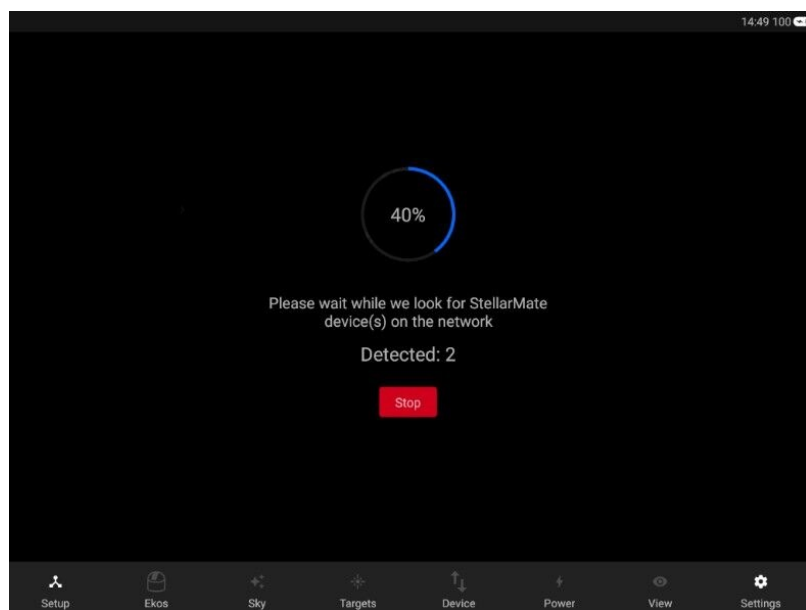
Note

Before using the StellarMate App to configure your unit for the first time, please use the networking settings in your iOS/Android phone/tablet to connect to the HotSpot first. Once connected, proceed to run the StellarMate App.

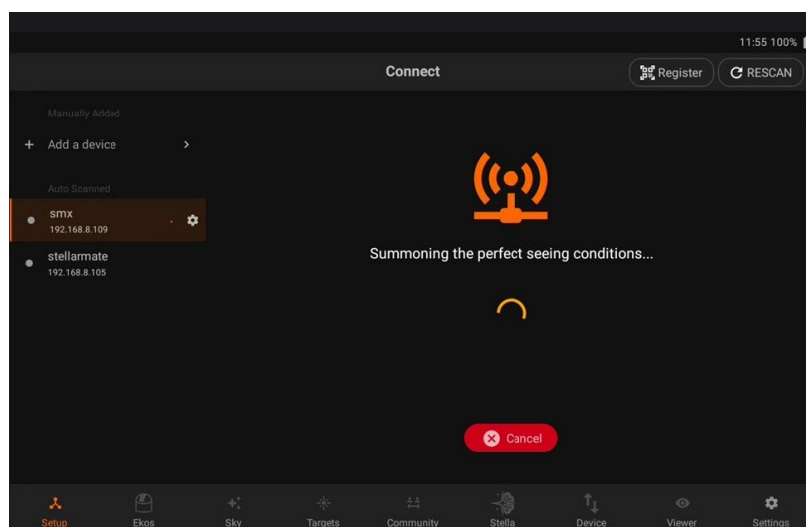


After connecting to StellarMate, go back to the App:

- Tap on RESCAN to start the scanning process. Discovered devices would be listed on the left side pane.



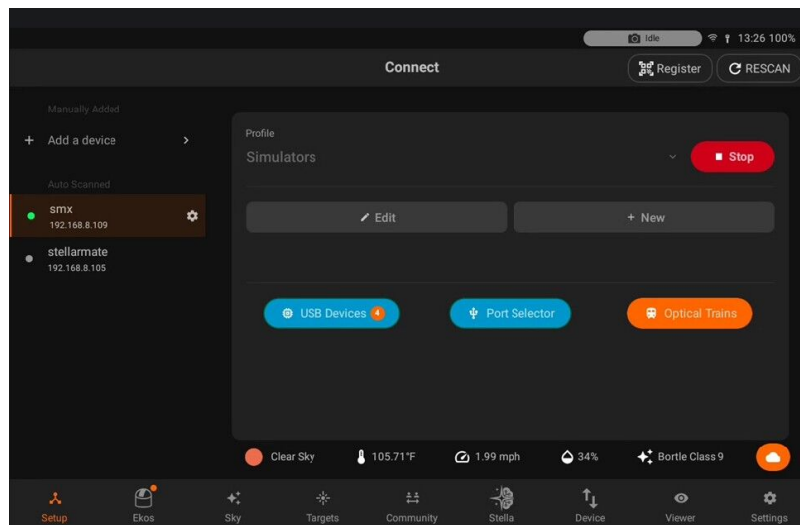
- After StellarMate is detected, tap on it to establish connection. Wait for a few seconds and the LED would turn green indicating a stable successful connection.



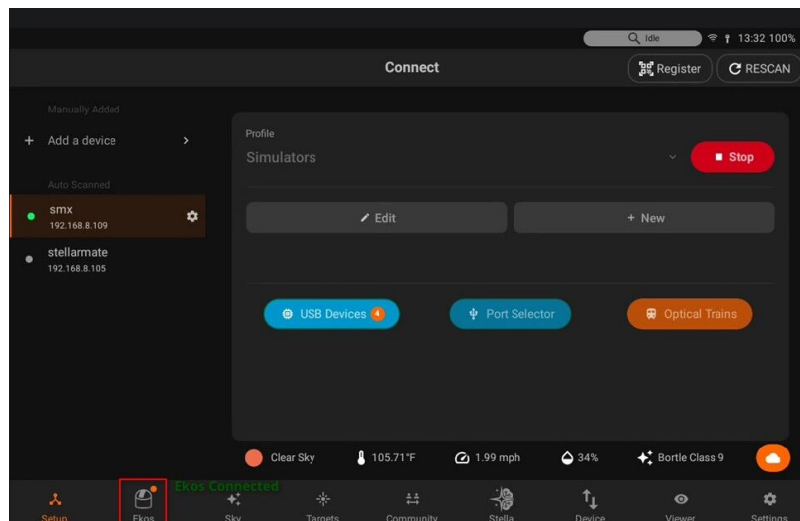
The right side pane should now display the Equipment Profile page. Now you are ready to connect to your astronomical equipment.

5.2.1 Connecting your devices

Most astronomical equipment such as telescopes, cameras, filter wheels, and focusers connect via a USB cable. To add your devices, you need to create a new Equipment Profile. Tap on the Add (+) icon next to the profiles to start the equipment profile wizard.

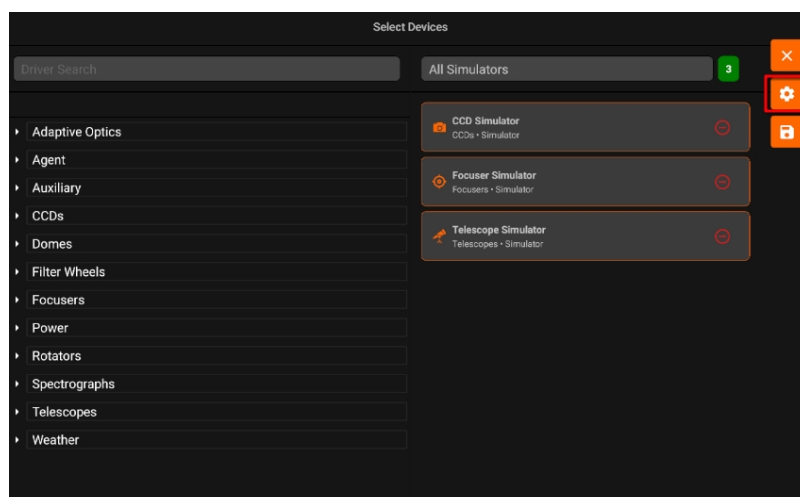


Once you start the Ekos profile and if it gets successfully connected you will see small LED Icon on the top of Ekos tab. This means you Ekos profile is running.



5.2.2 Advanced Settings

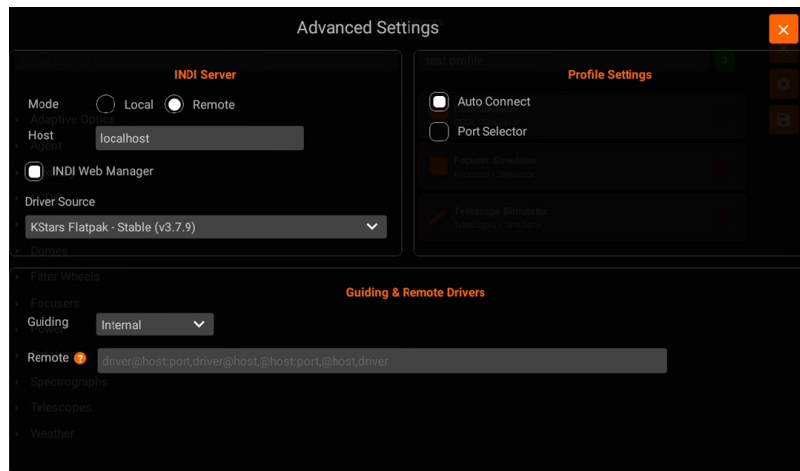
When creating a new equipment profile, you can adjust advanced settings including remote drivers and guider settings. Furthermore, advanced users can even start the profile in remote mode using StellarMate Web Manager.



Note

The information below is intended for advanced users. If you are new to StellarMate, you can skip this section — the default settings work perfectly for most setups.

Driver Source By default, the **Driver Source** is set to **System INDI Drivers**. This means that the INDI drivers will continue to run, even if any service goes down, until the StellarMate device is powered off.

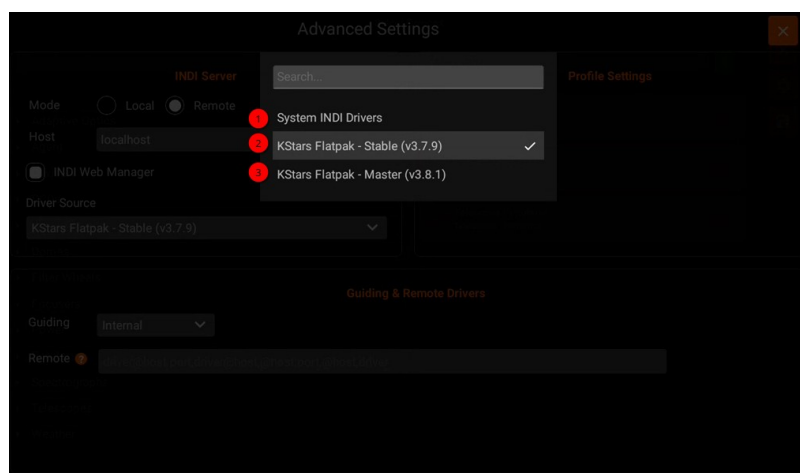


Understanding Flatpak vs System Drivers KStars is installed on StellarMate as a **Flatpak** application. This means KStars runs in an isolated container environment, separate from the rest of the system — including all INDI drivers. This isolation provides several benefits:

- **Consistency:** KStars and its dependencies are bundled together, ensuring the same behavior regardless of the underlying system configuration.
- **Security:** The Flatpak container is sandboxed from the rest of the system.
- **Easy Updates:** Flatpak allows you to switch between different versions of KStars easily.

However, this also means that by default, the INDI drivers available inside the Flatpak container are limited to what is bundled with it. The **Driver Source** setting lets you choose which set of drivers KStars will use:

- **System INDI Drivers** (default): Uses the INDI drivers installed directly on the StellarMate system, outside the Flatpak container. These drivers continue running even if KStars restarts or crashes.
- **Flatpak INDI Drivers:** Uses the INDI drivers bundled inside the KStars Flatpak container. These drivers are tied to the lifecycle of the KStars application.



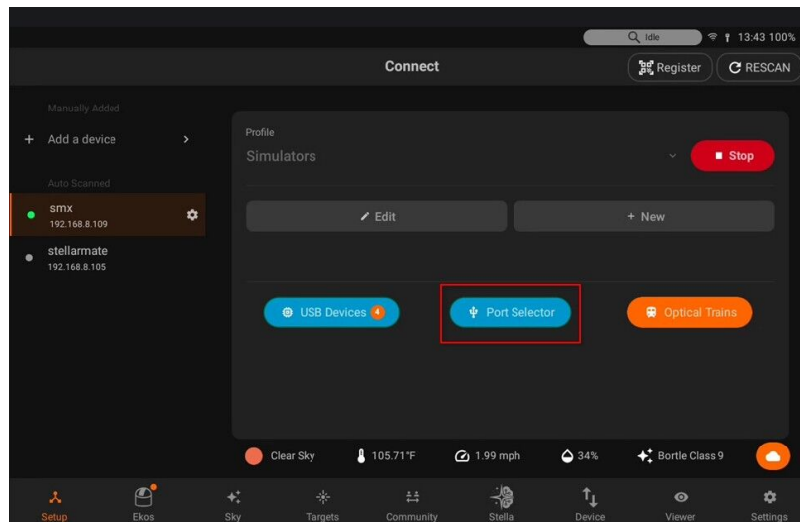
5.2.3 Port Selector

Your equipment profile may contain one or more serial port and/or network-enabled devices. Before establishing connection to such devices for the first time, StellarMate Port Selector tool helps you to assign the appropriate ports and addresses for each. Serial devices may include mounts, focuser, and filter wheels using USB-to-Serial adapters. You need to know the baud rate for the device as by default it is set to 9600.

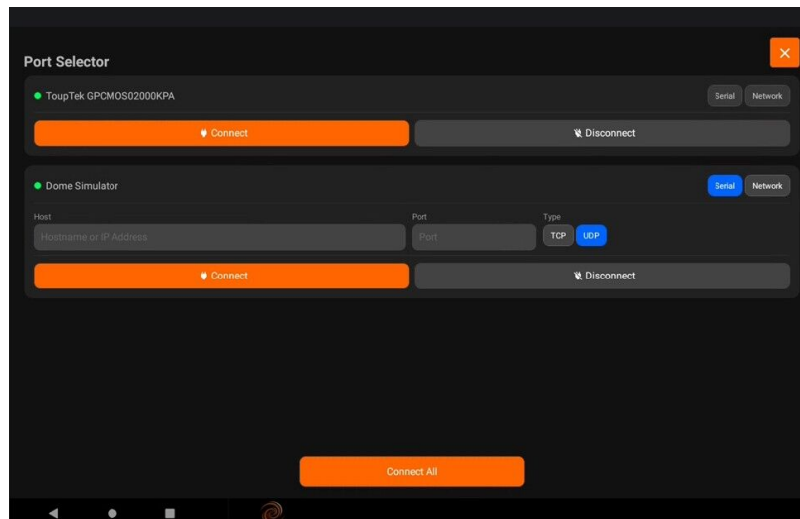
Warning

PORT SELECTOR IS NOT APPLICABLE TO PURE USB DEVICES SUCH AS CAMERAS.

For networked devices over Ethernet or WiFi, you need to supply the device host name or IP address and the device port. This information is usually supplied by your device manufacturer. It is important to ensure that all networked devices are within the same network as StellarMate. For example, if StellarMate is operating in hotspot mode (IP 10.250.250.1) then your network-enabled device must be connected to the same hotspot network and have an IP address in this range (e.g. 10.250.250.5). On the other hand, when StellarMate is operating in infrastructure mode (i.e. it is connected to an external WiFi network like Home WiFi), then the other network-enabled devices must be connected to the same network in order for all devices to talk to each other. The Port Selector dialog can be accessed as any time by click on the Port Selector button. When creating an equipment profile for the first time, it is automatically opened so you can configure the ports before establishing connection to your devices either individually or via clicking Connect All button.



You can specify the ports for serial and network devices using the Port Selector.



The serial ports can be selected from the drop-down. The addresses are unique to each connected device (similar to COM1, COM2..etc on Windows OS) but the automatically generated port names usually do not tell you which device they are connected to. When you have multiple serial devices, it can be tricky to find out which is which. StellarMate automatically tries to connect to the serial devices and attempts handshake with each device, but this might lead to multiple drivers trying to talk at the same time to multiple devices which might lead to traffic collision.

Therefore, it is better to select the correct ports from the beginning. This is only required once in the initial setup. One method to know a device's serial port is simply by connecting one device at a time via USB, and then check the serial port that is displayed in the drop-down. Make note of this port name and then connect the next device and check again, the new serial port in the drop-down should belong to the 2nd device. Now you know for certain the ports for the connected devices.

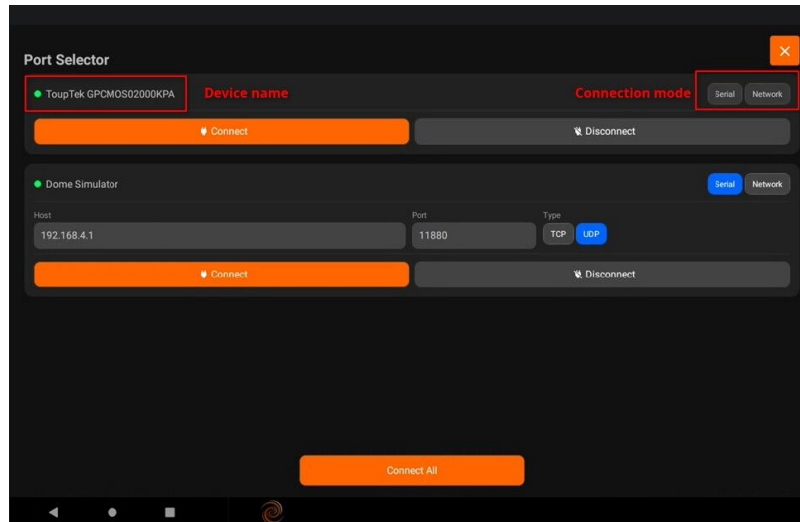
Once the ports and network settings are selected, press Connect All to establish connection.

Connection Status - Green: device is connected. - **Yellow:** connecting to device. - **Red:** connecting to device failed.

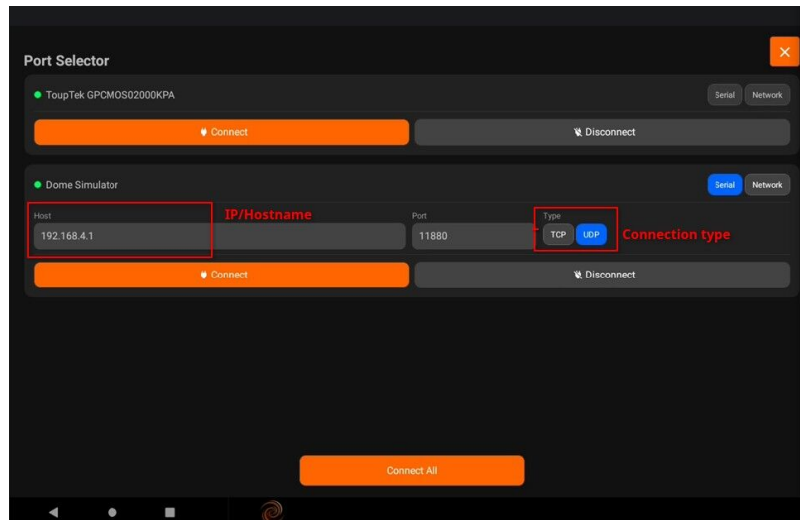
Connection Mode

- **Serial:** For mounts, filter wheels, and focusers that are connected via a Serial-to-USB adapter. To connect to serial devices, you need to select the port and baud rate. StellarMate provides the detected system ports in a drop-down menu to select from, but you can also enter your own port manually.
- **Network:** For any network-enabled device (e.g. Mounts over WiFi like SkyWatcher AZ-Gti). To connect to networked devices, ensure they are connected to the same network where StellarMate is connected to. You need to enter the host-name or preferably the IP address of the device in addition to the connection port and connection type (TCP or UDP).

Baud Rate: Set the devices baud rate **Connect All:** Connects to all the devices and closes the Port Selector

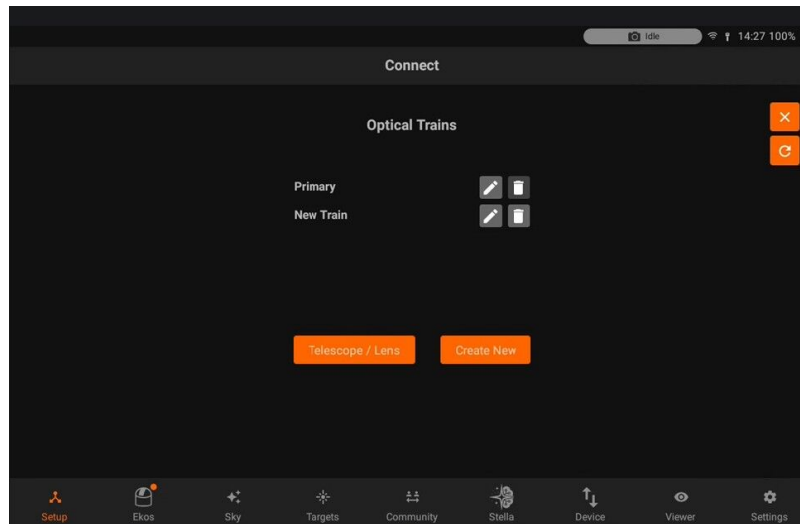


When connecting a serial device, you can specify the port by selecting from the drop-down or typing it in the text field



For network devices, you have to specify the host-name or IP of the device and the port. Also you can choose the network type (TCP/UDP).

5.2.4 Optical Trains

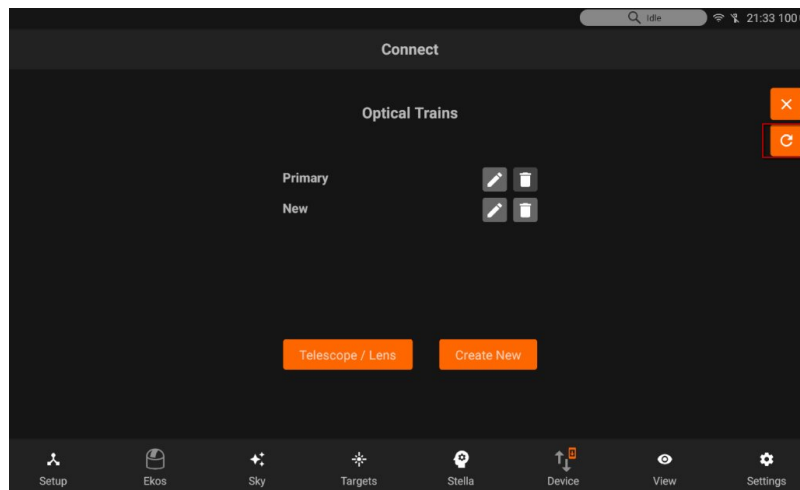


Optical Trains organize your equipment into separate unique optical paths. Each camera must have its own optical train. The following elements are specified in each train:

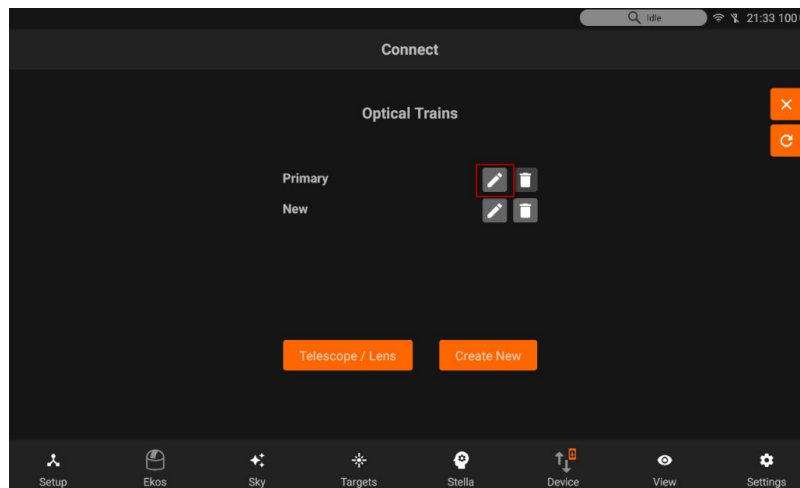
- 1) **Mount:** Select which mount to use. Typically, all optical trains in the same profile use the same mount.
- 2) **Dust Cap:** Select a mechanized dust cap if any (e.g. FlipFlat).
- 3) **LightBox:** Select a flat field lightbox if any (e.g. FlipFlat).
- 4) **Scope or DSLR Lens:** Select the scope or lens used in the optical path. To add, edit, or delete optical elements, tap the Telescope & Lens button.
- 5) **Reducer / Barlow:** Select if any reducer or barlow is used in the train.
 - **Reducer:** By default it is specified at 1.0 which means that has no effect. Range is 0.1x to 0.9x.
 - **Barlow:** If the value specified is over 1.0x, then it is considered a barlow element (focal length is increased by this factor).
- 6) **Rotator:** Select a mechanized rotator if any.
- 7) **Focuser:** Select a mechanized focuser if any.
- 8) **Filter Wheel:** Select a filter wheel. This must be a standalone filter wheel connected to Stellarmate via USB. If you have a filter wheel that is embedded in a camera, leave this field mandatory.
- 9) **Camera:** Select imaging camera for this train. Each camera must have its own train.
- 10) **Guider:** Select the device that receives the guiding correction pulses. This can be one of the following devices:
 - **Mount:** If the Mount can receive guiding correction pulses, then it is best to select it so that the pulses are directly sent to the mount. This is the recommended option.
 - **ST4:** If using an ST4 cable between the guide camera and mount, then you should select the Guide Camera as the Guider.
 - **Dedicated Guider:** If using a dedicated guider interface device (like Shoestring GPUSB) then select it as the Guider.

If a device provides more than one functionality, then it should be specified in all relative fields. For example, MoonLite Nightcrawler is a Rotator and Focuser at the same time, so we select NightCrawler under both Rotator and Focuser fields.

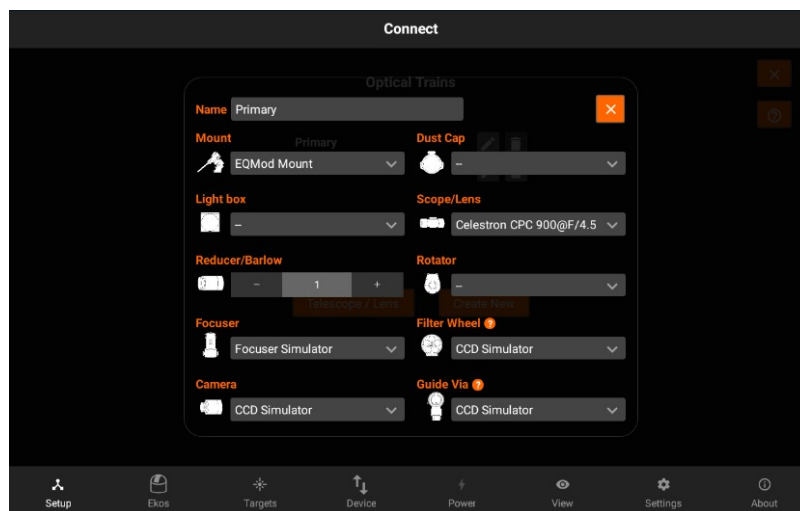
Once the optical trains are configured, specify which trains to use in each Ekos module. Typically, the Primary optical train is used in Capture, Focus, and Align modules while the Secondary train is used in Guide. Tap the help Button to view an [external video tutorial](#) on Optical Train.



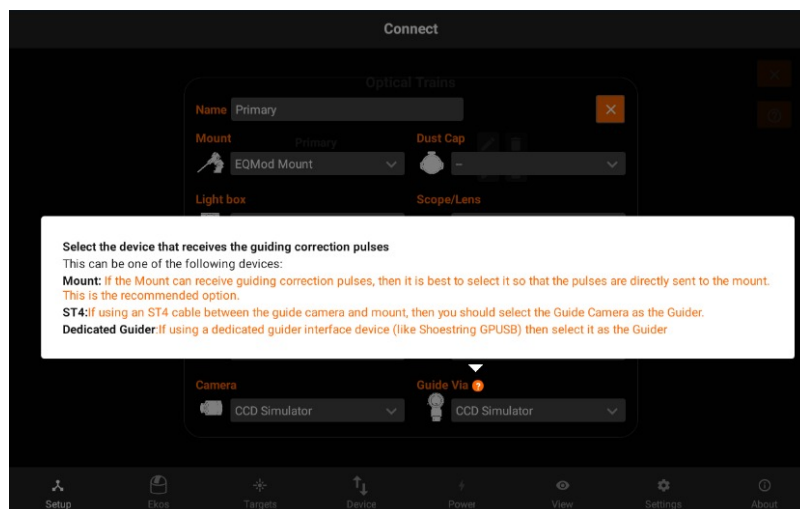
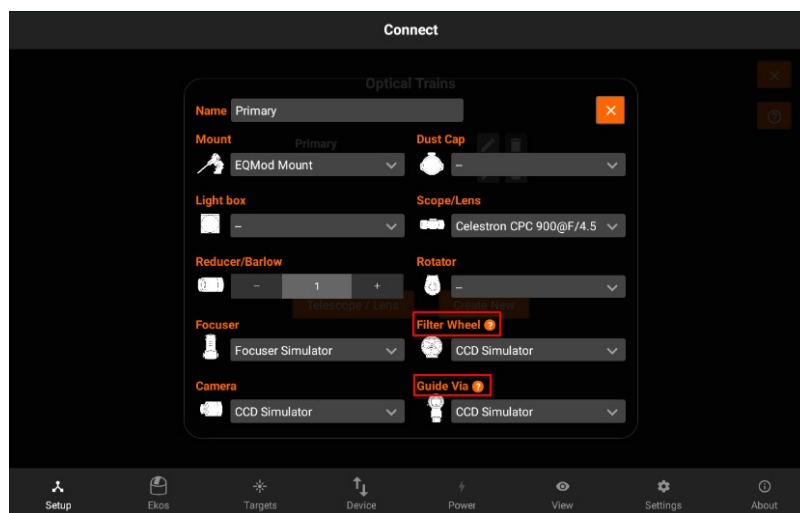
Tap the edit button and it will open the Optical train modal with the specific settings of a train.



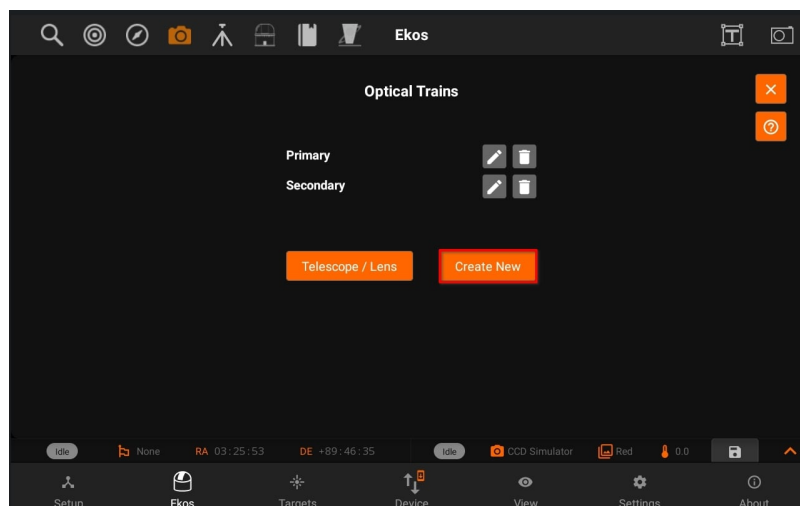
You can also reset the train configuration by pressing Red “Delete Icon” beside the name

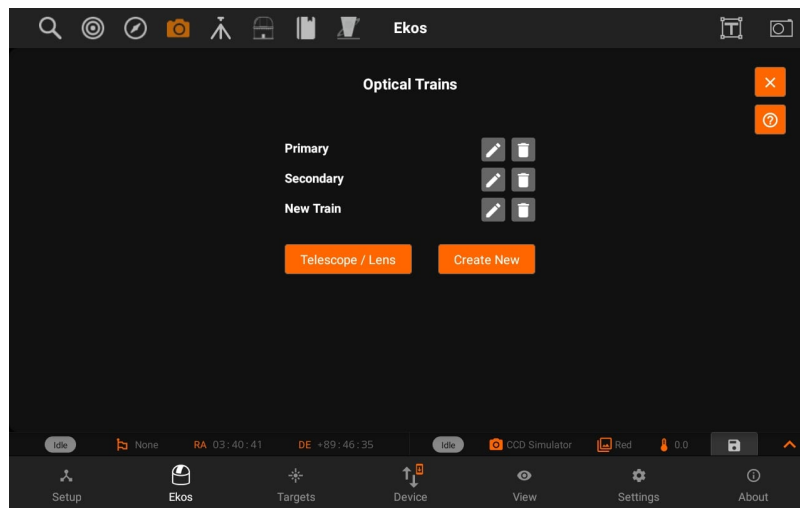


You can now view tool-tip for the description of some devices as shown in the images below:

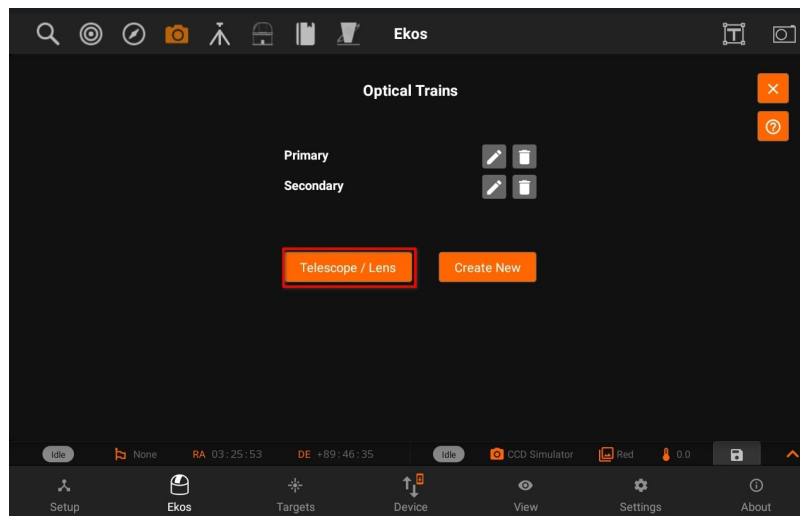


Tapping on Create new to creates a new train with a “New Train” name of previous / default settings.

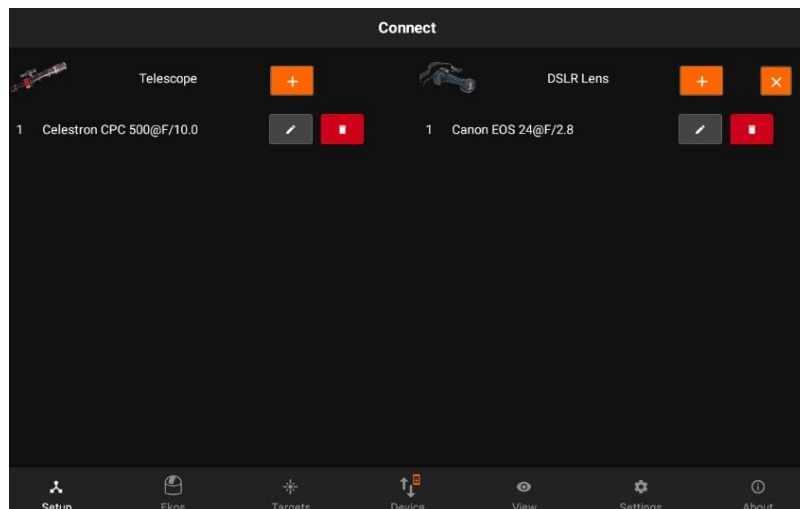




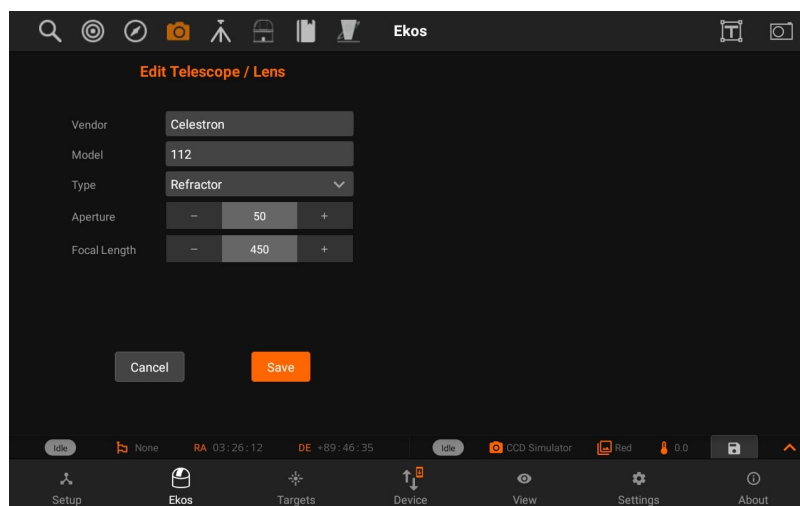
Telescope & Lens:



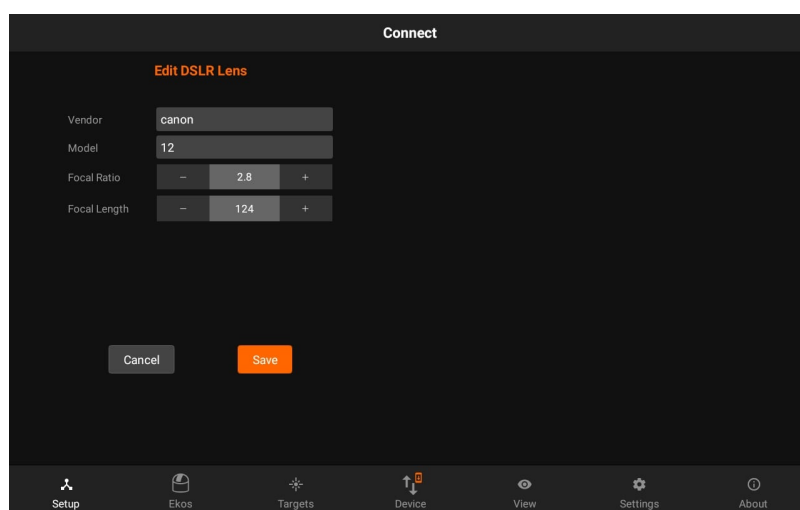
Displays Telescope / Lens View. So, you can Add / Update telescope and lens and then use those in different trains.



Tap on the Add/Edit button next to the telescope to edit the details of the telescope. All units are in millimeters. You can specify a Telescope and DSLR lens for your trains.



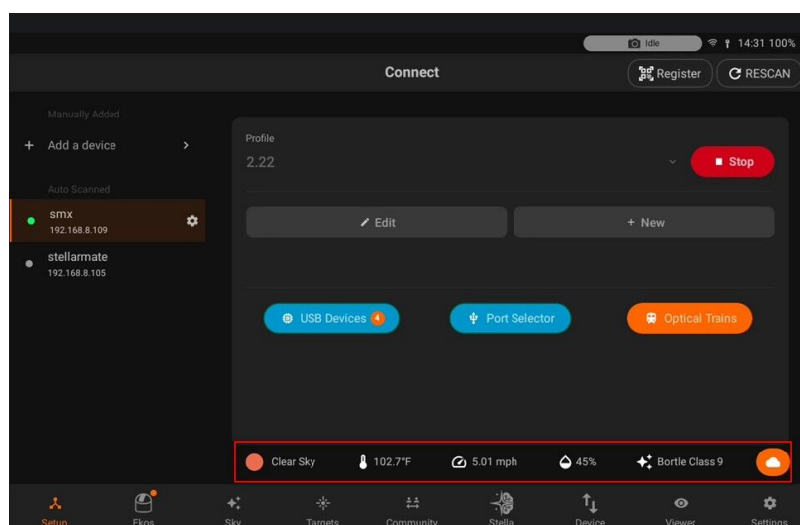
Similarly, you can add/edit DSLR lens and then use Scope/Lens in different Optical trains.



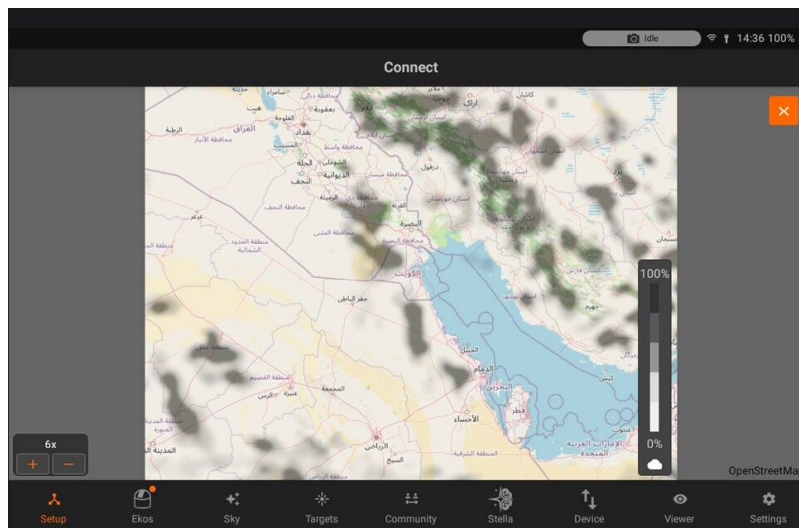
You can also access Optical train from the Setup Tab and Camera quick controls.

5.2.5 Weather Information

Weather Information are available in the setup page. The weather bar displays current weather information for the surrounded region. It provides the current state of the weather, temperature, wind speed, humidity and the Bortle Class. The Bortle Class is a measure of the brightness and observation of the sky relative to light pollution. Bortle Class 1 is ideal and 9 is the worst.



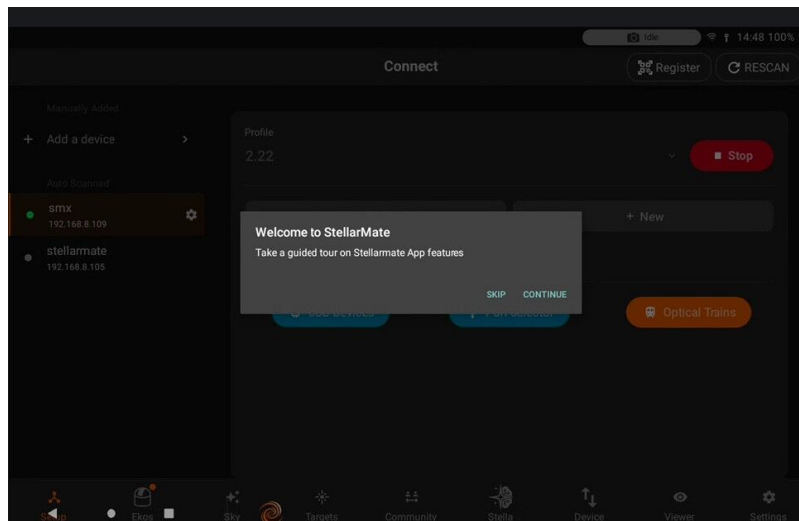
The cloud button displays the 3-hour cloud map based on your current location.



The visibility bar displays the percentage of cloud coverage over the map.

5.2.6 Tour Guide

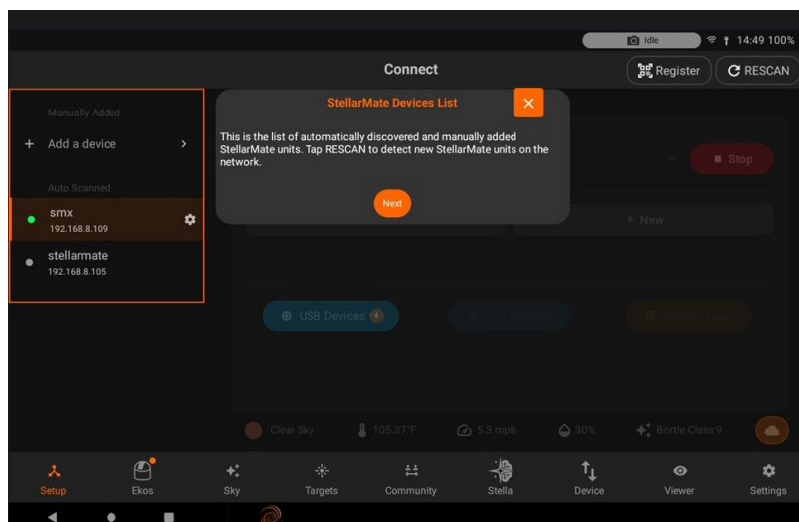
If you would like to take a tour guide, you will see a pop up whether to continue Tour Guide or later.



Currently Tour guide is available for few important features i.e Setup, Ekos & Targets.

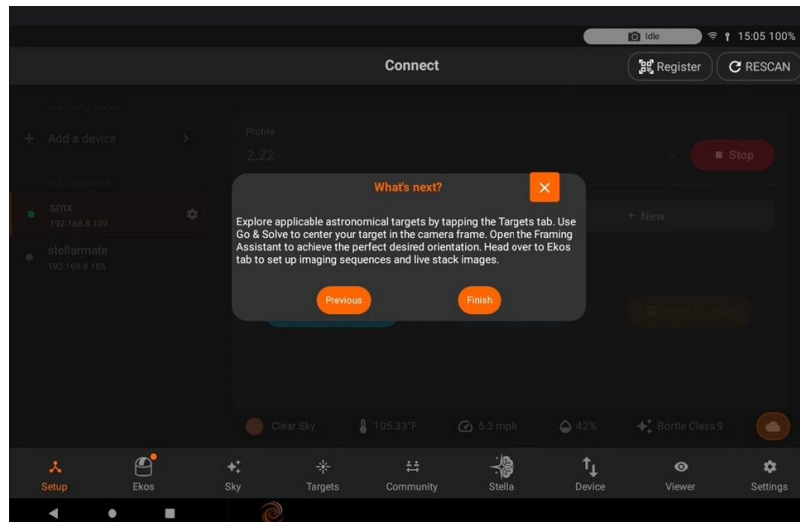
Tour Guide can be seen in the few images below:

For Setup, you can tap “Next” to proceed to the next tour zones.

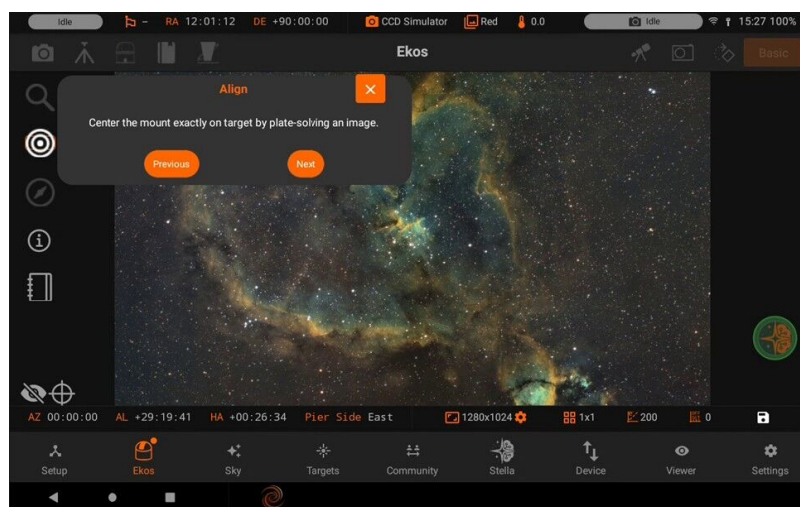


On tap “Finish”, the tour guide for specific tap will be considered as completed. You can also tap “X” during Tour guide to close it. That will also be considered as completed.

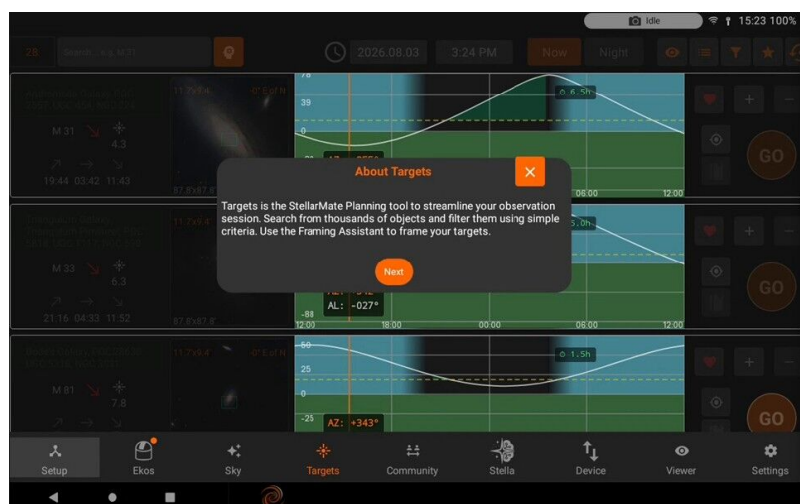
ON tap “Previous” button, to view the previous tour guide zone.

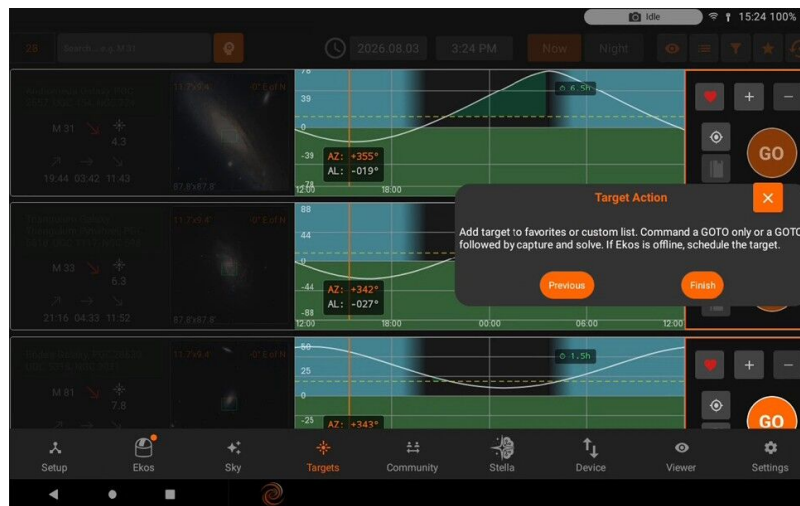


In Ekos, one line description of modules and Quick controls is explained.



In Targets, the main features are explained as shown in the few images below.

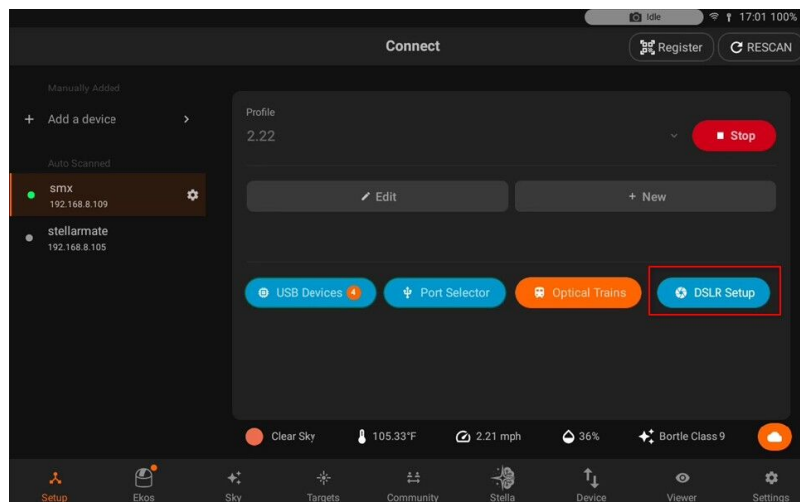




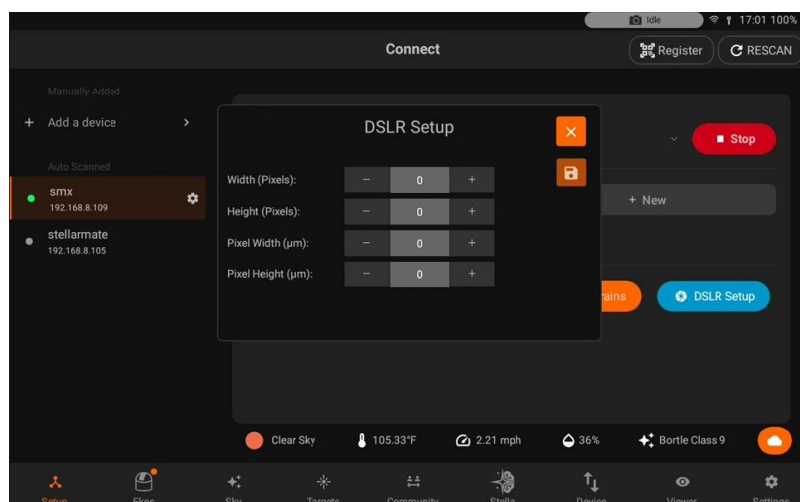
5.2.7 DSLR Setup

StellarMate supports many DSLR cameras from various manufacturers. When a DSLR is detected, StellarMate attempts to identify it and then fill in the necessary metadata required to run the camera. These include width and height in pixels, and the pixel (pitch) size in microns. If StellarMate is unable to find this information, a DSLR Setup button is displayed in the Equipment Profile page. Tap it to enter the information manually.

Once your DSLR is connected, it will ask you to setup it.

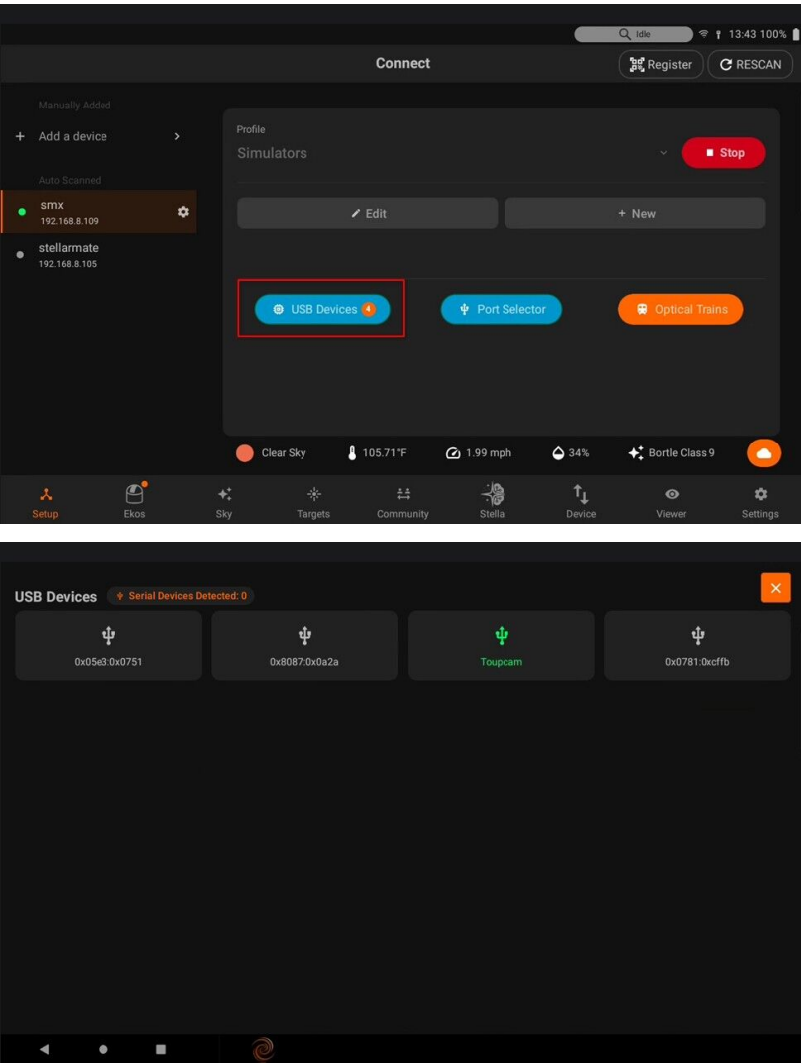


After configuring it, you can tap the save button.

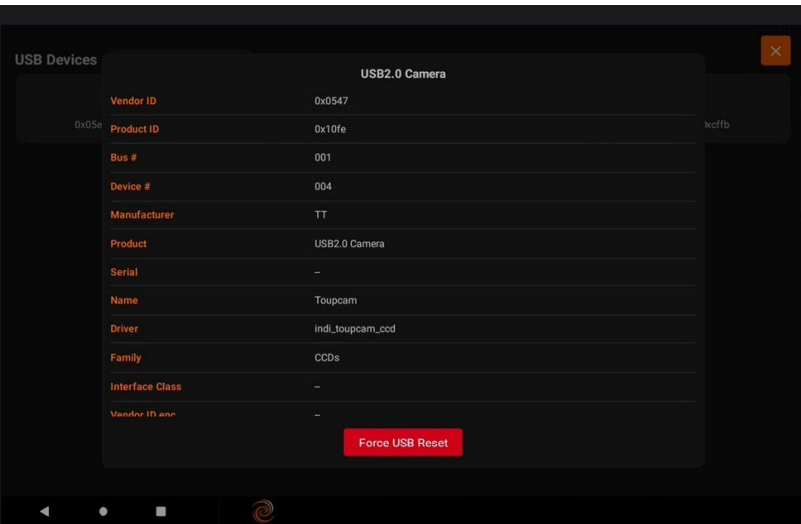


5.2.8 USB devices

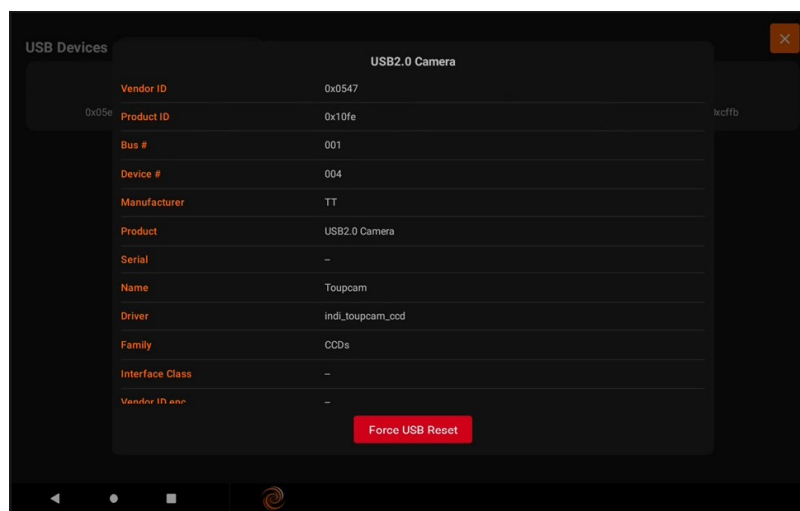
Now you are able to view the connected devices and it's details from StellarMate App.



Pressing on each Device list, you will be able to the it's information.



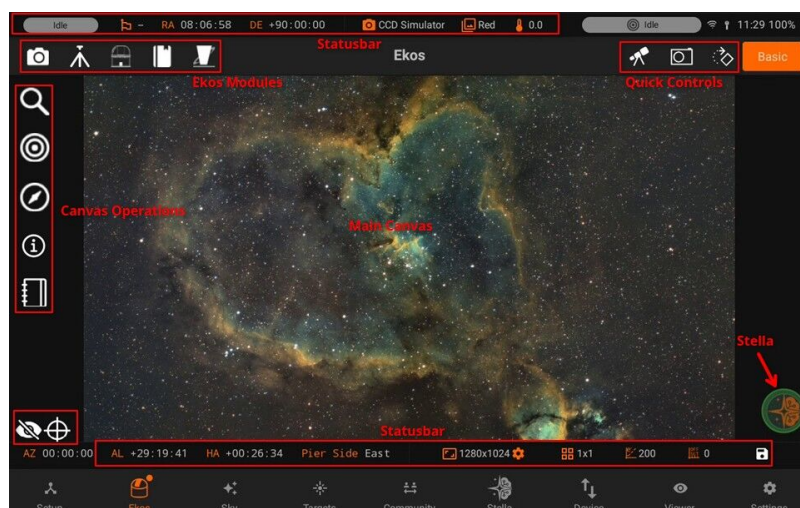
You can also reset a device connected via USB by pressing on the “Force USB Reset” button.



5.3 Ekos

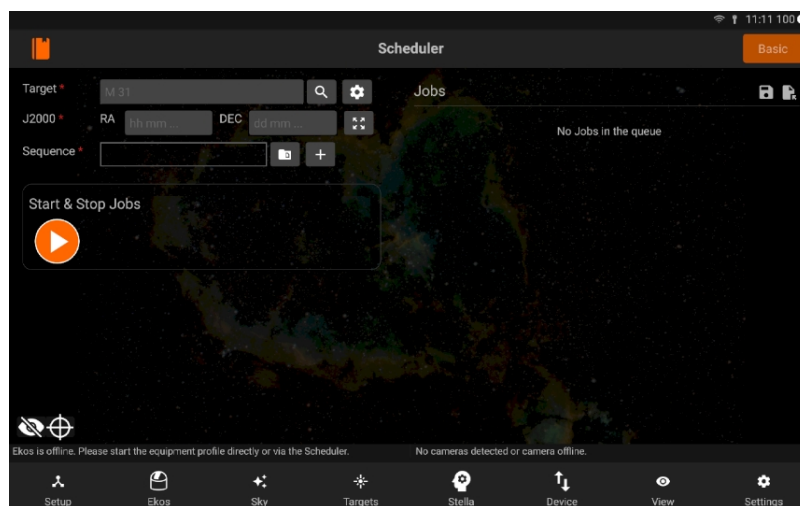
Ekos is where all the astrophotography workflow takes place. You can control all your equipment, run sequences, and automate your workflow with the scheduler.

It is divided into different sections to facilitate access.

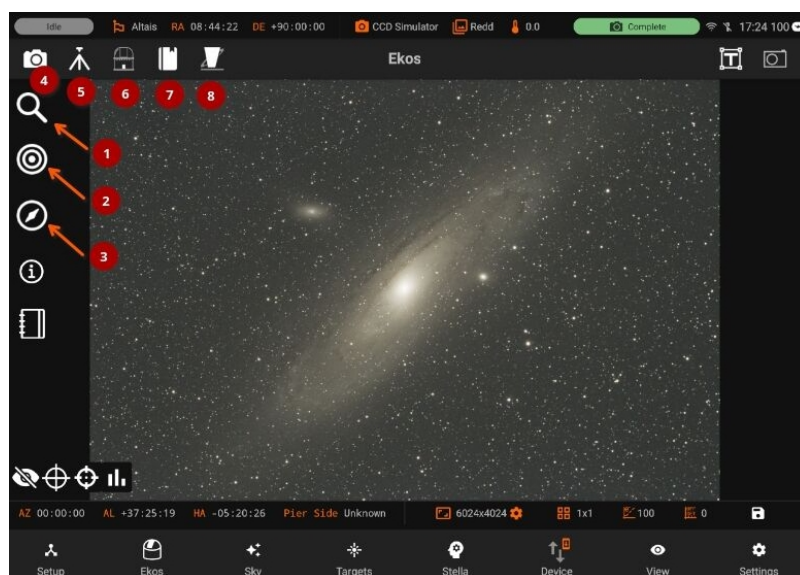


- **Main Canvas:** Displays the captured images.
- **Canvas Operations:** Control image histogram, toggle overlays, or display the summary view. Includes Advanced controls for Focusing, Guiding, Alignment
- **Ekos Modules:** Capture, Mount, Observatory, Scheduler, and INDI Control Panel.
- **Quick Controls:** Quick access to Camera, Mount, and Rotator (if available) operations. With Camera quick controls, you can capture previews, videos, and toggle live stacking. Mount quick control provides mount speed & directional controls in addition to tracking, goto, and parking operations.
- **Status Bar:** Divided to Mount and Camera status bars to display current status and any relevant information. Two status bars. One on top and one at the bottom. Also includes Device Battery level, WiF, Ethernet status and a badge with shows overall Status of modules whether Capurting, Aligning etc.

Ekos modules and Quick Controls are only available after an equipment profile is started in the Setup screen. However, if no equipment profile is started, you still have access to the Scheduler module as it can be used to schedule your targets and command startup and shutdown of equipment automatically. From the scheduler, you may select targets and sequences to create jobs. Job constraints impose conditions that must be met. Once the scheduler is running, it will select the best targets for imaging and would automate the rest of the workflow without any operator intervention.



When an equipment profile is started, the Ekos modules are activated:

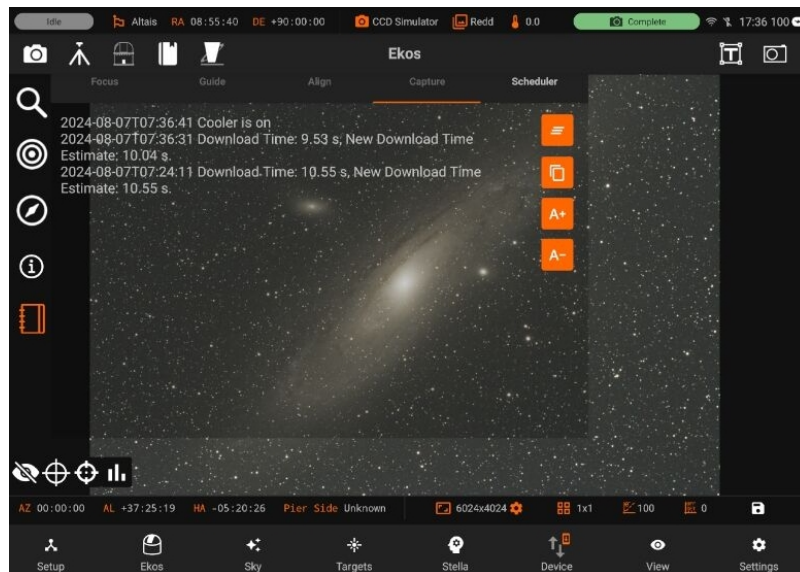


- 1) **Focus:** Focus your camera either automatically via an electronic focuser, or manually by adjusting the focus while framing, or by using Bahtinov Mask Assistant. Create presets for different configurations and set advanced settings to control the star detection and focusing algorithms.
- 2) **Align:** Align your mount to get highly accurate GOTOs and to ensure you target is always in the center. You can also load an existing image to plate solve and then command the mount to go to the exact center in the sky. Perform Polar Alignment to ensure sharp images for long-exposure astrophotography.
- 3) **Guide:** Guiding enables long-exposure astrophotography by ensuring your mount tracks accurately with time. It can automatically select and lock a guide star and send correction pulses to the mount to keep it always centered.
- 4) **Capture:** Manage capture presets and jobs. Run sequences, adjust filter offsets, and manage your dark library.
- 5) **Mount:** Manage Meridian Flip & Limit settings.
- 6) **Observatory:** Control Dome or Roll-off observatories. Command mechanized Dust Caps.
- 7) **Scheduler:** Select targets and specify startup conditions and constrains, then let Ekos manage the rest.
- 8) **INDI Control Panel:** Direct access to all INDI devices and their properties.

Quick Controls are simplified quick-access settings for the camera, mount, and rotator located on the top-right panel. They can be toggled at any time. Once toggled, the corresponding control is overlaid on the top of your existing view where you can quickly and efficiently control your devices.

- 1) **Mount:** Toggle parking & tracking. Adjust speed and use directional keys to move the mount just like the handset. Issue GOTO and SYNC commands by searching for objects.
- 2) **Camera:** Capture previews, record videos, and toggle live stacking.
- 3) **Rotator:** Control absolute position.

Logs Quick access to Ekos logs. All Ekos logs are now consolidated in an easy to access view. Simply swipe right from the edge of the left screen to show the logs. Depending on which module you are currently using, the active logs would be displayed.

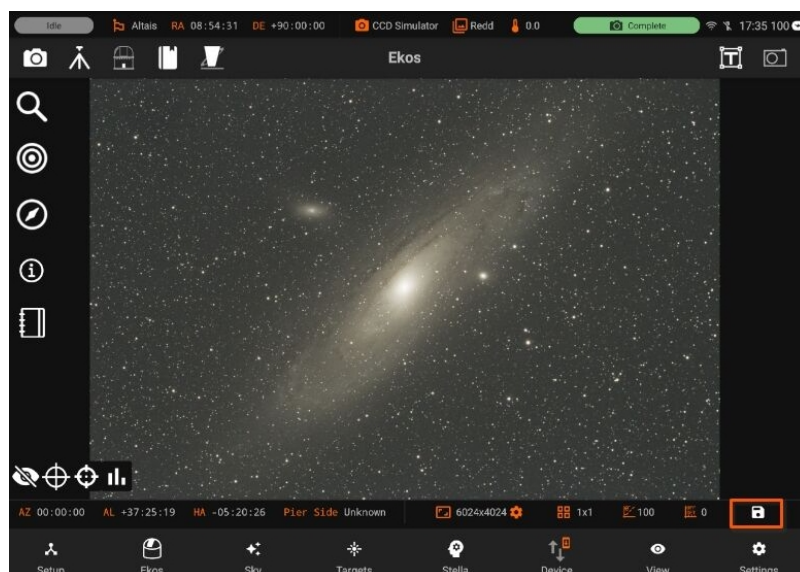


You can also:

- Clear the logs
- Copy the logs text
- Increase/Decrease font size

Save Images

All canvas images can be saved directly to the phone/tablet image Gallery by pressing the Save icons button at the bottom-right. The image name is auto-generated with a timestamp.

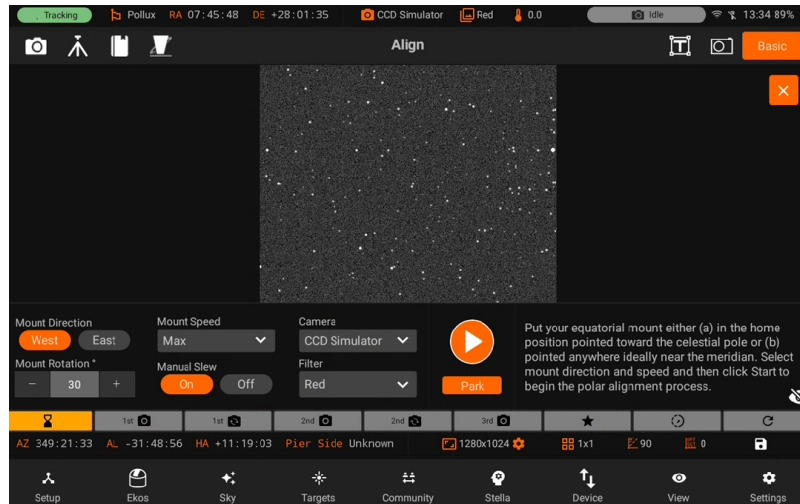


5.3.1 Basic Mode

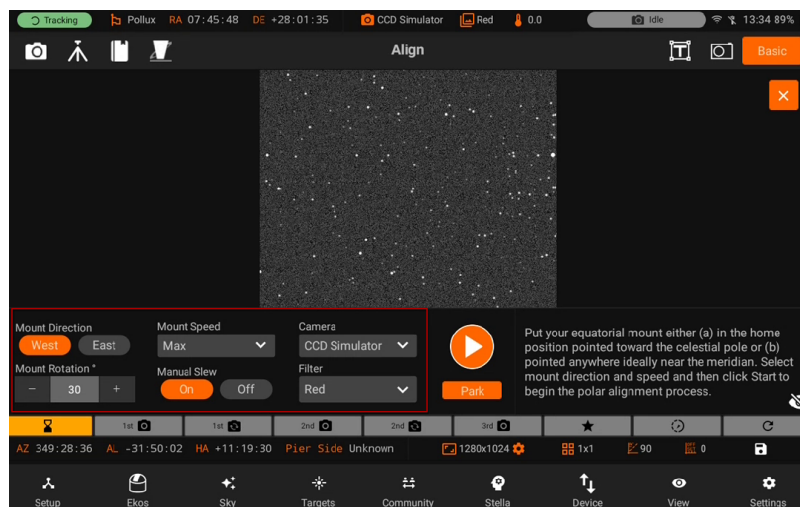
StellarMate App Ekos module operates in Basic or Expert modes. Basic mode is for beginner users. It has a simple UI with basic settings. It works step by step. You can navigate to any step at anytime. You can easily switch between Basic/Expert mode.

Following are the steps: * Polar Alignment * Targets * Focus * Guide * Capture * Summary

5.3.1.1 Polar Alignment



To manage the polar alignment, use the Polar Alignment controls. Note that Ekos performs two mount rotations during this process.



You need to set the desired speed, angle, and direction (West/East) for the mount rotation. Press play to begin the alignment.



Then, follow the guided instructions provided on screen until the Polar Alignment process is complete.

5.3.1.2 Targets Selection



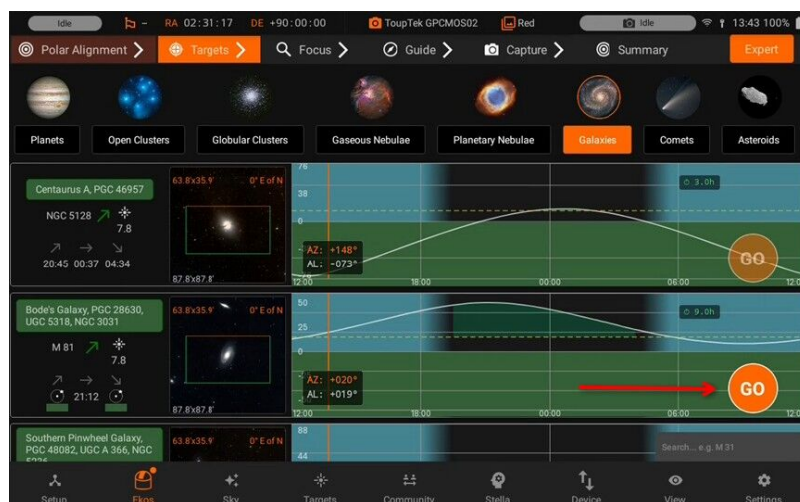
In the Targets Selection mode, you can search for various astronomical objects across different classes.



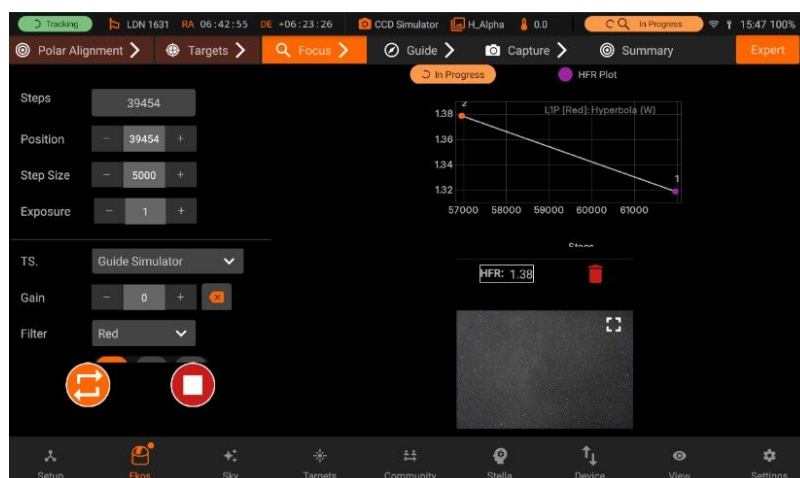
You can view the Object Info for each target. It includes object designations, observability, rise, set times and also Altitude vs. Time chart to assess the observability data for any celestial target.



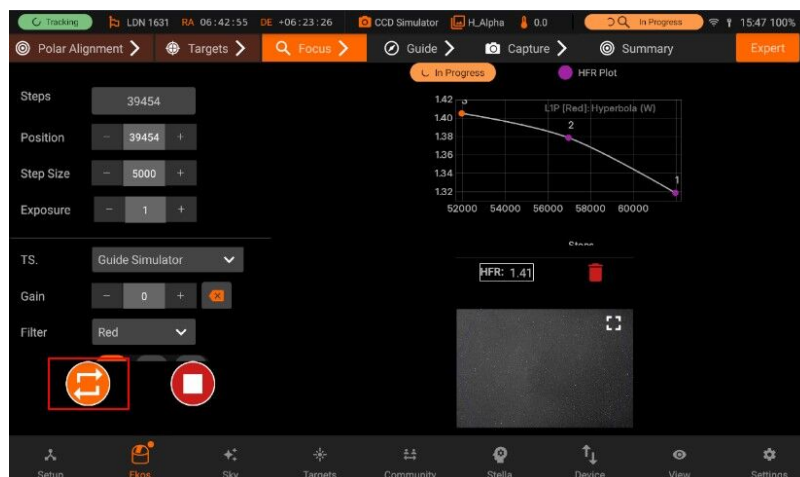
Use the GO button for slewing and centering the target.



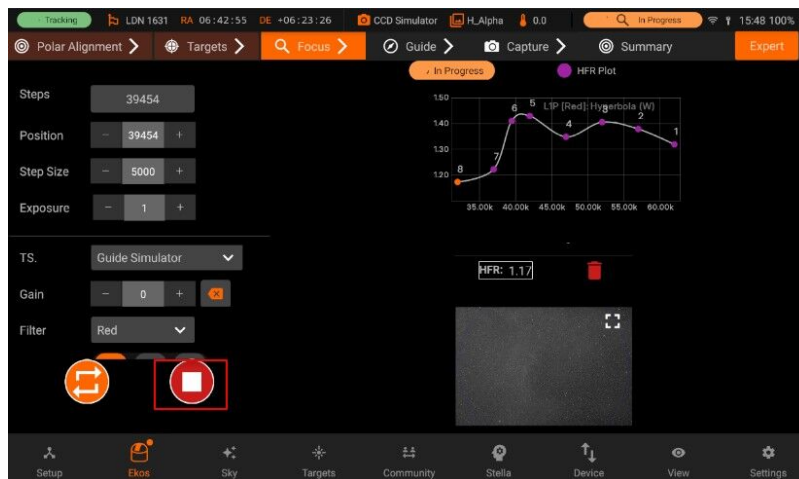
5.3.1.3 Focus



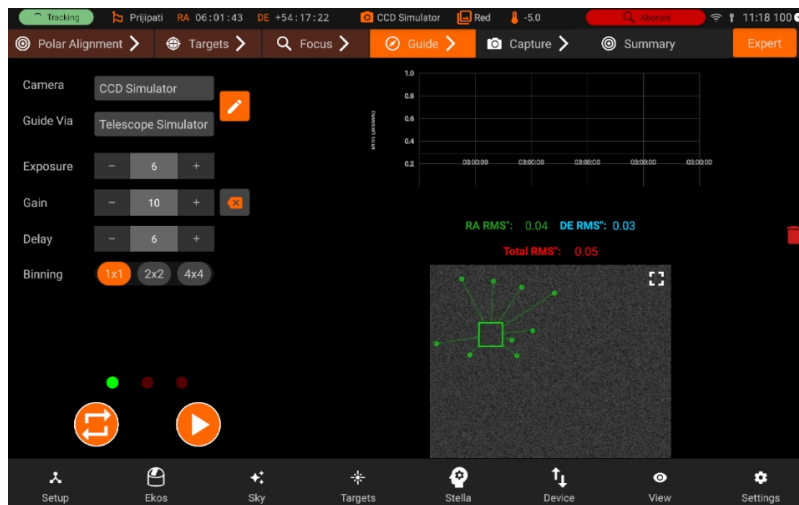
To focus your target effectively, you can utilize an electronic focuser for achieving crisp images. Within the Focus Controls, you should first frame a target area containing clearly resolvable stars using the loop button.



After setting an appropriate step size for your equipment, press play to initiate the fine autofocus process. You can monitor the progress using the Focus Graph, which displays the HFR versus the focuser step position, illustrating the focus quality; the autofocus routine works by generating a V-curve on this graph to pinpoint the Critical Focus Zone (CFZ). When simply looping exposures, the HFR for each frame will be plotted here. Additionally, keep an eye on the actual star sharpness in the Focus Image display, which can be toggled to full screen for a more detailed view.

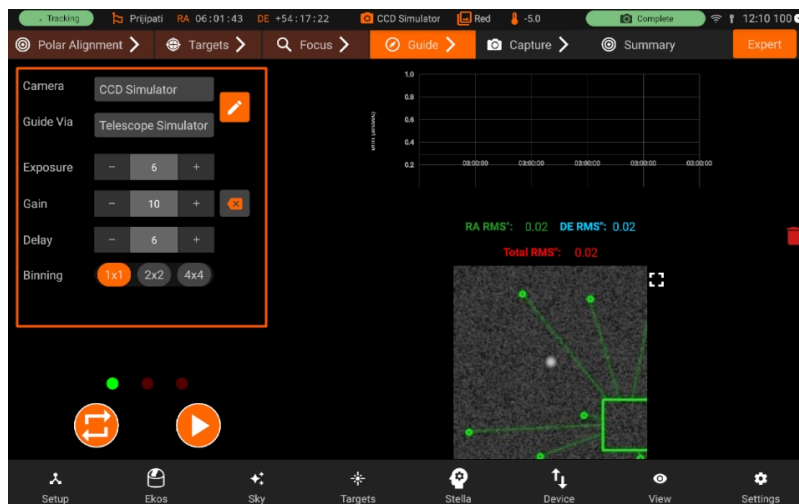


5.3.1.4 Guide

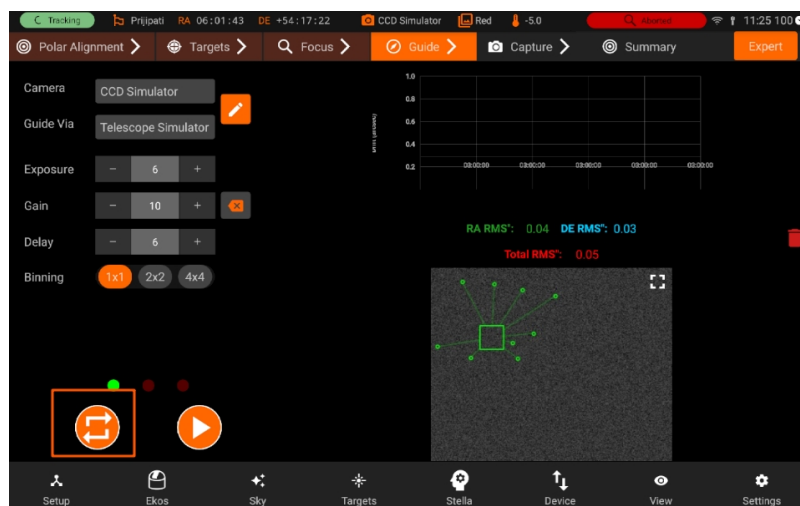


Auto Guiding is essential for keeping targets accurately centered during long-exposure imaging, typically achieved using a dedicated guide scope or an Off-Axis Guider (OAG).

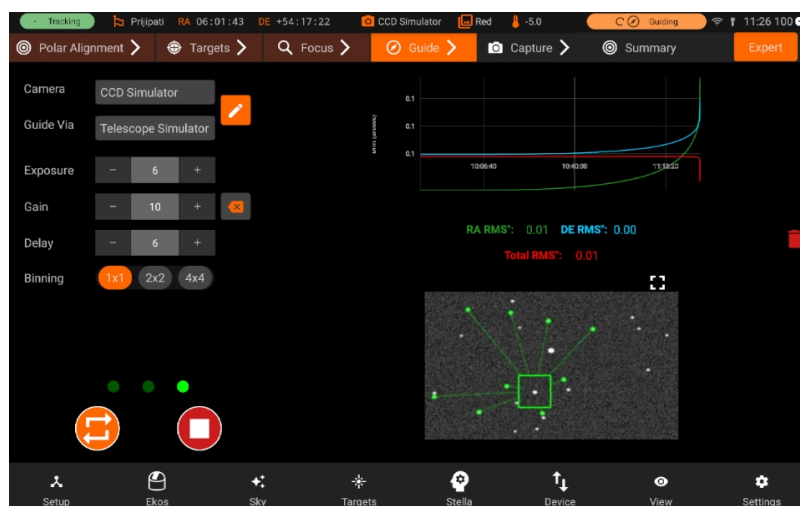
On the left side, Guide Controls where you can adjust the guide camera settings. You'll also need to specify how Ekos sends guide corrections by setting the 'Guide-Via' option, usually to the mount (the default) or via an ST4 connection.



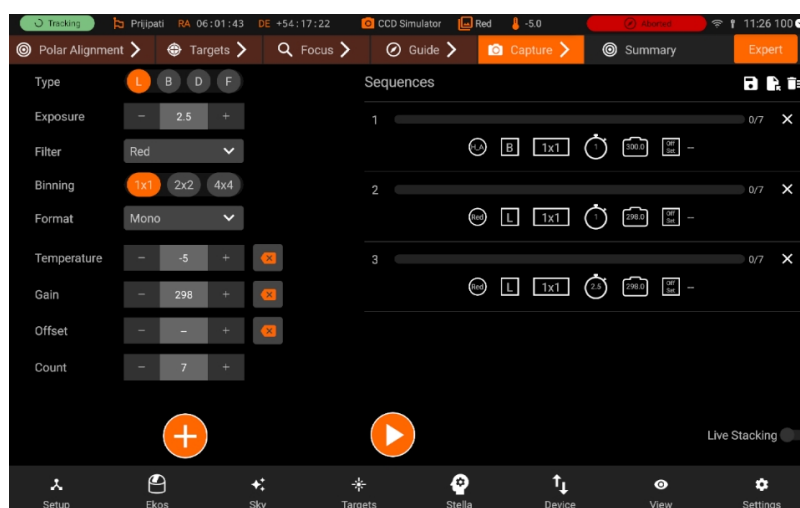
Use the framing button to ensure the guide stars are clearly resolvable.



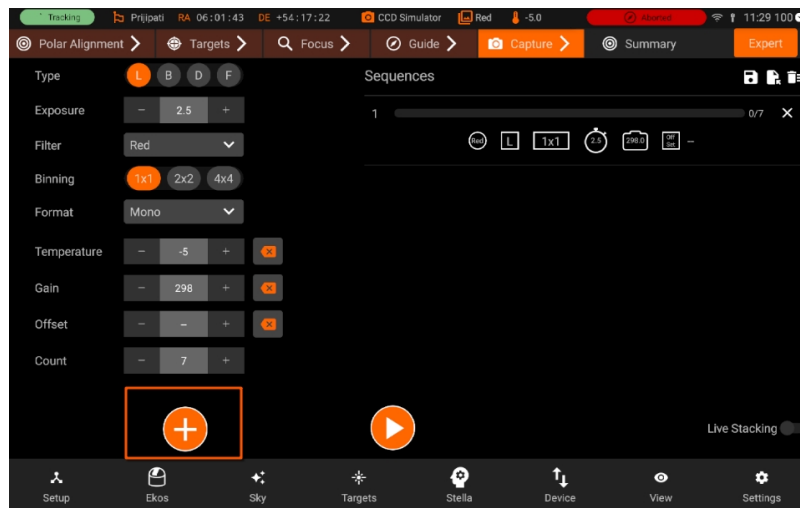
Once configured, press the play button to initiate the calibration sequence followed by active autoguiding. You can monitor the performance using the Guide Chart, which presents a trend graph illustrating tracking accuracy through RMS errors over time for Right Ascension (Green), Declination (Blue), and the total combined error (Red). Additionally, the Guide Image provides a visual representation from the guide camera, featuring a multi-star tracking overlay; you can toggle this view to full screen for a more detailed inspection of the guiding process.



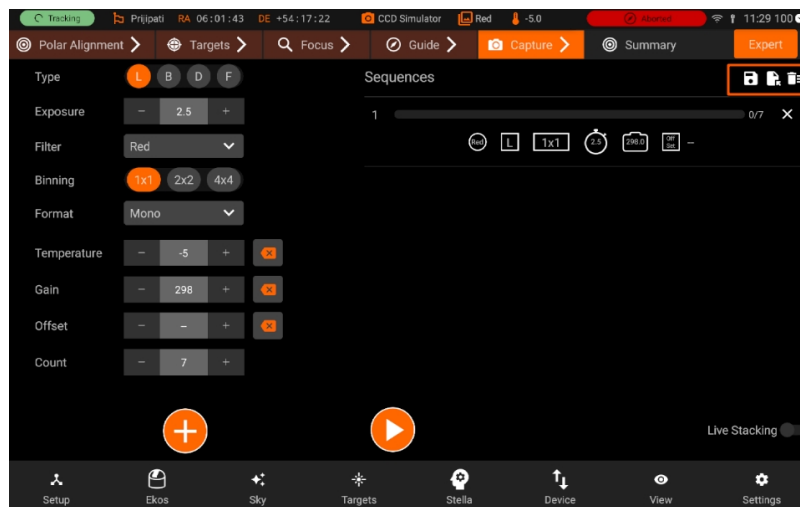
5.3.1.5 Capture Planner



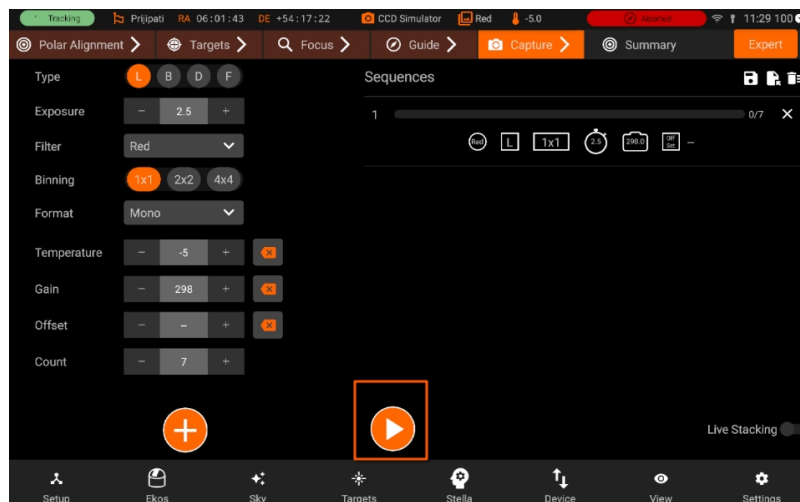
The Capture Planner is the central hub for defining your imaging session. Here, you can configure image capture settings such as exposure duration, filter choice, binning, and more, adding these configured jobs to your overall sequence. Within the Capture Controls, you'll specify the details for each job, like setting the frame count, and then use the 'add' button to include it in the sequence queue.



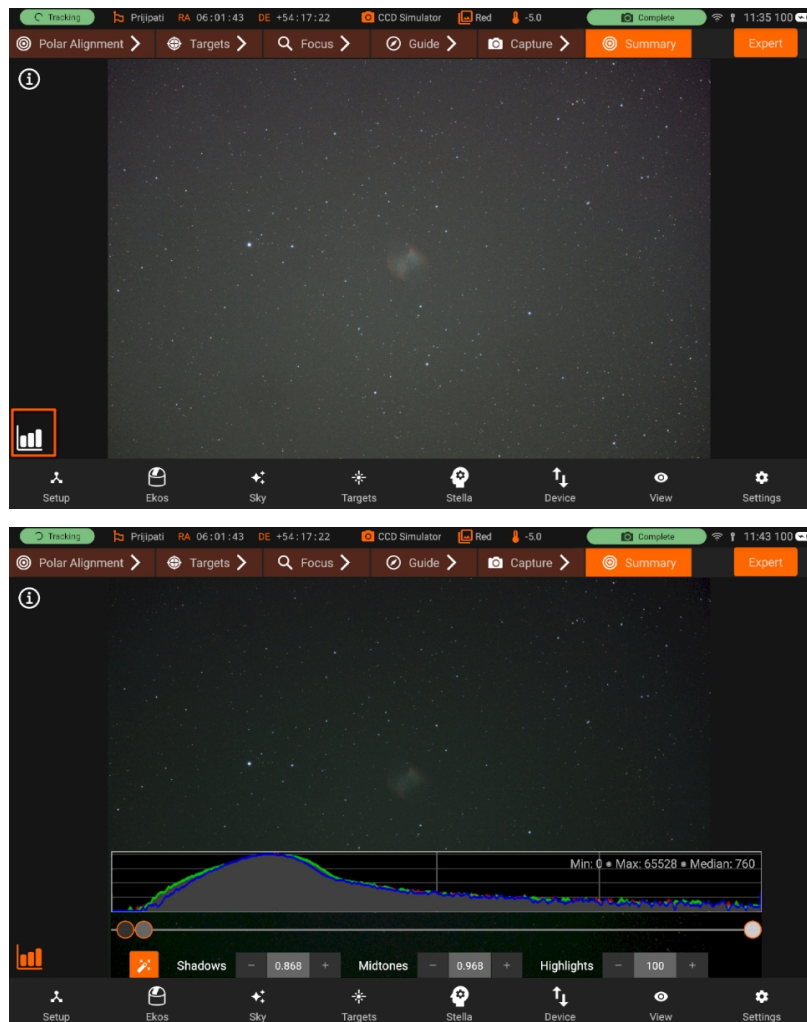
To handle your different imaging plans, the Manage Sequences section allows you to Save, Load, Delete, and Organize your imaging sequences for reuse or modification.



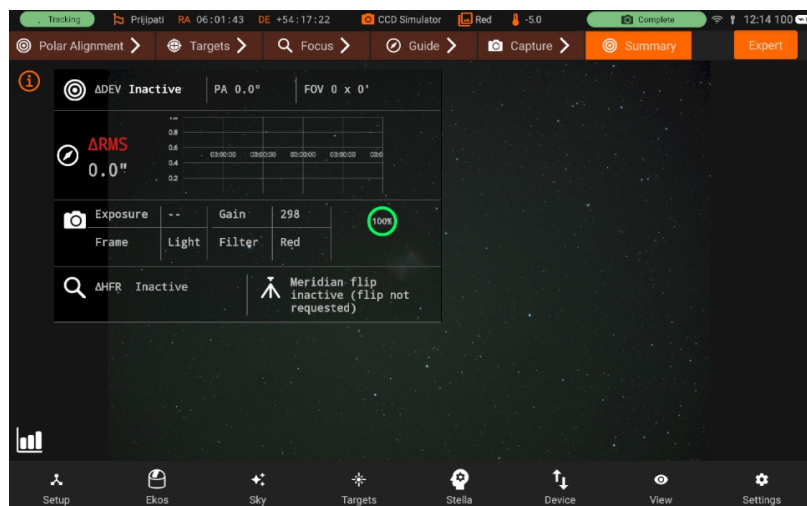
Finally, under Capture Actions, you press the 'play' button to start the entire imaging sequence.



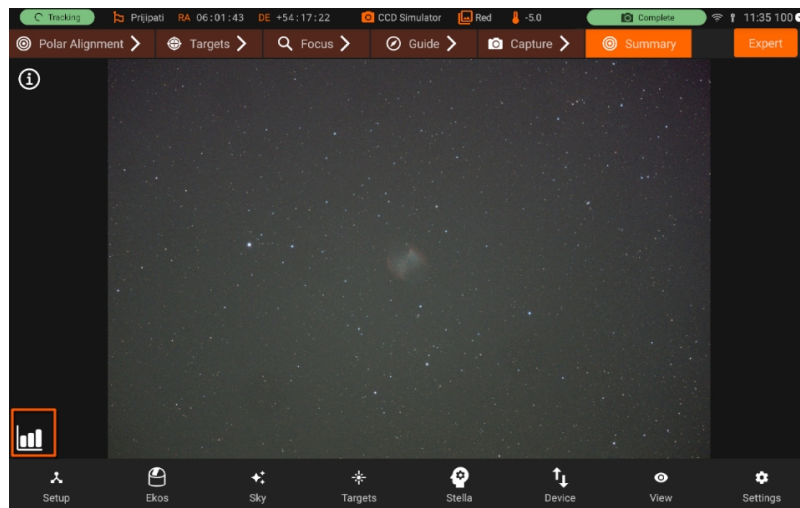
You can toggle the live-stacking feature on or off. Enable this option to see combined images generated in real-time. Individual frames captured during the sequence will be saved separately.



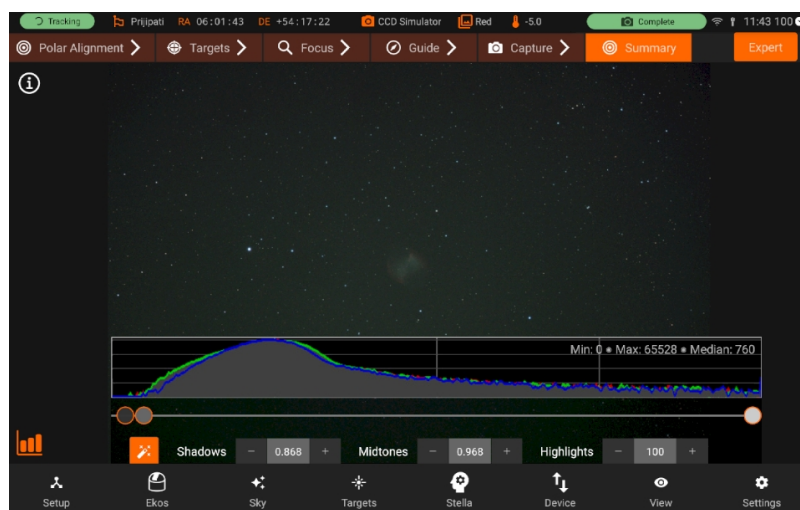
5.3.1.6 Summary View



In the Summary view, monitor all key operations: guiding, focusing, alignment, and image capture. Captured images are also displayed in this view.

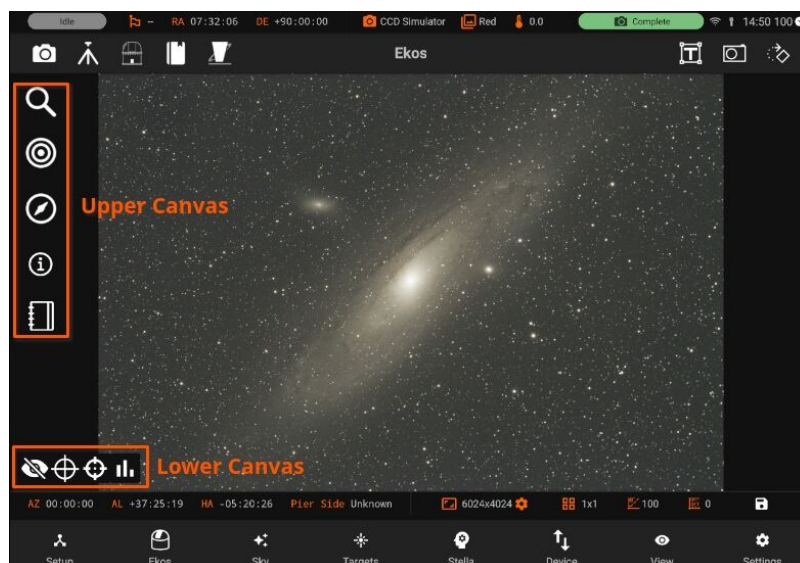


Within this view, you can toggle the Histogram display. This tool allows you to inspect the tonal distribution of your images and adjust the shadows, midtones, and highlights, but note that these adjustments are applied only to the individual sequence images and do not affect any images generated through live-stacking.



5.3.2 Canvas

Canvas is the primary imaging display area where images, video, and live stacking takes place. The canvas operations are divided into upper and lower canvas controls. The upper controls include draggable widgets for Focus, Align, and Guide modules along with Summary and Log views. Lower canvas controls are used to toggle overlays, command GOTOs by tapping and holding anywhere on the image, and to display the histogram and HiPS overlays for the image.



Upper Canvas

- Focus
- Align
- Guide
- Summary View
- Logs

Lower Canvas

- Histogram
- HiPs Overlay
- Crosshair
- Target GOTO
- Hide/Unhide the Lower Canvas



You can center the mount to a specific target in the main image if plate-solving was successful. From Ekos Align module, Capture and Solve an image. If successful, an orange align icon is displayed in the Main Image View indicating that solving is successful. For any subsequent images captured and displayed in the Main Image View, you may now select the target by tapping on it. A red bullseye animation designates the target. Control image histogram, toggle Overlay or display the summary view.

5.3.2.1 Summary View



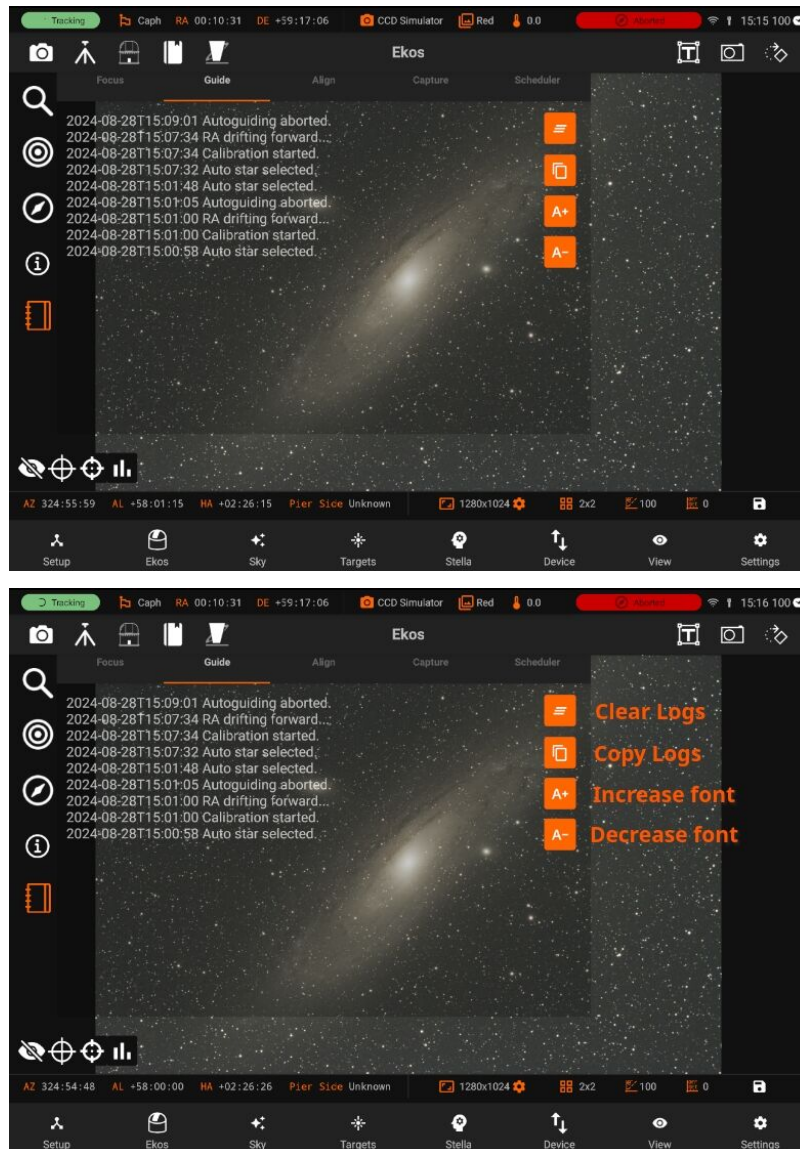
The summary view includes the gist of your astrophotography workflow so you can always take a quick look at the most important parameters without navigating to other screens. Depending on which Ekos modules are active, the information may include the following:

- 1) **Alignment**
 - a) Total deviation error in arcsecs. The deviation is updated when you perform a capture and solve operation.
 - b) Position Angle (PA) in degrees East of North.

- c) Field of View (FOV) in arcminutes.
- 2) **Guide:** Total RMS error in addition to the guide deviation chart.
- 3) **Capture:** Current sequence settings and a progress indicator. Two timers are displayed to the right of the progress indicator when a sequence is running:
 - a) **Top timer:** Sequence job timer countdown. This is the countdown until the current active sequence is complete.
 - b) **Bottom timer:** Overall timer countdown. If you have multiple sequences, the timer indicates the estimated time until all sequences are complete.
- 4) **Focus:** Half-flux-radius (HFR) measurement.
- 5) **Mount:** Current meridian flip status.

5.3.2.2 Logs

You can view Logs of modules which includes Focus, Align, Guide, Capture and Scheduler.

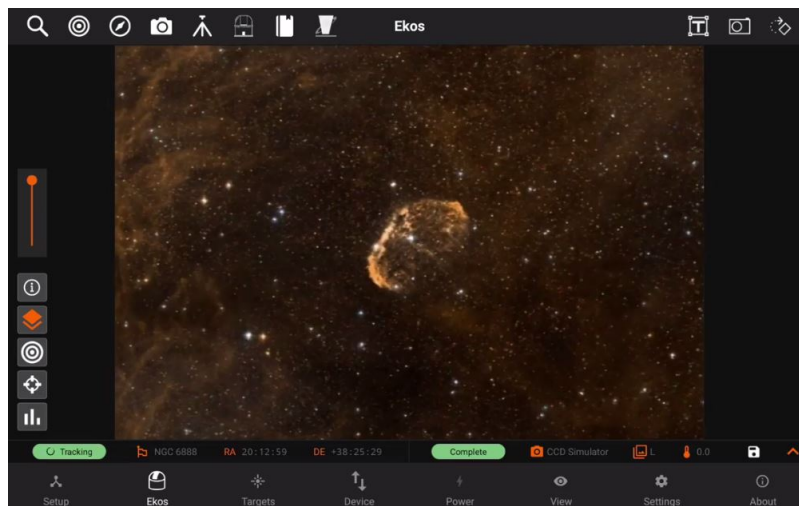


5.3.2.3 hiPs Overlay

Toggle Overlay to increase the Hips opacity. image It is only available when WCS is enabled, image is plate-solved and once your Camera FOV is 60 arcminutes or more.

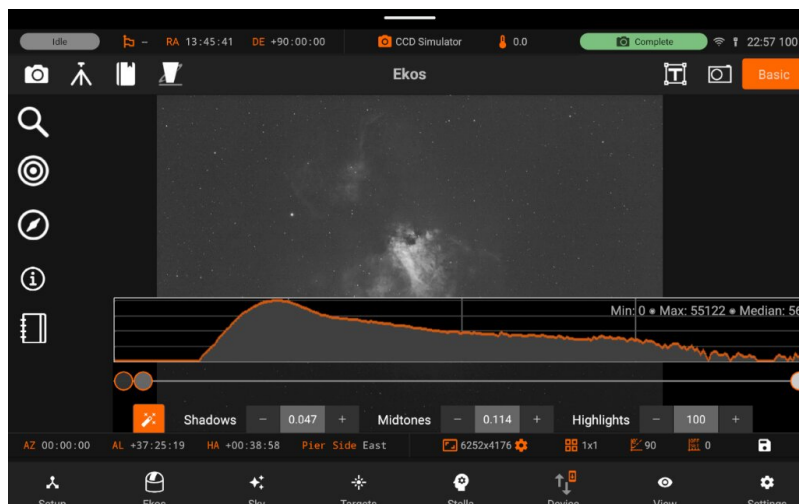


Once preview is captured, you can toggle it and increase/decrease the HiPs opacity.



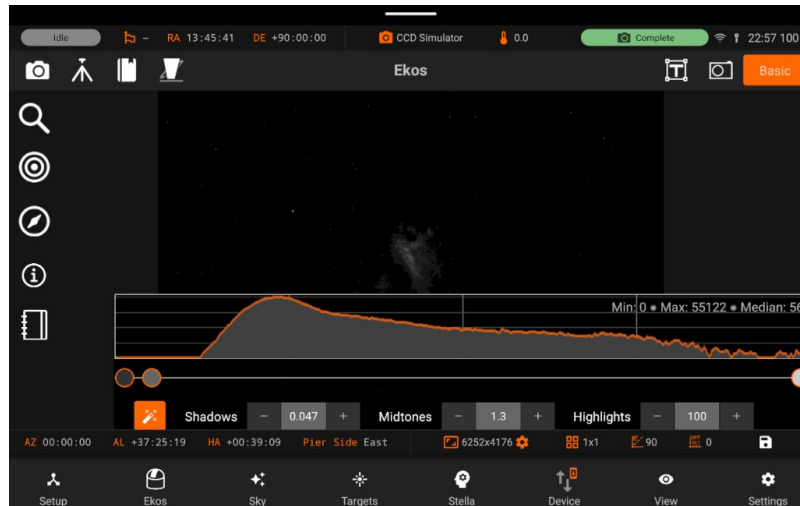
5.3.2.4 Histogram

Histogram When available, clicking the histogram button in the main image view toggles the non-linear histogram. The histogram is generated for both mono and rgb images.



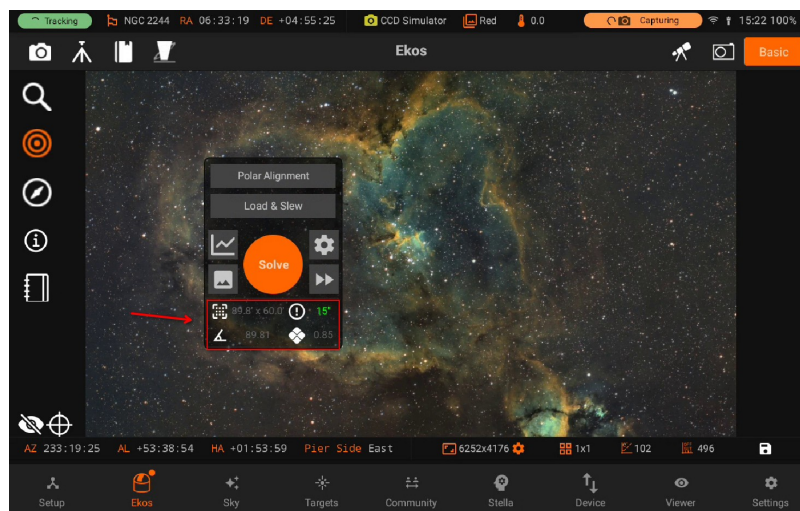
The sliders in the middle control the shadow, midtone and clipping parameters. You can move them, left or right, and as you move them, a real-time (but low resolution, for compute reasons) preview of the stretch is shown. When you let go of the slider, the setting is kept, but the button returns to the middle of its range so that you can make further adjustments—there

is very little screen space. You can tell the setting is kept as the number shown should not change after you release the button. Think of these as “relative” sliders. Also, when you let go of the slider, you also get the full-resolution image, instead of the real-time approximation.



5.3.2.5 Target GoTo

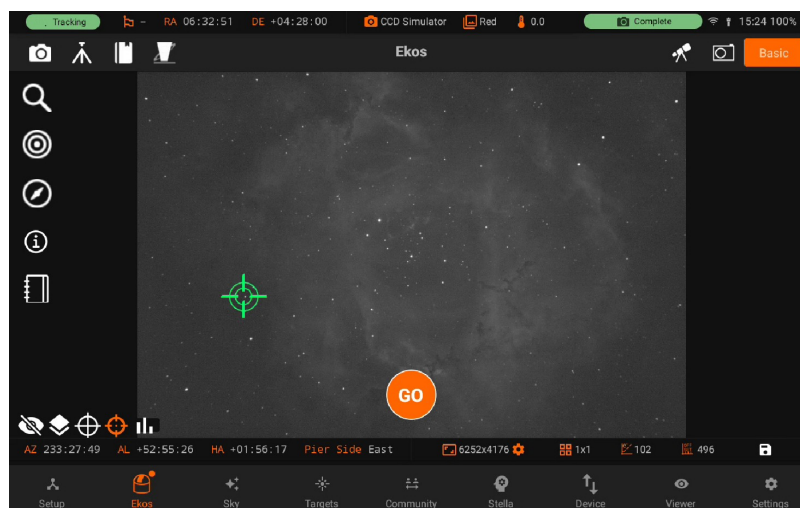
Canvas on Main Image You can center the mount to a specific target in the main image if plate-solving was successful. From Ekos Align module, Capture and Solve an image. If successful, an orange align icon is displayed in the Main Image View indicating that solving is successful. For any subsequent images captured and displayed in the Main Image View, you may now select the target by tapping on it. A red bullseye animation designates the target.



Tap GO button to command the mount to slew. If successful, the indicator icon changes to yellow and once motion is complete, it switches to green. Capture a preview to verify the mount indeed centered the target as desired. Repeat if necessary. Hold on your desired target, mount will start moving to that specific target. Yellow animation will be appeared while it is in process. Can also be seen in the below images.

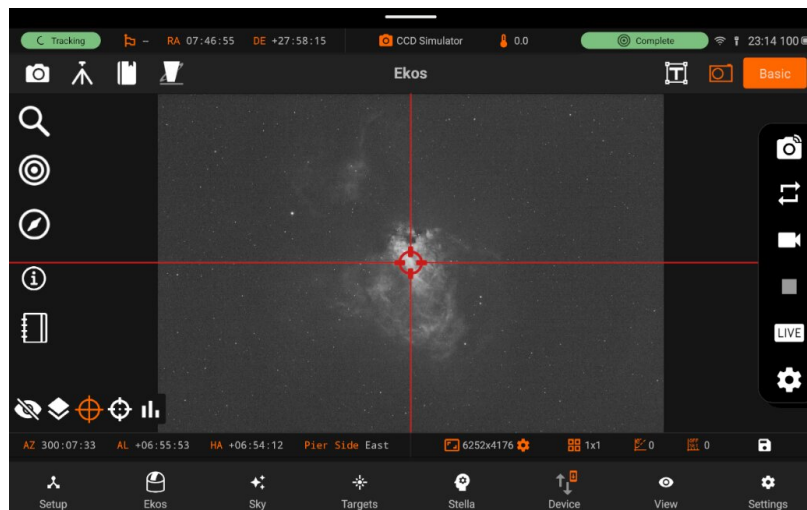


On success, the animation will turn to green. On capture new image, the target lock animation will be reset to default.

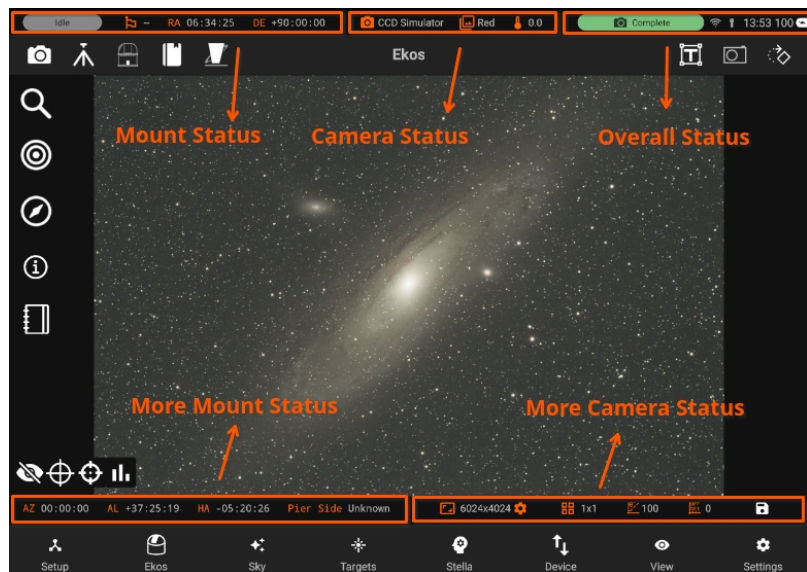


5.3.2.6 Crosshair

Crosshair Use crosshair on captured image, which is appeared on the center of captured image. Once it is toggled, you can see the crosshair on the image.



5.3.3 Status bar

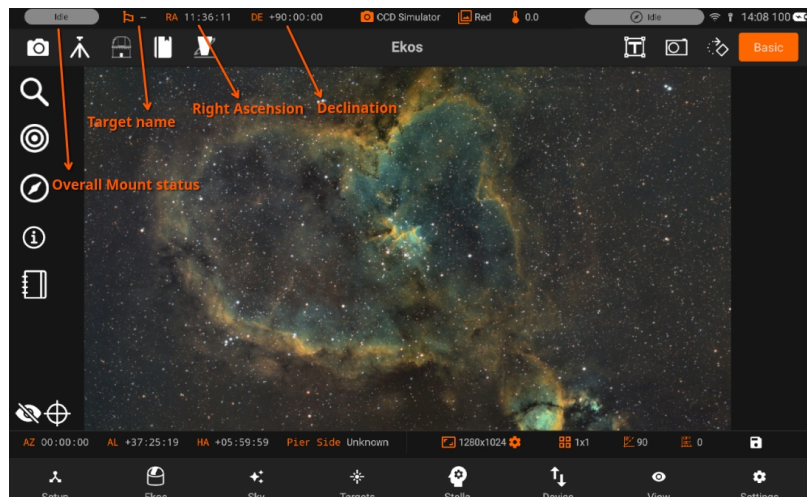


The important information of Mount and Camera is shown at the top and at the bottom:

- Top
- Bottom

5.3.3.1 Top

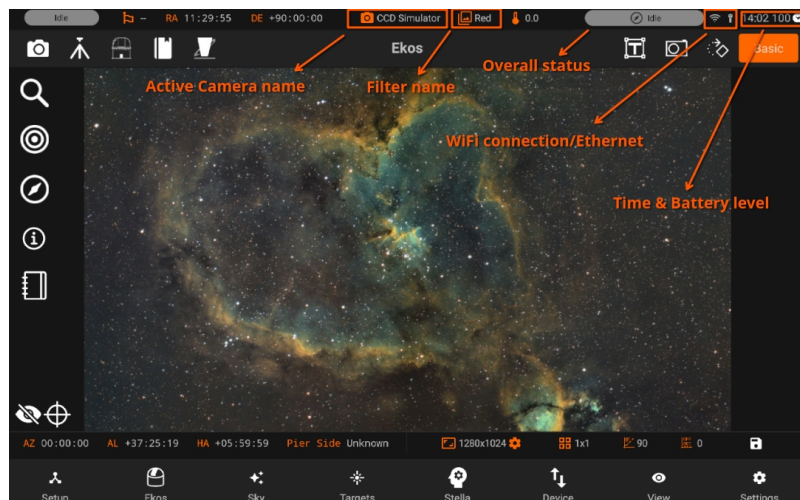
Mount Status



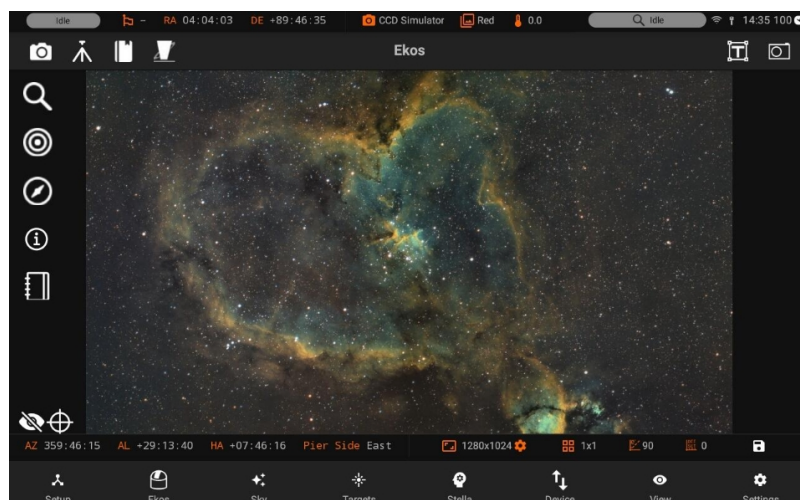
- **Mount status:** Displays current operational state (PARKING, UNPARKING, SLEWING, or TRACKING).

- **Target object:** Shows name of currently selected celestial object.
- **R.A.:** Indicates current Right Ascension coordinates of the mount.
- **DEC.:** Indicates current Declination coordinates of the mount.

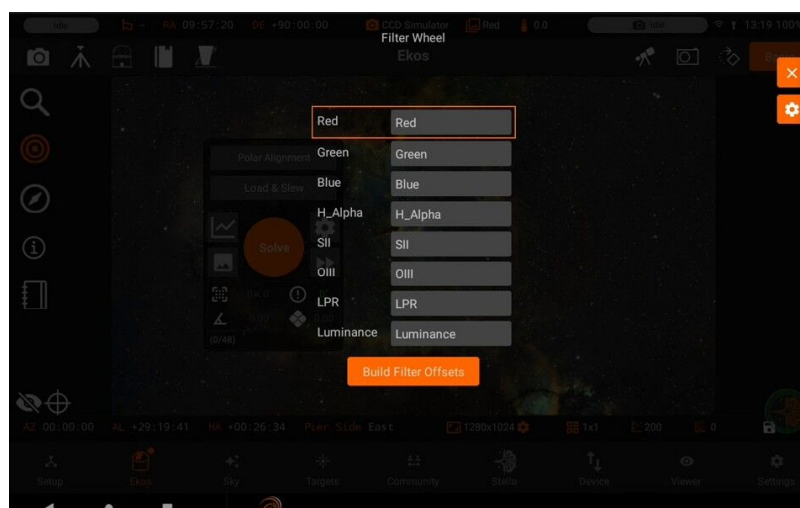
Camera Status



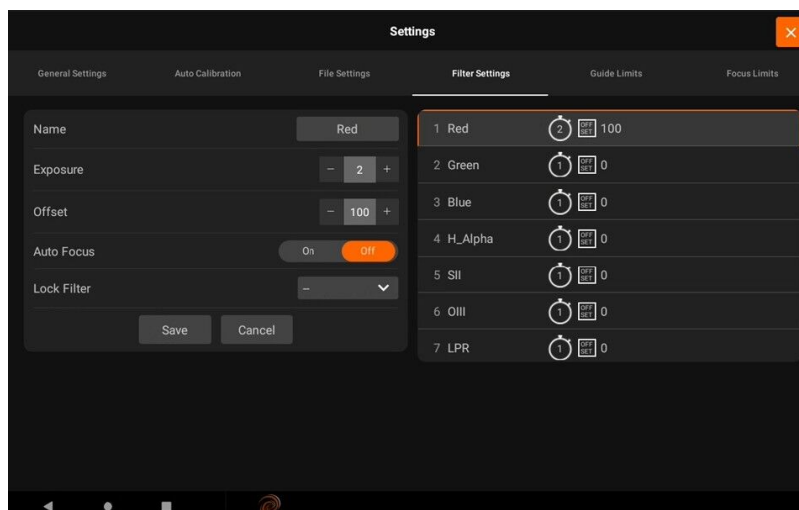
- Shows the camera's current operational state:
 - **Capturing:** Camera is actively taking images
 - **Complete:** Image or sequence capture successfully finished
 - **Idle:** Camera is ready but not currently capturing
- Displays the camera name and active filter name.



Once you press on the filter name, you will be able to edit Filter names.

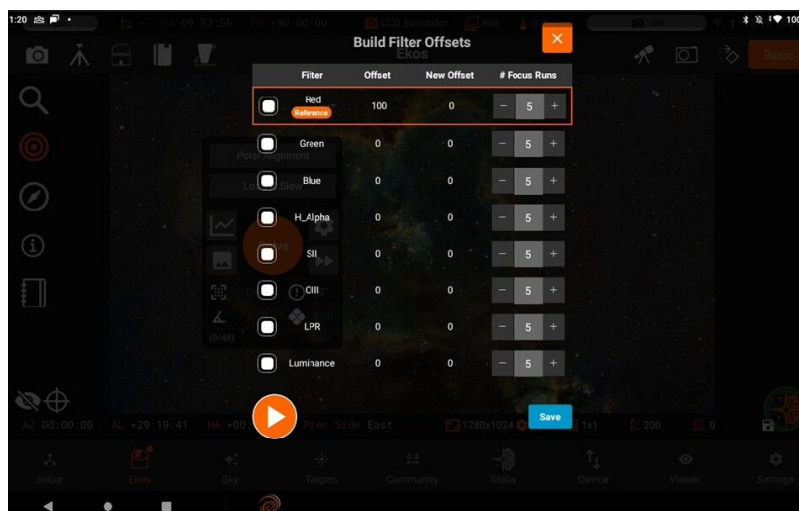


You can also access Capture settings by pressing the Cog wheel button on the top right.

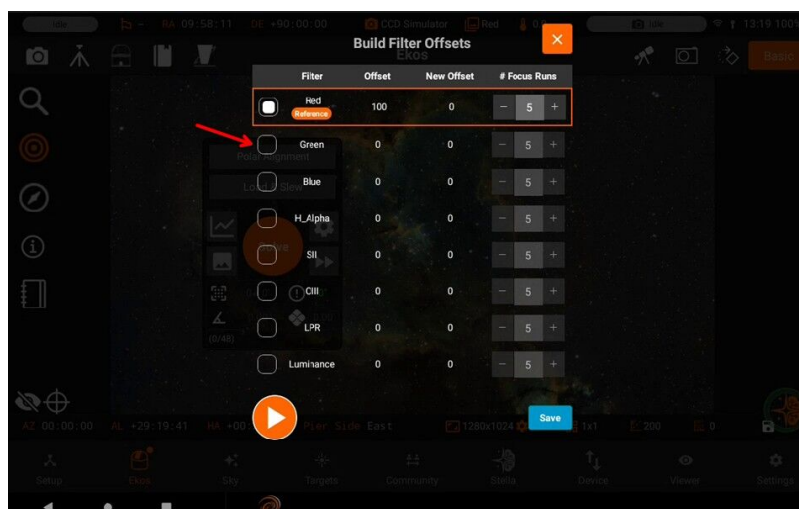


Build Filter Offsets

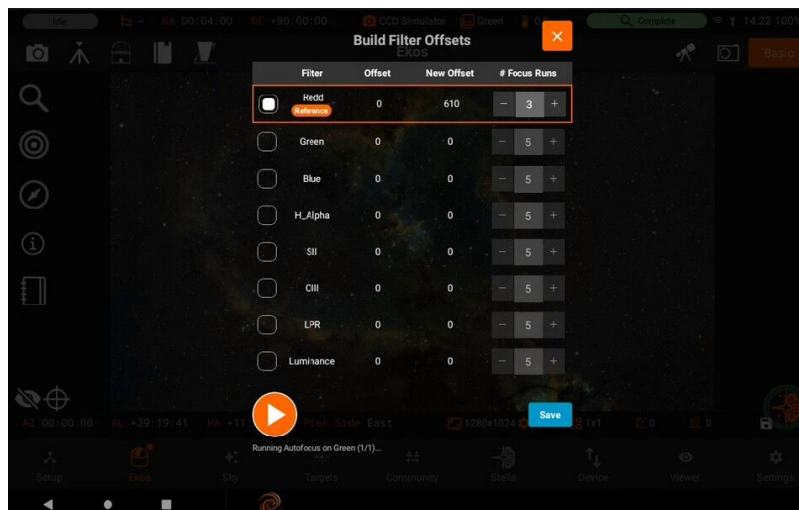
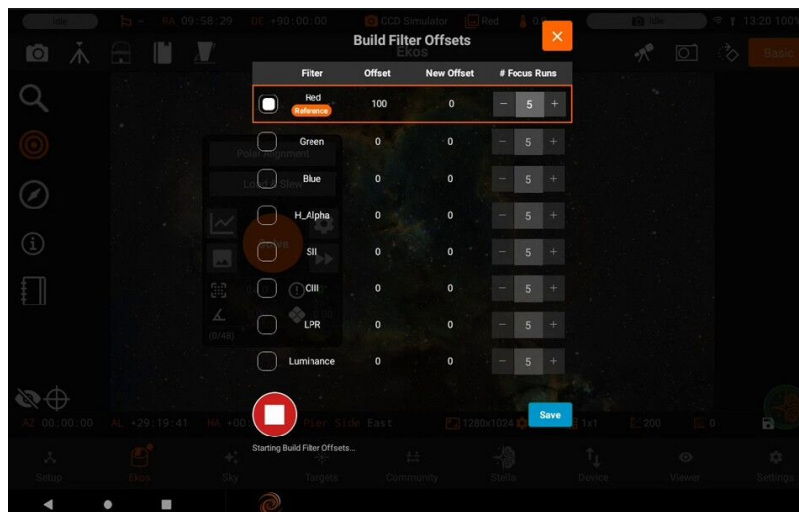
It automates the process of setting up these offsets, rather than requiring you to manually run Autofocus several times per filter, average the results, and calculate the differences yourself. It runs (or uses) focus results across your filters, builds a grid of relative offset values, and lets you review/adjust them — including toggling an Adapt Focus option and changing which filter is used as the reference. (The selected filter is the reference filter)



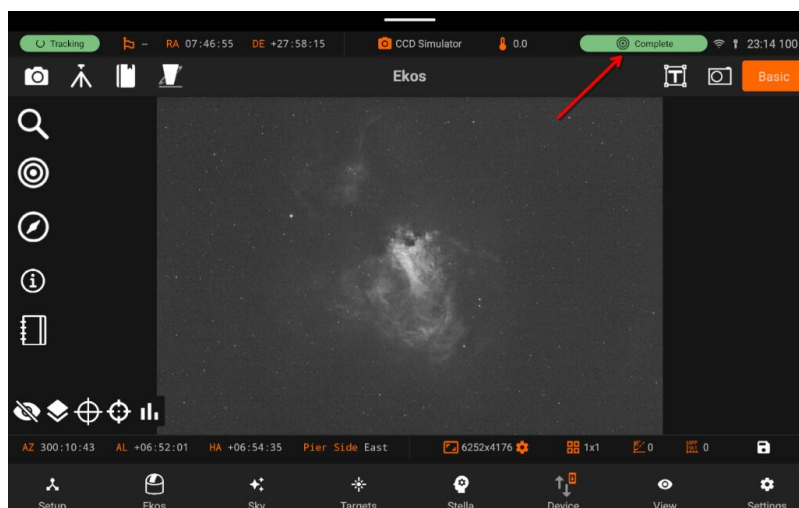
Select the desired filter to change the reference filter



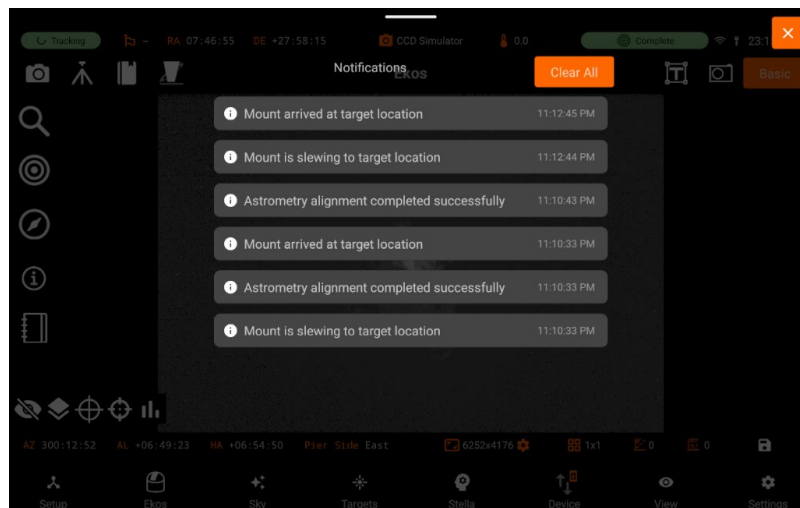
Press the start button to start Progress and wait for the new offset value.



- **Status Indicator:** Displays current camera temperature. Active in all modules except Mount (which has its own status badge).
- **Operation:** Tap the temperature status badge to view Notifications History - a chronological list of recent system notifications.



Clear all notifications



View network connectivity status in the status bar: - WiFi Mode: Orange when in hotspot mode and White when in station mode - Ethernet Connected: Shows Ethernet connection status

Battery level Check your device's current battery level at a glance. The indicator displays remaining power percentage for your mobile/tablet.

5.3.3.2 Bottom

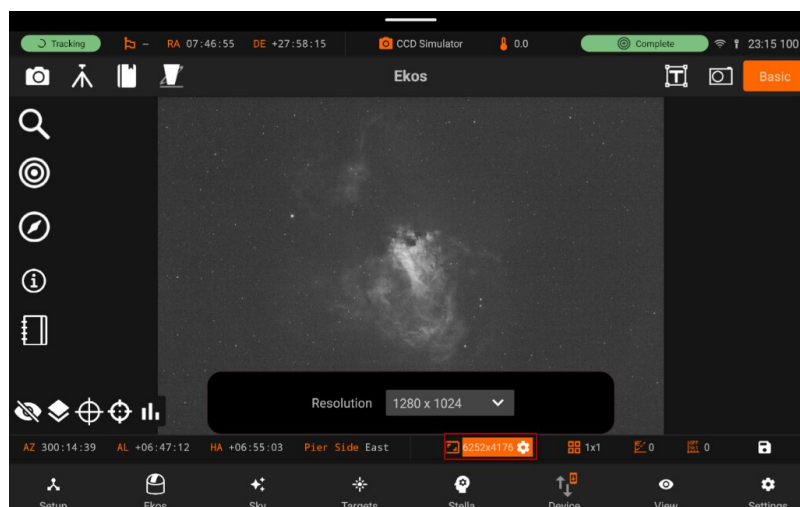
4 - More Mount information:

Correct AZ, AL, HA values Pier Side

5 - More Camera Information

Resolution:

- Tap the cog icon to open the Resolution Updater dialog.
- Select the desired resolution from the available list.



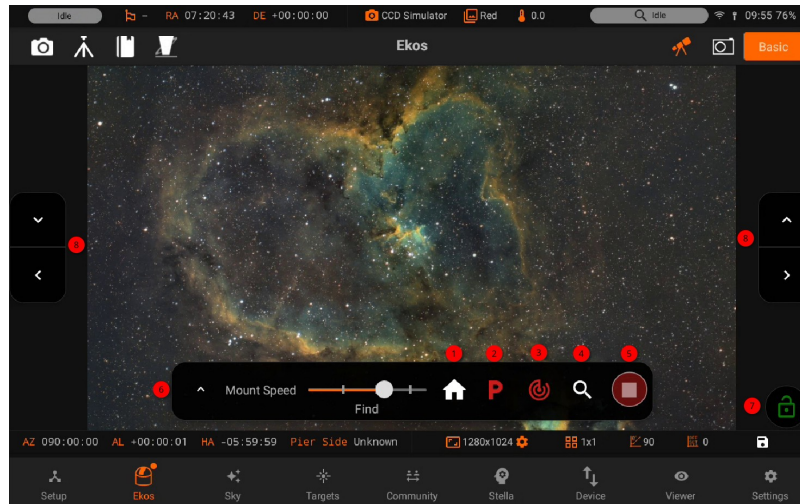
- Binning
- Gain
- Offset
- Save main image

5.3.4 Quick controls

StellarMate App has a total of three Quick Controls Modules which are used to control three astronomical instruments as suggested by their names: mounts/telescopes, cameras, and rotators.

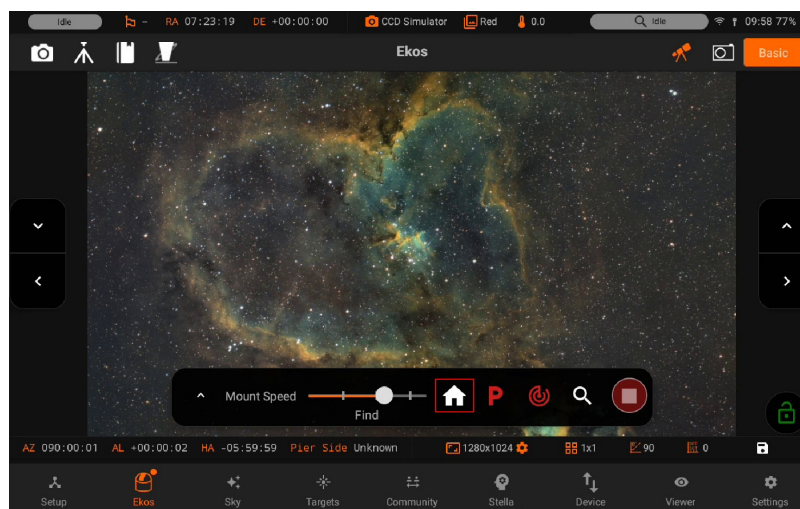
- Mount Quick Controls
- Camera Quick Controls
- Rotator Quick Controls

5.3.4.1 Mount



Mount quick controls allows you to control your mount quickly and easily, it has the following features:

- 1) **Home Support:** Toggle **Home Support** options



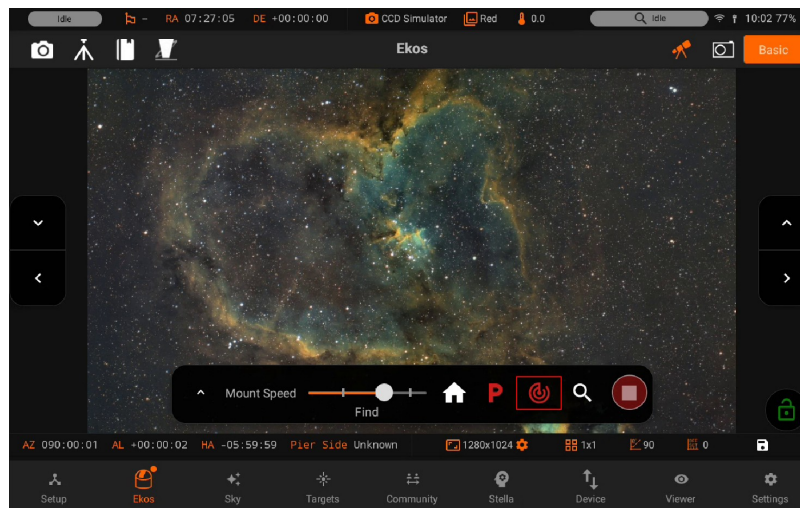
- 2) **Park/Unpark:** Park or Unpark mount.
- 3) **Tracking On/Off:** Toggle Mount tracking.
- 4) **Goto/Sync:** Send a GOTO or SYNC command to the mount using a target or a position.
- 5) **Abort:** Immediately abort any mount motion
- 6) **Mount Speed:** Select mount speed when moved via directional keys. Numeric rates (e.g. 600x) usually indicate speed 600 times the sidereal tracking speed. This only affects speeds for manual motion via directional keys and does not change SLEW/GOTO speeds.
- 7) **Lock Mount Controls:** Disable the Mount Controls
- 8) **Controls: Buttons from which you can move your Mount**
Left/Right/Up/Down: Move your Mount towards specific directions.

Unparking Your Mount

To unpark your mount, tap on the green button, it should turn red signifying that the mount is now **UnParked**, and the mount status bar shows **Idle**.

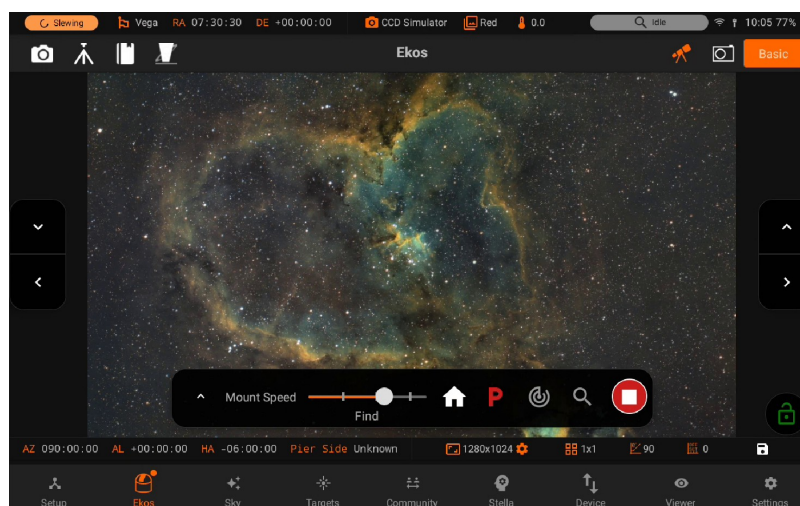
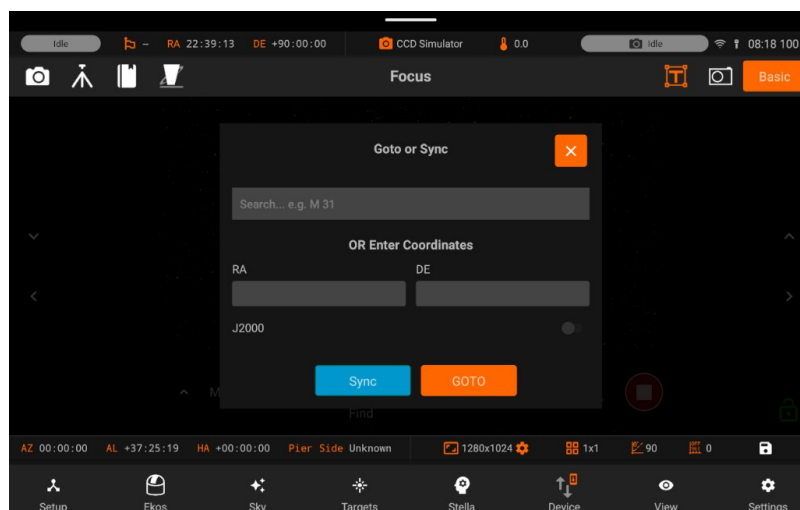
Tracking On/Off

For mount that support tracking control, you can toggle tracking by clicking on button. If tracking is engaged, the icon turns to green and the mount status bar will show **Tracking**.



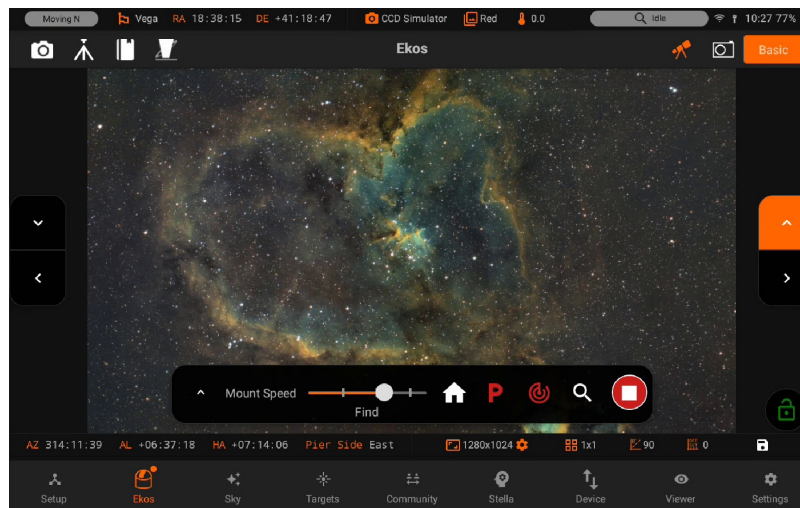
Goto or Sync

You can goto or sync by clicking on the **GOTO** button, a dialog will pop-up where you can goto or sync to your last target, choose one of your last recently used targets, or select a category and choose a new target.



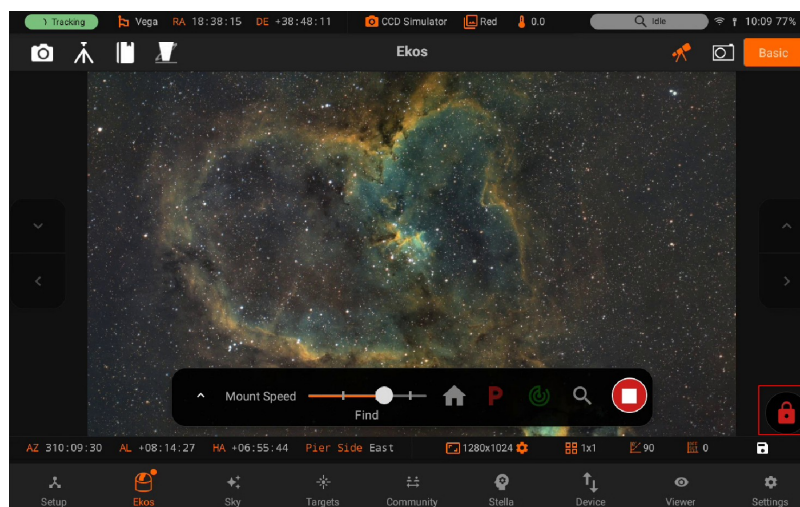
Moving to a specific direction manually

You can move your mount to a specific direction manually by using the Directional pads on the left and right side of the screen.



Locking Mount Controls

You can lock mount controls using the **Lock** button on the bottom-right of the screen. This will disable all the controls, and can be used to avoid any accidental touches.



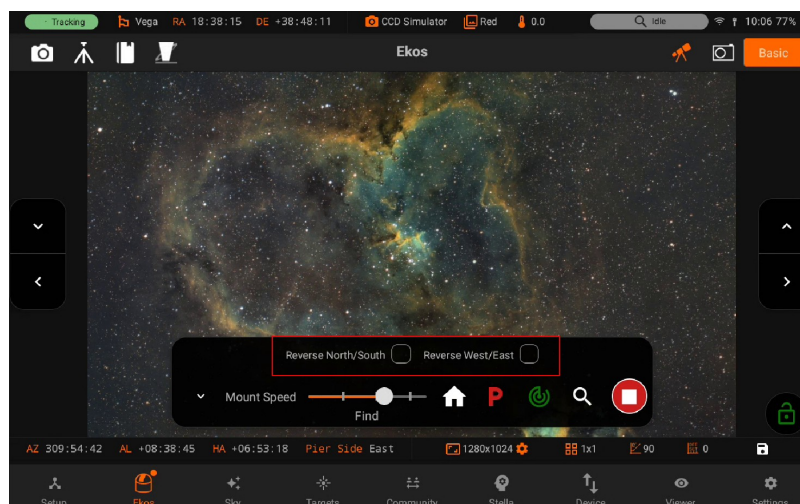
Parking Your Mount

You can park your mount by clicking on the red button, this will turn the button to the yellow color while Parking your mount. After it is done parking, the button will turn to the color green, showing Parked status in the mount status bar.

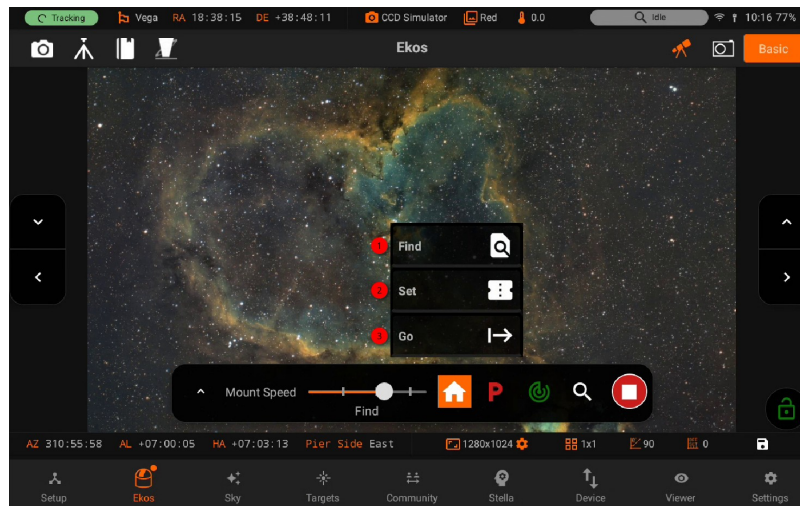
Reverse Directions:

You can reverse the directions of your mount:

- **North/South:** Mount directions will be reversed for North/South when enabled.
- **West/East:** Mouth directions will be reversed for West/East when enabled.



5.3.4.1.1 Home support



Some mounts offer support to slew to a predefined or custom Home position. It is important to clarify the differences between the mount's Park and Home positions:

Park: Park position is the position the mount should start at when powered on, or stop at before being powered off. A parking position can be fixed by the mount's firmware or customizable by the user. Usually after a mount is parked, it is expected to be powered off next. Some mounts do not respond to any command when parked.

Home: A home position is the mount's startup or zero position. For many mounts with relative encoders, the home and park positions are the same. Depending on the mount's type, the home positions can be different:

Equatorial Mount: Telescope looking at celestial pole with counter weights down.

Alt-Az Mount: Telescope is level with ground looking due North in the Northern hemisphere and South in the Southern hemisphere.

For mounts that support homing, there are usually three operations available in the Mount's Quick Control bar. Please note that not all mounts support the three operations, some only support a limited subset of these operations:

Find: Search for mount's home index positions.

Set as current: Save current position as the mount zero position.

Go: Go to mount predefined home position.

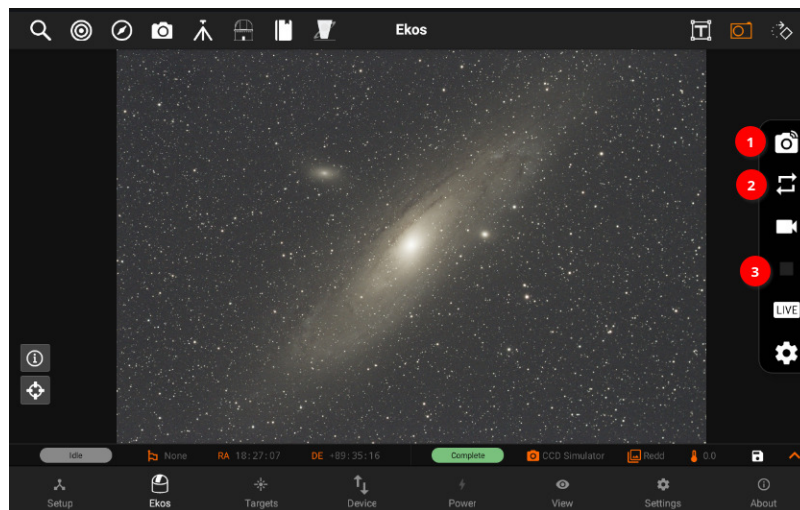
5.3.4.2 Camera

Camera quick controls allows you to control your camera quickly and easily. You can quickly change **Settings** and capture a **Preview** image, or start a continuous loop **Framing** until explicitly stopped. Stream and **Record** videos if supported by your camera. Get amazing pictures with **Livestacking**

5.3.4.2.1 Preview Framing

Warning

Preview images are not saved in Internal Storage



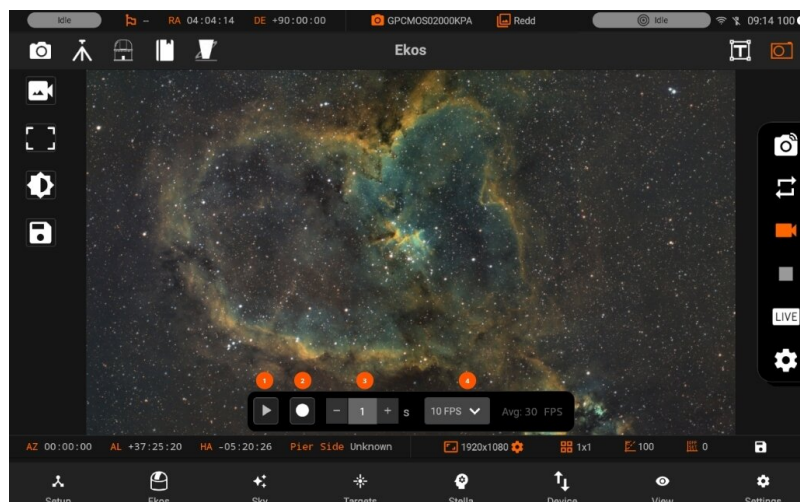
1) **You can capture a preview image by tapping on the Camera button.**

An animated circular progress icon will show the progress of the current capture and will show you when the image is being downloaded to the app by showing a green cloud download icon.

2) Looping can be done as well by tapping on the Loop button (repeat icon).

3) You can stop the capturing process by tapping on the Stop button anytime while it's capturing.

5.3.4.2.2 Video Recording



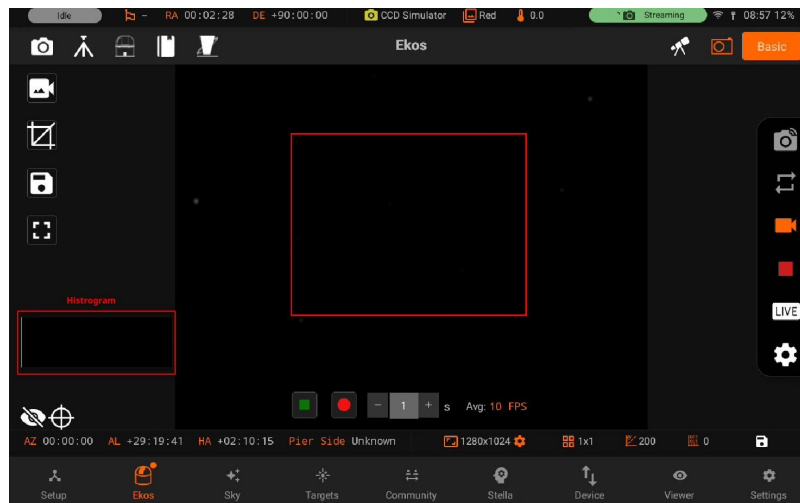
Videos are recorded as lossless SER format. By default, they are saved to the StellarMate Videos directly which can be accessed via Network share on Windows, Mac, and Linux.

These are the following options in Video Recording:

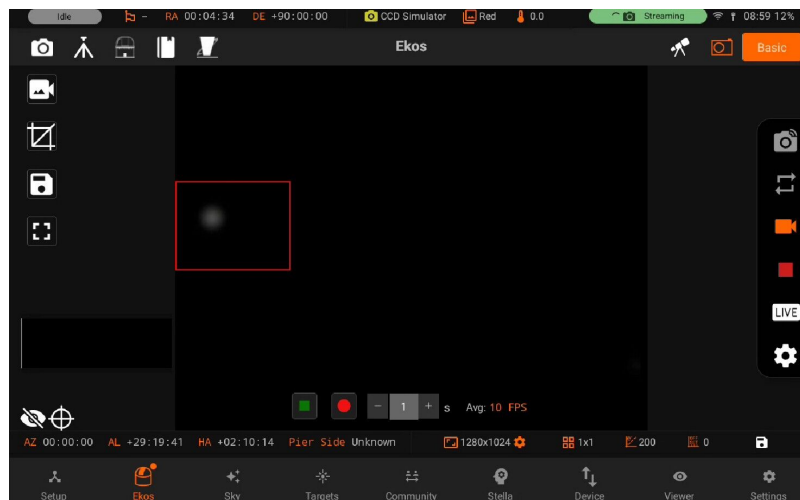
- 1) **Play:** Enables the video streaming if supported by the camera.
- 2) **Record / Stop:** Starts the recording, if the recording is started. Icon will be changed to stop icon. So, you can stop the recording.
- 3) **Duration:** Select one from the predefined video duration.
- 4) **FPS:** Record stream until these many frames are captured
- 5) **Avg FPS:** Average running Frame per second

Streaming

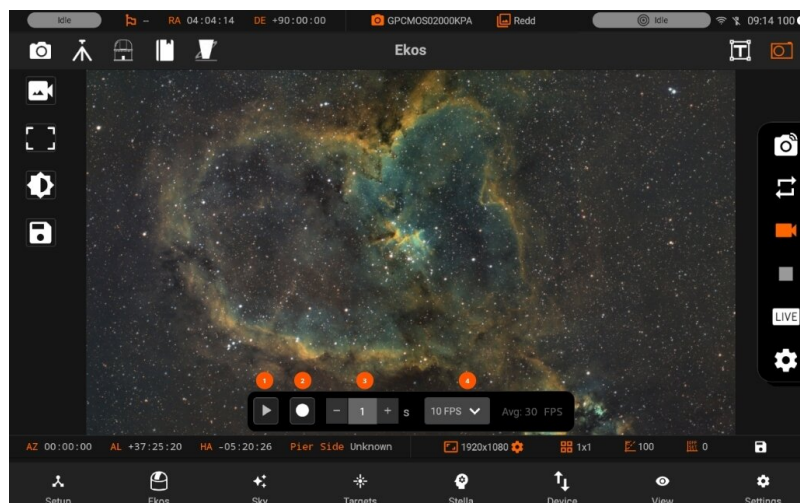
Once you starting video streaming, a box is shown on the screen. You can resize it using the resize button from the bottom right. Live histogram view is also shown.



Once resize, you can also drag the box. Double tap on the box to set the Streaming ROI frame values.

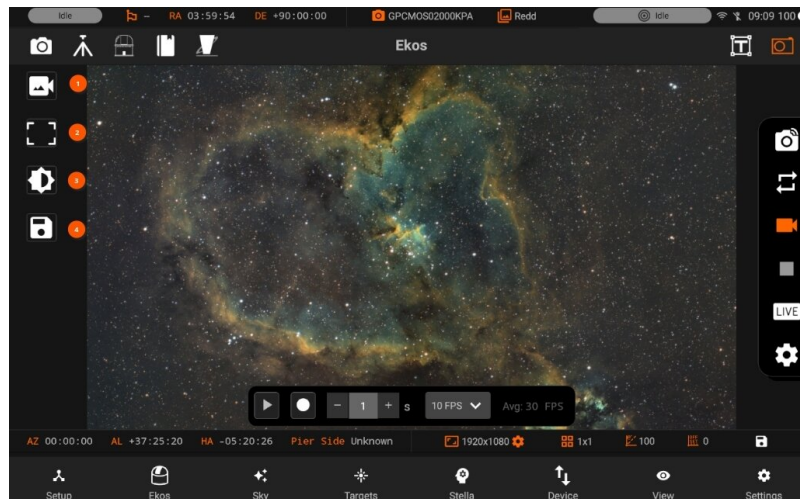


- 6) **Binning:** Horizontal and Vertical binning
- 7) **Left:** Specifies the area of x position i.e Horizontal
- 8) **Top:** Specifies y position i.e Vertical
- 9) **Width:** Current width of Active camera
- 10) **Height:** Current height of Action camera
- 11) **Settings:** Directory and filename settings



Press outside the box to reset the Streaming frame.

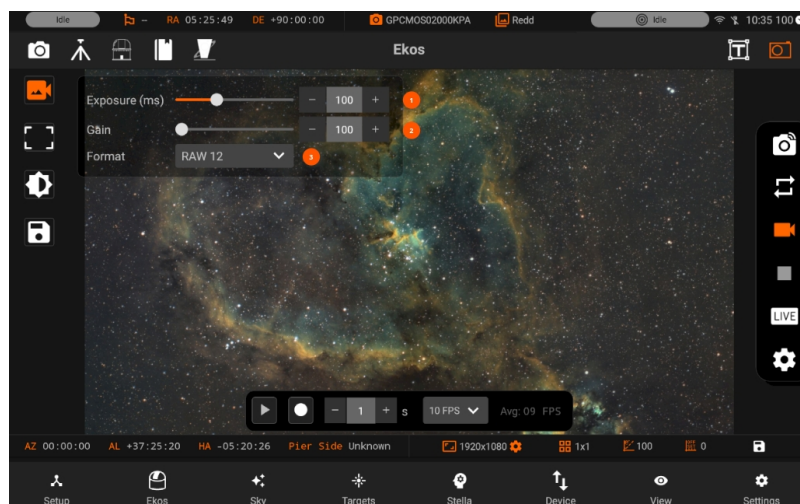
5.3.4.2.2.1 Canvas



On the left side, you can see Video adjustment controls:

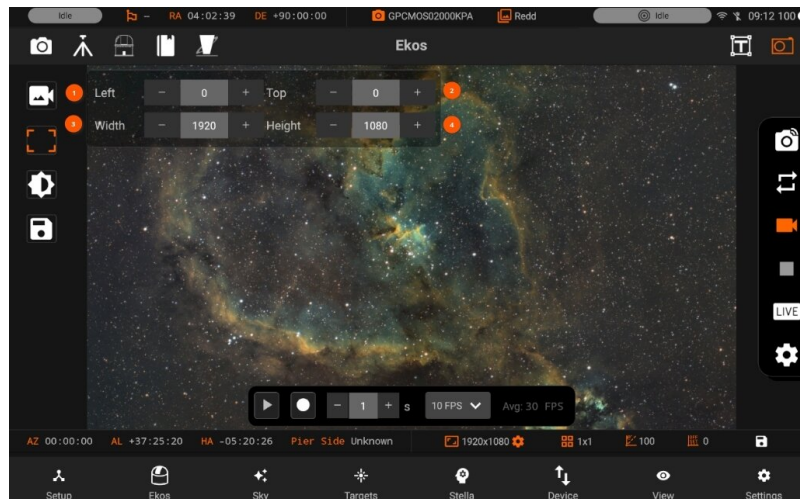
- 1) Exposure/Gain controls
- 2) ROI Frames
- 3) Camera adjustments
- 4) File saving

5.3.4.2.2.2 Exposure/Gain



Adjust Exposure, Once it is changed Streaming will automatically restart. Adjust Gain value. Select format of the Stream

5.3.4.2.2.3 ROI Frames

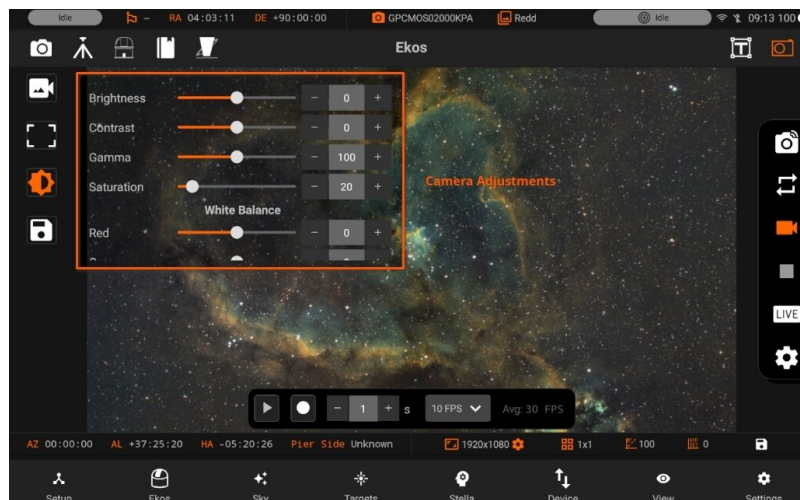


Region of Interest: Specify the video frame. By default, a full frame is captured. All units in pixels

- **Left:** Left offset
- **Top:** Top offset
- **Width:** Width (unbinned)
- **Height:** Height (unbinned)

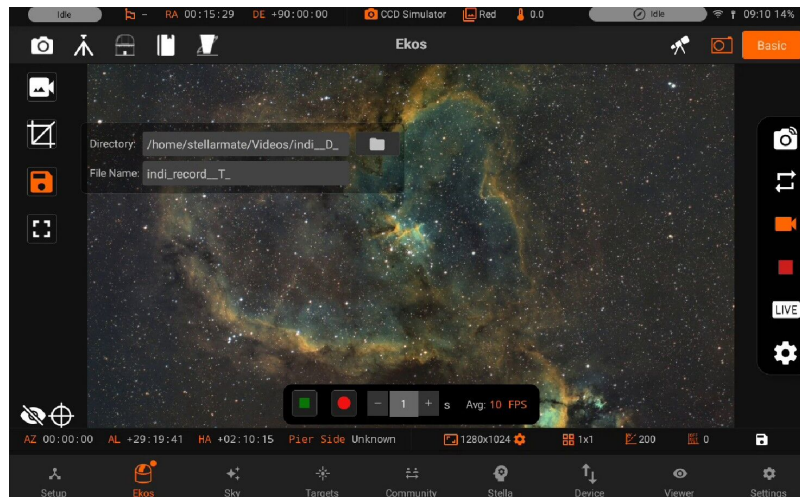
Left+Width should not exceed the maximum width of the camera. The same rule applies to Top+Height.

5.3.4.2.2.4 Adjustments



Adjust Camera controls with the live histogram view when the Live Streaming is in progress

5.3.4.2.2.5 File save



1) **Directory:** Path of videos is set using Directory browser.

2) **File Name**

[Set SER video file name. Record files may contain some patterns to make them dynamic.]

- **_D_:** For the date in YYYY-MM-DD
- **_H_:** For time in HH:MM:SS.
- **_T_:** For ISO8601 time stamp.
- **_F_:** For filter name, if any.

1) **Directory:** Path of videos is set using Directory browser.

2) Toggle Directory browser

3) **File Name:** Set SER video file name. Record files may contain some patterns to make them dynamic. **_D_:** For the date in YYYY-MM-DD **_H_:** For time in HH:MM:SS. **_T_:** For ISO8601 time stamp. **_F_:** For filter name, if any. **Offset:** Target camera offset **Gain:** Target camera gain

Videos are recorded as lossless SER format. By default, they are saved to the StellarMate Videos directly which can be accessed via Network share on Windows, Mac, and Linux.

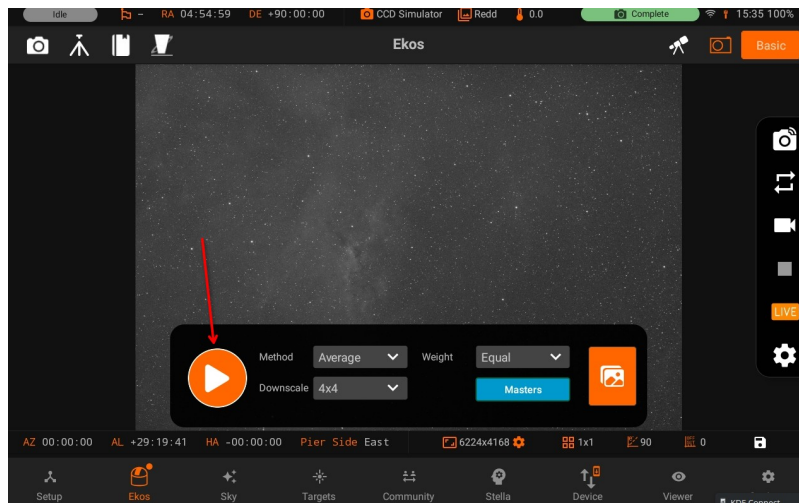
5.3.4.2.3 Live Stacking

Live Stacking is a powerful Electronic Assisted Astronomy (EAA) feature in the StellarMate App that combines incoming frames in real time to boost the Signal-to-Noise Ratio (SNR) of your image. It is based on the powerful [Ekos LiveStacker](#). As each new sub-frame is captured and stacked, noise is progressively reduced and the contrast of deep-sky objects improves. Galaxies, nebulae, and star clusters begin to emerge within minutes without any post-processing.

Prerequisites Before starting Live Stacking, the following conditions must be met:

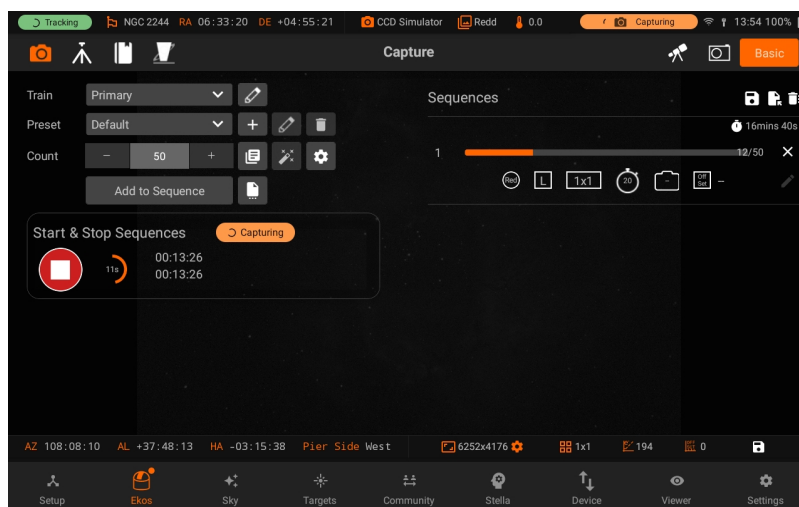
1. Plate Solve first. Live Stacking depends entirely on plate solving to align frames. Each incoming sub-frame must carry valid WCS (World Coordinate System) data embedded in its FITS header. Make sure the Alignment module has completed a successful solve before engaging the livestacker. Without it, frame registration will fail.
2. The image must be well-focused. Poor focus reduces the number and quality of detected stars, which the alignment algorithm relies on. Run autofocus before starting your session.
3. Sufficient stars must be present in the frame. The stacking algorithm detects stars in each captured sub to compute the registration transform. Very sparse star fields or extremely narrow-band targets may reduce alignment reliability.
4. Guide for exposures longer than 30 seconds. Most consumer-grade mounts begin forming star trails beyond 30 seconds. For longer exposures, activate guiding before starting the livestacker. Good polar alignment significantly improves results at all exposure lengths.

Starting Live Stacking

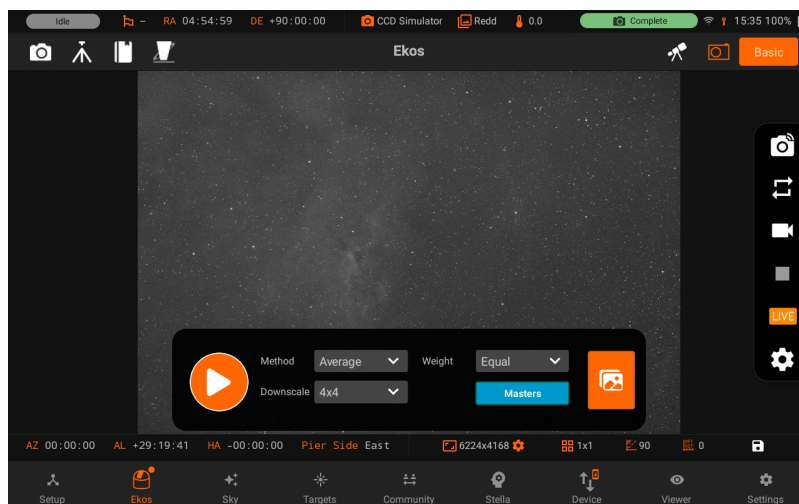


Tap the LIVE button in the Camera Quick Controls to access the Live Stacking panel, then tap Play to begin.

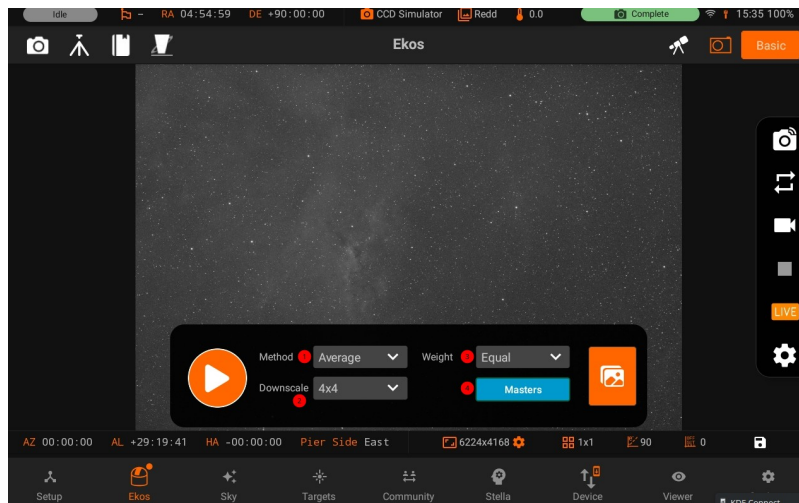
Without a running sequence: If no capture sequence is active, the livestacker starts an automatic capture loop using the primary camera settings from Quick Controls. For example, if your exposure is set to 5 seconds, a 5-second loop runs continuously until you stop it.



With a running sequence: If a sequence queue is already running, enabling the livestacker causes it to wait for the next arriving frame and stack it as part of the ongoing sequence.

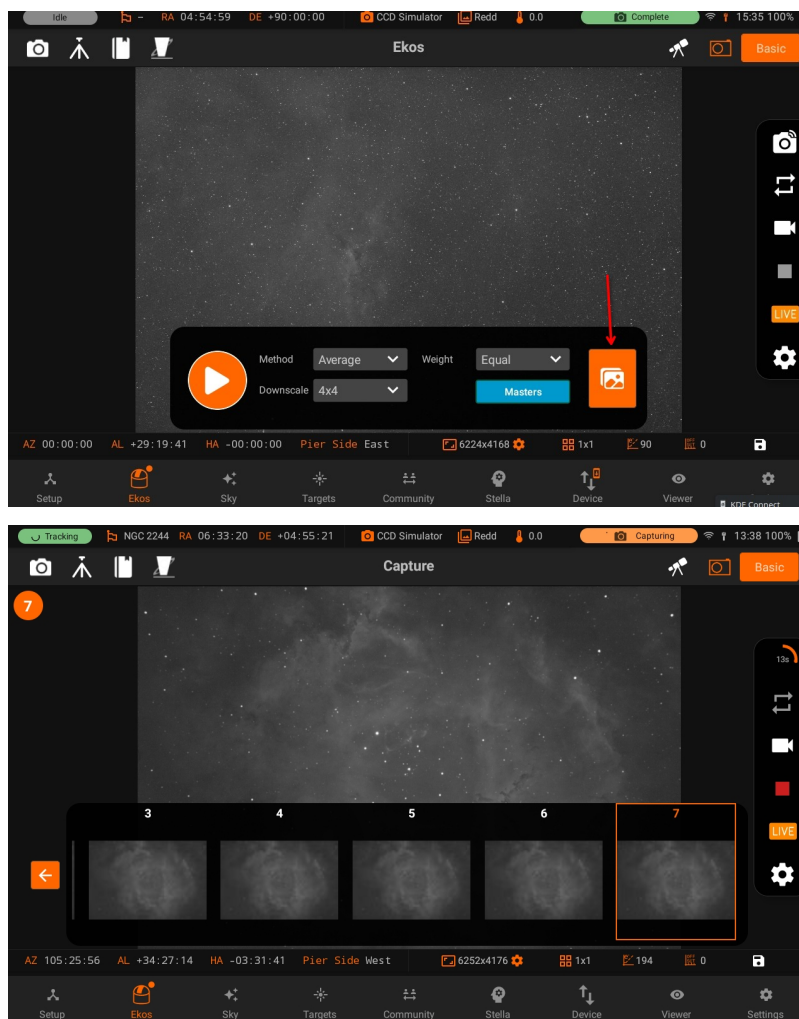


In both cases, the first captured frame is used to extract the reference star pattern and establish the WCS reference. Actual stacking begins from the second frame onward.



Viewing Stacked Images

As stacked images arrive, they are displayed in the main view. A thumbnail carousel at the bottom of the screen shows the last 10 captured frames, numbered sequentially. Tap any thumbnail to view that specific frame. When the livestacker is restarted, all images are cleared and the carousel resets.



Stacking Settings

1. **Stacking Method** Controls how pixel values are combined across frames:

- **Average:** Simple mean of all pixel values. No rejection is applied. Fast and straightforward, best for clean conditions.
- **Sigma Clipping:** Rejects outlying pixels that deviate beyond a statistical threshold. Helps suppress hot pixels, cosmic rays, and satellite trails.
- **Winsorized Sigma Clipping:** A more robust variant of sigma clipping that limits, rather than removes, outlying pixel values. Better behavior with small frame counts.

- **ImageMM:** Implements the ImageMM stacking algorithm as described in this [astronomical paper](#). Produces excellent results for faint targets but is significantly more resource-intensive than other methods. Use with caution on lower-powered hardware.

When Live stacked images are received, they are displayed in the main view with a thumbnail carousel at the bottom. Each image is numbered sequentially. To ensure proper performance, only the last 10 captured images are available in the carousel. To view a specific image, simply tap its thumbnail in the carousel. When the livestacking is restarted again, all images would be cleared.

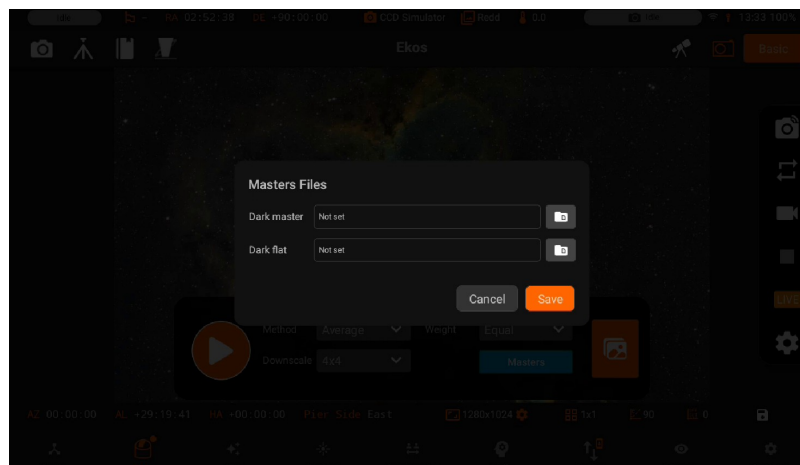
2. Downscale Reduces the resolution of sub-frames and the master stack before processing. Useful for improving performance on resource-constrained devices or when real-time speed is more important than full resolution:

- **None:** Full resolution, no downscaling.
- **2×2:** Subs and master stack downsampled by a factor of 2.
- **3×3:** Downsampled by a factor of 3.
- **4×4:** Downsampled by a factor of 4.

3. Frame Weighting Determines how much influence each frame has in the final stack:

- **Equal:** All frames contribute equally regardless of quality.
- **HFR:** Frames are weighted by $1 / \text{Average HFR (Half-Flux Radius)}$. Sharper frames with smaller HFR carry more weight.
- **Num Stars:** Frames are weighted by the number of detected stars. Frames with more detected stars are considered higher quality and weighted accordingly.

4. Calibration Masters Optional calibration frames to improve image quality:



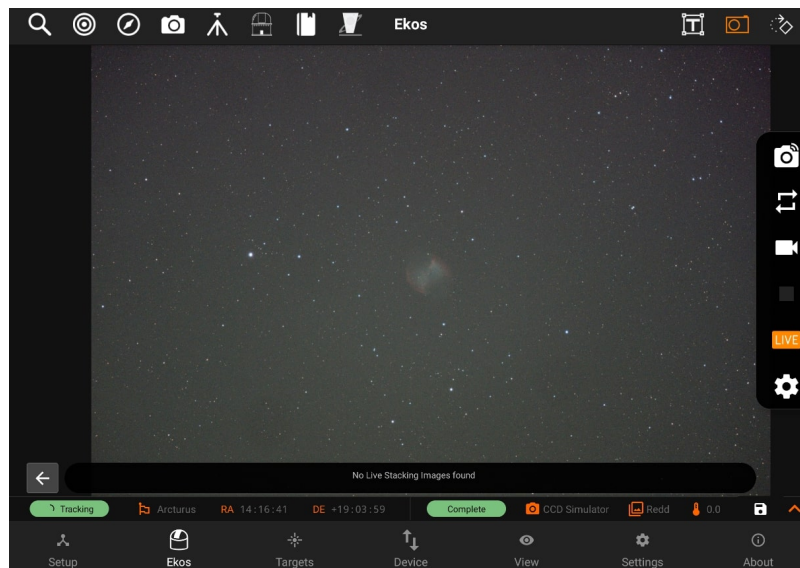
- **Master Dark:** Select a master dark frame to subtract thermal noise and hot pixels from each incoming light frame.
- **Master Flat:** Select a master flat frame to correct for optical vignetting and sensor dust.

Both masters should be matched to your camera settings (gain, temperature, binning) for best results.

Saving Stacked Images Live stacked images are saved as FITS files in the StellarMate Pictures directory. They retain full 16-bit or 32-bit data fidelity and include WCS header information, making them suitable for further processing in PixInsight, Siril, or other astrophotography tools. Saved images can be accessed later via the Gallery, StellarMate network share, or FTP.

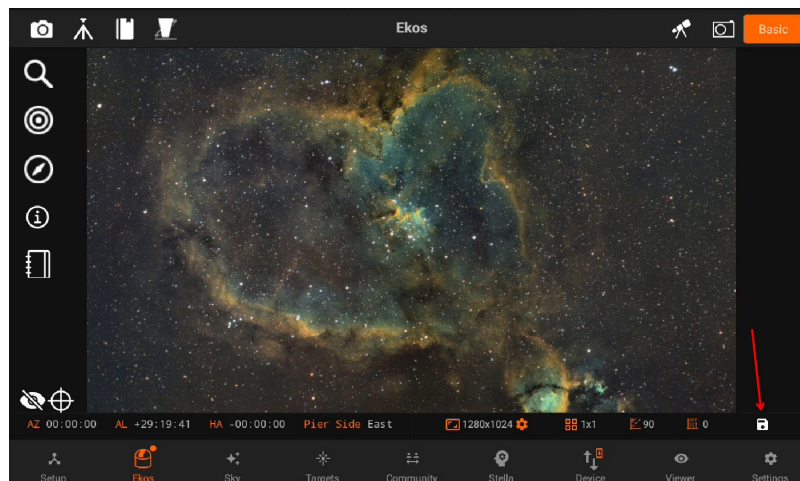
Warning

Previous versions of the StellarMate App saved stacked images as JPG. The current system saves in FITS format to preserve full data quality.



All live stacked images are saved as JPG in StellarMate Pictures directory, where they can be accessed later via the Gallery, StellarMate network share, or FTP.

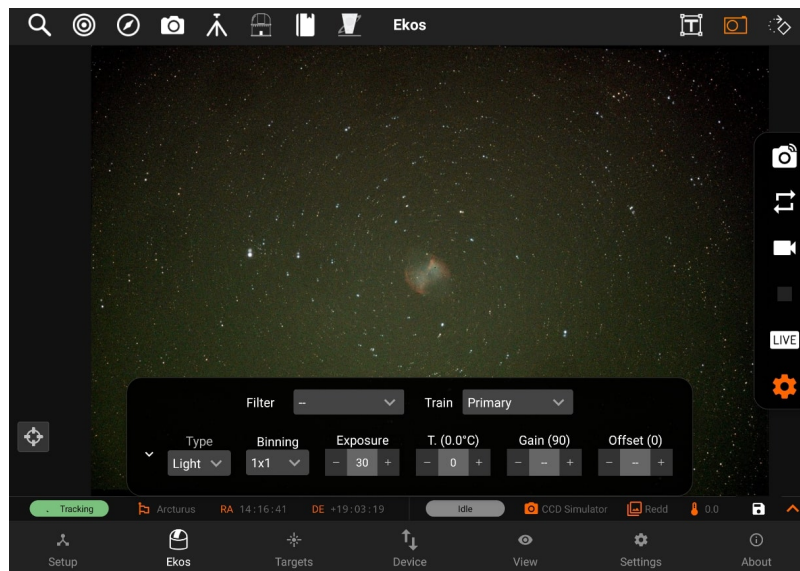
To save an image in the tablet/phone storage, tap the Disk icon in the camera's info bar.



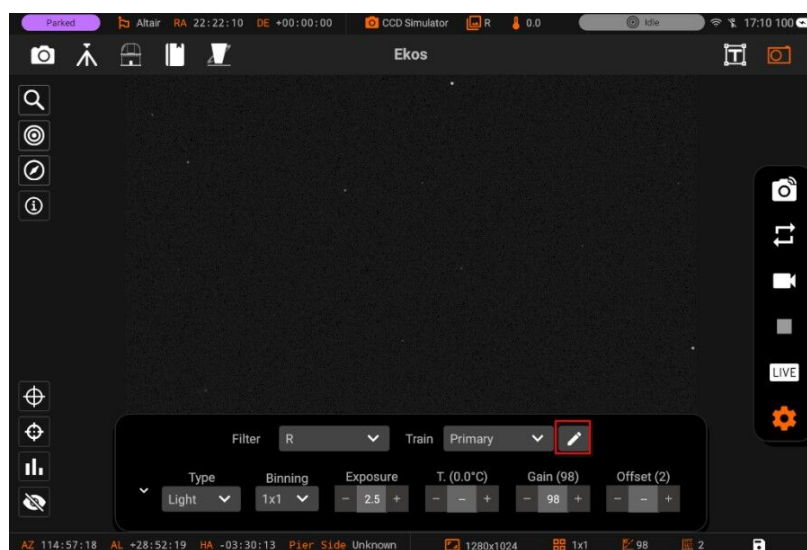
5.3.4.2.4 Settings

You can quickly take custom preview captures or loop frames by tweaking the settings in the **quick settings** bar by tapping on the **Quick Settings** button. The quick settings bar can be expanded by tapping on the up expand arrow on the left side of the bar. Different settings can be changed for a specific camera i.e Frame type, Binning, Exposure, Temperature, Gain & Offset.

Note: Choosing a temperature will set the temperature immediately.



You can also toggle Optical trains from the Quick Camera Settings



5.3.4.3 Rotator

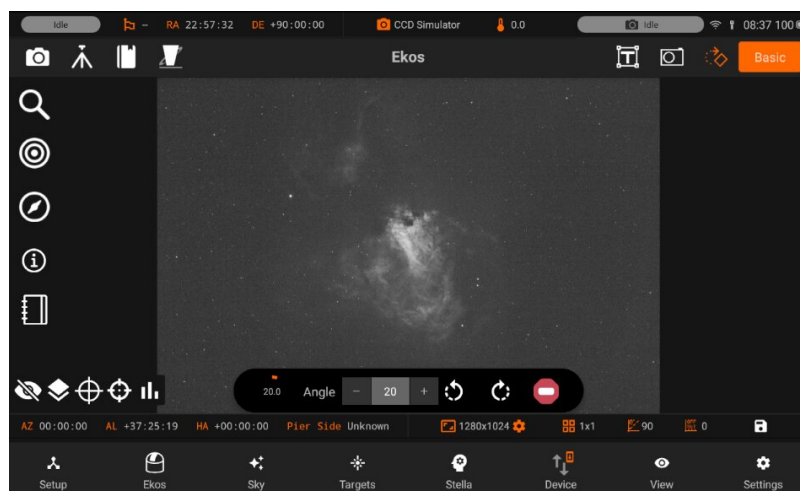
Rotator quick controls allows you to control your rotator quickly and easily, it has the following features:

Display Current Angle (please note all angles are in degrees)

Goto absolute angle 10-step Counter-Clock-Wise Movement 10-step Clock-Wise Movement Abort Motion

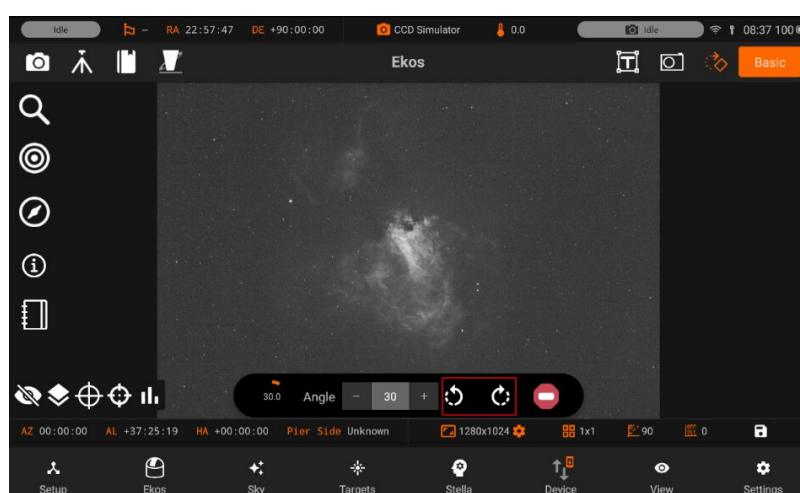
Going to absolute angle

You can go to an absolute angle by tapping on the textbox and typing it the angle you want to go to, then tap on the Goto button next to the text-box on the right. You will be able to see the angle display view changing along the way to its final angle.



Going to an angle position by steps

You can rotate the rotator to a different angle using the **CW** and **CCW** rotation buttons, which will change the rotation by 10 steps depending on the direction chosen.

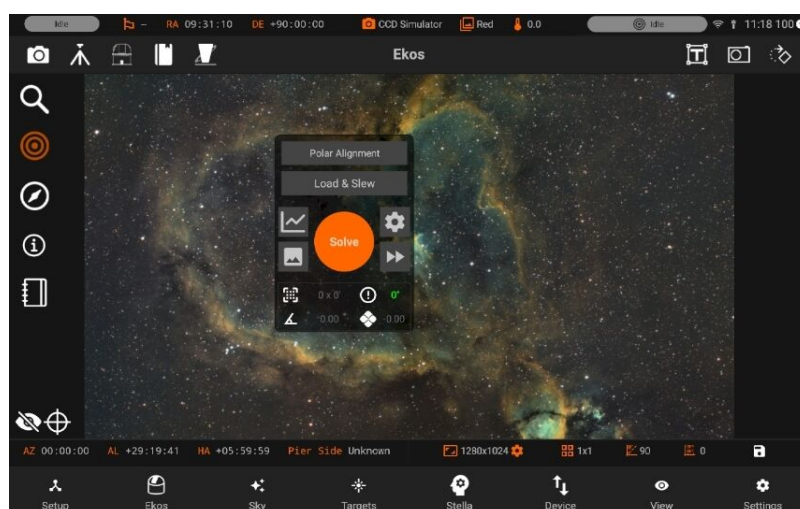


5.3.5 Modules

Advanced controls for Focusing, Guiding, Alignment, Capture, Mount, Observatory, Scheduler, and INDI Control Panel.

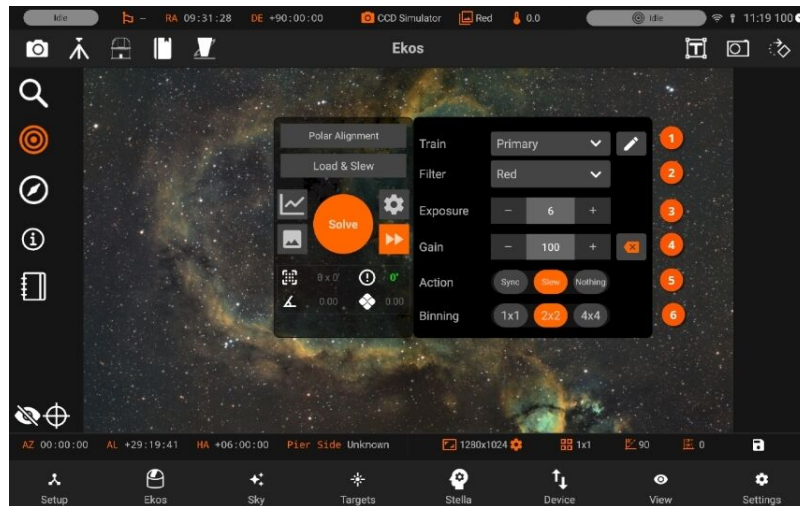
StellarMate App has a total of six Ekos Modules which are used to control various astronomical instruments such as: CCD cameras, DSLR cameras, mounts/telescopes, dustcaps, domes, roll-off shutters, filter wheels, rotators, focusers, and more.

5.3.5.1 Align



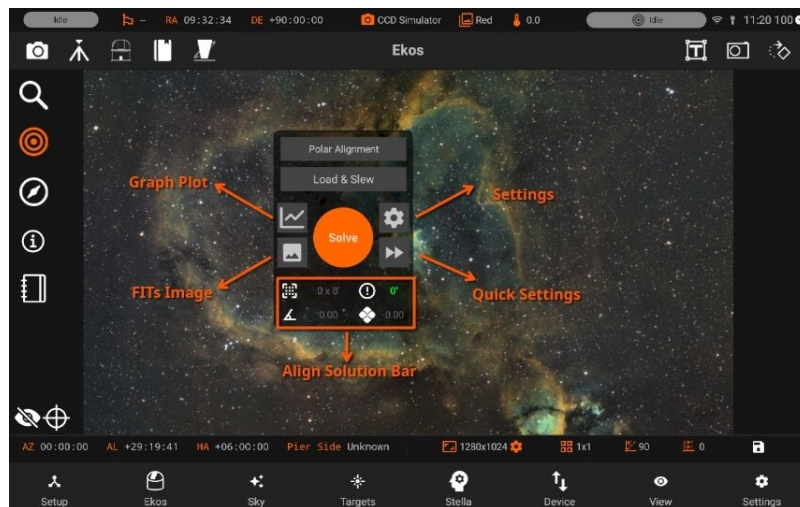
The Align module enables highly accurate GOTOs and dead-center target images by utilizing plate-solving. The process starts with capturing an image and plate-solving it to get the exact sky coordinates. Once the coordinates are obtained, the

mount is synchronized and then commanded to slew to the correct target position. This cycle repeats until the mount is within a few arcsecs from the target.

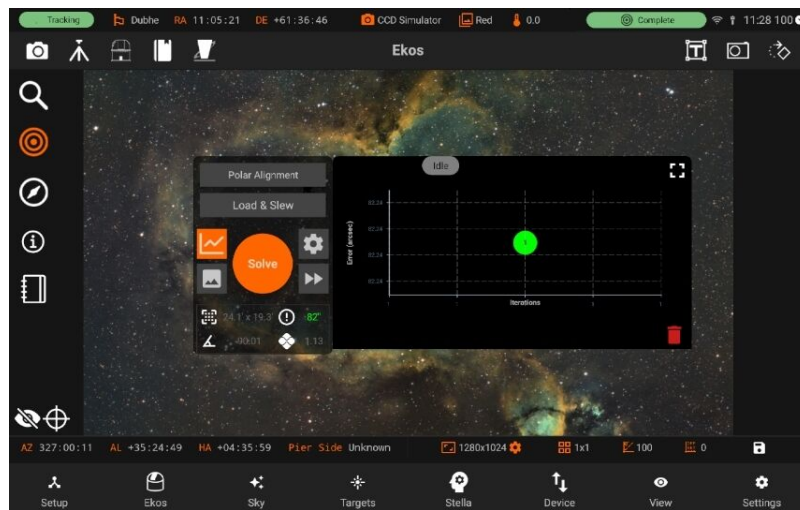


It has the following features:

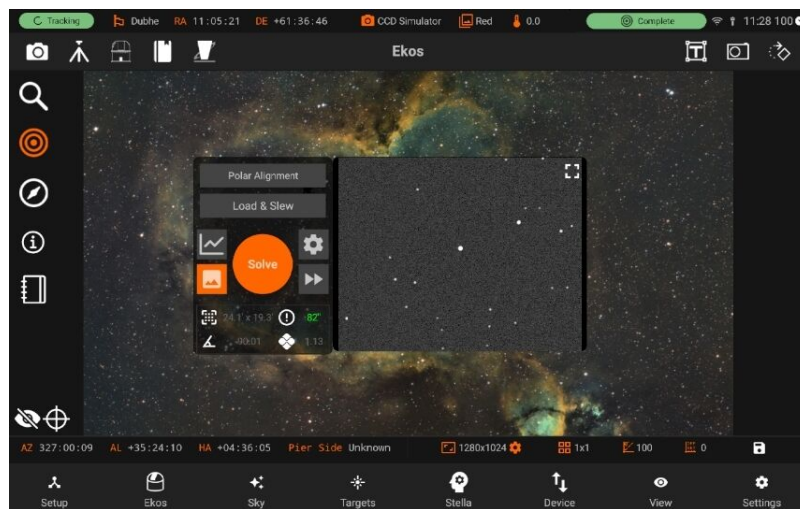
- 1) Manage / Select Optical trains.
- 2) Filter
- 3) Exposure
- 4) Gain
- 5) **Action:** Sync, Slew to target or do nothing.
- 6) Binning



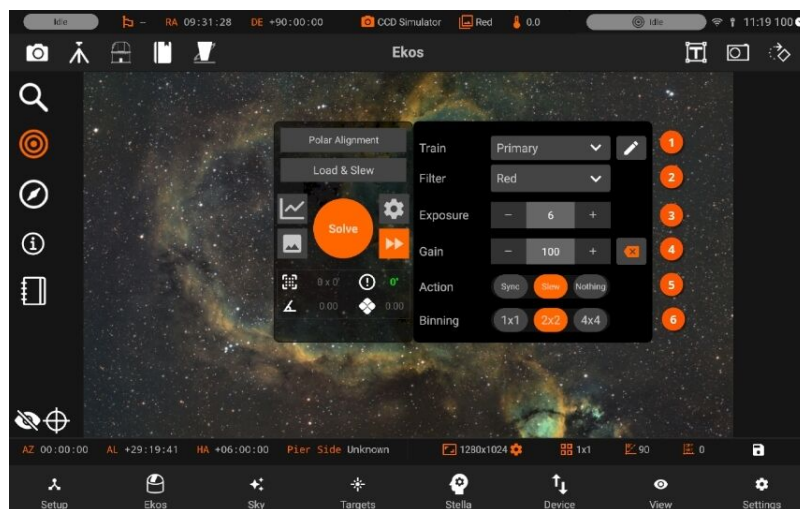
Graph Plot: Displays the alignment graph when the image has been plate-solved.



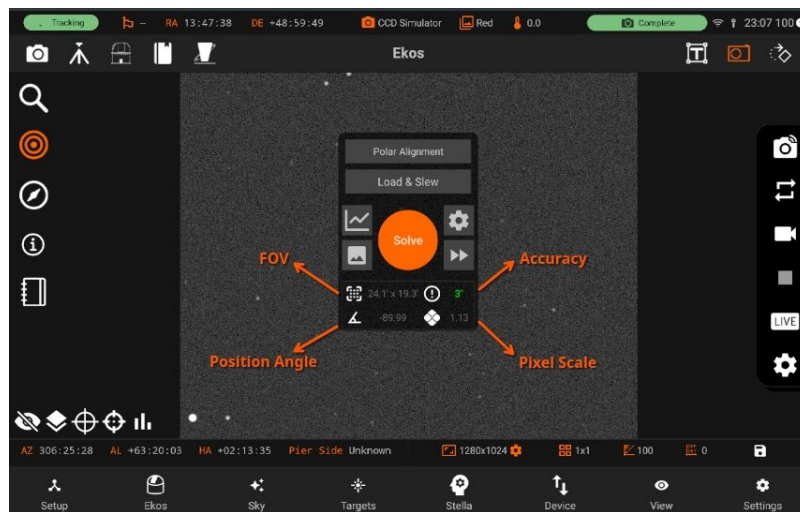
FiTs Image: Displays the most recent aligned image.



Settings: Opens the alignment settings menu. **Quick Settings:** Provides a quick method to modify the settings.



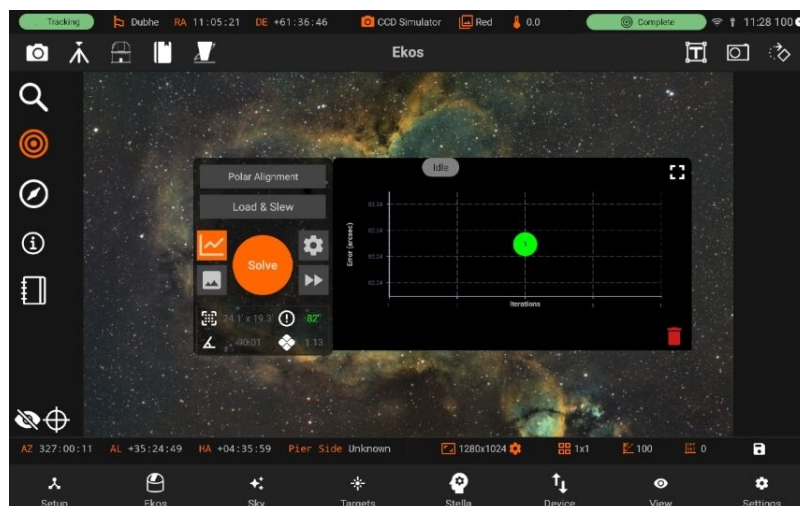
Solution Bar: Displays information such as field of view (FOV), position angle, error, and other details when the image has been plate-solved.



FOV: Effective field of view in arc-minutes. * **Position Angle:** Image Rotator angle, East of north. * **Accuracy:** Difference between target and solution coordinates in arcsecs. * **Pixel Scale:** Image pixel scale in arcsecs/pixel

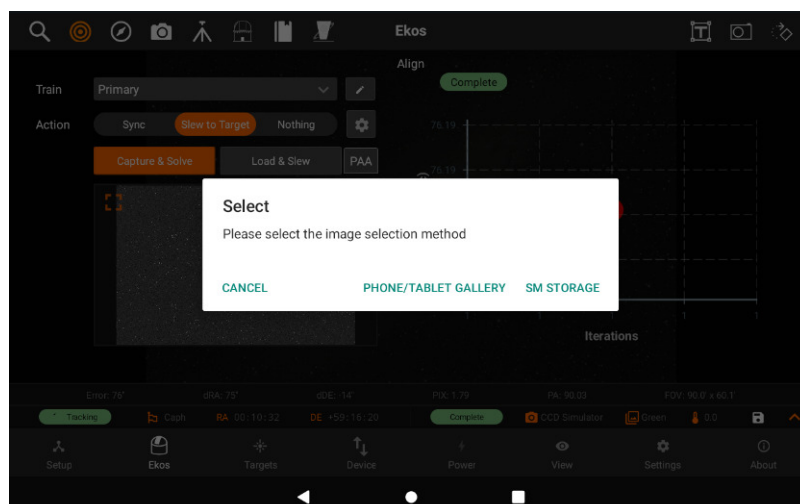
Capture & Solve

To start capturing and solving, just tap on the Capture & Solve button and the StellarMate will take care of the rest. When it's done, you will be able to see the current Alignment capture preview, alignment info on the solution bar on the bottom, and the points on the Alignment plot.



Load and Slew

It is used to command the mount to the center of the uploaded image. First, the provided image is plate-solved and then the mount is commanded to slew to the target. Afterwards, a second plate-solve with the camera takes place to ensure the mount is in the correct spot.

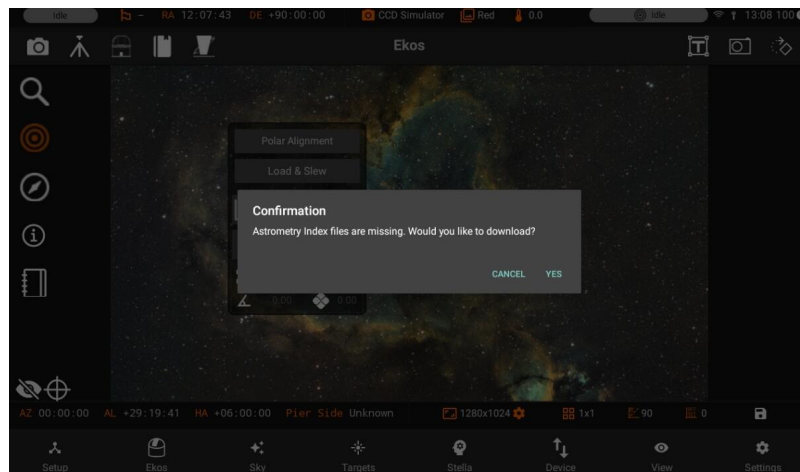


You can load Fits file from the tablet or using Directory browser to access SM device files. To start a load and slew action

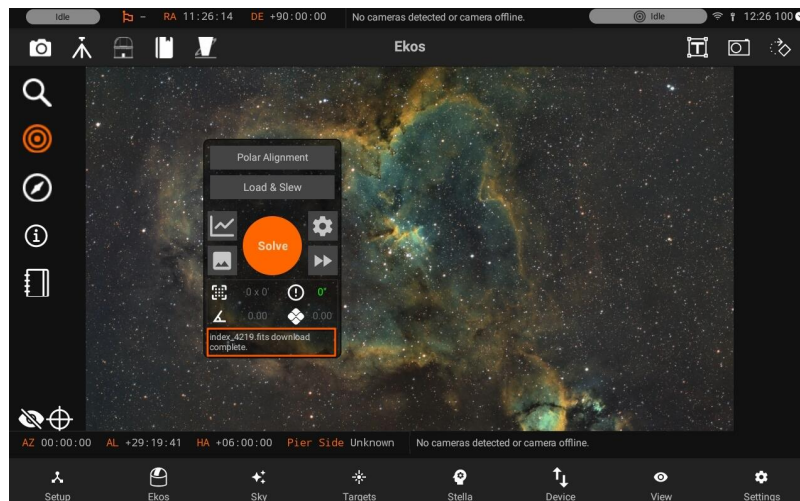
by tapping “Phone/Tablet Gallery” and selecting an image to slew to. Stellar-solver is very accurate at this and will be able to slew to object in the image.

Astronomy Index Files:

If index files are missing, a pop-up notification will prompt the user to decide whether to download the required files.



Below, the interface displays the status of the download progress to keep the user informed.



5.3.5.1.1 PAA

Polar Alignment Assistance (PAA)

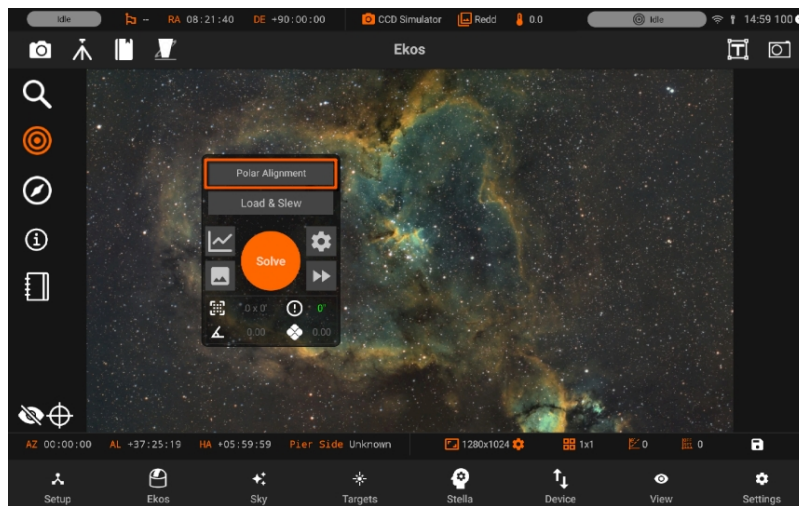
If your mount supports Polar Alignment, you can use the Polar Alignment Assistant (PAA) to improve your alignment.

The key is that you need a clear view of some stars, but they don't specifically need to be Polaris. The tool will analyze the star's movement pattern to determine the alignment corrections needed.

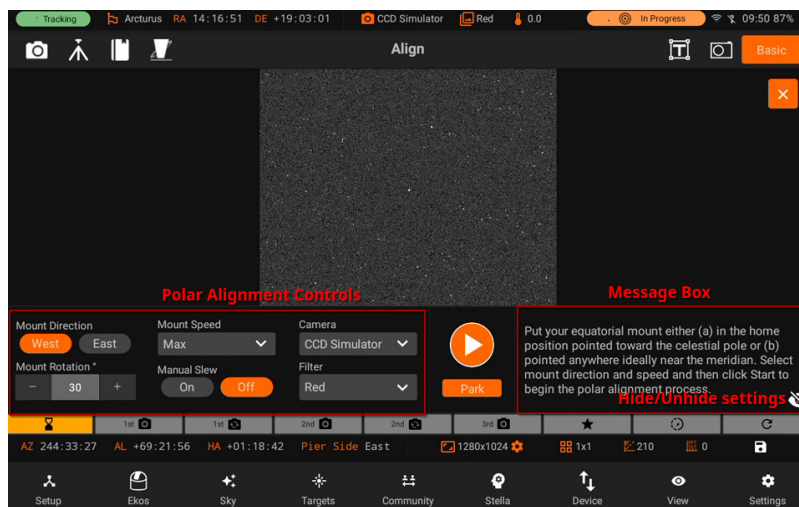
However, for best results:

Choose a star that's relatively high in the sky (around 30-60 degrees altitude) Make sure your mount is roughly aligned (within several degrees) Ensure your mount is level Use a star that isn't too close to the meridian (To prevent a meridian flip)

To start the polar alignment process, open the polar alignment assistance by clicking on PAA button.



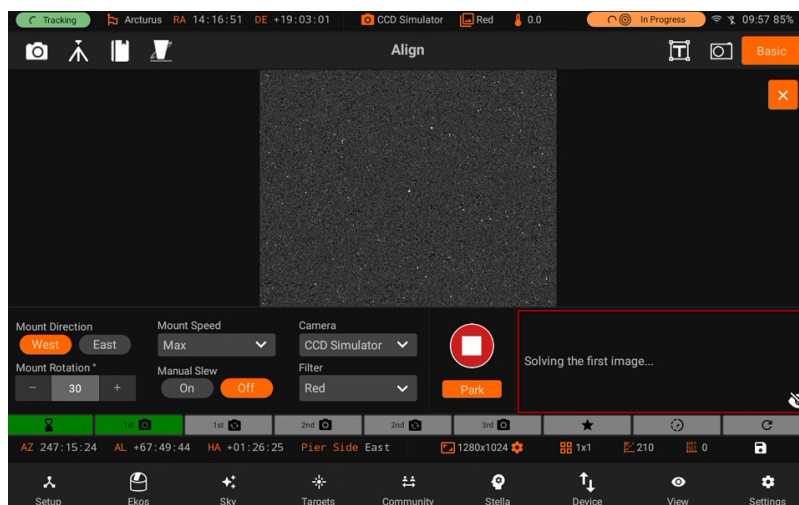
Use the Polar Alignment Settings to modify the settings.



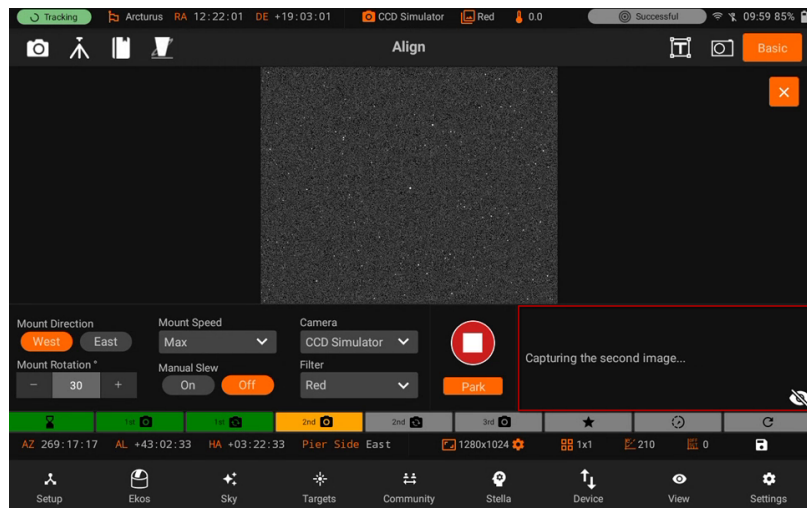
You can adjust the mount direction (1) by selecting West or East rotation. Adjusting the Mount Speed (2) by opening the speed menu and selecting the preferred rotation speed. Mount Rotation (3) allows the user to modify the amount of rotation the mount rotates after every capture. Manual Slew (4), the option to allow the user to manually rotate the mount after every capture and continue the process manually.

Set the preferred settings and follow the instructions at each step to complete the process.

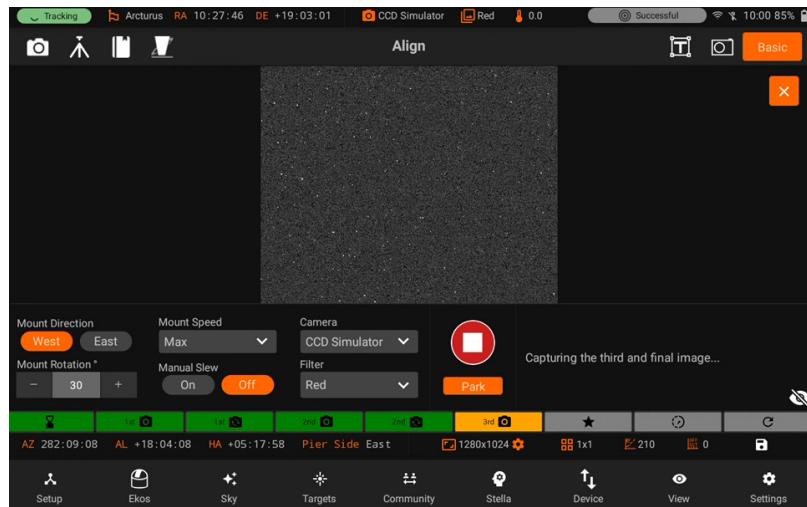
First Capture



Second Capture

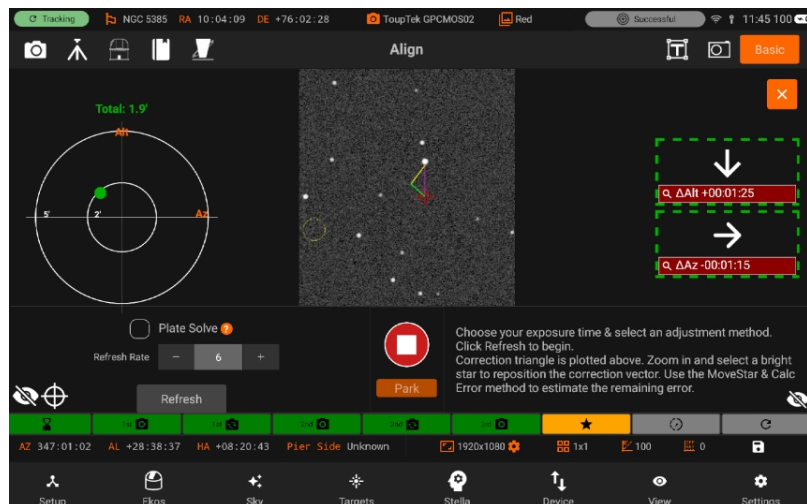


Third Capture

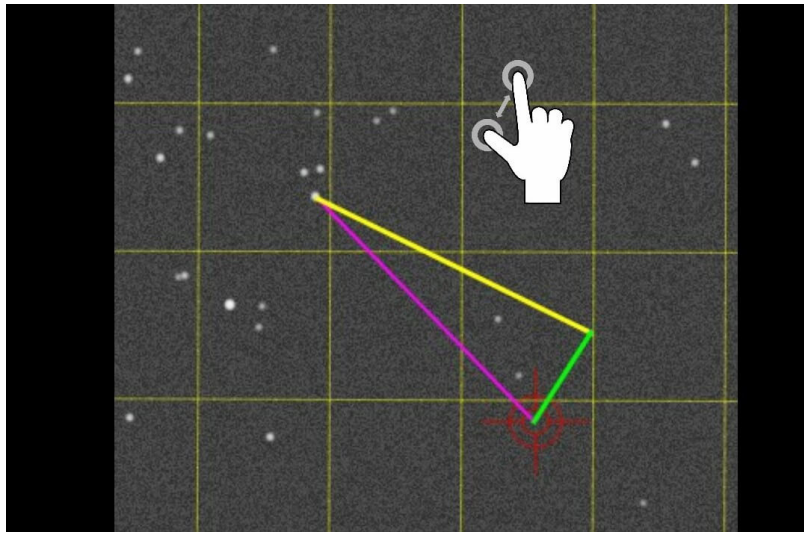


Select Star

Once all 3 images have been captures, you are shown the correction vectors. You can select a star to see the correction vectors relative to the selected star.



The correction vectors and screen will move to the selected position. At this stage you can use the pinch or spread gesture to use zoom in or out as shown. The zooming and tap features also works while the image is minimized.



Select Refresh & Algorithm

In the Refresh Stage, the user can adjust the refresh rate by changing the input on the right side, pressing Refresh to start the process.

(Note: at this stage, the refresh only starts once Refresh is clicked)

There are two different algorithms you can choose for PAA:

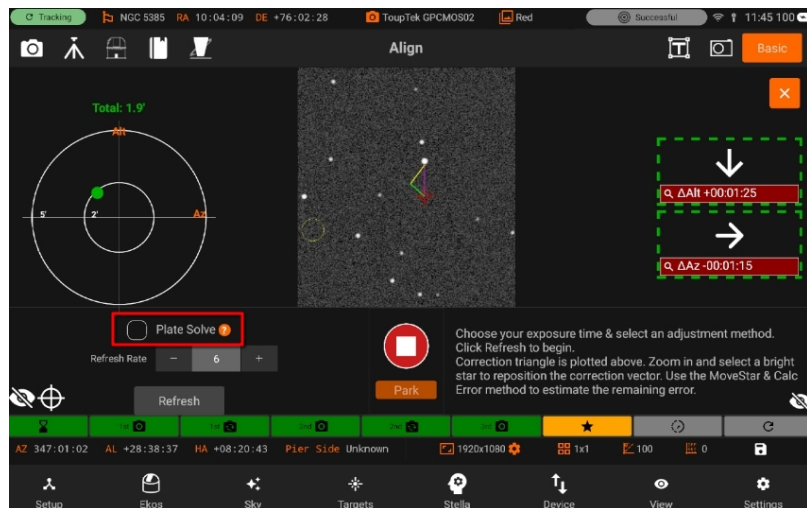
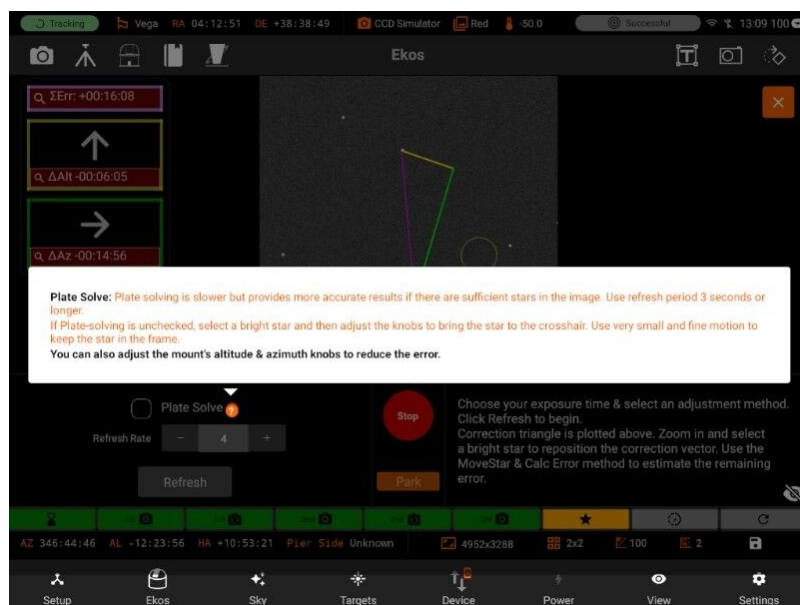


Plate Solving: Uses plate solving to track what the corrected alignment error is during the refresh process . User should try reduce the error in the Updated error line below and minimize the size of arrows. This is the only scheme that can fully correct an error larger than the image field-of-view, but depends on reliable plate solving.

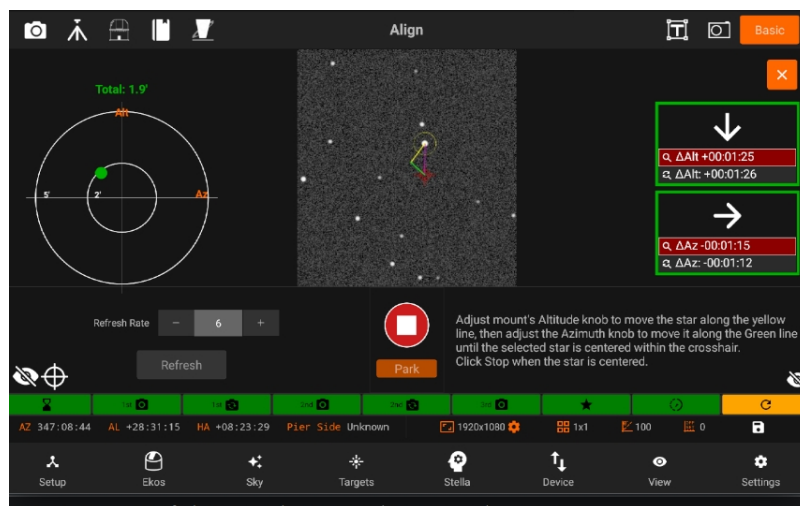
If Plate solve is unchecked, “Move Star & Calc error” Algorithm is used.

Move Star and Calc error: Like Move Star, but Ekos attempts to track the star being moved and estimates the current alignment error when it can.



Refreshing

Refreshing begins and can still be adjusted using the slider. Once done with Polar Alignment, simply press the Stop button.

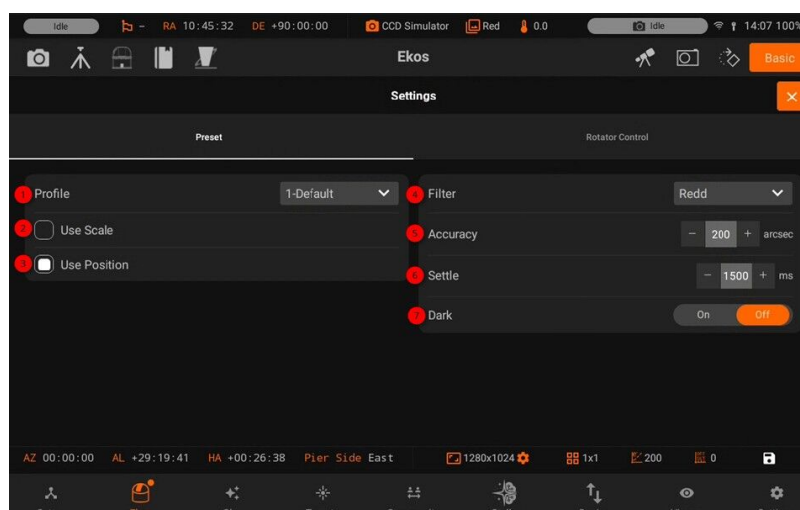


5.3.5.1.2 Settings

Following settings are from Align module:

5.3.5.1.2.1 Presets

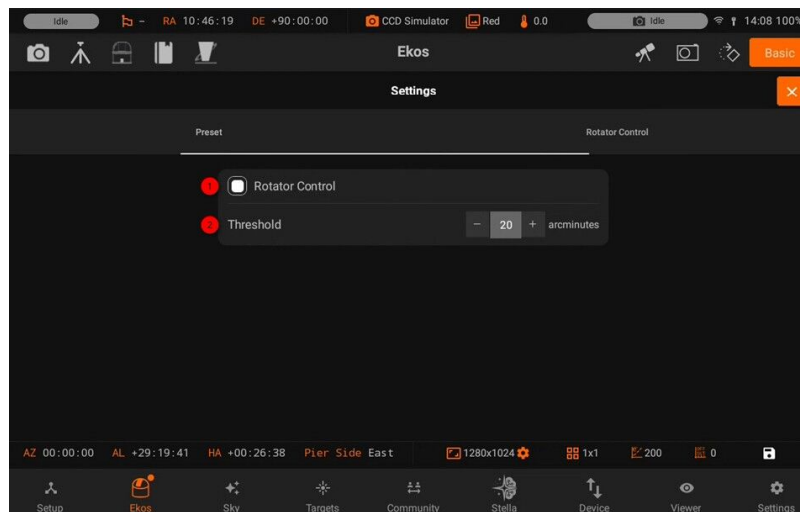
Preset Settings



Preset settings has the following structure:

1. **Profile:** Selects the Options profile to use for Plate Solving.
2. **Use Scale:** Use image scale to speed up astrometry solver. This speeds up the solver greatly as it limits the number of image scales it needs to sift through.
3. **Use Position:** Limit the astrometry solver to only search for solutions near the mount coordinates. This can significantly speed up the solving process.
4. Filter
5. **Accuracy:** Acceptable difference between reported telescope coordinate and actual solved coordinates
6. **Settle:** amount of time to allow mount to settle (in milliseconds)
7. **Dark Frame:** Subtract Dark frame. Create dark frames or defect maps in the Dark Library tool in the capture module.

5.3.5.1.2.2 Rotator control



Rotator control

1. **Rotator Control:** Use automatic or manual rotation control when using Load & Slew. For automatic control, the mechanized rotator is commanded to rotate to match the desired position angle. For manual control, the user is asked to manually rotate the camera until the desired position angle is reached.
2. **Threshold:** Rotator threshold in arc-minutes when using Load & Slew. If the difference between measured position angle and FITS position angle is below this value, the load & slew operation is considered successful.

5.3.5.2 Guide

The Guide module manages guiding the mount to ensure targets are locked at the center during imaging. A dedicated guide camera is required in the secondary optical train. It has the following features:

- AI Guiding Assistant
- Manage / Select Optical trains.
- Start guiding
- Preview
- Advanced Settings
- Image viewer
- Guide Plot



AI Guiding Assistant

The AI Guiding Assistant adds a trained, mount-specific feed-forward predictor to the internal guider. After a one-time training session, the AI learns the repeatable part of your mount's tracking error — such as periodic error and slow drift — and adds a predicted correction to each guide pulse before the error becomes visible in the guide image. The standard guiding algorithm keeps running underneath at all times and corrects whatever the prediction misses.

Warning

: The AI Guiding Assistant is an experimental feature under active development. Trained models are tied to your specific mount, camera, and guide settings. Always verify your guiding performance after enabling it, and be prepared to switch back to the Standard or GPG algorithms if your results are not better with the AI.

Expectations and Prerequisites

Please read this part carefully before investing time in training a model — it will save you from disappointment later.

Warning

AI guiding **augments** a well-functioning guiding setup — it does not repair a poorly functioning one. It predicts the *repeatable* part of your mount's error and layers that prediction on top of the standard guiding algorithm. It will **not** fix:

- poor polar alignment,
- imbalance, cable drag, or differential flexure,
- wind gusts, vibrations, or bad seeing,
- a mount or guide system that is not already well tuned.

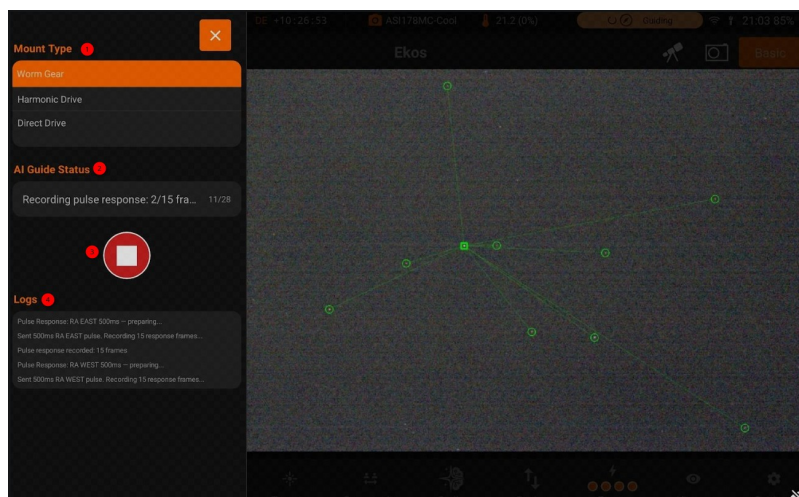
None of these are repeatable errors, so no amount of training can predict them. If standard guiding does not work well on your system, fix that first. The improvement from AI guiding varies considerably from mount to mount, and on some mounts you may see no measurable benefit at all.

Before running the assistant, make sure that:

- You are using the internal guider, with a working guide camera and a completed, successful calibration.
- Ordinary guiding with the Standard algorithm already works reliably on your setup.
- Your mount is well polar-aligned, balanced, and free of cable snags.
- You know your mount's drive type: worm gear (most equatorial mounts), harmonic/strain-wave drive, or direct drive.
- Your guide exposure is the one you intend to keep using: the model is trained and locked to the guide exposure, binning, and guide settings used during data collection.
- You have 20–45 minutes of clear, reasonably steady sky to spend on data collection, depending on the mount type.

Data Collection with the AI Guiding Assistant

Training a model starts with a system identification session: the assistant points the mount at a few positions in the sky and records how the guide star drifts, both with guiding running and with guiding deliberately paused (“free drift”), so that the mount’s raw error signature can be measured. Click AI Guiding (Experimental) → AI Guiding Assistant... on the Guide page to start the wizard.

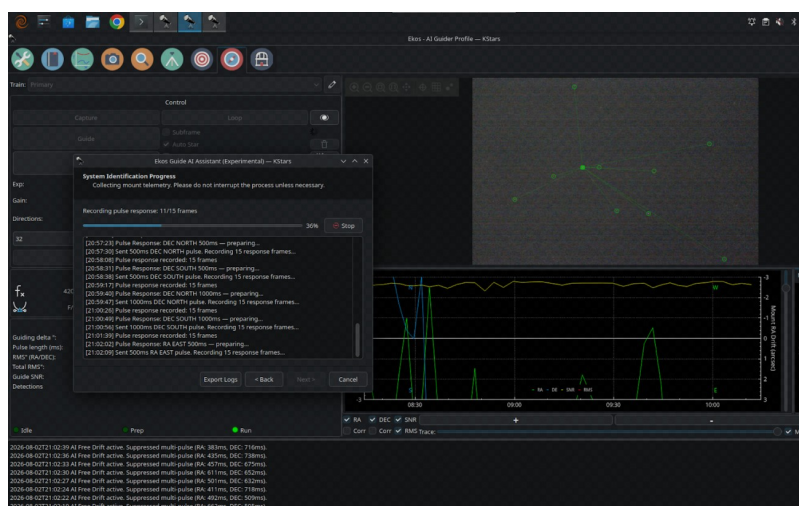


Verify the detected mount type: - Worm Gear - Harmonic Drive - Direct Drive. Also recommends a guide exposure per drive type — 2.0 s for worm gears, 0.5–1.0 s for harmonic drives (depending on guide star signal), and 1.0–3.0 s for direct drives. Set your exposure before proceeding: the trained model is locked to it.

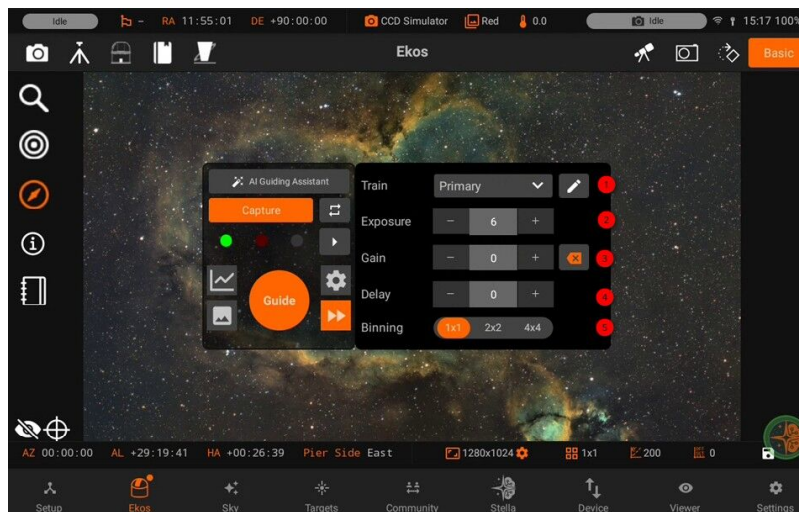
The protocol depends on the mount type:

- ****Worm Gear (~45 minutes):** ** three pointings at high, lower, and high altitude, each combining standard guiding with several minutes of free drift. The long free-drift phases capture roughly three full worm cycles, which is what allows the periodic error to be measured.
- ****Harmonic Drive (~35 minutes):** ** free drift and standard guiding at two pointings, plus a series of short pulse-response tests (50, 100, and 200 ms pulses in all four directions) that measure how the drive reacts to corrections.
- ****Direct Drive (~20 minutes):** ** short guiding and free-drift phases at three different altitudes.

Press the Play button to start the guider, then monitor the AI Guider log for status updates.



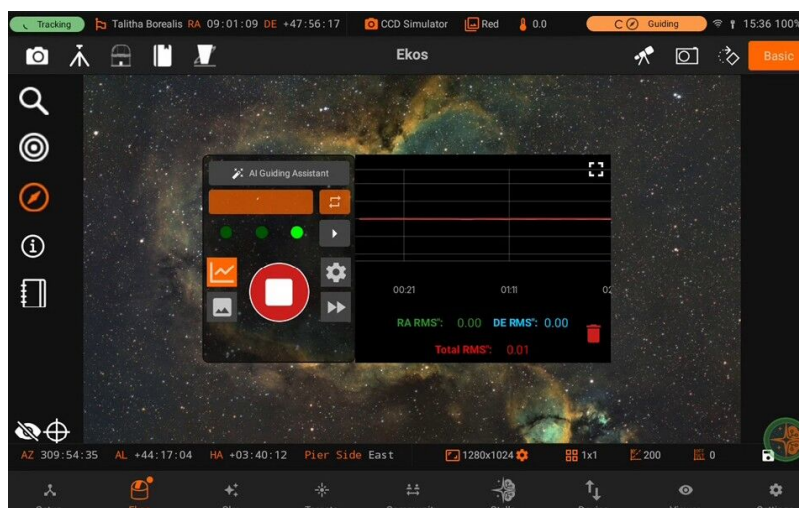
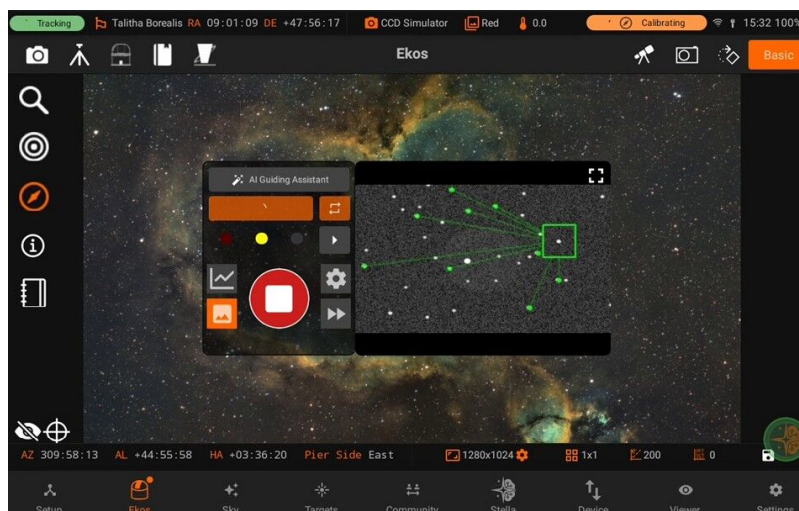
Guide Quick Settings



- 1) **Train:** You can Select / Edit a train specifically for Align module. Each module has it's own train. Visit Optical trains topic for more.
- 2) **Exposure:** Exposure time in seconds
- 3) **Delay:** Delay in seconds between image captures.
- 4) **Binning:** Guide camera binning. It is recommended to set to 2x2 or higher.

Guiding

You can start guiding by tapping on the Start button. The guide module will start by calibrating, and then will start the guiding process. When guiding is in progress, you will be able to see the Guide plot being populated with lines for the RA drift, DE drift and the Total RMS. You can also check the values for RA RMS, DE RMS and Total RMS under the plot.

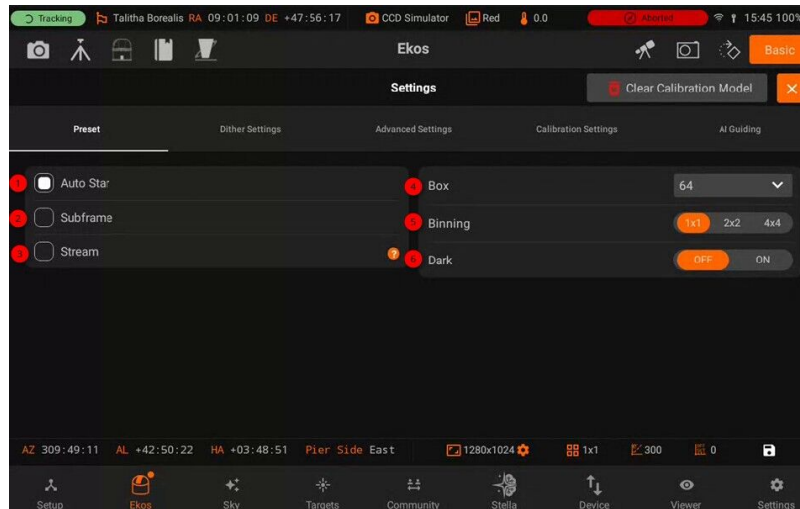


5.3.5.2.1 Settings

Following are the settings from Guide module:

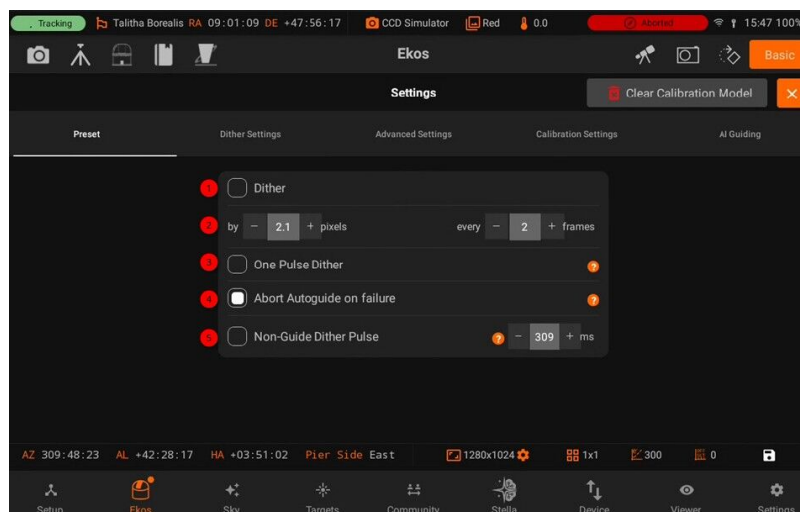
Preset settings Advanced settings Calibration settings

5.3.5.2.1.1 Preset



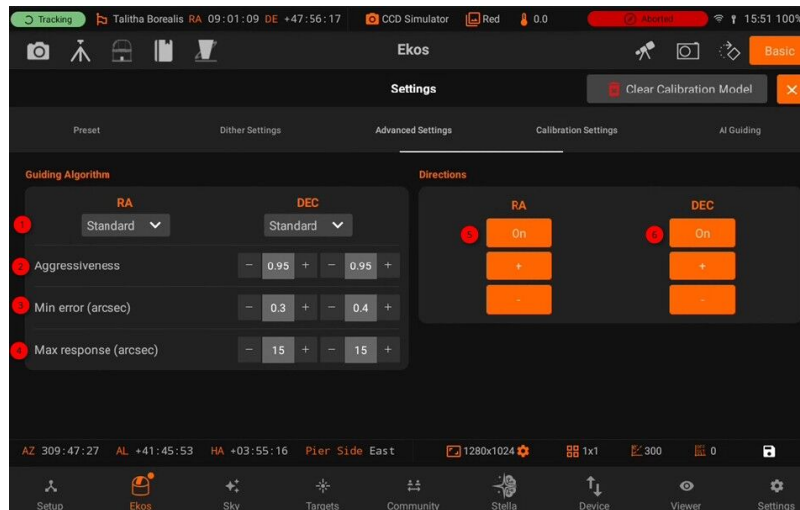
- **1. Auto star:** Automatically select the calibration star. SEP Multi Star does always use ‘auto star’ detection.
- **2. Subframe:** Subframe the image around the guide star. Or for PHD2, receive the Guide Star Image instead of the full image frame. For the Internal Guider, before checking this option, you must first capture an image and select a guide star. Uncheck it to take a full frame again.
- **3. Stream:** Enable streaming guide mode. When checked and the camera supports video streaming, the guide module captures frames via a continuous video stream instead of individual exposures. This significantly reduces per-frame overhead and enables higher guiding frequencies (e.g. 2-5 Hz) required by harmonic drives. Not compatible with dark-frame subtraction.
- **4. Box:** Guide star tracking box size. Box size must be set in accordance to the selected star size.
- **5. Binning:** Guide camera binning. It is recommended to set binning to 2x2 or higher.
- **6. Dark:** Subtract dark frame. If no dark frame is available, a new dark frame shall be captured and saved for future use.

5.3.5.2.1.2 Dither



- 1. Dither:** Allows manual dithering. **3. Pulse:** If checked, dithering amount is randomly generated, pulses are sent, but the resultant pixel dithering amount is not enforced so only the one dither pulse is sent. This is quicker, and recommended as dither amount is random anyway. It is necessary when 2-D dither is required but guiding is only done in one axis **4. Abort Autoguide::** Abort Autoguide on failure **5. Perform Dithering:** Perform dithering, When not guiding

5.3.5.2.1.3 Advanced



1. Algorithm: Select the guide pulse algorithms for RA and DEC. * **Standard:** The traditional proportional guide algorithm. It computes a pulse to correct the computed guide drift. The aggressiveness parameter decides what proportion of the error is corrected. Errors smaller than MinError won't be corrected. Max response limits the largest correction. The hysteresis parameter is not used. * **Hysteresis:** Hysteresis is like the standard algorithm but weights in the previous correction according to the hysteresis parameter. Integral gain does not apply. * **Linear:** This is similar to the PHD2 Lowpass2 algorithm. It computes the error pulses based on a short history of recent errors. This may be applicable to very stable mounts. Hysteresis and Integral gain do not apply. * **GPG:** (RA Only) The GPG algorithm tries to predict periodic error and linear drifts. It uses the aggressiveness, min and max parameters here, and more parameters on the separate GPG tab. Hysteresis and Integral gain do not apply. **2. Aggressiveness:** How aggressively the guider attempts to correct the guide deviations. 1.0 would attempt to fully correct the error. It's best to use an aggressiveness less than 1.0 to avoid oscillations. **3. Min Error (arcsec):** Minimum guide deviation in arc-seconds for which a guide pulse would be sent to the mount. If the guide error is less than this value, then no pulse is sent to the mount. **4. Max Response (arcsec):** Maximum guide pulse that is generated by the guider and sent to the mount in arc-second units. That is, the guider will not attempt to move the mount more than this many arc=seconds at any given time.

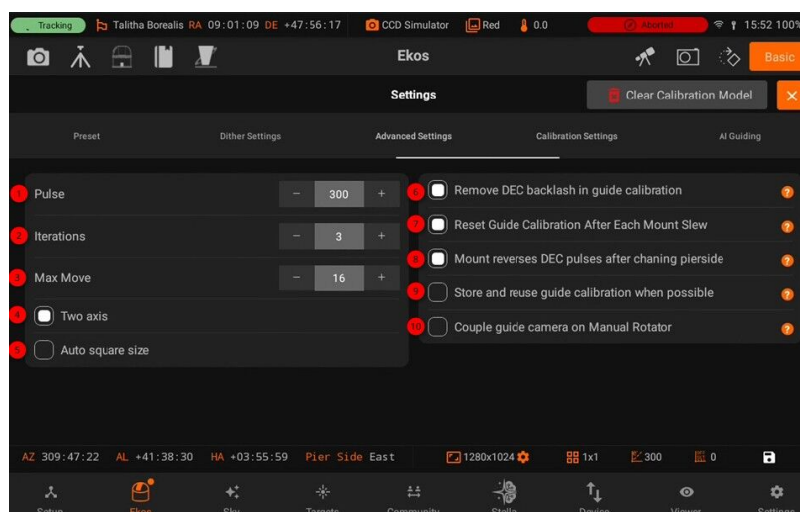
Directions: Shows the values of RA and DEC. **5. RA:** Guide Right Ascension Axis

- +: East Direction Guiding
- -: West Direction Guiding

6. DEC: Guide Declination Axis

- +: North Direction Guiding
- -: South Direction Guiding

5.3.5.2.1.4 Calibration

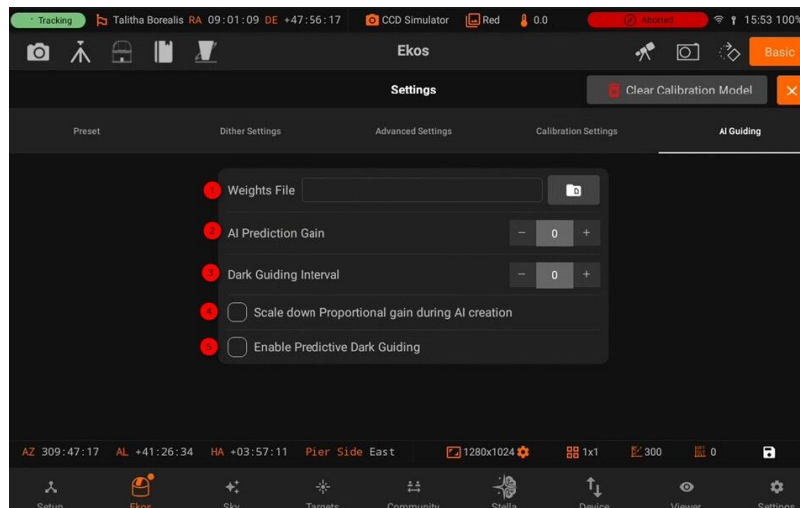


- **1. Pulse:** Initial pulse size for calibration.

- **2. Iterations:** Maximum number of iterations calibration should use per phase. It may use fewer (If max move is reached).
- **3. Max move:** Maximum number of pixels the calibration should move. Once it exceeds this amount, it will finish the calibration phase. It may move less if max iterations is reached.
- **4. Two axis:** Check if you want the calibration process calibration in both RA & DEC. If unchecked, the calibration is only performed in RA.
- **5. Auto square size:** Automatically select the square size based on the selected star width.

Checkbox options * **6. calibrate_backlast:** Remove DEC backlash in guide calibration * **7. reset_calibration:** Reset Guide Calibration After Each Mount Slew * **8. pierside:** Mount reverses DEC pulses after changing pierside * **9. reuse_calibration:** Store and reuse guide calibration when possible * **10. Manual rotator:** Couple guide camera on Manual Rotator

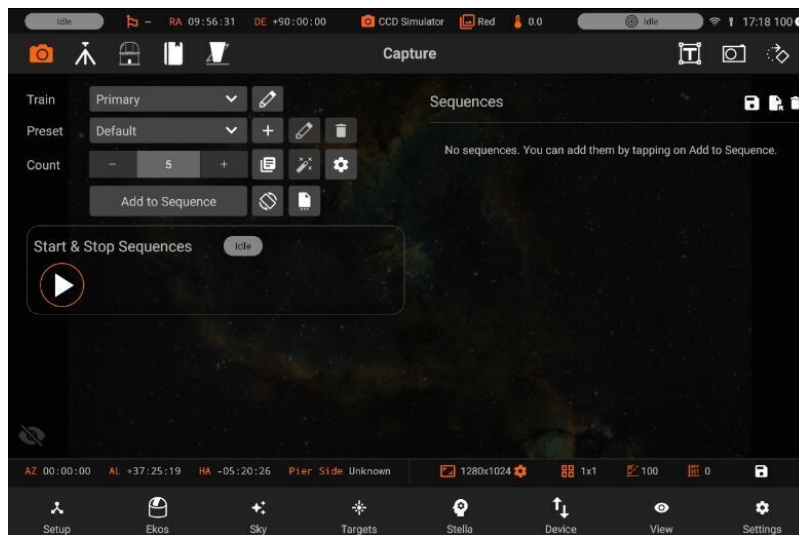
5.3.5.2.1.5 AI Guider



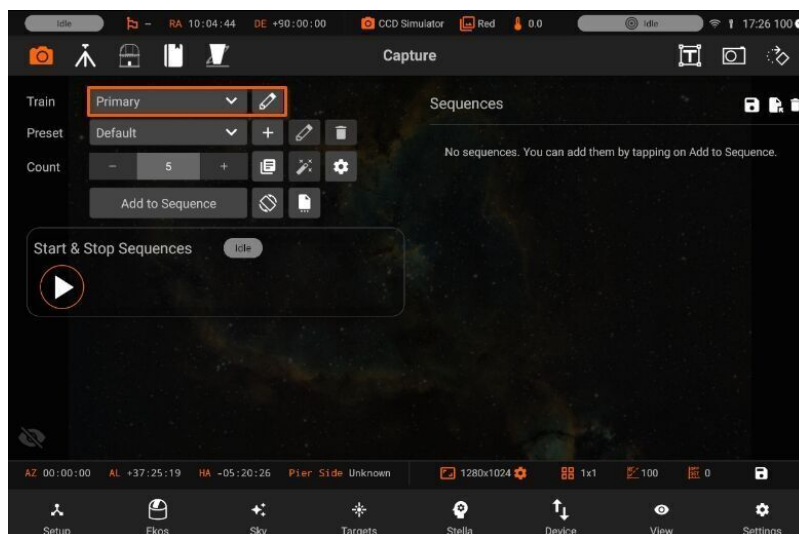
1. **Weights File:** path to the trained model weights (JSON).
2. **AI Prediction Gain (default 0.5):** how strongly the AI prediction is blended into the guide pulses. 0.0 ignores the AI entirely; 1.0 applies its full prediction. Start at the default and increase gradually if guiding improves.
3. **Dark Guiding Interval (default 1.0 s):** seconds between predicted pulses when no guide-star measurement is available.
4. **Scale Down Proportional:** Gain During AI Correction (default off): reduces the standard proportional response by up to half when the AI is highly confident, to avoid the two controllers over-correcting the same error.
5. **Enable Predictive Dark Guiding (default off):** keeps emitting predicted corrections during gaps in guide star measurements — dither settling, autofocus runs, or camera downloads — by extrapolating the periodic error forward in time.

5.3.5.3 Capture

The Capture module is the primary interface for managing imaging tasks on StellarMate. It allows you to preview images, configure settings, create capture sequences, and configure imaging settings.



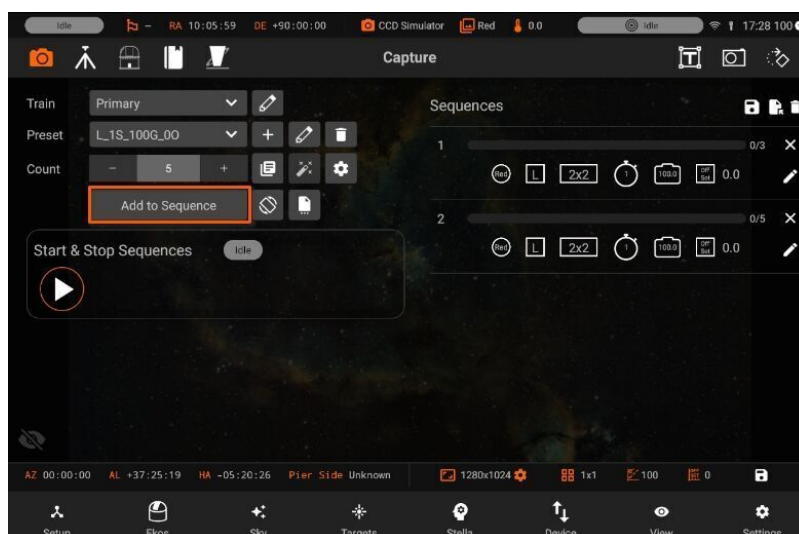
All captures are performed using an Optical Train. An optical train is a collection of devices including camera, telescope, mount, filter wheel, and other devices that work together to capture images.



The terms Sequence and Job are used interchangeably in this document.

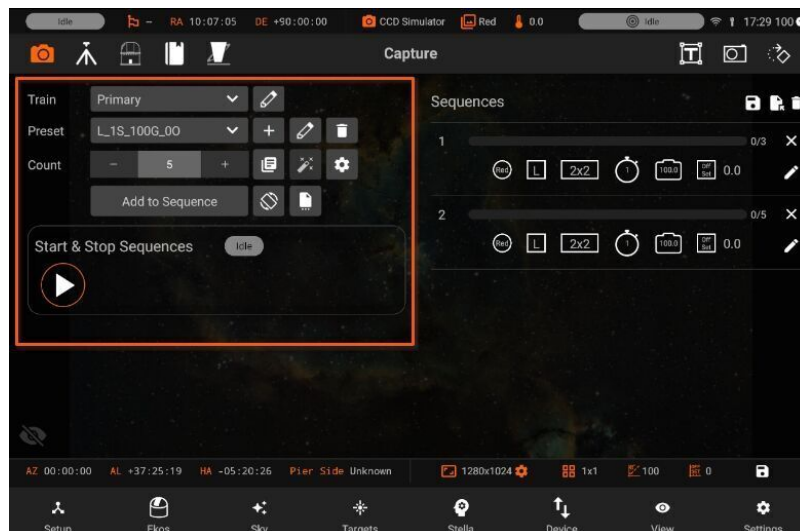
Sequences are a collection of **capture jobs**. Each job is defined by a **preset** that specifies the imaging **parameters**. These parameters include **exposure time**, **binning**, **filter**, and **other settings**.

To create a new sequence, select a **preset** and specify the desired number of images to capture (count). Then, tap “Add to Sequence” to add the job to the Sequence Queue.



This structure allows you to efficiently capture multiple images with consistent settings, making it easier to manage your astro-photography sessions. The left side of the Capture module is used to configure settings, optical trains, and presets,

while the right side displays a list of sequence jobs.

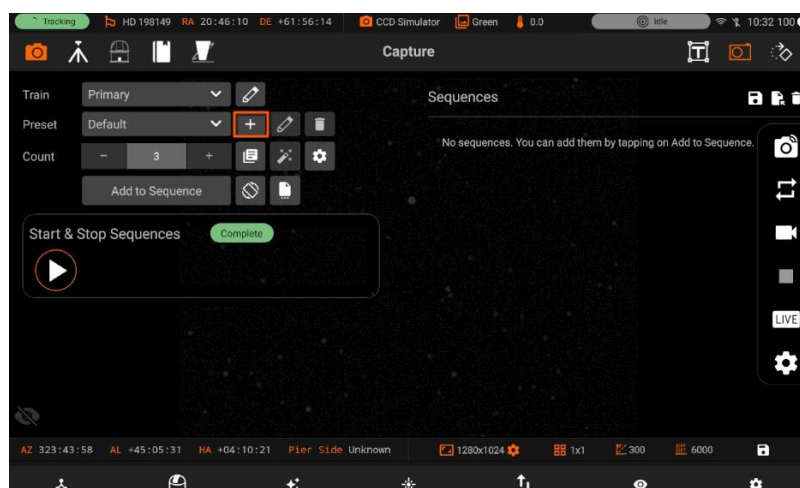


5.3.5.3.1 Presets

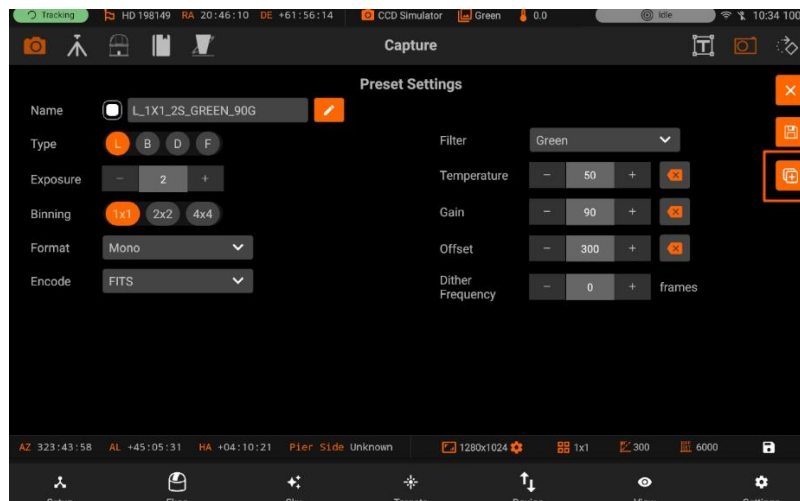
A preset is a collection of settings for a single capture job. These settings are applied to each capture job, while the capture settings are applied globally to all jobs.

When creating a new preset, the preset label is automatically generated based on the selected settings (e.g., exposure time, binning, filter). This helps you easily identify presets in the future.

To add a new Capture Preset, tap the + icon.

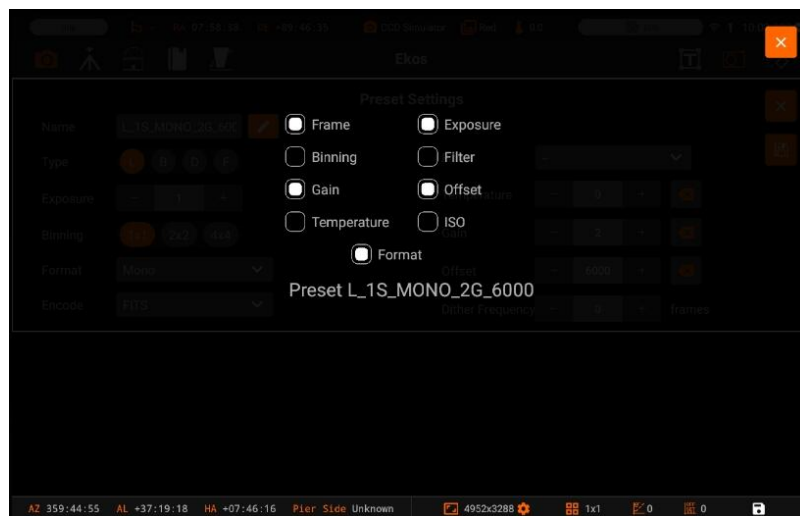
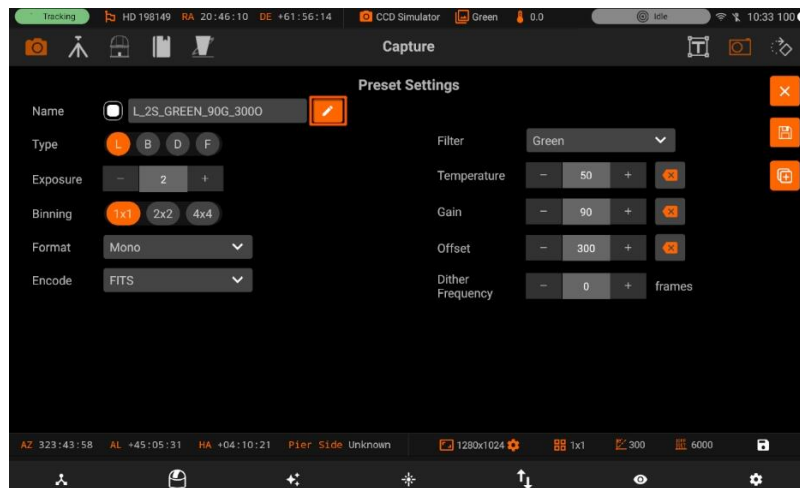


All settings marked with “–” mean leave as-is. For example, if the current gain is 100, and the job is executed, the gain would be left as-is.

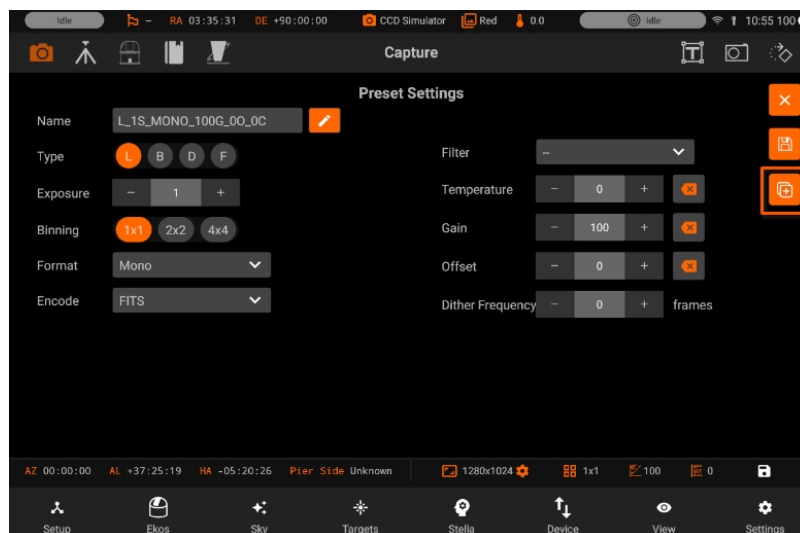


Once you press the Saved button (on the right side) Preset will get saved.

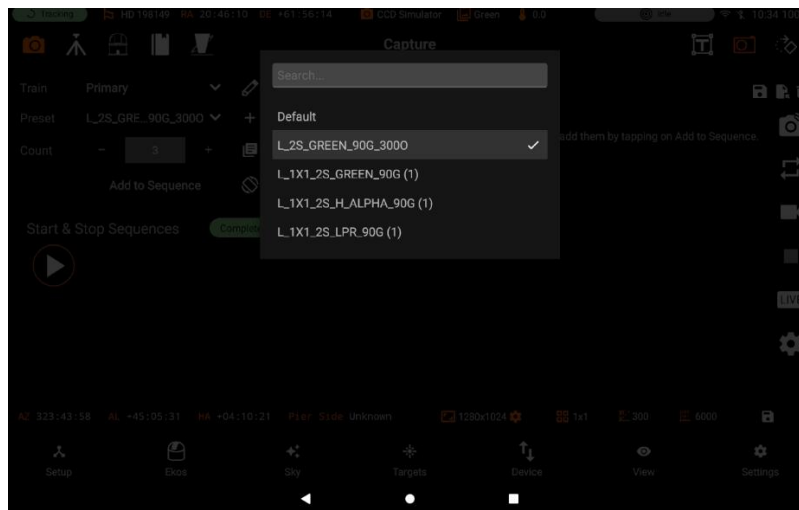
To customize the preset label generation, tap the “Edit” icon next to the preset name. You can modify the label format to suit your preferences



When you edit a preset, you can also duplicate the Preset. Duplicating a preset can be handy when you need to only alter one or two fields while keeping the rest the same. To duplicate a preset, tap on the duplication icon.

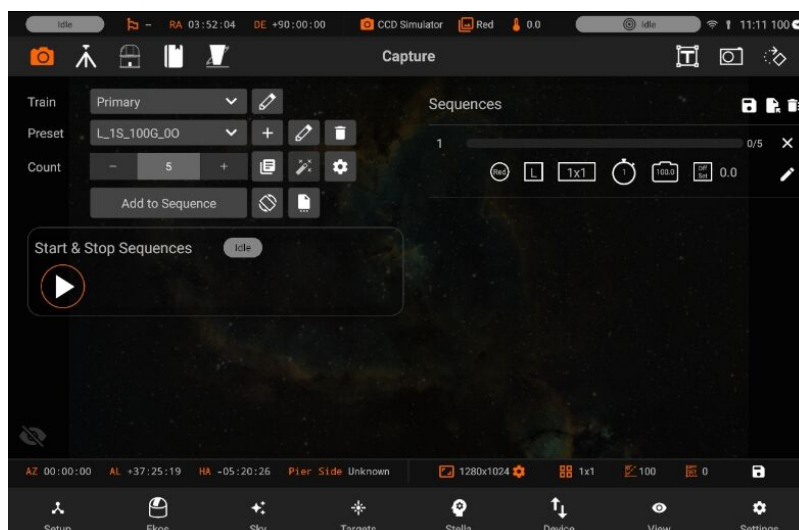


You can also create the same preset with the multiple filter names. Hence with multiple filter names you can have presets as shown in the screenshot below:

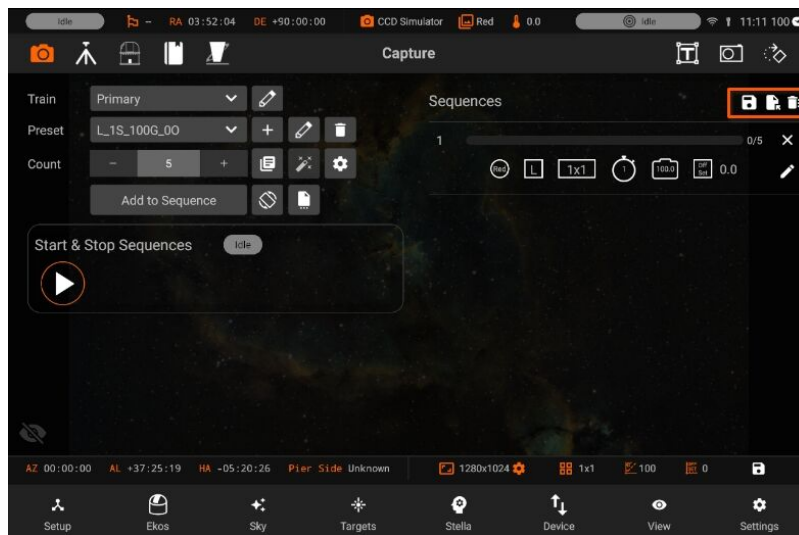


- **Preset Editor** contains the following fields:
- **Preset name:** Name of the preset.
- **Frame Type:** Specify the type of desired camera frame. Options are Light, Dark, Bias, and Flat frames.
- **Exposure:** Specify exposure duration in seconds.
- **Binning:** Specify horizontal (X) and vertical (Y) binning.
- **Format:** Specify capture save format (FITS, XISF, or Native when available)
- **Encoding:** For DSLR cameras, you can an additional option to save in Native format (e.g. RAW or JPEG).
- **Filter:** Specify desired filter.
- **Temperature:** Set the desired temperature, if your camera is equipped with a cooler. Check the option to force temperature setting before any capture. Capture process is only started after measured temperature is within requested temperature tolerance
- **Gain:** Specify the value of gain. Leaving it to – would not change the current gain set in the camera
- **ISO:** For DSLR cameras, specify the ISO value.
- **Offset:** Specify the value added to avoid the reads to clip at value “zero”. Leaving it to – would not change the current offset set in the camera.
- **Dither frequency:**

5.3.5.3.2 Sequences

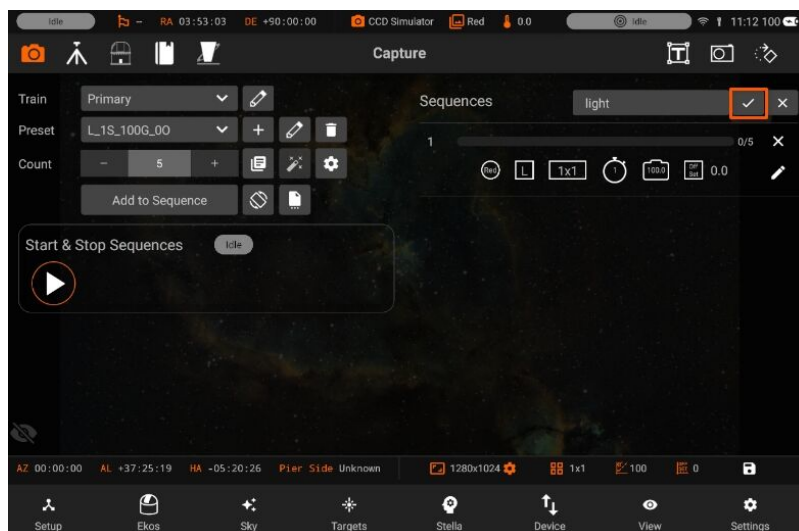
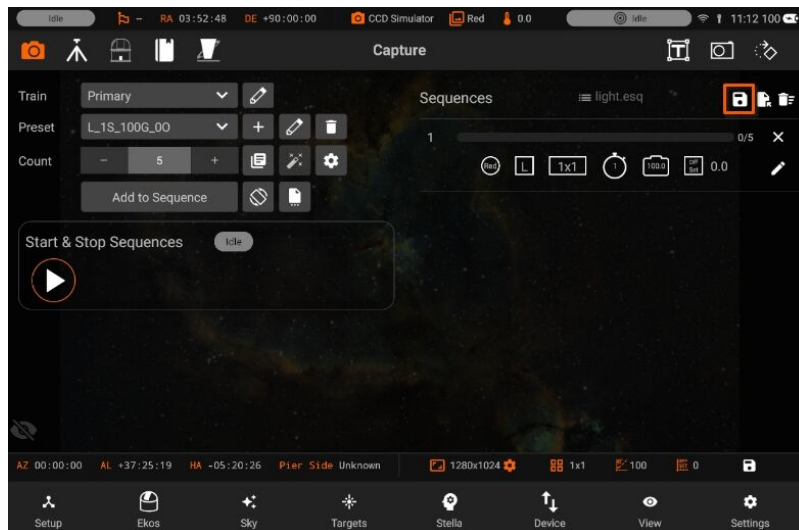


Manage, save, and load sequences in the sequence queue.

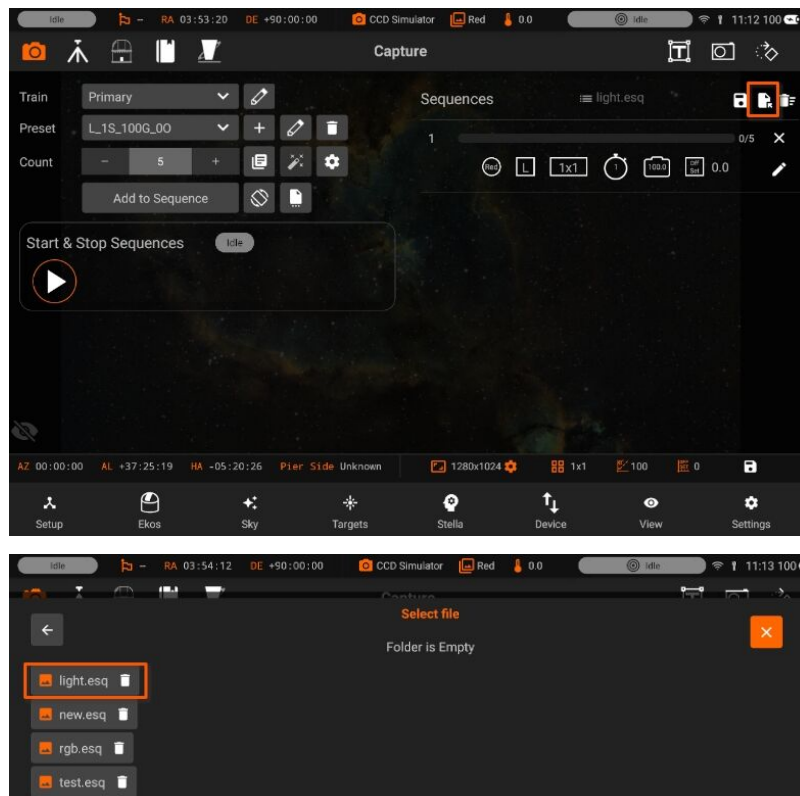


The queue displays a list of sequences where each sequence status, count, and preset is displayed using icons for common settings such as Filter, Gain, ISO, and Offset.

Once a sequence is added, you can save the sequence list by tapping on the Save Icon on the top-right. Tap the trash icon to clear all jobs.

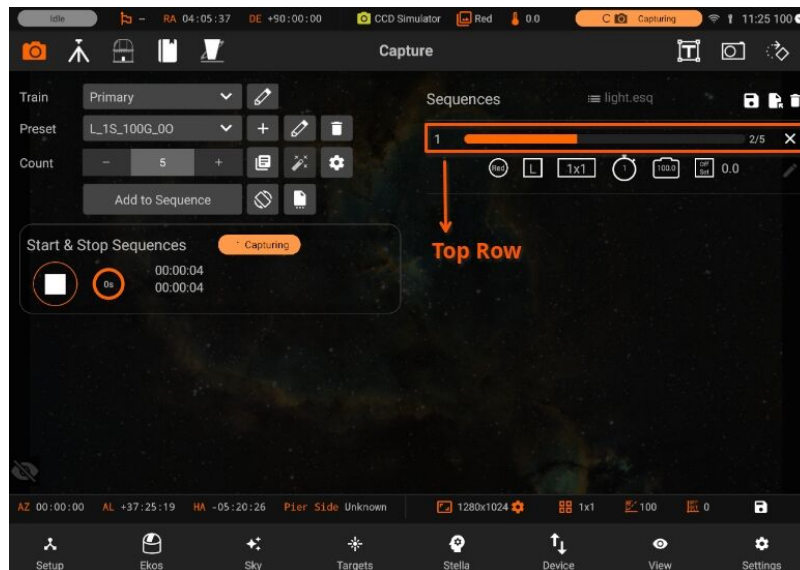


Sequences are stored under the Documents folder followed by your camera name. The sequence file can be re-used in future sessions when desired, especially when using the scheduler.



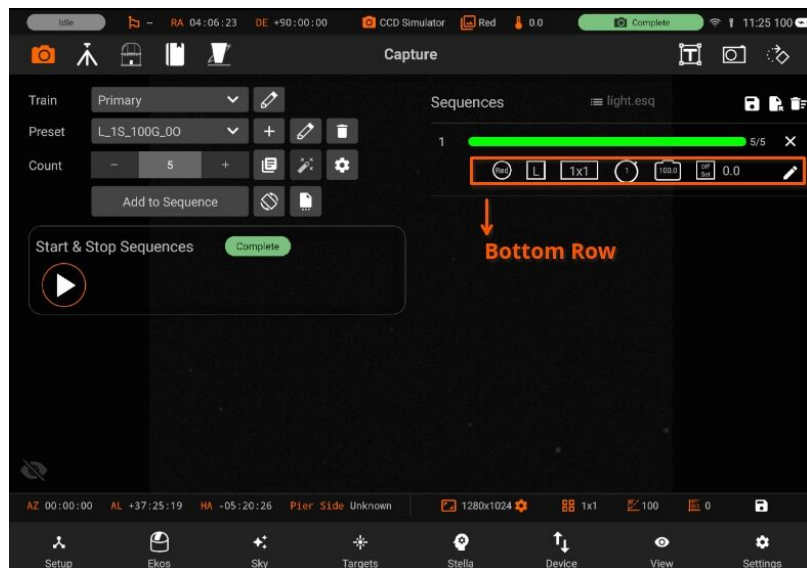
Sequences have the following structure, displayed through icons for simplicity:

Top row

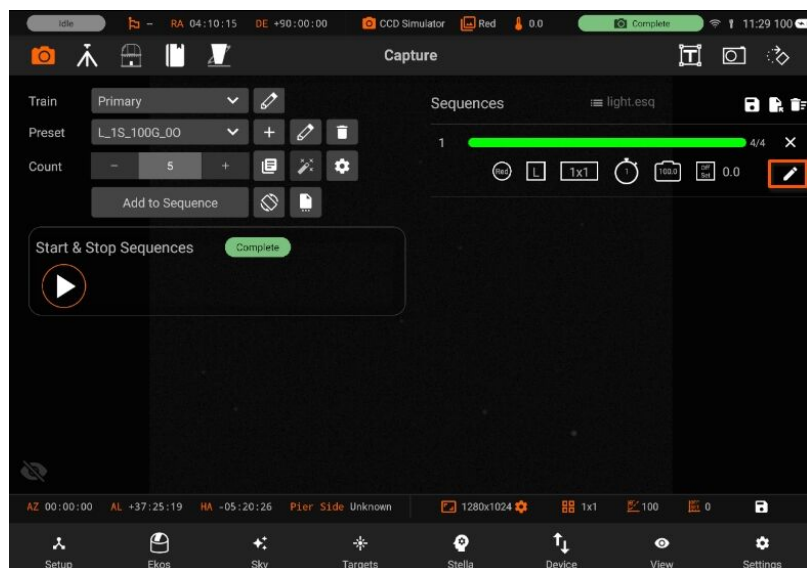


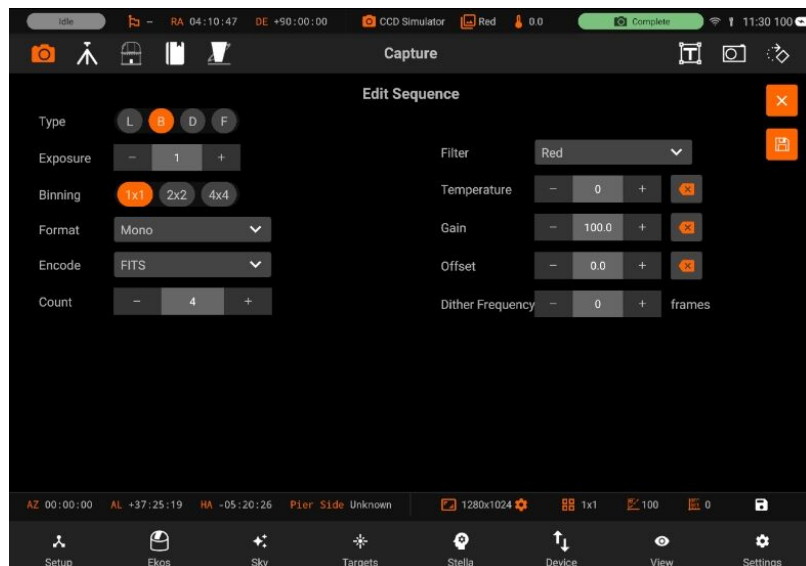
- Job Number
- Job Progress Bar
- Count Progress
- Delete Job

Bottom row

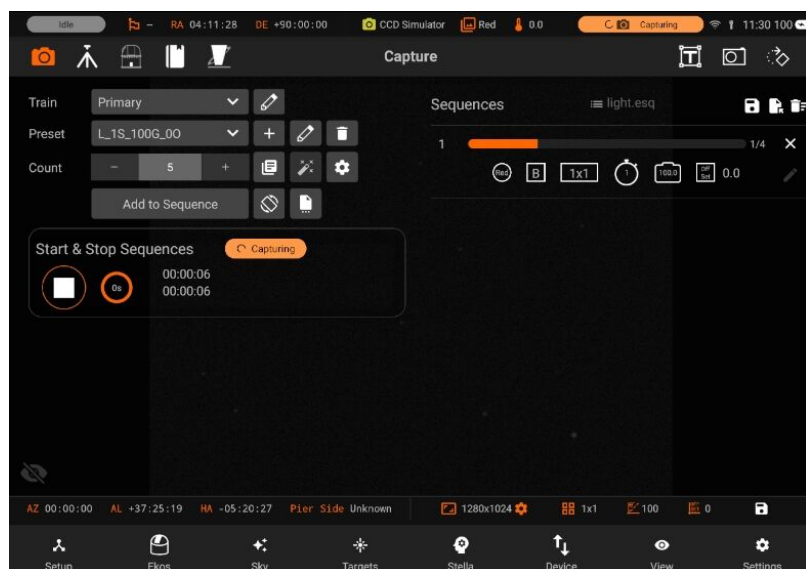


- Filter
- Frame Type
- Binning
- Exposure
- Gain/ISO
- Offset
- Edit Sequence



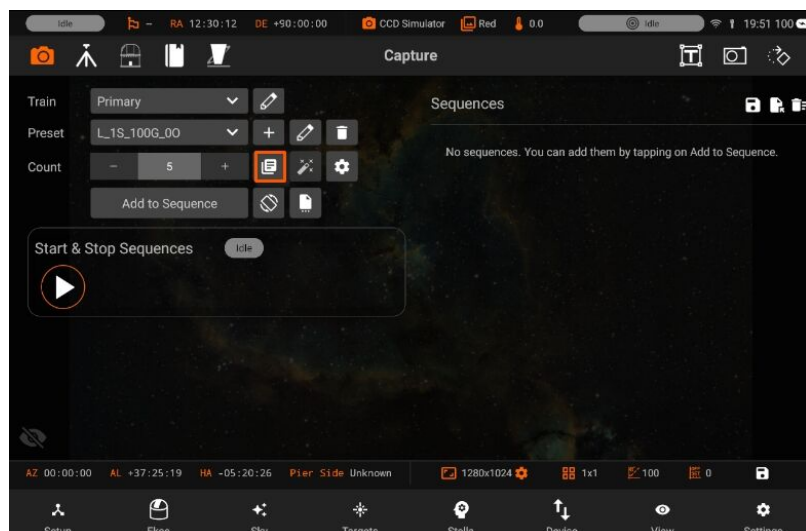


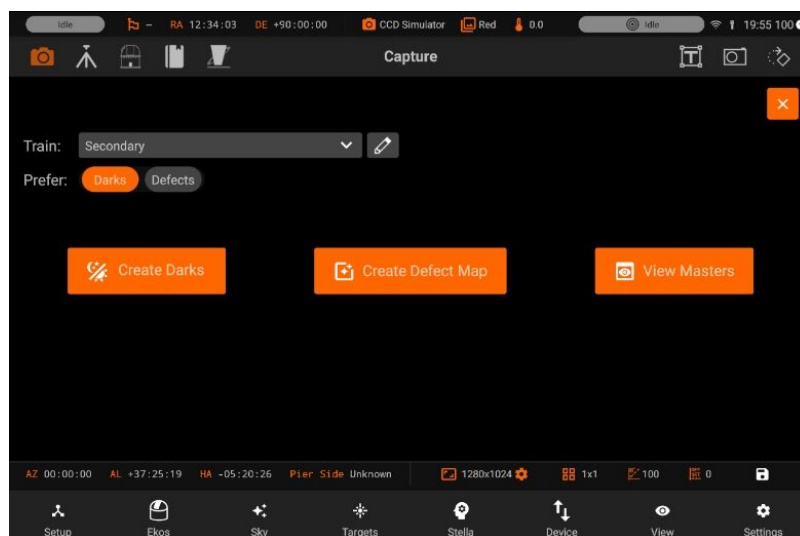
After adding the sequences, tap on the Play button under the Progress header to start the capture process. A soft ding sound is played for each captured image (if enabled in settings).



5.3.5.3.3 Dark Library

Dark Library





The Dark Library is a collection of dark frames captured from your cameras under different settings. There are basically five primary types of frames:

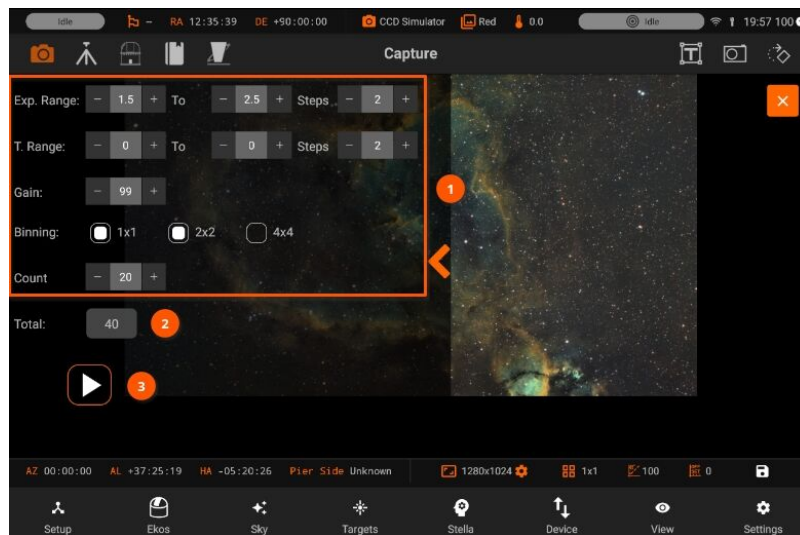
- **Light Frame:** This is the regular image captured by your sensor. It is called light because it captures the incoming light received at the sensor.
- **Dark Frame:** A frame captured with the same settings as the light frame (same temperature, exposure time, and binning) but with the shutter closed so that no photons reach the sensor. This is used to record the electronic noise generated by the sensor without any incident photons. It is used to remove noise from the Light Frame by means of subtraction since the Light Frame includes signal from both the incoming photons and electronic noise generated by the sensor.
- **Bias:** A very short exposure with the shutter closed.
- **Flat:** A frame captured with the same settings as the light frame (same temperature, exposure time, and binning) but subjected to an illuminated flat field source (such as an LED panel). This is used to correct for optical aberrations in the imaging train including dust motes.
- **Dark Flats:** Special type of dark frames captured at the same exposure of flat frames. This is used to calibrate the flat frames.

Dark Library is used to capture dark images.

Generating a dark library for your equipment profile is highly recommended. When capturing frames in focus, guide, and align modules, the system searches the dark library for suitable dark frames. If a suitable match is found, the light frame is calibrated and this can greatly enhance the performance and accuracy of all Ekos modules. * **Note:** “Dark Library is not used to calibrate your sequence images, it is only used to calibrate the Align, Focus, and Guide module frames.” Dark frame calibration can be applied using two methods: * **Dark Subtraction:** The dark frame is simply subtracted from the light frame. This is the recommended method when using a cooled camera. * **Defect Maps:** For uncool-ed cameras (e.g. Guide), dark frames may not be suitable for removing the hot and pixels present in the image. An alternative method generates a map of bad pixels that should be treated in the light frame. You can adjust the Hot and Cold pixels sliders to include or exclude pixels. It’s recommended not to include more than 5,000 pixels as it can become computationally expensive to correct this many pixels in guide images. Ekos corrects each defective pixel by using calculating the median value from surrounding pixels.

- **Preset:** Select which capture preset to use. The camera name, gain, and offset are used from the preset while the exposure and temperature settings (if supported) are configured in the Create Dark Library window.
- **Prefer:** Select which dark calibration method to utilize for the selected preset. Both methods are used to remove noise from the light frame:
 - **Dark:** Remove noise by means of dark frame subtraction.
 - **Defect Maps:** Remove noise by means of defect map substitution.

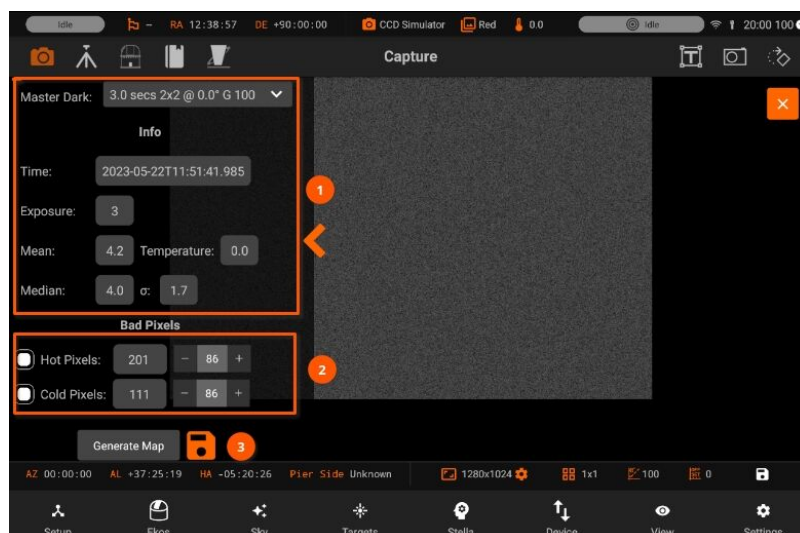
1. Create Darks:



Create a master dark frame by capturing and averaging a number of individual dark frames.

1. Select the range of exposures, binning, temperatures and count (if applicable) required.
2. Each time you change a selection, the Total Frames count is updated to reflect the required frames.
3. When ready, tap the Play button to start the process.

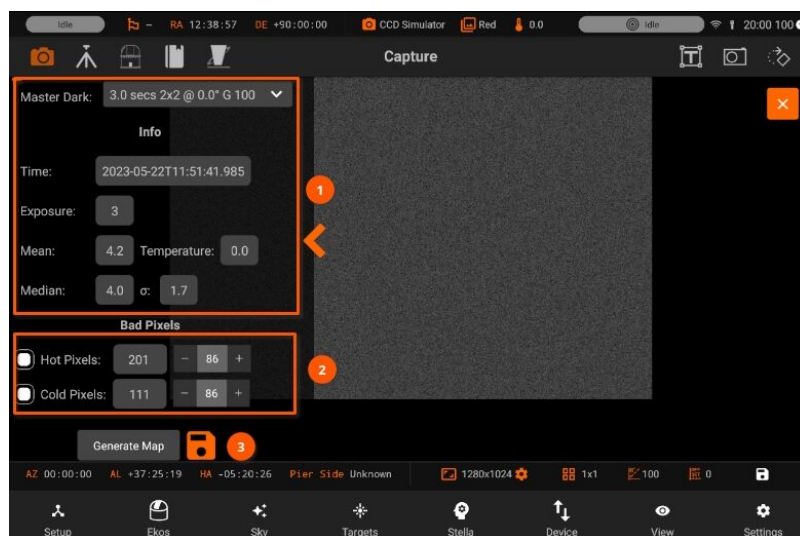
2. Create Defect Map:



After creating a master dark, you can create a defect map for your camera. Usually, defect maps are used when dark frame subtraction does not improve the quality of the calibration result. This is especially evident when using uncool-ed guide cameras that can exhibit hot pixels that are hard to treat with classical dark frame subtraction methods.

1. Selecting the master dark frame, loads the information of the image
2. Then adjust Hot and Cold pixel sliders to include or exclude pixels.
3. Click Generate Map to inspect the results and once satisfied tap the save button to store the defect map for future use.

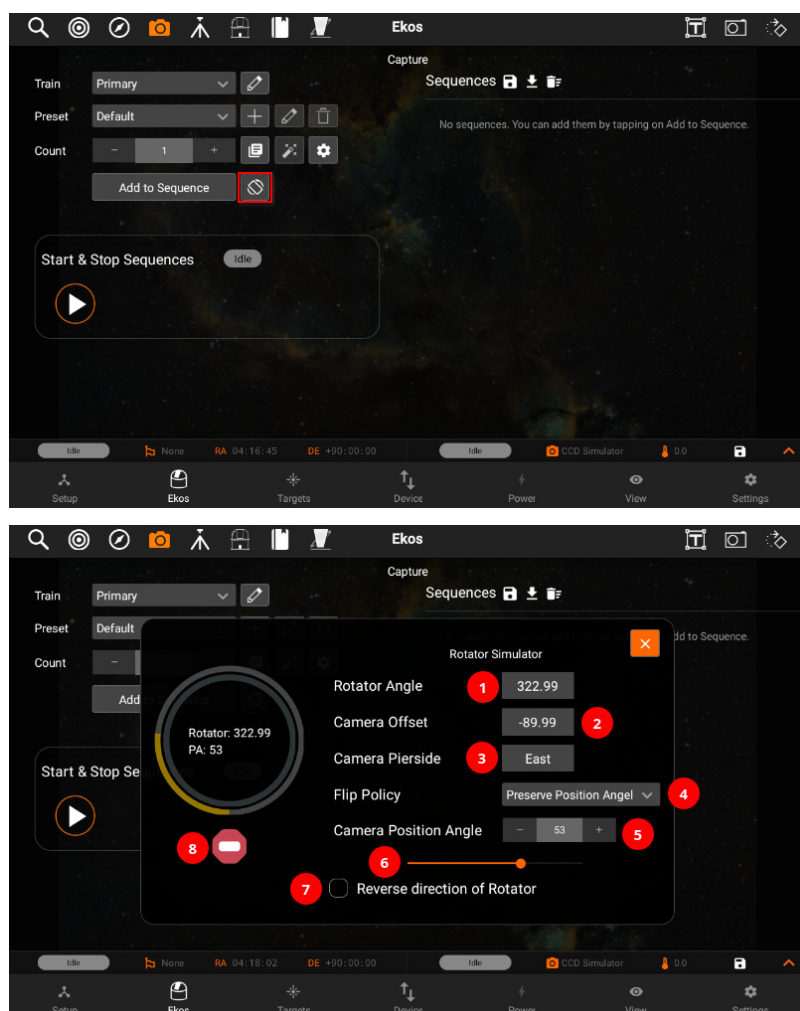
3. View Masters:



Inspect master frames of a specific camera.

5.3.5.3.4 Rotator Control

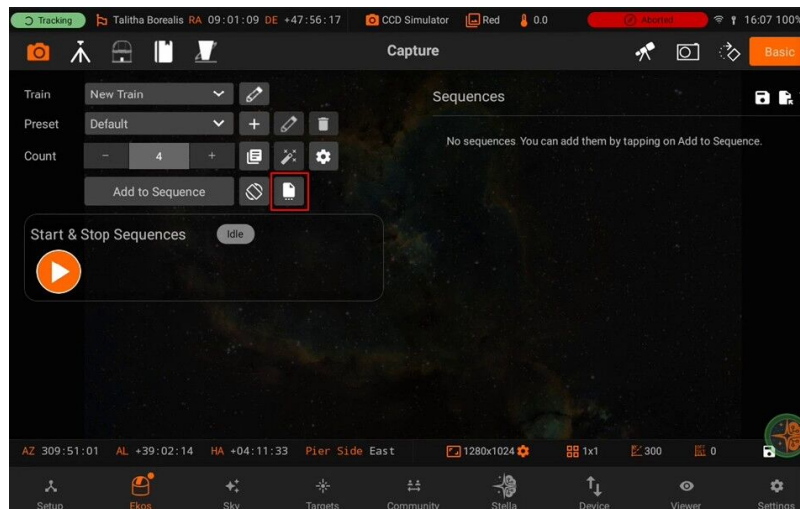
Rotator control settings are available if Rotator is selected in the active train.



1. The raw rotator full circle angle of the rotator device, which is calculated as the difference of the rotator origin (zero angle) respective to North on pierside WEST or respective to South on pierside EAST.
2. The angle of the camera upright direction (see FOV) respective to the rotator origin direction. The camera offset is determined automatically by a Capture & Solve or a Load & Slew in the Align module. The camera offset is measured in position angle scope (-179.99° to 180.00°).
3. The current pierside of the mount. A red frame indicates an unknown pierside. This is normal if the mount is parked.

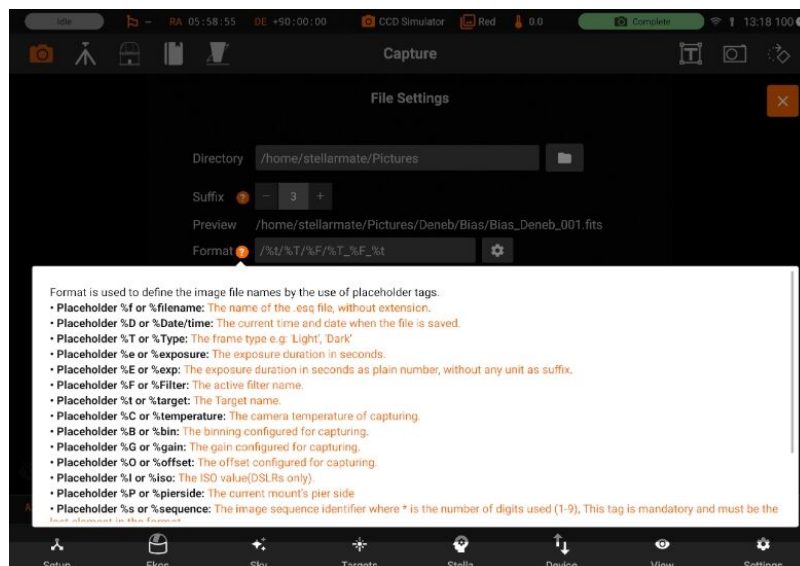
4. Flip Policy determines how the rotator reacts after a flip or if the result of a solved reference image reports a different pierside respective to the actual mount pierside.
5. Setting the camera position angle shall move the rotator. The gauge reflects the state of the rotator. Depending on the accuracy of the rotator there can be some deviation in the ending position angle. If Save Camera Position Angle to Sequence Job is toggled, any subsequent jobs added to the sequence queue would always rotate to this position angle before capture begins. The position angle is measured East of North in degrees.
6. Change Camera position angle.
7. Reverse the direction of rotator.
8. Abort Rotator movement.

5.3.5.3.5 Files

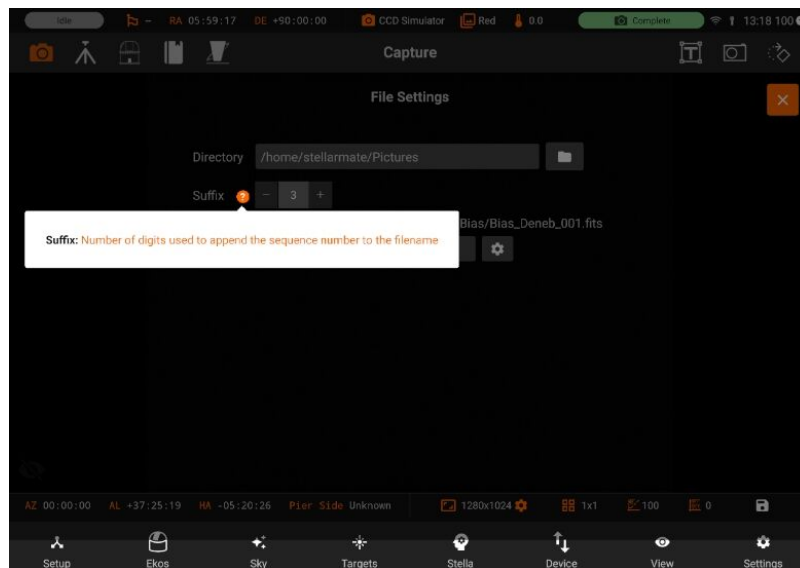


Settings for specifying where captured images are saved to, and how to generate unique file names.

Directory: Local directory to save the sequence images to. **Format:** Format is used to define the image file names by the use of placeholder tags.

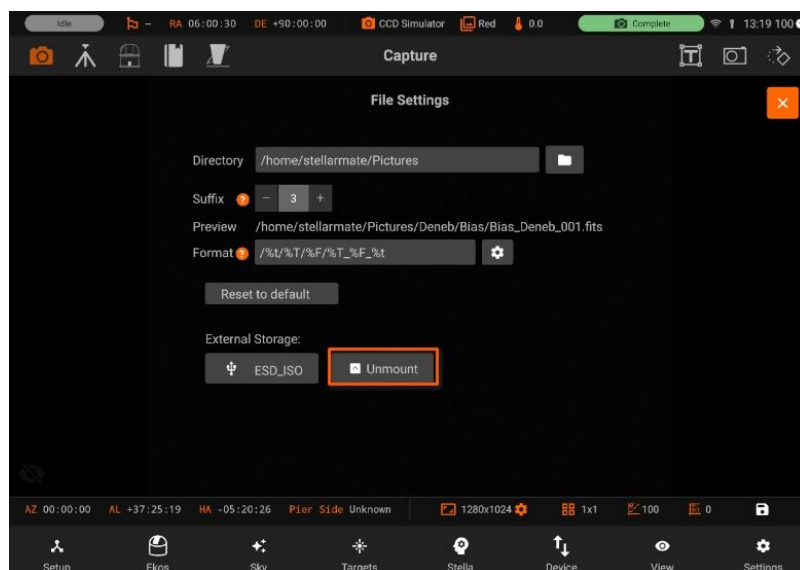


Suffix: Number of digits used to append the sequence number to the filename

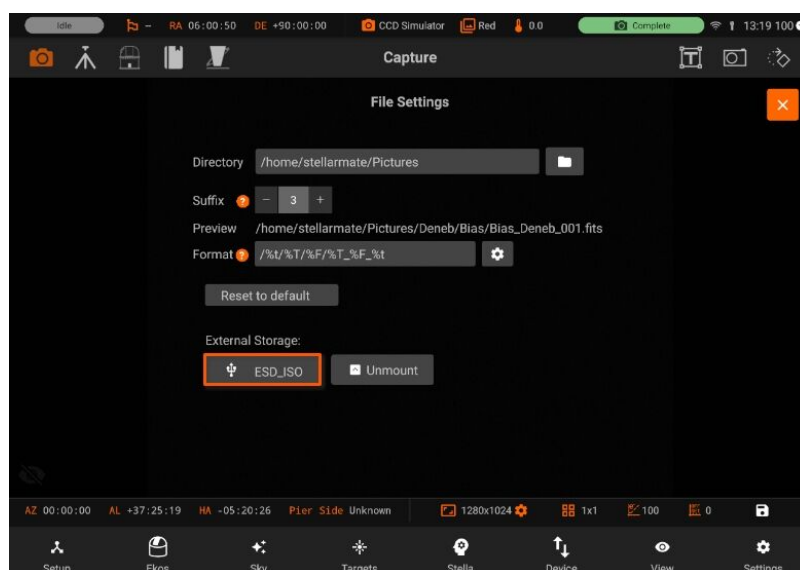


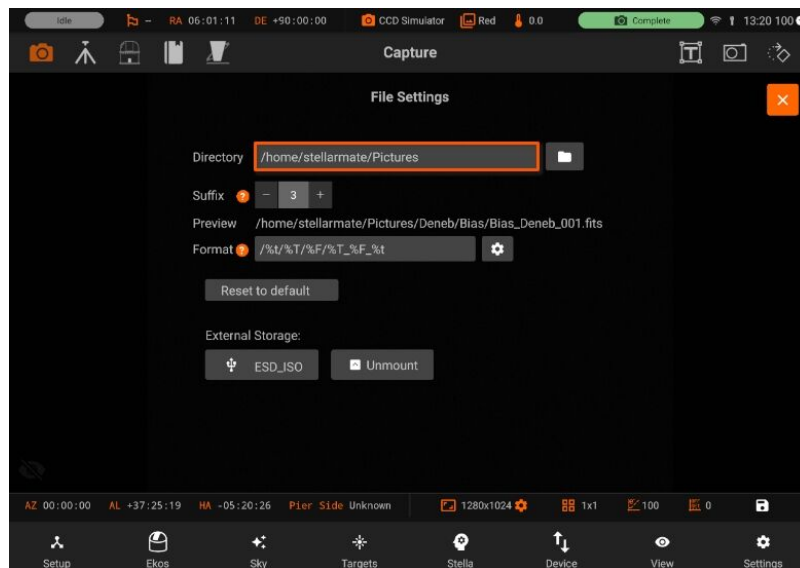
Preview: Path of your filename

You can now also unmount your USB device by pressing “Unmount” button next to your external storage device.



You can also set the directory path of your USB device (if attached). If USB device is connected, then External Storage devices are visible. By selecting on of them, will set the Directory path of it.



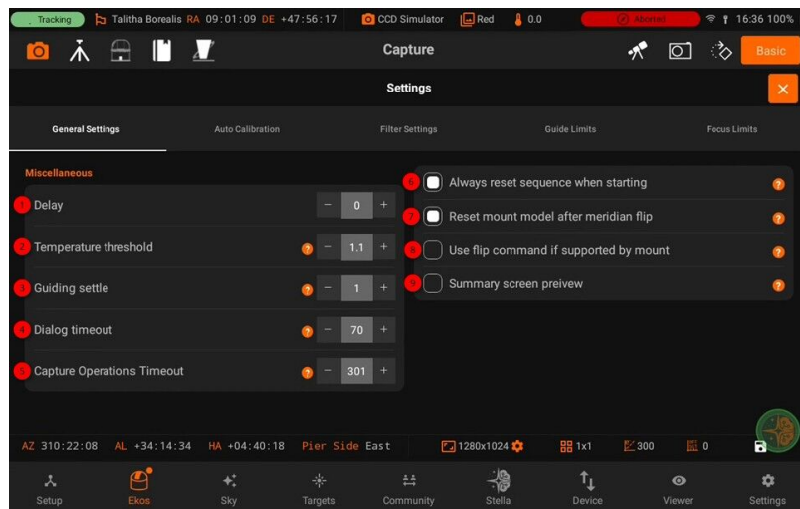


5.3.5.3.6 Settings

Following are the settings from Capture module:

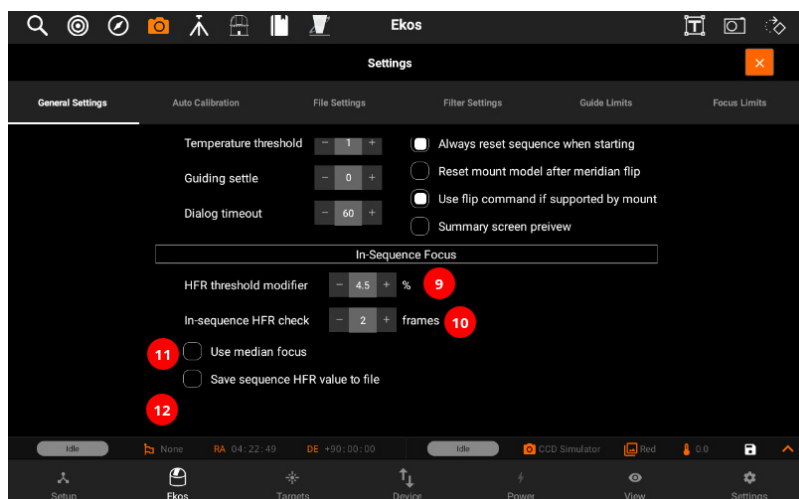
- General Settings
- Auto Calibration
- Filter Settings
- Guide Limits
- Focus Limits

5.3.5.3.6.1 General



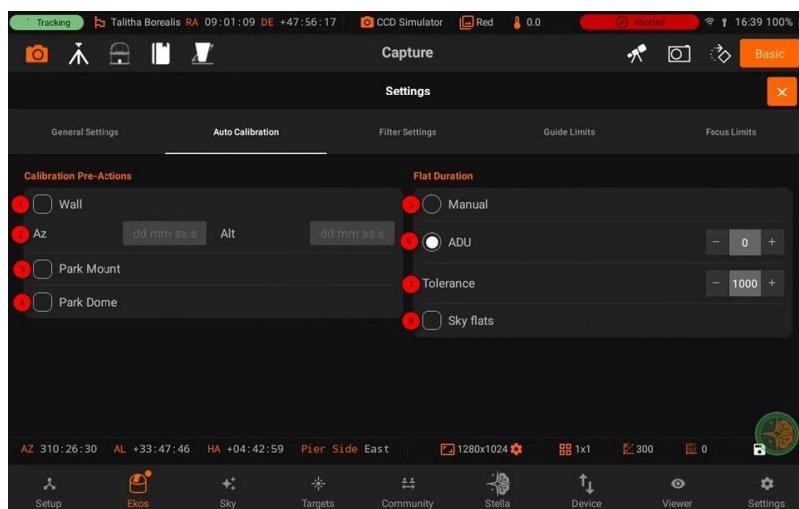
- 1) Delay in seconds between consecutive images.
- 2) Maximum acceptable difference between requested and measured temperature set point. When the temperature threshold is below this value, the temperature set point request is deemed successful.
- 3) Wait this many seconds after guiding is resumed to stabilize the guiding performance before capture.
- 4) Cover or uncover telescope dialog timeout in seconds
- 5) Maximum number of seconds to wait before aborting the capture if operations like filter wheel changes or meridian flips take too long. Also bounds the time the Scheduler spends establishing guiding (Calibration and lock) before starting capture.)
- 6) When starting to process a sequence list, reset all capture counts to zero. Scheduler overrides this option when Remember job progress is enabled.
- 7) Reset mount model after meridian flip

- 8) Use flip command if it is supported by the mount.
- 9) Display received FITS in the Summary screen preview window.



- 9) Set HFR Threshold percentage gain. When an autofocus operation is completed, the autofocus HFR value is increased by this threshold percentage value and stored within the capture module. If In-Sequence-Focus is engaged, the autofocus module only performs auto-focusing procedure if current HFR value exceeds the capture module HFR threshold. Increase value to permit more relaxed changes in HFR values without requiring a full autofocus run.
- 10) Run In-Sequence HFR check after this many frames.
- 11) Calculate median focus value after each autofocus operation is complete. If the autofocus results become progressively worse with time, the median value shall reflect this trend and prevent unnecessary autofocus operations when the seeing conditions deteriorate.
- 12) In-sequence HFR threshold value controls when the autofocus process is started. If the measured HFR value exceeds the HFR threshold, autofocus process is initiated. If the HFR threshold value is zero initially (default), then the autofocus process best HFR value is used to set the new HFR threshold, after applying the HFR threshold modifier percentage. This new HFR threshold is then used for subsequent In-Sequence focus checks. If this option is enabled, the HFR threshold value is constant and gets saved to the sequence file.

5.3.5.3.6.2 Auto Calibration



Note: You can only edit calibration settings for capture jobs that have the frame type as Bias (B), Dark (D), or Flat (F).

For Flat Field frames, you can set calibration options in order to automate the process. The calibration options are designed to facilitate automatic unattended flat field frame capture. It can also be used for dark and bias frames if desired. If your camera is equipped with a mechanical shutter, then it is not necessary to set calibration settings unless you want to close the dust cover to ensure no light at all passes through the optical tube. For flat fields, you must specify the flat field light source, and then specify the duration of the flat field frame. The duration can be either manual, or based on ADU calculations.

- **Wall:** Slew mount to the specified Azimuth/Altitude coordinates before taking flat field images
- **AZ:** Slew mount to the specified Azimuth/Altitude coordinates before taking flat field images

- **ALT:** Select which actions to perform before a Bias/Dark/Flat frame is captured
- **Park mount:** Select which actions to perform before a Bias/Dark/Flat frame is captured.
- **Park dome:** Select which actions to perform before a Bias/Dark/Flat frame is captured
- **Flat Field Duration:**
- **Manual:** Use the frame exposure value
- **ADU:** Calculate optimal exposure time given the required ADU. If a controllable device is selected, calculate optimal brightness.
- **Tolerance:** Accept ADU values that fall within this range around the desired ADU C target. For example, if the ADU value was set to 10000 and the tolerance was set to 100, then frames with ADU values of 9900 and 10100 shall be accepted.
- **Sky flats:** When shooting flats on sky that can change intensity. Will use simpler exposure calculation.

Before the calibration capture process is started, you can request Ekos to park the mount and/or dome. Depending on your flat source selection above, Ekos will use the appropriate flat light source before starting flat frames capture. If ADU is specified, Ekos begins by capturing a couple of preview images to establish the curve required to achieve the desired ADU count. Once an appropriate value is calculated, another capture is taken and ADU is recounted until a satisfactory value is achieved.

5.3.5.3.6.3 Filters

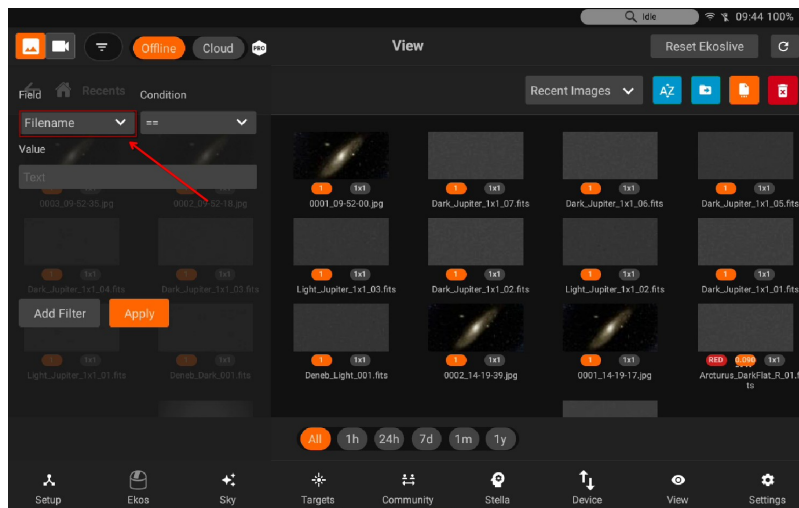
You can edit filters by tapping on the Filter button. The filter settings page will open and allow you to edit filter settings for each filter of the filter wheel selected in the drop-down menu.

Configure settings for each filter individually:

- **Name:** Filter Name
- **Exposure:** Set exposure time used when performing focus under this filter. By default, it is set to 1 seconds.
- **Offset:** Set relative offsets. Ekos will command a focus offset change if there is a difference between the current and target filter offsets. For example, given the values in the example image to the right, if the current filter is set to Red and next filter is Green, then Ekos shall command the focuser to Focus In by +300 ticks. Relative positive focus offsets denote Focus Out while negative values denote Focus In.
- **Auto Focus:** Check this option to initial AutoFocus process whenever the filter is changed to this filter.
- **Lock Filter:** Set which filter should be set and locked when performing autofocus for this filter.

Let's take an example. Suppose the capture sequence is running and the current filter is Green, so the relative already offset is set to +300. The next image in the sequence uses Hydrogen Alpha (H_Alpha) so before Ekos captures the next frame, the following actions take place:

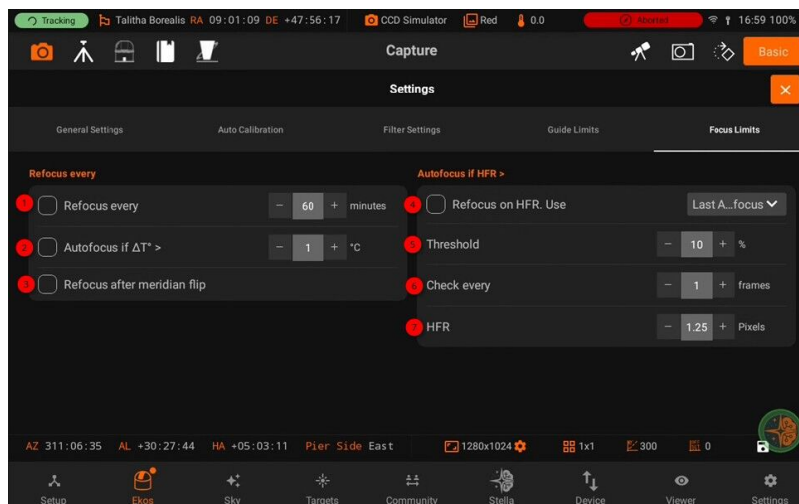
- Since Lumonosity is specified as the locked filter and auto-focus is checked, the filter is changed to Lumonosity
- A focus offset of -300 is applied since the prior filter Green was moved +300 previously.
- Auto Focus process is initiated.
- Once Auto Focus is complete, the filter is changed to H_Alpha.
- A focus offset of -1200 is applied.
- Capture sequence is resumed.



To edit a filter, tap on it on the panel on the right-side of the page. All of its details will be filled in the panel on the left-side to be edited.

After you edit the filter, tap on the Save button to save the filter settings. The panel on the right-side will shown the new settings for the filter you just edited.

5.3.5.3.6.4 Focus

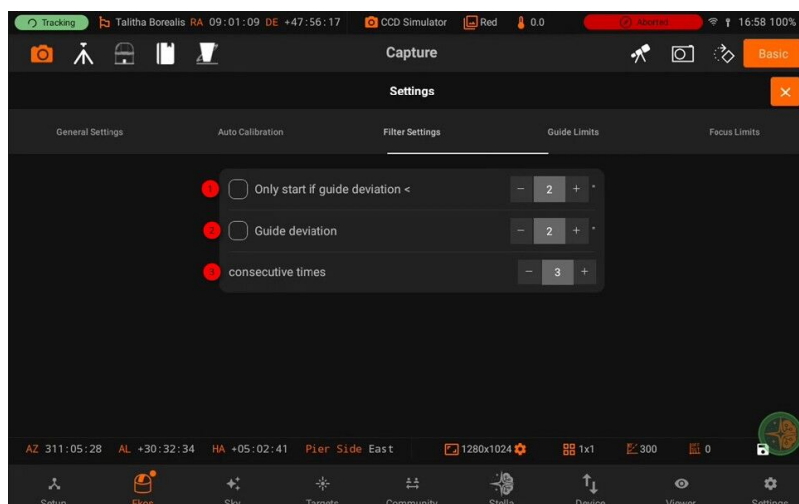


Focus limits settings are applicable to all the images in the sequence queue. When a limit is exceeded, Ekos shall command the appropriate action to remedy the situation as explained below:

- 1) **Refocus every**: Check to force an Autofocus every N minutes. Timer is reset at each Autofocus. **Refocus** value in minutes
- 2) **Autofocus**: Check to force an Autofocus when the change in temperature since last focus exceeded this value. Reference temperature is reset at each Autofocus.
- 3) **Refocus meridian flip**: Check to force an Autofocus after a Meridian Flip.
- 4) **Refocus on HFR**: Check to perform an HFR Check between Subframes. The Check may result in an Autofocus.
Algorithm: The HFR Check algorithm:
 1. **Last Autofocus**: This is the default algorithm and uses the HFR value from the most recent Autofocus run as the reference for the check.
 2. **Fixed**: This algorithm lets the user specify a fixed HFR to use in the check.
 3. **Relative Measure**: This algorithm collects datapoints from Autofocus and HFR Checks, maintains the data in a sequenced list and uses the median value as the reference for the next HFR Check.
- 5) **Threshold**: Specify the % to apply to the HFR Check value appropriate to the selected algorithm, to use as the threshold to perform the HFR Check.
- 6) **Check every frames**: Run HFR check after this many sub-frames.

- 7) **HFR**: The HFR Check value in pixels. This is an output field when Last Autofocus or Relative Measure is selected, and an input field for Fixed. In all cases, the user can override the system generated value.

5.3.5.3.6.5 Guide

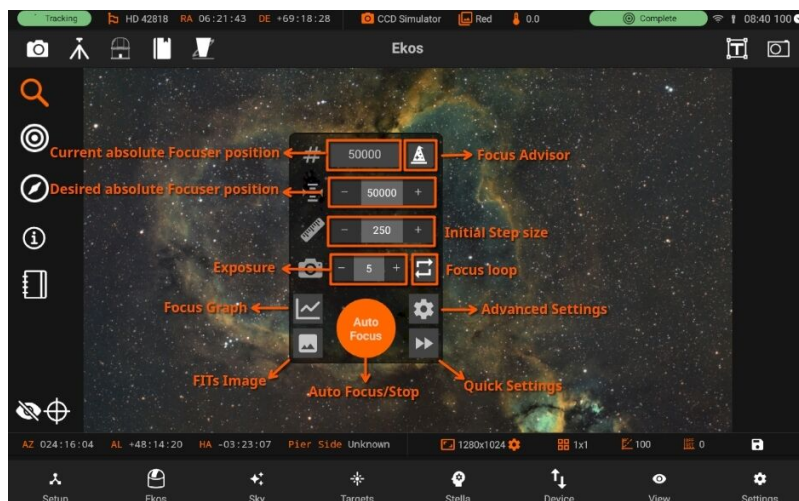


Guide limit settings are applicable to all the images in the sequence queue. When a limit is exceeded, Ekos shall command the appropriate action to remedy the situation as explained below.

- **Only start Guiding Deviation:** Start capturing only if guide deviation is below the given threshold (ignored for previews)
- **Only start Guiding Deviation Value**
- **Guide Deviation:** Abort sequence if guiding deviation exceed this value N consecutive times
- **Guide Deviation Value**
- **Consecutive times:** Abort sequence if guiding deviation exceed this value N consecutive times
- **Dither per Job:** If global dither is enabled, then dither every N number of frames for this job, Set to 0 to use global dither frequency.

5.3.5.4 Focus

StellarMate App Focus module goal is to get crisp images either automatically via an electronic focuser, or manually by adjusting the focus knob.



Quick Focus Guide For optimal performance, ensure the telescope is positioned near the Critical Focus Zone (CFZ). Avoid initiating autofocus when stars are barely visible or overly bloated. For reflectors, consider enabling the Donut Buster feature to address donut-shaped stars.

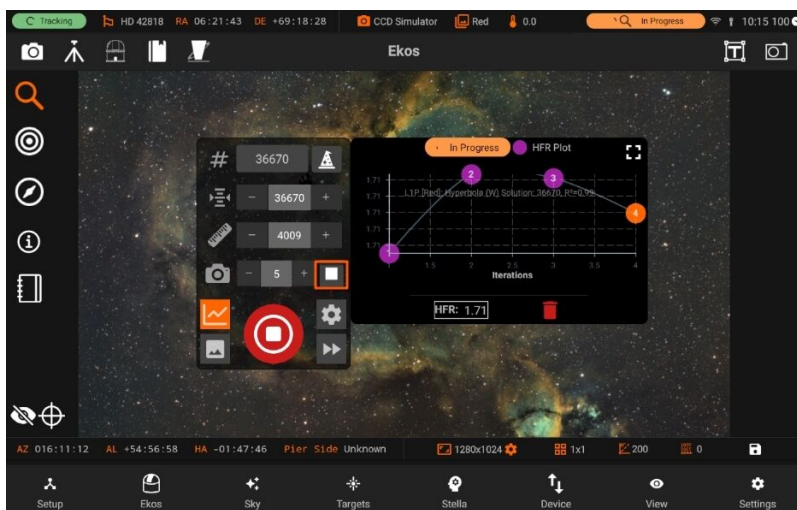
Before starting autofocus for the first time, run the Focus Advisor to fine-tune settings for your specific optical setup.

Absolute Focuser: While many parameters and settings play a role in a successful Autofocus run, two parameters are important to consider: **Step Size:** This is the value the autofocus algorithm uses to map the V-curve. Too small of a step

size and it would not be able to find the minima. Conversely, very large step sizes might miss the minima. A good step size is where you notice changes in the reported HFR value by more than 0.2. Since it can be hard for some setup to estimate the optimal value, the Focus Advisor can be used to empirically measure the best step size for your particular setup. **Exposure duration:** Use a reasonable value of more than 1 second and less than 5 seconds. If stars are not visible by 5 seconds, try adjusting the gain.

Manual Focuser

Tap the loop icon to start the framing process. Adjust the focuser manually while monitoring the HFR values in the chart. Make gentle and slow adjustments.



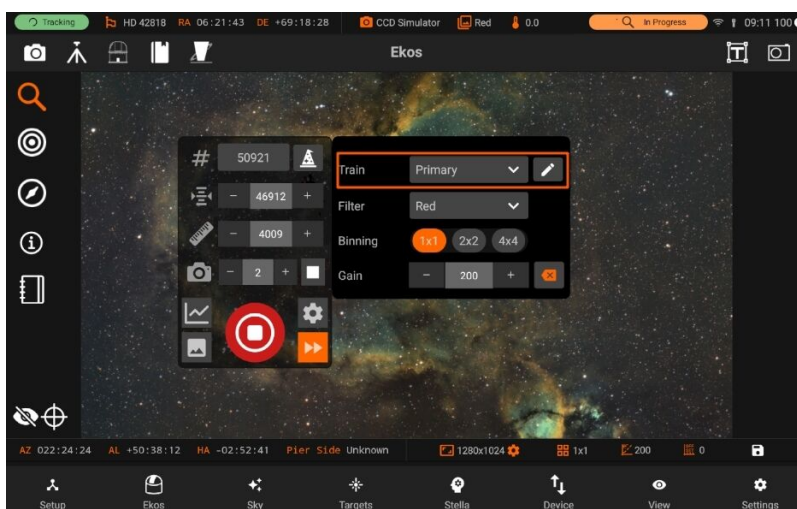
DSLR Cameras DSLR cameras like Canon and Nikon have built-in focusers. There is limited support for autofocus using these cameras mainly due to the limited focusing capabilities.

Focuser Group All INDI-compatible focusers are supported. It is recommended to use absolute focusers for the best results since their absolute position is known on power up. In INDI, the focuser zero position is when the drawtube is fully retracted. When focusing outwards, the focuser position increases, while it decreases when focusing inwards. The following focuser types are supported:

- **Absolute:** Absolute Position Focusers such as RoboFocus, MoonLite, ASI ZWO
- **Relative:** Relative Position Focusers.
- **Time Based:** Time based focusers with no position feedback that adjust focus position by moving for a certain amount of time. The Focuser field contains the focuser in the attached Optical Train.

For absolute and relative focusers, the step size is in units of ticks and for simple, or time based, focusers, the step size is in milliseconds. The In and Out buttons can then be used to move the focuser by the number of ticks defined in the Initial Step Size field in the Mechanics tab.

Optical train group



Optical Train group displays the currently selected Optical Train. By default this will be the primary imaging train, but other trains can be selected. The group consists of:

Train: The Optical Train currently in use by the Focus tab. Hover the mouse over this field for a more detailed description of the selected train. **Edit Button:** Brings up the Optical Train dialog to view and potentially change the optical trains. Focus parameters are saved per Optical Train automatically and so multiple trains can be setup to manage different configurations with different parameters. When a new Optical Train is created, Focus will attempt to default parameters from other, similar Optical Trains. The attributes that must match for this are the Focuser and the scope type. If this is the first train for the selected Focuser and scope type then default parameters are created.

It is recommended to use the Focus Advisor tool on new Optical Trains to set parameters appropriately.

5.3.5.4.1 Theory

In order to focus an image, StellarMate needs to establish a numerical method for gauging how good your focus is. It's easy when you look at an image and can see it as unfocused, as the human eye is very good at detecting that, but how can StellarMate possibly know that?

The most tried and tested method is Half-Flux-Radius (HFR), which is a measure of the width in pixels counting from the center of the star until the accumulated intensity is half of the total flux of the star. As you move closer to the point of optimum focus, the HFR gets smaller, reaching a minimum at the point of focus before increasing as you start to move away from focus. HFR has been used on lots of different types of equipment and has proved to be stable in a wide range of circumstances. In addition to HFR, Ekos supports other focus measures, including an adjusted HFR measure, FWHM, Number of Stars and Fourier Power.

It is recommended to start with HFR and when the user has become proficient in focusing their equipment, to try the other measures. After Ekos processes an image, it selects either a single star and starts measuring its HFR, or it selects a set of stars matching the criteria that have been set and calculates an average HFR. It can automatically select stars, or you can select a single star manually. It is recommended to allow Ekos to select a set of stars.

5.3.5.4.2 Algorithms

Ekos supports 4 different focus algorithms: Linear 1 Pass, Linear, Iterative, Polynomial. Linear 1 Pass is the recommended algorithm.

Linear 1 Pass In the Linear 1 Pass algorithm, Ekos establishes a V-Curve and fits a curve to the data to find the focus solution. It then moves to the calculated minimum. Key features include:

The algorithm compensates for focuser backlash. The algorithm is fast, taking 1 pass to identify optimum focus. The algorithm uses more sophisticated curve fitting to pinpoint the optimum focus position. The algorithm is highly configurable with user control over many parameters like step size, number of steps and how to deal with outliers in the datapoints.

Providing the focuser behaves in a repeatable way, i.e. when commanded to go to position X, it always goes to the same position, then this algorithm will be the best to use.

Linear

In the Linear algorithm, Ekos steps outward from its starting point then moves inward taking regular datapoints through the point of optimum focus and then further inward, to draw a V-Curve. It then fits a quadratic curve to the datapoints and calculates the point of optimum focus. It then moves out again past the point of optimum focus, halves the stepsize and moves in again for a second pass. It looks to follow the curve from the first pass and find the minimum HFR. Due to randomness in the HFR measurements it uses the % tolerance to help decide when it has found a solution. Key features include: – The algorithm compensates for focuser backlash. – The algorithm is slow, taking 2 passes to identify optimum focus. – The algorithm uses curve fitting to pinpoint the optimum focus position in pass 1, but then uses % Tolerance to try to stop as close as possible to this HFR on pass 2. – The algorithm is highly configurable with user control over many parameters like step size and number of steps. If the focuser behaves in an inconsistent way, i.e. when commanded to go to position X, there is variability in the position it goes to, then this algorithm will be the best to use as it has some built in tolerance for this variability

Iterative

In the Iterative algorithm, Ekos operates iteratively by moving in discrete steps, decided initially by the user configurable step size and later by the slope of the V-Curve, to get closer to the optimal focus position where it then changes gears and performs smaller, finer moves to reach the optimal focus. The focus process stops when the measured HFR is within the configurable tolerance of the minimum recorded HFR in the process. In other words, whenever the process starts searching for a solution within a narrowly limited range, it checks if the current HFR is within % difference compared to the minimum HFR recorded, and if this condition is met then the Autofocus process is considered successful. The default value is set to 1% and is sufficient for most situations. The Step options specify the number of initial ticks the focuser has to move. If the image is severely out of focus, we set the step size high (i.e. greater than 250). On the other hand, if the focus is close to optimal focus, we set the step size to a more reasonable range (less than 50). It takes trial and error to find the best starting

tick, but Ekos only uses that for the first focus motion, as all subsequent motions depend on the V-Curve slope calculations. Key features include:

The algorithm relies on the focuser having well controlled backlash. The algorithm can be fast using a minimum number of steps. The algorithm works on a “good enough” paradigm whereby it stops when the HFR is within % Tolerance of the perceived minimum. **Polynomial**

In the Polynomial algorithm, the process starts off in Iterative mode, but once we cross to the other side of the V-Curve (once HFR values start increasing again after decreasing for a while), then Ekos performs quadratic curve fitting to find a solution that predicts the minimum possible HFR position. Key features include:

The algorithm relies on the focuser having well controlled backlash. The algorithm can be fast using a minimum number of steps. The algorithm uses curve fitting to pinpoint the optimum focus position.

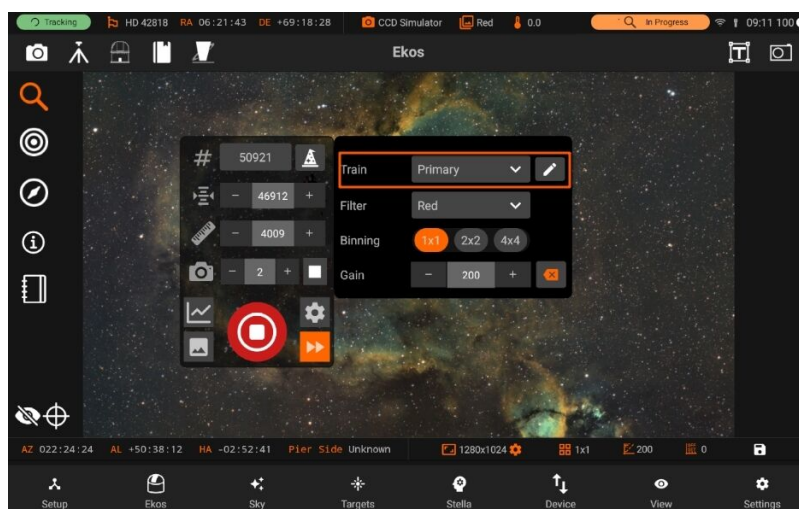
5.3.5.4.3 Advisor

The Focus Advisor dialog is a feature to assist with setting up of focus parameters. To use, select the required options and press Run. The purpose of Focus Advisor is to help people to use the Focus module within Ekos. The Focus module is functionally rich and contains a lot of parameters that need to be set self-consistently to achieve good results. Focus Advisor is designed to help with basic parameter setup that should achieve focus. It is not designed to achieve the best possible focus for your equipment; you will have to experiment with your setup to achieve that. But Focus Advisor provides a place to start that experimentation. Focus Advisor is aimed towards the less experienced users. If Focus Advisor does not appear to give good results on your setup why not start a discussion on the forum so it can be enhanced to give better results in the future. This way it will build over time to be more useful. When you click on Focus Advisor it works out a series of parameter recommendations based on the Optical Train you are using in Focus. There are 4 checkboxes on display that by default are all checked. Some can be toggled off if required. For example, Update Parameters will reset most parameters to standard settings. Once run, it is not necessary to repeatedly run this option so the associated checkbox can be toggled off for subsequent runs.

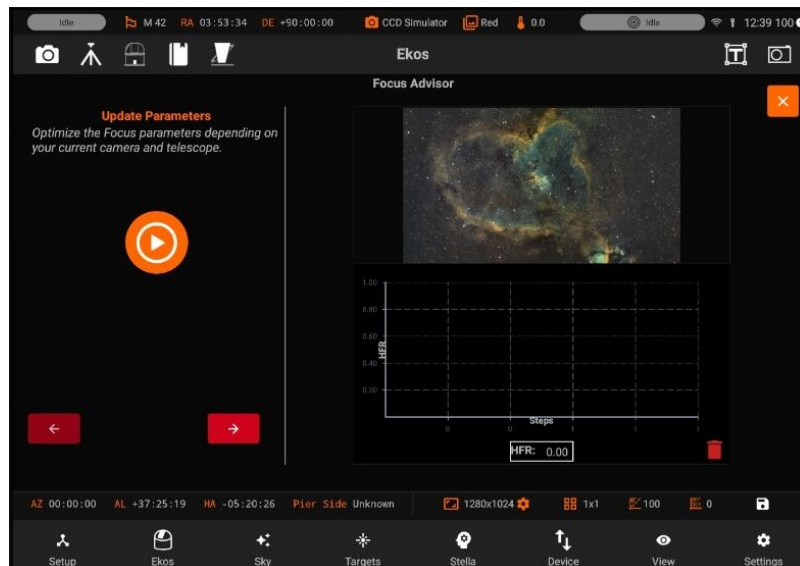
- **Run:** Press this button to run Focus Advisor for the checked options. The V-Curve will be dynamically updated with progress, as will the Focus Advisor dialog.
- **Stop:** Press this button to stop Focus Advisor. Note that the Stop button on the main Focus panel does the same thing.
- **Close:** Press this button to close the Focus Advisor dialog. The following checkbox options are available:

5.3.5.4.3.1 Update Parameters

This sets the parameters in Focus Settings to standard values that should enable Autofocus to successfully complete. Note that parameters are stored per Optical Train so it is a good idea to set this option when starting. Note that some parameters, e.g. step size are better defaulted from a trial and error approach by running Autofocus. So these parameters can be better set by some other options below. Note that when a new Optical Train is created, Focus Advisor will setup default parameters when the Optical Train is used for the first time in Focus. Also note that subsequent Focus Advisor functions depend on certain parameters being selected, for example the Linear 1 Pass focus algorithm, so it is recommended to run Update Parameters at the start of using Focus Advisor.



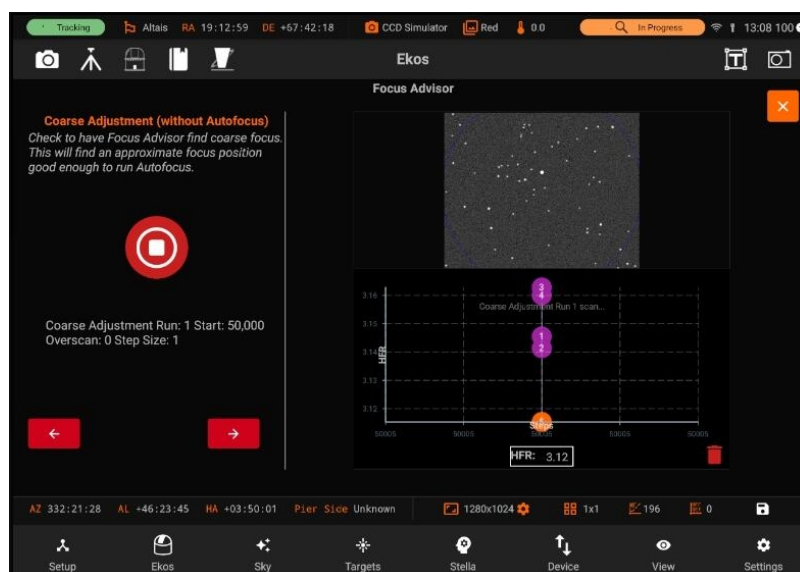
5.3.5.4.3.2 Find Stars



This function is designed to search the range of motion of the focuser to locate stars. If stars are already visible in subframes then there is no need to run this function. The algorithm will start at the current focuser position and search an area outward then inward of the starting position looking for stars. If no stars are found it will continue expanding the search area whilst staying within the allowed range of motion of the focuser. Eventually either stars will be located or the whole range of motion of the focuser will have been searched without locating any stars. In this latter case, the step size will be halved and the search restarted from the beginning. The search process uses a series of jumps of 10 x step size to try and locate stars. To use this function start the focuser as near to where stars are likely to be found as possible. If you have no idea then the algorithm will locate stars but the search will likely take longer. In addition, use a step size as close as possible to a good value for your equipment. If a value too small is chosen then the number of steps will be larger and the search will take longer. If a value too large is chosen then its possible that the range of focus positions where stars are visible will be “jumped over” in the search and it will appear that there are no stars visible anywhere. If you have no idea what a good starting value is then use the default and let Focus Advisor try to figure it out.

The results table in the Focus Advisor dialog shows a single line for Find Stars. In this case, Find Stars was started at position 70,000 and the Step Size was 250 (giving a Jump Size of 2,500). No stars were found at 70,000 (point 1 on the V-Curve) so an outward sweep started at 95,000 and moved in 2,500 jump by jump until 70,000 was reached (points 2-11) when the inward sweep started. Stars were first detected at 60,000 (point 15). The algorithm then continues to Jump inwards until no stars are found (point 34). This gives the range of positions where stars were located as 15,000 (point 33) to 60,000 (point 15) with a centre at 37,500.

5.3.5.4.3.3 Coarse Adjustment (Without Autofocus)

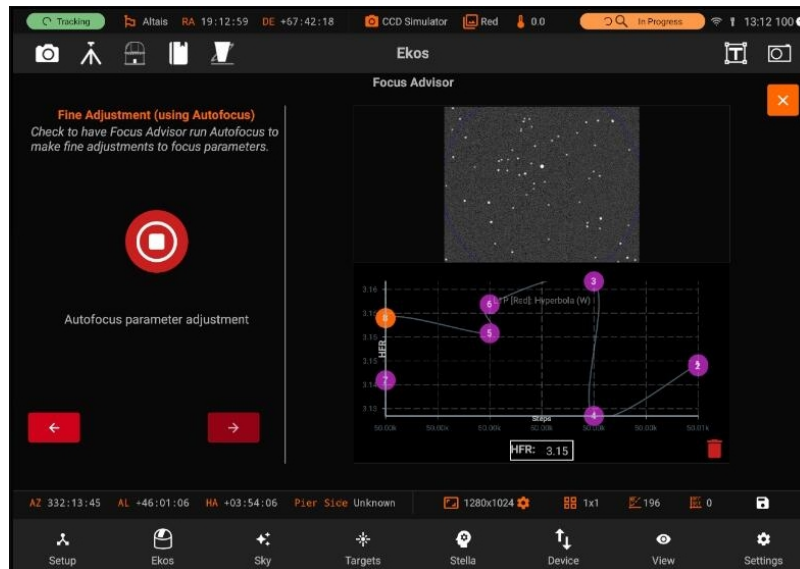


This function is designed to provide coarse adjustment to the start position, Step Size and AF Overscan (or backlash) fields. The purpose is to provide “good enough” values for these parameters in order for the next stage, Fine Adjustment to work.

An iterative process is used to home in on acceptable values. Here is an example to describe how it works:

Coarse Adjustment was run from a starting position of 37,500 with a Step Size of 250 and AF Overscan of 0. This is recorded in Run 1 in the results table in the Focus Advisor dialog. The comment column says that the Max/Min Ratio = 0.9 which means that the “Max HFR” / “Min HFR” of the datapoints is 0.9 which is too low. So Focus Advisor starts Run 2 from position 38,875 with an increased Step Size of 803 and Overscan of 250. Run 2 again had a Max/Min ratio too low, so Run 3 was started. Run 3 (which is shown in the V-Curve) started from 35548 with Step Size of 2544 and Overscan of 7477. This resulted in a Max/Min of 2.0 which is good enough at this stage. The datapoints form a V-Curve with no obvious uncorrected backlash (this would show as a flat spot on the right hand side of the curve if there was any). So the Coarse Adjustment completes after Run 3.

5.3.5.4.3.4 Fine Adjustment (With Autofocus)

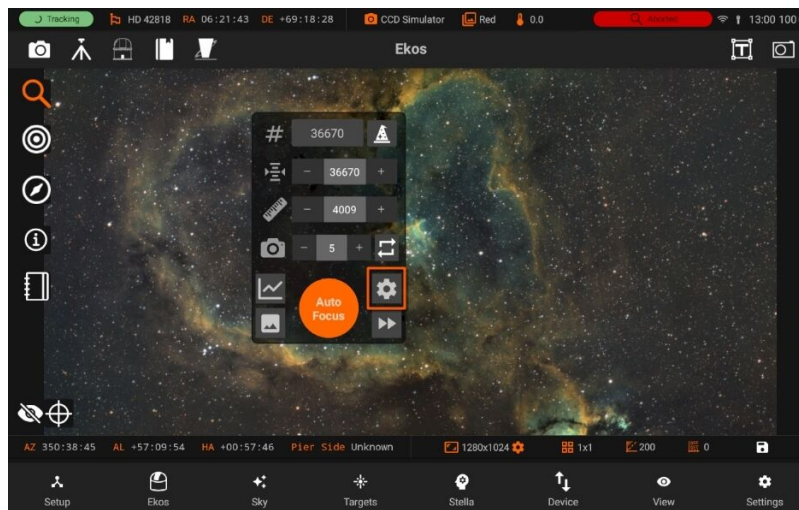


This function is designed to provide fine adjustment to the start position, Step Size and AF Overscan (or backlash) fields. Fine Adjustment runs Autofocus including curve fitting and analyses the result to determine whether or not it can be improved. If so, it adjusts parameters and re-runs. An iterative process is used to home in on parameter values. Here is an example to describe how it works:

Fine Adjustment was run from a starting position of 35,548 with a Step Size of 2544 and AF Overscan of 7477. This is recorded in Run 1 in the results table in the Focus Advisor dialog. The comment column says that the Max/Min Ratio = 1.9 which means that the “Max HFR” / “Min HFR” of the datapoints is 1.9 which could be improved. So Focus Advisor starts Run 2 from position 38,092 with an increased Step Size of 4888 and Overscan of 3738. The Overscan value is reduced here to see if a smaller number would adequately compensate backlash. Run 2 had a Max/Min ratio of 4 which is a little high, and calculated an Overscan value of 8626 so Run 3 was started. Run 3 (which is shown in the V-Curve) started from 38092 with Step Size of 4254 and Overscan of 8626. This resulted in a Max/Min of 3.1 which is good. The datapoints form a V-Curve with no obvious uncorrected backlash (this would show as a flat spot on the right hand side of the curve if there was any). The R2 of the curve fit is 0.999 which is also good so the Fine Adjustment completes after Run 3.

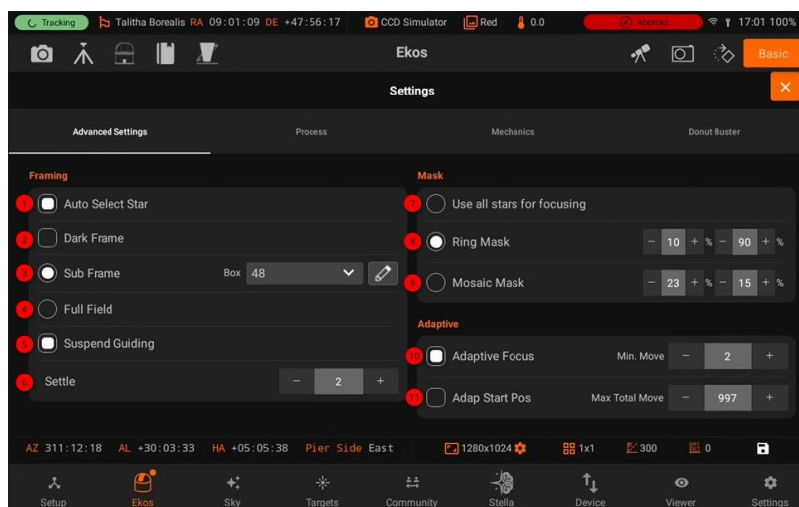
5.3.5.4.4 Settings

You will be able to see the Settings by pressing the Icon



Following are the settings from Focus module: * Advanced settings * Process settings * Mechanics settings

5.3.5.4.4.1 Advanced

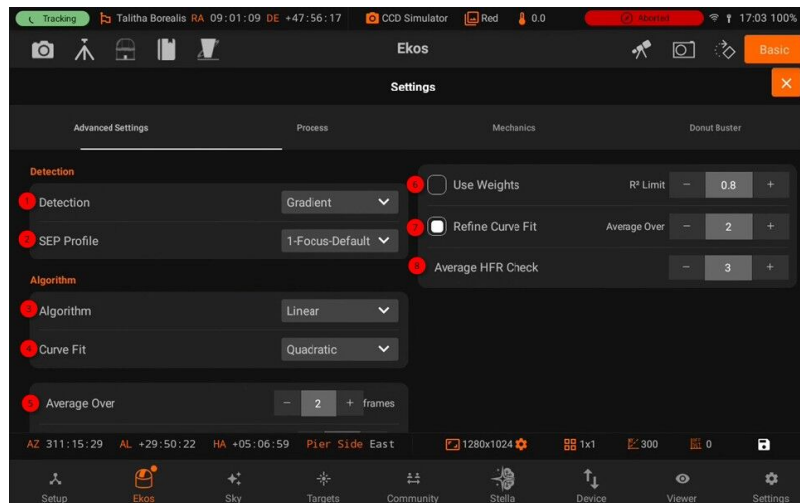


The Settings page has the following options:

1. **Auto Select Star:** Automatically detect and select best star for guiding in the image.
2. **Dark Frame:** Check this option to capture a dark frame if necessary and perform dark-frame subtraction. This option can be useful in noisy images.
3. **Subframe:** Subframe around the focus star during the autofocus procedure. Enabling subframing can significantly speed up the focus process. **Box:** Sets the box size used to enclose the focus star. Increase if you have very large stars.
4. **Full field:** Measure average HFR from all stars combined in a full frame. This method defaults to the Centroid detection, but can use SEP detection too. Its performance decreases as the number of stars increases.
5. **Suspend Guiding:** Suspend Guiding while autofocus in progress. If the focus process can disrupt the guide star (e.g. when using Integrated Guide Port IGP whereas the guider is physically attached to the primary CCD), then it is recommended to enable this option. When using Off-Axis guider, then this option is not necessary.
6. **Settle:** Sets the amount of seconds to wait before resuming guiding.
7. All stars are used for focusing.
8. During Full Field focusing, this controls the size of an Annulus centred at the middle of the sensor to include for processing. Set inner % to zero to include the centre of the sensor and set outer % to 100 to include the outer edges of the sensor.
9. Aberration inspector style mask with a 3x3 mosaic formed with tiles from the center, the corners and the edges.
10. Enable Adaptive Focus between subframes. This is an experimental feature. 1.Min move: The minimum size of an adaptive focus change that will be sent to the focuser.

11. Adapt the Autofocus start position based on filter and the Adaptive Focus settings. This is an experimental feature.
 1. The maximum total Adaptive focuser movement between Autofocus runs. If this value is hit, adaptive focusing is suspended. The purpose of this control is to handle runaway adaptive focusing.

5.3.5.4.4.2 Process



The Process page has the following options:

1. Detection: Select star detection algorithm. Each algorithm have its strengths and weaknesses. It is recommended to keep the default value unless it fails to properly detect stars.

- **SEP:** Source Extractor and Photometry, an efficient source detection method based on Source Extractor (Bertin and Arnouts 1996; Bertin 2016). See SEP: Source Extractor as a library in the Journal of Open Source Software.
- **Centroid:** a source detection based on estimating star mass around signal peaks.
- **Gradient:** a single source detection based on the Sobel filter. Initial or full-field analysis will use SEP instead of this method.
- **Threshold:** a single source detection based on pixel values. Initial or full-field analysis will use SEP instead of this method.
- **Bahtinov:** This is useful for users who do not have a motorized focuser and prefer to focus manually with the aid of a Bahtinov Mask. After capturing an image in the focus module with the Bahtinov mask algorithm selected, Ekos would analyze the images and stars within it. If Ekos recognizes the Bahtinov star pattern, it will draw lines over the star pattern in circles on the center and on an offset to indicate the focus.

3. Algorithm

[Select the auto focus process algorithm :]

- **Iterative:** Moves focuser by discreet steps initially decided by the step size. Once a curve slope is calculated, further step sizes are calculated to reach optimal solution. The algorithm stops when the measured HFR is within percentage tolerance of the minimum HFR recorded in the procedure.
- **Polynomial:** Starts with iterative method. Upon crossing to the other side of the V-Curve, polynomial fitting coefficients along with possible minimum solution are calculated. This algorithm can be faster than purely iterative approach given a good data set.
- **Linear:** Samples focus inward in a regular fashion, using 2 passes. The algorithm can be slow, but it is more resilient to backlash. Start with the focuser positioned near good focus. Set Initial Step Size and Max Travel for the desired sampling interval and range around start focus position. Tolerance should be around 5%.

4. Curve fit: Select the type of curve to fit to the data :

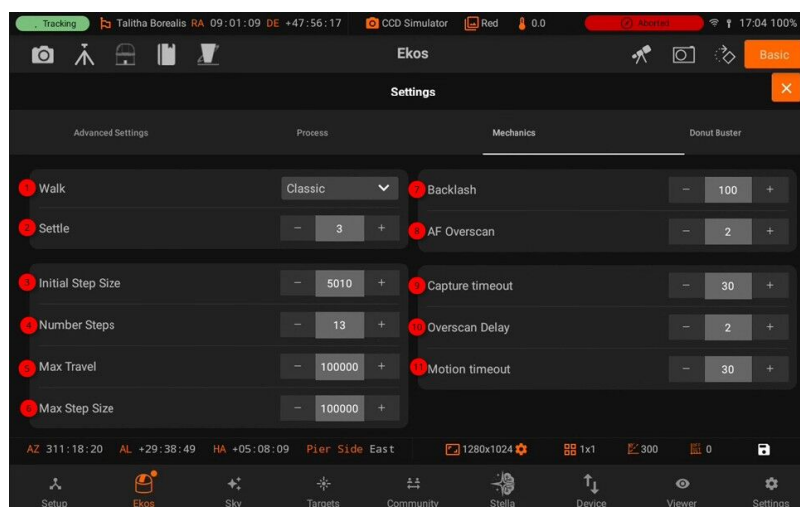
- **Quadratic:** Uses a polynomial fit of degree 2. This is currently the default option and currently the only option for all Algorithms except Linear 1 Pass.
- **Hyperbola:** Fits a hyperbola to the data points. This is currently only available for the Linear 1 Pass Algorithm.
- **Parabola:** Fits a parabola to the data points. This is currently only available for the Linear 1 Pass Algorithm.

- **5. Average over:** Sets the number of frames to capture in order to average the HFR value at the current focuser position.
 - **Tolerance:** The tolerance percentage values decides when the autofocus process stops in the Iterative algorithm. During the auto focus process, HFR values are recorded, and once the focuser is close to optimal position, it starts measuring HFRs against the minimum recorded HFR in the sessions and stops whenever a measured HFR value is within % difference of the minimum recorded HFR. Decrease value to narrow optimal focus point solution radius. Increase to expand dsolution radius.
- **6. Use weights:** Check to use the standard deviation of the star HFR or FWHM as a weighting to the curve fitting algorithm. If unchecked, all data points are given equal weighting. Currently only available when using Full Field (multiple stars) and a Curve Fit of Hyperbola or Parabola under the Linear 1 Pass algorithm.
- **: R2 Limit:** Set a minimum for the acceptable R2 when performing an Autofocus run. The value is between 0 (no fit) and 1 (perfect fit). 0.8 is a good start. If the minimum is not met, Autofocus will rerun once to try to improve the R2. Currently only available for the Linear 1 Pass algorithm when using a Curve Fit of Hyperbola or Parabola.
- **7. Refine Curve Fit:** Set a minimum for the acceptable R2 when performing an Autofocus run. The value is between 0 (no fit) and 1 (perfect fit). 0.8 is a good start. If the minimum is not met, Autofocus will rerun once to try to improve the R2. Currently only available for the Linear 1 Pass algorithm when using a Curve Fit of Hyperbola or Parabola.
- **8. Average HFR Check:** No. of frames to capture when running in-sequence HFR-check. If using linear 1 pass, the point of optimum focus will also capture this number of frames.

Warning

Setting the value too low might result in repetitive loop and would most likely result in a failed autofocus process.

5.3.5.4.4.3 Mechanics

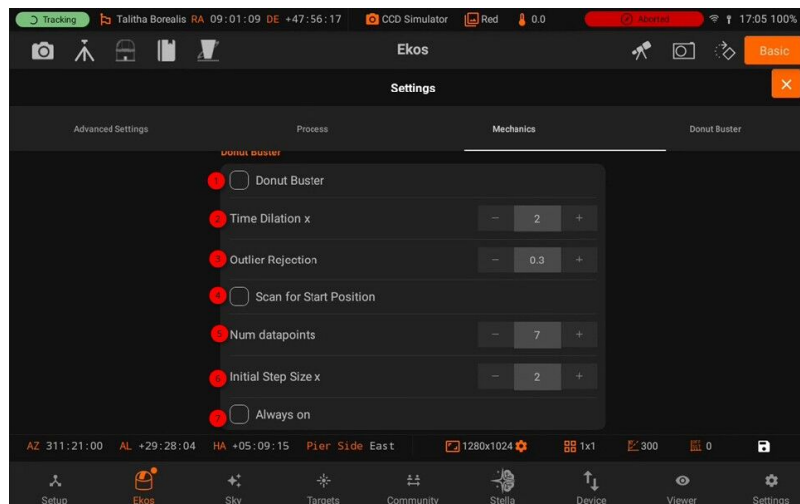


The Mechanics page has the following options:

- **1. Walk:** Select the type for the focuser to take when using Linear 1 Pass. For Linear only Classic is available.
- **2. Settle:** Settle time (in seconds) after moving the focuser before capturing the next image during Auto Focus and after an Adaptive focus movement.
- ****3. Initial Step Size:** ** In ticks to cause a noticeable change in HFR value. For timer based focuser, it is the initial time in milliseconds to move the focuser inward or outward.
- **3. Number steps:** This number is multiplied by initial-step-size is number of outward steps the Linear Focus algorithm moves away from the initial position at the start of focusing.
- **4. Max Travel:** Maximum travel in ticks before the auto-focus process aborts.
- **5. Max Step size:** The maximum single step size the algorithm is allowed to command as it searches for the critical focus zone. The calculated step size would be limited to this maximum value.
- **6. Backlash:** Number of average frames to capture. During each capture, an HFR is recorded. If the instantaneous HFR value is unreliable, you can average a number of frames to increase the signal to noise ratio.

- **7. AF Overscan:** Provides backlash overscan in ticks for outward focuser movements during an Autofocus run. This is in addition to any Driver Backlash provided by the device driver and set in the Driver Backlash field. Set to 0 to disable. If set, AF Overscan is applied to all focuser movements initiated by the Focus module. Typically either Focuser Backlash or AF Overscan is set.
- **8. Capture timeout:** Maximum time in seconds to wait for a captured image to be received before declaring a timeout.
- **9. Overscan Delay:** Delay between completing the outward motion of an Overscan and starting the inward motion. For most focusers 0s is fine.
- **10. Motion timeout:** Maximum time in seconds to wait for the focuser to move to the desired position before declaring a timeout.

5.3.5.4.4 Donut buster

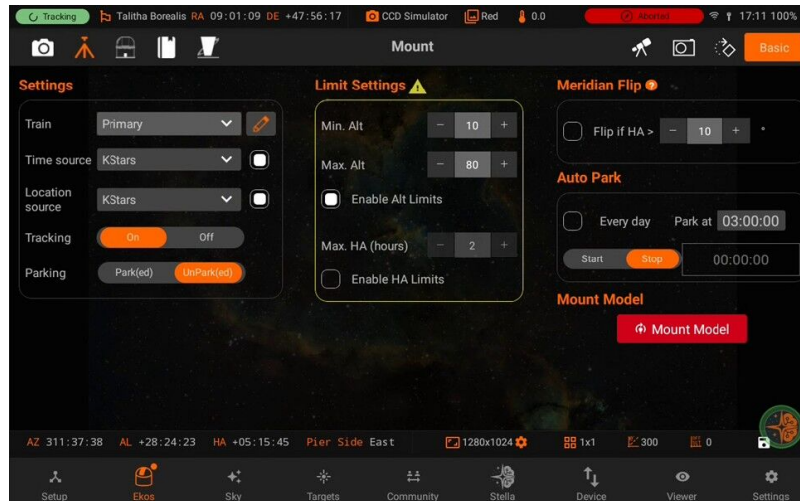


- **2. Time dilation X**
[The furthest datapoints have their exposure times increased by this factor. The in focus datapoint exposure is not increased. Intermediate points have their exposures scaled appropriately.]
– Set to 1 to disable this option.
- **3. Outlier Rejection:** Aberration inspector style mask with a 3x3 mosaic formed with tiles from the center, the corners and the edges.
- **5. Num datapoints:** The number of datapoints to be used during the scan for start position
- **6. Initial Step Size:** Scan for start position uses a step size = Initial step size multiply by Initial step size x.
- **7. Always On:** Click to always run Scan for start Position, uncheck to run after a failed Autofocus.

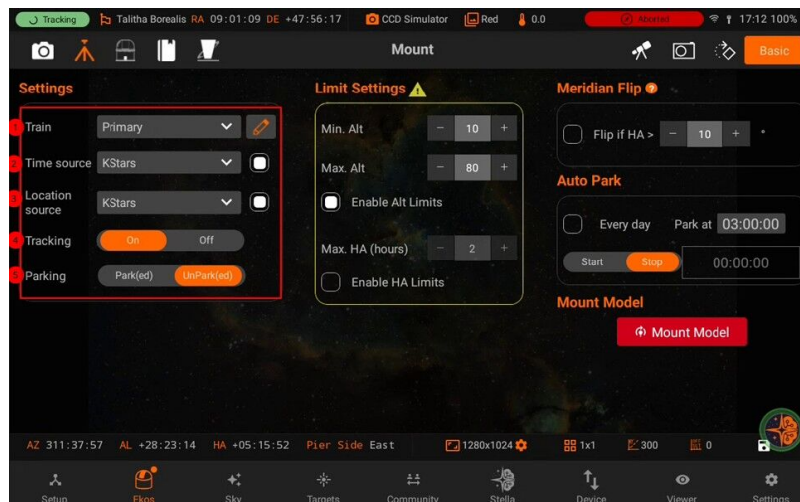
5.3.5.4.5 Videos

John Evans is the architect of many of the focusing algorithms used in Ekos. To learn more about the advanced features of Ekos Focus module, check out *John Evans Youtube channel* <<https://www.youtube.com/@johnneevans1>>.

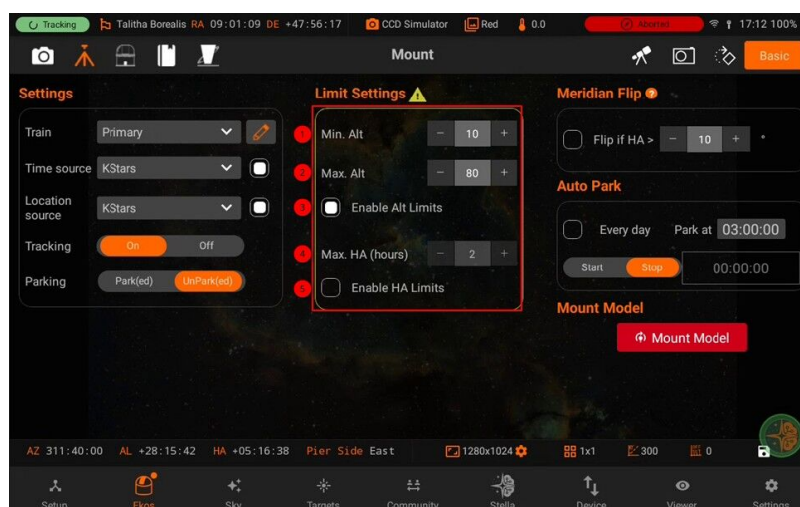
5.3.5.5 Mount



The Mount module allows you to do Meridian Flips and set limits for your Mount, it has the following features:

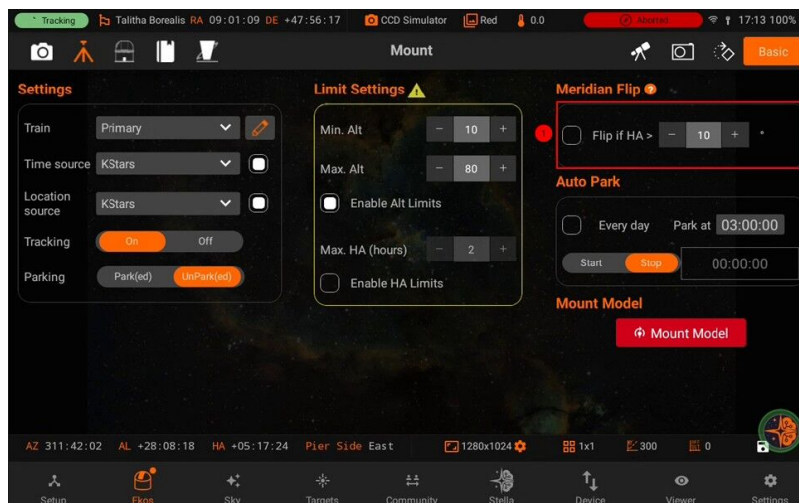


1. Manage / Select Optical trains.
2. **Time source:** Enable time synchronization upon connection between Kstars and INDI
3. **Location source:** Enable geographic synchronization upon connection between Kstars and INDI.
4. Tracking On/Off
5. Mount Park/UnPark

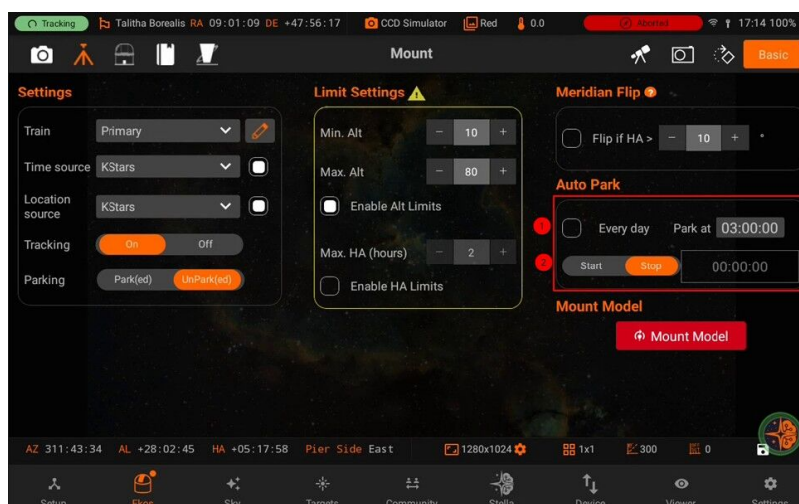


Limit Settings: * **1. Min Alt:** Minimum telescope altitude limit. If the telescope is below this limit, it will be commanded to stop. * **2. Max Alt:** Maximum telescope altitude limit. If the telescope is above this limit, it will be commanded to stop. * **3. Enable Alt limits:** Enable or Disable the mount travel range limits. Once enabled, Ekos monitors the mount's

altitude while slewing or tracking. If the mount slews/tracks below or above the limits, it shall be commanded to stop and tracking will be turned off. * **4. Max Hours:** Maximum Hour Angle limit if the mount has not flipped. If the telescope is above this limit, it will be commanded to stop. * **5. Enable HA Limits:** Enable or Disable the mount Hour Angle limit. Once enabled, Ekos monitors the mount's hour angle while slewing or tracking. If the mount slews/tracks past the limit while the Pier Side is in the state that does not allow that, it shall be commanded to stop and tracking will be turned off. Requires a mount that reports the pier side correctly.



Auto Park



1. Automatically start the park timer on startup.
2. Park at: Park at Specific time
3. Whether to Start/Stop Auto Park.
4. Shows remaining time to Auto park

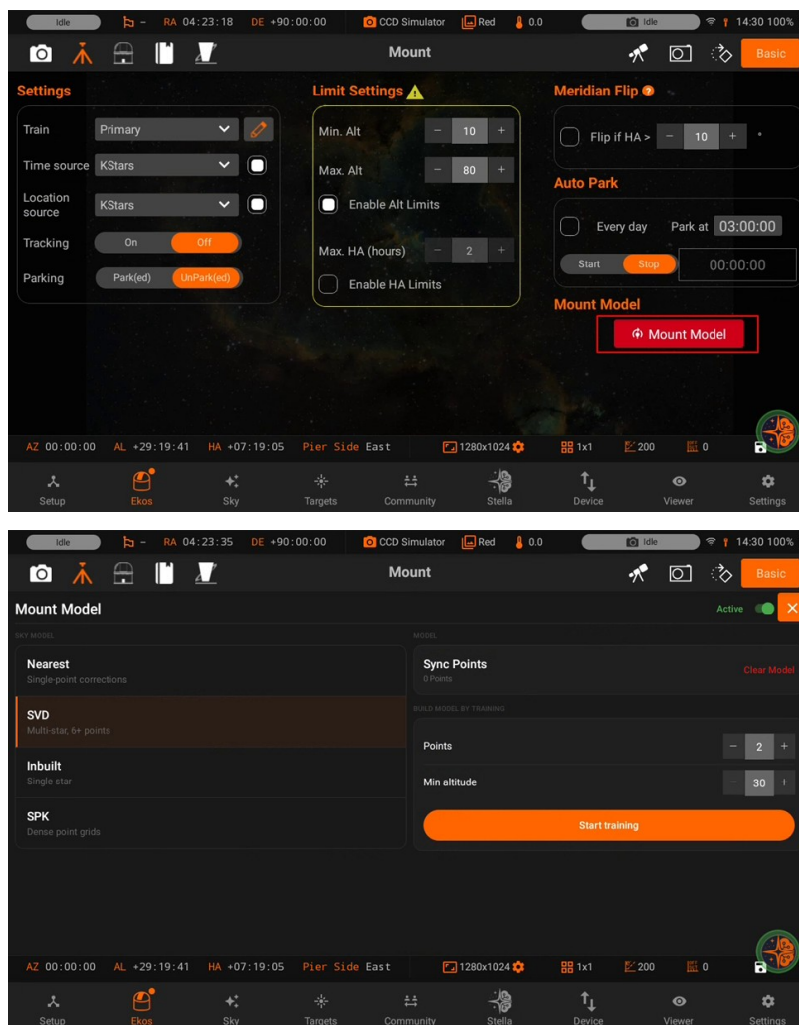
Meridian Flip

- **Flip if HA >:** Request a meridian flip if the hour angle exceeds the specified value. Capture and Guiding will be suspended and resumed after the flip is complete.
- **Pier Side:** Shows the pier side direction.

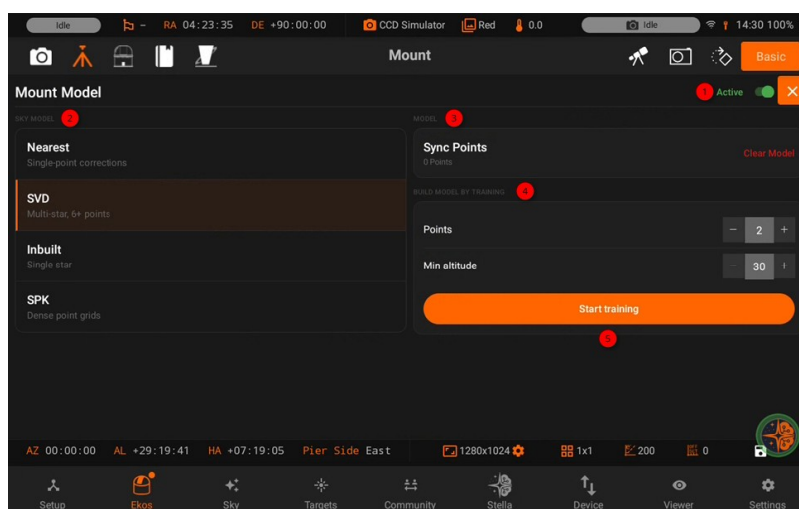
You can do a Meridian Flip from the Mount Module. Equatorial mounts flip after crossing the meridian in order to prevent the imaging equipment train from hitting the tripod. With Ekos, you can set an hour angle limit which if exceeded, the mount will be commanded to flip. The mount must begin tracking east of the meridian in order for the meridian flip to be commanded in Ekos. When commanding a meridian flip, Ekos will suspend the auto-guiding process and wait until the mount completes the flip. Once the mount begins tracking again post meridian flip, Ekos will plate-solve and make any necessary slew commands to bring the mount to the exact location it was tracking prior to the flip. Next, it will automatically capture a frame and select a suitable guide star, performs calibration, and resumes auto-guiding. If In-Sequence focusing is enabled, it will also capture and focus a suitable star. It then resumes the capture process from where it left. All these steps are completely automated and require no user intervention! So just set when you want the meridian flip to occur at the mount module. Remember that the setting is in Hour Angle (HA). 1 HA = 15 degrees, therefore 0.1 HA = 1.5 degrees West of the Meridian. Always use a positive value to ensure proper meridian flip takes place. Using zero could theoretically

work but it is at the very edge where the decision to flip or not is made by the mount, so it's safer to use a slightly higher value like 0.1 HA.

Mount Model

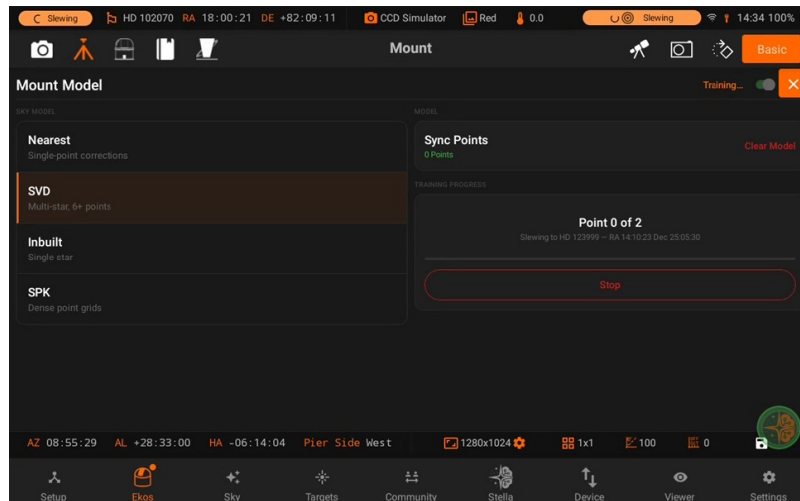


A mount model is a collection of calibration data points that describe and correct for mechanical, alignment, or optical errors in your telescope setup. These errors can be due to manufacturing tolerances, polar alignment issues, flexure, or other imperfection. The mount model helps the system understand how the actual pointing of the telescope differs from its theoretical, commanded position at various points in the sky.



- 1. The Alignment Subsystem property turns the pointing-correction model on or off.
- 2. **Math Plugins:**
 - Nearest: picks whichever recorded sync point is geometrically closest rather than fitting a matrix model across all points; faster/simpler but less consistent, as shown in the earlier testing.

- Built-in: the default plugin, used automatically if no other is explicitly loaded. It scans the alignment database and builds transformation matrices from your sync points (all RA/Dec points get converted to Alt/Az using each point's stored timestamp before the matrices are computed).
 - SVD: the more robust N-star model, better at handling larger or spread-out point sets; generally the recommended choice when it's available.
 - SPK: Spline interpolation, Best for Smooth, accurate points in Sky
3. ****Synced Points:** ** are the individual data points that make up your Mount Model — each one is a record of “the mount thought it was pointing here, but it was actually pointing there”
 4. Ability to change Points and minimum altitude
 5. Start training - Each successful point that is plate solved adds up one sync point.



5.3.5.6 Observatory

The Observatory module allows you to control your Dust Cap, Light Box and Dome/Roll-off roof, it has the following features:

Dome & Rolloff Roof

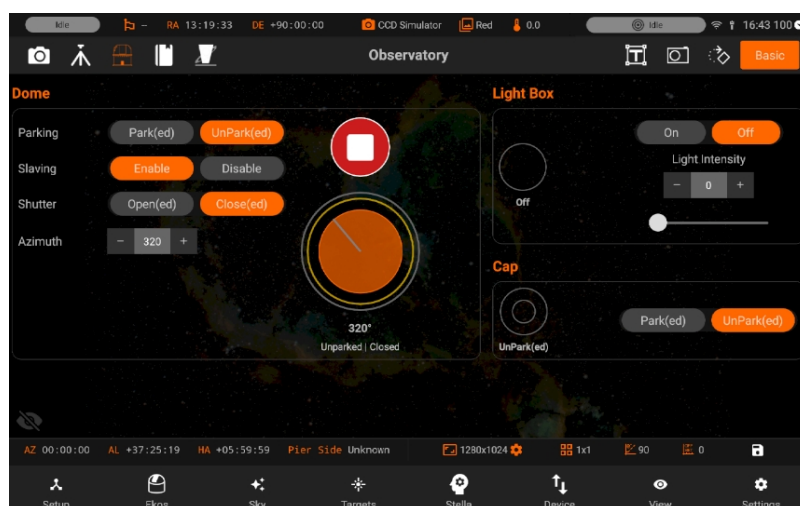
StellarMate supports both classical domes and rolloff roofs. For rolloff roofs, the only controls available are the Park and Unpark actions.

Park/UnPark Park: Moves the dome to its home position. Always park when finishing observations.

UnPark: Releases the dome from its parked position. Use this command to enable dome movement and rotation control during your observation session.

Classical domes support more features like dome slaving and controls for shutter and azimuth.

Slaving



Dome slaving automatically synchronizes your dome's azimuth position with the telescope's pointing direction. This ensures the telescope always has an unobstructed view through the dome's slit or opening during observation and imag-

ing sessions. Achieving accurate and reliable slaving requires careful measurement of your observatory's geometry and understanding key configuration parameters.

All geometric measurements should be provided in **meters**. These parameters are typically found in the INDI Control Panel under your Dome Driver's **Slaving** tab within the **Measurements** group.

Geometric Measurements - Radius (m): The internal radius of the dome, measured from the exact center of the dome floor to the inner surface of the dome wall. - **Shutter width (m):** The clear, unobstructed width of the dome's shutter opening. While currently used to calculate a theoretical minimum/maximum azimuth range for the opening, this parameter is primarily intended for future optimizations to minimize unnecessary dome movements during slews. The core slaving calculation targets the center of this opening based on the optical axis intersection. - **N displacement (m):** The North/South displacement of the telescope's mount pivot point (intersection of RA and Dec axes for GEMs, or Az/Alt axes for Alt-Az mounts) from the exact center of the dome floor.

- **Positive values:** Displacement towards the North.
- **Negative values:** Displacement towards the South.

E displacement (m): The East/West displacement of the telescope's mount pivot point from the exact center of the dome floor.

- **Positive values:** Displacement towards the East.
- **Negative values:** Displacement towards the West.

Up displacement (m): The vertical displacement (height) of the telescope's mount pivot point relative to the level of the dome's base ring (the equator of the dome sphere).

- **Positive values:** Pivot point is above the dome equator.
- **Negative values:** Pivot point is below the dome equator.

OTA offset (m): The perpendicular distance between the telescope's optical tube axis (OTA) and the mount's pivot point (RA/Dec intersection for GEMs).

- **Fork Mounts:** This value is typically zero as the optical axis usually passes through the pivot point.
- **German Equatorial Mounts (GEMs):** This is a critical non-zero value representing the distance from the RA/Dec intersection point to the center line of the telescope tube. It accounts for the offset caused by the mount's design.

Slaving Parameters Autosync threshold (deg): (Found under the Params property group)

- This defines the minimum difference in degrees between the dome's current azimuth and the calculated target azimuth required to trigger an automatic dome movement (sync).
- The default value is typically 0.5 degrees.
- **Smaller values:** Result in more frequent, smaller dome movements, keeping the slit very precisely aligned but potentially causing more wear or vibration.
- **Larger values:** Result in less frequent, larger dome movements, reducing wear but potentially allowing the telescope's view to drift slightly off the slit center between moves. Choose a value that balances alignment accuracy with minimizing unnecessary motion for your setup.

Meridian side: (Found under the Meridian side property group)

- This parameter is crucial, especially for German Equatorial Mounts (GEMs), as it tells the slaving algorithm which side of the pier the telescope tube (OTA) is currently situated. This directly affects the calculation of the optical axis position relative to the dome center.
- **Available Options:**
 - **East / West:** Manually forces the calculation to assume the OTA is on the specified side of the pier. Use only if the automatic methods fail or for specific testing.
 - **Mount:** (Recommended for most GEMs) Uses the pier side information directly reported by the connected INDI mount driver. This is generally the most reliable option if your mount driver supports and correctly reports pier side.
 - **Hour Angle:** Calculates the pier side based on the telescope's Hour Angle (HA). It assumes HA > 0 (pointing West) means the OTA is East, and HA < 0 (pointing East) means the OTA is West. Note: When pointing very close to the celestial pole (typically Declination > +/- 85 degrees), where HA becomes less reliable for side determination, this mode intelligently uses the telescope's Azimuth instead (Az < 90 or > 270 implies OTA West, Az between 90 and 270 implies OTA East) to infer the side.

- **Ignore:** Assumes the OTA offset is effectively zero relative to the pier, as in a Fork or Alt-Az mount configuration. Select this for non-GEM mounts.

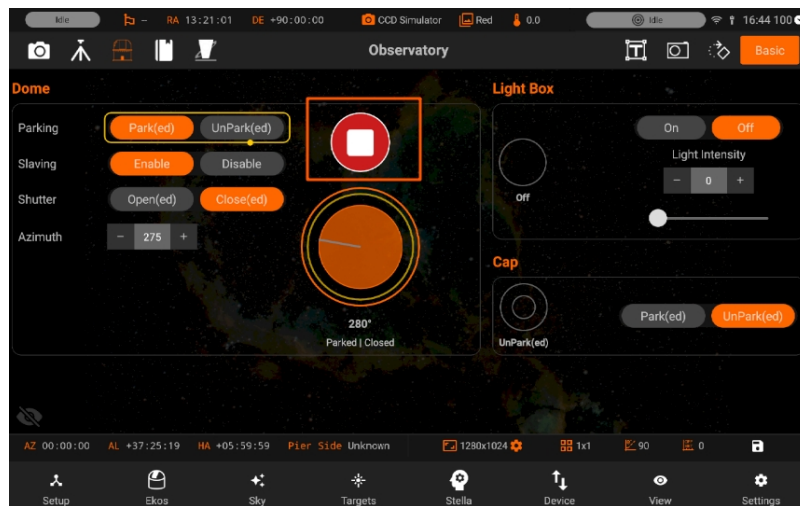
Troubleshooting & Tips

- **Inaccurate Slaving:** Double-check all geometric measurements under the Measurements group. Small errors, especially in displacements and OTA offset, can lead to significant pointing inaccuracies. Ensure units are correct (meters).
- **Incorrect GEM Behavior:** Verify the Meridian side setting. Using Mount is preferred if your mount reports pier side correctly. If not, Hour Angle is a good alternative. Incorrect settings here are a common cause of slaving errors after a meridian flip.
- **Dome Moves Too Often/Not Often Enough:** Adjust the Autosync threshold (deg).
- **Check Logs:** Enable verbose logging for the dome and mount drivers in INDI Control Panel to see detailed coordinate information, calculated target azimuths, and potential error messages. This is invaluable for diagnosing issues. Look for logs related to GetTargetAz, UpdateMountCoords, and UpdateAutoSync in the dome driver logs.

Shutter

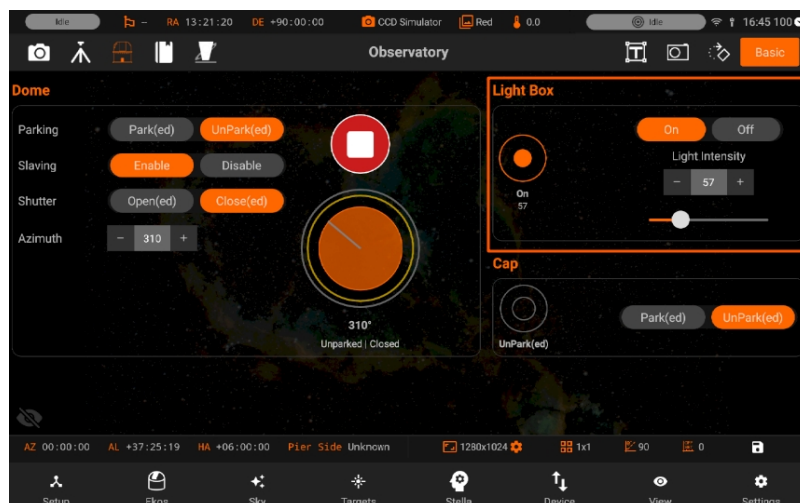
Azimuth

Abort



Stop operation: Halts all dome movement immediately. Use to stop rotation, parking/unparking, or shutter operations in progress.

Light Box

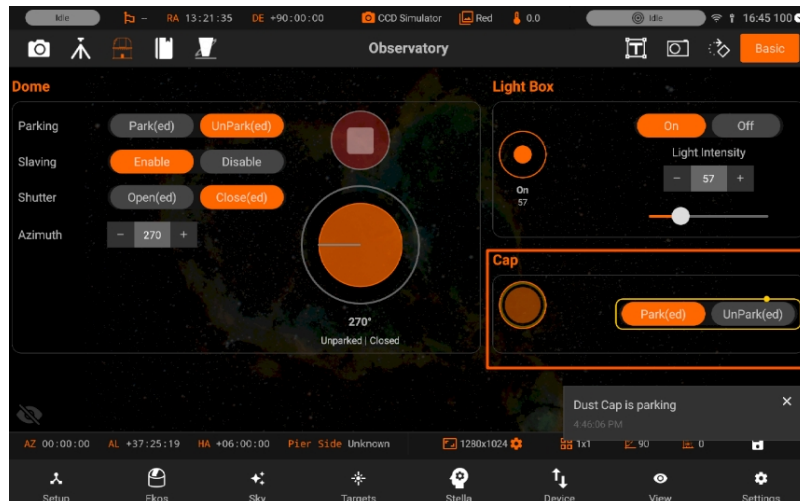


- **Enable:** Turns on the light box for illumination.
- **Disable:** Turns off the light box.

Light Intensity

- Adjust the brightness of your light box using the slider control. Move the slider to the right to increase illumination intensity. Move the slider to the left to decrease illumination intensity.

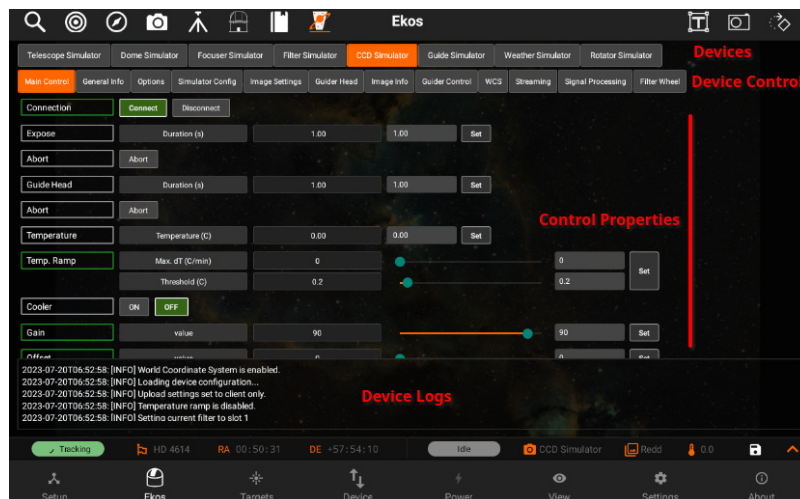
Dust Cap



Park: Close the dust cap to protect optical elements when not observing. **Unpark:** Open the dust cap to allow light to enter the telescope during observation.

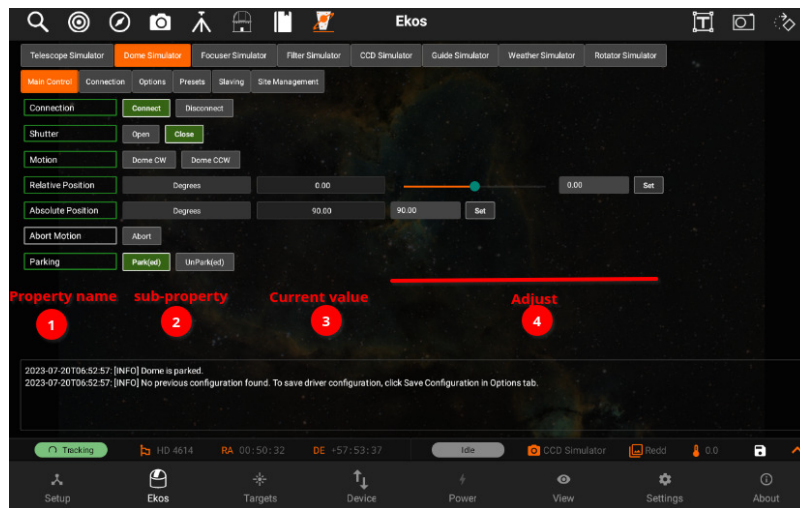
5.3.5.7 INDI Control Panel

INDI Control Panel provides an interface to interact with the drivers of the devices connected to Stellarmate. It is a front-end for the INDI controls available on KStars.



The connected devices are show at the top :

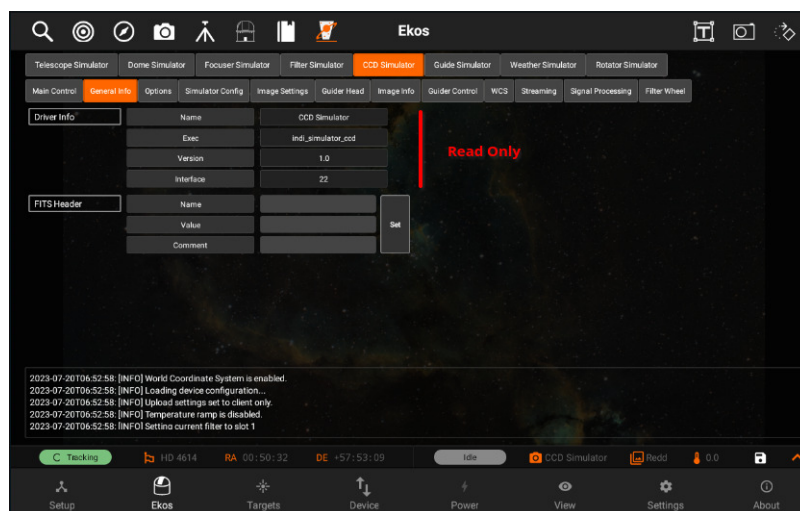
- 1. Selecting one will show it's control groups
- 2. Selecting one of the control groups displays it's properties in



Each property :

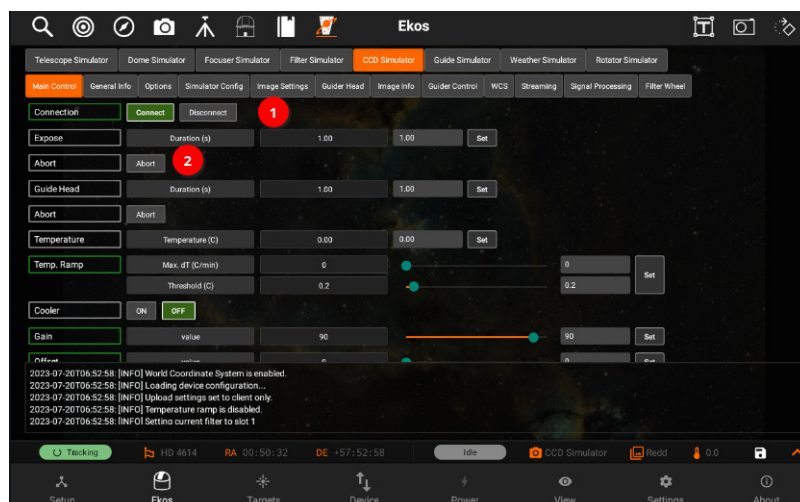
- 1. can have multiple sub-properties
- 2. The current value for the sub-property is shown at
- 3. The status of the property (1) would change from gray (idle) to green (successful), red (failed) or yellow (in-progress) when any changes have been set.

Some properties allow values to be adjusted. They can be changed using text field (and sometimes a slider for some number properties), and once you are done changing a property, you press Set (5) to send the new property settings to the corresponding device, to change the value.



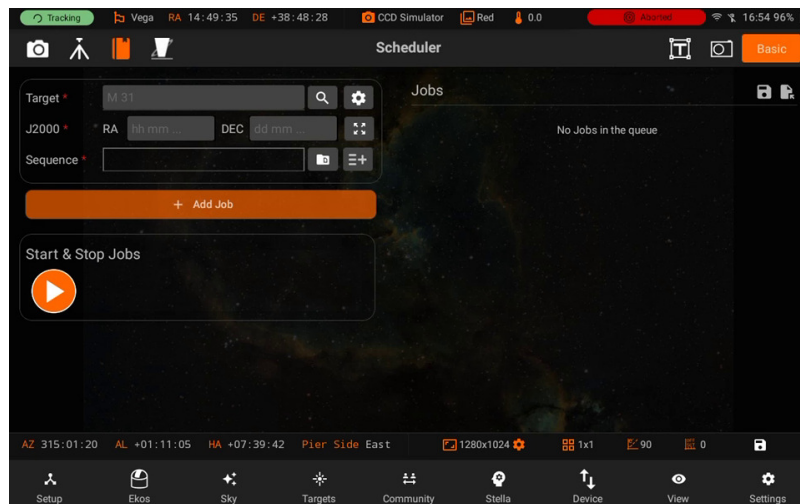
Some properties are read only and cannot be changed.

Some buttons show the active button (1), and a different button can be set active simply by pressing it. Other buttons (2) only send the action once pressed and we can tell if it was successful from the property status (3).



5.3.5.8 Scheduler

Ekos Scheduler is an indispensable arsenal in building your robotic observatory. A Robotic observatory is an observatory composed of several subsystems that are orchestrated together to achieve a set of scientific objectives without direct human intervention. It's recommended to use Ekos Scheduler after you are familiar with using all the Ekos modules manually first. Fine-tune the settings for each module to suit your particular equipment setup.



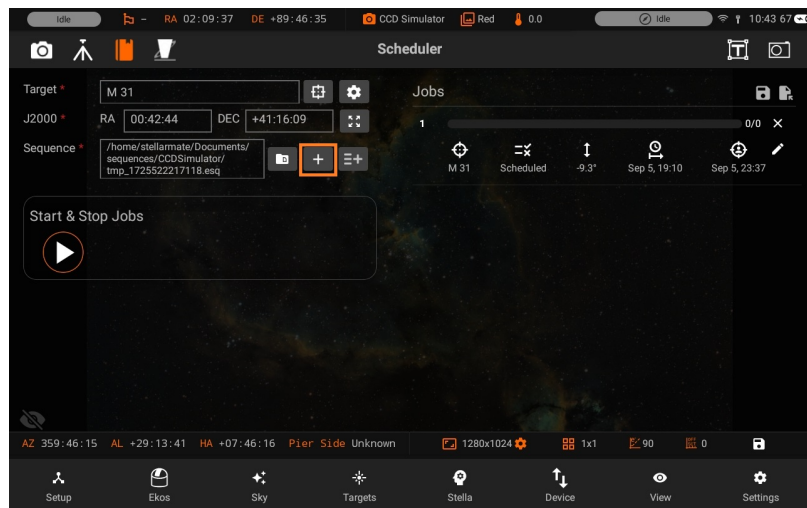
Ekos Scheduler provides a simple interface to aid the user in setting the conditions and constraints required for an observation job. To add a new scheduler task, or job as it is called in Ekos, you need to select the following: To add a new scheduler task, or job as it is called in Ekos, you need to select the following:

1. **Target:** Target can be selected directly by tapping on the Select Target button or by finding a target in the Targets module and then tapping Schedule while Ekos is in offline mode.
2. **Sequence:** A sequence file describes the required settings for each batch of images. Create a sequence file in the Capture module and save it for later.
3. **Steps:** Each job goes through a sequence of discrete steps. Each step or stage can be toggled on or off as desired:
 - a. **Track:** Mount is commanded to slew to target.
 - b. **Focus:** Camera auto-focus (if applicable) is started.
 - c. **Align:** Plate-solving is performed to ensure the correct location, framing and orientation of the target is met. If a FITS file is specified in General Settings, then this file is first plate-solved and then mount is commanded to slew to target solution coordinates. This is followed by another plate-solving process to ensure we are within tolerance at the target solution coordinates. If the position angle of the FITS image is different from the current camera orientation, the camera orientation can be automatically adjusted if a mechanized rotator is detected. Otherwise, a manual camera rotation is required until the image position angle is satisfied.
 - d. **Guide:** Using a guide camera, the mount tracking is locked to a guide star to enable long-exposure astrophotography

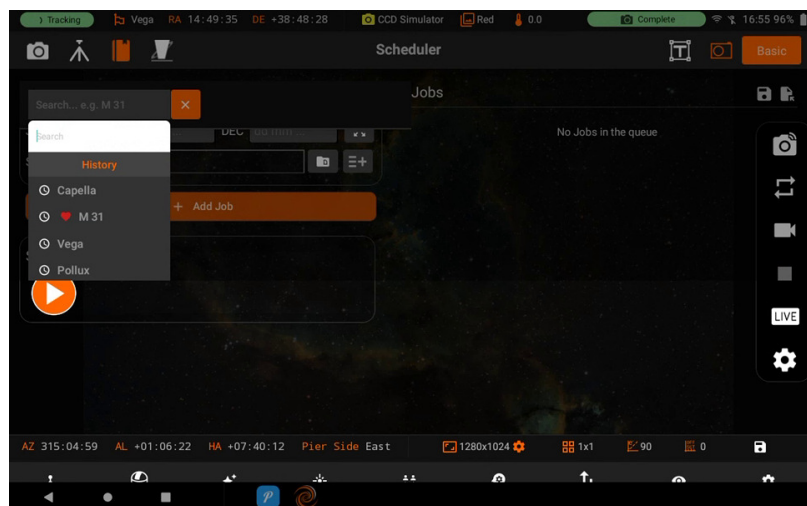
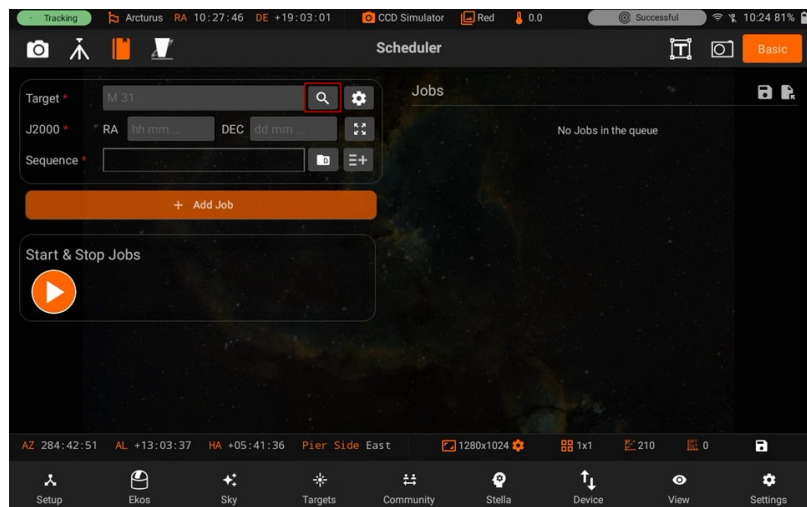
After the first 4 stages are complete, the sequence file is loaded in the capture module and batch capture commences. All images are saved to storage and can be accessed in the View tab. For EkosLive Pro subscribers, all images are also uploaded to the cloud storage if StellarMate is connected to the internet.

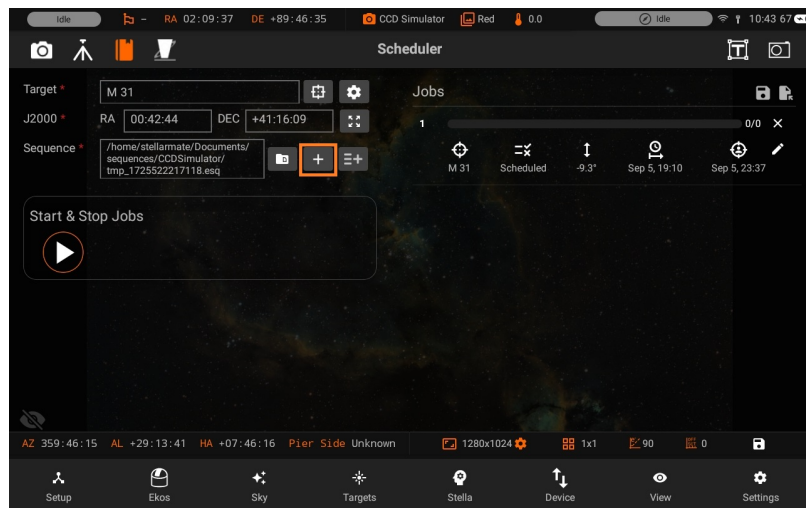
5.3.5.8.1 Jobs

You must select the **Target** and **Sequence** before you can add a job to the Scheduler. When the scheduler starts, it evaluates all jobs in accord to the conditions and constraints specified and attempts to select the best job to execute. Selection of the job depends on a simple heuristic algorithm that scores each job given the conditions and constraints, each of which is weighted accordingly.

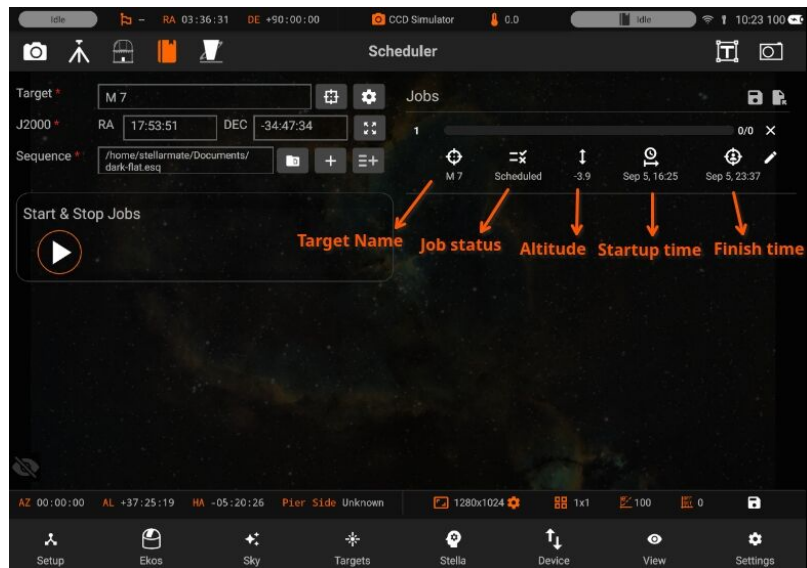


Target can be selected by pressing on the search button



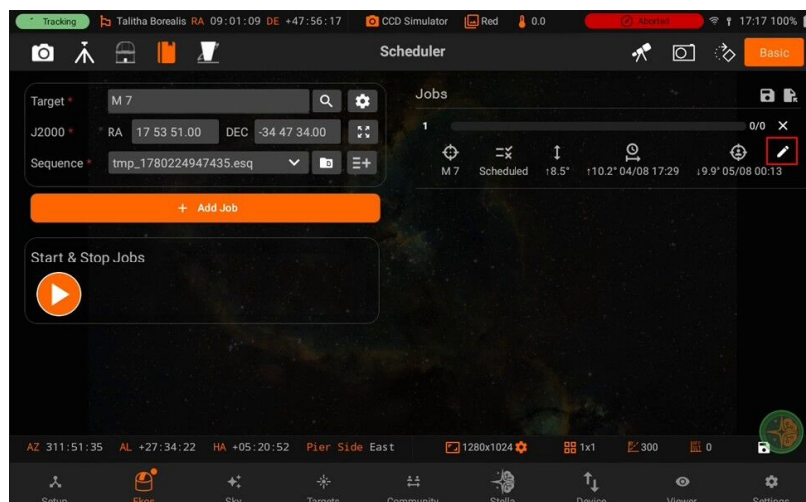


You can press on the Add button to Add a Scheduler Job. Jobs are on the right side of the screen.

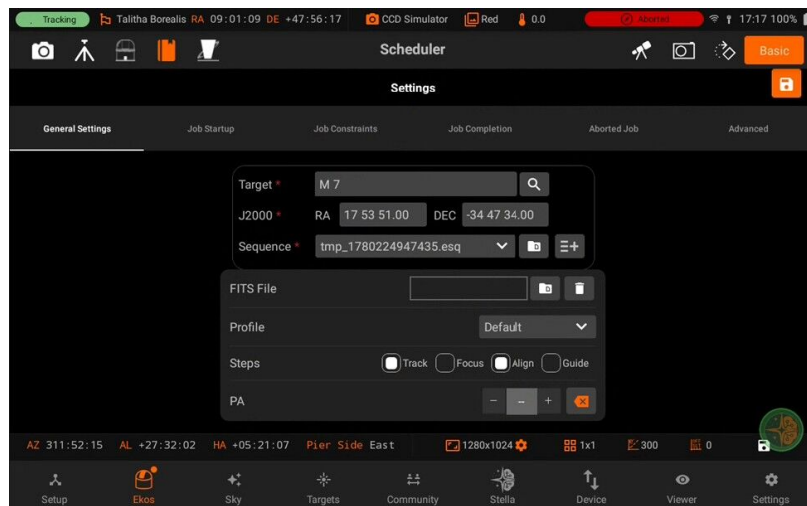


Above, you can see the details of the Job. Its specifies the following:

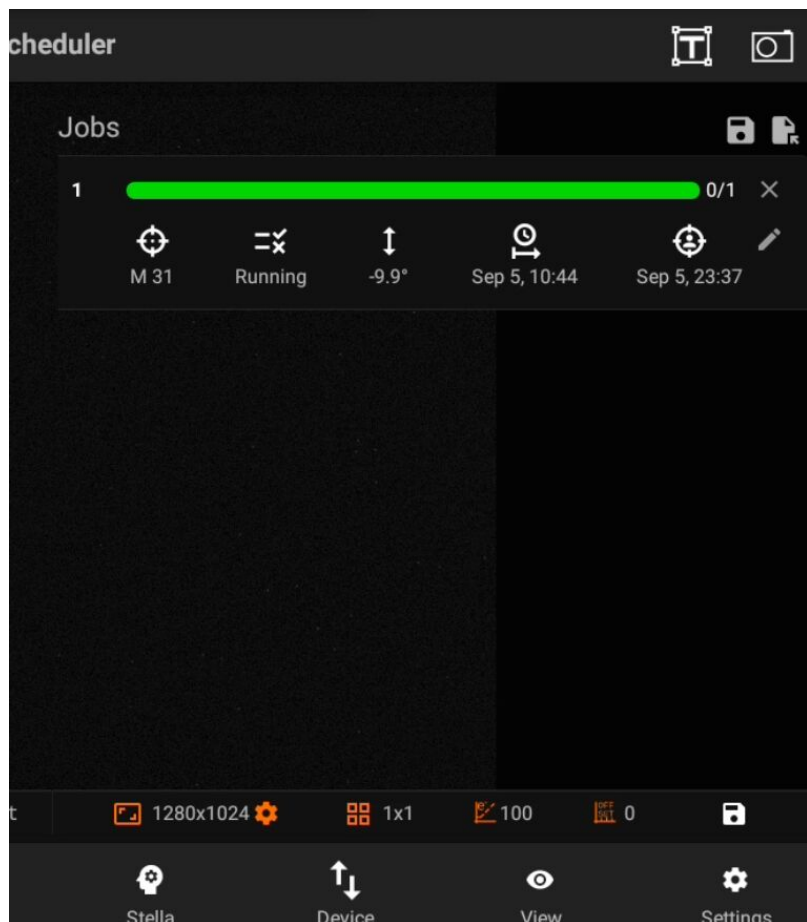
- Name of the Target object
- Current Status of the Job
- Altitude in degrees
- Starting time of the Job
- Completion time of the Job



Edit a Job when it is not running.

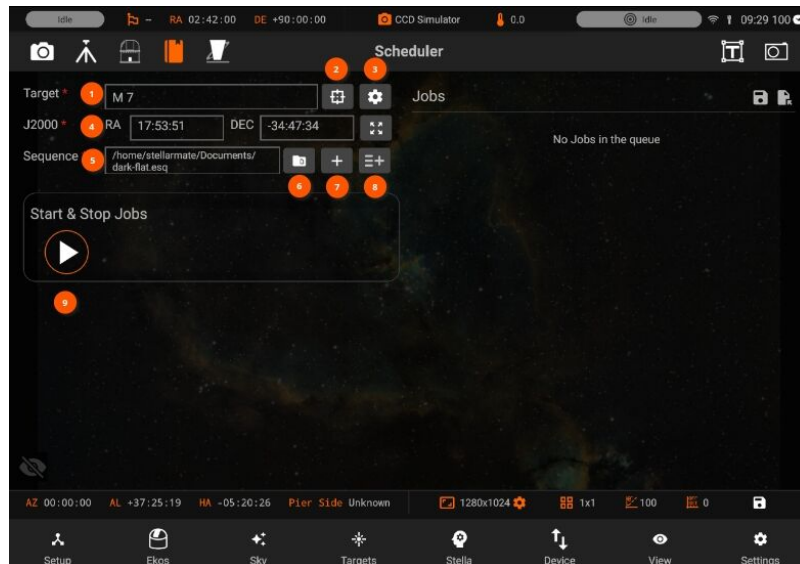


Target, Sequence and all other settings can be updated.

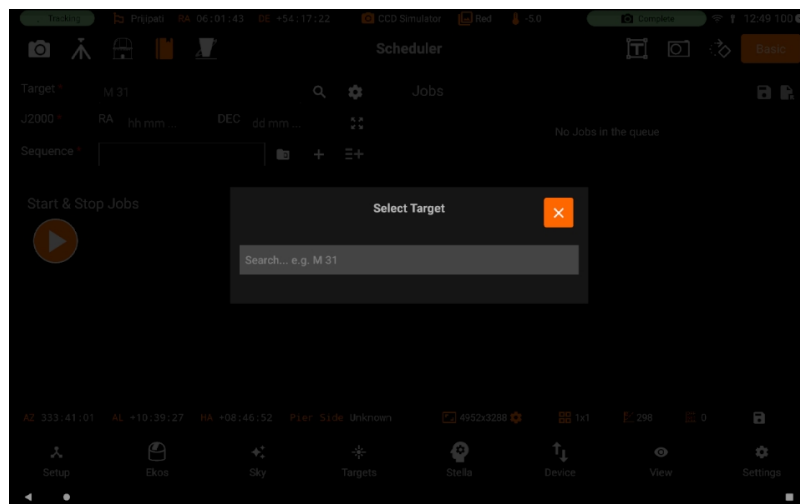


Once the Job is completed, the linear progress is turned to green and Job status is also updated when it is completed.

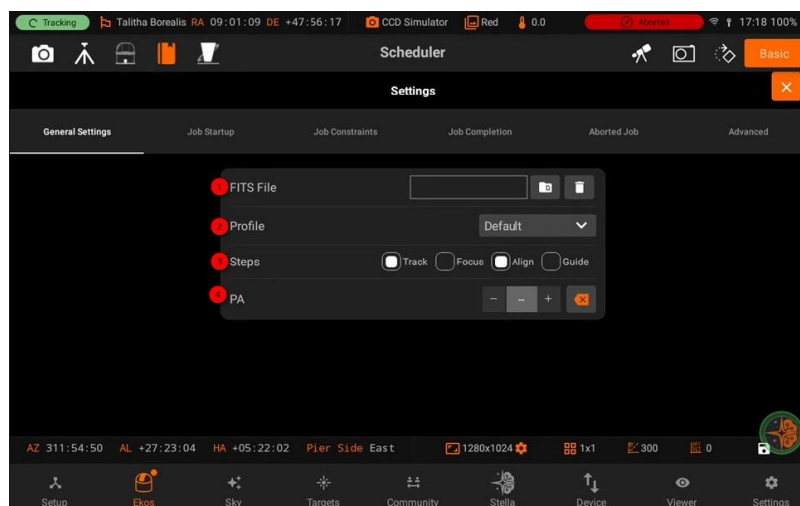
5.3.5.8.2 Settings



1. **Target name:** Target designation is automatically filled. It can be adjusted manually..
2. **Target Selector:** Search Targets can be also selected from the Targets tab when Ekos is offline.

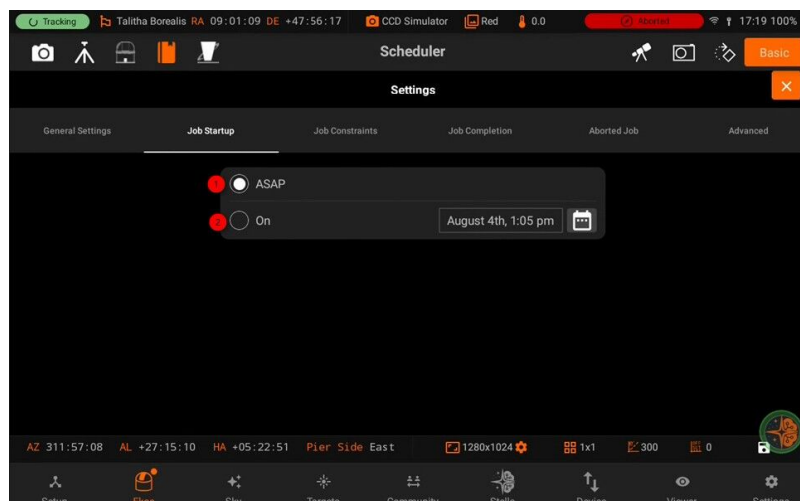


3. **Toggle Scheduler Settings**
4. **J2000:** RA and DEC are displayed of a specific target. You can also manually enter the desired coordinates.
Toggle Mosiac Planner
5. **Sequence File:** Sequence: A sequence file describes the required settings for each batch of images. Create a sequence file in the Capture module and save it for later.
6. You can select the file using Directory browser.
7. **Settings:** Contains all of the settings of Scheduler module.
General Settings:



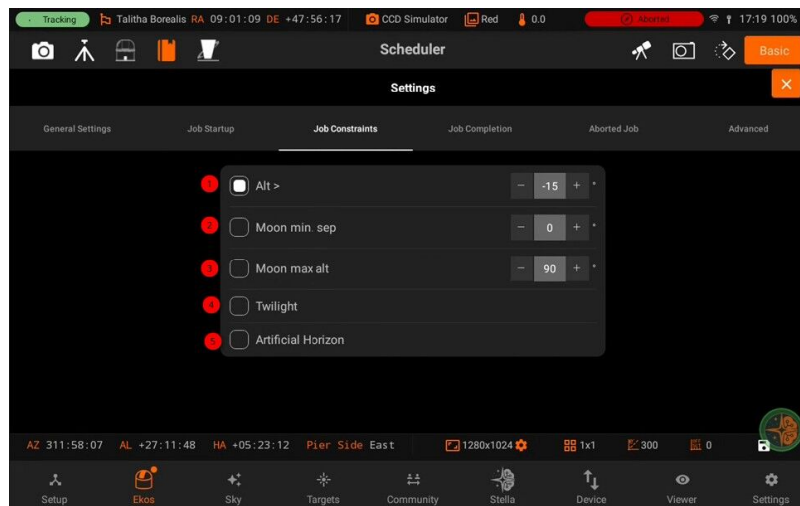
1. **Optional FITS file:** If a FITS file is specified, the astrometry solver shall solve the file and use the central RA/DEC as the target coordinates. You can select the file using Directory browser. **Removes selected FITS file.**
2. **Profile:** Select which equipment profile to utilize when starting Ekos. If Ekos & INDI are already started and online, this selection is ignored.
3. **Steps:** Each job goes through a sequence of discrete steps. Each step or stage can be toggled on or off as desired:
 1. **Track:** Mount is commanded to slew to target.
 2. **Focus:** Camera auto-focus (if applicable) is started.
 3. **Align:** Plate-solving is performed to ensure the correct location, framing and orientation of the target is met. If a FITS file is specified in General Settings, then this file is first plate-solved and then mount is commanded to to slew to target solution coordinates. This is followed by another plate-solving process to ensure we are within tolerance at the target solution coordinates. If the position angle of the FITS image is different from the current camera orientation, the camera orientation can be automatically adjusted if a mechanized rotator is detected. Otherwise, a manual camera rotation is required until the image position angle is satisfied.
 4. **Guide:** Using a guide camera, the mount tracking is locked to a guide star to enable long-exposure astrophotography
4. **Position Angle:** Select the desired Sky Position Angle in degrees (East of North). Ignore this setting to image using the camera current position angle. Use Target tab Framing Assistant tool to visually adjust the field of view until the desired orientation is achieved. on angle: You can also specify and position angle.

Job Startup



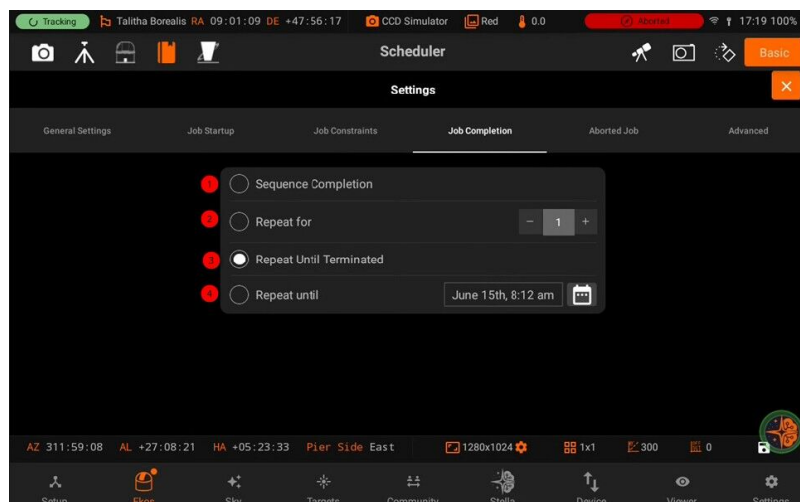
1. **ASAP:** Start the observation job as soon as all the constraints, if any, are met. The best candidate target shall be imaged first.
2. **ON:** Start the job on the specified date and time.

Job Constraints:



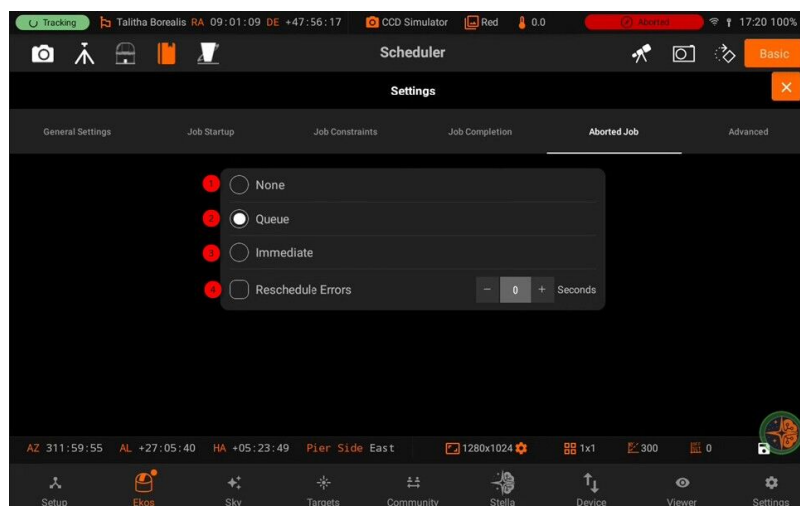
1. **Alt:** The object's altitude must remain equal or higher than the given value.
2. **Moon:** The moon separation must remain equal to or higher than the given value.
3. **Weather:** Weather conditions must remain safe. When weather conditions become dangerous, shutdown procedure is initiated.
4. **Twilight:** The twilight restriction constrains jobs to execute in astronomical darkness. Use the dusk and dawn offsets in the Ekos Scheduler options to adjust the interval.
5. **Artificial Horizon:** The A.H restriction constrains the attitude of the target to be above the artificial horizon. If any are defined and enabled. See the artificial horizon item in the KStars Settings menu.

Job Completion:



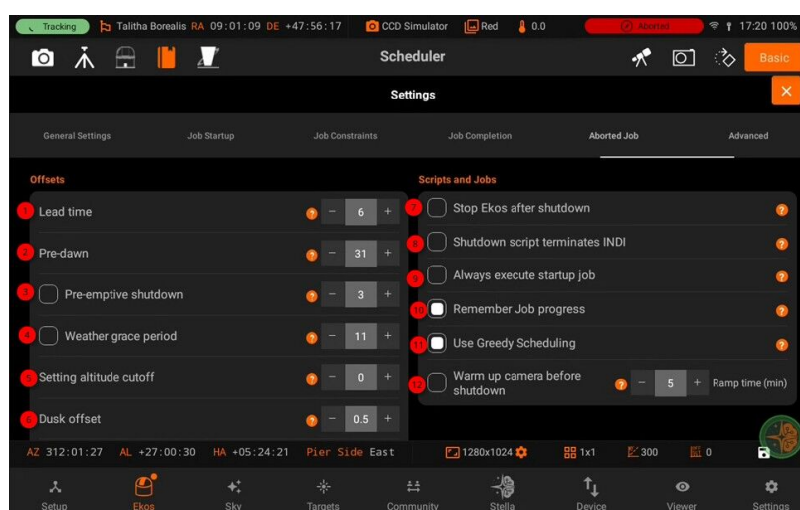
1. **Sequence Completion:** The observation job is completed when the sequence is complete.
2. **Repeat for:** No. of times sequence will repeat.
3. **Repeat until terminated:** Restart the sequence job indefinitely.
4. **Repeat until:** Terminate the job on given date and time.

Aborted Job:

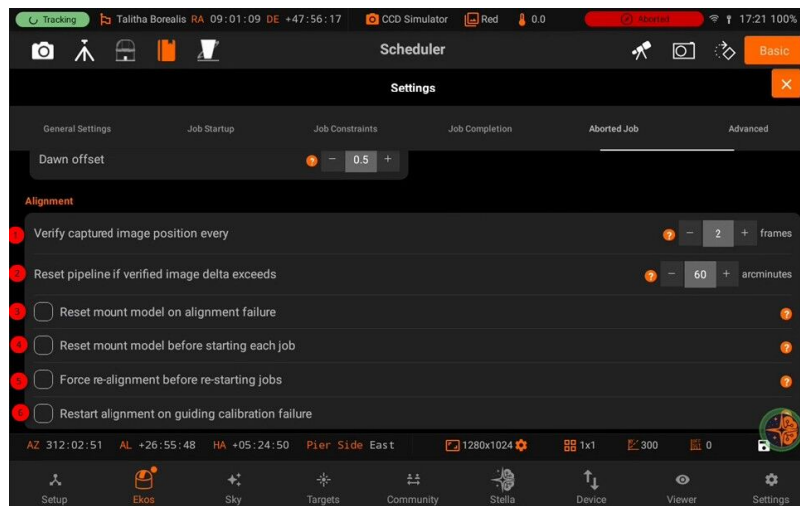


None: Do not reschedule aborted jobs. **Queue:** Reschedule aborted jobs as soon as all executable jobs are either completed or aborted. **Immediate:** Reschedule an aborted job immediately. **Reschedule errors:** Treat errors like aborts. (Delay in seconds).

Scheduler

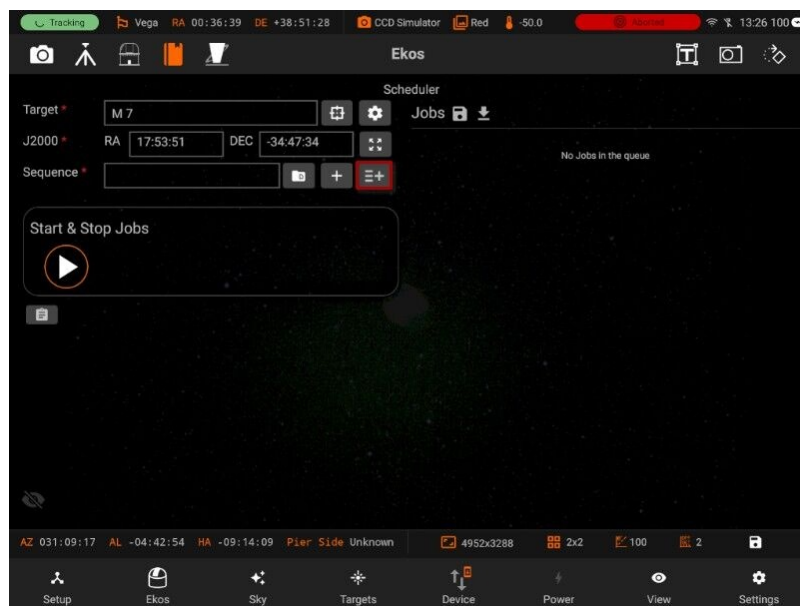


1. **Lead time** is the minimum time in minutes between jobs. The scheduler starts execution of a job before its scheduled startup time by this lead time. Early execution is useful as focusing, alignment, and guiding procedures may take prolonged periods of time to complete.
2. **Do not permit** jobs to be scheduled or executed past this many minutes before dawn.
3. **In case no** scheduler job is scheduled for this many hours, perform a complete shutdown procedure and restart observatory operations once the next job is ready.
4. **Enable Weather-Based Scheduling:** Prevents new jobs from starting during weather warnings or alerts. Existing jobs continue during warnings, but are aborted during alerts. System initiates a soft shutdown and waits for improved conditions or grace period expiration, after which the current job is terminated.
5. **Do not permit** jobs to be scheduled less than this many degrees before the altitude restriction. Actual execution proceeds until the altitude limit.
6. **Offset astronomical dusk** by this many hours. This positive or negative value adjusts the twilight restriction.
7. **Offset astronomical dawn** by this many hours. This positive or negative value adjusts the twilight restriction.
8. **After shutdown** procedure is successfully executed, stop INDI and Ekos.
9. **If the shutdown** script terminates INDI server, enable this option so that no disconnection errors are generated.
10. **When processing** a scheduled job, resume the sequence starting from the last image present in storage.
11. **When checked** the Scheduler tries to run lower priority jobs when no higher priority job can run. Recommended
12. ****Warm up the **** Camera sensor before shutting it down.

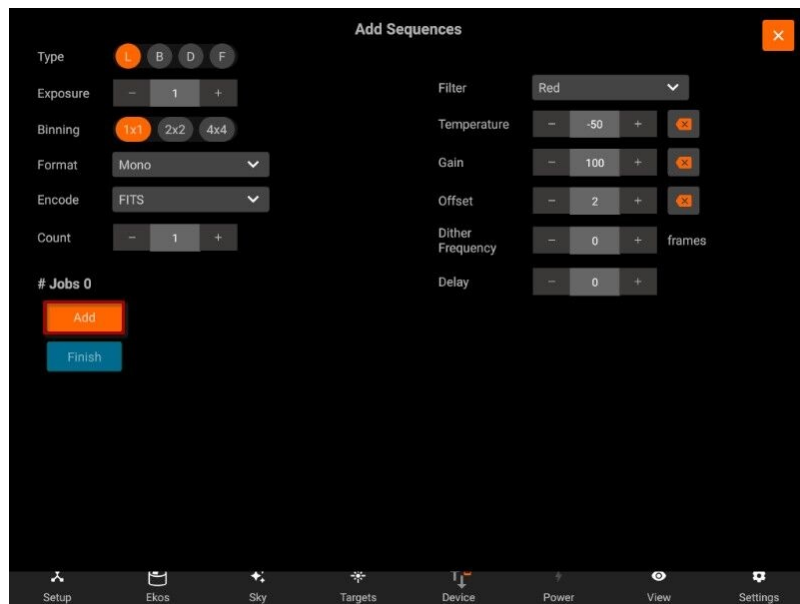


1. **When calculating** position after captures, compute it every Nth capture. Set to 0 to disable.
2. **If captured** position exceeds target position by more this many arcminutes, abort capture and reschedule the pipeline.
3. **Reset mount** model on alignment failure
4. **Reset mount** model before starting each job
5. **If Align** is enabled, scheduler would initiate a realignment procedure before restarting any jobs even if guiding is active.
6. **If guiding calibration** fails then restart alignment process before proceeding to guiding recalibration process again. This can help recentre the target object in the field of view if the calibration process strayed too far off.

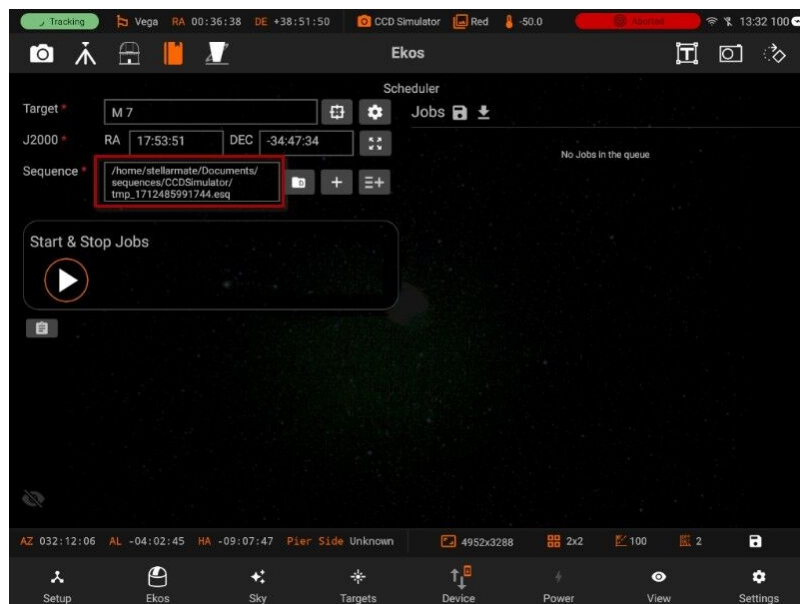
5.3.5.8.3 Standalone Sequences



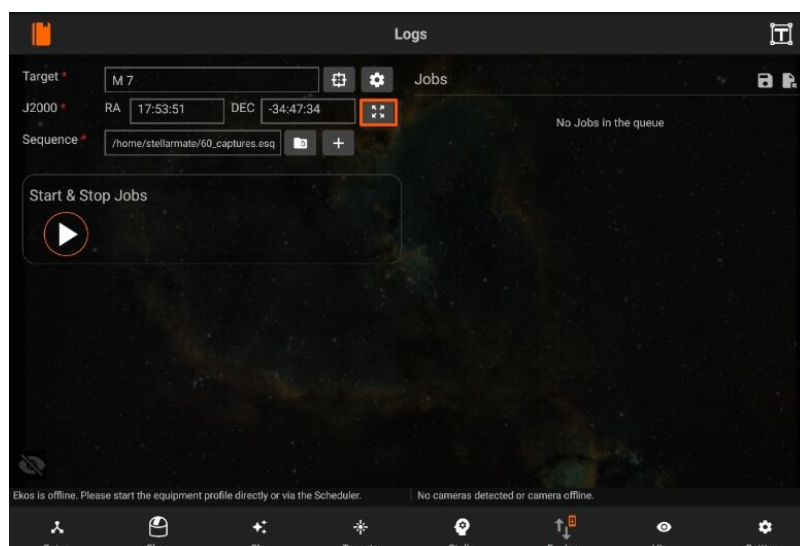
At minimum, a scheduler job requires a target and a sequence file. The sequence files contain the sequence jobs that need to be carried out in the capture module (e.g. capture 60x15 LRGB images). You can create and save sequence files in the capture module. They are saved to Documents/sequence folder so they can be reused in the future.



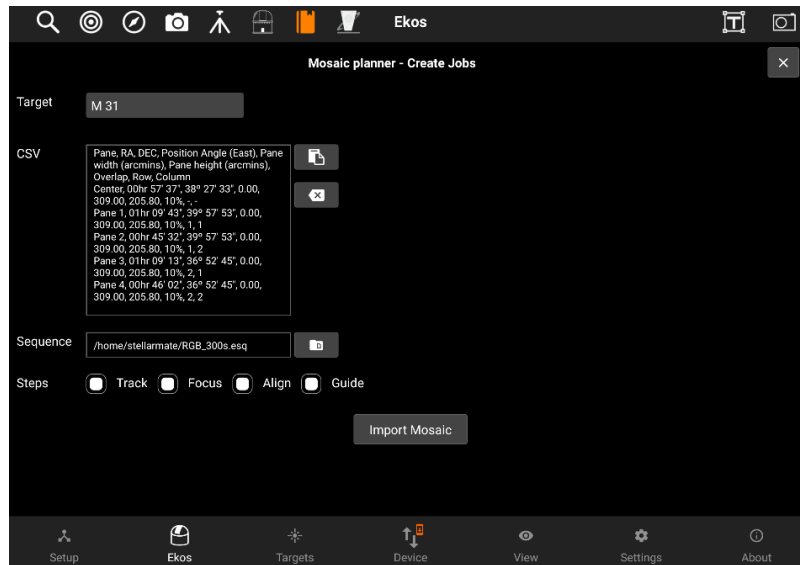
Alternatively, you can generate sequences on the spot with the Standalone Sequence editor. If Ekos is online, the editor will be based on the values of your current setup (e.g. filter list). On the other hand, if Ekos is not started yet, it will rely on settings from your previous session. You can add as many jobs as desired. When done, a sequence file is generated and automatically saved to the sequences folder.



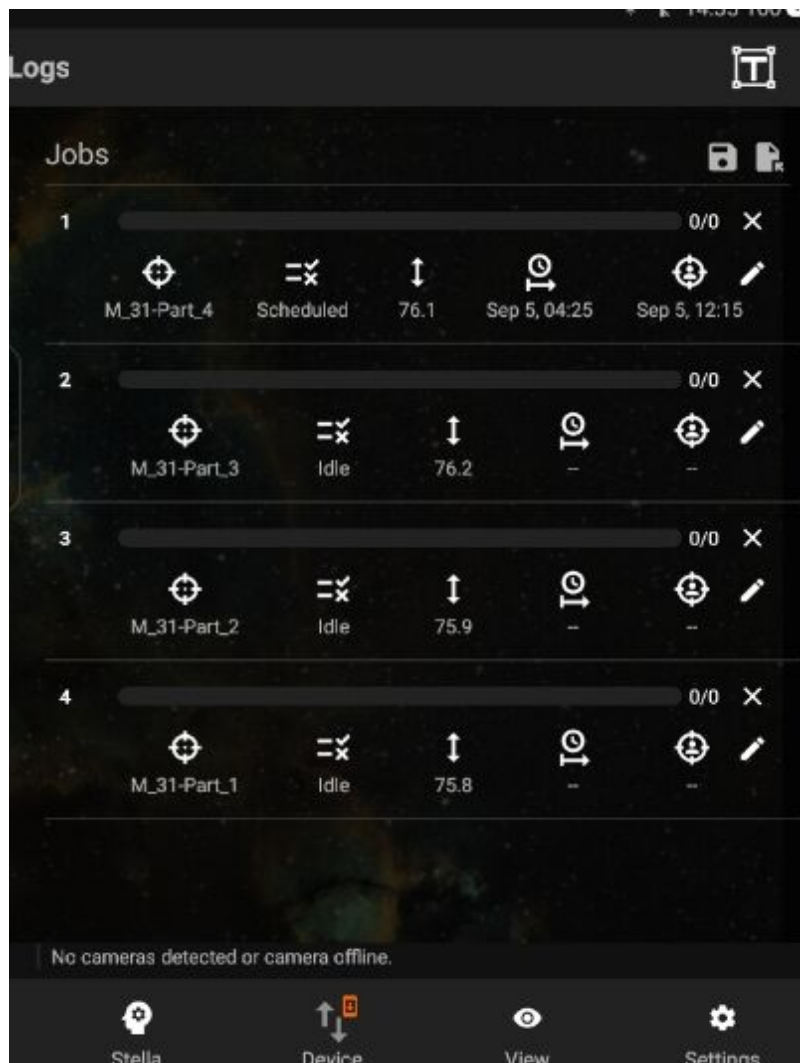
5.3.5.8.4 Mosaic Planner



Mosaics can be imported from Telescopius online tool.



1. **Target:** Name of the target.
2. **CSV:** You can copy coordinates from <https://telescopius.com/> and paste it here. Make sure you include center coordinates and then copy csv.
3. **Sequence:** Include sequence from the directory browser.
4. **Steps:** Enable steps to perform.
5. **Import Mosaic:** Imports mosaic sequences.



Mosaic planner sequences are added here, After importing mosaic.

5.3.5.8.5 Data acquisition

The overall procedure typically utilized in an observatory can be summarized in three primary stages:

1. Startup
2. Data Acquisition (including pre-processing and storage)
3. Shutdown

Ekos Scheduler only initiates the startup procedure once the startup time for the first observation job is close (default lead time is 5 minutes before startup time). Once the startup procedure is completed successfully, the scheduler picks the observation job target and starts the sequence process. If a startup script is specified, it shall be executed first.

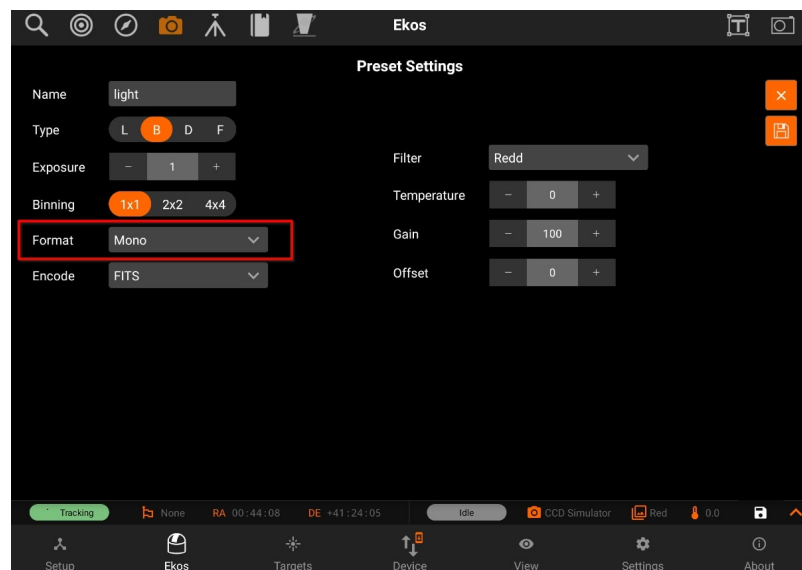
Data acquisition

Depending on the user selection, the typical workflow proceeds as following:

- Slew mount to target. If a FITS file was specified, it first solves the files and slew to the file coordinates.
- Auto-focus target. The auto-focus process automatically selects the best star in the frame and runs the auto-focus algorithm against it.
- Perform plate solving, sync mount, and slew to target coordinates.
- Perform post-alignment focusing since the frame might have moved during the plate solving process.
- Perform calibration and start auto-guiding: The calibration process automatically selects the best guide star, performs calibration, and starts the auto-guide process.
- Load the sequence file in the Capture module and start the imaging process.

5.3.6 Data Storage

Formats



By default, all captured images are saved as FITS (Flexible Image Transport System) files. FITS is the standard image format for astronomical images and is supported by all astronomical image processing software. For DSLR cameras, saving RAW images directly (e.g. CR2) is also supported by editing the DSLR camera capture preset. Depending on the camera settings and support, images can be captured as Mono, RAW, or RGB.

1. Mono:

Monochromatic single channel images store only intensity information in either 8bit or 16bit. Camera sensors generating 10bit or 12bit data are stored as 16bit by padding zeros, they are not up-scaled or modified.

2. RAW:

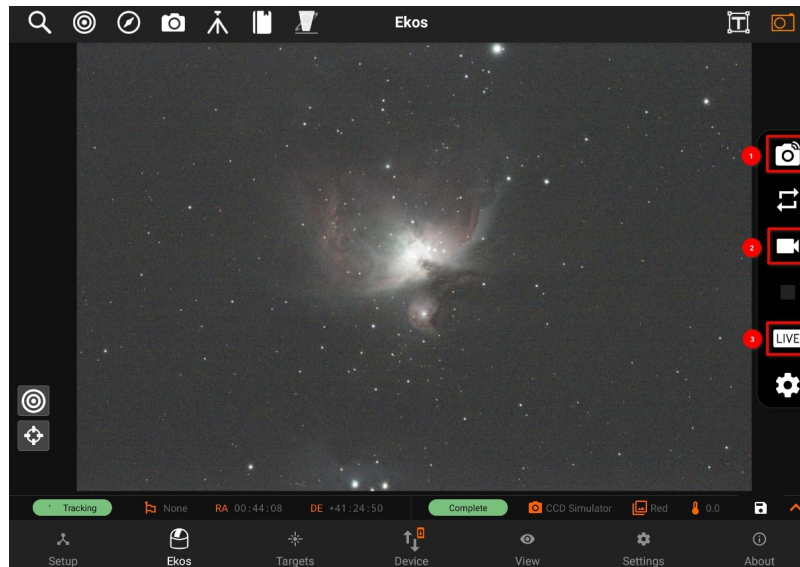
Color cameras with a Bayer filter often support RAW8 or RAW16 formats. The bayer pattern (e.g. RGGB) depends on the camera model. StellarMate saves the RAW images as is, but debayers them for display purposes. RAW format is the recommended format for color cameras.

3. RGB:

Color cameras can export a three channel RGB24 (8 bit per channel) or RGB48 (16 bit per channel) if supported

by the camera sensors. Usually, the RGB output is generated by an internal debayer mechanism in the camera firmware. Files tend to be larger in size compared to RAW images but do not require any debayering.

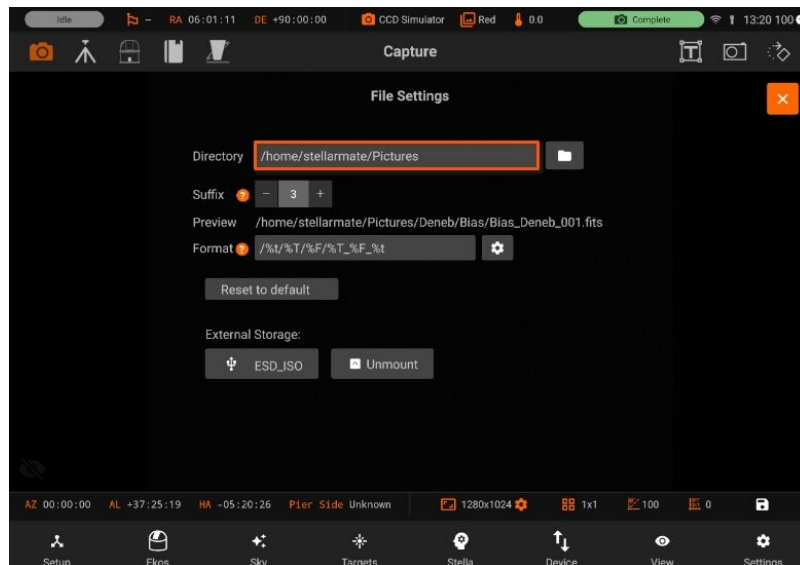
Capture modes:



1. **Previews** Preview images captured using Quick Camera Control are not saved to the internal StellarMate storage.

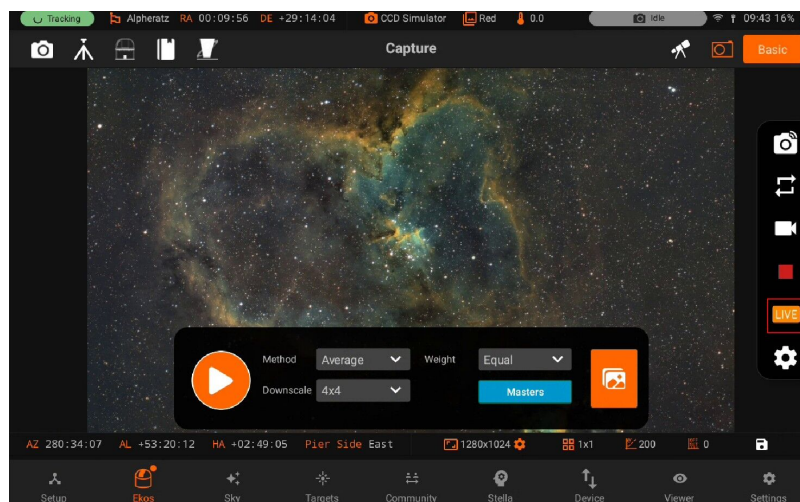
2. Sequences

- Sequence images captured in the Capture Module are saved to default storage location on StellarMate internal storage. The default full directory path is `/home/stellarmate/Pictures`.
- The Pictures directory can be changed in the Capture Module File Settings. If an external storage (e.g. SSD) is detected, you can select it as the default storage location.



- All sequence images are saved along with their metadata and can be viewed in the View tab.

3. Live Stacking



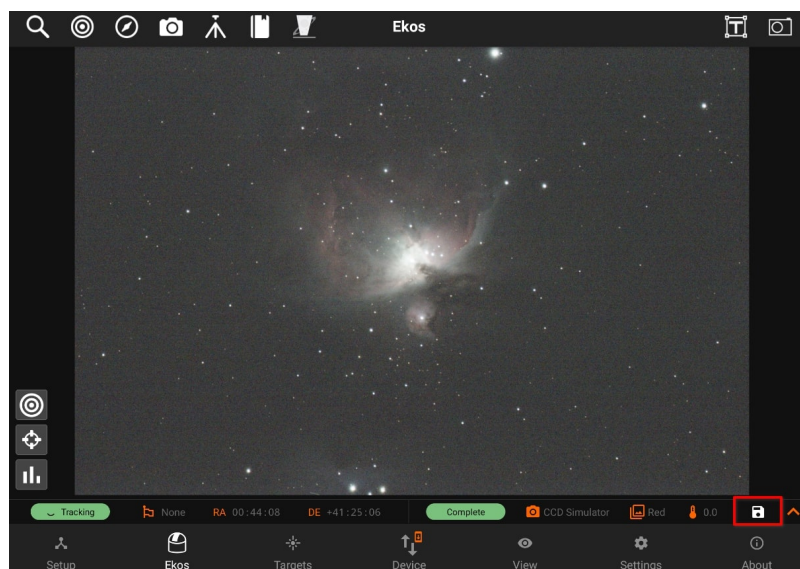
- Live Stacked images are automatically saved to /home/stellarmate/Pictures/livestacking and are also available in the View tab.
- If a sequence is already in progress, then live stacking starts when the next sequence image is captured. When no sequences are in progress, StellarMate starts capturing images continuously (looping) as per the settings in the Camera Quick Settings.
- After each image is captured, it is then live-stacked and the generated output is displayed sequentially in the thumbnail carousel.

4. **Video** If supported by the camera, video streams can be saved to the internal storage by clicking on the Video icon in Camera Quick Control. By default, video files are stored under /home/stellarmate/indi_D where D designates the date.

1. **SER** Save streaming images in SER lossless format. Beware that this can consume storage space very quickly. To view the video, you need to export the SER video file to a PC/Mac and open it using an SER player.

2. **OGV** Ogg Theora is a free and open lossy video compression format that sacrifices image quality to decrease storage space. To view the video, you need to export it to a PC/Mac and use a video player with support for Ogg Theora format.

Exporting to Phone/Tablet storage

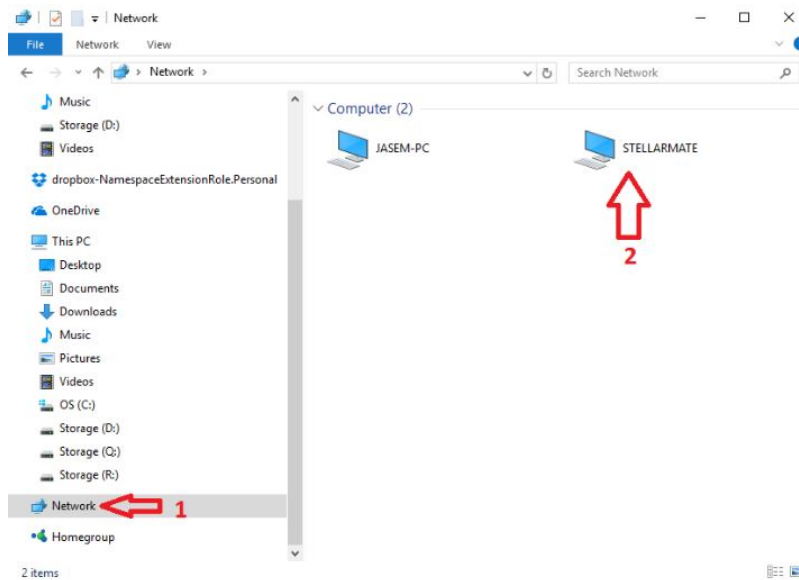


Any images displayed in the main image view can be exported to phone/tablet storage by clicking on the save icon on the camera status bar. It is saved as a time-stamped JPG image.

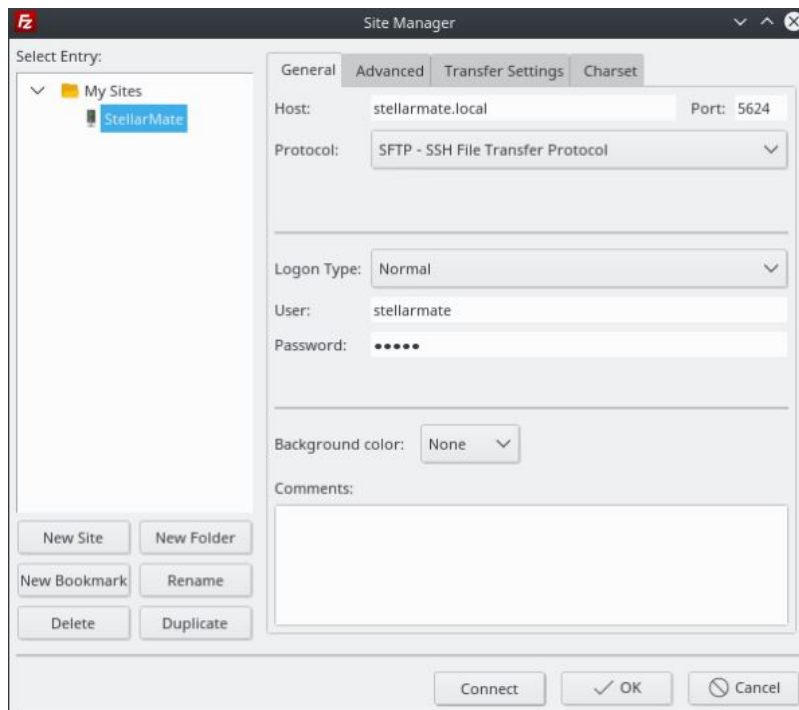
Exporting to PC/Mac

If you captured images and saved them to StellarMate, then they should be available by default under /home/stellarmate/Pictures. To access the images over the network, there are two options:

- On Windows, click on the Network icon in the left pane of File Explorer as illustrated below.

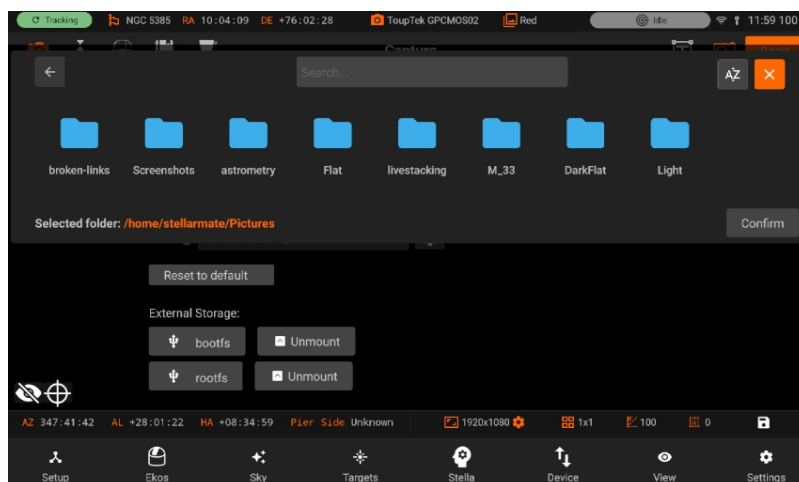


On Linux & MacOS: Use FileZilla to connect to StellarMate via Secure FTP (sftp) using your username (stellarmate) and password (smate). Remember to set port to 5624.



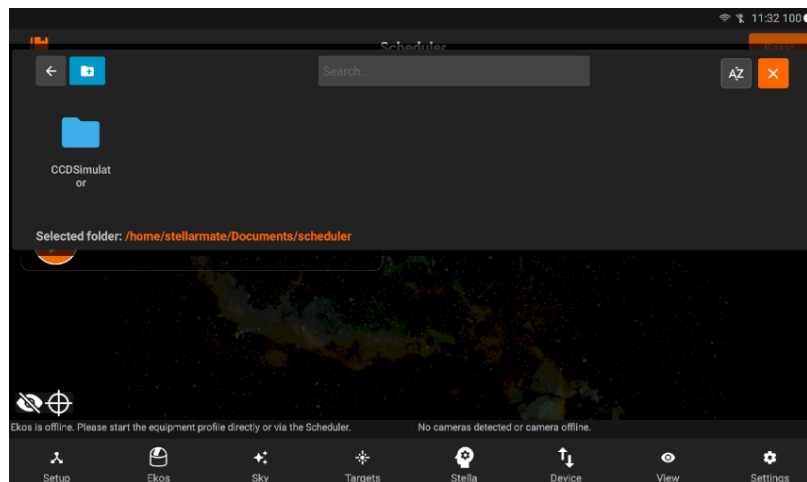
5.3.7 Directory Browser

Directory browser

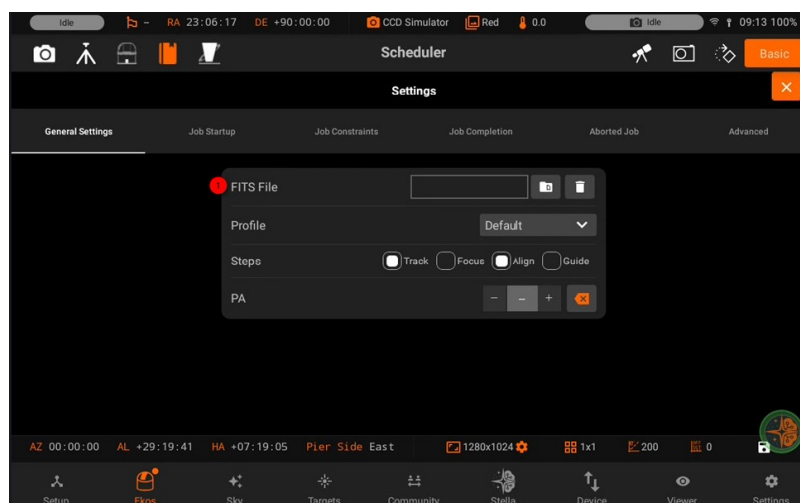


You can now choose files i.e Script file, Sequence file, fits file etc. Directory browser will extract the path from Stellarmate dolphin and set it according to the requirement input. We are using Directory browser on different places.

1. Scheduler:

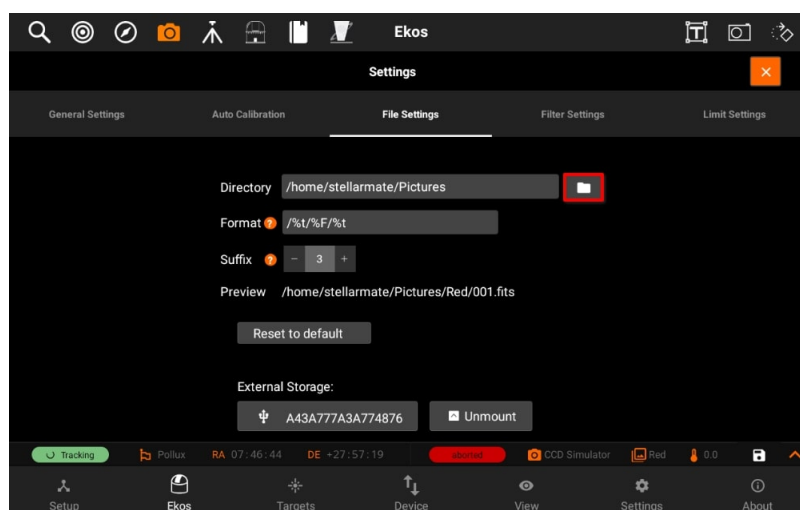


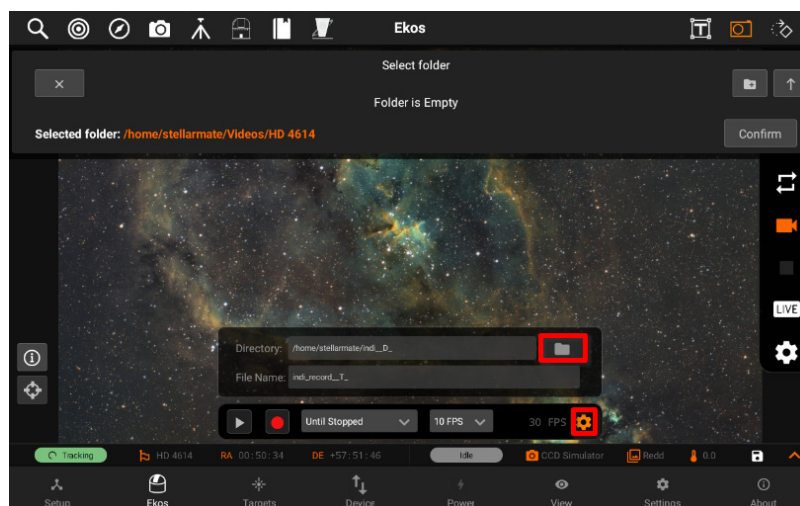
While selecting the sequence file or .fits file for Scheduler, we use Directory browser.



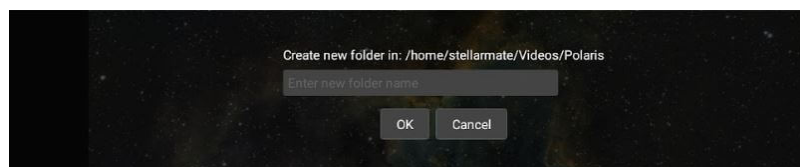
2. Path:

It is also used to set path for images in File Settings & recording settings using Directory browser.





You can also create directories via Directory browser.



5.4 Sky Map

The Sky Map tool provides an interactive all-sky planetarium view within the StellarMate App. It includes multiple toggleable layers for solar system objects, stars up to 12th magnitude, galaxies, nebulae, and star clusters.

To track an object, double-tap it. An orange crosshair indicates the object is being tracked. Once tracked, you can zoom in and out without losing track of the object. To exit track mode, tap anywhere else on the sky map.



5.4.1 Search

Use the search function to locate objects from all available catalogs. Tap an object in the search results to center it on the map. The object information panel will display, showing its type and coordinates.



5.4.2 Objects Bar

Toggle the visibility of celestial objects and layers:

- Stars
- Deep Sky Objects
- Solar System
- Constellation Lines
- Milky Way
- Equatorial Grid
- Horizon
- Digital Sky Survey (DSS)
- Mosaic Planner

5.4.3 Push To Assistant

The Push To Assistant is designed to help center objects on manual Alt-Az mounts using a camera aligned with the primary optical axis. For accurate operation, the camera must be precisely aligned with the eyepiece, as there is no offset compensation.

Equipment Setup

To use this tool, create an equipment profile containing the following devices:

- Telescope Simulator
- Camera driver for your camera make.

When configuring your profile, select or create the telescope profile (Focal length and aperture). This refers to the smaller guide scope or finder scope used with the camera, not your primary telescope. Accurate telescope specifications are essential for proper plate-solving.



Centering Process

1. **Target Selection:** Select your desired object in the sky map, then sync the Telescope Simulator to it.
2. **Initial Positioning:** Manually move your mount as close as possible to the target object.
3. **Set Target Center: From the Push To Assistant window, choose your desired target center using one of these methods:**
 - **Star Icon:** Select the currently selected object as the target center
 - **Frame Icon:** Select the sky map center as the target center
4. **Begin Centering: Press Start to initiate the process. StellarMate will:**
 1. Capture an image
 2. Plate-solve the image
 3. Display a correction vector showing how to adjust your mount to reach the target
5. **Make Adjustments:** Follow the correction vector to manually adjust your mount position. If you close to the target, make sure to make small gentle movements. The sky map will also show the Telescope Simulator position and the target position, so you can use the Sky Map as your guide during the centering process.
6. **Wait for Next Cycle:** After successful plate-solving, StellarMate will wait for the configurable delay period (10 seconds by default) before capturing the next image. This delay allows you to make mount adjustments without causing motion blur in subsequent captures.
7. **Repeat:** Continue this process until you achieve satisfactory centering results.

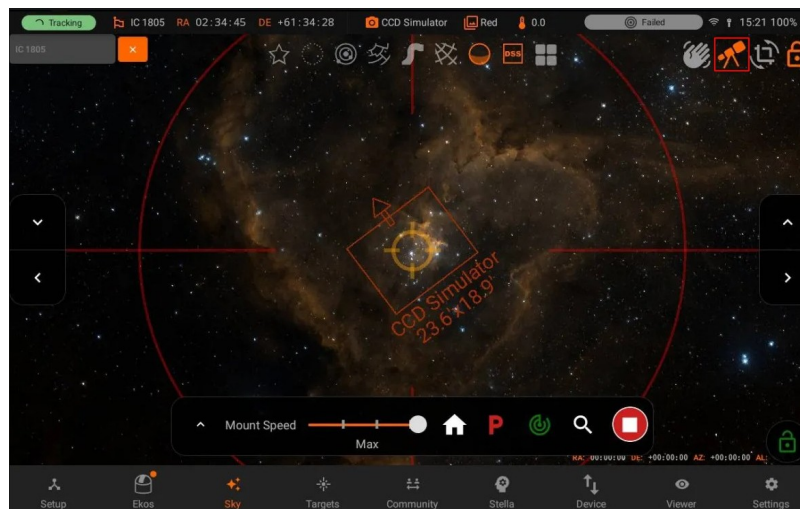
Plate-solving Tips

The Push To Assistant relies on successful plate-solving of captured images and uses the same settings specified in the Ekos Align module. It is generally recommended to first test plate-solving in the Ekos Align module to ensure it works correctly with your system, adjusting parameters like exposure time and gain appropriately for your equipment.

If plate-solving fails during Push To Assistant operation, simply wait for the next automatic capture attempt. If failures persist, consult the [Alignment Troubleshooting](#) guide for additional assistance.

5.4.4 Quick Mount Controls

Access mount controls to adjust speed, homing, parking, and tracking. Use the directional keys to manually move the mount.



5.4.5 Lock Sky Map to Mount

When enabled, this option keeps the mount crosshair centered on the map even when the mount moves. This is useful for continuously monitoring the mount position.

5.4.6 Object Panel

Tap any object on the sky map to display the Object Panel. The panel shows the object's magnitude (if available) and its horizontal and equatorial coordinates. You can perform GOTO, SYNC, or Go & Solve operations. The panel outer rim changes color to indicate the current operation status:

- Magenta: GOTO in progress
- Yellow: Plate solving in progress
- Green: GOTO or plate solving complete
- Red: An error occurred

5.4.7 FOV Indicator

At the center of the map, the Field of View (FOV) indicator shows the sky area visible to the camera sensor. The FOV size changes based on the selected camera and telescope. Below the FOV indicator, the camera name and width/height in arc-minutes are displayed. The up-arrow indicates the top side of the camera frame.

The Sky Map simulates the night sky using your device's current time and location.

5.4.8 Mosaic Planner

Overview

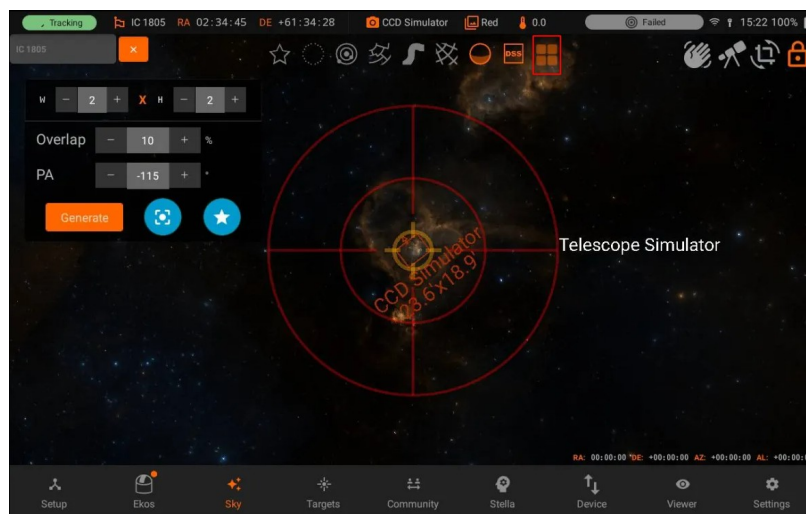
The Mosaic Planner creates wide-field images by stitching multiple overlapping captures into a single large image. This allows you to capture targets larger than your telescope's field of view without changing equipment.

Mosaic imaging involves two steps:

- Capture multiple overlapping images of the target area
- Process and stitch images together using external post-processing software

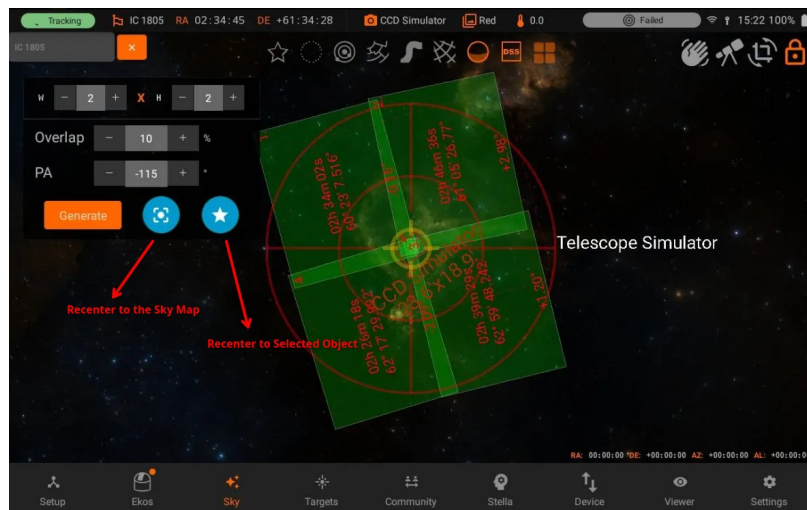
Enabling the Planner

The Mosaic Planner creates multiple Scheduler jobs based on a central target. To toggle the planner, press the grid button as shown below:

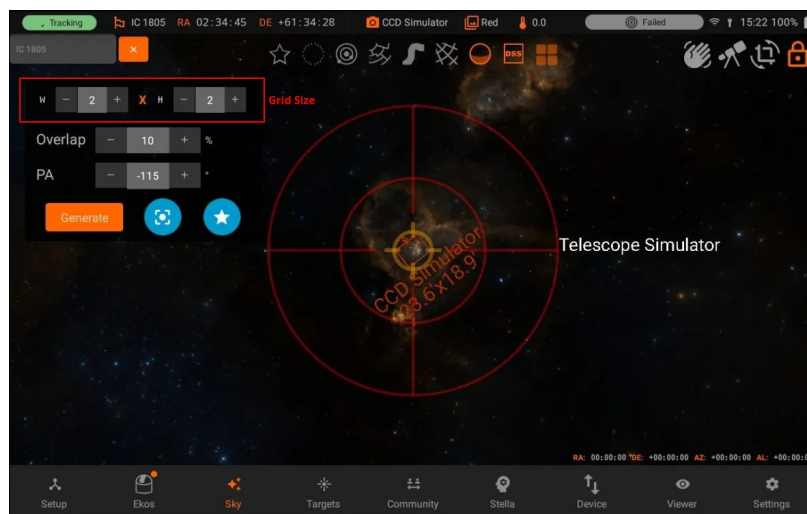


Configuring Mosaic Settings

Center the mosaic panel to the current sky map view or to a selected object using the recenter options.

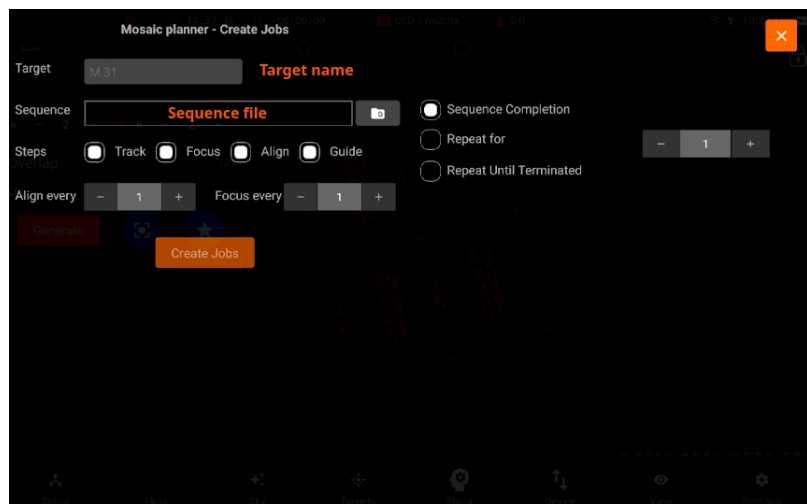


Configure the grid size and overlap percentage for the mosaic panels. Set the Position Angle to match the desired mosaic orientation in the sky. If the Position Angle differs from your camera's usual orientation, you may need to rotate the camera manually or via a mechanized rotator when the scheduler jobs execute.



Creating Mosaic Jobs

Once configured, press **Create Job**.

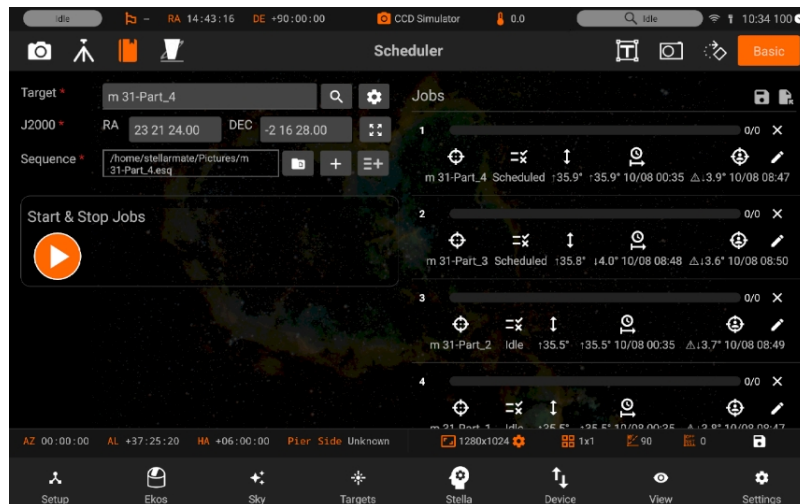


Select the sequence file for each tile. The Target field may be automatically filled but can be changed as needed. Select the steps each scheduler job should execute in sequence (Track -> Focus -&; Align -> Guide -> Capture), and adjust the frequency of automatic alignment and focus routines during the mosaic operation. For example, if Align Every is set to 2 Scheduler Jobs, the first job will run astrometry alignment while the second job will skip it. When the third job executes, alignment is performed again.

To alternate between different mosaic tile jobs, enter a group name that all tile jobs will share and select a repeating

completion condition.

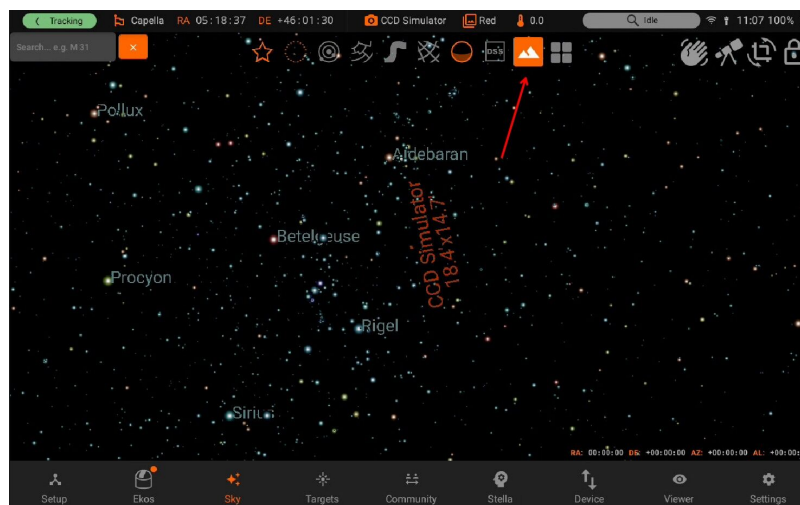
Press **Create Jobs** to generate mosaic scheduler jobs and add them to the schedule queue. You can edit the jobs individually like normal Scheduler jobs.



5.4.9 Artificial Horizon

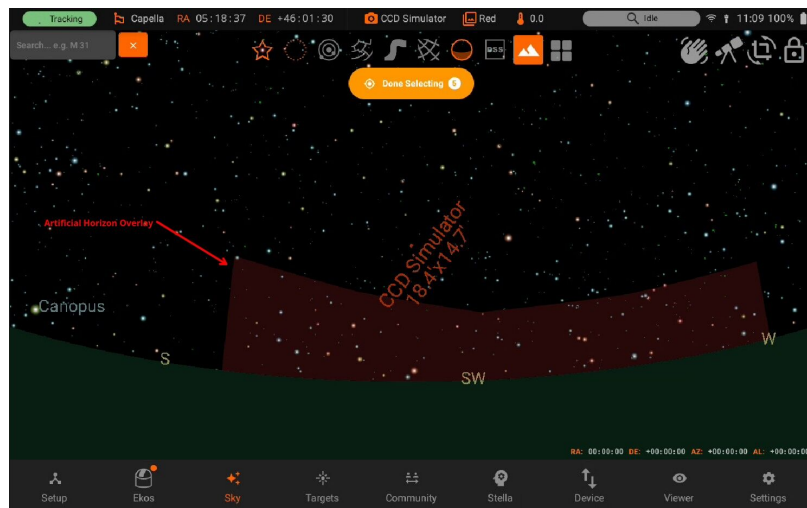
Overview

The artificial horizon feature allows you to define a custom horizon line within the sky map. This can be useful to simulate the view from a specific location where natural obstructions like trees, buildings, or other landscape features block parts of the sky. By setting an artificial horizon, you can accurately represent the visible sky from your observing site and plan your observations accordingly. This helps in determining when celestial objects will rise above such obstructions, allowing for better scheduling of observations and imaging sessions.

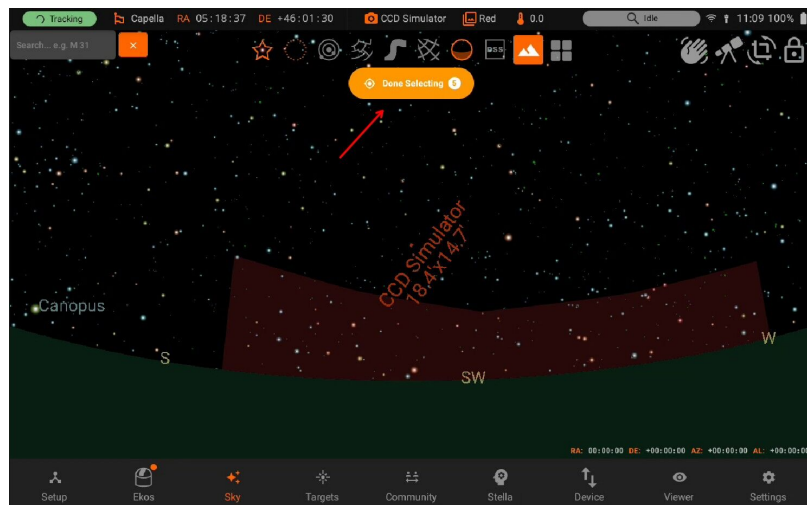


Once the Artificial Horizon is toggled, you can either select points manually on the map or import a horizon file.

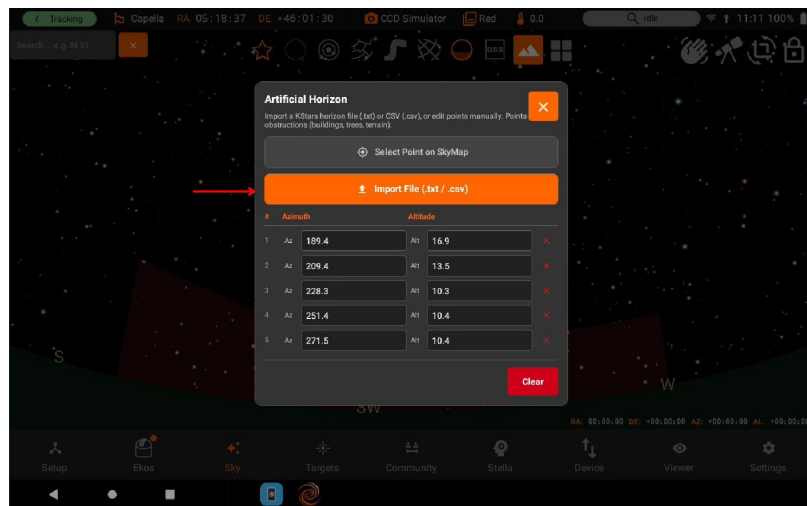
Select Points To define horizon points manually, enable the **Select Points** option and tap the desired locations on the map.

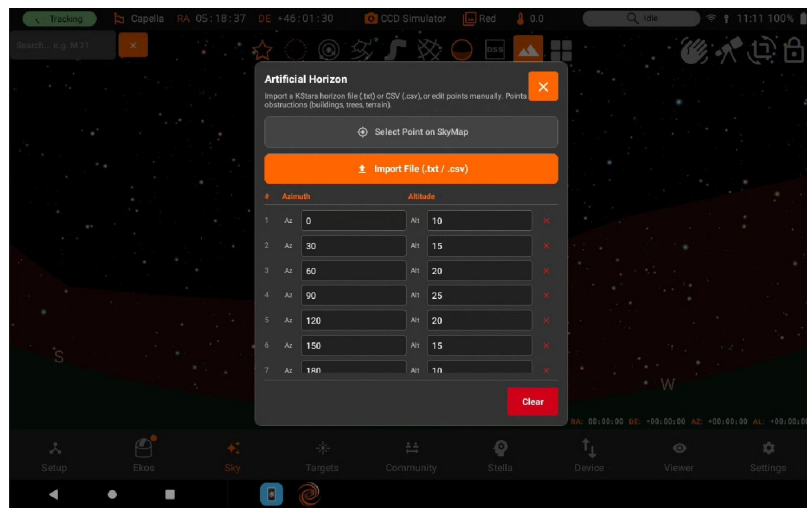


Once all points have been placed, press the **Done Selecting** button to activate the Artificial Horizon.



Import Horizon To activate the Artificial Horizon using a file, import a horizon file from your mobile device or tablet.





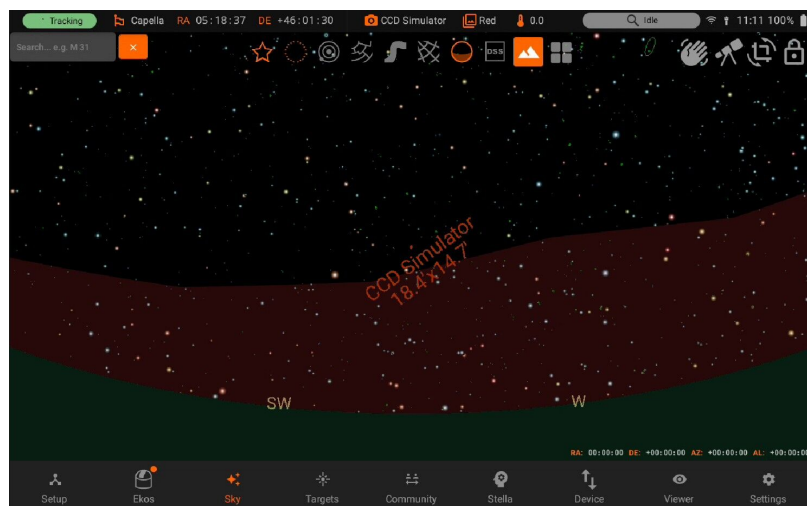
The supported file format is .txt. The file should be structured as follows:

```

1 # KStars Artificial Horizon export (Alt Az)
2 #
3 Horizon artificial_horizon
4 0 10
5 30 15
6 60 20
7 90 25
8 120 20
9 150 15
10 180 10
11 210 15
12 240 20
13 270 25
14 300 20
15 330 15
16 360 10
17

```

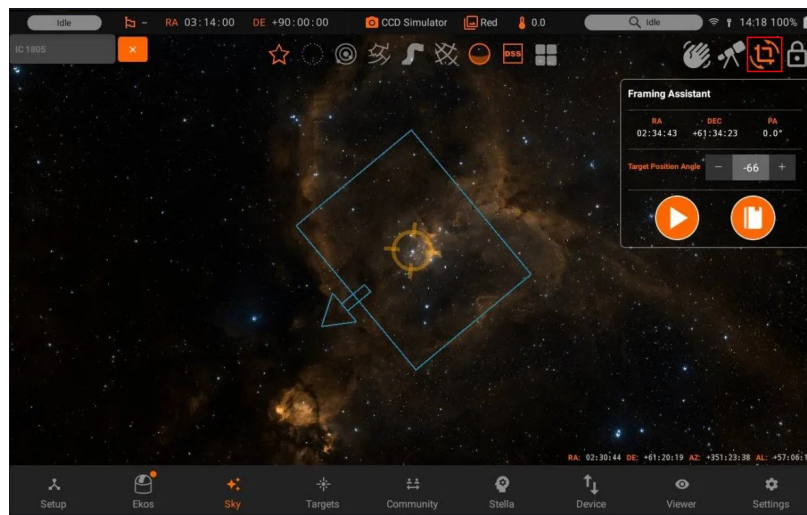
Once the file is imported successfully, the horizon overlay will appear on the Sky Map.



5.4.10 Framing Assistant

Overview

The framing assistant tool puts precise framing control at your fingertips. * Intuitive Interface: Easily adjust your target's position and orientation within the frame using straightforward controls. * Clear Visual Feedback: See the exact area that will be captured with the field-of-view indicator, ensuring perfect framing every time. * Simple Adjustments: Make quick and precise adjustments to frame your subject exactly as you envision.

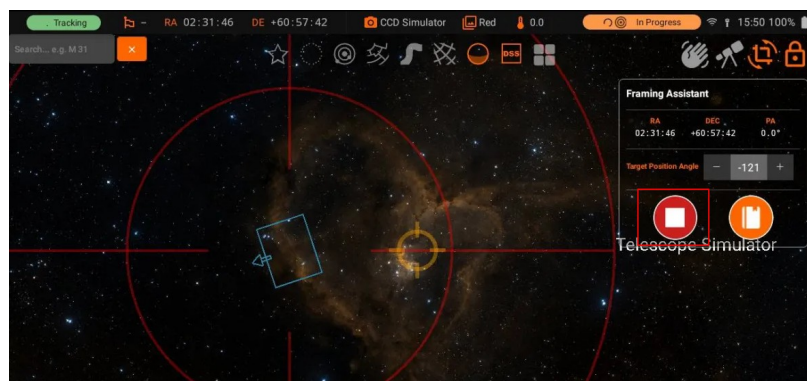


When you toggle Framing Assistant, the FOV Position angle and RA,DEC is synced to your current camera information. You can pan and rotate the desired FOV to Slew or Schedule.

You can see in the image below, the desired FOV is now pointing on other object.



Once your desired target is achieved, press Play Icon button to GoTo and Solve.



5.5 Targets



StellarMate Targets is the StellarMate Planning tool to streamline your observation session. Search from thousands of objects and filter them according to criteria important to every astrophotographer. Objects are sorted by brightest object first (if their magnitude is known). The number of objects listed is limited to the brightest 100 objects that satisfy the conditions set in the Filters section. To search for any arbitrary object, enter its name in the search bar and tap the Find icon. If the object is found, it should be added to the My Searches list. Add objects of interest to a quickly accessible Favorites list, or create and manage lists for your seasonal targets. Use the almanac info box to find Lunar, Solar, and Twilight times.

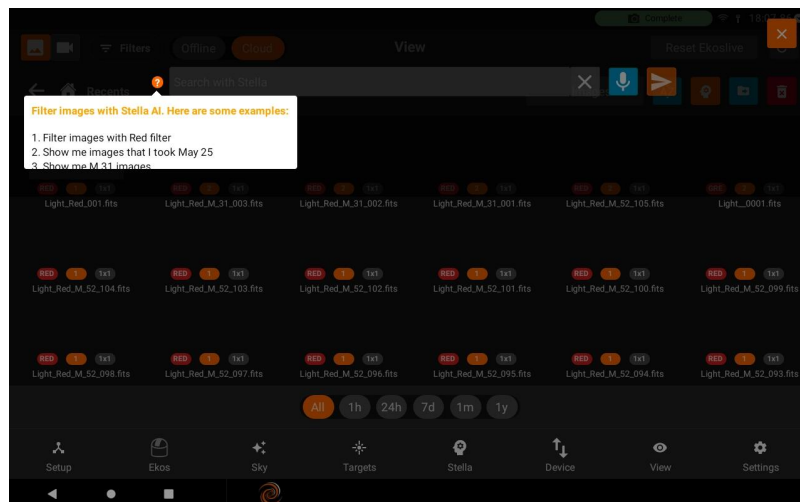
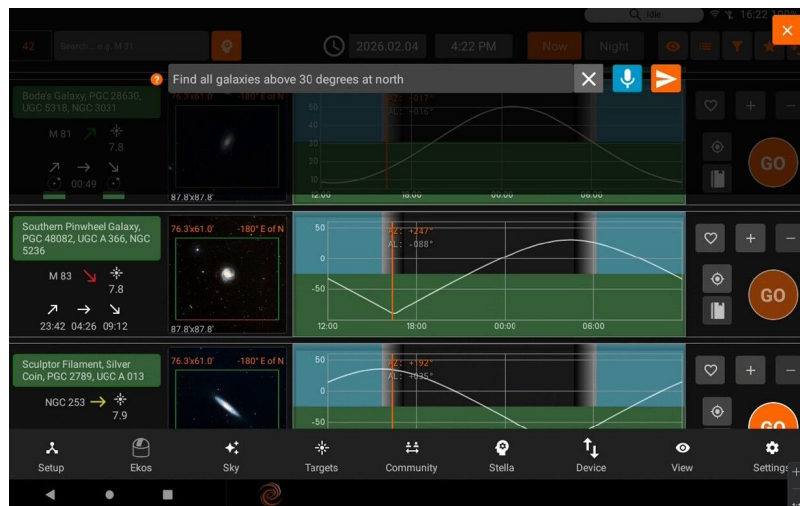


Stella Assistant:

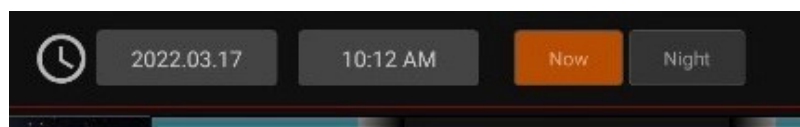
You can use Stella in Targets.



Once it is toggled, you can filter the targets.

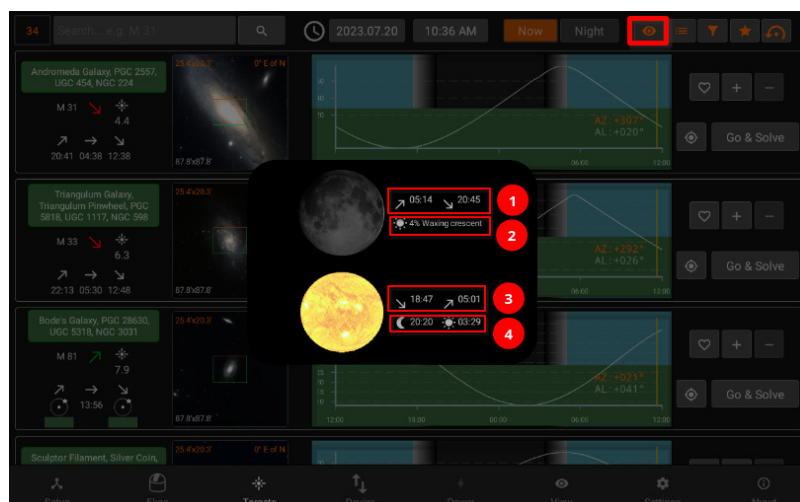


Date & Time:



You can preview the targets available at a different date or time by changing the settings (This option is disabled if Ekos is running)

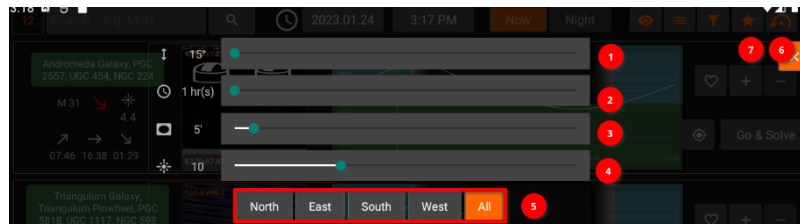
Sun/Moon Visibility



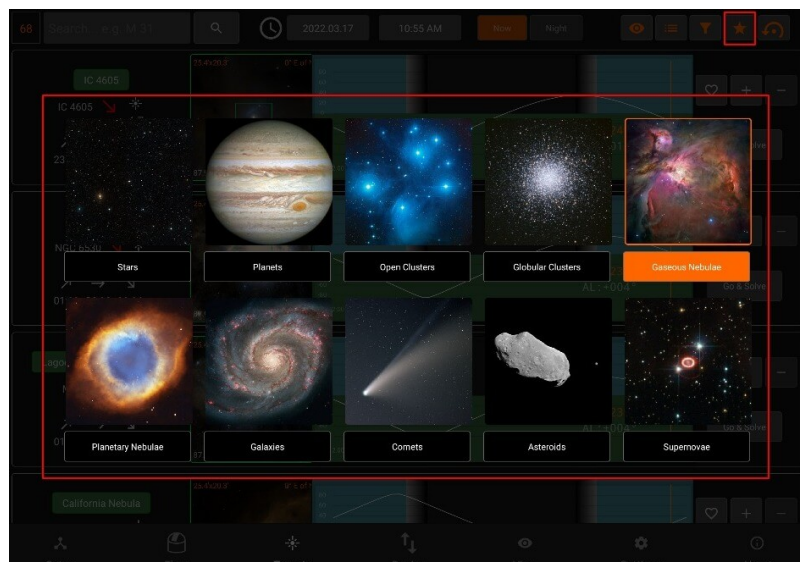
1. Moon rise/set times
2. Illumination percentage and lunar phase name
3. Sunset/Sunrise

4. Astronomical Twilight Dusk/Dawn

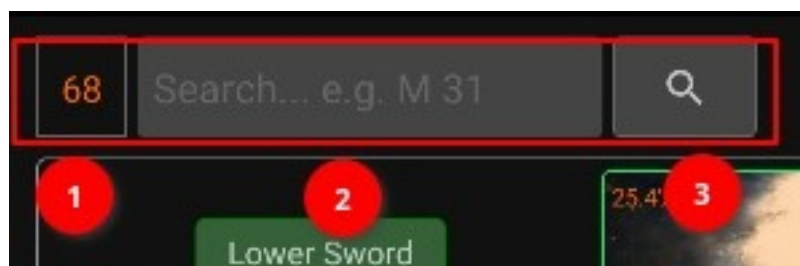
Filters



1. Minimum object altitude in degrees.
2. Minimum duration in hours where the object must meet the altitude condition above. For example, if altitude is 20 degrees, and duration is two hours, then only objects that remain above 20 degrees for at least two hours are going to be included in the search results.
3. Minimum Field of View (FOV) in arcminutes. This is only applicable to extended objects like nebulae and galaxies and not to point sources like stars.
4. Maximum Magnitude. Lower it to limit it to more bright objects.
5. Filter the objects by type.
6. Reset all filters to default value.
7. Filter the objects by their horizontal direction.

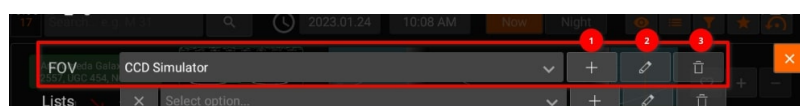


Search Results



1. Number of results
2. Filter by object name (only filters currently displayed results)
3. **Extended Search:** You can search for an object by name only without adjusting any filters. This would search for ALL objects of all types regardless of filters. If the object is found, it is then added to the **My Searches** list.

FOV Profile



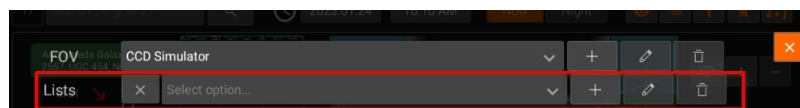
You can overlay a Field-of-View (FOV) indicator on the top of the displayed image. This aids in target framing. By default, the FOV rectangle color is green with the top marked in orange. The top coincides with your camera/frame top. Using the overlay helps to determine exactly how the target appears in a captured image. All units are in arcminutes. 1 arcminute is 1/60 of a degree. For reference, the Moon is 30 arcminutes or half a degree across the sky. When the equipment profile is running, the FOV for each connected camera is automatically generated. You can simply select it from the dropdown menu to activate it. Furthermore, you can add your own FOV indicators manually as illustrated below. In order to use the Framing Assistant, it is necessary to select an FOV profile first.

1. FOV profile dropdown
2. Add | Edit | Delete (FOV profile)
3. Exit list (returns to normal targets browsing)

Adding an FOV profile in opens up the following panel:

After setting the Focal Length, Camera width & height and pixel width & height, the FOV can be calculated by pressing the Calculate FOV button.

Lists



It contains Lists dropdown. Add, Edit the list name or Delete the selected list.



Target Info

1. Object designations.
2. Object name.
3. **Object Phase:**
 - Green: Object is rising

- Yellow: Object is transiting the meridian
- Red: Object is sitting

- Magnitude
- Object Image and FOV Overlay.
- Altitude vs. Time Plot. The X-Axis designates time starting from 12 PM to 12 AM, with local Midnight (00:00) at the center of the image. The yellow vertical line indicates the current time. Next to the current time line are the object's current Azimuth and Altitude values in degrees.
- Add to Favorites.
- Add to custom list.
- Remove from current list.
- Sync to the target.
- Schedule the target
- Go & Solve:** Go to object and plate solve (required to use Framing Assistant).

When Ekos is offline, Targets will be used to schedule the coordinates information to Scheduler.



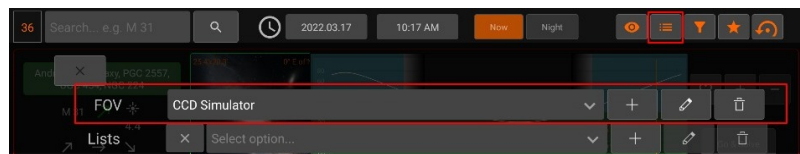
When Ekos is offline, you can also use framing assistant to Schedule the coordinates to Scheduler. The border of each target displays it's status:

- Idle: Grey
- Plate-Solving: Yellow
- Skewing to target: Purple
- Plate-solving successful and target is centered: Green
- Plate-solving unsuccessful or beyond acceptable accuracy threshold: Red

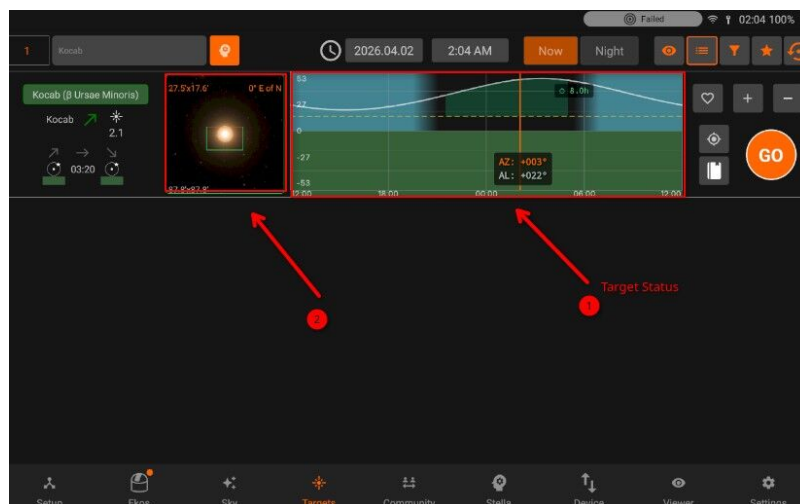
5.5.1 Framing Assistant

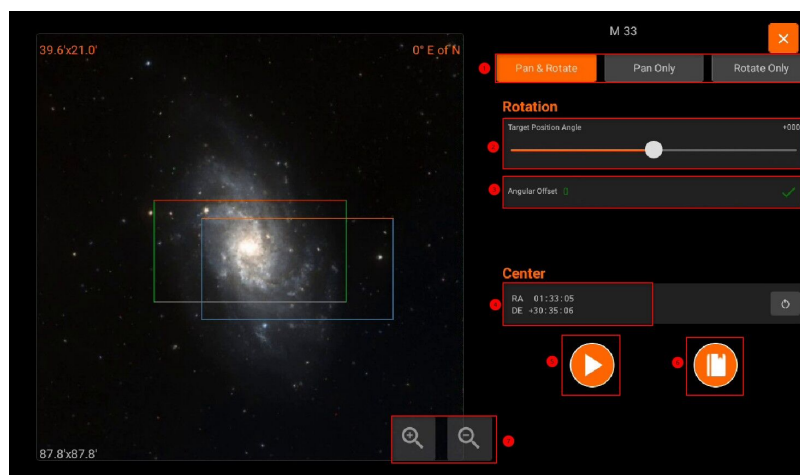


To open the framing assistant, make sure to have selected an **FOV Profile** and press **Go & Solve**.



StellarMate will command the mount to slew to the target location. This is indicated by a magenta border around the target. Once Slew is complete, the alignment process begins which is indicated by a yellow border. A red border indicated alignment error or alignment is not within threshold. Please wait until the solver iterates to center the target exactly in the center of the sensor. Once this is done, the border turns to Green. Now that the plate solving is complete, you may proceed to use the Framing Assistant tool that helps you in adjustment the orientation of the camera to match your desired orientation either manually or automatically if a rotator device is detected. Once the status turns to green (1), press the image (2) to open the Framing Assistant





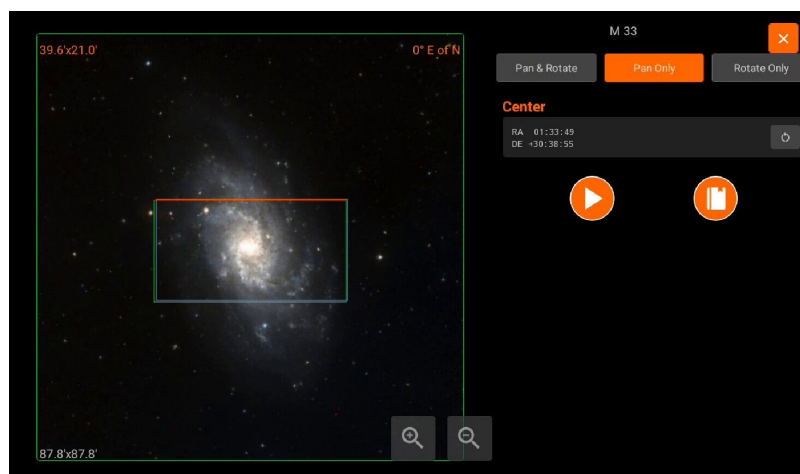
1. Framing Assistant The framing assistant tool puts precise framing control at your fingertips. * **Intuitive Interface:** Easily adjust your target's position and orientation within the frame using straightforward controls. * **Clear Visual Feedback:** See the exact area that will be captured with the field-of-view indicator, ensuring perfect framing every time. * **Simple Adjustments:** Make quick and precise adjustments to frame your subject exactly as you envision.

To access the framing assistant, simply tap the target image. If the field-of-view (FOV) indicator isn't visible, choose the desired FOV from the dropdown menu. For a more automated approach, tap Go & Solve to initiate a sequence of actions: the mount will slew to the target (marked by a magenta border), followed by plate solving to align the image (indicated by a yellow border). Pay attention to border colors during alignment: red signals an error or misalignment, requiring patience as the solver works to center the target. Once successful, a green border confirms perfect alignment, readying you for a perfectly framed capture. Once the status turns to green (1), press the image (2) to open the Framing Assistant. Adjust the rotation and/or position of the desired frame by using hand gestures to pan and rotate. Zoom in or out using the designated buttons to increase or decrease the field of view.

1. The Framing Assistant provides three gesture modes to provide fine controls:

1. **Pan & Rotate:** Pan and Rotate the desired target frame freely.
2. **Pan only:** Only allow panning, no rotation permitted. This can help if you want to avoid accidentally rotating the target frame while panning.
3. **Rotate only:** Only allow rotation, no panning is permitted. This can help if you want to avoid accidentally panning the target frame while rotating.

If an automated rotator is connected, then all rotation commands are handled automatically by StellarMate. If no rotator is connected, you can manually adjust the camera. Set the desired target rotation first, then check the required Angular Offset value. Go to your camera and rotate it manually by hand using your best judgment. Tap play to measure the new orientation of the camera. Once plate solving is complete, the new camera orientation and angular offset are updated. Repeat this process as many times as necessary until you are satisfied with the result. Your goal is to bring the Angular Offset down to zero.

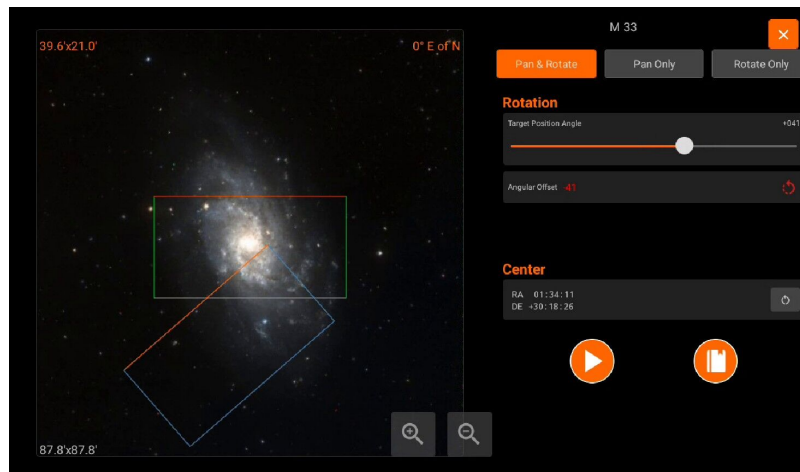


2. Adjust the rotation of the desired FOV orientation with either the slider or hand gestures. The target FOV rectangle color is blue with orange designating the top. The green rectangle with orange on top is your camera's current FOV & orientation in the sky.
3. Rotation offset in degrees between the current (Green) FOV and the target (Blue) FOV. When manually adjusting

the camera, rotate it clockwise or counterclockwise as per the indicated icon.

4. J2000 Center Right Ascension & Declination coordinates.
5. Once all the necessary adjustments are made, tap GOTO & Rotate to start the framing process. If a rotation offset is required, Ekos will issue a GOTO command followed by a rotation command if applicable.
6. Add the target to the Scheduler module. This commands Ekos to plate solve and adjust the captured image frame to match the desired position angle either automatically (if a rotator device is connected) or manually.
7. Zoom in/out to get the desired HIPs Object image.

If Ekos is offline, you can Schedule your target coordinates by using framing assistant in Scheduler module.



5.6 Community

Share your images with fellow astrophotographers, browse equipment from numerous manufacturers, manage your observatory, and customize your EkosLive social profile in the Community section of StellarMate App.

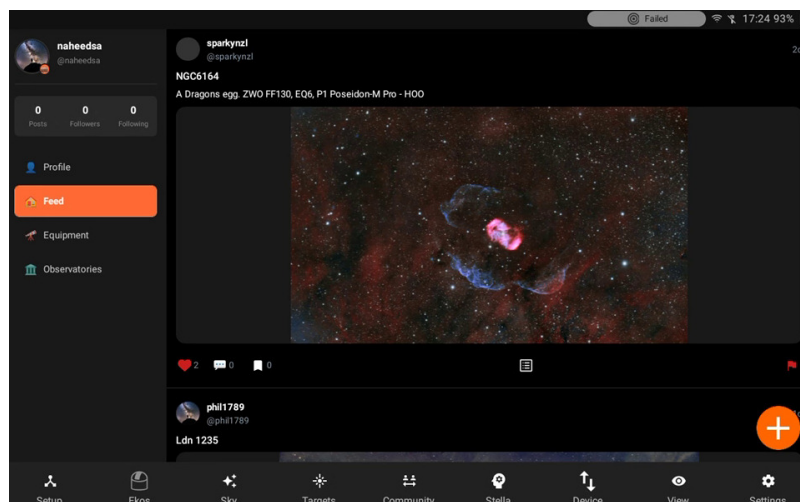
Share your post-processed astronomical images with rich equipment and acquisition metadata, thanks to seamless EkosLive integration.

Create equipment profiles for your observatory that include all your physical hardware, then map them to Ekos equipment profiles so INDI drivers are automatically matched to your gear.

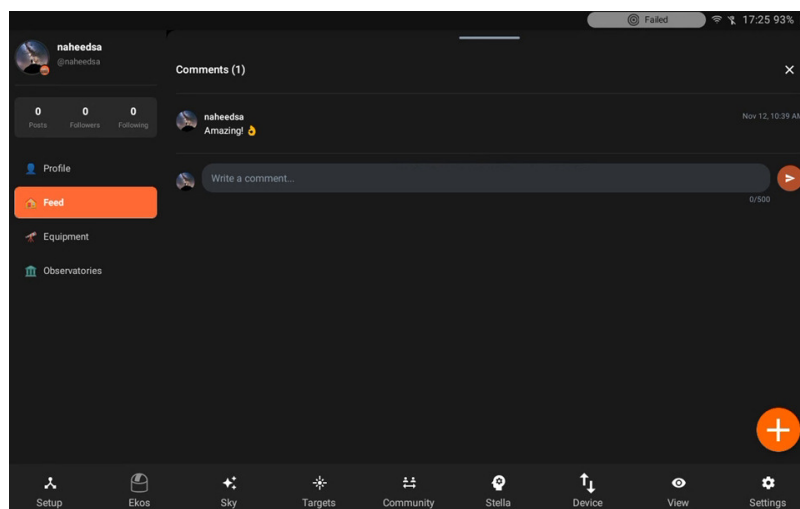
For advanced features such as Observatory Rentals, Live Video feeds, and much more, visit [EkosLive Online](#).

The Community section consists of four sections:

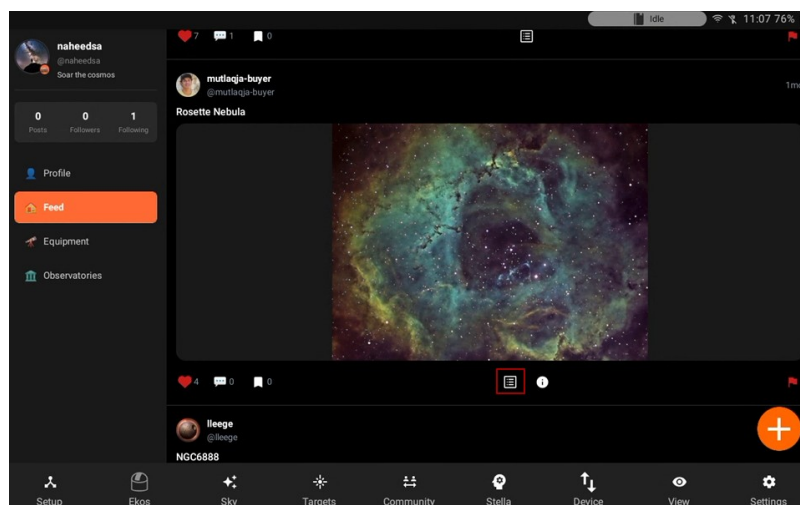
- **Profile:** View your profile.
- **Feed:** See posts from users.
- **Equipment:** View Equipment manufacturers and models
- **Observatory:** See your observatories



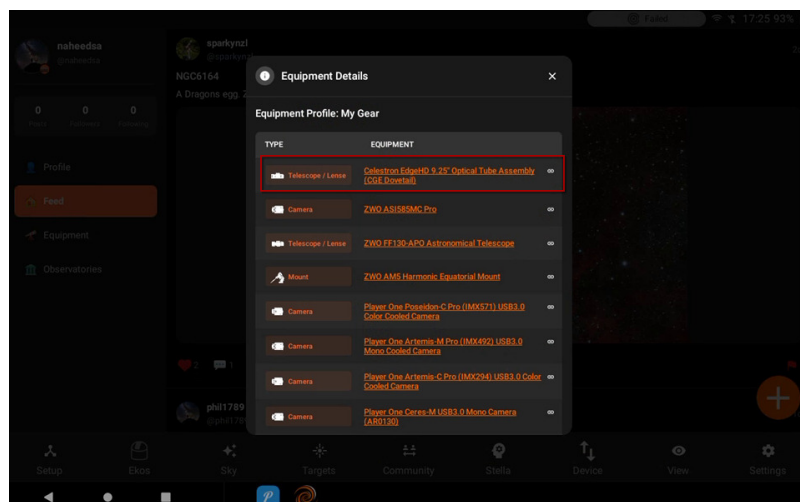
Tap on the comment icon to open or close the comments section for any post.

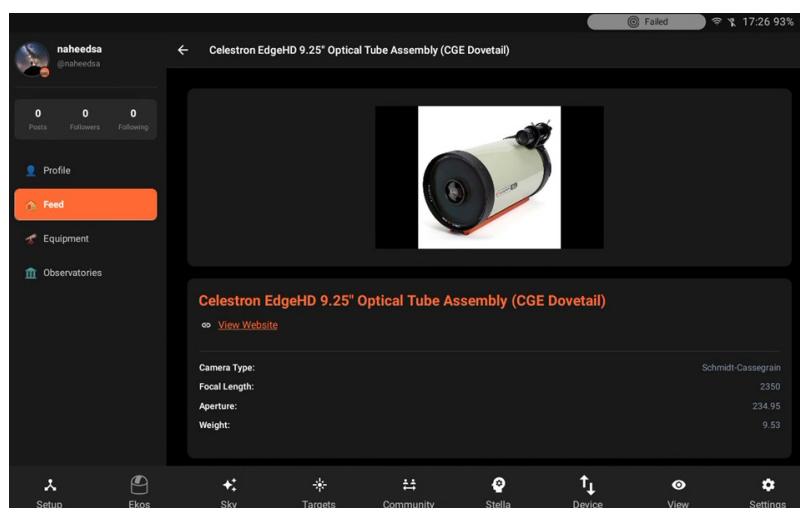


To view the user's equipment, toggle the Equipment Profile option. This will display the observatory equipment used in the post.

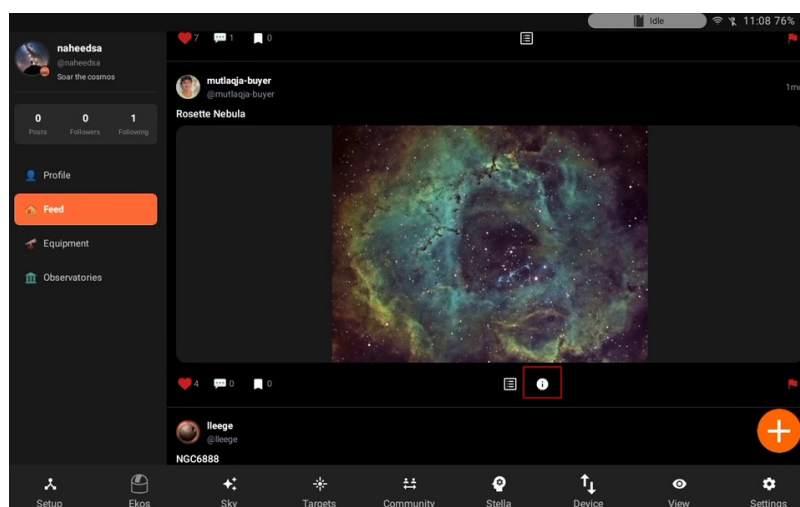


You can tap the Equipment icon to see the equipment details directly.

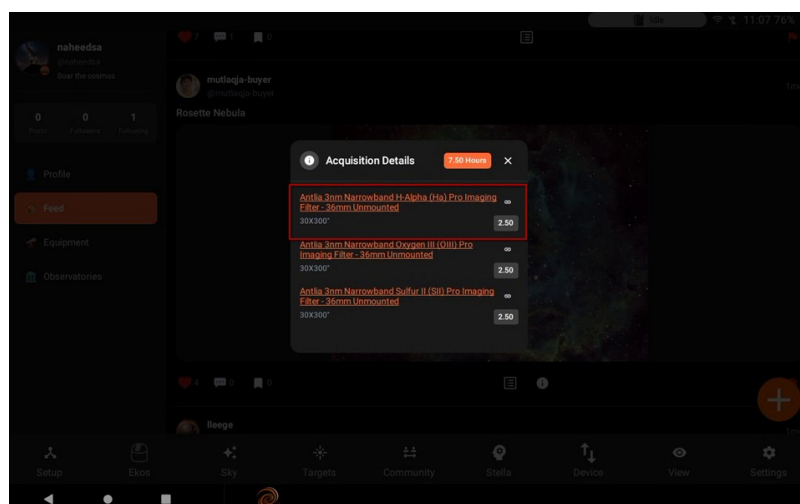


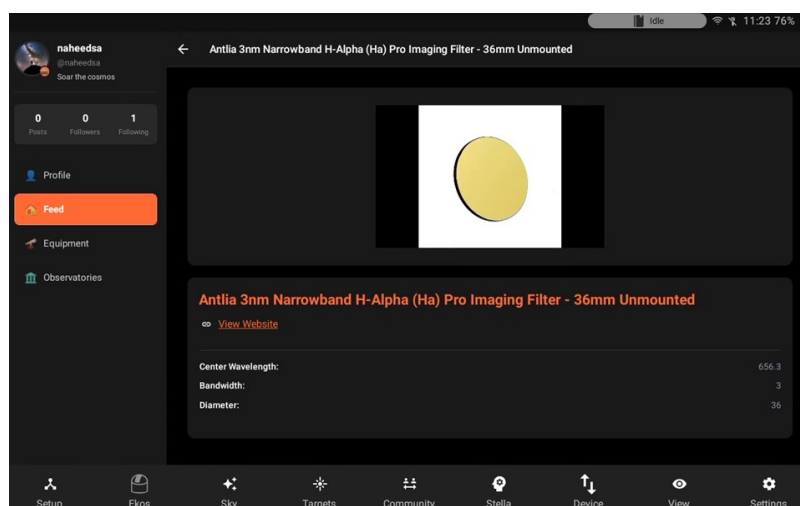


Toggle the Acquisition Info option to view the filters and settings used to capture the image. This helps you understand the capture parameters used by the user.

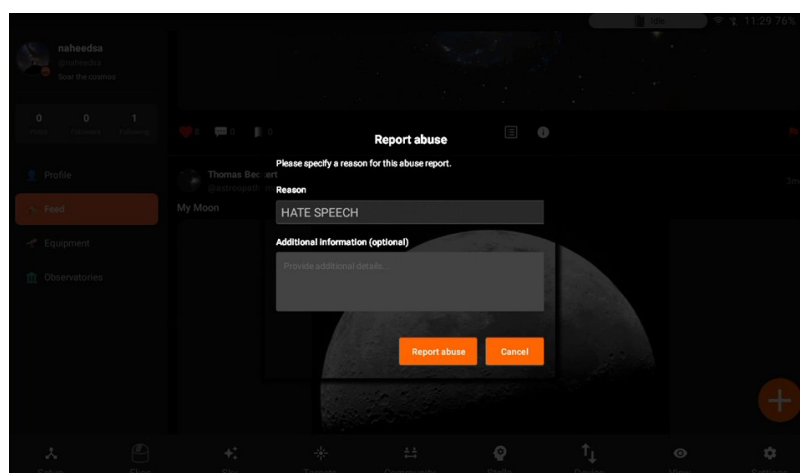


For more detailed information, tap the Acquisition Info section to see the full capture settings.





If you come across a post that is not related to astronomy or astrophotography, you can report it. Tap the Report button to flag the post for review.

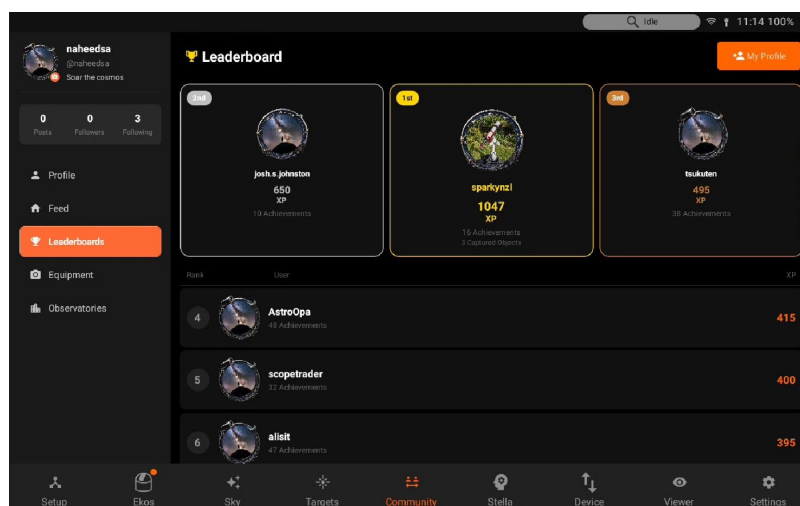


5.6.1 Leaderboards

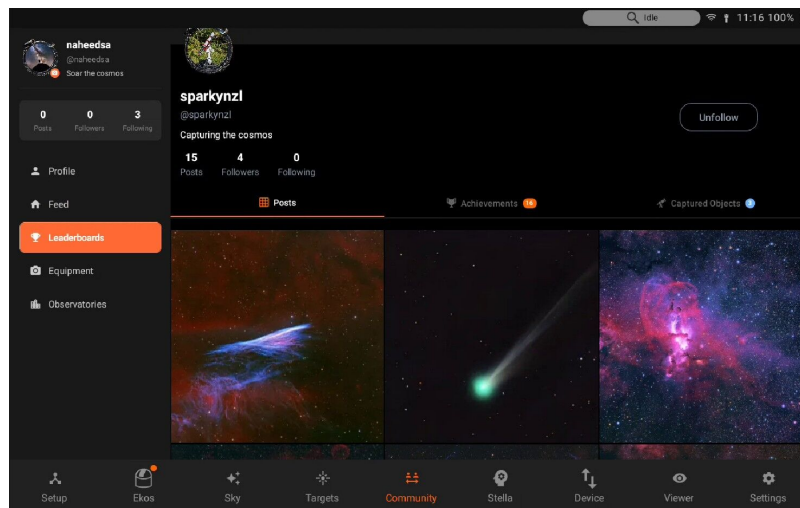
Overview

Community Leaderboards allows you to compete with other StellarMate users. It displays a ranked list of the top 50 users. XP is calculated based on the following criteria:

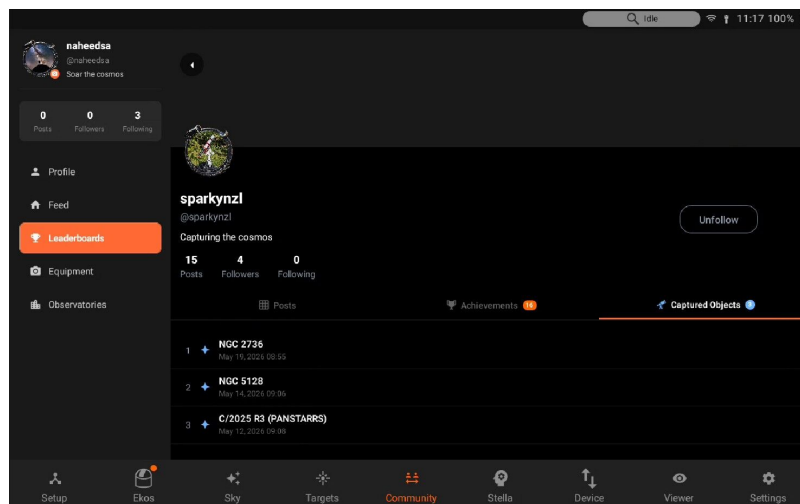
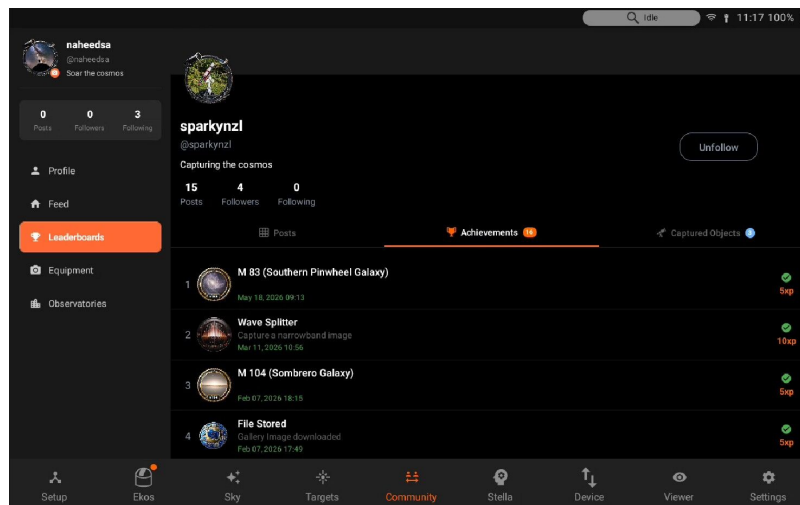
- Number of posts uploaded to EkosLive
- Number of captured objects
- Total number of achievements completed



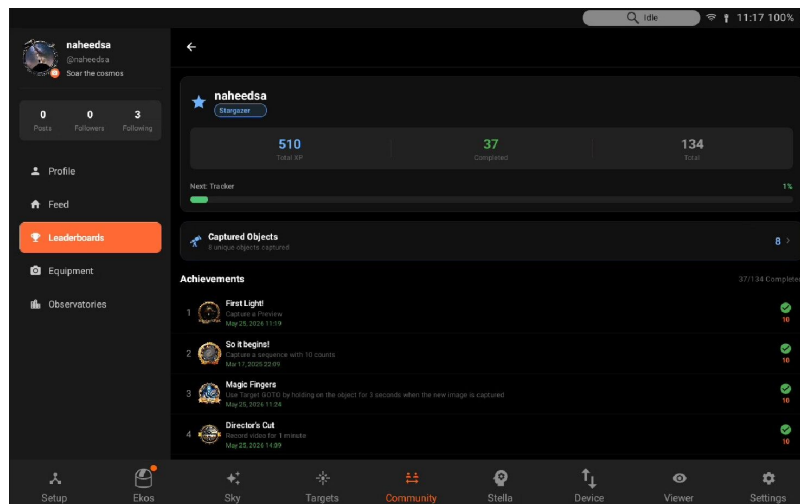
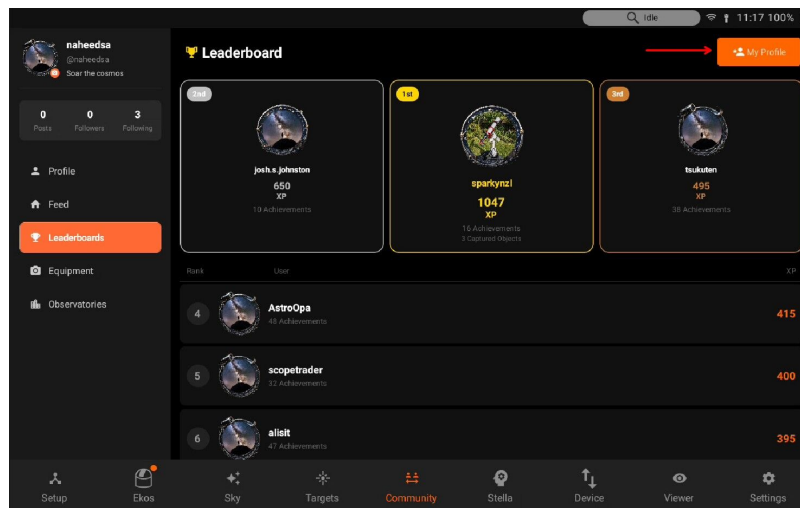
Tap a user's badge to access their profile, where all uploaded posts are displayed.



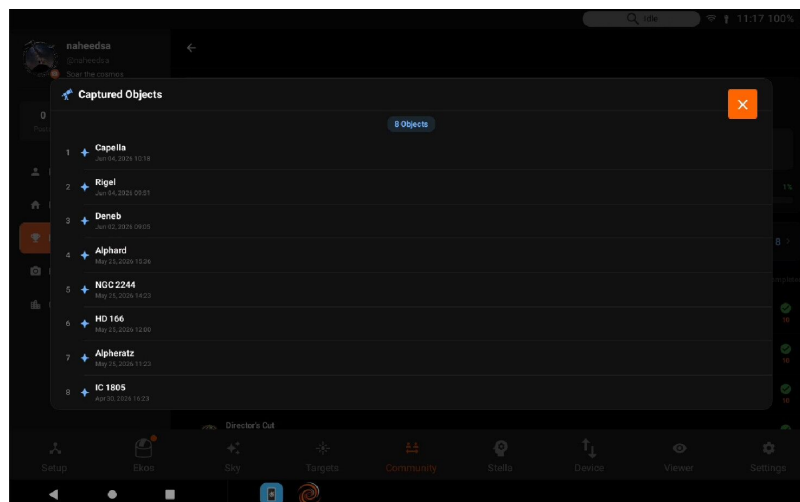
From the profile, you can also view the user's completed achievements and captured objects.



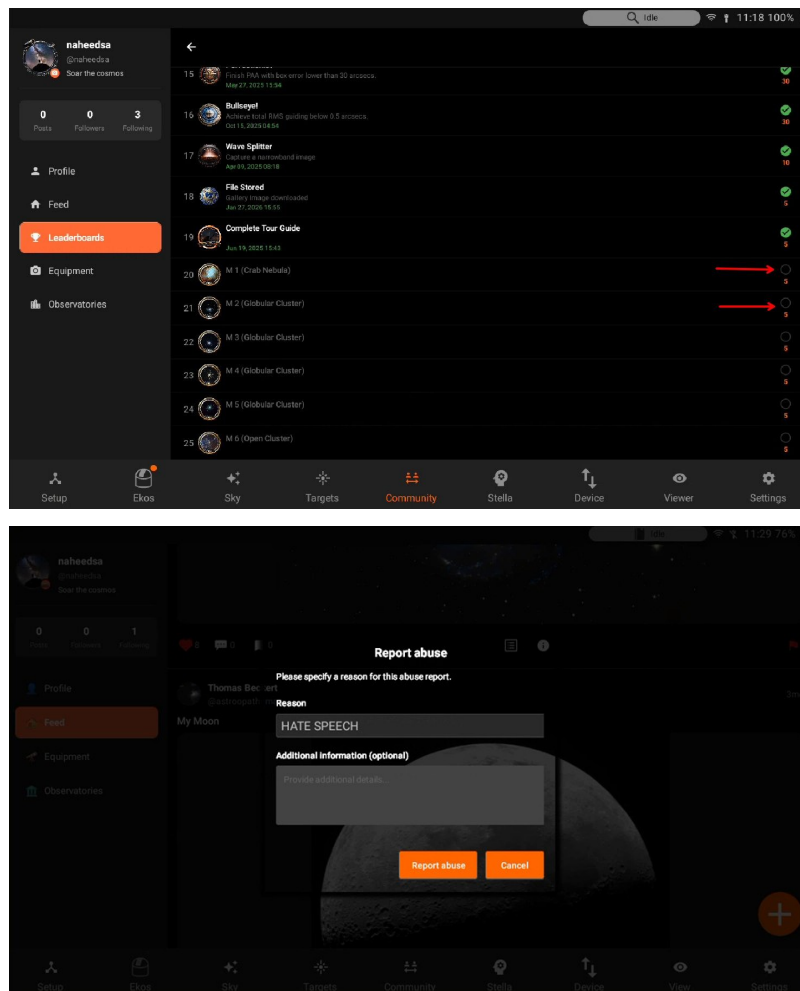
The main leaderboards screen also provides access to your own profile statistics.



From your profile, you can review all captured objects.



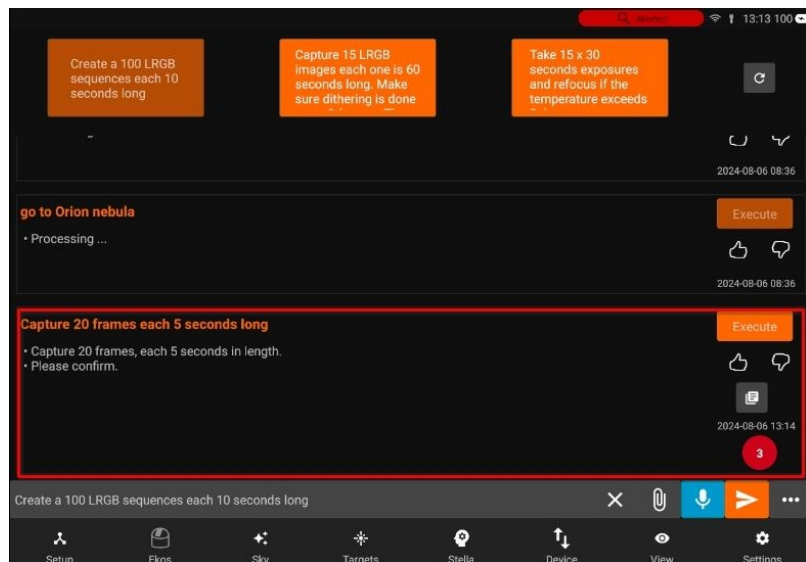
You can also track all completed and pending achievements.



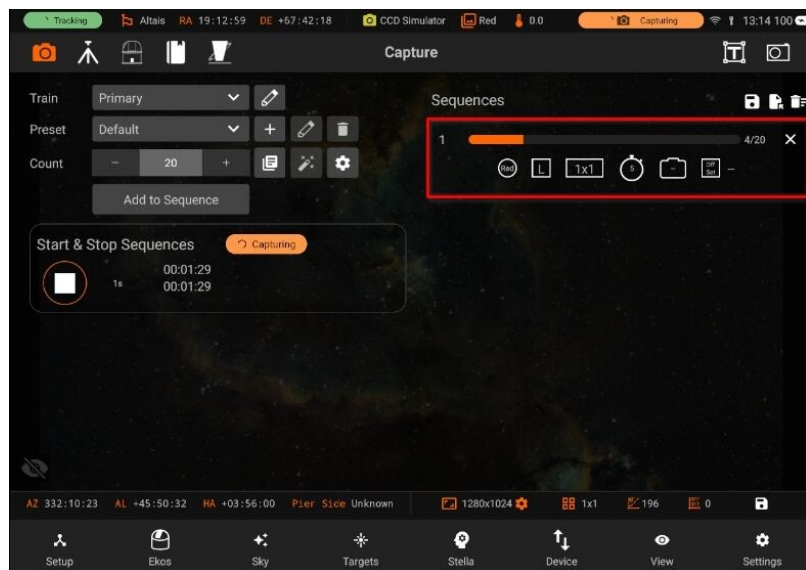
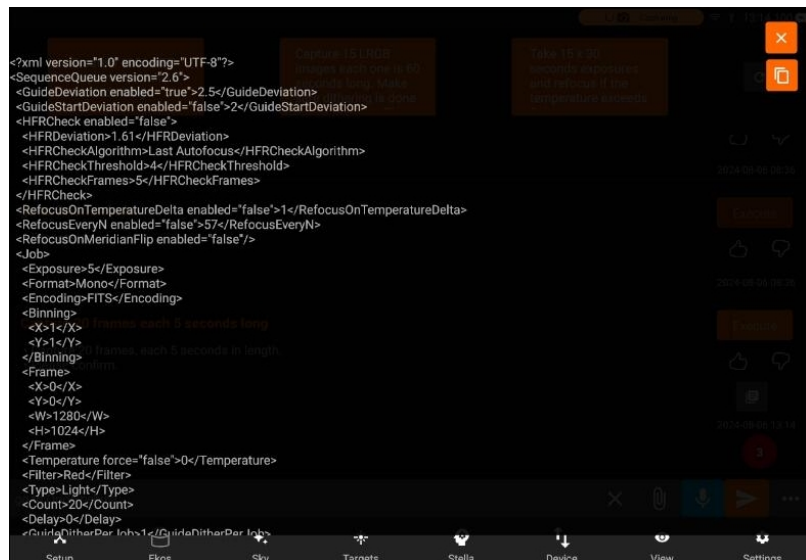
5.7 Stella

Stella is a smart assistant for EkosLive & StellarMate App. It can query information from online or offline data sources including your equipment, weather, and environmental conditions. You can communicate with Stella using natural language via text or voice. To use Stella, the StellarMate App must be connected to the internet. You can command Ekos to perform complex functions including creating image sequences and scheduling targets. To speak to Stella, press the microphone button and talk. After you complete your request, you can press the microphone button again to transcribe your voice to text. This gives you the chance to edit the text before sending it to Stella. Alternatively, you can directly press the enter button to send the voice request directly to Stella. It is also integrated with the Targets and View tabs. In targets, use Stella to find targets of interest. For example, you can ask Stella to find all globular clusters above 50 degrees that are brighter than 5th magnitude. For EkosLive Pro subscribers, Stella can also search your cloud images using any number of criteria (e.g. Find all images for Heart Nebula captured in HA filter in the last 2 months). Since all images are uploaded with rich metadata, you can use many fields to narrow your search. To create sequences, start by saying Capture followed by your request. For example:

Capture 20 frames each 5 seconds long



If Ekos profile is running, Stella will generate an XML file that can be dispatched to Ekos. You can inspect and view this file before Executing it. To execute a request, tap Execute or simply type or say Execute. Once executed, you can go to the Ekos tab to check the progress.



Scheduling targets requires the target name and the sequence details. All requests must start with Schedule. Schedule M42 and capture 10 frames each 60 seconds long in RGB filters. If the request is successful, Stella will generate the sequence and scheduler XML files. Stella uses the default settings in your equipment profile and only alters the parameters explicitly set by you in the request. Each Stella request includes one or more parameters. Depending on the request type, you can specify any of the parameters below:

1. Capturing a sequence

- Guide RMS
- Guide Start RMS
- HFR deviation
- HFR Algorithm
- HFR threshold
- HFR check frames
- Refocus delta T
- Refocus time
- Meridian Flip refocusing
- Exposure time
- Color format
- Encoding
- Binning
- Filter
- Type
- Count
- Delay
- Dither setting
- Directory
- Upload Mode
- Flat Duration.

2. Scheduling a target

- Target
- Startup Condition
- Minimum altitude
- Weather
- Twilight
- Artificial Horizon
- Step

3. Searching targets

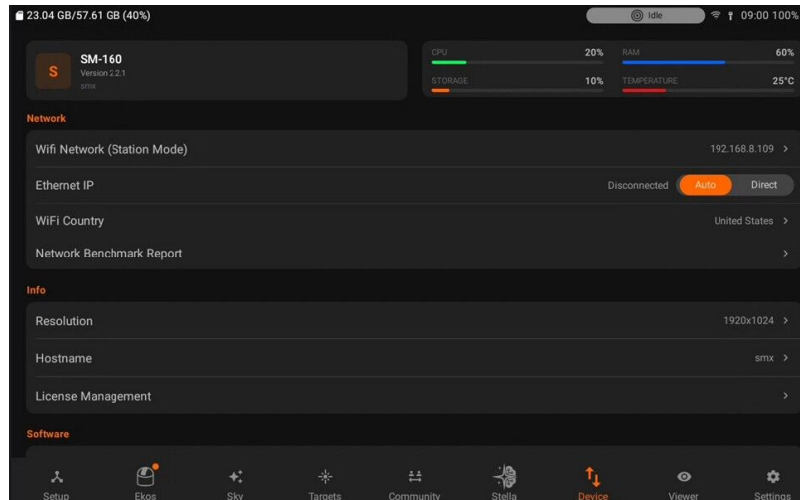
- Minimum altitude
- Maximum magnitude
- Type of object
- Direction
- Minimum duration
- Minimum FOV
- Maximum FOV
- Julian Date

4. Filtering images

- Filter
- Frame

- Minimum and maximum air mass
- Binning
- Date
- Minimum and maximum exposure
- Object name

5.8 Device



The Device page manages the health, settings, and updates for your StellarMate. It is divided into the following sections:

System

Info

- WiFi Network
- Ethernet
- Resolution
- Hostname

Software

- Firmware Updates
- Remote Support

Logs

- Sharing logs

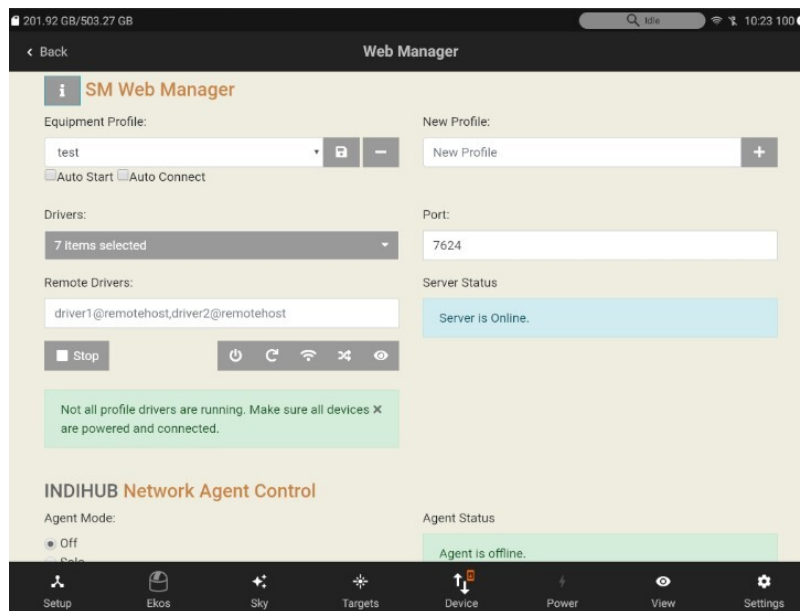
5.8.1 System

System shows the Utilization of SM device. It includes:

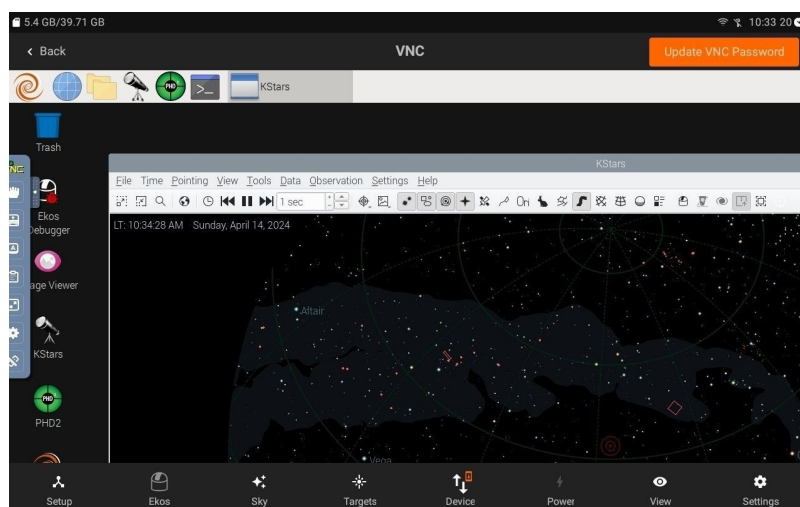
- CPU
- RAM
- Storage
- Temperature

It also has main controls i.e

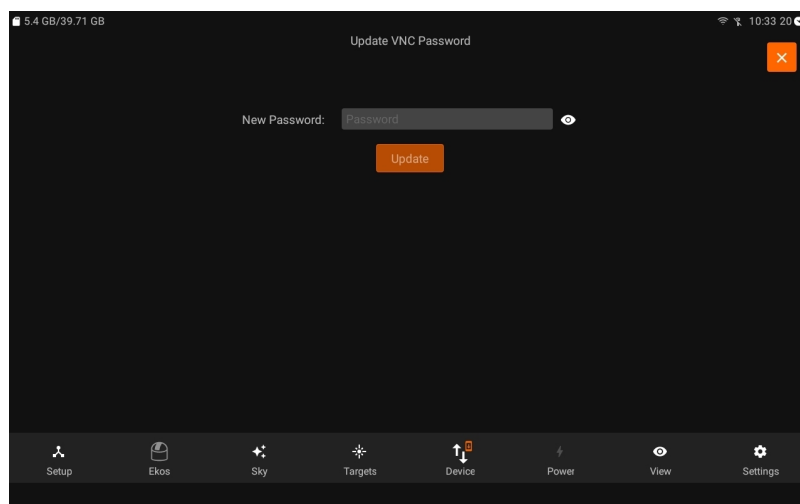
- Access Web Manager. It can also be accessed from the browser i.e <http://localhost:8624>



- Access of VNC. Can be accessed from the browser i.e <http://localhost:6080>



You can also update your VNC password by pressing on the top right “Update VNC Password”



5.8.2 Network

Your equipment profile may contain one or more serial port and/or network-enabled devices. Before establishing connection to such devices for the first time, StellarMate Port Selector tool helps you to assign the appropriate ports and addresses for each. Serial devices may include mounts, focuser, and filter wheels using USB-to-Serial adapters. You need to know the baud rate for the device as by default it is set to 9600.

Note

PORT SELECTOR IS NOT APPLICABLE TO PURE USB DEVICES SUCH AS CAMERAS.

For networked devices over Ethernet or WiFi, you need to supply the device host name or IP address and the device port. This information is usually supplied by your device manufacturer. It is important to ensure that all networked devices are within the same network as StellarMate. For example, if StellarMate is operating in hotspot mode (IP 10.250.250.1) then your network-enabled device must be connected to the same hotspot network and have an IP address in this range (e.g. 10.250.250.5). On the other hand, when StellarMate is operating in infrastructure mode (i.e. it is connected to an external WiFi network like Home WiFi), then the other network-enabled devices must be connected to the same network in order for all devices to talk to each other.

The Port Selector dialog can be accessed at any time by clicking on the Port Selector button. When creating an equipment profile for the first time, it is automatically opened so you can configure the ports before establishing connection to your devices either individually or via clicking Connect All button.

You can specify the ports for serial and network devices using the Port Selector.

The serial ports can be selected from the drop-down. The addresses are unique to each connected device (similar to COM1, COM2..etc on Windows OS) but the automatically generated port names usually do not tell you which device they are connected to. When you have multiple serial devices, it can be tricky to find out which is which. StellarMate automatically tries to connect to the serial devices and attempts handshake with each device, but this might lead to multiple drivers trying to talk at the same time to multiple devices which might lead to traffic collision.

Therefore, it is better to select the correct ports from the beginning. This is only required once in the initial setup. One method to know a device's serial port is simply by connecting one device at a time via USB, and then check the serial port that is displayed in the drop-down. Make note of this port name and then connect the next device and check again, the new serial port in the drop-down should belong to the 2nd device. Now you know for certain the ports for the connected devices.

Once the ports and network settings are selected, press Connect All to establish connection.

Connection Status

- Green: device is connected.
- Yellow: connecting to device.
- Red: connecting to device failed.

Connection Mode

- **Serial:** For mounts, filter wheels, and focusers that are connected via a Serial-to-USB adapter. To connect to serial devices, you need to select the port and baud rate. StellarMate provides the detected system ports in a drop-down menu to select from, but you can also enter your own port manually.
- **Network:** For any network-enabled device (e.g. Mounts over WiFi like SkyWatcher AZ-Gti). To connect to networked devices, ensure they are connected to the same network where StellarMate is connected to. You need to enter the host-name or preferably the IP address of the device in addition to the connection port and connection type (TCP or UDP).

Baud Rate: Set the devices baud rate

Connect All: Connects to all the devices and closes the Port Selector

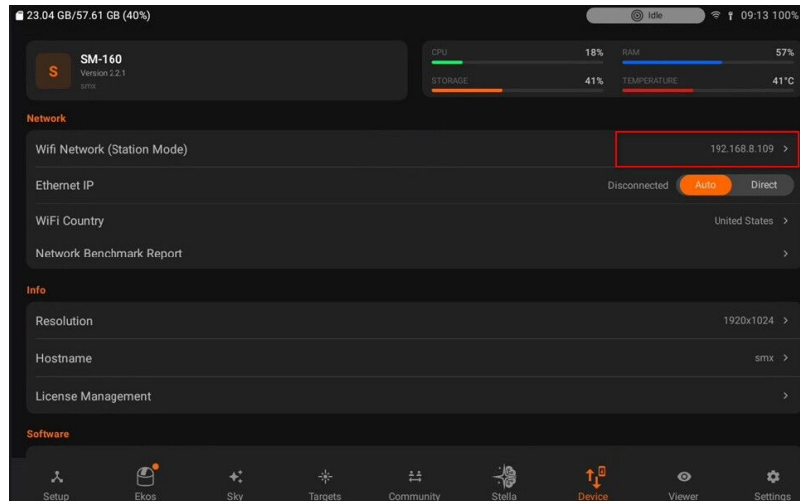
When connecting a serial device, you can specify the port by selecting from the drop-down or typing it in the text field

For network devices, you have to specify the host-name or IP of the device and the port. Also you can choose the network type (TCP/UDP). Info

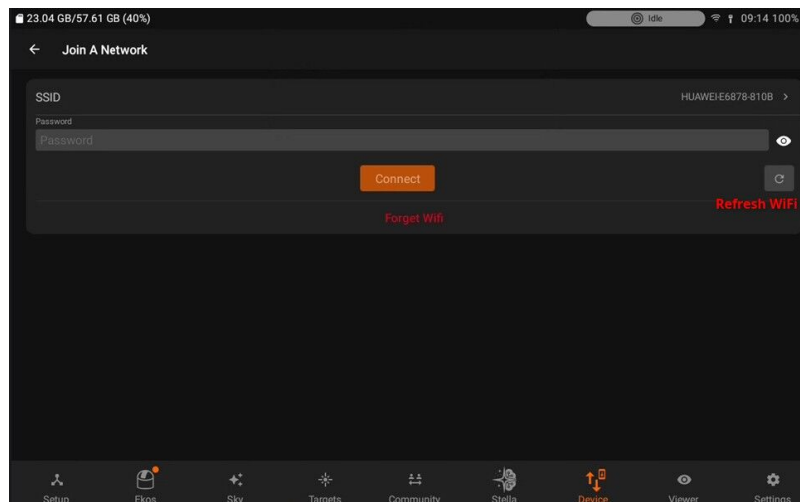
Device Info includes:

- WiFi network
- Ethernet IP
- Resolution
- Host-name
- **Model:** Displays the correct Model of SM Unit
- **Version:** Displays current version of StellarMate OS

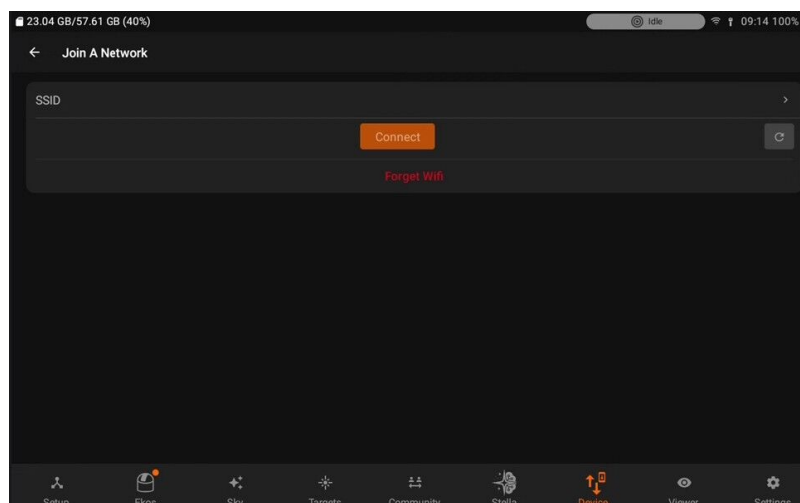
5.8.2.1 WiFi Network



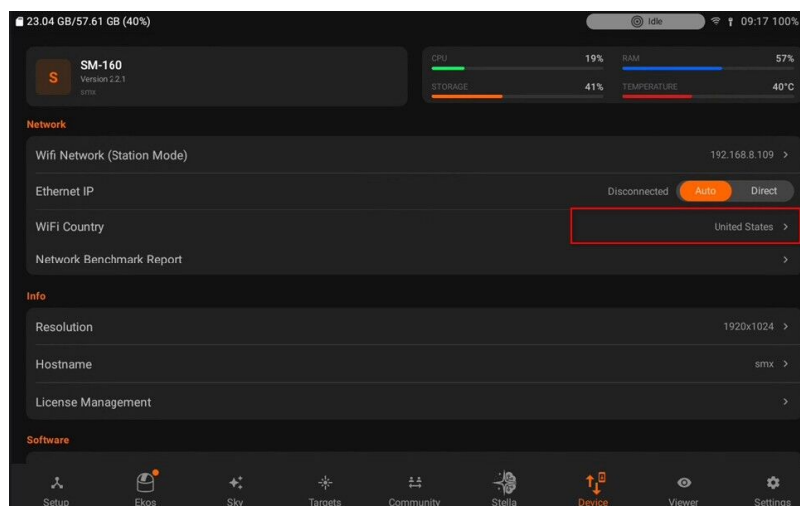
Toggle WiFi network by pressing on the button as shown in the image above.



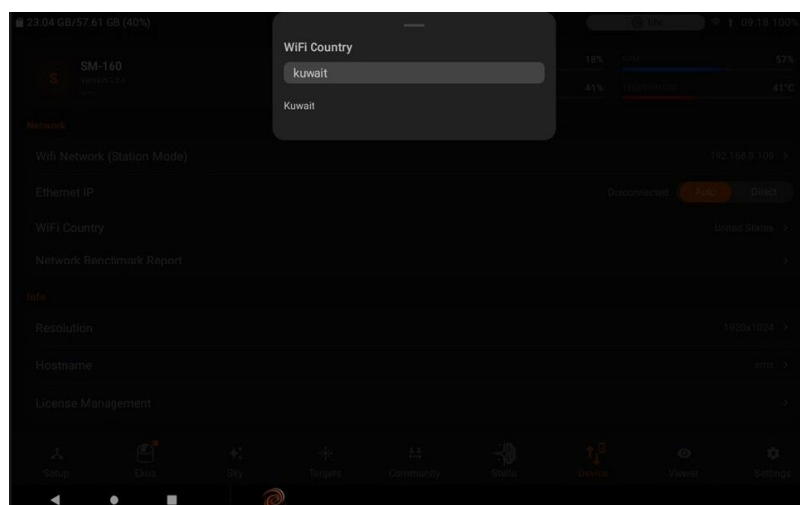
1. **Reset Network:** Network configuration gets reset. Make sure to reboot after resetting.
2. **Forget WiFi:** WiFi network information is removed and StellarMate reverts to HotSpot mode (IP Address 10.250.250.10). If the Unit is connected to your LAN via Ethernet, you can still access it via its LAN IP address like before.



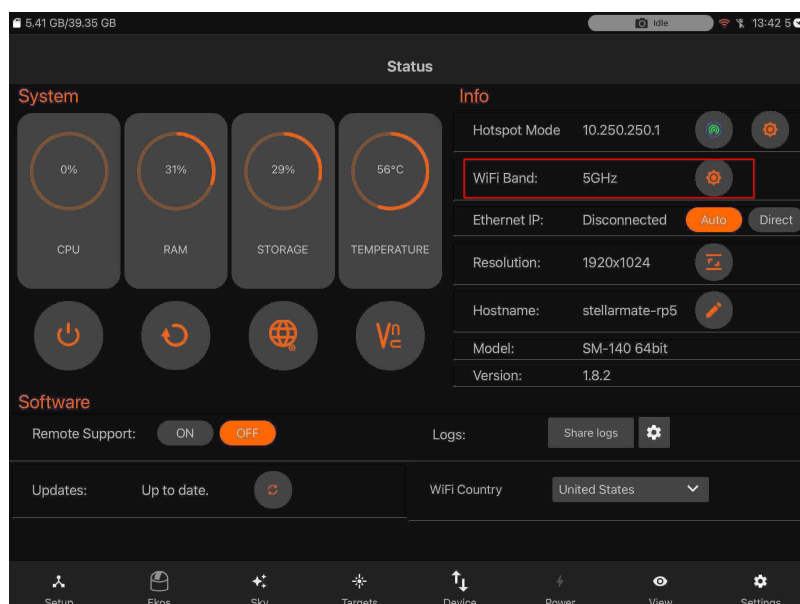
Connect to Home WiFi: Select a WiFi network as detected by StellarMate and then supply the password if it is protected. Press connect, After a successful connection, please wait up to 2 minutes before using any of the unit functions again.



You can set your current WiFi country. It modifies your WPA network file. It is essential for compliance with local regulations regarding wireless communication frequencies, power levels and other parameters.



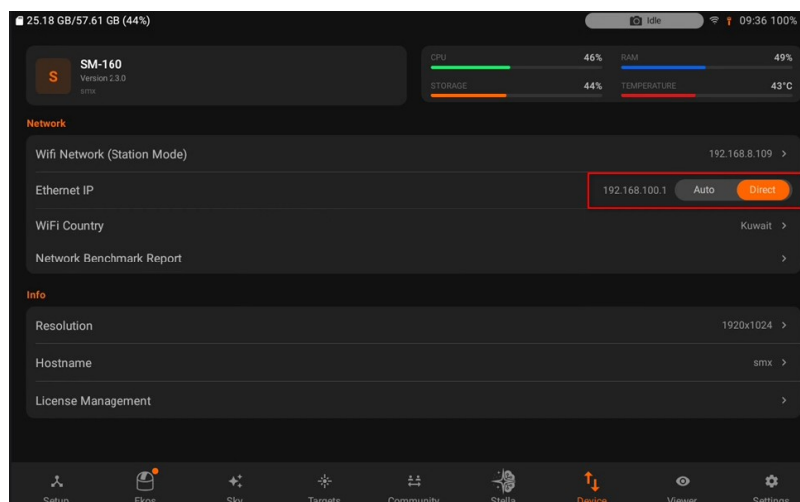
5.8.2.2 Changing Hotspot WiFi Band



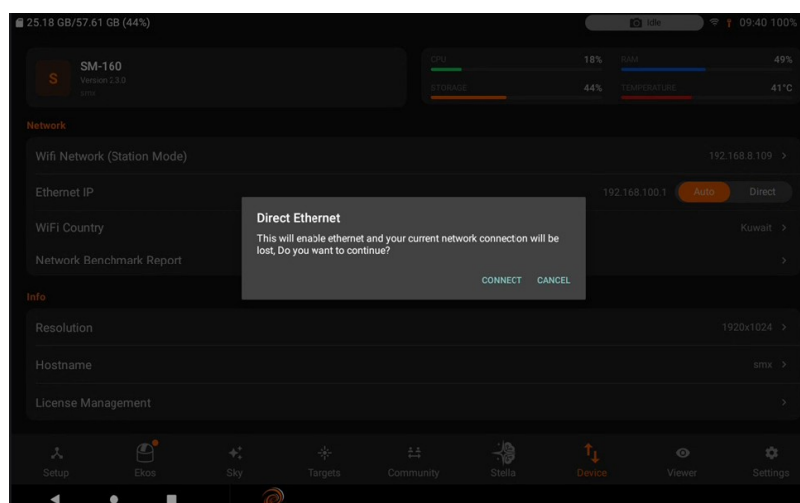
5.8.2.3 Ethernet IP

There are two methods for Ethernet connections:

- **Direct Ethernet** Connection Between StellarMate and your PC/Laptop: This can be useful in the field if you want a fast response time, at the expense of more cables. Ethernet is always faster and more reliable than WiFi connections (at the moment at least). When using Direct Connection, the HotSpot is activated

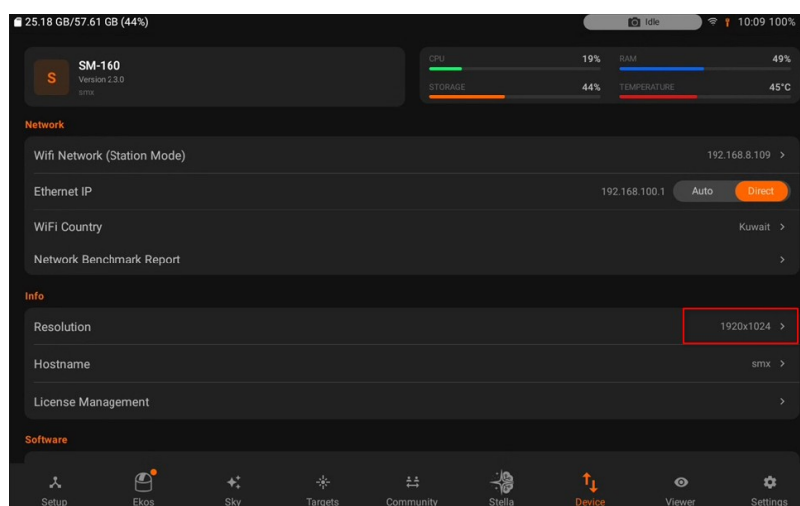


- **LAN Ethernet Connection:** Connect Ethernet to Router/Switch. Your router shall assign an IP address for StellarMate automatically, or you can configure the router to assign StellarMate a permanent IP address.

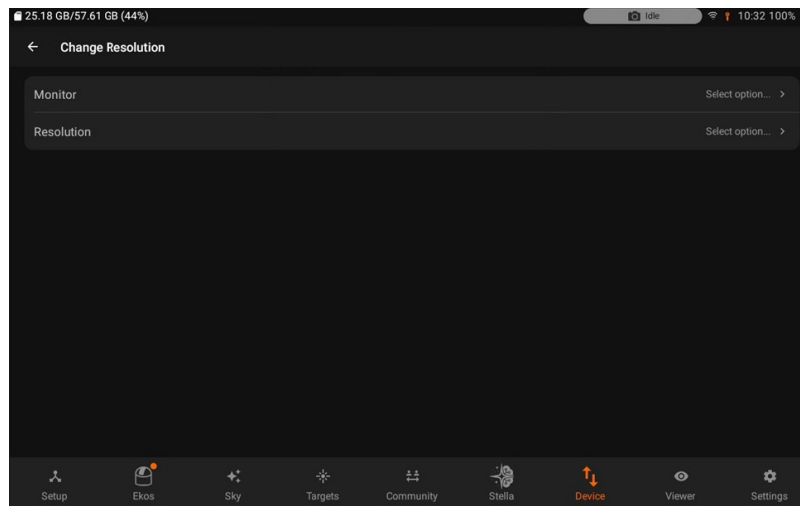


5.8.2.4 Resolution

Change Resolution: Select available monitor display and change its resolution.



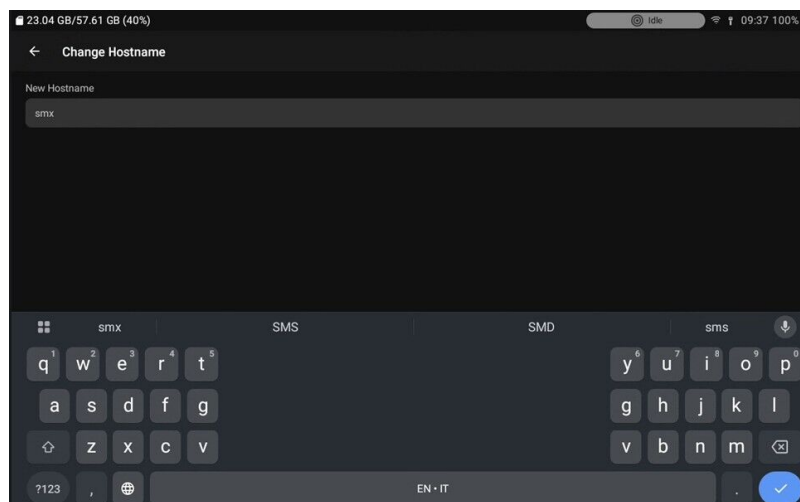
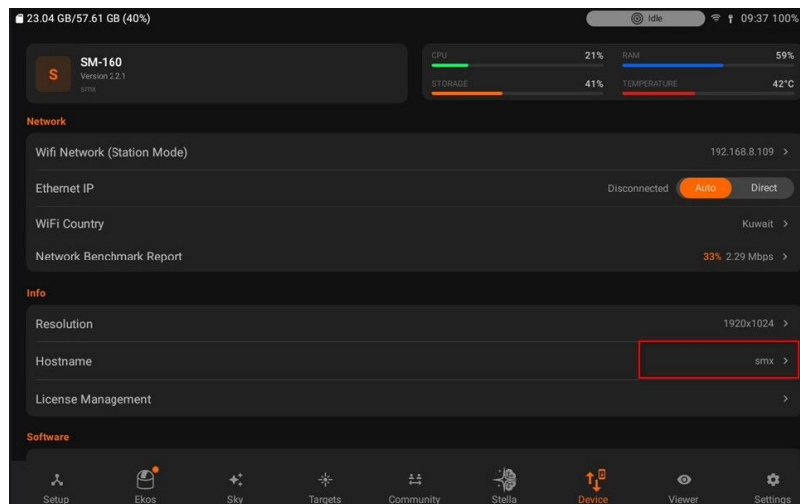
Change external monitor: If you are using model SMA-120 and it's connected with an external monitor. You can select that one.



5.8.2.5 Hostname

Change Name : You can change device name (and its hostname) to another name without any spaces. For example, if you rename it to myobservatory, the host name shall be changed to <http://myobservatory.local>.

Apply entering desired hostname, press “Apply” and reboot your SM unit to get settings applied all over.



5.8.3 Software

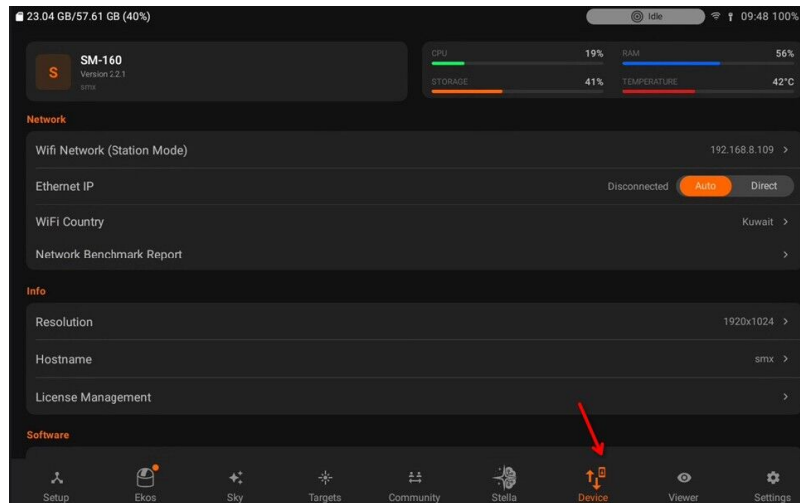
Software

[You can handle the SM OS updates and to give access to SM support using remote support ID.]

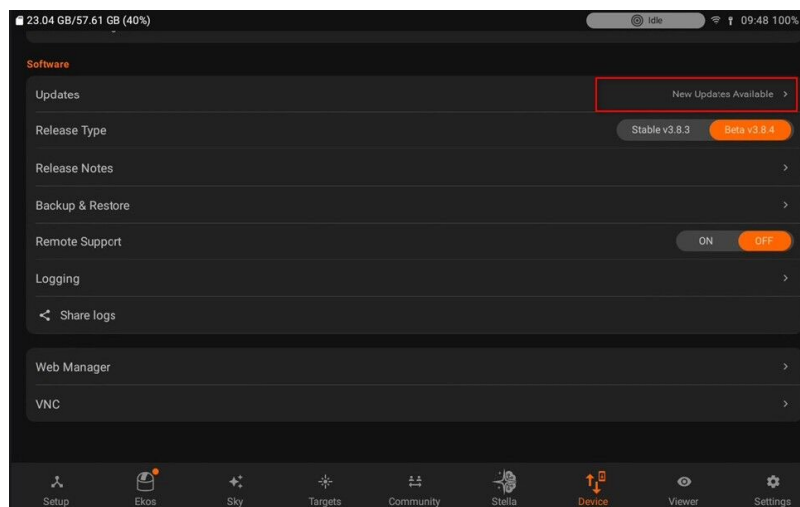
- Firmware Updates
- Remote Support

5.8.3.1 Firmware Updates

When there is an update available for StellarMate, an icon will show up on Device tab.



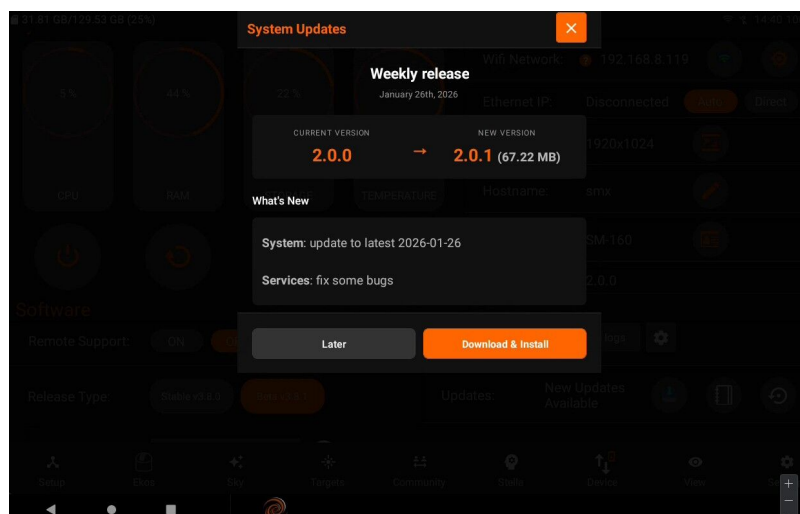
To update StellarMate, simply click the download button and wait for the the process to complete.



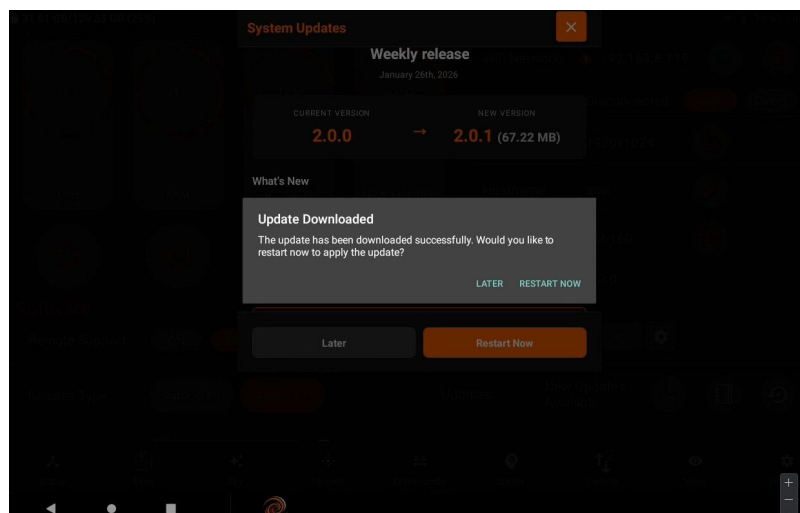
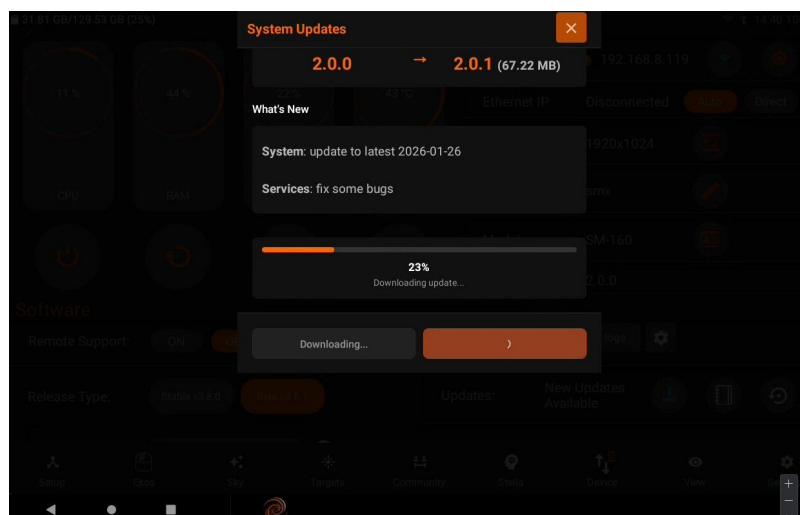
**Delta Updates

Updates are delivered as complete, tested packages and applied all at once to maintain system consistency. Delta updates download only the changes, reducing bandwidth usage. To roll back an update, open StellarMate App or StellarMate Tools and select a previous version. This ensures reliable recovery, especially for remote setups.

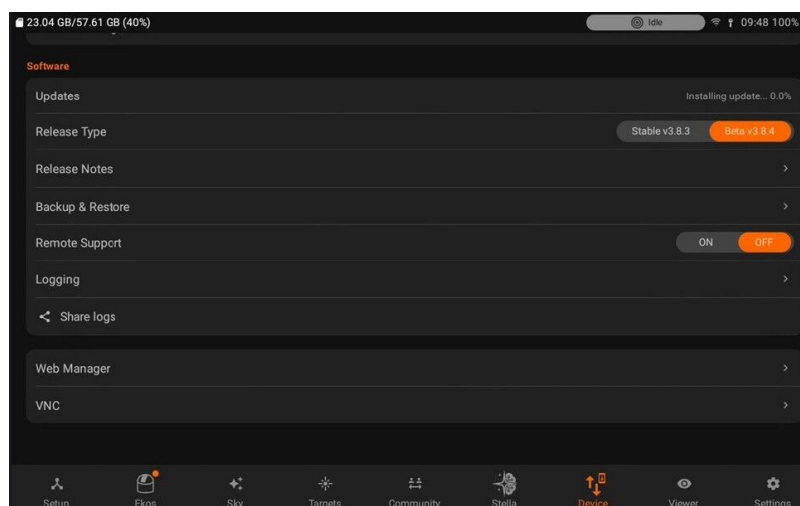
If delta updates are available, you will see a popup with a detailed view.



Once you start downloading, you can also see the download progress.



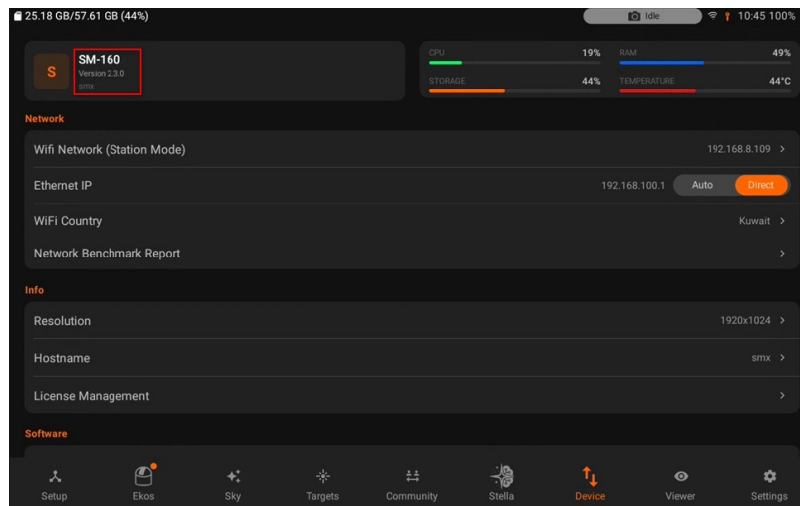
If there are no delta updates, then the system will only apply hot-fixes.



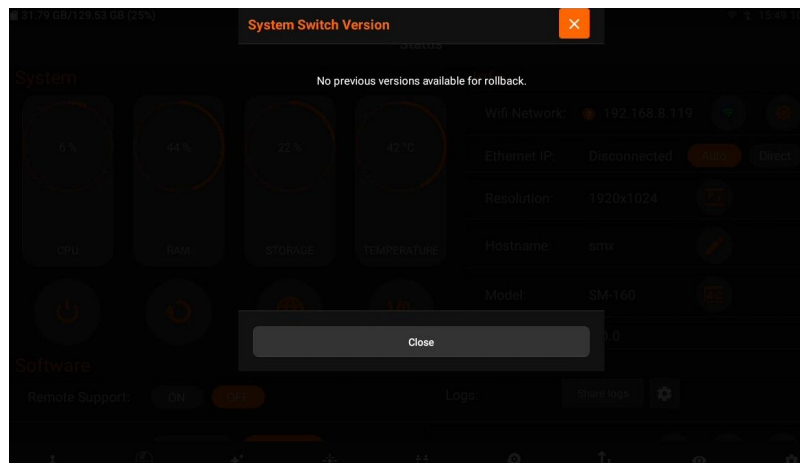
Once the update is complete, you will be prompted to restart Stellarmate for the updates to take effect.

****Rollback**

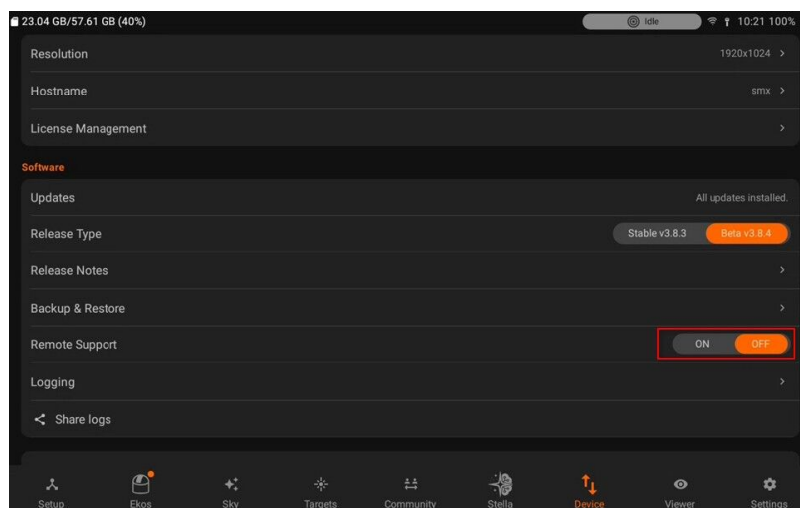
The system automatically creates snapshots before updates and configuration changes. To restore a previous state, open StellarMate App or StellarMate Tools, select a snapshot from the available list, and confirm to restore the system. Use snapshots to safely test configurations and roll back changes when needed.



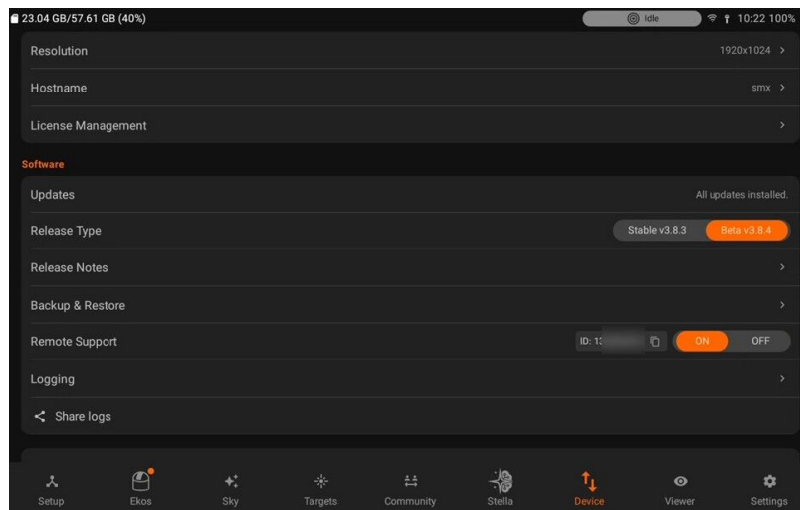
If no rollback version is available, the system displays “No previous versions available for Rollback.”



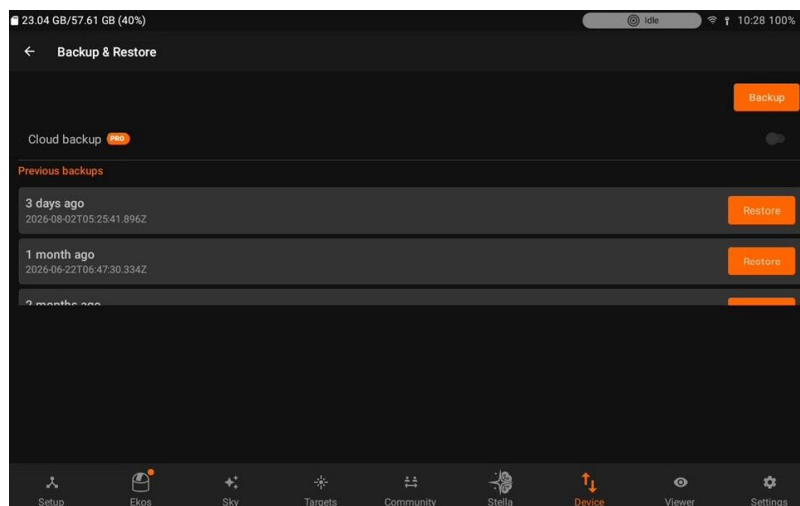
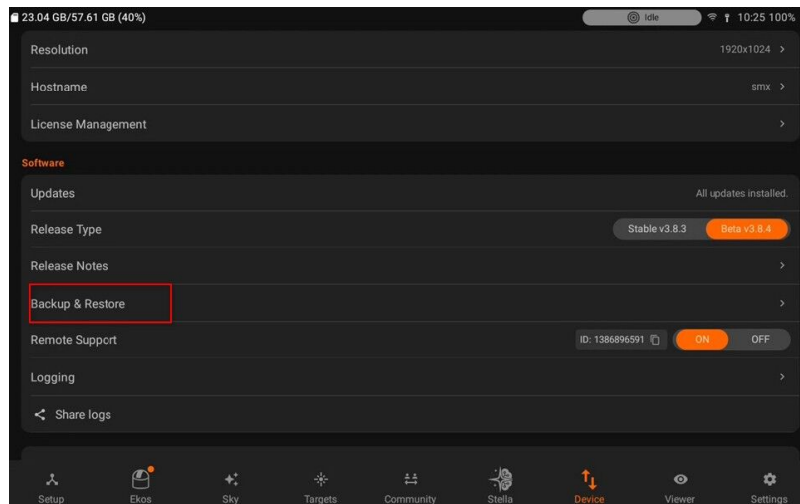
5.8.3.2 Remote Support



You can toggle Remote support if SM support asks for its access to investigate the issues you face. Once you toggle it ON, You will see an ID.

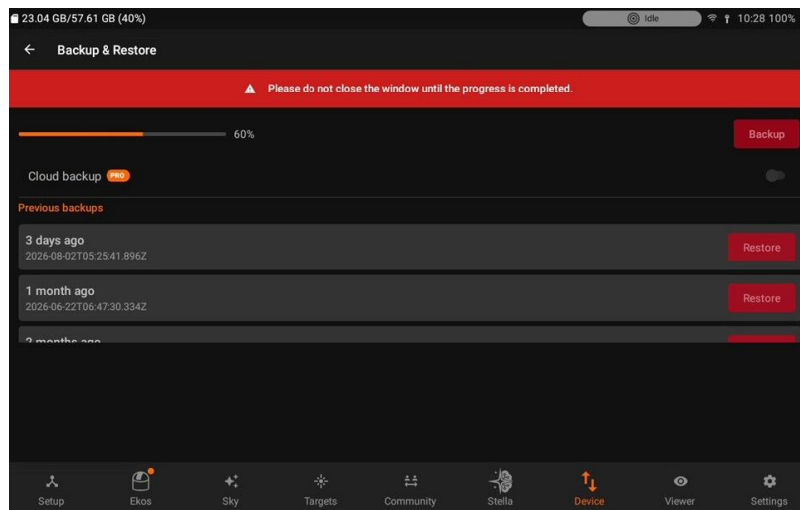


5.8.3.3 Cloud Backup & Restore

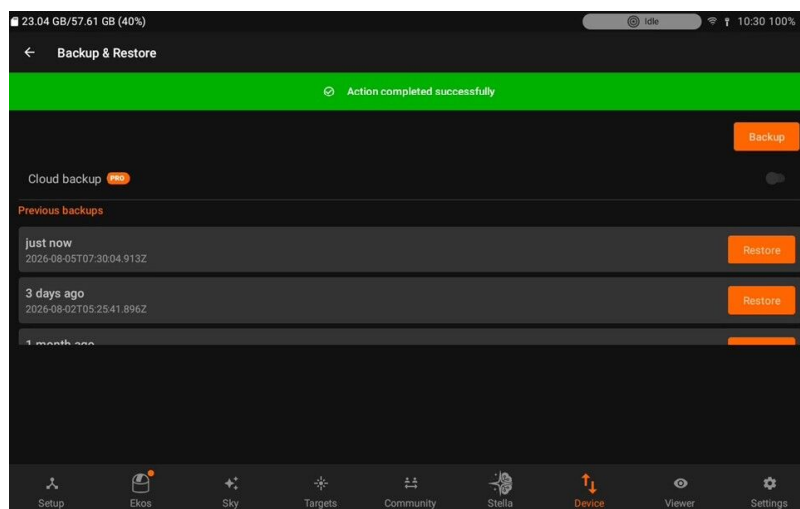


Back up StellarMate OS settings using the following options

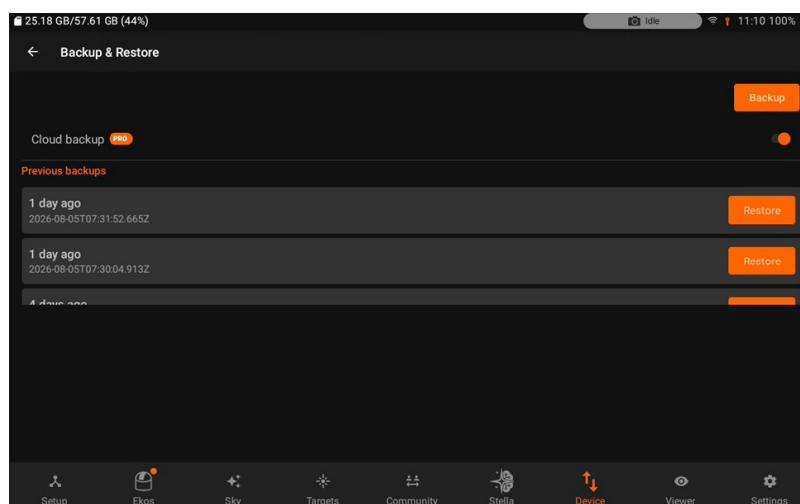
Local Backup



- Save backup files directly inside StellarMate storage. All the backup files are located in ~/Documents/backup_files
- Ability to download & upload offline backup files is planned for future release.

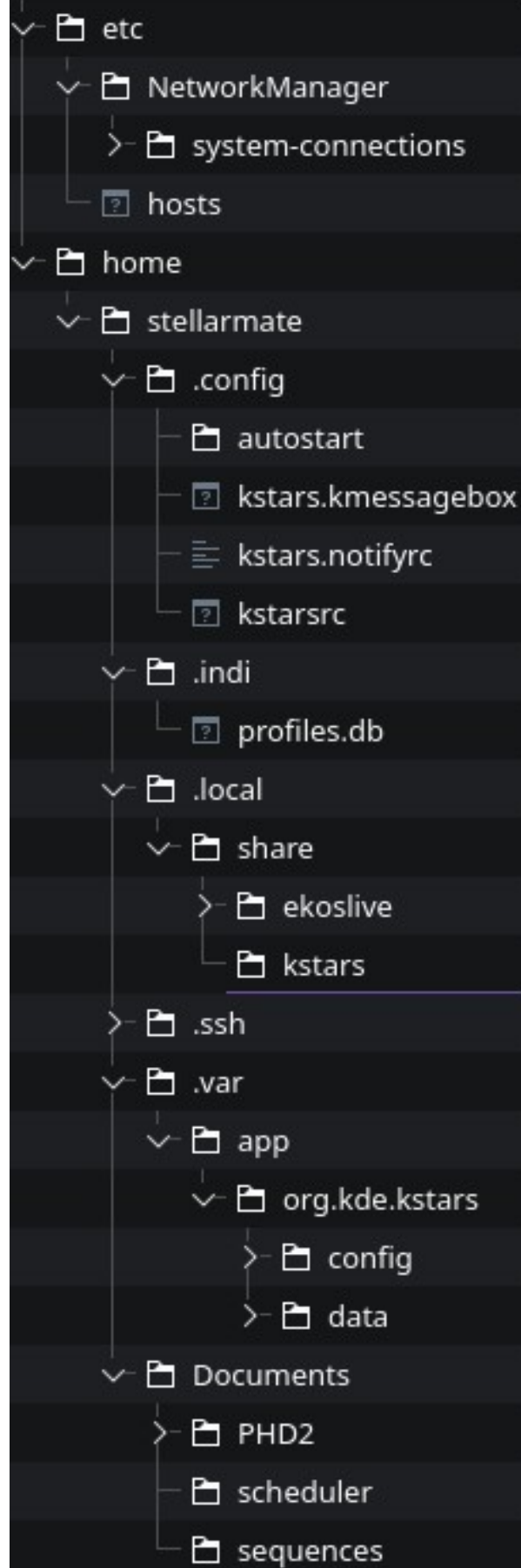


Cloud Backup



- Cloud backup is only accessible to EkosLive Pro & Ultimate subscribers.
- A total of three backups are stored and rotated in the cloud.

These files should be stored in the backup file.



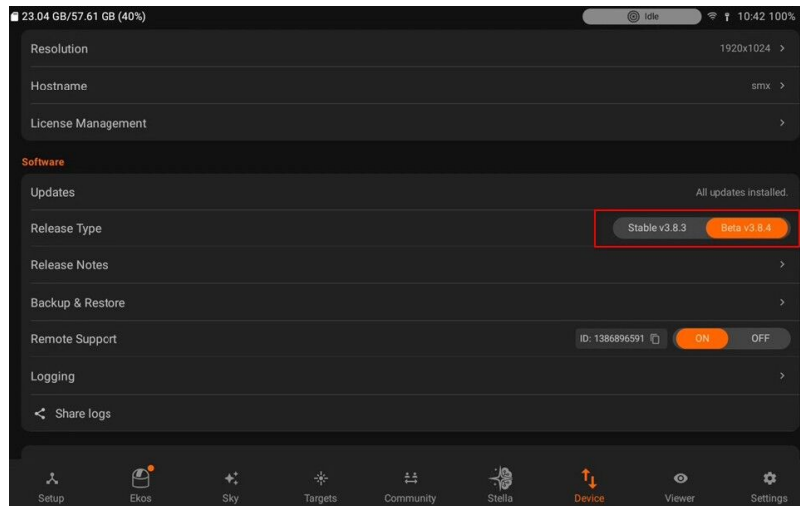
To restore from cloud

- Select your backup file from cloud storage
- Restore your data as needed.

5.8.3.4 Change Release

You can now easily switch between the Stable and Nightly release types. **Stable:** Contains the official, tested release updates. **Nightly:** Includes the latest, in-progress updates, which may contain experimental features or bug fixes.

If you encounter any issues with the Stable version, switch to Nightly to check if the issue has been resolved in the latest updates. If Nightly is not already installed on your StellarMate device, switching to Nightly will automatically download and install the latest version for you.



5.8.4 Logs

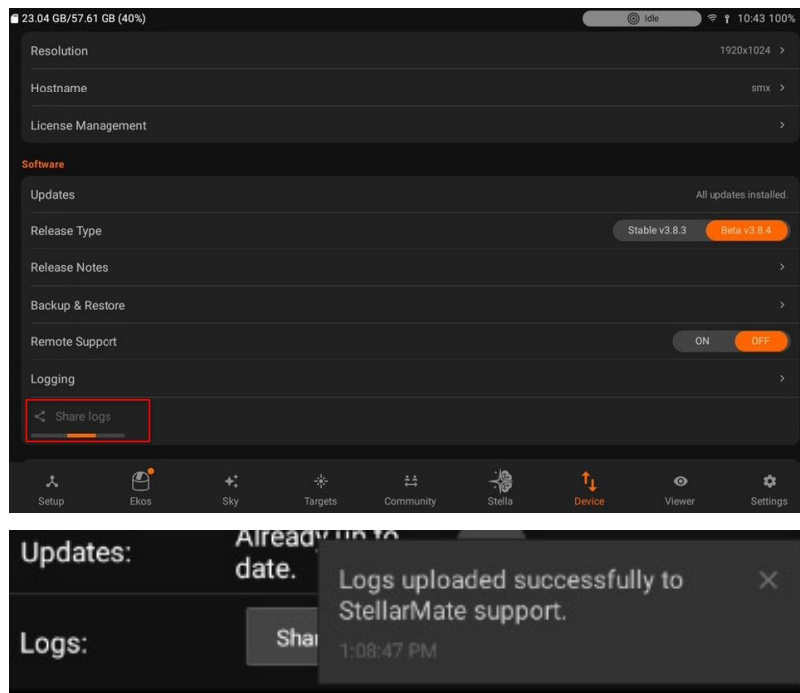
Logs generated by StellarMate can be useful to diagnose system and/or driver issues. The logs are categorized into the following:

- Driver logs for the camera, mounts, filter wheels, focuser..etc
- Ekos logs for Capture, Focus, Align, Scheduler, and Guide modules.
- System logs for the underlying system that includes boot and micro-services.

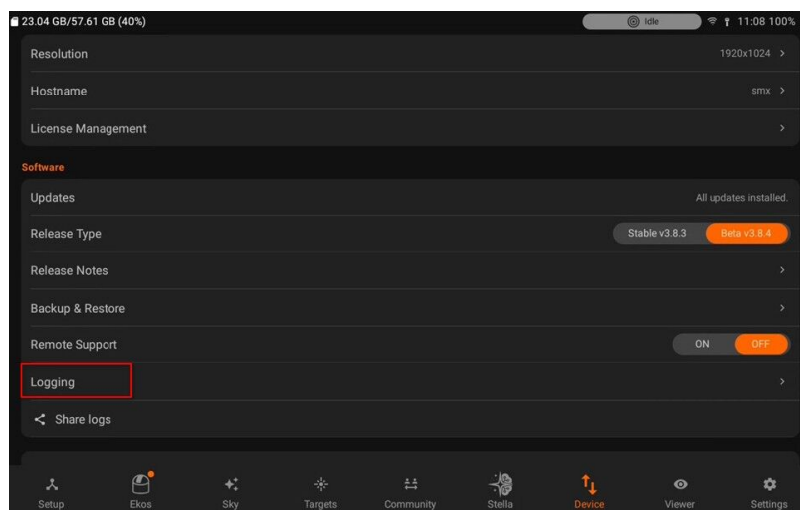
Only enable logs when planning to diagnose and submit an issue to StellarMate support. Logs can be quite verbose and may result in performance degradation so only use them when necessary.

Submitting Logs

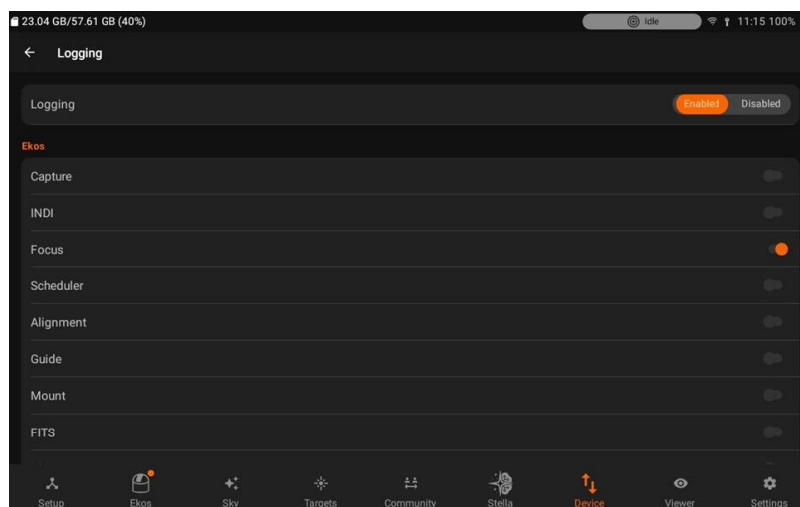
- Toggle the necessary logs to reflect the issue being diagnosed by tapping the settings icon.
- Start equipment profile and use the system normally to replicate the issue.
- Tap **Share Logs** to send the logs to StellarMate servers.
- Open a ticket with StellarMate support describing the issue. Please note the date and time when you submitted the logs so we may extract the logs relevant to the issue.



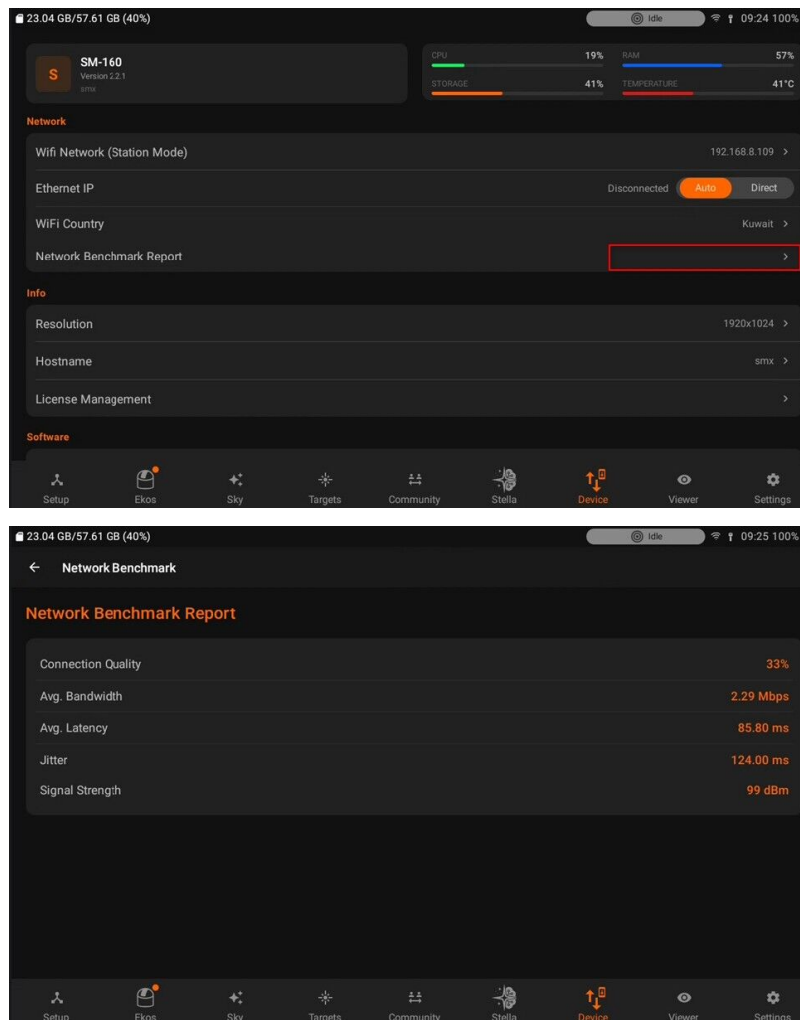
Ekos Logs



Enable logs to diagnose issues with Ekos and INDI. Only enable the necessary logs to help in diagnosing specific problems. Logs consume resources and may slow down the system. Turn off logs when no longer used.

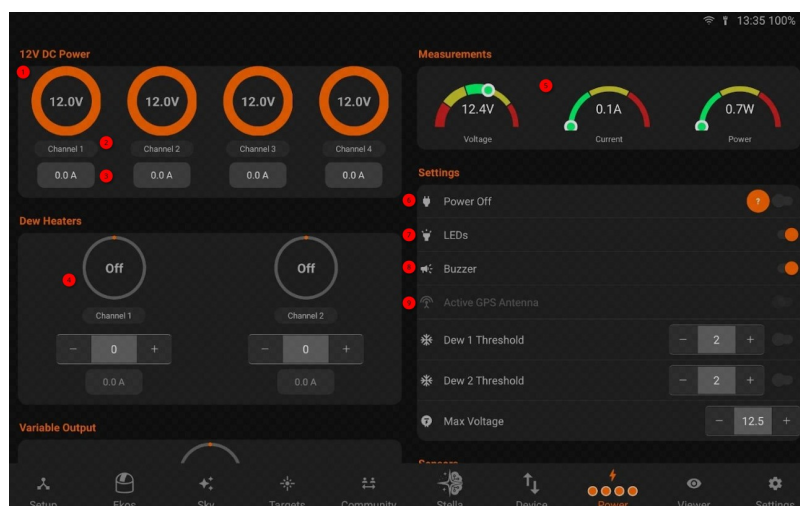


Network Benchmark tool measures real-time network performance to ensure reliable connectivity for your astronomical equipment. This is essential for stable remote operations, especially during long imaging sessions.



5.9 Power

Power tab provides access to StellarMate Pro power dashboard and environmental sensor measurements. The top half of the dashboard controls the DC, PWM, and variable voltage outputs, while the bottom half includes measurements, settings, and sensor widgets.



The following controls are available: 1. Toggle the power to each output. This setting is remembered on the next power cycle. 2. Assign a unique name to each output. 3. Measurement of the output voltage or current. 4. Set dew heater duty cycle from 0% to 100% 5. Voltage, Current, and Power measurements. 6. **Power Off:** Only power your equipment with Ekos equipment profile is running. When an equipment profile is stopped, power shall be switched off to all connected equipment. 9. Toggle All the unit LEDs on or off. This is remembered on the next power cycle. 10. Toggle buzzer 11. Activate GPS

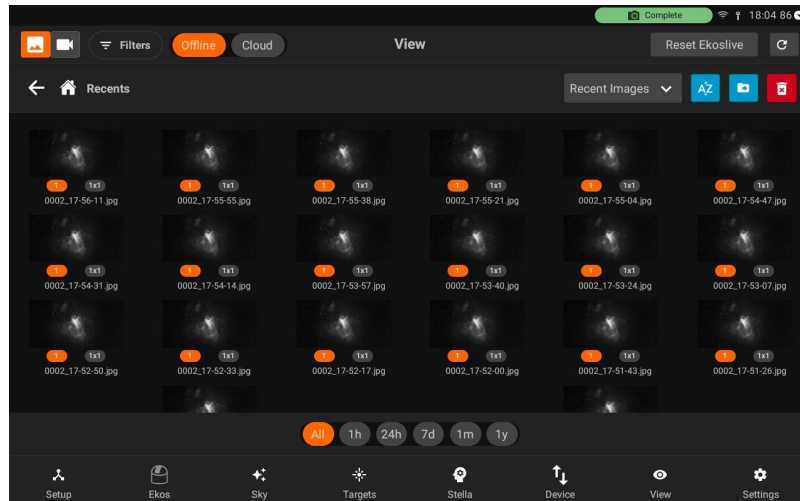
Toggle Auto Dew. This feature requires an external environmental temperature & humidity sensor to calculate the dew

point. If toggled, then the dew heater shall be turned on if the ambient temperature is within the dew point threshold as indicated in the settings. 1. Set variable voltage level (3 to 9 VDC) 2. Current Temperature and weather

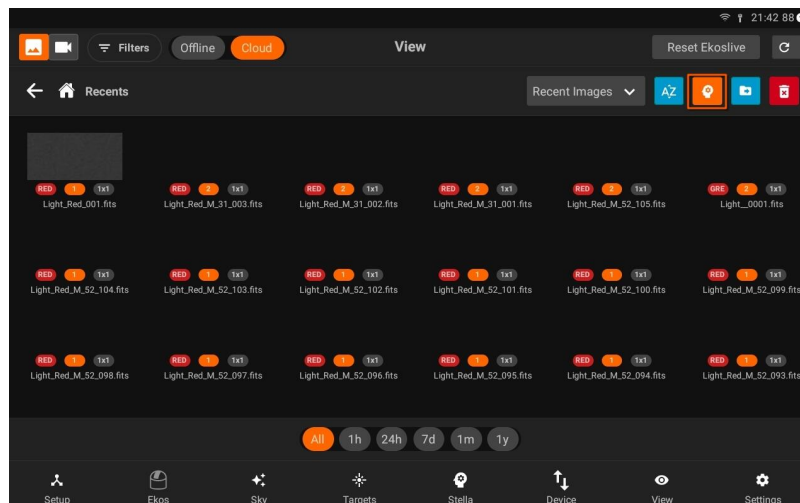
GPS Lock indicator * **Yellow:** GPS lock in progress. * **Green:** GPS 3D lock successful. * **Red:** GPS lock failed.

5.10 View

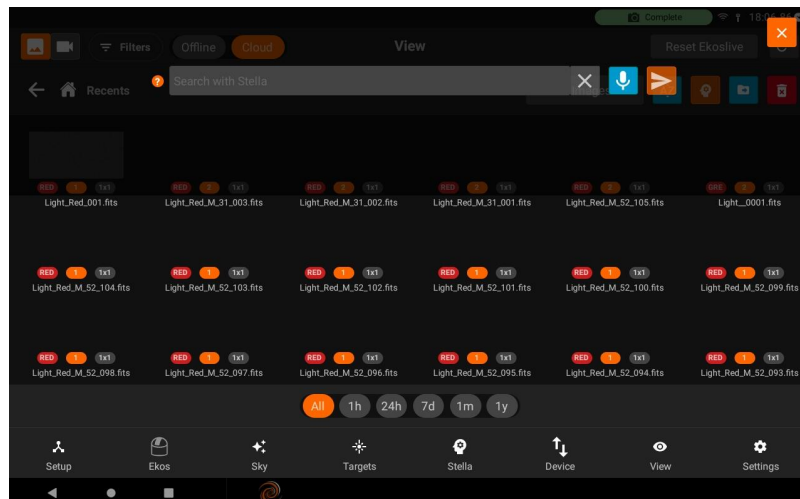
The View tab displays online images saved on the cloud (requires EkosLive Pro subscription, refer to Resources section) and offline images captured on StellarMate. All metadata is preserved so you can sort and search your images at any time. You can toggle between Cloud or Offline images. You can also switch between Images / Videos.

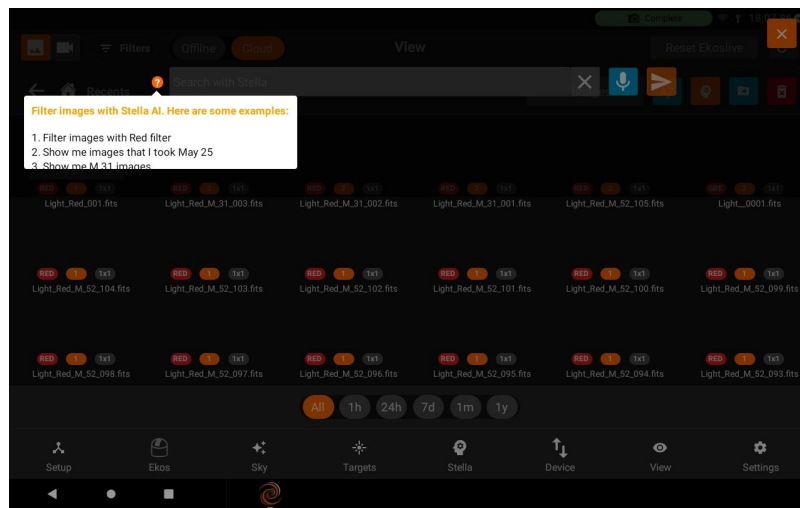


Stella Assistant: Once the Cloud is enabled, you can use Stella.



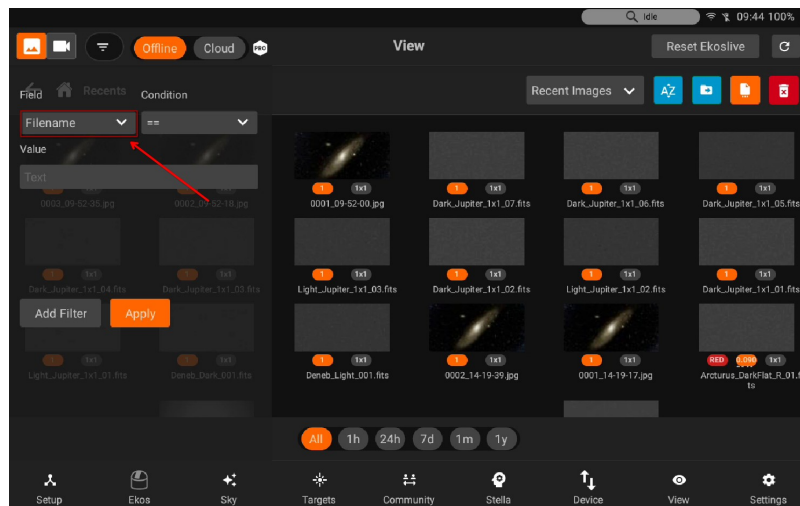
You can use the following commands to filter the images.

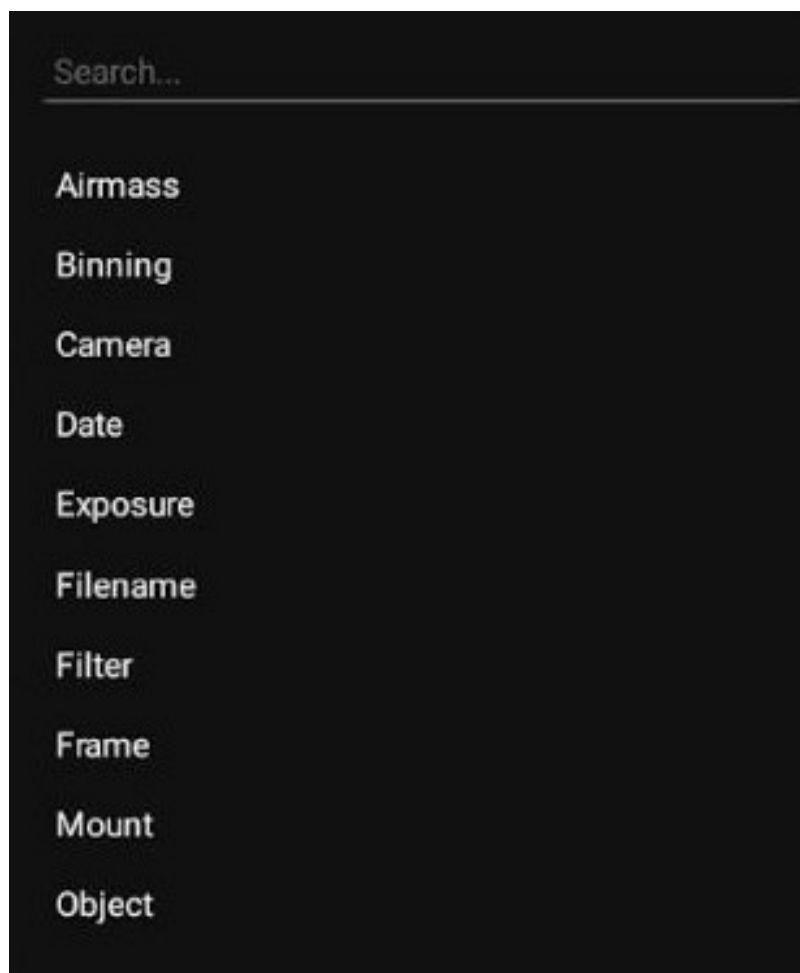




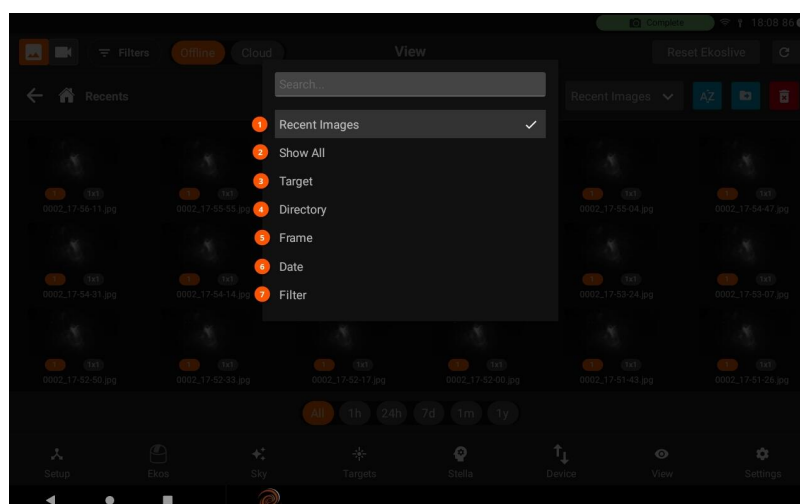
5.10.1 Images

Images are displayed in a grid view. Under each image there are badges for Filter, exposure duration, and binning. By default, all images are displayed in the grid without any filtering or sorting. Click on an image to view the full-size version which also provides further actions such as export and export. You can filter the images by using the left panel. Changing the Field, allows you to select to filter using different options based on the chosen condition. Advanced search is available from the left panel. Select the condition that must be met from the metadata fields. You may add multiple conditions to further restrict the search.

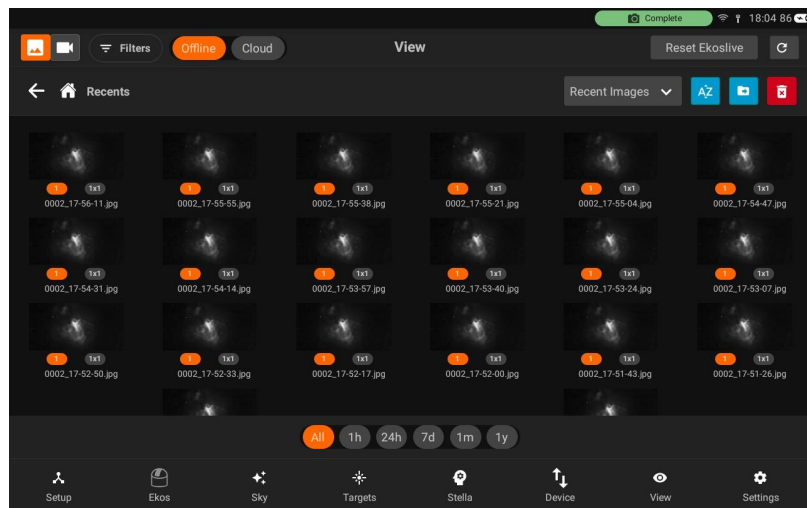




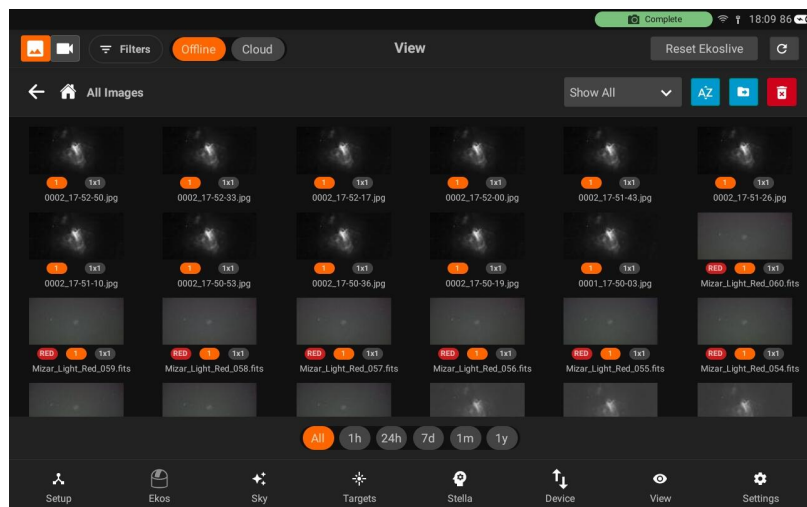
StellarMate aggregates images in Virtual Folders based on the selected Virtual Group:



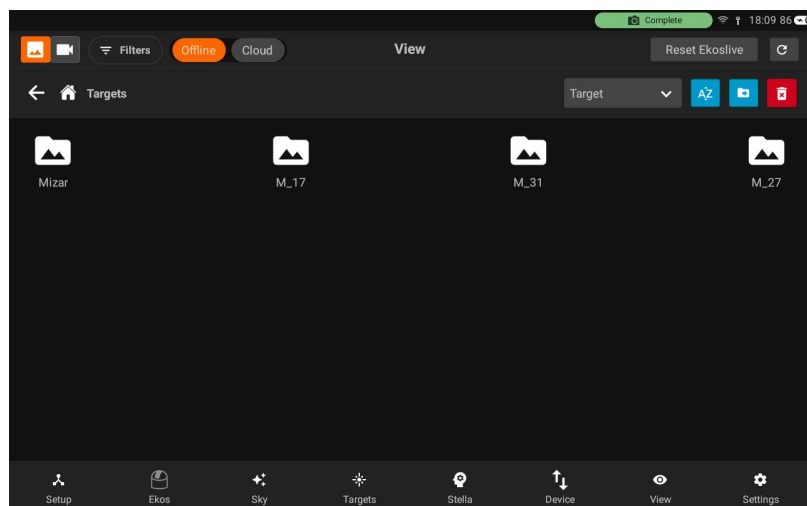
1. **Recent Images:** Shows 20 latest images captured.



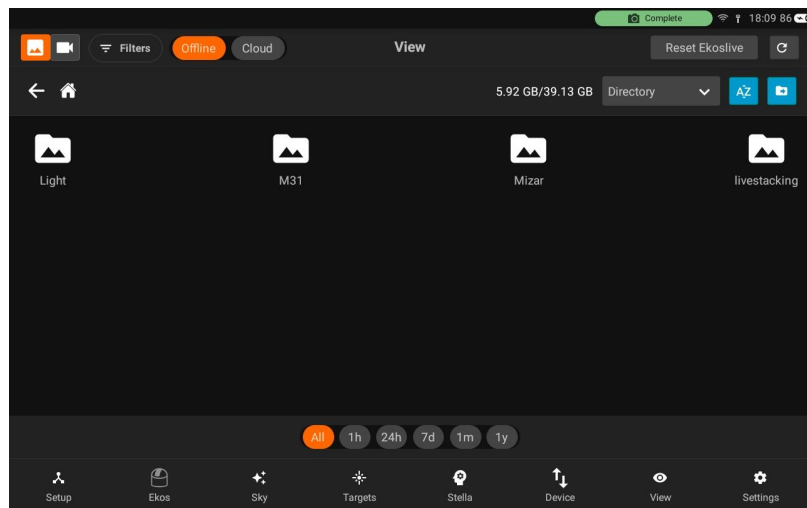
2. **Show all Images:** Show all directories & images under /home/stellarmate/Pictures.



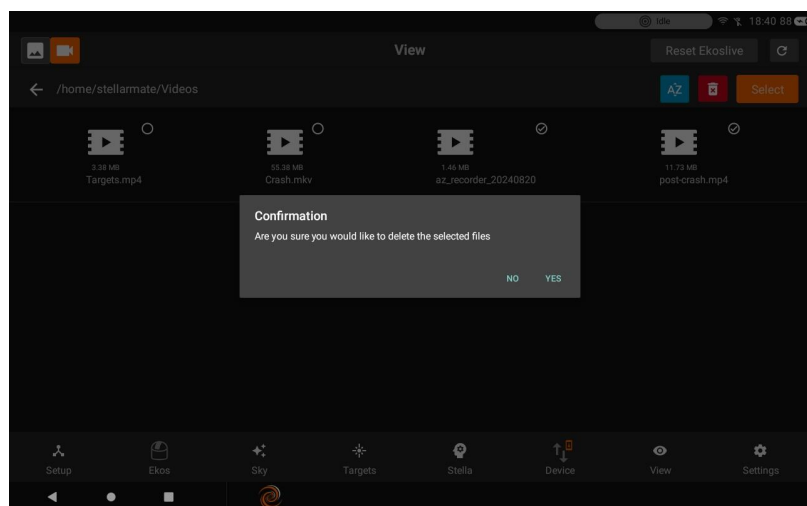
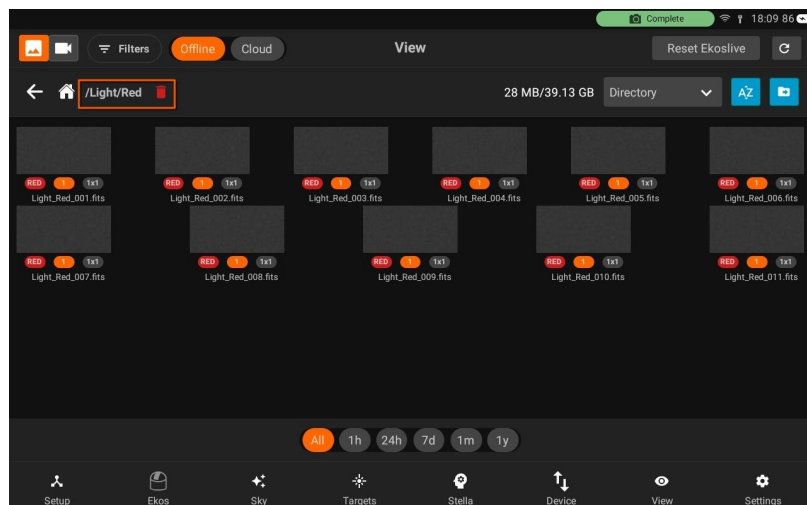
3. **Target:** Group images by each unique target together regardless of where they are physically located on the device.



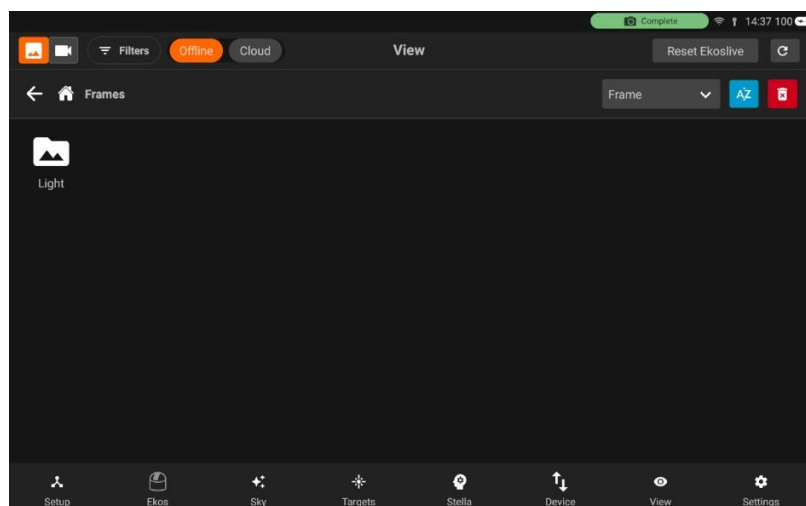
4. **Directory (Default):** This is similar to a traditional File Explorer where images are grouped by directory on StellarMate.



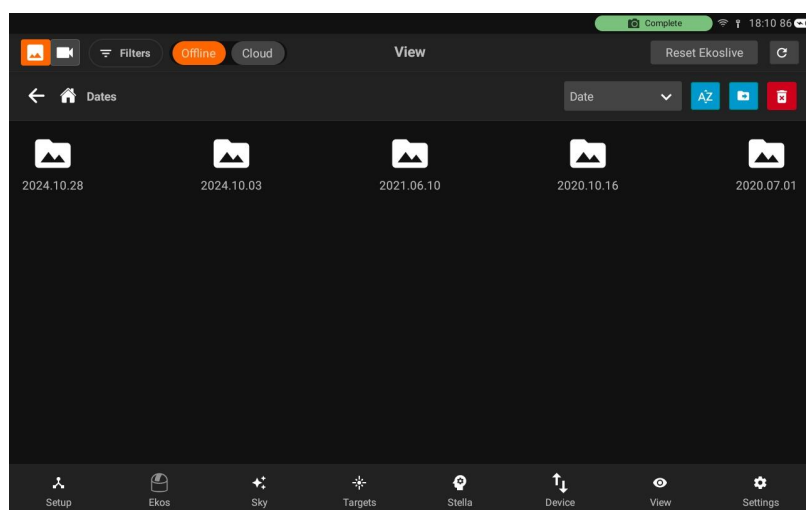
You can now also delete the directories. In order to delete a directory, just visit the directory and you will see the delete icon button beside the directory locatory to delete all images in a directory.



5. **Frame:** Group images by each unique frame type (i.e. Light, Bias..etc).

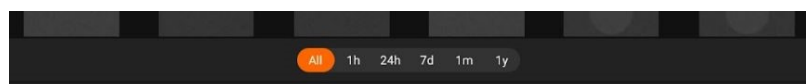


6. **Date:** Group images by date whereas images captured on the same day are grouped together.

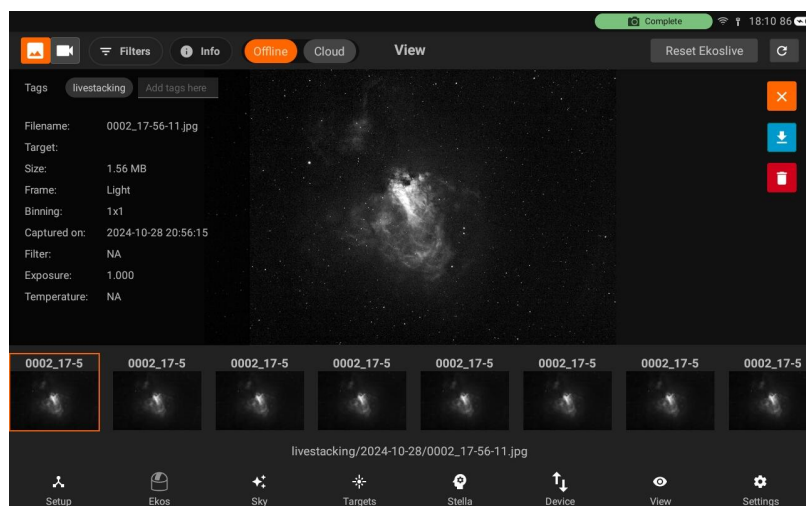


1. **Per filter:** Images are shown per filter. Those folder directories are Virtual folders.

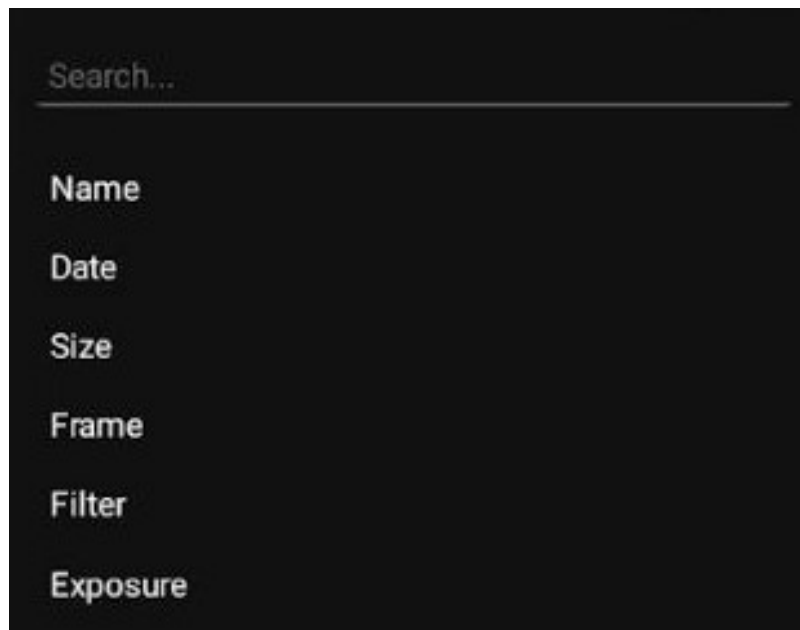
Images can be further filtered chronologically by tapping on the bottom chrono selector. By default, images captured at all times are displayed. To filter only recent images, tap the chrono selector. For example, tapping **1H** would only show images captured within the last hour.



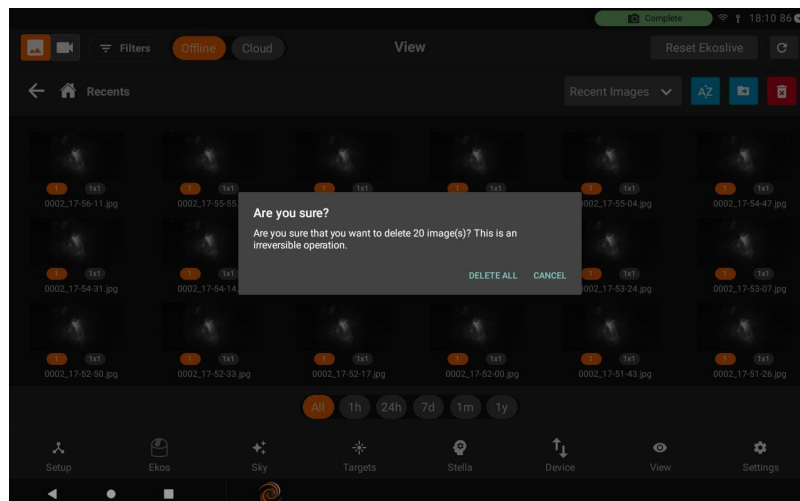
You can view the image in full size by click on a specific image. Below the list of images which are in that Directory are shown. On each image click, the image and it's information will be loaded. You can also download and delete the selected image on the right side. To view detailed metadata, tap the top-left **Info** button, the information of a specific image is displayed as illustrated below.



Sort: It allows you to sort the images according to different options which includes, Name, date, Size, frame, Filter and Exposure.

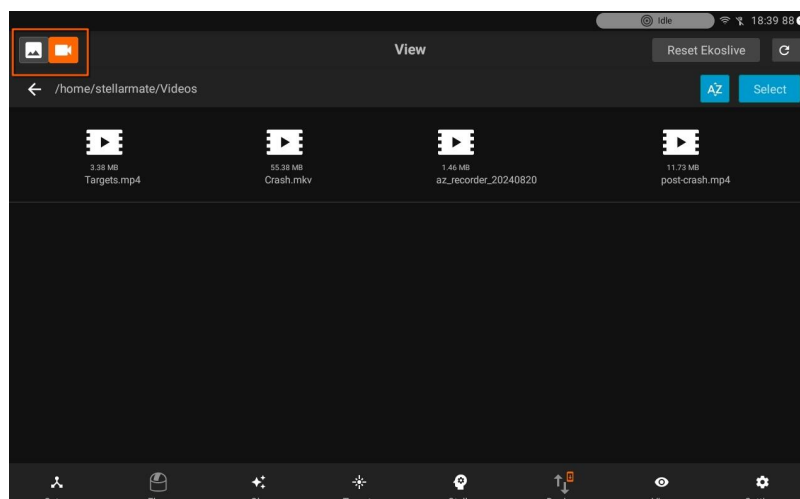


Delete all: Deleting all images will delete all the images exists in the specific directory. i.e If you are in Per filters option and RED filter directory. It will only delete your images within RED directory virtual folder.

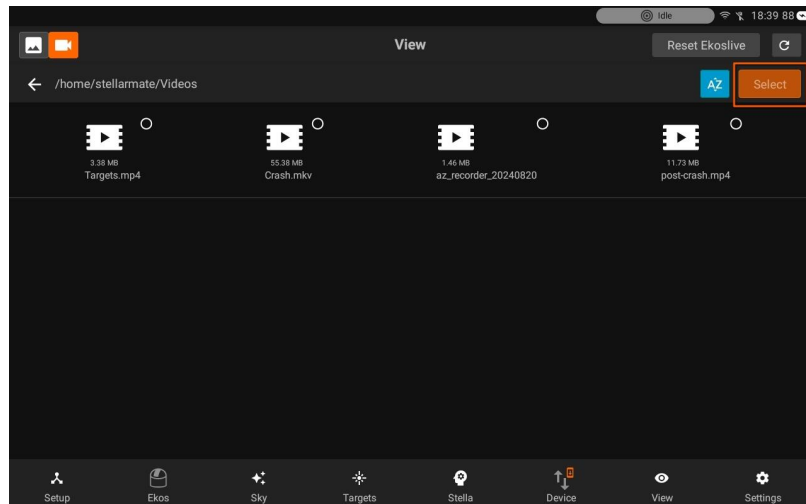


5.10.2 Videos

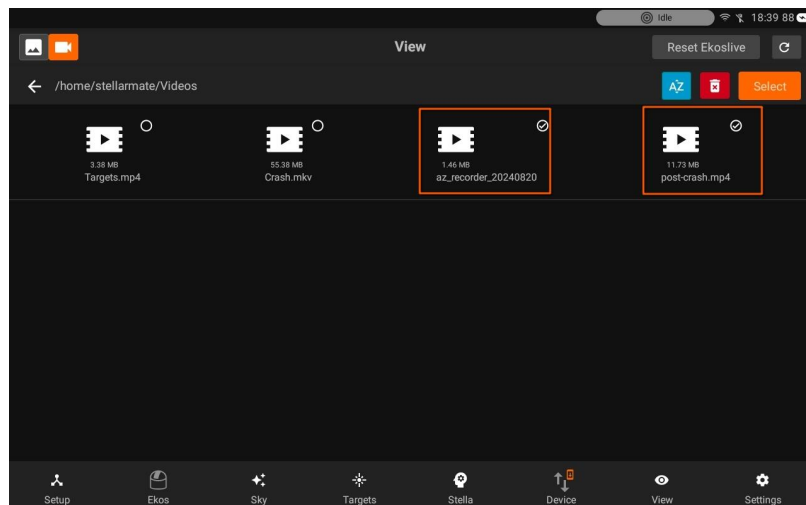
In videos section, you can view folders and files under “/Videos” directory. Directory name and it’s is displayed under the folder/file.



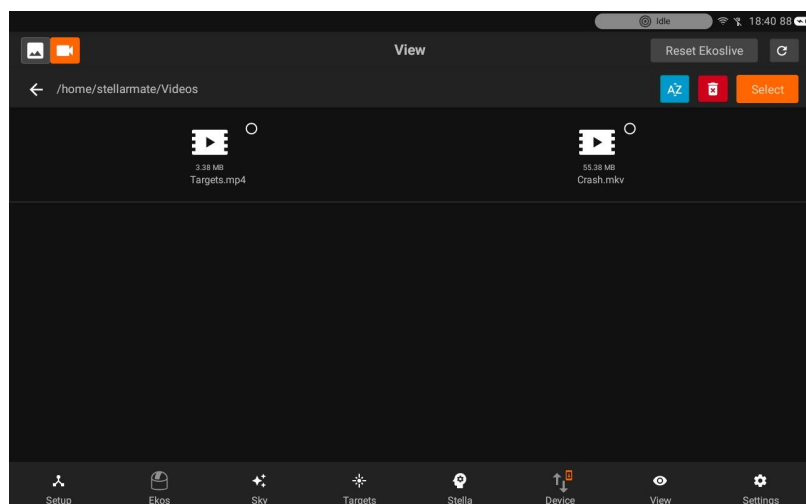
You can press on the select button, once selected press on the files you would like to delete.



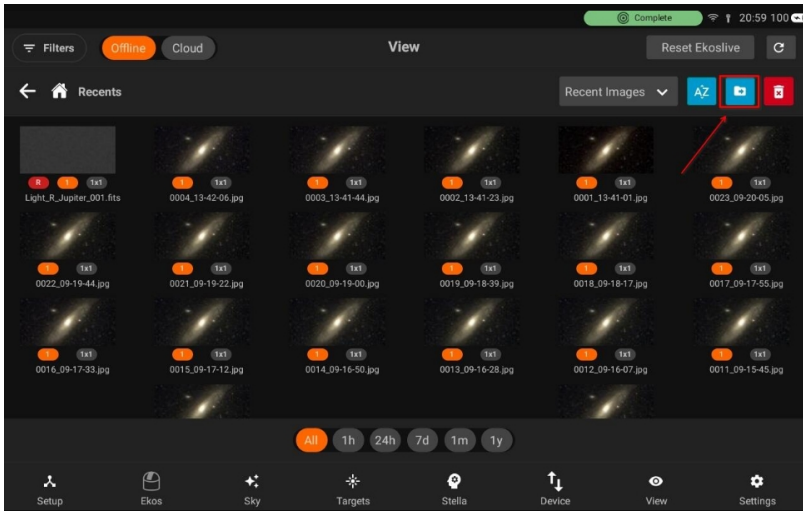
Once the files are selected, you can see the checkmarks on the top of it.



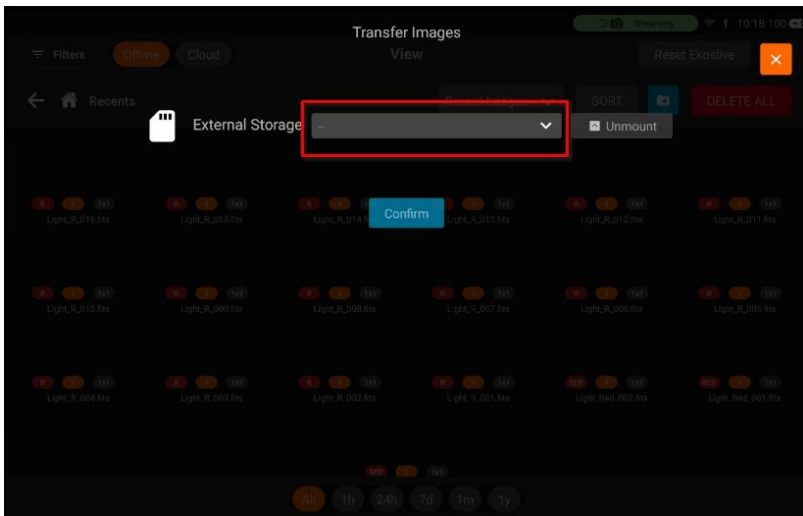
Once you confirm deleting the files, selected files are deleted from the filesystem.



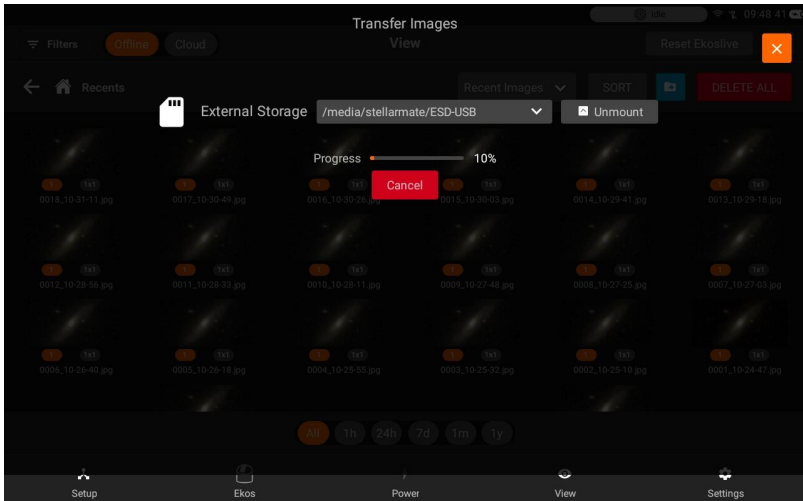
5.10.3 Transfer Images



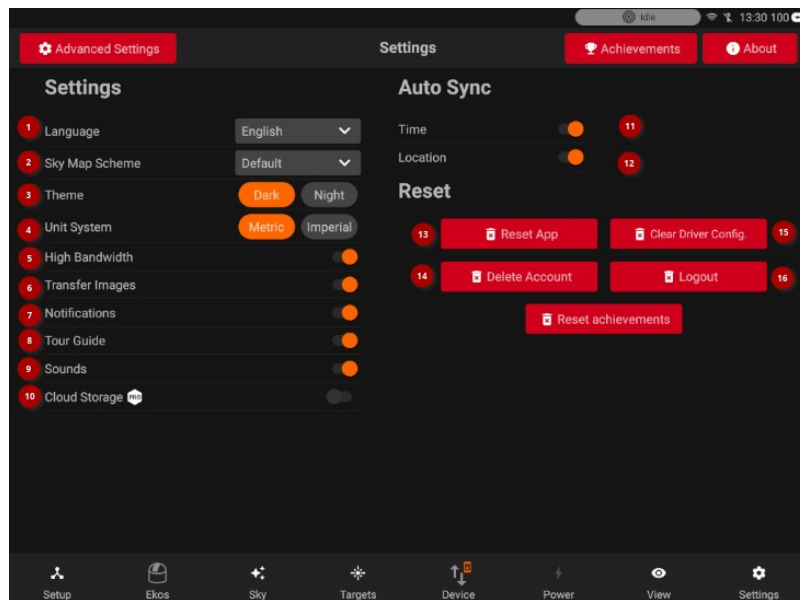
Synchronizing your images to an external USB thumb drive is now very easy! From the View tab, select the desired external USB drive and transfer all your images.



For subsequent transfers, the system only transfers the new images since your last sync.



5.11 Settings



General Settings

1. **Language:** Supported Languages are:

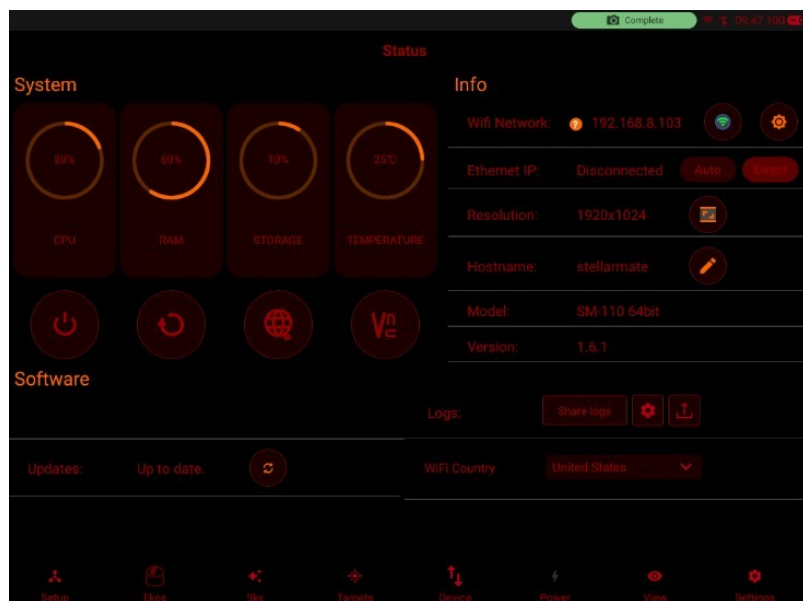
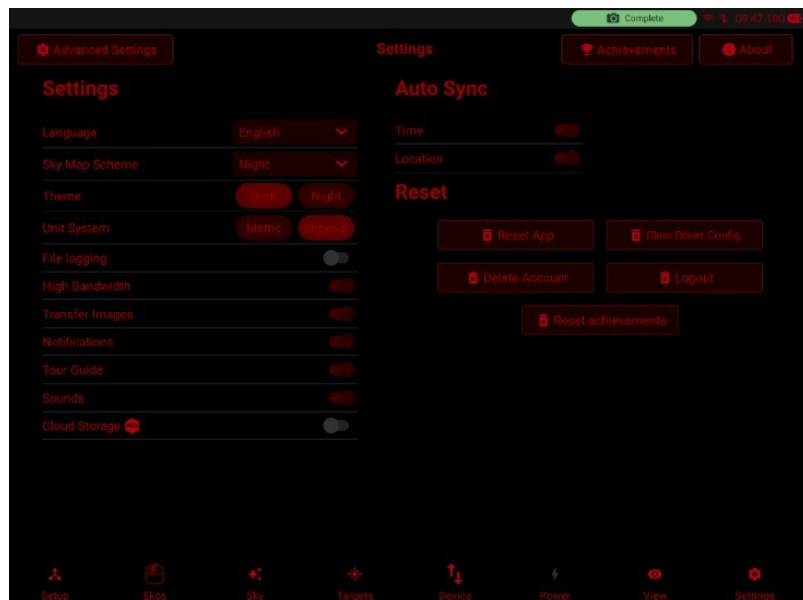
- English (Default)
- French
- Spanish
- German
- Chinese
- Japanese

You can help with translating the StellarMate App. Visit the [StellarMate App Translations Github repo](https://github.com/knro/smtranslation) <<https://github.com/knro/smtranslation>>_ for more information.

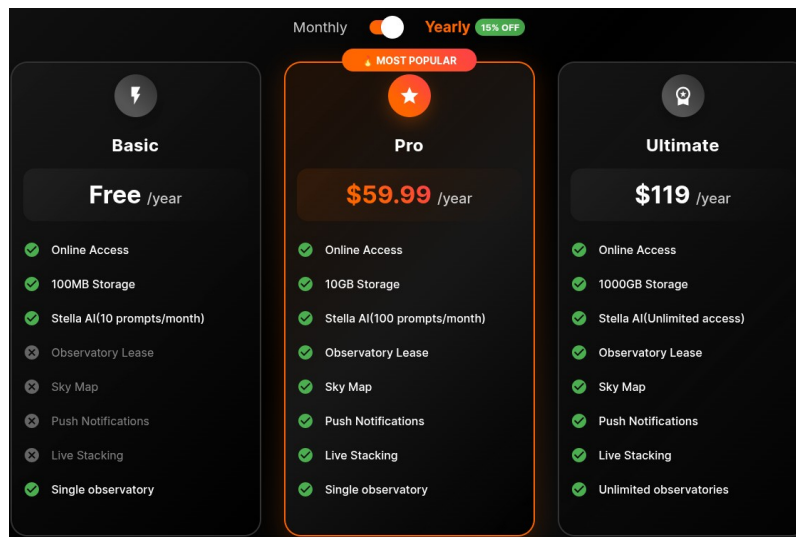
2. **Sky Map Scheme:** Change the Sky Map color scheme.

- English (Default)
- French
- Spanish
- German
- Chinese
- Japanese

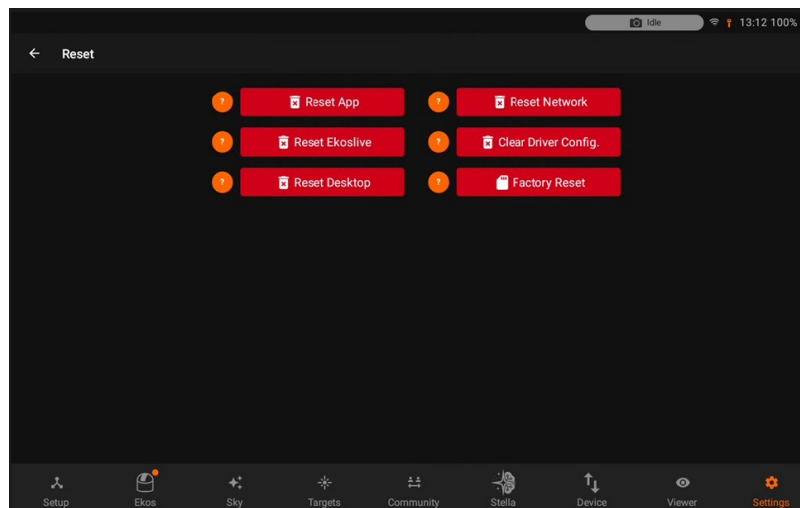
3. **StellarMate App theme:** Please note that if the App theme is changed to Night this automatically switches Sky Map theme as well to Night Theme: Overall App theme. StellarMate App provides two themes: Dark (default) and Night. When night is toggled, all controls are rendered using a red hue to help with eye adaptations in the dark.



4. **Unit System:** Unit system used for weather related information. All other units in the App use the Metric System by default unless explicitly mentioned.
5. **High Bandwidth:** If your WiFi link is slow or suffers from packet losses, toggling high bandwidth to Off might help as it applies more compression to all images to save on bandwidth.
6. **Notifications:** Toggle in-App notifications.
7. **Tour Guide:** Toggle to re-enable the App Tour Guide.
8. **Sounds:** Enable sound notifications, the following events trigger a sound notification:
 - When the capture sequence is aborted or completed
 - When the Polar Alignment mount position changes
9. **Current Plan** User's current active plan.
10. **Cloud Storage:** Toggle saving images in the cloud. Required an active EkosLive Pro Subscription. StellarMate unit needs to have a reliable and fast internet connection for the cloud storage to reliably work. Sequence images are compressed and uploaded to the cloud where they can be viewed at any time from either the App or EkosLive online portal. All the image metadata is preserved in the process which can help in filtering, organizing, and searching for images at any time.
 - Pro users** can enable the Push notifications. If they are enabled, users will be able to get the notifications on their Tablet device.
 - Users who are not subscribed to EkosLive Pro will see a pop up as shown below:
 - In order to subscribe, you can follow the link here.



11. **Stella Assistant** Disable Stella in Ekos
12. **Push Notifications** Use Pushoverlay Notifications
13. **Cloud Backup** Backup your SM OS file and restore for later.
14. **Auto-sync Time and Location:** When the SM App is started, it syncs tablets time and send to Ekos.
15. **Reset App:**

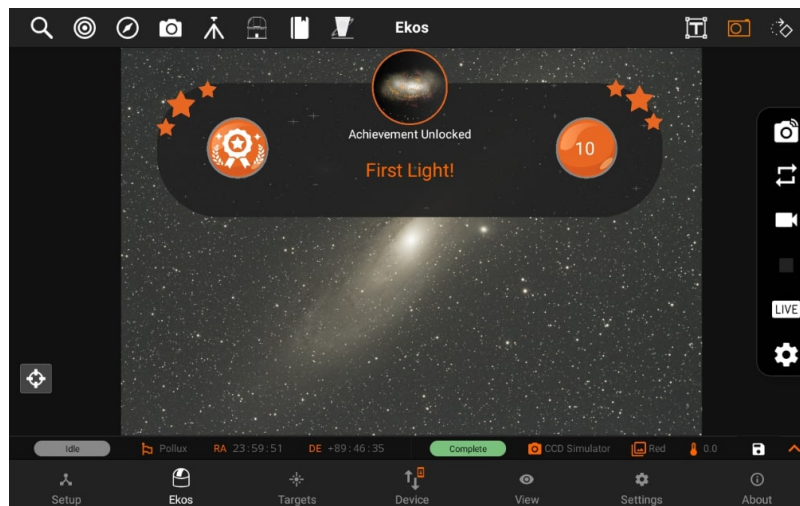


1. Reset App and start from scratch.
2. Reset Ekoslive and regenerate the images
3. Reset Desktop if your desktop is messed up
4. Reset Network to set the default network settings
5. Clear Driver Configuration files
6. Factory reset data
7. **Delete Account:** Delete your account in stellarmate.com. Once deleted, the account and associated data will be permanently deleted.
8. **Logout:** Sign out of StellarMate App. Only use this if you need to sign in using a different accounts.

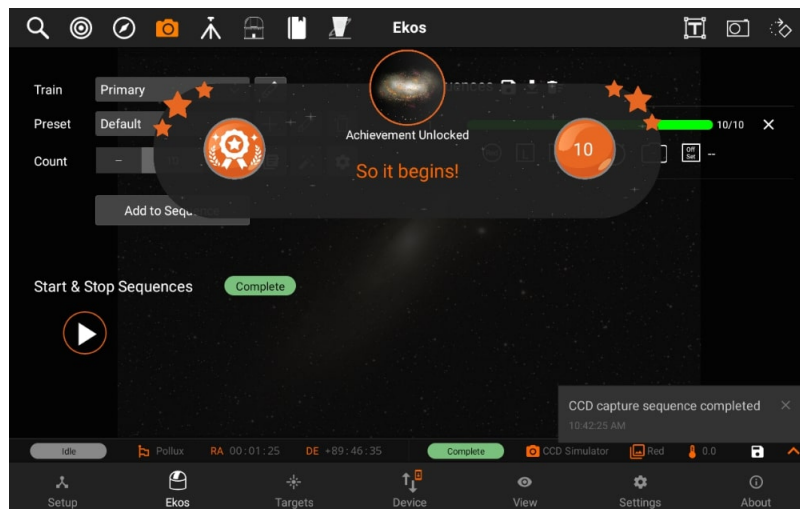
5.11.1 Achievements

Once you complete the Achievement, Achievement earned pop up is displayed. Which includes the title of the Achievements and it's points. Few of the common achievements are:

1. **Capture a preview:**

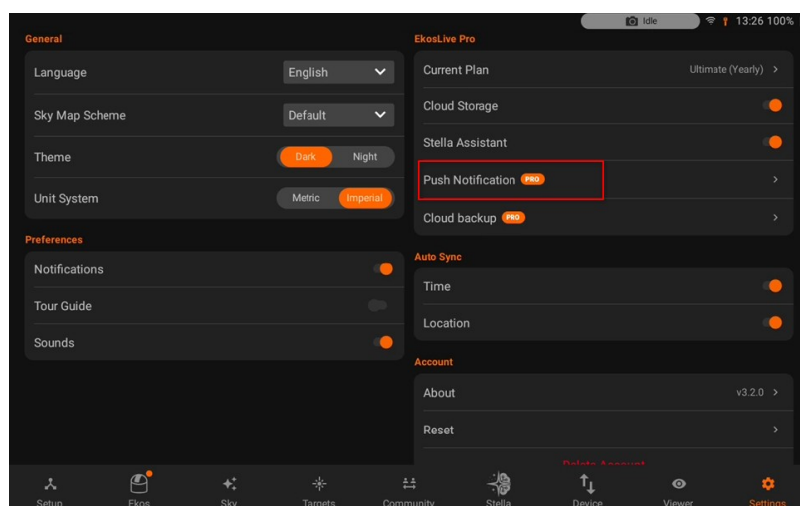


2. Capture ten sequences:

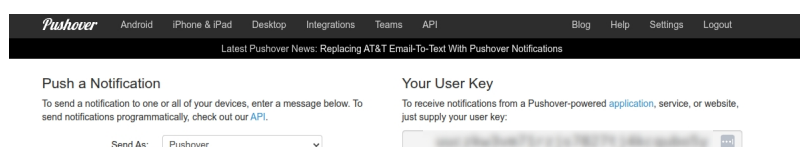


5.11.2 Push notifications

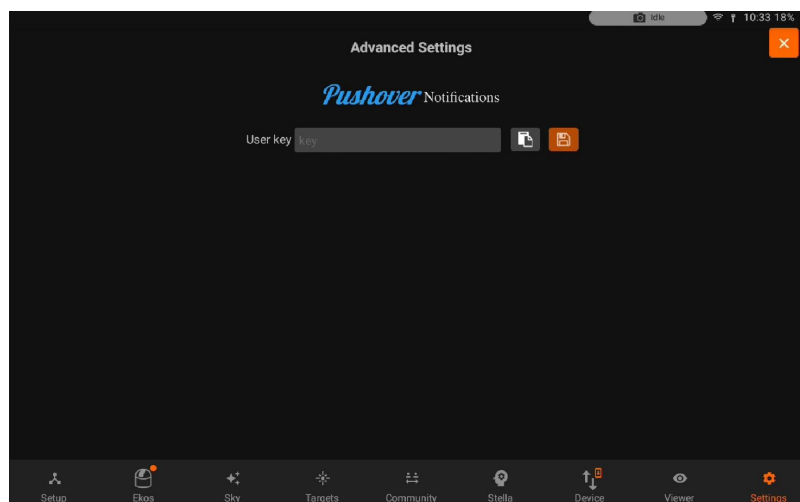
StellarMate App supports Pushover notifications to keep you informed of system events and alerts on your mobile device.



Setup Requirements - Download the Pushover application from Google Play Store or Apple App Store - Create a Pushover account and obtain your user key

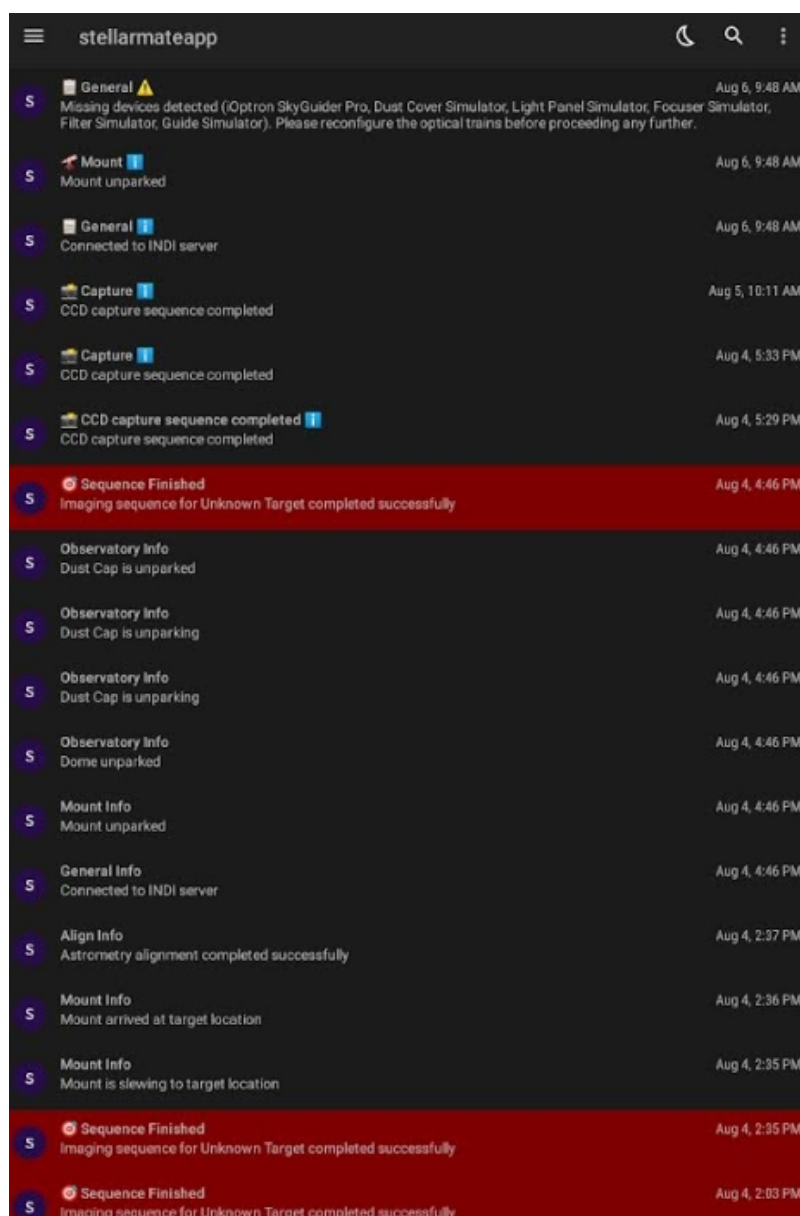


Configuring Notifications - Paste your Pushover user key in the designated field - Tap Save to store your configuration



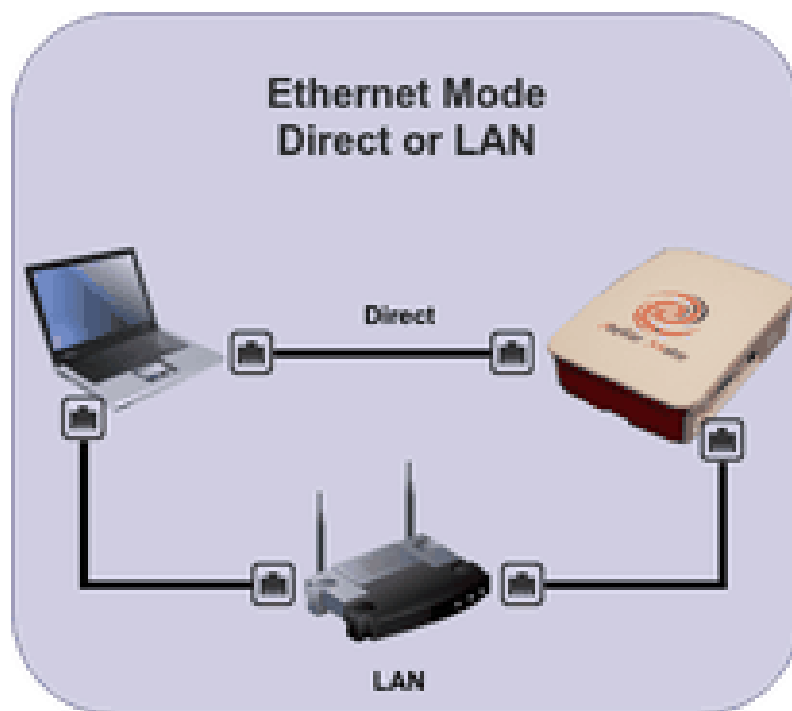
- Adjust notification categories to select which events trigger alerts
- Set severity levels to control notification priority and delivery method

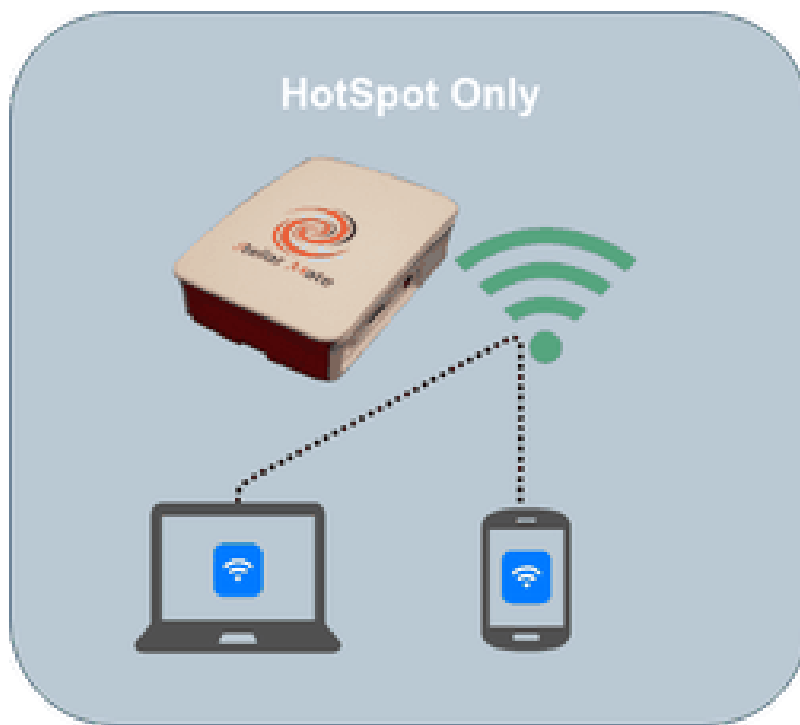
Once configured, you will receive real-time notifications on your mobile device for selected StellarMate events and system alerts.



Connection Methods

Depending on how you want to connect to StellarMate, click on any of the following options



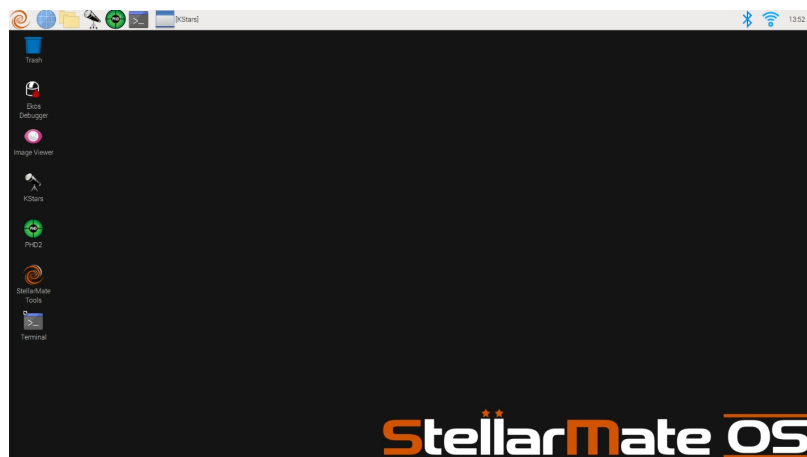


6.1 HDMI

Note: You must first complete the First Time Setup guide before proceeding with this tutorial.

By default, StellarMate operates in HotSpot mode. Even if configured for WiFi connection or LAN, StellarMate always switches back to HotSpot mode when the other connection modes become unavailable. This ensures you to always have access to the device regardless of network availability. StellarMate gadget is shipped with a 1.8 meters HDMI cable. Connect the cable to any monitor or TV. Make sure the cable is connected to StellarMate before powering on the unit.

Unless the HDMI connection purpose is for viewing only, you also need a keyboard + mouse to control to the StellarMate OS. You can use wired or wireless mouse and keyboards.



StellarMate unit is shipped with a full-featured Linux® Operation System that you can directly access. The default username and password are:

username: stellarmate

password: smate

This is the same username and password you will use when accessing the unit over Web VNC as well. It is highly recommended to change the default password after your first login to the system.

6.2 WiFi

Note You must first complete the First Time Setup guide before proceeding with this tutorial.

You can connect to StellarMate **wirelessly** either via:

- Direct Connection to the StellarMate **HotSpot** or
- Joining StellarMate to your **Home WiFi**.



By default, StellarMate runs in HotSpot Mode. Click on the desired mode of connect to learn more about connecting StellarMate.

6.2.1 Access Point

Warning

You must first complete the First Time Setup guide before proceeding with this tutorial.

By default, StellarMate operates in HotSpot mode. Even if configured for WiFi connection or LAN, StellarMate always switches back to HotSpot mode when the other connection modes become unavailable. This is to enable you to always access the device regardless of network availability.



6.2.2 Station Mode

Warning

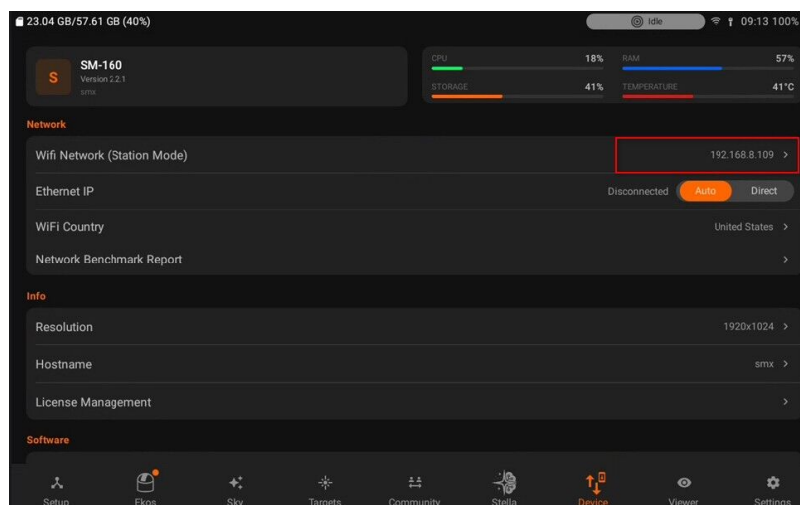
Station mode is where StellarMate joins an existing WiFi network. You must first complete the First Time Setup guide before proceeding with this tutorial.



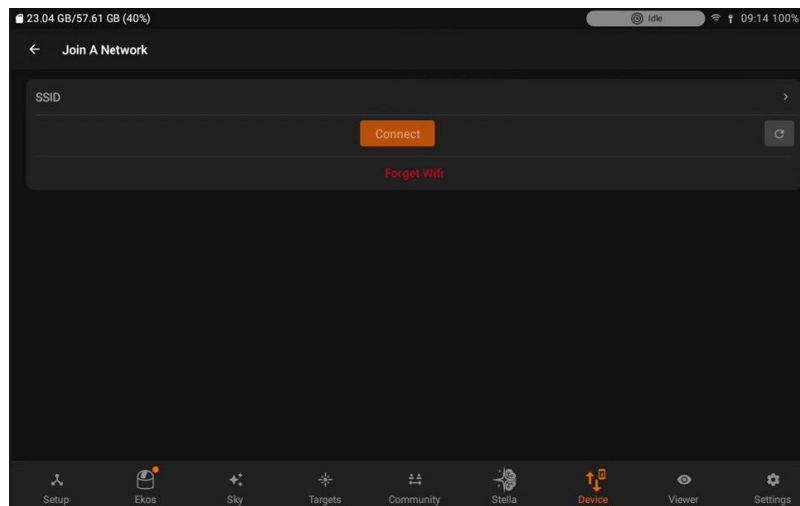
Connecting to WiFi Network Use the StellarMate App to connect to your WiFi network. From your mobile OS, connect first to the StellarMate HotSpot, then launch the StellarMate App and tap RESCAN to connect to the unit. Advanced networking configuration is located in the StellarMate App Device tab.

The Hotspot IP address is always 10.250.250.1 and the hostname is stellarmate.local. The IP address and stellarmate can be used to connect to the unit remotely from KStars or a web browser. To access StellarMate Web Dashboard, visit <http://stellarmate.local> or <http://10.250.250.1>

Similarly, when setting an equipment profile on a PC/Mac connected to the same hotspot, use the IP address 10.250.250.1 to connect to the unit.

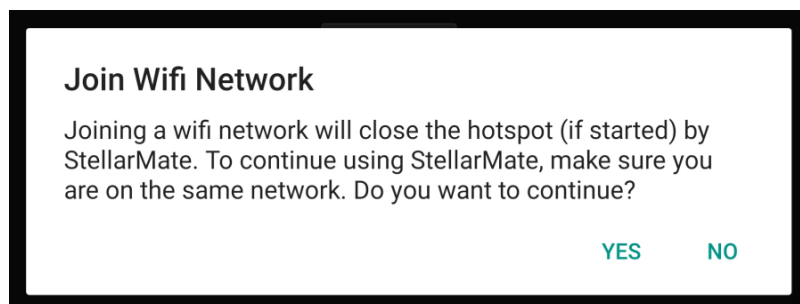


To join an existing WiFi networking, tap on the Manage WiFi button (orange cogwheel next to green WiFi icon). The App should display a list of detected WiFi networks in the vicinity.



Select the desired WiFi network from the list and press Connect. Enter and double check the WiFi password. A final confirmation warning popup about switching to WiFi station mode is displayed, press Yes to continue.

The App will command StellarMate to join the WiFi network and then begins to scan for StellarMate in the local network. This assumes your phone/tablet will automatically switch to your home WiFi network since it will be disconnected from the hotspot and in most cases this causes Android/iOS to fall back to the next available network. If this does not happen, then go to Network Settings in your mobile OS and connect to the same WiFi network selected above.



This process can take up to 2 minutes. If successful, the device IP address is going to change to the new WiFi IP address. Go back to the setup page to make sure the device is connected. If not, tap RESCAN to scan the new network for attached StellarMate units. Once detected, tap the detected device to ensure it is connected properly. Once StellarMate is joined to a WiFi network, it will always try to connect to this network unless it is out of range. In this case, it will default back to the HotSpot.

6.2.3 StellarMate Address

Whether you are accessing StellarMate from PC, Mac, or Mobile, you can always reach it by the address **stellarmate.local**. This is the address that should be used in Ekos if you are using Ekos on a PC/Mac to connect remotely to Ekos. To access StellarMate Web Manager, type in **stellarmate.local:8624**

Note

When accessing StellarMate directly via Hotspot (Access Point), the unit IP address is always 10.250.250.1. Therefore, if you are having an issue accessing the unit via its hostname, you can simply use the IP address in your browser to access StellarMate Web Manager (<http://10.250.250.1:8624>).

6.3 Ethernet

Note

You must first complete the First Time Setup guide before proceeding with this tutorial.

All StellarMate units are shipped with a Gigabit ethernet. Compared with WiFi, wired Ethernet connection offers higher speeds and reliability. It is recommended for fixed observatory setups. By default, StellarMate operates in HotSpot mode. Even if configured for WiFi connection or LAN, StellarMate always switches back to HotSpot mode when the other connection modes become unavailable. This is to enable you to always access the device regardless of network availability.

When plugged to a network, StellarMate should be assigned an IP address from the router. The IP address is not fixed and managed by the router. Advanced users can assign a fixed IP address from the router directly (where supported) by assigning a fixed IP address to StellarMate unit MAC address.

6.3.1 Direct Ethernet

StellarMate includes a Gigabit (1000Mb/s) Ethernet port. You can connect StellarMate to your home router. Alternatively, you can also directly connect StellarMate to your PC/Mac. This can be done using a regular Ethernet cable, at home or in the field. Wired connections are very fast and highly reliable. For users who prefer the wired solution, you can follow the video guide to connect your StellarMate to PC/Mac.

Remote Control

StellarMate provides multiple methods to access the system locally or remotely:

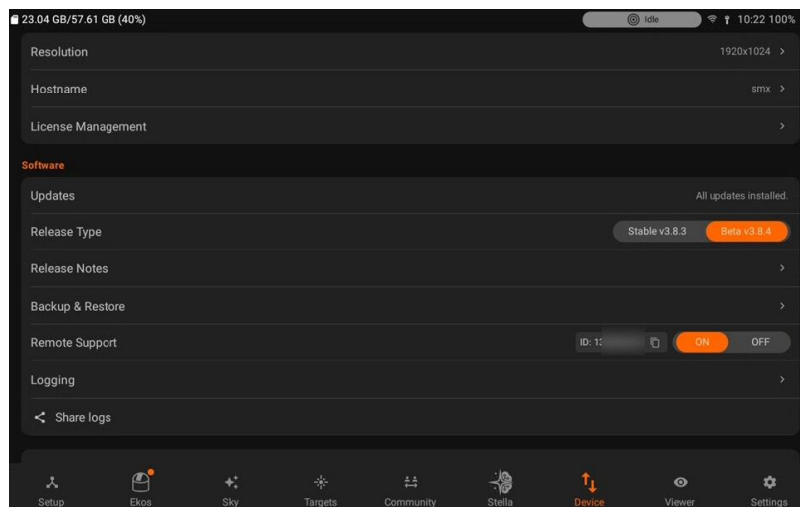
1. **Locally:** You can connect Keyboard, Mouse, and HDMI to access StellarMate directly since it is a mini computer.
2. **Local WiFi:** Connect to StellarMate over WiFi Hotspot or Station mode via Remote KStars, StellarMate App, Rustdesk, or VNC.
3. **Internet:** Use Remote KStars, StellarMate App (requires ports 3000 and 8624 to be open), [Ekoslive](#), or [Rustdesk](#).

7.1 VNC

StellarMate is shipped with a VNC Server. This enables access to the whole StellarMate desktop remotely. To connect to VNC, you can either use a Desktop/Mobile VNC Client, or simply via any browser. The web VNC address is: <http://stellarmate.local:6080> If StellarMate is inaccessible via its host name, you can replace stellarmate.local with the IP address (e.g. 192.168.1.2). You can find StellarMate IP and hostname in the StellarMate App. Any VNC client (e.g. RealVNC) can be used to access StellarMate over the local network. Once you access StellarMate, you can use it like any full-fledged computer. The default username is **stellarmate** and default password is **smate**.

7.2 Rustdesk

StellarMate is shipped with Rustdesk Remote Control software. RustDesk is a free, open-source remote desktop tool that offers fast, secure, and user-friendly remote access to computers across various platforms. It prioritizes user privacy with end-to-end encryption and is suitable for both casual and professional users. The difference between Rustdesk and VNC is that Rustdesk can be used over the internet without having to open any ports on the router. You can use Rustdesk to access StellarMate desktop remotely over the internet. In the StellarMate App, you can toggle Rustdesk service and copy the Rustdesk ID.



Download the Rustdesk client on MacOS, Windows, Android, or Linux and use the Rustdesk ID and password to remotely access your unit. By default, the password is [stellar@Mate123!](#) It is highly recommended to change the Rustdesk password after enabling the service.

7.3 SM App

StellarMate App communicates with StellarMate controllers over WiFi. By default, StellarMate Controller creates its own Access Point (Hotspot) that you can connect to by joining your Phone/Tablet to the StellarMate hotspot and then scanning for StellarMate devices on the network.

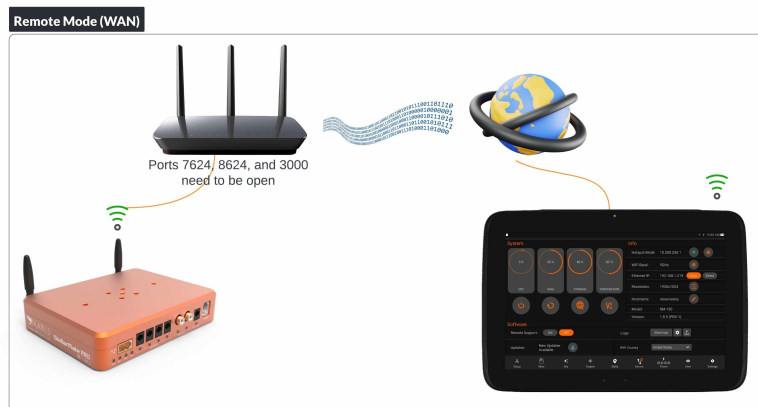
To configure StellarMate network settings, use StellarMate App Device tab to configure WiFi, Frequency, Channel, and Direct Ethernet.

7.3.1 LAN

StellarMate can be connected to your local network (LAN) either wirelessly or via wired Ethernet connection. This is done either via configuring StellarMate Controller to run in Station Mode (i.e. Home WiFi) or via connecting an Ethernet cable to the local network. Wired connections are highly recommended as they offer the best reliability and speed over wireless connections. Once connected to the local network, use StellarMate App to RESCAN for StellarMate devices on the network. Always make sure that your Phone/Tablet is connected to the same network where StellarMate resides.

7.3.2 WAN

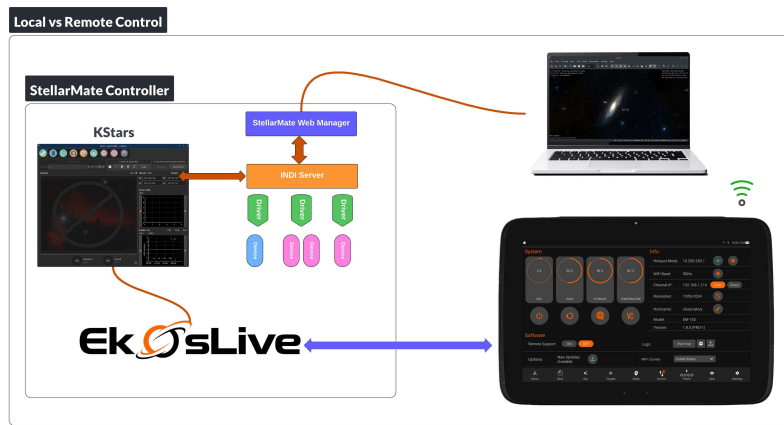
If connecting over WAN, ports 7624 and 8624 must be opened over the remote router and forwarded to the StellarMate controller running KStars.



7.4 KStars

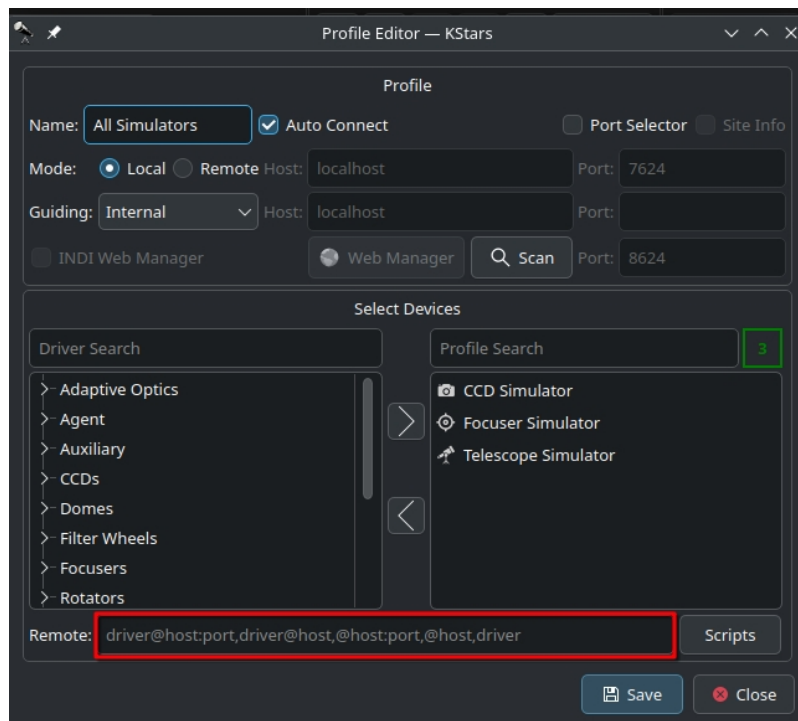
KStars is free, open source, cross-platform Astronomy Software. It provides an accurate graphical simulation of the night sky, from any location on Earth, at any date and time. Bundled with KStars is **Ekos astrophotography suite**, a complete astrophotography solution that can control and automate all your astronomy equipment. The topology of StellarMate App, KStars, Ekos, and INDI can be simplified to the following points:

1. Astronomy devices are connected to StellarMate via USB or Network (WiFi/Ethernet).
2. Each device is controlled by a corresponding INDI driver. An INDI driver provides an abstraction layer so that clients like Ekos can issue commands regardless of the underlying implementation of each unique device.
3. INDI drivers can be managed directly in KStars by starting and stopping INDI server, or via StellarMate Web Manager that provides an API to remotely start and shutdown INDI server.
4. An INDI server is a hub where all drivers communicate with each other and the clients.
5. When using Ekos inside StellarMate directly (HDMI, VNC, or SM App via EkosLive), Ekos completely manages the INDI server.
6. EkosLive is a middleware that allows external applications to talk with Ekos over websockets.
7. When using Ekos on a remote PC/Mac, it can control the equipment by bypassing KStars completely and launching the INDI server remotely via the StellarMate Web Manager.
8. EkosLive not only provides communication between StellarMate App and Ekos, but it also connects KStars to the online ekoslive.com portal where you can use a web-based interface similar to StellarMate App to control Ekos remotely.



KStars can be connected to StellarMate Controller in a number of ways

1. **Directly in StellarMate OS** Use VNC, Rustdesk, or HDMI to directly operate KStars inside StellarMate. Using KStars inside StellarMate gives the fastest results since images are saved immediately on the local storage.
2. **Remote KStars** Since KStars communicate with the INDI server using TCP/IP, KStars can be used to run devices on any StellarMate Controller remotely.



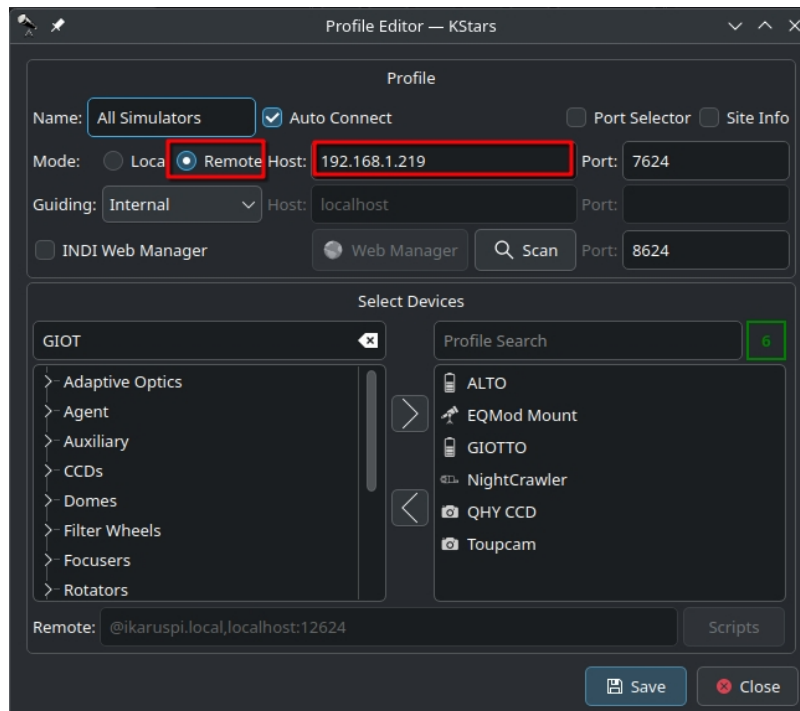
When configuring KStars for remote connection:

1. Change mode to Remote
2. Enter remote StellarMate Controller IP address or host name.
3. Enable StellarMate Web Manager

SM Pro: Add to remote drivers @localhost:12624

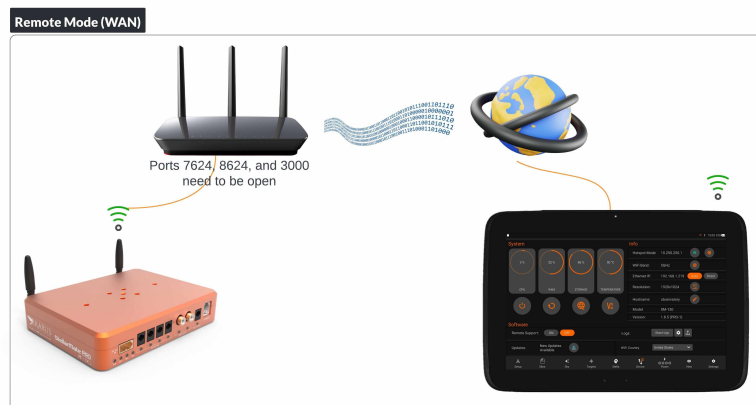
7.4.1 LAN

When connecting over LAN, ensure to configure your equipment profile in Remote mode. Put the StellarMate unit IP address or hostname (e.g. stellarmate.local). Make sure that the INDI Web Manager checkbox is checked.



7.4.2 WAN

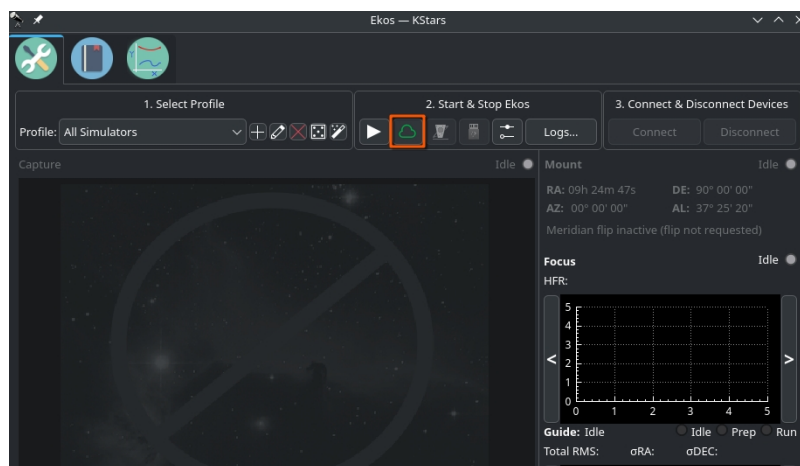
If connecting over WAN, ports 7624 and 8624 must be opened over the remote router and forwarded to the StellarMate controller running KStars.



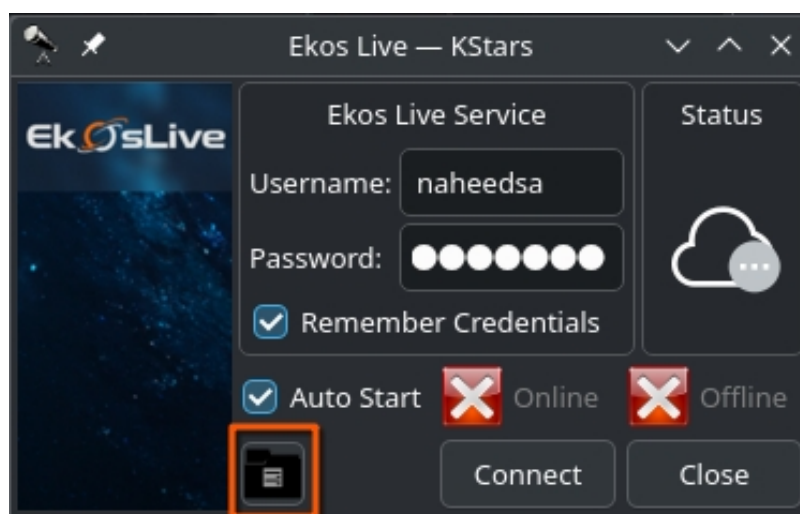
7.5 Ekoslive

EkosLive is an online platform to access your StellarMate remotely. It offers simplified web-based controls for Ekos along with advanced features such as Stella AI, Cloud Storage, and Observatory Management. EkosLive Basic subscription is completely free for all StellarMate users.

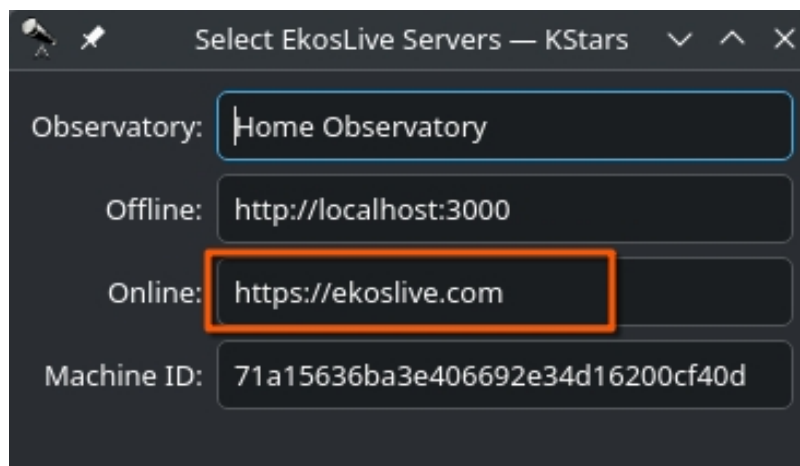
Once StellarMate is configured via StellarMate App, connect StellarMate to the unit and head over to EkosLive to access it remotely. You can check To monitor whether **EkosLive** is successfully connected, look for the connection status icons. These icons are represented by **cross icons** that indicate whether the connection is established or not. Ekoslive is connected successfully.



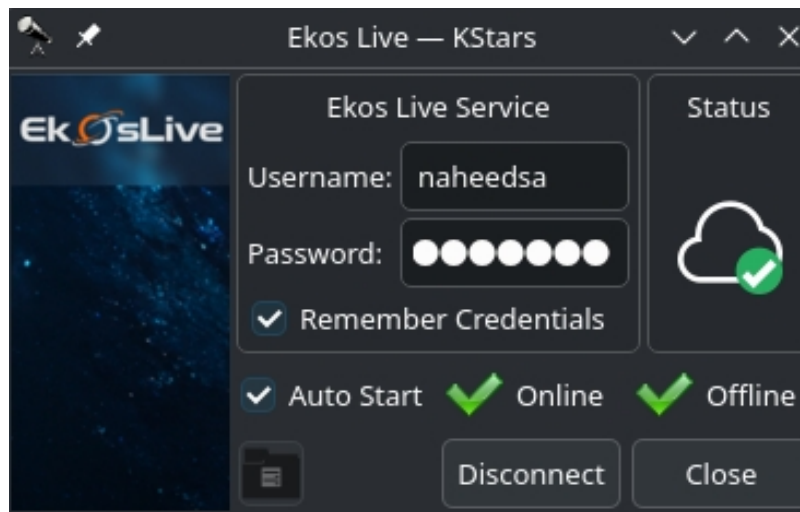
To manage the connection settings, click on the **configuration icon**. This icon allows you to toggle between different connection options and configure your settings as necessary.



Within the configuration settings, you will find a field where you can insert the **URL for EkosLive Online**. Make sure to provide the correct URL that points to your EkosLive instance.

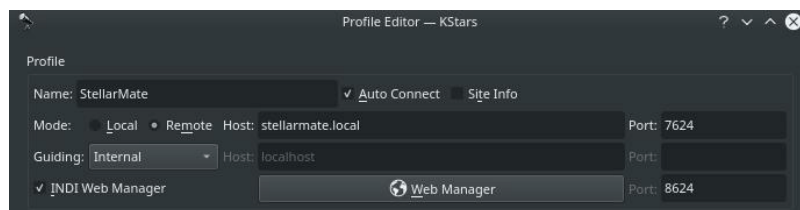


Once the URL has been entered, press the **Connect** button. Upon successful connection, both **EkosLive Online** and **EkosLive Offline** will establish a connection with **KStars**. This will enable the synchronization between the two platforms.

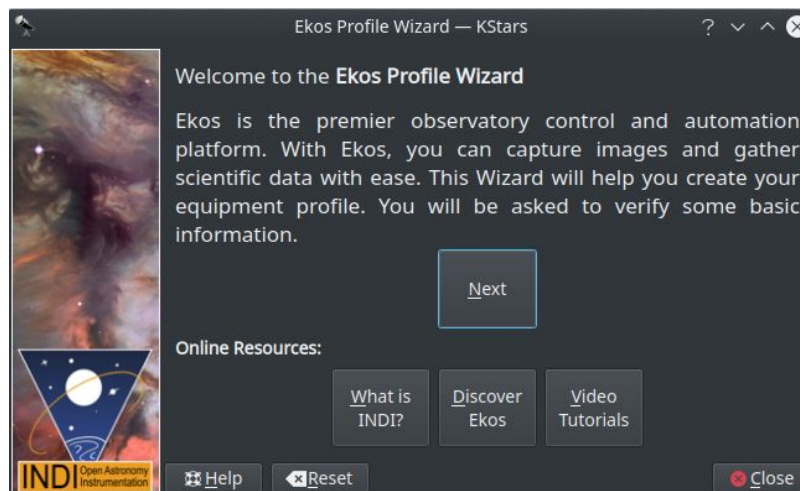


7.6 Connecting from Ekos via Ethernet/WiFi

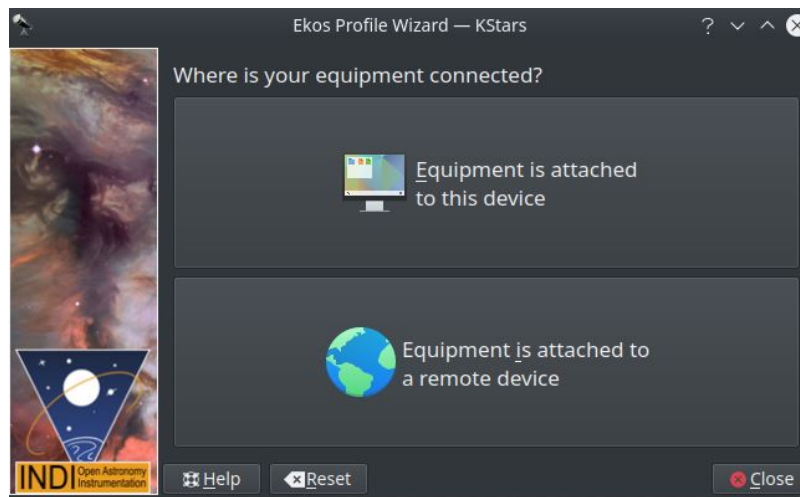
When you use Ekos on your PC/Mac, set the profile to Remote and set the Address to **stellarmate.local**. Make sure INDI Web Manager checkbox is checked.



It is recommended to use the Ekos Profile Wizard to set up your first profile. The wizard automatically starts up the first time you fire Ekos in KStars. To start it again, please click on the wizard icon in Ekos summary screen.



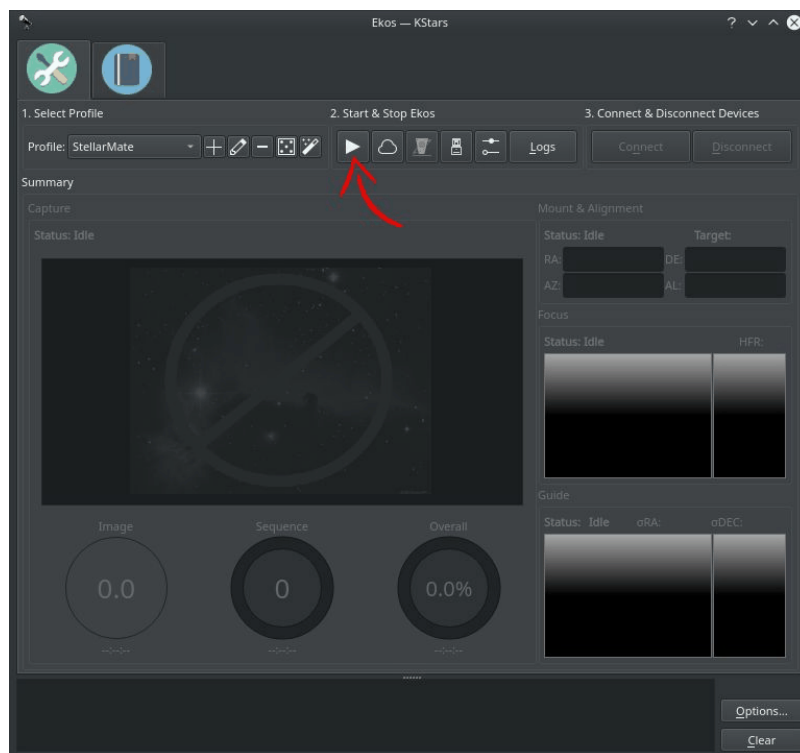
Click Next to proceed to the next screen.



In here you need to select if your equipment is attached to StellarMate or elsewhere:

1. If you are running Ekos **within** StellarMate OS, then select Equipment is attached to this device.
2. If you are running Ekos on a PC/Mac, then select Equipment is attached to a remote device.

Next, select your equipment profile name and any additional services you want to run then proceed to create the profile.



To connect to your equipment and start using Ekos, simply click the Start button as illustrated above.

Ports

StellarMate runs few back-end services that use the following ports.

Service	Port	WAN/Internet Control
SSH	562	Not required
INDI Web Manager	8624	Required
INDI Web Server	7624	Required
EkosLive Server	3000	Required
Web VNC	6080	Not required
VNC	5900	Not required
NetBIOS	139	Not required
Samba	445	Not required

To make StellarMate accessible from internet, the ports designated as **Required** above need to be opened in the router's firewall settings. This is only required if you need to access StellarMate remotely over the internet or Wide Area Network (WAN). For local Hotspot and Home WiFi Connections, no need to open any ports. Beware that there is no authentication/authorization portal provided by StellarMate, so only open portals at your own risk or by providing an additional layer of secur

Transferring Images

There are several convenient ways to access the image and video files captured with your StellarMate. The best method depends on your network setup, technical comfort level, and specific needs. Here are the primary methods:

9.1 1. Network Share (Samba/Windows Share)

Best for: Easily accessing files from a Windows, macOS, or Linux computer connected to the same home network as your StellarMate after a capture session.

Requirements: StellarMate must be connected to your home Wi-Fi or Ethernet network.

How it works: StellarMate runs a Samba server, making its folders accessible like standard network shares.

Steps:

- Find StellarMate: You can usually access StellarMate using its hostname `stellarmate.local` or by its IP address on your network.
- On Windows: Open File Explorer. You might see StellarMate under “Network”. If not, type `\\stellarmate.local` or `\\<StellarMate_IP_Address>` (e.g., `\\192.168.1.10`) into the address bar and press Enter.
- On macOS: Open Finder. Go to the “Go” menu and select “Connect to Server...”. Enter `smb://stellarmate.local` or `smb://<StellarMate_IP_Address>` and click “Connect”.
- On Linux: Use your file manager (e.g., Nautilus, Dolphin). Look for a “Connect to Server” option or browse the network. Enter the address `smb://stellarmate.local` or `smb://<StellarMate_IP_Address>`.
- Access Files: Look for a shared folder, typically named Pictures, which corresponds to the `/home/stellarmate/Pictures` directory on StellarMate where captures are usually stored. You may be asked to connect as a “Guest” or authenticate using the username `stellarmate` and password `smate`. You can then browse, copy, or move files directly. For persistent access, you can map this share as a network drive.

9.2 2. StellarMate App & USB Drive Transfer

Best for: Transferring files directly from the StellarMate unit without needing a computer on the same network, useful in the field.

Requirements: StellarMate App running on your phone/tablet, a USB thumb drive (formatted with FAT32 or exFAT recommended).

How it works: The StellarMate App provides an interface to copy files from the StellarMate’s internal storage to a connected USB drive.

Steps:

- Plug the USB thumb drive directly into a free USB port on the StellarMate device itself.
- Connect to your StellarMate using the StellarMate App on your phone or tablet.
- Navigate to the file management or image transfer section within the StellarMate App. (Refer to the StellarMate App Manual - Transfer Images section for specific instructions).
- Select the desired images or videos stored on StellarMate.
- Choose the connected USB drive as the destination and initiate the transfer.
- Once the transfer is complete, safely remove the USB drive from the StellarMate device and plug it into your computer to access the files.

9.3 3. SFTP (Secure File Transfer Protocol)

Best for: Advanced users who need direct, secure file system access over the network. Works reliably across various network configurations (home network, direct Wi-Fi connection).

Requirements: An SFTP client application (e.g., FileZilla, WinSCP, Cyberduck, command-line `sftp`), StellarMate connected to a network accessible by your computer.

How it works: Connect directly to StellarMate’s SFTP server using specific credentials and port number.

Steps:

- Open your preferred SFTP client software on your computer.
- Configure a new connection with the following details:
 - Protocol: SFTP
 - Host/Address: stellarmate.local or <StellarMate_IP_Address>
 - Port: 5624 (Note: This is a non-standard port)
 - Username: stellarmate
 - Password: smate
- Connect to StellarMate.
- Once connected, navigate to the directory /home/stellarmate/Pictures. This is the default location for captured images and videos, often organized in sub-folders.
- Use the SFTP client's interface to download files from StellarMate to your computer or manage files directly.

9.4 4. EkosLive Cloud Storage

Best for: EkosLive Pro or Ultimate subscribers who want automatic cloud backup of sequence images and access from anywhere with an internet connection.

Requirements: An active EkosLive Pro or Ultimate subscription, “Cloud Storage” feature enabled in Ekos/StellarMate settings before capture, and the StellarMate device must be connected to the internet during the capture sequence.

How it works: When enabled, images captured as part of an Ekos sequence are automatically uploaded to your EkosLive cloud storage.

Steps:

- Ensure you have an active Pro/Ultime subscription and have enabled Cloud Storage within your Ekos settings for the desired sequence(s).
- Run your capture sequence while ensuring StellarMate has a stable internet connection.
- After the capture (or even during, as uploads happen), log in to your account on the ekoslive.com website.
- Navigate to your cloud storage section to view and download your sequence images.

Note: This method primarily applies to images captured via Ekos sequences configured for cloud upload. Videos, planetary recordings, or single snapshots taken outside these sequences are generally not uploaded via this method.

Choose the method that best suits your workflow and technical setup to easily manage your astrophotography data captured with StellarMate.

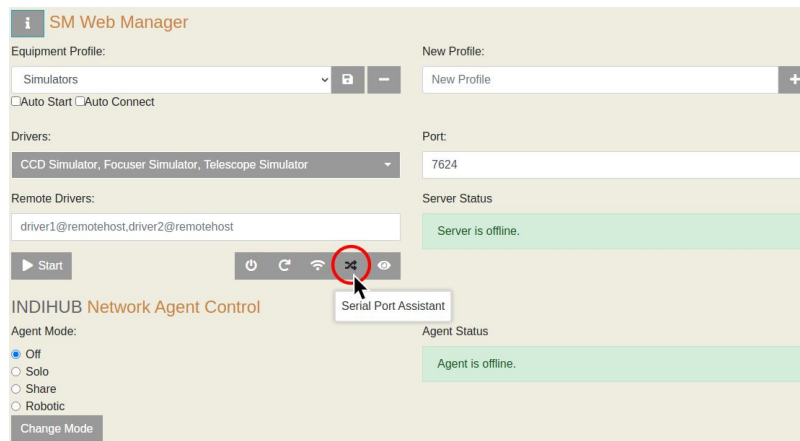
Connecting Equipment Via Bluetooth

There are two ways to connect your bluetooth device:

1. Bluetooth Wizard provided in Serial Port Assistant
2. Manually pair your bluetooth device

10.1 Serial Port Assistant Bluetooth Wizard

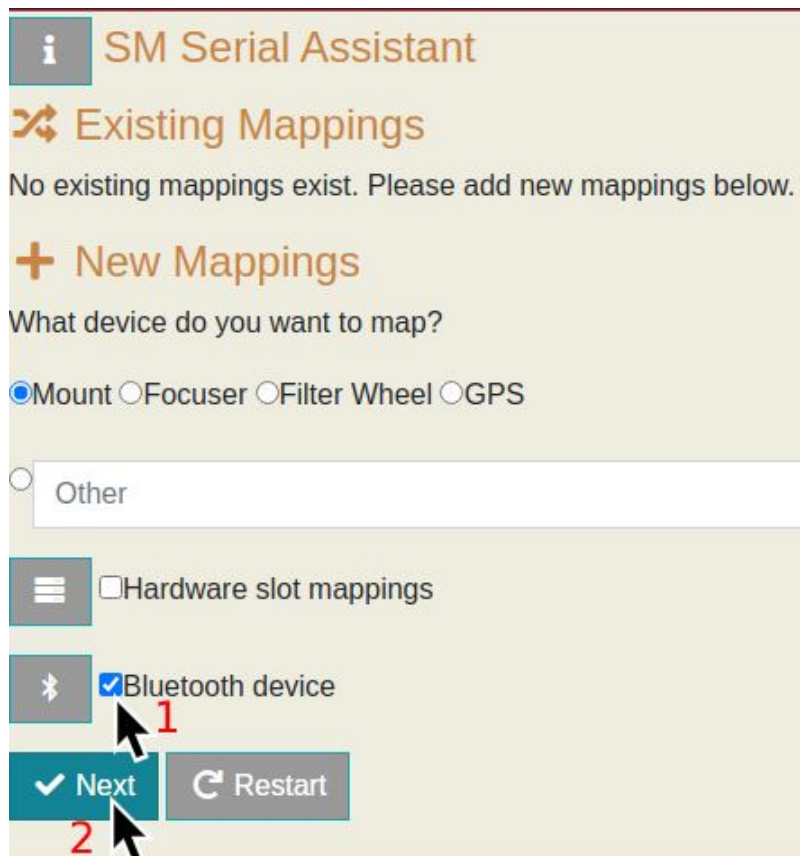
StellarMate allows connecting bluetooth mounts easily through StellarMate Web Manager, all you have to do is follow these steps: **Connecting to a Bluetooth Device** 1. Open StellarMate Web Manager 2. Click on **Serial Port Assistant**



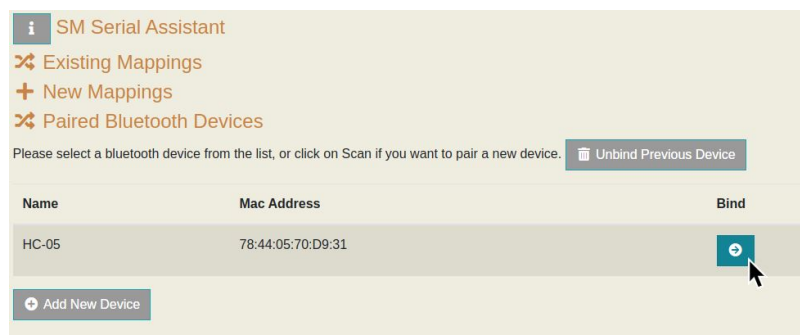
3. Click on **Next**.



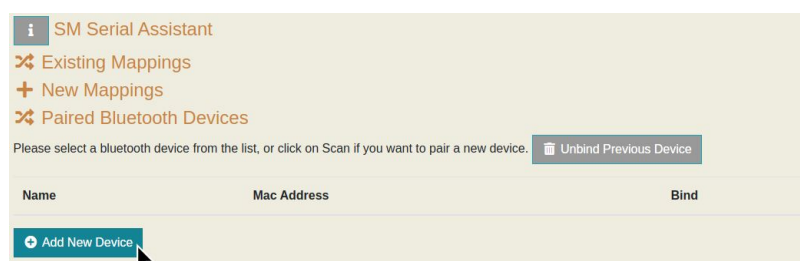
4. Check the **Bluetooth device** checkbox, and then click **Next**.



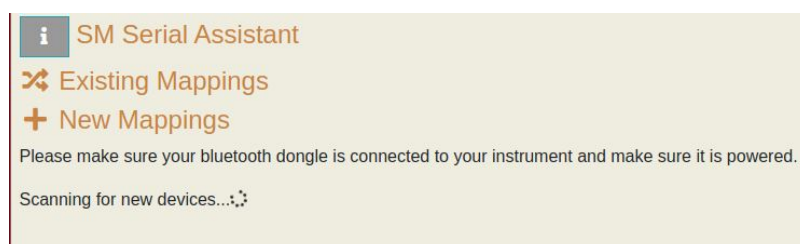
5. If you have **already paired** your device to StellarMate before, you can set it to **Auto-bind** on startup by clicking on the **Bind** button next to the device's details. You will be met with a dialog that confirms that your device has been **binded** to StellarMate.



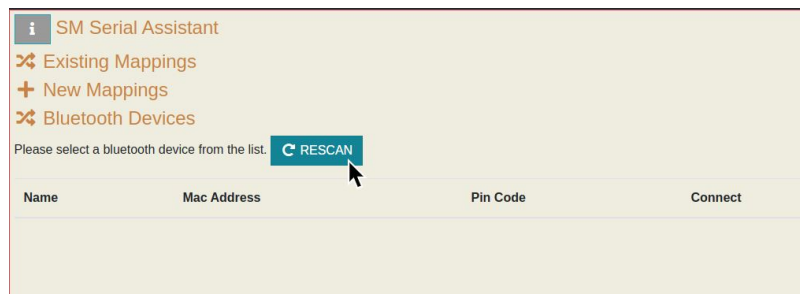
6. If you have not paired your device and would like to **add a new device**, click on the Add New Device button.



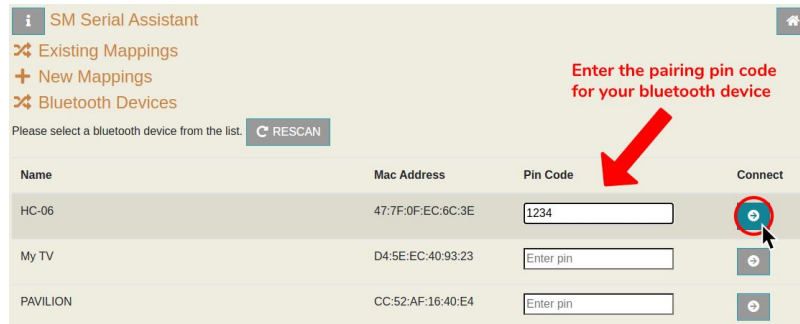
7. The Bluetooth Wizard will now scan for available bluetooth devices.



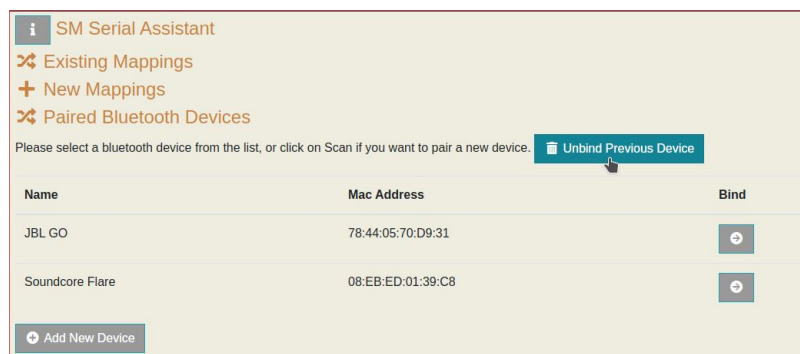
8. If the scanner does not find any devices, click on **RESCAN**.



9. If you find your device, **enter the pin code** and then click on the **Connect** button. (eg. Shoestring Astronomy HC-06's pin code is 1234, you can find the pin code number by finding the bluetooth device's documentation made by the manufacturer)



10. Wait a few seconds until a pop-up dialog shows up to confirm if the pairing and binding process was successful or not. **Unbinding a Bluetooth Device** To stop a device from being auto-bound on startup, go to the Bluetooth Wizard by following steps 1-4 and then click on **Unbind Previous Device**.



A confirmation dialog will be shown to you.

10.2 Manual Pairing

Bluetooth dongles are supported. Before you can start communicating with your device from StellarMate, you need to pair it. In order to pair the device, please log in to StellarMate OS either via Direct HDMI connection or via VNC Viewer in the StellarMate App.



After you pair your device, you should have a bluetooth ported assigned to it (e.g. `/dev/rfcomm0`). This is the port you

should use in INDI when communicating with your device.

Connecting CCDs

StellarMate X supports a broad range of cameras (CCD/CMOS). Find out if your camera is supported in the INDI Camera Portal.

StellarMate X includes 4 USB 3.0 ports, it natively supports USB 3.0 cameras using full bandwidth.

Cameras' power can be either external (AC) or internal (battery) or supplied by the USB bus connection. They can be either connected directly to StellarMate or to an external USB hub.

IMPORTANT

Unreliable & Unstable **Power** is the primary cause for majority of camera issues. Ensure the camera is properly powered to avoid instabilities. StellarMate controller ships with a 3A 5v power adapter. StellarMate OS users should invest in a similar adapter.

The classes of cameras supported by StellarMate:

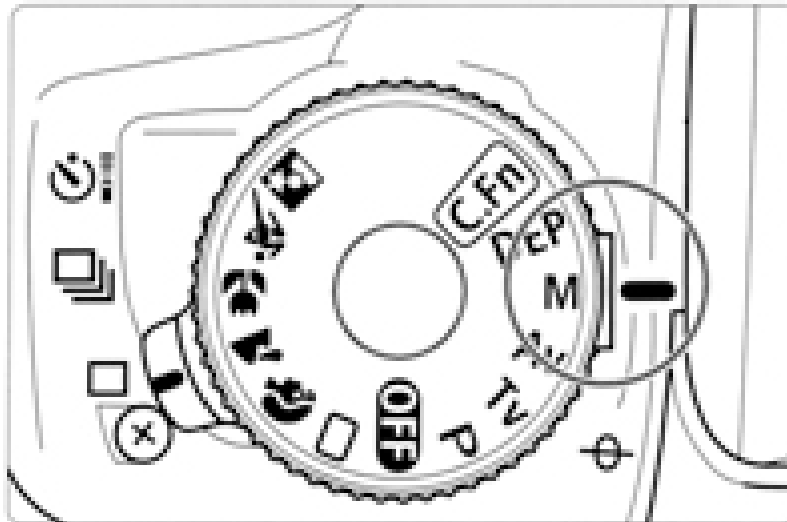
CCD Cameras. CMOS Cameras. Web Cameras. DSLRs

StellarMate supports cameras with built-in Filter Wheels and ST4 port for pulse-guiding.

Connecting DSLRs

StellarMate supports DSLR cameras using the INDI GPhoto driver based on libgphoto2 library. It includes supports for Canon, Nikon, Sony, Pentax and other DSLR cameras. To know if your specific model is supported, please check the DSLR Supported Cameras List. In order to use your camera with StellarMate, it must meet the following requirements:

- It must support USB. Connect a USB cable from the camera to StellarMate. WiFi cameras are not supported yet.
- It must support **BULB/MANUAL** mode where the shutter is controlled by an external program.



Tip: Some modern cameras do not have a Bulb (B) dial. You can set Bulb Mode by selecting Manual (M) dial and then change the exposure duration until you see BULB in the camera.

Tip

Some modern cameras do not have a Bulb (B) dial. You can set Bulb Mode by selecting Manual (M) dial and then change the exposure duration until you see BULB in the camera.

The shutter control can be either executed internally if supported by the camera, or externally via an external release cable (e.g. DSUSB). The INDI GPhoto driver documentation includes all the details on operating DSLR cameras. The INDI driver requires the camera resolution and pixel size upon first connection. When the camera is first detected, StellarMate would look up the camera specifications and fill out the necessary information automatically. Please make sure this information is correct in the INDI Control Panel → Image Info Tab.

Tip

Pentax cameras are supported in INDI GPhoto driver and also in INDI Native Pentax driver. The native driver is experimental but offers more support to Pentax cameras. It's recommended to try both drivers to see which is more fit for your specific camera model. Captured images are downloaded to StellarMate, and depending on the sensor size and the quality of the WiFi connection, it can take a few seconds for large frames to transfer. Live view video streaming is available on most models to aid in focusing the camera. Selected Canon cameras support focusing operations and can autofocus using the Ekos Focus module. Manual focus is available via Live View or Bahtinov Mask Assistant Tool.

12.1 Supported DSLRs

StellarMate supports a wide selection of DSLR cameras manufactured by popular brands like Canon, Nikon and several others. The following is a list of the most popular supported cameras.

12.1.1 Canon

Camera Model	Abilities	Comments
Canon Digital IXUS	Configuration	
Canon Digital IXUS 100 IS		

continues on next page

Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon Digital IXUS 110 IS		
Canon Digital IXUS 120 IS		
Canon Digital IXUS 130		
Canon Digital IXUS 132		
Canon Digital IXUS 180	Image Capture, Live view, Configuration	
Canon Digital IXUS 185		
Canon Digital IXUS 255HS		
Canon Digital IXUS 30 (normal mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS 300	Image Capture, Liveview, Configuration	
Canon Digital IXUS 300 HS		
Canon Digital IXUS 330	Image Capture, Liveview, Configuration	
Canon Digital IXUS 40 (PTP mode)		
Canon Digital IXUS 400 (PTP mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS 430 (PTP mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS 50 (PTP mode)		
Canon Digital IXUS 500 (PTP mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS 55 (PTP mode)		
Canon Digital IXUS 60 (PTP mode)		
Canon Digital IXUS 65 (PTP mode)		
Canon Digital IXUS 70 (PTP mode)		
Canon Digital IXUS 700 (PTP mode)		
Canon Digital IXUS 75 (PTP mode)		
Canon Digital IXUS 750 (PTP mode)		
Canon Digital IXUS 80 IS		
Canon Digital IXUS 800 (PTP mode)		
Canon Digital IXUS 85 IS		
Canon Digital IXUS 850 IS (PTP mode)		
Canon Digital IXUS 860 IS		
Canon Digital IXUS 90 IS		
Canon Digital IXUS 900Ti (PTP mode)		
Canon Digital IXUS 95 IS		
Canon Digital IXUS 950 IS (PTP mode)		
Canon Digital IXUS 960 IS (PTP mode)		
Canon Digital IXUS 970 IS		
Canon Digital IXUS 980 IS		
Canon Digital IXUS 990 IS		
Canon Digital IXUS i (normal mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS i (PTP mode)		
Canon Digital IXUS i5 (normal mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS II (PTP mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS IIs (PTP mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS iZ (PTP mode)		
Canon Digital IXUS v	Image Capture, Liveview, Configuration	
Canon Digital IXUS v2	Image Capture, Liveview, Configuration	
Canon Digital IXUS v3 (normal mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS v3 (PTP mode)	Image Capture, Liveview, Configuration	
Canon Digital IXUS Wireless (PTP mode)		
Canon Digital PowerShot SX730HS	Image Capture, Liveview, Configuration	
Canon Digital Rebel XT (normal mode)	Image Capture, Liveview, Configuration	

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Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon Digital unknown 3	Image Capture, Liveview, Configuration	
Canon Elura 50 (normal mode)	Image Capture, Liveview, Configuration	
Canon Elura 50 (PTP mode)		
Canon Elura 65 (PTP mode)		
Canon EOS (WLAN)	Image Capture, Liveview, Configuration	Testing (Beta)
Canon EOS 1000D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 100D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 10D	Image Capture, Liveview, Configuration	
Canon EOS 10D (PTP mode)		
Canon EOS 1100D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1200D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1300D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1500D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1D C	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1D Mark II (PTP mode)		
Canon EOS 1D Mark III (PTP mode)	Image Capture, Trigger Capture, Configuration	
Canon EOS 1D Mark IV	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1D X	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1D X MarkII	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 1D X MarkIII	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 2000D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 200D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 20D (normal mode)	Image Capture, Liveview, Configuration	
Canon EOS 20D (PTP mode)		
Canon EOS 250D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 300D (normal mode)	Image Capture, Liveview, Configuration	
Canon EOS 300D (PTP mode)		
Canon EOS 30D (PTP mode)	Image Capture, Trigger Capture, Configuration	
Canon EOS 350D		
Canon EOS 350D (normal mode)	Image Capture, Liveview, Configuration	
Canon EOS 350D (PTP mode)		
Canon EOS 4000D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 400D (PTP mode)	Image Capture, Trigger Capture, Configuration	
Canon EOS 40D (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 450D (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 500D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 50D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 550D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 5D (normal mode)	Image Capture, Liveview, Configuration	
Canon EOS 5D (PTP mode)		
Canon EOS 5D Mark II	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 5D Mark III	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 5D Mark IV	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 5DS	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 5DS R	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 600D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 60D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 650D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 6D	Image Capture, Trigger Capture, Liveview, Configuration	

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Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon EOS 6d Mark II	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 700D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 70D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 750D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 760D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 77D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 7D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 7D MarkII	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 800D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 80D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS 90D	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS D30	Image Capture, Liveview, Configuration	
Canon EOS D60	Image Capture, Liveview, Configuration	
Canon EOS Digital Rebel (normal mode)	Image Capture, Liveview, Configuration	
Canon EOS Digital Rebel (PTP mode)		
Canon EOS Digital Rebel XTi (PTP mode)	Image Capture, Trigger Capture, Configuration	
Canon EOS Kiss Digital (normal mode)	Image Capture, Liveview, Configuration	
Canon EOS Kiss Digital (PTP mode)		
Canon EOS Kiss Digital N (normal mode)	Image Capture, Liveview, Configuration	
Canon EOS Kiss Digital X (PTP mode)	Image Capture, Trigger Capture, Configuration	
Canon EOS Kiss X2 (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS Kiss X3	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M		
Canon EOS M10	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M100	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M2	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M200	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M3	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M5	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M50	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M50m2	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M6	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS M6 Mark II	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS R	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS R5	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS R6	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS Rebel T1i	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS Rebel T6	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS Rebel T7i	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS Rebel T8i	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS Rebel XSi (PTP mode)	Image Capture, Trigger Capture, Liveview, Configuration	
Canon EOS RP	Image Capture, Trigger Capture, Liveview, Configuration	
Canon FV M1 (normal mode)	Image Capture, Liveview, Configuration	
Canon IXUS 125HS		
Canon IXUS 160		
Canon IXUS 165		
Canon IXUS 310IS		
Canon IXY 220 IS		
Canon IXY 3000 IS		

continues on next page

Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon IXY DIGITAL	Configuration	
Canon IXY DIGITAL 300	Image Capture, Liveview, Configuration	
Canon IXY Digital 40 (normal mode)	Image Capture, Liveview, Configuration	
Canon IXY Digital L2 (normal mode)	Image Capture, Liveview, Configuration	
Canon IXY DV M	Image Capture, Liveview, Configuration	
Canon IXY DV M2 (normal mode)	Image Capture, Liveview, Configuration	
Canon MV630i (normal mode)	Image Capture, Liveview, Configuration	
Canon MV650i (normal mode)	Image Capture, Liveview, Configuration	
Canon MV750i (PTP mode)		
Canon MVX 10i (normal mode)	Image Capture, Liveview, Configuration	
Canon MVX 3i (normal mode)	Image Capture, Liveview, Configuration	
Canon MVX100i	Image Capture, Liveview, Configuration	
Canon MVX150i (normal mode)	Image Capture, Liveview, Configuration	
Canon MVX25i (normal mode)	Image Capture, Liveview, Configuration	
Canon MVX2i	Image Capture, Liveview, Configuration	
Canon MVX3i (PTP mode)		
Canon Optura 10	Image Capture, Liveview, Configuration	
Canon Optura 20	Image Capture, Liveview, Configuration	
Canon Optura 20 (normal mode)	Image Capture, Liveview, Configuration	
Canon Optura 200 MC	Image Capture, Liveview, Configuration	
Canon Optura 300 (normal mode)	Image Capture, Liveview, Configuration	
Canon Optura 40 (normal mode)	Image Capture, Liveview, Configuration	
Canon Optura 600 (PTP mode)		
Canon Optura Xi (normal mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A10	Image Capture, Liveview, Configuration	
Canon PowerShot A100	Image Capture, Liveview, Configuration	
Canon PowerShot A1000 IS		
Canon PowerShot A1100 IS		
Canon PowerShot A1300IS		
Canon PowerShot A1400		
Canon PowerShot A20	Image Capture, Liveview, Configuration	
Canon PowerShot A200	Image Capture, Liveview, Configuration	
Canon PowerShot A2000 IS		
Canon PowerShot A2100 IS		
Canon PowerShot A2200		
Canon PowerShot A2300IS		
Canon PowerShot A2400IS		
Canon PowerShot A2500		
Canon PowerShot A2600		
Canon PowerShot A30	Image Capture, Liveview, Configuration	
Canon PowerShot A300 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A3000 IS		
Canon PowerShot A310 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A3100 IS		
Canon PowerShot A3500IS		
Canon PowerShot A40	Image Capture, Liveview, Configuration	
Canon PowerShot A400 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A4000IS		
Canon PowerShot A410 (PTP mode)		

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Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon PowerShot A420 (PTP mode)		
Canon PowerShot A430 (PTP mode)		
Canon PowerShot A450 (PTP mode)		
Canon PowerShot A460 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A470		
Canon PowerShot A480		
Canon Powershot A495		
Canon PowerShot A5	Configuration	
Canon PowerShot A5 Zoom	Configuration	
Canon PowerShot A50	Configuration	
Canon PowerShot A510 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A520 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A530 (PTP mode)		
Canon PowerShot A540 (PTP mode)		
Canon PowerShot A550 (PTP mode)		
Canon PowerShot A560 (PTP mode)		
Canon PowerShot A570 IS (PTP mode)		
Canon PowerShot A580		
Canon PowerShot A590 IS		
Canon PowerShot A60 (PTP)	Image Capture, Liveview, Configuration	
Canon PowerShot A610 (PTP mode)		
Canon PowerShot A620 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A630 (PTP mode)		
Canon PowerShot A640 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A650IS (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A70 (PTP)	Image Capture, Liveview, Configuration	
Canon PowerShot A700 (PTP mode)		
Canon PowerShot A710 IS (PTP mode)		
Canon PowerShot A720 IS (PTP mode)		
Canon PowerShot A75 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A80 (PTP)	Image Capture, Liveview, Configuration	
Canon PowerShot A800		
Canon PowerShot A810		
Canon PowerShot A85 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot A95 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot D10		
Canon PowerShot ELPH 350 HS		
Canon PowerShot Elph135		
Canon PowerShot Elph340HS		
Canon PowerShot G1	Image Capture, Liveview, Configuration	
Canon PowerShot G1 X		
Canon PowerShot G10	Image Capture, Liveview, Configuration	
Canon PowerShot G11		
Canon PowerShot G12		
Canon PowerShot G15		
Canon PowerShot G16		
Canon PowerShot G2	Image Capture, Liveview, Configuration	
Canon PowerShot G3 (normal mode)	Image Capture, Liveview, Configuration	
Canon PowerShot G3 (PTP mode)	Image Capture, Liveview, Configuration	

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Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon PowerShot G3 X	Image Capture, Liveview, Configuration	
Canon PowerShot G5 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot G5X	Image Capture, Liveview, Configuration	
Canon Powershot G6 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot G7 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot G7 X	Image Capture, Liveview, Configuration	
Canon PowerShot G7 X Mark II	Image Capture, Liveview, Configuration	
Canon PowerShot G9 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot G9 X Mark II	Image Capture, Liveview, Configuration	
Canon PowerShot IXY Digital L (normal mode)	Image Capture, Liveview, Configuration	
Canon PowerShot Pro70	Configuration	
Canon PowerShot Pro90 IS	Image Capture, Liveview, Configuration	
Canon PowerShot S1 IS (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S10	Configuration	
Canon PowerShot S100		
Canon PowerShot S100 (2000)	Configuration	
Canon PowerShot S110 (2001)	Image Capture, Liveview, Configuration	
Canon PowerShot S110 (PTP Mode)		
Canon PowerShot S120		
Canon PowerShot S2 IS (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S20	Configuration	
Canon PowerShot S200	Image Capture, Liveview, Configuration	
Canon PowerShot S230 (normal mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S230 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S3 IS (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S30	Image Capture, Liveview, Configuration	
Canon PowerShot S300	Image Capture, Liveview, Configuration	
Canon PowerShot S330	Image Capture, Liveview, Configuration	
Canon PowerShot S40	Image Capture, Liveview, Configuration	
Canon PowerShot S400 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S410 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S45 (normal mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S45 (PTP mode)		
Canon PowerShot S5 IS (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S50 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S500 (PTP mode)	Image Capture, Liveview, Configuration	
Canon Powershot S60 (PTP mode)	Image Capture, Liveview, Configuration	
Canon Powershot S70 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S80 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot S95		
Canon PowerShot SD10 Digital ELPH (normal mode)	Image Capture, Liveview, Configuration	
Canon PowerShot SD100 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot SD1000 (PTP mode)		
Canon PowerShot SD110 (PTP mode)	Image Capture, Liveview, Configuration	
Canon Powershot SD1100 IS		
Canon Powershot SD1200 IS		
Canon PowerShot SD1300 IS		
Canon PowerShot SD20 (normal mode)	Image Capture, Liveview, Configuration	
Canon PowerShot SD200 (normal mode)	Image Capture, Liveview, Configuration	

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Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon PowerShot SD40 (PTP mode)		
Canon PowerShot SD430 (PTP mode)		
Canon PowerShot SD450 (PTP mode)		
Canon PowerShot SD500 (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot SD600 (PTP mode)		
Canon PowerShot SD630 (PTP mode)		
Canon PowerShot SD700 (PTP mode)		
Canon PowerShot SD750 (PTP mode)		
Canon PowerShot SD770 IS		
Canon PowerShot SD780 IS		
Canon Powershot SD790 IS		
Canon PowerShot SD850 (PTP mode)		
Canon PowerShot SD880 IS		
Canon PowerShot SD900 (PTP mode)		
Canon PowerShot SD940 IS		
Canon PowerShot SD970 IS		
Canon PowerShot SD990		
Canon PowerShot SX10 IS		
Canon Powershot SX100 IS (PTP mode)	Image Capture, Liveview, Configuration	
Canon PowerShot SX110 IS	Image Capture, Liveview, Configuration	
Canon PowerShot SX120 IS		
Canon PowerShot SX130 IS		
Canon PowerShot SX150 IS		
Canon PowerShot SX160IS		
Canon PowerShot SX170 IS		
Canon PowerShot SX20 IS		
Canon PowerShot SX200 IS		
Canon PowerShot SX210 IS		
Canon PowerShot SX220HS		
Canon PowerShot SX230HS		
Canon PowerShot SX240HS		
Canon PowerShot SX260HS		
Canon PowerShot SX280HS		
Canon PowerShot SX40HS		
Canon PowerShot SX500IS		
Canon PowerShot SX510 HS		
Canon PowerShot SX520 HS		
Canon PowerShot SX530 HS	Image Capture, Liveview, Configuration	
Canon PowerShot SX540 HS	Image Capture, Liveview, Configuration	
Canon PowerShot SX600 HS	Image Capture, Liveview, Configuration	
Canon PowerShot SX60HS		
Canon PowerShot SX70 HS	Image Capture, Liveview, Configuration	
Canon PowerShot SX740 HS	Image Capture, Liveview, Configuration	
Canon PowerShot unknown 1	Image Capture, Liveview, Configuration	
Canon PowerShot unknown 2	Image Capture, Liveview, Configuration	
Canon Rebel T2i	Image Capture, Trigger Capture, Liveview, Configuration	
Canon Rebel T3	Image Capture, Trigger Capture, Liveview, Configuration	
Canon Rebel T3i	Image Capture, Trigger Capture, Liveview, Configuration	
Canon Rebel T4i	Image Capture, Trigger Capture, Liveview, Configuration	

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Table 1 – continued from previous page

Camera Model	Abilities	Comments
Canon SX 620HS	Image Capture, Liveview, Configuration	
Canon SX 720HS	Image Capture, Liveview, Configuration	
Canon ZR70MC (normal mode)	Image Capture, Liveview, Configuration	

12.1.2 Nikon

12.1.3 Sony

12.1.4 Pentax

Camera Model	Abilities	Comments
Pentax K01	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K1	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K1 (PTP Mode)		
Pentax K100D	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K100DS	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K10D	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K200D	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K20D	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K3	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K3 (PTP Mode)		
Pentax K3 II (PTP Mode)		
Pentax K30	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K3II	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K50D	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K5D	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K5II	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K5IIs	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K70	Image Capture, Trigger Capture, Configuration	Testing (Beta)
Pentax K70 (PTP Mode)		
Pentax Optio 33WR	Image Capture, Liveview, Configuration	
Pentax Optio 43WR		
Pentax Optio 450	Image Capture, Liveview, Configuration	
Pentax Optio W90		

12.1.5 Fuji

12.2 Troubleshooting

In case the camera fails to connect or capture, please make sure of the following:

Make sure the battery in the camera is full. Make sure the SD card in the camera has enough space. Make sure camera is set to Bulb/Manual mode. You might need to rotate the dial to Bulb or Manual and then adjust camera settings to enable BULB mode. Turn off any power-saving feature of the camera that might cause it to hibernate or sleep. Some cameras support adjustable inactivity timers before automatically turning off. Set such timers to 15 minutes or more. Try a different USB cable. Try a different USB port. Turn off Noise Reduction settings in the camera. Turn off mirror lock in the camera settings.

Connecting Mounts

StellarMate supports a broad range of mounts. For a mount to be connected it must satisfy the minimum requirements

It must be a **GOTO** mount. It must have a **serial, USB, Bluetooth, Wired, or Wireless interface** to an external device or computer.

The documentation for each mount, including supported connection methods, are included in the mount-specific documentation on the INDI devices portal.

13.1 Mount Connection Guide

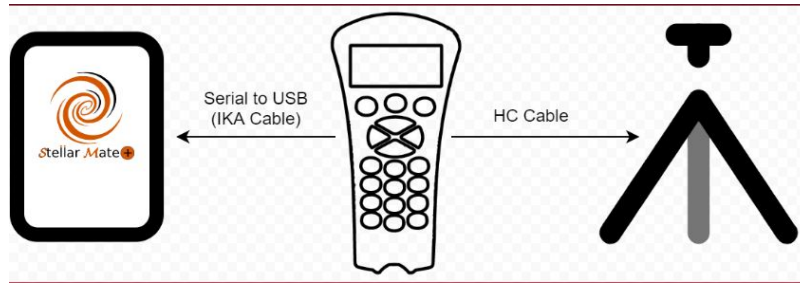
In order to know what connections your mount supports, check the following table:

Manufactur- er	HC	Direct	WiFi	Ethernet	Bluetooth	Comment	Cables
Meade	Yes	NA	Yes	NA	NA	WiFi re- quires external Stella WiFi Adapter	IKA-203 & IKA-204
Celestron	Yes	NA	Yes	NA	NA	1. Na- tive WiFi sup- port for Evo- lution Mounts using INDI Cele- stron Aux driver. Other mod- els re- quire Sky- Portal WiFi Mod- ule. 2. Hand- sets before 2016 with RJ11 port re- quire Stel- lar- Mate IKA- 205 cable. Post 2016 Hand- set have mini USB port that can be con- nected di- rectly to Stel- lar- Mate.	IKA-205

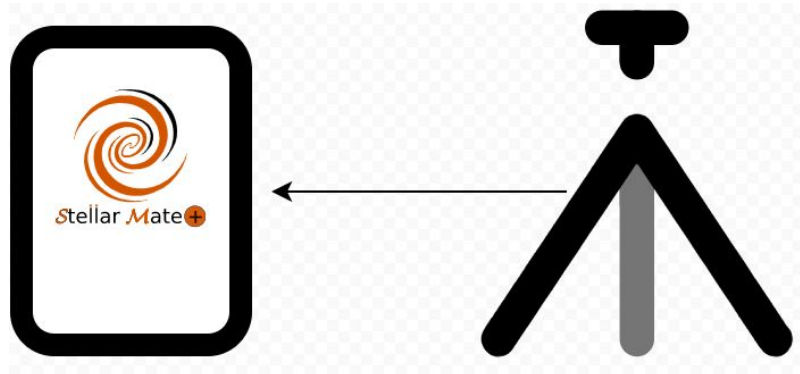
Methods of Connection

The following diagrams illustrates the methods of connection:

- HC (HandSet Controller)

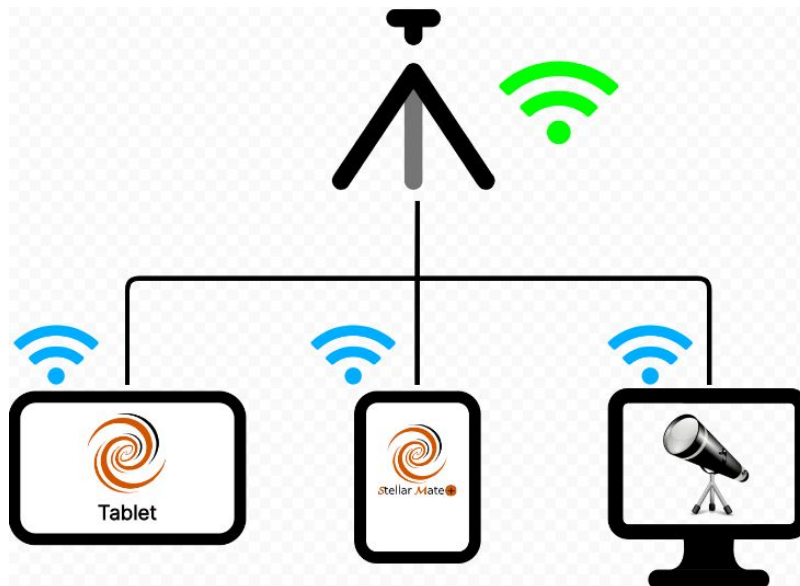


- Direct

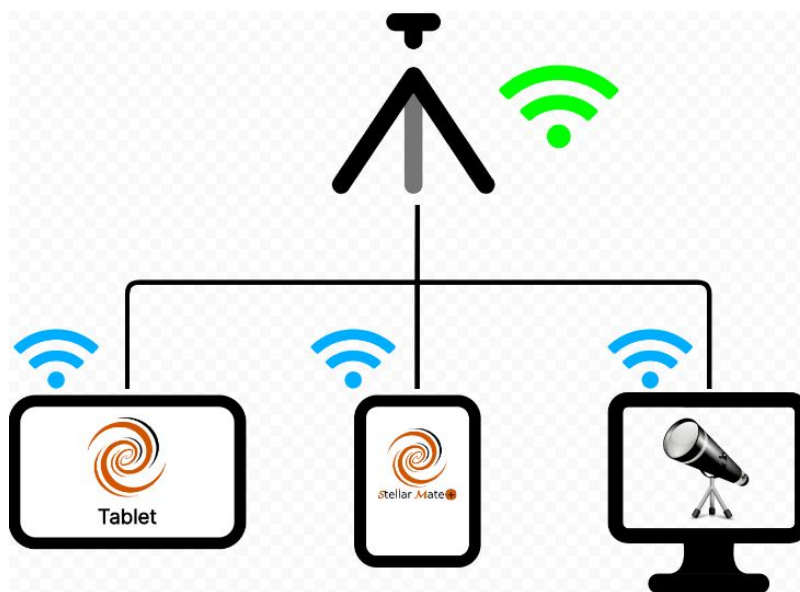


- WiFi

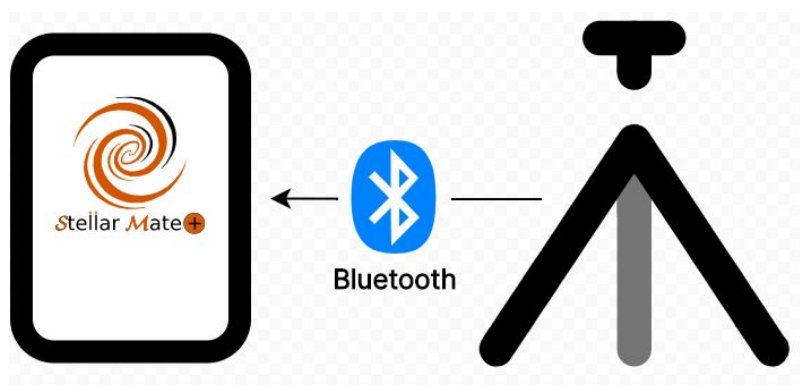
1. Hotspot Mode



2. WiFi Infrastructure



- Bluetooth



WiFi Infrastructure

Bluetooth

13.2 Serial to USB

IMPORTANT

In order to connect your mount via Serial to USB, you need to get a mount-specific Serial to USB cable, which can be bought from Ikarus Technologies. Most mounts provide an RS232 port (usually located in the handset). An RS232 to USB cable is required in order to connect the mount to StellarMate. StellarMate is equipped with 4 USB ports. However, it is highly recommended to use an external powered USB Hub as it can reliably support power to your equipment. **WARNING** Most problems in operating your equipment with StellarMate are related first and foremost to power problems. Therefore, please invest in reliable power supply for all your equipment!

13.3 Wired Network

Some mounts support wired networked connection via a dedicated Ethernet port. Depending on the mount manufacturer, the mount can be either connected directly via an Ethernet cable (StellarMate to Mount direct), or the mount can be connected to a wired router where it can be accessed over the network. Consult the mount manual to find which mode it supports and what is the default IP address and port of the mount once it is connected to the network.

Direct Ethernet: When connecting a Direct ethernet cable without a router in between, an automatic IPv4 address is created. The automatic IP address is usually in the form of 169.254.XXX.XXX. In order for StellarMate to communicate with the mount, the exact IP address and port must be specified in the INDI Control Panel. StellarMate can also be configured to any IP address manually in order to communicate with whatever IP schema used by the mount.

Ethernet LAN: If the mount can be connected to a router, it should be able to obtain an IP address automatically from the router. Access your router configuration page and find the IP address assigned to the mount. Use this IP address in the INDI Control Panel in order to establish communication with it. The port number should be listed in your mount manual.

13.4 Wireless Connection

Wireless mounts are usually connected either directly (via mount own Hotspot) or they can be configured in Infrastructure Mode where they can join an existing WiFi network.

Mount HotSpot: When connecting a mount hotspot, make sure that all devices including the laptop, tablet, StellarMate..etc are all connected to the mount hotspot. This is to ensure that all the devices are on the same network talking to each other. You cannot have half the devices on a different network. Once the devices join the mount HotSpot network, they should be assigned their own IP addresses. Use the mount hotspot IP address in INDI Control Panel in order to establish communication with the mount. The port number should be listed in your mount manual. **Mount Infrastructure:** Some Wireless mount can be configured in Infrastructure Mode. This is the mode where the mount does not start its own hotspot but insteads joins an existing WiFi network. Make sure all the relevant devices (StellarMate, Laptop, Tablet..etc) are all joined to the same WiFi network so that they can talk to each other. Find out the mount IP address and enter it in INDI Control Panel in order to establish communication with the mount. The port number should be listed in your mount manual.

Connecting Focusers

StellarMate supports a broad range of focusers from professional focusers to DIY types. Most focusers fall in the following two categories:

Absolute/Relative Focusers: Absolute focusers are usually stepper motors that can go to a specific step that is remembered across power cycles. This is the recommended type to use since Auto Focus operations are reliable with this type of focuser. **DC Focusers:** DC Focusers are open loop simple motors in which the program can control the speed and direction of the focuser, but not its exact position. These exist in cheap focusers and DSLR cameras. It is generally recommended to avoid such focusers.

To check if your focuser is supported, please visit the INDI Focuser Portal. Check the documentation for your focuser before you operate it for the first time.

14.1 Serial to USB

Most equipment is connected via USB. StellarMate is equipment with 4 USB ports. However, it is highly recommended to use an external powered USB Hub as it can reliably support power to your equipment. **WARNING** Most problems in operating your equipment with StellarMate are related first and foremost to power problems. Therefore, please invest in reliable power supply for all your equipment!

For many Focusers that use RS232 connectors, you need to purchase a Serial-To-USB adapter suitable for your Focuser model from the manufacturer. When you plug in your Serial-To-USB devices, they are assigned a specific port under StellarMate (e.g. /dev/ttyUSB0). However, this port is not static. That is, next time you plug in the same device on another session, it might get assigned another port (e.g. /dev/ttyUSB1). Since INDI drivers require the port name to communicate with the device, this could lead to communication issues. With the help of StellarMate Serial Port Assistant, you can assign permanent designations for your devices so that they always get the same port whenever they are connected.

14.2 Focusers

Mount	Driver	Devices
ActiveFocuser	indi_activefocuser_focus	
Armadillo/Platypus	indi_armadillo_focus/	
Astroberry Focuser	indi_rpfocus	
AstroLink 4	indi_astrolink4	
Astromechanics	indi_astromechfoc	
Baader SteelDrive	indi_steeldrive_Focus	
Bee Focuser	indi_beefocus	
Celestron SCT	indi_celestron_sct_focus	
DeepSkyDad FP1	indi_deepskydad_fp1	
DeepSkyDad FR1	indi_deepskydad_fr1	
DeepSkyDad AF1	indi_deepskydad_af1_focus	
DeepSkyDad AF2	indi_deepskydad_af2_focus	
DeepSkyDad AF3	indi_deepskydad_af3_focus	
FLI CCD FLI CFW FLI PDF	indi_fli_ccd indi_fli_wheel indi_fli_focus	CCD Driver: FLI CCD driver (indi_fli_ccd) for all
FocusLynx	indi_lynx_focus	
Integra	indi_integra_focus	
JMI MOTOFOCUS	indi_lx200classicautostar	
SmartFocus	indi_smartfocus_focus	
Lacerta MFOC	indi_lacerta_mfoc_focus	
Meade 1206 Primary Mirror Focuser	indi_lx200classic	
LX200 Autostar	indi_lx200autostar	
MoonLite	indi_moonlite_focus	
myFocuserPro2	indi_myfocuserpro2_focus	

Mount	Driver	Devices
Nightcrawler	indi_nightcrawler_focus	
Gemini Focusing Rotator	indi_gemini_focuser	
Optec TCF-S	indi_tcfs_focus/indi_tcfs3_focus	
Pegasus DMFC	indi_dmfc_focus	
Pegasus Falcon	indi_falcon_rotator	
RainbowRSF	indi_rainbowrsf_focus	
RBFocus	indi_rbfocus_focus	
nFocus	indi_nfocuser	
Rigelsys nFrame	indi_nframe_rotator	
Rigelsys nStep	indi_nstep_focus	
RoboFocus	indi_robo_focus	
Seletek Rotator	indi_seletek_rotator	
Sesto Senso	indi_sestosenso_focus	
FCUSB	indi_fcusb_focuser	
USBFocusV3	indi_usbfocusv3_focus	
ASI EAF	indi_asi_focuser	

Connecting Filter Wheels

StellarMate supports a broad range of filter wheels. Most filter wheels fall in the following two categories:

Standalone: The filter wheel operates independently from any other device and has its own USB connection to StellarMate/PC. The filter wheel is operated from a dedicated INDI driver. **Internal:** Several camera models ship with an internal Color Filter Wheel (CFW) and therefore operating the filter wheel happens in the INDI camera driver. The INDI control panel would include an additional Filter tab whereas the filter slots and corresponding designations can be updated.

To check if your filter wheel is supported, please visit the INDI Filter Wheel Portal. Check the documentation for your filter wheel before you operate it for the first time.

15.1 USB & Serial to USB

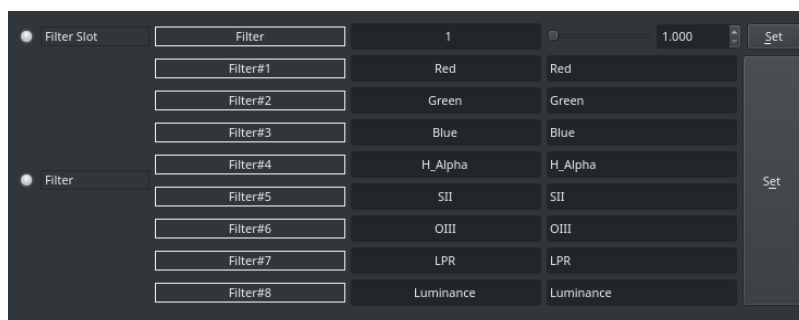
Most equipment is connected via USB. StellarMate is equipment with 4 USB ports. However, it is highly recommended to use an external powered USB Hub as it can reliably support power to your equipment.

WARNING Most problems in operating your equipment with StellarMate are related first and foremost to power problems. Therefore, please invest in reliable power supply for all your equipment!

15.2 Operating Filter Wheel

Filter Wheels are relatively simply devices. There are two primary controls for most filter wheel drivers:

Filter Slot: This is the current active slot of the filter wheel. It starts from 1 to the maximum number of slots available. To change the filter, simply change the slot number. **Filter Names:** On first connection, filter names (e.g. Red) are generated by the driver. Change the filter names to reflect the actual installed filter using the Capture Module in Ekos (KStars).



15.3 Filter Wheel

Mount	Driver	Devices	Comments
FLI CCD FLI CFW FLI PDF	indi_fli_ccd	indi_fli_wheel indi_fli_focus	
Optec IFW	indi_optec_wheel		
QHY CCD	indi_qhy_ccd		
QSI CCD	indi_qsi_ccd		
Quantum Wheel	indi_quantum_wheel		
Baader SBIG CCD	indi_sbig_ccd		
Starlight Xpress Filter Wheel	indi_sx_wheel		
TruTech	indi_trutech_wheel		
XAGYL Wheel	indi_xagyl_wheel		
ASI EFW	indi_asi_wheel		

Devices

- Telescope
- Cameras
- Focusers
- Filter wheels
- Auxiliary
- Adaptive optics
- Weather stations
- Covers & light sources
- Domes
- Controllers
- Spectrographs

16.1 Mounts

Following mounts are supported in StellarMate:

- Celestron
- SkyWatcher
- Astrophysics
- Omegon
- Vixen
- IOptron
- Meade
- Orion

Mount Name	Driver Executable
10 Micron	indi_lx200_10micron
AHP GT Mount	indi_ahpgt_telescope
AOK Skywalker	indi_lx200aok
LX200 FS2	indi_lx200fs2
Astrotrac 360	indi_astrotrac_telescope
Avalon StarGo	indi_lx200stargo
Paramount	indi_paramount_telescope
BRESSER Messier EXOS-2 EQ GoTo	indi_bresserexos2
Celestron GPS	indi_celestron_gps
CRUX TitanTCS	indi_crux_mount
Digital Setting Circle	indi_dsc_telescope
Explore Scientific PMC-Eight	indi_pmc8_telescope
HEQ-5 MCU Update	indi_lx200basic
iOptron HC8406	indi_ioptronHC8406
LX200 Basic	indi_lx200basic
Pegasus NYX-101	indi_lx200_pegasus_nyx101
OpenAstroTech	indi_lx200_OpenAstroTech
Losmandy	indi_lx200gemini

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Table 1 – continued from previous page

Mount Name	Driver Executable
LittleFoot Vpower	indi_lx200basic
Planewave	indi_planewave_telescope
Pulsar2	indi_lx200pulsar2
Rainbow	indi_rainbow_telescope
SkyAdventurer GTi	indi_skyadventurergti_telescope
SkyCommander	indi_skycommander_telescope
SkySafari	indi_skysafari
SkySensor2000PC	lx200ss2000pc
Star Adventurer 2i WiFi	indi_staradventurer2i_telescope
STAR2000	indi_star2000
SynScan Legacy	indi_synscanlegacy_telescope
Takahashi Temma	indi_temma_telescope
TeenAstro Mount	indi_lx200_TeenAstro
Telescope Scripting Gateway	indi_script_telescope
ZWO AM5	indi_lx200am5

16.1.1 Celestron

Before connecting to your mount 1. Ensure the mount firmware is the latest as provided by your manufacturer. 2. Ensure mount has proper and sufficient power to operate. This is often a primary source of issues connecting to mounts. 3. Read the mount manual and learn about the mount startup or Home Position. This is the mechanical position the mount must be in before you turn on the power to the mount. This basically falls under three categories:

Equatorial Mount: Telescope should be looking at the Celestial Pole (Polaris for the Northern Hemisphere) with counter-weights down. **Alt-Az Mount:** Telescope should parallel to the ground looking exactly North (for Northern Hemisphere) or South (for Southern hemisphere). **Alt-Az Mount on Wedge:** Telescope should be looking at Celestial Equator due South (for Northern Hemisphere) or Celestial Equator Due North (for Southern hemisphere).

4. Decide on how you will connect to the mount. Is it using a cable to the handset? or cable directly to the mount? WiFi? Bluetooth?
5. **If connecting over WiFi, then ensure the device where you are running the INDI driver (e.g. Raspberry PI4) is on the same network as your mount so they can communicate with each other. Such mounts can be configured to run in two modes:**

Mount Wireless Hotspot Mode: The mount hotspot acts as the router and you can connect your devices to the mount's own network (e.g. your Raspberry PI and iPad). **Mount Wireless Station Mode:** The mount joins an existing WiFi network (e.g. your home WiFi network or StellarMate hotspot). The IP address assigned to the mount is determined by your router. It is best to know the IP address assigned to the mount so that you can enter it in the IP address field in the driver Connection tab. However, this is not strictly necessary since the driver can automatically scan the local network for mounts, albeit this operation may take a few minutes to complete whereas if the IP address is known beforehand then the connection is immediate.

Selecting the correct driver Selecting the appropriate driver for your mount usually depends on two factors: 1. Mount model. 2. Naming Convention: Driver labels can indicate which communication method they use

HC: Hand Controller or Hand Set (e.g. Celestron Advanced VX HC) **Wired:** AUX/PC Port (e.g. Celestron Advanced VX Wired) **WiFi:** WiFi connection (e.g. Celestron Advanced VX WiFi)

3. Connection method (AUX Port, PC Port, Handset, WiFi, ..etc).

Mou	Drive	Con-	Comments
		nec-	
		tion	
		Met	
Ad- vance AVX	Ce- le- stron GPS	Serial- to- USB	Older Nexstar HCs come with RJ9 plug. You need Serial-to-USB adapter cable from HC to PC/Device. Modern Nexstar HCs come with USB Type-B port that you can connect directly via a USB cable to your device (no serial to USB adapter is required). When connecting via Nexstar Handset (HC), there is a single driver (Celestron GPS). The rest of the drivers (e.g. Celestron CPC..etc) are aliases to the base Celestron GPS driver. You must power and align your mount using the handset using any supported alignment method (e.g. SkyAlign). Without aligning your mount first, the driver will not connect to the handset.
Ad- vance AVX WiFi	Ce- le- stron WiFi	WiFi	WiFi drivers automatically try to connect to the mount over WiFi (Default IP address 1.2.3.4 using TCP port 2000). If your mount is using a different IP address, set it in the Connection tab of the INDI driver. Handset is not required and no alignment is necessary before establishing connection to the mount. If using a Wedge, make sure to only select "Evolution WiFi Wedge" driver.
CGE / CGE II WiFi	Ce- le- stron WiFi	WiFi	Same as above
CGX / CGX L WiFi	Ce- le- stron WiFi	WiFi	Same as above
Evo- lu- tion WiFi	Ce- le- stron WiFi	WiFi	Same as above
Ad- vance AVX AUX	Ce- le- stron AUX	Wire	Wired AUX or PC Port (located on top of the base of the scope). Under driver Connection tab: Set Connection Mode to Serial. Set Port Type to AUX/PC. Handset is not required and no alignment is necessary before establishing connection to the mount.
CGE / CGE II	Ce- le- stron AUX	Wire	Same as above
CGX / CGX L	Ce- le- stron AUX	Wire	Same as above
CPC	Ce- le- stron AUX	Wire	Same as above
Ad- vance VX	Ce- le- stron AUX	Wire	Same as above
CGE II Wire	Ce- le- stron AUX	Wire	Same as above
CGX Wire	Ce- le- stron AUX	Wire	Same as above

16.1.2 SkyWatcher

All SkyWatcher & Orion Mounts, including EQMod driver.

Before connecting to your mount Ensure the mount firmware is the latest as provided by your manufacturer. Ensure mount has proper and sufficient power to operate. This is often a primary source of issues connecting to mounts. Read the mount manual and learn about the mount startup or Home Position. This is the mechanical position the mount must be in before you turn on the power to the mount. This basically falls under two categories: Equatorial Mount: Telescope should be looking at the Celestial Pole (Polaris for the Northern Hemisphere) with counter-weights down. Alt-Az Mount: Telescope should parallel to the ground looking exactly North (for Northern Hemisphere) or South (for Southern hemisphere). Decide on how you will connect to the mount. Is it using a cable to the handset? or cable directly to the mount? WiFi? Bluetooth? If connecting over WiFi, then ensure the device where you are running the INDI driver (e.g. Raspberry PI4) is on the same network as your mount so they can communicate with each other. Such mounts can be configured to run in two modes: Mount Wireless Hotspot Mode: The mount hotspot acts as the router and you can connect your devices to the mount's own network (e.g. your Raspberry PI and iPad). Mount Wireless Station Mode: The mount joins an existing WiFi network (e.g. your home WiFi network or StellarMate hotspot). The IP address assigned to the mount is determined by your router. It is best to know the IP address assigned to the mount so that you can enter it in the IP address field in the driver Connection tab. However, this is not strictly necessary since the driver can automatically scan the local network for mounts, albeit this operation may take a few minutes to complete whereas if the IP address is known beforehand then the connection is immediate. Selecting the correct driver Selecting the appropriate driver for your mount usually depends on two factors:

Mount model. Connection method (Cable, WiFi, Bluetooth..etc).

Mount	Driver	Connection Method	Comments
HEQ5	EQMod Mount	EQDirect Cable	This cable is a DIRECT cable from mount to your device. No handset is connected nor required in this setup. Astroshop.eu EQDirect Cables. OPT Corp EQDirect Cables.
EQ6	EQMod Mount	EQDirect Cable	Same as above
EQ6R Pro	EQMod Mount	EQDirect Cable	Same as above
AZ-EQ5	EQMod Mount	EQDirect Cable	Same as above
AZ-EQ6 Pro	EQMod Mount	EQDirect Cable	Same as above
EQ8	EQMod Mount	EQDirect Cable	Same as above
EQ8 Pro	EQMod Mount	EQDirect Cable	Same as above
EQ3 Pro	EQMod Mount	EQDirect Cable	Same as above
EQM-35 Pro	EQMod Mount	EQDirect Cable	Same as above
Orion Sirius	EQMod Mount	EQDirect Cable	Same as above
Orion Atlas	EQMod Mount	EQDirect Cable	Same as above
HEQ5	EQMod Mount	Bluetooth	Use a Bluetooth adapter from Mount to your device. You must pair and trust the Bluetooth dongle first from your PC/Device. The dongle should create a serial port (e.g. /dev/rfcomm0) that you need to select when connecting to the mount. Quite a few EQMod Bluetooth dongles have been obsoleted. Therefore, it is generally NOT recommended to connect to your Mount using bluetooth.
EQ6	EQMod Mount	Bluetooth	Same as above
EQ6R Pro	EQMod Mount	Bluetooth	Same as above
AZ-EQ5	EQMod Mount	Bluetooth	Same as above
AZ-EQ6 Pro	EQMod Mount	Bluetooth	Same as above

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Table 2 – continued from previous page

EQ8	EQMod Mount	Bluetooth	Same as above
EQ8 Pro	EQMod Mount	Bluetooth	Same as above
EQ3 Pro	EQMod Mount	Bluetooth	Same as above
EQM-35 Pro	EQMod Mount	Bluetooth	Same as above
Orion Sirrius	EQMod Mount	Bluetooth	Same as above
Orion Atlas	EQMod Mount	Bluetooth	Same as above
HEQ5	EQMod Mount	Synscan Wifi Adapter	Select Network in EQMod Connection tab. Ensure IP address is correct before establishing connection to the mount. Do not use EQMod Mount driver to connect to any Alt-Az mount via the dongle, EQMod Mount driver can only operate Equatorial Mounts.
EQ6	EQMod Mount	Synscan Wifi Adapter	Same as above
EQ6R Pro	EQMod Mount	Synscan Wifi Adapter	Same as above
AZ-EQ5	EQMod Mount	Synscan Wifi Adapter	Same as above
AZ-EQ6 Pro	EQMod Mount	Synscan Wifi Adapter	Same as above
EQ8	EQMod Mount	Synscan Wifi Adapter	Same as above
EQ8 Pro	EQMod Mount	Synscan Wifi Adapter	Same as above
EQ3 Pro	EQMod Mount	Synscan Wifi Adapter	Same as above
EQM-35 Pro	EQMod Mount	Synscan Wifi Adapter	Same as above
Orion Sirrius	EQMod Mount	Synscan Wifi Adapter	Same as above
Orion Atlas	EQMod Mount	Synscan Wifi Adapter	Same as above
AZ-GTi WiFi (With Equatorial Wedge)	AZ-GTi Equatorial WiFi	WiFi	AZ-GTi mount must be running firmware v3.37+ (Right ARM, AZ/EQ Dual Mode).
AZ-GTi	AZ-GTi Wired	WiFi	WIRED cable from AZ-GTi RJ12 port to USB. For Equatorial mode, AZ-GTi mount must be running firmware v3.37+ (Right ARM, AZ/EQ Dual Mode).
AZ-GTi (Alt-Az)	SkyWatcher Alt-Az WiFi	WiFi (Native)	WiFi Native is the WiFi that comes with the mount built-in without any external adapters.
All SkyWatcher Dobsonian GOTOs	SkyWatcher Alt-Az WiFi	WiFi (Native)	Same as above
All Orion Dobsonian GOTOs	SkyWatcher Alt-Az WiFi	WiFi (Native)	Same as above

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Table 2 – continued from previous page

Any SkyWatcher/Orion with Synscan Handset (HC)	Synscan	Serial-to-USB	Older Synscan HCs come with RJ11 plug. You need Serial-to-USB adapter cable from HC to PC/Device. Modern Synscan HCs come with USB Type-B port that you can connect directly via a USB cable to your device (no serial to USB adapter is required). Synscan driver offers a limited subset of features compared to other drivers. If possible connect using EQDirect cable or WiFi.
SkyWatcher Virtuoso	SkyWatcher Virtuoso	WiFi	
SkyWatcher Star Adventurer 2i Pro	SkyWatcher Star Adventurer	WiFi	
SkyWatcher Star Adventurer 2i WiFi	SkyWatcher Star Adventurer	WiFi	Same as above
SkyWatcher Star Adventurer 2i Pro	SkyWatcher Star Adventurer	USB	Direct USB cable from Mount to PC/Device.
SkyWatcher Star Adventurer 2i WiFi	SkyWatcher Star Adventurer	USB	Same as above
SkyWatcher Star Adventurer	SkyWatcher Star Adventurer	NA	This driver is the INDI Telescope Simulator. It can be used just as a placeholder if you have the older non-GOTO Star Adventurer mount.

16.1.3 Astrophysics

INDI Library supports Astrophysics range of mounts. Due to the evolution of AP mounts over the years, the protocol used to communicate with the mount naturally evolved. INDI provides three drivers you can select from to best suit your mount.

How is meridian flip handled? The meridian flip feature is handled by the AstroPhysics GTO controller. The INDI driver does not handle that logic for these mounts. For this to work properly you would need to be sure to do the following:

The controller has to be initialized with the proper location and time (daylight savings set appropriately, UTC offset, etc.)

If you have a good polar alignment then a one star sync is needed or if you have a rough polar alignment then a 2 star sync will do. This initialization is done with the hand control or the INDI driver when using your client (e.g. KStars) so be sure you have all the proper settings in the client. Once this is done properly then your mount will do a meridian flip after it receives a goto command and the object has crossed the meridian. For example if you were imaging an object and during the exposure it crossed the meridian and you have the setting in your client (e.g. the Ekos image tab) set to flip meridian if HA>0 then before the next exposure starts a new goto command is issued to the same object by the client and the mount will know to flip as the controller handles the logic.

Mount	Driver	Devices	Comments
• `AstroPhysics Ex-perimental`_	• `indi_lx200ap_ex-perimental`_		
• `Astrophysis GTOCP2`_	• `indi_lx200ap_gtocp2`_		
• `Astrophysis`_	• `indi_lx200ap`_		
• `AstroPhysics V2`_	• `indi_lx200ap_v2`_	• `Snoop device`_ * `GPS`_ * `Dome`_	

16.1.4 Omegon

Omegon mounts are a collection of Alt-Az and Equatorial mounts for visual observation and astrophotography.

Mount	Driver	Devices	Comments
EQ500X	indi_eq500x_telescope		

16.1.5 Vixen

Mount	Driver	Devices	Comments
Starbook	indi_starbook_telescope		

16.1.6 IOPtron

1. Which driver is right for my mount?

Due to the many versions of Hand Controller (HC) and RS232 Command Set versions for all the iOptron mounts released, it can be confusing to select which driver

is appropriate for your mount.

2. Why are the mount GOTOs offset by one hour?

Make sure to turn OFF Daylight Saving (DST) setting in the mount hand set (HC). It must be off at all times.

3. Why dithering causes big jumps in RA and DE?

Make sure to turn OFF Periodic Error Correction (PEC) in the handset.

4. Why is the mount not performing meridian flip as expected?

You have to let the mount track some time AFTER CROSSING MERIDIAN, otherwise MF is not going to happen. In iOptron driver, the Meridian Behaviour setting Flip or Stop does not matter here, since Meridian Flip will be triggered by the client (e.g. Ekos); but the Limit you set does matter. Basic rule is:

$0 < \text{Client Limit} < \text{Mount Limit}$

Example: set Client (e.g. Ekos) to trigger MF 3° after crossing the meridian, and set mount limit to 6° after crossing meridian. You must set the 6° in the iOptron INDI driver.

Ekos limit should be greater than 0, because Ekos and mount must exactly agree on which side on the meridian we are: allowing to track some degree after crossing it, relaxes the precision needed and accounts for small difference in models and approximations between Ekos and mount firmware.

Mount limit should be greater than Ekos limit, because some time is usually needed to complete the running capture when filp time occurs (should be: MOUNT LIMIT - EKOS LIMIT > LONGEST EXPOSURE PLANNED). And MOUNT LIMIT should be small enough to avoid the mount smashing your equipment on a tripod leg.

Mount	Driver	Connection Method	Comments
iOptronV3	indi_ioptronv3_telesc	Serial-to-USB	Direct connection from mount to device
GotoNova 8400 Kit	lx200gotonova	Serial-to-USB	The driver supports the following Gotonova 8400 based controllers
CEM60	indi_ieq_telescope	Serial-to-USB	Firmware 140807 and later
CEM60-EC	indi_ieq_telescope	Serial-to-USB	Firmware 140807 and later
iEQ45 Pro	indi_ieq_telescope	Serial-to-USB	Firmware 140807 and later
iEQ45 Pro AA	indi_ieq_telescope	Serial-to-USB	Firmware 140807 and later
ZEQ25	indi_lx200zeq25	Serial-to-USB	Direct connection from mount to device
SmartEQ	indi_lx200zeq25	Serial-to-USB	Same as above
iEQ30	indi_lx200zeq25	Serial-to-USB	Same as above
iEQ45 EQ/AA	indi_lx200zeq25	Serial-to-USB	Same as above

16.1.7 Meade

INDI supports all Meade mounts via a number of drivers tailored to each model family (Classic, GPS..etc). The only mount that is NOT support is Meade LS since it uses a serial chip that fails to work with Linux & MacOS. There is no support from Meade on Meade LS.

Mount	Driver	Devices	Comments
LX200 Autostar	indi_lx200gps	ETX LX50 LX90 LX200	
LX200 16	indi_lx200_16		
LX200 Classic	indi_lx200classic		
LX200 GPS	indi_lx200gps		

16.1.8 Orion

Mount	Driver	Connection Method	Devices	Comments
SynScan	indi_synscan_telescope	Serial-to-USB	Snoop devices GPS Dome	

16.2 Cameras

CCDs, Autoguiders & Webcams

Cameras	Driver	Devices	Comments
Altair	indi_altair_ccd		
Apogee CCD	indi_apogee_ccd		
Atik	indi_atik_ccd		
Nightscape 8300 CCD	indi_nightscape_ccd		
GPhoto CCD	indi_gphoto_ccd		
FLI CCD FLI CFW FLI PDF	indi_fli_ccd	indi_fli_wheel indi_fli_focus	
INova	indi_nova_ccd		
V4L2 CCD	indi_v4l2_ccd		
Lacerta MGen Autoguider	indi_mgenautoguider		
Meade DSI Pro (I/II)	indi_dsi_ccd		
MI CCD	indi_mi_ccd		
Pentax DSLR (Native)	indi_pentax		
PlayerOne CCD	indi_palyerone_ccd		
QHY CCD	indi_qhy_ccd		
QSI CCD	indi_qsi_ccd		
RPI Camera	indi_rpicam		
SBIG CCD	indi_sbig_ccd		
SVBony	indi_svbony_ccd		
Toupcam	indi_toupcam_ccd		
V4L2 CCD (Duplicate)	indi_v4l2_ccd		
INDI Webcam	indi_webcam_ccd		
ASI CCD	indi_as_i_ccd		

16.3 Focusers

Devices	Driver	Comments
Focusers	Focusers	
ActiveFocuser	indi_activefocuser_focus	
Armadillo/Platypus	indi_armadillo_focus/	
Astroberry Focuser	indi_rpifocus	
AstroLink 4	indi_astrolink4	
Astromechanics	indi_astromechfoc	
Baader SteelDrive	indi_steeldrive_Focus	
Bee Focuser	indi_beefocus	
Celestron SCT	indi_celestron_sct_focus	
DeepSkyDad FP1	indi_deepskydad_fp1	
DeepSkyDad FR1	indi_deepskydad_fr1	
DeepSkyDad AF1	indi_deepskydad_af1_focus	
DeepSkyDad AF2	indi_deepskydad_af2_focus	
DeepSkyDad AF3	indi_deepskydad_af3_focus	
FLI CCD FLI CFW FLI PDF	indi_fli_ccd indi_fli_focus	indi_fli_wheel CCD indi_fli_ccd, Wheel Driver: indi_fli_wheel, indi_fli_focus Driver: Filter Focuser Driver:
FocusLynx	indi_lynx_focus	
Integra	indi_integra_focus	
JMI MOTOFOCUS	indi_lx200classicaustostar	

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Table 3 – continued from previous page

Devices	Driver	Comments
SmartFocus	indi_smartfocus_focus	
Lacerta MFOC	indi_lacerta_mfoc_focus	
Meade 1206 Primary Mirror Focuser	indi_lx200classic	
LX200 Autostar	indi_lx200autostar	
MoonLite	indi_moonlite_focus	
myFocuserPro2	indi_myfocuserpro2_focus	
Nightcrawler	indi_nightcrawler_focus	
Gemini Focusing Rotator	indi_gemini_focuser	
Optec TCF-S	indi_tcfs_focus/indi_tcfs3_focus	
Pegasus DMFC	indi_dmfc_focus	
Pegasus Falcon	indi_falcon_rotator	
RainbowRSF	indi_rainbowrsf_focus	
RBFocus	indi_rbfocus_focus	
nFocus	indi_nfocus	
Rigelsys nFrame	indi_nframe_rotator	
Rigelsys nStep	indi_nstep_focus	
RoboFocus	indi_robo_focus	
Seletek Rotator	indi_seletek_rotator	
Sesto Senso	indi_sestosenso_focus	
FCUSB	indi_fcusb_focuser	
USBFocusV3	indi_usbfocusv3_focus	
ASI EAF	indi_asi_focuser	

16.4 Filter Wheels

Filter wheels	Driver	Devices	Comments
FLI CCD FLI CFW FLI PDF	indi_fli_ccd	indi_fli_wheel indi_fli_focus	
Optec IFW	indi_optec_wheel		
QHY CCD	indi_qhy_ccd		
QSI CCD	indi_qsi_ccd		
Quantum Wheel	indi_quantum_wheel		
Baader SBIG CCD	indi_sbig_ccd		
Starlight Xpress Filter Wheel	indi_sx_wheel		
TruTech	indi_trutech_wheel		
XAGYL Wheel	indi_xagyl_wheel		
ASI EFW	indi_asi_wheel		

16.5 Auxiliary

Auxiliary devices, spectrometers, sensors, encoders, switches, motor..etc

CCDs, Autoguiders & Webcams

Auxiliaries	Driver	Devices	Comments
AstroLink 4	indi_astrolink4		
Astromechanics LPM	indi_astromech_lpm		
DeepSkyDad FP1	indi_deepskydad_fp1		
GPSD	indi_gpsd		
GPS NMEA	indi_gpsnmea		
GPUSB	indi_gpusb		
Java Raspberry Pi GPIO	i4jRaspberryPiGPIONDriver		
MyDCP4ESP32	indi_mydcp4esp32		
Pegasus UPB	indi_pegasus_upb		
Seletek	I4JSeletekDriver		
SQM	indi_sqm_weather		
USB_Dewpoint	indi_usbdewpoint		
Watchdog	indi_watchdog		

16.6 Adaptive Optics

Optics	Driver executable	Devices	Comments
Starlight Xpress AO	indi_sx_ao		

16.7 Weather Stations

Weather stations, cloud & rain detectors...

Stations	Driver	Devices	Comments
AAG Cloud Watcher	indi_aagcloudwatcher		
Vantage	indi_vantage_weather		
MBox	indi_mbox_weather		
Sky Quality Meter-LU	I4JSQMDriver		
WeatherMeta	indi_meta_weather		
Weather Safety Proxy	indi_weather_safety_proxy		
Weather Watcher	indi_weatherwatcher		
WeewxJSON	indi_weewx_json		

16.8 Covers & Light Sources

Dust Covers & Flat Light Sources

Sources	Driver	Devices	Comments
Wanderer Cover V3	indi_wanderer_cover		
FlipFlat	indi_flipflat		
SnapScap	indi_snapcap		
ALTO	indi_alto		
GIOTTO	indi_giotto		

16.9 Domes

INDI Dome support includes all observatory enclosures of different designs such as roll-off roofs, regular domes, and clamshell-style domes.

To implement your own roll-off roof driver, here are the basic requirements: **Hardware** 1. **AC/DC Motor:** The motor must be electronically controllable either via a relay or a controller board (Arduino..etc). The only controls needed are start/stop and direction control (CW and CCW). In INDI, a fully opened roof is considered Unparked, while a fully closed roof is considered Parked. Anything between these two (partially open) is considered an Unknown state. 2. **Limit switches:** Fully closed and fully opened limit switches are required in order to sense when the roof is fully opened and closed. These limit switches serves two purposes:

1. Cut off power to motor once limit is reached.
2. Sense when roof is parked or unparked.

Therefore, Motor + 2 limit switches is all you need to have a working roll-off roof hardware system to be used with INDI.

Software The roll-off roof requires an INDI driver so that it can be controlled from any INDI-compatible client. You can either use the Dome Scripting Gateway driver or customize the sample INDI roll-off driver to fit your needs. The Dome Scripting Gateway driver relies on executing Python scripts to command actions for Open and Close. It is recommended to use this driver if you have limited programming experience but can manage to write simple Python script to control your motor.

Customizing the INDI Roll-off driver is optimal if you know some rudimentary C++. Here are some real-world examples of roll-off drivers to get you started:

Aldi Roof Driver: The roof is powered by a 550W electric hoist purchased from Aldi. The arduino controls 4 relays connected to the hoist's hand controller which override the manual switch. The indi driver communicates with the arduino using the frimata protocol. **Ikarus Observatory Driver:** Using Digital Loggers Din Relay, Limit switches, Raspberry PI **Arduino Roll Off Driver:** It is a INDI rolloff roof driver and includes two examples of Arduino programs communicating over USB. The driver is packaged as a third party driver but has not been included with the standard distribution. The Arduino code needs to be modified to match the motor control selected, the INDI driver should work once installed. **Odroid INDI Roof:** This indi driver is used to control an observatory box. It is just a very compact box with an automated lid, opened by two linear actuators, 2 micro-switches act as position sensors (open/close). The all lot is powered by an Odroid-C1 and a standard 8 relays board.

Dome Slaving** Dome slaving refers to the dome slit synchronization with the telescope position as the mount traverse across the sky. The dome slit follows the telescope whether it is slewing from one object to another, or while tracking. When tracking, the dome would move when the difference between its current and target position exceeds the Autosync Threshold parameter, which default to 0.5 degree. Therefore, the dome calculates its target position every second, but only commands motion when the difference exceeds the autosync threshold.

You can slave the dome to the mount by setting the required slaving parameters:

1. Radius is for the radius of the dome in meters.
2. Shutter width is the clearance of the shutter of the dome in meters
3. N displacement is for North displacement. If telescope is not in its ideal central position this parameter allows to configure how much it is displaced from the center. Displacement to north are positive, and to south are negative.
4. E displacement is for East displacement. Similar as the above, displacement to east are positive, and to west are negative.
5. Up displacement is for displacement in the vertical axis. Up is positive, down is negative.
6. OTA offset is for the distance of the optical axis to the crossing point of RA and DEC. In fork mount this is generally 0, but for German like mounts is the distance from mount axis cross to the center line of the telescope. West is positive, east is negative.

After settings the parameters above, go to Options tab and click Save in Configurations so that the parameters are used in future sessions. You can also set the Autosync threshold which is the minimum distance autosync will move the dome. Any motion below this threshold will not be triggered. This is to prevent continuous dome moving during telescope tracking.

Dome is not correctly slaving 1. Make sure that the dome azimuth movement and position are correct and repeatable. If the azimuth is incorrect or not repeatable you will never get a good sync. Good means to within a couple of degrees. 2. Align the mount. For a celestron GEM that's polar aligned a quick align should be good enough but once again you can't get a good sync without a good alignment. Within a degree should do. 3. Set the dome radius to a sensible value, Do not change it again. 4. Set the mount to hour angle 6h, declination 90. This is the Align position, looking at the pole with the counterweight shaft down. In this position the OTA offset will have no effect on the dome azimuth, not will the NS position of the mount. 5. Adjust the mount EW offset until the scope is looking through the centre of the dome slit. 6. Move the mount so the counterweight shaft is horizontal and the OTA is looking at the Southern horizon. In this position the main things that affect where the dome needs to be are the EW mount offset and the OTA offset.

We have already set the EW offset so set the OTA offset. Try this with the mount on both side of the meridian and iterate as required to get the scope able to see out in both cases. set the scope so it is looking at the East or west horizon, this should be with the dec counterweight shaft pointing down. Adjust the Ns offset so the OTA can see out. Do this both looking East and West.

Debugging Calculations Ferran Casarramona, the developer of the Dome Slaving routine, wrote a spreadsheet to debug the calculations. You can make a copy and play with it to see how parameters affects the outcome.

You can enter the values in blue cells, and output are in the orange cells. You enter your telescope parameters, and your latitude. Also enter target declination and target hour angle (angular distance to the meridian, in hours).

Domes	Driver	Devices	Comments
DDW Dome	indi_ddw_dome		
Baader Dome	indi_baader_dome		
DragonFly Dome	indi_dragonfly_dome		
NexDome Beaver	indi_nexdome_beaver		
MaxDomeII	indi_maxdomeii		
NexDome	indi_nexdome		
Rigel Dome	indi_rigel_dome		
ScopeDome	indi_scopedome_dome		
Talon6	indi_talon6		

16.10 Controllers

Joysticks & Game pads

Controllers	Driver	Devices	Comments
Joystick	indi_joystick		

16.11 Spectrographs

Spectrographs, radio and optical

Spectrograph	Driver	Devices	Comments
RTL-SDR	indi_rtlsdr		

Time & Location

In order to ensure smooth and accurate operation of the astrophotography workflow, both time and location information must be precise across all devices in the system. Therefore, the time and location on StellarMate must be in sync with the time and location on all connected devices, especially mounts.

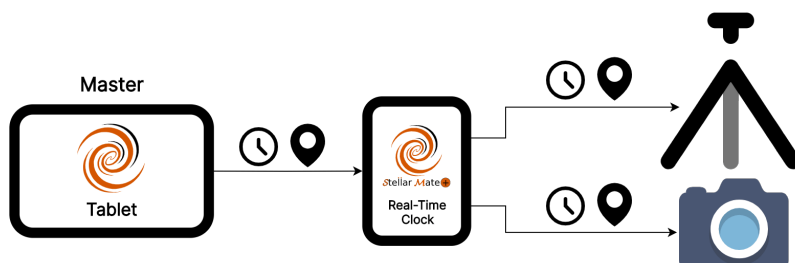
Note

For users who installed StellarMate OS on their own Raspberry Pi 4 SBCs, it's recommended to invest in installing a DS3231 RTC module or use a GPS dongle.

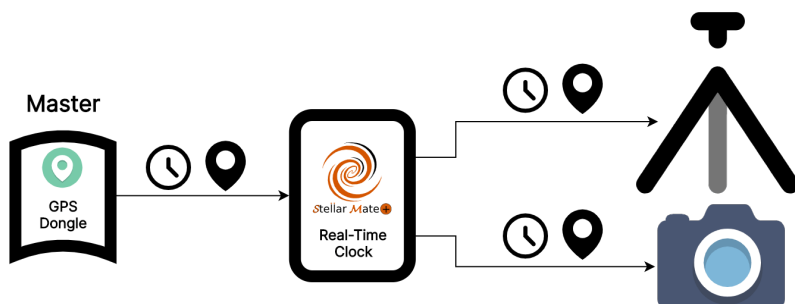
StellarMate Pro is equipped with a GPS receiver and can provide accurate time and location data. For fixed observatory controllers not equipped with a GPS receiver, an RTC (Real Time Clock) is sufficient to keep track of the time when the unit is switched off. Furthermore, if StellarMate is always connected to the internet, then it is always in sync with online NTP servers without any further configuration.

For GPS-based solutions, there are several options available:

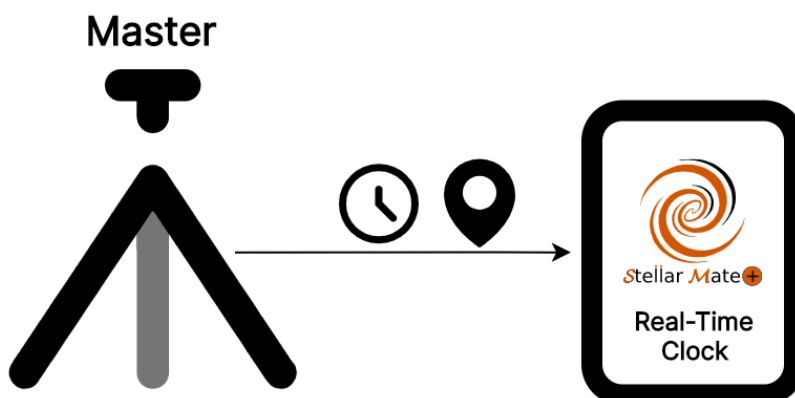
Tablet/Mobile GPS: The StellarMate App relays the tablet/mobile time and location information to StellarMate. Every time the SM App is connected to SM Plus, it automatically synchronizes both time and location information accordingly.



External GPS Dongle: StellarMate Controllers supports a number of dedicated external GPS dongles connected via USB. Once connected, select the GPSD driver in your equipment profile in order to utilize the GPS.

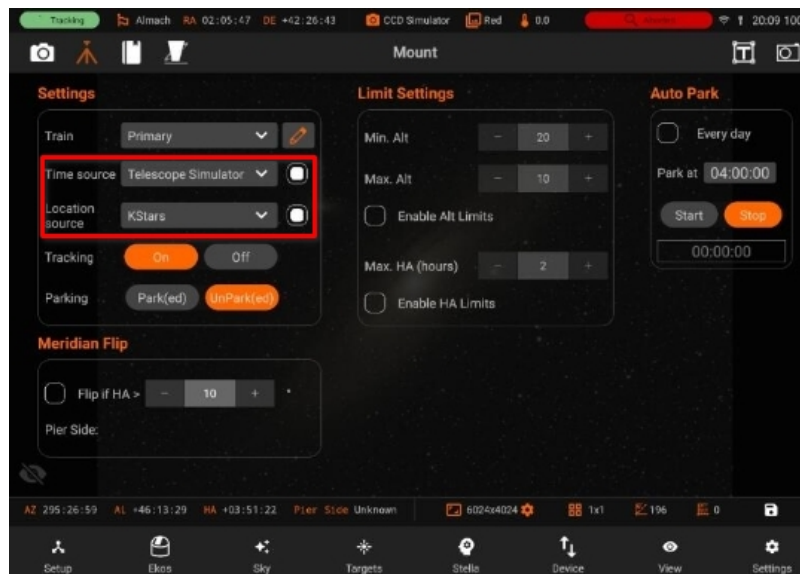


Mount with GPS: Some mounts have internal or external GPS adapters. These adapters cannot be connected directly to StellarMate; they are used to update the time and location on the mount handset. You can select Mount as the source of data if desired.



Every time the StellarMate Mobile App is connected to StellarMate, it syncs both time and location information from the tablet/phone GPS. If the SM App is not used (for example, when using Ekos on a PC/Mac), then StellarMate relies primarily on RTC as the time source.

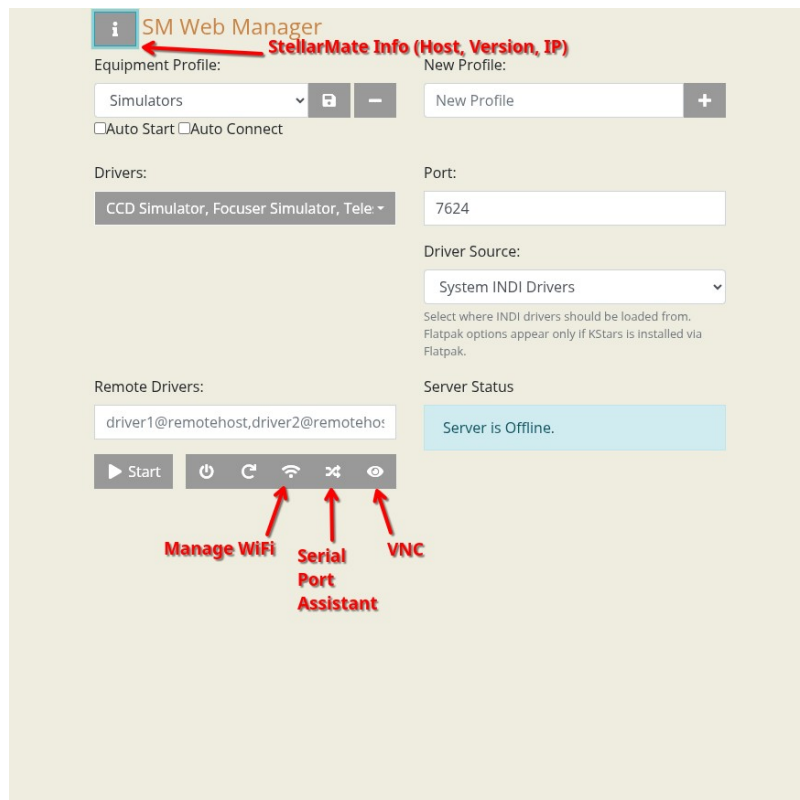
In KStars, it is possible to specify the Location & Time Sources. To set the sources, go to Ekos → Mount module.



Tip: You can use the StellarMate App to quickly synchronize StellarMate Plus time and location. The time and location are automatically set whenever the App communicates with StellarMate. Afterwards, you may continue to use the SM App, or use Ekos to set up your astrophotography workflow.

Web Manager

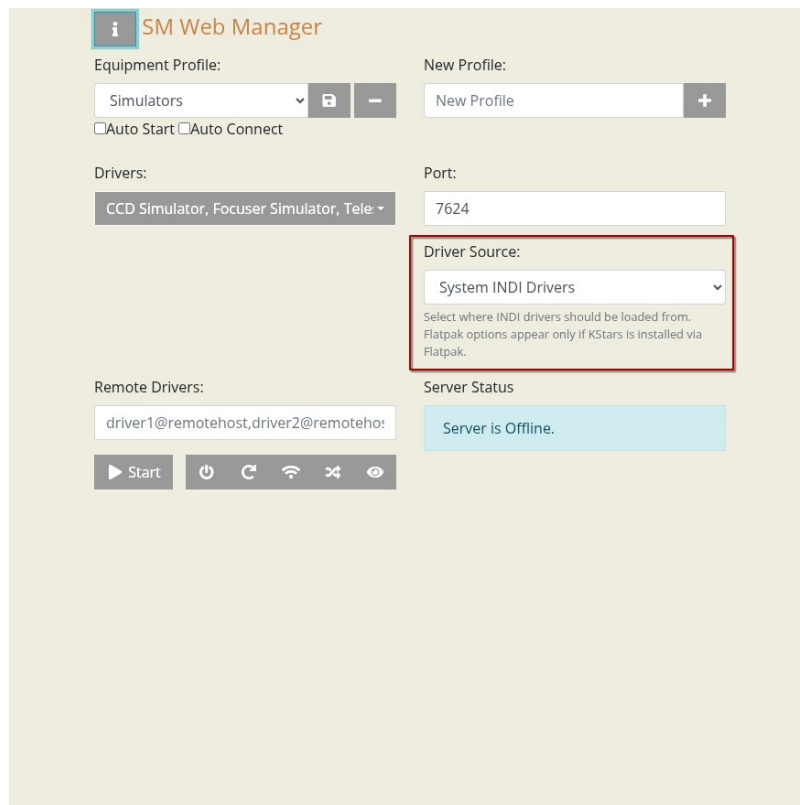
StellarMate Web Manager is a simple Web Application to manage INDI server and control StellarMate. It is accessible as long as there is a network connection (WiFi/Ethernet/Hotspot) between you and StellarMate. For example, if you are in inside the house with a PC/Mac/Tablet, you could use your browser to remotely manage StellarMate drivers. It supports multiple driver profiles along with optional custom remote drivers. It can be used to start INDI server locally, and also to connect or chain to remote INDI servers. You can use it to Restart or Shutdown the unit, and to connect to VNC frontend from the web. Furthermore, the Web Manager provides a RESTful API where you can issue simple calls to start and stop INDI services over the network. With the Web Manager, you can access StellarMate Serial Port Assistant and VNC. Furthermore, you can also restart and shutdown INDI from the interface.



By default, StellarMate is shipped with the Simulator profile. It is composed of the following drivers:

- Telescope Simulator
- CCD Simulator
- Focuser Simulator

****Driver Source**



By default, Driver Source is System INDI Drivers. You can select is from the list that are available. You can run the Simulator profile to test the simulators and connect to them from any client.

18.1 Web Manager URL

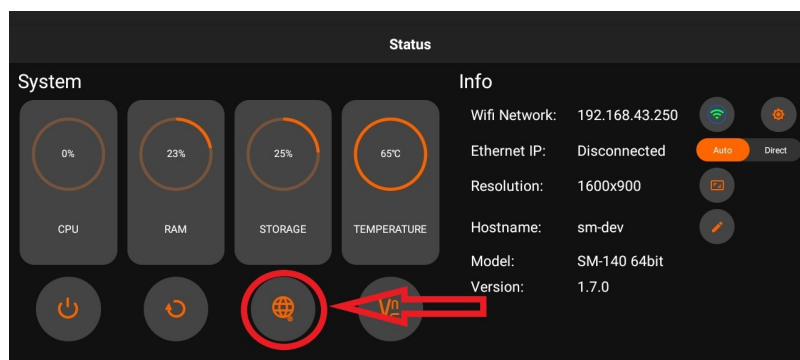
You can access the Web Manager from any browser at this url:

<http://stellarmate.local:8624>

Note

When accessing StellarMate directly via Hotspot (Access Point), the unit IP address is always 10.250.250.1. Therefore, if you are having an issue accessing the unit via its hostname, you can simply use the IP address in your browser to access StellarMate Web Manager (<http://10.250.250.1:8624>).

Furthermore, it can be access in the StellarMate App by going to the device tab and click on Web Manager button.



Note

Interacting with the StellarMate Web Manager is usually not necessary since both Ekos and the StellarMate App can operate the equipment profiles directly. The Web Manager is useful when you are not using the StellarMate App and need to remotely manager the drivers directly.

18.2 Device Information

The device information button brings up an information popup to show the following information:

StellarMate Unit name. StellarMate Unit model. StellarMate OS Version. List of IP addresses: Connection to StellarMate is usually done via its hostname, however, you can connect directly via IP address.

18.3 Adding New Profile

Before you add a new profile, you need to identify which drivers you need for your equipment. You can browse all available devices in the INDI Devices page, or you can simply scroll through the list of available drivers in the Driver selection dropdown. To add a new profile:

1. Enter the device name
2. Click the Plus button
3. **Once the new device is added, select the appropriate drivers from the list. Please note that you may need to run some drivers from the Auxiliary class in the following situations:**
 - Joystick:** If you plan to use a joystick with your mount, select the Joystick driver from the auxiliary list.
 - SkySafari:** To monitor and control your mount from SkySafari, select the SkySafari driver from the auxiliary list.
 - WatchDog:** This driver is required for secure remote operation of observations. In the case of communication loss, you can configure the driver to perform a safe shutdown of your observatory.
4. Click the Save button to save your profile.
5. Click Start to start INDI server. If all goes OK, you should see a message in the notification area.

18.4 Removing Profile

To remove an equipment profile, press the Minus sign next to it. Please note this operation is permanent.

18.4.1 Auto Start

If you want to automatically start a particular equipment profile whenever StellarMate is powered on, check the AutoStart checkbox.

18.5 Auto Connect

In addition to Auto Starting an equipment profile, you can also connect all equipment which is equivalent to pressing the connect button for all the drivers. The connection command is usually sent 2 seconds after starting the profile. To enable auto connection, check the Auto Connect checkbox.

18.6 Starting & Stopping Server

Click Start to establish the INDI server. The list of active drivers running should be displayed in the info box. Once the server is established, you can connect to StellarMate from any INDI client.

Note

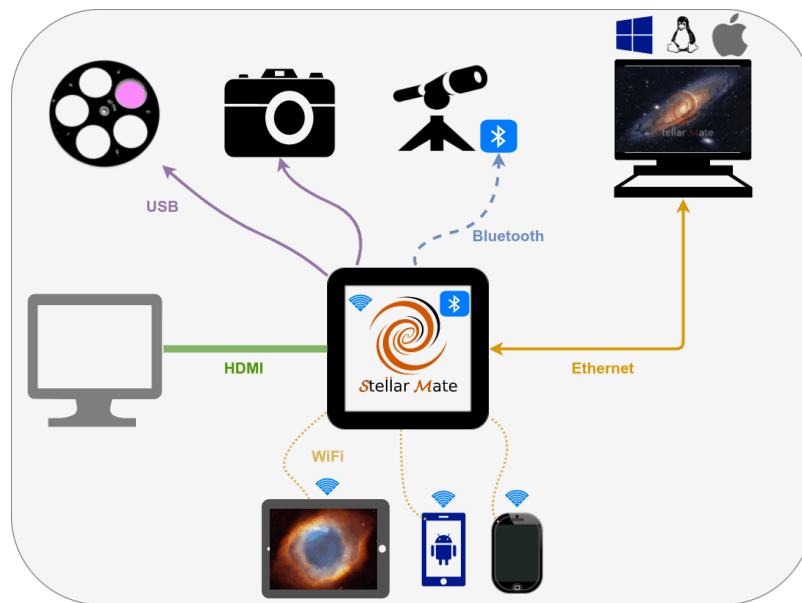
If you are using Ekos, you do not need to manually start/stop drivers in the web manager. Simply check INDI Web Manager checkbox in Ekos Profile Editor, and Ekos manages starting/stopping INDI drivers transparently.

Serial Port Assistant

StellarMate supports a broad range of astronomical equipment including Mounts, DSLRs, CCDs, Focusers, Filter Wheels, Domes, Weather Stations, and other Auxiliary devices. For a complete list, please check **INDI Devices** Page.

StellarMate Equipment video All equipment must be powered before you connect them to StellarMate. Most astronomical devices can be connected to StellarMate via the following methods:

- USB: This includes Serial-To-USB devices.
- Bluetooth
- Network: Wired or Wireless



19.1 USB

Most equipment is connected via USB. StellarMate is equipment with 4 USB ports. However, it is highly recommended to use an external powered USB Hub as it can reliably support power to your equipment.

WARNING

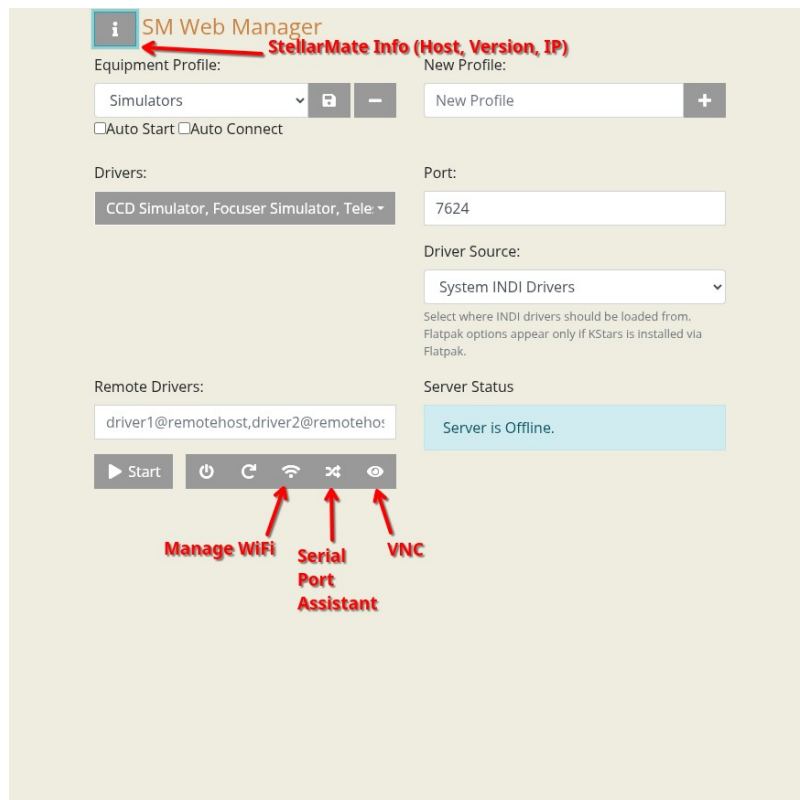
Most problems in operating your equipment with StellarMate are related first and foremost to power problems. Therefore, please invest in reliable power supply for all your equipment!

For many Mounts & Focusers that use RS232 connectors, you need to purchase a Serial-To-USB adapter suitable for your Focuser model from the manufacturer. When you plug in your Serial-To-USB devices, they are assigned a specific port under StellarMate (e.g. `/dev/ttyUSB0`). However, this port is not static. That is, next time you plug in the same device on another session, it might get assigned another port (e.g. `/dev/ttyUSB1`). Since INDI drivers require the port name to communicate with the device, this could lead to communication issues. With the help of StellarMate Serial Port Assistant, you can assign permanent designations for your devices so that they always get the same port whenever they are connected.

19.2 Network

Some devices can be connected to over the network (TCP/IP). For such devices, the only requirement is that the device is available on the same subnet as StellarMate. To connect to a networked device, you need its IP address (or hostname) and its port.

19.3 StellarMate Serial Assistant



Serial Port Assistant ensures that your serial device designations are saved permanently. When you plug your mount, it is assigned a random port (e.g. COM2 or /dev/ttyUSB1). This port is required in order for INDI to communicate with your mount. Using the assistant, you can assign a permanent ID to your device (e.g. /dev/mount). Therefore, every time you plug in your device, it is always assigned a designated port that INDI uses to communicate with the device.

To use the Serial Port Assistant, go to StellarMate Web Manager either from StellarMate App or from any browser and click on the Serial Port Assistant Icon at the bottom right. Simply follow the instructions in the step-by-step guided wizard to assign permanent designations to your Serial-To-USB devices.

Video Tutorial: <https://www.youtube.com/watch?v=VQHUaO5Hmi0>

Note

StellarMate Serial Assistant is only applicable to Serial-To-USB devices, for regular USB devices, do not use it.

StellarMate Dashboard

The StellarMate Dashboard is an internal web interface that allows you to monitor system health, network connectivity, and hardware status. It also provides backup and restore services, and diagnostic logs for built-in services such as the Web Manager. To access the dashboard:

- Open any web browser and navigate to: <http://stellarmate.local>
- Alternatively, you can access the dashboard by entering the IP address directly if known (e.g. <http://10.250.250.1>)

If the dashboard is not accessible, check the following:

- Ensure your device is connected to the same network as StellarMate
- If connected via StellarMate's hotspot, verify that mobile data is disabled on your device
- Check for any software or settings that might block the connection

IMPORTANT

In order to open the StellarMate Control Panel you need to be connected to the same network as your StellarMate. If StellarMate is in hotspot mode, you can connect to it by going to your computer/laptop WiFi settings and connecting to the SSID stellarmate with the password [stellar@mate](#). Do not open StellarMate Control Panel from StellarMate itself, it is meant to be opened from your computer/laptop.

StellarMate Control Panel is a web application for StellarMate OS. It provides any functions such as displaying the connection status of the controller, backup and restore, network and factory reset, etc.

20.1 Status Bar

The Status Bar is available on every page on the top-right corner as it is informative to the user and has some shortcuts.



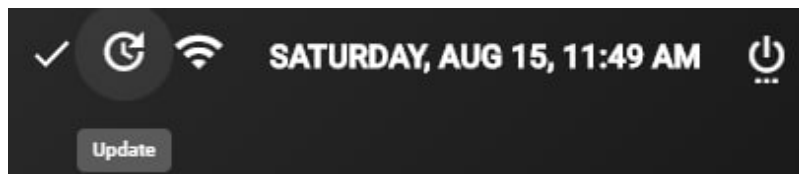
The Status Bar has the following features:

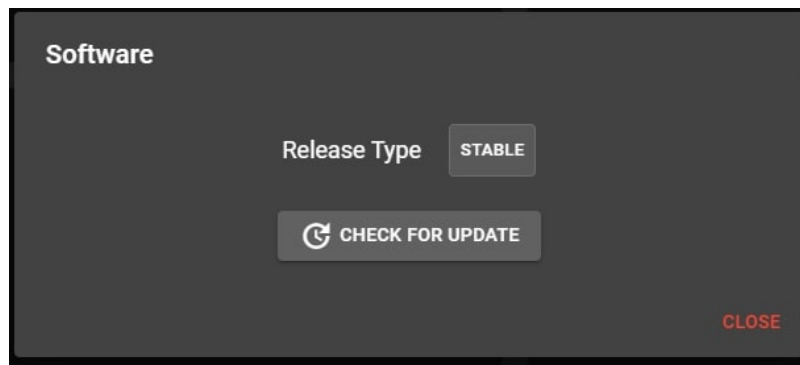
- Shows the connection status
- Shortcut to update StellarMate OS build
- Shows the type of connection to StellarMate (Hotspot, WiFi or ethernet)
- Shows the Date and Time
- Allows shutting down or restarting StellarMate

If the connection is spotty and keeps getting disconnected, the status bar will inform you by showing a yellow exclamation mark icon.

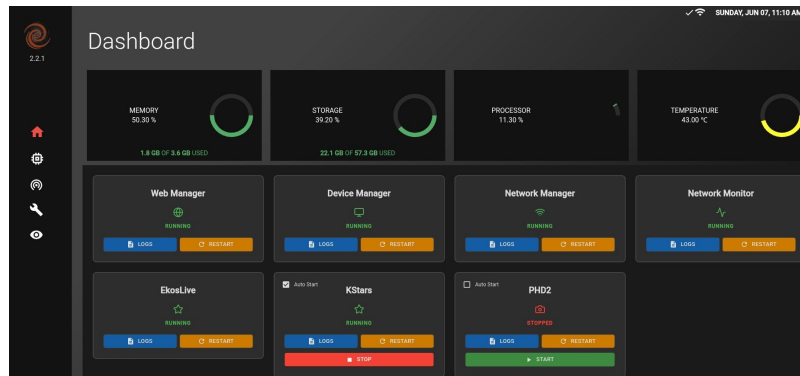


To update using the status bar, click on the update icon and a dialog will pop-up, allowing you to check for an update and install it.





20.2 Dashboard



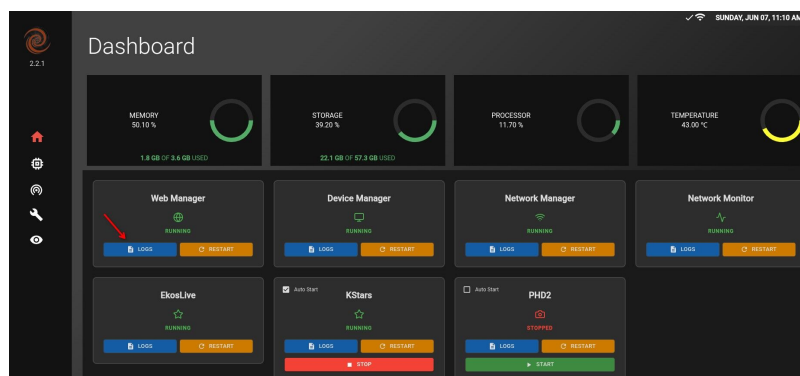
The home page of the StellarMate Control Panel is the Dashboard, which shows the following information:

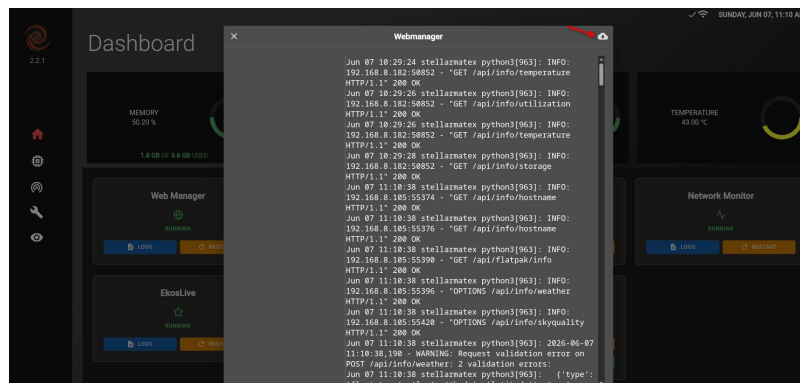
1. RAM Usage
2. Storage Usage
3. CPU Usage
4. Device Temperature
5. Network Graph
6. Weather and Location Information
7. Screen Resolution
8. Services status
9. Services logs

20.2.1 Logs

EkosLive logs should be sent to the Stellar Mate support when there are issues about EkosLive being down or for issues with Live Stacking. This is an instructional guide for how to View or Extract Logs. It will be explained step by step in this section of the manual.

Logs can be viewed from the dashboard main page and also download from the Icon on top-right side.





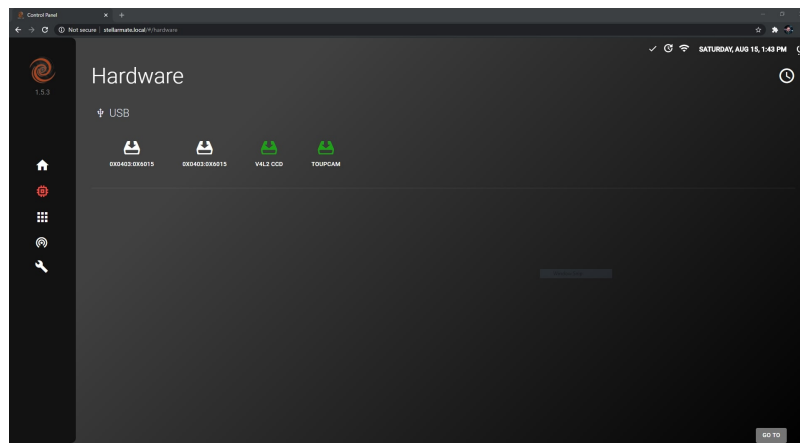
Weather Units

Weather units can be toggled from Metric to Imperial and vice-versa.

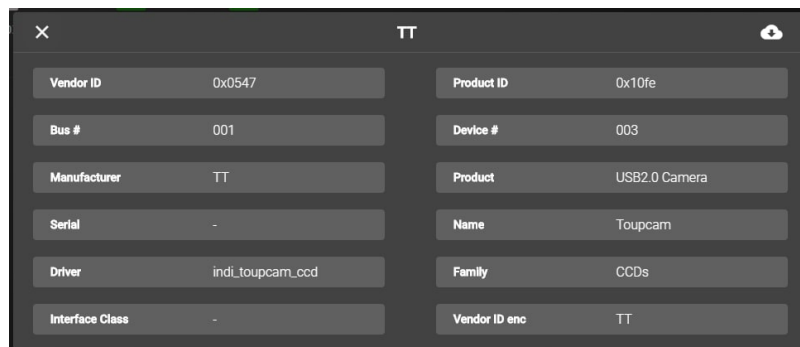


20.3 Hardware

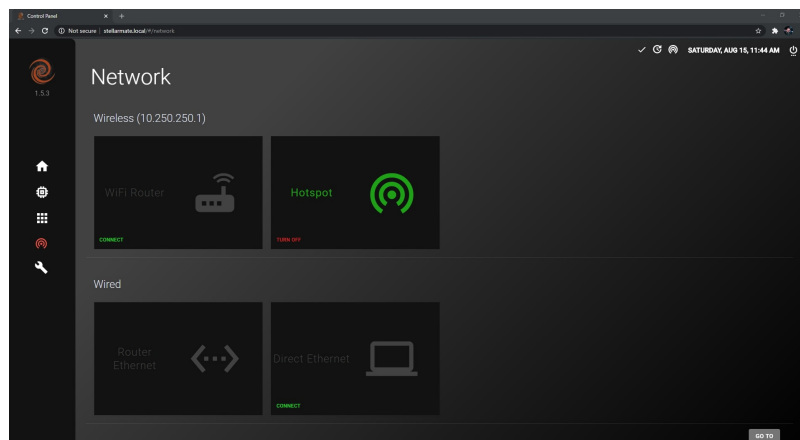
In this page, you can see all the hardware devices that are connected to StellarMate.



Clicking on a device will show its information, which can be downloaded by clicking on the **Download** button (cloud icon) on the top-right.



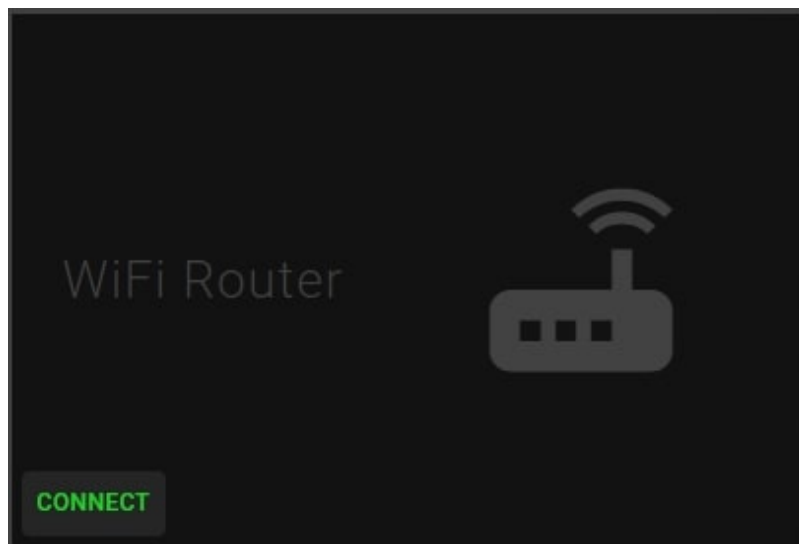
20.4 Network



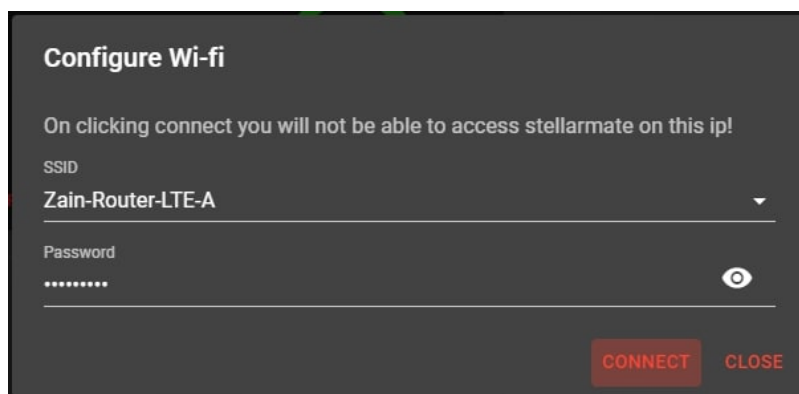
Wireless You can connect to StellarMate through a WiFi Router or the broadcasted HotSpot network.

To connect to StellarMate through a WiFi Router, you have to connect StellarMate to the WiFi Router first by following these steps:

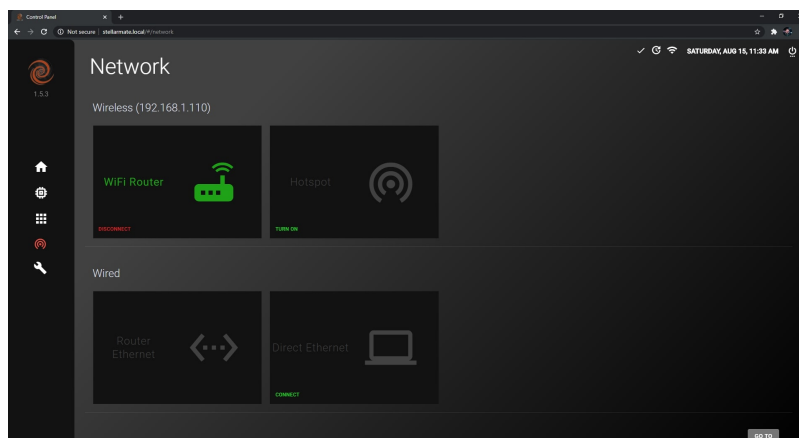
1. Click on **Connect** on the WiFi Router card



2. **Select** your WiFi Router network connection and then put in the password if there is one, then click on **Connect**.



3. Connect to the same WiFi network on your computer/laptop and then refresh the page, the network page should look like the image below.



You can always switch back to **HotSpot** mode whenever you want by clicking on the **Turn On** button under HotSpot.

Wired

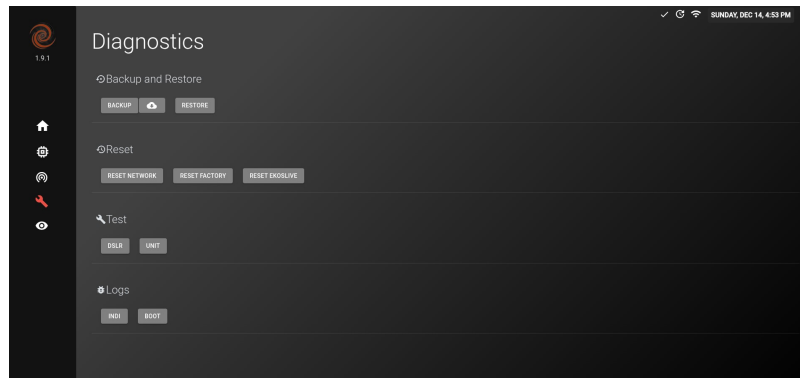
StellarMate can be connected through **Router Ethernet** or **Direct Ethernet**

To connect to StellarMate through Router Ethernet, just connected an Ethernet cable to StellarMate and connected the other end to your Router.

Now connect to the same network on your computer and refresh the page.

To connect to StellarMate through Direct Ethernet, follow the video tutorial on this page.

20.5 Diagnostics



The Diagnostics page contains Backup and Reset functions as well as many important information to help StellarMate developers fix any issues that StellarMate users face.

Backup and Reset This section provides the user with the ability to:

Reset Network: In case you face any persistent problems with the network settings, you can reset all network settings to default by clicking on the Network Reset button. Any WiFi networks or manual network settings will now be discarded. StellarMate must be restart for this change to take effect. **Reset Factory:** In case StellarMate is experiencing unresolved instabilities, it is possible to restore it to Factory Settings by click on the the Factory Reset button. After the confirmation dialog, you need to enter StellarMate password (default: smate). The controller name is reset to stellarmate. It must be restarted afterwards. **Backup:** StellarMate settings can be backed up to a file to help in restoring any settings when either flashing a new StellarMate OS or in case in restoration of damaged SD card. The settings include all KStars and INDI settings which includes the profiles and driver-specific options. This creates a backup compressed file that can be used later to restore your StellarMate configuration. **Restore:** StellarMate settings can be restored through a backup file generated by the backup function.

Test Test your hardware devices such as DSLR. This will tell you if your DSLR is working correctly with StellarMate or not.

Logs

In order to check the logs, you can:

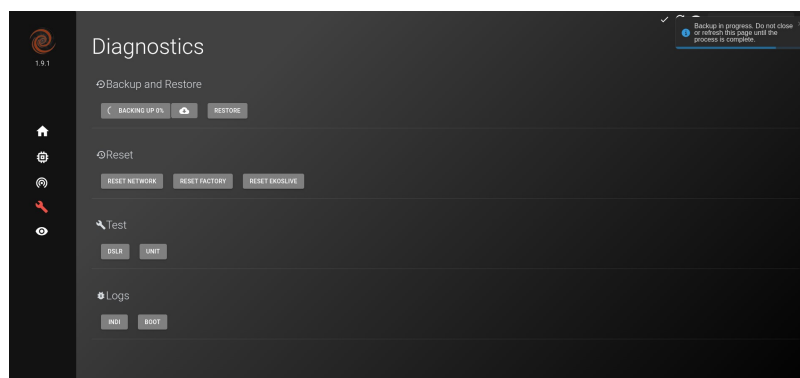
- Extract logs for diagnosing an error or an issue that has happened during usage of StellarMate.
- This can be used by StellarMate developers to help fix the issue. StellarMate support may ask you to attach logs in your support ticket if they need to investigate the issue.

20.5.1 Backup and Restore Process

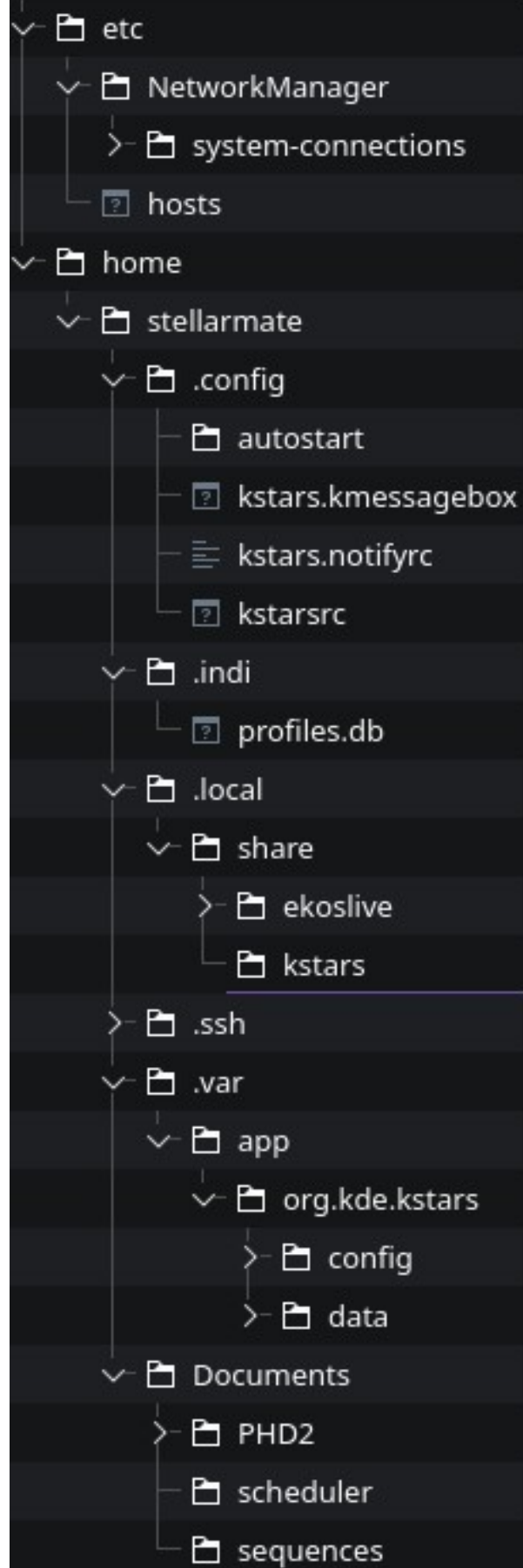
This is an instructional guide for the Backup and Restore process. It will be explained step by step in this section of the manual.

Backing up StellarMate configuration In order to backup your StellarMate configuration, please follow these steps:

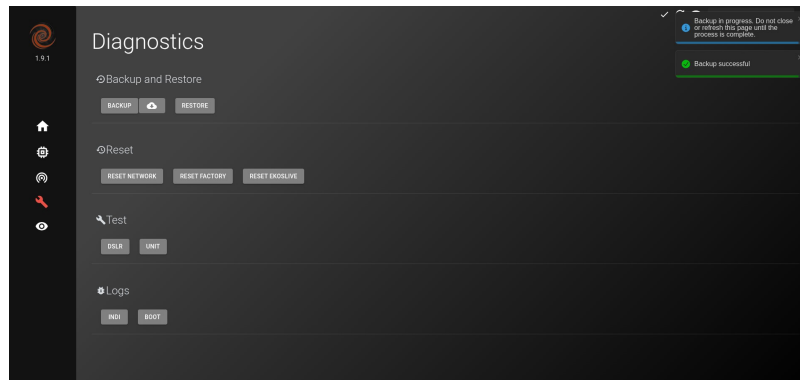
1. Click on the **Backup** button.



2. Wait for the Backup process to generate a backup file, this might take long if you have lots of images.
3. Click on the **Download** button (cloud icon) and select the backup file that has been generated.

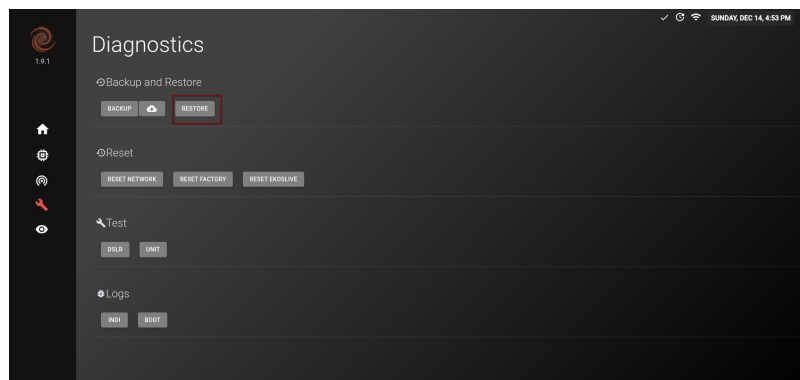


4. You should get a Backup Successful message. You should now have a backup file on your computer that you can use later to restore your StellarMate configuration.

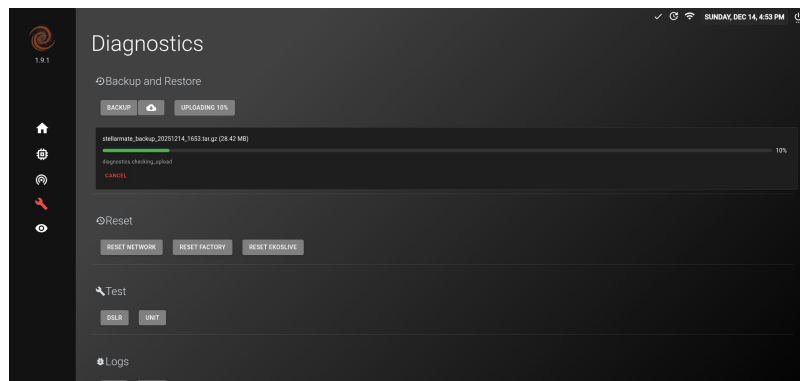


Restoring StellarMate configuration In order to restore your StellarMate configuration, please follow these steps:

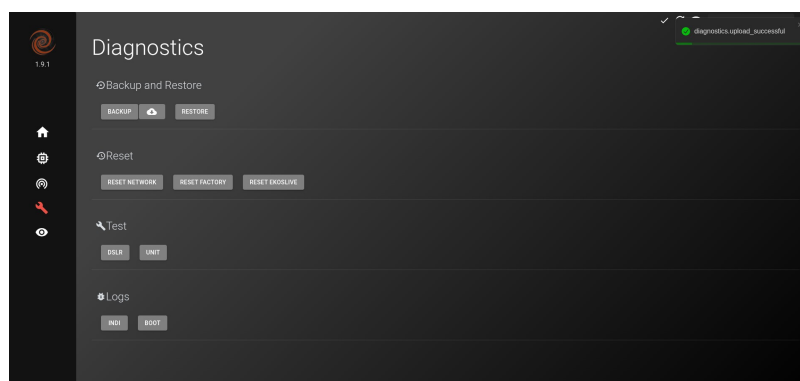
1. Click on the **Restore** button.



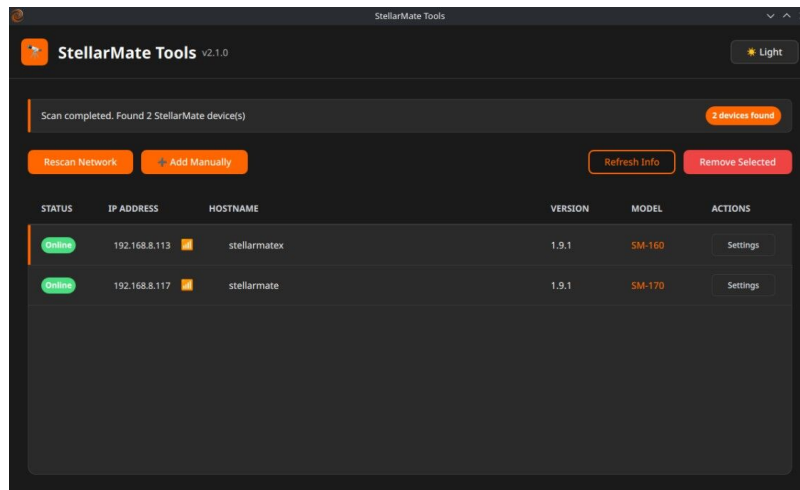
2. Select your backup file and click on **Open**.
3. Wait for the upload process to complete.



4. You should get a Upload Successful message, which means that the restore was successful.



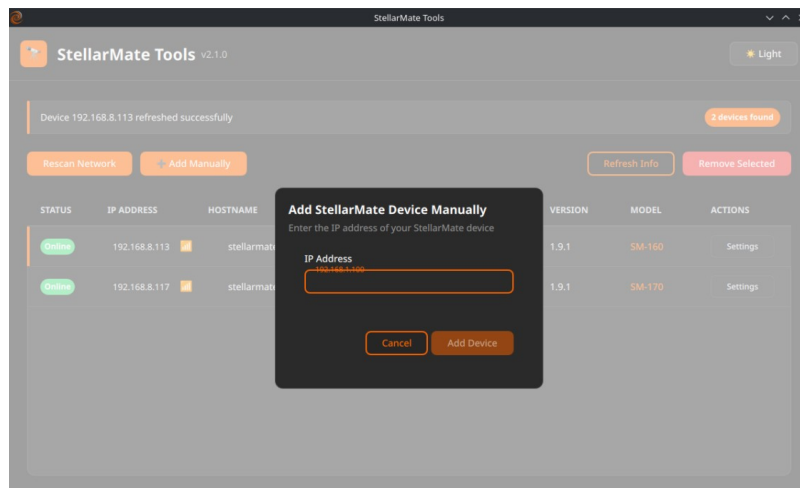
StellarMate Tools



Manage all StellarMate devices on your network from this interface. Follow these steps to control your devices:

Discover Your Devices

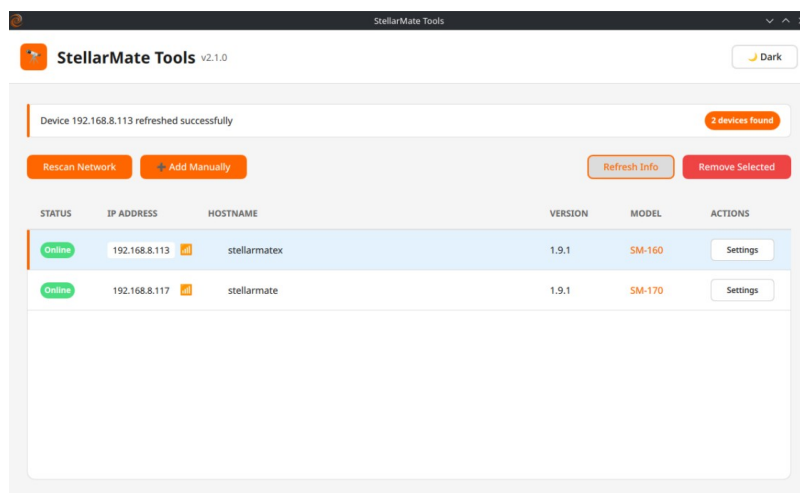
Click **Rescan** to automatically detect all connected StellarMate devices on your network. If a device doesn't appear, manually add it by entering its IP address directly.



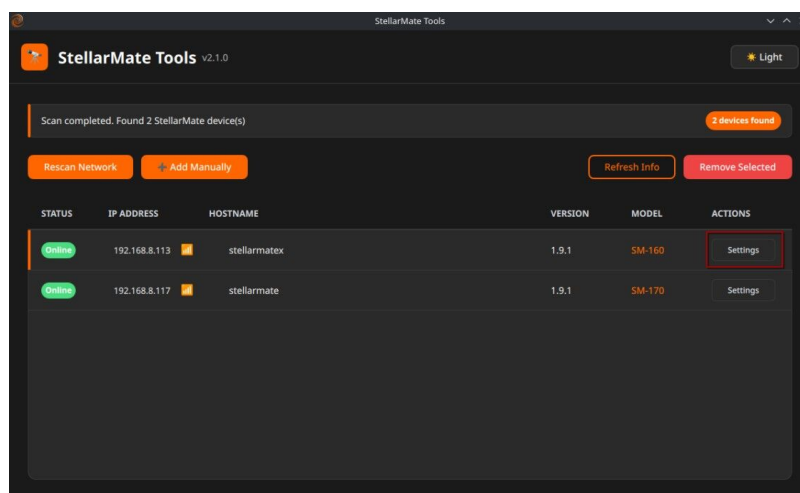
Manage Your Device List

- Select any device from the list to work with it
- Click **Refresh** to update device information
- Click **Remove** to delete devices you no longer need

Important: Ensure all devices connect to the same network to appear in this view.

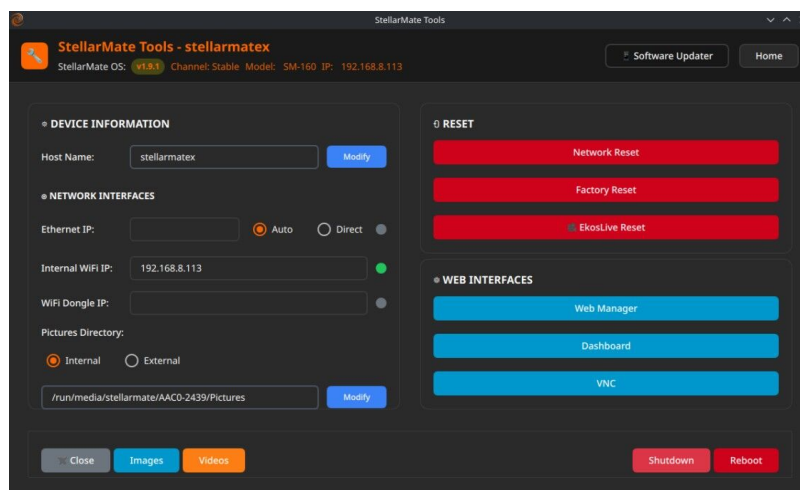


Switch between light and dark mode as needed for your viewing preference.

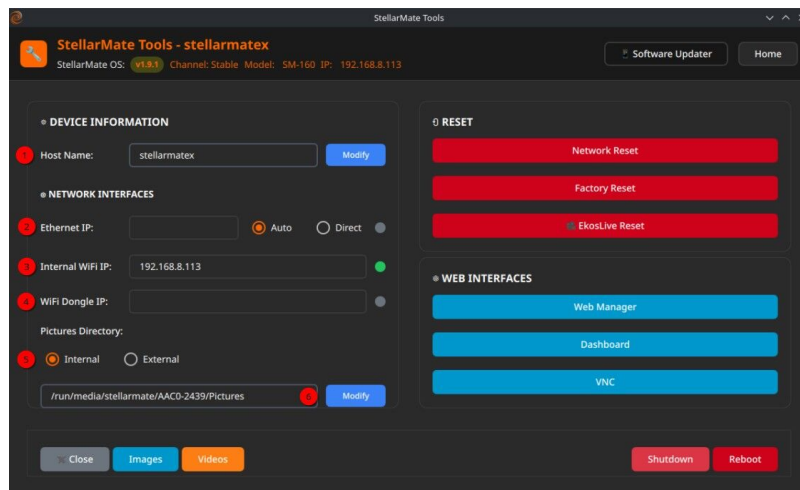


Access device settings by selecting your device and clicking **Settings**.

The device configuration options will display, allowing you to make necessary adjustments.



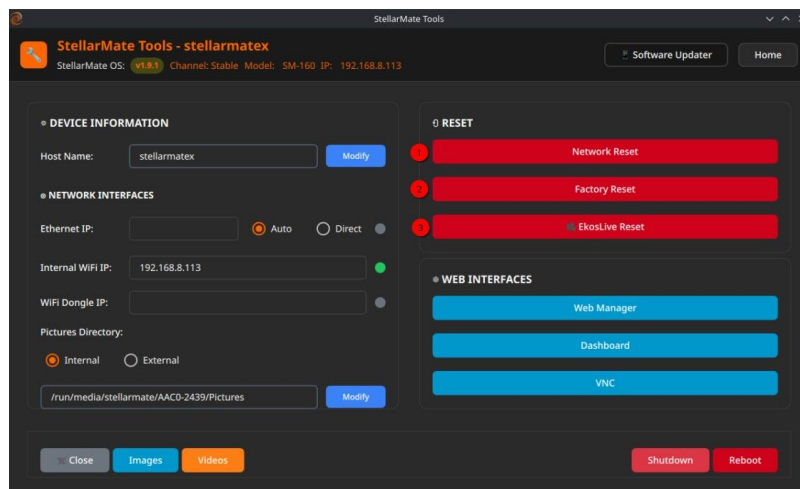
Device Information



Configure device settings and information on this page:

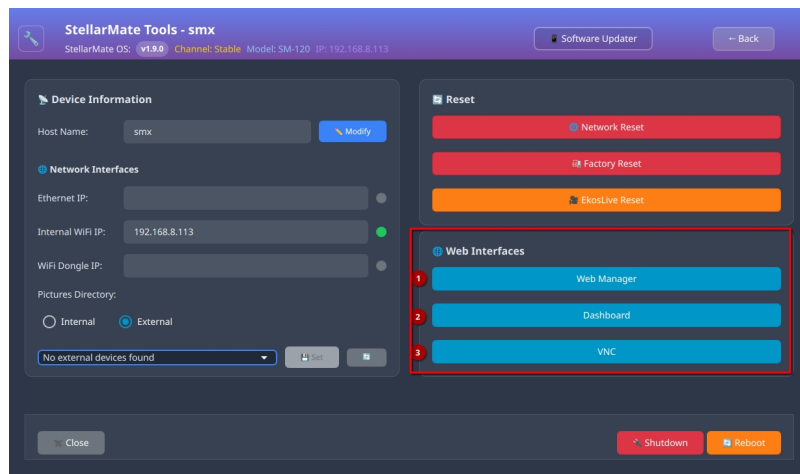
1. **Hostname:** Modify the hostname as needed. Press the confirm button after editing.
2. **Ethernet IP:** View your wired connection address (when cable is connected)
3. **HotSpot Configuration:** Select which network interface runs the StellarMate HotSpot (10.250.250.1). By default, StellarMate runs the HotSpot on the built-in WiFi chip. Use this switch to run the HotSpot on your external WiFi dongle, which frees up the built-in WiFi for other network connections. - **Internal WiFi:** Monitor IP address for internal built-in WiFi. Usually shows HotSpot IP address 10.250.250.1 unless the unit runs in station mode and connects to an external network. - **External WiFi:** Connect to router networks or external network devices.
4. **WiFi Dongle IP:** Monitor your dongle connection status when using WiFi Dongle.
5. **Pictures Directory:** Change pictures directory to external USB device or custom folder. **Reboot required after modifying the directory.**

Reset Options



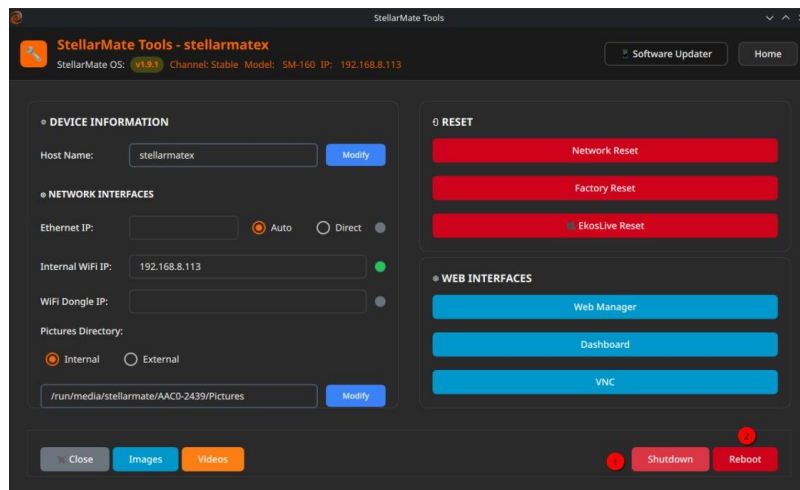
Choose the appropriate reset level for your needs:

1. **Reset Network:** Restore all wired and wireless network settings to factory defaults.
2. **Factory Reset:** Reset all system settings to factory defaults. User images remain available.
3. **Reset EkosLive:** Clear EkosLive settings including all preview images and thumbnails.

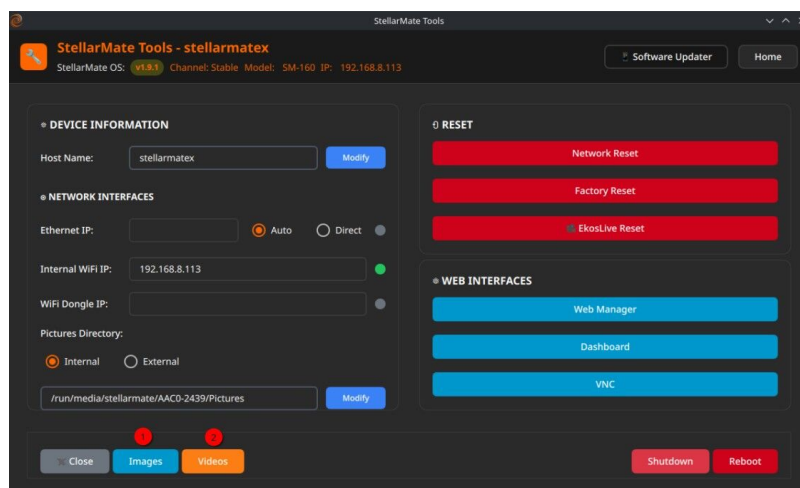


Access StellarMate services directly from your browser:

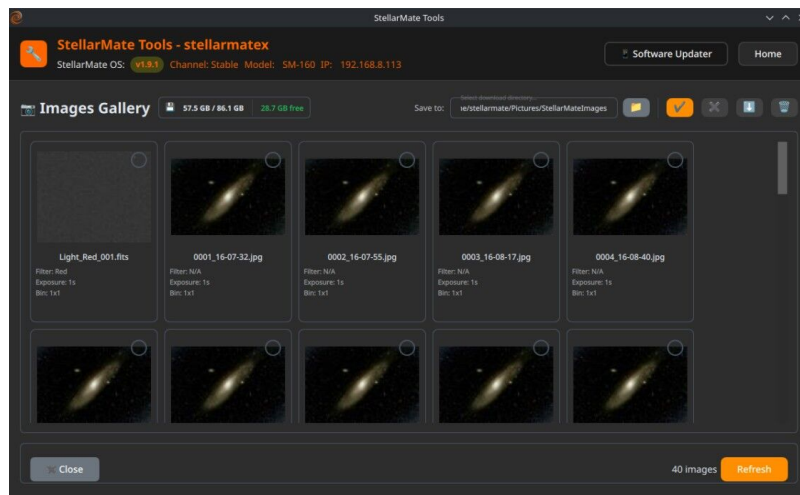
1. **Web Manager:** Launch the complete Web manager service in your browser
2. **Dashboard:** Open the StellarMate Dashboard
3. **VNC:** Access remote desktop via browser



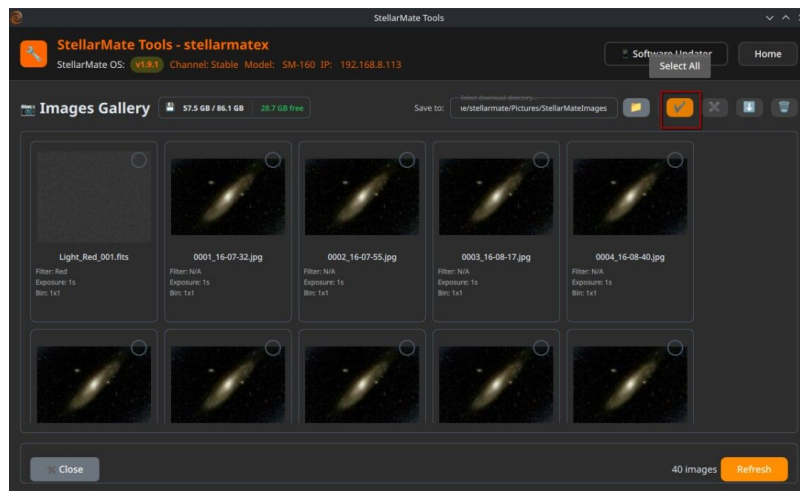
1. **Images:** Access captured images.
2. **Video:** View recorded .SER Videos (SER player is not available).



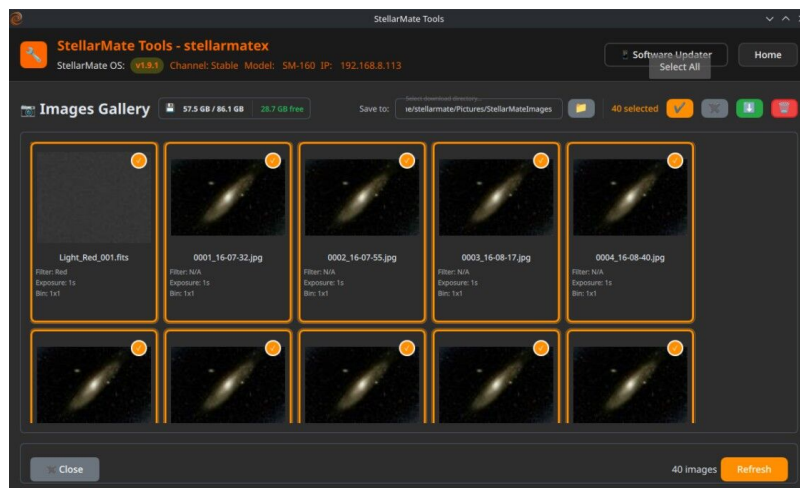
Manage Your Captured Images



View all captured images in this section.



Select individual images or click **Select All** for batch operations. Click the download icon button to download your selected images.



Downloaded images save to ~/Pictures/StellarMateImages

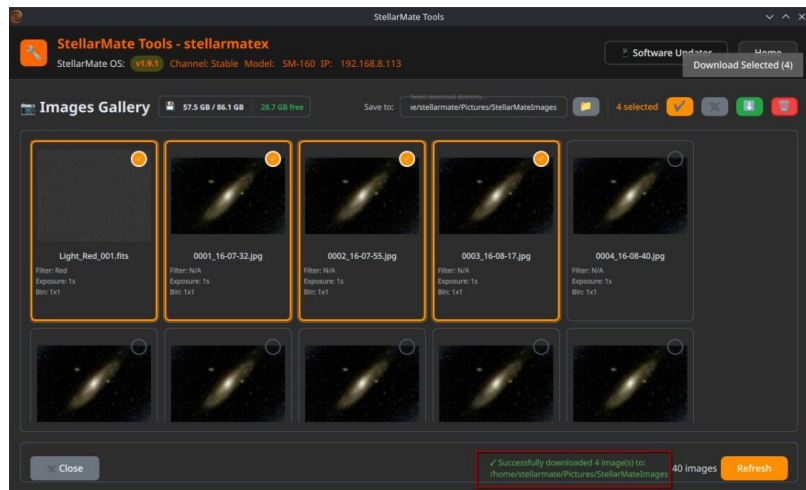
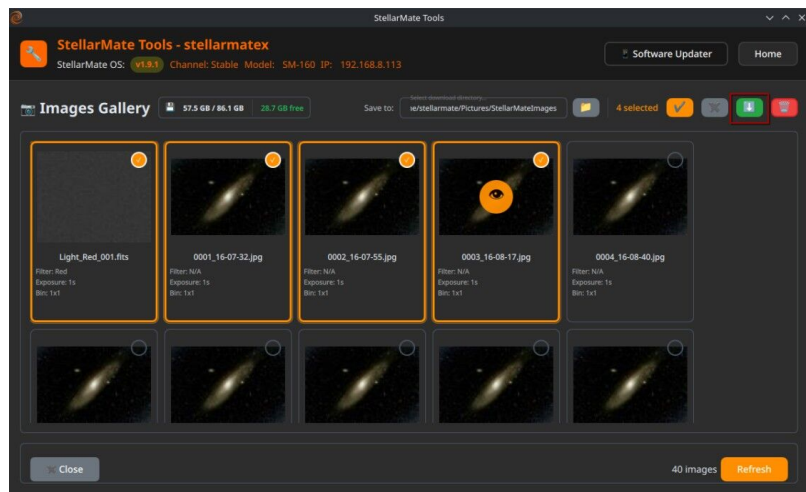
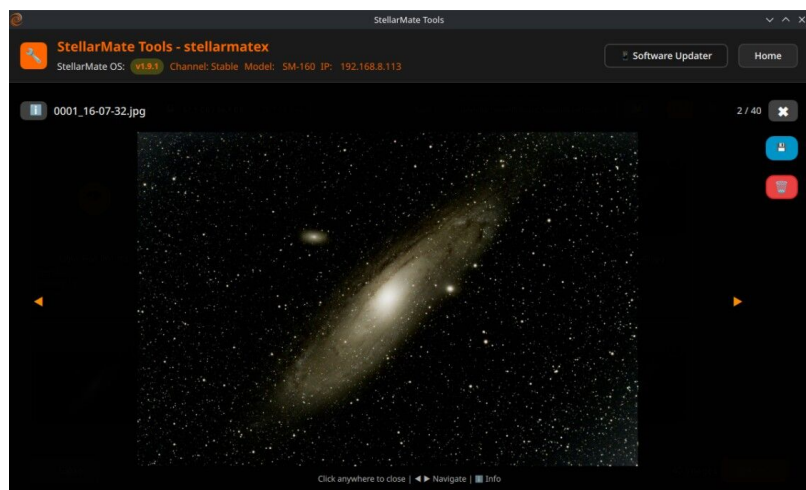
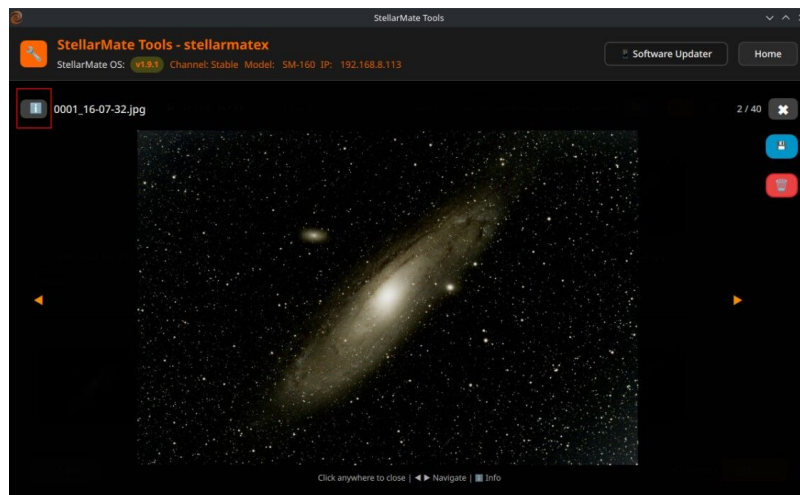


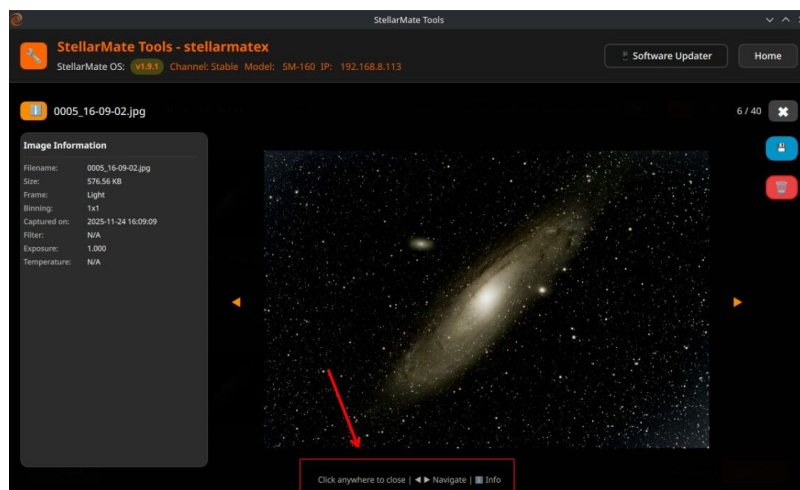
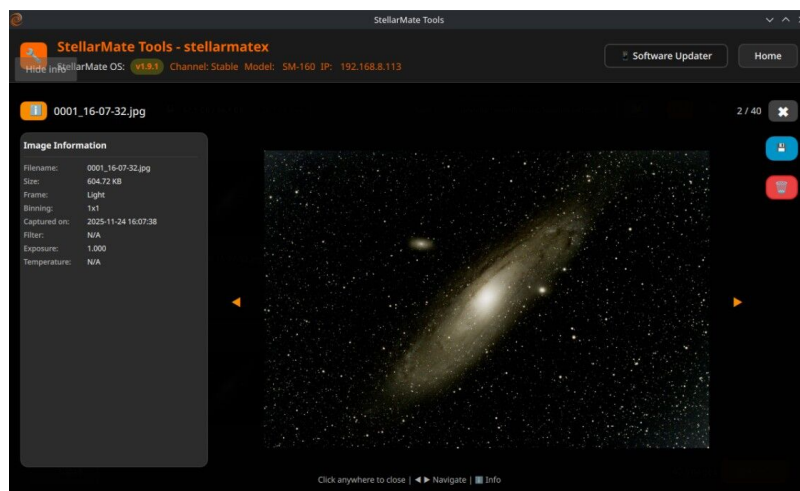
Image Viewing Controls



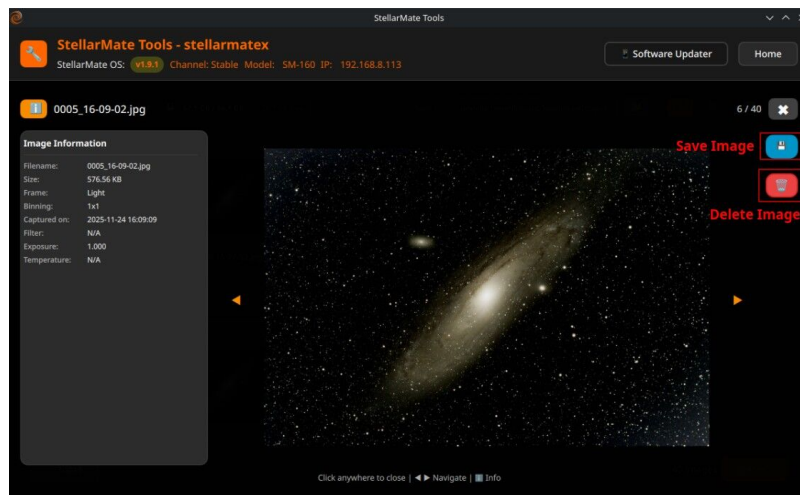
Click any image to toggle full-image view.



Toggle the Info icon button to view detailed image information.



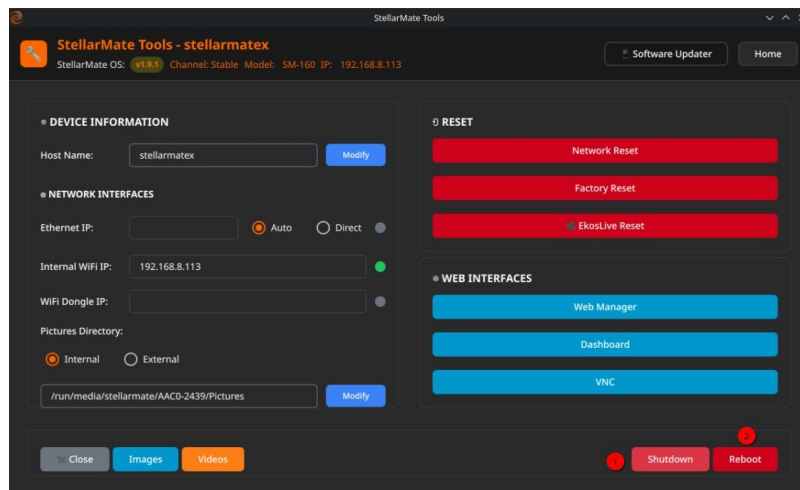
Navigate between images using keyboard left/right arrow keys.



Use these buttons to save or delete individual images.

System Control

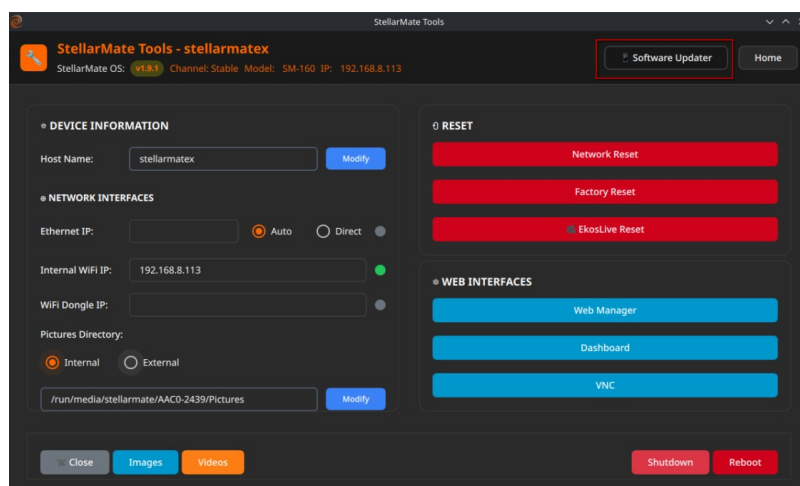
1. **Shutdown:** Power down your StellarMate device safely
2. **Reboot:** Restart your device to apply configuration changes



21.1 Updating StellarMate

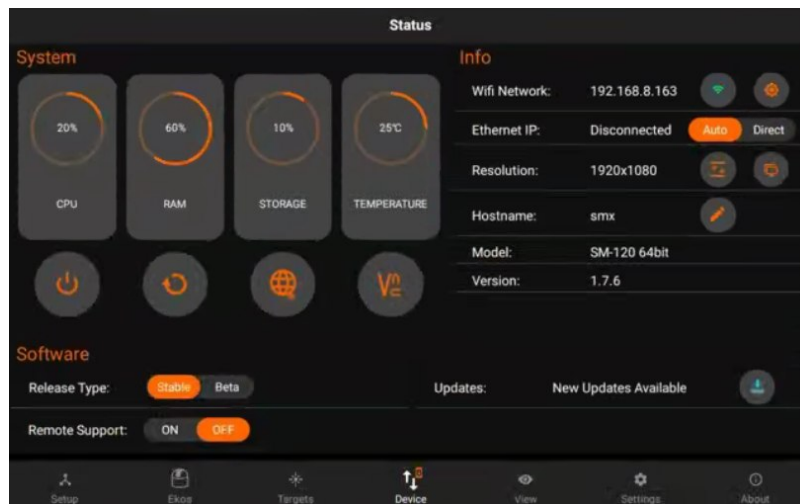
Ikarus Technologies releases a new StellarMate update every 2 months. Hot fixes are pushed on demand. To update your unit, the controller must be connected to the internet either via WiFi or Ethernet.

There are two methods to update StellarMate OS: 1. **Via VNC** Run StellarMate Tools from the desktop. Click Software Updater to begin the update process. It might take a few minutes to complete. Do not restart the unit until the process is complete.



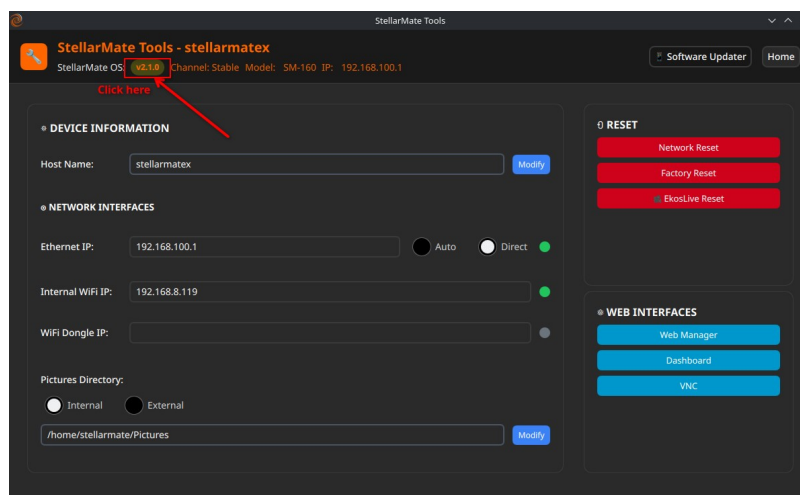
2. Via StellarMate App

Navigate to the Device Tab and then tap Software Update. After the update is complete, please restart the unit

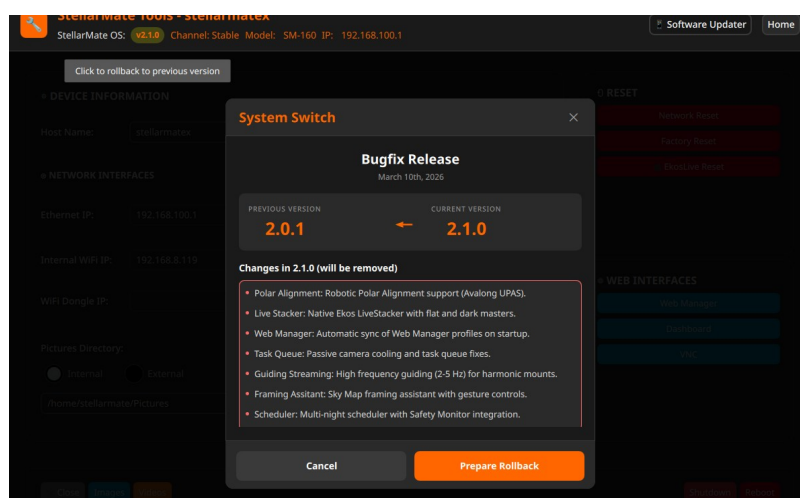


Switch Version

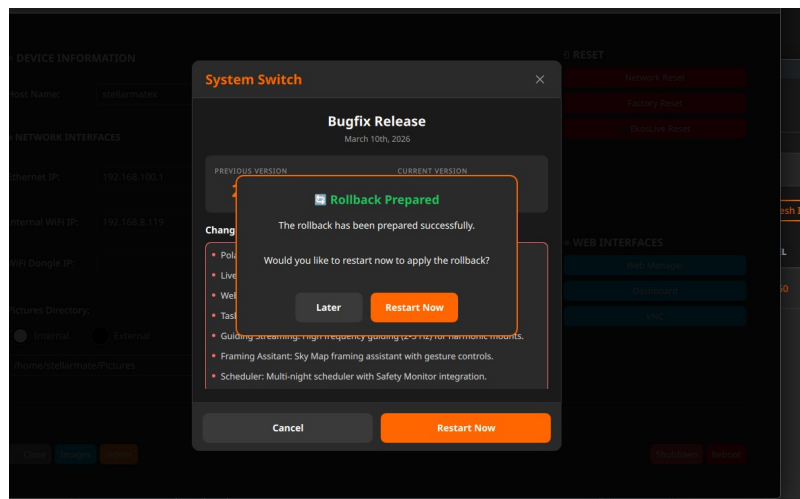
The Switch Version feature allows you to roll back to a previously installed version of StellarMate OS. This is useful if you encounter issues after an update and need to revert to a stable state. If you are currently on the latest version (e.g. 2.1.0), you can check whether a previous version is available to switch to.



If a previous version is available, click Prepare Switch to begin the rollback process. StellarMate OS will configure the system to boot into the selected version on the next restart.



Once the preparation is complete, restart your device to apply the changes and boot into the previous version.



Using GPS

Time and Location settings are critical to the proper operation of StellarMate. The sources of each can be from GPS, Internet, or StellarMate App. When using StellarMate App, the time and location data from the phone/tablet is dispatched to StellarMate which is then synchrhoized. Therefore, a GPS is not strictly necessary when using the SM App directly to control StellarMate.

Time

Time can be fetched from StellarMate App, or Internet (if available), or GPS module. On the StellarMate Pro, the built-in GPS should provide accurate time and location data. For StellarMate on Raspberry PI and MiniPC, an external USB GPS dongle would be necessary for accurate time keeping.

Location

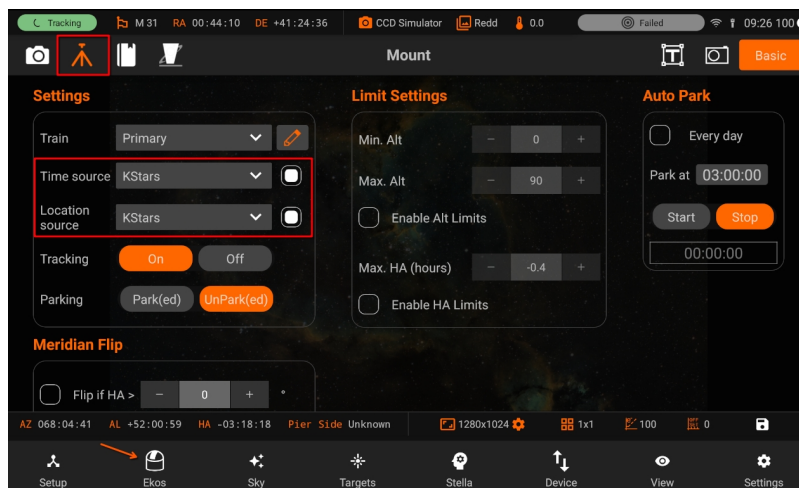
Location can be fetched from StellarMate App or GPS module. When connecting remotely to StellarMate from KStars, ensure that both your local KStars and remote system have the same time, location, and timezone to ensure accurate simulation of the night sky.

The time & location settings are not only used for KStars, but also to synchronize the mount and any other devices with time & location dependencies. For example, some weather drivers depend on location to query and retrieve information about the current weather.

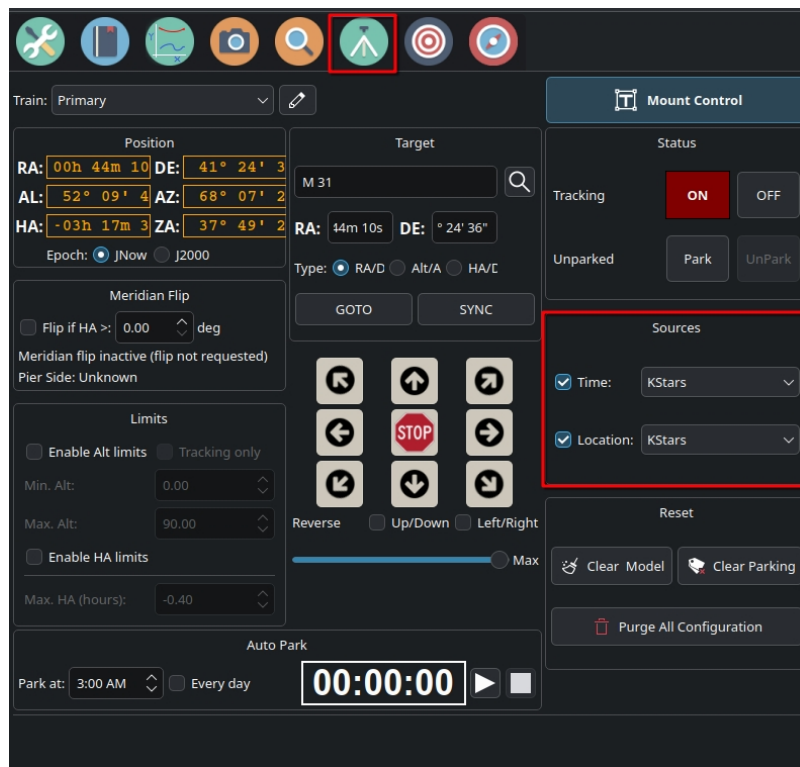
You can select the *master source* of each field to give you fine control. Some INDI drivers (e.g. GPSD) can provide location and time services and therefore can be selected as the master source. When using StellarMate Pro, you can either use KStars as the master source or allow StellarMate (SM Pro GPS) to act as the primary time and location provider. In both cases, KStars will synchronize once Ekos starts.

Note When using GPS dongle or StellarMate Pro, the unit's time & location are automatically synced on startup given the GPS achieved a lock. There is no reason to use GPSD driver nor modify master source, leaving it to KStars is fine as the system time and location is updated automatically by StellarMate

From SM App:



From Ekos:



22.1 Selecting a GPS Dongle

Any U-Blox based GPS USB dongle would work with StellarMate. Here are a few from Amazon:

1. Diymall Vk-172
2. Stratux Vk-162
3. USB GPS Receiver

Most of these dongles need to be outdoors to receive any satellite signals. They can be connected to any USB slot in StellarMate.

22.2 Configuring GPS in StellarMate

After plugging the USB dongle for the first time, you need to do the following:

1. Use StellarMate Serial Port Assistant tool to assign a permanent designation to the USB dongle.
2. Configure KStars to mark GPS as the primary source for Location & Time updates.
3. Create an Equipment profile with the GPSD driver selected in one of the Aux. dropdowns.

This [video tutorial](#) covers all the steps above.

Support

We are proud to offer top-notch support to our customers. Please make sure to check out first the Frequently Asked Questions. To report any issues with StellarMate or Ekos, please submit a ticket and our support team should get back to you as soon as possible. Please make sure to submit the relevant logs to aid in diagnosing and resolving the issue efficiently.